DRAFT

Proposed Strategy Framework for the Maine Climate Action Plan

September 4, 2020

Important notes on this draft framework:

This draft framework represents a first draft version of a two-part document to be presented to the Maine Climate Council by staff that includes the recommendations proposed by the six Maine Climate Council working groups in summary form and incorporated into consolidated strategies.

The Maine Climate Council members have not yet taken a position on the draft proposed strategies and framework (and ultimately the Action Plan) which will continue to be refined, clarified, and shaped by the Council process. Public comment in written form will continue to be accepted by the Maine Climate Council through September 24, 2020, for consideration prior to final climate council decision making. The final four-year Maine Climate Action Plan is due to be submitted to the Governor and Legislature on December 1, 2020.

Table of Contents

Introduction

This draft framework organizes the draft climate actions under consideration by the Maine Climate Council for the state's climate action plan. These draft actions were recommended by the six working groups—(1)Transportation; (2)Buildings, Infrastructure and Housing; (3)Energy; (4)Community Resilience, Emergency Management and Public Health; (5)Coastal and Marine; and (6)Natural and Working Lands—and were presented to the Climate Council at the June 2020 meeting.

The draft strategy framework also references several additional analyses conducted over the last several months. First is an evaluation of the costs and benefits of the various recommended strategies. *Assessing the Impacts Climate Change May Have on the State's Economy, Revenues, and Investment Decisions*, an analysis by Eastern Research Group and Synapse Energy Economics, includes 4 volumes:

- Volume 1, Vulnerability Mapping: A mapping analysis that identifies vulnerable communities, geographies, and economic sectors.
- Volume 2, Cost of Doing Nothing Analysis: Estimates of losses that the State of Maine and its citizens could incur if the State does not take action to prevent or prepare for climate change. The cost of not adapting to a changing climate is large and will accelerate over time, with flooding serving as the largest overall threat.
- Volume 3, Maine Emissions Analysis: An energy use and emissions baseline based on current state and regional policies, as well as an assessment of options for meeting Maine's energy needs (and allowing economic growth) while reducing greenhouse gas emissions.
- Volume 4, Economic Analyses of Adaptation and Mitigation Strategies: Economic analyses to provide context for the majority of the adaptation and mitigation strategies developed by the Maine Climate Council.

Second is a summary of the public input surveys conducted over the summer. More than 4,400 individuals provided input through feedback survey on the website, climatecouncil.maine.gov. Members of the public were invited to learn about the impacts of climate change on the State, read the strategies recommended by the working groups, and provide feedback through a series of short surveys. Numerous organizations helped amplify the message, and staff conducted more than twenty outreach presentations this summer. Residents from more than two-thirds of Maine communities submitted comments. The public input survey effort built on the stakeholder engagement conducted as part of working group process to develop the draft recommendations which was conducted via public meetings, calls, surveys, and individual and organizational input.

Third, the framework references the executive summary of the draft report, *Strengthening Maine's Clean Energy Economy*, which will be released in mid-September by the Governor's Energy Office and the Governor's Office of Policy Innovation and the Future. This plan will

identify pathways and strategies for the advancement of Maine's clean energy economy that includes the development and sustained operations of renewable energy resources and energy efficiency services.

Finally, the report *Assessing the Potential Equity Outcomes of Maine's Climate Action Plan: Framework, Analysis and Recommendations*, an analysis by the University of Maine's Senator George J. Mitchell Center for Sustainability Solutions, is currently being finalized and will be shared with the Climate Council in the coming weeks. The report analyzes how the draft strategies ensure the equitable distribution of the benefits of climate protection efforts, and address inequitable burdens created by climate change and the policies designed to alleviate it.

The Climate Council will meet from September until November to consider and prioritize strategies for the four-year climate action plan, which is due to the Governor and the Legislature on December 1, 2020.

Maine's Climate Goals

Maine has adopted some of the country's most ambitious climate and energy goals. Maine's climate vision and policy envisions achieving our climate goals while creating jobs and growing a more diverse, sustainable economy.

Investing in renewable energy and energy efficiency can create the good-paying jobs of Maine's future, from solar and heat pump installers to engineers and contractors designing and building the offshore wind farms of the future. The steps we take now to prepare and protect our communities, people, and businesses from the impacts of climate change will create jobs and save money in the long-term. These actions will improve public health and protect our environment. The benefits from our climate strategies must benefit all Mainers equitably.

Goal 1: Create jobs and economic opportunity

The draft report, *Strengthening Maine's Clean Energy Economy* finds that the State of Maine is poised to significantly grow and expand its clean energy economy. Research shows that 41 states including Maine have reduced their energy-related carbon dioxide emissions while increasing gross domestic product (GDP).

"Innovative developments and the use of forest products and biofuels in the energy sector provide unique opportunities for Maine, particularly in the rural areas of the State. Energy efficiency investments and programming have already proven greatly successful throughout Maine, with integration across the State to reduce energy consumption and provide energy cost savings to Maine consumers. Simultaneously, Maine is facing an economic downturn and related challenges as a result of the COVID-19 pandemic. As Maine charts the course for economic recovery, clean energy should be a key component of economic development as it creates good paying, long-term jobs, spurs economic growth, all while helping to reduce the State's climate impacts."

Our strategies to prepare Maine communities for climate change impacts can also create new economic opportunity for Maine. We know that because of climate change, we are going to experience more frequent severe storms and flooding of our streams and rivers. Sea level increases will cause more frequent coastal flooding. Maine currently has a backlog of state and municipal projects designed to reduce flood and other hazard risks to community, business and transportation infrastructure. Investments in climate-ready infrastructure like working waterfronts, roads and bridges, and water treatment systems, will create good paying jobs while making our communities more proactively resilient against future climate impacts and potentially reduce future expenditures on climate response measures.

Goal 2: Reduce Maine's greenhouse gas emissions

Maine's Climate Action Plan must put us on a trajectory to reduce greenhouse gas emissions by 45% by 2030 and at least 80% by 2050. Reducing Maine's emissions is core to our State's effort to contribute meaningfully to national and international efforts to slow emissions, and as a result, to slow global climate change. Human activities have already caused approximately 1.0°C (1.8°F) of warming globally (IPCC, 2018), with Maine warming 3.2°F since 1895. If global climate warming is kept at or below 1.5°C (2.7°F) above the pre-industrial average, climate-related risks to humans and natural environments are lower than at 2°C of warming or above. Maine has committed to scientifically rigorous emissions reductions goals recommended by the Intergovernmental Panel on Climate Change to help keep global climate change within the warming level of 1.5°C and do our part to reduce the effects of climate change.

In addition to greenhouse gas emission reduction goals, Maine has committed to a goal of reaching carbon neutrality by 2045. Our working forests, farmlands, and natural areas, including wetlands, are already storing carbon long-term, and they could store more, while continuing to provide critical economic, recreation, habitat and drinking water protection benefits. Balancing reducing emissions and increased carbon storage (sequestration) will allow Maine to reach of goal of sequestering at least as much carbon as our State emits.

Goal 3: Prepare Maine residents, businesses and communities for climate change impacts

From increasing land and ocean temperatures, to rising sea levels, more frequent severe storms, increased environmental damage, and public health risks, Maine scientists have catalogued the significant effects of rising greenhouse gases and climate change on our State.

Maine's Climate Action Plan must ensure Maine people, environment, industries, and communities are more resilient to the impacts of climate change. These efforts should include supporting transitions for communities, businesses, families and workers who will be most impacted by climate impacts. And it should support both planning and adaptation to help Maine's communities and people better withstand the current and future impacts of climate change.

Goal 4: Ensure that Maine's climate strategies are equitable

Maine's climate strategies can help address inequities that are exacerbated by the effects of climate change. We must ensure that we protect our most vulnerable communities from the impacts of climate change, and that all Mainers benefit from the economic, quality of life, and public health benefits of our climate strategies. This includes engaging diverse groups of Maine people and communities in the development and implementation of effective climate solutions, especially those most impacted.

Proposed Climate Strategy Framework

The following sections present six proposed strategies to achieve Maine's climate and energy goals. They are:

Part 1: Reduce Maine's Greenhouse Gas Emissions

A. Bring the Future of Transportation to Maine
B. Modernize Maine's Buildings: Energy Efficient, Smart and Cost-Effective Homes and Businesses
C. Drive Innovation to Reduce Carbon Emissions in Maine's Energy and Industrial Sectors

Part 2: Prepare for Climate Change Impacts

D. Build Healthy and Resilient Communities
E. Invest in Climate-Ready Infrastructure
F. Protect Maine's Environments and Natural Resource Economies and Promote Natural Climate Solutions

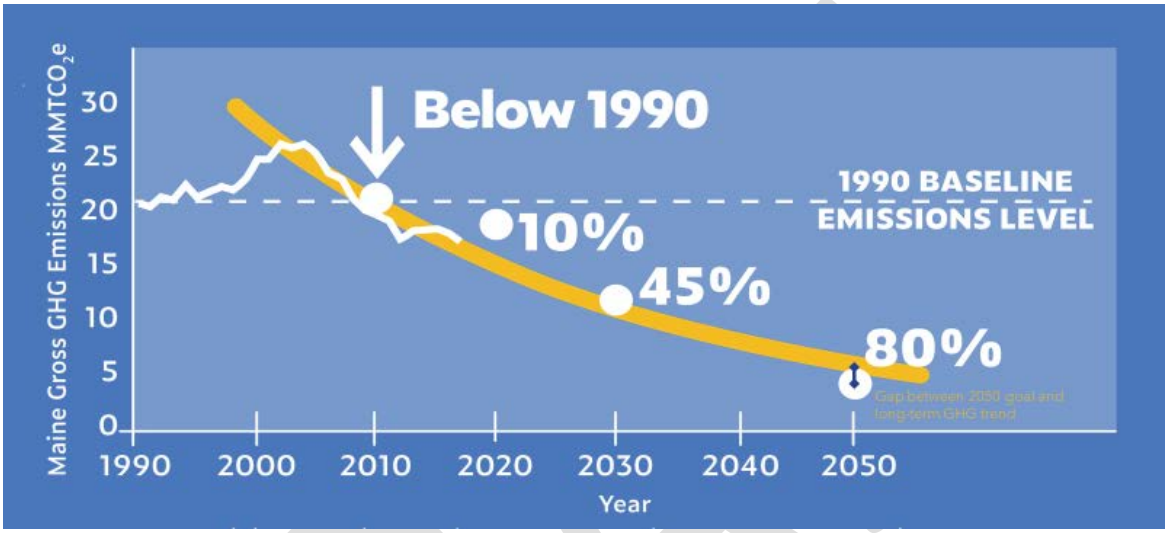
The actions recommended within each of the proposed strategies include cost-benefit considerations from the Cost-Benefit and Modeling Analysis conducted by the Maine Climate Council consultants Eastern Research Group and a summary of the feedback from the public surveys conducted by the Governor's Office of Policy Innovation and the Future during the summer of 2020. They also refer to the impacts of climate change described in the *Scientific Assessment of Climate Change and Its Effects in Maine,* from the Maine Climate Council's Scientific and Technical Subcommittee. These reports as well as the June 2020 Working Group reports are available at https://www.maine.gov/future/initiatives/climate/climate-council/reports.

Part 1: Reduce Maine's Greenhouse Gas Emissions

Maine must reduce our greenhouse gas emissions by 45% by 2030 and at least 80% by 2050, as required by law. By Executive Order, the State must also achieve carbon neutrality by 2045.

While Maine has made progress in reducing its gross greenhouse gas emissions since 1990, there is still significant work to be done to create a pathway to reach 2030 and 2050 goals.

Figure 1: Maine's Greenhouse Gas Emissions



In Maine, most greenhouse emissions come from transportation, followed by residential, commercial, and industrial sectors.

Maine can meet our greenhouse gas emissions reduction goals through a combination of transportation, buildings and energy sector strategies. Many strategies can provide a cost benefit in the short- or long-term. The table below provides examples of proposed strategies to reduce Maine's greenhouse gas emissions, with the most cost-effective strategies in the top

rows. Consideration of strategies that have the highest cost-effectiveness first will be key, although a variety of strategies will be required to meet emissions reductions targets.

Table 1. Cost-Effectiveness of Strategies to Reduce or Sequester Carbon

Greenhouse Gas Reduction or Sequestration Strategy	Cost-Effectiveness to Reduce or Sequester Carbon Dioxide
• Building codes focused on energy efficiency • Geothermal heat and cooling for buildings • Heat pumps and heat pump water heaters • Building weatherization • A potentially well-crafted work from home policy	**Highest cost-effectiveness:** These strategies have cost savings over their lifetimes and CO_2 reduction
• Electric vehicle adoption • Renewable energy adoption	**Very cost-effective, with potential for cost savings** over time with mass production
• Preserving natural working lands to sequester carbon	**Very cost-effective:** about \$4–\$20 per metric ton of CO_2 sequestered
• Methane to energy projects	**Medium cost-effectiveness:** about \$100–\$200 per metric ton of CO_2 reduced
• Vehicle miles traveled fee/fuel tax	**Lower cost-effectiveness:** about \$250–\$750 per metric ton of CO_2 reduced
• Restoring marsh and eelgrass to sequester carbon	**Less cost-effective:** more than \$1,000 per metric ton of CO_2 reduced (but can provide other value in flood protection and to commercial fisheries)

Greenhouse gas modeling demonstrates the strategies that will be needed to achieve Maine's emissions goals. In an analysis of the sustained policy baseline emissions scenario, in which current policies continue, Maine's total emissions in 2050 are 13.8 million metric tons, which is 9.6 million metric tons above the 2050 goal.

An analysis of the strategies proposed to reduce emissions from Maine's transportation and heating sectors finds that Maine's emissions are projected to decline through 2050. Under this "proposed strategies" scenario, Maine's total emissions are 13.9 million metric tons, which is 2.3 million metric tons in 2030 above the 2030 target. By 2050, Maine's total emissions are 7.3 million metric tons, which is still 3 million metric tons above the 2050 target. This suggests the proposed strategies make significant progress toward the required reductions, but are not fully sufficient based on current modeling scenarios.

The proposed strategies modeled in the scenarios (based on the working group proposals) include:

- By 2030, 16 percent of light-duty vehicles and 25 percent of heavy-duty vehicles are electric.
- By 2050, 90 percent of light-duty vehicles and 80 percent of heavy-duty vehicles are electric.

- By 2030, 32 percent of households have heat and hot water pumps; 14% of commercial heat is electrified.
- By 2050, 90 percent households adopt heat pumps for space and water heating; 90% of commercial heat is electrified.

Figure 2: Sustained Baseline Emissions

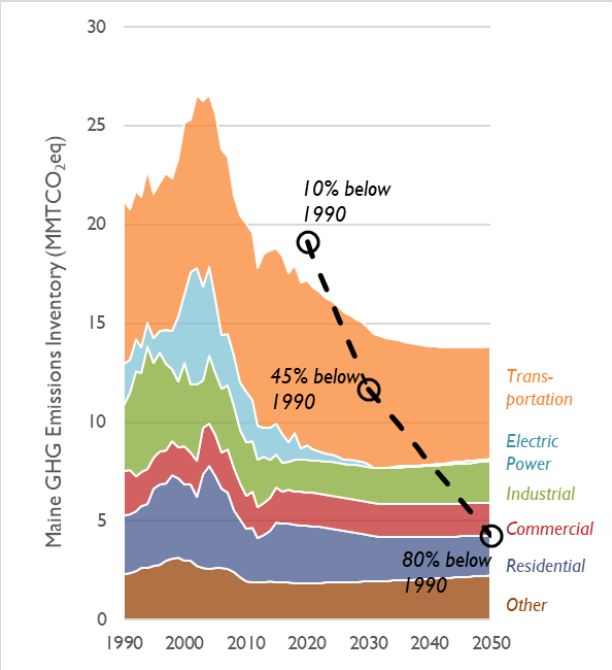
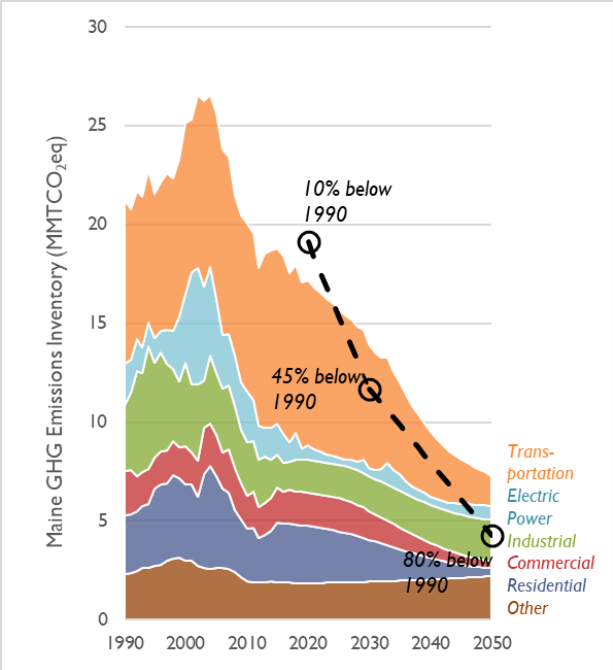


Figure 3: Proposed Transportation and Heating Strategy Emissions



Greenhouse Gas Modeling Parameters

	2030 Emissions Under the Bold Strategies Model	2050 Emissions Under the Bold Strategies Model	2050 Emissions Under the Business as Usual Model
Light duty vehicles	16% are electric	90% are electric	11% are electric
Heavy duty EVs	25% are electric	80% are electric	0% are electric
Vehicle Miles Traveled (VMT)	Remains constant	Remains constant	Remains constant
Fuel Efficiency		42 mpg for new cars; 30 mpg for new light trucks	42 mpg for new cars; 30 mpg for new light trucks
Managed EV charging	yes	yes	no
Weatherization	2.2% residential energy reduction through weatherization	2.2% residential energy reduction through weatherization	2.2% residential energy reduction through weatherization
Heat pumps	32% of households have heat pumps; 14% of commercial heat is electrified	90% of households have heat pumps and 90% of commercial heat is electrified	41% of households have heat pumps

A. Bring the Future of Transportation to Maine

Transportation is responsible for 54 percent of Maine's greenhouse gas emissions—the most of any sector. As emissions in other areas declined in recent decades, transportation-related emissions increased, up from 44 percent in 1990. Major changes must be made within the transportation sector for Maine to reach its emissions reduction goals by 2030 and 2050.

When broken down by type of vehicle, Maine's transportation-related emissions are:

- 59 percent from light-duty passenger cars and trucks
- 27 percent from medium and heavy-duty trucks
- 14 percent from rail, marine, aviation, and utility equipment.

Maine's rural character and moderate emissions from other sectors also makes our transportation emissions disproportionately high compared to other states. The average Maine vehicle travels approximately 12,000 miles per year. An analysis of "Vehicle Miles Driven" in Maine has found that 65 percent of our driving occurs in rural areas, with 35 percent in urban and suburban regions. Most of these miles are driven in the southern half of the State. In addition to the emissions from Maine vehicles, Maine's transportation emissions also include the emissions from 37 million visitors per year (2018, Maine Office of Tourism).

Emissions reduction is possible in Maine's transportation sector through large-scale electrification of Maine's transportation system, combined with strategies to reduce the number of miles Mainers drive like expanding telework and teleservice opportunities, expanding public transportation, and supporting development in priority areas, and strategies to increase the efficiency of the existing gas- and diesel-powered vehicles. In addition to reduced carbon dioxide emissions to achieve Maine's emission reduction goals, there are also major health benefits associated with cleaner air from reduced nitrogen oxides, sulfur dioxide, and particulate matter.

The transition to a lower emission transportation sector will have positive impacts but it does not come without a cost. The State must explore mechanisms to fund current transportation needs along with strategies that facilitate emission reduction within the transportation sector.

The following actions are proposed to reduce greenhouse gas emissions from Maine's transportation sector:

1) Increase electric vehicle (EV) use;
2) Reduce emissions from current gas and diesel engines;
3) Reduce Vehicle Miles Traveled (VMT); and
4) Explore funding options for transportation needs & emissions reductions.

Action 1: Increase electric vehicle (EV) use.

- ***Provide equitable incentives and grants that encourage voluntary expansion of electrification.***
- ***Design a comprehensive and consistent approach to expand EV charging infrastructure (EV Roadmap).***

Expanding the electrification of light-duty vehicles to between 50-90% and heavy-duty vehicles to 55-80% of the total fleet by 2050 would achieve substantial greenhouse gas emissions reductions.

EVs emit significantly less greenhouse gas emissions per mile compared to gas or diesel vehicles, but battery electric vehicles account for less than 0.5 percent of registered vehicles in Maine. While EV sales may increase gradually with improvements to EV features, infrastructure and consumer preference, it will not be enough to meet Maine's emission reduction goals.

A typical gasoline vehicle emits more than 5 tons of carbon dioxide per year. This is more than four times the amount of carbon emissions of an electric vehicle (EV) that is powered by electricity from the current New England electrical grid. As the grid gets cleaner, driving EVs will result in fewer emissions.

To encourage the adoption of EVs across the State, Mainers need a reliable and robust charging infrastructure system and incentives to support EV purchases, especially for lower-income and rural residents. A comprehensive EV expansion study and plan that considers existing efforts, anticipates future needs, and prioritizes coordinated actions would ensure the charging infrastructure is designed and built properly, while creating jobs needed for this infrastructure expansion.

<u>Cost-Benefit Analysis</u>

A major benefit of transportation electrification is reduced carbon dioxide (CO_2) emissions, which will help Maine achieve its 2030, 2045, and 2050 goals. As Maine's electric grid becomes cleaner, this will further reduce emissions. Major health benefits and reductions in healthcare costs are associated with cleaner air from reduced NO_x, SO_2, and particulate matter as electric vehicles do not emit tailpipe emissions. The negative health burdens of air pollution disproportionately fall on disadvantaged communities and have outsized consequences for the most vulnerable populations.

Battery electric vehicles tend to cost more than conventional internal combustion engine vehicles and may require the purchase of an at-home charging station. However, the annual costs for charging the vehicle are lower than the annual costs for fueling conventional vehicles. Maintenance costs for electric vehicles are also significantly lower than those for conventional vehicles.

With no subsidy, a consumer would pay about $1,868 more to purchase an electric light-duty vehicle over 10 years in 2030. Therefore, a $2,000 subsidy would allow a customer to break even over 10 years. By 2050, however, an electric vehicle owner is projected to break even in less than five years with no subsidy.

If Maine were to provide a $2,000 incentive for all light-duty vehicles and a $20,000 incentive for all heavy-duty vehicles purchased in 2030, the cost would be approximately $82 million per year; the benefit would be $130 million per year, when improved health from reduced nitrogen oxides, sulfur dioxide, particulate matter, and the social cost of carbon are included. This becomes a benefit-cost ratio of about 1.6 to 1, not including benefits to individual buyers.

By 2050, each electric vehicle owner would also accrue a net benefit of $2,609 (light-duty vehicle) or $8,315 (heavy-duty vehicle) for 10 years of ownership over owning a conventional vehicle. At that time the State purchase incentives would no longer be needed.

Maine is currently offering rebates for eligible battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) through funding from the settlement against Volkswagen® for violating Maine's environmental protection laws. The rebates ($2,000 for a battery electric vehicle) are higher for low-income Maine residents ($3,000).

Public Input Survey

Increasing electric vehicle use was among the most favorable of the strategies put forward by the Transportation Working Group, with just over 82% of respondents indicating it is either a "great fit" or "good fit" for their community. However, many respondents also expressed concern about the viability of EVs for residents of rural areas of the State.

For more information on this action, see the Transportation Work Group's Strategy #1.

***Action 2: Reduce emissions from current gas and diesel engines*.**

- ***Encourage Freight Companies to Voluntarily Participate in the US Environmental Protection's (EPA) SmartWay Program to improve freight transportation efficiency.***
- ***Expand Alternative Fuels such as locally produced renewable biofuels and biodiesels from used vegetable oils.***

Maine is currently reliant on internal combustion engines for most of its access and mobility needs. While Mainers are transitioning to more electric vehicles, we will need to reduce the emissions of our existing internal combustion engine fleet. If up to 20% of Maine's light- and heavy-duty vehicles used low carbon fuels and fuel efficiency reached 45% for light duty vehicles and 33% for heavy duty vehicles by 2050, respectively, the State could achieve emission reduction goals with less aggressive vehicle fleet electrification. For reference, low carbon fuels are lower in carbon intensity and include reductions not only in tailpipe emissions

but also all other associated emissions from production, distribution and transportation of the fuel

The National Highway Traffic Safety Administration (NHTSA)'s Corporate Average Fuel Economy (CAFE) standards regulate how many miles vehicles must travel on one gallon of fuel. Emissions are projected to decline due to improvements in fuel efficiency required by CAFE standards. However, the recent rollback of federal CAFE standards could slow emissions reductions.

EPA's SmartWay program helps improve freight efficiency and save money with new technologies such as aerodynamic design, low resistance tires, and reduced idling. Participation could be encouraged using loans, grants, or incentives for efficiency technologies, by ensuring technology is available, and by recognizing excellence within the program.

Biofuels, such as biodiesel, emit less carbon when burned than petroleum-based diesel. These alternative fuels can be used instead of petroleum-based fuels to reduce emissions. Operational logistics of producing biofuels and lack of distributors in the State continue to be a concern. However, there is an economic opportunity for production in the State to meet an increased demand for biofuels.

Cost-Benefit Analysis

A cost-benefit analysis was not conducted for this strategy.

Public Input Survey

Reducing emissions from gas and diesel engines was the most favored strategy put forward by the Transportation Working Group, with nearly 83 percent of survey respondents deeming it a either a "great fit" or "good fit" for their community.

For more information on this action, see the Transportation Work Group's Strategy #2.

Action 3: Reduce Vehicle Miles Traveled (VMT).

- ***Expand telework and teleservice opportunities.***
- ***Expand public transportation.***
- ***Support development in priority areas.***

Enabling Mainers and tourists to drive less will reduce our greenhouse gas emissions. Reducing the miles traveled by 27-40% for light-duty vehicles and 4.2% for heavy-duty vehicles by 2050 would result in a decrease of greenhouse gas emissions state-wide and allow the State to achieve emission reduction goals with less aggressive vehicle fleet electrification. It would also significantly reduce demand on the electrical grid. (See Figure 5 in the Transportation modeling results, below).

Miles traveled can be reduced by expanding remote services including remote work, medicine, education, and other opportunities to allow people to access those services without driving to get there. The expansion of broadband internet access would allow for more people to take advantage of these services. This action is especially of interest given the current COVID-19 pandemic and extensive recent local experiences with telecommuting. Expanding broadband is also a key recommendation in the State's 10-year economic strategy and was one of the top priorities identified by the Economic Recovery Committee to stabilize Maine's economy against the economic damage COVID-19 has caused. In July 2020, Maine passed a $15 million bond to invest in high-speed internet infrastructure for unserved and underserved areas. Earlier this year, the USDA Rural Development awarded $10 million in federal grants and loans to improve rural internet access in Maine.

It is estimated that $600 million in funds is needed to provide high speed internet access to the majority of Maine communities and people (Economic Recovery Committee Report).

Expanding public transportation and ride-sharing programs, including GO MAINE and creative public transportation options in rural areas, can replace drive-alone trips and reduce household vehicle costs. Maine currently spends just 86 cents per capita on public transportation, which is substantially lower than the national median of $5 per capita. For comparison, Vermont spends $12 per capita, while neighboring New Hampshire spends 95 cents. Funding for public transit needs to be expanded in order to make the necessary improvements to increase participation.

Transportation emissions are also reduced when the places people need to go are located near each other (e.g., rural crossroads, in village areas, neighborhoods and urban centers). This facilitates walking and biking, and also supports the operation of efficient public transportation and sharing rides to nearby common destinations. In addition to the emission reduction impacts, this would reduce the cost burden of building and maintaining private and public infrastructure and help Maine's significant senior population age in place. Supporting development in these areas would require effective local, regional, and state land use policies. It could also include encouraging state capital investments such as affordable housing, schools, and state buildings, and safe pedestrian and bicycling infrastructure in places where people live, work and play.

Cost-Benefit Analysis

Reducing the number of miles that vehicles travel would allow the State to hit emission reduction targets with less aggressive electrification targets and demand on the electrical grid.

Due to COVID, the State of Maine transitioned nearly 87 percent of the non-public safety workforce to remote work earlier this year. A mileage analysis using data from a survey of 6,850 state workers found that 934,000 commuting miles were saved each week from May compared to February due to the significant increase in working from home. For state employees alone, this is equal to 38,000 gallons of fuel saved, and 200,000 pounds of carbon emissions reduced each week.

The expansion of public transportation that is easily accessible and climate-friendly as well as expansion of remote service opportunities would result in additional benefits related to air quality, health, cost savings, and safety. Increased telework opportunities will also reduce travel fuel costs and time spent traveling to and from work. Easier access to critical destinations will reduce travel fuel costs and promote more active means of travel, such as bicycling.

National data suggests that commuting by bus results in lower CO_2 emissions than commuting by private vehicle, and Bus Rapid Transit (BRT) systems have even lower emissions. Bus rapid transit (with 40 FT compressed natural gas buses) produces approximately 1/6 the emissions of a personal vehicle and 1/5 the emissions of an existing bus; if a bus rapid transit system were to be installed, it would result in a reduction of over 650,000 metric tons of CO_2 over 20 years.

Public Input Survey

Enhanced public transportation was viewed favorably, with 77 percent of respondents deeming it either a "great fit" or "good fit" for their community. Respondents highlighted congested tourist routes (Acadia) and commuter routes (I-295) as important focus areas. Many respondents highlighted biking and walking infrastructure and passenger rail as alternative transportation modes that should be encouraged. Broadband expansion to facilitate telework and reduce driving was also supported throughout respondent comments.

For more information on this action, see the Transportation Work Group's Strategy #3.

Action 4: Explore funding options for transportation needs & emissions reductions.

Maine's transportation infrastructure is chronically underfunded and facing a significant backlog of urgently needed projects from roads and bridges to rails and public transportation. The recent 129th Legislative Session (2019-2020) convened the bipartisan "Blue Ribbon Commission to Study Funding Solutions" which found the State had an annual transportation shortfall of $232 million, or only enough funds to cover about 57% below what is needed for the capital budget. The Commission considered several different mechanisms to generate the additional revenue needed, including a gas tax increase of no more than 9 cents per gallon, as well as other potential funding sources, but the group was unable to agree upon unanimous recommendations to fund transportation.

The Transportation and Climate Initiative (TCI) is a potential northeast regional initiative to implement a cap, trade and invest system to reduce transportation emissions. TCI is modeled after the Regional Greenhouse Gas Initiative (RGGI) that was formed to reduce CO_2 from the energy sector. In TCI's model, fuel suppliers must purchase allowances for each ton of carbon produced by the gas and diesel they sell. The fuel suppliers may pass on the cost of these allowances to consumers buying gasoline and diesel fuel. Participating states can then invest the allowance proceeds in strategies to reduce pollution and improve access to local transportation options; TCI allows each state to determine how to invest its proceeds. Currently TCI is working to release a *Memorandum of Understanding* for the member states. Details are

yet to be publicly released and may not be released until later in 2020. Maine is currently monitoring this initiative.

Maine must continue to explore different revenue sources for stable, sufficient, and sustainable funding for both its current and future transportation infrastructure needs. New transportation funding solutions should also support the State's efforts to reduce greenhouse gas emissions strategies. This action recommends continued progress on funding solutions that will support current Department of Transportation (DOT) needs and climate transportation goals like electric vehicle, pedestrian and bicycle infrastructure and public transportation.

Cost-Benefit Analysis

The analysis of the costs and benefits of transportation funding mechanism included a fuel tax increase fee based on vehicle miles traveled, a carbon tax, and carbon allowances under the Transportation and Climate Initiative.

All mechanisms resulted in reduced emissions. The reduction of other air pollutants like PM2.5, SO_2, and NO_x is a co-benefit of these proposed funding mechanisms. Each mechanism will require further consideration.

Public Input Survey

In general, survey respondents offered a variety of suggestions for funding transportation needs and emissions reductions, including support for TCI, but also a concern for how transportation funding would be shared with rural areas.

For more information on this action, see the Transportation Work Group's Strategy #5.

Greenhouse Gas Modeling of Proposed Transportation Actions

Figure 4 presents the results of the greenhouse gas modeling for three alternative transportation sector scenarios, described in Figure 6. The baseline scenario includes very low electrification rates and current national Corporate Average Fuel Economy (CAFE) standards for fuel efficiency. The alternative scenarios included varying degrees of electrification of the vehicle fleet, reductions in vehicle miles traveled, light duty vehicle fuel economy improvements, and displacement of gasoline and diesel fuels with low-carbon fuels.

- Scenario T1 includes high rates of electrification, but vehicle miles traveled (VMT) remains the same as today.
- Scenario T2 also includes high rates of electrification, as well as decreases in vehicles miles traveled and higher fuel efficiency.
- Scenario T3 includes lower rates of electrification, and more significant decreases in vehicle miles traveled.

Baseline emissions are projected to decline due to improvements in fuel efficiency required by CAFE standards, although the recent rollback of the standards could slow emissions reductions. The T1, T2, and T3 scenarios result in emissions reductions between 2020 and 2050 of 82%, 84%, and 82%, respectively. The impacts of reduced VMT and increased fuel efficiency in the T2 scenario have a larger impact in the earlier years when fewer EVs are on the road; by 2050, the impact is smaller because most vehicles are electric. T3 results in greater emissions reductions through 2030 due to its more ambitious VMT reduction target.

Figure 4: Transportation Sector Greenhouse Gas Emissions Modeling

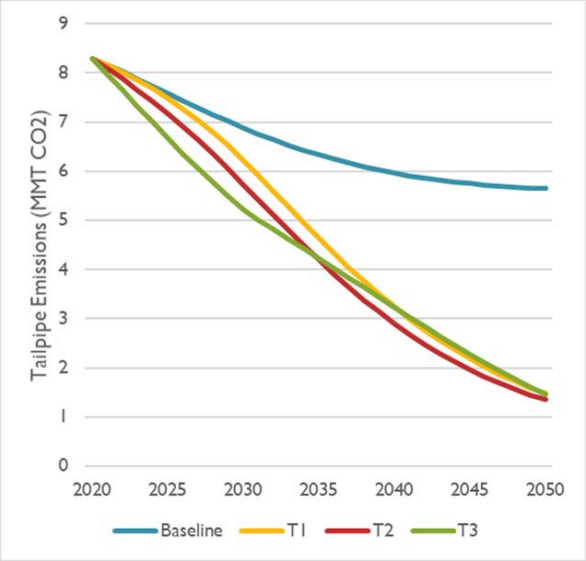


Figure 5: Transportation Sector Electricity Demand Modeling

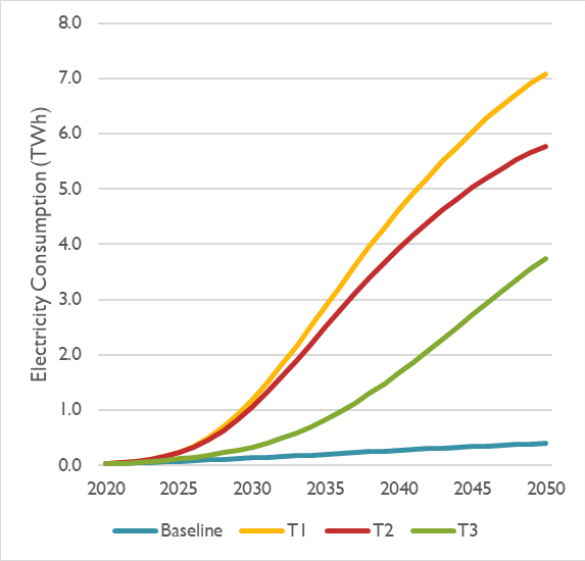


Figure 6: Transportation Scenarios

Baseline	T1	T2	T3
Worst case electrification—CAFE standards remain	**Electrification—baseline efficiency**	**Electrification—aggressive efficiency**	**Reduced electrification—extreme efficiency and low carbon fuels**
• 11% of LDVs are electric by 2050 • 0% of HDVs are electric by 2050 • VMT per LDV remains constant through 2050 • VMT per HDV remains constant • Fuel efficiency reaches 42 MPG for new cars and 30 MPG for new light trucks by 2050	• 90% of LDVs are electric by 2050 • 80% of HDVs are electric by 2050 • VMT per LDV remains constant through 2050 • VMT per HDV remains constant • Fuel efficiency reaches 42 MPG for new cars and 30 MPG for new light trucks by 2050 • Managed EV charging	• 90% of LDVs are electric by 2050 • 80% of HDVs are electric by 2050 • VMT per LDV declines 12.1% by 2030 and 27.2% by 2050 • VMT per HDV declines 2.1% by 2030 and 4.2% by 2050 • Fuel efficiency reaches 45 MPG for new cars and 33 MPG for new light trucks by 2050 • Managed EV charging	• 65% of LDVs are electric by 2050 • 55% of HDVs are electric by 2050 • VMT per LDV declines 25% by 2030 and 40% by 2050 • VMT per HDV declines 2.1% by 2030 and 4.2% by 2050 • Fuel efficiency reaches 45 MPG for new cars and 33 MPG for new light trucks by 2050 • Managed EV charging • 20% of LDVs use low carbon fuels • 20% of HDVs use low carbon fuels

B. Modernize Maine's Buildings: Energy Efficient, Smart and Cost-Effective Homes and Businesses

Heating, cooling and lighting of buildings is responsible for 30 percent of Maine's greenhouse gas emissions. Residential homes emit 19 percent of Maine's emissions; commercial buildings 11 percent. Greenhouse gas emissions in Maine homes and businesses come primarily from the energy used for space heating and cooling, water heating, appliances and lighting.

Maine can reduce greenhouse gases by modernizing and improving our buildings, so they use less energy and cleaner fuels, and are built with lower carbon materials. These strategies will also make Maine's homes and businesses safer, healthier, more comfortable, and more affordable.

Actions to modernize and reduce the greenhouse gas emissions from Maine's buildings include:

1) Improve the design and construction of new buildings;
2) Promote climate-friendly building products such as mass timber and wood-fiber insulation made in Maine;
3) Transition to cleaner heating and cooling systems;
4) Institute a Renewable Fuel Standard (RFS) for all heating fuels

5) Weatherize existing buildings;
6) "Lead by Example" in publicly funded buildings; and
7) Incentivize Maine's hospitals to become carbon neutral.

Action 1: Improve the Design and Construction of New Buildings

- ***Provide incentives and code requirements that encourage net-zero, renewable energy ready homes and businesses by 2035.***
- ***Establish mechanisms to expand and increase code compliance across the State.***

The most cost-effective time to improve a building's energy efficiency is during construction.

This strategy would improve the design and construction of new buildings to increase energy efficiency by adopting more stringent building codes over time, reaching net zero emission building codes by 2035. Net zero buildings combine energy efficiency and renewable energy generation to create homes with very low utility costs and emissions.

Building codes set the standards for building design, construction, safety and performance and are the most powerful tool to advance best practices in new construction. Maine can reduce greenhouse gas emissions from the building sector by adopting progressively tighter building codes over time, training code officers and contractors to improve compliance, and supporting municipalities to improve enforcement.

Cost-Benefit Analysis

Building codes focused on energy efficiency are one of the most cost-effective strategies to reduce greenhouse gas emissions.

The cost-benefit analysis of this action found that while building to a higher energy efficiency standard adds to the initial cost of construction, the reduced operating costs over time lead to net cost savings.

For new single-family homes, taking into account both higher initial costs and lower operating costs, the present value over 30 years of costs and cost savings of building new buildings to higher energy efficiency standards over time are net cost savings of about $1,300 to $1,700 per house (or $0.60 to $0.75 per square foot) and roughly one metric ton of CO_2 is saved per house per year.

For new multi-family homes, building to a more stringent energy efficiency standard costs about $26,000 more per unit (or $0.37 per square foot), but annual operating costs are about $500 lower per unit (or $0.89 per square foot). Building new multi-family homes to a more stringent energy standard costs about $300 to $3,000 for the initial build per metric ton of CO_2 saved (depending which building standard is used).

While reduced energy bills mean cost savings for consumers over time, financial assistance or incentives may be required to help with the higher up-front construction costs, especially for buildings that will be occupied by renters.

Public Input Survey

Nearly 83 percent of respondents to the Buildings, Infrastructure and Housing (BIH) Working Group survey deemed improving the design and construction of new buildings either a "great fit" or "good fit" for their community. Fifty-six percent of respondents marked "great fit," the lowest among BIH strategies. In the open comments, many respondents said retrofitting existing buildings was a more pressing need in their community than new construction.

For more information on this action, see the Building, Infrastructure and Housing Work Group's Strategy #1.

Action 2: Promote climate-friendly building products such as mass timber and wood-fiber insulation made in Maine

Maine should promote the use of low carbon building materials such as mass timber and wood-fiber insulation. These innovative wood products reduce greenhouse emissions from the building sector while also supporting economic development in Maine's forest products sector. The State should seek opportunities to use mass timber building technologies in state construction projects and encourage related manufacturing facilities to locate in Maine.

"Embodied carbon" describes energy used to create and manufacture building materials. Wood and other bio-based materials provide a double benefit: they have low embodied carbon (compared to steel, many types of insulation, concrete, and fossil fuel-based products), they naturally store carbon, and source wood can be regrown to remove more carbon from the atmosphere. Utilizing more wood products, especially those produced in Maine, for building construction has positive climate and economic benefits.

Cost-Benefit Analysis

A cost-benefit analysis was not conducted for this strategy.

The forest products sector is statewide, multi-faceted, and provides around $8 billion in economic impacts to Maine, over 33,500 full- or part-time positions (4.13 percent of the employment in Maine), and $1.8 billion in labor income. The State's 10-year economic strategy highlights the opportunity to leverage Maine's forest resources and forest-based economy to respond to consumer demand for more sustainable products including innovative building materials that sequester carbon and make buildings more energy efficient.

Efforts to strengthen the forest products sector could increase employment opportunities in Maine's rural and working forest communities.

Public Input Survey

In the Natural and Working Lands Working Group survey, 52 percent of respondents deemed promoting the use of Maine's value-added forest products as a "great fit" for their community.

For more information on this action, see the Natural and Working Lands Work Group's Strategy #4.

Action 3: Transition to cleaner heating and cooling systems

- ***Expand financial incentives and phase in tighter regulations to encourage consumers to purchase highly efficient electric heat pumps, heat pump water heaters, and efficient, modern wood heat.***
- ***Develop mechanical licensing standards to ensure that those systems are installed and serviced with consistent quality control and safety.***

Nearly 70% of the fuels currently used for home heating in Maine are either oil or propane—the highest percentage in the country. There is a growing opportunity in Maine to transition to new technologies for heating (and cooling) that produce lower greenhouse gas emissions. New high-performance electric heat pumps are 60 percent more efficient than oil burners.

With assistance from Efficiency Maine Trust incentives, 45,000 high performance heat pumps and 25,000 heat pump water heaters have been installed in Maine in the past several years to lower emissions and energy bills. These products have been shown to work well in the Maine climate, particularly as technologies have continued to improve. Modern wood heating presents an opportunity to support Maine's forest products industry while reducing emissions from home heating as compared to oil or propane systems.

Cost-Benefit Analysis

High efficiency natural gas boilers, whole home electric heat pumps, and heat pump water heaters are among the best performers taking into account both net cost savings and CO_2 reduction, saving roughly $100 to $400 per metric ton of CO_2 reduced, and with benefits (in terms of energy cost savings) that exceed costs by a factor of between one and three.

Financial assistance or incentives may be required to help with the up-front project costs.

Public Input Survey

Transitioning to cleaner heating and cooling systems was a favorable strategy put forward by the BIH Working Group, with 87 percent of respondents deeming it either a "great fit" (70 percent) or "good fit" (17 percent) for their community.

For more information on this action, see the Building, Infrastructure and Housing Work Group's Strategy #2.

Action 4: Institute a Renewable Fuel Standard (RFS) for all heating fuels

- ***Provide incentives sufficient to drive rapid reductions in emissions from heating and industrial process fuels used in Maine.***

Maine is currently the most heating-oil dependent state in the United States when it comes to home heating. As a result, as a cold weather state with aging and inefficient housing stock, a significant amount of the State's greenhouse gas emissions come from the residential heating sector.

An RFS for the heating sector would require that a certain percentage of heating fuels be renewable in order to replace or reduce the quantity of greenhouse gas emitting heating fuels in residential, commercial, and industrial sectors. This would encourage the development of renewable fuels and technologies in Maine, such as biofuels made from wood biomass, biodiesels from used vegetable oils, and fuels made from anerobic digesters on farms. These projects could create jobs in Maine's rural communities and reduce both carbon and methane emissions and heating and operating costs.

Cost-Benefit Analysis

Further Maine-specific analyses are needed on the cost-effectiveness of reducing CO_2 emissions by using biofuels to power anaerobic digesters, using biodiesel for home heating (an area that particularly lacks literature on cost-effectiveness), and using biofuel from woody biomass.

Public Input Survey

Just over 51 percent of respondents to the Energy Working Group survey deemed a Renewable Fuel Standard for Heating as a "great fit" for their community. Thirteen percent of respondents also deemed it "not a good fit" for Maine, which was among the highest percentages of unfavorable responses registered for any working group strategy.

For more information on this action, see the Energy Work Group's Strategy #4.

Action 5: Weatherize existing buildings

- ***Expand access to weatherization programs for low- and moderate-income households including multi-family rental properties.***
- ***Adopt requirements that commercial buildings disclose their energy usage to support continuous improvement***
- ***Incentivize participation in smart device load management programs that lower peak demand on the electricity system***

Many of the 550,000 existing homes in Maine are aging and energy inefficient, with 56 percent having been built before 1980. Expanded weatherization programs will reduce emissions and save money for homeowners on utility bills by reducing air leakage and improving insulation.

Maine has successfully implemented weatherization programs to improve the energy efficiency of more than 20,000 market-rate homes since 2010, and many thousands more through the low-income programs of Maine Housing and the Community Action Programs. Weatherization improvements reduce energy usage and carbon emissions, increase resident comfort, build home equity, save residents money, and offer opportunities to remediate mold, lead, and other health hazards.

Cost-Benefit Analysis

Weatherizing homes involves up-front installation costs but reduce both energy costs and CO_2 emissions for the lifetime of the measure.

Financial assistance or incentives may be required to help with the up-front project costs.

Public Input Survey

Improving the energy efficiency of existing buildings was the most favored strategy put forward by the BIH Working Group, with 89 percent of respondents deeming it a "great fit" (71 percent) or "good fit" (18 percent) for their community.

For more information on this action, see the Building, Infrastructure and Housing Work Group's Strategy #3.

Action 6: "Lead by Example" in publicly-funded buildings.

- ***Amend the rules and policies for procurement of affordable housing, state government buildings, and schools at the K-12, community college, and university levels to improve energy efficiency, incentivize clean heating and cooling, promote renewable energy and distributed energy resources, and reduce emissions.***
- ***Demonstrate the successful use of low-carbon building materials and high-efficiency systems***

The State can take a leadership role in reducing emissions from the buildings sector by requiring best practices in construction, including building materials selection, heating, cooling and lighting systems, and enhanced efficiency and weatherization.

This will save taxpayers money and show what modern construction materials, systems and practices can achieve to reduce both emissions and the operating costs of state and municipal government buildings, schools, universities, and affordable housing.

Cost-Benefit Analysis

The cost-benefit analysis of this action noted that while the return-on-investment benefits of "Lead by Example" projects will vary depending on the nature of the project, there is additional value to demonstrating the cost-effectiveness of these projects to the public.

Public Input Survey

Lead-by-example policies were deemed a "great fit" for their community by 58 percent of respondents, which was the second lowest of any BIH strategy, and a "good fit" by 23 percent of respondents, for a total favorable response of 81 percent.

For more information on this action, see the Building, Infrastructure and Housing Work Group's Strategy #4.

Action 7- Incentivize Maine's hospitals to become carbon neutral

The U.S. healthcare sector is responsible for nearly 10% of all greenhouse gas emissions and hospitals make up more than one-third of those emissions. Hospitals can reduce their greenhouse gas emissions and energy costs with energy efficiency and renewable energy investments. (Note: this recommendation came from the Public Health subcommittee, which felt that given the significant health implications of climate change, that hospital and health care should help lead the way.)

Cost-Benefit Analysis

A case study suggests that the implementation of numerous energy conservation measures—including LED lighting upgrades, existing HVAC systems upgrades, and retro-commissioning of air-handling units—reduced the health care facility's annual emissions by nearly 4,000 metric tons of CO_2 and produced an annual cost savings of $361,000. With a payback period of approximately 2.3 years, these strategies provide both cost savings after just a few years and emissions reductions. This case study could be used to estimate the CO_2 emission reductions of a Maine health facility given the facility's annual energy usage per square foot and the square footage of the facility.

Equity Review

Small rural health care facilities need special consideration. Patients often must travel further to reach these facilities and some rural systems are facing significant financial challenges.

Public Input Survey

Over 83 percent of respondents to the Community Resilience, Public Health and Emergency Management Working Group survey deemed incentivizing Maine's hospitals to prepare for climate change as a "great fit" (65 percent) or "good fit" (18 percent) for Maine.

For more information on this action, see the Public Health Sub Group's Strategy #4.

Greenhouse Gas Modeling of Proposed Buildings Actions

Figure 6 presents the results of the greenhouse gas modeling for three alternative building sector scenarios, described in Figure 7.

In the baseline scenario, heat pump retrofits increase in line with Maine's 2025 goal and continue in line with ISO New England projections through 2029. The alternative scenarios included varying degrees of weatherization, heating and hot water electrification through the installation of heat pumps, and low carbon fuels.

- Scenario H1 includes current rates of weatherization and high rates of heating and hot water electrification
- Scenario H2 includes higher rates of weatherization and high rates of heating and hot water electrification
- Scenario H3 includes current rates of weatherization, slightly higher high rates of heating and hot water electrification relative to the baseline, and low carbon fuels (wood, biodiesel, and renewable natural gas (RNG))

The H3 scenario leads to the greatest emissions reductions by 2030 due to substitution of biofuels for fuel oil and natural gas.

Figure 7: Buildings Sector Greenhouse Gas Emissions Modeling

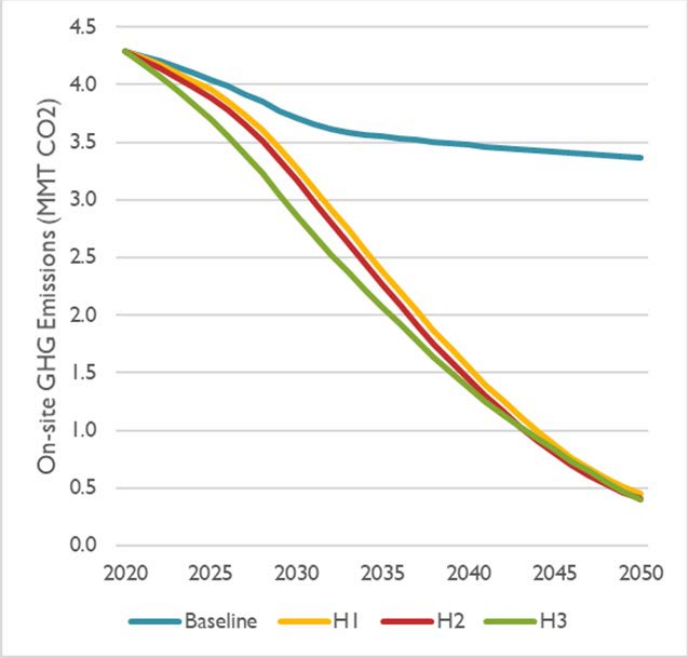


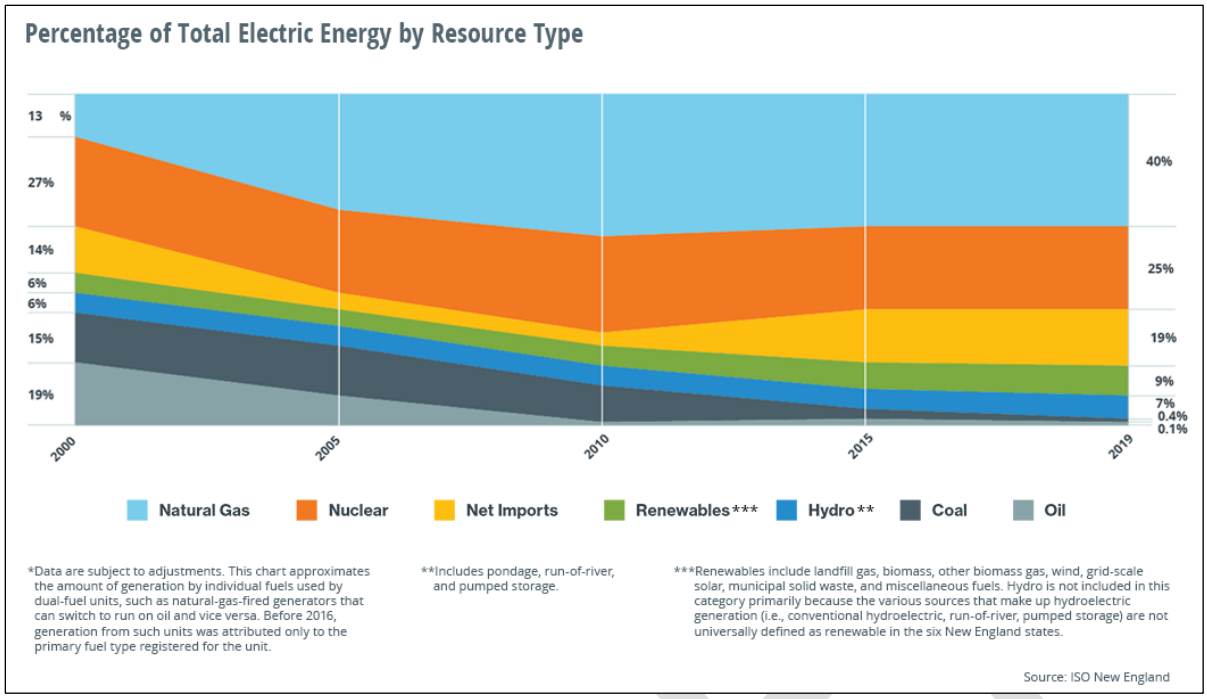
Figure 8: Buildings Scenarios

Baseline	H1	H2	H3
Continued efforts to install residential retrofit heat pumps—baseline efficiency	**Full Electrification—baseline efficiency**	**Electrification—aggressive efficiency**	**Electrification—baseline efficiency and low carbon fuels**
• 2.2% cumulative residential space heat energy reduction by 2050 through weatherization • 41% of households have heat pumps or legacy resistance heating by 2050	• 2.2% cumulative residential space heat energy reduction by 2050 through weatherization • 90% of households have heat pumps and 90% of commercial heating load is electrified by 2050	• 20% cumulative residential space heat energy reduction by 2050 through weatherization • 90% of households have heat pumps and 90% of commercial heating load is electrified by 2050	• 2.2% cumulative residential space heat energy reduction by 2050 through weatherization • 67% of households have heat pumps and 60% of commercial heating load is electrified by 2050 • Remaining load in 2050 is primarily supplied with biodiesel and fuel oil blends and renewable natural gas

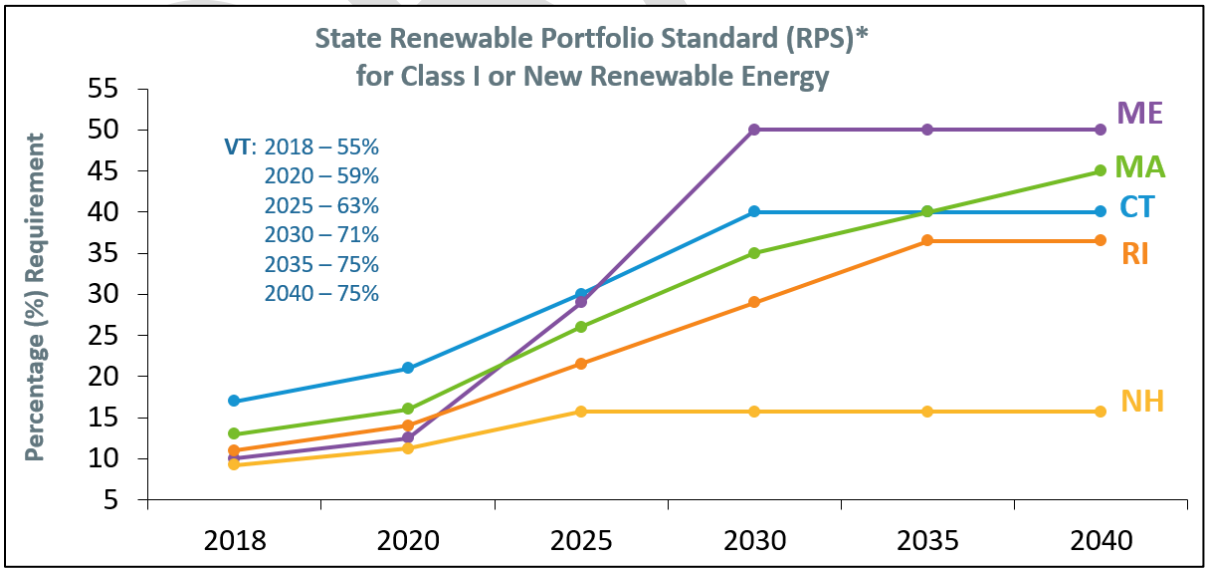
C. Drive Innovation to Reduce Carbon Emissions in Maine's Energy and Industrial Sectors

Maine's climate goals will require sectors with high greenhouse gas emissions, such as transportation and heating, to shift energy sources from fossil fuels to electricity and low-carbon fuels. This makes it essential that Maine's electricity is increasingly produced by clean, low-carbon resources.

Maine's domestic electricity generation is largely produced by renewable resources, with 75 percent from hydropower (water), wood, and wind, although some of that power is sold outside of Maine. Maine is part of a regional electricity grid, which has historically utilized coal and oil sources, both high greenhouse gas emitters. Over the last ten years, the regional grid has begun to move away from these sources toward natural gas and renewables.



A renewable portfolio standard (RPS) establishes a percentage of electricity that a utility is required to purchase from renewable resources. To encourage more lower-emission electricity generation, Maine has increased the state RPS from 40% to 80% by 2030, with a goal of 100% clean electricity by 2050. Additionally, incentives for small-scale renewable energy generation, with the option to include energy storage development, were created by law in 2019. Storage development, like large-scale batteries, can help the electric grid accommodate increased demand and reduce peak generation needs.



Source: ISO-NE

Maine's clean energy resources provide a significant opportunity to embrace energy innovations that can drive economic growth. As overall demand for electricity increases,

continued efforts must also encourage energy efficiency, and support shifts of usage away from high-use periods through demand management and "load flexibility" strategies. This will help to make the grid more reliable and reduce costs.

The following strategies are proposed to reduce greenhouse gas emissions from Maine's energy sector:

1) Ensure adequate affordable clean energy supply to meet Maine's energy and climate goals;
2) Initiate a stakeholder process to make recommendations to modernize Maine's electric grid, energy systems, and policies while ensuring it is done efficiently and affordably;
3) Accelerate the decarbonization of industrial use and processes;
4) Encourage highly efficient Combined Heat and Power (CHP) facilities; and
5) Develop and implement new financing options necessary to meet Maine's clean energy and emission reduction targets.

Action 1: Ensure adequate affordable clean energy supply to meet Maine's energy and climate goals.

Maine will need to ensure adequate affordable clean energy supply to meet our 100% Renewable Portfolio Standards (RPS) goal and any increased load through the development of centralized generating resources, distributed energy resources, and other measures.

We can leverage our unique renewable energy resources, strategic location and low-cost of development to ensure the highest benefits to Maine. This will require additional purchases of clean energy supply and development of targets for offshore wind, smaller distributed energy resources like solar located at homes and businesses, and energy storage. We will also need to carefully consider the siting of future energy assets and engage the public and stakeholders early in the process.

Continued development of clean energy resources to meet the State's RPS, clean energy and climate goals will create the opportunity for growth of a clean energy economy, including significant quality job creation. As Maine shifts to a cleaner electricity sector, efforts must be made to reduce negative impacts on residents and businesses, particularly in vulnerable populations. Programs for rural and low-to-moderate income households to afford new technologies and efficiencies should be expanded. Careful consideration should be given to ensure a just transition for Maine workers.

<u>Cost-Benefit Analysis</u>

An analysis of the costs and benefits of renewable energy resources found that renewable energy sources can provide energy at a levelized cost comparable to nonrenewable sources. (Levelized costs include the cost per unit of electricity generated over the entire lifespan of the generating plant, including capital and operating costs). In addition to the greenhouse gas

emissions reductions, increased use of renewable energy also has major health benefits associated with cleaner air from reduced nitrogen oxide, sulfur dioxide, and particulate matter.

The analysis also noted that as electric power use increases in Maine, and dependence on non-renewable sources of power such as natural gas and oil decreases, the State may prevent costly investments to the grid by implementing energy storage systems and demand management strategies. These can alleviate the burden on the grid from increased electricity use by decreasing peak demand.

Public Input Survey

Over 86 percent of respondents to the Energy Working Group survey deemed ensuring an adequate affordable clean energy supply as either a "great fit" (73 percent) or "good fit" (13 percent) for their community, among the most favorable responses of any energy strategy.

For more information on this action, see the Energy Work Group's Strategy #1.

Action 2: Initiate a stakeholder process to make recommendations to modernize Maine's electric grid, energy systems, and policies while ensuring it is done efficiently and affordably.

To meet Maine's Greenhouse Gas (GHG) emission reduction targets, large portions of the energy used in the Maine economy will need to be converted from higher carbon-emitting sources, like fossil fuels, to electricity—a transition referred to as beneficial electrification—and this electricity must increasingly come from renewable and clean generation sources.

Beneficial electrification in heating and transportation may require significant expansion and investment in Maine's electricity transmission and distribution system, or electric grid. Effective preparation for increased electricity usage requires a modernized electric grid, grid-management, energy systems, and policies, while ensuring it is done efficiently and affordably.

> ***Beneficial electrification:*** *Converting from higher carbon emitting sources, like fossil fuels, to electricity that is increasingly procured from clean, renewable resources will advance Maine's climate goals.*

The Power Sector Transformation Stakeholder Process will examine and provide recommendations regarding the transformation and planning of Maine's electric sector to facilitate the recommendations of the Maine Climate Council and achieve Maine's GHG reduction requirements and clean energy goals.

The process will be managed by the Governor's Energy Office (GEO) in coordination with the Maine Public Utilities Commission (MPUC). Areas for analysis should include: utility structure, load management, data and information access, non-wires alternatives (NWA) and distributed energy resources, efficient and equitable cost allocation, regional collaboration, and changes in law and regulation.

Cost-Benefit Analysis

A cost-benefit analysis was not conducted for this strategy.

Public Input Survey

Over 86 percent of respondents to the Energy Working Group survey deemed transitioning and modernizing Maine's energy grid as either a "great fit" (69 percent) or "good fit" (17 percent) for Maine, among the most favorable responses of any energy strategy.

For more information on this action, see the Energy Work Group's Strategy #2 and Buildings, Infrastructure, and Housing Work Group's Strategy #6.

Action 3: Accelerate the Decarbonization of Industrial Use and Processes

- ***Expand funding for industrial energy efficiency programs***
- ***Pursue a long-range plan for industrial fuel switching in process heating. Support demonstration and pilot projects for industrial fuel switching in the near-term.***

Industrial facilities in Maine have historically shown strong and active participation in energy conservation programs, and there are additional cost-effective opportunities that could be pursued. Expanding programs like the industrial energy efficiency program offerings through Efficiency Maine will encourage corporate investments in efficiency, result in more competitive manufacturing businesses, and support reduce emissions.

Achieving deep emissions reductions in this sector will likely require significant shifts away from carbon-intensive fuels to cleaner alternatives. Some fuel switching opportunities can be both cost-effective and reduce greenhouse gas emissions, such as converting from use of fossil fuels to natural gas and increasing efficiencies through use of Combined Heat and Power (CHP). Other opportunities, such as shifting to renewable gas or oil (e.g., hydrogen rich fuels produced using renewable energy electrolysis or using carbon capture and sequestration) are not close to being commercially available and competitive but may be in the future.

Cost-Benefit Analysis

Fuel switching can result in cost-effective measures over time that reduce emissions. Switching to state-based energy production over imported energy would give Maine more autonomy and create less sensitivity to market fluctuations—in addition to creating and retaining jobs.

Public Input Survey

Reducing greenhouse gas emissions from industrial processes was deemed a "great fit" by 45 percent of respondents to the BIH Working Group survey. This strategy also had nearly equal "good fit" and "neutral" responses (21 percent), which stood out. Looking at the open field comments, this high number of "neutral" responses seems to stem from a numerous respondent saying their communities lack industry.

For more information on this action, see the Buildings, Infrastructure, and Housing Work Group's Strategy #5.

Action 4: Encourage Highly efficient Combined Heat and Power (CHP) facilities

Highly efficient Combined Heat and Power (CHP) facilities capture heat from electricity generation to provide steam or hot water for use in space heating and cooling, water heating, and industrial processes to increase overall facility efficiency. CHP both reduces energy loss and reduces the need for additional energy to accomplish heating and industrial processes. CHP can both reduce Maine's emissions and support existing industrial businesses and large organizations.

Maine should continue to support the growth of highly efficient CHP facilities through the Maine Public Utilities Commission (Maine PUC) long-term contracting authority.

Cost-Benefit Analysis

The installation of CHP can provide both direct and indirect job creation. Direct job creation is provided by the manufacturing, installation, and ongoing operations of the facility, in addition to the indirect jobs associated with the supply chain for the development of a CHP facility. As the entities utilizing the CHP facility increase productivity and efficiencies, their cost savings allow them to operate more competitively and potentially increase their employment opportunities.

A cost-benefit analysis of this action found that combined heat and power facilities recycle the heat byproduct from power generation and use it to warm areas, thus reducing emissions and redundancy. Because of this dual use, combined heat and power also saves costs and is economically beneficial in the long term.

Public Input Survey

Only 41 percent of respondents to the Energy Working Group Survey deemed encouraging Combined Heating and Power facilities as a "great fit" for their community. This strategy also had more than 13.5 percent of respondents deem it "not a good fit" for their community, which was the highest percentage of unfavorable responses of any working group strategy.

For more information on this action, see the Energy Work Group's Strategy #3.

Action 5: Develop and implement new financing options necessary to meet Maine's clean energy and emission reduction targets.

- ***Create the mechanisms or entities necessary to finance Maine's energy system effectively.***

- ***Investigate of structural approaches to reducing clean energy infrastructure costs in Maine.***
- ***Investigate the potential of multistate or national carbon pricing beyond the electric power sector.***

Achieving Maine's clean energy and climate goals will require additional capital to finance clean energy projects and to fund energy-related programs (e.g., clean energy supply resources, energy efficiency and weatherization, transportation and other beneficial electrification, etc.). This requirement will likely be met through a variety of existing and new funding sources, both private and public, and mechanisms (e.g., policy incentives, financial incentives, regulatory mandates, public education, codes and standards, etc.).

Cost-Benefit Analysis

A cost-benefit analysis was not conducted for this strategy.

Public Input Survey

Developing new financing options necessary for meeting Maine's clean energy targets was deemed either a "great fit" (70 percent) or "good fit" (15 percent) for Maine by nearly 85 percent of respondents to the Energy Working Group survey.

For more information on this action, see the Energy Work Group's Strategy #5.

Greenhouse Gas Modeling of Proposed Energy Actions

Meeting aggressive greenhouse gas emissions reduction targets requires fuel-switching from petroleum-based fuels and natural gas used in the transportation and buildings sectors to clean renewable electricity and low-carbon fuels. The focus of the energy sector modeling was the transition to an electric grid with low and zero carbon emissions generation sources and beneficial electrification of the transportation and buildings sectors.

The baseline scenario includes Transportation Baseline Scenario (very low electrification rates and current national Corporate Average Fuel Economy [CAFÉ] standards for fuel efficiency) and Buildings Baseline Scenario (current rates of weatherization and heating and hot water electrification).

Transportation Scenario T1 and Buildings Scenario H1 results were used for the electric sector decarbonization scenario, which also included 100% RPS in Maine (but not the rest of New England).

- Scenario T1 includes high rates of electrification, but vehicle miles traveled (VMT) remains the same as today.
- Scenario H1 includes current rates of weatherization and high rates of heating and hot water electrification.

Under a business as usual scenario based on current policies, the modeling shows that Maine's greenhouse gas emissions are expected to be 13.8 million metric tons in 2050, which is 9.6 million metric tons above the 2050 target of an 80 percent reduction from 1990 levels.

Under this "proposed strategies" scenario, Maine's total emissions are 13.9 million metric tons, which is 2.3 million metric tons in 2030 above the 2030 target. By 2050, Maine's total emissions are 7.3 million metric tons, which is just 3 million metric tons above the 2050 target.

These proposed strategies include:

- By 2030, 16 percent of light-duty vehicles and 25 percent of heavy-duty vehicles are electric.
- By 2050, 90 percent of light-duty vehicles and 80 percent of heavy-duty vehicles are electric.
- By 2030, 32 percent of households have heat and hot water pumps; 14% of commercial heat is electrified.
- By 2050, 90 percent households adopt heat pumps for space and water heating; 90% of commercial heat is electrified.

Baseline	T1
Worst case electrification—CAFE standards remain	**Electrification—baseline efficiency**
• 11% of LDVs are electric by 2050 • 0% of HDVs are electric by 2050 • VMT per LDV remains constant through 2050 • VMT per HDV remains constant • Fuel efficiency reaches 42 MPG for new cars and 30 MPG for new light trucks by 2050	• 90% of LDVs are electric by 2050 • 80% of HDVs are electric by 2050 • VMT per LDV remains constant through 2050 • VMT per HDV remains constant • Fuel efficiency reaches 42 MPG for new cars and 30 MPG for new light trucks by 2050 • Managed EV charging

Baseline	H1
Continued efforts to install residential retrofit heat pumps—baseline efficiency	**Full Electrification—baseline efficiency**
• 2.2% cumulative residential space heat energy reduction by 2050 through weatherization • 41% of households have heat pumps or legacy resistance heating by 2050	• 2.2% cumulative residential space heat energy reduction by 2050 through weatherization • 90% of households have heat pumps and 90% of commercial heating load is electrified by 2050