

NRRI Mission:

Deliver research solutions to balance our economy, resources and environment for resilient communities.

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Fall Greetings!

As we watch the brief but glorious colors emerge from the hardwoods of the north, I'm reminded that it's not exactly a 'walk in the park' for all involved... er, so to speak.

Leaf color change is the trees response to the stress of more intense sun and cold. Textbooks are just starting to incorporate this new information. NRRI learned of this back in 2016 when Eric Singasaas joined our staff. He shared research he took part in that was published in *Plant Physiology*, Vol. 133, 2003.

So when you're out oohing and aaahing this fall, take a moment to pit the poor stressed out trees.

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Rail history stays on track with NRRI clean fuel trials

Steam locomotives built the America we know today. And fossil coal powered those economic engines of change. NRRI is developing a cleaner fuel that will help keep the historic relics chugging along for train historians and tourists.

This summer, NRRI's torrefied solid biofuel – a roasted, wood-based briquette product – was tested on a full size, 1920's steam locomotive at the Everett Railroad in Hollidaysburg, Pennsylvania. Ultimately, the goal is to develop a clean biofuel to supplant fossil coal to reduce carbon and heavy metal emissions while minimizing smoke. In order to keep the train fireman happy, it also has to store and shovel like coal and generate enough heat to keep the pressure up. The results were promising.

"It burned with plenty of heat to keep up steam with minimal, if no, additional effort compared to shoveling coal," said Zach Hall, Everett Railroad steam foreman. "It lights quickly and burns hot."

This is NRRI's first step in demonstrating pretreatment of biomass that can lead to a full portfolio of carbon-based products – from fuels to higher value materials – that sequester carbon.

NRRI's partnership with the Coalition for Sustainable Rail made this unique test possible. NRRI has been working to develop this solid fuel for more than 10 years, testing a variety of biomass sources and binders to perfect the product. In the Everett No. 11 trials, briquettes of 100 percent torrefied biomass fuel and a



Everett Locomotive No. 11 operated smoothly, and cleanly, with biomass-based fuels developed at NRRI.

50/50 blend of biomass fuel with fossil coal were both tested.

"We were generally pleased with the results of each type of fuel," said Don Fosnacht, NRRI associate director for the Energy Management Group. "We're still working to minimize embers in the emissions by testing different binders and briquette sizes."

There are about 200 historic steam trains in the U.S. – about 150 burn coal – hauling a couple million people per year. The folks who are passionate about running the locomotives are concerned about finding a reliable source of high-quality coal that meets their specifications. Smoke pollution is an environmental concern and distasteful to the tourists who ride the trains.

"Large amounts of visible smoke are something that we must be very mindful of in the areas we operate,"

said Foreman Hall. "The ability to test this alternative fuel is exciting for us as we seek modern ways to help keep historic railroading alive for generations to come."

NRRI is also working with the Coalition for Sustainable Rail to convert old railroad ties into solid biofuel to impact a waste problem for the rail industry. According to the Railway Tie Association, some 4 million cross-ties are landfilled each year. The initial lab-scale tests yielded promising results. Funds are being sought to scale up the research.

The biomass fuels were also recently tested in a coal-fired blacksmith forge with success. These niche markets for a coal replacement represent first step markets for the innovative product.

NRRI holds workshop on carbon sequestering

Dad, you were wrong. Money does grow on trees. Or pretty close. Forested lands have tremendous potential to reduce carbon dioxide in the atmosphere and slow or reverse climate change impacts. That's great. But there's growing interest in monetizing that ecosystem service and now landowners can reap the rewards of what forests do naturally.

It's a trend that many states are moving ahead on and it's time for Minnesota to get on board. NRRI is holding an invited workshop on October 8 to get the conversations started among large land managers at the city, county and tribal level. Other non-governmental organizations have also been invited.

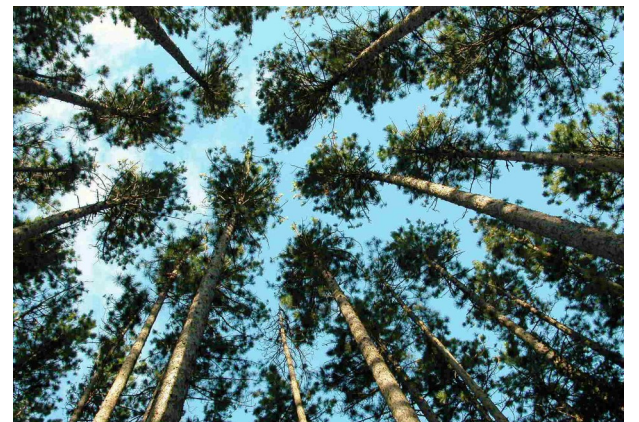
States looking to reduce carbon emissions in the wake of increasing climate change impacts are moving toward setting caps on industry emissions. Those industries that can't meet the cap limit must buy carbon credits from more efficient emitters or carbon offsets from landowners who manage for sequestered carbon. California is the first to onboard this "cap and trade" carbon program. Blandin UPM is currently Minnesota's only large carbon offset project.

"Minnesota has tremendous potential to monetize carbon capture," said Christopher Wright, NRRI landscape scientist. "Develop a management plan that can sequester carbon on the land, get a credit determination and sell it on the market."

Wright instigated this workshop not only out of personal concern for climate change, but also because it meets NRRI's mission to promote economic development around natural resources. This invited workshop will include background information on carbon markets, natural climate solutions and agricultural land use solutions, followed by panel discussions.

Currently, the cost of for carbon offsets is \$15 per metric ton, which many investors think is very low and will increase dramatically.

"This is a growing trend and I want to help this be a priority for our state," said Wright. "It's a market-based solution that will drive innovation."



The University of Minnesota Cloquet Forestry Center red pine plantations sequester carbon while offering research sites.

How sequestration works

Carbon dioxide isn't evil. Trees and plants need it to thrive, absorbing the carbon and converting it into sugar and cellulose. Trees store the carbon in their wood, roots and leaves. Trees and their wood resource are about 50 percent carbon by weight. As long as the wood stays whole as timber or solid wood products, the carbon is stored.

The natural carbon cycle includes a slow release of carbon into the atmosphere. But humans have released far more carbon and other greenhouse gases than is natural by the use of fossil fuels – coal, oil and natural gas. Deforestation and urban development globally means there are fewer trees to do the important work of sequestering carbon.