Forest Sustainability in the Development of Wood Bioenergy in the U.S.

Pinchot Institute for Conservation

The Heinz Center

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The H. John Heinz III Center For Science, Economics and the Environment

The Pinchot Institute for Conservation
Leadership in Conservation Thought, Policy and Action

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The mission of the Pinchot Institute is to advance conservation and sustainable natural resource management by developing innovative, practical, and broadly-supported solutions to conservation challenges and opportunities. We accomplish this through nonpartisan research, education and technical assistance on key issues influencing the future of conservation and sustainable natural resource management.

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Executive Summary

With the development of renewable energy sources to meet the challenges of energy security and climate change, wood bioenergy and biofuels have the potential to become a much larger part of the nation's energy future. There is concern that efforts to expand the production and use of this energy source could have unintended environmental and economic consequences for forests in several regions of the United States. However, there are policy options at the federal, state, and local levels, as well as opportunities, that can minimize the sustainability risks related to the development of a wood bioenergy industry.

Over the past year, the Pinchot Institute for Conservation and the H. John Heinz III Center for Science, Economics and the Environment convened a national policy dialogue on ensuring forest sustainability in the development of wood bioenergy in the United States. This dialogue brought together a highly knowledgeable group of individuals and organizations representing the forest and energy sectors, as well as state, local, and tribal government, conservation organizations, and academia.

Key issues addressed in the dialogue were:

- **Biomass supply estimates:** The need for reliable and accurate methods for assessing the available and sustainable supply of wood biomass — nationally, regionally, and locally — to serve as a basis for informed decisions by energy companies and local communities to site new or expanded wood bioenergy or biofuel facilities.
- **Sustainability standards:** The need for adequate environmental safeguards to address the more intensive type of wood harvesting that is done for energy purposes, through state forest practices policies, through non-governmental sustainability certification programs, and through responsible sourcing policies by energy companies.
- **Range of biomass energy options:** The need for decision makers and stakeholders to consider the full range of wood bioenergy and biofuels options before facility citing decisions are made, including factors such as scale, distribution, and efficient utilization of wood biomass as they relate to local environmental, social, and economic circumstances.
- **Federal and state policy alignment:** The need to align federal and state policies with the appropriate financial incentives, tax credits, and targets for renewable energy production and with existing policies aimed at ensuring the sustainable management of both public and private forests. In addition, specific issues related to federal forests were discussed at length at two of the regional workshops.

The dialogue included a series of five workshops, a national workshop in February 2009 and subsequent regional workshops in the South, Great Lakes, Interior West, and on the Pacific Coast. Participants brought their firsthand knowledge and experiences to this open and transparent forum with the expectation that their participation would help to identify critical issues and assist in the development of policy mechanisms to ensure the long-term sustainability of forests as the bioeconomy develops.

Background

Recent and proposed national policies aimed at increasing renewable energy production to promote energy security and mitigate climate change could have important economic and environmental sustainability impacts for key forest regions in the United States. These issues were first explored in depth at a conference convened by the Pinchot Institute in 2007 (www.pinchot.org/bioenergy). Preliminary studies from the Department of Energy (DOE), the Department of Agriculture (USDA), and the Environmental Protection Agency (EPA) indicated that as much as a billion tons of biomass would be required annually in order to meet the Renewable Fuel Standard (RFS) targets for production of cellulosic ethanol and other advanced biofuels established in the Energy Independence and Security Act of 2007.

More than 30 states have already enacted mandatory or voluntary goals roughly centered on a goal of 25 percent renewable electricity by 2025 (25 x '25). These targets and timetables vary by state with California's goal of 30 percent by 2020 among the most ambitious. In addition, Congress is considering a Renewable Electricity Standard (RES) that would require electric power producers to achieve a target of 20 percent of their electricity from renewable sources such as energy efficiency, solar, wind, geothermal, and renewable biomass by 2020.[1] While some states have ample opportunities to develop wind, solar, and geothermal, others must rely to a greater degree on biomass. Much of this need can be fulfilled by forest and agricultural residues, energy crops, and urban wood waste, but it could also require as much as a doubling of roundwood production, raising concerns about potential impacts on forests that are most likely to become apparent when the upper bounds of renewable electricity mandates are reached (e.g., going from 10 percent to 20 percent).

[1]In H.R. 2454, commonly referred to as "Waxman-Markey," up to 8 percent of the 20 percent renewable energy production requirement could come from renewable efficiency upgrades and not necessarily new renewable electricity production. Still, more than 30 states have RPS mandates that require new renewable electricity production.

Views of biomass energy development vary widely across the country. Regions differ significantly in their concerns about biomass energy, their approaches to sustainability, and the policy instruments used to achieve desired outcomes. Several state governments have developed additional regulations or guidelines to address concerns about the effects of biomass harvesting on soil productivity, water quality, wildlife habitat, biodiversity, and other values. There are concerns in communities where traditional forest products manufacturing represent an important part of the local economy, especially in the South and the Great Lakes region, that a major expansion of wood biomass energy facilities could cause disruptions to existing wood-based industries, with significant impacts on local income and employment. Long-term supply issues will be an important consideration. The operational life of a bioenergy facility may be 30 years or more, so decisions made today will affect their region's communities and forests for many decades into the future.

Timber harvesting, especially on public lands, has been a focus of major legal and policy controversy in the U.S. for most of the last half-century. Public concerns over wildlife habitat, water quality, wilderness, and endangered species have put federal lands largely off-limits to commercial timber harvesting, and have become an important factor influencing the management of private forests as well. While federal and state natural resource agencies and the forest products industry are well acquainted with these public concerns, the energy industry generally is not. Their primary concern has been securing enough biomass fuel to furnish bioenergy facilities and meeting a complex array of regulatory requirements. With the energy industry poised to become a large consumer of wood, understanding and proactively addressing potential issues of forest sustainability will help to avoid a repeat of prior controversies.

Key Findings and Recommendations

Finding 1: There is concern over the potential effects on forests from meeting existing and proposed mandates for bioenergy and biofuels that could potentially require more than doubling the current level of wood harvesting in the U.S. Improved estimates of biomass supply and better state and local government coordination are essential to avoid future issues of forest sustainability.

Ambitious renewable energy goals and timetables in federal and state policy, in combination with powerful financial incentives that are available for a limited time, can result in many simultaneous decisions to increase the capacity for wood bioenergy and biofuels production. Several new facilities in close proximity to one another can collectively create a level of wood demand that cannot be sustainably supplied locally. Similarly, wood bioenergy facilities located close to existing wood products manufacturing facilities can create high local wood demand, put upward pressure on wood prices, and have adverse effects on local industry, employment, and community economic stability. In addition, lack of adequate supply could lead to the intensification of biomass production in regions, like the Southeast, that have significant amounts of plantation forestry. Such an intensification of production may include improved genetic stock, increased fertilization of vegetation, and conversion of natural forests to plantations and energy crops. However, a more direct concern expressed throughout the dialogue was that price competition associated with lack of supply could lead to displacement of other wood-using industries.

Federal and state agencies currently provide periodic forest inventories estimating the overall amount of biomass in the nation's forests. However, estimating how much of the forest biomass is truly economically available, accessible, and can be sustainably supplied over a period of many years is difficult. Participants acknowledged that national and regional estimates are not sufficient as a guide to energy companies and local governments assessing the feasibility of potential new bioenergy or biofuel plants. Project-specific estimates are needed, considering a variety of local factors (land ownership patterns, transportation infrastructure, existing and future wood using industries, and the ability to access potential supply from federal lands) that could influence actual biomass availability and cost over the operational life of a planned facility. Such estimates will also need to be linked with an evaluation of different energy conversion options to determine which technologies are best suited to utilize biomass supply that may be sustainably sourced over the long-term.

Several regional discussions pointed to the need for an independent evaluation of the effects that the existing RFS, the proposed RES, and state Renewable Portfolio Standard (RPS) programs could have on other industries, commodity markets, conservation values, and environmental quality. It was suggested that the National Academy of Sciences may be an appropriate entity to perform such a study.

Recommendations:

- Assist state and local governments in the development of localized biomass supply/demand estimates and facilitate the appropriate dissemination of this information to developers of proposed biomass energy sites.
- Assist state governments in developing assessments of current and projected wood biomass supply/demand and the effects of wood biomass harvesting as part of the existing federal requirements for periodic State Forest Resource Assessments.
- Facilitate state government coordination at the regional level to identify and ameliorate knowledge gaps that pertain to biomass removal thresholds and other techniques intended to maintain ecosystem service values in state/eco-regional biomass harvesting guidelines.
- Promote cooperation between private forestry consultants and the bioenergy industry to allow for more accurate site-specific assessments for private forest landowners.

- Provide guidance on the amount of biomass available from hazardous fuel treatments on federal lands as well as areas that are "off-limits" due to sustainability concerns.
- Provide consistent models of project-level due diligence for energy developers unfamiliar with forest statistics and biomass supply estimation methodologies.
- Place research into sustainable bioenergy systems and regional bioeconomy development on par with technology research by supporting region-specific participatory research programs that involve state and local governments, energy and forest products companies, and others.

Finding 2: Standards are needed to ensure sustainable wood biomass harvesting practices.

There was close to universal agreement among participants that lands should be managed in a sustainable manner that maintains their biodiversity, productivity, and regeneration capacity, protects watersheds, and meets future societal needs, although opinions varied on how this may best be achieved. There was recognition that sustainability should also be addressed at the landscape level. Biomass harvesting can be more intensive than conventional harvests, and include the removal of tops and limbs that would usually be left on the forest floor following a typical harvest. This can result in unintended consequences for soil fertility, water quality, wildlife habitat, and biodiversity. Most states have enacted standards and guidelines for timber harvesting and reforestation following harvests, but many of these standards are voluntary and did not anticipate the extensive use of forests for energy, or the more intensive types of harvesting regimes.

Additional research is being done on the effects of wood biomass harvesting, and several state governments have taken steps to supplement their existing forest practice regulations with additional standards for wood biomass harvesting. Other states may recognize the need to review and update their forest practice standards and harvesting guidelines, but lack the resources to do so. Moreover, states may be hesitant to adopt safeguards in the absence of scientific certainty regarding the risks of biomass removal and the benefits of biomass retention.

Adequate safeguards to ensure sustainable forest management and biomass harvesting play a key role in providing public assurance and avoiding the kinds of public controversies that have characterized forest management in the U.S. Adherence to these safeguards has been essential for public forestry agencies and forest products companies to maintain their "social license" through their compliance with forest practice regulations, participating in independent third-party certification programs, and adopting responsible sourcing policies. These are largely new concepts to energy companies. A demonstrated commitment by bioenergy and biofuels companies to responsible sourcing will be essential for the long-term sustainability of the wood bioenergy business.

Recommendations:

- Develop flexible policies that incorporate robust science-based standards with certain baseline protections that delineate measurable criteria. This would apply to: state biomass harvesting guidelines, forest restoration policies, revised best management practices that integrate biomass removal standards, and third-party forest certification and/or forest management plans prepared by a licensed professional forester.
- Encourage the collaboration of state governments in the development and monitoring of science-based biomass harvesting guidelines at the state and/or eco-regional level.
- Increase investments in research on biomass sustainability and the potential environmental, economic, and social impacts of biomass harvesting.
- Ensure that legislation to improve the economics of the biomass supply chain integrates science-based biomass production and harvesting standards.

Finding 3: Policies to define the role of federal forests in biomass supply are inconsistent. Clear policy direction is essential in developing guidelines to ensure continued conservation and sustainable use of these public lands.

A significant area of federal forest land is at high risk of large-scale wildfire or insect/pest diseases. Ecosystem restoration treatments reduce hazardous fuel loads in forests and limit damage from insect infestations or disease, but tend to be costly. The net cost of the treatments could be reduced if the biomass were utilized for energy purposes by appropriately scaled local facilities.

Participants expressed concern that a new wood bioenergy industry geared to the volume of biomass from the current backlog of forest restoration activities might not be sustainable over the long-term once the backlog has been addressed. This could result in significant economic and social dislocation in local communities and pressure on federal agencies to supply more wood than ecosystem restoration objectives would otherwise require. Federal forest planning has been an area of controversy and there remains intense interest in ensuring that federal harvest activities are acceptable to a broad range of stakeholders. For bioenergy facilities of even modest scale to be developed, capital investment requires reasonable certainty of feedstock supplies, typically over at least a 20-year period. While federal land management agencies have been granted statutory authority for entering into multi-year contracts for accomplishing forest stewardship objectives, federal acquisition regulations make this infeasible for multi-year supply agreements that involve substantial private investments in biomass utilization infrastructure.

Recommendations:

- Encourage the development of a uniform legislative definition of renewable biomass.
- Develop standards for biomass harvesting in connection with ecosystem restoration treatments, especially for areas of unique conservation value or high environmental sensitivity.
- Provide federal land management agencies flexibility to waive contract cancellation ceilings for multi-year stewardship contracts for biomass removal associated with ecosystem restoration projects, or pool funds to form a contract cancellation ceiling reserve pool at the national level.
- Enable collaborative planning and multi-party monitoring in which community, business, and environmental considerations are addressed in an open, transparent, and inclusive process, creating the "social license" for timely implementation of forest management projects.

Finding 4: Federal and state policies do not adequately recognize the full range of wood biofuel and bioenergy options, especially options that have been shown to offer greater energy efficiency and be better suited to local availability of biomass supplies.

Somewhat unique among renewable energy resources, biomass can readily contribute to all three of the major energy sectors: transportation fuel, electricity, and heating and cooling. Energy policy currently focuses on electricity and biofuels but not on thermal energy, which currently represents roughly one-third of domestic energy use. There are also significant R&D investments and strong incentives for renewable transportation fuels. Many locations are particularly well-suited to biomass utilization options, such as combined heat and power (CHP, cogeneration), and direct thermal technologies, such as "Fuels for Schools," due to their lower biomass demands and local resource availability. In general, these technologies are 3-4 times more efficient users of biomass than electricity-only facilities, which release half of their energy as waste heat. Large electric power plants tend to generate local opposition due to their environmental impacts, but also can distribute large quantities of electricity more efficiently than smaller scale CHP or thermal energy facilities.

Recommendations:

- Develop renewable energy policies that recognize and incentivize renewable biomass energy options for heating and cooling (thermal energy).
- In crafting subsidies and various financial incentives, attention should be given to those technologies that provide high levels of efficiency.
- Consider policies that support distributed and "appropriately scaled" approaches that may provide socio-economic benefits such as employment in natural-resource-based industries and provide high levels of efficiency.

Conclusion

Expanding the use of renewable energy and facilitating the sustainable management of the nation's forest resources are both important public policy goals. With thoughtful planning and foresight, there is a path forward where these goals can be mutually supportive. The potential development of a forest bioeconomy must be guided by informed and insightful policies that encourage innovation in the efficient use of this renewable, but limited, resource. The recommendations above can help facilitate a diversity of different types, scales, and locations of biofuels and bioenergy facilities that are well-matched to socio-economic goals for local community development and that are grounded in a continued commitment to the conservation and sustainable management of forests for the full range of values and services they represent.

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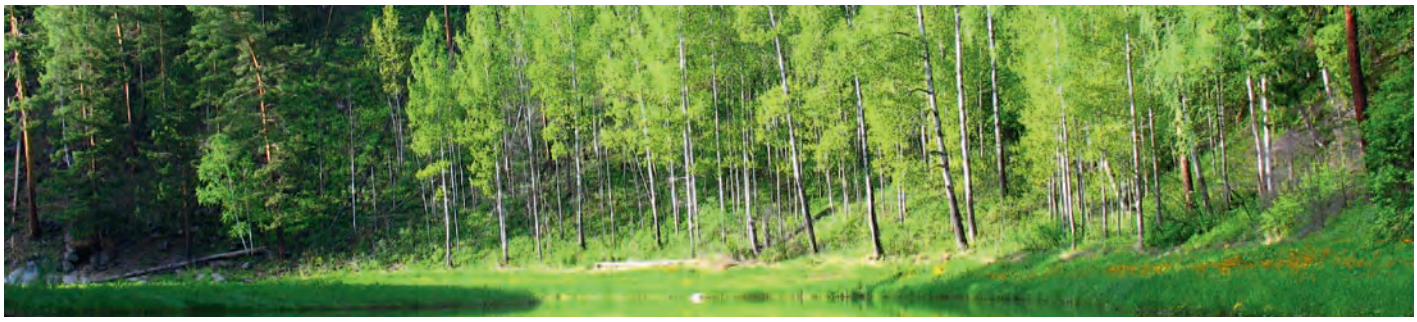


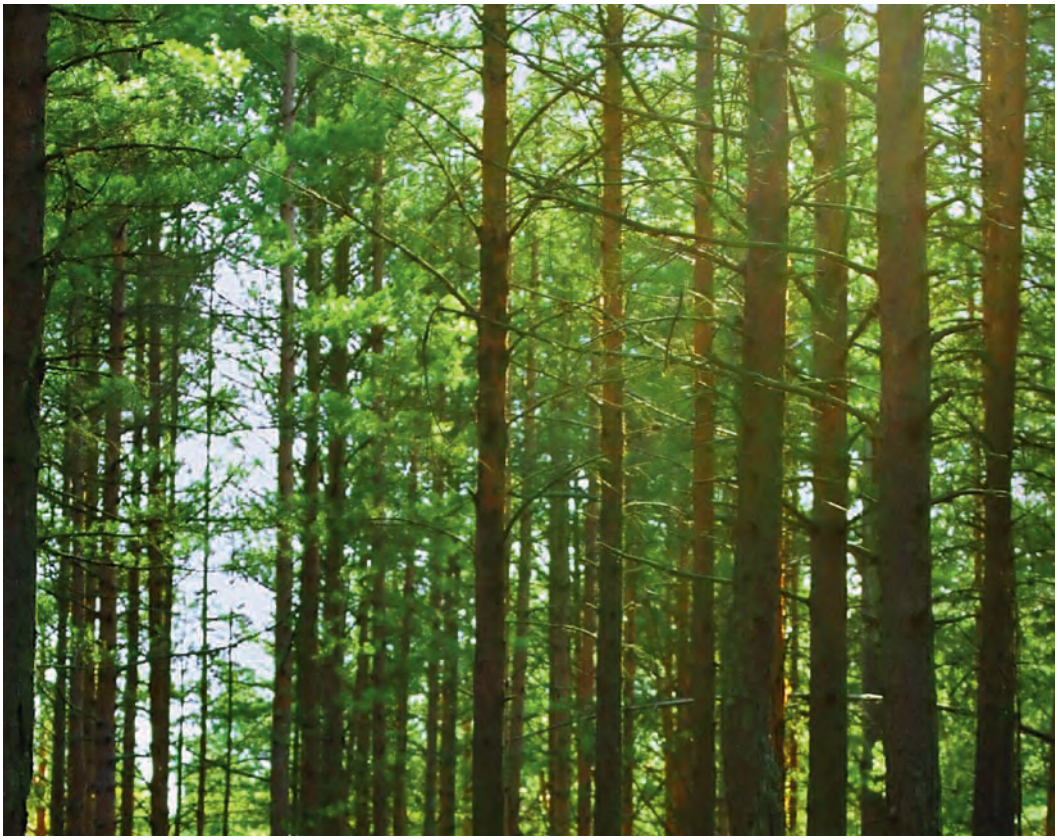
Introduction

The interlocked challenges of energy security and climate change continue to reveal complex dilemmas for decision makers. For those concerned with the conservation of natural resources, these dilemmas increasingly involve decisions that will impact our relationship with forest ecosystems. Expanding efforts to develop a low-carbon economy, based in large part on the production of renewable energy, as well as new markets that value the ecosystems services provided by forests, have led to a novel confluence of climate, energy, and forest policy. To date, energy policies in the form of mandated renewable energy production goals and financial incentive programs have garnered the bulk of policymakers' attention, with forest policy only tangentially considered. We have arrived at a point where issues of energy and climate are now largely steering public policy on the management of forest resources. The energy and forest sectors are moving closer together, which presents new opportunities for forests to provide yet another set of values to the public, but also increase chances for misunderstanding and renewed controversy over forest management. While it is clear that clean and renewable energy production will continue to see a significant amount of public and private investment over the coming decades, what remains less clear are the short- and long-term implications that this evolving paradigm will have for forests.

Society faces decisions today about which approaches to renewable energy production will be most sustainable across the landscape and provide the highest net benefit. Existing policies call for large commitments to energy infrastructure being constructed within this decade. For bioenergy options, the operational life of most commercial-scale facilities may be 30 years or more, so the decisions made today will shape what opportunities can be pursued in the future. Biomass is somewhat unique among renewable energy options in its ability to provide renewable forms of energy across the entire spectrum of our energy demands. One consequence of this flexibility is that the multiple policies in play have created a situation in which the same limited biomass supply is expected to contribute to multiple energy goals. Moreover, other policies call for these same forests to sequester more carbon from the atmosphere, continue to provide other ecosystem services, and remain an integral part of the existing wood products industry. Clearly the evolving realm of renewable energy is extremely dynamic, and the role that forest-biomass will play remains uncertain in both policy and practice.

It was with an acknowledgement of these uncertainties and an appreciation for the complexities of the energy-climate-forest policy nexus that the Pinchot Institute for Conservation and the H. John Heinz III Center for Science, Economics and the Environment undertook a yearlong policy dialogue on the potential development of forest-based bioenergy in the United States. This multi-sector dialogue involved over 280 stakeholders and experts actively engaged in North America's rapidly developing bioenergy industry. These participants represented federal and state agencies, local and tribal governments, energy and forest products companies, conservation organizations, and universities. Each contributed their first hand knowledge and experiences to this policy dialogue under the premise that their participation would help lead to policy solutions that would ensure the long-term sustainability of forest-based bioenergy in the North America. More than 30 of these individuals also contributed information and results from their own analyses, and this information has been compiled by the Pinchot Institute as an on-line public resource that is available at www.pinchot.org/bioenergy_paper.

The core of the dialogue consisted of five workshops held at locations around the U.S. (see the Appendix for specific dates and locations). The Pinchot Institute and the Heinz Center first convened a national policy workshop held in Washington, D.C. in February 2009. This was followed by a series of workshops in four major forest regions of the U.S., hosted by various universities. These workshops were meant to identify common goals and objectives for environmentally sustainable development of a wood biofuels/bioenergy industry in the U.S.; develop the basis for consistent and reliable estimates of sustainable wood biomass supply; and review regional and state efforts to develop safeguards for sustainable wood biomass production and harvesting. The results of each of these workshops are reflected in this report, and in the more detailed proceedings from each workshop which can be found at the Pinchot Institute and Heinz Center project websites (see http://www.pinchot.org/gp/RegionalMeetings and http://www.heinzctr.org/forestbioenergy/index.shtml).



The Rising Importance of Biomass Energy

National biomass supply projections and energy policy goals

When it comes to sustaining a planned bioenergy project, the most critical piece of information is a realistic estimate of the wood biomass supply that is available and sustainable within a feasible transportation distance of the proposed facility. Ensuring the environmental and social sustainability of planned bioenergy projects is also a key aspect of—and is directly linked to—ensuring that projects will be economically sustainable. Overestimates of local supply can mislead energy companies into decisions to site facilities that are too large, too numerous, or simply too close in proximity to one another or existing facilities already consuming significant amounts of wood fiber. This can lead to pressure to overharvest locally available resources in the short term. In the longer term, as local demand exceeds local supply and securing adequate feedstocks becomes more costly, some of these facilities are likely to become financially unviable, leading to disruptions in income and employment in local economies. These kinds of setbacks for energy companies and their investors can result in a reluctance to invest in other renewable energy facilities in the future. On the other hand, macroeconomic changes within the pulp and paper and solid wood products industries throughout North America present what may appear to be the potential for an increasingly available wood supply for new wood users.

In response to policy goals and financial incentive programs, numerous new projects for wood bioenergy, biofuels, and wood pellets have been announced recently, some of them close enough to one another that the areas from which they plan to draw their wood biomass feedstocks are overlapping. In some locations, a significant portion of the net annual growth of wood biomass is already being utilized by existing wood-using industries. Occasionally, biomass supply estimates by energy companies focus not on net growth, but on the total volume of forest inventory, perhaps because they are more accustomed to considering nonrenewable fuel resources such as coal. A core precept in forest management is limiting harvesting to a level that can be sustained in perpetuity, rather than drawing down a resource over a fixed period of time to the point at which it is exhausted.

While biomass supply studies and environmental review policies are the most important aspects of ensuring the sustainability of proposed individual facilities, having adequate estimates of biomass supply at the regional and national scales is essential for policymakers grappling with complex public policy decisions. With this in mind, the Pinchot Institute assessed the adequacy of the nation's biomass supply—as projected by several Department of Energy (DOE) and Department of Agriculture (USDA) studies—to meet current and potential goals for both biofuels and renewable electricity. The results of this analysis, which are summarized below, were presented at the beginning of each regional workshop of the policy dialogue, as were other analyses of regional biomass availability.

DOE/USDA "billion ton study"

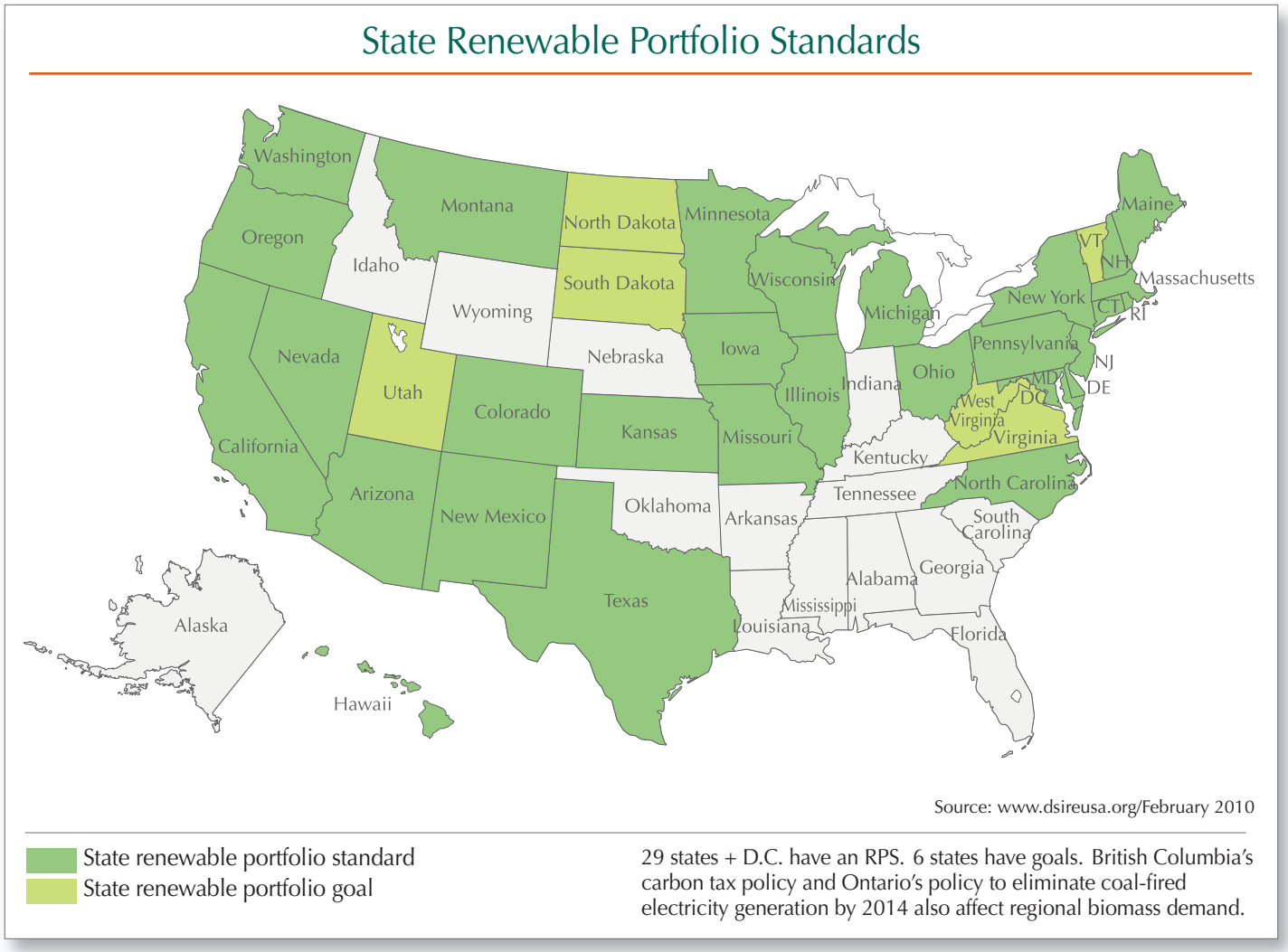
Because of somewhat different motivations and policy objectives, the energy sector itself is fragmented in its approach to forest resources. The primary motivation of policy initiatives to expand domestic production of renewable biofuels has been to decrease the dependency of the U.S. transportation sector on imported fossil fuels. The pressing need to find substitutes for transportation fuels derived from imported petroleum was the basis for a 2004 Congressional request to the DOE to assess the feasibility of supplying up to 30 percent of the nation's transportation fuel needs with biofuels by 2030. The study, undertaken in cooperation with the USDA and the Environmental Protection Agency (EPA) (Perlack et al. 2005) found that roughly 1.3 billion dry tons of biomass could be supplied annually, including 368 million tons from wood biomass in various forms (e.g., logging residues, mill residues, hazardous fuel treatments).

Each biomass source has different prospects for expansion based on current utilization and price (see discussion below). The wood biomass portion of the "billion ton study" took into account that there are large areas of U.S. forest land that would be uneconomic to harvest, or that have been legislatively or administratively placed off-limits to timber harvesting (e.g., national parks, wilderness areas, and inventoried roadless areas). These results suggested that there are ample supplies of biomass available in the U.S. to meet a domestic biofuels production goal of 30 percent of transportation fuels.

One of the things not taken into account in the 2005 "billion ton study" is that there is rapidly increasing demand for wood biomass for renewable electricity production. Nearly two-thirds of the states have now enacted a Renewable Portfolio Standard (RPS), calling for electric power producers to generate some significant portion of their electricity from renewable sources. There is significant variation in these policies in terms of both their production levels and timetables, but many state RPS policies coalesce around the concept of increasing the renewable share of state electricity production to 25 percent by 2025.

While some states have opportunities to satisfy a significant portion of their RPS from wind, solar, or geothermal energy, others will have to rely heavily on biomass from agriculture and forests. The biomass that is necessary to meet RPS goals for renewable electricity production must come from the same resources that the "billion ton study" assumed would be available for renewable biofuels production through the Renewable Fuel

Figure 1.



Standard (RFS).[2] What would be the combined effect on forests from achieving both renewable electricity and renewable transportation fuel goals?

Answering this question was the purpose of a 2007 study conducted by DOE that examined the potential environmental and economic effects of *simultaneously* implementing both a nationwide 25 x'25 Renewable Electricity Standard (RES)[3] and a 25 percent RFS by the year 2025 (EIA 2007b). While this is not the precise combination of policy goals that exists today,[4] such a combination of goals represents the upper bound of what has been considered by policymakers. The DOE's results indicate that the wood biomass needed to achieve such a combination of goals would require more than doubling the current level of wood harvesting in the U.S. The report suggested that the additional competition for wood could have a significant effect on existing wood-using industries in the U.S., due to increases in raw material prices and local shortages. Environmental effects would include potential impacts on soil and water resources, biodiversity, and other values.

[2] The biomass volumes in the DOE analysis did not reflect subsequent legislative restrictions (i.e., the federal definition of "renewable biomass").

[3] Legislation introduced in the U.S. Congress (H.R. 2454) would call for a 20 x '20 RES that is the functional equivalent of the production timeline of 25 x'25, while not requiring the same ultimate level of renewable energy production.

[4] The DOE study found that producing 25 percent of the nation's transportation fuels by 2025 would require the production of 61 billion gallons of ethanol, 28 billion gallons of which would be cellulosic ethanol (EIA 2007b). These levels are significantly higher than the goals in the RFS established by 2007 Energy Independence and Security Act (EISA), which called for 36 billion gallons of ethanol production by 2022, with 21 billion gallons of this coming from advanced biofuels such as cellulosic ethanol. In terms of electricity production, many, but not all, state RPS standards are currently at or above a 25 percent mandated production level. A national level RES is being considered, for which the latest proposal (H.R. 2454) would require that anywhere between 12 and 20 percent of electricity produced nationwide would be from renewable sources by 2020.

Availability of biomass from forests and agricultural sources

Increased competition for feedstocks is expected to push up the price of energy from all sources, including agricultural sources of biomass energy. Based on biomass supply curves developed by DOE using the National Energy Modeling System, supplies of agricultural and forest residues would increase steadily in response to higher prices. But once wholesale energy prices exceed roughly $5.00 per million BTU (2003 dollars), most of these biomass sources will have reached a maximum level of output, determined largely by limited land availability (Haq 2006). The supply of agricultural residues levels out at roughly 127 million dry tons per year, energy crops at 173 million dry tons/yr, urban wood waste at 29 million dry tons/yr, and forestry residues at 162 million dry tons/yr. Thus, the maximum total biomass available from these sources is projected to be approximately 491 million dry tons/yr in 2025 (see Figure 2). Assuming a moisture content of 10 percent for agricultural residues and energy crops, and 50 percent for forestry residues and urban wood waste, this translates to a maximum of roughly 715 million green tons of biomass from these resources being available on an annual basis in 2025, leaving a significant gap between the biomass that is available from these sources and the 1,302 million green tons needed to achieve a dual 25 x'25 goal. It is worth noting that the DOE analysis also assumes a significant increase in energy crop production between 2007 and 2025, much of which would occur on marginal and highly erodible agricultural lands currently enrolled in the USDA's Conservation Reserve Program.

Wood biofuels

Although it varies by technology pathway, it takes approximately two green tons of wood biomass to produce 86 gallons of cellulosic ethanol. A cellulosic ethanol plant producing 50 million gallons/year requires approximately 1.2 million green tons of wood biomass annually. In the near term, a significant portion of the supply for plants such as this is expected to come from wood waste and residues, but as capacity increases, a greater proportion of the wood biomass for biofuels production must come from roundwood harvested for this purpose (Barmore 2009). At a forest stocking rate of 1,322 cubic feet of growing stock per acre, which is typical of forests in the U.S. South (Smith et al. 2004) where many of these plants would likely locate, this would require clearing the equivalent of an average of 28,000 acres of forest each year to supply each plant of this size. To supply this amount of wood on a sustainable basis (i.e., harvesting only the annual net growth) would require approximately 630,000 acres of timberland in the South, where net annual growth averages about 57 cubic feet per acre (Smith et al. 2004). Sustainably supplying a similar plant in the North (Northeast and Lake States), where net annual growth averages only 34 cubic feet per acre, would require a timberland base of more than 1 million acres.

Wood bioenergy

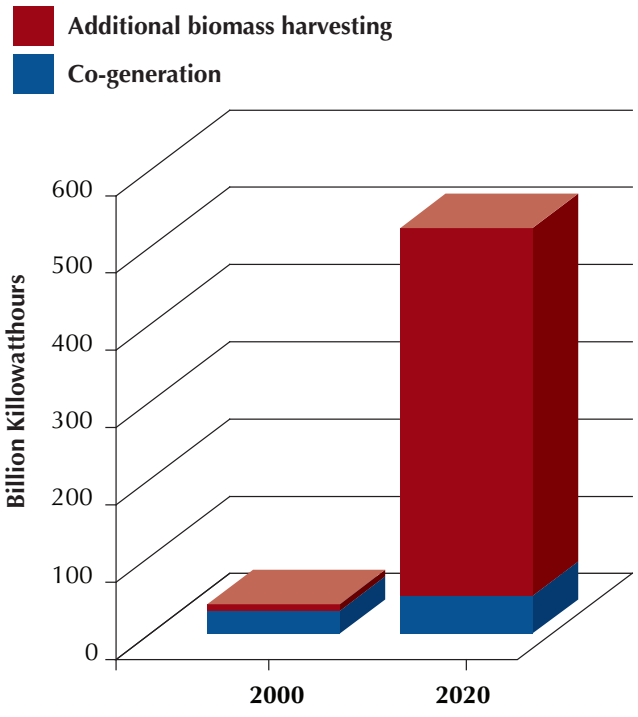
Electric power generation from wood biomass is expected to result in greater increases in demand on forests than biofuels. Under the 25 x'25 scenario, DOE projects that both wind and biomass

Figure 2. Biomass utilization under a combined 25% RFS and RES, by 2025

[Millions]	2007 Actual Dry Tons[1]	2025 Projected Dry Tons[2]	2025 Projected Green Tons[3]
Agricultural residues		127	141
Urban wood waste	8	29	58
Forest residues	47	162	324
Energy crops		173	192
Subtotal:	55	491	715
Roundwood	35		587
Total:	**90**	**491**	**1302**

[1] EIA 2008. Electricity Net Generation from Renewable Energy.
[2] Haq, Z. 2006. Introduction to Biomass. Energy Information Administration.
[3] Average moisture content 10% for agricultural residues, energy crops; 50% for forest forest residues, urban wood waste.

Figure 3. Electricity generation from biomass with 20% renewable electric standard



Source: EIA. 2003. Biomass for Electricity Generation. Energy Information Administration, U.S. Department of Energy, Washington, D.C.

power capacity may increase tenfold from current levels. Electric power generation from biomass is expected to rise to 495 billion kilowatthours from the current 55 billion kilowatthours (EIA 2007b).

In 2007, renewable energy from all sources accounted for 8.4 percent (351 billion kilowatthours) of total electricity production nationally (EIA 2008a). Of this, electricity from wood accounted for 38.5 billion kilowatthours or 11 percent. Most of the electricity currently generated from wood biomass, about 76 percent, is from industrial cogeneration, and most of that (94 percent) is generated and used by the pulp and paper industry (EIA 2008b). Since this power is generated as a byproduct, the wood biomass that is utilized results in no increase in the volume of wood harvested. Much of the remaining 24 percent of electricity generated from wood biomass is generated from wood residues and waste products such as sawdust, planer shavings, slabs, and edgings from lumber production. So the area of forest land currently harvested specifically to provide wood for energy is negligible.

This picture would be expected to change significantly under a mandatory 25 x'25 goal. As the amount of electricity generated from renewable sources increases toward this goal, a greater proportion is expected to be generated from wood and other biomass (EIA 2001). However, if the development of wind, solar, geothermal, and other renewables occur differently than projected by DOE, biomass demand for electricity production could be considerably different. Biomass demand may also change depending on how biomass is classified in a federal RES and in individual state RPS policies. The DOE projects that the amount of electricity produced through cogeneration is expected to increase by 66 percent by 2020, from 29 billion kilowatthours to 49 billion kilowatthours. While this is a substantial increase it is only a small fraction of the renewable energy that is derived from biomass sources (see Figure 3). The proportion generated from additional harvesting of biomass is projected to increase by a much greater amount, from 8 billion kilowatt hours to more than 475 billion kilowatthours, or nearly 60 times current usage (EIA 2003).

Meeting Combined Goals for Wood Bioenergy and Biofuels

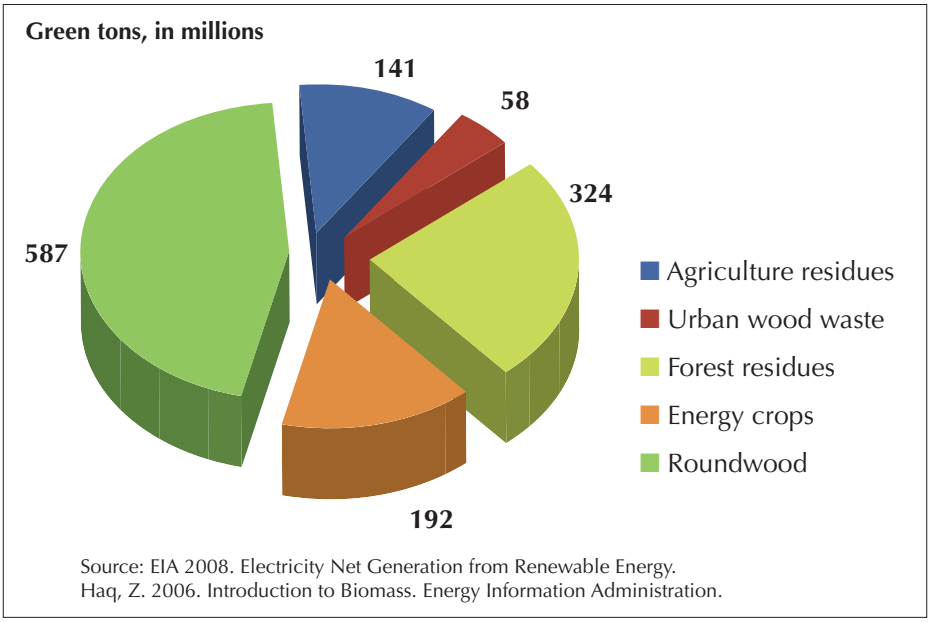
Assuming that a combined 25 x'25 RES and a 25 percent RFS would require 1,302 million green tons of biomass annually (EIA 2007b), and that the combination of energy crops, urban wood waste, and agricultural and forest residues would be able to supply 715 million green tons annually (Haq 2006), the balance of 587 million green tons would be met with additional roundwood harvests (see Figure 4).

Harvesting roundwood is not the lowest cost source of biomass for energy production, but it is the most plentiful. Indeed, some bioenergy facilities, both overseas and domestically, already source a large percentage of their feedstock as roundwood. There are lower-cost sources such as urban wood waste, which is mostly from land clearing for development, but as the demand for renewable fuels increases, virtually all available urban wood waste will be utilized. Mill residuals and logging residues are another lower cost source, but like cogeneration they depend on production levels in traditional wood products industries. Once the limits are reached for these lower cost sources of wood biomass, energy producers would be expected to compete directly with wood-based industries for roundwood. As competition for roundwood increases and prices rise, marginal existing wood-based industries would likely be displaced sometime around 2012, further reducing the supply of residuals and byproducts, and further accelerating the price increase for roundwood (Galik et al. 2009).

The 587 million green tons of roundwood that would be needed based on the dual 25 x'25 scenario translates to a harvest of 17.6 billion cubic feet of roundwood annually.[5] The current net growth of growing stock on all 504 million acres of timberland in the U.S. is estimated at 23.7 billion cubic feet annually (Smith et al. 2004) so just meeting these additional energy requirements would utilize the equivalent of more than 74 percent of net annual growth.

[5] Assumed conversion rates of 1.1 bdT (2.2 gT) of wood required per thousand kilowatthours, and 30 cubic feet of wood per green ton.

Figure 4. Sources of biomass for achieving 25% RFS and RES, by 2025



Source: EIA 2008. Electricity Net Generation from Renewable Energy.
Haq, Z. 2006. Introduction to Biomass. Energy Information Administration.

The annual harvest of roundwood for all wood products over the past two decades has averaged approximately 15.5 billion cubic feet (Smith et al. 2004). Continued wood demand for wood products, when combined with the projected new wood demand for biofuels and bioenergy, would total just over 33 billion cubic feet per year by 2025, more than double recent harvest levels. Some degree of displacement is possible as increased wood prices result in declines in the forest products industry. The demand on forests for a combination of energy and wood products could exceed current net growth by as much as 40 percent.

There are many opportunities to increase forest growth rates between now and 2025, although some of these opportunities remain highly controversial (e.g., genetically modified trees). Whether the potential returns from wood biomass energy will justify the investments that would be necessary to achieve such significant increases in net growth has yet to be determined. Under the most basic definition of sustainable forestry, wood removals must be limited to less than the net growth of the forest itself, but sustainable forest management as we know it today involves more than simply balancing forest growth and removals.

The policy scenario described above illustrates the sheer scale of the new demands that markets for energy could place on the nation's forested landscapes. Energy markets also have the potential to alter the type of harvesting and forestry that is practiced, which has raised questions about the potential for negative impacts to forest ecosystems at the site level. The potential for a substantial increase in wood harvesting, and the manner in which wood biomass for energy is harvested, may have important implications for important forest values such as soil productivity, water quality, wildlife habitat, and biodiversity at both the individual site and landscape levels.

Sustaining Forest Ecosystems While Sustaining Biomass Supplies

In forest ecosystems, the matrix of deadwood that is comprised of standing dead trees (snags) and down woody material (DWM) is an important structural characteristic. This material can range in composition, but usually consists of primary branches, stumps, trunks, tree tops, and whole dead trees with upturned root wads. There are almost always more organisms inhabiting deadwood than live trees. As a major energy source in forest ecosystems, deadwood provides habitat and a food source for many invertebrates (e.g., arthropods, earthworms, and beneficial microbes) and terrestrial vertebrates (e.g., small mammals, amphibians, reptiles, and birds) (Harmon et al. 1986; Hagan and Grove 1999).

In general, managed forests are characterized by smaller quantities of DWM than unmanaged forests. Opportunities for accumulation of new DWM generally decrease as the time period between rotations decreases, and as more intensive harvesting practices (e.g., whole tree harvesting) are adopted (Lonsdale et al. 2008). There is concern that forest biomass harvests will be more intensive than typical harvests and that this could alter the natural progression of DWM and negatively impact a variety of ecosystem service values.

While forest health thinnings can often be a positive management tool for wildlife habitat and forest health and productivity, there is a balance between removing more dead and dying standing trees and ensuring that there will be sufficient

DWM in the future to maintain ecosystem processes. In one study of the impacts of DWM removal from stands of loblolly pine, breeding bird abundance declined by nearly 50 percent (Lohr et al. 2002). When harvesting biomass it can sometimes be difficult to distinguish between pre-existing DWM and newly created logging slash, and in some areas, it is common practice to treat all this material the same through collection or disposal. This is standard practice in some forest types, such as loblolly pine plantations or in forests where slash piles add to the risk of wildfire or insect infestation, and biomass markets promise a way to pay for activities that previously presented an added cost to landowners. However, this is certainly not the case for all forest types, and some suggest that biomass harvests pose a high level of risk to the forest floor and the forest structure, unless careful measures are taken (Bragg and Kershner 1999; Brown et al. 2007; Janowiak and Webster 2010).

The size, shape, volume, composition, and location of DWM all play a role in wood decomposition and the cycling of nutrients in forest ecosystems (Harmon et al. 1986; Wu et al. 2005; Li et al. 2007; Berg and McClaugherty 2008). Decomposition of DWM improves the physical and chemical characteristics of forest soils over time by enhancing soil organic matter and nutrient content, and by increasing rates of nutrient uptake through associations with ectomychorryzal fungi (Harmon et al. 1994; Hagan and Grove 1999; Hafner et al. 2005). Fungi remove nutrients from DWM, making these nutrients available in forest soils. Many fungal communities have associations with certain tree species and even specific sizes of DWM. In general the diversity of fungal communities is an indicator of overall forest health and productivity. Studies in Sweden and Finland—two countries where biomass harvesting using whole tree removal systems is practiced widely—have measured significant loss in the abundance of liverworts and fungi in instanced where DWM was removed during successive harvests (Amaranthus et al. 1994; Stupak et al. 2008; Eriksson 2010).

When it comes to biomass harvesting, the maintenance of soil fertility and related forest productivity are two of the main areas of concern for managers. Risk of nutrient depletion is related to the quantity and type of material that is removed during harvests. Provided that steps are taken to ensure that sufficient DWM is left on site and that regeneration will occur, most forests have the capability to restore site nutrients over time following harvests. However, this depends on a number of factors including soil type, forest type, climate, and management decisions. Due to the high nutrient concentration in branches, leaves, and roots, it is essential to ensure that biomass harvesting does not mine the long-term site nutrient capital. Subsequent unplanned and intensive harvests have the potential to negatively impact soil nutrient pools if these interventions are not timed appropriately to ensure that the soil nutrient capital is restored.

If biomass is to be harvested on a large scale many experts believe that increasingly mechanized whole tree removal systems will be employed much more often. While a more efficient means of tree removal, whole tree harvesting can reduce the long-term availability of soil nutrients, in part because a higher percentage of foliage and twigs, the above-ground parts of trees that contain the most nutrients, are transported off site, where they no longer contribute to forest nutrient pools. The results of several studies going back to the 1970s suggest that under certain conditions, whole tree clear cut harvesting techniques may lead to significant quantities of nutrients (up to 10 percent if there is no biomass retained on site) being directly removed and leached from forest soils (Huntington and Ryan 1990).

Even highly productive loblolly pine plantations on the coastal plain of the Gulf Coast experienced a loss of productivity following whole-tree harvesting clear cutting operations, with one long-term productivity study finding an average productivity reduction of 18 percent (Scott and Dean 2006). On intensively managed sites in Sweden and Finland, where clear-cutting with whole-tree harvesting systems was practiced in successive rotations, researchers noted a 10 percent drop in forest productivity (Amaranthus et al. 1994; Stupak et al. 2008; Eriksson 2010; Mahendrappa and Salonius 2006). The loss of forest productivity has led to recent regulations in Sweden requiring the application of wood ash in an attempt to ameliorate or prevent soil nutrient loss. Conversely, data collected over the first decade of the USDA Forest Service Long Term Soil Productivity study (LTSP) of 26 sites across the nation suggests that the removal of biomass during sawtimber harvests had no detectable influence on forest growth within the first 10 years following harvests (Powers et al. 2005). Based on these conflicting studies there appears to be no scientific consensus on the risks that biomass harvesting practices present to nutrient cycling in forests, beyond the recognition that there is wide variability from site to site.

Are bioenergy and biofuel goals achievable and sustainable?

While DOE's National Energy Model provides some guidance for policymakers, the real world dynamics of policy, technologies, and economics are difficult to predict. It is difficult to know how large a role forests will play in America's energy future. What is clear, however, is that the recent expansion of interest and investment in bioenergy has brought together the forest sector and the energy sector—two groups that have not worked together closely before in a significant way—and that norms, values, and modes of operation of both will need to be accommodated. While the outcomes remain largely unpredictable, it is clear that large abrupt changes in the energy and forest sectors will produce significant economic repercussions.

While there appears to be broad support for increased renewable energy production, climate change mitigation, and sustainable forest management, addressing each of these public policy goals simultaneously through effective policy is a significant challenge. In an effort to improve the collective knowledge of the intricacies of this challenge and to begin to identify potential solutions, the Pinchot Institute and Heinz Center turned to the stakeholders in the energy and forest sectors to gather their expertise and perspectives on the emerging bioeconomy. The explicit purpose for engaging stakeholders in a dynamic setting was to foster a productive dialogue where those with scientific and practice-based knowledge could learn from one another and better inform the policy process. It is the belief of the Pinchot Institute and the Heinz Center that it is often through such processes that solutions to complex public policy issues begin to emerge.

The National Policy Dialogue on Sustainable Wood Bioenergy

In September 2007, the Pinchot Institute convened a scoping workshop, hosted by the Rockefeller Brothers Fund, to identify the key issues and opportunities associated with sustainable wood bioenergy development. A diverse group of experts and stakeholders (found in the Appendix) developed a list of topics on which additional information and research is needed, and recommended the convening of a national dialogue to examine the implications for federal and state energy policies, from the broadest possible diversity of perspectives. The Pinchot Institute subsequently compiled a comprehensive on-line white paper, consisting of more than 30 individual-contributed papers on a full range of topics relating to sustainable wood bioenergy development. In February 2009, the Pinchot Institute and the Heinz Center convened a national workshop on ensuring sustainability in the development of wood bioenergy in Washington, D.C. Among the 55 experts who participated were representatives of state and local governments, federal and state natural resource agencies, the energy industry, the forest products industry, conservation organizations, and academicians (a complete list of participants can be found in the Appendix). Key issues included:

- the apparent acceleration in the pace of bioenergy development in response to federal incentive programs,
- differing views regarding the availability and adequacy of wood biomass feedstocks,
- appropriate measures to safeguard the environmental, economic, and social sustainability of the rapidly developing industry, and
- how state and federal policies can support and ensure bioenergy development that will contribute constructively to sustainable forest management and stable rural economic development.

Over the course of the discussion, the dialogue at the national policy workshop revolved around four main issues related to the sustainability of wood bioenergy:

- **Biomass supply estimates:** The need for reliable and accurate methods for assessing the available and sustainable supply of wood biomass — nationally, regionally, and locally — to serve as a basis for informed decisions by energy companies and local communities to site new or expanded wood bioenergy or biofuel facilities.
- **Sustainability standards:** The need for adequate environmental safeguards to address the more intensive type of wood harvesting that is done for energy purposes, through state forest practices policies, through non-governmental sustainability certification programs, and through responsible sourcing policies by energy companies.
- **Range of biomass energy options:** The need for decision makers and stakeholders to consider the full range of wood bioenergy and biofuels options before facility citing decisions are made, including factors such as scale, distribution, and efficient utilization of wood biomass as they relate to local environmental, social, and economic circumstances.
- **Federal and state policy alignment:** The need to align federal and state policies with the appropriate financial incentives, tax credits, and targets for renewable energy production with existing policies aimed at ensuring the sustainable management of both public and private forests. In addition, specific issues related to federal forests were discussed at length at two of the regional workshops.

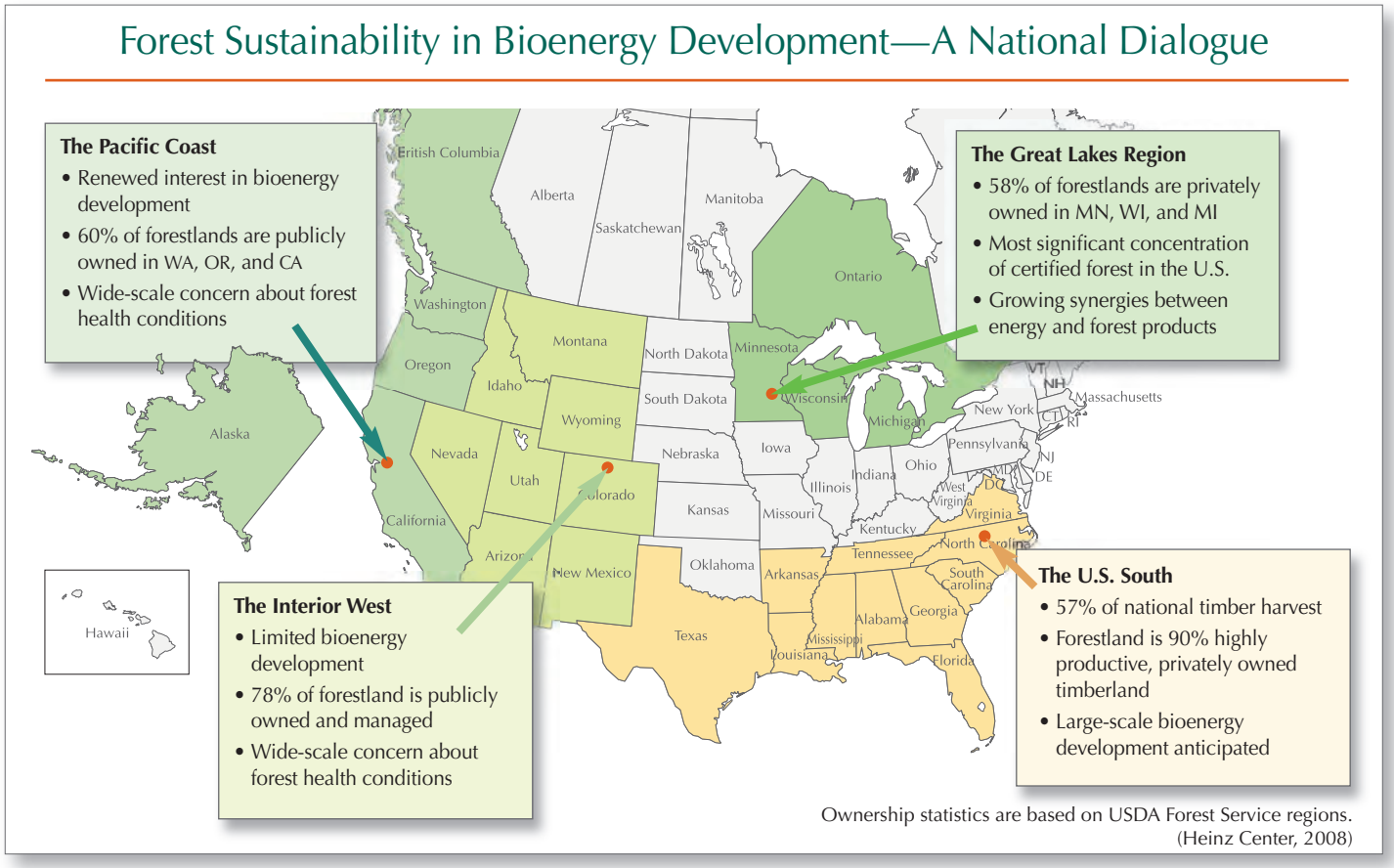
Participants noted that the desired outcomes of bioenergy and biofuels policies are inconsistent and in some instances contrary to one another. The group suggested that such "policy ambiguity" is

likely due to the fragmented nature of the policy process, which attempts to address multiple objectives simultaneously (i.e., displacement of foreign sources of energy, reduced greenhouse gas (GHG) emissions, rural economic development, and forest restoration), with the result that no single objective is being met effectively. Participants expressed the view that policy governing bioenergy development should be technology neutral—not favoring certain fuels or forms of energy.

The national policy workshop revealed that there is a continued lack of trust among participants in the forest management arena (and hence the energy arena), especially with respect to whether current or proposed policies are adequate to ensure sustainable use of public and private forests. This manifested itself most prominently in the discussion over the potential expansion of the "eligible" sources of forest biomass for energy incentive programs. Despite this apparent mistrust, there was a strong desire among participants to develop and refine a shared vision of sustainable bioenergy to inform the policy process. There was also agreement that the nation needs to develop as many low carbon fuel sources as possible, within the bounds of sustainability, and that forest bioenergy will have a role to play. However, given the complex nature of the term "sustainability,"[6] there emerged no single clear vision, but rather a number of paths toward defining sustainable wood bioenergy.

Some suggested that incentives for biofuels and bioenergy be distributed according to the performance of facilities and conversion pathways with respect to greenhouse gas life cycle emissions and comparative environmental benefits and efficiency, and take into account regional variation. Others thought that desired outcomes related to sustainability should include such things as regional contributions to overall renewable energy objectives, GHG life-cycle analyses, the effects on long-term forest economics, the impacts on environmental quality, the rate of biomass resource use, and community economic viability. There was a general sense that the regional level was the appropriate scale for defining sustainability relative to socio-economic and environmental outcomes, and that broad-based stakeholder processes guided by sound science are desired.

Figure 5.



[6] Sustainability is defined in this report as a condition in which resources are to be used in a way that meets the needs of the present without compromising the ability of future generations to meet their needs (UN 1987).

Differences in Regional Strategies and Perspectives

One of the strongest and most widely supported suggestions from participants was that the Pinchot Institute and Heinz Center delve more deeply into bioenergy strategies being developed independently in several ecologically, economically, and culturally distinct regions of the U.S., both to inform—and be informed by—the different approaches being pursued within each region. Over the next year, four two-day workshops were organized and convened across the country, each in cooperation with a respected state university within the region (see map of regional workshop locations, Figure 5).[7]

More than 280 experts and stakeholders from across each of the regions presented perspectives from the energy industry, the forest products industry, state and federal forestry agencies, native tribes, forest landowners, local governments and economic development entities, conservation organizations, and academic institutions. Each workshop used the same set of four topics to frame the information presented:

- Development and communication of accurate, reliable forest biomass supply estimates
- The adequacy of existing sustainability safeguards, and opportunities for strengthening standards in state forest practices regulations and independent sustainability certification programs
- Assessing a full range of options for scale, distribution, and types of wood bioenergy or biofuels facilities that would best characterize a sustainable "build out" of the wood bioenergy industry in the region
- Opportunities for better aligning federal and state policies to support sustainable wood bioenergy strategies within the region, and ensure adequate flexibility in the development of future federal policy

Following are key observations from each of the regional workshops, highlighting not only important differences, but common features as well. Complete regional workshop reports are available electronically at the Pinchot Institute and Heinz Center websites (see http://www.pinchot.org/gp/RegionalMeetings and http://www.heinzctr.org/forestbioenergy/index.shtml).

The South

While relatively few states in the South have state renewable portfolio standards (North Carolina and Texas, mandatory; Virginia, voluntary), continued forest bioenergy development is likely given the South's current role as "wood basket" of the U.S. The region has approximately 214 million acres of forested lands, 95 percent of which are either planted timberlands or natural/semi-natural timberland that could support harvesting (and not in a reserved area) (Heinz Center 2008). In 2005, the region harvested 12.2 billion cubic feet of timber, 57 percent of the national harvest. A large majority of this harvest was from privately owned forests, which represent almost 90 percent of the forested lands in the region (Heinz Center 2008).

Despite opportunities for harvest, and growing stocks that exceed harvest, energy companies in the region have often found it a challenge to accurately estimate biomass supply on a local scale. Often companies have made poor siting decisions based on inaccurate estimates of volume and type of biomass (often involving inflated estimates of primary logging residues, secondary mill residues and wood waste) and price (often not assessing competing markets or adequately accounting for transportation costs). This in turn has lead to increased competition for roundwood in the near term (even with decreased demand for wood, paper, and other products during the recession) and increased reliance on energy crops in the future. Dialogue participants suggested that there were opportunities for greater cooperation between the energy industry and experienced private forestry consultants, who might be able to give more accurate assessments of supply based on competition for feedstock with local industry, private forest landowner response to markets, and sustainability standards.

[7] Regional workshops focused on the U.S. South (hosted by North Carolina State University, August, 2009), the Great Lakes region including Ontario (hosted by University of Minnesota, September, 2009), the Interior West (hosted by Colorado State University, October, 2009), and the Pacific Coast region including Alaska and British Colombia (hosted by University of California-Davis, February, 2010).

The sustainability of biomass harvesting techniques is also an issue in the South. Much of the forested land in the South is in small patches (often 10 square miles or less) with significant urban and suburban development pressures. These same forest patches provide habitat to a relatively large number of native animal species at risk of extinction (Heinz Center 2008). The type of forest is also changing. The percentage of planted timberland in the South has increased twentyfold in the past half century, and the potential for significant expansion of forest plantations and energy crops has many stakeholder concerned over the effects on wildlife habitat and water resources. Similarly, significant areas of existing forest plantations that are currently operating on 25 - 45 year rotations have the potential to be converted to short-rotation energy crops operating on a 3 - 5 year rotation. These concerns are compounded due to an increase in the amount of land owned by Timber Investment Management Organizations and Real Estate Investment Trusts, private entities that tend to invest less in forest management.

There are mixed views in the South on how to ensure sustainable practices. Some believe landowners should be responsible, others believe that energy companies should be responsible for their supply chain—understanding the source of their feedstock and bearing responsibility for ensuring that their feedstock is supplied in a renewable and sustainable manner—a view which much of the energy industry is unaccustomed to. Dialogue participants were wary of additional management practices and preferred that any mandated sustainability standards be set by individual states rather than at the federal level. The identification of appropriate bioenergy "development zones" and high conservation areas for increased public investment in easements were highlighted as means for building out the wood bioenergy industry in a sustainable manner.

Participants suggested that federal policymakers could provide the greatest support for forest bioenergy development in the South by harmonizing the federal definitions of biomass available for credit under various mandates and by supporting renewable thermal approaches using advanced wood combustion, combined heat and power (CHP), and district heating and cooling. There was also strong agreement that federal research and development into the sustainability of bioenergy should be a higher priority.

The North

The forests of the North cover 171 million acres, from the Great Lakes states to the Northeastern states, with the large majority of forest in private ownership. Forest area in the North has increased slightly in the past 60 years, and consists primarily of lands sufficiently productive to allow for harvest. Approximately 4 percent of the forest area in the region is reserved forest land (e.g., national parks, federal and state lands), and timber growth exceeds harvest in the region by over 3 billion cubic feet per year (Heinz Center 2008). Most states in the region have an RPS.

A workshop was held in the Great Lakes region, as many New England issues have been identified previously by the Biomass Energy Resource Center (BERC) and the University of New Hampshire, which undertook a "Northern Forest Biomass Energy Initiative" (http://www.biomasscenter.org/pdfs/NFBI.pdf) based on a multi-stakeholder process. In the Great Lakes area, participants identified a critical need for both regional and site-level resource assessments to assist in planning and policy development and to evaluate tradeoffs in any bioenergy development. There was general consensus that site-level feedstock assessment should take into account the elasticity of supply (given factors such as environmental availability), preferences of non-industrial private landowners, transportation costs, and feedstock characteristics (e.g., species, composition, and moisture). There was support for a strong federal role in making this information available and spatially explicit to complement information gathered by energy companies.

Participants also recognized the role of the public sector in shaping any build-out of the bioenergy industry, particularly in maximizing the efficiency of biomass use, minimizing conflict with existing forest product users, and crafting state and federal public incentives. CHP and thermal technologies were cited as being particularly energy efficient and worthy of incentives.

The Great Lakes area has often been supportive of forest certification, and Minnesota pioneered the development of biomass harvesting guidelines to limit the risk of future supply disruptions and potential controversy over sustainability. In general, most participants favored a state implementation of sustainability standards and thought that any "look back" required by federal law be accompanied by federal funds for monitoring and evaluations. Many thought that sustainability standards should focus on regional and international cooperation between Ontario and the Great Lake States and on sustainable sourcing programs for industry, and that standards should also be applied to energy crops to encourage sustainable agricultural practices.

In New England, stakeholders convened in a separate process by BERC identified the need to determine the area's capacity to supply wood biomass on a sustainable basis in a manner that would safeguard against overharvesting. To achieve this goal, stakeholders recommended wood supply assessments to identify the amount of low-quality wood biomass potentially available on a long-term sustainable basis, along with annual comparisons of forest harvest volume to forest growth. Participants supported development of a model wood-fuel procurement standard that ensures biomass is harvested on a sustainable basis (for use on public and private lands) as well as workforce training and forest landowner education program on sound harvesting techniques. In addition, there was support for stable public funding, tax incentives, and current-use taxation programs to support sustainable biomass harvesting in public and private forests.

Participants encouraged the use of bioenergy technologies that were energy efficient, matched community-scale uses, enhanced local economies, and met or exceeded air emissions regulations.

Massachusetts was one of the first states to pass RPS legislation. Like other states, Massachusetts has also enacted comprehensive climate change mitigation legislation in lieu of effective climate change legislation at the federal level. While Massachusetts has made strides in solar, wind, and especially energy efficiency, expansion of the state's bioenergy capacity remains a significant part of the state's renewable electricity and liquid transportation fuels strategy.

With emerging public concerns over the sustainability of biomass energy and the passage of a comprehensive greenhouse gas mitigation policy, the state suspended all applications for new biomass energy facilities until the state had refined its RPS policy related to biomass to include "sustainability requirements for eligible biomass." The state has interpreted the meaning of sustainability to include both a forest-management and a greenhouse-gas-life-cycle-emissions perspective. The subsequent policy actions taken by the state could have far-reaching implications for the future growth of bioenergy in Massachusetts and beyond.

The Interior West

Forests of the Interior West (151 million acres) are characterized by large public landholdings and relatively lower productivity than other regions in the U.S. (Heinz Center 2008). Thirteen percent of the area is set aside as reserved land (national parks and wilderness areas where timber harvesting is prohibited by statute) and another 38 percent has limited harvesting as the forest grows too slowly or sparsely to support timber harvest under current economic conditions. The remaining forest is primarily "natural/semi-natural" timberland as there is limited planted timberland in the region (less than 2 percent of the forest area). Combined, Interior West forests provide approximately one-sixth of the nation's timber harvest. Growth rates decrease from north to south in this region, with Idaho and Montana having significantly higher growth rates than Arizona and New Mexico.

Past forest and wildfire management practices have led to the accumulation of biomass in the region (as much as 1.5 billion cubic feet per year) and made some forest areas particularly vulnerable to disturbance from wildfire, insects, or disease (Heinz Center 2008). As so much of the forest is in the public domain (75 percent), the supply (how much is present on the land) and availability (what is socially and economically feasible) of biomass has become largely a function of social, political, and legal processes influencing management activities meant to address declining forest health conditions and the viability of the traditional wood products industry.

While over half of the states in the region have RPS policies, many dialogue participants highlighted challenges in "building out" forest bioenergy in the region. Many energy companies look to source biomass primarily from hazardous fuel reductions and forest health activities (e.g., removal of diseased or damaged trees). Siting plants, however, has proven challenging as biomass from such restoration activities is of limited volume and offered inconsistently. Transportation costs inhibit sourcing from distant forests, and overall biomass costs remain high when biomass is not sourced from an integrated harvest that removes saw logs as well as residual biomass. Several participants suggested that the federal government either expand the scale of restoration activities or target existing incentives (grants, loans, tax credits, etc.) toward supporting appropriately scaled utilization infrastructure (e.g., small log mills and bioenergy facilities) that takes into consideration the unique circumstances of the Interior West.

Participants also recommended that state and federal organizations facilitate development by coordinating biomass offerings from fuel treatments and landscape restoration projects in order to offer steady volumes over a predictable timeline. In addition, by extending the length of stewardship contracts, the federal government could help the energy industry secure greater backing from creditors and investors. Longer term (greater than five or even ten years) contracts however have not been favored by the Forest Service because of a perceived lack of flexibility to respond

to changing markets and ensure competition between contractors. Participants also emphasized that a more significant barrier to stewardship contracts in the region is that contract cancellation ceilings associated with federal acquisition regulations require that federal funds be set aside to compensate contractors for infrastructure investments in the event a contract is dissolved (Pinchot Institute 2010).

This makes the development of new wood utilization infrastructure (e.g., bioenergy facilities that are appropriately scaled to forest restoration needs) difficult unless significant appropriated dollars are available for such uses (Becker et al. 2009). There was a general sense that many existing forest plans do not adequately consider evolving biomass markets, and that they might be more helpful if they did so in the future. In the absence of an unlimited supply of appropriated dollars, participants suggested that the identification of market outlets for low value and small diameter timber should be an important consideration for planners given that the bulk of silvicultural activities in the region in the coming years will likely address the removal of such material. While such market identification is usually reserved for individual projects, participants recognized that the economic and ecological conditions of the Interior West call for a strategic and longer term focus.

Sustainable harvest practices were discussed in less specific terms in Interior West than other regions in part because forest soils are thought to be less sensitive to nutrient depletion than those in the East. However, participants agreed that it was important to ensure that forest ecological needs drive silvicultural prescriptions, not the need for bioenergy facilities. Many agreed that energy efficiency could be achieved though the promotion of thermal and CHP applications (e.g., the "Fuels for Schools" program) in the region, and several participants supported policies that favor or at least treat this application equally with others (i.e., fuels, electricity).

The Pacific Coast

Forests cover 88 million acres in the Pacific Coast states, almost three quarters of which is timberland (Heinz Center 2008). The region is characterized by a diversity of forest management and restoration objectives and energy and climate policy goals and has a long history of bioenergy development (California for example has 32 facilities generating approximately 700 MW of electricity). Motives for participation in the bioenergy sector vary; some see biomass as a mechanism to restore forest ecosystem health and resiliency, while others see opportunities for community economic development and rural energy security. All states in the region have renewable portfolio standards, including California's RPS of 33

percent by 2020, the most aggressive RPS in the nation. Like the Interior West, much of the region's forest is on public land.[8] Timber growth in the region has exceeded harvest by over 2 billion cubic feet per year in recent years (Heinz Center 2008).

At the Pacific Coast workshop, participants expressed the need to develop uniform standards and common assumptions in performing biomass supply estimates. In the 1980s California energy companies overbuilt bioenergy capacity based on faulty feedstock assumptions and the assumption that price supports would continue. Many of these companies are no longer in operations or have had to modify their feedstock procurement; the most successful have relied on a range of feedstock options. In gauging biomass supply, participants saw the need for long term estimates (30-40 years) and a better understanding of both the biophysical capability of forests to supply biomass and the degree to which biomass would remain off limits to harvest either due to public land policies or economics (e.g., permit or road building costs, unsubsidized transportation). They also expressed an interest in better understanding supply competition between the existing forest industry and emerging forest bioenergy industries, and demand relative to existing energy infrastructure and fossil fuel prices. Collaborative processes, planning, and long-term stewardship will be extremely important to understanding biomass supply.

Participants generally agreed that there should be a baseline level of safeguards to ensure that ecosystem services (water quality, soil, productivity, biodiversity, etc.) are maintained at a site level commensurate with biomass harvests. As state forest practices vary across the region, participants recommended that there should be a "policy gap analysis" to determine if state forest practices acts or other relevant natural resource policies need to be augmented. It was also suggested that third-party forest certification programs could be developed to ensure site-level sustainability, although there was some concern that the costs of such a program could be a burden to entities operating with small margins. There was no consensus on whether certification should apply to the management of federal forests, but there was general agreement that the federal government should clarify the definition of "renewable biomass" in federal policy. Participants also discussed the possibility of developing a "precautionary approach," using spatial analysis and decision support tools to identify areas where extra precautions may need to be taken to mitigate potential risks.

Participants highlighted the importance of communicating the energy value of various technologies in common units (i.e., BTUs) so that decision makers can accurately evaluate the merits of various biomass utilization options. Small (5-10 MW) to very small (< 5 MW) CHP facilities may be particularly viable in the region, but tend to have higher upfront capital costs, higher operation and maintenance costs, and less-replicable designs than larger stand-alone biopower facilities.

There was a general sense from workshop participants that greater care should be taken in designing market interventions in order to avoid unintended consequences. Performance-based mechanisms were identified as a constructive way to incentivize sustainable harvest and bioenergy utilization options that yield new ecosystem service benefits.

[8] Sixty percent of forests in Washington, Oregon, and California are publicly owned, with much higher percentages of British Columbia and Alaska being in public and tribal ownership.

Findings

Finding 1: There is concern over the potential effects on forests from meeting existing and proposed mandates for bioenergy and biofuels that could potentially require more than doubling the current level of wood harvesting in the U.S. Improved estimates of biomass supply and better state and local government coordination are essential to avoid future issues of forest sustainability.

Since the release of the original DOE/USDA "billion ton study" in 2005, there has been a significant evolution and improvement in the information on available and sustainable supplies of wood biomass—nationally, regionally, and locally. Nevertheless, the way in which this information is communicated to national policymakers and local governments—and how it is interpreted by decision makers in an energy industry that is relatively new to the politics of forest management and wood supply—will strongly influence the way the wood bioenergy and biofuels industry develops in the U.S.

Continued refinements in the DOE/USDA "billion ton study" estimates, particularly through the work of the Forest Service's Forest Products Laboratory, are expected to result in the wood biomass availability estimates being revised downward significantly (Skog 2009, National Policy Workshop). These revised estimates, which were presented to participants at each regional workshop, reflect more precise county-level data from the Forest Inventory and Analysis (FIA) program gathered by the Forest Service, refinements in assumptions about the practical feasibility of collecting logging residues and mill wastes, and policy changes regarding the harvesting of wood biomass from federal forests that occurred after the "billion ton study" was published.

Participants thought that national and regional-scale biomass estimates are important for moving the policy discourse toward identifying appropriate production targets for biofuels and renewable electricity. However, there was broad agreement that national and even regional estimates of wood biomass supply were of limited use in actual facility-siting decisions. In each region, participants emphasized that project developers need accurate fine-scale information to evaluate project feasibility in order to be able to acquire equity partners to finance project development. Project-level due diligence requires that developers ensure that the biomass supply is significantly larger than the planned sourcing capacity in order to account for future competition and supply disruptions during the 30-40 year service life of a given facility.

State and local government representatives also repeatedly voiced the need for local biomass supply and demand information that is as complete, accurate, and up-to-date as possible, as they face decisions about which approaches to renewable energy are best suited to their particular needs and circumstances, and to the level of wood biomass production their local forests can supply sustainably. Given the 30-year life of most bioenergy facilities, the decisions made today will affect the region's communities and forests, and potentially limit other options, for many decades into the future. Participants expressed concern that once these decisions are made, and the resources committed, this may also limit flexibility to consider other options in the future.

In many of the workshops, participants stated that regional-scale information on biomass supply in their region existed, but that there were often several competing estimates, some of which presented larger volumes than others. Participants noted that while it is important to "have a second opinion," it would be helpful to have a common framework of acceptable assumptions and methodologies, or at least greater articulation of the assumptions and methodologies used in estimates.

Participants generally agreed that the most useful and accurate regional- and project-level estimates would consider a variety of factors, including:

Defining "appropriately scaled" bioenergy in the Lake States

Minnesota Power Company (MPC) set out in 2007 to construct a 50 MW biomass energy facility using harvest residues from roundwood harvests in surrounding forests in northern Minnesota. The wood bioenergy facility would facilitate the company's compliance with the Minnesota RPS requirement for 25 percent energy production from renewable energy sources by the year 2025. A biomass supply assessment conducted after the announcement of the plant determined that, although wood biomass is available, the presence of existing forest products companies in the area—many of which purchase electricity from Minnesota Power—would make it difficult to procure a consistent volume at a reasonable price. So, rather than compete against their own customers for feedstock, Minnesota Power opted to decrease the size of the planned facility to 24 MW. Not only would this make it easier to procure a sustainable supply of wood biomass, but it also would create opportunities for MPC to expand its renewable power operations through new cogeneration facilities located alongside existing forest products facilities—collaborating with, rather than competing against valued customers.

- The coarse biophysical capability of forests to supply a range of potential forest biomass quantities over a given length of time. This could be quantified using the best available FIA data and spatial data sets, and a broadly agreed-upon set of assumptions.
- A public policy overlay of lands that are "off-limits" either for legislative, judicial, or administrative reasons or because of their high conservation value (determined by a multi-stakeholder science-based process).
- Analysis of the effect that applying biomass harvesting standards across a given supply area has on forest biomass yield.
- An economic analysis of biomass transportation networks and utilization infrastructure (e.g., road network analysis for both subsidized and unsubsidized transportation; administrative costs such as permits and associated analysis; and the specific supply requirements of the proposed utilization capacity and technology).
- Analysis of the current and future potential supply competition between existing wood product facilities in the region and the emerging bioenergy industry.
- Analysis of demand relative to existing wood products and energy infrastructure and fossil fuel prices.

Such analyses are highly technical and may be beyond the expertise of local decision makers just getting up to speed on the intricacies of biomass supply. Participants noted that government agencies are well-suited to provide this type of information, but participants also emphasized that the development of regional- and project-level estimates of sustainable supply would benefit from more outright collaboration between state and local governments, forestry consultants, and energy companies.

In regions characterized by mixed ownerships, especially those with large blocks of federal land, Coordinated Resource Offering Protocol (CROP) studies have provided a useful source of information on local biomass availability. These studies are based on survey information gathered from the managers of public and private forests and are particularly informative because they identify biomass availability within a feasible transportation range of a proposed biomass energy facility, using a rolling five-year projection tempered by data on actual performance relative to past projections (Mater and Gee 2010).[9] Such multi-year and performance-based projections give energy companies the ability to better predict the total wood biomass supply that is likely to be available from all sources within a feasible transportation range. As such they can better account for the different ways that market forces and government policies affect public and private wood biomass suppliers. Participants noted that CROP allows local governments, permitting agencies, and the energy companies themselves to make better informed decisions about the volume and type of wood biomass that can be sustainably supplied, and to plan the scale and other characteristics of the proposed facility accordingly. Like most supply assessment methodologies, CROP is limited in its ability to predict available biomass supplies in time increments projected out further than 5 years, which may be insufficient to garner the requisite financial investment.

As expected, the regional workshops underscored the significant differences among major forest regions of the U.S. in the proportion of net annual forest growth that is currently being utilized (Smith et al. 2004; Heinz Center 2008; Figure 5). These differences may point to opportunities for new entrants in regional wood markets. However, some of the regions with the highest net growth rates in the country, such as the South, also have some of the highest rates of current utilization of that growth by existing industries, suggesting that opportunities for new entrants could be limited by supply constraints. Participants from all sectors acknowledged the potential for significant competition and suggested that regional demand analyses include not only estimates of current and projected demand from primary producers such as manufacturers of solid wood products (lumber, panels) and pulp and paper, but also estimates from secondary manufacturers (e.g., manufacturers of medium-density fiberboard (MDF) for cabinets and furniture, or manufacturers of wood pellets) that rely on mill wastes and residues from the primary industries.

Energy companies that have located near existing primary producers on the expectation of using mill wastes and residues may find themselves scrambling for biomass supply after learning that most of these byproducts are already being fully used by secondary manufacturers or by the primary manufacturers themselves for on-site energy production. However, as evidenced by the recent closure of a large pulp and paper mill in Franklin, Virginia, and the several projects that have already been proposed to redevelop this mill into a bioenergy facility, a transition from solid wood and paper products to energy products may become commonplace in some locations.

Despite real and perceived socially undesirable effects of competition between these two industries, participants from both the energy and forest products sectors noted strong potential synergies, many going as far as to state that existing forest products facilities can be a valuable part of a healthy supply chain for both industries. Since there is great uncertainty regarding emerging technologies (e.g., advanced biofuels) and an uncertain future for the forest products industry, participants felt that identifying and supporting these potential synergies through policy is exceedingly complex.

Many participants observed that it pays to be the "first one in the door," as each new facility will likely find it more difficult than the last to secure adequate feedstocks. Given the challenges of sourcing large volumes of biomass, energy companies that are unable to

[9] CROP analyses are available for an increasing number of areas in major forest regions of the U.S. (www.crop-usa.com).

Repurposing a paper mill in the South

April 15, 2010 marked the last day of production at International Paper's pulp and paper mill in Franklin, Virginia, just one year after the closing of a connected lumber mill. The Franklin mill was one of the three largest paper mills in Virginia, producing over 600,000 tons of uncoated freesheet paper each year (accounting for 19 percent of International Paper's total annual production). It is estimated that this mill closing will cost the region approximately 2,400 jobs (the mill employed 1,100, the remainder are expected to come from affiliated industries) and $27 million in annual tax revenue. A number of renewable energy investors have expressed interest in purchasing the now-closed mill and converting it to a biomass energy plant. As many as 15 different energy projects have been proposed. One bid indicated that the proposed facility would only accept wood biomass from sources that adhere to "prescribed sustainability standards," which "will not include clearcuts or tall, large diameter trees." The proposed energy facility would require "less wood than the paper mill running at full capacity." Many in the South view bioenergy as a means to revitalize rural economies. The conversion of the Franklin mill, and the emergence of the bioenergy industry as a major player in the South more generally, presents opportunities to expand commitments to sustainable forest management practices throughout the region.

secure multi-year biomass supply contracts may determine that the risk is unacceptable, and either delay or cancel plans for new or expanded facilities. Workshop participants noted that, most regions of the U.S. have a limited number of large private forest ownerships well-suited to enter into long-term biomass supply agreements. A few federal and state forest management agencies have statutory authority to enter into multi-year supply agreements, but thus far only a small number of such contracts have been approved.

Given these challenges to supply, some participants speculated that after an initial surge in new or expanded capacity for wood bioenergy and biofuels production, investments by the energy industry itself may slow considerably. Others suggested that it may simply take longer than expected to reach the established goals for renewable biofuels and renewable energy, and that the timeline for achieving these goals may have to be extended. Many pointed out that while the recent recession has knocked back private investment in biofuels and bioenergy projects, when the financial climate improves, investors and project developers will still face the challenges of securing large volumes of supply.

Others acknowledged that DOE projects that the U.S. will likely fall short of the RFS goals for biofuels production by about 6 billion gallons by 2022,[10] largely due to persistent technological impediments and the challenging economics of supplying large amounts of biomass to biorefineries. Participants recognized that commercial scale biofuels production will require robust supply chains, capable of driving down the cost of harvesting and transporting biomass. In many regions, participants emphasized that the forestry and logging infrastructure, especially the necessary human capital, is extremely insufficient to meet the expectations of a biofuels industry, for which the economics of agricultural biomass (residues and energy crops) are much more favorable. Participants were also concerned that the enormous cost of supplying large volumes of wood biomass would lead participants in the supply chain to seek to cut costs wherever possible. There was some thought that localized demands could lead to unsustainable management.

Many participants thought that that increased demand did not necessarily equate to increased supply. Participants pointed to the fact that two-thirds of U.S. forest land is in the hands of ten million private woodland owners, many of them families, and survey after survey has shown that the objectives for which these forests are managed are as diverse as the owners themselves. It was repeatedly noted that it is still unclear as to the degree to which these private forest landowners will respond to these higher prices by supplying more wood. A majority of family woodland owners consistently report that income from wood production is less important to them than other objectives such as recreation or providing wildlife habitat (Butler 2008). Another potential challenge to biomass supply from private forests is the consideration that urban/suburban development continues to fragment forested landscapes, decreasing the operability of hundreds of thousands of acres each year.[11]

Historically the market price for wood biomass used for energy production has been significantly lower than pulpwood or sawtimber prices. But wood prices in many regions of the U.S. are projected to rise significantly in response to increased competition for limited feedstocks, driven by policy goals for renewable energy production and financial incentives aimed at accelerating the

[10] The 2009 Annual Energy Outlook predicts that the RFS production goal can be met by 2030, however, assuming a further doubling of biofuels production from biomass between 2022 and 2030, and a quadrupling of net ethanol imports (EIA 2008c).

[11] Total forest area is projected to decrease by roughly 23 million acres by 2050, with another 44 million acres of private forest land seeing significant increases in housing density by 2030, greatly decreasing the availability of timber and biomass from these lands (http://www.fs.fed.us/projects/four-threats/).

development of the renewable energy industry (Abt and Abt 2010; Sedjo and Sohngen 2010). In all regions, participants recognized that a federal RES would make a significant difference in the demand for biomass.

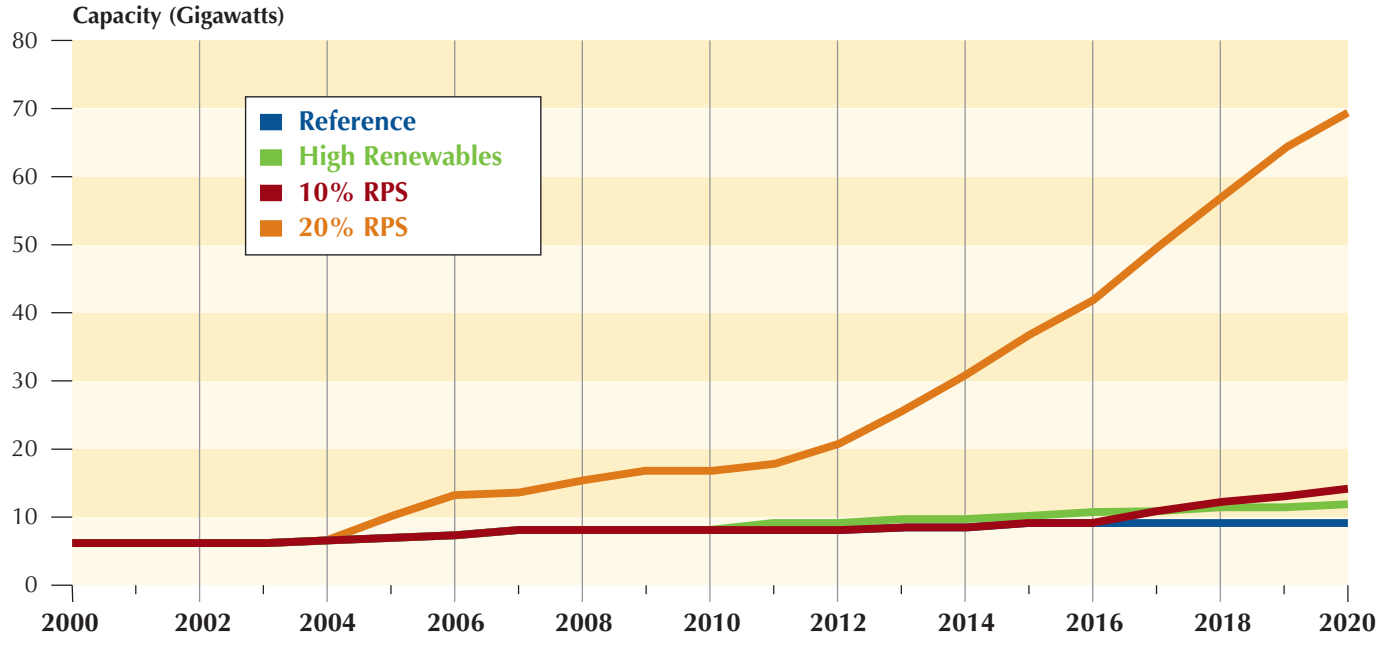
More specifically, a DOE study of alternative goals for renewable electricity production describes different demands for biomass between a 10 percent renewable electricity requirement to a 20 percent requirement. The DOE found that reaching a 10 percent goal by 2020 would lead to increasing biomass-fired generating capacity to approximately 15 gigawatts, whereas the 20 percent goal would require an increase to approximately 70 gigawatts (see Figure 6) (EIA 2003). At the 10 percent goal, much of the demand for renewable bioenergy could be supplied by wind power, which is more economical than biomass. Shifting to a 20 percent goal translates to a much larger demand for biomass feedstocks—70 gigawatts of additional electrical generation capacity from biomass translates to 700 new 100 MW power plants, each of them consuming an average of 1.2 million green tons of wood annually. The DOE analysis raises the question of whether there would be sufficient land to sustain the required level of biomass production, as it estimated that 9.6-14.4 million acres of land would have to be devoted to energy crops, including up to 37 percent of all land currently in the Conservation Reserve Program (CRP) (EIA 2003).

Participants recognized that energy crops represented a land use in which producing the largest amount of biomass over the shortest length of time was the preeminent objective, and some questioned the environmental sustainability of this. As discussed extensively in the Southern regional workshop, participants felt that the net growth of U.S. forests could be significantly increased over current levels through more intensive forest management practices and higher levels of investment in silvicultural treatments such as thinning and fertilization, or introduction of new technologies such as genetic modification to increase tree growth and limit the effects of insects and disease. Economically motivated forest owners may be willing to make these additional investments to increase growth rates, assuming that the market price for wood biomass will be adequate to justify them. Others questioned the ecological and environmental impacts of such intensification.

Recommendations:

- Assist state and local governments in the development of localized biomass supply/demand estimates and facilitate the appropriate dissemination of this information to developers of proposed biomass energy sites.
- Assist state governments in developing assessments of current and projected wood biomass supply/demand and the effects of wood biomass harvesting as part of the existing federal requirements for periodic State Forest Resource Assessments.
- Facilitate state government coordination at the regional level to identify and ameliorate knowledge gaps that pertain to biomass removal thresholds and other techniques intended to maintain ecosystem service values in state/eco-regional biomass harvesting guidelines.

Figure 6. Projections of biomass-fired generating capacity in four cases, 2000–2020



Source: EIA, 2003. Biomass for Electricity Generation

- Promote cooperation between private forestry consultants and the bioenergy industry to allow for more accurate site-specific assessments for private forest landowners.
- Provide guidance on the amount of biomass available from hazardous fuel treatments on federal lands, as well as areas that are "off-limits" due to sustainability concerns.
- Provide consistent models of project-level due diligence for energy developers unfamiliar with forest statistics and biomass supply estimation methodologies.
- Place research into sustainable bioenergy systems and regional bioeconomy development on par with technology research by supporting region-specific participatory research programs that involve state and local governments, energy and forest products companies, and others.

Finding 2: Standards are needed to ensure sustainable wood biomass harvesting practices.

There is a broad spectrum of views on the best way to ensure that biomass harvesting is done in a sustainable manner. This diversity of opinions was expressed across the various regions of the country, but it was also evident within the diversity of stakeholders at individual workshops. Some are inherently more ready to adopt the precautionary principle and take a more regulatory approach before unknown problems occur; others are much more comfortable using voluntary or performance-based approaches.

Despite the diversity of opinions on the potential risks, and ways to mitigate such risks, there was a consistent view that forest ecosystems are important for all the values society ascribes to them. While the existing definition of renewable biomass in the 2007 Energy Independence and Security Act does, in theory, protect "natural" forests from landscape-scale conversion, increased demand for fiber has the potential to contribute to conversion of "semi-natural" plantation forests to shorter rotation energy crop plantations. In regions where it is expected that biomass for energy is going to be the best future market for wood, plantation forests harvested for wood biomass today may be replaced not with a regenerated forest, but with short-rotation woody crops that are harvested on a 3-5 year basis. In some instances, these short-rotation woody crops may be non-native species, and may be genetically engineered for physical and/or chemical characteristics that make them conducive to producing bioenergy or biofuels (Hinchee et al. 2009). Forest type conversion and genetic modification have both shown that they have the potential to become a source of public controversy. Some dialogue participants pointed out that state governments may adopt a proactive approach to identify and assess the potential environmental effects of these activities, and ensure that acceptable safeguards are in place.

In each of the regional workshops, participants indicated that states with existing forest practices regulations are in the process of identifying whether the additional sustainability challenges associated with the systematic removal of a higher proportion of

biomass requires the augmentation of their forest practices codes to address these additional challenges. The key issues are to ensure that sufficient nutrient-containing wood debris is left behind to maintain site productivity and biodiversity and to prevent soil erosion and impacts on water quality. In some regions of the country, such as the South, where whole-tree harvesting is practiced widely, participants pointed to substantial research that has already been completed on how best to protect soil nutrient cycling and water resources. In other regions, participants noted that there is a limited scientific basis for designing augmented forest practices codes to address the additional challenges of biomass removal, and significant new research is needed quickly. Participants felt that in the absence of scientific certainty on what percentage of material should be retained as standing dead trees and down woody material, forest management regimes may have to increase resource allocations to monitoring in order to better inform the modification of management regimes over time. However, in each regional workshop it was recognized that monitoring is usually the last thing to receive funding in tight government budgets.

While most state Best Management Practice (BMP) programs are designed around implementing activities that protect water quality, some states have detailed BMP programs and forest practice regulations that are designed around the creation of new biological legacies during harvests. Likewise, the management of snags and down woody material is a central aspect of all biomass harvesting guidelines developed to date (Evans et al. 2010). Many dialogue participants, some of whom were instrumental in the creation of such guidelines, encouraged the development of these guidelines. At least one estimate by the Environmental and Energy Study Institute concluded that, based on the estimated cost of Minnesota's Biomass Harvesting Guidelines (~$150,000), $7.5 million would be sufficient to cover costs of preparing guidelines in all 50 states (Caputo 2009).[12] Such cost may be further reduced by evaluating whether interstate collaboration may be desirable to develop guidelines based on forest type rather than jurisdictional boundaries. Still, guidelines are intended to complement existing state policy frameworks and this may make regional level guidelines less practical. It was noted that the process of developing guidelines is usually time consuming and often requires evaluating scientific information that is less than complete, particularly information on biomass removal thresholds and techniques intended to maintain ecosystem service values. While defining the amount of biomass that can sustainably be removed is largely a subjective question that depends highly on the conditions of individual sites and is thus often left to the discretion of foresters and other natural resource professionals, participants felt that it is important to offer clear guidance in reference documents such as BMP manuals and harvesting guidelines. Some noted that measurable criteria and indicators are preferred, particularly as state BMPs are often voluntary.

Participants cautioned that focusing purely on biomass to be removed or retained, whether in the context of state forest practices codes, BMPs, or the standards used in independent sustainability certification programs like those of the Forest Stewardship Council (FSC), Sustainable Forestry Initiative (SFI) or the American Tree Farm System, addresses only one part of the sustainability question. Focusing just on the removal of logging residues following the harvest of timber for traditional wood products such as lumber or pulp does not necessarily address concerns over impacts to forest ecosystems and environmental quality on a landscape scale. When presented with real world examples, and the overall trends in regional and national biomass supply and demand, many were concerned that lands within the supply zone of large bioenergy facilities would experience a significant increase in timber harvests conducted solely for the purpose of supplying wood biomass for energy and that some of the economic and environmental effects of such harvests could be undesirable.

[12] This cost estimate does not include the cost of monitoring both the rate of implementation of guidelines and evaluating the effectiveness of the practices that comprise such guidelines based on empirical evidence gathered through monitoring.

In order to head off the potential for a repeat of past public controversies over timber harvesting, some participants felt that state governments had a significant role to play and that state forestry agencies may also want to consider factoring wood biomass energy harvesting into future updates of state forest resource management plans, and work with their state legislatures to ensure that policies aimed at increasing renewable energy production do not set up unrealistic expectations for wood biomass supply. Adequate coordination between state wildlife and forestry agencies can help identify high value conservation areas as identified in State Wildlife Action Plans and other landscape level strategies. Adequate coordination can also identify areas where additional care is needed to maintain wildlife habitat and biodiversity at the landscape scale, by protecting ecological connectivity and by promoting opportunities where biomass harvesting can be consistent with the precepts of ecological forestry.

Recommendations:

- Develop flexible policies that incorporate robust science-based standards with certain baseline protections that delineate measurable criteria. This would apply to: state biomass harvesting guidelines, forest restoration policies, revised best management practices that integrate biomass removal standards, and third-party forest certification and/or forest management plans prepared by a licensed professional forester.
- Encourage the collaboration of state governments in the development and monitoring of science-based biomass harvesting guidelines at the state and/or eco-regional level.
- Increase investments in research on biomass sustainability and the potential environmental, economic, and social impacts of biomass harvesting.
- Ensure that legislation to improve the economics of the biomass supply chain integrates science-based biomass production and harvesting standards.

Finding 3: Policies to define the role of federal forests in biomass supply are inconsistent. Clear policy direction is essential in developing guidelines to ensure continued conservation and sustainable use of these public lands.

The two Western regional workshops reemphasized that federal forest lands present their own special case. In part as a result of the past controversies over forest management and timber harvesting, National Forests and forests managed by the federal Bureau of Land Management are among the most heavily regulated and closely watched of any of the nation's forests. Public forests in general are expected to serve numerous purposes, and protect certain environmental and cultural values, that commercial private forests are not—especially the protection of wilderness, wildlife habitat, biodiversity, and aesthetic values often associated with old-growth, late-successional forests, or simply "natural" forests. Following numerous epic battles in Congress and the federal courts, an uneasy truce has settled in, and there are few who would like to see the "timber wars" over federal lands re-ignited.

Nevertheless, there is a wide spectrum of views on the role that federal forests can or should play in expanding renewable energy production. There are millions of acres of federal forests in the western U.S. that have been designated as fire regime "condition class 3" at extreme risk of large-scale wildfire or pest infestation due to overcrowded and climatically stressed conditions. In parts of the Western U.S. where hazardous fuel buildups pose a significant risk of catastrophic wildfires and insect infestations (and major additions to atmospheric carbon), the amount of wood biomass that could be utilized is substantial—up to 60 million tons per year (Perlack 2005). However, hazardous fuel treatments involving thinnings and removals tend to be extremely costly, and holistic ecosystem restoration is often more expensive still. Many participants saw promise in emerging markets for biomass for energy, suggesting that these markets can provide an economic outlet for such materials, and significantly reduce the net cost of these forest treatments.

Participants in the two Western regional meetings highlighted the need for local decision makers to be attuned to policy decisions that will determine the degree to which wood biomass is likely to be available on a sustainable basis from federal forest lands. A provision of the 2007 Energy Independence and Security Act (EISA) placed federal forests largely off-limits as a source of wood biomass for cellulosic biofuels. The definition of renewable biomass in EISA determines the eligibility of biofuels for federal credits, based on the source of the wood biomass feedstock. The 2008 Farm Bill included a somewhat different definition of renewable biomass that includes biomass from federal lands harvested under certain conditions. How these different definitions of renewable biomass are reconciled in federal policy—and what definition is included in the proposed federal RES—will have a major influence on the amount of wood bioenergy and biofuels that can be produced nationally.

One viewpoint that was widely expressed by participants was that federal land management agencies have not only an opportunity to conduct such treatments, but a responsibility to do so—to protect other values that are at risk on public forests, such as wildlife habitat or water quality, and also to protect adjacent private forests that would be damaged if wildfires or insect and disease infestations were to spread from federal lands. Reducing the risk of wildfires, and channeling the wood biomass into energy production to substitute for fossil fuels is seen as a win-win-win solution: reducing carbon emissions through substitution and reducing the incidence of stand-replacing wildfire; restoring forest ecosystem resiliency; and creating jobs in economically stressed rural communities. Participants who held these views tended to support including federal lands in the definition of renewable biomass in federal energy policy.

Others expressed a countervailing view that wildfires and insect infestations are long-standing agents of natural disturbance in forest ecosystems, and the risk of a few such events fails to outweigh the potential impacts of logging and roadbuilding in relatively natural forests, and the creation of a new forest-dependent industry that could become a potent political force for increased logging in the future should wood biomass supplies get tight. Participants who held these views tended to support excluding federal lands in the definition of renewable biomass in federal energy policy.

Still other participants saw a middle ground and felt that advanced analytical tools and technologies could help identify acceptable options for biomass harvesting on federal forests that are other than all-or-nothing. Spatial analysis tools can help highlight forest areas that are exceptionally valuable from a biodiversity conservation standpoint, or exceptionally vulnerable due to factors such as steep slopes or highly erodible soils. While some areas of federal forests, such as wilderness or roadless areas, may continue to be entirely off-limits as a matter of principle, it may be practical and acceptable to remove biomass for hazardous fuels reduction or other ecological restoration purposes from other areas of federal forests, through the development of special standards designed to protect the particular values in question. Participants who held these views tended to support including federal lands in the definition of renewable biomass in federal energy policy with the caveat that certain lands should most certainly be off-limits and that ecological sustainability is best determined at the local level through existing planning and environmental review processes, using the best available spatial data to locate areas off-limited and areas requiring that additional measures be applied to safeguard conservation values.

No matter the definition of renewable biomass in federal policy, participants continually voiced that the predominance of federal lands in the West and the high stakeholder interest in forest management decisions creates a context in which the "social license" for forest management is crucial. Dialogue participants noted several pockets of activity across Western forest landscapes with active multi-stakeholder collaborative processes that form the basis for determining areas where silvicultural treatments are to be applied to address concerns over forest restoration and wildfire risk. In the absence of clear, or the presence of several conflicting, national-level goals with regard to restoring forest ecosystem health and resiliency, place-based and regional collaborative groups are coming up with their own goals, objectives, and strategies, often independent of national-level goals and policies. Participants commented that one consequence of this process is that these collaborative efforts are often not adequately supported by the federal budget process.

Forest restoration and cogeneration in the Pacific Coast

As in many areas of the West, the forest products industry has declined significantly in Lakeview, Oregon, a rural community adjacent to the Fremont-Winema National Forest. The region's "dry-side" forests are also experiencing what many describe as a forest health crisis. Since 2003, the Lake County Resources Initiative, a community-based non-profit organization, and the Collins Pine Company have worked to develop a strategy that balances the restoration of the region's forests with new opportunities for rural economic development. After evaluating the different options and assessing the available and sustainable biomass supply from restoration activities on both public and private lands, Oregon's Governor Kulongoski announced that a biomass cogeneration plant would be built to work with the Collins Pine Companies' new small-diameter sawmill. This announcement also marked the beginning of a 20-year biomass supply agreement between the Collins Company and the USDA Forest Service's PNW Region. The Forest Service is in the process of developing three ten-year stewardship contracts on the Fremont-Winema National Forest that would result in a consistent biomass supply for the cogeneration facility. Although federal appropriations will be needed up front to complete the removal of low-value small-diameter timber, the stewardship contracts are expected to produce a positive return over the long term, providing multiple economic benefits to the local community in terms of income and employment. The Oregon government estimates that the construction of the cogeneration facility will result in 200-250 temporary jobs. Once it is operating, the facility will provide 18 skilled jobs. The long-term supply contracts are also expected to create 50-60 jobs in the woods, and another 59 indirect jobs in the community of Lakeview.

Participants generally felt that these collaboratives should be supported and pointed to instances where deliberative collaborative processes have resulted in agreement on harvesting standards and the acceptable volumes of biomass that can be removed from the federal forests through long-term stewardship contracts. Participants repeatedly noted a long-term local and regional collaborative process in Lakeview, Oregon that has resulted in defining broadly supported silvicultural treatments across thousands of public and private acres that are bundled in three 10-year stewardship contracts, the costs of which are expected to be offset by providing the biomass supply for a CHP facility operating in conjunction with a small-log saw mill.

Participants pointed to other large landscape-scale projects like the Four Forests Restoration Initiative in Arizona, where a multi-year collaborative process worked to identify 1.7 million acres across a 2.4 million acre landscape that has been identified as needing a comprehensive landscape restoration effort. Despite this agreement, the project requires significant capital investment to process the large amount of material that would be generated through restoration activities, and federal acquisition regulations are presenting a roadblock to the collaborative group's momentum in exploring biomass utilization options through stewardship contracts.

Federal agency representatives identified that their inability to enter into multi-year supply agreements is another factor that has thus far limited wood biomass production from federal lands, and helped discourage energy companies from investing in biomass energy facilities where most of the locally available biomass is on federal lands. Since 2003, both the Forest Service and Bureau of Land Management have had clear statutory authority to enter into multi-year agreements for ecosystem management and forest stewardship purposes (including thinning and hazardous fuels reduction) in which the contractor is allowed to utilize the biomass removed as full or partial compensation for the services rendered (P.L. 108-7). These goods-for-services agreements, known as stewardship contracts, are ideally suited for biomass removal, especially as the value of wood biomass for energy increases.

Thus far, neither federal agency has made extensive use of this authority to establish long-term supply agreements with new biomass utilization facilities, in spite of strong support—even impatience—from Congress and the Department of Agriculture, the Department of the Interior, and the agencies themselves. This is partially attributed to a requirement in the federal acquisition regulations that a federal agency establish a "contract cancellation ceiling reserve" from which to pay the contractor should the agency need to cancel the contract prematurely (Pinchot Institute 2010). Local agency units, already straining under tight budgets and limited contracting personnel, are generally unable to put up a reserve to cover the cost of constructing the biomass energy facilities that would utilize the biomass generated during stewardship projects. The agencies have proposed modifications to the contract cancellation ceiling reserve requirements that would allow several pending multi-year biomass supply agreements to move ahead, but this requires Congressional action that has yet to take place.

Recommendations:

- Encourage the development of a uniform legislative definition of renewable biomass.
- Develop standards for biomass harvesting in connection with ecosystem restoration treatments, especially for areas of unique conservation value or high environmental sensitivity.
- Provide federal land management agencies flexibility to waive contract cancellation ceilings for multi-year stewardship contracts for biomass removal associated with ecosystem restoration projects, or pool funds to form a contract cancellation ceiling reserves pool at the national level.
- Enable collaborative planning and multi-party monitoring in which community, business, and environmental considerations are addressed in an open, transparent, and inclusive process, creating the "social license" for timely implementation of forest management projects.

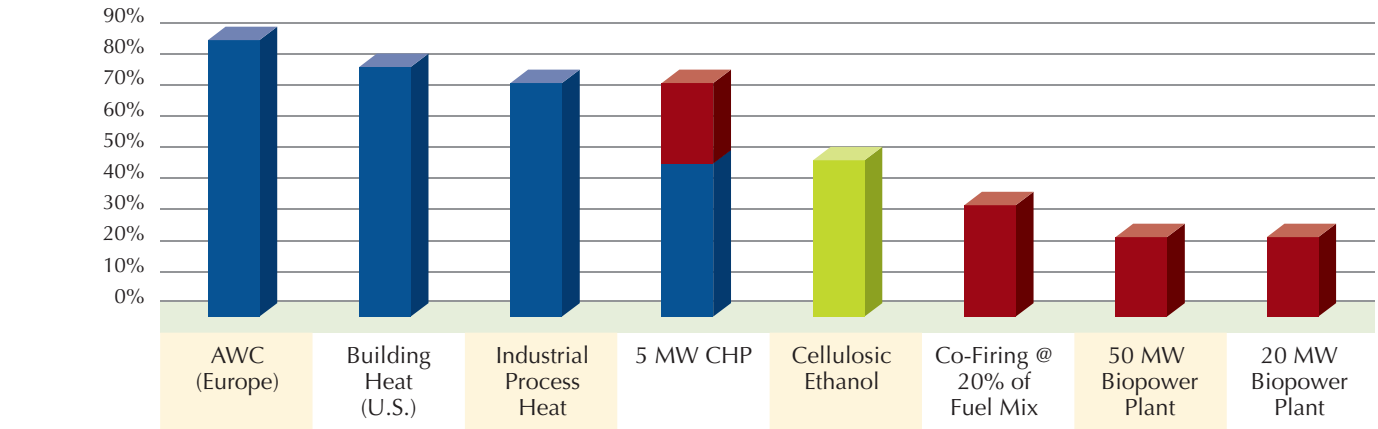
Finding 4: Federal and state policies do not adequately recognize the full range of wood biofuel and bioenergy options, especially options that have been shown to offer greater energy efficiency and be better suited to local availability of biomass supplies.

Forest biomass is often described as a vast and largely untapped resource. Yet, as noted in discussions during each workshop in this dialogue, wood can only supply a small fraction of our overall energy needs. Participants recognized the private sector's driving role in determining a final "build-out," but also emphasized that public policy is largely behind the magnitude of these investments. Wood will continue to be a scarce resource in economic terms, and mandatory goals such as those being considered for the RES will make demand for wood and wood biomass increasingly inelastic. These and other challenges associated with providing large volumes of low-cost biomass over the long term, as well as the need to stay competitive in electricity markets, can make investments in bioenergy projects a risky endeavor. Participants noted that federal and state policy efforts to overcome this risk are premised on the idea of making these investments more attractive by promising some upfront returns, yet such policies do not necessarily address the underlying risk involved in sourcing biomass.

In part due to a collective realization of the limits of biomass supply and the potential negative impacts of pushing these limits, there was a strong and consistent voice from multiple sectors that policy may need additional focus on promoting the efficient use of a limited biomass resource. Some participants emphasized the relative efficiency of some technologies (thermal and CHP), noting the potential for public policy to promote efficient use of limited biomass resources (see Figure 7). Participants recommended that the crafting of tax subsidies and other kinds of financial incentives be aimed at supporting the growth of the domestic renewable energy industry and include adequate incentives for the most efficient technologies.

At the same time, participants acknowledged that CHP and district thermal energy systems have practical upper bounds tied to the need for these projects to service an appropriate heat sink. Other obstacles to expansion of CHP and thermal that were identified include community willingness or ability to invest, the

Figure 7. Relative biomass conversion efficiency of bioenergy technologies.



	AWC (Europe)	Building Heat (U.S.)	Industrial Process Heat	5 MW CHP	Cellulosic Ethanol	Co-Firing @ 20% of Fuel Mix	50 MW Biopower Plant	20 MW Biopower Plant
Biofuel					50%			
Electricity				25%		35%	25%	25%
Thermal	89%	80%	75%	50%				

Source: Biomass Energy Resource Center; Richter et al. 2009.

status of existing wood markets and infrastructure, and interconnection policies that are biased in favor of large-scale producers.

The concept of "appropriate scale" was at the foundation of discussions about the various technological options. Participants recognized that there may be places across the country where large-scale electricity-only power plants, biorefineries, or pellet plants may be the best option, and may be appropriately scaled to the economically available and environmentally sustainable biomass resource. Some voiced that in regions with large biomass resources, energy production should seek economies of scale that larger facilities offer. Still others saw cofiring of biomass with coal at existing power plants as the most immediately viable and beneficial option.

Participants cited instances where communities considering larger scale power plants, on the order of 50 MW to 100 MW, that require 1.2 million tons of sustainably supplied wood annually, are better served by facilitating the construction of several smaller CHP facilities distributed across the region and located in conjunction with a user capable of utilizing the thermal energy produced during the production of electricity. In the example above, the power that was originally planned through a single central power plant may not be easily achieved through distributed generation; however the net energy produced—albeit in the form of both useful thermal energy and electricity—will be greater. These CHP systems are so efficient because they are designed around thermal energy output, with electricity being generated as a byproduct. Some participants countered that, energy demand is increasing and not decreasing and that renewable electricity is needed more than renewable heat. Proponents of CHP argued that the need to locate at sites with electricity and heating and/or cooling demands keeps biomass supply requirements manageable, because CHP facilities are usually on the small-to-medium scale, are more efficient users of wood, and thus require less biomass.

Across Europe communities have installed more than a thousand smaller scale (10 MW or less) power plants that provide both heat and power to both urban and rural communities. Smaller advanced wood combustion technologies (AWC) provide heat to rural communities, are remarkably efficient (up to 90 percent), produce minimal amounts of greenhouse gases or other air pollutants, and are linked to the sustainable management of local forests (Richter et al. 2009). In Austria, more than 100 of these plants combine heat and electric power to serve towns, portions of cities, industrial complexes, and public institutions (Bratkovich et al. 2009). It is estimated that if one state, North Carolina, were to construct one facility of this type each year in each of its 100 counties over a 5-year period, the $100 million annual investment costs would soon be offset by fuel savings of up to $180 million each year, and fossil emissions of greenhouse gases would be reduced by up to a million tons annually (Richter et al. 2009).

Biomass energy in Vermont

Over the last few decades the state of Vermont has quietly become a forest biomass energy leader. The Northeast consumes 84 percent of the nation's heating oil, which is a significant expense for the region. In an effort to combat this trend Vermont began the first "Fuels for Schools" program in the mid-1980s. Today, 20 percent of the state's students learn in buildings heated by high efficiency wood boilers at 45 public schools throughout the state. The Fuels for Schools concept has been successfully replicated in seven other states, with pilot programs in two more. Vermont is also a leader in mid-sized district energy facilities. In 2009, Middlebury College unveiled an advanced biomass gasification facility that offers efficiencies up to 89 percent. This small-scale gasification unit is expected to cut Middlebury's annual carbon dioxide emissions by 40 percent and reduce fuel oil consumption by 50 percent, while providing heat and electricity to the campus. The college has also invested in 10 acres of short-rotation willow crops grown on marginal agricultural land a short distance from campus, which serves as both a supplemental fuel source and demonstration project. On the larger scale, Burlington, Vermont's 50 MW McNeil generating station has operated for more than 25 years without negatively impacting the region's forests. This plant has developed a multi-tiered wood procurement standard to ensure that biomass is supplied in a sustainable manner. The facility employs a professional forester who monitors each harvest to ensure that the procurement standard is adhered to, and each planned harvest must first be approved by the Vermont Department of Fish and Wildlife.

Participants who felt that policy initiatives ought to facilitate this kind of development in the U.S. recommended that policymakers: (1) institute carbon management policies that encourage the substitution of wood for fossil fuels for use in highly efficient energy conversion technologies; (2) make AWC the energy system of choice for new construction and renovations in communities with adequate local wood supplies; (3) make more efficient use of urban wood waste from tree removals and construction; and (4) expand construction of AWC-powered district-energy systems in which heat is supplied from a central source to complexes of

commercial/institutional buildings. The upfront capital costs of AWC can intimidate potential would be users, yet the payback is generally less than 10 years, with these projects becoming revenue positive in a shorter timeframe than larger projects. The advantages that larger projects can achieve through economies of scale, and their ability to attract equity investors in ways that AWC presently does not, may be largely negated by a greater potential for supply-chain risk and public disapproval.

In every regional workshop, participants noted that thermal energy from renewable sources has thus far received little attention in federal policy, even though space heating and cooling accounts for nearly one-third of energy consumption in the U.S. Federal and state agencies charged with protecting air quality generally have not supported increased use of wood heat in individual homes (with the exception of woodstove exchange programs) because of high levels of particulates typically emitted by household woodstoves. In recent years, however, household-scale wood pellet furnaces that operate at much higher temperatures, and thus provide much more complete combustion, have become widely available and increasingly affordable.

Highly efficient low-emission industrial-scale wood furnaces have been installed on college campuses, at hospital complexes, in greenhouses, and in downtown areas of numerous communities where they provide heat (and in some cases cooling as well) to several closely situated buildings. These "district energy" facilities sometimes include electric power generation for local use as well. These relatively small-scale facilities are among the most efficient converters of wood biomass to energy, and for the most part are easily supplied from sustainably managed local forests. They bring the added benefit of providing a variety of local employment in wood harvesting and transportation, as well as keeping expenditures for energy circulating within the local economy rather than sending these dollars to distant fossil fuel producers.[13]

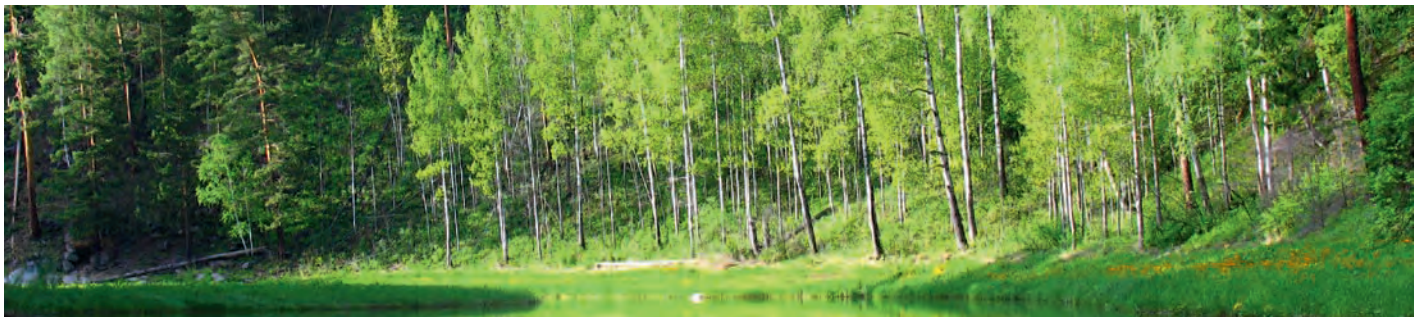
Some dialogue participants promoting thermal and CHP pointed to Arizona and Massachusetts as examples of states that include thermal energy as a compliance option in their state RPS. Power plants that capture and utilize heat that would otherwise be wasted (i.e., CHP) are allowed to substitute thermal energy for electric power in meeting mandatory targets for electricity production from renewable sources (3,413 BTU of heat is equivalent to 1000 kWh of electricity). Such a provision creates a new market-based incentive for the most efficient means of utilizing wood biomass for energy.

Other states may follow suit with their RPS, and inclusion of thermal and CHP remains an option being considered for the federal RES. Such a provision in a federal RES could allow electric power producers to reach a portion of their renewable energy targets by purchasing credits from thermal-only facilities that use wood biomass (i.e., using the same ratio of 3,413 BTU = 1000 kWh), creating a potentially significant performance-based incentive for renewable thermal energy producers, at a low cost or even no cost to government. Participants noted that when thermal energy options are included and equally valued, ambitious targets for renewable energy production, such as a 25 x'25 goal, are more likely to be achieved, and with far less additional harvest pressure on U.S. forests.

Recommendations:

- Develop renewable energy policies that recognize and incentivize renewable biomass energy options for heating and cooling (thermal energy).
- In crafting subsidies and various financial incentives, attention should be given to those technologies that provide high levels of efficiency.
- Consider policies that support distributed and "appropriately scaled" approaches that may provide socio-economic benefits, such as employment in natural resource-based industries, and provide high levels of efficiency.

[13] It is estimated the $6 billion leaves the Northern Forest Region in NY, VT, NH, and ME each year through petroleum-related fuel consumption (Biomass Energy Resource Center).



Conclusion

Addressing the interlocked challenges of energy security and climate change is perhaps the most urgent challenge facing humanity in our era. It is not simply an environmental issue. It is an economic and social issue of enormous proportions here in the U.S., in other industrialized nations, and especially in developing nations around the world. Energy conservation and the expansion of zero-carbon energy sources like wind, solar, and geothermal will get us part of the way there, but renewable, low-carbon energy sources like wood and other biomass must inevitably play a large and essential role.

Finding a substitute for petroleum-based transportation fuels will become an increasingly urgent priority as well. As the basic physical infrastructure of the U.S.—the layout of our cities, suburbs, highways, and transit systems—developed after the near-total shift to fossil fuels, the functioning of U.S. society relies heavily on the continued supply of abundant, cheap energy. The DOE points out that a 25 percent production target in both the electricity generation and transportation fuel markets would lead to higher energy prices (as producers substitute more expensive renewable fuels for less expensive fossil fuels that do not currently internalize the cost of carbon emissions) and that these higher energy prices will have an impact on economic activity (EIA 2007a).

When it comes to addressing the nation's increasing demands for electricity, especially renewable electricity, the details of renewable energy policy are extremely important for forests. As concluded by the Department of Energy, much of the energy needed to meet a 10 percent national renewable electricity standard could be supplied by wind power, while a 20 percent goal would likely rely more heavily on biomass, and require as many as 700 new 100 MW power plants, each of them consuming an average of 1.2 million green tons of wood annually (EIA 2003) and the annual net growth from close to 1 million acres of timberland.

There are multiple alternative energy sources for electricity and heat, but for domestic renewable transportation fuels there are few significant alternatives to biomass. Our physical infrastructure of suburbs and highways cannot be changed overnight. If Americans are faced with the choice of enduring the economic and social impacts of higher energy costs, or accepting greater environmental impacts on the nation's forests, it will not be an easy decision and the outcome is far from certain.

Accurate, reliable information on wood biomass supply that can be sustainable over the long term is essential if state and local government officials are to decide how to best meet their constituents' needs. These needs include protecting and sustainably managing natural resources that ensure clean water, wildlife habitat, and the other essential ecosystem services that forests provide, as well as renewable energy. Such information is essential to the energy industry and community leaders as they decide the type, scale, and location of a biofuels or bioenergy facility that will be best suited to the locally available and sustainable supply of biomass, and that will be financially viable as competition for feedstocks increases. And it is essential for natural resource managers charged with the responsibility of ensuring that forests continue to be managed in accordance with accepted standards of sustainability, but who also recognize that even the best standards are of little value if too many wood-dependent facilities get placed in too close a proximity to one another and wood demand simply overwhelms local supply. Therefore, it is essential that state environmental review of proposed projects address the full range of sustainability considerations, from site-level impacts at project construction through plant decommissioning decades in the future, while appropriately considering impacts to forests.

Perhaps most importantly, this information is essential to national and state policymakers who are considering ambitious mandatory goals for renewable energy production, and who will design the subsidies, tax credits, trade tariffs, and other incentives that they think will best support the development of a biofuels and bioenergy industry that will meet those goals. Policies to define the role of federal forests in biomass supply are inconsistent. Clear policy direction is essential to the development of guidelines to ensure continued conservation and sustainable use of these public lands.

It is clear that forests are poised to play a major role in the nation's energy future. This can be a positive development from the standpoint of making the transition to renewable energy and improving the health and productivity of U.S. forests. But it is essential that policymakers, energy producers, and all of us as energy consumers do not lose sight of the fact that U.S. forests, extensive though they may seem, are a scarce resource relative to what they are expected to provide. Almost too late did we comprehend that forests were not an inexhaustible resource during an earlier era in which we depended on forests as our primary energy source. Their utilization must be guided, by informed, insightful policies that encourage innovation in the efficient use of this limited resource; that facilitate a diversity of different types, scales, and locations of biofuels and bioenergy facilities that are well matched to local circumstances; and that are grounded in a continued commitment to the conservation and sustainable management of forests for the full range of values and services they represent.

When the U.S. last relied upon wood as a major source of energy—up through the end of the 19th century—the nation's forests were down to their smallest area in history and were being rapidly depleted (Starr 1865). The shift to fossil fuels in transportation, heating, electricity, and industrial processes in the late 1800s came just in time, and gave America's forests a century to recover (Williams 1989). With adequate foresight and planning, wood biomass can play a significant role in meeting the nation's energy needs in the 21st century, avoiding the pitfalls of the past and ensuring that the use of wood for energy contributes in positive ways to the sustainable management of both public and private forests across the country.

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Appendix

Policy Dialogue Workshop Dates and Locations

Scoping Workshop — Pocantico Conference Center, Tarrytown, New York. September 17–19, 2007
National Workshop — Resource and Conservation Center, Washington, D.C. February 9–10, 2009
Southern Regional Workshop — North Carolina State University, Raleigh, North Carolina. August 26–27, 2009
Great Lakes Regional Workshop — University of Minnesota, Chaska, Minnesota. September 9–10, 2009
Interior West Regional Workshop — Colorado State University, Fort Collins, Colorado. October 7–8, 2009
Pacific Coast Regional Workshop — University of California, Davis, California. February 24–25, 2010

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Two major national priorities—mitigating climate change, and achieving greater energy security though increased domestic renewable energy production—have converged to create rapidly expanding demands on U.S. forests for wood-based bioenergy. Careful consideration and forethought is needed, however, to ensure that increases in wood harvesting do not lead to unintended consequences for biological diversity, water quality, and other forest ecosystem values. This report summarizes the results of a two-year study of the challenges and opportunities for sustainable wood bioenergy, including a national dialogue involving more than 280 experts and stakeholders across the U.S. and Canada, and contains recommendations that can help achieve important public policy goals for both renewable energy and sustainable forest management.

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