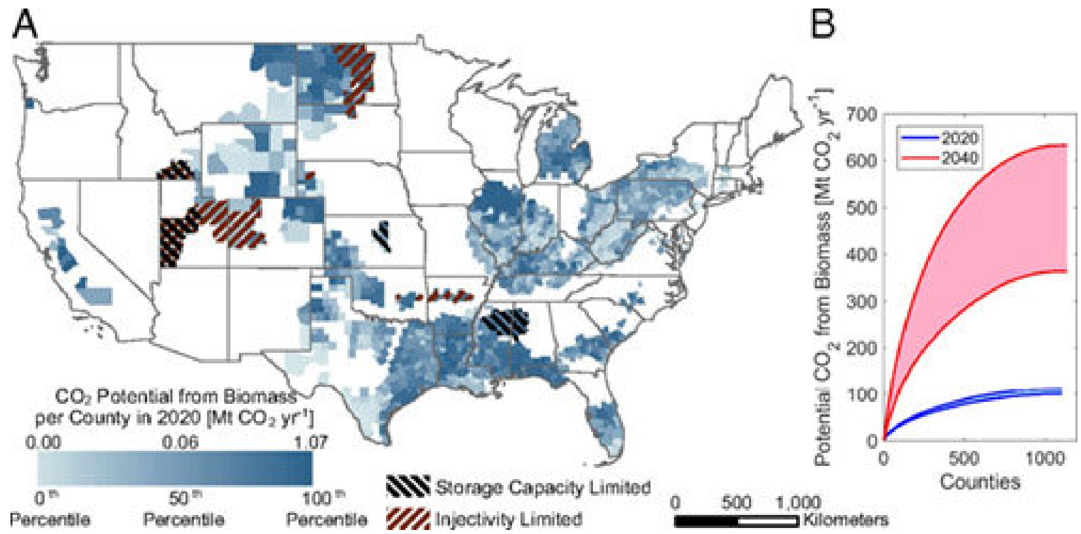
Setting expectations for negative-emission systems in U.S. to protect climate

March 13 2018, by Mark Golden



Distribution of technical potential of BECCS. (A) Map of technical potential of CO2 that would be available from biomass in 2020. Regions with highest CO2 potential and colocated storage sites are northern Illinois basin, the Gulf region, and western North Dakota. (B) Cumulative sum of the potential CO2 in counties with a suitable storage site for 2020 and 2040. Credit: Stanford University

Nearly every major plan to limit the damage from climate change relies in part on combining bioenergy with carbon capture and storage, a technology in early development known as "BECCS." Feedstock plants would grow by absorbing carbon dioxide from the air, and the carbon-dioxide generated from burning the biomass to produce electricity would be captured and permanently stored underground. Producing electricity that actually reduces CO2 has obvious appeal.

However, estimates of the potential for BECCS in any given country have been based largely on the available biomass, whether from agricultural waste, forest management or the capacity to grow plants dedicated to energy production. Past BECCS estimates have almost always overlooked whether the biomass-growing areas are located near good underground sites for storing CO2. That is a problem, because transporting either biomass or CO2 can be expensive or subject to regulatory complications.

A new study for the first time examines in detail biomass growing sites, CO2 storage sites, co-location and transportation to estimate BECCS potential in the United States. In the near term, the technology if deployed rapidly could possibly remove 100-110 million tons of CO2 annually, the study finds. That is about 1.5% of total U.S. emissions currently.

Questions about the feasibility of transportation make it important to understand the options for co-location of biomass and suitable storage. Currently, about a third of the good U.S. biomass areas are located near good storage sites, the study finds. By midcentury, a three-fold scale-up of biomass supply in basins with good CO2 storage sites could lead to a U.S. potential of 360-630 million tons, according to the study, published today by the *Proceedings of the National Academy of Sciences*.

"BECCS can certainly help provide a source of negative emissions, but other approaches will also be needed to achieve the negative emissions that models suggest will be required to limit warming to 2o C," said co-author, Sally Benson, a professor of energy resources engineering at Stanford University.

U.S. as bellwether

"In addition to assessing the BECCS potential, we also identify the most promising, low-cost locations to begin to deploy BECCS," said the study's lead author, Ejeong Baik. "The U.S. areas that would be the most effective for near-term deployment are in Illinois, western North Dakota, and some Gulf states, if the Gulf states were to begin growing a significant amount of energy crops."

While the study shows a way for any country to estimate its BECCS potential, the United States is a good place to focus on realistic expectations. It has a relative abundance of both biomass growing and CO2 sequestering prospects.

For a carbon sequestration site to be suitable for the BECCS project or projects that will feed into it, the storage location should have the appropriate storage capacity and ability to handle the expected rate of injection. Injecting CO2 more quickly than the formation can accommodate can damage the site's cap rock or activate faults. Generally, large storage capacity and high injection rates make storage sites less expensive to operate.

"In the U.S., only 30% of the biomass is co-located with suitable sequestration sites, limiting the short-term deployment potential," said Baik, a Ph.D. candidate in energy resources engineering.

No perfect picture

Scenarios for meeting the potential of 100 million tons of CO2 annually range from establishing more than 1,000 localized BECCS projects with a co-located power plant and injection site, to aggregating BECCS projects by transporting biomass and CO2 over long-distances to centralized facilities. Both ends of the spectrum present challenges.

At the localized end of the spectrum, transport costs are minimized, but almost all the BECCS projects are small. On average, a single project would remove 60,000 tons of CO2 annually, compared with a median of 1.8 million tons at existing carbon capture and storage projects, (for example, in gas processing and coal-fired power plants). Also, the local BECCS projects would generate an average of 12 megawatts of electricity, compared with a median of 23 MW at currently operating U.S. biomass plants, which do not have carbon capture and storage. The small BECCS projects would lack the economies of scale needed to contain costs.

Absent co-location, BECCS developers generally would either build a power plant near the biomass and transport the CO2 via pipeline to the storage site or build a power plant by the storage site and transport the biomass. Transporting biomass is expensive due to low energy density compared to fossil fuels. For some of the most common biomass candidates—corn waste and miscanthus—transportation can be prohibitively expensive for distances of just 12 miles, the study says.

If developers were to build power plants—or other processes for extracting value from the plant—near biomass sources lacking co-located sequestration sites, pipelines would be required to transport CO2 to sequestration sites. The United States has about 5,000 miles of CO2 pipelines built for CO2-enhanced oil recovery. They have limited excess capacity for shipping CO2 to the best sites purely for sequestration, like large saline aquifers and exhausted oil and gas reservoirs. Building many new pipelines would be expensive and permitting is time-consuming, running into stormy "not in my backyard" resistance.

More information: Ejeong Baik et al. Geospatial analysis of near-term potential for carbon-negative bioenergy in the United States, *Proceedings of the National Academy of Sciences* (2018). DOI: 10.1073/pnas.1720338115

Provided by Stanford University

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