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NetZero Pathfinders

Provided by

Bloomberg

2021 Status Report

Contents

Section 1. Executive Summary

With the volume and severity of extreme weather events growing and the planet warming, the existential threat of climate change can seem downright unconquerable. However, as the danger has grown over the last two decades, governments around the globe, supported by academics, entrepreneurs, financiers, civil society and other innovators have been experimenting with policies and other new ideas to address the problem. Many of these solutions are now ready for global adoption, having been workshopped previously in cities, states and nations. Collectively, they have the potential to put the world on a path to achieving net-zero greenhouse gas.

The NetZero Pathfinders initiative highlights these solutions with the aim of accelerating their adoption. The project represents a collaboration between BloombergNEF, Bloomberg LP, Bloomberg Philanthropies and its partner organizations. Through this report and an accompanying web site, the initiative seeks to illuminate paths to a net-zero future. It aims to inform policy makers and others ready to act decisively on climate change.

Pathfinders breaks the overall climate challenge into four, more manageable 'pillars of net-zero strategies':

1. Accelerate deployment of mature climate solutions
2. Support the development of new climate solutions
3. Manage the transition or phase-out carbon intensive activities
4. Create appropriate climate transition governance structures

Pathfinders then details 50 solutions to address these pillars that policy makers and others can implement today to ensure a strong first phase in the race to net zero. These solutions also address the longer-term challenge of decarbonizing harder-to-abate sectors post-2030.

Pathfinders identifies six major stakeholder groups affected by climate change who, alongside policy makers, must lead the way in addressing it. Four are the largest CO2-emitting sectors of the global economy – energy, industry/materials, transportation and agriculture. The other two are the financial services community and civil society.

This report explains the Pathfinders methodology in greater detail in Section 2. It then in Section 3 offers a brief level-setting on where the world stands today in addressing climate through an examination of current national government commitments.

The heart of this report, Section 4, discusses each solution in detail. The section also highlights a number of best practices that have been tested in various jurisdictions globally. And it links extensively to the Pathfinders web site, which goes deeper in providing users a searchable database of policy best practices sortable by pillar, stakeholder, or level of jurisdiction (municipal, state/provincial or national).The criteria for selection of best practices include data-backed replicable measures that have had meaningful impact towards a green and just transition.

As there are no one-size-fits-all climate solutions, this report offers no sweeping conclusions. Rather, it identifies specific, attainable goals policy makers should pursue to address the overall climate challenge. Below is a sample of these by pillar.

Accelerate deployment of mature climate solutions

- Speed construction of cost-competitive clean power plants
- Proliferate the installation of heat pumps and other technologies
- Promote energy efficiency retrofits for homes and commercial building
- Embed 'circular' economy goals into all decision making
- Speed the use of bioplastics in consumers and business products
- Support build-out of charging infrastructure to support electric vehicles (EVs)
- Rethink urban policy to encourage bicycle use and cut car and truck traffic
- Implement sustainable management systems in agriculture
- Support targeted fertilizer usage and use of low-carbon products
- Replicate proven private investment models and accelerate public investment in less mature markets
- Support public acceptance and understanding of clean alternatives by making clean options easy to choose

Support the development of new climate solutions

- Support deployment of low-carbon hydrogen
- Back development of new end uses for hydrogen
- Invest in carbon capture, utilization and storage (CCUS) projects
- Promote use of other lower-carbon fuels in hard-to-abate sectors
- Electrify industrial processes
- Support the electrification of hard-to-abate vehicles
- Trial low-emitting agriculture machinery and vehicles
- Invest in research and development of alternative proteins
- Back technologies that cut emissions from livestock and crops production
- Leverage finance for less profitable low-carbon solutions
- Accelerate finance for research and development

Manage the transition or phase-out carbon intensive activities

- Support deployment of low-carbon hydrogen
- Integrate environmental considerations in trade policies
- Implement carbon-pricing mechanisms
- Phase out fossil fuel-fired capacity
- Set a goal to phase out the use of internal combustion engine vehicles
- Leverage private sector financial products to help industries transition from fossil fuel reliance
- Leverage public funds to support a just transition of communities
- Back development of new end uses for hydrogen

Create appropriate climate transition governance structures

- Establish independent bodies focused on implementing climate goals and projects
- Ensure continuity of climate goals and projects
- Encourage corporate climate commitments
- Align financial institutions' portfolios with climate targets
- Encourage climate-related financial disclosures
- Drive social development and equality across the value chain

Since there is no single path to decarbonization and solutions can vary widely by sector or jurisdiction, the NetZero Pathfinders platform is structured as a flexible and ongoing framework that can continually evolve. We encourage engagement from all types of stakeholders and invite further examples of progress in the race to zero. To learn more or to share your success stories, contact us at: pathfinders@bloomberg.net.

Section 2. About NetZero Pathfinders

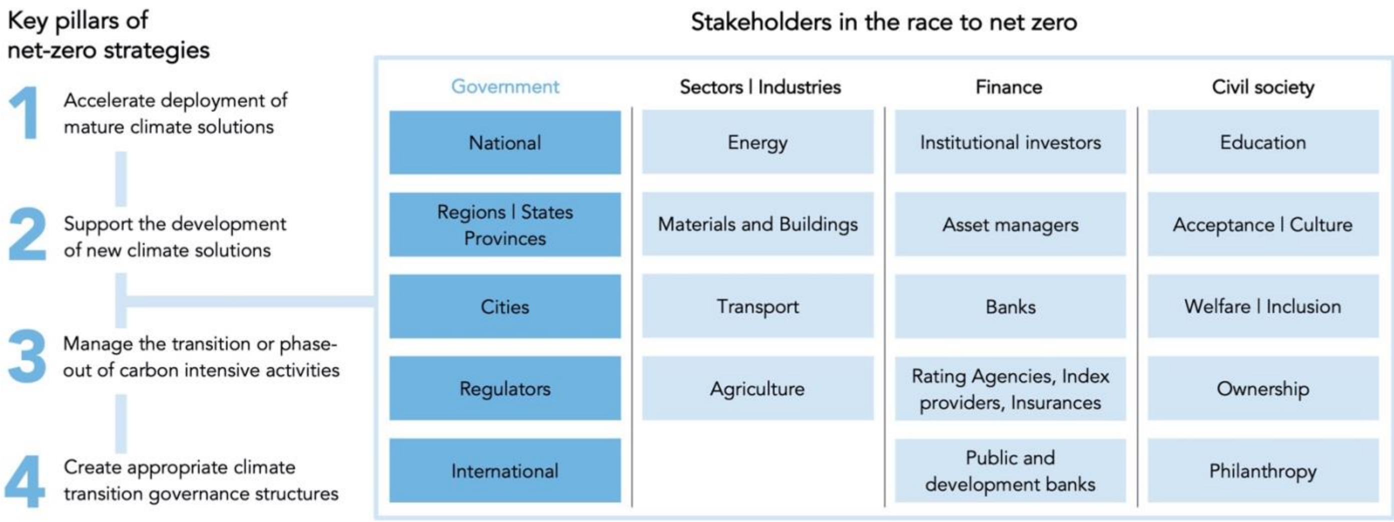
NetZero Pathfinders is a public resource that provides concrete, actionable policy insights for achieving a decarbonized economy. Pathfinders leverages the capabilities of Bloomberg LP, Bloomberg Philanthropies and numerous partner organizations to make these policy solutions available via its web portal, www.bloomberg.com/netzeropathfinders.

The initiative aims to serve municipal, regional, national and international policy makers, financiers, business leaders and others. Pathfinders illuminates paths to net zero by:

1. **Identifying the overarching challenges decarbonization efforts must address.** These represent the pillars of net-zero strategies, major emitting sectors of the economy and key stakeholder groups in the race to zero (Figure 1). The pillars encompass:
   - Accelerate deployment of mature climate solutions
   - Support the development of new climate solutions
   - Manage the transition or phase-out carbon intensive activities
   - Create appropriate climate transition governance structures

   High-emitting sectors include energy, materials and industry, transport and agriculture, while the main stakeholder groups comprise government, industries, finance and civil society. Climate change poses a complex threat, but there are specific, concrete actions everyone can take to address it.

Figure 1: NetZero Pathfinders framework



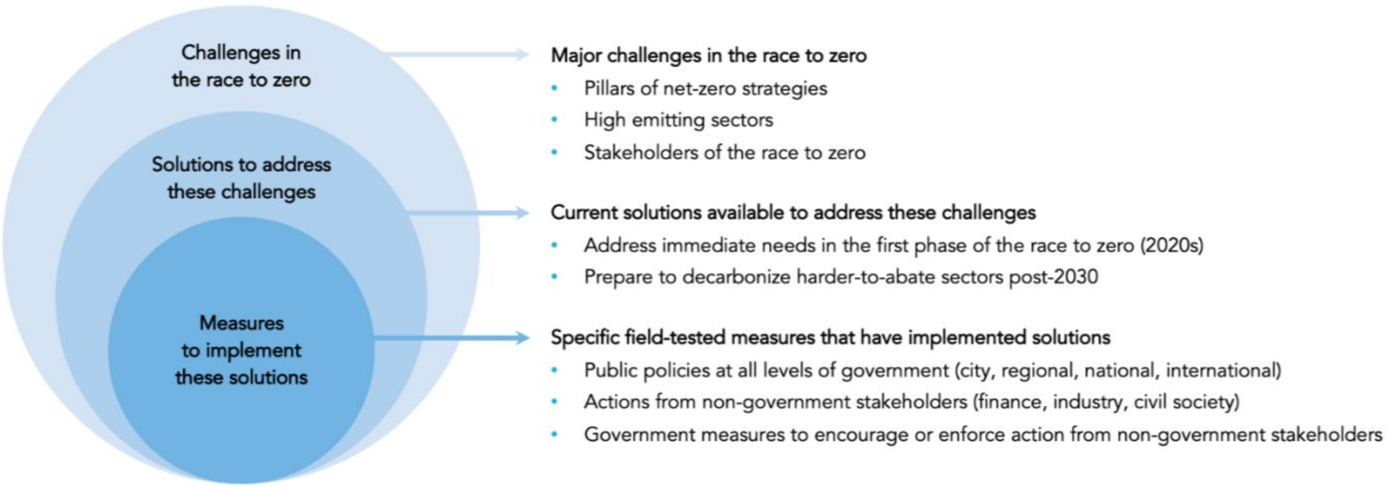
Source: NetZero Pathfinders

2. **Highlighting solutions that can be effective today.** The next 10 years will be crucial in the race to zero, as without substantive efforts, the world is likely to reach 1.5 degrees Celsius above pre-industrial levels by 2028-35[1]. Identifying policy or other measures that can work today is therefore critical. Pathfinders lays out the crucial solutions that could put the world on track for a successful first phase of the race to zero this decade, and prepare to decarbonize harder-to-abate sectors post-2030.

1 IPCC, *Climate Change 2021: The Physical Science Basis*, Working Group 1, August 9, 2021.

3. **Illustrating specific cases where such solutions already make a difference.** Through trial and error, governments and others have for more than four decades been testing potential decarbonization solutions. Pathfinders profiles field-tested measures that have been implemented internationally, nationally, and locally and their results. Pathfinders case studies can serve as inspiration for others formulating their own net-zero strategies.

Figure 2: NetZero Pathfinders structure



Source: NetZero Pathfinders

There is no single path to decarbonization and solutions can vary widely by sector or jurisdiction. The Pathfinders platform is structured as a flexible and ongoing framework that can continually evolve. We encourage engagement from all types of stakeholders and invite examples of progress in your race to net zero.

Section 3. State of the race to zero

In 2015 in Paris, governments agreed to keep the increase in global surface temperature below 2 degrees Celsius and make efforts to limit warming to 1.5 degrees. However, six years later, global warming is on track to reach 1.5 degrees Celsius above pre-industrial levels by 2028-35, according to the Intergovernmental Panel on Climate Change's (IPCC) latest report published in August 2021.[2] This is a decade earlier than the midpoint of the range given to be likely in the 2018 special report (2030-52).[3] Without substantive efforts by governments and companies, by 2100, warming could be close to 5 degrees in the IPCC's least ambitious scenario. This section discusses the challenge posed by rising greenhouse-gas emissions and how governments have responded – both with pledges and, to a lesser degree, concrete policies.

3.1. Emissions

Reaching net-zero emissions will be no easy task: global greenhouse-gas output climbed 1.5% per year 1990-2019 driven by population and economic growth. Much of the rise has occurred since 2000 due to the growth of emerging Asian economies: China expanded its share of global emissions from 9% to 24% over the period, India from 3% to 7%. In contrast, the EU's share almost halved to 8%, while the U.S. decreased less sharply from 17% to 12%.

At a sectoral level, economic development and industrialization have meant that energy-related emissions for power and heat production, transport and industry have driven the increase in the global trend over the last 30 years. In contrast, agriculture's share of the total shrank from 16% to 12% even though absolute emissions rose a fifth 1990-2019. In the last decade, energy-efficiency savings and increasing use of renewables have slowed the rise in electricity emissions worldwide. As a result, although this sector retains the largest share of the global total, some developed countries like the U.K. and France have seen transport become their top emitter.

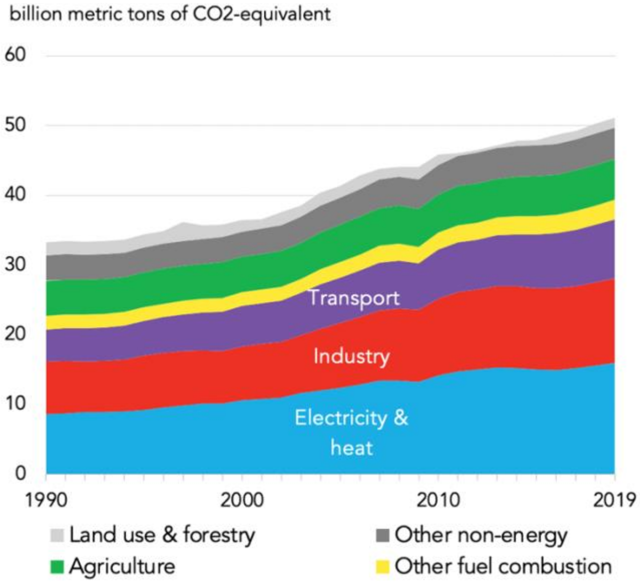
Based on estimates on the sensitivity of global surface temperatures to rising emissions, the latest IPCC report provides an updated estimate on the remaining 'carbon budget' – the upper limit of cumulative CO2 emissions allowed to remain within a temperature threshold like 1.5 or 2 degrees. In 2018, the IPCC estimated the world can emit 420-1,170 billion metric tons of CO2 cumulatively from 2018 for a 67% chance of limiting global warming to 1.5-2 degrees Celsius above pre-industrial levels. This latest report's estimate is "of similar magnitude" of 400-1,150 billion metric tons from the start of 2020. It also reconfirms that limiting global warming to a certain level will require reaching "at least net zero CO2 emissions along with strong reductions in other greenhouse gas emissions".

Figure 3 compares projected annual emissions in the 'Economics Transition Scenario' from BNEF's *New Energy Outlook 2020* with the IPCC's five scenarios, which range from the most pessimistic ('Very high') to the most optimistic ('Very low'). Under our ETS, which assumes continuing cost declines for clean technologies but no major new policy support, emissions track between the 'Low' and 'Medium' scenarios from the IPCC, and result in 3.3 degrees Celsius of warming relative to pre-industrial levels by the end of the century. The scenarios presented in the *New Energy Outlook 2021* explore a world in which greater policy support creates a more ambitious trajectory and net-zero emissions are achieved by 2050. 'BNEF NEO 2021' in Figure 4 is on track with the IPCC's 'Low' scenario until 2028 and then plays catch-up with the 'Very low' scenario as from 2040.

2 IPCC, Climate Change 2021: The Physical Science Basis, Working Group 1, August 9, 2021.

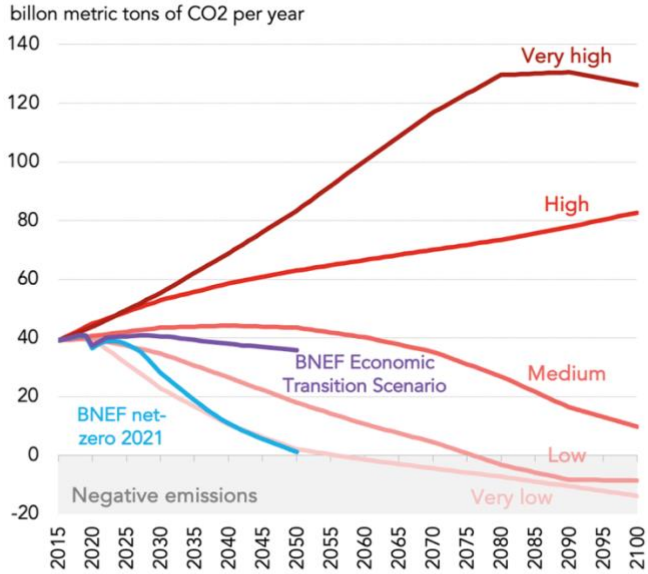
3 IPCC, Special Report on Global Warming of 1.5°C, Oct. 8, 2018.

Figure 3: Historical greenhouse-gas emissions by sector



Source: 1990-2018 – World Resources Institute; 2019 – BloombergNEF, New Energy Outlook 2021.

Figure 4: Projected CO2 emissions under IPCC and BloombergNEF scenarios



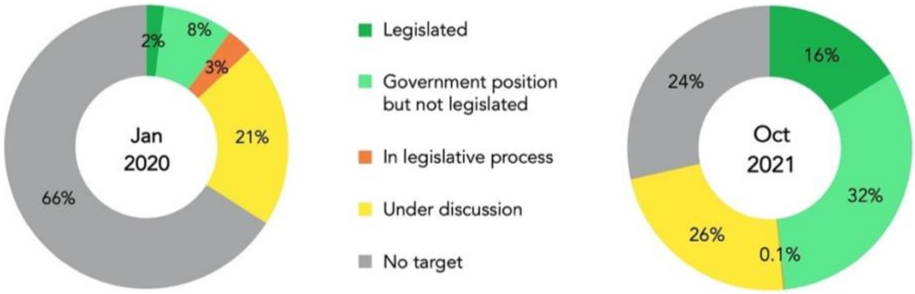
Source: BloombergNEF, New Energy Outlook 2021; IPCC Working Group 1, Summary for Policy makers.

While the NEO 2021 trajectory keeps us on track with global warming of around 1.75 degrees Celsius by the end of the century, decarbonization will have to accelerate even faster in some sectors and countries over the next decade to reduce the chance of extreme weather events and mitigate rising sea levels aligned with a global warming of 1.5 degrees. Alternatively, with more emissions in the period up to 2040, a larger role could be played by negative-emission technologies in the second half of this century to keep us on track. But overshooting emissions in the short term is not without risk as additional feedback loops caused by global warming could accelerate the impact of climate change.

3.2. Climate commitments

Global CO2 emissions would need to fall by some 45% below 2010 levels by 2030 and reach 'net zero' around 2050, according to the IPCC's special report. Since its release in 2018, governments' net-zero commitments for 2050-60 have surged: countries and states responsible for some 49% of global greenhouse-gas output have such a target in force compared with a tenth just 18 months ago. Around a third of the net-zero targets in place today (eg, the U.K.'s commitment) have been enshrined in law, while the remainder (including China's pledge) have been announced as official government targets, with no plan announced for legislation. A further quarter of global emissions are covered by potential new net-zero goals – whether under discussion (such as the U.S.) or in the legislative process (eg, South Korea). (Figure 5)

Figure 5: Global greenhouse-gas emissions by status of net-zero target



Source: Governments, WRI CAIT, BloombergNEF. Note: Greenhouse-gas emissions including land use and forestry by status of EU, national and state-level net-zero or carbon-neutrality goals.

However, there has been less movement toward setting emission targets in line with limiting warming to 1.5 degrees Celsius. Countries' climate plans known as Nationally Determined Contributions (NDCs) submitted by end-2020 would mean emissions in 2030 would be just 0.5% below 2010 levels, according to the UN Environment Programme's (UNEP) 2020 Emissions Gap Report. Not only is this much less than the decrease required to meet the 1.5-degree goal but it is also behind on the 25% reduction on 2010 levels needed to limit warming to 2 degrees above pre-industrial levels. Some governments have announced more ambitious pledges in 2021. But to date, only seven of the G-20 have 2030 emission pledges in line with a 2-degree goal, of which only four have targets in line with 1.5 degrees (Figure 6). Not even all G-7 countries have 1.5-degree targets, despite agreeing in June 2021 to that these were necessary. (Figure 7)

Figure 6: Change in absolute emissions based on G-20 members' NDC targets, 2010-30

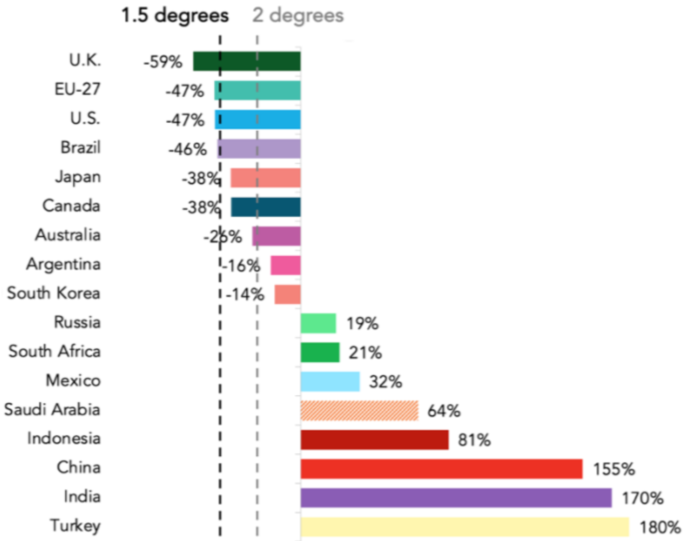
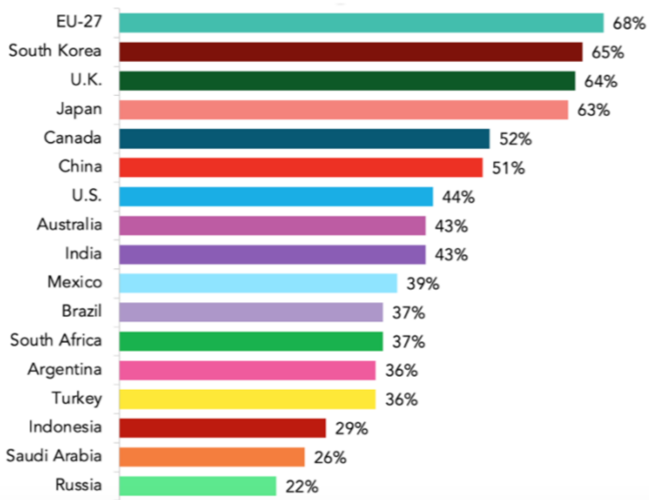


Figure 7: G-20 countries' total scores in BNEF's Zero-Carbon Policy Scoreboard



Source: WRI CAIT, UNFCCC, BloombergNEF. Note: France, Germany and Italy are covered by the EU-27 NDC target. Saudi Arabia's NDC does not include a quantitative emission target.

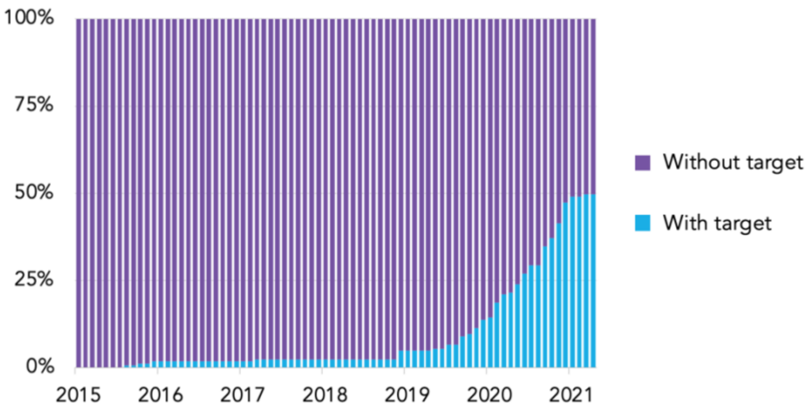
The Paris Agreement does not impose binding emission targets or penalties for non-compliance: rather it relies on a system of mutual peer pressure spurring governments to be 'climate leaders' or at least keep up with competitors. So far 122 countries have submitted an updated or new NDC, representing just over half of global emissions. Of this total, 72 (a third of world emissions) contain more ambitious emission targets. This means 43 or so nations have yet to make a submission since 2020, including some major economies such as China, India and Saudi Arabia.

In addition, most countries in the world have yet to implement concrete policy support to achieve their pledges – let alone reaching net-zero emissions by 2050. This is shown in BloombergNEF's *G-20 Zero-Carbon Policy Scoreboard*, published in February 2021, which scored the G-20 countries out of 100% based on 122 qualitative and quantitative metrics (Figure 8).[4] The countries in the top quartile – Germany, France, South Korea, the U.K. and Japan – have the best policy mixes in place to spur decarbonization. Their targets tend to be ambitious but achievable, they have introduced policies to drive change on the supply and demand side, and their policy-making processes are relatively transparent and predictable. Much of the progress achieved to date globally in cutting the rate of growth of CO2 emissions has come in the power sector, with an average G-20 score of 58%. But even the highest-scoring countries have room for improvement in the other sectors, notably buildings and industry, which had average scores of 42% and 37%, respectively.

The figures above also highlight that some countries (eg, Brazil and Australia) face significant gaps between their climate ambitions and levels of concrete policy support in place. The G-20 governments also continue to provide hundreds of billions of dollars a year to fossil fuels and few have made significant progress on introducing a carbon pricing or enforcing climate-risk disclosure.[5]

In addition to the raft of government climate commitments, companies are also announcing pledges, in a bid to outdo their competitors and meet the demands of investors. The UN's 'Race to Zero' campaign has seen over 3,000 companies commit to reach net zero and by May 2021 some 83 of the 167 Climate Action 100+ 'focus companies' deemed to be the private sector's biggest emitters have done the same.[6] This is important because, if achieved, these goals could make a significant contribution to countries' net-zero targets: some companies' emissions are similar to those of a medium-sized country. For example, the targets of oil majors Shell and BP are expected to cut greenhouse-gas output by 1.2 billion metric tons – more than Japan's annual total. If mining giant Glencore achieves its net-zero goal, this would mean an Italy-sized reduction in emissions.

Figure 8: Climate Action 100+ focus companies with net-zero targets



Source: BloombergNEF, Climate Action 100+, company filings. Note: As of May 2021. Only includes company targets with an explicit deadline.

Governments can take steps to spur companies to cut emissions and promote sustainability (Section 4.4). They can also seek to ensure that these pledges make a meaningful contribution to decarbonization because many of those announced to date have been relatively unambitious in terms of deadline and scope. And in the same way as governments' climate plans need companies' participation, the latter also need support from policy makers to achieve their pledges – eg, clean energy incentives, carbon-offset programs.

4 BloombergNEF, *G-20 Zero-Carbon Policy Scoreboard – Issue 2021*, Feb. 1, 2021.

5 BloombergNEF, *Climate Policy Factbook*, July 20, 2021.

6 See: BloombergNEF, *Corporate Net-Zero State of Play: Key Trends*, May 20, 2021.

Section 4. Challenges and solutions

The sheer magnitude of climate change can make it difficult to discern how best to address the problem. The good news is that effective solutions have been tested and proven already in cities, states and nations around the globe. Many of these are now ready to be implemented in other contexts and at far greater scale. This section breaks the climate challenge down into the four pillars of net-zero strategies, describes crucial solutions to address these challenges and then highlights specific policy responses that have been trialled and proven highly effective. It also contains many links to the Pathfinder web site for those seeking more information about these solutions.

As highlighted in Section 2, the pillars of net-zero strategy are relevant for all major emitting sectors of the economy and key stakeholder groups in the race to zero. They encompass:

- Accelerating deployment of mature climate solutions
- Supporting the development of new climate solutions
- Managing the transition or phase-out carbon intensive activities
- Creating appropriate climate transition governance structures

Thanks to extraordinary progress achieved over the past decade, zero-CO2 emitting technologies now exist that are lower cost than their fossil-fueled rivals. The list includes wind and solar power projects in most of the world and electrified vehicles in a small but growing number of nations. Yet these climate-friendly technologies do not always flourish, in part due to policies that explicitly protect incumbents. For examples of fielded-tested initiatives that have been rolled out locally, nationally and internationally to *accelerate deployment of currently viable strategies and technologies*, click here or see Section 4.1.

While the current suite of cost-competitive zero-carbon technologies – wind, solar, batteries and electrified transport, among others – is poised to cut emissions meaningfully over coming decades, more will be needed to zero out emissions entirely. Technologies will be required to provide around-the-clock, zero-carbon power, to decarbonize industrial processes, to cut emissions associated with livestock production and to meet other challenges. For pivotal examples of measures that can help develop *technologies and other solutions achieve deep decarbonization*, click here or see Section 4.2.

Despite the immediate threat posed by climate change, governments continue to subsidize the burning of fossil fuels or underwrite their extraction through state-owned companies. While this clearly must cease, phasing out high-emitting sources and scaling back subsidies that artificially cap consumer gasoline and electricity prices can be politically challenging. This will also require a transformation of the corporations, utilities, and communities that have historically relied on the operation of these technologies and bold policy support to ensure a 'just transition'. Nonetheless, policy makers and others have found innovative ways to get the job done. For successful examples of measures to *phase out support for the existing, CO2-emissing fossil-fuelled infrastructure and manage the impact of the transition*, click here or see Section 4.3.

Finally, the scope of the climate crisis is forcing policy makers to take a multi-decadal view of the problem but policies are only as good as the frameworks that exist to implement and enforce them. Policy makers must recognize that to attract investment for low-carbon technologies – and enjoy the associated economic benefits – they must construct governance structures that are durable. For examples of important measures that can *build or strengthen governance structures to support the transition to a lower-carbon world*, click here or see Section 4.4.

4.1. Accelerate deployment of mature climate solutions

While much of the climate discussion centers on long-term goals 20, 30 or even 40 years away, notching intermediate achievements is also critical. Thankfully, due to the extraordinary progress of the past decade, zero-CO2 emitting technologies exist today that are lower cost than their fossil-fueled rivals. The list includes wind and solar power projects in most of the world and electrified vehicles in a small but growing number of nations. Yet these climate-friendly technologies do not always flourish, in part due to policies that explicitly protect incumbents. This emphasizes the need for immediate, concrete policy action to accelerate decarbonization today.

BloombergNEF's New Energy Outlook 2021 (NEO) highlights that emissions must fall to 30% below 2019 levels over the coming decade, or decline an average of 3.2% per year, for the world to be on track by 2030 to cut emissions sufficiently in the long run. Little suggests we're on the right path. Global emissions have started growing again as the globe recovers from the Covid-19 pandemic and energy emissions rose 0.9% year-on-year in the five years leading up to 2020.

In the immediate term, the power sector must certainly drive decarbonization of the economy, but other sectors cannot be overlooked. NEO 2021 finds that more than three quarters of the abatement effort through 2030 falls to the power sector and the faster deployment of wind and solar PV. Another 14% is achieved via greater use of electricity in transport, building heat and to provide lower-temperature heat in industry. Greater recycling in steel, aluminum and plastics accounts for 2%, and growth of bioenergy for sustainable aviation fuel and shipping another 2%. Below we examine how mature climate solutions can be deployed at greater speed and scale in each of the major emitting sectors. (Figure 9)

Figure 9: Options for accelerating deployment of mature climate solutions, by sector and stakeholder

Emitting sectors and industries				Finance	Civil society
Energy	Materials and industry	Transport	Agriculture		
Speed construction of clean power plants	Embed goal of a 'circular economy' in all appropriate decision-making	Speed deployment of EVs & charging infrastructure for road transport	Implement sustainable management systems	Replicate proven private investment models in more mature markets	Support public acceptance and understanding of clean alternatives
Accelerate build-out of current energy storage technologies	Speed use of bioplastics in consumer and business products	Boost walking, micro mobility and public transportation	Encourage sustainable food consumption	Accelerate public investment in less mature markets	Make clean solutions easy to choose
Proliferate heat pumps and other clean technologies to buildings	Establish and enforce industrial energy efficiency standards		Support targeted fertilizer usage and use of low-carbon products		
Promote efficiency retrofits for homes and commercial buildings					

Source: BloombergNEF, NetZero Pathfinders

Energy

Speeding construction of clean power plants is one of the pivotal and most logical steps to get on track this decade. Either wind or solar PV is the cheapest form of new-build electricity generation in countries accounting for two-thirds of world population, more than three-quarters of global GDP, and 91% of all electricity generation. Furthermore, it is now cheaper to build new renewables from scratch than operate existing coal and gas plants in a growing number of countries, including China, India and much of Europe. With the most cost-effective zero-carbon solutions and large, established supply chains, clean power is an obvious pathway to decarbonization for the energy sector.

Decarbonizing power at a faster clip is vital to getting CO_2 reductions on track by 2030. NEO 2021 finds that power sector emissions need to drop 57% from 2019 levels, which means delivering around 55GtCO_2

of abatement. Under the NEO[7] 'Green' Scenario[8], getting to zero emissions will require an average of around 1,400 gigawatts of renewables added every year for the next three decades. To put that in context, the world had less than 1,500 gigawatts of wind and solar in total on line as of the end of 2020.

Overall, although both utility-scale and small-scale clean energy and storage technologies are becoming more popular across the globe, progress remains concentrated among richer nations. BNEF's Climatescope 2020 project highlighted that the power sector CO2 emissions trajectories have differed widely between the world's wealthiest nations and emerging markets, reflecting in part their very different stages of economic development. Developed nations' power sector emissions have dropped 20% since 2012 but risen 20% in emerging markets over the same period. (Figure 10 and Figure 11) This discrepancy has to be addressed in order to reach and sustain a net-zero world.

Figure 10: Developed countries' estimated power sector CO2 emissions

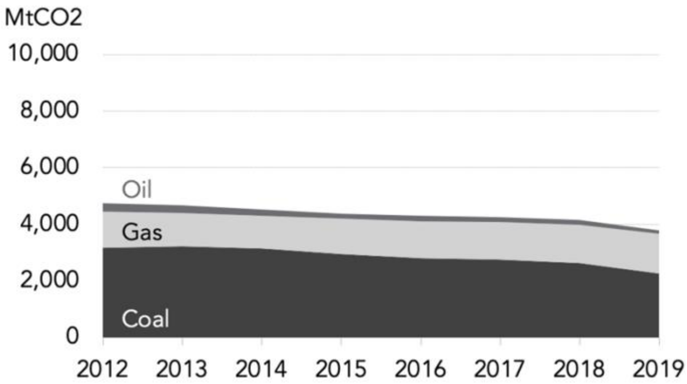
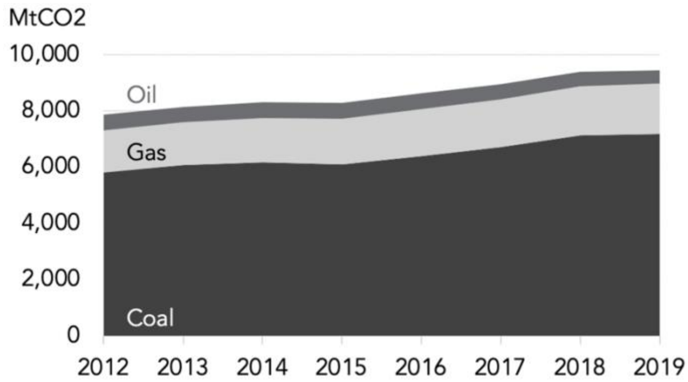


Figure 11: Developing countries' estimated power sector CO2 emissions



Source: BloombergNEF. Note: Developed countries include OECD nations, minus Chile, Colombia, Mexico and Turkey. Developing markets include all other nations.

Renewable energy policies are the most widely implemented climate-related policies and remain fundamental to ensure the sector's continued growth. A good clean energy policy framework provides clarity to investors, minimizes bureaucracy and incentivizes construction of new capacity. Typically, strong frameworks have included at the very least an overall clean energy target, plus reverse auctions for clean power-delivery contracts, or feed-in tariffs.

Best practices

Auctions play a crucial role in spurring renewables deployment: they give project developers long-term revenue certainty while enabling governments to better control their financial outlay. China and India have been the front-runners, awarding a cumulative 188GW of clean energy capacity by end-2020 – over half the global total. Where auctions have been less successful, common issues have been delays and cancelations, permitting challenges, public opposition and onerous local content requirements. Tax incentives are another common policy tool and are often one of the first mechanisms implemented in markets new to renewable energy. They have also been pivotal to clean energy deployment in the U.S. in the form of the production and investment tax credits, although these have their downside. Read more on the website about renewable energy auctions and tax incentives.

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7 The New Energy Outlook (NEO) is BloombergNEF's annual long-term scenario analysis on the future of the energy economy. Click here for more details.

8 NEO Green Scenario is a clean-electricity and green-hydrogen net-zero pathway. Here, hydrogen produced from water using electrolyzers powered by wind and solar is applied in sectors such as industry and heavy transport, as well as in power generation to complement electrification. Click here for more details.

As generation from intermittent sources grow, it is also fundamental to **accelerate build-out of current energy storage technologies**. These will be key to integrate renewables, allow deeper penetration of variable clean energy and ensure resilient supply in all markets.

By end of 2020, the world had installed around 33.4GWh of behind-the meter and utility-scale storage systems, excluding pumped hydro, up from just 15.8GWh two years before. Still, over 77% of this is concentrated in the U.S, China, Europe and South Korea. In other markets, especially developing economies, deployment of energy storage has been limited due to high technology costs and lack of adequate policy frameworks.

Under the New Energy Outlook 2021 Green scenario, to get on track in the power sector, the world would need to add 245GWh new battery storage on average every year to 2030. This is over 26 times the amount of battery storage added in 2020.

Storage has multiple applications, but those related to flexibility present the greatest short and medium-term potential for decarbonization. Ensuring sufficient system flexibility will become a priority for system operators as variable sources of supply grow and traditional sources of flexibility decrease. A flexible system is one that can respond to planned and unplanned variations in order to balance supply and demand over multiple time frames. Electricity demand and supply need to be matched at all times yet currently power systems have limited storage capacity, and imbalances can result in blackouts.

Specific subsets of increasing flexibility requirements include, among others frequency regulation, peaking capacity, renewable energy integration and transmission and distribution network management. Enabling energy storage for frequency regulation often requires market reform. In competitive markets there typically needs to be some kind of premium compensation for faster-response and accuracy or a carve-out. In some cases, high energy prices encouraged generators to invest in lithium-ion of their own accord. They were then able to ramp up their thermal assets without worrying about their reserve obligations.

Peaking capacity resources are often contracted to ensure they are available in scenarios of peak demand. An increased share of renewable generation supply can intensify the demand for peaking capacity as the renewable energy output may be unavailable during peak demand times. There are a number of market design mechanisms that are being deployed to either incentivize new capacity build or to ensure that existing capacity stays online, including:

Energy-only markets, with a carbon market linked to a strong carbon constraint.

- Central auctions for renewable energy, accompanied by centrally-administered capacity markets or reserves.
- Energy supplier obligations for decarbonization. More radical still would be to mandate energy suppliers both to decarbonize and to guarantee resource adequacy.

As renewable energy resources become more widespread, system operators are grappling with how to efficiently integrate them without compromising reliability. This becomes more challenging, and probably more costly as penetration rises. Concerns include system-level constraints and network congestion management.

Transmission and distribution (T&D) network operators constantly extend and upgrade their infrastructure. Transmission utilities need to ensure transmission lines continue to transport electrons from centralized distant power plants to load centers, while expanding capacity to do so in new locations. Distribution utilities also upgrade their networks on an ongoing basis as infrastructure ages or as demand in certain locations increases, but they are also adapting to higher levels of distributed energy resources (DERs) and changing demand patterns.

Distribution utilities are overhauling their management of the network, moving from a static seasonal approach to active grid operations which, to date, has been achieved by modernizing grid equipment, and deploying advanced software and sensors. Increasingly though, DERs are viewed as offering part of the solution to the challenges they pose. In order to use energy storage for this application, utilities or network operators will need regulations that provide a framework to consider energy storage when doing resource planning. The regulator will need to allow the utility to rate base investments in energy storage assets in the same way it would pass through the costs for traditional network reinforcement.

Best practices

Policy makers have adapted renewables auction designs to ensure sufficient flexible resources in the power mix. India completed its first round-the-clock round in May 2020, with the winner expected to use a mix of wind, solar and storage. The offtakers (the power distribution companies) are advocating new types of auction to match their demand profiles more closely and shift the burden for balancing variable wind and solar to independent power producers. The U.S. state of Massachusetts has opted for a clean peak standard to require utilities and power retailers to meet a minimum share of annual peak demand by clean energy resources. More certificates are awarded to projects with storage and associated revenue could be high. Read more on the website about India's round-the-clock auctions and Massachusetts' clean peak standard.

Residential and commercial buildings account for almost a third of global final energy consumption on average. Despite differences because of climate, the majority of this energy is consumed in residential buildings for use in space heating, hot water and cooking. Thus, **proliferating heat pumps and other clean technologies in buildings** is a major measure to be on track this decade.

A range of electric heating technologies is available, including direct electric boilers, radiators and heat pumps. However, policy makers often focus on heat pumps because of their high coefficient of performance – the measure of heat pump efficiency. Because they transfer heat from the ambient air, water or ground for use in buildings, they consume less total energy from the grid to produce the same amount of useful heat in the home. There are two common types: air-source heat pumps, which take advantage of the ambient air for heat energy, and ground-source heat pumps that absorb thermal energy from the ground. The former have a lower upfront cost and are simpler to install compared with the latter, which require underground pipes to be laid. This makes air-source heat pumps the most popular type today, although ground-source models are more efficient, particularly in colder climates.

Heat pumps have the potential to play a significant role in decarbonization strategies. But their high upfront costs compared with gas and oil boilers, poor building insulation (which can increase their cost) and challenges around noise and lack of qualified installers remain key barriers. In most of the world, heat pumps struggle to compete with gas-fired boilers and furnaces (Figure 12). While they are often more competitive than oil on a lifetime cost basis, high upfront costs can still lead to long payback periods for purchasers (Figure 13). As such, policies can play a big role in improving the economic competitiveness of heat pumps against fossil-fuel units.

Figure 12: Unsubsidized accumulated lifetime cost of heating for heat pumps versus gas, 2020

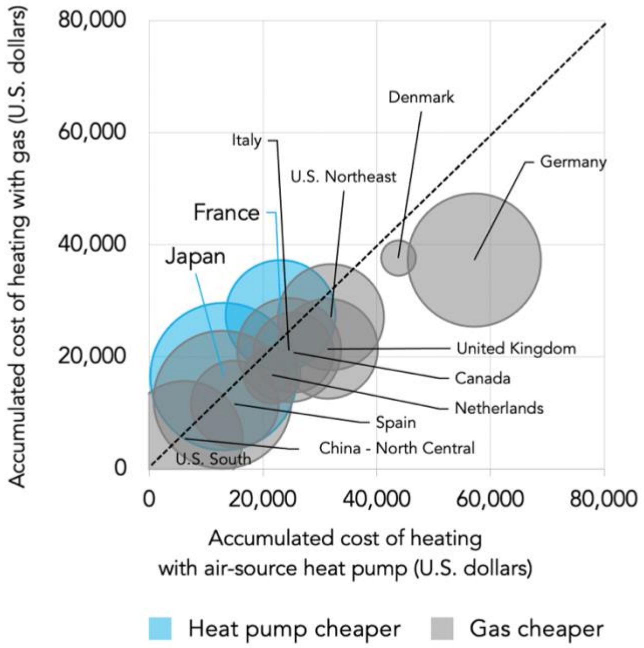
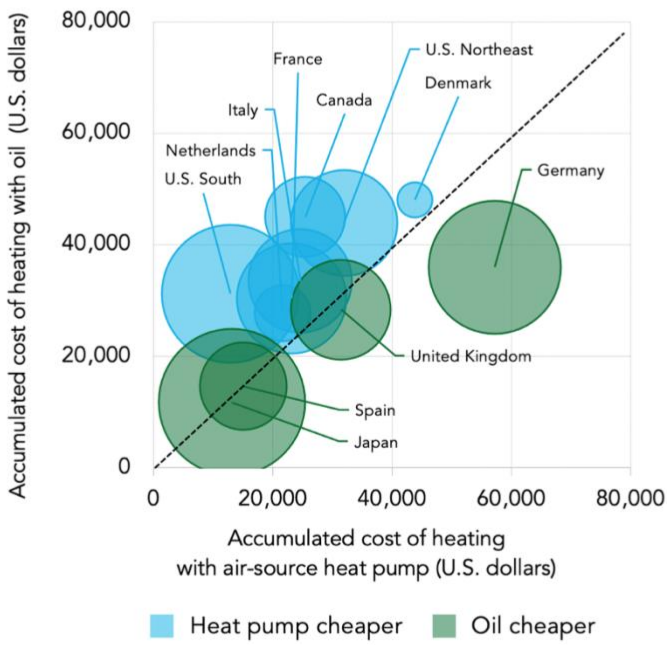


Figure 13: Unsubsidized accumulated lifetime cost of heating for heat pumps versus oil, 2020



Source: BloombergNEF. Note: Bubble size reflects number of households in the country.

Best practices

Policy makers (eg, France and Italy) have sought to mitigate the high costs of heat pumps through direct subsidies on upfront costs, while schemes focused on operating costs only (eg, the U.K.'s Renewable Heat Incentive) have proved less effective. Some governments will have to implement regulations to drive the transition away from fossil fuels. France and the U.K. have announced bans on natural gas in new homes, and China has targeted coal phase-outs. Read more on the website about heat-pump incentives.

NEO 2021 estimates that, for buildings, getting on track for net-zero means cutting emissions 16% from 2019 levels by 2030, or 1.5% a year. Emissions in this sector grew around 1.3% per year 2012-2019.

Low-carbon heating solutions like heat pumps, low-carbon district heating and direct electric heating can be used instead of fossil fuel based heating units to provide space heating and hot water, thereby reducing emissions. In the case of heat pumps, the solution also results in lower total energy consumption. NEO 2021 finds that the world would need to add an average of 18 million new heat pumps each year to 2030, or 186 million by the end of the decade to be on track.

In addition to deploying clean technologies, **promoting energy efficiency retrofits for homes and commercial building** will be necessary. Energy-efficiency improvements seek to reduce energy consumption for heating and cooling and thus help to achieve long-term decarbonization goals. They focus on two main areas:

- Buildings: using better materials such as wall insulation or windows, or building structures that maximize efficiency to cut total heating and cooling needs.
- Appliances: improving the efficiency of equipment such as lights, boilers, refrigerators and other devices to cut fuel and electricity use.

Overall, governments are lagging behind on cutting emissions from buildings, and they must expand their strategies to achieve net-zero targets. The distributed nature of the problem in the form of millions of structures, the need to educate multiple stakeholders, and higher costs of change all remain challenges.

Best practices

Governments have sought to promote energy-efficiency retrofits through a range of mechanisms, including regulatory standards (eg, the U.K. and Mexico) and financial incentives (eg, France and Canada). In particular, South Korea's capital Seoul implemented a loan program for commercial and residential building retrofits. The scheme offers loans for up to 100% of the cost of eligible energy efficiency measures with preferential terms, at low interest rates repayable over eight years (rates are 0% in 2021, down from 0.9% in 2020). The program is open to building owners and tenants, contractors and energy service companies. Eligible measures include installation of efficient lighting, insulation for windows and walls, energy efficient HVAC and waste heat recovery. Read more on the website about energy-efficiency incentives for buildings.

Materials and industry

Materials and industry – the supplying of raw materials to manufacturers and the production of finished goods to consumers – is not only a critical segment of the overall economy, but also a major user of and a massive producer of CO2 emissions. In all, the category accounts for around 30% of global energy consumption and a fifth of greenhouse gas emissions.

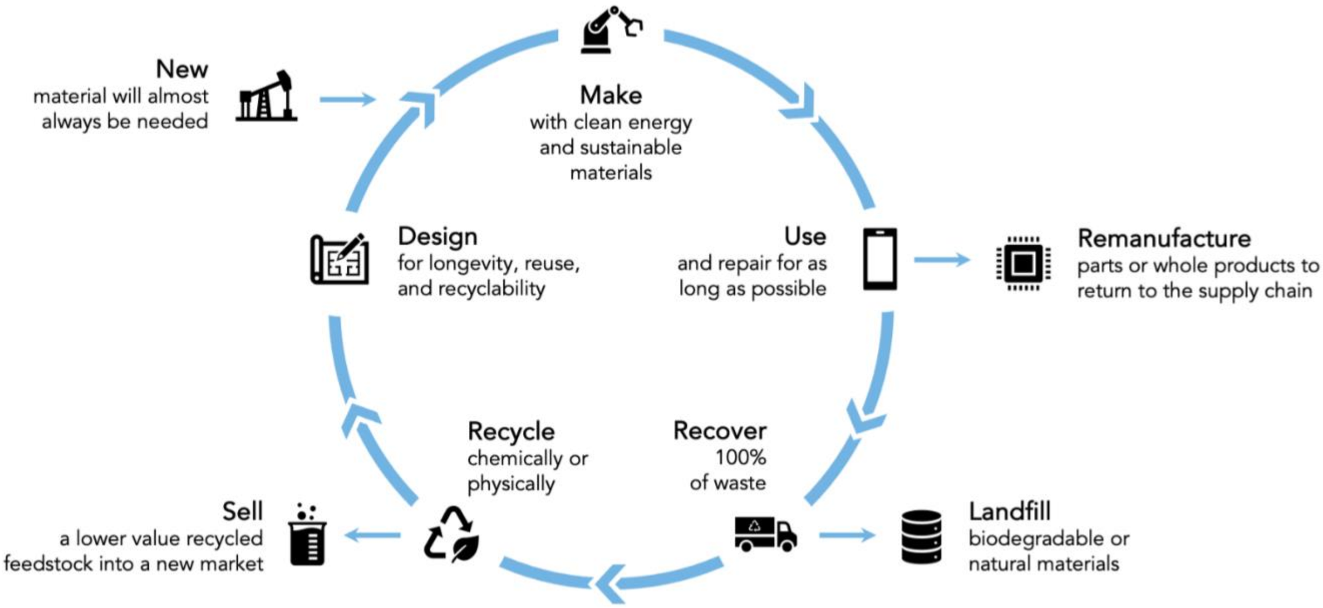
Processes for raw material production often require very high temperatures, which make them highly energy-intensive and dependent on burning fossil fuels. Steel production, for example, relies heavily on coal both as a fuel and as an agent in the chemical process itself. In petrochemicals, oil and gas are both feedstocks and energy carriers for the production process. Decarbonizing these high-heat processes is a challenge, especially in the short- to medium-term. However, there are abatement options available today that can get the sector on the path to net-zero.

Embedding goals of a 'circular' economy in all appropriate decision-making is an important first step towards decarbonizing materials and industry. The primary focus of the circular economy is to reduce waste and prevent materials at the end of their useful life from harming the environment. However, a secondary effect of making the global economy more circular is that it would also lower carbon emissions. Reducing material demand by reusing as much as possible avoids material production emissions, and making recycled materials typically has a lower carbon footprint than new (virgin) (Figure 14). For instance, recycled steel has 84% fewer emissions associated with it than new steel, and recycling plastics typically saves 50-60% of greenhouse-gas output compared to virgin production.

Decarbonizing the production of materials has proven quite challenging to date due to the requirements for high-temperature heat or petrochemical feedstocks. However, as materials are responsible for roughly 20% of global emissions, decarbonizing these processes is critical to reaching net-zero goals[9].

9 BloombergNEF report G-20 Zero-Carbon Policy Scoreboard: Issue 2021, published on February 1, 2021.

Figure 14: Elements of a circular economy



Source: BloombergNEF report G-20 Zero-Carbon Policy Scoreboard: Issue 2021.

NEO 2021 finds that for industry to contribute its share for achieving a net-zero world, the volume of aluminum recycled must rise 67% from 2020 levels by 2030. For steel, the required improvement is 44% and for plastics 149%. This scrap is then feedstock for lower-energy and lower-emissions secondary production, which accounts for 43% of total steel, 37% of aluminum and 22% of plastics production in 2030. Greater recycling in these three materials accounts for 10% of the abatement effort required in industry to slash emissions to zero in each of BNEF's long-term scenarios.

Recycling also becomes increasingly important as the energy transition accelerates. As clean power additions grow, so does the looming challenge of sustainably managing their end of life. Demand for electric vehicles and stationary storage will create 2 million metric tons of lithium-ion battery scrap available for recycling per year by 2030, BNEF estimates. Regulators will therefore need to develop life-cycle management programs such as second-life applications, recycling, and safe disposal.

Best practices

Waste import and export bans have helped to spur the shift to a circular economy. In particular China's 2017 National Sword Policy, which effectively banned waste imports, left many countries scrambling to find another market to accept the waste, or to find recycling capacity at home. Many Southeast Asian countries have followed China's example. Australia has taken the opposite approach, having introduced a gradual export ban on most of its waste. More locally, pay-as-you-throw schemes (such as those in South Korea and Japan) have been highly effective in decreasing municipal solid waste generation and increasing recovery and recycling rates. Read more on the website about trade rules on waste, and pay-as-you-throw schemes.

In addition to growing the circular economy overall, **speeding the use of bioplastics in consumer and business products** in particular can play a significant role in accelerating transition. Bioplastics are materials made from biological feedstocks like corn and sugarcane. They typically have much smaller carbon footprints in production than petrochemical plastics, and are gaining attention from consumer companies as a way to make their products more sustainable.

To date, however, there has been limited policy support for bioplastics. Producers of such materials complain that today they must compete with the established petrochemical industry on an uneven playing field where fossil-based chemicals are relatively unconstrained by the harm they cause to the planet. In countries that have sought to address this, the implemented policies have been weak.

In terms of the politics, support for bioplastics varies by region and can be driven by different motivations. For example, in the U.S., the potential for job creation and protecting agricultural industries is paramount. In contrast, Japan and the EU focus more explicitly on sustainability. As such, producers face a mixed global policy and political landscape defined by a patchwork of policies and tools without comprehensive support schemes.

Best practices

More and more governments at all levels are implementing regulations on single-use plastics – a major contributor to waste. Countries (such as Japan and the U.K.) have introduced charges on single-use shopping bags, while others (eg, South Korea) have imposed an outright ban. Japan has also sought to support promote deployment of recycling capacity through funding and a tough target. In addition, governments have mandated that certain products must contain a certain share of recycled material – from April 2022, plastic bottles in the U.K., for example, must contain at least 30% recycled plastic, while the government of Maharashtra, India's second-most populous state, announced that industrial packaging produced in the state must include at least 20% recycled material. Read more on the website about recycled content mandates and regulations on single-use plastics.

Establishing and enforcing industrial energy efficiency standards can also significantly contribute to decarbonization by reducing energy consumption and thus emissions. Energy-efficiency measures are sometimes called the 'low hanging fruit' of climate policy because some require little change or outlay (in the long term they may reduce expenditure). However, broadly speaking, industry has less efficiency potential compared with other areas of the economy (eg, buildings): energy accounts for such a significant share of operating costs that companies are already incentivized to be as efficient as possible. Estimates of potential efficiency savings are around 15-20%.

Overall, industry-focused incentives are generally lacking, except for energy-efficiency standards. There may be good reasons why it will be difficult to decarbonize some industrial sectors. But governments with net-zero ambitions need to take action sooner rather than later, as even the most effective policy will take time to become effective, and industrial equipment has especially long lifetimes.

Best practices

Some governments that have seen the most significant reduction in industrial energy consumption have combined market-based financial incentives with binding energy-efficiency targets. Notable examples are India's Perform, Achieve and Trade scheme and China's Top Industrial Energy Conservation Programs. Elsewhere, policy makers have provided funding, and the EU has implemented product-related regulations through its Ecodesign Directive. Read more on the website about industrial energy-efficiency incentives.

Transport

Transport is one of the fastest-growing sectors in terms of emissions, and passenger road vehicles accounted for 45% of the total transport emissions in 2018. Although electrification is not the only path to decarbonize the transport sector, electric vehicles (EVs) offer a commercially available, economically viable route. Between 2010 and 2020, average lithium-ion battery pack prices fell 89% to $137/kWh, bringing EVs closer to cost-competitiveness than ever. Our analysis suggests battery prices are on track to fall to $58/kWh by 2030. This trajectory means that EVs are likely to reach upfront price parity with comparable internal combustion vehicles, without subsidies, as soon as 2022 in some passenger car segments in Europe and North America. By the end of the decade parity is likely to be reached in all segments and geographies.

Therefore, **speeding deployment of EVs and charging infrastructure for road transport** is a crucial pathway towards decarbonization. NEO 2021 estimates that getting on track for transport means adding an average of 35 million electric vehicles each year so that by 2030 there are 355 million EVs. Still, in 2020, just 3.1 million, or 4%, of all global passenger cars sold were electric, up from 2.1 million in 2019 and 2.0 million in 2018. For two- and three-wheelers and buses, 44% and 39% of all sales were electric in 2020.

So far, EV sales have been concentrated in richer markets, thanks to more robust policies and competitive prices. BloombergNEF's G-20 Zero-Carbon Policy Scoreboard[10] shows France, Germany and China rank the highest for road transport decarbonization policy, with all three countries offering the strongest support for EVs – starting with demand-driving EV purchase subsidies, to charging infrastructure deployment support and fuel economy targets to activate supply. The results of such robust support are visible, with the three leading the way in terms of passenger EV adoption rates across analyzed countries.

Best practices

Purchase subsidies have been a key driver of EV deployment to date, spurring early-stage adoption as they lower upfront costs. The most generous incentives are offered by EU member states, including Croatia, Romania and Germany. But their effectiveness depends, in part, on the overall price of an EV in the country. Governments have also implemented financial and regulatory policies to ensure sufficient charging infrastructure is rolled out. Canada, the U.K. and the U.S. states of New York and Washington offer funding and tax credits. In the Netherlands, in urban areas, every EV driver has a right to a charging station within 200 meters of their home, helping the country install the most public connectors in Europe. Read more on the website about EV purchase subsidies and charging incentives.

In addition to shifting from internal combustion vehicles to electric vehicles, governments should also lower car use by **boosting walking, micro mobility and use of public transportation.** Investments in walking and cycling infrastructure reduce emissions by reducing the number of short car trips. Meanwhile, greening and growing public transport networks can reduce emissions directly through vehicles with zero tailpipe emissions, and indirectly through modal shifts, lowering the number of journeys taken by private cars.

City-level and national policy makers play a great role on incentivizing modal shifts. Governments can seek to make car ownership less necessary by making massive investments in public transit networks and smaller but meaningful investments in cycling lanes. These projects, however, would take time and require some modal shifts (i.e., behavioral changes) by consumers. Governments can also make car ownership less attractive and convenient by ratcheting up the cost of buying or restricting the use of cars in urban city centers.

Best practices

In Paris, the city government has invested in new cycling infrastructure that extends out to the periphery. The city created 650km of cycle paths in 2020 and early 2021 by reallocating road space from cars, including a number of pop-up cycle paths, to help citizens move around their city when lockdown measures began to ease. This marked a continuation of 'Plan Velo', a 150-million-euro plan over 2015-20 aimed at transforming Paris into a cycling capital. Paris has also encouraged residents to use the national government's 50 euros grants for bicycle repairs and it offers up to 500 euros cash benefit for purchasing electric and cargo bikes. Read more about Paris' initiative on the website.

In Jakarta, the government has procured 100 zero-emission buses representing 3% of the current municipal fleet and aims for 10,000 electric buses in service by 2030. Bus operators finance the buses and depot chargers, and the city pays them back at a fixed rate per kilometer of transit operation. Infrastructure for charging e-buses along routes was also introduced to support deployment, and the city's total bus fleet has been expanded to help reduce traffic from private vehicles. Read more on the website about Jakarta's initiative.

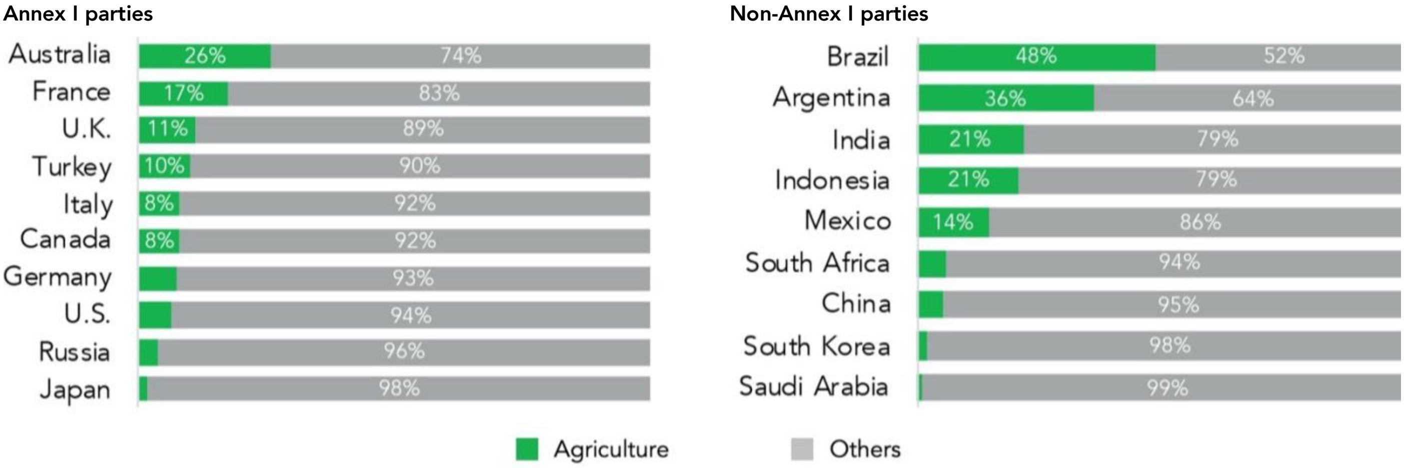
10 BloombergNEF's *G-20 Zero-Carbon Policy Scoreboard*, published in February 2021, which scored the G-20 countries out of 100% based on 122 qualitative and quantitative metrics.

Agriculture

Global emissions from agriculture have risen nearly a third over the last 30 years due to population and economic growth. Agriculture remains the fourth-biggest emitter, after transport, and provides a livelihood to some 2 billion people – a quarter of the world's population. But industrialization and other changes have meant that the sector's share of world greenhouse-gas output has shrunk by four percentage points to 12%. This conceals significant variation across countries, however. Looking only at the G-20, agriculture's share of national emissions in 2018 varies from just under half for Brazil (excluding land use and forestry) to 1% in Saudi Arabia (Figure 15).

Broadly speaking, developing and developed economies are seeing different trends in agriculture emissions: in the G-20, agriculture on average accounted for a tenth of generally wealthy Annex I countries' emissions compared with 17% for non-Annex I countries. One of the main reasons for this discrepancy is that wealth and population growth in developing economies have raised demand for agricultural products, especially livestock. In contrast, in Annex I nations, stagnating demand for beef, better feed quality, breeding for larger animals and improved animal healthcare have caused livestock emissions to decline.

Figure 15: Agriculture share of total greenhouse-gas emissions in G-20 countries



Source: World Resources Institute; BloombergNEF. Note: 2018 greenhouse-gas emissions excluding land use and forestry.

Encouraging the sector to **implement sustainable management systems** will be a crucial step to tackling agriculture emissions. Given that livestock accounts for half of agriculture-related global greenhouse-gas output, more productive and efficient practices in this area could make a significant contribution to cutting emissions, especially of methane. For example, better feed quality, animal health and genetic selection do not necessarily lower overall greenhouse-gas output. But they have enabled farmers in North America and Europe to improve the ratio of emissions per animal to slow emission growth. Another strategy for greenhouse-gas savings (and potentially boosting profitability) would be to lower the number of unproductive animals on a farm. Improving 'stocking rates' can be combined with feed or breeding approaches so that the number of livestock kept in a given space may be reduced without reducing production volumes.

Fertilizer use is a major driver of agriculture emissions, especially in developing economies (see below). Agricultural strategies involving regenerative or precision farming that enable the use of synthetic fertilizers to be reduced or replaced can create emissions benefits.[11] Regenerative farming practices focus on restoring soil health, increasing soil organic carbon and promoting biodiversity, while conservation farming promotes

11 BloombergNEF, *Technology Radar: Precision Agriculture Edition*; *Advancing Agriculture: Majors Bet on Digital Technology*; and *Advancing Agriculture: Regenerative Farming.*

minimal soil disturbance and maintenance of permanent soil cover. With both systems, practitioners plant cover crops and use animal or green manure to provide nutrients to the soil, reducing or replacing the need for synthetic fertilizers. In contrast, such products are banned in organic farming, with farmers often using tillage to manage pests and disease.

Precision farming is the practice of using data and technologies to boost crop yields and efficiency. These techniques have been aided by the advent of new digital technologies. Big data analytics enable farmers to make more informed decisions on the use of crop inputs like fertilizer, and intelligent equipment allows variable rates of these inputs to be applied based on these analytics. As a result, agricultural suppliers have built digital-service divisions to help meet sustainability targets and customer demand for precision agriculture services.

Manure is another source of agriculture emissions – accounting for nearly 40% of the livestock total – without an easy fix. Intensive arable farming and a high number of livestock on industrial farms can produce so much manure that it cannot be spread as liquid slurry. Removing it to an outside storage facility has high mitigation potential under the right conditions, as does solid-liquid separation using gravity or a mechanical system. In addition, large pork and dairy farms in Europe and Australia have increased use of industrial biogas to manage manure emissions. But just under 90% of farms around the world are small (2 hectares or less) and may find biogas systems too expensive or not especially efficient at reducing emissions.

Even where measures have been put in place, farmers have reported a lack of understanding and clarity about what to do. In some cases, policies unrelated to climate action deter practices that reduce emissions, and in others, enforcement and compliance of regulations have been weak. 'Soft' or technical resources can therefore address the lack of awareness and understanding in the agriculture sector regarding the need for climate action and understanding of how best to act. Government-funded training programs could focus on improving workers' academic qualifications as well as demonstrating practical skills.

Measures required to cut agriculture emissions can spark opposition from farmers and others. Getting stakeholders on board early can improve the chances of a policy success as can partnership approaches at all levels of government and with regulators and the agriculture sector. Such collaborations may facilitate discussions on how to achieve climate mitigation and adaptation, or they may focus on testing and deploying specific new technologies – for example, the use of digital services to improve the precision farming methods.

The presence of carbon pricing regimes can also help drive change in agriculture. In some jurisdictions with such schemes in place, farmers can earn revenue by selling offsets from low-carbon projects to participants in carbon-pricing programs or companies with sustainability mandates. Agriculture and forestry offsets tend to garner higher prices on the voluntary market than those from other areas such as clean energy production.

Best practices

Some governments such as France and Germany have implemented specific emission targets for agriculture, although these are relatively rare. Instead, the most common policy types are mandates and financial incentives. For example, Canada's AgriScience program offers grants of up to C$5 million over five years or a cost-sharing arrangement for projects that promote sustainable growth and emission reduction. Other programs (eg, Germany's KfW loan scheme) provide financial incentives to reduce the cost of switching to biogas production through anaerobic digestion (to cut emissions from manure). National and state-level policy makers can also force change by implementing mandates – eg, on minimum storage capacity for manure, as in the EU. In addition, governments can support the use of digital technologies to promote new agricultural strategies like regenerative farming. This could include funding for pilot and demonstration projects (eg, Australia's Traceability Grants) and carbon offset schemes. Read more on the website about digitalization to promote agriculture sustainability and livestock management methods.

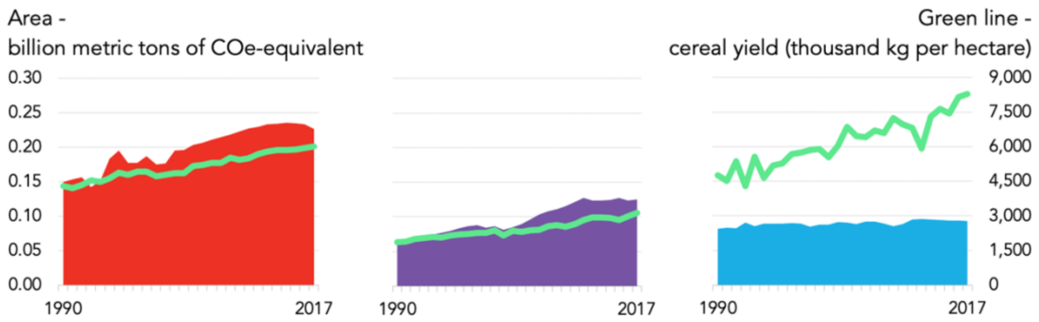
Encouraging sustainable food consumption is another important area where governments can help to cut emissions. The food system is resource-intensive and responsible for around a third of global greenhouse-gas emissions.[12] Not only does the food system contribute to global warming but it is also at risk from the effects of climate change. Indeed, food security is already impacted by rising temperatures, changing precipitation patterns and more frequent extreme weather events. And it will be increasingly affected by future climate change as well as other factors, including population and income growth, and demand for animal products.

Best practices

The first step in promoting sustainable food consumption is to ensure consumers have access to accurate and clear information on what food is better for the environment and their health. This can mean requiring clear and understandable product labels. Already, labelling has encouraged consumers to purchase more energy-efficient devices such as Energy Star-branded refrigerators in the U.S. In the food realm, similar awareness-raising initiatives will likely be needed. Healthier or more sustainably produced foods may be, or may be perceived to be, more expensive. In such cases, governments can look to adjust the price signals in favor of the climate-friendly option and use information campaigns to correct the misperception. For example, taxes on sugary drinks have proved effective in cutting consumption: U.K. households purchased almost 10% less sugar in soft drinks one year after the government announced the soft drink industry levy. Read more on the website about sustainable food consumption policies.

Greater use of fertilizers for intensive arable crops has significantly increased nitrous oxide emissions in recent years, especially in developing economies. Indeed, global emissions from the use of synthetic and organic fertilizers rose 28% over 2000-17, meaning it will be important for governments with net-zero targets to **support targeted fertilizer usage and use of low-carbon products**. This area is particularly important for developing countries, as non-Annex I parties doubled fertilizer emissions over the period, in most part driven by China and India, which saw increases of 30% and 49% over 2000-17. However, despite higher usage of fertilizers, the Asian countries have not seen significant yield improvements: even though the U.S. had lower fertilizer emissions, its cereal yield exceeded that of China and of India by over 2,000 kilogram and 5,000 kilogram per hectare (Figure 16).

Figure 16: Greenhouse-gas emissions from synthetic and organic fertilizer use and cereal yield in selected G-20 countries



Source: UN FAO, BloombergNEF. Note: All figures cover 2000-17 and include synthetic fertilizer emissions and manure left on soil.

One of the principal reasons behind this trend is government subsidies for fertilizer application: in India, for example, this funding is substantial – 1.3 trillion rupees ($11 billion) was included in the revised estimates for the 2020/21 budget, 4% of total government spending.[13] Manufacturers receive the subsidy when the fertilizer has been sold to farmers or other buyers. But this shields them from market competition, while

12 Study backed by UN Food and Agriculture Organization: Crippa, M., Solazzo, E., Guizzardi, D. *et al.* Food Systems Are Responsible for a Third of Global Anthropogenic GHG Emissions, *Nat Food* **2**, 198–209, 2021.

13 Government of India, *Union Budget (2021-22) – Department of Fertilisers*, Feb. 2, 2021.

farmers are insulated from the true cost of the fertilizer and, as is often the case with fossil-fuel support, subsidies tend to disproportionately benefit richer farmers. In addition, in some countries such as India, there is no cap on purchases. Hence over-use is common, causing residues to vaporize into the atmosphere as nitrous oxide – the main source of greenhouse-gas emissions from fertilizer use.[14]

As discussed above, an alternative approach could be for governments to promote agricultural strategies that involve less (or no) use of synthetic fertilizers such as precision or organic farming.

Best practices

As a first step, governments can look at how to reform fertilizer subsidies. In India, for example, there have been proposals to replace subsidies with direct cash transfers to farmers, enabling them to buy fertilizer from manufacturers at the market price. This may require the creation of a comprehensive and robust database of farmers, including 'landless' laborers (who do not own or rent a farm). Promoting better usage of fertilizers also requires monitoring and reporting of, for example, soil and water quality. Governments have implemented programs to encourage this data to be collected – whether by farmers themselves or third-party organizations. India has Soil Health Cards and has introduced incentives to promote organic farming. Germany aims for a fifth of its agricultural land to be organically farmed by 2030 and the state and federal governments offer funding. Regulations have a clear role to play in preventing excess nitrogen from agricultural sources polluting waters. For example, the EU Nitrates Directive set limits on nitrate concentration in bodies of water and rules on when and where nitrogen fertilizer may be applied on land. Read more on the website about synthetic and organic fertilizer incentives.

Finance

Replicating proven private investment models in more mature markets is fundamental to accelerate deployment of today's net-zero technologies. Despite progress in energy transition investment, investor appetite for clean technologies often exceeds the volume of investment opportunities.

The Climate Finance Leadership Initiative (CFLI) highlights that in part, this stagnation is due to policy reversals or uncertainty, which undermine the stable revenue models that support clean energy investment. Development of new coal-fired power plants continues even in markets where low-carbon alternatives are already cost-competitive, particularly in emerging markets with rapidly growing power demand[15].

As clean energy projects have increasingly come to resemble traditional infrastructure investments rather than risky alternatives, a larger pool of investment capital has emerged. However, project developers and banks are still responsible for the majority of financial flows. Asset managers and asset owners still face challenges to investing in clean energy due to a lack of financial products suitable to the asset allocation approach of many larger investors.

CFLI points out that this presents an opportunity for private finance to show leadership and to scale sustainable financial products accessible to institutional investors. The growing success of financial products that are labeled "green" or "sustainable" demonstrates that private-sector institutions within the investment chain can work together to scale up low-carbon finance. The securitization of clean energy project debt in bonds has allowed project developers to access capital markets for long-tenor, fixed-rate financing and expanded funding opportunities beyond the use of non-recourse loans.

14 In addition, excess nitrogen leaches into streams and oceans, so they become over-rich in nutrients ('eutrophication'). This leads excessive plant and algal growth, and ultimately the death of organisms. Fertilizer over-use also results in soil acidification, depleting naturally occurring microbes and affecting nutrient cycles and crop production.

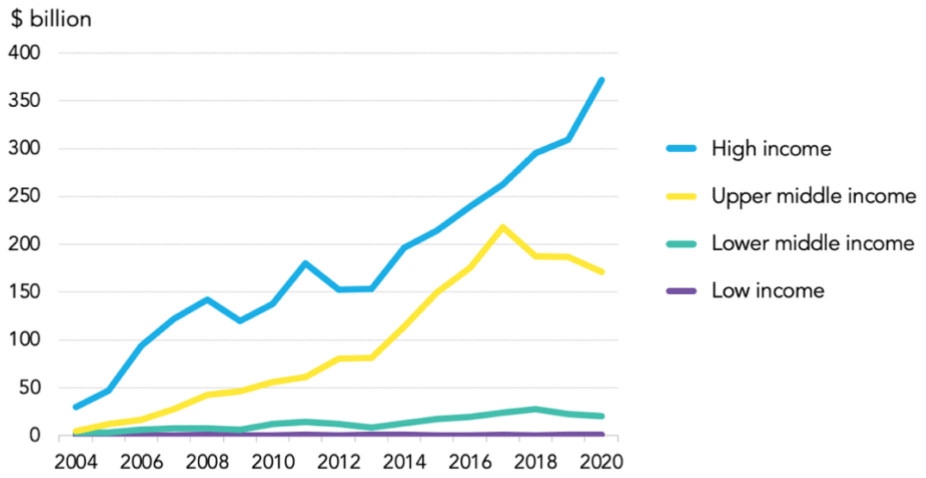
15 For more details see CFLI report Financing the Low-Carbon Future

Best practices

Governments can play a role in helping to stimulate investment in wind and solar by implementing ambitious, long-term targets and ensuring a stable policy environment. Countries that have a history of unexpected policy changes or even retroactive cuts have seen renewables investment plummet. Policy makers can help provide revenue certainty by offering incentives or other assistance to promote corporate power-purchase agreements. Norway's Export Credit Guarantee Agency provides a guarantee against offtaker risk, for instance. An alternative is to hold auctions for 'subsidy-free' contracts-for-difference as are planned in the U.K. Governments can also cut red tape, as permitting delays and public opposition have caused markets such as Germany and Italy to see significant slowdowns in renewables roll-out. Read more on the website about strategies to stimulate investment in wind and solar.

Accelerating public investment in less mature markets is pivotal for a global decarbonization. The recent rise of clean energy investment – both public and private – is highly concentrated in high-income countries, China, and a select group of fast-growing economies (Figure 17). Despite rapidly increasing energy demand, other emerging markets have struggled to attract capital for mature clean energy technologies – even in cases where wind and solar may be more competitive than fossil fuels. This lack of investment is due to several factors, including country- and project-specific risks, a lack of policies and regulations to support clean energy markets, underdeveloped local capital markets, and the absence of experienced project developers and value chains. Such factors can deter investment or significantly raise risks for investors compared with advanced markets. The resulting increase in the cost of capital disproportionately affects capital-intensive investments such as renewable energy projects.

Figure 17: Global energy transition investment by country income level



Source: BloombergNEF. Note: Includes asset finance for renewable energy, hydrogen, energy storage, electrified transport, electrified heat and CCS. Income level classified according to the World Bank.

CFLI highlights that development finance institutions (DFIs) can be critical for opening new markets and sectors to private investment by establishing a track record for investment, facilitating the regulatory change needed for commercial investment, and supporting project pipeline development through project preparation facilities. In more mature markets and sectors, DFIs can unlock more capital by partnering with banks and asset managers to co-finance projects and developing fixed income and structured finance products for other institutional investors. In instances where commercial opportunities do not exist, DFIs can leverage private investment through risk-sharing tools, such as guarantees and political risk insurance.

The private sector can also help unlock new low-carbon markets. In addition to providing asset financing where enabling conditions permit, international equity and debt providers can invest in or partner with local developers or other companies along the value chain. Investing in developers, rather than projects, can offer higher returns and earlier stage access to growth markets. Private-sector organizations can also communicate clear guidelines for factors that make projects more appealing to investors.

Best practices

As a first step spur investment in emerging markets', governments can refocus their power-sector plans on to clean energy and allow independent power producers to generate and sell electricity. In many emerging markets, the utility has yet to be fully unbundled – eg, Mexico, Kenya and Indonesia. Policy makers can devise standardized PPAs, as in Brazil and South Africa, to reduce investment risk and longer-tenor agreements to help developers secure debt financing, as in Argentina and Vietnam. Read more on the website about strategies to accelerate public investment in less mature markets.

Civil society

Public acceptance and understanding of clean alternatives is fundamental to ensuring fast deployment of green technologies and solutions. In the power sector, for example, local 'NIMBY' (not-in-my-backyard) opposition has hindered wind project development in certain parts of the globe leaving developers struggling to find sites.

Civil society organizations and governments can play pivotal roles in enhancing public understanding and acceptance of clean technologies. For example, the Let's Go Zero 2030 campaign unites and supports U.K. schools to become zero carbon by the end of the decade. In addition to reducing GHG emissions, the initiative helps students and their families see the benefits of thinking and acting more sustainably.

As consumers become more important and directly involved in the transition, **making clean solutions easy to choose** is also key. Ride hailing companies can allow users to choose to call an electric vehicle, rather than an internal combustion engine car. Power suppliers can allow customers to choose the type of electricity that they would like to purchase.

Best practices

EU standards require informative labelling of consumer appliances to encourage consumers to buy the most energy-efficient goods. By providing clear and simple labelling, on a scale from A-G, consumers can easily compare the energy efficiency of appliances. EU legislation has also made it easier for consumers to choose the most efficient light bulbs by successively banning old inefficient bulbs from 2009-2021. The legislation forced companies to innovate and create efficient LED bulbs that give off warmer light to meet consumer tastes. More efficient lighting products will also allow Europe to save up to 34TWh of electricity per year by 2030. See NetZero Pathfinders best practices page to find more examples.

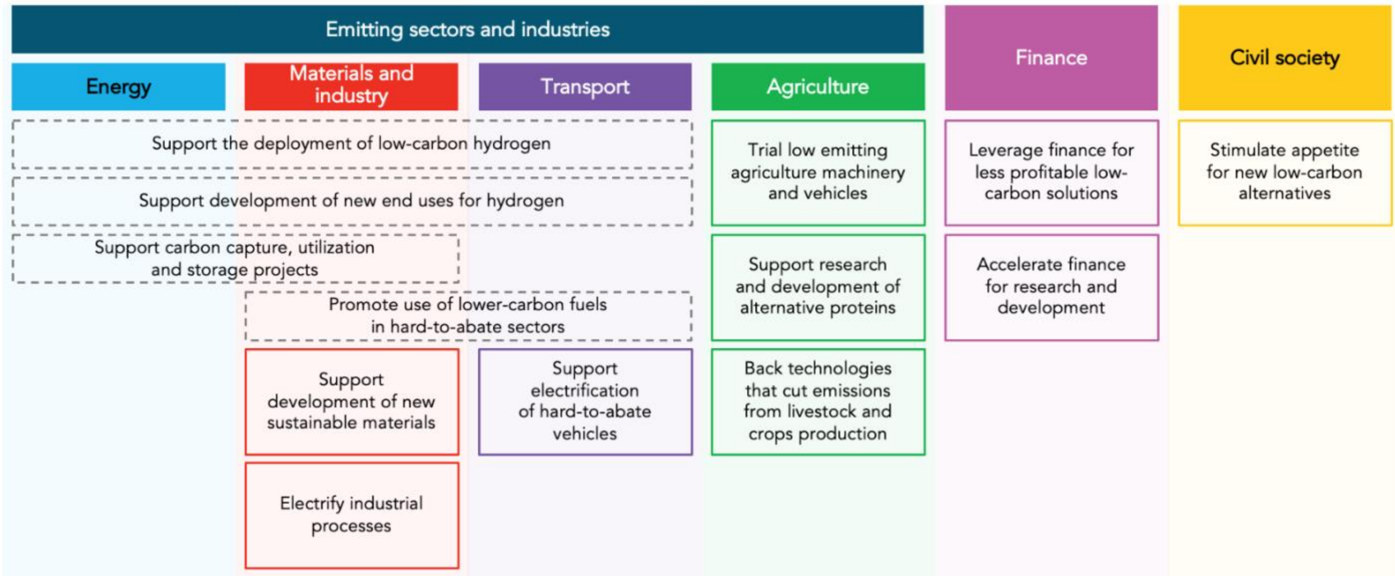
4.2. Support development of new climate solutions

The current suite of cost-competitive zero-carbon technologies – wind, solar, batteries and electrified transport, among others – is poised to cut emissions meaningfully over coming decades. But to zero out emissions entirely, more technologies will be required to provide around-the-clock, zero-carbon power, to decarbonize industrial processes, to cut emissions associated with livestock production and to meet other challenges.

Thus, in addition to accelerating the deployment of mature climate solutions, this decade also requires the piloting and scaling up of new technology for deployment in the 2030-2050 timeframe.

To achieve global net-zero, every sector of the energy economy needs to eliminate emissions completely by mid-century. There can be no free riders. Even the hardest-to-abate sectors will need to adopt carbon-free solutions, only turning to carbon removals where absolutely necessary. (Figure 18)

Figure 18: Supporting the development of new climate solutions



Source: BloombergNEF, NetZero Pathfinders

Cross-cutting solutions for energy, materials and industry and transport

While the world has made progress adding new renewable energy generating capacity, expanding the electric vehicle fleet, and transitioning to lower-carbon heating technologies, the burning of fossil fuels continues to account for the vast majority of global CO2 emissions. Policy makers and industry should therefore look to support alternative fuels with lower greenhouse-gas output or technologies that could reduce the emissions from fossil-fuel production and consumption.

Table 1: Hydrogen applications

Use	Sector
Fuel	Power generation
	Road transport
	Ship propulsion
	Air travel
Heat	Space and water heating
	Aluminum recycling
	Cement, glass & steel production
Feed-stock	Oil refining
	Methanol, ammonia & steel production

Source: BloombergNEF

Supporting deployment of low-carbon hydrogen is potentially fundamental for the next phase of decarbonization. Not only can hydrogen be produced with low or no greenhouse-gas emissions under the right circumstances, it can potentially be used for heating and feedstock in a range of applications (Table 1). It can be transported and stored, and could also help to extend the useful life of existing gas infrastructure. Although hydrogen does not play a meaningful abatement role in the 2020s, getting it to scale is a potentially critical task for this decade.

Under BNEF's long-term Green scenario for the energy transition, hydrogen accounts for 14% of the total abatement to net-zero by 2050. This includes hydrogen used to generate high-temperature heat in industrial processes such as steel making, chemicals and cement, hydrogen used as a fuel in transport, including aviation, shipping and some road and rail transport, and hydrogen used in boilers for space and water heating. Combining hydrogen in power generation and the end-use economy, it makes up 23% of total emissions reduction in the Green Scenario[16]. NEO finds that 1.9TW of electrolyzers need to get deployed by 2030 to kick-start the hydrogen sector, up from far less than 1GW of green hydrogen electrolyzers online now.

Today, nearly half of hydrogen produced is as an industrial by-product, while most of the remainder is made deliberately through fossil-fuel-based reactions. In 2018, less than 1% came from water electrolysis. If powered by renewables, electrolysis can produce zero-carbon hydrogen, while a low-carbon alternative is to use steam methane reforming or coal gasification with carbon capture and storage (CCS). On the demand side, almost all hydrogen is used as feedstock for manufacturing chemicals and basic materials. The volume

16 NEO Green Scenario is a clean-electricity and green-hydrogen net-zero pathway. Here, hydrogen produced from water using electrolyzers powered by wind and solar is applied in sectors such as industry and heavy transport, as well as in power generation to complement electrification. Click here for more details.

produced via water electrolysis has mostly supplied small, distributed applications and its use is generally motivated more by economics, than a move to reduce emissions.

Best practices

Most governments have yet to implement policies specifically targeted at spurring low-carbon hydrogen deployment. The most common to date are plans or strategies: as of August 2021, 16 countries have released hydrogen 'roadmaps', including Canada, France and Australia. Another 27 are under development – eg, Russia, Brazil and the U.S. Not all roadmaps are equal, however – they come with varying levels of funding and focus on different production methods and applications. Even if they do not have a roadmap, many governments offer direct subsidies to support the development of low-carbon hydrogen projects, with over $11.4 billion per year in national government support available, according to BNEF analysis. A further $4.6 billion per year in technology-neutral funding are to be available in the EU, from projects such as Horizon Europe. In addition to net-zero emission targets and carbon pricing, governments are devising new policies beyond R&D funding to incentivize low-carbon hydrogen. The EU and Germany are considering contracts for difference (CfDs), which would award companies a top-up payment equivalent to the price difference between the cost of carbon avoidance technology (eg, hydrogen) and the European carbon price. Policy also has a role to play in ensuring sufficient capital is available to adapt and install new hydrogen transport and storage infrastructure. Some countries (eg, Japan, Canada and France) have policies to promote refueling stations for fuel cell vehicles. Read more on the website about low-carbon hydrogen policies.

Hydrogen today is used in a limited number of applications: predominantly refining, ammonia and methanol. To unlock its economic potential and realize its role as a tool for decarbonization, it will also be key to **support the development of new end uses for hydrogen** to expand it to all hard-to-electrify sectors – especially industry, buildings, heavy transport and backup power. This will require the development of new demand-side technologies and expertise.

In industry, switching plants to furnaces, boilers and other processes that burn hydrogen instead of fossil fuels, is key to decarbonization of high-temperature processes. In NEO's Green Scenario, hydrogen-based heat replaces around 43% of fossil fuel use in industry to 2050. In buildings, hydrogen can also play a relatively large role. Hydrogen-fired boilers are responsible for around 40% of the abatement in the sector over the outlook.

In the transport sector, ammonia derived from hydrogen can become a dominant solution in shipping for new vessels post-2030, and hydrogen-fueled planes can emerge for short- to medium-haul flights between 500 kilometers and 4,500km. Hydrogen-fuelled trains can also see a small uptake in the next decades.

In the power sector, the dominance of low-cost renewables leaves limited space for hydrogen, but the technology will still be fundamental to provide flexible and dispatchable power to complement wind and solar generation. It can effectively take over the role played by natural gas, especially as gas turbines can burn a range of fuels, including hydrogen.

Alongside hydrogen, **supporting carbon capture, utilization and storage (CCUS) projects** will be crucial for the next phase of decarbonization. CCUS is the process of reducing a facility's carbon emissions by separating, compressing and transporting the CO2 for use in industrial or drilling processes elsewhere or storage. It can also contribute to the 'circular carbon economy' by creating a second life for captured CO2 by 'upcycling' it into new products including concrete, nanotubes, chemicals or fuels. Some of these products are converted back into energy at the end of their life or decompose, potentially releasing the captured CO2 into the atmosphere. However, CO2 at stationary facilities can be captured again, creating a circular loop. Finally, CCUS can be used to produce low-carbon hydrogen from natural gas, coal or biomass and can even be applied to biomethane production sites.

Like hydrogen, it does not play a meaningful abatement role in the 2020s, but getting it to scale is a critical task for this decade if it is to make major impact in the 2030s and beyond. Today, carbon capture is experiencing rapid growth, with $3 billion of investment in 2020 and 33 commercial projects announced in the first half of 2021. Governments' and companies' net-zero targets are drivers of this activity. However, in order for CCUS to play a significant role as a decarbonization technology, the industry needs widespread adoption to bring down costs.

In addition, a growing number of end-products that use and store carbon are emerging, although they remain at very early stages of commercialization. These include construction materials like aggregate and concrete, fuels and chemicals like ethanol and methanol, polymers like polyurethane, and additives like carbonates and carbon nanotubes. Each product uses a different amount of CO2 and has its own value and market size. Together, however, they could match or exceed the amount CO2 demand seen for enhanced oil recovery. Concrete in particular may be the 'low-hanging fruit' for utilization, due to its scale and relative insensitivity to CO2 prices.

Best practices

Governments can play significant roles in supporting CCUS projects, by setting roadmaps or targets for the technologies, implementing R&D programs, establishing funding mechanisms and other incentives. But for the technology to realize its full potential, financial incentives will be needed to promote deployment and reduce costs. Adding first-of-a-kind CO2 capture equipment to an existing power facility can require billions in investment, depending on project size. In addition to research programs backing a range of energy technologies including CCUS, some countries have implemented dedicated funding streams – to varying degrees of success. The U.K. government launched in May 2021 a call for industrial CCS clusters, which may receive support from the 1-billion-pound ($1.4-billion) Carbon Capture and Storage Infrastructure Fund. However, most countries still lack sufficient financial or fiscal incentives targeted at CCUS. The exception is the U.S., thanks to the federal government's 45Q tax credit, and additional policies in some states such as California's Low-Carbon Fuel Standard. Governments can also create market signals for CCUS by putting a price on CO2 emissions (Section 4.3). Read more on the website about incentives for carbon capture, use and storage.

Promoting use of other lower-carbon fuels in hard-to-abate sectors can also help close the gaps in high-emitting segments in industry and transport, where electrification, hydrogen or CCUS are not viable options. Other lower-carbon fuels include biofuels, biogas and biomethane.

Biofuels can play a role in power generation, heat or transport. Today, biofuels represent one of the few available options for cutting emissions from hard-to-abate transport sectors like heavy-duty road vehicles, shipping or aviation. Governments around the world have introduced incentives in their favor and biofuels production has risen more than 10-fold since 2000. But their use remains marginal, averaging less than 3% of transport energy consumption.

Biogas and biomethane are renewable sources of energy derived from organic matter, such as crops and waste. Biogas is most often produced in an anaerobic digester, which can break down a variety of organic feedstock including energy crops, municipal solid waste, manure and agricultural waste. Raw biogas consists of methane and carbon dioxide, along with a mix of other gases, and may be used to generate power and produce building and industrial heat.

When the methane is separated from this mixture to meet standard pipeline quality specifications, it is referred to as 'biomethane', or 'renewable natural gas' (RNG). From this point, it is fully compatible with traditional natural gas and can be used in existing equipment and pipelines. As with biogas, biomethane may be employed for baseload power generation and heating for buildings and industry, but it may be used for higher temperatures and for transport.

Aviation is a hard-to-abate sector where using more sustainable fuel is commonly regarded as the best path to cutting its emissions. Sustainable aviation fuel (SAF) is available today, but a lack of policy support, strict performance criteria, and competition for biofuel supply from other sectors, such as road transport, have held back wide-scale uptake. Currently there are just a handful of commercial plants producing SAF at scale. Cost has also been a barrier. Fuel makes up around 30% of an airline's operating expenses and SAF currently costs between two and four times conventional jet fuel. SAF can be produced using a variety of low-carbon inputs, such as biomass, municipal solid waste, or water, electricity and CO2 via hydrogenation.

NEO estimates that sustainable aviation fuels need to increase to 18% of total jet fuel use by 2030, and greater emphasis needs to be placed on operational efficiency in shipping as well as increasing biofuels use to 4% of fuel.

In particular, policy makers need to ensure there is sufficient demand for the fuels to increase their competitiveness with fossil fuels and to attract investors in production capacity. Enough feedstock should be available to meet that demand and regulation to ensure its sustainability. For instance, Brazil and the U.S. account for over 60% of global liquid biofuels production and consumption. This has been largely down to policy. The most common types of incentives globally are demand-side targets or regulations mandating certain shares of biofuels be blended with fossil fuels. Such mandates have been implemented by 13 of the G20 countries at national level, and a further two have such incentives at state or province levels.

Materials and industry

New sustainable materials can play a key role in decarbonizing industry over the next decade. Steel, for instance, is the most widely used metal in the world. The scale of its production makes it one of the largest single sources of carbon emissions, and therefore a crucial sector to decarbonize. The Sweden's HYBRIT consortium – formed to make carbon-free steel using hydrogen (H2) – is one example of innovation in the sector. It produced its first sponge iron on June 21. This is an intermediate for steel production and a critical step on the path to zero-emissions steel.

Best practices

The HYBRIT consortium consists of Vattenfall AB, SSAB AB and LKAB. It is one of 13 projects identified by BloombergNEF pursuing the use of hydrogen in the production of steel. Other trials are led by heavyweights such as Tata Steel Ltd and ArcelorMittal SA. All 13 proposed projects are in Europe.

BNEF estimates that hydrogen-based steelmaking will need a carbon price of $86 per metric ton of CO2 to outcompete coal-based production, if hydrogen costs $2 per kilogram (kg). While most countries will make renewable hydrogen at under $2/kg before 2030, only the EU, U.K. and Canada are set to reach the required CO2 price by then.

HYBRIT's milestone is a sign of things to come. More than half of global GDP is covered by net-zero emission targets. Meeting these will require higher CO2 prices, raising the prospects for hydrogen-based steel in much of the world. See Netzero Pathfinders best practices page to find more examples.

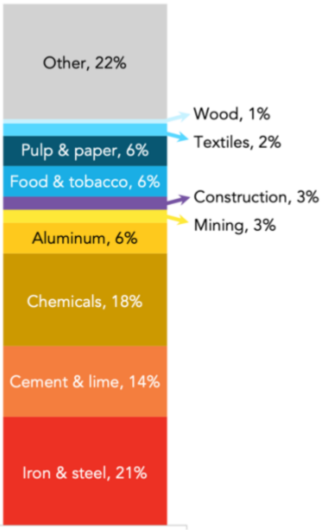
Electrifying industrial processes to switch from using fossil fuels to electricity is the single most effective way to reduce sector emissions. This is an available option in many sectors where only low-temperature heat is required, particularly in petrochemicals and aluminum recycling. Other lower-temperature processes, such as those in food and tobacco, and in pulp and paper, can also be electrified. Under BNEF's long-term NEO estimates, switching to electricity can abate 41-46% of industrial sector emissions.

In G20 countries, for example, at least 79% of industrial process heat is produced through fossil-fuel combustion. In some sectors, industrial-scale electrification is closest to commercialization among the technologies capable of reaching sufficiently high temperatures. Still, various electrification options under development remain pre-commercial and can only be used for certain materials and processes. For example, plasma heating has been used to provide heat for calcination in cement production. In the longer term, these electrification options could produce high-temperature heat as well as delivering efficiency gains and process improvements over fossil fuels.[17] Despite these potential benefits, there is generally a lack of government support for such technologies. The exceptions are product standards in some markets and a limited number of R&D programs.

17 While equipment fuelled by electricity are only slightly more energy-efficient than fossil fuels, industrial boilers have lower maintenance and investment costs.

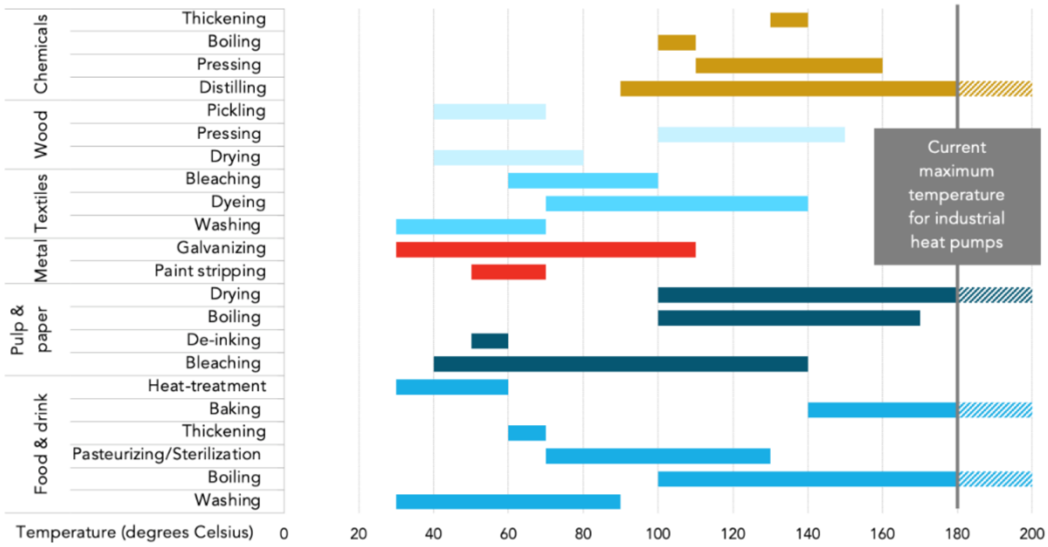
Hybrid electric-fossil fuel systems are available for low- and medium-temperature heat production, potentially by being co-located with a wind or solar plant. These face lower energy costs, and may secure additional revenue by providing balancing services to the electricity grid.

Figure 19: G20 countries' industrial energy use



Source: IEA, BloombergNEF.

Figure 20: Most common applications using lower-temperature heat



Source: IEA, Carbon Trust, German Energy Solutions, BloombergNEF. Note: Figure is non-exhaustive.

An alternate electrification option is to install an industrial heat pump, which is as much about waste-heat recovery and efficiency as it is about electrification. Industrial heat pumps take waste heat from one process, and top it up to a usable temperature for another process.[18] This is in contrast to heat pumps for space heating and hot water, which use ambient air, ground or water as their heat source. While industrial heat pumps can be used for cooling, they are most often used to supply process heat. They are also limited in the operational temperatures they can reach, with current models able to achieve up to 180 degrees Celsius.

A key advantage of heat pumps is their efficiency, which is determined by the coefficient of performance (COP) – the amount of electricity needed to power the pump. A high COP boosts the heat output for the same amount of electricity, reducing power demand and thus operating costs. Their ability to reuse waste heat and integrate heating and cooling processes is also a benefit.

Governments at all levels can offer financial or fiscal incentives for industrial heat pumps than pure electric systems to help overcome heat pumps' high upfront costs, which are on average five times as high as for a conventional gas boiler.

Other barriers to the uptake of industrial heat pumps and electrification more broadly relate to technical feasibility, meaning governments could support research already underway. Some of this research is around output temperature: work is being done today to test the ability of heat pumps to reach higher temperatures, particularly of around 200°C. Since sectors requiring only low-to-medium temperatures account for around 60% of industrial heat use across the G20 countries (Figure 19) this could significantly expand the number of applications for which industrial heat pumps are suitable (Figure 20). As well as implementing incentives for heat pumps in these areas, government should finance information campaigns and training courses to raise awareness and knowledge about the technology, and increase the pool of qualified installers.

18 BloombergNEF defines industrial heat pumps as those used for industrial process heat – not for buildings.

Transport

Although smaller, opportunities to **support the electrification of hard-to-abate vehicles** also exist. In aviation, aircraft on commuter routes have the potential to become electric in the medium-term, for instance. However, these routes make up just 5% of total aviation fuel consumption.

In shipping, domestic and short-haul general cargo vessels, ferries, cruises and other light vessels could be electrified. Under BNEF's Green long-term New Energy Outlook scenario, electric vessels are used for 10% of spoke routes[19] and 30% of domestic routes from 2030 onward. This would result in a 3% abatement of shipping emissions. In rail, there is good potential for electrification of freight that currently runs on diesel, which accounts for 1.6% of energy use in transport.

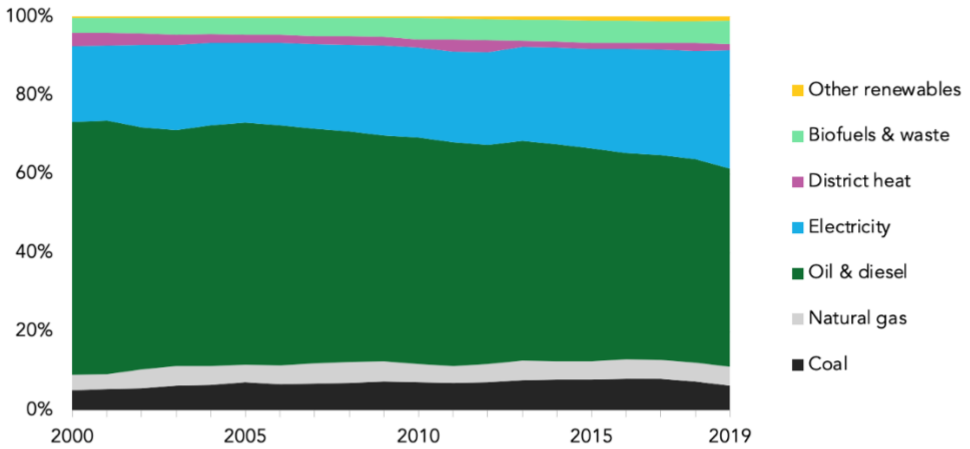
National governments can support the development of new electric vehicles for hard-to-abate sectors by implementing clear targets or roadmaps for the sector to give clarity to investors and support companies through R&D initiatives. In addition, carbon, fuel tax and credits policies can help spur the market by raising the cost of burning fuel and incentivizing airlines and shipping companies to seek alternatives.

Policy to regulate aviation emissions has been limited so far, but recent proposals such as the EU's 'Fit for 55' package show signs of increasing policy attention on this sector. Western Europe and North America are the main regions to have included aviation in their decarbonization agendas. In Asia, the Japanese government aims to finalize a roadmap for decarbonizing aviation by the end of 2021.

Agriculture

Trialling low-emitting agriculture machinery and vehicles would help countries progress toward their net-zero targets, as energy use is the third main driver of emissions in the sector. Oil and diesel continues to dominate the fuel mix, although its share shrank 14 percentage points to 50% over 2000-19. Electricity has been the main beneficiary, although this trend's impact on emissions ultimately depends on the power-generation mix where equipment charges. Globally, use of renewables is modest at about 7%. (Figure 21)

Figure 21: Global agricultural energy consumption by fuel



Source: IEA, BloombergNEF

The previous sections discuss the growing electrification of the road transport market, especially for passengers and light-duty commercial vehicles. Yet the same trend has not been seen in the agriculture sector for practical reasons: current batteries lack the energy density required to power the pulling of heavy loads for long periods and farmers cannot afford long durations of downtime during intensive equipment-use periods, such as harvest time. (In comparison, a traditional fossil-fueled equivalent might be able to last

19 Planes, ships and trucks may operate on a centralized hub-and-spoke distribution model whereby routes are a set of 'spokes' connecting to a central 'hub'.

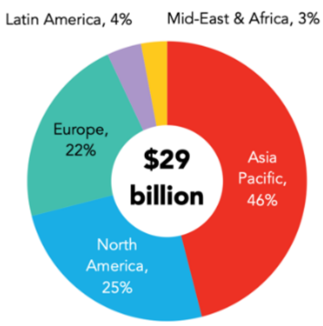
10-12 hours, with very little time required for refueling.) The components also need to be durable and withstand the wear and tear of operating off-road in vehicles with a potential lifetime of 20 years or so.

Electric tractors and other machinery are in development: conventional tractor developers are focusing on electrifying specific functions of the tractor first, while agricultural robot manufacturers are already offering fully electric versions of their systems. Further falls in lithium-ion battery prices should trickle down to small-volume applications, leading to more electrification of farming vehicles and equipment. In 2020, lithium-ion battery packs had a volume-weighted average price of $137/kWh – 13% down on the preceding year. Pack prices will further decline to $58/kWh by 2030, according to BloombergNEF analysis.[20] There is little policy targeted specifically at encouraging farmers to switch to lower-carbon machinery or fuels. Such support will be required if electrified tractors and other equipment are to reach commercialization and come down in cost.

Electrification of farm vehicles and machinery only contributes to a country's net-zero target if farmers, including those in rural areas, have access to affordable and reliable power. Policy support to promote grid connections and deployment of off- and mini-grid power systems helped boost global electricity access 2013-19. However, progress varies significantly across countries: 75% of the population in Kenya had access to electricity in 2019 compared with 38% for its southern neighbor, Tanzania, and 1% in South Sudan to the northwest. As well as initiatives to promote energy access, governments can support research to test and demonstrate electrified agricultural equipment using mini- or off-grid power systems. They can also encourage deployment in rural areas by offering mobile repair services for electrified machinery, because risk of delays due to repairs and lost revenue can deter uptake.

Another barrier facing countries is that some farming activity still relies on manual labor or animals. This is more prevalent where the sector comprises a high number of small farms. For example, the U.S. and much of Europe have a mechanization rate of around 95%. In comparison, India stands at around half and China at 70%. In countries with low mechanization rates in the agriculture sector, policy makers can offer low-cost financing toward purchases of new machinery, or incentivize financial institutions to do the same. National government can set state-level targets for mechanization in farming, set up local facilities that loan out machinery, and create apps and websites that connect farmers with machinery-hiring services in their area.

Figure 22: Total plant-based retail market by region



Source: Bloomberg, Good Food Institute.

Best practices

Governments have implemented some renewables or energy-resilience programs open to the agriculture sector – eg, France's Heat Fund and Australia's Regional and Remote Communities Reliability Fund. To target the farming sector in particular, policy makers could offer incentives similar to those for passenger electric vehicles – eg, purchase subsidies or fiscal incentives. A rare example is the funding for zero-emission farming vehicles and equipment available through California's FARMER Program. This support will also need to overcome the challenge of charging infrastructure and long asset lives: much farm machinery lasts around a decade and tractors can operate for up to 15-20 years. As for digitalization, funding for pilot and demonstration projects is crucial: under the EU's Horizon 2020 program, some 1 billion euros ($1.2 billion) of funding was made available for research and innovation as part of the 'Digitising European Industry', including agriculture. Carbon offset programs could further encourage farmers to switch fuels and install digital technologies. Read more on the website about renewables and electrification incentives for farming and equipment and support technologies in the digital agriculture sector.

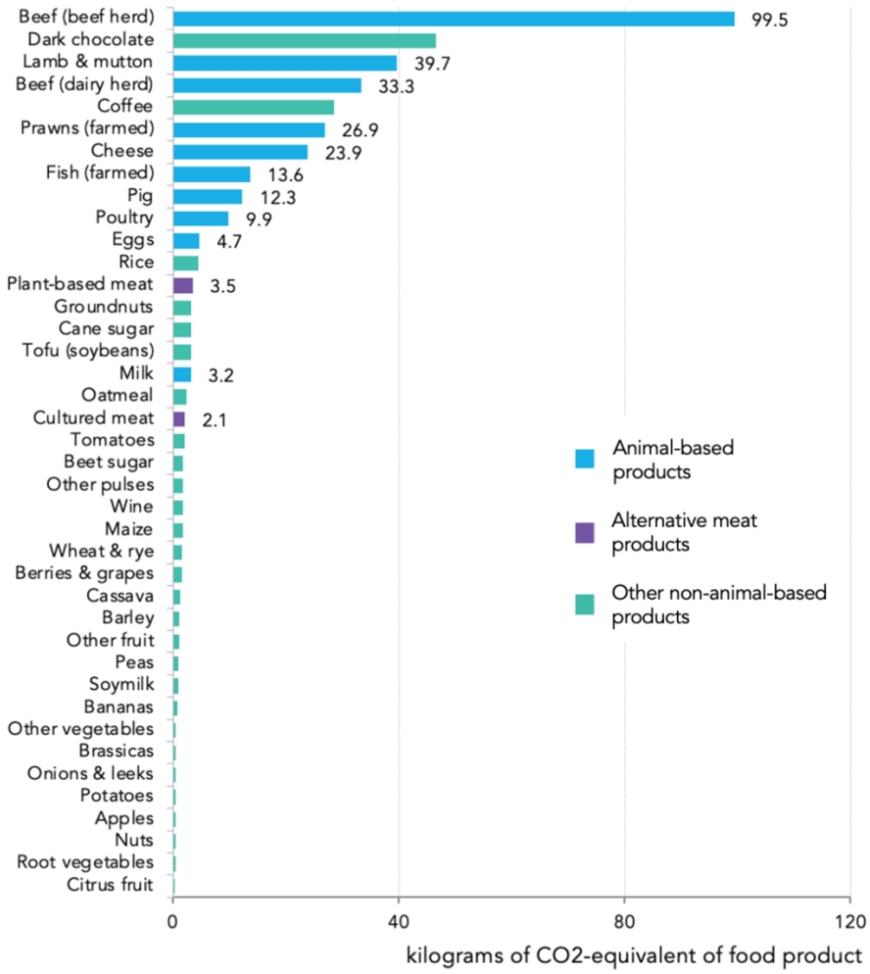
Given that around half of global agriculture emissions are from livestock, consumers' dietary choices – more specifically demand for animal-based products – can have significant implications for countries' decarbonization efforts. One option therefore is for governments to **support research and development**

20 BloombergNEF, *2020 Lithium-Ion Battery Price Survey*.

of alternative proteins. Plant-based and cultured meat[21] have significantly lower emissions than conventional meat products. They also require less land and water.

The plant-based food alternatives sector is on the rise: the global retail market for such products could reach $162 billion by 2030 – up from $29 billion in 2020 – according to Bloomberg analysis.[22] Today, the market is dominated by dairy milk substitutes but meat sales are expected to catch up by the end of the decade. The regional split is set to remain the same, with the Asia Pacific region likely retain the biggest share of plant-based sales (Figure 22). Production costs are also expected to decline as the sector matures, closing the gap to price parity with conventional meat products.[23]

Figure 23: Greenhouse-gas emissions per kilogram of food product



Source: Alternative meat products – Good Food Institute. Others – Ritchie, H. and Roser, M., Environmental Impacts of Food Production, 2020, accessed: August 2021.

In contrast, cultured meat is a relatively new field of food production and is much more expensive than conventional meat: a cultured beef burger costs some $441 per kilogram ($200 per pound) compared with $1.45 per kilogram ($0.66 per pound) to raise and slaughter a cow for meat. There is a growing number

21 Plant-based meat refers to products that imitate and act as substitutes of animal meats but do not contain animal products. Cultured (also known as lab-brown or in-vitro) meat uses engineering techniques found in regenerative medicine to grow, repair or replace damaged cells or tissue from a living animal.

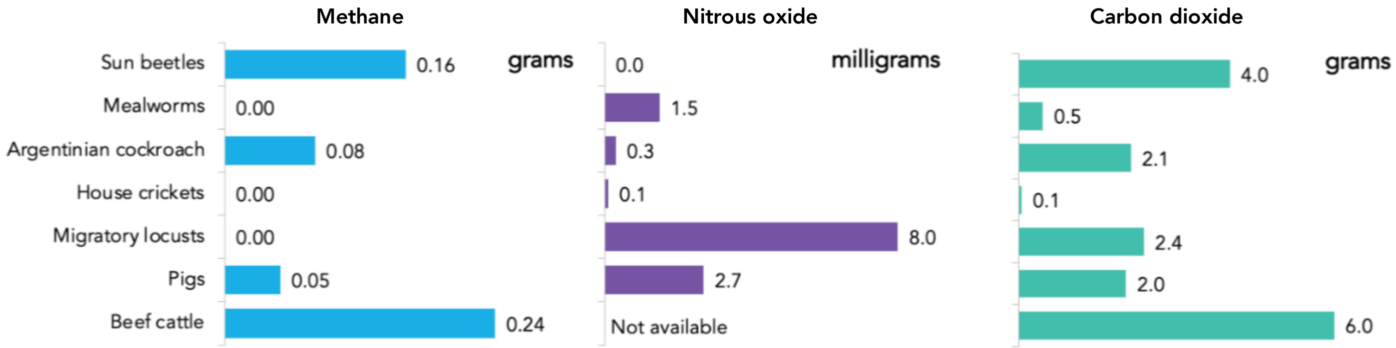
22 Bloomberg Intelligence, *Plant-Based Foods Poised for Explosive Growth*, August 2021

23 BloombergNEF: *Alternative Proteins: Fake it Till You Make it*

of cultured meat labs and demonstration projects, and at end-2020, the first cultured meat product was approved for sale by a regulatory authority.

Edible insects represent another type of alternative protein and already around 2,000 species are eaten worldwide. While unconventional to some cultures, for sure, insect cultivation would use much less land, water and energy compared with traditional farming and have a considerably lower carbon footprint. Crickets produce as much as 80% less methane than cows, according to research by the University of Wageningen. They can also be reared sustainably on organic side streams (eg, manure or pig slurry). But again consumer acceptance would be one of the largest barriers to uptake, particularly in many Western countries.

Figure 24: Production of selected greenhouse gases per kilogram of bodymass per day for five insect species, pigs and beef cattle



Source: Oonincx, D., van itterbeeck, J., Heetkamp, M., van den Brand, H., van Loon, J. and van Huis, A., An Exploration on Greenhouse Gas and Ammonia Production by Insect Species Suitable for Animal or Human Consumption, Plos One, 2010.

Governments have a key role to play in supporting the development of alternative proteins and ensuring the right regulatory framework is in place.

Regulatory uncertainty is likely to be a significant barrier to the roll-out of some alternative proteins, notably cultured meat. And companies are unlikely to expand their pilot manufacturing facilities (and help to bring down costs) until the regulatory framework is in place. Many of the ingredients used for growing cultured meat have yet to be reviewed and approved for food consumption in the vast majority of countries. This process can be long and expensive, and while industry players agree on the need to work together to overcome regulatory barriers, they are unlikely to be willing to share too many details on their products and processes.

Until deployment of plant-based products reaches a scale that triggers cost declines, national and state-level policy makers may want to consider adjusting the price signals in their favor compared with animal products. In such cases, they should consider the impact on low-income households, as meat demand may be relatively inelastic to changes in price.

Best practices

Governments can make a significant contribution to the growth of all types of alternative protein by helping to fund research, development and demonstration. For example, Canada has invested some C$153 million ($122 million) in the 'Protein Industries Canada' supercluster, to accelerate innovation in the plant-protein sector. Governments are also starting to consider the regulatory changes that might be required. Policy makers can also help by holding workshops and training events to promote knowledge sharing and raise consumer acceptance. As these products are commercialized, governments and public-sector institutions (eg, schools and hospitals) can play an important role in encouraging consumers to try them. Until deployment of plant-based products reaches a scale that triggers cost declines, national and state-level policy makers may want to consider adjusting the price signals in their favor compared with animal products. In such cases, they should consider the impact on low-income households, as meat demand may be relatively inelastic to changes in price. Read more on the website about cultured meat solutions and plant-based meat maturity process.

Section 4.1 above outlined mitigation pathways relating to livestock and manure management that are already in practice. Another option is for governments to **back technologies that cut emissions from livestock and crops production.** Some of these strategies focus on enteric fermentation:[24] this part of the digestive process in ruminant animals (cattle, sheep, goats, etc.) produces methane and is responsible for nearly two-thirds of livestock emissions.

A number of companies and academic institutions are also developing novel feed additives that achieve significant emission reductions. For example, several recent studies have found that mixing asparagopsis taxiformis (a red seaweed) into feed could reduce methane emissions by 80% or more.[25] The first licenses were granted in April 2021 to establish a commercial seaweed farm in South Australia to aquaculture company CH4 Global in partnership with Narungga Nation Aboriginal Corporation. This was followed in June 2021 by what's believed to be the first red-seaweed-offtake agreement: aquaculture company CH4 Global will initially provide Pirie Meats with enough asparagopsis seaweed supplement for up to 10,000 heads of cattle.[26]

Other companies are devising wearable devices that change methane into CO2 and water. For example, U.K. startup Zelp has created a mask-like accessory which it claims can more than halve methane emissions. Agriculture producer Cargill announced in June 2021 that it would start selling the devices to European dairy farmers in 2022.[27] A key barrier will be cost, although farmers may be able to recoup some of the expense by selling carbon offsets. A price for the device has yet to be announced by Zelp but the company has said that it could charge an annual subscription fee starting at $80 a cow. For reference, in 2020 there were just over 23 million dairy cows in the EU and U.K.,[28] meaning a potential annual subscription bill of $18.5 billion if all cows wore Zelp masks.

In addition, academic institutions and companies are investigating new technologies to cut emissions from manure. For example, lab tests to add tannic acid and fluoride to pig manure reduced ammonia emissions by up to 95% and methane up to 99%, according to researchers from the University of Southern Denmark and Aarhus University.[29] Their plan was to develop a granulate that farmers can add to manure but the technology costs must be reduced before roll-out.

Other solutions involve the use of advanced biologicals – an emerging technology based on soil microbes that improves crop productivity and health while reducing chemical inputs to the soil.[30] The technology, however, is still at the early stage. Currently available biologicals could reduce nitrogen fertilizer use by 10-20% for specific crops in certain locations today. Some startups aim to ultimately replace fertilizer use entirely.

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24 The animal eats grass containing carbon. Microbes in the stomach help to digest the grass, and some of the carbon is converted to methane, which is then released into the air.

25 For example, BloombergNEF, War on Cow Burps Enlists Slimy Weapon to Thwart Methane: BNEF Q&A, Feb. 24, 2021. Roque BM, Venegas M, Kinley RD, de Nys R, Duarte TL, Yang X, et al., Red Seaweed (Asparagopsis Taxiformis) Supplementation Reduces Enteric Methane by Over 80 Percent in Beef Steers, PLoS ONE 16(3), 2021.

26 Press release: Pirie Meats, CH4 Global, Organic Technology Holdings and Siemens Australia Launch Advanced Processing Collaboration, June 2021.

27 Bloomberg, Cargill Backs Cow Masks to Trap Methane Burps, June 1, 2021.

28 Agriculture and Horticulture Development Board, data from Eurostat and U.K. government.

29 Dalby, F.R., Svane, S., Sigurdarson, J.J., Sørensen, M.K., Hansen, M.J., Karring, H. and Feilberg, A., 'Synergistic Tannic Acid-Fluoride Inhibition of Ammonia Emissions and Simultaneous Reduction of Methane and Odor Emission from Livestock Waste', Environmental Science & Technology, May 2020.

30 BloombergNEF, *Advancing Agriculture: Biologicals*

Best practices

A number of governments, including the U.K. and Australia, offer grants and loans for projects that trial technologies to cut livestock and crops emissions. For example, to be used at scale as a feedstock for livestock, seaweed would need to be cultivated in aquaculture operations. However, it can be difficult for project developers to obtain low-cost financing and sign offtake deals due to revenue uncertainty. Policy makers could therefore devise mechanisms – eg, a contract-for-difference or feed-in premium system – between providers of new technologies or products, and livestock producers. Regulation could also be used to create demand for these products. With regard to advanced biologicals, governments can help to mitigate the lack of data by funding collection initiatives and mutual access to data libraries among academic institutions and potentially industry. Read more on the website about feed additives and other technologies to lower livestock emissions.

Finance

Leveraging finance for less profitable low-carbon solutions is pivotal to enable the solutions discussed above. In contrast to the growing cost-competitiveness of renewable energy generation and electric vehicles in the power and light-duty transportation sectors, fewer viable alternatives exist in other areas of the global economy with significant shares of emissions. These include heavy industry, heavy-duty transport and agriculture, forestry, and land use. In some cases, solutions for decarbonizing these sectors are technically viable but not yet economical due to high capital costs and lack of incentives or revenue models. In other cases, the necessary technologies require further development to reach commercialization.

Public funding can provide revenues for low-carbon investments, for example, through market-based subsidy mechanisms or other results-based finance schemes. Incentives leveraging public finance are especially attractive in markets and sectors where the introduction of fully fledged carbon markets is not yet viable or when carbon market prices are too volatile to support long-term investment.

Best practices

Governments can take various steps to improve the economics of low-carbon solutions. The first is to phase out fossil-fuel support: the G-20 countries alone provided $3.5 trillion in direct support for coal, natural gas, oil and fossil-fueled power in 2015-20, based on BNEF analysis. This distorts the economics and leads to emission-intensive assets being locked in for future decades. In addition, policy makers can put a price on carbon: around a quarter of world emissions are covered by a CO2 tax or market. (See Section 4.3 for more on both strategies.) In addition, governments can implement public-procurement policies, for example South Korea's 'Eco-Label' scheme and the U.S. Environmentally Preferable Purchasing program. Countries including the Netherlands, U.K. and Germany are considering, or have introduced, 'climate auctions', which award the most cost-competitive projects a guaranteed carbon price floor for each ton of emissions mitigated. Read more on the website about incentives to attract finance for less mature low-carbon solutions.

Accelerating finance for research and development is also key to supporting development of new climate solutions. For technologies that are not yet commercially viable, R&D and demonstration projects from both the public and private sector can help bring innovative products to the market, while publicly financed incentive structures can create a more acceptable return profile for higher-risk technologies.

Public funding can be essential to the development of new technologies whose long R&D life cycles are difficult to support on corporate timescales. Public budgets can also support the commercialization of technologies through subsidy mechanisms and risk-sharing models like loan guarantees. Activities that help bridge the gaps between demonstration and commercialization will also be critical. Some coalitions of private investors, such as the Breakthrough Energy Coalition, that seek to enhance private support of early-stage technologies will be critical.

Risk sharing between public and private institutions in specific sectors can also help bridge the gap between demonstration and commercialization. In the HYBRIT partnership, for instance, steel producer

SSAB, iron ore extractor LKAB, power company Vattenfall, and the Swedish government have joined forces to create a fossil-fuel-free steel plant that replaces coking coal with hydrogen.

Civil society

Adoption of new technologies is often intimidating, but consumers will need to catch up with the fast pace of the transition to ensure the world stays on the net-zero track. Thus civil society organizations and governments must implement initiatives that **stimulate appetite for new low-carbon alternatives**. This could include educational campaigns and public-private partnerships to promote novel technologies.

4.3. Manage the transition or phase-out carbon activities

Despite the immediate threat posed by climate change, national governments continue to build thermal power plants, subsidize the burning of fossil fuels or underwrite their extraction through state-owned companies. Over 2010-2020, fossil-fuel fired capacity grew by over 1,000GW, with coal accounting for more than half. Despite climate pledges, the world added nearly 280GW of new coal-fired power generating capacity since the Paris Agreement. Another 480GW of new coal-fired power plants are officially under development today[31].

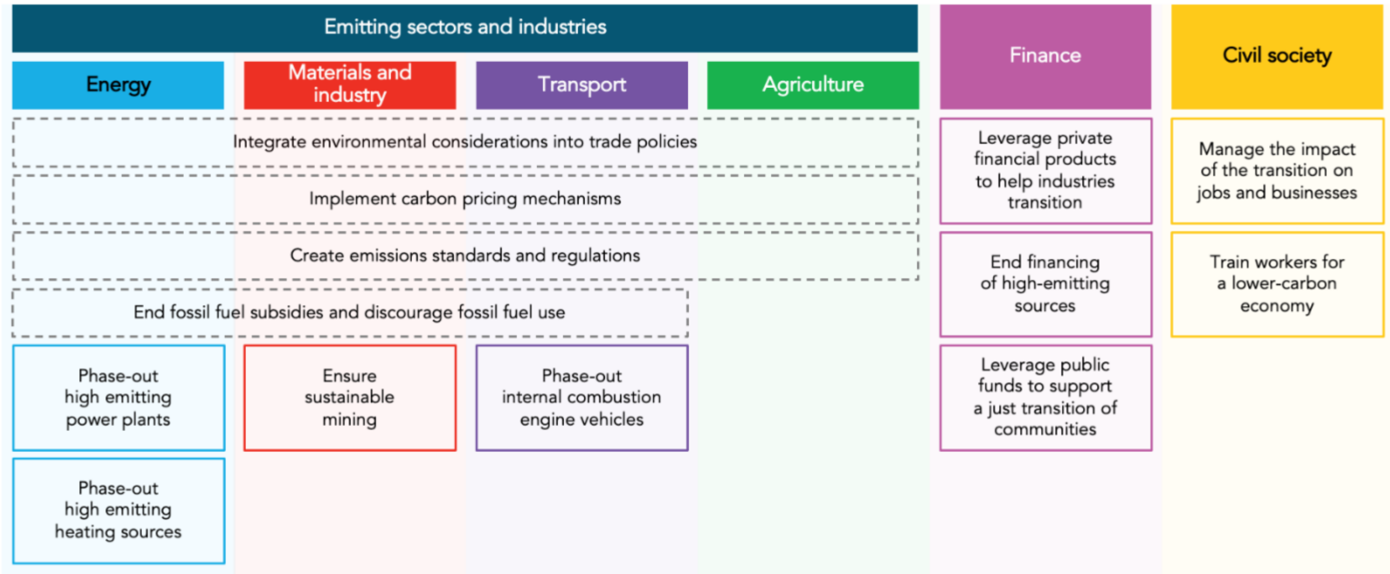
Phasing out high-emitting sources and scaling back subsidies that artificially cap consumer gasoline and electricity prices can be politically challenging. However, these are fundamental measures to limit global warming.

Many assets in the real economy are long-lived, ranging from around 15 years for cars and buses, up to 50 years for fossil fuel power plants, and 100 years or more for buildings. However, many of these will need to be retired early to get the world on a 1.5- degrees trajectory. This will require a transformation of the corporations, utilities, and communities that have historically relied on their operation.

Although the benefits of the low-carbon transition will far outweigh the costs, the structural change will need to be managed to ensure new benefits created are inclusive. As the global economy transitions from high-carbon assets to low-carbon alternatives due to market forces or regulatory interventions, workers and communities that rely on these assets must be supported, in what has been coined a "just transition." This will require a strong, coordinated action among governments, communities, investors, and businesses. (Figure 25)

31 Global Energy Monitor

Figure 25: Managing the transition or phasing-out carbon activities



Source: BloombergNEF, NetZero Pathfinders

Cross-cutting solutions for energy, materials and industry, transport and agriculture

Integrating environmental considerations in trade policies will become fundamental as the world transitions towards true decarbonization. Governments with ambitious climate goals will need to look across their economies for emissions-reduction potential, including sectors exposed to international competition. However, this raises concerns of 'carbon leakage' whereby a company moves operations to markets with lower environmental compliance costs (eg, no carbon price). If this occurs, then a carbon price or other policy has failed to reduce global net emissions – it has simply shifted them to another location.

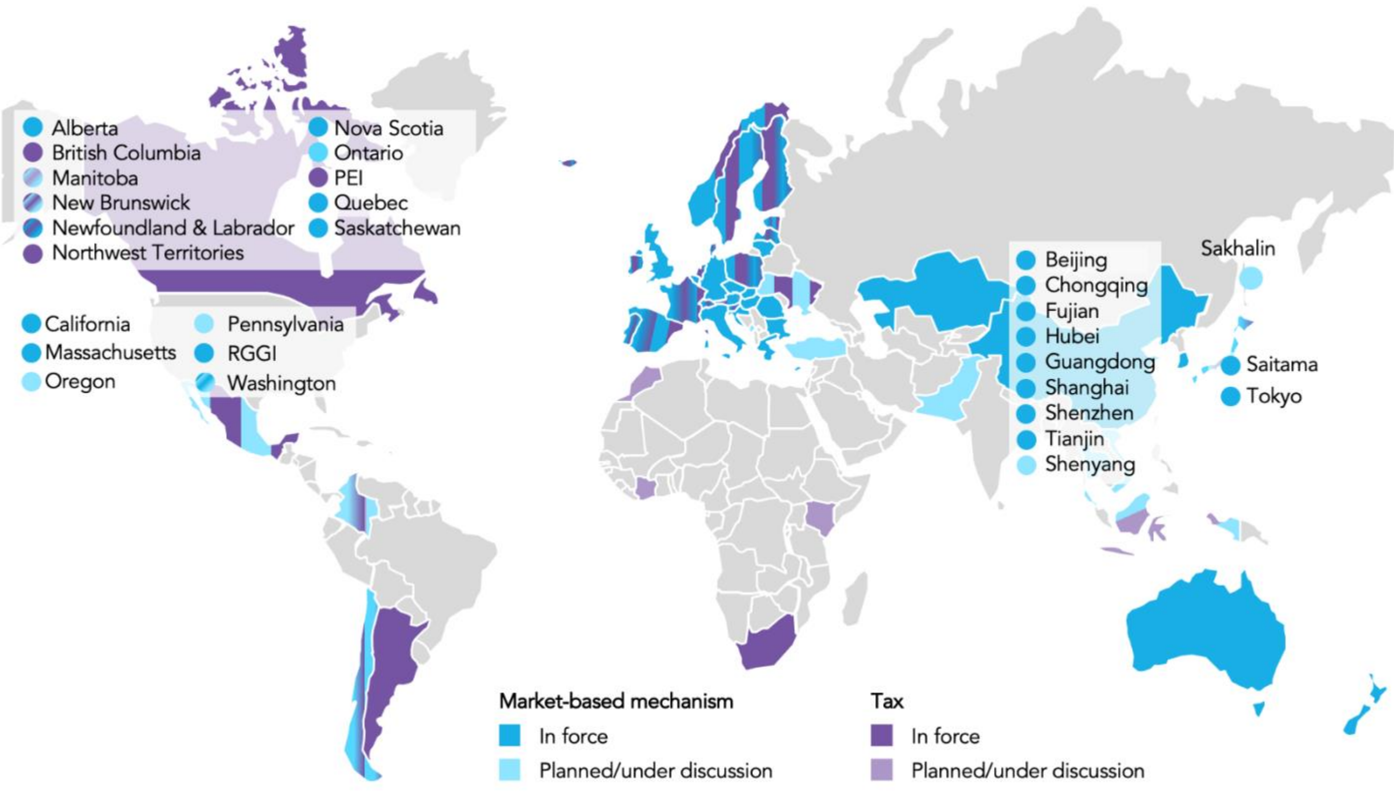
As a result, governments implementing a carbon price have often granted concessions to companies deemed to be at risk of carbon leakage. These may take the form of lower tax rates, or a share of 'free allocation' in the case of emissions trading schemes such as the EU and South Korea markets. Companies granted such concessions have less incentive to decarbonize, even though they may need to reduce emissions for a country or state to realize its climate goals. As such, some governments are exploring whether to implement a carbon border adjustment mechanism (CBAM). These policy measures seek to ensure that domestic and overseas companies face similar environmental costs, hence removing carbon leakage risk. California's cap-and-trade scheme, implemented in 2013, is the world's only example of a CBAM in the power sector. The state relies on imports from other states to meet around a third of its electricity consumption. Importers must buy allowances to cover emissions from out-of-state generation not covered by California's emission-trading scheme. Adapting regulation to minimize 'resource shuffling' has been challenging. This refers to a form of carbon leakage whereby 'dirtier' power initially scheduled for California is diverted to another region, resulting in no change to overall emissions.

The European Commission has proposed a more ambitious CBAM covering an array of industrial goods. The aim is to safeguard the competitiveness of EU industry as the bloc's carbon price rises, and companies invest in lower-emission production (eg. making steel with renewable hydrogen). If legislated over the coming year, the scheme is to be phased in from 2023 and cover imported steel, cement, aluminum, fertilizer and electricity. Benchmarking will be critical, as the European Commission will price embedded CO_2 according to emission intensities determined at a country, regional and – should companies cooperate – facility level.

The scheme is contentious within the EU and among trade partners, and is sure to be challenged under World Trade Organization rules. Yet if passed and watertight from a trade-law perspective, it could well inspire copycats. For instance, the Biden administration has stated its general support for a carbon tariff to be imposed on goods. Benchmarks and standards will prove important in other areas – the EU's plans to regulate imported batteries and natural gas are but two examples. Moreover, addressing trade flows is in line with another shift: certain governments, such as France, are considering acting to address emissions embedded within imports.

A key solution to deterring the use of fossil fuels is to **implement carbon-pricing mechanisms**, which aim to force polluters to pay for the costs they impose on the environment and incentivize them to cut emissions. The most common types are carbon taxes or market-based mechanisms like emission-trading schemes. The former gives participants more certainty on the future cost of carbon but does not guarantee a specific level of emission reduction. Setting the tax rate at the right level is also tricky: too low and companies (and households) will choose to continue polluting and just pay the tax. If the rate is too high, costs could rise higher than necessary to reduce emissions, potentially hurting profits.

Figure 26: Carbon pricing around the world



Source: Governments, BloombergNEF. Note: PEI = Prince Edward Island. RGGI = the U.S. Regional Greenhouse Gas Initiative

An emission-trading or 'cap-and-trade' program places an upper limit on emissions but the price is set via market forces, meaning more uncertainty for participants. Almost all cap-and-trade schemes today have mechanisms to stabilize the market because it is challenging to forecast emission trajectories accurately and the fixed cap often cannot respond automatically to changes in the supply-demand balance.

Many governments have incorporated into their carbon taxes or markets 'flexibility mechanisms' – measures that reduce the compliance burden for companies. These are especially common in the early stages of a program and can take various forms – eg, allocation of free permits, tax-free allowances, the ability to bank allowances into future years, and the option to comply by submitting offsets from low-carbon projects.

Another reason for flexibility mechanisms is the risk of carbon leakage – where companies move operations to markets with weaker environmental regulations – in sectors exposed to international competition. However, these concessions may mean that some companies are not incentivized to decarbonize, potentially running counter to a government's climate targets. Hence the European Commission proposed in July a CBAM as part of its 'Fit for 55' package.[32]

In order for a carbon price to be an effective driver of decarbonization, it needs to cover a sufficient share of emissions and be sufficiently high. Today, around a quarter of global emissions are produced in jurisdictions that price carbon, but the vast majority of this operate under regimes with prices too low to spur change. An explicit CO2 price of $40-80 per metric ton is needed by 2020 and $50-100 by 2030 in order to limit global warming to 2 degrees above pre-industrial levels by the end of the century, according to the World Bank's High-Level Commission on Carbon Prices 2017 report.[33] However, taxes have an average price of $29.8 per metric ton but cover less than 5% of global emissions, while markets cover around a fifth of global greenhouse-gas output but have a mean price of some $18 per metric ton.

Carbon pricing is best used as part of a decarbonization policy package, with targeted supplementary measures. It is a careful balance because parallel policies (eg, a renewables portfolio standard) could lead to inefficiencies. In addition, these supplementary measures could cut greenhouse-gas emissions, thereby lowering demand for carbon permits and thus prices. This then reduces the incentive for participants to take climate action, could mean that carbon-intensive assets are locked in for decades more, and results in an imbalance in the cost of emission reduction across sectors.

However, there is a range of cases where additional government support is likely to be required. For example, funding may be needed to incentivize technological research because carbon pricing may not provide sufficient incentive for innovation, especially the types and scale of innovation likely to be required to reach a net-zero world. A fluctuating carbon price may also not provide the certainty required for companies to make long-term investments.

Governments with carbon-pricing plans may well need to take steps to bolster public acceptance, especially relating to the perceived fairness. One option is to set aside or 'recycle' some revenue from tax collection or permit auctions for specific areas, such as environmental projects. Another is to implement measures to offset any regressive effects such as making payments to low-income households. Acceptance is also likely to be affected by overall trust in government, especially for taxes where policy makers fix the price. The pace and scale of price rises are important, as is clear and timely communication.

Best practices

The European Union's Emissions Trading System (EU ETS) is the cornerstone of the EU's climate change policy. The scheme covers around 40% of total greenhouse gas emissions of the EU. Any covered installation, such as a power plant or industrial plant, must surrender one European Emissions Allowance (EUA) to the relevant authorities for every metric ton of carbon that it emits. An upper limit, a cap, is set for total annual emissions. The cap declines every year, as does the number of EUAs available. Trading ensures that the most cost-effective emissions reductions are found. By 2030, emissions will be at least 43% lower than in 2005, but a 2021 legislative proposal by the European Commission would enforce a 61% drop on emissions. See NetZero Pathfinders best practices page to find more examples.

Emissions standards and regulations are diverse tools that can help deliver lower-carbon and cleaner products. Used well, emissions standards can signal to manufacturing industries and companies to reduce the emissions intensity of their products and processes.

Standards and regulations can be flexible policies established across the value chain for a product – including regulating upstream emissions from raw materials and energy use, or the operational emissions of a product sold to consumers. Such standards are often applied to products that combust fuel during their use – such as vehicles or heating units.

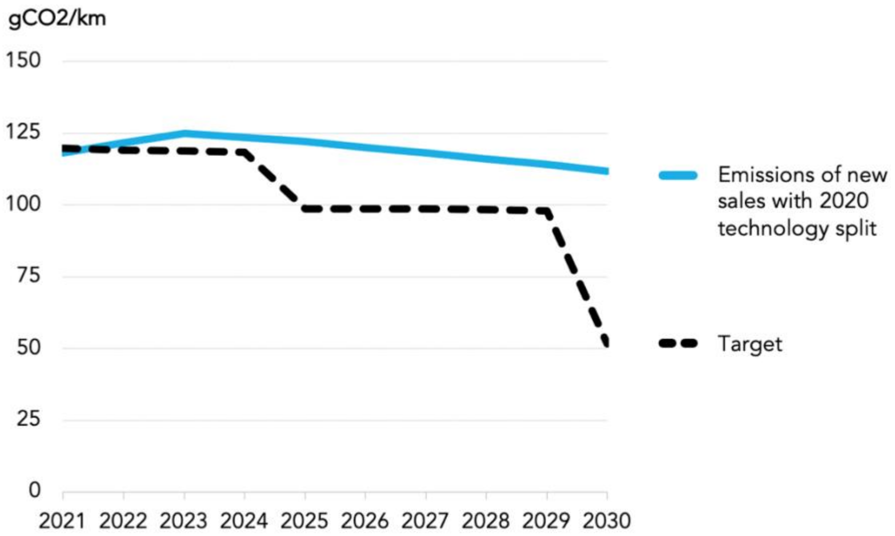
32 BloombergNEF, *EU's Controversial Carbon Tariff Faces Trade Headwinds*

33 Carbon Pricing Leadership Coalition, *Report of the High-Level Commission on Carbon Prices*, 2017.

Emissions standards can be designed to increase in stringency over time, by requiring new products to become cleaner. This can give a long-term signal to industry stakeholders and manufacturers to adapt their activities. A case study of this is the European Union's CO2 emissions performance targets for passenger cars. These standards affect automakers selling new vehicles in the region and are increasing in stringency over time. The targets announced by the European Commission as part of its Fit for 55 package in 2021 imply that at least 60% of new car sales will have to be fully electric vehicles in 2030, because manufacturers will not be able to meet the standards with sales of efficient internal combustion engines or hybrid vehicles alone.

The European Commission is also likely to use these CO2 targets to effectively phase out internalcombustion engine sales by 2035. This would set a hard deadline for automakers to stop producing new combustion engine vehicles (and even hybrid vehicles). Already, compliance with the EU CO2 emissions standards for passenger vehicles has led to increased model availability of electric vehicles among automakers and higher sales. Similarly, many European countries are also implementing minimum emissions performance standards for new buildings, which is helping to drive up adoption of cleaner heating systems such as heat pumps. (Figure 27)

Figure 27: EU CO2 emissions targets and industry trajectory for passenger cars



Source: BloombergNEF, European Commission. Note: Shows emissions on the World harmonized Light-duty vehicles Test Procedure (WLTP) testing cycle. Target is BNEF estimate; performance and target emissions are sales-weighted averages for the manufacturers. May slightly differ vs. overall industry values.

These examples from Europe demonstrate how the use of emissions performance standards can work effectively in regulating new passenger vehicle sales and new building developments. However, standards can also be applied to operational emissions of existing assets – for example the government of South Africa is attempting to implement minimum emissions standards from coal-fired power plants, which require state-owned utility Eskom to retrofit its power plants that exceed pollution limits.

There are additional layers of complexity that can affect the strength of emissions standards and regulations. Increasingly, some policy makers are considering standards that would calculate the lifecycle emissions of a product – rather than just assessing operational emissions alone. Such standards could prove challenging to implement in practice as they can be particularly complex to calculate and standardize. But they could help to boost discussions around the optimal way to incentivize sustainable value chains through regulation.

Best practices

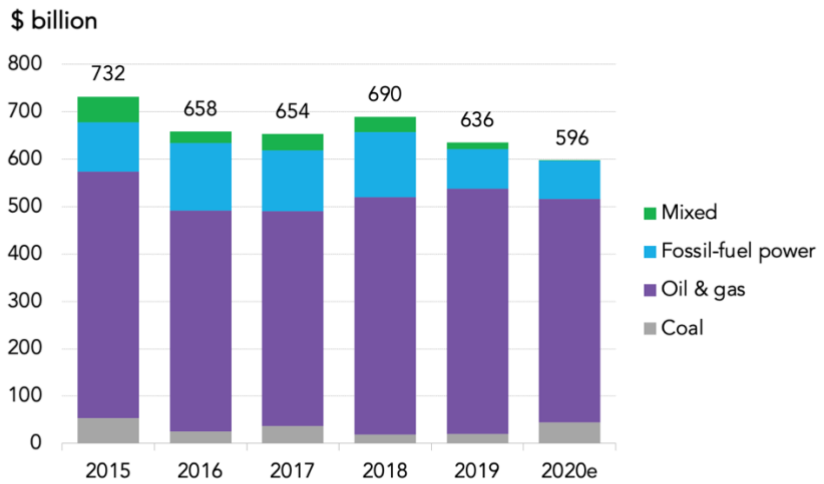
Vancouver's "Zero Emissions Building Plan" establishes specific targets and actions to achieve zero emissions in all new buildings by 2030. The energy and emission limits for new buildings have been integrated into the local building code and the limits will be reduced over time. New buildings in 2019 are estimated to produce almost 50% less carbon emissions than in 2007. Read more on the website about Vancouver's initiative.

True decarbonization also means ending fossil-fuel subsidies and discouraging fossil fuel use. BloombergNEF estimates that the Group-of-20 countries alone provided nearly $4 trillion in direct support for coal, natural gas, oil and fossil-fueled power in 2015-20. At current prices, that amount of funding could build enough new solar energy to power the entire U.S. and all of Asia – and then some. These figures are probably under-counts, given the limited transparency.

Fossil-fuel support provided by G-20 countries slid 6% in 2020, based on provisional estimates. The 2020 overall decline was driven by a 29% drop in the value of subsidies for energy consumers as fossil-fuel and electricity usage decreased during the pandemic. Factoring out lower consumer price subsidies, total fossil-fuel support would have stayed level 2019-20 after governments and state-owned organizations provided special funding in response to the pandemic. (Figure 28)

This support encourages the (potentially wasteful) use and production of fossil fuels. It can also distort prices and risks carbon 'lock-in' – whereby assets funded today will be around for decades, locking in high levels of future emissions. All of these factors hinder the climate transition. The lion's share of the subsidies (60% in 2019) goes to producers and utilities, despite government climate commitments and proliferation of cost-competitive clean technologies. Even consumer-targeted subsidies disproportionately benefit wealthier consumers. Subsidies can take a number of forms, from lowering the price paid by an electricity consumer, to providing grants to oil companies for drilling.

Figure 28: Fossil-fuel support by G-20 countries



Source: OECD, International Energy Agency, Oil Change International, Overseas Development Institute. Note: Includes budget transfers, tax expenditure, public finance, investment by state owned enterprises (SOE) and consumer-price support. 2020 data is provisional only.

Eliminating fossil-fuel supports can be a slow and politically delicate process. However, national governments can implement other policies to offset these supports without the same potential downsides. These include financial incentives for renewables and energy storage, capacity mechanisms in the power market, and 'just transition' strategies to support companies, workers and local communities affected by the shift from fossil fuels to cleaner technologies.

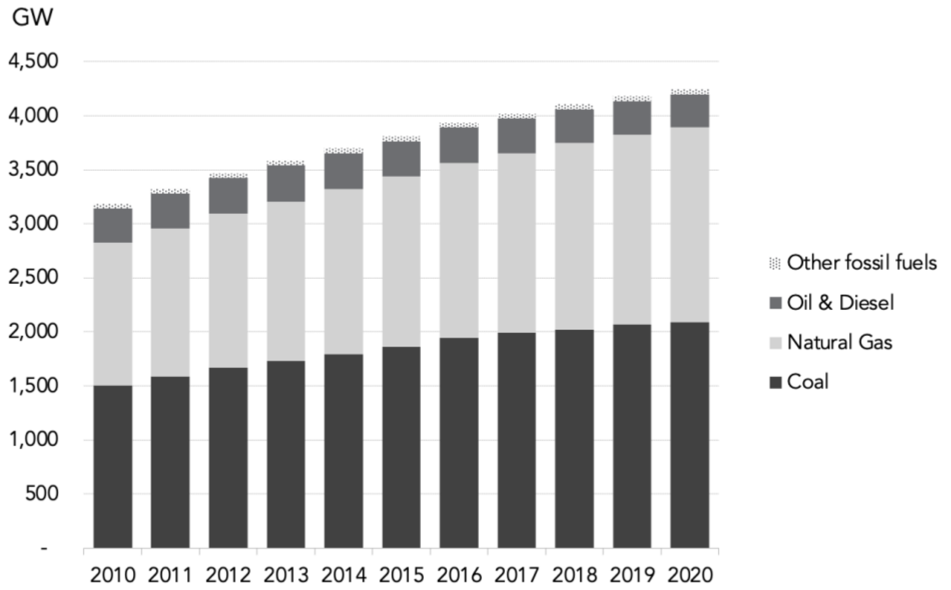
Intergovernmental discussions can also play key role on this matter. The need to reduce greenhouse-gas emissions and the growing number of lower-carbon technologies have spurred some policy makers to agree to reduce fossil fuel subsidies. Indeed, at the G-20 Pittsburgh Summit in 2009, governments committed to "phase out and rationalize over the medium term inefficient fossil fuel subsidies". They did not define "inefficient" other than to say that such subsidies "encourage wasteful consumption, distort markets, impede investment in clean energy sources and undermine efforts to deal with climate change". They also did not specify a deadline year to achieve this goal. In June 2021, G-7 countries also pledged to end support for "unabated international thermal coal power generation". But loopholes could mean that higher-efficiency thermal coal technologies (eg, ultra supercritical boilers or combined heat and power) could still be allowed. The agreement also did not define the "limited circumstances" under which the countries could still provide support. In addition, the G-7 deal only related to coal power plants abroad, while a total of 481GW is in the pipeline across 40 countries.

In an attempt to speed up the phase-out process, G-20 finance ministers developed a framework for voluntary peer reviews of fossil-fuel subsidies in 2013. The idea was to facilitate sharing of experiences and learnings in phasing out fossil-fuel subsidies between countries. China and the U.S. were the first to undertake such reviews of each other's fossil-fuel support, published in 2016. Germany and Mexico followed in 2017, then Indonesia and Italy in 2019. Argentina and Canada, and France and India, are in the process of undertaking peer reviews. The reviews are likely to have varying degrees of success. Unless there is a strict timeline set out for the phase-out of subsidies, countries may feel little pressure to act upon the reviews.

Energy

In addition to boosting clean energy additions, **phasing out fossil fuel-fired capacity** will be one of the most important steps to decarbonize the global economy. Under NEO's Green Scenario[34], the world has to retire than 100GW of coal-fired capacity on average each year so that by 2030 coal-fired power is 67-72% below 2019 levels. However, fossil fuel power-generating capacity grew by around 1TW 2010-2020 with coal accounting for over half the total. (Figure 29)

Figure 29: Global fossil fuel-fired capacity

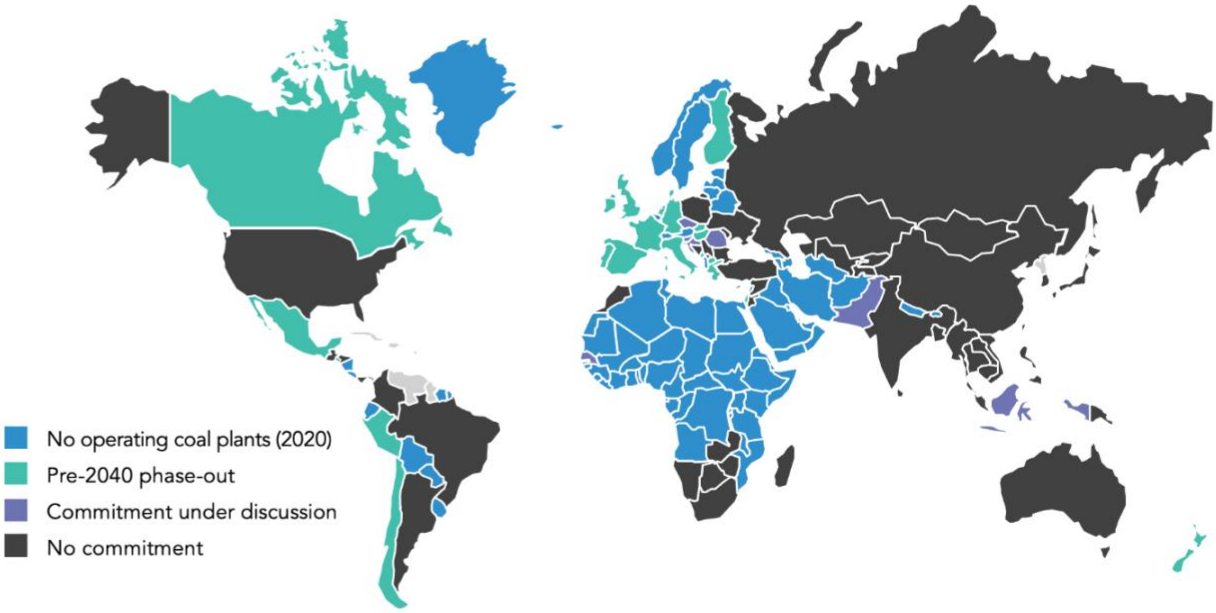


Source: BloombergNEF, Climatescope

34 NEO Green Scenario is a clean-electricity and green-hydrogen net-zero pathway. Here, hydrogen produced from water using electrolyzers powered by wind and solar is applied in sectors such as industry and heavy transport, as well as in power generation to complement electrification. Click here for more details.

While the number of pledges to shut down coal plants is rising, significant additional effort from policy makers, utilities and investors will be needed to ensure follow-through. As of September 2021, 25 countries have pledged to phase out coal before 2040, but 45 nations with operational coal capacity still have not committed to phase out their plants. Together, these countries account for nearly 2,000GW of coal, or 92% of the world's total coal-fired capacity. (Figure 30)

Figure 30: Coal phase-out commitments



Source: BloombergNEF, Climatescope

As economics alone won't drive major buildings retrofits in the short term, governments must push to **phase out high emitting heating sources**. Bans on emissions-intensive heating options, such as gas or oil boilers are growing in G20 countries. While these types of policies can support a range of low-carbon options, heat pumps are a key beneficiary due to their comparability in size and application.

Germany and France, for example, plan to ban oil boilers in the next few years. These bans will affect new buildings and existing homes, once the installed oil boiler reached end of life. In addition, France and the U.K. have announced bans on the use of natural gas in new homes with many starting in 2021.

Best practices

The Netherlands, once considered a haven for cheap natural gas, has become the first country to commit to phasing out domestic sources of the fuel by 2050. The National Climate Agreement of 2019 includes measures to remove residential homes from the gas grid by 2050, a policy with wide-ranging implications The agreement sets a timeline to transition homes and buildings away from gas-fired heating. This is a significant commitment, as around six million Dutch homes are connected to the gas grid. Hitting the 2050 phase-out targets will require as many as 200,000 homes to disconnect from the gas grid per year. Municipalities have until 2021 to prepare their plans for shifting to low-carbon heating. See Netzero Pathfinders best practices page to find more examples.

Materials and industry

Ensuring sustainable mining is a pivotal step to establishing a truly decarbonized economy. This is especially important as a fast transition will create significantly higher demand for metals and minerals fundamental in the production of virtually every green technology. Electric vehicles, for example, have zero tailpipe emissions, but have associated upstream emissions battery manufacturing, in addition to power generation.

Transport

Setting a goal to phase out the use of internal combustion engine vehicles has the potential to accelerate the transition significantly in the transport sector. Moreover, moving away from conventional cars and trucks is critical for addressing climate change. According to BNEF's Long-Term Electric Vehicle Outlook, across all segments, sales of new internal combustion vehicles must cease post-2035 for the transport sector to contribute its share toward achieving net zero. Even then, some early retirements and conversions of older vehicles will be required in the 2040s.

Some countries have already issued plans to abolish ICE vehicle sales altogether over time. At least 14 national governments have stated long-term policy goals to ban ICE sales, including three G-20 countries.[35] Together, the countries with national targets accounted for over 13% of all new car sales in 2019. Over 30 regional and municipal governments around the world have also voiced intentions to phase out ICE vehicle sales. The U.K. said in November 2020 that it would bring forward its ICE phase-out date by five years to 2030. Canada and France have 2035 and 2040 as their targets.

Finance

Bold commitments from investors to **end financing of high-emitting sources** are also fundamental to put the world on track for a successful first phase of the race to zero this decade. Multiple nations and investors have recently committed to end coal financing, but more remains to be done.

In June 2021, for instance, the G7 leaders agreed to end new direct government support for unabated coal-fired power stations abroad by the end of 2021 and accelerate the transition away from unabated coal capacity in line with 2030 climate targets and net zero commitments. But as discussed above, vague wording and undefined loopholes weaken the impact of this pledge.

Leveraging private sector financial products to help industries transition from fossil fuel reliance will be critical. Investors and lenders can develop a wider range of financial products to support corporations that have adopted ambitious transition goals, such as transition bonds or corporate bonds linked to longer-term transition strategies. Supporting corporations in their transition can create a virtuous cycle: more money invested in clean companies can create a greater appetite for the transition – lowering financing costs and ultimately leading to more investment[36].

Leveraging public funds to support a just transition of communities is also fundamental, as a sector may account for a substantial share of local jobs and without policy maker intervention, a phase-out could result in mass unemployment and migration, and social unrest. Such a transition will require strong, coordinated action among governments, communities, investors, and businesses. Public policies that link climate, macroeconomic, industrial, and labor policies can help lay the foundation for inclusive growth, both through short-term programs that mitigate negative impacts on workers and communities (e.g., income support) and through longer-term industrial strategies or retraining programs. Corporations and investors, recognizing the long-term value of inclusive growth, can also integrate social factors into their investment strategies or how they engage with corporations. All of these must be done in consultation and offer transparent dialog with the communities undergoing a transition.

Public budgets can provide direct support to communities, households, and workers affected by the transition. This support can include measures to mitigate short-term impacts, such as providing compensation, workforce development programs, and community grants to diversify local economies, while also investing in longer-term industrial transition strategies that may not generate the level of financial returns needed to attract private investment.

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35 Note that some EU member states could see their phase-out targets affected by bloc-level regulations.

36 For more details see CFLI report Financing the Low-Carbon Future

Best practices

Germany's coal phase-out plan, announced in 2020, included some 40 billion euros ($47 billion) – the bulk of the compensation – for the affected regions and local communities. Projects were announced to help absorb the estimated 30,000 job losses, covering infrastructure, manufacturing and clean energy. Similarly Australian policy makers announced a range of funding streams in 2016 after Engie announced the closure of the country's largest coal-fired power plant (Hazelwood) in five months' time. This included A$20 million for local job creation, diversifying the regional economy and building a highly skilled workforce via projects determined by community output. These initiatives – together with the agency set up to manage and support the transition – helped to re-orient the region. They also contributed to tackling challenges such as the suddenness of the closure, the area's negative economic reputation, and the reluctance to move away from its traditional image and reliance on coal mining. This is similar to the Czech government's RE:START program to support the transformation of the country's three mining regions. Policy makers could also look to support regional diversification. For example, the German government's support for building battery manufacturing capabilities in Europe could help ease its transition away from coal. Read more on the website about leveraging public funds to support a just transition of communities.

Civil society

Many assets in the real economy are long-lived, with fossil-fuel power plants lasting up to 50 years. As a result, the financing decisions of the past can lock in carbon emissions well into the future. "Committed" emissions from existing fossil fuel-based assets in the power, industrial, and transport sectors are already incompatible with a 1.5-degree trajectory. Consequently, some carbon-intensive assets will likely need to be retired early, requiring a transformation of the corporations, utilities, and communities that have historically relied on their operation. Thus, policy makers and civil society organizations will need to implement initiatives that **manage the impact of the transition on jobs and businesses.** As new technologies emerge fast, all nations around the globe will also need to **train workers for the low-carbon economy.** This is fundamental to ensure that new technologies can be implemented fast and safely. Over the coming years, policy makers and civil society will need to prepare younger professionals and reskill workers from high-emitting sectors to install and operate green technologies.

4.4. Create appropriate climate transition governance structures

The scope of the climate crisis is forcing smart policy makers to take a multi-decadal view of the problem, which encompasses multiple sectors and stakeholders. But policies are only as good as the frameworks that exist to implement and enforce them. Policy makers must recognize that to attract investment in low-carbon technologies – and enjoy the associated economic benefits – they must construct governance structures that are durable for the long term. Investors, corporations and civil society all have key roles to play in ensuring that the transition is fast, but does not leave anyone behind. (Figure 31)

Figure 31: Creating appropriate climate transition governance structures

Source: BloombergNEF, NetZero Pathfinders

Cross-cutting solutions for energy, materials and industry, transport and agriculture

Establishing independent bodies focused on implementing climate goals and projects is key to supporting, informing and advising policy makers. These entities, comprised of independent experts, can ensure alignment between policy and the latest climate science, and enable better scrutiny over government decisions. Ongoing research and analysis by these entities can also help to hold policy makers to account for short-term progress toward longer-term climate targets. They can also help in the process of target-setting and identifying optimal pathways to achieving these goals.

Many governments already work alongside an official independent body that advises and scrutinizes policy at the national level. These are typically comprised of leading experts on climate and energy. For example, the U.K.'s Committee on Climate Change has a leading role in shaping the country's climate targets – and was notably the driving force behind the legislating of an economy-wide net-zero target by 2050.

Denmark also has established an independent council on climate change responsible for monitoring and evaluating progress towards emissions reductions targets and advising climate policy – the Klimaradet. Sweden's Climate Policy Council, Klimatpolitiska Radet, fulfils a similar role.

Best practices

The U.K.'s Committee on Climate Change (CCC) is an independent body that advises the government on its progress to emissions targets. The CCC's advice is usually – but not always – integrated in government action. The process for target setting is transparent and goes through the standard legislative procedure. Ongoing research and analysis by entities like the CCC can help to hold policymakers to account for short-term progress toward longer-term climate targets. Read more on the website about U.K.'s CCC.

Governments should also ensure continuity of climate goals and projects. This means establishing and maintaining robust processes for policy making, with clearly communicated timelines for changes, and actively consulting with industry and experts.

Continuity in policies supporting clean energy and other climate-related projects is vital, because governments risk seeing investment activity deteriorate rapidly if they tamper with enabling environments that support clean technology projects. There are numerous examples of where sudden or retroactive changes to the policy landscape have badly damaged investor confidence in a market and limited progress towards clean energy goals.

Figure 32: Wind and solar capacity deployment in Spain, 2005-2020

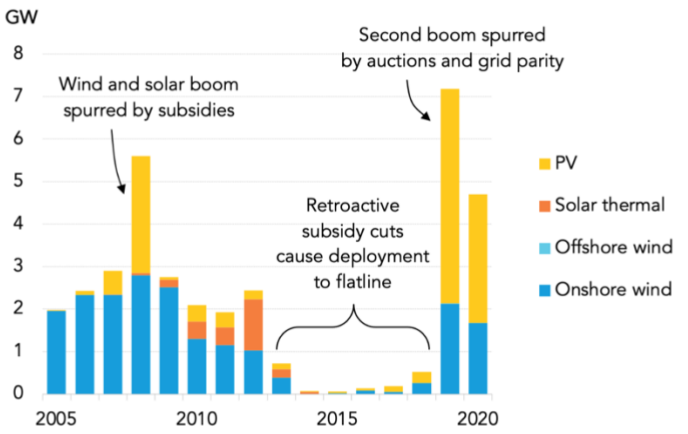
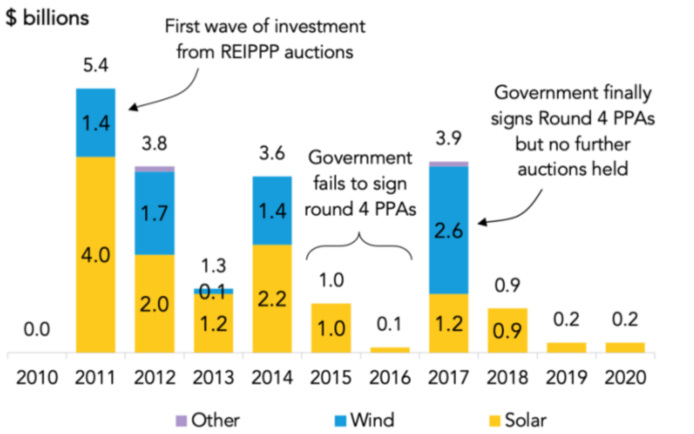


Figure 33: Clean energy investment in South Africa, 2010-2020



Source: BloombergNEF.

Spain was an early mover in procuring large volumes of renewables to its grid. Wind and solar's share of installed capacity skyrocketed from 5% to 30% over 2000-10, driven by feed-in tariffs which created a boom in renewables installations. The country paid a hefty price for the generous subsidies that catalyzed its first renewables boom. Annual costs of maintaining renewables subsidies ballooned from 1.2 billion euros in 2005 to 8.4 billion in 2012. At 3% of GDP, this tariff deficit ranked the highest of any EU market. (Figure 32)

The government imposed retroactive cuts on renewable assets and a 7% tax on all power generation. The cuts were particularly damaging to investor confidence in the market because they came at a time when new-build wind and solar were still dependent on subsidies to be viable. This severely undermined investor confidence and caused investment activity in renewables to flatline over 2012-16 due to high perceived investment risk. But the sector has since rebounded after the government reintroduced clean energy auctions and the economic viability of subsidy-free projects has improved with technology cost declines.

Another example is South Africa, which experienced uneven investment in clean energy due to a lack of stability in the government's clean energy auction program. Four rounds of the government's auction program, the Renewable Energy Independent Power Producers Programme (REIPPP), were held between 2011 and 2015, spurring over 5GW of new renewables build with 20-year PPAs. This program is the primary route to market for new renewable energy projects, as South Africa's power sector is highly regulated. (Figure 33)

Unstable policy led to large annual fluctuations in wind and solar project financing in South Africa, dependent on the signing of PPAs. The lack of auction rounds over 2015-2020 also severely limited the options for developers to build new projects and dampened investment. The announcement of the fifth round in March 2021 was meant to help reactivate investment and get the country back on track to delivering its clean energy targets.

National, regional and local governments must work collaboratively to implement climate policies effectively and **enhance cross-governmental coordination**. Successful collaboration is particularly relevant when it comes to cutting emissions from buildings or the deployment of EV charging infrastructure. Local authorities are often responsible for relevant structural codes while states or national governments are the ones to set broader infrastructure goals or offer incentives such as tax breaks.

Under the banner of coordination, national governments must also ensure adequate funding is made available for local decarbonization initiatives. National governments have broader tax bases and often have well-established credit-ratings making their access to funding superior to that of most local governments. National governments should thus see it as their obligation to provide adequate funds to implement local decarbonization measures.

Data sharing and transparency is also crucial for successful cross-government coordination. For national funds to be effectively spent by local governments, it is crucial that local governments are consulted at an early stage of setting up new funding infrastructure. Local governments can influence national governments by providing them with valuable data and insights, which can aid policy and budget planning processes. For example, in the U.S., Seattle is enhancing EV use by facilitating an advanced data-sharing platform that powers car sharing and EV charging services. The city aims to demonstrate solutions that could be implemented across the country.

Coordinated timing of policy implementations lead to more successful outcomes. Pairing local regulatory measures with nationally available grants has proven to be a working solution for decarbonizing transport in many European cities. For example, in London the implementation of the Ultra Low Emissions Zone, an area where the most polluting vehicles must pay a levy in order to use the roads, has been expanded while the national government is providing a grant for anyone who buys a new zero-emission vehicle.

While many decarbonization efforts require coordination between government agencies at multiple levels of government, it is often useful to have a single entity take the lead in implementing a key policy. Lacking that, consumers, project developers or others seeking to take advantage of a program can get frustrated by excess bureaucracy.

Partnerships between governments and non-profit organizations, non-governmental organizations and others in civil society can also further decarbonization. In Ireland, for instance, knowledge-sharing is supported by organizations such as the Climate Action Regional Offices and the C40 partnership between mayors of major cities around the globe. In Canada, the British Columbia and Vancouver governments have partnered with companies in the building trade to establish a knowledge center for zero-carbon construction. In Indonesia, the government is counting on partnerships with global corporations to educate the workforce needed to set up large-scale EV manufacturing.

Best practices

The EU-funded Sharing Cities project aims to develop scalable digital and collaborative solutions for cities, through fostering international collaboration between cities and industries. With a project budget totaling $32 million (28 million euros), concept demonstration areas were developed in Milan, London, and Lisbon over 2016-2021. Milan's Sharing Cities Project developed a Sustainable Energy Management System for the Porta Romana district in 2015, including smart grids and internet connected street lighting and 60 electric vehicle chargers. The system collects near real-time data from the electricity distribution grid and can aid long-term grid development plans. The project also included retrofitting buildings and used co-design workshops for collaborative decision making to ensure that different stakeholders needs were considered. See NetZero Pathfinders best practices page to find more examples.

Transparency and disclosure requirements have the potential to **encourage corporate climate commitments**, which can play a key role in driving decarbonization. The European Union, for instance, set up a voluntary framework for how companies should disclose their environmental impact in 2017, and large companies have been mandated to disclose this information since 2014.

Voluntary codes and public procurement standards can also drive corporate decarbonization. By defining what counts as a "green" activity, the EU taxonomy stands to help investors navigate different ambition levels of corporate climate commitments, and thus indirectly encourages companies to set more ambitious climate goals. The taxonomy can also help governments set new climate-related requirements for public procurement.

Industry-led initiatives, such as the RE100 initiative for companies committing to 100% renewable energy, are challenging companies to make specific, public pledges to clean up their activities. To date, the 318 companies that have joined RE100 as of June 2021 are together expected to procure over 340TWh of renewable electricity directly or through green certificates by 2030. This is equivalent of around half of Germany's power production in 2020.

Best practices

The Science Based Targets initiative (SBTi) defines and promotes best practices when setting a science-based decarbonization target. It is one of the most established voluntary frameworks for corporate climate targets. The framework is established through a partnership between the not-for-profit charity CDP, the United Nations Global Compact, World Resources Institute (WRI) and the Worldwide Fund for Nature (WWF). By September 2021, 1,781 companies worldwide have committed to emissions reductions targets under the SBTi. Together, the nine largest U.S. and European utilities with net-zero goals are expected to cumulatively reduce their Scope 1 and 2 emissions (from fuels burned and electricity consumed) by 436MtCO2 from 2019 to 2050. Read more on the website about corporate climate targets.

Finance

Aligning financial institutions' portfolios with climate targets is fundamental to getting activities on track this decade to achieve net zero by mid-century. The financial sector must do more to account systematically for material climate-related information in financial decision-making. However, today, decision-useful information and methodologies to understand climate-related risks and opportunities are lacking. There is also an insufficient volume of low-carbon investment opportunities available across asset classes.

In addition, investors and lenders can work to more systematically align financial flows with a well-below 2 degree pathway, including by partnering with corporations through investing and financing to achieve climate-related targets, transition strategies, and industry-specific transition pathways. Credit rating agencies can routinely, consistently, and transparently integrate climate-related risks and opportunities into their credit assessments. Including climate risk and transition analysis in mainstream ratings could steer private-sector capital to corporations that are best positioned in the transition to a low-carbon economy.

The sovereign shareholders of public and multilateral financial institutions – notably development banks, sovereign wealth funds (SWFs), and government pension funds – can lead by example by encouraging institutions to align portfolios with well-below 2 degree pathways. Multilateral development banks and DFIs are already aligning their decision-making with the Paris Agreement, while a growing number of SWFs and government pension funds plan to integrate climate-related factors into their portfolio management activities.

Encouraging climate-related financial disclosures is pivotal to greening the financial system as investors need high quality, comparable and reliable information on climate risks.

Organizations across the investment chain can work to incorporate climate-related risks and opportunities into governance and financial decision-making. As part of this effort, financial-sector leaders can emphasize the importance of climate-related disclosure to inform their decision-making, such as reporting in line with the recommendations of the Task Force on Climate-Related Disclosures (TCFD).

Spearheaded by former Bank of England Governor and former Financial Stability Board Chair Mark Carney and chaired by Michael Bloomberg, the TCFD was the first private-sector-led initiative working to develop consistent climate-related financial disclosures to inform investing, lending, and underwriting decisions. The task force developed four widely adoptable recommendations on climate-related financial disclosures that are applicable to public companies and financial institutions across sectors and jurisdictions.

The importance of a coordinated approach to climate risk disclosure has become more widely recognized by governments. In June 2021, G7 countries agreed to move towards mandatory climate-related financial disclosures that provide consistent and decision-useful information for market participants and that are based on the TCFD framework, in line with domestic regulatory frameworks.

Civil society

As the public's understanding of the eminent danger posed by climate change, civil society has a key role to play in **pushing for binding goals that include concrete CO2 reduction targets**.

Examples of increased public pressure for climate action have already be seen in the form of large-scale political protests and climate litigation. A strong example of successful civil society action can be seen in the Netherlands. In 2013, the Dutch NGO Urgenda' initiated a lawsuit against the Dutch state aiming to order the state to reduce the country's GHG emissions by 40% at the end of the year 2020, or at least by a minimum of 25% in comparison the year 1990. In December 2019, the country's Supreme Court decided that the Netherlands has an obligation to take measures for the prevention of climate change and that it had to reduce its GHG emissions by at least 25% by the end of 2020, compared to 1990 levels.

Driving social development and equality across the value chain is fundamental to ensure that a fast transition does not translate into a greater economic disparity across the globe. Demand for metals such as copper, cobalt, nickel and steel will increase as the world transitions to a low-carbon economy. Over half of Africa's 52 countries host at least one of the metals required to support the energy transition.

In spite of the opportunity, Africa's economic share of the global value chain is low. Over 90% of cobalt produced in the Democratic Republic of the Congo is exported to China and refined into finished goods. Similarly, almost all the manganese produced in South Africa is processed into intermediary products and shipped to China. Investing in refineries and value addition in Africa could boost equity and ensure that the region is not marginalized as the world transitions to cleaner energy sources.

Some mining communities stand to be significantly impacted by the energy transition. South Africa's coal sector employs over 90,000 people. Thousands of others in the country rely on the industry. A diversification from coal without a comprehensive social transition plan has the potential to hurt communities. Factors like skills retraining, community programs and alternative sources of livelihood could help lessen the blow and offer new opportunities.

About us

NetZero Pathfinders is a public resource that provides concrete, actionable policy ideas for achieving a decarbonized economy. Pathfinders leverages the capabilities of Bloomberg L.P., Bloomberg Philanthropies and numerous partner organizations to make these policy solutions available via web portal Bloomberg.com/netzeropathfinders. The initiative aims to serve municipal, regional, national and international policy makers, financiers, business leaders and others.

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