APPENDIX I: COMPLIANCE WITH THE CARBON-FREE STANDARD

This Appendix to the 2025-2039 Integrated Resource Plan ("2025 IRP") provides information regarding Minnesota Power's (or the "Company's") compliance with the carbon-free electricity standard ("Carbon-Free Standard" or "CFS") that was passed into law in 2023.[1] Information is provided in the following sections:

- Part A: Introduction
- Part B: Reporting Requirements
- Part C: Minnesota Power's Pathway to Compliance in 2040
- Part D: Biomass

A. Introduction

The CFS establishes a standard for utilities to generate or procure electricity generation from a carbon-free energy technology equivalent to 100 percent of the utility's retail electric sales by 2040. The CFS establishes additional benchmarks for compliance, so that an electric utility with 100,000 to 200,000 retail electric customers in Minnesota generate or procure electricity generation from a carbon-free energy technology equivalent to 80 percent of the utility's retail electric sales by 2030 and 90 percent by 2035.

House File No. 7 took effect on February 7, 2023, amending Minn. Stat. § 216B.1691 Renewable Energy Objectives to include changes to Minnesota's existing Renewable Energy Standard ("RES") and Solar Energy Standard ("SES") and the introduction of the state's CFS. The statute provides direction to the Minnesota Public Utilities Commission (the "Commission") and grants it authority to modify or delay implementation of standard obligations to protect the public interest and to issue necessary Orders that detail the criteria and standards used to measure an electric utility's efforts to meet and comply with the RES, SES, and CFS.

To this effect, the Commission initiated a proceeding on April 28, 2023 to address what changes or clarifications are needed to the criteria and standards used to measure electric utilities' compliance with the RES and SES, and to comply with the changes made to Minn. Stat. § 216B.1691.2 The initial timelines and docket process have since been amended due to extensions and Commission decisions. Table 1 below shows the docket schedule as of the time this Appendix was prepared.

[1] Minn. Stat. § 216B.1691 Subd. 2g. requires "each electric utility must generate or procure sufficient electricity generated from a carbon-free energy technology to provide the electric utility's retail customers in Minnesota, or the retail customers of a distribution utility to which the electric utility provides wholesale electric service, so that the electric utility generates or procures an amount of electricity from carbon-free energy technologies that is equivalent to at least" 80 percent by the end of 2030 for public utilities, 90 percent by the end of 2035 for all electric utilities, and 100 percent by the end of 2040 for all electric utilities."

[2] *In the Matter of the Commission's Investigation into Implementing Changes to the Renewable Energy Standard and the Newly Created Carbon Free Standard under Minn. Stat. § 216B.1691*, Docket No. E-999/M-23-151, Notice of Comment Period (Apr. 28, 2023).

Table 1. CFS Implementation Docket Process and Timelines

Round	Content	Comment Period Date	Agenda Meeting Date	Order Date
1	Changes to RES and SES	Initial: August 2, 2023 Reply: August 18, 2023	October 19, 2023	December 6, 2023[3]
1.5	Additional clarifications: changes to RES and SES	Initial: January 19, 2024 Reply: February 7, 2024	March 14, 2024	April 12, 2024[4]
2	New and Amended Terms	Initial: June 28, 2024 Reply: July 24, 2024	September 26, 2024	November 7, 2024[5]
New Docket	Complex Fuels Life-Cycle Analysis[6]	Initial: June 5, 2025 Reply: July 17, 2025	Q4 2025	By December 31, 2025
3	CFS Compliance	Initial: January 29, 2025 Reply: February 19, 2025	Q2 2025	
4	Off-Ramp Process	Q3 2025	Q4 202	

To date, the Commission has issued orders clarifying the process including what entities are subject to the standards, new and amended definitions, reporting responsibility and requirements, and has initiated a separate proceeding to clarify the applicability of the CFS to complex fuels such as biomass and municipal solid waste.

Minnesota Power has been an active participant in every phase of this proceeding and continues to advocate for a reliable and increasingly clean energy future. The Company is preparing for its first CFS compliance report in 2030 by proactively developing robust, flexible, and achievable reporting requirements in the CFS Proceeding before the Commission, and the accompanying life-cycle analysis ("LCA") docket established by the Commission.[7] As the first utility in the state to reach 50 percent carbon-free generation, the Company continues to explore all possibilities for providing reliable, affordable, and increasingly clean electricity for its unique customer mix as it decarbonizes its energy portfolio. Minnesota Power will adhere to the specific

[3] *In the Matter of the Commission's Investigation into Implementing Changes to the Renewable Energy Standard and the Newly Created Carbon Free Standard under Minn. Stat. § 216B.1691*, Docket No. E-999/M-23-151, Order Clarifying Implementation of Changes to Minn. Stat. § 216B.1691 and Directing Additional Comment Period (Dec. 6, 2023).

[4] *In the Matter of the Commission's Investigation into Implementing Changes to the Renewable Energy Standard and the Newly Created Carbon Free Standard under Minn. Stat. § 216B.1691*, Docket No. E-999/M-23-151, Order Further Clarifying Implementation of Changes to Minn. Stat. § 216B.1691 (Apr. 12, 2024).

[5] *In the Matter of the Commission's Investigation into Implementing Changes to the Renewable Energy Standard and the Newly Created Carbon Free Standard under Minn. Stat. § 216B.1691*, Docket No. E-999/M-23-151, Order Initiating New Docket and Clarifying "Environmental Justice Area" (Nov. 7, 2024).

[6] *In the Matter of a Commission Investigation into a Fuel Life-Cycle Analysis Framework for Utility Compliance with Minnesota's Carbon-Free Standard*, Docket No. E-999/CI-24-352.

[7] *In the Matter of a Commission Investigation into a Fuel Life-Cycle Analysis Framework for Utility Compliance with Minnesota's Carbon-Free Standard*, Docket No. E-999/M-24-352, Order Initiating New Docket and Clarifying "Environmental Justice Area" (Nov. 7, 2024).

scheduling and reporting requirements issued by Commission following the conclusion of these dockets but anticipates reporting on the following topics discussed in Part B below as indicated in Minn. Stat. § 216B.1691.

B. Reporting Requirements

Although the first reporting period for the CFS is not until 2030, and the process and requirements are still being finalized, Minnesota Power submits this preliminary report in response to the requirements outlined in Minn. Stat. § 216B.1691, subd. 3.

Renewable Energy Mix

In 2020, Minnesota Power became the first utility in Minnesota to supply an energy portfolio to customers that was 50 percent renewable, exceeding the 2020 compliance requirements set by the RES by 30 percent. With this 2025 IRP, the Company is pleased to report that renewable sources make up 50 to 60 percent of the current supply mix with more renewable acquisitions currently proposed. This places the Company well within compliance of the RES requirement that 55 percent of retail electric sales to Minnesota customers be generated by or procured from eligible renewable energy technologies by the end of 2035.

Minnesota Power tracks and reports on its renewable energy mix annually as required by the Commission, with the Company's most recent report filed June 3, 2024.[8] The Company has proposed to use a similar system to track and report its compliance with the CFS.[9] Minnesota Power currently reports on its generation and retirement of Renewable Energy Credits ("RECs") in the RES annual report. Reporting requirements and REC usage are currently under discussion in an active Commission proceeding, and the Company will continue to adhere to all requirements put forth in Minnesota Statute, Rules, and Commission orders.

Minnesota Power proposes that preparedness reporting for upcoming CFS requirements be included in the Company's IRPs filed with the Commission pursuant to Minn. Stat. § 216B.2422. The IRP already details the utility's current generation portfolio and future changes over a 15-year horizon. Including CFS compliance readiness in the IRP, in an appendix such as this or in another format if the Commission prefers, would allow the Commission to regularly assess the utility's preparedness within an existing scheduled proceeding.

Minnesota Power also proposes that the Commission measure compliance with the CFS in an annual compliance filing on the same schedule as that for the RES, streamlining reporting and making it easier for regulatory review and public participation. Utilities should report compliance in a spreadsheet detailing the amount of carbon-free energy (in megawatt hours, or "MWh") generated by (or purchased from) eligible carbon-free technologies compared to the annual energy sales to its customers.

A REC used to meet the RES in a compliance year may also be applied to the CFS provided it meets CFS eligibility requirements. Other carbon-free energy that might not produce a REC (i.e., nuclear or green hydrogen) but is eligible for CFS can be applied to meet compliance requirements. This flexibility to have multiple options for applying different types of eligible energy technology to the standard is critical to a utility's ability to comply with state energy goals while providing reliable and affordable electricity to customers.

[8] *In the Matter of Commission Consideration and Determination of Compliance with Renewable Energy Standard and Solar Energy Standard for Year 2024*, Docket No. E-999/PR-24-12, Compliance Filing (June 3, 2024).

[9] *In the Matter of the Commission's Investigation into Implementing Changes to the Renewable Energy Standard and the Newly Created Carbon Free Standard under Minn. Stat. § 216B.1691*, Docket No. E999/M-23-151, Phase 3 Initial Comments (Jan. 29, 2025).

Efforts to Meet Obligations

Minnesota Power is committed to transparently reporting its efforts to plan for and meet CFS requirements. The Company will continue to provide detailed updates on its progress in future IRPs or in any proceedings specified by the Commission. These reports will include comprehensive information on the strategies and initiatives Minnesota Power is implementing to transition to carbon-free energy sources.

Minnesota Power has multiple utility-scale solar and wind acquisition projects in various stages of development and negotiation, which, when completed, will result in hundreds of new megawatts of carbon-free, renewable generation before 2030. Coupled with this, the Company is aggressively upgrading infrastructure at the transmission and distribution level to support the integration of new renewable energy and improve grid reliability.

Both independently and in collaboration with industry and government partners, the Company is working to develop innovative solutions for meeting state energy goals. These include transmission infrastructure buildout, prudently piloting new technologies, and enhancing energy efficiency programming.

Potential Obstacles

Foreseeable obstacles to compliance include the high cost and readiness of emerging technologies, supply chain disruptions, and permitting challenges. In recent years, a number of energy technologies have received a great deal of public attention as governments and businesses set energy transition goals, such as hydrogen, small modular nuclear reactors (or "SMRs"), and long duration energy storage ("LDES") batteries. The Company continues to monitor and evaluate the state of readiness for each of these technologies for implementation at a future date. However, a significant obstacle to adoption of these technologies is that all are in pilot phases nationally, and the reliability and cost effectiveness for these technologies (and others) remains to be seen. Utilities have historically been cautious in adopting new or emerging technologies due to the high costs and risks involved. New technologies often come with wide cost ranges and unproven performance at utility scale, making it challenging for utilities to justify investing in such technologies until they are proven and cost effective. However, these types of pilot deployments are what is needed to advance and accelerate the adoption of emerging technologies. Therefore, Minnesota Power's 2025 IRP includes a request for a $30 million budget to support research and development ("R&D") projects with interested customers during this historic time of energy technology evolution.

For proven renewable generation technologies such as wind and solar, supply chain disruption remains a significant concern. Fluctuating prices for components can hinder the timeline for implementation and disrupt delivery from manufacturers and vendors. Manufacturing and supply chain disruptions started during the COVID-19 pandemic resulted in a run on certain electricity technology and components, which persist today. Additionally, permitting new and existing technologies can be a lengthy and complex process that can delay adoption and implementation, particularly if the technology is new or has not been permitted for some time.

Potential Solutions

The Inflation Reduction Act ("IRA") and the Infrastructure Investment and Jobs Act ("IIJA") provide funding opportunities and tax incentives to reduce costs for customers and make new technologies more competitive. The continuance of state and federal funding opportunities for both the testing of new technologies and the expansion of proven ones like wind, solar, and their accompanying transmission needs reduces customer rate impacts and incentivizes utilities to pilot promising technologies. Minnesota Power has been successful in securing federal and state

funding to lessen customer impacts for certain projects supporting its clean energy transition, as discussed in Appendix L.

Supporting and approving pilot programs for technology demonstrations can help utilities test new technologies in real-world conditions, gather data, and build confidence in their performance and cost-effectiveness. Utilities need assurance that they can recover costs associated with testing these technologies. This can be achieved through regulatory mechanisms that allow for cost recovery and incentivize innovation. Implementing flexible customer programs can also enable utilities to move faster in adopting new technologies and meeting their obligations. These programs can provide customers with more options and incentives to participate in clean energy initiatives.

Employment Data for Minnesotans in Facility Construction

The Company will track employment data for Minnesotans involved in the construction of any new projects and provide estimates of the local construction workforce. For pending solar construction projects in Minnesota, the Company requires compliance with federal prevailing wage and apprenticeship utilization standards as well as state prevailing wage requirements that apply to large generation projects. These projects prioritize construction career opportunities for local construction workforce, defined as workers that permanently reside in Minnesota Power's service territory, in the state of Minnesota, or within 150 miles of the project site.

Worker Retention and Retraining Efforts for those from Closed Facilities

Minnesota Power is committed to a just workforce transition and has a history of retraining and reassigning workers from closed fossil fuel facilities. In 2005, Minnesota Power's generation mix was 95 percent coal. To support its decarbonization efforts, seven of the Company's nine coal units have been closed or refueled since then. With time and thoughtful transition, the Company managed this downsizing and changes on operations through hiring freezes, relocations, and planned retirements. Of the positions eliminated as part of this transition, only a handful were laid off (with a preference for rehire). The Company will continue to thoughtfully plan for employees during this period of historic transition.

Impacts on Environmental Justice Areas

The Company continues to prioritize environmental justice areas for projects that will aid in the energy transition, provide local jobs, and support local industry. In addition to expanding non-emitting generation resources' role in the Company's portfolio, Minnesota Power will continue to explore prudent investments in emissions control equipment at its thermal generating facilities and currently implements the Best Available Control Technologies ("BACT") for its facilities, meeting or exceeding all permit requirements. This is especially important for vulnerable populations in environmental justice areas who are disproportionately affected by pollution. The transition to renewable and cleaner energy sources can create new job opportunities in the energy sector including construction, maintenance, and operation of new facilities as well as secondary economic benefits. Ensuring that these opportunities are accessible to local communities can help promote economic equity. Minnesota Power's commitment to environmental justice includes engaging with local communities to ensure their voices are heard in the planning process, including the year-long engagement process that was undertaken prior to filing this 2025 IRP as well as conducting public open houses and listening sessions prior to constructing new facilities.

Diversity Efforts in Workforce and Vendors

Minnesota Power has and continues to prioritize diversity in both its workforce and vendors. For example, in the Company's most recent request for proposals for new wind and solar resources, the Company requested that bidders detail how they intend to maximize employment

of, and provision of construction career opportunities for, people of color, women, and veterans on the project, including existing or proposed partnerships with labor unions, registered apprenticeship programs, and/or community based organizations to recruit, train, and employ these populations on the proposed projects. Since creating its supplier diversity program in 2021, the Company has committed to building its infrastructure and understanding its spending with diverse and small businesses across the nation. Building the infrastructure has included capturing business classifications in our supplier system, building dashboards to monitor how much work we have with diverse and small businesses, establishing an internal subcommittee within Supply Chain and hiring a full time position to manage the program, partnering with business development organizations, going through a supplier data enrichment process, incorporating supplier diversity questions into bids over a certain limit, and including a supplier diversity clause in our terms and conditions for new suppliers. As the Company continues to build out its energy infrastructure into 2040 these priorities will remain in place.[10]

C. Minnesota Power's Pathway to Compliance in 2040

Minnesota Power's 2025 IRP results in 95 percent carbon emission reduction since 2005 and an annual electricity portfolio of 90 percent renewable energy by 2035, in compliance with the CFS. This achievement aligns with global and national efforts to combat climate change, reduce greenhouse gas ("GHG") emissions, and promote renewable energy sources. Minnesota Power's approach is designed to be prudent, realistic, ambitious, and customer-focused, ensuring a reliable and increasingly clean energy portfolio at a cost customers can afford.

In accordance with the Commission's November 7, 2024, Order Initiating New Docket and Clarifying "Environmental Justice Area" in Docket No. E-999/CI-24-352,[11] Minnesota Power has included carbon free energy associated with bilateral purchases from specific resources in its EnCompass modeling for this 2025 IRP.[12]

Commitment to Sustainability

Minnesota Power's pathway to 2040 represents a significant step toward reducing the environmental impact of its energy production. With actions that will increase the Company's reliance on renewable energy sources, the Company's 2025 Plan aims to balance environmental responsibility with economic and operational feasibility. The transition will involve continued investments in renewable and cleaner energy sources, infrastructure modernization, and exploration of innovative technologies to enhance energy efficiency and sustainability.

[10] Minnesota Power reports on its diversity efforts annually, with the most recent report filed in March 2025. *See In the Matter of Annual Utility Diversity Reporting*, Docket No. E,G-999/PR-25-97, Minnesota Power Annual Report (Mar. 17, 2025).

[11] *In the Matter of a Commission Investigation into a Fuel Life-Cycle Analysis Framework for Utility Compliance with Minnesota's Carbon-Free Standard*, Docket No. E-999/M-24-352, Order Initiating New Docket and Clarifying "Environmental Justice Area" (Nov. 7, 2024) (provisionally directing utilities to (1) calculate the percentage of carbon-free market purchases on an applicable regional transmission organization subregion using annual energy fuel mix data as practicable and (2) calculating the percentage of carbon-free energy when a utility purchases energy from a specified resource such as in the context of a bilateral contract or power purchase agreement based on the percentage of carbon-free energy generated by the resource).

[12] Specifically, the carbon-free purchases included in the Company's modeling are: Manitoba Hydro 250 MW and 133 MW power purchase agreements ("PPAs"), 250 MW Nobles 2 PPA, 99 MW Oliver I-II PPAs, 1 MW Community Solar Garden PPA, and Laskin/Duluth/Sylvan Solar PPAs. Due to the timing of the Commission's November 7, 2024 Order, Minnesota Power has not modeled any portion of Midcontinent Independent System Operator ("MISO") market purchases as carbon free but will incorporate this assumption in future modeling.

Key Components of CFS Compliance

Expanding Renewable Energy Sources

- Increasing investments in wind and solar power.
- Developing new renewable energy projects and enhancement of existing facilities.
- Collaborating with industry partners to optimize renewable energy integration.

Enhancing Energy Storage and Grid Reliability

- Deployment of advanced battery storage solutions to help optimize fluctuations in renewable energy generation.
- Strengthening grid infrastructure to support a diverse and resilient energy mix.
- Adoption of smart grid technologies to improve efficiency and reliability.
- Modernizing transmission and distribution systems to accommodate renewable energy growth.

Ceasing Coal Operations

- Taking a carefully phased approach to removing coal as a fuel source, being mindful of the major implications for energy production and a just workforce transition.
- Ensuring the continuity of reliable baseload power by evaluating and cost effectively implementing energy from less carbon-intensive sources such as natural gas, biomass, hydroelectric, hydrogen, and other emerging sources.
- Evolving Utilization of Fossil Fuels.
- Tracking the development of new fuel technologies like hydrogen and renewable forms of natural gas.
- Evaluating feasibility and cost effectiveness of carbon capture and utilization technologies.
- Partnering with customers to explore innovative opportunities for new clean, firm technologies through a new R&D initiative.

Customer-Focused Approach

- Ensuring affordable energy rates while making the transition to a carbon-free future is a priority.
- Providing incentives and support for customers to adopt energy-efficient practices.
- Engaging communities and stakeholders in decision-making processes to create inclusive energy solutions.

Considerations for 100 Percent Carbon-Free Energy

While achieving an annual electricity portfolio that is 90 percent carbon-free energy by 2035 is a viable and balanced goal under the current CFS, reaching 100 percent with existing and known technology presents additional challenges. A system relying solely on wind, solar, and battery storage would result in exorbitant costs for customers, as these technologies require extensive infrastructure investment to meet electric system requirements. Furthermore, intermittent renewable energy solutions do not address reliability and resiliency concerns, increasing the risk of blackouts and service disruptions. Without advancements in energy storage,

nuclear technology, or other baseload capable alternatives, and a budget to support R&D for innovative technology pilot programs or demonstrations, a completely carbon-free system remains financially and operationally challenging.

Future Innovation and Technology Monitoring

Minnesota Power recognizes the need to continue updating our plan in future IRPs on how the Company will accomplish the last 10 percent of the CFS. As emerging technologies evolve and become market ready, the Company remains committed to evaluating and integrating innovative solutions that could enhance grid reliability, affordability, and sustainability. Minnesota Power aims to ensure a responsible and practical path toward a carbon-free energy future. Minnesota Power's *Energy**Forward*** resource strategy continues to reflect a strong commitment to a cleaner, more sustainable energy future while ensuring reliability remains at the forefront and that customers can afford to pay their energy bills. By embracing innovation, collaboration, and responsible energy management, the Company continues to take a leadership role in decarbonization efforts.

D. Biomass

Frameworks

As utilities in Minnesota progress toward compliance with the CFS, a significant technical challenge is how to provide firm, dispatchable energy without reliance on traditional carbon emitting fossil fuels. Outside of nuclear power, biomass is the only market-ready non-fossil fuel that can generate baseload power and is already defined as an Eligible Energy Technology for compliance with the RES statute.

Opponents of biomass-derived energy argue that because more carbon dioxide ("CO_2") is emitted at the stack from biomass than an equivalent amount of coal, biomass is not carbon neutral. This argument does not consider the life cycle of sustainably sourced and waste biomass and the forest regrowth that such sourcing stimulates. It is the Company's position that the state of Minnesota is uniquely suited to utilize biomass-derived energy to generate electricity that is carbon neutral when measured with a carbon life-cycle analysis. As noted above, the Commission initiated a new docket to evaluate what such an LCA would look like.[13] Minnesota Power is actively participating in this proceeding.

Minnesota, with its rigorous forest certification process, long history of a sustainable forest products industry, and ready supply of unmerchantable, infested, or wildfire susceptible materials in need of an outlet is in an ideal position to sustainably integrate biomass fuel into its energy portfolio. Some frameworks for the sustainable use of biomass energy already exist and can provide useful insights and methodologies for developing a framework for the state of Minnesota, including:

- Roundtable on Sustainable Biomaterials, "RSB Principles & Criteria."[14]
- Dovetail Partners, "Biomass Energy Utilization Whitepaper."[15]

[13] *In the Matter of a Commission Investigation into a Fuel Life-Cycle Analysis Framework for Utility Compliance with Minnesota's Carbon-Free Standard*, Docket No. E-999/M-24-352.
[14] Roundtable on Sustainable Biomaterials, RSB Principles & Criteria Version 4.0, available at https://rsb.org/wp-content/uploads/2024/05/rsb-principles-criteria-std-01-001-v4-1.pdf (Dec. 18, 2023).
[15] Fernholz, K. Bowyer, J. McFarland, A., Biomass Energy Utilization Whitepaper, Commissioned by the Maryland Forestry Foundation available at https://extension.umd.edu/sites/extension.umd.edu/files/2021-03/Biomass_Energy_Utilization_Whitepaper_2020.pdf (May 2020).

Biomass offers important, non-greenhouse gas related environmental benefits compared to current thermal resources like coal. In addition to carbon-neutral emissions, pollutants like oxides of sulfur ("SO_X"), oxides of nitrogen ("NO_X"), and mercury would be significantly reduced by refueling a coal plant with wood pellets, and existing state-of-the-art pollution control equipment in place for coal units could drive those emissions lower yet. Even the ash from a biomass operation would provide benefits, as biomass ash is a highly sought-after soil amendment that helps boost nutrient availability in soils. Current state practices allow for the beneficial reuse of wood ash, and Minnesota Power's own Hibbard Renewable Energy Center ("HREC") has a long history of reusing wood ash as an agricultural amendment. As with the HREC facility, biomass also has the potential to provide an important outlet for unmerchantable roundwood affected by emerald ash borer, spruce budworm, and other pests. HREC is the only biomass facility north of the Twin Cities within an Emerald Ash Borer quarantine zone, allowing it to receive infested wood for combustion without a compliance agreement. This public service allows for beneficial use of otherwise unmerchantable feedstock that could potentially spread to other forest areas if left unmanaged.

The benefits of biomass extend to host community and just workforce transition considerations as well. The refueling of a coal facility with biomass would not only provide important reliability benefits for the electric system, but would also require skilled labor for the construction, operation, and maintenance of the facility. In addition to retaining skilled labor in the energy industry, expansion of biomass-derived energy would also provide significant opportunities for related industries, like logging and sawmill operations, as well as reducing wildfire fuels.

With that said, Minnesota Power recognizes that there are diverse perspectives on the use of biomass as a fuel source. In addition to the extensive engagement that took place across a broad group of stakeholders prior to filing the IRP, Minnesota Power also discussed biomass with local Tribal Nations to obtain initial feedback on key issues. In those discussions, initial concerns were expressed about the use of sulfates in the biomass process and its effect on wild rice. Minnesota Power recognizes that wild rice is a key part of the Ojibwe culture and that there may be additional areas that need to be considered as we continue to investigate biomass as a future carbon free alternative.

Biogenic and Anthropogenic Carbon

Biogenic carbon refers to carbon derived from biological sources, such as plants and animals, which is part of the natural carbon cycle. When biogenic carbon is released, like that present in biomass, it is generally considered carbon-neutral because it was recently absorbed from the atmosphere by living organisms.

Anthropogenic carbon, on the other hand, refers to carbon emissions resulting from human activities, such as burning fossil fuels, deforestation, and industrial processes. These emissions add to the atmospheric carbon load and contribute to climate change.

In the context of carbon-free standards, biogenic carbon is often accounted for differently than anthropogenic carbon and should be considered in the characterization of biomass. For example, the ISO 21930 standard states that biogenic carbon entering a system is characterized with a factor of -1, representing a reduction in emissions, while its release is characterized with a factor of +1.

Carbon Neutrality

The amount of carbon dioxide emitted by natural processes like decomposition and then recaptured by vegetation in the natural carbon cycle is called biogenic carbon. Biomass does create biogenic carbon emissions when combusted; however, it is important to delineate between

biogenic emissions and anthropogenic (or fossil-based) emissions. Carbon emitted from fossil fuels that have been stored underground for millions of years result in a rapid conversion of solid or liquid carbon into carbon dioxide and other greenhouse gases which exceed the ability of vegetation to absorb via photosynthesis. Biogenic emissions, on the other hand, exist within the vegetation-carbon cycle and do not contribute to the long-term presence of carbon dioxide in the atmosphere. According to a 2020 white paper compiled by Dovetail Partners for the Maryland Forestry Foundation, "[t]he carbon impacts of woody biomass energy depend upon several factors including the raw material being utilized and the energy production technology. In general, use of residues, waste materials, low-value materials, or biomass from sustainably managed forests in highly efficient or combined heat and power systems provide the greatest carbon benefits in comparison to non-renewable, fossil-fuel based systems."[16]

Because it is part of the natural biogenic carbon cycle and does not result in the rapid release of stored fossil carbon, woody biomass should be treated as carbon free. Even without carbon capture and storage systems on a biomass generation facility, common sense practices like sourcing biomass from sustainably managed forests and residues (as well as accounting for minor amounts of fossil-based carbon emissions during biomass procurement) can further improve the efficiency of the biomass carbon cycle. This rationale is also reflected in how the EPA has approached carbon regulation from new and existing electrical generating units ("EGUs"), exempting woody biomass EGUs from the Clean Air Act Section 111 requirements and instead focusing carbon limits and technology prescriptions for EGUs with fossil-based carbon emissions.

Life-Cycle Analysis Discussion

An LCA of biomass evaluates the environmental impacts associated with all stages of biomass energy production, from raw material extraction to end-of-life disposal. Below are key components of such an analysis:

- **Feedstock production.** This includes the cultivation and harvesting of biomass. Sustainable practices, such as using industrial or agricultural residues, can minimize environmental impacts. Any LCA of biomass would factor in GHGs emitted by machinery in the procurement process.
- **Transportation.** The biomass must be transported from the production site to the processing facility. Transportation emissions depend on the distance and mode of transport. Using local biomass sources can reduce these emissions.
- **Processing and conversion.** Biomass is converted into energy through processes like combustion, gasification, or pyrolysis. Each process has different environmental impacts. For example, pyrolysis can produce biochar, which can sequester carbon and reduce overall GHG emissions.
- **Energy production.** The conversion of biomass into electricity or heat. The efficiency of this process and the type of technology used (e.g., combined heat and power systems) influence the environmental footprint.
- **End-of-life.** This includes the disposal or recycling of by-products. For example, biochar produced from pyrolysis can be used as a soil amendment, providing long-term carbon sequestration benefits.

[16] Fernholz, K. Bowyer, J. McFarland, A., "Biomass Energy Utilization Whitepaper." Commissioned by the Maryland Forestry Foundation at 4, available at https://extension.umd.edu/sites/extension.umd.edu/files/2021-03/Biomass_Energy_Utilization_Whitepaper_2020.pdf (May 2020).

- **Overall environmental impact.** The LCA considers various impact categories, such as global warming potential, acidification, eutrophication, and resource depletion. Biomass energy can significantly reduce GHG emissions compared to fossil fuels, especially when using sustainable feedstocks and advanced conversion technologies.
- **Scenario analysis.** Different scenarios, such as changes in energy sources or improvements in technology, can be analyzed to understand their impact on the overall life-cycle emissions. This helps in identifying the most sustainable pathways for biomass energy production.

The Commission has initiated proceedings to address compliance with the CFS[17] and its impact on the RES, including a proceeding to address a LCA framework.[18] The Company's position in this pending docket is that biomass-derived energy to generate electricity can be net carbon neutral when measured with a carbon life-cycle analysis, meeting the CFS requirements.

[17] Minn. Stat. § 216B.1691 Subd. 2g requires "each electric utility must generate or procure sufficient electricity generated from a carbon-free energy technology to provide the electric utility's retail customers in Minnesota, or the retail customers of a distribution utility to which the electric utility provides wholesale electric service, so that the electric utility generates or procures an amount of electricity from carbon-free energy technologies that is equivalent to at least" 80 percent by the end of 2030 for public utilities, 90 percent by the end of 2035 for all electric utilities, and 100 percent by the end of 2040 for all electric utilities."

[18] *In the Matter of a Commission Investigation into a Fuel Life-Cycle Analysis Framework for Utility Compliance with Minnesota's Carbon-Free Standard*, Docket No. E-999/CI-24-352.