CITY OF BURLINGTON, VERMONT
CITY COUNCIL TRANSPORTATION, ENERGY & UTILITIES COMMITTEE

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Councilor Mark Barlow, **Chair,** *North District*
Councilor Gene Bergman, *Ward 2*
Councilor Hannah King, *Ward 8*

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Transportation, Energy and Utilities Committee of the City Council
Special Meeting – McNeil Symposium
Tuesday June 13, 2023 – 6:30PM

City Hall Contois Auditorium
149 Church Street, Burlington, VT 05482

Live Stream: https://www.youtube.com/watch?v=n8nRQLA4ntY
Join via Zoom: https://zoom.us/j/97174018338
To call into the meeting, Phone number: 1-929-205-6099, Webinar ID: 971 7401 8338
To attend in person, you may join us at City Hall in Contois.

–DRAFT AGENDA–

1. **Agenda**
2. **Introduction (3 minutes)**
   - Chair Barlow
3. **Panelist Remarks on TEUC Question Prompts in 3 blocks (up to 80 minutes)**
   - Burlington Electric Dept (BED)
   - Moomaw/Rooney-Varga
   - Sherman/Kosiba/Roen
4. **Break (5 minutes)**
5. **Questions solicited from the public and curated by the TEUC (up to 30 minutes)**
   - Members of the public should use the following form to submit a question for consideration in advance of the meeting: https://forms.gle/JRuQshE5jXU1i8B58
   - Questions must be submitted by Tuesday 6/13 12:00PM
6. **Public Forum (up to 60 minutes)**
   - 10 minutes of comment followed by 10 minutes of Panelist remarks – repeat 3 times
   - In person comments will be prioritized. Comments from Zoom will be taken time permitting
7. **Possible follow up questions from TEUC (if time permits)**
8. **Closing remarks (2 minutes)**
9. **Adjourn**

TEUC Questions about Biomass Electricity Generation at McNeil Station:

1. What are the annual GHG emission related to the operation of McNeil and how are they calculated?

2. What scientific methods exist for estimating the climate impacts of burning biomass, considering the global warming effects of the greenhouse gases released at burning and the time needed for forests to reabsorb those gases (grow and store or sequester)?

    a. What considerations related to forestry practices are relevant to this discussion?

    b. Based on the above, can the emissions from burning wood be reabsorbed in a timeframe that ameliorates the climate impacts and how does this compare to a forest that is not harvested and burned?

3. Can the emissions from wood burning at McNeil be charted over a life cycle so that the processes of storage and sequestration can be accounted for so that actual emissions are accurately counted in each year or group of years?

    a. If Yes, then what is the period of years to look at and has there been such an accounting? What is it?

    b. If No, then what would it look like, how long would it take, and who would be best to do this?

4. This summer the City Council will be considering a district energy project to use the waste heat from McNeil. Based on the following questions and then answers provided by BED, can you please share your thoughts and reflections on whether or not to proceed with a district heating project at McNeil:

    a. Will the project require more wood to be burned to service the district energy customers? *BED: This depends in part on plant operations. The plant will realize some efficiency gains through district energy. Operations also fluctuate in terms of net electric generation seasonally and due to power supply market conditions. With that said, we estimate that running the district energy system would require an additional week and a half's worth of fuel (18,000 tons) annually. That figure could range from no additional fuel annually in certain scenarios, to up to 3.5 weeks additional fuel in other scenarios.*

b. How will the proposal offset current energy use by customers served by the district energy project? *BED: District Energy will avoid approximately 225,000 MMBtu of gas consumption annually at customer sites, equivalent to approximately 16% reduction in commercial sector natural gas use in Burlington, based on latest estimates from Ever-Green Energy, and using data for commercial sector in Burlington from the annually published Synapse Energy Economics Net Zero Roadmap updates (next one in June, 2023). https://www.ever-greenenergy.com/project/city-of-burlington/*

c. What is the net GHG emissions offset created by this project? *BED:VEIC study (https://www.burlingtonelectric.com/wp-content/uploads/VEIC-Final-Memo-to-BED-LCA-of-GHG-emissions-4.29.22-.pdf) which looked at older version of district heat, and only at Medical Center, found net reduction of over 6,000 tons CO2e annually (including upstream fossil fuel consumption related to wood transportation/plant operations). Ever-Green analysis estimates based on current version of project (but not including upstream emissions associated with transport/plant operations) finds reduction of up to 13,000 tons annually based on primary connection at UVM Medical, with additional potential connections at UVM and Intervale Center. https://www.ever-greenenergy.com/project/city-of-burlington/*

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    a. What considerations related to forestry practices are relevant to this discussion?

    b. Based on the above, can the emissions from burning wood be reabsorbed in a timeframe that ameliorates the climate impacts and how does this compare to a forest that is not harvested and burned?

3. Can the emissions from wood burning at McNeil be charted over a life cycle so that the processes of storage and sequestration can be accounted for so that actual emissions are accurately counted in each year or group of years?

    a. If Yes, then what is the period of years to look at and has there been such an accounting? What is it?

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    a. Will the project require more wood to be burned to service the district energy customers?

    b. How will the proposal offset current energy use by customers served by the district energy project?

    c. What is the net GHG emissions offset created by this project?

McNeil Station Biomass Symposium

Open meeting and approve agenda *(6:30PM)*

Symposium Introduction

Panelist Remarks on TEUC Question Prompts

Break

Questions solicited from the public and curated by TEUC

Public Forum

Possible follow up Questions from TEUC *(if time permits)*

Closing remarks

Adjourn *(9:30PM)*

Speakers

Juliette Rooney-Varga

Professor Rooney-Varga is an internationally recognized expert in climate change and sustainability. Through her research, advocacy, and educational efforts, she is teaching – at the state, national and international levels – what it takes to understand and take action to mitigate climate change. Professor Rooney-Varga develops and uses interactive simulations in her work as an educator at UMass Lowell, where she is a professor of environmental science, directs the Climate Change Initiative, and co-directs the Rist Institute for Sustainability and Energy.

William Moomaw

Dr. Moomaw is Emeritus Professor of International Environmental Policy and Founding Director of the Center for International Environment and Resource Policy at The Fletcher School. He began working on climate change in 1988 as the first director of the climate program at World Resources Institute in Washington. He has been a lead author of five Intergovernmental Panel on Climate Change (IPCC) Reports. He is a co-author of a recent paper declaring a Climate Emergency that has been endorsed by over 11,000 scientists.

Darren Springer

Mr. Springer serves as General Manager of the Burlington Electric Department. in developing the pioneering Net Zero Energy Roadmap, recognized as the "first US Net Zero 2030 plan" by the Smart Electric Power Alliance. Under his tenure, Burlington became the top northeastern city for solar per capita in 2019 and 2020, while launching numerous electrification incentive programs to facilitate the transition to clean electric technologies. Darren previously served as BED's Chief Operating Officer and played key roles in the Governor's Office and Vermont Public Service Department, driving renewable energy legislation and standards.

Adam Sherman

Mr. Sherman is a senior consultant at VEIC, specializing in renewable heating and cooling, where he helps clients achieve building decarbonization goals. With two decades of experience, Adam's expertise in evaluating and implementing renewable heating programs, and his collaborative approach, contribute to the adoption of renewable heating technologies on various scales. Prior to joining VEIC, Adam was the Program Director of BERC. During his time at BERC, Adam's worked spanned across technical, economic, project development, policy and regulatory categories.

Alexandra Kosiba

Professor Kosiba is a forest ecophysiologist and Extension Assistant Professor of Forestry at the University of Vermont. As the Extension Forester, she creates resources and conducts applied research to help landowners, foresters, and decision-makers better understand the impacts of climate change and other stressors on Vermont's forests and management techniques to improve forest resilience. Ali serves as a regional educator on forest carbon science and management and is the state lead on the Vermont Forest Carbon Inventory.

Harris Roen

Mr. Roen is a Vermont Licensed Forester with over 30 years working on public and private lands in the Northeast. He holds a Bachelor of Science in Forestry from the University of Vermont, and a Masters of Science in Resource Management and Administration from Antioch New England.

Allan Thompson

Vermonters use a lot of wood products. As a forester, I engage in sustainable forest management that produces a variety of wood products for Vermonters, including chips through a regulated process. These chips come from unhealthy trees that are cut as part of approved forest management plans and are specifically timed and designed to regrow healthier, longer-lived trees. These trees, if cut, would provide more durable and longer-lived wood products. Selling chips to BED provides an invaluable resource to be able to improve the health of Vermont woodlands through sustainable forest management. Can sustainable forest management be used to improve carbon storage, sequestration and climate resilient forests? How has Vermont's managed forests changed, since or as a result of BED [McNeil Station] construction in 1978?

Fred Glanzberg
Do Professors Moomaw and Rooney Vargas have data from northeastern deciduous hardwood stands?

Fred Glanzberg
Can you please comment on the effects of age class distribution on carbon sequestration and storage?
Said in a slightly different way by
Pike Porter
Darron Springer, Alexandra Kosiba, and Andrew Sherman have all made the claim that, "While older forests store much more carbon than younger trees, they sequester carbon at a slower rate ," and they have suggested that we need to replace older trees with younger trees because they sequester at a higher rate. I wonder if you can speak to the recent findings by Dominick Dellasala and his work with NASA that indicate that trees sequester CO2 at much higher rates after the age of 80 years old, or point to other studies that demonstrate the ability of older trees to sequester CO2?

Kevin McCallum
How would a prohibition on the use of whole trees for chips affect the operations of McNeil and/or the sustainability of the operation?

Todd Waldron

Vermont's Initial Climate Action Plan document includes numerous pathways and strategies that have been identified to help support our collective efforts in reaching Vermont's climate targets. Along with emissions targets, the plan also includes maintaining and expanding Vermont's natural & working lands role in the mitigation of climate change, and to manage natural and working lands for biodiversity, forest health and climate resilience. This project includes several elements that support working and natural lands' role in achieving Vermont's Climate Action ambitions outside of emissions considerations. While emissions reductions are a key consideration, could you speak to other co-benefits and/or impacts that this project can bring to the table for biodiversity, forest health and climate resilience?

Brian Williams

While burning biomass is still a debit on the CO2 balance sheet, reducing CO2 absorption by switching younger trees for older ones, the concern I have is the low efficiency of the existing plant. My understanding is that only 25% of the total available energy is actually produced leaving the remaining 75%, that still generates CO2, as lost energy. What are the plans to significantly improve on this?

Michael Brown

Many questions focus on the fact that McNeil station is the largest single point of emissions in the state/local area of Burlington. This makes sense as the plant generates power for the largest city/metropolis in the state. If hypothetically the McNeil plant were to be taken offline for power production and waste heat recapture, what is a viable fuel replacement that is more carbon neutral? What would a timeline be for this?

Presentation on
McNeil and District Energy
6.13.23

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About Burlington Electric Department (BED)

- Burlington's municipal electric utility
  - Public Power since 1905
  - 118 employees, including the McNeil Generating Station
  - Third-largest electric utility in Vermont
- 21,000+ customers
  - 17,282 residential, 3,983 commercial and industrial
  - 5,500-6,000 residential accounts turn over each year
- Renewable Energy and Innovation :
  - Summer peak: ~65 MW; Annual energy use: ~330,000 MWH
  - McNeil is the largest energy producer in Vermont with Vermont Yankee retirement
  - 100% of power from renewable generation as of 2014, transition began in 2004 with decision to stop purchasing nuclear energy, move off fossil fuels
  - BED is working with the City of Burlington on implementing the ambitious Net Zero Energy 2030 Roadmap

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About the McNeil Generating Station

- **Jointly Owned by Vermont Utilities -** Jointly Owned by Burlington Electric Department (50%), Green Mountain Power (31%), and Vermont Public Power Supply Authority (19%)..

- **Built to Replace Coal -** McNeil is a 50 megawatt electric generator, that runs on wood chips. It is the largest power producer in the state of Vermont since Vermont Yankee nuclear closed. Voters approved revenue bonds to finance it, and it was built in the 1980's under Mayor Bernie Sanders, to replace the Moran coal plant.

- **Reliable Renewable Energy -** Unique for a renewable generator, McNeil can store fuel on-site and be dispatched based on market pricing signals. Can run 24/7 during the winter to reduce the ISO-New England region's overreliance on fossil fuels during that high-price time of year. McNeil was able to secure a full winter wood supply for 21-22 and 22-23, periods of high cost and where ISO-NE had reliability concerns. The ISO New England grid fuel mix as of 2022 was over 54% fossil fuel (primarily natural gas), 26% nuclear, and only 19% renewable including large hydro. Analysis from VEIC looking at ISO dispatch shows that natural gas is the "marginal" fuel for well over 90% of McNeil's runtime, meaning if McNeil was not running natural gas would replace it on the grid.

- **Innovation –** McNeil will be host to a new solar research facility, in partnership with UVM and supported by Senator Sanders.

Resources - https://www.burlingtonelectric.com/mcneil and https://www.iso-ne.com/about/key-stats/resource-mix and https://www.burlingtonelectric.com/wp-content/uploads/VEIC-Final-Memo-to-BED-LCA-of-GHG-emissions-4.29.22-.pdf

Air Emissions and Health

- **Air Emissions Reductions -** In 2008, McNeil installed a Regenerative Selective Catalytic Reduction system, reducing nitrogen oxide emissions to levels well below state requirements.

- **Memo from Jared Ulmer, Climate and Health Program Manager at VT Dept. of Health, to Vermont Climate Council Biomass Task Group**:

  "Health effects associated with McNeil & Ryegate – Based on the available data sources I have reviewed, the health impacts caused by air pollution from the two biomass power plants are essentially negligible and thus cannot be elaborated on in any detail….This is mainly a result of the two generating facilities operating with relatively efficient combustion technology and with extensive filtration, pollution controls, and regulations that in combination greatly limit emissions."

  "A question was raised about whether rates of asthma and cancer were higher near the two biomass power plants. In short, I cannot find any evidence to suggest that nearby asthma or cancer rates are influenced by either power plant. This is based on 1) the disease rates near either facility do not differ substantially from the rest of Vermont, and 2) published scientific evidence suggests that the amount of air pollution from either facility should not have a measurable impact on asthma or cancers."

Resource: https://outside.vermont.gov/agency/anr/climatecouncil/Shared%20Documents/Follow_Up_Response_Health_Impacts_Jared_Ulmer.pdf

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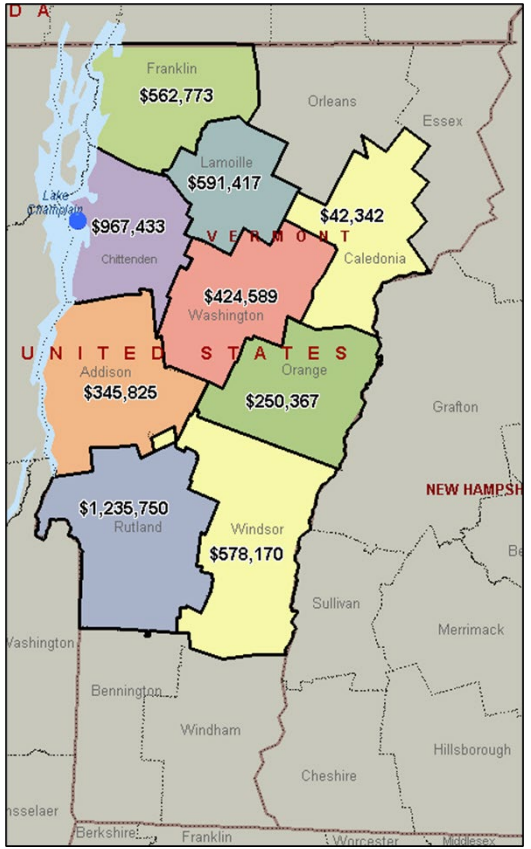
Jobs and Economy

- **Economic Impacts –** Analysis from Innovative Natural Resource Solutions using 2022 data indicated McNeil provides over $55 million in annual economic activity in Vermont, including wood purchases in that year from lands in 9 Vermont counties (see map to right).

- **Jobs –**Innovative Natural Resource Solutions report also indicated "McNeil Station is responsible for the creation of 87 jobs at the facility and in the wood fuel supply chain, with total wages for these positions estimated to be $5.6 million annually. Importantly, these jobs are maintained as long as McNeil Station is operating and using wood fuel. This is in contrast with some other forms of renewable electricity generation, where most jobs are associated with the development and construction of generation units, not their ongoing operations."

Resources: Forthcoming Innovative Natural Resource Solutions Report for BED 2023 Integrated Resource Plan (IRP)



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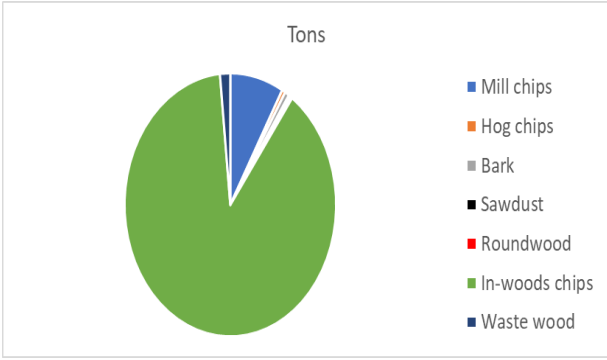
Forestry

Sustainable Forestry - McNeil employs four Vermont professional licensed foresters to monitor harvests and maintain sustainable wood supply. By providing a market for lower-value residues, the McNeil Station allows landowners to follow their forest management plans and keep lands as working lands, instead of developing them and reducing carbon sequestration. Wood ash from McNeil is used as a soil conditioner, and heavier ash for road projects.

Harvest - USDA Forest Service data indicates that Vermont's forests added net growth from 2014 to 2019, and that wood chips for McNeil in 2019 used only 4% of the net annual growth.

2023 analysis from Innovative Natural Resource Solutions shows that McNeil Station procures the vast majority (88%) of its biomass fuel as chips from harvesting projects where most of the wood harvested is for other purposes such as lumber or papermaking. McNeil uses "in-woods chips" that constitute tops and limbs left over from these operations. Another 8% of fuel is mill residue (bark, mill chips, hog chips, and sawdust) from sawmills. McNeil Station purchases small volumes of roundwood (from trees not appropriate for lumber or other uses), which can be stored and used during times when loggers cannot operate (such as mud season). Fuel purchased as roundwood was 0.3% of McNeil's fuel supply in 2022. Lastly McNeil operates a popular waste wood yard for residents to dispose of clean untreated wood waste (instead of landfilling it) which is then chipped for fuel for McNeil .



Resources:
https://www.burlingtonelectric.com/sites/default/files/2019%20BED%20harvest%20vs%20State%20growth%20data%20summary.pdf and
https://www.burlingtonelectric.com/wp-content/uploads/McNeil-Carbon-6.2023.pdf and forthcoming INRS analysis related to BED's 2023 IRP

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PLAY VIDEO

Empowered Energy Heroes, used with permission from Kiki Goshay, Director/Producer.

Narrating is Dan Reicher, former Assistant Secretary of Energy during Clinton Administration, former Advisor to President Obama, former Director of Climate Change and Energy Initiatives at Google, and Senior Research Scholar, Stanford Woods Institute for the Environment.

Climate and GHG

IPCC 2007: "In the long term, a sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber, fibre or energy from the forest, will generate the largest sustained mitigation benefit."

IPCC 2019: "Sustainable forest management aimed at providing timber, fibre, biomass, non-timber resources and other ecosystem functions and services, can lower GHG emissions and can contribute to adaptation (*high confidence*)"

Resource: https://archive.ipcc.ch/publications_and_data/ar4/wg3/en/ch9s9-es.html and https://www.ipcc.ch/srccl/chapter/summary-for-policymakers/

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BURLINGTON Electric DEPARTMENT

CITY OF BURLINGTON, VT. ORGANIZED FEB. 21, 1865

Climate and GHG

U.S. Energy Information Administration: "Burning either fossil fuels or biomass releases carbon dioxide (CO_2), a greenhouse gas. However, the plants that are the source of biomass for energy capture almost the same amount of CO_2 through photosynthesis while growing as is released when biomass is burned, which can make biomass a carbon-neutral energy source." "According to current international convention (see the Intergovernmental Panel on Climate Change's "2006 IPCC Guidelines for National Greenhouse Gas Inventories"), carbon released through biomass combustion is excluded from reported energy-related emissions."

White House Council on Environmental Quality (CEQ) 2016 Obama Administration – "This Guidance establishes guidelines for Federal agencies in calculating and reporting GHG emissions fluxes from different sectors and sources associated with agency operations, and seeks to avoid double counting. Though its goals differ from those of the IPCC inventory (i.e., to develop a common system for countries to inventory all anthropogenic GHG emissions, including fossil and biogenic CO2 emissions, across all sectors), both this effort and the IPCC inventory guidelines seek to avoid double counting. To that end, in IPCC inventories, carbon sequestration and CO2 emissions within biological systems, including the growth and harvest of terrestrial biomass, are assigned to Land Use, Land Use Change and Forestry (LULUCF) sector. Therefore, when biomass is burned for energy, the related biogenic CO2 emissions are accounted for in the LULUCF sector where the carbon was stored and initially emitted via harvest, not the Energy sector. (IPCC, 2006)"

Resource: https://www.eia.gov/energyexplained/biomass/biomass-and-the-environment.php#:~:text=Burning%20either%20fossil%20fuels%20or and https://www.eia.gov/totalenergy/data/monthly/pdf/sec11_n.pdf and https://www.sustainability.gov/pdfs/federal_ghg%20accounting_reporting-guidance.pdf

Climate and GHG

EPA 2011 Obama Administration publication entitled, *ACCOUNTING FRAMEWORK FOR BIOGENIC CO_2 EMISSIONS FROM STATIONARY SOURCES-*

> ”As discussed in Section 2, fossil and biogenic carbon interact with the overall carbon cycle on very different time scales, and this difference has implications for understanding estimates of biogenic CO2 emissions from stationary sources. CO2 emissions from the consumption of fossil fuels will inevitably increase the amount of carbon in the atmosphere on policy-relevant time scales, but such an outcome is not inevitable with the consumption of biologically based feedstocks. The amount of biologically based feedstocks consumed at stationary sources during a year may be partially or completely balanced by the amount of feedstock that grows during the year. On that basis, as discussed in Section 2, EPA concludes that in order to develop an accounting framework to adjust total onsite biogenic emissions at a stationary source, it is essential to assess the carbon stored by growth of biologically based feedstocks.”

Resource, page iv - https://www.epa.gov/sites/default/files/2016-08/documents/biogenic-co2-accounting-framework-report-sept-2011.pdf

Climate and GHG

Vermont Agency of Natural Resources: Per IPCC guidelines ANR does not include biogenic CO_2 in Vermont's emission inventories.

"An important distinction when considering accounting practices for biogenic CO_2 is that carbon dioxide emissions from the combustion of fossil fuels are coming from a geologic source, which is on a significantly longer time scale than carbon in the much faster carbon cycle which moves between pools on the order of months to centuries, which means that combusting fossil fuels adds more carbon that was in long term storage and effectively out of circulation into the atmosphere and into the more immediate carbon cycle. Carbon dioxide emitted from the combustion or decomposition of biogenic materials which are a part of the faster carbon cycle are assumed to be sequestered by the regrowth of the biogenic material that produced them, and are captured in the flux from the land use change as described above."

"Carbon dioxide from electricity generated through biomass combustion is not included because the CO_2 is of biogenic origin, but CH_4 and N_2O emissions are included in totals. States in the region differ on this accounting practice, however, it is consistent with IPCC inventory guidelines for the treatment of biogenic CO_2."

Resource: Vermont Agency of Natural Resources, Greenhouse Gas Emissions Inventory and Forecast, Methodologies, April 2023

INRS Report 2023 on McNeil

"Carbon accounting for biomass is complex and not well understood, with some disagreement about how to account for the near-term release of carbon from combustion compared to the role that forests play in capturing and storing carbon and the time over which that occurs. As noted above, the U.S. Energy Information Agency assumes that the "release of carbon from biomass combustion is assumed to be balanced by the uptake of carbon when the feedstock is grown, resulting in zero net emissions over some period of time." Others have suggested a "debt-then-dividend" accounting framework for biomass carbon emissions, where the biomass combustion is weighed against future forest growth. Under this scenario, the use of logging residues (and mill residues) provides a favorable fuel type:

> "The harvest and use of tops and limbs for biomass can have an important influence on carbon recovery times and profiles: tops and limbs decay quickly if left in the forest and so their use comes with little carbon 'cost" which tends to shorten carbon recovery times."
>
> "It is interesting to consider the 'harvest' and use of just tops and limbs…The results in this case indicate rapid recovery, with nearly 70% of the carbon losses "recovered" in one decade. Thus, all bioenergy technologies—even biomass electric power compared to natural gas electric—look favorable when biomass 'wastewood' is compared to fossil fuel alternatives."

Given the fact that whole tree chips represent such a small portion (16%) of total roundwood harvest in the Vermont counties where McNeil Station procures fuel, it is fair to assume that most of the "whole-tree chips" purchases are tops and branches, and thus a carbon-favored fuel source under the debt-then-dividend biomass accounting framework."

Resource: https://www.burlingtonelectric.com/wp-content/uploads/McNeil-Carbon-6.2023.pdf

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McNeil Station GHG Emissions 2022 VEIC Report

- **Carbon Accounting and Forestry - "**While biogenic carbon emissions do not yield long-term net increases in atmospheric CO_2 levels, it is imperative that forests are managed sustainably and are able to grow more new wood than is harvested annually. McNeil sources over 90 percent of its wood fuel from managed forests in Vermont and Northern New York and follows detailed sustainability requirements enforced by the State of Vermont. At the landscape level, Vermont's forests grow more new wood each year than is harvested by a 2 to 1 ratio. Based on a 2019 study conducted for the State of Vermont's Department of Forests, Parks and Recreation, analysis that examined FIA data on forest inventory, growth, mortality, and wood harvesting levels, Vermont and Northern New York's forests have been adding forest inventory (and stored carbon) consistently for decades."
- **Natural Gas is the Marginal Fuel When McNeil Operates – "**Whether using a capacity-weighted average when more than one fuel was listed as marginal or considering only time periods in which only one marginal fuel was listed, the result is that natural gas was marginal 92-98% of the time McNeil is running."
- **Methodology and Result – "**The data and methods used in this assessment conform with national and international carbon inventory methods by differentiating between biogenic and non-biogenic CO_2, and intentionally err on the side of being conservative in how the GHG emissions from wood fuels are compared to those of natural gas. Two examples of this conservative approach are the choice to include all the upstream emissions from sourcing wood fuels, while excluding the potential methane leakage that occurs upstream from the use of natural gas. Additionally, the McNeil Station is located extremely close to the load it serves (i.e. the City of Burlington) which drastically reduces transmission line losses. An alternative scenario with ISO-NE regional power plants would likely have higher line losses that would impact the carbon emissions attributed to that energy. As presented in the results section, the McNeil Station currently directly contributes to reducing regional GHG emissions by over 90,000 tons of CO_2e per year."

Resource: https://www.burlingtonelectric.com/wp-content/uploads/VEIC-Final-Memo-to-BED-LCA-of-GHG-emissions-4.29.22-.pdf

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McNeil Station GHG Emissions 2022 VEIC Report – Additional Indirect Benefits of McNeil

- "**Keeping forests as forests** – without healthy local markets for low-grade wood (which allows foresters and landowners to not cut as many higher-quality trees), private forestland owners often struggle to cover the costs of owning and properly managing forests. Markets for low-grade wood help foresters conduct timber stand improvement (TSI) thinnings, prevent high-grading of forests when only harvesting the highest quality trees, and ultimately avoid forest fragmentation, parcelization, and land clearing for development. Keeping in-tact forests as forests is widely regarded as one of the most critical strategies for mitigating global climate change.
- **Supporting the durable wood products market** – thinning stands to enhance the growth of high-quality timber helps sawmills and producers of dimensional lumber. When these products are used in building construction, it stores carbon dioxide for longer periods of time and displaces other carbon-intense building materials like steel, concrete, and plastics.
- **Anchoring market for woodchip heating in Vermont** – large consumers of woodchip fuel like McNeil Station are vital for logging and chipping contractors to sell enough volume while also selling relatively small amounts of wood chip fuel to the numerous schools, hospitals, and colleges that heat with woodchips. Without a viable supply of wood chip fuel, these facilities would be burning millions of gallons of heating oil each year."

Resource: https://www.burlingtonelectric.com/wp-content/uploads/VEIC-Final-Memo-to-BED-LCA-of-GHG-emissions-4.29.22-.pdf

INRS 2023 Report

"Converting the forest carbon to CO_2 equivalent using a factor of 3.67, there are 24.3 million tons of additional forest CO_2 equivalent over the 13 year period from 2007 to 2020, or 1.87 million tons annually or 5,128 tons of CO_2 equivalent daily. Photosynthesis converts atmospheric CO2 to sequestered carbon and free oxygen as plants grow."

Resource – https://www.burlingtonelectric.com/wp-content/uploads/McNeil-Carbon-6.2023.pdf

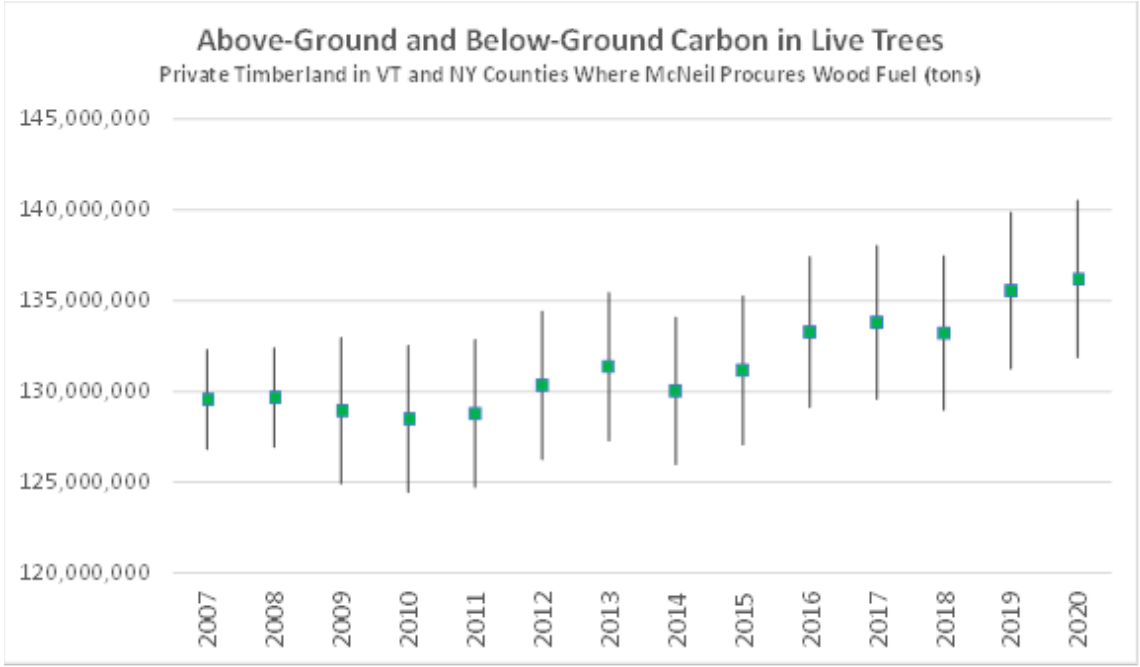

Figure 1. *Tree Carbon on Private Timberland in Vermont (Addison, Chittenden, Franklin, Lamoille, Orleans, Rutland, Washington, and Windsor) and New York (Clinton, Essex, Franklin, and Warren) Counties*

INRS 2023 Report – Annualized Forest Carbon CO2 additions and McNeil Stack Emissions Comparison

"[T]he combustion of biomass for electricity production does have emissions, though these are balanced by forest growth in the region. In 2022, McNeil station emitted 375,540 tons of CO_2. Additionally, plant operations used 7,935 gallons of gasoline and 41,003 gallons of diesel in 2022, resulting in an additional 537 tons of CO_2 emissions. As a result, the facility is responsible for 376,077 tons of CO_2 annually. As demonstrated in Figure 1, the total forest carbon on private timberland in the counties McNeil Station purchases wood from was 129,556,074 tons in 2007; in 2020 this had grown to 136,186,750 tons of carbon. Given this information, the private timberland in the region added over 6.6 million green tons of carbon over this 13-year time period....Converting this to CO_2 equivalent, this represents 24.3 million tons of additional forest CO_2 equivalent over the 13-year period from 2007 to 2020; 1.87 million tons annually or 5,128 tons of CO_2 equivalent daily. Given the 376,077 tons of CO_2 that McNeil Station is responsible for, this represents 73 days of carbon additions on private timberlands in the region, or 20% of annual additions."

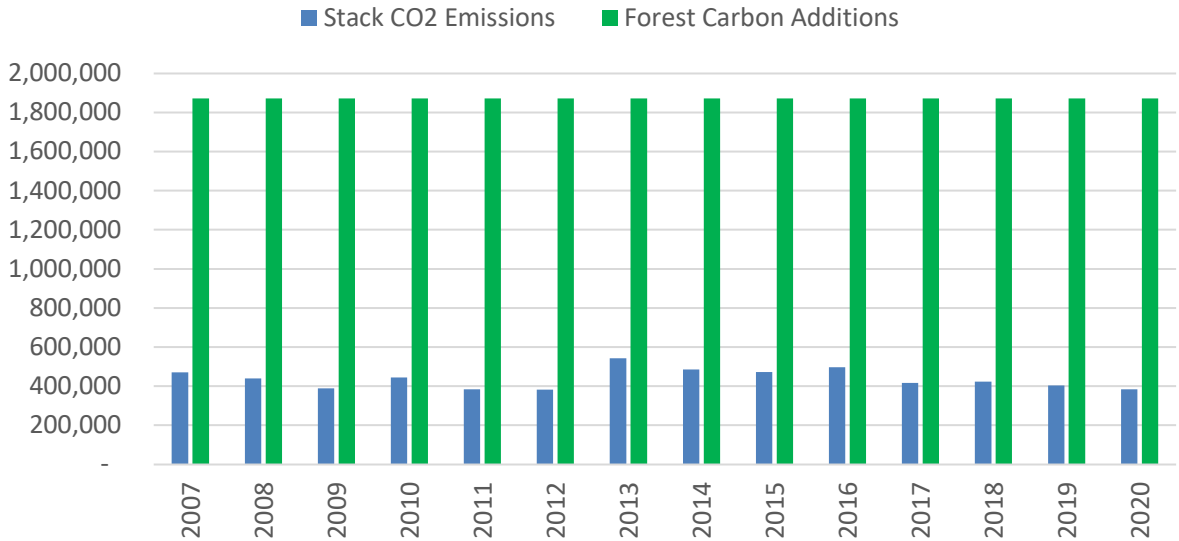

***Figure 5**. Forest carbon CO_2e additions (annualized) in the supply area, and McNeil emissions, 2007 – 2020*

Resource: https://www.burlingtonelectric.com/wp-content/uploads/McNeil-Carbon-6.2023.pdf

INRS 2023 Report – Annualized Forest Carbon CO_2 additions and McNeil Stack and Operations Emissions Comparison

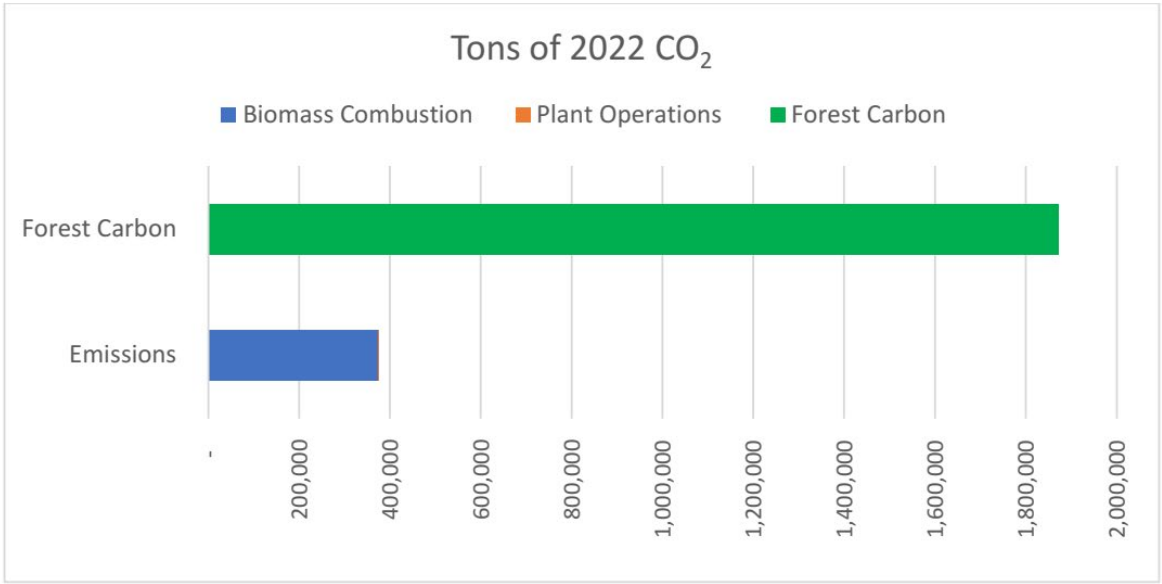

***Figure 4**. Annual forest carbon CO_2e additions in the supply area, and McNeil emissions, 2022*

Resource: https://www.burlingtonelectric.com/wp-content/uploads/McNeil-Carbon-6.2023.pdf

NET ZERO ENERGY
BURLINGTON VERMONT

Background on District Energy System (DES) in Burlington

- **What is district energy?** – District energy in Burlington is the idea of capturing waste heat and additional steam from the McNeil plant, and transporting it underground (via steam or hot water pipes) to be utilized for thermal energy at large buildings, such as UVM Medical Center (UVMMC) or UVM.

- **Why is it important for Burlington? –** McNeil was designed to accommodate district energy all the way back in the 1980's, and the project would turn McNeil into a combined heat and power plant, moderately improving efficiency. For Burlington, district energy was identified as one of four key pathways in Burlington's 2019 Net Zero Energy Roadmap, and is projected to help reduce commercial sector natural gas use by 16% or more in the City. It is the single-biggest step we can take to address emissions in that sector.

Resource - https://www.ever-greenenergy.com/project/city-of-burlington/

NET ZERO ENERGY
BURLINGTON VERMONT

Background on District Energy System (DES) in Burlington

- McNeil Generating Station state permit (first issued in **1981**) included language referring to plant's capabilities to support a DES specifically for UVM and UVMMC. Feasibility studies were completed in **1994, 1996, 1998, 2002,** and **2014,** but there never was agreement to move beyond feasibility to Phase 2 detailed engineering work for any of those efforts, with low conventional fuel prices limiting interest.

- **2014** – Mayor Miro Weinberger tasked BED with determining once and for all if Burlington would be able to advance a DES and explaining why such a project could or could not move forward.

- **2016/2017** –BED, VGS, UVM, UVMMC, CityPlace partnered with Corix Utilities through MOU on new feasibility study.

- **2018/2019** – City Council approved filing with PUC on local rate regulation for district energy. BED received legislative approval to fund feasibility work via thermal energy and process fuel (TEPF) funds.

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Moving Forward with Ever-Green Energy

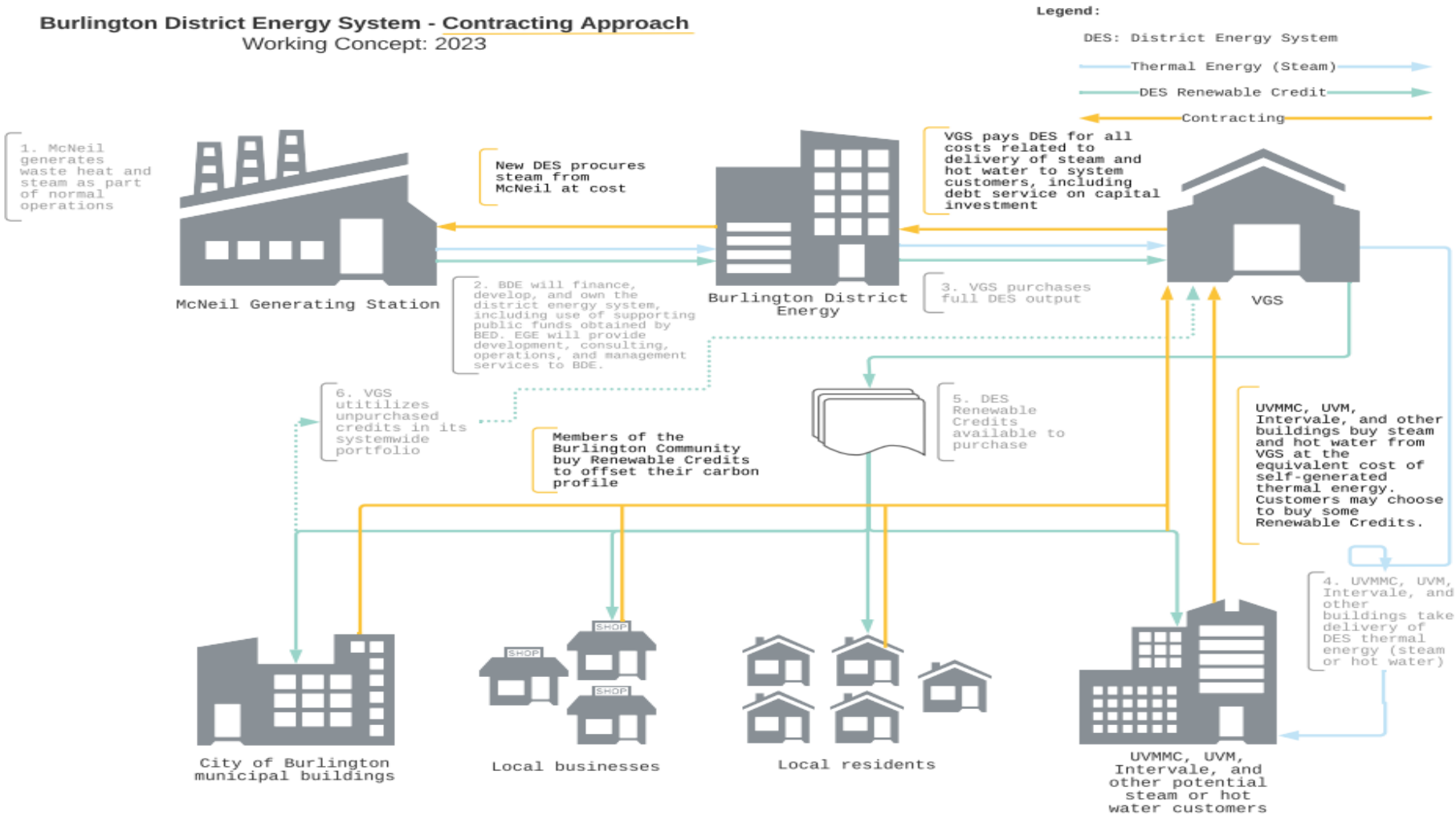
- **Follow-up -** BED had discussions with key potential customers and partners – UVMMC, VGS, UVM, and CityPlace in late 2018 and early 2019 to assess whether DES remained viable. Based on those discussions, BED and VGS engaged with Ever-Green (which had studied DES in Burlington in 2014) to conduct a revised feasibility analysis focused on bringing steam system to UVMMC and UVM buildings.

- **Feasibility analysis and system design** – Ever-Green conducted 3 phases of feasibility analysis between 2020 and 2022. It worked to engineer and design project, with BED and VGS working on financial and regulatory model. McNeil conducted operational tests and project added Intervale Center as potential customer. Funding from Senator Leahy was secured for over $5 million towards capital for infrastructure and electric boiler. The City Council approved creation of a 501c3 non-profit to finance and construct project, and construction bids received in 2022. District Energy Act 250 documents have been filed in 2023.

Resources: https://www.burlingtonelectric.com/milestone-step-forward-to-phase-2-of-updated-district-energy-system-project/ **and** https://www.burlingtonvt.gov/Press/mayor-miro-weinberger-burlington-electric-department-vgs-uvm-medical-center-ever-green-energy **and** https://www.burlingtonvt.gov/Press/mayor-miro-weinberger-and-partners-announce-district-energy-system-ready-for-act-250-state

Burlington District Energy System - Contracting Approach

Working Concept: 2023



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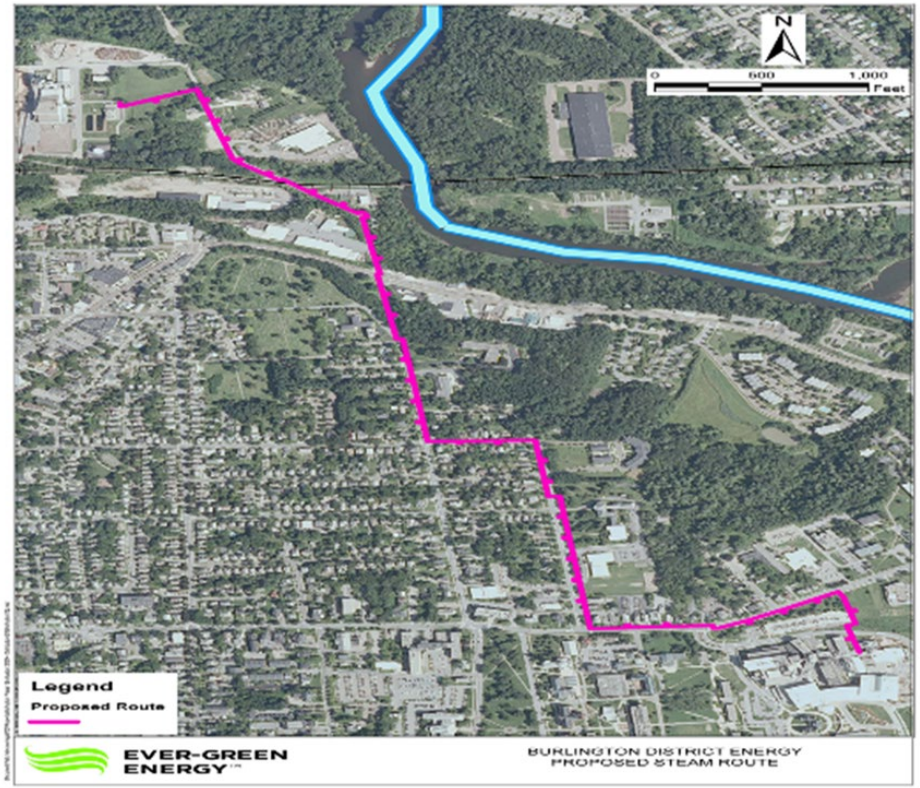

- Intervale Road to North Prospect
- North Prospect to North Street
- North Street to Mansfield Ave.
- Mansfield Ave. to Colchester Ave.

VEIC 2022 Report Analysis of District Energy System Emissions Reduction

Older system design, including upstream McNeil emissions – DES reduces emissions by over 6,000 tons CO2 equivalent annually

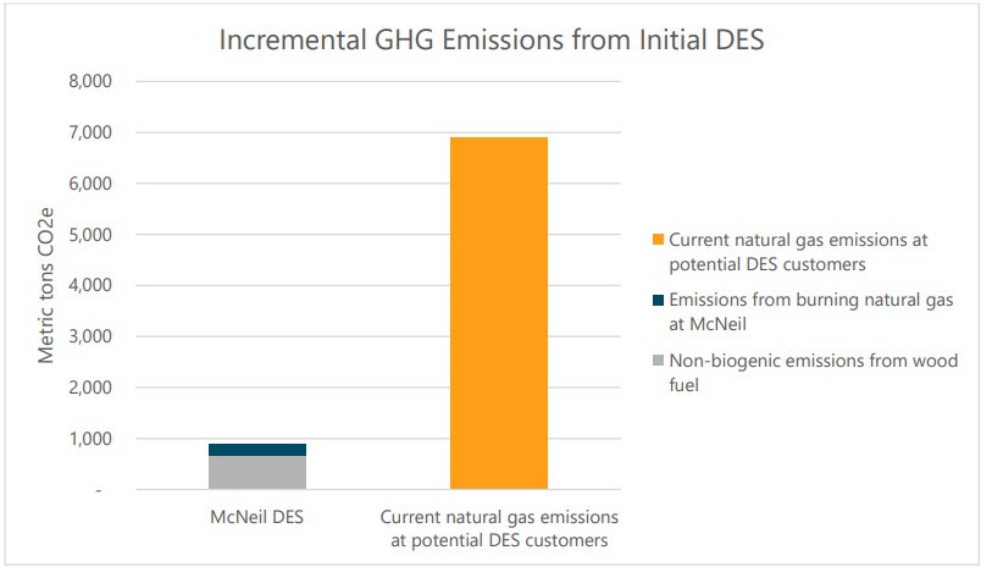

Figure 5 - Incremental emissions impact from initial DES

Resources - https://www.burlingtonelectric.com/wp-content/uploads/VEIC-Final-Memo-to-BED-LCA-of-GHG-emissions-4.29.22-.pdf

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BURLINGTON Electric DEPARTMENT

CITY OF BURLINGTON VT. ORGANIZED FEB. 21 1865

GREET Carbon Score for District Energy

The GREET model is specifically referenced in the recently enacted Affordable Heat Act passed by the Vermont Legislature and supported by a wide coalition of environmental groups (see, for example - https://www.eanvt.org/chs-commentaries/)

"To promote certainty for obligated parties and clean heat providers, the Commission shall, by rule or order, establish a schedule of lifecycle emission rates for heating fuels and any fuel that is used in a clean heat measure, including electricity, or is itself a clean heat measure, including biofuels. The schedule shall be based on transparent, verifiable, and accurate emissions accounting adapting the Argonne National Laboratory GREET Model, Intergovernmental Panel on Climate Change (IPCC) modeling, or an alternative of comparable analytical rigor to fit the Vermont thermal sector context, and the requirements of 10 V.S.A. § 578(a)(2) and (3)."

Resource, page 24 - https://legislature.vermont.gov/Documents/2024/Docs/ACTS/ACT018/ACT018%20As%20Enacted.pdf

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GREET Carbon Score for District Energy

A carbon score evaluates the life-cycle carbon emissions related to the use of a particular energy source. The score is relative to the prior state of operation. For example, if the use of a fossil fuel is replaced by a renewable fuel, the score would reflect a credit for the avoided fossil emissions. The score measures intensity, which means a common unit of energy is used across all measurements so that they are comparable to one another. The unit use to measure carbon intensity is grams of carbon dioxide-equivalent per megajoule of energy. You may see this abbreviated as g C02e/MJ. Carbon dioxide equivalencies allow for a common unit of measure across various greenhouse gases that have different climate impacts.

The GREET model was developed by Argonne National Laboratory to estimate life cycle carbon emissions for a wide variety of energy sources and uses. It is continually updated by the Lab, and is used by many State governments to measure carbon intensity under emissions reduction regulations. First Environment was retained by VGS to estimate carbon intensity for McNeil and the proposed district energy system using the GREET model. Their modeling assumes that steam energy displaces the use of natural gas for customers of the system. Results of initial modeling are shown below, indicating McNeil District Heat Proposal (including electric boiler) reduces GHG emissions over 95% compared with current natural gas usage.

Fuel	CI Score (g C02e/MJ)
Natural Gas	79
McNeil Steam	3.76
Electric Steam (BED Portfolio)	0.039
McNeil CHP with Electric Boiler	3.60

*Note that the natural gas score above is an approximation of carbon intensity on a life cycle basis, meaning that it includes the use of energy in production, transportation and distribution, and accounts for both emissions from combustion and from fugitive emissions like leaks. The CI score is based on initial modeling, is DRAFT, subject to revision. Resource - https://www.burlingtonelectric.com/wp-content/uploads/CI-Model-Letter-Report-draft-ver-3.pdf

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BURLINGTON Electric DEPARTMENT

CITY OF BURLINGTON, VT. ORGANIZED FEB. 21, 1865

Ever-Green Energy Analysis of District Energy for Burlington

Proposed district energy system design would produce:

- 190,000 MMBTU per year of renewable thermal energy
- Plus an additional 34,000 MMBTU in efficiency savings at the hospital
- More than 16% reduction in Burlington commercial sector natural gas-related GHG emissions

Resources - https://www.ever-greenenergy.com/project/city-of-burlington/

CITY OF BURLINGTON, VERMONT
CITY COUNCIL TRANSPORTATION, ENERGY & UTILITIES COMMITTEE

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Councilor Mark Barlow, **Chair,** *North District*
Councilor Gene Bergman, *Ward 2*
Councilor Hannah King, *Ward 8*

Inquiries:
Madeline Suender
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Transportation, Energy and Utilities Committee of the City Council
Special Meeting – McNeil Symposium
Tuesday June 13, 2023 – 6:30PM

City Hall Contois Auditorium
149 Church Street, Burlington, VT 05482

–DRAFT MINUTES–
Meeting Starts 6:32 PM.

1. **Agenda**

Councilor Hannah King moves to adopt the agenda. Seconded by Councilor Bergman. All in favor, passes unanimously.

2. **Introduction (3 minutes)**
   - Chair Barlow gives opening remarks

See Program.

3. **Panelist Remarks on TEUC Question Prompts in 3 blocks (up to 80 minutes)**
   - Burlington Electric Dept (BED)

Darren Springer gives presentation.

   - Moomaw/Rooney-Varga

Gives presentation.
Starts at 7:06PM

   - Sherman/Kosiba/Roen

Kosiba starts at 7:55 to comment on Vermont's forests
Sherman starts at 7:59 to comment on BED Study
Roen starts at 8:03 to comment on northern Vermont forest management and selective forestry.

4. **Break (5 minutes)**

Chair Barlow moves to break at 8:06PM

5. **Questions solicited from the public and curated by the TEUC (up to 30 minutes)**
   - Members of the public should use the following form to submit a question for consideration in advance of the meeting: https://forms.gle/JRuQshE5jXU1i8B58
   - Questions must be submitted by Tuesday 6/13 12:00PM

Chair Barlow asks questions from Waldron and Thompson.

6. **Public Forum (up to 60 minutes)**
   - 10 minutes of comment followed by 10 minutes of Panelist remarks – repeat 3 times
   - In person comments will be prioritized. Comments from Zoom will be taken time permitting

Judy Dow – Biomass Task Force and lifecycle analysis.
Phillip Merrick – BED accounting metrics.
Joe Nelson – Forester from Ferrisburgh. Manage many properties and have BED as one of the markets.
Nick Persampieri – VEIC study, concerns with reporting
Fred Glanzberg – Forester, Grand Isle. Resilient forest focus.

Darren Springer – Adress public comment
Rooney-Vega – Adress public comments
Sherman – Adress public comments
Moomaw- Address public comments

Luke McNally – Forester
Jeff Comstock - Burlington resident
Cheryl Joy Lipton – Ecologist from Chester. Reducing consumption needed.
Howard Jennings – Climate change is happening. Old growth forests are needed.
Ashley Adams – Need to stop burning wood

Roen – Trees for sequestration are essential. Wood for McNeil is not cut for McNeil, it is secondary use.
Springer – McNeil is first 100% renewable energy utility. Biogenic emissions have a lifecycle
Moomaw – Need to keep trees growing to sequester carbon. Need to use less energy
Rooney-Vega – Biomass no longer makes sense as sustainable option.

7. **Possible follow up questions from TEUC (if time permits)**
8. **Closing remarks (2 minutes)**

Rooney-Vega – Impressed and encouraged by community engagement
Moomaw – Great involvement like this is what we need.
Springer - Energy efficiency is important. Continue to engage in this goal. Advocating for climate.
Roen – Appreciate being here. District heat supporter

Councilor King – Thank you for coming
Councilor Bergman – Thank you all for participating. Will work to continue this conversation. Would like to sort through this for District Energy.
Chair Barlow - Would like to come to a common understanding. Will need time to develop questions based on this meeting. Form to enter public comments about the symposium: https://forms.gle/9P2FwavUt7ew1cbi8

9. **Adjourn**

Meeting ends 9:29PM.

The carbon and climate impact of wood bioenergy in Burlington

Juliette Rooney-Varga, Ph.D., Professor, Rist Institute for Sustainability and Energy, UMass Lowell

William Moomaw, Ph.D. Professor Emeritus, Tufts University

UMASS LOWELL | RIST INSTITUTE FOR SUSTAINABILITY & ENERGY

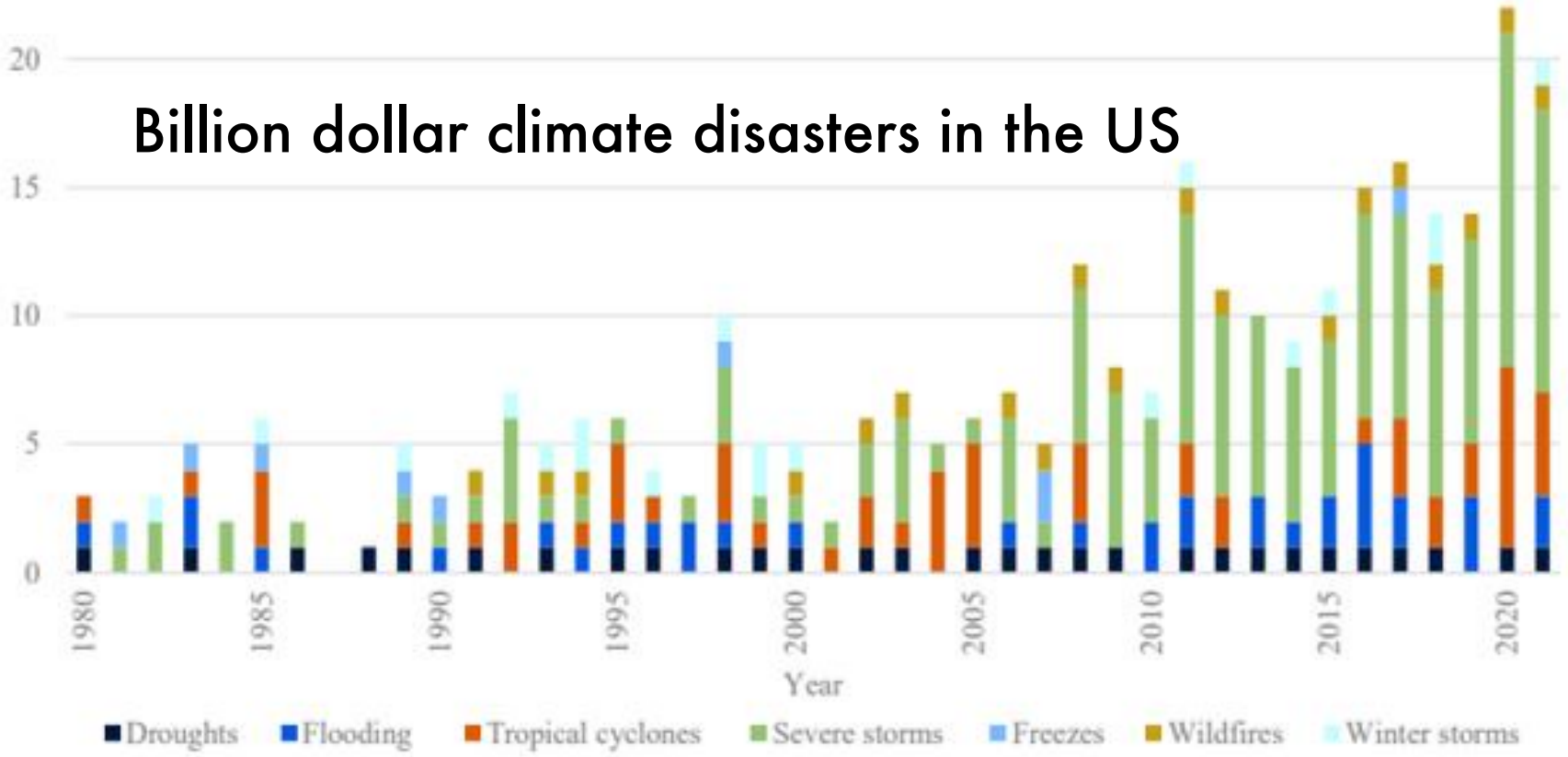
Tufts UNIVERSITY

Outline

- Climate and carbon cycle context
- Dynamic life cycle analysis of wood bioenergy carbon emissions
- Climate impact of wood bioenergy
- Emissions at McNeil

The Climate Has Already Changed!

Changes in the science and impacts of climate change



Sources: NCEI (2021, 2022).
Note: Disaster costs are adjusted for inflation using the Consumer Price Index for All Urban Consumers.

Two different roles for forests

A Resource to be Exploited

- Since 1620 forests were removed to make way for farms and urban development
- They provided material for buildings and fuel for energy
- Today, the US Forest Service classifies 97% of all forests in Vermont as *TIMBERLANDS*

A critical Component of Earth's Operating System

- Globally, forests annually absorb an amount of CO_2 equal to nearly 29% of all fossil fuel emissions.
- They store approximately as much carbon in the trees and soils as is in the atmosphere
- If managed differently, they might store twice as much carbon
- US forest remove 12% of our fossil fuel emissions

IPCC Clarification of crediting bioenergy emissions

- **“The combustion of biomass generates gross GHG emissions roughly equivalent to the combustion of fossil fuels.** If bioenergy production is to generate a net reduction in emissions, it must do so by offsetting those emissions through **increased net carbon uptake of biota and soils**.”
- “The neutrality perception is linked to a misunderstanding of the guidelines for GHG inventories”
- “…in the specific case of existing forests that may continue to grow if not used for bioenergy, some studies employing counterfactual baselines show that **forest bioenergy systems can temporarily have higher cumulative CO2 emissions than a fossil reference system** (for a time period ranging from a few decades up to several centuries; (Repo et al., 2011; Mitchell et al., 2012; Pingoud et al., 2012; Bernier and Paré, 2013; Guest et al., 2013; Helin et al., 2013; Holtsmark, 2013).”

- *IPCC AR5 WG III, 11.13.4 2014 GHG Emission Estimates of Bioenergy Production Systems*

Role of forests in achieving climate goals is to store the most carbon out of the atmosphere

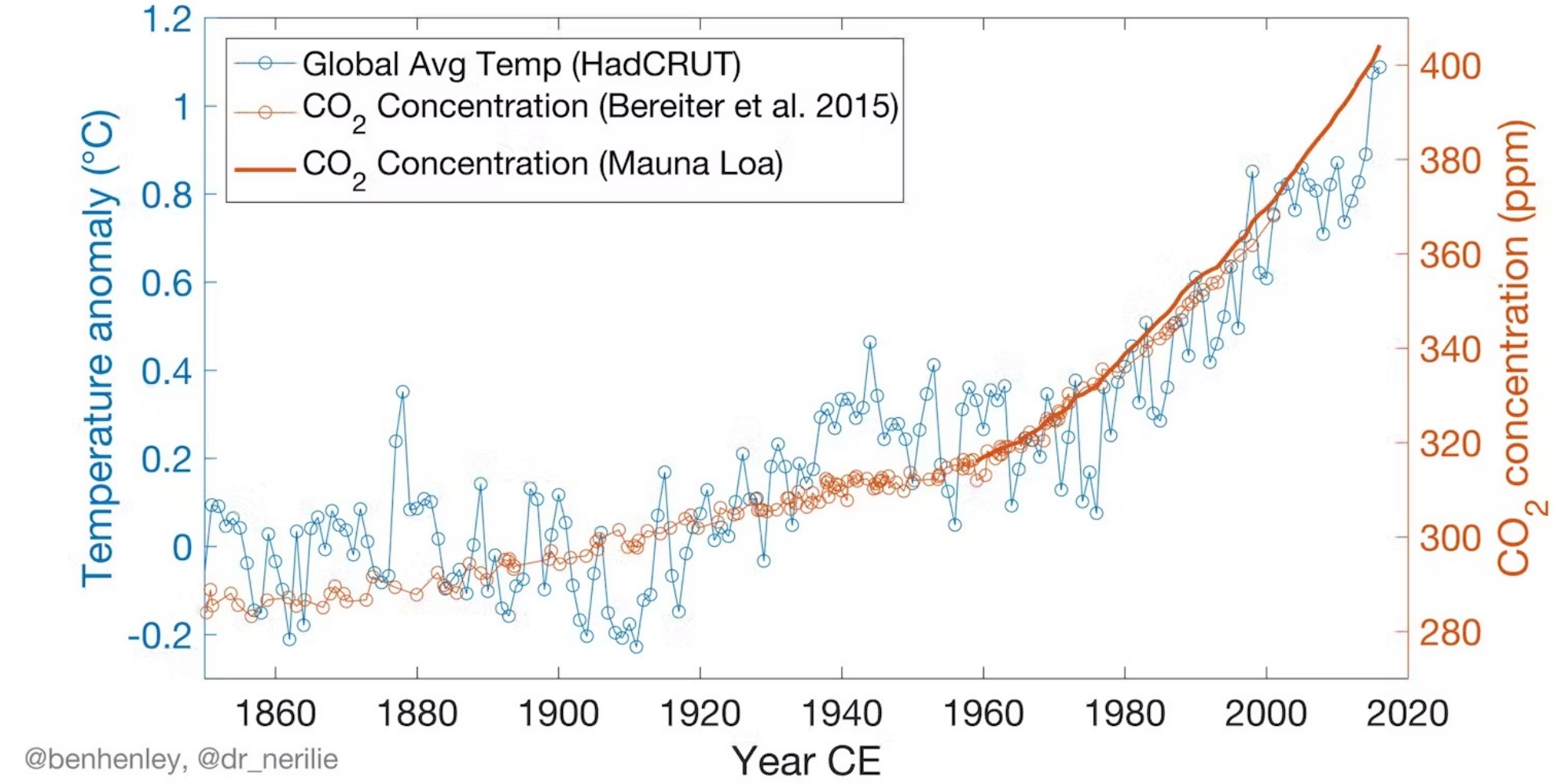
- UN Framework Convention on Climate Change Article 2:

"The ultimate objective of this Convention …Parties may adopt is to achieve, stabilization of greenhouse gas ***concentrations in the atmosphere*** *at a level that would prevent dangerous anthropogenic interference with the climate system."*

- IPCC AR 6 Working Group 2 Chapter 2 page 303:

"…protection of existing natural forest ecosystems is the ***highest priority*** *for reducing GHG emissions (Moomaw et al., 2019) and restoration may not always be practical…"*

Average Global Temperature and CO_2 1850 - 2019



Global Temperature and CO_2 since 1850. Ben Henley and Nerilie Abram

Quebec Wildfire – What happens to the CO_2 ?

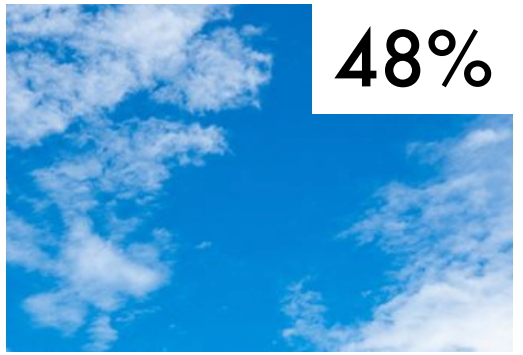
Quebec fire

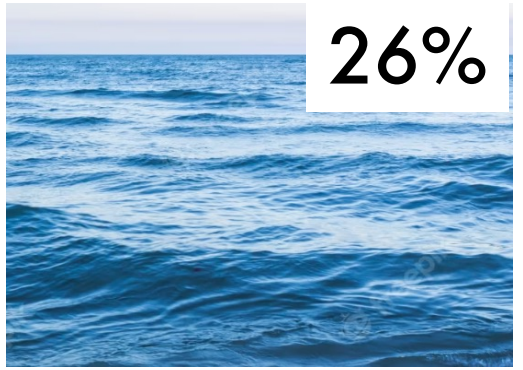
Smoke and particulates in New York

There is only one carbon cycle

Forest and ocean CO_2 removal do not privilege CO_2 from wood burning from power stations over fossil fuel CO_2

Atmospheric CO_2



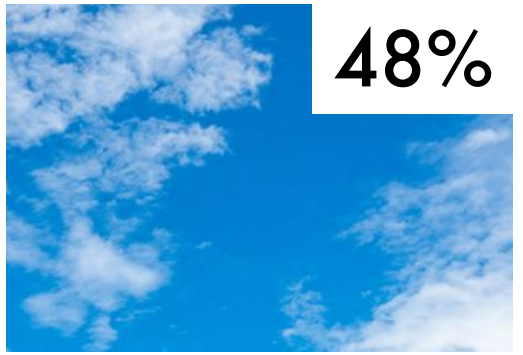


Source: Friedlingstein et al 2022; Global Carbon Project 2022

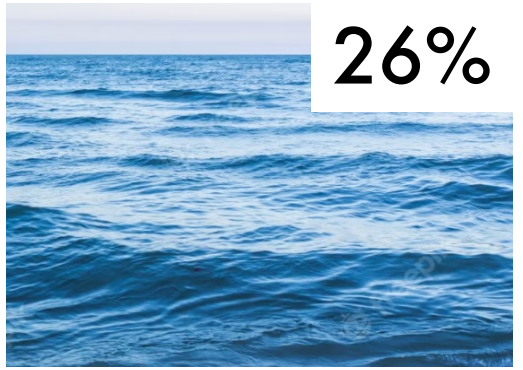
There is only one carbon cycle

Forests only remove additional carbon from the atmosphere if there is net forest growth

Atmospheric CO_2



48%



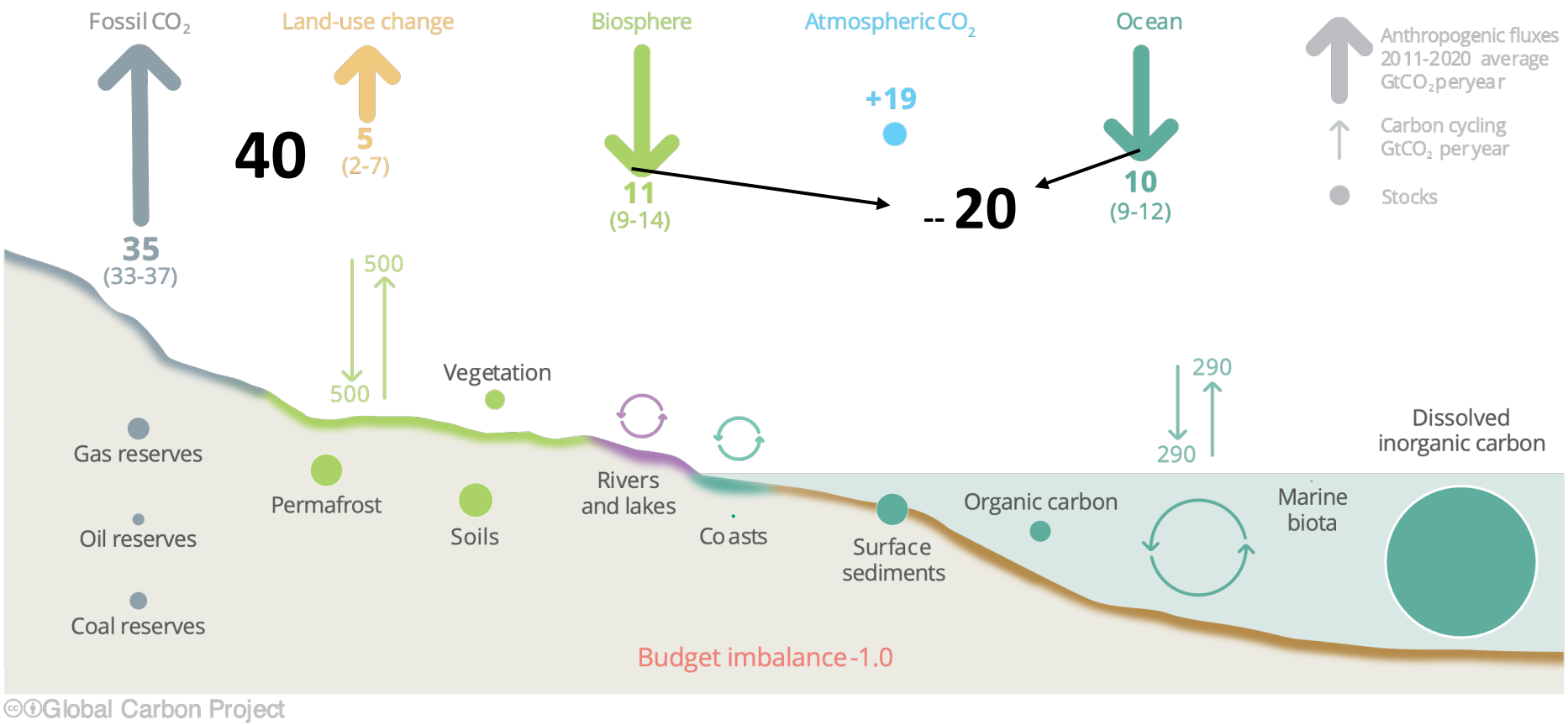
26%

29%

Source: Friedlingstein et al 2022; Global Carbon Project 2022

Anthropogenic perturbation of the global carbon cycle

Perturbation of the global carbon cycle caused by anthropogenic activities, global annual average for the decade 2012–2021 **($GtCO_2$/yr)**



The budget imbalance is the difference between the estimated emissions and sinks.

Source: NOAA-ESRL; Friedlingstein et al 2022; Canadell et al 2021 (IPCC AR6 WG1 Chapter 5); Global Carbon Project 2022

How did we get here?

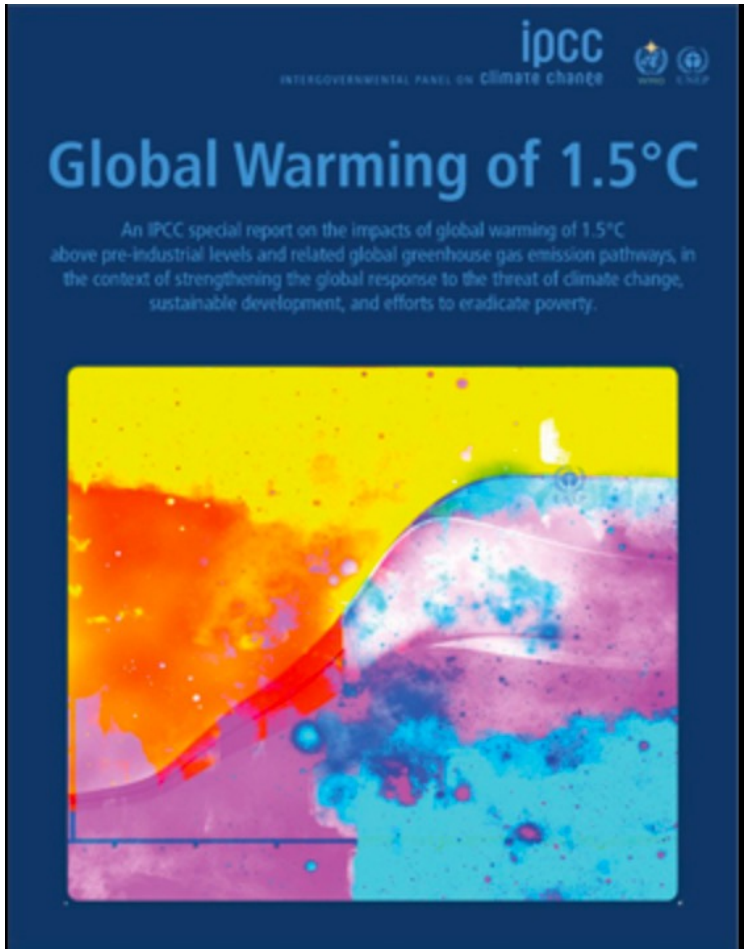
- Historical context
- Where do we need to go?

Internationally Agreed Climate Goals

- 1992 – UN Framework Convention on Climate Change
  - *"… achieve … **a concentration of greenhouse gases in the atmosphere** that will avoid dangerous anthropogenic interference in the climate system."*
- Paris Climate Agreement 2015
  - *"… (hold) the increase in the global average temperature to well below 2°C (3.6°F) above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C (2.7°F) above pre-industrial levels."* - Article 2
  - *"Parties should take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases … **including forests**."* Article 5

- **Global temperature has already risen by 1.2°C (2.7°F)**

Above 1.5° C Amplifying Feedbacks Cause Irreversible Changes
How to Avoid exceeding that Temperature?
Ask the Intergovernmental Panel on Climate Change!



IPCC Special Report *Global Warming of 1.5°C (2.7°F)* 2018

To keep temperatures from rising above 1.5°C
"… global ***net*** anthropogenic carbon dioxide emissions (must) decline by about 45% from 2005 levels by 2030 … reaching ***net*** zero around 2050" …and net negative beyond 2100

Must simultaneously reduce carbon dioxide emissions from fossil fuels and increase its removal from the atmosphere

Intergovernmental Panel on Climate Change 2022

- *"**Safeguarding biodiversity and ecosystems is fundamental to climate resilient development** (very high confidence)."*

- *"... maintaining the resilience of biodiversity and ecosystem services at a global scale depends on effective and **equitable conservation of approximately 30% to 50% of Earth's land, freshwater and ocean areas**, **including currently near-natural ecosystems** (high confidence)."*

Summary for Policy Makers D.4 page 3 https://www.ipcc.ch/report/ar6/wg2/

- *"It is also the case that **protection of existing natural forest ecosystems is the highest priority for reducing GHG emissions** (Moomaw et al., 2019) ... ."*

AR6 WGII_page 303 *https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC*

What are emissions associated with operating McNeil?

- What are emissions associated with operating McNeil?
- Scientific methods for estimating the climate impacts of biomass?
- Should Burlington invest to expand the use of McNeil?

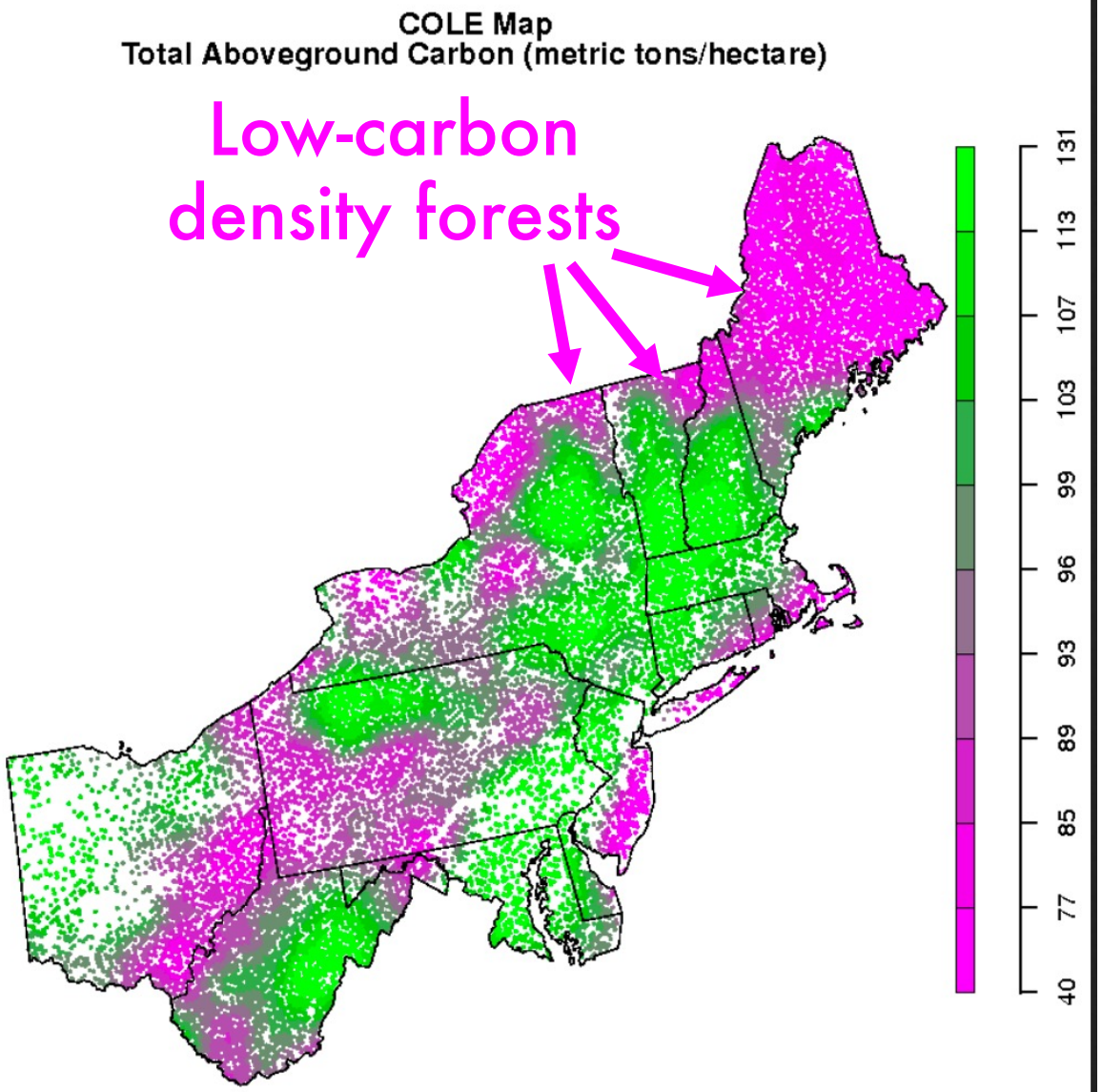
How much would carbon emissions need to be cut in order to limit warming to 1.5 °C?

It depends on when you start…

McNeil Plant

2023: Faster than we have ever cut them before, starting now

1984: Not until after 2050



- 95% of New England forests are <100 years old.
- New England forests could **continue to accumulate additional carbon for >100 years (Lutz et al. 2018).**

Yesterday vs. today

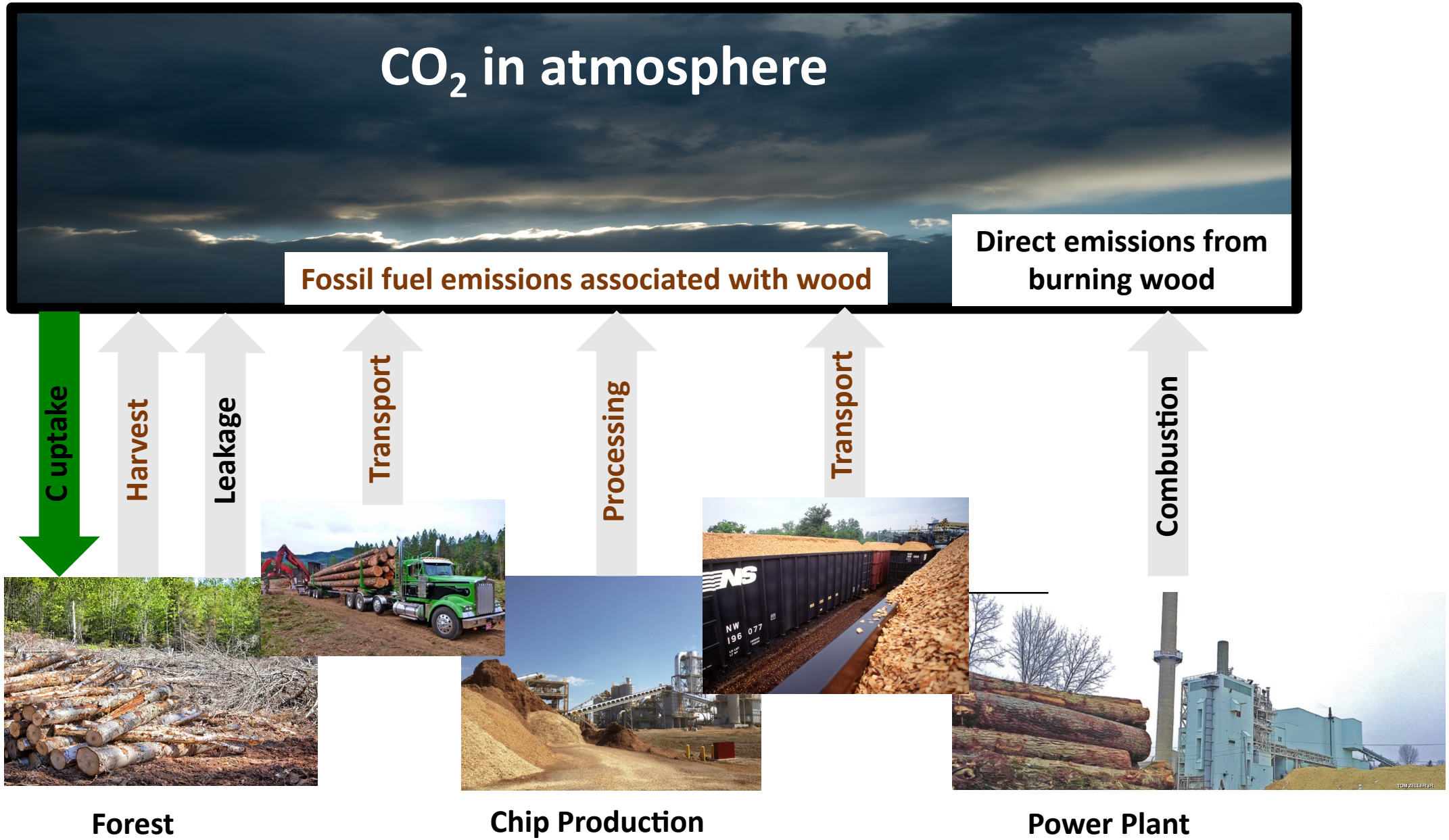
Yesterday (1984):

- Climate is relatively stable; impacts are uncertain and in the future
- Peak oil
- Zero carbon energy is expensive and not widely available
- **Appropriate counterfactual: continued use of fossil fuels and wood**

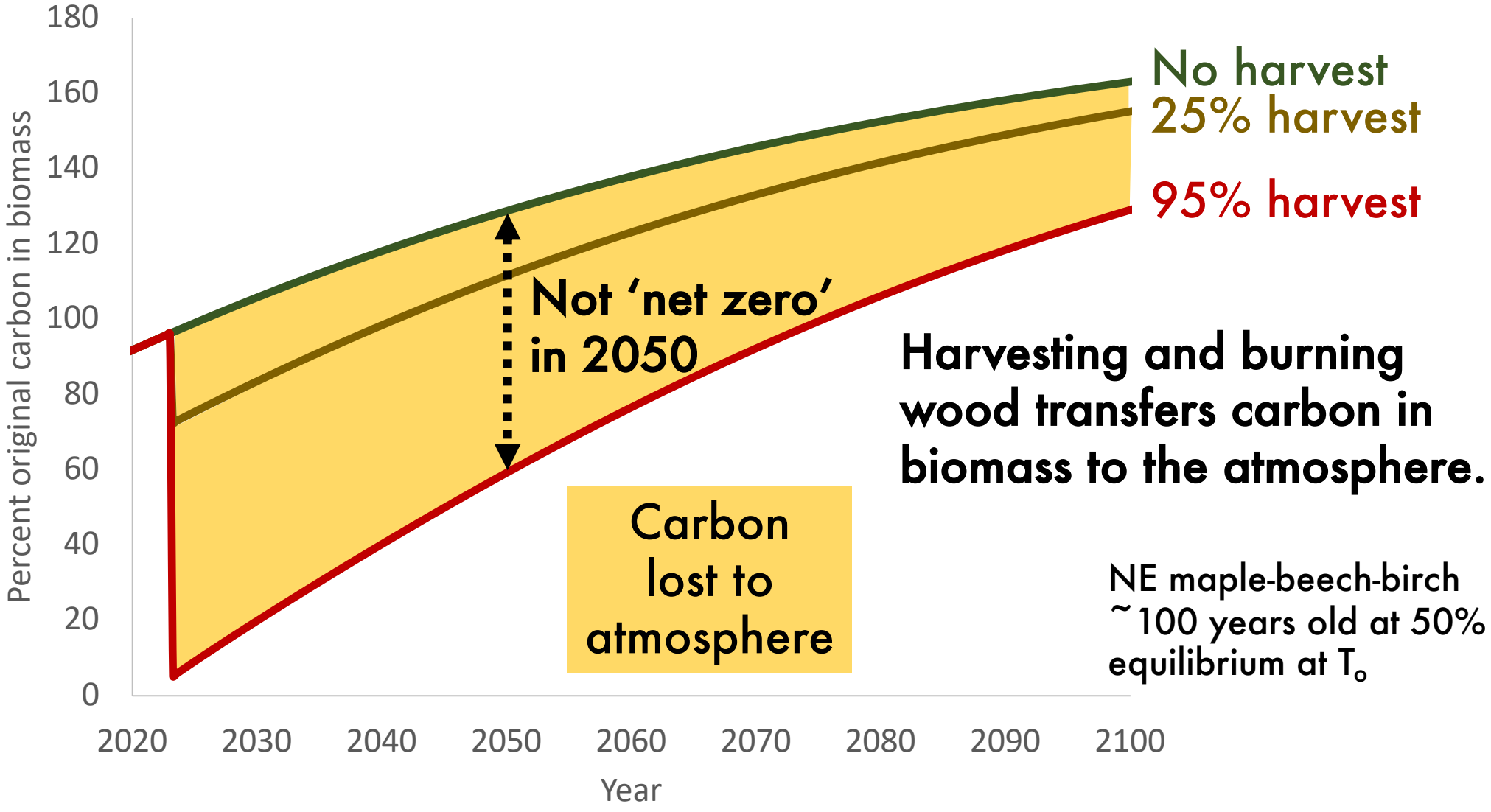
Today (2023)

- Warming is accelerating and consequences are here
- Immediate and steep cuts in carbon emissions needed
- Zero carbon energy is far more accessible and affordable
- **Appropriate counterfactual: Rapid transition to zero carbon energy and proforestation**

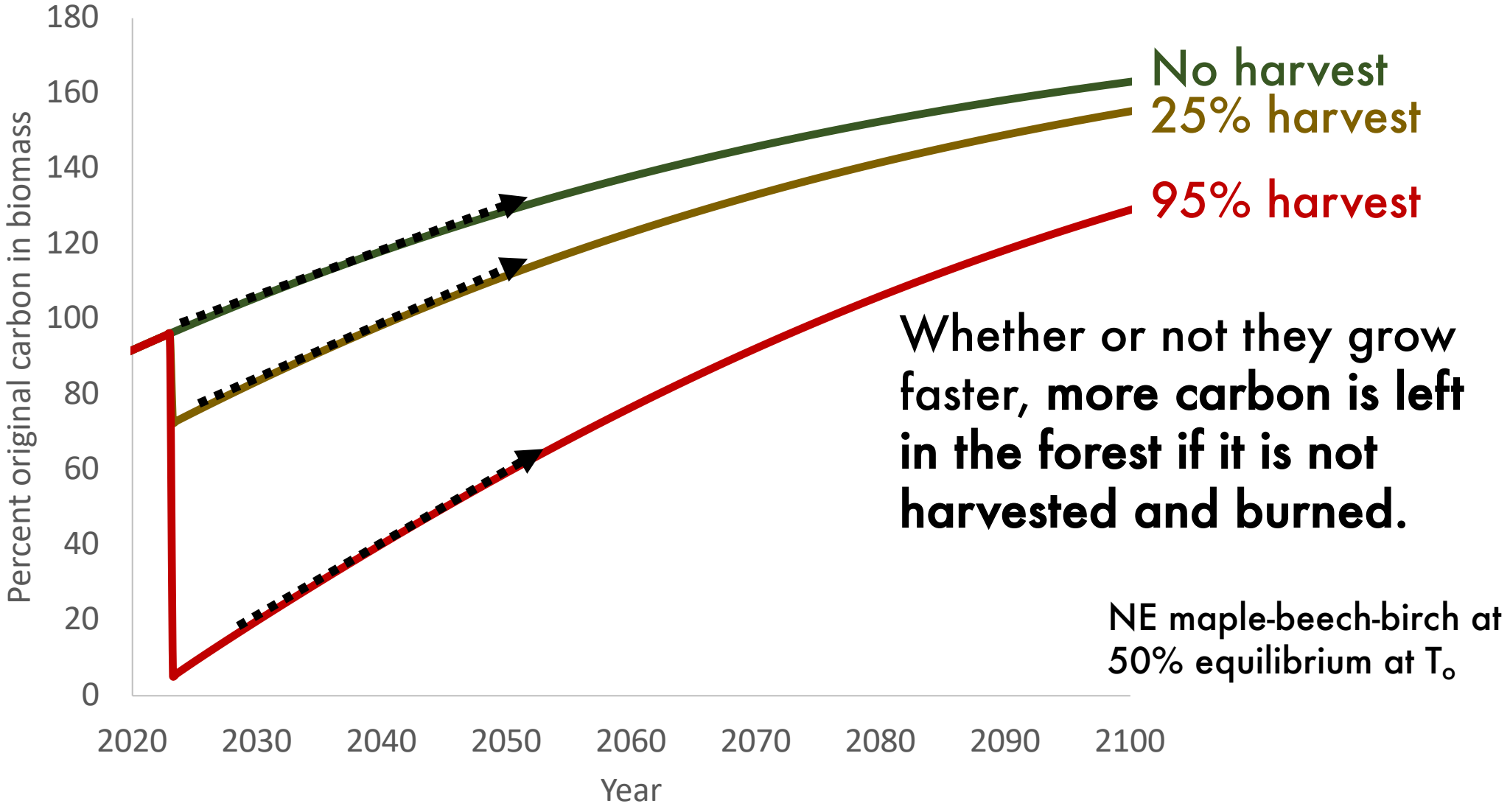
Life Cycle and Combustion Emissions from Wood Supply Chain



Carbon accounting: forest biomass



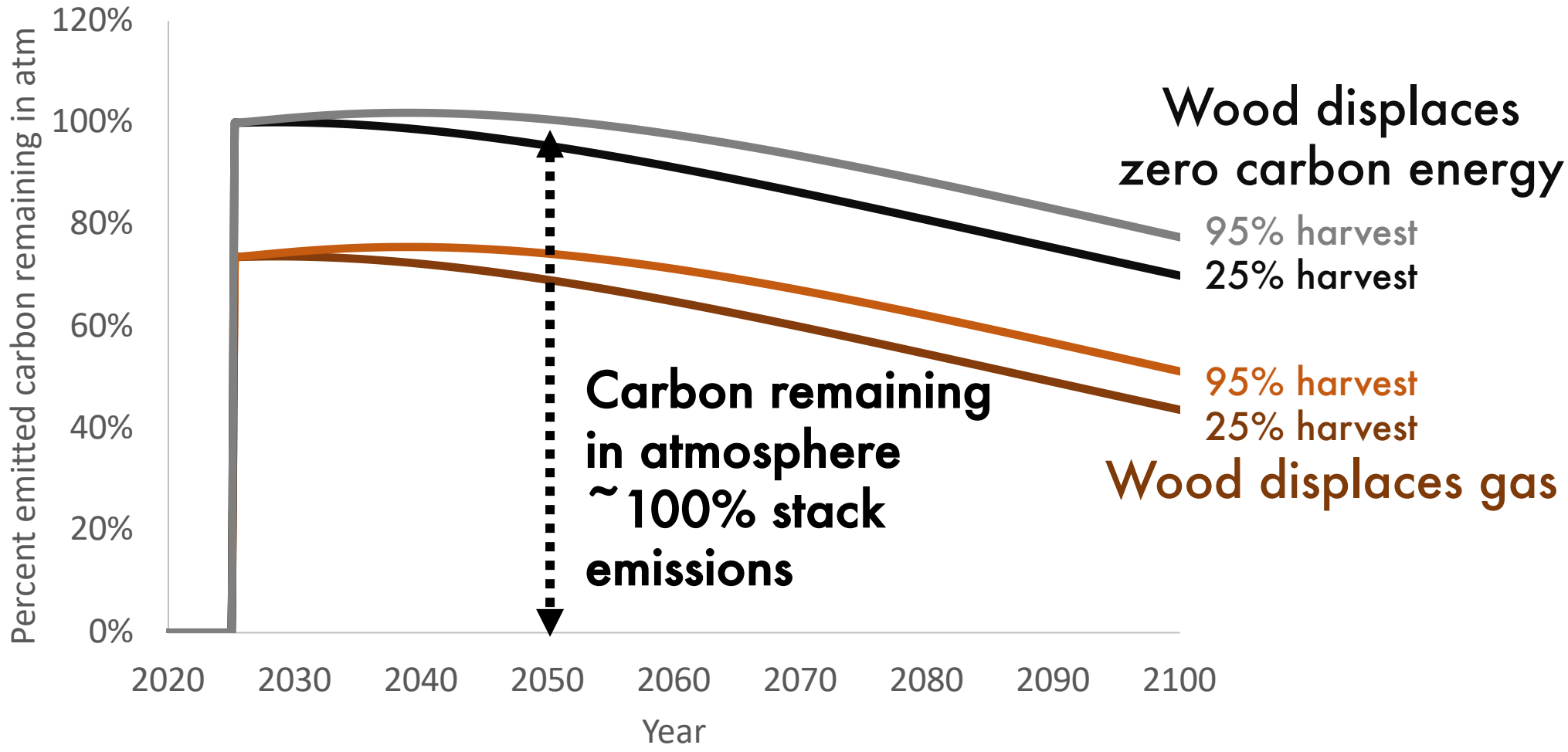
But don’t thinned forests grow faster?



Whether or not they grow faster, **more carbon is left in the forest if it is not harvested and burned.**

NE maple-beech-birch at 50% equilibrium at T_o

Is wood better than burning gas?
Is it the same as zero carbon energy sources?



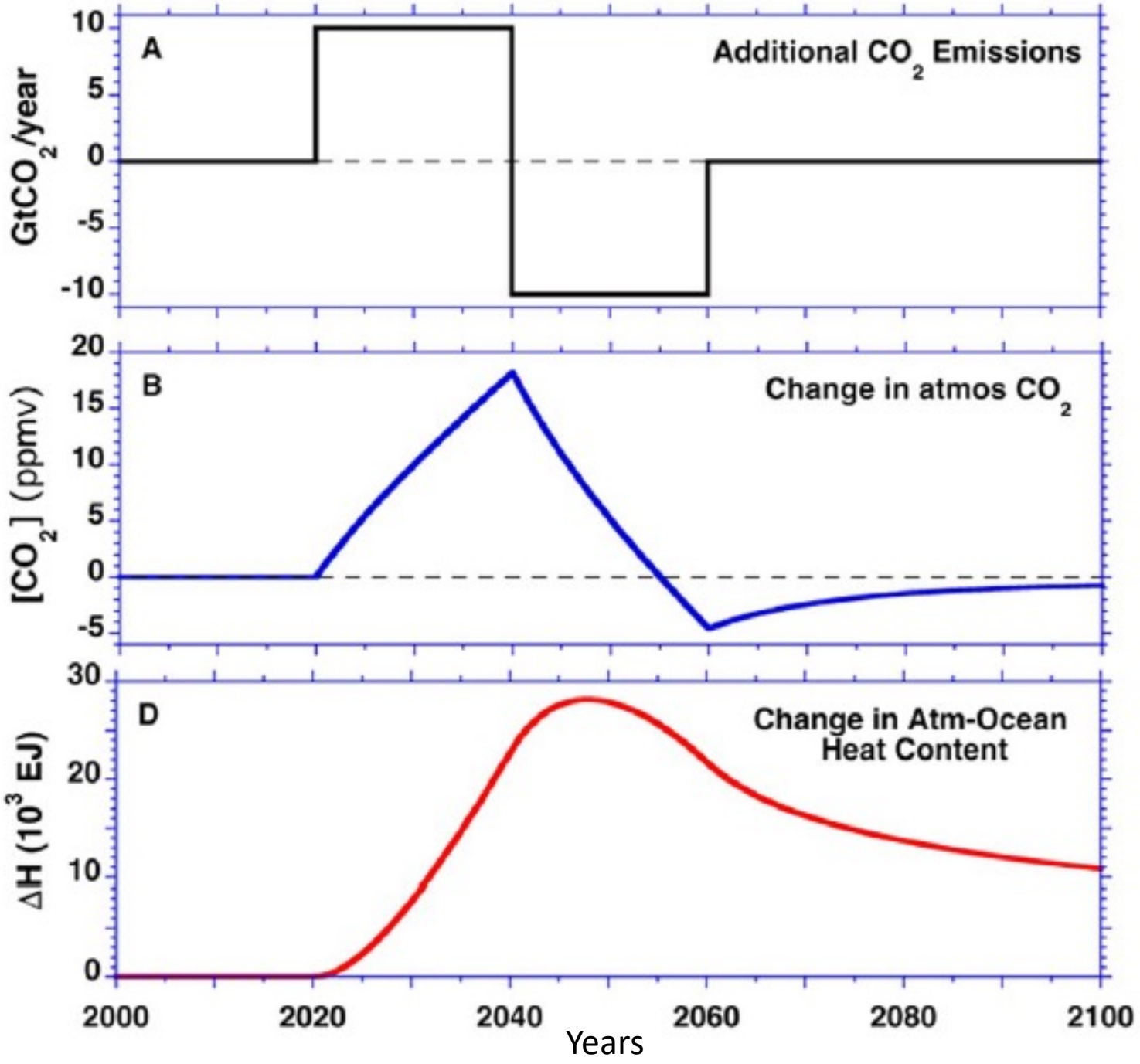
What if only residues are burned?

- Research shows carbon payback times for burning residues are years to decades compared to decomposition
  - (Booth 2018 *Environ. Res. Lett.* **13** 035001).

- An economically attractive counterfactual:
  - Oriented strand board
  - Wood cellulose insulation

Wood-associated CO_2 emissions from McNeil

Data from EPA and Lane and Sherman 2022



Delayed carbon neutrality is not climate neutral

- Sterman et al. 2018. *Environ. Res. Lett.* **13** 015007
  Sterman *et al* 2018 *Environ. Res. Lett.* **13** 128003

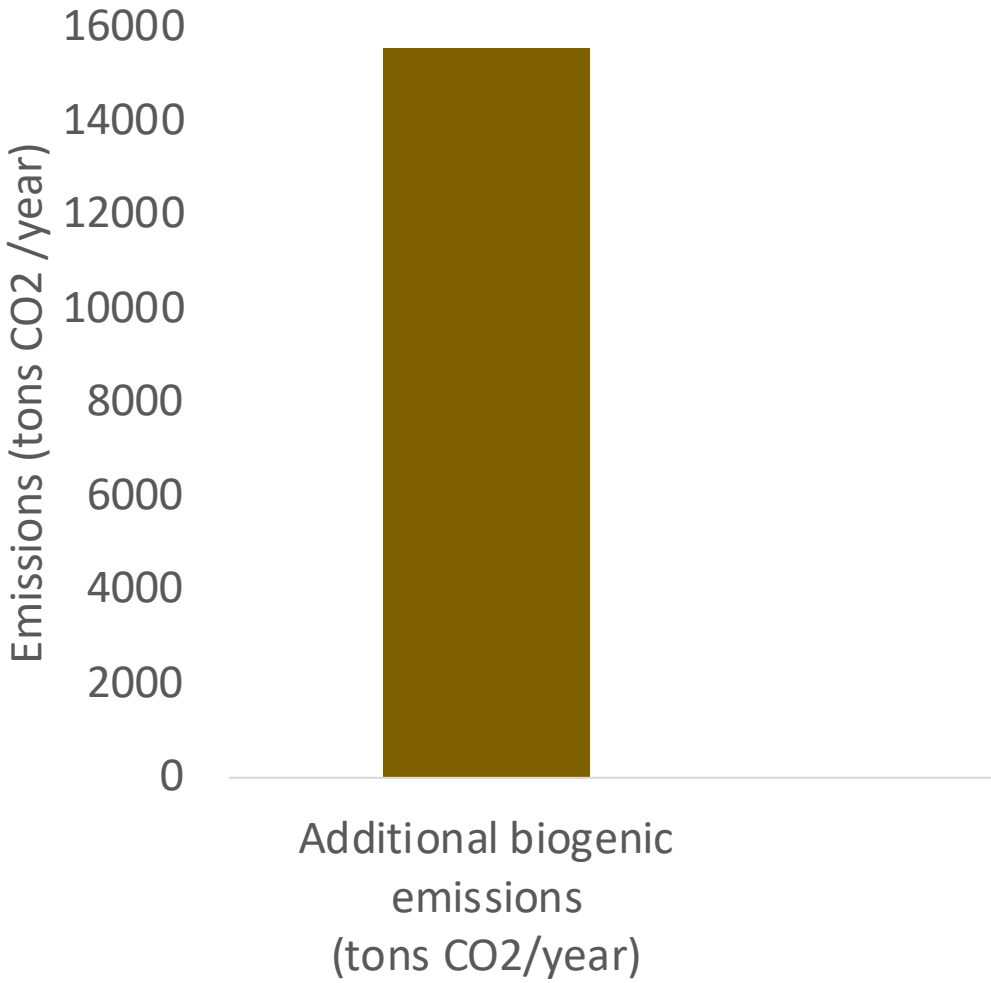
Even temporary (centuries of) warming causes irreversible climate damage

https://www.nytimes.com/2011/09/01/us/01bridges.html

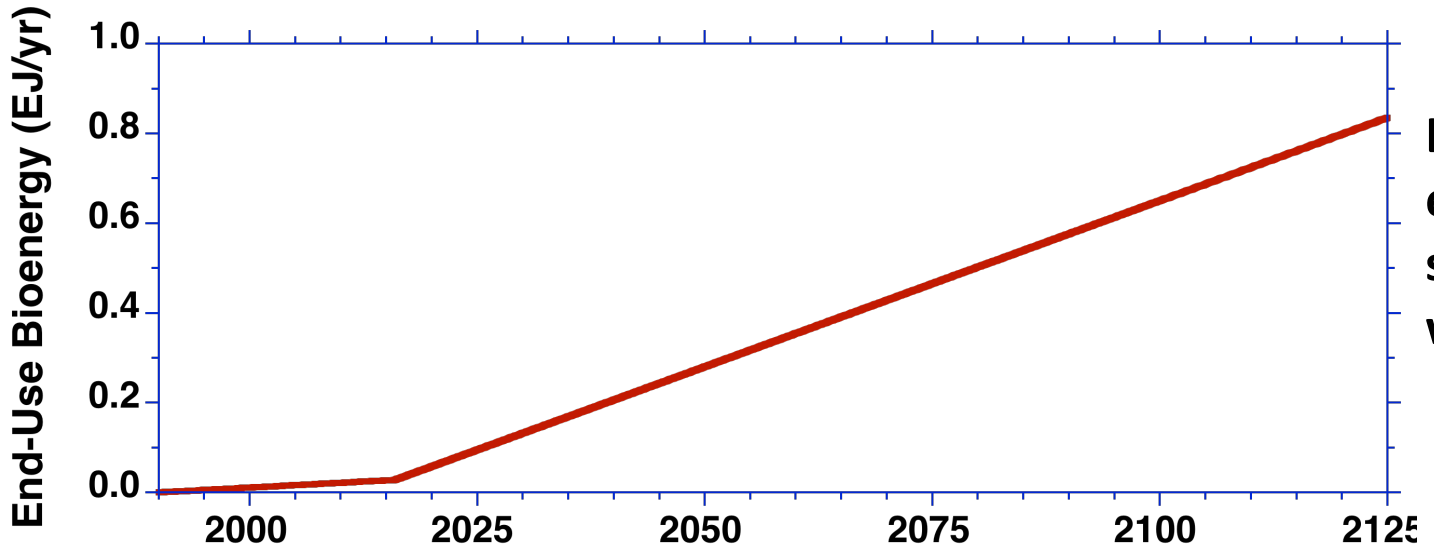
Rushing floodwaters during Irene took down even ski lodges in Killington, Vermont in 2011. Credit: Getty Images

Does the proposed steam line make climate sense?

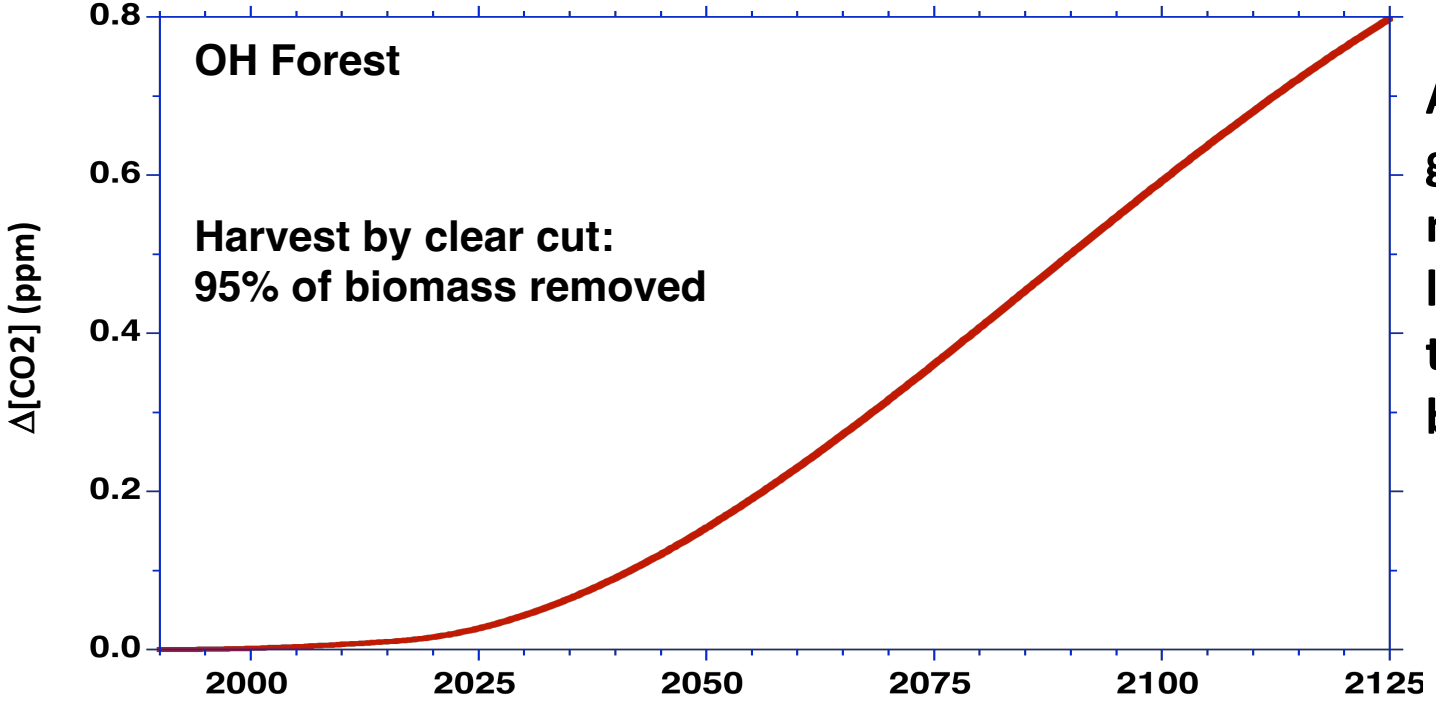
- Increases emissions
- Increases wood bioenergy
- Prolongs the life of the McNeil plant
- Puts Burlington at risk of being committed to high-carbon, high-cost energy



Increasing wood bioenergy increases net loss of forest carbon



Linear growth in end-use energy supplied by wood



Atmospheric CO2 grows: Each year more carbon is lost from forest than is taken up by forest growth.

Prior and changing public perception and policy

- **"The neutrality perception is linked to a misunderstanding of the guidelines for GHG inventories,"** IPCC AR 5 2013

wbur LOCAL COVERAGE

What to know about the new Mass. climate law

05:56

Updated August 11, 2022 By Miriam Wasser

The turbines of the Block Island Wind Farm off the coast of Rhode Island. (Jesse Costa/WBUR)

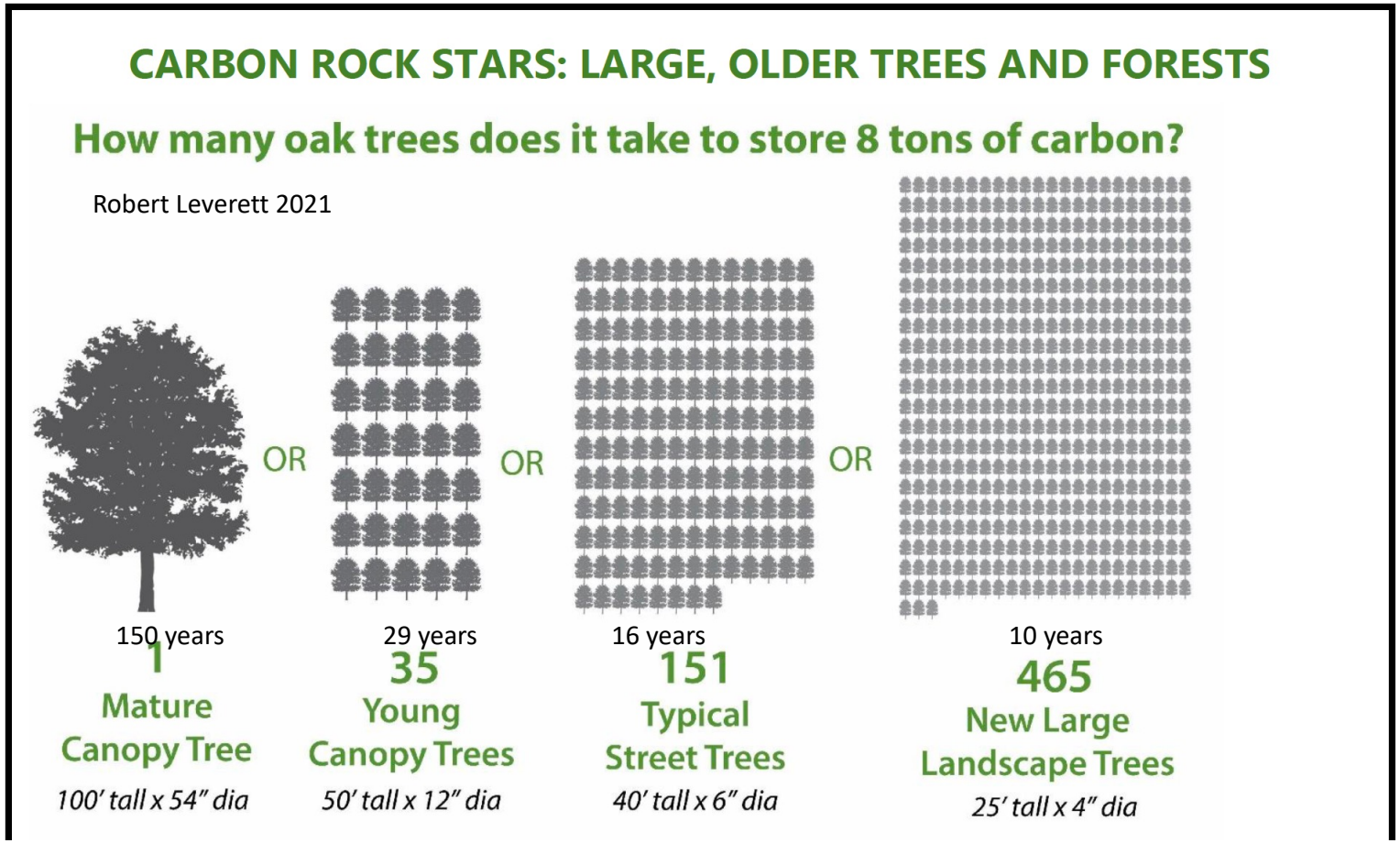
New Massachusetts climate law: Wood is excluded from the Renewable Portfolio Standard (RPS) and its subsidies

Declares biomass electricity isn't renewable

Whether to give renewable energy credits to wood-burning biomass facilities has been a contentious topic in Massachusetts over the last few years. The new law supersedes the Department of Energy Resources' controversial proposal to rewrite biomass rules.

Now, a woody biomass facility can only get credits for the electricity it generates if it was already getting those credits as of January 1, 2022. In practice, this just means that the two small combined-heat and power facilities in the state can continue to qualify.

A large trees stores more carbon than many smaller ones



To accumulate the greatest amount of carbon in forests Let them grow!

Proforestation Management is managing forests *without harvest* **to reach their potential for carbon accumulation and biodiversity** in trees and soils

Larger trees in mature and old growth forests accumulate the most atmospheric carbon over time, and store it in the wood of their trunk and limbs and in soils

Policy recommendations: An opportunity for climate leadership

- **Count wood bioenergy emissions at the stack**
- **Avoid further investment in McNeil and transition away from burning coal, oil, gas, and wood**
- Create **strategic forest carbon reserves** to support forest growth
- Incentivize private landowners to preserve forests for **long-term accumulation of carbon**

Thank you

- Questions?