THE SEARCH IS ON FOR CLEANER, better ways to fuel our future, while cutting emissions of climate-altering greenhouse gases. Scientists at the Earth Institute have long been investigating ways to capture and sequester carbon dioxide produced as a byproduct of human activity. Now they are looking at ways to put that carbon to use in the form of liquid fuel, instead of just storing it away underground.

Carbon is one of the basic useful ingredients in biofuels, which are created from CO₂-capturing plants such as corn. But standard biofuels have some disadvantages, like requiring a lot of land and the use of fertilizers to grow the crops from which they are made.

“We’re working to accomplish the same goals as plants,” says Chris Graves, who did his doctoral work at the Lenfest Center for Sustainable Energy. “But the process will look very different.” Graves’ thesis was on recycling carbon dioxide and water into hydrocarbon fuels by electrolysis, which produces synthesis gas, the precursor to liquid fuel. “When you want to store things compactly and conveniently, liquid hydrocarbon fuels are the way to go,” he says. “Batteries can inherently never be as energy dense as liquid fuel.”

Graves is part of a larger group of scientists—headed by Klaus Lackner, director of the center, and including others like Lenfest Junior Professor in Applied Climate Science Alissa Park—that is working to make more environmentally friendly fuels. The group is putting together a production process that builds on innovations in the capture of carbon dioxide from the air, desalination to produce large amounts of fresh water, photovoltaics to power the whole process with low-cost solar electricity, and electrolyzers connected to fuel synthesis reactors to convert carbon dioxide and water into liquid hydrocarbon fuel.

The process also makes use of the principles of mass production. “When you get smaller, and when you mass produce,” says doctoral candidate Tom Socci, whose work is focused on refining the production of fuel from synthesis gas, “things can get cheaper and more efficient.” Typically, energy production happens at big scales, with large machines performing many complicated production steps. But the team is proposing a strategy that would break the entire process into smaller units, so that pieces could be produced more cheaply and replaced more easily as technology improves.

“What attracted me to this work is literally reusing and recycling the carbon out there, rather than mobilizing new carbon,” says Socci. Although traditional energy sources will likely be used in some form for years to come, the demand for liquid hydrocarbons is predicted to expand and could double by 2050.

So finding new and novel ways to produce liquid fuels is an important focus for science—to say nothing about all that carbon dioxide that could be removed from the atmosphere and recycled.

Recycled CO₂ + Sunshine + Water = Fuel

Klaus Lackner, director of the Lenfest Center for Sustainable Energy, and researcher Christoph Meinrenken (above) are part of a team exploring ways to turn solar energy and recycled carbon dioxide into liquid fuel. Allen Wright, senior staff associate, is helping design methods for filtering carbon dioxide from the air.