Energy Conservation and Demand Management Plan

Draft Submission Copy

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Executive Summary

On January 1st, 2012, the Energy Conservation and Demand Management Plans Regulation (O. Reg. 397/11) came into effect under the Green Energy Act 2009. The regulation requires public agencies, including universities, to report their annual energy consumption and greenhouse gas (GHG) emissions as well as to implement an Energy Conservation and Demand Management Plan (ECDMP) beginning in 2014. These plans are required to be reviewed and updated every 5 years.

This University of Windsor ECDMP will serve as a guide to better understand its energy usage, educate its community (including students, faculty and staff) and identify strategies for reducing energy consumption and corresponding greenhouse gas (GHG) emissions. Conserving energy will not only aid the University in realizing a reduction in waste, but also lower operating costs. Additionally, this comprehensive plan contributes to the development of a larger foundation and framework that will ensure continuous sustainability integration throughout the University of Windsor campus and community.

The ECDMP also ensures compliance to O. Reg. 397/11 and aids in providing a framework for communicating targets, planning for new and retrofit equipment and infrastructure installations, and monitoring progress in reducing energy demand.

This document is available on the University of Windsor public website. It is available in print or other formats to suit individual needs, upon request.

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Introduction

A.0 Institutional History

The University of Windsor (University of Windsor) is a public comprehensive and research university in Windsor, Ontario, Canada. It is Canada's southernmost university, and has approximately 10,000 full-time and part-time undergraduate students and over 3,000 graduate students. The University of Windsor has graduated more than 100,000 alumni.

The University of Windsor has nine faculties, including the Faculty of Arts, Humanities and Social Sciences, the Faculty of Education, the Faculty of Engineering, Odette School of Business, the Faculty of Human Kinetics, the Faculty of Law, the Faculty of Nursing, the Faculty of Science, and the Faculty of Graduate Studies. Through its faculties and independent schools, Windsor's primary research interests focus on automotive, environmental, and social justice research, yet it has increasingly began focusing on health, natural science, and entrepreneurship research.

The University dates to the founding of Assumption College in Windsor, Ontario in 1857. Assumption College, a primarily theological institution, was founded by the Basilian Fathers of the priestly teaching Congregation of St. Basil, in 1857. The college grew steadily, expanding its curriculum and affiliating with several other colleges over the years. In 1919, Assumption College in Windsor affiliated with the University of Western Ontario. Originally, Assumption was one of the largest colleges associated with the University of Western Ontario. Escalating costs forced Assumption University (a denominational university) to become a public institution to qualify for public support. It was granted university status in 1953.

In the early 1960s, the City of Windsor's growth and demands for higher education led to further restructuring. A petition was made to the Province of Ontario for the creation of a non-denominational University of Windsor by the board of governors and regents of Assumption University and the board of directors of Essex College. The University of Windsor came into existence through its incorporation under an Act of the Legislative Assembly of Ontario on December 19, 1962. The transition from an historic Roman Catholic university to a non-denominational provincial university was an unprecedented development. On July 1, 1963, the entire campus with all its facilities and faculty became known as the University of Windsor.

From 1967 to 1977, University of Windsor grew from approximately 1,500 to 8,000 full-time students. In the 1980s and early 1990s, this growth continued. Among the new buildings erected were the Odette Business Building and the CAW Student Centre.

The university has developed a number of partnerships with local businesses and industry, such as the University of Windsor/Fiat-Chrysler Canada Ltd. Automotive Research and Development Centre, the only one of its kind in North America.

A.1 Academics

University of Windsor offers more than 120 majors and minors and 55 master's and doctoral degree programs across nine faculties:

- Faculty of Arts, Humanities & Social Science
- Faculty of Education
- Faculty of Engineering
- Odette School of Business
- Faculty of Human Kinetics
- Faculty of Law
- Faculty of Nursing
- Faculty of Science
- Faculty of Graduate Studies

University of Windsor also provides Inter-Faculty Programs offering cross-departmental majors like Forensics, Environmental studies and Arts & Science concentration. There are nine cooperative education programs for 1,100 students.

A.2 Campus

Located in Canada's traditional "automotive capital" across the border from Detroit, the campus is situated near the United States and its busy port of entry to and from the United States. It is framed by the Ambassador Bridge to the west and the Detroit River to the north.

The campus covers 51 hectares (130 acres) (contiguous) and is surrounded by a residential neighborhood. The campus features a small arboretum, which represents most of the species from the Carolinian forest, and is approximately a 10-minute drive from downtown Windsor. The University has moved some academic programs to the downtown core, including Social Work and the Executive and Professional Education program. Music and Fine Arts will follow by early 2018.

The CAW Student Centre has a view of the Ambassador Bridge, and houses a food court and the campus bookstore. Also within the CAW Centre: Student Health Services, a dental office, counselling services, a photographer, a pharmacy, the University of Windsor Students' Alliance (UWSA), a Multi-Faith Space, the campus community radio station CJAM-FM, and an information desk.

The St. Denis Centre, located at the south end of campus on College Avenue, is the major athletic and recreational facility for students. It has a weight room, exercise facilities, and a swimming pool. The new South Campus Stadium built for the 2005 Pan-American Junior Games is beside the St. Denis Centre - which also has dressing rooms for Lancer teams - and borders Huron Church Road, the major avenue to and from the border crossing.

Energy Conservation and Demand Management

B.0 Introduction

At the University of Windsor, the Facility Services department, along with the Environmental Sustainability Advocate, are actively involved in campus sustainability initiatives and leads the development and implementation of this ECDMP. They are also responsible for all related reporting under O. Reg. 397/11. Under this regulation all broader public sector (BPS) organizations, including Universities, are required to:

- Prepare, publish, make available to the public and implement energy conservation and demand management plans or joint plans in accordance with sections 6 and 7 of the Act and with this Regulation. O. Reg. 397/11, s. 4 (1).
- An energy conservation and demand management plan is composed of two parts as follows:
  - A summary of the public agency's annual energy consumption and greenhouse gas emissions for its operations.
  - A description of previous, current and proposed measures for conserving and otherwise reducing the amount of energy consumed by the public agency's operations and for managing the public agency's demand for energy, including a forecast of the expected results of current and proposed measures. O. Reg. 397/11, s. 4 (2)

All reports and submissions are available on the University of Windsor website (uwindsor.ca/sustainability). In addition, the ECDMP and its energy conservation efforts were presented to the Vice President, Planning and Administration, for approval. As required under O. Reg. 397/11, approval by senior management for this ECDMP is documented in Appendix B.

B.1 Energy Conservation Goals

A. Energy Intensity

Under O. Reg. 397/11, public agencies are required to develop goals and objectives for conserving and otherwise reducing energy consumption and managing demand for energy. At University of Windsor, the ECDMP is an evolving document built on several proposed technical, organizational and behavioral measures. The measures aimed at conservation are based on a number of factors including organizational gaps and needs, current consumption, available funding, incentives from local utility companies, existing infrastructure, new technologies, etc. Over the next 5 years, University of Windsor aims to reduce overall energy intensity across campus by 5% (as compared to 2011 baseline) and to foster a stronger sense of sustainability in the organizational culture.

B. Greenhouse Gas Emissions

As part of its action against climate change, Ontario has become the first province in Canada to set a mid-term greenhouse gas (GHG) pollution reduction target for 2030. The long-term target for the province is to reduce emissions by 80 percent below 1990 levels by 2050.

In order to help achieve its long-term target, the province is committing to a new mid-term target to reduce emissions by 37 percent below 1990 levels by 2030. The province uses 1990 as a baseline year for its targets, which is common in the international community and aligns with the United Nations Framework Convention on Climate Change.

The University of Windsor fully supports the provincial targets. Over the next 5 years, University of Windsor aims to reduce overall GHG emissions across campus by 5%.

B.2 Sustainability Strategy

A. Overview

Recognizing that energy conservation and carbon neutrality are moving targets where technology and applications are ever changing and improving, University of Windsor has adopted an integrated sustainability approach. Through Facility Services department, resources are dedicated to the ongoing integration, performance measuring and reporting of sustainability initiatives.

Facility Services has led the development of the ECDMP, which will highlight current practices and target future actions that will influence the quantity, or patterns, of energy consumed by the University of Windsor. Our five-year strategy will focus on energy use reduction while also considering renewable and other on-site generation applications.

B. Alignment with Strategic Mandate Agreement

The University's SMA identifies the student experience as one of our top priorities. The student experience is greatly impacted by the facilities that students occupy. Enhancing the facilities with improved lighting, ventilation, and other energy efficiency measures will improve the student experience.

The University is undergoing a significant capital transformation as the University knows that the conditions of the interior and exterior spaces that campus stakeholders use impacts their experience.

This plan being proposed fully aligns with the University's SMA and is a key next step in the capital transformation of campus.

C. Categories

The University of Windsor has divided its five-year strategy for the ECDMP into three primary categories – Efficient Buildings, Efficient Energy Sources & Distribution, and Renewable Energy.

In addition, two secondary categories were also included - Future Technology and Demand Management. Future Technology is focused on potential future technologies to assist the University achieve the mandated long-term target to reduce GHG emissions below 1990 levels by 37 percent by 2030 and 80 percent by 2050, and Demand Management discusses options for the University to participate in the IESO's Industrial Conservation Initiative (Class A Global Adjustment).

D. Efficient Buildings

The Efficient Building category is divided into three primary action items:

1. Connect all buildings to central energy distribution systems.
2. Retrofit and optimize buildings for energy efficient operation.
3. Perform continuous monitoring, targeting, and commissioning, to ensure best-in-class performance is maintained at all times.

The University recognizes that their energy efficiency efforts must start with ensuring that the buildings on campus, which are the primary energy consuming loads, are utilizing the minimum amount of net energy possible. The pinnacle of energy efficiency for buildings is known as a zero-energy building, also known as net zero building. This is defined as buildings with zero net energy consumption, meaning the total amount of energy used by the buildings on an annual basis is roughly equal to the amount of renewable energy created on the site.

Over the next 5 years, the University is planning to systematically address the energy efficiency of their buildings by executing projects that will lower total building energy consumption, while simultaneously improving the student experience. The typical types of projects that the University expects to undertake will address the following three key building systems: lighting, HVAC and building envelope. More detail about these specific ECMs can be found in Section C of this plan.

The University submitted two applications for the Greenhouse Gas Retrofits Program (GGRP), as offered by the Ministry of Advanced Education and Skills Development (MAESD) in December 2017 and January 2018. The scope of these projects is to perform major retrofits of the lighting, HVAC, and building envelope on two of the largest buildings on campus - Human Kinetics Building and St. Denis Athletic & Community Centre, and Essex Hall. The University has also identified the Chrysler Hall/Tower complex, as well as the Biology Building, as the next targets for synergistic deep energy efficiency retrofits.

E. Efficient Energy Sources & Distribution

The Efficient Energy Sources & Distribution category is divided into three primary action items:

1. CHP Optimization
2. Steam System Optimization
3. Chilled Water System Optimization

1. CHP Optimization

The University recognizes that that for at least the next decade their existing 4 MW CHP facility will be a key part of their operation to provide efficient and cost-effective electrical and thermal energy to the campus. The primary benefits the CHP provides are:

- Decreased energy costs
- Enhanced energy resiliency
- Reduced risk from uncertain energy prices
- Increased economic competitiveness

Given that the CHP is a key part of the University's energy plan, it is critical that it is operated and maintained in a pristine manner, and has as many modern features installed that make sense from both an efficiency and economic perspective. These features may include but are not limited to:

- Higher efficiency turbine
- Duct burner(s)
- Condensing economizer
- Natural gas pre-heating
- Inlet air cooling
- Water injection
- Steam expander

2. Steam System Optimization

The steam system on the University's main campus provides thermal energy to most of the major buildings for the purposes of space heating and domestic hot water. It is realized by the University that if the campus was built to today's standard, it would be very unlikely to utilize steam for thermal energy distribution, and that it would likely be replaced by a medium or low temperature hydronic system. The potential of replacing the steam system with a hydronic system for the campus will be investigated over the next few years. In the meantime, the University will be ensuring their existing steam system is optimized, including but not limited to the following measures:

Steam Generation

- Check feedwater quality and implement correct feedwater treatment
- Optimize the boiler blowdown and recover the blowdown heat
- Boiler insulation
- Optimize the furnace draft
- Prepare and follow best operating and maintenance practices

Steam Distribution

- Correct pipe sizing
- Insulation
- Correct drain pockets
- Leaks
- Correct steam distribution pressure
- Air venting
- Correct steam trapping
- Shutdown & layup of main campus steam distribution system in summer

Steam Utilization

- Correct pressure/temperature control
- Correct steam trapping and air venting
- Trap health monitoring

Condensate Recovery

- Check the condensate recovery factor
- Correct design of condensate recovery system

3. Chilled Water System Optimization

The chilled water system on the University's main campus provides thermal energy to most of the major buildings for the purpose of air conditioning. It is understood that the chilled water system is the most efficient technology to provide cooling, as it can approach an efficiency of 0.5 kW/ton, compared to direct-expansion air conditioning systems which typically can only approach efficiencies of 1.0 kW/ton. Therefore, the chilled water system is expected to be part of the long-term future of the University's energy system.

Given the long-term future of the chilled water system, it is critical that it is operated and maintained in a pristine manner, and has as many modern features installed that make sense from both an efficiency and economic perspective. To accomplish this goal, during the second half of 2017 the University had two engineering studies completed on each of the chilled water generation systems located on campus, and is currently planning to proceed with a third engineering study in 2018 to assess the efficiency of the chilled water distribution system. It is forecasted that these engineering studies will result in one or more projects in the 2019 – 2022 timeframe to increase the efficiency of the chilled water system, including but not limited to the following measures:

- More efficient base load chillers
- Variable speed trim load chillers
- Improved coordination between chiller generation systems
- Variable speed pumps
- Upgraded instrumentation and controls
- Chilled water & condenser water temperature setpoint reset
- Piping reconfiguration

F. Renewable Energy

The Renewable Energy category is divided into five primary action items:

1. Solar Photovoltaic
2. Solar Air
3. Solar Thermal
4. Micro Wind
5. Heat Pumps

The University recognizes that in order to make progress towards 'net-zero' energy usage on the campus, renewable energy sources must be extensively utilized. One of the fundamental tenants of renewable energy is to consider that all of the sunlight that lands on the University's property, and all of the wind that blows across it, is an energy resource that can be tapped into. Practical technologies that currently exist which the University is studying for implementation include:

- Solar Photovoltaic
  - Solar panels on building roofs
  - Solar carports
  - Solar powered electric vehicle charging stations
  - Solar powered exterior lighting
- Solar Air
  - Solar walls (air preheating)
- Solar Thermal
  - Solar hot water
- Micro Wind Turbines

A heat pump is a device that transfers heat energy from a source of heat to a destination called a "heat sink". Heat pumps are designed to move thermal energy in the opposite direction of spontaneous heat transfer by absorbing heat from a cold space and releasing it to a warmer one. A heat pump uses a small amount of external power to accomplish the work of transferring energy from the heat source to the heat sink.

Heat pumps have two primary technologies – ground-sourced and air-sourced. Heat pumps are typically considered to be a hybrid renewable energy source, as they require external power to operate, usually in the form of electricity. However, they achieve higher overall efficiency than conventional heating and cooling systems because of their utilization in the difference in temperature between the setpoint for HVAC systems and the ground or air.

The University has previously had a ground-sourced heat pump system on a now demolished building. Their experience with it was less than ideal, due to the relatively shallow location at which the bedrock is located under Windsor. Due to this, the system required a greater number of pipes to be installed at a shallower depth, which increased the cost of the system and decreased its efficiency. It is not forecasted that ground-sourced heat pumps will be utilized by the University in the future.

Air-sourced heat pump technology has been greatly improved over the last 15 years, and now offers competitive efficiencies and installation costs. Units with a positive COP at an air temperature as low as -30C are available. In Japan, over 40% of medium and large size commercial buildings are exclusively heated with air-sourced heat pumps, primarily due to the fact that Japan must import virtually all of their fossil fuels. Therefore, they utilize nuclear power plants to produce electricity to power the heat pumps, in order to reduce their fossil fuel consumption.

The University has the potential to provide a vast majority of the heating thermal energy required for the campus with air-sourced heat pumps. Given that the electricity produced for Ontario's grid contains a small percentage of fossil fuel generation, air-sourced heat pumps have the ability to allow the University to significantly reduce its GHG emissions. However, the installation, operational and maintenance costs will be significantly higher than fossil fuel based heating. Further details about this trade-off can be found in section D, 'Obstacles and Challenges'.

G. Future Technology

The University understands that in order to achieve the mandated long-term targets to reduce GHG emissions by 37 percent below 1990 levels by 2030, and 80 percent below 1990 levels by 2050, that forecasting and predictions about potential future technology need to be included in this ECDMP.

The Future Technology category is divided into four primary action items:

1. Electric Vehicles
2. Battery Storage
3. District Energy
4. Nuclear Power

1. Electric Vehicles

The University recognizes that electric vehicle (EV) technology is maturing at a rapid rate, and that the two key opportunities exist to capitalize on the ongoing deployment:

- Install publicly accessible charging stations
  - Installing EV charging stations will encourage the students and staff of the University to purchase and utilize EVs in lieu of vehicles powered by fossil fuels. This will lead to a reduction in the indirect amount of GHG emissions generated for transportation associated with the University.
- Replace fleet vehicles with EVs and install private charging stations
  - The University could replace all of their fleet vehicles with EVs. Given the compact nature of the main campus, and the short 3km distance to their buildings in the downtown core, EVs are considered to be very practical for the University. This will lead to a reduction in the direct amount of GHG emissions generated for transportation by the University.

2. Battery Storage

There have been great advances in battery storage technology in the last 10 years, and the progress is continuing to increase the storage density and reduce the cost of these products. The primary function of these systems is to allow for energy to be stored when it is available but not immediately required, then utilizing the energy when demand is high.

Examples of systems where the University could utilize battery storage are:

- Solar powered exterior lighting
- Replacement of diesel & natural gas backup generators with batteries
- Pairing of batteries with Solar Photovoltaic and/or Micro-Wind systems
- Grid-scale battery storage system for entire campus

The University has great interest in battery storage, and will be exploring opportunities for implementation over the next 5 years.

3. District Energy

District energy is the production and supply of thermal energy. Hot water or steam, and chilled water, are produced at central plants and distributed to surrounding buildings via a closed-loop underground distribution system known as a thermal grid. The thermal energy delivered to the buildings is used for space heating, domestic hot water heating and air conditioning. Buildings connected to the thermal grid do not need their own boiler or furnaces, chillers or air conditioners. Commercial buildings, condominiums, hotels, sports facilities, universities, and government complexes are all examples of buildings commonly connected to a thermal grid.

District energy is not a new concept. Its origins stem from the hot water-heated baths and greenhouses of ancient Rome. Today, it is an internationally accepted method of heating, cooling and powering communities. In some European countries, such as Denmark, district energy is mandated. In Canada, a number of communities have operated district energy systems for many decades. The oldest system is in London, Ontario dating back to 1880. In Ontario, district energy systems are currently operating in Toronto, Ottawa, London, Markham, Hamilton, Sudbury, Cornwall, and Windsor. The University of Windsor already has their own district energy system, which comprises of the steam and chilled water systems which distribute thermal energy to most of the buildings on the main campus.

The Community Energy Plan developed by the City of Windsor indicated a potential opportunity for a city-wide district energy system. The plan envisions first connecting the University's system to the existing system in the downtown core, run by the Windsor Utilities Commission. Next, the system would be expanded to connect to St. Clair College, Ford Windsor site, and FCA Windsor Assembly Plant. By doing so, greater coverage area and overall efficiency could be attained by integrating residential, commercial and industrial buildings onto a single system.

Further investigations into the potential an integrated district energy system will be considered.

4. Nuclear Power

The University see the potential application of nuclear power technology to allow them to self-generate most or all of their electrical and thermal energy needs. Small modular reactors are a type of nuclear fission reactor which are smaller than conventional reactors, manufactured at a plant, and brought to a site to be fully constructed. Modular reactors allow for less on-site construction, increased containment efficiency, and heightened nuclear materials security.

The technology needed to implement small modular reactors has been successfully demonstrated. However, there is currently no regulatory or licensing mechanism available in Canada to allow for this type of reactor to be constructed or operated. The University could explore this option if the regulatory environment changes in the future.

H. Demand Management

The University's average electrical demand from the grid exceeds 1 MW, therefore they are eligible to participate in the Industrial Conservation Initiative (ICI) as offered by the Independent Electricity System Operator (IESO).

The Industrial Conservation Initiative (ICI) is a form of demand response that allows participating customers to manage their global adjustment (GA) costs by reducing demand during peak periods. Customers who participate in the ICI, referred to as Class A, pay GA based on their percentage contribution to the top five peak Ontario demand hours (i.e. peak demand factor) over a 12-month base period.

Ontario`s electricity system is built to meet the highest demand periods of the year. By reducing demand during peak periods, ICI participants can both reduce their global adjustment costs and help defer the need for investments in new electricity infrastructure that would otherwise be needed. In 2016, ICI is estimated to have reduced peak demand by 1,300 MW.

The University is currently not participating in the ICI, therefore their electricity billing rate is calculated as a Class B customer. Under Class B, the rate the University pays for electricity is based on their total monthly energy usage (kWh), with their demand during the peak periods having no effect.

Based on a high-level review of the University's energy systems, load profile, and generation capacity of the existing CHP, it is forecasted that there may be potential for the main campus of the University to participate in the ICI through the design and installation of specific systems, controls and measures to allow for the lowering of the demand of the campus during peak periods. This would likely result in a reduction of the average cost per kWh of electricity, and a coincident reduction in third party GHG emissions as during peak periods as the majority of the grid peak demand power is supplied by natural gas fired generation units.

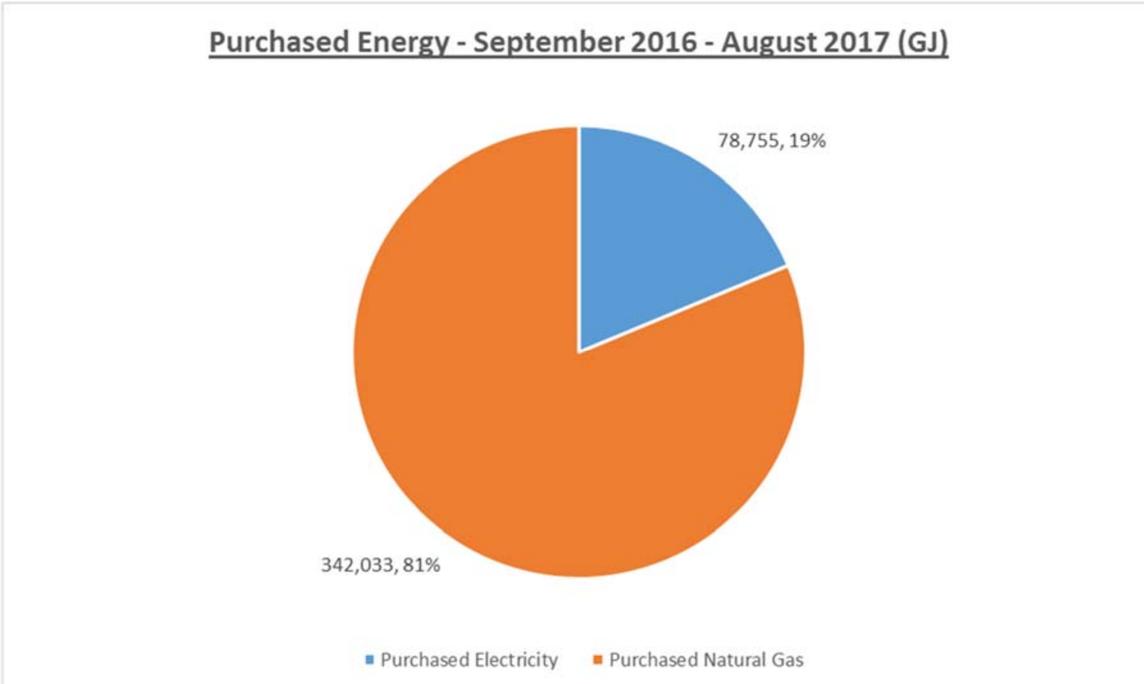
The specific items the University plans to investigate to allow them to control and reduce the peak demand of the main campus during peak periods is as follows:

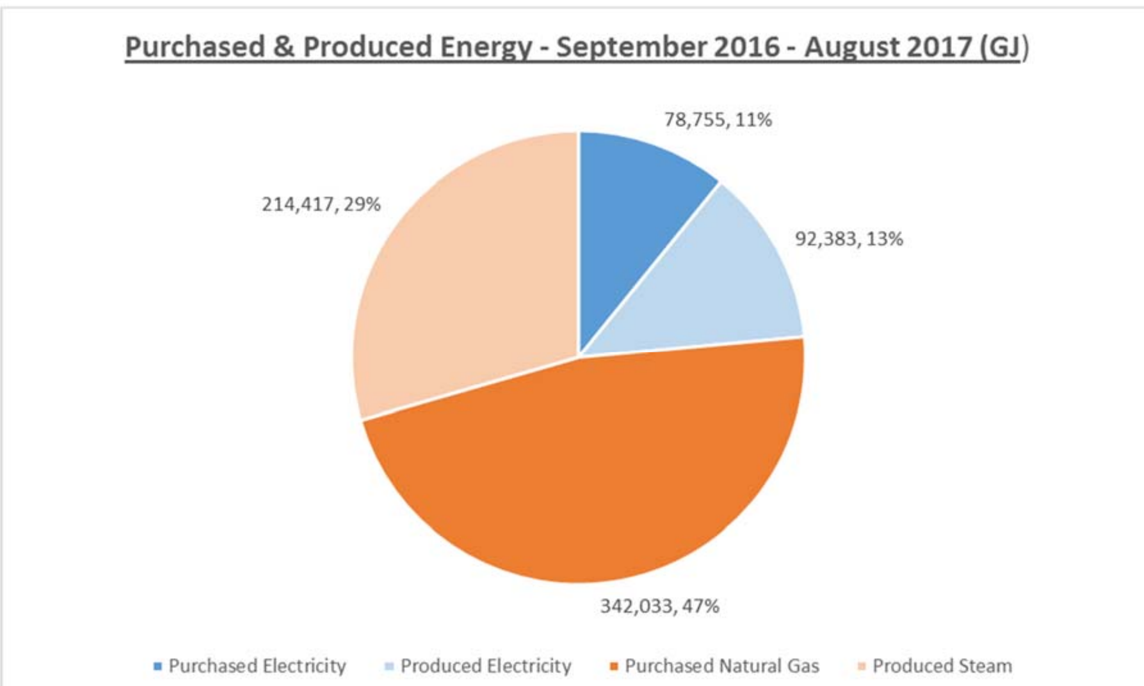
1. Maximization of CHP output
2. Chilled Water Storage Tanks
3. HVAC Curtailment & Setback
4. Lighting Controls
5. Battery Storage

B.3 Energy Consumption Review

A. Overview

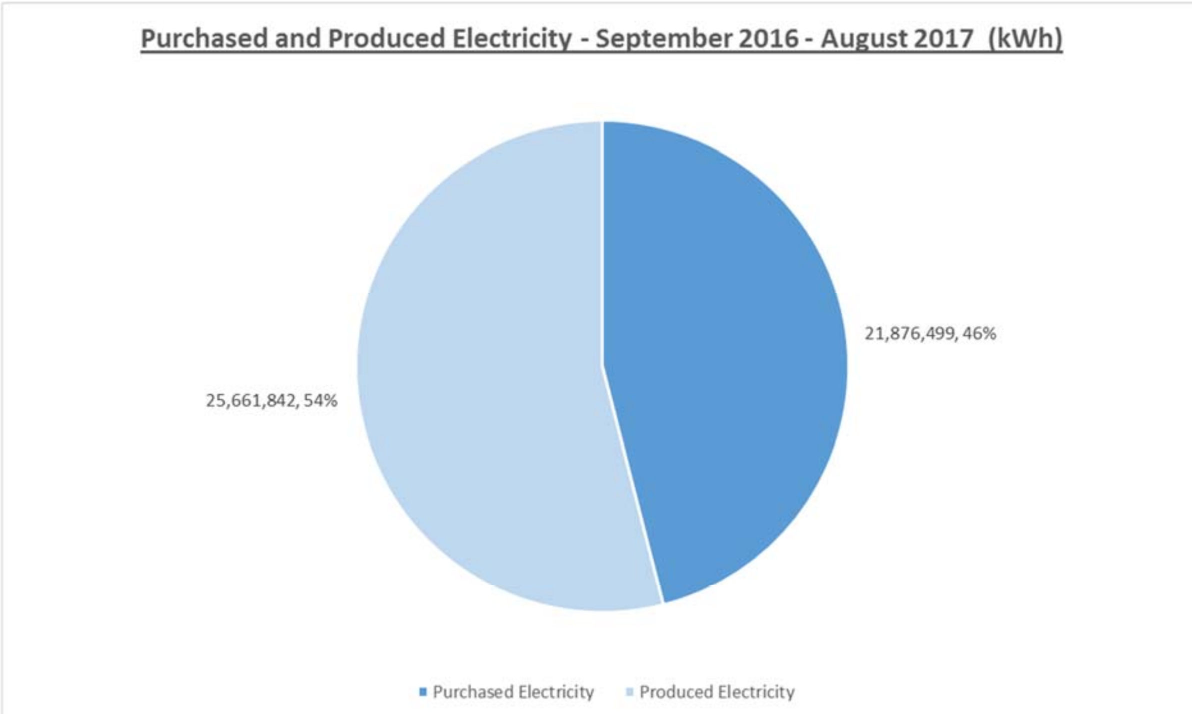
The purchased and produced total energy for the University of Windsor main campus for a 12-month period is shown graphically below:

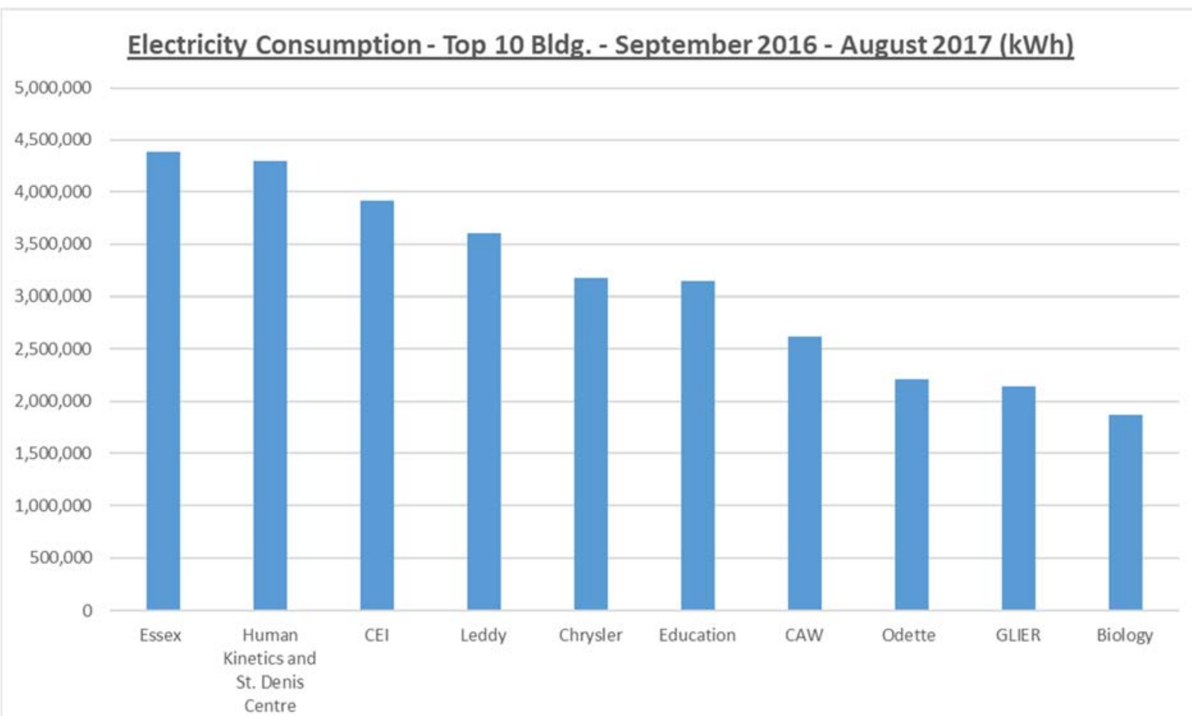




B. Electricity

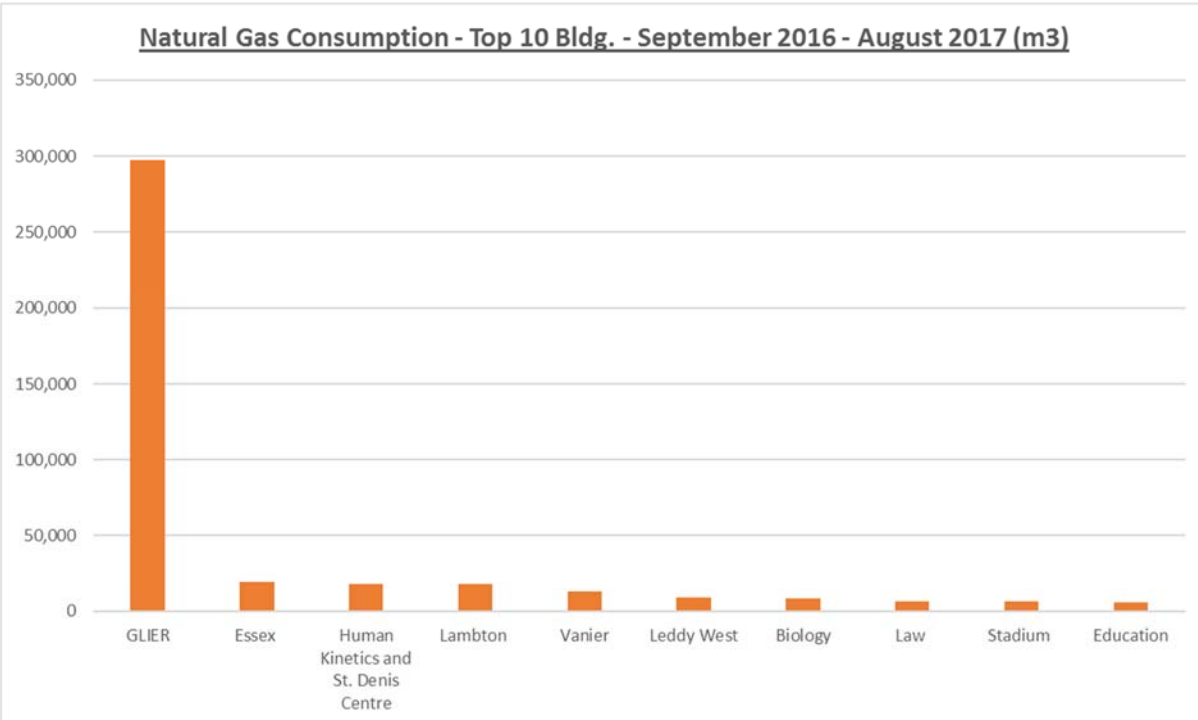
The purchased and produced electricity and the Top 10 buildings for the University of Windsor main campus for a 12-month period is shown graphically below: (*Excludes ECC & CRP)





C. Natural Gas and Steam

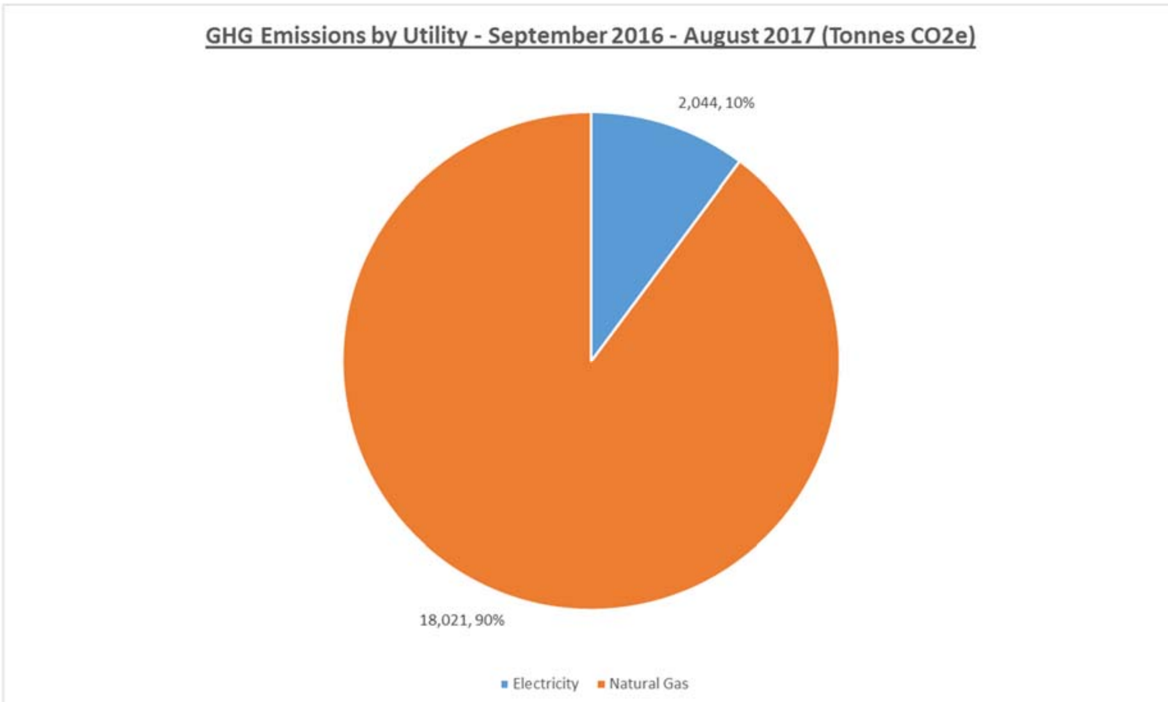
The natural gas and steam consumption for the Top 10 buildings for the University of Windsor main campus for a 12-month period is shown graphically below: (*Excludes ECC & CRP)

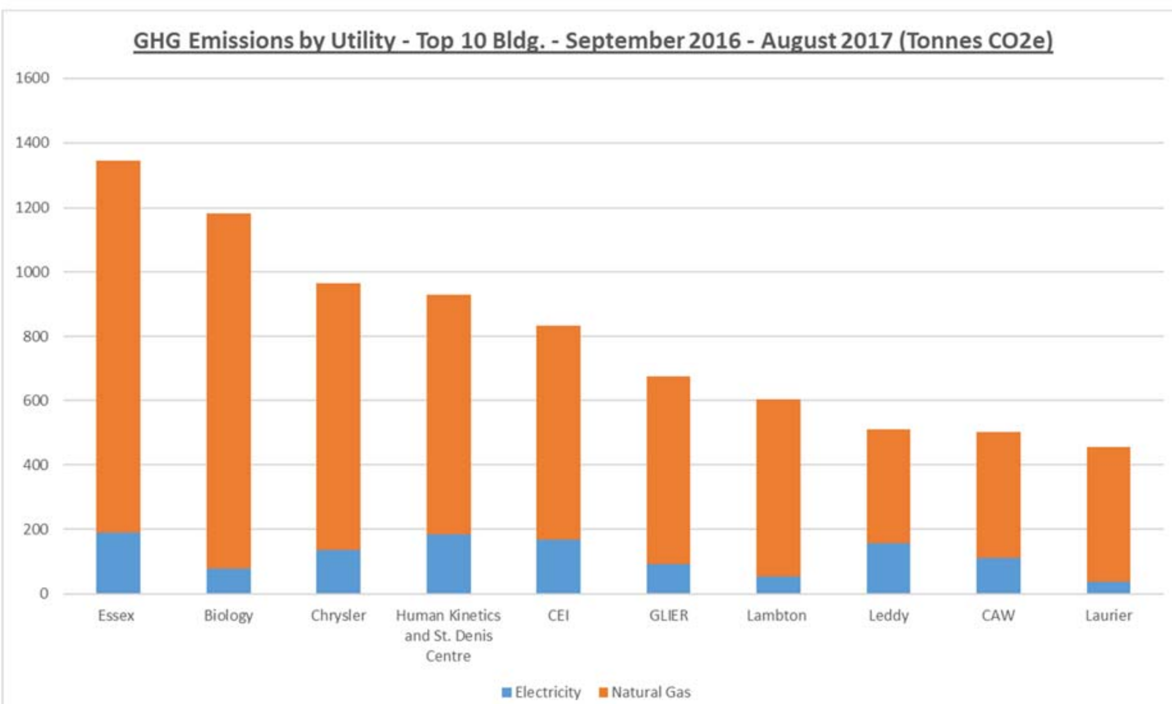


B.4 Greenhouse Gas Emissions Review

A. Overview

The total GHG emissions for utilities at the University of Windsor main campus, and the Top 10 GHG emitting buildings for a 12-month period are shown graphically below:





Energy Conservation Measures

C.0 Overview

Based on discussions with University of Windsor operations and technical staff, as well as a review of the design and condition of the buildings on campus, the following list of energy conservation measures (ECM)s were selected to be discussed in further detail. These ECMs are representative of the typical projects for the campus buildings that the University is considering for implementation over the next 5 years that will result in both energy usage reductions and GHG emissions reductions:

C.1 – LED Lighting and Controls

C.2 – HVAC Retro-commissioning

C.3 – HVAC Controls

C.4 – HVAC Retrofits

C.5 – Building Envelope Upgrades

C.1 ECM – LED Lighting and Controls

A. Overview

Indoor and outdoor lighting systems need to provide the right amount of light, at the right time, using the minimal amount of energy.

B. Specifics

LED lighting is the most efficient lighting technology currently available. In addition to being efficient, it also has a longer life compared to previous lighting technology, which reduces ongoing maintenance costs.

The University currently has a mix of different types lighting installed, other than LED, including incandescent, fluorescent and metal halide. The detailed action items are:

- High Efficiency Lighting Systems (e.g., LED)
  - Replace all non-LED lighting with LED lighting that, at a minimum, is a listed product by the DesignLights Consortium® (DLC).
- Controls and Sensors
  - Install, upgrade and commission lighting controls to minimize energy usage, including ones based on but not limited to scheduling, occupancy, daylight harvesting, multi-level switching, and manual dimming.

C.2 ECM – HVAC Retro-commissioning

A. Overview

HVAC systems need to provide efficient temperature control and the right amount of fresh air, at the right time, using the minimal amount of energy.

B. Specifics

Retro-commissioning is a process to improve the efficiency of an existing building's equipment and systems. It can often resolve problems that occurred during design or construction, or address problems that have developed throughout the building's life as equipment has aged, or as building usage has changed. Retro-commissioning involves a systemic evaluation of opportunities to improve energy-using systems. In addition to improving energy efficiency, retro-commissioning of HVAC equipment also typically improves the indoor air quality.

The typical kinds of problems that retro-commissioning will identify and fix include:

- Equipment that is on when it may not need to be
- Systems that simultaneously heat and cool
- Belts and valves that are not functioning properly
- Thermostats and sensors that are out of calibration
- Air balancing systems that are less than optimal
- Economizers that are not working as designed
- Controls sequences that are functioning incorrectly
- Variable-frequency drives that operate at unnecessarily high speeds or that operate at a constant speed even though the load being served is variable

The key project steps to implement retro-commissioning are:

1. Review existing systems and related documentation
2. Develop retro-commissioning plan
3. Perform calibration and maintenance checks
4. Implement diagnostic monitoring/trending
5. Perform functional tests
6. Analyze the monitoring/trending and test data
7. Assess and document the current operating strategies and sequences of operation for all systems and equipment included
8. Document operations and maintenance improvement opportunities
9. Calculate energy impacts and develop implementation cost estimates for operations and maintenance opportunities
10. Develop and deliver the final retro-commissioning report

C.3 ECM – HVAC Controls

A. Overview

HVAC systems need to provide efficient temperature control and the right amount of fresh air, at the right time, using the minimal amount of energy.

B. Specifics

The HVAC system for buildings can be broken into two major components – mechanical equipment and controls. If the mechanical equipment is well designed and integrated into the building, and is modern, efficient and has useful service life remaining, then upgrading or replacing the HVAC controls can be the best option for improving the overall energy efficiency. The detailed action items are:

- CO2-Based Demand Ventilation
- Controls for Entrance Heaters
- Building Automation Systems – New or Upgrades, and/or reprogramming software
- Real-time Energy Monitoring – Meters and software

C.4 ECM – HVAC Retrofits

A. Overview

HVAC systems need to provide efficient temperature control and the right amount of fresh air, at the right time, using the minimal amount of energy.

B. Specifics

The HVAC system for buildings can be broken into two major components – mechanical equipment and controls. If the mechanical equipment is poorly designed by today's standards building, or is obsolete, inefficient and is past its useful service life, then consideration must be given to performing comprehensive HVAC retrofits, including the following detailed action items:

- Heat Recovery / Enthalpy Wheels for Ventilation
- Economizers
- High Efficiency HVAC Systems
- High Efficiency Rooftop and MUA units
- Heating System Upgrade (e.g. forced air to radiant heating)

C.4 ECM – Building Envelope Upgrades

A. Overview

Buildings envelopes need to provide the highest possible insulative and air sealing performance available to minimize the amount of thermal energy lost.

B. Specifics

The building envelope is the primary interface with the external environment. It is the physical separator between the conditioned and the unconditioned environment of a building; the design and construction of the exterior of a building including the resistance to air, water, heat, light and noise transfer. It also includes the broader aspects of appearance, structure, safety from fire and security.

A good building envelope involves using exterior wall materials and designs that are climate-appropriate, structurally sound and aesthetically pleasing. The three basic elements of a building envelope are weather, air and thermal barriers. The building envelope consists of a building's roof, sub floor, exterior doors, windows and the exterior walls.

The external environment is very dynamic. People want the internal environment to be constant. To create a good building with low energy and high comfort for its occupants, designs rely first on the envelope and second on the services. The detailed action items are:

- Energy Efficient Windows/Doors/Skylights (e.g. lower thermal conductivity fenestration)
- Air sealing projects
- Green Roof
- New Roof (with high insulation factors)
- Passive Building Strategies (e.g. solar sun shading)
- Increased Wall & Roof Insulation (with increased air tightness)

Obstacles and Challenges

D.0 Overview

Based on discussions with University of Windsor operations and technical staff, as well as a review of the design and condition of the buildings on campus, the following list of obstacles and challenges were selected to be discussed in detail:

D.1 – Funding for Capital Projects

D.2 – Long Term Plan for Existing CHP

D.3 – Economics and GHG Emissions of Natural Gas versus Electricity

D.1 Funding for Capital Projects

A. Overview

The capital funding available for projects that improve energy efficiency and GHG emissions is forecasted to lag behind demand.

B. Specifics

The University of Windsor, like many other post-secondary institutions in Ontario, has a large inventory of buildings that are more than 20 years old, and limited capital funds to perform campus wide or synergistic deep retrofit projects to the buildings to improve their energy efficiency.

It is expected that the cost of energy will increase faster than the rate of inflation, and as the cost of energy increases, more projects will be viable from a financial perspective (return on investment). However, this may not occur quickly enough to insulate the University from energy price spikes, or reach the mandated GHG emission reduction targets.

In order to address this challenge, the Facility Services department will strive to create a 7 to 10 year energy efficiency investment plan for the University, with the goal being to have the plan approved and funded by the Board of Governors, as well as utilizing all sources of outside funding available including government grant programs and utility incentives.

D.2 Long Term Plan for Existing CHP

A. Overview

The operation of the existing 4 MW CHP at the University produces positive financial results, but conflicts with the ongoing efforts to reduce total GHG emissions.

B. Specifics

The 4 MW CHP, installed in the mid-1990s and operated nearly continuously since then, produces a significant amount of the electricity and thermal energy for the main campus at an overall efficiency greater than grid-purchased electricity and thermal energy from the boilers. In addition, it also lowers the University's overall utility costs, as the 'spark-spread' between natural gas generation and purchasing electricity has been favorable almost the entire period it has been in operation.

However, with Ontario now entering a 'Cap and Trade' market for GHG emissions, the long-term operation of the CHP is at risk. Of the approximately 27 kT of GHG emissions the University produces each year, approximately 17 kT (63%) is a result of the natural gas used in the CHP turbine. In order to make the mandated target of 37% percent total GHG emission reductions by 2030, the CHP will need to be maintained at peak performance levels, and upgraded with modern features. It may also need to be operated intermittently, rather than continuously, which will allow the University to reduce its GHG emissions while still producing a positive financial benefit. To reap benefits from intermittent operation, the University would need to participate in the Industrial Conservation Initiative. More details about the ICI are in section of this plan titled 'Demand Management'.

By 2050, in order to achieve the 80% percent GHG emissions reduction target, it is unknown whether operation of the CHP will be feasible. Further research and planning is required over the next 5 years to understand how the CHP will be part of the University's long-term plans past 2030.

D.3 Economics and GHG Emissions of Natural Gas versus Electricity

A. Overview

The mandated GHG emissions reduction targets strongly imply moving away from natural gas as a fuel source, but the economics of doing so are not favorable at this time.

B. Specifics

Natural gas is a safe, clean burning and affordable fuel source. When combusted, it produces very low levels of nitrous oxides compounds, and virtually no sulfur oxides or particulates, unlike liquid or solid fossil fuels such as gasoline, kerosene, diesel, or coal. The primary emission from natural gas usage is carbon dioxide (CO_2), which is the most significant long-lived greenhouse gas in Earth's atmosphere. Since the Industrial Revolution, anthropogenic emissions – primarily from use of fossil fuels and deforestation – have rapidly increased its concentration in the atmosphere, leading to global warming. The CO_2 released into the atmosphere as a result of the use of fossil fuels "represents 99.4% of CO_2 emissions in 2013". Carbon dioxide also causes ocean acidification because it dissolves in water to form carbonic acid.

In an effort to reduce further GHG emissions, Ontario has joined the Western Climate Initiative, and has implemented a cap & trade program for GHG emissions in partnership with Quebec and California. Ontario's cap and trade program is a market-based system that sets a hard cap on greenhouse gas emissions while giving flexibility to businesses and industry in terms of how they meet their caps. The cap limits how many tonnes of greenhouse gas pollution businesses and institutions can emit. The cap drops each year to encourage lower emissions. Businesses must have enough allowances (also known as permits or credits) to cover their emissions if they exceed the cap. To comply, businesses can generally:

- Invest in clean technologies to become more efficient
- Switch to lower carbon fuels
- Purchase additional credits

Replacing virtually all of the usage of natural gas at the University is technically feasible with today's technology. The primary systems where usage could be eliminated would be the CHP, and the auxiliary boilers. Without using natural gas in the CHP or the boilers, the University would be required to purchase the majority of their electricity from the grid, and would need to convert their building heating systems from natural gas, steam or hot water based to air sourced heat pumps. Air source heat pumps operate on solely on electricity, and would be effective and efficient in the Windsor area as it rarely approaches a temperature -30C in the wintertime, with the record low being -29.1C, which occurred on January 19th, 1994.

Given that the electricity purchased from Ontario's grid is very clean from a GHG emissions perspective due to the large amount of baseload nuclear and hydroelectric, the University could potentially meet their 2030 and 2050 GHG emissions targets of 37% percent and 80% percent reductions by aggressively moving ahead with converting their building heating systems to air sourced heat pumps. The first result of this conversion would allow the University to idle their boilers, and eventually reduce their peak steam demand lower than the CHP output. Once this occurred, in the interim the steam output of the CHP could be utilized for additional electricity production for net economic benefit. Eventually, the CHP and steam system could be decommissioned and the campus energy system would be entirely electrical based.

However, the economics of this action plan are not favorable at this time. The cost of electricity in Ontario per GJ is significantly higher than the cost of natural gas per GJ. Converting buildings to utilize air sourced heat pumps and decommissioning the CHP is forecasted to increase the University's purchased electricity cost by a factor of 3X to 5X. In addition to the utility cost impacts, air sourced heat pumps are also more expensive to install and maintain than natural gas, steam, or hot water based HVAC equipment.

Further research and planning is required over the next 5 years to understand the how to achieve the proper balance of economics and GHG emissions between the usage of natural gas versus electricity.

Summary and Targets

E.0 Summary

The University of Windsor's organizational culture for promoting energy conservation and sustainable initiatives is evident through its planning for both existing and new infrastructure, as well as through education, outreach and awareness. This ECDMP is a dynamic document intended to not only ensure compliance to O. Reg. 397/11, but also highlight and document the organization's energy and demand management conservation goals, and to measure its progress against them. The University of Windsor understands its responsibility towards promoting energy conservation and sustainability, and commits to providing leadership for current and future generations at its organization.

This report provides a background of the University's current energy conservation practices and highlights the measures that will be taken to further reduce campus-wide consumption over the next 5 years (2022).

Building on past successes and many existing efforts, the EDCMP is anticipated to result in improved efficiencies, utility cost savings, improved energy management, future cost avoidance, and lower greenhouse gas emissions. The Plan also positions the University in compliance with the Green Energy Act, O. Reg. 397/11.

E.1 Targets

Through this EDCMP, it is recommended that by 2022, the University of Windsor achieves a minimum of:

- 5% GHG emissions reduction from 2017 levels by the year 2022
- 5% purchased electricity reduction from 2017 levels by the year 2022
- 5% natural gas reduction from 2017 levels by the year 2022

Appendix A – List of Acronyms

ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BAS	Building Automation System
COP	Coefficient of Performance
ECDMP	Energy Conservation and Demand Management Plan
ECM	Energy Conservation Measure
GEA	Green Energy Act
GJ	Gigajoule
HVAC	Heating, Ventilation, and Air Conditioning
IESO	Independent Electricity System Operator
LED	Light Emitting Diode

Appendix B – ECDMP Approval from Senior Management

This document has been reviewed and approved by:

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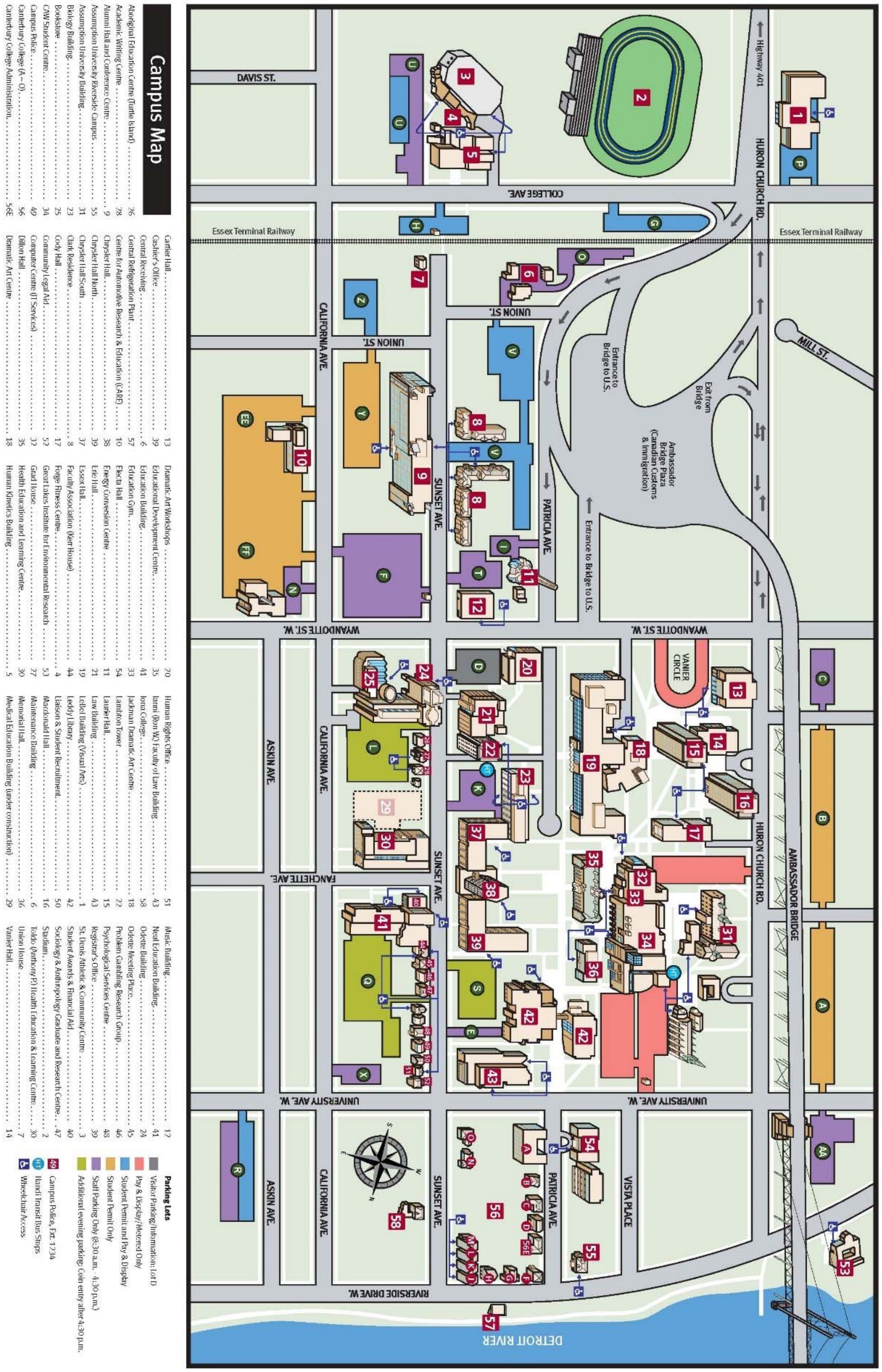
Sandra Aversa, BComm, CPA, CA

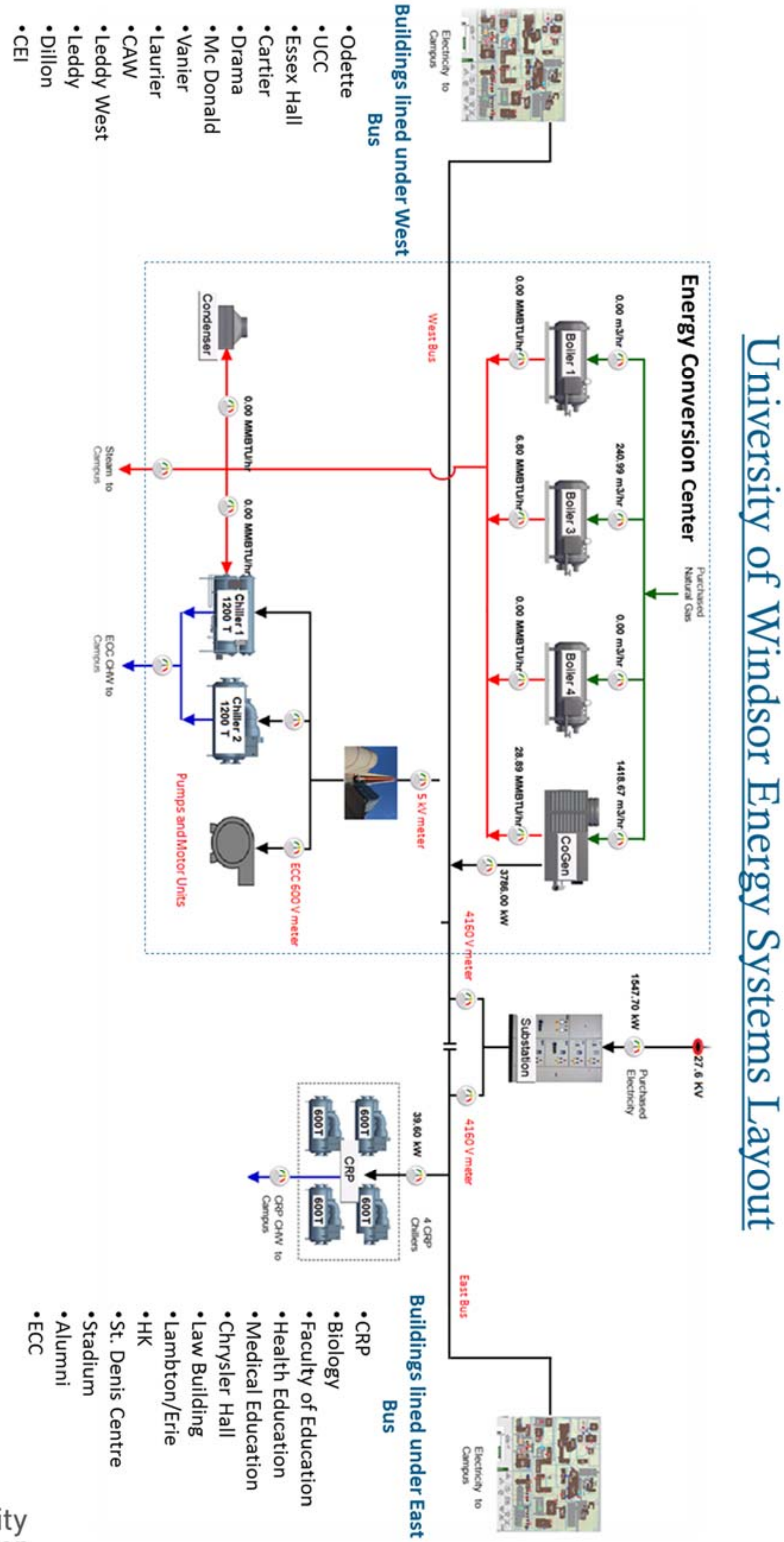
Vice President, Planning & Administration

University of Windsor

Appendix C – Main Campus Map


Campus Map
Parking Lots
Highway 401
HURON CHURCH RD.
DAVIS ST.
COLLEGE AVE.
Essex Terminal Railway
Essex Terminal Railway
MILL ST.
UNION ST.
UNION ST.
Exit from Bridge
Entrance to Bridge to U.S.
Ambassador Bridge Plaza (Canadian Customs & Immigration)
Entrance to Bridge to U.S.
CALIFORNIA AVE.
SUNSET AVE.
PATRICIA AVE.
WYANDOTTE ST. W.
WYANDOTTE ST. W.
VANIER CIRCLE
ASKIN AVE.
CALIFORNIA AVE.
SUNSET AVE.
FANCHETTE AVE.
HURON CHURCH RD.
AMBASSADOR BRIDGE
UNIVERSITY AVE. W.
UNIVERSITY AVE. W.
VISTA PLACE
PATRICIA AVE.
SUNSET AVE.
CALIFORNIA AVE.
ASKIN AVE.
RIVERSIDE DRIVE W.
DETROIT RIVER

Appendix D – Main Campus Energy Systems Layout


University of Windsor Energy Systems Layout
Energy Conversion Center
Electricity to Campus
Buildings lined under West Bus
•Odette
•UCC
•Essex Hall
•Cartier
•Drama
•Mc Donald
•Vanier
•Laurier
•CAW
•Leddy West
•Leddy
•Dillon
•CEI
Purchased Natural Gas
0.00 m3/hr
240.99 m3/hr
0.00 m3/hr
1418.67 m3/hr
Boiler 1
Boiler 3
Boiler 4
CoGen
0.00 MMBTU/hr
6.80 MMBTU/hr
0.00 MMBTU/hr
28.89 MMBTU/hr
3786.00 kW
West Bus
Condenser
Steam to Campus
Chiller 1 1200 T
Chiller 2 1200 T
ECC CHW to Campus
5 kV meter
ECC 600 V meter
Pumps and Motor Units
4160 V meter
27.6 KV
1547.70 kW
Purchased Electricity
Substation
39.60 kW
CRP
600T
4 CRP Chillers
CRP CHW to Campus
East Bus
Buildings lined under East Bus
•CRP
•Biology
•Faculty of Education
•Health Education
•Medical Education
•Chrysler Hall
•Law Building
•Lambton/Erie
•HK
•St. Denis Centre
•Stadium
•Alumni
•ECC