WORLD RESOURCES INSTITUTE

WORKING PAPER

# TRACKING PROGRESS OF THE 2020 CLIMATE TURNING POINT

MENGPIN GE, KATIE LEBLING, KELLY LEVIN, AND JOHANNES FRIEDRICH

## EXECUTIVE SUMMARY

In 2017 several leading climate analysis organizations came together as part of the Mission 2020 campaign to define six milestones—in energy, transport, land use, industry, infrastructure, and finance—that would need to be met by 2020 to bend the curve in global greenhouse gas emissions and put the world on a pathway consistent with the Paris Agreement. To achieve each milestone, the organizations identified two or more outcomes, and this working paper takes stock of progress made toward those outcomes.

### Highlights

- For the best chance of limiting temperature increase to 1.5 degrees Celsius (°C), global greenhouse gas (GHG) emissions must peak by 2020 and dramatically decline thereafter.
- Transformations in policy, behavior, finance, and technology are needed to reach this climate turning point and meet the objectives of the Paris Agreement.
- Analysis of existing data shows that while meaningful progress has been made, we are not yet on track to achieve the 2020 climate turning point.
- Progress is uneven across the six milestones: For some underlying outcomes in several milestones, action has been progressing and accelerating. However, in most cases action is insufficient or progress is off track.

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Box ES-1 | **Six Milestones Identified in *2020: The Climate Turning Point***

1. ENERGY: Renewables outcompete fossil fuels as new electricity sources worldwide.
2. TRANSPORT: Zero-emissions transport is the preferred form of all new mobility in the world's major cities and transport routes.
3. LAND USE: Large-scale deforestation is replaced with large-scale land restoration, and agriculture shifts to earth-friendly practices.
4. INDUSTRY: Heavy industry—including iron and steel, cement, chemicals, and oil and gas—commits to being Paris-compliant.
5. INFRASTRUCTURE: Cities and states are implementing policies and regulations to fully decarbonize buildings and infrastructure by 2050.
6. FINANCE: Investment in climate action is beyond US$1 trillion per year, and all financial institutions have a disclosed transition strategy.

- Greater transparency is needed in many areas where outdated or insufficient data exist for assessing progress.
- Governments, businesses, and finance institutions urgently need to ramp up ambition, fulfill commitments, and deliver net zero emissions by 2050.
- Tremendous opportunities to scale up and accelerate action remain untapped across all sectors. For almost all milestones and outcomes, the opportunities must be harnessed quickly if these goals are to stay within reach.
- Under the Paris Agreement, countries have the opportunity to enhance their commitments, or nationally determined contributions (NDCs), by 2020, which can catalyze action in the short term to avoid lock-in of an emissions-intensive pathway in the longer term. These updated NDCs will in turn need to translate into changes in policy, actions, and investments.

## Background

**Climate change presents both tremendous challenges and opportunities. To avoid the worst climate impacts, the global community must first halt growth in GHG emissions, and then swiftly reduce emissions to reach net zero by midcentury as agreed in the Paris Agreement.** In doing so, the world can unlock multiple benefits, from new jobs and innovation to improved health and protection of ecosystems and their services, to name a few.

To reach our targets, we must first know where we are and how big the remaining gap in action is. That's why monitoring our progress in bending the global emissions trajectory downward is of critical importance. We already know that peaking global emissions by 2020 gives us the least-cost likely chance of limiting warming to 1.5˚C by the end of the century. In 2017, the *2020: The Climate Turning Point* report took stock of what it would take to peak global GHG emissions by 2020, including transforming policy, technology, behavior, and investment (Revill and Harris 2017). A collaboration between multiple experts in the field, the peer-reviewed report identified six milestones across key emitting sectors that must be reached to deliver such a turning point in the world's emissions trajectory (Box ES-1). Encouragingly, the milestones that *2020: The Climate Turning Point* identified are also desirable and achievable in the context of sustainable development and human well-being.

**With two years left until the end of 2020, this working paper seeks to**

- **assess the world's collective progress toward achieving the six milestones that *2020: The Climate Turning Point* identified; and**
- **identify untapped opportunities for making progress toward those milestones.**

This paper takes stock of the latest available data to determine whether the global community is on track toward meeting the above milestones, what further action is needed, and the opportunities for getting ahead.

**This paper is targeted at national and subnational leaders, as well as leaders of major corporations and investors.** A secondary audience is subject experts who support such decision-makers in strengthening implementation of existing commitments, as well as increasing ambition in the future.

## Key Findings and Recommendations

**This paper reaches the following conclusions:**

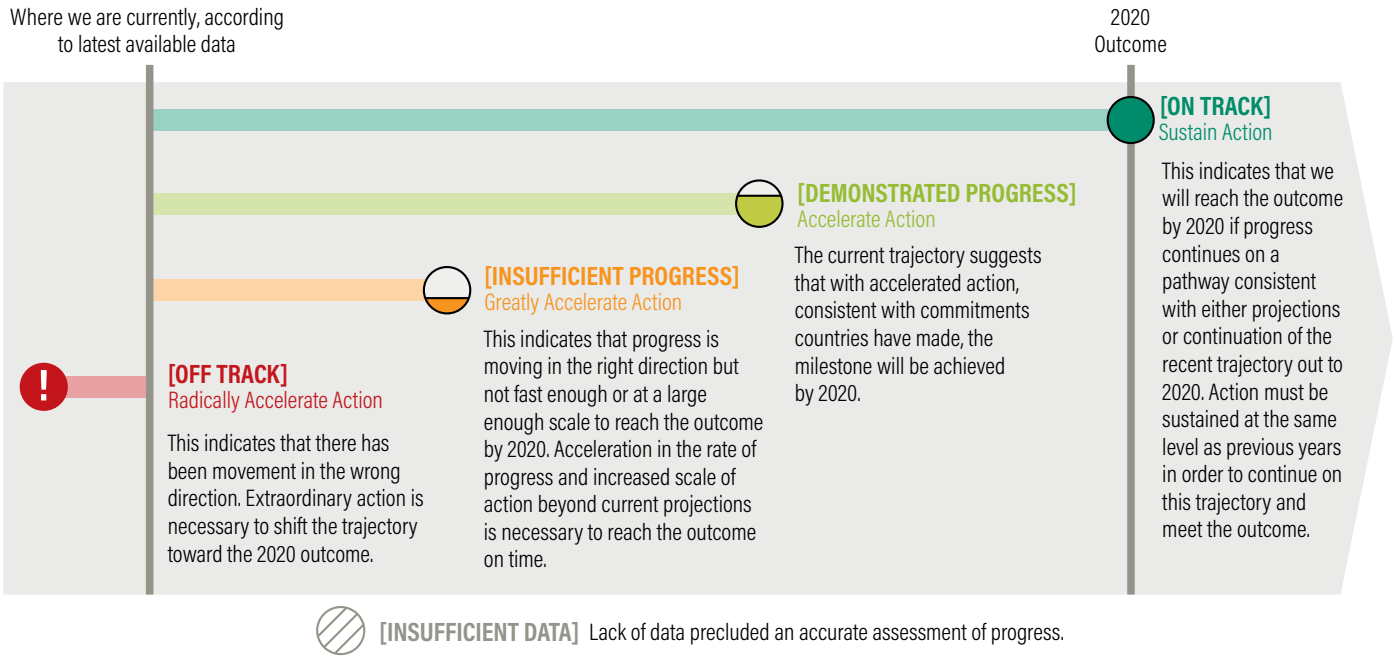
- **Progress is uneven across the six milestones: For some underlying outcomes in several milestones, action has been progressing and accelerating. However, in most cases action is insufficient or progress is off track (see Figure ES-1 and ES-2).**

- **Tremendous opportunities to scale up and accelerate action remain untapped across all sectors.** For almost all milestones and outcomes, the opportunities must be harnessed quickly if these goals are to stay within reach. Countries also have the opportunity to enhance their commitments, or nationally determined contributions (NDCs), by 2020, under the Paris Agreement, which can catalyze action in the short term to avoid lock-in of an emissions-intensive pathway in the longer term. These updated NDCs will in turn need to translate into changes in policy, actions, and investments. Related opportunities are highlighted throughout this report.

- **More transparent tracking of progress is needed across many areas.** Greater transparency and monitoring systems will allow us to more accurately track progress across all of the sector milestones. Our ability to track progress toward these milestones is limited by data availability. In some cases, there are data lags that may not accurately capture the action on the ground today, and it can take time for recent commitments to take effect. Generally, the completeness and lag in available data may distort the current evaluation of progress. In other cases, insufficient data impede any endeavor to assess progress toward reaching some milestones. Efforts are needed to increase transparency and generate necessary data to hold countries, companies, and regions accountable to achieving any individual commitments they have made that contribute to the milestones. Establishment of tracking systems can bring significant benefits and help identify opportunities, adjust existing plans, and guide the adoption of new actions.

Below are key findings for each of the outcomes under the six milestones (see Figure ES-2).

Figure ES-1 | **Explanation of Progress Designations to Achieve the Outcomes**



## 2020 ENERGY MILESTONE:
## Renewables outcompete fossil fuels as new electricity sources worldwide

The past decade has seen a remarkable shift toward electricity generation from renewable sources and away from fossil fuels, especially coal plants. This shift has been driven by rapidly declining costs and increased utilization rates of renewable generation technologies, making coal-fired power an uneconomic choice in many regions. In 2017 renewables accounted for the majority of new power-generating capacity added worldwide (IEA 2018f), a significant turnaround from just a decade ago. Deployment of renewables is growing fastest in developing nations, with new-build additions rising 20.4 percent year-on-year in these countries (BNEF 2018c).

Moving away from fossil fuels improves health outcomes, reduces healthcare costs, reduces climate impacts, contributes to emissions reduction goals, and provides more jobs than fossil fuels, among many other benefits (NCE 2018). The International Renewable Energy Agency (IRENA 2018a) estimates that benefits from a long-term energy transition would yield cost savings of $6 trillion annually by 2050 just from reduced air pollution, better health, and reduced environmental damage. Achieving this milestone would mean:

Renewables make up at least 30 percent of the world's electricity supply:
**[DEMONSTRATED PROGRESS]** Accelerate Action

Global renewable electricity generation reached 25 percent in 2017 and renewable energy accounted for more than two-thirds of net capacity growth added to meet new electricity demand (IEA 2018b; REN21 2018). Combined with recent analysis that finds renewable sources will be cost competitive with most fossil fuel power generation by 2020 (IRENA 2018b), the 30 percent share advised by the 2020 milestone is tentatively within reach if current trends accelerate. Given that past projections have typically underestimated the rapid growth of renewable energy, it is possible that projections made today could similarly underestimate future progress.

Recent shifts in renewable generation have been driven largely by cost declines, like that of solar photovoltaic (PV), which has seen an 81 percent price decline for modules since 2009 (REN 21 2018).

Private sector movement to divest from the fossil fuels, direct engagement efforts such as Climate Action 100+, commitments like those made by companies to use 100 percent renewable power through RE100 and increased interest in climate-related financial disclosures are all expected to help accelerate these trends. Seventeen countries were already producing more than 90 percent of their electricity from renewable sources (including hydropower) in 2017, providing a strong example of what is possible for other countries to follow (REN21 2018).

No new coal-fired power plants being built:
**[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

All existing coal-fired power plants are in the process of being retired:
**[OFF TRACK]** Radically Accelerate Action

The growth of new installed capacity of coal-fired power plants has been slowing down globally—65 gigawatts (GW) of coal power capacity were added in 2017 compared to 107 GW in 2015 (CoalSwarm 2018). At the same time, the rate of coal retirement has increased, from around 2 GW in 2006 to more than 28 GW in 2017 (CoalSwarm 2018). Coal plant retirements have accelerated in parts of the developed world, while progress is more uneven in the developing world; however, in net terms coal capacity is still being added.

Many governments have recognized that the economics of coal power—combined with falling costs for renewable technology, national goals for climate action, preservation of air quality, and quantification of public health costs—make new coal power economically and socially unfavorable compared to renewable energy (IRENA 2018b)

Eighty national and subnational governments and businesses have joined the Powering Past Coal Alliance (PPCA 2018), committing to phasing out coal power and supporting clean power generation. Additionally, at least 19 major banks have declined further financial support for new coal plants (Banktrack 2018). All told, nearly 1,000 institutional investors with more than $6 trillion in assets have committed to divesting from fossil fuels, up from just $52 billion four years ago (Arabella Advisors 2018).

## OPTIONS FOR 2020 NDC ENHANCEMENT: **ENERGY**

The energy sector has been included in virtually all NDCs, whether economy-wide targets, sectoral targets, or policies and actions. Over 130 Parties mention renewable energy actions and plans in their NDCs, and 89 include a quantitative target related to renewable energy (ClimateWatch 2018). With enhanced or updated NDCs coming by 2020, countries that do not currently have specific targets for renewable energy should consider adding them. Those with targets already outlined should increase their ambition and outline specific actions or policies to achieve these targets, including for closure of coal plants and cancellation of planned capacity, expansion of energy storage and distributed renewable energy, support of renewable energy generation, and creation of favorable conditions for continued sustainable energy transitions, through commitments to reduce fossil fuel subsidies, for example.

## 2020 TRANSPORT MILESTONE:
## Zero-emissions transport is the preferred form of all new mobility in the world's major cities and transport routes

Transportation accounts for over 15 percent of global emissions, with international bunker fuels responsible for an additional 3 percent (WRI 2017). In addition to being a crucial step toward meeting the goals of the Paris Agreement, transitioning to zero-emissions transport brings significant benefits, including lowering levels of particulate matter, which leads to improved air quality and the prevention of premature deaths. Achieving this milestone would mean:

Electric vehicles account for 15–20 percent of new car sales globally:
**[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Global annual sales of electric vehicles (EVs) grew exponentially—by 54 percent—in a single year, reaching a record of 1.1 million in 2017 (IEA 2018d), with 4 million EVs on the road in 2018 (BNEF 2018d). However, the share of EVs in global sales of new vehicles was just 1.4 percent, and EVs are projected to only account for 3 percent of new car sales in 2020 (BNEF 2018b), falling very short of the outcome.

Announcements and targets have been made by 66 countries, 71 cities or regions, and 48 companies toward phasing out internal combustion engines and shifting to additional zero-emissions vehicles. Twenty-three automobile manufacturers have also been introducing electric car models and EV sales targets (SLoCaT 2018). Many new EV commitments have been made in the last year, such as the Zero Emissions Vehicle (ZEV) Challenge by over 60 partners, including subnational states and regions, businesses, and cities. Additionally, strong policy signals, such as those sent in China and Norway, have shown that it is possible to boost EV sales significantly.

Heavy-duty vehicle efficiency standards are 20 percent higher across all major economies; transport routes in major cities are operated with zero-emissions modes:
**[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Reduction in the average fuel consumption of new heavy-duty vehicles (HDVs), through various areas of efficiency improvement, can save millions of barrels of oil per day, in addition to saving emissions (GFEI 2017). Yet only 50 percent of HDV sales are covered by fuel economy and emissions standards (IEA 2017c), and only five countries have HDV fuel economy regulations in place. While more major economies are now considering such regulations, we are not on track to achieving efficiency standards for HDVs that are 20 percent higher across all major economies.

Regarding zero-emissions transport routes, pioneering leaders from 26 cities, with a combined population of over 125 million, have joined the C40 Fossil-Fuel-Free Streets Declaration (C40 2018a), which could drive demand for electric HDVs. Modal shift to rail freight also provides an alternative to heavy duty vehicles. Action needs to be rapidly accelerated if the outcome is to be reached. Realizing such an outcome lessens air pollution and brings significant health benefits.

Public transport doubles its market share:
**[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

In 2015, the share of public transport of trips taken globally was 19 percent, falling short of the 32 percent outcome (the goal to double 2005 market share). The share also differs significantly by region, ranging from 7 percent in North America, 22 percent in Latin America, and over 27 percent in Africa (OECD 2017). Action to reach this outcome needs to be accelerated if it is to be met in 2020.

Providing convenient access to public transportation improves road safety, assists vulnerable populations, and saves millions of barrels of oil. It also improves access to employment opportunities and expands the supply of urban land, thereby driving down housing costs (NCE 2018).

The aviation sector reduces total emissions per kilometer traveled by 20 percent below 2013 levels:
**[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Energy intensity, which was used in this report to calculate trends in emissions intensity given a lack of data, has fallen by 4.5 percent between 2013 and 2015. An accelerated rate is needed to reach 20 percent reduction by 2020.

Members of the International Air Transport Association (IATA) and the International Civil Aviation Organization (ICAO) recently announced new initiatives to reduce emissions and improve efficiency, which can be built upon.

The shipping sector announces plans for market measures or other instruments to eliminate emissions from their sector: **[ON TRACK]** Sustain Action

The International Maritime Organization (IMO) recently announced its initial strategy for reducing carbon emissions at least 50 percent by 2050 compared to 2007 levels, for phasing out emissions in this century, and for putting itself on a trajectory consistent with Paris Agreement temperature goals (IMO 2018). Additionally, Maersk, the world's biggest shipping company, announced a goal to be carbon-neutral by 2050.

## OPTIONS FOR 2020 NDC ENHANCEMENT: **TRANSPORT**

One hundred and seven NDCs include transportation actions targeting fleet efficiency, fuel use, transit-oriented planning, and more. Thirty-two NDCs include public transportation actions, 6 mention actions on aviation, and 4 include maritime emissions. Thirty-six NDCs include quantified mitigation targets for transport, of which 13 specify emissions-reduction targets. Seven include targets for public transport, and 5 for electric vehicles (ClimateWatch 2018). Countries should specify further transport actions, including regarding aviation and maritime shipping at the national level, and increase the stringency of existing targets.

These plans would benefit from being further formalized through transparent data collection efforts such as the IMO's data collection system, complemented by concrete actions to achieve goals even earlier. In addition, countries can adopt initiatives and actions that complement and facilitate IMO action.

### 2020 LAND USE MILESTONE:
### Large-scale deforestation is replaced with large-scale land restoration, and agriculture shifts to earth-friendly practices

Reducing deforestation and degradation, accelerating restoration, and boosting crop and pasture yields to increase food production, without further agricultural land expansion, are critical for reducing emissions and maintaining ecosystem services. However, at present, land use—both agriculture and forests—is a major contributor to global GHG emissions. Achieving this milestone would mean:

The world's nations, civil society institutions, and corporations act to end net deforestation by the 2020s, putting us on a path to reducing emissions from forestry and other land use 95 percent below 2010 levels by 2030:

Net natural forest loss:
**[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Gross tree cover loss:
**[OFF TRACK]** Radically Accelerate Action

Net natural forest loss has declined in recent years while gross tree cover loss has increased (FAO 2018; Hansen et al. 2018). Net numbers count naturally reforested areas as offsetting forest loss in another location, whereas gross tree cover loss counts regrowth and loss separately. Looking just at net numbers can be misleading since forest loss in one place cannot always be counted as equivalent to regrowth in another. A more careful examination of the drivers and locations of gross forest loss shows we are not moving in the right direction regarding deforestation as a whole, even though net natural forest loss is declining. Reflecting the difference between net and gross numbers, net emissions from deforestation have declined to just over 3 gigatons of carbon dioxide equivalent ($GtCO_2e$) in 2016 (FAO 2018), while gross emissions have increased.

Forests provide critical ecosystem services, including protection from extreme disasters such as floods and droughts, provision of food and fiber, and protection of biodiversity. If further deforestation is avoided, the global economy would be boosted by at least US$40–80 billion per year (NCE 2018).

Nearly 500 companies have committed to reducing or eliminating supply-chain driven deforestation by different target dates (Supply Change 2018). Among companies with exposure to commodities in their supply chains, those with commitments account for at least twice the revenue of those without (Donofrio et al. 2017).

Restore and conserve at least 150 million hectares of degraded land, enhancing biodiversity and building ecosystem resilience: **[INSUFFICIENT DATA]**

Under the Bonn Challenge—a global effort to bring 150 million hectares (Mha) into restoration by 2020–32 national and subnational actors have thus far committed to restoring 94 Mha. While progress has only been assessed in six jurisdictions so far, analysis shows that less than half of the committed hectares has been restored (23.2 Mha restored of 53.2 Mha pledged among those six countries) (IUCN 2017). As comprehensive data to track progress across all jurisdictions have yet to be collected and published, these values are underestimating progress to date, but the subset of data currently available shows we may not be on track to reach the 2020 milestone.

Restoration can provide new income streams that could boost smallholders' incomes in developing countries by $35–40 billion per year within the next 15 years (NCE 2018). It is estimated that meeting the adopted 150 Mha restoration outcome alone would bring $85 billion per year in net benefits (Ding et al. 2017).

Ramp up the implementation of sustainable agricultural practices that reduce $CO_2$ emissions, increase $CO_2$ removals, and halt the growth in non-$CO_2$ emissions:

Practices to reduce $CO_2$ and non-$CO_2$ emissions:
**[OFF TRACK]** Radically Accelerate Action

Practices to increase $CO_2$ removals:
**[INSUFFICIENT DATA]**

Direct emissions from agriculture, of which nearly all are non-$CO_2$ emissions, have increased from 4.6 $GtCO_2e$ in 2000 to 5.3 $GtCO_2e$ in 2016. Indirect emissions from agriculture, which include $CO_2$ emissions, are counted in other sectors and not tracked in this report. While some efforts to enhance carbon removals on farms, through soil management or cover cropping, are starting to take shape, global data tracking uptake are not available. To halt growth in direct agricultural emissions by 2020, progress must be greatly accelerated to bend the trajectory of agricultural emissions downward (FAO 2018).

On the supply side, focusing on increasing agricultural productivity without expanding land can yield direct benefits while lessening the impact on forests, and initiatives like 4 per 1000 are working to improve soil quality. On the demand side, initiatives like Champions 12.3 and shifting diets are aimed at reducing growth in demand for agricultural products and providing a foundation for scaling up action in this sector. Additionally, over 40 companies involved in the food supply chain have committed to science-based targets to reduce their emissions (SBT 2018).

## OPTIONS FOR 2020 NDC ENHANCEMENT: **LAND USE**

Over 150 NDCs consider land use–related mitigation options, such as reforestation or afforestation, under their GHG reduction targets, with 124 referencing ongoing or planned efforts in the forest sector; however, only 58 of those include quantitative forest sector targets (ClimateWatch 2018).

As countries enhance or update NDCs by 2020, they should strengthen their commitments around forests and land use by laying out specific quantitative targets or by strengthening existing quantitative targets through enhancing ambition and/or specifying policies or actions to create the conditions for achieving those targets, including mobilizing finance to protect forested areas or improving monitoring programs to track impact.

For agriculture, governments can commit to reforming inefficient and environmentally harmful agricultural subsidies, and to aligning fiscal and policy incentives to encourage earth-friendly agriculture, among other solutions. Investments in smallholders could spare millions of hectares from deforestation (WEF 2017).

## 2020 INDUSTRY MILESTONE:
## Heavy industry—including iron and steel, cement, chemicals, and oil and gas—commits to being Paris-compliant

Heavy industries, such as iron and steel, cement, chemicals, and oil and gas, are energy intensive and collectively responsible for around a quarter of global $CO_2$ emissions (IEA 2018d). Emissions from industrial processing itself have increased almost twofold compared to 1990 levels (Gütschow et al. 2018), although the rate of growth has slowed in recent years (IEA 2018d). If no further actions are taken, emissions from the industrial sector are expected to continue to increase to over 17 percent higher than 2016 levels in 2050 (IEA 2017a).

Mitigation opportunities, however, exist on many fronts. Recent analysis has found that it is technically and economically feasible for chemicals, steel, and cement to reach net zero emissions by midcentury at a cost of less than 0.5 percent of global gross domestic product (ETC 2018). Achieving this milestone would mean:

Heavy industry firms have developed, published, and begun implementing roadmaps for their transition to a decarbonized economy in 2050:

Heavy industry firms have developed and published roadmaps: **[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Heavy industry firms have begun implementing roadmaps: **[INSUFFICIENT DATA]**

Various international efforts are under way to support companies, including heavy industry firms, in setting short- and long-term goals and related planning. For example, nearly 300 heavy industry companies[1] in the industrial, materials, and energy sectors have registered 677 cooperative and individual actions in the Global Climate Action portal of the United Nations Framework Convention on Climate Change (UNFCCC 2018), committing to various initiatives such as Science Based Targets (SBTs), the Low Carbon Technology Partnerships initiative (LCTPi), and RE100 for 100 percent renewable power, among others. Roadmaps with clear timelines and milestones, coupled with transparent systems to track progress, can support implementation and realization of the commitments.

Increased energy and material efficiency of heavy industry processes also bring benefits such as energy savings, reduced production costs, and increased jobs. Technology innovations also can bring new economic opportunities and environmental benefits (NCE 2018).

Heavy industries are increasing their energy, emission, and material efficiencies and are on a trajectory to halve emissions by 2050 using science-based targets: **[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Positive steps have been taken in heavy industries. For example, the global carbon intensity of cement production leveled off between 2014 and 2016 (IEA 2018d). By deploying energy and material efficiency measures and best available technologies, emissions could be kept at a level below current levels through 2060 (IEA 2017a). For a trajectory to halve emissions by 2050 and to reach a Paris-compliant scenario, or limit warming even lower, switching to low-carbon fuels and innovative low-carbon technologies such as low-carbon hydrogen generation, solar thermal for alumina refining, and carbon capture and sequestration (CCS) will be needed in the longer term (IEA 2017a). Those innovative technologies are at various stages, ranging from under research and development to commercially available. Advancing those technologies and making them available in the long-term require significant investment in research, development, demonstration, and deployment, as well as a policy push to remove institutional barriers in the short term.

### OPTIONS FOR 2020 NDC ENHANCEMENT: **INDUSTRY**

Around 40 NDCs include actions and plans in relation to heavy industries, such as cement, chemicals, iron, and steel. Only 15 NDCs include quantitative targets related to heavy industry, such as reductions in the sector's emissions and increased share of additives in cement production (ClimateWatch 2018). While companies have a major role to play in decarbonizing heavy industries, momentum can be created and complemented by specifying actions and policies in NDCs. Countries should drive accelerated actions by nonstate actors in heavy industry sectors, advancing policies such as carbon pricing material and efficiency mandates.

In addition, 26 heavy industry companies have committed to establishing science-based targets (SBT 2018), and 5 of these have approved targets.[2] No sufficient public accessible data exist to assess the magnitude of those targets, such as the share of emissions in the industry sector by those companies, or how they add up and compare to a trajectory of halving emissions by 2050.

## 2020 INFRASTRUCTURE MILESTONE: Cities and states are implementing policies and regulations to fully decarbonize buildings and infrastructure by 2050

Infrastructure construction and operation, including electricity generation and distribution, industry, buildings, and transport systems, account for 70 percent of global GHG emissions (World Bank 2018b). Investing in low-carbon infrastructure can help mitigate GHG emissions, reduce air pollution, and improve traffic congestion. Expansion of infrastructure related to adaptation, such as seawalls and flood protection, will also help increase climate resilience and reduce vulnerability.

Cities and states have been increasingly making commitments toward decarbonizing infrastructure and buildings (C40 2018b). Over 9,000 cities registered actions on the UNFCCC's Global Climate Action portal (UNFCCC 2018). More than 70 mayors have committed to developing and implementing climate action plans by 2020 and to becoming emissions-neutral by no later than 2050. While these commitments extend beyond just buildings and infrastructure, many of them include related actions. Additionally, 815 cities signed the One Planet Charter (Global Covenant of Mayors 2018) to reinforce their commitments and take continued actions to reach zero-emissions buildings and zero-waste objectives. National governments will also play an important role in policy development, finance, capacity building, and other measures to build an enabling environment for further action. Achieving this milestone would mean:

At least $300 billion is invested annually to support infrastructure decarbonization, in addition to the necessary $6 trillion in annual business-as-usual infrastructure: **[INSUFFICIENT DATA]**

Investment in low-carbon infrastructure is likely not commensurate with what is needed to meet the 2020 outcome. In 2017, the multilateral development banks (MDBs) reached a record high of $32.5 billion in climate finance,[3] a 20 percent increase from the previous year.

Those same projects also attracted cofinancing of over $50 billion (MDBs 2018), of which approximately $11.5 billion was dedicated to infrastructure financing (Meltzer 2018). There are not enough data to know how much investment occurred beyond the MDBs, making it impossible to assess progress. However, if the MDBs are a significant percentage of finance to support infrastructure decarbonization, progress may very likely be insufficient. Developed countries are encouraged to fulfill their international pledges, and the private sector will need to increase investment while public financing continues to de-risk those projects.

Investing in sustainable infrastructure is not necessarily costly and can be achieved without compromising economic development (NCE 2014). Failure to invest in low-carbon technologies for infrastructure can cause lock-in to a higher emissions pathway as these assets have long lifespans.

New buildings are built to zero or near-zero energy standards: **[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

The number of zero-energy buildings has been growing exponentially, with over 700 percent more since 2012 in the United States and Canada. However, high-performance buildings such as near-zero-energy buildings account for less than 5 percent of construction in most markets today (IEA 2018d), and still well less than 1 percent of the global building stock (Laski and Burrows 2017).

However, there has been movement recently. For example, the World Green Building Council's Net Zero Carbon Building Commitment (WorldGBC 2018) has 44 signatories from cities, regions, and businesses,[4] committing to all new buildings reaching net zero operating emissions by 2030 and all buildings operating at net zero carbon by 2050.

At least 3 percent of the world's existing building stock, on average, is upgraded to zero- or near-zero-emissions structures annually: **[INSUFFICIENT DATA]**

Existing buildings were retrofitted at an annual rate of around 1–2 percent as of a few years ago (GABC 2016). If this rate has remained unchanged, then retrofits will need to accelerate to 3 percent annually and increase the stringency of upgrades to meet net zero emissions standards to reach 100 percent of zero-energy buildings

in 2050. Less than a third of countries had introduced mandatory building energy codes or building energy certifications in 2017, and only 18 countries have building codes targeted at the existing building stock (IEA 2018a). No publicly available data source has been found to provide a more recent and accurate estimate of the current retrofit rate of the world's existing building stock.

### OPTIONS FOR 2020 NDC ENHANCEMENT: INFRASTRUCTURE

Over 130 NDCs mention the building sector, and 45 of these put forward building-related plans and actions, with 38 including plans and policies that address building efficiency. Only 13 NDCs list specific quantitative mitigation targets such as emissions reductions and demand-side efficiency in buildings (Climate-Watch 2018). Countries should include or complement existing policies in their future NDCs. Furthermore, mentioning more specific actions, targets, and technologies in NDCs—such as new building codes, building envelope improvement, and enhanced heating and cooling efficiency—that are crucial for decarbonizing buildings would create a clearer path for achieving those ambitions.

## 2020 FINANCE MILESTONE: Investment in climate action is beyond $1 trillion per year, and all financial institutions have a disclosed transition strategy

Access to sufficient financing is a prerequisite for scaling mitigation and adaptation action. Public financing for climate has been growing over time and will need to sustain and even accelerate that growth going forward. Private investment also needs to be scaled up and better aligned with climate objectives.

There has been growing interest from the private sector in greater transparency around the climate risks of investments as these risks become more apparent and the opportunity for new and innovative instruments expands. Achieving this milestone would mean:

Invest at least $200 billion of public and $800 billion of private resources in climate action each year:

- Public: **[ON TRACK]** Sustain Action
- Private: **[INSUFFICIENT DATA]**

In 2016, global investment to tackle climate change—covering only a portion of the global flows due to data gaps—is estimated to have totaled between $455 billion[5] and $681 billion, with the high estimate including investment in energy efficiency[6] (Oliver et al. 2018; Watson et al. 2018). While it is possible the $1 trillion outcome will be reached by 2020, especially the public finance component, lack of complete data will make it difficult to tell.

A number of recent initiatives and commitments by both private and public sector entities point to a growing pool of green finance. This growth will need to accelerate to sufficiently finance the transition to a Paris-compliant economy.

Increase the amount of philanthropic funding for the climate movement tenfold from 2016 levels: **[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Twenty-nine philanthropies came together at the Global Climate Action Summit (GCAS) in September 2018 to announce a $4 billion commitment toward climate action over the next five years—the largest commitment ever to climate philanthropy (ClimateWorks 2018). While it falls short of a tenfold increase from 2016 levels, which would be at least $2.6 billion each year,[7] this commitment still represents a significant acceleration in giving compared to recent years. It also does not represent all philanthropic giving toward climate.

In line with the growing commitment to climate evidenced by the $4 billion pledge, a survey of 10 major foundations in the United States and Europe, representing more than $240 million in climate funding per year, found that the majority of foundations have increased their focus on climate and will continue to do so (Foundation Center 2018). Nearly 200 major foundations have also committed to divesting from coal or all fossil fuels (Fossil Free 2018).

Multiply the green bond market annual issuance tenfold from 2016 levels: **[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Growth in green bond issuance has been strong over the past five years, increasing from less than $12 billion in 2013 to $162 billion in 2018. While 2018 saw a leveling off in this growth as compared to 2017, the overall trend reflects strong and growing interest. However, this pace of growth is not fast enough to reach the $810 billion outcome by 2020 (which would represent a tenfold increase over 2016 levels of $81 billion).

For issuers, green bonds provide a means to raise finance for climate friendly projects; for investors, they provide a clear indication of climate consideration as well as increased transparency of the projects and their impact.

In addition to labeled green bonds, there is a larger universe of more than $1 trillion in outstanding bonds from issuers who derive most (75–95 percent) of their revenue from climate-aligned projects, indicating strong potential for expansion of labeling, as well as growth in overall issuance (CBI 2018).

Institutions disclose climate-related financial risks and that credit ratings fully incorporate them: **[INSUFFICIENT DATA]**

Over 500 companies and other organizations with a combined market capitalization of nearly $8 trillion have pledged to support the recommendations of the Task Force on Climate-Related Financial Disclosures (TCFD 2018) since they were published in 2017, and more than 1,000 companies already disclose information on physical or financial risks aligned with TCFD recommendations (CDP and CDSB 2018). Investor demand for credit rating agencies to take environmental, social, and governance risks into consideration is increasing (PRI 2017), and credit rating agencies are increasing their focus on environmental risks, but data are not available to track progress in this area.

Companies and investors need access to complete information to make informed investment decisions. Conversely, credit rating agencies need to fully incorporate climate risks into their ratings in order to provide full information for investors. The importance of this information increases as the effects of climate change become more tangible, with impacts on physical infrastructure as well as on business and profitability through the transition to a greener economy. Direct engagement efforts such as Climate Action 100+, through which nearly 300 investors representing $31 trillion in assets under management have committed to engage with the world's largest GHG emitters to accelerate climate action, are expected to accelerate these trends.

Eliminate fossil fuel subsidies:
**[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Fossil fuel subsidies have declined from $443 billion in 2010 to $373 billion in 2015. However, partial data for just member countries of the Organisation for Economic Co-operation and Development (OECD) in 2016 show a leveling off of this progress (OECD 2018). Member countries of the G7, the G20, the Asia Pacific Economic Cooperation, and the European Union have all continually committed to phasing out fossil fuel subsidies, and while the data show incremental progress at the global scale, movement at the country level is varied. All told, the Global Commission on the Economy and Climate estimates that more than 40 countries partially reduced subsidies for fossil fuels between 2015 and 2017 (NCE 2018).

Progress remains uneven, and subsidies are not currently decreasing fast enough to be eliminated in the next few years. Furthermore, a prolonged economic upswing and lower oil prices mean that reduced subsidies cannot always be attributed to policy but rather are partly due to lower prices spurring less need for subsidization.

Subsidies for coal, oil, and gas essentially act as a negative carbon price, reducing the costs for these polluting substances and taking up funding that could instead be used for other expenditures, including investment in sustainable development.

Cancel capital expenditure for coal, oil, and gas production:
**[INSUFFICIENT DATA]**

While evidence shows a decline in capital expenditures for new fossil fuel extraction projects, particularly new coal mines, no comprehensive data set exists that tracks the cancellation of capital expenditure for all fossil fuel projects globally. Accordingly, it is difficult to track progress toward this milestone. The appetite of commercial and development banks to finance these projects has declined, with many announcing restrictions or total bans on financing of coal mines or other fossil fuel extraction projects (Banktrack 2018). If investments are not shifted, investors stand to lose $1–4 trillion globally when fossil fuel assets become stranded (Mercure et al. 2018).

The shift away from fossil fuels, especially coal, is under way, with effects being felt as renewable energy already outcompetes coal on price in many markets (Benn et al. 2018). Looking ahead, this shift toward renewable energy is expected to continue as technologies advance and costs continue to fall.

Implement a carbon pricing mechanism within and across all major economies: **[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

As of late 2018, 52 national and subnational carbon taxes or emission trading schemes (ETS) had been implemented or were planned for implementation, including 25 ETS and 27 carbon taxes covering 19.5 percent of global GHG emissions, according to the World Bank (World Bank 2018a). This represents a nearly fourfold increase from 10 years ago when 5 percent of emissions were covered. Fourteen of the G20 economies have a national or subnational carbon tax or ETS planned or implemented. Many of these pricing initiatives, however, can increase their prices and expand the scope of their emissions coverage in order to increase their impact.

Well-designed carbon pricing schemes can be set up as revenue-neutral, and proceeds can be redistributed back to households in the form of rebates higher than the cost they incurred (Nuccitelli 2018).

### OPTIONS FOR 2020 NDC ENHANCEMENT: **FINANCE**

Discussion of climate finance in the first NDCs is largely with regard to countries specifying conditional elements of NDCs and describing finance needed to implement their NDCs. However, some countries also mention specific financial mechanisms. Fifteen countries mention the intention to reduce or remove fossil fuel subsidies, but these do not include the countries that provide the bulk of global fossil fuel subsidies (ClimateWatch 2018). Additionally, over 80 mention market-based mechanisms and carbon pricing (DIE 2018). In enhanced or updated NDCs, there is an opportunity to accelerate and increase the ambition of these commitments and include new ones—for example, to halt production of fossil fuel reserves.

We are seeing a shift to a new, more sustainable way of living across all sectors of the economy. Shifts in investments, plummeting costs of clean energy technologies, and increased understanding of climate impacts, with communities connecting the dots between extreme events and human-induced warming, are driving scores of companies and countries to enhance their climate commitments.

Reaching most of the milestones laid out in *2020: The Climate Turning Point* is still technically feasible, but whether they are met depends upon much more concerted policy and investment action, alongside shifts in behavior and mindsets. We are already at the cusp of achieving several of them. However, across the board, we need to deepen action and unlock ambition across all sectors and geographies.

Meeting the milestones outlined in this report is far from easy, but if we are successful, we will have a better chance of peaking global emissions by 2020, our climate turning point (Revill and Harris 2017). Realizing this vision will bring significant economic gains, create more resilient and secure livelihoods, increase job opportunities, ensure our air and water is clean, protect human health, fashion more livable cities, and protect species and ecosystems and the services they provide (NCE 2018). The 2020 turning point will allow us to make this future a reality. It's necessary, desirable, and achievable.

Figure ES-2 | **Summary of Progress toward 2020 Outcomes**

## 2020 ENERGY MILESTONE

### OUTCOMES PROGRESS

- Renewables make up at least 30 percent of the world's electricity supply [DEMONSTRATED PROGRESS]
- No new coal-fired power plants being built [INSUFFICIENT PROGRESS]
- All existing coal-fired power plants are in the process of being retired [OFF TRACK]

## 2020 TRANSPORT MILESTONE

### OUTCOMES PROGRESS

- Electric vehicles account for 15–20% of new car sales globally [INSUFFICIENT PROGRESS]
- Heavy-duty vehicle efficiency standards are 20% higher across all major economies; transport routes in major cities are operated with zero-emissions modes [INSUFFICIENT PROGRESS]
- Public transport doubles its market share [INSUFFICIENT PROGRESS]
- The aviation sector reduces total emissions per kilometer traveled by 20% below 2013 levels [INSUFFICIENT PROGRESS]
- The shipping sector announces plans for market measures or other instruments to eliminate emissions from their sector [ON TRACK]

## 2020 LAND USE MILESTONE

### OUTCOMES PROGRESS

The world's nations, civil society institutions, and corporations act to end net deforestation by the 2020s, putting us on a path to reducing emissions from forestry and other land use 95% below 2010 levels by 2030:

- Net natural forest loss [INSUFFICIENT PROGRESS]
- Gross tree cover loss [OFF TRACK]
- Restore and conserve at least 150 million hectares of degraded land, enhancing biodiversity and building ecosystem resilience [INSUFFICIENT DATA]

Ramp up the implementation of sustainable agricultural practices that reduce $CO_2$ emissions, increase $CO_2$ removals, and halt the growth in non-$CO_2$ emissions:

- Practices to reduce $CO_2$ and non-$CO_2$ emissions [OFF TRACK]
- Practices to increase $CO_2$ removals [INSUFFICIENT DATA]

## 2020 INDUSTRY MILESTONE

### OUTCOMES PROGRESS

Heavy industry firms have developed, published, and begun implementing roadmaps for their transition to a decarbonized economy in 2050:

- Heavy industry firms have developed and published roadmaps [INSUFFICIENT PROGRESS]
- Heavy industry firms have begun implementing roadmaps [INSUFFICIENT DATA]
- Heavy industries are increasing their energy, emission, and material efficiencies and are on a trajectory to halve emissions by 2050 using science-based targets [INSUFFICIENT PROGRESS]

## 2020 INFRASTRUCTURE MILESTONE

### OUTCOMES PROGRESS

- At least USD $300 billion is invested annually to support infrastructure decarbonization, in addition to the necessary $6 trillion in annual business-as-usual infrastructure [INSUFFICIENT DATA]
- New buildings are built to zero or near-zero energy standards [INSUFFICIENT PROGRESS]
- At least 3 percent of the world's existing building stock, on average, is upgraded to zero or near-zero emissions structures annually [INSUFFICIENT DATA]

## 2020 FINANCE MILESTONE

### OUTCOMES PROGRESS

Invest at least $200 billion of public and $800 billion of private resources in climate action each year:

- Public [ON TRACK]
- Private [INSUFFICIENT DATA]
- Increase the amount of philanthropic funding for the climate movement by 10x from 2016 levels [INSUFFICIENT PROGRESS]
- Multiply the green bond market annual issuance by 10x from 2016 levels [INSUFFICIENT PROGRESS]
- Institutions disclose climate-related financial risks and credit ratings fully incorporate them [INSUFFICIENT DATA]
- Eliminate fossil fuel subsidies [INSUFFICIENT PROGRESS]
- Cancel capital expenditure for coal, oil, and gas production [INSUFFICIENT DATA]
- Implement a carbon pricing mechanism within and across all major economies [INSUFFICIENT PROGRESS]

# INTRODUCTION

The latest science suggests that global greenhouse gas (GHG) emissions must reach a turning point by 2020 and decline rapidly thereafter if we are to have a decent chance of meeting the Paris Agreement's goals to limit warming to 1.5˚C (UNEP 2018). Delaying the peak date beyond 2020 will result in higher temperatures and increase risks of lock-in of high-carbon technologies and infrastructure and will decrease our chances of achieving the Sustainable Development Goals (SDGs). This will result in higher costs and will limit options to reduce emissions and adapt to climate impacts. In addition, a later peak date will require unprecedented rates of decarbonization and reliance on unproven technologies at scale to compensate for the delay (Fay et al. 2015; Rogelj et al. 2016), with the resultant risk of overshooting temperature targets.

In April 2017, several climate analytical organizations, including Carbon Tracker, Climate Action Tracker, and Yale University, working together as part of the Mission 2020 campaign, published *2020: The Climate Turning Point* (Revill and Harris 2017). The report outlined what it would take to transition to a low-carbon economy and shift behavior to allow for peaking of emissions by 2020 with a steep decline thereafter. The report outlined six critical milestones across key sectors that would need to be achieved by 2020:

1. ENERGY: Renewables outcompete fossil fuels as new electricity sources worldwide.

2. TRANSPORT: Zero-emissions transport is the preferred form of all new mobility in the world's major cities and transport routes.

3. LAND USE: Large-scale deforestation is replaced with large-scale land restoration, and agriculture shifts to earth-friendly practices.

4. INDUSTRY: Heavy industry—including iron and steel, cement, chemicals, and oil and gas—commits to being Paris-compliant.

5. INFRASTRUCTURE: Cities and states are implementing policies and regulations to fully decarbonize buildings and infrastructure by 2050.

6. FINANCE: Investment in climate action is beyond US$1 trillion per year and all financial institutions have a disclosed transition strategy.

Several underlying outcomes, or targets, were identified for each milestone. These outcomes serve to help steer policymaking, finance, and technology deployment.

The 2017 report made a compelling case that attaining the six milestones and their outcomes is not only necessary for realizing a 2020 climate turning point but also desirable and achievable in the context of economic development and for human well-being. This working paper explores whether efforts are on track to achieve these milestones and what opportunities exist to achieve them.

The paper first turns to an explanation of our methodology and explains our assumptions and research limitations. The sections that follow present the latest data on the six milestones and assess whether action is on track to achieve them. While this paper presents overall progress toward each milestone, the analysis largely focuses on tracking progress toward the underlying outcomes for each of the six milestones. Under each of the milestones, in addition to tracking progress toward the outcomes, we also briefly present options for further action, with a focus on enhancement of countries' commitments under the Paris Agreement, known as nationally determined contributions (NDCs). Countries have been invited under the agreement to update or resubmit their NDCs by 2020, and there are tremendous opportunities to do so, which can send signals to decision-makers in high-emitting sectors, the private sector, and subnational governments to deepen their action and thus reap the benefits of transitioning to a low-carbon society. While implementation of the NDCs will take place over a longer period, beyond the 2020 milestones, enhanced NDCs can send a signal to investors, sectors, cities and states, and other actors that a low-carbon economy is the future and catalyze action accordingly. Lastly, in the conclusion, we reflect on whether we are on track to reach a "Climate Turning Point" in 2020 and shift policy, behavior, finance, and technologies so that global emissions peak by 2020 and steeply decline thereafter.

## Methodology, assumptions, and limitations

**Determining the milestones and outcomes:** For this working paper, the milestones and outcomes from the 2017 report *2020: The Climate Turning Point* (Revill and Harris 2017) are taken as they stand. It was beyond the scope of the analysis to perform any additional analysis on the milestones and their underlying outcomes, or on whether the milestones are still sufficient for achieving the Paris Agreement's temperature goals. Accordingly,

validation of the milestones was not conducted, and the authors have not adjusted the milestones or outcomes. Future research could focus on an evaluation of progress achieved by 2020 and the design of revised targets, in light of the long-term transitions that are required to meet the Paris Agreement's goals.

**Methodology for tracking progress:** The theoretical approach to tracking progress toward the outcomes is reasonably straightforward in most cases.[8] In the case of an outcome framed as a reduction or increase from a historical level of an indicator, we calculate what the percent reduction/increase implies for the target year value of the indicator. For example, if a goal is to double investments, the base year value of investments is multiplied by two. If a goal is to reduce emissions 95 percent relative to 2010 levels by 2020, the target year level of emissions in 2020 is 5 percent of the 2010 levels. Some outcomes are framed as a number that is to be achieved in a target year (e.g., all sales of new cars are held to a standard, or all major economies have a certain type of policy), in which case the target year value of the indicator is already explicit.

In a limited number of cases, the authors add more precision to the milestones' wording so that they can be tracked. For example, if no base year was identified for the goal, and the goal was framed as a reduction or increase of some indicator relative to historical values, we have gone back to the original data source to identify the base year upon which the goal was based. When an original data source cannot be identified, we assume the base year is 2017, when *2020: The Climate Turning Point* was published. In all cases, any further assumptions about our interpretations of the goals and milestones are made explicit in this working paper.

**Data for assessing progress:** In order to track progress toward the goals and milestones, the analysis is limited to the availability of data. In some cases, no data, or limited data, exist to show progress toward a milestone, and this has been noted accordingly.

The following principles were used to identify relevant data sources that we used to track progress:

- Independent of bias
- Open: Data that can be freely used, reused, and redistributed
- Reliable: Peer-reviewed or official government data produced by transparent, established methodologies
- Timely: Frequently updated or most recent, complete data available, to the extent possible
- Cover the largest geographical area possible, ideally global
- Consistent: The data collection approach does not change through the time series
- Long historical record, to the extent possible

When multiple data sets could be used, we have selected the one that meets the most preferred data set attributes. We also verified trends with other data sets to the extent they exist to assess accuracy.

In many cases, there is a lag in the data available, and these data may not reflect the changes in the real economy that are occurring in many jurisdictions. This is a large shortcoming of our ability to track progress, as the current data may not accurately capture the action on the ground, which may be reflected only in the coming years' data. Accordingly, throughout the text we have taken note of other parameters of change to illustrate progress on the ground. Also, while we can document commitments made in the past year, it can take time for these to take effect.

For assessing progress toward some outcomes, we relied upon published projections to understand future trends. When doing so, we chose those that were most up-to-date and relevant to the outcome at hand.

**Designation of progress toward outcomes:** We measured progress toward the achievement of each outcome and categorized each according to whether progress was on track, demonstrated progress, insufficient, or off track. The terms we use are illustrative of broad trends and not necessarily representative of the scale of change needed that may vary significantly within a category. In some cases, data were insufficient to judge progress. See Figure ES-1 for an explanation of progress designations.

It should be noted that some of the outcomes are more challenging to meet than others. For example, some outcomes are with regard to certain actors making pledges to act, while others are related to the results of such pledges (e.g., reduction of GHG emissions).

## ENERGY: RENEWABLES OUTCOMPETE FOSSIL FUELS AS NEW ELECTRICITY SOURCES WORLDWIDE

The past decade has seen a remarkable shift toward electricity generation from renewable sources and away from fossil fuels, especially coal plants. This shift has been driven largely by rapidly declining costs of renewable generation technologies, which now make coal an uneconomic choice in many regions.

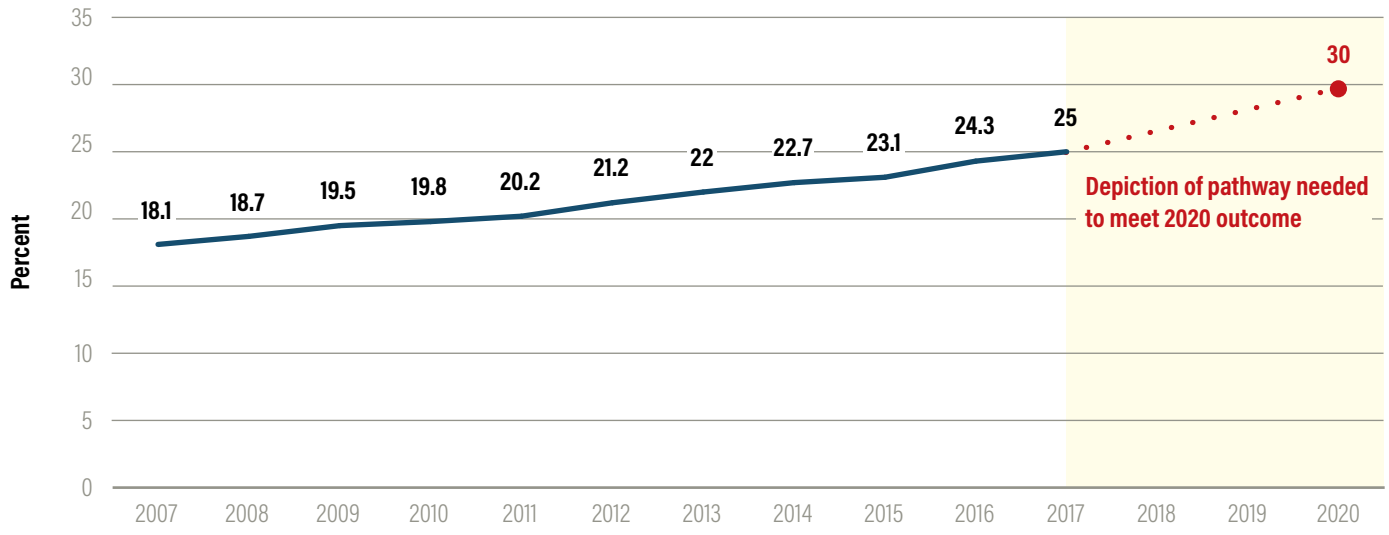
Continuing this shift is not only technically feasible, it is also desirable from an economic and social benefit perspective. Moving away from fossil fuels can improve health outcomes, reduce climate impacts, contribute toward our emission reduction goals, and provide more jobs than fossil fuels, among many other benefits (NCE 2018). The International Renewable Energy Agency (IRENA 2018a) estimates that benefits from a long-term energy transition would yield cost savings of $6 trillion annually by 2050 just from reduced air pollution, better health, and reduced environmental damage.

Renewables make up at least 30 percent of the world's electricity supply:
**[DEMONSTRATED PROGRESS]** Accelerate Action

Twenty-five percent of electricity generation came from renewable sources[9] in 2017, up from 18 percent in 2007, and renewables accounted for more than two-thirds of net capacity growth added to meet new electricity demand in 2017 (IEA 2018b; REN21 2018). Looking ahead, IRENA (2018b) estimates that by 2020, electricity generated from renewables will be consistently cheaper than electricity from most fossil fuels, indicating we are approaching a tipping point in the global electricity system transition.

In 2015, the International Energy Agency (IEA) projected that by 2020 renewable sources could supply 26 percent of electricity generation (up from 22 percent in 2013), which has nearly been met two years early. Based on global scenarios by the Joint Global Change Research Institute, renewable electricity production could reach up to 29.7 percent[10] by 2020 if we rapidly increase ambition (Fawcett et al. 2015). Combined with IRENA's estimation that electricity from renewables will outcompete most fossil fuel generation in most places by 2020, the 30 percent by 2020 outcome can be within reach only if deployment of renewable sources accelerates (see Figure 1.1).

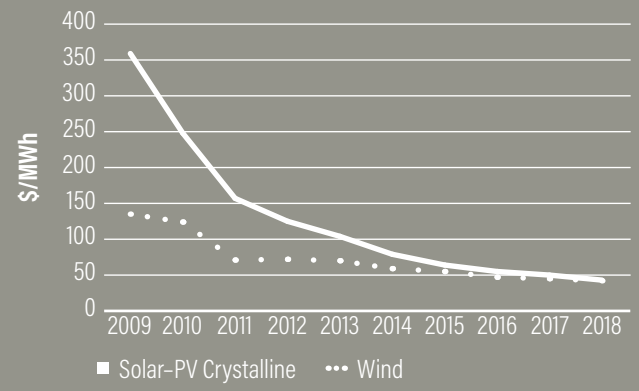
Figure 1.1 | **Renewable Energy as a Percentage of Electricity Generation**




*Source:* IEA (2018d).

## Box 1.1 | Declining Costs of Renewable Energy Generation Technologies

The reduction in the cost of renewables has been an incredible success story and a major driver of their increased competitiveness and deployment. Solar PV prices have declined most dramatically, with an 81 percent decrease in solar PV module prices since the end of 2009. In auctions for renewable power, a key indicator for the competitiveness of different generation sources, onshore wind power is already one of the most competitive sources in Brazil, Canada, Germany, India, Mexico, Morocco, and parts of the United States. Notably, although the absolute investment in renewable power was lower in 2017 than in 2016, the capacity of installations was higher, due to the rapidly falling costs (REN21 2018).




*Source:* Lazard (2018).

Installed capacity of renewables saw its biggest jump ever in 2017, increasing nearly 9 percent over 2016, and more capacity was added just in solar photovoltaic (PV) than net fossil fuel and nuclear additions combined (REN21 2018). Much of this progress is driven by rapid declines in costs of generation technology, of which solar PV is a particularly remarkable case (see Box 1.1).[11] The growth of renewables has surpassed many expectations, but accelerating this momentum is necessary as electricity demand continues to grow and other sectors of the economy, such as transport and heating and cooling, move toward greater electrification. Investment in renewable energy continues to grow, up 3 percent in 2017, even as costs of renewable energy decline (BNEF 2018a) (see Box 1.1).

India and China are the main drivers of increasing global power demand and are both major investors in renewable energy sources. In 2017, China accounted for 40 percent of clean energy investment, and investment in India is expected to increase to pursue ambitious solar and wind targets of 100 GW and 75 GW, respectively, by 2022; in total, developing nations saw 20.4 percent year-on-year growth in new clean energy deployment (BNEF 2018a, 2018c). Finally, 17 countries were already producing more than 90 percent of their electricity with renewable sources (including hydropower) in 2017, providing proof of success that other countries can look to (REN21 2018).

While investment in renewable energy grows, governments must continue to push forward concurrent efforts to create favorable conditions for its continued expansion, including working to reduce and ultimately eliminate fossil fuel subsidies, which were estimated to be double those of renewable energy in 2016 (NCE 2018). Private sector movement to divest from fossil fuels, direct engagement efforts such as Climate Action 100+, commitments like those made by companies to use 100 percent renewable power through RE100, and increased interest in climate-related financial disclosures are all expected to help accelerate these trends.

No New Coal-Fired Power Plants Being Built, and All Existing Coal-Fired Power Plants Already in the Process of Being Retired:

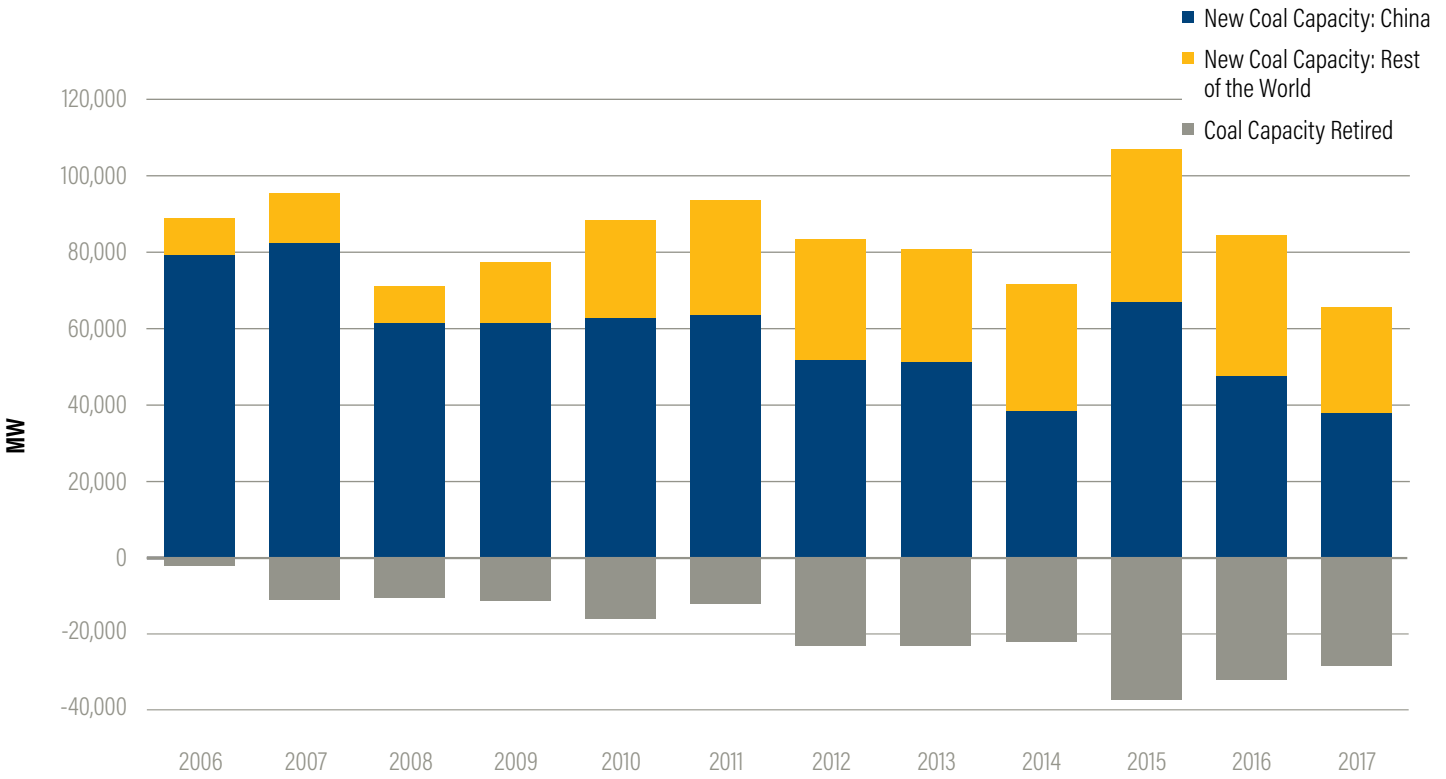
No new coal-fired power plants being built:
**[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

All existing coal-fired power plants are in the process of being retired:
**[OFF TRACK]** Radically Accelerate Action

The growth of new coal-fired power plant capacity has been slowing globally—65 GW of coal power capacity were added in 2017[12] compared to 107 GW in 2015—and the rate of coal retirement has increased from around 2 GW in 2006 to more than 28 GW in 2017 (CoalSwarm 2018). These trend lines are both moving in the right direction but not quickly enough to meet the 2020 outcomes.

Focusing on the outcome of no new coal plants being built, as of July 2018, 365 GW of coal plants, mostly in Asia, were identified as still in the planning phase.[13] However, there is no guarantee that these will all move ahead—only 3 percent, or 12.5 GW, entered the approval process in the first half of 2018, while an additional 106 GW of

Figure 1.2 | **New and Retired Coal Capacity by Year**




*Source:* CoalSwarm (2018).

previously planned plants were canceled (Nace 2018; see Figure 1.2). The pipeline of coal plants in preconstruction and construction has been declining significantly not only in China and India but also in the rest of the world, from 1,428 GW globally in 2016 to 659 GW in 2018 (Shearer et al. 2018).

In terms of retiring existing plants, it appears unlikely that by 2020 all existing coal-fired power plants will be in the process of being retired. Over 2,000 GW of coal capacity are in operation globally (CoalSwarm 2018), and much of this capacity is far from the end of its lifespan, which presents a significant barrier to achieving this outcome.

Global coal generation declined in 2015 and 2016 but rebounded by 3 percent[14] in 2017, mainly due to increases in demand for power in India and China. The IEA (2018d) expects that this trend puts us off track for the Sustainable Development Scenario, which is consistent with limiting warming to 1.7–1.8˚C.

Many governments have recognized that the economics of coal power, combined with falling costs for renewable technology, national goals for climate action, preservation of air quality, and quantification of public health costs, make new coal power unfavorable compared to renewable energy (IRENA 2018b). However, despite its drawbacks, moving away from coal can be challenging as it is entrenched politically, socially, and technologically in many countries. Additionally, countries that are working to expand access to electricity are expected to continue to rely on coal to some extent, although the percentage of renewable sources used to provide electricity access has increased. From 2000 to 2012, 28 percent of people who gained access to electricity did so via renewable sources; since 2012 that figure has increased to 34 percent, and it could reach 60 percent by 2030 (IEA 2017f).

A few countries, especially China and India, are responsible for the bulk of growth in coal demand in recent years. This growth in Asia has offset flattening or declining energy demand in much of the developed world (IEA 2017d), where coal plant closures have been reaching record highs (BNEF 2018e; Marcacci 2018). At the same

time, India and China are also some of the biggest investors in renewable energy. Restrictions put in place in China in 2016 and 2017 led to 444 GW of coal capacity being suspended, and in India 65 percent of the country's existing coal power capacity is no longer competitive with new tariff bids on solar and wind power.

Political and private sector will to move away from coal are growing: 80 national and subnational governments and businesses have joined the Powering Past Coal Alliance (PPCA 2018), committing to phasing out coal power and supporting clean power generation. Additionally, at least 19 major banks have declined further financial support for new coal plants (Banktrack 2018). The European Bank for Reconstruction and Development announced in December that it will no longer finance coal (Kynge and Hook 2018), and the World Bank recently declined funding for a major coal-fired power plant in Kosovo (see Box 1.2). All told, nearly 1,000 institutional investors with more than $6 trillion in assets have committed to divest from fossil fuels, up from just $52 billion four years ago (Arabella Advisors 2018).

In sum, while coal plant closure and slowing approval trends are encouraging, coal capacity additions currently outweigh coal capacity retirements. Progress across different economies is also uneven, with the developing world, which drives most continued coal demand, also leading the charge on renewable energy deployment. Developing economies have steadily increased the share of renewable sources in total electricity capacity additions to reach more than half in 2017, up from just 14 percent in 2012 (BNEF 2018c), indicating a growing movement away from coal.

Box 1.2 | **World Bank Removes Support for Kosovo Coal Plant**

In October 2018, the World Bank decided not to go forward with support for a 500 MW coal-fired power plant in Kosovo, a decision driven by the mandate that the bank follow the lowest-cost option, which is no longer coal-powered generation. The plant in Kosovo was the last coal-fired power plant under consideration for funding by the bank after it revised its policies in 2013 to no longer provide coal financing except in exceptional circumstances.

## OPTIONS FOR 2020 NDC ENHANCEMENT: ENERGY

The energy sector has been included in virtually all NDCs, whether economy-wide targets, sectoral targets, or policies and actions. Over 130 Parties mention renewable energy actions and plans in their NDCs, and 89 include a quantitative target related to renewable energy (ClimateWatch 2018).

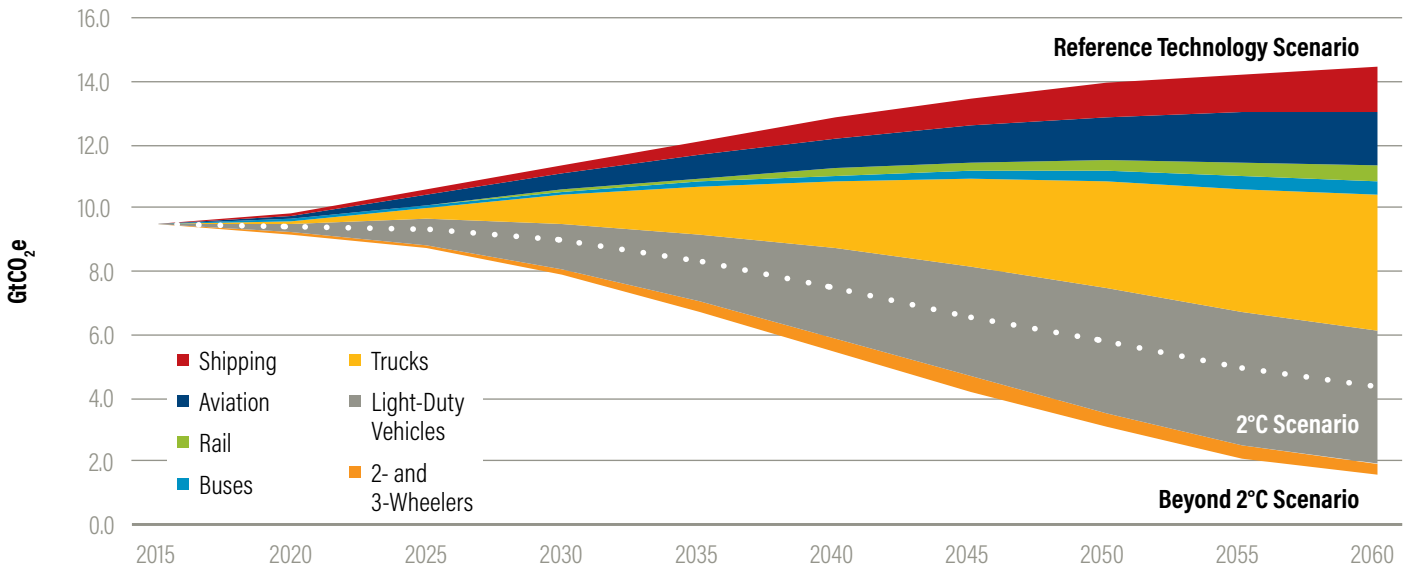
With enhanced or updated NDCs coming by 2020, countries that do not currently have specific targets for renewable energy should consider adding them. Those with targets already outlined should increase their ambition and outline specific actions or policies to achieve these targets, including for closure of coal plants and cancellation of planned capacity, expansion of energy storage and distributed renewable energy, support of renewable energy generation, and creation of favorable conditions for continued sustainable energy transitions, through commitments to reduce fossil fuel subsidies, for example.

## TRANSPORT: ZERO-EMISSIONS TRANSPORT IS THE PREFERRED FORM OF ALL NEW MOBILITY IN THE WORLD'S MAJOR CITIES AND TRANSPORT ROUTES

Transportation accounts for over 15 percent of global emissions, with international bunker fuels responsible for an additional 3 percent (ClimateWatch 2018). The rate of growth in transportation emissions has slowed in recent years (0.6% in 2017 compared to 1.7% in the past decade) due to efficiency improvements, electrification, and alternative fuels. For a Paris-compatible trajectory,[15] IEA (2018d) modeling suggests that transportation emissions need to peak around 2020.

Transitioning to zero-emissions transport is a crucial step toward a Paris-compatible future. It can also bring significant benefits: a recent study estimated that actions from 96 C40 cities across various sectors can lead to an 87 percent decrease in GHG emissions, a 49 percent drop in particulate matter (PM2.5), and the prevention of 223,000 premature deaths per year (C40 2018c). Uptake of electric vehicles has been one of the major solutions

Figure 2.1 | **Decarbonization Pathways for the Transport Sector**




*Note:* The Beyond 2°C scenario (B2DS) is a pathway consistent with a 50 percent chance of limiting average global temperature increase to 1.75°C by 2100. The 2°C scenario (2DS) is consistent with a 50 percent chance of limiting average global temperature increase to 2°C by 2100. The Reference Technology scenario (RTS) takes into account current and announced commitments in countries' nationally determined contributions (NDCs) under the Paris Agreement.

*Source:* IEA (2017a).

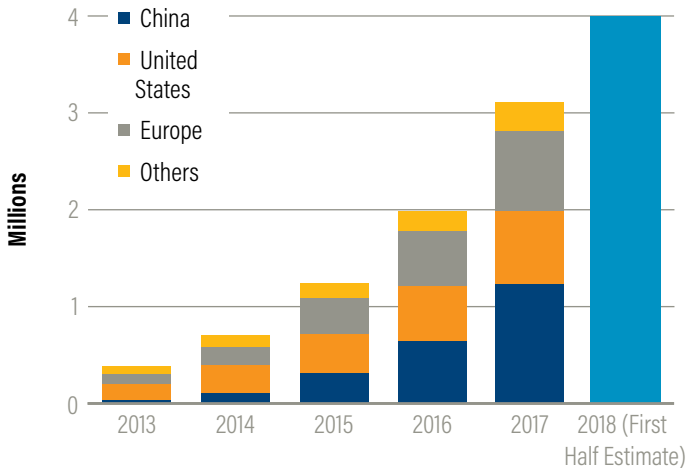
for decarbonizing the transport sector (see Figure 2.1), including light-duty and heavy-duty road vehicles alike. Decarbonizing aviation and shipping sectors also presents significant mitigation potential, although mitigation can be challenging, as a sizable portion of these activities falls outside national jurisdictions' boundaries. International collective efforts, technology, and rapidly increased fuel efficiency standards are thus crucial.

Electric vehicles account for 15–20 percent of new car sales globally:
**[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Today the global electric vehicle (EV)[16] stock has surpassed 4 million (BNEF 2018d). EV sales have been growing exponentially, with record sales of 1.1 million in 2017 (IEA 2018d) and nearly another million in just the first half of 2018 (see Figure 2.2). The share of EVs in global sales is still comparably small, just 1.4 percent of the almost 80 million total new vehicles sold in 2017 (Scotiabank 2018), and under 2 percent in most global regions (IEA 2018c; BNEF 2018b), which falls significantly short of the outcome of reaching 15–20 percent of global share in 2020.

The outcome is more ambitious than current forecasts. Bloomberg estimates that the share of EVs in global sales will reach just 3 percent in 2020, 11 percent in 2025, and 28 percent in 2030. In absolute numbers, Bloomberg projects EV sales to increase from 1.1 million worldwide in 2017 to 11 million in 2025 and then surge to 30 million in 2030 as the vehicles become less expensive than internal combustion engine (ICE) cars (BNEF 2018b). By 2040, 55 percent of all new car sales and a third of the global

Figure 2.2 | **Number of Electric Cars in Circulation**




*Source:* IEA (2018d); BNEF (2018d).

fleet are projected to be electric (BNEF 2018b), and by 2060 90 percent of all cars on the road are projected to be electric (IEA 2017a).

Norway has been the biggest market of EVs by share, with over 50 percent of new car sales being electric (OFV 2018), and the highest per capita ownership of electric cars (IEA 2018c). The high penetration rate results from a strong policy push and various incentives, such as subsidies and tax benefits. China has become a booming market and the biggest by volume, contributing more than half of global sales in 2017 and 40 percent of world's electric cars on the road. However, China's current EV market share is still not significant, at only 2.2 percent in 2017 (IEA 2018c) (see Box 2.1).

Box 2.1 | **China Leads the EV Market**

China is now the biggest EV market by volume, with over 650,000 electric cars on the road (IEA 2017a). China also represents over 94 percent of global electric bus stock of 370,000 in 2017 (IEA 2018d). Bloomberg New Energy Finance (BNEF 2018b) projects that China is and will continue to be the largest EV market in the world through 2040. China's New Energy Vehicle (NEV) mandate, finalized in September 2017 and based on California's Zero Emission Vehicle (ZEV) mandate, has been a key policy instrument promoting EV penetration in the country (ICCT 2018). In addition, strong policy levers exist in China to boost EV sales, including high subsidies and tax deductions as well as license plate and registration privileges, such as exceptions of EVs from license-plate lotteries (Hertzke et al. 2018; He et al. 2018).

Regulations that restrict internal combustion engine vehicles are also important drivers for the uptake of EVs.

Announcements and targets have been made by 66 countries, 71 cities or regions, and 48 companies toward phasing out fossil fuel vehicles and shifting to additional zero-emissions vehicles. Twenty-three automobile manufacturers have also been introducing electric car models and EV sale targets (SLoCaT 2018). The IEA's Electric Vehicles Initiative (EVI) announced in 2017 the goal of reaching 30 percent market share for electric vehicles[17] by 2030 through its EV 30@30 campaign (IEA 2017b). The campaign now has 11 member countries and 19 supporting companies and organizations (CEM-EVI 2018).

At the Global Climate Action Summit in September 2018, a record number of commitments were made promoting electric vehicles (The Climate Group 2018b), with the #ZEVchallenge bringing together initiatives for states (Under2 Coalition ZEV commitment), cities (C40 Cities—Green & Healthy Streets), and businesses (EV100). However, these commitments must be translated into implementation.

In addition to policies and commitments that incentivize EVs with subsidies and place restrictions on ICE vehicles, technology advancement continues to bring down battery cost and improve EV performance, and accordingly makes EV production and ownership of EVs more cost-competitive than that of ICE vehicles. The massive adoption of EVs can only be made possible with further infrastructure investment for accessible charging stations. Decarbonizing and modernizing the power grid is also crucial. Electrification of the transport sector will bring emissions reduction benefits only with a grid powered by renewable energy. Increased capacity of renewable energy can help meet the increased electricity demand and ease adoption of electric vehicles.

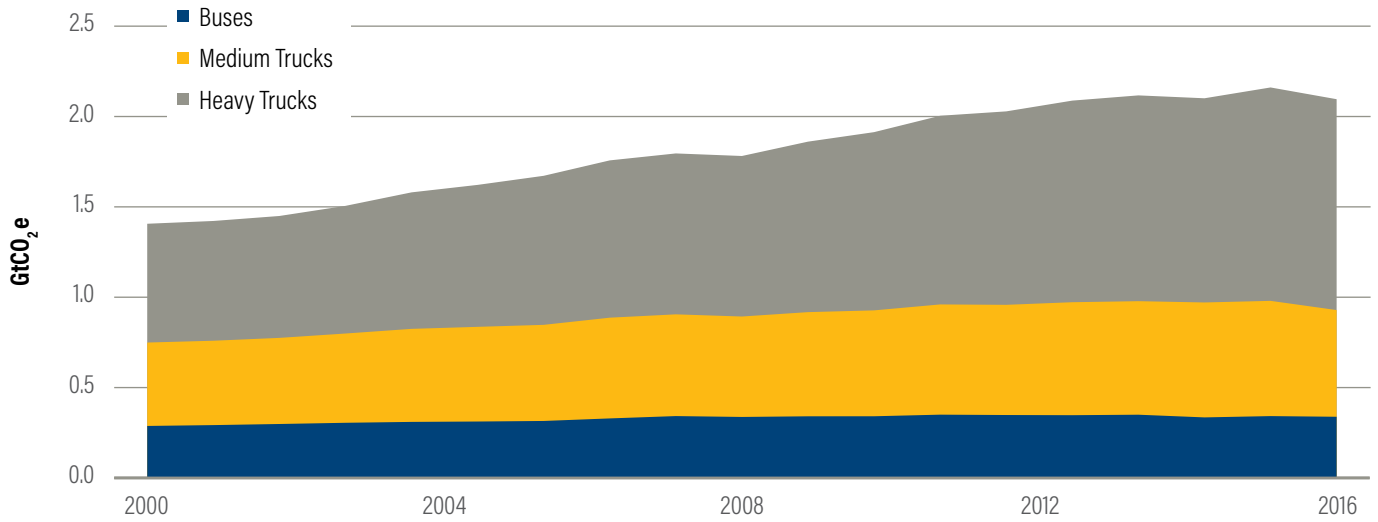
Heavy-duty vehicle efficiency standards are 20 percent higher across all major economies; transport routes in major cities are operated with zero-emissions modes:
**[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Emissions from heavy-duty vehicles (HDVs) have grown almost 50 percent from 2000 levels, faster than any other transport mode (IEA 2018d). This growth is driven mainly by stronger economic activity demanding more road freight transport, which is largely powered by fossil fuels (see Figure 2.3). Meeting part of the growth through shifting to more efficient modes, such as rail, can help reduce demand for heavy-duty vehicles.

Fuel economy standards and green freight programs are the two most promising policy instruments in the near and midterm to improve the efficiency of road freight services. At the moment, only 50 percent of HDV sales are covered by fuel economy and emissions standards, compared to 80 percent for light-duty vehicles (IEA 2017c).

Only five countries—Canada, China, Japan, the United States, and most recently India—have HDV fuel economy regulations in place. A few more countries and regions—such as the European Union, Brazil, Mexico, and South Korea—have regulations under consideration (IEA 2017c).

Figure 2.3 | **Emissions from Heavy-Duty Vehicles**




*Source:* IEA (2018d).

Still, it will take a long time to develop and implement efficiency standards across all of the world's major economies. We are not on track to set and achieve efficiency standards for HDVs that are 20 percent higher across all major economies.

The Global Fuel Economy Initiative (GFEI), a partnership of six organizations—the International Energy Agency (IEA); the International Transport Forum (ITF); the United Nations Environment Programme (UNEP); the International Council on Clean Transportation (ICCT); the University of California, Davis; and the Fédération internationale de l'automobile (FIA Foundation)—sets a target of 35 percent reduction in average fuel consumption of new HDVs by 2035 from 2015 levels (GFEI 2017). Achieving the target, through various areas of efficiency improvement, is estimated to bring millions of barrels in oil savings per day, and 1–2 billion tons of carbon dioxide ($CO_2$) emissions savings per year in 2035 (GFEI 2017).

There have also been positive developments in electric and fuel-cell HDVs by companies. For example, Tesla announced that its electric trucks will begin production in 2019; Mercedes-Benz also announced mass production of its electric trucks by 2021; and the U.S. company Nikolas introduced the hydrogen-based fuel cell that will be used in 800 trucks ordered by brewing company Anheuser-Busch in 2018 (CAT 2018a).

Pioneering leaders from 26 cities—including Paris, London, Los Angeles, and Copenhagen—with a combined population of over 125 million have joined the C40 Fossil-Fuel-Free Streets Declaration (C40 2018a),[18] pledging to procure only zero-emissions buses beginning in 2025 and to ensure that a major area of their cities is zero-emissions by 2030. The pledges, if fully implemented, will help drive decarbonization of heavy-duty vehicles, address air pollution, and bring health benefits to residents. Analysis taking into account the air quality in these cities shows a potential to avoid 11,000 premature deaths per year (C40 2018b). Trucks have been a major contributor to emissions from heavy-duty vehicles, as emissions from buses and medium-weight trucks are expected to flatten over the past decade (see Figure 2.3). However, very few commitments have been made toward limiting HDVs in cities.

Public transport doubles its market share:
**[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

In 2017, almost 55 percent of world's population lived in urban areas, a share projected to increase to 60 percent by 2030 and 68 percent by 2050 (UN 2018). Providing convenient access to public transportation is one target of sustainable development goals to improve road safety and address populations with vulnerability.[19] It is also critical to reducing emissions in the sector.

The International Association of Public Transport (UITP) announced in 2009 its objective to double the market share of public transport by 2025 (PTx2) (UITP 2013) from 2005 levels, reaching 32 percent in 2025. Achieving the target is expected to bring 550 million tons of $CO_2$ equivalent in emissions reductions, save around 170 million tons of oil, and reduce urban traffic fatalities by 15 percent (UITP n.d.). In 2015, the global average share of public transport in passenger kilometers traveled was 19 percent, which falls short of the outcome if the historical trend continues (OECD 2017a).

Furthermore, the modal share of daily trips can differ significantly between developed and developing countries, ranging from 7 percent in North America to over 27 percent in Africa (OECD 2017a). Half of the trips made in cities in developed countries are by private vehicles, while almost 70 percent of trips in developing cities are made through a public transport mode (27%) or nonmotorized transport (40%), such as walking and cycling.

With projected growth in population, global daily trips in urban areas could increase by 50 percent in 2025 compared to 2005 levels (Sustainable Mobility for All 2017). If the current trend continues, most of this increase will be generated as people shift from walking and cycling to private vehicles, primarily in developing countries.

To meet the outcome, it will be crucial to reduce trips made by private vehicles in developed cities, and meet all new trip demands with public transportation in developing cities, to the extent possible as private vehicle ownership dramatically increases (Sustainable Mobility for All 2017).

Buses represent a significant share of the public transport mode, at 63 percent, compared to metro, tram/light rail, and suburban rail, at 37 percent combined (UITP 2017). There is an enormous potential to drive emissions down further with the expansion of electric buses. It is also estimated that the uptake of electric buses will grow faster than that of light-duty vehicles (BNEF 2018b).

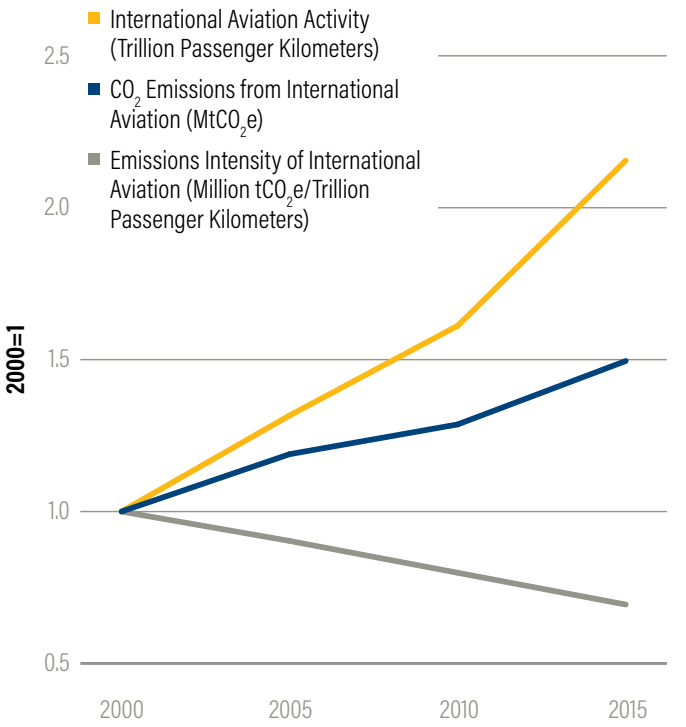
Better zoning and city planning, combined with a transition to other newly emerging mobility modes, such as shared-mobility (ride share and bike share), offers additional options to further decarbonize the transportation sector.

The aviation sector reducing total emissions per kilometer traveled by 20 percent below 2013 levels:
**[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Air transport is responsible for around 2 percent of global $CO_2$ emissions, of which 65 percent is from international aviation (IEA 2016a). World air passenger traffic is projected to grow 5 percent annually and almost double by 2035 (IEA 2017a). Aviation emissions (domestic and international combined) increased by 3 percent from 2013 to 2014 (IEA 2016a).

Average international aviation emissions per passenger kilometer traveled have been on the decline since 2000—having decreased over 30 percent despite distances traveled more than doubling during the same time frame (see Figure 2.4). If the trend is sustained, a 20 percent improvement in 2020 compared to 2013 levels of emissions intensity will be reachable for emissions from international aviation. However, it is worth noting that international flights tend to be more efficient than shorter domestic flights (IPCC 2014) (see Figure 2.4).

Figure 2.4 | **International Aviation Emissions Intensity on the Decline**




*Source:* Author calculations based on activities and emissions data from the IEA (2017a, 2018b).

## Box 2.2 | Timeline of Aviation Industry Goals

In 2009, International Air Transport Association (IATA) members committed to an average 1.5 percent improvement in fuel efficiency annually from 2009 and 2020, a cap on net aviation $CO_2$ emissions with carbon-neutral growth from 2020, and reduction in net aviation emissions of 50 percent by 2050 relative to 2005 levels (IATA 2018b). The fuel efficiency of airlines improved 10.2 percent compared to 2009 in 2016 (IATA 2018c). The IATA (2018a) also has set goal of "reaching 1 billion passengers on flights fueled by sustainable aviation biofuels by 2025."

In 2010, the International Civil Aviation Organization (ICAO), at its 37th Assembly, announced the goal of improving fuel efficiency by 2 percent annually through 2050, for all international flights, with a medium-term goal of reaching carbon-neutral growth for international aviation from 2020 (ICAO 2013).

In 2016, the ICAO's 39th Assembly adopted the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) (ICAO 2016). The aim is to stabilize $CO_2$ emissions from international aviation from 2020 and to reduce emissions using sustainable alternative fuels and through operational, technological, or infrastructure measures. Any further emissions will be offset through market-based measures (IEA 2017a). CORSIA will be implemented with a pilot phase from 2021 through 2023 and a first phase from 2024 through 2026.

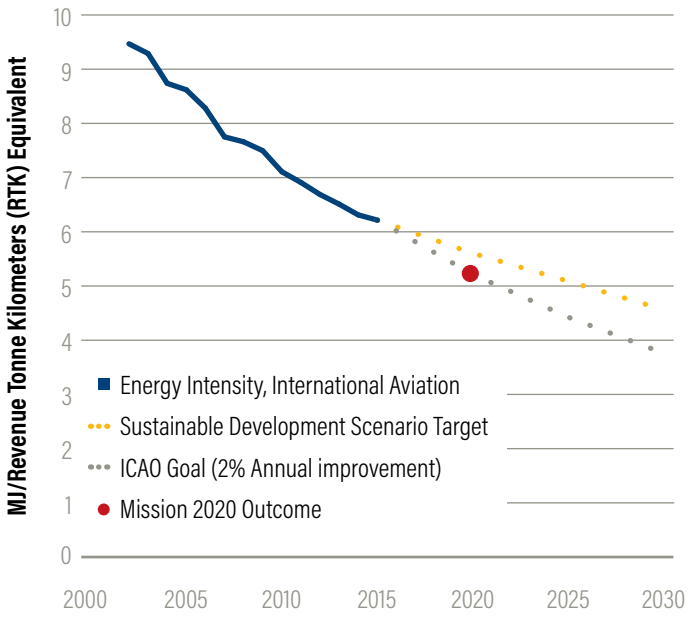
In 2017, the ICAO adopted its first-ever $CO_2$ emissions certification standard for new aircraft. The standard will apply to new aircraft design from 2020, when it comes into effect, and new aircraft of existing designs as of 2028.

It should be noted that there has been criticism of the ICAO targets, such as the arguments that the carbon price set under CORSIA is too low to drive behavior change (Pavlenko 2018; King 2016), that offsetting coverage is not comprehensive enough to achieve carbon-neutral growth (Olmer and Rutherford 2016), and that the $CO_2$ standard does not go beyond what is already achievable by market forces (ICCT 2016). It remains to be seen whether the targets will be strengthened over time.

Recent energy intensity improvements have averaged around 3 percent each year since 2005, exceeding aviation industry goals (IEA 2018d). For a Paris-compatible pathway,[20] the energy intensity of international aviation needs to decline by more than 3 percent annually through 2030 (IEA 2018d). For the sector to be on track for decarbonization in the longer term, large-scale adoption of sustainable aviation fuels and deployment of technology improvements for engines will be necessary.

The aviation industry has been setting goals and adopting schemes to improve fuel efficiency and reduce emissions in this sector (see Box 2.2). Energy intensity fell by 4.5 percent between 2013 and 2015, a rate that would cause it to fall short of a 20 percent reduction in 2020 (both the Sustainable Development Scenario target and the *2020: The Climate Turning Point* outcome; see Figure 2.5).[21]

Figure 2.5 | Energy Intensity Improvement of Aviation




*Note:* MJ = megajoule. Revenue tonne kilometer (RTK) equivalent is calculated as the combination of revenue tonne kilometers (RTKs) and revenue passenger kilometers (RPKs), considered at 150 kilograms per passenger.

The Sustainable Development Scenario (SDS) is an IEA scenario used for benchmarking progress that was first introduced in the World Energy Outlook (IEA 2017e). The scenario aligns with the Paris Agreement's goal of "holding the increase in the global average temperature to well below 2 degrees Celsius (°C) above preindustrial levels and pursuing efforts to limit the temperature increase to 1.5°C." https://www.iea.org/weo/weomodel/sds/.

The ICAO applies a constant of 3.16 tons of $CO_2$ for each ton of fuel burned. A fixed factor is assumed here to convert the *2020: The Climate Turning Point* outcome related to emissions intensity (per passenger kilometer) reduction to energy intensity reduction (per passenger kilometer) to place it on the same chart above.

*Source:* IEA (2018d).

The shipping sector announces plans for market measures or other instruments to eliminate emissions from their sector: **[ON TRACK]** Sustain Action

The shipping sector accounts for 2 percent of $CO_2$ emissions from fuel combustion (IMO 2014). Carbon dioxide emissions from international marine shipping have increased almost 30 percent compared to 2000 levels (IEA 2018d). Under a reference scenario,[22] the sector's emissions are estimated to continue to grow another 30 percent in 2030 and almost double by 2060 (OECD 2017b).

Maersk, the world's largest container shipping company, announced in December 2018 its commitment to be carbon-neutral by 2050. The company also stated that carbon-neutral vessels need to be commercially viable by 2030.

The International Maritime Organization (IMO) adopted its initial strategy (IMO 2018b) in April 2018 to (1) reduce the carbon intensity of shipping by implementing further phases of the Energy Efficiency Design Index (EEDI)[23] for new ships; (2) reduce $CO_2$ emissions by at least 40 percent until 2030 and pursue efforts toward 70 percent by 2050, compared to 2008 levels; and (3) peak emissions from international shipping as soon as possible and reduce GHG emissions by at least 50 percent by 2050 compared to a 2008 baseline, and to pursue efforts to phase them out as soon as possible in this century. While the Paris Agreement does not explicitly address international shipping, the target aligns with the Paris Agreement's temperature goals (IEA 2018e). The IMO (2018c) also established its data collection system for fuel oil consumption of ships, which will contribute to GHG emissions reporting.

The strategy also includes candidate short-, medium-, and long-term measures with possible timelines and their impacts on IMO member countries. Market-based measures are considered part of the medium-term solutions over the 2023–30 period to incentivize GHG reductions (IMO 2018a), although it has yet to be determined whether market-based measures are most effective for decarbonizing the shipping sector (UNCTAD 2018).

The IMO thus has advanced goals for decarbonization of international shipping as soon as possible in this century and will start considering candidate measures to achieve these goals in the spring of 2019. In addition to strengthening IMO goals and their implementation and transparent tracking, countries will need to adopt initiatives and actions that complement and facilitate IMO actions (OECD 2017b). The provision of lower-carbon refueling infrastructure across a network of ports connected by shipping lanes will be an equally important objective to enable deep decarbonization of the sector.

### OPTIONS FOR 2020 NDC ENHANCEMENT: TRANSPORT

One hundred and seven NDCs include transportation actions targeting fleet efficiency, fuel use, transit-oriented planning, and more. Thirty-two NDCs include public transportation actions, six mention actions on aviation, and four include maritime emissions. Thirty-six NDCs include quantified mitigation targets for transport, of which thirteen specify emissions-reduction targets. Seven include targets for public transport, and five for electric vehicles (ClimateWatch 2018). Countries should specify further transport actions, including regarding aviation and maritime shipping at the national level, and increase the stringency of existing targets.

## LAND USE: LARGE-SCALE DEFORESTATION IS REPLACED WITH LARGE-SCALE LAND RESTORATION, AND AGRICULTURE SHIFTS TO EARTH-FRIENDLY PRACTICES

Forests play a critical role as natural emissions sinks, able to remove $CO_2$ from the air as well as regulate the climate itself, with the ability to reduce extreme weather and increase resilience (Wolosin and Harris 2018). But at present, land use, including both agriculture and forestry, is a major contributor to global GHG emissions. Based on the most recent data, the direct emissions from agriculture are slightly more than five gigatons $CO_2$ equivalent ($GtCO_2e$) per year, while land use change and forestry emits just over three $GtCO_2e$ per year, together accounting for roughly 17 percent of current global emissions (FAO 2018). The main sources of emissions in agriculture are livestock and crop cultivation, while emissions caused by forest conversion to other land uses are counted as part of the land use sector.

Reducing deforestation and degradation, accelerating restoration and boosting crop and pasture yields to increase food production without further agricultural land expansion is critical to reducing emissions and maintaining the ecosystem services and benefits that forests provide. Meeting the internationally agreed 150 million hectares (Mha) restoration target alone is estimated to bring $85 billion per year in net benefits (Ding et al. 2017). If further deforestation is avoided, the global economy would be boosted by at least $40–80 billion per year (NCE 2018). As companies and governments consider how best to reduce emissions and reduce risk in their supply chains, the benefits forests provide should be considered against potential risk and damage.

The world's nations, civil society institutions, and corporations act to end net deforestation by the 2020s, putting us on a path to reducing emissions from forestry and other land use 95 percent below 2010 levels by 2030:

Net natural forest loss:
**[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

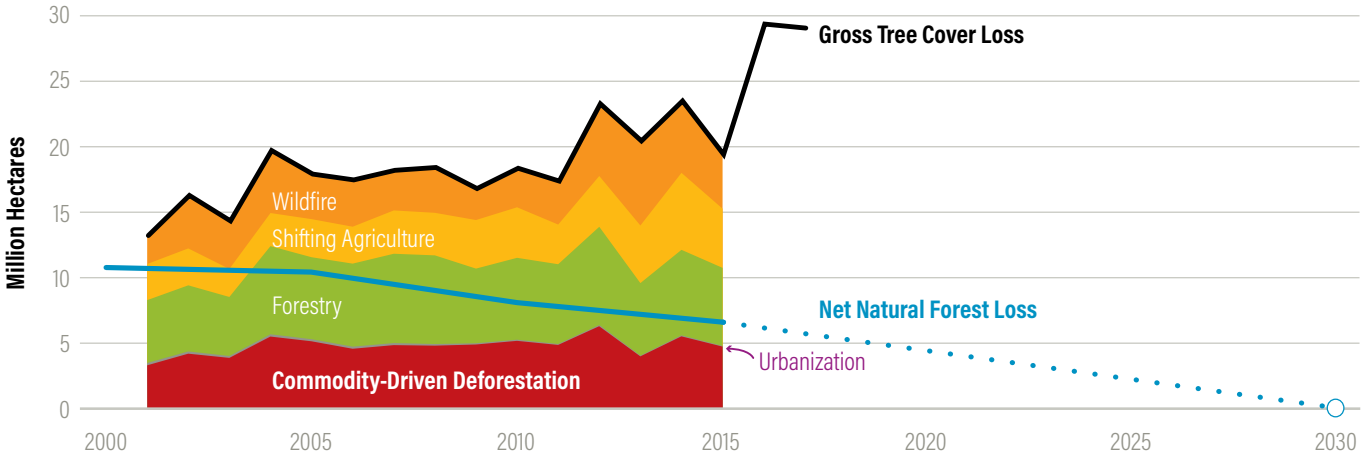
Gross tree cover loss:
**[OFF TRACK]** Radically Accelerate Action

Globally, the rate of net natural forest loss[24] has been slowly declining over the past decade (FAO 2018) driven by tree cover gain outside of the tropics, offsetting a net loss of forest cover in the tropics. However, looking just at forest loss and not counting regrowth as offsetting that loss, gross tree cover loss has been generally increasing since 2000, and this loss is concentrated in the tropics, where it is more likely to be permanent compared to loss outside the tropics (Hansen et al. 2018). The most recent data available show gross tree cover loss at just under 30 Mha in 2017—up from an average of 23 Mha loss over the previous five years (Hansen et al. 2018). Net natural forest loss was 6.5 Mha in 2015 (FAO 2015) (see Figure 3.1).

In 2017 tropical forests saw the second-highest gross tropical tree cover loss since 2001 (Weisse and Goldman 2018), contributing to the second-highest levels on record for gross emissions from tropical forests, 63 percent above a 2001–14 baseline (Hansen et al. 2018). Net emissions from land use change and forestry globally, however, paint a different picture (reflecting the above-mentioned difference between gross and net forest loss); net emissions from land use change and forestry have declined slightly over a similar time frame, from 3.6 $GtCO_2e$ in 2000 to 3.1 $GtCO_2e$ in 2016 (FAO 2018).

Forest loss has been driven by forest clearing and degradation for commodities (such as palm oil, soy, cattle, and gold), clearing for small-scale subsistence agriculture, wildfires, and logging, with each of these drivers causing around a quarter of forest loss (Curtis et al. 2018) (see Figure 3.1). Forest loss driven by commodities, and to some extent shifting agriculture, is largely confined to the

Figure 3.1 | **Gross Tree Cover Loss and Its Drivers Compared to Net Natural Forest Loss**




*Note:* This figure shows data tracking net natural forest loss (FAO) and gross tree cover loss (GFW), as well as the drivers of gross tree cover loss, to illustrate the different approaches to tracking the state of global forests. The net natural forest loss data include natural forest regrowth in one area as offsetting forest loss in another area, while gross tree cover loss treats forest loss and gain separately. The dotted line represents an extrapolation of where trends would need to go in the future to reach the outcome (2030 has been taken as the target year according to the language "by the 2020s").

*Sources:* GFW (Hansen et al. 2018); FAO (2015, 2018).

tropics and more likely to be permanent forest loss—or true deforestation—while fires and forestry are concentrated in temperate and boreal climates and are more likely to lead to temporary losses (Curtis et al. 2018). Successfully ending net deforestation by the 2020s will require more attention to areas where forest loss is more likely to be permanent, as well as to the drivers causing that loss.

Corporations play a significant role in forest conversion to agricultural land, whether this is for expansion of commodities (which is likely to lead to permanent forest loss) or logging (which is more likely to be temporary). The effects on biodiversity and emissions are likely more severe for forest loss due to commodities, and some companies are taking steps to lessen their impacts. The number of commitments from companies to reduce and eventually halt commodity-driven deforestation reached 735 across 471 companies in December 2018, according to Supply Change (2018), which tracks commitments with respect to commodity-driven deforestation across 718 companies that have supply chains dependent on commodities. Among these 718 companies, the aggregate annual revenues and market capitalizations of those with commitments are more than twice those of the companies without commitments (Donofrio et al. 2017).

Commitments cover nearly two-thirds of the international palm oil markets as well as most major paper and pulp producers, though larger gaps in commitment coverage remain for cattle and soy. Taking the next step to measure the implementation and impact of these commitments becomes more difficult, as reporting progress on policy adoption and traceability systems is voluntary, and those that choose to report rarely have independent verification (NYDF 2018). A 2017 assessment found that companies and financial institutions with the greatest influence on forests are not on track to meet their 2020 targets (Rogerson 2017). Combined with increasing gross forest loss numbers, this assessment adds further urgency.

There is an opportunity and a need for more governments to take policy steps to complement corporate commitments, particularly in countries with more severe deforestation, like Brazil and Indonesia (see Box 3.1, for example). Strengthening forest governance through land tenure reform, safeguarding Indigenous Peoples' territories and protected areas, and ensuring that new agricultural development does not result in additional deforestation can all help prevent further forest loss. Further, reforming agricultural subsidies—worth $519 billion per year on average (2014–16)—could reduce economic distortions that can incentivize forest clearing and free up public finance for other uses (NCE 2018). It is clear that there is widespread political motivation to make progress along these lines, as evidenced, for example, in the New York Declaration on Forests' 10 goals with respect to forest protection and the Sustainable Development Goals' Target 15.2 to halt deforestation by 2020, but ensuring these commitments turn into action is the next, and more difficult, step.

Overall, net natural forest loss has been declining in recent years, though not quickly enough to end it by the 2020s and gross tree cover loss has continued to increase. The number of corporate commitments to reduce or eliminate supply-chain-driven deforestation is growing, and the coming few years provide a key opportunity to make progress on implementing these commitments and to take advantage of forests' great potential as providers of climate benefits.

### Box 3.1 | Indonesia Reduces Tropical Tree Cover Loss

Even as 2017 saw the second-worst forest cover loss in the tropics globally, Indonesia's tree cover loss was 60 percent lower than in 2016. This shift was likely due to government policies to prevent usage of land designated as primary forest or peatland and restore 2.4 Mha, as well as favorable climatic conditions that prevented fires (Hamzah et al. 2018) and strengthened law enforcement.[25] As consistently one of the top countries in terms of tree cover loss, this indicated a significant shift and pointed to the important role regulation can play when there is support for it. Progress remains fragile, however, as companies and smallholder farmers continue to vie for the land and as fires return to some areas.

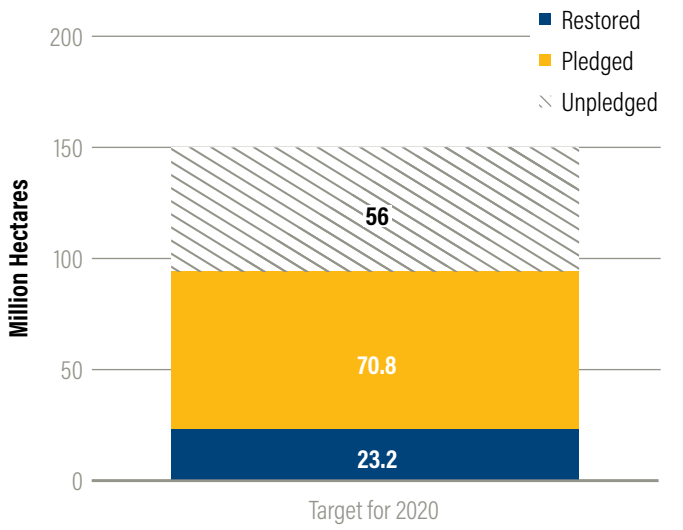
Restore and conserve at least 150 million hectares of degraded land, enhancing biodiversity and building ecosystem resilience: **[INSUFFICIENT DATA]**

Political will for forest and landscape restoration is strong and continues to grow. The Bonn Challenge, first launched in 2011 with a goal of restoring 150 Mha of deforested and degraded land by 2020, is an indicator of this commitment from governments, nongovernmental organizations (NGOs), and companies. In 2014, this target was expanded and extended under the New York Declaration on Forests, aiming to reach 350 Mha by 2030.

Regional restoration initiatives, such as AFR100 in Africa and Initiative 20x20 in Latin America and the Caribbean, directly contribute[26] to the Bonn Challenge goal. There are currently 57 commitments to the Bonn Challenge totaling 170 Mha in restoration—94 Mha of this is committed for 2020 and 76 Mha more is committed for 2030 (Bonn Challenge 2018). Multistakeholder approaches, like the Cerrado Manifesto, in which over 60 Brazilian NGOs and over 70 global corporations have signed on to the goal of halting deforestation in Brazil's Cerrado (or tropical savanna), complement these commitments.

Efforts to systematically track progress on forest and landscape restoration are under way and expected to be improved in 2019. As an example, the Bonn Challenge Barometer, a reporting platform for Bonn Challenge commitments, is under development by the International Union for Conservation of Nature (IUCN) and will be rolled out in 2019, with efforts in 2019 and 2020 to encourage countries to use the framework for reporting. Progress assessments have already been made under the Bonn Barometer for five countries[27] in 2017 (IUCN 2017). In total about 13.4 Mha (IUCN 2017) aggregated across these countries and states is under restoration, although 12.3 Mha of this comes from the United States alone. Separately, India has announced that 9.8 Mha of degraded land has been restored (IISD 2018a), bringing the total to 23.2 Mha, or 44 percent of the aggregated commitments made by those six countries[28] and just under a quarter of the total area pledged for 2020 (see Figure 3.2).

Figure 3.2 | **Targets and Pledges for Restoration and Completed Restoration for the 2020 Outcome**




*Sources:* Bonn Challenge (2018); IISD (2018a).

To support turning commitments into implementation, it is estimated that new finance will be needed on the order of $23–67 billion per year of investment between 2015 and 2030 to restore 350 Mha of degraded forest landscapes (NCE 2018). Most finance for restoration currently comes from public budgets, as the benefits from restoration are often difficult to monetize and are not short-term, which can make it difficult to attract private investors. Partnerships like AFR100 and Initiative 20x20 are working to increase private investment in restoration, with the financial partners of AFR100 and Initiative 20x20 earmarking over $3 billion in risk capital for investment in restoration projects (Ding 2017). To date, approximately $300 million has been invested in projects on the ground, and efforts are under way to increase this level of investment.

Conversely, investment in restoration can create a variety of new income streams, such as through sustainable harvesting or tourism, and it is estimated that new income streams from such sources have the potential to boost smallholders' incomes in developing countries by $35–40 billion per year within the next 15 years (NCE 2018) (see Box 3.2).

The 94 Mha in commitments made thus far for restoration under the Bonn Challenge are just under two-thirds of the 2020 goal. Of the progress able to be assessed thus far—which is limited to only a few countries—a little under half of the committed hectares have been restored (23.2 of 53.2 Mha in aggregated pledges). As comprehensive data to track progress across all jurisdictions have yet

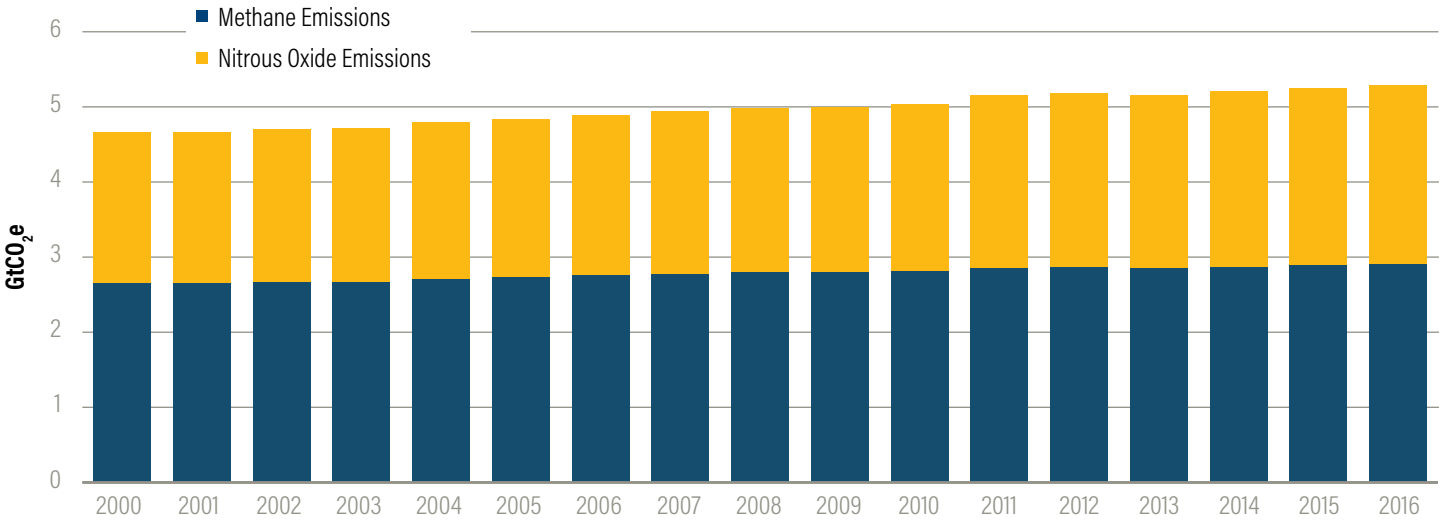
Box 3.2 | **Land Tenure Reform Spurs Restoration and Livelihood Improvement in Niger**

In the Maradi and Zinder regions of southern Niger, 250,000 ha of severely degraded land have been restored through agroforestry techniques, and agricultural productivity has increased on 5 Mha of land. The main driver of this improvement was a change in land tenure policy that gave rights to smallholder farmers to protect, manage, harvest, and benefit from on-farm trees.

Farmers in the region produce at least 100 kg/ha more grain than before, and gross annual income has grown by $1,000/household for over 1 million households—more than doubling real incomes.

*Source:* Buckingham and Hanson (2015).

Figure 3.3 | **Emissions from Agriculture by Gas**




*Source:* FAO (2018).

to be collected, these values may be significantly underestimating progress to date. Even so, the next two years are critically important to move decisively from commitment to action and to improve data collection and validation to capture action on the ground.

Ramp up the implementation of sustainable agricultural practices that reduce $CO_2$ emissions, increase $CO_2$ removals, and halt the growth in non-$CO_2$ emissions:

Practices to reduce $CO_2$ and non-$CO_2$ emissions:
**[OFF TRACK]** Radically Accelerate Action

Practices to increase $CO_2$ removals:
**[INSUFFICIENT DATA]**

Agriculture contributes just under 11 percent of total greenhouse gas emissions, or slightly more than 5 $GtCO_2e$ in 2016. This figure has increased steadily, from 4.6 $GtCO_2e$ in 2000 to 5.3 $GtCO_2e$ in 2016 (FAO 2018) (see Figure 3.3). Counting only direct emissions from agriculture (excluding energy use on farms and emissions caused by deforestation for conversion to agricultural land),[29] emissions are entirely methane and nitrous oxide from synthetic fertilizers, cows' digestive processes, rice cultivation, burning of crop residues, and livestock manure, and both of these gases have a much stronger global warming impact than carbon dioxide.

Reducing emissions in agriculture can be achieved through actions to change production and/or consumption of agricultural products. On the production side, this includes implementation of agricultural practices to increase productivity and resilience and reduce greenhouse gas emissions from crops, livestock, fisheries, and aquaculture. There are many cases of successful interventions in, for example, agroforestry, grassland management, and livestock management that could be adapted elsewhere, but there are no global data tracking their implementation (FAO n.d.). There is also large potential for technological innovations in the sector, such as feed compounds that reduce methane emissions from cattle, nitrification inhibitors for fertilizers, and crops bred for higher yields even under climate change, which could provide significant benefits in the future (Searchinger et al. 2018). Other advances, such as drones to optimize agricultural inputs like water and fertilizer, have already been successfully piloted and have shown increased yields and profits (TechnoServe 2018).

On the demand side, there is great potential to reduce emissions both through shifting diets away from emissions-intensive products like beef (Ranganathan et al. 2016) and reducing food loss and waste, which constitutes one-third by weight of all food produced (Lipinski et al. 2013) and causes emissions equivalent to that of a country, just behind China and the United States (Hanson and Mitchell 2017). While both interventions have enormous potential

to contribute to a more sustainable food system, global data are currently insufficient to show the effects of these interventions. For example, meat consumption in the United States has increased since the 1970s, but it is shifting from beef to chicken, which requires only one-seventh the land and emits one-seventh the greenhouse gases of beef production (Waite 2018).

Recently launched initiatives like the Food Loss and Waste Protocol are working toward more comprehensive tracking. SDG Target 12.3, which calls for halving food loss and waste, spurred the creation of Champions 12.3, a coalition of governments, businesses, research organizations, and others dedicated to accelerating progress on this target. Additionally, over 40 companies involved in the food supply chain have committed to science-based targets to reduce their emissions (SBT 2018), and a new initiative called the Cool Food Pledge, launched in 2018, aims to engage many more companies to reduce their food-related emissions through diet shifts. As with the production side, there is also potential for disruptive technological innovations to spur rapid change—for example, with innovations such as plant-based meat substitutes, which became much more available in 2018.

Soil carbon sequestration offers another opportunity to reduce emissions. Increasing productivity of grasslands and croplands can add carbon in roots and residues, and improved soil management techniques like cover cropping, composting, and agroforestry can further sequester carbon. While some studies indicate potential for soil carbon sequestration to reach 1 Gt $CO_2$/year (Wollenberg et al. 2016), there are currently no global data tracking efforts on enhancing soil carbon. Additionally, recent scholarship and experience indicate that soil carbon sequestration is harder to achieve than previously thought (Searchinger et al. 2018). Efforts like the 4 per 1000 initiative encourage agricultural practices that help increase the soil carbon stock.

Increasing productivity and implementing demand-side measures both reduce agricultural land demand and potential for deforestation, facilitating the forest protection and restoration outcomes listed above. However, to ensure that productivity gains do not fuel additional agricultural expansion elsewhere, governments should explicitly link efforts to boost crop and pasture yields with legal protection of forests and other natural ecosystems from conversion to agriculture (Searchinger et al. 2018).

In sum, agricultural emissions continue to rise, indicating we are not on track to halt their growth by 2020. Due to the numerous ongoing and possible interventions in the agricultural system, it will be critical to follow a multi-pronged approach encompassing both production and consumption through technology, finance, and policy improvements, involving the public and private sectors. Several initiatives have recently been launched to tackle demand for agricultural products, and technology development to address both the demand and supply side is advancing, indicating growing attention to the importance of this effort.

### OPTIONS FOR 2020 NDC ENHANCEMENT: LAND USE

Over 150 NDCs consider land use–related mitigation options, such as reforestation or afforestation, under their GHG reduction targets, with 124 referencing ongoing or planned efforts in the forest sector; however, only 58 of those include quantitative forest sector targets (ClimateWatch 2018).

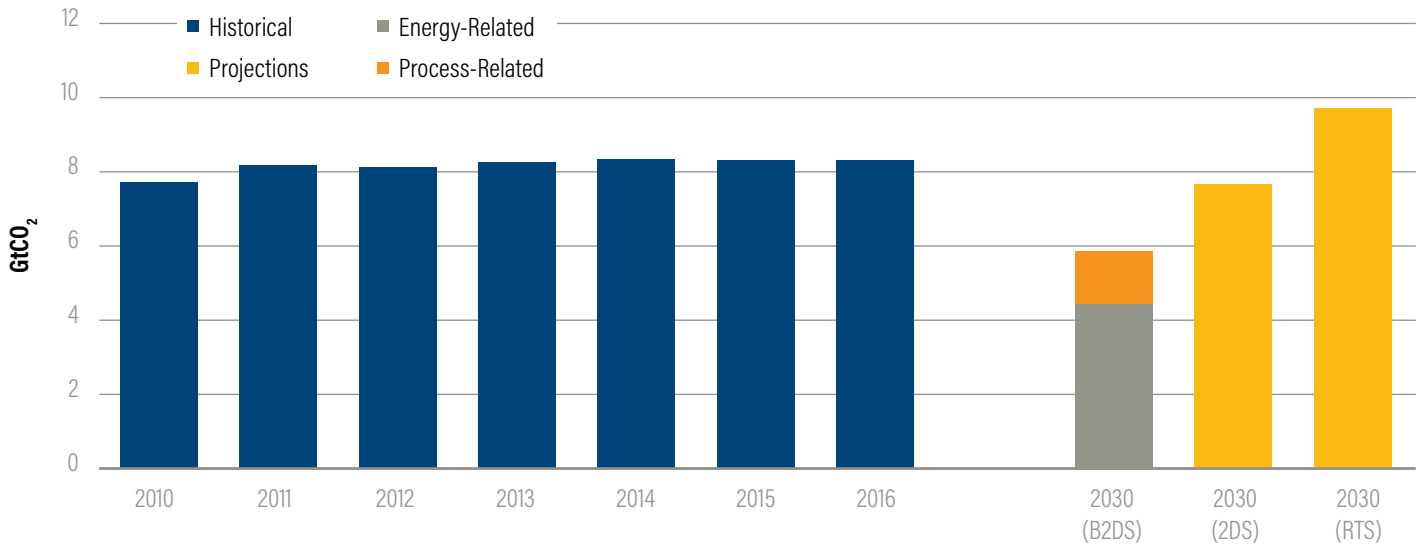
As countries enhance or update NDCs by 2020, they should strengthen their commitments around forests and land use by laying out specific quantitative targets or by strengthening existing quantitative targets through enhancing ambition and/or specifying policies or actions to create the conditions for achieving those targets, including mobilizing finance to protect forested areas or improving monitoring programs to track impact.

For agriculture, governments can commit to reforming inefficient and environmentally harmful agricultural subsidies, and to aligning fiscal and policy incentives to encourage earth-friendly agriculture, among other solutions. Investments in smallholders could spare millions of hectares from deforestation (WEF 2017).

## INDUSTRY: HEAVY INDUSTRY—INCLUDING IRON AND STEEL, CEMENT, CHEMICALS, AND OIL AND GAS—COMMITS TO BEING PARIS-COMPLIANT

Heavy industries, such as iron and steel, cement, chemicals, and oil and gas, are energy intensive and collectively responsible for around a quarter of global $CO_2$ emissions (IEA 2018d). Emissions from industry processing itself

Figure 4.1 | **Growth in Direct Industrial Carbon Dioxide Emissions**




*Note:* Direct emissions in this chart include both energy- and process-related emissions. The Beyond 2°C scenario (B2DS) is a pathway consistent with a 50 percent chance of limiting average global temperature increase to 1.75°C by 2100. The 2°C scenario (2DS) is consistent with a 50 percent chance of limiting average global temperature increase to 2°C by 2100. The Reference Technology scenario (RTS) takes into account current and announced commitments in countries' nationally determined contributions (NDCs) under the Paris Agreement.

*Source:* IEA Tracking Clean Energy Progress (TCEP) (historical) (IEA 2018d) and IEA *Energy Technology Perspectives* (ETP) (projections) (IEA 2017a).

have increased almost twofold compared to 1990 levels (Gütschow et al. 2018), although the rate of growth has slowed in recent years (IEA 2018d).

If no further actions are taken beyond current commitments, emissions from the industrial sector are expected to continue to increase to over 17 percent higher than 2016 levels in 2050 (IEA 2017a) (see Figure 4.1). For heavy industry to be Paris-compliant, it is crucial to decouple the sector's greenhouse gas emissions from industrial production. As over 75 percent of direct industry emissions come from energy use, scaling up renewable energy is also vital. Industrial emissions will need to peak before 2020 and be reduced by more than 60 percent compared to current levels by 2050 for a Beyond 2°C scenario (IEA 2017a).

While significant commitments have been made, as evidenced by outcomes below, emissions are currently off track to be consistent with the temperature limits of the Paris Agreement. Action will need to be stepped up accordingly. Mitigation opportunities, however, exist on many fronts.

Recent analysis has found that it is technically and economically feasible for chemicals, steel, and cement to reach net zero emissions by midcentury at a cost of less than 0.5 percent of global gross domestic product (GDP) (ETC 2018). A more circular economy through improved material and energy efficiency can reduce $CO_2$ emissions from plastic, steel, aluminum, and cement by 40 percent by 2050 (ETC 2018). Other measures include deployment of best available technologies, such as recycling post-consumer scrap to offset primary production of materials; sustainable utilization of industrial wastes and by-products, as well as recovering excess energy flows; and further technology innovation.

Increased energy and material efficiency of heavy industry processes also brings benefits such as energy savings, reduced production costs, and increased jobs. Technology innovations can also bring new economic opportunities and environmental benefits (NCE 2018).

Policies such as energy and material efficiency mandates, labeling of lifecycle embodied carbon in products, and support for technology research, development, and deployment can further drive the process. Industrial associations are also key drivers of private sector actions (ETC 2018).

Heavy industry firms have developed, published, and begun implementing roadmaps for their transition to a decarbonized economy in 2050:

Heavy industry firms have developed and published roadmaps: **[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Heavy industry firms have begun implementing roadmaps: **[INSUFFICIENT DATA]**

Recent years have seen a rapid increase in commitments made by companies to address climate change. The Global Climate Action portal of the United Nations Framework Convention on Climate Change (UNFCCC 2018) displays close to 20,000 commitments to act on climate change, almost 6,000 from 2,400 companies. The We Mean Business coalition (2018) registered 1,347 commitments from 827 companies representing $16.9 trillion market cap to date. Various international efforts are under way to support companies, including heavy industry firms, in setting short- and long-term goals and related planning.

Nearly 300 heavy industry companies[30] in the industrial, materials, and energy sectors have registered 677 cooperative and individual actions on the UNFCCC's Global Climate Action portal (UNFCCC 2018), committing to various initiatives such as Science Based Targets (SBT), the Low Carbon Technology Partnerships initiative LCTPi), RE100 for 100 percent renewable power, EP100 for smart energy use, Reduce Short-Lived Climate Pollutant Emissions, Put a Price on Carbon, and many more, as well as individual actions registered under CDP (see Box 4.1, for example).

The LCTPi has working groups focused on identifying low-carbon technologies for cement (the Cement Sustainability Initiative, or CSI) and reducing the operational carbon footprint for chemicals (Chemicals LCTPi). The CSI currently includes 18 member companies working to integrate sustainable development into business practices. CSI members represent around 20 percent of the world's cement production and, if scaled to the entire cement sector, will have a mitigation potential of almost 1 $GtCO_2e$ of emissions by 2030 (WBCSD 2017). The Chemicals LCTPi includes five member companies. The sector has an abatement potential of 0.4 $GtCO_2e$ compared to business as usual, and the potential to leverage an additional 1 $GtCO_2e$ of emissions savings each year by 2030 by serving key sectors such as buildings, automotive, packaging, and food (WBCSD 2016).

The Oil and Gas Climate Initiative (OGCI 2018a) has member companies that account for 30 percent of global oil and gas production, including some of the major players in the industry. The initiative announced commitments to reduce methane intensity and to a collective $1 billion in climate investments to reduce methane and carbon dioxide emissions. However, ambition can be accelerated (OGCI 2018b). It is also critical that companies not exploit the current fossil fuel reserves; they can start by measuring and reporting the potential of their reserves (Russell 2016).

While an increased number of companies have started to join low-carbon initiatives and commitments, data are currently insufficient to assess progress and implementation. It is now crucial for them to realize those commitments. Companies need to set roadmaps with clear timelines and milestones and concrete actions to decarbonize the economy. It is equally important to create transparent systems to collect data and track progress toward their commitments.

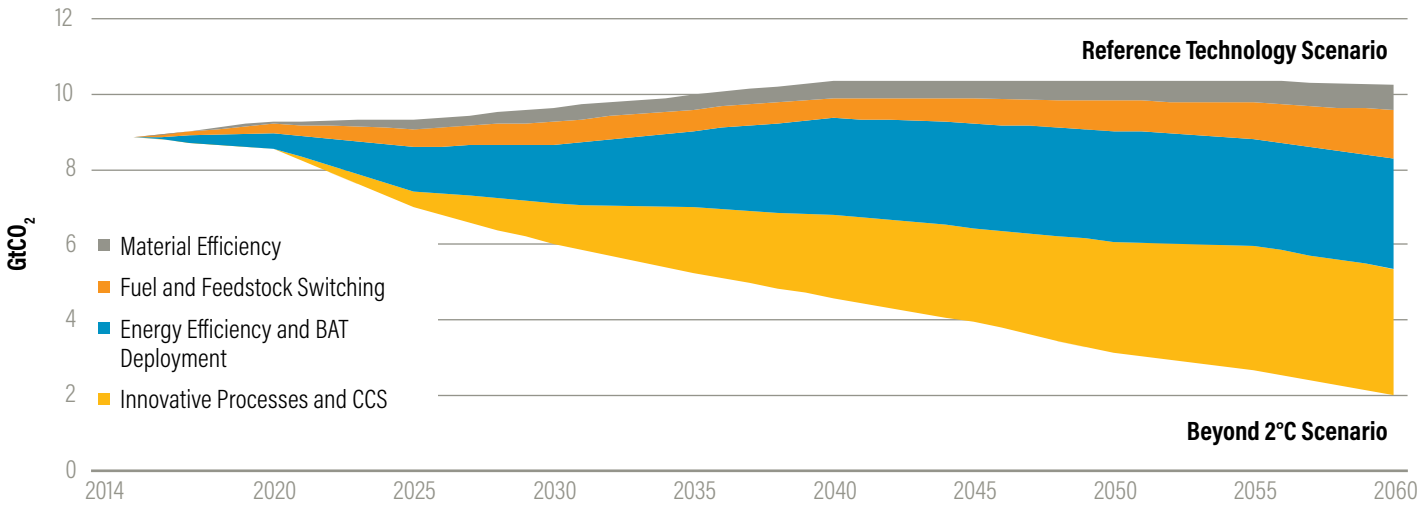
### Box 4.1 | Dalmia Cement

In 2016, Dalmia Cement became one of the first cement companies to join both RE100 and EP100 (The Climate Group 2018a). The company committed to transitioning toward 100 percent renewable electricity with RE100, with an interim target of increasing the share of renewable energy fourfold in Dalmia's electricity consumption by 2030, compared to 2015 levels. Under EP100 (The Climate Group 2017), the company also pledged to double its energy productivity by 2030 compared to a 2010–11 baseline. Dalmia Cement is also a member of the LCTPi (WBCSD 2018) and commits to set a science-based target (*Economic Times* 2018).

Heavy industries are increasing their energy, emission, and material efficiencies and are on a trajectory to halve emissions by 2050 using science-based targets: **[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Positive steps have been taken in heavy industries. By deploying energy and material efficiency measures and best available technologies, emissions could be kept at a level below current levels through 2060 (IEA 2018d). However, for a trajectory to halve emissions by 2050 and to reach a Beyond 2°C scenario, or limit warming even lower, innovative low-carbon technologies such as low-carbon hydrogen generation, solar thermal for alumina

Figure 4.2 | **Scenarios for Direct $CO_2$ Emissions in Industry by Mitigation Strategy**




*Note:* BAT = best available technology. The Beyond 2°C scenario (B2DS) is a pathway consistent with 50 percent chance of limiting average global temperature increase to 1.75°C by 2100. The Reference Technology scenario (RTS) takes into account current and announced commitments in countries' nationally determined contributions (NDCs) under Paris Agreement.

*Source:* IEA (2017a).

refining, and carbon capture and sequestration (CCS) will be needed in the longer term (IEA 2017a) (see Figure 4.2 and Box 4.2). Those innovative technologies are at various stages from commercially available to under research and development. Advancing those technologies and making them available in the long term will require significant investment in research, development, demonstration, and deployment, as well as a policy push to remove institutional barriers in the short term.

Material efficiency offers important mitigation opportunities in the short term. Further efficiency improvements could be achieved through measures such as increased postconsumer recycling for aluminum, iron, and steel; increased ratio of clinker substitute for cement production; and improved plastic recycling rates. Current recycled content in global steel, aluminum, and copper supply is around 20 percent (McCarthy et al. 2018).

Heavy industries have been progressing on energy efficiency improvements. For example, the energy intensity of steel production peaked in 2009. While the intensity fell by 1 percent in 2016, recent modeling efforts find that it needs to decline by 1.2 percent annually till 2030 to reach a 1.5°C compatible trajectory (IEA 2018d).[31] Recovery and reuse of excess energy and waste heat will help further reduce energy consumption in heavy industrial plants.

Some heavy industries have already been decoupling emissions. The global carbon intensity of cement production leveled during 2014–16 (IEA 2018d). In addition to improved material and energy efficiency, switching to low-carbon fuels and technology innovation will also be needed to bring emissions to a trajectory consistent with the Paris temperature goals (IEA 2017a).

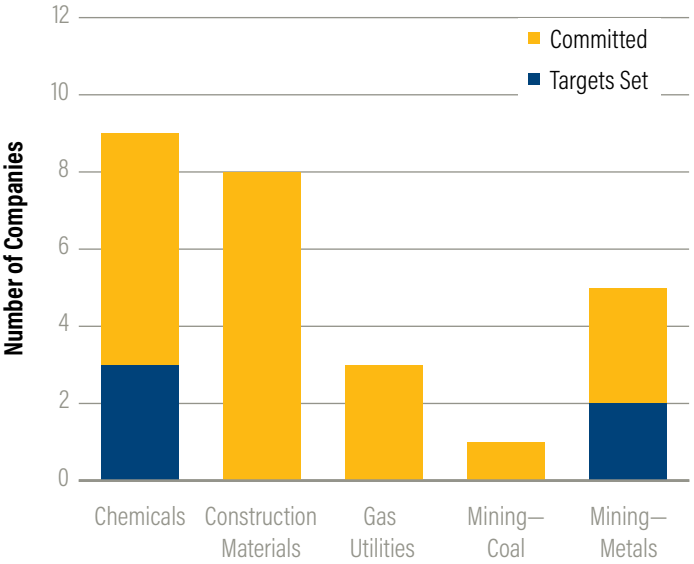
Box 4.2 | **Large-Scale CCS for Heavy Industry**

Carbon capture and storage (CCS) will play a significant role in decarbonizing the heavy industry sector to meet a 1.5°C target (IEA 2017a). The world's first fully commercial CCS facility for iron and steel production, Abu Dhabi CCS, began operation in 2016, capturing up to 0.8 $MtCO_2$ annually. Two CCS facilities for chemical production are now under construction in China (Sinopec Qilu Petrochemical CCS and Yanchang Integrated Carbon Capture and Storage Demonstration) and will start operation in 2019 and 2020, with 0.4 $MtCO_2$ per year capture capacity each. The Lake Charles Methanol project planned in Louisiana (United States) will have the potential to capture over 4 $MtCO_2$ per year from synthetic gas in chemical production by 2022. And the Norway Full Chain CCS project will have the potential to capture 0.8 $MtCO_2$ by 2023–24 from its cement production and waste-to-energy recovery plant (Global CCS Institute 2018).

## Science-based targets

Twenty-six heavy industry companies have committed to establishing science-based targets (SBT 2018), and five of these have approved SBTs (see Figure 4.3).[32] As those commitments are voluntary, it will also be crucial to ensure the accountability of those companies, so that progress toward and achievement of the targets may be assessed. Public accessible data are insufficient to assess the magnitude of those targets, such as these companies' share of emissions in the industry sector, or how they add up and compare to a trajectory of halving emissions by 2050.

Figure 4.3 | **Number of Heavy Industry Companies with Science-Based Targets**




*Source:* SBT (2018).

### OPTIONS FOR 2020 NDC ENHANCEMENT: INDUSTRY

Around 40 NDCs include actions and plans in relation to heavy industries, such as cement, chemicals, iron, and steel. Only 15 NDCs include quantitative targets related to heavy industry, such as reductions in the sector's emissions and increased share of additives in cement production (ClimateWatch 2018). While companies have a major role to play in decarbonizing heavy industries, momentum can be created and complemented by specifying actions and policies in NDCs. Countries should drive accelerated actions by nonstate actors in heavy industry sectors, advancing policies such as carbon pricing material and efficiency mandates.

## INFRASTRUCTURE: CITIES AND STATES ARE IMPLEMENTING POLICIES AND REGULATIONS TO FULLY DECARBONIZE BUILDINGS AND INFRASTRUCTURE BY 2050

Infrastructure construction and operation, including electricity generation and distribution, industry, buildings, and transport systems, account for 70 percent of global GHG emissions (World Bank 2018b). Accordingly, decarbonizing infrastructure is crucial to limiting warming to 1.5°C. Investing in low-carbon infrastructure can help mitigate GHG emissions, reduce air pollution, and improve congestion. Expansion of infrastructure related to adaptation, such as seawalls and flood protection, will also help increase climate resilience and reduce vulnerability.

Cities and states have been increasingly making commitments to decarbonize infrastructure and buildings (C40 2018b). Over 9,000 cities registered actions on the UNFCCC's Global Climate Action portal (UNFCCC 2018). More than 70 mayors have committed to developing and implementing climate action plans by 2020 and becoming emissions-neutral by no later than 2050. While these commitments extend beyond just buildings and infrastructure, many of them include related actions. The One Planet Charter was signed by 815 cities to reinforce their commitments and take continued actions to reach zero-emissions buildings (see Box 5.1) and zero-waste objectives (Global Covenant of Mayors 2018). Countries will play an important role in policy development, finance, capacity building, and other measures to build an enabling environment for further action.

Box 5.1 | **Net Zero Carbon Building Commitment**

The World Green Building Council's Net Zero Carbon Building Commitment was launched at the Global Climate Action Summit in 2018 (WorldGBC 2018b). Its 44 signatories, including cities, regions, and businesses,[33] committed to significantly cutting GHG emissions in new and existing buildings, with all new buildings reaching net zero operating emissions by 2030 and all buildings operating at net zero carbon by 2050. The commitment is part of the World Green Building Council's global campaign Advancing Net Zero (WorldGBC 2018a), launched in 2016.

At least $300 billion is invested annually to support infrastructure decarbonization, in addition to the necessary $6 trillion in annual business-as-usual infrastructure: [INSUFFICIENT DATA]

Investing in sustainable infrastructure is not necessarily costly and can be met without compromising economic development (NCE 2014a). Failure to invest in low-carbon technologies will cause lock-in to a higher emissions pathway and lead to overshooting the Paris Agreement's limit of keeping warming to well below 2°C, let alone 1.5°C.

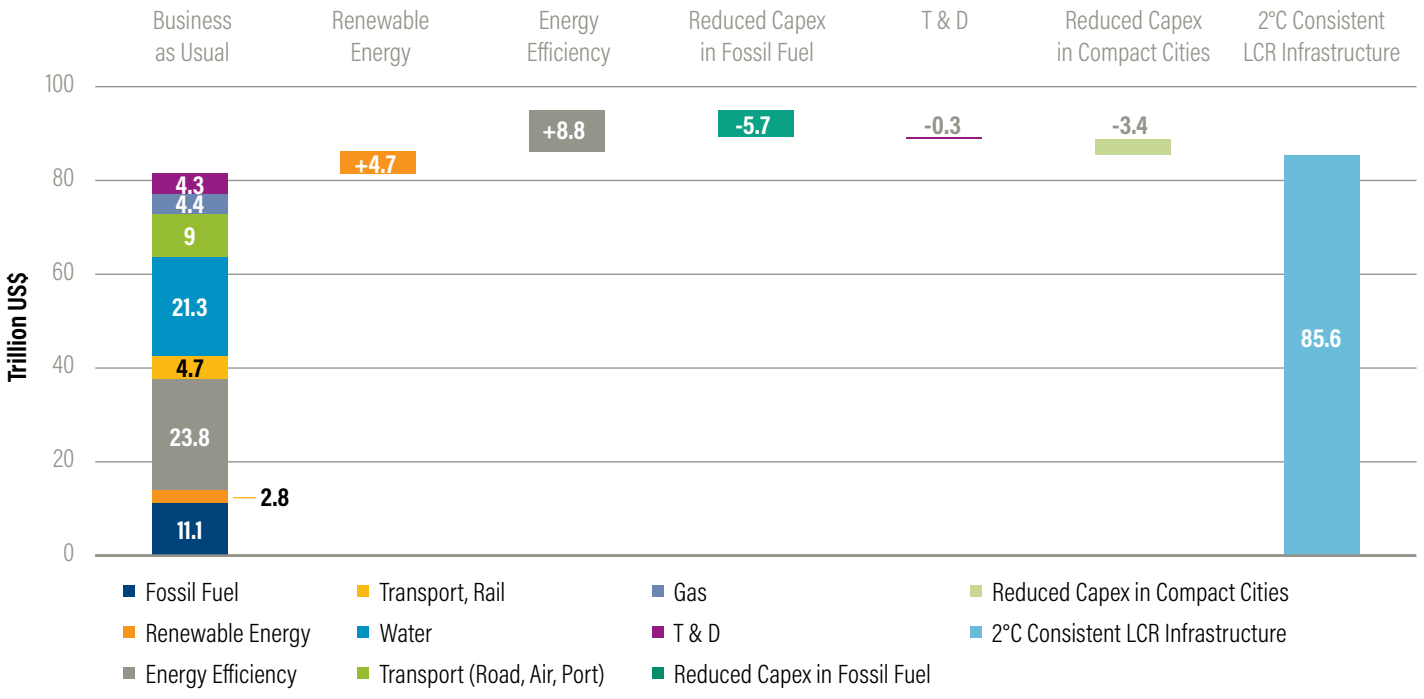
Various analyses (NCE 2014a; Meltzer 2016, 2018) have estimated that infrastructure investment needs will almost double the estimated $50 trillion of current infrastructure stock to nearly $90 trillion by 2030.[34] Developing infrastructure that is sustainable and low carbon is expected to require cumulative additional investment of almost $14 trillion compared to business-as-usual, with approximately $1 trillion in upfront costs per year. However, factoring in the potential savings[35] that come from more sustainable infrastructure, a net increase of $4 trillion in cost between 2015 and 2030 (NCE 2014b), or about $260 billion per year (see Figure 5.1), reflects the cost of investing in a carbon-resilient future.

The difficulty of this investment lies in the upfront costs needed in the short term to achieve the long-term savings. Investment in infrastructure comes from various sources, including multilateral development banks (MDBs), multilateral climate funds,[36] and private sources.

In 2017, the MDBs reached a record high of $32.5 billion in climate finance,[37] a 20 percent increase from the previous year. Those same projects also attracted cofinancing of over $50 billion (MDBs 2018), of which approximately $11.5 billion was dedicated to infrastructure financing (Meltzer 2018). Data are insufficient to know how much investment occurred beyond the MDBs, making it impossible to assess progress. However, if the MDBs are a significant percentage of finance to support infrastructure decarbonization, progress may very likely be inadequate. Developed countries are encouraged to fulfill their international pledges, and the private sector will need to increase investment while public financing continues to de-risk those projects.

Given limited public finance, the private sector would need to finance 35 to 50 percent of infrastructure investments (Bielenberg et al. 2016). Private institutional investors have significant untapped potential, with over

Figure 5.1 | **Low-Carbon Infrastructure Investment Needs (2015–30, Cumulative)**




*Note:* LCR=Low-Carbon Climate-Resilient. T & D = Transmission and Distribution.

*Source:* Meltzer (2018).

$85 trillion in assets currently under management and over $110 trillion expected by 2020 (Meltzer 2018). However, current allocations to infrastructure are approximately just 1 percent of the total assets (OECD 2015). The higher risk profile of low-carbon infrastructure investments, as well as even or higher costs of capital compared to the rate of return on those projects in most cases, have prevented such projects from attracting more funding. Public finance can play a crucial role in de-risking those projects (Meltzer 2018). In addition, integrating the social cost of return will show the benefits of those investments (Meltzer 2018).

Subnational governments will need to have better access to finance and the ability to attract investments in projects that need support. A report published in 2018 showcases nearly 400 cities with 1,143 projects worth almost $60 billion in investment needs (Moro et al. 2018). Making sure those needs are met and financial resources are allocated accordingly are crucial steps toward realizing a low-carbon, resilient future.

Investment in low-carbon infrastructure is generally lacking at the moment, and not commensurate with the need. If the MDBs are a significant percentage of finance to support infrastructure decarbonization, progress may very likely be insufficient. Developed countries are encouraged to fulfill their international pledges, and the private sector will need to step up while public financing continues to de-risk those projects. Public-private partnership (PPP) investment has been a promising avenue complementing traditional funding for infrastructure projects. During 2012–16, for example, the World Bank Group approved more than 400 loans, totaling over $15 billion, for projects with a PPP component (World Bank 2018b).

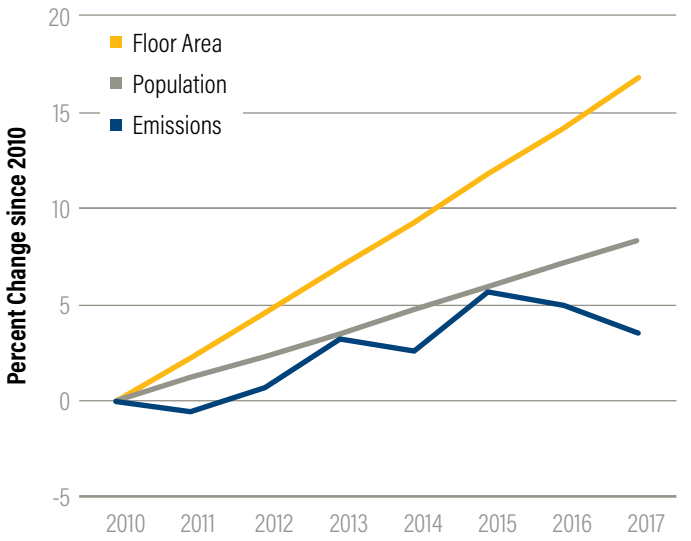
### New buildings are built to zero- or near-zero-energy standards: [INSUFFICIENT PROGRESS] Greatly Accelerate Action

The building sector represents 39 percent of global energy-related $CO_2$ emissions[38] and almost one-third of global energy use (GABC 2018). The total building stock is expected to nearly double by 2050, growing at a rate of 5.5 billion square meters ($m^2$) per year to almost 415 billion $m^2$ in 2050, compared to the current global building stock of 223 billion $m^2$ (GABC 2016).

Ensuring new buildings are built to zero-energy and net-zero-energy standards (see Box 5.2 for definitions) is crucial so that we do not lock ourselves into a high-emissions future. Investing in low-carbon technologies can be cost-competitive, with savings in the long run with better efficiency (NCE 2014a).

Improving global average building energy intensity (energy use per $m^2$) by 30 percent by 2030 is necessary to meet the Paris Agreement's temperature limits. This will require that zero- and near-zero-energy and zero-emissions buildings become the standard for construction within the next decade (WorldGBC 2017). This will also require further action beyond current trends (see Figure 5.2).

Figure 5.2 | **Trends in Floor Area, Energy Consumption, and Emissions for Building Operations**




*Note:* Emissions are $CO_2$ emissions from building operations.

*Source:* GABC (2018).

Zero- or near-zero-energy buildings can be achieved with high energy-efficiency levels that reduce energy consumption and on-site renewable energy generation that offsets energy use (WorldGBC 2018c).

National and subnational governments can provide important policy incentives to drive the market of zero-energy buildings, such as building energy codes, incentives, and certification policies. Less than a third of countries had mandatory building energy codes or building energy certifications in 2017 (IEA 2018a).

Recent progress toward uptake of net zero-energy buildings has been significant. The number of zero-energy buildings has been growing exponentially since 2012, with more than a 700 percent increase (see Figure 5.3). There are nearly 500 zero-energy building projects identified in the United States and Canada (New Buildings Institute 2018) and 2,000 net zero-energy housing units worldwide (Laski and Burrows 2017). However, high-performance buildings such as near-zero energy (NZE) buildings make up less than 5 percent of construction in most markets today (IEA 2018d) and still well less than 1 percent of the global building stock (Laski and Burrows 2017). Existing projects have so far been concentrated in private housing units (mostly constructed as early demonstration of NZE buildings) and commercial office projects. It will be critically important to move from isolated projects to mass market uptake as soon as possible.

Box 5.2 | **Key Definitions**

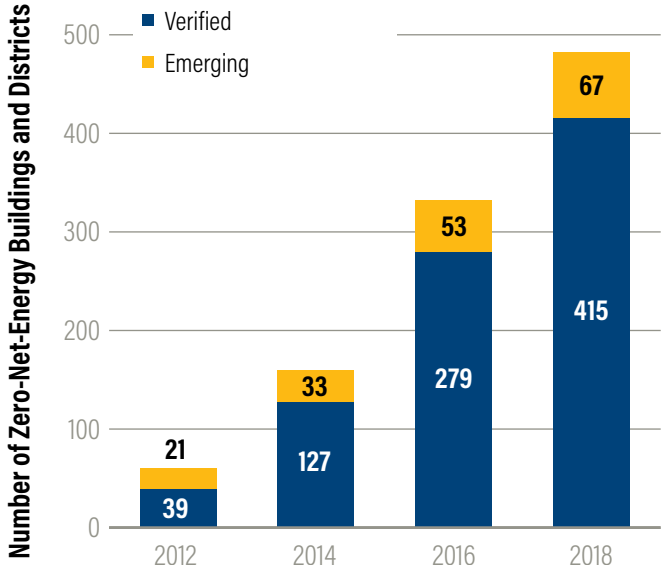
In recent years, concepts such as net zero-carbon buildings and net zero-energy buildings have emerged, with varying focus (buildings' direct emissions or their energy use). This also brings a greater variety of options to address climate change and meet standards. Given the phrasing of outcomes in this chapter, it is worth taking stock of relevant definitions.

- **Zero-energy building (ZEB):** A building that relies on both energy efficiency and entirely on-site renewable energy production to reach its balance of energy consumed and energy produced (UKGBC 2015). The concept is also referred to as **net zero-energy** or **zero net-energy (ZNE)**, with "net" reflecting the fact that "zero" is technically energy used offset by renewable energy produced, but more recently "net" is often removed for simplicity in communication with nontechnical audiences (IPEEC 2018).
- **Zero-carbon building:** "A highly energy-efficient building with all remaining operational energy use from renewable energy, preferably on-site but also off-site production, to achieve net zero carbon emissions annually in operation" (WorldGBC 2018c).

Notably, zero-carbon buildings enable more flexibility in the source of clean energy supply and require more attention to policies for clean energy procurement in addition to construction practice. In both cases, the focus to date has been primarily on the "operational" use of energy and generation of emissions, which are energy consumed to serve the primary functions of the buildings. Embodied emissions from the life cycle of building and construction materials are generally considered indirect emissions (Scope 3) but need to be recognized.

High-performance buildings such as near-zero-energy buildings (nZEB) have also been picked up by countries, especially those markets that are not fully net zero. Other terms used include *zero-energy compatible*, or *zero-energy ready*, and *ultralow-energy buildings*, generally referring to buildings that have reached energy performance similar to that of zero-energy buildings but lack the additional renewable energy component to reach zero energy (New Buildings Institute 2018).

Figure 5.3 | **Number of Zero-Energy Buildings in the United States and Canada**




*Source:* New Buildings Institute (2018).

At least 3 percent of the world's existing building stock, on average, is upgraded to zero- or near-zero-emissions structures annually: [INSUFFICIENT DATA]

Improving energy performance and reducing emissions in existing building stock are equally crucial to ensuring that new buildings are built to zero-emissions standards. Current rates of renovation are around 1–2 percent of the building stock annually, with 10–15 percent energy intensity improvements (GABC 2018).

To reach 100 percent of zero-carbon buildings in 2050, existing buildings will need to be retrofitted at an accelerated rate from 1–2 percent today to 3 percent annually and to increase the stringency of upgrades to meet net zero-emissions standards (GABC 2016). The renovation rate will need to be even higher if there is delay. The rate can also differ given different country

circumstances: in developing countries where a higher share of new buildings is being built, the renovation rate would need to increase 1.5 percent by 2025 and 2 percent by 2040; developed countries would need to reach a 2 percent renovation rate by 2025 and 3 percent by 2040 (Laski and Burrows 2017). Successful business models, such as "Energiesprong," that provide net-zero-energy building retrofit services in developed countries can be learned from (see Box 5.3).

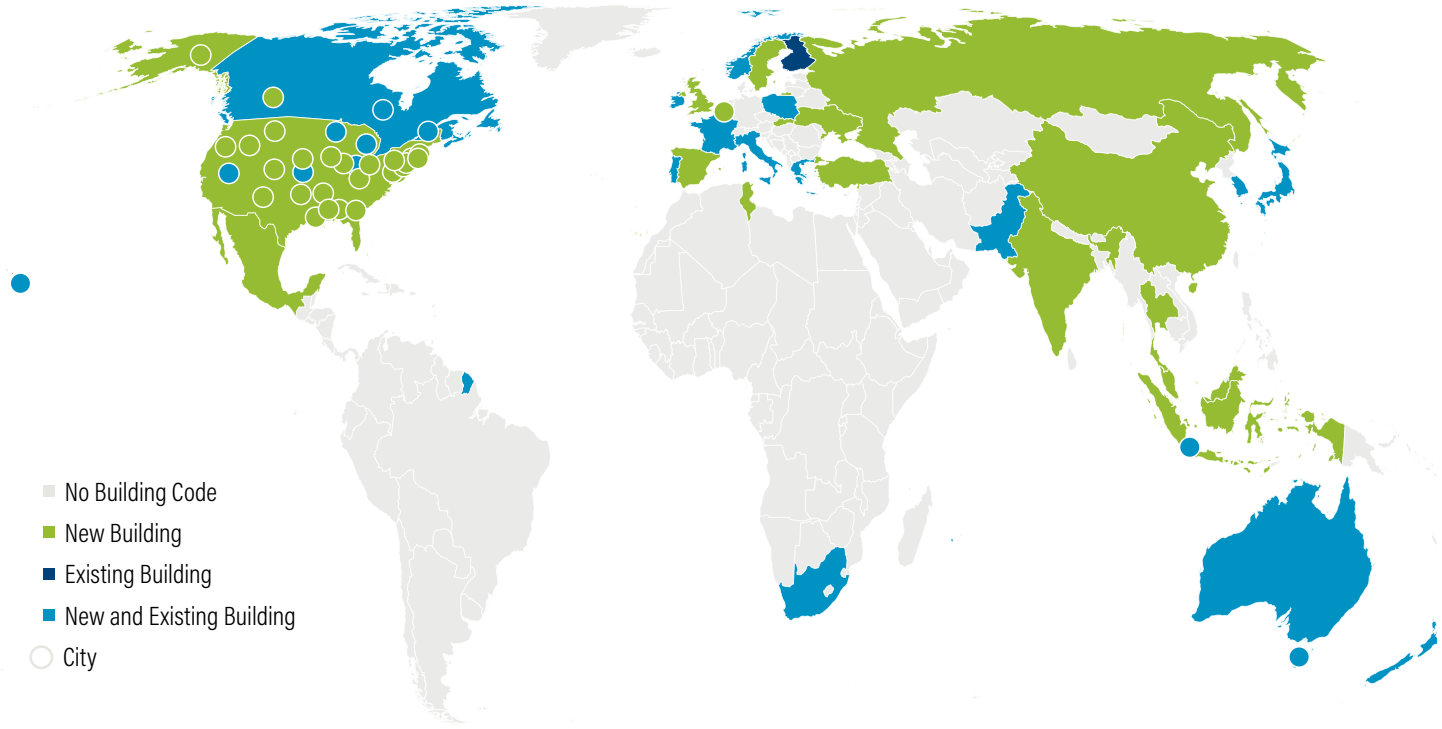
No publicly available data source has been found to provide a more recent and accurate estimate of the current retrofit rate of the world's existing building stock to zero and near-zero standards.

To transition to low- and zero-carbon existing buildings, building energy codes and policies need to be designed to improve efficiency of existing buildings, and transparency needs to be encouraged in building energy asset characteristics and energy performance. Currently, however, most countries lack the mandatory policies that make building improvement a priority. Only 18 countries now have building energy codes that target improvements at the existing building stock (see Figure 5.4), and many of these codes are not mandatory. Thirty-six countries have building labeling in place (IEA 2018a).

Box 5.3 | **The Energiesprong Model**

Regarding renovation, one of the best-known initiatives has been the "Energiesprong" program, which is now present in four countries—France, Germany, the Netherlands, and the United Kingdom—as well as some jurisdictions in the United States. This innovative effort seeks to achieve affordable zero-energy building retrofits. In the Netherlands, 4,500 homes have been built using the "Energiesprong" model, with over 14,000 planned ("Energiesprong" 2018).

Figure 5.4 | **Countries with building codes aimed at new and/or existing buildings**




*Source:* IEA (2018a).

### OPTIONS FOR 2020 NDC ENHANCEMENT: INFRASTRUCTURE

Over 130 NDCs mention the building sector, and 45 of these put forward building-related plans and actions, with 38 including plans and policies that address building efficiency. Only 13 NDCs list specific quantitative mitigation targets such as emissions reductions and demand-side efficiency in buildings (Climate-Watch 2018). Countries should include or complement existing policies in their future NDCs. Furthermore, mentioning more specific actions, targets, and technologies in NDCs—such as new building codes, building envelope improvement, and enhanced heating and cooling efficiency—that are crucial for decarbonizing buildings would create a clearer path for achieving those ambitions.

## FINANCE: INVESTMENT IN CLIMATE ACTION IS BEYOND $1 TRILLION PER YEAR, AND ALL FINANCIAL INSTITUTIONS HAVE A DISCLOSED TRANSITION STRATEGY

Access to sufficient financing is a prerequisite for scaling mitigation and adaptation action. While public financing for climate has been growing over time, it remains insufficient compared to the total needs, and private investment also needs to be scaled up and better aligned with climate objectives.

There has been growing interest from the private sector in greater transparency around the climate risks of investments as these risks are becoming more apparent and opportunities expand for new and innovative instruments. Current estimates suggest that the green economy represents around $4 trillion, or 6 percent of market capitalization of global listed companies, around the same size as the fossil fuel sector, and with significant opportunity for continued growth across sector, company size, and industry (FTSE Russell 2018).

Invest at least $200 billion of public and $800 billion of private resources in climate action each year:

Public: **[ON TRACK]** Sustain Action

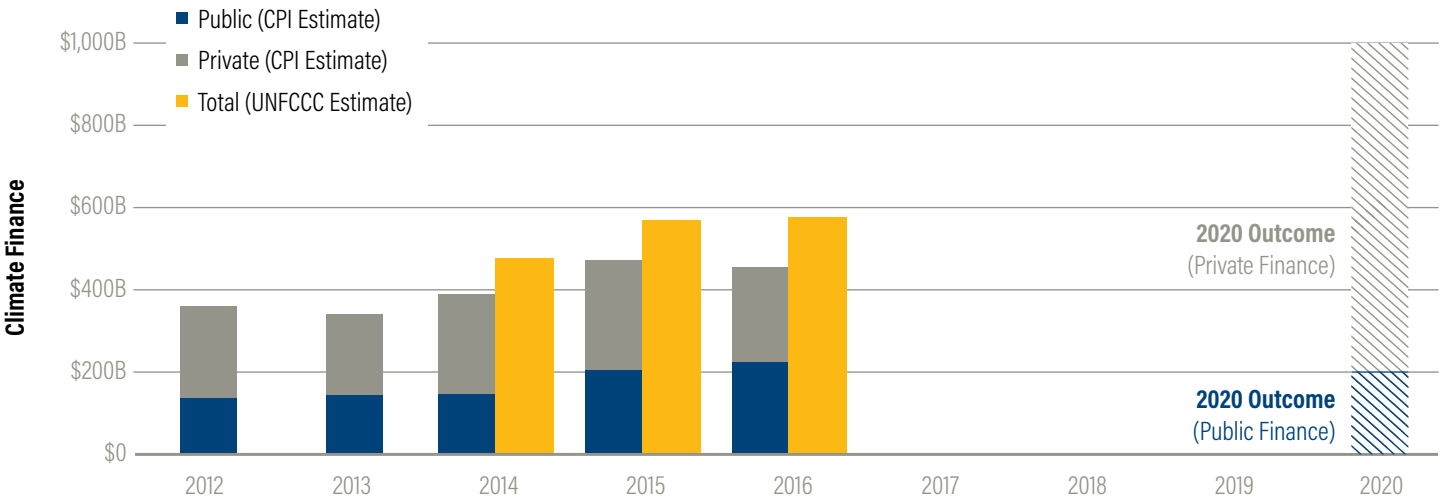
Private: **[INSUFFICIENT DATA]**

In 2016, global investment to tackle climate change—covering only a portion of the global flows due to data gaps—is estimated to have totaled between $455 billion[39] and $681 billion, with the high estimate including investment in energy efficiency (Oliver et al. 2018; Watson et al. 2018).[40] These estimates do not include public finance from domestic budgets, as there are no globally consistent data that avoid double counting; nor do they include the totality of private finance, as most areas outside of renewable energy and electric vehicle investments do not have comprehensive data. This lack of a complete global data set precludes us from forming a comprehensive picture of low-carbon investments.

As seen in Figure 6.1 on page 40, climate finance flows for which there are data to be estimated follow an inconsistent but generally upward trajectory, and preliminary numbers for 2017 indicate an upward trend on the order of 15 percent (Oliver et al. 2018). Following the current trajectory for total, public, and private investment, the $200 billion public finance outcome will continue to be met in 2020, and it is also possible that the $800 billion private finance outcome will be met, though this will be difficult to confirm due to lack of complete data. Furthermore, the identified outcomes may not capture the full landscape of finance needed at that time, or align with impact, as many technology costs are falling, meaning more climate benefits can be achieved for less.

A number of initiatives and commitments by both private and public sector entities—such as the World Bank's December 2018 commitment to double its current five-year climate investments to around $200 billion over the period 2021–25 (World Bank 2018c)—point to a growing pool of green finance (see Box 6.1 on page 40). This growth will need to continue and accelerate to sufficiently finance our transition to a Paris-compliant economy.

Figure 6.1 | **Estimates of Global Flows of Climate Finance as Compared to the 2020 Outcome**




*Note:* The estimates from CPI and the UNFCCC are calculated using different approaches, but neither captures the full landscape of climate finance flows. Furthermore, the outcome of $1 trillion in climate finance by 2020 does not necessarily reflect climate finance needs at that point.

*Sources:* Buchner et al. (2017); Oliver et al. (2018); Watson et al. (2018).

Box 6.1 | **Major Initiatives and Commitments to Make Finance Greener**

Movement toward greener public and private finance can be seen in a number of initiatives by companies, financial institutions, and governments to bring more finance in line with climate-aligned activities, including, among many efforts:

- the Investor Agenda, by which nearly 400 investors representing $32 trillion in assets under management (AUMs) have pledged to accelerate climate action;
- the Green Bond Pledge and Global Green Bond Partnership;
- the Climate Action 100+, by which nearly 300 investors representing $31 trillion in AUMs have committed to engage with the world's largest GHG emitters to accelerate climate action; and
- pledges by more than 15 major insurance companies, including Axa, Swiss Re, and Zurich, to stop underwriting coal-related companies.

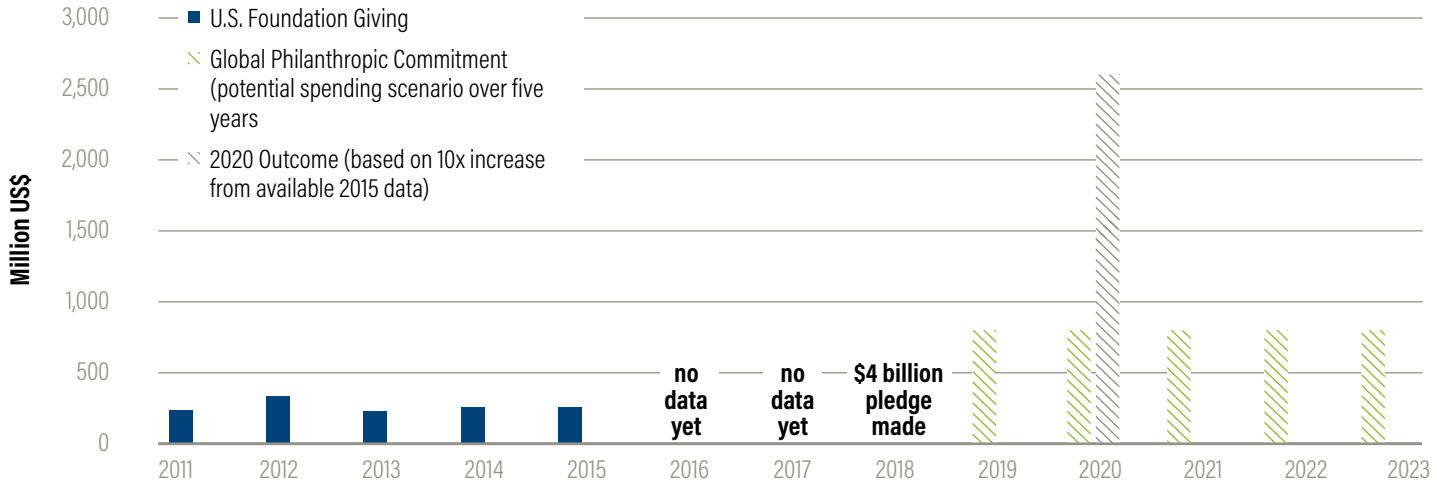
Additionally, Article 2.1c of the Paris Agreement calls for governments to make all finance flows consistent with a low greenhouse gas, climate-resilient pathway, and the Sustainable Development Goals Target 13a calls for mobilization of $100 billion annually from 2020. All of these point to a growing pool of finance for climate mitigation and adaptation action.

Increase the amount of philanthropic funding for the climate movement tenfold from 2016 levels: **[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Twenty-nine philanthropic organizations came together at the Global Climate Action Summit (GCAS) in September 2018 to announce a $4 billion commitment to climate action over the next five years—the largest commitment ever to climate philanthropy (ClimateWorks 2018). This funding will support healthy energy systems, inclusive economic growth, sustainable communities, land and ocean stewardship, and transformative climate investments.

This contributes to the milestone of increasing climate philanthropy tenfold from 2016 levels by 2020 and is a strong step in the right direction; it also does not encompass all philanthropic giving toward climate. According to the Foundation Center, which tracks the thousand largest U.S. foundations, $259 million went to climate action in 2015 (data are not yet available for 2016, nor globally) (Foundation Center 2018a), representing around 1 percent of all U.S. foundation giving. However, this figure underestimates the actual amount of climate-related support. For example, up to another 3 percent of giving that goes toward sustainable agriculture and clean energy also indirectly supports climate action (Foundation Center 2018b). While these numbers include only U.S. foundations, and the $4 billion pledge is global, the figures

Figure 6.2 | **Philanthropic Funding for Climate Action**




*Note:* The blue bars represent total philanthropic contributions for climate action from U.S. foundations; the $4 billion commitment, shown in green, includes global foundations and shows a possible spending scenario over the five-year commitment; the gray bar represents a tenfold increase over 2015 giving, based on available data.

*Source:* Foundation Center (2018a).

provide an indication of the current level of funding compared to where it will go. Furthermore, philanthropy in favor of the climate has only grown, by 9 percent between 2011 and 2015,[41] so this commitment would help accelerate that growth rate significantly, if spent in roughly equal amounts each year (see Figure 6.2).

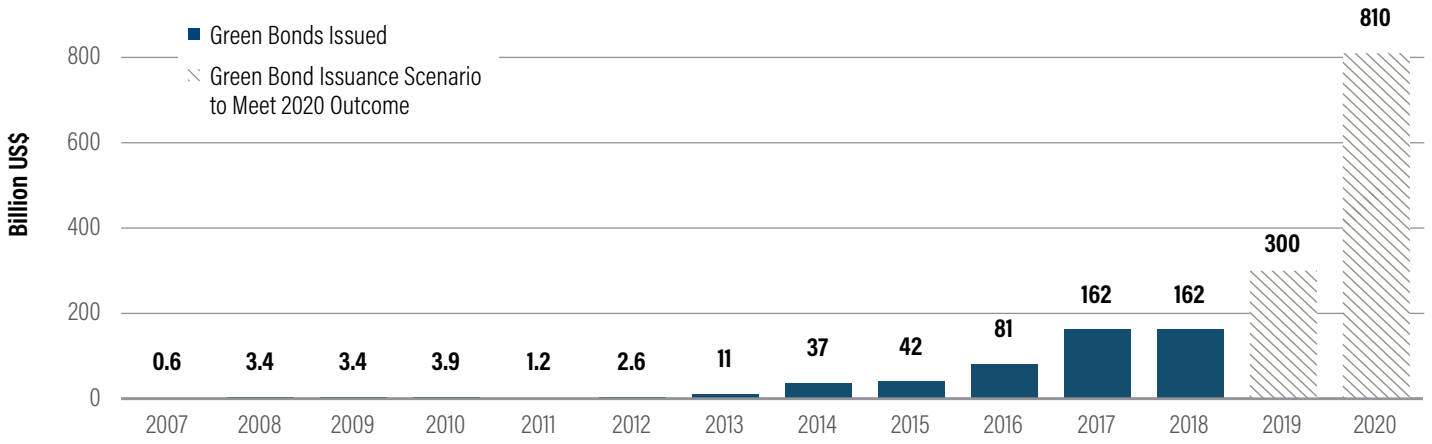
In line with the growing commitment to climate evidenced by the $4 billion pledge, a survey of 10 major foundations in the United States and Europe, representing more than $240 million in climate funding per year, found that the majority of foundations have increased their focus on climate and will continue to do so (Foundation Center 2018b). Nearly 200 major foundations have also committed to divesting from coal or all fossil fuels (Fossil Free 2018).

Multiply the green bond market annual issuance tenfold from 2016 levels: **[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Growth in green bond issuance has been very strong over the past five years, and while 2018 saw a bit of a leveling off, the overall trend reflects strong and growing interest, though perhaps not fast enough to reach the $810 billion-outcome in 2020 (a tenfold increase over 2016 levels of $81 billion). Green bonds, which raise finance for climate-aligned[42] projects, are among the fastest-growing sectors in the investment world, reaching $162 billion issuance in 2017 (CBI 2018b) up from less than $11 billion in 2013 (CBI 2014). This growth includes nearly doubling from $42 billion to $81 billion between 2015 and 2016, doubling again to $162 billion in 2017, and then leveling off in 2018 to the same $162 billion (CBI 2019) (see Figure 6.3 on page 42).

Green bond issuance has grown substantially over the past few years, both in size and breadth, with Europe leading the way, followed by North America and China and with a growing presence of emerging markets. Transport and renewable energy are the largest sectors of focus. In addition to labeled green bonds, there is a larger universe of more than $1 trillion in outstanding bonds from issuers that derive most (75–95 percent) of their revenue from climate-aligned projects, indicating strong potential for expansion of labeling, as well as growth in overall issuance (CBI 2018a).

Figure 6.3 | **Green Bond Issuance Compared to 2020 Outcome**




*Source:* CBI (2019).

For issuers, green bonds provide a means to raise finance for climate-friendly projects; for investors, they provide a clear indication of climate consideration as well as increased transparency regarding the projects and their impact (see Box 6.2).

Challenges are inherent in the expansion of this relatively new sector. There is concern about differing standards across issuers, and about use of the term "green bond" where the investment is not sufficiently climate-aligned (for example, energy efficiency measures that lock in infrastructure that is not efficient enough). This concern can be especially important in emerging markets. China, for example, has its own definition of green bonds that does not yet align fully with international green definitions. Several different organizations are working to provide guidance with respect to issuance and definitions.[43]

Box 6.2 | **Sovereign Green Bonds**

In December 2016, Poland became the first country to issue a sovereign green bond (an ordinary government bond whose proceeds are used for climate-aligned projects). It was joined by France, Fiji, and Nigeria in 2017, and Indonesia, Belgium, and Lithuania in 2018. Soon thereafter, Poland issued a second sovereign green bond, becoming the first country to do so. Sovereign green bonds, the sales of which reached around $20 billion by mid-2018, are becoming an important tool for governments to raise capital for projects to meet national climate commitments under the Paris Agreement. They can also serve as a signal of political will and a means to help develop domestic green markets (CBI 2017).

As a signal of increasing commitment from issuers, the Green Bond Pledge, announced at the Global Climate Action Summit in September 2018, commits signatories to using green bonds, in order to incorporate climate risk when financing long-term infrastructure or capital projects. This pledge is a sign of growing commitment to the seriousness of the challenge and the magnitude of the opportunity. Current signatories include the state of California and Mexico City, among many others.

Meeting the goal of $810 billion in green bond issuance by the end of 2020 appears more out of reach as 2018 bond issuance remained the same as 2017 levels; further, achieving it would still be a small slice of the $100 trillion global bond market. The onus is now on banks and corporations to move decisively from ordinary bonds to green products, reflecting the brown-to-green transition in their balance sheets and forward capital expenditure plans.

Institutions disclose climate-related financial risks and that credit ratings fully incorporate them: **[INSUFFICIENT DATA]**

Companies and investors need access to complete information to make informed investment decisions. Conversely, credit rating agencies need to fully incorporate climate risks into their ratings in order to provide full information for investors. This information is especially important as the effects of climate change become more tangible and have impacts on physical infrastructure as well as on business and profitability through the transition to a greener economy.

The Task Force on Climate-Related Financial Disclosures (TCFD), formed in December 2015 at the request of the Financial Stability Board and operating by mandate of the G20, issued a set of recommendations in 2017 to provide guidance on what types of information companies should disclose as part of their financial filings to inform investor and other stakeholder decisions, as well as their own operations. The guidelines include 11 pieces of information across four areas: governance, strategy, risk management, and metrics and targets (TCFD 2017).

As of September 2018, 457 companies and 56 other organizations, including governments and industry associations, had signed on to the recommendations, totaling over 500 supporters, up from around 100 in mid-2017. Combined, they have a market capitalization of nearly $8 trillion and include 287 financial firms responsible for assets of nearly $100 trillion (TCFD 2018). As an example of one pilot initiative, the United Nations Environment Programme's Finance Initiative (UNEP FI 2018) has partnered with 16 of the world's largest insurers, representing $5 trillion in assets under management, to develop tools to inform industry disclosures in line with TCFD recommendations. Additionally, research into more than 1,600 companies across 14 countries and 11 sectors shows that the vast majority of companies acknowledge that climate change poses financial risks for their business, with 83 percent of companies recognizing the physical risks and 88 percent identifying policy changes or new regulations as the main risks of transitioning to a low-carbon economy (CDP and CDSB 2018).

A progress report released in late 2018 provides baseline data on what companies are already including in recent filings to help inform development of a roadmap forward (TCFD 2018).[44] The report found that the majority of companies disclose some climate-related information, such as risks and opportunities in the short, medium, and long terms, but more rarely, financial implications or how resilient strategies are, fell under different climate scenarios. The coming months will be focused on increasing uptake of the recommendations by companies, and a follow-on progress report will be released at the G20 in 2019, where uptake will be more systematically tracked. Disclosing risks is only the first step; companies will also need to build risk management practices into their long-term plans and operations. Movement among financial regulators has already begun: the European Union is addressing these issues in its Financing Sustainable Growth Roadmap; the recently launched Network for Greening the Financial System is bringing together central banks and supervisors to assess risks and develop tools (European Commission 2018; NGFS 2018), and France became the first country to pass related legislation (see Box 6.3).

In terms of incorporating climate risk into credit ratings, investor demand for credit rating agencies to take into consideration environmental, social, and governance (ESG) risks (as proxies for climate risks) is increasing (PRI 2017). Within that, credit rating agencies are increasing their focus on environmental risks, but external communication and transparency are lacking around this process, in part because rating agency methodologies are by nature not transparent. Accordingly, not enough data exist to track progress.

In 2016, Principles for Responsible Investment, an international network of investors, published a statement on ESG in credit ratings, where credit rating agencies commit to collaborate on more systematic and transparent incorporation of ESG into credit ratings (PRI 2017). By June 2018, 16 credit rating agencies had signed it, including the major three—Moody's, Fitch, and S&P (PRI 2018)—up from 6 two years prior. The European Union is also considering including environmental and social sustainability guidance in its disclosure guidance for credit rating agencies (High-Level Expert Group on Sustainable Finance 2018). While complete data on uptake of TCFD recommendations are yet to come and data on incorporation of climate risks in credit ratings are not available, increased interest from both investors and rating agencies indicate movement in the right direction.

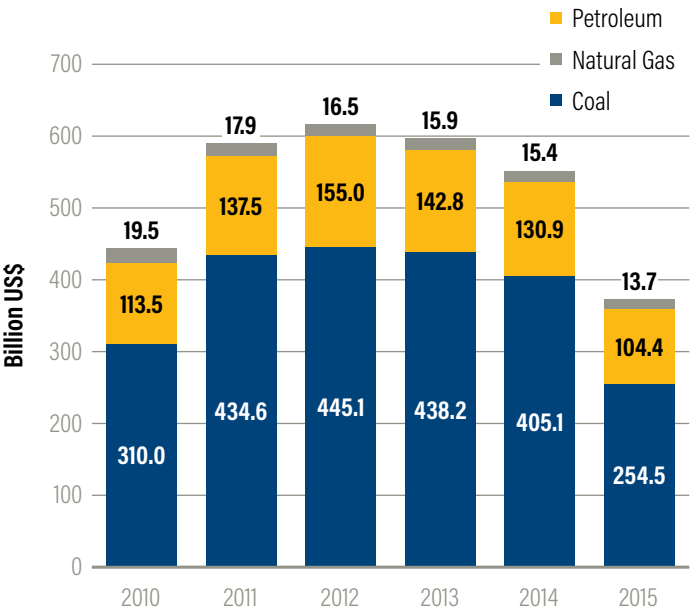
### Box 6.3 | Mandatory Disclosure of Climate-Related Financial Risks in France

In 2015, France became the first country to pass legislation on mandatory disclosure of climate-related financial risks for institutional investors and asset management companies (FIR 2016). France's legislation could serve as a framework for other countries, showing how to mainstream the TCFD recommendations into national law.

Eliminate fossil fuel subsidies:
**[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Subsidies for coal, oil, and gas essentially act as a negative carbon price, reducing the costs for these polluting substances and taking up funding that could instead be used for other expenditures, including investment in sustainable development. Analysis from the Organisation for Economic Co-operation and Development (OECD) and the IEA offers the best available global data on fossil fuel subsidies, finding that they have declined from $443 billion in 2010 to $372 billion in 2015 (see Figure 6.4). The combined data set covers 76 countries, responsible for 94 percent of global $CO_2$ emissions (OECD 2018). Partial data for 2016, covering only OECD countries, show that subsidy levels have remained about the same between 2015 and 2016.

Figure 6.4 | **IEA-OECD Joint Estimate of Support for Fossil Fuels**




*Source:* OECD (2018).

Member countries of the G7, G20, Asia-Pacific Economic Cooperation, and the European Union have all committed to phasing out "inefficient"[45] fossil fuel subsidies, indicating some political will among some of the wealthiest and fastest growing economies to act on the issue. However, despite recommitments to their pledge every year since 2009, G7 countries continue to provide more than $100 billion (in 2015 and 2016) in government support for the production and consumption of fossil fuels at home and abroad, adding uncertainty as to their will to meet their commitment by 2025 (Whitley et al. 2018).

While the data show incremental progress at the global scale, movement at the country-level is varied. In many developing countries, subsidies are more direct, as fuel and/or electricity prices are more likely to be set by the government, while in developed countries, subsidies are more likely to come through less transparent means like preferential tax treatment for fossil fuel companies. There are some examples of steps forward: members of the European Union have pledged to phase out subsidies for hard coal (Gençsü and Zerzawy 2017); Indonesia adopted reforms to reduce subsidies for fuel and electricity in 2014 and 2015 (IEA 2016b); India reduced its spending on subsidies from $36 billion to $20 billion between 2014 and 2016 (Garg et al. 2017); and the United Arab Emirates phased out subsidies for gasoline and diesel in 2015 (CAT 2018b). All told, the Global Commission on the Economy and Climate estimates that more than 40 countries partially reduced subsidies for fossil fuels between 2015 and 2017 (NCE 2018). At the same time, a prolonged economic upswing combined with a multiyear slump in fossil fuel prices means that these reductions in subsidies cannot always be fully attributed to policy intervention but can also result from lower prices for fossil fuels, spurring less subsidization (NCE 2018).

While the combined OECD and IEA numbers for fossil fuel subsidies count price transfers, budgetary transfers, and forgone revenue, there is a wide range of estimates from other organizations, the variation in which can be attributed to disagreement over what counts as a subsidy. Estimates based on these broader definitions come to $5.3 trillion for 2015 (Coady et al. 2017).[46]

In addition to direct subsidies, public finance flows to fossil fuel projects through domestic and international finance, export credit agencies, or state-owned enterprises can sometimes also be considered subsidies—for example, preferential treatment through lower interest rates for public loans. Between 2013 and 2015, the G20 countries and the Multilateral Development Banks provided around $72 billion per year to fossil-fuel-related projects that benefited from preferential rates (OECD 2018).

As with many reforms, increased transparency is often the first step to driving change. Although reforms are progressing, they remain fragile and are not decreasing fast enough to be eliminated in the next few years, regardless of how subsidies are defined.

Cancel capital expenditure for coal, oil, and gas production: **[INSUFFICIENT DATA]**

If we are to achieve the Paris Agreement's temperature goals and create a more sustainable energy system, investment in the production of coal, oil, and gas needs to be phased out. Market dynamics and regulatory pressure are already driving this shift in some places, though progress varies by fuel type and country.

The shift away from fossil fuels, especially coal, is already under way and its effects are being felt as renewable energy outcompetes coal on price in many areas (Benn et al. 2018). Looking ahead, this shift toward renewable energy is expected to continue as technologies advance and costs continue to decline. However, to be on track toward limiting warming to 1.5˚C, the shift must also be accelerated through additional policy action. Stranded assets will occur with technological advancement alone, but their magnitude will also depend on the level of ambition of national climate policies (Mercure et al. 2018).

Carbon Tracker Initiative's 2015 report found that just under $2 trillion in capital expenditure will need to be canceled through 2025 to be in line with a 2°C scenario (Leaton 2015). This covers coal, oil, and gas and indicates that while oil holds two-thirds of the capital risk (through 2025), coal has two-thirds of the carbon risk (through 2035) and just 10 percent of the capital risk.[47] Capex for oil and gas production has dropped with the price of oil since its peak in 2014 (Bousso 2018). This has resulted in higher-cost projects being put on hold and has made investors more cautious about betting on high oil prices. Only time will tell whether there is a rebound in investment with oil prices, or if this is a structural change. Either way, oil and gas together are more than 90 percent of the capex risk, and more data are needed to track their progress.

As the market for thermal coal exports undergoes structural change, any new thermal coal mines would be inconsistent with achieving climate goals under the Paris Agreement. Some new mines have been proposed, but they are the exception, not the norm (IEA 2017d) (see Box 6.4), and the capex still being spent is focused on developing existing brownfield sites rather than new greenfield mines. A number of the largest diversified mining companies have been disposing of thermal coal assets as they implement strategies to focus on core assets for the future, with Rio Tinto becoming coal-free in 2018 (Reuters 2018). At least 21 major banks, including HSBC, Deutsche Bank, and Credit Suisse, have decided not to finance new thermal coal mines (Banktrack 2018).

If investments are not shifted, globally investors stand to face a $1–4 trillion loss of wealth from stranded fossil fuel assets (Mercure et al. 2018). Given the inevitability of this shift, it is critical for asset owners and regulators to prepare for this transition to minimize negative impacts through a combination of policy options (Benn et al. 2018).

### Box 6.4 | Adani's Carmichael Coal Mine in Australia Does Not Receive Government Financing

The Australian government recently decided not to provide government financing to build what would be one of the world's largest coal mines. Adani, an Indian conglomerate planning to build the mine, had asked for around $730 million to finance the project, but Adani announced in November that it will scale back the project, which the corporation will finance itself (Cave 2018).

This decision can be seen as a tipping point in the global shift toward more sustainable energy sources, indicating the lack of interest and willingness of governments and banks to finance new coal mines.

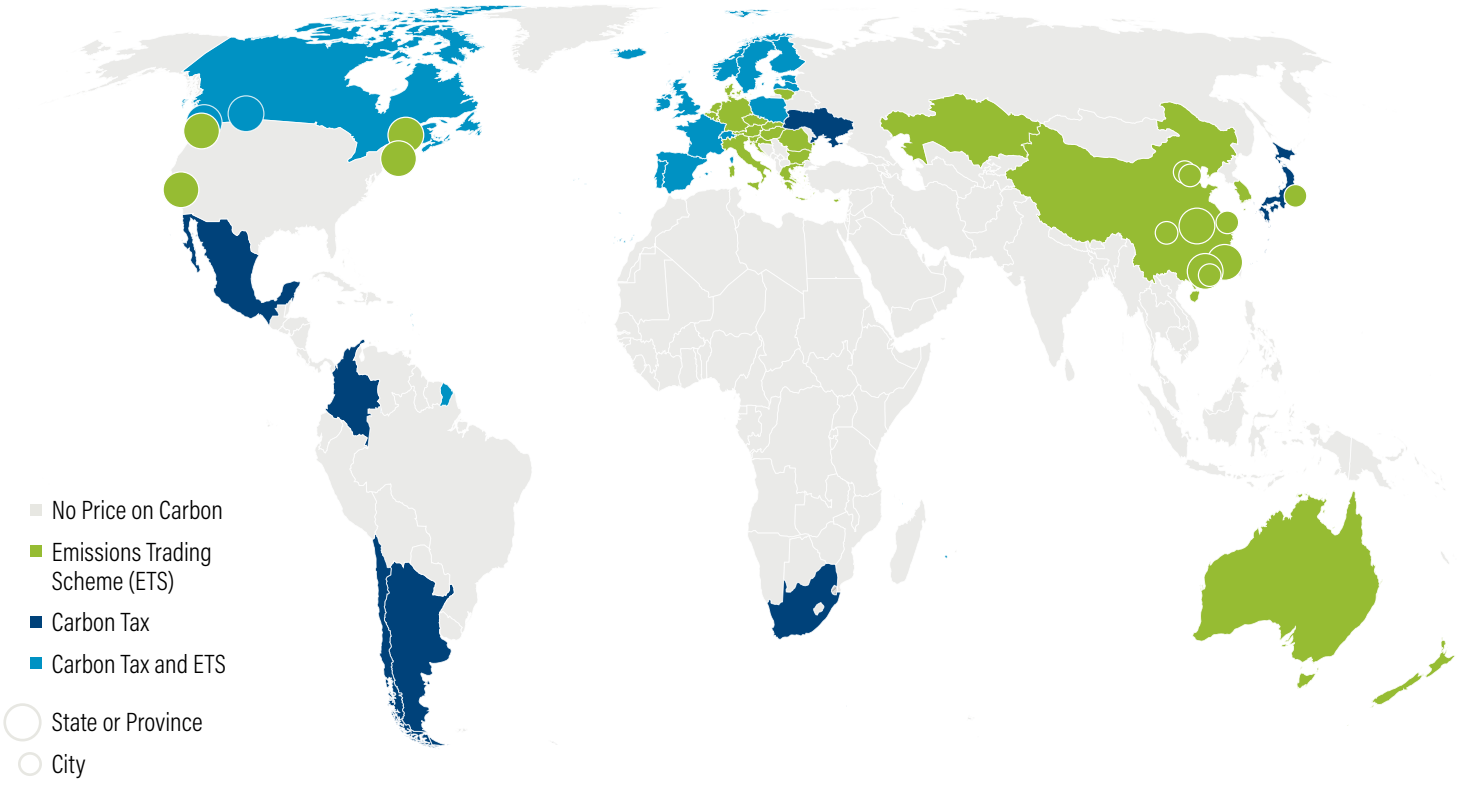
Implement a carbon pricing mechanism within and across all major economies: **[INSUFFICIENT PROGRESS]** Greatly Accelerate Action

Pricing carbon is fundamental to shifting investment, production, and consumption, since it can bring the price of carbon in line with its full impact on society and the environment. It is necessary to implement policies that put a high cost on carbon in order to achieve cost-effective alignment with pathways consistent with limiting warming aligned with Paris Agreement goals (Rogelj et al. 2018). At the same time as carbon prices are implemented, there must be concurrent effort to remove fossil fuel subsidies, which essentially act as a pull in the other direction, lowering the price of carbon.

As of late 2018, 52 carbon pricing initiatives had been implemented or were planned for implementation, including 25 emissions trading schemes and 27 carbon taxes; they cover 19.5 percent of global GHG emissions, according to the World Bank (2018a) (see Figure 6.5). This represents a nearly fourfold increase from 10 years ago, when 5 percent of emissions were covered. Among major economies (using the G20 as a proxy), 14 have carbon pricing implemented or are planning to implement it at the national or subnational levels (those without are India, Indonesia, Russia, Saudi Arabia, Brazil, and Turkey, though the last two have previously considered a carbon tax or emissions trading scheme). Many of these have prices that are too low to change investments and behavior (CPLC 2017) and could expand the scope of their emission coverage. The fact that an increasing number of jurisdictions are implementing carbon prices and that more than 80 countries mention market-based mechanisms and carbon pricing in their NDCs (DIE 2018) points to a positive trend.

The High-Level Commission on Carbon Prices recommended in 2017 that carbon prices be in the range of $\$40–80/tCO_2e$ by 2020 and $\$50–100/tCO_2e$ by 2050 to be consistent with achieving the Paris temperature targets (CPLC 2017). More recently, the Special Report on 1.5°C by the Intergovernmental Panel on Climate Change (IPCC) recommends a higher price, with a minimum of $\$135/tCO_2e$ up to $\$6,050/tCO_2e$ in 2030 for a below 1.5°C pathway (Rogelj et al. 2018). While some carbon prices have increased over time, just six are currently within the $\$40–80/tCO_2e$ range or above (Ramstein et al. 2018). Importantly, the countries with the highest carbon prices, including Sweden and Finland ($\$127/tCO_2e$ and

Figure 6.5 | **Map of Carbon Pricing Schemes Implemented or Planned for Implementation**




*Source:* World Bank (2018a).

$71/tCO_2e, respectively)(World Bank 2018a), have seen continued economic growth while emissions have declined (Aden 2016). Ensuring public understanding of and buy-in to such schemes is also critical for ensuring their success (see Box 6.5).

Box 6.5 | **Carbon Pricing in Canada**

Canada's government announced in October 2018 that all provinces in the country will be covered by a carbon pricing system in 2019 (IISD 2018b). Provinces that do not have a carbon pricing system yet have the flexibility to design their own systems on the basis of their circumstances; for those not on track, a federal backstop system went into effect in January 2019 with a minimum price of CAN$20/$tCO_2e$ (US$16/$tCO_2e$) in 2019, rising to CAN$50/$tCO_2e$ (US$39/$tCO_2e$) in 2022 (Ramstein et al. 2018). The program will be revenue-neutral, with rebates to households expected to more than offset household cost increases (Nuccitelli 2018).

This announcement builds on carbon pricing success at the provincial level, particularly in British Columbia, often cited as an example of a well-designed system with political success (Davenport 2018). British Columbia's system includes an increasing carbon price where the revenues are returned to the people, particularly low-income households.

As an indication of potential growth, 88 NDCs covering 56 percent of global emissions plan to use or are considering using carbon pricing or market mechanisms. This includes three countries (Argentina, Mali, and Uruguay) that did not mention carbon pricing in their INDCs but added it in their NDCs (Ramstein et al. 2018). As countries are requested to communicate new or updated NDCs in 2020, there is an opportunity for more countries to consider carbon pricing.

Complementing the explicit carbon prices that come through carbon taxes and cap-and-trade systems, the private sector has also begun using internal carbon pricing—over 1,400 companies in 2018 are using internal, or "shadow," carbon prices to incorporate the costs of carbon in their investment decisions and operations (NCE 2018). Six of the Multilateral Development Banks pledged in 2014 to use shadow carbon pricing where appropriate to help prioritize projects. In 2017, the World Bank committed to using a carbon price for all projects in highly emitting sectors (Hawkins and Wright 2018).

OPTIONS FOR 2020 NDC ENHANCEMENT:
**FINANCE**

Discussion of climate finance in the first NDCs is largely with regard to countries specifying conditional elements of NDCs and describing finance needed to implement their NDCs. However, some countries also mention specific financial mechanisms. Fifteen countries mention the intention to reduce or remove fossil fuel subsidies, but these do not include the countries that provide the bulk of global fossil fuel subsidies (Climate Watch 2018). Additionally, over 80 mention market-based mechanisms and carbon pricing (DIE 2018). In enhanced or updated NDCs, there is an opportunity to accelerate and increase the ambition of these commitments and include new ones—for example, to halt production of fossil fuel reserves.

## CONCLUSION

We are already seeing key shifts to a new, more sustainable way of living across sectors of the economy. The evidence is mounting—of shifts in investments, scores of companies and countries making commitments to increase action, costs of clean energy technologies plummeting, and increased understanding of climate impacts, with communities around the world connecting the dots between extreme events unfolding around us and human-induced warming.

Achieving most of the milestones laid out in *2020: The Climate Turning Point* is still technically within reach, but whether they are met will require much more concerted policy and investment action, as well as shifts in behavior and mindsets. We are already on the cusp of meeting several of the milestones. However, across the board, we need to deepen action and unlock ambition that will sweep across all sectors and geographies over the next few years. Our success in meeting the six milestones will rest on extraordinary leadership at all levels of society—including governments, businesses, and citizens—that drive decisions needed to pull together financing, develop technologies, and undertake smart policies. If we are successful, we will have a better chance of peaking global greenhouse gas emissions by 2020, our climate turning point (Revill and Harris 2017).

While $CO_2$ emissions from energy and industry showed signs of leveling off between 2014 and 2016, 2017 saw the highest amount of carbon pollution ever, and 2018 emissions are projected to be even greater (Global Carbon

Project 2018). Developed countries are not curbing their fossil fuel consumption quickly enough, and, at the same time, emissions growth is not slowing in other parts of the world; in many cases, it is accelerating. While almost 20 countries, contributing 20 percent of global $CO_2$ emissions, have decoupled fossil fuel $CO_2$ emissions from economic growth over the past decade, globally economic growth has not been decoupled from emissions.

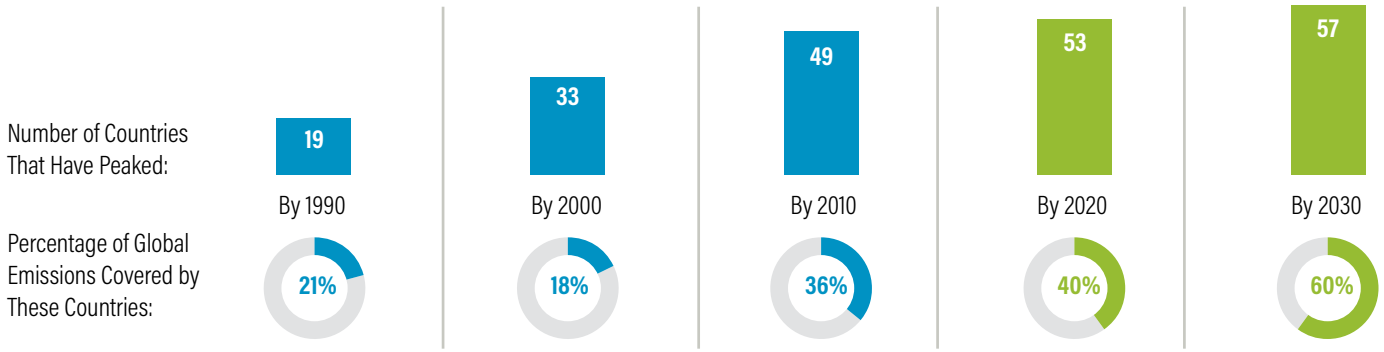
Even with full implementation of the current NDCs, which countries are not on track to meet without additional action, emissions are projected to increase through 2030, delaying our climate turning point by at least a decade. However, at the national level, we are already seeing steady progress in the number of countries reaching peak emissions over time (Levin and Rich 2017). By 1990, only 19 countries had peaked (representing 21% of global emissions); by 2020, this number is likely to grow to 53 countries (representing 40% of global emissions). Among the 53 countries that have peaked already or have a commitment that implies a peak by 2020 are some of the world's largest emitters, including the United States,[48] Russia,[49] Japan, Brazil, and Germany (see Figure 7.1).

While this trend is encouraging, it is far from where we need to be. The world's ability to limit warming to 1.5°C depends not only on the number of countries that have peaked over time but also the global share of emissions represented by those countries, their emissions levels at peaking, the timing of peaking, and the rate of emissions reductions after peaking.

There are many opportunities in the near term to accelerate action and make new commitments. It will be critically important to do so in the context of the necessary long-term transitions, avoiding lock-in of carbon-intensive infrastructure and investing in necessary shifts, such as phasing out of coal; moving swiftly toward renewable energy; ramping up electrification of demand in transport, buildings, and industry; and moving to sustainable land practices. Revisions to nationally determined contributions (NDCs), which Parties are invited to submit by 2020, and the development of long-term plans and strategies can provide helpful signals to catalyze short-term action.

If countries, especially the major emitters, embrace the actions outlined in the milestones in highly emitting sectors, we will have a better chance of bending our emissions trajectory. Countries with emissions that have not yet peaked can also make and achieve commitments to peak their emissions as soon as possible, set their peaks at lower emissions levels, and commit to a significant rate of emissions decline after peaking. Countries with emissions that have already peaked should commit to further ambitious reductions in emissions so that emissions can be phased out by midcentury to increase the odds of achieving the Paris Agreement's temperature goals. And in addition to countries, all hands—including companies, cities, finance institutions, and individuals—will need to be on board to enhance implementation and deepen commitments to achieve the six milestones (NCE 2018). If we are able to realize this transformation, we will create more resilient and secure livelihoods, ensure our air and water is clean, protect human health, enjoy more livable cities, increase job opportunities, and protect species and ecosystems and the services they provide (NCE 2018). We still have time to make 2020 a real turning point that will allow us to turn this vision into reality.

Figure 7.1 | **Growth in Peaking of Countries' GHG Emissions over Time**




*Source:* Levin and Rich (2017).

Figure 7.2 | **Summary of Progress toward 2020 Outcomes**

## 2020 ENERGY MILESTONE

### OUTCOMES PROGRESS

- Renewables make up at least 30 percent of the world's electricity supply [DEMONSTRATED PROGRESS]
- No new coal-fired power plants being built [INSUFFICIENT PROGRESS]
- All existing coal-fired power plants are in the process of being retired [OFF TRACK]

## 2020 TRANSPORT MILESTONE

### OUTCOMES PROGRESS

- Electric vehicles account for 15–20% of new car sales globally [INSUFFICIENT PROGRESS]
- Heavy-duty vehicle efficiency standards are 20% higher across all major economies; transport routes in major cities are operated with zero-emissions modes [INSUFFICIENT PROGRESS]
- Public transport doubles its market share [INSUFFICIENT PROGRESS]
- The aviation sector reduces total emissions per kilometer traveled by 20% below 2013 levels [INSUFFICIENT PROGRESS]
- The shipping sector announces plans for market measures or other instruments to eliminate emissions from their sector [ON TRACK]

## 2020 LAND USE MILESTONE

### OUTCOMES PROGRESS

The world's nations, civil society institutions, and corporations act to end net deforestation by the 2020s, putting us on a path to reducing emissions from forestry and other land use 95% below 2010 levels by 2030:

- Net natural forest loss [INSUFFICIENT PROGRESS]
- Gross tree cover loss [OFF TRACK]
- Restore and conserve at least 150 million hectares of degraded land, enhancing biodiversity and building ecosystem resilience [INSUFFICIENT DATA]

Ramp up the implementation of sustainable agricultural practices that reduce $CO_2$ emissions, increase $CO_2$ removals, and halt the growth in non-$CO_2$ emissions:

- Practices to reduce $CO_2$ and non-$CO_2$ emissions [OFF TRACK]
- Practices to increase $CO_2$ removals [INSUFFICIENT DATA]

## 2020 INDUSTRY MILESTONE

### OUTCOMES PROGRESS

Heavy industry firms have developed, published, and begun implementing roadmaps for their transition to a decarbonized economy in 2050:

- Heavy industry firms have developed and published roadmaps [INSUFFICIENT PROGRESS]
- Heavy industry firms have begun implementing roadmaps [INSUFFICIENT DATA]
- Heavy industries are increasing their energy, emission, and material efficiencies and are on a trajectory to halve emissions by 2050 using science-based targets [INSUFFICIENT PROGRESS]

## 2020 INFRASTRUCTURE MILESTONE

### OUTCOMES PROGRESS

- At least USD $300 billion is invested annually to support infrastructure decarbonization, in addition to the necessary $6 trillion in annual business-as-usual infrastructure [INSUFFICIENT DATA]
- New buildings are built to zero- or near-zero-energy standards [INSUFFICIENT PROGRESS]
- At least 3 percent of the world's existing building stock, on average, is upgraded to zero- or near-zero-emissions structures annually [INSUFFICIENT DATA]

## 2020 FINANCE MILESTONE

### OUTCOMES PROGRESS

Invest at least $200 billion of public and $800 billion of private resources in climate action each year:

- Public [ON TRACK]
- Private [INSUFFICIENT DATA]
- Increase the amount of philanthropic funding for the climate movement by 10x from 2016 levels [INSUFFICIENT PROGRESS]
- Multiply the green bond market annual issuance by 10x from 2016 levels [INSUFFICIENT PROGRESS]
- Institutions disclose climate-related financial risks and credit ratings fully incorporate them [INSUFFICIENT DATA]
- Eliminate fossil fuel subsidies [INSUFFICIENT PROGRESS]
- Cancel capital expenditure for coal, oil, and gas production [INSUFFICIENT DATA]
- Implement a carbon pricing mechanism within and across all major economies [INSUFFICIENT PROGRESS]

# ENDNOTES

1. Defined as with business activity of chemicals, construction materials, mining-coal, mining-aluminum, other metals, and oil and gas.
2. Sectors: chemicals; mining—metals (iron, aluminum, other metals); mining—coal; construction materials.
3. Developed countries have the discretion to choose what counts toward climate finance and have adopted different approaches for doing so (Nakhooda et al. 2013).
4. As of January 10, 2019; https://www.worldgbc.org/thecommitment.
5. This includes $224 billion from the public sector and $230 billion from the private sector.
6. Investments in energy efficiency are excluded from the lower estimate due to lack of granularity in the data in terms of financial instrument, the source and destination of the finance, and the possibility that these investments are locking in infrastructure that is more efficient but not compatible with a 1.5°C pathway.
7. With the data available, this figure is considering only funding provided by U.S. foundations (estimated at $259 million in 2015 by the Foundation Center) scaled up by a factor of 10, as in the outcome text.
8. See the GHG Protocol Mitigation Goal Standard (WRI 2014) for further information on calculations used for tracking progress toward GHG reduction goals.
9. Including hydropower, wind, solar PV and solar thermal, geothermal, biomass, tidal/wave/ocean, and biofuels and hydrogen derived from renewable sources.
10. Data available on Climate Watch. This scenario ("Paris—Increased Ambition") assumes that Parties meet their unconditional NDC commitments until 2030.
11. Generation technology, however, is only one component of the system. Transmission and distribution and balancing will also require investment as more renewable sources are integrated into the system, as will battery storage (Milligan et al. 2015).
12. To a total operational capacity of 2,003 GW globally (CoalSwarm 2018).
13. The "planning phase" includes plants that are marked as announced, pre-permitted, and permitted and excludes plants that are currently under construction.
14. This includes only unabated coal generation, or generation from plants without carbon capture and storage technology.
15. Based on the Sustainable Development Scenario (SDS), which is within range with a 1.7–1.8°C warming based on the IPCC's Special Report on Global Warming of 1.5˚C, and fully compatible with the Paris temperature goals.
16. Electric vehicles (EVs) cover battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PLEVs), and fuel-cell electric vehicles (FCEVs), as well as passenger light-duty vehicles (PLDVs), trucks, and buses. "Electric cars" refers to EVs that are PLDVs.
17. Including cars, buses, trucks, and battery-electric, plug-in hybrid, and fuel-cell vehicle types.
18. As of November 6, 2018.
19. SDG Target 11.2: By 2030, provide access to safe, affordable, accessible, and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities, and older persons. SDG Indicator 11.2: Proportion of population that has convenient access to public transport, by age, sex, and persons with disabilities.
20. Based on the Sustainable Development Scenario in line with well below 2°C of global warming (in the range of 1.7–1.8°C).
21. The International Civil Aviation Organization (ICAO) applies a constant of 3.16 tons of $CO_2$ for each ton of fuel burned. A fixed factor is assumed here to convert the 2020: The Climate Turning Point target of emissions intensity (per passenger kilometer) reduction to energy intensity (per passenger kilometer) reduction for assessing progress.
22. The Reference Technology scenario (RTS) of Energy Technology Perspectives provides a baseline that takes into account existing energy- and climate-related commitments by countries, including NDCs pledged under the Paris Agreement and the International Maritime Organization's Energy Efficiency Design Index (EEDI).
23. The EEDI is an efficiency standard for new ships, requiring an annual average improvement in energy efficiency of 1 percent between 2015 and 2025.
24. The UN Food and Agriculture Organization's Global Forest Resource Assessment (FRA) and World Resources Institute's Global Forest Watch (GFW) both track global forest cover but differ in scope. The FRA tracks "net natural forest loss," which counts both loss and gain, so that forest loss in one region may be compensated by the regrowth of forests in another area, and reports every five years. (The "natural" part of the indicator name means that planted forests are not counted as forest gain.) GFW counts loss and gain separately. For more details see https://www.wri.org/blog/2016/08/insider-global-forest-watch-and-forest-resources-assessment-explained-5-graphics.
25. Peatland, which is very rich in underground carbon stores, can be drained and used as new agricultural land, also leaving it vulnerable to fires, which swept Indonesia and choked neighboring countries in 2015.
26. There are a few discrepancies between the commitments listed by the Bonn Challenge and those by Initiative 20x20 due to whether planned restoration is in forest or agricultural land.
27. These are the United States, El Salvador, Rwanda, Brazil, and the Mexican states of Quintana Roo, Campeche, and the Yucatán.
28. India, the United States, El Salvador, Rwanda, and the Mexican states mentioned in the previous note have made commitments for 2020, while Brazil's commitment is for 2030.
29. The FAO's emissions from agriculture contain all the emissions produced in the different agricultural emissions subdomains following Tier 1 IPCC 2006 Guidelines for National GHG Inventories.
30. Defined as with business activity of chemicals, construction materials, mining-coal, mining-aluminum, other metals, and oil and gas.
31. Based on the Sustainable Development Scenario (SDS), which is compatible with a well-below 2°C of global warming trajectory, within the range of 1.7–1.8°C; https://www.iea.org/weo/weomodel/sds/.
32. Sectors: chemicals; mining-metals (iron, aluminum, other metals); mining-coal; construction materials.
33. As of January 10, 2019.
34. Specifically, $89 trillion in NCE (2014), $75 to 86 trillion in Meltzer (2016), $85 trillion in Meltzer (2018).
35. NCE (2015) and Meltzer (2018) include reduced capex on fossil fuels ($6 trillion), $0.3 trillion from reduced electricity transmission and distribution, $3 trillion from reduced capex in compact cities. This estimate does not include additional an $5 trillion potential savings from reduced operating costs from the low-carbon infrastructures, which would bring actual costs down at $1 trillion net savings compared to business as usual.

36. The Green Climate Fund (GCF), Global Environment Facility (GEF) (including the Least Developed Countries Fund and the Special Climate Change Fund), Adaptation Fund, Climate Investment Funds (CIFs) (comprising the Clean Technology Fund and Strategic Climate Fund). CIFs, the GEF, and the GCF represent over 90 percent of multilateral climate funds.
37. Developed countries have the discretion to choose what counts toward climate finance and have adopted different approaches for doing so (Nakhooda et al. 2013).
38. Energy-related $CO_2$ emissions, including upstream power generation.
39. This includes $224 billion from the public sector and $230 billion from the private sector.
40. Investments in energy efficiency are excluded from the lower estimate due to lack of granularity in the data in terms of financial instrument, source, and destination of the finance, as well as the possibility that these investments are locking in infrastructure that is more efficient but not compatible with a 1.5°C pathway.
41. There was a jump in 2012 attributed to a $100 million grant from the William and Flora Hewlett Foundation to Climate-Works.
42. Climate-aligned bonds are defined as bonds from issuers that derive more than 75% of their revenues from "green" business lines. Green business lines are those in at least one of six climate-sustaining areas: clean energy, low-carbon transport, water management, low-carbon buildings, waste management, and sustainable land use. See www.climatebonds.net for more details.
43. The Climate Bonds Initiative, a London-based organization, monitors green bond issuance and certifies bonds that are consistent with a 2°C pathway under the Paris Agreement and is continually updating guidance in terms of what counts as a green bond for projects in different sectors. The International Capital Markets Association, which provides governance guidelines for capital markets, has created Green Bond Principles as voluntary best practice guidelines for issuing green bonds, and the European Commission and others are developing definitions to ensure that green labels are valid. As the green bond market matures, investors are also gravitating toward internationally accepted definitions of what constitutes green finance and green bonds.
44. Not enough time had elapsed between the release of TCFD recommendations and time to file reports for uptake to be meaningfully tracked.
45. The term "inefficient" is used here because there was no consensus on achieving a complete phase-out of fossil fuel subsidies—some countries argue that there is such a thing as an "efficient" fossil fuel subsidy and that such a subsidy is necessary to enable their poorest population to access energy.
46. Broader definitions include not only direct support to lower consumer prices and reduce costs of production but also the difference between the price consumers pay and the economically efficient price that incorporates externalities on the environment and human health.
47. Financial risk and carbon risk come from the overhang of unneeded capital expenditure (through 2025) and avoided carbon emissions (through 2035) across coal, oil, and gas in a 2°C-compliant scenario, compared to business as usual.
48. Although U.S. emissions increased from 2017 to 2018 (Rhodium 2018), such increases do not surpass the U.S. peak in 2007.
49. Russia's emissions peaked prior to 1990. Although Russia's commitments for 2020 and 2030 indicate an intended increase from recent emissions levels, its future commitments do not propose to surpass 1990 emissions levels.

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## ABOUT THE AUTHORS

**Mengpin Ge** is an associate in WRI's Global Climate Program.

Contact: mge@wri.org

**Katie Lebling** is a research analyst with WRI's Global Climate Program.

Contact: katie.lebling@wri.org

**Kelly Levin** is a senior associate with WRI's Global Climate Program.

Contact: kelly.levin@wri.org

**Johannes Friedrich** is a senior associate with WRI's Global Climate Program.

Contact: jfriedrich@wri.org

# ABOUT WRI

World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity, and human well-being.

**Our Challenge**

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

**Our Vision**

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

**Our Approach**

COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.