WHAT ARE CLIMATE SOLUTIONS?

A "climate solution" is anything that helps lower the rate of increase of greenhouse gas (GHG) concentrations in the atmosphere, either by slowing GHG emissions or increasing GHG sequestration. GHGs include:

- Carbon dioxide (CO_2). Carbon dioxide makes up 80% of U.S. GHG emissions by volume.[1] The largest source of carbon dioxide emissions from human activities in the United States is from burning fossil fuels for electricity, heat, industrial processes, and transportation.
- Methane (CH_4). Methane accounts for 10% of U.S. GHG emissions by volume, and although it breaks down more quickly than carbon dioxide in the atmosphere, it is 25 times more potent in terms of its greenhouse effect (the degree to which it traps heat in the Earth's atmosphere).[2] Methane sources include landfills, oil and natural gas systems, agriculture, coal mining, stationary and mobile combustion, wastewater treatment, and certain industrial processes.
- Nitrous oxide (N_2O). Nitrous oxide accounts for about 6% of U.S. human-made GHGs by volume.[3] Sources of nitrous oxide include agriculture (specifically, soil management and fertilizer use), fuel combustion, industry, and waste. The impact of 1 pound of N_2O on warming the atmosphere is almost 300 times that of 1 pound of carbon dioxide.
- Fluorinated gases, such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). These are emitted by a variety of industrial processes. In the U.S., they make up 3% of human-made GHG emissions,[4] but they trap a lot of heat despite their small share of the GHG pie.

In order to compare apples to apples when considering the emissions reduction/sequestration capacity of different climate solutions, all GHGs can be converted into "carbon dioxide equivalent," or CO_2e, which is defined as "the number of metric tons of CO_2 emissions with the same global warming potential as one metric ton of another greenhouse gas.[5]"

Some gases stay in the atmosphere for longer before breaking down, meaning that they can continue to do damage for longer, even after sources of emissions have been reduced. Methane remains in the atmosphere for 12.4 years, nitrous oxide for 121 years, and fluorinated gases range from a few weeks to thousands of years.[6] The lifetime in the atmosphere of carbon dioxide varies because CO_2 molecules are constantly in flux between the atmosphere, the oceans, the land, and living and dead biomass. Protection and restoration of "carbon sinks" like forests, grasslands, seagrass meadows, mangroves, salt marshes, and untilled soils can help reduce CO_2 concentrations in the atmosphere and is part of a complete portfolio of climate

[1] Center for Climate and Energy Solutions (2019) "U.S. Emissions." https://www.c2es.org/content/u-s-emissions/
[2] Center for Climate and Energy Solutions (2019) "U.S. Emissions." https://www.c2es.org/content/u-s-emissions/
[3] Center for Climate and Energy Solutions (2019) "U.S. Emissions." https://www.c2es.org/content/u-s-emissions/
[4] Center for Climate and Energy Solutions (2019) "U.S. Emissions." https://www.c2es.org/content/u-s-emissions/
[5] EPA. https://www3.epa.gov/carbon-footprint-calculator/tool/definitions/co2e.html
[6] EPA. Climate change indicators: Greenhouse gases. https://www.epa.gov/climate-indicators/greenhouse-gases

solutions. Other GHGs are not naturally sequestered once emitted, and will remain in the atmosphere until they break down on their own.

Climate solutions can be technologies, actions, or even policy structures. The category of "climate solutions" includes anything that brings down atmospheric GHG concentrations over time by:

- Displacing the GHG emissions through deployment of lower- or zero-emissions activities as substitutes;
- Reducing the need for GHG emissions through demand reduction and energy efficiency;
- Sequestering GHG emissions that would otherwise enter the atmosphere, through enhancement of natural carbon sinks or carbon capture technology.

Note that alternative energy technologies like renewable energy, nuclear, and hydropower are generally considered "climate solutions" even through, on their own, they do not reduce or sequester atmospheric GHG concentrations or emissions. What *does* reduce emissions is the slowing or cessation of burning fossil fuels like coal, oil, and natural gas for energy, but because modern economies and standards of living are dependent on continuously available electricity and externally powered transportation modes, it is both politically impossible and socially inadvisable to simply *stop* using fossil fuels, without figuring out how to replace them so as to metaphorically and literally keep the lights on. Because of this, deployment of renewable and zero-emissions energy technology is considered a "climate solution." However, it is important to remember that on its own, such deployment does nothing to reduce GHG emissions; to accomplish this latter objective, it must coupled with a reduction in use of fossil fuels.

Climate solutions can be grouped into several sectors or categories:

- Buildings
- Electricity
- Transportation
- Land use
- Agriculture
- Food
- Engineered carbon sinks
- Land-based carbon sinks
- Ocean and coastal carbon sinks

Many of these solutions *reduce future GHG emissions* by reducing the amount of energy needed, changing the ways that energy is produced, and addressing non-energy sources of GHG emissions such as farming, waste, and industrial processes. Other solutions *reduce GHG concentrations in the atmosphere* by sequestering carbon dioxide that has already been emitted.

In developing the list of climate solutions to consider, we have relied heavily on an online resource and accompanying book called Project Drawdown (https://drawdown.org), which contains information on 82 climate solutions, including the volume of GHG emissions that each

one is projected to reduce or sequester worldwide, the cost in billions of US$ of deploying each solution at the scale needed to reduce/sequester this amount, and the lifetime net cost savings or profit associated with deploying it at this scale.

For each of the 82 solutions evaluated by Project Drawdown, we considered whether it is applicable at scale in the U.S. and whether it is likely to make a significant contribution to GHG reduction/sequestration in the U.S. We then completed desk research on each solution to garner insights into how it helps "solve" climate change, its current level of deployment, opportunities for and barriers to greater deployment, economics (costs, savings, profits), policy needs and implications, and environmental externalities (non-emissions impacts on the environment and natural resources). Finally and critically, we assessed each solution with regard to its "fishery friendliness."

Continue reading at https://fisheryfriendlyclimateaction.org/solutions