YALE FOREST FORUM
SPEAKER SERIES SUMMARY

YFF Review

The Future of Forest Products in a Changing Climate: Bioenergy from Forests

January – April 2022

New Haven, Connecticut, USA

The Forest School at the Yale School of the Environment

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Front cover photo: Wood chips for bioenergy at the Plainfield Renewable Energy plant. Photo by Gary Dunning.

Back cover photo: Bruks chipper loading biomass for transport. Photo courtesy of Oregon Department of Forestry. CC BY 2.0, via Flickr.

YALE FOREST FORUM AND *YFF REVIEW*

The Yale Forest Forum (YFF) is the convening hub of The Forest School at the Yale School of the Environment. YFF offers weekly webinar Speaker Series during the academic year to provide opportunities to hear from leaders in forest management, conservation, academia, and policy. Each YFF Speaker Series is organized around a key theme or challenge facing forests, forestry, and people. Guest speakers represent a wide range of perspectives and organizations, including government, NGOs, and businesses, and across scales from local to international. The *YFF Review* is a publicly available output of the series, summarizing key learnings and examples from the YFF Speaker Series.

Biomass markets could provide economic value to small diameter trees such as these in Sproul State Forest, Pennsylvania. Photo by Nicholas A. Tonelli.

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Conifer forest. Photo courtesy of Pexels.

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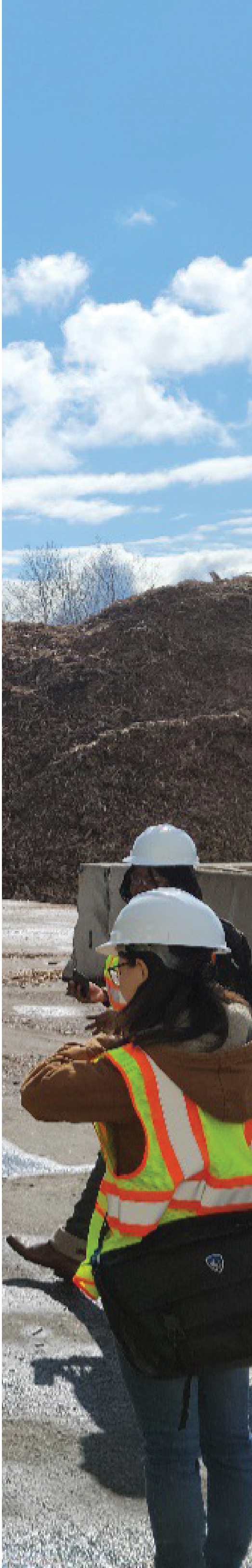
Introduction

By: Yvonne Shih

The Yale Forests Forum (YFF) has been engaging people on the most important issues in forestry since 1994. In the spring of 2022, YFF brought together more than 1,000 registered attendees from around the world to hear from twenty experts and leaders discussing the future role of bioenergy from forests in addressing climate, resource, societal, and environmental challenges at regional and global scales. Speakers represented forestry, energy, policy, communities, conservation, industry, and academia.

Energy generated from the combustion of wood, wood wastes, or biofuels derived from wood, collectively known as bioenergy from forests, has been heralded by some as a promising renewable energy source. Yet others raise concerns over negative impacts on the environment and human health, as well as potential increases in greenhouse gas emissions. Currently, in the United States, the Biden Administration's climate emphasis has inspired renewed conversations over a full suite of energy technology and natural climate solutions, including biomass energy produced from both hazardous fuels and managed forest systems. Some consider bioenergy from forests an important component in the transition away from fossil fuels while reducing greenhouse gas emissions, key to achieving economy-wide net-zero targets. For others, the efforts to scale up bioenergy from forests raises concerns about natural resource demands and larger sustainability priorities.

The speakers from this series share a range of perspectives on the potential impacts that bioenergy from forests might have on forests, communities, and global carbon budgets. The seminar instructors Mark Ashton, Gary Dunning, Reid Lifset, and Anastasia O'Rourke began the series by providing a broad overview of the current understandings and key issues related to bioenergy from forests, touching upon a life cycle overview, methods for turning wood into energy, energy systems, environmental and social impacts, and key areas of contention.



The bioenergy seminar students tour the Plainfield Renewable Energy plant.
Photo by Gary Dunning.

Forest bioenergy is often considered as an alternative to fossil fuels that could reduce greenhouse gas (GHG) emissions. However, the net benefit of forest bioenergy as an alternative to fossil fuels has generated controversy. Alice Favero discussed the impacts of bioenergy from forests on forest land use and climate change mitigation. Annie Levasseur highlighted how a life cycle assessment (LCA) can be applied to assess forest bioenergy pathways and to compare their carbon balances to those of fossil fuels. Ann Bartuska provided an overview of the policy vehicles that address land use issues, carbon accounting, federal vs state-based oversight, and the positioning of forest bioenergy as a renewable fuel.

Steve Hamburg delved into the reasons why forest biomass is so contentious, exploring the influence of land-use history, metrics, and forestry practices. William Moomaw considered the discourse around bioenergy from forests as a nature-based solution. To fully understand the scope of the extent of forest bioenergy use and its benefits, Kim DuBose and Richard Peberdy presented biomass industry perspectives, highlighting that the U.K. and Europe are driving the use of wood energy and how sustainable wood pellet production impacts working forests in the U.S. South. Treva Gear and Adam Colette highlighted environmental justice and economic impacts of large-scale industrial logging on the U.S. South, with a particular focus on the wood-pellet biomass industry, which has rapidly expanded across the region over the past ten years. From the western United States, Dan Sanchez and Matt Donegan spoke about the potential role of bioenergy in mitigating wildfire including through the use of wood residues and maximizes carbon benefits.

The series concluded with a panel of practicing foresters, sharing their perspectives on current and future challenges and opportunities of forest bioenergy. Whether discussing new research on forest bioenergy or the environmental justice impacts on communities, every presentation in this YFF series exposed audience members to the cutting-edge ideas and research at the forefront the rapidly evolving field of forest bioenergy.

Tree tops from harvests such as this in Finland are often used in biomass energy.
Photo by Samuli Skantsi.

"The Future of Forest Products in a Changing Climate: Bioenergy from Forests" was jointly hosted by The Forests Dialogue, the Yale Center for Industrial Ecology at the Yale School of the Environment, and the Yale Carbon Containment Lab. The Forests Dialogue was created in 2000 to provide a platform for leaders in forestry from across the world to engage in dialogue about and develop solutions to the most pressing issues in sustainable forest management. The Center for Industrial Ecology was established in 1998 and designed to bring together Yale staff, students, visiting scholars, and practitioners to develop knowledge at the forefront of the field of industrial ecology. The Yale Carbon Containment Lab tackles the challenge of climate change by developing carbon containment methods that are low cost, safe, and scalable, focusing on adapting and managing natural systems involved in sequestering carbon.

All materials referenced in this document including, bios for speakers, readings, and all webinar recording material, can be found at the Yale Forests Forum website.

Biomass production facility. Photo courtesy of Daniel Sanchez.

Overview of Bioenergy from Forests (BEF)

January 25, 2022

MARK ASHTON, PhD, *Morris K. Jesup Professor of Silviculture and Forest Ecology*
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THE FORESTS DIALOGUE/THE FOREST SCHOOL

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YALE CARBON CONTAINMENT LAB

By: Max Wasser

Mark Ashton

Gary Dunning

Reid Lifset

Anastasia O'Rourke

This Yale Forest Forum speaker series was kicked off by Mark Ashton, senior associate dean of The Forest School at the Yale School of the Environment, who introduced the topic of wood bioenergy from forests. In this opening webinar, Ashton introduced the other instructors and co-leads, as well as the geographical scope and limitations of the series' discussions. He explained that while forest bioenergy is still a critical part of the energy mix, this semester's webinar focuses on the integration of forest bioenergy specifically into the North American Energy system.

The three other seminar co-instructors were: **Anastasia O'Rourke**, managing director at the Carbon Containment Lab at YSE, bringing expertise in carbon sequestration; **Reid Lifset**, Research Scholar and Resident Fellow in Industrial Ecology at YSE, providing expertise in wood product and bioenergy life cycle assessment; and **Gary Dunning**, Executive Director of The Forests Dialogue and The Forest School, whose work remedies forestry conflicts by bringing together forest stakeholders.

Lifset presented a systems overview of forest bioenergy and some factors which must be considered when analyzing these systems: fossil fuel inputs for harvest, transportation and processing, and the biomass' source. Emissions from forest degradation must also be carefully measured.

Wood Bioenergy System Overview: CO_2

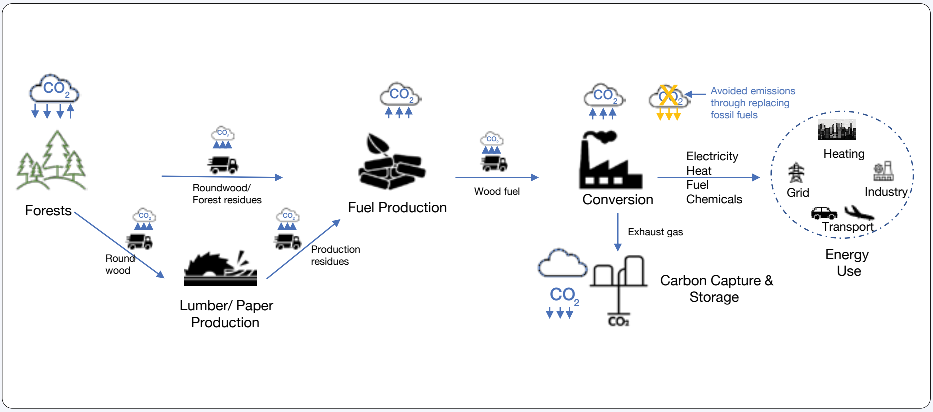


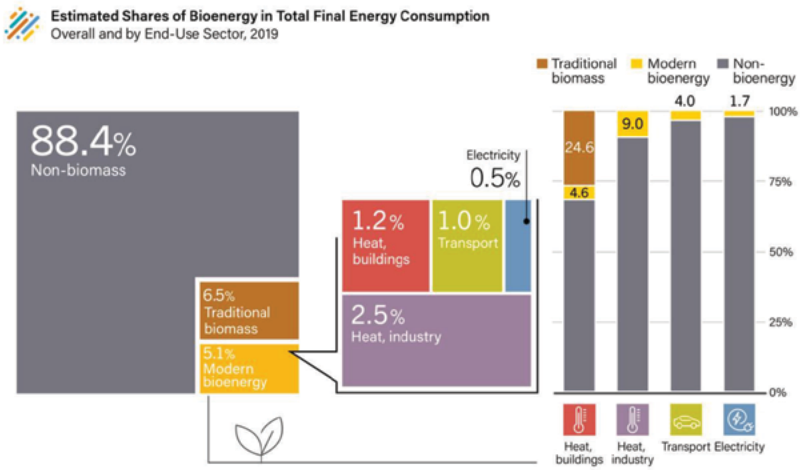
Image credits: Glyph.faisalovers, Vecteezy.com, www.equinor.com

An overview of CO_2 in wood bioenergy systems. Figure courtesy of Reid Lifset.

Beyond environmental and resource impacts, positive social and economic effects, including jobs and tax revenues, must also be weighed against negative impacts such as air pollution and environmental justice concerns.

O'Rourke discussed the potential role of forest bioenergy as a negative emissions technology, how carbon capture and storage can be utilized with forest bioenergy, and finally how the forest bioenergy can be used. She indicated that there are different bioenergy types: forest products, agricultural crops, garbage, and agricultural waste. However, this seminar focuses on use of wood as an energy source. She then provided an overview of how we can turn wood into energy:

Bioenergy's share of global total energy consumption



Biomass's share of global total energy consumption. Figure by REN21, 2021.

O'Rourke noted that while bioenergy constitutes 11% of global energy, only half of that 11% is considered modern, and 0.5% of global energy consumption is electricity generated by biomass. In the United States, wood and waste combined make up of less than 3% of electrical generation.

O'Rourke finished her presentation by indicating that negative emissions technology must play a role if we are to reach net-zero. When combined with carbon capture and geological storage, forest bioenergy can be a negative emissions technology. With a parting thought, O'Rourke left us pondering "how sustainably are these sources being consumed and how efficiently are we doing that?"

Dunning concluded the presentation with an overview of some of the challenges that the industry is facing. Most notably, the shipping of American wood pellets to Europe fuels significant controversy. He left us with the questions to guide viewers throughout the series: "Is bioenergy from forests one of those tools that can positively address climate change? If so: where, when? If not, why?"

Optimal Use of Forestland Under Future Bioenergy Demand Scenarios

February 1, 2022

ALICE FAVERO, *Associate Director Graduate Studies*
SCHOOL OF PUBLIC POLICY, GEORGIA TECH

By: Thomas Harris

Alice Favero

In the second session of the YFF speaker series, Alice Favero, associate director of graduate studies at the School of Public Policy, Georgia Tech, presented research on the impact of bioenergy on forestland around the globe.

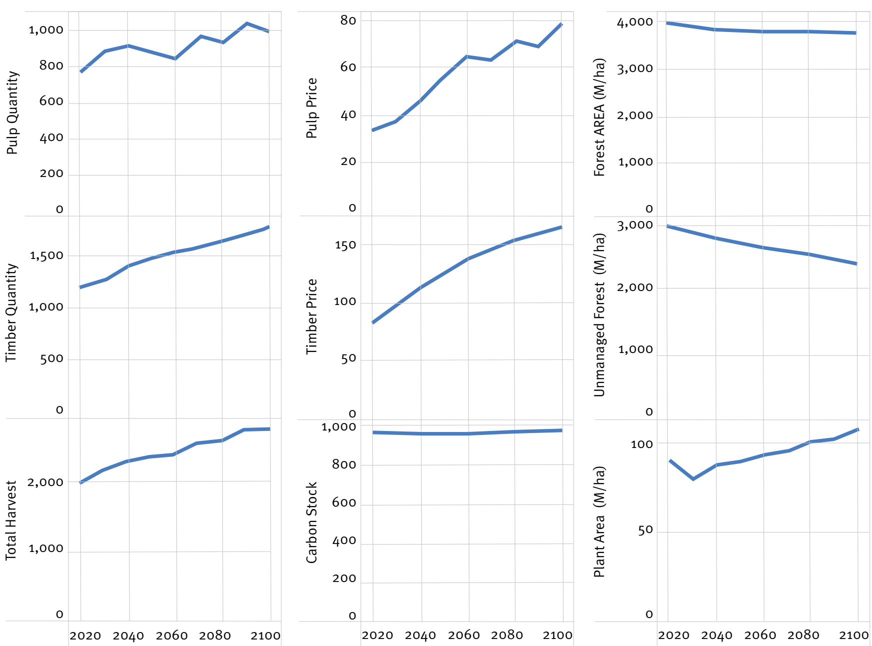
In response to the pressing challenge to reduce an increase in global temperature to moderate the impact of climate change, Favero highlighted the contributions forests and bioenergy can play in storing carbon in working forest systems and reducing emissions. Under the Intergovernmental Panel on Climate Change goal of holding warming to 1.5 degrees, bioenergy could account for 27% of energy production by 2050 and offset reliance on fossil fuels. Her results and analysis show that as goals of reducing warming become more ambitious, bio-energy demand increases.

However, managing forests to help our climate goals is not straight forward. Favero points to the debate over the use of biomass for energy production. There are two prevailing risks:

1. If harvesting increases, will standing biomass in forests and associated carbon sequestration (e.g., carbon debt) also be reduced?

2. Will the blossoming bioenergy demand facilitate the conversion of primary forests to working forests, resulting in a loss of ecosystem services provided by those forests?

Favero utilized the Global Timber Model (GTM) to test the potential impacts of different scenarios on the world's forest carbon stocks. The strength of the GTM is that it is a forward-looking model that can simultaneously solve for ecosystem benefits while comparing different spatial and intertemporal scales. The GTM also incorporates the impacts of form changes in forest product markets and forest management activities. The model allowed her to test the effect of today's demand on future investment in bioenergy and how investment in one region impacts other regions. These various scenarios are compared by calculating the net present value (NPV) of the current and all future management actions, bringing those scenarios to a value of consumer and producer surplus. The two main inputs for the model were global income and population growth. The results from forecasting the baseline scenario are shown in the corresponding figure.



The expected volume of harvest, carbon stocks, forest area, and value of different forest products using the Global Timber Model (GTM) under the baseline scenario. Figure courtesy of Alice Favero.

Favero analyzed the effects of increasing bioenergy demand scenarios on the current carbon debt baseline. She demonstrated that a low increase in bioenergy demand is not enough to justify new investment in forests, but instead justifies the conversion of natural, unmanaged forests to managed forests, thereby increasing the carbon debt. On other hand, the mid to high demand scenarios justify the conversion of more land to forests, overall increasing total aboveground carbon stocks in forests, with the carbon debt being met in 20 to 40 years.

Slash pile following logging. Photo courtesy of the Oregon Department of Forestry.

To implement the results of the analysis, Favero suggests two policy options:

1. **A forest carbon rent** involving a payment to the landowners for carbon stored in their forests
2. **Tax on bioenergy consumption** which applies additional costs to the consumption of biomass for energy. She recommended the rent-based approach, citing higher potential for natural forest preservation across all biomass demand pathways tested.

To summarize the results, Favero points to four key outcomes of increased demand for biomass:

1. **More land** will be converted to managed forests.
2. **More traditional timber products** will be replaced by woody biomass production.
3. **More investments** will be devoted to increasing growth and yield of managed forests.
4. **A tax on bioenergy consumption** is a potential policy solution.

In conclusion, the regulation and policy instruments available to reduce negative effects of bioenergy help maximize the suite of direct benefits of forest carbon storage and sequestration and the indirect benefits of protecting natural and primary forest cover. Favero discussed several avenues for additional research, including the impact of climate change on the availability and productivity of forests, new wood-based products such as mass timber and cross laminated timber, and linking the role the forest sector plays in climate change mitigation.

Small diameter logs are collected on the landing to be transported to a bioenergy plant in Finland. Photo by Samuli Skantsi.

Carbon Accounting of Forest Bioenergy Using Life Cycle Assessment

February 8, 2022

ANNIE LEVASSEUR, PhD, *Professor*
DEPARTMENT OF CONSTRUCTION ENGINEERING, ÉCOLE DE TECHNOLOGIE SUPÉRIEURE

By: Yulan Lu

Annie Levasseur

Annie Levasseur, professor at the École de Technologie Supérieure and scientific director of the Center for Intersectoral Studies and Research on Circular Economy, discussed applications and challenges of life-cycle assessments (LCA) in carbon accounting of forest bioenergy in her YFF presentation.

LCA is a process for evaluating the potential environmental impacts of all activities associated with the entire life cycle of a given product, process, or technology. The International Organization for Standardization (ISO) provides a framework to conduct LCA, with greenhouse gas (GHG) emissions being a key component.

In the life cycle of the generation and use of forest bioenergy, carbon flows from the atmosphere to growing trees and then back to the atmosphere during processes of harvesting, manufacturing, transportation, and combustion. An LCA is used to assess every stage of bioenergy production and consumption in order to understand the environmental impacts of bioenergy and to quantify its potential to mitigate climate change.

PROCESS OF CONDUCTING LCA

1. **Making a comparison with a functionally equivalent system,** such as a fossil fuel cycle, using shared functional units and appropriate system boundaries.

2. **Generate a life cycle inventory** to account for all processes in the life cycle, including emissions of GHGs, other forms pollution, and those caused by flows of materials and energy in the production process. Life cycle inventories incorporate two types of inventory data. Primary or specific data are directly obtained from the forest industry, plants, energy providers, etc. Secondary or generic data are retrieved from more general sources such as literature, statistics, modeling, databases, etc.

Wood chips are unloaded from a truck at a biomass energy plant. Photo courtesy of Richard Peberdy

3. **Converting emissions into their relevant environmental impacts.** For climate change, global warming potential (GWP) is frequently used.

4. **Interpretation, drawing conclusions and providing recommendations** to mitigate the environmental impacts of the life cycle. The results also include limitations and sensitivity analysis.

Previous LCA studies have revealed that the supply chain GHG emissions of forest bioenergy are usually lower than that of fossil fuels. A majority of GHG emissions from bioenergy combustion are compensated by the carbon sequestered from the atmosphere during the growth of the trees. LCA could help us identify forest management strategies that may reduce GHG emissions, but some challenges must still be overcome.

CHALLENGES OF LCA FOR FOREST BIOENERGY

Carbon Accounting

For a long time, bioenergy has been considered carbon neutral. Recent studies have shown that bioenergy can be a net emitter or net sink under different forest conditions. Levasseur drew an example from a forest in Canada that was harvested 100 years ago. With the forest now in a stable state, almost all tree species serve as carbon sinks with negative net emissions. On the other hand, if harvesting is not followed by forest regrowth, then carbon emitted from this bioenergy source would be equivalent to fossil fuels.

There are three main challenges of carbon quantification. First, carbon flow is highly dependent on local parameters (climate, species, soil, etc.) and forest management practices. Second, modeling of carbon in biomass, growing trees, and soil is complex. Third, a baseline scenario of no human intervention has to be defined and it is difficult to assess carbon flows in such a scenario.

Wood waste is ground in preparation to be burned at the Plainfield Renewable Energy Plant. Photo by Gary Dunning.

Timing

The time taken for the harvested forest to return to a non-harvest state is termed its "carbon debt" and varies with type of biomass, the energy produced, and fossil fuels substituted. In the non-harvest scenario, trees will continue to grow, sequestering a given amount of carbon per year. When whole standing trees are harvested, the carbon stored is immediately released to the atmosphere and it takes years for the forest to regrow. The use of branches and forest residues generally produces short carbon debt periods as they will still decay naturally in the non-harvest scenario. Different management styles and bioenergy pathways should be taken into account when seeking to minimize carbon debt.

Biometric pathways showing that carbon debts associated with timber harvesting can range from short to long term. Figure courtesy of Annie Levasseur.

Overall, due to the complex nature of forest bioenergy production and forest regrowth, a combination of strategies is necessary to manage forest resources to maximize the benefit to the environment. LCA serves as an essential tool to measure carbon emissions and other environmental impacts and can therefore help us identify the most effective strategies.

Determining Forest-derived Bioenergy's Impacts on the Climate: Why Is It So Contentious?

February 15, 2022

STEVEN HAMBURG, PhD, *Chief Scientist*
ENVIRONMENTAL DEFENSE FUND

By: Yvonne Shih and Desmond Tutu Owouth

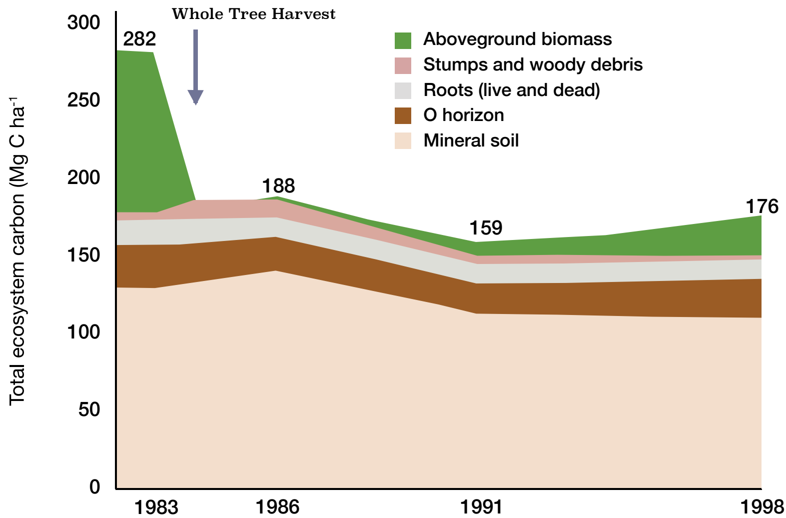
Steven Hamburg

Steven Hamburg, chief scientist and senior vice president of the Environmental Defense Fund (EDF) and executive manager of MethaneSAT LLC, joined the Yale Forest Forum to discuss the efficacy and complexities of forestry-derived bioenergy. Hamburg focused on exploring forest-derived bioenergy's impacts on the climate. This included the influence of temporal and spatial scales, metrics, forest practices, land-use history, pests, and the diversity of ways forestry is practiced across the globe.

Referring to his research on a case study on the Hubbard Brook Experimental Forest in the Northeastern U.S., specifically Watershed 5, Hamburg provided a carbon budget for the watershed for the first 15 years after harvest for bioenergy feedstock. In this case, the whole tree was used for bioenergy. His results illustrate forest carbon content change over time, notably highlighting a decrease in soil carbon over the study period.

Hamburg emphasized the importance of forests as a carbon sink. However, the demand for wood products does not go away and in most cases, substitutes require much more intensive methods that may lead to the release of even more greenhouse gases. Therefore, the use of production byproducts or materials that would otherwise have gone to the landfill could be an easy way to produce bioenergy from the system. Carbon emissions do increase when power plants burn more material to produce bioenergy. However, Hamburg explained what the effect of the material would be if it were not collected and instead were to remain on the ground or decay in a landfill. The resulting carbon emissions would not be that different.

Hubbard Brook Experimental Forest Watershed 5 (22 ha) – Northern Hardwood Forest

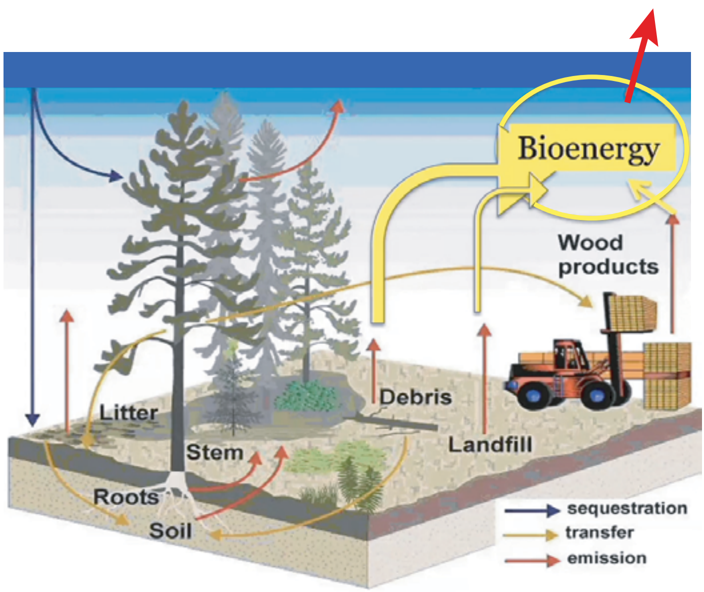


Forest carbon changes over time, in both above and below-ground Carbon pools. Figure courtesy of Steven Hamburg.

Hamburg stated that most would agree that taking waste material and burning it or using it to produce energy is probably “okay” from a climate perspective. Beyond this, however, there is almost no agreement. There are very strong-held opinions across the spectrum of bioenergy from forests, from those who believe it is a critical part of solving the climate problem to those who believe that bioenergy can never contribute constructively to climate issues.

One challenge is the inconsistency of classifying and qualifying what is considered waste material in forest management and the forest products industry. Waste from one production process in a mill may not be present in another more efficient mill. Does slash remaining following harvest constitute waste if left in the forest, or does it serve another purpose? There is a lack of consensus on how waste is defined, especially in economic terms. Hamburg acknowledged that woody debris left in the forest, which some consider to be waste, can reduce the forest's net primary productivity. However, this is not always the case.

Forest Carbon Cycle: Using Waste



Forest biomass can be complementary to the production of wood products. Figure courtesy of Steven Hamburg.

Hamburg explained five issues that need to be addressed to understand the impact of bioenergy from forests on the climate:

SPATIAL SCALES

The spatial scale at which bioenergy from forests is examined matters enormously, from the scale of the stand, woodshed, region, or globe. Hamburg provided an example of a plot of land that is harvested, with the wood burned for energy. This would emit carbon dioxide to the atmosphere, but as regeneration occurs, the growing biomass sequesters more carbon. Over time, if the carbon stocks are returned to pre-harvest levels, the net emissions are zero. The single harvest is not changing the carbon in the atmosphere to a large degree because of all the regrowth simultaneously occurring across the landscape.

TIME

Over what time period is the analysis being considered? This depends on the objectives of the study and there is no single right answer. Hamburg emphasized that a carbon accounting system cannot be accurate across all time scales.

BASELINE OR COUNTERFACTUAL

No one can be certain of how the forest's carbon stocks would change if no action were taken. Both the forest and market demand for forest products are always changing. Hamburg cites the spruce dominated forests in the Northeastern U.S. as an example. The proportion of spruce in forests today have dramatically declined from their proportion at the time of European settlement due to climate change. In the future, the forest will look very different.

The innerworkings of the Plainfield Renewable Energy plant. Photo by Gary Dunning.

DISTURBANCE HISTORY

Species composition within forests is determined by its past disturbance and land use history. Hamburg emphasized the need to manage forests in a healthy and sustainable way in light of climate change and invasive species like the emerald ash borer.

CONSISTENT DEFINITIONS

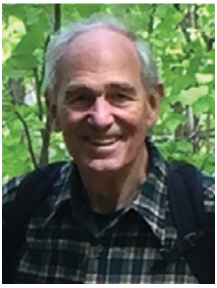
Hamburg explained the need for consistent definitions of sustainability and what is meant by whole tree harvesting. Sustainability does not necessarily equate with climate benefits. There can be sustainable management that can lead to negative climate impacts and unsustainable management that may benefit the climate.

Hamburg highlighted the need for carbon accounting that is operationally feasible, encourages the preservation of existing forest carbon stocks, reduced the net carbon emissions to the atmosphere, and encourages the use of forest products, forest ownership, and protection. However, carbon accounting depends on all of the previously mentioned factors: at what scale, on what timeframe, and toward what goal? In addition, Hamburg explained that the common assumption that forest biomass is inherently carbon neutral simply is not true. Carbon neutrality is not the correct perspective when thinking about forest bioenergy because it undercuts the value that forests can play in mitigating climate change.

Hamburg concluded his presentation by stating that bioenergy from forests is a classic goldilocks problem. There is an opportunity to produce some bioenergy from forest feedstocks, but the production can also go too far in emitting greenhouse gases. There needs to be a middle ground that allows the harvesting of forests while maintaining their role as a carbon sink and improving forest health. Hamburg believes this middle ground is feasible, but it has been a highly contested space.

Forest Bioenergy and Climate Goals

February 22, 2022


William Moomaw

WILLIAM MOOMAW, PhD, *Professor Emeritus of International Environmental Policy*
THE FLETCHER SCHOOL, TUFTS UNIVERSITY

By: Raqib Valli

William Moomaw, professor emeritus at Tufts University and distinguished visiting scientist at Woodwell Climate Research Center, challenged attendees at the Yale Forest Forum to reconsider the premise that forest bioenergy is a viable 'nature-based solution' in the effort to avert climate disaster.

Moomaw began by acknowledging that much of the discourse around producing bioenergy from forests occurs in different conceptual spaces depending on the parties involved, all of which are legitimate. While many stakeholders are primarily concerned with extracting forest goods and services in a sustainable manner, Moomaw stated that his role was to discuss "the physical and ecological science that reveals the urgent need to slow and reverse climate change" in a way that allows for productive engagement between these two often contrary perspectives. Accordingly, Moomaw noted that while his vision involves the eradication of fossil fuel use, he recognizes the value of forestry and the necessity of the exploitation of working forests, as exemplified by his own wooden net-zero home. As such, Moomaw identified the metric that he would use to judge the overall utility of bioenergy (and the relative merits of other competing forms of energy production) as the total amount of CO_2 and other greenhouse gases emitted into the atmosphere, framing this as the primary determinant of whether we will avoid the "dangerous anthropogenic interference in the climate system" described in the Paris Climate Agreement.

Moomaw began his critique of the widely touted assumption that bioenergy is "carbon neutral" at global scales by taking the example of the shift from coal to bioenergy in the U.K. driven by imported wood pellets.

Companies importing this wood claim their industry is a "critical part of maintaining healthy forests" and that "the IPCC recognizes bio-energy as a renewable energy source that is critical to a low-carbon future." Moomaw countered these claims by stating that while the International Panel on Climate Change (IPCC) recognizes bioenergy as "renewable," it does not explicitly describe it as "low-carbon," and it is critical not to conflate these terms. Furthermore, the same IPCC report states that bioenergy consumption is assumed to equal regrowth but does not comment on how often this is actually the case.

Moomaw then discussed some common claims made by bioenergy proponents and his responses to these claims:

Claim 1: To address climate change, it is necessary to replace fossil fuels with renewable energy.

Counterclaim: The goal should be to eliminate emissions of CO_2 and other heat-trapping gases. Wood is more carbon intensive than coal or gas, and its conversion to electricity is significantly less efficient.

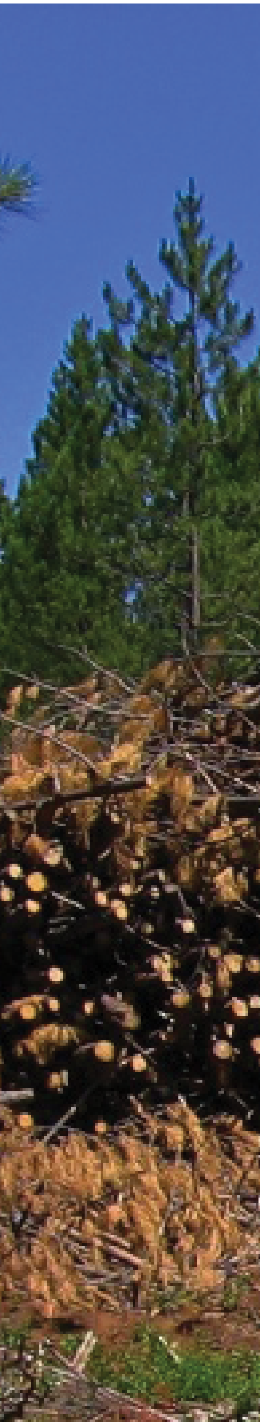
Claim 2: Wood bioenergy is renewable energy.

Counterclaim: Burning wood is instantaneous and growing it back is a slowly renewable process that still increases the CO_2 concentration in the atmosphere. It is arguable whether subsequent carbon neutrality is achieved at climactically relevant timescales.

Claim 3: Wood bioenergy is carbon neutral. Carbon that is emitted now and reabsorbed later has no impact on the climate.

Counterclaim: Emissions from burning wood are comparable to burning coal. Burning it now and removing the CO_2 later causes changes that are not reversed when trees grow back. For instance, added CO_2 from burning wood traps additional heat throughout the regrowth period, melts glaciers and sea ice, raises sea levels, and releases additional methane from permafrost. None of this is reversed when trees grow back; eventual carbon neutrality is not climate neutrality.

A managed forest in Finland in which slash is used o generate boienergy. Photo by Samuli Skantsi



Furthermore, even if forests for biomass are grown, harvested, and regrown in a sustainable manner, the opportunity cost of lost carbon sequestration in managed forests versus the 'old growth' forests that would have arisen if there was no harvest is significant and often excluded from carbon-accounting for forest bioenergy.

Claim 4: Young trees grow faster than older trees. We should harvest older trees for bioenergy and replace them with faster growing younger trees.

Counterclaim: The goal should be to accumulate the most carbon out of the atmosphere by any given date in the future – young trees hold very little carbon compared to older trees, even though their rate of sequestration may be higher. Indeed, Leverett (2021) found that one mature 150-year-old canopy red oak tree carries as much carbon as 35 young canopy trees or 465 very young landscape trees, underlining how trading old trees for young trees is a poor carbon (and biodiversity) trade-off at climactically-relevant timescales, even if more younger trees are planted.

Claim 5: Wood bioenergy is carbon neutral if only waste wood is burned since this waste would simply rot and release CO_2 anyway.

Counterclaim: Waste wood emits just as much CO_2/lb as does burning whole trees, logging waste decay releases CO_2 much more slowly than does burning, and some decaying wood often becomes soil carbon. In reality, whole trees are a significant portion of wood biofuel.

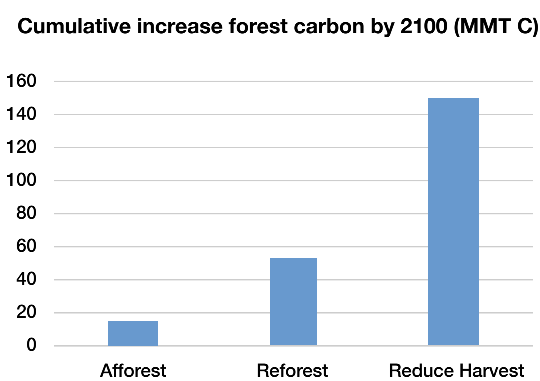
Claim 6: As long as more carbon is removed by forests than is emitted from them, burning wood is immediately carbon neutral.

Counterclaim: Forests in aggregate remove about 25% of human CO_2 emissions from all sources including from bioenergy. Growing forests do not absorb 100% of emissions from wood burning, rather only 25% of those emissions, along with 25% of all other types of CO_2 emissions. Hence, assuming that a regenerating forest will lead to the resorption of all emissions released from burning is misleading.

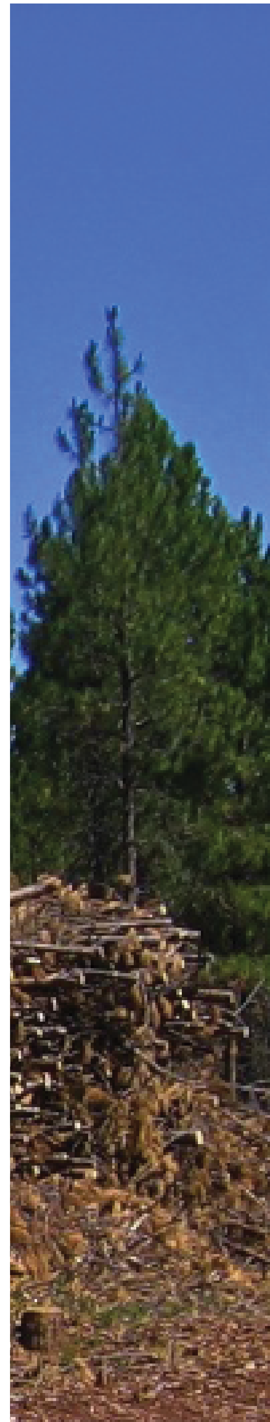
Material destined for wood biomass. Photo courtesy of the U.S. Bureau of Land Management.

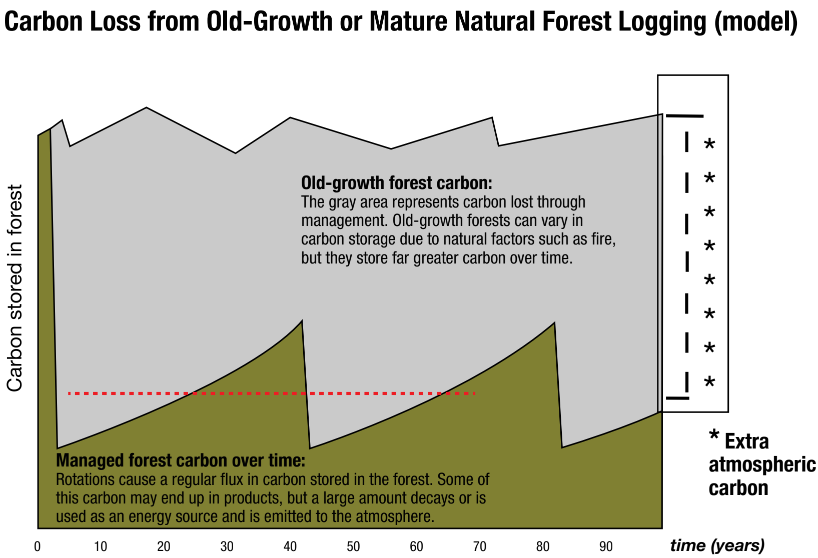
Moomaw concluded that for all these reasons, keeping trees in the ground where they are already growing is likely the most cost-effective and efficient way to slow climate change, arguing that this is well-supported by recent silvicultural literature. Lutz et al. (2018) state that "the largest one percent of trees in mature forests represent 50% of forest biomass worldwide" and that only 7% of U.S. forests are over 100 years old. Altering forest management to let more trees grow would allow global forests to accumulate twice as much carbon under current management practices. Clearly, there are considerable carbon-sequestration advantages to natural forests as compared to managed forests.

This led Moomaw to his major recommendation for forest management going forward. Proforestation is the practice of growing forests to their ecological potential for biodiversity and carbon accumulation in trees and soils. In terms of counter-factuals, the total carbon accumulation in forest stands would be much greater compared to managed stands and would be orders of magnitude less costly than technological methods of carbon capture. When compared to other popular forest management strategies, such as afforestation and reforestation, Proforestation comes out on top, according to Moomaw.



Restricting harvests to half of current rates on public lands and lengthening harvest cycles contributes most to carbon accumulation compared with business-as-usual management. Figure adapted from Law et al. 2018 and Luyssaert et al. 2008, as published in Moomaw's presentation.





Carbon storages over time in old growth forests vs. forests managed for carbon. Image provided by Daniel Sanchez's presentation to the Yale Forest Forum. Harmon and Franklin, 1990.

In summary, to reach net zero carbon goals by 2050, Moomaw argued that we need to slow additions of GHG's to the atmosphere by removing more atmospheric CO_2 than we are adding. Moomaw argues that we do not have enough time for newly planted trees to remove sufficient carbon between now and 2030 or 2050. Forest offsets simply transfer credit but do not alter atmospheric concentrations. Replacing fossil fuels with zero-emitting solar and wind while letting some forests continue to grow is the fastest way to reduce CO_2 additions to the atmosphere. This does not preclude the existence of working forests – a better economic and climate use for forest residues is fibre insulation to make buildings more efficient, rather than burning forests for bioenergy. For these reasons, Moomaw considers dividing forests into those for Proforestation and those for industrial use, which, in conjunction with preventing deforestation, wetlands drainage, and soil loss, is the most effective and cost-efficient means to slow climate change, averting its catastrophic impact on biodiversity and humanity.

BEF Opportunities for Working Forests and Climate Mitigation

March 1, 2022

KIM CESAFSKY DUBOSE, *Director of Sustainability*
ENVIVA

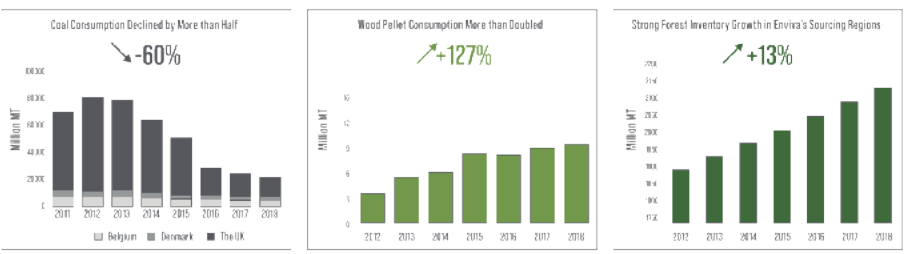

Kim Cesafsky DuBose

By: Jackie Ruggiero

In her talk, “BEF Opportunities for Working Forests and Climate Mitigation,” Kim Cesafsky DuBose, the director of sustainability at Enviva offered a biomass producer’s perspectives to the Yale Forest Forum. Enviva Inc. is the world’s largest producer of sustainable wood pellets. Enviva produces their pellets in the U.S. South and sells most of their 6 million metric tons of annual production to customers in the U.K., Europe, and Asia. DuBose explained that Enviva operates in the U.S. Southeast because it is one of the world’s largest working-forest regions, with about 20% of the global timber market.

Enviva’s main goals are to displace coal for energy, grow more trees, and help fight climate change. Their business creates a market for low value wood and residuals which incentivizes landowners to keep forests as forests in order to take advantage of this market. DuBose talked about how sustainable biomass is an essential part of the climate solution, included in all IPCC 1.5-degree scenarios, as well as the International Energy Agency’s 2050 net zero climate plan. She mentioned that Enviva has made a net zero by 2030 commitment to eliminate scope 1 and 2 emissions by 2030 and is also working on reducing their scope 3 value chain emissions.

DuBose described the benefits of biomass and its different impact on the carbon cycle compared to fossil fuel energy sources such as coal. She mentioned that biomass is part of an “all-in” strategy on renewable energy, as it can provide dispatchable baseload power, which helps to balance the intermittency of wind and solar energy. This means that there can be backup biomass plants instead of backup coal plants. In fact, DuBose stated that Enviva's wood pellets effectively displaced over 14 million metric tons of coal through 2019 and will displace another 86 million metric tons of coal by 2044. DuBose also claimed that removing slash leftover from timber harvesting for biomass energy can also help keep forest soil healthier. Common practice site prep activities in areas with a significant amount of biomass leftover following harvest damage the soil. DuBose also explained the difference between biogenic emissions and fossil fuel emissions. Biogenic emissions are immediately sunk back into the forests as they regrow, resulting in no net emissions to the atmosphere. Fossil fuels emissions, on the other hand, always add net emissions into the atmosphere. She also noted that biomass emissions are calculated at the time of harvesting in the land use sector, instead of at the time of combustion, ensuring that these emissions are accounted for, which is a common misconception.



Impact of Enviva's Operations from 2011-2018. If done correctly, Sustainable wood biomass could displace coal and fight climate change. Image courtesy of DuBose.

Even with the potential benefits of biomass, it is critical to ensure that the biomass comes from sustainable and healthy forests. DuBose explained that Enviva is very focused on producing "good biomass." She defines good biomass as being made from low-value wood that is a byproduct of a planned timber harvest or operation. It is not made from large, high-value trees that could be used for longer-lived products. It comes from regions where forest carbon stocks are stable or increasing and from harvest practices that safeguard biodiversity. Finally, good biomass comes from a forest that is returned to forest after harvest, not land that will be converted to other uses. Wood pellets account for only about 3%

of wood removals in the U.S. South as the rest of harvested wood is used for high-quality saw timber and a wide variety of other end uses. Enviva values third-party forest certification standards and has certified over 70,000 acres of private forest land in the U.S. Southeast to American Tree Farm System (ATFS) and Forest Stewardship Council (FSC) Standards.

In addition to only sourcing “good biomass,” Enviva has a broad sustainability strategy to lessen their environmental impact. As part of their Responsible Sourcing Policy, they focus on protecting water quality in harvest areas and sourcing from land that will remain forestland after harvest. They also work with stakeholders to conserve vulnerable ecosystems and species, and they believe that there are special forests that should remain intact. Enviva fulfills this mission in part through their Forest Conservation Fund, a $5 million fund to conserve sensitive ecosystems in Virginia and North Carolina. DuBose explained that when looking at new growth areas, Enviva looks for world class fiber resources where growth exceeds harvest, along with the availability of a local employment pool, and access to transportation infrastructure. DuBose made it clear that Enviva’s mission is to reduce emissions from fossil fuels through creating a market for sustainable biomass that supports the growth and health of working forests.

Protected ecosystems in the U.S. Southeast. Photo courtesy of Kim Cesafsky DuBose.

Bioenergy from Forestry: A Perspective from the Energy Sector

March 8, 2022


Richard Peberdy

RICHARD PEBERDY, *Head of Sustainable Forests*
DRAX BIOMASS

By: Dan Alberga

Richard Peberdy is the head of sustainable forests at the Drax Group, a British power generation company that owns and operates the biggest wood-pellet burning electricity generation facility in the world. At Drax, Peberdy is responsible for monitoring the long-term sustainability of the source forests for Drax's pellets, which are primarily located in the Southeastern US and Western Canada. During his presentation at the Yale Forest Forum, Peberdy sought to provide the perspective of a major global wood-pellet producer and electricity generator on a diverse array of topics related to bioenergy from forests, including impacts on ecosystem integrity, policy drivers of bioenergy demand, and bioenergy with carbon capture and storage (BECCs).

At the start of his presentation, Peberdy reminded the audience of the dual challenges of meeting the energy needs of a growing world population while addressing climate change and preserving the integrity of the biosphere. Given these challenges, he explained that Drax's corporate purpose is to "enable a zero carbon, lower cost energy future" through sustainable bioenergy production," and that their ambition is to be a carbon negative company by 2030. He went on to provide more details about the history of the company and its business segments, noting that there are two main areas of activity: biomass production, along with power generation and system services.

Biomass Production: Drax has 13 operational pellet plants spread across North America, in British Columbia, Alberta, Arkansas, Louisiana, and Mississippi. In aggregate, these plants have a capacity of 4 million tons (Mt) of pellets per year, set to rise to 5 Mt including plants in development, with a goal of 8 Mt by 2030.

Power Generation and System Services: The Drax power station is located in North Yorkshire, England and was originally a coal-fired plant that opened in 1974. During the 2010s, Drax began to transition to biomass-burning, and by this upcoming September, it will cease burning coal, with four generating units being fully converted to biomass use (3.9 GW total). During 2021, the Drax Power Station burned 7.7 Mt of biomass to produce 15 terawatt-hours (TWh) of electricity, comprising 6% of the U.K.'s total electricity consumption.

Pellet Production and Forests: With regards to sustainable sourcing of wood required for pellet production, Peberdy began by listing Drax's four forest sustainability principles:

1. **Reduction of CO_2** – Drax seeks to help the U.K. fulfill its 2050 net zero target through sustainable biomass usage.
2. **Protection of the natural environment** – the integrity of forest ecosystems, including soil and water quality, biodiversity, and habitat protection.
3. **Commitment to people and communities** – well-being and quality of life of forest workers, owners, and communities in sourcing areas.
4. **Investment in research, outreach, and intervention** – working with governments, NGOs, academia, and other stakeholders to iterate and improve sourcing practices.

Peberdy then moved on to policy drivers of bioenergy growth, and explained that in the E.U., the Renewable Energy Directives (I and II) have catalyzed much of the bioenergy demand. In the U.K., the Renewable Obligation has had a similar effect. He noted that these renewable energy policy instruments include stringent sustainability regulations to protect biodiversity, ecosystem services, social impacts, and more.

Biomass-generated electricity from the Plainfield Renewable Energy plant is added to the grid. Photo by Gary Dunning.

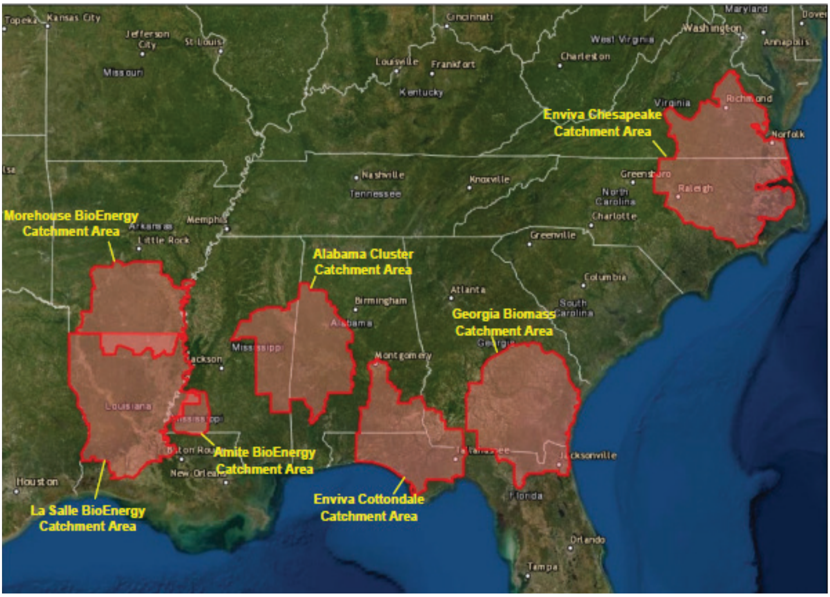
On the topic of power sector decarbonization, Peberdy emphasized the importance of bioenergy as a dispatchable, renewable replacement fuel for coal, which has been rapidly phased out in electricity production in the U.K. over the past few decades. He stated that, including supply-chain emissions, the current carbon intensity of Drax's biomass plants was approximately 125 gCO_2/kWh, and he foresees this value dropping to 100 gCO_2/kWh in the upcoming years through efficiency improvements. Furthermore, he discussed the intermittency of solar and wind resources in the U.K., showing how biomass can be a valuable tool for grid operators to balance load and supply. He summarized his argument by sharing a quote from EU Climate Chief Frans Timmermans: "Without biomass, we're not going to make it, we need biomass in the mix… but we need the right biomass in the mix."

Peberdy touched on climate outcomes by bringing up some arguments made by previous YFF speakers. Firstly, he highlighted the framework introduced by Professor Annie Levasseur of life cycle analysis coupled with forest carbon analysis to verify potential net GHG mitigation. He then brought up Steve Hamburg's point about the importance of sound assumptions and counterfactuals, and that it is more appropriate to look at the landscape level, not the stand level, for carbon analysis of bioenergy. In particular, Peberdy pointed to a recent paper by Cowie et al. (2021) titled "Applying a science- based systems perspective to dispel misconceptions about climate effects of forest bioenergy" for a full discussion of issues associated with biomass.

Connecting this to Drax, he explained that the expansion of the wood-pellet industry has led to increased carbon sequestration through the growth of source forest standing timber volume, shown in the corresponding graph. (He also noted that the decrease seen in the Cottondale forest was due to a hurricane rather than harvesting). He referred to a paper by Aguilar et al. (2020) titled "Expansion of US wood pellet industry points to positive trends but the need for continued monitoring" to support the claim that a 'healthy market' for bioenergy has positive effects on managed forest growth and integrity.

Peberdy concluded his presentation with some brief remarks on the future of BECCs in the U.K., monitoring effects on biodiversity, and

The tops and limbs of hardwood trees such as these can also used for bioenergy production. Photo by Felix Mittermeier, courtesy of Pexels



The Drax Catchment Area Analysis focuses on understanding the effects of demand for bioenergy on Carbon Dynamics in the regions used to source the biomass. Image courtesy of Richard Peberdy.

a few high-level takeaways from his presentation. He explained that in 2019 and 2020 Drax's first two BECCs small-scale pilots began operation, and that by 2024 the construction of large-scale units using BECCs technology is set to begin. With regards to biodiversity, Peberdy added that some jurisdictions, like British Columbia, have pre-existing forest management-level certification schemes to assist in biodiversity monitoring, while other regions, like the Southeastern U.S., do not. In those cases, Drax performs their own auditing to ensure that standards are met. He wrapped up with the following take-away points:

1. Biomass generation will help the U.K. move toward a low-carbon grid.

2. Sustainable sourcing of biomass can make the operation 'climate positive.'

3. Using a landscape oriented LCA can show that the assumption of a pulse of carbon is not necessarily substantiated.

Innovative Wood Products for Carbon-beneficial Forest Management in California

March 29, 2022


Daniel Sanchez

DANIEL SANCHEZ, PhD, *Assistant Professor of Cooperative Extension*
UNIVERSITY OF CALIFORNIA–BERKELEY

By: Sean Mahoney

Daniel Sanchez, assistant professor of cooperative extension at the University of California, Berkley, spoke at the Yale Forest Forum about the important role that forest derived transportation fuels, electricity generation with carbon capture, and engineered wood products will play in reducing wildfire risks across California. These new markets will enable a series of modeled forest management scenarios which will help the state meet net zero climate commitments by 2045. These scenarios are based on the findings from a recent publication Sanchez co-authored in 2021, titled "Innovative wood use can enable carbon-beneficial forest management in California."

Context around forest ecology, land use history, public policies, and social values have been key during this speaker series. Sanchez chose to frame the current conditions in California with a narrative recounting recent megafires which released 100 million tons of CO_2 and impacted 5 million acres of forests last year. He then posed a series of questions related to addressing climate change in California.

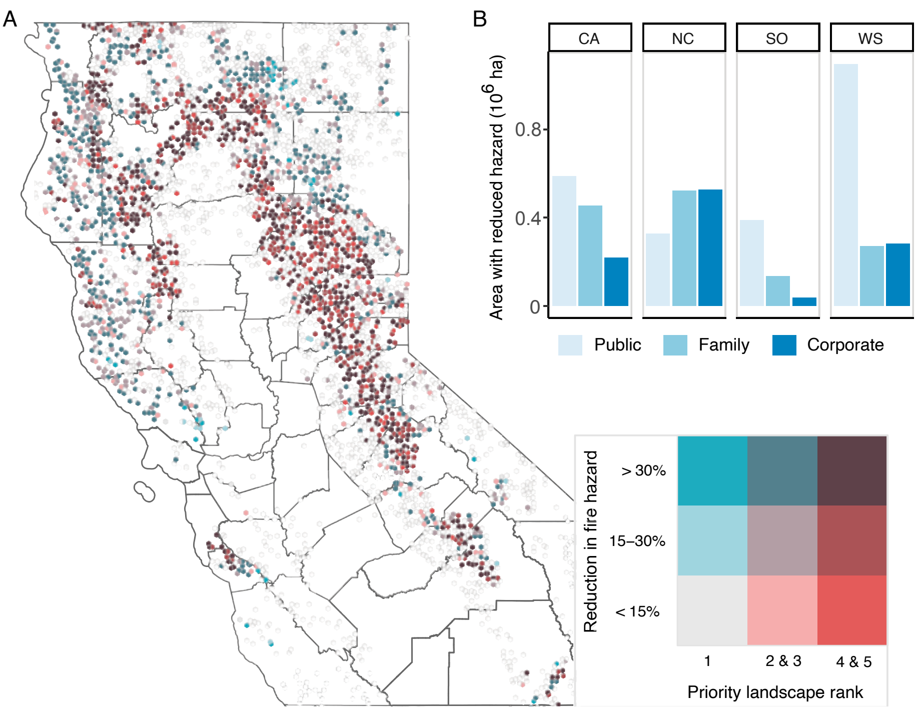
1. How does California reduce current climate change impacts and respond to fire? (climate adaptation)

2. How does California reduce its future emissions or mitigate climate change? (emissions reduction)

3. Can innovative wood products help California align its climate change mitigation and adaptation goals?

Forest restoration efforts correcting decades of fire exclusion, Sanchez explained, are implemented by public and private forest managers across the state using prescribed fire and mechanical thinning. Sanchez then went on to explain that mechanical thinning is the most feasible of the two treatment options to be implemented now due to high fuel loads.

Sanchez presented declining harvest volumes and the decline in the number of sawmills operating in California side-by side to illustrate that timber production markets are necessary for forest restoration to be contracted. There is no pulp market in California to utilize tops, branches, and small diameter trees



Opportunities for forest thinning treatments in California, as predicted by an LCA integrated with the Forest Inventory and Analysis. Figure from Cabiyo et al. 2021.

so they are left to decay or are burned in large pile burns at the end of a harvest. This represents lost economic potential and a less-than-optimal GHG emissions profile from forest management operations.

Innovative wood products present a pathway to use forest residues more efficiently in terms of economic value and climate benefits. Sanchez defined innovative wood products as providing higher economic value than conventional wood products such as lumber, heat, and electricity. For building, innovative wood products include cross laminated timber, glue laminated beams, and oriented strand board. For energy, innovative wood products include biomass electricity with carbon capture and wood-derived transportation fuels. One specific example he provided is a technology called oxy-combustion, a pure oxygen environment, making carbon easier to capture and store.

Public policy is an important component of the needed shift in forest products markets across California. Sanchez used three specific government actions to make this point. The first was the Joint Institute for Wood Products Innovation established in 2018 by Governor Jerry Brown. The second action was a study conducted by Lawrence Livermore National Laboratory to identify additional pathways needed for California to reach net zero emissions by 2045. The third is the shared stewardship agreement between the State of California and the U.S. Forest Service to treat 1 million acres per year to reduce wildfire risks. This agreement has the potential to provide much more reliable feedstock supply from federal lands to leverage private investment in the manufacture of innovative wood products.

These three policy actions set Sanchez up to return to the question he posed at the beginning of the presentation: Can innovative wood products help California align its climate change mitigation and adaptation goals?

Sanchez then went on to pose three additional questions for the audience to contemplate.

Forest fire prevention requires the use of prescribed fire or mechanical vegetation removal (thinning). Photo courtesy of Daniel Sanchez.

1. What new wood products can attract higher prices and what California polices can help drive their development?
2. What impact would these new markets have on forest management and fire risks across the state?
3. What are the ultimate carbon impacts of expanded management and new markets?

To address these questions, Sanchez shared the findings of a recently published paper led by Cabiyo et al. 2021, which included fully integrated modeled assumptions of different forest management practices with life cycle analyses for multiple innovative wood products, including wood biomass chips.

Sanchez noted that according to the economic analysis by Cabiyo et al., a price paid of $100 per bone dry ton (BDT) could make harvesting of non-merchantable trees and tops for innovative wood products viable during wildfire risk reduction treatments while having little impact on existing markets for sawn timber. According to the analysis, wildfire risk reduction treatments could prevent stand replacing fires (fires that kill all or most of overstory trees, initiating regrowth) on 12.1 million acres, with an additional 3.1 million acres of potential stand replacing fires avoided, fire mortality being reduced by 28%, and 47% of the benefits occurring on high priority landscapes. This would create additional climate benefits over the next 40 years while conducting necessary forest management operations to protect communities from wildfire. Sanchez believes raising the feedstock price to $100/BDT is critical to shifting away from conventional bioenergy or the management practice of leaving biomass in the woods to decay.

In concluding the talk, Sanchez described the potential impact of implementing the modeled wildfire hazard reduction treatments over 40 years with new markets for innovative wood products. In California, 12.1 million acres of forests could be treated to reduce wildfires resulting in CO_2 emissions reductions of 6.5 million tons/year. He indicated that this benefit could be further increased to 16.4 million tons of CO_2 per year if polices are in place to support the manufacture of engineered wood

for multi-unit buildings. This holistic view, based on empirical data, provided an important linkage back to the fall 2021 Yale Forest Forum speaker series on mass timber and reminded the audience that a diversified approach is required to address the pressing issue of climate change.

Thinned open stand. Photo courtesy of Oregon Department of Forestry. CC BY 2.0, via Flickr.

The Potential Role of Bioenergy in Mitigating Wildfire in the West

April 5, 2022

MATT DONEGAN, *President*
DONEGAN ADVISORS, LLC

By: Jesse Cohen

Matt Donegan

Matt Donegan, president of Donegan Advisors LLC, joined the Yale Forest Forum to deliver a presentation titled, "The Potential Role of Bioenergy in Mitigating Wildfire in the West." Donegan has held a diverse range of positions including co-president of Forest Capital Partners, founding chair of the Oregon Wildfire Council, and senior adviser at the Yale Carbon Containment Lab. Drawing from his professional experiences across operations, policy, and innovation, Donegan addressed key issues at the intersection of bioenergy and wildfire in the American West: What role could an expanded bioenergy industry play in mitigating the wildfire crisis in the West? How can we incorporate public values including climate change mitigation, avoided economic costs from wildfires, and social justice into the bioenergy industry? What are the key challenges to enacting this vision, and how can public and private sector organizations work together to overcome them?

Donegan began his talk by examining the policy issues related to bioenergy and wildfire. All the fundamental issues around traditional bioenergy management still apply when considering bioenergy in the context of wildfire mitigation. Potential benefits include clean energy development, extraction of economic value from land, and job creation. Risks include damage to ecosystem sustainability and the potential for social injustice from differentiated development. However, as Donegan explained, the mounting catastrophic wildfire crisis has created additional risk and benefit considerations, as well as a new sense of urgency.

Over a century of wildfire suppression has left Western forests filled with excess fuels, explained Donegan. Treating forests to meaningfully

address the problem is projected to be massively expensive, and difficult to complete quickly. The Oregon Wildfire Council estimates it has a treatment backlog of 5.6 million acres, costing upwards of $4 billion. Even moving at four to six times typical speed, it will take another ten years to complete. On the national level, the United States Department of Agriculture (USDA) estimates there are 50 million acres of high priority forests to treat for wildfire risk reduction beyond the next ten years' baseline management plans of 20 million acres. These forests are primarily at the wildland-urban interface, where human life and property are most at risk. Completing this work would require more than tripling the current pace of treatment, at an additional cost of approximately $50 billion.

While the short-term expenses associated with wildfire action are large, often unaccounted for long-term damages (detailed in the corresponding figure) are even greater. Studies estimate long-term damages to be on the order of eleven times the short-term expenses, with a wide range depending on location and values at risk. As Donegan explained, investing in more proactive landscape treatments can therefore avoid significant total costs. An expanded market for bioenergy can help defray the initial costs of such investments, creating an economic incentive for firms to remove unmanaged fuel for wildfires from forests, converting it instead to clean fuel for power, heat, and transportation.

While the potential benefits from integrating expanded bioenergy into wildfire management in the West are large, significant challenges remain. In his presentation, Donegan highlighted four key issues for policymakers and industry:

1. **The cost of producing and transporting wood waste:** While current economics present a challenge to the conversion of wood waste to bioenergy, incentives and policy certainty can help the industry supply chain mature, bringing down long-run costs.

2. **Competing markets for wood waste, both in terms of economic and climate benefits:** To address this issue, Donegan stresses the importance of properly valuing the

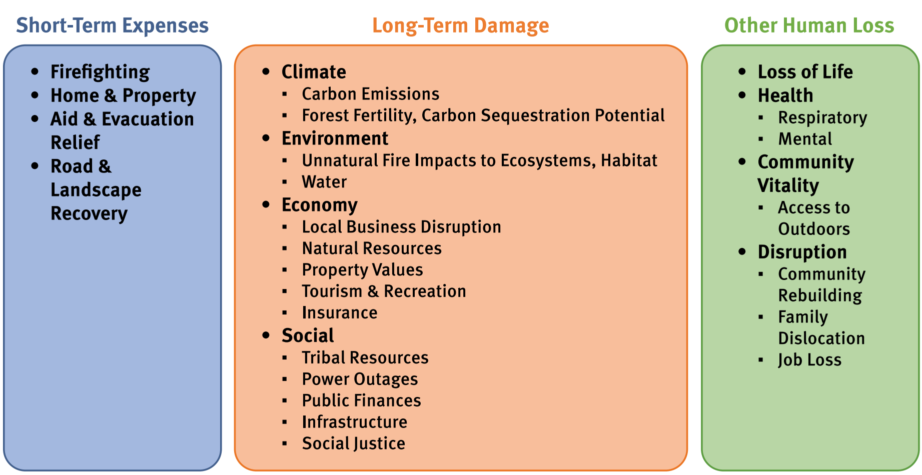
In Oregon's vibrant wood pellet industry, most pellet mills use sawdust and planar shavings as raw material. Photo courtesy of Oregon Department of Forestry. CC BY 2.0, via Flickr.

wide spectrum of services provided by bioenergy and putting them on a level playing field with other land uses.

3. **Monetizing the wildfire benefits provided from expanded bioenergy:** To do so requires accurately forecasting costs, measuring baseline emissions to establish additionality, and cultivating buyers for often-unpriced services such as greenhouse gas emissions reductions, clean water, and clean air.

4. **Establishing strong public-private partnerships in this industry:** Unlike in the American Southeast, where markets for bioenergy have grown rapidly, the forests of the American West are largely publicly owned. This ownership structure has the potential to raise new challenges, as state and federal government forest owners participate in markets and simultaneously develop those markets through public policy.

To overcome these challenges, Donegan advocated for expanded interdisciplinary research and multi-sectoral leadership to foster a regional forest restoration economy. Through public funding and the creation of long-term supply contracts, the federal government can also play a leading role in galvanizing lower-risk market opportunities, and accelerating progress in developing sustainable, just, cost-effective, and climate-friendly wildfire mitigation strategies in the West.



Short-term expenses, long-term damages, and other non-monetized human losses associated with wildfires. Figure courtesy of Matt Donegan.

Industrial Logging and Environmental Justice in the U.S. South

April 12, 2022

Treva Gear

Adam Colette

TREVA GEAR, PhD, *Founder and Chair*
CONCERNED CITIZENS OF COOK COUNTY

ADAM COLETTE, *Program Director*
DOGWOOD ALLIANCE

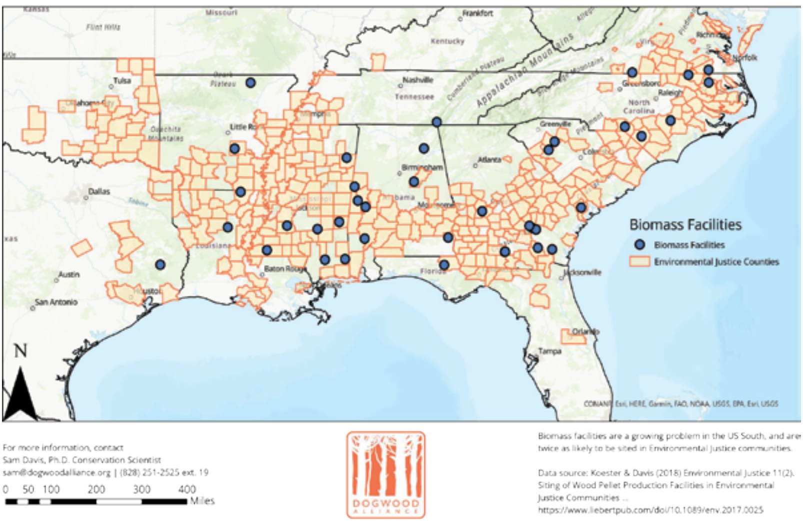
By: Ruolin “Eudora” Miao

Treva Gear, founder and chair of the Concerned Citizens of Cook County, and Adam Colette, program director at the Dogwood Alliance, brought an Environmental Justice (EJ) and community perspective to this Yale Forest Forum speaker series. Their talk focused on the environmental justice and economic impacts of large-scale industrial logging in the U.S. South.

After a brief refresher from Gear on the concept of EJ, Colette pointed out that in the U.S. South, ground-zero for industrial logging, the biomass industry perpetuates a history of placing extractive and polluting facilities within communities of color. Dogwood Alliance’s geospatial analysis revealed that the location of wood pellets manufacturing facilities often overlaps with the EJ communities in the South. Their research indicated that a biomass facility in the U.S. South is two times as likely to be placed in an EJ community than a non-EJ community.

Gear then discussed a case study that is close to her heart – from her hometown Adel, Georgia. Adel is a predominantly People of Color (POC) community and has a high poverty rate. Gear recounted when the Concerned Citizens of Cook County, a community grassroot organization, first learned that a wood pellet plant planned by the Renewable Biomass Group was coming to town. “It was not in a local paper, no one knew it was coming,” said Gear, even though the biomass plant. A biomass facility could bring significant health impact on the Adel community, as it would decrease the air quality and lead to an increase in respiratory illnesses, such as asthma and cardiovascular diseases from the fine particulate matter emission.

Biomass and EJ Communities



Biomass facilities (blue dots) are most likely to occur in Environmental Justice communities (the counties in orange). Figure courtesy of Treva Gear and Adam Collette.

The community could also experience smog and acid rain from the nitrogen oxide emission. Other negative impacts include constant noise that can reach up to 80 decibels. Adel already had a bitcoin mining industry that brought noise and air pollution; however, the law does not look at cumulative impact of multiple projects and industries on one community. In addition, Gear pointed out that the benefits to the community were not clear. While the Concerned Citizens of Cook County was told that the plant would provide 50-70 jobs, Gear emphasized that these are only jobs that are provided for the first two years of the project. They are mostly short-term construction jobs, rather than permanent jobs. “Some people won’t even be able to get the job because of the skills needed,” said Gear.

After hearing about the case study from Adel, the YFF audience was very interested in learning how to better involve communities as the field of biomass energy continues to develop. The speakers emphasized again that we are leaving out important, valuable stakeholders in the conversations because we have been so focused on how to do logging better when we should focus on what benefits the communities on the ground. Gear urged that we need to involve community members early to see what they think. Colette pointed out that oftentimes, when projects or companies mention that they are "engaging people on the ground," they are usually engaging the landowners. But less than 1% of landowners in the U.S. South are people of color; hence, focusing on landowners as a solution will inherently leave out many community members who are impacted by the project.

View of a biomass production facility from above. Photo courtesy of Treva Gear and Adam Collette.

The Policy Context for Forest Bioenergy

April 19, 2022

ANN BARTUSKA, PhD, *Senior Advisor*
RESOURCES FOR THE FUTURE

Ann Bartuska

By: Musawenkosi Joko

Ann Bartuska is an ecosystem ecologist who serves as a senior adviser for Resources for the Future, an environmental economics think tank in Washington D.C., where she focuses on sustainable forest management and natural climate solutions. She is also a senior contributing scientist at the Environmental Defense Fund, focusing on natural climate solutions through forestry and agriculture.

In her talk, Bartuska started by laying a foundation of the carbon cycle in time and space and describing how forest bioenergy fits into the overall carbon cycle, especially in response to climate change.

She then discussed wood and biomass utilization in the U.S. coastal Southeast from 2011 to 2020. She stated that wood utilization for forest bioenergy has remained constant around 4% of the total of forest products during this period.

Bartuska continued to describe different policy contexts, first in the U.S. at the federal level, and then in Europe, providing a summary of the last two congresses and bills that are continuing to surface. According to Bartuska, federal agencies are placing a lot of attention on the role of renewables, and they are coming up with strategies to promote a renewable energy transition.

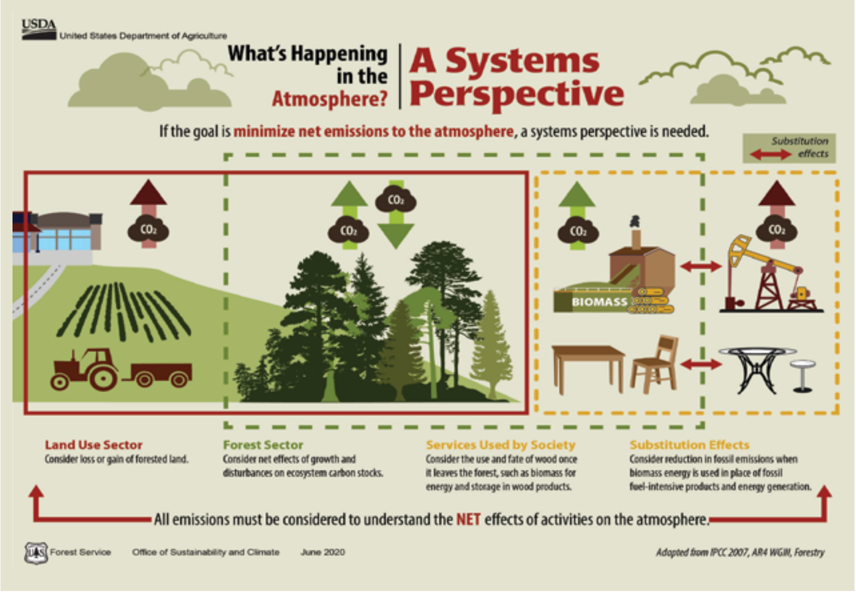
Bartuska listed four acts that have an influence on bioenergy use:

1. **S.3600 – Department of Energy Science for the Future Act** looks at investments in research and development activities.

2. **S.2836 – America's Revegetation and Carbon Sequestration Act** monitors the carbon stored in wood biomass energy feedstocks.

3. **H.R.2639 – Trillion Trees Act** is a driver of restoration and has biomass demonstration projects on tribal lands in Alaska.

4. **S.4603 – Forest Health and Biomass Energy Act of 2020** promotes the use of forest residues for renewable energy.



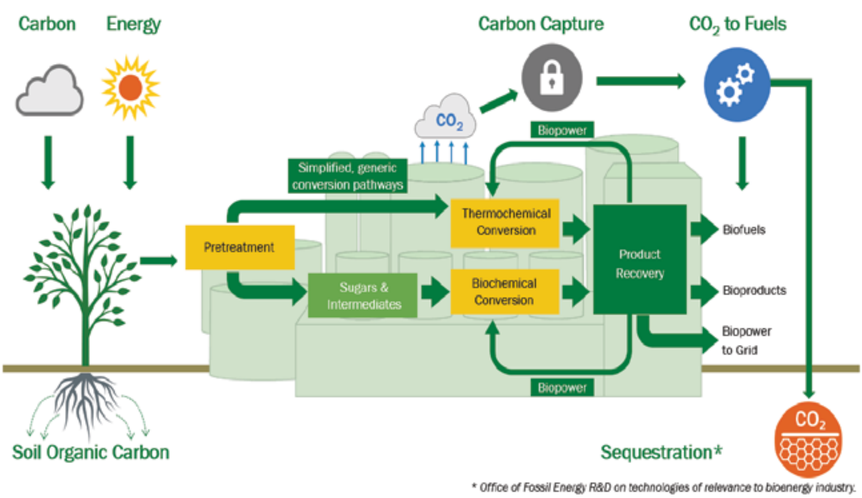
Assessment must take a systems approach and consider net effects of activities on the atmosphere. Figure courtesy of Ann Bartuska.

The U.S. Department of Agriculture (USDA) Farm Bill Energy Title programs from 2018 include 12 distinct programs that look at different aspects of the utilization of biomass and its relationship to energy production. These programs promote financial assistance for landowners to produce and deliver feedstock, provide grants for energy audits and renewable energy development assistance, and fund biomass research and development. They also include a program that matches grants for building innovative wood product facilities.

Bartuska continued to discuss the USDA Forest Service Renewable Wood Energy Program, which seeks to expand renewable energy by promoting the "use of wood waste," economic development, and sustainable forest management. It also considers the sustainable management of forests in areas with wildfire, damaging insects and disease, and invasive species.

According to Bartuska, the U.S. Department of Energy (DOE) also plays a significant role in using science to test bioenergy technologies before adoption, partnering with different industries sharing net-zero goals.

Additionally, Bartuska discussed the role of biomass on Sustainable Aviation Fuel (SAF). She considers this as an opportunity to use bioenergy in creative ways, and an important opportunity for reducing greenhouse gas emissions.



The Department of Energy is actively researching ways to make bioenergy more sustainable. Figure courtesy of Ann Bartuska.

Bartuska also highlighted the distribution of feedstock supply in different regions across the U.S. The interior West was noted for being potentially suitable for biomass production, given that most of the area is federal land and the region is prone to wildfire and insect or disease infestation. In the Northeast, the primary feedstocks are from agricultural waste, algae, dedicated energy crops, forest products waste, forest residues or slash, and urban waste such as food waste.

The U.S. Environmental Protection Agency (EPA) plays a pivotal role in biomass standards. The renewable fuels standard is triggered by biomass energy, requiring an analysis of direct and indirect GHG reductions throughout its life cycle. EPA also developed a scientific process for biogenic carbon assessment, including the appropriate baselines and spatial and temporal scales. The location, species, and size of the harvesting unit are especially important. Ideally, assessment occurs at a landscape scale including multiple stands, allowing for multiple rotating harvests.

In the international context, Bartuska touched upon the European Forest Strategy which, in 2020, recognized the value of forests for their value to biodiversity and encouraged the growth of non-commercial forests. This policy has great implications, especially in terms of exporting wood products from the U.S. to Europe. It addresses the importance of sustainable forest management and the need to find substitutes for CO_2-intensive fossil-based materials and energy. The E.U. has issued biomass sustainability criteria to prevent negative environmental impacts such as habitat loss.

Bartuska closed with an idea of how we can move forward. Recognizing that forest bioenergy will continue being considered a renewable energy and a tool for reducing waste, we must acknowledge that forests are heterogeneous and that the carbon impacts of forest biomass must be calculated throughout a forest's life cycle. Carbon accounting must be standardized at the appropriate temporal and spatial scales and also must be incorporated into third party certification systems.

Stacked logs. Photo by Edouard Chassaigne.

From Plants to Practice: Forester's Views of Bioenergy

April 26, 2022

PANELISTS:

ALEX FINKRAL, PhD, *Chief Forester and Vice President of Conservation*
THE FORESTLAND GROUP

VICTORIA LOCKHART, *Manager*
ESG, RESOURCES MANAGEMENT SERVICE, LLC

HELENA MURRAY, *Wood and Biomass Utilization Specialist*
U.S. FOREST SERVICE

PHIL RIGDON, *Superintendent*
YAKAMA NATION'S NATURAL RESOURCES DEPARTMENT

MODERATOR:

RICHARD DONOVAN
INDEPENDENT FOREST ADVISOR


Alex Finkral


Victoria Lockhart


Helena Murray

By: Walker Cammack

The Yale Forest Forum wrapped up the series by bringing together a panel of practicing foresters from across the United States to discuss the challenges and opportunities of bioenergy within the forest sector. The conversation was moderated by **Richard Donovan**, an independent forest advisor with over 45 years of forestry experience, including a long tenure with the Rainforest Alliance as a senior forest advisor. The panelists represented a diverse range of forestry perspectives and geographic regions with robust forest sectors, including the Pacific Northwest, California, and the Southeast. Panelists included **Phil Rigdon**, superintendent of the Yakama Nation's Natural Resource

Phil Rigdon

Richard Donovan

Department; **Helena Murray**, a wood and biomass utilization specialist for the US Forest Service in California; **Victoria Lockhart**, manager at Resource Management Services, a timber investment management organization (TIMO) that has holdings throughout the Southeast; and **Alex Finkral**, the chief forester and vice president of conservation for the Forestland Group, a TIMO that largely manages hardwood forests in the southeast.

Unlike prior webinars in the series, the session had no formal time set aside for presentations. Instead, Donovan expertly guided the conversation, covering everything from the major barriers inhibiting the development of a robust biomass industry to musings on how quickly accelerating carbon markets might compete with biomass production. The panelists used the subject of biomass production as a lens to explore a range of hotly debated topics that lie at the heart of the forestry profession.

A reoccurring theme throughout the discussion was the panelists' attempts to parse out what the ideal role of biomass production would look like in the United States within the context of the wider forest products sector. Finkral explained that generations of silviculturalists have tried to find ways to pay for the removal of small diameter and poor-quality wood to promote better future forest outcomes. He believes biomass provides an opportunity to do just this. Lockhart and Murray built on this sentiment by emphasizing that biomass production is just one piece of the greater wood products puzzle, helping to utilize small-diameter and low-quality wood. This can help fund intermediate silvicultural thinning treatments that improve the quality of forests. Finkral and Lockhart, the two panelists providing perspectives on bio-energy in eastern forests, emphasized that biomass production currently makes up a very small portion of overall wood being harvested from eastern landscapes—only 2% in the case of Resource Management Service.

Murray and Rigdon provided a view of biomass production through a western forest lens. Murray explained that instead of asking how the forest sector can support bioenergy production, we should be asking how bioenergy production can support the forest sector. Both she and Rigdon went on to explain that a robust biomass market could provide the economic incentive needed to promote thinning of overstocked western forests that are highly susceptible to fire. Finkral agreed that thinning treatments in megafire-prone forests can be a cost-effective preemptive fire mitigation strategy. Murray suggested that we should reframe these thinning treatments for biomass as being a waste management strategy that has the added benefit of smoke mitigation.

While the panelists agreed that there is a role for biomass production in all parts of the country, they also recognized a myriad of barriers that will be challenges to address. Rigdon used mill closures around the Yakama Indian Reservation as an example of how infrastructure that has historically supported the wood products industry is dwindling. He explained that building out a robust biomass industry in the west would require huge investments in infrastructure. Securing these necessary investments is arguably

The Forests Dialogue explores carbon in wood supply chains, including that in small diameter logs destined for bioenergy, in planted forests in Finland. Photo by Samuli Skantsi.

the single biggest barrier to scaling biomass production in the west. According to Rigdon, the lack of experienced labor for both harvesting and processing wood products is also a major barrier. Lockhart added that there are similar concerns in the eastern United States, as well as concerns around increasing insurance costs for mills and forest operators, making it harder for these rural workers to make their livelihoods.

Donovan played the devil's advocate, echoing a number of concerns that have been raised by opponents of the bioenergy industry. The first concern brought up was the fear that scaling biomass could lead to overharvesting of forests in the United States. Lockhart and Finkral emphasized that right now a very small fraction of harvested wood is going to biomass and that a large increase is highly unlikely because of competing markets for small diameter wood like the existing pulp and paper markets and fast-developing carbon markets. Rigdon emphasized that the high stocking levels of western forests is very abnormal compared to historical standards. He explained that a lack of management in the past has led to these high fuel loads which are partially responsible for increased intensity of forest fires. Murray added that there is an estimated 5 million dry tons of wood that could be removed from western forests each year to go toward biomass production while mitigating fire risks.

Donovan followed up by highlighting the ecological value of coarse woody debris and asked if there were industry or scientific standards that ensure sufficient levels remain on the landscape after harvesting. Finkral mentioned that the Forest Stewardship Guild published regionally specific biomass harvesting guidelines that are widely used to ensure that harvesting objectives align with ecological objectives. Rigdon provided the example of western bud worm decimating huge swaths of western forests in recent years, which has resulted in an abundance of woody debris on the landscape waiting to burn. He explained that historic levels of woody debris should dictate wood removal from a disturbed landscape like one decimated by bud worm.

Small diameter logs are collected on the landing to be transported to a bioenergy plant in Finland. Photo by Samuli Skantsi.

The final concern Donovan raised was the potential threat of cutting old growth or other ecologically valuable forests for biomass production. Finkral and Lockhart explained that there is very little old growth left in the east due to historical land uses and assured the audience that the chances that biomass production would have anything to do with cutting any remaining old growth is minuscule due to the small diameter size class that the biomass industry relies on. Both Rigdon and Murray made the argument that a biomass industry in the west could actually promote the development of old growth characteristics in forests through thinning treatments. Rigdon emphasized that contrary to mainstream beliefs, old growth forest conditions arose partially due to active forest management and land stewardship by Indigenous communities. He was clear in saying that without human management of western forests, old growth conditions would likely not develop due to increasing disturbance regimes attributed to climate change.

The other major theme discussed throughout the conversation was how developing carbon markets might impact the biomass industry in the United States. Finkral described the recent and ongoing economic shift that has started to value small diameter trees for their carbon value. These smaller trees have historically gone towards pulp and paper production, as well as biomass production. Finkral explained that as prices for carbon continue to increase, this will economically incentivize land managers to keep smaller trees in the forest rather than cutting them for industries like biomass. Murray followed up by suggesting that the current circumstances surrounding fire susceptibility in western forests does not set them up to successfully store carbon for the long-term. Because of this, there is a role for developing small-diameter wood economies like biomass to help manage these forests to eventually get to a more stable place where carbon markets may be appropriate.

Conclusion

By: Yvonne Shih

The Yale Forest Forum's Speaker Series, "The Future of Forest Products in a Changing Climate: Bioenergy from Forests," brought together speakers to explore the potential role bioenergy from forests can play in mitigating climate change, incentivizing sustainable forest management, and addressing a range of resources, societal, and environmental challenges. Speakers highlighted a number of potential benefits associated with using forest bioenergy, as well as a number of challenges, outstanding questions, and controversies, including policy and economic gaps, impacts of biomass plants on public health and communities, and greenhouse gas emissions accounting for the full life cycle of forest bioenergy. As these questions and challenges are addressed, knowledge-sharing platforms like the Yale Forest Forum will be crucial to overcoming controversies within the bioenergy field and ensuring actors can move forward with the best available information.

Handful of Biomass. Photo courtesy of Oregon Department of Forestry. CC BY 2.0, via Flickr.

Trucks drop off wood waste at the Plainfield Renewable Energy plant for processing. Photo by Gary Dunning.

Yale *Forest Forum*