
The New Carbon Economy Consortium (NCE) is an alliance of universities, national labs, and NGOs partnering to enable a carbon-removing world.

Launched in 2017, the Consortium connects and supports individuals from across institutions and disciplines to pose new research questions, establish shared resources, and articulate pathways to the broad implementation of carbon removal solutions. This executive summary and the accompanying innovation plan mark the Consortium's first endeavor together and aims to consolidate the group's priorities for future research activities.

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OUR VISION

Today, a great resource lays underutilized.

While carbon emissions are largely considered a pollutant, emerging innovative technologies and land management practices hold the potential to transform carbon in the atmosphere into a valuable, productive resource. Combined with increasingly abundant clean energy and insights into the roles carbon plays in soils, human ingenuity and innovation can enable a previously unimaginable vision: a prosperous, growing economy that captures and stores more carbon than it emits. This economy shifts away from our history of extraction and degradation towards a future where we harness our lands to boost crop yields and soil health and transform carbon emissions into better chemicals and building materials. Under this revolutionary paradigm, new and reimagined industries can provide jobs, economic opportunity, and prosperity, all while mitigating climate change and supporting other important environmental goals.

NEW CARBON ECONOMY (n.)

a prosperous, growing economy that captures and stores more carbon than it emits

The New Carbon Economy Consortium brings together fourteen academic institutions, national laboratories, and NGOs under this unified vision. Success, however, is not inevitable; significant knowledge gaps and challenges remain. Public and private capital currently offers little support for technological and land management innovation and nearly nonexistent incentives to bring these technologies and practices to scale. Overcoming these barriers and changing the status quo will require a monumental shift in the way we pursue the innovation agenda around carbon.

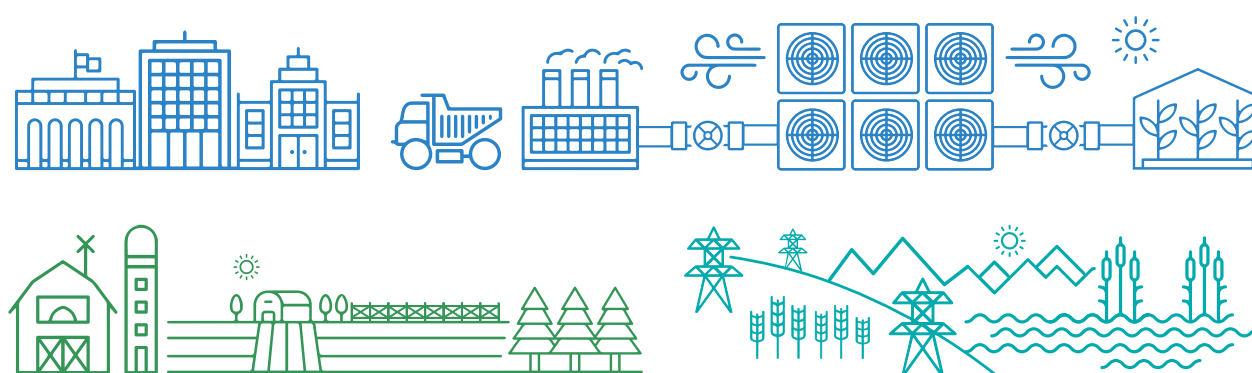
To realize this shift, we must start building the foundation for a new carbon economy today. This innovation plan outlines the contours of that foundation, by recommending promising research focus areas for three solution pathways and critical research infrastructure needed to bring the new carbon economy to fruition. This document marks the first collective endeavor of the New Carbon Economy Consortium and will serve as a foundation as we seek additional resources and partners.

OUR FRAMEWORK

The knowledge base of the new carbon economy spans many disciplines and economic sectors. The Consortium has identified three primary innovation pathways, each including carbon removal, that hold the greatest potential to activate the new carbon economy. We built this report around these three pathways, and their accompanying research avenues:

FIGURE 1. *Solutions in a New Carbon Economy*

The knowledge foundation of the new carbon economy spans many disciplines and economic sectors.



ENGINEERED SOLUTIONS, which include technologies and systems that capture, convert, and store CO₂ from the air and oceans, such as direct capture of CO₂ from air and point sources, converting CO₂ into valuable products (e.g., concrete or fuels), and the accelerated mineralization of CO₂ for sequestration.

BIOLOGICAL SOLUTIONS, which include the use of working forests and farmland to store carbon, increase yields, and improve ecosystem functions. Biological solutions include ecosystem restoration, improved forestry practices, changes in agricultural practices, developing soil amendments that improve soil health, and cultivating and converting algae into valuable products such as fertilizer and animal feed.

HYBRID SOLUTIONS, in which biological and engineered pathways come together to create energy and/or products. Hybrid energy solutions can include bioenergy with carbon capture, biochar production, waste-to-energy systems, and carbon-cultivating aquaculture.

In this innovation plan, we present a detailed exploration of each innovation pathway and its related solutions. From there, we identify the existing technical gaps, pinpointing high-priority areas for research over the short, medium, and long terms. First, we describe efforts that can start today to provide the information that is critical to enable early successes within a few years. Second, we propose work that requires more time to develop but that can provide large, meaningful outcomes in less than a decade. Finally, we outline additional foundational elements that will take at least a generation to bring to fruition and ultimately serve as an enduring knowledge substrate.

FIGURE 2. *Technical Chapter Structure*

Chapters 3-5 of the accompanying innovation plan identify promising solutions and research gaps to be addressed in the next thirty years. The research needs described for each innovation pathway feed into the final recommendations of the report and will guide the Consortium's first undertakings.



While the bulk of this document focuses on laying out a technical research plan, we recognize a need for major scholarship in legal, socioeconomic, and policy fields to complement and augment the technical tracts. This is particularly noteworthy where communities of practice are key to acceptance (e.g., by farmers in agronomy practices), where societal acceptance is a key component of success (e.g., carbon capture and storage), and where economic and policy incentives can catalyze deployment at scale. Many topics in the new carbon economy are inherently interdisciplinary, and thus require a combination of research topics and approaches to bring solutions to market. Therefore, research related to a new carbon economy would greatly benefit from integrating across conventional academic silos to incorporate scholarship from both technical and socioeconomic fields.

OUR FINDINGS AND RECOMMENDATIONS

Based on the technical gap identification and suggested research priorities, our innovation plan ends with an outline of the additional resources and infrastructure needed to enact this ambitious agenda. The following findings and recommendations will serve as the guiding principles for setting up the Consortium's core functions over the coming years.

CLOSE THE RESEARCH GAP. As evidenced by this report, there is a significant lack of integrated technical and socioeconomic knowledge related to the new carbon economy. Today, there are few research and development programs dedicated to filling this knowledge gap, and the ones that do receive insufficient funding to spur the significant breakthroughs required. One emergent recommendation is that the US federal government should substantially expand existing research programs related to the new carbon economy and build any other necessary research and training programs from scratch. Philanthropy, civil society, and industry have a large role to play in supporting the creation of a New Carbon Economy Consortium Secretariat to coordinate research, as well as translate relevant findings into business and policy action.





SHARE SUCCESSES—AND FAILURES. Current opportunities to catalyze research in carbon removal, especially those that can provide foundational information and early successes, can greatly benefit from discussion and knowledge-sharing early and often, both in person and virtually. Because many of the key research avenues to develop a new carbon economy inherently require partnership among technical and social science experts, it will be important to provide platforms for interdisciplinary translation and collaboration.

LAY THE ACADEMIC GROUNDWORK. Enacting this ambitious research agenda and bringing forth successful carbon removal solutions requires expertise that does not yet fully exist. Academic institutions need to develop curricula and academic programs at the intersection of relevant fields, and help build and train the workforce of tomorrow. Creating interdisciplinary research and training clusters, professional development opportunities, fellowships, and courses that address those pathways is critical to the new carbon economy.

BUILD THE CARBON-REMOVAL NETWORK. Finally, while assets and infrastructure related to carbon removal partially exist today, they are often distributed and isolated from interested parties in science, business, and policy. In addition, current frameworks and standards for evaluating carbon removal pathways are highly fragmented and inconsistent, creating uncertainty and hindering the deployment of solutions. Coordinated investment in research infrastructure and developing common standards for the Consortium to share can alleviate these barriers. Since managing carbon is essential in a new carbon economy, it is crucial to continue to develop and improve templates for measurement and verification, lifecycle analyses, and techno-economic comparison. These frameworks can be accompanied by a coordinated network of testbed projects across geographies to evaluate the performance and efficacy of carbon removal pathways in varying social contexts, climates, and ecosystems. The New Carbon Economy Consortium should work to establish and support new platforms to facilitate data compilation, standardization, aggregation, and distribution. To ensure the research agenda will be successfully coordinated and implemented, the Consortium should develop centers of excellence to help support and maintain the research infrastructure critical for scaling up the new carbon economy.

FIGURE 3. *Findings and Recommendations*

Significant work is required to realize a new carbon economy. Based on the technical gap identification in Chapters 3-5, we recommend a series of activities to be pursued by the Consortium and other institutions over the coming years.

	FINDINGS	RECOMMENDATIONS
 KNOWLEDGE AND RESOURCE GAP	<ul style="list-style-type: none"> • There is a fundamental gap in integrated knowledge related to strategies for building the new carbon economy • There are very few R&D programs supporting key elements of the new carbon economy, and their funding level is insufficient to deliver breakthroughs 	<ul style="list-style-type: none"> • Widen the range of R&D programs serving the new carbon economy and increase their funding • Create a New Carbon Economy Secretariat to rapidly gather and fund research teams, disseminate information, and prepare reports on the state of the new carbon economy and its components
 LIMITS TO OPPORTUNITY	<ul style="list-style-type: none"> • Every discipline pertinent to the new carbon economy includes near-term, high-impact endeavors that are not fully mapped • There are limited fora to discuss and address R&D needs in all new carbon economy disciplines • Many topics in the new carbon economy are inherently interdisciplinary and, in many cases, require a mixture of “bench,” field, and social science approaches to bring key opportunities to markets and stakeholders 	<ul style="list-style-type: none"> • Select topics and teams to map national and global opportunities for research, development, and demonstration of key new carbon economy pathways • Convene disciplinary and interdisciplinary meetings and fora around the central topics holding back the emergence of the new carbon economy
 HUMAN CAPITAL	<ul style="list-style-type: none"> • There are few programs that train experts in the integrated disciplines of the emerging new carbon economy 	<ul style="list-style-type: none"> • Create interdisciplinary clusters and courses that address new carbon economy topics • Establish training programs to support research and human capital development focused specifically on the new carbon economy
 COLLABORATION AND SCIENTIFIC INFRASTRUCTURE	<ul style="list-style-type: none"> • Although assets and infrastructural elements for the new carbon economy partially exist today, they are distributed and often isolated from interested researchers, leaders of research institutions, business leaders, and policymakers • The lack of consistent frameworks and standards for discussing and measuring the techno-economic and carbon-sequestering potential of solutions limits their uptake and deployment 	<ul style="list-style-type: none"> • Develop platforms and test beds to analyze carbon uptake, utilization, and storage, and create templates for measurement and verification, lifecycle analyses, and techno-economic comparison • Create and support new platforms to compile, aggregate, analyze, and share data • Sponsors and host institutions should create and support centers of excellence for new carbon economy studies

CONCLUSION

As this innovation plan makes clear, the promise of the new carbon economy is great. And yet, a fundamental gap exists between our current knowledge and what we need for a new carbon economy to flourish. Few research and development programs exist today to supply that knowledge, and most are too under-resourced to achieve national or global impact. Without a concerted research and deployment effort, we will never realize the potential of the recommendations and findings outlined here. No single academic institution or national lab is equipped to take on this challenge alone. Together, the New Carbon Economy Consortium has the power and expertise to not only formalize the innovation plan laid out in this document, but to move forward to execute it. The benefits from economic growth, new industry creation, and equal access to opportunity will manifest only through investment and commitment to that vision. We hope you will join us in building the new carbon economy.



To read the full innovation plan, please go to
www.carbon180.org/newcarboneyconomy

For questions on the New Carbon
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