KNOWLEDGE BRIEF

Biomass Utilization

What is Biomass Utilization?

Biomass, for this research study, is defined as the by-products of forest harvesting and management, including all woody parts, such as tree tops, branches, bark, stumps, needles, and leaves.[1,2] Biomass is the wood waste left behind after logging or thinning, as well as residues from the manufacturing process, and from forests damaged by wildfire, insects, disease, or other natural disasters. Biomass can also come from organic municipal, industrial, and agricultural processes and wastes, and energy plantations.[3]

Biomass utilization is the "harvest, sale, offer, trade or utilization of woody biomass to produce bioenergy… and bio-based products".[2] With rising fuel costs, increasing uncertainty of resource supplies and energy markets, and concern over climate change, utilizing wood waste has become a more attractive and feasible endeavour.[1] Biomass utilization has the potential to reduce dependence on non-renewable energy, reduce energy costs and increase self-sufficiency, reduce wildfire risk, offset greenhouse gas emissions, develop new opportunities for the forest sector, enhance rural economies, and improve forest health and sustainability.[1,4] Several jurisdictions, including BC, NWT, Yukon, Alaska, and many European countries, have biomass utilization strategies and have made investments and advancements in modern biomass energy systems and innovations.[4,5] The International Energy Agency reports that "bioenergy is expected to account for 17% of all energy by 2060, up from 4.5% today".[6] While biomass utilization, simply put, is the use of organic matter – something humans have been doing for thousands of years, the use of wood "waste" has become a topic of considerable interest, investment, and innovation around the world in recent years, with a variety of usages being explored and employed.[7]

Feasibility Factors

There are a number of factors that affect whether biomass utilization is feasible. From policy and regulation, to procurement and processing, technology, transportation, and marketing, utilizing biomass requires research, planning, and financing, and is context specific. The US Forest Service has created a "Woody Biomass Utilization Scorecard" to discern whether biomass utilization is a viable endeavour.[8] The scorecard outlines a number of considerations, such as need – does woody biomass need to be removed to restore and maintain ecosystem health? And if so, what type and size of species exist, is it accessible, and are there benefits to its removal? It also considers availability, with particular attention to whether the wood waste removal will be short term or long term, and estimating the supply over time. An initial biomass inventory is important for determining volume and type of wood available.[5] The overall environmental sustainability of acquiring the wood is also a caution, particularly in light of an already stressed forest resource base.[9]

Factors also relate to the technology, equipment, and infrastructure required to process and produce the end product. The volume and type of wood will inform the potential products that could be generated[10] (see more in Utilizations section below). Transportation is a key consideration, particularly in rural and remote areas, and may influence the cost-competitiveness of the product. Consumer attraction and marketing are also essential aspects of assessing biomass utilization potential.[10,11] Will the product be used on site or destined for domestic or export markets, and what markets exist to support production? The workforce and expertise to acquire, produce, distribute, and promote the product is also essential to the feasibility equation[11]. Biomass utilization requires significant capital, and if capital is limited, then the options for bioenergy or bio-based product development are reduced.[10] The potential for partnerships is another factor which can contribute to the success of biomass utilization projects, including industry partners, as well as government, Indigenous, and academic support.

Utilizations

There are a variety of uses – from low value to high value-added products, where wood waste can be utilized. These include lumber, composites, furniture, housing components, paper and pulp, chemicals, ethanol and other liquids, as well as wood waste as an energy feedstock. The US Forest Service shares a number of biomass utilization success stories on their website.[12] Many include wood waste for energy use, such as replacing the use of coal with wood chips at a power plant in Colorado, and using the slash from fuel treatment projects for heating homes and schools in Montana. Most of Canada's and British Columbia's biomass energy is in solid form (such as hog fuel, chips, and pellets) and liquid form (such as ethanol), and the pulp and paper industry has historically been the largest industrial consumer of bioenery.[5,9] Wood for heating homes, community buildings and district energy systems, and fueling industrial processing are common uses of solid form biomass energy.[9,13]

With the depletion of fossil fuels and a need to reduce greenhouse gas emissions globally, there is considerable research and effort focussed on a shift from petroleum based fuels, like coal and oil, to bio-based fuels, like ethanol and methanol.[14,15] It has been estimated that in British Columbia "forest-industry wastes alone could provide enough solid and liquid fuels to replace much of the current oil consumption, once the energy conversion technologies are proven to be economic".[9] Biomass, or lignocellulosic feedstocks, offer a vast number of applications.[16] There are, however, obstacles associated with production to liquid biofuel, particularly related to the physicochemical architecture and deconstruction of the cell wall, as well as pre-treatment methods, including physical, chemical, and biological approaches to generating value-added fuel

products.[16] While methanol produced from wood waste may be a viable alternative to traditional fuels for transportation and industry, currently, agriculture and food supplies, such as corn and wheat, are more cost competitive in producing ethanol.[9] Further research and innovation is required in order to develop efficient, cost-competitive processes to create a viable biomass energy in liquid form.[15,16]

The cascade use or "cascading" is increasingly being discussed in relation to biomass utilization, particularly in the European Union, with a common theme that "material use of wood should be prioritized over energy use of wood".[17] Cascading means that "biomass is used (and reused or recycled) at least once or several times as a product before its end-of-life (e.g. energy use or landfill)". In general, higher value-added products add more to the economy – often creating jobs in small rural communities, such as Troy, Montana where locals came together to purchase a kiln that is used by several independent small mill owners. Businesses are manufacturing a variety of specialized, high value products, such as flooring, molding, and decorative finishing.[18] A project in Idaho explored using a portable saw mill to make use of small diameter trees acquired from fire hazard reduction projects, turning what would have been waste wood into high value tongue and groove paneling.[19] This speciality product proved to be much more economically viable than lumber. Similarly, the Colorado Wood Utilization and Marketing Program explored commercial opportunities for pinyon and juniper, moving away from firewood and fence posts to flooring, wainscoting, molding, and novelty items, like coat hangers and children's toys.[11] In British Columbia, there may be an array of specialized ways to utilize wood waste and a selection of niche markets, particularly with efficiencies, new equipment, technologies, and innovations.[20]

Biomass Utilization in BC

British Columbia has a significant volume of woody biomass on the landscape that could be used. Some argue that it must be removed in order to improve ecosystem health and decrease the increasing threat of wildfires.[21] A significant current source of wood is pine beetle killed wood, where 20 - 50% of trees harvested are left on site.[10] Residues from paper and sawmills are a significant source of biomass, and non-merchantable stems and roadside slash could also be salvaged.[10,22]

Access to this biomass however, along with market conditions, presents significant impediments to utilization in BC – with many variables influencing the challenge, such as costs associated with extraction, processing, and transportation, and having a high enough valued end product to make the venture worthwhile.[21] While forests are predominately owned by the Province of British Columbia, it is the existing forest tenure holders and mill owners who hold the majority of logging rights, and most of the annual allowable cut is already allocated.[10]

Much of the biomass utilization in BC has thus been focussed on biomass energy production, including stand alone heat generation, such as fueling kilns at sawmills for lumber production, and stand alone power generation.[23] Biomass energy can also be cogeneration of heat and electricity, which is employed at many pulp mills across the province – amounting to over 600 MW of capacity.[24] According to the BC Council of Forest Industries, BC's forest industry is the largest bioenergy producer in North America.[25] According to Clean Energy BC, the total generation potential for all wood sources in BC is in the order of 2,300 MW, and there is competition in developing biomass electricity generation, as demonstrated by BC Hydro's Requests for Proposals for increasing BC's biomass capacity.[24] The challenge however, is that at current electricity rates, the sale of power from cogeneration is so low that production has been subsidized.[21] The BC Utilities Commission, as the energy price regulatory, will play a key role in the wood-fuelled electricity energy sector.[10]

The Government of BC is working towards creating viability for biomass utilization in the province. The government has created an information guide for First Nations, municipalities, and industry to support the pursuit of biomass energy opportunities, outlining options, potential hurdles and financing, and the steps and technologies required in bioenergy project development.[10] The BC Bioenergy Strategy supports commitments under the BC Energy Plan, with a goal to reduce greenhouse gas emissions, strengthen long-term competitiveness, and electricity self-sufficiency.[5] In addition, the BC Bioenergy Network was established to support investment and innovation, championing bioenergy development in BC and around the world. The Ministry of Forest, Lands, Natural Resource Operations & Rural Development is taking initiative to support the use of post-harvest timber, with a Fibre Action Plan.[26] This Ministry has Fibre Recovery Process guidelines to be employed in Natural Resource Districts where there is demand for residual fibre and where primary harvesters are not using the biomass, suggesting that the "most efficient and effective method of using residual fibre is for primary harvesters and secondary users to form business-to-business relationships".[22,27] This is a direct effort to improve the utilization of biomass that remains on roads and landings after primary harvest has occurred. The BC Government is also working with FPInnovations to conduct biomass inventories for Timber Supply Areas in BC, and is hosting a series of workshops in 2018 on Woody Debris Management.[22,28]

Alongside government initiatives, are researchers, such as a team at the University of British Columbia (UBC), who are actively working on innovation in the emerging "bioeconomy". The wood pellet research laboratory at UBC is focused on the critical process of converting raw biomass into a high value end product.[29] This group of scientists and engineers is developing mathematical models for supply chain analysis and techno-economic assessments. The University of Northern BC (UNBC) has also hosted research related to biomass utilization, including the Wood Pellet Pilot Project and development of a Bioenergy Plant, as well as reports on the future of fibre use and a forum connecting "community and industry leaders with experts in forest products, markets, and regional development".[30] The academic community plays an important role in the research and development required for biomass utilization to reach its full potential.

Industry is also taking leadership, and industry partners have been key to investments and innovation in this emerging sector. Vancouver-based Nexterra Systems Corp. is an example, pioneering gasification and syngas conditioning technologies for bioenergy production. A recent partnership with UBC demonstrates North America's first commercial system that combines Nexterra's technologies with a high-efficiency internal combustion engine, producing 2 MW of electricity and generating 3 MW of thermal energy to heat the campus.[31] The 2018 Canadian Bioeconomy Conference and Exhibition which took place in Prince George, highlighted that this is still a fledging industry, outlining the many accomplishments, but with hurdles yet, such as the sustainability of the product, competition for the feedstock, and the high cost of developing technologies to process wood fibre.[32]

Biomass utilization is about sector transformation, transitioning old industries into new ones, and determining the highest and best use "so that it constitutes a social and economical benefit to not only Canadian and multinational corporations, but also the rural communities of BC".[21] It's about transition – from "waste" to use, non-renewable to renewable, and creating new technologies, industries, and markets. The potential for BC is enormous, with the world already viewing the province as a bioenergy hot spot.[5] With continued research, innovation, and testing, biomass utilization is poised to be a major component of BC's future, with diverse applications across sectors. As noted at the recent Canadian Bioeconomy Conference, industry and

KNOWLEDGE BRIEF

government leaders suggest that the growth of the bioeconomy starts with community-level projects – from procurement to project development, communities are leading the way in effective approaches to biomass utilization.[32]

References

1. Foster, C. D., Gan, J. & Mayfield, C. What is Woody Biomass? in *Sustainable Forestry for Bioenergy and Bio-based Products: Trainers Curriculum Notebook* (eds. Hubbard, W., Biles, L., Mayfield, C. & Ashton, S.) 27–30 (Southern Forest Research Partnership, Inc., 2007).
2. US Forest Service. What is Wood Biomass Utilization? (2018).
3. Kumar, A. Biomass utilization for food, fuels and chemicals. *Science 2.0* (2009).
4. Yukon Government. *Yukon Biomass Energy Strategy*.
5. Province of British Columbia. *BC Bioenergy Strategy: Growing Our Natural Energy Advantage*. (2015).
6. Murray, G. Takeaways from the 2018 European Pellet Conference.
7. Biomass Magazine. Biomass Magazine: About Us. *Biomass Magazine* (2018).
8. US Forest Service. Woody Biomass Utilization Scorecard - Is it a viable opportunity? (2018).
9. Cruickshank, W. H., Robert, J. E. & Silversides, C. R. Biomass Energy. *Can. Encycl.* (2014).
10. BioCap Canada. *An Information Guide on Pursuing Biomass Energy Opportunities and Technologies in British Columbia*. (2008).
11. Colorado Wood Utilization and Marketing Program. *Beyond Firewood and Fence Posts: Exploring and Expanding the Commercial Potential of Colorado's Pinyon-Juniper Woodlands*. (2007).
12. US Forest Service. Success Stories. (2018).
13. Akhtaria, S., Sowlatia, T. & Day, K. Economic feasibility of utilizing forest biomass in district energy systems – A review. *Renew. Sustain. Energy Rev.* **33,** 117–127 (2014).
14. Soni, S. K., Sharma, A. & Soni, R. Cellulases: Role in Lignocellulosic Biomass Utilization. in *Cellulases: Methods in Molecular Biology* (ed. Lübeck, M.) 3–23 (Humana Press, 2018).
15. BioMed Research International. Bioenergy and Biomass Utilization. (2018).
16. Kumar, A. K. & Sharma, S. Recent updates on different methods of pretreatment of lignocellulosic feedstocks: a review. *Bioresour. Bioprocess.* **4,** (2017).
17. IEA Bioenergy. *Cascading of woody biomass: definitions, policies and effects on international trade*.
18. USDA Forest Service. Economic Action Montana. (2018).
19. USDA Forest Service. Economic Action Idaho. (2018).
20. USDA Forest Service. Pyramid Mountain Lumber Company - Case Study. (2018).
21. Gray, R. W. Biomass availability in BC. *Canadian Biomass Magazine*
22. Ministry of Forests Lands Natural Resource Operations & Rural Development. Residual Fibre Recovery. (2018).
23. Atlantic Power Corporation. Atlantic Power Corporation - Williams Lake. (2018).
24. Clean Energy BC. Biomass. (2018).
25. BC Council of Forest Industries. Forestry for the Future. (2018).
26. Ministry of Forests Lands Natural Resource Operations and Rural Development. *Fibre Action Plan to Increase Use of Wood Residue*. (2015).
27. Forest Tenures Branch. *Fibre Recovery Process*. (2015).
28. FPInnovations and BC Government. Woody Debris Management Workshops. (2018).
29. Yazdanpanah, F. UBC Receives New Equipment for Wood Pellet Research. (2018).
30. University of Northern British Columbia. Federal Government Supports Beetle-Related Projects at UNBC. (2008).
31. Nexterra Systems Corp. Projects - University of British Columbia. (2018).
32. Church, M. Bioeconomy leaders converge in Prince George for CBCE. *Canadian Biomass Magazine*

The Columbia Basin Rural Development Institute, at Selkirk College, is a regional research centre with a mandate to support informed decision-making by Columbia Basin-Boundary communities through the provision of information, applied research, and related outreach and extension support.
Visit www.cbrdi.ca for more information.