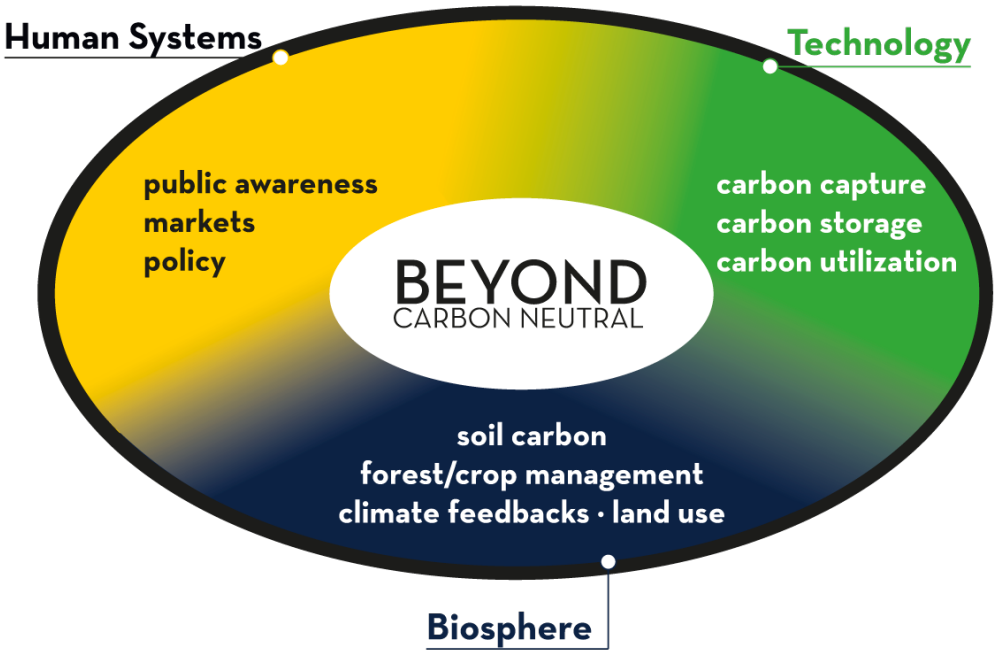
Beyond Carbon Neutral

A major new initiative to develop technologies, programs and policies to raise the rate at which CO_2 is removed from the atmosphere.

Climate change is a defining issue of the 21st Century, and an existential threat to humanity. To address this challenge, we must deploy a diverse set of solutions to minimize or reverse global warming and adapt to its impacts. To complement existing efforts to reduce greenhouse gas (GHG) emissions, the University of Michigan Energy Institute is developing an ambitious, creative new initiative called *Beyond Carbon Neutral.* This multidisciplinary research effort investigates technologies, processes and policies to increase the rate at which carbon is removed from the global carbon cycle.

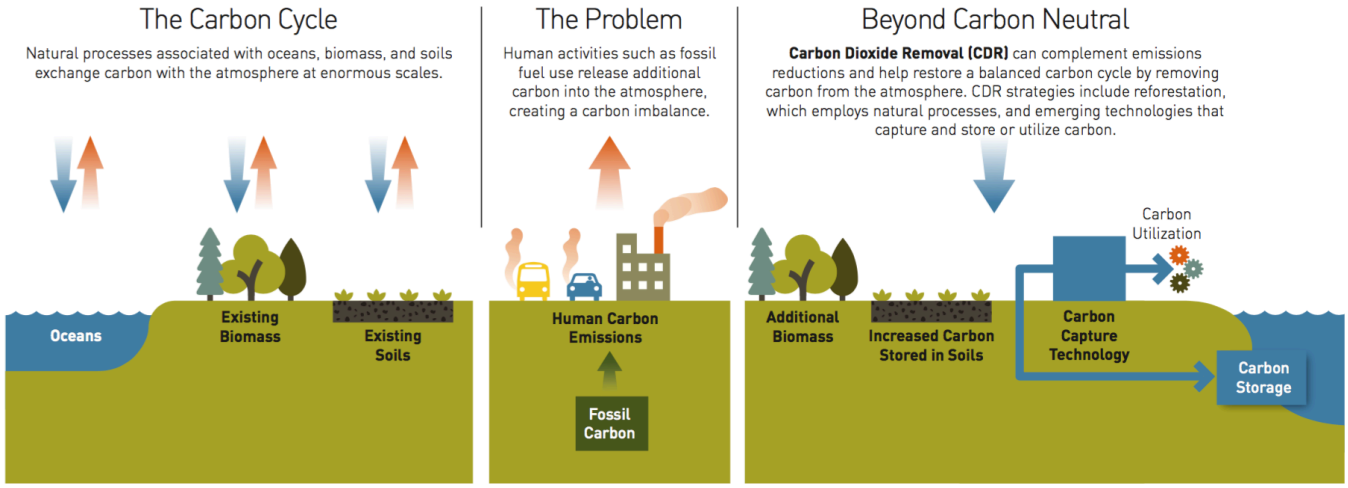
Carbon dioxide (CO_2) emitted from fossil fuel use is the largest source of anthropogenic GHG emissions and its buildup in the atmosphere is the largest driver of the radiative forcing that destabilizes the Earth's climate. Carbon dioxide removal (CDR) refers to actions that increase the rate at which CO_2 is removed from the atmosphere and converted into carbon-based materials that can be either sequestered or substituted for fossil carbon. Sometimes called "negative emissions," CDR strategies remove CO_2 from the air faster than it is already being removed through natural processes. What distinguishes CDR is that its aim is not merely to achieve carbon neutrality, but rather to greatly increase the rate of negative emissions through mechanisms that go *Beyond Carbon Neutral*.

The Energy Institute has worked with over 70 faculty to develop more than 50 inventive research proposals investigating different aspects of CDR. These research activities fall into three overlapping areas: the biosphere, technology, and human systems. As the figure below illustrates, some *Beyond Carbon Neutral* research activities fall clearly into one research area, while others bridge the conceptual divides that too often limit the scope and ambition of academic research.



A well-known example of CDR is reforestation, which can increase the rate of CO_2 uptake for decades. Others include agricultural practices that increase soil carbon uptake and other forms of terrestrial carbon management. If productive lands are appropriately managed, bioenergy with carbon capture and storage is a possible CDR mechanism. A range of technologies can also be developed to further

expand CDR capability. *Beyond Carbon Neutral* will support research into each of these areas, examining ways to increase carbon uptake, as well as methods for storing and utilizing excess carbon.



At present, CDR is under-researched and not well understood by policymakers and the public. No coherent strategy exists to systematically research, develop, test, refine and scale up CDR on par with efforts underway to reduce GHG emissions. *Beyond Carbon Neutral* is designed to take the necessary steps to develop this crucial area and raise its profile for action at local and global levels.

The breadth of faculty expertise at the University of Michigan makes us uniquely positioned to pursue this far-reaching topic. Within the areas of the biosphere, technology, and human systems, the suite of *Beyond Carbon Neutral* research projects are the foundation for a world-class initiative and bring a new focus to this emerging and urgent area of climate change research. The table below provides examples of the 50+ research projects developed by faculty in conjunction with the Energy Institute.

Biosphere	Technology	Human Systems
Develop and incorporate climate variability scaling factors such as wildfires into climate change models.	Assess the technical, economic, and social feasibility of onboard carbon capture from mobile internal combustion engine sources.	Quantify public understanding of CDR. Test acceptability of various CDR approaches, including responses to different framings.
Understand soil carbon sequestration mechanisms and improve soil carbon storage via mycrorrhizal, microbial, and biochemical means.	Design novel catalysts and sorbents for atmospheric carbon dioxide capture and conversion to products such as fuels and chemicals.	Understand the economics of forest, and land use changes domestically and internationally, and evaluate effective policy approaches.
Examine forest system responses to climate change and identify resilience mechanisms.	Develop biological approaches for capture and conversion of carbon dioxide to useful substances.	Evaluate the risks and benefits of decision support tools for the deployment of CDR approaches.
Investigate ecosystem services and yield production associated with soil carbon sequestration.	Create durable materials from captured carbon.	Examine social and cultural changes needed to enable a carbon-negative market.

For more information

Mark Barteau, Director & Principal Investigator
barteau@umich.edu
Susan Fancy, Manager, Programs & Development
sfancy@umich.edu
John DeCicco, Research Professor
decicco@umich.edu
Daniel Raimi, Research Specialist
draimi@umich.edu