

## Making Biomass Pay: Obstacles and Opportunities

*Removing hazardous fuels to reduce the risk of wildfire has become a priority for land managers across the United States. Utilizing biomass taken from forests to cover the cost of fuel reduction is an attractive ideal. Effective utilization could also address important national challenges such as improving forest health, increasing domestic energy supplies, reducing carbon emissions, and revitalizing rural economies. However, getting woody biomass from the forest to the consumer is economically and logistically difficult, and efforts to make biomass utilization profitable have been disappointing so far. JFSP-funded researchers have found that, while there is no recipe for building a successful economy around forest biomass, certain elements are essential: commitment and budget support from land-management agency leaders, processing and transportation infrastructure, developed or potential markets, and the ability of community members to work together. The researchers' findings give land managers and community leaders a basis for assessing whether biomass utilization can be successful in their communities.*



Dalia Abbas

A fuels-reduction thinning in ponderosa pine forests on the Deschutes National Forest in central Oregon, conducted with a cut-to-length harvesting system.

## No silver bullet

Dangerously heavy fuel loads in the nation's forests. The high cost of energy. Stagnating rural economies.

These separate challenges have an important link, and that is wood—tops and limbs from harvested trees, boles of small trees thinned from the forest, live trees riddled with bark beetles, dead trees lying on the ground, stumps and snags, stems and twigs from shrubs. This is the stuff timbermen once dismissed as the dregs of the forest, fit only to be burned or left on the forest floor to rot.

These days, forest biomass is high on the agendas of the nation's policymakers because it seems to hold out the promise of solving several thorny problems at once. Take it out of the woods, and the woods are less likely to burn up in a wildfire. Then sell it to a company that pelletizes it for woodstoves, or burns it to heat schools and city halls, or uses it to fuel the boilers of electric-generation plants, or grinds it up into garden mulch, or distills it into ethanol to run our cars.

Unfortunately, it's not quite that simple. "Ten years ago people thought this was an easy fix, a no-brainer," says Dennis Becker. "We just bring the stuff to the roadside, we haul it off, we make electricity out of it." Becker, a University of Minnesota forest policy analyst, and his colleagues conducted a JFSP-funded study of 10 regions engaged in a wide variety of projects to make biomass pay (Project No. 07-3-2-08). "But that hasn't happened, and the people involved have come to realize how complicated it is."

After 10 years of trial, error, and a few limited successes, the promise of biomass remains tantalizingly out of reach, says Todd Morgan, who directs forest industry research for the University of Montana's Bureau of Business and Economic Research. Morgan is the lead researcher on a JFSP-funded study of the economics of biomass utilization (Project No. 07-3-3-03). "There's no question that there's enough woody material out there, but can we get access to the wood? Will there be an environmental backlash? Will there be air-quality issues?"

The list of hurdles goes on. Are there enough skilled contractors to harvest the material efficiently and in an environmentally sensitive way? Is there a processing plant within a reasonable hauling distance? Is anyone in the vicinity willing to pay for this low-value material? If the wood is in a federal forest, is

there enough funding and administrative capacity to harvest it while complying with environmental regulations? Will nearby communities support such efforts or fight them? What happens when wood prices fall during the two or more years it takes to get a biomass project completed?

## "Biomassing" the federal forests

Recent severe wildfire seasons have focused attention on the woody fuels that continue to build up in the nation's forests, especially in the West. Federal budgets allocate money to managers of national forests, BLM lands, and other federal lands to treat these fuels to minimize the wildfire hazard. Treatments call for grinding up the resulting biomass and leaving it in the woods, piling and burning it, or hauling it out and finding some use for it.

The highest-quality biomass comes from whole tree boles. These can be used for small sawlogs, posts and poles, and other small-dimension products, or they can be ground up into chips for pulp and paper or particle-board manufacturing. Solid-wood biomass can also be chipped finely and compressed into wood-stove pellets

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Wood chips from a Forest Service project in central Oregon on the Deschutes National Forest.

Dalia Abbas

or manufactured firelogs, or used for other applications where the fuel needs to be clean. The smaller pieces and the coniferous bark, if clean, can fuel the boilers that generate electricity or steam for sawmills or heat for community buildings.

The higher grades of biomass can be cooked into ethanol, a highly capital- and technology-intensive (and expensive) process. The lowest-quality biomass, containing bark and dirt, can be ground up into landscape mulch (which can have high value in the right market) and animal bedding.

While some environmental groups fear that “biomassing” the federal forests, as some call it, will lead to unsustainable logging and strip the forest of vital nutrients, many conservation-minded groups and communities have embraced the idea of responsibly removing biomass, not only to lower the risk of severe fire but to achieve other ecological benefits. For example, multipartner coalitions in communities near the Francis Marion and Sumter National Forests along the South Carolina coast collaborated on a project to remove woody fuels from hurricane-damaged loblolly and longleaf pine forests by a combination of prescribed burning and mechanical thinning. The treatments are improving habitat conditions for endangered red-cockaded woodpeckers and for several other sensitive wildlife species, and they provide fuel to sell into a robust wood-chip market.

## Boosting the nation’s energy supply

The promise of biomass utilization ties into a larger national effort to make the United States less

**“...some experts say forests could yield about 368 million dry tons of usable biomass per year...”**

dependent on foreign oil and other non-renewable fuels. According to a 2005 report from the Departments of Energy and Agriculture, biomass has surpassed hydropower as the largest domestic source of renewable energy and now meets about 3 percent of U.S. domestic energy needs. (All sources of renewable energy combined account for just 7 percent of domestic energy needs).

Congress has set a target of replacing 30 percent of the current U.S. petroleum consumption with biofuels by 2030. The DOE-USDA analysis estimated that a billion dry tons of biomass per year would be enough to meet that target, and calculated that the nation’s farmlands and forestlands together could potentially produce that much and more. While most of the material is expected to come from agricultural lands, some experts say forests could yield about 368 million dry tons of usable biomass per year—about two-and-a-half times what’s currently being used. Some assert that using wood to replace fossil fuels also could potentially reduce greenhouse-gas emissions and thus help mitigate global warming.

But national vision statements and federal policy initiatives gloss over the wide variety of regional and local conditions, says Dennis Becker. The woods may be full of flammable material, but utilizing it profitably requires commitment and budget support from forest agency leaders, a processing and transportation infrastructure, and the ability of community members to work together. Most of all, a successful biomass economy needs investors who are willing to add value to a material that has historically been of little account, and it needs a market that will pay them a fair profit for it.

A reliable supply of raw material would seem to be essential to a successful enterprise. It’s reasonable to suppose that supply will attract processing capacity, just as it does in a conventional timber economy. The federal forest managers interviewed by Becker believed that, to attract significant investment, they would need to be able to guarantee a steady supply. However, they didn’t feel confident they could do that, both because they couldn’t count on sufficient budgets and staffing to meet their fuel-reduction objectives, and because they could never be sure that a project would go forward without being delayed by an environmental challenge.

These managers are partly right, Becker says; a ready source of raw material may be necessary, but it’s not sufficient. “I was concerned with what I heard as the rallying cry: we just need to solve the supply



Dennis Becker

McNeil wood-fired generating station, Burlington Electric. The electric plant acquires its wood material from private sources throughout Vermont, New York, and Quebec. It produces approximately 50 megawatts of power.

issue—figure out a way for agencies to offer a consistent, reliable supply of biomass, and then investors will appear and the problem will be solved.” This “if-we-build-it-they-will-come” assumption was one of 10 “conventional wisdoms” that Becker and his team examined closely.

Like most conventional wisdoms, this one is true under certain circumstances, but not so widely valid as it seems. For starters, the threat of environmental delays appears to be a less-overwhelming obstacle than in the past. “It was an issue in some places, but we didn’t see much of it across the country,” Becker says. “In fact, [biomass utilization] became a point on which varying groups could agree in principle. Everybody wants forest restoration; everybody agrees that community economic development is a good thing.”

As for the supply issue, there’s no question that it poses a chicken-and-egg conundrum: businesses are reluctant to locate near a forest until they’re sure of a reliable supply of raw material, while forest managers are reluctant to embark on the environmental-review process specifically for biomass-extraction projects until there’s a processor standing ready with a checkbook. (Otherwise, they might rather spend the time and money on the wider range of fuels-reduction projects that don’t have to yield merchantable biomass.)

The chicken-and-egg conundrum is particularly problematic in the western landscape, where federal forests are widespread, milling infrastructure is slipping away, and the buildup of fuels is most urgent. “But even if they solved their supply issue,” Becker says, “other issues would emerge.”

“Obviously, where there are good markets for the material, you have a better economic situation,” says Zander Evans, research director for the nonprofit organization Forest Guild, based in Santa Fe, New Mexico. In his own JFSP-funded study (Project No. 07-3-2-02), Evans surveyed 40 areas engaged in a variety of biomass-utilization efforts. “You can’t choose what people are paying in your area for wood chips. If nobody is paying a decent price, you can try to figure out what the market might be and form community partnerships to try to build that market.”

Becker’s and Evans’s studies were separate but related. Evans took the broader view, surveying his study areas to learn their varying objectives, degrees and types of collaboration, natural ecology of their home forests, fire history and fire risk within those

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forests, local economics of biomass utilization, implementation of projects, and regional differences. Becker’s closer look at his 10 communities focused on forest administration, industry presence, and community social capacity.

(Dennis Becker’s 10 cases were added to the Forest Guild list to make a total of 50; readers may see all of them at

<http://biomass.forestguild.org>.

The study areas differ quite a lot in social and physical context, the amount and type of biomass available, the degree of wildfire risk, social capacity, historical ties to the forest-products industry, access to processors and markets, and availability of skilled workers. “We found a lot of regional differences,” says Becker, “and capacity for success varied widely.” He and his colleagues interviewed nearly 150 participants about their roles in Forest Service, BLM, and Bureau of Indian Affairs biomass projects. Respondents included state and federal agency staff, tribal representatives, project planners, local government representatives, loggers, wood-products manufacturers, environmentalists, and community partners.

The “conventional wisdoms” that emerged in conversations with these respondents caught the team’s interest. All, they suspected, were highly contingent, and so it proved. “Taking the ‘conventional wisdom’ approach allowed us to enter the discussion without



Dalia Abbas

Jefferson State Forest Products in Hayfork, California, uses small-diameter material from fuels-reduction projects to produce vegetable displays for national grocery retailers.

judging whether these might be ‘true’ in the abstract or not,” Becker says. “We looked at them to see which ones might be blown out of proportion and how that influenced local strategies.”

One of these conventional wisdoms has already been mentioned: the notion that federal forest managers are too hampered by environmental concerns to guarantee the supplies of biomass in quantities that would attract investors. The nuance here, says Becker, is not that a steady supply is trivial to a manufacturer—it is critically important—but that the inability to guarantee supply in some areas may have less to do with writing bulletproof National Environmental Policy Act (NEPA) documentation than with having viable market outlets.

In fact, managers may enter into long-term supply agreements through the legal mechanisms provided by the authority given to the Forest Service and BLM to contract the stewardship of end results (P.L. 108-7). Some places have also used memoranda of understanding (MOUs). However, these do not amount to supply guarantees. In central Oregon, for example, federal forest managers and a partnership headed by the Confederated Tribes of Warm Springs were operating under a 20-year MOU that called for

**“...the problem was not lack of supply but poor markets...”**

treating fuels on 8,000 acres of Forest Service and BLM lands within 75 miles of the tribal sawmill and pledged that the agency would “endeavor to offer” significant quantities of biomass. Despite those good intentions, and even with significant community collaboration, the project fell victim to an economic downturn. Poor lumber markets closed the sawmill, so the tribes and their partners no longer had wood waste from the mill to balance the higher-cost biomass from the federal forests. As a result, they had to postpone indefinitely the upgrading and expansion of their 40-year-old cogeneration power plant.

In this case, the problem was not lack of supply but poor markets. “The cases suggest that lack of clear and predictable sources of supply of biomass can be a barrier, particularly for large facilities,” acknowledged the researchers in their final report. However, they point out, the commitments that federal managers were able to supply did not lead to new investment in any of the communities.

A related conventional wisdom is that long-term stewardship contracts were the best strategy for extracting ongoing supplies of raw material. One rationale for this assumption was the success of the 10-year White Mountain Stewardship Contract

### Partnerships Are Key in Central Oregon

Haul distances are long and markets are few for biomass from central Oregon’s Deschutes National Forest, the BLM rangelands around Prineville, and the 600,000-acre Warm Springs Indian Reservation. Yet strong partnerships among traditionally opposed factions are working on making biomass pay even in the current poor economy.

The area is vast and mostly sparsely populated, except for the cities of Bend and Redmond, which were enjoying booming growth until the recent economic downturn. Central Oregon is a significant destination for outdoor recreationists from Portland and other west-side cities. For that and other reasons, forest-management projects tend to generate a lot of public debate.

The Sisters Ranger District has been using stewardship contracting to bring the community together on biomass projects and identify business partners to process the material removed. Their efforts are aided by the Central Oregon Partnership for Wildfire Risk Reduction, a diverse group of stakeholders that includes community groups and statewide nonprofits along with federal, state, tribal, and industry representation. The partnership is working on strategies to lower haul costs, expand markets, and advocate for favorable laws and policies.



Gutches Shavings of White City, Oregon, makes animal bedding from mill wastes from local sawmills.

Dennis Becker

in attracting new biomass-utilization investment to the Apache-Sitgreaves National Forest in eastern Arizona.

Stewardship contracts, authorized by Congress in 2003, are a way for managers of Forest Service and BLM lands to contract for such work as restoring watersheds to more-desirable conditions, improving wildlife habitat, reducing fuel loads, improving timber stands, and reducing damage from insects and diseases. The arrangement allows the agency to recoup the value of the products removed to offset the cost of the work. By making the projects available to local businesses, stewardship contracts are also intended to contribute to rural economic development.

***“Smaller-scale projects tended to be more viable than larger ones...”***

Several of the study areas were in the process of developing stewardship contracts, although some respondents doubted that these arrangements would yield enough merchantable biomass to interest investors. One respondent in the Colorado Front Range told Becker’s team that the forestlands in question had been offered up under conventional timber sales three times in the past with no takers.

While stewardship contracting worked well in some places, say the researchers, it did not lend itself to areas where the timber had little value. In several cases, ordinary service contracts, which do not require that the biomass be removed and utilized (in fact, it may not be sold commercially), worked better for fuel-reduction projects. Other drawbacks to stewardship contracting: large, long-term contracts can tie up the majority of available biomass in an area and thus exclude competing businesses; contracts are complex and time-consuming to administer; and they do not provide timber receipts to counties in the way that traditional timber sales do. In some places, shorter-term (less than 10 years) stewardship contracts were effective in getting the low-value material out of the forest and fostering community collaboration on fuel treatments.

### ***From the Ground Up***

The Village of Ruidoso, New Mexico, sits in one of the highest fire-risk areas in the country. “It scares the hell out of you when you drive through it in the middle of the summer,” says Dennis Becker. Building on a history of cooperation with the adjacent Mescalero Apache Tribe and the Smokey Bear Ranger District of the Lincoln National Forest, Ruidoso has been vigorous in drafting wildfire protection plans, prioritizing fuel treatments, and imposing zoning ordinances to create defensible space. In the process, the town has developed its own biomass economy from scratch.

Ruidoso uses a city property tax to encourage landowners to thin their forests, clear their brush, and create fire-safe zones. If a landowner takes appropriate fire-safe measures, the tax is reduced. Tax revenue goes to pay for city crews to pick up the biomass for free and take it to a local landscape-mulch manufacturer. Tax money also subsidizes the mulch company and gives it incentive to expand its processing capacity. “What they’ve done is tied all those pieces together,” says Becker. “The program has been going on for several years now, and it has substantially reduced wildfire risk.”



Dalia Abbas

Fuels-reduction thinning project on private land within the wildland-urban interface of the Village of Ruidoso, New Mexico.

### **Additional findings**

➔ Smaller-scale projects tended to be more viable than larger ones, despite the real concern that only industrial-scale utilization can hope to keep up with the huge quantities of biomass that need to be removed from fire-prone forests. In Colorado, utilization efforts focused on industrial heating and animal bedding; in Vermont and Montana, the focus was heating and small-scale electrical generation. “Individually these projects use a small amount of material,” the researchers noted, “but collectively they have the potential to make an impact in terms of fuel reduction.”

That impact will probably still be too small. Research forester Morgan points out that, if 10 percent of the biomass were removed from only 1 percent of the timberland in Montana, there’d be enough wood to keep 950 Fuels for Schools furnaces burning for 100 years. Says Becker: “So now we’re reassessing the ‘small is beautiful’ idea, and one thing we heard was that businesses need to be able to scale up to become financially solvent.” Yet these enterprises still need to stay

close to the resource base, remain part of the local culture, and not outgrow the raw-material supply. “Trying to find that sweet spot is kind of difficult,” Becker acknowledges.

- ➔ Conventional wisdom has it that most or all biomass is low-value waste material. In fact, some types—for example, lodgepole pine thinnings—can be merchantable. However, in many western forests, where the fuel problem is greatest, the distance to markets and other infrastructure challenges make it cheaper to masticate small-diameter material or pile and burn it on site.
- ➔ Depending on location and market demand, wood chips or even firewood can fetch more revenue than sawlogs or pulpwood. For example, the expense of heating oil in Vermont created a high demand for fuelwood.
- ➔ The most viable biomass-utilization efforts tended to be part of integrated forest operations, where profit from timber harvest can offset the costs of removing and processing the rest of the biomass. Areas lacking primary forest-products infrastructure will likely need market-development subsidies of one kind or another. However, many of Becker’s respondents were concerned that subsidies could skew market values and reduce the long-term viability of biomass projects. Moreover, in places where there is already a market for biomass (for example, areas with a well-developed pulp and paper industry), subsidies could be perceived as fueling unfair competition for the resource.

Targeted incentives at the state or local level may be useful, says Becker. “For example, Oregon has a transportation credit of \$10 a green ton—transportation being one of the greatest barriers—and it’s transferable.” Colorado’s recently enacted forest enterprise zones, in which landowners assess themselves to pay for forest-health and fuel-reduction efforts, is another example.

## Dollars and cents

Todd Morgan’s study focused on the financial and economic factors of biomass utilization. He and research associate Jason Brandt conducted focus groups with nearly 100 silviculturists, contracting officers, timber management officers, fuels specialists,

and stewardship coordinators in the Forest Service and the National Park Service. They were curious about how these managers were penciling out the costs and benefits of their biomass projects, and whether their analyses were working for them. “We wanted to know how much economic analysis goes into NEPA [the environmental assessment process], how much financial feasibility analysis is done prior to NEPA, and how much financial analysis is done prior to the sale itself,” Morgan says.

Given that their respondents were working in diverse economic and ecological environments, Morgan and Brandt did not find a one-size-fits-all analysis methodology, nor did they expect to. But of the wide variety of analytical methods they encountered, not all were as effective as they could be. “We found many units trying to overcome past situations where insufficient analyses of project costs were done early on in the process,” Morgan says.

“They were finding out too late—after the time and money was spent on NEPA and the project went out for bid—that the selected alternatives were not financially feasible and potential buyers would not bid on them.” Some respondents found that traditional timber-sale financial tools such as Transaction Evidence Appraisal (TEA) do not lend themselves to biomass costing, especially in states or regions with wide variations in geography, forest type, and market prices.

Other agency personnel were using methods that they had customized to their local situations. For example, managers on the Kootenai National Forest had developed spreadsheets for costing out different alternatives and identifying make-or-break thresholds. Even so, most respondents expressed the need for an easy-to-use, locally tailored approach to the complexities of financial analysis that would help them evaluate multiple alternatives with limited data and time.

Morgan and Brandt, along with their research collaborators at the University of Montana’s College of Forestry and Conservation, developed an annotated bibliography of literature on the economic and financial aspects of biomass utilization. The bibliography also lists analytical tools such as spreadsheets, calculators, and computer models. These tools are potentially useful, but they are not always locally relevant, kept up to date, or packaged such that managers can easily learn and use them. This can be a particular hindrance for offices where economics

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## How Much Biomass Is Out There?

Whether they're going to haul biomass out of the woods or burn it in place, managers engaged in fuels-reduction projects need to know how much material they'll be dealing with. Two JFSP-funded studies are providing knowledge and tools for better in-the-woods estimates of biomass quantity. The first, by David Chojnacky of Virginia Tech and Jennifer Jenkins of the University of Vermont, will synthesize the literature on methods for calculating biomass in trees and shrubs (Project No. 07-3-1-05). The study builds on work the researchers conducted in 2003–2004 on individual-tree biomass equations. The authors will assemble the equations into an easily searchable database. They will also conduct a meta-analysis to develop generalized equations for various species groups. The final report is expected in December 2009.

In the second study, researchers Clinton S. Wright and Robert E. Vihnanek of the Forest Service PNW Research Station have analyzed hand-built piles of various kinds of vegetation and developed equations for estimating the quantity of biomass contained in these piles (Project No. 07-2-1-57). Most previous work has been on estimating biomass quantity in machine-built piles. Because these are different in character, estimating methods developed for them don't lend themselves well to hand-built piles. Results of the project allow managers to assess hand-piled biomass more precisely, helping them to better predict smoke output and thus to schedule burns at the most favorable times. Findings will be incorporated into the widely used fuel and fire management software CONSUME 3.0.



Dalia Abbas

Habitat restoration project on the Francis Marion National Forest in South Carolina.



Dennis Becker

Fuels-reduction thinning on BLM lands in southern Oregon, part of a short-term stewardship contract.

experts are not available and analyses must be conducted by people trained in other areas.

And even the best analytical tools will not change hard market realities. The fact remains that, in most places, biomass is a low-value material, and making it pay is not easy. "It is particularly not easy," Morgan says, "if little or no existing forest products infrastructure is available locally," a situation that is widespread throughout the West as federal management priorities have shifted and mills have closed for lack of federal timber.

Morgan observed the same thing Evans and Becker did: that the most successful projects included merchantable trees to cover the cost of extracting the biomass. Revenues had to be carefully balanced with costs, and local infrastructure was needed to conduct the work and process the material removed. "Just throwing in timber without an awareness of the original cost components and the timber market can make a bad project even worse," says Morgan. It could also make the project more vulnerable to environmental challenge.



## The promise—again

Sometimes the stars do line up. The markets are there, the community is willing, the prices are right, and good things happen—although it generally takes a lot of effort. The new biomass-fired heating/cooling system in Idaho's Council School District is a case in point.

The town of Council, population 800, had been in a slump since Boise Cascade closed its sawmill in the late 1990s. The school district's heating system, consisting of a 50-year-old diesel boiler and radiant electric heat, was costing as much as \$10,000 a month to heat space for about 300 students and teachers. School officials looked into the Forest Service's

program, Fuels for Schools and Beyond, which started in the Bitterroot Valley of Montana in 2001. (It was inspired by the first Fuels for Schools project in Vermont in 1986; today one in five Vermont public school students attends a wood-heated school.)

The Council school officials thought hard about their options. A modern diesel boiler would have been cheaper initially than a biomass boiler, but ongoing fuel costs would be very expensive. A biomass system would cost almost \$3 million to set up, but there was plenty of wood in the surrounding Payette National Forest to feed it for years to come.

A \$510,000 grant from Fuels for Schools kick-started the campaign. After intensive outreach and public education, the community approved a \$2



Results of a fuels-reduction thinning project on the Deschutes National Forest in central Oregon.

## Lessons Learned

Here are some insights on biomass utilization from the work of Becker, Evans, and Morgan. (For full information with all the nuances, please consult the reports listed in Suggested Reading.)

- The most effective biomass projects combine multiple objectives—reducing fuels, restoring ecological functioning and wildlife habitat, improving forest stands, and enhancing rural economies. Projects need to be designed to fit the biophysical and social context.
- Uncertainty of supply from federal forests presents a chicken-and-egg conundrum that is real and must be addressed, yet environmental appeals and lawsuits are less of a constraint in some regions or areas than many people think.
- Collaboration is a key element in successful projects; therefore, community capacity is very important.
- Biomass removal can provide substantial ecological benefits by helping to reestablish presettlement fire regimes, but the environmental impacts of removing biomass from the forest's ecological cycle need more study.
- Biomass removal seldom yields income by itself, but it can be profitable when appropriately combined with other forest operations, such as commercial timber harvests. Appropriate mechanization can make biomass harvesting more cost-effective.
- Agency budgets seldom cover the cost of all needed fuel reductions, and there may also be administrative barriers to funding these projects—for example, constraints on using firefighting dollars for fuel reduction. Subsidies may be needed, and targeted state and local policies may also be useful.
- Project planners should think their way through the supply chain, and if there are gaps, find ways to fill them. They should focus on what will make their projects ecologically sustainable, financially viable, and physically doable.
- Project planners should start small and be prepared to scale up.



Wood-shavings warehouse for JTS Animal bedding in Redmond, Oregon.

Dalia Abbas

million bond on the second try (the first failed by 10 votes). The new heating/cooling system went operational at the beginning of the 2005 school year.

Fuels for Schools embodies the promise of biomass utilization—a promise more likely to be realized as researchers like Evans, Becker, and Morgan deepen policymakers' understanding of the obstacles and opportunities of biomass.

“There’s been quite a lot of progress, but there are still significant challenges.” In the meantime, the lessons learned by the early adopters have made the learning curve a little easier for the next generation. “The process is evolving in all its aspects,” says Zander Evans. Markets are expanding as new uses are being perfected. Technology is adapting to use smaller material. More land managers and communities are trying to restore fire-adapted ecosystems. New administrative and regulatory options are available. Collaborative partnerships are more common.

As forest fuels continue to build, as petroleum prices climb, and as rural communities continue to languish, the pressure to solve those challenges is increasingly urgent. Researchers like Becker, Evans, and Morgan would like to see biomass evolve to a broader level, capturing the economies of scale that would give it the muscle to be a real, home-grown contender in the global energy arena—and maybe solve a few other problems, too.

## Suggested Reading

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These shavings, often used for horse bedding, are produced from sawmill waste in Redmond, Oregon.

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