Washtenaw Community College

Climate Action & Sustainability Plan

January 15, 2014

Washtenaw Community College

Office of the President

October 1, 2013

Members of the Campus Community:

On behalf of the faculty, staff and students of Washtenaw Community College, I want to extend our collective thanks to the Climate Action Task Force for its leadership of the College's efforts to address the American College and University Presidents' Climate Commitment (ACUPCC).

As part of this commitment, WCC will make environmental sustainability a priority and an integral part of practices designed to make the College carbon-neutral by 2060. The College will implement this comprehensive climate action plan, which sets forth cost-effective short- and long-term goals that take into account existing infrastructure and resources, together with proven strategies and innovative technologies for reducing dependence on nonrenewable energy resources. By employing a wide range of expertise, resources, and reputation, WCC can become a model of environmental stewardship, thereby furthering the College's commitment to social responsibility.

Sustainability is one of the underlying principles supporting the ability of Washtenaw Community College to achieve its mission and vision for the future. WCC developed this Climate Action Plan as a strategic planning tool to reduce greenhouse gas emissions as effectively and rapidly as possible and as a communications platform for conveying a long-term goal to become a climate-positive institution. Our plan maps out an ambitious vision of our campus – emphasizing energy efficiency, renewable energy generation and climate offsets – to become climate neutral before 2060.

Climate change requires positive action, collaboration and creative problem solving. I call on all members of the WCC community to join with me in accepting this challenge in order that we may address it as a unified community.

I urge every member of the Washtenaw Community College community to read this document and recognize that there is a role for each of us to play in the College's effort to meet its goal of contributing significantly to the understanding of climate change and, ultimately, leading the way in the struggle to prevent the future degradation of the earth's climate.

I am confident that through the dedication and combined efforts of our faculty, students and staff, Washtenaw Community College will achieve all elements of this thoughtful, comprehensive and ambitious plan.

Sincerely,

Rose B. Bellanca

Rose B. Bellanca, Ed.D.
President

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1.0 Executive Summary

In 2007, Washtenaw Community College (WCC) became a signatory of the American College and University Presidents' Climate Commitment (ACUPCC or PCC). Under this commitment, WCC has agreed to complete ongoing inventories of its greenhouse gas (GHG) emissions and develop a Climate Action Plan (CAP) to guide the College down a path toward carbon neutrality. WCC has established the goal of becoming carbon neutral by 2060.

This document represents WCC's first Climate Action Plan (CAP) and is intended to provide a clearer understanding of the challenges ahead and identifies several measures that can be taken in the next three to five years. One thing is clear: attaining carbon neutrality will require significant internal collaboration and diligent data management in order to implement changes and track performance over time.

WCC is committed to reducing our GHG emissions on an absolute basis by adopting new policies and procedures designed for reducing energy consumption and preparing students for their future roles as responsible stewards of their communities.

Reduction strategies have been organized into seven issue areas: Buildings/Energy, Transportation, Waste, Water, Food & Agriculture, Purchasing & Operations, and Carbon Offsets. Each strategy contains multiple measures that have been categorized as short-term, mid-term, and long-term. The focus of this initial CAP has been on the short-term measures to be implemented mainly between 2013 and 2016. The goals stated within this CAP are aggressive for WCC, demonstrating the level of effort needed to reach climate neutrality and the importance of two critical areas: conservation within existing buildings and commuting patterns.

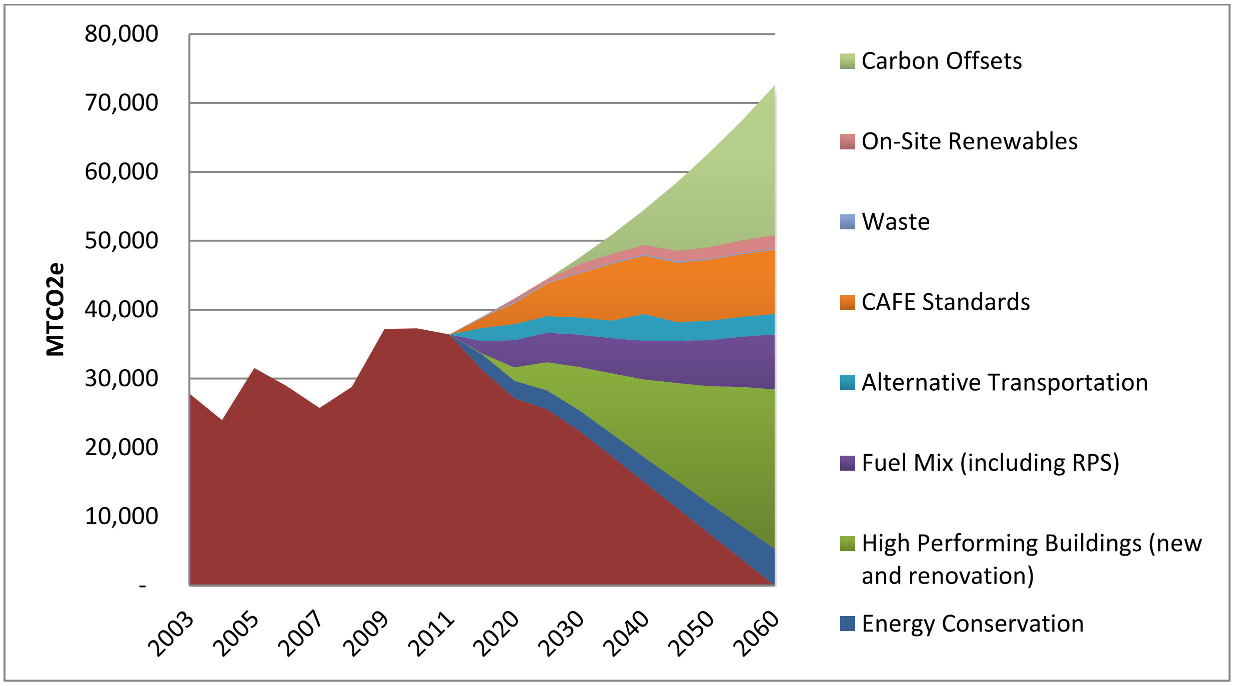
Summary of Impacts from Short-Term Measures by Issue Area

	Cost	Annual Cost Savings	Simple Payback	Estimated Annual GHG Savings
Short Term	$	$/yr	Years	MTCO2e/yr
Buildings/Energy	$1,823,200	$356,560	5.1	2,861
Transportation	$36,000	$51,000	0.7	1,925
Waste	$5,000	$2,000	2.5	50
Water	$41,300	$15,939	2.6	102
Total Short-Term GHG Reduction	**$1,905,500**	**$425,499**	**4.5**	**4,938**

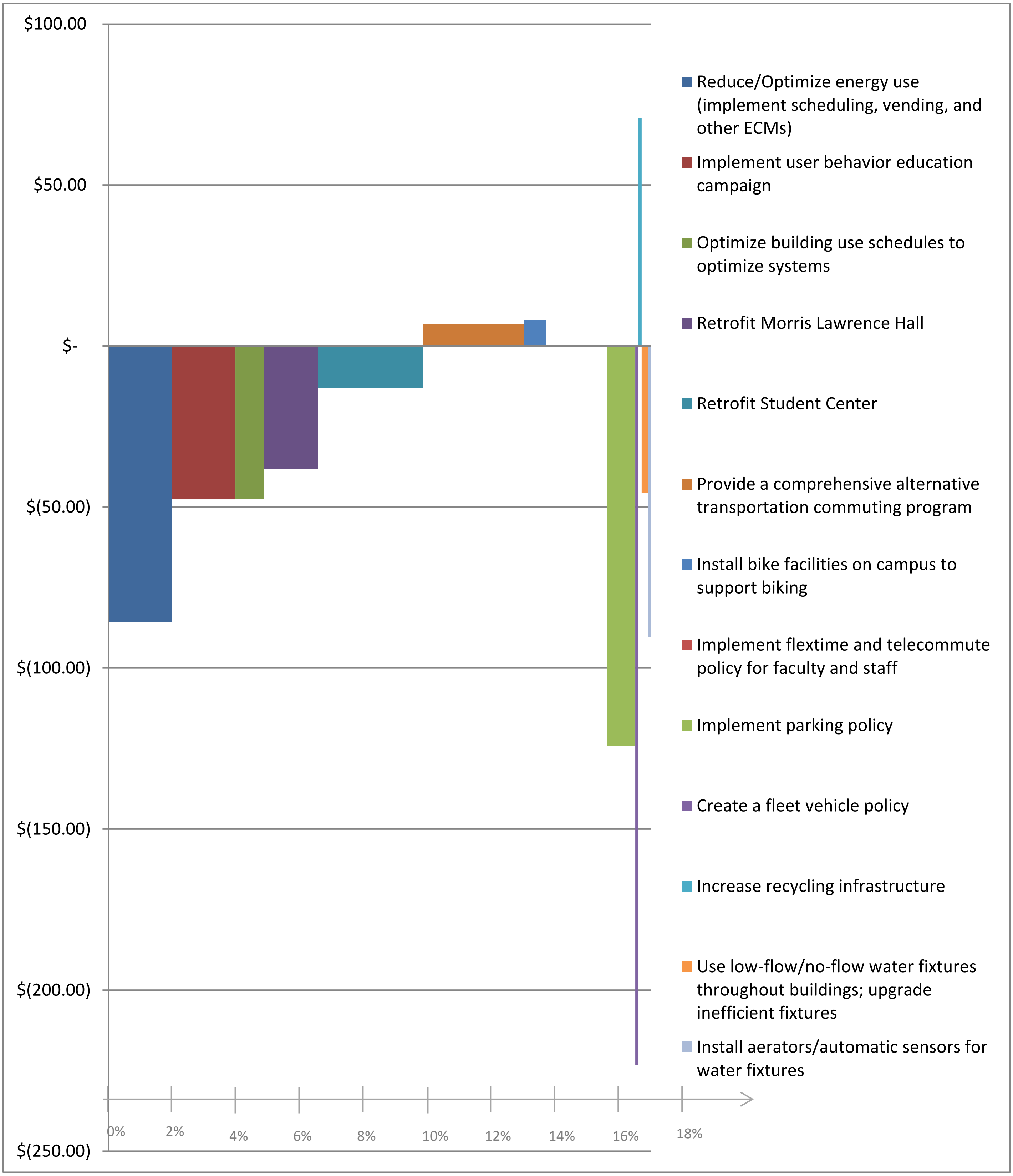
As part of the CAP effort, WCC's baseline GHG inventory was set at 2008 with GHG emissions of 28,778 MTCO2e per year. The total savings associated with short-term measures in this CAP represent a reduction of 4,938 MTCO2e, or 17.2% below the baseline by FY2015 and a 12.7% reduction from the business-as-usual scenario accounting for future growth.

It will take a serious commitment to action by all of us as WCC stakeholders across campus to make this a living document and a tool to help reach annual carbon targets. The impact of doing nothing is significant as the figure below illustrates the impact on GHG emissions over the next 50 years if the College does nothing to change current practices (business-as-usual); it also demonstrates how reduction strategies play a role to counter business-as-usual and stay on the path of carbon neutrality.

Washtenaw Community College Wedge Analysis (2003-2060)



Washtenaw Community College Short-Term Strategy Investment/Reduction Analysis



2.0 Introduction

At Washtenaw Community College, many of our students know about "sustainability" on a personal level. Whether they come from a disadvantaged environment, or have been hit by adversity in the middle of their lives, they come to WCC to get on their feet and on with their dreams. They bounce back from poverty, losing children, losing marriages, losing jobs, and acts of violence to gain the skills and knowledge they need to create a better future for themselves. We help them do this every day.

"Our college strives to make a positive difference in people's lives through accessible and excellent educational programs and services." – WCC Mission Statement

We understand that making a "positive difference" requires us not only to help students deal with the immediate challenges they face, but also to thrive in and help shape the future, a future which is increasingly uncertain. There have been dramatic changes in the last 100 years, in technology, medicine, wealth, and knowledge of how the world works, but the next 100 years may well see declines rather than advances if our society does not quickly learn how to live sustainably. Many of civilization's apparent advances have been made possible by consuming non-renewable resources of the earth and stretching the renewable systems to their limits. This means that we have been essentially borrowing from future generations. Despite the comfort many of us in this country still live in, fossil fuel resources are becoming depleted, clean water is a shrinking resource for many, and air pollution costs billions of dollars annually.[1] We have lost half of the world's tropical and temperate forests, and arable land loss is estimated at 30 times the historical rate. These are serious losses and their long range effect has not yet been felt or understood. That will change. In addition to all of these devastatingly serious problems, climate change threatens to destabilize many of the systems society depends on. As a society we have to turn this around. Obviously, educational institutions have an enormous role to play as we move forward. We have a responsibility to make positive contributions, and to propose creative solutions to the problems we face as a society.

For some, discussions about how we need to address these future problems raises the concern that becoming more sustainable will cost money we don't have. However, the contrary is really true. The college recognizes its responsibility to sustain itself financially and be a good steward of the student and taxpayers' money. By making wise decisions on how the college acquires and consumes electricity for example, we buffer ourselves against rising fuel prices and shortages that are likely to come in the future. We believe that long term financial sustainability is closely connected to meeting our responsibilities to people and the environment.

[1] Muller, Nicholas Z., Robert Mendelsohn, and William Nordhaus. 2011. "Environmental Accounting for Pollution in the United States Economy." *American Economic Review*, 101(5): 1649-75.

In addition to helping students directly, as a community college we also have a responsibility to strengthen the community around us. The WCC Mission states, "We cooperate with other community organizations in seeking solutions to local economic and social problems… We work to improve the quality of life in the communities we serve." By helping to build the "green economy", by modeling how to be a sustainable business and by partnering with local businesses, non-profits and government institutions, we are working to build a community that will be resilient in the face of the coming environmental challenges and sustainable for many generations to come.

"The ultimate test of a moral society is the kind of world that it leaves to its children"
-Dietrich Bonhoeffer

2.1 Climate Change

Climate change is a complex phenomenon that has far-reaching effects on the environment, global economy, human health and our communities in diverse, disastrous ways. The term "climate change" refers to the long-term changes in the temperatures and weather patterns of the planet. Currently, the Earth is undergoing an unprecedented warming trend. In conjunction with various governments, businesses and colleges, Washtenaw Community College has made a commitment to join the efforts to curb the negative effects of climate change by implementing our climate action plan, including sustainable practices and education throughout our college.

"What we do in the next two to three years will determine our future."

-I.P.C.C. chairman, Rajendra Pachauri, November 2007

The Intergovernmental Panel on Climate Change (IPCC) is a scientific body making up thousands of scientists from over a hundred countries under the auspices of the United Nations.

They, along with the major scientific agencies of the United States — including the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) — agree that climate change is occurring, is very likely caused by human activities, and poses significant risks for a broad range of human and natural systems.[2,3]

The global average temperature increased by more than 1.4°F over the last century.[4] According to the NOAA, the years 2000 to 2010 was the warmest decade on record.[5] and 2012 is the warmest year on

[2] IPCC (2007). ***Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*** [Pachauri, R.K. and A. Reisinger (eds.)]. Geneva, Switzerland.

[3] NRC (2011). *America's Climate Choices: Final Report* . National Research Council. The National Academies Press, Washington, DC, USA.

[4] NRC (2010). ***Advancing the Science of Climate Change***. National Research Council. The National Academies Press, Washington, DC, USA.

[5] NOAA (2011). ***2010 Tied For Warmest Year on Record*** . National Oceanic and Atmospheric Administration. Accessed 3/16/2012.

record.[6] Many of the extreme precipitation and heat events that we have seen in recent years are consistent with what we would expect given this amount of warming.[7] Scientists project that Earth's average temperatures will rise between 2 and 12 degrees Fahrenheit by 2100.[8]

The span of Earth's history covers 4.6 billion years. Evidence shows that the Earth has been through many cycles of warming and cooling, caused by natural factors such as changes in the solar output, orbital positions or volcanic activity. This has been closely examined, and the warming we have seen in the past 50 years cannot be explained by natural factors alone.[9]

Greenhouse gases, such as carbon dioxide, methane, nitrous oxides and various fluorinated gases, act like a blanket around Earth, trapping heat leaving Earth in the atmosphere and causing it to warm. This phenomenon is called the "greenhouse effect" and is necessary to support life on our planet. Many earthly processes produce greenhouse gas emissions, like volcano emissions and animals breathing. Other processes absorb the greenhouse gases, like plants and the oceans. These natural processes have kept the greenhouse effect in balance for millions of years, allowing life to flourish on our planet.

Since the early 1800s, however, human activities have released large amounts of greenhouse gases into the atmosphere, far beyond what is typically produced or can be absorbed in nature. Ice core measurements reveal that carbon dioxide levels in the atmosphere are higher than they have been for at least 800,000 years. [6] On average, the amount of carbon dioxide in the atmosphere is growing by about 2 parts per million (ppm) per year. That's 100 times faster than at the end of the Ice Age. Back then, it took 7,000 years for carbon dioxide to reach 80 ppm, and we have now attained a level of 400 ppm and rising.[10] Most scientists believe anthropogenic greenhouse gas emissions are at the core of this problem.[11][12]

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[6] NOAA (2012). *U.S. "State of the Climate" Report.* National Oceanic and Atmospheric Administration's National Climatic Data Center, 2012.

[7] USGCRP (2009). *Global Climate Change Impacts in the United States*. Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.

[8] NRC (2011). *America's Climate Choices: Final Report* . National Research Council. The National Academies Press, Washington, DC, USA.

[9] USGCRP (2009). *Global Climate Change Impacts in the United States*. Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.

[10] *Dr. Pieter Tans, NOAA/ESRL (www.esrl.noaa.gov/gmd/ccgg/trends/)*

[11] IPCC (2007). ***Climate Change 2007: Synthesis Report*. *Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*** [Pachauri, R.K. and A. Reisinger (eds.)]. Geneva, Switzerland.

[12] NRC (2011). *America's Climate Choices: Final Report* . National Research Council. The National Academies Press, Washington, DC, USA.

The majority of greenhouse gases come from burning carbon-rich fossil fuels, like coal, methane and oil, to produce energy. Other releases result from deforestation, industrial processes, landfills and some agricultural practices. The more gases that are added, the more heat that is trapped which results in an "enhanced" greenhouse effect. This is like adding more and more blankets to the Earth, causing more heat to be trapped and less to escape back to space.

The end result is a rise in global temperatures that has often disastrous implications that vary by location. Some places have experienced more intense rain and flooding. Other locations are contending with drought conditions. Severe heat waves are becoming more common. Extreme weather events, like Hurricane Sandy, are expected to become more commonplace. Oceans are warming and becoming more acidic, ice caps are melting, and sea levels are rising.[13] All of these changes are evidence that our world is getting warmer. These changes will globally impact our food supply, water resources, infrastructure, ecosystems, economies, and even our own health.

It is not too late to have a significant impact on future climate change and its effects on us. Technologies exist today to make cars that run cleaner and burn less gas, modernize power plants and generate electricity from renewable sources, and cut our electricity use through energy efficiency. The challenge is to be sure these solutions are put into practice.With appropriate actions by governments, communities, individuals, businesses, and colleges like WCC, we can reduce the amount of greenhouse gas pollution we release and lower the risk of much greater warming and severe consequences. Many of the actions that we can take to address climate change will have multiple social, environmental and economic benefits, such as cleaner air and the development of sustainable energy sources. Not only do we serve to educate our students on climate change, but we must lead by example through our actions and to implement sustainability on every possible level.

2.2 Institutional Profile

Founded in 1966, Washtenaw Community College (WCC) is a comprehensive, 2-year public community college located in Ann Arbor, Michigan. The majority of students are from Southeastern Michigan, but the College also attracts students from all over the world. Over the last decade, the number of full-time students has grown by more than 50 percent to the current enrollment of over 9,700.

Washtenaw Community College is located in Washtenaw County near the intersection of U.S. Route 23 and Geddes Road. By its nature, WCC is a commuter college offering no campus housing for students, staff, or faculty. Parking on campus is free on a first-come, first-served basis. When enrollment numbers are high, such as in 2010-2011, parking lots are at capacity at peak hours during the week. The Ann Arbor Transportation Authority (AATA) operates two bus routes that serve WCC approximately every 30-60 minutes on weekdays. There are other regional bus services that expand public transportation options to further cities and towns such as the Western Washtenaw Area Value Express (WAVE). The Border-to-Border Trail is a shared-use trail and bike lane system that runs adjacent to the WCC campus. In addition, the college operates a small fleet of vehicles for facilities, grounds, and administrative purposes.

[13] EPA (2010). *Climate Change Indicators in the United States*. U.S. Environmental Protection Agency, Washington, DC, USA.

The campus is comprised of 19 buildings totaling 1,007,251 square feet. Buildings range in size from under 200-sf storage facilities to the 180,000-sf Crane Liberal Arts & Science Center. The oldest building is the Technical & Industrial building (1970); the two newest facilities are the Health & Fitness Center (2007) and a new parking structure (2012). The average age of the building stock is 23 years old, with the average size just over 50,000-sf. Buildings are centralized on the 285 acre site surrounded by surface parking lots, a ring road and natural landscaped areas.

The Health and Fitness Center at WCC was certified as a LEED Gold building, the first fitness facility in the country to achieve that rating.

2.3 ACUPCC

In 2007, WCC president Larry Whitworth signed the American College and University Presidents' Climate Commitment (ACUPCC or PCC). In 2012, President Rose Bellanca reaffirmed WCC's commitment. The ACUPCC maintains an ultimate goal of eliminating carbon emissions from college and university campuses while incorporating higher levels of sustainability into the curriculum and campus operation. To date, nearly 700 American colleges and universities serving more than 6,000,000 students have signed onto this commitment. Under this commitment, we have agreed to (a) develop and approve three interim Tangible Actions directed at reducing emissions, (b) undertake and complete a comprehensive Greenhouse Gas Inventory, and (c) develop a Climate Action Plan (CAP) to guide the College down a path to carbon neutrality.

2.3.1 Tangible Actions

In 2007, WCC committed to the following four of the seven ACUPCC prescribed Tangible Actions:

1. Establish a policy that all new campus construction will be built to at least the U.S. Green Building Council's LEED Silver standard or equivalent.
   - All facilities over 5,000-gsf and major capital renovations must achieve LEED Silver or better
   - All new construction projects must be designed to earn at least 40% of LEED points for energy performance
   - College is committed to achieving LEED for Existing Buildings for all existing buildings
2. Adopt an energy-efficient appliance purchasing policy requiring purchase of ENERGY STAR certified products in all areas for which such ratings exist.
   - For products where ratings are not available, choose products that are in the top 25% for energy efficiency.

3. Encourage use of and provide access to public transportation for all faculty, staff, students, and visitors at our institution.
   - Free bus rides on AATA for students, staff, and faculty traveling from WCC campus.
4. Participate in the Waste Minimization component of the national RecycleMania[14] competition, and adopt 3 or more associated measures to reduce waste.
   - Develop an active program to sell or donate campus surplus property.
   - Work with vendors to reduce packaging and shipping materials.
   - Reuse and/or redistribute packing materials from central stores and distribution centers.

In 2009, we conducted our first Greenhouse Gas Inventory for campus operations. Details on the inventory are presented in the GHG Inventory section of this report.

2.4 Climate Action Plan Methodology

WCC is committed to reducing its GHG emissions on an absolute basis by adopting new policies and procedures designed for reducing energy consumption and preparing students for their future roles as responsible stewards of their communities. Climate Action Plan (CAP)-related activities are being led by WCC's multi-disciplinary Climate Action Task Force that was formed in 2011. The Task Force consists of administrative staff, facilities & engineering staff, and faculty. Other campus groups working toward sustainability include the WCC Environmental Committee, Students for Sustainable Food Systems, and the Sustainability Literacy Task Force charged with incorporating sustainability into the WCC curriculum.

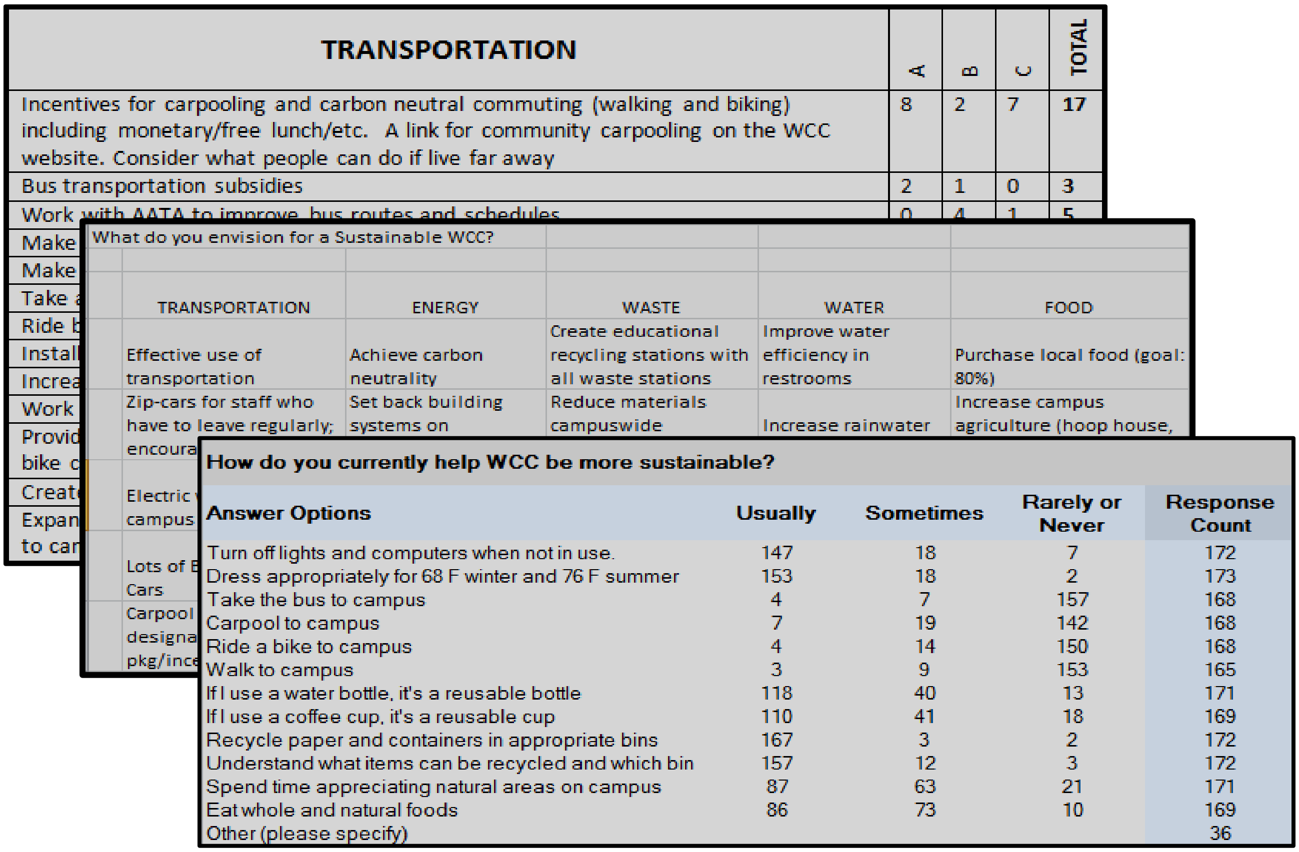
Faculty, staff and administrators came together for the initial kickoff session to begin developing the Climate Action and Sustainability Plan.

The CAP was developed from the ground-up through a participatory process. The college hosted two student-focused CAP sessions in conjunction with the Environmental 101 course (2012 spring semester). During these sessions, students were presented with the facts around climate change and a summary of the PCC followed by a discussion of what WCC is doing well and a focused brainstorm of ideas for improvement. Over 40 students participated in these sessions. In addition, WCC invited faculty and staff to a half-day charrette focused on envisioning a sustainable WCC. In a similar format to the student sessions, attendees were presented with information and then engaged in an active discussion and brainstorming session on what a Sustainable WCC would look like. Figure 1 includes several examples of how this stakeholder data was collected and analyzed for inclusion in the CAP. Over 40 faculty and staff attended representing the administration, facilities, grounds, student services, and faculty from across the college. Finally, the college administered an online survey asking students, staff, and faculty about their perceptions and

[14] *Recycle Mania.* 2012. RecycleMania, Inc. 29 Nov. 2012. http://www.recyclemaniacs.org.

priorities around sustainability issues on campus; nearly 200 people submitted responses. The CAP is a culmination of the ideas and priorities contributed by these WCC stakeholders.

Figure 1: Samples from Climate Action Planning Process



How do you currently help WCC be more sustainable?				
Answer Options	**Usually**	**Sometimes**	**Rarely or Never**	**Response Count**
Turn off lights and computers when not in use.	147	18	7	172
Dress appropriately for 68 F winter and 76 F summer	153	18	2	173
Take the bus to campus	4	7	157	168
Carpool to campus	7	19	142	168
Ride a bike to campus	4	14	150	168
Walk to campus	3	9	153	165
If I use a water bottle, it's a reusable bottle	118	40	13	171
If I use a coffee cup, it's a reusable cup	110	41	18	169
Recycle paper and containers in appropriate bins	167	3	2	172
Understand what items can be recycled and which bin	157	12	3	172
Spend time appreciating natural areas on campus	87	63	21	171
Eat whole and natural foods	86	73	10	169
Other (please specify)				36

This document fulfills the ACUPCC's requirement for a CAP and provides a framework to guide WCC toward climate neutrality in a proactive and thoughtful manner. This Plan includes several measures and policies planned for WCC for the next three-five years, with a strong emphasis on reducing emissions and energy use, as well as new policies intended to create a sustainable and healthy environment for the campus community.

This CAP was created to provide:

- A better understanding of the scope of the challenge ahead
- An opportunity to define goals, strategies, and tactics
- A blueprint for action – defining the best way to proceed
- Milestones to measure progress
- A process which encourages collaboration and brings people together
- An institutional commitment and an effective response to climate change[15]

[15] *Cool Campus! A How-to-guide for College and University Climate Action Planning*. 2009. Association for the Advancement of Sustainability in Higher Education. 29 Nov. 2012. http://www.aashe.org/files/resources/cool-campus-climate-planning-guide.pdf.

2.5 Acknowledgements

The Washtenaw Community College Climate Action Plan is the result of the contributions of numerous individuals. Your willingness to engage in a dialogue, dream big, use good judgment and fair evaluation, and roll up your sleeves to make carbon reduction a reality is noteworthy and appreciated. Of particular note are the contributions of the following groups and individuals.

Washtenaw Community College Climate Action Task Force:

- **Bill Abernethy**, Vice President of Instruction
- **Suzanne Albach**, Professional Faculty, Geology and Environmental Sciences
- **Stuart Blacklaw**, former Vice President of Instruction
- **Annessa Carlisle**, Executive Director, Public Relations & Marketing
- **Laura Crawford**, former Senior Managing Editor, Public Relations and Marketing
- **Barb Fillinger**, Director of Budget and Purchasing
- **Damon Flowers**, Associate Vice President of Facilities Development and Operations
- **Steven Hardy**, former Vice President of Finance
- **Bill Johnson**, Vice President of Finance
- **Peter Leshkevich**, Director of Student Development Activities
- **Dale Petty**, Professional Faculty, Industrial Technology
- **Les Pullins**, Professional Faculty, HVAC

Washtenaw Community College Sustainability Literacy Task Force for developing the Curriculum Component of the Plan:

- **Maryam Barrie**, Professional Faculty, English
- **Alice Gannon-Boss**, Professional Faculty, Culinary Arts
- **David Mackres**, Adjunct Faculty, Anthropology
- **Dale Petty**, Professional Faculty, Industrial Technology
- **Emily Thompson**, Professional Faculty, Biology and Environmental Science

A special thanks is extended to Suzanne Albach and Emily Thompson for opening their classroom and engaging their students in the CAP process; Peter Leshkevich for spearheading the campus survey on sustainability; to Elaine Stegg for providing the campus wide greenhouse gas data; to Beau Burgen for facilitating the campus-wide energy assessment; and to Dale Petty for keeping the sustainability momentum going in the classroom and beyond.

Sebesta Blomberg & Associates assisted in developing this Plan.

3.0 Greenhouse Gas (GHG) Inventory

As part of the ACUPCC, WCC has agreed to inventory and mitigate the following categories of GHG emissions:

1. **Direct combustion of fossil fuels (stationary and mobile sources)**
2. **Fugitive emissions (on-campus releases of refrigerants and application of fertilizers)**
3. **Purchased electricity**
4. **Commuting by students, faculty and staff**
5. **Air travel paid for by the school**
6. **Waste disposal**

Emissions are classified into three “scopes”. Scope 1 emissions are reported GHG emissions that result from sources owned or directly controlled by WCC. This includes direct combustion of fossil fuels by equipment such as boilers, furnaces, and fleet vehicles. It also includes “fugitive emissions” from on-campus releases of chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFC’s). Scope 2 emissions consist of all reported indirect GHG emissions that are a consequence of activities that take place within the organizational boundaries of WCC. The actual emissions occur at sources owned or controlled by another entity (e.g. electricity produced at a power plant). Scope 3 emissions consist of all indirect emissions not covered in Scope 2 including commuting by students, faculty, and staff to and from campus; business air travel; and solid waste disposal.

It should be noted that the forest land at WCC is not considered a “carbon sink” because of its nature as an existing condition. However, any future changes to land that result in removal of forested area, such as construction of a new building or parking lot, must be recorded as a carbon negative offset. Conversely, if WCC uses current non-forested land or acquires new land and designates it for permanent forested land for carbon sequestration, that land may be recorded as a carbon positive offset.

3.1 Methodology

In 2009, WCC developed its official GHG inventory for the initial year (FY2008) using the Clean Air – Cool Planet (CA-CP) Campus Carbon Calculator v6.1, which is compliant with WRI protocol. Certain data for the inventory has been tracked and incorporated in a FY2009-FY2012 update using the CA-CP Campus Carbon Calculator v6.85 (the most recent version) with an updated report released for FY2012. The organizational boundary used to define the inventory contained everything owned and operated by WCC at its Ann Arbor campus. For each emission source, emissions of CO2, CH4, and N20 were calculated. Emission Factors were provided within the CA-CP calculator tool (see Appendix A). Global Warming Potential (GWP) in the CA-CP calculator uses 100-year GWP from the 2005 *Inventory of U.S. GHG Emissions and Sinks: 1990-2003* (EPA 430-R-05-003), which are taken from the IPCC Third Assessment Report (TAR). The CA-CP spreadsheet file containing raw data and the calculated emissions inventory is available from Elaine Stegg, Secretary to the Vice President of Administration & Finance and has been submitted to the ACUPCC Reporting System.

3.2 Results

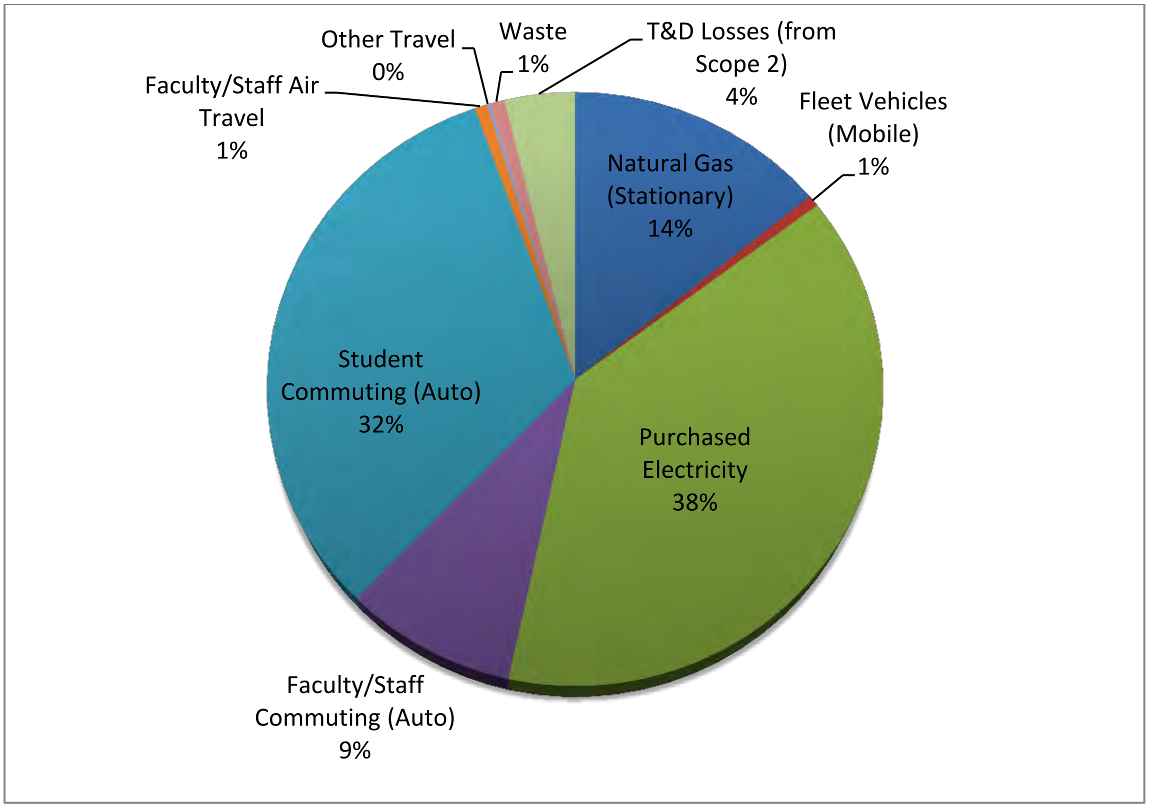
As the earliest year for which WCC has reliable emissions data, we are using emissions for FY2008 as the baseline year for this Plan. It should be noted that major changes on campus since FY2008, including an increase in enrollment of nearly 25% in FY2009-FY2011, resulted in an increase in emissions. Table1 below shows a summary of the FY2008 GHG inventory. Figure 2 shows a visual distribution of emissions for FY2008.

Table 1: Summary of GHG Emissions Inventory

	MTCO2e	
Scope 1 Emissions	**FY2008**	**FY2008 %**
Stationary (Natural Gas)	4,078	14.17%
Mobile (Fleet)	177	0.62%
Fugitive	-	0%
Total Scope 1 Emissions	4,255	14.79%
Scope 2 Emissions		
Purchased Electricity	11,102	38.58%
Total Scope 2 Emissions	11,102	38.58%
Scope 3 Emissions		
Faculty/Staff Commuting*	2,537	8.82%
Student Commuting*	9,314	32.37%
Air Travel	193	0.67%
Other Travel	50	0.17%
Solid Waste	228	0.79%
Scope 2 T&D Losses	1,098	3.82%
Total Scope 3 Emissions	13,871	48.20%
Total Emissions (1+2+3)	28,778	100%
Per Student Emissions (MTCO2e/student)	3.65	

*Estimates based on educated assumptions
**Estimates - data not available for fiscal year

Figure 2: Distribution of GHG Emissions Inventory by MTCO2e (FY2008)



Scope 3 sources are the largest source of emissions for WCC, accounting for over 48% of total emissions. Almost all Scope 3 emissions are from commuting, which can be attributed to WCC being a commuter school with no residence halls. Purchased electricity (the only Scope 2 source) is the second largest emissions source, accounting for over 38% of total emissions. Electricity also contributes an additional 4% in Scope 3 emissions (for T&D Losses), which means that strategies to reduce electricity use on campus will have a significant impact on WCC's carbon footprint. The third largest is Scope 1, which is primarily stationary fuel combustion (natural gas), associated with operating the campus buildings. Air travel, waste disposal, fugitive emissions, and mobile emissions associated with the WCC vehicle fleet are fairly minimal in the context of the overall inventory. Reduction measures will focus on the largest emission sources, although smaller, "low-hanging-fruit" in the other categories will be implemented.

3.3 Historical Data & Trends

Complete GHG inventories are not available for years prior to 2008, but some historical data is available for electricity and natural gas consumption from 2003 through 2011. General assumptions can be made about other data points based on known values, however, the accuracy of this data is not confirmed or verified and requires a closer assessment before any solid conclusions can be drawn. WCC used this historical energy consumption data and GHG emission factors from Clean Air Cool Planet to identify general trends in WCC energy consumption over the previous eight years and the associated trend in GHG emissions for stationary Scope 1 and Scope 2.

As illustrated in Figure 3, there is an overall trend of increasing GHG emissions since Fiscal Year 2003 (September 1, 2002 – August 31, 2003) with a particularly large increase between 2007-2009, which coincides with the addition of the 77,000-sf Health and Fitness Center and a rapid increase in enrollment as well as faculty and staff. In terms of Energy Use Intensity (EUI), which normalizes for square footage, the historical data shows that WCC trended upward during periods of rapid growth in enrollment and is beginning to level off in terms of how many units of energy (BTU) are consumed per square foot of building space (Figure 4).

Figure 3: Historical GHG Emissions FY2003-FY2011, Scope 1 Stationary + Scope 2

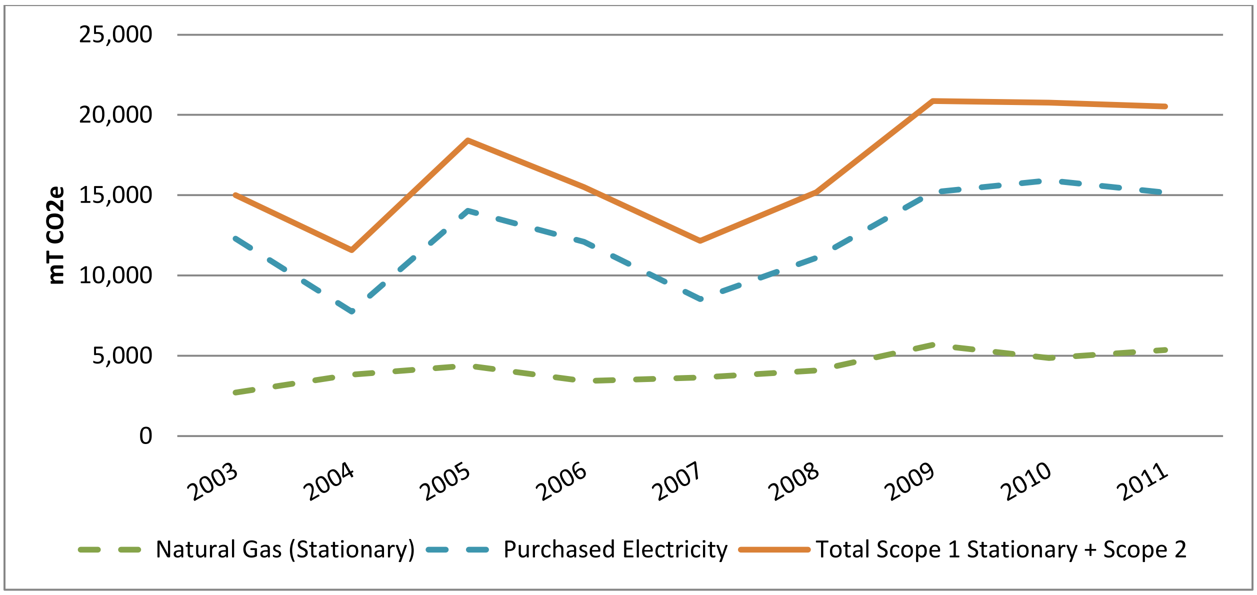
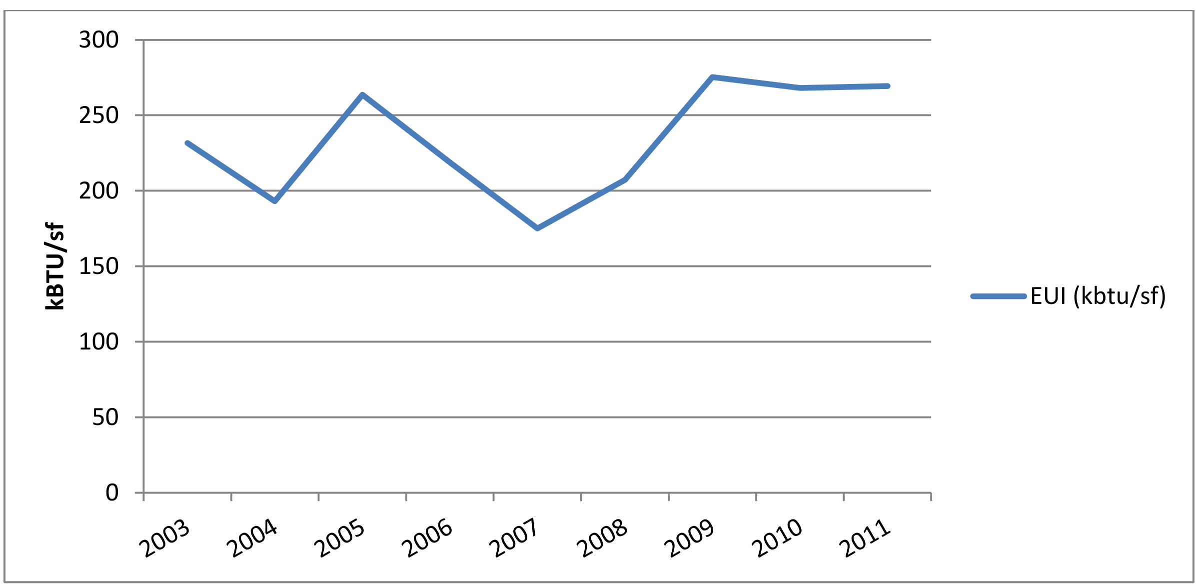


Figure 4: Historical Energy Use Intensity FY2003-FY2011



3.4 Uncertainties/Limitations

Although best efforts have been made to ensure accurate emissions reporting, there are inevitably a fair number of uncertainties within the original baseline inventory. There are "scientific uncertainties" surrounding the GWP values and emissions factors used in the older version of the CA-CP tool; and "estimation uncertainties" are significant for the Scope 3 commuting emissions. Commuting calculations in 2008 were based on an average distance of student's zip code to the college with many rules of thumb and educated guesses concerning vehicle MPG[16], distance traveled, and number of trips per week. The percentage of students using the bus was estimated based on an Ann Arbor Transit Authority survey from 2008, the most recent data available. Percentages of students and faculty using other modes of transportation were estimated, but are not officially tracked. For example, it was estimated that 2% of students and 2% of staff utilize carpooling and that each carpool has two people per car.

The emissions inventory has not been verified by a third party. WCC will likely conduct future inventories in a similar manner, led internally by the Secretary to the Vice President of Administration & Finance with assistance from staff, students, and third parties, as necessary.

3.5 Future Inventory Reporting

Washtenaw recently completed updated inventories for FY2009 – FY2012. The College intends to continually track and report data so that trends in emissions can be identified and progress toward the stated goals monitored in order to meet the requirements of the PCC agreement. Overall, tracking and reporting systems are in various stages of development and will continue to be improved upon in order to gather and record the necessary (accurate) data.

Internal processes, staffing, and tools are needed to accurately record and monitor sustainability efforts. Without it, we will not be able to accurately measure progress against the established goals and will be less likely to achieve any significant or lasting reductions. Washtenaw Community College will prioritize setting up a system for tracking data on an ongoing basis. This may involve using spreadsheet tools, internal data bases, or software programs. In addition, WCC must allocate staff time for maintaining the inventory in order to efficiently and effectively monitor GHG emissions (and changes) on an annual basis.

Annual MTCO2e emissions will be the primary tracking and reporting metric. Other metrics used to document progress towards achieving goals and meeting objectives include:

- Reduction of energy consumption (absolute and per student)
- Square footage and EUI of new and renovated space
- LEED certifications obtained for new construction and major renovation projects
- Number of students, faculty and staff using carpool, public transportation, and other alternative transportation modes
- Waste totals and recycling/compost percentage

[16] *Personal vehicle fuel efficiency taken from U.S. DOT, Bureau of Transportation Statistics, National Transportation Statistics 2012; average for entire U.S. Table 4-11, including passenger cars, light trucks, and motorcycles*

- Reduction of water consumption (absolute and per student)
- New class offerings, certificates, and degree options relating to sustainability
- Student-run sustainability initiatives and class projects (metrics vary)

By the end of 2013, the WCC Sustainability Task Force, in partnership with the Office of Administration & Finance, will define an internal review and reporting process for updating the GHG inventory and CAP, including definition of:

- Who will conduct the inventories and review(s)
- Review procedures
- Frequency and schedule
- How findings will be addressed (corrective action / continuous improvement process)
- Resources to be assigned

3.6 Goals

- Establish an internal review and reporting process by the end of 2013
- Create an updated GHG inventory for FY2012 and FY2013
- Assess the need to hire a part-time or full-time Sustainability Coordinator

3.7 Responsibility

The Vice President for Administration & Finance will oversee the updating of the carbon footprint as required by the ACUPCC.

4.0 Reduction Targets

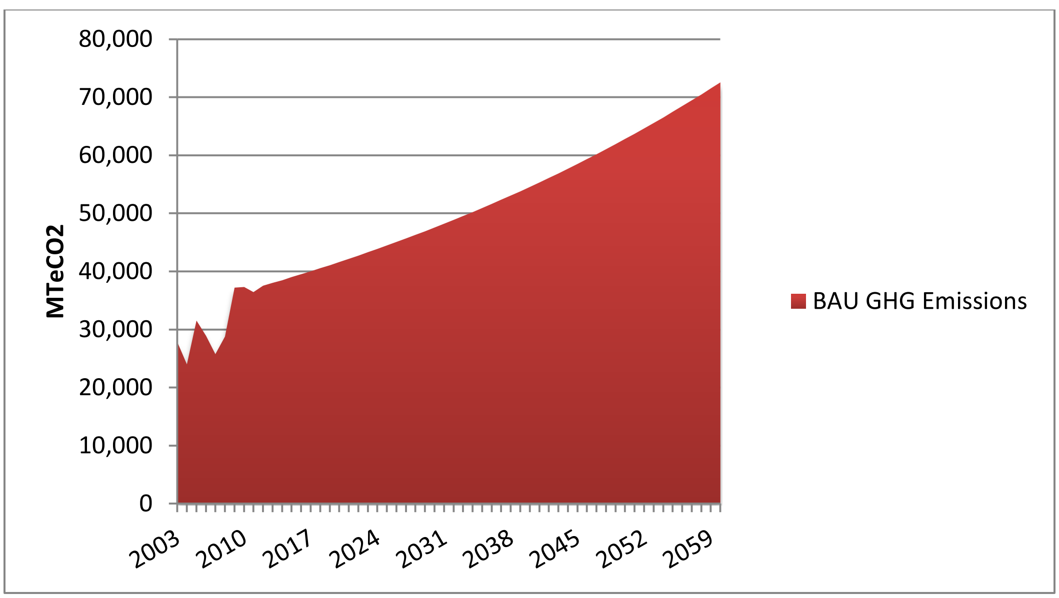
There are many recommendations from leading climate and environmental organizations about how much carbon reduction is needed in order to stabilize climate conditions. As shown in Table 2, all suggested reduction targets are aggressive and will take careful planning and diligent implementation to achieve.

Table 2: Sample GHG Reduction Targets

Organization	Recommended Targets	Baseline
Intergovernmental Panel on Climate Change (IPCC)	25%-40% by 2020 85%-95% by 2050	1990
National Wildlife Federation	"2% pathway" based on a steady reduction averaging at least 2% per year	2005
City of Ann Arbor[17]	8% by 2015 25% by 2025 90% by 2050	2000

Under "Business As Usual" (BAU) conditions, or in the case that WCC chooses not to proactively address activities that contribute to GHG emissions, WCC's emissions forecast increases at a steady rate as shown in Figure 5. This rate was based on an estimated increase in enrollment of 0.5% per year; a 0.3% increase per year of staff and faculty; a 10% increase in building square footage every five years; and an increase in electricity, gas, and fuel use of 3% per year.

Figure 5: Business As Usual GHG Emissions Forecast 2003-2060 (MTCO2e)



WCC emissions reduction goals were set by considering the above mentioned broad scale recommendations and the realistic potential for GHG reductions on campus given a limited budget. These

[17] *City of Ann Arbor Climate Action Plan. 2012. City of Ann Arbor. http://www.a2gov.org/government/publicservices/systems_planning/energy/Pages/ClimateProtection.aspx.*

goals are intended to establish a set of progressive targets that are reachable and realistic, albeit challenging. **The goal for neutrality is 2060.** Interim targets start with a 10% reduction by 2015 (below FY2008) and continue to increase by 10% every 5 years (2% per year) as outlined in Table 3. Generally, WCC needs to reduce emissions at an **average of 576 MTCO2e per year** from the 2008 baseline or an average of 1,451 MTCO2e per year from the Business-As-Usual (BAU) scenario.

Table 3: WCC GHG Reduction Goals

Year	Reduction Target	GHG Emission Target	GHG Emission Reduction (from baseline)	GHG Emission Reduction (from BAU)
FY2008	**Baseline**	**28,778**	**0**	**0**
FY2010	N/A	37,288	-8,510	N/A
2015	10%	25,900	2,878	5,421
2020	20%	23,023	5,756	11,775
2025	30%	20,145	8,633	18,350
2030	40%	17,267	11,511	25,167
2035	50%	14,389	14,389	32,248
2040	60%	11,511	17,267	39,618
2045	70%	8,633	20,145	47,303
2050	80%	5,756	23,023	55,333
2055	90%	2,878	25,900	63,739
2060	100%	0	28,778	72,558

Figure 6 illustrates historic GHG emission estimates back to 2003 in combination with forecasted reduction targets through 2060. Additionally, Figure 7 demonstrates GHG emissions following the business as usual (BAU) trajectory compared to the targeted reduction path.

Figure 6: Historic and Target Forecast GHG Emissions 2003-2060 (MTCO2e)

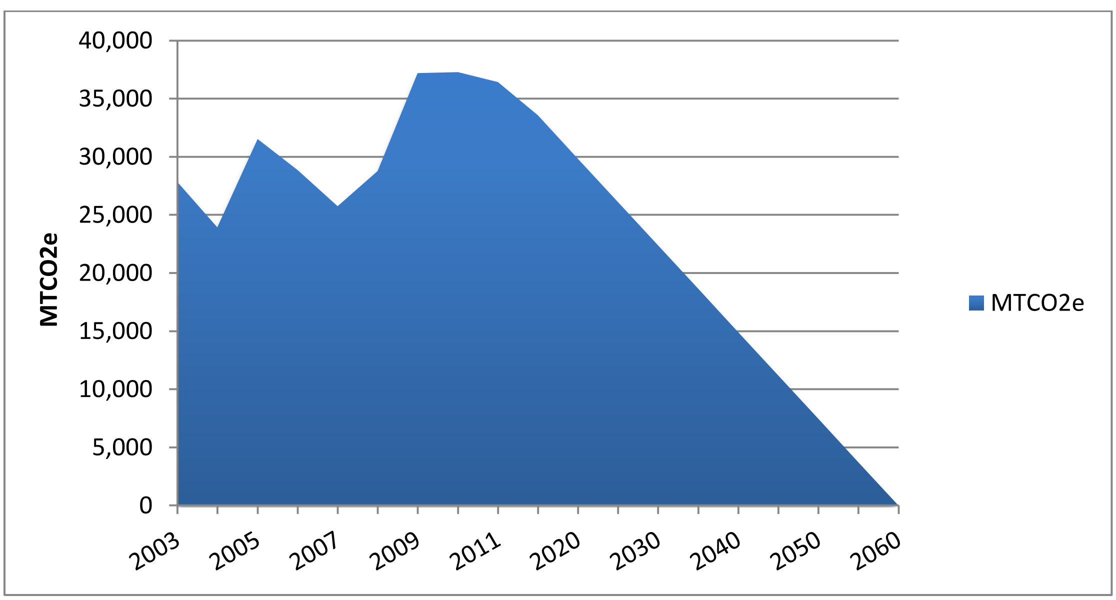
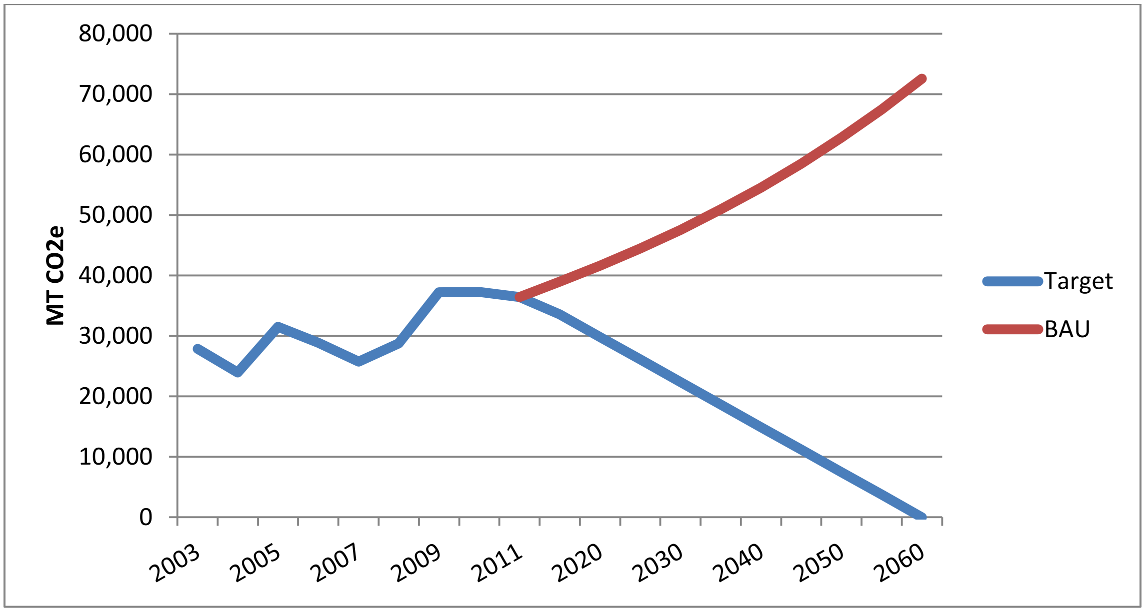


Figure 7: BAU vs. Target GHG Emissions Forecast 2003-2060 (MTCO2e)



As indicated earlier, FY2008 was selected as the baseline year because it is the earliest year that complete verified GHG data is available. There were several major changes on campus between FY2008 and FY2012 including the addition of a four-level parking structure in early 2012, renovation and expansion of the Occupational Education (OE) building, and significant growth in full-time students between FY2008 and FY2009 (growth of nearly 25%). To mitigate the effect of these changes, goals are expressed in absolute terms, as well as emissions per square foot and/or emissions per student. Goals will be publicly reported and updated through ACUPCC as part of this Climate Action Plan and future updates.

5.0 Existing Conditions

Prior to the creation of this CAP, the WCC Environmental Committee had been working to advance the awareness of environmental issues affecting the WCC campus and planning strategies to address them.[18] The Facilities Department has implemented energy efficiency and building operations measures such as minimizing equipment run-times; implementing cost effective retrofit opportunities around lighting, motors, water fixtures, and other equipment; and installing occupancy sensors in classrooms and office areas. As mentioned above, the College made a commitment when it signed on to the PCC to implement four "tangible actions" around green building, energy efficient appliances, promoting transportation options, and waste reduction. These are expected to continue and expand.

Based on participation in the Climate Action Plan development process, the College also benefits from strong and enthusiastic staff and faculty who already look for, and implement, sustainability actions in our own departments and areas of influence.

Existing practices are discussed in more detail by issue in the Mitigation Strategies section which follows this section.

[18] *"About the WCC Environmental Committee". 2012. Washtenaw Community College. 29 Nov. 2012.* http://www.sustainable.wccnet.edu.

6.0 Mitigation Strategies

Greenhouse Gas mitigation strategies and measures were developed from the student, faculty, and staff stakeholder sessions, a review of best practices at other colleges and universities, and an analysis of a campus-wide energy audit conducted by Sebesta Blomberg & Associates, Inc. (Sebesta Blomberg) in September 2012. Strategies were grouped into seven issue areas with each measure, or action item, assigned to a strategy. The strategies are as follows:

Issue Area	Strategy
Buildings/Energy	
	Improve Energy Efficiency & Conservation
	Increase Use of Renewable Energy
Transportation	
	Improve Alternative Transportation Infrastructure
	Reduce Vehicle Impacts
	Increase Alternative Transportation Advocacy
Waste	
	Improve Recycling System
	Reduce Waste
	Expand Composting
Water	
	Reduce Building Water Use
	Reduce Irrigation Water Use
	Reduce Stormwater Runoff
Food & Agriculture	
	Grow Food
	Offer Healthy Food Options
	Support Local Food
Purchasing/Operations	
	Reduce Impact from Purchasing
	Reduce Impact from Housekeeping
	Reduce Impact from Site Management
Carbon Offsets	
	Purchase Carbon Emission Offsets

In order to identify priorities, measures (action items) from each strategy were scored on five criteria and each criterion was assigned a relative weight based on importance in GHG mitigation. Measures that scored highly were deemed short-term actions that should receive immediate attention for implementation (0-3 years). Measures that scored slightly lower were considered mid-term measures for implementation 3-7 years out. Measures that scored lowest were labeled long-term measures that should be re-evaluated in the future to determine feasibility and implementation. The criteria and their relative weights are outlined in Table 4.

Table 4: WCC Mitigation Measure Criteria

CRITERIA	Implementation Cost	Impact (GHG Savings)	Difficulty	Visibility	Estimated Annual Cost Savings
RELATIVE WEIGHT	30%	25%	10%	15%	20%

Short-term measures were analyzed in a quantitative manner where data was available (primarily those in the Buildings/Energy category). Other measures were assessed quantitatively using estimates, as well as qualitative criteria. From that ranking, we identified eleven measures to focus on over the next 3 years.

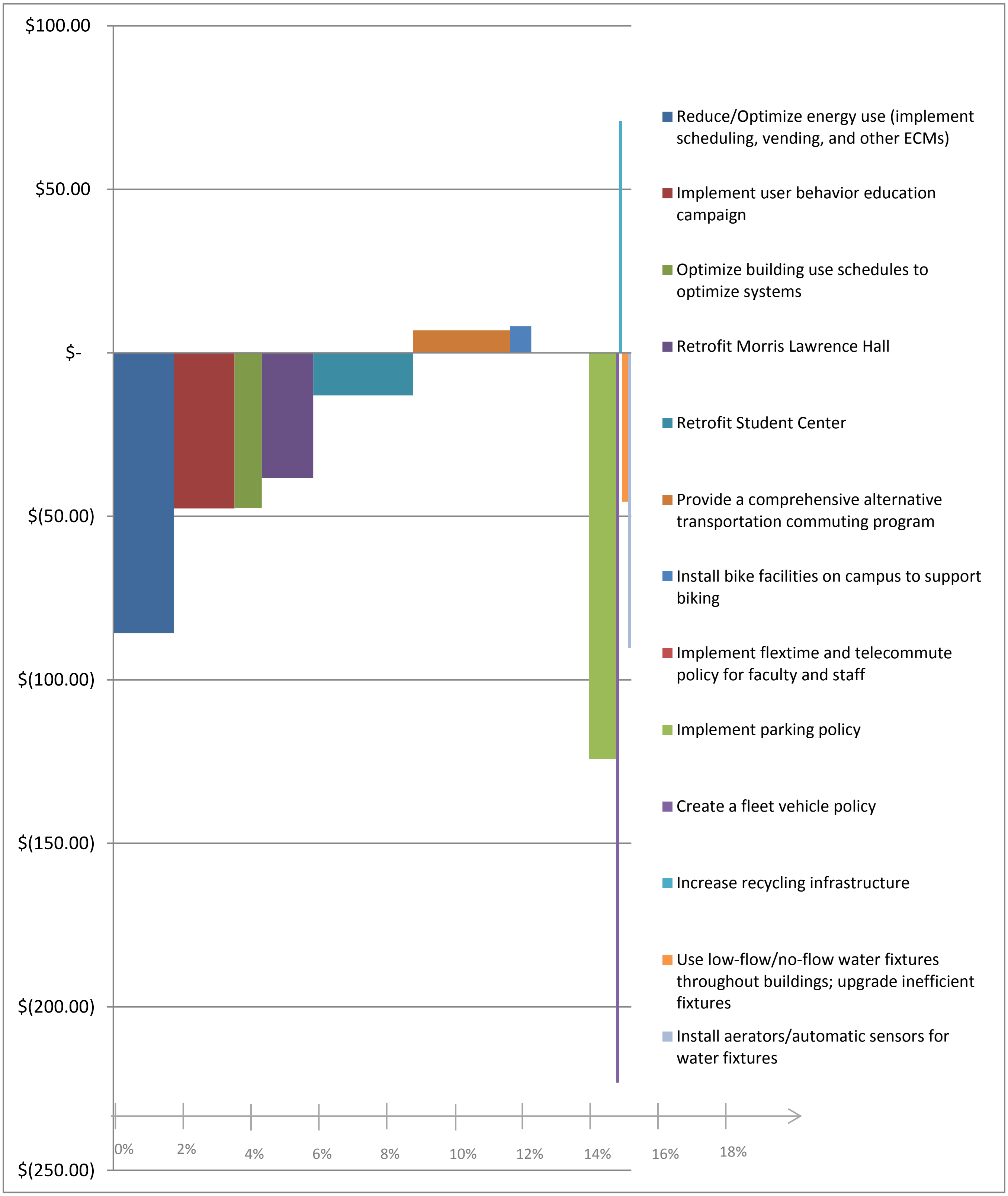
Table 5 provides a summary of costs and savings for all of the short-term measures identified. All short-term measures are described in more detail in the sections below. Total savings from short-term measures is 4,938 MTCO2e, which is a 17.2% reduction below 2008 (baseline) levels and a 12.7% reduction from the business-as-usual scenario. Note that these savings would result in GHG emissions that are significantly below the FY2010 GHG inventory numbers due to a sharp increase in emissions between 2008 and 2010 as a result, in part, to growth in enrollment and bringing a new building online.

Table 5: Summary of Short-Term Measures 2013-2016

Short Term Measures	Cost	Annual Cost Savings	Simple Payback	Estimated Annual GHG Savings
BUILDINGS/ENERGY	**$**	**$/yr**	**Years**	**MTCO2e/yr**
Implement ECMs to Reduce/Optimize Energy Use[19]	$36,300	$87,574	0.4	596
Implement User Behavior Education Campaign[20]	$10,000	$52,420	0.2	557
Optimize Building Use Schedules to Optimize Systems	$5,000	$25,900	0.2	275
Retrofit Morris Lawrence Hall	$468,200	$66,354	7.1	472
Retrofit Student Center	$1,303,700	$124,312	10.5	961
Subtotal – Buildings/Energy	**$1,823,200**	**$356,560**	**5.1**	**2,861**
TRANSPORTATION				
Implement Alternative Transportation Commuting Program[20]	$10,000	n/a	n/a	909
Install Bike Facilities to Support Biking	$25,000	n/a	n/a	206
Implement Flextime and Telecommute Policy	$0	$0	n/a	561
Implement Parking Policy	$1,000	$50,000	0	247
Create a Fleet Vehicle Policy	$0	$1,000	0	3
Subtotal - Transportation	**$36,000**	**$51,000**	**0.7**	**1,925**
WASTE				
Increase Recycling Infrastructure	$5,000	$2,000	2.5	50
Subtotal – Waste	**$5,000**	**$2,000**	**2.5**	**50**
WATER				
Upgrade and Optimize to Low-Flow Water Fixtures	$40,500	$11,997	3.4	76
Install Aerators and Sensors for Restroom Lavatories	$800	$3,942	0.2	26
Subtotal – Water	**$41,300**	**$15,939**	**2.6**	**102**
TOTAL FOR SHORT-TERM MEASURES	**$1,905,500**	**$425,499**	**4.5**	**4,938**

[19] See Appendix B for Campus wide Energy Audit Report from December 2012.
[20] Costs & savings do not include additional staff (i.e. Sustainability Coordinator). Costs are annual. Short-term focus is on increased awareness. Costs will vary based on implementation of this strategy.

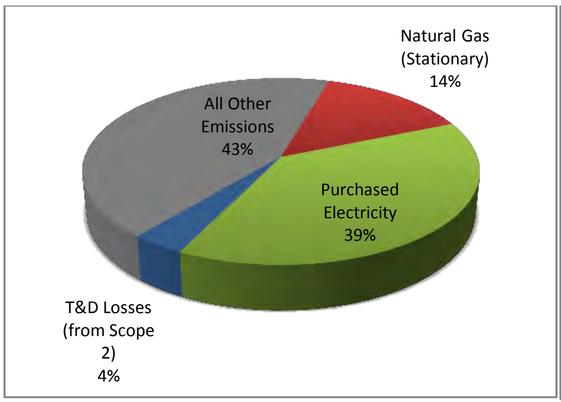
Figure 8: Washtenaw Community College Short-Term Strategy Investment/Reduction Analysis

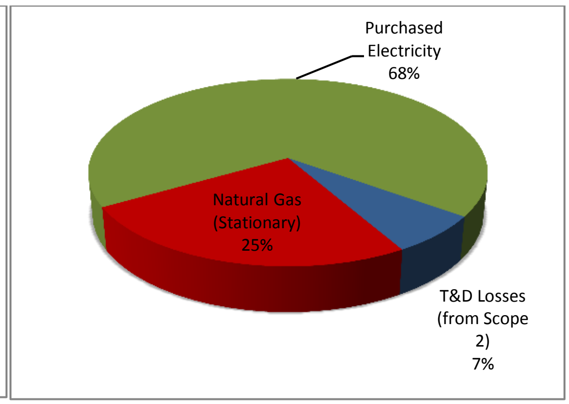


6.1 Buildings and Energy

Energy use at Washtenaw Community College (WCC) has a significant impact on the environment and is the largest source of greenhouse gas emissions for the College (57%). Direct energy emissions (Scope 1) come primarily from the use of natural gas for heating and hot water, and makes up approximately 14% of the school's carbon footprint. Indirect emissions from purchased electricity (Scope 2 emissions) represent 38% of all campus emissions, the largest single source of greenhouse gas emissions for WCC. This percentage increases to 42% when Scope 3 emissions for transmission and distribution losses are included. Both natural gas and electricity are supplied by DTE Energy.

Figure 9: Building/Energy Related Emissions





Overall **Building Energy Only**

6.1.1 Existing Conditions

The WCC campus is made up of 21 buildings and structures for over 1 million square feet of academic and support space with the largest building at 181,000-sf. The campus is served primarily by a central plant located in the Energy Center, powered by electricity and natural gas, which supplies hot water and chilled water to some campus buildings for conditioning. Other buildings have independent heating and cooling. Natural gas is used for heating and hot water. Electricity use peaks in the summer months due to the cooling load; natural gas use peaks in the winter months due to heating load. The average energy use intensity across the fifteen largest buildings on campus was 160.4 kbtu/sf for FY11-12, down from 179.0 kbtu/sf in FY10-11.

Washtenaw Community College has established several policies to help reduce energy consumption including a policy to purchase Energy Star rated products where possible and when constructing new buildings to design to a LEED Silver (or better) standard. In addition, WCC has integrated several energy conservation strategies into our operations such as adjusting temperature setpoints (higher in summer, lower in winter), scheduling buildings to set back at night and on weekends, and minimizing HVAC system and equipment run times. Finally, WCC has been aggressive, especially in recent history, with implementing energy efficiency projects around efficient lighting, HVAC, motors, variable frequency drives (VFDs), controls such as occupancy sensors, and more.

In 2011, WCC finished a significant renovation project on the Occupational Education (OE) Building. That project included installing the first geothermal heating/cooling system as well as a solar thermal installation that generates enough energy to supply hot water for the entire 123,000-sf building (as well as act as a teaching tool for WCC students). As part of the OE project, WCC installed two displays and an integrated website that highlights the building's energy performance in real-time.

Energy Manager Bill Ghrist explains the geothermal system that heats and cools Occupational Education building. The project is expected to be LEED Gold.

In 2012, WCC contracted with engineering firm Sebesta Blomberg & Associates, Inc. to conduct a campus wide energy audit. This included a detailed review of fifteen of the 21 largest buildings on campus. The assessment focused on operating practices, building usage, HVAC systems and controls, lighting systems, water use reduction, and the chiller and boiler plant. The purpose of the assessment was to develop building operating strategies and building-specific projects that WCC could implement to reduce energy consumption and greenhouse gas emissions. The full results from Sebesta Blomberg's Energy Audit Report are included in Appendix B.

6.1.2 Challenges

Building and site energy use at WCC is the biggest factor in GHG emissions, and therefore it is extremely important to focus on managing building energy in the short- and long-term. Energy management at WCC will need to be deliberate and intentional in order to move towards and maintain facilities that use less energy without sacrificing comfort and function. It is not enough to implement energy conservation measures at a single point in time; monitoring the ongoing performance of the building is essential for long-term energy conservation. Systems and schedules must be maintained and reviewed on a regular basis to identify what is not working correctly and where there are opportunities for further savings.

Renewable Energy students inspect the evacuated tube solar hot water collectors at the Occupational Education building.

One possibility for reducing emissions from energy use is to procure energy from sources with lower energy intensity. While WCC has little control over the energy sources used by the utility company, there are opportunities for developing renewable energy systems on or near campus for use in WCC buildings. These systems, such as solar photovoltaic, solar thermal and wind turbines tend to have a high capital cost and in some cases may not be compatible with the campus and/or buildings.

In addition to reducing energy consumption from existing conditions, WCC will need to be strategic about managing growth in the future as the school continues to grow in terms of enrollment and building space. The College already has implemented a policy to construct all new buildings to a LEED Silver (or better) standard. The College should also consider identifying guidelines specific to the energy efficiency of new buildings such as designing to meet the 2030 Challenge[21], designing to be a certain percentage better than the current ASHRAE 90.1 standard[22], or even designing for Net Zero Energy. In addition, if renewable energy systems are not included as part of the original design, buildings should be made "renewable ready" so renewable systems can be integrated at a later time.

In order to overcome the challenges that are inherent in operating a campus, WCC will need to take a holistic approach to energy efficiency, energy management, energy production.

6.1.3 Outside Factors

While WCC can curb greenhouse gas emissions by reducing the demand for energy, there are other factors outside of the school's control that will impact GHG emissions in the future. It is possible that carbon legislation will be put in place at the federal level in the short- to mid-term. Carbon legislation will have financial implications for entities that emit greenhouse gases, particularly larger facilities with higher energy use. In simple terms, there will be a price associated with carbon dioxide equivalents (CO2e) emitted, meaning that there will be increased monetary value for projects that reduce GHG emissions.

As a regulated utility, DTE Energy will have to comply with any federal GHG emission regulations. Many utilities, including DTE Energy, are looking at ways to proactively reduce the carbon content of their electricity mix through cleaner power sources (nuclear, biomass, wind), energy efficiency, and carbon sequestration. DTE Energy reports that they were able to stabilize GHG emissions to 1990 levels by 2000 and for eight of the ten years from 2001-2010, they remained at or below the 1990 level.[23] Figure 9 illustrates the CO2 intensity of the Detroit Edison fuel mix from 1996 - 2010 (Detroit Edison is an arm of DTE Energy that supplies electricity to the Ann Arbor region). CO2 intensity is a metric that measures CO2 emissions per megawatt-hour (MWh) produced.

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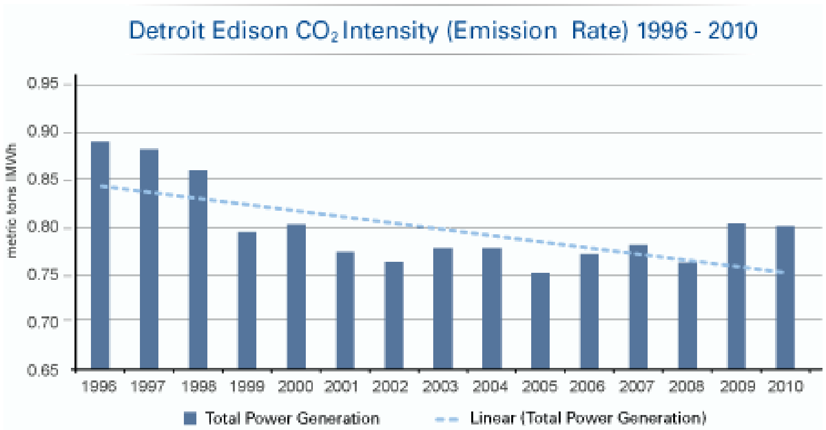
[21] *2030 Challenge. 2012. 2030, Inc./Architecture 2030. 29 Nov. 2012.* http://architecture2030.org/.
[22] *The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) is a building technology society that focuses on building systems, energy efficiency, indoor air quality, and sustainability. They develop standards for design and maintenance of indoor environments including the building energy standard, ASHRAE 90.1. See* www.ashrae.org.
[23] *DTE Energy. 2012. DTE Energy. 16 Nov. 2012 <*www.dteenergy.com*>.*

Figure 10: Detroit Edison CO2 Intensity (source: www.dteenergy.com)



In addition, the State of Michigan has adopted a Renewable Portfolio Standard (RPS), which requires DTE Energy to obtain at least 10 percent of their energy generation from renewable sources by 2015. As of September 2011, DTE Renewable Energy was at about 5 percent.

What this means for WCC is that the carbon content of the electricity purchased from DTE Energy is expected to reduce over time. We have not included future GHG emissions impact from carbon legislation or DTE Energy initiatives into this section of the plan due to the uncertainty of its effect at WCC; however, we have included it in the wedge analysis provided in the conclusion of this report. In the short- to mid-term, we assume that the changes will likely result in a decrease in GHG emissions from purchased electricity by 5-20% by 2020 (not adjusted for campus growth.)

6.1.4 Goals

- Implement all short-term measures identified in the energy audit by 2014.
- Reduce building energy-related GHG emissions by 10% (from baseline) by 2015.
- Reduce building energy-related GHG emissions by 40% (from baseline) by 2025.
- Produce 5% of energy used on campus from renewable resources by 2020.

6.1.5 Strategies

1. Improve Building Energy Efficiency and Conservation
   - Implement low-cost energy conservation measures (ECMs) to reduce and optimize energy use
   - Implement a user behavior education campaign targeting energy and sustainability issues
   - Optimize building use schedules to use most efficient systems
   - Retrofit Morris Lawrence Hall to increase efficiency
   - Retrofit Student Center to increase efficiency
   - Implement a continuous commissioning program
2. Increase Use of Renewable Energy Resources

- Evaluate opportunities for increased renewable energy sources
- Evaluate opportunities for incorporating geothermal throughout campus

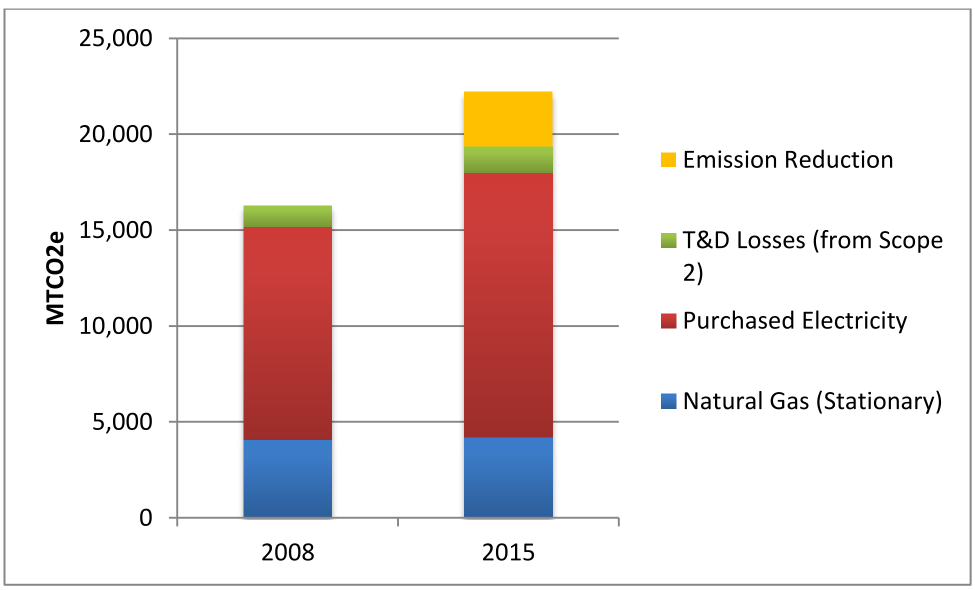
6.1.6 Short-Term Measures

The short-term measures presented below are estimated to reduce GHG emissions by 2,861 MTCO2e by 2015.

Table 6: Summary of Short-Term Buildings/Energy Measures 2013-2015

Short Term Measures	Cost	Annual Cost Savings	Simple Payback	Estimated Annual GHG Savings
BUILDINGS/ENERGY	**$**	**$/yr**	**Years**	**MTCO2e/yr**
Implement ECMs to Reduce/Optimize Energy Use	$36,300	$87,574	0.4	596
Implement User Behavior Education Campaign	$10,000	$52,420	0.2	557
Optimize Building Use Schedules to Optimize Systems	$5,000	$25,900	0.2	275
Retrofit Morris Lawrence Hall	$468,200	$66,354	7.1	472
Retrofit Student Center	$1,303,700	$124,312	10.5	961
Subtotal – Buildings/Energy	**$1,823,200**	**$356,560**	**5.1**	**2,861**

Figure 11: Estimated GHG Emissions from Buildings/Energy by 2015



Implement ECMs to Reduce/Optimize Energy Use. The campus-wide energy audit that was conducted in 2012 revealed several energy conservation measures (ECMs) that were consistent across several buildings on campus and had a payback of two years or less. By implementing two of these widespread ECMs, in addition to four smaller ECMs, WCC can look to save nearly $88,000 in energy costs and 596 MTCO2e annually. Collectively, it is estimated that these efforts cost $36,300 to implement resulting in a simple payback of 0.4 years.

The low-cost ECMs that should be implemented in 2013 are:

1. Scheduling Refinement. By reviewing mechanical and electrical equipment schedules for buildings throughout campus, building engineers can identify areas where systems can be optimized to run for shorter periods of time. The simple payback for going through this exercise in the nine buildings identified in the energy audit is 2-3 months.
2. Vending Machine Controls. Vending machines exist in all major buildings on campus. While most of the machines are equipped with efficient LED lighting and motion controls to turn lights off during periods of inactivity, additional compressor controls that adjust the temperature of machines with non-perishable goods.
3. Tunnel Piping Insulation. Repairing or adding pipe insulation where needed in the tunnels that connect the Energy Center Central Plant to various buildings will reduce energy losses in the transmission of chilled water and high temperature hot water. The implementation of this measure can be done for less than $2,000 and yield a simple payback of a few months.
4. Boiler Trim. Also in the Energy Center Central Plant, provide O2 boiler trim with the blower motor variable frequency drive to reduce annual natural gas costs by nearly $5,000 for a simple payback of 2 years.
5. Condenser Water Reset. In the Health and Fitness Center, using a condenser water reset strategy over a constant condenser water supply temperature will allow the compressor to operate more efficiently during periods of milder weather. This is a relatively low-cost fix that should yield a simple payback of one year.
6. Open Triple Duty Valves. Opening these valves will not change the performance of the associated pumps, but will allow them to operate more efficiently. The labor cost for implementing this measure is low with a simple payback of 2-3 months.

Solar powered emergency phone stations avoid the cost of running underground wires to remote locations. Solar powered trash compactors reduce the trips required to empty them.

Implement a User Behavior Education Campaign. Washtenaw Community College should implement various campaigns on campus to change behavior among students, faculty, and staff. These campaigns are great opportunities for student involvement and can often be planned and implemented by student groups or classes as part of a class assignment. In fact, implementation costs for a user behavior education campaign can be kept minimal by incorporating these strategies into student projects and club activities already happening on campus. Faculty will continue to look for opportunities to use WCC as a "living laboratory" for sustainability pilot programs and energy reduction campaigns. Students expressed a desire for information on "better" behavior around energy issues indicating that they are willing to take different actions when it comes to energy if they know they are making a difference. A comprehensive user behavior campaign should incorporate energy and non-energy initiatives highlighted below such as transportation, waste, and water.

Consider using kiosks and other public spaces to market user behavior initiatives; post tips for turning off lights, computers, and other electronics in visible places throughout campus – create a "brand"; install building dashboards or other third party tracking solutions to present real-time data to students, staff, and faculty; and email blasts with "green tips" for improving energy decisions on campus and at home. Integrate energy education into the curriculum where possible, including calculating personal carbon footprints and challenging students to reduce their footprint over the semester.

Optimize Building Use Schedules. As indicated in the recent campus energy audit, there are one or two buildings on campus that are well-suited for scheduling classes and events outside of normal operating hours. While all buildings are used during weekdays throughout the school year, there are times such as weekday evenings, weekends, and weeks during the summer when the need for space is greatly reduced. However, if even one class is scheduled for a building at any given time, operating the central plant, common area lights, and other systems is required.

The Morris Lawrence Building and the Business Education Building are independent of the central plant (they have their own heating and cooling capacity) and are therefore good choices for scheduling activities outside of normal operating hours. We should note that by completing the energy retrofits suggested for the Morris Lawrence Building (see below), moving after hours activities to this building will save even more energy, water, and monetary resources.

Scheduling classes and other activities outside of faculty and staff's typical buildings may be a change that is not entirely welcomed; therefore additional education about the value of these efforts may be needed in order to gain the necessary buy-in.

Retrofit Morris Lawrence Hall. Morris Lawrence Hall (ML) is a 71,377-sf building constructed in 1990 that houses a large auditorium, dance studios, and classrooms. The building is one of the few on campus that has its own chiller and boiler plants (all original) and not served by the campus central plant. Focus on this building is the result of three key factors: 1) the systems are original and close to the end of their useful life, 2) opportunities for enhanced energy efficiency, and 3) the opportunity to use this building to consolidate after hours classes and activities. There are opportunities in the areas of controls, HVAC, scheduling, and lighting (see energy audit report in Appendix B for details).

Further engineering study is necessary to determine the best options for a deep retrofit of ML. Engineering and architectural design services for this and other retrofit projects must establish an energy reduction goal at the onset of the project and should use energy and sustainable design standards such as ASHRAE 189.1[24] and ASHRAE 90.1 to guide the design in order to take full advantage of the retrofit to improve efficiency and operational savings.

It is anticipated that a project of this scale would not be implemented until late 2014 at the earliest and therefore energy and GHG emissions reductions have not been accounted for until 2014-2015.

Retrofit Student Center. The WCC Student Center (SC) is a 164,598-sf structure, built in 1975, at the center of campus. It houses student and academic services; a cafeteria, coffee shop, and other food services; a data center; and the Culinary Arts program teaching kitchen and restaurant. Similar to the ML building, the benefits to retrofitting the SC are multi-faceted including mechanical systems that are approaching their end of life and in need of an overhaul in addition to being the most heavily used building on campus and the hub for each student, staff, faculty member, visitor, and parent. There are opportunities in the areas of controls, lighting, scheduling, and HVAC (see energy audit in Appendix B for full details).

Campus walkway lighting has been converted to energy efficient LED fixtures.

Although the simple payback of a whole building retrofit for the Student Center is longer than retrofits at other buildings, that is primarily due to replacing existing HVAC equipment that is at the end of its useful life. The capital costs of replacing this equipment will have to be borne by WCC at some point in the near future, and by doing so in conjunction with energy upgrades the school can optimize available funding and physical assets.

Like ML, further engineering study is needed to determine the best opportunities for upgrading systems and implementing other energy conservation measures. When procuring engineering design services for this retrofit project, WCC should establish a goal of at least 20% energy reduction compared to existing performance and should reference ASHRAE 189.1 and ASHRAE 90.1 as guidelines for sustainable and energy-efficient design.

Because of the scale and significance of this project, it is anticipated that savings from these efforts will not be realized until 2015 at the earliest.

[24] The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) develops standards for design and maintenance of indoor environments including the building energy standard, ASHRAE 90.1 and the high-performance, green buildings standard, ASHRAE 189.1. See www.ashrae.org.

6.1.7 Mid-Term Measures

Continuous Commissioning Program. To ensure efficient operation of the systems into the future, it is recommended that WCC create and implement an ongoing commissioning program. This type of program will test the functional performance of systems and identify situations where equipment is not operating the way it is intended. Continuous commissioning should result in efficient operations on an ongoing basis.

New Construction and Existing Building Renovation Projects. By the target year for carbon neutrality (2060), it is expected that all existing buildings will have been renovated at least once and new buildings will be added on campus. Each of these construction projects are an opportunity to improve operations and reduce energy usage on campus. The College has already set a target of LEED Silver rating for all new buildings, however, WCC needs to go further in setting specific and aggressive goals for energy and water efficiency before the project enters into design. As mentioned previously, WCC should consider requiring all new buildings meet the 2030 Challenge, designing to be a certain percentage better than the current ASHRAE 90.1 standard, and/or designing for Net Zero Energy. At a minimum, buildings must be made "renewable ready" so renewable systems can be integrated at any time in the building's life.

Evaluate opportunities for incorporating geothermal throughout campus. Washtenaw Community College has had some success with geothermal heating and cooling at the Occupational Education (OE) building. Geothermal systems use the earth to either pump heat energy from the ground into a building in the winter, or transfer heat from a building back into the ground in the summer. Although not considered a renewable energy system, an appropriately sited geothermal system can reduce energy consumption 30% compared to traditional systems.[25] Geothermal should be evaluated as a potential system on future new construction and retrofit projects that are not served by the Energy Center. Emissions reductions from ground source heat pumps can be marginal, due to year-round electric consumption for pumps and the relatively low emissions avoided from displaced natural gas consumption.

Evaluate utility scale wind turbine for renewable energy generation on campus. Washtenaw Community College has marginal wind resources at elevations for commercial scale wind turbines. However, utility scale wind turbines reach higher elevations where higher average wind speeds improve the economic viability of such a project.

Identify opportunities for solar photovoltaic installation on campus. Washtenaw Community College has moderate solar radiation (4.3 peak sun hours). However, a moderately sized array can produce significant electricity annually to offset electricity purchased from the grid. System installation costs have declined steadily in recent years and financial incentive programs are in flux, but these should be monitored on an annual basis as a solar photovoltaic array may be an economically viable project if installation costs continue to decline. Opportunities for installing

[25] *"Geothermal Heat Pumps and Direct Heating Uses." Geothermal Energy Association. 2012. 3 Dec. 2012. < http://geo-energy.org/pdf/GeothermalHeatPumpsandDirectHeatingUses.pdf>*

solar arrays over and around parking lots and on buildings with sufficient structural strength exist on campus and should be explored to enable WCC to annually offset electricity purchased from the grid. The College may choose to explore a Power Purchase Agreement[26] strategy to incorporate solar and stabilize electricity prices without the upfront capital costs.

If natural gas rates change, reevaluate solar thermal (hot water) installation on campus. Washtenaw Community College is paying a very low rate for natural gas. Since natural gas is the traditional method for hot water heating, a solar thermal system is not economically viable at this time.

Complete a feasibility assessment for a biomass-fueled combined heat and power (CHP) plant. Washtenaw Community College is rated favorably for biomass resources, which can include crop residues, forest and primary mill residues, secondary and urban wood waste, methane emissions from landfills, domestic wastewater treatment, and animal manure. Biomass can be used as fuel for a combined heat and power (CHP) plant to generate electricity for WCC and use the heat generated from the electric generation process to serve buildings and hot water loads. CHP applications offer increased energy efficiency by making use of the heat byproduct that would otherwise be rejected and wasted. This increased efficiency can yield to significant emission reductions.

6.1.8 Responsible Parties

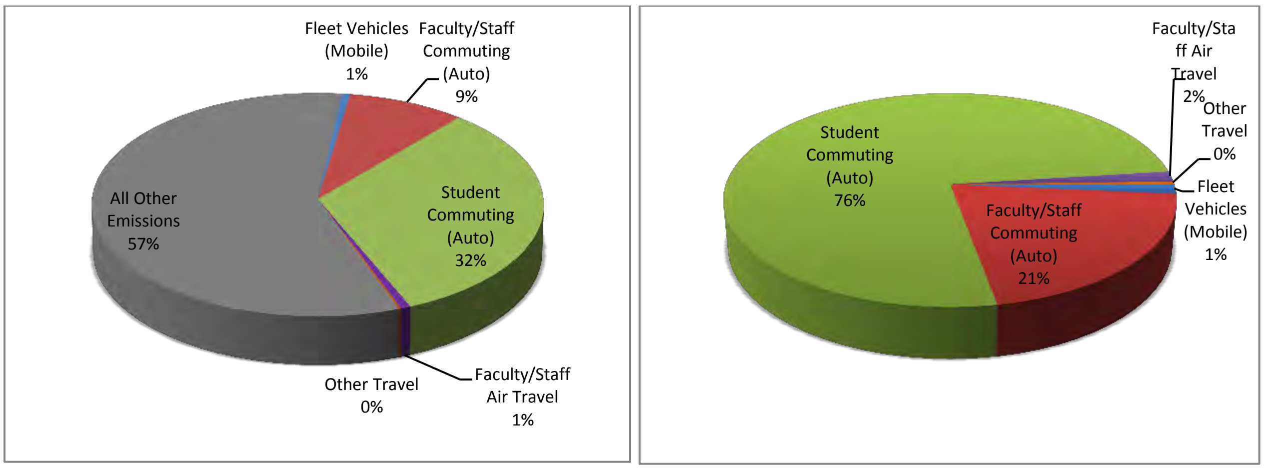
The primary responsibility for building/energy related improvements will be the Facility Management Department spearheaded by the Director of Facility Management, with support from Finance & Administration, Public Relations and Marketing, and the President’s Office.

[26] *A Solar Power Purchase Agreement is a financial arrangement in which a third-party developer owns, operates, and maintains the photovoltaic system, and a host customer agrees to site the system on its roof or elsewhere on its property and purchases the system’s electric output from the solar services provider for a predetermined period.*

6.2 Transportation

Transportation at Washtenaw Community College (WCC) is the second largest source of greenhouse gas emissions for the institution (43%), and as a commuter college, it is likely the most difficult to mitigate. Student commuting represents over 32% of emissions with faculty/staff commuting accounting for an additional 8.8%, with fleet vehicles (0.62%), air travel (0.67%), and other vehicle travel (0.17%) contributing to total transportation emissions.

Figure 12: Transportation Related Emissions



Overall **Transportation Only**

6.2.1 Existing Conditions

As a commuter college with no campus housing, all of WCC students, faculty, and staff must travel to and from campus on a daily basis. The majority of the population currently travels to campus using single occupancy vehicles (approx. 90%) although a small percentage commute by public transportation (approx. 3%), carpool (approx. 2%), or bicycle (negligible). Vehicle parking on campus is free of charge and on a first-come, first-serve basis. There are approximately 3,000 parking spaces on campus including 473 in a new parking structure on the south side of campus. The parking structure has limited designated parking for carpools, as well as six charging stations for electric vehicles.

Student boards an AATA hybrid, bio-diesel bus at the campus bus stop. The college pays bus fare for riders when leaving campus.

The Ann Arbor Transportation Authority (AATA) operates two bus routes that directly serve WCC approximately every 30-60 minutes on weekdays. The College and AATA have partnered to offer free bus rides to students, staff, and faculty from the campus (riders are required to pay for trips to campus). In addition, WCC provides free, needs based, bus passes to students. The Border-to-Border Trail is a shared-use trail and bike lane system that follows the Huron River through Washtenaw County and cuts through the WCC campus. There are bicycle racks located throughout the campus that provide parking for several dozen bicycles. WCC promotes Michigan Rideshare as an online tool for matching commuters for carpools and vanpools.

6.2.2 Challenges

There are significant transportation-related challenges inherent to being a commuter college. Many students at WCC balance academic courses with full- or part-time jobs, family responsibilities, or both, which can lead to irregular commuting schedules that complicate the use of transportation modes other than single occupancy vehicles. During the recent surge in enrollment, there were times during the day when parking was at nearly maximum capacity, which left drivers circling the lots for parking. The inability of incentive programs such as bus passes, free shuttle to remote parking and encouragement of carpooling to reduce the parking demand, and the anticipation of continued growth, led the college to construct a parking structure in 2012. Should growth of the college resume and gas prices remain low, demand is expected to rise unless effective ways are found to convince students, faculty, and staff to find alternate ways of getting to campus. Providing parking to accommodate each student, staff, and faculty member will be costly and may be a detriment to the existing campus character.

Stakeholders expressed concerns over safe bicycle and pedestrian routes to and from campus as an impediment to non-motorized transportation options. Additionally, they identified education on safe bicycling techniques as something that would encourage more people to bike instead of drive. Many participants did not know how to identify carpool partners using the Michigan Rideshare program and were not aware of the AATA agreement for free transit rides from campus.

WCC must be creative and bold in identifying transportation alternatives that will continue to serve our stakeholders while limiting the impact on the campus and the environment.

6.2.3 Outside Factors

Independent of any action from WCC, it is anticipated that there will be a reduction in GHG emissions due to improvements in vehicle fuel economy. In 2007, the United States Congress passed the Energy Independence and Security Act, which changed the target for Corporate Average Fuel Economy (CAFE) standards (the national fuel economy standard) of 35 miles per gallon (mpg) by 2020. In 2011 and 2012, U.S. Department of Transportation (DOT) and the U.S. Environmental Protection Agency (EPA) released additional fuel efficiency standards that change the previous target of 35.5 mpg to 2016, and add targets through model year 2025, which increases fuel economy to the equivalent of 54.5 mpg for cars and light trucks.

We have not included the GHG emissions impact from these standards into this section of the plan due to the uncertainty of its effect at WCC; however, we have included it in the wedge analysis provided in the conclusion of this report. We assume that the new standards will gradually increase fuel efficiency of commuters' vehicles and could result in a decrease in GHG emissions by 5-20% (not adjusted for campus growth or mode shift.) in the short- to medium-term.

6.2.4 Goals

- Conduct annual transportation survey to better understand actual commuting practices.
- Reduce transportation-related GHG emissions by 7% (from baseline) by 2015.
- Reduce single occupancy vehicle trips by students to 82% and by staff/faculty to 80% by 2015.
- Reduce transportation-related GHG emissions by 20% (from baseline) by 2025.
- Reduce single occupancy vehicle trips by students to 70% and by staff/faculty to 50% by 2025.

6.2.5 Strategies

1. Improve Alternative Transportation Infrastructure
    - Provide a comprehensive alternative transportation commuting program
    - Install bike facilities on campus to support cyclists
2. Reduce Vehicle Impacts
    - Develop and implement campus wide parking policy
    - Develop and implement a fleet vehicle policy
    - Increase online class options
3. Increase Alternative Transportation Advocacy
    - Work with public agencies to improve transportation options, including more bus service and safer biking and walking routes to campus

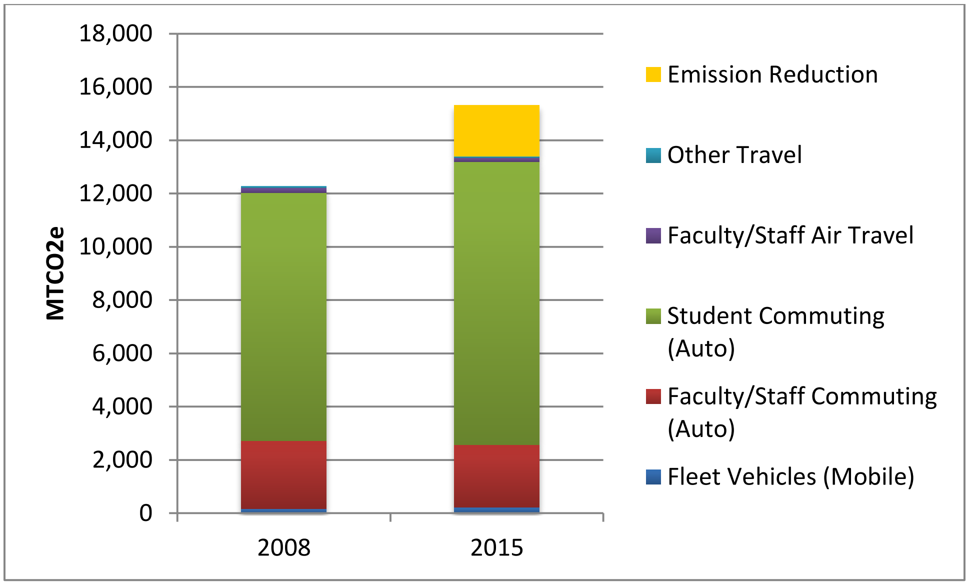
6.2.6 Short-Term Measures

The short-term measures presented below are estimated to reduce GHG emissions by 1,925 MTCO2e by 2015.

Table 7: Summary of Short-Term Transportation Measures 2013-2015

Short Term Measures	Cost	Annual Cost Savings	Simple Payback	Estimated Annual GHG Savings
TRANSPORTATION	**$**	**$/yr**	**Years**	**MTCO2e/yr**
Implement Comprehensive Alternative Transportation Commuting Program	$10,000	n/a	n/a	909
Install Bike Facilities to Support Biking	$25,000	n/a	n/a	206
Implement Flextime and Telecommute Policy	$0	tbd	n/a	561
Implement Parking Policy	$1,000	$50,000	0	247
Create a Fleet Vehicle Policy	$0	$1,000	0	3
Subtotal - Transportation	**$36,000**	**$51,000**	**0.7**	**1,925**

Figure 13: Estimated GHG Emissions from Transportation by 2015



Comprehensive Alternative Transportation Commuting Program. There are a number of opportunities for WCC to provide more transportation options for students, staff, and faculty. The College should create a comprehensive transportation commuting program that makes it easier for stakeholders to choose alternative transportation modes to get to and from campus. As important is creating a campaign for communicating the Program and transportation alternatives to the campus population. Education around transportation options should be ongoing as new students and staff arrives on campus at the start of each new semester.

The Program should address the following:

- Carpooling:
  - Evaluate MIRideshare and other commuter connection tools and promote the preferred tool to stakeholders
  - Create preferred parking spaces in the existing parking lots for carpools
  - Incentivize carpooling
  - Promote the financial and social benefits of carpooling
  - Identify deterrents to carpooling and attempt to mitigate those deterrents
- Transit
  - Incentivize transit through bus subsidies and other incentives
  - Coordinate class and transit schedules
- Non-Motorized (walking/biking)
  - Incentivize non-motorized modes
  - Promote health benefits of walking and biking
  - Offer bike maintenance and safety workshops
  - Connect experienced cyclists with novice cyclists to increase comfort

Bike Infrastructure. Evaluate existing bicycling infrastructure including quality and quantity of bicycle storage, access to convenient and clean showers and locker rooms, and bike-ability of campus roads. Install new bike racks and covered storage in convenient and secure locations, where needed.

Campus bike racks fill up regularly. The Border-to-Border trail along the Huron River offers dedicated infrastructure from Ann Arbor and Ypsilanti.

Flextime and Telecommute Policy for Faculty and Staff. Consider creating and implementing a flextime and telecommute policy for faculty and staff encouraging them to use a flextime schedule (e.g. work four longer days and take the fifth day off) and/or telecommute from home (and therefore avoid driving) at least one day per week. This type of policy can increase employee productivity and satisfaction while reducing parking congestion and GHG emissions from driving.

Campus Wide Parking Policy. Consider implementing a parking fee for anyone commuting to campus in an automobile. The College can offer a monetary discount and preferred parking spaces for carpools and vanpools. Funds raised by the fee program can be used to start a Sustainability Fund to provide financing for future sustainable projects.

Fleet Vehicle Policy. Washtenaw Community College should develop and implement a policy around fleet vehicle use that includes choosing the most fuel efficient vehicle for a task, minimum efficiency standards for future purchases, consolidation of fleet instead of fleet growth, implementing a no-idling policy, and conversion to bio-fuels. Payback for replacing vehicles with more efficient versions is typically longer than the life of the vehicle; however, if replacement is necessary, a policy will guide the purchasing decision. It should be noted that growing the vehicle fleet will likely increase GHG emissions from mobile sources and should be avoided. The focus should be on reducing the size of the conventional vehicle fleet while increasing use of alternative vehicles and high efficiency vehicles.

E-Ride all electric delivery vehicles are used by Campus Services for local deliveries.

6.2.7 Mid-Term Measures

Online Class Options. As WCC continues to increase its student population and course offerings, the school should encourage and facilitate access to online classes. Not only will this reduce vehicle miles traveled to campus, it also may increase the school's marketability to a broad range of students.

Work with Public Agencies to Improve Transportation Options. Washtenaw Community College has an active relationship with the Ann Arbor Transit Authority. The College should continue to work with AATA to improve bus routes and schedules to campus. The goal is to create schedules that better correspond to course offerings, making pick up and drop off more convenient for students and staff. In addition, WCC should engage in discussions with the City of Ann Arbor and Washtenaw County to create and improve safe bicycle routes to campus. Ann Arbor was named the 14th most bike-friendly city in America in 2010[27] and is adding more on-road bike lanes every year. The City also may be a great resource for bicycle safety education. While discussions are ongoing, changes to routes and schedules are seen as a mid-term measure in terms of when the results may be realized.

6.2.8 Responsible Parties

The primary responsibility for short-term transportation related improvements will be shared by the Administration & Finance Department, Student Development and Activities, and Public Relations and Marketing. Primary responsibility for fleet-related emissions will be with the Facilities Management Department. A transportation audit will be done annually (during the fall or spring) to track progress with transportation mode and awareness of programs and amenities. Discussions around mid- and long-term recommendations should start immediately as many of the recommendations require more time for planning and coordination.

[27] *Bicycling Magazine. "Bike Friendly Cities: America's Best Bike Cities Bicycling's Top 50." Bicycling Magazine February 2011. 24 October 2012 <http://www.bicycling.com/news/featured-stories/bicyclings-top-50>.*

6.3 Waste

Waste at Washtenaw Community College (WCC) makes up a small percentage of greenhouse gas emissions for the institution (0.79%). While emissions associated with waste disposal contribute to less than one percent of WCC's total GHG emissions, improved recycling rates are an important and tangible action in which students, faculty and staff can all have a role. In addition, waste reduction often yields savings by forgoing steep landfill tipping fees and reducing the amount of on-going consumables purchased such as paper, cups, and plastic ware. Such savings can help to fund waste minimization and recycling initiatives in future years.

6.3.1 Existing Conditions

There is a very active Recycling and Waste Management program at WCC. The college has had a full time recycling coordinator since 2011. Washtenaw Community College has recycling facilities throughout campus, but has not conducted a recent waste stream audit to identify strengths and areas for improvement in the way waste disposal is currently done. A wide range of materials can be recycled on campus including paper, cardboard, glass, metal and plastic containers, scrap metal from the Welding and Machine Tool departments, Styrofoam, and technology waste. In addition, WCC started a food composting program in 2012 that includes the cafeteria, commercial kitchen(s) and the student kitchen.

There are recycling containers in every classroom and public area and in several locations outdoors. Five Big Belly solar compactors have been installed outdoors in key locations. The Recycling Manager has visited classrooms at the invitation of faculty to discuss recycling with students and has visited academic departments to work out solutions for recycling specific kinds of waste. In addition, used materials are re-purposed through online auction sites or the local ReUse Center.

The College has made strides in reducing materials used by minimizing press runs of campus publications, reducing distribution of hard copy phone books and switching to online directories, and reducing use of Third Class junk mail.

The school already participates in the 8-week RecycleMania[28] competition and typically performs well against its peer schools. In 2012, WCC ranked 51st out of over 600 participating schools nationwide with a recycling rate of 42.47% (up from 35.11% in 2011). The College has placed in the top five in the Waste Minimization category for the last three years.

WCC has consistently placed in the top ten in the National RecycleMania contest in the Waste Minimization category.

[28] *Recycle Mania.* 2012. *RecycleMania, Inc. 29 Nov. 2012. <http://www.recyclemaniacs.org>.*

Top schools have a recycling rate of 80% or higher. Continuing this initiative is important as the school works to expand and improve recycling campus-wide.

6.3.2 Challenges:

Student, staff, and faculty sentiment is that WCC can do better when it comes to waste reduction. While there are recycling facilities throughout campus, they are not always clearly labeled and aren't as prevalent as traditional waste receptacles. The contents of outdoor recycling containers are not currently being recycled. Books, print-outs, and hard copy forms are widely used when electronic versions may be an option. Printers are not always set to print double-sided as a default setting. Food and packaging waste in the cafeteria and from vending machines tends to be disposed of as traditional landfilled waste.

It should be noted that reducing waste, while extremely important from a resource management perspective, will not contribute significantly to GHG emission reductions for WCC because it is such a small percentage of the emissions produced by the school. However, as mentioned earlier, waste reduction strategies tend to be visible and tangible for all members of the campus community and can inspire further action in areas that have a larger impact (energy and transportation).

6.3.3 Goals:

- Conduct annual waste stream audit by 2013.
- Increase recycling rate on campus to at least 50% by 2015.
- Increase recycling rate on campus to at least 75% by 2025.
- Achieve recycling rates of 75% or higher for all new construction or renovation projects.

6.3.4 Strategies

1. Reduce Waste
    a. Reduce consumption of bottled water on campus
    b. Increase use of electronic documents
2. Improve Recycling
    a. Conduct a waste audit
    b. Evaluate cost options for single stream recycling to increase diversion rate
    c. Conduct a campus inventory of recycling containers and improve container location and labeling
    d. Integrate outdoor recycling containers into recycling program
    e. Implement a campus wide recycling education campaign
    f. Create a "trading center" for people to exchange used materials
3. Expand Composting
    a. Expand composting program on campus

6.3.5 Short-Term Measures

The short-term measure presented below is estimated to reduce GHG emissions by 0-50 MTCO2e by 2015.

Table 8: Summary of Short-Term Waste Measures 2013-2015

Short Term Measures	Cost	Annual Cost Savings	Simple Payback	Estimated Annual GHG Savings
WASTE	**$**	**$/yr**	**Years**	**MTCO2e/yr**
Improve Recycling Infrastructure	$5,000	$2,000	2.5	50

Improve Recycling Infrastructure. 1) Conduct a waste audit to identify how much recyclable material is discarded in campus trash. 2) Consider moving to single stream recycling based on results from waste audit. 3) Conduct a campus-wide inventory of recycling facilities and place clearly labeled recycling bins in convenient and highly trafficked areas, adjacent to all common trash receptacles. The easier it is to recycle, the higher the participation rate will be. 4) In addition, implement a campus wide education campaign around reducing and recycling waste. Education should include information on how and where to recycle standard materials (paper, cardboard, comingles) as well as light bulbs, batteries, and computers and electronic waste.

6.3.6 Mid-Term Measures

Reduce Consumption of Bottled Water on Campus. Reducing consumption of bottled water on campus can significantly reduce waste, but should be accompanied by providing water fountains and bottle fillers at convenient locations throughout campus. Providing every student, staff, and faculty member with a reusable bottle can create a great marketing opportunity of sustainability efforts across campus. In addition, WCC should eliminate bottled water at campus sponsored events.

Increase Use of Electronic Documents. Although difficult to quantify, waste reduction measures such as reducing the amount of paper used by moving to electronic formats, must be part of any effort to reduce GHG emissions. The College should start by looking at standard school forms that may be completed online instead of as hard copy. In addition, WCC should evaluate the use of e-textbooks and submitting and grading coursework electronically instead of using paper copies. Faculty and librarians can promote research techniques that utilize electronic documents instead of printing research.

Recycling Operations Manager Barry Wilkins and Recycling Technician Leslie Gibson turn the lid of the "Earth Tub" composting unit. The tub composts most of the food preparation waste collected from campus kitchens.

Expand Composting. Current composting efforts on campus should be formalized and expanded. WCC should evaluate its new program for composting cafeteria waste and grow it to include yard waste. There are opportunities for synergy by growing food on campus for WCC's Culinary Program and using on-site compost to improve the garden soils. Alternatively, there are many small farming operations around Ann Arbor that may be able to use the compost. It should be noted that food scraps are a major source of methane emissions from landfills; depending on how the waste is managed after it leaves WCC, composting could have real impact on GHG emissions.

6.3.7 Long-Term Measures

Create a "Trading Center" for Community Materials Exchange. Although it is not estimated to reduce WCC's GHG emissions significantly or at all, providing a centralized place for members of the WCC community, as well as the greater Ann Arbor community to exchange used items can reduce landfilled waste and provide a great service to the community. There are many ways to implement this measure including annual or bi-annual events, a centralized "trading center", or decentralized "trading centers" that could be set up in office pods where administrative staff could share information between pods.

6.3.8 Responsible Parties

The primary responsibility for implementing waste reduction strategies will be the Facilities Management Department with support from the Office of Administration and Finance, Student Development & Activities, and Public Relations & Marketing, specifically around the educational campaign. A waste audit should be done annually (during the fall or spring) to track progress with waste reduction and diversion. Facilities will track and analyze waste data and will make recommendations for further improving waste reduction.

6.4 Water

Water consumption does not show up directly in WCC's carbon footprint. However a measureable amount of energy is used every day to pump, transport, heat, and cool the water consumed on campus. In addition, water conservation measures protect the region's water resources, which are a defining asset of the area.

6.4.1 Existing Conditions

Washtenaw Community College is supplied water from the City of Ann Arbor Water Utilities. In FY2012, WCC used 27,053,664 gallons of water campus wide (2,465 gallons per student/staff/faculty). The College pays a combined water and sewer rate of approximately $0.008 per gallon.

The College has made progress in reducing water use by implementing strategies such as installing low-flow and waterless fixtures as well as automatic lavatory faucets in some restrooms on campus and replacing water consuming heat pumps in the central plant. In addition, WCC has deployed stormwater management strategies including pervious parking lots (2), bioswales at the Athletic Fields, and vegetated roofs (2). Despite these advances, there are still restrooms with original, high-flow fixtures, there is a significant amount of non-pervious paving due to surface parking lots, and the landscaping is primarily a mix of natural forest and manicured turf grass/lawn.

The Sustainability Literacy Task Force selected a Water theme for the 2012-2013 academic year. Planned activities included a book read with a talk and workshop given by the author, talks by local experts on Michigan water issues and the ecology of the Huron River, field trips to local creeks and the Huron River, service projects to clean up the river and remove invasive species, recreational water activities, and dinner and movie nights with dinners prepared by Culinary Arts students and water theme movies.

6.4.2 Challenges

Water is recognized as an important asset in the Ann Arbor region with lakes and the nearby Huron River playing a strong role in the region's identity. Similar to waste, water use reduction is extremely important from a resource management perspective, but it can be difficult to quantify the impact on energy and GHG emissions reductions. Currently, water is priced at a relatively inexpensive rate and for many institutions, doesn't get the same kind of attention that energy does. However, there is some evidence that water issues are likely to gain prominence in the near future as potable water becomes scarcer relative to demand (for drinking, washing, irrigation, and flushing).

6.4.3 Goals

- Reduce water consumption by at least 25% by 2015.
- Reduce water consumption by at least 50% by 2025.
- Install low-flow or waterless fixtures in all new construction or renovation projects.
- Use native or adaptive, drought tolerant plants for all new landscaping projects.

6.4.4 Strategies

1. Reduce Building Water Use
    a. Upgrade and Optimize low-flow water fixtures in key areas
    b. Install aerators and sensors in restroom lavatories
2. Reduce Irrigation Water Use
    a. Create natural open spaces to replace existing turf grass
    b. Capture rainwater & use for irrigation or other means
    c. Use advanced watering systems for grounds
3. Reduce Stormwater Runoff
    a. Create permeable parking lots

6.4.5 Short-Term Measures

The short-term measures presented below are estimated to reduce energy-related GHG emissions by 102 MTCO2e annually.

Table 9: Summary of Short-Term Water Measures 2013-2015

Short Term Measures	Cost	Annual Cost Savings	Simple Payback	Estimated Annual GHG Savings
WATER	**$**	**$/yr**	**Years**	**MTCO2e/yr**
Upgrade and Optimize Low-Flow Water Fixtures	$40,500	$11,997	3.4	76
Install Aerators and Sensors for Restroom Lavatories	$800	$3,942	0.2	26
Subtotal – Water	**$41,300**	**$15,939**	**2.6**	**102**

Upgrade and Optimize Low-Flow Water Fixtures. Although WCC has installed some low-flow and waterless fixtures in campus restrooms, there are some key areas that haven't been upgraded and still have water closets that use 3.5 gallons per flush (gpf). With a focus on restrooms in the Business Education building, Morris Lawrence Hall, Plant Operations building, Student Center, Health & Fitness Center, and the Technical & Industrial building, existing water closets should be replaced with updated models that use 1.6 gpf or less (water closets should be tested to ensure compatibility with existing plumbing). Replacement and new urinals should strive for flow rates of 0.5 gpf or less (there are several models that use as little as 0.125 gpf available on the market today. Additionally, shower heads, especially in high use areas such as the Health & Fitness Center should by replaced with low-flow versions (there are good models available at 1.8 gpm). A conservative estimate of the impact of these changes is a reduction in water use of nearly 1.5 million gallons of water a year. In areas where there are existing low-flow fixtures, flows and sensors should be checked and adjusted as needed to ensure they are operating as intended. Finally, better labeling and education on how to use non-traditional fixtures such as dual-flush water closets will likely result in water savings on campus.

Install Aerators and Sensors in Restroom Lavatories. Similar to the measure mentioned above, there are areas on the WCC campus where restroom lavatories have 2.2 gpm flow rates. For a very small cost, these fixtures should be fitted with a 0.5 gpm aerator to reduce flow by over 75%. The same buildings listed in the low-flow water fixture measure (above) should be the target of these changes. Evidence shows that reduced flow from restroom lavatories does not impact their performance. The estimated water savings from this action is over 470,000 gallons annually. In addition, there will be marginal energy and GHG emissions savings from the reduced need to heat and pump this water.

6.4.6 Mid-Term Measures

Create Natural Open Spaces. The existing campus landscape is primarily manicured turf grass. A few natural landscape initiatives on campus, such as bioswales, have proven successful. Landscapes that make use of native plants tend to require fewer resources (time, money, and energy) to maintain, promote biodiversity, are more drought tolerant and therefore need less water for irrigation (and may not need permanent irrigation systems), and help with stormwater management including from runoff of paved surfaces. Whenever undergoing a new project that includes landscaping or when an opportunity arises to transition existing open space from turf grass, WCC should opt for native and natural plants and trees. In addition, design the landscape to direct rainwater runoff through the site in order to provide vegetation with additional water supply and keep landscape areas mulched to prevent evaporative water loss. There are a number of professional native landscape businesses in Ann Arbor from which the college could receive consultation and training for the grounds crew.

One of several areas on campus planted with native plants.

6.4.7 Long-Term Measures

Capture Rainwater for Irrigation. Although a more costly capital item up front, capturing and storing rainwater for irrigation or other uses makes use of a valuable resource and can also ease the burden on the stormwater system during major storm events.

Use Advanced Watering Systems. When installing new landscaping, choose advanced watering systems such as drip, mirco-mist, and subsurface irrigation and smart irrigation controllers that monitor moisture levels before providing irrigation. The College should move towards computer-controlled monitoring from a central location.

Create Permeable Parking Lots. To reduce stormwater runoff, increase the number of pervious parking lots throughout campus as new lots are built or as existing lots are resurfaced. Monitor effectiveness of existing pervious lots to ensure they are operating as intended. The College should adopt ongoing inspection and maintenance activities to ensure proper functioning and should limit application of deicing agents such as sand and chemicals to prevent the system from clogging.

6.4.8 Responsible Parties

The primary responsibility for implementing water use reduction strategies will be the Facilities Management Department with support from Public Relations and Marketing. Facilities will track and analyze water data to determine effectiveness of water reduction measures.

6.5 Food and Agriculture

Greenhouse gas emissions from Food and Agriculture were not included in WCC's carbon footprint. However, on a macro level and as part of a larger community, choices around food affect emissions through transportation, energy used to grow and process food, water quality, public health, and strengthening the local economy.

Food and Agriculture is considered a secondary focus area for WCC, but one that students, staff, and faculty feel passionate about. During stakeholder outreach, there was consensus around supporting local and healthy food options. Measures that should be the focus of any food efforts are two-fold:

1. Increase food produced on campus, and
2. Support development of the local/regional food shed

These efforts around food and agriculture should have high visibility on campus and in the community, which can be important on overall sustainability efforts. However, it should be noted that these efforts will not reduce WCC GHG emissions and will likely contribute slightly to an increase in Scope 1 emissions (due to more immediate control over agriculture inputs), but it remains a good sustainable practice nonetheless.

Culinary Arts and Hospitality faculty and students presented a 'Dinner and a Movie' night for the community in conjunction with the academic Year of Energy. The food included vegetarian and vegan options and was largely locally sourced.

Increase Food Produced on Campus. Building on existing student and staff interest, WCC should assess the ability and desire to develop agriculture on campus including permaculture, community gardening, and a hoop house. Connecting campus agriculture to the curriculum in areas such as the Culinary Arts program, agriculture classes, environmental science courses, and community education offerings will help to leverage the concepts of urban farming and food production. Using and promoting food produced on campus in the cafeteria will make local food and agriculture a visible part of most students' WCC experience.

Support Development of the Local/Regional Food Shed. A desire to bring more healthy food options to campus, coupled with a strong local food movement in the region makes it a good time for WCC to look internally at food operations (cafeteria, catering, Culinary Arts program, and vending) and establish guidelines for purchasing food produced regionally (often defined as within 100-300 miles). Seasonal cooking concepts can be integrated into the Culinary Arts program and community education offerings can promote the same ideas for the community-at-large.

"Learn to Cook with Local Food" is one of several sustainable food and gardening non-credit classes offered through the College of Life Long Learning at WCC.

6.5.1 Responsible Parties

The primary responsibility for assessing opportunities for food and agriculture should be a partnership between the Facilities Management Department, Food Services, and Purchasing, with participation from Culinary Arts faculty and support from Public Relations & Marketing.

6.6 Purchasing

Purchasing practices is another area that currently does not show up in WCC's carbon footprint, although WCC may choose to track paper purchasing as a Scope 3 emission in the future. Adjusting purchasing and operational practices can reduce costs while reducing waste and creating a healthier environment for building occupants.

Purchasing and Operations is also considered a secondary focus area for WCC, but one that is fairly easy to implement and to make progress. Three initial actions that the College should consider are:

1. Create campus purchasing guidelines

Create Campus Purchasing Guidelines. Washtenaw Community College should develop guidelines for purchasing that each department on campus can follow. The guidelines should include recommendations and goals for purchasing ongoing office materials, especially paper products, which have recycled content or meet other sustainability criteria. The College should identify other regularly purchased items where more sustainable options exist at a competitive price point (e.g. paper, toner cartridges, batteries). Other areas the guidelines should address include:

- Energy star rated/energy-efficient equipment
- Furniture that meets Greenguard or other standards
- Low-mercury, high-efficiency light bulbs
- Bulk purchasing to reduce packaging and shipping waste
- Working with vendors to minimize packaging
- Arranging for vendors and producers to take back and properly dispose of products at the end of their useful life

6.6.1 Responsible Parties

Primary responsibility for developing a campus wide purchasing policy falls to the Purchasing Department with input from faculty and other administrative staff. Support will be provided by Public Relations & Marketing.

6.7 Operations

Operations are also considered a secondary focus area for WCC, but one that is fairly easy to implement and to make progress. Two initial actions that the College should consider are:

1. Continue and expand green cleaning policy and program
2. Develop and Implement a site management plan

Continue and Expand Green Cleaning Policy and Program. To date, WCC has implemented a green cleaning program and primarily purchases cleaning products that are Green Seal[29] certified. The program also addresses safe handling and storage of cleaning chemicals. The whole program should be reviewed and revised, if necessary, to include:

- Purchase of green cleaning products and materials
- Purchase of cleaning equipment that reduce building contaminants and environmental impact
- Safe handling and storage of chemicals
- Training of maintenance personnel on safety, disposal/recycling of chemicals, dispensing and dilution, and other best practices
- Promotion and improvement of hand hygiene
- Evaluation process for determining success of program and opportunities for improvement

Develop and Implement a Site Management Plan. Given the amount of both landscape and hardscape areas on campus, WCC would benefit from creating a Site Management Plan that provides guidelines, including preferred products and management techniques, around several areas of site management. Implementing a Plan that utilizes best management practices in each of these areas can significantly reduce harmful chemical use, energy and water waste, GHG emissions, and chemical runoff. The Plan should cover the following elements:

A controlled burn is used to combat invasive species in a wooded area on campus.

- Snow and Ice Removal – choose environmentally friendly snow/ice melt products; calcium chloride and sodium chloride can be toxic to vegetation and local waterways. In addition, use manual snow removal techniques where possible.

[29] *Green Seal is an independent, nonprofit organization that works to achieve a healthier and cleaner environment by promoting products and services that cause less toxic pollution and waste, conserve resources and habitats, and minimize global warming and ozone depletion.* www.greenseal.org

- Maintenance Equipment – use lower impact equipment, such as electric-powered, low-decibel leaf blowers, and mulching mowers, for maintaining landscape and hardscape areas in order to reduce GHG emissions and noise pollution.
- Chemical Fertilizer Use – minimize the use of chemical fertilizers by landscaping with native or adapted plants, using organic or natural fertilizers such as compost and grass clippings, maintaining soil health, and using fertilizer only as needed and during times of plant uptake.
- Landscape Management – divert landscape waste from the waste stream through composting, mulching, or other means.

6.7.1 Responsible Parties

Primary responsibility for operations is the Facilities Management Department. Support will be provided by Public Relations & Marketing.

6.8 Carbon Offsets

Climate neutrality is defined as achieving a state where the operation has zero *net emissions* of greenhouse gases. Since most forms of energy, many materials, and wastes all contribute to GHG emissions, in order for WCC to meet its climate neutrality goal, the College must invest in some level of emissions offsets. Emissions offsets are quantified GHG reductions purchased and used to negate or cancel out an equivalent emission from the operation.

Washtenaw Community College's first priority should be to move toward carbon neutrality through actions and measures that reduce GHG emissions. Offset purchases should be a strategy evaluated and employed each time we account for our emissions if we have not reached our target reduction or if we want to achieve deeper reductions than our original targets.

Carbon offsets vary in price on the open market and are influenced by quantity of offsets purchased, type and location of offset project, and other market forces. A report released by the U.S. Environmental Protection Agency in 2010, working in conjunction with 12 government agencies and outside experts, arrived at a cost of $21 per ton of carbon; experts estimate the costs per ton to range from $5 to $65. For illustration purposes only, at $21 per ton, if WCC chooses to purchase offsets for 10% of its baseline emissions (3,729 MTCO2e), it would cost the College $78,306 annually. As the effects of climate change become more dramatic and more government action is taken, the cost of carbon offsets is likely to rise dramatically.

The College will need to identify and dedicate sufficient funding sources for purchasing offsets, which may come from the cost savings or money generating measures mentioned above. Alternatively, WCC may choose to target certain activities for producing revenue for offsetting GHG emission impacts such as event ticket fees to offset athletic team travel and waste generated from events or surcharges for field trips and other travel.

When possible, WCC should purchase offsets from sources generated in close proximity to the Ann Arbor area or in Michigan. Before offsets are purchased, WCC should carefully establish criteria that define required offset quality to ensure offsets are true and verifiable and consistent with overall college values and goals (consider Green-e[30] certified offsets). The College should evaluate opportunities to leverage our offset purchasing by partnering with other colleges and universities in Michigan with similar climate neutrality commitments that may further enhance renewable energy production in the state.

6.8.1 Responsible Parties

Creating the guidelines and managing the contracts for any emissions offsets is the responsibility of the Office of Administration and Finance.

[30] *Green-e is a leading independent certification and verification program for renewable energy and greenhouse gas emission reductions in the retail market (www.green-e.org).*

7.0 Curriculum, Education, & Engagement

The inclusion of environmental, sustainability, and climate change issues in classes at WCC has grown steadily over the years, mostly in an informal way, with individual instructors including assignments or lectures on these issues. In some cases these issues have become a regular part of the course, though they are not necessarily specifically listed in the Master Syllabus. In other cases, their inclusion depends on the passion of a particular instructor. Recently, two new programs were initiated which have a specific environmental focus: the Environmental Science Associates in Science and the Green Building Certificate. In addition, in response to the need to write this part of the Climate Action Plan, the Sustainability Literacy Task Force was created with the support of the Vice President of Instruction. This is the first time such a group has existed at WCC. In addition to conducting surveys and writing up this part of the Plan, the group has started planning programs and resources to help move sustainability literacy forward at the College and to make sustainability part of the culture on campus.

Environmental Science students take a tour of the city of Ann Arbor Materials Recovery Facility (MRF

7.1 Existing Conditions: Curriculum

There are several current educational offerings (both curricular and extra-curricular) related to climate change and sustainability. Two academic programs, initiated in 2011, have a major focus on the environment and sustainability.

The Environmental Science Associates in Science degree is designed to prepare student to deal with environmental issues and concerns from a global point of view. Because environmental science is an evolving, diverse field with various career options, we offer two different program tracks. The Environmental Science Associates in Science degree is a 2-year program based on physical science which prepares students to transfer to a 4-year institution to complete their Bachelor's in Environmental Science. This program is designed to give students first hand lab experiences in studying environmental problems from a scientific perspective, as well as propose and implement solutions to sustainability. It is ultimately preparing students for careers in resource management, waste management, sustainability, environmental consultation and the like. The Environmental and Society Certificate is a 5-semester program emphasizing the social

HVAC students learn to install and troubleshoot heat pumps in the HVAC lab, which are tied to the geothermal field used to heat & cool the building.

science perspective. Both tracks integrate biology, chemistry and geology. Three new courses, ENV 101, ENV 201 and ENV 105 were developed to be the core courses in the program (see below for descriptions.)

The Green Building certificate program is intended as an add-on to a Construction Technology, HVAC or Electrical Technology certificate or degree. Students take classes in green building practices (CON 180), energy auditing (HVA 201) and renewable energy (ELE 106), and finish with a capstone course (CON 247). See below for descriptions of these courses.

Students and instructor test the solar panel on a mobile cart in a renewable energy class.

Though not necessarily reflected in the master syllabus, several courses include sustainability and/or climate change regularly in the course. In some cases, such as CON 180: Introduction to Green Building, they are the main focus of the course. In other cases, such as SOC 207: Social Problems, these issues are covered in one or two particular units. Table 10 is a summary of current courses offered that address sustainability and/or climate change issues.

Table 10: Sustainability in Current Curriculum

Department	Course Title	Course Description
Automotive Technology	Issues related to technological adaptation and mitigation in terms of changing fuel and climate practices are addressed in several contexts, most notably in the ASV 261 Alternative Fuels and Hybrid Vehicles course.	
Biology	Sustainability is discussed and/or included in an assignment in eight Biology courses. Sustainability is not currently in the official course objectives in any of the courses, but is being considered.	
	BIO 101: Concepts of Biology/BIO 103: General Biology II	Provides a comprehensive survey of biological concepts and shows the interrelationship of topics covered from the molecular to the biome level. Basic principles and concepts of biology are surveyed in lecture and laboratory.
	BIO 107: Introduction to Field Biology	Subjects such as native trees and shrubs, wild flowers, and various animals, pond and stream life, and different Michigan terrestrial and aquatic communities will be covered.
	BIO 200: Current Topics in Biology	An introduction to scientific inquiry into some of these issues, which may include medical advances, global warming, environmental issues, agriculture, evolution, and space biology.
	BIO 227: Biology of Animals	An intensive study of the diversity, evolutionary and environmental relationships, structures and functions of the major animal groups.
	BIO 228: Biology of Plants	Introduces plant biology as a field and covers major topics, including: plant biochemistry, plant structure and function, plant growth, nutrition and regulation, plant evolution and classification of the major divisions focusing on flowering plants.
	BIO 237: Microbiology	The structure of microbes that have a significant impact on humans is described and their genetics introduced.
	BIO 267: Winter Field Study	A study of life outside in winter. Topics such as plant and animal identification, observation, adaptations, and interrelationships are discussed.
Childcare Professional	Credentialing from the Child Development Association (CDA) requires some competency in educating children about the environment.	
	CCP 122 and CCP 123: Child Development Credentialing I & II	These courses, as part of Child Development Association (CDA) credentialing, address issues of safety and health related to the repurposing and recycling of materials in the classroom and educate children about sustainable practices.
Construction Technology	Sustainability issues and concerns are currently a feature of several courses.	
	CON 180: Introduction to Green Building	Students are introduced to green and sustainable building

Department	Course Title	Course Description
		concepts and practices including LEED certification, building systems, materials, site selection, air quality, and remodeling.
	CON 247: Sustainable Building Practices	Students relate green building theory and practice, learned in previous courses, to the processes of weatherizing and creating energy-efficient structures on the construction site.
Culinary Arts	Sustainability is becoming a significant issue in the food service industry. Consequently these issues come up in many of the Culinary Arts and Hospitality classes.	
	CUL 100: Introduction to Culinary Arts Industry	Topics include eco-tourism, sustainable practices, and making decisions with the environment in mind.
	CUL 114: Baking I, CUL 115: Pastry I, CUL 124: Baking II, and CUL 125: Pastry II	Topics include recycling, buying local, taking field trips to local sources, and composting.
	CUL 120: Culinary Skills and CUL 230: Quantity Food Production	Includes sustainable kitchen practices including reusing hot water from chafers to wash counters and floors, composting.
	CUL 121: Introduction to Food Preparation Techniques; CUL 231: A La Carte Kitchen	Includes sustainable kitchen practices including reusing products when possible, and composting.
	CUL 150: Food Service Management; CUL 151: Food Service Marketing	Topics include marketing, purchasing decisions, who to buy from, specifying local content in vendor contracts and being a good community member by being an environmental steward when making overall decisions in the marketplace.
	CUL 230/232/120/121:	Purchasing products from local suppliers; teaching proper composting techniques; being conscious of water usage and trying to minimize when possible.
Electricity/Electronics	One course is offered which is directly related to sustainability and one course contains part of a unit on sustainability.	
	ELE 106: Renewable Energy Technology	An introduction to various renewable energy technologies with an emphasis on solar photovoltaic. Students complete a design project (on paper) such as a solar photovoltaic system for a home or a campus building.
	ELE 204: National Electrical Code	Part of one week's lesson is Article 690 Solar Photovoltaic Systems.
Environmental Science	The two courses offered in this field present a comprehensive introduction and overview of current research and practice related to a core understanding of Environmental Science.	
	ENV 101: Environmental Science I	Covers the physical processes that affect the environment, the impact of people on the environment and the physical resources in our environment. It also explores the causes, consequences and possible solutions to both local and global environmental issues. Emphasis is placed on a holistic approach to environmental science, using laboratory exercises, class discussions and projects to reinforce scientific principles.
	ENV 105: Environment and Society	This course provides an in-depth look at the relationships between individuals, societies and the environment from the perspective of science, humanities and social science disciplines. Local to global environmental issues and topics will be presented and analyzed through a combination of lecture, readings, classroom discussions and activities.
	ENV 201: Environmental Science II	Offers an in-depth, interdisciplinary approach to the understanding of the environment and environmental issues. Environmental issues are studied from a scientific, as well as social scientific, perspective. Students complete a capstone project.
Geology	Three courses have significant sustainability content in them and all six Geology courses discuss sustainability issues. Textbooks are heavily based on environmental issues and sustainability is therefore included in a variety of class discussions.	
	GLG 100: Introduction to Earth Science	Provides a basic understanding of geology, hydrology and meteorology and includes an overview of both local and global environmental problems and possible solutions.
	GLG 103: Field Geology	Examines the processes that have formed the local landscape. Emphasis is placed on environmental impact on the landscape and waters of Washtenaw County.
	GLG 104: Weather	Introduces students to analysis of weather phenomena and atmospheric processes. Units on climate change and global warming are included.
	GLG 114: Physical Geology	Examines the processes that have formed the earth.

Department	Course Title	Course Description
		Emphasis is placed on the local geology of Michigan and the Great Lakes.
	GLG 202: Earth Science for Elementary Teachers	Presents the content and methodology for teaching elementary earth science. Topics include climate change and environmental issues.
Heating, Ventilation, and Air Conditioning	Several courses provide students with instruction and certification to enable them to make careers in this important field.	
	HVA 105: Residential and Light Commercial Heating Systems	Covers heat pumps (geothermal) along with conventional heating systems.
	HVA 107: Residential and Light Commercial Air Conditioning Systems	Covers heat pumps (geothermal) along with conventional cooling systems.
	HVA 201: Energy Audits	Prepares students to conduct an energy audit on residential, commercial and industrial structures and HVAC systems.
Sociology	Courses are an integral part of General Education credits which students can transfer to 4 year colleges and universities.	
	SOC 207: Social Problems	This course examines social problems that affect societies and the lives of the people who live in them. One unit in the class focuses on problems of Environmental Injustice.

In addition to the courses listed above in which sustainability is integrated into the curriculum, several individual WCC faculty members have taken the initiative to include climate change and sustainability in their courses where they had the flexibility to do so. Table 11 describes several of these courses.

Table 11: Sustainability in Current Curriculum

Department	Course Title	Course Description
Anthropology	At least one instructor makes it a point to address sustainability concerns in several courses.	
	ANT 201: Introduction to Cultural Anthropology	This course provides a survey of how different human subsistence systems adapt to and impact the environment, emphasizing the consequences of contemporary globalization trends and the dependency of complex social systems on sustainable human-land relationship.
	ANT 202: Introduction to Physical Anthropology	This course examines humans in terms of bio-cultural evolution and ecology, placing Homo sapiens squarely in the natural world, emphasizing how humans are as subject to the constraints of natural selection as any other organism despite the insulating cultural practices we have erected.
	ANT 205: Introduction to Archaeology	This course reviews the long-term trajectories of socio-cultural evolution in response to both climate change and environmental degradation, detailing the unanticipated consequences of excessive resource extraction and the resulting decline and reorganization of social systems.
Biology	The department is strongly interested in sustainability issues, with all full-time instructors expressing interest. At least half of existing BIO courses could be modified to make sustainability more of an issue and the biggest impact would be to do this for BIO 101 which has about 25 sections each semester, and therefore about 1300 students per year. The department is already talking about sustainability issues, with emphasis on reducing costs and environmental impact while maintaining quality in both labs and classrooms. They purchase Energy Star equipment, used lab coats, plastinated bodies (good for one year), substitute non-toxic for toxic chemicals, reuse glassware and lab supplies and materials wherever possible, and schedule classes to minimize student transportation carbon footprint.	
	BIO 107: Introduction to Field Biology	A week of the class is devoted to studying and cleaning up the environment around campus. Students have pulled paper, plastic bags, beer bottles, an old mattress and even a discarded toilet out of the campus woods and pond. Students learn how the waste affects the environment that is home to creatures on campus.
	BIO 227: Biology of Animals	Students are given the option of doing a research paper or presenting a “poster session” at the college's Earth Day.
Business Management	Several instructors of Business Management make it a point to include sustainability in their courses.	
	BMG 140: Introduction to Business	Students were introduced to green business concepts, chose to research the life cycle cost of paper towels, and decided that electric hand dryers were more sustainable. They made a recommendation to the Environmental Committee, and after some discussion, the Facilities

Department	Course Title	Course Description
		Department has installed two dryers as a pilot project.
	BMG 160: Principles of Sales	Study includes the marketing advantages of promoting your business as "green"; the need to weigh costs against environmental benefits is part of class discussions.
	BMG 207: Business Communications	Three of the research project/presentations assigned to students were Going Green on Campus, Parking, and Healthy Food Choices. Faculty and staff were invited on the final day of class to observe the presentations.
	BMG 241: Innovation - Process and Application	The theme "Innovation in Campus Technology" was used as a focus for the class. Students studied the concepts of business innovation as applied to campus environmental problems and solutions including: solar and wind technology, organic farms, recyclable material, electric carts for Security, grey water cisterns, and xeriscapes.
	BMG 220: Principles of	When studying capital budgeting, students do an assignment around a what-if analysis/costing on wind turbines.
Chemistry	Several chemistry instructors have been using 'green chemistry' techniques in their classes. This affords students an opportunity to not only hear about a sustainable practice, but to participate in it.	
Criminal Justice	CJT 120: Criminal Justice Ethics	This is a course that examines values and issues relevant to success in the criminal justice area and may examine unequal treatment of pollution offenses under the law
Economics	ECO 110: Introduction to Economics	This course may educate students about externalities of economic practices on the environment, accounting for its effects on the "free goods" of nature.
English	Many instructors expressed interest in learning more about sustainability literacy for themselves and indicated that they would be open to including more resources and curriculum if it were easily available to their students. Many instructors include open ended research assignments, and include sustainability issues as options students may choose. The English department has a commitment to including issues of sustainability and social justice within their courses. In ENG 111 Composition all students select a research and writing topic from a list which includes suggested topics that have "green" themes, such as the Slow Food Movement, Organic Farming, and Green Housing.	
Foreign Language	The Foreign Language teachers at WCC expressed interest when polled in helping to reduce the campus' carbon footprint, as well as to increase community and student awareness of sustainability literacy concerns.	
Graphic Design Technology	Instructors have actively supported Environmental Committee events by assigning students to produce posters and flyers.	
Music	MUS 146: Songwriting and Creative Improvisation	Students were assigned the task of creating music with an environmental theme. The top songs were performed at the college Earth Day Festival.
Nursing	Sustainability is an emerging topic in healthcare. Individual faculty are researching and sharing articles that are being integrated into "discussion" in their classes. Nursing students took an active role in the 2012 Earth Day Festival. Faculty members are aware that hospitals have huge levels of waste and there is strong opportunity to recycle and reuse. They are intrigued by the organic garden at St. Joseph hospital across the street from our campus which is used to grow food for patients and visitors.	
Photography	PHO 220: Advanced Studio Techniques	Students produce a Public Service Announcement [PSA] poster that requires them to produce photographs in the studio that communicates the campaign idea, *Put Climate Change on a Human Scale*. One of the assignment requirements is the utilization of subject matter that is found or in a state of re-use, which addresses an issue of sustainability by deterring the purchase / consumption of new products.
Radiography	RAD 111: Clinical Education	This course provides students with the knowledge and skills needed to operate basic x-ray equipment and maintain safe and sustainable disposal practices.

7.2 Existing Conditions: Faculty and Staff Professional Development

Since signing on to the Presidents' Climate Commitment, WCC faculty and staff have had the opportunity to engage in several professional development initiatives. A few of these are highlighted below.

- In November 2008, the Faculty Professional Development Committee (FPD) hosted an evening presentation by faculty in five different disciplines, English, Sociology, Photography, Industrial Technology and Biology, explaining how they had included sustainability in their courses.
- In November 2009, Juliana Goodlaw-Morris, the Midwest Campus Field Coordinator for the National Wildlife Federation's Campus Ecology program gave a talk to faculty and staff on how WCC could work with Campus Ecology to improve our sustainability initiatives. She talked about campus climate action planning, working with students to lead the progress of sustainability on the campus and resources available to WCC through Campus Ecology and other programs.
- In January 2010 the college brought in Debra Rowe from neighboring Oakland Community College as the keynote speaker for in-service. After her keynote talk, Ms. Rowe gave a follow-up workshop and then spent the day at WCC, meeting with the President and Vice President, the Environmental Committee, and two groups of faculty and staff to discuss what could be done to integrate sustainability into the curriculum and campus operations.
- In February 2010, Susan Santone, director of Creative Change Educational Solutions was brought to the college by the faculty professional development committee to give a workshop in exploring sustainability as a context for reframing courses in multiple departments. In an on-site program, Creative Change engaged faculty in hands-on activities to explore human-environmental interactions, the Commons, life cycles, and the links between culture and ecology. Faculty then generated ways these concepts connected to their disciplines, ranging from nursing to chemistry to business. In a follow-up survey to all faculty, 142 faculty responded to a FPD survey on sustainability in the curriculum and 110 faculty indicated they would definitely or maybe like to integrate sustainability in their classes.

WCC Biology instructors David Wooten and Ross Strayer lead faculty and staff on a "Walk on the Wild Side" tour of campus natural areas.

- In 2011, two nursing instructors developed and taught a class through LifeLong Learning for 2.3 CEUs that focused on the ANA's Principles of Environmental Health for Nursing Practice with Implementation Strategies.
- The Public Relations and Marketing Department has been instrumental in helping to educate faculty and staff. Their publications including Link-Up, e-Link, Career Focus, Colleague and Green-Link have regularly featured stories on ways that departments, individuals and committees are working to green the campus, on specific activities such as Earth Day and RecycleMania, and on useful green tips for individuals and departments. Green Link was started in 2011 specifically to provide sustainability news to students, staff and faculty.

7.3 Existing Conditions: Other Educational Experience

The Student Development and Activities Department has been quite active in providing students with extra-curricular opportunities to learn about climate change and sustainability. In 2008, 2009 and 2010 they presented an Environmental Lecture Series in which faculty and outside speakers gave small group lectures on a wide range of topics including Carbon Footprint, Green Architecture, Solar Photovoltaic Systems, Environmental Justice, a talk by the Mayor of Ann Arbor, and others.

Biology students carry a 54-pound toilet bowl to the weigh-in during WCC's Field Biology class junk-collecting competition on campus.

For three years, students were offered a summer educational experience at the University of Michigan Pellston Biological Station. Students spent a week in a beautiful natural place in northern Michigan learning about field biology from the researchers at the station.

Environmental science students do water quality testing in Fleming Creek at nearby Parker Mill Park.

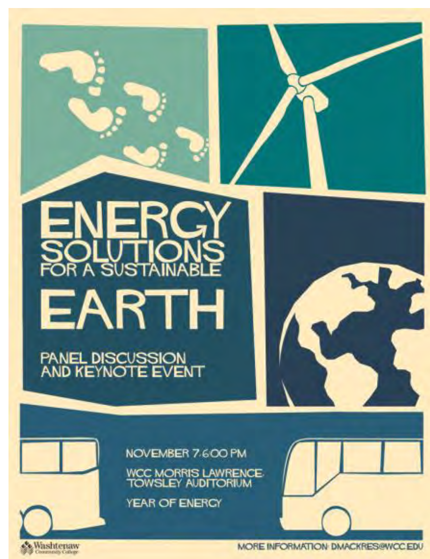
Given the demographics of WCC (1 to 2 year programs, all students are commuters, many students are part-time and work part or full-time and have families), it is difficult to start clubs and keep them thriving. However, WCC has had some success in this area. Based on a high level of interest in one of the speakers at the lecture series, students started a Permaculture Club that lasted for one year. The students and advisor met once or twice a month and went on several field trips. In 2011, a group of students enrolled in ENV 101 started the Students for Environmental Conservation and Sustainability (SECS) club, with one of the Environmental Science instructors as their advisor. The club hosted a "cook-out for a cause" in early spring which attracted about 200 people and gave their group some visibility. They have several events scheduled for summer and fall 2012.

The award winning student newspaper, the Washtenaw Voice[31] regularly has articles related to both campus and community environmental issues. Recent titles include "A Rescue Mission for the Birds", a feature on local Parks, mountain top removal, a climate action plan for the college, invasive species removal, the student Environmental Club, the college's Green Fund, RecycleMania, localization, small farming, and Earth Day.

River cleanup volunteers return to the Gallup Livery with canoes of trash collected from the Huron River.

In 2012, students from the Culinary Arts, Baking and Pastry, and Hospitality programs created the student club, Students for Sustainable Food Systems (SFSFS). The club has been the major force behind the environmentally themed "Dinner and a Movie" nights.

Over the past several years, the Environmental Committee hosted several educational events for students, staff and faculty. Each spring there is an Earth Day festival at which many local "green" organizations and businesses set up information tables and demonstrations on everything from Great Lakes water quality to custom made electric motorcycles. The festival is held in the Student Center in the middle of the day so many hundreds of students benefit from the event. In the last few years, student participation in putting on the event has increased in the form of volunteering, making posters to promote the event, making educational posters to display at the event, performing music and giving poster sessions on research projects they did for a particular class. The Environmental Committee has also participated in the fall and winter Welcome Day with an informational table providing students with information on recycling, climate change, and the work of the Committee.



Poster designed by a Graphic Design student for a Year of Energy event.

The Environmental Committee has been active in developing partnerships across various departments to enhance sustainability events including working with the Student Development and Activities Department to publicize RecycleMania and Moving Planet Day activities and partnering with the campus bookstore to have special displays related to environmental books and "green" products such as recycled notebooks and reusable water bottles. The bookstore has also had special offers or sales on these products at special times such as around Earth Day.

[31] http://www.washtenawvoice.com/

The Poetry Club recently published a chapbook to accompany an environmentally themed display at the WCC art gallery, and an anthology titled *Words for the Earth*. In addition, the Bailey Library at WCC has had special displays on topics such as sustainability, renewable energy, food, and water.

In addition to programming and curriculum, many parts of the college built environment and grounds include sustainable features. These impact the students in a variety of ways, from simple awareness to active participation. For example, there are three interactive kiosks in the Occupational Education building that display information about green building features including water bottle filling stations, room occupancy sensors, and water conserving restrooms fixtures. Students participating in Environmental Science and HVAC classes become aware of and work with other features such as the ground source heat pump ("geothermal ") system, the vegetative roof, solar hot water system, and the solar photovoltaic system.

7.4 Existing Conditions: Student Engagement

Washtenaw Community College is keenly aware of the need to get students engaged in sustainability on campus. Efforts have been made to integrate students into the ACUPCC process starting with the first Greenhouse Gas Inventory, conducted in 2008, when two students were hired to assist with that effort for the College.

A Green Fund of $10,000 was established by the Vice President of Finance in 2011. Any student, staff or faculty member or group may submit a proposal for how they think a portion of the money should be used.

A solar powered electric tractor owned by the Ann Arbor Community Farm is displayed at the annual WCC Earth Day festival.

Students, staff, and faculty were all key stakeholders that were targeted during development of this Climate Action Plan. Three charrettes were held early in the process with two of these targeted to students and conducted in conjunction with Environmental Science classes. The charrettes allowed for approximately 50 students to share their goals and ideas around sustainability and to shape the Plan itself. As a follow-up to the charrettes, students were polled using a SurveyMonkey© survey, but the response rate was limited.

Plans have not been made as to how best to have students implement the Climate Action Plan, but it is certain that for any Plan to be successful, it needs to have student buy-in and acceptance.

7.5 Strategies

There are several planned actions intended to make climate neutrality and sustainability part of the curriculum and overall educational experience for students, staff, and faculty. These are works in progress, but are actively being pursued for full roll out and implementation in the short-term.

7.5.1 Sustainability Literacy Task Force

With the generous support of the Vice President for Instruction, the Sustainability Literacy Task Force (Task Force) was created in 2011 with the goal of developing the educational component of the Climate Action Plan. The group began by visiting with departments and individual faculty to survey what is currently being done. Work will continue on this in the next year.

As mentioned above, the group has been very busy developing a Water Theme for the 2012-2013 academic year. Planned activities include a book read with a talk and workshop given by the author, talks by local experts on Michigan water issues and the ecology of the Huron River, field trips to local creeks and the Huron River, service projects to clean up the river and remove invasive species, water recreational activities, and dinner and movie nights with dinners prepared by Culinary Arts students and water theme movies.

Working with the library staff, a "LibGuide" research guide is being prepared on Water and another guide is being prepared on Sustainability. The guides will assist students in researching topics such as water quality, governmental agencies that protect water, and local water organizations. These guides will be included as default resources in all courses using Blackboard. The Task Force has been promoting the Water Theme year at in-service sessions, through emails and through the Faculty Professional Development Committee, which has given the Task Force space on their blog site. In addition, a member of the Sustainability Literacy Task Force will be speaking on the Water Theme to new faculty enrolled in a semester long orientation class.

Washtenaw Technical Middle College and the Ninth Grade Sustainability and Citizenship Pilot Program

Washtenaw Technical Middle College (grades 9-12) will pilot a new program for ninth graders at Washtenaw Community College for the 2012-2013 academic year. This program's curriculum will be designed to comprehensively develop students' knowledge of sustainability. Twenty-five students who applied and were selected through a lottery will study such issues as food systems, water use, and energy generation and consumption while using elements of the traditional core courses English, science, math, social studies, history, and civics. For example, students will use an integrated approach to study brownfields, which are abandoned or underused industrial sites. For this project, they might read Upton Sinclair's The Jungle (English), visit a local brownfield in order to study water and soil samples (science and math), examine the historical context that allowed the brownfield to arise (social studies, history), and devise plans for remediation (civics and citizenship).

7.5.2 Other Actions Being Considered

Work has been ongoing for a couple years to research and develop a Small Farmer curriculum that would combine classes in farming and business to help existing small farmers who want to improve their business skills and to help others get into the field of farming. The local food, urban agriculture and farmer's market movements are very strong in Michigan and this program could be a real asset to the community.

The Sustainability Literacy Task Force plans to look into the possibility of setting graduation requirements or add-on certificates in sustainability. The group will be looking into what is being done at other colleges, especially community colleges, and coming up with criteria for assessing sustainable course content. The group hopes to send one or two Task Force members to AASHE's *Sustainability Across the Curriculum Leadership* workshop next year and eventually launch something along the lines of Johnson Community College's Sunflower Project.

8.0 Community Outreach

As a community college, WCC's mission is closely connected with the needs of the local community. As stated in the college's Mission Statement, "Our college strives to make a positive difference in people's lives through accessible and excellent educational programs and services." We provide these programs and services through a caring, open-door teaching and learning environment, by providing excellent teaching, counseling, and support services, by reaching out to people who have limited income or other barriers to success, and by working in partnership with the communities we serve. The section of the Mission Statement on Community Outreach closely aligns with educating and helping the community develop sustainable systems: "We cooperate with other community organizations in seeking solutions to local economic and social problems. As a primary educational resource in the community, we work to improve the quality of life in the communities we serve."

Our primary mission is to provide education to the community. WCC offers several courses and programs that relate to sustainability including: science courses in physics, geology and biology; courses specifically in environmental science; and occupational programs in HVAC, renewable energy, green construction and hybrid auto repair. In addition, many instructors incorporate lessons and exercises on topics such as climate change, water resources, energy conservation, and sustainable food systems, as part of their regular classes.

Year of Energy panel discussion, "Energy Solutions for a Sustainable World", with local experts on renewable energy, green construction and green transportation.

The college has been involved in many ways beyond credit course offerings in working with the community on sustainability. As part of the 2012/13 academic Year of Water developed by the Sustainability Literacy Task Force, several public events were offered. Two Dinner and a Movie nights were offered which included a sustainably focused dinner prepared by WCC students and faculty and an environmental themed movie. A talk and book reading was given by Michigan writer Jerry Dennis based on his recent book, From Michigan Rivers to Windward Shores. A public talk on Great Lakes Water Rights, Fracking and Conservation was given at the college by Nick Schroeck, Great Lakes Environmental Law Center, and a public talk on The Health of the Huron River Watershed was given by Laura Rubin, Executive Director of the Huron River Watershed Council.

The college presents an annual WCC Earth Day festival every year in April that is publicized and open to the campus and broader community. The festival includes information tables and demonstrations from local organizations and business that offer "environmental solutions". Several academic departments and student groups also participate. The festival covers many issues including vermicomposting, land conservancy, recycling, electric motorcycles, hybrid cars, green office and building supplies, great lakes ecosystems, parks and recreation areas and renewable energy.

Also beyond credit classes, the college offers a number of non-credit classes to the community related to sustainability through the Division of Economic and Community Development and the Department of Community Enrichment In recent years classes have been offered in green remodeling, permaculture, earth oven construction, organic gardening certification, and cheese making, to name a few.

The college has been host to several meetings and community events related to sustainability. Transition Ypsilanti has presented a film and a greywater system presentation at the college. The Huron River Watershed Council and the Ann Arbor Ecology Center have held annual meetings at the college in recent years. The college partnered with Environmental Educators Network of Washtenaw (EENOW) to host the Ann Arbor area Earth Day celebration in 2009 and 2010 which a couple thousand community members attended. WCC and the Food System Economic Partnership co-sponsored the Small Holder Farm Career Day & Job Fair, an event that encouraged farmers to hire those who can provide the needed skills to make their farms thriving businesses, such as website developers, welders, production managers, bookkeepers, food safety coordinators and field laborers. WCC partnered with local food organizations and hosted the HomeGrown Local Food Summit: (Re)Imagining a Fair Food System in February 2013. The food for the conference was primarily sourced from local farmers and food businesses and prepared by Washtenaw Community College's Culinary Arts & Hospitality Management Program students and faculty. Several workshops on Solar Photovoltaic and Solar Domestic Hot Water workshops have been offered at the college over the years by the Great Lakes Renewable Energy Association (GLREA).

WCC construction students put beams in place to support the vegetative "green roof" over the adobe pizza oven at the Growing Hope Center in Ypsilanti.

Through the Construction Institute, students have been involved in several construction projects in the area, including major support for the Growing Hope Center, a local organization that promotes locally grown sustainable food. Students have volunteered with local organizations including Huron River cleanup days and invasive species removal. WCC video students have produced public service videos for a local environmental organization.

There are many organizations and individuals in the adjacent Ann Arbor and Ypsilanti communities that are actively working to promote sustainability, giving WCC many opportunities to continue partnerships in sustainability in the areas of food, energy, water, land conservation, native landscaping, environmental justice, green construction and more. The city councils in both Ann Arbor and Ypsilanti passed Climate

Action Plans in the last year and nearby the University of Michigan and Eastern Michigan University are both actively promoting climate action and sustainability.

Immediate plans for community outreach include hosting public events in connection with the 2012/13 academic Year of Energy. A panel discussion with local alternative energy experts, a talk on green remodeling, a talk on low carbon automotive technology, and two Dinner and a Movie evenings will be available to WCC students, staff and faculty as well as the broader community. Four-part "low carbon diet" workshops will be offered to the campus community to help individuals lower their carbon footprint in both the fall 2013 and winter 2014 semesters.

In addition, the college will continue to inform the campus and broader community of its actions to implement a climate action plan and increase the sustainability of the campus. Under discussion are a plan to showcase the green construction projects on campus (e.g. LEED certified Fitness Center and Occupational Education building renovation), and working WCC's environmental message into the college's boiler plate messaging.

Raptor handler from Leslie Science and Nature Center shows off one of her birds to wide eyed children at Ann Arbor Area Earth Day 2010. The event was hosted by WCC and attracted about 2,000 visitors from the area.

9.0 Funding Strategies

Identifying funding strategies is imperative to successful implementation of WCC's Climate Action Plan. Funding opportunities and funding sources will vary with the scope of each project. There are some projects that will be easier to fund than others due to cost, payback, and political willingness. The following are possible financial strategies to fund the identified measures.

9.1 WCC Capital and Operating Budgets

Most of the early projects implemented at WCC should be able to be funded by existing capital and operating budgets. There are representatives from the Department of Administration & Finance and the Facilities Management Department on the Climate Action Task Force and should provide guidance on funding availability and project selection as it fits within the larger planning context of the college.

9.2 Sustainability/Green Fund

An initial step toward isolating WCC funds for carbon neutrality is to create a separate fund specific to the ACUPCC or to sustainability in general. The Vice President of Finance has established a Green Fund of $10,000. Students, staff, and/or faculty may submit proposals for how they think a portion of the money should be used. This fund can continue to be financed from a variety of means including a one-time initial allocation from the capital or operating budgets, grants from foundations or business partners, alumni donations and other fundraising, "sustainability fees" tagged on to WCC-sponsored activities such as sporting events, concerts, and theatre productions, newly implemented parking fees, and/or student "green" fees. The fund can be sustained through the same mechanisms, in addition to annual energy/water cost savings from implementation of conservation measures.

Before additional fees are added, WCC should engage with its student body to discuss feasibility of a student fee that would go directly toward funding sustainability projects. A $5 per year fee per student would yield approximately $45-50,000 per year assuming a student population of 9,000-10,000 students. A student endorsed "sustainability fee" can have the added benefit of buy-in and a sense of ownership from students. A parking fee of $10 per year (or $5 per semester) for all single-occupancy vehicle drivers (students, staff, and faculty) would yield approximately $115,000 per year.

The Climate Action Task Force should consider all options for creating and sustaining a Sustainability Fund with leadership on the issue coming from the Department of Administration & Finance, Student Development & Activities, and the President's Office.

9.3 Rebates/Incentives

As previously mentioned, electricity and gas are supplied by DTE Energy. DTE Energy offers incentives for certain activities that reduce energy used by commercial customers. Both prescriptive rebates (for predetermined activities) and custom incentives (for less common, qualified projects) are available for installing efficient lighting, controls, HVAC systems, refrigeration, and food service equipment. DTE Energy also offers incentives for are also available for new construction and major renovation projects that change the use of a space or add new load.

Incentives have not been included in the simple payback calculations done for energy measures. As they become known, payback calculations and prioritization should be revisited as some projects may become more attractive.

9.4 Grants

The State of Michigan has enacted legislation that addresses energy efficiency, conservation, and production throughout the state. Of particular interest is Public Act (P.A.) 295, which sets a goal of "reducing state government grid-based energy purchases 25% by 2015 compared to a 2002 baseline." The State reports that, as of July 2010, Michigan had reached a 22% reduction in energy use in state facilities. In addition to efficiency and conservation, the State has created the renewables portfolio standard (RPS), revised the net metering law, and formed the Wind Energy Resource Zone Board. As a state institution, WCC may have access to public funds and/or other resources for energy conservation, production, and GHG emission reductions as they become available. In addition, there may be opportunities to leverage the buying power of other State institutions for benefit at WCC.

Grant funding may also be available through the following:

- **Energy Efficiency and Renewable Energy Revolving Loan Fund Program:** These Programs were developed by the Michigan Saves and the Michigan Public Utilities Commission to provide financing for energy projects. The Program includes several sub-sections including for Commercial Energy Loan Program[32] (low-interest loans for efficiency measures) and Passive Solar Systems[33] (for structures to extend the growing season).
- **DSIRE:** The Database of State Incentives for Renewables and Efficiency[34] provides a centralized, up-to-date list of available incentives for energy efficiency and renewable energy production.
- **Higher Education Opportunity Act 2008:** WCC should monitor the progress of the Higher Education Opportunity Act of 2008[35] which is intended to provide funding for sustainability projects on a select number of campuses nationwide through the University Sustainability Program. The Program authorizes the Department of Education to make grants to colleges, community colleges, universities, and to nonprofit consortia, associations, alliances, and collaborations operating in partnership with higher education institutions. Funding for the Program has not been appropriated yet.

[32] http://www.michigansaves.org/Customers/BusinessEnergyFinancing.aspx
[33] http://www.michigan.gov/mdcd/0,4611,7-122-25676-217576--,00.html
[34] http://www.dsireusa.org
[35] http://ed.gov/policy/highered/leg/hea08/index.html

10.0 Tracking Progress

WCC recognizes that successful implementation of the Climate Action Plan will require long-term support from a broad range of stakeholders – from the Board of Trustees, Administration, faculty, staff, students, and the surrounding community. Its success will depend to a large degree on how well these groups can work together and integrate the Plan with the higher level goals of the college including the Mission and Strategic Plan. Change will need to occur on both a narrow level in the specific actions of students, staff, administrators and faculty, and on a broad, cultural level in the way everyone on campus thinks. Some of the goals such as "reduce building energy-related GHG emissions by 10% (from baseline) by 2015" are very specific and relatively easy to measure and track. Other goals such as increasing student understanding of climate change will be harder to quantify and harder to obtain good data on. Also, some goals such as the main goal of eliminating WCC's greenhouse gas emissions by 2060 may remain fairly constant, while other goals will need to be adjusted over the years as our situation and technology changes.

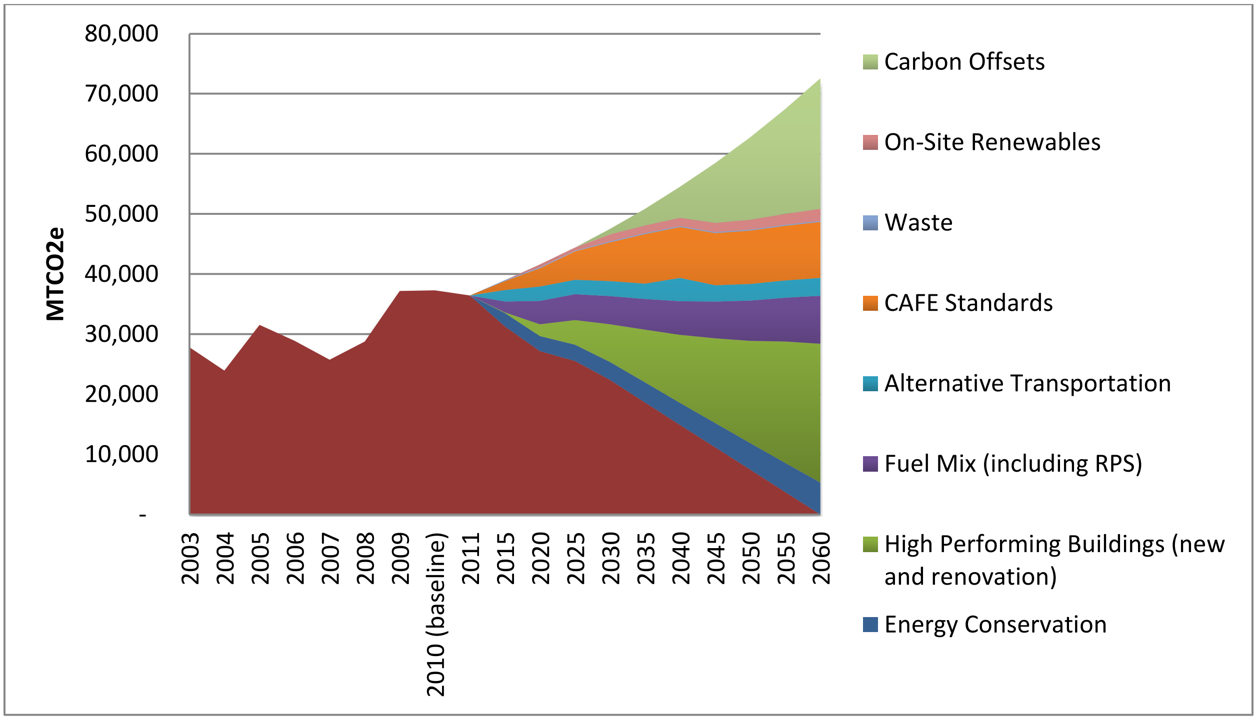
To help implement the plan and to track our progress, the college will create a Sustainability Council, with sub-committees for each of the major areas listed in the Mitigation Strategies section above, i.e. Buildings and Energy, Transportation, Waste, etc. Each sub-committee will prioritize their goals and strategies, help move them forward, track and report progress on the goals, and update the goals as appropriate. Since successful implementation will depend on working across department lines, the sub-committees will include the Responsible Parties listed in the plan, as well as individuals in related key departments, and students, staff and faculty who have a passion for a particular area. The college will explore using the Sustainability Tracking, Assessment & Rating System™ (STARS) program to track progress on sustainability issues that go beyond climate action.

The Climate sub-committee of the Council will have responsibility for tracking progress toward our greenhouse gas emission goals, making recommendations and writing biennial GHG and Progress reports (in alternating years) to ACUPCC. Greenhouse gas emission data will be collected by individuals in the Financial Services department and Facilities department.

11.0 Conclusion

A goal of carbon neutrality is admirable and ambitious, and yet, given current climate science, it is imperative that institutional leaders like Washtenaw Community College take on the challenge. It will take an array of strategies and a commitment to collaboration across campus to reach annual carbon targets. Figure 13 illustrates an estimated projection of greenhouse gas emissions and reduction strategies that will help WCC stakeholders counter business-as-usual and stay on the path of carbon neutrality over the next 50 years.

Figure 14: Washtenaw Community College Wedge Analysis (2003-2060)



List of Appendices

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Appendix A: Emission Factors

Table 12: Emissions Factors from Clean Air-Cool Planet (v6.8)

	Unit	CO2	CH4	N20	Note
GWP		1	23	296	
Electricity	kg/kWh	0.753	0.000067	0.0000096	- eGrid RFCM - This varies annually based on the makeup of production sources.
Natural Gas	kg/MMBtu	52.719	0.00528	0.00011	
Gasoline	kg/gal	8.77	0.00186	0.0006	- Varies per year - Does not account for b10, b85, biodiesel
Diesel	kg/gal	10.15	0.00057	0.00026	
Air Travel	kg/mile	0.587	0.0000057	0.0000065	

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Appendix B: Washtenaw Community College Campus Energy Audit

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Campus-Wide Energy Study

Washtenaw Community College

SBA Project No. 599481.01

Final Report

SEBESTA BLOMBERG

December 13, 2012

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Prepared by Sebesta Blomberg and Associates
Sebesta Blomberg Project 599481.01

Sebesta Blomberg is an independent multi-disciplinary engineering firm committed to improving building performance in commercial and institutional facilities through practices in engineering design, commissioning and energy and sustainability.

This work was prepared for Washtenaw Community College.

Client:	Washtenaw Community College		
Facilities:	Business Education Campus Green Parking Structure Campus Safety & Security Crane Liberal Arts & Science Energy Center Family Education Great Lake Regional Training Center Gunder Myran Health & Fitness Center Henry Landau Skilled Trades Maintenance Garage Morris Lawrence Larry Whitworth Occupational Education Plant Operations Storage & Receiving Student Center Technical & Industrial	***Investigation Team:***	Peter Dahl, Ph.D., LEED AP *Sustainability Specialist, Project Manager* James Miller, PE, CEM *Mechanical Engineer* Jeffrey Seewald, PE, CEM *Senior Energy Engineer*
		Analysis and Report Preparation:	Jeffrey Seewald, PE, CEM *Senior Energy Engineer*
Primary Contact(s):	Beau Burgen *Manager, Mechanical Systems & Electrical Services*	***Study Date(s):***	August 2012 – December 2012

Acknowledgement: Sebesta Blomberg would like to thank Beau Burgen, Terry Reeves and Bill Ghrist for their time in acquainting the Sebesta Blomberg team with the facilities at Washtenaw Community College, and for openly sharing their extensive knowledge of the campus and its buildings.

Disclaimer: The recommendations and estimates of costs and savings are based on owner-provided data, on-site assessments and studies and engineering calculations, and are not intended to be a guaranty of performance. Actual project costs and energy savings are dependent on construction markets, project conditions, weather, and operational factors outside of the control of Sebesta Blomberg.

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Washtenaw Community College
Campus-Wide Energy Study

Sebesta Blomberg Project 599481.01

1.0 Executive Summary

Washtenaw Community College is committed to reducing its energy and environmental impact, and in concert with efforts and commitments to reduce greenhouse gas emissions in accordance with the American College and University Presidents Climate Commitment, WCC is seeking opportunities to improve building performance across its facilities that encompass more than one million square feet of floor space. Sebesta Blomberg conducted this ASHRAE Level I energy audit and study which is intended to facilitate identification and quantification of potential energy and water conservation opportunities. This work was conducted during the months of August through October 2012, and this report documents the analysis and resulting recommendations to support progress towards improved building performance across the Washtenaw Community College campus.

In the process of the study, it became clear that the building operations and facilities team at Washtenaw Community College is already doing a lot of things well with the facilities on campus. Positive facilities management and operational practices include the following:

- **HVAC**
    - High-quality, well-maintained equipment
    - Economizing in many buildings when possible
    - Efficient chiller plant operation
    - Hot water heating
    - Use of two-way valves for chilled water and hot water coils
    - Liberal use of variable speed drives
    - Humidification of spaces
- **Lighting**
    - Efficient lighting in place, primarily fluorescent T-8
    - Lighting controls applied in many areas
    - Ongoing conversion to LED exterior lighting
- **Controls**
    - Scheduling of buildings and systems
    - Use of building automation systems
    - Widespread use of occupancy controls
    - CO_2 monitoring
- **Electrical**
    - Active sub-metering at the building level with data collection

- **Water**
    - Use of efficient fixtures in newer buildings

At the same time, this study shows that WCC buildings consume energy at rates higher than their peers, and that there is potential for improvement. The proposed revisions recommended for the campus buildings include mechanical, lighting and controls improvements. Major elements include:

- **HVAC**
    - Retro-commissioning
    - Optimization of existing systems
    - Mechanical equipment replacement, including boiler upgrades, chiller upgrades and air handling unit replacement
- **Lighting**
    - Potential for T-8 re-lamping
    - Addition and re-commissioning of daylighting controls
    - High-bay lighting retrofits
    - Upgrade of accent and down lights to LED
- **Controls**
    - Demand control ventilation
    - Use of occupancy controls for HVAC control
    - Thermostat replacement
    - Controls upgrades/retrofits
- **Water**
    - Fixture upgrades

Recurring themes from the analysis, those measures that apply in multiple buildings, include:

- Retro-commissioning: A number of buildings, in particular the larger and more complex facilities, are candidates for comprehensive retro-commissioning, a systematic in-depth review and analysis to bring to the surface and resolve operational issues and improve performance by correcting an array of low-cost, high-benefit measures.
- Optimization: High-quality systems in place in many of the buildings can be further optimized to improve energy performance. For example, cooling towers can be operated to further reduce chiller energy consumption, and demand control ventilation can be applied to reduce heating and cooling of incoming outside air.
- Lighting: Further improvements can be made to reduce lighting power consumption by upgrading lighting to more efficient lighting technologies. In particular, there are some high-bay areas and various architectural, accent and down-lights that are prospects for upgrades. T-8 re-lamping appears in many of the buildings as a potential measure, but this first must be prototyped and tested, and maintenance costs must be carefully considered as well.

- Lighting Control: In conjunction with lighting upgrades, the addition or re-commissioning of existing controls can further reduce lighting energy consumption. There are a number of areas across campus where existing daylighting controls are not working properly, or where there is an opportunity to apply daylighting controls.
- Water: Several of the buildings have older plumbing fixtures. Where that is the case, upgrades to fixtures can yield substantial water savings.

Examining the potential impact of the identified measures across the buildings on campus and balancing the potential impact with investment and risk, yields insights into where to focus efforts. Note that the analysis presented here estimates energy savings only, and does not factor in other savings such as maintenance savings. The total potential for each building based on the ECMs identified is tabulated in Table 1 below.

Table 1: Potential impact of ECMs across all buildings

Building	Proposed Energy Savings			Estimated Investment	Payback
	(kBtu/ft^2)	(%)	($/year)	($)	(years)
Business Education	52.2	31.1%	$21,493	$188,400	8.8
Campus Green Parking Structure	N/A				
Campus Safety & Security	N/A				
Crane Liberal Arts & Science	22.0	13.1%	$43,249	$301,700	7.0
Energy Center			$19,194	$239,500	12.5
Family Education	N/A				
Great Lakes Regional Training Center	15.5	9.3%	$8,532	$40,400	4.7
Gunder Myran	25.3	15.1%	$42,063	$245,900	5.8
Health & Fitness Center	21.3	12.7%	$35,689	$144,800	4.1
Henry Landau Skilled Trades	1.6	1.0%	$306	$1,100	3.6
Maintenance Garage			$1,033	$4,000	3.9
Morris Lawrence	71.3	42.5%	$66,353	$468,200	7.1
Larry Whitworth Occupational Education	18.6	11.1%	$39,747	$197,500	5.0
Plant Operations	N/A				
Storage & Receiving			$1,162	$4,500	3.9
Student Center	49.0	29.2%	$111,439	$1,284,200	11.5
Technical & Industrial	28.2	16.8%	$38,486	$214,500	5.6

The proposed energy conservation measures are listed in greater detail by building with various attributes including energy savings, estimated investment, and payback in the master table below.

Recommendations based on this study are three-fold:

- Develop implementation programs:
    - To implement low-cost, low-risk measures, such as lighting controls and lighting upgrades.
    - To implement mid-term and long-term operational and capital improvements.
- Evaluate retro-commissioning for selected facilities, in particular for Gunder Myran and Crane Liberal Arts & Sciences. These buildings stand to benefit the most from retro-commissioning.
- Consider comprehensive or deep energy retrofits for the Morris Lawrence Building and the Student Center. Morris Lawrence, as an ideal place to consolidate activities outside of normal operational hours, is also a strong candidate for major upgrades to mechanical and electrical systems. Likewise, the Student Center, as a building that is used continuously at a high level of energy consumption and has systems at the end of life, presents an opportunity for a deep retrofit.
- Implement additional sub-metering, in particular for natural gas at each building.
- Consider areas of further study and evaluation, such as interval/demand data analysis and ENERGY STAR rating.

In accordance with these recommendations, potential next steps include:

- Short-term and long-term building improvement program development
- Solicitation of proposals for retro-commissioning services
- Engagement in further energy and engineering study for the following buildings:
    - Morris Lawrence Building
    - Student Center

Table 2: Energy conservation measures summary

Building	Energy Conservation Measure #	Description	Electricity Savings: Demand (kW)	Electricity Savings: Consumption (kWh/yr)	Electricity Savings: Total ($/year)	Natural Gas Savings: Consumption (therms)	Natural Gas Savings: Total ($/year)	Gas & Electric: Total (kBtu)	Estimated Annual Savings ($/year)	Estimated Implementation Cost ($)	Payback (years)
BE	**Business Education**										
RCx	1	Refine/enhance scheduling	3.0	26,338	$2,275	1,524	$696	242,237	$2,971	$1,200	0.4
RCx	2	Retro-commissioning	6.8	59,259	$5,120	3,428	$1,566	545,034	$6,686	$25,100	3.8
Controls	3	Demand control ventilation	46.4	20,462	$1,768	3,535	$1,662	290,685	$3,429	$31,600	9.2
HVAC	4	Boiler upgrade	0.0	0	$0	9,412	$4,424	941,239	$4,424	$74,800	16.9
Lighting	5	Replace 32W T8s with 25W T8s	9.1	38,287	$3,308	0	$0	130,637	$3,308	$38,700	11.7
Lighting	6	Replace HID fixtures with LED	0.9	7,820	$676	0	$0	26,682	$676	$17,000	25.2
LA	**Crane Liberal Arts & Sciences**										
RCx	1	Refine/enhance scheduling	8.7	75,918	$6,559	6,609	$3,019	919,947	$9,577	$1,200	0.1
RCx	2	Retro-commissioning	19.5	170,815	$14,757	14,871	$6,792	2,069,882	$21,549	$83,700	3.9
Controls	3	Demand control ventilation	3.1	26,827	$2,318	6,235	$2,930	714,991	$5,248	$23,900	4.6
HVAC	4	Eliminate portable cooling	1.5	13,140	$1,135	0	$0	44,834	$1,135	$8,300	7.3
Lighting	5	Replace 32W T8s with 25W T8s	11.9	66,428	$5,739	0	$0	226,653	$5,739	$184,600	32.2
EC	**Energy Center**										
Controls	1	Chiller plant optimization	14.2	124,656	$10,769	0	$0	425,325	$10,769	$217,300	20.2
Controls	2	O2 boiler trim with blower motor VFD	0.0	0	$0	10,609	$4,986	1,060,898	$4,986	$9,900	2.0
HVAC	3	Chilled water pipe insulation (per 100ft of pipe)	0.4	2,753	$238	0	$0	9,394	$238	$800	3.4
HVAC	4	Hot water pipe insulation (per 100ft of pipe)	0.0	0	$0	3,177	$1,493	317,672	$1,493	$700	0.5
Lighting	5	Replace metal-halide high-bay fixtures with fluorescent	2.3	19,764	$1,707	0	$0	67,435	$1,707	$10,800	6.3
GL	**Great Lakes Regional Training Center**										
RCx	1	Refine/enhance scheduling	3.6	31,603	$2,730	2,407	$1,100	348,562	$3,830	$1,200	0.3
Controls	2	VAV zone occupancy control	0.7	6,321	$546	481	$220	69,712	$766	$6,300	8.2
Controls	3	Demand control ventilation	1.4	11,851	$1,024	903	$412	130,711	$1,436	$7,300	5.1
HVAC	4	Heat pump water heater	5.4	11,340	$980	0	$0	16,174	$410	$3,100	7.6
Lighting	5	Replace 32W T8s with 25W T8s	4.3	24,196	$2,090	0	$0	82,556	$2,090	$22,500	10.8
GM	**Gunder Myran**										
RCx	1	Refine/enhance scheduling	6.7	58,544	$5,058	5,097	$2,328	709,416	$7,386	$1,200	0.2
RCx	2	Retro-commissioning	15.0	131,724	$11,380	11,467	$5,238	1,596,187	$16,618	$83,700	5.0
Controls	3	Demand control ventilation	3.1	26,827	$2,318	6,235	$2,930	714,991	$5,248	$17,700	3.4
Lighting	4	Replace 32W T8s with 25W T8s	25.9	145,140	$12,539	-	$0	495,219	$12,539	$142,400	11.4
Lighting	5	Replace elevator lighting with LED	0.4	3,154	$272	-	$0	10,760	$272	$900	3.3
HFC	**Health & Fitness**										
RCx	1	Refine/enhance scheduling	11.2	98,190	$8,483	2,809	$1,283	615,945	$9,766	$1,200	0.1
RCx	2	Recommission daylighting controls	2.8	24,302	$2,100	0	$0	82,918	$2,100	$7,700	3.7
RCx	3	Open triple-duty valves	32.8	131,357	$11,348	0	$0	448,191	$11,348	$2,400	0.2
Controls	4	Condenser water reset	15.0	60,000	$5,184	0	$0	204,720	$5,184	$5,300	1.0
Lighting	5	Replace 32W T8s with 25W T8s	13.4	75,294	$6,505	0	$0	256,903	$6,505	$125,900	19.4
Lighting	6	Replace elevator lighting with LED	0.2	1,402	$121	0	$0	4,782	$121	$400	3.3
Lighting	7	Retrofit accent lighting to LED	1.3	7,709	$666	0	$0	26,302	$666	$1,900	2.9
HVAC	8	Solar thermal hot water heating	0.0	0	$0	9,059	$4,258	905,900	$4,258	$105,000	24.7
HLST	**Henry Landau Skilled Trades**										
Lighting	1	Occupancy control	0.4	3,545	$305	0	$0	12,095	$305	$1,100	3.6
MG	**Maintenance Garage**										
Lighting	1	Replace HID fixtures with fluorescent, bi-level occupancy	1.7	11,960	$1,033	-	$0	40,809	$1,033	$4,000	3.9

Building	Energy Conservation Measure #	Energy Conservation Measure Description	Electricity Savings Demand (kW)	Electricity Savings Consumption (kWh/yr)	Electricity Savings Total ($/year)	Natural Gas Savings Consumption (therms)	Natural Gas Savings Total ($/year)	Gas & Electric Total (kBtu)	Estimated Annual Savings ($/year)	Estimated Implementation Cost ($)	Payback (years)
ML	**Morris Lawrence**										
RCx	1	Refine/enhance scheduling	6.5	56,530	$4,884	2,610	$1,192	453,861	$6,076	$1,200	0.2
Controls	2	Install VFDs - Fans	7.7	67,836	$5,861	0	$0	231,457	$5,861	$27,500	4.7
Controls	3	Demand control ventilation	4.8	42,398	$3,663	1,957	$894	340,396	$4,557	$19,800	4.3
Controls	4	DDC controls upgrade	9.7	84,795	$7,326	3,915	$1,788	680,792	$9,114	$107,100	11.8
HVAC	5	Chiller upgrade	50.0	250,000	$21,598	0	$0	853,000	$21,598	$145,200	6.7
HVAC	6	Boiler upgrade	0.0	0	$0	17,834	$8,382	1,783,400	$8,382	$72,600	8.7
HVAC	7	On-demand domestic hot water	0.0	0	$0	3,915	$1,788	391,470	$1,788	$10,900	6.1
Lighting	8	Replace 32W T8s with 25W T8s	12.5	69,949	$6,043	0	$0	238,666	$6,043	$72,900	12.1
Lighting	9	Retrofit T12 fixtures	2.0	11,364	$982	0	$0	38,775	$982	$6,600	6.7
Lighting	10	Retrofit downlights to LED	7.5	22,605	$1,953	0	$0	77,128	$1,953	$4,400	2.3
OE	**Larry Whitworth Occupational Education**										
RCx	1	Refine/enhance scheduling	10.8	94,202	$8,138	4,508	$2,059	772,252	$10,198	$1,200	0.1
RCx	2	Recommission daylighting controls	1.6	14,130	$1,221	0	$0	48,213	$1,221	$7,400	6.1
Controls	3	Welding exhaust system control	22.3	73,263	$6,329	0	$0	249,975	$6,329	$24,200	3.8
Controls	4	VAV zone occupancy control	6.5	56,521	$4,883	2,705	$1,236	463,351	$6,119	$12,600	2.1
Controls	5	Demand control ventilation	4.0	35,326	$3,052	1,691	$772	289,595	$3,824	$14,600	3.8
Lighting	6	Replace 32W T8s with 25W T8s	21.6	120,835	$10,439	0	$0	412,289	$10,439	$125,900	12.1
Lighting	7	Retrofit high bay lighting	6.2	18,720	$1,617	0	$0	63,873	$1,617	$11,600	7.2
SR	**Shipping & Receiving**										
Lighting	1	Replace HID fixtures with fluorescent with bi-level occupancy	1.9	13,455	$1,162	0	$0	45,910	$1,162	$4,500	3.9
SC	**Student Center**										
All	1	Refine/enhance scheduling	7.1	62,547	$5,404	3,009	$1,374	514,328	$6,778	$1,200	0.2
All	2	Retro-commissioning	32.1	281,463	$24,316	13,541	$6,185	2,314,477	$30,501	$98,800	3.2
Controls	3	Kitchen exhaust hood controls	37.1	47,710	$4,122	722	$330	162,786	$4,122	$16,500	4.0
HVAC	4	Convert/replace constant volume dual duct system with VAV	34.3	300,227	$25,937	14,444	$6,597	2,468,776	$32,535	$952,000	29.3
Controls	5	Eliminate thermostat setpoint controls	8.6	75,057	$6,484	3,611	$1,649	617,194	$8,134	$10,900	1.3
Controls	6	Demand control ventilation	187.7	82,837	$7,156	10,199	$4,794	1,302,577	$11,950	$29,100	2.4
Electrical	7	Replace 32W T8s with 25W T8s	36.0	201,633	$17,420	0	$0	687,971	$17,420	$175,700	10.1
HVAC	8	Retrofit kitchen equipment from steam to electric	44.0	145,200	$12,544	0	$0	495,422	$12,544	$19,500	1.6
TI	**Technical & Industrial**										
RCx	1	Refine/enhance scheduling	5.8	50,764	$4,386	3,867	$1,766	559,894	$6,152	$1,200	0.2
RCx	2	Retro-commissioning	13.0	114,218	$9,868	8,701	$3,974	1,259,762	$13,842	$63,500	4.6
Controls	3	VAV zone occupancy control	3.5	30,458	$2,631	2,320	$1,060	335,937	$3,691	$12,600	3.4
Controls	4	Demand control ventilation	4.3	38,073	$3,289	2,900	$1,325	419,921	$4,614	$25,500	5.5
Lighting	5	Daylighting control	1.6	14,277	$1,233	0	$0	48,714	$1,233	$3,700	3.0
Lighting	6	Replace 32W T8s with 25W T8s	18.5	103,642	$8,954	0	$0	353,627	$8,954	$108,000	12.1
Campus	**Exterior Lighting**										
Lighting	1	Parking lot lighting retrofit	14.0	30,660	$2,649	0	$0	104,612	$2,649	$40,000	15.1
Lighting	2	Sidewalk lighting retrofit	18.0	39,420	$3,406	0	$0	134,501	$3,406	$72,000	21.1
Campus	**Vending**										
Controls	1	Compressor control	8.2	42,432	$2,933	0	$0	144,778	$2,933	$6,444	2.2
Total											
	Total for all ECMs		**922.4**	**4,209,473**	**$362,932**	**200,307**	**$92,502**	**34,166,080**	**$454,534**	**$3,577,644**	**7.9**
		Note: Totals are intended to show order of magnitude only, and do not account for mutually exclusive measures, dependencies or interaction effects.									

Table 3: Water conservation measures summary

Building	Water Conservation Measure				Estimated Annual Savings	Estimated Implementation Cost	Payback
	#	Men's/Women's	Existing Conditions	Recommendation	($/year)	($)	(years)
BE	**Business Education**						
	1	Men's	6 water closets at 3.5 gpf	6 water closets at 1.6 gpf	$331	$3,000	9.1
	2	Men's	8 urinals at 0.5 gpf	None	$0	$0	
	3	Men's	6 faucets at 2.2 gpm	6 faucets at 0.5 gpm	$222	$60	0.3
	4	Women's (estimated)	12 water closets at 3.5 gpf	12 water closets at 1.6 gpf	$992	$6,000	6.0
	5	Women's (estimated)	8 faucets at 2.2 gpm	8 faucets at 0.5 gpm	$222	$80	0.4
	Total				**$1,767**	**$9,140**	**5.2**
ML	**Morris Lawrence**						
	1	Men's	6 water closets at 3.5 gpf	6 water closets at 1.6 gpf	$309	$3,000	9.7
	2	Men's	5 water closets at 1.6 gpf	None	$0	$0	
	3	Men's	9 urinals at 0.5 gpf	None	$0	$0	
	4	Men's	2 faucets at 2.0 gpm, 10 faucets at 1.5 gpm	12 faucets at 0.5 gpm	$224	$120	0.5
	5	Men's	one faucet at 0.5 gpm	None	$0	$0	
	6	Women's (estimated)	6 water closets at 3.5 gpf	6 water closets at 1.6 gpf	$1,133	$3,000	2.6
	7	Women's (estimated)	3 water closets at 1.6 gpf	None	$0	$0	
	8	Women's (estimated)	10 faucets at 1.5 gpm	10 faucets at 0.5 gpm	$224	$100	0.4
	9	Women's	one faucet at 0.5 gpm	None	$0	$0	
	Total				**$1,890**	**$6,220**	**3.3**
PO	**Plant Operations**						
	1	Men's	1 water closets at 3.5 gpf	1 water closets at 1.6 gpf	$76	$500	6.6
	2	Men's	1 waterless urinals	None	$0	$0	
	3	Men's	1 faucets at 2.2 gpm, one faucet at 2.0 gpm	2 faucets at 0.5 gpm	$45	$20	0.4
	4	Women's (estimated)	2 water closets at 3.5 gpf	2 water closets at 1.6 gpf	$228	$1,000	4.4
	5	Women's (estimated)	1 faucets at 2.2 gpm, one faucet at 2.0 gpm	2 faucets at 0.5 gpm	$45	$20	0.4
	Total				**$394**	**$1,540**	**3.9**
SC	**Student Center**						
	1	Men's	8 water closets at 3.5 gpf	8 water closets at 1.6 gpf	$1,235	$4,000	3.2
	2	Men's	3 water closets at 1.6 gpf	None	$0	$0	
	3	Men's	4 urinals at 1.0 gpf	4 urinals at 0.5 gpf	$325	$2,000	6.2
	4	Men's	11 urinals at 0.5 gpf, one urinal at 0.125 gpf, one waterless urinal	None	$0	$0	
	5	Men's	8 faucets at 2.2 gpm, 5 faucets at 2.0 gpm, 2 faucets at 1.5 gpm	15 faucets at 0.5 gpm	$1,006	$150	0.1
	6	Men's	one faucet at 0.5 gpm	None	$0	$0	
	7	Women's (estimated)	14 water closets at 3.5 gpf	14 water closets at 1.6 gpf	$3,963	$7,000	1.8

Building	Water Conservation Measure				Estimated Annual Savings	Estimated Implementation Cost	Payback
	#	Men's/Women's	Existing Conditions	Recommendation	($/year)	($)	(years)
	8	Women's (estimated)	4 water closets at 1.6 gpf	None	$0	$0	
	9	Women's (estimated)	12 faucets at 2.2 gpm, 3 faucets at 2.0 gpm, 2 faucets at 1.5 gpm	17 faucets at 0.5 gpm	$1,006	$170	0.2
	Total				**$7,535**	**$13,320**	**1.8**
TI	**Technical & Industrial**						
	1	Men's	8 water closets at 3.5 gpf	8 water closets at 1.6 gpf	$840	$4,000	4.8
	2	Men's	6 waterless urinals	None	$0	$0	
	3	Men's	4 faucets at 2.2 gpm, one faucet at 2.0 gpm	5 faucets at 0.5 gpm	$497	$50	0.1
	4	Men's	6 faucets at 0.5 gpm	None	$0	$0	
	5	Women's (estimated)	14 water closets at 3.5 gpf	14 water closets at 1.6 gpf	$2,519	$7,000	2.8
	5	Women's (estimated)	4 faucets at 2.2 gpm, one faucet at 2.0 gpm	5 faucets at 0.5 gpm	$497	$50	0.1
	Total				**$4,353**	**$11,100**	**2.5**
Total							
	Total for all water conservation measures				**$15,939**	**$41,320**	**2.6**

2.0 Introduction

Sebesta Blomberg was retained by Washtenaw Community College to complete a campus-wide ASHRAE Level I energy audit and study which is intended to facilitate identification and quantification of potential energy and water conservation opportunities. Tasks conducted in the course of this study included:

- On-site building surveys with a focus on building envelope, mechanical and electrical systems
- Data collection on utilities, systems and equipment
- Analysis of utilities, including electricity and natural gas consumption
- Identification and analysis of energy and water conservation opportunities

An ASHRAE Level I energy study is a high-level study intended to develop an understanding of what opportunities exist and the magnitude of their impact and cost. This information can in turn be applied to facilitate prioritization and develop action plans to improve building performance. In a multiple building campus scenario, such as at WCC, this is also an instrumental to actively managing potential performance improvements to a portfolio of buildings.

This work was conducted during the months of August through October 2012, and this report summarizes the buildings with their systems and equipment and associated observations. Analysis and resulting recommendations are intended to support progress towards improved building performance across the Washtenaw Community College campus.

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3.0 Campus

Figure 1: WCC Campus Map

The Washtenaw Community College campus is situated just east-southeast of Ann Arbor, Michigan. Of the 21 buildings and structures on campus, this study focused on fifteen buildings, including all major academic facilities as well as some support facilities. Gross square footage for the buildings in the scope of this study ranged from about 7,000 square feet up to 181,000 square feet. Table 1 below lists the buildings and structures and highlights those included in this study.

Table 4: WCC buildings

Building		Floor Space (Gross Square Feet)	Year Constructed
	Athletic Complex Building	2,417	2010
BE	Business Education	41,673	1996
	Chemical Storage	192	2000
	Campus Green Parking Structure		2012
	Campus Safety & Security		2012
LA	Crane Liberal Arts & Science	180,757	1971
EC	Energy Center	15,724	1999
FE	Family Education	8,923	1980
GL	Great Lake Regional Training Center	21,946	2003
GM	Gunder Myran	139,390	2002
	Hazardous Materials	564	
HFC	Health & Fitness Center	76,831	2007
HLST	Henry Landau Skilled Trades	7,362	2012
MG	Maintenance Garage	15,356	1992
ML	Morris Lawrence	71,377	1989
	Motorcycle Storage	871	
OE	Larry Whitworth Occupational Education	123,301	1980
PO	Plant Operations	7,368	1980
SSR	Storage & Receiving	23,013	1997
SC	Student Center	164,598	1976
TI	Technical & Industrial	105,757	1970
	Total	**1,007,816**	
Notes:			
1. Buildings included in the scope of this study are highlighted.			

3.1 Utilities & Resources

Washtenaw Community College provided several years of utility data, including electricity, gas and water, as well as electrical sub-meter data for the last six months. The sections that follow provide analysis and characterization of resources consumption.

3.1.1 Total Energy

Table 2 shows the energy usage index, or average annual energy consumption per square foot, for the campus as a whole, and compares that average to benchmarks derived from the United States EIA 2003 Commercial Building Energy Consumption Surveys (CBECS) for education and all non-mall buildings in the Midwest region. Total campus energy consumption exceeds the selected CBECS benchmarks, but it is important to establish some context around this comparison:

- Note that the education category in CBECS includes K-12 as well as higher education, and K-12 buildings are typically much less energy intensive than higher education buildings in general. Therefore, the most appropriate comparison likely resides between Education and All Buildings, and both benchmark values are presented in the table below.
- It is important to note that the CBECS benchmark values are only a point of reference for understanding building performance as it relates to a larger statistical pool, and more meaningful comparisons can be developed among smaller sets of peer buildings, in this case, across community colleges for example.

Figures below illustrate this comparison in terms of energy and cost on a monthly basis.

Table 5: Energy usage index and benchmarks

Year	EUI	Relative to Benchmarks		Cost	Relative to Benchmarks	
	($kBtu/ft^2$)	Education[1]	All[2]	($\$/ft^2$)	Education[3]	All[4]
2011	179.0	107.4%	80.9%	$2.41	148.6%	91.4%
2012	160.4	85.9%	62.2%	$2.29	135.6%	81.4%
Average	**169.7**	**96.6%**	**71.6%**	**$2.35**	**142.1%**	**86.4%**
Benchmark - Education	**86.3**			**$0.97**		
Benchmark - All Buildings	**98.9**			**$1.26**		

Notes:

1. U.S. EIA CBECS 2003 total energy consumption per square foot for education buildings in the Midwest.
2. U.S. EIA CBECS 2003 total energy consumption per square foot for all non-mall buildings in the Midwest.
3. U.S. EIA CBECS 2003 total energy cost per square foot for education buildings in the Midwest.
4. U.S. EIA CBECS 2003 total energy cost per square foot for all non-mall buildings in the Midwest.
5. Figures are not adjusted for inflation. The last published benchmark data from the U.S. EIA is from 2003 CBECS, and the industry is awaiting updated data.

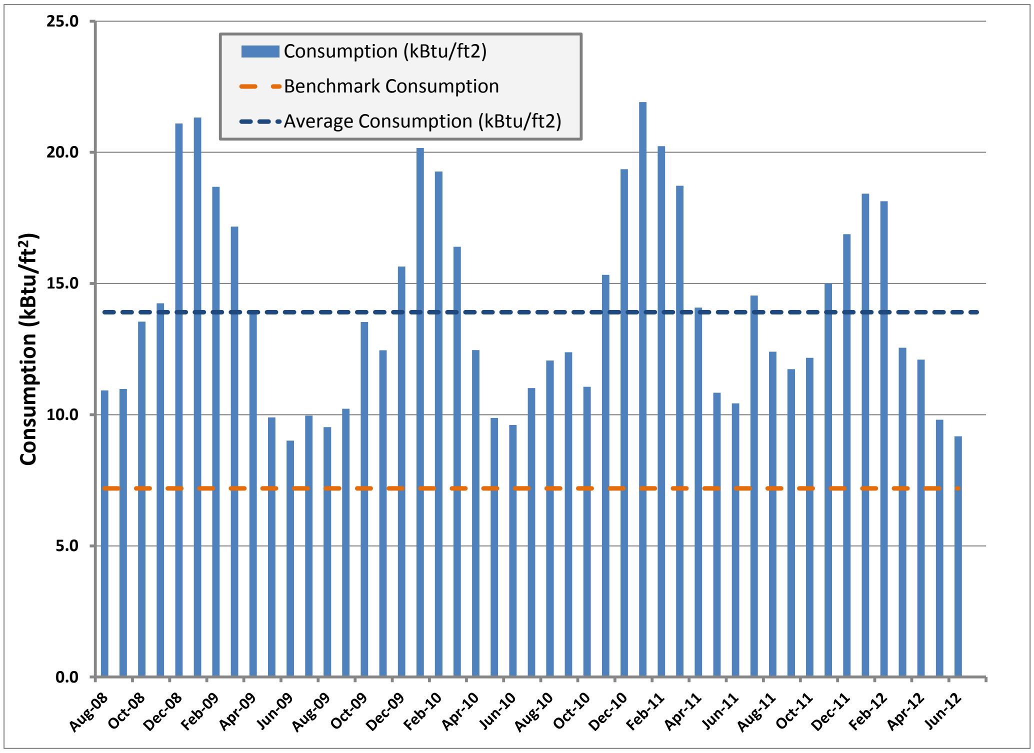

Figure 2: Total Campus Energy Usage Index

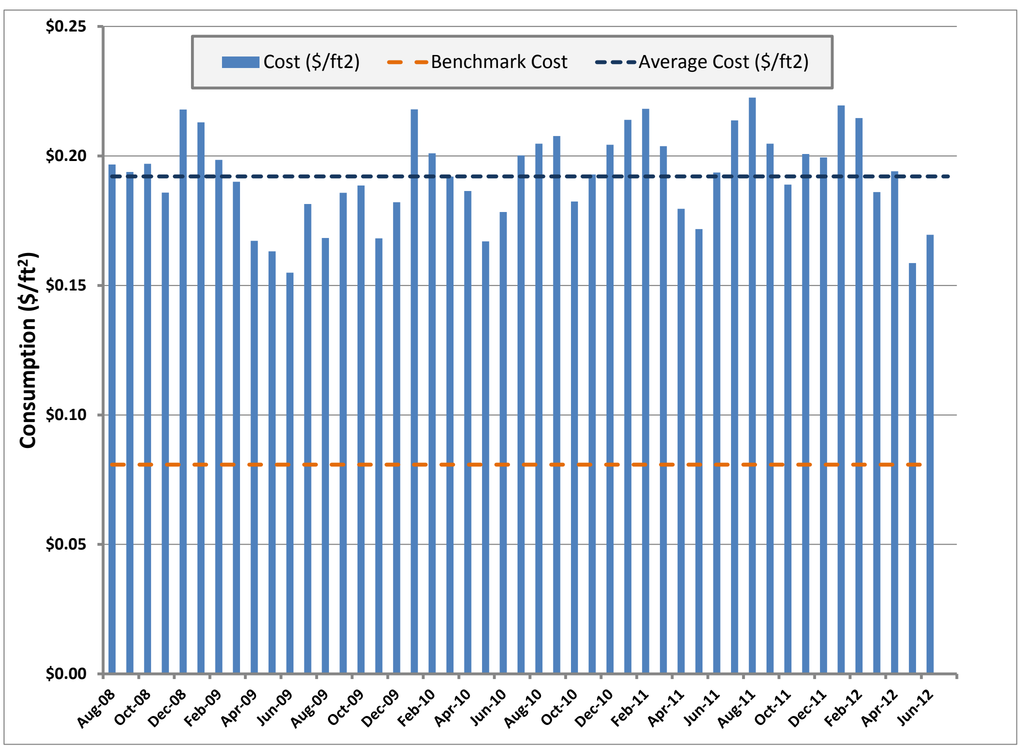

Figure 3: Total Campus Energy Cost Index

3.1.2 Electricity

Electricity consumption for the campus ranges from about 1,500 MWh per month to 2,300 MWh per month, with consumption peaking in the summer months. Corresponding peak demand ranges from just under 2,500 kW up to 4,000 kW, again peaking in the summer months coincident with the cooling season. Sub-meters for many of the more prominent buildings on campus allow for a closer look at energy consumption, and Figure 5 illustrates electricity use per building over the last six months.

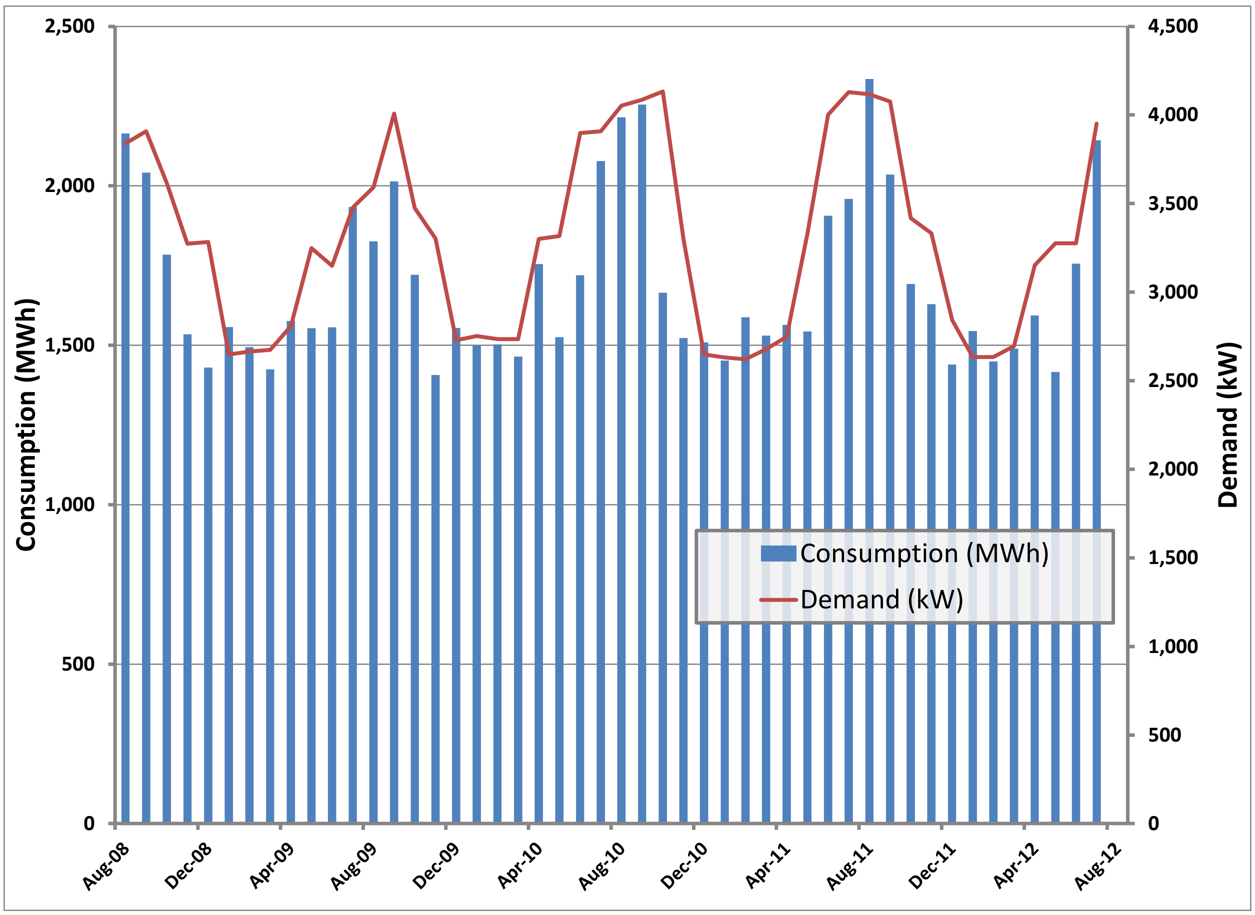

Figure 4: Campus Electricity Consumption

The average cost of electricity computed as part of this analysis was determined to be $0.086 per kWh, which compares favorably with the average 2011 commercial rate of $0.1023 per kWh obtained from the U.S. Energy Information Administration.

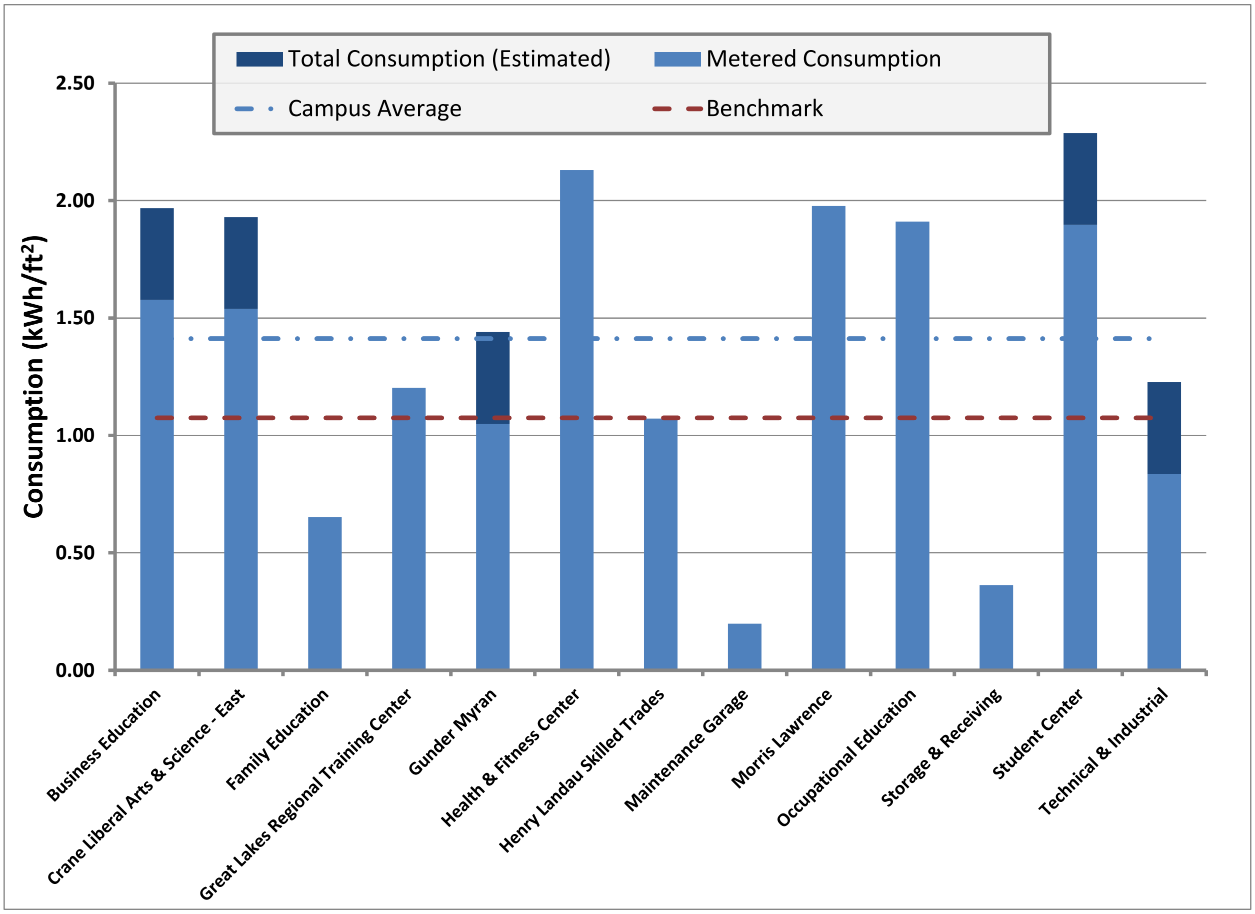

Figure 5: Per Building Electricity Consumption

Many of these buildings support activities that incur substantial energy use, and the top six standout electricity consumers are as follows:

- Student Center
- Health and Fitness
- Morris Lawrence
- Business Education
- Crane Liberal Arts & Science
- Larry Whitworth Occupational Education

In most cases, the greater electricity consumption can be explained to some degree qualitatively as a function of activities that take place in these three buildings:

- The Student Center includes a data center, a variety of food service amenities, and kitchens that support the dining as well as culinary instruction.

- The Health and Fitness Center includes a natatorium, fitness equipment and locker rooms with spa facilities.
- Morris Lawrence has its original and aging mechanical systems, and includes a gun range and locker rooms in the basement.
- There are medical and cadaver labs in the Liberal Arts and Sciences Building that require substantial laboratory exhaust.
- The Larry Whitworth Occupational Education Building has a variety of specialized labs and shops. For example, the welding shop uses considerable electricity for both the welding processes themselves as well as the supporting exhaust systems. A motorcycle dynamometer lab has its own climate control system to simulate extreme climate conditions.

While these energy consuming activities partly explain the consumption, there is also considerable potential for improvement.

3.1.3 Natural Gas

As anticipated, natural gas consumption for the campus peaks in the winter heating season. Further understanding of natural gas energy consumption could be developed with the application of natural gas sub-meters on a per-building basis.

The average cost of natural gas computed as part of this analysis was determined to be $0.470 per CCF. Note that this rate includes both commodity and distribution charges from Dillon Energy Services and DTE, respectively. Like electricity, this rate compares favorably with average 2011 commercial rate of $0.893 per CCF obtained from the U.S. Energy Information Administration.

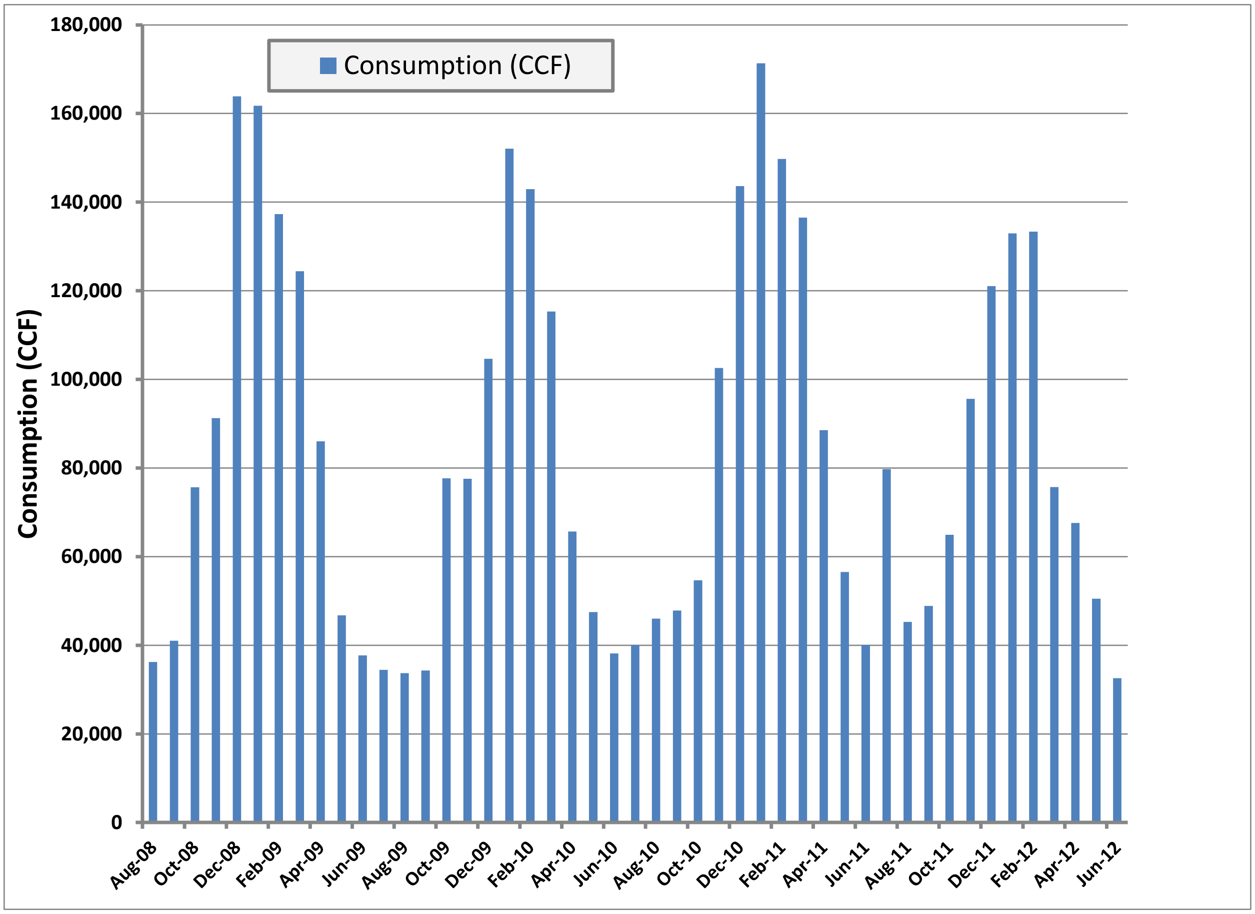

Figure 6: Campus Natural Gas Consumption

3.1.4 Energy End Use

End use of energy in the buildings on campus varies considerably with each building's primary function and associated activities taking place. For example, buildings that offer primarily classroom space will consume energy as may be expected of a typical education facility. On the other hand, buildings such as the Larry Whitworth Occupational Education Building and the Crane Liberal Arts & Sciences Building, with energy intensive areas such as laboratories and shops, will diverge from typical patterns and incur higher energy usage intensities. Without more discrete sub-metering in place, it is a challenge to characterize energy end use in a meaningful manner. However, estimated end use is approximated for major buildings and presented in Appendix A.

3.1.5 Water

Washtenaw Community College provided water bills for the period April 2011 through June 2012. The college receives a 10% discount for making early payment. Water consumption is summarized for the 12-month period ending June 2012:

Consumption in CCF	36,168
Consumption in gallons	27,053,664
Total Paid	$229,792

The marginal cost for each additional gallon consumed is $0.008356, which includes sewer charges but excludes fixed account fees. This unit cost is used to calculate potential savings from plumbing fixture retrofits.

In August 2012, all unisex and Men's restrooms were surveyed for plumbing fixture count and flush/flow rate. Women's restrooms were not accessed by project personnel. Women's restroom fixture counts were estimated using floor plans. Women's restroom fixture flush/flow rates were assumed to be the same as the fixtures used in the Men's restroom for each building.

Current plumbing standards (IPC and UPC) follow these flush and flow rates:

Fixture	Rate
Water closets	1.6 gpf
Urinals	1.0 gpf
Lavatory faucets	0.5 gpm
Kitchen Sink	2.2 gpm
Shower	2.5 gpm

In general, water closets found in the Men's restrooms are 1.6 gallons per flush (gpf) or 1.28 gpf; a total of (36) 3.5 gpf water closets were identified out of a total count of 102. Urinals were also generally found to be efficient fixtures with (26) 1.0 gpf out of a total of 85 fixtures identified and the remainder including 0.5 gpf, pint flush and waterless fixtures. However, lavatory faucets were found to be less efficient, with only 20 faucets having 0.5 gpm aerators. A quality aerator entrains air into the water stream to facilitate hand washing, but reduces total water consumption.

Five buildings with lower performance fixtures were analyzed to evaluate the economic feasibility of plumbing fixture upgrades. These buildings have 3.5 gpf water closets and lavatory faucets with flow rates greater than 1.0 gpm, since they have the greatest potential for water savings. Water savings are determined using estimates for number of uses per day, which are calculated based on the occupancy of each building. Results are summarized by building, with a detailed fixture count for each restroom campus-wide provided in the Appendix.

Other buildings where plumbing retrofit opportunities exist include Family Education, Industrial Technology, Maintenance Garage, Shipping/Receiving and Energy Center. Prior to replacing all fixtures and fittings in an existing building, we recommend testing the proposed replacement fixture in the facility. Supply water pressure, waste pipe slope and fixture mount are key elements that need to be considered to ensure economic feasibility and operational performance.

3.2 Systems

Campus-wide, Washtenaw Community College takes great pride in constructing and maintaining high quality, comfortable facilities.

3.2.1 Envelope

Building envelopes are relatively consistent across campus producing a common look and feel. Many of the buildings are concrete and brick, and some also have substantial metal components. Newer roofing materials are white membrane type. All buildings' windows are double-pane glass.

3.2.2 Mechanical/HVAC

A central plant serves several buildings on campus, approximately 770,000 square feet, with chilled water and high temperature hot water. A sub-grade tunnel provides the conduit for piping of utilities to each of the buildings. Buildings not served by the central plant have a variety of mechanical/HVAC systems including geothermal systems, air handling units with independent chiller/boiler plants, and unitary equipment such as rooftop units. Mechanical equipment is generally high quality and well-maintained.

3.2.3 Chilled Water

Two Trane centrifugal chillers are at the heart of the central chilled water system that uses a constant primary, variable secondary chilled water flow arrangement. Condenser water is constant flow through a two-cell cooling tower with two-speed fans. Chilled water valves at air handling unit coils are generally two-way valves corresponding with the use of variable-flow chilled water.

3.2.3.1. Hot Water

Two 25 MMBtu boilers, and a third 6 MMBtu for summer operation, generate high temperature hot water at 235°F. This water is circulated to the buildings on campus and converted at heat exchangers to a lower temperature heating hot water. In some cases, it is also used for domestic hot water preparation. A few of the buildings have independent boiler plants, including Business Education, the Health & Fitness Center, and the Morris Lawrence Building. Hot water valves at air handling unit coils are generally two-way.

3.2.3.2. Energy Recovery

Several of the buildings have energy recovery units.

3.2.3.3. Humidifiers

Many of the facilities surveyed are actively humidified during the heating season with the use of various types of humidifiers that inject vapor within air handling units. The consistent use of humidifiers is considered important to comfort at WCC.

3.2.4 Electrical/Lighting

3.2.4.1. Exterior

Exterior lighting consists mostly of parking lot and sidewalk lighting. WCC has embarked on a program recently to upgrade exterior lighting to LED. The surface parking lots were recently converted to LED, and the new parking garage was constructed with bi-level motion-controlled LED lighting. Sidewalk lighting is next on the docket for conversion to LED.

3.2.4.2. Interior

Interior primary lighting consists of T8 fluorescent with 32W lamps, and WCC staff reported that 93% of the fluorescent lighting on campus was T8. Some small areas with T-12 lighting remain. As with any campus, facilities have a variety of architectural, accent and down lights and other light fixtures. Occupancy sensors are liberally applied to control lighting in classrooms, offices and conference rooms. Daylighting control is applied in selected buildings and spaces, but is not working well in most cases.

3.2.4.3. Sub-Metering

WCC has electrical sub-metering in place for the major buildings on campus that provides electrical power and consumption data for individual buildings. Gas and water are not sub-metered, and end use loads are generally not sub-metered. Two data centers in the Student Center and the Business Education Building are electrically sub-metered. Sub-meters are connected to a central system that collects and manages meter data.

Figure 7: Electrical sub-meter

3.2.4.4. BAS and Controls

Three building automation systems are used on campus, including Siemens Apogee, Honeywell EBI and Honeywell Comfortpoint, an adaptation of Tridium NiagaraAX, and operate independently of one another. The campus has been slowly bringing buildings onto the Siemens Apogee system as the opportunity arises. Most buildings have digital controls, but a few buildings still have remnants of pneumatic controls with digital control overlay. Established temperature setpoint standards call for a range of 68 to 76. Indoor humidification is controlled during the heating season.

Table 6: WCC building automation systems

BAS/Controls	Building
Siemens Apogee	Business Education Campus Green Parking Structure Campus Safety & Security Crane Liberal Arts & Science Energy Center Henry Landau Skilled Trades Morris Lawrence Larry Whitworth Occupational Education Shipping, Storage & Receiving Technical & Industrial
Honeywell EBI	Great Lakes Regional Training Center Gunder Myran Student Center
Honeywell Comfortpoint	Health & Fitness Center
Programmable Thermostats	Family Education Maintenance Garage Plant Operations

3.3 Potential Campus-Wide Conservation Measures

3.3.1 Consolidate and Expand BAS

The majority of buildings are on the Siemens Apogee system, and as WCC has constructed new buildings, such as the Henry Landau Skilled Trades Building, they are also added to the Apogee system. Continuing along this path of consolidation into one campus-wide BAS is a good approach that will facilitate more efficient facility operations, and that a single campus-wide BAS can also be leveraged to realize energy efficiency improvements. There are also a number of smaller buildings that are not on a BAS, and WCC indicated their desire to expand the BAS to include these buildings as well.

3.3.2 Exterior Lighting

WCC is already making headway in upgrading exterior lighting from conventional metal-halide fixtures in parking lots and along sidewalks to LED fixtures, with a corresponding dramatic reduction in energy use. All of the surface parking lots have already been upgraded, and WCC has plans in place to upgrade the sidewalk lighting. In addition, LED light fixtures with bi-level motion controls light the new parking garage.

The table below estimates the total savings once all campus exterior surface parking lot and sidewalk lighting retrofits are completed.

Table 7: Exterior lighting ECMs (LED retrofits)

Building / Area	Energy Conservation Measure #	Description	Electricity Savings: Demand (kW)	Electricity Savings: Consumption (kWh/yr)	Electricity Savings: Total ($/year)	Natural Gas Savings: Consumption (therms)	Natural Gas Savings: Total ($/year)	Gas & Electric: Total (kBtu)	Gas & Electric: Estimated Annual Savings ($/year)	Estimated Implementation Cost ($)	Payback (years)
Campus	Exterior Lighting										
Lighting	1	Parking lot lighting retrofit	14.0	30,660	$2,649	0	$0	104,612	$2,649	$40,000	15.1
Lighting	2	Sidewalk lighting retrofit	18.0	39,420	$3,406	0	$0	134,501	$3,406	$72,000	21.1

Notes:

- Implementation cost is before utility rebates.

3.3.3 Space Utilization

Of the larger buildings on campus, three of them are potentially well-suited for scheduling of classes and events outside of normal operating hours. The Morris Lawrence Building is independent of the central plant in terms of heating and cooling utilities, and is therefore a good place to hold such after-hours activities as the central plant is not required to run for this building to be occupied. Scheduling an event over the weekend in one of the facilities that relies on the central plant for heating and cooling may require that the central plant run just to support that one activity. Consolidating events appropriately according to available utilities in addition to suitable space will result in energy savings. Another candidate for consolidation of activity beyond normal operating hours is the Occupational Education Building, which also has its own heating and cooling plant that operates independently of the central plant. Finally, the Business Education Building may also be a good venue for consolidation as it has its own boiler plant.

3.3.4 Vending

There are numerous vending machines across campus in all major buildings. Some of these machines, those without perishable items, can be further controlled or scheduled using relatively inexpensive control devices, limiting their operation during unoccupied hours and saving energy. Most of the vending machines already are equipped with efficient LED lighting, and employ motion sensing to turn off lights during periods of inactivity. However, one additional step to enhance energy savings would be to apply compressor control to the vending machines that cool non-perishable items, such as beverages. Compressor control can be applied on a scheduled basis, such that machines with non-perishable beverages shutdown during unoccupied periods, turning back on prior to occupied periods to cool the beverages back to the desired temperature.

Table 8: ECM for vending machines

Building / Area	Energy Conservation Measure #	Energy Conservation Measure Description	Electricity Savings Demand (kW)	Electricity Savings Consumption (kWh/yr)	Electricity Savings Total ($/year)	Natural Gas Savings Consumption (therms)	Natural Gas Savings Total ($/year)	Gas & Electric Total (kBtu)	Gas & Electric Estimated Annual Savings ($/year)	Estimated Implementation Cost ($)	Payback (years)
Campus	**Vending**										
Vending	1	Compressor control	8.2	42,432	$2,933	0	$0	144,778	$2,933	$6,444	2.2

4.0 Buildings

Figure 8: Business Education Building

4.1 Business Education

The Business Education building was originally constructed in 1996 and is primarily a classroom building. This building is unique relative to others on campus as it uses the central chilled water system for cooling, but not the central hot water system. Instead, this facility has its own boiler plant.

4.1.1 Systems

Envelope:

- Brick and concrete
- Double-pane glass

Mechanical:

- Air-Handling Units
    - Two VAV AHUs serve the building's spaces.
    - A packaged unit cools the communication/data closet.
- Utilities
    - Chilled water is provided by the central plant.
- Boilers
    - While chilled water is provided from the central loop, how water heating is provided by two 2.4 MMBtu input boilers.
- Domestic hot water
    - Domestic hot water preparation is also provided in the building by two hot water heaters.
- A 10T packaged unit cools a communications/data room with under-floor air distribution.

Electrical:

- Lighting
    - Lighting is primarily T8 fluorescent.
    - Many classrooms have occupancy sensors to control lighting only.
    - Stairways are illuminated by thirty-four 175 watt metal halide light fixtures.

Controls:

- BAS and HVAC
  - BAS: Siemens Apogee
- Lighting
  - Lighting controls are present in the form of occupancy sensors in classrooms.
  - Lighting controls are on a Plexus system.

Other:

- Numerous vending machines are located in this building, as well as across campus in various locations.

4.1.2 Observations

Mechanical:

- While this building relies on the central plant for chilled water, it has an independent boiler plant for hot water heating.

Electrical/Lighting:

- Metal halide light fixtures provide light in the entry/stairway areas. At the time of the site visit, most of these lights were off given sufficient daylight.

4.1.3 Energy Conservation Measures

ECMs for the Business Education Building are tabulated and notated below.

Table 9: ECMs for Business Education

			Electricity Savings			Natural Gas Savings		Gas & Electric			
Building	Energy Conservation Measure #	Description	Demand (kW)	Consumption (kWh/yr)	Total ($/year)	Consumption (therms)	Total ($/year)	Total (kBtu)	Estimated Annual Savings ($/year)	Estimated Implementation Cost ($)	Payback (years)
BE	Business Education										
RCx	1	Refine/enhance scheduling	3.0	26,338	$2,275	1,524	$696	242,237	$2,971	$1,200	0.4
RCx	2	Retro-commissioning	6.8	59,259	$5,120	3,428	$1,566	545,034	$6,686	$25,100	3.8
Controls	3	Demand control ventilation	46.4	20,462	$1,768	3,535	$1,662	290,685	$3,429	$31,600	9.2
HVAC	4	Boiler upgrade	0.0	0	$0	9,412	$4,424	941,239	$4,424	$74,800	16.9
Lighting	5	Replace 32W T8s with 25W T8s	9.1	38,287	$3,308	0	$0	130,637	$3,308	$38,700	11.7
Lighting	6	Replace HID fixtues with LED	0.9	7,820	$676	0	$0	26,682	$676	$17,000	25.2

Notes:

- With natural gas being relatively inexpensive at the current time, the boiler upgrade is not recommended. However, when it comes time to replace the existing boilers, high-efficiency condensing boilers should be evaluated. Alternatively, WCC can evaluate placing this building on the central hot water loop.

4.1.4 Water Conservation Measures

Water conservation measures for the Business Education Building are tabulated below.

Table 10: Water conservation measures for Business Education

M/W	Existing Conditions	Recommendation	Estimated Cost	Estimated Savings	Simple Payback
Men's	6 water closets at 3.5 gpf	6 water closets at 1.6 gpf	$3,000	$331	9.07
Men's	8 urinals at 0.5 gpf	None	-	-	-
Men's	6 faucets at 2.2 gpm	6 faucets at 0.5 gpm	$60	$222	0.27
Women's (estimated)	12 water closets at 3.5 gpf	12 water closets at 1.6 gpf	$6,000	$992	6.05
Women's (estimated)	8 faucets at 2.2 gpm	8 faucets at 0.5 gpm	$80	$222	0.36

4.2 Campus Green Parking Structure

A new parking ramp was constructed in 2012. It incorporates state-of-the-art LED lighting throughout the parking areas.

Figure 9: Campus Green Parking Structure

4.2.1 Systems

Envelope:

- Concrete and brick
- Double-pane glass

Electrical:

- Lighting
  - Parking garage lighting is bi-level LED with motion sensing controls

Controls:

- Lighting
  - Motion sensors control LED garage fixtures.

4.2.2 Observations

General:

- High quality systems and construction.
- Advanced lighting.

Figure 10: Parking structure LED lighting

Figure 11: LED fixture

Electrical/Lighting:

- LED fixtures appeared to be functioning as intended with bi-level motion control based on movements of people and automobiles.

4.2.3 Energy Conservation Measures

No ECMs are proposed for the parking structure.

4.2.4 Water Conservation Measures

No water conservation measures are proposed for the parking structure.

4.3 Campus Safety & Security

The Campus Safety offices are attached to the parking structure, and were also completed in 2012.

Figure 12: Campus Safety & Security

4.3.1 Systems

Envelope:

- Concrete and brick
- Double-pane glass

Mechanical:

- A geothermal water-source heat pump system with five water-to-air heat pumps provides cooling and heating
  - Heat pumps share the ground source loop (well field) with the Larry Whitworth Occupational Education Building
  - Two loop pumps
    - 5hp each
  - Hot water pumps are variable volume on VFDs
- An dedicated outside air energy recovery unit provides ventilation
- Boilers
  - Two small boilers provide supplemental heating
    - 285,000 Btu each
  - Hot water pumps are constant volume
    - 1.5hp each

Figure 13: Mechanical heat pump systems

Electrical:

- Lighting
  - Lighting is primarily T8 fluorescent in the security offices

Controls:

- BAS and HVAC
    - BAS: Siemens Apogee
- Lighting
    - Occupancy sensors are in place where appropriate.
    - Motion sensors control LED garage fixtures.

4.3.2 Observations

General:

- High quality systems and construction.

4.3.3 Energy Conservation Measures

No ECMs are proposed for the Parking Ramp and Security offices.

4.3.4 Water Conservation Measures

Replacing lavatory faucet aerators with 0.5 gpm aerators will reduce water consumption at a very low implementation cost. At this time, we do not recommend replacing the existing plumbing fixtures (water closets and urinals) in this building for the sole purpose of water savings.

4.4 Crane Liberal Arts & Science

The Crane Liberal Arts & Science building was originally constructed in 1971. A major building addition was completed in 1999, and subsequent renovations were completed in 2000, 2002 and 2005. And it is the largest building on campus. Levels one through three consist primarily of a combination of classroom and laboratory space. A greenhouse resides on Level 4 along with the mechanical penthouse.

Figure 14: Crane Liberal Arts & Science Building

4.4.1 Systems

Envelope:

- Brick and concrete
- Mix of single-pane and double-pane glass
  - The original portion of the building has single-pane glass

Mechanical:

Figure 15: Laboratory exhaust fans

- Air-Handling Units
  - 14 AHUs, consisting of a mix of constant volume and VAV.
  - AHUS 1 through 5, 7 and 9 have variable speed drives.
  - Packaged units cool the cadaver laboratory and the communication/data closets.
  - Strobic exhaust fans move air from laboratory hoods and cadaver stations.
- Utilities
  - Chilled water is provided by the central plant.
  - High temperature hot water is converted to heating hot water at the building, and is also used for domestic hot water preparation.

Figure 16: Cadaver Laboratory

- A tunnel provides the conduit to and from the building for chilled water and high temperature hot water from the central plant.
- Other
  - Additional equipment serves laboratories:
    - Two large air compressors
    - Two vacuum pumps
  - A communications room is cooled by a portable cooling unit that will be replaced by a split system.

Electrical:

- Lighting
  - Lighting is primarily T8 fluorescent.
  - Many classrooms have occupancy sensors to control lighting only.

Figure 17: Laboratory fume hoods

Controls:

- BAS and HVAC
  - BAS: Siemens Apogee
  - Staff reported calibration issues with CO_2 sensors.
- Lighting
  - Lighting controls are present in the form of occupancy sensors in classrooms.
  - Labs use motion sensors to control lighting.
- Fume hoods
  - Fume hoods and associated exhaust are controlled by laboratory hood sash position. At a minimum, one exhaust fan is running at all times when fume hoods are all at minimum sash positions. As sashes are opened, fans stage on to increase exhaust air flow.

4.4.2 Observations

General:

- According to analysis of sub-meter data, the Liberal Arts & Science Building consumes the greatest share of electricity of all buildings on campus.

Mechanical:

- Some insulation of tunnel piping is damaged.

Table 11: Crane Liberal Arts & Science space conditions

Floor	Area	Temperature (°F)	CO_2 (ppm)
1	Physics Lab	74 (setpoint)	1000
2	Cadaver Lab	60 (setpoint) 50 (supply air)	
CHWS (@ AHU 3)	Chilled water supply	48	
CHWR (@ AHU 3)	Chilled water return	70	

Table 12: Crane Liberal Arts & Science AHU drive frequencies

AHU	Supply Fan Frequency (Hz)	Return Fan Frequency (Hz)
1	48	47
2	50	47
4	46	50
5	46	46

4.4.3 Energy Conservation Measures

ECMs for the Crane Liberal Arts and Sciences Building are tabulated and notated below.

Table 13: ECMs for Crane Liberal Arts & Science

Building	Energy Conservation Measure		Electricity Savings			Natural Gas Savings		Gas & Electric			
			Demand	Consumption	Total	Consumption	Total	Total	Estimated Annual Savings	Estimated Implementation Cost	Payback
Category	#	Description	(kW)	(kWh/yr)	($/year)	(therms)	($/year)	(kBtu)	($/year)	($)	(years)
LA	Crane Liberal Arts & Sciences										
RCx	1	Refine/enhance scheduling	8.7	75,918	$6,559	6,609	$3,019	919,947	$9,577	$1,200	0.1
RCx	2	Retro-commissioning	19.5	170,815	$14,757	14,871	$6,792	2,069,882	$21,549	$83,700	3.9
Controls	3	Demand control ventilation	3.1	26,827	$2,318	6,235	$2,930	714,991	$5,248	$23,900	4.6
HVAC	4	Eliminate portable cooling	1.5	13,140	$1,135	0	$0	44,834	$1,135	$8,300	7.3
Lighting	5	Replace 32W T8s with 25W T8s	11.9	66,428	$5,739	0	$0	226,653	$5,739	$184,600	32.2

Notes:

- Retro/re-commissioning should be balanced with upgrades. For example, if WCC elects to upgrade controls, the systems to which the upgrades apply should not be first re-commissioned.
- Demand control ventilation includes the application of CO_2 sensing for monitoring and control of ventilation levels.

4.4.4 Water Conservation Measures

Replacing lavatory faucet aerators with 0.5 gpm aerators will reduce water consumption at a very low implementation cost. At this time, we do not recommend replacing the existing plumbing fixtures (water closets and urinals) in this building for the sole purpose of water savings.

4.5 Energy Center

The Energy Center, located sub-grade in the center of campus (under the Crane Liberal Arts & Sciences Building) provides central utilities, including chilled water and high temperature hot water, to five major buildings on campus.

4.5.1 Systems

Mechanical:

- Chillers and Chilled Water
  - Two Trane CVHF 910T chillers
  - Primary-secondary chilled water flow arrangement
  - Primary chilled water pumps are constant volume
  - Secondary chilled water pumps are variable flow (on VFDs)
- Boilers and Hot Water
  - Two large 25 MMBtu boilers run during the heating season
  - One smaller 6 MMBtu boiler runs in the summer to provide for summer heating needs, including VAV reheat
  - Primary-secondary hot water flow arrangement
  - All pumps are constant volume

Electrical:

- Lighting consists of 27 250W high-bay metal halide fixtures in the plant
- Office areas are lit by T8 fluorescent fixtures

Figure 18: Chillers

Figure 19: Main boiler and summer boiler

Figure 20: High temperature hot water pumps, replacement on left and original on right

Figure 21: Utilities tunnel

Table 14: Central plant equipment

System	Item	Quantity	Capacity / Power	Notes
Chilled Water	Chillers	2	910T	Trane CVHF Centrifugal (R-123)
	Primary chilled water pumps	3	40 hp	
	Secondary chilled water pumps	3	75 hp	
	Condenser water pumps	3	100 hp	
	Cooling tower	1		Two cells, two-speed fans
Hot Water	Primary boilers	2	25 MBtu	
	Summer boiler	1	6 MBtu	
	Primary hot water pumps	4	7.5 hp	
	Secondary hot water pumps	4	40 hp	
	Hot water sump pump	1	3 hp	

4.5.2 Observations

General:

- The central plant is very well-maintained.
- Equipment is high quality.

Mechanical:

- Staff reported issues and failures with high temperature hot water pumps. New pumps installed on a trial basis are expected to be a significant improvement over the existing pumps.
  - The existing pumps use city water to cool the pump bearings, resulting in a significant volume of water and waste heat being lost as this water is piped directly to the city drain.

Electrical/Lighting:

- Metal-halide high bay fixtures provide ample lighting throughout the plant, but these fixtures cannot be effectively controlled based on occupancy due to required restrike times.

4.5.3 Energy Conservation Measures

ECMs for the Energy Center are tabulated and notated below.

Table 15: ECMs for the Energy Center

Building	Energy Conservation Measure #	Description	Electricity Savings Demand (kW)	Electricity Savings Consumption (kWh/yr)	Electricity Savings Total ($/year)	Natural Gas Savings Consumption (therms)	Natural Gas Savings Total ($/year)	Gas & Electric Total (kBtu)	Gas & Electric Estimated Annual Savings ($/year)	Estimated Implementation Cost ($)	Payback (years)
EC	Energy Center										
Controls	1	Chiller plant optimization	14.2	124,656	$10,769	0	$0	425,325	$10,769	$217,300	20.2
Controls	2	O2 boiler trim with blower motor VFD	0.0	0	$0	10,609	$4,986	1,060,898	$4,986	$9,900	2.0
HVAC	3	Chilled water pipe insulation (per 100ft of pipe)	0.4	2,753	$238	0	$0	9,394	$238	$800	3.4
HVAC	4	Hot water pipe insulation (per 100ft of pipe)	0.0	0	$0	3,177	$1,493	317,672	$1,493	$700	0.5
Lighting	5	Replace metal-halide high-bay fixtures with fluorescent	2.3	19,764	$1,707	0	$0	67,435	$1,707	$10,800	6.3

4.5.4 Water Conservation Measures

Replacing lavatory faucet aerators with 0.5 gpm aerators will reduce water consumption at a very low implementation cost. At this time, we do not recommend replacing the existing plumbing fixtures (water closets and urinals) in this building for the sole purpose of water savings. However, we do recommend that WCC continue to evaluate replacement pumps to eliminate the significant water and heat waste associated with the water-cooled pumps.

4.6 Family Education

The Family Education Building is the home to the on-campus children's daycare for the college's staff and students.

4.6.1 Systems

Envelope:

- Metal and brick
- Double-pane glass

Mechanical:

- HVAC
  - Eight residential-style furnaces/air handling units
    - DX cooling with outdoor condensing units
    - Each furnace/air handler has a Nortec humidifier
- Domestic hot water
  - One electric and one gas water heater prepare domestic hot water

Electrical:

- Lighting
  - Lighting is primarily T8 fluorescent.

Controls:

- BAS and HVAC
  - BAS: None
  - Programmable thermostats
- Lighting
  - Manual control

4.6.2 Observations

Mechanical:

- Equipment appeared to be in good condition.

Electrical/Lighting:

- Staff appeared to be conscientious about turning lights off.

4.6.3 Energy Conservation Measures

No energy conservation measures were analyzed for the Family Education Building; however, there is one consideration for the HVAC systems. When it comes time to replace the HVAC systems which are presently residential style air handlers/furnaces with DX cooling, it is recommended that heat pumps, water-to-air or air-to-air, be considered.

4.6.4 Water Conservation Measures

Replacing lavatory faucet aerators with 0.5 gpm aerators will reduce water consumption at a very low implementation cost. At this time, we do not recommend replacing the existing plumbing fixtures (water closets and urinals) in this building for the sole purpose of water savings.

4.7 Great Lakes Regional Training Center

The Great Lakes Regional Training Center was originally constructed in 2003, and is attached to the Larry Whitworth Occupational Education Building. This two-level facility is primarily used as a training facility to conduct large group training sessions for organizations such as the United Association of Plumbers and Pipefitters. To this end, spaces include an HVAC&R lab and a piping lab as well as an auditorium.

4.7.1 Systems

Envelope:

- Brick
- Double-pane glass

Mechanical:

- HVAC equipment includes:
  - A rooftop unit
  - An energy recovery unit serves the two large labs with significant exhaust.

Electrical:

- Lighting
  - Lighting is primarily T8 fluorescent (in 90% of the building).
  - Occupancy sensors control lighting in classrooms/labs.
  -

Controls:

- BAS: Honeywell EBI

4.7.2 Observations

General:

- Space CO_2 levels were observed at 510 ppm.
- Thermostats are located throughout the building.
- The building was empty with substantial lighting and air conditioning running.

4.7.3 Energy Conservation Measures

ECMs for the Great Lakes Regional Training Center are tabulated and notated below.

Table 16: ECMs for Great Lakes Regional Training Center

Building Category	#	Energy Conservation Measure Description	Electricity Savings Demand (kW)	Electricity Savings Consumption (kWh/yr)	Electricity Savings Total ($/year)	Natural Gas Savings Consumption (therms)	Natural Gas Savings Total ($/year)	Gas & Electric Total (kBtu)	Gas & Electric Estimated Annual Savings ($/year)	Estimated Implementation Cost ($)	Payback (years)
GL		Great Lakes Regional Training Center									
RCx	1	Refine/enhance scheduling	3.6	31,603	$2,730	2,407	$1,100	348,562	$3,830	$1,200	0.3
Controls	2	VAV zone occupancy control	0.7	6,321	$546	481	$220	69,712	$766	$6,300	8.2
Controls	3	Demand control ventilation	1.4	11,851	$1,024	903	$412	130,711	$1,436	$7,300	5.1
HVAC	4	Heat pump water heater	5.4	11,340	$980	0	$0	16,174	$410	$3,100	7.6
Lighting	5	Replace 32W T8s with 25W T8s	4.3	24,196	$2,090	0	$0	82,556	$2,090	$22,500	10.8

Notes:

- Given the intermittent and variable occupancy of this building, a combination of occupancy control for lighting and HVAC and demand control ventilation can potentially be applied very effectively.
- Demand control ventilation includes the application of CO_2 sensing for monitoring and control of ventilation levels.

4.7.4 Water Conservation Measures

Replacing lavatory faucet aerators with 0.5 gpm aerators will reduce water consumption at a very low implementation cost. At this time, we do not recommend replacing the existing plumbing fixtures (water closets and urinals) in this building for the sole purpose of water savings.

4.8 Gunder Myran

The Gunder Myran Building was constructed in 2002, and is the third largest building on campus. It houses the campus library, photography lab, student computer labs, classrooms and offices.

Figure 22: Gunder Myran Building

4.8.1 Systems

Envelope:

- Concrete and brick
- Double-pane glass

Mechanical:

- Air handling units
  - Two large primary air handling units serve the building areas
  - A third smaller air handling unit serves the sky-bridge
  - All units are VAV
  - Each air handling unit has a steam humidifier
- Chilled water
  - Chilled water provided by the central plant
  - 2-way control valves at air handling unit coils
- Hot water
  - Two variable volume hot water pumps on VFDs
  - 2-way control valves at air handling unit coils
- Three elevators

Electrical:

- Lighting
  - Lighting is primarily T8 fluorescent (in 80% of the building).
  - Elevator lighting is incandescent
    - Nine 25W lamps per elevator

Controls:

- BAS and HVAC
  - BAS: Honeywell EBI
- Lighting
  - Occupancy sensors in some areas


Figure 23: Air handling unit with outside air dampers


Figure 24: Computer lab

4.8.2 Observations

Mechanical:

- All air handling units were running at full supply fan capacity despite relatively mild conditions.

Electrical/Lighting:

- Lighting levels in the library and computer labs are relatively high.

4.8.3 Energy Conservation Measures

ECMs for the Gunder Myran Building are tabulated and notated below.

Table 17: ECMs for Gunder Myran

Building	Energy Conservation Measure		Electricity Savings			Natural Gas Savings		Gas & Electric			
			Demand	Consumption	Total	Consumption	Total	Total	Estimated Annual Savings	Estimated Implementation Cost	Payback
Category	#	Description	(kW)	(kWh/yr)	($/year)	(therms)	($/year)	(kBtu)	($/year)	($)	(years)
GM	Gunder Myran										
RCx	1	Refine/enhance scheduling	6.7	58,544	$5,058	5,097	$2,328	709,416	$7,386	$1,200	0.2
RCx	2	Retro-commissioning	15.0	131,724	$11,380	11,467	$5,238	1,596,187	$16,618	$83,700	5.0
Controls	3	Demand control ventilation	3.1	26,827	$2,318	6,235	$2,930	714,991	$5,248	$17,700	3.4
Lighting	4	Replace 32W T8s with 25W T8s	25.9	145,140	$12,539	0	$0	495,219	$12,539	$142,400	11.4
Lighting	5	Replace elevator lighting with LED	0.4	3,154	$272	0	$0	10,760	$272	$900	3.3

Notes:

- Variable occupancy spaces such as the library and computer labs make Gunder Myran a good candidate for modulation of ventilation using demand control ventilation.
- Demand control ventilation includes the application of CO_2 sensing for monitoring and control of ventilation levels.

4.8.4 Water Conservation Measures

Replacing lavatory faucet aerators with 0.5 gpm aerators will reduce water consumption at a very low implementation cost. At this time, we do not recommend replacing the existing plumbing fixtures (water closets and urinals) in this building for the sole purpose of water savings.

4.9 Health & Fitness Center

The Health and Fitness Center, a LEED Gold building constructed in 2007, is a full service fitness facility with a range of exercise facilities including an indoor swimming pool and track.

Figure 25: Health and Fitness Center

4.9.1 Systems

Envelope:

- Metal and brick
- Double-pane glass
- Daylighting is provided by a large volume of windows as well as skylights

Mechanical:

- Air-Handling Units
  - AHUs 1, 2, and 4-6 are VAV
  - AHU 3 serves the pool and is an ERV
  - AHUs 7-9 serve mechanical rooms
  - Demand control ventilation is based on CO_2
  - AHUs 1-6 are economizer capable
- Chiller
  - A single chiller serves the building
  - All pumps are on VFDs
  - A single-cell cooling tower provides heat rejection
    - The cooling tower fan is on a VFD
- Boilers
  - Two 3 MMBtu boilers
  - Multiple steam generators for saunas/steam rooms

Electrical:

- Lighting
  - Lighting is primarily T8 fluorescent (in 80% of the building).
  - Elevator lighting is incandescent

Controls:

- BAS and HVAC
  - BAS: Honeywell Comfortpoint
- Lighting

- Lighting control system is in place.

4.9.2 Observations

Mechanical:

- AHUs 1 through 6 are capable of economizing; however, AHUs 7, 8, and 9 are not.
- AHUs use demand control ventilation based on CO_2 sensing.
- AHUs were running at higher frequencies in some cases, suggesting that they are not modulating effectively given a relatively mild day and minimal occupancy at the time of the site visit.
- Staff noted that the pool energy recovery unit (AHU 3) has exhibited corrosion issues and motor failures.
- The chilled water pumps, condenser water pump and cooling tower fans have variable speed drives.
- Cooling tower is controlled to a fixed condenser water supply temperature of 80°F.

Electrical/Lighting:

- High-bay fluorescent fixtures in the gym appear to operate continuously.
- Numerous accent lights highlight signage and bulletin boards.
- Elevator lighting is incandescent.
- Many areas/spaces are substantially day-lit.
- Staff noted that lighting controls do not appear to work as intended.

Table 18: Health and Fitness Center Space Conditions

Floor	Area	Temperature (°F)	CO_2 (ppm)
1	Common	77	567

Table 19: Health and Fitness Center AHU Drive Frequencies

AHU	Frequency (Hz)
1	60.0
3	58.0
4	36.5

4.9.3 Energy Conservation Measures

ECMs for the Health & Fitness Center are tabulated and notated below.

Table 20: ECMs for the Health & Fitness Center

Building	Energy Conservation Measure		Electricity Savings Demand	Electricity Savings Consumption	Electricity Savings Total	Natural Gas Savings Consumption	Natural Gas Savings Total	Gas & Electric Total	Gas & Electric Estimated Annual Savings	Estimated Implementation Cost	Payback
Category	#	Description	(kW)	(kWh/yr)	($/year)	(therms)	($/year)	(kBtu)	($/year)	($)	(years)
HFC	Health & Fitness										
RCx	1	Refine/enhance scheduling	11.2	98,190	$8,483	2,809	$1,283	615,945	$9,766	$1,200	0.1
RCx	2	Recommission daylighting controls	2.8	24,302	$2,100	0	$0	82,918	$2,100	$7,700	3.7
RCx	3	Open triple-duty valves	32.8	131,357	$11,348	0	$0	448,191	$11,348	$2,400	0.2
Controls	4	Condenser water reset	15.0	60,000	$5,184	0	$0	204,720	$5,184	$5,300	1.0
Lighting	5	Replace 32W T8s with 25W T8s	13.4	75,294	$6,505	0	$0	256,903	$6,505	$125,900	19.4
Lighting	6	Replace elevator lighting with LED	0.2	1,402	$121	0	$0	4,782	$121	$400	3.3
Lighting	7	Retrofit accent lighting to LED	1.3	7,709	$666	0	$0	26,302	$666	$1,900	2.9
HVAC	8	Solar thermal hot water heating	0.0	0	$0	9,059	$4,258	905,900	$4,258	$105,000	24.7

Notes:

- Daylighting control applies to several distinct areas within the fitness center, including the upper deck fitness areas, the gym, and the pool.
- Solar thermal hot water heating is estimated based on an assumption that 50% of membership consumes hot water at an average rate for a fitness center. It is recommended that a more detailed assessment be completed to estimate savings and cost with greater accuracy.

4.9.4 Water Conservation Measures

Replacing lavatory faucet aerators with 0.5 gpm aerators will reduce water consumption at a very low implementation cost. At this time, we do not recommend replacing the existing plumbing fixtures (water closets and urinals) in this building for the sole purpose of water savings.

4.10 Henry Landau Skilled Trades

The Henry Landau Skilled Trades Building is the newest building on campus constructed in 2012.

Figure 26: Henry Landau Skilled Trades Building

Mechanical:

- HVAC
  - Two rooftop units
    - DX cooling
    - Gas heat

Electrical:

- Lighting
  - Lighting is T8 fluorescent

Controls:

- BAS and HVAC
  - BAS: Siemens Apogee

4.10.1 Observations

General:

- Building and systems are new as of 2012.

4.10.2 Energy Conservation Measures

Limited ECMs are proposed for the Henry Landau Skilled Trades Building. Re-lamping of T8 fixtures is possible, but given the type of activity in the building, it may be beneficial to students and staff to maintain current light levels. However, occupancy control may be considered for the space for lighting, and perhaps for HVAC as well.

Table 21: ECMs for the Henry Landau Skilled Trades

			Electricity Savings			Natural Gas Savings		Gas & Electric			
Building	Energy Conservation Measure		Demand	Consumption	Total	Consumption	Total	Total	Estimated Annual Savings	Estimated Implementation Cost	Payback
Category	#	Description	(kW)	(kWh/yr)	($/year)	(therms)	($/year)	(kBtu)	($/year)	($)	(years)
HLST	Henry Landau Skilled Trades										
Lighting	1	Occupancy control	0.4	3,545	$306	-	$0	12,095	$306	$1,100	3.6

4.10.3 Water Conservation Measures

Replacing lavatory faucet aerators with 0.5 gpm aerators will reduce water consumption at a very low implementation cost. At this time, we do not recommend replacing the existing plumbing fixtures (water closets and urinals) in this building for the sole purpose of water savings.

4.11 Maintenance Garage

The Maintenance Garage is a basic structure housing maintenance equipment and related storage.

4.11.1 Systems

Envelope:

- Metal

Mechanical:

- HVAC
    - Two residential-style furnaces/air handling units
    - One gas-fired unit heater
- Domestic hot water
    - One electric and one gas water heater prepare domestic hot water

Electrical:

- Lighting
    - Lighting is T8 fluorescent with the exception of the high bay area
    - High-bay lighting is metal-halide
        - Eight 400W fixtures

Controls:

- BAS and HVAC
    - BAS: None
    - Programmable thermostats
- Lighting
    - Manual control

4.11.2 Observations

Electrical/Lighting:

- Staff appeared to be conscientious about turning lights off.

4.11.3 Energy Conservation Measures

ECMs proposed for the Maintenance Garage are limited to lighting.

Table 22: ECMs for the Maintenance Garage

Building	Energy Conservation Measure		Electricity Savings			Natural Gas Savings		Gas & Electric			
Building	Energy Conservation Measure		Demand	Consumption	Total	Consumption	Total	Total	Estimated Annual Savings	Estimated Implementation Cost	Payback
Category	#	Description	(kW)	(kWh/yr)	($/year)	(therms)	($/year)	(kBtu)	($/year)	($)	(years)
MG	Maintenance Garage										
Lighting	1	Replace HID fixtures with fluorescent with bi-level occupancy	1.7	11,960	$1,033	-	$0	40,809	$1,033	$4,000	3.9

4.11.4 Water Conservation Measures

Replacing lavatory faucet aerators with 0.5 gpm aerators will reduce water consumption at a very low implementation cost. At this time, we do not recommend replacing the existing plumbing fixtures (water closets and urinals) in this building for the sole purpose of water savings.

4.12 Morris Lawrence

The Morris Lawrence Building was constructed in 1989, with multiple additions since its original construction. It houses a large auditorium, dance studios and classrooms. A gun range is also located in the building along with a gym and locker rooms. This is one of the larger buildings on campus; however, unlike the other large buildings, it is not served by the central plant, but instead has its own chiller and boiler plants, with all original HVAC equipment.

Figure 27: Morris Lawrence Building

4.12.1 Systems

Envelope:

- Brick and concrete
- Double-pane glass
- Large central atrium with translucent Kalwall material

Mechanical:

- Air handling units
  - All units are constant volume and serve constant fan-powered terminal units
  - One DX rooftop unit serves the kitchen
- Chilled water
  - Two reciprocating air-cooled chillers
    - 120T each
    - R-22 refrigerant
  - Two constant volume chilled water pumps, 20hp each
  - 3-way control valves at coils
- Hot water
  - Two hot water boilers
    - 4.5 MMBtu input each
  - Two constant volume hot water secondary pumps, 7.5hp each
  - 3-way control valves at coils

Electrical:

- Lighting
  - Lighting is primarily T8 fluorescent (in 80% of the building)
  - Some T12s remain (approximately 5%)
  - Common areas: Down lights with various lamps
    - 27 150W metal halide fixtures, can lights
    - 28 100W metal halide fixtures, can lights
    - 24 100 metal halide fixtures, high interior/exterior
  - Auditorium:
    - Auditorium lighting appears to be dimmable of an incandescent type, but light quality is poor.
      - 24 205W lamps
    - Existing stage lighting is conventional, and according to staff, is very old.

Controls:

- BAS and HVAC
  - BAS: Siemens Apogee
  - Pneumatic controls with DDC overlay
- Lighting
  - Occupancy sensors are in place where appropriate.

4.12.2 Observations

General:

- The Morris Lawrence Building is a suitable place to consolidate after-hours events and activities as its systems are capable of supporting operation of the building independent of the central plant.

Mechanical:

- Systems are approaching end of life. Chillers and boilers are in working order but are aging.

Electrical/Lighting:

- There are several opportunities to improve lighting quality and efficiency.

4.12.3 Energy Conservation Measures

ECMs proposed for the Morris Lawrence Building are tabulated and notated below.

Table 23: ECMs for the Morris Lawrence Building

Building	Energy Conservation Measure		Electricity Savings			Natural Gas Savings		Gas & Electric			
			Demand	Consumption	Total	Consumption	Total	Total	Estimated Annual Savings	Estimated Implementation Cost	Payback
Category	#	Description	(kW)	(kWh/yr)	($/year)	(therms)	($/year)	(kBtu)	($/year)	($)	(years)
ML	**Morris Lawrence**										
RCx	1	Refine/enhance scheduling	6.5	56,530	$4,884	2,610	$1,192	453,861	$6,076	$1,200	0.2
Controls	2	Install VFDs - Fans	7.7	67,836	$5,861	-	$0	231,457	$5,861	$27,500	4.7
Controls	3	Demand control ventilation	4.8	42,398	$3,663	1,957	$894	340,396	$4,557	$19,800	4.3
Controls	4	DDC controls upgrade	9.7	84,795	$7,326	3,915	$1,788	680,792	$9,114	$107,100	11.8
HVAC	5	Chiller upgrade	50.0	250,000	$21,598	-	$0	853,000	$21,598	$145,200	6.7
HVAC	6	Boiler upgrade	-	-	$0	17,834	$8,382	1,783,400	$8,382	$72,600	8.7
HVAC	7	On-demand domestic hot water	-	-	$0	3,915	$1,788	391,470	$1,788	$10,900	6.1
Lighting	8	Replace 32W T8s with 25W T8s	12.5	69,949	$6,043	-	$0	238,666	$6,043	$72,900	12.1
Lighting	9	Retrofit T12 fixtures	2.0	11,364	$982	-	$0	38,775	$982	$6,600	6.7
Lighting	10	Retrofit downlights to LED	7.5	22,605	$1,953	-	$0	77,128	$1,953	$4,400	2.3

Notes:

- As a good location for consolidation of after-hours events and activities, and with aging mechanical systems approaching end of life, the Morris Lawrence Building is an excellent candidate for an energy efficiency and mechanical systems upgrade.
- Boilers and domestic hot water heaters: The paybacks on these items are not very attractive as stand-alone retrofits; however, if they are considered in the context of a renovation, then the incremental cost would be weighed against the benefit and these options would make more sense. In the case of on-demand hot water heating , the on-demand heaters will also have a longer service life than conventional water heaters.
- Atrium lighting: The Morris Lawrence Building atrium would be a good place to showcase LED lighting with a corresponding improvement in light quality.
- Auditorium and stage lighting: It is recommended that further study be devoted to looking at options to replace both auditorium and stage lighting. Such lighting is specialized, and further study is required to examine the options, potential savings and costs. There are now LED options available for both auditorium and stage lighting. And, the application of LED lighting in the auditorium would greatly reduce maintenance costs.
- Demand control ventilation includes the application of CO_2 sensing for monitoring and control of ventilation levels.

4.12.4 Water Conservation Measures

Water conservation measures proposed for this building are tabulated in the table below.

Table 24: Water conservation measures for Morris Lawrence

	Existing Conditions	Recommendation	Estimated Cost	Estimated Savings	Simple Payback
Men's	6 water closets at 3.5 gpf	6 water closets at 1.6 gpf	$3,000	$309	9.71
Men's	5 water closets at 1.6 gpf	None	-	-	-
Men's	9 urinals at 0.5 gpf	None	-	-	-
Men's	2 faucets at 2.0 gpm, 10 faucets at 1.5 gpm	12 faucets at 0.5 gpm	$120	$224	0.54
Men's	one faucet at 0.5 gpm	None	-	-	-
Women's (estimated)	6 water closets at 3.5 gpf	6 water closets at 1.6 gpf	$3,000	$1,133	2.65
Women's (estimated)	3 water closets at 1.6 gpf	None	-	-	-
Women's (estimated)	10 faucets at 1.5 gpm	10 faucets at 0.5 gpm	$100	$224	0.45
Women's	one faucet at 0.5 gpm	None	-	-	-

4.13 Larry Whitworth Occupational Education

The Larry Whitworth Occupational Education Building is a very unique facility on campus as its spaces span a wide range of uses, including machine and welding shops, and automotive and motorcycle shops. Since its original construction in 1980, the building underwent multiple additions. A substantial renovation to the building in 2010 and 2011 incorporated numerous energy-efficient and sustainable features including a geothermal water-source heat pump system, low-volume toilets and sinks, rooftop photovoltaic and thermal solar panels, LED lights, rubber flooring and carpeting made from recyclable materials, and light sensors in hallways and classrooms. A new roof combines a reflective, energy-efficient material and a live, vegetative system to help preserve building temperature and control storm water runoff.

Figure 28: Larry Whitworth Occupational Education Building

4.13.1 Systems

Envelope:

- Concrete
- Single-pane glass
- Small atrium with clear glass

Mechanical:

- A geothermal water-source heat pump system provides cooling and heating
  - Two 25 hp loop pumps
  - Chilled water pumps are variable flow with VFDs
  - Hot water pumps are constant volume
- Make-up air units
  - Two make-up air units with energy recovery serve the building
- Shop exhaust
  - A large exhaust system with specialized filtration serves the welding and machine shop
- Solar thermal array
  - Serves an 80 gallon domestic water heater

Electrical:

- Lighting
  - Lighting is primarily T8 fluorescent (in 80% of the building)
  - High-bay lighting is used in several areas:
    - Welding and machine shop
    - Automotive shop
    - Auto body shop
    - Motorcycle shop
    - Motorcycle lab
    - Atrium
    - Car barn
- Solar photovoltaic array
  - Two panels, total of 430W

Controls:

- BAS and HVAC
  - BAS: Siemens Apogee
- Lighting
  - Occupancy sensors are in place where appropriate.

Figure 29: Roof view with vegetated area

Figure 30: Roof view with solar PV and thermal arrays

Figure 31: Modular geothermal water-to-water heat pump

Figure 33: Automotive shop lighting

Figure 32: Welding booths with exhaust

Figure 34: Welding shop exhaust system

4.13.2 Observations

General:

- The Occupational Education Building is a suitable place to consolidate after-hours events and activities as its systems are capable of supporting operation of the building independent of the central plant.

Mechanical:

- Staff reported that the heat pump system has been challenging to operate with numerous faults on a daily basis, and also requires that the thermal loop water be very clean.

Electrical/Lighting:

- Various high bay areas are opportunities for occupancy control.

4.13.3 Energy Conservation Measures

ECMs proposed for the Larry Whitworth Occupational Education Building are tabulated and notated below.

Table 25: ECMs for the Larry Whitworth Occupational Education Building

Building	Energy Conservation Measure		Electricity Savings			Natural Gas Savings		Gas & Electric		Estimated Implementation Cost	Payback
			Demand	Consumption	Total	Consumption	Total	Total	Estimated Annual Savings		
Category	#	Description	(kW)	(kWh/yr)	($/year)	(therms)	($/year)	(kBtu)	($/year)	($)	(years)
OE	Occupational Education										
RCx	1	Refine/enhance scheduling	10.8	94,202	$8,138	4,508	$2,059	772,252	$10,198	$1,200	0.1
RCx	2	Recommission daylighting controls	1.6	14,130	$1,221	-	$0	48,213	$1,221	$7,400	6.1
Controls	3	Welding exhaust system control	22.3	73,263	$6,329	-	$0	249,975	$6,329	$24,200	3.8
Controls	4	VAV zone occupancy control	6.5	56,521	$4,883	2,705	$1,236	463,351	$6,119	$12,600	2.1
Controls	5	Demand control ventilation	4.0	35,326	$3,052	1,691	$772	289,595	$3,824	$14,600	3.8
Lighting	6	Replace 32W T8s with 25W T8s	21.6	120,835	$10,439	-	$0	412,289	$10,439	$125,900	12.1
Lighting	7	Retrofit high bay lighting	6.2	18,720	$1,617	-	$0	63,873	$1,617	$11,600	7.2

Notes:

- Demand control ventilation includes the application of CO_2 sensing for monitoring and control of ventilation levels.

4.13.4 Water Conservation Measures

Replacing lavatory faucet aerators with 0.5 gpm aerators will reduce water consumption at a very low implementation cost. At this time, we do not recommend replacing the existing plumbing fixtures (water closets and urinals) in this building for the sole purpose of water savings.

4.14 Plant Operations

Plant Operations is a smaller stand-alone facility constructed in 1980. This building houses the facility management and operations staff with office and conference room spaces.

Figure 35: Plant Operations

4.14.1 Systems

Envelope:

- Brick over wood frame
- Double-pane glass

Mechanical:

- HVAC
    - Five residential-style furnaces/air handling units
        - DX cooling with outdoor condensing units
        - Gas heat
    - One make-up air unit serves the restrooms and locker room
- Domestic hot water

Electrical:

- Lighting
    - Lighting is primarily T8 fluorescent in the security offices

Controls:

- BAS and HVAC
    - BAS: None
    - Programmable thermostats
- Lighting
    - Occupancy control in conference room

4.14.2 Observations

Electrical/Lighting:

- Staff appeared to be conscientious about turning lights off.

4.14.3 Energy Conservation Measures

No ECMs are proposed for the Plant Operations offices.

4.14.4 Water Conservation Measures

Water conservation measures proposed for this building are tabulated in the table below.

Table 26: Water conservation measures for Plant Operations

	Existing Conditions	Recommendation	Estimated Cost	Estimated Savings	Simple Payback
Men's	1 water closets at 3.5 gpf	1 water closets at 1.6 gpf	$500	$76	6.58
Men's	1 waterless urinals	None	-	-	-
Men's	1 faucets at 2.2 gpm, one faucet at 2.0 gpm	2 faucets at 0.5 gpm	$20	$45	0.44
Women's (estimated)	2 water closets at 3.5 gpf	2 water closets at 1.6 gpf	$1,000	$228	4.38
Women's (estimated)	1 faucets at 2.2 gpm, one faucet at 2.0 gpm	2 faucets at 0.5 gpm	$20	$45	0.44

4.15 Storage & Receiving

This facility is shared by two functions. One half is devoted to Industrial Technology education with a comprehensive machine shop, while the other half houses the college's shipping, storage and receiving area.

4.15.1 Systems

Mechanical:

- HVAC
  - A single constant-volume air handling unit with DX cooling serves the industrial technology area
    - The condensing unit is on grade beside the building
  - Two rooftop units serve the shipping, storage and receiving area
    - DX cooling
    - Gas heat

Electrical:

- Lighting
  - Lighting is 32W T8 fluorescent
  - The high bay storage area on the shipping, storage and receiving side is lit by metal-halide fixtures
    - 10 400W fixtures

Controls:

- BAS and HVAC
  - BAS: Siemens Apogee

4.15.2 Observations

General:

- Shipping, storage and receiving will be relocated to a new facility in the near future.

Mechanical:

- Rooftop units are in need of replacement. Replacement units are on the ground.

4.15.3 Energy Conservation Measures

ECMs proposed for this building are limited to lighting in Shipping &Receiving.

Table 27: ECMs for the Shipping & Receiving Building

Building	Energy Conservation Measure		Electricity Savings			Natural Gas Savings		Gas & Electric			
			Demand	Consumption	Total	Consumption	Total	Total	Estimated Annual Savings	Estimated Implementation Cost	Payback
Category	#	Description	(kW)	(kWh/yr)	($/year)	(therms)	($/year)	(kBtu)	($/year)	($)	(years)
SR	Shipping & Receiving										
Lighting	1	Replace HID fixtures with fluorescent with bi-level occupancy	1.9	13,455	$1,162	-	$0	45,910	$1,162	$4,500	3.9

4.15.4 Water Conservation Measures

Replacing lavatory faucet aerators with 0.5 gpm aerators will reduce water consumption at a very low implementation cost. At this time, we do not recommend replacing the existing plumbing fixtures (water closets and urinals) in this building for the sole purpose of water savings.

4.16 Student Center

The Student Center, constructed in 1976, is the hub of the campus, housing student and academic services and providing food service, including a cafeteria, coffee shop, Subway sandwich shop, and culinary arts teaching kitchen and restaurant. The building consists of three levels, with the food service and student activity areas on the first level, student services on level two and offices and a data center on level three.

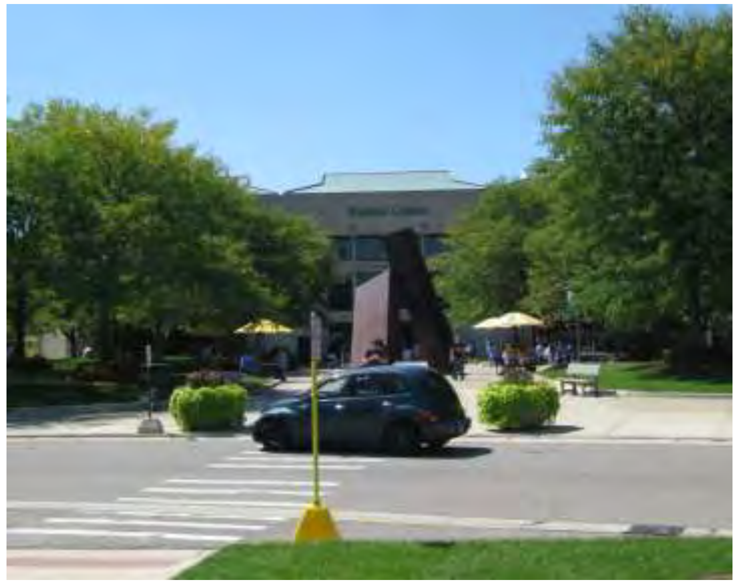

Figure 36: Student Center

4.16.1 Systems

Envelope:

- Concrete
- Double-pane windows
- Membrane roofing, black
- Eight large skylights
- Metal roofing over mechanical rooms

Mechanical:

- Air-Handling Units
  - All units are constant volume dual duct
  - 2 MAUs (make-up air units) serve the kitchen
  - Kitchen hoods provide exhaust
  - 8 original AHUs on the uppermost floor serve remainder of the building
  - OA estimated at 10-15%
  - AHUs are capable of limited economizing, except for AHUs 7 and 8
  - Common return for every 2 AHUs
  - 2-way chilled and hot water valves
  - While most buildings on campus have humidification, the Student Center does not.
- Data Center
  - 3 DX CRAC units cool the data center
- Utilities
- Kitchen
  - Dedicated steam-to-hot water system serves kitchen kettles.
- Other

Electrical:

- Lighting
  - Primarily fluorescent T8, various fixture types
  - CFL down lights

Controls:

- BAS and HVAC
  - BAS: Siemens Apogee
- Lighting
  - Occupancy sensors for lighting in offices

4.16.2 Observations

Mechanical:

- Mechanical systems are aging and approaching end of life. This is particularly true of the penthouse air handling units that exhibited air leaks and leaking condensate.

Table 28: Student Center space conditions

Floor	Area	Temperature (°F)	CO_2 (ppm)
1		73	410
2	Lobby	76	500
2	Offices	76	583
3	Data Center	Cold zone: 74 Hot zone: 84	

Electrical/Lighting:

- Lighting is primarily T8 fluorescent.

4.16.3 Energy Conservation Measures

ECMs proposed for the Student Center Building are tabulated and notated below.

Table 29: ECMs for the Student Center

Building	Energy Conservation Measure		Electricity Savings			Natural Gas Savings		Gas & Electric			
Building		Energy Conservation Measure	Demand	Consumption	Total	Consumption	Total	Total	Estimated Annual Savings	Estimated Implementation Cost	Payback
Category	#	Description	(kW)	(kWh/yr)	($/year)	(therms)	($/year)	(kBtu)	($/year)	($)	(years)
SC	Student Center										
All	1	Refine/enhance scheduling	7.1	62,547	$5,404	3,009	$1,374	514,328	$6,778	$1,200	0.2
All	2	Retro-commissioning	32.1	281,463	$24,316	13,541	$6,185	2,314,477	$30,501	$98,800	3.2
Controls	3	Kitchen exhaust hood controls	37.1	47,710	$4,122	722	$330	162,786	$4,122	$16,500	4.0
HVAC	4	Convert/replace constant volume dual duct system with VAV	34.3	300,227	$25,937	14,444	$6,597	2,468,776	$32,535	$952,000	29.3
Controls	5	Eliminate thermostat setpoint controls	8.6	75,057	$6,484	3,611	$1,649	617,194	$8,134	$10,900	1.3
Controls	6	Demand control ventilation	187.7	82,837	$7,156	10,199	$4,794	1,302,577	$11,950	$29,100	2.4
Electrical	7	Replace 32W T8s with 25W T8s	36.0	201,633	$17,420	0	$0	687,971	$17,420	$175,700	10.1
HVAC	8	Retrofit kitchen equipment from steam to electric	44.0	145,200	$12,544	0	$0	495,422	$12,544	$19,500	1.6

Notes:

- Demand control ventilation includes the application of CO_2 sensing for monitoring and control of ventilation levels.

4.16.4 Water Conservation Measures

Water conservation measures proposed for this building are tabulated in the table below.

Table 30: Water conservation measures for the Student Center

	Existing Conditions	Recommendation	Estimated Cost	Estimated Savings	Simple Payback
Men's	8 water closets at 3.5 gpf	8 water closets at 1.6 gpf	$4,000	$1,235	3.24
Men's	3 water closets at 1.6 gpf	None	-	-	-
Men's	4 urinals at 1.0 gpf	4 urinals at 0.5 gpf	$2,000	$325	6.15
Men's	11 urinals at 0.5 gpf, one urinal at 0.125 gpf, one waterless urinal	None	-	-	-
Men's	8 faucets at 2.2 gpm, 5 faucets at 2.0 gpm, 2 faucets at 1.5 gpm	15 faucets at 0.5 gpm	$150	$1,006	0.15
Men's	one faucet at 0.5 gpm	None	-	-	-
Women's (estimated)	14 water closets at 3.5 gpf	14 water closets at 1.6 gpf	$7,000	$3,963	1.77
Women's (estimated)	4 water closets at 1.6 gpf	None	-	-	-
Women's (estimated)	12 faucets at 2.2 gpm, 3 faucets at 2.0 gpm, 2 faucets at 1.5 gpm	17 faucets at 0.5 gpm	$170	$1,006	0.17

4.17 Technical & Industrial

The Technical & Industrial Building was originally constructed in 1970 as a square building with an open courtyard in the center. It underwent subsequent minor additions over the years. In 2008, a substantial renovation and addition converted the central courtyard to more building space. During this renovation, the building received all new mechanical systems. This facility is mixed use with general classrooms and computer labs.

Figure 37: Technical & Industrial Building

4.17.1 Systems

Envelope:

- Concrete and brick
- Double-pane glass

Mechanical:

- Air handling units
  - Six primary air handling units
    - Two VAV air handling units
    - Four VAV energy recovery units
  - A mix of blower coils and packaged units supplement the primary air handling systems
  - Steam humidifiers
- Chilled water
  - 2-way control valves
- Hot water
  - Two hot water pumps
    - 15hp each with VFDs
  - 2-way control valves

Electrical:

- Lighting
  - Lighting is primarily T8 fluorescent

Controls:

- BAS and HVAC
  - BAS: Siemens Apogee

- Lighting
  - Occupancy sensors are in place in some areas.

4.17.2 Observations

Mechanical:

- High quality air handling equipment

Electrical/Lighting:

- Lights remain on in corridors with substantial daylighting

Figure 38: Humidification equipment

Figure 39: Zoning

Figure 40: Energy recovery unit

Figure 41: Corridor with daylighting

4.17.3 Energy Conservation Measures

ECMs proposed for the Technical & Industrial Building are tabulated and notated below.

Table 31: ECMs for Technical & Industrial

Building	Energy Conservation Measure		Electricity Savings Demand	Electricity Savings Consumption	Electricity Savings Total	Natural Gas Savings Consumption	Natural Gas Savings Total	Gas & Electric Total	Gas & Electric Estimated Annual Savings	Estimated Implementation Cost	Payback
Category	#	Description	(kW)	(kWh/yr)	($/year)	(therms)	($/year)	(kBtu)	($/year)	($)	(years)
TI	Technical & Industrial										
RCx	1	Refine/enhance scheduling	5.8	50,764	$4,386	3,867	$1,766	559,894	$6,152	$1,200	0.2
RCx	2	Retrocommissioning	13.0	114,218	$9,868	8,701	$3,974	1,259,762	$13,842	$63,500	4.6
Controls	3	VAV zone occupancy control	3.5	30,458	$2,631	2,320	$1,060	335,937	$3,691	$12,600	3.4
Controls	4	Demand control ventilation	4.3	38,073	$3,289	2,900	$1,325	419,921	$4,614	$25,500	5.5
Lighting	5	Daylighting control	1.6	14,277	$1,233	0	$0	48,714	$1,233	$3,700	3.0
Lighting	6	Replace 32W T8s with 25W T8s	18.5	103,642	$8,954	0	$0	353,627	$8,954	$108,000	12.1

Notes:

- Demand control ventilation includes the application of CO_2 sensing for monitoring and control of ventilation levels.

4.17.4 Water Conservation Measures

Water conservation measures proposed for this building are tabulated in the table below.

Table 32: Water conservation measures for Technical & Industrial

	Existing Conditions	Recommendation	Estimated Cost	Estimated Savings	Simple Payback
Men's	8 water closets at 3.5 gpf	8 water closets at 1.6 gpf	$4,000	$840	4.76
Men's	6 waterless urinals	None	-	-	-
Men's	4 faucets at 2.2 gpm, one faucet at 2.0 gpm	5 faucets at 0.5 gpm	$50	$497	0.10
Men's	6 faucets at 0.5 gpm	None	-	-	-
Women's (estimated)	14 water closets at 3.5 gpf	14 water closets at 1.6 gpf	$7,000	$2,519	2.78
Women's (estimated)	4 faucets at 2.2 gpm, one faucet at 2.0 gpm	5 faucets at 0.5 gpm	$50	$497	0.10
Women's	6 faucets at 0.5 gpm	None	-	-	-

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5.0 Energy Conservation Measures

The matrix below summarizes the application of energy conservation measures to the various buildings on campus.

Table 33: ECM matrix

Washtenaw Community College Energy Conservation Measure Matrix

	Energy Conservation Measure	Business Education	Crane Liberal Arts and Sciences	Energy Center	Family Education	Facilities Operations Buidling	Great Lakes Regional Center	Gunder Myran Building	Health and Fitness	Henry Landau Skilled Trades	Maintenance Garage	Morris Lawrence Building	Occupational Education Building	Green Parking Ramp/Security	Student Center	Shipping and Receiving/Industrial Technology	Technical and Industrial Building
Lighting	Replace 32W T-8s with 25W T-8s	●	●				●	●	●			●	●		●	●	●
Lighting	Replace High Bay HID fixtures with Fluorescent			●							●		●			●	
Lighting	Replace Elevator Lighting with LED							●	●								
Lighting	Add occupancy controls						●			●							
Lighting	Add daylighting controls																●
Lighting	Retrofit T-12 Fixtures with T-8s											●					
RCx	Scheduling Refinements - The cost to provide HVAC for 1 hour each day.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
RCx	Retrocommissioning	●	●					●							●		●
RCx	Re-commission Daylighting Controls System to Ensure Proper Operation								●				●				
RCx	Open Triple Duty Valves on Pumps with VFDs								●								
Controls	Install VFDs - Pumps								●								
Controls	Install VFDs - Fans											●					
Controls	CO2 Demand Ventilation Control	●	●				●	●	●			●	●		●		●
Controls	Non-operable Thermostats														●		
Controls	Extend DDC Controls, Eliminate Pneumatic Logic		●									●					
Controls	Condenser Water Reset								●								
Controls	Control Occupancy in VAV Zones Based on Occupancy Sensors	●	●				●	●					●				●
Controls	O2 Boiler Trim with Blower Motor VFD			●													
Controls	Welding Exhuast Station Controls												●				
Controls	Chiller Plant Optimization Package			●													
Controls	Kitchen Hood Controls System														●		
HVAC	Convert/Replace Constant Volume Dual Duct System with VAV														●		
HVAC	Eliminate Portable Cooling Needs in Phone Room		●														
HVAC	Tunnel Piping Insulation			●													
HVAC	Combustion Air Pre-Heater and/or fuel-air trim			●													
HVAC	Install Heating Piping Infastructure/Connect to the Central Heating Loop	●															
HVAC	Boiler upgrade	●										●					
HVAC	Chiller upgrade											●					
HVAC	Domestic hot water heater upgrade						●					●					
HVAC	Replace kitchen equipment														●		
HVAC	Comb Fins on Condenser Coils/Provide Hail Guards									●						●	
Water	Install Low Flow Aerators on Lavatories	●				●						●			●		●
Water	Heat Pump Domestic Water Heaters						●										
Water	Low Flow Urinals	●										●			●		●
Water	Low Flow Toilets	●				●						●			●		●

5.1 Lighting

This section describes the recommended lighting energy conservation measures. These measures include upgrades to more efficient lighting technology, application of lighting controls, and improved control strategies.

5.1.1 Replace 32 Watt Fluorescent T-8 Lamps with 25 Watt

Linear fluorescent fixtures in all buildings provide a significant amount of interior lighting. In some cases, the interior lighting levels are higher than may be required for the tasks currently going on in the building. Many buildings older than 15 years were designed for workstations where tasks at desk level required high light levels for reading and working. Today, many activities involve computers which do not require much general light. 32 Watt T-8 lamps were identified in the buildings, but there are 25 Watt and 28 Watt fluorescent replacement lamps available that will slightly reduce light levels in the building but can reduce electric consumption of the lighting in a building by up to 20%.

There are a few considerations to keep in mind when considering lower wattage T-8 lamps:

- The higher cost of the lower wattage lamps must be taken into consideration along with other lifecycle cost issues, such as the need to maintain more types of replacement lamps.
- Existing ballasts may or may not be compatible with the lower wattage lamps, and should be evaluated for compatibility. In the course of this study, it was determined that the existing ballasts are not compatible and would therefore need to be replaced as part of this measure.
- Prior to implementation, it is recommended that this measure be tested on a set of small rooms or areas prior to widespread implementation to ensure ballast compatibility and that the lighting levels will be acceptable.
- This measure can make sense when re-lamping an existing building or part of a building as part of a renovation; however, it may not be a practical measure under many other circumstances.

5.1.2 Replace High-Bay HID (Metal Halide) Fixtures with Fluorescent

There are a number of areas or rooms in campus buildings with high-bay lighting. In some cases, the lighting is already very efficient, but in others room for improvement remains. In particular, there are a number of areas with high-bay metal halide lighting that can be retrofitted to fluorescent with a significant reduction in lighting power consumption.

5.1.3 Convert Elevator Lighting to LED

The elevator cars in some of the buildings are lit with halogen or incandescent lamps (25, and 50 watt). Retrofitting the halogen lamps to LED lamps would provide equal lighting output while greatly reducing the energy consumption and heat generation.

5.1.4 Replace Halogen Accent Lighting with LED

Decorative and accent lighting is currently provided by halogen MR-16 light fixtures, particularly in the Health & Fitness Center. Typically, these lights are used to illuminate signage or create an impressive ambiance. The halogen lamps in these fixtures can be replaced with LED fixtures that put out the same amount of light, create less heat and consume a fraction of the electricity.

5.1.5 Replace Fluorescent T-12 Lamps with T-8 Lamps

T-12 lamps were identified in only one building, the Morris Lawrence Building. Nonetheless, these fixtures and lamps should be updated to T-8. T-12 lamps consume more energy with lower light quality, and the lamps will soon no longer be available and the cost for replacement lamps is expected to rise rapidly. Note that replacing T-12 lamps with T-8 typically requires that the corresponding ballasts be replaced as well.

5.1.6 Add Occupancy Controls

Restrooms, offices, classrooms and conference rooms, and some corridors are candidates for occupancy control. The recommended control scheme for restrooms and corridors is automatic-on automatic-off. For offices, classrooms and conference rooms, the recommended scheme is a bi-level manual-on automatic-off control strategy:

1. Primary manual on to 50%
2. Secondary manual on to 100%
3. Automatic off based on occupancy/vacancy

This allows for lights to only come on when required, but to automatically shut off when there is no activity.

5.1.7 Add Daylighting Controls

Various areas across campus are candidates for daylighting control. As noted in previous sections of this report, this includes areas such as fitness and pool areas in the Health and Fitness Center as well as corridors in the Technical and Industrial Building. The addition of daylighting controls would simply allow for ambient lighting to be used when it is available, and electrical lighting to supplement when it is needed.

5.2 Retro-Commissioning

This section outlines the recommended retro-commissioning energy conservation measures. These measures include troubleshooting the existing control systems, calibrating sensors, upgrades to controls hardware and software, and changes to setpoints that can be accomplished without large capital investment or significant changes to the existing systems.

5.2.1 Scheduling Refinement

While systems on campus are scheduled in most cases, or operated on an as-needed basis, a thorough review of schedules for mechanical and electrical equipment is recommended to identify areas for potential improvement; thus, leading to reducing hours of operation of mechanical and electrical systems.

5.2.2 Comprehensive Retro-commissioning

At least a few buildings on campus would benefit from a comprehensive retro-commissioning process, where all mechanical and electrical systems are surveyed in depth, reviewed for proper operation, and in some instances, functionally tested. Data logging is also used to examine the operation of systems over time and in various conditions. Out of this process comes corrective measures to further improve operational and energy performance.

5.2.3 Re-commission Daylighting Controls

There are existing daylighting controls that have either been decommissioned or manually overridden in response to operational complaints. The Health and Fitness Center as well as the Larry Whitworth Occupational Education Building exhibit areas where daylighting controls should be controlling, but are not working properly. These issues should be investigated further and the best remedy determined.

5.2.4 Open Triple Duty Valves on Pumps with VFDs

When pumps are balanced, the triple duty valve is often throttled back to restrict flow and create an artificial pressure drop. During the walkthrough, some valves in the Health & Fitness Center were partially closed. It takes extra energy for a pump to move water through an artificial pressure drop. Ideally, when a pump is first installed the impeller should be trimmed to the appropriate size to balance the flow as opposed to use of a balancing valve at the pump – but this is expensive if it must be done onsite. Since the pumps were also installed with VFDs they have a mechanism for controlling to a specific system required pressure. The triple duty valves can be opened and the VFD will automatically modulate. The pump will no longer have to overcome the artificial pressure drop, and continue to control to the same differential pressure setpoint the system has required since it was first installed.

5.3 Controls

This section outlines the recommended controls energy conservation measures. These measures range from the application of variable speed drives, to revised control strategies, to complete DDC controls retrofits that comprise a significant capital investment.

5.3.1 Install VFDs – Pumps

The hydronic (heating or chilled) water pumping systems in the building are currently constant volume. Variable Frequency Drives (VFDs) could be installed on the pumps that would reduce the pump speed, and associated electrical consumption, to the minimum possible while maintaining the building load. This would require the control valves throughout the system to be 2-way, and a differential pressure sensor. As the 2-way valves close down with a reduced load, pressure builds up in the system than when sensed by the differential pressure sensor would signal the pumps to slow down until the system reaches equilibrium.

5.3.2 Install VFDs - Fans

There are HVAC fan systems in the building that are currently constant volume. Variable Frequency Drives (VFDs) could be installed on the fan motors with appropriate controls that would reduce the fan speed, and associated electrical consumption, to the minimum possible while maintaining the building load. This is a simple installation for single zone systems. Instead of the discharge air temperature controlling to the space set point. The fan speed will control to the space set point at the same discharge air temperature. The result is the same amount of heating or cooling energy being delivered with less fan energy.

5.3.3 Demand Control Ventilation (CO_2-Based)

For many of the air handling units, the outside air dampers are currently set at a fixed minimum position. This is intended to ensure that enough outside air is being brought into the building when it is fully occupied to be appropriately ventilated. Since space occupancy can vary dramatically, usually presenting lower occupancy than at design conditions, there is more outside air being brought into the building than is required. Since heating and cooling outside air is energy intensive it would be cost effective to limit the amount of outdoor air brought in to the level required by the building load. By installing carbon dioxide (CO_2) sensors in various strategic places throughout the building, the outside air dampers can be actively controlled to maintain a maximum CO_2 level. The outdoor air dampers would only open to the level required by the amount of occupants. While this is a code acceptable method of outdoor air control, attention must also be paid to air contaminants other than CO_2 as this system will not account for them. A minimum outside air flow or damper position setpoint should also be taken into consideration to avoid negative building pressurization.

5.3.4 Eliminate Local Thermostat Setpoint Control

Some of the buildings have adjustable temperature setpoints at the thermostats located in the space. In at least a few instances during the on-site survey, setpoint dials were observed to be set at the maximum cooling position. Replacing these thermostats with communicating thermostats with setpoint controls is recommended. The BAS can then be aware of the setpoint setting and override it where appropriate. A limited setpoint range of +/- 3°F is recommended for adjustment by occupants.

5.3.5 Extend DDC Controls, Eliminate Pneumatic Logic

In a few of the buildings, the building control systems are currently a combination of pneumatic, electric and direct digital controls (DDC). There is an industry consensus that DDC controls are superior to pneumatic controls for ease of operation, self-diagnostics, and safety reasons. Replacing/upgrading the existing controls to DDC will enhance the effectiveness of the building control system. An upgrade would allow building staff to troubleshoot the building for energy wasting issues much more effectively. It would also allow the controls system to take advantage of more aggressive energy saving strategies that they are currently unable to be accomplished because of the inability to coordinate the terminal devices with the central systems. Many levels of upgrades are available and generally the greater level control installed the more efficient a system is capable of operating.

5.3.6 Condenser Water Reset

A condenser water reset strategy is recommended over a constant condenser water supply temperature to enhance the efficiency of chilled water production. Resetting the condenser water as ambient outdoor conditions allow minimizes condenser head pressure allowing the chiller's compressor to operate at a lower power draw, increasing chiller efficiency.

5.3.7 Control Occupancy in VAV Zones Based on Occupancy Sensors

Existing lighting controls, and in particular occupancy controls, can be used to also control HVAC systems by shutting off or minimizing air flow to unoccupied rooms or zones. Implementation of this strategy depends on having the ability to integrate lighting controls with the BAS, either with network communication or through discrete inputs.

5.3.8 O_2 Boiler Trim with Blower Motor VFD / Combustion Air Preheat

These boiler-specific techniques focus on optimizing the fuel-air mixture and increasing the conversion of fuel to heat; thus, increasing boiler efficiency. The first method involves the application of a variable speed drive to the burner blower motor, while the second involves preheating or ducting of combustion air.

5.3.9 Welding Exhaust Station Variable Flow Controls

The welding exhaust system in the Larry Whitworth Occupational Education Building is a large constant-volume exhaust system. One potential way to reduce the energy consumption of this system is by converting it to a variable-volume system with the following control elements:

- Occupancy sensors in welding booths detect that the booth is in use.

- A damper opens enabling exhaust for that booth.
- A variable frequency drive modulates the welding exhaust system motor speed to produce the flow required for the welding booths currently in use.
    - The variable frequency drive minimum speed is set to assure proper operation and filtration by the system.

Further feasibility study is recommended to assure that such an arrangement would work with the current system, and that it would not adversely impact the effectiveness of the system.

5.3.10 Chiller Plant Optimization

The chiller plant at the Energy Center is an excellent candidate for optimization. All equipment and systems have DDC controls, and chilled water pumps are on variable speed drives. Optimization would further enhance plant efficiency by minimizing total energy consumption across all plant components: chillers, cooling tower and pumps. In this case, modifications to the cooling tower may also be necessary to upgrade the cooling tower fans to be capable of full modulation instead of two-speed operation.

5.3.11 Kitchen Hood Controls System

The Student Center houses kitchen facilities that serve both dining and culinary instruction roles. Several kitchen hoods remove heat, vapor, smoke or grease from when the kitchen is in use. Building codes require minimum flows and velocities based on the size of the hood and what kitchen equipment is underneath of it. Typically, the whole hood is sized for the worst case equipment. A packaged kitchen hood controls system can be installed that monitors the heat and smoke in the hood and modulates the speed of the exhaust fans and make-up air units accordingly. During periods of inactivity, or minimal activity, the hoods go to minimum speed. In addition to reduced fan electrical consumption, less outside air will need to be conditioned as it is brought in to make-up the exhaust air.

5.4 HVAC

5.4.1 Convert/Replace Constant Volume Dual Duct System with VAV

There are constant volume dual-duct air handling units that provide HVAC for much of the Student Center. These units are inherently inefficient because they require mixing of hot and cold air streams and constant air volumes to match the heating and cooling loads of the space. Conversion to a standard Variable Air Volume (VAV) system could be accomplished by a retrofit of the existing equipment, which has already undergone a comprehensive overhaul at an earlier point in time. As has been done on several air handling units throughout the downtown complex buildings, each multi-zone unit is replaced by a standard VAV unit as well as the distribution ductwork and terminal devices. New controls are installed at the same time.

5.4.2 Eliminate Portable Cooling Needs in Phone Room

One small computer/communications room in the Liberal Arts and Sciences building is cooled by a portable cooling unit that rejects heat into the building space. This is a temporary arrangement while WCC procures a split system for the space.

5.4.3 Tunnel Piping Insulation

In the utility tunnel connecting the various buildings to the central plant, there are areas where pipe insulation is damaged on chilled water or high temperature hot water piping, or where piping is exposed. Repairing or adding pipe insulation would reduce piping energy losses. Note that losses are much greater for high temperature hot water piping than for chilled water piping.

5.4.4 Install Heating Piping Infrastructure/Connect to the Central Heating Loop

The Business Education Building uses the central chilled water system for cooling, but retains its own boiler plant for heating. An alternate option for heating this building is to add it to the hot water infrastructure from the central plant; however, this may have already been considered at a prior time. Alternatively, the existing boilers can be upgraded to high-efficiency condensing boilers.

5.4.5 Comb Fins on Condenser Coils/Provide Hail Guards

Air cooled condensing units rely on cooling coils that have copper, aluminum or tin fins that provide surface area for heat exchange in order for the cooling system to reject the heat it collects to the ambient air. In order to cool anything, the heat needs a consistent rejection medium. At the Henry Landau Skilled Trades building, the coil fin surfaces on cooling equipment were observed to be damaged. When coil fins get plugged, are bent or are flattened the surface area available for heat transfer rejection is reduced thereby reducing the cooling capacity and efficiency of the equipment. Any damaged fins should be combed straight, any plugs cleaned and any damaged fins replaced in order to have cooling unit operate at maximum efficiency. Hail guards are also available for most units or can be field fabricated in order to protect the fins from damage.

5.4.6 High-Efficiency Condensing Boilers

Fire tube boilers operate at a maximum combustion efficiency of approximately 80%.This the maximum possible efficiency for two reasons:

- High return water temperatures must be maintained in order to prevent boiler shock.

- The combustion gases must leave the boiler and vent stack at temperatures high enough such that they do not condense.

Boiler shock or condensed flue gasses which are acidic will eventually cause boiler failure. These types of boilers may be replaced with condensing boilers that operate at a maximum combustion efficiency of approximately 95%.Condensing boilers are specifically designed to be shock-able and to be able to handle acidic condensed flue gasses. They are also most efficient at part-load conditions with low return water temperatures.

5.4.7 Domestic hot water heater upgrade

Two upgrade options for domestic hot water heating are noted in this report.

- Heat pump hot water heater: A heat pump water heater is a good alternative to an electric water heater with a substantial efficiency advantage.
- Tank-less or on-demand hot water heater: On-demand water heaters can save anywhere from 10% to 50% of the energy required to prepare domestic hot water relative to their conventional storage tank counterparts, with the savings varying according to how they are applied.

5.5 Sub-Meters

WCC has already taken steps to sub-meter electric power demand and consumption at each of the major buildings. All of the existing sub-meters collect data at a central system. Further improvements in sub-metering would enable a better understanding of energy end use:

- At a minimum, natural gas service should also be metered at each building.
- Going to the next level, when renovating or building a new building, it is recommended that all energy sources be metered at the panel level by major end use, including HVAC, lighting, plug load and any other significant process loads such as labs or data centers.

While no direct energy savings can be attributed to sub-meters, they do enable development of a more thorough understanding of how energy is being used, and subsequently, how energy performance can be improved. The results of improvements can be tracked and verified with proper metering in place. Furthermore, advanced sub-meters applied in a more granular fashion establish a foundation for monitoring-based commissioning, an emerging technique of continuous and automated commissioning that is seen as an effective way to assure consistent optimal performance.

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6.0 Recommendations

Based on this study, recommended next steps include:

- Continue key initiatives.
- Develop implementation programs.
    - To implement low-cost, low-risk measures, such as lighting controls and lighting upgrades.
    - To implement long-term capital improvements.
- Evaluate retro-commissioning for selected facilities.
- Consider further study to support an energy retrofit for the Morris Lawrence Building.
- Apply additional sub-metering.
- Consider other areas of further evaluation and study.

6.1.1 Continue Key Initiatives

As noted previously, WCC is doing a number of things well, including efforts underway to address various observations cited in this study. It is recommended that you continue these current efforts:

- Evaluate replacement pumps to eliminate water and heat waste in the Energy Center associated with water-cooled pumps.
- Continue exterior campus lighting retrofit to LED technology.
- Continue to sub-meter buildings and key loads, and to track and analyze sub-meter data.

6.1.2 Develop Implementation Programs

Re-assembling the information yielded by this study into short-term and long-term implementation plans will support planning and budgeting processes, and support commitments to reduce emissions. A short-term implementation program will include low-cost low-risk measures, and should include:

- A review and changes to scheduling and space utilization
- High-bay lighting control
- High-bay lighting retrofits
- Down-light, elevator and accent lighting retrofits
- Re-commissioning of daylighting controls
- Retrofit of remaining T-12 fixtures

A mid to long-term program will cover larger operational expenses and capital improvements that in addition to improving energy performance must be done for other reasons as well. For example, replacement of the air handling units in the student center will have to be tackled at some point due to maintenance and end-of-life issues that go well beyond energy performance. Other items that fall into this category are retro-commissioning and central plant optimization.

6.1.3 Evaluate Retro-Commissioning

Based on this study, the Gunder Myran and Crane Liberal Arts & Sciences Buildings stand to benefit the most from retro-commissioning. Seeking proposals for retro-commissioning services will inform decisions in this regard.

6.1.4 Apply Additional Sub-metering

Beyond the existing sub-metering system, additions to sub-metering would enable a better understanding of energy end use. At a minimum, natural gas service should be metered at each building. Selected buildings targeted for further study and evaluation should also be sub-metered to support evaluation. Good candidates for such evaluative sub-metering include the Student Center and Morris Lawrence. Going to the next level, when renovating or building a new building, it is recommended that all energy sources be metered at the panel level by major end use, including HVAC, lighting, plug load and any other significant process loads such as labs or data centers. With this sub-metering foundation in place, energy performance can be understood in greater detail, and improvements tracked and verified. And, it allows for the potential application of monitoring-based commissioning, an emerging technique of continuous and automated commissioning that is seen as an effective way to assure consistent optimal performance.

6.1.5 Further Study and Evaluation

Two more minor tasks present themselves as potential items for further study and evaluation in the near term:

- Interval/Demand data: The raw interval data from the utility and electric sub-meters can be evaluated. Patterns in demand offer insights into building performance that cannot be otherwise discerned.
- ENERGY STAR rating: Sub-meters at each building for natural gas would enable data collection to support ENERGY STAR rating, and ultimately labeling for those buildings that exceed the required performance thresholds. To make this manageable, WCC could start with one or two selected buildings.

6.1.6 Evaluate Deep Retrofit Potential: Student Center and Morris Lawrence

Two buildings in particular, the Morris Lawrence Building and the Student Center, are good candidates for further study for potential deep retrofits. Both buildings offer substantial opportunities for energy savings combined with systems and equipment approaching end of life. Both buildings are also potential high-use forums, Morris Lawrence for events and after-hours activity, and the Student Center as as the hub of campus life. Investment grade studies of these two buildings would yield the following useful results:

- In-depth understanding of current systems' operational performance
- Modeling of whole building energy performance and design alternatives
- Increased accuracy and precision of energy savings estimates and implementation costs
- Engineering pre-design, consisting of design concepts and narrative, consideration of design alternatives, and outline specifications

6.2 Next Steps

In accordance with these recommendations, potential next steps in the near-term include:

- Short-term and long-term building improvement program development
- Solicitation of proposals for retro-commissioning services
- Consider engagement in further energy and engineering study, in particular investment grade studies, on the Morris Lawrence Building and the Student Center

END OF REPORT

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Appendix A: End Use Estimation

Appendix A presents end use approximations for each of the major buildings. Note that these are truly approximations as individual buildings are metered for electricity only, and not natural gas. Furthermore, many of the buildings house energy-intensive areas such as labs and shops. As such, approximations of end use for each building are based on the available data and knowledge of the building, with gaps in knowledge approximated based on relevant industry data.

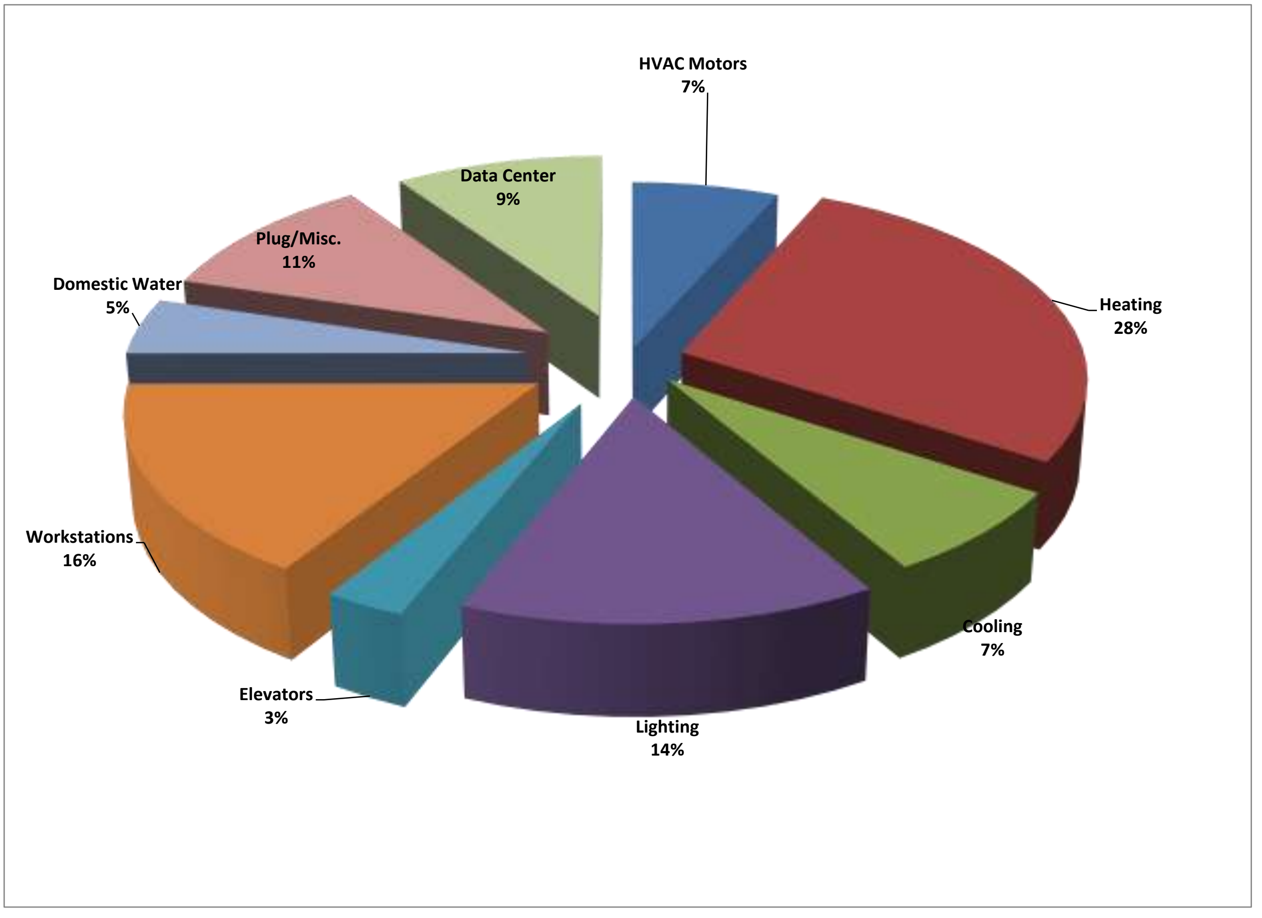

Figure 42: Business Education end use

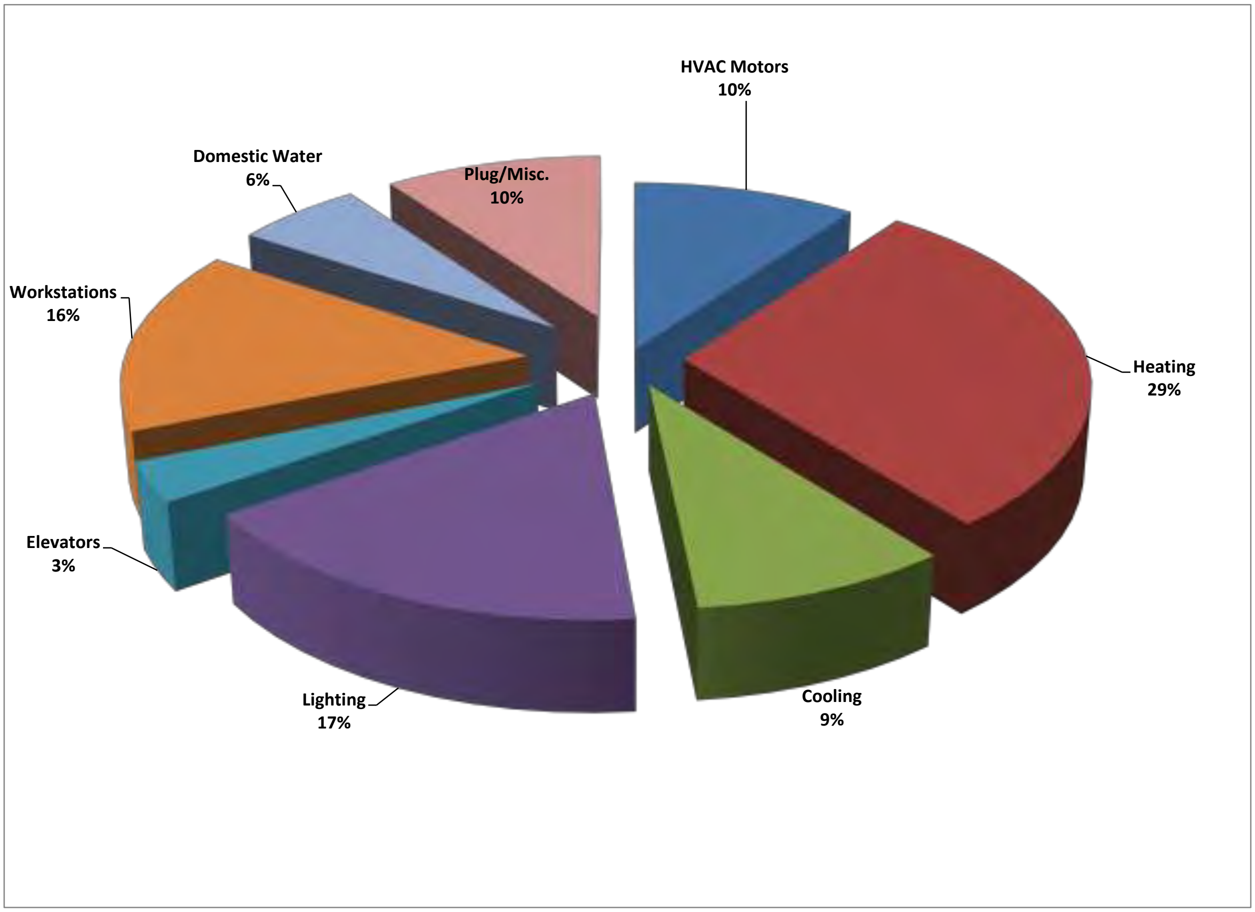

Figure 43: Gunder Myran end use

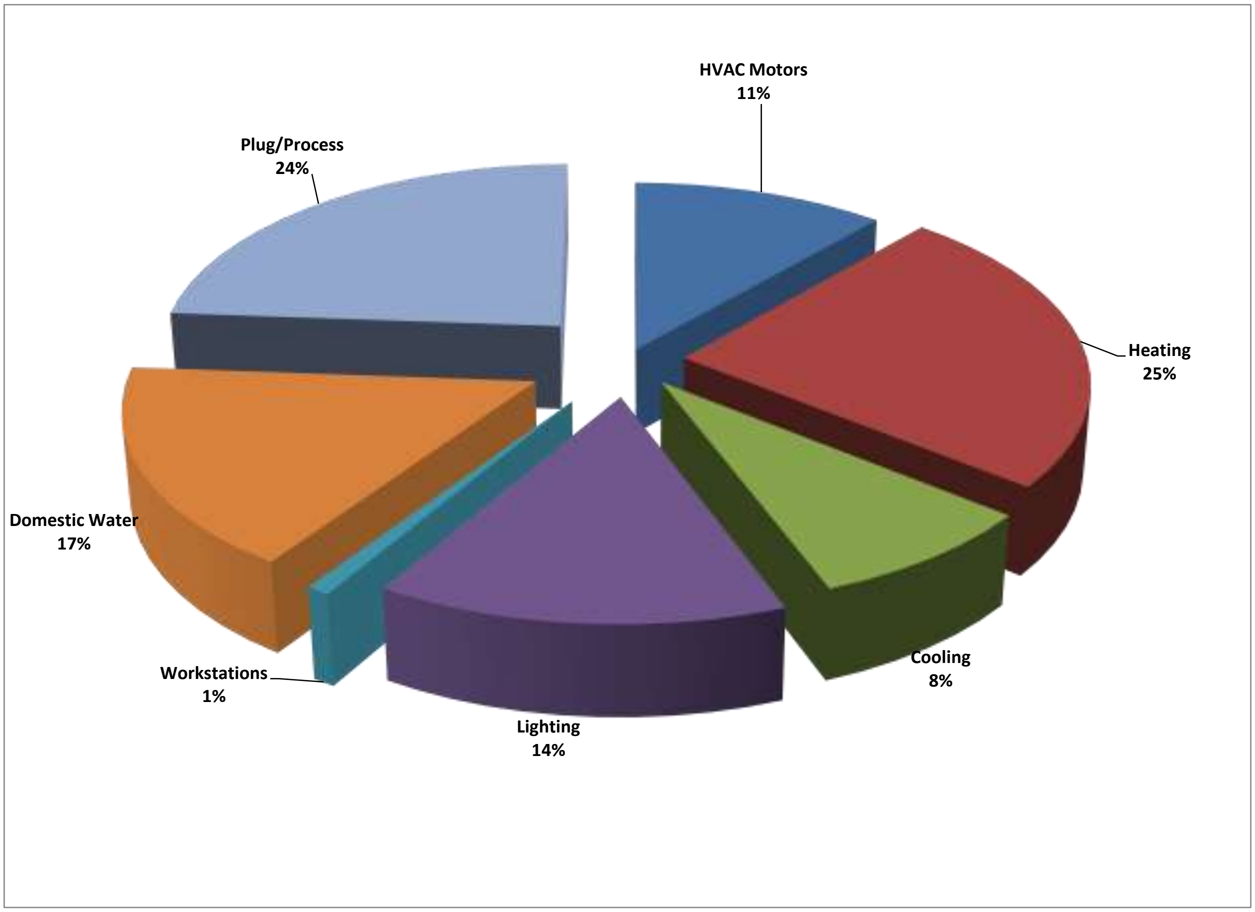

Figure 44: Health & Fitness Center end use

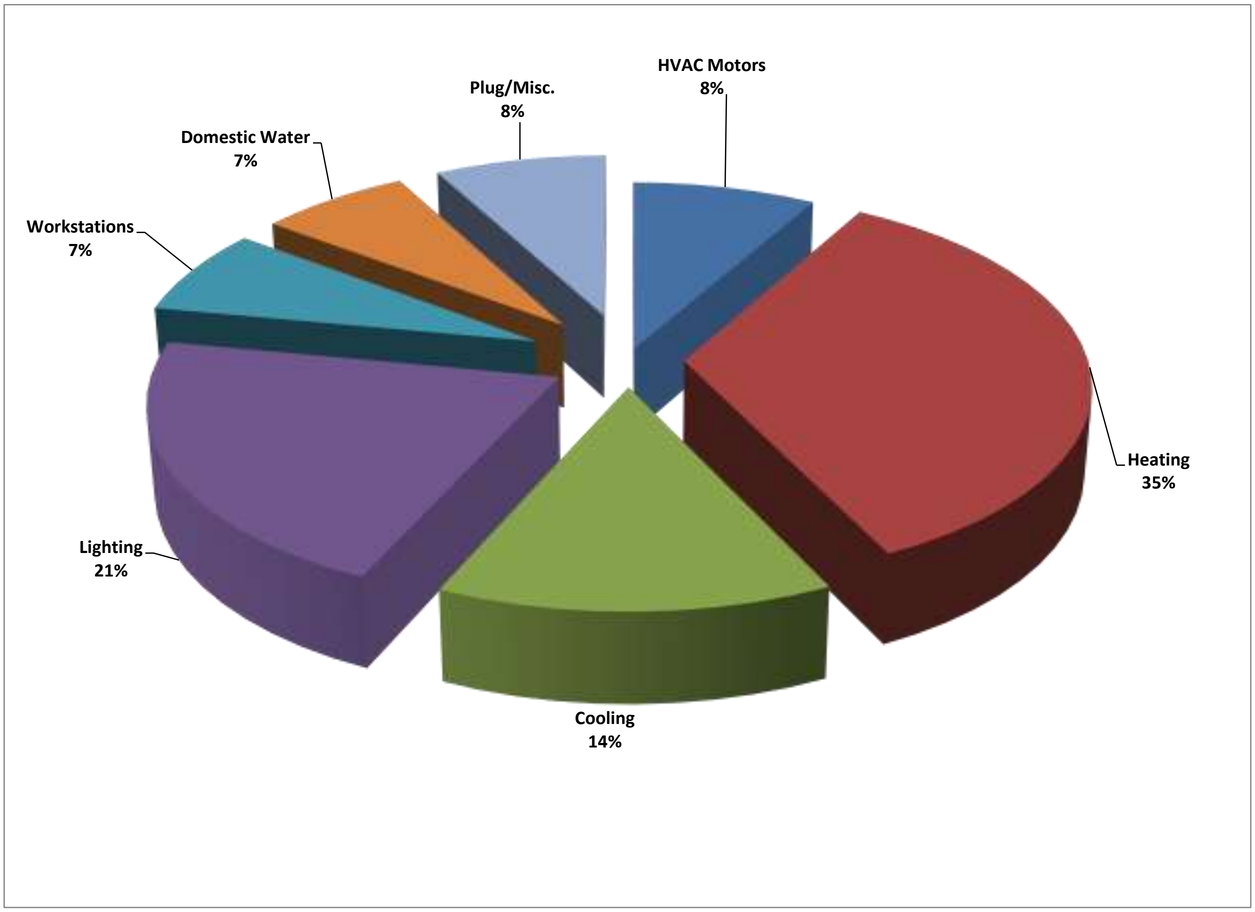

Figure 45: Great Lakes Regional Training Center end use

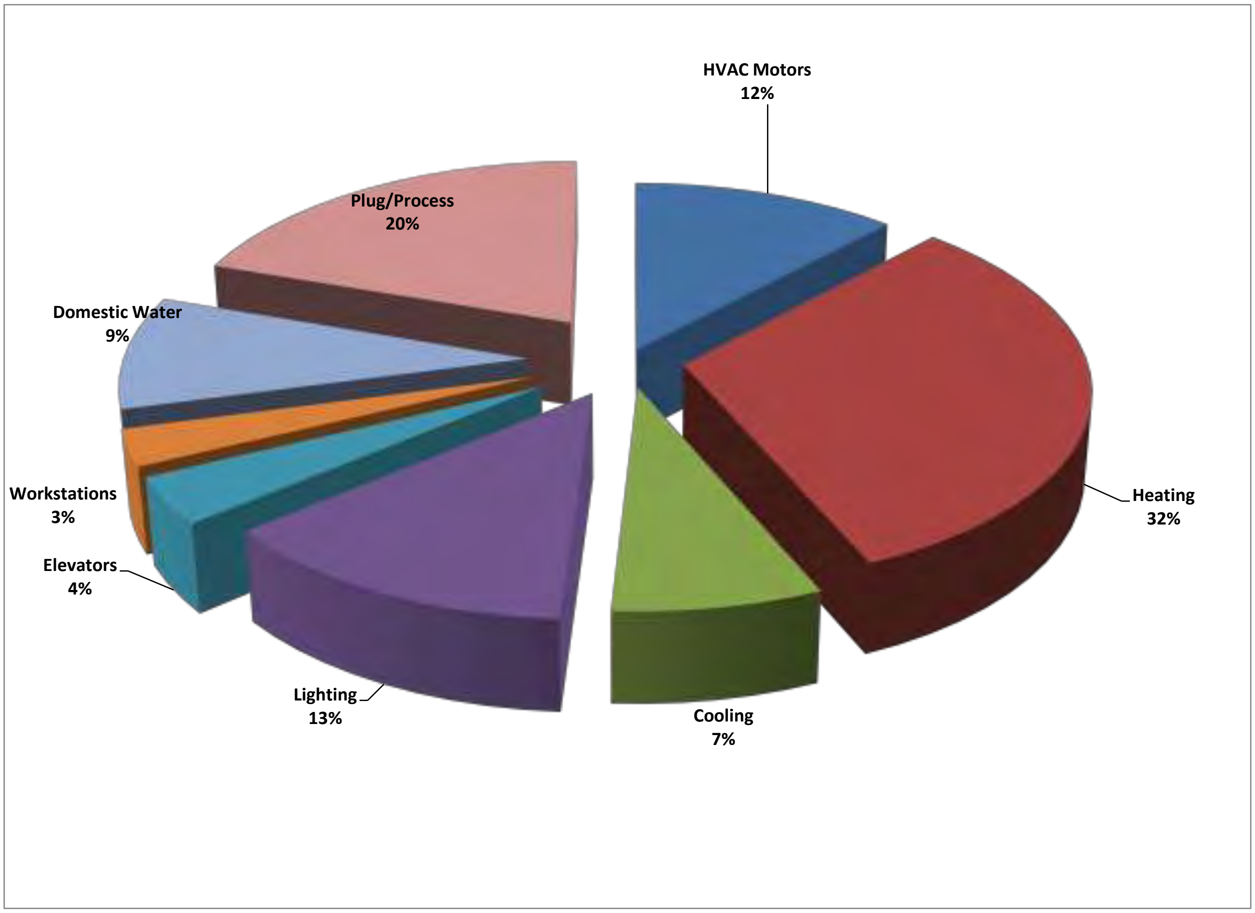

Figure 46: Crane Liberal Arts and Science end use

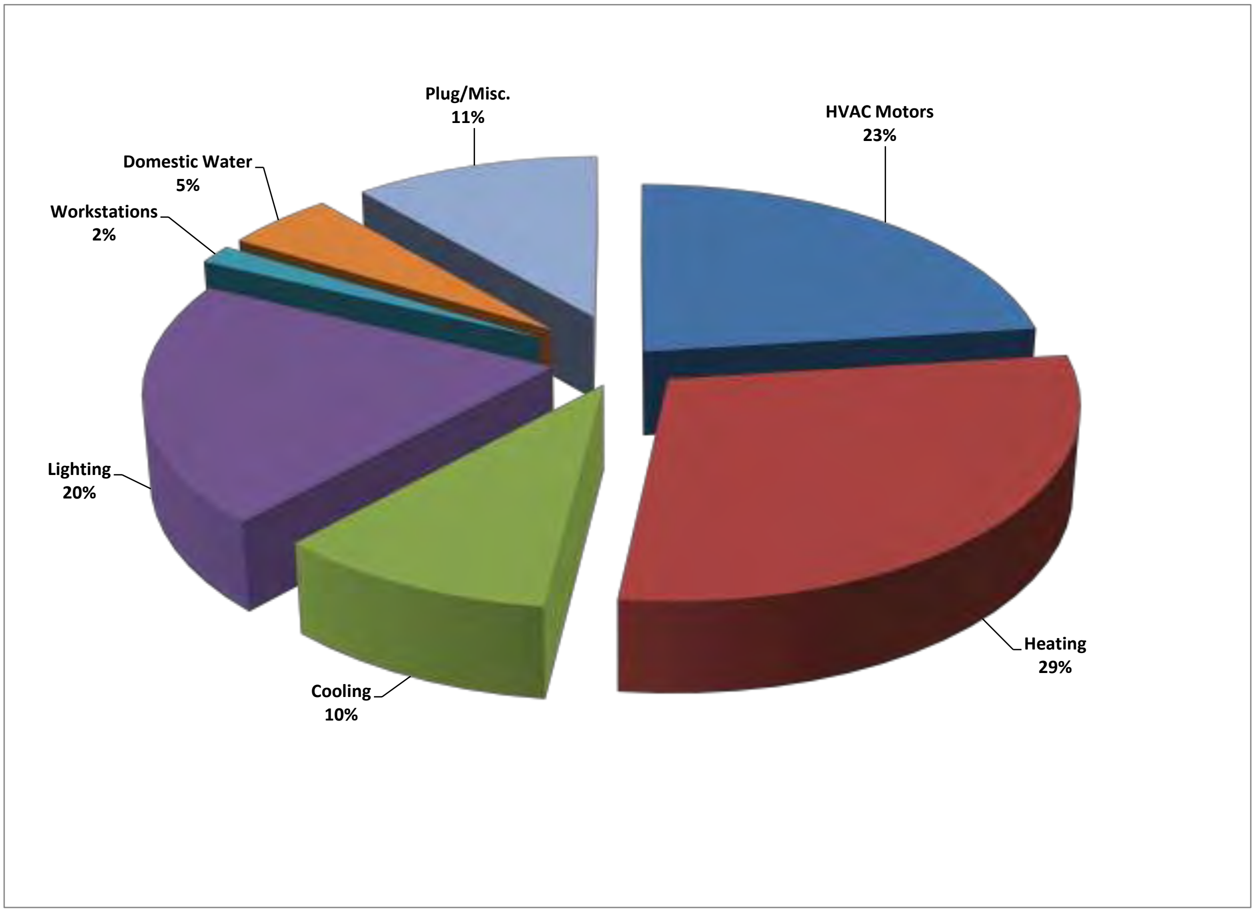

Figure 47: Morris Lawrence end use

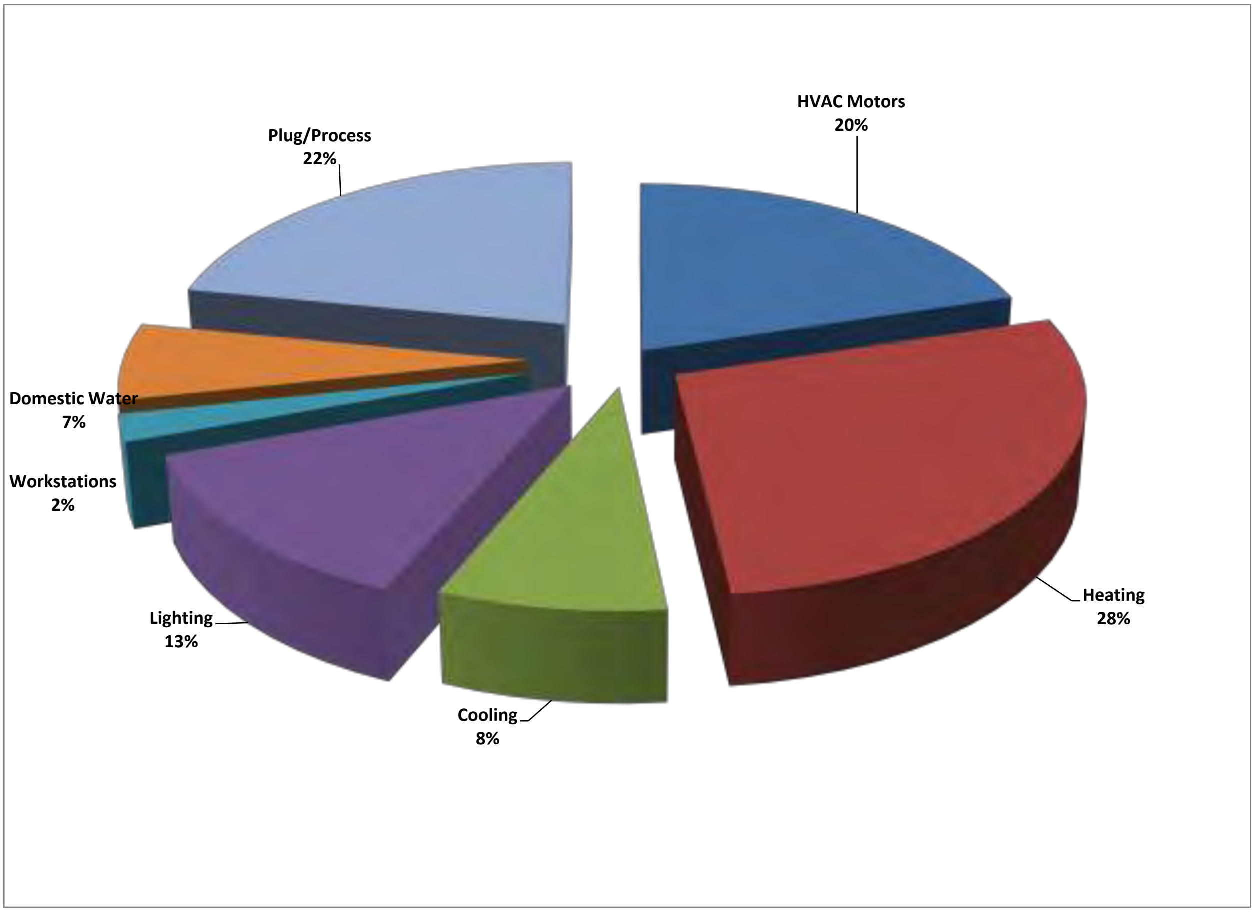

Figure 48: Larry Whitworth Occupational Education Building end use

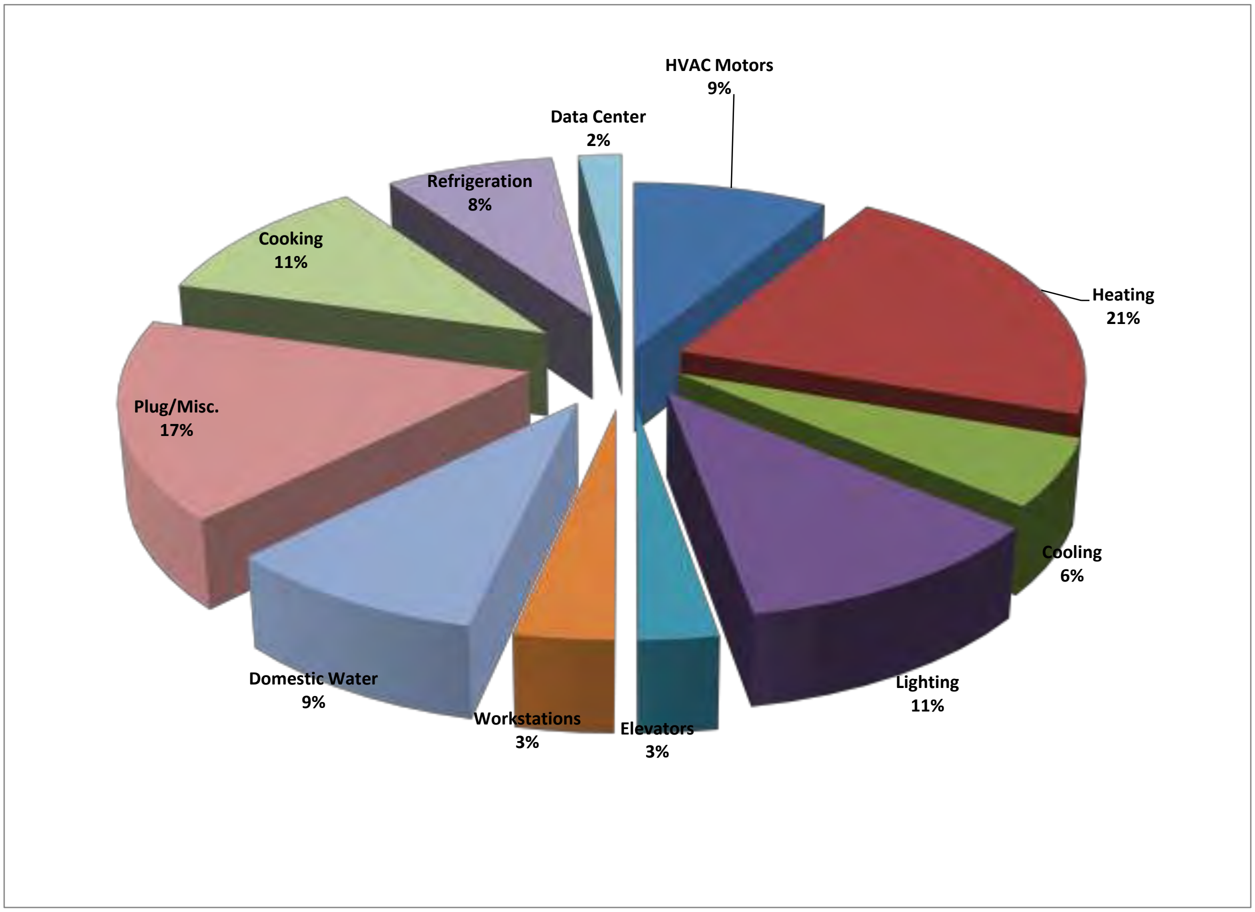

Figure 49: Student Center end use

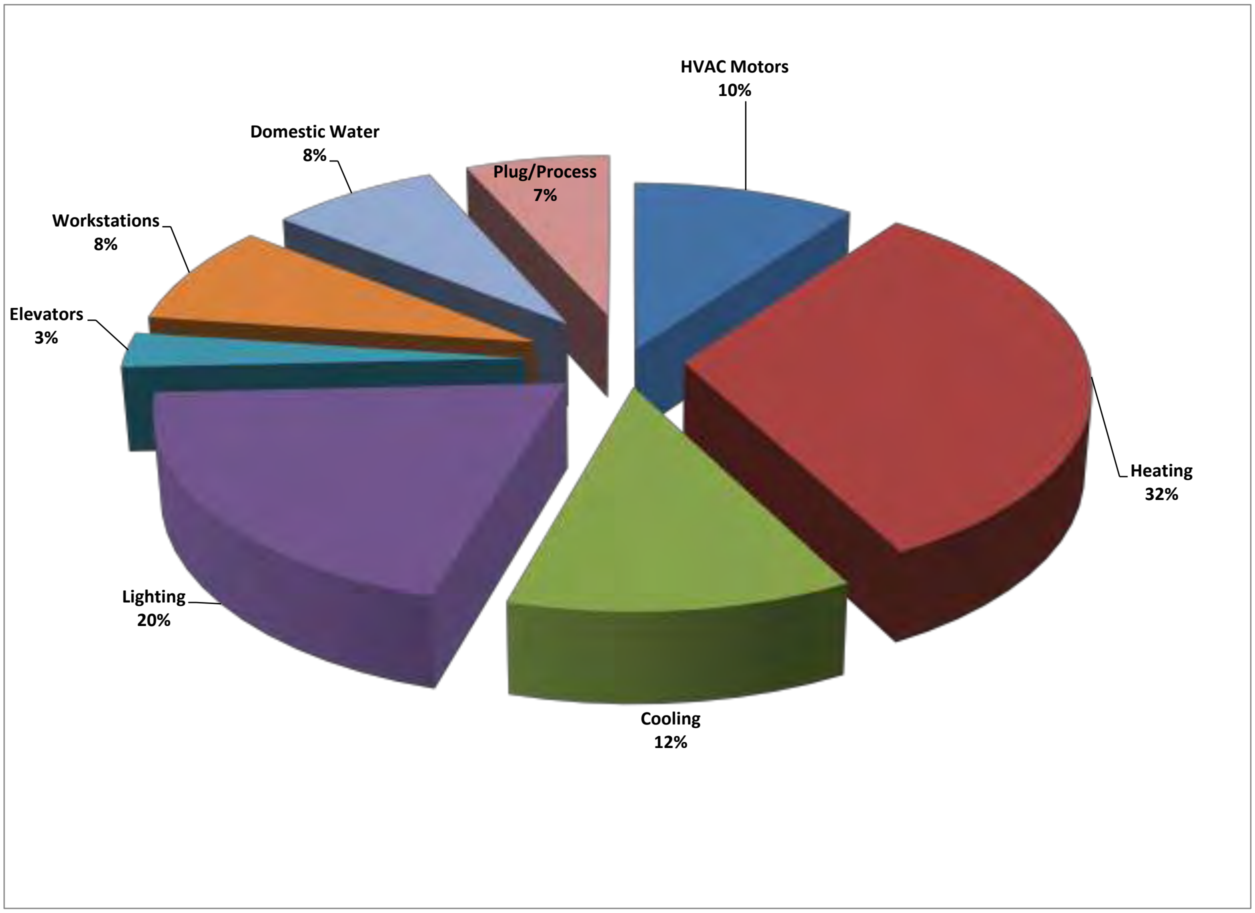

Figure 50: Technical & Industrial end use

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