CLIMATE CENTRAL SOLUTIONS BRIEF: GETTING TO NET ZERO

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Research brief by
Climate Central

CLIMATE CENTRAL

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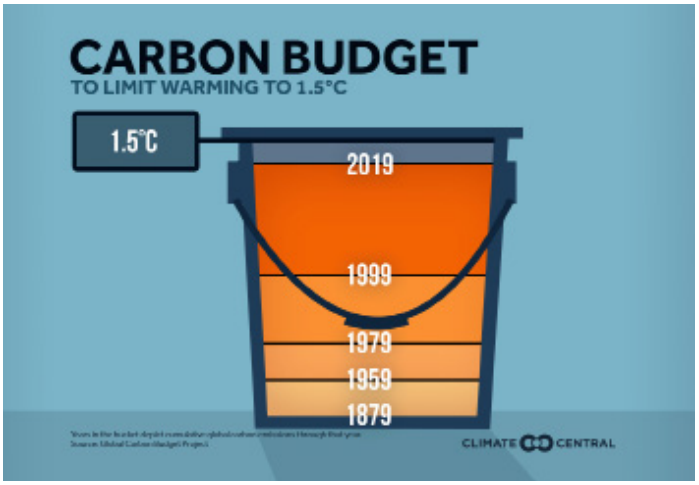
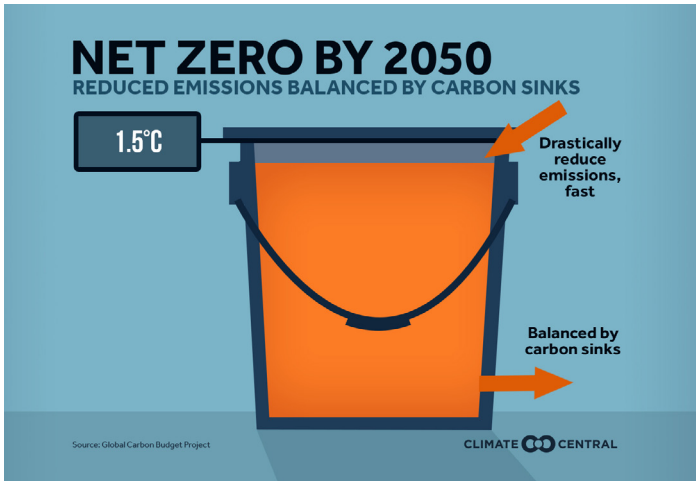
What is Net Zero? And can we really get there?

The planet needs to go on a carbon diet. Our current catastrophes—fires, storms, and rising seas—are consistent with the warnings scientists made in the 1980s and 1990s. Past burning of fossil fuels, including oil, coal, and natural gas, has released greenhouse gases into the atmosphere and caused the earth to warm by 2 degrees Fahrenheit (a bit more than 1 degree Celsius) since the pre-industrial era (1880-1900).

In 2015, the Paris Climate Agreement set goals for countries to try and limit the increase in global warming to well below 2.0°C (3.6°F) above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C (2.7°F). In 2018, the Intergovernmental Panel on Climate Change (IPCC) reported that to reach these targets, global greenhouse gas emissions need to be cut in half by 2030, and must reach "net zero" by mid-century for the 1.5°C degree target. This not only requires drastically cutting our greenhouse gas emissions fast, but removing CO2 from the atmosphere. **The term "net zero" simply means that any greenhouse gas emissions released are balanced by an equal amount being taken out of the atmosphere.**

If we want to stop the climate warming that is already exacerbating damage across our country and around the world by making weather more extreme, worsening air quality, and threatening water and food systems, then getting to net zero is an essential goal.





We are almost at the limit of our global carbon budget in order to stay below a 1.5°C (2.7°F) increase in warming. Unless we start adopting Net Zero solutions soon, we will far exceed our carbon budget by 2050.

So how do we get to net zero?

First, we have to know the big GHG emitting sectors. In the U.S., they are transportation (28%), electricity (27%), and industry (22%), followed by agriculture (10%), commercial (7%), and residential (6%). But a number of existing solutions and technologies already exist. In the United States, wind power generated about 7% of our electricity in 2019, up from just 0.1% in 1990. And there are now about 1 million plug-in electric cars and trucks on our country's roads, helping to flatten emissions when these vehicles are powered by renewable or nuclear electricity.

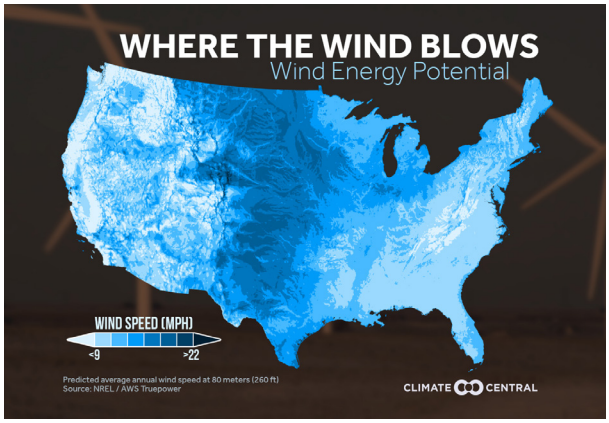
Some other sectors, like agriculture and air travel, will likely continue to produce GHG emissions for the next few decades. Therefore, we must draw an equivalent amount of carbon dioxide out of the atmosphere, in effect, creating negative emissions. **"Carbon neutrality"** is another term that describes this balance of carbon emissions and sequestration.

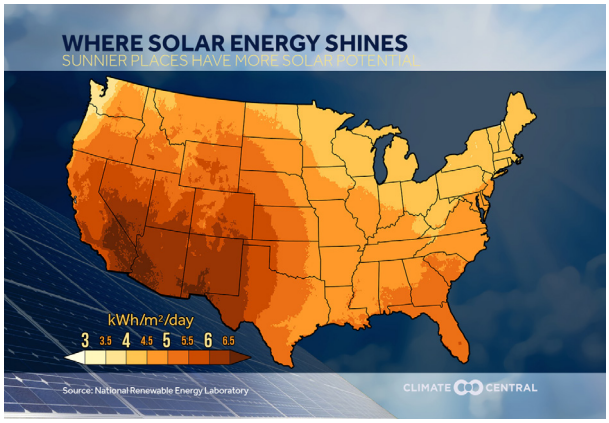
Scientists, engineers, and other researchers are exploring pathways and models to figure out what needs to happen over the next few decades in order to get the United States to net zero. The Net-Zero America Project (NZAP), being released in December 2020, models several technology pathways for the U.S. to reach net-zero GHG emissions by mid-century, based around six pillars: electrification and efficiency, clean electricity, bio-energy and zero-carbon fuels, carbon capture and storage, reductions in other greenhouse gases (like methane), and enhanced carbon absorption by trees and soil (also called land sinks). Another initiative, the Zero Carbon Action Plan (ZCAP), released in October 2020, looks at decarbonizing six key sectors—power, transport, industry, buildings, food and land use, and materials—to get to zero carbon by 2050. And there are other net zero plans and carbon management solutions, including reports from the Center for Energy and Climate Solutions, the Center on Global Energy Policy, House Select Committee on the Climate Crisis, the Senate Democrats' Special Committee on the Climate Crisis, and Project Drawdown.

While their modeling and projections may incorporate different inputs and show different outcomes, all of these projects highlight the same core areas of our economy that need to undergo major transformation in order to get to net zero. And we know how to do most of these things, we just need to do more, and faster.

Carbon-free electricity

The U.S. power generation sector is already showing movement toward decarbonization. As of November 2020, 34 utilities declared net-zero targets by mid-century. But realizing those targets requires big changes. In 2019, about 63% of our electricity was generated by burning fossil fuels, 20% came from nuclear energy, and only about 18% was from renewables (including solar, wind, and hydropower). That means a lot more large-scale wind turbines and solar installations need to be built. We currently have nearly 110,000 megawatts (MW) of wind-generating capacity installed, enough to power 33 million American homes, but there is a potential in the U.S. for more than 100x that amount. In the third quarter of 2020, solar photovoltaic (PV) installations reached 85,000 MW, enough to power 16.1 million homes. Residential solar accounted for about 20% and utility-scale made up 67% of all solar generation. An additional 100,000 MW of solar capacity is projected to be installed over the next 5 years, 42% more than was installed over the last 5 years, according to the Solar Energy Industries Association.





Electrification of transportation

At 28% of total emissions in 2019, the transportation sector edges out electricity production as the largest source of GHG emissions in the U.S. Within this sector, personal (light-duty) vehicles (cars and

SUVs) account for 59% of those emissions, and 23% come from medium- and heavy-duty vehicles (trucks). If electricity generation transitions to zero-carbon emissions, then electric vehicles are a key step to get to net zero. But it will require a massive adoption of electric cars, buses, and trucks and their accompanying plug-in charging infrastructure. According to one study, 1 in 5 cars globally will need to be electric in order to reach the Paris 2030 reduction goals—which equates to 40-50 million vehicles here in the U.S. The U.S. today has about 1 million electric vehicles.

Electrification of buildings & energy efficiency

A cleaner supply of electricity will also allow us to lower emissions through building electrification, involving homes and commercial businesses shifting away from fossil fuels, such as natural gas, for cooking and oil for heating. About 10% of U.S. GHG emissions now come from homes and businesses burning natural gas, oil, or propane on-site for space and water heating. A number of cities have banned natural gas or require electrification of heating and cooking in new buildings. Zero-energy buildings produce enough energy onsite (typically from solar panels) to equal or exceed the energy needed to run their equipment and appliances. And innovations in heat pumps can make our homes more efficient, delivering 2 to 4 times more energy as heat in the winter as the electricity used to run them. In the summer, the same heat pump works in reverse, using electricity to move heat from inside a building to outside, the way air conditioners do today. Energy efficiency measures—insulation, energy-saving windows, efficient lighting—also reduce energy demand on very hot and cold days, when the grid is most stressed.

Transformation of farming and our food habits

Farming contributes to our emissions, but also presents an opportunity to take carbon out of the atmosphere. Global emissions from cattle and dairy cows are about equal to total U.S. GHG emissions. Agriculture is responsible for about 10% of emissions in the U.S., and there are a number of pathways to reducing this, including decreasing fertilizer inputs, capturing methane emitted by cow manure as it decomposes, and improving soil management. Also, food waste in the U.S. generates the same amount of GHG emissions as 37 million cars (including the energy used to grow unused food and the methane from rotting food in landfills).

The next big thing: Can we really suck carbon emissions out of the sky?

Most of the pathways to keeping global temperature increases below 2 degrees—and every pathway to stopping at 1.5 degrees—incorporates absorbing carbon emissions from the atmosphere. Carbon dioxide is the only greenhouse gas that can be taken out of the atmosphere and stored easily, but doing this at a scale large enough to make a difference is a challenge.

Natural carbon sinks: trees, grasslands, wetlands, soil

About 25% of our carbon emissions have historically been captured by forests, farms and grasslands. Research has shown that nature alone can provide about one-third of the carbon reductions needed to meet the Paris Agreement through restoration of forests and wetlands, and better management of agriculture and grasslands. This has led to a number of corporations and countries investing in reforestation projects to offset their greenhouse gas emissions. Also, sustainable farming methods can offset carbon emissions. In the U.S. alone, these techniques have the potential to store up to 200 million tons of CO2 per year—offsetting the annual emissions of 42 million gasoline-fueled cars.

Reservoirs in the rocks

In geological carbon sequestration, carbon dioxide is stored in underground porous rock formations, or depleted oil wells. This process involves capturing carbon dioxide from a stationary industrial source, such as a cement plant or a natural gas power plant, pressurizing it to be as dense as a liquid, and injecting it into porous formations for long-term storage. There are some caveats to this method, including that the pollution point sources—power plants or factories—are often a long distance from suitable geological formations, requiring transport (which could emit more CO2).

Carbon dioxide removal technologies
The costs of solar, wind, and battery storage have all fallen dramatically in recent years, making them more viable. Are negative emissions technologies next? Scientists and engineers are finding ever more affordable ways to pull carbon dioxide out of the air, or injecting it underground to be stored. Such technologies include "direct air capture," one version of which uses large banks of fans to blow air through a chemical solution that selectively removes CO2. Then there is Pioneer Energy's CO2 Craft Brewery Recovery System, which captures CO2 created during the fermentation process, but usually released into the air. Now microbreweries can use the captured CO2 to carbonate their beer.

Where are net zero commitments being made?

In the U.S., a growing number of state governments have committed to GHG reduction targets through legislation or by executive order. Twenty-three states plus the District of Columbia have adopted GHG reduction targets to address climate change. Twelve states now have net-zero mandates by 2050. As of July 2020, 19 countries and the European Union had adopted net-zero targets.

Climate reports, events, & solution sources you need to know

The Intergovernmental Panel on Climate Change (IPCC) prepares comprehensive reports about knowledge on climate change, its causes, potential impacts, and response options. The next 5-yearly assessment report is due to be released in 2021.

The National Climate Assessment (NCA) assesses the science of climate change and variability and its impacts across the United States. The Fourth NCA was released in 2018 and has 12 chapters on the impacts of climate change on health, the economy, ecosystems, and on communities across the United States.

The Paris Agreement was adopted by nearly every nation in 2015 to address climate change and its negative impacts.

The UN Climate Change Conference of Parties, Glasgow (or COP26) is the decision-making body responsible for monitoring and reviewing the implementation of the United Nations Framework Convention on Climate Change meeting every year.

Net-Zero America Project
The project aims to provide policy makers with the necessary analyses to determine a pathway to net-zero greenhouse emissions in the United States.

America's Zero Carbon Action Plan (ZCAP)
Sustainable Development Solutions Network USA (SDSN USA) has released a policy framework that presents a strategic plan to create a carbon-neutral economy for the United States by 2050.

The yearly UNEP Gap Report compares where GHG emissions are heading against where they need to be, and highlights the best ways to close the gap. The Emissions Gap Report 2019 looks at the potential of the energy transition in the power, transport and buildings sectors, as well as efficiency potential in the use of materials such as iron steel and cement.

Energy Policy Simulator
You can try your hand at designing your own energy policy to reach the 2015 Paris Climate Accord goals and see the effects your policies have on emissions and the economy.

Project Drawdown
This initiative is an ongoing review and analysis of global climate solutions to reduce greenhouse gases in the atmosphere.

Decarbonization Glossary

Cities, states, utilities and corporations often use different language for their climate goals or targets. It's important to know the subtle differences.

Carbon Free means no carbon dioxide emissions. For example, a utility would be distributing all of its electricity from renewable or clean sources like solar, wind or nuclear. **Zero Carbon** is another term for carbon free.

Carbon Offsets are reductions in emissions of carbon dioxide made in order to compensate for emissions made elsewhere. Offsets are measured in tonnes of carbon dioxide-equivalent (CO2e). They allow individuals, institutions, and companies to invest in environmental projects around the world in order to balance out their own carbon footprints. Individuals and companies can purchase offsets that have been authenticated by third-party certification programs, such as Verified Carbon Standard, Gold Standard, and Green-e Climate Standard.

Carbon sinks are places that absorb more carbon dioxide than they release, such as some parts of the ocean, forests, wetlands, and grasslands. (Coal, oil, and natural gas were produced by carbon sinks that were operating millions of years ago. These deposits store carbon that was originally of biological origin, but burning them releases thousands of accumulated carbon back into the atmosphere)

Clean energy typically encompasses all renewable energy, like wind, solar, and hydropower, that do not produce carbon emissions. It can also include nuclear energy and fossil fuel consumption with carbon-capture technology.

Net Zero To avoid worsening climate impacts, global greenhouse gas (GHG) emissions will need to drop by half by 2030, then reach net-zero around mid-century. Net zero refers to the balance between the amount of greenhouse gas emitted to the atmosphere and the amount removed from the atmosphere. Net zero is reached when the amount we are adding is exactly matched by the amount being taken away, which can be achieved through planting trees or underground sequestration of CO2 captured from the air. **Carbon neutral** is another term for net zero.

Renewable energy comes from sources that cannot be depleted, such as solar, wind, geothermal, or tidal.