SHERIDAN COLLEGE
INSTITUTE OF TECHNOLOGY & ADVANCED LEARNING

INTEGRATED ENERGY & CLIMATE MASTER PLAN

Final Report

Dated June 17, 2013

Prepared for:

Sheridan College

1430 Trafalgar Road,

Oakville, Ontario L6H 2L1

Prepared by:

Sheridan Integrated Energy & Climate Master Plan Taskforce

Acknowledgements

Colleges and Universities play a crucial role in helping society adapt to a changing planet and to challenging issues such as climate change and resource depletion. Over the last two years Sheridan stakeholders and partners, representing many aspects of the institution's business and academic services, contributed to a transformative 20-year technical and investment plan to reduce the institution's energy and carbon emissions by 50% and lead the way to becoming a Zero Waste Campus by 2020. The combined initiatives will be launched as Mission Zero in the Fall, 2013. With significant support from the College's Faculties of Arts, Animation and Design (FAAD) and Applied Science and Technology (FAST), these initiatives form the foundation to Sheridan's Sustainability Initiatives.

While this report is a comprehensive technical, investment and savings plan which provides greater detail into the processes, methodologies and assumptions used to develop Sheridan's Integrated Energy and Climate Master Plan, the real story is about the internal intellectual and emotional honesty that it has spurred on about where we are as an institution and more importantly, where we could go from here. This multidisciplinary project combined deep pockets of applied faculty knowledge with the resolve and 'can do' attributes of a seasoned business team, turning a discussion that could have been entirely focused on *risk and efficiency* to a new narrative about the purpose of higher education and the kinds of student skills necessary in a 21st Century economy. Through active participation of our students and faculty in project work, the IECMP could establish a strong foundation for energy and climate leadership in Canada by using Sheridan's campuses as *Living Laboratories* for Creativity & Sustainability. This integration of operations and academia would also serve to integrated natural environment, built environment and the strong relationships between them.

A *Mission to Zero*, as the late Ray Anderson[1] and Bill Gates[2] have often alluded to, is a gift—one which we should be grateful to be part of and feel a responsibility to ensuring its success and credibility. The next five to seven year implementation phase is a tribute to the confidence bestowed upon us by the institution's executive and Board of Governors.

Finally, this acknowledgement would not be complete without an important thank you to the Garforth International llc mentorship team and The Natural Step Canada (Sustainability Analysis, 2011). We are deeply indebted to Peter Garforth, Annie Marston, Gerd Fleischhammer, Bruce Bremmer, Dr. Karl Henrik Robert[3] and Pong Leung for their genuine interest in helping us reach higher, beyond our sector boundaries and across international borders for best practices which have helped shape our thinking and will leave a lasting legacy in Sheridan's journey in the years to come. A special thank you to Dr. Anthony Cortese[4] for his early guidance.

Success of Mission Zero will require the engagement of Sheridan's entire community and a united approach to communicating our message. Working together, we can design transformative new processes and work toward a sustainable future, ensuring a safer, healthier place to live and work. I hope you will join us in our Mission to Zero!

ELAINE HANSON
Director, Office for Sustainability
Sheridan College

[1] Ray Anderson (Interface): http://www.youtube.com/watch?v=F2LOUBme8rw&list=PLBF4875F87ED4A88C OR http://sorightsosmartfilm.com "film except"

[2] Bill Gates on Energy, Climate and the importance of ZERO: http://www.youtube.com/watch?v=JaF-fq2Zn7I

[3] Dr. Karl-Henrik Robert: http://www.youtube.com/watch?v=VvFRB7HuLgo

[4] Anthony Cortese: http://www.youtube.com/watch?v=9ZNF8YwF5HA

Core* and Contributing IECMP Team Members

Finance & Administration
Steven Parfeniuk, CFO*

Office for Sustainability
Elaine Hanson*
Cathy Sloat*
Herb Sinnock*

Finance
Simpson Siu*

Facilities Management
Jim Fletcher*
Gord Ide*

Corporate Planning
Andre Plante*
Brian Scannell

Information Technology
Sumon Acharjee*
Pat Burns
John McCormick
Paul Khangura
Chris Adams
Chris Descheneaux
James Duncan
Trevor Hanekamp

Purchasing
Michael Burjaw*
Helen Kuan

Advancement & Corporate Communications
Christine Szustaczek

Faculty of Applied Science & Technology (FAST)
Jocelyn Piercy
Herb Sinnock
Jonalyn Sagisi*
Chris Beaver*
Dave Clark*
Oluremi Egiebor
Chris Ferguson*
Michael Muller*
Lewis Mununga*
Judy Higginson
Maria Luisa Manganaan
Donna Newberry
Tony Orlando
Aravind Venkatapathy
Dave Wackerlin*

Faculty of Business (FOB)
David Nowell*
Doug Greenwood*

Faculty of Arts, Animation & Design (FAAD)
Ronni Rosenberg
Angela Iarocci*
Claire Ironside*
Elizabeth Littlejohn*
Doug Whitton*
Doug Donald*

Co-op Student
Colin Buddin
Jaspreet Gill
Akhtarhusain Goria
Andrew Henein
Boris Jankulovski
John Malapit
Michael Oracion
Muhammad Shahid
Jashan Sidhu
Harmeet Singh
Ranveer Singh

Student Volunteers
Michael Balon
Brian Baxter
Maddison Bonnett
Erino Caporilla
Eftal Cavlaz
Henry Chan
Bobby Choi
Andrew Connell
Jeric De Ramos
Utkarsh Desai
Sharanjit Dhanoa
Anmol Farmah
Jemel Ferdis
Andrew Gujarati
Shareef Habibulla
Remedan Hamid
Wilson Ho
Yu Imamura
Simon Jiang
Uttam Kalletla
Basel Kaltan
Olayemi Labinjo
Zhengzhu Li
Diego Morales
Anthony Mulders
Holena Newton
Michael Ovas
Rideyjeet Palia
Guillaume Perreault
Marlon Rizk
Anmol Sekhon
Arwa Sheikhalzoor
Charanjeet Singh
Sharanjit Singh
Erin Sutton
Terry Sywanicz
Kamil Szewczyk
Corey Tallevi-Keller
Michael Yalcin

Mentor Partners
Garforth International*, llc
Oliver Baumann
Bruce Bremer*
Gerd Fleischhammer*
Peter Garforth*
Annie Marston*
Cindy Palmatier*
Dr. Karl Henrik Robert
Pong Leung

Table of Contents

Table of Figures

1 Executive Summary

Sheridan College's mission is to 'deliver a premier, purposeful educational experience in an environment renowned for *Creativity and Innovation'*. In keeping with this mission, the Office for Sustainability began a project in 2011 which examined the long-term economic and environmental risks surrounding energy use at the College and re-envision Sheridan's energy future.

The institution recognized the importance of looking at energy more strategically, and authorized the development of an Integrated Energy & Climate Master Plan (IECMP or Plan) looking forward to 2030. Sheridan's Integrated Energy & Climate Master Plan was developed over 16 months by a Team which included operational staff, faculty members and students, mentored by a partner with global reach and expertise. From the outset, the Team was challenged to create an energy plan that met the following goals:

- Use at least 50% less energy by 2030
- Cause at least 60% less Greenhouse Gas emissions
- Generate at least a 7% Internal Rate of Return on recommended investment
- Create a campus-wide energy culture
- Ensure energy supply reliability
- Be a platform for new energy and waste technologies
- Use Sheridan as a 'living laboratory' to develop competitive sustainability, energy & climate curricula
- Create a national and community role model with world-class energy performance

The Team took a fully integrated view of Sheridan's energy use under different scenarios to arrive at final recommendations.

In 2011, Sheridan spent $4.4M on natural gas and electricity, a 42% increase since 2005. There are substantial uncertainties over future energy prices depending on how global market forces, environmental regulations and local policies play out. Using two price risk cases, the Team forecast that Sheridan's yearly energy cost could rise to between $7.5M and $10.6M by 2030.

This energy use caused 9,700 metric tons of greenhouse gas emissions in 2010. Aside from undesirable environmental impacts, this creates an additional annual cost risk of over $200,000 under possible future regulations.

Sheridan's energy use is average compared with similar institutions in Canada and the U.S. When compared with systematic global best practices, it is between 40% and 100% higher, underlining the efficiency potential. The College's 200,000 square metres of buildings date from 1970 to 2012 and represent a wide range of energy efficiencies and construction practice.

Using detailed computer models of all the buildings, the impact of different efficiency retrofits and improved energy management practices were assessed. At the same time, the possibilities of more efficient energy distribution and supply throughout Sheridan campuses, particularly in upgrading heating and cooling distribution systems, along with alternative energy supply options, were evaluated.

This evaluation resulted in a set of recommendations that created an optimum combination of investment returns, efficiency and environmental performance. The recommendation combines control, building improvements and efficient distribution and supply of energy across all campuses. It is a long-term platform for ongoing continuous improvement through world-class energy management. It is a robust foundation for even deeper emissions reductions through extended heat recovery and the possible use of biofuels. It is a powerful platform for faculty to develop world-class sustainability, energy & climate curricula.

The Plan recommends investing in a comprehensive energy and greenhouse gas reduction solution over the coming 5-7 years. This comprises campus-wide control and metering, building efficiency retrofits, upgraded and expanded heating and cooling distribution, on-site heat and power generation and extensive solar PV applications. This investment does not factor in any provincial or vendor incentives. The Plan is a strategy developed with sufficient detail to enable overall priorities and overall investments to be approved. Individual sub-projects called for by the Plan will require detailed technical and financial planning prior to implementation.

To ensure these investments deliver their full potential for years to come, the Plan also underlines the importance of engaging the entire college population - students, staff and faculty – in energy and climate management on a continuing basis.

As new campuses and major buildings are added, these will be built to at least LEED Gold standards with an energy performance separately specified to meet systematic global best practices, even if these are higher than LEED goals.

Combined these measures are expected to deliver the following results:

- Reduction in energy use of 65%
- Reduction of greenhouse gas emissions by 47%
- Internal Rate of Return of between 15.8% and 19.3%

In addition to creating these breakthrough operational results, the IECMP also recommends creating a ‘living laboratory’ structure (Center for Applied Sustainability) to engage faculty & students in multi-disciplinary research and curricular initiatives.

2 Key Learning

Building on numerous recommendations highlighted in its 2011 Institutional Sustainability Analysis, developed in partnership with The Natural Step Canada, the Office for Sustainability began a project in 2012 which examined the long-term economic and environmental risks surrounding energy use at the College with the purpose of re-envisioning Sheridan’s energy future. While the Plan outlines a specific set of recommendations to achieve its goals, it is important to highlight four key areas of learning which occurred throughout the process.

First, ***big goals matter*** in motivating change. John Elkington describes ‘five stepping stones’ in his Pathways to Zero Model[5] which take organizations and institutions from breakthrough insights to transformative change, where impacts become so evident that they become a core element in decision making[i]. He suggests, however, that movement from one stage of innovation to another is far from guaranteed; establishing that moving forward has a cost in time, effort, risk and investment. These can grow exponentially if organizational structures do not align and evolve in alignment with a common vision.

Second, ***the story matters***. The development of a strong communication and engagement strategy is a significant contributor to the success of any organizational sustainability journey. It is important to strike a balance between sharing success and contextualizing Sheridan’s transition as part of a long-term sustainability journey to maintain momentum. Equally important will be the consistent and persistent internal message among staff, faculty, students and partners regarding the value of sustainability within the institution. Sharing the story accurately and punctually will be critical to maintaining engagement and positioning Sheridan as the College/University of choice for leaders of tomorrow.

[5] http://thezeronauts.com

Third, ***collaboration & engagement are vital*.** Workplaces, like any institution, have their own intended sets of values. An executive team has a critical role to play in inculcating the value-set of the institution among employees and students. Given the right parameters, this will drive greater efficiency and greater levels of sustainability and innovation. Employees and students can be incentivized through sanctioned activities and often stand as representatives of the values and beliefs of the institution, as a whole. With sustainability and energy, programs that fail to connect formally with all aspects of an organization's structure, or evolve this structure to reflect its value, are unlikely to succeed.

Fourth, ***making Sheridan a 'living laboratory' for sustainability and establishing a Center to drive interdisciplinary projects presents tremendous opportunities for collaboration and creativity***. Over 100 students, faculty, staff and partners were involved in Sheridan's initial IECMP. The learning suggests that the bulk of Sheridan's potential to affect positive change in the world lies in its capacity to equip students with the new knowledge, skills and attitudes necessary to thrive in a carbon constrained world. Engaging students on all levels, from curriculum course offerings and research to co-op placements and co-curriculars, and establishing expectations and orientation regarding their behavior while on campus will be a key success factor. Several key opportunities have developed as a result of the IECMP Plan, including FAAD's involvement in visualizing Canada's first large-scale District Energy program, engagement partnerships with Zerofootprint, creation of an IECMP for YMCA's of Toronto, Net Zero Housing project with Canada's largest NetZero Housing Builder. A broader structure for sustainability would be required to bridge across operational, academic, and research areas to fully harness and capture this potential.

3 Integrated Energy and Climate Master Plan Introduction

3.1 Background

Colleges and universities are poised to take a leadership role in helping Canada advance sustainability, energy efficiency, innovation and the creation of an energy independent economy. Canadian colleges and universities are witnessing transformational changes on their campuses - a new energy economy in motion. The post-secondary sector is at the forefront of advancing efficient and renewable energy production—from wind and solar generation, to natural gas cogeneration, to geothermal and biomass heating and cooling systems. Equally impressive are the dramatic measures being taken to *maximize* the operating efficiency of campus designs and infrastructure.

During the past decade, institutions around the globe have systematically decreased energy consumption through lighting upgrades, weatherization initiatives, energy and greenhouse gas audits and system-level controls, and have implemented institution-wide procurement policies. Campus buildings adhering to high-performance energy-efficient criteria are now commonplace on many college and university campuses. The post-secondary sector is also embracing aggressive programs for water conservation, zero waste and recycling, alternative fuels for campus vehicles, and local & community food production—each having direct and indirect impacts on campus energy demand.

Why is this occurring? Some of these changes have been spurred on by a growing environmental and social consciousness among students and faculty. With the majority of global ecosystems in decline[ii], climate change and its financial and environmental impacts increasingly visible, rising concerns over air and water quality, shrinking biodiversity and weakening social fabric of our communities, energy transformation has become the single most important global priority.

Changes are also representative of the post-secondary sector's commitment to equip students to be future leaders and problem solvers within a starkly different energy and post carbon economy than that of only a few decades ago. The pursuit of energy savings and energy sourcing also reflects a commitment to significant energy efficiency among presidents and campus business leaders, and a mounting consensus that *business as usual* is no longer acceptable and campus operations are now critical to containing costs.

Ensuring Sheridan College's long-term energy reliability and financial security are crucial elements in advancing Sheridan's mission. In keeping with this mission and its commitments to sustainability, a decision was made by College executive in 2011 to examine the long-term economic and environmental risks and opportunities surrounding the approximately $4 million of energy used annually by the College.

Sheridan College educates close to 18,000 students each year (35,000 full-time and part-time combined). Increasing access to, and affordability of, Sheridan's programs is a priority and extending these opportunities to as many Canadian citizens as possible provides thousands of individuals each year with the education they need to forge successful careers and lives which contribute to Canada's productivity, long-term prosperity and global competitiveness. In short, Sheridan aims to play a critical role in developing the human capital and skill sets required in a 21st Century economy.

Because Sheridan's primary mission is to educate and support students, the largest share of the College's costs are in support of the people who teach its students, conduct applied research and manage the buildings and infrastructure that allow Sheridan to achieve its mission. Following closely behind are the costs affiliated with operating and maintaining 27 campus buildings and a wide range of physical infrastructure. Today, Sheridan expends more than $8.9

million per year in the operations and maintenance of its buildings and grounds and over $4 million each year on energy (not including water utilities), about three-quarters of this directed toward electricity generation, distribution and supply.

The stewardship of energy resources highlighted in this Integrated Energy & Climate Master Plan (IECMP) bears a direct impact on Sheridan's ability to be a good steward of its financial resources. Opportunities to significantly reduce energy consumption and carbon emissions directly correlate to the College's ability not only to contain costs, but also to maximize taxpayer dollars, whether they are provincial operating funds or federal grants and contracts supporting its applied research efforts. Increasing the institution's energy efficiency stretches taxpayer dollars further as Sheridan employees work to develop new innovative solutions which drive efficiency and benefit consumers and society at large.

Sheridan views the creation of its Integrated Energy & Climate Master Plan as serving a dual purpose; playing a critical role in the development of a highly-skilled, educated and socially responsible workforce, as well as becoming an integral part of the economic viability of the communities in which it operates. Sheridan is often one of the largest employers in the community and region, and generates significant economic activity.

Post-secondary institutions have a vested interest in seeking out energy management practices, not only to create more comfortable learning environments but also to reduce the resources spent on utility bills. The potential for cost savings is substantial. Ontario's colleges and universities spend an estimated $235 million each year on energy[6].

3.2 Global Influences, National and Provincial Context

The uncertainties surrounding Sheridan's current energy use are significant in both scale and number. They arise from a mix of major global influences, some specific to North America, Canada and Ontario. The growth in energy demand by the so-called emerging economies such as China, India, Brazil, Mexico and Indonesia, is reshaping the global energy markets. As of 2010, for the first time in modern history, the energy use of the emerging economies exceeded that of the major OECD regions of North America, Europe, Japan and Oceania-- *"Almost all (93%) of the energy consumption growth is in non-OECD countries"*[iii].

This widening gap will create structural changes to the world's energy market with unknown long-term impacts on prices and supply chains. In addition, the accident at the Fukushima Daiichi reactor (Japan) in 2011 had a major impact on nuclear electricity generation[iv]. Germany has accelerated the shutdown of all of its reactors; Japan is on track to close all but a few; China is halting or slowing down the approval and construction of over a 100 planned units; and France is facing a major end-of life decision over whether to continue its near 100% commitment to nuclear generation. In North America and Europe, the process to permit new reactors is slow and increasingly unsuccessful[v]. This is driving rapid increases in natural gas usage as a generating fuel and refocusing national policies around efficiency and renewable electricity sources.

The impacts of the use of fossil fuels, mostly natural gas, coal and oil, on long-term climate patterns is a major area of uncertainly. The possibility of new legislation placing significant taxes or other costs on greenhouse gas (carbon) emissions, clearly exists. These are already in place in the European Union (EU), parts of the U.S. and Canada, Australia and a growing list of other countries and regions around the world. Recent reports suggest that sectors account for obligations in new carbon market systems and *prepare for it in their bottom lines* regardless of developments at the international level[vi]. Developing countries, including China, are now

[6] p. 51 Managing a complex energy system: http://www.eco.on.ca/uploads/Reports-Energy-Conservation/2011-v2/2010-Energy-Conservation-Annual-Report-volume-2.pdf

introducing mandatory carbon markets. These reports conclude that after 2020, companies and institutions are likely to be carbon constrained in all major emitting and emerging countries and a global carbon market will likely appear[vii]. Additional background on carbon markets is included in Appendix 7.

Major trends such as these have the significant potential to increase the demand for lower carbon fuels, predominantly natural gas, and to further grow the market for carbon free renewable supplies and efficiency. The Ontario Long Term Energy Plan (OLTEP) specifically highlights this risk and states *"Ontario will be ready for when North America moves to GHG regulations".*[viii]

In North America, the rapid exploitation of new natural gas supply from shale has pushed natural gas to its lowest prices in decades. While many see this as a new normal, there is a very real risk that public concerns over the local impacts of shale gas could introduce legislation that radically changes the cost structure or constrained supply. Even without this, the low price is already accelerating demand, even in non-traditional areas such as transportation, which creates the underlying condition needed to potentially prompt a market adjustment.

There has been decades of under-investment in energy infrastructure in much of North America, including Ontario. This raises the specter of substantial investment in the next decade to bring systems to acceptable standards. Again, this is recognized in OLTEP: *"We will need to rebuild another 15,000 MW of generating capacity over the next 20 years"*. Combined with increasing weather uncertainty, this requirement also increases the possibility that the reliability of supply of both gas and electricity may be less certain in the future than it has been in the past.

This brief summary of some major factors influencing energy markets highlights the uncertainty that Sheridan (and the majority of post-secondary institutions) faces in terms of future energy prices, impacts of legislation around climate change, and reliability and quality of supply.

Sheridan's Executive Team recognized the need for a strategic response. They took this as an opportunity both to build expertise and new skills, and create an institutional 20-year Integrated Energy & Climate Plan (IECMP). The IECMP summarized in this report mitigates energy risks to the College and also seeks out areas of opportunity to enhance its business operations and academic programming.

3.3 Planning in Complex Systems and Creativity

Using a strategic approach for developing effective sustainable strategies called *backcasting*[ix] outlined in Figure 3.1. the IECMP Team was able to plan a pathway to an invented future asking *'what do we need to do to reach a desired outcome?'*.

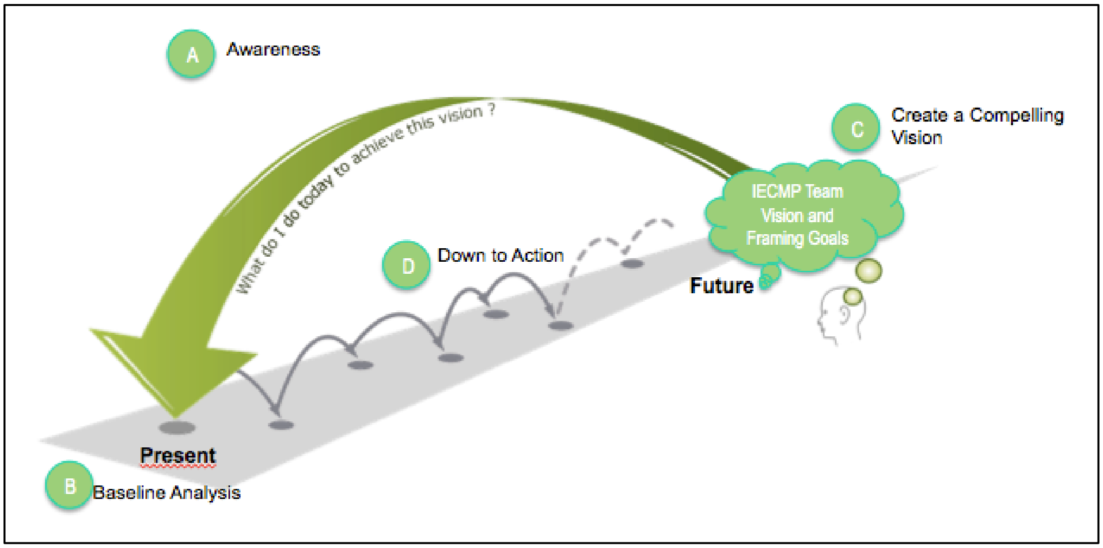


Figure 3-1 Backcasting in Complex Systems Planning[x]

This is a more effective form of planning to achieve breakthrough sustainability outcomes. Within this context, any number of scenarios can be thought of in the design of a sustainable society in which we have a shared picture of where we want to go. Forecasting, tends to have the effect of presenting a more limited range of options, hence stifling creativity, and more importantly, projecting today's problems into the future.

Natural systems and social systems are complex and non-linear. Within an organizational context, there is often pressure to force a system into an established model to try to predict how they will behave. The IECMP process took a different approach, asking how an institution could create an integrated and sustainable energy system, taking a whole systems perspective within the constraints of the biosphere and employing backcasting from sustainability principles. This way, acknowledging the value-laden reality of ecological and social boundaries and taking a multi-disciplinary approach to learning and planning in complex systems toward the creation of a sustainable society.

3.4 Relationship of Zero Waste and Energy

Zero Waste is not an unattainable target. Communities, corporations and institutions that have adopted Zero Waste goals are achieving significant results. For instance, San Francisco, U.S.A., Kamikatsu, Japan and Caparoni, Italy are diverting 80% of their waste while municipalities and institutions in Canada are diverting an average of 33%. Considering that 40% of municipal waste is recyclable and another 40% is organic, Canadian diversion rates should be much higher. According to the Conference Board of Canada, our country produced more waste per capita than any of the other 17 industrialized countries surveyed.

According to a 2008 Statistics Canada report, Canadians generate 25,871,310 tonnes of waste per year or 640kgs per person, about three times the EU average. Only 8,473,257 tonnes, or 33%, was diverted. Another study estimates that each Canadian**,** on average, produces 2.2 kilograms of waste each day, 30 million tonnes of waste in total each year. What happens to this trash? It may disappear from our curbs, but it doesn't disappear from the planet. Some gets recycled or recovered and some is burned, but the majority is buried in landfills.

In 2011, Sheridan's waste diversion was 18%. Wood, metals, chemicals, minerals, organics, aggregates and other resources are valuable and should never be burned or buried. In a world of finite resources and diminishing renewable resources, Sheridan needs to reduce what is purchased, drive innovation with its purchasing power, and continuously reuse and recycle the resources that it uses.

While buildings get most of the attention relative to energy savings, Sheridan's materials' stream also has an impact on energy use. As a public institution, allowing all of those resources to go to waste is a tragedy that taxpayers are funding to dispose of all this unnecessary waste. Looking at best practices from around the world to find ways of achieving diversion rates of 80%.

One area where improvements can immediately be made is by taking organics out of the waste stream. In Fall, 2013, Sheridan will launch its first Zero Waste pilot which will see source separation of organics at Trafalgar B Wing. Almost 50% of Sheridan's waste is organic material, a significant amount of compostable material is filling up regional landfills where it breaks down into methane — a very potent greenhouse gas. The institution could significantly impact greenhouse gas emissions, decrease the need for landfill and return valuable nutrients to a 'Sheridan Campus Community Garden' benefitting the larger community and ensuring all organics are composted on site.

In 2012, in parallel with Sheridan's Integrated Energy & Climate initiatives, a Zero Waste taskforce examined the implications of waste at the College. Based on 2012 final report findings and recommendations, a 2-year investment will see the rollout of infrastructure (waste cluster bins) across four campuses between 2013-2014. Reduction, Recycling & Reuse of its waste saves a tremendous amount of energy. As students learned in the first President's Creative Challenge, recycling just one ton of aluminum cans saves approximately 200 million (Btu); with 5.8 million Btu's in a barrel of crude oil, that's equivalent to 36 barrels of oil.

In a post-secondary institution now poised to re-think itself within a low carbon economy through its IECMP, combining Zero Waste, Energy and Carbon initiatives will inspire new thinking about the way waste is viewed and managed. High level support provides permission for staff to begin with a clean sheet and redesign Sheridan systems and infrastructure to enable stakeholders to work together towards the new goal. Every institution will take a different approach, based on their material flows and their increasing energy and Zero Waste knowledge. The next step will be a formal Zero Waste policy (Fall, 2013) which will filter down, drive innovation and offer a significant opportunity to build new student leadership skills.

3.5 IECMP Scope

The energy- and climate-related items that would be included in the final IECMP scope were clarified and confirmed during the Kick-off Meeting in February, 2012 and are summarized in Figure 3.2.

Item	Scope
Baseline Year	• 2010
IECMP End Year	• 2030 with calculation available to 2035
Geography	• Trafalgar Campus • Davis Campus • Science & Technology Center (STC)
Public utilities	• Electricity • Natural Gas
Energy Uses	• All normal building uses • All special uses inside buildings • Campus street lighting • Use for on-site distribution • Use for on-site conversion

Buildings	All current buildings with selected exceptions All anticipated future buildings or expansions All anticipated future demolitions
On-site primary energy	Baseline: None Future: All reasonable alternatives assessed
Greenhouse gas emissions[xi]	Scope 1: On-site stationary combustion sources Scope 2: On-site use of grid electricity

Figure 3-2 Scope of Sheridan IECMP

The energy- and climate-related items that were discussed and specifically excluded from the current IECMP scope items are summarized in Figure 3.3.

Item	Scope
IECMP Timeframe	• 2011 and 2012 assumed same as 2010
Geography	• Hazel McCallion Campus – see comments in this section
Public utilities	• Water
Energy Uses	• College owned transportation – all uses • Other on-site transportation • Other off-site transportation
Buildings	• New Trafalgar residence
Greenhouse gas emissions	• Scope 1: College owned mobile sources • Scope 3: Other on-site mobile sources • Scope 3: Other off-site mobile sources • Scope 3: Emissions from embedded energy in goods and services procured or caused by Sheridan

Figure 3-3 Energy- and climate related Items Excluded from IECMP Scope

Strategically, the IECMP embraces all four Sheridan campuses, including the new Mississauga Hazel McCallion North Campus. However, a team decision was made to exclude the new campus from the initial integration. The first reason was that 2010 was chosen as the IECMP Baseline year. At the time of developing the Plan (2012) there was only one building on this campus, HMC, and this building was still in the commissioning phase (only six months of utility data available). At the same time, the second building, HMC North, was being specified, and the remaining buildings on this campus were in the very early stages of definition. The last factor at play was the City of Mississauga's continuing interest in exploring the use of Sheridan's campuses as an initial "anchor" or "node" in a downtown district energy strategy. For these reasons, the GIL Team was separately asked to prepare a focused energy assessment. The final report and appendices are provided as an attachment to this report, with document titles referenced in Appendix 5 of this report.

3.6 IECMP Methodology

3.6.1 Team Structure

The College formed a core team of faculty, facility staff and students to develop the IECMP under the project management of the Director of Sustainability. This Team worked with a small group from Garforth International LLC with internationally recognized energy expertise, to mentor the process. The Team was structured this way to ensure the College is building its own expertise to successfully implement the plan and to help the College build its reputation by becoming a 'living laboratory' for operational sustainability, curricular innovation and interdisciplinary sustainability research excellence[xii].

The IECMP was developed under the overall senior sponsorship of the Sheridan College Vice-President of Finance and Administration. The full membership of the Team is included in Appendix 3.

3.6.2 Overall framework

The IECMP seamlessly addresses the entire energy value chain of the College on all three campuses (Trafalgar, Davis and STC) starting from end-uses, through to all forms of primary fuel used both on and off the site, as outlined in Figure 3.4.

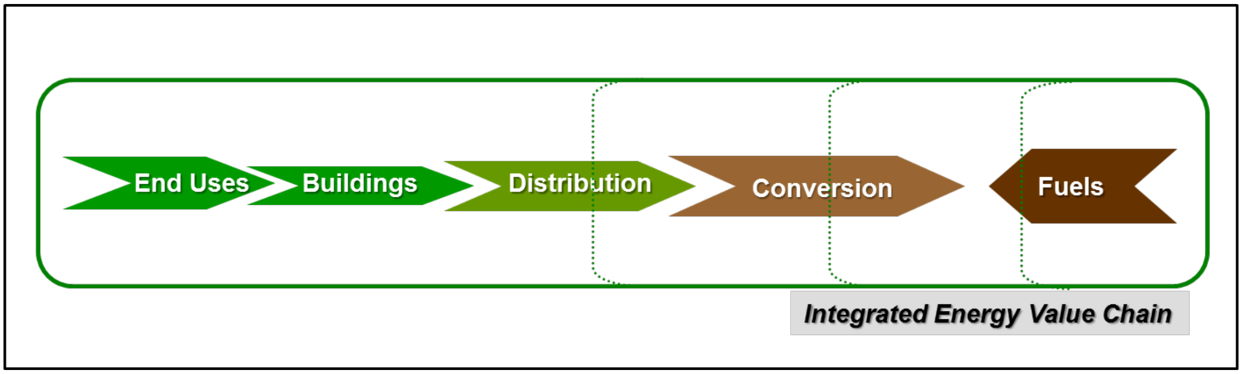


Figure 3-4 Developing the IEMP - Overall Framework

The IECMP includes recommendations that optimize investments and management measures between end-use efficiency, energy distribution on the campuses, and on-site and off-site energy supply choices, including fuels. The IECMP systematically addresses the following questions in a balanced way:

- Do the IECMP recommendations meet acceptable reliability standards?
- How much energy is really needed by the final end-uses?
- Do solutions meet acceptable financial returns?
- Are greenhouse gas emissions minimized?

3.6.3 Process

The process for developing the Sheridan IECMP was aimed at ensuring that decisions on energy demand and supply infrastructure involve stakeholders, consider all possible energy supply and demand options, and are consistent with Sheridan's sustainability policy (Appendix 4). The IECMP was developed following a highly collaborative process outlined in Figure 3.5. The following description is a general overview of the process. Detailed findings are covered in the subsequent sections of this report.

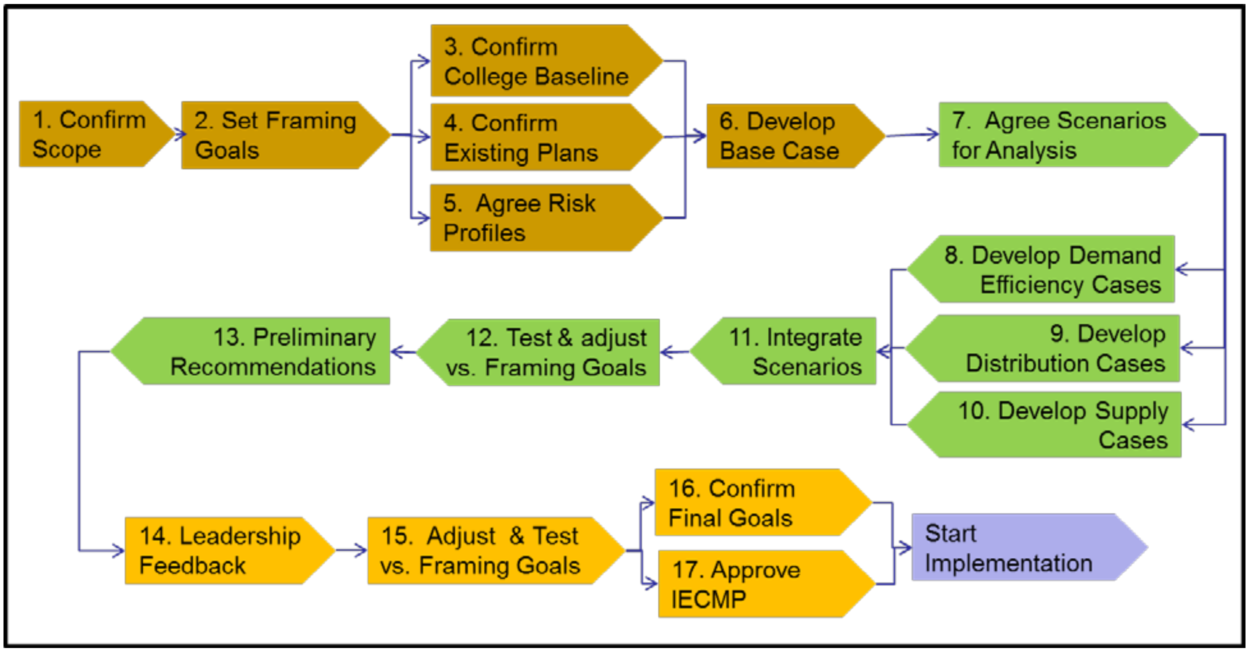


Figure 3-5 Developing the IEMP - Process Overview

The IECMP was launched at a Project Kick-off Meeting in February, 2012 with the participation of the Sheridan Team, Mentors and senior leadership including the Sponsor. The scope of energy-related activities included in the IECMP was clarified and confirmed (Step 1). Alignment was also reached between all stakeholders on the Framing Goals, all of which would ideally be met by the completed IECMP (Step 2). These Framing Goals establish the preconditions for the Team prior to starting on detailed analysis. To be effective the Framing Goals should meet the following criteria:

- Must encompass the entire energy use of the College
- Must balance often conflicting outcomes
- Must establish pathways to achieving goals, even if these are not clear at start of IECMP process
- Must highlight quantitative indicators which are easily derived from readily available data
- Must include non-quantitative goals which are 'core' to final recommendations and build on Sheridan's "living laboratory" initiatives
- Must aim high, motivate change and, if achieved, lead to significant institutional successes

Following the Kick-off, a detailed analysis of the energy use, emissions and costs for the Baseline year on each campus was developed (Step 3).

A team of co-op students under the guidance of the Faculty of Applied Science and Technology (FAST) and a Mentor gathered detailed information on all 27 buildings across Sheridan's three campuses and created detailed computer energy models of each using the EnergyPlus[xiii] Version 7 modeling software developed by the U.S. Department of Energy and widely used in both the U.S. and Canada. The modeling gives a high-reliability estimate of the energy end-use needs of each building for heating, cooling, lighting, other electricity and other functions such as laboratories and catering, and translates them into the gas and electricity required by each building.

The energy losses of the heating networks and the boilers supplying them on the Trafalgar and Davis campuses were estimated using the differences between the total gas and electricity purchases, the estimated efficiencies of the central plant and the end-use computer modeling.

Any existing plans that would affect the future energy profile were confirmed. (Step 4). This includes planned expansions, repurposing or demolition of buildings. It also includes overall activity growth and the general sustainability goals of the College.

The final IECMP includes recommendations based on future risks around energy pricing, environmental legislation and any other uncertainties that are relevant. A key step was to gain agreement with all stakeholders on these risk profiles (Step 5).

The Base Case representing a "business-as-usual" view of energy use from the Baseline year to 2030 was then developed (Step 6), incorporating existing activity and infrastructure plans, along with the cost impacts of the various risk profiles. The Base Case highlights energy vulnerabilities of the College, and the degree to which the Framing Targets would be missed if no significant energy-related actions were implemented by the College.

Since the IECMP takes a "service-to-fuel" perspective for a large, complex College on three campuses, there could be an unwieldy number of possible combinations of efficiency, energy distribution and supply choices. Using the insights from the Base Case analysis and the experience of the Team, the scenarios to be analyzed in-depth were selected (Step 7). This was completed for the Base Case and Scenario Review Meeting with the full Team in July, 2012.

Once the scenarios were agreed to, each was analyzed as a combination of Demand Efficiency (Step 8), Energy Distribution (Step 9) and Supply (Step 10) for each of the agreed risk profiles. The cost and effectiveness of the efficiency measures applied to the existing buildings were again estimated using the EnergyPlus computer models. The efficiency of new construction was based on the College's requirement to have new buildings constructed at a LEED Gold[xiv] rating. The Team also benchmarked findings against German A-Rated[xv] practice.

By its nature, an integrated energy plan requires the manipulation of large amounts of interconnected data from the final end use, through distribution and supply options. The Team created a set of Integration Workbooks in MS Excel that allowed the various options and scenarios to be combined. Figure 3.6 shows the basic structure of the workbooks.

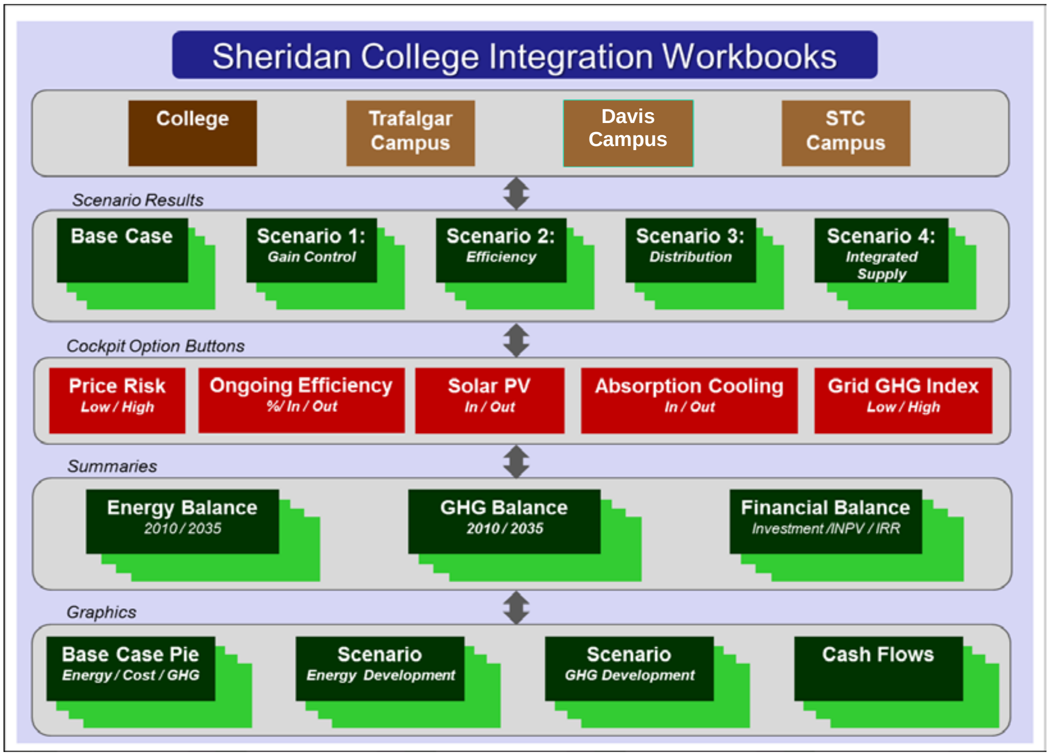


Figure 3-6 Structure Overview of Sheridan IECMP Integration Workbooks

Workbooks were developed for each campus along with a combined College workbook. Multiple options and assumptions could be adjusted to evaluate their impact on meeting the Framing Goals. This structure allowed the optimum set of recommendation to be developed.

The results of each scenario were evaluated against the degree to which they meet all of the Framing Goals (Step 11). This assessment allowed the Team to make short-, medium-, and long-term recommendations for the investments in energy management, building efficiency, energy distribution and supply on the College' campuses (Step 13). The Preliminary Recommendations were established at a full Team meeting in September, 2012.

This was followed by a refinement and finalization process of the IECMP (Steps 14 to 16) with a further full Team review in December, 2012. The IECMP gained conditional approval in February, 2012 (Step 17). It will now set the foundation for Sheridan's ongoing Energy and Climate Strategy, laying out priorities, continuous improvement, carbon and energy reductions and risk avoidance approaches for the next 20 years. As of this report, the IECMP Project Implementation Plan (PIP) has highlighted eight major sub-projects to be implemented over the next five to seven years.

3.7 College Overview

Sheridan College has undergone dramatic growth and change since its founding in 1967 as an Oakville-based community college that was home to several hundred students.

Today, Sheridan is one of Ontario's leading post-secondary institutions, educating approximately 18,000 full time and 17,000 part time students on four campuses in three cities – Oakville, Brampton, and Mississauga. These learners, coming to Sheridan from Ontario, across Canada, and increasingly around the world, pursue a variety of credentials including certificates, diplomas (two and three year), bachelor's degrees that are career-focused or meet specific labour market needs, and post-graduate certificates. Over 127,000 people count themselves as

Sheridan alumni and play a critical role in shaping the future course of our society in the fields of arts, business, community service, health, technology, and the skilled trades.

Sheridan's next transformation, currently underway, is to become Sheridan University – Ontario's first post-secondary institution that is exclusively dedicated to undergraduate teaching in professional and applied areas of study. To achieve this vision, Sheridan is taking a first-in-Canada approach to embedding creativity into all facets of the curriculum so that it becomes a tangible and defining hallmark of a Sheridan education. Equally important is the focus on innovation, in which students will be accorded even more opportunities to collaborate with Sheridan faculty and external practitioners on solution-focused, applied research projects that are directly relevant to their chosen fields.

3.7.1 Trafalgar Campus Overview

Sheridan College's Trafalgar Campus is set in the lakeside city of Oakville, just west of Toronto, and is home to over 6,000 students.

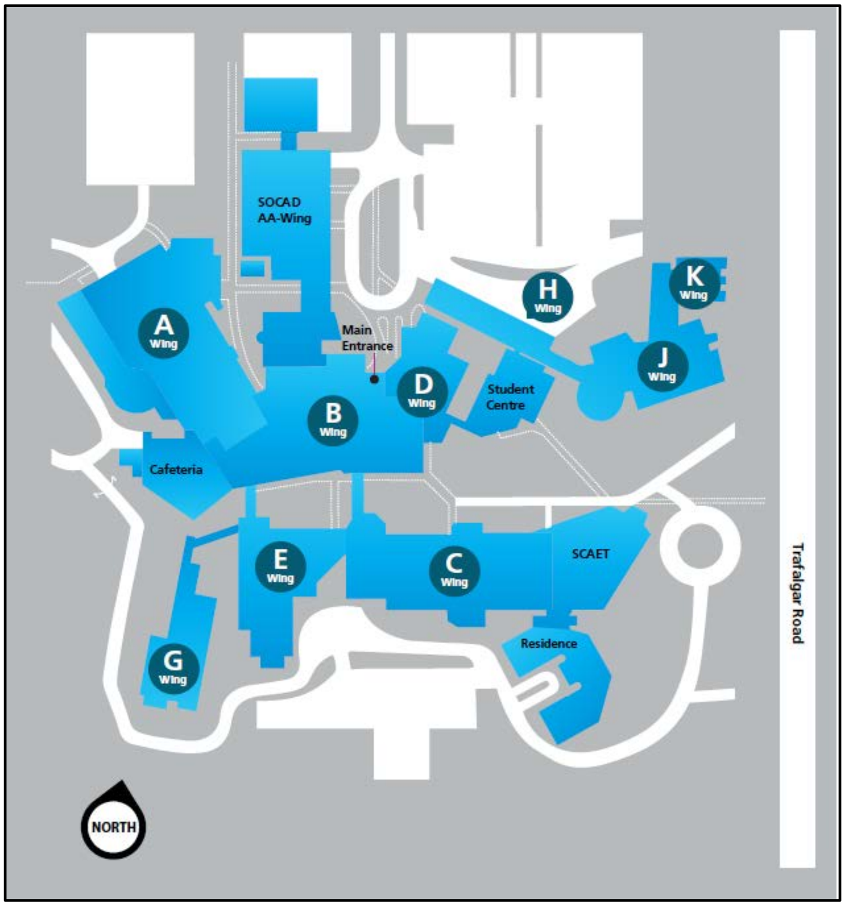


Figure 3-7 Map of Trafalgar Campus Showing Major Buildings

Bordered on one side by wooded trails, this liberal, creative and artistic campus is home to programs such as animation, arts and design (photography, illustration, interior design, glass blowing, ceramics, furniture making), advanced film and television, music theatre performance, as well as business, community studies, liberal arts and applied science and technology.

Trafalgar Campus boasts its own live theatre, weekly student television show and newspaper, student centre, and newly renovated library and learning commons. Renovations to Sheridan Stadium have also given the campus one of the finest outdoor college sport facilities in the province. The campus includes a working Montessori school where students in Early Childhood Education can hone their skills. Trafalgar is also home to SERC – the Sheridan Elder Research Centre, which for the past 10 years has created strategies based on its own applied research to improve the quality of life for older adults and their families. Long considered Sheridan's main campus, Trafalgar is home to the College's administrative leadership.

Notable events in 2013 include: having over 60 alumni contribute to 11 films that were nominated for Oscars; having 97 graduates contribute to two programs nominated for a Daytime Emmy Award; having faculty member Dr. Ian Williams nominated for The Griffin Poetry Prize, Canada's most lucrative and prestigious award for this discipline; and the addition of a new 350-bed residence to open in the fall, which will double the capacity to accommodate out-of-town students.

3.7.2 Davis Campus Overview

Named after William G. Davis, formerly both Minister of Education and Premier of Ontario, the Davis Campus is now Sheridan's largest. Located in Brampton, one of the fastest growing and most ethnically diverse communities in Canada, Davis is home to approximately 9,000 students.

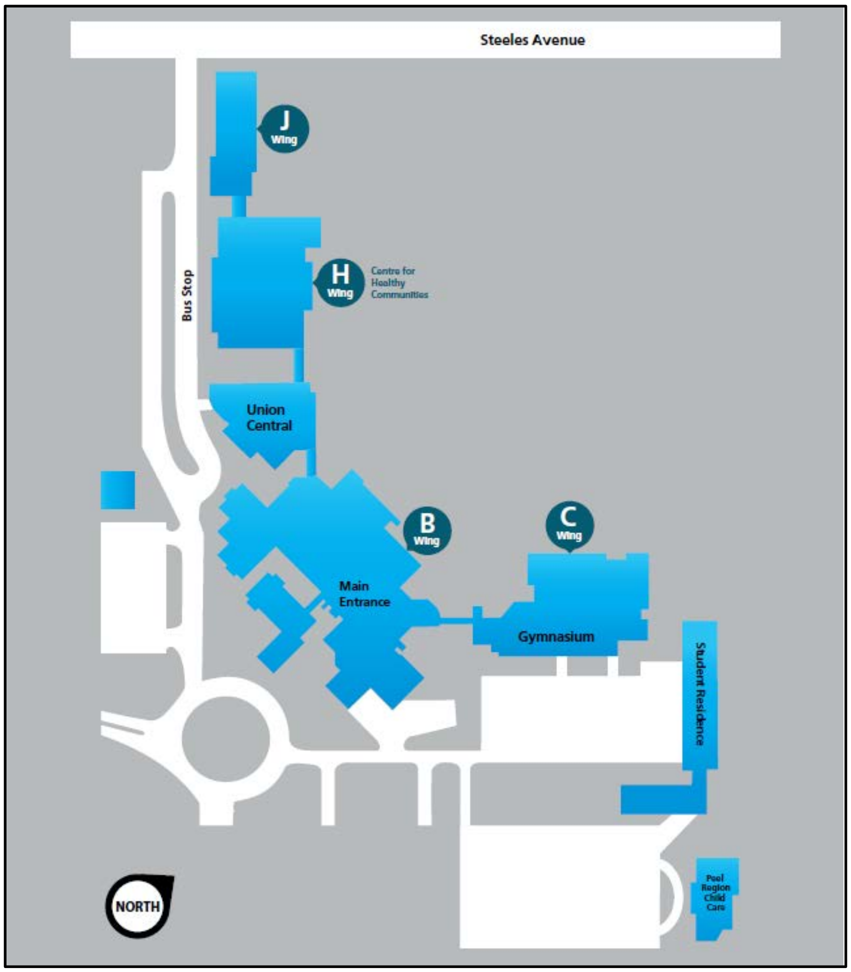


Figure 3-8 Map of Davis Campus Showing Major Buildings

Programs available at this bustling, innovative and multicultural campus include Business, Health Care, Community Studies, Liberal Arts, Engineering, Architecture and Information Technology.

Davis Campus is home to a new student centre, recently upgraded library and learning commons, a state-of-the-art simulation lab for practical nursing, a mock courtroom for paralegal studies, an animal care centre, and a 28,000 square foot facility advanced manufacturing design labs featuring top-in-Canada machinery for 3D printing. It boasts 19 newly-renovated flexible classrooms that feature new computers, wireless microphones, document cameras, movable podiums and commercial-grade projectors to give faculty and students ultimate mobility and access to technology when learning or presenting.

Davis is also home to a cricket team and some of Sheridan's varsity teams including two 2013 Ontario Colleges Athletics Association Champions: Men's Indoor Soccer and Men's Basketball. Equally notable in 2013 was the participation of the Sheridan Motorsports team in Formula North, an event in which teams of engineering and marketing students design, build and market a single-seat, open-cockpit autocross vehicle. Sheridan competed against 30 universities from Canada, the U.S. and Estonia.

3.7.3 Skills Training Center Overview

The Skills Training Centre, located in Oakville, is home to Sheridan's pre-trades and apprenticeship programs. STC is widely considered to be among the best training facilities of its kind in Ontario. This campus is home to 1,300 students who receive hands-on instruction in trades such as electrician, plumber, welder, industrial mechanic millwright, tool and die maker, general machinist, and pattern or mould maker.

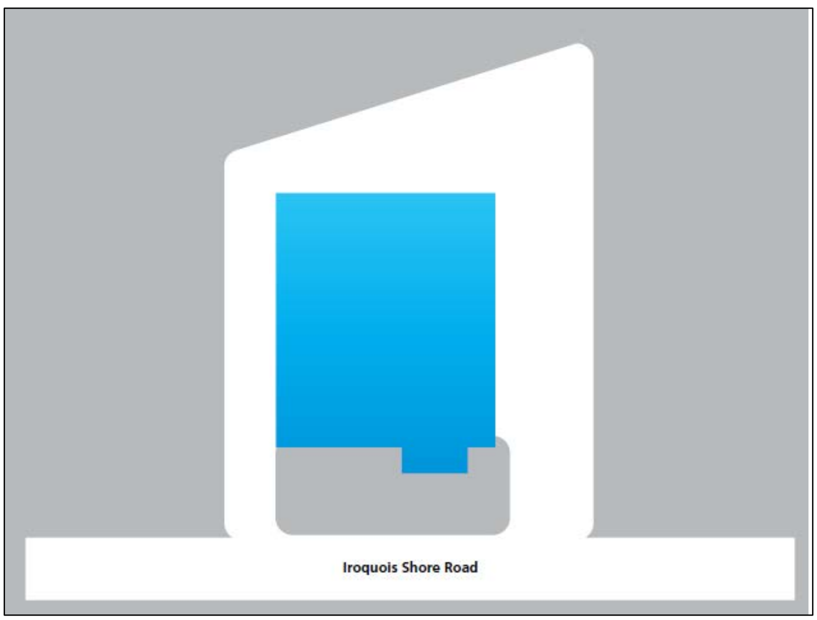


Figure 3-9 Map of Skills Training Centre

Students at STC learn on sophisticated, industry-standard equipment as well as study accompanying theory in trade calculations, precision machining, mechanical drafting, computer-aided drafting and design, computer-aided manufacturing, and understanding blueprints, safety codes, standards and regulations. They also learn to conduct a job search, maintain proper work documentation, and communicate effectively on the job. Graduates of the programs can directly enter the workforce, or use their credentials as a stepping-stone into many other diploma programs to continue their post-secondary education.

Highlights from this past year include having two students earn bronze medals at the annual Ontario Skills Competition and the contribution of STC faculty and technicians who opened their facilities and lent their expertise to teams of local high school students working to build 140-pound robots that competed at a major Canadian robotics competition.

3.8 Framing Goals

The Framing Goals established in the Kick-off Meeting addressed six strategic areas.

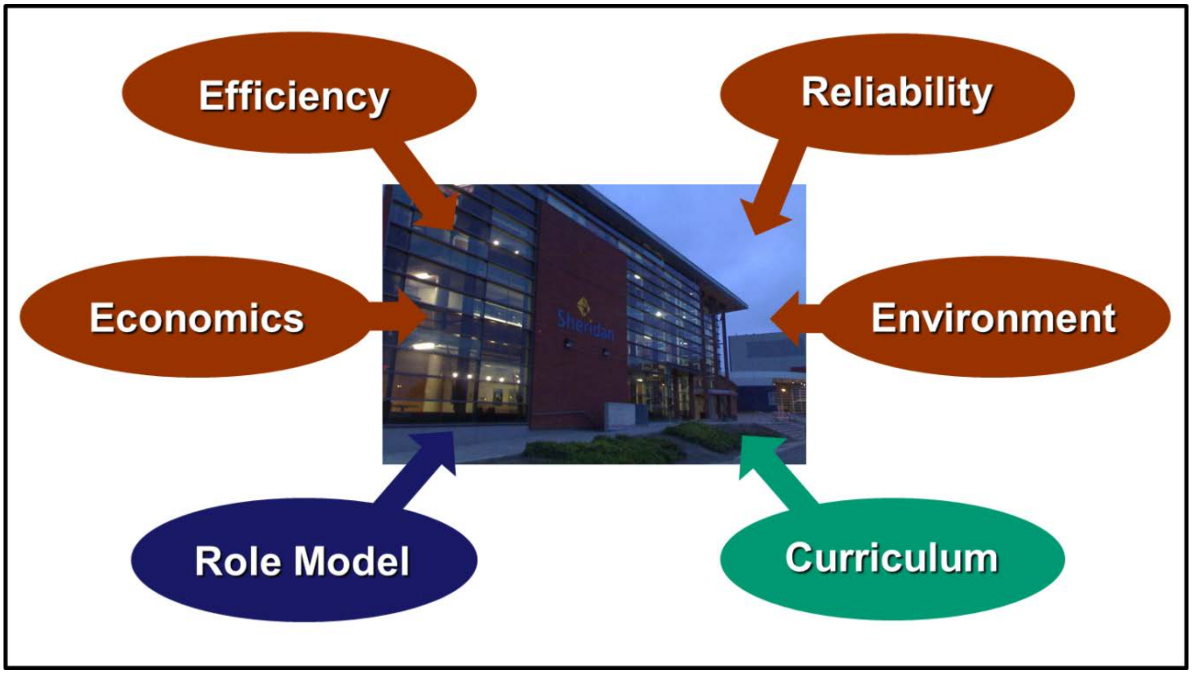


Figure 3-10 Balanced IECMP Framing Goals

Specific Framing Goals were defined and confirmed by the College leadership. These challenged the IECMP Team to develop recommendations that would meet all of these goals as closely as possible in a balanced way.

3.8.1 Efficiency – Source Energy

By 2032, the source energy use of the College will be at least 50% less than the Base Case. Source energy includes all energy used on the College, plus the additional energy used to generate and distribute electricity purchased from the grid.

3.8.2 Environment - Carbon Footprint

By 2032, the College will cause at least 60% less energy-related greenhouse gas emissions from both on-site stationary sources (Scope 1) and purchased electricity (Scope 2).

3.8.3 Economics – Internal Rate of Return

Investments that are required to achieve all the IECMP Framing Goals will achieve a long-term Internal Rate of Return (IRR) of at least 7%, or approaching twice the current return on 30-year Canadian Government Bonds.

3.8.4 Role Model – Campus Culture

Sheridan College will have a pervading, visible and unquestioned commitment to excellence in energy and climate performance. Faculty, staff and students will be well informed and engaged.

3.8.5 Reliability – Energy Supply Quality and Security

The current levels of energy quality and supply security can be maintained in the face of increased weather and grid reliability risks.

3.8.6 Role Model - Technology

The energy systems of Sheridan College will be a platform to evaluate and demonstrate new efficient, low-carbon technologies and energy waste management technologies.

3.8.7 Curriculum

The energy systems and energy management processes will be a “living laboratory” for a full range of sustainability, energy, and climate academic and professional development programs. These will be consistently recognized as among the best few in their class in the world.

3.8.8 Role Model

Sheridan College will be recognized as a national Canadian, Provincial and local role model through its achievement of world-class, sustained energy and climate performance as a result of the delivery of all its Framing Goals.

4 Baseline and Base Case

4.1 Energy Management Practices

An institution with above average energy performance will always have well-established and consistent energy management practices, encompassing both energy use and energy purchases.

Supported by input from the Facility Team, Information Technology and other College staff, the Team assessed the current energy management practices as part of documenting the 2010 Baseline for the IECMP. Currently the energy use on the College's campus is predominantly managed by a professional, well-motivated Facilities Team. However, their focus is maintaining functional availability of the College's facilities with energy performance being a secondary concern, managed on a sporadic basis. Some observed examples of this are:

- There is limited schedule and activity management in terms of matching the lighting and conditioning of buildings to the specifics of the campus schedules. There is no evidence that energy requirements are a consideration when establishing activity schedules.
- Energy-related management tends to be reactive to pressing needs rather than built into all aspects of campus planning.
- There is limited staff / student / faculty engagement over energy- and climate-related topics, with no regularly structured energy efficiency-related events or process.
- On the purchasing side, there is no contract or invoice quality control; an area where there are typically significant opportunities
- There is no consolidated natural gas contract negotiation for the College as a whole.
- There is no systematic management of accessing provincial incentives for energy efficiency, climate change mitigation or other energy-related incentive programs.
- There are no formal operational or purchasing energy improvement goals.
- The energy-related opportunities and impacts are a minor, or even a nonexistent, consideration in the planning of new construction and strategic infrastructure planning.

An overall assessment guided by the categories from the Energy Star Energy Management Assessment Matrix[xvi], is summarized in the Figure 4.1. In this context *"energy"* includes *"energy-related greenhouse gas emissions"*

ES Criterion	Sheridan Assessment	H	M	L
Commit to continuous energy performance improvement				
Energy Manager appointed	At the time of assessment, no single point of overall energy productivity accountability. (New Manager, Sustainable Energy Systems now hired)			
Energy Team established	No formal or informal multidisciplinary College energy management team			
Energy Policy in place	No formal Energy Policy in place. Sustainability Policy in place encompasses energy			
Assess of energy performance and opportunities				
Gather and track data	Some quality energy data tracking; lacks completeness and consistency			
Normalized energy data	No standardized consistent indexing of energy use and costs to activity			
Establish Baseline	No standardized energy baseline established for performance purposes			
Benchmark performance	No systematic benchmarking with peer institutions			
Analysis	Some analysis of energy demand anomalies and artifacts			
Technical audits	No systematic energy audits; some selective external assessments			
Establish energy performance goals				
College-wide energy goals	No short or long-term energy performance goals			

Identify efficiency potential	Some studies and assessment of potential efficiencies; not systematic			
Campus-wide energy goals	No short or long-term energy performance goals			
Create energy action plan				
Energy action plan	No energy-specific Campus or College technical action plan			
Assign energy plan resources	No energy-specific Campus or College technical action plan			
Implement energy action plan				
Communication plan	No energy-specific communication plan			
Raise Awareness	Some energy efficiency communication as part of Sustainability			
Build capacity	No systematic energy management training and resource building			
Track & monitor	Some regular tracking of energy performance			
Evaluate progress				
Measure plan results	No formal energy plan			
Review energy plan	No formal energy plan			
Recognize energy performance achievements				
Internal recognition	Minimal recognition of energy performance achievements			
External recognition	Growing recognition for sustainability efforts which encompasses energy			

Figure 4-1 Sheridan College Energy Management Assessment Overview

The above profile is not untypical for any organization making the transition from managing energy in a way that is reactive to pressing needs. It highlights the day-to-day energy productivity potential from enhanced energy practices that is available to Sheridan College.

4.2 Utility Supply – College

All campuses have electricity and natural gas from public networks as energy sources. Electricity is used for cooling, lighting, mechanical and other equipment. Natural gas is predominantly used for heating and service hot water. Only a very small fraction of gas is used for other purposes such as for kitchens, kilns, etc.

The Baseline year is 2010. This is the reference point for all evaluated scenarios. There is no on-site electricity generation. Natural gas for heating is either used in central boilers which feed heat into networks that serve groups of buildings by either hot water (Davis) or steam (Trafalgar) distribution pipes, or in individual boilers dedicated to serve single buildings. The latter is mainly in newer buildings where the current central heat supply infrastructure has insufficient capacity to meet the expanded needs.

All campuses have a single electrical utility meter. There is minimal electrical sub-metering. Natural gas utility meters are in place for the central boiler plants and for buildings with their own boilers. There is no sub-metering for distributed heat and steam. Neither the electricity used for generating chilled water, nor the generated and distributed chilled water itself is metered.

The total energy and greenhouse gas (GHG) balances for both the campuses and the College as a whole is derived from overall utility consumption. The balances comprise both a calculation for the energy use on the campuses themselves (site balance) and a balance including generation and distribution losses for electricity (source balance). The fuel efficiency chain for grid supplied electricity services is assumed throughout to be 33%[xvii]. Another way of looking at this is that it takes 3.03 units of fuel at the power plant to get one unit of electricity delivered to the College.

The GHG emissions index used in this report for electricity purchased by the College is 200 kg CO_2e/MWh[xviii]. This is about the Canadian average and is low by North American standards.

The index has dropped rapidly in recent years, caused mainly by Ontario decommissioning its coal-fired power plants. The GHG emissions index for the on-site combustion of natural gas coincidentally is also 201 kg CO_2e/MWh. As will be seen later in evaluating future scenarios, this parity creates interesting challenges in reducing the carbon footprint of the College. The source to site factor for natural gas is 1.047[xix].

The Baseline total energy use and costs are shown in Figure 4.2. The total used area on all three campuses is 165,740 m² (1,784,000 ft²).

Sheridan College Totals		**Site Energy**	**Source Energy**	**GHG Emissions**	**Energy Costs**
Item	**Usage**	**MWh/yr**	**MWh/yr**	**metric tons/yr**	**$/yr**
Natural Gas	2,235,000 m^3	20,320	21,275	4,085	1,044,000
Electricity	28,054,800 kWh	28,055	85,015	5,615	3,354,000
Total		***48,375***	***106,315***	***9,700***	***4,398,000***

Figure 4-2 Sheridan College - Total Energy & Carbon Baseline

In simple headlines, in the Baseline year of 2010, Sheridan spends about $4.4M on energy, equaling 9% of its total operating costs, and has an energy-related carbon footprint of 9,700 metric tons.

The College's energy and emissions indexed to the total floor area is shown in Figure 4.3.

Sheridan College Indexes	**Site Energy**	**Source Energy**	**GHG Emissions**	**Energy Costs**
Building Area 145,375 m²				
Item	**kWh/m²*yr**	**kWh/m²*yr**	**kg/m²*yr**	**$/m²*yr**
Natural Gas	140	146	28	7.20
Electricity	193	585	39	23.10
Total	***333***	***731***	***67***	***30.30***

Figure 4-3 Sheridan College - Energy & Carbon Indexes Baseline

It is a widespread industry practice to index building energy performance to the finished floor area and is a commonly used benchmarking value as will be seen late in the report.

The breakdown of this overall College picture by campus follows in the next three sections.

4.2.1 Utility Supply – Trafalgar Campus

Trafalgar Campus is supplied with electricity by Oakville Hydro. Natural gas is delivered by Shell Energy and the local gas delivery network is operated by Union Gas.

Trafalgar Totals		**Site Energy**	**Source Energy**	**GHG Emssions**	**Energy Costs**
Item	**Usage**	**MWh/yr**	**MWh/yr**	**Metric tons/yr**	**$/yr**
Natural Gas	1,433,000 m^3	13,025	13,600	2,620	654,000
Electricity	18,029,300 kWh	18,030	54,600	3,605	2,106,000
Total		***31,055***	***68,200***	***6,225***	***2,760,000***

Figure 4-4 Trafalgar Campus - Total Energy & Carbon Baseline

In simple headlines, Sheridan spends about 63% of its energy bill on the Trafalgar Campus while creating 64% of its carbon footprint.

Trafalgar Indexes	**Site Energy**	**Source Energy**	**GHG Emssions**	**Energy Costs**
Building Area	*80,700 m²*			
Item	**kWh/m²*yr**	**kWh/m²*yr**	**kg/m²*yr**	**$/m²*yr**
Natural Gas	161	169	32	8.10
Electricity	223	677	45	26.10
Total	***385***	***846***	***77***	***34.20***

Figure 4-5 Trafalgar Campus - Energy & Carbon Indexes Baseline

4.2.2 Utility Supply – Davis Campus

Davis Campus is supplied with electricity by Hydro One Brampton. Natural gas is delivered by Shell Energy and the local gas delivery network is operated by Enbridge.

Davis Totals		**Site Energy**	**Source Energy**	**GHG Emssions**	**Energy Costs**
Item	**Usage**	**MWh/yr**	**MWh/yr**	**Metric tons/yr**	**$/yr**
Natural Gas	698,000 m^3	6,340	6,640	1,275	346,000
Electricity	8,751,300 kWh	8,750	26,515	1,750	1,093,000
Total		***15,090***	***33,155***	***3,025***	***1,439,000***

Figure 4-6 Davis Campus - Total Energy & Carbon Baseline

In simple headlines, Sheridan spends about 33% of its energy bill on the Davis Campus while creating 31% of its carbon footprint.

Davis Indexes	**Site Energy**	**Source Energy**	**GHG Emssions**	**Energy Costs**
Building Area	*56,500 m²*			
Item	**kWh/m²*yr**	**kWh/m²*yr**	**kg/m²*yr**	**$/m²*yr**
Natural Gas	112	118	23	6.10
Electricity	155	469	31	19.30
Total	***267***	***587***	***54***	***25.40***

Figure 4-7 Davis Campus - Energy & Carbon Indexes Baseline

4.2.3 Energy Supply – Science and Technology Centre

STC is supplied with electricity by Oakville Hydro. Natural gas is delivered by Shell Energy And the local gas delivery network is operated by Union Gas.

STC Totals		**Site Energy**	**Source Energy**	**GHG Emssions**	**Energy Costs**
Item	**Usage**	**MWh/yr**	**MWh/yr**	**Metric tons/yr**	**$/yr**

Natural Gas	104,600 m^3	950	1,000	190	44,550
Electricity	1,274,200 kWh	1,275	3,860	255	154,450
Total		***2,225***	***4,860***	***445***	***199,000***

Figure 4-8 Science & Technology Centre - Total Energy & Carbon Baseline

In a simple headline, Sheridan spends less than 0.5% of its energy bill on the Science & Technology Centre.

STC Indexes	Site Energy	Source Energy	GHG Emssions	Energy Costs
Building Area	*8,175 m^2*			
Item	**kWh/m²*yr**	**kWh/m²*yr**	**kg/m²*yr**	**$/m²*yr**
Natural Gas	116	122	23.4	5.40
Electricity	156	472	31.2	18.90
Total	***272***	***594***	***54.6***	***24.30***

Figure 4-9 Science & Technology Centre - Energy & Carbon Indexes Baseline

4.3 Building Management Systems

The installed building management system on each campus is a series of disparate control systems, there is little integration or inter-operability. Energy metering on site is limited to building level in the best case.

Trafalgar campus has two BMS control systems. Siemens is the primary system controlling all buildings. G-Wing is controlled by a Kruger system. This system is not connected to the Siemens system.

Davis campus has two BMS control systems. Siemens is the primary system controlling all buildings except J-Wing. J-Wing is controlled by a TRANE Tracer system; Siemens has limited control through BACnet. The residence has a Kruger control system which is a stand-alone system.

Figure 4.10 summarizes the BMS systems and controls on the three campuses.

	Davis Campus			Trafalgar Campus		Skills Training Center
	All Buildings	J-Wing	Residence	All Buildings	G-Wing	
BMS System manufacturer	Siemens	Trane	Kruger	Siemens	Kruger	None
Centralized system or distributed	Centralized			Centralized		
Number of points monitored / controlled	8000	unknown	1000	9000	unknown	
Centralized weather control	Yes	Yes	Yes	Yes	unknown	
Standalone or network	Network	Stand Alone	Stand Alone	Network	Stand Alone	
What equipment and parameters are monitored	All	All	All	All	All	

What equipment and parameters are controlled	All	All	All	All	All	
Metering systems monitored	Elect	Elect	Elect	Elect	Unknown	Elect
Manual or semi-automated scheduling practices	Semi	Semi	unknown	Semi	Semi	N/A

Figure 4-10 College Baseline – Overview of Current Control Systems

4.4 Building Energy Use – College

Sheridan College, excluding the Mississauga Campus, has 145,375 sq m / 1.56M sq. ft. of buildings. Uses include classrooms, laboratories, learning spaces and offices. The buildings range in age from 1970s to 2012, with a wide range of construction standards and energy performance.

The energy needs of each individual building were modeled and the results were then aggregated to provide a picture of each campus and the College as whole. These baseline models are matched to the metered data from the site and adjusted appropriately[xx].

The College has two main building types. The first, residences, have many of the characteristics of apartments and hotels. The second, campus buildings, are a mix of teaching rooms, laboratories and administrative offices. A joint Team of faculty and co-op students with consultant support modeled every building using detailed site observation, available technical documentation and the best assumptions on existing construction, HVAC systems, lighting, other energy uses and operating patterns.

The modeled baseline energy use of the buildings on all three Sheridan campuses is shown in Figure 4.11. This energy is the demand energy of the buildings, the actual energy the buildings need.

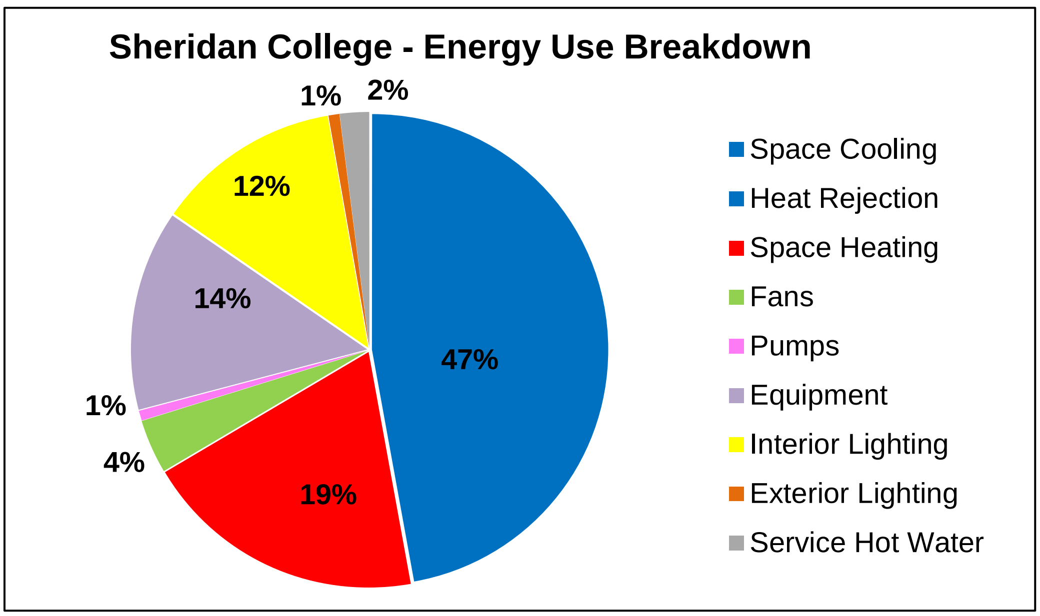


Figure 4-11 Sheridan College Baseline – Modeled Building Energy End-Uses

This assumes an efficiency of 1 for any boilers and chillers within the building itself and should not be confused with the utilities consumed by the buildings. The heating and hot water are nearly half of all utility needs, followed by lighting and so-called “equipment or plug load”. Plug load includes all the electricity used for appliances, computers, vending machines, personal space heaters, coffee machines, televisions etc. Cooling, while in high demand during the summer, is the smallest major utility use on an annual basis, assuming a typical efficiency of 4 for an electric chiller.

The detailed breakdown of the annual energy use intensity in kilowatt hours per square meter by building is shown in Figure 4.12

Energy Use Intensity [kWh/m²]	Heating	Cooling	Lighting	Plug Load	Fans / Pumps	DHW	Building Totals
A-Wing	63	228	74	55	18	-	439
Annie Smith	127	158	133	12	15	-	444
AA wing	13	59	46	345	7	-	470
Athletic Center	146	280	105	29	32	-	592
B-Wing	69	175	55	90	22	-	410
C-Wing	82	349	59	78	12	-	580
D-Wing	111	454	86	45	18	-	713
E-Wing	141	617	131	48	32	-	969
G - wing	82	299	46	21	14	-	461
HJK - Wing	470	1,038	173	123	131	-	1,935
SCAET	157	189	58	41	44	-	323
Student Center	24	179	61	92	23	-	379
Residence	111	62	77	43	8	76	377
TOTAL Trafalgar	**99**	**242**	**69**	**71**	**23**	**76**	**514**
J Wing	121	176	61	55	20	0	433
H Wing	15	378	40	81	29	14	557
Student Centre	92	373	66	53	31	-	616
M Building	115	71	64	80	5	-	335
B Wing	62	177	51	28	23	12	354
C Wing	79	124	80	21	8	49	363
Residence	103	58	71	40	8	71	351
TOTAL Davis	**76**	**179**	**60**	**43**	**18**	**27**	**411**
TOTAL STC	**94**	**30**	**110**	**67**	**-**	**-**	**307**
TOTAL College	**90**	**206**	**68**	**60**	**20**	**16**	**459**

Figure 4-12 Sheridan College – Modeled Baseline Building Energy End-use Indexes by Building

This same information broken down by end-use across each campus is shown in Figure 4.13.

Energy Use Intensity [kWh/m²]	Trafalgar Campus	Davis Campus	STC	Sheridan College Total
Area [m²]	80,700 m²	56,500 m²	8,175 m²	145,375 m²
Heating	99	76	94	90
Cooling	242	179	30	206
Lighting	69	60	110	68
Plug Load	71	46	67	60
Fans/Pumps	23	18	7	20

DHW	10	27	-	16
TOTAL	514	403	307	459

Figure 4-13 Sheridan College Baseline – Modeled Building Energy Indexes by Campus

The results were benchmarked against a number of North American and German performance indexes to understand how the Sheridan portfolio compares with both local "business as usual" counterparts and higher performance standards.

The "business as usual" comes from CICES data[xxi], which is the current energy use of educational buildings in Ontario. Higher standard benchmarks included LEED Gold rating with energy performance at least 30% above ASHRAE 90.1 2007 and 45% below MNECB[xxii]. The German A-rated academic building performance was chosen as an example of current systematic best practice. The benchmarks' energy use intensities are shown in Figure 4.14.

Universities – 2008	**CICES**	
	Ontario (GJ)	Ontario (MWH)
Total Energy Use	7,220,205	2,005,612
Floor Area	5,604,391 m^2	5,604,391 m^2
Energy Use Intensity	1.24 GJ/m^2	344 kWh/m^2
Ontario Ministry of Education Goals		
Current Energy Use in Schools	241 to 496kWh/m^2	
Future 35% Energy Savings	200 kWh/m^2	
LEED Gold Benchmarking		
LEED = 45% below Canadian Code 1997	189 kWh/m^2	
LEED = 26% below Canadian Code 1997	152 kWh/m^2	
LEED = 30% below 90.1 2007	179 kWh/m^2	
LEED = 45% below 90.1 2007	133 kWh/m^2	
Current USA code 90.1 2007		
NREL DoE Model Secondary School ASHREA 90.1 2004 (virtually the same as 2007)		
	255 kWh/m^2	
CBECS – North East USA (2003)		
Educational Institutions	308 kWh/m^2	
German Benchmarking		
Educational Institution Label A	95.8 kWh/m^2	

Figure 4-14 North American and German Building Performance Benchmarks

The performance of each campus against these benchmarks is summarized in Figure 4.15

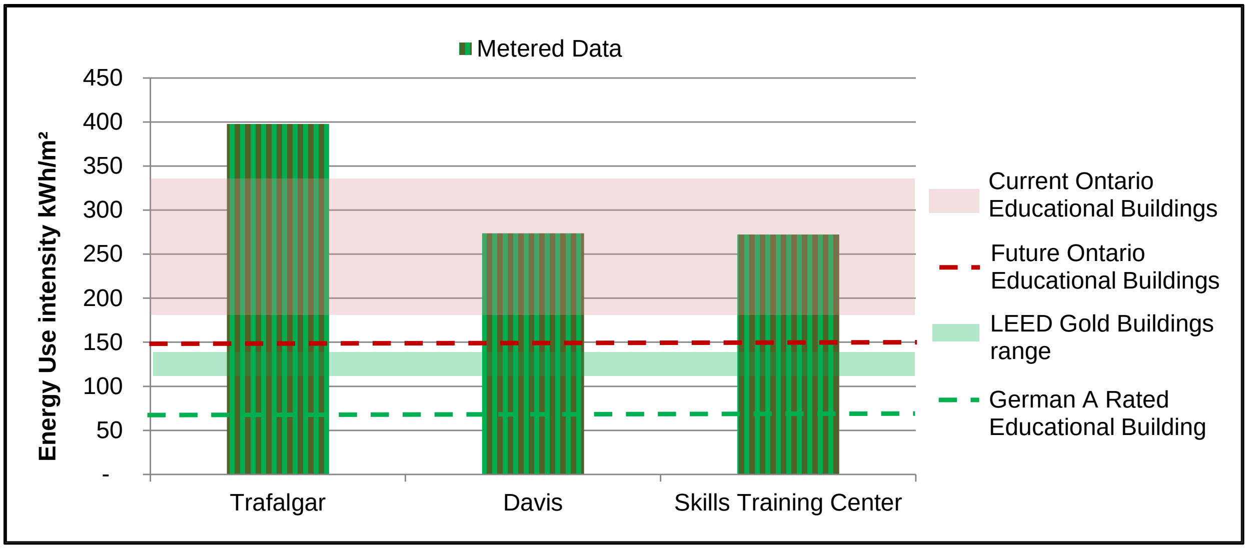


Figure 4-15 North American and German Building Performance Benchmarks

Overall, the benchmarking indicates that there is substantial end-use energy efficiency potential in the existing buildings. There is also a major opportunity to capture significant energy use reduction in all new construction by designing against more aggressive benchmarks.

4.4.1 Building Energy Use – Trafalgar Campus

Trafalgar campus has a mix of teaching buildings, laboratories and residences as well as a student centre. An overview of the layout and main buildings is shown in Figure 4.16.

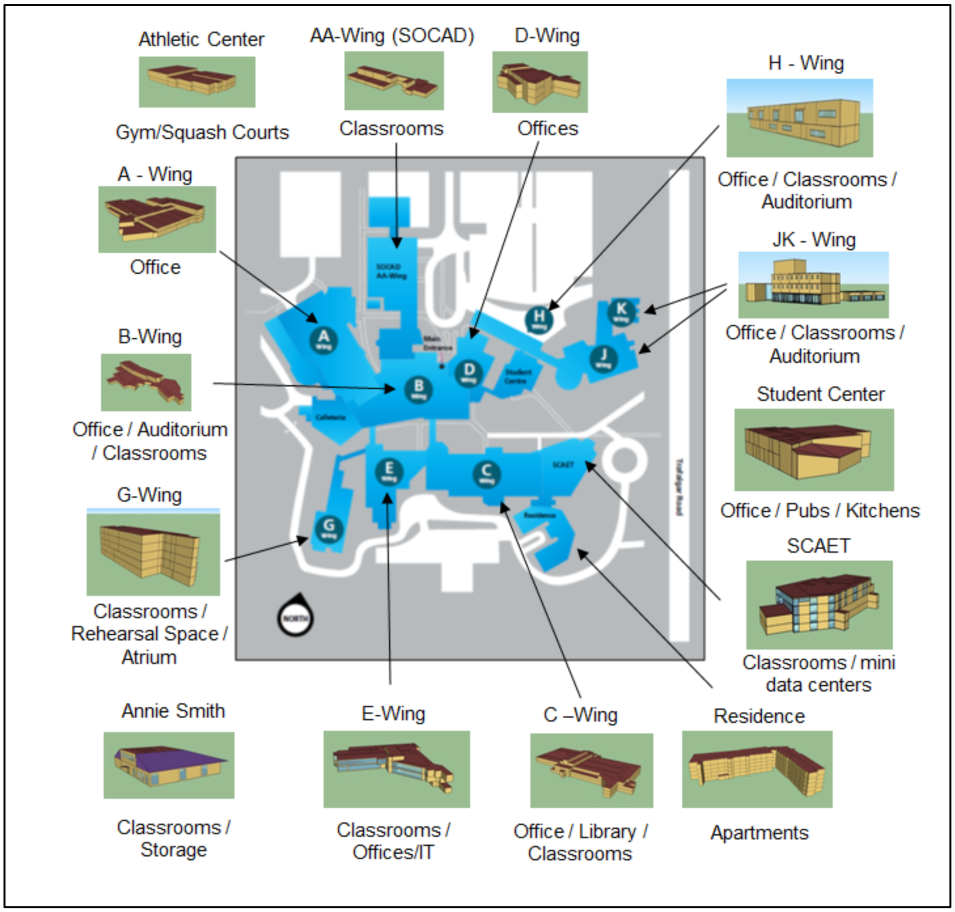


Figure 4-16 Trafalgar Baseline – Overview of Modeled Buildings

The breakdown of the modeled energy demand by end-use is shown in Figure 4.17.

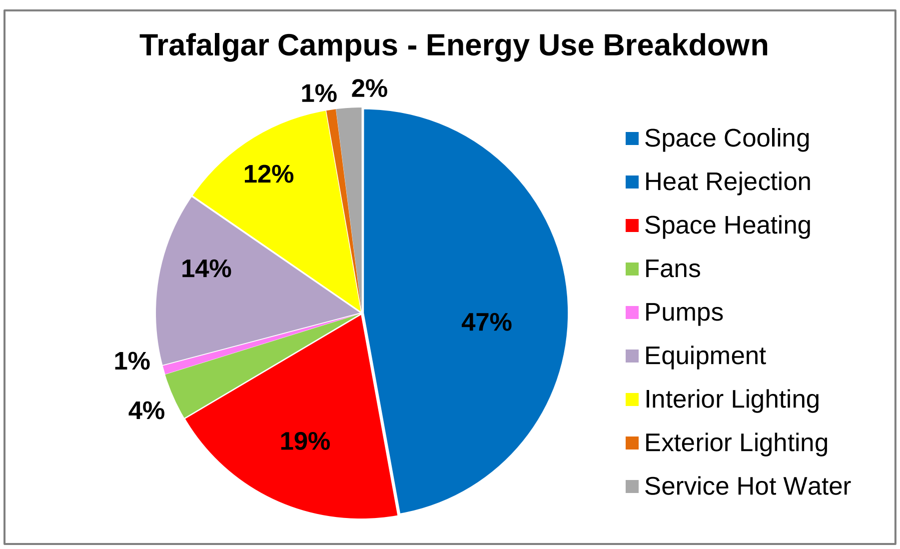
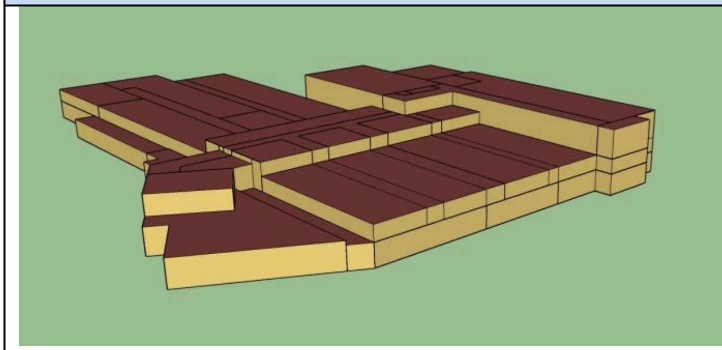


Figure 4-17 Trafalgar Campus Baseline – Modeled Building Energy End-uses

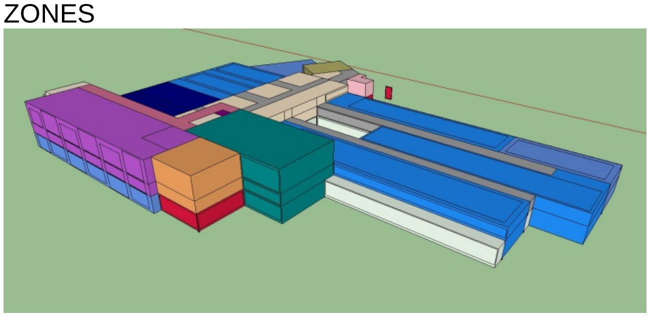
A building-by-building assessment including a description of the general condition of each building and the models used to calculate their estimated energy needs follows.

A Wing



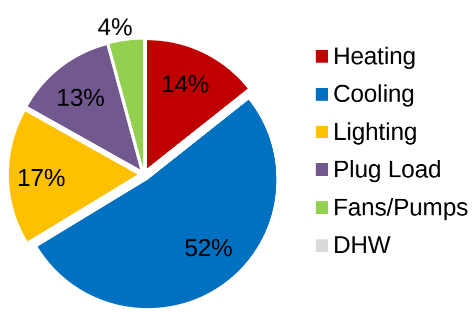
Floor area	113,558ft² / 10,550 m²
Built	1970
Construction Type	Steel and Poured Concrete; CMU / Framed Curtain Wall
Lighting Density	15.4 W/m²
Schedule	10 hours a day 8am – 6pm
Space usage	Classroom with some office space
HVAC	CAV w/Winter Reheat, on the steam loop

ZONES



Central Plant	No
Networked Piping	Steam/Cool
Stand Alone	No
RTUs	Yes
Chiller	No
Boilers	No
Gas Fired Unit Heater	No
BMS	Network
Gas Fired DHWT	No

Energy Use Intensity – Whole Building 439 kWh/m², the cooling load dominates this buildings energy use. Lighting, heating and equipment use equal amounts of energy.



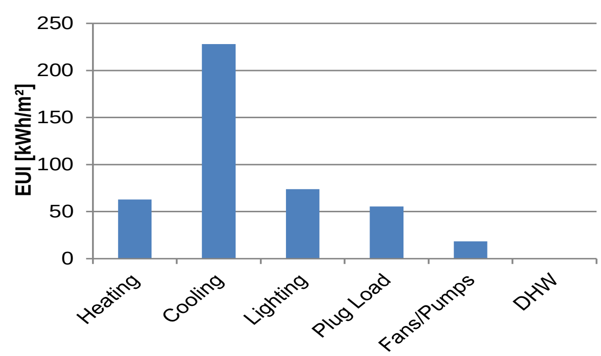
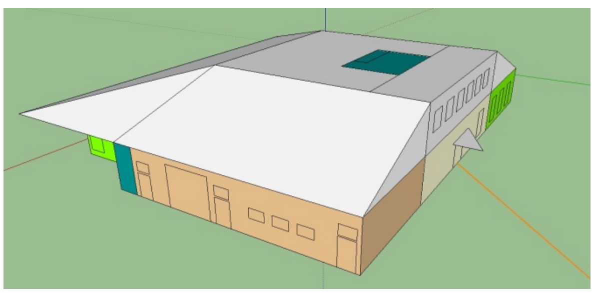


Figure 4-18 Trafalgar Campus - A-Wing Modeling Results

Annie Smith

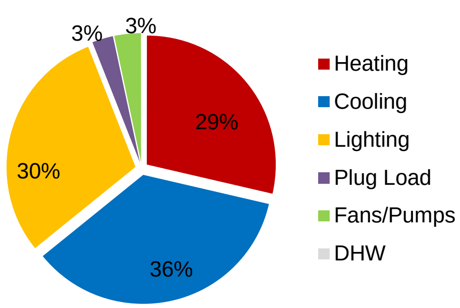
• Floor area	• 12,825 ft² / 1,191m²
• Built	• 1999
• Construction Type	• Steel; Framed Brick-Clad Wall
• Lighting Density	• 18.2 W/m²
• Schedule	• 10 hours a day 8am – 6pm
• Space usage	• Classroom, mechanical room and storage
• HVAC	• Central Plant with Gas Fired District hot water

ZONES



Central Plant	Steam
Networked Piping	Steam/Cool
Stand Alone	No
RTUs	No
Chiller	No
Boilers	No
Gas Fired Unit Heater	No
BMS	Network
Gas Fired DHWT	Yes

Energy Use Intensity – Whole Building 444 kWh/m², the cooling, heating and lighting loads dominate this buildings energy use.



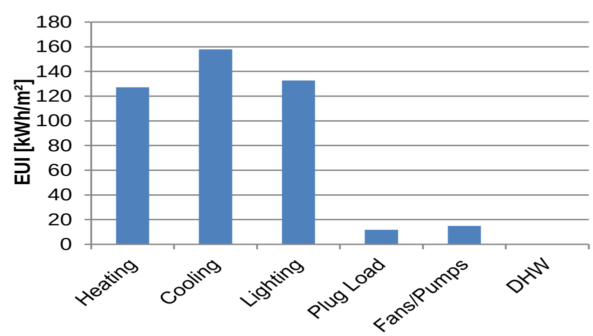
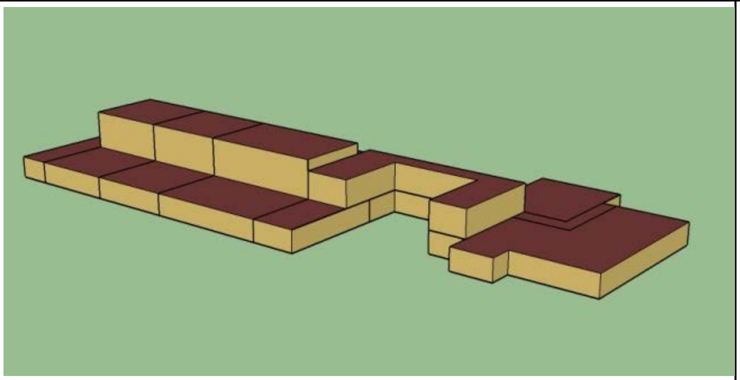


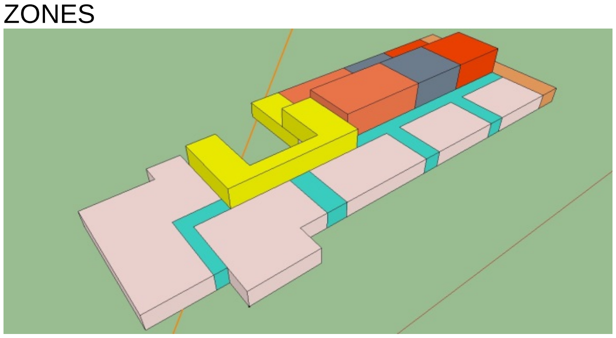
Figure 4-19 Trafalgar Campus – Annie Smith Modeling Results

AA Wing (SOCAD)



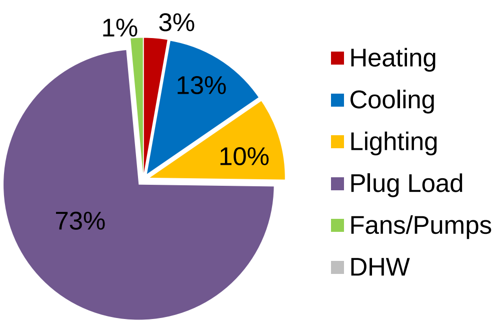
• Floor area	• 40,473 ft² / 3,760m²
• Built	• 2007
• Construction Type	• Steel; CMU Wall
• Lighting Density	• 8.4 W/m²
• Schedule	• 10 hours a day 8am – 6pm
• Space usage	• Classrooms
• HVAC	• Steam Loop connected, CAV w/Winter Reheat,

ZONES



Central Plant	Steam
Networked Piping	Steam/Cool
Stand Alone	No
RTUs	No
Chiller	No
Boilers	No
Gas Fired Unit Heater	No
BMS	Network
Gas Fired DHWT	Yes

Energy Use Intensity – Whole Building 563 kWh/m², the cooling, heating and lighting loads dominate this buildings energy use.



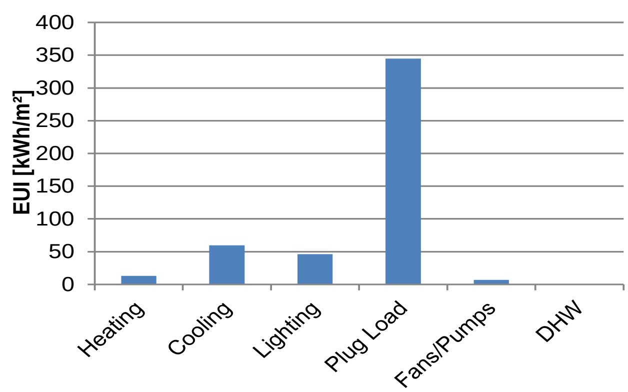
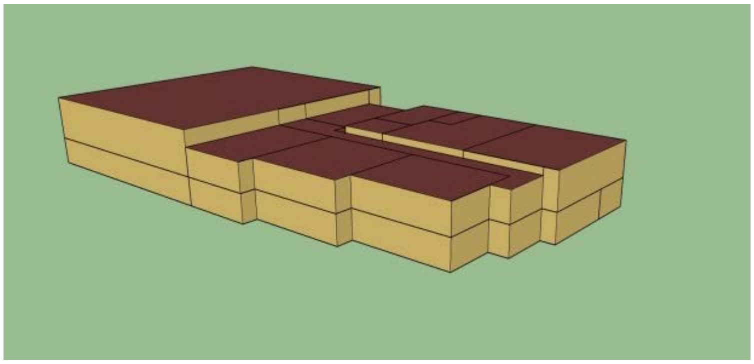


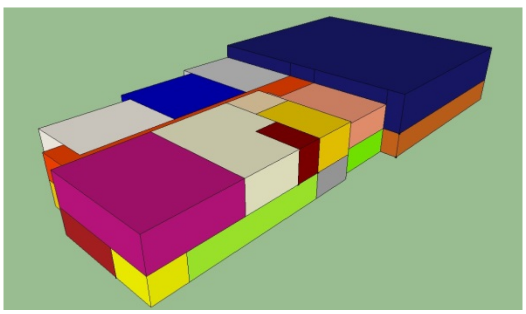
Figure 4-20 Trafalgar Campus – AA Wing Modeling Results

Athletic Center



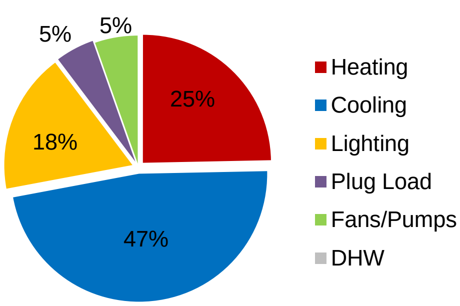
Floor area	31,302 ft² / 2,908m²
Built	1984
Construction Type	Steel w/ Concrete Slab; CMU / Framed Curtain Wall
Lighting Density	5.8 W/m²
Schedule	14 hours a day 8am – 10pm
Space usage	Gym, Squash Courts, Changing Rooms, Workout Rooms
HVAC	CAV w/Winter Reheat

ZONES



Central Plant	Yes
Networked Piping	HW/Cool
Stand Alone	Yes
RTUs	No
Chiller	Yes
Boilers	No
Gas Fired Unit Heater	No
BMS	Network
Gas Fired DHWT	Yes

Energy Use Intensity – Whole Building 592 kWh/m², the cooling, heating and lighting loads dominate this buildings energy use.



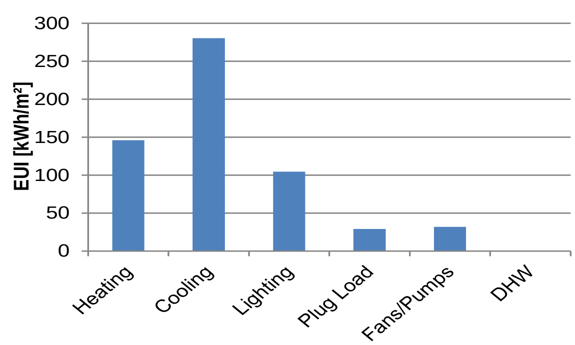
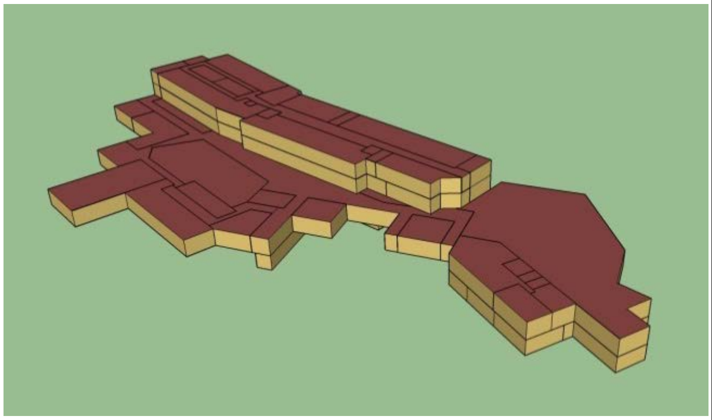


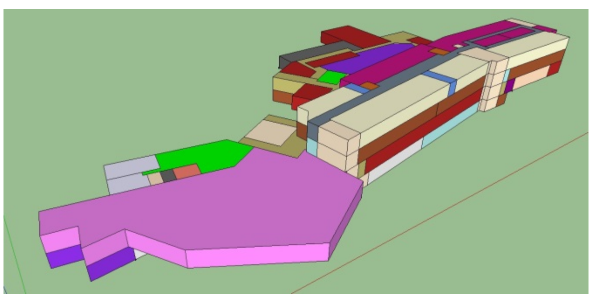
Figure 4-21 Trafalgar Campus - Athletic Centre Modeling Results

B-Wing



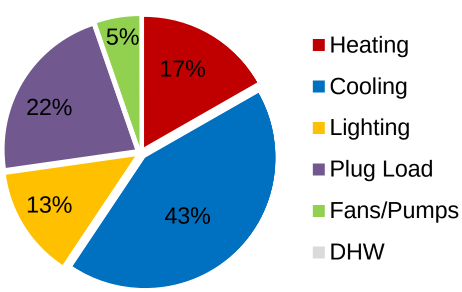
Floor area	128,337 ft² / 11,923m²
Built	1970
Construction Type	Steel and Poured Concrete; CMU / Framed Curtain Wall
Lighting Density	9.3 W/m²
Schedule	10 hours a day 8am – 6pm
Space usage	Offices, Auditorium, Classrooms, Mechanical Rooms
HVAC	CAV w/Winter Reheat, VAV

ZONES



Central Plant	Yes
Networked Piping	Steam/Cool
Stand Alone	No
RTUs	Yes
Chiller	Yes
Boilers	No
Gas Fired Unit Heater	No
BMS	Network
Gas Fired DHWT	Yes

Energy Use Intensity – Whole Building 410 kWh/m², the cooling loads dominate this buildings energy use.



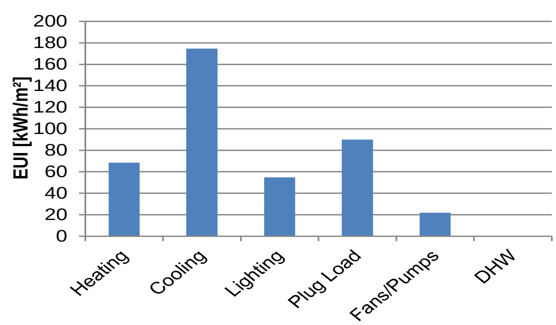
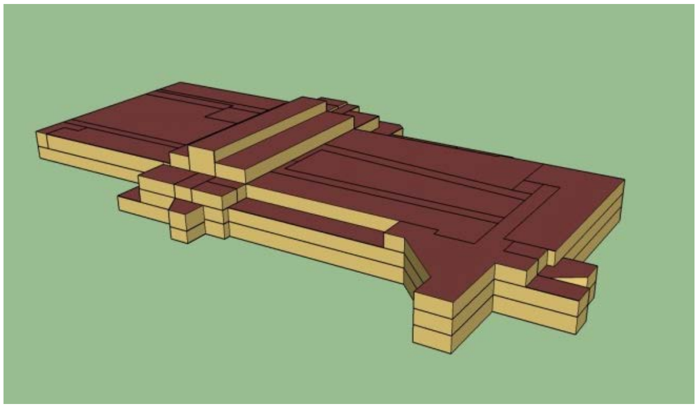


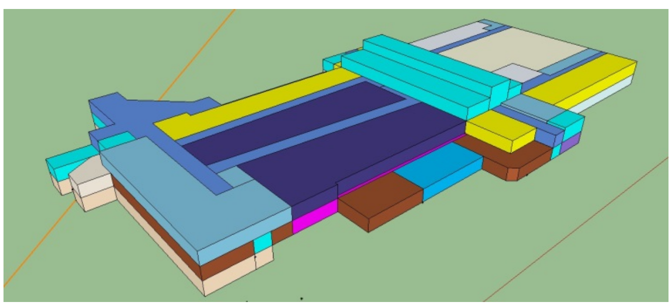
Figure 4-22 Trafalgar Campus - B Wing Modeling Results

C-Wing



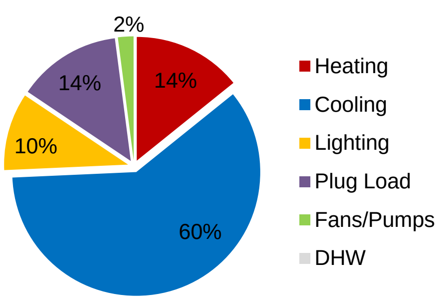
Floor area	77,970 ft² / 7,244m²
Built	1972
Construction Type	Steel w/ Concrete Slab; CMU / Framed Curtain Wall
Lighting Density	4.9 W/m²
Schedule	10 hours a day 8am – 6pm
Space usage	Library, Classrooms, Offices
HVAC	CAV w/Winter Reheat

ZONES



Central Plant	Yes
Networked Piping	HW/Cool
Stand Alone	No
RTUs	Yes
Chiller	Yes
Boilers	Yes
Gas Fired Unit Heater	No
BMS	Network
Gas Fired DHWT	Yes

Energy Use Intensity – Whole Building 580 kWh/m², the cooling loads dominate this buildings energy use when a COP of 1 is considered. The heating, lighting and equipment loads consume roughly equal amounts of energy.



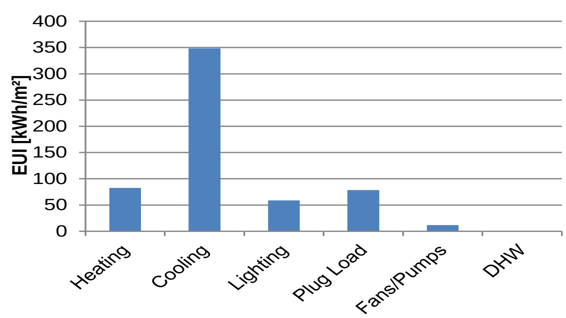
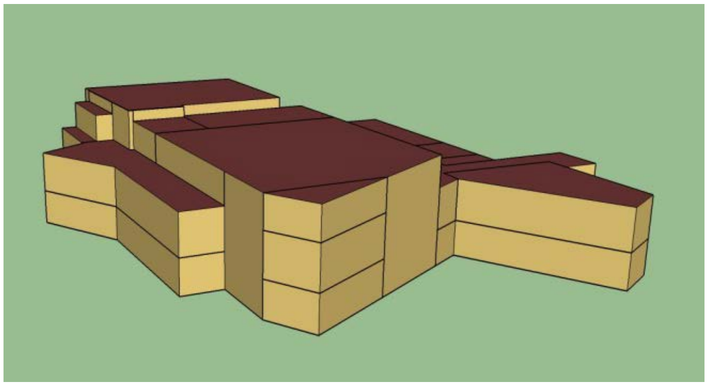


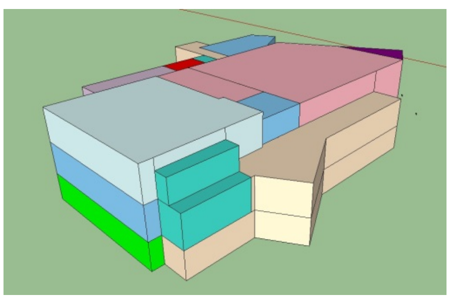
Figure 4-23 Trafalgar Campus - C Wing Modeling Results

D-Wing



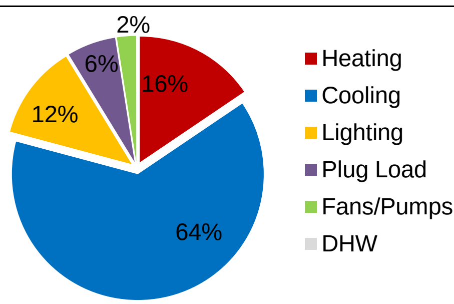
• Floor area	• 28,874 ft² / 2,682m²
• Built	• 1975
• Construction Type	• Steel; CMU Wall
• Lighting Density	• 8.6 W/m²
• Schedule	• 10 hours a day 8am – 6pm
• Space usage	• Offices
• HVAC	• CAV w/Winter Reheat, RTU

ZONES



Central Plant	No
Networked Piping	Steam/Cool
Stand Alone	No
RTUs	Yes
Chiller	No
Boilers	No
Gas Fired Unit Heater	No
BMS	Network
Gas Fired DHWT	No

Energy Use Intensity – Whole Building 713 kWh/m², the cooling loads dominate this buildings energy use when a COP of 1 is considered. The heating and lighting loads consume roughly equal amounts of energy.



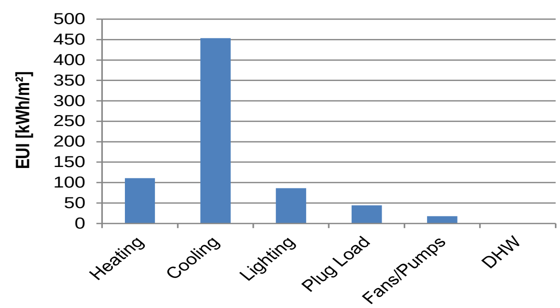
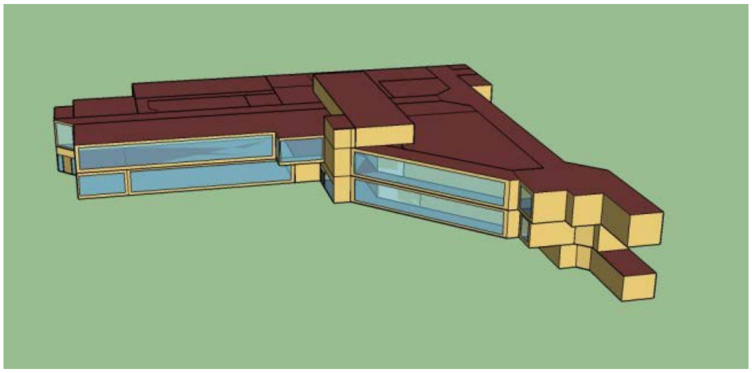


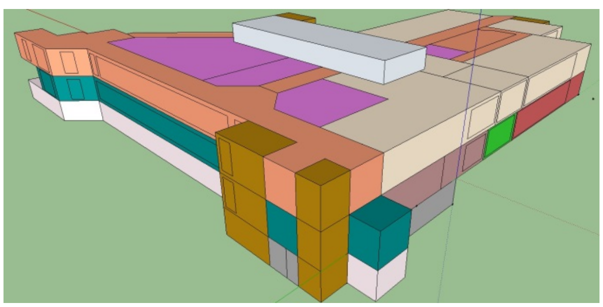
Figure 4-24 Trafalgar Campus - D Wing Modeling Results

E-Wing



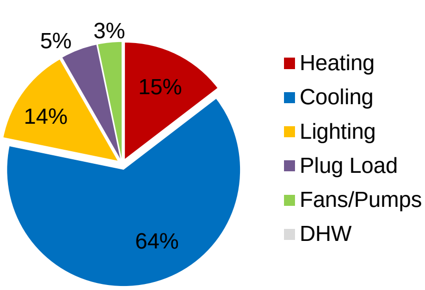
• Floor area	• 46,144 ft² / 4,287 m²
• Built	• 1985
• Construction Type	• Steel w/ Concrete Slab; CMU / Framed Curtain Wall
• Lighting Density	• 43.9 W/m² (8.9W/m²)
• Schedule	• Varying schedules ranging from 3 hours to 17 hours a day
• Space usage	• Offices, Classrooms, IT rooms
• HVAC	• RTUs

ZONES



Central Plant	No
Networked Piping	HW/Cool
Stand Alone	No
RTUs	Yes
Chiller	No
Boilers	No
Gas Fired Unit Heater	No
BMS	Network
Gas Fired DHWT	Yes

Energy Use Intensity – Whole Building 969 kWh/m², the cooling loads dominate this buildings energy use when a COP of 1 is considered. The heating and lighting loads consume roughly equal amounts of energy.



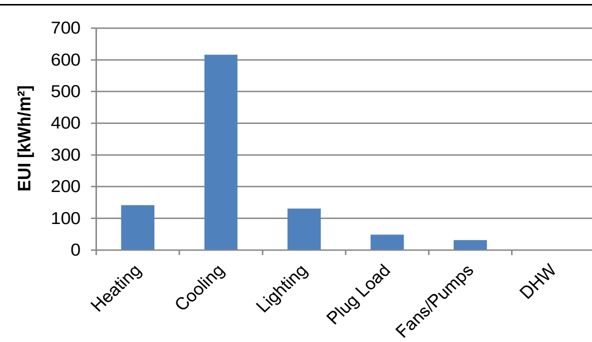
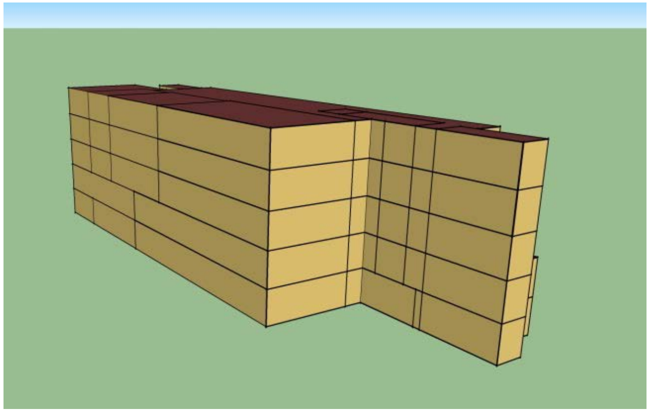


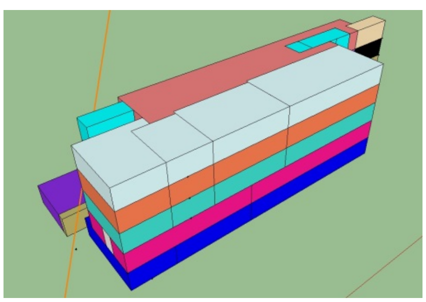
Figure 4-25 Trafalgar Campus - E Wing Modeling Results

G-Wing



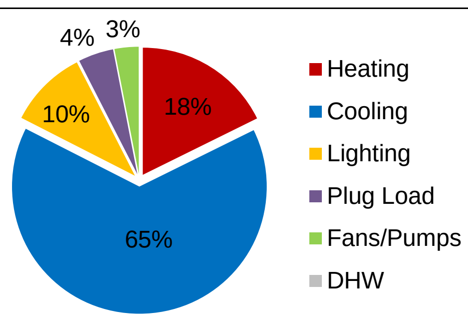
Floor area	58,810 ft² / 5,464 m²
Built	1991
Construction Type	Steel w/ Concrete Slab; CMU / Framed Curtain Wall
Lighting Density	7.9 W/m²
Schedule	10 hours a day 8am – 6pm
Space usage	Classrooms, Rehearsal Space, Large Atrium
HVAC	VAV

ZONES



Central Plant	Heating
Networked Piping	HW/Cool
Stand Alone	Yes
RTUs	No
Chiller	No
Boilers	Yes
Gas Fired Unit Heater	No
BMS	Stand Alone
Gas Fired DHWT	Yes

Energy Use Intensity – Whole Building 641kWh/m², the cooling loads dominate this buildings energy use when a COP of 1 is considered. The heating and lighting loads consume roughly equal amounts of energy.



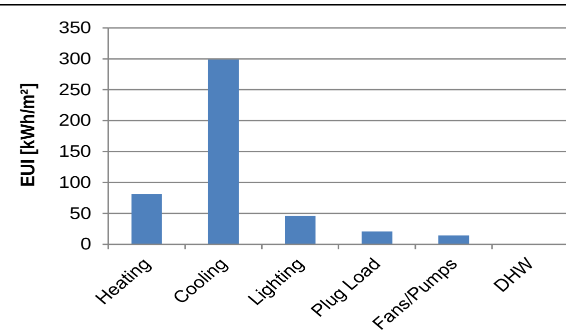
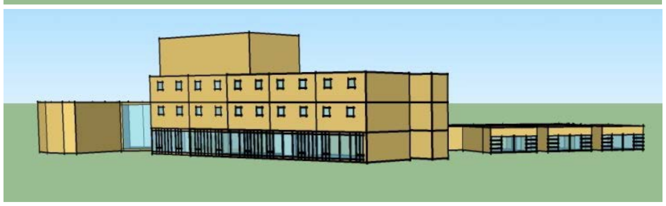


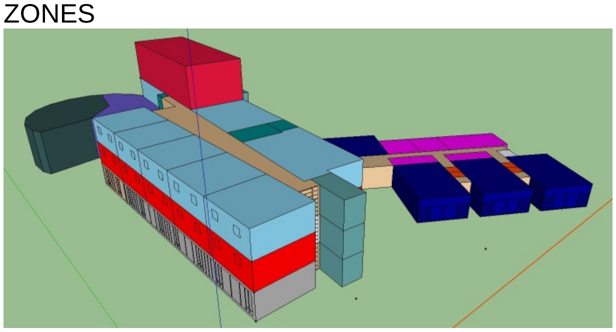
Figure 4-26 Trafalgar Campus - G Wing Modeling Results

HJK-Wing



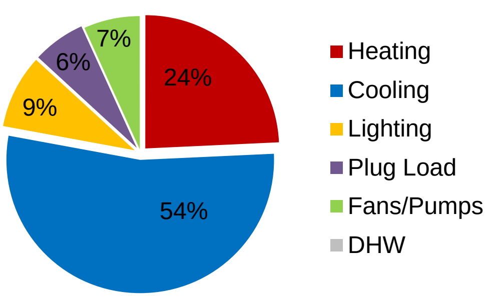
Floor area	89,676 ft² / 8,331m²
Built	2003
Construction Type	Steel w/ Concrete Slab; Framed Wall w/ Some CMU
Lighting Density	12.3 W/m²
Schedule	10 hours a day 8am – 6pm
Space usage	Classrooms, Offices, Auditorium
HVAC	VAV

ZONES



Central Plant	No / Yes / No
Networked Piping	HW/Cool
Stand Alone	No / No / No
RTUs	No / Yes / No
Chiller	No / No / No
Boilers	No / Yes / No
Gas Fired Unit Heater	No / No / No
BMS	Network
Gas Fired DHWT	Yes / Yes / No

Energy Use Intensity – Whole Building 1935 kWh/m², the cooling loads dominate this buildings energy use when a COP of 1 is considered. The heating loads also consume a large amount of energy.



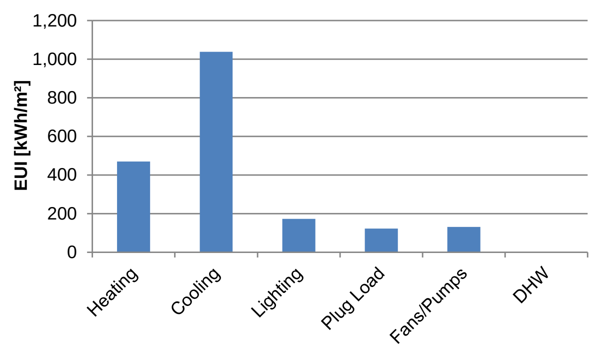
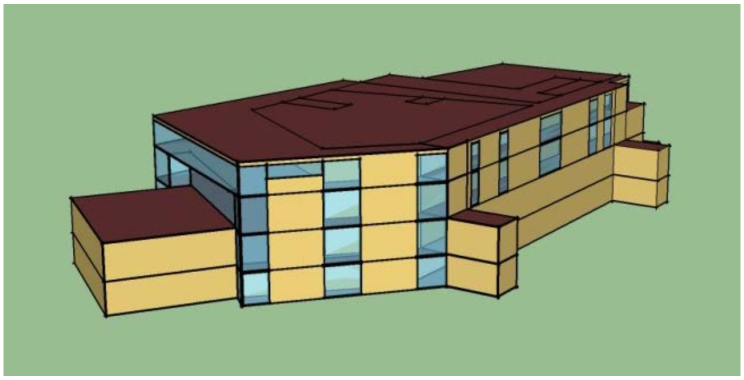


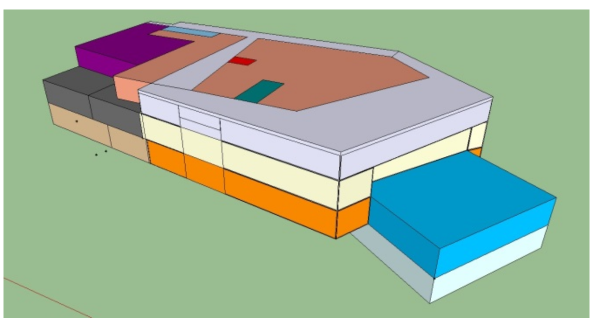
Figure 4-27 Trafalgar Campus - HJK Wing Modeling Results

SCAET-Wing



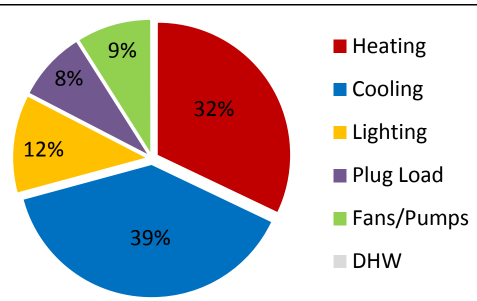
Floor area	85,000 ft² / 7,897 m²
Built	1991
Construction Type	Steel; Framed Wall w/ Brick, Wood, Steel Clad
Lighting Density	11.8 W/m²
Schedule	10 hours a day 8am – 6pm
Space usage	Classrooms, Mini Data Centers, Auditorium
HVAC	VAV

ZONES



Central Plant	Yes
Networked Piping	HW/Cool
Stand Alone	Yes
RTUs	No
Chiller	No
Boilers	Yes
Gas Fired Unit Heater	No
BMS	Network
Gas Fired DHWT	Yes

Energy Use Intensity – Whole Building 323 kWh/m², the cooling loads dominate this buildings energy use when a COP of 1 is considered. The heating loads also consume a large amount of energy.



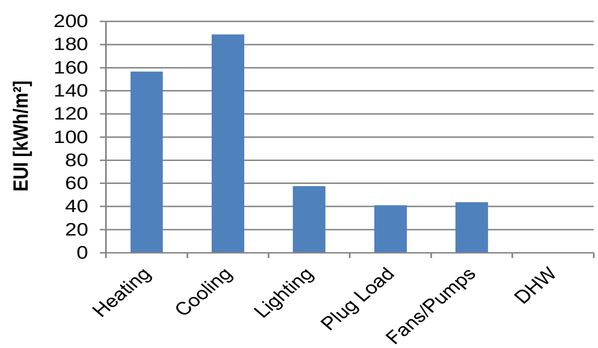
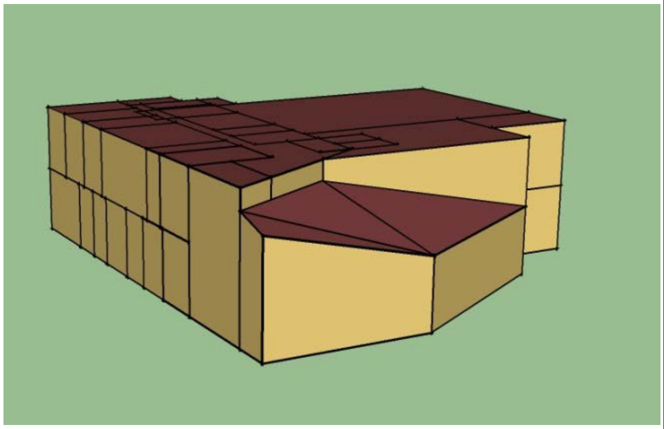


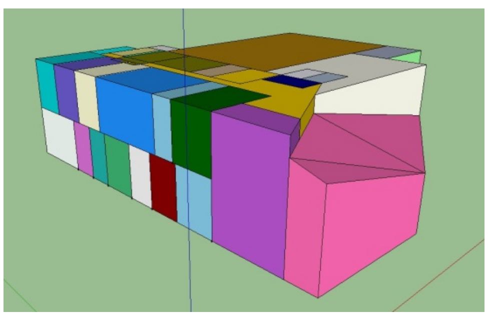
Figure 4-28 Trafalgar Campus - SCAET Wing Modeling Results

Student Center



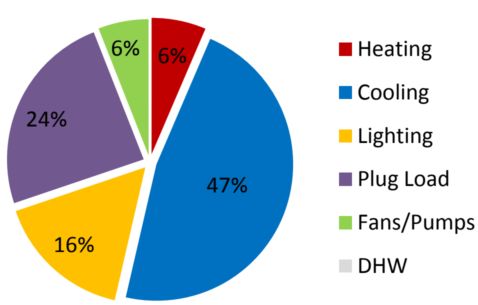
Floor area	17,278 ft² / 1,605 m²
Built	1991
Construction Type	Steel; CMU / Framed Curtain Wall
Lighting Density	13.2 W/m²
Schedule	10 hours a day 8am – 6pm
Space usage	Office, Pub and Kitchens
HVAC	RTUs

ZONES



Central Plant	No
Networked Piping	No
Stand Alone	Yes
RTUs	Yes
Chiller	No
Boilers	No
Gas Fired Unit Heater	No
BMS	Network
Gas Fired DHWT	Yes

Energy Use Intensity – Whole Building 654 kWh/m², the cooling loads dominate this buildings energy use when a COP of 1 is considered. The equipment and lighting loads also consume a large amount of energy.



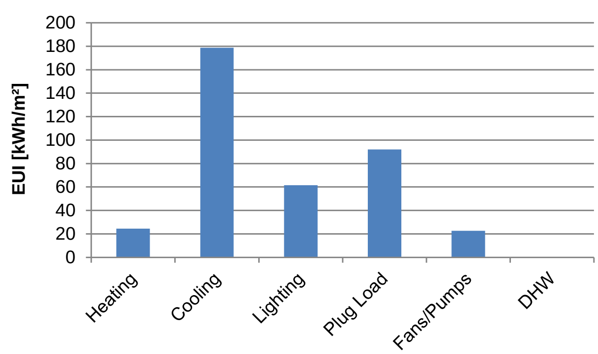


Figure 4-29 Trafalgar Campus – Student Centre Modeling Results

4.4.2 Building Energy Use – Davis Campus

Davis campus has a mix of teaching buildings, laboratories and residences as well as a student centre. This campus has a science and engineering focus with large open areas in the buildings for lab work. An overview of the layout and main buildings is shown in Figure 4.30.

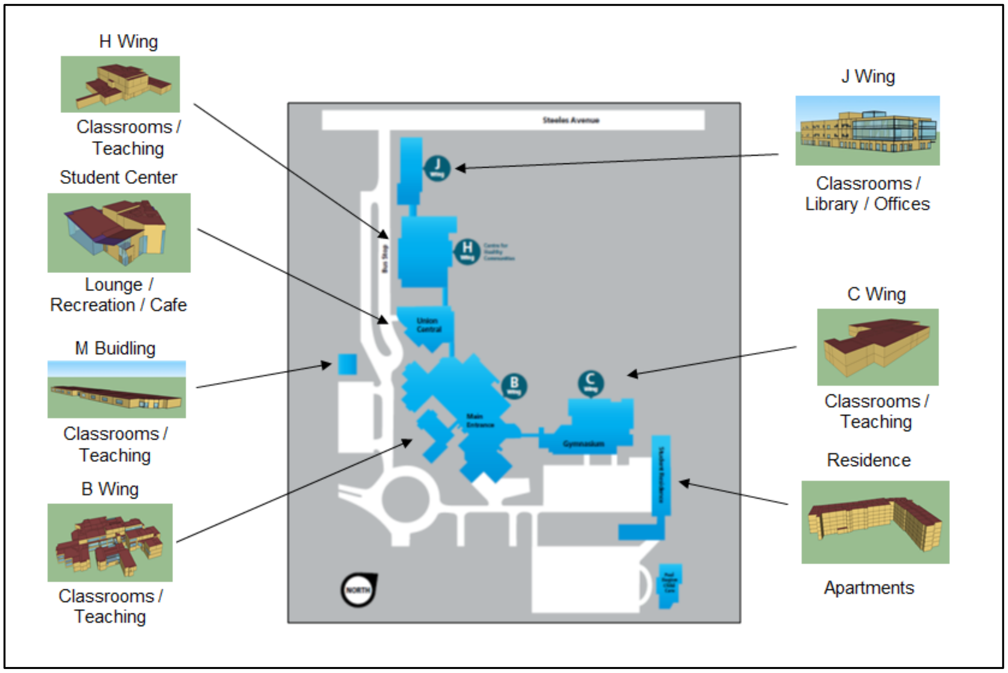


Figure 4-30 Davis Campus – Overview of Modeled Buildings

The breakdown of the energy use by modeled end-use is shown in Figure 4.31.

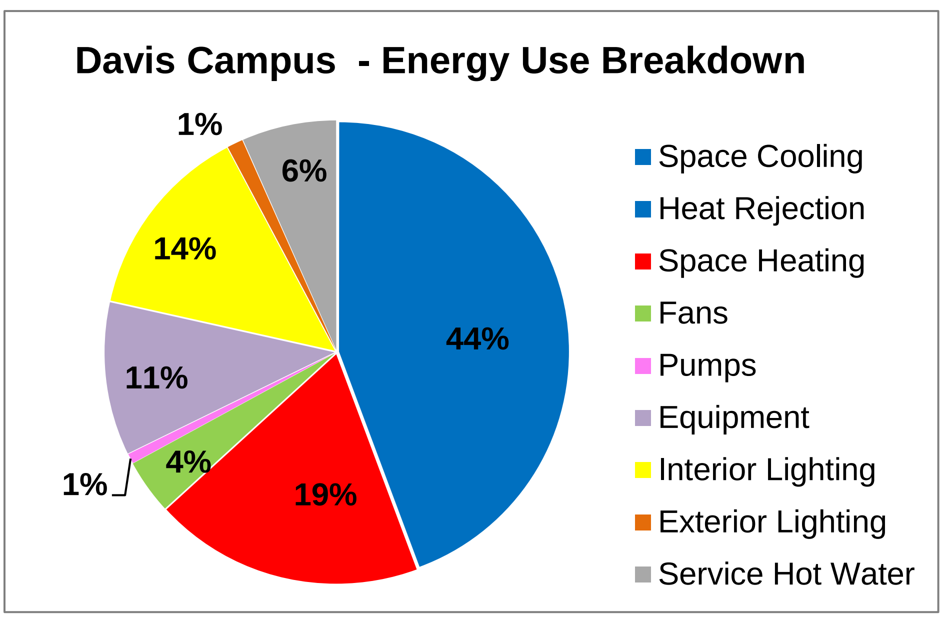


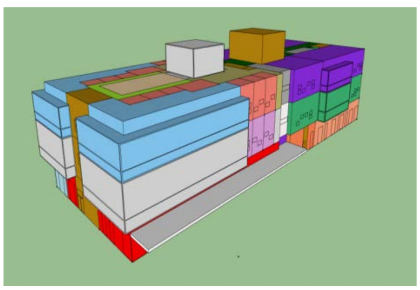
Figure 4-31 Davis Campus Baseline – Modeled Building Energy End-uses

A building-by-building assessment including a description of the general condition of each building and the models used to calculate their estimated energy needs follows.

J-Wing

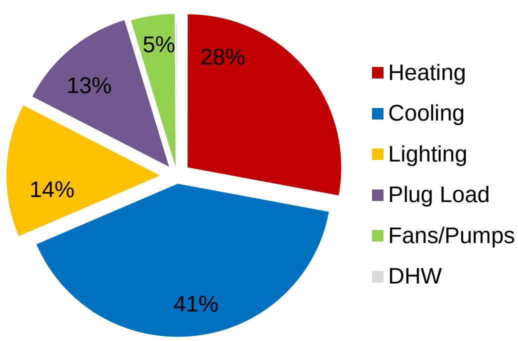
Floor area	69,988 ft² / 6,502 m²
Built	2009
Construction Type	Steel/concrete structure, framed shell
Lighting Density	10.94 W/ft²
Schedule	5 – 13hrs/day
Space usage	Classrooms, library/study, Tim Horton's, offices, puddle rooms
HVAC	Heated and cooled by 6 rooftop units 5 x 30 Tons, 1 x 40 Ton

ZONES



Central Plant	No
Networked Piping	No
Stand Alone	Yes
RTUs	Yes
Chiller	No
Boilers	No
Gas Fired Unit Heater	No
BMS	Stand Alone
Gas Fired DHWT	Yes

Energy Use Intensity – Whole Building 433 kWh/m², the heating and cooling loads dominate this buildings energy use. Lighting and equipment use about equal amounts of energy.



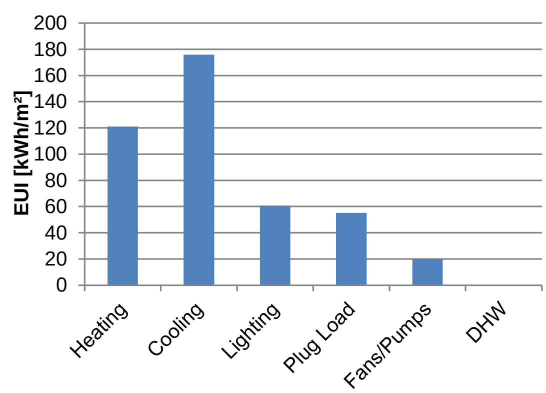
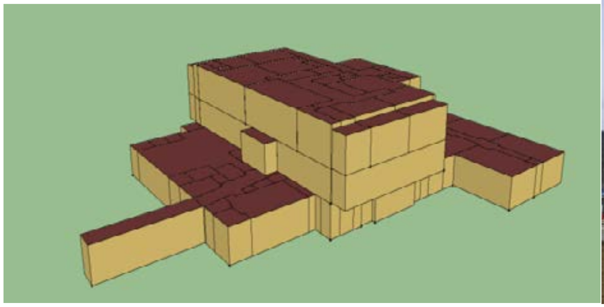


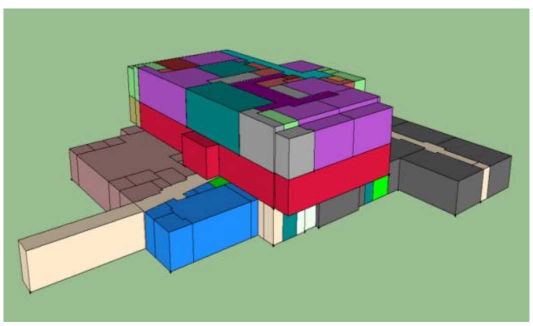
Figure 4-32 Davis Campus – J Wing Modeling Results

H-Wing



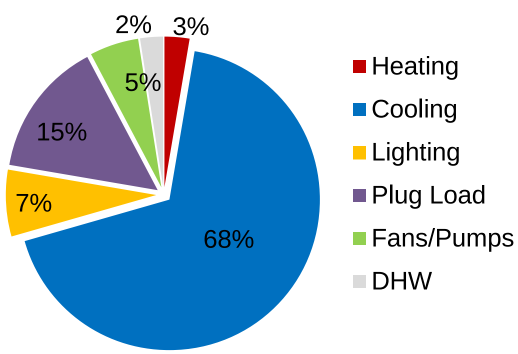
• Floor area	• 85,649 ft² / 7,957 m²
• Built	• 2007
• Construction Type	• Steel/concrete structure, framed shell
• Lighting Density	• 7.7 W/ft²
• Schedule	• 14hrs/day
• Space usage	• Classrooms, IT, boardrooms, gym, offices, puddle rooms
• HVAC	• 5 heating & cooling coils,1 x 50HP emergency service boiler, 1 x steam boiler-winter

ZONES



Central Plant	No
Networked Piping	HW/Cool
Stand Alone	No
RTUs	No
Chiller	No
Boilers	Yes
Gas Fired Unit Heater	No
BMS	Network
Gas Fired DHWT	No

Energy Use Intensity – Whole Building 615 kWh/m², the cooling load and plug load dominates this buildings energy use (≈75%). The heating energy in this building is fairly low.



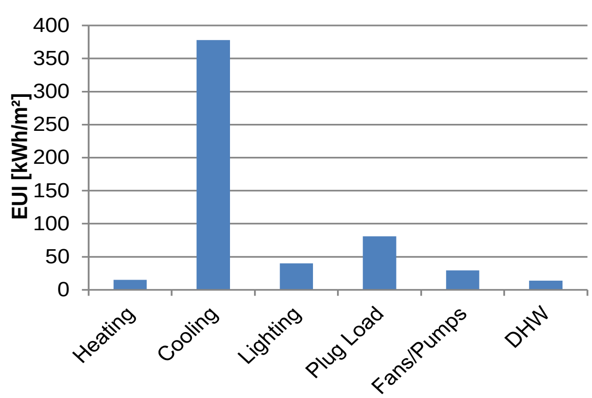
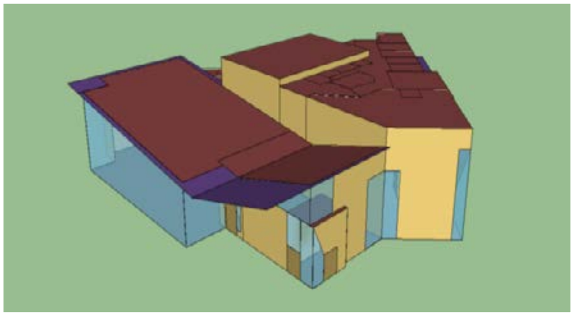


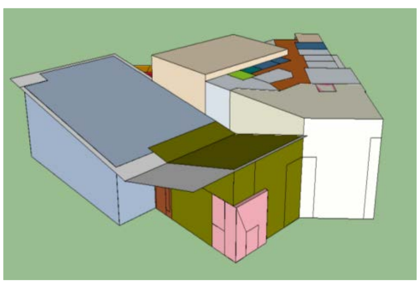
Figure 4-33 Davis Campus – H Wing Modeling Results

Student Center



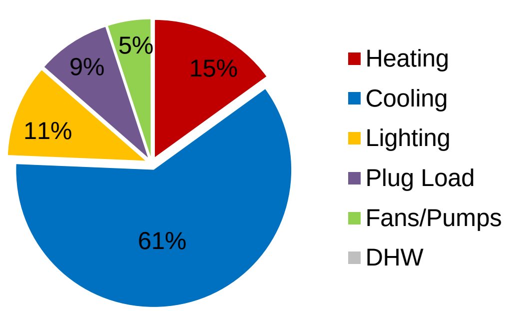
Floor area	22,500 ft² / 2,090 m²
Built	2000
Construction Type	Steel structure framed shell
Lighting Density	5.5 W/ft²
Schedule	Offices 8hrs/day, Corridors 12hrs+
Space usage	Pub, kitchen, storage, offices, A/V, coffee house
HVAC	3 heating and cooling coils 1 air handling unit with makeup heat

ZONES



Central Plant	No
Networked Piping	HW/Cool
Stand Alone	No
RTUs	No
Chiller	No
Boilers	No
Gas Fired Unit Heater	No
BMS	Network
Gas Fired DHWT	Yes

Energy Use Intensity – Whole Building 753 kWh/m², the cooling and equipment loads dominate this buildings energy use. Fans, pumps and heating use equal amounts of energy.



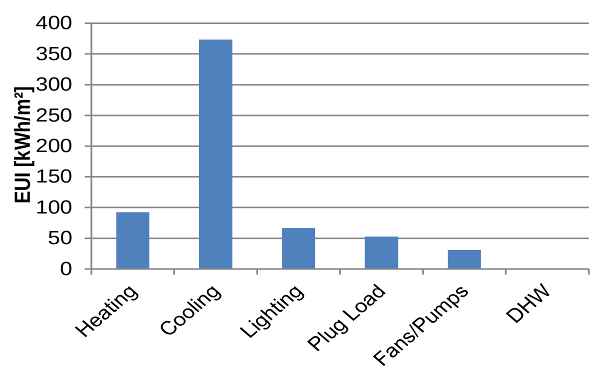
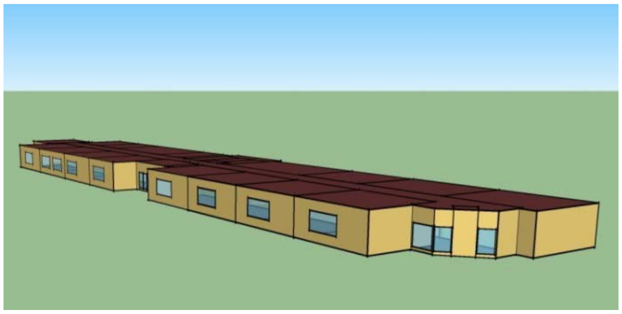


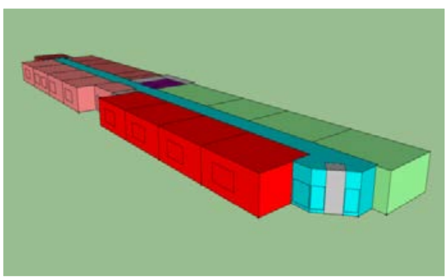
Figure 4-34 Davis Campus – Student Centre Modeling Results

M-Building



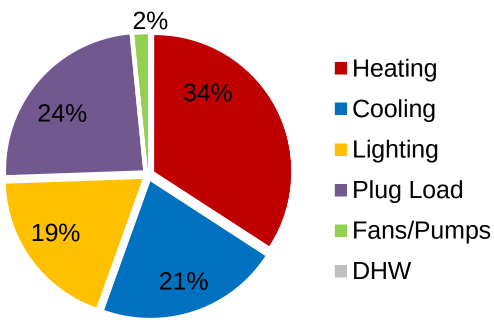
Floor area	22,876 ft² / 2,125 m²
Built	1982
Construction Type	Steel structure, framed shell
Lighting Density	6.2 W/ft²
Schedule	14hrs/day
Space usage	Classrooms, puddle rooms, corridor, washrooms
HVAC	Heated and cooled by 2 RTUs, with electric heat

ZONES



Central Plant	No
Networked Piping	No
Stand Alone	Yes
RTUs	Yes
Chiller	No
Boilers	No
Gas Fired Unit Heater	No
BMS	Network
Gas Fired DHWT	Yes

Energy Use Intensity – Whole Building 335 kWh/m², the heating load and plug load dominates this buildings energy use. The lighting and cooling loads are also fairly high.



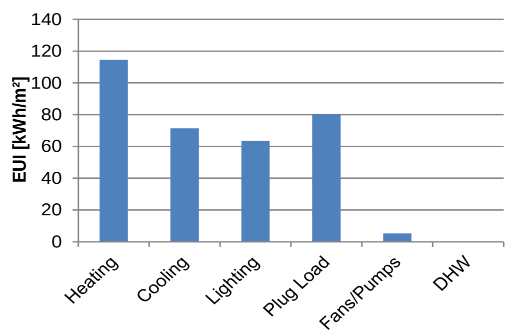
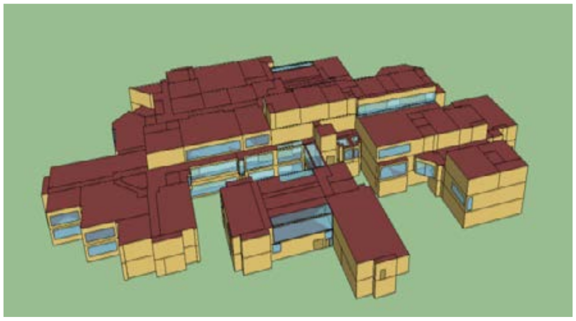


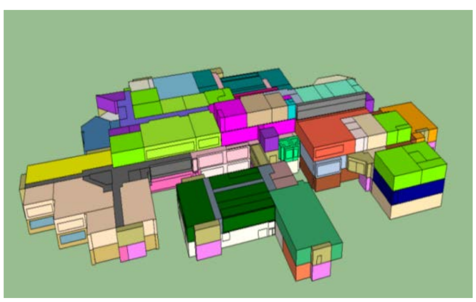
Figure 4-35 Davis Campus – M Building Modeling Results

B-Wing



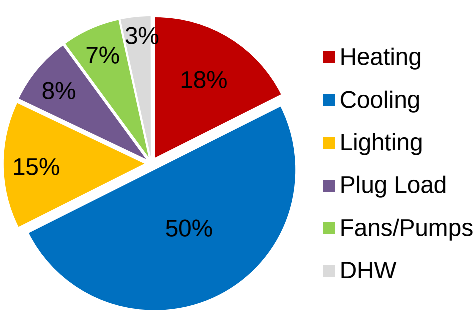
Floor area	15,599 ft² / 18,037 m²
Built	1977
Construction Type	Poured concrete
Lighting Density	8.9 W/ft²
Schedule	14hrs/day
Space usage	Classrooms, CAD labs, offices, admin, bookstore, food services, IT, puddle room
HVAC	Central boiler and chiller plant, with 6 heating and cooling coils, 5 cooling only coils, and 2 heating only coils, 1 Univent System (w 16 unit fans), and 3 RTUs (2 gas heat, 1 electric)

ZONES



Central Plant	Yes
Networked Piping	HW/Cool
Stand Alone	No
RTUs	Yes
Chiller	Yes
Boilers	Yes
Gas Fired Unit Heater	No
BMS	Network
Gas Fired DHWT	Yes

Energy Use Intensity – Whole Building 354 kWh/m², the cooling load dominates this buildings energy use. The lighting and heating is also fairly high.



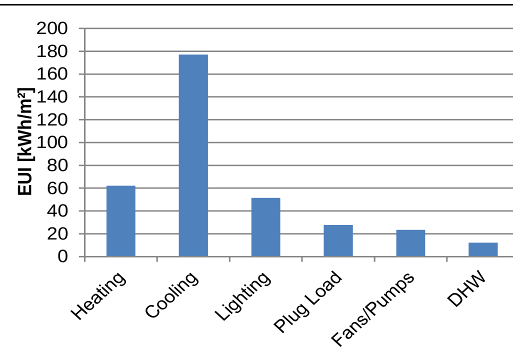
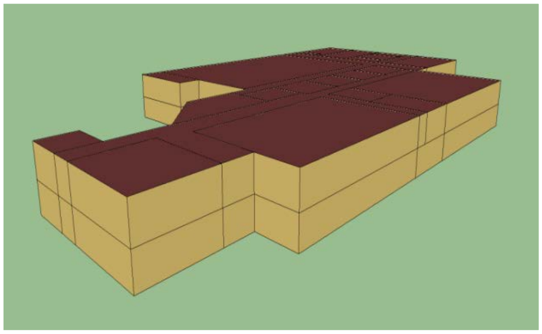


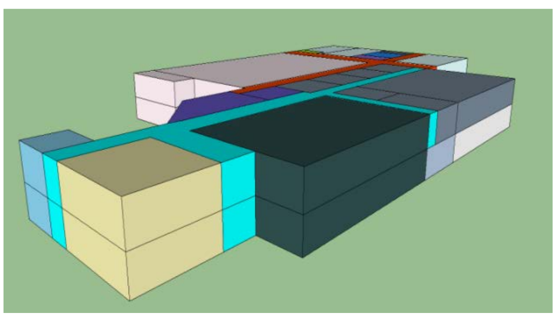
Figure 4-36 Davis Campus – B Wing Modeling Results

C-Wing



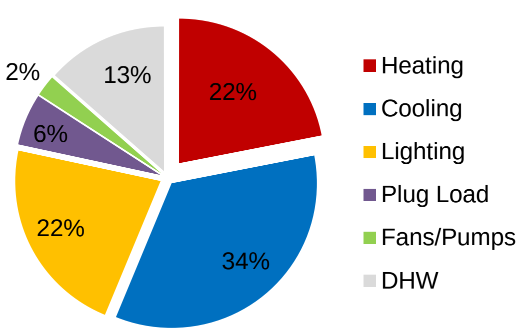
Floor area	72,335 ft² / 6,721 m²
Built	1977 renovated 2004
Construction Type	Poured concrete (old), steel structure with framed wall (new)
Lighting Density	8.4 W/ft²
Schedule	14hrs/day
Space usage	Gym, classrooms, electromechanical and electronics labs,
HVAC	3 heating and cooling coils: 1 with VAV and heating/cooling deck;
	1 with heat wheel unit, and; 1 with thermo deck, 1 additional gas-fired RTU

ZONES



Central Plant	No
Networked Piping	HW/Cool
Stand Alone	No
RTUs	Yes
Chiller	No
Boilers	No
Gas Fired Unit Heater	No
BMS	Network
Gas Fired DHWT	No

Energy Use Intensity – Whole Building 388 kWh/m², the heating, cooling, and lighting loads dominate this buildings energy use. The domestic hot water also has fairly high energy use.



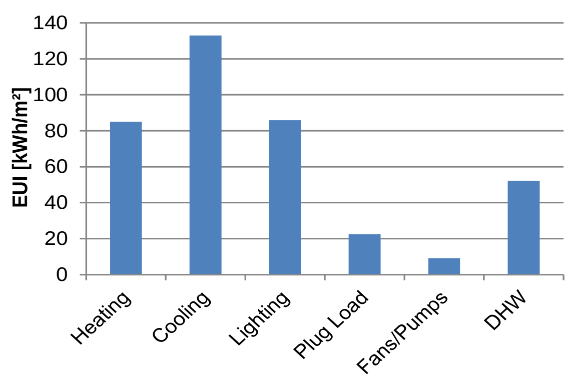
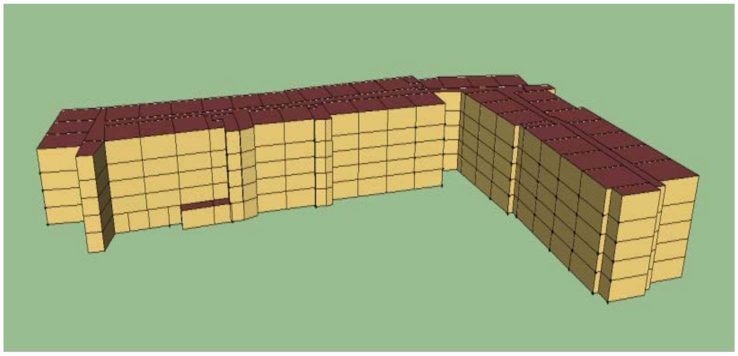


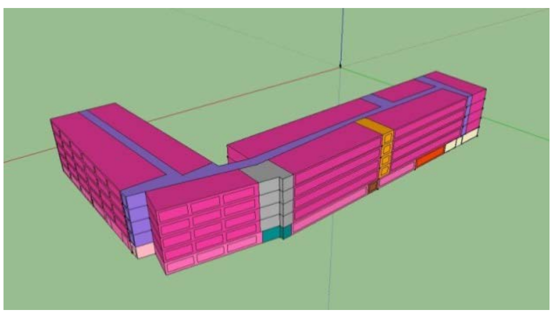
Figure 4-37 Davis Campus – C Wing Modeling Results

Residence



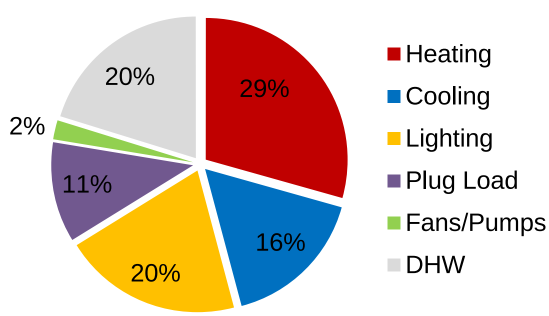
Floor area	120,188 ft² / 11,166 m²
Built	2001
Construction Type	Steel structure, framed shell
Lighting Density	12.4 W/ft²
Schedule	24 hrs
Space usage	Living quarters, corridors, IT rooms, reception, communal areas
HVAC	Heated and cooled by 6 rooftop units 5 x 30 Tons, 1 x 40 Ton

ZONES



Central Plant	Yes
Networked Piping	No
Stand Alone	Yes
RTUs	No
Chiller	Yes
Boilers	Yes
Gas Fired Unit Heater	No
BMS	Stand Alone
Gas Fired DHWT	Yes

Energy Use Intensity – Whole Building 351 kWh/m², the heating, domestic hot water and lighting load dominates this buildings energy use. The equipment and cooling also have fairly high energy use



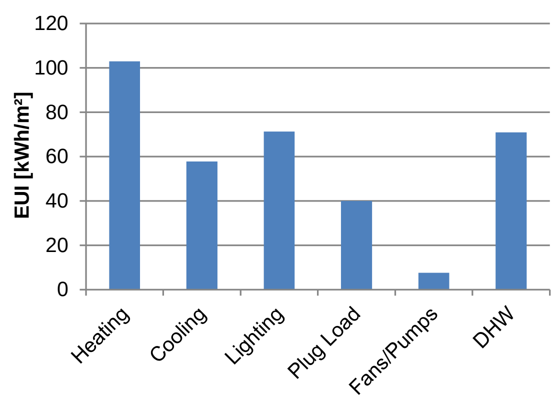


Figure 4-38 Davis Campus – Residence Modeling Results

4.4.3 Building Energy Use – Skills Training Center

The STC campus has one building which contains labs and classrooms. An overview of the layout and main building is shown in Figure 4.39.

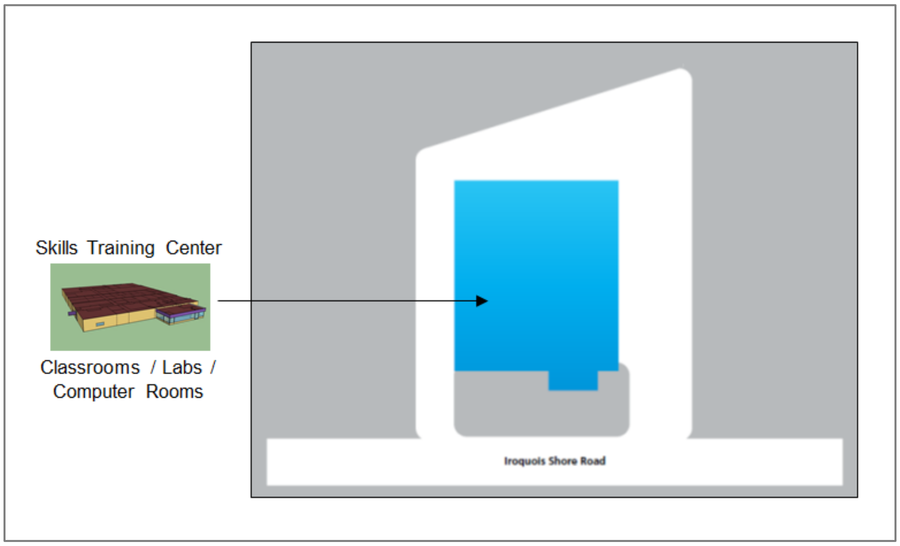


Figure 4-39 Davis Campus – Layout of Modeled Building

The breakdown of the modeled energy end-uses is shown in Figure 4.40.

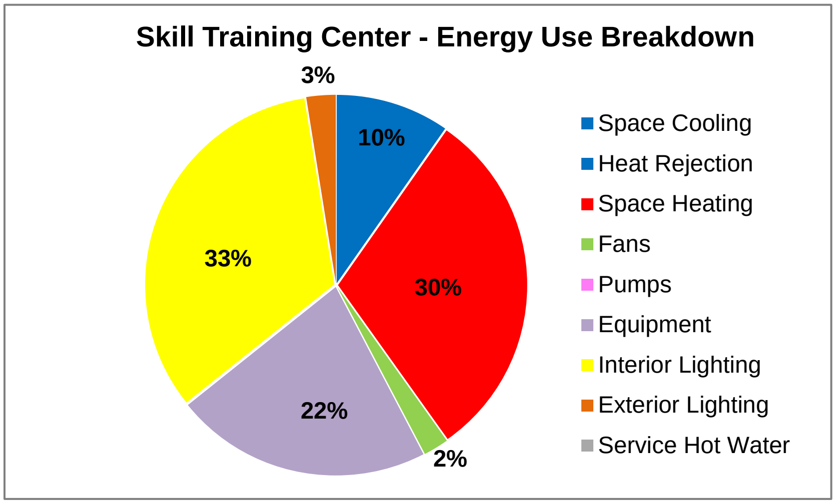
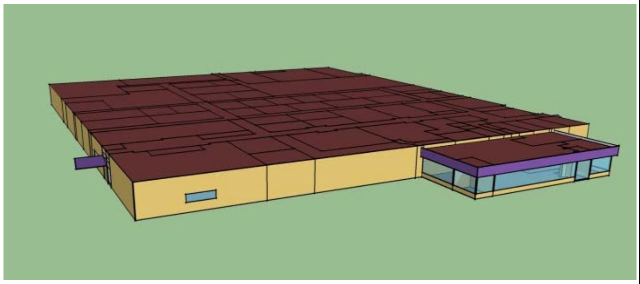


Figure 4-40 Skills Training Center Baseline–Modeled Building Energy End-uses

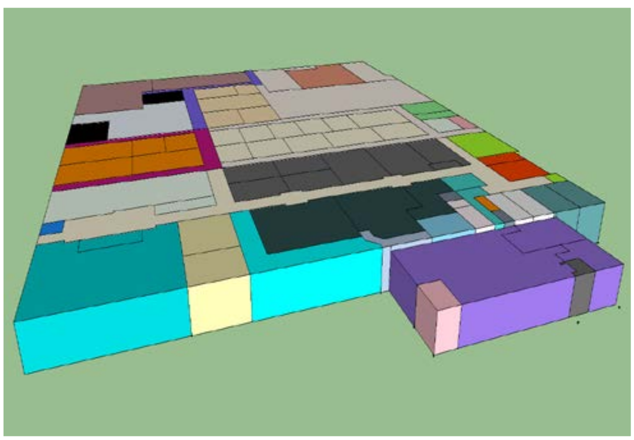
A building assessment including a description of the general condition of the building and the models used to calculate the estimated energy needs follows.

Skills Training Center

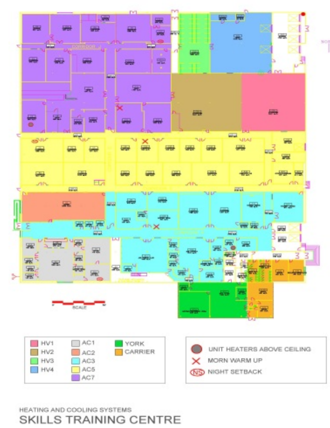


Floor area	88,000 ft² / 8,175 m²
Built	1971
Construction Type	Steel framed metal building
Lighting Density	10.9 W/ft²
Schedule	5 – 13hrs/day
Space usage	Classrooms, Labs, Computer rooms
HVAC	7 RTUs natural gas fired, 20 exhaust fans, 6 unit heaters and 17 electric duct heaters

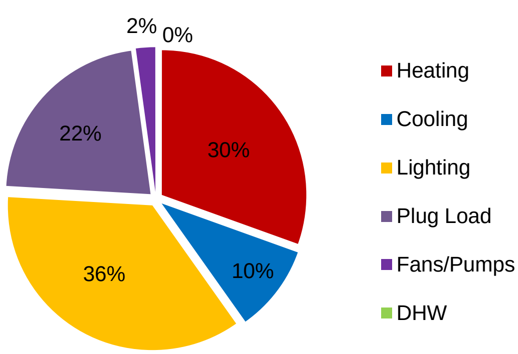
ZONES



HVAC - Example



Energy Use Intensity – Whole Building 307 kWh/m², the heating and lighting loads dominate this buildings energy use.



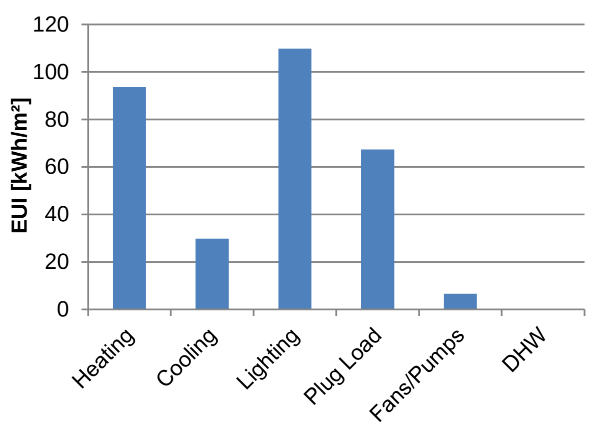


Figure 4-41 Skills Training Center – Modeling Results

4.5 Supply & Distribution

All campuses are supplied with electricity and natural gas from public utilities. Electricity is transformed and distributed to all buildings via the campus electricity grids, maintained and managed by College Facilities staff.

Natural gas is supplied directly to the buildings that have standalone boilers or roof top units for heating purposes. The balance of the natural gas is supplied to central heating boilers, which generate heat which is, in turn, distributed to the remaining buildings via campus heating networks. The heating networks are also maintained and managed by College Facilities staff.

Energy consumption in both units and costs is only metered at the point of supply from the respective public utility. There is no systematic sub-metering on any campus for electricity, hot water, steam or chilled water.

STC is an exception as it is a single complex and has single public utility meters for electricity and natural gas. It is a single building, with the associated in-building internal distribution and use of energy. For analysis purposes, STC was treated as a single building.

4.5.1 Supply & Distribution – Trafalgar Campus

On Trafalgar campus the only metered energy volumes are at the electricity and natural gas main meter. There is no systematic sub-metering on the campus.

Electricity distribution

The main electricity feed to Trafalgar Campus is delivered from Oakville Hydro and fed to the main sub-station at the north entrance off Trafalgar Road. The main feed into the College is supplied at 27,000 volts (27K). At this location, the voltage is stepped down to 13,800 volts and fed to sub-stations in the following buildings: A Wing, B Wing, C Wing, E Wing, H Wing and SCAET/Residence. At each of these sub-stations, the electricity is stepped down once again and distributed at 600 volts, 347 volts, 208 volts and 120 volts throughout the buildings. There are no obvious issues with the campus distribution system.

Heating

There are two heat supply methods on the Trafalgar campus. The largest part of the campus is supplied with district heating distributed via steam through a piping network in a tunnel system. The network reuses condensed steam through a condensate return system. Figure 4.42 shows the heat distribution network.

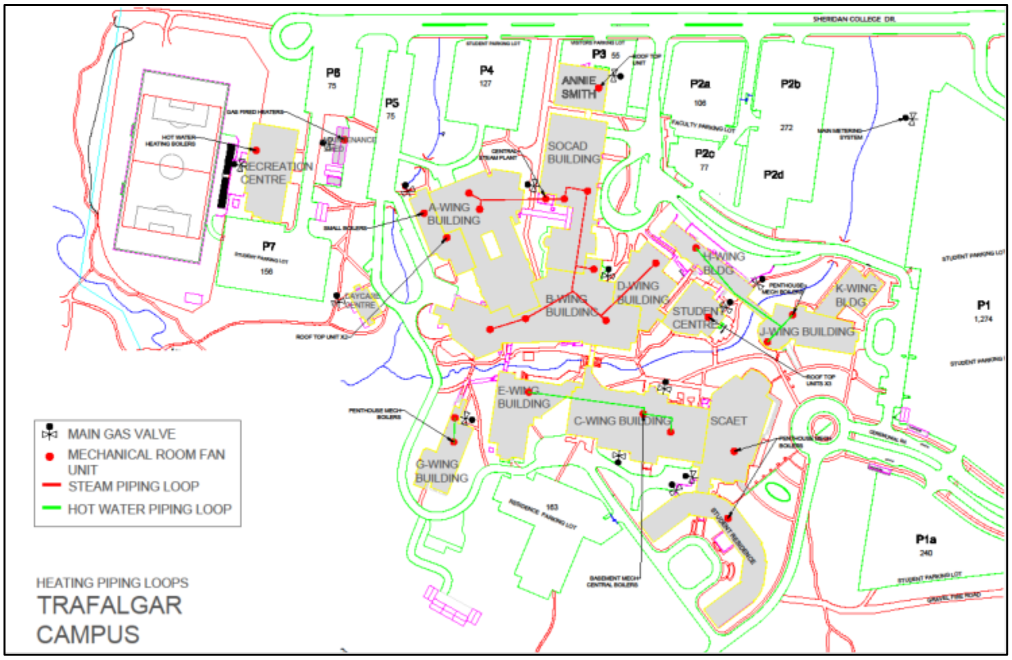


Figure 4-42 Trafalgar Campus – Baseline Heating Network

The following buildings are served by district heating from the main steam network, connected via unmetered steam to hot-water heat exchangers.

- A Wing
- B Wing
- D Wing and
- SOCAD Building

Two small groups of buildings (E and C-Wing, H and J-Wing) share hot water boilers, effectively forming very small islanded district heating networks. All other buildings are heated by individual boilers or gas-fired roof-top units.

In the absence of metered data, average boiler efficiencies are assumed to be 80%. The average age of the steam network is 25 to 30 years and approaching the time where major refurbishment would be needed. The combination of the higher losses intrinsic to a steam system and the network age, the average network heat losses between the boiler and the connection to the buildings were conservatively assumed to be 25%. The additional losses from distributing heat within the buildings' internal heating systems were captured within the building energy demand modeling.

Cooling

Most buildings on the campus are supplied with district cooling from a central cooling plant with two 600 ton (2.1 MW_{th}) chillers shown in Figure 4.43.

Figure 4-43 Trafalgar Campus – Baseline Cooling Overview

The supply temperature of the district cooling system is 7°C / 44°F. The SCAET Building and Residence are cooled by individual chillers with hydronic distribution within the buildings. The A Wing expansion, Daycare and Athletics Buildings have roof top units.

4.5.2 Supply & Distribution – Davis Campus

On Davis campus there is only the main meter for electricity. Natural gas is metered at the central heating plant and at each building which has either standalone heating boilers or rooftop units. There is no further sub-metering for distributed hot water or chilled water.

Electricity distribution

The main hydro feed to Davis Campus is delivered from Brampton Hydro at 600 volts and fed to various transformers located outside B Wing, Student Residence, Student Union and J Wing. From each of these transformers, the electricity is fed to each of these buildings at 600volts. Once inside the buildings main electrical rooms, the electricity is distributed at 600 volts, 347 volts, 208 volts, 120 volts throughout the buildings. There are no obvious issues with the Davis campus electrical distribution system.

Heating

There are three different supply situations all over the campus. The core section of the campus is supplied with heating via an insulated hot water network from a central boiler facility. Figure 4.44 shows the heating network of the campus.

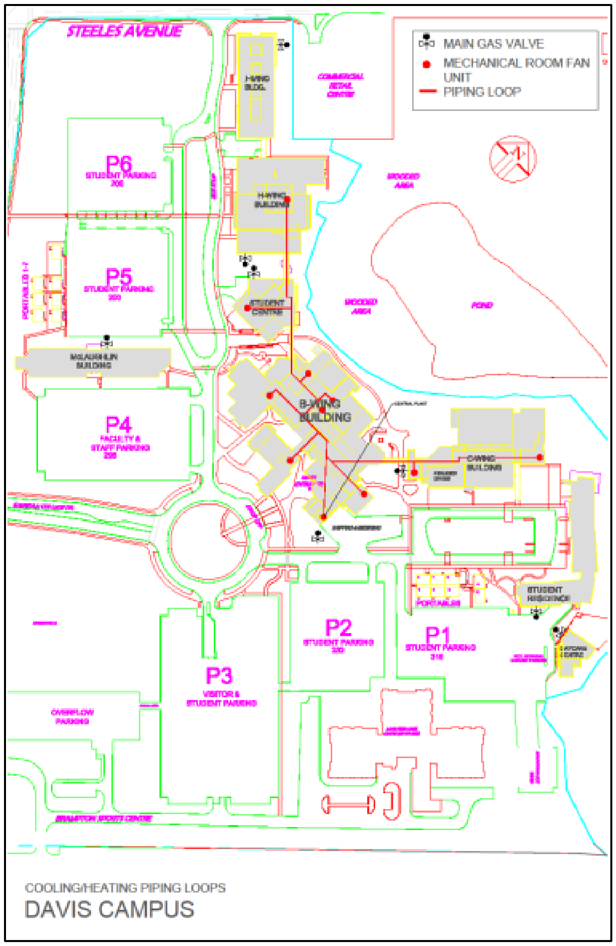


Figure 4-44 Davis Campus – Baseline Heating Network

The following buildings are served by district heating from the main hot water network and integrated into the internal hydronic distribution in the buildings. Neither the network nor the individual building deliveries are metered.

- B Wing
- C Wing
- H Wing and
- Student Centre

Buildings J and M-Wings have rooftop units for heating and cooling. The Residence Building has its own hot water boiler with hydronic internal distribution.

In the absence of metered data, average boiler efficiencies are assumed to be 80%. For analysis purposes, the districting heating pipes are treated as part of the internal building distribution with all losses captured in the building demand modeling.

Cooling

Most buildings on the campus are supplied from a central cooling plant with two 400 ton (1.4 MW_{th}) chillers shown in Figure 4.45.

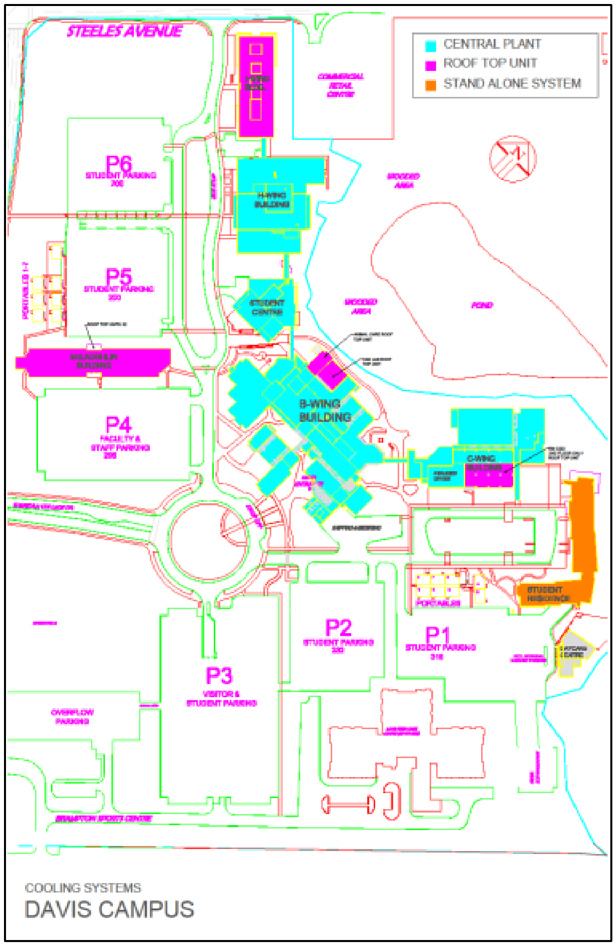


Figure 4-45 Davis Campus – Baseline Cooling Overview

The supply temperature of the distribution system is 7° / 44°F. The chilled water pipes run parallel to the district heat distribution network.

Residence Building is cooled by its own chiller. C Wing, J Wing and M Building have roof top units. B Wing is cooled by 16 Uni-vent fan coil units.

4.6 Baseline Summary

An Integrated Energy & Climate Master Plan (IECMP) requires a well-documented Baseline to establish how, where, and by whom, energy is used throughout an institution in order to focus activities on what will generate the best energy decreasing results. Information about Sheridan's energy consumption established an energy consumption Baseline and enabled the Team to better understand the projects and activities that would best lead Sheridan to meeting its IECMP goals and savings. It is anticipated that Sheridan's Baseline will help in establishing additional indicators against which the IECMP Project Implementation Plan (PIP) will be measured in the future.

In 2010, the College spent approximately $4.4 million on the 48,375 MWh of electricity and natural gas it purchased from the grid for all purposes. This requires about 106,315 MWh of fuel and causes a total of 9,700 metric tons of greenhouse gas emissions.

There is no on-site generation of electricity. Trafalgar and Davis Campuses have a mix of steam and hot water distribution networks for heating purposes. Both campuses have buildings with standalone heating supply creating some integration potential to include additional buildings to these central systems. For cooling, there is a similar situation with partial networking however, cooling offers somewhat less integration opportunities. STC campus is a single building complex with no further integration potential.

Benchmarking

As part of Sheridan's IECMP, the Team benchmarked findings against several Colleges and Universities to compare campus energy efficiency in similar climates with similar structures. This was an important step in the Team's evaluation because it informed the process, built confidence around existing building standards and those in other countries and revealed common factors that drive energy use. Benchmarking the institution across similar conditions enabled the Team to determine and understand key assessment metrics and to identify building upgrade opportunities which could increase Sheridan's profitability by lowering energy and operating costs. Finally, the benchmarking process in this report enabled the Team to identify best practices which could be replicated over time, either within one Sheridan building or across a portfolio of campus buildings. It also triggered an important link between best practices, the need for measuring and rewarding good performance, and the importance of employee and student engagement in sustainability initiatives moving forward--allowing the institution to identify top-performing facilities for recognition and to prioritize poorly performing facilities for immediate improvement.

Sheridan College uses 333 kWh of site energy (utilities) for every square meter of building area. This is compared to benchmarks in Figure 4.46.

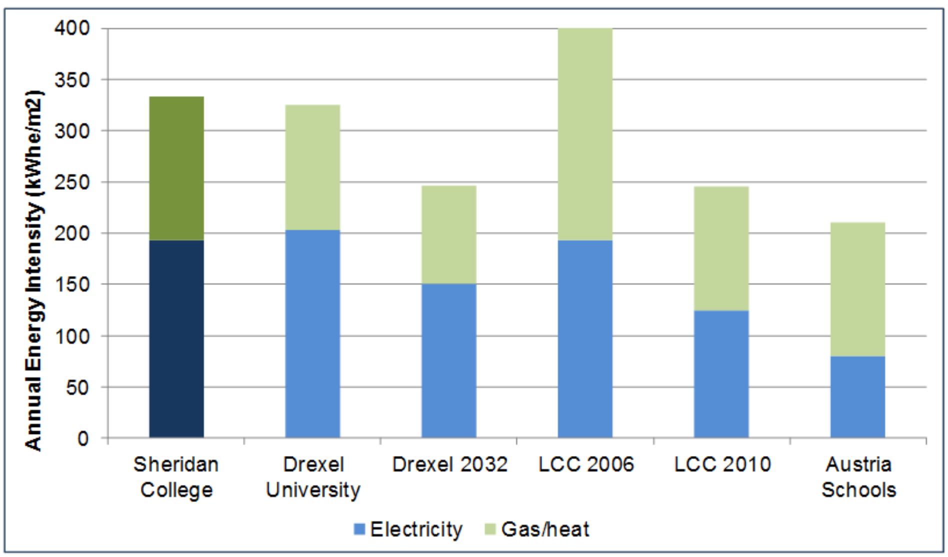


Figure 4-46 Sheridan College Baseline - Site Energy Benchmark Comparisons

Benchmarks indicate that Sheridan's overall energy consumption is about 2% higher than Drexel University[xxiii] in Pennsylvania, a large and complex campus in a similar climate. The Drexel plan established targets of 25% site energy reductions by 2032. Another benchmark places Sheridan College about 17% more energy efficient than Lakeland Community College[xxiv] in Ohio, in 2006. However, Sheridan is now 36% less efficient than the same college in 2010 after four years of IECMP implementation.

Compared to an average pool of Austrian Universities and Colleges from 2004 to 2006 data, Sheridan's baseline has 59% higher energy intensity[xxv]. The Austrian pool has more than a 2:1 spread from highest to lowest, indicating at least a 60% efficiency potential relative to systematic global best practice.

Sheridan uses 731 kWh of source energy for each square metre of building space. How this compares to the same benchmarks is shown in Figure 4.47.

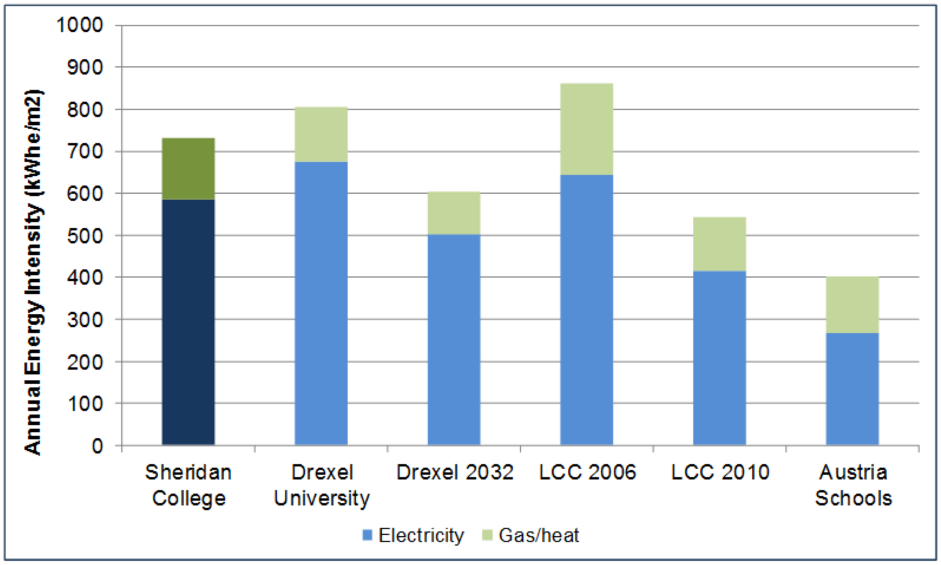


Figure 4-47 Sheridan Baseline - Source Energy Benchmark Comparisons

In general, the ratios are similar, except for the effect of a large use of on-site Combined Heat and Power generation[xxvi] (CHP), renewables and wider district heating networking in Austria results in a proportionally greater reduction in source energy.

The breakdown of how the energy is used on the campuses is summarized in Figure 4.48.

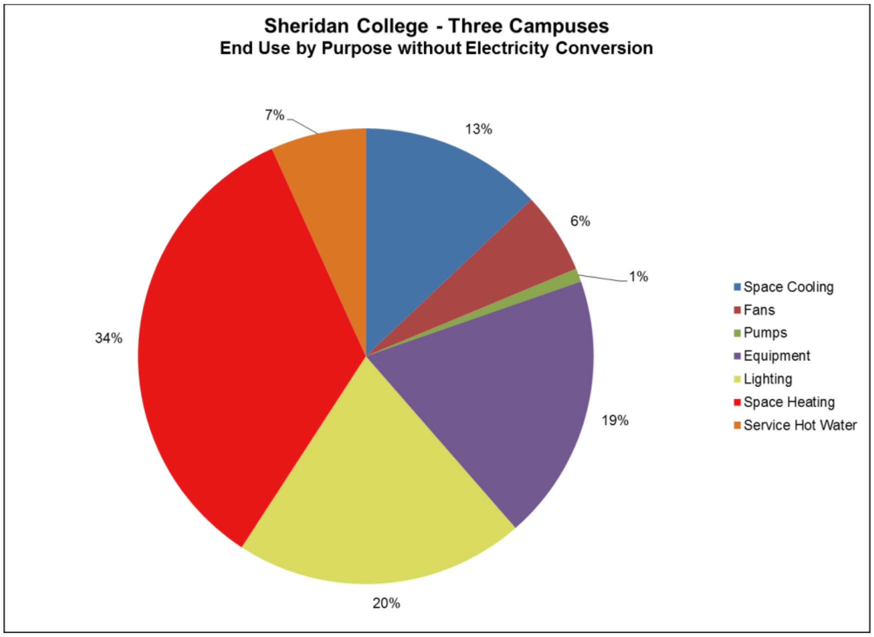


Figure 4-48 Sheridan Baseline – Utility Consumption by Energy Uses

Heating and hot water combined account for 41% of all energy used and will be a significant part of the efficiency opportunity assessment. By comparison, the electricity used to create cooling is only 13% of the total, assuming a chiller efficiency of about 4. The fans and pumps needed to run heating and cooling systems comprise a relatively small 7%.

Lighting is a fifth of all energy use and an even larger part of the cost, indicating a high potential for an aggressive lighting strategy around scheduling, day lighting, awareness and advanced technologies

The remaining 19% is all the electricity used for appliances, computers, vending machines, personal space heaters, coffee machines, televisions and other so-called "plug loads", an opportunity with rich potential for personal behaviour and procurement efficiencies.

The same breakdown by cost is shown in Figure 4.49.

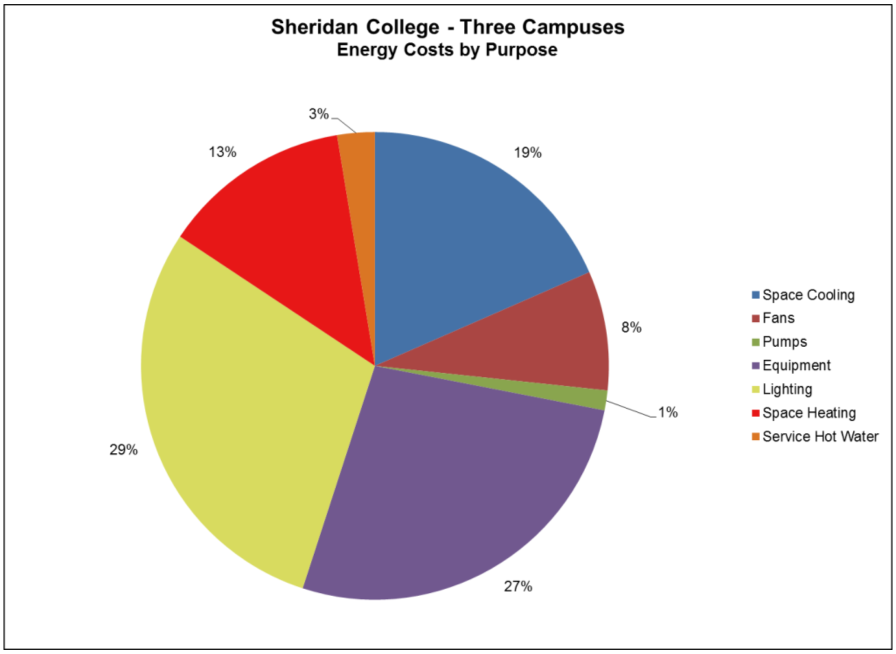


Figure 4-49 Sheridan Baseline – Energy Costs by Energy Use

The key item to highlight is that while heating and hot water are 41% of the baseline utility use, they are only 15% of the baseline cost, underlining the impact of the relatively low natural gas prices. As will be seen later, between 2010 and 2012, gas prices dropped even further. This creates multiple economic risks around possible changes in both gas and electricity pricing in the future.

The way in which each energy use causes greenhouse gas emissions (GHG) is shown in Figure 4.50.

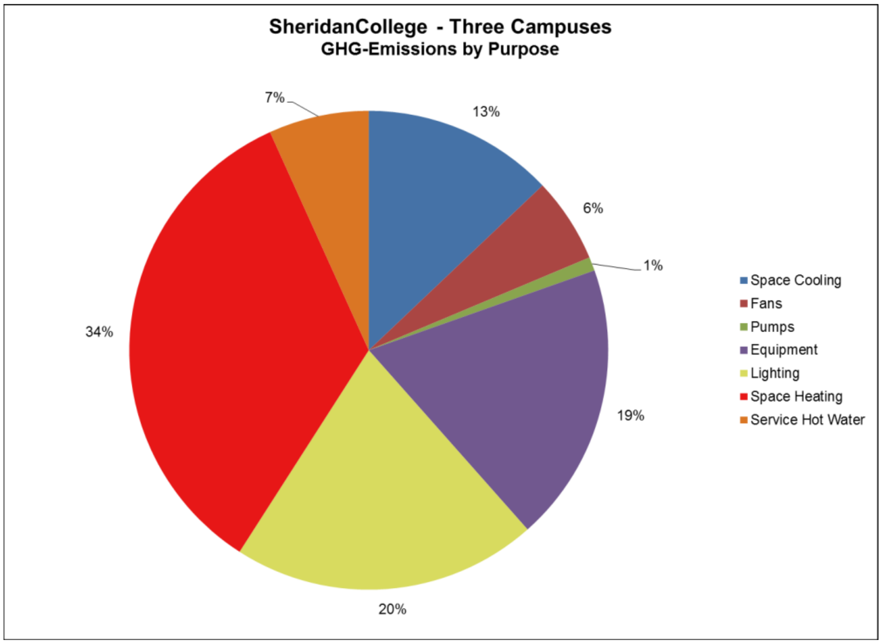


Figure 4-50 Sheridan Baseline – GHG Emissions by Energy Use

The relationship between the amount of energy used and GHG-emissions is about the same, since the emission factors of natural gas and electricity in Ontario are nearly equal. The likelihood is that the grid will further reduce its emissions index, underlining the importance of direct and indirect fuel efficiency to meet all the Framing Goals.

Sheridan's energy system is also showing signs of age which will ultimately result in 'creeping' increases of operating and maintenance costs. The energy system is maintained and assessed by Sheridan staff. The reliability of its systems is good and similar to other public post-secondary institutions. The institution's energy services are currently managed to react to user demands with overall efficiency being a secondary consideration.

Finally, there is very limited staff, student and faculty engagement around sustainability, energy and climate management. Workplaces, like any institution, have their own intended sets of values. Upper management has a critical role to play in inculcating the value-set of the organization among employees and students. Given the right parameters, this will drive greater efficiency and greater levels of innovation. Employees and students can be incentivized through sanctioned activities and often stand as representative of the values and beliefs of the institution, as a whole. With sustainability and energy, programs in the workplace that fail to garner the support of organizational leadership are unlikely to succeed.

In the Baseline year, there was no approved long-term investment or management plan around energy and climate change.

4.7 Base Case Outlook – College

In order to assess the impacts of various efficiency and other measures, a Base Case from 2010 to 2030 had to be developed. In effect this would be the agreed "business-as-usual" case from which the IECMP results would be measured. The following Base Case assumptions were agreed by the Team:

- Energy prices are unpredictable with the Team agreeing to the Higher Risk and Lower Risk profiles described in detail in Section 5.3.
- The energy efficiency of existing buildings would be unchanged.

- The efficiency of the boilers, chillers, and heating and cooling networks will remain the same.
- There would be no improvements in the BMS and associated sub-metering.
- Energy management practices including schedule management would remain the same.
- There would be no proactive staff/student energy and climate programs.
- All new buildings would meet LEED Gold standards of energy efficiency.
- The emissions index of the electrical grid would decrease from 200 kg CO2e/MWh to 150 kg CO2e/MWh by 2030.
- All new buildings would not connect to the heating or cooling networks and would have their own boilers and chillers.
- Existing buildings would continue to be supplied with heating and cooling in the same way as they are today.
- There would be no new on-site generation of heat or electricity.
- While Sheridan has significant expansion plans on each of its four campuses, for the purpose of the IECMP, other than some immediate specific expansions, all growth activity on the Trafalgar, Davis and STC campuses would take place within the existing buildings footprint. Reserve capacity has been allowed for in the energy solutions to handle additional growth.

The effect of these assumptions on the energy and carbon footprint of the College is shown in Figure 4.51

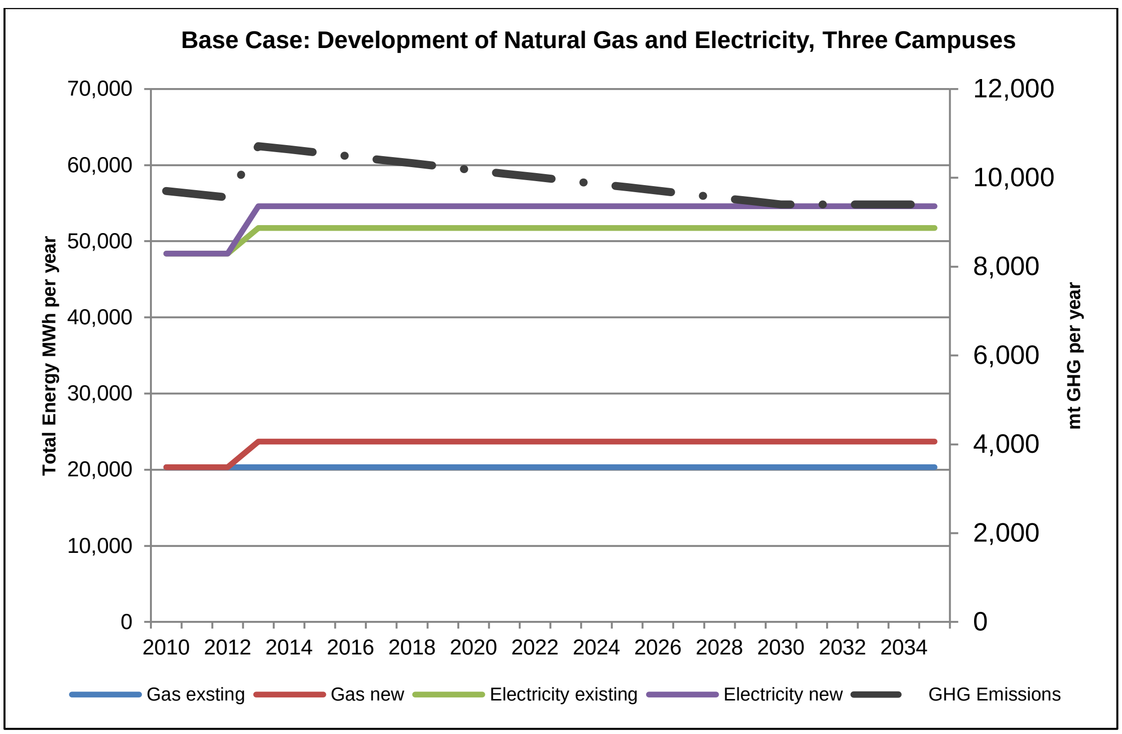


Figure 4-51 Sheridan College Base Case – Utility Needs and Emissions to 2030

There is a significant increase in energy use as the new residences and some other near-term growth is completed, followed by an essentially stable energy demand through to 2030. The emission footprint grows to 10,700 mt CO2e in 2014, and then declines as a result of the lowering grid emission index. By 2030, the carbon footprint is only slightly less than the Baseline.

Figure 4.52 shows the cumulative impact on energy costs of the Low Risk Price Case.

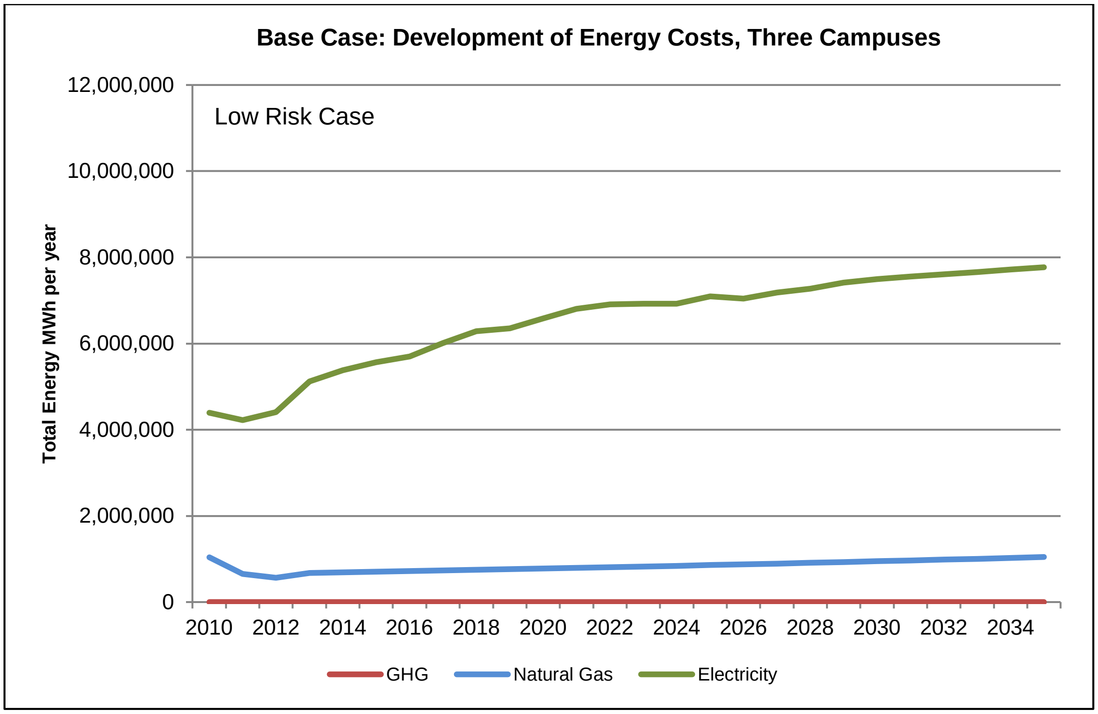


Figure 4-52 Sheridan College Base Case – Utility Costs 2030 – Low Risk Price Case

In this pricing picture the utility cost goes from $4.4M in 2010 to $7.5M in 2030, with all of the increases coming from purchased electricity.

Figure 4.53 shows the cumulative impact on energy costs of the High Risk Price Case.

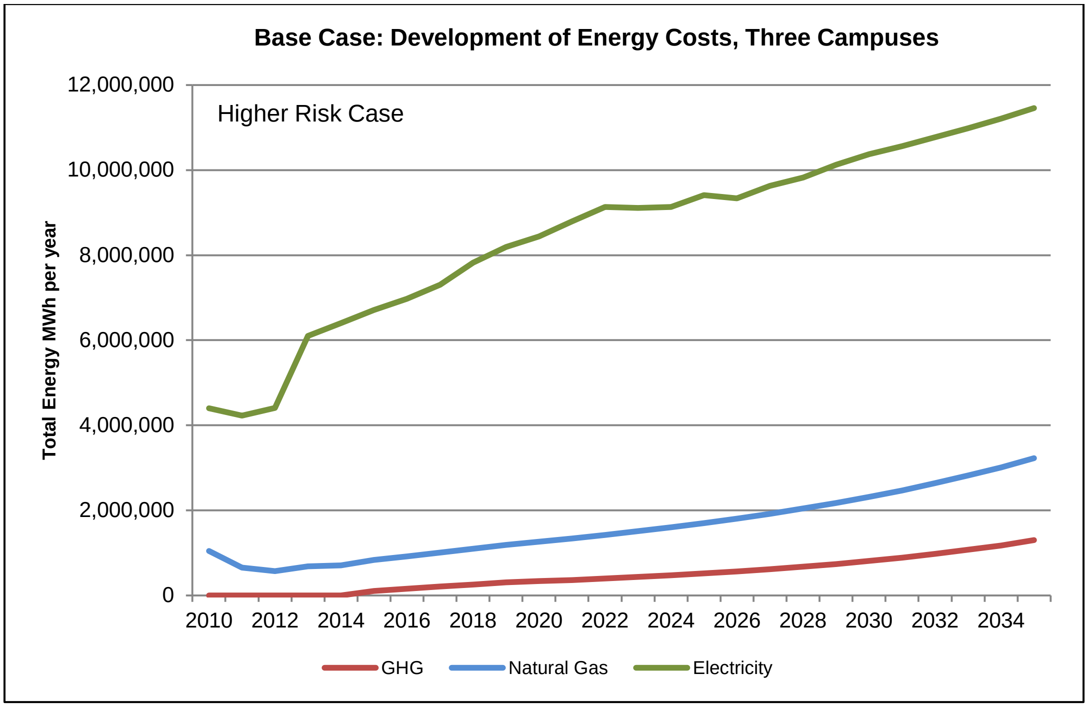


Figure 4-53 Sheridan College Base Case – Utility Costs 2030 – High Risk Price Case

In this picture, the utility and emissions costs grow from $4.4 M in 2010 to $10.4M in 2030. Natural gas doubles from its 2012 low, electricity grows to be $8M of the total. As a result of very low carbon content of the Ontario grid and gas-based heating, the effect of relatively aggressive carbon penalties is only $0.8M or 8% of the total.

At this point it should be emphasized that both the high and low risk case were selected on the basis of either being equally probable. This underlines the importance of energy price risk management.

4.7.1 Base Case Outlook – Trafalgar Campus

The following Figures 4.54 to 4.56 summarize the Base Case outlook for the Trafalgar campus.

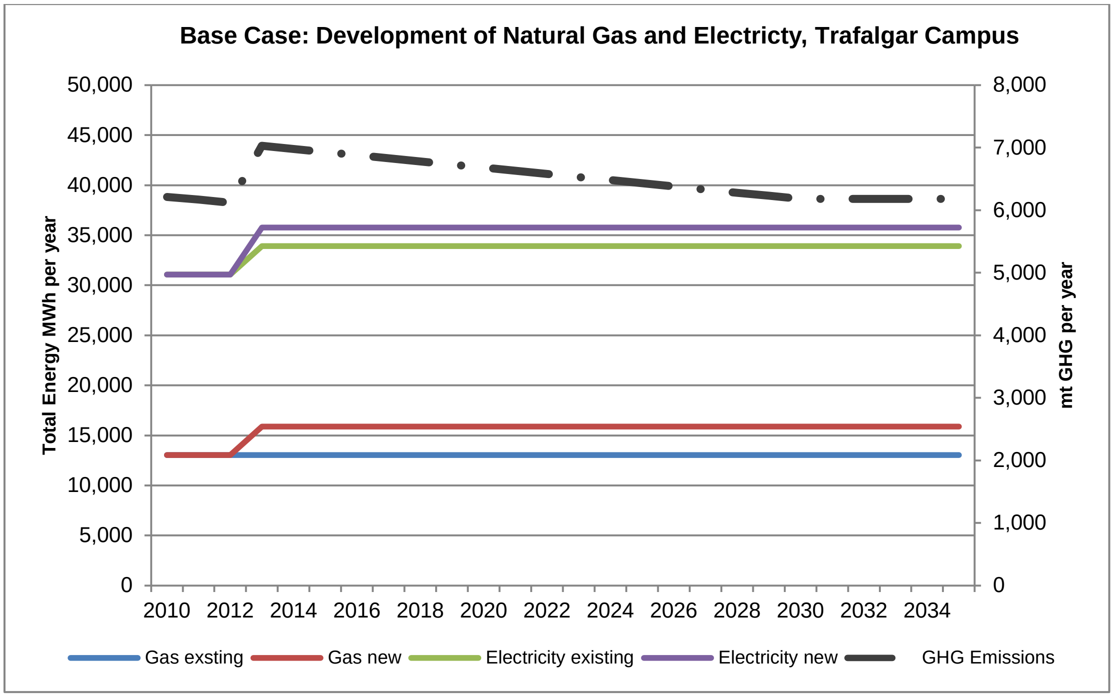


Figure 4-54 Trafalgar Campus Base Case – Utility Needs and Emissions to 2030

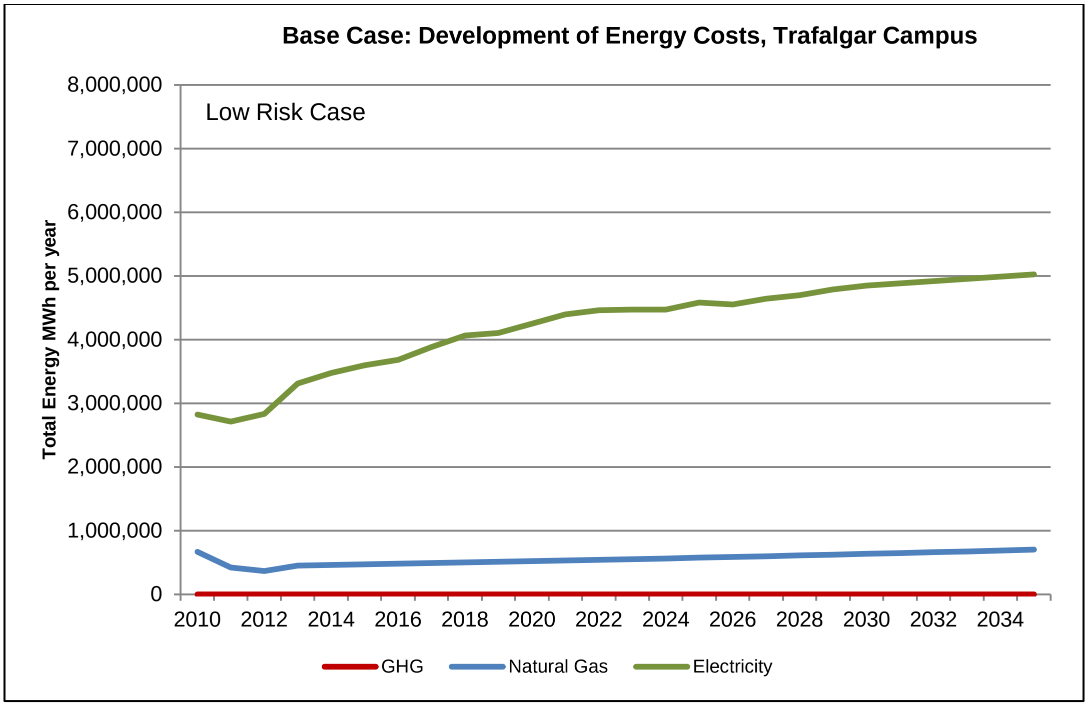


Figure 4-55 Trafalgar Campus Base Case – Utility Costs 2030 – Low Risk Price Case

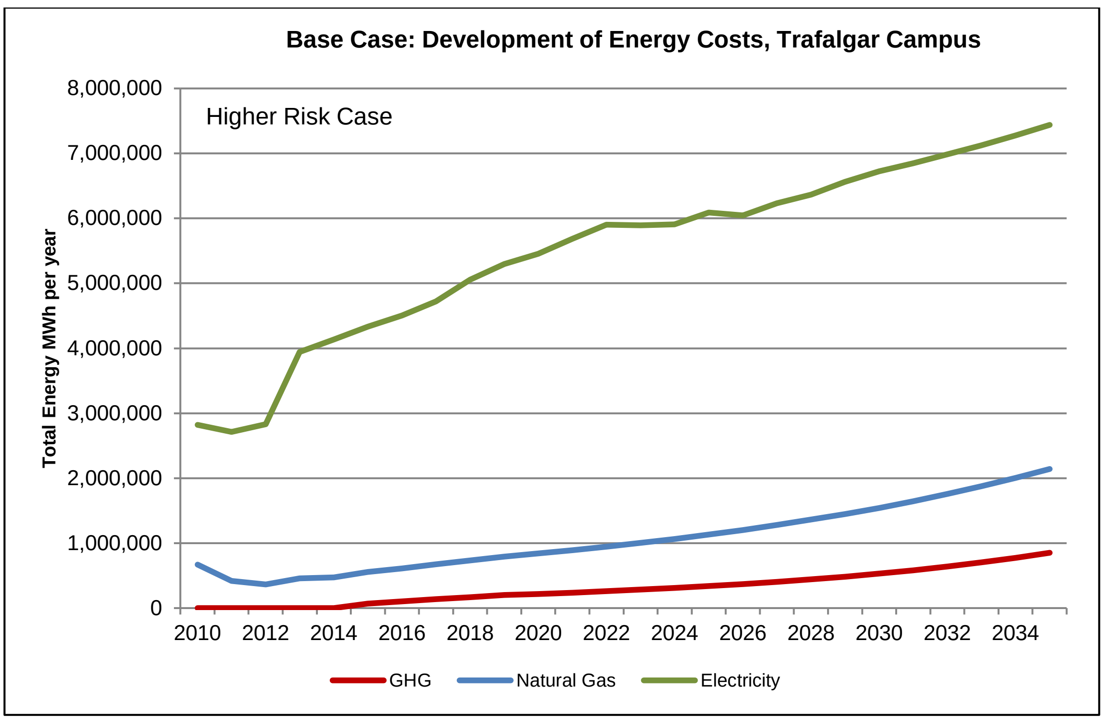


Figure 4-56 Trafalgar Campus Base Case – Utility Costs 2030 – High Risk Price Case

4.7.2 Base Case Outlook – Davis Campus

The following Figures 4.57 to 4.59 summarize the Base Case outlook for the Davis campus.

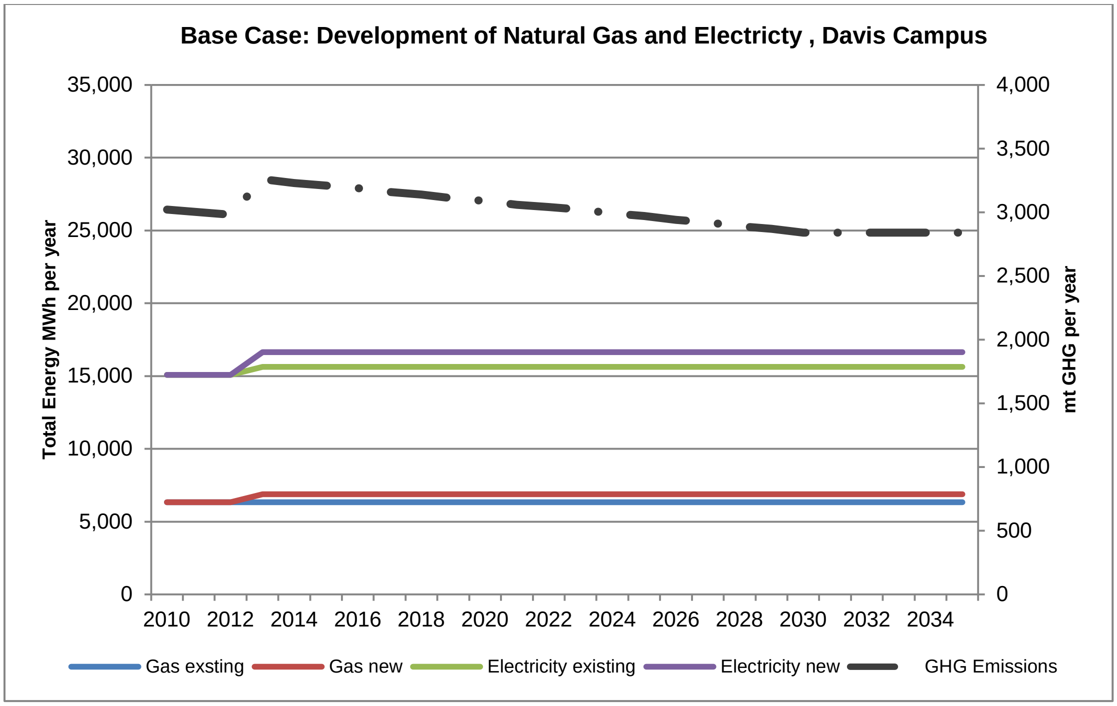


Figure 4-57 Davis Campus Base Case – Utility Needs and Emissions to 2030

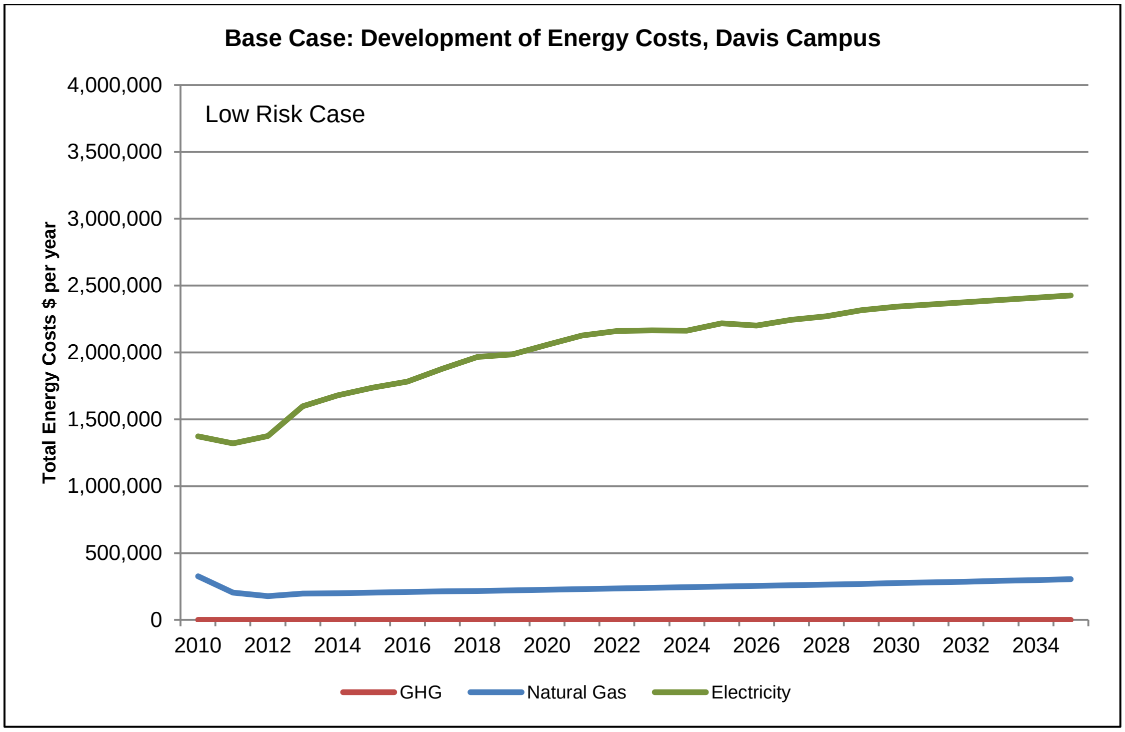


Figure 4-58 Davis Campus Base Case – Utility Costs 2030 – Low Risk Price Case

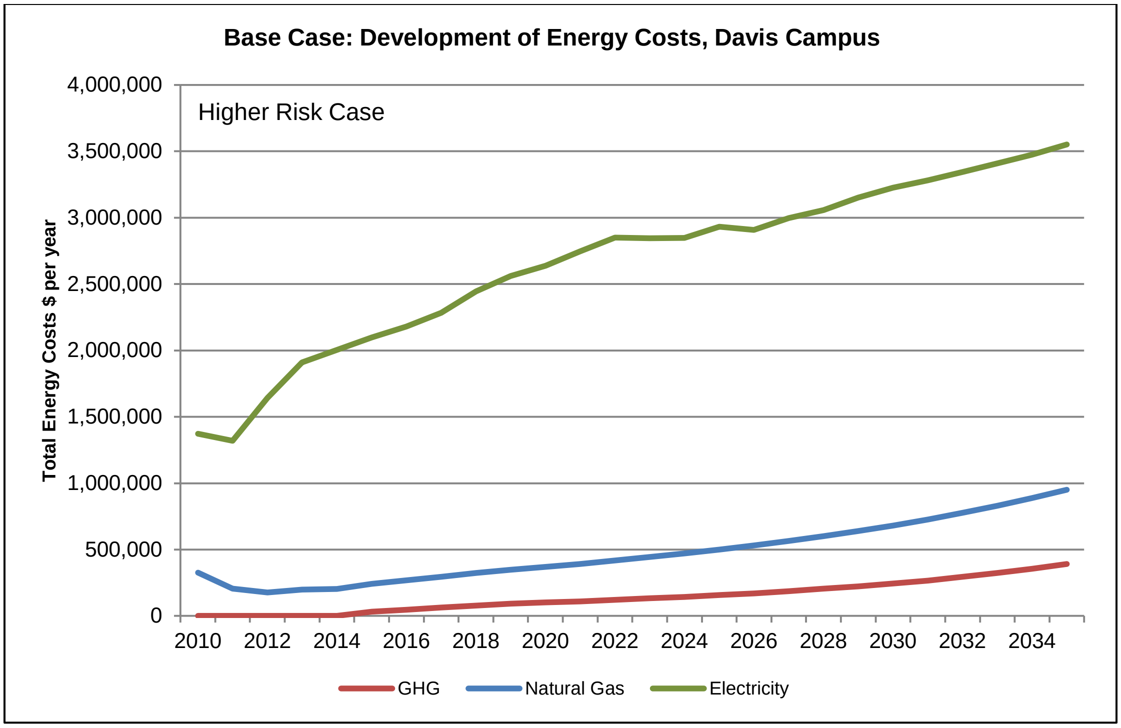


Figure 4-59 Davis Campus Base Case – Utility Costs 2030 – High Risk Price Case

5 Future Case

5.1 Framing Goals

The core Framing Goals can now be restated from the results of the Base Case assessment, shown in Figure 5.1

Category	Framing Goal	Target %	2010 Baseline	2035 Base Case	Target
Efficiency	Source Energy Efficiency	50%	106,500 MWh	***118,400***	***59,200 MWh***
Environment	Carbon Footprint	60%	9,700 mt	***9,400***	***4,700 mt***
Economy	Internal Rate of Return	7%	NA	***NA***	***7%***

Figure 5-1 Key Framing Goals

The IRR calculation will be relative to the Base Case.

5.2 Scenarios Overview

Based on insights garnered through Sheridan's Baseline assessment, the Team selected various scenarios for further detailed analysis. These are summarized in Figure 5.2.

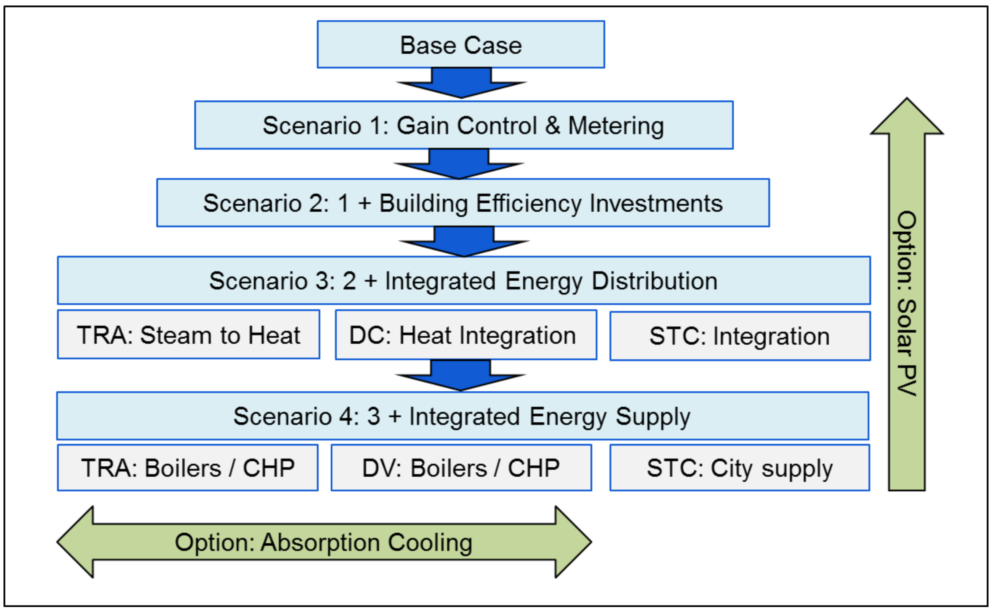


Figure 5-2 Overview of IECMP Scenarios Selected for Analysis

All scenarios are analyzed relative to the Base Case described in Section 4. The basic assumption is that the Base Case will be the outcome in the normal course of business.

Each scenario should be viewed as an integrated solution to be assessed against the Framing Goals. A description of each is summarized in the following paragraphs.

5.2.1 Scenario 1 - Gain Control & Metering

This allows comprehensive control and measurement of all significant energy flows and carbon emissions to and across all campuses of the College and includes:

- Consistent Building Management System (BMS) architecture facilitating control across and between campuses and within all buildings to zone level.

- Zones defined as used for the building modeling with reasonable control flexibility to redefine zones in the future.
- Sub-metering for electricity, heat, gas, water, and cooling, at least to building level.
- Automated equipment schedule and weather management including forecasting and outside air differential set points.
- Active staff-student-faculty engagement programs include Toyota-style Treasure Hunts[xxvii] every 12 months.
- Unchanged buildings' envelope and mechanical systems.
- Unchanged supply and distribution including electricity emissions index.

5.2.2 Scenario 2 – Building Efficiency

This builds on Scenario 1 making existing buildings more efficient and ensuring that new buildings meet higher expectations and includes:

- Existing buildings are upgraded with a moderate portfolio of envelope and mechanical efficiency retrofits that achieve efficiencies in the range of 5% to 15% efficiency gain on a building-by-building basis, above those offered by improved management and control measures.
- New buildings will have efficiencies that exceed LEED Gold and would be at about German A-Rated levels and in this scenario, would have their own stand-alone heating and cooling supply.
- No changes in supply and distribution.

5.2.3 Scenario 3 – Integrated Energy Distribution

This builds on Scenario 2 adding upgrades to improve the efficiency and reduce the costs of heat distribution on the two main campuses:

- Davis Campus hot water network is extended to incorporate all existing and new buildings, including residences.
- Trafalgar Campus steam network is converted to a modern hot water system and extended to incorporate all existing and new buildings, including residences.
- Electricity supplied from public utilities with the same greenhouse gas emissions index as Baseline.
- Heat supplied from existing or new gas-fired heat only sources.
- No on-campus renewables.
- Some thermal integration of the STC heating and cooling distribution.

5.2.4 Scenario 4 – Integrated Energy Supply

This final Scenario 4 completes the energy integration by adding new on-campus energy supply including:

- Davis Campus and Trafalgar Campus integration of an optimally-sized combination of heat only boilers (HOB) and Combined Heat and Power (CHP) generation sized to meet heat requirements.
- Electricity supplied from public utilities with the same greenhouse gas emissions index as Baseline.
- No on-campus renewables.
- No change in STC supply.

5.2.5 Scenario Option – Solar Photo Voltaic

To assess the impacts of Solar Photovoltaic (PV) on the overall energy and climate performance of the College, the analysis allows for the addition of about 3.25 MW of solar PV to all four scenarios.

5.2.6 Scenario Option – Absorption Cooling

To explore the impacts of using excess heat capacity in the summer to serve some part of the cooling needs using absorption chillers on both the Davis and Trafalgar Campuses. This can only be applied to Scenario 4.

5.3 Energy Pricing Outlook

Two energy pricing outlooks were developed to evaluate the range of financial impacts of future efficiency and supply measures – a Lower Risk (LR) and a Higher Risk (HR) Price Case. Both build on the 2010 Baseline conditions[xxviii], 2011 actual and the anticipated changes to 2012 are outlined in Figure 5.3.

Item	2010 Value	2011 Value	2012 Value
Natural Gas for Boilers and CHP	$ 51.40 / MWh	$ 32.27 / MWh	$ 28.05 / MWh
Grid Electricity	$ 119.55 / MWh	$ 127.28 / MWh	$ 136.90 / MWh
CHP Electricity	$ 119.55 / MWh	$ 127.28 / MWh	$ 136.90 / MWh
Solar PV	$ 443.00 / MWh	$ 443.00 / MWh	$ 443.00 / MWh
Wind power	$ 135.00 / MWh	$ 135.00 / MWh	$ 135.00 / MWh
Electricity GHG Index	200 kg / MWh	200 kg / MWh	200 kg / MWh
Natural Gas GHG Index	201 kg / MWh	201 kg / MWh	201 kg / MWh
Carbon cost	$ 0 / mt CO_2e	$ 0 / mt CO_2e	$ 0 / mt CO_2e
Electricity Site / Source ratio	3.03	3.03	3.03
Natural Gas Site/Source Ratio	1.047	1.047	1.047

Figure 5-3 Baseline 2010 Pricing Conditions

The Price Cases were established based on the Ontario Long Term Energy Plan[xxix] (OLTEP) wherever possible. The OLTEP is primarily based on electricity and associated emissions. Team assessments were used for the natural gas pricing. The OLTEP spans 2010 to 2030 and conveniently has the same end year as the IECMP. Year-on-year assumptions on the pricing used in the IECMP are in Appendix 6. These include Team extrapolations to 2035.

The Higher Risk case is driven by the following factors:

- Grid reliability issues caused by aging infrastructure and extreme weather requires accelerated investments that must be recovered in electricity prices.
- Tougher GHG emissions reductions targets and regulation has a knock on effect in the pricing of fossil fuels and electricity.
- Upgrading and reinforcing provincial electricity and gas networks to manage a larger portfolio of distributed clean and renewable generation.
- Closer scrutiny and regulation of shale gas will increase the future price of natural gas.
- Accelerating national and international demand for natural gas for both reducing carbon emissions and resulting from very low North American prices relative to the rest of the world, will increase its future price

5.3.1 Electricity Grid Pricing

The OLTEP has extensive background on the evolution of the grid generating mix, the expected demand growth, and investments in supply and distribution. Section 7 of the OLTEP discusses pricing impacts in detail.

Ontario's history of underinvestment and underpricing will come to an end. Combined these will have significant impacts on electricity prices. OLTEP is proposing a Clean Energy Benefit (CEB) for eligible residential, farming and small business consumers of 10%. The IECMP assumes Sheridan would not be eligible.

OLTEP does not give an explicit estimate of the rate of increase for institutional or commercial clients. The Low Risk case is assumed to be the average between the OLTEP Industrial and Residential estimates, starting at $119.55 / MWh and rising to $199.44 / MWh in 2030.

The HR Case was assumed to be the year-on-year OLTEP Residential profile plus 1% per year resulting from some combination of the risk factors listed earlier. In the HR Case, 2030 electricity prices are $243.54 / MWh. As an aside, there are parts of North America where prices are already approaching these levels.

5.3.2 Natural Gas Network Pricing

The OLTEP does not include gas prices. Given there is a large degree of commonality between the U.S. and Canadian gas markets, the U.S. DoE Energy Information Agency outlook[xxx] was taken as a starting point. The EIA Texas wholesale gas price forecast is shown in Figure 5.4.

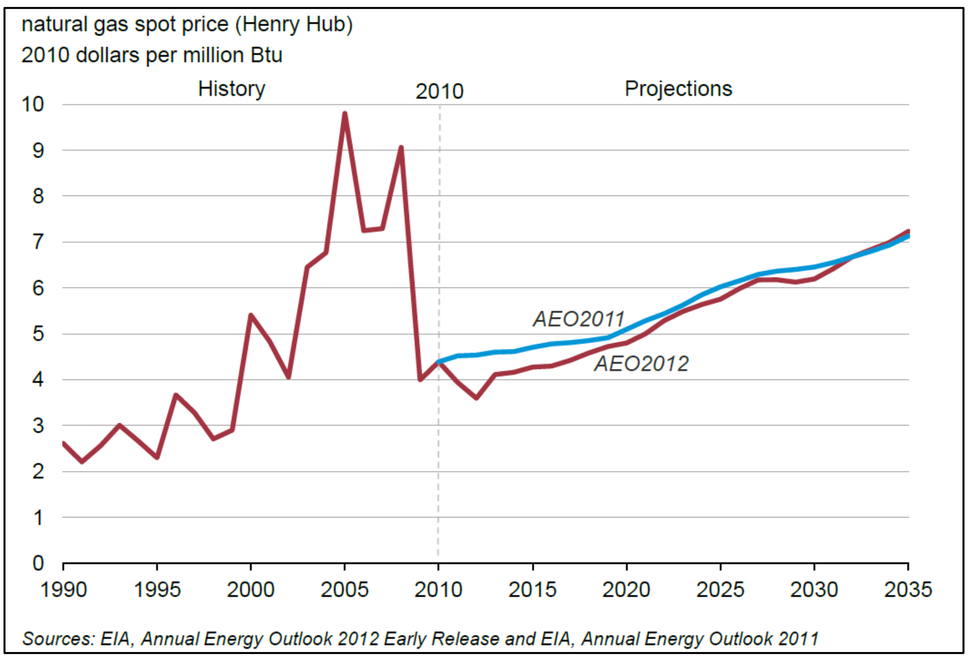


Figure 5-4 US Department of Energy Wholesale Gas Price Forecast

The EIA outlook is for a 51% increase from 2012 to 2030. The IECMP LR Case has prices increasing at 2% per year after 2012 through the Plan period. Relative to the 2010 Baseline price of $51.40, this actually results in a decrease to $40.06 / MWh in 2030. Referenced to the 2012 levels of $28.05 / MWh the LR Case represents an increase of 43%. Given all the possible upside risks, by any standards this is a very conservative estimate[xxxi].

The HR Case has a 3% annual increase for 2013 to 2015, mostly caused by increased demand both in Canada and the U.S. as a result of fuel switching. This is followed by a 5% per year increase for the balance of the Plan period caused by a combination of accelerating demand, international exports, and shale regulation. This results in 2035 prices of $81.33 / MWh. Incidentally, this is less than the market peaks that North America experienced after Hurricane Katrina, and well below current market levels in other major regions of the world.

5.3.3 Combined Heat and Power Pricing

Both Davis and Trafalgar campuses evaluate CHP as part of Scenario 4 with no power exports to the grid. The capacity on each site is less than 20MW_{el} so these would fall under the Ontario Power Authority CHP Standard Offer Program[xxxii]. The IECMP assumes this, or a similar program, would continue.

The LR Case for gas prices as fuel for CHP is that it will be treated no differently from any other gas purchases and will be the same as the normal network price.

In the HR Case, policy aimed at more aggressive carbon reduction will encourage CHP as a low-carbon strategy. In the HR Case, gas for CHP is assumed to be 2% below HR retail from 2013. Incidentally, discounts of this level or higher are not uncommon due to the increased volume of gas purchase even without changes in public policy.

In terms of the value of CHP electricity, in the LR Case net-metering is used throughout, effectively giving on-site power the full retail value. In the HR Case, the relative generosity of net metering will probably be constrained as distributed scale CHP becomes the norm. A reduction of 3% from the HR grid price of electricity from 2013 factors in this risk.

5.3.4 Carbon Index and Pricing

The LR Case in general assumes current Ontario and Federal policy will continue relative to GHG emission reductions. This can be summarized as ambiguous in that major structural efforts to reduce GHG are in place, but there is a reluctance to impose transaction costs on greenhouse gas emissions through carbon taxes, emissions trading or compliance penalties.

The grid has a low GHG index of about 200 kg CO_{2e} / MWh which still includes about 23% fossil fuel (gas/coal). OLTEP targets the fossil content to drop to 8% by 2030 through a mix of clean and renewable sources and switching to natural gas as a generating fuel. This would imply an index of about 25 kg CO_2e / MWh, a level most believe to be laudable but close to impossible.

In both the LR and HR Cases, the IECMP assumes the grid index will drop linearly from 200 kg CO_2e / MWh to 150 kg CO_2e / MWh by 2030.

In terms of carbon pricing, in the LR Case, there is no regulated cost on carbon. In the HR Case, a carbon tax or equivalent is assumed to be in place by 2015, modeled on the British Columbia example. In the first phase, it increases from \$10/mt CO_2e to \$30/mt CO_2e by 2019. This is followed by 10% per year annual increases to \$86/mt CO_2e in 2030, or less than the level as Sweden today.

5.3.5 Solar PV Prices

The HR Case assumes the current Ontario policy remains in force to 2030, with no change to the Solar PV Feed in Tariffs (FIT)[xxxiii]. For the LR Case the FIT is reduced by 2% per year from 2022 to reflect widespread implementation, increasing efficiency and lowering costs. In a detailed model, it would be much more complicated due to the grandfathering of early phases for 20 years. For the purposes of the IECMP this latter effect is statistically minor and has been ignored.

5.3.6 Wind Power Prices

Wind power[xxxiv] is not a recommended scenario. The Team developed pricing assumptions which are available if needed for future sensitivity analysis.

5.4 Control & Efficiency – College

The control and efficiency scenarios outlined in Section 5.2 were developed for each building in the College. The buildings were generally performing as would be expected for educational building in Ontario, albeit to the top of the peer group range. As the benchmarking described in

Section 4indicates, there is significant room for improvement, especially when benchmarked against more stringent standards such as LEED and German A-rated buildings.

The Base Case modeling and the site visits showed clear patterns and highlighted areas for improved efficiency in most buildings. Many buildings were dominated by heating and cooling loads. This was due to combinations of thermostatic control, the HVAC systems that were in place and the lack of comprehensive control of the building and campus systems as a whole. The lighting and plug loads in some buildings were very high, which leads to using extra cooling.

The efficiency and control measures were developed using a combination of two main sources. The first was the result of the Baseline models described in Section 4. The second was the knowledge of faculty and facility staff of both the buildings and how the campus worked as a whole. The measures were split into the two scenarios described in Section 5.2 "Gain Control & Metering" and "Building Efficiency".

The range of efficiency measures considered and selectively applied to the individual building energy models is summarized in Figure 5.5.

	Baseline Status	**Change to be made**
Scenario 1: "Gain Control and Metering"		
Setpoint Control	Winter Setpoint: 20°C 24hr Summer Setpoint: 20°C 24hr	Winter Setpoint: 20°C with 18°C setback Summer Setpoint: 24°C with 27°C setback
Control Lighting	Lights on 24hrs a day	Turn lighting off when people leave • Notices asking people to turn the lights off when they leave
BMS & Metering	Limited integrated controls and sub-metering	Add enhanced BMS and sub-metering
Scenario 2 "Building Efficiency"		
Lighting upgrade	T8 28W	Change to T8 25W
Lighting Controls Upgrade	No controls except on/off switch	Install daylight and motion detectors
Roof Upgrade	No insulation	Add 12" of insulation
Weather proofing	Infiltration through cracks and gaps in the façade	Weather proof around windows and doors to reduce infiltration
Lower Solar Direct Gain	No exterior shading	Add exterior shading on to windows
Manage Air Quality	Constant fresh air	Add CO_2 sensors in order to vary outdoor air conditioning and allow enough fresh air for high occupancy times.
HVAC Controls upgrade - Economizer	Constant fresh air, cooling even when outdoor air is cool enough to cool the space	Add economizer to make use of outdoor air for cooling when possible
HVAC Controls upgrade – Night Cycle	Fans on constantly through the night	Add night cycle to the fan control so they cycle on and off to control the temperature in the space when unoccupied
Recommissioning	Buildings not commissioned	Commission building and equipment in order to ensure everything is working as designed

Figure 5-5 Typical Control, Metering and Efficiency Measures

A combination of these measures was applied to each building as judged appropriate from the building's observed condition, form and function, as well as the results from the Baseline energy modeling. The energy use comparison between Baseline Control and Efficiency scenarios is shown in the graph in Figure 5.6.

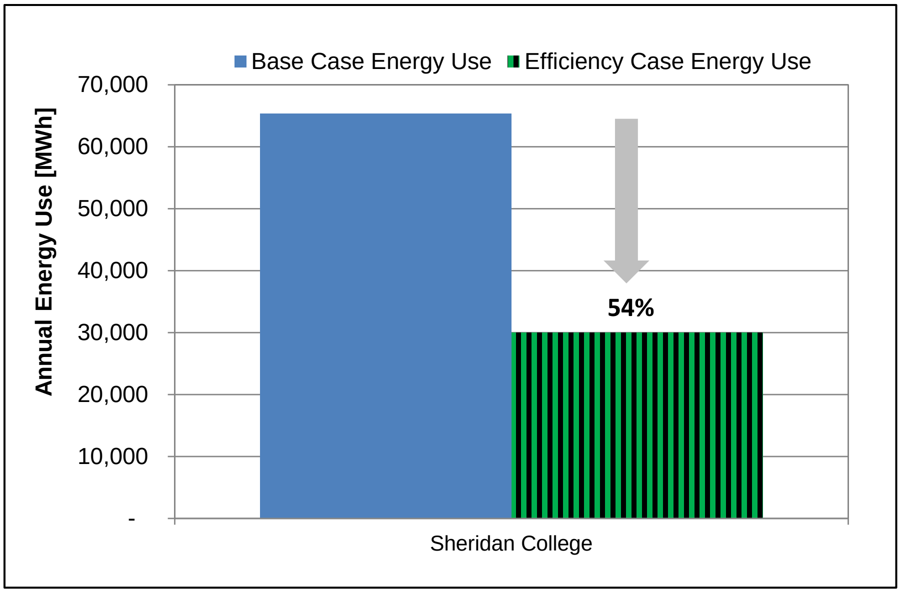


Figure 5-6 Sheridan College – Control/Efficiency –Total Energy Use Compared to Baseline

The overall impact is a 54% reduction in the modeled end-use energy needs. To avoid any confusion, as in the Baseline, this again is looking at the energy needs with all chillers and boilers having a COP of 1 so should not be interpreted as utility savings.

The breakdown by specific end-use is shown in Figure 5.7.

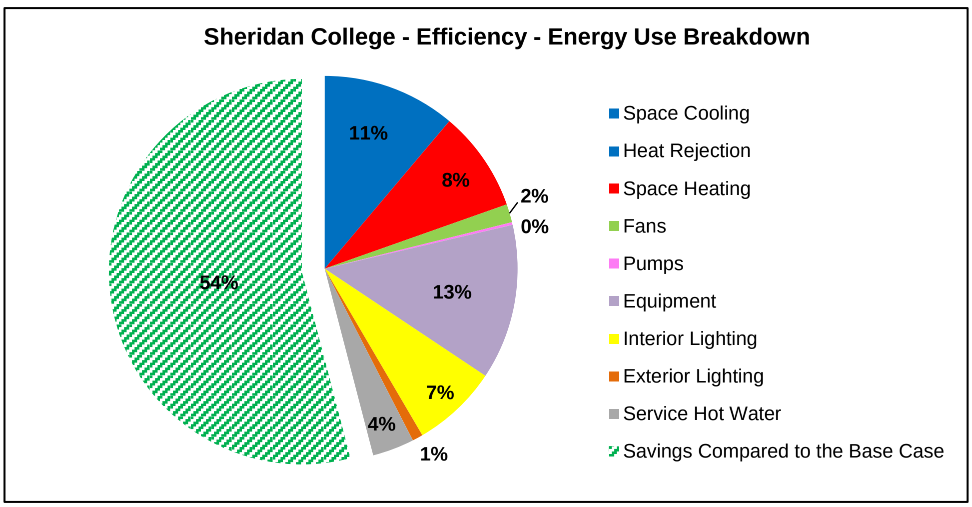


Figure 5-7 Sheridan College – Control/Efficiency – Energy End-uses Compared to Baseline

Once again this is looking at a comparison between the energy needs of the building when the chillers and boilers have a COP of 1.

The same breakdown by campus is summarized in Figure 5.8.

	Trafalgar	Davis	STC	Sheridan College
Heating	99	76	94	90
Cooling	242	179	30	206
Lighting	69	60	110	68

Plug Load	71	43	67	60
Fans and Pumps	23	18	7	20
DHW	10	17	-	16
Total	514	403	307	259

Figure 5-8 Sheridan College – Control/Efficiency – Building Energy Indexes by Campus

Figure 5.9 shows each campus' estimated energy use as well as Sheridan College as a whole, considering efficiencies of the buildings HVAC systems, benchmarked against Ontario standards, U.S. averages, LEED Gold and German A-rated building standards.

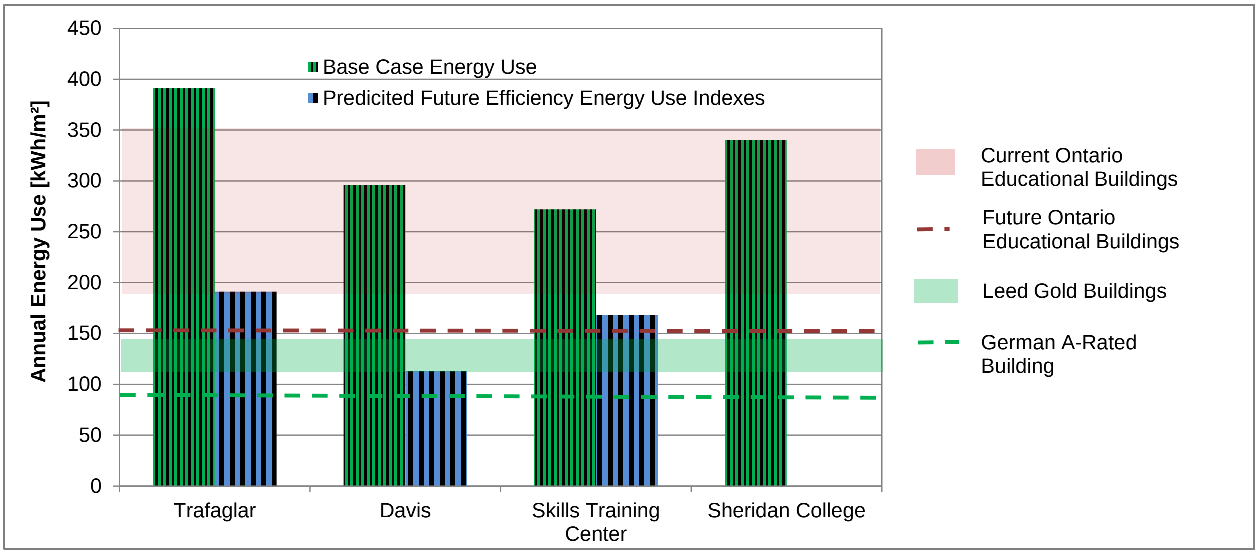


Figure 5-9 Control/Efficiency – College and Campus Benchmarking

For comparison, the utility view of the energy indexes has been used in Figure 5.9. The potential for a 50% reduction in the buildings' use of energy alone is clearly seen with comprehensive investment in control and efficiency.

5.4.1 Control & Efficiency – Trafalgar Campus

The following efficiency measures, shown in Figure 5.10 were applied to the Trafalgar campus buildings.

	Control and Metering		Building Efficiencies							
	Setpoint Control	Lighting Schedules	Lighting upgrade	Lighting Controls upgrade	Roof upgrade	Weather proofing	Lower Solar Direct Gain	CO_2 Sensors	HVAC Controls upgrade	Recommissioning
A Building	x	x	x	x	x	x	x	x	x	x
AA Building (SOCAD)	x	x	x	x	x	x	x	x	x	x
Annie Smith	x	x	x	x	x	x	x	x	x	x
Athletic Centre	x	x	x	x	x	x	x	x	x	x
B Wing	x	x	x	x	x	x	x	x	x	x
C Wing	x	x	x	x	x	x	x	x	x	x

E Wing	x	x	x	x	x	x	x	x	x	x
G Wing	x	x	x	x	x	x	x	x	x	x
H/J/K Wing	x	x	x	x	x	x	x	x	x	x
Student Centre	x	x	x	x	x	x	x	x	x	x
SCAET	x	x	x	x	x	x	x	x	x	x
Residence	x	x	x	x	x	x	x	x	x	x

Figure 5-10 Trafalgar Campus Control/Efficiency Measures by Building

Due to the age of these buildings and the choice of energy efficiency measures it was decided that all measures should be applied to all buildings in order to improve the overall performance of the individual buildings and the campus itself.

Throughout the walk around and as a general observation by faculty and facility staff it was noticed that the lights tend to stay on in the buildings 24 hours a day and the thermostats are set to a constant temperature. Both these things can be improved by educating staff and students to turn lights off when leaving a room and to paste notices on the exits of each room reminding people to do so. The thermostats can be reprogramed to supply the rooms with higher temperatures in the summer (currently set at 20°C, changed to 24°C) and with setbacks when the spaces are unoccupied. This will both increase comfort within the space and save energy.

The most common lighting type in the spaces for the whole campus was T8 28W bulbs. These should be replaced by T8 25W as and when they need to be. This is a no cost measure that will help the energy reduction on site. Appling motion detectors and daylight controls to the lighting in each space will also help utilize the natural light as well as reducing the lighting use significantly.

The older buildings on campus, as well as some of the newer ones, would all benefit from insulation upgrades in the roof; in general another 30 cm should be added where possible. Weather stripping and exterior shading throughout the buildings will help to reduce infiltration and solar heat gains in the summer, again making the space more thermally comfortable as well as putting reduced load on the HVAC system.

Finally because most of the buildings on Trafalgar Campus are older than 10 years, recommissioning as well as HVAC upgrades are recommended. Recommissioning will ensure the building is working as designed as well as highlighting areas where energy can be saved. HVAC controls will reduce the energy used by the HVAC by bringing in extra fresh air when possible as well as controlling the air that runs through the system efficiently. CO_2 sensors are recommended for all buildings. This not only helps keep employees and students in the spaces alert and comfortable but also reduces the load on the HVAC by reducing the quantity of fresh air that has to be conditioned before entering the space.

The efficiency measures were applied to the Base Case buildings showing between 20 – 75% energy savings in each building, as shown in Figure 5.11. The energy use indexes in Figure 5.11 consider the COP of the chillers and boilers to be 1 so as to be an appropriate comparison to the Base Case models.

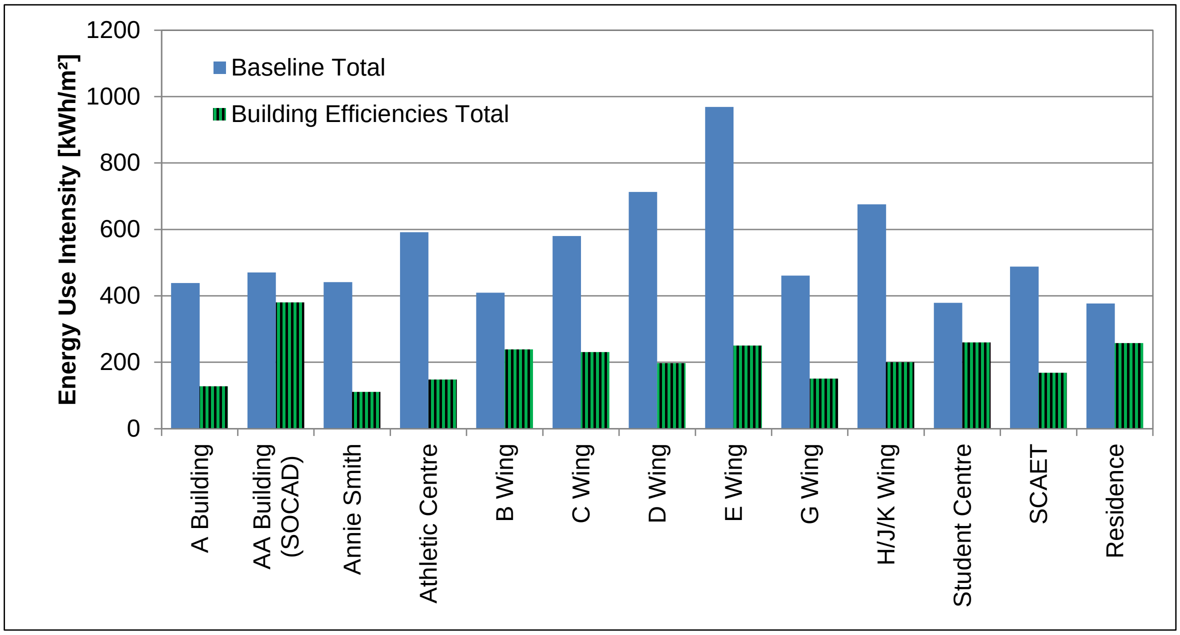


Figure 5-11 Trafalgar Campus Control/Efficiency Energy Compared to the Base Case

The total energy savings for Trafalgar campus was approximately 60% energy savings for the whole campus when these efficiency measures are applied.

Figure 5.12 shows the savings against the Base Case and the percentage break down of energy uses on the Trafalgar campus considering a COP of 1 for all boilers and chillers on site.

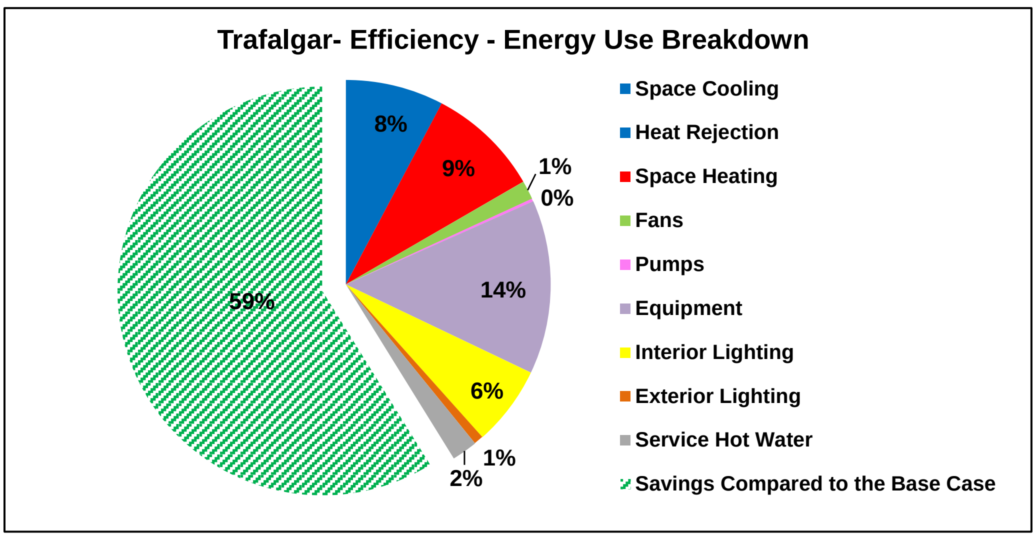


Figure 5-12 Trafalgar Campus Savings Against the Base Case

5.4.2 Control & Efficiency – Davis Campus

The following efficiency measures, shown in Figure 5.13, were applied to the Davis campus buildings.

	Control and Metering	Building Efficiencies

	Setpoint Control	Lighting Schedules	Lighting upgrade	Lighting Controls upgrade	Roof upgrade	Weather proofing	Lower Solar Direct Gain	CO_2 Sensors	HVAC Controls upgrade	Recommissioning
J Building	x	x	x	x				x		x
H Building	x	x	x	x				x	x	
Student Centre	x	x	x	x				x	x	
McLaughlin Building	x	x	x	x	x	x	x	x		x
B Wing	x	x	x	x	x	x	x	x	x	
C Wing	x	x	x	x	x	x	x	x	x	x
Residence			x	x	x		x			

Figure 5-13 Davis Campus Efficiency Measures by Building

When collecting information for the Base Case energy models it was noticed that most of the buildings on Davis Campus have constant temperature setpoints as well as lights that were left on in empty rooms. From these observations all buildings had the setpoint control and lighting schedules altered as an efficiency measure in the models. Most lights in the buildings on Davis campus have T8 28W light bulbs. As time goes on it is recommended these change to T8 25W in order to reduce energy in these spaces. None of the buildings had lighting controls such as daylight or motion detectors. This was also a measure that was recommended for all buildings.

The envelop upgrades are applied to the McLaughlin building, B Wing and C Wing. These are the older buildings and it was seen that each could take around 12” of insulation in the roof. They also would benefit from solar exterior shading, and whilst this is being added to these buildings, weather-proofing the exterior of the building could also be done and be of benefit to each building. The residence had potential for increasing the insulation levels in the roof as well as weather-proofing. Solar exterior shading was not considered for this building

It was recommended that each building should have CO_2 sensors installed in the public spaces. This reduces the amount of outdoor air each building will need to condition, increasing the energy savings. CO_2 sensors also increase the fresh air when a classroom or room in the building is full, this helps keep the people in the room alert and increases their comfort in the space. It was seen that H-Wing, Student Center, B Wing and C Wing could use some HVAC upgrades.

Finally from the modeling results and the energy audits it was seen that J-Wing, C-Wing and McLaughlin building required some recommissioning.

The efficiency measures were applied to the Base Case buildings showing between 30 – 60% energy savings in each building, as shown in Figure 5.14. The energy use intensity considers a COP of 1 for all boilers and chillers in both the efficiency case and the Base Case.

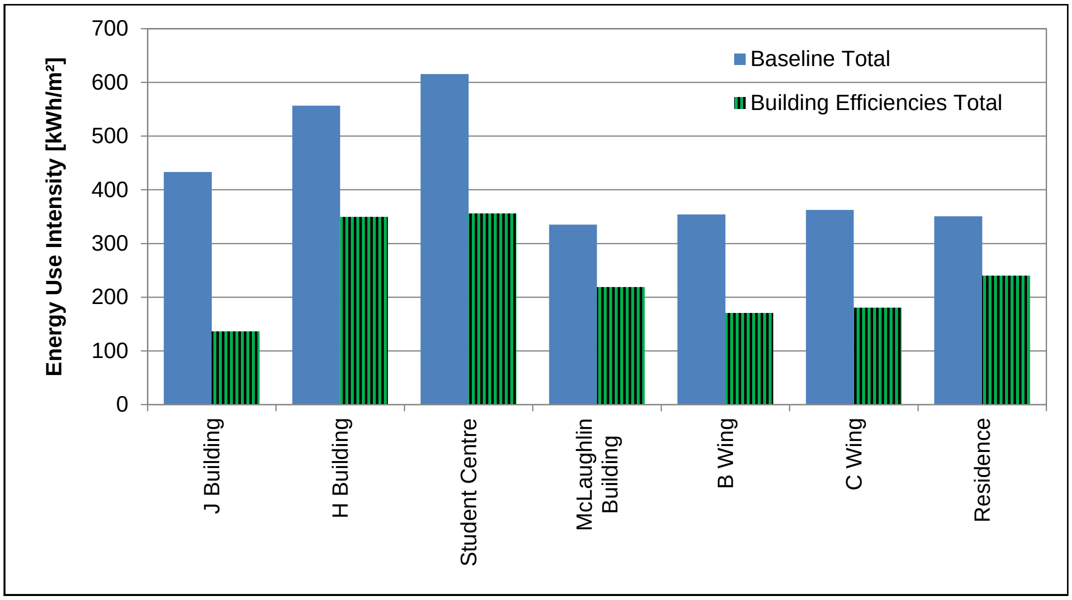


Figure 5-14 Davis Campus Control/Efficiency Energy Compared to the Base Case

The total energy savings for Davis Campus was approximately 45% energy savings for the whole campus when these efficiency measures are applied. Figure 5.15 shows the savings against the Base Case and the percentage break down of energy uses on the Trafalgar campus. In both cases the COPs of the chillers and boilers are set to 1.

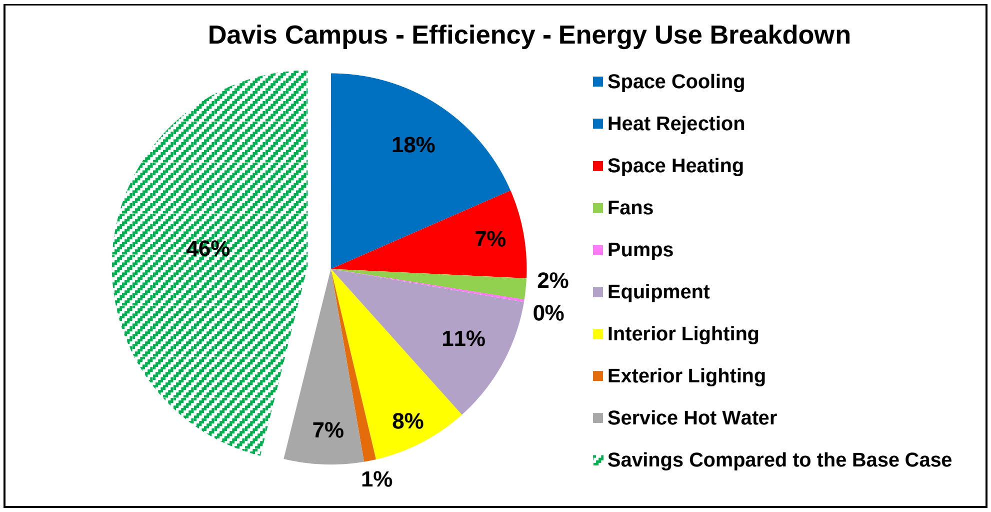


Figure 5-15 Davis Campus Savings Against the Base Case

5.4.3 Control & Efficiency – Skills Training Center

The following efficiency measures, shown in Figure 5.16, were applied to the Skills Training Center.

	Control and Metering	Building Efficiencies

	Setpoint Control	Lighting Schedules	Lighting upgrade	Lighting Controls upgrade	Roof upgrade	Weather proofing	Lower Solar Direct Gain	CO_2 Sensors	HVAC Controls upgrade	Recommissioning
Skills Training Center	x	x	x	x	x	x	x	x	x	x

Figure 5-16 Skills Training Center Control/Efficiency Measures by Building

All measures were applied to STC. It was the perfect candidate for each measure and will benefit significantly from them all.

The efficiency measures when applied to the Base Case building showed a 46% energy savings. Both Base Case and efficiency case show the EUI when the boilers and chillers have a COP of 1.

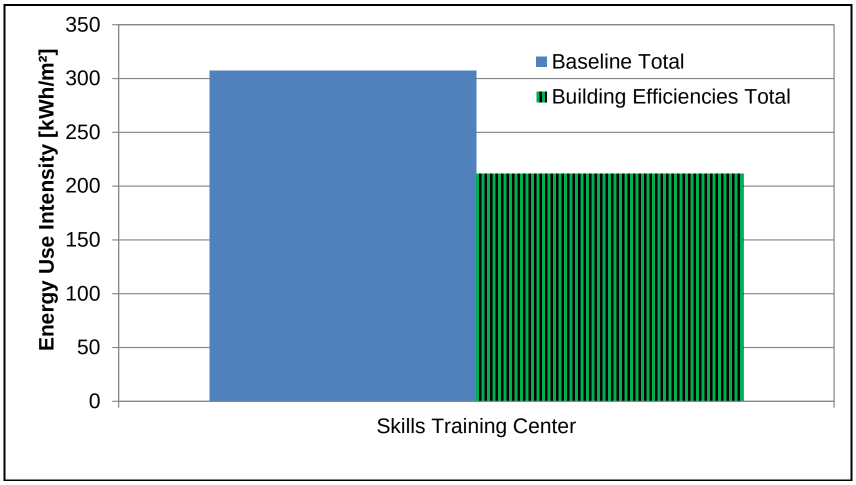


Figure 5-17 Skills Training Center Control/Efficiency- Energy Compared to the Base Case

The total energy savings for STC campus was approximately 45% for the whole campus when these efficiency measures are applied. Figure 5.18 shows the savings against the Base Case and the percentage break down of energy uses on the STC campus.

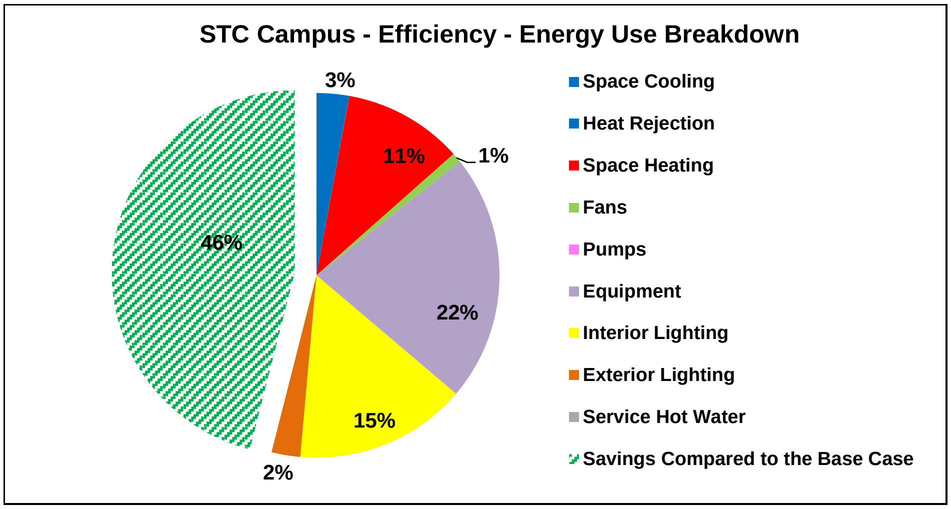


Figure 5-18 Skills Training Center - Energy Savings Against the Base Case

5.5 Distribution – College

This section details Scenario 3 "Distribution" outlined in Section 5.2. The priority energy distribution focus is on heating and hot water, which is 41% of the Baseline utility consumption. Much of this need will be reduced by the measures outlined in Section 5.4, and in Scenario 2, further efficiency potential is captured on the two larger campuses by updating both to closed hot water systems, and extending the district heating networks to encompass most, and ultimately, all, buildings on the campuses.

On the Trafalgar Campus, the estimated 25% heat losses in the steam network are roughly reduced by a factor of three through steam to hot water conversion. On both the Trafalgar and Davis campuses, the extension of heating to all buildings allows the heating plant to be optimized across the campus as a whole. This allows the plant to operate at higher levels of efficiency. It also allows the heat supply portfolio to be adapted over time, to eliminate the least efficient sources, and to add more efficient or less polluting alternatives. This conversion also avoids some inevitable future maintenance investments and reduced operating and maintenance costs.

Creating a modern and complete heating distribution system can be seen as both a source and an enabler of new efficiencies. It is also now efficiently sized for future expansions.

Electricity for cooling is only 13% of all the utilities used by the College. Again, the efficiency actions applied to all buildings in Scenarios 1 and 2 significantly reduces this cooling need. There is sufficient cooling capacity in the existing supply and distribution systems, especially after the Scenario 1 and 2 measures are completed. As there is already a central structure on all campuses for most buildings, there was no strategic assessment in the IECMP for cooling. The only extended cooling integration that was included in Scenario 3 is to include the new students' residences. As a matter of future energy management discipline when a needed chiller replacement comes up, the possibility of sharing chillers with neighboring buildings should be assessed. This additional potential benefit has not been included in the IECMP.

5.5.1 Distribution Trafalgar Campus

Trafalgar Campus currently supplies heating and domestic hot water with a mix of steam and hot water. The future heating network included in Scenario 3 is shown in Figure 5.19.

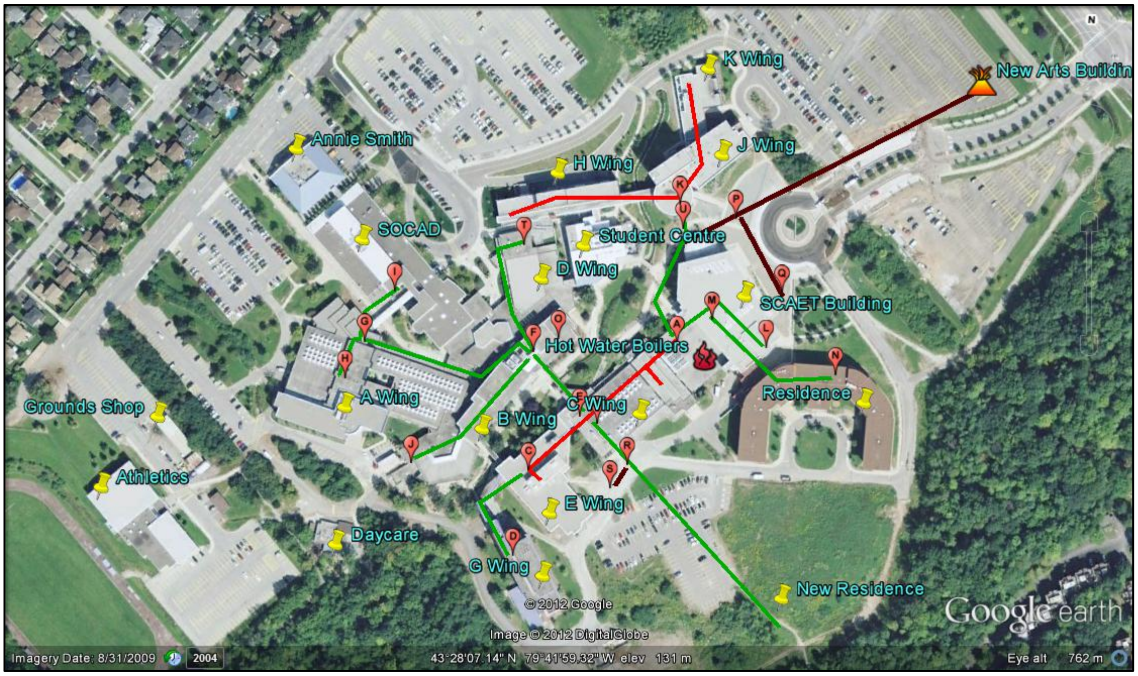


Figure 5-19 Trafalgar Campus Scenario 3: Heating Network Upgrade and Expansion

The red lines are the existing hot water pipes. The existing steam connections shown in Figure 4.42 will be replaced with hot water connections, in some cases taking different routes. These converted links will be both integrated with the existing hot water network and extended to capture new buildings. All new pipes are shown as green lines.

The conversion of the steam distribution will be a multi-year process coordinated with the implementation of building efficiency measures. The timing of conversion will ensure sufficient capacity and connections are available as appropriate for building upgrades or new construction. The IECMP assumed this would be completed in about 5 years.

The dark red line in Figure 5.19 indicate future development options. Neither the efficiency benefits nor the necessary investment is included in the IECMP calculation.

The efficiency of the distribution increases by replacing old steam and condensate pipes. This is partially offset by additional network losses through expanded coverage. In total, the distribution losses will be reduced by about one-third compared to the historic steam losses.

The final hot water network will be about 1.5 km, plus the current hot water system of only 132 meters.

5.5.2 Distribution Davis Campus

The Davis campus already has a relatively efficient hot water based district heating system. Figure 5.20 shows the future changes in Scenario 3.

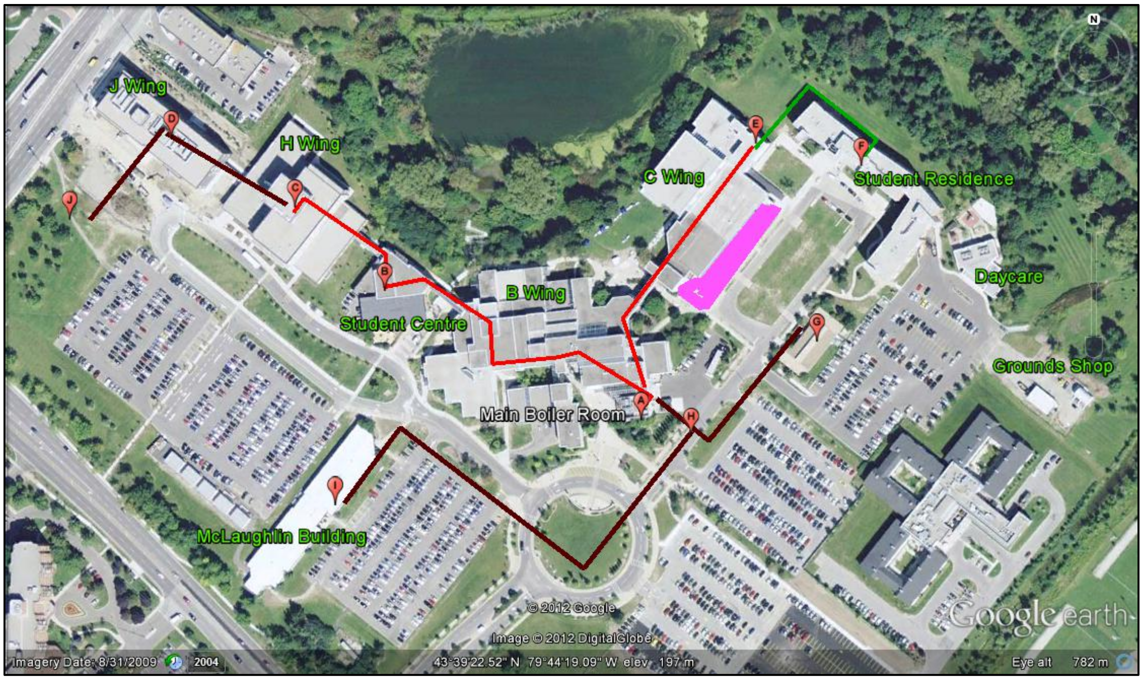


Figure 5-20 Davis Campus Scenario 3: Heating Network Expansion

An extension is only viable for the new student center. All other building cannot be connected to the current system for the following reasons:

- Distance for connection relative to the loads
- Small building size with very small heating loads after the measures of Scenarios 1 and 2 are implemented
- Multiple existing roof-top units with high connection costs to include in network

The effect on heat distribution efficiency is negligible. The benefit is a higher future potential for CHP and even biofuel renewable heating sources.

The new Student Residence will be connected to the existing heating system and to the chilled water system.

5.6 Supply – College

The heat supply of all campuses in the future will be primarily based on hot water boilers. On the Davis campus and at STC, the existing boilers will continue to be used.

On Trafalgar Campus the existing steam boilers are replaced by a mix of the existing hot water boilers and some additional hot water boilers. These will be sized to cover the greatly reduced future heat demand resulting from the combined efficiency impacts of Scenarios 1, 2 and 3.

The seasonal profile of the future heat demand for Trafalgar and Davis Campus allows the consideration of gas-fired CHP engines as a base load heat source, in turn creating high levels of fuel efficiency when both the power and heat outputs are considered.

Figure 5.21 shows examples of CHP engines from a size of 250 to 1,200 kW (electric) per unit.

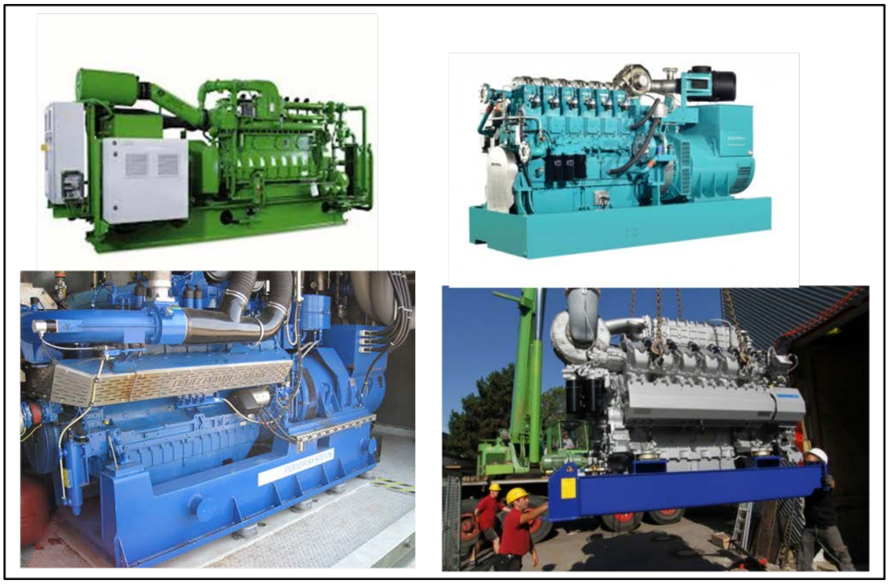


Figure 5-21 Typical CHP installations (250 kW to 1.2 MW electrical power)

These engines generate heat and electricity with the same unit at the same time, a process known as co-generation or Combined Heat and Power (CHP). CHP engines adapted to use natural gas as fuel have been in widespread use in many parts of the world since the 1980s. As a result there is a proven track record of reliability, costs and technical performance. Their use in the U.S. and Canada has been relatively limited, primarily due to unfriendly utility regulation. Recent changes in Ontario are beginning to change that pattern in the Province.

The heat from the cooling water jacket and the exhaust heat is used via heat exchanger as a hot water source at about 90°C. The engine is also coupled with a generator for electricity generation. CHP engines are delivered as a pre-manufactured module ready for simple installation on site.

The engines suitable for the Sheridan campuses convert natural gas to the combination of heat and power with an overall fuel efficiency of 85% to 88%. If there were to be no heat recovery, the efficiency of converting the natural gas to electricity alone would have an efficiency of between 36% to 40%. Combining heat and power generation effectively doubles the fuel efficiency.

5.6.1 Heat Supply - Trafalgar Campus

In Scenario 4, the Trafalgar heat supply is based on meeting the combined adjusted needs of Scenarios 1, 2, and 3, as described in the preceding sections. Over the five years of the network conversion and network expansion, steam demand will be shut down incrementally. The future heat demand will be covered with existing boilers and new boiler capacity to be added.

In addition to new boilers, Scenario 4 includes gas-fired CHP engines sized to efficiently provide base-load heat for a large part of the year. Figure 5.22 shows the estimated operating curve for the Trafalgar CHP units.

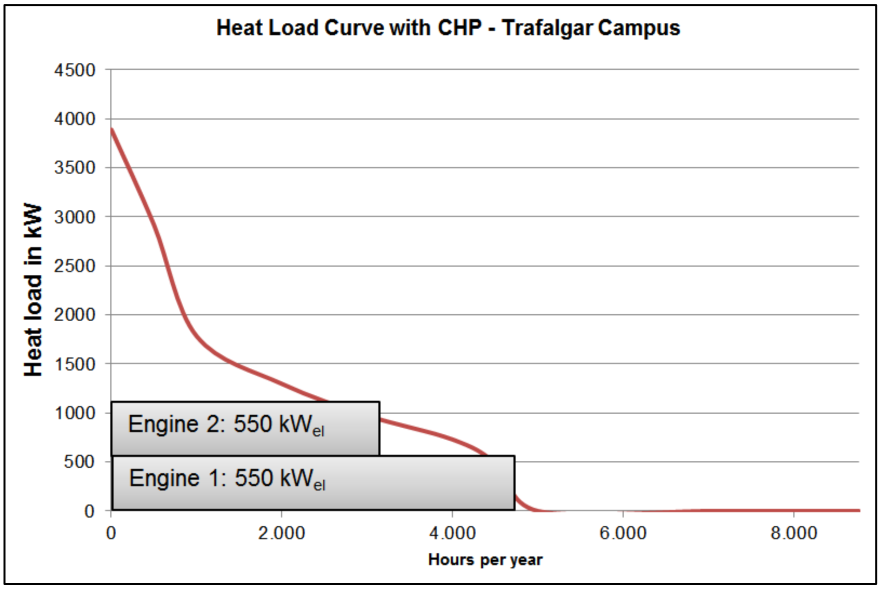


Figure 5-22 Trafalgar Campus Scenario 4: Heat Demand and CHP Sizing

The red line is the heating demand curve for a full year of operation after the efficiencies of Scenarios 1, 2 and 3 have been applied. In the IECMP assumptions these investments are complete by 2017. Based on this need, a combination of two 550 kW_{el} CHP engines would supply most of the base load heat, with one running about 4,750 hours / year and the other about 3,250 hours. CHP engines are most efficient when they are fully loaded on both heat and electricity, and the Team used this as the criterion to model the operating cycle. The grey bars indicate the heat generated from CHP. The remaining heat demand represented by the white areas below the red curve, will be covered by hot water boilers.

The CHP units will be installed after completion of the network integration and conversion and will be operating in 2018.

5.6.2 Heat Supply - Davis Campus

On the Davis campus, the hot water distribution is already in place and will only be extended to supply the new Students' Residence. CHP with gas-fired engines can take place in 2014 with full operation in 2015. Figure 5.23 shows the estimated operating curve for the Davis CHP units.

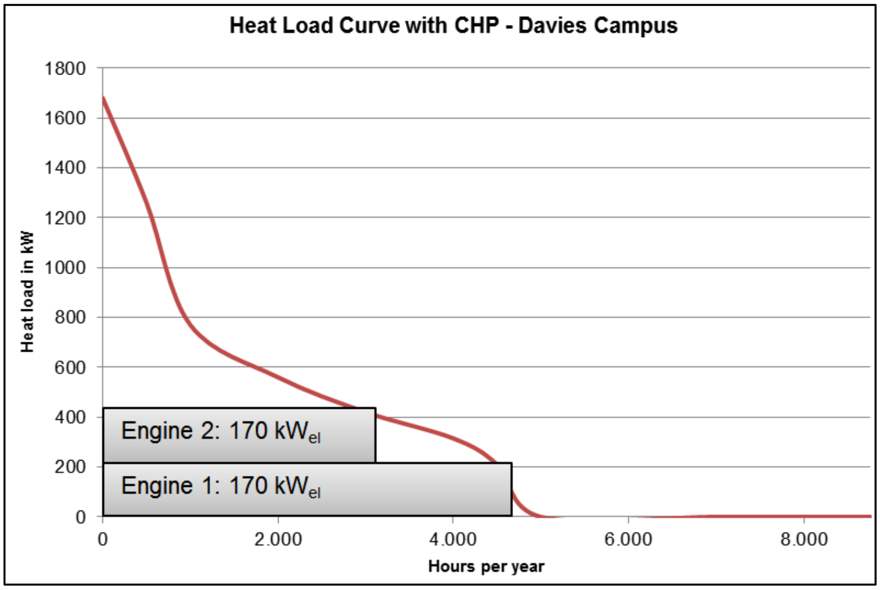


Figure 5-23 Davis Campus Scenario 4: Heat Demand and CHP Sizing

The background to the operating cycle for Davis is basically the same as outlined in Section 5.6.1 for Trafalgar.

5.7 Supply – PV Option

As indicated in Section 5.2.5, the IECMP allows for the assessment of the impact of a sizable addition of Solar Photovoltaic (PV) generation to the Davis and Trafalgar campuses. This has been implemented as an option "button" in the Integration Workbook and can be applied to Scenarios 1, 2, 3 or 4.

There are essentially two ways to select a reasonable size for a PV installation:

1. Estimate the available suitable rooftop and ground based space
2. Chose the capacity based on possible summer peak load reduction

The first is a pragmatic assessment of what is physically feasible. The second is using PV for its value in reducing grid purchases during periods of high demand when summer air conditioning load is at its highest. Ontario is likely to move to time-of-use electricity tariffs[xxxv] in future, potentially making peak load an economic, as well as a technical and environmental, asset.

Sheridan decided to size the PV area to reduce the summer peak electricity purchases from the grid as both future electricity cost risk mitigation and a significant greenhouse gas reduction. Based on the current College load profile and suitable ground and roof based areas, a summer load reduction of 70% of the installed peak capacity is possible.

For each of the campuses, the electrical load curve was estimated along with the possible installation areas. This led to the following installed PV peak capacities:

- Trafalgar Campus: 1,500 kW requiring 22,300 m² panel area

- Davis Campus: 1,500 kW requiring 22,300 m^2 panel area
- STC: 250 kW requiring 3,700 m^2 panel area

As an example, Figure 5.33 shows the load curve and the background to a typical PV calculation for Trafalgar Campus.

The IECMP assumes PV would be installed from 2015 to 2019 linearly. Based on Ontarian solar radiation it is calculated to get 1,250 kWh per kW installed peak PV[xxxvi].

Figures 5.24 and 5.25 show the possible available space for PV on Trafalgar and Davis campuses is sufficient to support these installation sizes.

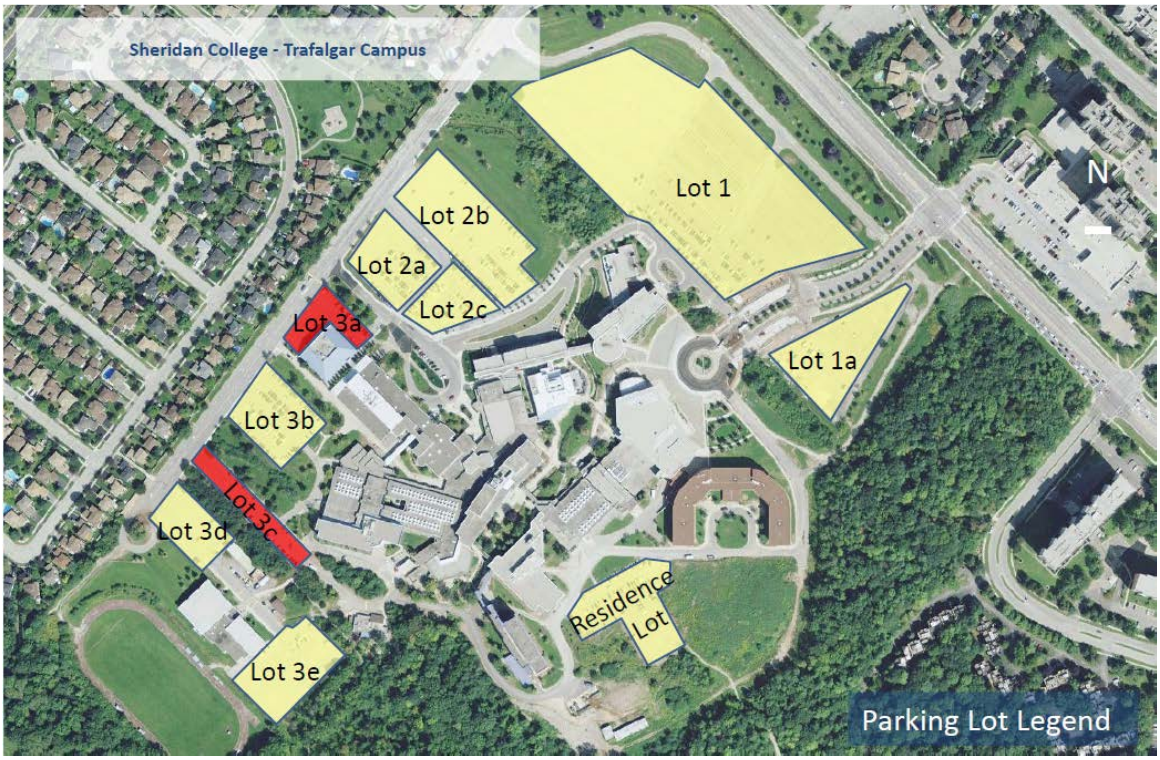


Figure 5-24 Trafalgar PV Option – Possible Installation Locations (approx. 60,000 m^2 total)

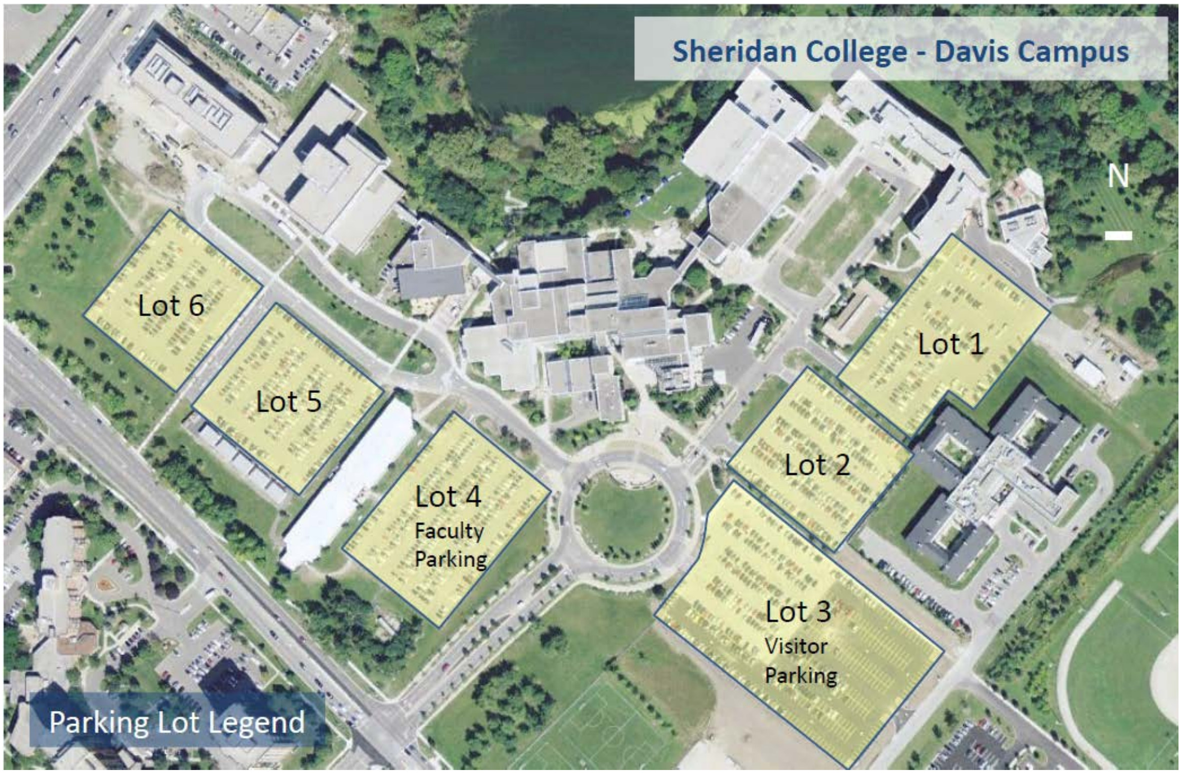


Figure 5-25 Davis PV Option – Possible Installation Locations (approx. 45,000 m^2 total)

5.8 Supply – Absorption Chiller Option

As indicated in Section 5.2.6, the IECMP allows for the assessment of the impact of adding absorption chilling to the Davis and Trafalgar campuses. This has been implemented as an option "button" in the Integration Workbook and can be applied to Scenario 4.

Typically chilled water will be produced in compression chillers driven by electricity, as is the current and future case on all Sheridan campuses. An alternative could be to use heat as a source to generate chilled water with an absorption chiller. While technically less efficient than electric chillers, this can make economic and environmental sense when cheap heat is available from CHP or waste heat from industrial processes, for example.

At Sheridan absorption chilling is an option when the CHP engines are used in Scenario 4 as described in Section 5.6.1 and 5.6.2. No other suitable "waste" heat with the required 85° to 90°C level is available. Suitably sized absorption chillers for Sheridan campuses have a COP of 0.75, compared to between 4 and 5 for an electrical chiller. As a result, an absorption chiller needs 5 to 6 times more site energy than an electrical one. This disadvantage can only be compensated for with efficient heat generation in CHP, or with cheap renewable fuels, or by using waste heat.

Figure 5.26 show typical absorption chillers that would be suitable for Trafalgar and Davis.

Figure 5-26 Absorption Chiller Option Scenario 4 – Typical 100 to 50 tons Installations

The absorption chillers for Trafalgar and Davis campuses are sized that they can use 100% of the heat output of the engines. The respective capacities are:

- Trafalgar Campus: 256 tons
- Davis Campus: 100 tons

As a consequence of the efficient heat generation by CHP, the Colleges source energy use can be reduced by about 3%. The economics are good as a result of the increasing spread between gas and electricity prices in both the Low and High Risk Case energy price outlooks. There will be sufficient flexibility in the mix of electric and absorption cooling to adjust operating regimes as price spreads change.

5.9 Other Measures

A number of other energy efficient or low-carbon measures were considered and not included in the immediate current version on the IECMP scenarios. The rationale behind each is summarized in the following paragraphs.

5.9.1 Wind Power

The possible installation of between 1 and 3MW of wind on the Trafalgar and Davis campuses was considered. This was rejected for two reasons. The wind quality is average to poor and siting with the necessary safety clearances is a challenge. The implementation of small-scale wind applications for image or teaching reasons is clearly an option but should be considered as an academic investment, distinct from the IECMP operational goals.

5.9.2 Solid fuel biomass

This was not included due to site limitations and the short term outlook for natural gas prices. Handling biomass fuels requires the appropriate space and storage, and must be a reliable, low cost supply. The likelihood of it proving a viable option is very low for the immediate future. However, the upgrade and integration of the heating systems leaves this as a potential for future consideration.

5.9.3 Onsite biogas

This was not included due to site limitations. The development of facility-scale biogas from biomass is unlikely to be viable or acceptable for the foreseeable future. However, a small-scale anaerobic digester handling food and landscaping waste is not out of the question to both manage solid waste and be an example to the Sheridan community. The investments should be considered as a future investment, distinct from the IECMP.

5.9.4 Network biogas

There is no technical reason why network biogas could not be used. However, it has not been included in the IECMP calculations. In some countries, Germany as an example, utility-scale production of biogas is becoming common, and is being blended with natural gas in the public networks. The result is a reduction in the emissions index which can affect both Scope 1 and Scope 2 emissions. There is no immediate indication that this will happen in Ontario, but if it does, recalculating any scenario would be simple, and all the technology selected would be compatible.

5.10 Scenario Summary

The results of the combination of the control, efficiency, distribution and supply scenarios are summarized in this section.

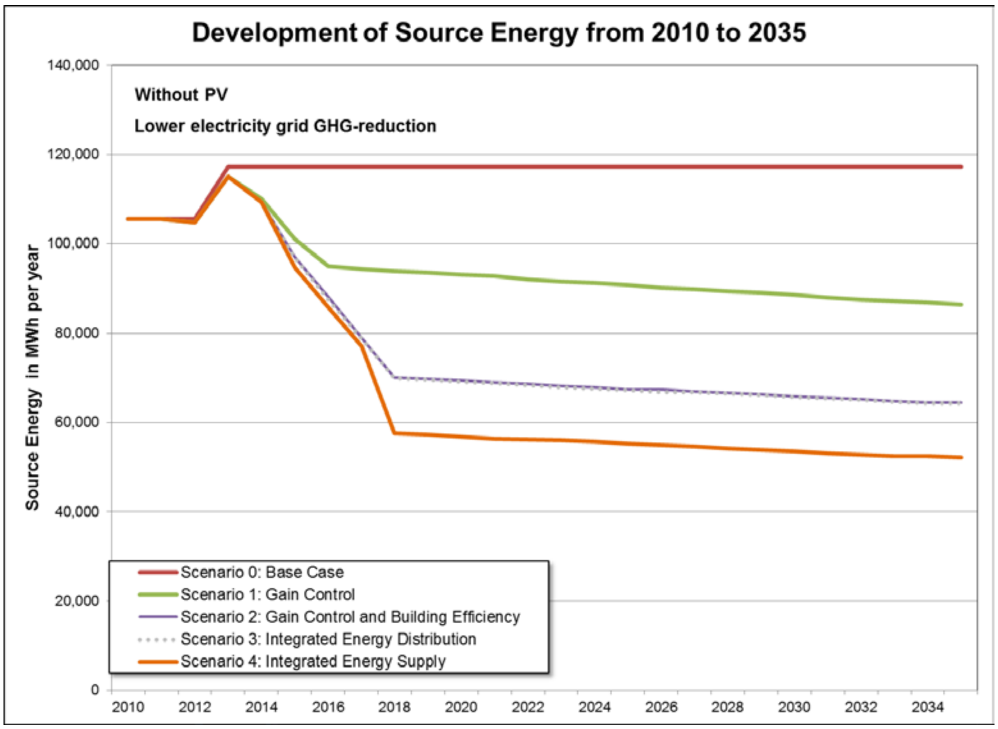


Figure 5-27 Sheridan College – Source Energy Use by Scenario to 2035

With full implementation of all scenarios, source energy use for the College goes from 118,000 MWh in 2010 to 53,300 MWh in 2035.

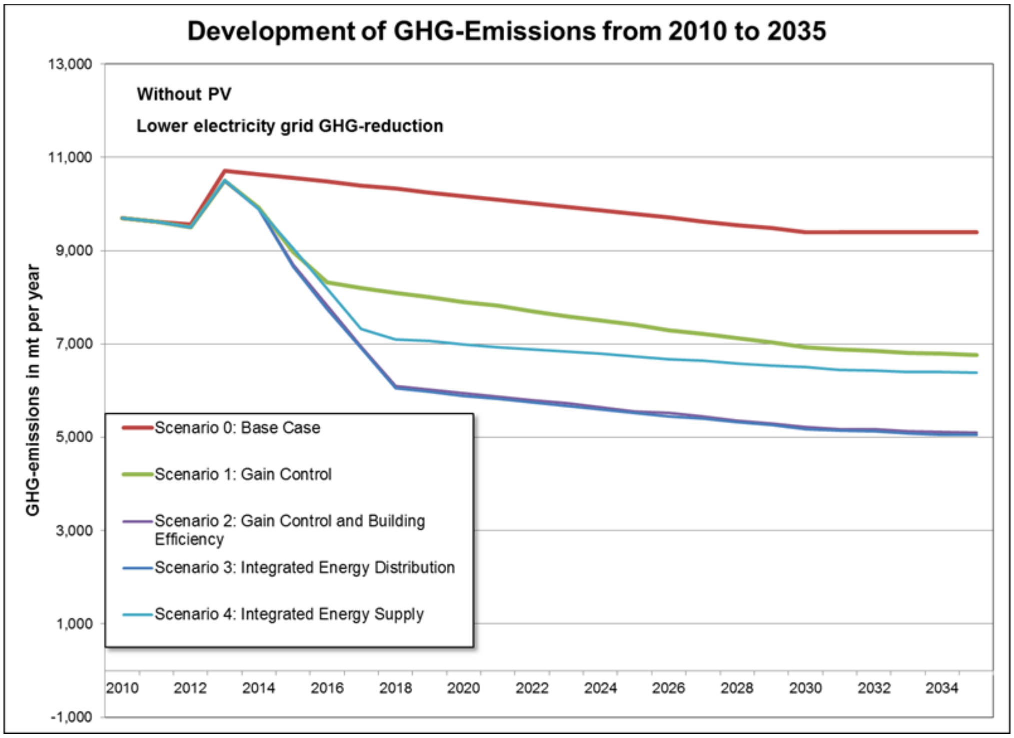


Figure 5-28 Sheridan College – Greenhouse Gas Emissions by Scenario to 2035

Greenhouse gas emissions drop from 9,700 mt to 6,380 mt over the same period, assuming no change in the grid emission index.

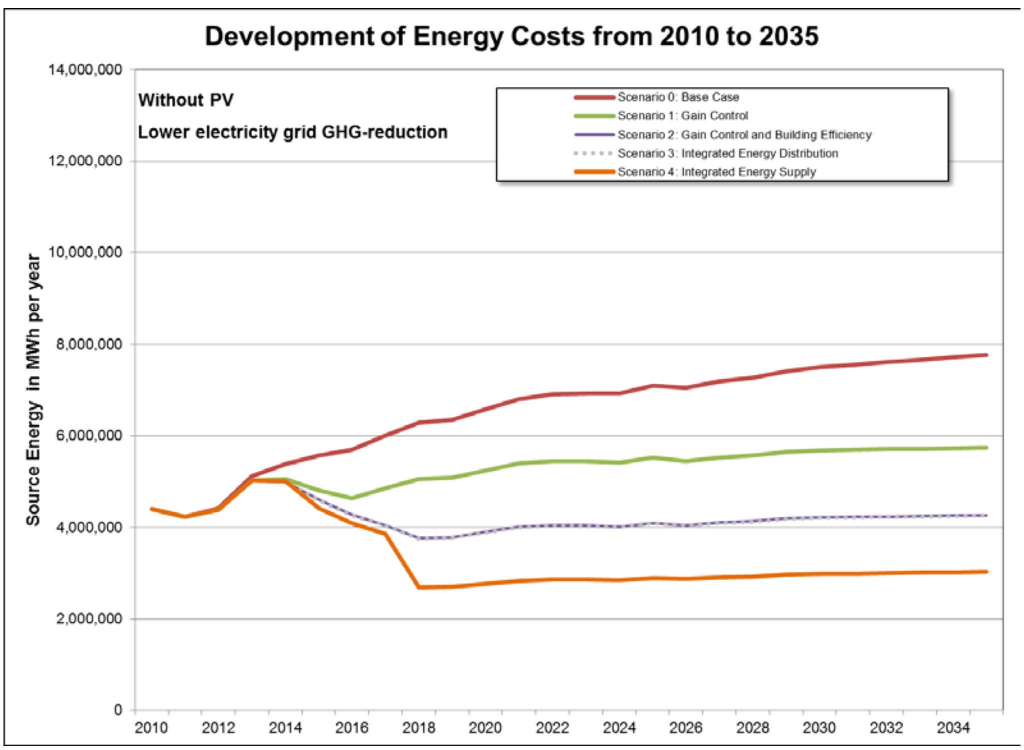


Figure 5-29 Sheridan College – Energy Costs by Scenario to 2035 - Low Risk Case

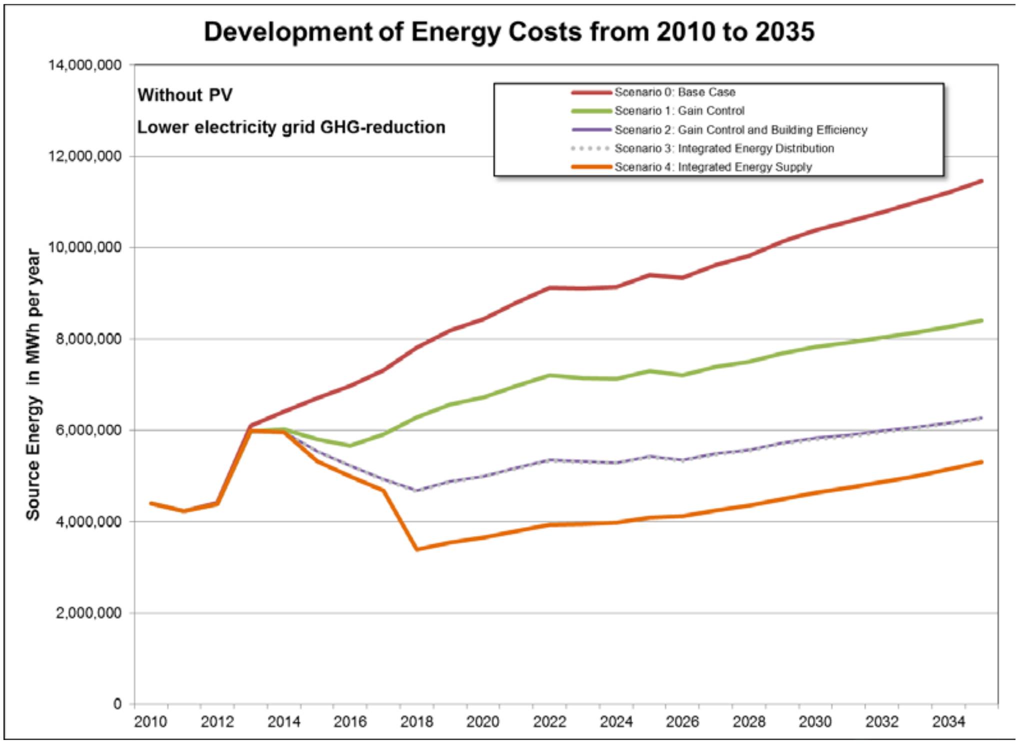


Figure 5-30 Sheridan College – Energy Costs by Scenario to 2035 - High Risk Case

With Scenario 4 fully implemented, 2035 energy costs are constrained to somewhere between a Low Risk Price Case total of $3.0M against a Base Case of $ 7.7M. For the High Risk Price Case, the total energy costs rises to $5.3M against a Base Case total of $11.4M.

5.11 Scenario Assessments

The last step in the process is to assess each scenario and the options against the three key Framing Goals restated in Figure 5.31.

Category	Framing Goal	Target %
Efficiency	Source Energy Efficiency	50%
Environment	Carbon Footprint	60%
Economy	Internal Rate of Return	7%

Figure 5-31 Key Framing Goals

The energy and emissions results, without Solar PV, are shown in Figure 5.32.

Condition	Energy (MWh/year)					Emission	Savings (%)		
Scenario	Gas	Electricity Purchase	Electricty Conversion	Total on site	Total Source	CO_2 (mt)	Energy on site	Energy Source	CO_2
Without PV *Low Risk Case*									
Baseline 2010	20,300	28,100	57,100	48,400	106,500	9,700	0%	0%	0%
2035 Results									
Scenario 0: Base Case	23,700	30,900	62,700	54,600	118,400	9,400	-	-	-
Scenario 1: Gain Control	16,400	23,100	46,900	39,500	87,200	6,760	28%	26%	28%
Scenario 2: Gain Control and Building Efficiency	12,600	17,100	34,700	29,700	65,000	5,100	46%	45%	46%
Scenario 3: Integrated Energy Distribution	12,400	17,100	34,700	29,500	64,800	5,060	46%	45%	46%
Scenario 4: Integrated Energy Supply	25,100	8,900	18,100	34,000	53,300	6,380	38%	55%	32%

Figure 5-32 Energy and Emission Results – without Solar PV

Only Scenario 4 meets the 50% source energy Framing Goal. None of the scenarios meet the very challenging Carbon Footprint reduction of 60%. However, all scenarios achieve at least a 32% reduction from Base Case; by no means a poor performance.

The effect of adding Solar PV is shown in Figure 5.33.

Condition	Energy (MWh/year)					Emission	Savings (%)		
Scenario	Gas	Electricity Purchase	Electricty Conversion	Total on site	Total Source	CO_2 (mt)	Energy on site	Energy Source	CO_2
Including PV Low Risk Case									
Baseline 2010	20,300	28,100	57,100	48,400	106,500	9,700	0%	0%	0%
2035 Results									
Scenario 0: Base Case	23,700	30,900	62,700	54,600	118,400	9,400	-	-	-
Scenario 1: Gain Control	16,400	19,400	39,400	35,800	76,000	6,670	34%	36%	29%
Scenario 2: Gain Control and Building Efficiency	12,600	13,400	27,200	26,000	53,800	5,010	52%	55%	47%
Scenario 3: Integrated Energy Distribution	12,400	13,400	27,200	25,800	53,600	4,960	53%	55%	47%
Scenario 4: Integrated Energy Supply	25,100	5,100	10,400	30,200	41,800	5,810	45%	65%	38%

Figure 5-33 Energy and Emission Results – including Solar PV

The relatively large scale installation of Solar PV causes a further reduction in source energy to 65% from Base Case in Scenario 4, and also meets the 50% Framing Goal in Scenarios 2 and 3. The effect on overall emissions is relatively small, with the largest shift being a further 6% reduction in Scenario 4 relative to Base Case.

The challenge of meeting the 60% Framing Goal is basically around the good news that the Ontario grid has decarbonized quickly compared to many other parts of North America. The results in Figures 5.47 and 5.48 above assume there will be no further decarbonization. However, the Ontario Long Term Energy Plan calls for ongoing reductions, so the Team included an option to model a year-on-year reduction of 1%/year in the emission factor of grid electricity. The effect of this is shown in Figure 5.34.

Condition	Energy (MWh/year)					Emission	Savings (%)		
Scenario	Gas	Electricity Purchase	Electricty Conversion	Total on site	Total Source	CO_2 (mt)	Energy on site	Energy Source	CO_2
Including PV Low Risk Case									
Baseline 2010	20,300	28,100	57,100	48,400	106,500	9,700	0%	0%	0%
2035 Results									
Scenario 0: Base Case	23,700	30,900	62,700	54,600	118,400	5,540	-	-	-
Scenario 1: Gain Control	16,400	19,400	39,400	35,800	76,000	3,780	34%	36%	32%
Scenario 2: Gain Control and Building Efficiency	12,600	13,400	27,200	26,000	53,800	2,870	52%	55%	48%
Scenario 3: Integrated Energy Distribution	12,400	13,400	27,200	25,800	53,600	2,830	53%	55%	49%
Scenario 4: Integrated Energy Supply	25,100	5,100	10,400	30,200	41,800	5,170	45%	65%	7%

Figure 5-34 Energy and Emission Results – including Solar PV and Grid CO_2 Reductions

If this aspect of Ontario Policy is successful, the emissions in 2035 will be 2,830 mt for Scenario 3, or 49% below Base Case. However, the Base Case itself has changed due to the change of the grid factor. Compared to 2010, the emissions in Scenario 3 are 71% less. In Scenario 4 they increase to 5,170 mt owing to the implementation of efficient on-site natural gas-fired CHP, as opposed to purchasing inefficient nuclear-fired power and hydroelectricity. This configuration assumes public policy success and is clearly beyond the control of the College, and must be treated with caution.

A full implementation of Scenario 4 with a sensibly phased implementation of the PV option far exceeds the financial and efficiency goals, and makes a substantial contribution to emissions reductions.

5.12 Energy Management – Continuous Improvement

A prerequisite for effective energy and climate management is a campus-wide BMS with capability to manage and meter energy use at the building and sub-building level. However, technology alone without some significant changes in energy culture and management practice will not deliver the results outlined in Section 5.11.The investments and changes in practice outlined are meant to create the technical basis for developing an ongoing process of continuous evaluation and improvement of the College's energy and GHG performance.

The comprehensive control and metering system also provides relevant data and visualization to facilitate engagement of staff, students and faculty in the ongoing energy and climate performance of the College. The added use of one of the emerging sustainability behaviour change engagement platforms[xxxvii] could help build knowledge and collaboration across the College and even into the wider community.

A key element of ensuring Sheridan College delivers ongoing continuous improvement in energy and climate performance will be to create an environment where energy efficiency and pride in energy and climate accomplishments becomes an irreversible part of the campus culture.

Industrial and commercial experience points to the effectiveness of "Low Cost / No Cost" programs that actively engage all parts of the College community, and typically deliver up to 25% of the potential energy saving, with the balance coming from improved sourcing and capital based projects.

The use of facilities at Sheridan varies significantly depending on the day of the week, the time of day and the academic year. This wide variance currently causes significant energy waste through sub-optimal schedule planning including under-utilization of facilities. Energy is wasted through the heating, cooling and lighting of empty facilities due to changes in schedule, poor planning or lack of communication. Continuously improving the rigor of schedule management is made feasible with the modernized BMS and improved energy infrastructure, but will only be captured by ongoing cooperation between faculty, students and facility staff.

Modern BMS systems also have the capability to be configured to anticipate weather outlooks using predictive control strategies based on local weather forecasting, further adding to the potential for "finer-tuning" College energy performance.

The IECMP is calling for a consciously structured staff and student engagement programme. This should include Toyota-style "Energy Treasure Hunt" (ETH) as part of a disciplined program underpinning low-cost/no-cost continuous improvement. These will involve all operations staff including the Office of Sustainability and the facility team. The participation of students and faculty should be actively encouraged both for the value of their contributions and as a part of the "living laboratory". There will be a relatively formal process to present the Treasure Hunt recommendations and to approve their implementation. The frequency of these should be at least once a year and ideally twice.

Metered data should be used for the creation of standard and customized graphic dashboards that can be accessed via the College intranet and on the public website of the College. Performance against Framing and other Goals should be continuously updated, and regularly benchmarked against peer institutions.

The results in Section 5.12 assume effective engagement programs are in place and delivering a continuous improvement of about 0.5% per year.

5.13 Curriculum Development

Systematically implementing the IECMP across all the Sheridan College campuses creates a unique opportunity to develop energy and climate focused academic programs. These have the potential to make the College the leading Canadian Center of Excellence for integrated energy and sustainability planning, implementation and management.

The uniqueness of these programs comes from the fully-integrated way in which the IECMP treats the technical, economic and environmental outcomes as equally important aspects of a sustainable energy solution for the College. The integration also is a differentiating feature of the way the technical solutions encompass all aspects of energy use, distribution and supply, including carbon reduction. The last integration aspect will come from the creation of energy management disciplines that will ensure continuous improvement of energy and climate performance involving staff, faculty, and students.

Sheridan's strength in arts, graphic design, computer animation, and human factors are as important as the technical, business and managerial aspects. They add the potential of unique multi-disciplinary offerings.

The global benchmarking aspect of the IECMP was key to setting credible breakthrough targets, and should be maintained as the implementation rolls out. The concept can easily be extended to developing teaching programs that take advantage of this global perspective.

Most current tertiary educational programs in the energy and climate space focus on narrow aspects of the sustainable energy solution, and fail to build the integrated understanding and skills appropriate to deliver breakthrough energy performance. The market is increasingly looking for these holistic skill sets, creating a window of opportunity for Sheridan.

5.14 Recommendations

The Team is recommending the full implementation of Scenario 4 including the large scale solar PV option on the Trafalgar and Davis Campuses. Appropriate resourcing of the sub-projects will be key to long-term success. This will include the following:

- College-wide energy and carbon control, metering and reporting systems
- Portfolio of end-use efficiency measures in most buildings
- Restructured and more efficient heating distribute systems on Trafalgar and Davis campuses
- Reconfigured more efficient clean and renewable heat and electricity on-site generation on both Davis and Trafalgar campuses

The Team is also recommending the following strategic changes in management practices supported by appropriate policy changes:

- Annual allocation of management resources starting in 2014 to implement a "Low-Cost/No Cost" energy management program that engages staff, students and faculty in the energy and climate performance of the College.
- Requiring all new buildings on the Davis and Trafalgar campuses to be connected to the relevant heating and cooling networks.
- All new buildings will have energy performance representing systematic global best practice in the year of construction. In 2013 this would be higher than LEED Gold rating and at about German A-Rated levels.

- Submit annual Greenhouse Gas Performance report for the College to the voluntary Carbon Disclosure Project to ensure transparency and support ongoing accountability for successful implementation of the IECMP.

Combined, these measures will achieve the following:

- Primary energy use reduction of 65% compared to Base Case
- Greenhouse gas emissions reduction of about 40% compared to 2010 levels

5.15 Next Steps

Following formal acceptance of the IECMP, the following next steps should be taken:

- Policy Development
    - Establish an Energy and Climate Policy
    - Establish a Zero Waste Policy
    - Establish energy performance standards for new construction to ensure they perform at systematic global best-practice levels of energy efficiency
    - Establish energy performance standards for building renovation to ensure they perform at levels consistent with the efficiency targets of the IECMP
- IECMP Oversight
    - Form Sustainability Advisory Committee to provide IECMP & Zero-Waste implementation review and oversight (note: This may be a sub-committee within a future "Sheridan Centre for Applied Sustainability")
- Energy Management
    - Establish long-term energy and climate continuous improvement program framed around Energy Star Energy Management recommendations and tracked using Energy Star Assessment Matrix, as a pre-cursor to possible ISO 50001 certification.
    - Establish timetable and process for regular Energy Treasure Hunts, with the first being no later than 2016
- Resources
    - Fill position of Officer, Sustainability Data, Assessment and Reporting to fulfill mandatory and voluntary reporting & assessment requirements
    - Fill position of Manager, Zero Waste initiatives
    - Fill position of Manager, Sustainability Engagement and Communication
    - Finalize IECMP financing plan in collaboration with Sheridan Finance Department
- IECMP Sub-Project Implementation
    - Outline structure for the Sheridan IECMP Project Implementation Plan (PIP)
    - Finalize detailed 2013 to 2015 sub-project implementation plans
    - Finalize and approve 2013 to 2015 sub-project budgets
    - Create sub-project implementation teams with team leads
- Green Revolving Fund
    - Implement first phase of Sheridan's Green Revolving Fund by September 2013
- Curriculum Development and Multi-disciplinary Opportunities
    - In collaboration with Faculties, develop a curriculum plan based on IECMP insights and anticipated skill sets for executive review by Fall, 2013
- Centre for Applied Sustainability:
    - Develop a comprehensive plan for a Centre for Applied Sustainability to encourage multi-disciplinary projects around community and industry challenges and fuel Sheridan's *Living Laboratory.*
    - Form a Sustainability Advisory Committee to oversee Centre development

- Climate Action Plan
    - Conduct the 2013 Greenhouse Gas Inventory *(note: the IECMP already has a comprehensive inventory of Scope 1 and Scope 2 energy related emissions. The broader GHG Inventory would include Scope 3 and any non-energy related Scope 1 and Scope 2 emissions)*
    - Develop Sheridan's Climate Action Plan (CAP), aligning with the Canadian Presidents' Climate Change Commitments and Province of Ontario CAP

Appendix 1 – Glossary of Terms and Abbreviations

Term	Definition
ASHRAE	The American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
Base Case	Forecast of the 2010 to 2035 energy needs assuming no changes in efficiency and fuel mix.
Baseline	Estimation of the present energy use, greenhouse gas emissions, and the prevailing conditions affecting them. In this report the average of 2010, 2011 and 2013 was used.
Biomass	Vegetation such as wood, agricultural or animal waste, catering waste or landfill gas, etc. used as a fuel. Suitably separated municipal waste falls into this category.
Building Code	Legally required construction practices.
Building Standard	Voluntary construction practices, generally exceeding code requirements.
Built Infrastructure	General term referring to all the residential and non-residential buildings.
Cap and Trade	Regulatory approach to reduce greenhouse gas and other emissions. The Cap is the maximum permitted emissions. An emitter who emits less than the Cap can sell the difference to an emitter who is exceeding their Cap. The price is set by the supply and demand needs in a free market.
Carbon Dioxide	The most common form of greenhouse gas. Over 70% of man-made greenhouse gas emissions are from the use of fossil fuels (oil, gas, coal) and are in the form of carbon dioxide.
Carbon Dioxide Equivalent	Where "e" is used to denote the term "equivalent": Greenhouse effect of the other five greenhouse gases identified in the Kyoto Treaty expressed in equivalents of carbon dioxide. This unit of measure is used to allow the addition of or the comparison between gases that have different global warming potentials (GWPs). Since many greenhouse gases (GHGs) exist and their GWPs vary, the emissions are added in a common unit, CO_2e. To express GHG emissions in units of CO_2e, the quantity of a given GHG (expressed in units of mass) is multiplied by its GWP.
Carbon Footprint	General term of the amount or intensity of greenhouse emissions caused by a building, city, vehicle or individual.
Carbon Tax	Regulatory approach to reduce emission to reduce greenhouse gas emissions by taxing the carbon content of fossil fuels.
CHP	See "Combined Heat and Power"
Clean and Renewable Energy	This phrase is used to indicate some combination of renewable energy and Combined Heat & Power (CHP) energy sources.
CO_2	See "Carbon Dioxide"
CO_2e	See "Carbon Dioxide Equivalent"
Coefficient of Performance	The efficiency with which a device converts energy from one form to another. In this report used for boilers (gas to heating); compressor chillers (electricity to cooling) and absorption chillers (heat to cooling)
Cogeneration	Generating electricity in such a way that most of the heat produced is usefully used. A common definition is that an average minimum overall fuel efficiency of 70% is expected. Peak efficiency would typically exceed 90%. Also known as "CHP."
Combined Heat and Power	Generating electricity in such a way that most of the heat produced is usefully used. A common definition is that an average minimum overall fuel efficiency of 70% is expected. Peak efficiency would typically exceed 90%. Also known as cogeneration.
Compact Station	Alternative term for "sub-station".

Cooling Degree Days	A measure of how hot a location was over a period, relative to a base temperature. In the Report the base temperature is 18 deg C and the period is one year. If the daily average temperature exceeds the base temperature, the number of cooling degree-days for that day is the difference between the two temperatures. However, if the daily average is equal to or less than the base temperature, the number of cooling degree-days for that day is zero.
Cooling Needs	Cooling requirements of a property irrespective of how that cooling is supplied.
COP	See “Coefficient of Performance”
Day lighting	Designing buildings to maximize the use of natural daylight to reduce the need for electricity.
District Cooling	Cooling services delivered via District Energy systems.
District Energy	Networks that deliver heating or cooling to energy consumers carried through the medium of chilled or hot water. Heating and cooling is transferred to the home or buildings via a heat exchanger. Earlier systems used steam and if this is being referred to it will be made clear by the context.
District Heating	Heat services delivered via District Energy systems.
EIA	See “US Energy Information Agency”
Electrical Conversion Losses	The difference between the energy values of the fuel used to make electricity and the energy value of the electricity itself.
Emission trading	Alternative usage for “Cap and Trade”
Emissions	Used throughout to refer to greenhouse gas emissions only
Emissions Index	Greenhouse gas emission caused by the use of electricity and fuels. In this report applies to electricity, natural gas and biomass, expressed in kilogrammes of carbon-dioxide equivalent per megawatt hour.
EN 13941	European standards for installing District Energy piping systems
EN 253	European standards for District Energy piping systems material
ENERGY STAR®	Joint U.S. Environmental Protection Agency and U.S. Department of Energy programs http://www.energystar.gov/ supporting energy efficiency as a cost-effective way to reduce greenhouse gas emissions in home, buildings, industry and equipment.
Energy Performance Label	Certificate showing how much energy a home or building actually used in the recent past compared to similar structures in Ontario. Voluntarily available whenever a home or building is sold or rented, or displayed in buildings used regularly by the public.
EnergyPlus	Software used to estimate the heating, cooling, lighting, hot water and other electricity requirements of different types of buildings.
EPL	See “Energy Performance Label”
EU	European Union
FIT	See “Feed in Tariff”
Feed in Tariff	Price for electricity delivered to the grid from CHP or renewable sources (solar and wind) guaranteed by the Province of Ontario.
Fossil Fuels	Combustible material obtained from below ground and formed during a geological event. For purposes of this report, examples of such fuels include coal, oil and natural gas.
Geothermal systems (low temperature)	Systems that use the relatively constant temperature of the ground starting about 6 to 10 feet below ground to cool buildings in summer and heat them in winter.
German A-rated Building	German new or renovated construction that exceeds local codes and has an EPL A-Rating for energy performance. This is about 20% of the current (2013) market in Germany.
GHG	See “Greenhouse Gases”

Green Energy	Energy derived from conservation, renewable sources of energy and clean distributed energy. What energy forms are included varies depending on local jurisdictions and practices.
Greenhouse Gases	A greenhouse gas absorbs and radiates heat in the lower atmosphere that otherwise would be lost in space. The main greenhouse gases are carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbons (CFCs) and nitrous oxide (N_2O), sulphur hexafluoride (SF_6), hydrofluorocarbons (HFC) and perfluorinated carbons (PFC). The most abundant greenhouse gas is carbon dioxide (CO_2).
GHG Monetization	Processes to convert tradable energy and environmental benefits into cash or cash equivalents.
Grid	Distribution system for electricity.
GW / GW_{el} / GW_{th}	Gigawatt / Gigawatt electrical / Gigawatt thermal : 1,000 megawatts-capacity related to the use or supply of the relevant energy form.
GWh / GWh_{el} / GWh_{th}	Gigawatt-hour / Gigawatt-hour electrical / Gigawatt-hour thermal : 1,000 megawatt-hour of the use or supply of the relevant energy form
Heat Only Boilers	Boilers that supply hot water only, as opposed to either steam or CHP
Heating Degree Days	A measure of how cold a location was over a period, relative to a base temperature. For this report, the base temperature is 18 deg and the period is one year. If the daily average temperature is below the base temperature, the number of heating degree-days for that day is the difference between the two temperatures.
Heating Needs	Heating requirements of a property irrespective of how that heating is supplied.
High-Priority Areas	Areas of the City recommended for immediate inclusion in the District Heating system and analyzed in depth.
HOB	See “Heat Only Boilers”
Insolation	The amount of solar energy received on a surface over a period of time. It is usually expressed in units of kilowatts-hours per square meter (kWh/m2), "peak sun hours", megajoules per square meter (MJ/m2) or Langleys (L), for the given period such as a day or hour.
Integration Workbook	Analysis tool use to consolidate and manipulate all data associated with the Plan.
Internal Rate of Return	The discount rate at which the present value of all future cash flow is equal to the initial investment, or in other words the rate at which an investment breaks even. The MS Excel IRR function was used in this report.
IRR	See “Internal Rate of Return”
Kilometre	Distance measure of 1,000 metres.
Kilowatt-hour	A unit of electrical energy universally used as the basic billing unit and equals the use of one thousand watts of electrical energy in one hour.
km	See “kilometre”
kW / kW_{el} / kW_{th}	kilowatt / kilowatt electrical / kilowatt thermal : 1,000 watts-capacity related to the use or supply of the relevant energy form.
KWh	See “Kilowatt-hour”
KWhe	See “Kilowatt-hour equivalent”
kWh / kWh_{el} / lWh_{th}	kilowatt -hour / kilowatt -hour electrical / kilowatt -hour thermal : 1,000 watt-hour of the use or supply of the relevant energy form.
Leadership in Energy and Environmental Design	A voluntary system for rating existing and new residential and non-residential buildings and neighborhoods based on their overall environmental performance including energy and water use. Developed by US Green Buildings Council ad adapted by the Canadian Green Buildings Council.
LEED	See “Leadership in Energy and Environmental Design”
m^2	See “square metre”

Megawatt	An energy source (or sink) of any kind with the capacity to continuously create (or need) up to the equivalent of one megawatt of electricity. Used in this report for natural gas or where the energy form context is clear.
Megawatt- electrical	An electricity source (or sink) with the capacity to continuously create (or need) up to one megawatt.
Megawatt- thermal	A thermal source (or sink) of any kind with the capacity to continuously create (or need) up to the equivalent of one megawatt of electricity. Used in this report mostly for heating and cooling.
Megawatt-hour	A unit of energy in any form with the same energy content as one megawatt-hour of electricity. Used in this report for natural gas or where the energy form context is clear.
Megawatt-hour electrical	A unit of electrical energy equal to the use of one million watts of electrical energy in one hour.
Megawatt-hour- equivalent	A unit of energy from any source equivalent to one megawatt-hour of electricity. Used to get a standard measurement for comparison of different forms of energy.
Megawatt-hour-thermal	A unit of thermal energy with the same energy content as one megawatt-hour of electricity. Used for standardized comparison of different forms of energy – in this report mostly heating and cooling.
Metric Ton	Unit of weight equal to 1,000 kilograms. Often used in this report as a measure of greenhouse gas emissions.
mt	See “Metric Ton”
MW	See “Megawatt”
MW_{el}	See “Megawatt- electrical”
MWh	See “Megawatt-hour”
MWhe	See “Megawatt-hour equivalent”
MWh_{el}	See “Megawatt-hour electrical”
MWh_{th}	See “Megawatt-hour thermal”
MW_{th}	See “Megawatt- thermal”
Net Present Value	Present value of the sum of all future positive and negative cash flows discounted by a selected discount rate. The MS Excel NPV function was used in this report.
Network	Distribution system for heating, cooling or natural gas.
NGOs	Non-governmental organizations.
Non-Residential Buildings	All building not used for housing or industrial manufacturing.
NPV	See “Net Present Value”
OBC	See “Ontario Building Code”
OECD	Organization for Economic Cooperation and Development
OLTEP	See “Ontario Long-Term Energy Plan”
Ontario Building Code	Statutory building code for all new construction in Ontario.
Ontario Long-Term Energy Plan	Provincial Plan related to the supply of electricity in Ontario to 2031.
PV	See “Solar Photovoltaic Systems”
Renewable Energy	Energy generated from sources other than fossil fuels, most commonly sun, wind, water and various animal and plant derived (biomass) fuels. These create the least greenhouse gases in operation.
Residential Buildings	All buildings predominantly used for housing.
Smart Meters	Energy meters (heat/electricity/cooling/gas) capable of gathering energy use patterns, applying different tariffs depending on time of day and use level, and

	capable of being integrated into wider information and control systems.
Solar Photovoltaic Systems	Systems that directly convert sunlight into electricity either for use locally or for delivery to the wider grid.
Square Metre	Measure used throughout for finished floor area of homes or buildings.
Standard Offer Program	Provincial incentive programs for clean and renewable energy supply and energy efficiency.
Sub-station	Device to connect a District Heating or cooling network to a building. Includes a heat exchanger and heat/cooling meter.
Sustainability	Meeting the needs of the present generation without compromising the ability of future generations to meet their own needs.
UNFCC	United Nations Framework Convention on Climate Change
US Energy Information Agency	Agency of the U.S. Department of Energy responsible for maintaining energy statistics for the United States.

Table 0-1 Glossary of Terms and Abbreviations

Appendix 2 – IECMP Assumptions

This is a comprehensive listing of all the assumptions and sources used in the IECMP.

Item	Assumption	Source	Comment
Scope			
Baseline year	2010	IECMP Team	
End Year (Plan)	2030	Sheridan CFO	Senior Management Sponsor of IECMP
End Year (Analysis)	2035	IECMP Team	
Analysis outlook	2013 to 2035	IECMP Team	2011 & 2012 energy use assumed same as 2010
Geography	Trafalgar/Davis/STC Campuses	IECMP Team	Mississauga Campus analyzed separately
Buildings	All except Trafalgar residence	IECMP Team	
Energy use – End Uses	• Heating • Cooling • Interior Lighting • Other electricity • Misc.: Catering, labs etc. • Exterior lighting	IECMP Team	Consistent with Energy Plus version 7 modeling categories
Energy use – Losses considered	• Steam distribution • Hot water distribution • Grid electricity grid distribution • Grid electricity conversion • On-campus heat generation • On-campus electricity generation • All in-building end-use losses	IECMP Team	
Emissions	Scope 1 and Scope 2 only	IECMP Team	See Section 2.2
Grid Electricity - Technical			
Supplier	• TRA & STC: Oakville Hydro • DC: Brampton Hydro		
Historical usage	Utility bills	Utilities	
Emissions index	200 kg CO_{2e}/MWh	Govt. Canada	2008 Canadian Average – See Section 3.2 and endnotes
Emissions index change	• No change to 2030 (Option 0) • Reduce linearly to 150 kg/MWh by 2035 (Option 1)	OTLEP	

Site to Source Ratio	3.03	IECMP Team	Estimated from 2010 generating mix
Natural Gas – Technical			
Supplier (Distribution)	• TRA & STC: Union Gas • DC: Enbridge		
Supplier (Commodity)	Shell		
Historical usage	Utility bills	Utilities	Obtained from Facilities Management
Emissions index	201 kg CO_2e/MWh	Govt. Canada	
Emissions index change	Constant to 2030	IECMP Team	
Site to Source ratio	1.047	US Govt.	Standard used by all US Government Agencies
Electricity - Pricing			
Baseline grid price	$120 / MWh	Utility bills	Average for all three campuses
Low Risk grid price increase	2% / yr to 2030	OLTEP	Government of Ontario
Higher Risk grid price increase	• 2% / yr to 2014 • 5% / yr to 2030	IECMP Team	See Section 4.3 and Appendix 6
CHP Electricity -Low risk	Net metered	OPA SOP	
CHP Electricity -Higher risk	3% below grid price	IECMP Team	See Section 4.3 and Appendix 6
PV Electricity –Low risk	• $443 / MWh to 2021 • -2% / yr from 2022 t0 3030	• OPA SOP • Team	• Policy assumed unchanged to 2021 • See Section 4.3
PV Electricity –Higher risk	• $443 / MWh to 2030	• OPA SOP	• Policy assumed unchanged to 2030
Natural Gas - Pricing			
Baseline network price	$27.50 / MWh	Utility bills	Average for all three campuses
Low Risk network price increase	2% / yr to 2030	Team	See Section 4.3 and Appendix 6
Higher Risk network price increase	• 3% / yr to 2016 • 5% / yr to 2030	Team	See Section 4.3 and Appendix 6
Gas for CHP – Low risk	Same as network price	Team	See Section 4.3 and Appendix 6
Gas for CHP – High Risk	2% below network price	Team	See Section 4.3 and Appendix 6
GHG Emissions - Pricing			
Carbon Cost – Low risk	$ 0.00 / mt CO_2e	Team	No change in current Ontario policy
Carbon Cost – Higher Risk	• $0.00 to 2014 • $10.00 in 2015 • $5.00 / mt / yr to 2019	Team	See Section 4.3 and Appendix 6

	• 10% / yr to 2030		
Solar Thermal – Pricing			
Effective heat price – all risks	$0.00	Team	Treated as end-use efficiency
Weather			
Climate Zone	Zone 6b	Govt.Canada	http://climate.weatheroffice.gc.ca/climateData/canada_e.html
Climate Zone outlook	No change	Team	Climate change not considered
Building End-use – Baseline			
Energy modeling software	EnergyPlus version 7.0	US DoE	Recognized by US DoE and NRCan
Building zones	By primary function	IECMP Team	See Section 3.4
Building condition	100% on-site assessment	IECMP Team	See Section 3.4
Buildings modeled	100% except TRA residence	IECMP Team	See Section 3.4
Building End-use – Base Case			
Existing- buildings	No change in efficiency	Team	See Section 3.7
New buildings	LEED Gold	CGBC	Energy related elements of LEED rating only
Equipment – Base Case			
Boiler efficiency – All campuses	80% - no change over time	IECMP Team	In reality this would deteriorate
Trafalgar steam network losses	25% - no change over time	IECMP Team	Conservative and would definitely deteriorate over time
Davis hot water network losses	Not applicable	IECMP Team	Included in Building EnergyPlus modeling
Compressor Chiller COP	4	IECMP Team	Used to estimate electricity use for cooling
Equipment - Scenario Case			
Boiler efficiency	86%	IECMP Team	Industry Norm
CHP Electrical efficiency	36 % (Davis) 40% (Trafalgar)	IECMP Team	Industry Norm
Efficiency – Scenario Case			**$**
Hot water network – TRA	6.25% thermal losses	IECMP Team	Assumed 75% reduction after conversion from steam
Building EEMs (Technical)	As modeled by EnergyPlus version 7	IECMP Team	
Building EEMs (Investment)	Industry Norms	RS Means IECMP Mentors	Based on current market in USA and Canada

Appendix 3 – IECMP Core Team Members

Name	Position
Sheridan College Members	
Elaine Hanson	Director, Office for Sustainability
Cathy Sloat	Office for Sustainability
Herb Sinnock	Manager, Sustainable Energy Systems
Simpson Siu	Director Financial Services
Jim Fletcher	Director, Strategic Projects/Facilities Services
Gord Ide	Manager, Building Maintenance & Services
Andre Plante	Associate Vice President, Corporate Planning
Brian Scannell	Project Manager - Major Capital Projects
Sumon Acharjee	Chief Information Officer
Michael Burjaw	Director of Security, Emergency Preparedness, Purchasing
Dave Wackerlin	Associate Dean, Faculty of Applied Science and Technology
Chris Ferguson	Professor, School of Architectural Technology
Michael Muller	Professor, Faculty of Applied Science and Technology
Lewis Mununga	Professor, Faculty of Applied Science and Technology
Jonalyn Sagisi	Faculty of Applied Science and Technology
Chris Beaver	Faculty of Applied Science and Technology
Dave Clark	Faculty of Applied Science and Technology
David Nowell	Professor, Faculty of Business
Angela Iarocci	Professor, Faculty of Arts, Animation and Design
Claire Ironside	Professor, Faculty of Arts, Animation and Design
Elizabeth Littlejohn	Professor, Faculty of Arts, Animation and Design
Doug Whitton	Professor, Faculty of Arts, Animation and Design
Mentors	
Peter Garforth	Principal, Garforth International llc
Bruce Bremer	Principal, Bremer Energy Consulting LLC (IECMP Consulting Project Mgr.
Cindy Palmatier	Business Manager, Garforth International LLC
Annie Marston	Head of Building Performance, Ebert and Baumann Consulting Engineers Inc
Oliver Baumann	Partner, Ebert and Baumann Consulting Engineers Inc
Gerd Fleischhammer	Owner, Ingenieurbüro Gerd Fleischhammer

Figure 0-1 Project Work Team Members

Appendix 4 – Sustainability Policy

SHERIDAN COLLEGE INSTITUTE OF TECHNOLOGY AND ADVANCED LEARNING

SHERIDAN COLLEGE POLICY	NO OF PAGES: **2**	POLICY NO.: **To Be Determined**
TITLE: **SUSTAINABILITY POLICY**	APPROVED BY:	
REPLACES POLICY: **SUSTAINABILITY POLICY**	EFFECTIVE DATE: **December 1, 2011**	REVIEW DATE:

1.0 PURPOSE

As an academic institution, employer, investor and community partner, Sheridan College believes that we can and must lead the way in ensuring a sustainable future. To us, sustainability is about balancing economic, social and environmental priorities as a responsible corporate citizen.

The purpose of an institutional sustainability policy is to:

1.1 commit to developing sustainable business operations

1.2 minimize negative impacts that our activities could have on the environment and society at large

1.3 perform a restorative function through innovation in academic practices, curriculum development, public engagement, and partnerships with our stakeholders.

Step by step, Sheridan College will strive to align our business operations, academic, research, student services, human resources, and stakeholder relationships with sustainability principles in ways that advance our long-term academic objectives.

2.0 APPLICATION AND SCOPE

This policy applies to any person making a decision on behalf of Sheridan College including all board members, college staff, faculty members and others including volunteers, consultants and contractors engaged by the college to provide consulting and other services to the college.

The Office for Sustainability shall be responsible for supporting the policy required by The Sheridan College Institute of Technology & Advanced Learning.

This Sustainability Policy shall establish the principles through which sustainability will be integrated across Sheridan College.

3.0 SUSTAINABILITY PRINCIPLES

Sheridan College commits to the ongoing pursuit of alignment with these **four sustainability principles**[xxxviii] **:**

. In a sustainable society, nature is not subject to systematically increasing concentrations of substances extracted from the earth's crust.

This means substituting our use of certain minerals that are scarce in nature with others that are more abundant, using all mined materials efficiently, and systematically reducing our dependence on fossil fuels.

. In a sustainable society, nature is not subject to systematically increasing concentrations of substances produced by society.

This means systematically substituting certain persistent and unnatural compounds with ones that are normally abundant or break down more easily in nature, and using all substances produced by society efficiently.

. In a sustainable society, nature is not subject to systematically increasing degradation by physical means.

This means drawing resources only from well-managed eco-systems, systematically pursuing the most productive and efficient use of resources and land, and exercising caution in all kinds of modifications of nature, such as overharvesting and the introduction of invasive species.

. In a sustainable society, people are not subject to conditions that systematically undermine their capacity to meet their needs.

This means offering products and services and changing practices, suppliers, and business models to those who demonstrate through their policies and practices that human rights are respected, income-making barriers are removed, safe and healthy work environments are provided, and living conditions allow local communities to meet the needs of citizens.

RELATED DOCUMENTS

- Sheridan Sustainable Purchasing Policy
- Sheridan Sustainable Purchasing Guidelines
- Sheridan Supplier Sustainable Purchasing Questionnaire

Appendix 5 – Mississauga Campus

As an attachment to this report, please find the following two documents for reference:

Sheridan Hazel McCallion Campus - Energy Performance Assessment – Phases I and II – Final Report (dated June 14, 2012)

Sheridan Hazel McCallion Campus Energy Performance Assessment – Phases I and II – Appendices (dated May 21, 2012)

Appendix 6 – Energy Pricing Outlook

High and Low Risk price assumptions used in the IECMP

Electricity from Grid

Year	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
$/MWh Base Case-LR	119.55	127.28	136.90	143.66	151.55	157.18	161.13	170.70	179.15	180.85	187.61	194.37	197.18	197.18	196.62	201.69	199.44	203.38	205.63	209.58	211.83
$/MWh Base Case-HR	119.55	127.28	136.90	175.26	184.36	190.05	195.74	203.71	217.36	226.47	232.16	241.26	249.23	245.81	243.54	249.23	243.54	249.23	251.50	257.19	260.61

Gas from Network

Year	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
$/MWh Base Case-LR	51.40	32.27	28.05	28.61	29.18	29.77	30.36	30.97	31.59	32.22	32.87	33.52	34.19	34.88	35.57	36.29	37.01	37.75	38.51	39.28	40.06
$/MWh Base Case-HR	51.40	32.27	28.05	28.89	29.76	30.65	32.18	33.79	35.48	37.26	39.12	41.08	43.13	45.29	47.55	49.93	52.42	55.04	57.80	60.69	63.72

Gas for CHP

Year	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
$/MWh Base Case-LR	51.40	32.27	28.05	28.61	29.18	29.77	30.36	30.97	31.59	32.22	32.87	33.52	34.19	34.88	35.57	36.29	37.01	37.75	38.51	39.28	40.06
$/MWh Base Case-HR	51.40	32.27	28.05	28.31	29.16	30.04	31.54	33.12	34.77	36.51	38.34	40.25	42.27	44.38	46.60	48.93	51.38	53.94	56.64	59.47	62.45

CHP Electricity

Year	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
$/MWh Base Case-LR	119.55	127.28	136.90	143.66	151.55	157.18	161.13	170.70	179.15	180.85	187.61	194.37	197.18	197.18	196.62	201.69	199.44	203.38	205.63	209.58	211.83
$/MWh Base Case-HR	119.55	127.28	136.90	170.00	178.83	184.35	189.87	197.60	210.84	219.68	225.20	234.02	241.75	238.44	236.23	241.75	236.23	241.75	243.96	249.47	252.79

PV Pricing

Year	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
$/MWh Base Case-LR	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	434.14	425.46	416.95	408.61	400.44	392.43	384.58	376.89
$/MWh Base Case-HR	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00	443.00

Carbon Pricing

Year	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
$/MWh Base Case-LR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
$/MWh Base Case-HR	0	0	0	0	0	10	15	20	25	30	33	36	40	44	48	53	58	64	71	78	86

Wind Pricing

Year	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
$/MWh Base Case-LR	135	135	135	135	135	135	135	135	135	135	135	135	135	134	132	131	130	128	127	126	125
$/MWh Base Case-HR	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135

Ontario Solar FIT Summary

This is the summary of the prevailing FIT in Ontario. For Davis and Trafalgar Campuses the assumption is that the Ground Mounted category applies (highlighted).

Solar PV Projects			
Contract price	Rooftop	≤ 10 kW	80.2 ¢/kWh
	Rooftop	> 10 kW ≤ 250 kW	71.3 ¢/kWh
	Rooftop	> 250 kW ≤ 500 kW	63.5 ¢/kWh
	Rooftop	> 500 kW	53.9 ¢/kWh
	Ground-mounted	≤ 10 kW	64.2 ¢/kWh
	Ground-mounted*	***>10 kW ≤ 10 MW***	***44.3 ¢/kWh***
Length of contract	20 years		
Percentage escalated	Not eligible		
Peak performance factor	Not eligible		
Average lead time	1 year for smaller projects 3 years for larger projects		
Contacts for getting connected to provincial grid	• Ontario Energy Board • Local distribution company • Independent Electrical System Operator • Electrical Safety Authority		
Industry associations and government	For more information on the *Green Energy Act*, visit the Ministry of Energy and Infrastructure (MEI). For more information on solar PV training, conferences, government incentives and a step-by-step guide to determine if solar is right for you, visit the Canadian Solar Industry Association (CanSIA). For resources, training and education information and information to assist community-based projects and Aboriginal projects, contact the Ontario Sustainable Energy Association (OSEA). The Toronto Renewable Energy Co-operative's (TREC) Our Power project is a residential solar program that helps homeowners simplify the decisions involved with investing in a solar PV system on their roof. Other member-based organizations representing the solar sector include the Ontario Federation of Agriculture and the Ontario Co-operative Association. For information on developing solar PV on Crown lands, visit the Ministry of Natural Resources (MNR). For information on renewable energy approvals, visit the Ministry of the Environment (MOE).		

Ontario Wind FIT Summary

This is the summary of the prevailing FIT in Ontario. For Davis and Trafalgar Campuses the assumption is that the On-shore category applies (highlighted).

Wind Energy Projects	
Contract price*	***On-shore any size: 13.5 ¢/kWh***
Length of contract	20 years
Percentage escalated	Ontario Consumer Price Index (CPI) indexation to contract milestone commercial operation date
Peak performance factor	Not eligible
Average lead time	3 years for on-shore
Contacts **for getting connected to provincial grid**	• Ontario Energy Board • Local distribution company • Independent Electrical System Operator • Electrical Safety Authority
Industry associations and government	For information on the *Green Energy Act*, visit the Ministry of Energy and Infrastructure (MEI). For fact sheets, information and decision-making tools on wind, visit the Canadian Wind Energy Association (CanWEA). Ontario's Renewable Energy Atlas The Renewable Energy Atlas is an interactive web tool that allows Ontarians to create and view maps of wind and water renewable energy resources in the province. For resources, training and education information and information to assist community-based projects and Aboriginal projects for wind energy, contact the Ontario Sustainable Energy Association (OSEA). For information on developing wind energy on Crown lands, visit the Ministry of Natural Resources (MNR). For information on renewable energy approvals, visit the Ministry of the Environment (MOE).

Appendix 7 – Climate Change and Carbon Market Background

Human activities - primarily burning fossil fuels and destruction of natural systems has led to an increase in atmospheric levels of carbon dioxide above historic highs (IPCC, 2007). The scientific consensus suggests that we need to reduce global emissions of greenhouse gases by at least 80% by mid-century at the latest in order to avert the worst impacts of global warming and to reestablish a more stable climate (IPCC, 2007). It is one of the most difficult challenges of our time, the 'system' we call earth, does not recognize (nor acknowledge) how difficult it is for humans to change existing economic systems and, inevitably, only responds to physical impacts—on its own schedule. For this reason, many in higher education have advocated for what Orr describes as a:

"curriculum organized around the study of the relationships between energy, environment, and economics with applicability across various scales of knowledge" (Orr, 2003).

The implications on higher education and leadership are significant and will play prominently in the transformation of economic systems, urban centers, industry and daily lives. No other sector in society has the innate potential and motivation to collaborate and influence hubs of knowledge across sectors (Cortese, 2003). As risk and adaptation to new economic, environmental and societal pressures increase, the post secondary sector is placed at the center of the transition to a low-carbon economy.

- The economics of climate change (risk, costs and opportunities) will be shaped by science and a common belief that human induced climate change is caused by accumulating levels of greenhouse gases (GHGs) over the past one hundred years (IPCC, 2007).
- Scientific research clearly suggests that a 2 degree increase would be difficult for nations to cope with and will cause major social and environmental disruptions through the rest of the century (International Aliiance for Research Universities, 2009).
- The International Energy Agency (IEA) has predicted that the climate goal of limiting warming to 2 degrees is becoming more difficult and more costly with each passing year. The agency predicts that global demand will increase by more than one-third by 2035 corresponding to a long-term average global temperature increase of 3.6 °C. The report takes into consideration all new developments and policies (IEA, 2012) and establishes the economic potential for energy efficiency and the critical interrelationships between energy consumption and water as natural resources become stressed and access more contentious (IEA, 2012).
- According to the Stern's Review, sanctioned by the Majesty's Treasury, the United Kingdom's economics and finance ministry, reductions in the order of 50 to 80 per cent will be required by mid- century needing broad-based and sustained co-operation (Stern, 2006). Economic risk is estimated between 5 and 20 per cent of world GDP if no action is taken (Stern, 2006).
- To put this into context, the Kyoto Protocol (first international treaty to reduce emissions) required nations to reduce on average, 5 per cent (UNFCCC, 2008).
- 2012 became the 36^{th} consecutive year annual temperatures were above average with weather and climate events costing over $1 billion per year in 2011 and 2012, more than any other year in recorded history (WRI, 2013).
- One of the most extensive UN sanctioned ecological studies undertaken to date states that almost 60% (15 of 24) of global ecosystems (the systems upon which we rely on for

survival) are being degraded or used unsustainably (including fresh water, fisheries, air and water purification) (United Nation, 2005).

- Global investment in renewable and 'clean' energy is growing by 30% with many countries issuing low-carbon growth plans which aim to reduce energy consumption and emissions, build competitive advantage and seek 'first mover' advantage (NRTEE, 2012). It is anticipated that first-mover institutions in all sectors stand to benefit through 'learning-by-doing' that will occur through low or zero-emissions goals.
- Despite a growing cleantech sector, Canada is unprepared to compete in a carbon-constrained world facing many challenges in bringing low-carbon ideas to market and will see labour shortages in a world competing for skills and innovative talent. Given lack of a unified strategy or long-term approach to establishing climate policies, Canada displays significant differences in regional emissions profiles and economic interests differ considerably (NRTEE, 2012).
- A 2012 Rockefeller Foundation and Deutsche Bank report examined financing and capital investment opportunities in building energy projects and concluded that there were far reaching economic, climate, and employment opportunities through efficiency investments. The report estimates that investment in energy savings in the US would be equivalent to 30% of the annual electricity spending (equal to approximately 10 per cent reduction in greenhouse gas emissions in the US). *Most interesting, if all the retrofits were undertaken, more than 3.3 million cumulative job years of employment would be created in a range of skill qualifications* (Rockefeller Foundation, Deutsche Bank Group, 2012).
- In 2011, the International Renewable Energy Agency stated that *renewable energy technologies had higher labour intensities than fossil energy technologies* (IRENA, 2011), which has many implications around energy, across all faculties. While these studies are highly dependent on national policies, the underlying belief is that countries dependent on fossil fuels will see energy sector jobs declining over time, in contrast with countries that invest early in wider deployment of renewables. *The assertion is that jobs generated per dollar of investment will be generally higher in renewable energy than in fossil fuel generation* (IRENA, 2011). Given heightening sustainability mandates, many countries have also identified renewable energy as a way of addressing poverty through additional incomes, jobs and enterprises (Biello, 2011).
- While slow to move on energy efficiency and climate change policy, the Canadian government has re-affirmed its commitment to Copenhagen Accord targets and its recently announced Climate Change Mitigation Plan sets out to develop sector-based regulations and incentives for low-carbon technologies (iisd, 2013).
- In a global low-carbon transition, countries that can supply low-carbon goods and services will profit. Global spending on low-cost goods and services was roughly $339 billion in 2010, a number estimated to rise between $3.9 and $8.3 trillion by 2050 (dependent on climate policy assumptions) (NRTEE, 2012). According to the NRTEE, if Canada were to reduce emissions by 65% (from 2005), it would drive domestic spending of roughly $60 billion in 2050 (NRTEE, 2012). Without a unified approach to pricing emissions or carbon content (coal, fossil fuel, natural gas), government cannot drive innovation and differ to industry to exploit the lowest cost to reduce emissions through new technologies, processes and ideas that further mitigate emissions. Even if proposed climate policies were taken into account, the low cost goods sector grows more rapidly than the Canadian economy overall (NRTEE, 2012).

Works Cited

Biello, D. (2011, June 30). *How do we solve energy poverty?* (I. Scientific American, Producer) Retrieved March 9, 2013, from Scientific American: http://www.blogs.scientificamerican.com/observations/2011/06/30/how-do-we-solve-energy-poverty/

Cortese, A. D. (2003, March-May). The Critical Role of Higher Education in Creating a Sustainable Future. (C. L. Turcotte, Ed.) *Planning for Higher Education* , 16-17.

IEA. (2012). *World Energy Outlook 2012 Executive Summary.* Outlook Report, International Energy Agency, Paris.

iisd. (2013). *Canadian Carbon Policy year in Review and Emergin Trends, 2012.* Winnepeg: iisd.

International Aliiance for Research Universities. (2009). *Synthesis Report from Climate Change Global Risks, Challenges & Decisions.* Australian National University, ETH Zurich, National Univeristy of Singapore, Peking University, University of California-Berkeley, University of Cambridge, University of Copenhagen, University of Oxford, The University of Tokyo, Yale University. Copenhagen: International Alliance of Research Universities.

IPCC. (2007). *Climate Change 2007: Synthesis Report.* PICC Plenary XXVII. Valencia, Spain: IPCC.

IRENA. (2011). *Renewable Energy Jobs: Status, Prospects and Policies.* IRENA & IISD. IRENA.

NRTEE. (2012). *Climate Prosperity: framing the future, embracing a low-carbon economy.* National Round Table on the Envirionment and the Economy, Ottawa.

Orr, D. (2003). Four Challenges of Sustainability. *School of Natural Resources-The University of Vermon Spring Seminar Series 2003- Ecological Economics* (p. 3). Burlington: The University of Vermont.

Rockefeller Foundation, Deutsche Bank Group. (2012). *United States Building Energy Efficiency Retrofits: Market Sizing and Financing Models.* Rockefeller Foundation. New York: Rockefeller Foundation, Deutsche Bank Group.

Stern, N. (2006). *Stern Review on the Economics of Climate Change.* HM Treasury Cabinet Office. Cambridge: Cambridge University Press.

UNFCCC. (2008). *Kyoto Protocol Reference Manual on Accounting of emissions and Assigned Amount.* UNFCCC.

United Nation. (2005). *Millennium Ecosystem Assessment: Ecosystems and Human Well-Being Synthesis.* WRI. Washington, DC: Island Press.

WRI. (2013). *2012: A year of record-breaking extreme weather and climate.* World Resources Institute. Washington, DC: WRI.

End Notes and References

---

[i] Elkington, J. (2012). *The Zeronauts.* Abingdon, Oxon, UK: Routledge.

[ii] United Nation. (2005). *Millennium Ecosystem Assessment: Ecosystems and Human Well-Being Synthesis.* WRI. Washington, DC: Island Press.

[iii] BP Energy Outlook 2030 (January, 2013) http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/BP_World_Energy_Outlook_booklet_2013.pdf

[iv] World Nuclear Association (2013) http://www.world-nuclear-news.org/EE-Fukushima_impacts_global_nuclear_generation_in_2011-1304124.html

[v] Of interest, nuclear power supplies more than 50 per cent of Ontario's electricity needs through the Province's two nuclear power stations (Pickering and Darlington Nuclear Power Stations) Ontario Power Generation http://www.opg.com/power/nuclear/

[vi] Ernst & Young (2013), The future of Global Carbon Markets http://www.ey.com/Publication/vwLUAssets/The_future_of_global_carbon_markets/$FILE/The_future_of_global_carbon_markets.pdf

[vii] Ernst & Young (2013), The future of Global Carbon Markets http://www.ey.com/Publication/vwLUAssets/The_future_of_global_carbon_markets/$FILE/The_future_of_global_carbon_markets.pdf

[viii] Ontario Long-Term Energy Plan (2010) http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf

[ix] See http://www.naturalstep.org/backcasting

[x] Figure used courtesy of The Natural Step

[xi] See http://www.ghgprotocol.org/

[xii] A Living Lab is an Innovation Ecosystem involving students, residents, municipalities, regions, business & industry on a sustainable campus. It is a multi-stakeholder Living Lab which involves itself in innovation in the field of education, sustainable development and regional/municipal economic strengthening with an ultimate goal to support the transition to low carbon cities and promote a high quality of life. A Living Laboratory would fund initiatives which lead to new sustainable processes, efficiencies and actively engage in awareness and the dissemination of knowledge through the collective intelligence of communities, colleges & universities, citizens, associations, and businesses.

[xiii] See http://apps1.eere.energy.gov/buildings/energyplus/

[xiv] See http://www.cagbc.org/

[xv] See http://www.enev-online.de/index.htm (in German). Sheridan performance was confirmed against EnEV 2009 A-Ratings for educational institutes in comparable climate zones.

[xvi] See http://www.energystar.gov/index.cfm?c=guidelines.assess_energy_management

[xvii] See http://www.ieso.ca/imoweb/media/md_newsitem.asp?newsID=5930 for the generating mix evolution of Ontario. In 2010, this was 77% thermal (nuclear, gas, coal). Assuming a generating efficiency of 33% for thermal, 95% for hydro, and 10% grid losses, the Report used 3:1 efficiency between primary (source) energy and delivered electricity. The IECMP Integration Workbook allows convenient adjustment of this factor to evaluate the impact of changing efficiency.

[xviii] See http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=EAF0E96A-1#section1 . Canadian 2008 average was 200 kg/MWh, the last year of definitive reporting. Ontario generation in the same year was reported as 170 kg/Mwh. The Provincial policy is for rapid decarbonization. The SIECMP Integration Workbook allows for convenient adjustment of this factor to evaluate impact of changing scenarios.

[xix] Factor recommended by US Government Agencies for standardized carbon footprint calculations. Source US Army Corps of Engineers guidance to GIL on US Navy IECMP Project (2012).

[xx] See Section 2.3 – "IECMP Methodology" for further background.

[xxi] See http://oee.nrcan.gc.ca/publications/statistics/cices06/chapter1.cfm

[xxii] See http://oee.nrcan.gc.ca/commercial/newbuildings/16765 and https://www.ashrae.org/standards-research--technology/standards--guidelines

[xxiii] Data from Drexel Campus Energy Strategic Plan available upon request from Sheridan

[xxiv] Data from Lakeland Community College obtained directly from LCC facilities. Integrated Energy Master Plan available on request from Sheridan

[xxv] Source MVV Consulting GmbH, Mannheim

[xxvi] CHP is the simultaneous generation of heat and electricity increasing the efficiency fuel used to make useful energy by about a factor of 2 compared to traditional electricity generation, For further background see http://www.cogeneurope.eu/what-is-cogeneration_19.html among many sources.
[xxvii] See http://www.energystar.gov/ia/business/industry/Bremmer_Toyota.pdf for an example of a presentation by Bruce Bremer, former Head of Utilities at Toyota North America. Bruce Bremer was Mentoring Project Manager for the Sheridan IECMP.
[xxviii] See Appendix 2 Assumptions and Appendix 6 Energy Pricing Outlook for further details and assumptions.
[xxix] Available at the Ontario Ministry of Energy website: http://www.energy.gov.on.ca/en/ltep/
[xxx] Available at US DOE EIA website http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf
[xxxi] Garforth International llc private communication: On a major classified US Government IEMP, the client insisted on a low risk price case significantly above the official forecasts.
[xxxii] See http://www.powerauthority.on.ca/combined-heat-power-standard-offer-program-chpsop
[xxxiii] See Appendix 6 for summary of PV FIT programme and further background and links
[xxxiv] See Appendix 6 for HR and LR wind power priding and summary of Wind FIT programme and further background and links
[xxxv] See http://www.ontarioenergyboard.ca/OEB/.../FAQ+-+Time+of+Use+Prices/
[xxxvi] See http://pv.nrcan.gc.ca/ for solar maps
[xxxvii] See as an example: http://www.zerofootprint.net/
[xxxviii] Dr. Karl-Henrik Robèrt, Founder, The Natural Step