Clean Energy Innovation Roundtable Series

Summary:
Session VI: Putting the "Net" into "Net Zero"

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On June 3, the Aspen Institute Energy & Environment Program virtually convened the sixth and final session in its 2021 series of Clean Energy Innovation Roundtables. This convening brought together experts to discuss the meaning of "net zero", types of negative-emissions approaches, and ways that markets are supporting carbon removal. This summary captures some of the key topics of discussion.

"Net Zero"

"Net zero" has become a ubiquitous term as various actors set their climate ambitions; it is the topic of the moment on target-setting. "Net zero" is a scientific term describing a state where the level of emissions is simultaneously and equally matched by the level of removals – a state that must be achieved within a reasonable timeframe in order to stabilize global temperatures at a compatible and adaptable level.

The term becomes murkier when applied to an individual entity's goal. For example, as more companies achieve the goal of 100% renewable electricity procured on an annualized basis, either through power purchase agreements or renewable energy credits (RECs), and adopt or consider net-zero targets, many are trying to figure out what net-zero actually means in their electricity portfolios – i.e., whether reductions in energy emissions everywhere at all times is required or whether an electricity number that is itself a net number is part of the broader net-zero goal.

Still, the increased focus on "net zero" may be a very helpful development. Unlike targets focused on global temperature change, which no one has a lever to control, "net zero" brings a more practical lens for viewing long-term climate goals, as entities do have control over emissions. In addition, the concept has enabled companies in harder-to-decarbonize sectors (e.g., airlines) to make climate pledges that they would not otherwise have been able to make.

The "net zero" concept opens up a set of options – carbon dioxide (CO_2) removals – that would not otherwise be on the table. Achieving direct emission reductions is still the main priority for meeting climate targets – as well as for addressing the disproportionate impacts that frontline communities experience – but even after steep declines in emissions from electricity and fuels, some emissions will likely remain from harder-to-decarbonize sectors (e.g., aviation), as well as significant levels of non-CO_2 emissions. All net-zero scenarios combine large reductions in emissions with negative-emissions strategies; removal is not a substitute for reductions but a complement. Removal solutions need to scale up separately from emission reductions, and there may need to be different accounting systems for the two. To meet climate goals, several gigatons of carbon dioxide will have to be removed annually by 2050. There is a need for an inclusive set of strategies to achieve climate objectives, given the magnitude and urgency of the climate challenge.

Indeed, governments and companies should be more ambitious in their thinking about the role of carbon removal. Beyond net-zero goals, governments and companies should set net-negative goals – committing to remove their historic emissions – to be in line with the climate math, though the role that carbon removals should play in a company's portfolio of climate efforts is probably different for every sort of emitter in the economy.

Negative Emissions

Negative-emissions approaches have a critical role to play. Negative emissions can involve sequestration of carbon in the biosphere, geologic sequestration, or sequestration in products.

Sequestration in the biosphere generally involves nature-based solutions, including reforestation, improved forest management, mangrove restoration, improved soil health, improved grassland management, and other approaches in different ecosystem types that can enhance carbon sequestration. Natural climate solutions have the potential to contribute significantly to the carbon mitigation needed over the next decade. They face numerous challenges, however, some of which have been around for decades, such as issues about additionality, permanence, and leakage, although there has been significant progress over the past couple of decades in thinking about and trying to address these issues. Challenges also persist with respect to conditions that hinder nature-based climate solutions from achieving scale globally, including absence of clear land title, fractionated ownership, adverse trade and land policies, and upfront costs for preparing lands to generate carbon credits.

In the United States, land-based negative emissions are expected to decline – perhaps by as much as half by 2050. Most of the U.S. carbon sink is on the East Coast, but as those forests mature, their rate of carbon uptake will decline. In the West, modeling suggests that forests in northern states may have some carbon uptake through 2050, but forests in the more arid states in the Southwest (including California) may be a net source of carbon, releasing more than they take up (e.g., due to wildfires). Scenarios that successfully achieve net-zero involve either holding the U.S. land sink constant (i.e., acting to balance out the decline) or enhancing it. The majority of U.S. forested lands are privately owned, so it is vital to develop programs to catalyze opportunities for private forest landowners to get involved. Restoring the health of forests in the West, perhaps combined with bioenergy with carbon capture and storage (BECCS), could be an opportunity to achieve significant climate benefits while also improving the ecology of the West, though biomass energy is not universally recognized as a good thing.

The scale of annual removals needed to meet climate targets is unlikely to be met by nature-based solutions alone, especially as they are vulnerable to reversal. While nature-based solutions should absolutely be deployed today, it is also essential to develop and deploy technological carbon removal options, such as ones that use chemical processes to mimic photosynthesis and then bury the captured CO_2 underground. Direct air capture (DAC) technologies filter ambient air through chemical solutions that bind with CO_2, resulting in a pure stream of CO_2 for geologic sequestration (or for use in products). The technology works, but DAC is really high in cost today, with prices around $500/ton, though there is line of sight to $50-100/ton. There are about a dozen pilot- or commercial-scale DAC projects around the globe, but most DAC plants today are on the order of 1,000 to 10,000 tons removed per year, not billions; there is one new plant planned in Texas that would get to 1 million tons, but solutions have mostly been deployed on small and niche scales. There are few scalable business models. Even if costs come down, a key constraint on the total amount of negative emissions possible is annual injection rates in different basins across the United States.

There are also technological removal approaches that are a sort of mix of biological and geological sequestration. For example, enhanced mineralization involves speeding up the natural weathering of rocks by increasing the surface area; the pulverized rock is spread on land and binds with CO_2. Enhanced weathering involves high energy use but results in fairly permanent sequestration. Another blended negative emissions technology is BECCS, in which the biomass removes CO_2 from the atmosphere as it grows and then the emissions from its combustion are captured and geologically sequestered. BECCS faces a number of challenges around sustainability, lifecycle accounting, direct and indirect land use changes, water use, competition with food production, indigenous sovereignty, and forest protection.

Captured CO_2, such as from DAC or BECCS plants, can also be used as a feedstock in a range of materials (e.g., plastics), rather than being sequestered underground. Near-term markets for such products represent spaces that entrepreneurs can move into. Climate change is a waste management problem where no one is paying for the cleanup, so these markets represent payers. The near-term markets will not result in meaningful tons removed in the scale of the climate challenge, but they are a way to give technologies a foothold and drive down their cost.

The technological carbon removal approaches can result in permanent and verifiable sequestration for thousands of years, in addition to providing economic and job benefits. Like renewable energy technologies before them, carbon removal technologies need to come down the tech and cost learning curves over the next decade in order to realize their potential.

Markets & Private-Sector Investments

As countries and companies step up their ambitions, there is growing private-sector interest in incorporating carbon dioxide removal into climate goals. There are at least three ways the private sector is investing in negative emissions. First, there are compliance markets. Globally, roughly 20% of emissions are covered by carbon pricing systems, several of which allow some level of offsets with nature-based solutions. Second, policy vacuums have led to the current balkanized system, with states, cities, corporations, and other actors each pursuing net-zero targets separately, leading to both substantial inefficiencies and robust interest in voluntary carbon markets. Voluntary carbon markets have thus seen rapid growth and are leading the way on negative emissions, though the scale is still relatively small. Third, there are companies with innovation funds and other market development efforts that are investing in first-of-a-kind projects; they are paying high prices but are creating a market to drive down costs and accelerate deployment of negative-emissions options.

Voluntary markets involve offsets, which are controversial. Voluntary offset markets have lacked strong enforcement of quality, and some see them as a race to the bottom. The availability of high-quality carbon removal opportunities is extremely limited at the moment. The issues related to permanence, additionality, verifiability, leakage, and double-counting are a big concern, and it is unrealistic to think that most companies and countries can do an extremely high level of diligence and review in a sustainable way. Currently, there is a wide spectrum of quality in terms of offset protocols, especially for land-based solutions, and there is no good way at the moment to ensure quality standardization. Many companies buy offsets because they are low-cost and easy; they are not aiming for quality, and the low levels of public awareness and education mean there is little external pressure on these companies to do so. Interestingly, while a company buying an offset is on controversial ground, a company buying a REC is applauded, even if that REC has little carbon value (e.g., if it is from a renewable resource on a grid saturated with renewables and thus is not displacing any carbon). Not all offsets are created equal, but the same could be said about RECs. Current attitudes toward best corporate practices are not carbon- or climate-optimized, which could affect the growth of the negative-emissions sector.

Nature-based offsets are using ever-improving methodologies and standards, developed through open processes, for monitoring, reporting, and verification, but criticisms persist, and there is room for more improvement. There is a need for better accounting, standards, and oversight. Accounting and transparency systems must be able to ensure reductions are real, verified, permanent, and not double-counted. Some of the issues faced by nature-based solutions can be addressed in their selection and design. For instance, projects can be avoided in places that are highly dynamic and prone to disruption. Nature-based offsets can also recognize the risks from fires and other landscape changes, such as through a buffer pool that spans projects; like an insurance mechanism, the projects can still deliver credits if such a circumstance arises. (While buffer pools are important, some recent research and evidence suggests there has been an underestimation of the scale of buffer pools necessary to account for land-based reversals.) Nature-based solutions can vary in their durability, but they generally are not permanent solutions. The perfect cannot be the enemy of the good, but it is important to know the drawbacks of solutions and try to address them.

In the short term, nature-based offsets have to be a huge part of the carbon removal market. Longer-term, it might be worth considering ways to think of the value of nature-based solutions as encompassing more than just carbon removals. Investments in nature can also reduce climate impacts and bring numerous other benefits; there could be a market for investing in nature where carbon removals are part of the solution but may not need to be held to a level of accounting rigor that may be unrealistic.

Removal offsets are not just nature-based. Companies purchasing tons from DAC or other removal technologies and applying those tons to their net-zero or other climate goals are treating those removals as offsets. These offsets have more permanence and fewer accounting challenges than nature-based solutions.

While offsets remain controversial, CO_2 removals can compensate in the near term for emissions further out of companies' control (e.g., Scope 3 emissions) and in the long term can remove historic emissions. Using offsets outside of one's sector in addition to pursuing in-sector reductions may also be better (or more justifiable) than using them inside one's sector.

There are a few companies that are procuring removal tons and not applying them to their ledgers. These companies are really focusing on a market creation and innovation play. While revolutionary, that is probably not scalable. By investing in removal technologies, private-sector actors can support the creation of a market for them, so that eventually the supply will be greater, of high quality, and available at a reasonable price point for others to support at scale. It is important to lay the foundations for removals to be done and done well. Early investments can drive the space forward, particularly in the absence of other incentives for the private sector to deploy these solutions. Near-term markets, whether in the form of offsets or innovation investments, can start driving volume, improving the economics and scalability.

Scaling up removal solutions – both nature-based and technology-based – will be a significant challenge, but there is cause for optimism. There are proven tools that have been used to scale other carbon solutions, such as renewables. Government actions, such as regulations and investments in R&D and infrastructure, could help drive removal solutions forward. The value of R&D in technologies such as DAC and CCS is equal to tens or hundreds of billions of dollars in terms of reducing the costs of achieving net-zero and avoiding catastrophic climate change. Early technologies are expensive, with external values that cannot be fully internalized. Government subsidies are one way to overcome that (as is voluntary private-sector demand). There has been a huge amount of bipartisan, bicameral interest (as well as in the Biden Administration) in carbon removal. It is top of mind for policymakers, but there is a need to drastically ramp up to get to scale by 2050.