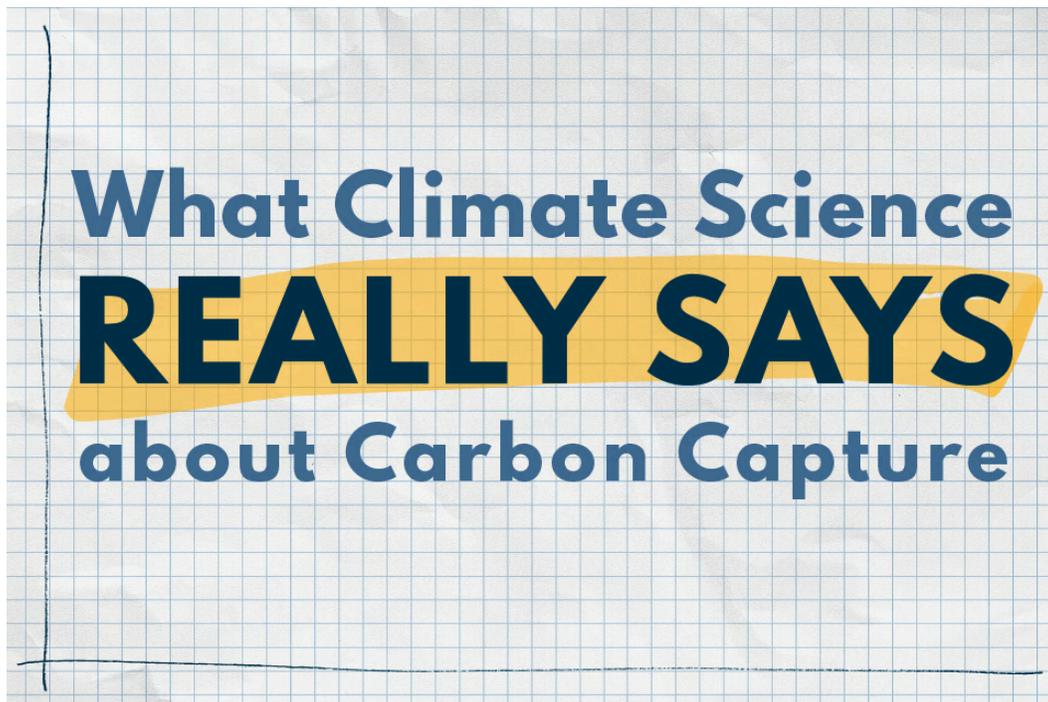


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# The Science-Based Case for CCUS

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Where the science leads, we must follow. If we believe the scientists and modelling that tell us that climate change is an existential crisis, then we must also believe them when they tell us how to solve this crisis. And they agree that we must use carbon capture, use, and storage (CCUS) technologies both to lower emissions and remove carbon dioxide from the atmosphere.

Global authorities on climate change such as the Intergovernmental Panel on Climate Change (IPCC), the International Energy Agency (IEA), the National Academies of Science, Engineering, and Medicine (NASEM), have extensively and impartially modelled the role that certain technologies will need to play to limit global warming to 1.5 to 2°C. They don't choose favorites, but they do consider all the potential technologies that can help solve climate crisis and the specific role that they could play. They're clear that without CCUS, it will be much harder and maybe impossible to reach net-zero emissions by 2050.

With a new administration vowing to rejoin the Paris Agreement and committed to letting the science guide policy again, we need to make sure the science is easily accessible and clearly understandable. Here, we've condensed the global scientific consensus on CCUS into a repository of highlights, figures and quotes from the IPCC, IEA, and NASEM.

On Dec. 4 at 10:30 a.m. ET, Third Way, Clean Air Task Force, the World Resources Institute, the National Wildlife Federation, and Carbon180 convened a group of leading contributors to IPCC reports to discuss these topics. Watch the webinar [here](#):

## **Intergovernmental Panel on Climate Change (IPCC)**

Established in 1988, the [IPCC](#) is an organization of the United Nations that “provides regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation.” It consists of many scientists from many nations who “volunteer their time to assess the thousands of scientific papers published each year to provide a comprehensive summary of what is known about the drivers of climate change, its impacts and future risks, and how adaptation and mitigation can reduce those risks.”

Every few years, they produce reports that are reviewed by experts and governments around the globe.

“AR5 Synthesis Report: Climate Change 2014”

## Highlights

- Most modeling pathways that keep global warming to 2 degrees C above pre-industrial levels are *not* able to do so without significant carbon capture and storage (CCS).
- The overall abatement cost of reaching net zero emissions by 2050 is more than double (138% more expensive) if done without using CCS (See Figure below.)



2100 concentrations (ppm CO <sub>2</sub> -eq)	Mitigation cost increases in scenarios with limited availability of technologies <sup>d</sup> [% increase in total discounted <sup>e</sup> mitigation costs (2015–2100) relative to default technology assumptions]				Mitigation cost increases due to delayed additional mitigation until 2030 [% increase in mitigation costs relative to immediate mitigation]	
	no CCS	nuclear phase out	limited solar/wind	limited bioenergy	medium term costs (2030–2050)	long term costs (2050–2100)
450 (430 to 480)	138% (29 to 297%) 	7% (4 to 18%) 	6% (2 to 29%) 	64% (44 to 78%) 	44% (2 to 78%) 	37% (16 to 82%) 
500 (480 to 530)	not available (n.a.)	n.a.	n.a.	n.a.		
550 (530 to 580)	39% (18 to 78%) 	13% (2 to 23%) 	8% (5 to 15%) 	18% (4 to 66%) 	15% (3 to 32%)	16% (5 to 24%)
580 to 650	n.a.	n.a.	n.a.	n.a.		

**Symbol legend—fraction of models successful in producing scenarios (numbers indicate the number of successful models)**

 : all models successful	 : between 50 and 80% of models successful
 : between 80 and 100% of models successful	 : less than 50% of models successful

Source: Climate Change Synthesis 2014 Synthesis Report, IPCC, Table SPM.2., 2014.

## Quotes

*"...many models cannot reach 450 ppm CO<sub>2</sub>-eq concentration by 2100 in the absence of carbon dioxide capture and storage (CCS)." -p. 28*

*"Scenarios that are likely to maintain warming at below 2°C include more rapid improvements in energy efficiency and a tripling to nearly a quadrupling of the share of zero- and low-carbon energy supply from renewable energy, nuclear energy and fossil energy with carbon dioxide capture and storage (CCS) or BECCS [Bioenergy with Carbon Capture and Storage] by the year 2050." -p. 82*

**Special Report titled "Global Warming of 1.5° C" (2018)**

## Highlights

- Three of the four main pathway scenarios to keep global warming to 1.5°C require gigatons of CCS by mid-century. The one pathway that does not include significant expansion of CCS relies on a sweeping array of social, business, and technological innovations to lower energy demand at an extraordinarily rapid pace.
- Carbon dioxide removal (CDR) that includes direct air capture (DAC) will likely be necessary to stay below 5°C warming.
- Even if we use CCS to its maximum technical potential to keep global warming to 1.5°C, there is still plenty of permanent underground CO<sub>2</sub> storage space across the globe to bury captured CO<sub>2</sub> safely for the rest of the 21<sup>st</sup>
- Carbon capture is especially important as a tool to decarbonize heavy industries

## Quotes

*"Studies have shown the importance of CCS for deep mitigation pathways (Krey et al., 2014a; Kriegler et al., 2014b), based on its multiple roles to limit fossil-fuel emissions in electricity generation, liquids production, and industry applications along with the projected ability to*

remove CO<sub>2</sub> from the atmosphere when combined with bioenergy. This remains a valid finding for those 1.5°C and 2°C pathways that do not radically reduce energy demand or do not offer carbon-neutral alternatives to liquids and gases that do not rely on bioenergy.” -p. 134

“In energy-intensive processing industries, 1.5°C-compatible trajectories require radical technology innovation through maximum electrification, shift to other low emissions energy carriers such as hydrogen or biomass, integration of carbon capture and storage (CCS) and innovations for carbon capture and utilization (CCU).” -p. 460

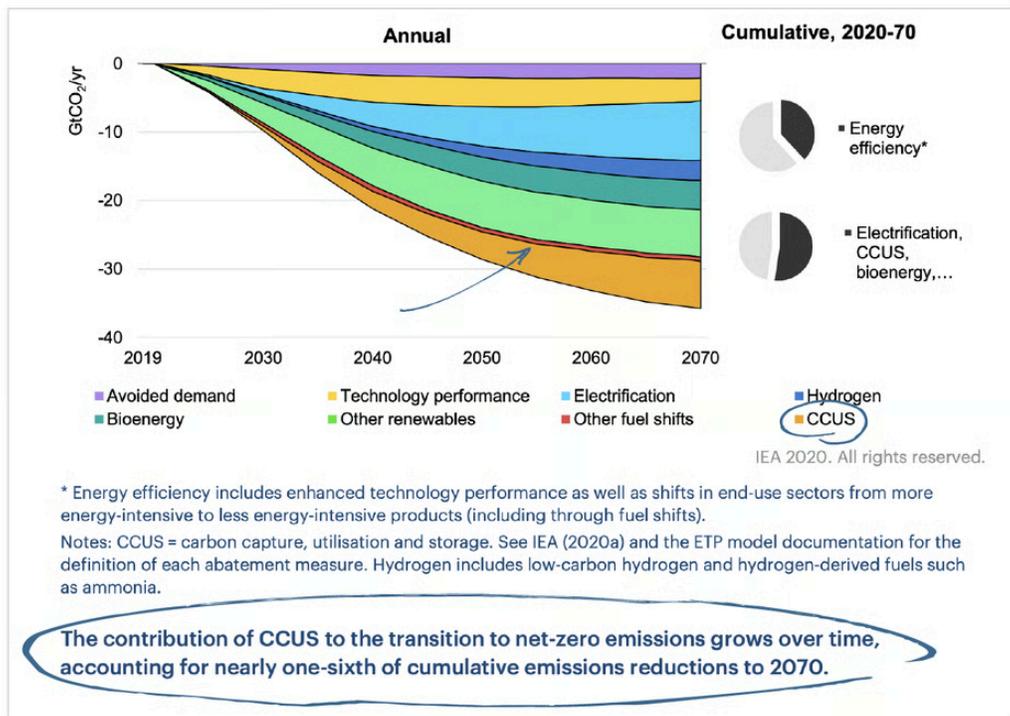
## International Energy Agency (IEA)

Founded in 1974, the IEA is an autonomous intergovernmental organization of nations across the globe that provides “authoritative analysis, data, policy recommendations, and real-world solutions to help countries provide secure and sustainable energy for all.”

“CCUS in Clean Energy Transitions” (2020)

### Highlights

- CCUS enables a faster transition to net zero emissions.
- It will be *nearly impossible* to decarbonize heavy industries such as cement without relying on CCUS.
- As we approach mid-century, we will have to deploy CCUS technologies more and more to help us reach decarbonization goals. (See Figure below)
- Captured CO<sub>2</sub> could be used to make a number of marketable products, such as carbon neutral aviation fuels.



Source: CCUS in Clean Energy Transitions, International Energy Agency, Figure 2.1, September 2020.

## Quotes

*“Reaching net zero will be virtually impossible without CCUS.” -p. 13*

*“It is the only group of technologies that contributes both to reducing emissions in key sectors directly and to removing CO<sub>2</sub> to balance emissions that cannot be avoided – a critical part of “net” zero goals.” -p. 13*

*“A faster transition to net zero increases the need for CCUS. CCUS accounts for nearly 15% of the cumulative reduction in emissions in the Sustainable Development Scenario. Moving the net-zero goalposts from 2070 to 2050 would require almost 50% more CCUS deployment.” -p. 14*

*“Heavy industries account for almost 20% of global CO<sub>2</sub> emissions today. CCUS is virtually the only technology solution for deep emissions reductions from cement production. It is also the most cost-effective approach in many regions to curb emissions in iron and steel and chemicals manufacturing. Captured CO<sub>2</sub> is a critical part of the supply chain for synthetic fuels from CO<sub>2</sub> and*

hydrogen – one of a limited number of low-carbon options for long-distance transport, particularly aviation.” -p. 14

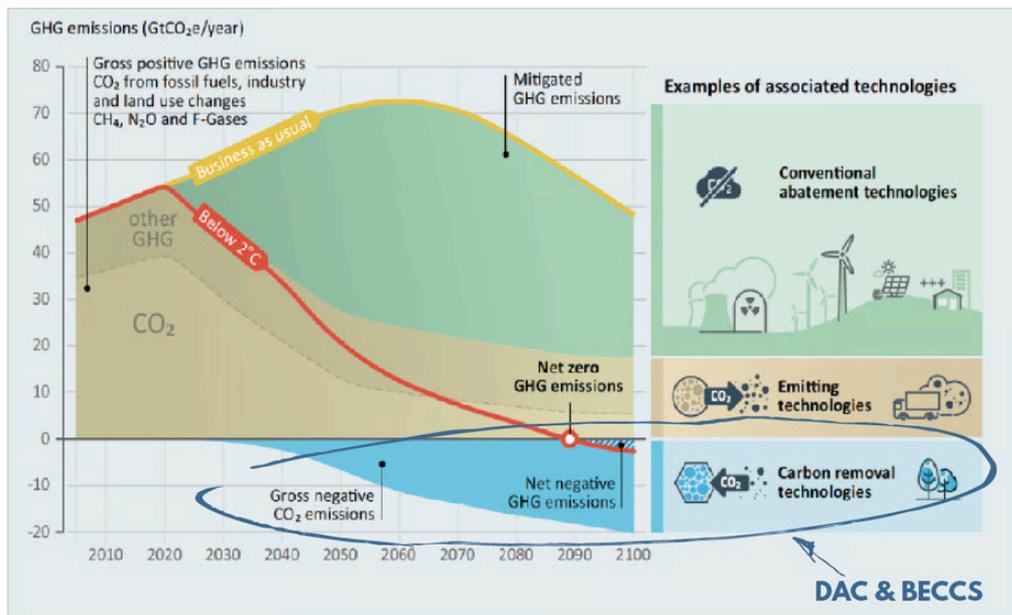
## The National Academies of Sciences, Engineering, and Medicine (NASEM)

*“Negative Emissions Technologies and Reliable Sequestration: A Research Agenda” (2019)*

NASEM consists of the United States’ foremost scientists from the three private, nongovernmental institutions: National Academy of Science, National Academy of Engineering, and National Academy of Medicine. The Academies work together “to provide independent, objective analysis and advice to the nation and conduct other activities to solve complex problems and inform public policy decisions to advise the nation on issues related to science and technology.”

### Highlights

- There are a number of technologies and processes that remove carbon directly from the atmosphere. These tools will need to deliver an annual total of 10 gigatons of carbon dioxide removal (CDR) worldwide by 2050.
- Bioenergy with Carbon Capture and Storage (BECCS), which NASEM defines as “energy production using plant biomass to produce electricity, liquid fuels, and/or heat combined with capture and sequestration of any CO<sub>2</sub> produced when using the bioenergy and any remaining biomass carbon that is not in the liquid fuels” will play an important role in lowering the net CO<sub>2</sub> in the atmosphere.
- We can safely store more CO<sub>2</sub> underground than we can capture in the next 80 years.
- Direct air capture (DAC) has many benefits over other forms of CDR (e.g., it can theoretically be deployed almost anywhere), it just needs to become cheaper to enable greater deployment.



Source: Negative Emissions Technologies and Reliable Sequestration: A Research Agenda, NASEM, Figure S.1, 2019.

## Quotes

*“Four negative emissions technologies are ready for large-scale deployment: afforestation/reforestation, changes in forest management, uptake and storage by agricultural soils, and bioenergy with carbon capture and storage (BECCS). These [negative emissions technologies] have low to medium costs (\$100/t CO<sub>2</sub> or less) and substantial potential for safe scale-up from current deployment.” -p. 8*

*“Including combustion-based BECCS as being ready for large-scale deployment implies that the committee believes that geologic sequestration is ready for large-scale deployment.” -p. 8*

*“If made less expensive, direct air capture technologies could be scaled up to remove very large amounts of carbon.” -p. 353*

## Conclusion

Climate policymakers should pay very close attention when the top global authorities on climate and energy modeling, like the IPCC, IEA, and NASEM, are all telling us loud and clear: we’ll need carbon capture, use, and storage (CCUS) to achieve our climate goals.

The important question, then, is not whether we need it, but how much and how fast we can deliver it. It's great news that the number of CCUS projects has grown over the last few years, but the IEA says that we'll need a 100-fold scale up of large-scale CCUS facilities in the next *20 years* to reach net-zero emissions by mid-century. Accomplishing this will take both significant RD&D and more robust and long-term market incentives for captured, stored, and utilized CO<sub>2</sub>. The next Congress and next administration have the opportunity to put CCUS on a path to widescale commercial deployment and must quickly seize that opportunity for the sake of our climate goals.

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