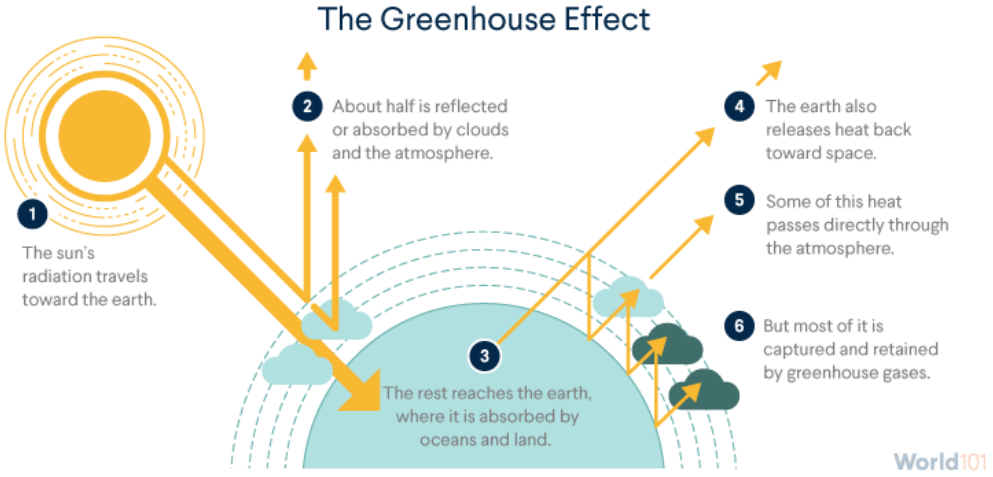
2021 Model Senate on Science and Technology
Briefing Paper – Carbon Capture and Sequestration
December, 2021

Topic Background - Climate Change and Greenhouse Gases

Climate change is an existential threat to humanity and has subsequently become one of the greatest policy challenges confronting the global community today. Climate change presents both short term and long term threats to life on earth, including arable soil and drinkable water on every continent, endangering the food and water systems needed to support over seven billion humans. Additionally, climate change threatens to exacerbate devastating natural disasters like fires, floods, and hurricanes. Fortunately, a recent climate report from the Intergovernmental Panel on Climate Change (IPCC) has indicated that there is still time to combat some of the most severe negative effects of climate change, given swift and comprehensive action in a number of policy areas.[1] Among the principal suggestions from the report centers on limiting **emissions** from human sources.

While climate change occurs naturally due to long term changes in weather patterns, geological features, solar fluctuations, and other natural phenomena, it is humanity's impact on the climate that worries scientists, policymakers, and citizens. Chief among these concerns is the burning of **fossil fuels**, and the long term overconsumption of natural resources. Since the **industrial revolution**, fossil fuels have served humanity's growing appetite for goods and services, however, only in recent decades have citizens and policymakers begun to understand the impacts of fossil fuels on the planet.



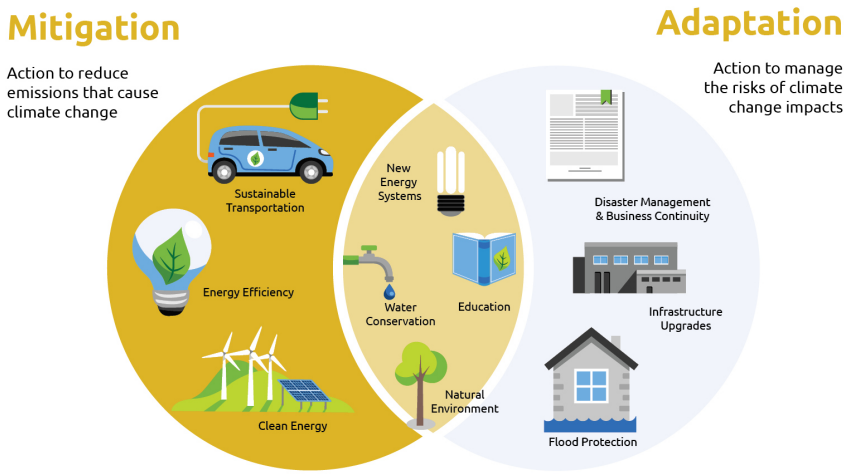
One of the leading causes of climate change is the release of **Greenhouse Gases (GHG)** into the atmosphere. GHGs like carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) among others, are

[1] "A Major Report Warns Climate Change Is Accelerating And Humans Must Cut Emissions Now." (NPR, 2021)

released primarily through the burning of fossil fuels. The buildup of GHGs in the atmosphere increases the **Greenhouse Effect**, where radiation emitted from the sun is trapped in the Earth's atmosphere. Trapped radiation slowly warms the planet, threatening both natural ecosystems and humans. According to the IPCC report mentioned above, in order to minimize potential damage to the planet and ensure a habitable world in the short, medium and long term, humans must limit or even reduce the amount of GHGs in the atmosphere.

Climate Action

In response to growing concern about climate change, scientists, and policymakers have promoted a number of policies to combat the negative effects of climate change. **Climate action** generally falls into two main categories: adaptation and mitigation. The principle of **adaptation** acknowledges that to some extent, whether by natural phenomena or human cause, climate change will occur, and that humanity should adjust to known or expected changes in the climate. NASA describes the goal of adaptation practices as: "to reduce our [humanity's] vulnerability to the harmful effects of climate change".[2]



Adaptation actions seek to reduce harm and build resilience to expected changes in the planet's environment. An example of a climate action policy focused on the adaptation principle is the building of sea walls or levees in communities at sea level. The acknowledgment in these policy decisions is that sea levels will ultimately rise, regardless of other actions, and therefore humanity should work to protect low lying communities from the hazards of a rising ocean. However, equity issues arise when considering many adaptation practices. Well-resourced countries have a greater ability to institute adaptation practices, which can often be very expensive and inaccessible to countries with less resources. In addition, wealthier people within any country may have greater access to adaptation practices than their lower-income neighbors. Any good adaptation policy must account for equity concerns and impact all members of a society.

Mitigation practices attempt to combat climate change by addressing the root issues of climate change. One of the principal ways to limit climate change is by limiting or reducing the amount of greenhouse

[2] Responding to Climate Change. (NASA)

gases in the atmosphere. Another positive mitigation strategy is increasing the number or size of **carbon sinks**, which act to capture and store greenhouse gases. One of the simplest examples of a carbon sink are naturally occurring forests, which act to capture carbon dioxide from the atmosphere and store it as organic matter. A simple example of a mitigation policy already in effect is the creation or replacement of carbon sinks, including the planting of new forests and aquatic biomes. However, these seemingly simple strategies take considerable time, land, and political coordination, offering significant obstacles.

While adaptation practices offer a lot of innovative policy areas to explore, the IPCC report suggests that climate change mitigation policies remain at the forefront of climate policy. One of the newest and most promising areas of climate policy revolves around extracting the most abundant greenhouse gas, carbon dioxide, directly from the atmosphere and storing it in long term isolation.

Carbon Capture and Sequestration

Carbon Capture and Sequestration (CCS) practices are climate change mitigation strategies aimed at reducing carbon dioxide emissions and preventing the buildup of greenhouse gases in the atmosphere. CCS involves a variety of methods of capturing carbon dioxide at the point of emission, and preventing its release into the atmosphere. The captured carbon emissions are then transferred and stored in secured locations, often deep underground, preventing their release into the atmosphere for hundreds or thousands of years. Two significant limitations challenge the effectiveness of CCS technologies; the first challenge is that carbon capture must occur at a stationary location, usually an industrial source of carbon dioxide, such as power plants or energy generating substations. This may potentially limit its viability in some markets, while preventing its adoption in mobile polluters, such as vehicles. The second challenge is that the process of carbon capture is a significantly energy-intensive step, sometimes referred to as the **energy penalty** or **parasitic load**, which also increases the cost of CCS technologies**.** Reducing the amount of energy needed to capture carbon dioxide is critical to the development of CCS as a viable long term mitigation strategy. CCS is a relatively new technology and, over time, the amount of energy needed to capture carbon dioxide will likely decrease.

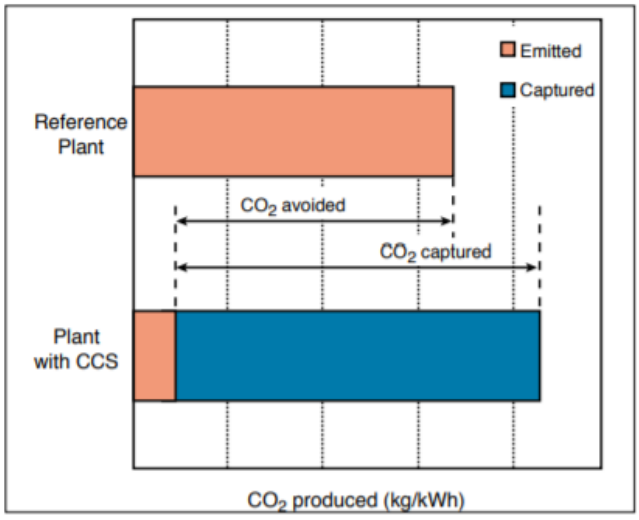


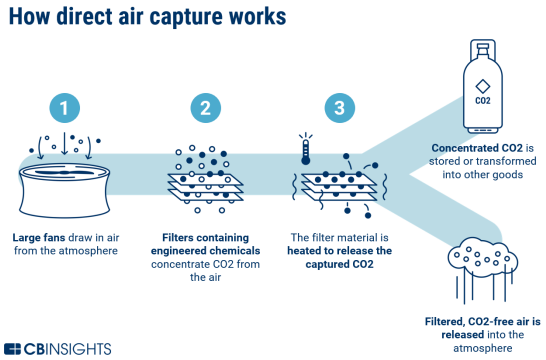
Figure SPM.2. CO_2 capture and storage from power plants. The increased CO_2 production resulting from the loss in overall efficiency of power plants due to the additional energy required for capture, transport and storage and any leakage from transport result in a larger amount of "CO_2 produced per unit of product" (lower bar) relative to the reference plant (upper bar) without capture (Figure 8.2).

An alternative to CCS technologies, and one favored in some industry and political circles is **Carbon Capture, Utilization and Storage (CCUS),** which diverts some of the captured carbon to the production of other carbon-based products such as cements, plastics, and various fuels. Therefore, CCUS allows for the repurposing of captured carbon, which has the potential to provide significant economic incentives for private sector adoptees.

One critique of CCUS technologies is that any products created from the capture of carbon dioxide may ultimately be consumed in a way that ends up releasing greenhouse gases back into the environment. While CCUS may lead to significant economic incentives, and therefore greater adoption of CCUS technologies, it may be potentially harmful to the long term health of the environment.

Direct Air Capture

Direct Air Capture (DAC) is an emerging technology and represents a climate change mitigation strategy focused on removing carbon dioxide from the atmosphere.[3] DAC pulls carbon dioxide directly from the atmosphere, and stores or transfers the carbon to long term sequestration. Some industry leaders and environmental advocates suggest that DAC is an important technological innovation necessary to bring the world to a state of **net-zero** emissions. With net-zero emissions, the amount of carbon dioxide captured would roughly equal the amount discharged into the atmosphere, potentially slowing the accumulation of greenhouse gases in the atmosphere. Currently, there are 15 DAC plants operating throughout the world, however plans for scaling up have gained traction in recent years.



Like other mitigation strategies, there exist challenges to the large-scale adoption of these emerging technologies. As with many policy solutions, cost is a limiting factor, with significant costs associated with building or retrofitting DAC facilities. Another principal challenge for DAC is scale. While there exist a few different methods of DAC, most require a significant energy input, as well as access to a significant amount of water and other natural resources. Finally, as mentioned, the planet produces such massive quantities of carbon dioxide from millions of sources, that the amount of DAC needed to reach net-zero emissions represents a significant challenge.

The Congressional Toolbelt - Budgeting and Appropriations

While Congress generally defers major policy directives to the President, it still controls a number of methods to impact federal, state, and local policies and practices. Legislation is the principal means of

[3] "Direct Air Capture." (International Energy Agency, 2020)

ensuring specific actions, as codifying rules and regulations into federal law will guarantee that both the private and public sectors adopt certain policies or practices. However, the partisan nature of Congress, as well as the lengthy legislative process can make legislative solutions less appealing or unviable.

While legislative action may be increasingly difficult in today's polarized political climate, the House and Senate still retain a number of important tools to promote or disincentivize certain policies and practices. Congress has the **power of the purse**, and is responsible for the federal budget and **appropriations,** the annual process of establishing and modifying the budgets of federal agencies and programs**.** Through the appropriations and budgeting process, Congress has a number of tools at its disposal to encourage certain environmental practices, or discourage poor environmental practices.

For example, CCS and CCUS technologies have become interesting avenues of climate action for both Democrats and Republicans, as they offer tangible climate action in a market-oriented way. As such, Congress increased the appropriations to the **Fossil Energy Research and Development (FE R&D)** budget from $740 million in Fiscal Year (FY)2019 to $750 million in FY2020 to retrofit coal plants with CCS technologies. In addition to altering federal funding, Congress can also provide tax incentives for certain desirable practices. For example, companies who use CCS technologies may be eligible for federal tax credits, reducing their corporate tax rate and incentivizing the adaptation of CCS technologies. Likewise, Congress can institute penalties for certain policies though fines or taxes. Both incentivizing and disincentivizing certain behaviors brings potential benefits and drawbacks, and members of Congress will often consider their decisions in the light of how their constituents may view them.

Subcommittee Charge

The United States Senate is tasked with the oversight, regulation, appropriations and lawmaking of nearly all aspects of life in the United States. From food safety, to military contracts, and space exploration, the United States Senate is tasked with ensuring that U.S. policy is aligned to their, and their constitutions policy preferences. In order to distribute this massive responsibility, the Senate is split into distinct Committees with broad responsibilities and then subcommittees with more specific jurisdiction. Each of the 100 members of the United States Senate are assigned to one or more committees where the majority of legislative debate, discussion and review occur. For a bill to become a law, it must be approved in its respective committee before being elevated to the Senate floor.

Carbon capture and sequestration practices are under the jurisdiction of the **Committee on Environment and Public Works,** and more specifically, **the Subcommittee on Clean Air, Climate and Nuclear Safety.** The subcommittee has a number of policy avenues to explore including incentivizing the adaptation of CCS or CCUS technologies on established industrial infrastructure, encouraging the adaptation of DAC technologies, or modifying the budgets of research and development programs like the FE R&D program listed above. Some proposals may be of interest to one party, while entirely unpalatable to members of the other party. Bipartisan action is critical to the success of the committee session. In the Model Senate

program, time will also be at a premium, and it is vital for Senators to identify areas of bipartisan action, in order to maximize their legislative action.

Questions to Consider

1. What is the Greenhouse Effect? What is the relationship between fossil fuels, emissions, and climate change?

2. Define climate change mitigation and climate change adaptation. In your opinion, which should be the policy priorities for members of Congress?

3. Describe one of the following technologies in brief detail: Carbon Capture and Sequestration (CCS), Carbon Capture, Utilization, and Sequestration (CCUS) or Direct Air Capture (DAC). What are some pros and cons of your selected technology?

4. What is the power of the purse? What tools does Congress have to incentivize or disincentivize certain actions in the private sector?

5. Besides budgetary measures, how can Congress influence local, state, and federal policy?

Additional Research

- Go to the Council's **2021 Model Senate Resource Guide** for additional recommended resources to continue your research after you are finished reading this briefing paper and answering the Questions to Consider above.
- *Bonus research task:* Try to find out how this issue affects other countries. A global context of the topic will help you have a more nuanced understanding of the topic and might help you craft recommended policy solutions for the U.S. Senate based on some actions other countries may be taking already to remedy some of the issues outlined in the briefing paper above.

Glossary of Terms

Term	Description
Adaptation	This principle acknowledges that climate change will occur, and that humanity should adjust to known or expected changes in the climate. NASA says the goal of adaptation should be to reduce our vulnerability to these effects.
Appropriations	A legislative grant of money to finance a government program or agency

Arable	Used or suitable for growing crops.
Carbon Capture & Sequestration	Carbon capture and storage or carbon capture and sequestration is the process of capturing carbon dioxide before it enters the atmosphere, transporting it, and storing it for centuries or millennia.
Carbon Capture, Utilization and Storage	A process that captures carbon dioxide emissions from sources like coal-fired power plants and either reuses or stores it so it will not enter the atmosphere.
Carbon Sinks	A forest, ocean, or other natural environment viewed in terms of its ability to absorb carbon dioxide from the atmosphere.
Climate Action	Stepped-up efforts to reduce greenhouse gas emissions and strengthen resilience and adaptive capacity to climate-induced impacts.
Climate Change	a change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.
Direct Air Capture	A process of capturing carbon dioxide directly from the ambient air and generating a concentrated stream of CO 2 for sequestration or utilization or production of carbon-neutral fuel and windgas.
Emissions	The production and discharge of something, especially gas or radiation.
Energy Penalty	The fraction of the fuel that must be dedicated to CCS activities.
Fossil Energy Research and Development	The Office of Fossil Energy (FE) programs are focused on activities related to the reliable, efficient, affordable and environmentally sound use of fossil fuels which are essential to our nation's security and economic prosperity.
Fossil Fuels	A natural fuel such as coal or gas, formed in the geological past from the remains of living organisms.
Greenhouse Effect	The trapping of the sun's warmth in a planet's lower atmosphere, due to the greater transparency of the atmosphere to visible radiation from the sun than to infrared radiation emitted from the planet's surface.
Greenhouse Gases	A gas that contributes to the **greenhouse effect** by absorbing infrared radiation, e.g., carbon dioxide and chlorofluorocarbons.
Industrial Revolution	The Industrial Revolution was the transition to new manufacturing processes in Europe and the United States, in the period from between 1760 to 1820 and 1840.
Mitigation	Practices that attempt to combat climate change by addressing the root issues of climate change

Net-Zero	A target of completely negating the amount of greenhouse gases produced by human activity, to be achieved by reducing emissions and implementing methods of absorbing carbon dioxide from the atmosphere.
Parasitic Load	Electrical devices that continue to use or draw current after the ignition switch is turned to OFF position, also known as standby power.
Power of the Purse	The constitutional power of Congress to raise and spend money. Congress can use this as a negative or checking power over the other branches by freezing or cutting their funding.