Carbon: Future Impact and Policy Differences

The US experience and lessons for Ireland by Ciarán Hayes

Summary

This briefing focuses on carbon and its human-caused impact on climate and the environment. It explains its contribution to a warming climate, details carbon composition in the atmosphere and outlines various strategies and options for reducing the concentration. While acknowledging the current carbon debate in Ireland, it explores the issues exercising policy makers across different administrations and the growing influence carbon will have on decision-makers into the future. The Briefing will be of interest to senior policy makers across government and local government in Ireland as well as having an international relevance to readers in other jurisdictions.

Introduction.

Carbon tax and carbon budgets have been a primary focus of the carbon debate in Ireland to date with the introduction of Decarbonised Zones also exercising the minds of the Local Government sector. Accompanied by a predictable debate concerning the timing and political expediency of annual increases in the price of carbon, particularly in the aftermath of the pandemic and the Russia/Ukraine impact on energy prices, it is easy to overlook the fact that two years have already been lost in reaching our statutory 2030 carbon emission targets. Every sector will therefore be further challenged to achieve higher targets in the remaining eight years.

Significant additional reductions in carbon emissions will therefore become necessary, but the formulation of a comprehensive carbon policy will entail a broader focus beyond the reduction of carbon emissions alone. It will entail the introduction and acceleration of a range of technological solutions running in parallel, solutions being actively pursued in other jurisdictions.

Understanding the Carbon Cycle

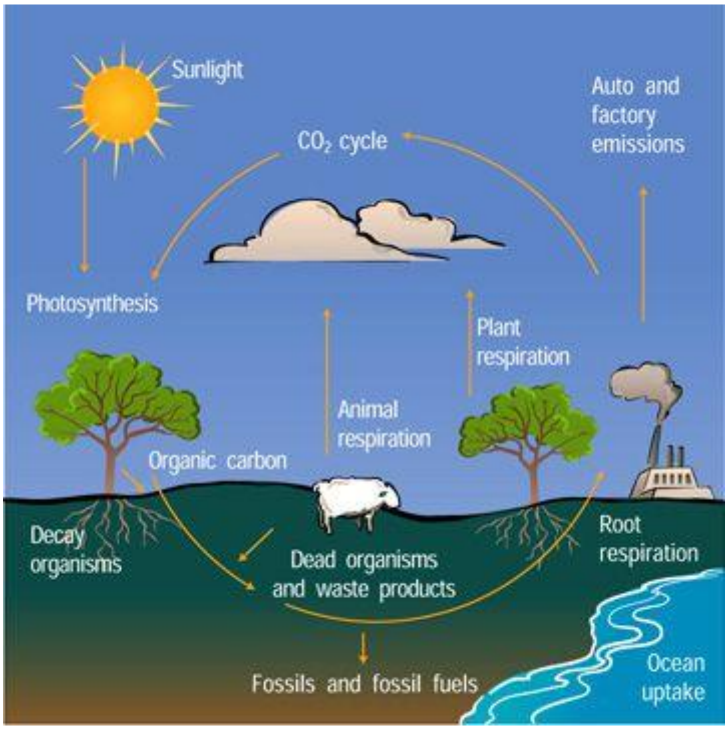
Framing carbon policy relevant to each sector requires an understanding of the carbon cycle and assists with the choice of options appropriate to each sector. If carbon dioxide is recirculated in the air, carbon neutrality is achieved. But if it's pulled out of the air and kept from going back either through Carbon Capture and Sequestration (CCS), Bioenergy and Carbon Capture and Sequestration (BECCS) or Direct Carbon Removal otherwise known as Carbon Dioxide Removal (CDR) the result is carbon negative.

Nature has already covered the planet in solar-powered carbon dioxide absorbers, and they've been removing greenhouse gases from the atmosphere for millennia.

Using sunlight, plants and micro-organisms take in carbon dioxide and emit oxygen. Those plants are eaten by animals, who then convert the plants to energy and exhale carbon dioxide. Uneaten plants die and decay, putting some carbon in the soil and returning the remainder to the atmosphere.

It's almost a closed loop, though over the course of millions of years, enough decaying plant and animal matter gradually build up in the ground to yield vast reserves of fossil fuels while reducing the carbon dioxide in the atmosphere bit by bit.

Humans have breached this cycle by digging up fossil fuels and burning them, leading to carbon dioxide building in the atmosphere faster than natural systems can soak it up, resulting in a net increase in greenhouse gases in the atmosphere, causing the planet to heat up.



The carbon cycle. University Corporation for Atmospheric Research

Land Use

From a land use perspective, every acre of restored temperate forest can sequester 3 metric tons of carbon dioxide per year. In the US, forests already offset about *13 percent* of the country's carbon emissions. Globally, forests absorb ***30 percent*** of humanity's emissions. So, restoring forests can be an effective way to reduce the concentration of carbon dioxide in the air.

Similarly, ***crops grown for human consumption*** like grains and grasses can also lead to negative emissions. These plants move atmospheric carbon dioxide into their root systems. Even if they're eaten or burned for fuel, they leave some carbon in the soil. But the balancing act is not as easy since crops also require energy inputs like fertilizer and harvesting equipment.

Clearing land to grow crops can also increase the greenhouse gas footprint.

Another approach is to use ***holistic grazing*** practices for livestock (as is prevalent in the Irish context). Rather than penning up animals in factory farms, allowing them to graze over wider pastures can help restore grasslands as cattle, sheep, and pigs aerate the soil and enrich it with manure. The restored grasses then take in more carbon dioxide and store it in the soil.

Such methods to fight climate change have yielded the best results so far in the US and although significant experience has been built up, they are often overshadowed by the technological options. Yet of the four technologies that are ready for deployment, three involve the natural carbon cycle: planting new forests, improving forest management, and storing carbon in agricultural soils.

It has also been shown that restoring nature and planting more crops is often cheaper than building and deploying hardware.

But all present difficult choices. A major problem with these strategies remains the existing association of inter-generational land use with the tight constraints on how we use land. Forests, food, and housing needs compete for the same land and there is not enough viable land to grow enough plants to completely offset all of humanity's carbon dioxide emissions.

It's also difficult to value the climate benefits of pristine or restored ecosystems against more measurable economic upsides like long-standing agricultural practices, building housing or mining for resources.

While Ireland can justifiably point to greater sustainability in terms of its agricultural land use, there is no room for complacency. The sector will remain challenged to achieve its carbon reduction target and cannot discount the need for additional improvements to farming practices and introduction of technological solutions.

Impact on Carbon Targets

Globally, average annual greenhouse gas emissions reached the highest level in human history between 2012 – 2019 (IPCC 6th Assessment Report) with a concentration of 410 parts per million, about 0.04 percent of the atmosphere.

We are not on track to limit global warming to 1.5°C. As of 2019, 64% of all emissions comprised Carbon Dioxide (CO_2) from fossil fuels, 18% Methane (M), 11% net CO_2 from land use, 4% Nitrous Oxide (N_2O) and the balance of 2% from Flourinated gases (F-gases).

Global temperature will only stabilise when we reach net zero carbon emissions. Although some countries have achieved steady decreases consistent with a 2°C target and over 826 cities and 103 regions have set zero emission targets, unless there are immediate and deep reductions across all sectors, the 1.5°C target will be unachievable.

Greenhouse gas emissions in the EU-27 declined by 24% between 1990 and 2019, implying the EU will largely exceed its 2020 target of 20% emissions reduction. However, according to the European Commission's impact assessment of the climate target plan, the average reduction rate observed in the past is not enough to reach the current 40% target by 2030, let alone the more ambitious targets recently agreed.

The current and planned policies and measures will boost the emissions reduction rate, but not sufficiently with the European Commission estimating that by 2030, only a 41% reduction will be achieved. A wide gap between existing and planned measures and the 55% target exists.

Given the potential challenges of meeting the targets through emissions reductions alone, Carbon Dioxide Removal (CDR) alternatives need to be assessed and incorporated into the design of EU mitigation strategies.

Technology Options

Looking to the US, five Federal technology carbon removal options are detailed below.

Name	**Primary implementing federal agency**	**Carbon Removal Type**	**Funding Level**
Carbon Negative Shot	Department of Energy	All (DAC, forests and agricultural soils, mineralization, etc.)	Various — will leverage new and existing Department resources, including annual appropriations
Direct Air Capture Hubs	Department of Energy	DAC	$3.5 billion over five years

Reforestation	Department of Agriculture, US Forest Service	Forests	$2.5 billion plus $265 million annually through the Reforestation Trust Fund
Climate Smart Agriculture and Forestry	Department of Agriculture	Forests and agricultural soils	$1 billion for the Partnerships for Climate Smart Commodities program; $10 million for soil carbon monitoring through CRP; $10 million for EQIP in 10 targeted states
Transport and Storage for CO_2	Department of Energy	DAC (as well as point source capture)	$2.5B for geological storage, $2.1B for CO_2 transport, $300M for CO_2 utilization, $100M for engineering and design, and $75M for geological storage permitting over five years

Although these initiatives represent an enormous increase in carbon removal funding and demonstration projects in the U.S. – which must be accompanied by a commitment to equity, public engagement and environmental integrity – much more is still needed.

In addition to the land-based carbon removal pathways set to further develop in 2022, increased research and development of ocean-based carbon removal is also required, which could leverage the ocean's massive carbon removal potential and could greatly expand the portfolio of carbon removal approaches. The National Academies recently outlined a research agenda for ocean carbon removal, highlighting the potential and need for research funding.

To reach the carbon removal goals outlined in the U.S. Long-Term Strategy, the federal government must also pass provisions such as those included in the 2021 Build Back Better Act, which would direct tens of billions of dollars to climate-smart agriculture and forestry and would enhance tax credits for carbon capture and Direct Air Capture (DAC) or Carbon Dioxide Removal (CDR) projects to support faster deployment.

Carbon removal can help the U.S. achieve its climate goals — but scaling carbon removal must be done with careful consideration of environmental and social impact. The US can lay the building blocks for effective and responsible carbon removal, but only if swift action is taken this decade.

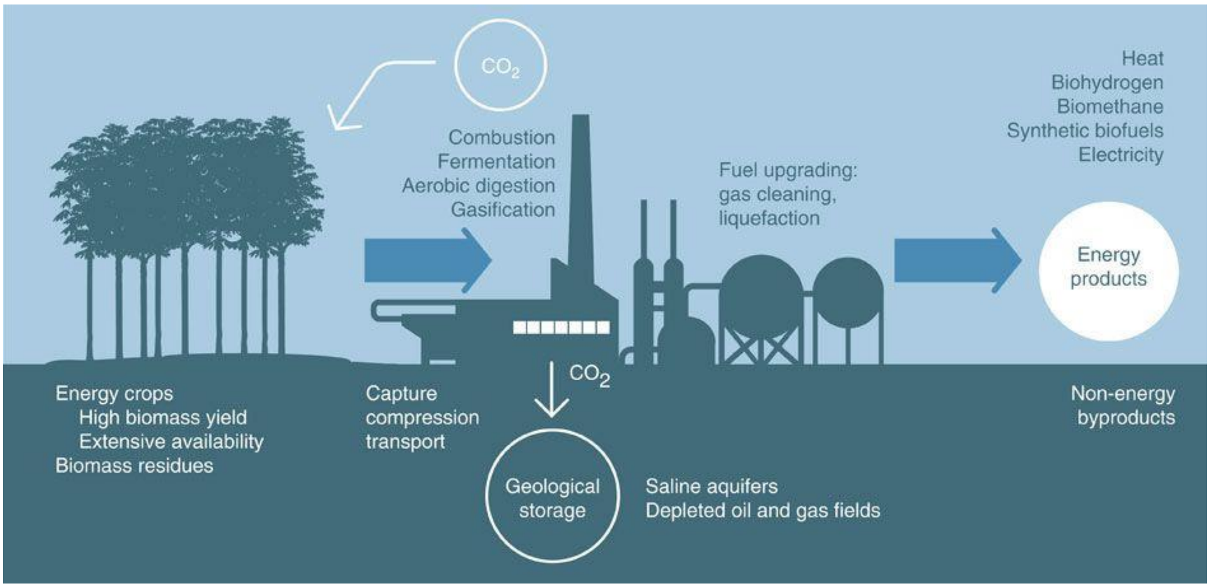
From a marine perspective, Ireland's strategic island location in the northeast Atlantic would appear to present options and opportunities to positively address the global carbon emission imbalance. That is of course subject to the adoption of an appropriate marine policy backed up by research and development funding streams. The creation of such funding streams will likely give rise to calls for complementary tax incentive policies.

With carbon reduction by itself being insufficient, other options that exist presently to reduce emissions by 2030 across all sectors including Energy, Transport, Land use, Buildings, Industry, Urban and Demand and Services need to be considered. As outlined above, they include Carbon Capture and Sequestration (CCS), Bioenergy with Carbon Capture and Sequestration (BECCS) and Direct air capture of Carbon or simply, Carbon Dioxide Removal (CDR).

CCS is the process of capturing carbon in the production process and storing it underground. While the production of the product may be carbon neutral or even negative, the subsequent use of the product may still be positive.

BECCS on the other hand presents the ability to produce power with negative emissions. Since the carbon in crops grown for fuel are drawn from the atmosphere rather than underground reservoirs, biofuels can in theory be **carbon neutral**, or close to it.

However, where the greenhouse gases are captured and sequestered from a bioenergy plant, the production system can be made carbon negative while also making heat, electricity, and fuels. The more crops you plant, burn, and sequester, the more carbon dioxide you remove from the air. Such is the logic behind bioenergy with carbon capture and sequestration (**BECCS**).



Schematic: How bioenergy with carbon capture and sequestration (BECCS) leads to negative emissions. *Nature Climate Change*

BECCS has the added benefit of producing something you can sell to pay for the system. However, the same constraints that apply to afforestation also apply here. To limit global warming to 2 degrees Celsius using BECCS, one estimate found that it would require biomass planted over an area larger than India.

Fighting climate change with BECCS also requires producers to be very picky about their **biomass sources**. Cutting down an old tree to burn and replace it with a sapling takes years before the new plant will be able to absorb the same amount of carbon dioxide as its predecessor, thus limiting the kind of trees, crops and grasses that can be used sustainably for BECCS.

With carbon dioxide at its highest levels in recorded history and neither CCS or BECCS providing the silver bullet technological solution, consideration needs to be given to direct Carbon Dioxide Removal (CDR) i.e. building a machine to filter a huge volume of air through a scrubber in order to extract the carbon, which in itself requires a considerable amount of energy.

Nonetheless, there are companies that have already pulled this off. **Carbon Engineering** in Canada has built a plant that captures about 1 ton of carbon dioxide per day.

Meanwhile **Climeworks** is running three direct air capture plants — in Iceland, Switzerland, and Italy — together capturing 1,100 tons of carbon dioxide per year.

Climeworks DAC plant. Photo by Julia Dunlop/Climeworks

The challenge then is what to do with the carbon dioxide once you have it. In that regard, Carbon engineering is working on an air to fuels pathway while in Iceland, Climeworks is turning its captured carbon dioxide into basalt rock. In Switzerland, the gas is used as a fertilizer in a greenhouse, and in Italy, the company is using the carbon dioxide to make methane fuel for trucks.

While the technology exists, the scale does not. Currently, carbon is captured on the scale of hundreds of tons while the IPCC's low-end estimate for carbon capture we need by 2100 is 100 gigatons. That's 100,000,000,000 tons of carbon dioxide i.e. 800,000 times current annual direct air capture capacity by 2100 if we're going to rely on this method alone to limit warming to 1.5 degrees Celsius.

Summary

Achieving the 1.5% global warming target presents major political and policy challenges requiring significant increases in carbon emission reduction and removal across all sectors and all options. That includes current and future options such as those being advanced by scientists exploring how to extract carbon from the air with **seawater** as well as **enhanced weathering** of rocks so that they react with atmospheric carbon dioxide.

Notwithstanding the need to extract carbon at the scale required, likewise there should be no underestimation of the scale of the political and practical challenges presented to governments and companies if investment in these technologies are to be successful, as they require a **price on carbon**.

Those challenges must nevertheless be addressed if

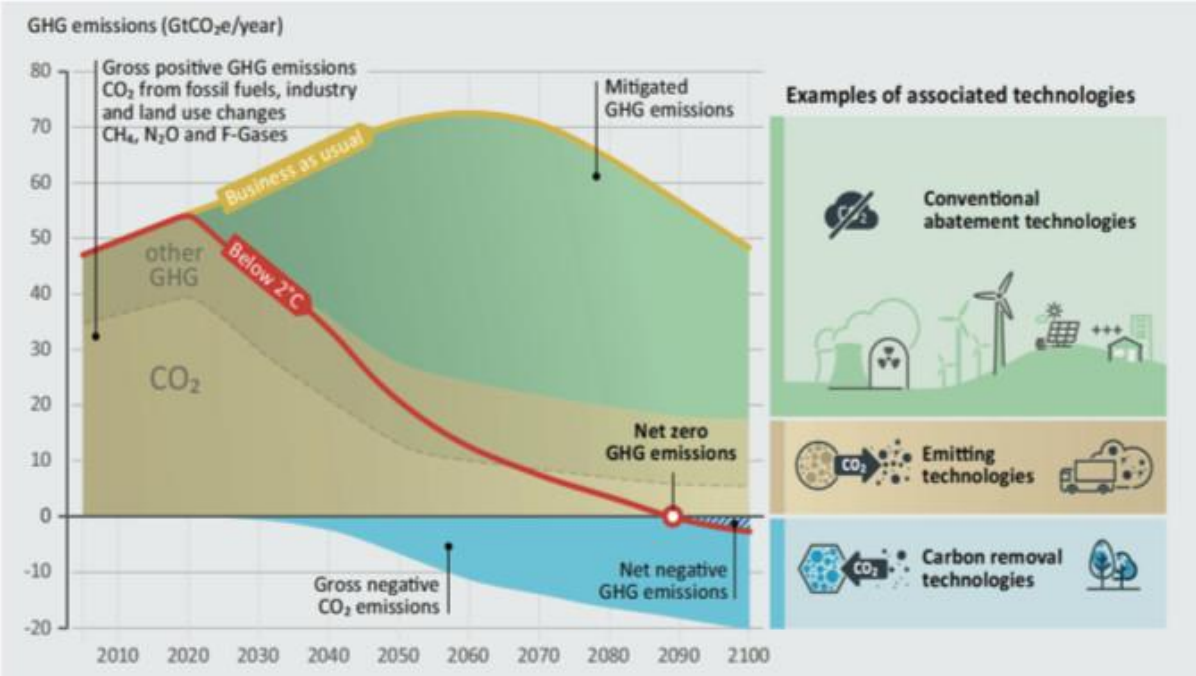
Direct air capture, for example, would be especially useful for offsetting some of the hardest sectors to decarbonize, like air travel. However, companies estimate it costs about $100 per ton to withdraw carbon dioxide from the air, so a carbon price would have to be higher than that. Or the technology has to become much, much cheaper.

As noted above, there are commercial uses for captured carbon dioxide that can offset the price tag. Right now though, one of the most common uses for captured carbon dioxide is **enhanced oil recovery**. For example, the world's largest carbon capture facility is at the **Petra Nova** coal plant in Texas. The captured carbon is sold to an oil producer to help extract more oil from a nearby well. Now, Petra Nova's carbon dioxide is scrubbed from a flue, not directly from the air like direct air capture, but enhanced oil recovery was a key part of the business case for the plant.

So it's capturing carbon dioxide and injecting it underground ... to extract more carbon.

That means we need coordinated policies with climate change at the center to make carbon dioxide removal work to fight warming. In addition to pricing carbon, it would require pricing **ecosystem services**, research and development grants, and tax credits to encourage deployment of carbon dioxide removal.

And, as the National Academies points out, the heavy lifting will still come from accelerating the entire suite of low-emissions technology at the same time, from energy efficiency to renewables, as the chart below shows.



Carbon dioxide removal is only a small piece of the climate change puzzle. *National Academies of Sciences/United Nations Environment Programme*

Only then will carbon removal truly start to have an impact in the fight against climate change.

The Long-Term Strategy of the United States lays out an ambitious path to net-zero greenhouse gas emissions by 2050, which includes removing 1-1.8 billion metric tons of carbon dioxide equivalent (CO_2e) per year by 2050 through a combination of technological and nature-based carbon removal approaches. This is equivalent to removing the emissions of 220 - 400 million passenger vehicles per year.

The U.S. has a particularly large role to play in leading global development of carbon removal approaches and technologies. Given its outsized contribution to the CO_2 that is already in the atmosphere (known as its "legacy emissions") carbon removal will be needed not only to counter-balance residual emissions — or those that can't be reduced or eliminated by midcentury, for example from long-haul shipping or aviation — but also to address these legacy emissions.

As the U.S. has emitted more carbon dioxide to date than any other country in the world, the country's investment in scaling carbon removal could help contribute to greater equity in global climate action.

5 Federal Carbon Removal Initiatives to Watch

The U.S. Long-Term Strategy draws upon several types of carbon removal approaches, as WRI recommended in its CarbonShot analysis. These include engineered carbon dioxide removal such as direct air capture and carbon mineralization on land or in the ocean, and carbon removal that enhances natural carbon sinks in forests, soils and coastal ecosystems.

In the near-term, restoring trees to the landscape represents the largest opportunity for carbon removal in the U.S.; however, natural carbon removal alone will likely not be sufficient to reach net-zero by 2050, or to address legacy emissions.

Because there is a need to increase carbon removal to a large scale quickly, and because many carbon removal technologies are still in development, investment is needed across pathways to reduce risk of any individual pathway falling short. Development and deployment of all pathways must also prioritize equity in addition to technological and economic considerations.

Research, demonstration, planning and public engagement in the coming years will lay the groundwork for an effective and equitable scaling of carbon removal over the next decade. Here are five carbon removal initiatives to watch:

1. Carbon Negative Shot

What is it? In 2021 the U.S. Department of Energy (DOE) launched an initiative to lay the foundation for scaling both technological and land sector carbon removal to one gigaton per year. This initiative also aims to decrease removal and storage costs across technologies to under $100 per metric ton of CO_2 within the next decade.

Currently, carbon removal via direct air capture (DAC), a leading technological approach, costs between $600 and $2,000 per ton of CO_2 depending on the company, but costs are expected to decline as DAC is developed and deployed. Tree restoration can, however, already offer carbon removal at less than $100 per ton.

Among the removal pathways Carbon Negative Shot would support is emerald hydrogen, which uses sustainable or waste biomass to produce hydrogen and captures the carbon contained in the biomass — WRI's recently-released analysis estimates that this pathway could provide up to 500 million tons yearly of carbon removal by 2050. Funding for hydrogen hubs in the 2021 Infrastructure Investment and Jobs Act (IIJA) and funding for DOE's Hydrogen Shot could contribute to developing emerald hydrogen.

Carbon Negative Shot will include research on the feasibility of carbon removal through emerald hydrogen, as well as environmental impacts of various other CO2 removal approaches, including production of components and CO_2 transportation and storage.

What will implementation look like? Carbon Negative Shot will prioritize equity and environmental integrity in carbon removal by drawing upon public engagement with diverse stakeholders and analyzing potential social environmental impacts to identify sites for carbon removal demonstration projects. The Carbon Negative Shot initiative is also intended to create well-paying jobs for communities across the country.

2. Direct Air Capture Hubs

What is it? Direct Air Capture (DAC) is carbon removal technology that uses chemicals to selectively bind with CO_2, pulling it out of the air. Captured CO_2 can then be injected into underground storage sites or used in products like cement or carbon fiber.

The 2021 Infrastructure Investment and Jobs Act (IIJA) includes $3.5 billion for four DAC hubs, projects that will each capture at least one million metric tons of CO_2 per year when complete (equivalent to annual emissions from over 200,000 passenger vehicles per hub) and will serve as learning opportunities for future DAC development.

While carbon dioxide removal by DAC in the next decade will be relatively small compared to carbon removal from reforestation and restoration of ecosystems, DAC hubs will help lay the groundwork for gigaton-scale DAC by 2050.

What will implementation look like? The US Department of Energy Office of Carbon Management and Fossil Energy (FECM) is charged with the implementation of these DAC hubs: They must solicit applications for project proposals by May 2022 and select projects within three years after that. In December 2021, FECM released a request for information to formally gather public input on location and best practices for building these hubs.

DAC plants have the advantage of being relatively flexible in their siting, unlikely to emit chemicals with public health concerns during operation and are expected to produce new employment opportunities. DAC, however, is also energy-intensive, and uses sizeable amounts of land, water and chemicals.

Public engagement and education are essential to ensure that communities impacted by DAC hubs understand the potential impacts of DAC plants and have had the opportunity to negotiate community benefits. Robust environmental assessment will also be needed to ensure that the configurations of DAC plants and energy resources minimize environmental impact.

A DAC plant operated by Climeworks, a DAC development company. Photo by Julia Dunlop/Climeworks

3. Reforestation

What is it? In order to meet its climate goals, the U.S. needs to restore trees at a grand scale. The IIJA includes over $2.5 billion for post-fire forest restoration, reforesting abandoned mine lands, and updating the National Seed Strategy to ensure that there are sufficient seedlings for reforestation and restoration projects.

The bill also removes the current cap on the Reforestation Trust Fund, unlocking $264 million per year for reforestation on National Forest Land. These reforestation efforts could remove 103 million metric tons CO_2e per year by 2030.

What will implementation look like? Reforestation at scale will require a step-change increase in seed collection and production of seedlings, as well as developing a workforce to prepare sites, plant and steward young trees. Scaling the reforestation workforce equitably means that all workers — including workers employed by federal workforce development programs and guest workers with H-2B visas — must earn living wages and work in safe conditions.

4. Climate Smart Agriculture and Forestry

What is it? The US Department of Agriculture has initiated several efforts to support farmers, ranchers and forest owners in increasing carbon sequestration and climate resiliency on their lands. This includes $10 million in funding for improved soil carbon monitoring and research through the Conservation Reserve Program (CRP); $10 million in additional funding for a climate-smart agriculture and forestry pilot through the Environmental Quality Incentives Program (EQIP). Secretary Vilsack also recently announced USDA's plan to channel $1 billion through the Commodity Credit Corporation to provide grants for the development of pilot projects for the new Partnerships for Climate Smart Commodities program.

These three initiatives will help to quantify the carbon impact of farm and forest management practices, incentivize farmers and forest owners to adopt climate-friendly practices, and take the first steps toward building markets for climate-smart commodities.

What will implementation look like? Increasing adoption of climate-smart practices will require increased technical assistance from state and federal agencies, as well as land grant universities and other partners, and financial support for landowners and land managers. Quantifying the impact of these practices will also entail increased soil carbon research, as well as research assessing the carbon impacts of climate-friendly land and forest management.

Perkins' Good Earth Farm in Indiana practices climate-smart agriculture, including no-till, cover crops, wind buffers and hedgerows, supported with contracts from USDA programs. Photo by Brandon O'Connor/USDA-NRCS

5. Carbon Dioxide Transport, Utilization and Storage

What is it? Scaling CDR will require building more infrastructure to transport CO_2, research and piloting to ensure that CO_2 storage is safe and permanent, and developing markets for carbon dioxide utilization. The IIJA includes, over five years, $2.1 billion for low-interest loans for shared CO_2 transport infrastructure, $2.5 billion for geological storage, or permanent storage of captured CO_2 in natural wells or aquifers deep underground, and $310 million for grants issued to state and local governments for carbon utilization market development.

What will implementation look like? Building out carbon transport, utilization and storage involves researching and identifying the environmentally friendly and economical ways to transport CO_2 in a given area (e.g., pipelines, trucks, boat) and the best uses for captured CO_2. It also requires identifying the best locations for CO_2 storage and ensuring that storage locations and transportation infrastructure are safe, have plans for long-term monitoring, and align with community needs.

Carbon Removal Initiatives to Watch

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To Reach Carbon Removal Goals, More is Needed

These five carbon removal initiatives represent an enormous increase in carbon removal funding and demonstration projects in the U.S., which must be accompanied by a commitment to equity, public engagement and environmental integrity. But much more is still needed.

For example, in addition to the land-based carbon removal pathways set to further develop in 2022, increased research and development of ocean-based carbon removal is also needed, which could leverage the ocean's massive carbon removal potential and could greatly expand the portfolio of carbon removal approaches. The National Academies recently outlined a research agenda for ocean carbon removal, highlighting the potential and need for research funding.

To reach the carbon removal goals outlined in the U.S. Long-Term Strategy, the federal government must also pass provisions such as those included in the 2021 Build Back Better Act, which would direct tens of billions of dollars to climate-smart agriculture and forestry and would enhance tax credits for carbon capture and DAC projects to support faster deployment.

Carbon removal can help the U.S. achieve its climate goals — but scaling carbon removal must be done with careful consideration of environmental and social impact. This decade, the country has the opportunity to lay the building blocks for effective and responsible carbon removal.

As a party to the Paris Agreement, the European Union has committed to implementing climate mitigation policies to keep the average temperature rise to well below 2°C, while pursuing efforts to limit it to 1.5°C. Meeting the more ambitious goal of 1.5°C requires bringing the level of global net greenhouse gas emissions to zero by around 2050, according to the Intergovernmental Panel on Climate Change (IPCC). Following this scientific consensus, the European Commission presented in 2019 the European Green Deal as the strategy towards a climate-neutral Europe by 2050, and proposed a European climate law in 2020 to make this target legally binding. The IPCC scenarios consistent with limiting the temperature rise to 1.5°C show that removing CO2 from the atmosphere is essential and complements the implementation of emissions reduction policies. In line with this, the European science academies recommend prioritising deep emissions cuts, but also to start developing a portfolio of carbon dioxide removal (CDR) options immediately. Various options are being discussed in light of the growing consensus that meeting the established targets is dependent on CDR. These range from nature-based practices – such as forestation, soil carbon sequestration and wetland restoration – to technological alternatives such as enhanced weathering, bioenergy with carbon capture and storage, and direct air capture and storage. Naturebased solutions stand out as more cost-effective and viable in the short run, while some technological alternatives have potential to become more relevant later this century. The European Commission recognisesthe crucial role of CDR, and intends to focus on nature-based options. An extensive revision of the EU climate mitigation legislation, planned for 2021, will provide an opportunity to set a regulatory framework for CDR. The European Parliament has repeatedly called for prioritising emissions reductions over CDR, and stressed the importance of conserving biodiversity and enhancing natural sinks and reservoirs. Its position on the proposed European climate law involves removing GHGs that exceed manmade emissions in the EU and each Member State from 2051. In this Briefin

EU policy related to carbon dioxide removal The European Green Deal, the proposed tightened climate targets, and the subsequent revision of EU climate legislation planned in 2021, provide a unique opportunity to create a regulatory framework for CDR.6 The Commission focuses on using ecosystems for CDR in the short term, although it recognises the need for both nature-based and technological options. The Parliament has repeatedly called for prioritising emissionsreductions over CDR and stressed the importance of conserving biodiversity and enhancing natural sinks and reservoirs, especially forests. It amended the proposal for the European climate law to include the requirement that removals of GHGs by sinks should exceed anthropogenic emissions in the EU and each Member State from 2051. Under the current framework, the most relevant legislation concerning nature-based CDR is Regulation (EU) 2018/841 for including GHG emissions and removals from land use, land-use change and forestry (LULUCF) in the 2030 climate and energy framework. This regulation extends emissionsand removals-related accounting obligations to all types of land use from 2021 – except wetlands, which will be included from 2026. The regulation commits Member States to ensure that accounted LULUCF emissions do not exceed removals over 2021-2030 and the sector contributes to enhancing the carbon sinks in the long term. The regulation includes certain flexibilities. For instance, if the LULUCF sector in a given Member State results in net removals, the exceeding removals can be transferred to other Member States or used to meet the targets under the Effort-sharing Regulation (EU) 2018/842 (ESR). A Member State with net emissions can meet its commitments by buying removals from another Member State or using emissions allocations under the ESR. The Commission recognises that this regulation does not sufficiently enhance carbon sinks, and hence intends to propose amendments in June 2021. This, along with a review of the ESR, should provide stronger policy incentives. For the review, the Commission is considering the following policy options: making the regulation more ambitious, strengthening the flexibility with ESR, and combining agriculture and LULUCF in one sector with a separate target. In the climate target plan, the Commission proposes creating a robust CDR certification system by 2023, to incentivise carbon sequestration and facilitate substantial removals from LULUCF, whose certificates could compensate for hard-to-abate emissions across the economy. Other relevant policies include the 2030 biodiversity strategy with the nature restoration plan at the core; the current and upcoming soil strategy; the Farm to Fork strategy, particularly the forthcoming carbon farming initiative; the forest strategy and its planned revision; the adaptation strategy and its expected new version; and the new common agricultural policy with the creation of eco-schemes as crucial in this context. Regarding CDR technologies, BECCS and DACCS are dependent on CCS development. The CCS Directive 2009/31/EC establishes a legal framework for the safe selection of storage sites and regulates the concession of storage permits. Moreover, it includes provisions on CO2 capture and