Pathways for Sequestration and Storing Carbon

Vermont's natural and working lands and waters are our greatest asset in mitigating the impacts of climate change. Natural climate solutions (as outlined in section 13) are conservation, restoration and improved land management actions that increase carbon storage or avoid greenhouse gas emissions in landscapes and wetlands. Combined with taking action to reduce our emissions through the preceding strategies and actions, natural climate solutions offer Vermont some of our best options in the response to climate change. These strategies and actions will help us build a more resilient and adaptive Vermont while also helping us sequester and store more carbon. Natural and working lands (NWL) in Vermont currently store over 2,000 MMT CO_2–e and sequester carbon at a current annual rate of -2.91 MMT CO_2 –e [1]. Steps must be taken to ensure this sequestration and storage capacity are maintained and enhanced.

Those that live and work in these ecosystems have a critical role in helping us reduce our net emissions. Management decisions on NWLs can result in both the reduction of emissions and also increased absorption and storage of carbon dioxide (sequestration) from the same unit of land – these management choices also result in net sequestration across forestry, wetlands, and agricultural emissions.[2] Therefore, it is critical that landowners and those within the farm and forest sectors are empowered to select the best management decisions to both ensure the continued sequestration and long-term storage of carbon, while maintaining economically viable operations. A critical component of moving into a resilient and adaptive future in the face of our changing climate lies squarely in our ability as a state to empower, embrace, and increase the inherent resiliency of our natural and working lands and ecosystems to provide for our shared future.

Outlined below is a set of pathways, strategies, and actions that will not only empower Vermont's land to store and sequester carbon, but uplift and resource the land stewards,

[1] Galford et al. 2021. A Carbon Budget for Vermont. Insert link https://outside.vermont.gov/agency/anr/climatecouncil/Shared%20Documents/Carbon%20Budget%20for%20Vermont%20Sept%202021.pdf

[2] Ex-ACT modeling from carbon budget. https://outside.vermont.gov/agency/anr/climatecouncil/Shared%20Documents/Carbon%20Budget%20for%20Vermont%20Sept%202021.pdf

landowners, farmers, foresters, and caretakers who interact with our natural and working lands every day. As a result, Vermont will also realize significant co-benefits, including buffering the impacts of extreme precipitation and drought stress, reducing downstream flood risks, supporting biodiversity and regional habitat connectivity, protecting water quality, and enhancing productivity of healthy soils. This work also seeks to acknowledge the systems in which we are currently mired, those that capitalize farmers and foresters into extractive methods of production and result in both inequity to our land base, historically marginalized populations, frontline, and impacted communities, including farmers and foresters themselves.

Efforts to invest in the capability of Vermont's natural and working lands to sequester and store carbon are being undertaken by farm and forest managers on their lands throughout Vermont today, but as we face increased extreme weather events, generational land transfer, exacerbated income and social inequity it will be incumbent upon us all to transform the manner with which we design and implement our approach moving forward to ensure that both an equity and climate lens are first and foremost in how we prioritize our actions. Vermont is fortunate to have large forest, wetland, and agricultural carbon stocks and we must take action to maintain them. While carbon sequestration rates are not constant, we can invest in conservation practices and more while also further advancing research and monitoring to foster a deeper understanding of Vermont's sequestration potential.

In fact, an analysis conducted for the VCC by Cadmus indicates that Vermont has seen a steady decline in annual sequestration. If that historic trend continues the state will not meet the GWSA's 2050 net zero target, even if the 2025 and 2030 emission reduction targets are achieved. The Cadmus analysis indicates Vermont must maintain sequestration at or above projected 2035 levels in order to be net zero by 2050.

To meet the required objectives of the GWSA and mitigate drivers of climate change, it is critical that the State of Vermont invest in measures to protect existing carbon stocks, increase the net balance of carbon sequestration in natural and working landscapes, better understand the way land management changes influence the storage and sequestration of carbon, and accurately track changes over time. These strategies and actions give land managers the financial and

technical support to implement practices that protect and increase carbon in the landscape so that Vermont can complement its emission reductions with sequestration and storage goals that get the state to net zero.

PATHWAY - Maintain and expand Vermont's natural and working lands' role in the mitigation of climate change through human interventions to reduce the sources and enhance the sinks of greenhouse gases.

STRATEGIES AND ACTIONS

1. **Leverage, expand, and adapt existing State of Vermont programs that support the agricultural sector's mitigation of climate change through:**
   - *Prevention—of emissions to the atmosphere by conserving existing carbon pools in soils or vegetation, or by reducing emissions of methane (CH_4) and nitrous oxide (N_2O);*
   - *Sequestration—by increasing the size of existing carbon pools, and thereby extracting carbon dioxide (CO_2) from the atmosphere; and*
   - *Substitution—substituting of biological products for fossil fuels or energy-intensive products, thereby reducing CO_2 emissions.*

   a. Implement agronomic practices that reduce tillage and increase vegetative cover, e.g., no-till, cover crop.
   b. Expand Capital Equipment Assistance Program (CEAP) program to extend beyond water quality and incorporate climate change criteria.
   c. Implement grazing practices that increase vegetative cover and forage quality, e.g. rotational grazing.
   d. Implement agroforestry and silvopasture practices that integrate woody vegetation in agricultural production.
   e. Implement edge-of-field practices that increase herbaceous and woody vegetation, e.g. riparian forest buffer (e.g. CREP).

f. Implement natural resource restoration practices that support climate mitigation and resilience, including river corridor easements, wetland restoration, and afforestation practices with consideration to agricultural land loss.

g. Implement Nutrient Management and Amendments (e.g., biochar, compost) on cropland and grazing land.

h. Implement methane capture and energy generation on farms, e.g., anaerobic digesters and covers.

i. Research and pilot programs for improved manure management and storage.

j. Research and develop a climate feed management program, including both feed amendments (e.g., seaweed, biochar) and feed quality (e.g., forage quality) to reduce enteric methane emissions; consider downstream impacts, sustainability, and equity.

Preliminary Assessment of Strategy against Criteria
Impact: Over 300,000 acres of cumulative agricultural conservation practices have been implemented by farmers in Vermont since 2016.[3] The adoption of natural climate solutions (NCS) and technologies to address water quality impacts on farms have co-benefits for GHG mitigation goals in Vermont. USDA reports that mitigation efforts across agricultural cropland management, manure management, and pasture management can provide over 70 MMT of CO_2-e emission reduction across the United States.[4]
Equity: Soil health can be improved across all sectors of Vermont agriculture. Access to state programs is coordinated with federal programs to attempt to provide the most coverage for different sized farms with different planning and management goals. Any new programs created and existing programs when feasible should be assessed utilizing the Just Transitions'' subcommittee's Guiding Principles. *Cost-effectiveness*: A 2021 study reports that in Canada, agricultural

[3] Clean Water Interactive Dashboard based on data from Vermont Clean Water Initiative 2020 Performance Report. January 15, 2021. https://app.powerbigov.us/view?r=eyJrIjoiNTI5Y2QxZDEtODY3Ni00ZmYwLThjZTAtNjdiNTM3YTQyZjRkIiwidCI6IjIwYjQ5MzNiLWJhYWQtNDMzYy05YzAyLTcwZWRjYzc1NTljNiJ9.

[4] Pape, D., J. Lewandrowski, R. Steele, D. Man, M. Riley-Gilbert, K. Moffroid, and S. Kolansky, 2016. "Managing Agricultural Land for Greenhouse Gas Mitigation within the United States." Report prepared by ICF International under USDA Contract No. AG-3144-D-14-0292. July 2016. https://www.usda.gov/sites/default/files/documents/White_Paper_WEB_Final_v3.pdf.

cropland management could provide the most GHG mitigation potential by 2030 at the most cost-effective price point across all natural climate solutions evaluated, with over 68% of the 44.4 MT CO_2-e mitigation potential for agriculture costing less than $100/MT CO-e.[5] Quantifying the mitigation benefit of existing agricultural conservation practices and extending their reach is an immediate first step Vermont can take to mitigate agricultural GHG emissions.
Co-Benefits: Vermont's air, biodiversity, soil, water, and social considerations are improved through the implementation of existing agricultural conservation programming described in actions (a) – (j) above. Specific examples of co-benefits in addition to GHG mitigation potential include: • Overall adaptation, resilience, and water quality benefits • Reduced soil erosion • Reduced nutrient runoff • Increase in soil organic matter (soil health, infiltration, water storage) • Reduced flooding • Resilience to drought and extreme rain events • Reduced nitrogen fertilizer if planting legumes • Reduced ground temperatures due to albedo effect of plant cover
Technical Feasibility: Yes

2. **Create a system for tracking and accounting metrics and indicators for natural and working lands.** The tracking and accounting for emissions reductions and sequestration are inadequate for natural and working lands and need improvement and additional resources for development and maintenance. Extensive datasets exist for water quality implementation but need specific quantification for climate mitigation (a). Additionally, the current tools used for quantification are inadequate for the complicated management mechanisms and natural processes occurring on natural and working lands that lead to climate mitigation (b). Finally, update the state's inventory to reflect guidance set by the Intergovernmental Panel on Climate Change (IPCC) of the United Nations to account for net emissions. Adequately

[5] Drever, C Ronnie et al. "Natural Climate Solutions for Canada." *Science Advances* 7, 1 (June 2021). https://www.science.org/doi/10.1126/sciadv.abd6034.

tracking and accounting for emissions gains and losses from natural and working lands is essential to justly credit and further incentivize ongoing climate mitigation work by farmers, foresters, and other land managers.

a. Develop a methodology and protocol for quantifying climate mitigation, resilience, and adaptation impacts of existing state and federal water quality implementation programs as reported through the annual Clean Water Initiative Performance Report. The Clean Water Initiative Performance Report "summarizes the State of Vermont's clean water efforts and demonstrates how investments are making a difference through accountability measures."[6] As mentioned, most water quality conservation practices and programs also have climate mitigation, resilience, and adaptation benefits. Recommend using existing tracking systems and quantify the climate benefits from this existing implementation and data tracking. The data spans state and federal funding programs and regulatory programs that drive clean water efforts and coordinates across agencies to track these efforts and monitor progress.
b. The Vermont Climate Council has recommended developing and issuing a Request for Proposals (RFP) that will review and analyze methodological gaps of emission inventory tools currently used by the State of Vermont to quantify greenhouse gas emissions for evaluating changes in the Agriculture, Forestry and Other Land Use (AFOLU) sector and the tools' alignment with the Intergovernmental Panel on Climate Change (IPCC), Environmental Protection Agency (EPA), and peer state methodologies and approaches. The specific recommendations for this RFP can be found in the Carbon Budget Report memo found in Appendix XX.
c. Based on the findings of the technical RFP mentioned in action step (b) of this strategy, the VCC should consider recommending that the State of Vermont GHG emissions inventory protocol established in 10 V.S.A. § 582 be amended to include an inventory of GHG emissions that align with the intent and standards of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories that will include a net GHG emission accounting for the agriculture, forestry and other land use (AFOLU) sector.

[6] Vermont Clean Water Initiative 2020 Performance Report. January 15, 2021. https://dec.vermont.gov/sites/dec/files/wsm/erp/docs/2021-01-15_CleanWaterPerformanceReport_SFY2020-FINA-PDF-A.pdf.

Preliminary Assessment of Strategy against Criteria
Impact: Currently, agricultural mitigation in the form of management practices that reduce emissions as sequestration on agricultural cropland is not counted in the current GHG Emissions Inventory. With over 300,000 acres of agricultural conservation practice implementation since 2016 that have GHG mitigation potential and associated Emission Reduction Coefficients – these practices are currently tracked but not counted for agricultural mitigation. The scale of mitigation from the agricultural sector has been identified by a Canadian study to be the largest single opportunity amongst all evaluated natural climate solutions (NCS) – the potential scale of impact for mitigation is large in Vermont if mitigation potentials are counted through the VT GHG Emission Inventory.
Equity: The current GHG Emissions Inventory only quantifies non-CO_2 emissions from the agricultural sector. Absent from current emission accounting are the stocks and fluxes of CO_2 from agricultural cropland – management impacts are also not provided for in the current GHG Emissions Inventory for agriculture. Ensuring that the State of Vermont GHG Emissions Inventory comports with the IPCC framework for the tracking and reporting of the AFOLU sector is essential for an equitable and accurate accounting of emissions and mitigation.
Cost-effectiveness: Over 300,000 acres of agricultural conservation practices have been tracked on an acre-by-acre basis through state and federal programs since 2016 for water quality improvement metrics. Development and implementation of a protocol to count existing agricultural programming that has co-benefits for agriculture is a cost-effective approach that leverages existing programs.
Co-Benefits: Co-benefits for water quality are tracked through existing state and federal tracking mechanism which are quantified for phosphorus reduction benefits for water quality.
Technical Feasibility: Yes

3. **Implement a Payment for Ecosystem Services (PES) program for natural and working lands.** Managers of natural and working lands, including farmers and foresters, provide

important environmental or ecosystem services to the public, such as clean air and water, reduced flooding, or sequestration and storage of carbon. A Payment for Ecosystem Services (PES) program provides a quantifiable and verifiable framework to credit and compensate for the benefits of stewardship that produces numerous ecosystem goods and services. PES programs vary in design and could focus on particular ecosystem services or land uses, i.e. (a) farms or (b) forests, or both, and could offer direct payments or other financial compensation, such as tax credits (c). Regardless of design, PES is an innovative and important mechanism to further climate mitigation occurring on natural and working lands.

a. Develop and implement a PES program for healthy soils and soil carbon sequestration on farms.

   Act 83 of 2019 convened the Payment for Ecosystems Services Working Group whose purpose is to recommend financial incentives designed to encourage farmers in Vermont to implement agricultural practices that improve soil health, enhance crop resilience, increase carbon storage and stormwater storage capacity, and reduce agricultural runoff to waters. Final program recommendations from the PES Working Group are due in January 2023.[7]

b. Develop and implement a PES program for forestland owners including water filtration/cycling, carbon sequestration, etc.

c. Incentivize management for ecosystem services through a tax credit system that compensates landowners/managers for maintaining or restoring ecosystem services.

Preliminary Assessment of Strategy against Criteria
Impact: A PES program – as conceived for Vermont – seeks to leverage Vermont's natural and working lands (NWLs) to deliver ecosystem services on a performance basis that provides cost-effective additionality to Vermont's existing environmental programming. Quantifying whole-farm and whole-parcel management and the entirety of bundled or stacked practices can help provide a fuller picture of ecosystem service benefit Vermont's NWLs can deliver for Vermont's climate goals.

[7] https://agriculture.vermont.gov/pes

Equity: A core consideration for the development of a PES Program in Vermont is how to ensure a program is implemented equitably – should payments be based on annual, incremental environmental benefit, or threshold based with payments above a set additionality. Goals of a PES Program are to be inclusive of the multiple agricultural sectors in Vermont, not just the largest land users and managers.
Cost-effectiveness: Literature suggests that natural and working lands and the application of natural climate solutions (NCS) are cost-effective and immediate contributions to GHG mitigation efforts that can be deployed across land uses at cost-effective rates.[8]
Co-Benefits: The PES Working Group has identified water quality, climate change mitigation, and watershed resilience as the three focus areas for evaluation and payment in a PES program around soil health. Multiple more co-benefits can be quantified through the enhancement of soil health.
Technical Feasibility: Yes

4. **Address upstream waste and downstream emissions from food waste and synthetic fossil-fuel based inputs.**
    a. Develop program for tracking and limiting the use of chemicals, substances, or products that contribute to climate change in Vermont and leverage existing legislative activity on this topic.
        i. VAAFM currently tracks statewide commercial pesticide use as well as statewide fertilizer use. This data is currently used to establish trends in the use of these inputs as our agricultural systems evolve.
        ii. Programs to track these agricultural inputs already exist at VAAFM but have not been assessed through the lens of contributions to climate change. VAAFM or the new newly established Agricultural Innovation Board (AIB) established by Act 49 of 2021 can prioritize an assessment of the impacts and benefits our agronomic management systems have on offsetting climate change.

[8] Drever, C Ronnie et al. "Natural Climate Solutions for Canada." *Science Advances* 7, 1 (June 2021). https://www.science.org/doi/10.1126/sciadv.abd6034.

iii. An assessment of Vermont's different agronomic practices and management, such as, conventional, organic, no-till, and cover cropping, should be weighted for impacts on climate change based on agricultural inputs, fuel consumption, carbon sequestration and other measurable factors.

b. The state should identify simple, low- and no-cost mechanisms to increase organics diversion and provide incentives and business and workforce development to private organics haulers and composters (including farms).

i. Act 41 of 2021 created an Agricultural Residuals Management Program to be administered by VAAFM. The purpose of this new chapter of law is to establish a program for the management of residual wastes generated, imported to, or managed on a farm for farming in Vermont.

Preliminary Assessment of Strategy against Criteria
Impact: Both actions may help to identify and implement further actions and strategies to reduce GHG emissions.
Equity: The AIB includes 13 members named by the General Assembly which represent multiple stakeholders in the process – farmer input is embedded in the process with required farmer surveys in every county to better help understand farm use of inputs.
Cost-effectiveness: Leveraging existing state processes to the extent possible ensures no duplication of efforts and that available resources are targeted for maximal impact.
Co-Benefits: Reduction of external inputs for farming operations can help reduce operating costs and increase farm profitability. Co-benefits for soil health if composting of food residuals and application to cropland is conducted in conformance with state requirements.
Technical Feasibility: Yes

5. **Develop and implement programs which incentivize management practices which maintain or increase forest carbon storage.** Approximately 80% of Vermont's 4.5 million acres of forestland are in private ownership. Private forestland owners in Vermont have the opportunity to take meaningful action towards mitigating the impacts of climate change and

building resiliency in our forests but are generally excluded from traditional carbon markets (and the associated revenue, which could enable these actions) due to the average parcel size and the high up-front cost associated with developing such complex projects. Models which provide for incentive payments to landowners who adopt specific Improved Forest Management practices which measurably enhance carbon sequestration could provide the economic opportunity which is currently missing.

a. Create or adopt existing certification standards where management activities account for principles of Improved Forest Management towards increased carbon storage, as well as maintaining and creating resiliency (as described in existing state guidance such as *Maintaining and Creating Resilient Forests in Vermont: Adapting Forests to Climate Change*, VTFPR 2015, or as modeled in existing programs such as the American Forest Foundation's *Family Forest Carbon Program*).
b. Apply these certification standards to the procurement of forest products utilized in energy or thermal generation facilities subject to PUC oversight (parallel to the existing review for state mapped deer winter yard, etc.) through potential revisions to the renewable energy standard.
c. Explore additional market opportunities for certified products, expanding the potential revenue base to support Improvement Forest Management (parallel FSC, SFI, etc.)

Preliminary Assessment of <u>Strategy</u> against Criteria
Impact: 80% of Vermont's forests are in private ownership. Vermont's forests store over 1.7 billion metric tons (Mt) of CO2 equivalent (CO2e) and sequester (take in) more than 5 million Mt CO2e each year
Equity: Expands opportunity to smaller 'Vermont Scale' forest landowners who would otherwise be excluded from traditional carbon markets; removes significant upfront capital requirements which would otherwise be a barrier
Cost-effectiveness: Potentially allows smaller forestland owners to access climate finance (private capital) from existing markets; leverages market-based incentives for adoption of practices
Co-Benefits: Sustaining all fundamental ecological functions of intact forests

Technical Feasibility: Yes

6. **Leverage market-based solutions, such as existing or new regional carbon market opportunities, to incentivize forest management practices which sequester and store greater amounts of carbon in our forests.** Carbon markets provide a largely untapped opportunity for forestland owners in Vermont. The generation of carbon offset credits can provide a significant revenue stream to forestland owners, increasing capacity for improved management, and the ability to hold and maintain intact forestland. Financially viable projects generally require large (5,000+ acre) ownerships, therefore aggregation for parcels (generally 200+ acres in size) is critical for viability, Aggregation is currently allowed for under existing Voluntary Market standards. These opportunities build on existing incentives and/or provide synergy from multiple stewardship mechanisms. Recent spatial analysis by the Vermont Land Trust and UVM Carbon Dynamics Lab has identified close to 330,000 acres in privately held forest parcels > 500 acres in size which could be eligible for such aggregation opportunities. In terms of conservation priority, these parcels present the greatest opportunity for aggregated carbon projects to contribute to the sustainability and ecological functionality of Vermont's working landscape through the maintenance of these forests and the Improved Forest Management practices employed.
    a. Work to develop a new Vermont based or regional (modeled on RGGI) Carbon Credit marketplace with necessary research and standards which address concerns around the efficacy of baseline establishment, accounting for additionality, the potential for leakage, and address equity for the diversity of wood lot owners across the state
    b. Incentivize the in-state purchase of carbon credits developed by Vermont-based or regional carbon projects through a system which addresses concerns of accounting (i.e., additionality and leakage)

Preliminary Assessment of <u>Strategy</u> against Criteria
Impact: 80% of Vermont's forests are in private ownership. Vermont's forests store over 1.7 billion metric tons (Mt) of CO2 equivalent (CO2e) and sequester (take in) more than 5 million Mt CO2e each year

Equity: Such models could still exclude smaller forest holdings (<200 acres, which could potentially access practice-based payments as described in preceding strategy) but would provide an opportunity for mid-sized forestland owners currently excluded from existing markets.
Cost-effectiveness: Potentially allows smaller forestland owners to access climate finance (private capital) from existing markets; leverages market-based incentives for adoption of practices
Co-Benefits: Sustaining all fundamental ecological functions of intact forests
Technical Feasibility: Yes

7. **Increase tree coverage.** Trees remove carbon dioxide from the atmosphere through the process of photosynthesis and capture that carbon in the form of wood or other organic matter. Trees remain the most efficient and cost-effective form of carbon capture technology at scale presently available.
    a. Expand tree and other planting efforts on private land to promote restoration efforts to reforest riparian areas, wetland buffers, and degraded lands.
    b. Expand funding and support to the Vermont Community Canopy Program.
    c. Provide incentives for restoration and expansion of floodplain forests.
    d. Explore the potential to amend Tier III of the Renewable Energy Standards (RES) to make increased tree planting eligible for funding.
    e. Increase support, funding, and education for increased urban tree planting efforts expansion to increase access to natural spaces and improve carbon sequestration/storage in the urban environment.

Preliminary Assessment of Strategy against Criteria
Impact: Impact is scaled to the degree of increased tree cover; a typical hardwood tree can absorb as much as 48 pounds of carbon dioxide per year, sequestering approximately 1 ton of carbon dioxide by the time it reaches 40 years old
Equity: The financial capacity to support planting efforts presents a potential barrier. Afforestation efforts will need to account for land use changes which impact existing use.

Cost-effectiveness: High
Co-Benefits: Mitigation of heat island effects in urban areas; associated impacts to water quality and landscape scale restoration; wildlife habitat enhancement; aesthetics
Technical Feasibility: Yes

PATHWAY - Energy & Materials: Support and empower Vermont's farmers, foresters, and land workers to capacitate renewable energy and building product transitions

Vermont's farmers, foresters, and land workers can be key actors in harnessing appropriate renewable energy on farms and working lands while protecting those lands, soils, and resources for the valuable multiple benefits they provide from food to biodiversity to clean water. In addition, farmers, foresters, and workers can bring materials from wood to straw to building markets which can reduce the use of high carbon footprint materials like steel and concrete. Overall, the state must track the sustainability of the climate transition to be aware of and mitigate the potential adverse consequences of renewable energy and materials to people and natural resources.

STRATEGIES AND ACTIONS

8. **Educate, track, and appropriately reward on-farm renewable energy**: Farms can be the source of renewable electricity like solar. However, farmers need information about how best to undertake analysis for their farm's potential, what incentives are available for installation, and how to protect valuable farmland, soils, and forests while contributing to renewable energy production.
    a. Reward and support renewables on farms on rooftops, barns, storage facilities, and minimizes or avoids loss of working and natural lands to renewables development.
    b. Increase outreach and incentives to on-farm solar installation on existing built infrastructure.

Preliminary Assessment of Strategy against Criteria
Impact: Can increase distributed, renewable energy sourcing across the state on farms while protecting working lands for other climate purposes.
Equity: Provides for equity among farm sizes to both produce electricity and receive payments for doing so. Directing renewables onto the built part of farms would ensure lands, waters, and soils remain for climate storage, adaptation and resilience.
Cost-effectiveness: Through utilizing such federal grant programs as Rural Energy for American Program (REAP), could lower costs for farmers and makes time to payback to farmers and Vermont achievable.
Co-Benefits: Preserves working lands for other climate benefits; provides additional income stream/cost savings for farmers and foresters that improves their viability and provides more resources for additional climate related practice implementation in land management.
Technical Feasibility: Yes

9. **Promote and incentivize use of local wood and agricultural products to reduce embodied carbon footprint.** Vermont can be an important source of its own and other adjoining states' building materials that can reduce the carbon footprint of construction. Steel and concrete require extensive carbon to produce and create emissions in their production. Materials can include wood, straw, and other materials. See such New England initiatives as Tallhouse at https://generatetechnologies.com/work-tallhouse and relatively recent changes to the Massachusetts' state building code (780 CMR 9th edition), which allows mass timber buildings, including cross-laminated timber.
    a. Promote and incentivize use of agricultural and sustainably harvested wood -based construction materials (subject to existing certification criteria or procurement standards to be developed) over imported wood and/or non-wood materials with high carbon footprints (such as steel, concrete, etc.) Continue to research life-cycle accounting of these products for greatest impact.

b. Through state procurement standards, require that publicly funded building projects use chain of custody certified wood products (MASS timber, cellulose insulation, etc.) that have been harvested under sustainable procurement standards over materials with a higher carbon footprint (such as steel, concrete, etc.). Prioritize locally sourced wood products when possible.
c. Develop a regional certification standard for forestry to validate carbon storage values for forest building products (methodologies supporting supply chain validation for carbon storage are frequently using FSC as a proxy; regional-scale certification standards focused on net carbon benefit are needed for product transparency)
d. Develop alternative markets for non-timber wood, focusing on cellulose insulation, bioplastic composites, or biofuels

Preliminary Assessment of Strategy against Criteria
Impact: Can reduce carbon-intensive building materials in Vermont while increasing local economies providing local materials for local building and construction as well as other products such as bioplastics.
Equity: Provides additional markets for local farmers and foresters. Would need to be designed well to allow small lot owners to participate. However, if not implemented appropriately, could do harm to natural lands, wildlife, and foraging in forests.
Cost-effectiveness: Would require additional manufacturing and industry not currently in place to bring such products to scale. Such an effort would seek to harness market forces and draw on private dollars. Though, certification programs will require costs to create and maintain.
*Co-Benefits: P*rovides additional income to farmers, foresters, and forestry-related businesses to increase their viability while increasing a more locally-driven construction and other products' supply chain.
Technical Feasibility: Yes

10. **Transition fuel sources for the forestry and maple sector.** To also reduce GHG emissions from the forestry and maple sectors, incentives and support can be provided to move to lower carbon fuels for such activities evaporators and vacuum pumps for maple production and biofuels for forest equipment.
    a. Provide funding to incentivize sugar makers to switch evaporators from fossil fuels to wood pellets and incentivize elimination of diesel generators for sap vacuum pumps.
    b. Incentivize alternative fuels such as biofuels or offsets for logging equipment.

Preliminary Assessment of Strategy against Criteria
*Impact: R*educe carbon footprint of local sugar maple industry and logging
Equity: Provides incentives for often small-scale producers and businesses to convert to lower carbon alternatives so they too can have support and be part of the overall transition. Biofuels would need to be assessed for sustainability, further degradation of the land base for biofuels is counter to our goals.
Cost-effectiveness: Requires up front technical support and incentives for change with longer-term benefits of reduced GHG emissions from Vermont enterprises.
*Co-Benefits: P*rovides potential cost-savings and payback to producers over time.
Technical Feasibility: Yes

11. **Sustainably source renewable energy products and materials.** While Vermont will benefit from renewable energy sources and materials produced in Vermont and elsewhere, these sources and materials may also have adverse impacts to air and water quality (e.g., the mining of rare earth metals for batteries), natural lands (the fragmentation of habitat due to wind or solar projects), Indigenous peoples (the harm to sacred sites, traditional hunting and foraging lands from large-scale hydro), and environmental justice populations. Vermont should develop and deploy ways to ensure our efforts to address climate do not pose undue and unintended consequences to nature or people.
    a. Fund competitive research to track and innovate on the sustainability and ethical implications of renewable energy materials and products being consumed to meet the CAP including solar, wind, biomass, energy storage, and recycling of materials.

Preliminary Assessment of Strategy against Criteria
Impact: Over time ensuring that climate choices supported by the State do not create adverse consequences.
Equity: Can provide an important screen for choices that may affect traditionally marginalized populations.
Cost-effectiveness: Requires cost upfront without direct benefit initially but over time can inform and shape transition choices in a more responsible and equitable way.
Co-Benefits: Reduction in harm to air, water, soils, wildlife, and people.
Technical Feasibility: Yes

12. Address the use of biomass for appropriately scaled institutional and residential thermal heat generation for climate mitigation, co-benefits, and impacts while preventing the expansion of biomass for industrial-scale commercial electricity production. [*NOTE: the Ag and Eco subcommittee has not had time to engage with Cross-Sector mitigation on this important but complex topic – on either the substance or whether oversight of certain topics fall within CSM or Ag and Eco's purview - nor sufficient time to research, understand and offer more specific actions on this topic. Please note that Ag and Ecosystem Subcommittee does not have consensus agreement on all recommended actions that follow – some individual actions are opposed by some individual subcommittee members.]*

Definition: As used in this section, "biomass" means material from trees, woody plants, or grasses, including limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, farm, rangeland, or wildland-urban environment that is the product of forest management, land clearing, ecosystem restoration, or hazardous fuel reduction treatment (from Biomass Energy Developing Working Group, Final Report, Vermont Legislative Council, January 2012)

a. Prohibit the expansion of current, and/or construction of any new, large-scale, industrial electric generation biomass facilities in the State of Vermont. Existing facilities shall:
    a. Set GHG emissions reduction targets, to be incorporated into operations license(s).
    b. Remediate negative impacts to surrounding communities, cultural/historical/archeological sites and/or resources, and to the State of the Vermont's residents, air quality, and natural resources.
    c. Source material from within the state of Vermont, ensuring appropriate oversight of harvest activities for all wood products procured for use.
    d. If such facilities operations cannot be sufficiently improved to address the above, then the facilities be closed should and job transition assistance provided to employees.
    e. Expansion is defined as an increase in the physical footprint, emissions, or any increased impact on adjacent communities and natural and cultural resources. Improvements without expansion may include changes that result in increased efficiency with no increase in footprint, reductions in GHG emissions, other air pollutants or impacts to the community.
b. Utilize existing research (*such as Buchholz, T., Gunn, J.S. and Saah, D.S., 2017. Greenhouse gas emissions of local wood pellet heat from northeastern US forests. Energy, 141, pp.483-491*) to inform if and under what conditions biomass in institutional or residential applications for thermal or combined heat/power applications could provide for a transition away from fossil fuel use, reduce GHG emissions, and have not net impact on Vermont's forests for storage and sequestration.
c. The following GHG impacts should be accounted for when developing policy and/or associated regulations for biomass:
    a. all greenhouse gas emissions associated with producing the fuel (including extraction or harvesting, manufacturing, or processing, transportation)
    b. greenhouse gases emitted by the fuel when used
    c. efficiency of the heat generation system being used
    d. carbon stocks in the forest

d. The following considerations should be accounted for if permitting any new pellet producing facility(s) in the state:
    a. Pellet production must be from combined sawmill residue (i.e., sawdust) or other byproducts of forest product manufacturing (i.e., cants, bark, etc.) and biomass—generally produced as a byproduct of harvesting associated forest products. Sourcing criteria should be established restricting biomass to a maximum percentage that is effectively monitored and enforced [*see Buchholz, Gunn, Saah in* Energy, *December 2017*].
    b. Monitoring and enforcement must ensure that harvest levels are maintained, with no net increase resulting in an increased demand for pellet fiber (increased demand in pellet fiber is offset by reductions in other markets); shifting existing harvest of pulpwood volume to pellets. Procurement standards ensuring sustainable forest management which protect ecosystem integrity should be developed, applied, and monitored
e. Regulate, including preventing, if necessary, flow of wood pellets or similar commercial scale wood-derived energy products based on research in "b" above to ensure sustainable harvesting of "net GHG-reducing" pellets (i.e., composition, source wood, etc.).
f. In addition, develop a program of education and outreach, as well as technical assistance, to encourage appropriate methods and practices when using wood heat, while also ensuring oversight and regulation of those appropriate methods and practices.

Preliminary Assessment of Strategy against Criteria
Impact: Through research and appropriate oversight and management, seeks to ensure that biomass for thermal heat is sustainable and reduces GHG emissions.
Equity: Prevents expansion of industrial-scale biomass for electricity's adverse and inequitable impacts to people and land and provides clear guidelines for biomass for thermal heat in Vermont. Strategies utilizing biomass for energy will also be inequitable to the land and other natural resources unless it is implemented in a specific, regulated, and enforced manner regarding both emissions and source wood impacts.

Cost-effectiveness: Through conducting research and improving regulation and oversight, as this strategy intends, if implemented appropriately, can ensure biomass for thermal heat in Vermont is utilized in a healthy and viable way. The intent is to utilize biomass without unintended and adverse consequences, including costs to people, air, land, and climate.
Co-Benefits: Carefully managed biomass may help sustain natural lands for a host of storage, sequestration, and resilience purposes, provide a means of affordable heat to Vermonters, and provide income to Vermont's forestry sector.
Technical Feasibility: Yes

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