2019

HANOVER HIGH SCHOOL CLIMATE ACTION PLAN

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ACRONYMS AND ABBREVIATIONS

B&G	Hanover High Buildings & Grounds Department
BAU	business-as-usual
°C	degrees Celsius
CAFE	Corporate Average Fuel Economy Standards
CAP	Climate Action Plan
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
EPA	U.S. Environmental Protection Agency
EV	electric vehicle
FSC	Forestry Stewardship Council
GDP	gross domestic product
GHG	greenhouse gas
HHS	Hanover High School
LED	light-emitting diode
$MTCO_2e$	metric tons of carbon dioxide equivalent
NHCAP	New Hampshire Climate Action Plan
NHSDP	New Hampshire State Development Plan
ppm	parts per million
REC	Renewable Energy Credit
RGGI	Regional Greenhouse Gas Initiative
RPS	Renewable Portfolio Standard
UNFCCC	United Nations Framework Convention on Climate Change
UNH	University of New Hampshire
W/m^2	watts per meter-squared

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1 INTRODUCTION

Given the overwhelming consensus that anthropogenic or “human-made” greenhouse gas (GHG) emissions are causing global climate change, Hanover High School (HHS) is joining an increasing number of entities and local governments committed to addressing climate change at the local level. HHS recognizes the risk that climate change poses to its constituents and is acting now to reduce the GHG emissions, or “carbon footprint,” through the innovative programs laid out in this Climate Action Plan (CAP). Ultimately, individual behavior changes and collective action is needed to reduce HHS’s contribution toward the problem of climate change and adapt to its current and future effects. This CAP takes advantage of common-sense approaches and cutting-edge policies that HHS is uniquely positioned to implement. These actions can reduce energy use and waste, conserve water, and reduce fossil fuels used for transportation. This CAP aims to be consistent with the larger plans for the Town of Hanover, New Hampshire and other state and regional plans.

This is the first CAP developed for a high school in the United States. Further, this plan was written by Hanover High School students under the guidance of Hannah Kornfeld (HHS 2010), who served as a volunteer consultant and made substantial contributions to the production and formatting of this report.

1.1 PURPOSE, SCOPE, AND PROCESS

1.1.1 Purpose

By creating a clear course of action so that everyone can have a role in creating and achieving climate and sustainability goals, the CAP drives and coordinates efforts toward a reduction in GHG emissions of 6 percent below 2016-17 school year emission levels by 2025 and 77 percent below 2016-17 school year emission levels by 2050. These targets are discussed further in Section 3.

The CAP is a framework for the development and implementation of actions that reduce HHS’s GHG emissions and provides guiding objectives and strategies to realize HHS’s GHG reduction goals.

1.1.2 Scope

This CAP covers strategies for reducing GHG emissions resulting from operational activities associated with HHS. It addresses the major sources of emissions from HHS and sets forth objectives and strategies in seven focus areas (i.e., emissions sectors) that both the school and community can implement together to achieve GHG reductions:

- Building Energy
- Employee Commute
- Student Commute
- School Buses
- Solid Waste Generation
- Wastewater Generation
- Water Consumption

1.1.3 Process

The approach used for this CAP was developed by ICLEI and is called the Five Milestones for Climate Mitigation (see Figure 1 below).

Milestone One: Conduct a baseline emissions inventory and forecast.

Milestone Two: Adopt an emissions reduction target for the forecast year.

Milestone Three: Develop a climate action plan.

Milestone Four: Implement the climate action plan.

Milestone Five: Monitor progress and report results.

Figure 1. ICLEI's 5 Milestones for Climate Mitigation

2 HANOVER HIGH SCHOOL'S GREENHOUSE GAS EMISSIONS

Through the completion of a local emissions study, or "greenhouse gas inventory," the Earth Systems and Ecological Design classes of 2017-18 and 2018-19 have determined emissions levels for the school's operations. Emissions include all sources for which the HHS exercises direct operational control including building energy, waste generation, water consumption, and school bus fuel consumption. Emissions associated with vehicle trips by employees and students commuting to the school were also included in the inventory.

An important aspect of GHGs is the unit of measurement used to inventory and estimate emissions. While carbon dioxide (CO_2) is the most prevalent and recognized GHG, there are other GHGs such as methane and nitrous oxide. To simplify the discussion and comparison of these emissions collectively, CAPs use a metric known as carbon dioxide equivalent (CO_2e). The CO_2e metric translates each GHG to an equivalent volume of CO_2 by weighing its relative global warming potential. Methane and nitrous oxide are 25 and 310 times more potent, respectively, than CO_2 in their abilities to trap heat in the atmosphere (DES 2009). Converting these GHG emissions into CO_2e using global warming potential values allows us to consider all gases in comparable terms and makes it easier to communicate how various sources and types of GHG emissions contribute to climate change using a standard unit of measurement of the amount of GHG emissions produced and released into the atmosphere.

2.1 2016 GREENHOUSE GAS EMISSIONS

One of the main objectives of this CAP is to identify and reduce HHS's contributions to global GHG emissions. Measuring GHG emissions is a critical first step in developing the CAP for several reasons. First, the GHG inventory identifies major sources and quantities of GHG emissions associated with the activities and choices currently made by HHS, its staff, and its students. Second, the inventory provides the baseline that is used to forecast emission trends and to develop an accurate near-term emissions reduction target consistent with State objectives. Finally, the inventory sets the baseline for HHS to develop, evaluate, and implement measures to achieve its GHG reduction targets.

The GHG emissions inventory focuses on direct activities that occur within the physical boundaries of HHS (e.g., electricity, gas, wood, and water consumption in the building), the surrounding region associated with HHS's operation (e.g., student and staff commute, school bus use), and other off-site activities such as disposal of solid waste or treatment of water or wastewater.

GHG emissions from the 2015-16 school year were prepared for HHS's operations. The 2015-16 school year inventory shows that HHS's operations generated 3,221 metric tons of CO_2e ($MTCO_2e$). HHS's GHG inventory is broken down into the following seven sectors:

- **Building Energy Use:** Building energy sector emissions include GHG emissions generated as the result of electricity consumption, wood burning, and fuel consumption at HHS.
- **Employee Commute:** Employee-generated GHG emissions associated with gasoline, diesel, or other fossil fuel consumption from vehicle trips and vehicle miles traveled during employee commute.
- **Student Commute:** Student-generated GHG emissions associated with gasoline, diesel, or other fossil fuel consumption from vehicle trips and vehicle miles traveled during student commute.
- **School Buses:** School bus-generated GHG emissions associated with diesel consumption from school bus routes.
- **Solid Waste Generation:** Solid waste sector emissions include the methane emissions from the decomposition of waste generated by staff and students at the Lebanon Landfill.
- **Wastewater Generation:** Wastewater treatment results in GHG emissions associated with the electricity consumed during treatment, as well as fugitive methane emissions resulting from the treatment process for wastewater.
- **Water Consumption:** Water-related GHG emissions are associated with the energy and fuel used to convey, distribute, and treat water used at HHS.

Table 1 and Figure 2 show the breakdown of HHS's GHG emissions in the 2015-16 school year.

Table 1 Hanover High School Baseline Greenhouse Gas Emissions in 2016

Emissions Sector	$MTCO_2e$	Percent of Total
Building Energy	1,462	45%
Employee Commute	536	17%
Student Commute	412	13%
School Buses	766	24%
Solid Waste Generation	12	<1%
Wastewater Generation	16	1%
Water Consumption	17	1%
Total	**3,221**	**100%**

Notes: $MTCO_2e$ = metric tons of carbon dioxide equivalent.

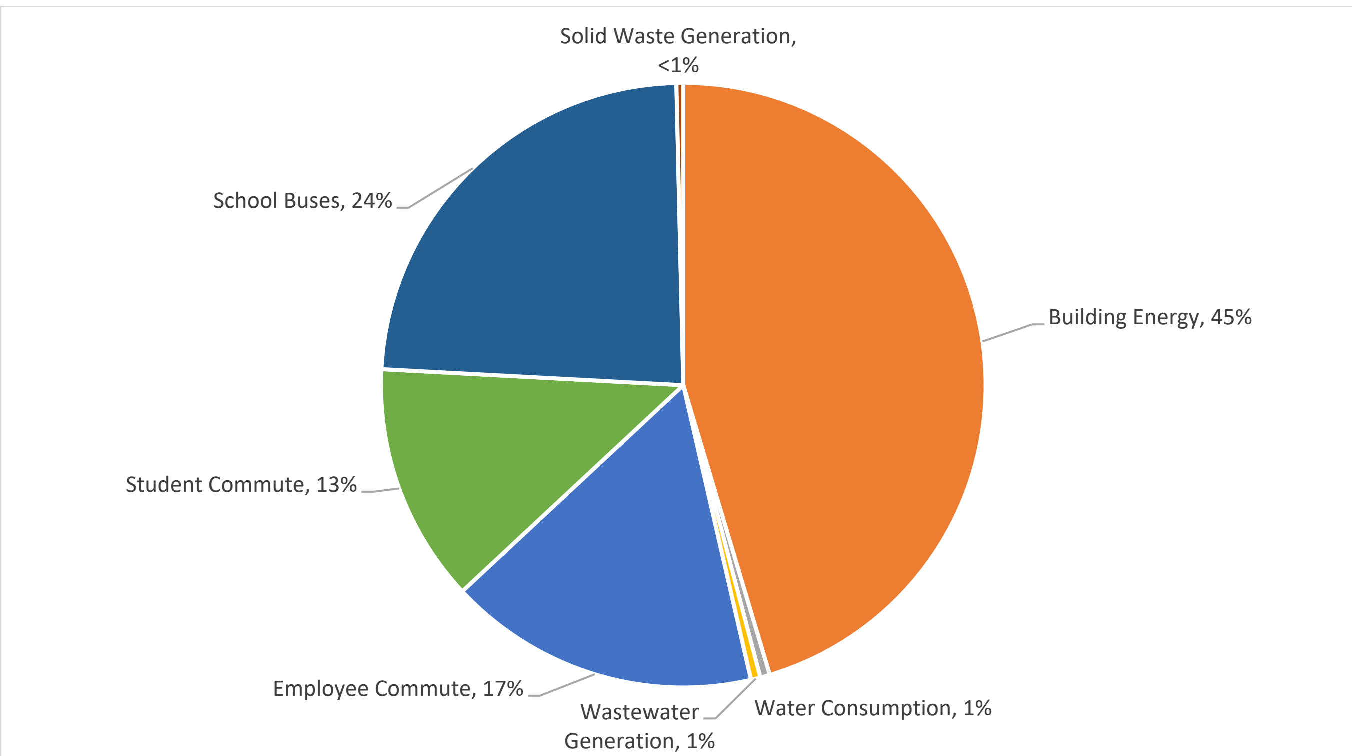

Figure 2. Hanover High School's 2016 Greenhouse Gas Emissions Inventory

2.2 PROJECTED GROWTH IN GREENHOUSE GAS EMISSIONS

GHG emission forecasts provide an estimate of future emission levels based on a continuation of current trends in activity. HHS has completed an emissions forecast based on projections of current data and expected future trends. The emissions forecast is a "Business-As-Usual" forecast, a scenario estimating future emissions levels if no further local action (i.e., measures within this CAP) were to take place. Growth projections in emissions are based on anticipated population growth in the Town of Hanover as provided by the New Hampshire 2016 Subcounty Projections for Hanover through the year 2050 (State of New

Hampshire 2016). The forecast indicates that, if HHS does not take action, GHG emissions will continue to increase. Table 2 shows the projected GHG emissions by emissions sector.

For complete information regarding the emissions inventory and forecast, including methodology and supporting data, refer to the Hanover High School Emissions Inventory Report located in Appendix A.

Table 2 Hanover High School Projected Greenhouse Gas Emissions: 2025 and 2050

Emissions Sector	GHG Emissions ($MTCO_2e$)		
	2016	2025	2050
Building Energy	1,462	1,462	1,462
Employee Commute	536	546	590
Student Commute	412	419	454
School Buses	766	766	766
Solid Waste Generation	12	12	12
Wastewater Generation	16	17	19
Water Consumption	17	17	18
Total	3,221	3,239	3,322

Notes: $MTCO_2e$ = metric tons of carbon dioxide equivalent.

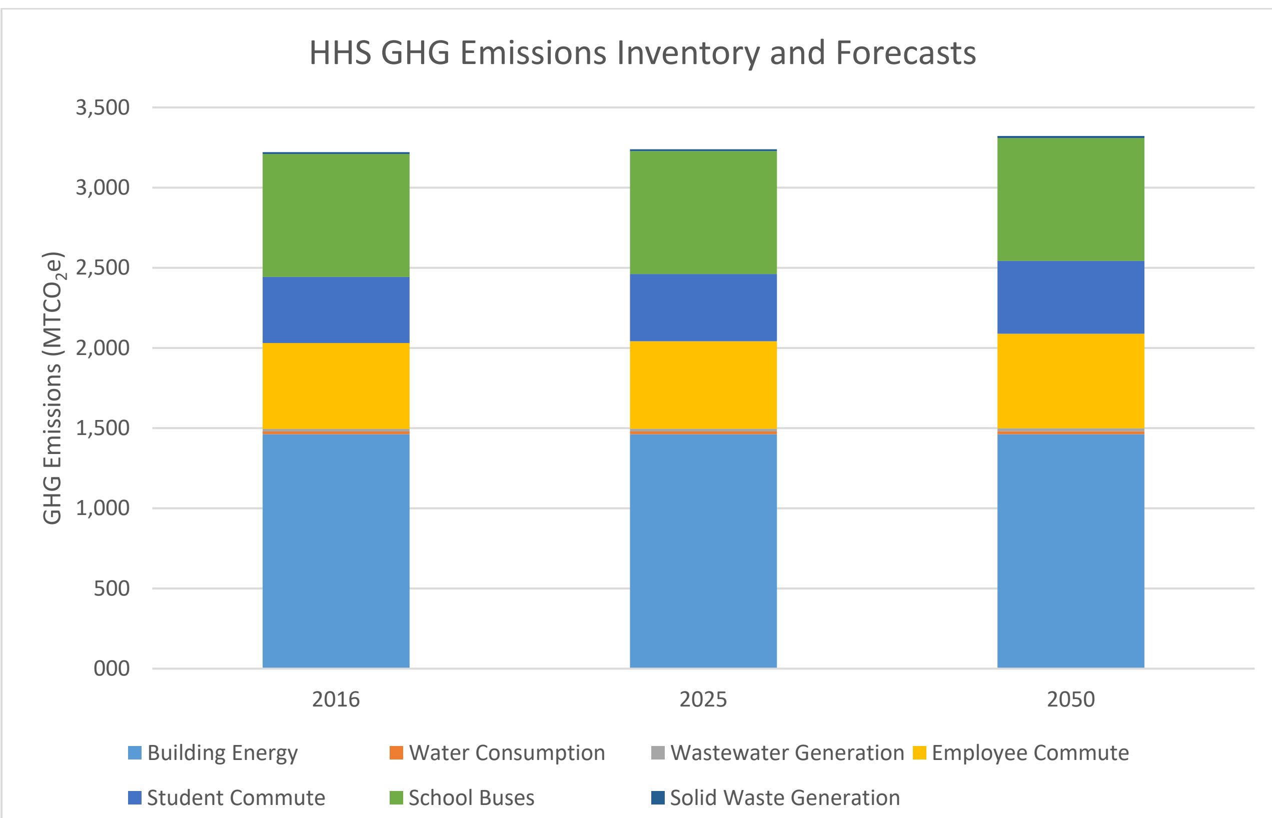

Figure 3. Hanover High School's Greenhouse Gas Emissions Forecasts: 2025 and 2050

3 GREENHOUSE GAS REDUCTION TARGETS

The State of New Hampshire aims to reduce its GHG emissions by 20 percent from 1990 levels by 2025 and 80 percent below 1990 levels by 2050 (DES 2009:24-25). Almost all scientific sources recommend a reduction of 80 percent by 2050, which is the amount of GHG reduction deemed necessary by the United Nations' Intergovernmental Panel on Climate Change to keep temperatures from exceeding a 2-degree Celsius (°C) increase. The HHS CAP aims to align with these recommendations, as described in the following section.

3.1.1 Emissions Reduction Target

Because HHS's 1990 GHG emission levels were not estimated, proportional targets for this CAP were calculated based on statewide changes in GHG emissions over time since 1990. To determine the proportional reductions needed from 2016 levels that would be equivalent to the State's targeted reductions from 1990 levels, the State's GHG inventories for 1990 and 2016 were compared. According to the inventories available in the New Hampshire CAP, statewide emissions were approximately 15.8 million $MTCO_2e$ in 1990 and 13.4 million $MTCO_2e$ in 2016 (DES 2009). Based on these statewide changes in emissions from 1990 to 2016, and in consideration of established statewide reduction targets for 2025 and 2050, applying proportional reductions to HHS's 2016 emissions levels would mean reductions of at least 6 percent by 2025 and 77 percent by 2050.

The combination of measures that are presented in this CAP are designed to achieve the 2025 goal and make substantial progress towards the longer-term 2050 goal. Table 3 shows HHS's GHG reduction targets for 2025 and 2050, which require a 6 and 77 percent reduction, respectively, from the baseline 2016 conditions. This level of reduction corresponds to an annual emissions limit of 3,044 $MTCO_2e$ in 2025 and 764 $MTCO_2e$ in 2050. This is the maximum amount of annual GHG emissions allowable while achieving the reduction targets. Figure 4 shows the trajectory of HHS's GHG emissions without additional action in comparison to the GHG reduction targets established.

Table 3 Hanover High School Greenhouse Gas Reduction Targets

	2016	2025	2050
BAU Emissions ($MTCO_2e$)	3,221	3,239	3,320
Percent Reduction below 2016 Levels	NA	-6%	-77%
Annual Emissions Allowable ($MTCO_2e$)	NA	3,044	764
Emission Reductions Needed to Meet Target ($MTCO_2e$)	NA	195	2,556

Notes: $MTCO_2e$ = metric tons of carbon dioxide equivalent; NA = not applicable.

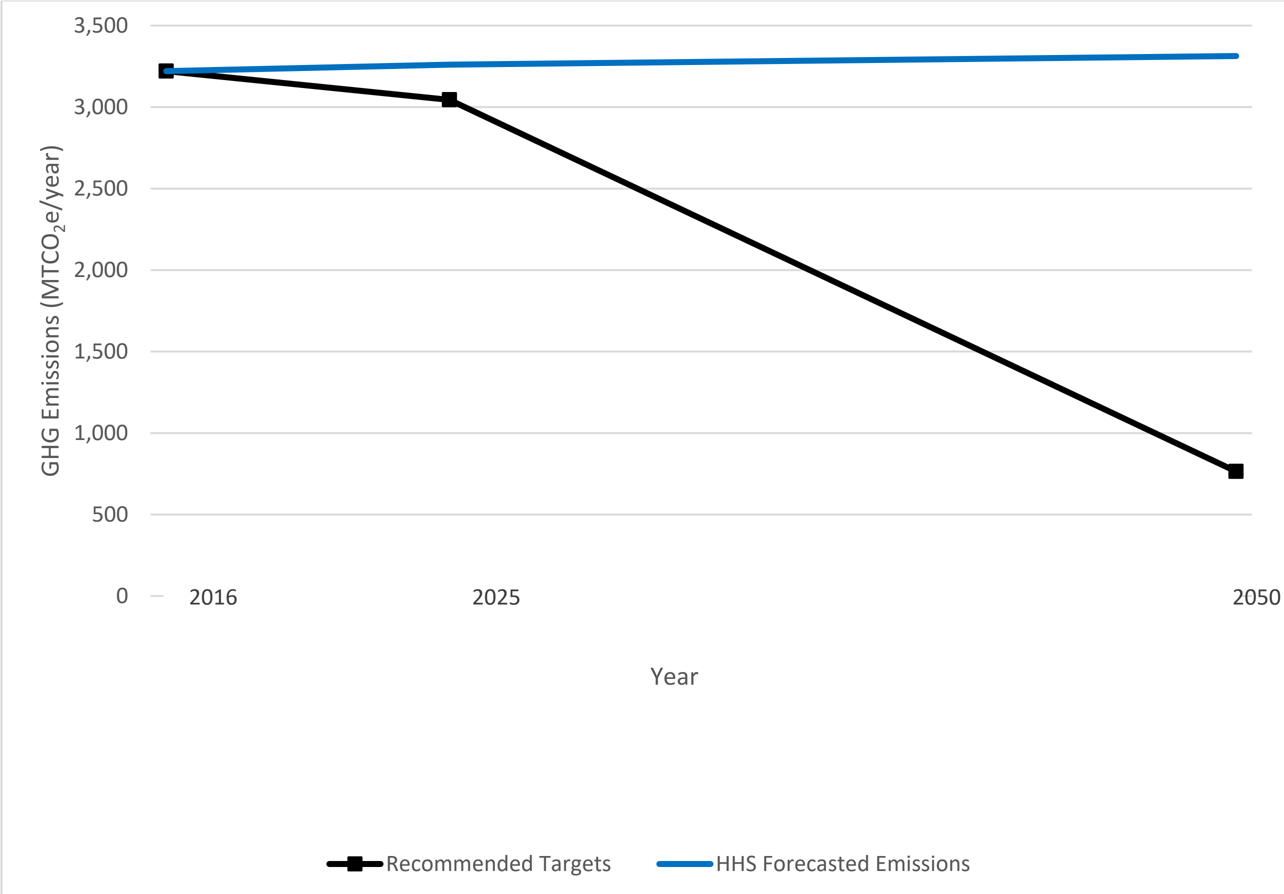

Figure 4. Hanover High School's Greenhouse Gas Reduction Targets: 2025 and 2050

3.2 SUMMARY OF CLIMATE ACTION PLAN

The summary table below identifies the emission sectors within the HHS CAP, the GHG-reducing measures within each emissions sector, and a comparison to HHS's GHG reduction targets for 2025 and 2050. Each GHG reduction measure has a detailed section within this document where specific actions are described.

While HHS cannot address climate change by itself, school policies and practices can dramatically reduce GHG emissions from a range of sources and help prepare HHS for the anticipated impacts of climate change. By working together, HHS can not only do its part toward achieving a stable climate - we can reap the benefits of healthier air, lower costs for building operation, cleaner transportation, water demand reduction, and many other positive co-benefits of reducing our carbon footprint. As shown in Table 4 below, the GHG reduction measures identified would exceed HHS's 2025 GHG reduction target and make significant progress towards achieving the 2050 longer-term GHG reduction goal.

It is important to note that only GHG reduction measures that have enough available data and methodology were quantified to show the anticipated GHG emissions reductions. While all of the measures included in the CAP would result in some GHG emissions, due to lack of available data or unknown methods, only those that can be quantified count towards HHS meeting its GHG reduction target for 2025. Although many GHG reduction measures are not quantified, they are still important particularly because of the co-benefits described below.

Table 4 Hanover High School Climate Action Plan Summary

GHG Reduction Measure Number	Measure Description	Anticipated GHG Reduction ($MTCO_2e$ by 2025)	Anticipated GHG Reduction ($MTCO_2e$ by 2050)
BE-1	Purchase certified sustainable wood chips	1,200	1,200
BE-2	Upgrade heaters	N/A	N/A
BE-3	Improved building insulation	N/A	N/A
BE-4	EnergyStar®-rated appliances	N/A	N/A
BE-5	Energy audit of building	N/A	N/A
BE-6	Install energy-efficient lighting	N/A	N/A
BE-7	On-site renewable energy generation	193	193
BE-8	Net metering	N/A	N/A
SW-1	Compost used paper towels	N/A	N/A
SW-2	Increase recycling and composting education	3	3
WA-1	Install dual-flush toilets	N/A	N/A
TR-1	Electric vehicle charging stations	11	14
TR-2	Carpool incentives for students	N/A	N/A
TR-3	Bike shelter	N/A	N/A
SB-1	Efficient school bus system	N/A	N/A
SB-2	Renewable diesel in school buses	766	766
SB-3	Replace diesel-fueled school buses with electric versions	N/A	N/A
SB-4	Bike and ski racks on school buses	N/A	N/A
C-1	Buy local food	N/A	N/A
C-2	Transition to reusable/compostable cutlery and dishes	N/A	N/A
M-1	Create CAP team with Environmental Club	N/A	N/A
M-2	Revise HHS Mission Statement to reflect climate goals	N/A	N/A
Total		2,173	2,176
Emissions Reduction Needed		194	2,558
Target Met?		Yes	No

Notes: GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; N/A = not applicable; CAP = Climate Action Plan.

3.3 CO-BENEFITS

While the measures included in the CAP are generally geared towards reducing GHG emissions, many will also result in environmental or economic “co-benefits.” Environmental co-benefits include improved air quality, water supplies, biological resources, public health outcomes, and beneficial outcomes for other resources. For example, a significant co-benefit of implementing CAP measures related to fossil fuel combustion will result in fewer toxic air contaminants, leading to better air quality and improved health for everyone. Other measures focus on improving energy and water efficiency, lowering overall operating costs at HHS.

A more detailed discussion of reduction measures, along with their co-benefits, can be found in Section 6, “Emissions Reduction Measures.”

4 CLIMATE CHANGE SCIENCE

4.1 CLIMATE CHANGE SCIENCE

Although climate change is the center of many political debates, the warming of Earth's climate system is a widely-accepted fact in the scientific world. Ninety-seven percent of "actively publishing climate scientists" agree that Earth's climate is changing as a result of human activities (NASA 2018). The atmosphere's current CO_2 levels (as of March 2019) are 410 parts per million (ppm), which is the highest measurement in the past 800,000 years (NASA 2018). Before the industrial revolution, Earth's CO_2 levels fluctuated between roughly 180 ppm during ice age periods and 280 ppm during interglacial periods (NASA 2018). These rising and falling levels are considered within the normal spectrum of the Earth's temperature cycles, which has a frequency of about 100,000 years. In a glacial cycle, temperatures and CO_2 levels fluctuate up and down, and about every 15,000 years the temperatures spike, and then rapidly fall soon after. In comparison, the current level of over 410 ppm represents uncharted territory. Because of the unprecedented levels of CO_2, scientists do not know exactly how these high CO_2 levels will affect humanity and other life that lives on this planet. However, scientists do know that throughout climate history, temperature is directly correlated with atmospheric CO_2 levels (NOAA 2008). When graphed, temperature and carbon dioxide follow each other closely.

CO_2 is just one of the GHGs in Earth's atmosphere that contributes to warming Earth. GHGs have a warming effect due to their ability to trap heat in the atmosphere. GHGs in Earth's atmosphere absorb infrared radiation emitted from Earth's surface and also re-emit infrared radiation, commonly known as heat. The greenhouse effect refers to the natural process of infrared radiation being absorbed by GHG molecules, and then re-emitted in all directions, some of which is directed back towards Earth. "Without naturally occurring greenhouse gases, Earth's average temperature would be near 0°F (or -18°C) instead of the much warmer 59°F (15°C)" (NASA 1998).

However, since the Industrial Revolution, the burning of fossil fuels and other human activities has led to a dramatic increase in the concentration of GHGs in the atmosphere. GHGs that have high global warming potentials have a long residence time in the atmosphere, absorb effectively in the infrared part of the electromagnetic spectrum, and have a relatively high concentration in the troposphere (lowest layer of the atmosphere). Once GHG molecules absorb infrared radiation, they collide with and transfer kinetic energy to other molecules in the atmosphere such as nitrogen and oxygen, which increases the temperature of the atmosphere. As the concentration of GHG molecules in the atmosphere increases, more energy is trapped. In this way, GHGs act as a "blanket" and prevent heat energy from escaping back out to space.

Scientific research published in peer-reviewed journals shows that the current CO_2 levels in Earth's atmosphere have been rising since the industrial revolution (Scripps Institution of Oceanography UC San Diego 2017). Human activity is also responsible for the release of methane, nitrous oxide, and other potent GHGs (Keeling 1997). Humans are already experiencing the effects of a warmer climate through more extreme weather events, increases in pests and disease, devastation to wildlife habitat, and perhaps most directly relevant to HHS, increased costs (Keeling 1997).

Arguably, the most concerning part of global climate change is that it is extremely difficult to reverse. Now that there is momentum in warming Earth, the extent of sea ice is diminishing, sea levels are rising, oceans are warming, and glaciers around the world are melting. Further, these events lead to positive feedback loops that amplify warming. Due to climate momentum, it will take hundreds of years for GHG concentrations in the atmosphere to return to preindustrial concentrations. For these reasons, we need to take responsibility for emissions coming from the HHS community and implement this CAP immediately.

4.2 GREENHOUSE GAS EMISSIONS SOURCES

Figure 5 below shows the sources of GHGs in the United States and their percentages of total GHG emissions. The transportation, electricity, and industry sectors produce the majority of GHGs because of the burning of fossil fuels. Commercial and residential use of fossil fuels and agriculture make up the rest. Land use and deforestation increase emissions by 11 percent, meaning that the lack of CO_2 uptake by trees, caused by deforestation, contributes to the overall increase in GHGs, so it can be treated as an emission source (EPA 2018a). Deforestation offset is not included in the graph. In the electricity sector, 67.9 percent of the emissions come from coal, 31.2 percent come from natural gas, and less than 1 percent of emissions come from petroleum (EPA 2019).

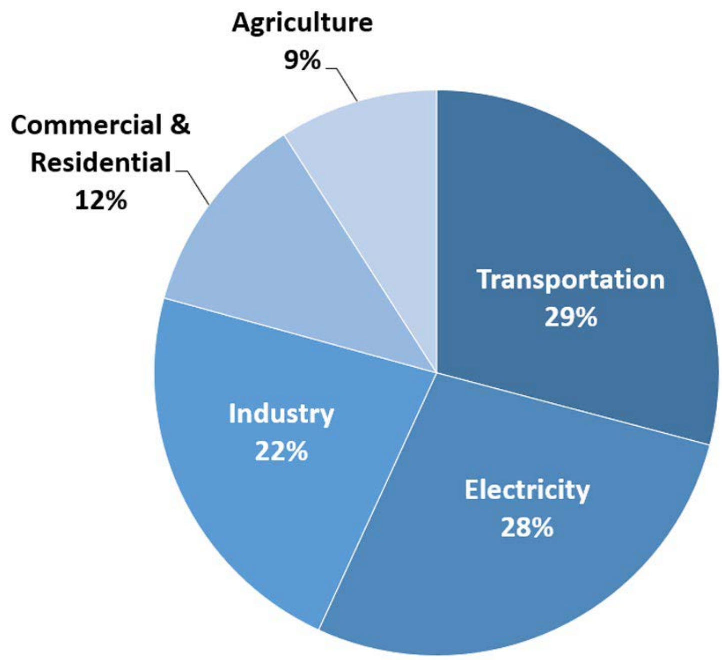

Figure 5 U.S. Greenhouse Gas Emissions by Source in 2017
Source: EPA 2019

Of all the GHG emission sectors, energy production, including the burning of coal, oil and natural gas for electricity, has changed the most over time. Emissions from energy peaked in 2007. Although emissions from decomposition of waste has decreased by 34.1 percent since 1990, GHG emissions from the energy sector have risen by 2.4 percent, emissions from agriculture have risen by 15 percent, emissions from industry have increased by 5.9 percent, and GHG sinks such as forests have decreased uptake by 12.5 percent due to deforestation (EPA 2018a).

4.3 EFFECTS OF CLIMATE CHANGE ON THE ENVIRONMENT

There are almost 200 worldwide scientific organizations that believe climate change is caused by human action (OPR 2019). This is creating an imbalance in Earth’s energy budget. Before the Industrial Revolution, Earth was in radiative balance, with 240 watts per meter-squared (W/m^2) hitting the surface of Earth, and 240 W/m^2 escaping from Earth’s atmosphere. However, it has been estimated that currently there is approximately 0.8 W/m^2 less energy escaping back into space as a result of human activity (NASA 2009). Despite this being a seemingly small difference, the 0.8 W/m^2 change is increasing the temperature of Earth’s atmosphere.

As Earth's atmosphere warms, glacial ice melts, exposing the dark surface of Earth which reduces the albedo, or reflectivity of Earth's surface. With less reflective material covering Earth, less light gets reflected back into space, and more gets absorbed by Earth's surface, contributing further to warming. This amplification of warming is known as a positive feedback loop. Rising temperatures are also causing the melting of permafrost, the frozen soil sublayer in the poles. As permafrost melts, bacteria decompose organic matter anaerobically. This produces methane, an even more potent GHG than CO_2. The release of methane increases the concentration of GHGs in the atmosphere and therefore contributes to Earth's warming temperatures which melts more permafrost, another example of positive feedback. "Global sea level has risen by about 8 inches since reliable record keeping began in 1880. It is projected to rise another 1 to 4 feet by 2100. This is the result of added water from melting land ice and the expansion of seawater as it warms" (NASA 2019b). Warmer water takes up more space than cooler water, causing sea levels to rise. Rising sea levels lead to destruction of land through erosion and flooding. Furthermore, as ocean levels increase, humans are forced to evacuate their communities. These displaced people have come to be known as climate refugees. In addition, as sea levels rise, ocean water is pushed inland against the fresh water of rivers. This phenomenon, known as salt water intrusion, contaminates drinking water sources of coastal areas, and changes the salinity of estuaries which impacts the structure and function of estuarine ecosystems.

Climate disasters are increasing in number and gravity and are impacting economies around the world. "In 2019 (as of April 9), there have been two weather and climate disaster events with losses exceeding $1 billion each across the United States" (NOAA 2019). The rise in temperature has caused plants to migrate from their original habitats to places that are within their preferred temperature range. Climate change is having profound impacts on Earth's ecosystems, leaving them less resilient and less able to provide the ecosystem services upon which humanity depends. As the effects of climate change continue, the scarcity of resources will increase conflicts among countries and people around the world.

Regionally, the northeastern U.S. will experience more heat waves, heavy downpours and sea level rise. "Infrastructure, agriculture, fisheries and ecosystems will be increasingly compromised" (NASA 2019b). As a result, many states and cities are beginning to incorporate climate change into their planning.

5 CLIMATE CHANGE POLICY

5.1 INTERNATIONAL

5.1.1 Paris Agreement

The Paris Agreement of 2015 was enacted at the Paris Climate Conference in December 2015 by the parties to the United Nations Framework Convention on Climate Change (UNFCCC). The Agreement is a formation of many articles, the most essential of which states that all parties seek to keep the global temperature rise this century to below 2°C above pre-industrial levels and to additionally pursue efforts to limit the temperature increase even further to 1.5°C. To achieve these goals, the Agreement emphasizes that the parties should aim to start reducing GHG emissions as soon as possible. The Agreement also requires that all parties report regularly on their emissions and on their implementation efforts. This refers specifically to the Nationally Determined Contributions which countries must prepare, work towards, and then report on every five years. According to the UNFCCC, developed countries should continue to take the lead by undertaking economy-wide reduction targets, while developing countries should continue enhancing their mitigation and adaptation efforts. Developing countries are also encouraged to move toward economy-wide targets over time (UNFCCC n.d.).

It is difficult to measure progress from the Agreement since it was only enacted recently, but there are some measures that indicate it has helped push the world towards sustainability. One of these measures is the number of non-state actors that have pledged their support of the Paris Agreement as well as the member parties. In the U.S. alone, more than 2,500 mayors, governors, businesses leaders, and investors have pledged their support to the Paris Agreement (Hobert 2017), including multiple New Hampshire towns: Hanover, Lebanon, Keene, Portsmouth, and Nashua (Greene 2017).

Another measure of progress is the global investment in renewable energy. As a result of the Paris Agreement, wind power is now less expensive than other forms of energy in many locations. In addition, new renewable energy capacity installed worldwide in 2016 reached 161 gigawatts, which is a 10 percent increase from 2015 (Hobert 2017). However, there have been setbacks as well, including the U.S.'s announcement to pull out of the Paris Agreement. Ultimately, progress will be determined in 2023 when the first "global stocktake" occurs in which the Conference of the Parties serving as the meeting of the parties to the Paris Agreement take stock of the implementation of the Paris Agreement and assess collective progress towards achieving the purpose of the Agreement and its long-term goals. This progress will continue to be measured every five years after 2023 (UNFCCC n.d.).

5.1.2 Under 2 Memorandum of Understanding

The Under 2 Memorandum of Understanding (The Climate Change Group 2018) was founded by 12 initial members in 2015. Now known as the Under 2 Coalition, the memorandum represents a legal agreement in which parties involved do not form a legal commitment. The founding members include: Acre, Baden-Württemberg, Baja California, British Columbia, California, Catalonia, Jalisco, Ontario, Oregon, Vermont, Wales, and Washington. By committing to the Under 2 Coalition, parties agree to conceive and implement a plan to help limit global warming to 2°C. The goal of the Coalition is to reduce GHG emissions to 80-95 percent of 1990 levels, which translates to limiting emissions to 2 $MTCO_2e$ per capita per year by 2050.

The plan has grown to over 200 members on six continents and 43 different countries in the three years since its founding. These members constitute 1.3 billion people and $30 trillion in gross domestic product (GDP), which constitutes 43 percent of the global economy (The Climate Change Group 2018). The reason that the Under 2 Coalition has so many members is that it allows local governments who want to do something about climate change to join, instead of having to wait for their federal government to join a formal agreement like the Paris Agreement. Because this coalition is relatively young, it is challenging to determine its effectiveness at this point, but its climb in membership bodes well for future success.

5.2 FEDERAL

5.2.1 Clean Power Plan

In 2015, the U.S. Environmental Protection Agency (EPA) under President Obama, published the first-ever limits on carbon pollution from U.S. power plants, the largest source of the pollution in the country that's driving climate change (NRDC 2017). Each state was given the opportunity to design an individual and cost-effective plan to reduce their carbon emissions. Development of the Clean Power Plan was a response to the impacts of climate change such as extreme weather conditions, droughts, floods and wildfires that have become more frequent in the United States (NRDC 2017).

Implementation of the Clean Power Plan was projected to cut carbon emissions from electrical power generation by 32 percent by 2030 relative to 2005 levels. Economists predicted that the plan would save the United States $20 billion by 2030, as well as generate other health and economic co-benefits. Under this plan, states were given economic incentives to switch to clean energy sources. The Clean Energy Incentive Program, in close conjunction with the Clean Power Plan, also awarded economic credits to develop energy efficiency programs in areas of low-income housing (NRDC 2017). In 2017, the EPA, under the Trump administration, proposed to repeal the Clean Energy Plan and replace it with the Affordable Clean

Energy Rule, which would give individual states more authority to make their own plans for regulating greenhouse gas emissions from coal-fired power plants (NPR 2018). Several nongovernmental organizations plan to continue to file comments and participate in court challenges, pressuring the EPA to implement strong carbon standards for power plants (Union of Concerned Scientist 2018).

5.2.2 Corporate Average Fuel Economy Standards

Corporate Average Fuel Economy Standards, commonly known as CAFE standards, were enacted in 1975 by Congress. These standards "reduce America's consumption of oil, save consumers money at the gas pump, and protect public health and the environment by curbing global warming pollution. They also help spur investments in new automotive technology, creating jobs and helping sustain the recovery of the American auto industry" (Union of Concerned Scientists 2017). CAFE standards are updated regularly based upon a five-year projection of automobile fuel efficiency. The standards are based on the average efficiency value of a fleet of cars per manufacturers. Efficiency in automobiles in the United States is measured in miles per gallon. For example, the 2017-2021 CAFE standards require manufacturers to have a fleet wide average of 40.3-41.0 miles per gallon for passenger cars and light trucks. When the 2017-2021 standards expire, a revised set of CAFE standards will be created for 2022-2025. The current CAFE standards set to expire in 2025 are currently under revision by the current administration.

5.2.3 EPA's SmartWay Transportation Partnership

The SmartWay Transportation Partnership is a voluntary public-private program started by the EPA in 2004 that helps companies advance supply chain sustainability by measuring, benchmarking, and improving freight transportation efficiency. The program was developed in response to the scale and growth of emissions from heavy-duty diesel trucks in the U.S. This program provides a system for tracking fuel use and freight emissions across supply chains, helps companies identify efficient freight carriers to improve supply chain sustainability, and reduces GHG emissions from the movement of goods (EPA 2017).

SmartWay also works to improve the relationship between the EPA and the transportation sector. Since its start, SmartWay has grown from 50 partners to currently more than 3,700 partners and affiliates. It has helped its partners save 215.4 million barrels of oil and has eliminated 103 million tons of air pollution (EPA 2018b). In addition to having a positive environmental impact, SmartWay has led to significant economic savings. SmartWay has helped U.S. trucking companies save $29.7 billion in fuel costs, and trucking is an industry that represents 8 percent of U.S. GDP. (EPA 2018b).

5.2.4 25 x '25 Initiative

"25x'25" is a movement by the United Nations, Rockefeller Brothers Fund, and the Energy Foundation which calls for more renewable energy in the U.S. Specifically, it sets a goal that by 2025, the U.S. will be producing 25 percent of its energy from renewable sources such as wind, solar, and biofuels. The 25x'25 goal has been endorsed by nearly 1,000 partners, 35 current and former governors, 15 state legislatures, and Congress through the Energy Independence and Security Act of 2007. Since the launch of the 25x'25 vision, the U.S. has increased renewable energy production by almost half. In 2013, 11.2 percent of energy consumed in the U.S. came from renewable energy sources. To achieve the 25x'25 plan, the U.S. needs to reform certain practices. These include increasing production of renewable energy, working on its efficiency and productivity, and delivering and expanding to markets.

If the U.S. is able to achieve these goals, between 4 and 5 million new jobs will be created. Additionally, the U.S. will have cleaner air through reduced urban smog and pollution in the atmosphere. This plan will also bring new technologies to the market and help to save consumer expenditures while reducing dependency on oil from Middle East such as Saudi Arabia. These changes will produce $700 billion in new economic activity annually and reduce CO_2 emissions by 1 billion tons. So far, the U.S. is on track to procure 24 percent of its energy from renewable sources by 2025 (25x'25 Initiative 2018).

5.3 REGIONAL

5.3.1 Regional Greenhouse Gas Initiative

The Regional Greenhouse Gas Initiative (RGGI) implemented in 2009, is the first mandatory market-based program in the United States to reduce GHG emissions from power plants. It is a cooperative effort among Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, Vermont, and New Jersey (RGGI 2018).

The program limits how much CO_2 power plants can legally produce and requires them to pay a fee which is proportional to the amount of CO_2 they produce. Furthermore, RGGI requires that states use the money to invest in the most feasible renewable energy and energy efficiency projects in their states. This usually includes customer rebates and efficiency projects. The system provides incentives for power plants to become more efficient while simultaneously creating jobs and infrastructure for renewable energy production.

To craft a viable plan, RGGI had to ensure that the economic damage of lost power plant revenue (caused by limiting CO_2 production and charging fees) was offset by the stimulation of the economy in the form of new energy-efficient projects (RGGI 2018). There has been $3 billion worth of economic growth due to RGGI since it officially began in 2009 and because of RGGI, public health concerns have been alleviated (especially in low income communities). Further, the price of electricity has fallen, and nearly 30,000 job-years have been created. These results incentivize states to remain in the agreement (Ropeik 2018).

The RGGI cap represents a budget for CO_2 emissions from the power sector among the participating states. In short, the states gave themselves until 2014 to reach a cap of 91 million short tons of CO_2 released into the atmosphere. The plan then was from 2015 to 2020 the cap was to decline by 2.5 percent every year (RGGI 2013).

RGGI's goal in 2005 was to reduce power plant CO_2 production by 10 percent by 2018. As of January 2018, member states had cut CO_2 production by 40 percent (Ho 2017). Due to the program's success, RGGI standards are becoming more demanding. The RGGI plans to lower the CO_2 cap and increase the price of CO_2 allowances, also known as Carbon Certificates, which are tradable coupons that are redeemed for the right to generate CO_2, by the ton. Member states expect to see a collective $3.95 billion dollars in economic growth and 34,000 job-years (Ho 2017).

5.4 NEW HAMPSHIRE

5.4.1 New Hampshire State Development Plan

The New Hampshire State Development Plan, *"New Hampshire in the New Economy: A Vision for Expanded Prosperity,"* (NHSDP) was proposed in 2000 and describes changes that New Hampshire must make in order to keep its economy successful. This plan focuses on providing a better-quality workspace for its workers. To achieve these goals, it is imperative that New Hampshire work towards having a cleaner and safer environment.

According to the NHSDP, the State of New Hampshire must lay out a need for “a commitment to investing in education, worker training, health care, environmental protection and modernization of state government” (State of New Hampshire 2000:4). With this commitment in mind, New Hampshire aspires to “ensure a prosperous future; one in which all its residents are afforded the opportunity to succeed” (State of New Hampshire 2000:4). New Hampshire recognizes the various aspects of this plan, including controlling the environmental needs and impacts of agriculture, business, and transportation.

The NHSDP features energy conservation as a key sector to ensure continued economic prosperity. A relevant goal is that the state aims “to assist schools in becoming more energy efficient and to educate students about renewable energy” (State of New Hampshire 2000:40).

5.4.2 RENEWABLE PORTFOLIO STANDARD

New Hampshire’s Renewable Portfolio Standard (RPS) was created in 2007 after an economic analysis by the University of New Hampshire (UNH). The UNH study looked at the success of other states in the region after enacting RPS legislation and concluded that establishing an RPS for New Hampshire could be beneficial for its economy and environment. The RPS was submitted to the New Hampshire Department of Environmental Services and Public Utilities Commission. The purposes of New Hampshire’s RPS are to provide fuel diversity to New Hampshire and the larger New England region, to lower the local dependence on fossil fuels, and to stabilize and lower energy costs. The RPS also encourages investment in renewable or low emission technologies to stimulate the local economy. This investment will help combat climate change and raise emission standards by ensuring that a larger share of the electricity consumed by residents of the state is produced using renewable methods.

The RPS achieves these goals by requiring that all electric service providers in the state purchase or generate Renewable Energy Credits (RECs). One REC is equivalent to the generation of one megawatt-hour of renewable electric power generation. Power companies can buy RECs from a company or individual who is producing electricity using renewable energy. RECs allow companies to support renewable energy efforts without having to generate the energy themselves. Power companies may also choose to get RECs by building their own renewable power generation. The target for renewable energy generation started at 4 percent in 2008 and has gradually risen each year. Its target of 24.8 percent renewable power generation will be reached by 2025. In order to ensure that companies are compliant with the RPS, the Public Utilities Commission conducts periodic reviews (Harrold 2016).

5.4.3 New Hampshire Climate Action Plan

The New Hampshire Climate Action Plan (NHCAP) was enacted in March 2009 by the New Hampshire Climate Change Policy Task Force.

The goal of the NHCAP is twofold: to lower current GHG emissions to 80 percent below the 1990 GHG emission levels by 2050, and to stimulate the state’s economy. In order to do this, NHCAP has identified energy efficiency, renewable energy, and lowering car dependence as the most effective ways to reach their goal. The State also says that maintaining its forests is critical to preserving carbon storage and tourist attractions. New Hampshire plans to implement education and outreach programs (DES 2009).

To increase energy efficiency, the NHCAP aims to improve efficiency in existing buildings, and change building energy codes to reduce environmental impact. In an effort to increase the use of renewable energy, New Hampshire plans to promote the generation of electric and non-CO_2-emitting energy, and to produce energy through the use of biogenic waste sources such as waste water, food waste, and animal manure. As the State attempts to cut down on car usage, which will decrease GHG emissions, New Hampshire plans to improve bus and train services on local and regional levels, build more infrastructure for bikes and pedestrians, and implement more park-and-rides (DES 2009).

The NHCAP includes actions specifically designed to reduce GHG emissions associated with schools throughout the state. The actions recommended in the NHCAP that address schools include GLA 2.6, which reads "Promote Public School Siting and Building Aid to Reduce Energy Use" and RCI 4.1, which reads "Include Energy Efficiency and Conservation in School Curriculum" (DES 2009:23-24).

5.5 HANOVER

5.5.1 Renewable Energy Commitment

In May 2017, the Town of Hanover, New Hampshire voted on a community goal to transition to 100 percent renewable energy. The goal currently states that Hanover will have 100 percent renewable electric energy by 2030, and 100 percent renewable heating and transportation energy by 2050 (Levy 2017). Hanover is the first town in New Hampshire to commit to the Sierra Club's "Ready for 100" goal, a national movement led by the environmental organization working to help cities convert to running on 100 percent renewable energy. The 69 cities who have already committed to the "Ready for 100" goal, range from smaller towns such as Blackburn, Virginia, to large metropolises such as San Diego, California and Orlando, Florida (Sierra Club 2018).

Members of the Hanover community made the decision to commit to the Sierra Club's campaign during a vote at a town meeting, making Hanover the first municipality in the United States to have a renewable energy goal both voted on and approved by community residents (Town of Hanover 2017). The Sustainable Hanover Town Committee, which endorses the transition to clean and renewable energy, proposed the idea for committing to the Sierra Club's campaign. The Town plans to spend $50,000 per year on energy-efficient improvements (Sears 2018). Hanover has been working with the Concord Energy Committee and plans to find more opportunities for solar power in the area.

6 EMISSIONS REDUCTION MEASURES

The following GHG emission reduction measures will help HHS meet its 2025 GHG reduction target and make significant progress towards meeting its longer-term 2050 goal. The GHG reduction measures are divided into eight sectors. Measures were developed by the 2017-18 and 2018-19 Earth Systems and Ecological Design classes, in collaboration with the Buildings and Grounds Department (B&G). Each measure includes a description of how it would result in GHG emission reductions, the co-benefits associated with the measure, and anticipated GHG reductions, as applicable.

6.1 BUILDING ENERGY

Energy consumed in the school building accounted for 45 percent of HHS's total GHG emissions in the 2015-16 school year. Improving the efficiency of the building will contribute significantly to achieving HHS's greenhouse gas reduction target. This section focuses on opportunities to retrofit and upgrade the building and to ensure that future activities in the building are compatible with our community's climate protection goals.

6.1.1 BE-1: Purchase Forestry Stewardship Council or Third Party Certified Sustainable Woodchips

The majority of HHS's building energy is associated with burning woodchips to provide area and water heating. Currently, woodchips that are purchased by HHS are not certified sustainable, meaning the woodchips are not sourced from a forest that has been certified to be well-managed. If woodchips purchased by HHS were certified sustainable, all GHG emissions associated with the school's burner would be effectively eliminated. The Forest Stewardship Council (FSC) is an example of an independent, non-profit organization that accredits wood suppliers as certified sustainable. FSC's goal is to protect forests for future generations.

HHS has a signed contract with a woodchip provider that expires July 1, 2019. HHS should renegotiate a contract with a woodchip provider that offers FSC-certified sustainable woodchips.

Co-Benefits
By using FSC-certified sustainable woodchips, HHS can support healthy forest management that conserves biological diversity, water resources, soils, unique ecosystems, and landscapes.

Anticipated GHG Reduction
2025: 1,200 $MTCO_2e$/year
2050: 1,200 $MTCO_2e$/year

6.1.2 BE-2: Upgrade Heaters

An air-to-air heat pump can provide both heating and cooling, is significantly more efficient than our heating system, and does not require combustion. About half of the GHG emissions that are produced at HHS come from burning woodchips for heat. Reducing combustion of woodchips by using heat pumps will reduce our GHG emissions. In addition, these units are extremely energy efficient and could be powered by on-site solar panels.

Co-Benefits
Many of the heating units at HHS need to be replaced (either now or in the near future). This investment will reduce HHS's electric bill. Furthermore, this will help stabilize the temperature in the building, which will increase comfort for both staff and students.

6.1.3 BE-3: Improved Building Insulation

Improved insulation in the building would reduce the amount of energy needed to heat the interior of the building. Energy conservation would mean less GHGs emitted from the heating system. Insulated windows reduce the amount of energy needed to heat a building.

Co-Benefits
Improved insulation would bring economic co-benefits because (after installation) the heat would remain inside, thus lowering the need for continuous heating and energy. Insulated windows can reduce exterior noise from reaching the inside of buildings. While providing noise reduction, insulated windows will also lower the amount of money the school spends on heating and cooling the building. Since less wood will be burned in the HHS heating plant, the school will consume and require less wood to be transported to HHS, thus decreasing the school's carbon footprint.

6.1.4 BE-4: EnergyStar®-Rated Appliances

There are currently many old refrigerators located in classrooms and offices throughout the school. Purchasing EnergyStar®-rated appliances will reduce GHG emissions because they reduce power plant emissions. Major home appliances account for about one-fifth of the energy-related GHG emissions in the U.S. Most EnergyStar®-rated appliances use about half the energy of conventional appliances.

Co-Benefits

Buying an energy efficient appliance reduces the tax associated with purchasing the appliance. Although these EnergyStar®-rated items may be slightly more expensive when you purchase them, it will lower the electricity bill because it uses less energy.

6.1.5 BE-5: Perform Energy Audit of Building

HHS should hire an energy services company to perform a building energy audit and to identify potential energy savings through efficiency measures.

Co-Benefits

Building energy efficiency savings through measures identified in the audit would reduce costs associated with building operation and maintenance.

6.1.6 BE-6: Install Energy-Efficient Lighting

Replacing fluorescent bulbs with light-emitting diode (LED) lights would decrease GHG emissions, because LEDs are 40 to 50 percent efficient, whereas the fluorescent light bulbs currently installed are about 20 percent efficient (DIAL 2016). LED bulbs typically last 15 to 25 years whereas fluorescent bulbs typically last about 10 years (NRDC n.d.).

Co-Benefits

Fluorescent bulbs contain mercury and a phosphor coating, both of which are considered hazardous waste. Fluorescent lights age significantly if they are frequently switched on and off (Stouch Lighting 2019). The light produced by LEDs has been shown to improve concentration, motivation, and mood.

6.1.7 BE-7: On-Site Renewable Energy Generation

Generating renewable electricity on-site would reduce and maybe even eliminate HHS's reliance on fossil fuels. If a solar photovoltaic system of 625 kilowatts (approximately 42,000 square feet or one acre) was installed to provide electricity to HHS, all GHG emissions associated with electricity generation would effectively be eliminated.

Co-Benefits

Economic co-benefits because we wouldn't need to pay for [as much] municipal power.

Anticipated GHG Reduction

2025: 193 $MTCO_2e$/year
2050: 193 $MTCO_2e$/year

6.1.8 BE-8: Net Metering

With net metering, the school would have solar panels that could produce surplus energy during the day, but the school would also be able to pull energy from the power grid at night when the solar panels were not producing energy. This means that the school could benefit from the power grid but would not need to rely on the grid completely. The school would consume less electricity and would be more self-sufficient, thus lowering the emission of GHGs.

Co-Benefits
Because the school would be producing more of its own energy, the electricity bill would be less expensive. If the school was able to produce surplus energy, the energy could be sold back to the power company or donated to low income residents who cannot afford to pay for electricity.

6.2 SOLID WASTE GENERATION

HHS's solid waste is disposed of, primarily, at the Lebanon Landfill. Emissions from decaying putrescible material directly contribute approximately 1 percent of HHS's total GHG emissions. However, this does not include the emissions associated with hauling of waste to the Lebanon Landfill. This section focuses on opportunities to reduce waste, reuse materials, and recycle what cannot be reused.

6.2.1 SW-1: Compost Used Paper Towels

Currently, the majority of our paper towels are sent to the landfill, and landfills are a source of GHG emissions. Composting paper towels will not only recycle carbon into bioavailable forms; it will also reduce the amount of waste, thus decreasing the amount of GHGs produced.

Co-Benefits
Composting paper towels could provide a source of fertilizer for future food growth, as well as reduce the weight of HHS waste, and therefore the cost, of hauling trash to the landfill.

6.2.2 SW-2: Increase Recycling and Compost Education

Waste in the landfill releases GHG as they decompose anaerobically. HHS has recycling and compost to reduce this effect. Without education for staff and students, these systems become underutilized, and trash ends up in the recycling or compost receptacles.

Co-Benefits
Working as a school to compost and recycle brings the school community together. By reducing the school's trash, the school may save money depending on the specific costs of recycling, composting, and trash disposal at the time.

Anticipated GHG Reduction
2025: 3 $MTCO_2e$/year
2050: 3 $MTCO_2e$/year

6.3 WASTEWATER GENERATION

Wastewater generation accounted for approximately 1 percent of HHS's total GHG emissions in the 2015-16 school year. There are currently no feasible reduction measures associated with this emissions sector.

6.4 WATER CONSUMPTION

Water-related GHG emissions accounted for approximately 1 percent of HHS's total GHG emissions in the 2015-16 school year. This section focuses on opportunities to reduce water consumption and its associated energy demand.

6.4.1 WA-1: Choice Flushing

Choice flushing on a toilet would decrease our water consumption. By using less water, the amount of energy and money that is spent on unnecessary water would also decrease. A toilet's water use is about 1.28 to 1.6 gallons per flush. However, the "liquid flush" option allows for a half flush because less water is necessary.

Co-Benefits
By using choice flushing, HHS can lower its water bill and use less energy. This change will also reduce HHS's exports to wastewater treatment plants, thus lowing GHG emissions.

6.5 EMPLOYEE AND STUDENT COMMUTE

GHG emissions associated with staff commute accounted for 17 percent of HHS's total GHG emissions in the 2015-16 school year. GHG emissions associated with student commute accounted for 13 percent of HHS's total GHG emissions in the 2015-16 school year. This section focuses on opportunities to reduce emissions associated with commuting and incentivizing carpooling and emerging technologies such as electric vehicles.

6.5.1 T-1: Electric Vehicle Charging Stations

Electric vehicles (EVs) reduce reliance on fossil fuels by using electricity to power the vehicle. Reducing fossil fuel consumption improves energy independence and energy security. Electricity can be generated from renewable sources such as solar photovoltaics or wind turbines. If electricity is sourced entirely from renewables, there are effectively no GHG emissions associated with driving EVs.

Co-Benefits
There are economic co-benefits because renewable energy is free (after installation of the infrastructure). There are also air quality and public health benefits to driving EVs because there is no tailpipe releasing emissions of pollutants.

6.5.2 T-2: Carpool Incentives for Students

Carpooling reduces the number of vehicles used on a daily basis. Each vehicle releases an amount of GHGs, starting from the construction of the vehicle, to when it is being operated on the road ways. The less vehicles being driven, the less GHGs emitted. Having an incentive for students to carpool will not only help lower GHG emissions by the school, but also create sustainable methods that can be passed on to future generations. An incentive to carpool could be to offer a free parking pass to those who carpool with a total of three students.

By carpooling to school, HHS can cut down the amount of GHG being released into the atmosphere. As shown in Figure 5, 28.5 percent of the U.S.'s GHG emissions comes from transportation, resulting in approximately 200 million $MTCO_2e$ in 2016. If half the number of cars were driven to HHS every day but students or staff, that would have a significant impact on the rate at which GHGs are being emitted.

Co-Benefits

A co-benefit of carpooling is an economic gain. Since driving requires gas and gas requires money, people who carpool will save a significant amount of money by not paying for gas. This would provide improved air quality, reduced traffic congestion, and reduced commute times. The cost of road repairs and gas money spent would be reduced. Also, the amount of money that is spent on a car or parking passes could be shared among students, which would result in more parking spaces available. Through this action, we would also create a more cohesive community.

6.5.3 T-3: Bike Shelter

Encouraging students and staff to bike to school would decrease reliance on cars and buses which emit GHGs. A bike shelter could also include a solar-powered charging station for electric bikes.

Co-Benefits

Encouraging biking for students and staff would encourage exercising which is a health benefit. By reducing use of vehicles on the way to and from school, the morning traffic would be reduced, thereby decreasing emissions from idling cars and reduce traffic congestion.

6.6 SCHOOL BUSES

GHG emissions associated with school buses accounted for 24 percent of HHS's total GHG emissions in the 2015-16 school year. This section focuses on opportunities to reduce GHG emissions associated with the use of diesel-fueled school buses.

6.6.1 SB-1: Efficient School Bus System

A school bus system that is efficient and accessible will decrease the number of vehicles driven to school. This will reduce the number of cars commuting into Hanover. Having an efficient school bus system means having the fewest number of school buses possible to pick up students.

Co-Benefits

The price of fossil fuels will continue rising so the sooner we can reduce our reliance on them the more money and ghg emissions we can save. A more efficient school bus system will also benefit the social environment of the school because there will be an increase in the number of students that ride school buses, and therefore they will have a time to bond and make new friends. It will also cut down on traffic for commuters.

6.6.2 SB-2: Renewable Biodiesel in School Buses

School buses relying on biodiesel (or other renewable diesels) will reduce GHG emissions because they are not a fossil carbon-based fuel. School buses running on biodiesel would also allow for soaps, oils, beauty products, and alcohols to be repurposed instead of wasted.

Co-Benefits

There are economic, social, and environmental co-benefits to using biodiesel fuel in school buses. In terms of economic benefits, once a streamlined system is established to create and pump the biodiesel, the ingredients of the biodiesel are much cheaper than the cost of diesel. Also, using biofuel would begin to reduce the U.S.'s reliance on fossil fuels. Less tax money would be allocated to protecting our oil supplies overseas. This money could instead be diverted to develop local biofuel initiatives. Environmentally, soap, beauty products, and cooking oil can be easily acquired through partnerships with hotel or restaurant industries who are looking to repurpose/recycle some of their waste. Also, making biodiesel is significantly less energy-intensive than refining gasoline and diesel. Socially, there are air quality and public health benefits that result from using biodiesel instead of fossil fuels.

Anticipated GHG Reduction

2025: 766 $MTCO_2e$/year
2050: 766 $MTCO_2e$/year

6.6.3 SB-3: Electric School Buses

Electric school buses would significantly decrease fossil fuel emissions by switching energy from diesel fuel to electricity. The buses could be charged at solar-powered charging stations to eliminate GHG emissions associated with school buses.

Co-Benefits

Electric buses require less maintenance as there are fewer parts than an internal combustion engine. They are quieter, and do not release harmful gases and particulates into the atmosphere. Also, it protects the community from the risk of global oil price hikes.

6.6.4 SB-4: Bike and Ski Racks on School Buses

Bike and ski racks on school buses would encourage more students to ride the bus, instead of using their own cars. Some students may drive themselves to school because they cannot take their equipment on the bus. Bike racks could also encourage students to bike to their bus stop, instead of driving to their bus stop. More students riding the buses would reduce GHG emissions and fossil fuel consumption because they would not be driving their own fuel-consuming vehicles.

Co-Benefits

More students riding the bus could result in more available parking spaces, which could be used for EV charging stations. Students could bring their bike to school in the morning on the bus when it is cool, but bike home in the afternoon when it is warmer.

6.7 CAFETERIA

6.7.1 C-1: Buy Local Food

Use of locally-grown food from small farms in lieu of food produced on large scale industrial farms will decrease the amount of GHGs associated with production and transport of food to the school. For example, synthesis of chemical fertilizers used in conventional agriculture requires significant amounts of fossil fuels. It will also decrease the fuel needed to transport food to the school.

Co-Benefits
Conventional agriculture uses chemical pesticides which can harm pollinators, and the health of many other organisms, including humans. Chemical fertilizers can runoff into local waterways causing eutrophication. By offering locally-produced food in the cafeteria, HHS can support farmers that employ sustainable farming practices. Buying locally-grown food can also help grow the local economy by supporting small-scale farms.

6.7.2 C-2: Transition to reusable or compostable cutlery and dishes

Currently, compostable cutlery and dishes are used in the Cafe, but unfortunately is not accepted by the compost company employed by HHS and is therefore sent to the landfill. Using a dishwasher to wash reusable dishes and utensils would reduce the waste HHS is sending to the landfill and therefore reduce GHG emissions. An alternative to purchasing reusable cutlery would be to find a compost company that takes compostable cutlery.

Co-Benefits
A co-benefit of using reusable dishes/cutlery is financial savings from a decreased purchasing demand. Additionally, there will be less waste in the landfills. Reusable materials in the Cafe are more pleasant to eat with and will encourage students to set aside time for lunch, thus building community. The sales from the Cafe will increase as well when students feel morally better about supporting their business.

6.8 MISCELLANEOUS

6.8.1 M-1: Create CAP Team with Environmental Club

Creating a CAP team of students committed to this project within the Environmental Club that can work with B&G, the school's administration, and the Dresden School Board to implement the CAP for HHS is critical. Monthly meetings with a representative from each of these groups will help ensure effective communication, provide an opportunity to discuss effective strategies for implementing the CAP, and will also build community.

Co-Benefits
The co-benefits of the creation of this team include raising awareness of the urgency of addressing climate change in our own community. Further, students will learn that they can reduce their own carbon footprint by making small changes in their own behavior and thereby contribute to the success of the CAP.

6.8.2 M-2: Revise HHS Mission Statement to Reflect Climate Goals

Include the word “action” in HHS mission statement such that it reads: "action to reduce HHS GHG emissions and mitigate the impacts of climate change."

Incorporating "action" in the HHS mission statement will highlight the importance of implementing this CAP. Similar to the emphasis on minds, heart, and voices, this would reinforce the school's commitment to addressing climate change.

Co-Benefits
Students will be more motivated to lead and participate in GHG reduction measures.

6.9 SUMMARY

As noted in Table 4 above, the GHG reduction measures identified in this CAP would reduce HHS’s GHG emissions to well below the 2025 reduction target and make significant progress toward the longer-term 2050 reduction goal. Figure 6 below demonstrates how the reduction measures achieve the identified target.

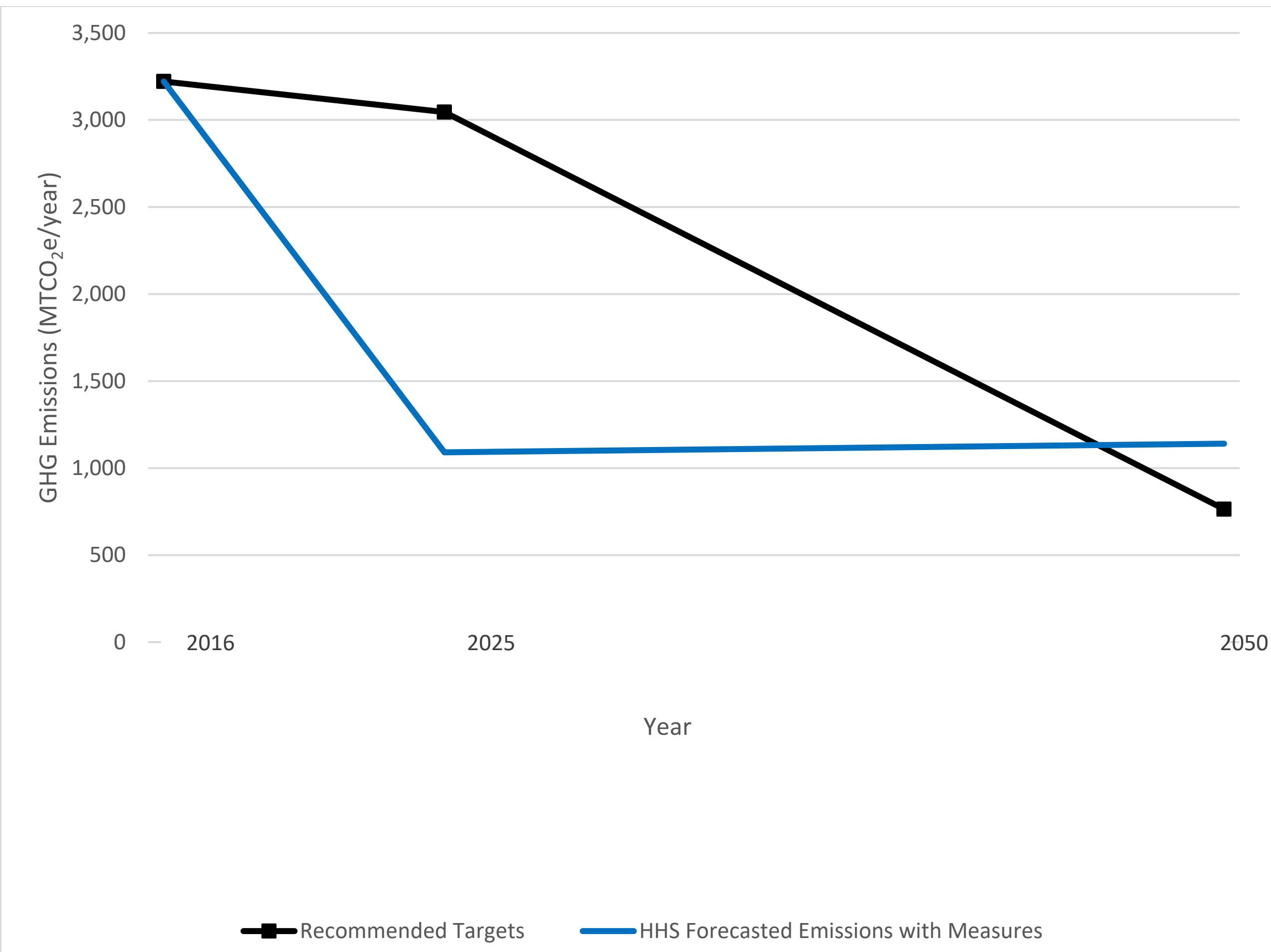

Figure 6. Hanover High School’s Forecasted Emissions with Implementation of Greenhouse Gas Reduction Measures

7 IMPLEMENTATION

Implementing each GHG reduction measure under the HHS CAP requires identifying the groups within the school that would be responsible for implementation, determining priority, anticipated cost, and timeframe required to complete the action. Priority and cost are categorized as low, medium, and high ($, $$, $$$ for cost) based on an analysis performed by the 2018-19 Earth Systems class. Timeframes are categorized as near-term (1 to 2 years), mid-term (3 to 6 years), and long term (more than 6 years). Table 5 below shows the implementation requirements of each GHG reduction measure.

Table 5 Implementation Matrix

Measure Number	Measure Description	Implementing Body	Priority	Cost	Timing
BE-1	Purchase certified sustainable wood chips	Building Administration	High	?	Near-term
BE-2	Upgrade heaters	Building Administration	Medium	$$$	Long-term
BE-3	Improved building insulation	Building Administration	High	$$$	Long-term
BE-4	EnergyStar®-rated appliances	Building Administration	High	$$	Long-term
BE-5	Energy audit of building	Building Administration	High	$$	Mid-term
BE-6	Install energy-efficient lighting	Building Administration	Low	$	Mid-term
BE-7	On-site renewable energy generation	Building Administration	Medium	$$$	Long-term
BE-8	Net metering	Building Administration	Medium	$	Long-term
SW-1	Compost used paper towels	Building Administration	Medium	$	Near-term
SW-2	Increase recycling and composting education	Environmental Club	High	$	Near-term
WA-1	Install dual-flush toilets	Building Administration	Low	$$	Long-term
TR-1	Electric vehicle charging stations	Building Administration	Medium	$$	Mid-term
TR-2	Carpool incentives for students	Building Administration Environmental Club / personally	Medium	$	Mid-term
TR-3	Bike shelter	Building Administration and Bike Club	High	$	Near-term
SB-1	Efficient school bus system	Building Administration	High	$	Near-term
SB-2	Renewable diesel in school buses	Building Administration	High	$$$	Mid-term
SB-3	Replace diesel-fueled school buses with electric versions	Building Administration	High	$$$	Long-term
SB-4	Bike and ski racks on school buses	Building Administration	Medium	$$	Mid-term
C-1	Buy local food	Building Administration and Environmental Club and Cafe Services	Medium	$$	Mid-term
C-2	Transition to reusable/compostable cutlery and dishes	Cafeteria	Medium	$	Mid-term
M-1	Create CAP team with Environmental Club	Environmental Club	High	$	Near-term
M-2	Revise HHS Mission Statement to reflect climate goals	HHS Council	Low	$	Mid-term

Notes: GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; N/A = not applicable; CAP = Climate Action Plan.

8 ACKNOWLEDGEMENTS

The students and teacher of HHS's Earth Systems and Ecological Design class would like to thank Hannah Kornfeld for providing guidance throughout this project, and for her significant contributions to helping write and edit this report. The Earth Systems class would also like to thank Educating for Sustainability consultant Scott Stokoe, Director of Facilities Anthony Daigle, and Principal Justin Campbell for their feedback and support.

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