The Forests Dialogue

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TFD Bioenergy from Forests Scoping Dialogue

NEW HAVEN, CT

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Co-Chairs' Summary

Co-Chairs: Jason Funk, Ann Bartuska, Gary Dunning, Sara Kuebbing, Phil Rigdon

CONTENTS

I. Introduction 2

II. Issues affecting potential demand for biomass energy 3

1. Social license 3

a. Climate goals and the prospect of bioenergy to contribute 4

b. Local level impacts of harvesting for bioenergy 5

c. Environmental justice and downstream use of biomass for energy 6

2. Quantifying climate change mitigation 7

3. Competing demands for land, timber, and low-quality biomass 8

III. Issues affecting potential supply of biomass feedstocks 10

1. Workforce training, maintenance, and career pathways 10

2. Regional differences in sustainable forest management conditions 11

a. Northeast 11

b. Southeast 12

c. West 13

3. Policy conditions and standards that affect forest management and biomass sourcing 14

a. California policy environment, including cap-and-trade 14

b. International trade in biomass and timber 15

c. Certification schemes 16

4. Infrastructure requirements to build out robust supply chains for biomass 16

a. Harvest and processing 16

b. Transportation 17

IV. Synthesis framework: A theory of change for biomass energy 18

V. Potential fracture lines 20

VI. Recommended next steps and conclusion 21

The Forests Dialogue, Yale University, 360 Prospect Street, New Haven, Connecticut, 06511, USA
O: +1 203 432 5966 T: @forestsdialogue W: www.theforestsdialogue.org E: info@theforestsdialogue.org

I. INTRODUCTION

Bioenergy from Forests (BEF) is the energy generated from the combustion of wood, wood wastes, or wood-derived biofuels. There is renewed attention around wood based energy, an important energy source for millennia, due to efforts to sustainably scale up its applications to meet energy resilience goals and replace green-house gas (GHG) intensive fossil fuel energy. While actions, mechanisms, and investments to scale up BEF for climate change mitigation are moving forward at a rapid rate, confusion and disagreement remains over when, where, and how BEF can deliver climate benefits as well as the potential negative or positive social and climate impacts that this rapid buildup could entail.

In this context, The Forests Dialogue's (TDF) Steering Committee proposed to explore the potential for dialogue to build trust and shared understanding across diverse actors engaged in BEF through the first step in a TFD initiative, a Scoping Dialogue. The Steering Committee proposed starting with a focus on biomass sourced from North America and specifically the United States. To inform a potential initiative TFD held a series of stakeholder-specific focus group discussions with forest owners and managers, members of civil society organizations, individuals working in research and academia, and groups working in the wood pellet and energy sectors. The focus group discussions centered around understanding stakeholders' priorities, areas of agreement and disagreement regarding BEF in the United States, and interest in engaging in a multi-stakeholder dialogue process.

The Scoping Dialogue, convened in collaboration with The Forest School at Yale School of the Environment on February 27th 2024, is the first step to launch the TFD initiative, structured as a broad, collective effort to understand BEF impacts and concerns while building coalitions for collaborative actions that respect and integrate all voices. The Scoping Dialogue convened 28 individuals representing Private Industry, Environmental Non-Governmental Organizations, Indigenous Peoples, Youth, and Academia.

BEF initiative goals

- **Gaining a deeper understanding of stakeholder views:** The initiative seeks to facilitate open and deliberate discussions to gain a comprehensive understanding of the diverse perspectives, interests, and concerns held by stakeholders in the BEF sector.
- **Creating larger learnings for informed policy:** The initiative aims to distill insights from regional dialogues, providing valuable recommendations for sustainable BEF that can shape local practices and inform policy decisions within the United States.
- **Generating global-scale insights:** Recognizing the interconnected nature of the global bioenergy sector, the initiative endeavors to generate insights with global relevance, exploring how global trends and demands intersect with the bioenergy landscape for a more comprehensive understanding of the sectors involved.
- **Catalyzing stakeholder-led action and collaboration:** Regional dialogues will be conducted to identify and learn from specific issues and opportunities in various geographic locations and catalyze action.

All materials related to the BEF Scoping Dialogue can be found digitally at:
https://theforestsdialogue.org/initiative/bioenergy-forests-bef-0

II. ISSUES AFFECTING POTENTIAL DEMAND FOR BIOMASS ENERGY

1. Social license

Participants discussed the ways in which BEF is subject to more scrutiny and criticism as a form of energy and forest product in comparison to other renewable energy sources and forest products. Participants viewed biomass energy as particularly exposed to this kind of reputation risk, due to questions about its contributions to climate mitigation, the visible impacts of forest harvesting, and environmental justice concerns which some groups attribute solely to biomass used for energy. Participants discussed the factors that influence the social license of BEF which is the ongoing acceptance of a company or industry's standard business practices and operating procedures by its employees, stakeholders, and the public.

TFD Executive Director, Gary Dunning, opens the Bioenergy from Forests Scoping Dialogue.

a. Climate goals and the prospect of bioenergy to contribute

Climate mitigation goals are a key motivation and driving force behind demand for biomass energy. Yet this demand requires social license, which is dependent on confidence that BEF does deliver positive climate impact. Dialogue participants touched on the prospect of BEF to contribute to climate goals in a number of ways. Dialogue participants did not agree on the climate benefits of a biomass from forests supply chain, with some raising concerns about scale and the prospect that the industry could be built up beyond what is sustainable, for example driving forest conversion to fast-growing monoculture plantations. Others expressed concern about the carbon debt of BEF and the near term immediate climate impacts of bioenergy. Some of the debate is based in complexities and differences in accounting methodology (summarized in Section 2. Quantifying Climate Change Mitigation). Yet, within this lack of agreement, in large part participants did agree that when bioenergy from forests yields climate benefits depends on the specific system, including the regional context and counterfactual land use and wood product. Dialogue participants called for collaborative efforts to build the evidence base of how and when BEF can be done well and deliver positive impacts, as well as to help understand what the boundaries should be around the system to ensure positive impacts.

Background Paper author, Weier Liu, presents an overview of the paper.

Several participants noted a tension or disconnect that arises because demand and supply are operating at different scales: demand is primarily driven by global demand (motivated by efforts and goals to reduce climate change and support actions that are sustainable, renewable, and create jobs) whereas supply often incurs local problems. Local stakeholders can sometimes be trampled or forgotten in the process of implementing globally oriented solutions. Global climate change can be low on the priority list for local communities, especially disadvantaged communities that face more immediate problems. Others cited how local communities can play a role in resolving a global problem driven by a classic economic externality, offering new economic opportunities. On the other hand, supplying biomass for a globally linked energy economy can have the effect of creating local-level externalities, such as air and water pollution. Solving one problem while creating new problems was an outcome to be avoided – on this, the participants agreed.

The dialogue explored options for policymakers to cultivate the conditions necessary for biomass energy to deliver positive benefits with minimal negative impacts. Presently, in some cases, incentives and regulations for low-carbon energy apply to all forms of renewable energy, boosting demand for biomass energy along with them. In a few specific scientific assessments – especially integrated assessment models – biomass energy with carbon capture and storage (BECCS) has featured prominently, due to its potential to generate energy with zero or even negative emissions. Yet some dialogue participants cautioned that while it may have this potential, there is much more needed to understand the contribution of BECCS to climate change mitigation. Some acknowledged the various interests that are in play, including: forest owners, forest workers, participants in fossil fuel energy, and communities dependent upon forest resources. All of them could be affected by growth of the biomass energy industry, sometimes in multiple ways. Navigating and balancing these interests would be a key challenge for policymakers; providing insight and guidance was a desired outcome of the dialogue participants.

b. Local level impacts of harvesting for bioenergy

Many participants noted the potential for biomass energy to contribute benefits beyond climate change mitigation. In particular, markets for low-grade forest biomass material could help to balance forest product markets for high-grade material and boost the overall profitability of sustainable forest management. An expansion of the fraction of forest under sustainable management could have a series of cascading local benefits, such as improved water quality, wildlife habitat, forest health, and forest fire resilience. Improving the overall value of forests could help to stem or even reverse forest loss under some conditions. All agreed that securing these benefits would be desirable, but creating the conditions for these outcomes would be tricky. The "social license" and ongoing support for the biomass energy industry could be dependent on getting these conditions right.

Dialogue participants share their perspectives on key challenges for Bioenergy from Forests in small group discussions.

Beyond the benefits to forests and sustainable management, participants also noted some of the factors that could influence social license as global demand has negative impacts at the local level. For instance, higher demand for biomass energy in distant markets could lead to overharvesting, poor forest management, and local air and noise pollution in biomass production areas. Affected stakeholders have little control or recourse to affect such demand. Coastal areas, which can move forest products quickly

and cheaply to other parts of the world, might be most closely tied to these global-level market forces. On the other hand, some participants saw how the reputational risks of biomass production for energy could cause abrupt collapse of demand when poor practices are exposed. This risk and the potential volatility in demand could pull the rug out from under communities that were dependent on forest biomass production or biomass feedstock processing.

A few participants felt that the reputational profile of biomass energy could be boosted and protected by greater awareness of its positive, indirect benefits. For instance, in the American West, the risk of wildfire is already seen as an imminent and widespread threat. Reducing the biomass stocks in these forests would correct a history of management mistakes, lowering the risk of wildfires. Connecting these issues in the public's mind was seen as a way to convey a value of biomass energy that might not be readily apparent to most communities.

c. Environmental justice and downstream use of biomass for energy

Beyond the potential for environmental impacts, dialogue participants were also cognizant of the human impacts of BEF, especially as they relate to environmental justice concerns in the vicinity of power plants and in biomass feedstock areas. Existing fossil fuel power plants, which are already causing harm to the communities where they are located, could be converted to co-fire biomass, extending their lifetimes and perpetuating ongoing community impacts. Since these communities are often poor, socially disadvantaged, and bear a legacy of past harms, they feel little power to change this outcome. Yet they are dubious, at best, about the prospect of biomass energy development, since it could provide yet another lifeline for fossil fuel facilities, further harming their communities.

Dialogue participants noted that the harms from biomass-burning power plants are similar in some ways to the harms that occur in biomass feedstock areas. Air pollution, noise pollution, and other harmful effects are not distributed equally; instead, they tend to fall on poor and disadvantaged communities. Participants expressed concern for these communities and recognized historical and potential future harms of energy production facilities. Participants expressed the need to increase knowledge of the impacts to local communities in order to do a better job of understanding the problems for the community, whether air, pollution, or economic. They expressed that the lack of information means it can be difficult to address issues in a meaningful way. Other participants shared existing sources of information and understanding of community experiences, urging participants to not wait for the perfect scientific data to take these concerns seriously. All recognized the importance of these factors as we consider any future growth of the industry. We would need to find solutions that improve conditions in both the supply areas and the use areas of biomass.

Participants were mindful of the dilemma many such communities face, especially in the biomass supply regions. Many members of these communities are part of the workforce that carries out wood harvesting, biomass processing, or feedstock transportation. Thus, growth of the industry could be an opportunity for more jobs and better job security in the future. But we agreed that such opportunities should not come with a tradeoff of higher pollution and worse health outcomes. The harmful effects of the industry

should be minimized or eliminated completely, decoupling the growth in livelihoods from the potential for negative community impacts.

Engaging with communities to better understand and address such issues is vitally important in any policy- relevant discussion of biomass energy. In many cases, communities will have little technical knowledge of the biomass energy industry, the complexities of its supply chain, and the processes that could lead to environmental and social harm or benefits. Many of the experts in the room hold such relevant knowledge, and we noted that we could play a key role in the engagement process. Such engagement is not always easy – it can take time, money, and specialized expertise to do it properly. Community engagement experts can guide the process, engaging subject-area experts in ways that inform communities, without inadvertently leading them into outcomes that might not be in their best interest. Fortunately, The Forests Dialogues has a long history of successfully conducting such engagement. Participants asked for opportunities to engage with local communities in any future field dialogues.

2. Quantifying climate change mitigation

Much of the dialogue discussion focused on the challenge of quantifying the GHG outcomes of biomass energy. We covered a number of different approaches, with a significant discussion on life cycle assessments (LCA). LCA is a flexible approach that can be applied to track the various GHG fluxes throughout a complex system. However, this flexibility can also lead to questions about the proper way to define the boundaries and temporal and spatial scales of such systems, resulting in widely varying estimates of GHG outcomes – even disputes about whether biomass is a net positive or net negative process. Participants agreed that uncertainty and continued debates in quantifying the climate change mitigation potential of BEF limits social license and the ability to make informed decisions to synergize forest and climate health.

Participants engage in breakout discussions.

Participants also discussed the counterfactuals considered in LCAs, highlighting that which energy forms and land use scenarios are being compared will affect the results. Participants discussed the nuance of counterfactuals as they depend on the specific context being considered including the history of land use, land tenure, forest ecology, and markets. For example, in some areas, the absence of a market for low-grade forest biomass material may mean the land will be converted from forest land to a different land use such as development, solar fields, or agriculture.

In other areas a lack of market for low-grade material may make the forest more prone to extreme fire. Participants also highlighted the uncertainty of future counterfactuals depending on the climate scenario we are in and technological advancements such as BECCS.

Participants reflected on the subjective nature of setting LCA boundaries, wondering if it is possible to establish a standard or best practice for LCA boundaries or a governing body to act as an authority on LCAs. Participants converged on the idea of seeking a greater understanding of and advancing a standardization of LCA practice in the context of biomass through research and analysis that engages both scientists and practitioners.

Other participants highlighted that variable LCA results are not only a matter of the decisions made when conducting the LCA (such as boundary and scale), but differences in the systems being analyzed as different regions have different resulting climate outcomes. There is a risk of extrapolating results from one area to a different regional context.

Many of the technical issues related to LCA are addressed in the accompanying background paper such as system boundary (section 2.2.1), temporal (2.2.2) and spatial scales (2.2.3), and counterfactuals in energy (2.3.1), and land use (2.3.2). To avoid redundancy, we direct readers to that paper as a resource on this topic.

3. Competing demands for land, timber, and low-quality biomass

Over the course of the dialogue, participants worked their way through detailed discussions of the many interconnected issues that relate to biomass energy and the forest bioeconomy. Toward the end of the dialogue, a consensus seemed to emerge: we would not be able to understand the dimensions of the issue without placing it in the context of other competing demands placed on forests. These demands include, *inter alia*, 1) other land uses that compete for the area of forest; 2) the demands for timber products, which could be complementary or in competition with the production of biomass feedstocks; and 3) other competing markets for low-quality biomass, such as pulp and paper. These other sources of demand have the potential – alongside demand for biomass energy feedstocks – to shape the extent and health of forests.

Forest industry representatives stated that one of their fundamental goals is to give landowners a market to help them keep their land, and other participants agreed with this objective. Whether their interests were driven by climate objectives, community economic development opportunities, or simply a desire for better forest health, all could support market opportunities that lead to more adoption of sustainable forest management practices. Participants understood that when market opportunities are aligned with sustainable forest management, they can become a mutually reinforcing combination, making forests healthier, more profitable, and more competitive in the landscape. The challenge would be in shaping the bioenergy market opportunity so that it would *only* be aligned with sustainable forest management, and unsustainable practices would not be bolstered by this emerging market.

Ideally biomass energy feedstocks will be derived from low-quality biomass (often from byproducts that have little or no market value). The group discussed competing demands for low-quality biomass in some detail. Many participants approach the topic from a frame of how to stimulate a forest bioeconomy where bioenergy is one product. Some participants urged the group to prioritize more durable wood products that don't currently have the required production infrastructure but could have less negative externalities. Others discussed promising applications of wood fiber insulation and biochar. Participants noted that having a low value market is critical for making sustainable forest management an economically viable approach, and such management is important for sustaining the ecological health of managed forests. Economic viability is also a key factor in keeping land as forestland so landowners are not selling their land for development in some areas.

All of the dialogue participants highlighted the pressures to convert forests to other, competing land uses and the potential for bioenergy demand to help keep forests economically viable. Many participants noted the expected increase in conversion pressure due to rising populations, growing demand for food, and dietary shifts that spur more meat and dairy production. Some saw demand for biomass energy as a market that could counterbalance these other market forces, to some extent, neutralizing some of the pressure for land conversion. This "land sparing" effect would preserve many other co-benefits (often unpriced) of forests, such as biodiversity, water quality and quantity, and recreation. Participants noted that the loss of these co-benefits cannot easily be replaced by other means, making forests even more valuable. And from a climate adaptation standpoint, a few pointed out that we must conserve 30-50% of every forest type in the world in order to have viable, biodiverse forests that can survive a changing climate. Several noted that the intensive cultivation of some areas could be a complementary strategy that allows other forest reserves to remain protected and ecologically functional.

Dialogue Co-Chair, Sara Kuebbing, facilitates a breakout discussion.

Participants noted that the factors driving the viability of sustainable forest management vary across geographies and over time. As a result, we were unlikely to find a "one-size-fits-all" approach that works for all locations and all economic conditions. The key task or challenge for future dialogues would be to understand the conditions under which biomass energy can contribute to sustainable forest management and reduce environmental injustices. This will likely emerge using regional examples to contextualize important ecological and social conditions for bioenergy. Then looking across regional examples would

allow for us to find commonalities or principles that could illuminate how the many stakeholders can achieve alignment. Participants recognized that such alignment may not be possible in all places, and that where it is possible, it would need to be maintained over time, in the face of changing economic conditions. Sustaining forest health and economic viability is not like a one-time vaccination that protects forests for a lifetime; rather, it is like an ongoing health regimen that requires continuous attention and effort.

Dialogue participants in between sessions.

III. ISSUES AFFECTING POTENTIAL SUPPLY OF BIOMASS FEEDSTOCKS

1. Workforce training, maintenance, and career pathways

For biomass energy to meet demand in a positive and successful way, a robust and well-trained workforce must be in place. The sustainability of supply – and therefore, the social license to maintain the industry – will depend upon the workforce having the requisite skills to carry out and document sustainable practices throughout the supply chain. Problems could arise if either the workforce capacity or its training are insufficient, so both of these considerations must go hand-in-hand.

Some participants noted that currently in their area, the forest management workforce is insufficient to support the needs of a growing industry. Moreover, by some accounts, the workforce is aging and shrinking. Other participants note that in their area, such as the Southeast US, much of the workforce for BEF can be, and is being drawn, from the existing forest bioeconomy workforce. Participants expressed concern about the prospect of cultivating the right workforce, at the right scale, in the right places, with the right training, and at the right time. Lining up these various factors to hit the "moving target" of demand could be a very complex challenge. Several participants cited the desperate need for skilled job opportunities in rural communities – particularly tribal communities that have been overlooked in the past. A "silver lining" identified in the dialogue is that most of the skills needed for sustainable forest management are

readily applicable to a wide variety of situations; biomass feedstock production would require relatively few specialized skills beyond the general training needed for sustainable forest management. Nevertheless, people who might consider entering the forestry workforce need to feel confident that they will earn good pay and have opportunities to advance in their careers.

Three other specific issues were connected to the discussion of workforce issues. First, a skilled workforce is only effective if it has the right equipment to do the job, all the way through the supply chain. This means that investments in developing the workforce will need to be complemented by capital investments in equipment and facilities. Second, in key areas (especially the West), the abundance of public lands means that forestry operations are heavily reliant on government contracts and approvals. These processes can be onerous, uncertain, and lack follow-through (especially when political priorities change). Third, the specialized and sometimes dangerous nature of the work in the forests, make this socially valuable enterprise unattractive to its potential workforce. These issues could be a significant obstacle to building and maintaining a high-capacity workforce in some areas.

Dialogue participants listen to report outs from breakout discussions on regional challenges and opportunities.

2. Regional differences in sustainable forest management conditions

Participants joined regional breakout groups to answer the following questions: 1) What are the specific challenges to your region? 2) What do you see as the key opportunities and needs to support social-ecological-climate sustainability of BEF?

a. Northeast

Northeastern forests are, on average, understocked and slower growing than many other forested regions in the US. Participants noted that past forest harvesting practices and increasing development of forests has led to lower forest plant diversity within individual stands as well as across the region. Demand for Northeastern wood products has been, and continues to, decline through time. There is currently no market for low-grade material, and mill infrastructure continues to decline. Forest health in the region is challenged by high pest and pathogen introductions, which reduce the quality of wood products. The current condition of most Northeastern forests is degraded, and participants felt that there was a strong need for funding to support sustainable forest management to improve the health of Northeastern forests.

Participants identified a few opportunities for the region. First, there is some public acceptance of industrial bioenergy in the region, especially in northern New England where many homes and some public utilities already use bioenergy. Participants felt that they could build on this opportunity of existing bioenergy markets, and support expansion of bioenergy markets by emphasizing that increasing bioenergy in the region could support rural economies and labor and increase forest climate resilience through sustainable management. Participants felt that bioenergy markets might be more viable in this region, because of the slower growth and low stocking rates. To achieve a viable market, there would need to be a stronger connection between Northeastern urban-rural communities and strong community management.

b. Southeast

Participants described the difficult land use dynamics in the Southeast where forest lands are predominantly privately owned and over ⅔ by families or individuals. There is a challenge to keep forested land as forest due to pressure to convert to development. Participants shared examples where if landowners are not generating revenue from their forestland, after a harvest they will consider selling or converting to agriculture or cattle pasture. There has been a loss of critical infrastructure and workforce, especially to do thinning of younger stands. There is currently a lack of access to diverse markets for low-value wood, and biochar was noted as having some potential as a new wood product. Participants called for creative thinking to solve current problems; they see an opportunity in the circular bioeconomy approach, in which BEF could be one of several low-value forest products. Participants discussed the opportunities of an industrial park model which provides the capacity for the production of diversified forest products.

In regional breakout discussions, participants reflect on key challenges and opportunities in the Southeast United States.

The Southeast is also unique in the US for its legacy of industrial activities and as the current center for biomass energy facilities. Legacy markets are moving away, leaving infrastructure abandoned. There are strong environmental justice concerns about the citing and operations of these facilities in the Southeast. Participants highlighted that there is currently not a good system to measure air quality across the US or in these industries. An approach to BEF that takes these concerns seriously should build in transparent air quality monitoring. This could be a way to build trust within these communities that have seen a legacy of industrial impacts. The bioenergy experience in the southeast emphasizes the need for effective stakeholder engagement. Participants discussed the role of diversity, values, trust, listening, accountability, and flexibility.

c. West

i. Wildfire management

Forest lands in the Western US are the locus of acute concerns about wildfire management. Participants described how after decades of fire suppression efforts, encroachment of dwellings into the wildland-urban interface, and forest health impacts fueled by climate change, the forests of the West have become more prone to wildfires that are more severe and more difficult to control. Management could play a role in removing excess dead biomass and thinning the remaining live trees, making them less vulnerable to catastrophic fire. Some of this biomass could be utilized as bioenergy feedstock, turning a growing source of concern into a self-financing source of relief.

Several obstacles must be overcome for BEF to have a positive effect on wildfire resilience. Federal lands in the West are also places where a history of fire suppression (among other factors) has led to an accumulation of biomass, which creates a wildfire hazard. Participants recognized the potential connection between the demand for biomass feedstock and the potential for supply from Western forests – a potential win-win-win for better forest health, better community opportunities, and lower wildfire risk. Yet the federal bureaucratic processes could stand in the way of this opportunity, unless better ways can be found to work through them. Several experienced participants expressed concern about a perceived lack of urgency at the federal level. Another obstacle is the means of transporting biomass out of forests and into processing facilities, along with the GHG emissions associated with this removal and transportation process.

These complexities and legacy effects make Western forests a minefield for policy making. Policymakers can see the factors that increase the risks of catastrophic wildfire, but changing these factors is a task that defies simple solutions or short-term political timeframes. Nevertheless, dialogue participants identified several policy-relevant opportunities that could promote fire resilient forests through making it easier to remove hazardous fuel loads from forests and stabilizing demand for the biomass that is removed. One set of opportunities centered on infrastructure investments, detailed in Section 4 Infrastructure Requirements to Build out Robust Supply Chains for Biomass. Another identified opportunity related to a more orderly schedule of NEPA crews to avoid stalling valuable projects and provide a more continuous flow of work, contracts, and finance.

ii. Indigenous lands in the US

Indigenous lands also present an important opportunity that will be difficult to bring to fruition. Tribes often seek to draw upon their traditional practices, such as prescribed burns, to inform their forest management practices. But these traditions have not been widely accepted, and their GHG implications have not been well-studied. Indigenous peoples tend to take a holistic approach, seeing connections across systems like forest management, wildlife management, sustainable food systems, and tribal health. These holistic and interconnected approaches do not align well with the reductionist, evidence-based approaches that often underpin policy-making. Indigenous representatives at the dialogue asked for greater recognition of the validity of their approaches to land management, with more opportunities to

measure their outcomes against conventional forest practices. Tribal experts suspect that their practices are more climate-friendly, but they lack sufficient evidence to convince policymakers to implement these practices in a broader way.

As a result, bioenergy mixes with Indigenous land policies in complex ways. On one hand, tribes seek new opportunities to make their form of sustainable forest management more economically viable, but the need to demonstrate GHG benefits in order to support the market for biomass feedstocks is a technical challenge that goes beyond their current capacities, and they see few opportunities to close this technical gap. Biomass feedstock harvest from tribal lands could support desperately needed jobs for Indigenous communities, but the industry may skip over these lands in favor of more straight-forward contracts with less restrictive landowners. Even biomass harvests on adjacent lands could benefit tribes by reducing the risk of wildfires crossing into tribal lands, but these adjacent lands are often federally owned, with all of its associated challenges. These factors leave tribes with a feeling of being left behind – left behind from opportunities, skipped over by markets, underinvested in terms of education, and unassisted with the means to address the risks rising around them.

Dialogue Co-Chair, Phil Rigdon, facilitates a breakout discussion.

3. Policy conditions and standards that affect forest management and biomass sourcing

a. California policy environment, including cap-and-trade

California's cap-and-trade approach to managing GHG emissions creates a nearly unique environment in the US – but this example may soon serve as a model for additional state and federal policies. California's system focuses primarily on fossil fuel emissions, but a small amount of forestry credits – combined with other regulations on air and water – open an important opportunity for forest-driven biomass energy.

Low-emissions energy, lower wildfire risk, and reduced air pollution represent a trifecta of benefits that is difficult for Californians to ignore. Biomass energy has the potential to deliver these benefits, but the nuanced, strict regulatory environment was not created with biomass energy in mind. Furthermore, constituents already traumatized by wildfires have trouble building support for a solution that involves burning more trees. Biomass energy may have its greatest potential and "best fit" in California, but making this potential into reality will be a long and convoluted road.

b. International trade in biomass and timber

Beyond the domestic policy context, decisions in other countries will affect the growth and expectations of biomass energy and feedstock supply in the US. Participants explained that international demand for biomass feedstock is already an important issue in the Southeastern US, and it is likely to affect other areas soon. Some participants fear that rising demand for sawtimber, mass timber, and other forest products can add to the overall burden on US forests, threatening to drive harvests beyond their sustainable limits – limits that may be shrinking under a changing climate. While other participants point to studies that show that increased demand actually results in increased forest productivity, carbon stock, and forest cover, and is projected to continue doing so. Europe is still the primary source of demand for biomass feedstocks, and this demand is poised to grow under European energy policy. However, gaps remain in our analytical understanding of the scale and locations of this demand. Uneven growth could add volatility to an already volatile biomass market, dampening investments in growth-fueling factors like workforce training and infrastructure development. Furthermore, some dialogue participants conclude that some aspects of biomass energy demand are built upon apparent benefits that arise from accounting omissions, rather than real GHG benefits, creating the potential for the social license for bioenergy to collapse once these omissions are corrected.

Dialogue Co-Chair, Ann Bartuska, leads a plenary discussion on future directions for collaboration on Bioenergy from Forests.

Some participants raised concerns related to the global transport of biomass and the lack of traceability. When stocks of biomass cannot be traced back to their source, it is difficult to link specific environmental and justice concerns to on the ground realities and difficult to address or remedy those impacts. Participants expressed that tracking, trade agreements, and enforcement can improve conditions to some degree.

c. Certification schemes

International certification schemes give buyers confidence in the sustainability of forest products, even if they can't be traced all the way back to their source. Participants with experience in certification noted that scalability is a challenge, and the voluntary nature of certification means that it rarely covers an entire market. For some aspects of the biomass market, regulation may be needed.

Nevertheless, participants expressed interest and cautious optimism about the potential for certification schemes to improve the integrity and function of the biomass market. Some noted that a specialized biomass feedstock certification may be needed in order to accomplish this purpose. Through an extended discussion, participants reached the conclusion that certifications tended to work best at mid-levels of scale, such as at state or regional levels. Efforts to craft global standards often failed, due to regional differences and the need to include specific community needs; at the same time, certification schemes usually failed to penetrate small-scale operations and local markets, instead focusing on industrial scale operations. Some participants noted a positive example when sourcing standards require loggers to receive training, which is then audited by an independent third party, and results in loggers being more likely to implement best management practices during harvesting operations on non-industrial private forests. Participants thought it would be worthwhile to explore these mid-scale opportunities, while also trying to push the effectiveness of certification toward both ends of the scale spectrum.

4. Infrastructure requirements to build out robust supply chains for biomass

a. Harvest and processing

Dialogue participants identified several opportunities related to supply-side infrastructure. One opportunity was infrastructure investment to provide better access to forests, while simultaneously lowering transportation costs. Infrastructure could also include milling and processing facilities, providing a second opportunity related to "stacking" of forestry revenues and benefits. This approach would use the diversification of products and services to help balance the volatility of specific markets, creating more resilient business opportunities built on multiple revenue streams. Wood-product campuses to provide training were proposed as a way to jumpstart this type of horizontal and vertical integration of forestry products.

A technology gap in existing harvesting equipment was one area where participants felt new investments could make a big difference. The locations of processing infrastructure in the past often exacerbated inequality and racial disparity in many areas. Growth and changes in markets could present opportunities to correct these problems and rebalance opportunities. Sustainability will be a key criteria in evaluating these opportunities, since disadvantaged communities will not wish to trade an absence of good opportunities for an abundance of bad ones.

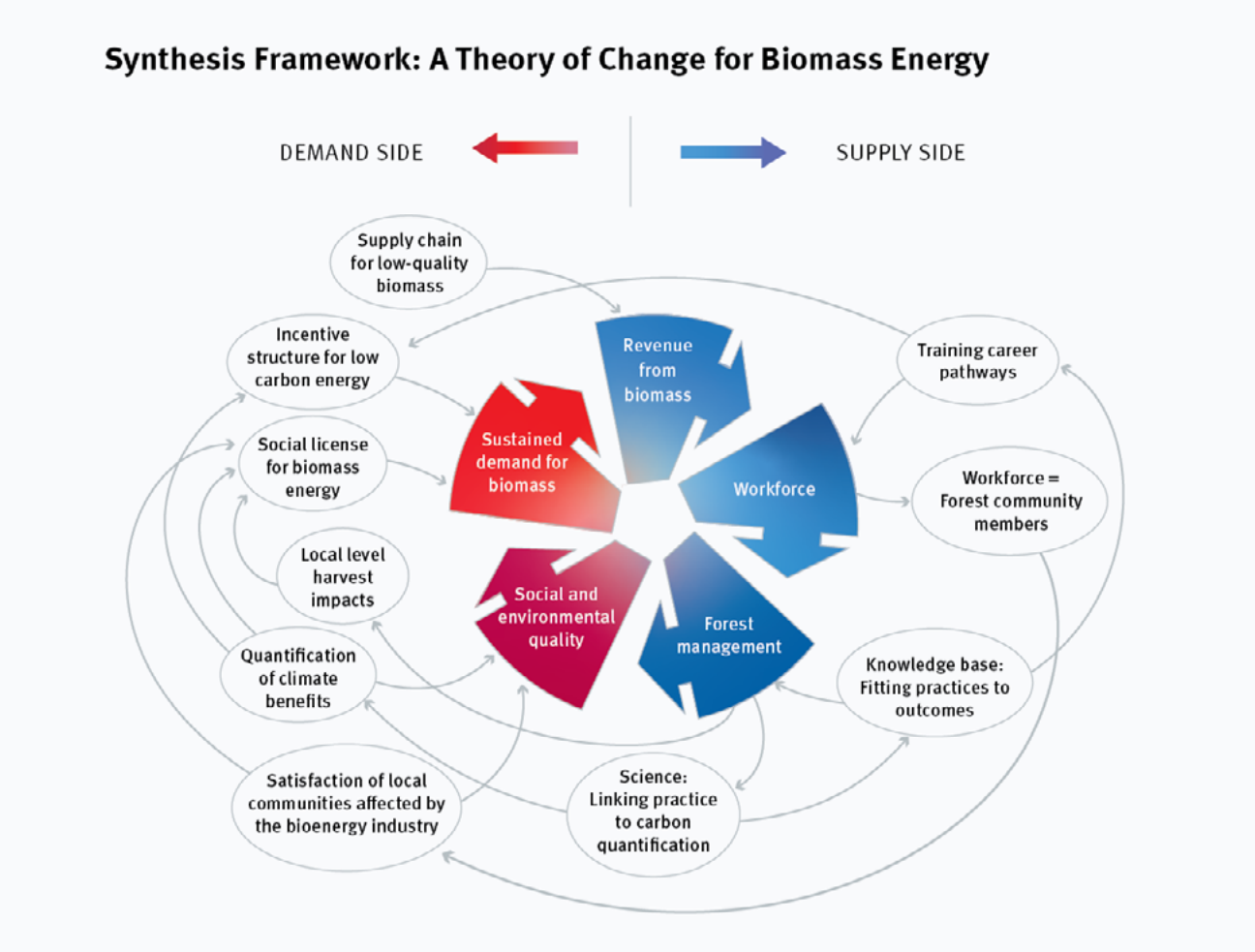
Beyond infrastructure for processing biomass, the dialogue noted that other options should be considered, along with their infrastructure needs. For instance, production of biochar might be a better fit for some locations, compared to biomass feedstock harvest. Biochar processing facilities, with their attendant benefits and drawbacks, should be considered alongside biomass processing investments.

As a lighter-impact alternative, the future value of standing, healthy forests might increase in the future, as carbon sequestration becomes more valuable. Participants noted that few systems can beat a forest, in terms of carbon uptake, when it is managed for health and sustainability. Forest owners and managers should be aware of the developing carbon markets, and forest management strategies to maximize carbon value. Biomass energy may find a place in forests managed for multiple values, since some biomass removal can be a feature of sustainable management practices, particularly in degraded forests or where invasive species have taken hold. The costs and benefits of these different options may be difficult to assess now – some aspects might be based on little more than educated guesses at this point – but further exploration and analysis can shed light on some of the less-known aspects of these decisions.

Dialogue Co-Chair, Jason Funk, suggests next steps for the Bioenergy from Forests initiative.

b. Transportation

Spatial factors became important as the participants dove deeper into questions about biomass supply and processing. These spatial factors often relate to the ease or difficulty of transporting feedstocks (transportation network) and the economies of scale that can be achieved within a particular locale (extent and quality of forest resource). Relative to other energy sources, biomass can be somewhat easier to transport and process, but some specific challenges will need to be addressed within the transportation system. Additionally, the relative distances between biomass source areas and processing facilities can affect the economics of the overall bioenergy enterprise. Investments that close gaps and improve transportation efficiencies can alter the economic opportunities offered by biomass energy in specific locations.



IV. SYNTHESIS FRAMEWORK: A THEORY OF CHANGE FOR BIOMASS ENERGY

The dialogue Co-Chairs synthesized the identified challenges to supply and demand of BEF into a framework to visualize *what must be true for biomass energy to live up to its potential*? (Assuming that the potential is greater than zero.) This framework serves as a theory of change that would underpin a sustainable bioenergy market. The market itself has five components that drive the relationship between the supply side and the demand side. Each of these components, in turn, is driven or affected by factors outside of the market itself. The theory of change is that for bioenergy to succeed, each of the components inside and outside of the market must be maintained.

1. Sustained demand for biomass

a. Requires building out clear, durable **incentive structure for low-carbon energy**

   i. Dependent on the acceptance and availability of reliable methods to **quantify the climate benefits of bioenergy (e.g. LCA)**

b. Ongoing **Social license for biomass energy from forests**

   i. dependent on maintaining **satisfaction of communities affected by the bioenergy industry** including local and downstream communities

2. **Revenue from biomass**
   a. Built-out and functional **supply chains for low-quality forest biomass**
3. **Forest bioeconomy workforce**
   a. **Forest community members make up the workforce for bioenergy**
      i. an element of maintaining **satisfaction of communities affected by the bioenergy industry**
   b. **Training programs** available in environmentally sound forest management practices that are the prerequisites for biomass climate contributions and other socio-environmental outcomes
      i. **Knowledge base** of management practice feeds into training programs
   c. Durable **career pathways** for workers
      i. linked to durable incentive structures for low-carbon energy
4. **Forest management practices** that yield biomass along with other ecological, social, climate, and economic values and within climate and other socio-environmental guardrails
   a. Knowledge base of management practices that can yield social and environmental quality
      i. based on science driver;
      ii. feeds into training driver
   b. Widely accepted scientific evidence that sustainable forest management practices can be linked reliably to carbon and other socio-environmental outcomes
5. **Social and environmental quality** must be maintained within and across all aspects: biomass production areas, supply chains, and areas adjacent to bioenergy facilities
   a. **Satisfaction of communities affected by the bioenergy industry**
      i. Members of the biomass workforce will be members of some of these communities, and their satisfaction depends in part on their job satisfaction, including pay and career pathways
   b. Widely accepted methods must be available to **quantify the climate benefit** component of bioenergy (dependent on widely accepted scientific evidence that sustainable forest management practices can be linked reliably to carbon and other socio-environmental outcomes)
      i. LCA has been used in the past, but it is no longer widely accepted, in part due to disagreement and subjectivity in setting boundaries of the LCA

V. POTENTIAL FRACTURE LINES

The following section details potential "fracture lines" of disagreement to explore in future dialogues which were identified by Co-Chairs based on the dialogue discussions.

1. Some do not believe that **social license** can be maintained because bioenergy i) does not yield a real climate benefit or ii) it cannot be delivered without harmful concurrent social and/or environmental impacts.
    a. WHILE others do believe that social license can be maintained through the delivery of i) conclusive scientific evidence that climate benefits are real, and/or ii) demonstration and wide adoption of practices that do not have harmful social and/or environmental impacts.
2. Some are not confident that a robust **incentive structure** for low-carbon energy (that includes bioenergy) can be built out because i) scientific evidence is not sufficient to demonstrate climate benefits; ii) scientific evidence is not sufficient to link practices with carbon outcomes; and/or iii) designing and implementing policies without creating unintended consequences is difficult.
    a. WHILE others are confident a robust incentive structure for low-carbon energy can be built out and maintained, based on i) past experiences with similar issues and ii) the political imperative for climate action.
3. Fear that **incentive structures** will not be durable enough to maintain career pathways for workforce or business models for bioenergy operators and forest managers.
4. Even if demand and incentive structures are in place, some are not confident that a sufficient **workforce** can be trained in time to service the industry at scale. The result of poorly trained workforce trying to service the industry will be poor forest management practices that lead to negative social and environmental impacts (and ultimately, the loss of social license).
    a. WHILE others are confident that existing training programs can be sufficiently adapted and scaled up in time to provide a highly competent workforce that matches the growing scale of the industry.
5. Some are not confident that **scientific evidence** can robustly link practices with outcomes.
    a. WHILE others are confident that – with sufficient scientific effort – the evidence will bear out this connection.
6. Fear that **policies** will fail to pay attention to downstream communities and aggregate impacts (externalities).
7. What is the definition of sustainable forestry and how is it used?

VI. RECOMMENDED NEXT STEPS AND CONCLUSION

As Co-Chairs, we note that a key (unanswered) question arose at the end of the dialogue: "where, when, and by how much should biomass feedstock production be part of a sustainable forest regimen?" There are two critical challenges to answer this question. First, diagnosing the right "where and when." Second, prescribing the right amount of biomass feedstock production. Any diagnosing or prescription must balance enough regulation to avoid unsustainable practices with the risk that overly-restrictive regulation will limit production. Most of the dialogue participants did not feel that they would be directly involved in diagnosing when and where or prescribing how biomass feedstock production should be incorporated into forest management practices. Rather, participants felt they could assist with developing general guidance on these challenges – diagnostic criteria to help landowners, forest managers, and industry professionals identify the "where and when," and prescriptive guidance to help policymakers, biomass processors, and forest resource managers understand their roles in shaping opportunities to grow biomass markets within sustainable limits.

Participants made some progress in discussing these challenges, and in the course of the dialogue, two potentially competing principles emerged. First, most participants agreed that it would be undesirable to construct a biomass industry that was overly reliant on subsidies; in general, most agreed that outcomes would be better if stakeholders could make decisions in an environment relatively free of the distortionary effects of subsidies (either for biomass or for other competing products and land uses).

However, a second principle emerged around the ways that unfettered markets can fail to drive good outcomes when conditions are imperfect. Participants suggested that interventions are sometimes necessary to address environmental justice concerns, such as when community benefits and climate benefits are at odds. Participants noted that emerging industries (in this case, biomass energy) can fail to anticipate the prerequisites for their own growth, especially the need to develop a trained forest bioeconomy workforce with sufficient specialization and scale to serve the industry in the future. Similarly, industries can struggle to build out sufficient infrastructure as they grow. And a third factor under this principle was that market volatility can be especially disruptive and difficult to interpret in the early days of a growing industry. Landowners, forest managers, and other decision-makers will struggle to align their expectations and decisions when they face noisy price signals for biomass and other competing demands. Foresters have been affected by economic "whiplash" within recent memory – such as the steep decline in demand for newsprint feedstock, driven by the rise of internet communications since the 1990s, followed by the rapid growth in demand for cardboard feedstock, driven by the emergence of online shopping and delivery services, which accelerated remarkably during the covid pandemic. In each of these examples, historical expectations that shaped species selection, management practices, and harvesting decisions were rendered obsolete by factors well outside of forest managers' control. At best, they could hope to adjust to correct any "mismatch" with markets and plan for flexibility in the future. Biomass energy has the potential to cause similar challenges in the future. Forest managers may do better when they can anticipate some of the future needs and make decisions today that can accommodate those needs, while recognizing that there is no perfect "crystal ball."

Co-Chairs identified the following key questions that can be further explored in future dialogues:

1. Under what conditions can biomass supply operations be better for environmental and social outcomes than other competing demands for land?
2. Under what conditions do forest management practices and using forest biomass for energy enhance GHG benefits?
3. Is there a scale at which biomass feedstock production exceeds the sustainable limits of forests?
    a. What means do we have for regulating scale to keep it within these limits?
    b. Does each region, ecoregion, or production approach have its own limits?
    c. To what degree will climate impacts and other factors affect these limits in the future?
    b. How much is the amount of biomass sourced for energy dependent on the demand for other forest products being extracted from the locale or region?
4. Under what conditions might communities face tradeoffs between health, jobs, and wellbeing?
    a. What systems do we have for monitoring such situations?
    b. What tools do we have for preventing or addressing such tradeoff situations?
    c. What would be needed to empower communities to manage these issues?
5. What more can we learn from research?
    a. What case studies would illuminate localized issues and their relationships?
    b. What modeling or assessments would illuminate issues at a larger scale?
6. Looking ahead to emerging markets
    a. Related technologies and markets: biofuels, bio oil, BECCS
    b. Diversifying markets for timber and non-timber forest products
7. Conditions for maintaining overall forest health
    a. How can biomass energy contribute to better health, and when does it undermine?