ENERGY AND EMISSIONS STRATEGY

AC UNPLUGGED: EDUCATE, COLLABORATE, OPERATE AND INNOVATE FOR A CLEAN ENERGY FUTURE

Prepared for Physical Resources
by Urban Equation

ALGONQUIN COLLEGE

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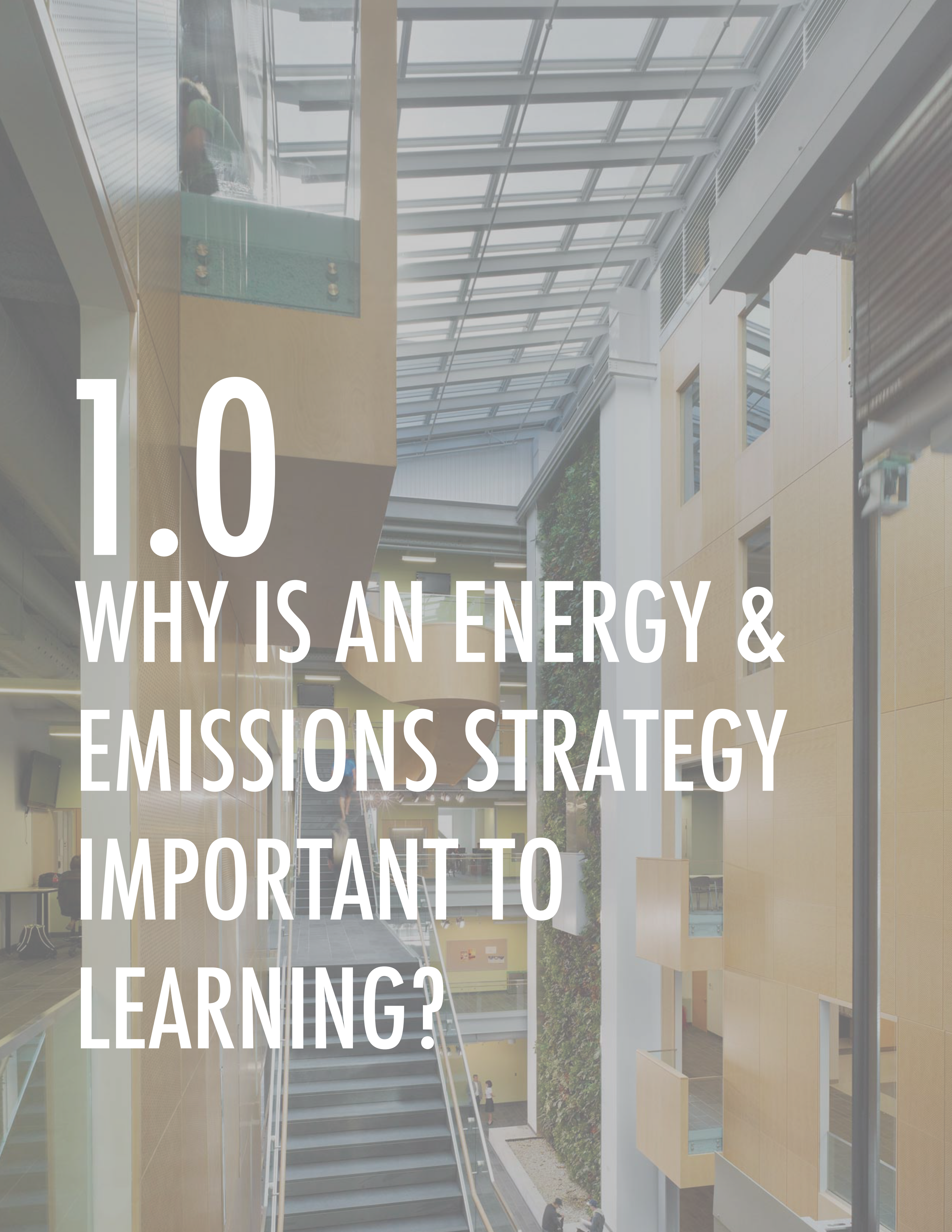


1.0

WHY IS AN ENERGY & EMISSIONS STRATEGY IMPORTANT TO LEARNING?

Energy is inextricably connected to our quality of life and learning. At Algonquin, energy is fundamental to its daily operation and to the mission of the College to transform hopes and dreams into lifelong success.

Affordable Energy is Imperative

In recent decades, institutions have focused on saving energy to reduce costs in order to divert limited financial resources towards learning. Over time, the energy solutions have become more sophisticated, innovative and nuanced.

For larger institutions, such as Algonquin, the pursuit of efficiency and reliability led to the creation of district energy systems that leveraged large centralized plants to distribute heating and cooling to many buildings across the Campus. At Algonquin's Ottawa Campus, a combined heat and power (CHP) plant has been installed that generates electricity by burning natural gas in two, two-megawatt cogeneration turbines which utilize the waste heat within a thermal network to heat and cool its buildings.

Reducing GHG emissions is necessary

The dominant use of carbon based fuel sources since the beginning of the industrial revolution has increased the atmospheric concentration of carbon dioxide (CO2) and global warming, leading to a range of climate change impacts that now threatens our quality of life and learning. There is a sense of urgency to reduce greenhouse gas (GHG) emissions. Reducing emissions while pursuing affordable energy has become a defining issue of our generation, and frames our current energy and emissions dichotomy.

These challenges require bold new thinking

Campuses of the 21st century will be defined by their ability to move away from carbon based energy, towards affordable clean energy sources. The future campus will be served by local, clean, renewable energy sources, and facilitate active and sustainable modes of transportation. This transition will be a lengthy journey, measured in decades, and will require collaboration and innovation at a global scale.

> *"This is our turn to dream. To be bold. To do our part to build, create, and move us into the future.*
>
> Cheryl Jenson – President, Algonquin College

As one of the largest colleges in Ontario, Algonquin is ready to begin its journey towards a clean energy future. The College recognizes its obligation to respond to emerging societal trends and expectations, and a responsibility to influence positive change in the every-day lives of its students, employees and communities, both on and off campus. Algonquin College's first Energy and Emissions Strategy will be its compass to establish a direction that will help the College align its goals with the province, achieve carbon neutrality, and serve as a catalyst for global citizenship.

HEAT + COOL

Why is it important?
Basic to human comfort and survival - affordability is a key concern

Where would you find it?
- HVAC systems
- Furnaces/Boilers
- Central Plants
- District Energy Systems
- Hot Water Heating

POWER

Why is it important?
Power drives our economy and productivity

Where would you find it?
- Industries
- Transportation
- Equipment
- Technology + Device Plug Loads
- Appliances

LIGHT

Why is it important?
Unlocks human potential and extends the day for reading, studying, working

Where would you find it?
- Interior Lighting
- Feature Lighting
- Exterior Pedestrian Pathways
- Exterior Parking Lots
- Street Lighting

Figure 1. Role of energy in our quality of life and learning.

1.1 STRATEGIC LINKAGES

Algonquin's Energy and Emissions Strategy has been developed within a quickly evolving landscape. The Strategy responds to, and aligns with, the College's core strategic documents as well as Federal and Provincial Policy. The following list represents some of the key strategies while others are captured in Appendix I.

- 50+5: Algonquin College Strategic Plan 2017-2022: The Strategic Plan reinforces the College's commitment to "reducing its environmental impact – with the ultimate goal of becoming carbon neutral and serving as a leader in the education, research and exchange of environmentally sustainable practices." The Energy and Emissions Strategy provides a framework to work towards these goals, by identifying ways in which the College can better manage, and reduce, the energy it uses; thereby reducing greenhouse gas emissions, inspiring the development of curriculum, and building capacity to deliver it;
- Integrated College Development Planning (ICDP) Framework: This innovative and agile approach to planning is used to plan, design, and implement physical and digital environments in a fluid academic environment. Energy connects to several planning principles within the ICDP framework, from stimulating engagement and collaboration to championing innovation and entrepreneurship and building resilience;
- Sustainability Strategy Framework: The Energy and Emissions Strategy is interconnected with the Sustainability Strategy Framework in several ways, and will advance social, economic and environmental objectives (see Appendix G for further information);
- Algonquin College Conservation Demand Management Plan (CDM): Public agencies in Ontario, starting in 2014, were required to produce a 5-year CDM Plan, as well as report annually on their emissions. The College's first CDM Plan was published in 2014, and it's anticipated that a new CDM Plan will be required in 2019; and
- Algonquin College Transportation Strategy and Water Strategy: Improved transportation infrastructure, such as a more pedestrian oriented campus with strong cycling connections, can reduce single occupancy vehicle trips, and therefore the College's Scope 3 greenhouse gas emissions. Using water more efficiently will reduce the amount of energy needed to produce and distribute potable water.

The Energy and Emissions Strategy also contributes to the following government priorities:

- Federal Sustainable Development Strategy (FSDS) for Canada (2016-2019): The FSDS is the Federal Government's response to sustainability. Among other things, it commits the country to taking action on climate change to support Canada's role in implementing the Paris Agreement, reducing emissions, ensuring all Canadians live in clean, sustainable communities that contribute to their health and well-being, and create jobs through clean technology;
- The Pan-Canadian Framework on Clean Growth and Climate Change: A collective plan between provinces, territories and the federal government that commits to growing the economy, while reducing emissions and building resilience to adapt to a changing climate. The plan commits to a price on carbon, and while it encourages provinces and territories to develop their own programs (such as a carbon tax or cap and trade program), the federal government has the ability to impose a carbon pricing system should provinces or territories fail to meet the agreed benchmarks;

- Ontario Climate Change Action Plan (2016-2020): This Plan establishes ambitious targets that aim to make the Province a North American leader in the deployment of low-carbon and zero-emission solutions. The Plan has a direct impact on the College. As a public institution the College will be expected to meet many of the actions outlined in the document, including similar targets. Using a baseline year of 1990, the Province's greenhouse gas reduction targets are as follows:
    - 6% by 2014 (achieved)
    - 15% by 2020
    - 37% by 2030
    - 80% by 2050
- Ontario Carbon Pricing Strategy: In 2017, Ontario implemented a Cap and Trade Program to meet its obligations within the Pan-Canadian Framework on Clean Growth and Climate Change. With a change in provincial government, this program is now under review; Algonquin benefited from provincial grants in 2017-18 resulting from the Cap and Trade Program.

  Without Cap and Trade, Ontario must implement a different pricing strategy for carbon emissions, or risk the Federal Government imposing carbon taxing protocols in provinces where no carbon pricing strategies are in place. Responding to the evolving carbon pricing strategy will be important for the College as outcomes may impact Algonquin in ways such as additional funding program opportunities and possible incremental carbon pricing costs.

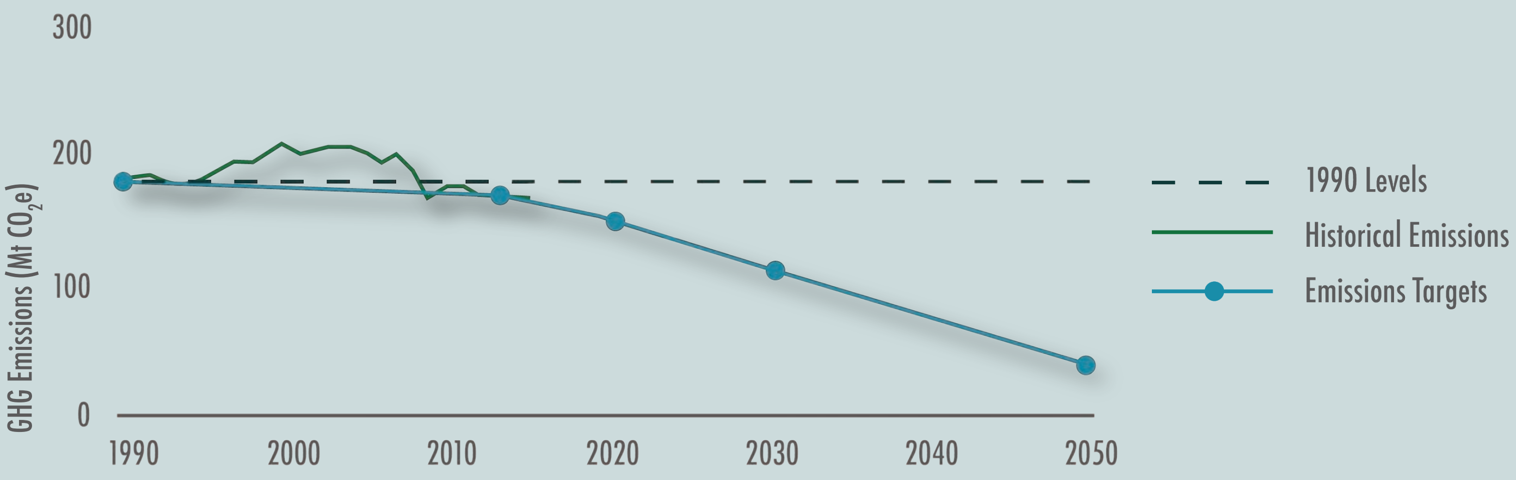


Figure 2. Ontario's historical GHG emissions and emissions-reduction targets.

2.0 THE BROADER PLANNING CONTEXT

2.1 ENERGY: CONTEXT

Globally, two long-term energy transitions are unfolding: decarbonization, the shift from fossil fuels to renewable and clean energy; and the electrification of the energy sector.

Energy transitions transform the world politically, economically and environmentally and take decades to unfold. Although government regulations and incentives may influence short-term changes, energy transitions are driven by energy costs and market forces in the long-term including the effects of climate change, innovation and advances in technology. These transitions will have major implications for the College's facilities infrastructure and operations while presenting opportunities for our mission as we develop the workforce and applied research for a clean energy future.

In Ontario, policy solutions have focused on both energy conservation and power generation. Conservation demand management policy has led to initiatives that focused on optimizing how we use energy, modernizing infrastructure and changing behaviour. Decarbonization has been particularly effective in cleaning Ontario's electricity production.

2.2 EMISSIONS: CONTEXT

Ontario began the process of decarbonizing its electricity grid in the early 2000’s and, by 2014, had complete eliminated the use of coal fired generation plants through new investments in cleaner energy sources, such as natural gas and renewables.

As a result, emissions in the Province have steadily decreased (see Figure 3), establishing Ontario as a global leader in the fight against climate change.

GHG emissions are a global concern and pollution from GHG emissions affects everyone. The full external costs of carbon emission pollution are not currently reflected in the price of the fuel sources making them seem more affordable. These costs include global warming, health care costs, crop damage and rising sea levels among other damages. Carbon pricing is one strategy to shift the cost of the damage back to the source so that those responsible for the damage are economically incentivized to reduce it. Also, carbon pricing makes renewable and clean energy more competitive.

Tracking GHG emissions can be complicated and the factors used to estimate it are constantly being reviewed and updated. For reporting purposes, Scopes 1 and 2 emissions are typically estimated and tracked. Scope 3 emissions, although significant, may be monitored and reported, but are usually noted separately.

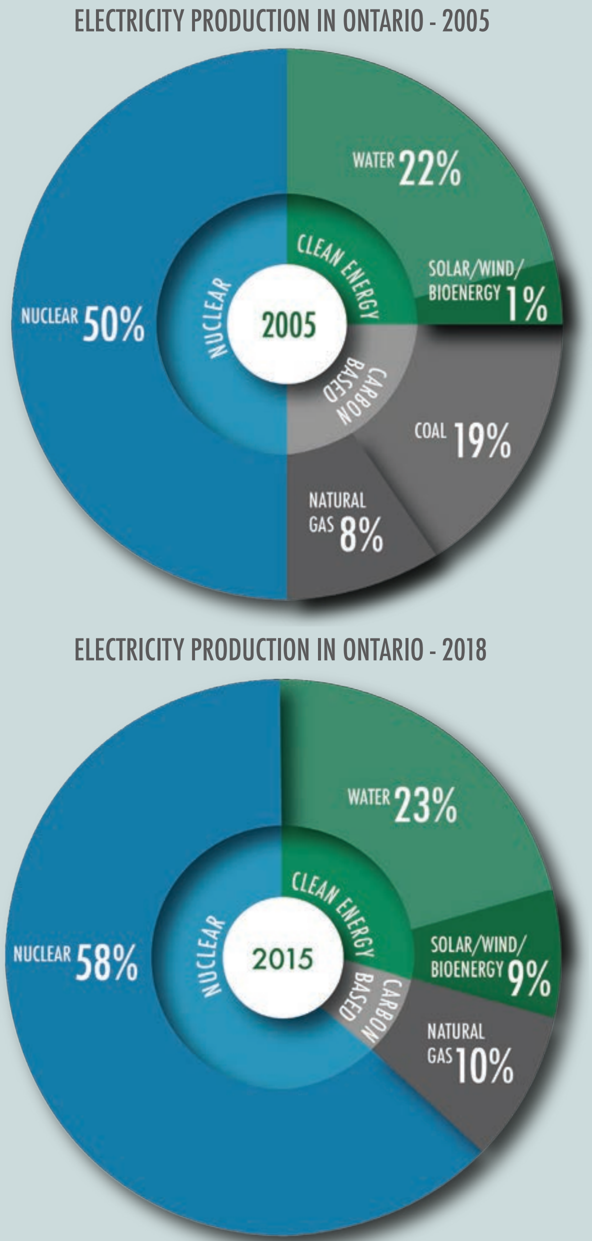


Figure 3. Electricity production in Ontario - 2005 vs. 2015.

OVERVIEW OF ENERGY FUEL SOURCES AND EMISSIONS

CARBON BASED ENERGY

	COAL	OIL	GAS
RESOURCE CLASS	Non-renewable energy	Non-renewable energy	Non-renewable energy
CHARACTERIZATION	“Dirty”/fossil fuel	“Dirty”/fossil fuel	“Dirty”/fossil fuel
ENERGY SECTOR	Combustion based	Combustion based	Combustion based
EMISSIONS RISK	Dirtiest	Dirty (half of coal)	Less dirty

RENEWABLE ENERGY

CARBON BASED / CLEAN ENERGY

	BIOMASS	WATER/HYDRO	SOLAR	WIND	GEOTHERMAL
RESOURCE CLASS	Renewable	Renewable	Renewable	Renewable	Renewable
CHARACTERIZATION	Transition fuel	Clean fuel	Clean fuel	Clean fuel	Clean fuel
ENERGY SECTOR	Electricity based	Electricity based	Electricity based/heat source	Heat/Cool	Heat/Cool
EMISSIONS RISK	Cleaner	Low	Low	Low	Low

NUCLEAR ENERGY

	NUCLEAR FISSION
RESOURCE CLASS	Non-renewable
CHARACTERIZATION	Clean but contentious
ENERGY SECTOR	Electricity based
EMISSIONS RISK	Nuclear waste

2.3 PLANNING CONTEXT AT ALGONQUIN COLLEGE

The type of energy, and the amount used, varies from campus to campus at Algonquin. As a result, each domestic campus has approached energy differently, and all have different stories to tell as it relates to managing energy, and efforts to reduce emissions.

As the largest user of energy (see Figures 4 & 5), the Ottawa campus has been working with Energy Service Companies (ESCOs) over the past ten years to find more efficient and cost-effective ways to manage energy, considering the complex variety of new and old buildings. In Perth, energy management most recently took the form of a new, modern campus building, while in Pembroke, the relocation of the entire campus offered an opportunity to redesign the infrastructure to new standards.

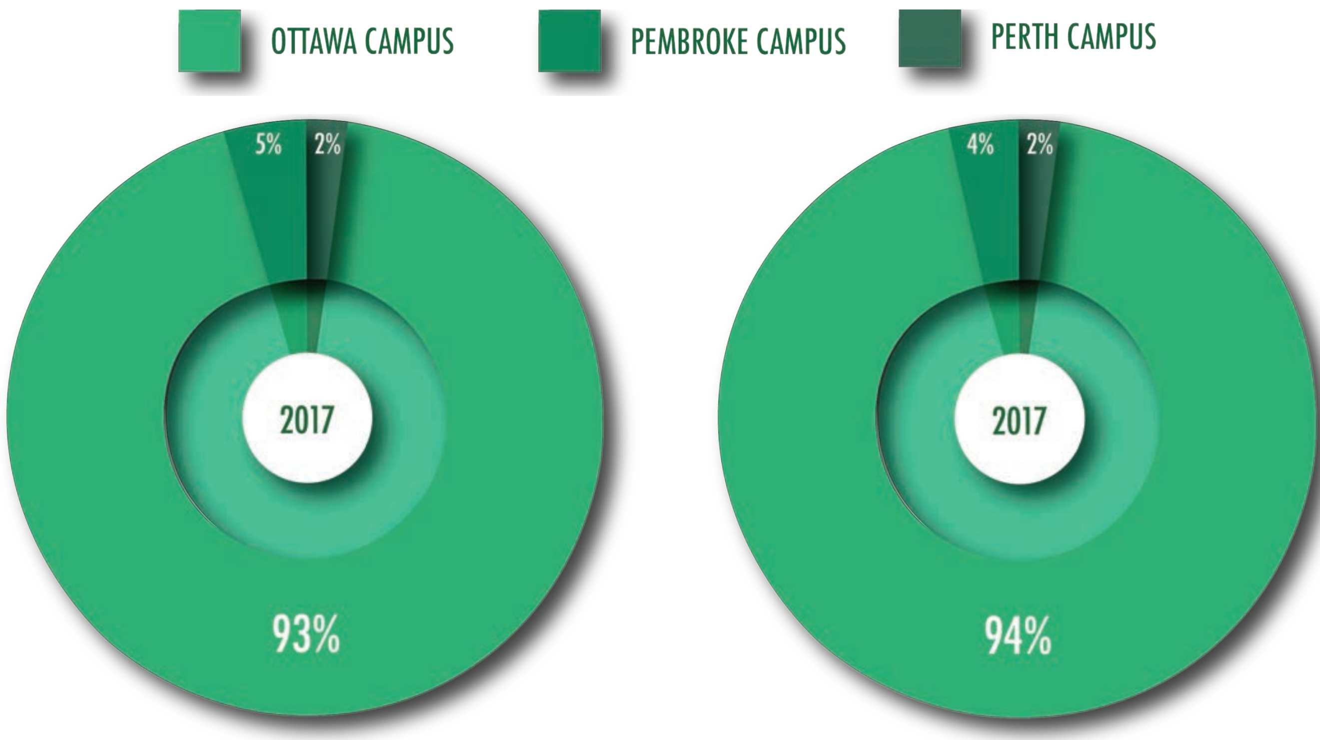


Figure 4. Energy use by Campus (2017).

Figure 5. Emissions by Campus (2017).

What are Emissions Scopes?

Greenhouse gas (GHG) emissions are classified into three scopes:

- Scope 1 (“Direct”) – Emissions created by the College’s operations or owned assets; for example the College “owns” a molecule of CO2 when it is created through cogeneration, or corporate vehicles.
- Scope 2 (“Indirect”) – Emissions created by the College’s operations, but purchased from a utility company; for example the College buys electricity from HydroOne.
- Scope 3 (“other Indirect”) – Emissions created from activities upstream and downstream of the College, neither owned nor controlled by the College. This might include business travel, purchased goods and services, student and employee commuting emissions, etc.

As a result of the efforts to manage energy more effectively, energy use across the College held relatively steady between 2005 and 2015, despite an 18% increase in the College's footprint (see figure 6). Where total energy use did increased, this in part can be explained by colder winters, as shown by the spikes in heating degree days. Heating degree days (HDD) quantify the demand for energy that is needed to heat a building or campus, the higher they are, the more heating required throughout the year.

A more accurate reflection of the achievements in energy management and energy use reduction can be seen by measuring energy use intensity. At Algonquin, energy use intensity between 2005 and 2015 decreased (see Figure 7), demonstrating the overall impact from two Energy Services Contracts (ESCO's), despite the additional growth in students during this time period.

With respect to emissions, these declined significantly between 2005 and 2015 primarily for two reasons (see Figure 8). One, the closure of coal-fired power generation plants had a profound impact on Scope 2 emissions generated by Ontario's electricity grid. Beginning in 2003 and ending in 2014, coal was phased out as a source of fuel, and the share of energy sourced from renewable energy increased;

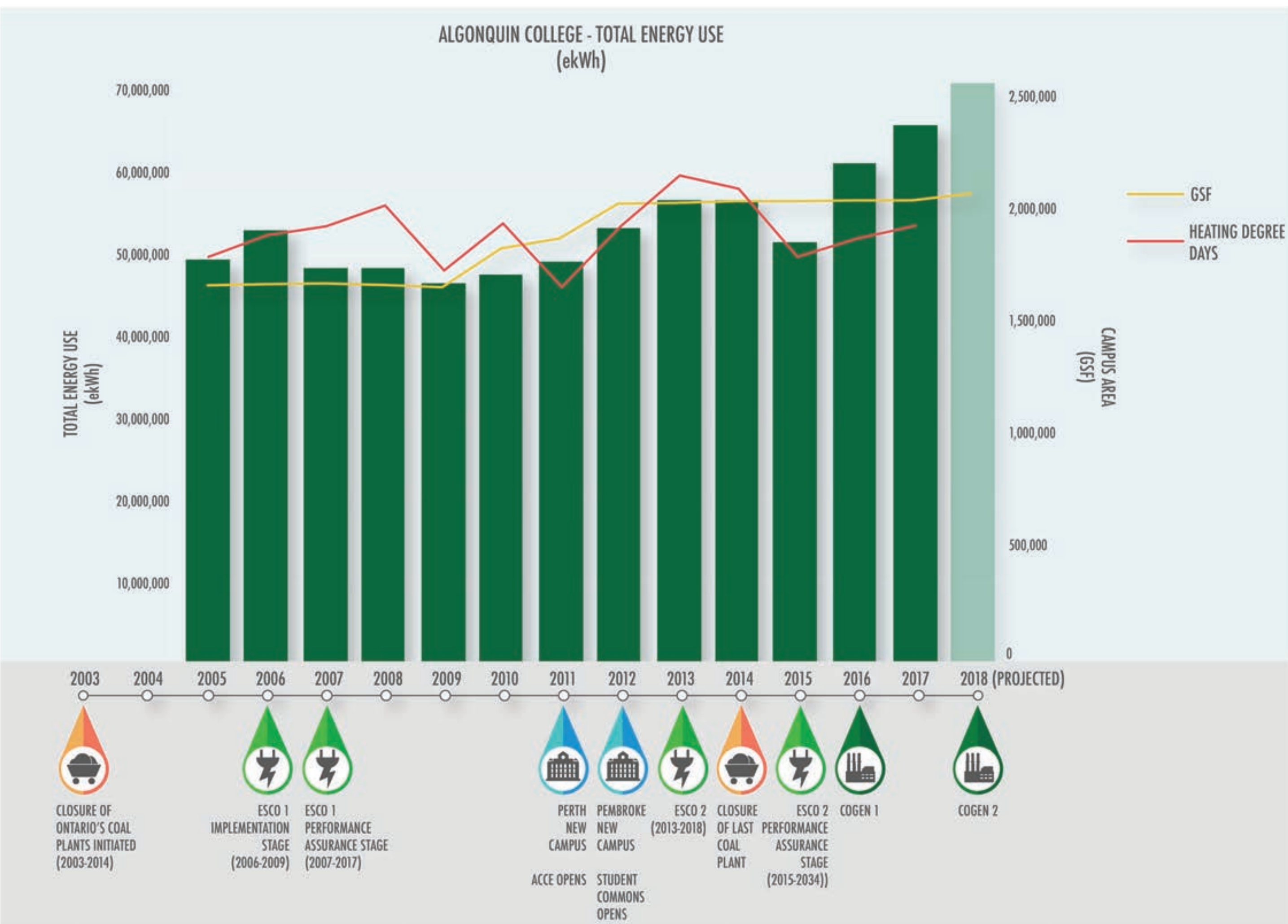


Figure 6. Total energy use (ekWh / GSF).

providing Ontario with one of the cleanest electricity grids in North America, if not globally. The second reason is the efficiency gains related to ESCO's 1 and 2, and the replacement of older buildings with newer, high performance buildings.

However, the introduction of the cogeneration plant in 2016 has had a significant impact on these trends:

- Cogeneration has increased Scope 1 emissions because more natural gas is being purchased and combusted on-site. (In comparison Scope 2 emissions have decreased due to purchasing less electricity from the grid);
- Total emissions have increased due to natural gas being a carbon based fuel, and 'dirtier' than the provincial grid; and
- Total energy use, in relation to the energy purchased from the gird, has increased because the combustion of natural gas is less efficient than pulling electrical energy from the grid; therefore more natural gas is required to produce the same amount of energy that would otherwise have been sourced by the grid.

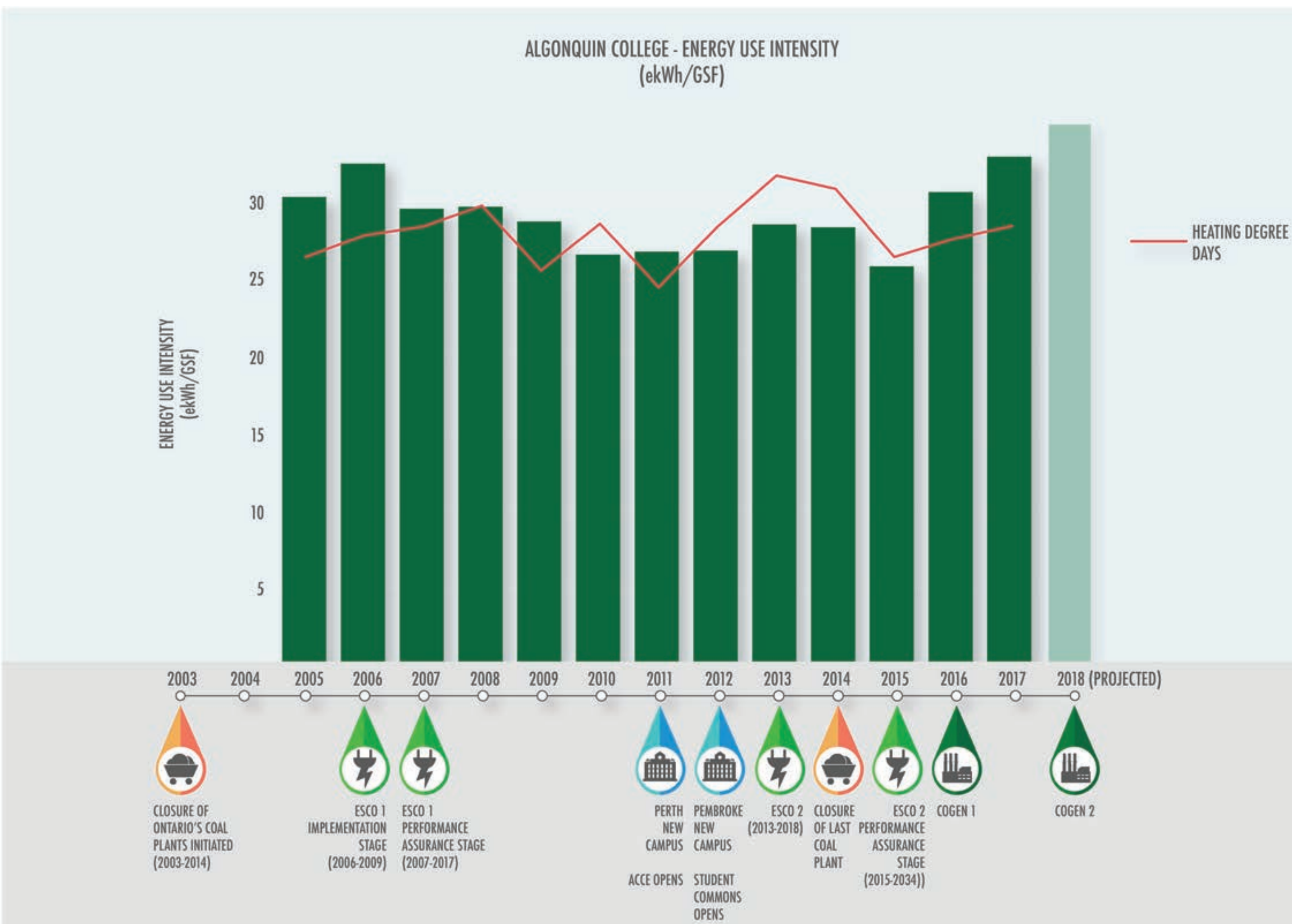


Figure 7. Energy use intensity (ekWh/GSF).

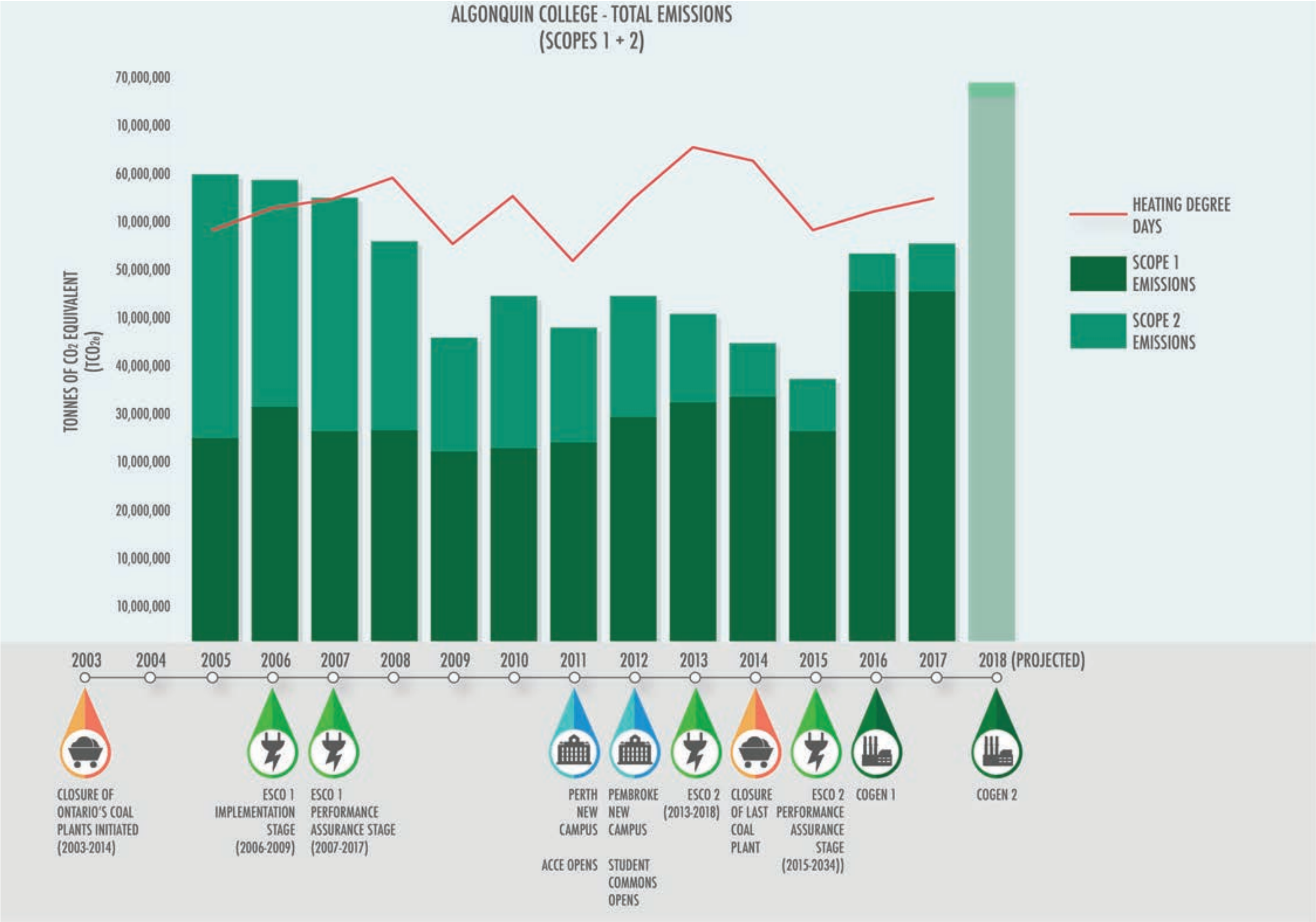
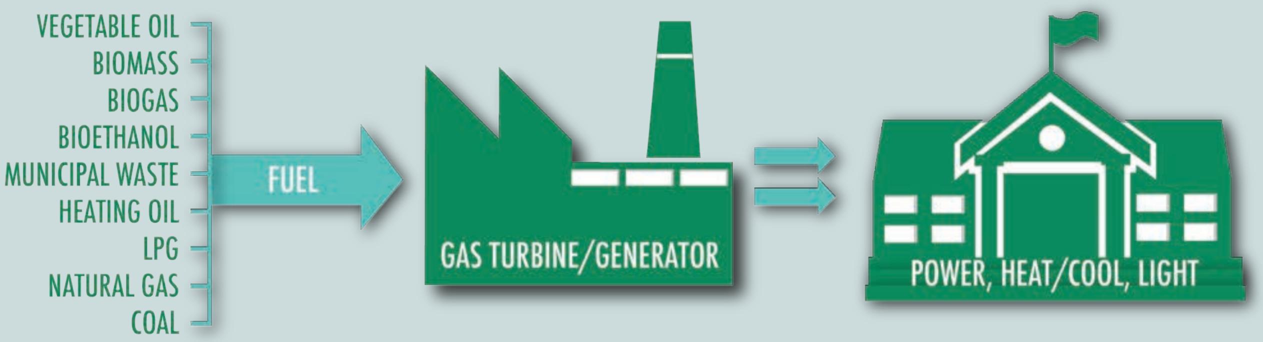


Figure 8. Total emissions.

WHAT IS COGENERATION?

Cogeneration or combined heat and power (CHP) is the use of a heat engine to generate electricity and heat at the same time. Cogeneration is more thermally efficient use of fuel than producing process heat alone because in electricity production some energy must be rejected as waste heat, but in cogeneration some of this thermal energy is put to good use.

Combined heat and power (CHP) plants recover otherwise wasted thermal energy for heating. This is also called combined heat and power district heating. Small CHP plants are an example of decentralized energy
.
The supply of high-temperature heat first drives a gas turbine-powered generator. The resulting low-temperature waste heat is then used for water and space heating. Cogeneration was practiced in some of the earliest installations of electrical generation. Before central stations distributed power, industries generating their own power used exhaust steam for process heating. Large office and apartment buildings, hotels and stores commonly generated their own power and used waste steam for building heat. Due to the high cost of early purchased power, these CHP operations continued for many years after utility electricity became available. In the current energy market in Ontario, the cost of purchased electricity makes CHP a cost effective way to heat / cool, power and light the College campus making CHP viable as a long-term facilities improvement measure (FIM).



OTTAWA CAMPUS: CURRENT STATE

The Ottawa campus has benefited from two ESCO projects over the past 12 years. While ESCO's 1 and 2 addressed "low-hanging" fruit at the College, ESCO 2, in particular, went further to include deeper retrofits, a district energy network, and in the introduction of smart grid infrastructure.

In both cases the College has begun to benefit from the financial savings associated with these projects.

As the need to transition away from carbon based fuels gathers momentum, and with the low-hanging fruit addressed, the Ottawa Campus will need to shift its attention towards more challenging and technical opportunities to materially reduce emissions, such as building envelopes, renewables and battery storage. These initiatives are generally more costly to implement; ongoing support from government incentive programs will be critical to build an investment case for deeper emission savings.

What is an ESCO?

An Energy Service Company (commonly referred to as an ESCO) is a business that develops, installs and arranges financing for projects designed to improve the energy efficiency and reduce deferred maintenance costs for facilities over a seven to twenty-year time period. ESCOs generally act as project developers for a wide range of tasks while assuming the technical and performance risk associated with the project. Typically, they offer the following services:

- develop, design, and arrange financing for energy efficiency projects;
- install and maintain the energy efficient equipment involved;
- measure, monitor, and verify the project's energy savings; and
- assume the risk that the project will save the amount of energy guaranteed.

These services are bundled into the project's cost and are repaid to the ESCO through the dollar savings generated. The long-term benefits for the project owner include reduced deferred maintenance, operational savings, and lower risk. Reducing carbon emissions is not a primary objective of ESCO projects and is typically only considered in conjunction with energy cost savings or financial incentive programs.

OTTAWA CAMPUS: ACHIEVEMENTS

Over the past fifteen years, the Ottawa campus has implemented several initiatives that have conserved energy, raised awareness, lowered emissions, and positioned the College to leverage emerging low carbon technologies. Some of these initiatives include:

- In 2006, Algonquin College entered in to an Energy Services Contract (ESCO 1) with Direct Energy. This 10-year, $6 million partnership to retrofit and upgrade energy infrastructure was deemed a success, and laid the foundation for a broader, more strategic partnership approach in a subsequent energy services contract (ESCO 2);
- In 2009, Algonquin College began requiring new buildings to achieve Leadership in Energy and Environment Design (LEED) Gold certification, an internationally recognized rating system for the design, construction, operation and maintenance of green buildings. There are now two LEED certified buildings at the Ottawa Campus College; Algonquin Centre for Construction Excellence (ACCE opened in 2011 - LEED Platinum) and Student Commons (opened in 2012 - LEED Gold), with a further project, the DARE District (opened in 2018 - also targeting LEED Gold;
- In 2009, the College developed its integrated design process (IDP) to inform the design and construction of LEED Gold buildings. One of the key outcomes of this collaborative, stakeholder driven process was the creation of a project vision and principles (PVP) document. The PVP included aspirational objectives related to energy and drove design decisions that would reduce energy use;
- In 2013, ESCO 2 was launched; a 20-year, $51 million partnership with Siemens Canada for energy management and education at Algonquin's Ottawa campus. This unique strategic partnership went beyond a traditional energy services contract to establish broader, and deeper goals to help the College address fundamental energy issues on campus, such as deferred maintenance and enabling deeper energy retrofits (see insert). In addition, the partnership focused on engagement, education and advancing the College's sustainability agenda;
- In April 2016, Algonquin College opened the Energy Centre at the heart of the Ottawa Campus. The 4MW cogeneration plant generates and distributes power and waste thermal energy to buildings on campus through a District Energy system. This microgrid meets provincial objectives for local, reliable, and resilient energy infrastructure and is supported by optimization software that reduces energy and costs. The combination of advanced building automation, a microgrid controller, renewable energy generation, and electric charging stations, means the College is setting a new standard with one of the most innovative microgrids, or smartgrids, in the Province;
- In 2017, new academic programs were developed, focused on building automation and controls, energy management and building information modeling; and
- In 2018, funding from the Ministry of Advanced Education and Skills Development (MAESD) was allocated to the College and will be spent, in part, on the installation of a 500kW solar array with batter storage.


Robert C. Gillett
Student Commons

ENGAGING INDUSTRY PARTNERS

In May 2013, Algonquin College and Siemens entered into a partnership aimed at Transforming the College into a Model of Energy Management and Sustainability.

This unique strategic partnership has gone beyond a traditional energy services contract (ESCO) to deliver on a broad set of initiatives, including:

- Reduced energy and water consumption at the Ottawa Campus by;
    - Lighting upgrades, controls and occupancy sensors;
    - New building level meters across the Ottawa campus; and
    - Building automation control upgrades.
- Renewed aging infrastructure and reduced deferred maintenance by:
    - Retrofitting heating, cooling and ventilation systems in 6 different buildings, including a deep retrofit of Building B systems;
    - Water fixture upgrades.
- Introduced new Energy Management tools;
- Introduced new thinking related to energy supply and demand management on campus environments, such as cogeneration and renewable energy;
- Introduced technology to support the development of a 'smart' microgrid;
- Provided living lab and applied research opportunities and a platform to showcase advanced technologies; and
- Engaging and inspiring the College community to enable a culture of change, by funding a Sustainability Coordinator position for 5 years.

PERTH AND PEMBROKE CAMPUSES: CURRENT STATE

While both Perth and Pembroke have benefited from redevelopment at each campus, technology continues to advance and open up new opportunities to improve efficiency through energy conservation measures.

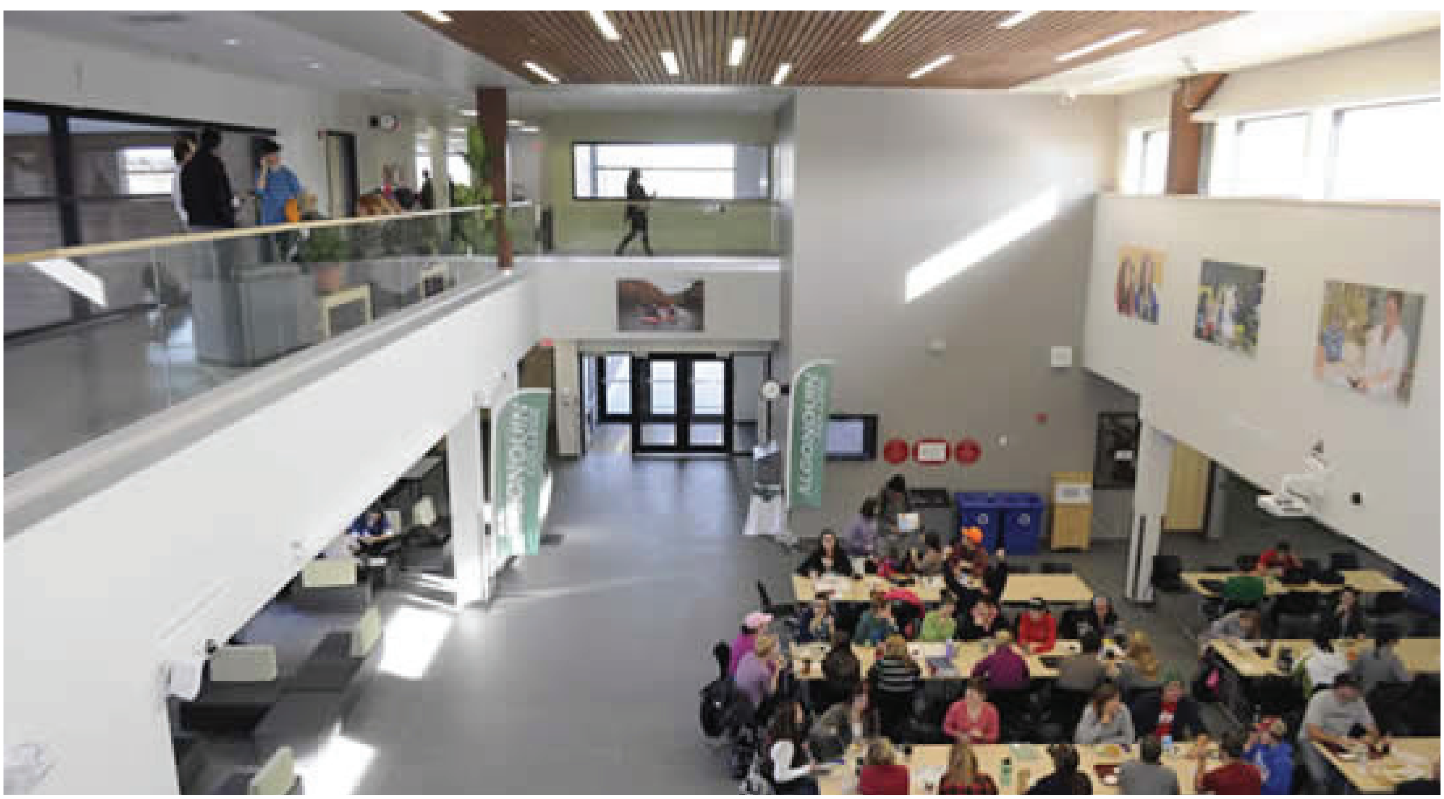
In 2017, energy audits were completed on both buildings to determine how the buildings could benefit from new innovations in energy efficiency, such as LED lighting. These audits identified a number of new, ‘low-hanging fruit’, measures that would further improve upon the energy performance of these buildings, and reduce costs and emissions. When completed, these campuses wold need to shift their attention to innovation and decarbonization strategies, such as solar, battery storage, or cleaner fuel sources.

PERTH AND PEMBROKE CAMPUSES: ACHIEVEMENTS

Both Perth and Pembroke campuses have been redeveloped within the past 10 years.

The redevelopments, which included new LEED Gold campus buildings (Perth 2011 and Pembroke 2012), have given the College state of art campus buildings which have provided a wide variety of benefits to students and staff, from sustainable transportation infrastructure, to healthier indoor learning and working environments, and more efficient energy and water systems.

These buildings, as was the case with Student Commons and ACCE, also went through an integrated design process to establish a Project Vision and Principles (PVP). The PVPs, focused on sustainability, also included objectives around energy performance, which were validated during the post occupancy reports completed in 2015.



3.0 ENERGY & EMISSIONS PLANNING VISION AND PRINCIPLES (PVP)

VISION

v2018.06.22

AC Unplugged: Educate, collaborate, operate and innovate for a clean energy future.

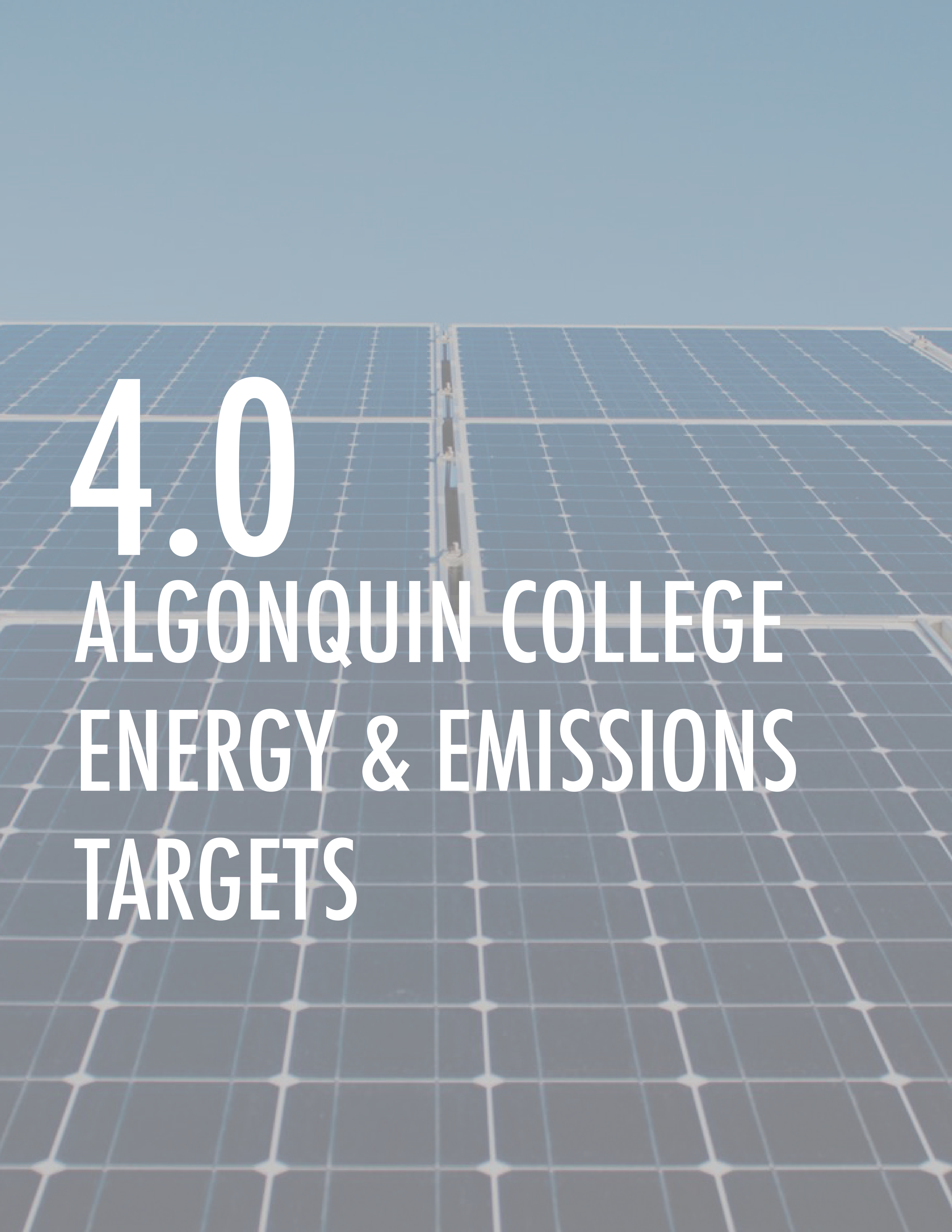
GUIDING PRINCIPLES

A. Build and Maintain Energy Awareness	B. Practice Energy Stewardship	C. Future-proof our Infrastructure	D. Leverage Innovations in Energy
Create a culture of awareness by engaging the College Community and inspiring action and teamwork related to energy and emissions.	Motivate the college community, stakeholders and strategic partners to use energy sustainably.	Create resilient building and energy infrastructure that will support a transition to a clean energy future and accommodate growth of the College.	Provide leadership by embracing innovative energy technologies and partners to support and stimulate the clean energy economy.

OBJECTIVES

Engage our community to make energy and emissions awareness relevant to the day to day lives of students, faculty and staff. Facilitate rational dialogue on the most pressing issues related to energy and emissions, to introduce debate and inform decision making.	Pursue College-wide carbon neutrality by 2050. Reduce energy intensity at each campus through energy conservation measures. Implement campus-wide monitoring, reporting and benchmarking. Conduct post occupancy assessments of all new building and major renovation projects, using the respective PVP as a baseline to determine success.	Design all new buildings and major renovation projects to achieve high energy performance requirements, in support of Leadership in Energy and Environmental Design (LEED) certification. Evaluate energy consuming equipment purchases through a sustainability lens that includes lifecycle costs, environmental impact, and community benefits. Improve energy resiliency by ensuring the Ottawa Campus can maintain critical operating functions during a power outage.	Develop strategic partnerships to establish the College as a leader in applied energy innovation. Expand collaboration between academic program teams and Physical Resources. Embrace innovative and pioneering projects that could advance the College, and industry, towards clean energy goals.

4.0 ALGONQUIN COLLEGE ENERGY & EMISSIONS TARGETS



In addition to the proposed AC Emission Reduction targets listed, the 2017-2022 College Strategic Plan identified a True North metric of net-zero carbon college, i.e. 100% emission reduction.

Table 1. Proposed emission reduction targets.

INDICATOR	BASELINE (2005[1])	2018[2]	2030	2050
Total Energy Use[3] - ekWh	49,319,255	*71,637,817*	68,000,000	68,000,000
Energy Intensity[4] - ekWh/m^2 (ekWh/gsf)	326 (30.3)	*380 (35.4)*	329 (30.5)	329 (30.5)
Emissions Reduction[5] - TCO_2e	9,928 TCO_2e	11,875 TCO_2e	37%	80%

[1] Algonquin's baseline year is 2005, rather than 1990. Comprehensive electrical and gas consumption data is not available prior to this date.
[2] Estimated peak year based on cogen 1 and 2 being fully operational - for reference.
[3] Based on energy purchased, such as natural gas and electricity. For example, solar panels generate electricity, reducing the energy purchased from the grid.
[4] Energy intensity is a measure of the energy efficiency of an organization. It is calculated as units of energy per unit of floor area, or students. Declining energy intensity is a proxy for optimization and modernization improvements. Algonquin's target is College-wide, new buildings will aim for much lower EUI targets, to be established as part of the action plan.
[5] Scope 1 and 2 emissions only

5.0 INITIAL RECOMMENDED PRIORITY PROJECTS & INITIATIVES

5.1 INITIAL RECOMMENDED PRIORITY PROJECTS & INITIATIVES

The following table lists the recommended short-term projects to be considered within the next five years subject to prioritization and funding.

Table 2. Short-term projects to be considered.

GUIDING PRINCIPLE	RECOMMENDED PRIORITY PROJECT
A. Build and Maintain Energy Awareness Create a culture of energy awareness by engaging the College Community and inspiring action and teamwork.	Establish an integrated, Energy Education and Engagement plan that: ▪ Fosters energy conservation behavior among students, faculty and staff; ▪ Provides opportunities for students to actively engage with energy management, discussion and debate; ▪ Creates and promotes an online hub for energy awareness at Algonquin College; ▪ Utilizes existing channels and annual events, such as orientation, to raise awareness; ▪ Identifies funding opportunities that support the development and delivery of engagement activities;
B. Practice Energy Stewardship Motivate the college community, stakeholders and strategic partners to use energy sustainably.	Develop and implement a monitoring process to ensure comprehensive and reliable energy data for the purpose of tracking and reporting at the college, campus, and building scales.
	Complete a GHG Inventory related to Scope 1, 2 and 3 emissions.
	Complete an Environmental Sustainability Plan, which provides strategies towards meeting the energy and emission targets at all College campuses.
	Optimize the performance of College energy systems by: ▪ Hiring an Energy Manager to respond to changes in facilities and advances in technology; ▪ Implementing a continuous commissioning program; ▪ Providing relevant, ongoing training for building operators;
	Collaborate with large College energy users to develop energy conservation measures, targets and specific Energy Action Plans
C. Future-proof our Infrastructure Create resilient building and energy infrastructure that will support a transition to a clean energy future and accommodate growth of the College.	Develop procurement guidelines to inform purchasing decisions for all energy using purchases, including vehicles, equipment, paper, transportation, etc.
	Develop a strategy to become energy resilient, and address: ▪ An emergency management policy for the Ottawa Campus that maintains at least 50% of the College's critical operating functions during a power outage; ▪ Access to at least two different electrical feeds for each building; ▪ Replacing the existing 44kV primary electrical feed to meet Hydro Ottawa 13.8kV standards.
	Assess the impact that cogeneration will have on projects pursuing LEED for New Construction, version 4.
	Develop Green Building guidelines that establish energy performance requirements for new construction, major renovation, existing building projects, and where relevant officially affirms the college's commitment to LEED.
D. Leverage Innovations in Energy Provide leadership by embracing innovative energy technologies and partners to support and stimulate the clean energy economy	Expand collaboration between academic program teams and Physical Resources to: ▪ Connect energy projects and initiatives with academic programming, experiential learning opportunities, and applied research; ▪ Maximize living lab opportunities using innovative on-campus technology and buildings; ▪ Disseminate knowledge and resources related to advancements in clean energy;
	Work with industry to: ▪ Develop a Centre for Applied Energy Innovation; ▪ Monitor, identify and participate in relevant incentive programs related to clean energy; ▪ Develop a transition plan for Cogeneration, with a view to accelerating a shift away from natural gas to a renewable fuel source; ▪ Introduce new programming related to emerging career opportunities in clean energy and energy demand management;

5.2 UNTANGLING ALGONQUIN'S ENERGY & EMISSIONS DICHOTOMY

Ontarians are already feeling the effects of climate change.

Higher average temperatures, more climate extremes and the increased incidence of drought, storms, and unseasonable temperatures are affecting people across the province. These effects have wide ranging impacts, from our health, to our forests, agriculture and food. Reducing emissions while pursuing affordable energy frames the College's current energy and emissions dichotomy.

In response to provincial policy, the College submitted its first conservation demand management plan in 2012 that put the Ottawa Campus on a path that focused on resiliency and financial savings (see Table 3). This plan laid the foundation for ESCO 2, and paved the way for a decision to invest in cogeneration technology and a district energy system. While cogeneration offered the College many benefits, its dependency on natural gas has increased the College's overall emissions.

These decisions, made within the context of the 2012-2017 Strategic Plan were well considered, and well intentioned, however they have also put the College at odds with recent provincial policy focused on reducing emissions. As the College pivots to support this new direction, as highlighted in its most recent strategic plan, it will be challenged to significantly reduce emissions following its commitment to cogeneration. Addressing the decisions and commitments made only a few years ago will take time and significant resources.

Table 3. College Strategic Energy Planning Paths.

STRATEGIC ENERGY PLANNING PATHS		
College Strategic Planning Horizons	**2012 - 2017**	**2017 - 2022**
Provincial focus	Energy use and demand management	Emissions and climate change
Provincial policy	Conservation Demand Management	Climate Change Action Plan
College direction / mindset	Financial sustainability Resiliency	Social, economic and environmental sustainability Resiliency
College goals	Energy savings Infrastructure renewal Financial savings	GHG emission savings
Aspirational goals	Net-zero energy	Net-zero carbon
Technology solutions	Cogeneration, district energy system, microgrid	Solar PV, energy storage, geothermal
Cost effective fuel source choices	Carbon based energy (natural gas)	Clean energy
Desired resolution of dichotomy	District energy system, using a clean energy fuel sources (Ottawa)	

5.3 LEVERS OF CHANGE

As the College considers a path towards the low carbon campus of the future, it will need to consider various levers of change in parallel to internal commitments (ESCO 2), and external risks. Internally the College is committed to ESCO 2 until 2034, making it difficult to move away from cogeneration technology until such time. Externally, the college could be impacted by other factors, such as:

- Political uncertainty could impact policy, and effect the availability of funding that supports energy and emission reduction strategies;
- Socially the way in which organizations are viewed;
- Sudden climate events could trigger an increased sense of urgency to meet targets;
- Advances in technology may provide alternative options to generate cleaner power;
- The cost of power, including carbon pricing, may impact the affordability of certain sources of energy; and
- Evolving climate science may shift the way in which emissions are measured, having an impact on organizational emissions despite no corresponding change in fuel consumption.

Within Algonquin College, there are a number of drivers, or levers, that will effect change (see Figure 9), many of which have been in play for years.

The green building policy, recent funding received by way of Ontario's cap and trade program, and ESCO's 1 and 2 provided opportunities to optimize and modernize campus infrastructure.

While these levers have already had a positive impact on emissions at Algonquin, deep decarbonization strategies will be needed to meet medium and long-term targets by addressing the current dependency on natural gas. These levers are discussed further in the Potential Pathways to Net-Zero (see Appendix H), and outlined in more detail in Table 4 (seen on the next page).

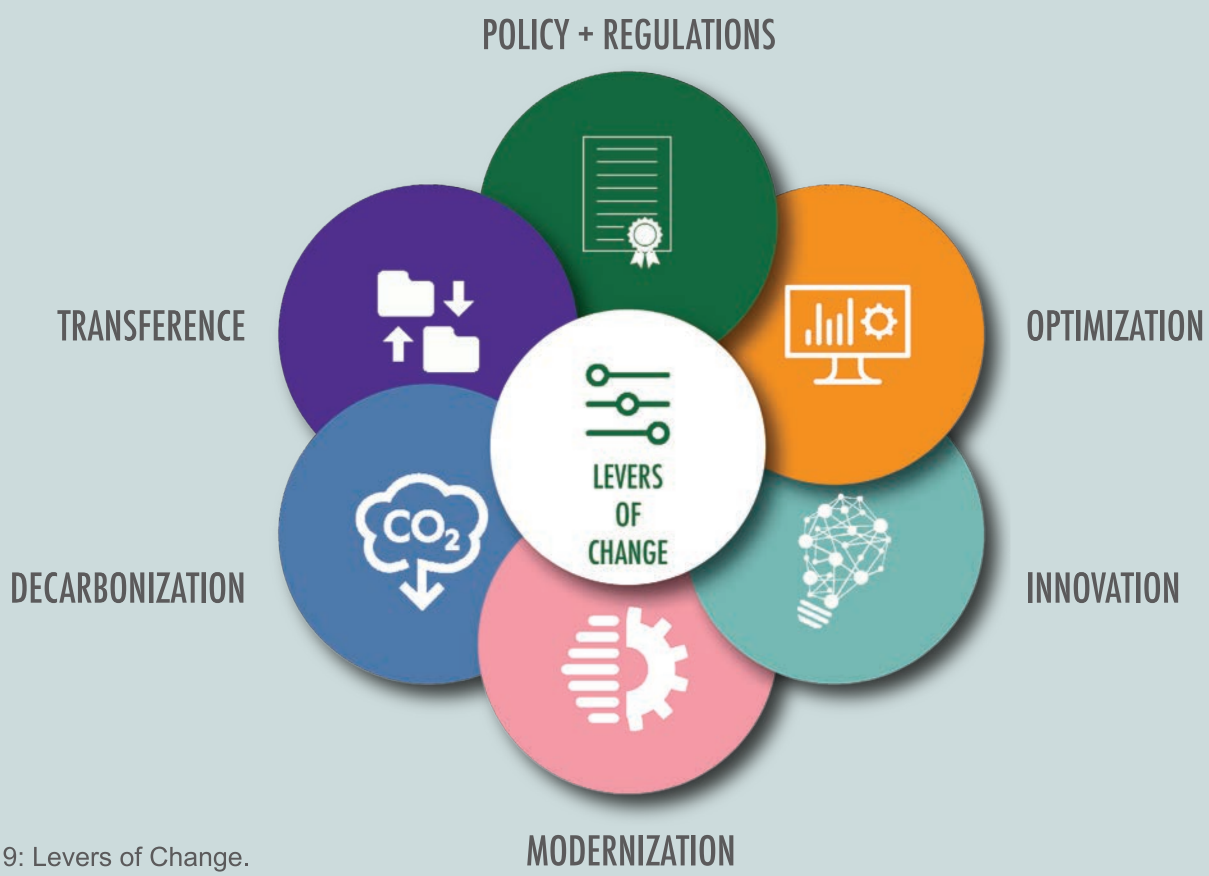


Figure 9: Levers of Change.

Table 4. Levers of Change.

LEVER	WHAT IS THIS?	POTENTIAL IMPACT
Policy / Regulation	These are internal policies and/or external regulations that commit us to a direction, set targets and incentivize change • Internally our 2017-2022 College Strategic Plan • Externally, the Ontario Cap and Trade System	The Ontario Cap and Trade System has created a windfall funding opportunity for the College.
Optimization	These are techniques that conserve energy or avoid the need for energy consumption by achieving more with less, and eliminating waste: • Space management • Lean AC Way • Minimize build new • Peak leveling / shaving • Behaviour change / conservation • Continuous commissioning…	This lever will help to keep the problem from growing or to shrink the problem but it will not achieve the net-zero carbon goal. Savings in these areas not only benefit energy and emissions, but also have significant follow-on effects including improved sustainability, cost savings, broader resource optimizations.

Innovation	These are new techniques and technologies that change how we use and store energy
	• Demand response
	• Innovative business models
	• Technology
	    • LEDs
	    • Intelligent buildings
	    • IoT
	    • Electricity Storage
		These have opportunities related to applied research, academic programming and upgrading.

Modernization	These are efforts to update our infrastructure and processes to use energy more efficiently by modernizing: • Our thinking (Design guidelines to include passive energy design, high performance buildings + systems…) • Our operations • Our technologies (Building Automation Systems BAS, LED lighting…) • Renew / Redevelop existing buildings and systems • Deep retrofits on existing buildings	Relates to ratio between useful output, vs. input of energy. Efforts to reduce use of energy or an energy service.
De-carbonization	These are techniques that allow us to move away from the combustion of fossil fuels • Fuel Switch • Clean Gas • Renewables	Ultimately, this is the largest and necessary challenge that we must solve to achieve a net-zero carbon future.
Transference	These are approaches that transfer our direct impacts by reducing the impact of carbon in other locations • Carbon Offsets and Credits • Renewable Energy Credits (Climate e-certified) • Renewable Energy Credits (Green e-certified)	


ALGONQUIN
COLLEGE

APPENDICES

APPENDIX A: GLOSSARY

ASHRAE – The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) is an international voluntary organization for people involved in heating, ventilation, air conditioning, or refrigeration (HVAC&R). ASHRAE Standards are often referenced in other model building codes and in the US Green Building Council's Leadership in Energy Design (LEED) green building rating system. LEED certification required that all new buildings and major renovation projects exceed the energy intensity targets of ASHRAE 90.1 2013 by 30%.

Carbon Dioxide (CO2) – A naturally occurring gas, also a by-product of burning fossil fuels and biomass, as well as from land-use changes and other industrial processes. It is the principal anthropogenic greenhouse gas that affects the Earth's radiative balance.

Carbon Dioxide Equivalent (CO2e) – A measure used to compare the various greenhouse gases based on their global warming potential. CO2 is the reference gas against which other greenhouse gases are measured and therefore has a global warming potential of 1, while methane has a global warming potential of 21. CO2e is therefore used to capture the potential global warming potential of all greenhouse gases. Often referred to as TCO2e, or tonnes of CO2e.

Carbon Offset – A carbon offset is a credit for greenhouse gas reductions achieved by one party that can be purchased and used to compensate (offset) the emissions of another party. Carbon offsets are typically measured in tonnes of CO2-equivalents (or CO2e) and are bought and sold through a number of international brokers, online retailers and trading platforms. Not all carbon offsets are created equal, and should be chosen carefully to ensure offsets purchased share the objectives of the College.

Carbon Neutral – refers to achieving a balance between the emissions generated, and the amount of carbon sequestered through the purchase of offsets, such as installing renewable energy, or buying carbon credits. Zero Carbon – while there are a number of definitions for zero carbon, One Planet Living defines zero carbon as a state whereby all building energy needs are met entirely via renewable energy supplies; where no emissions are generated, and no offsets required.

Climate Adaptation – Refers to an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

Climate Change – The United Nations Framework Convention on Climate Change (UNFCCC), defines "climate change" as: "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."

Climate Mitigation – Refers to any action taken to permanently eliminate or reduce the long-term risk and hazards of climate change to human life.

Cogeneration (or Cogen) – Cogeneration or combined heat and power (CHP) is the use of a heat engine or power station to simultaneously generate electricity and useful heat. Cogeneration is a thermodynamically efficient use of fuel. In separate production of electricity, some energy must be discarded as waste heat, but in cogeneration this thermal energy as a by-product for heating.

District Energy System The City of Toronto defines district energy as a thermal energy distribution system for multiple buildings at the neighbourhood scale. A district energy system consists of a heating and cooling centre and a thermal network of pipes connecting groups of buildings. Heating and cooling centres can utilize various low-carbon energy sources such as solar thermal, sewer heat, biogas, cold lake water, biomass and the ground.

Ecological Footprint – The World Wildlife Fund defines ecological footprint as the impact of human activities measured in terms of the area of biologically productive land and water required to produce the goods consumed and to assimilate the wastes generated. More simply, it is the amount of the environment necessary to produce the goods and services necessary to support a particular lifestyle.

Embodied Carbon – Defined as the greenhouse gas emissions associated with the production of a building, including the extraction, manufacturing and transportation of construction materials, as well as construction processes. Embodied carbon also accounts for any major renovations, where materials are added to a building and the end of life demolition of a building.

Emission Scopes – Greenhouse gas (GHG) emissions are classified into three scopes:

- Scope 1 (“Direct”) – Emissions created by the College’s operations or owned assets; for example the College “owns” a molecule of CO2 when it is created through cogeneration, or corporate vehicles.
- Scope 2 (“Indirect”) – Emissions created by the College’s operations, but purchased from a utility company; for example the College buys electricity from Hydro One.
- Scope 3 (“other Indirect”) – Emissions created from activities upstream and downstream of the College, neither owned nor controlled by the College. This might include business travel purchased goods and services, student and employee commuting emissions, leased assets, etc.

Energy Services Contract or Energy Services Company (ESCO) – ESCO is used for projects for energy and utilities savings achieved under an Energy Services Contract with a company specializing in building systems and energy performance. Energy savings is guaranteed, and is used to pay back the capital investment in the systems over the defined payback period.

Energy Intensity – A measure of the energy efficiency of an organization. It is calculated as units of energy per unit of floor area, or (for post-secondary institutions) students. Declining energy intensity is a proxy for efficiency improvements, providing other issues, such as weather, behaviour and number of students are accounted for.

Fugitive Emissions – Methane released into the air during the production and distribution of natural gas (and not from the usual sources such chimneys, stacks, and vents). It is estimated that 1-9% of natural gas is leaked, excluding methane that is unmeasured or immeasurable, such as methane leaked through groundwater, decommissioned wells and other means. Not all fugitive emissions are currently included in emission factors.

Fuel Switching – The act of replacing inefficient fuels with cleaner, more renewable alternatives. Fuel switching is one method of reducing energy consumption, costs, and carbon emissions.

Global Warming – Global warming refers to an unequivocal and continuing rise in the average temperature of Earth’s climate system. Since the early 20th century, the global air and sea surface temperature has increased approximately 0.8 °C (1.4 °F), with about two thirds of the increase occurring since 1980. Each of the last three decades has been successively warmer at the Earth’s surface than any preceding decade since 1850.

Global Warming Potential (GWP) – Weighting factors that allow comparisons between the different types of GHG emissions. Each type of GHG emission is weighted by its ability to trap heat over a period of time, relative to carbon dioxide. Canada uses the 100-year GWP metrics from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) released in 2007.

Greenhouse Gases (GHG's) – A greenhouse gas is a gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. The primary greenhouse gases in the Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Greenhouse gases greatly affect the temperature of the Earth; without them, Earth's surface would average about 33 °C colder than the present average of 14 °C. Since the beginning of the Industrial Revolution (taken as the year 1750), the burning of fossil fuels and extensive clearing of native forests has contributed to a 40% increase in the atmospheric concentration of carbon dioxide, from 280 to 392.6 parts per million (ppm) in 2012. This increase has occurred despite the uptake of a large portion of the emissions by various natural "sinks" involved in the carbon cycle.

Greenhouse Gas Intensity – A measure of the emission rate of carbon dioxide equivalent (CO2e) released per unit of floor area, or (for post-secondary institutions) per student. GHG intensity is useful to compare the impact of different sources of power.

Heating degree day (HDD) – A HDD is a measurement designed to quantify the demand for energy needed to heat a building. HDD is derived from measurements of outside air temperature. The heating requirements for a given building at a specific location are considered to be directly proportional to the number of HDD at that location. A similar measurement, cooling degree day (CDD), reflects the amount of energy used to cool a home or business.

Kilowatt (kW) – A unit of energy used to express the output power of engines and the power of electric motors, tools, etc.

Kilowatt hour (kWh) – A unit of energy expressed over time; commonly used as a billing unit for energy delivered.

Microgrid – A discrete energy system consisting of distributed energy sources (including demand management, storage, and generation) and loads capable of operating in parallel with, or independently from, the main power grid. The primary purpose is to ensure local, reliable, and affordable energy security for urban and rural communities, while also providing solutions for commercial, industrial, and federal government consumers.

Mitigation – Mitigation refers to efforts to reduce GHG emissions.

kW Demand – The amount of electricity required at any given point in time, based on past consumption. The utility must have x kW ready should a customer demand it. For example, in the following two scenarios the demand perspective changes, although consumption is the same for both:

- One 100-watt light bulb burning 10 hours --> the utility is required to have 0.1kW available;
- Ten 100-watt light bulbs burning for 1 hour --> the utility is required to have 10 times more capacity in response to 10 bulbs potentially operating at once.

kWh Consumption – The amount of electricity you use in one hour.

kWh Adjusted Consumption – The amount of electricity consumed when losses are accounted for. These include electricity delivery losses as heat from power lines, or equipment such as wires and transformers consuming power before reaching the home or business.

kVA Demand – Demand is the rate at which electric energy is delivered to a load and is expressed in kilovolt-amperes (kVA). It refers to the maximum amount of power drawn through a meter during a billing period.

LEED – The Canada Green Building Council defines Leadership in Energy and Environmental Design (LEED) as a rating system recognized as the international mark of excellence for green building in over 160 countries. LEED certified green buildings create a healthier indoor environment for occupants through better indoor air quality, less harmful products, and more natural daylight. They also reduce waste, conserve energy, decrease water consumption, and drive innovation, all of which positively affect the bottom line and productivity.

Net-zero Carbon – A building, or buildings, is said achieve net-zero carbon emissions when it produces enough on-site carbon-free renewable energy to offset the annual carbon emissions associated with building operations.

Net-zero Energy – Natural Resources Canada defines a net-zero energy building as one that produces at least as much energy as it consumes on an annual basis. The primary difference between net-zero carbon and net-zero energy is that the latter is restricted to on-site renewable energy generation.

Power Factor – Ratio between kW and kVA drawn by an electrical load where the kW is the actual load power and the kVA is the apparent load. It measures how effectively the current is being converted into useful work output and a good indicator of the effect of the load current on the efficiency of the supply system.
Renewable Energy – Energy from a source that is not depleted when used, such as wind, hydro or solar power.

Renewable Energy Certificate (REC) – A REC is a certificate representing proof that a given unit of electricity was generated from a renewable energy source such as solar or wind. These certificates are able to be sold, traded, or bartered as environmental commodities, where an electricity consumer can buy the renewable energy attributes of electricity to support renewable energy, even if they are consuming generic grid-supplied electricity that may be supplied by non-renewable sources.

APPENDIX B: CURRENT INITIATIVES

Ottawa Campus

The following initiatives are underway at the Ottawa Campus:

- An Investment Case has been developed to support the College's advocacy efforts as it pursues funding for the new Healthy Living Education (HLE) building. Work to date has investigated opportunities to design and build a net-zero building through more conventional building solutions, or by piloting new technology that would utilize a bio-fuel in the central plant that could reduce emissions by 20% across the campus. This pilot project would accelerate the College's shift to renewable fuel sources;
- In 2016, the College introduced a revised strategy for printing devices that reduced the number of printers from more than 800 units to approximately 400. This 50% drop in the number of printers has reduced energy demand on plug loads, along with all network-controlled multi-function printers automatically switching to electricity-conservation mode during periods of low usage;
- In 2017, the College completed additional energy audits to identify additional energy conservation measures and technologies to further improve efficiency, and reduce emissions;
- In 2018, the College received financial support from the cap and trade program, to support initiatives such as a thermal network extension, building envelop upgrades, and a new 500kw solar array and power storage project;
- In 2018, the College will begin annual measurement and verification of energy savings as part of ESCO 2, until 2035. The annual measurement and verification will be applied to the whole facility through bill comparisons for electricity and natural gas, and to stipulate energy/utility savings such as water and adjustments to energy/utility baseline data;
- In 2018, a Building System Analyst and Preventive Maintenance Planner will be hired to optimize the performance of College energy related systems by doing measurement and verification, ongoing commissioning and performing preventive maintenance; and
- Energy efficient equipment in food services kitchens.

Green wall in the LEED Platinum ACCE Building

The following charts demonstrate the Ottawa's campus' current performance as it relates to energy intensity, GHG emissions, and GHG emission intensity.

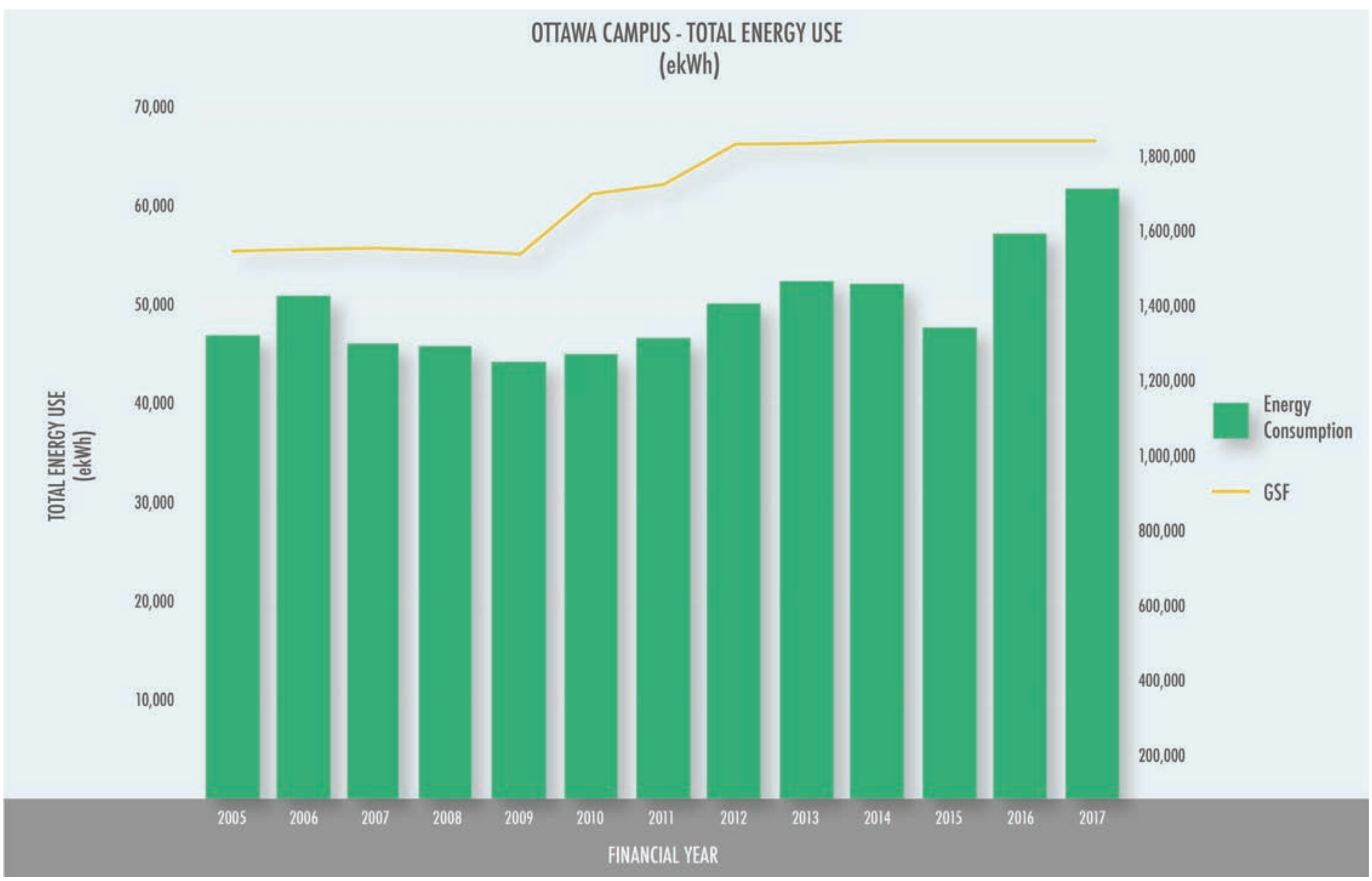


Figure 10. Total Energy Consumption (ekWh) - Ottawa Campus.

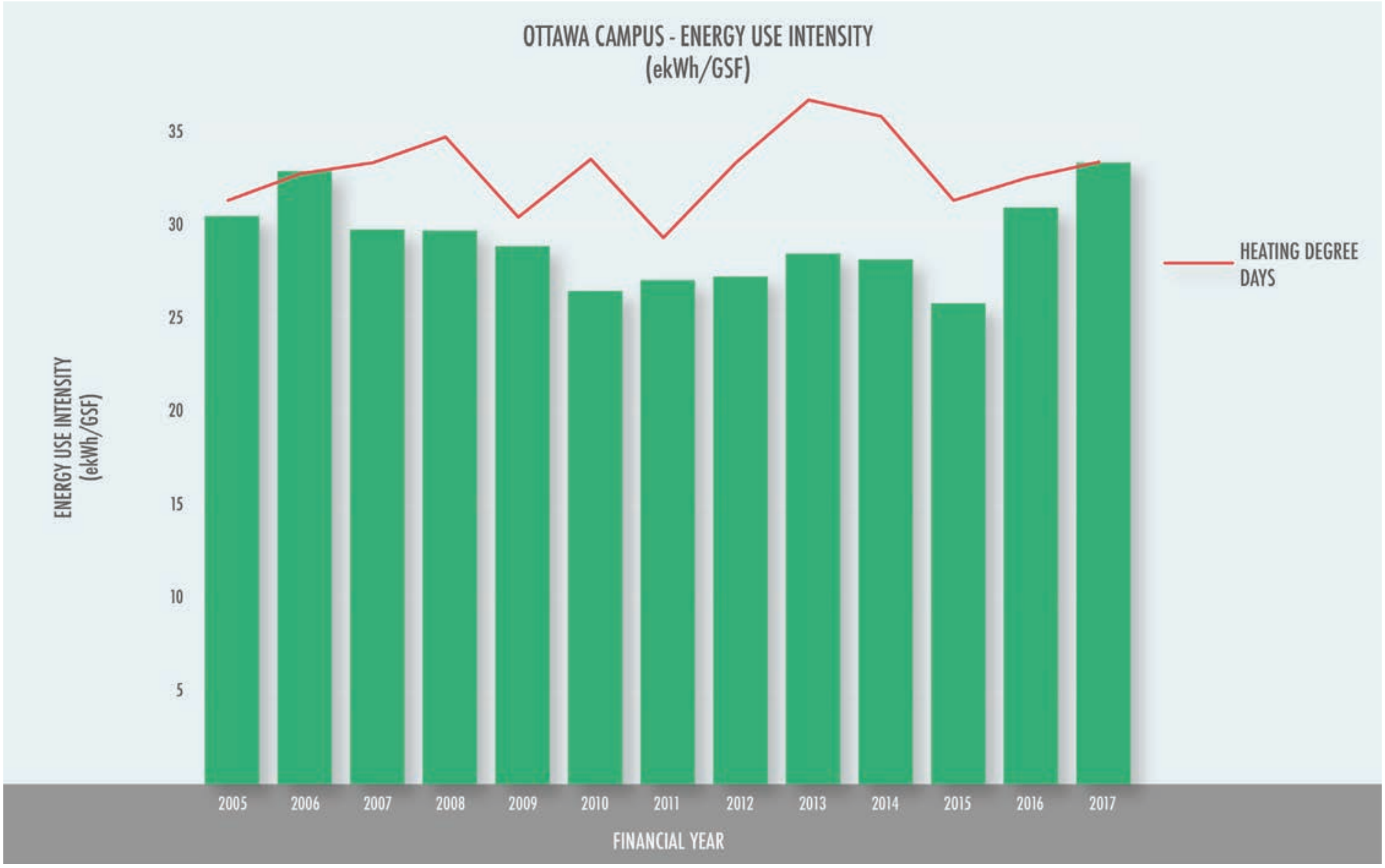


Figure 11. Energy Use Intensity (ekWh/gsf) – Ottawa. Campus.

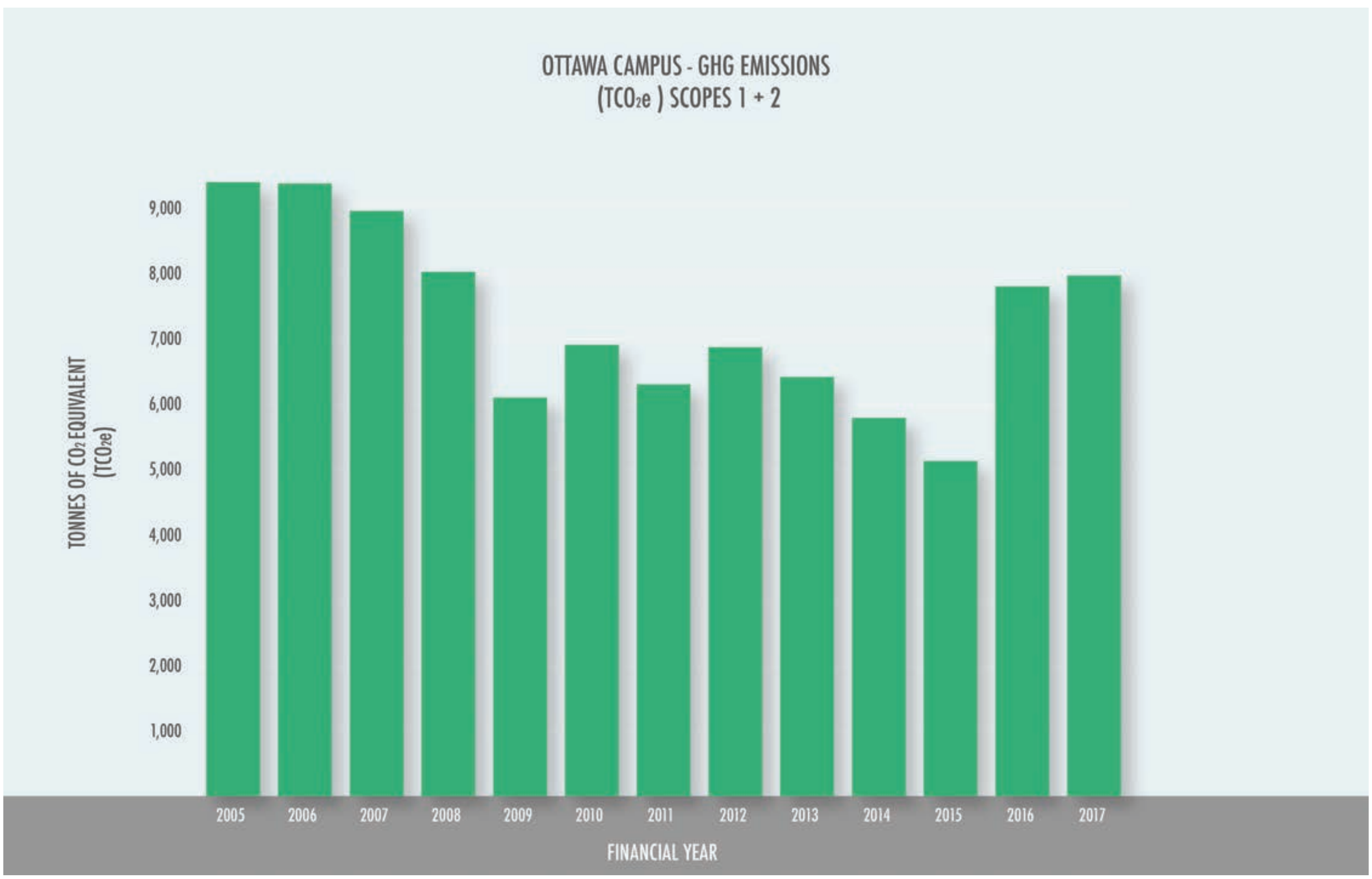


Figure 12. GHG Emissions (TCO2e) - Ottawa Campus.

Pembroke Campus

The following charts demonstrate the Pembroke campus' current performance as it relates to energy intensity, GHG emissions, and GHG emission intensity.

An energy audit, in 2017, identified a variety of energy conservation measures that will, over time, be implemented at the campus. These are explored further in Appendix H.

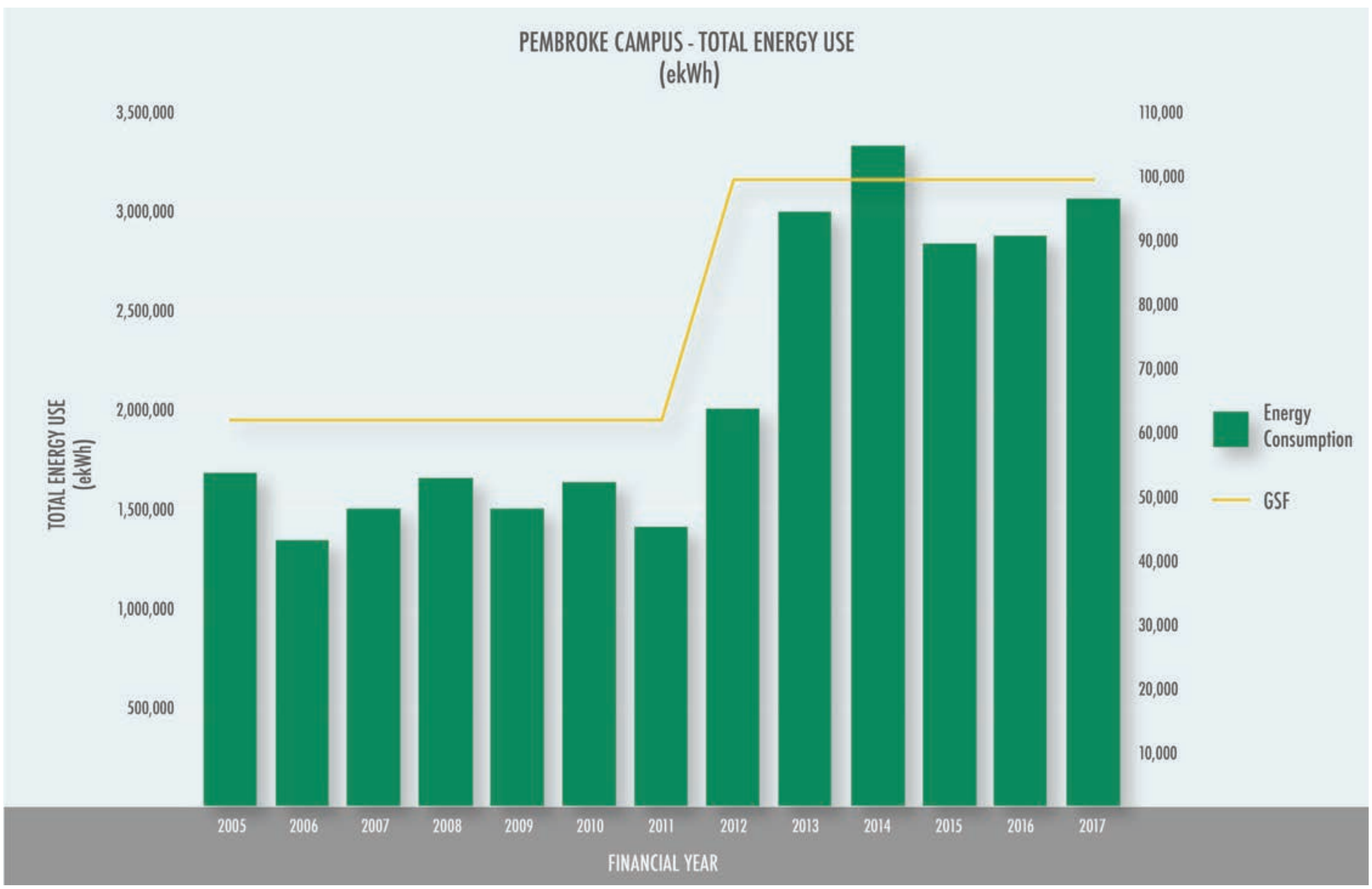


Figure 13. Energy Use (ekWh) - Pembroke Campus.

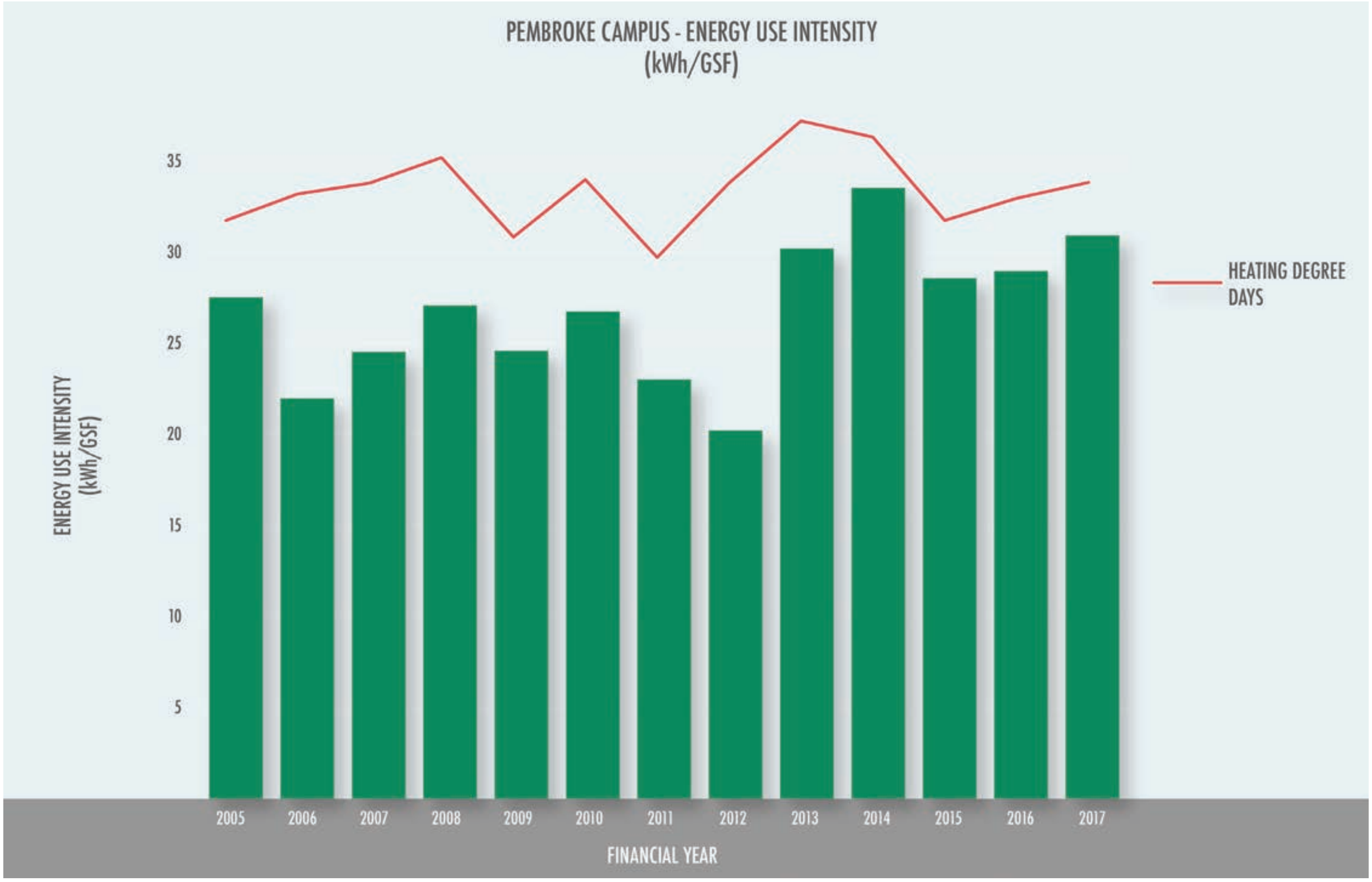


Figure 14. Energy Use Intensity (eWh / gsf) – Pembroke Campus.

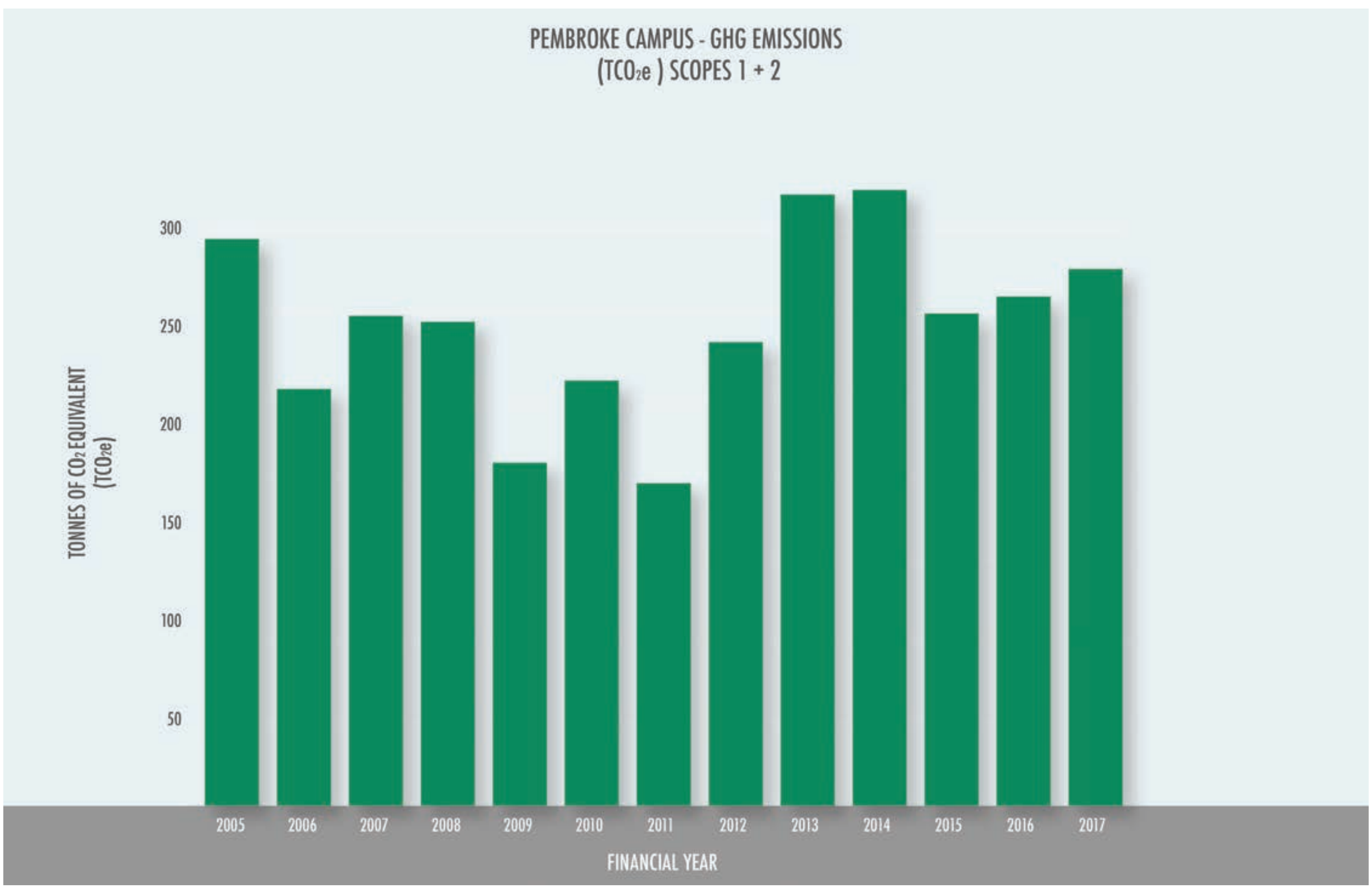


Figure 15. GHG Emissions (TCO2e) - Pembroke Campus.

Perth Campus

The following charts demonstrate the Perth campus' current performance as it relates to energy intensity, GHG emissions, and GHG emission intensity.

An energy audit, in 2017, identified a variety of energy conservation measures that will, over time, be implemented at the campus. These are explored further in Appendix H.

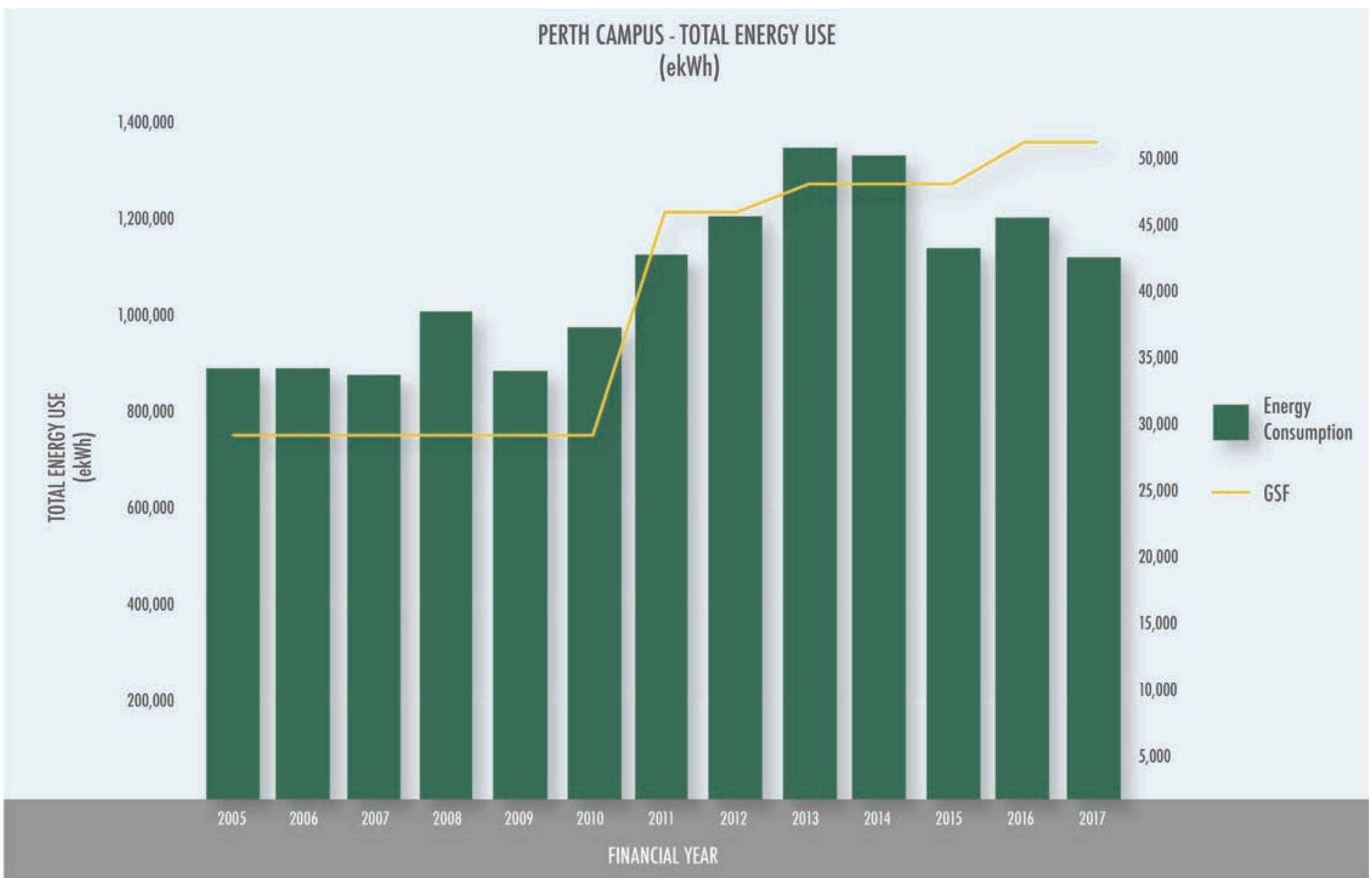


Figure 16. Energy Use (ekWh) - Perth Campus.

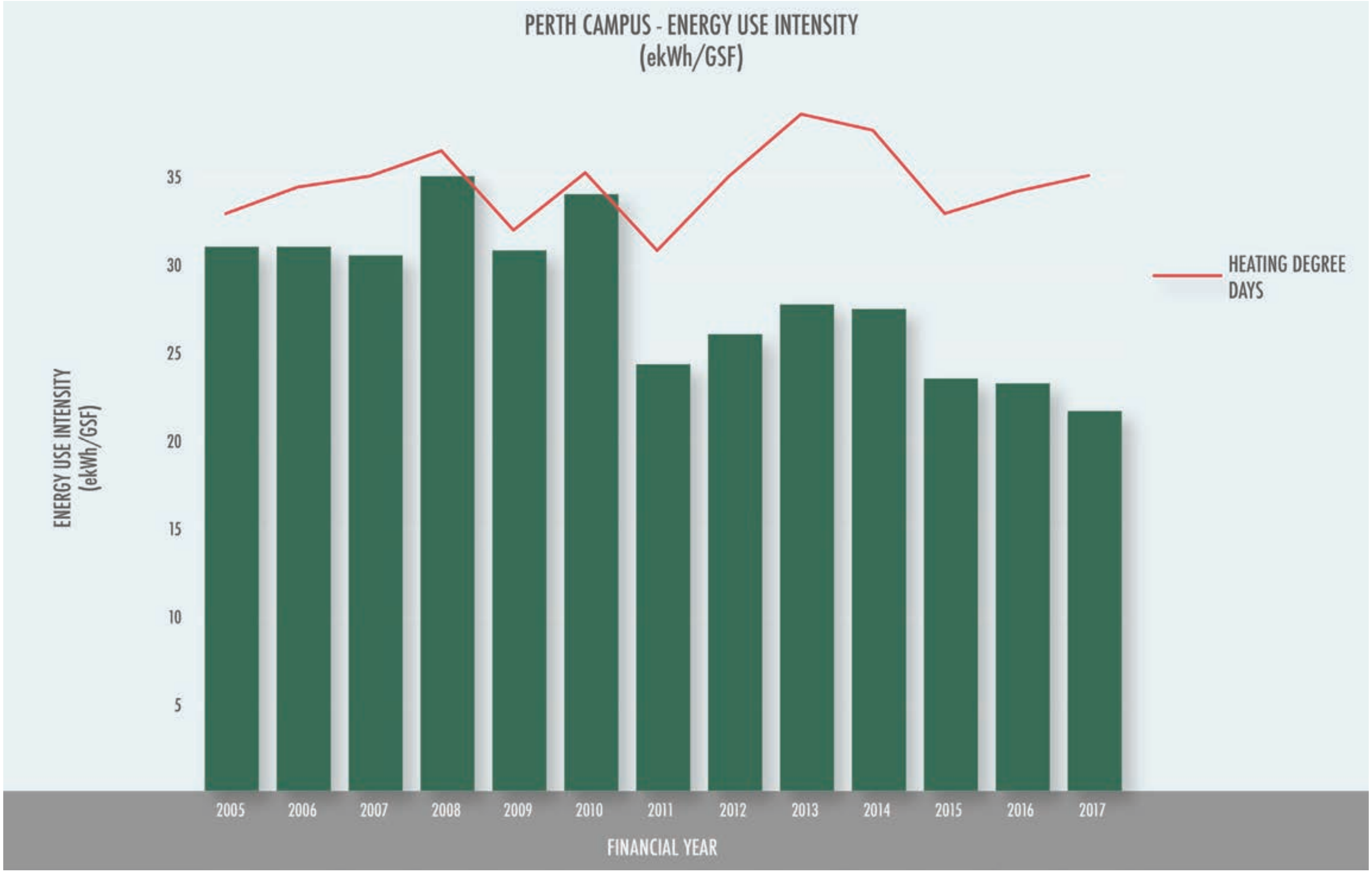


Figure 17. Energy Use Intensity (eWh / gsf) – Perth Campus.

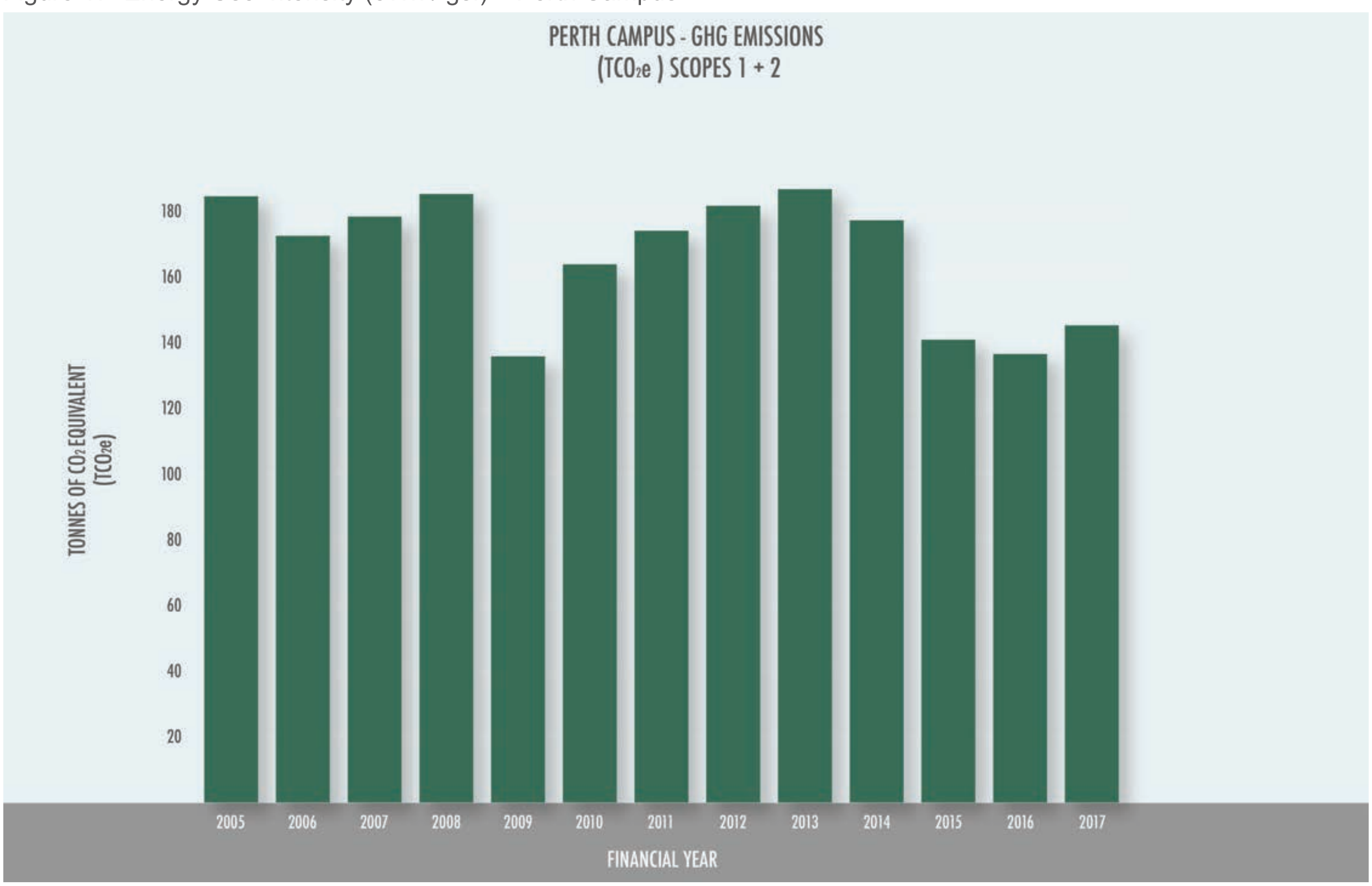


Figure 18. GHG Emissions (TCO2e) - Perth Campus.

APPENDIX C: LOCAL CAMPUS ISSUES

Key issues identified at the local campus levels included:

Ottawa Campus

- Deferred maintenance is a significant issue at the Ottawa campus, and addressing it with College funds limits the resources available for other learning and infrastructure initiatives;
- Except for the ACCE building, the infrastructure at Woodroffe is reliant upon a single 44kV primary electrical feed. This has been identified as a risk, but replacing the feed would be costly;
- Not all of the buildings are connected to the thermal network; and
- ACCE building is isolated from the main campus which limits the College's ability to enable the building to benefit from emerging innovations being implemented at the Ottawa main campus.

Perth Campus

- Despite the new campus building, envelope issues have been identified having an impact on the energy consumption and should be addressed;
- It will be important to continue to look for ways to reduce energy consumption to offset rising energy costs; and
- The Energy Audits completed by Siemens have identified energy conservation measures to consider at the Perth campus which will continue to improve efficiency, and reduce carbon emissions.

Pembroke Campus

- Staff at Pembroke identified the following issues to be addressed:
    - Incorrectly sized HVAC system (undersized);
    - Issues with the building envelope;
    - A kitchen exhaust system requiring [unplanned] continuous operation;
    - Programming the lighting control system for the common areas has been challenging; and
    - LED lighting were only installed in the parking lot, rather across the site, due to budget constraints at the time, and the cost of LEDs during design and construction. Since the new campus was opened the cost of LEDs has reduced significantly.

Some of these deficiencies have been, or are in the process of being, addressed.

APPENDIX D: ENERGY & EMISSIONS TREND LOG

As a defining issue of our time, the energy landscape will change considerably in the years to come as pressure mounts to reduce emissions. International and Provincial emission reduction targets; the cost of conventional energy; new advances in technology, and changing social preferences are converging quickly, and introducing a sense of urgency as it relates to reducing emissions. This uncertainty makes long-term decision-making challenging, reinforcing the need for an agile and flexible approach to planning.

Imagining how the market will change within the context of the College's key planning horizons provides an important perspective on how the College may need to respond in the years to come. By considering potential scenarios, Algonquin can do its best to make decisions within the context of emerging trends, risks, and opportunities. The following table is not intended to predict the future, but rather is intended to provide a log to capture this context. Where appropriate, the College could explore any of these issues in further depth, as needed.

PLANNING HORIZON	TREND & POTENTIAL DRIVER OF CHANGE	RISK / OPPORTUNITY	SHORT-TERM MITIGATION / RESPONSE
SHORT-TERM: 2017-2022	Public / student concern over climate change increases, putting additional pressure on the College to reduce greenhouse gas emissions.	Without action, the College could be perceived to be falling behind other institutions, impacting the reputation of the College, and rendering the College less competitive as students pursue learning and research opportunities at institutions with strong performance / reputation in sustainability and emissions reduction.	Create design standards for new and existing buildings. Pursue net-zero carbon for all new construction projects. Benchmark, and begin tracking Scope 3 emissions. Shift College owned vehicles to low / zero emission models. Increase awareness of students and employees. Investigate ways to reduce / offset emissions within certain programs / buildings through purchases of "green" natural gas (e.g. carbon neutral hospitality & tourism restaurant with Bullfrog power). Investigate renewable energy opportunities at all campuses. Investigate net-zero strategies for Perth & Pembroke campuses.
	Cap and Trade continues to provide funding for College-wide energy infrastructure investments	The Cap and Trade program began, in 2017/18, to provide Colleges with an annual infusion of grant money to the College, as well as interest free loans. The program will support different energy initiatives, and possible fuel switching.	Work with Colleges Ontario, as well as directly with the Provincial government, to lobby for additional support for fuel switching.
	Cap and Trade funding is discontinued.	The Cap and Trade program began, in 2017/18, to provide Colleges with an annual infusion of grant money to the College. There is a risk, with a new government, that this program could be discontinued, or scaled back, impacting the resources available to make investments in energy conservation measures.	Work with Colleges Ontario, as well as directly with the Provincial government, to lobby for additional support for fuel switching.

PLANNING HORIZON	TREND & POTENTIAL DRIVER OF CHANGE	RISK / OPPORTUNITY	SHORT-TERM MITIGATION / RESPONSE
	Ontario Cap and Trade system changes participation thresholds.	When fully operational, cogeneration will obligated the College to enroll in the Province's Cap and Trade program and report its emissions. Should thresholds be lowered the College may be required to purchase carbon allowances.	Assess the current and potential future implications of Cap and Trade on College resources.
	As climate science evolves, natural gas emission factors are revised upwards to account for fugitive emissions from upstream activities (see note below).	Including unaccounted fugitive emissions will increase GHG emissions associated with natural gas, leading to higher emissions at the College's despite no increase in consumption. As additional carbon is acknowledged, the cost of natural gas may increase due to carbon pricing.	Monitor. The College should investigate the potential impact that alternative emission factors would have on emissions and costs.
	Shale gas makes up a greater percentage of the natural gas used in the cogeneration plant.	Shale gas has a higher emission factor than conventional natural gas, and as climate science evolves new emission factors reflecting shale gas could be applied to College emissions; GHG emissions would increase with no direct correlation to consumption.	Monitor. The College should investigate the source of its natural gas, and consider the impact that alternative emission factors would have on emissions and costs.
	Cogeneration, as currently running, may be a barrier to meeting College-wide GHG targets.	Cogeneration constrains the College from meeting its GHG targets, which remain unattainable until an alternative fuel source is found, or the College pursues a path of electrification.	Monitor the impact of fuel switching on future GHG targets. Develop performance requirements for new / existing buildings. Consider constructing new buildings independent of cogeneration
	Cogeneration makes it challenging to certify future new building projects to LEED Gold.	Cogeneration, with natural gas, may make it more challenging to meet future LEED Gold or Net-Zero Carbon certification requirements, particularly as LEED continues its journey towards net-zero / low-carbon buildings.	Develop performance requirements for new / existing buildings. Consider constructing new buildings independent of cogeneration
	Renewables and other 'green' technologies become cost effective, enabling future buildings to achieve low-carbon performance as 'stand-alone' buildings.	Geothermal, solar, etc., may become cost competitive with natural gas, helping reduce the College's emissions and operational costs.	Investigate low-carbon technologies and alternative energy sources as part of any new construction project.
MID-TERM: 2023-2033	The cost of natural gas increases.	Natural gas is a commodity traded on the open market, and as such fluctuates in price. While prices have remained low, and generally steady over the past few years, there is a risk these could rise in the future.	Implement energy conservation measures. Explore fuel-switching to reduce the dependency on gas.
	Ontario's electricity grid becomes cleaner by reducing its dependency on natural gas.	The College becomes an outlier in the post-secondary system by finding it more challenging to meet its emissions reduction targets due to its reliance on natural gas.	Implement energy conservation measures. Explore fuel-switching to reduce the dependency on gas.

PLANNING HORIZON	TREND & POTENTIAL DRIVER OF CHANGE	RISK / OPPORTUNITY	SHORT-TERM MITIGATION / RESPONSE
	Emerging technology enables a shift to clean energy sources sooner than anticipated.	The College can meet energy targets in advance of current thinking, enabling the college to significantly reduce emissions, or put zero carbon within reach.	Monitor advances in bio fuels.
	Commitment to Ottawa Hydro ends.	The contractual obligation with Ottawa Hydro to run the cogeneration engines for a minimum number of hours per year, and produce a minimum amount of kW will be met, allowing the College the flexibility to optimize the engines with no constraints.	None.
	Ontario's electricity grid becomes 'dirtier', as dependency on natural gas increases as a result of some nuclear, zero-carbon, energy phasing out	The College may see emissions at the Perth and Pembroke campuses increase, however they may decrease (relative to other organizations), at the Ottawa campus.	Implement energy conservation measures. Monitor medium and long-term planning at the Ministry of Energy to understand projected emissions from Ontario's grid, and the impact on the College.
	The cost of battery storage comes down, making storage technically and commercially viable at the College.	Battery storage will enable the College to reduce energy costs by generating power during off-peak times (night), and using that energy during the day.	Work with Siemens to monitor the cost of battery storage.
LONG-TERM: 2034-beyond	The College continues with cogeneration	Cogeneration continues to offer the College significant financial benefits that discourages a transition to cleaner fuels, switching to the grid, or electrification.	None.
	The Ontario economy electrifies; shifting from combustion based to electricity based equipment.	The cost of transitioning to the provincial electricity grid reduces, making it more attractive to transition from cogeneration to the grid.	Monitor advances towards electrification, including battery storage, for opportunities to reduce emissions

APPENDIX E: THE METHANE MYSTERY

Greenhouse gases absorb and emit radiation, the fundamental cause of the greenhouse effect. The primary greenhouse gases in the Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone (see Figure 19), caused from a variety of direct and indirect activities, also known as Scopes 1, 2 and 3. Since the beginning of the Industrial Revolution (taken as the year 1750), the burning of fossil fuels and extensive clearing of native forests has contributed to a 40% increase in the atmospheric concentration of carbon dioxide, from 280 to 392.6 parts per million (ppm) in 2012. This increase has occurred despite the uptake of a large portion of the emissions by various natural "sinks" involved in the carbon cycle.

Source from the Economist, April 28th, 2018.
Every year human endeavour emit 50bn tonnes of "carbon dioxide equivalent". This way of measuring things reflects the climatic importance of CO2, which traps heat in the atmosphere for centuries before it breads down, compared with other, shorter-lived greenhouse gases.

Of that 50bn-tonne total, 70% is carbon dioxide itself. Half the remaining 15bn tonnes is methane. In the past decade methane levels have shot up, to the extent that the atmosphere contains two-and-a-half times as much of th gas as it did before the Industrial Revolution.

This is disturbing for 2 reasons. First, methane is a powerful heat-trapper. The second concern is that methane's latest rise if poorly understood. The explanations put forward by scientists range from the troubling to the truly hair raising. More research is needed to determine the correct degree of anxiety.

While the climate science continues to evolve, the United Nations Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) released an updated report in 2014 that included updated global warming potentials for methane which were higher than AR4 released in 2007. Emission factors for natural gas in Canada continue to be based on AR4, as were the conversions from natural gas to emissions within this strategy.

The impact on Ontario's GHG emissions of using the higher global warming potential is shown below in Figure 20. In short, GHG's associated with methane are currently being underreported, and should the National Inventory Report be updated to reflect the newer values, emissions across the Province will increase, despite no new increases in energy consumption.

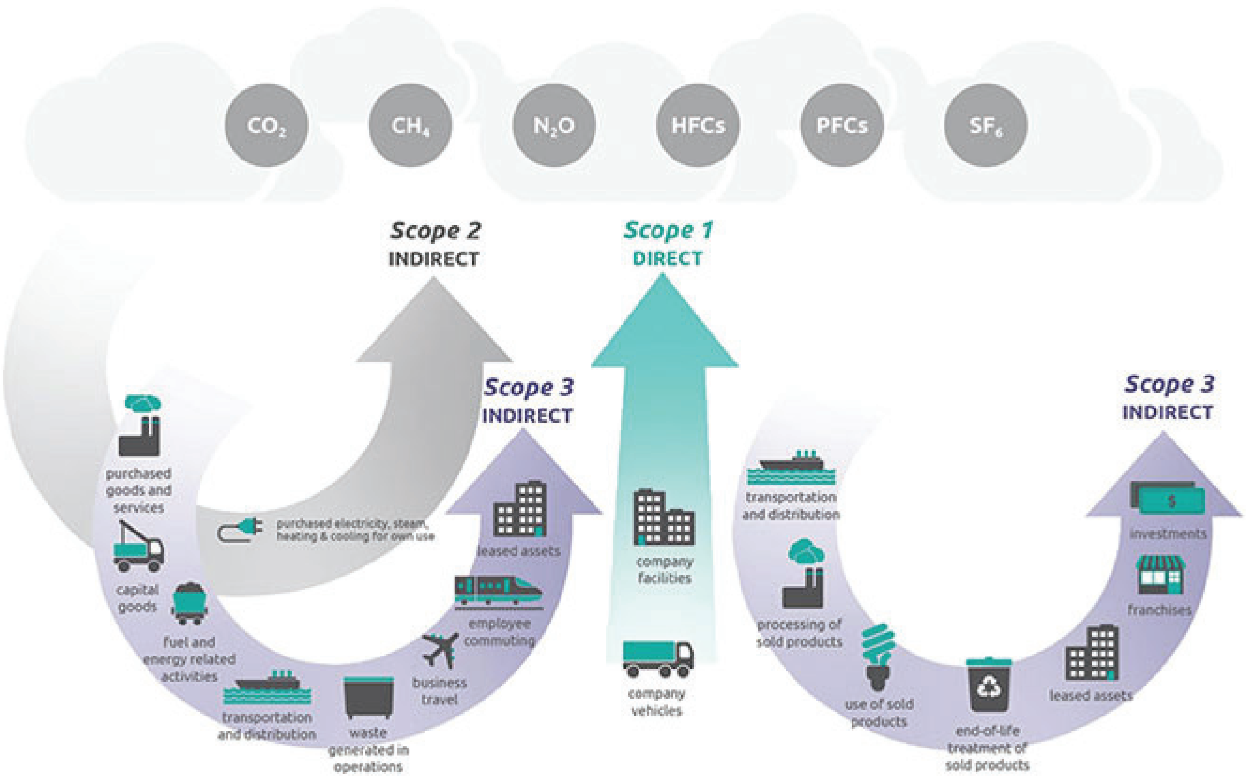


Figure 19. Emission Scopes.

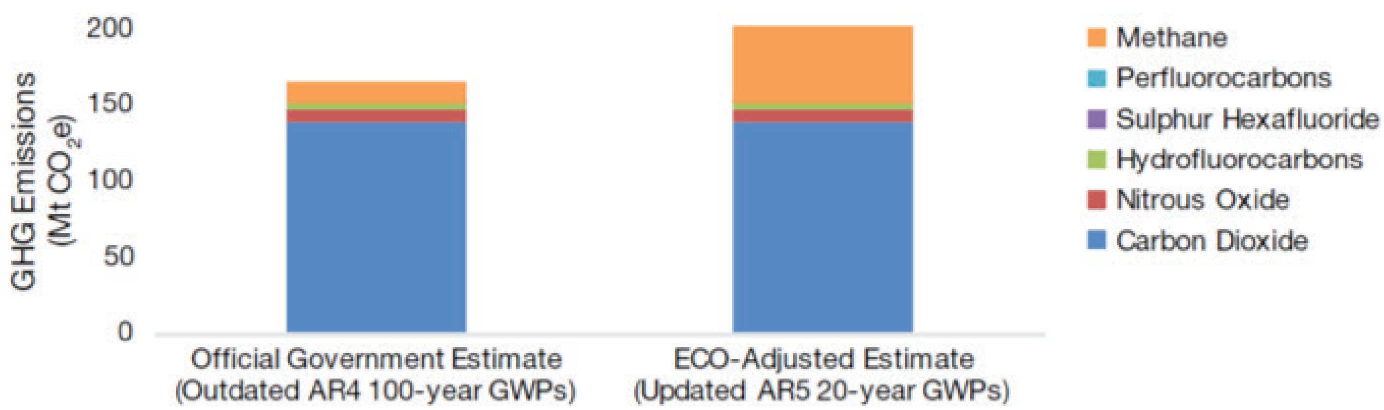


Figure 20. Global Warming Potential.

APPENDIX F: THE PROCESS AND ENGAGEMENT

Energy is a complex subject. Initially, as work began on this strategy, the focus was largely on energy in all its forms, and their impact on the College. However, throughout the process, we witnessed an emerging balance in the discourse as the College, Province and others began placing a greater emphasis on emissions. As a result, the strategy took longer than original anticipated, in large part to ensure the College understood (as much as possible), the changing landscape.

The Planning Vision and Principles (PVP) was the starting point for the Energy and Emissions Strategy. It was developed through consultation with stakeholders as part of the Integrated Design Process. The PVP provides succinct guidance to Design teams, Consultants, College staff and other Stakeholders to establish an understanding related to the College's ambitions for Energy.

The PVP has 3 parts: A Vision statement for the project; Guiding Principles; and Objectives. Consultants will use this document as a decision-making framework that allows them to make informed choices between competing alternatives. Priority projects have also been provided, offering more specific direction related to implementation. The objectives are used to evaluate the success of the Strategy once in operation.

The PVP sessions were held between March and June, 2014, and the PVP itself was updated in March 2018. Stakeholders that participated in the PVP process are listed below, and included a wide range of internal College staff, as well as external stakeholders. (Note: AC denotes Algonquin College staff).

The recent evolution of the strategy was managed by a working group, also noted below.

Working Group (Current Members)

- Todd Schonewille, Director, Physical Resources, AC
- Sarah Dehler, Sustainability Coordinator, AC
- Manon Levesque, Manager Facilities Operations & Maintenance Services, AC
- Phil Rouble, Associate Director, Facilities Planning & Sustainability, AC
- Steve Dulmage, Senior Consultant, Urban Equation

Working Group (Past Members)

- John Tattersall (chair), Director, Physical Resources, AC
- John Dalziel, Head of Major Construction, AC
- Udo Friesen, Manager, Facilities Operations and Maintenance Services, AC
- Paul Pilotte, Siemens

Stakeholder Engagement Participants

- Jo-Ann Aubut, Dean, AC
- Brent Brownlee, Director, Ancillary Services, AC
- John Dalziel, Head of Major Construction, AC
- Dave Donaldson, Dean, AC
- Jay Doshi, Siemens
- Jack Doyle, General Manager, Students' Association
- Steve Dulmage, Urban Equation (Facilitator)
- Sarah Dehler, Sustainability Coordinator, AC
- Udo Friesen, Energy Manager, AC
- Sophie Galvan, Manager, Student Residence, AC
- Mike Guertin, Hyrdo Ottawa
- Mark Hoddenbagh, Director, Applied Research, AC
- Rod Martin, ITS, AC
- Maria Parra, Professor, AC
- Paul Pilotte, Siemens
- Rebecca Reesor, Urban Equation
- Phillip Rouble, Associate Director, Facilities Planning & Sustainability, AC
- John Tattersall, Director, Physical Resources, AC
- Richard Thorne, Hydro Ottawa
- Rebecca Trueman, Chair, AC
- Helmut Walter, Physical Resources, AC
- Scott Howes, Siemens
- Christopher Janzen, Dean, AC
- Victoria Laaber, Councillor Chiarelli's Office
- Stephen Marchement, AC

APPENDIX G: ENERGY, EMISSIONS AND THE COLLEGE SUSTAINABILITY STRATEGY FRAMEWORK

Energy has a significant role to play in the College's Sustainability Strategy Framework. A holistic approach to energy will significantly advance the College's sustainability agenda. The following examples summarize how the Energy and Emissions Strategy relates directly to sustainability at the College.

Social

- Enhance Student Success: By developing more resilient infrastructure, we can ensure our campuses remain accessible, and operational, during power outages. Furthermore, the introduction of innovative approaches to energy management can provide experiential learning opportunities for students;
- Promote Human Development: By raising awareness, and fostering energy conservation behavior among students, staff and faculty, we can help individuals live a more sustainable lifestyle by reducing their carbon footprints; and
- Lead in Community and Corporate Social Responsibility: Working with our industry partners, we can take a leading role by piloting new technologies that can reduce campus emissions, and become leaders in energy management.

Economic:

- Institutionalize Sustainability: By taking a triple bottom line approach to energy management decisions, we can make decisions that environmental, social and economic objectives;
- Advance as an Incubator for a Green Economy: By leveraging innovative approaches to energy, and our industry contacts, Algonquin can be an incubator for a Green Economy; and
- Pursue Economic Strength: By leveraging the efficiency of cogeneration technology, the College can save significant resources to reinvest in learning.

Environmental:

- Reduce our Ecological Footprint: By increasing awareness of energy and carbon, we can influence people's behaviour both on and off campus, and reduce Scopes 1, 2 and 3 greenhouse gas emissions;
- Facilitate Debate on Environmental Issues: The installation of cogeneration offers an opportunity to facilitate a healthy debate about the dichotomy between energy and emissions, and different approaches to meeting medium and long-term objectives; and
- Restore and Regenerate our Environments: By continuing to innovate, the College has an opportunity to pursue net-zero carbon through fuel switching opportunities, and significantly reduce campus emissions.

The definition that inspires us
"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Brundtland Commission, 1987

The S-E-E Model of Sustainability reflects the notion that the world is an interconnected system of social, economic and environmental needs that must succeed over time and that Algonquin College will weigh in all its decisions.

APPENDIX H: POTENTIAL PATHWAYS TO NET-ZERO

Algonquin's energy and emissions profile is complicated.

In the short term, College emissions will increase until cogeneration is fully operational in 2018. New buildings, such as the Student Associations' Athletic and Recreational Centre, as well as a potential new building for the Healthy Living Education initiative, will potentially increase emissions further as these buildings leverage additional capacity within the cogeneration plant.

While energy audits have identified strategies for all three campuses, they are not sufficient to counter the increased emissions from cogeneration, and meet the College's 2030 target.

The following charts explore the ways in which the College can begin to resolve its dichotomy. They explore the relative impact that each lever of change would have on emissions, while identifying two possible decarbonization scenarios that would have the type of impact needed to address medium and long-term emission reduction targets. These scenarios are indicative, and would require more detailed analysis to determine their true impacts, both in terms of emissions reduction and costs. In addition, in the years to come other emerging technologies and innovative solutions will become available.

Arrival of the Energy Innovation Centre's co-generation engine.

Business As Usual

Business as usual outlines future potential emissions based on cogeneration becoming fully operational in 2018, the DARE district coming on online in 2018, adding 2 new buildings in the short term, and assuming energy consumption increases by 1% per annum to accommodate student growth, mobile devices on campus, etc. Figure 20 demonstrates emissions under a 'Business as Usual' scenario, whereby no action is taken to manage emissions on campus, other than typical maintenance.

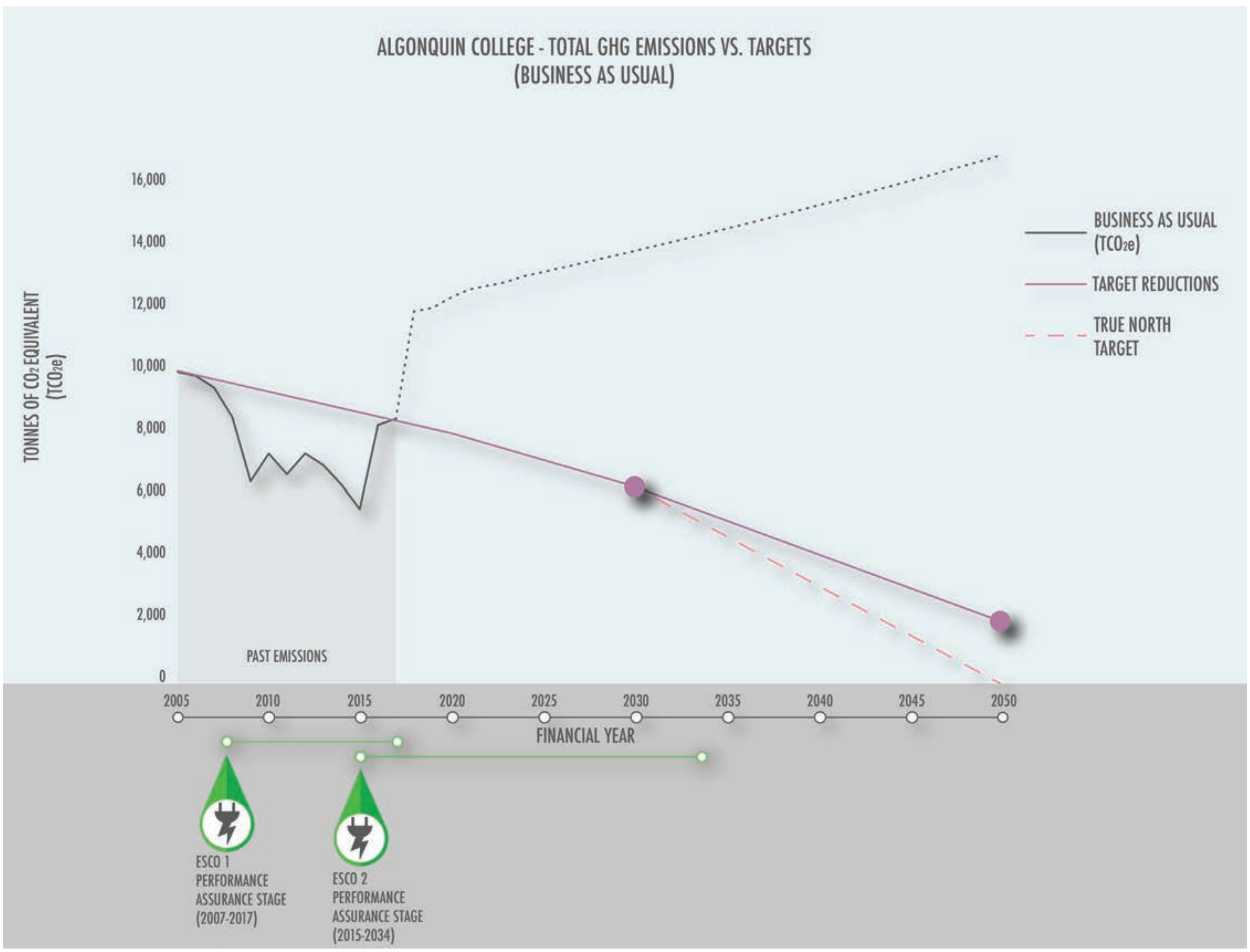


Figure 21. Business as Usual Emissions.

Optimization Strategies

Optimization strategies demonstrate the impact of strategies intended to achieve more with less energy. In this instance, the goal would be to hold energy and emissions steady from the year 2022. These strategies include approaches to space management, the Lean AC Way, minimizing new construction, behaviour change, implementing a 'year round College', and more.

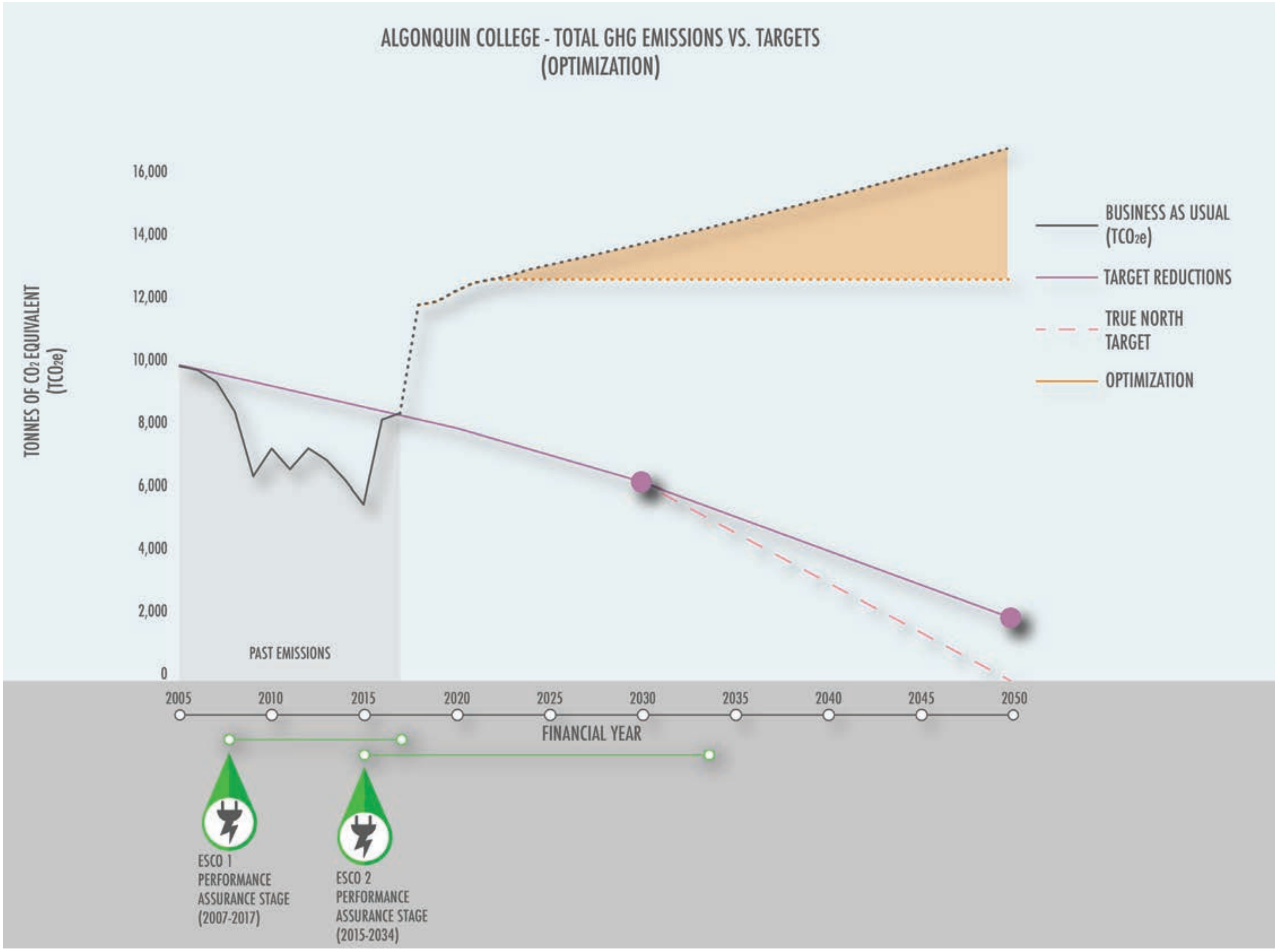


Figure 22. Potential impact of optimization strategies.

Innovation Strategies

Innovation strategies demonstrate the potential impact that solar, battery storage and the electric conversion of an air handling unit and one boiler would have on emissions. This project is currently confirmed, within funding received through MAESD, and the Cap and Trade Program. The second wedge (innovation – other) reflects the potential impact of transitioning another boiler from natural gas to electricity; another strategy identified, but not currently funded.

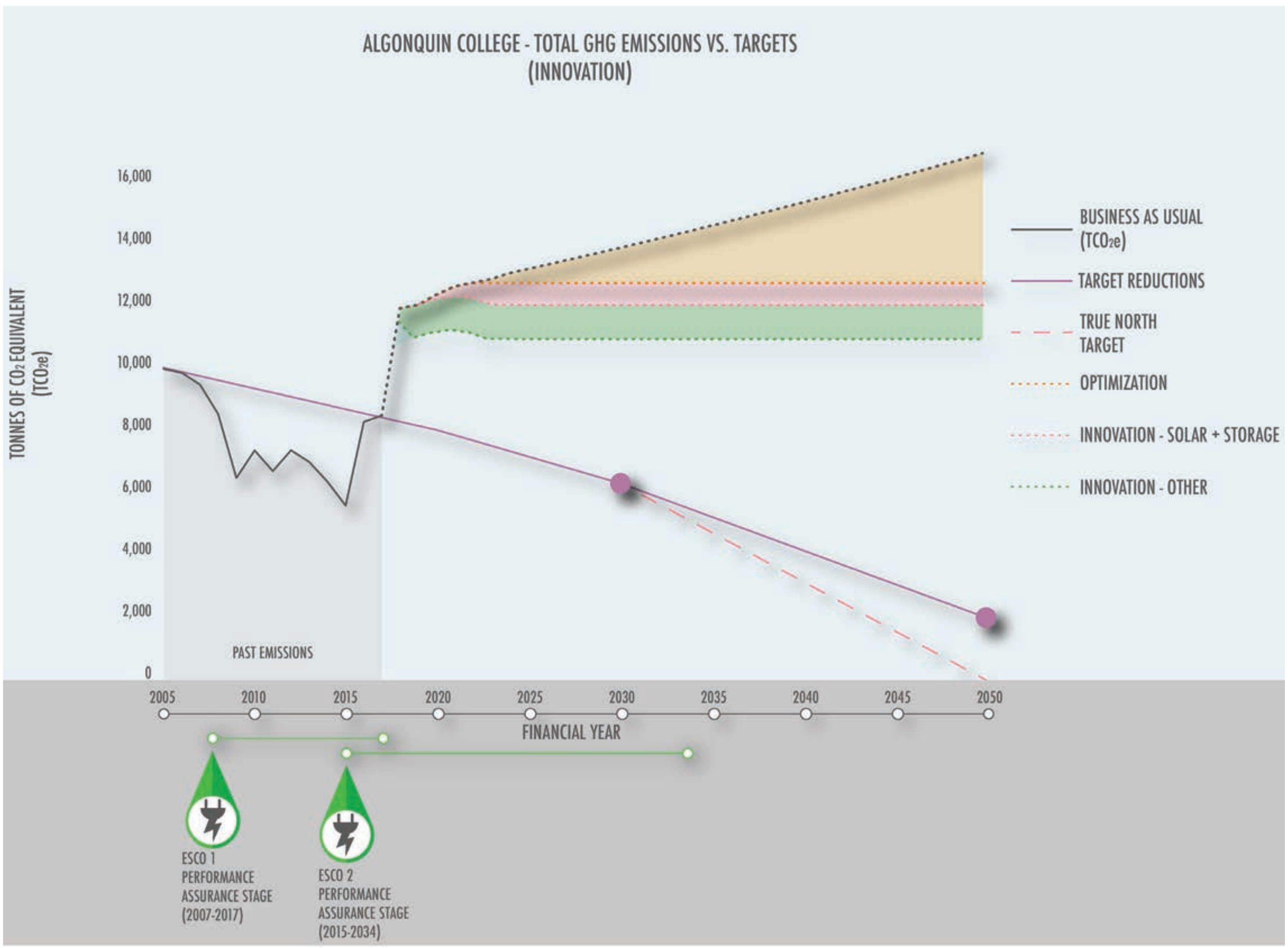


Figure 23. Potential impact of innovation strategies.

Modernization Strategies

Modernization strategies shows the impact that currently identified modernization strategies would have on emissions. These include lighting retrofits, removable insulation covers, load shifting, free cooling and pressurization controls, data centre cooling optimization, etc. Some of these initiatives are confirmed, while others were identified in various audits completed at all three campuses.

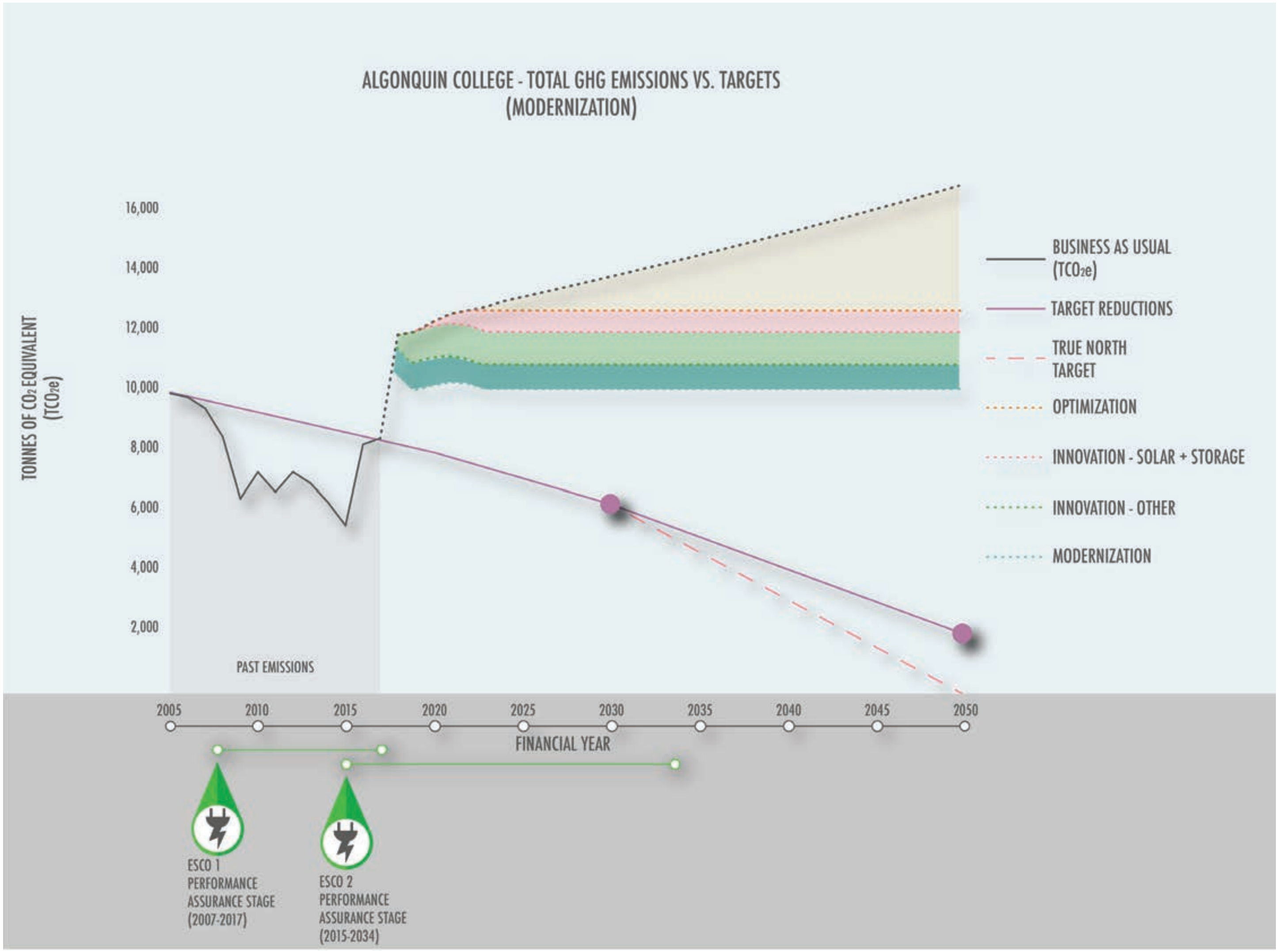


Figure 24. Potential impact of modernization strategies.

Decarbonization Strategies

When assessing the collective impact of these levers on overall GHG emissions, it's clear that deeper cuts are required to meet medium and long-term targets; decarbonizing the primary source of energy will be essential for Algonquin to meet its medium and long-term targets.

Figures 25 and 26 (seen on the following two pages) highlight two approaches to decarbonization that demonstrate the overall impact of strategies that target the College's primary fuel source, on emissions. Although indicative, the scenarios lay bare the need to reduce natural gas to meet medium and long-term targets, and the need for the College to carefully consider the approach it will pursue to meet these targets.

Decarbonization: Scenario A

Scenario A (Figure 25) demonstrates the impact a biogas would have. The biogas, possibly generated on campus, could offset up to 20% of the Ottawa campuses' natural gas it purchases. In this scenario it is assumed that the pilot technology would be implemented in 2024, and again in 2030. The remaining emissions would be addressed through transference, which would involve buying offsets to meet targets.

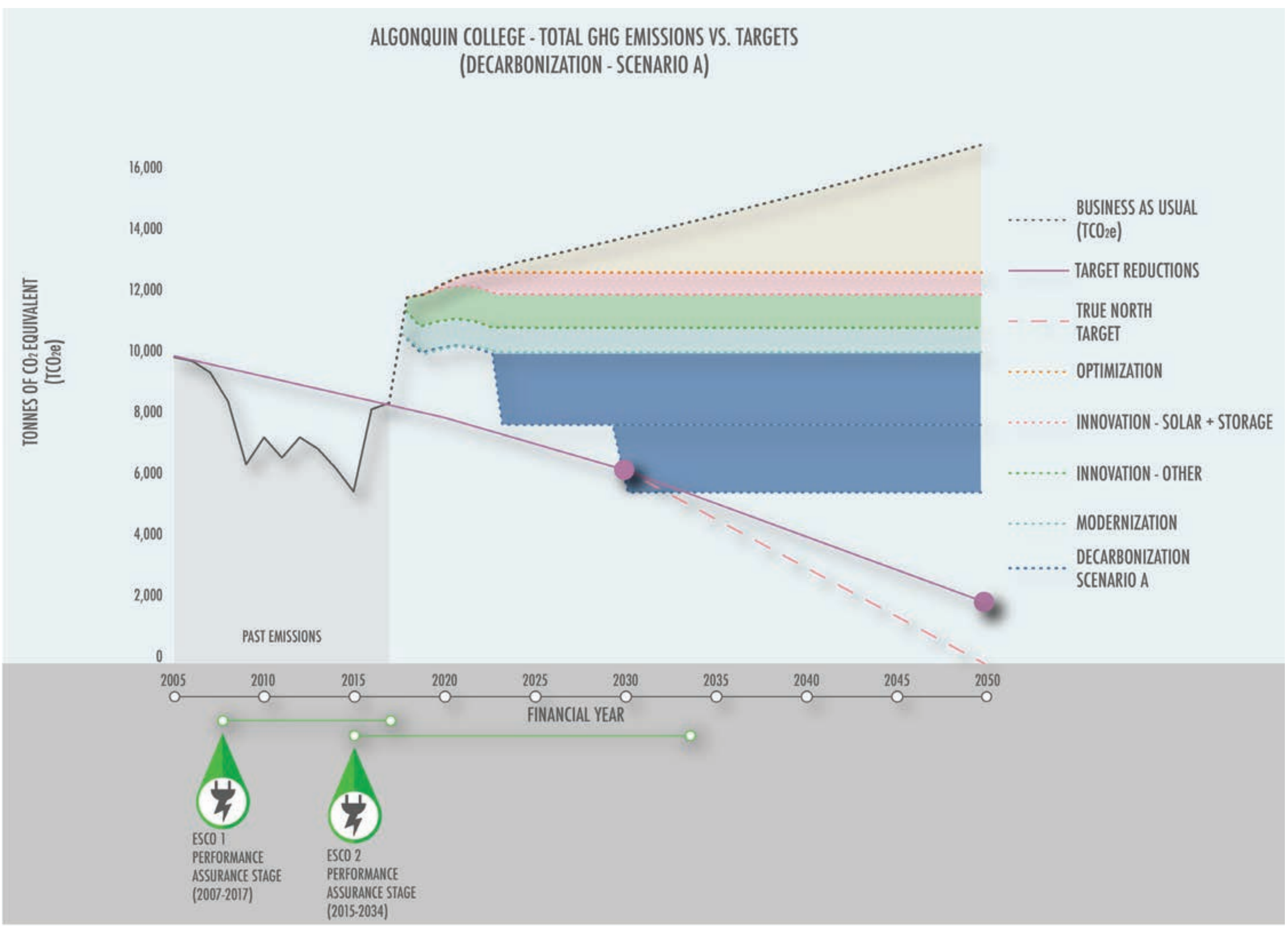


Figure 25. Potential impact of decarbonization strategies (biogas).

Decarbonization: Scenario B

Figure 26 demonstrates a shift from cogeneration back to the provincial grid in 2034, when contractual obligations around ESCO expire. The savings seen here represent backing out the increased emissions between 2015 and 2018 and assumes provincial emission factors remain the same. Additional decreases, seen in 2040, represent 'electrification' of the College, whereby much of the remaining natural gas consumption would be phased out at the Ottawa campus. Offsets, in this scenario, could be required between 2030 and 2034, as seen in Figure 27 (seen on the following page).

It's important to stress that these concepts represent just two ideas to reduce emissions, neither which of them have been costed out, nor considered within the context of future utility pricing, emission factors or emerging technology. They are intended to inform discussion only.

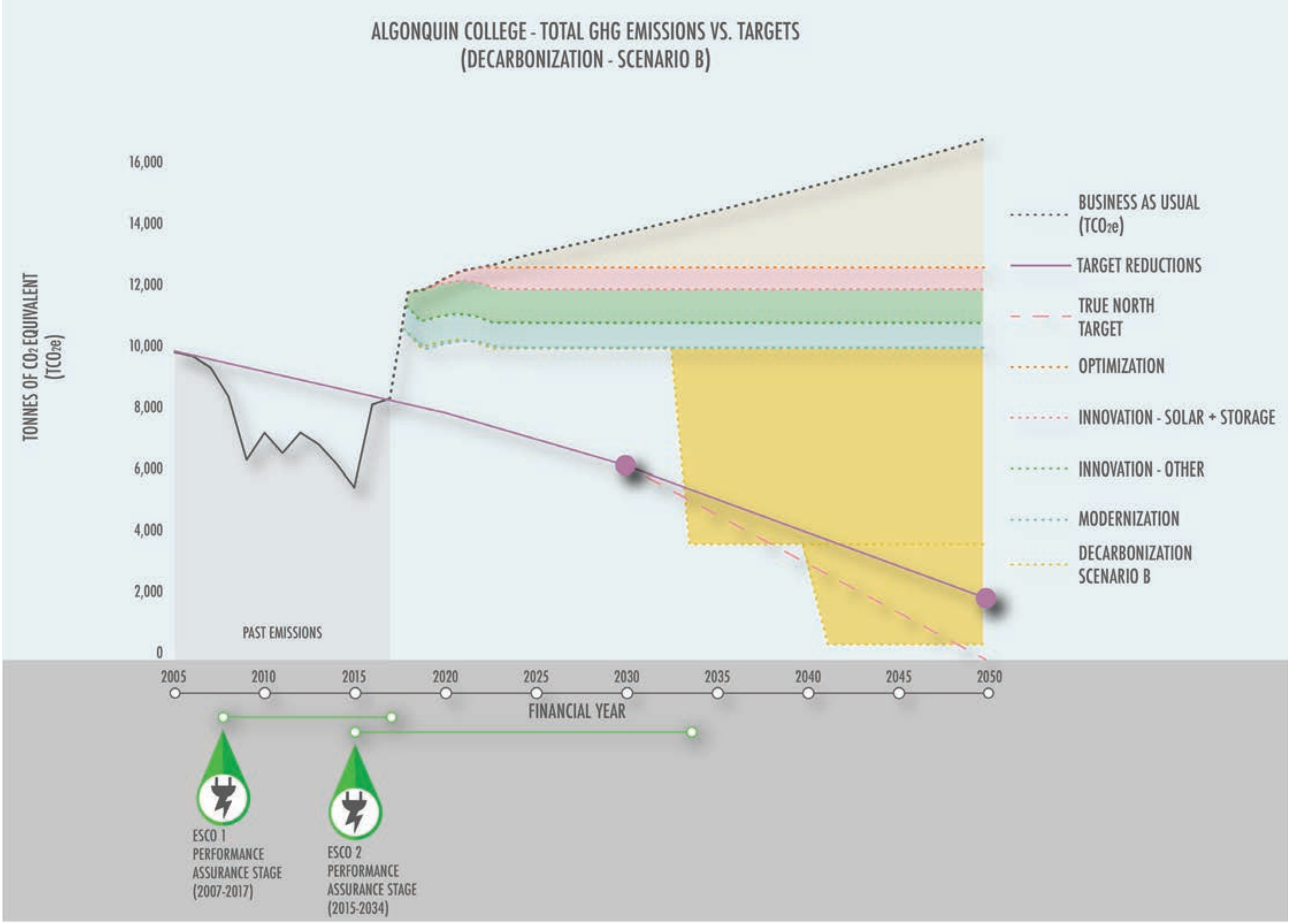


Figure 26. Potential impact of decarbonization strategies (conversion to grid).

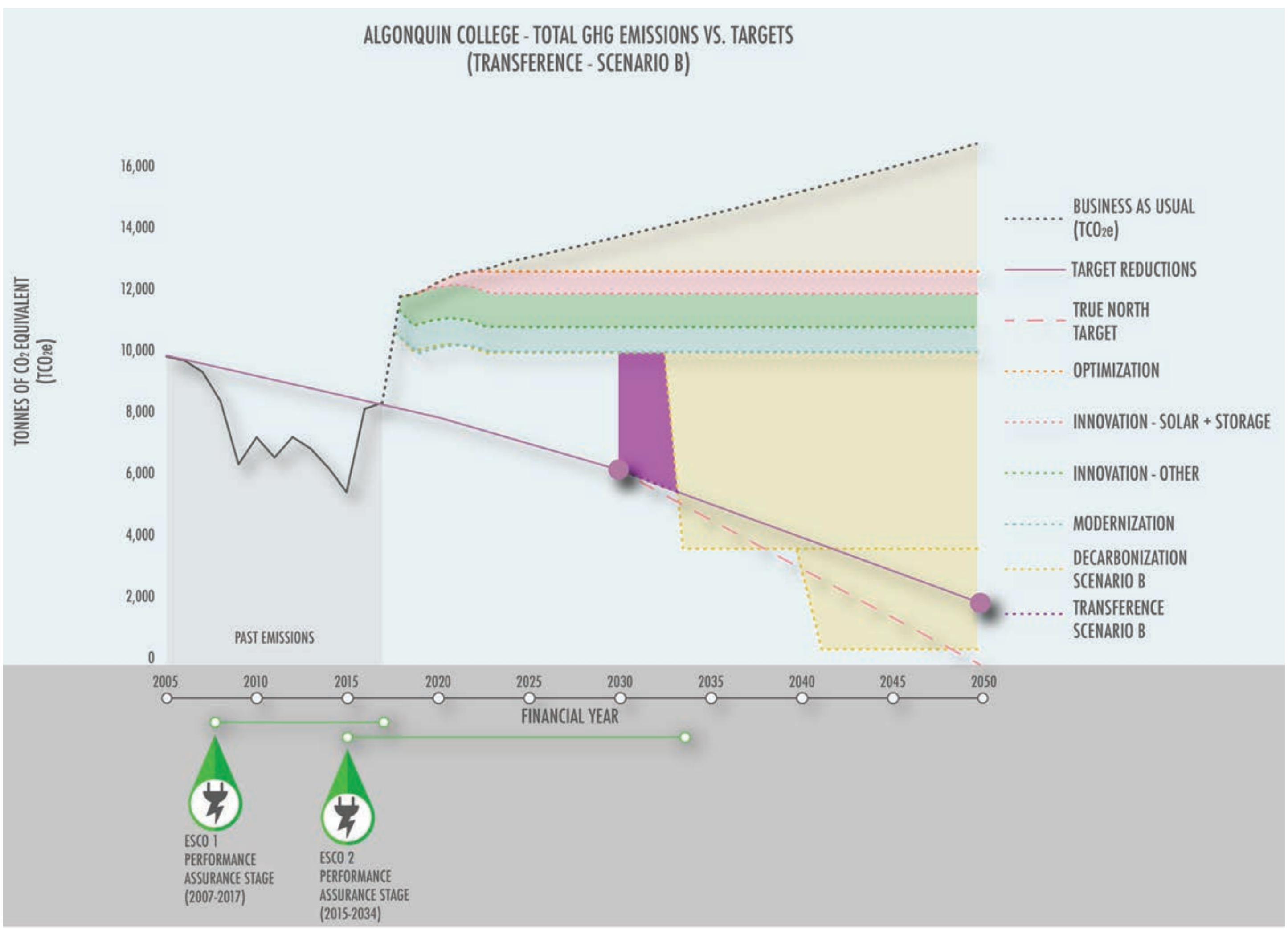


Figure 27. Potential impact of conversion to grid and transference (Scenario B).