

Decarbonizing Development: Planning ahead for a Future with Zero Emissions

Stabilizing climate change entails bringing net emissions of carbon dioxide (CO₂) to zero. CO₂ stays in the atmosphere for hundreds, if not thousands, of years. As long as we emit more than we capture or offset through carbon sinks (such as forests), concentrations of CO₂ in the atmosphere will keep rising, and the climate will keep warming. Countries can follow three principles in their efforts to create a zero-carbon future: (a) planning ahead for a future with zero emissions, (b) getting carbon prices and policies right, and (c) smoothing the transition and protecting the poor.

This policy note is drawn from *Decarbonizing Development: Three Steps to a Zero-Carbon Future* (2015) by Marianne Fay, Stephane Hallegatte, Adrien Vogt-Schilb, Julie Rozenberg, Ulf Narloch, and Tom Kerr. Washington, DC: World Bank.

Global leaders have agreed to stabilize climate change at about 2°C above preindustrial temperatures; to reach this target, global carbon emissions should be reduced to zero before 2100. Even if the target were higher than 2°C, carbon neutrality would still be needed to stabilize the climate. As long as we emit more than we capture or offset through carbon sinks (such as forests), concentrations of CO₂ in the atmosphere will keep rising, and the climate will keep warming. And there are other reasons to bring emissions to zero, linked to other environmental problems unrelated to climate change, such as local air pollution and ocean acidification.

With the scientific consensus suggesting we need to be at zero net emissions before 2100, the key question is what policy makers should do to get there.

How We Can Achieve Zero Net Emissions

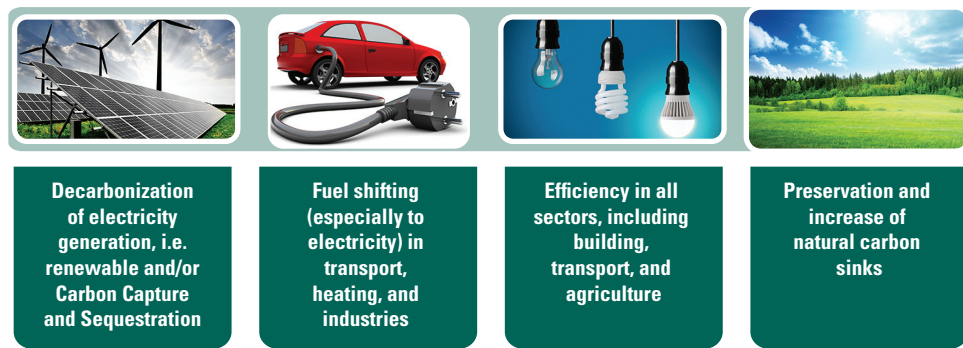
The latest report of the Intergovernmental Panel on Climate Change identified many technically feasible pathways to reach carbon neutrality by the end of

the century, based on the consensus of 830 scientists, engineers, and economists from over 80 countries and formally endorsed by the governments of 194 countries. Those pathways rely on four pillars (figure 1).

Pillar 1: Decreasing carbon intensity of global electricity production to near zero around 2050 is at the core of the decarbonization transition. This objective implies that both high-income countries and emerging economies (such as China, India, and South Africa) would have to decarbonize electricity around midcentury. Low-income countries—which represent a small share of global electricity consumption—would have a few more decades, but they too would eventually need to converge to zero-emissions electricity.

Carbon-neutral electricity can be produced from renewable sources (windmills, photovoltaic power, concentrated solar power, large dams and small hydropower, and biomass), nuclear power, and fossil-fuel resources with carbon capture and storage (CCS). In addition, bioenergy with CCS can produce electricity with negative emissions. Zero carbon electricity can be achieved using only a subset of these

FIGURE 1 The Four Pillars of Decarbonization



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technologies, for instance, even if nuclear power is ruled out and CCS turns out to be unavailable.

Pillar 2: Switching from fossil fuel to low-carbon electricity will drastically reduce greenhouse gas emissions in energy-intensive sectors, such as transportation, building, and industry. Technologies such as electric and plug-in hybrid vehicles, electric stoves and heat pumps, and electric furnaces are more energy efficient than fossil-fueled alternatives and will reduce carbon emissions when powered by clean electricity.

Pillar 3: Boosting energy efficiency can reduce emissions, make electrification easier, and save on energy bills. Boosting energy efficiency has high potential for the building, transport, and industry sectors. In agriculture and forestry, efficiency entails minimizing the loss and waste of food, increasing the supply of less emission-intensive products (including biofuels and wood materials), and changing food demand to shift consumption toward low-carbon food products and to free up land for other mitigation activities.

Pillar 4: Managing landscapes better will help countries increase their ability to act as net carbon sinks. Models reviewed by the Intergovernmental Panel on Climate Change show that the agriculture and forestry sector will likely need to achieve carbon neutrality by 2030 if the 2°C target is to be reached. Mitigation

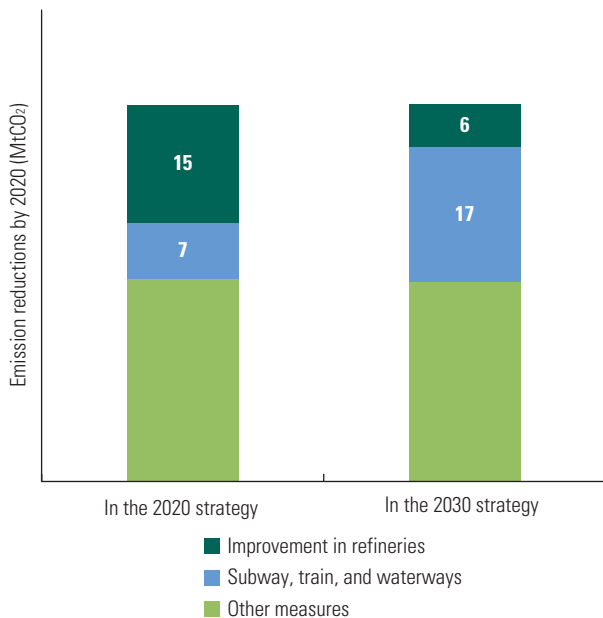
policies can reduce emissions from land management and land use conversion and can increase the removal of carbon from the atmosphere.

Stabilizing the climate requires bringing *net* emissions of long-lived greenhouse gasses to zero. That means positive emissions somewhere can be offset by negative emissions elsewhere: from improved natural carbon sinks—for example, through reforestation or better soil management—or by combining bioenergy (renewable energy derived from biomass, such as wood, crops, or crop residues) with CCS. Countries can therefore proceed at different speeds across the four pillars, but stabilizing the climate requires significant progress on all four.

Prioritizing on the Move to Net Zero Emissions

With the end goal clear, the relevant question for policy makers is how to prioritize. Many emission-reduction options come at a net benefit for the society, such as those that save energy or offer such co-benefits as reduced air pollution or less traffic congestion. But focusing on the cheapest options and on short-term benefit without considering structural changes and longer-term objectives could be shortsighted and result in carbon-intensive lock-ins and more expense in the longer term.

FIGURE 2 Using a Longer Time Frame Changes the Optimal Policy Mix for Brazil



Source: A. Vogt-Schilb, S. Hallegatte, and C. de Gouvello. 2014. "Marginal Abatement Cost Curves and Quality of Emission Reductions: A Case Study on Brazil." *Climate Policy*. doi:10.1080/14693062.2014.953908.

Note: The 2020 and 2030 bars amount to an equivalent amount of emission reduction, although they include a different mix of measures.

Timing is everything. As technologies evolve, they improve, become more affordable, and open up new options. But if everyone waits, those technologies will not be invented, and they certainly will neither improve nor become more affordable. And in the face of development pressure, especially in rapidly urbanizing countries, waiting for technological improvements is not always an option. Developing countries, which still need to build much infrastructure, should take the opportunity to plan ahead to grow and develop with their carbon footprint in mind.

Action should focus on what provides co-benefits and synergies with development, but also on what is most urgent. Some choices may be irreversible—such as unplanned low-density urban expansion or the cutting down of old-growth forests. Some abatement actions will take time to realize their benefits—such as building clean transportation infrastructure and developing new technologies. In these cases, measures need

to be implemented early in order to reach the end goal of full decarbonization.

Take the case of a low-carbon strategy analysis done for Brazil. As figure 2 shows, when striving to reach a particular goal in 2020, the easiest route is to take marginal actions that are cheap and easy to implement but that have a limited potential (like improved energy efficiency in refineries). In contrast, if this goal is a step toward a more ambitious one in 2030, more ambitious actions—investments in subways, trains, and waterways—that cost more and take longer to implement would be undertaken. The latter approach would result in the same amount of emission reduction by 2020, but it would keep the door open to deeper decarbonization by 2030. Applied to full decarbonization, this analysis shows the need to look not only at the cheapest emission reductions, but also at more costly options that will be required to reach zero emissions.

To avoid lock-ins and regrets in a few decades, countries can use short-term sectoral targets to trigger and monitor progress along the four pillars of decarbonization. Doing so would ensure not only that the appropriate *quantity* of emission reductions is achieved over the short term, but also that the *quality* of these abatements is appropriate, which means that they put the country on a cost-effective pathway toward decarbonization. For instance, a goal may be to produce 30 percent of the electricity from renewable sources by 2030, drive cars that emit fewer than 80 grams of CO₂ per kilometer by 2025, or use wood materials—from sustainably managed forests—instead of steel and cement in half of the new buildings by 2035. A short-term goal expressed as an economy-wide emission target is also useful but cannot replace those sectoral targets, since it could be reached with marginal actions that do not contribute sufficiently to meeting the long-term goal.

Sectoral pathways also provide operational guidance for sector plans and make it possible to use existing regulators and institutions to design and implement the measures. Table 1 provides examples of possible sectoral targets for a country or city.

Decarbonizing Development

TABLE 1 Examples of Possible Sectoral Targets for Tracking Progress toward the Net Zero End Goal

Pillar	Sector	Example of target	Rationale
Decarbonize electricity production	Power Generation	Produce at least 30% of electricity from renewable sources by 2025	This type of target prevents the power sector from locking into intermediate solutions, such as gas power or enhanced coal power, which do not have the potential to fully decarbonize the power sector. It also supports the development of new technologies (e.g., solar PV and smart grid able to manage intermittency).
Efficiency	Transport	Get 50 percent of the population to commute by public transport (bus, metro, tram) in 2025 in a city	At city scale, this target helps reduce energy expenditures, congestion and local pollution, and it contributes to reduced CO ₂ emissions and to building zero-carbon cities. Accessible public transit can also influence household localization choices, which have long-term consequences on energy and carbon efficiency.
	Building	Build 50% of zero energy buildings in 2030	Zero-energy buildings are needed for full decarbonization, to reduce energy bills and increase comfort. Action must start early because of the long lifetime of buildings.
	Cities	Transit-oriented urban development	Promoting urban development with access to public transport helps avoid urban sprawl. Urban sprawl is mostly irreversible, and locks inhabitants in carbon-intensive pathways as it makes it much more difficult to use public transit systems.
Fuel shifting/substitution	Transport	Reach 1% of electric vehicles in 2015	Favoring electric vehicles prevents locking into marginal improvements of combustion engines, and contributes to total decarbonization, as long as the electricity sector is being decarbonized at the same time.
	Buildings/Forestry	Use 20% of sustainable wood in new building structure by 2025	Wood material contributes to reaching zero carbon, if produced sustainably. It is one of the options to reduce emissions from construction materials.
Natural carbon sinks	Forestry	Stop deforestation by 2017	Deforestation (and associated loss of ecosystem services) are largely irreversible, so action in this domain cannot wait.