

THE BURNING QUESTION Moves to designate wood as a carbon-neutral fuel have alarmed environmentalists and divided scientists

By Warren Cornwall, in Duplin County, North Carolina

t took half a century for an acorn to grow into the 20-meter-tall oak tree standing here in a North Carolina hardwood forest near the banks of the Northeast Cape Fear River. But it takes just seconds to turn the oak into fuel for the furnace of a European power plant.

A logging machine—a cross between a tank and a one-armed crab—grabs

the tree with a metal claw. With a screech, a spinning blade bites through the trunk. Ultimately, the thickest bits of this tree and hundreds of others from this forest will be sliced into lumber. But the limbs from large trees like this, along with entire small or crooked trees, go to a specialized mill to be squeezed into tiny wood pellets. Shipped across the Atlantic Ocean, they will likely end up fueling a giant power plant in the United Kingdom that supplies nearly 10% of the country's electricity.

Over the roar of the logging, Bob Abt, a forest economist at North Carolina State University (NC State) in Raleigh, explains why this trans-Atlantic trade in wood pellets is booming: a push by policymakers, industry groups, and some scientists to make burning PHOTO: © GARY SMITH/ALAMY STOCK PHOTC

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ics argue that accounting for carbon recycling is far more complex than it seems. They say favoring wood could actually boost carbon emissions, not curb them, for many decades, and that wind and solar energy—emissions-free from the start—are a better bet for the climate. Some scientists also worry that policies promoting wood fuels could unleash a global logging boom that trashes forest biodiversity in the name of climate protection.

"It basically tells the Congo and Indonesia and every other forested country in the world: 'If you cut down your forests and use them for energy, not only is that not bad, it's good," says Tim Searchinger, a senior fellow at the World Resources Institute in Washington, D.C., who has studied the carbon impacts of wood energy.

OAK TREES IN NORTH CAROLINA are heading for a U.K. power plant largely because of a single number: zero. That's the amount of CO_2 that European power plants can claim they emit when burning wood. It's not true, of course, and in some cases wood-burning furnaces actually puff more CO₂ from their smokestacks per unit of electricity produced than those burning coal or natural gas. (In part, that's because wood can have a higher water content than other fuels, and some of its energy goes to boiling off the water.) But under the European Union's ambitious 2009 plan to produce 20% of its electricity from renewable resources by 2020, regulators endorsed an earlier decision to designate wood as a carbon-neutral fuel for the purposes of emissions accounting.

In response, some countries—including the United Kingdom, Belgium, Denmark, and the Netherlands—have built new woodfired plants or converted coal-fired plants to wood. The United Kingdom has been one of the most enthusiastic, with the government providing subsidies for wood pellets that make them competitive with fossil fuels. At the country's largest power station, a 4000megawatt behemoth in North Yorkshire, owner Drax Group has converted half of the furnaces to burn wood pellets.

For fuel, Drax and other firms have been eyeing forests around the world. Those of North Carolina and other states in the southeastern United States, filled with fastgrowing pines as well as hardwoods and just a short freighter trip from Europe, have become a major source of wood pellets. U.S. exports, nearly all from the southeast, grew from zero in 2005 to more than 6.5 million metric tons in 2016, according to Forisk Consulting, a firm in Athens, Georgia. Pellet exports are expected to grow to 9 million metric tons by 2021.

The boom has caught the attention of U.S. policymakers. Lawmakers in Congress, with

backing from parts of the forest products industry, have proposed legislation that would follow the European Union's lead and declare wood pellets a carbon-neutral fuel, which might encourage U.S. power companies to shift to wood. So far, those proposals haven't made it into law, in part because of skepticism from the Obama administration.

But they have alarmed some environmental groups and divided scientists. This past February, 65 scientists, many from major universities, penned a letter to Senate leaders warning that the carbon-neutral label would encourage deforestation and drive up greenhouse gas emissions. But a month later, more than 100 scientists took the opposite view in a letter to EPA, stating that "the carbon benefits of sustainable forest biomass energy are well established."

Abt and his colleagues on the EPA expert panel are trying to sort out those starkly different perspectives. The son of a forester for a Georgia logging company, Abt can deftly switch from talking about machinery with a logger to describing the complex computer models he builds to simulate what might happen in a world with more wood-fired power plants. The bottom line, researchers say, depends on multiple assumptions about forest ecology and the economic behavior of landowners, as well as on the time horizon of the calculations. "There are four or five different approaches that you can use in order to measure the greenhouse gas implications of forest biomass energy," says Madhu Khanna, an environmental economist at the University of Illinois in Champaign, and chair of the EPA expert panel. "There are huge differences in the answers you can get."

ONE SPECIES OF MODEL focuses on the biological picture, tallying how much carbon is emitted when biomass is burned, and how long it will take for an ecosystem to reabsorb that carbon. The calculations are relatively straightforward. But the details—such as what kinds of trees are cut, and whether the new trees are fast-growing pines or slow-growing hardwoods—can influence how big that initial carbon debt appears to be, and how long it will take to pay back.

Because of the lag between emissions and uptake, studies taking this approach often find that widespread use of wood fuel will cause emissions spikes that could last for decades, hastening the pace of global warming. Researchers working with the Natural Resources Defense Council (NRDC), an environmental group, concluded that a woodburning plant would have higher net carbon emissions than a comparable coal plant for the first 4 decades or more of operations. A similar study in the *Journal of Sustainable*

The Drax power plant in the United Kingdom can burn both coal and wood to produce electricity. Forests in the southeastern United States are a major source of its wood fuel.

more wood for electricity a strategy for curbing carbon dioxide (CO_2) emissions. Unlike coal or natural gas, they argue, wood is a lowcarbon fuel. The carbon released when trees are cut down and burned is taken up again when new trees grow in their place, limiting its impact on climate.

The idea is attractively simple, says Abt, a member of an expert panel that is studying the concept for the U.S. Environmental Protection Agency (EPA). "Another tree will grow here and sequester carbon again. So we're just recycling carbon."

Yet moves by governments around the world to designate wood as a carbon-neutral fuel—making it eligible for beneficial treatment under tax, trade, and environmental regulations—have spurred fierce debate. CritDownloaded from http://science.sciencemag.org/ on January 24, 2017

Forestry in 2013 found that greenhouse gases from a power plant fired by wood from New England forests would outrank emissions from a similar coal-fired power plant for nearly half a century.

The bottom line for climate can shift depending on how far into the future researchers peer. The EPA panel on which Abt and Khanna sit has endorsed a long view. In its latest draft, the group recommends doing carbon accounting over a 100-year timeframe, based on research suggesting that it takes that long for the planet to feel the full impact of cumulative greenhouse gas emissions. Such long tallies give new forests plenty of time to mature and recapture carbon, making wood appear closer to carbon neutral.

But some scientists object that such long timescales gloss over the risk that the nearterm spike in emissions produced by largescale wood burning will cause damage that can't be undone. "If we melt Arctic ice in the next 20 years, that's not going to come back," says William Schlesinger, a biogeochemist and president emeritus at the Cary Institute of Ecosystem Studies in Millbrook, New York, who sits on EPA's Science Advisory Board.

Such issues suggest policymakers should proceed with caution, says Sami Yassa, a forestry scientist with NRDC in Kittery, Maine. "Our belief," he says, "is that these uncertainties need to be resolved in favor of avoiding damage" to today's forests.

Meanwhile, Abt and some other researchers are pursuing modeling approaches that attempt to take into account the important role that economics and human behavior play in shaping future forests. At one extreme, logged forest might be converted into farmland or housing lots, never getting a chance to regrow and soak up carbon. Or a booming pellet trade could have the opposite effect: encouraging farmers to plant trees where crops or pasture grasses once grew, amplifying the carbon benefits.

One study using Abt's approach has offered a counterintuitive conclusion: that an expansion of the southeast's pellet industry might offer a net benefit, in terms of carbon, in the long run. That's because it could prompt landowners to plant more trees, leading to more carbon storage. And shipping pine pellets to Europe to produce electricity can make both economic and environmental sense, Abt and Khanna concluded in a 2015 study in Environmental Research Letters. Compared with coal, wood fuel cut carbon emissions by 74% to 85% when they took into account the entire life cycle of both fuels, including emissions from production and transportation, and possible land-use shifts. The point, Abt says, is that "you can't just tell a biological story. My thesis is that ignoring



markets gives you more of a wrong answer."

That's a view seconded by Tommy Norris, a North Carolina timber supplier in Rocky Point. His company, Tri-State Land & Timber LLC, bought the rights to log the Duplin County site. Demand for wood, he says, creates incentives for landowners to manage forests for the long term, and can prevent them from being converted to other uses. "If you don't have markets," he says, "people are just going to ignore their forests."



Economist Bob Abt has been examining the economic and ecological implications of wood fuels.

ROUGHLY 160 KILOMETERS NORTHEAST of the

logging site, NC State ecologist Asko Noormets is investigating what he believes is another important—and often overlooked part of the wood fuel puzzle. It's right beneath his feet. Under loblolly pines on a plantation owned by timber giant Weyerhaeuser, Noormets crouches next to a white plastic pipe embedded in the forest floor. A motor whines as a mechanism drops a small plastic dome over the end of the pipe, and a sensor takes a deep breath of the CO_2 inside, rising from the soil.

The measurements, taken every 30 minutes for the last 11 years, have Noormets worried. They suggest that logging, whether for biofuels or lumber, is eating away at the carbon stored beneath the forest floor. Every square meter of this forest is losing roughly 125 grams of carbon annually into the atmosphere, the data suggest. Over time, he predicts, logging could wear this fertile, peatbased soil down to the sandy layer below, releasing much of its carbon and destroying its long-term productivity.

When he has looked at emissions from other managed forests around the world, he's found similarly elevated rates of soil carbon loss. Noormets isn't certain what's driving the losses, but he suspects that by disturbing the soil, logging alters the activity of soil microbes that release CO_2 .

The soft-spoken scientist tends toward technical jargon. But he says that when he first saw the numbers a few years ago, "I was PHOTOS: © KATIE BAILEY



terrified." That's because soil carbon accounts for a significant portion of the total carbon stored in forests, so over time a decline could have major implications for the climate.

Other studies of managed forests have found less worrying carbon losses, or little evidence of long-term declines. Still, if Noormets's findings are upheld by further research, they might force a rethink of woodfuel accounting, which often assumes no soil carbon loss, Abt says. "Then just modeling the aboveground carbon is going to give you a wrong answer."

THE PELLET TRADE could also have more immediate ecological impacts. In the Roanoke River National Wildlife Refuge near Williamston, North Carolina, Adam Macon strolls down a dirt path past oak trees so thick he couldn't encircle one with his arms. Towering cypress trees splay their roots into the boggy soil. It's a textbook example of a bottomland hardwood forest, says Macon, who works for the Dogwood Alliance, an environmental group based in Asheville, North Carolina. It hosts dozens of plant species, more than 200 kinds of birds, and mammals including muskrats and black bears.

As a wildlife refuge, these trees are beyond the reach of the saw. But just a few kilometers away it's a different story. Unlike forests in the western United States, which are mostly owned by the U.S. government, more than 80% of southeastern forests are in private hands. Macon fears that if demand for wood pellets keeps growing, it will create yet another incentive for landowners to log relatively diverse hardwood forests—which already account for approximately a quarter of the pellets coming from the South—and convert them into less diverse but faster growing pine plantations.

A recent study in the journal *Global Change Biology Bioenergy* concluded that increased demand for wood fuel could cause some North Carolina hardwood ecosystems to shrink by about 10% by 2050. A companion study found that some species living in those forests could decline as well, including the cerulean warbler, a little blue songbird whose populations have fallen by nearly 75% since the mid-1960s. "We see this biomass industry as one of the biggest threats, if not the biggest threat, to these forests," Macon says.

Officials in the wood products industry say the fears of sweeping habitat destruction are unfounded. So far, predictions of a huge surge in European demand for wood pellets haven't been borne out, says Seth Ginther, executive director for the U.S. Industrial Pellet Association in Richmond, Virginia. Only a handful of European countries are subsidizing wood pellets, he says, and a number of proposed U.S. pellet plants have never materialized. "The way the market has shaken out, there's just not that much demand," Ginther says.

Overall, pellets consumed 3% of the wood cut in the southeast in 2013, far less than what goes to pulp or lumber. Still, at least Some trees cut from a logging site in Duplin County in North Carolina (left) will be squeezed into wood pellets (above), to be burned in power plants.

seven new pellet plants are expected to start operating in the region over the next 5 years, according to Forisk Consulting.

Both boosters and critics of labeling pellets as carbon-neutral now wonder how the incoming administration of President-elect Donald Trump might view wood fuels. With the Republican Party soon to be in control of both Congress and the White House, NRDC's Yassa predicts that industry groups and politicians from timber-rich states will again press their case that a carbon-neutral designation for wood would be good for the economy. But with Trump and his appointees vowing to dismantle domestic climate rules and withdraw from international agreements designed to promote the use of climatefriendlier fuels, it's not clear just how much cachet a carbon-neutral label will carry in the United States.

Elsewhere in the world, however, wood appears to be winning support. Demand for pellets is increasing in Japan and South Korea as those nations seek to meet renewable energy quotas. And at the end of November 2016, the European Commission recommended extending the European Union's existing wood-fuel policies until 2030, with some minor changes. Such policy decisions suggest the debate over wood and climate is far from over.





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