



**GRAND VALLEY
STATE UNIVERSITY**

Climate Action Plan

Working Report 2018



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Acknowledgements:

This report was compiled by the Climate Action Committee at Grand Valley State University. This committee consists of contributors from departments and areas throughout the campus community. The committee members have also relied on other collaborators in their departments and throughout the University to acquire the essential information to complete this document.

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Abbreviations:

| | |
|---------------------|--|
| ACUPCC | American College and University Presidents' Climate Commitment |
| CSW | Campus Sustainability Week |
| EPA | Environmental Protection Agency (US) |
| GHG | Greenhouse Gas |
| GVSU | Grand Valley State University |
| HFC | Hydrofluorocarbons |
| LEED | Leadership in Energy and Environmental Design |
| MTCO ₂ e | Metric Tons of Carbon Dioxide Equivalent |
| SAP | Sustainable Agriculture Project |
| SEC | Student Environmental Coalition |
| WRI | World Research Institute |

Executive Summary:

As a signatory of the American College and University Presidents' Climate Commitment (ACUPCC) on October 4, 2007, Grand Valley State University created the GVSU Climate Action Committee to determine the organization's carbon footprint. In addition, the Committee was tasked with analyzing the relevant data, projecting future greenhouse gas (GHG) emissions, and creating a plan to set the university on a path toward carbon neutrality.

The original Climate Action Plan was submitted to the ACUPCC in January 2010. An update was submitted in January 2012. This document is the second update, and additional updates will be submitted every two years moving forward.

The Climate Action Committee has recommended a plan that includes three phases. The progress of each phase will be measured against the baseline year of Fiscal Year 2006.

Phase 1: Conservation and Reduction (2010-2020)

Goal: To reduce GHG emissions by 20% from the 2006 benchmark

Phase 2: Renewable and Alternative Energy (2021-2030)

Goal: To reduce GHG emissions by 50% from the 2006 benchmark

Phase 3: Innovation and Efficiency (2031-2050)

Goal: To achieve carbon neutrality via innovation and technology upgrades.

The phases and primary GHG (Scope 1 and Scope 2) reduction goals were determined by the GVSU Climate Action Committee by using the Clean Air Cool Planet software to analyze emissions, both current and projected. The projections were used to set goals. Two additional goals were added in 2012 to include Scope 3 Emissions. While the calculation of Scope 3 Emissions is less certain, efforts are being made to improve the metrics to confirm an 80% reduction in total GHG emissions by 2050.

Introduction:

The roots of environmental sustainability at GVSU have been highlighted for decades, as GVSU's approximately 1,200 acre main campus in Allendale, Michigan co-exists with nature in a suburban setting. Adjacent to the main campus are deep ravines, farmland, GVSU's golf course (appropriately named The Meadows), the Grand River and Ottawa Creek, and other open space. Through the years, GVSU has developed and implemented several campus master plans to help accommodate GVSU's growth. These plans include restoration and preservation of natural environments to ensure that GVSU remains a good steward of the environment. GVSU has progressed and includes Leadership in Energy and Environmental Design (LEED) building standards into a policy for all future new building design and construction. As of June 2018, GVSU has completed 25 LEED certified building projects, with an additional building in the certification process. A list of GVSU's LEED certified projects can be found here:

https://www.gvsu.edu/cms4/asset/83D77566-0FCE-1482-0E85CB93ACE30B91/leed_projects_082218.pdf

GVSU has also developed an action plan centered around improving energy efficiency on campus. GVSU saves approximately \$1.8 million in energy costs annually due to a variety of projects and initiatives including: the installation of economizers in the smoke stacks, insulating steam pipes, installing variable frequency drives, control replacements, and lighting changes. In addition, GVSU has saved \$1.5 million on yearly implemented projects and procedures over the past thirteen years. GVSU has been investing these avoided costs into new energy projects.

Over the last few years, GVSU has also focused its efforts on improving its recycling rates and minimizing the overall generation of waste. GVSU has participated in the annual national RecycleMania competition, dramatically increasing recycling in many categories campus-wide. In 2009, GVSU began a composting trial in its campus dining facilities. The program was expanded in 2010 to include all dining areas, and again in 2011 to include paper towel from restrooms and a trial in an academic building. In FY2013, the university diverted 43% of its waste from the landfill. In 2014, composting was implemented in all of the living centers with the hopes of diverting even more. Additionally, the university opened a Surplus Store that has diverted over 500,000 pounds from the landfill since it opened in 2014.

With all of these ongoing environmental stewardship programs - improving the built environment, embedding sustainability in the curriculum, increasing energy efficiency, and reducing the amount of waste generated - the next step was the development of a climate neutrality plan. The first Climate Action Plan was completed in January 2010. The plan is updated every two years, to evaluate if emissions reductions are following the previous estimates and what changes need to be made if the trajectory has changed. This document is the fourth update to the 2010 Climate Action Plan.

Project Background:

Grand Valley State University attracts over 25,000 students with its academic excellence, first-rate faculty, and state-of-the-art facilities. GVSU is the comprehensive university for Michigan's second largest metropolitan area. It has campuses in Allendale, Grand Rapids, and Holland. It also has centers in Muskegon and Traverse City.

Thomas J. Haas is the president of GVSU and signatory of the American College and University Presidents Climate Commitment (ACUPCC). The Commitment was signed October 4, 2007. As a signatory, the university has committed to, and fulfilled, the following:

- Established a policy that all new campus construction and major renovations will be built to the U.S. Green Building Council's LEED Silver standard or higher
- Adopted an energy-efficient appliance purchasing policy requiring purchase of ENERGY STAR® certified products in all areas for which such ratings exist
- Encouraged the use of, and provide access to, public transportation for all faculty, staff, students, and visitors
- Participated in the Waste Minimization component of the national RecycleMania competition each year since 2008, and implemented composting, e-waste recycling, and a paperless classroom program.
- Developed a CO₂e baseline inventory for 2006 and established accompanying data from 2001 to 2011
- Developed a “business as usual” CO₂e inventory, projected to the year 2050
- Completed the first Climate Action Plan in 2010

The GVSU Climate Action Plan is intended to clarify the path toward carbon neutrality. GVSU anticipates further planning and adjustments to its greenhouse gas inventory as new information and data become available. An inventory is calculated every year, and the plan is updated bi-annually.

GVSU's Greenhouse Gas Inventory:

Campus Emissions:

The Climate Action Committee calculated a baseline greenhouse gas inventory of GVSU for FY2006 and did subsequent inventories each year through FY2014. Greenhouse gas emissions are expressed in metric tons of carbon dioxide equivalent (MT eCO₂). This is a common way to represent the six greenhouse gases regulated under the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydro fluorocarbons, and per fluorocarbons). Signatories are expected to calculate the emissions of each gas separately and aggregate them into carbon equivalent units based on each gas global warming potential.

Scopes:

To help delineate direct and indirect emission sources, improve transparency, facilitate fair comparisons, and provide utility for different types of organizations and different climate policies and goals, the GHG Protocol defines three "scopes" for GHG accounting and reporting purposes.

Scope 1 refers to direct GHG emissions occurring from sources that are owned or controlled by the institution, including: on-campus stationary combustion of fossil fuels; mobile combustion of fossil fuels by institution owned/controlled vehicles; and "fugitive" emissions. Fugitive emissions result from intentional or unintentional releases of GHGs, including the leakage of HFCs from refrigeration and air conditioning equipment.

Scope 2 refers to indirect emissions generated in the production of electricity consumed by the institution and thermal energy purchased.

Scope 3 refers to all other indirect emissions -- those that are a consequence of the activities of the institution, but occur from sources not owned or controlled by the institution.

Consistent with the standards for World Research Institute (WRI) GHG Protocol, the ACUPCC signatories agree to account for, and report on, emissions from Scopes 1 and 2. In addition, as specified in the Commitment, signatories agree to report some Scope 3 emissions, specifically those from air travel paid for by or through the institution and regular commuting to and from campus (to the extent that data are available). For the purposes of the Commitment, commuting is defined as travel to and from campus on a day-to-day basis by students, faculty, and staff. It does not include student travel to and from campus at the beginning and end of term or during break periods.

Inventory Methodologies:

The methodology used to calculate the GVSU greenhouse gas inventory primarily follows the ACUPCC implementation guide (first version 1.1 beginning in 2009, and then version 2.1 beginning in 2012). The ACUPCC guide also recommended the use of Clean Air Cool Planet software to aid in the inventory calculation, which was used for the GVSU assessment. The Clean Air Cool Planet calculator is consistent with the Greenhouse Gas Protocol put forth by the World Research Institute (WRI). In FY2017, Clean Air Cool Planet v. 9.0 was used. In FY2018, Grand Valley State University made the decision to switch to the World Resource Institute's Greenhouse Gas Protocol.

GVSU's Carbon Footprint:

In the base year of FY2006, GVSU's primary greenhouse gas (GHG) emissions (Scopes 1 and 2) were 57,260 MT eCO₂ (metric tons of carbon dioxide equivalent). In FY2014, GVSU's primary GHG were 57,951 MT eCO₂. This represents an increase of 691 MT eCO₂. During the same period, the number of faculty, staff, and students increased by 2,315. An additional 1,130,540 square feet of built space was also constructed.

As of FY2014, GVSU had reduced its MT eCO₂ emissions per square foot by 20.30%, achieving its first goal ahead of schedule. GVSU also reduced its MT eCO₂ emissions per faculty, staff, and student by 7.14%.

It should also be noted that the Environmental Protection Agency adjusted their grid for 2007 and subsequent years, resulting in 2,100 MTCO_{2e} more emissions per year.

The Scope 3 emissions add 31,112.5 MT eCO₂ to the inventory, for a total of 89,004.6 in FY2014. Compared to Fiscal Year 2006, the total GHG emissions (Scopes 1, 2, and 3), fell 19.39% per square foot and 6.07% per faculty, staff, and student. Reductions can be attributed to previously enacted conservation, efficiency improvements, and behavior-changing programs. While these numbers seem positive, without the implementation of additional mitigation strategies, GHG emissions are projected to increase 1-2% per year until 2050.

GVSU's Climate Action Plan Methodologies:

Scope 1

On Campus Stationary Sources

Stationary combustion sources on campus include dual-fueled boilers using distillate oil and natural gas to produce steam. There are also six relatively small users of propane on campus. The input data for the scope 1 emissions followed the implementation guide. Usage data was gathered from fuel purchasing records dating back to 2001.

University Fleet Vehicles

GVSU owns a fleet of gasoline and diesel powered vehicles that are used for transportation and maintenance. Again, the data was input following the implementation guide, and purchasing records were gathered dating back to 2001.

Refrigerants and Chemicals

Consistent with the GHG Protocol, the release of emissions from refrigerants is considered less than 5% of the university's inventory, therefore chemical release was classified as de minimis and not included in the inventory.

Agriculture Sources

Synthetic fertilizer has been purchased with 21% nitrogen content since 2001, and 22.5% since 2011. The amount purchased has been documented according to the recommended protocol.

Scope 2

Purchased Energy

Emissions attributed to purchased electricity and thermal energy are specific to each region, as the conversion factor of the local grid is taken into account. GVSU's data was gathered from purchasing records and then added to the Clean Air-Cool Planet calculator for the sub-region conversion.

Scope 3

Air Travel

Scope 3 emissions have proven to be more difficult to assess. Air travel for faculty has always been documented on a cost basis but not on a mileage basis. In the 2010 Climate Action Plan, a sample of faculty air travel was reviewed. Each trip was researched to ascertain miles traveled. Miles traveled per dollar spent was then extrapolated over the faculty air travel from 2001 to 2009. For the 2010 report, an effort was made to calculate all air miles traveled. Because this methodology varies greatly from that of 2010, comparisons have not been emphasized from 2001-2009. From Fiscal Years 2010-2014, Scope 3 emissions increased by 6,824.5 eCO₂, but again, the ability to collect more data has likely contributed to that increase.

Student air travel is predominately done by athletic teams. For this group, the travel information was gathered from 2011 for each athletic event with miles calculated from Grand Rapids to the destinations nearest commercial airports. GVSU athletic team event participation has remained relatively constant from year to year, so the same student travel figures were used for every year since 2001. The Study Abroad travel is not paid for, nor reimbursed by Grand Valley, so implementation guidelines were followed and the corresponding emissions were not aggregated to the inventory.

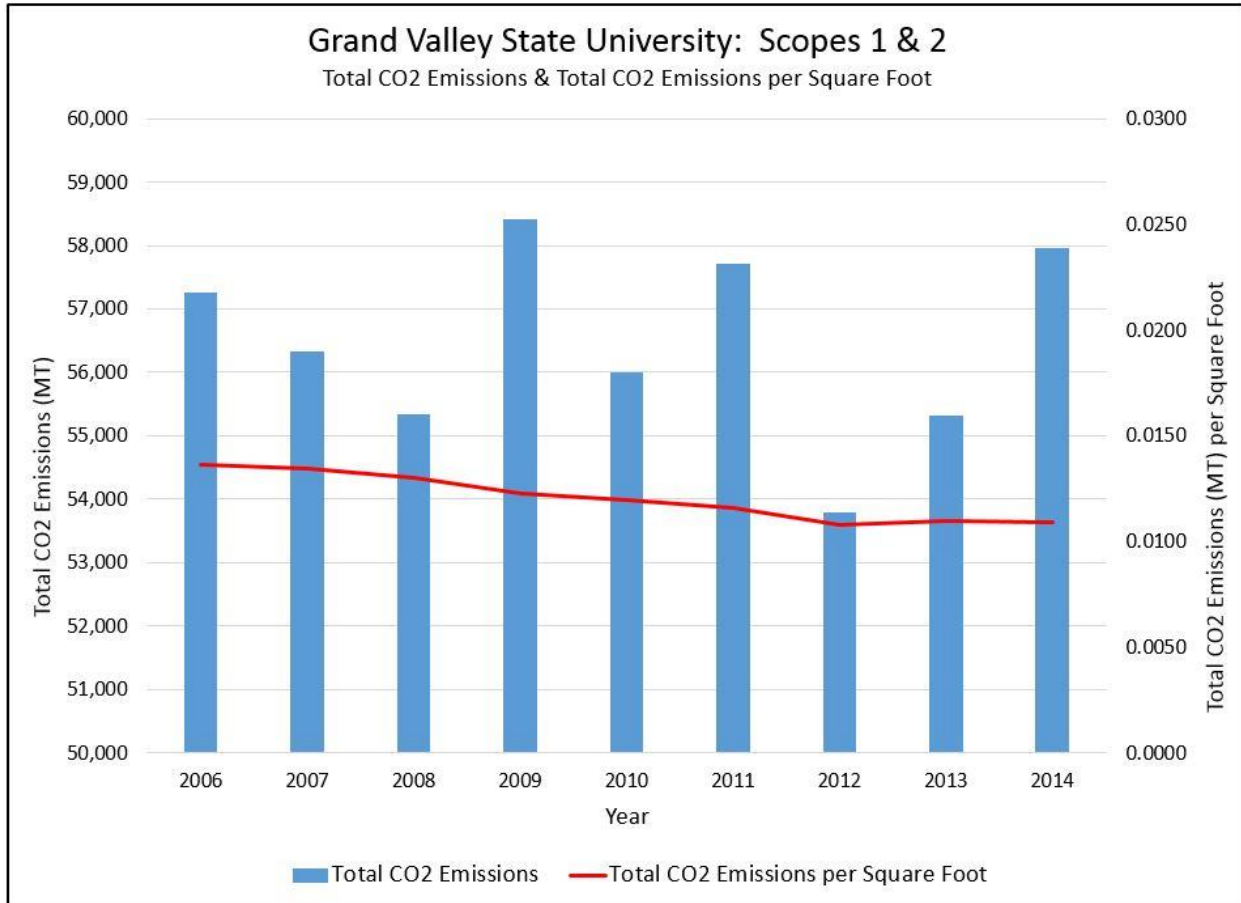
Commuting

Collecting data for an accurate commuter emission inventory can be challenging and after the work is completed, there is a great deal of subjectivity used in garnering a final tally. The methodology used to calculate student commuting started with a survey of bus riders. The survey revealed that 41% of student passengers also had commuting parking passes. In Fiscal Year 2009, there were 10,500 commuter parking passes issued and another 5,464 students lived on campus. Given these details, 1,845 students were deducted from the bus rider and parking pass totals to avoid duplication. The totals of 7,155 bus riders, 8,655 drivers, and 5,464 campus residents were then used in proportion to the student population to represent each category's commuting percentage (25% campus residents, 33% bus riders, 39% automobile drivers). The remaining 3% of the student body was assumed to be carpoolers. Bus ridership data also show the average trip covering slightly less than nine miles, with students participating twice a day, five times per week. Student drivers were estimated to take five round trips to campus during the week at an average distance of 10 miles each way. A school year consisting of 32 weeks was used. All staff and faculty parking pass holders were considered to be automobile driving commuters. Each pass holder was estimated to travel to campus and back five times with an average distance of 15 miles each way, over a period of 32 weeks.

Looking Forward:

GVSU has a strong history of conserving resources and increasing its efficiencies, and now factors its carbon footprint into its strategies and decision-making processes. Capital projects consider both the long-term cost of energy and ways to offset those expenditures. Capital projects are evaluated not only on the initial cost outlay and expected payback years, but also the project's impact on GHG emissions. The Princeton Review's "College Hopes and Worries Survey" showed that over two-thirds of student applicants said they would "value having information about a college's commitment to the environment." The Climate Action Plan is an opportunity for GVSU to document its commitment to the environment, and to showcase its continued efforts to promote a sustainable lifestyle for its faculty, staff, students, and visitors.

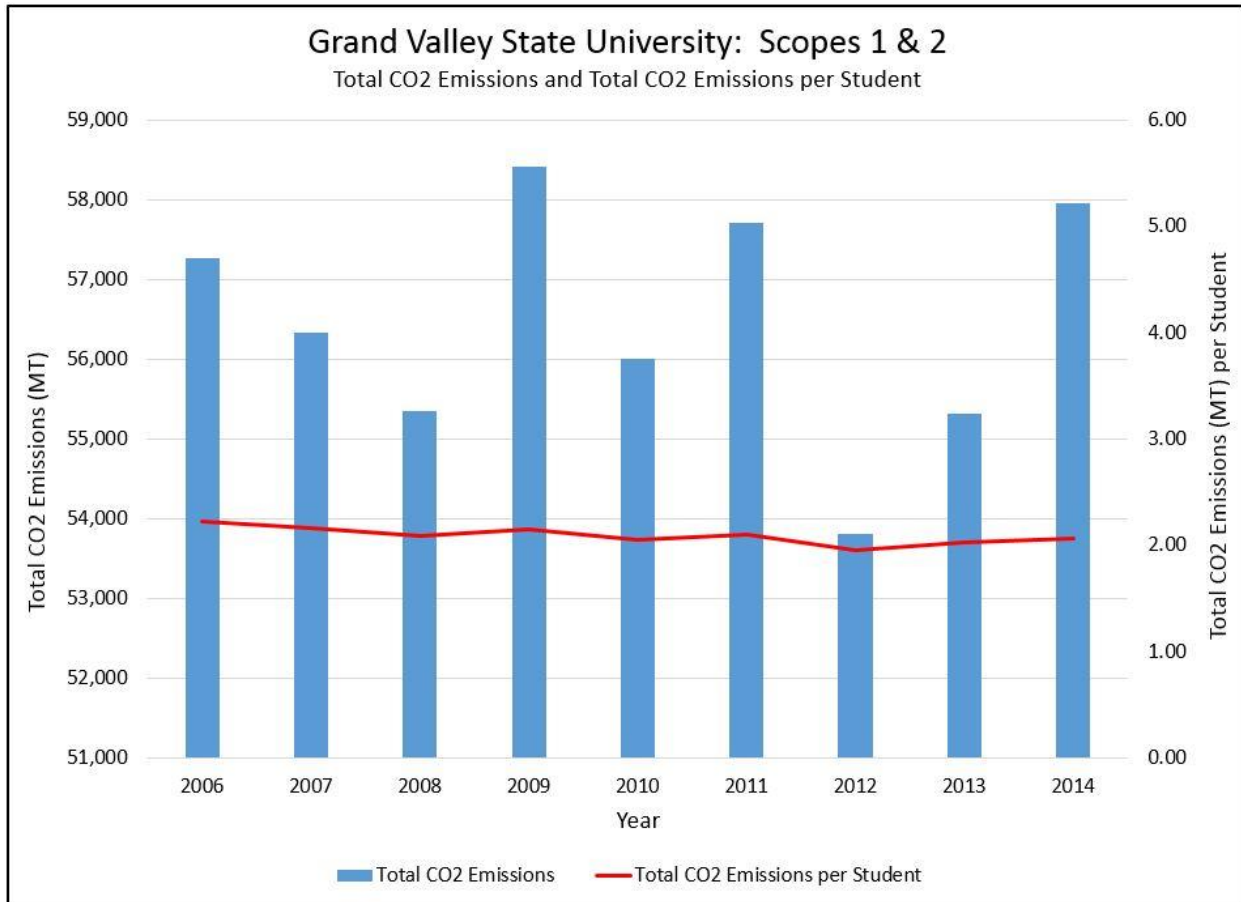
Summary of the Inventory:



Graph Summary

The FY2011 Scopes 1 and 2 emissions as a percentage of built square footage have fallen by 14.7% since FY2006. LEED building standards have been followed on new construction and significant remodeling projects since 2004.

The FY2014 Scopes 1 and 2 emissions per square foot have fallen by 20.30% since the baseline year of FY2006. All new building projects are designed to a minimum of LEED Silver standards, and GVSU received its first LEED Platinum certification in September 2014.



Graph Summary

The FY2011 Scopes 1 and 2 emissions reveal a 1.49% increase from the base year of FY2006 but a 9.5% decrease on a per student basis. The 2011 GHG inventory for Scope 1 and 2 emissions stands at 57,628 MT CO₂e. The slight increase in the footprint can be partly attributed to a change in the EPA grid calculation for years 2007 to present, and the university's rapid growth over the last ten years.

The FY014 Scopes 1 and 2 emissions per student have fallen by 7.13% since the baseline year of FY2006. This represents a slight increase over the FY2011 percentage, which can be attributed to the university's rapid growth.

Greenhouse Gas Mitigation Phases:

As mentioned previously, GVSU has been a leader in sustainable efforts that address all facets of the university. Recycling, waste reduction, behavioral change programs, and mass transit promotions have all made significant reductions to the overall carbon footprint of GVSU. These are just a few of the strategies that have already led to decreases in CO₂ emissions based on per student and square footage basis. Indeed these successful programs will continue. Because the strategies cover an extensive period of time, the Climate Action Committee has decided to break up the projects into three phases. The first will start immediately and run until 2020. The second phase will be from 2021-2030. The third phase will be from 2031-2050.

Phase 1

Phase 1 begins immediately with a list of projects, some of which are already under development. Even though all strategies listed are tentative, it is the projects in this first phase that the committee is most confident. The university will also see emission reductions from state mandated increases in renewable energy from power companies.

The follow efforts will be used in Phase 1:

- Behavioral Changes Campaign
- Energy Reduction Projects
- All new buildings to be LEED Silver compliant
- Mechanical Building Enhancements
- Lighting Replacement
- Installation of CO₂/Occupancy sensors
- Campus-wide Composting
- Novar Controls Replacement
- Utility Company's Renewable Energy Additions
- Replacement of 1280 Trane Chiller with Electric Chiller
- Purchase of 10% Wind Power
- Installation of Woodchip Boiler

Phase 1 Projects Previously Implemented

| Year | Project Description | Category | KWH Cost | KWH | mmBTU Cost | mmBTU* | Cumulative mmBTU (since project) | Annual GHG Reduction | Annual Savings |
|---------|--|----------|----------|---------|------------|--------|----------------------------------|----------------------|----------------|
| 2010 | Novar Controls Replacement - EC | Both | 0.0760 | 0 | 8.61 | 0 | 0 | 439 | \$30,000.00 |
| 2010 | Novar Controls Replacement - DeVos | Both | 0.0760 | 0 | 8.61 | 0 | 0 | 707.23 | \$48,250.00 |
| 2010 | Steam Traps - Phase 2 | Gas | | | 8.61 | 11,034 | 22,067 | 600.6 | \$95,000.00 |
| 2010 | Thermal Installation - Tunnel Steam Pipes | Gas | | | 8.61 | 15,099 | 30,197 | 821.86 | \$130,000.00 |
| 2010 | VFD's, Chilled Water, Occupancy Sensors, Actuators | Electric | 0.0760 | 670,341 | | 2,287 | 4,574 | 548 | \$50,945.95 |
| 2010 | DDC Controls | Electric | 0.0760 | 822,368 | | 2,806 | 5,612 | 673 | \$62,500.00 |
| 2010 | Lighting Projects | Electric | 0.0760 | 164,474 | | 561 | 1,122 | 135 | \$12,500.00 |
| | | | | | | 31,787 | 63,573 | 3,925 | |
| 2011 | Parking Lot Lighting - Pew Campus Ramp | Electric | 0.0770 | 519,481 | | 1,772 | 1,772 | 425 | \$40,000.00 |
| 2011 | CHS Lighting and Recomissioning Project | Both | 0.0770 | 415,584 | 6.88 | 1,418 | 1,418 | 417.18 | \$32,000.00 |
| 2011 | CHS Pony Boilers | Gas | | | 6.88 | 4,724 | 4,724 | 257.14 | \$32,500.00 |
| 2011 | Lighting Replacement | Electric | 0.0770 | 324,675 | | 1,108 | 1,108 | 266 | \$25,000.00 |
| 2011 | VFD's, Occupancy Sensors, Actuators | Electric | 0.0770 | 324,675 | | 1,108 | 1,108 | 266 | \$25,000.00 |
| 2011 | Lot O - Exterior Lighting - LED | Electric | 0.0770 | 28,571 | | 97 | 97 | 23.4 | \$2,200.00 |
| | | | | | | 10,227 | 10,227 | 1,655 | |
| 2010-11 | Grand Total of mmBTU's | | | | | | 73,801 | 5,579.62 | \$585,895.95 |

Phase 1 Mitigation Projects, Timeline, and Carbon Reductions

MTCO2E PER YEAR

| <u>YEAR</u> | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|--|------|------|------|------|------|------|------|------|
| <u>PROJECTS</u> | | | | | | | | |
| Padnos/Henry Heat Recovery System | - | - | - | 770 | 770 | 770 | 770 | 770 |
| Digital Demand Control - LSH, FH, Rec Center | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 |
| Lighting Replacement FH, LSH, Pew Ramp, MAN, PAC, LAT, CDC, LHH, ASH, Devos - Rescheduling Pew Ramp | 496 | 496 | 496 | 496 | 496 | 496 | 496 | 496 |

| | | | | | | | | |
|---|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| De-lighting in Buildings | - | - | - | 513 | 513 | 513 | 513 | 513 |
| Behavioral Change to reduce natural gas and electrical consumption by .5% per year | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 21 |
| Housing and academic Building shutdowns - Summer | - | 63 | 63 | 63 | 63 | 63 | 63 | 63 |
| Air Handling Unit - roof top replacement ASH, PAC | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Replace Roof of COM | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| Install CO2 sensors in all labs of CHS | - | - | - | 87 | 87 | 87 | 87 | 87 |
| Installation of occupancy/CO2 sensors in CHS offices | - | 475 | 475 | 475 | 475 | 475 | 475 | 475 |
| Woodchip Boiler | - | - | - | 5483 | 5483 | 5483 | 5483 | 5483 |
| Replace current 1280 Trane chiller with 1200 ton electric chiller | - | - | - | 816 | 816 | 816 | 816 | 816 |
| Adjust Winter/Summer set points by two degrees | - | - | - | 1540 | 1540 | 1540 | 1540 | 1540 |
| Steam Trap Replacement | 613 | 613 | 613 | 613 | 613 | 613 | 613 | 613 |
| Outside Lighting Retrofits - Phase 1 and 2 | - | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| CUB Boiler Controls | - | - | - | 1 | 1 | 1 | 1 | 1 |
| VFD Air Handlers - EC | - | - | - | 94 | 94 | 94 | 94 | 94 |
| Purchasing 10% Green-E RECs | - | - | - | 4872 | 4872 | 4872 | 4872 | 4872 |
| Purchase Green-E RECs for the Pew Library (\$1.55) | - | 269 | 269 | - | - | - | - | - |
| All Projects | 1261 | 2103 | 2103 | 2049 | 2049 | 2049 | 2049 | 2049 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Emissions | 6628 | 6787 | 6946 | 7105 | 7264 | 7423 | 7582 | 7741 |
| | 0 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |
| GVSU NET EMISSIONS AFTER MITIGATION (MTCO2e) | 6501 | 6576 | 6735 | 5056 | 5215 | 5374 | 5533 | 5692 |
| | 9 | 8 | 8 | 1 | 2 | 1 | 1 | 1 |

Phase 2

The second phase will begin in 2020 and conclude at the end of 2029. This decade looks to usher in some ambitious capital projects. The State of Michigan requires energy producers to increase the percentage of renewable supply to 25% by 2025. This increase will assist GHG reduction efforts.

- Behavioral Changes Campaign
- Energy Reduction Projects
- Mechanical and building enhancements
- Upgrade all traditional buildings to LEED specifications
- Purchasing 10% Green Power
- Purchasing 10% Wind Power
- Purchasing an additional 20% alternative energy
- Utility company renewable energy additions
- 1.65 mW Wind Turbine

Phase 2 Mitigation Projects, Timeline, and Carbon Reductions

MTCO₂e PER YEAR

| <u>YEA R</u> | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 |
|--|------|------|------|------|------|------|------|------|------|------|
| <u>PROJECTS</u> | | | | | | | | | | |
| Padnos/Henry Heat Recovery System | 770 | 770 | 770 | 770 | 770 | 770 | 770 | 770 | 770 | 770 |
| Digital Demand Control - LSH, FH, Rec Center | 110 | 110 | 110 | 110 | 110 | 110 | 110 | - | - | - |
| Lighting Replacement FH, LSH, Pew Ramp, MAN, PAC, LAT, CDC, LHH, ASH, Devos - Rescheduling Pew Ramp | 497 | 497 | 497 | 497 | 497 | 497 | 497 | 497 | 497 | 497 |
| De-lighting in Buildings | 513) | 513 | 513 | 513 | 513 | 513 | 513 | 513 | 513 | 513 |
| Behavioral Change to | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 |

| | | | | | | | | | | |
|---|------|------|------|------|------|------|------|------|------|------|
| reduce natural gas and electrical consumption by .5% per year | | | | | | | | | | |
| Housing and academic Building shutdowns - Summer | 63 | 63 | 63 | 63 | 63 | 63 | 63 | 63 | 63 | 63 |
| Air Handling Unit - roof top replacement ASH, PAC | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Replace Roof of COM | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| Install CO2 sensors in all labs of CHS | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 |
| Installation of occupancy/CO2 sensors in CHS offices | 475 | 475 | 475 | 475 | 475 | 475 | 475 | 475 | - | - |
| Woodchip Boiler | 5483 | 5483 | 5483 | 5483 | 5483 | 5483 | 5483 | 5483 | 5483 | 5483 |
| Replace current 1280 Trane chiller with 1200 ton electric chiller | 816 | 816 | 816 | 816 | 816 | 816 | 816 | 816 | 816 | 816 |
| Adjust Winter/Summer set points by two degrees | 1540 | 1540 | 1540 | 1540 | 1540 | 1540 | 1540 | 1540 | 1540 | 1540 |
| Steam Trap Replacement | 613 | 613 | 613 | 613 | 613 | 613 | 613 | 613 | 613 | 613 |
| Outside Lighting Retrofits - Phase 1 and 2 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | (34 |
| Carbon Offsets | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 |
| CUB Boiler Controls | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| | | | | | | | | | | |
|--|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Wind Turbine 1.65 MW | - | - | - | - | - | 2175 | 2175 | 2175 | 2175 | 2175 |
| CAC Boiler Projects- update controls and heat pumps | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 |
| VFD Air Handlers - EC | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 |
| Purchasing 20% Renewable Green-E RECs (Est. \$5 per MWH) | 1095 9 | 1095 9 | 1095 9 | 1095 9 | 1095 9 | 1095 9 | 1095 9 | 1095 9 | 1095 9 | 1095 9 |
| Renewable additions to grid per state of MI RPS (10% by 2015) | 4480 | 4480 | 4480 | 4480 | 4480 | - | - | - | - | - |
| Renewable Additions to grid per state of MI RPS proposal (25% by 2025) | - | - | - | - | - | 1521 9 | 1521 9 | 1521 9 | 1521 9 | 1521 9 |
| LEED Silver building upgrades to all traditional buildings (10% efficiency improvement on 80% of the 2009 square footage) | 4373 | 4373 | 4373 | 4373 | 4373 | 4373 | 4373 | 4373 | 4373 | 4373 |
| All Projects | 3598 9 | 3598 9 | 3598 9 | 3598 9 | 3598 9 | 4890 3 | 4890 3 | 4879 2 | 4831 8 | 4831 8 |
| Total Emissions | 7900 2 | 8059 2 | 8218 2 | 8377 2 | 8536 2 | 8695 2 | 8854 2 | 9013 2 | 9172 2 | 9331 2 |
| GVSU NET EMISSIONS AFTER MITIGATION (MTCO2e) | 4301 3 | 4460 3 | 4619 3 | 4778 3 | 4937 3 | 3804 9 | 3969 3 | 4134 0 | 4440 4 | 4499 4 |

Phase 3

The third phase will start in 2030 and run through 2050. Key components include the assumption that innovations at that time will provide incentives to add a diverse array of renewable energy sources to the campus. It is anticipated that carbon neutrality can be accomplished during this phase by adding these renewable energy innovations and augmenting those reductions with carbon offsets.

- Energy Reduction Projects
- Behavioral Changes Projects
- Purchasing an additional 20% alternative energy
- Photovoltaic panels to supply 20% of university electricity
- Geo-thermal to provide 20% of heating and cooling needs
- Utility Company Increasing Purchases of Small Nuclear Power
- Traditional building upgrades to LEED Silver specifications

Phase 3 Mitigation Projects, Timeline, and Carbon Reductions

MTCO₂e PER YEAR

| <u>YEA</u> <u>R</u> | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 |
|--|------|------|------|------|------|------|------|------|------|------|
| <u>PROJECT</u> <u>NAME</u> | | | | | | | | | | |
| Padnos/Henry Heat Recovery System | 770 | 770 | 770 | 770 | 770 | 770 | 770 | 770 | 770 | 770 |
| Lighting Replacement FH, LSH, Pew Ramp, MAN, PAC, LAT, CDC, LHH, ASH, Devos - Rescheduling Pew Ramp | 497 | 497 | - | - | - | - | - | - | - | - |
| De-lighting in Buildings | 513 | 513 | 513 | 513 | 513 | 513 | 513 | 513 | 513 | 513 |
| Behavioral Change to reduce natural gas and electrical | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 |

| | | | | | | | | | | |
|---|------|------|------|------|------|------|------|------|------|------|
| consumption by .5% per year | | | | | | | | | | |
| Housing and academic Building shutdowns - Summer | 63 | 63 | 63 | 63 | 63 | 63 | 63 | 63 | 63 | 63 |
| Air Handling Unit - roof top replacement ASH, PAC | 14 | 14 | 14 | 14 | 14 | 14 | 14 | - | - | - |
| Replace Roof of COM | 6 | 6 | 6 | 6 | 6 | 6 | 6 | - | - | - |
| Woodchip Boiler | 5483 | 5483 | 5483 | 5483 | 5483 | 5483 | 5483 | 5483 | 5483 | 5483 |
| Replace current 1280 Trane chiller with 1200 ton electric chiller | 816 | 816 | 816 | 816 | 816 | 816 | 816 | 816 | 816 | 816 |
| Adjust Winter/Summer set points by two degrees | 1540 | 1540 | 1540 | 1540 | 1540 | 1540 | 1540 | 1540 | 1540 | 1540 |
| Steam Trap Replacement | 613 | 613 | - | - | - | - | - | - | - | - |
| Outside Lighting Retrofits - Phase 1 and 2 | 34 | 34 | 34 | - | - | - | - | - | - | - |
| CUB Boiler Controls | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - |
| Wind Turbine 1.65 MW | 2175 | 2175 | 2175 | 2175 | 2175 | 2175 | 2175 | 2175 | 2175 | 2175 |
| CAC Boiler Projects-update controls and heat pumps | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 38 |

| | | | | | | | | | | |
|---|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| VFD Air Handlers - EC | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 |
| Purchasing 20% Renewable Green-E RECs (Est. \$5 per MWH) | 10959 | 10959 | 10959 | 10959 | 10959 | 10959 | 10959 | 10959 | 10959 | 10959 |
| Carbon Offsets | 9000 | 9000 | 9000 | 9000 | 9000 | 9000 | 9000 | 9000 | 9000 | 9000 |
| Purchasing an additional 20% alternative energy (Est. \$7 per MWH) | 13391 | 13391 | 13391 | 13391 | 13391 | 13391 | 13391 | 13391 | 13391 | 13391 |
| Renewable Additions to grid per state of MI RPS proposal (25% by 2025) | 15219 | 15219 | 15219 | 15219 | 15219 | 15219 | 15219 | 15219 | 15219 | 15219 |
| Utility Companies producing 10% more nuclear energy | 5584 | 5584 | 5584 | 5584 | 5584 | 5584 | 5584 | 5584 | 5584 | 5584 |
| Photovoltaic and Geothermal projects cut to natural gas and electricity purchases by 20% | 11375 | 11375 | 11375 | 11375 | 11375 | 11375 | 11375 | 11375 | 11375 | 11375 |
| LEED Silver building upgrades to all traditional buildings (10% efficiency improvement) | 4373 | 4373 | 4373 | 4373 | 4373 | 4373 | 4373 | 4373 | 4373 | 4373 |

| | | | | | | | | | | |
|--|-------------------|-------------------|-------------------|-------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| on 80% of the 2009 square footage) | | | | | | | | | | |
| All Projects | 825 80 | 825 81 | 814 71 | 814 37 | 8143 7 | 8143 6 | 8143 6 | 8141 7 | 8141 7 | 8141 7 |
| Total Emissions | 949 02 | 964 93 | 980 83 | 996 73 | 1012 63 | 1028 53 | 1044 43 | 1060 33 | 1076 23 | 1092 13 |
| GVSU NET EMISSIONS AFTER MITIGATION (MTCO_{2e}) | 123 22 | 139 12 | 166 12 | 182 36 | 1982 6 | 2141 7 | 2300 7 | 2461 6 | 2620 6 | 2779 6 |

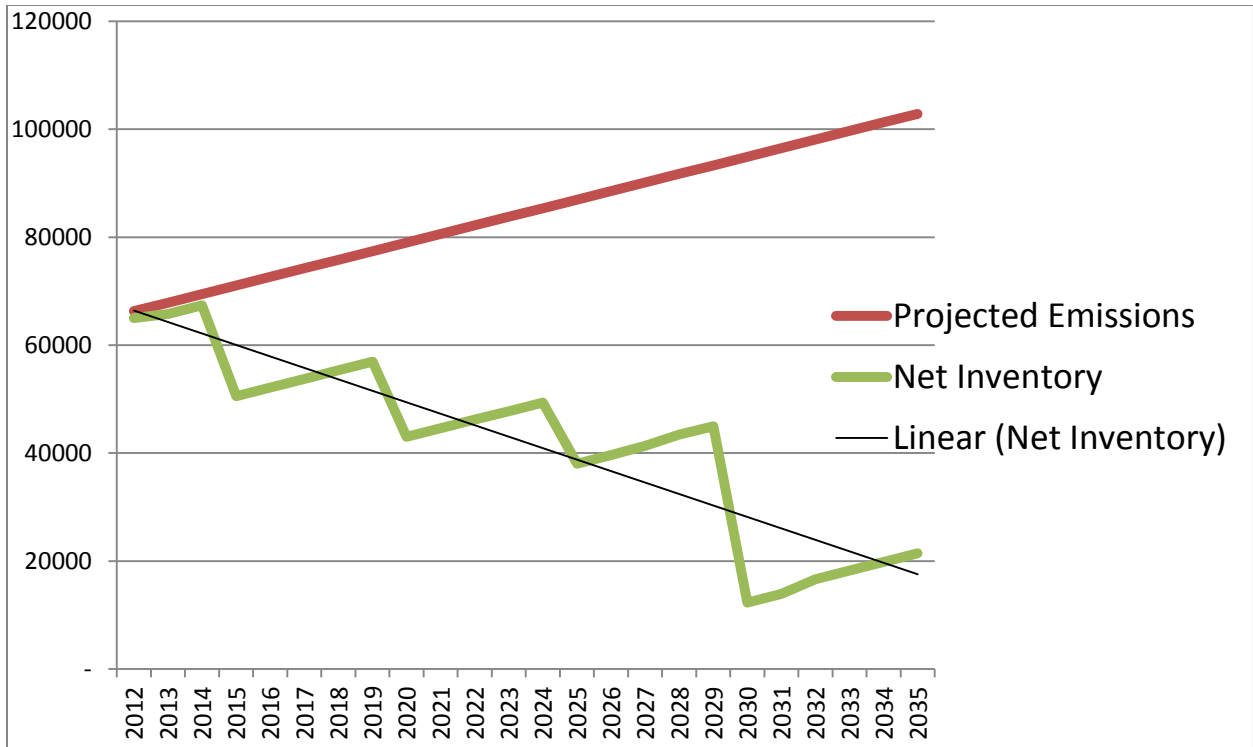
Goals

While the Climate Action Committee has set ambitious goals, the strategies listed are not exclusive. The committee sees the Climate Action Plan as a live document, in which more efficient strategies are constantly being pursued to achieve the agreed upon goals. Goals may also be adjusted in response to updated information and the changing strategies.

In the 2010 Climate Action Plan, goals were based exclusively on emissions from Scope 1 and 2 activities. For the 2012 CAP update, five goals are now required and at least two must address the totality of all three scopes. The steps toward climate neutrality are as follow:

1. Achieve 20% reduction in total of scopes 1 and 2 emissions by 2020 relative to baseline emissions in 2006.
2. Achieve 50% reduction in total of scopes 1 and 2 emissions by 2030 relative to baseline emissions in 2006.
3. Achieve 100% reduction in total of scopes 1 and 2 emissions by 2043 relative to baseline emissions in 2006.
4. Achieve 50% reduction in total of scopes 1, 2, and 3 emissions by 2030 relative to baseline emissions in 2006.
5. Achieve 80% reduction in total of scopes 1, 2, and 3 emissions by 2050 relative to baseline emissions in 2006.

The following graph shows the projection of scopes 1 and 2 emissions without the effects of mitigation strategies (red line) from 2012 to 2035. The downward trending steps (green line) indicate the MTCO_{2e} reductions from mitigation strategies and the linear trend line (black) projects carbon neutrality of scope 1 and 2 emissions to occur in approximately 2043.



Funding Mechanisms

In recent years, the University has funded energy saving projects with one-time contingency budget dollars in order to benefit from permanent energy savings in the utility budget. In effect, the energy savings projects were funded by the utility budget itself. Many of the projects in all three phases of the committee’s plan will be funded in a similar manner. Some of the more costly projects, if they are undertaken, such as the woodchip boiler, wind turbine, and LEED Silver compliant new buildings, could be funded in a variety of ways, such as the use of University reserves, a dedicated fee assessed to students, or debt financing.

Greenhouse Gas Mitigation Strategies:

Strategies to Affect Student Behavior

- The Office of Housing and Residence Life will provide students with sustainability tips and informational materials on ways to reduce energy use. Examples include brochures, posted reminders in residence halls, a sustainability guide within the student handbook, and tips and reminders on its website.
- The office of Housing and Residence Life has a Sustainability Showroom which is used to show prospective students opportunities to have a “green dorm.” GVSU has also participated in the Green Dorm competition.
- Campus communities will continue to compete in an energy competition where communities compete to reduce energy consumption twice each academic year. The community that shows the greatest energy reduction is awarded a sustainability-related prize.
- The GVSU community, including Housing and Residence Life, participates in RecycleMania, a nation-wide collegiate recycling competition, to increase student awareness of recycling on campus and waste minimization.
- During move-out week, donation areas will continue to be designated for items ranging from clothing and cleaning products to furniture in order to reduce solid waste. Donated computers and other electronics will be recycled to reduce e-waste. Donations of food from student rooms to a local agency will also be sought.
- High efficiency washers and dryers were installed in all on-campus housing laundry rooms Fall 2009 through Fall 2011. The machines cut utility costs by as much as 60% and use 11.8 gallons of water, on average, compared to 40 gallons.
- During Phase 1 reductions, real-time energy monitoring information will be posted in Niemeyer Honors Learning and Living Center to heighten students’ awareness of their energy consumption. If the model succeeds here the operation will be established in the 14 other communities on-campus.
- During Phase 1 reductions, residents will be given reusable water bottles upon move-in. This was done for three years. Filtered water systems will begin to be installed, in conjunction with Campus Dining, to provide an alternative to bottled water.
- Water bottle filling stations were installed around campus. Each station can save approximately 10,000 water bottles each year.
- In Fall 2009, composting was expanded to the dining halls. A student-led “Green Team” helps students to learn how to sort their waste.
- Various transportation options are promoted to students for travel on-campus and the greater community. These include the bus system, bicycling, walking, car-sharing, and car-pooling.

- The GVSU Surplus Store was created as an avenue to responsibly dispose of GVSU furniture and equipment that is no longer needed on campus. Its goal is to minimize waste and provide useful items to faculty, staff, students, and the general public.
- GVSU began hosting “zero waste” football games and other athletic events in 2012. In 2013, it placed 2nd in the nation for the Game Day Challenge.

Student Activities

Grand Valley students practice and promote sustainable behavior in a variety of campus clubs and organizations, including:

- **Alternative Energy Club:** The purpose of the AEC is to incorporate alternative sources of energy into practical engineering applications and projects.
- **Beekeeping Club:** This club is a collection of environmentally conscious students who understand the importance of the honeybee as an essential pollinator in our society. Students will work together to advocate for honeybees and to create apiaries throughout West Michigan.
- **Biology Club:** The purpose of this organization is to provide students with opportunities to build relationships with faculty and fellow students who have a similar interest in biology, to give students a chance to interact with the community through various events, and to gain awareness of career and research opportunities in biology related fields.
- **Cage Free:** The purpose of this organization is to provide students with the tools and knowledge to reshape their lifestyle choices to fit vegetarian and vegan diets. It will also help to build support in the local community by promoting organic and local farms.
- **Farm Club:** Farm Club is a group of students dedicated to promoting the principles and practices of sustainable agriculture. It provides an open space for veggies, knowledge, and relationships to grow. It aims to establish an environment of hands on learning, where students can be educated on the importance and principles of organic farming.
- **Food and Nutrition Club:** The purpose of this organization is to combat the negative outcomes that poor food choices can bring, whether they are social, environmental, economic, or physical. It will work toward this goal with education and service on campus as well as in the surrounding community. The organization also serves as a place for people with an interest in nutrition to gather and exchange ideas, including those that could lead to healthier lifestyle choices.

- Habitat for Humanity: The Grand Valley State University Chapter of Habitat for Humanity is a registered student organization existing under the guidelines set forth by the university. Members participate in the physical building of homes through our affiliate Habitat for Humanity of Kent County. It assists in fundraising and advocacy for our affiliate, so that they may continue in their mission of providing affordable and adequate housing for those in need.
- Humane Society: This is a student run organization dedicated to bettering the lives of animals and the environment we all live in. It does this by volunteering with local shelters, fundraising for causes that combat animal cruelty and help homeless animals, lobbying at the state and national levels, and educating the public.
- Hunger and Homelessness: This is a service and advocacy group that works weekly at different homeless shelters, food pantries and soup kitchens. Its goal is to improve the lives of others, change our community for the better, and become more informed about the issues of Hunger and Homelessness.
- Soil and Water Conservation Society: Its mission is to promote the science and art of soil, water and related natural resource management to achieve sustainability.
- Student Environmental Coalition: This is a service and advocacy organization intended to promote student interest in local, regional, and global environmental concerns. Its mission is “Helping to engage students at GVSU to be conscious citizens by promotion of environmental awareness.” It is dedicated to sustainability related issues in hopes that students may learn to conserve natural resources and care more about their local environment.
- West Michigan Anglers Conservation Club: This is a student club of anglers promoting the protection of native and anadromous freshwater fish species through conservation and restoration of freshwater ecosystems throughout West Michigan.

Energy Reduction Projects for Campus Offices and Classrooms

- Purchases (when available) will consist of:
 - High content from post-consumer recycled materials
 - Low embodied energy (consumed to extract, manufacture, distribute and dispose)
 - Non-toxic and recyclable materials
 - Durable and/or repairable appliances
 - Items that are produced in an environmentally and socially sustainable manner
 - Energy star certified products
- All computers and electronics will be set to energy saving specifications.
- Desktop computers will be phased out and replaced by laptops (when feasible).

- All equipment will be shut down or turned off at the end of business days and over university breaks.
- Lights will be turned off in offices that are not in use.
- Equipment that is not in regular use will be unplugged.
- Video conferences will be utilized in favor of traveling to conferences, when appropriate.
- Offices will increase recycling.
- Printing will be minimized.
- Necessary printing will be two-sided.

GHG Mitigation Strategies for Transportation

- Free bus service is provided to students, staff, and faculty to encourage the use of mass transit.
- The transportation department continually offers promotions, giveaways, and other marketing strategies to encourage student use on and off campus.
- Grand Valley is working with The Rapid to establish more “park and ride” locations.
- More hybrid buses will be added to the Grand Valley routes.
- Bus schedules are now only available online.
- Modestly priced bike rentals are available through GVSU’s Outdoor Adventure Center. This program currently offers semester-long bike rentals and is hoping to expand and offer daily rentals.
- A website with information on bike rentals and use has been developed and Grand Valley State University has received a silver designation as a Bike Friendly University.
- Bike awareness week is sponsored each spring, including a bike tour, safety events, promotions, and education on the benefits of biking.

Mitigation Strategies for Campus Dining

- Participation in a Meatless Monday program.
- Implement a visible food waste control system for pre-consumer waste.
- Continue to use food preparation forecasting software to reduce over production

- A student-led “Green Team” provides education for diverting waste from landfills to recycle or composting bins, as well as detailed signage.
- Continue monthly utility audits for dining locations with a focus on water reduction.
- Continue local purchasing whenever possible.

Climate Education and Research:

Climate Related Courses

ANT340: Culture and Environment

This course compares different adaptive strategies of cultures from around the world and seeks understanding of ethical and social values different groups have related to the environment. Attention is focused on how humans relied on cultural mechanisms in the past to adapt and change their physical and natural environment. Fulfills Cultures - World Perspectives. Part of the Sustainability Issue. Offered each semester.

ANT345: Perspectives on Globalization

The anthropology of globalization examines the emergence of “globalized local cultures.” Students employ the ethnographic approach to understand globalization as the intensification of interconnectedness, in which anthropologists learn that fundamental problems of deep and universal concern to humans everywhere will need to be addressed at local, national, and global levels. Offered fall semester, even years. Fulfills Cultures - World Perspectives. Part of the Globalization Issue.

ANT380: Environmental Archeology

A series of courses providing an in-depth study of a problem in anthropology and the methods of investigating it. Various topics of cross-cultural interest, such as human evolution, peasant cultures, climate change, preliterate societies, kinship pattern, and culture and personality is examined.

BIO105: Environmental Science

Study of natural ecosystems, their interrelationships, and human impacts and evolution of humans and environmental determinants of their cultures. Land use, resource and energy utilization, population trends and causative factors, air and water pollution, and economic factors influencing decision-making are emphasized. Does not count toward a biology major or minor. Fulfills Foundation - Life Sciences.

BIO107: Great Lakes and Other Water Resources

A study of our Michigan's water resources, including the Great Lakes, streams, and groundwater, and relationships of people with these systems. Does not count toward a biology major or minor. Designated lecture and laboratory sections are tailored for prospective elementary teachers.

BIO215: General Ecology

Population, communities, and ecosystems, including primary productivity and energy flow, materials cycling, succession, population dynamics, and systems modeling.

BIO319: Global Agricultural Sustainability

Study of the biological and environmental principles at the foundation of agricultural sustainability; how various traditional and modern agricultural practices follow those principles and how social, cultural, and economic factors ultimately control agricultural practices. Cohesiveness with other courses in this theme will be maintained by highlighting a specific geographical region.

BIO338: SWS Environmental Ethics

Examines philosophical underpinnings of environmental ethics. Explores approaches for understanding sustainability issues, solving ongoing environmental problems, and developing a global environmental ethic. Biology majors may not use both BIO 328 and BIO 338 as elective credit within the major. Part of the Sustainability Issue.

BIO407: Biology and Society

Biological topics related to biodiversity, sustainability, alternative energy, environmental policy and economics, land use, climate change, historical influences, and cultural/societal attitudes conducted within an international context. The society-based experience is combined with readings, lectures, papers, and discussions.

BIO417: International Field Biology

One to three week trips to international locations to study the fauna, flora, ecology of representative ecosystems, climate, geology, paleobiology, environmental problems, and/or human impacts upon the above. This field-based experience is combined with readings, lectures, papers, and discussions.

BIO450: Stream Ecology

Examines the structure and function of stream ecosystems, with emphasis on the physical, chemical, and biological factors that influence flowing-water habitats. Laboratory focuses on the

methods of stream ecology, including collection and analysis of physical, chemical, and biological data. Field work emphasizes local stream ecosystems.

BIO460: Terrestrial Ecosystem Ecology

Investigation of the structure and function of terrestrial ecosystems using a systems approach. Biotic and abiotic processes controlling interactions among biogeochemical cycles in ecosystems will be discussed and examined. Topics will include controls on primary production, evapotranspiration, decomposition, and herbivory; and potential for anthropogenic changes in ecosystem processes.

BIO651: Emerging Issues in Water Resources

The most pressing water resource-related issues facing the planet today will be discussed and analyzed. Particular emphasis will be placed on analyzing these problems from a variety of perspectives, including environmental, economic, societal, and political.

CHM427: Green and Environment Chemistry Laboratory

This course exposes students to the methods used in environmental chemistry analysis and the application of green chemistry principles, benign design, life cycle analysis through experimental design, practical aspects of environmental, and human health issues. A solid understanding of methodology used in environmental laboratories and application of green chemistry is attained.

CJ370: Environmental Crime

This course examines environmental crime, the laws designed to prevent and/or mitigate it, enforcement of those laws, and the relationship between race, class, and exposure to environmental harm around the world.

ECO345: Environmental and Resource Economics

Develops a systematic economic framework to analyze market and government allocations of natural and environmental resources. Topics include relationships between population growth, land development, and environmental quality; regulatory versus market oriented environmental policies; supplies and prices of mineral and energy resources; harvest and protection of forests and fisheries. Part of the Sustainability Issue.

EGR306: Urban Sustainability

Social, environmental, economic points of view engaged to study how successful cities work. Study approached using assigned reading compared to direct observation and immersion into urban environments. Focus: interaction of built environment with social, natural environment. How engineering decisions about materials used in buildings impact structural integrity, energy use, economics. Offered fall and winter semesters. Part of the Sustainability Issue.

EGR406: Renewable Energy Systems: Structure, Policy, and Analysis

A survey of the technological as well as economic, societal, and public policy issues associated with renewable energy systems. Topics include generation using renewable resources such as solar, wind, hydropower, and biomass as well as advanced energy storage systems and distribution. Energy research and analysis techniques are introduced.

EGR463: Alternative Energy Systems and Applications

Introduction to the current issues of energy for sustainability. Principles of alternative and renewable energy sources including solar thermal, solar photovoltaic, wind, hydropower, biomass, geothermal, hydrogen and nuclear energy. Fundamentals of combustion of hydrocarbon fuels and alternative fuels such as biofuels. Fuel cells and electrochemical energy storage units.

ENS201: Introduction to Environmental Studies and Sustainability

This is an interdisciplinary exploration of the multiple ways by which human society influences, and is influenced by, its natural environment. Economic, political, and socio-cultural dimensions of environmental studies are presented through an interdisciplinary approach. Principles of sustainability are examined.

ENS401: Environmental Problem Solving

A problem-solving seminar in Environmental Studies. Attention is given to vulnerabilities to environmental change, sustainable development, impact and risk assessment, adaptations to and mitigation of environmental problems at various scales. Multidisciplinary student teams, conduct original research and design sustainable practices and solutions for real-life environmental problems.

ENS412: Global Environmental Change

The main theme of this course is the changing nature of our environment and human-environmental interactions. Topics include climatic fluctuations, environmental reconstructions, the interaction between humankind and the environment since the prehistoric times, and human-induced environmental change of the last century at the global, continental, and regional scales. Crosslisted with GPY 412. Part of the Sustainability Issue.

GEO100: Environmental Geology

The relationship between people and their physical geological environment. Topics include geologic hazards, hydrology and human health, mineral and energy resources, and land use planning. Primarily for non-science majors; not for Geology or Earth Science majors. Lectures and field trips. Fulfills Foundation - Physical Sciences.

GEO103: Oceans

Scientific investigation of the oceans and interactions among ocean, atmosphere, and lithosphere. Introduction to the chemistry of seawater, physics of water movement, coastal processes, geological oceanography, changes in the oceanic system through geologic time, and the role of oceans in Earth's geologic evolution.

GEO105: Living with the Great Lakes

Introduction to Earth Science using the Great Lakes as a theme and Lake Michigan as a natural laboratory. Review of the Lakes' geologic setting, origin, and history; climatology and lake levels; physical processes including erosion; water chemistry as a function of geology; human interactions with the Lakes. Lectures and field trips. Fulfills Foundation - Physical Sciences.

GEO300: Geology and the Environment

Detailed examination of interactions and connections between people and their geologic environment from an Earth Systems perspective. Using case studies and current events, students investigate complex environmental processes and issues related to the lithosphere, hydrosphere, atmosphere, and biosphere. Students reach and defend decisions concerning personal, corporate, and governmental actions.

GPY100: Physical Geography

Explores the spatial patterns between landforms, natural systems of flora and fauna, and climate. Designed to increase awareness of the physical environment, its landscape, controls, and processes, and the interrelationships of natural phenomena.

GPY101: Sustainability and Place

The concept of sustainability holds that the social, economic, and environmental factors within human communities must be viewed in the context of their geographic locations. Strategies and decisions for sustainable development require understanding of the spatial patterns of human-environmental interactions, scale, and place. GPY 101 provides important place based perspectives on sustainability.

GPY235: Geography for a Changing World

Examines a world that is undergoing political, economic, social and environmental changes at many different spatial scales. Using geographic concepts, this course examines national, regional, and global interaction and development, and the diverse and complex processes that both hinder and help forge a global community. Fulfills Foundations - Social and Behavioral Sciences. Fulfills Cultures - World Perspectives.

GPY312: Urban and Regional Environmental Planning

An introduction to the urban planning strategies that help towns and cities to preserve, restore, and even capitalize on their natural resources. This course investigates threats to clean air, water, and healthy ecosystems in our communities and examines solutions in the form of governmental policies, green designs, and urban inventiveness.

GPY335: Globalization and Development

Development involves positive and negative social, political, economic, cultural, and environmental changes for people living in a region or a country. GPY 335 explores the complex geography of the processes associated with development and in particular global development.

GPY350: Geopolitics, Energy, and Environment of Russia and Eurasia

This course examines the unique role of Russia and Central Eurasia in the world's energy, water, and food security and many global geopolitical processes of the 21st century. With its complex ethno-cultural composition and vast deposits of oil, gas, coal, and uranium, this region is strategically important for the US. Fulfills Cultures - World Perspectives.

GPY361: People, Environment, and Development in the Amazon

This course explores natural resource use and human settlement over time in the Amazon Basin, from early tribal societies to the present. Topics include extractive economies, trade in animal and forest products, conservation and development initiatives, and the changing demands for resources in urban centers of Amazonia today.

GPY362: A Geography of World Agriculture and Farmers

A geography of the world's agricultural practices and development at different scales, from traditional methods to industrial agriculture with an emphasis on farming societies. Topics include indigenous agriculture and crop domestication, agroforestry and plantation systems, land use and rural societies, export crops, aquaculture and livestock, and drug cultivation. Fulfills Cultures - World Perspectives. Part of Globalization Issue.

GPY363: World Forests and Their Use

A geography of the world's forests and their use, from traditional to industrial practices over space and time. Topics include the local, national and international exploitation of forests, forest societies, foods, fuel and medicines, timber, protected areas, and the challenge of sustainable forest use in different regions and environments.

GPY410: Landscape Analysis

Landscape analysis is a broadly interdisciplinary study that includes concepts and methods of sustainable physical/human geography, ecology, planning, and architecture. It includes the biophysical and societal causes and consequences of landscape heterogeneity, processes and evolution. Conceptual and theoretical core of this course links natural sciences with related human disciplines.

GPY412: Global Environmental Change

The main theme of this course is the changing nature of our environment and human-environmental interactions. Topics include climatic fluctuations, environmental reconstructions, the interaction between humankind and the environment since the prehistoric times, and human-induced environmental change of the last century at the global, continental and regional scales.

HNR241: The Earth, A Global View

Course has two objectives: (1) understanding Earth as one global, holistic, delicately balanced dynamic system; and (2) understanding the critical interdependence between humans and Earth systems. Required field trip. Fulfills Foundation - Physical Sciences with a Lab.

LIB322: Wicked Problems of Sustainability

Sustainability, as a wicked problem, is an intractable, on-going and high-stakes issue. This course engages students in participatory research on the inextricably linked dimensions of sustainability, such as economics, environment and social equity. Students will work with community partners to address specific interdisciplinary problems of sustainability.

NRM140: The Climatic Factor

A study of the atmosphere, broad aspects of weather and climate, microclimatology, and the geography of climate and effects on terrain, vegetation, and people.

NRM150: Introduction to Natural Resources

Survey of natural resource issues and environmental problems. The course will use an integrated approach involving concepts from natural and social sciences to provide a foundation for understanding past, present, and future natural resource issues including biodiversity, land use, water and air pollution, human population, energy use, and waste management.

NRM240: Principles of Climatology

The atmosphere, broad aspects of weather and climate, microclimatology, and paleoclimatology. Instrumentation, data presentation, ecoclimate, and microclimatological field observations. Lecture, laboratory, and field trips.

NRM330: Environmental Pollution

Investigation of causes and effects of water, soil and air pollution. Prevention and management of pollution is discussed and examined from natural and social science perspectives. Design of impact assessment studies, data interpretation and laboratory methods. Topics include waste disposal, acid deposition, climate change, toxicology, and risk assessment.

NRM380: Renewable Energy Management and Molding

Lecture, discussion, laboratory, or field experience (or any combination of the preceding) in specific areas of resource management.

NRM395: GIS Applications in Resource Management

Explores applications of Geographic Information Systems (GIS) in natural resources management. Students work on projects and examine several case studies in which GIS is used for the management of natural resources, including watershed analysis, environmental impact of timber sales, habitat loss, and endangered species conservation.

NRM407: Natural Resources and Society: Study Abroad

Natural resources topics related to biodiversity, sustainability, alternative energy, environmental policy and economics, land use, climate change, historical influences, and cultural/societal attitudes conducted within an international context. The society-based experience is combined with readings, lectures, papers, and discussions.

NRM417: International Field Studies in Resource Ecology & Mgmt

Intensive field work related to natural resources ecology, conservation, preservation, and management conducted within an international context. The field-based experience is combined with readings, lectures, papers, and discussions.

NRM451: Natural Resource Policy

Study of how natural resource policy is developed and implemented in the United States. Focuses on public policies toward renewable resources such as forests, biodiversity, land, recreation, and water. Includes foundations of the American legal system, choice of policy instruments, and basic methods of policy analysis. Part of the Sustainability Issue.

NRM452: Watershed and Wetland Management

Theory and application of wild land and urban hydrology, including the values of watersheds and wetlands as domestic ecosystems.

OSH414: Environmental Safety and Health Regulations

A study of laws addressing environmental pollution and hazardous waste management.

PA671: Building Sustainable Communities

Provides an overview of ecological, energy, climatic and consumption issues impacting local communities. Through a multidisciplinary approach, students study the relationship among society, organizations, and the natural environment. Students examine how local governments and nonprofit organizations develop sustainable built landscapes, educate about sustainable best practices, and foster green economic development.

PH520: Environmental and Occupational Health

Presents basic concepts of environmental health and occupational health. Students explore the biological, chemical, and physical factors from the environment (community and occupational) that impact the health of the public at a global and local level. Topics covered include air and water quality and industrial hygiene.

PLS303: Introduction to US Environmental Policy

This course examines the decision making processes to cope with modern environmental problems. The course focuses on both domestic and international environmental issues with special attention to interests, ideas, and institutions.

SOC351: Urban Sociology

Explores urban theory (Chicago School, political economy, and cultural approaches); the evolution of cities; suburbanization, race relations, street life, sustainability (economic, social and environmental), redevelopment, urban politics, and international comparisons. Readings focus on theory, specific cities, and environmental concerns. Part of the Sustainability Issue.

WGS335: Women, Health & Environment

This course is an overview of contemporary women's health issues focusing on the interconnectedness between health and the environment. Topics include reproductive issues, pesticides, sustainable development, occupational hazards, health insurance, and breast cancer. Discussions and readings focus on the impact of race, class, and sexuality on women's health. Part of the Sustainability Issue.

GVSU offered 55 courses that addressed climate change in the 2016/2017 academic year.`

Climate Related Certificates

Green chemistry

Design thinking

Sustainable food systems

Sustainable urban and regional planning

GVSU Faculty Publications Related to Climate Change

Note: Bold indicates GVSU faculty.

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GVSU Faculty Presentations Related to Climate Change

Dobson, C., **Miller, H.R., Llerandi-Román, P. & Mattox, S.** 2013. Integrating Climate Change for Elementary Pre-Service Teachers: Tales from the Field. National Science Teachers Association Annual Meeting, April 10-13, San Antonio, Texas.

Bush, D.M., **Neal, W.J.**, and Richmond, B., 2013, Multiple Coastal Hazards of Puerto Rico: Abstracts with Programs, v. 45, no. 2, Geological Society of America Southeastern Section Meeting, San Juan, Puerto Rico, p. 1.

Bush, D.M., Jackson, C.W., and **Neal, W.J.**, 2013, Puerto Rico's Vulnerable Coast: Abstracts with Program, v. 45, no. 2, Geological Society of America Southeastern Section Meeting, San Juan, Puerto Rico, p. 2 (1-4).

Perison-Parrish, E.M., Runyan, R. M., **Siemer*, K.W.**, Jackson, C.W., Jr., Bush, D.M., **Llerandi Román, P.A.**, and **Neal, W.J.**, 2013, A Modified Coastal Vulnerability Index (CVI) for Small Associated Islands of Puerto Rico and the U. S. Virgin Islands: Abstracts with Programs, v. 45, no. 2, Geological Society of America Southeastern Section Meeting, San Juan, Puerto Rico, p. 1 (1-3).

Griffin, C.B., C. McGraw**, and A. Rogers**. 2014. Management Implications based on Permit Data from Michigan's Pine River. *Managing Rivers in Changing Climes: Training Tomorrow*. River Management Society, Denver, CO, Apr. 14-17.

Griffin, C.B. 2013. Analysis of the Location and Impact of User-Created Campsites in the Nordhouse Dunes Wilderness, George Wright Society Annual Conference-Protected Areas in a Changing World, Denver, CO, Mar. 11-15.

MacDonald, N.W. 2015. Spotted knapweed responses to fire: experimental evidence from greenhouse and field studies. Invited oral presentation and panel discussion at Burning Issues II - Ecological Restoration and Fire Conference, Lake States Fire Science Consortium, Battle Creek, Michigan, 13 January 2015.

Nordman, E Hope College Biology Department Seminar. September 2014. Holland, Michigan. "Renewable Energy Imperatives and Opportunities: Lessons from Kenya."

Nordman, E Rick Albin Morning Show (WOOD-FM radio news). June 2014. Interview on the EPA's Clean Power Rule for power plants.

Nordman, E GVSU Energy-Climate Lecture Series. February 2014. Grand Rapids, Michigan. "Africa: The Next Renewable Energy Frontier."

Nordman, E International Sustainable Development Research Conference. June 2013. Stellenbosch University, South Africa. “Energy transitions in Kenya’s tea sector: A wind energy assessment.”

Nordman, E Holland Historical Museum. October 24, 2013. “Harnessing the wind: Energy research at GVSU.” Presentation in conjunction with museum exhibit on wind power through the ages. Invited public presentation.

GVSU Grants Related to Climate Change

\$2,030,072 grants have been awarded to faculty for climate change research for 2017/2018

\$739,591 grant for climate change research is pending approval for 2018

GVSU Faculty Community Outreach Projects

AWRI

The mission of the Institute is to integrate research, education, and outreach to enhance and preserve freshwater resources. AWRI seeks to accomplish its mission through 1) interdisciplinary research into major question about water resources, 2) public education for a variety of groups, including K-12, university students, and the community, and 3) outreach to ensure that decision makers are equipped with the best available knowledge on environmental and water resource-related issues to reduce the uncertainty associated with their resource management decisions.

Collaborative Effort with Grand Rapids

As GVSU has signed the American College and University President’s Climate Agreement, the City of Grand Rapids has signed the U.S. Mayor’s Climate Protection Agreement as well. These two compliance and signatory agreements are similar in nature and have allowed the City of Grand Rapids and GVSU to work together and share best practices for reducing CO2 and GHG emissions. Significant efforts are being put on the use of renewable and alternative energy technologies, green and LEED buildings, energy conservation and efficiency, alternative transportation, and green environment strategies.

Green Town Conferences

GVSU and the City of Grand Rapids have been participants and contributors to several Green Town Conferences that have been held in Illinois and Grand Rapids, Michigan. The purpose of these Greentown Conferences is to bring together the public, private, and academic sectors as sustainable community stakeholders. Issues concerning public policy, governance, environmental stewardship, the built environment, local food, and sustainable development best practices are shared in collaborative workshops. GVSU has openly discussed the elements of climate action planning with other colleges and universities.

MAREC

GVSU has the Michigan Alternative Renewable Energy Center (MAREC) in Muskegon, MI. The mission of MAREC is to help demonstrate applied renewable and alternative energy technologies such as wind, solar PV, fuel cell, biomass, energy storage etc. MAREC is located in a Smartzone, has business incubator space, and works with other colleges and universities on research grants, training, and education for sustainable development.

Lake Michigan Offshore Wind Assessment Project

Grand Valley State University (GVSU) and its Michigan Alternative and Renewable Energy Center (MAREC) working in partnership with GVSU's Padnos College of Engineering and Computing, the University of Michigan and its Michigan Memorial Phoenix Energy Institute (MMPEI), and the Michigan Natural Features Inventory (MNFI) of Michigan State University Extension have secured funding for the *Lake Michigan Offshore Wind Assessment Project*. The principal objective of the project is to develop a better understanding of offshore wind resources as well as other physical, biological and environmental conditions on Lake Michigan and the Great Lakes in general, as precursor activity to the future development of offshore wind energy technology.

West Michigan Wind Assessment

The intent of this integrated assessment project is to comprehensively analyze the benefits and challenges to wind energy development in one particular region of coastal West Michigan, including Oceana, Muskegon, Ottawa and Allegan counties. By combining science and public participation, this integrated assessment will empower citizens and local governments to make informed decisions about wind energy facilities in their communities. The project will enhance local capacity to mitigate conflicts surrounding wind energy development, and will help Michigan achieve its ten-percent renewable energy target in a manner that is environmentally, economically, and socially appropriate.

Partnerships

Grand Valley has also worked with many other organizations to help host, create awareness, promote renewable energy, energy efficiency, and conservation within the greater Grand Rapids Community. Some of these organizations include Michigan Department of Environmental Quality, Michigan Economic Development Corporation, Next Energy, The Right Place Inc., West Michigan Strategic Alliance, and West Michigan Environmental Action Coalition. GVSU was also appointed by the governor to the Michigan Climate Action Council.

Project Calculator Executive Summary

| Project Name | Start Year | Duration (years) | Total Capital Cost | Total Capital Cost Including Incentives | Average Discounted Annual Cash Flow | NPV | IRR | Discounted Payback Time (years) | Annual Reductions (MT eCO2) | Total Lifetime Reductions (MT eCO2) | Discounted Cost per Reduction | Rank |
|---|------------|------------------|--------------------|---|-------------------------------------|---------------|---------|---------------------------------|-----------------------------|-------------------------------------|-------------------------------|------|
| All Projects | 2012 | 43 | (\$26,264,249) | (\$26,264,249) | \$2,967,008 | \$130,548,370 | 37.97% | N/A | (53,136.8) | (2,284,883.6) | \$57.14 | N/A |
| Projects with positive NPV | 2012 | 43 | (\$25,793,117) | (\$25,793,117) | \$3,050,658 | \$134,228,953 | 41.39% | N/A | (32,276.7) | (1,387,897.0) | \$96.71 | N/A |
| Padnos/Henry Heat Recovery System | 2015 | 25 | (\$457,173) | (\$457,173) | \$128,510 | \$3,341,250 | 51.77% | 2.06 | (770.3) | (19,257.2) | \$173.51 | 12 |
| Digital Demand Control - LSH, FH, Rec Center | 2012 | 15 | (\$87,247) | (\$87,247) | \$18,240 | \$291,834 | 38.51% | 2.78 | (110.2) | (1,653.5) | \$176.50 | 11 |
| Lighting Replacement FH, LSH, Pew Ramp, MAN, PAC, LAT, CDC, LHH, ASH, Devos - Rescheduling Pew Ramp | 2012 | 20 | (\$580,482) | (\$580,482) | \$62,707 | \$1,316,852 | 23.46% | 4.73 | (497.0) | (9,939.5) | \$132.49 | 20 |
| Delighting in buildings | 2015 | 30 | - | - | \$80,683 | \$2,501,167 | - | 0.00 | (513.2) | (15,395.8) | \$162.46 | 16 |
| Behavioral Change to reduce natural gas and electric consumption by .5% per year | 2012 | 30 | - | - | \$8,544 | \$264,868 | - | 0.00 | (21.9) | (658.0) | \$402.56 | 2 |
| Housing and Academic buidign shutdowns - Summer | 2013 | 30 | - | - | \$17,117 | \$530,638 | - | 0.00 | (63.1) | (1,892.4) | \$280.41 | 3 |
| Air Handling Unit - roof top replacement ASH, PAC | 2012 | 25 | (\$191,943) | (\$191,943) | (\$5,584) | (\$145,174) | | N/A | (13.6) | (340.7) | (\$426.05) | 29 |
| Replace Roof of COM | 2012 | 25 | (\$279,190) | (\$279,190) | (\$9,623) | (\$250,200) | | N/A | (5.9) | (148.2) | (\$1,688.56) | 30 |
| Install CO2 sensors in all labs of CHS | 2015 | 15 | (\$46,532) | (\$46,532) | \$14,144 | \$226,310 | 51.90% | 2.06 | (87.5) | (1,312.2) | \$172.47 | 13 |
| Installation of occupancy/CO 2 sensors in CHS offices | 2013 | 15 | (\$93,063) | (\$93,063) | \$65,955 | \$1,055,279 | 108.77% | 0.96 | (474.7) | (7,119.8) | \$148.22 | 18 |
| Woodchip Boiler | 2015 | 25 | (\$9,306,320) | (\$9,306,320) | \$1,035,828 | \$26,931,525 | 24.32% | 4.60 | (5,483.1) | (137,076.4) | \$196.47 | 7 |
| Replace current 1280 Trane chiller with 1200 ton electric chiller | 2015 | 25 | (\$872,468) | (\$872,468) | \$105,353 | \$2,739,167 | 25.97% | 4.28 | (816.4) | (20,410.9) | \$134.20 | 19 |
| Adjust Winter/Summer set points by two degrees | 2015 | 30 | - | - | \$242,048 | \$7,503,500 | - | 0.00 | (1,539.6) | (46,187.3) | \$162.46 | 16 |
| Steam Trap Replacement | 2012 | 20 | (\$343,171) | (\$343,171) | \$107,123 | \$2,249,573 | 54.82% | 1.93 | (612.9) | (12,258.2) | \$183.52 | 10 |
| Outside Lighting Retrofits - Phase 1 and phase 2 | 2013 | 20 | (\$13,088) | (\$13,088) | \$4,223 | \$88,679 | 55.88% | 1.90 | (34.2) | (684.0) | \$129.64 | 21 |
| Carbon Offsets | 2020 | 10 | - | - | (\$42,888) | (\$471,766) | - | N/A | (5,000.0) | (50,000.0) | (\$9.44) | 28 |
| CUB Boiler Controls | 2015 | 20 | (\$32,572) | (\$32,572) | \$7,541 | \$158,358 | 43.09% | 2.49 | (0.5) | (9.9) | \$15,975.65 | 1 |

| | | | | | | | | | | | | |
|---|------|----|----------------|----------------|-------------|---------------|--------|------|------------|-------------|----------|----|
| Wind Turbine 1.65 MW | 2025 | 25 | (\$3,838,857) | (\$3,838,857) | \$182,809 | \$4,753,021 | 13.61% | 8.52 | (2,175.2) | (54,379.3) | \$87.40 | 22 |
| CAC Boiler Projects- update controls and heat pumps | 2020 | 20 | (\$52,348) | (\$52,348) | \$5,394 | \$113,284 | 22.53% | 4.93 | (38.2) | (764.2) | \$148.25 | 17 |
| VFD Air Handlers - EC | 2015 | 25 | (\$69,797) | (\$69,797) | \$15,160 | \$394,148 | 41.47% | 2.60 | (94.1) | (2,352.3) | \$167.56 | 14 |
| Purchasing 10% Green E RECs | 2015 | 5 | - | - | (\$16,764) | (\$100,583) | - | N/A | (4,871.6) | (24,358.1) | (\$4.13) | 24 |
| Purchasing 20% Renewable Green-E RECs (Est. \$5 per MWH) | 2020 | 30 | - | - | (\$47,252) | (\$1,464,822) | - | N/A | (10,959.2) | (328,776.9) | (\$4.46) | 25 |
| Carbon Offsets | 2030 | 25 | - | - | (\$62,908) | (\$1,635,616) | - | N/A | (9,000.0) | (225,000.0) | (\$7.27) | 26 |
| Purchase Green-E RECs for the Pew Library (\$1.55) | 2013 | 2 | - | - | (\$411) | (\$1,234) | - | N/A | (269.4) | (538.8) | (\$2.29) | 23 |
| Purchasing an additional 20% alternative energy (Est. \$7 per MWH) | 2030 | 20 | - | - | (\$93,783) | (\$1,969,442) | - | N/A | (13,391.2) | (267,823.9) | (\$7.35) | 27 |
| Renewable additions to grid per state of MI RPS (10% by 2015) | 2015 | 10 | - | - | \$798,263 | \$8,780,898 | - | 0.00 | (4,480.5) | (44,804.6) | \$195.98 | 8 |
| Photovoltaic and Geothermal projects to cut natural gas and electricity purchases by 20% | 2030 | 25 | (\$10,000,000) | (\$10,000,000) | \$0 | \$58,070,371 | 42.98% | 2.50 | (11,375.0) | (284,374.9) | \$204.20 | 6 |
| Renewable additions to grid per state of MI RPS proposal (25% by 2025) | 2025 | 30 | - | - | \$3,067,395 | \$95,089,238 | - | 0.00 | (15,219.0) | (456,570.5) | \$208.27 | 5 |
| Utility Companies producing 10% additional nuclear energy | 2030 | 25 | - | - | \$1,126,912 | \$29,299,704 | - | 0.00 | (5,583.8) | (139,595.4) | \$209.89 | 4 |
| LEED Silver building upgrades to all traditional buildings (10% efficiency improvement on 80% of the 2009 square footage) | 2020 | 30 | - | - | \$777,174 | \$24,092,397 | - | 0.00 | (4,373.4) | (131,201.0) | \$183.63 | 9 |