PERC Case Studies

Tapping Our Forests for Green Energy

BY ALISON BERRY

Edited by Laura E. Huggins

Federally owned forests in the United States are facing financial and ecological problems. At the same time, the public's growing concern over environmental issues and future energy sources are pushing the promotion of renewable energy. Is woody biomass a viable alternative to fossil fuel? In this case study Alison Berry explores the pros and cons of using forest waste to create ethanol, electricity, and heat.

Alison Berry is a former research fellow at PERC. Berry has an undergraduate degree in biology from the University of Vermont and a master's degree in forestry from the University of Montana. She has worked as a supervisory botanist for the U.S. Forest Service and has been a restoration specialist with the Trustees of Reservations in Massachusetts. Her research has been published in the *Journal of Forestry* and the *Western Journal of Applied Forestry*.

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BACKGROUND

"I looked up at the dead and dying trees. In every catastrophe there's an opportunity." (Helman 2009)

—Mark Mathis
Confluence Energy

Political support for renewable energy is strong. President Barack Obama has pledged to mix two billion gallons of cellulosic ethanol into U.S. fuels by 2013 and to invest $150 billion over ten years in biofuels, alternative fuel vehicles, and renewable energy (Obama08 2008; Truong 2008). The 2009 stimulus package included $16.8 billion for the Energy Efficiency and Renewable Energy program, with $800 million specifically targeted for biomass projects (Voegele 2009). To date, twenty-two states have Renewable Energy Portfolio Standards requiring that energy be produced from renewable sources.

Combine this political support with the fact that millions of acres of trees on federal lands have been attacked by the mountain pine beetle, and few would object to using dead trees to provide renewable energy—especially when using these tinderboxes will lower fire risks. Secretary of the Interior Ken Salazar (2007) called the devastation caused by beetles the "[Hurricane] Katrina of the West." The Forest Service claims one-quarter of the trees on 29 million U.S. acres are at risk. Given that a million acres of beetle-killed lodgepole pine contain the energy equivalent of roughly 100 million barrels of oil, why aren't federal land management agencies more involved in an emerging biomass market (Helman 2009)?

BACKGROUND

Before hopping on the biomass bandwagon, a closer look at bioenergy is warranted. Are taxpayer dollars well spent in funding this technology? How can federal land management agencies prepare to harness the biomass market and promote restoration of mismanaged lands? This study focuses on energy from woody biomass; introduces the pros and cons of using biomass for ethanol, electricity, and heat; and examines how federal agencies can best take advantage of energy markets for woody biomass. Removing biomass on federal lands could be a critical step in turning back the clock on decades of mismanagement and a step toward managing timber assets profitably.

Woody biomass is a renewable resource and a source of energy. It can be processed into cellulosic ethanol to fuel cars and trucks, or burned to generate heat and electricity. As Americans search for alternatives to fossil fuels, forest byproducts could be the answer.

Woody biomass, which includes tree-tops, branches, and small trees, is abundant, and currently under-used. These materials are not big enough to be turned into lumber, and are often too low in quality to make paper. After timber harvests, biomass is left behind in the form of logging slash and is either burned or left to decompose on site.

BACKGROUND

On federally owned forests in the West, woody biomass is particularly plentiful because of policies that fail to encourage good stewardship at the taxpayer's expense. Decades of federal fire suppression, for example, have produced a proliferation of small trees (or fuel) in the understory despite the fact that fire is a critical component of forest ecosystem function. This problem was compounded during the 1990s when timber production declined due to a tightening of federal logging restrictions (Nelson 2000). The result: dense forests experiencing insect infestation and catastrophic wildfires (Congressional Digest 2002; Fretwell 1999).

The optimal approach would be for Congress and the administration to allow local supervisors to manage timber assets profitably in order to offset the costs of forest restoration. In the meantime, managers could thin out understory growth to repair past damage. But without a real market for biomass, thinning comes with high costs and no revenues. If federal agencies could effectively harness the opportunities of woody biomass energy, they could generate income to fund restoration activities.

Government agencies should take a lesson from private companies that have been using woody biomass to generate heat and power for decades. With a plentiful supply of milling byproducts, such as sawdust, businesses have found that they can cut energy costs by using wood as a fuel. Federal lands have a plentiful supply of biomass and could take advantage of this resource to help avoid insect infestations and catastrophic fires and to generate significant revenue while saving taxpayer dollars.

WOODY BIOMASS UTILIZATION: Pros, Cons, & Numbers

Pros:

- Woody biomass is produced domestically.

- Woody biomass is a renewable resource.

- Using woody biomass to generate energy is associated with reduced emissions compared to leaving woody biomass to burn in wildfires.

- A market for woody biomass could offset the costs of fire hazard reductions and reduce future fire suppression expenditures.

Cons:

- The current market for biomass is limited, with very few facilities processing wood into ethanol, electricity, or heat.

- Long haul distances can be prohibitively costly.

- Using woody biomass for energy provides an alternative to fossil fuels.

- Studies show that burning woody biomass is carbon neutral because the carbon released is equal to the uptake during growth (Spadaro et al. 2000).

- Harvesting woody biomass is expensive.

Numbers:

- 151 million acres of federal forests are in need of fuels reduction treatments to mitigate fire risks (FMI 2001).
- $6.7 billion were spent by the Forest Service on fire suppression between 2000 and 2006 (USDA Forest Service, various years).
- $1.7 billion[1] were spent by the Forest Service on fuels reduction between 2000 and 2006 (USDA Forest Service, various years).
- 10 million acres of national forests were treated for fuels reduction through thinning or prescribed burning between 2000 and 2006 (USDA Forest Service, various years).
- $231 are the estimated per-acre firefighting costs avoided by treating forests for fuels reduction in areas with moderate fire risks. In high risk areas, avoided costs are as much as $481 per acre (Mason 2008).

1. Budget data are adjusted to 2006 dollars.

BIOMASS POLITICS:
Federal Regulations, Mandates, & Subsidies

> *"The great dilemma for public policy is that, although biomass power generation is expensive, it also provides very valuable waste disposal services that would be lost if the industry were to fail."*
>
> —Gregory Morris (1999)
> Pacific Institute

Counter forces are at work. A number of federal regulations attempt to promote hazardous fuels reduction on federal forests by encouraging biomass removal and by mandating the use and production of alternative energy. In addition, government subsidies are passed out to help pump up alternative energy industries and spur markets for biomass. These policies will cost taxpayers billions of dollars. But is government intervention necessary when the private sector is already proving that markets for biomass can work? Moreover, does government involvement actually create potholes on the path toward renewable energy?

- Regulations aimed at facilitating biomass removal from federal forests for the purpose of wildfire hazard mitigation include: The National Fire Plan (2000), The Healthy Forests Initiative (2001), and The Healthy Forests Restoration Act (2003). Between 2001 and 2008, federal land management agencies treated more than 29 million acres of federal lands under these authorities—an area about the size of the state of Ohio (Healthy Forests and Rangelands 2009). While this is a considerable achievement, at this rate it will take more than **35 years to treat all 151 million acres** targeted for restoration.

BIOMASS POLITICS:
Federal Regulations, Mandates & Subsidies

- The Volumetric Ethanol Excise Tax Credit (2004) authorizes a tax credit of **51 cents per gallon** for fuel companies that blend ethanol with gasoline (RFA n.d.(a)). Ethanol production increased from 3.4 billion gallons in 2004 to 9 billion gallons in 2008 (RFA n.d.(b)).

- Promoting biomass electricity, The Energy Policy Act of 2005 authorizes a tax credit up to **1.5 cents per kilowatt hour** for producers of electricity from biomass (NRBP 2005). There was only a small increase in biomass electric generation—from 54 million megawatts in 2005 to 56 million megawatts in 2007 (Energy Information Administration 2009a).

- Mandating the production of biofuels, including **16 billion gallons** of cellulosic ethanol annually by 2022, The Energy Security and Independence Act (2007), provides **$525 million** a year in grants for research, development, production, and commercial application of biofuels (RFA n.d.(a)). This grant money has spurred a flurry of research, but there are currently no commercial-scale cellulosic ethanol plants in operation.

- The 2008 Farm Bill subsidizes cellulosic ethanol, providing a tax credit of **$1.01 per gallon** to producers of cellulosic biofuels (RFA n.d.(a)).[2]

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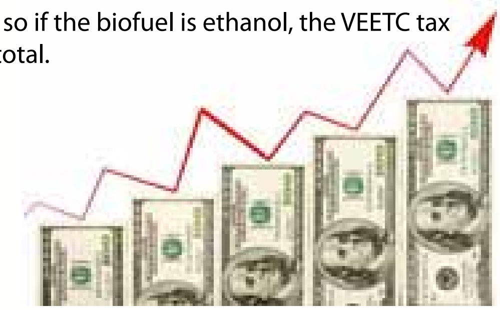
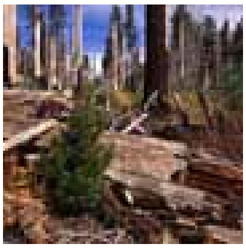
2. Total tax credits will not exceed $1.01 per gallon, so if the biofuel is ethanol, the VEETC tax credit of 51 cents per gallon counts toward this total.



BIOMASS POLITICS:
Federal Regulations, Mandates & Subsidies

- The 2009 American Recovery and Reinvestment Act (the "Stimulus Bill") provides **$16.8 billion** in funding for renewable energy research, development, demonstration, and deployment (Voegele 2009). Of this, **$800 million** is specifically targeted for biomass activities. An additional **$256 million** will go toward hazardous fuels reduction on federal lands.

The alternative to a heavy dose of government intervention is to allow markets to work where there are strong signs that they can succeed. History shows that top down intervention often has unintended consequences that can end up doing more harm than good. The Endangered Species Act, for example, provides incentives for private landowners to preemptively destroy habitat in order to discourage species of concern from living on their property (Lueck and Michael 2003). On national forests, excessive fire suppression by the Forest Service created an over abundance of biomass in the first place (Berry 2008). Turning to markets as a first course of action satisfies consumer demand, alleviates environmental problems, and imposes less of a burden on taxpayers.



BIOMASS ON FEDERAL LANDS:
Barriers & Solutions

"As challenging as the science issues and technical barriers surrounding woody biomass and energy are, the social and economic implications for woody biomass policy are even more complex."

—Ann Bartuska (2006)
Deputy Chief of Research and Development USDA Forest Service

Although there is a bountiful supply of woody biomass on federally owned forests, there are significant barriers to putting this resource to use. If an active timber market can be reestablished, there is still the hurdle of supply. To convert wood to energy, processing facilities need an abundant and steady supply of raw materials. Providing this supply of biomass is no small task and is probably the biggest barrier to utilizing biomass on federal lands. Essentially a new industry must be formed to harvest, transport, and prepare biomass into a usable form. Other barriers include the following:

BIOMASS ON FEDERAL LANDS:
Barriers & Solutions

Barriers

- Lack of access to markets

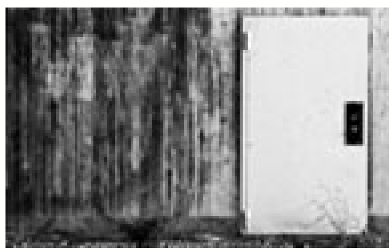
1. Biomass is expensive to transport, so markets for biomass must be close to harvesting sites, ideally within 100 miles.

2. Facilities to process biomass into heat, electricity, or ethanol need to be close to forests, and sited at frequent intervals.

3. Biomass processing facilities require significant capital investments. Businesses will not make these investments without an assurance of a supply of raw materials.

- Lack of an active timber program

Federal timber harvests are a fraction of what they once were—in 2008, the overall harvest was 2 billion board feet, compared to 13 billion in the late 1980s (USDA Forest Service 2009). Without federal timber, mills have shut down, and loggers have gone out of business. Without loggers to harvest biomass and mills to process it, there is little opportunity to put biomass to use.

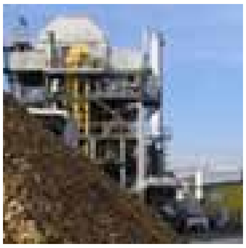


BIOMASS ON FEDERAL LANDS:
Barriers & Solutions

Solutions

- Long-term contracts will help to encourage investments in biomass processing facilities by guaranteeing a reliable supply of raw materials (Becker et al. 2009).

- Re-establishing an active timber program will keep loggers and mills in business. By selling some timber along with biomass, federal agencies can help to offset the costs of harvesting biomass. Timber and paper mills are currently the largest producers of bioenergy—using forest byproducts to generate heat and power for their facilities (Perlack et al. 2005). In order to promote biomass utilization, these facilities need to remain in operation.



WE'RE NOT OUT OF THE WOODS YET:
Harvesting Woody Biomass from Federal Lands

> *"Where ecologically appropriate, the choice is to utilize that woody biomass rather than to let it burn up."* (Quoted in Helman 2009)
>
> —Daniel Buckley
> Head of fire management-National Parks Service

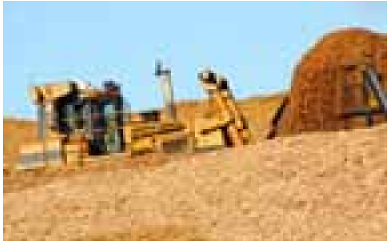
The harvest of woody biomass for energy has raised many questions. How much biomass can be removed from the forest sustainably? Is it possible to generate revenues harvesting biomass for renewable energy? Can biomass removal offset the costs of wildfire hazard reduction? Researchers on the Superior National Forest in northern Minnesota set out to answer these questions (Hemphill 2008; Arnosti et al. 2008).The study was a joint project between the nonprofit Institute for Agriculture and Trade Policy, the Superior National Forest, the Laurentian Energy Authority, and Forest Management Systems (a logger's cooperative). The team conducted nine different biomass harvests, using a range of harvesting techniques and equipment in various areas of the Superior National Forest. They sampled pre- and post-harvest ecological factors, and tracked costs and revenues (Arnosti et al. 2008).

The Minnesota state legislature signed into law a renewable energy standard in early 2007, requiring 25 percent of the state's energy usage to be fueled by renewable sources by 2025. Biomass from forests such as the Superior National Forest could play an important role in meeting this mandate. But environmentalists, loggers,

and forest managers had concerns. The environmental impacts were unclear. In the past, biomass would have been left to decompose on site, cycling nutrients back to the soil. Without this process, there was a fear that soils would become depleted. In addition, biomass harvesters did not know if they would be able to cover their costs through the sale of this relatively low-value product. And finally, managers wanted to discover whether the sale of biomass could offset the costs of wildfire hazard reduction.

Ecologically, the study showed that biomass harvesting had little negative affect on soil nutrient content. Even in areas where the intent was to remove the maximum possible amount of biomass, enough remained on site to maintain soil quality.

The economics were not so rosy. None of the treatments generated net revenues. Furthermore, the costs associated with harvesting biomass such as equipment, labor, and fuel outweighed any revenue generated from the sale of biomass (chips, bundles, loose materials, or roundwood). Only on test unit #7 did biomass harvesting offset wildfire hazard reduction treatment costs (See Table 1).



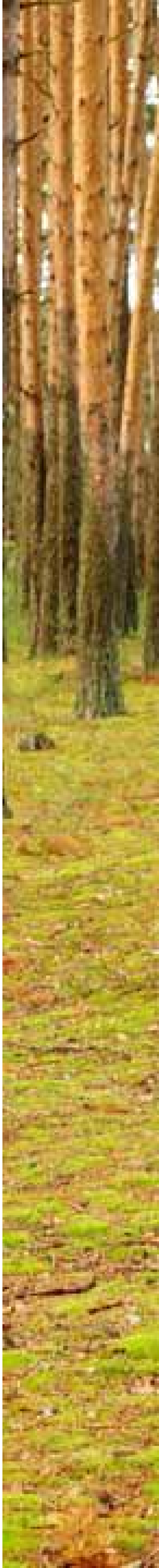


Table 1: Comparison of costs of conventional fuels reduction treatments vs. biomass harvesting on the Superior National Forest

Test Unit	Biomass Products	Amount of Biomass Products	Conventional Fuels Reduction Treatment Cost*	Biomass Harvesting & Transport Cost**	Biomass Revenue**	Net Biomass Cost	Conventional vs. Biomass Cost
		Tons/Acre	$/Acre	$/Acre	$/Acre	$/Acre	$/Acre
1	Chips	8.11	575.00	813.32	170.35	642.98	-67.98
2	Chips	13.70	575.00	1708.81	287.62	1421.19	-846.19
3	Chips	6.95	575.00	912.29	145.87	776.43	-191.43
4	Bundles	5.60	575.00	1068.03	78.47	989.56	-414.56
5	Bundles	4.24	575.00	839.00	59.34	779.66	-205.00
6	Chips & Roundwood	12.79	575.00	1217.05	537.23	679.82	-104.82
7	Bundles	3.20	350.00	371.00	44.79	326.20	23.80
8	Bundles	7.20	575.00	1236.45	100.77	1135.68	-560.68
9	Loose Material	10.04	462.50	1091.83	210.81	881.03	-418.53

Source: Arnosti et al. (2008, 44 & 47). Note: Financial data are in 2008 dollars.

* Conventional fuels reduction treatment costs are estimated for conventional pile and burn mechanical treatments on the Superior National Forest, based on the density of the fuels on the site and the types of equipment that would be used.

** Biomass harvesting and transportation costs and biomass revenues are the actual costs and revenues amassed by the logging contractors involved in this study.

WE'RE NOT OUT OF THE WOODS YET:
Harvesting Woody Biomass from Federal Lands

Through modeling, however, the researchers were able to generate scenarios that would result in reduced costs. The researchers concluded that if the following recommendations are incorporated into biomass harvests, then revenues can offset the costs of fuels reduction treatments.

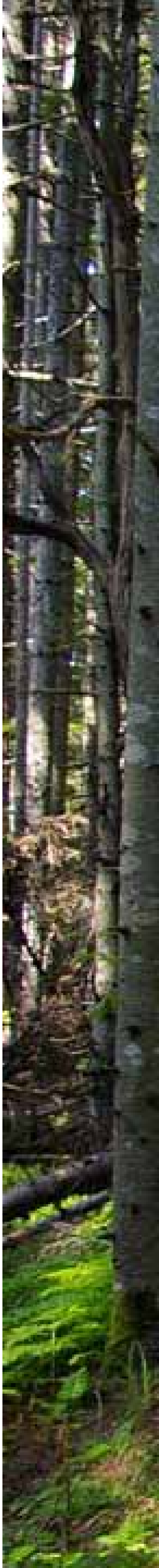
Key Recommendations:

- Start early by incorporating biomass harvesting goals during the planning process for fuels reduction treatments, thinning, or timber harvesting.
- Clear communication is important between forest owners, managers, biomass purchasers, and loggers.
- Larger management units help to keep per-acre costs down due to economies of scale.
- Clearly marking the harvesting units and removing markings from previous harvests can speed up operations.
- Roads and skid trails should be laid out in an efficient manner.

WE'RE NOT OUT OF THE WOODS YET:
Harvesting Woody Biomass from Federal Lands

- Using harvesting equipment specifically designed for biomass removals can cut expenses.
- Training will help loggers who are accustomed to harvesting sawtimber gain efficiency in biomass removals.
- Working in the summertime improves visibility of biomass piles, which can become obscured by snow in the winter.
- Combining biomass removals with timber harvests can improve on-site maneuverability and harvest efficiency.
- Keep haul distances short, preferably less than 100 miles.

Finally, this study does not incorporate the avoided future costs of fire suppression that biomass harvesting can generate. One study from the University of Washington estimates that fuels reduction treatments, including biomass harvests, can result in savings from future fire suppression spending of $231 per acre in areas of moderate fire risks to $481 per acre in areas of high fire risk (Mason 2008). In Arizona and New Mexico, researchers have found avoided future suppression costs of as much as $601 per acre (Snider et al. 2006). If these cost reductions were considered, it is likely that biomass would be able to pay its way out of the woods.



THE HOLY GRAIL OF BIOFUELS:
Cellulosic Ethanol

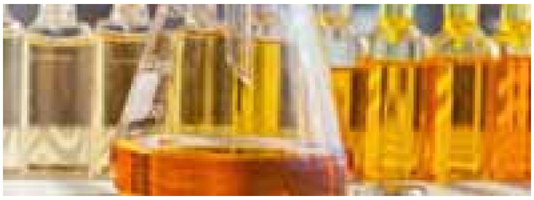
"The ethanol industry is preparing for a shift—from corn as a feedstock to cellulose."

—Kris Bevill (2008)
Editor, *Ethanol Producer Magazine*

Cellulosic ethanol is made from non-corn feedstocks such as woody biomass, grasses, or even municipal waste. It is chemically identical to the more common corn-based ethanol, and it can be blended with gasoline and used as a transportation fuel. Although cellulosic ethanol holds many advantages over the more common corn-based ethanol, commercial production of cellulosic ethanol has proven elusive. One reason is that cellulosic ethanol is costly to produce—33 percent more expensive than corn-based ethanol (Taylor and Van Doren 2007). Given that federal agencies have an ample supply of woody biomass—including 1 million tons per year from national forests alone (Perlack et al. 2005, 10)—the agencies might be able to generate revenue by supplying energy producers with raw materials for cellulosic ethanol.

THE HOLY GRAIL OF BIOFUELS: Cellulosic Ethanol

Cons:



- Ethanol has a lower energy content than gasoline. E85 (85 percent ethanol/15 percent gasoline) that can powers flex fuel vehicles, generally takes a driver 28 percent fewer miles per gallon than conventional gasoline—making E85 more expensive per mile (Scarborough 2008).

- Ethanol cannot be shipped via existing pipelines, because it takes on water. Without new pipelines, ethanol needs to be shipped by truck or rail, or produced regionally. Regional production would depend on the availability of viable feedstocks (DeLuca 2007).

- Commercial production of cellulosic ethanol has been "about five years away" for decades. There are currently no commercial scale cellulosic ethanol plants in operation.

Pros:

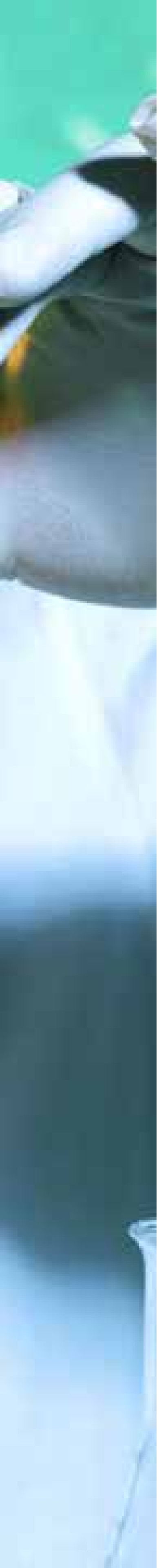
- Raw materials for cellulosic ethanol are abundant—cellulose is the most common organic compound on earth, found in any plant-based material.

- Cellulose is difficult—and costly—to break down into alcohol. Cellulosic ethanol production runs $3.35 per gallon compared to $2.35 for corn-based ethanol (Taylor and Van Doren 2007).

- Ethanol production has been subsidized since the 1970s. A recent estimate places ethanol subsidies between $1.05 and $1.38 per gallon, or around $5.1 billion to $6.8 billion annually (in 2006 dollars, Koplow 2006).

- Unlike corn-based ethanol, cellulosic ethanol does not require intensive agriculture.

- Cellulosic ethanol production does not interfere with food production.



THE HOLY GRAIL OF BIOFUELS: Cellulosic Ethanol

Making Cellulosic Ethanol: One company might have an answer

Oklahoma State University professor Ralph Tanner has been developing a process to produce cellulosic ethanol for ten years. Tanner works with an organism that he discovered at the bottom of a lagoon on the university campus. His lab recently entered into an agreement whereby Illinois-based Coskata, Inc. is licensed to use this technology.

The process hinges on the organisms from the lagoon, which secrete ethanol when they eat carbon monoxide and hydrogen. Using these organisms, Coskata can eliminate expensive enzyme pretreatments of cellulose, which are often required in the production of cellulosic ethanol (Sobolik 2008).

Coskata's process begins with any combustible feedstock, including agriculture and forestry waste or municipal solid waste. The feedstock is heated to create "synthesis gas"—carbon monoxide and hydrogen—which is then processed into ethanol by Tanner's organisms (Green Car Congress 2008).

THE HOLY GRAIL OF BIOFUELS: Cellulosic Ethanol

Coskata claims that it can produce ethanol for less than $1 per gallon. In contrast, other companies' costs are more than twice that much (TAPPI 2008). Coskata's small price tag has turned heads throughout the industry. In January 2008, General Motors entered a strategic partnership with Coskata to research and develop low-cost cellulosic ethanol. The auto manufacturer is planning to increase its production of flex fuel vehicles, which can run on ethanol blends and wants to ensure that that ethanol will be available to fuel the fleet (Sobolik 2008).

Although this technology can produce ethanol from biomass, Coskata isn't currently using biomass as a feedstock. Instead, they are using natural gas, industrial waste gases, and methane from landfills (Sobolik 2008, 64–65).

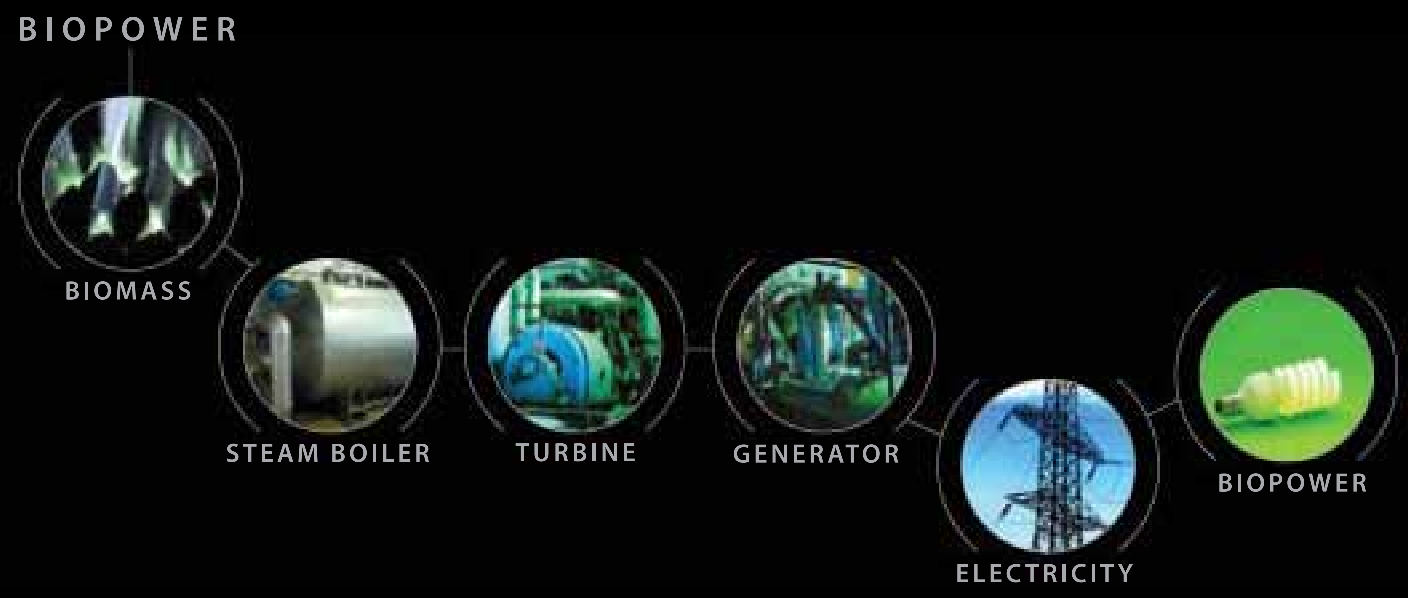
Coskata will have to further refine its process before it is truly producing cellulosic ethanol from biomass. Furthermore, production is nowhere near commercial-scale. Coskata is currently building a demonstration-scale plant with production of about 40,000 gallons of ethanol per year. A commercial-scale plant—able to produce 50 to 100 million gallons per year—is on the horizon, slated for completion in 2011.

BIOPOWER: Electricity from Biomass

"Biopower capitalizes on two of America's strengths: its highly productive farmland and its forests."

—U.S. Department of Energy (2009)

For decades, paper and lumber mills have found that they can reduce their energy bills by using sawdust to produce heat and power for their facilities. Four hundred lumber and paper mills around the country are currently using biomass for energy (Bain and Overend 2002, 13–14). For example, 70 percent of the energy used at Weyerhaeuser's pulp and paper mills was fueled by biomass in 2007. In addition, nearly 20 electric utilities use wood to generate electricity for sale on the grid (Bain and Overend 2002). Few realize that biomass is second only to hydropower in renewable electricity generation (Nicholls et al. 2008; Table 2: Electricity).



BIOPOWER: Electricity from Biomass

Pros:

- Biopower is based on mature technology.

- Emissions from biopower facilities are lower than fossil fuel-burning facilities (Table 2: Emissions).

- Because biomass technologies use combustion processes to produce electricity, they can generate electricity at any time, unlike wind and most solar technologies.

Cons:

- Biopower is subsidized. Tax credits to biopower producers amount to as much as $1.5 billion annually (Koplow 2004).

- Biopower can be more expensive than other types of electric power, depending on the costs of raw materials (Table 2: Costs).

- Biopower plants are limited in size by the amount of raw materials within a close radius. As such, biomass plants are unable to take advantage of economies of scale available to other facilities.

TABLE 2: Electricity, Emissions, and Costs

ELECTRICITY generation by fuel type in the United States, 2007 (Thousand Megawatts)

Conventional	
Coal	2,016,456
Natural Gas	896,590
Nuclear	806,425
Petroleum	65,739
Other (non-renewable)	25,684
Renewable	
Hydroelectric	240,614
Biomass	55,539
Wind	34,450
Geothermal	14,637
Solar	612

Source: Energy Information Administration (2009b).

EMISSIONS of greenhouse gas from electrical production by fuel type—Life-cycle analysis (grams of carbon equivalent per KWh)

Coal	206-366
Oil	149-246
Natural Gas	106-188
Solar (PV)	8.2-76.4
Hydroelectric	1.1-64.6
Biomass	8.4-16.6
Wind	2.5-13.1
Nuclear	2.5-5.7

Source: Spadaro et al. (2000). Emissions include carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, tetrafluoromethane, hyrdoflorocarbons, chlorofluorocarbons, and hydrochlorofluorocarbons, weighted for "Global Warming Potential" as recommended by the International Panel on Climate Change.

COSTS of Electric Generation by Fuel Type ($/KWh)

Alternative Energy (costs do not include alternative energy tax credits)		
Solar (PV)	$0.21–0.35	
Wind	$0.09–0.15	
Biomass	$0.08–0.12	
Geothermal	$0.08–0.12	
Conventional Fuels		
Coal	$0.07–0.14	
Nuclear	$0.10–0.12	(Does not reflect economic impact of federal loan guarantees or subsidies)
Gas	$0.07–0.10	(combined cycle, non-peaking)

Source: Lazard (2008). Costs are in 2008 dollars.

BIOPOWER: Electricity from Biomass

An Outlet for Biomass

In Arizona, two facilities are using wood from the Apache-Sitgreaves National Forest to generate electricity. Much of the forest is ponderosa pine, which historically burned at frequent intervals, but decades of Forest Service fire suppression over the past century have resulted in a buildup of hazardous fuels. This situation made headlines in 2002 when the Rodeo-Chediski fire burned 462,000 acres (NIFC n.d.). After the fire, local residents and forest managers wanted to prevent a repeat situation.

In 2003, the Forest Service offered a long-term contract, trading biomass from the Apache Sitgreaves National Forest for fuels reduction treatments on 8,000 to 15,000 acres per year over 10 years. These treatments cost anywhere from $300–$800 per acre, so the value of this service is $2.4 to $12 million per year (Abrams and Burns 2007).

A local forestry and alternative energy company, Future Forest, won the contract, and built a 3 megawatt wood-powered electric plant in order to put the biomass to use. The facility opened in 2004 and runs on about 100 tons of biomass each day, producing electricity for 3,000 homes (Nicholls et al. 2008). Future Forests sells electricity to Arizona Public Service (APS), an electric utility company for 7.7 to 12 cents per kilowatt hour (Johnston 2004).

BIOPOWER: Electricity from Biomass

Arizona Public Service also generates electricity from nuclear, coal, and natural gas fired power plants. The company predicts that Future Forest's biomass facility will help them reduce greenhouse gas emissions by as much as 13,000 tons per year (Neary and Zieroth 2007). Future Forests will also help APS to comply with Arizona's renewable energy requirement that 15 percent of electricity be generated from renewable sources by 2025.

A second biopower facility, owned by the alternative energy company, Renegy, opened in June, 2008. This 24 megawatt plant runs on biomass from a variety of sources. First, Renegy subcontracts with Future Forest to remove biomass from Apache-Sitgreaves National Forests. At least 75 percent of the plant's production is fueled by biomass from wildfire risk reduction treatments on Forest Service lands (Renegy 2008). In addition, the company has salvaged trees from 20,000 acres burned in the Rodeo-Chedeski fire. Renegy also uses by-products from a nearby paper mill and green waste from neighboring towns—keeping wood out of landfills (Renegy 2007). Renegy sells electricity to two Arizona utility companies for approximately 8.5 to 9.5 cents per kilowatt hour (Randazzo 2008).

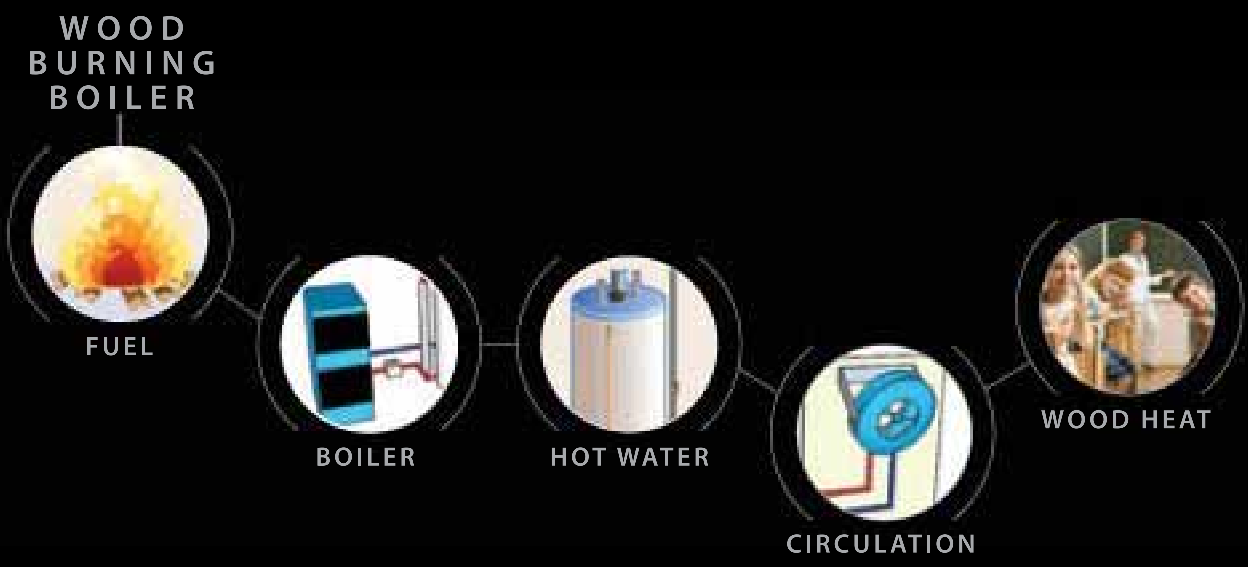
In eastern Arizona, energy producers are providing electricity and encouraging forest restoration at the same time. Biopower is not always the cheapest form of electricity, but it does have the advantage of reduced emissions of a range of greenhouse gases in comparison to fossil fuels and provides an outlet for fuels reduction treatments on overgrown forests.

FEED THE FIRE: Wood for Heat

"Probably 75 percent of the people up in the mountains here heat their houses with wood. And why? Because it's a lot cheaper than heating with electricity or natural gas or oil." (Quoted in Allen 2005)

—Murray Dagleish
Idaho town superintendent

A decidedly low-tech option might be the best outlet for woody biomass: burning wood for heat. Although this idea is far from cutting edge, it has provided a solution for high heating costs and overgrown forests in many areas of the country. As rural dwellers know, heating with wood can be less expensive than with other fuels.



FEED THE FIRE: Wood for Heat

Pros:

- Newer wood boilers are extremely efficient and have very low emissions.

- Under the right conditions, heating with wood can be less expensive than heating with other fuels.

Cons:

- Fireplaces and inefficient wood stoves and furnaces can produce high levels of emissions and airborne particulates.

- Compared with other fuels, heating with wood can be messy.

- Mid-size buildings (10,000 sq. ft. - 100,000 sq. ft.) are not ideal because they require a lot of heat but not so much that economics of scale work to their advantage.

- The infrastructure for delivery of wood heating fuels is less developed than for other heating fuels like natural gas, propane, heating oil, or electricity.

TABLE 3: Annual Home Heating Costs for Various Fuels

Fuel	Units	Cost/Units	BTU/Unit[a]	Efficiency[a]	Annual Home Heating Cost[b]
Natural Gas	Cubic Foot	12.16[c]	1,025,000	80%	$1,483
Firewood[e]	Cord	210.00[f]	13,760,000	77%	$1,982
Wood Pellets	Ton	270.00[d]	16,400,000	83%	$1,984
Heating Oil #2	Gallon	2.31[c]	138,800	83%	$2,005
Propane	Gallon	2.29[c]	91,300	79%	$3,175
Electricity	Kilowatt-hour	0.11[c]	3,413	98%	$3,289

Notes: [a]Forest Products Laboratory 2004, efficiency is average appliance efficiency used to turn fuel to heat. [b]Based on 100 million BTU for the heating season. [c]Energy Information Administration 2009c (average residential prices in January, February and March, 2009). [d]WoodPelletPrice.com (average price listed on June 15, 2009 from 19 states: CO, CT, ID, IN, KS, MA, MD, ME, MI, MN, MS, NH, NY, NY, OH, PA, UT, VT, WI). [e]Twenty percent moisture content [f]Hearth.com (Average of cordwood costs in 2008 in 17 states with reports: CA, CO, CT, DE, ID, KS, MD, ME, MI, NH, NJ, NM, NY, OH, UT, VA, and WA).

"What about the smoke?"

All wood-powered heat generates smoke, but some wood burning appliances are cleaner than others. Pellet stoves and chip systems installed in fuels for schools programs have extremely low emissions levels. In contrast, older wood-burning stoves and fireplaces can be very smoky. In most cases, however, burning biomass in boilers is associated with lower emissions than allowing biomass to burn in the woods, either in pile-burns or in wildfires (see Table 4).

Fuels for Schools

Across the country, towns are beginning to heat public buildings—particularly schools—with wood waste from nearby forests. In such "Fuels for Schools" programs, the word "fuels" has a double meaning. In the forest, woody biomass is potential fuel for a wildfire—a threat that managers try to mitigate. In the schools, woody biomass is fuel for heating. In this way, the program turns biomass from a liability into an asset.

Beginning in 1986, the state of Vermont developed a program, using mill waste to power boilers in the public schools. At the time, most schools in the state were heated with expensive electricity. Replacing electric heaters with wood-powered boilers resulted in considerable savings in heating costs. Today, 20 percent of Vermont public school students attend schools heated with wood (McElroy 2007).

The University of Idaho in Moscow has also used wood for heat since the 1980s. Originally, the university built wood-powered boilers as a

TABLE 4: Comparison of emissions (Pounds of emissions per ton of wood burned)

	Particulates Lbs/Ton	Nitrogen Oxides Lbs/Ton	Carbon Monoxides Lbs/Ton
Wood-powered Boiler	1.25	1.22	1.67
Slash Pile Burn	12.00	3.50	73.90
Wildfire	17.00	4.00	140.00

Source: Bergman and Maker 2007.

back up to their natural gas heating system, but they found that they were able to save money through heating with wood. In 2003, wood heating costs were $1,700 per day, compared with $7,000 per day for natural gas. Emissions are monitored constantly, and generally are less than half of the allowable level for particulates (Tennery 2006).

There are some subsidies involved with wood heat, but not anywhere near the level of ethanol or biopower. Between 2001 and 2003, the Fuels for Schools program in the Northern Rockies received about $2.2 million in federal funding for demonstration and pilot projects (Becker et al. 2008). Even this relatively small amount of funding was likely unnecessary, however, based on the fact that schools in Idaho and Vermont had switched to wood heat decades earlier without the help of federal dollars.

The small town of Darby, Montana, in the Bitterroot Valley south of Missoula, was one of the first communities in the Rockies to install wood-powered boilers in their schools. Darby is surrounded by national forests—75 percent of the lands in the county are federally owned—and local residents were well aware of heightened fire risks on federal lands. In addition, Darby school administrators were looking to cut down on heating costs. As a result, the Montana Fuels for Schools program sprang to life.

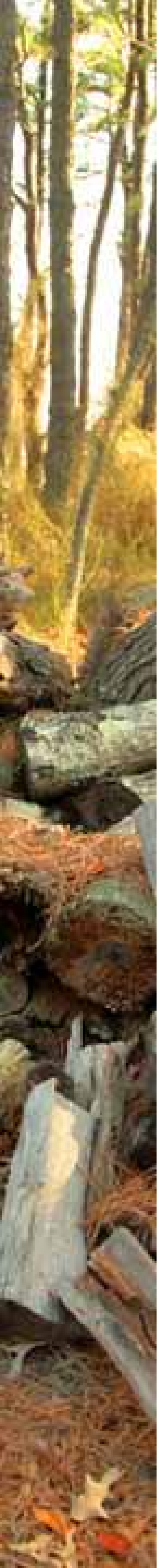
Darby replaced its oil-powered boiler with a wood-powered boiler in the summer of 2003. Emissions from the wood boiler, which is extremely efficient, are nearly 20 times cleaner than from a wood stove. After a couple years of using the oil boiler as backup, by 2006,

the school was heated entirely by wood. Annual heating costs fell by almost 50 percent (Coston 2007).

The ponderosa pine and douglas-fir forests in the Darby area can yield 10 tons of biomass per acre every 20 to 30 years. Since the Darby school burns 770 tons of biomass annually, it needs about 2,000 acres of forest to support it (Allen 2005). This is equivalent to a circular area with the radius of one mile—and the Darby public schools have a much wider area from which to draw. "In our Bitter-root Valley, there's hundreds of thousands of acres of forest that need to be thinned," says Dave Atkins, Fuels for Schools Program Manager for the Forest Service's Northern and Intermountain Regions (quoted in Allen 2005).

Darby contracts with a local logger, who delivers wood chips for an average of $32 per ton. Over the course of the 2003–2004 school year, the logger made 53 deliveries, averaging 12 tons per trip. The chips are stored in an underground bin and then delivered to the boiler through an automated system of augers and conveyor belts. At the boiler, the chips are burned to heat water, producing low-pressure steam to heat the schools (Bergman and Maker 2007).

Although the original intent was to rely primarily on wood from fuels reduction treatments from federal lands, Darby administrators have found that they are able to find a more steady supply of biomass from non-federal sources (Becker et al. 2009; Coston 2007). The national forests in the Darby area have not offered long-term contracts like the Apache-Sitgreaves National Forest in Arizona. The timber that is offered from federal lands in western Montana is sometimes



FEED THE FIRE: Wood for Heat

held up in lengthy environmental lawsuits. Even when the Forest Service wins in court, litigation can interrupt the flow of biomass to consumers.[3]

Without any guarantee of supply from federal lands, Darby administrators have been forced to seek alternatives. Seventy-five percent of the biomass used in Darby comes from private lands, 21 percent from public lands, and 4 percent from state lands. At least 50 percent of the biomass comes from fire hazard reduction treatments, and other sources include logging slash and by-products from post and pole operations (Bergman and Maker 2007).

This represents a lost opportunity for forest restoration and biomass removal on the federal forests surrounding Darby. The Forest Service could offer a long-term contract for biomass removal, like the arrangement between the Apache-Sitgreaves National Forest and Future Forests in Arizona. This would give Darby public schools the assurance of a reliable supply of biomass and also support restoration of federal lands.

The Darby example shows that it is possible to reduce heating costs and promote fire hazard reduction treatments through heating with wood. It also shows that the Forest Service needs to be able to provide a more stable supply of biomass to consumers. Even in Darby, where overgrown public lands dominate the landscape, private owners were better able to provide biomass to the schools.

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3 Personal communication via telephone with Kit Sutherland, Coordinator, Bitterroot Resource Conservation and Development, July 24, 2009.

A FUTURE FOR FEDERAL AGENCIES

"An opportunity we cannot afford to waste."

—USDA Forest Service (2009)

Woody biomass is an untapped resource. It is renewable, abundant, and can be used to generate energy. A market for biomass would encourage forest restoration, reduce risks of insect infestations and catastrophic fires, and supplement timber dollars. Removing biomass on federal lands could be a critical step in turning back the clock on mismanagement over the past century.

There are several barriers, however, to harvesting biomass from federal lands. Markets for biomass are not fully developed, and often the material has to be hauled long distances at high costs to reach processing facilities. Where biomass processing facilities do exist, inconsistent supplies from federal lands sometimes force energy producers to seek alternative sources. Finally, due to decreases in federal timber harvest programs, mills have shut down and loggers have gone out of business—limiting options for harvesting biomass and putting it to use.

In order to take advantage of the opportunities for woody biomass utilization, government land management strategies need to be adjusted. Policies should support markets for biomass and promote biomass removals from federal lands. Long-term contracts for harvesting biomass will encourage investment in processing facilities, improving market access for federal forests.

A FUTURE FOR FEDERAL AGENCIES

Maintaining an active timber program on federal forests will also help keep loggers and mills in operation—critical components of a biomass industry.

The most viable uses for biomass are in generating heat and electricity. These options are based on proven technologies, and offer advantages over fossil fuels, either through reduced costs or reduced emissions. Cellulosic ethanol might become economically viable through technological advances. But until a company such as Coskata can produce cellulosic ethanol cheaply and on a large scale, the place for cellulosic ethanol is still in the laboratory.

Federal forest managers should position themselves to take advantage of new and emerging markets for biomass. Currently, most biomass utilization is from the private sector. Even fuels for schools projects like the one in Darby, which is surrounded by federal lands, get the majority of their biomass from private landowners who provide a reliable supply at a reasonable price. If federal agencies are given the freedom and incentives to step up to the plate, there is a big role for public lands in the biomass energy industry.

ADDITIONAL RESOURCES

- Coskata
  www.coskata.com

- Forest Service Healthy Forests and Rangelands
  www.forestsandrangelands.gov ("Biomass politics")

- Forest Service Woody Biomass Utilization
  www.fs.fed.us/woodybiomass/ ("We're not out of the woods yet")

- Fuels for Schools
  www.fuelsforschools.info/

- Future Forest
  www.futureforest.info/ ("an outlet for biomass")

- Institute for Agriculture and Trade Policy (IATP)
  www.iatp.com ("We're not out of the woods yet")

- Renegy
  www.renegy.com ("an outlet for biomass")

Please Note: PERC does not endorse the sites behind these links. We offer them for your additional research.

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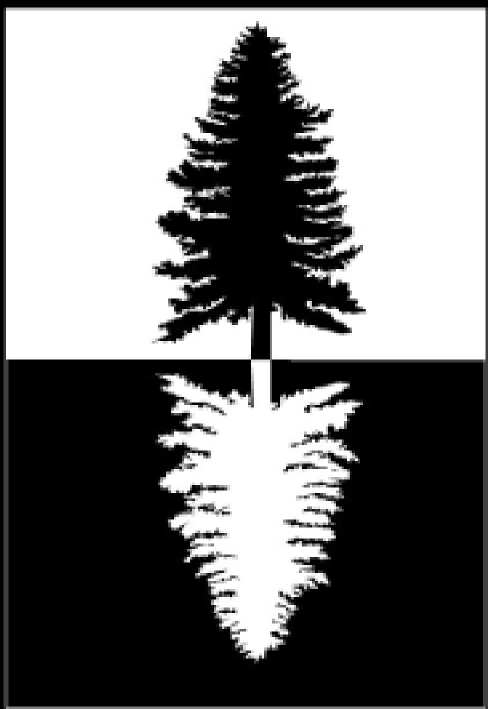

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