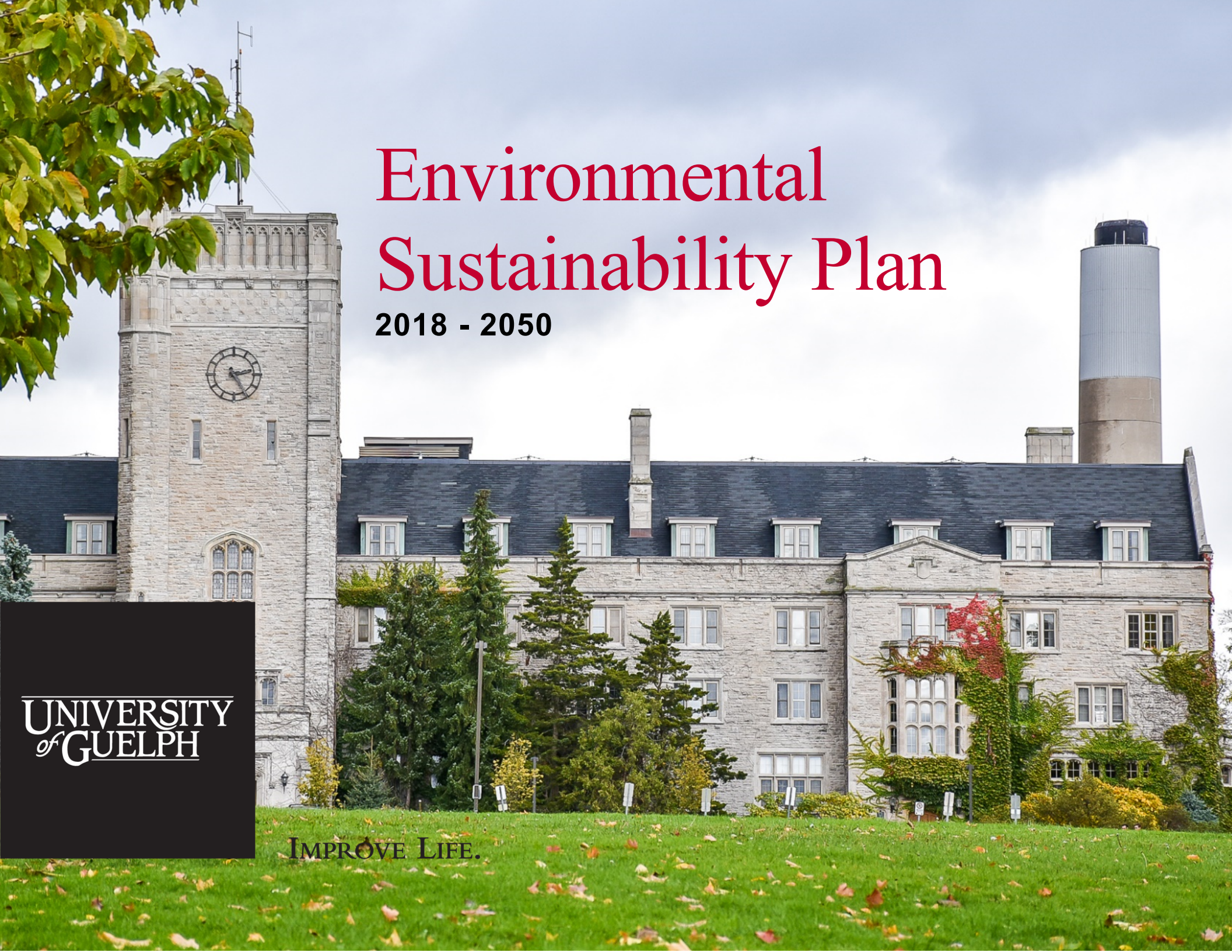

Environmental Sustainability Plan

2018 - 2050

UNIVERSITY of GUELPH

IMPROVE LIFE.

A History of Resource Conservation

The University of Guelph is proud of its history of building, maintaining and operating the best possible campus for our community to live, learn and grow. This includes a focus on resource use in an effort to reduce expenditures, carbon emissions and water usage.

Conservation Initiatives

In the early days of campus formation, planners had the good foresight to establish a central utility and district energy system that set the foundation for energy management campus wide. Through the energy crisis of the 70's and the decades that followed, the Physical Resources group responsibly managed energy resources.

In 2004 the student population became interested in global sustainability and wanted to take effective action on their campus. Encouraged by their positive working relationships with Physical Resource personnel and administration, the students made the unprecedented decision to each make a $20 yearly contribution to be used for energy conservation retrofit projects. Supporting this, the University committed to matching the student contributions. This new funding mechanism was called the Student Energy Retrofit Fund (SERF). The agreement between the students and the University called for the creation of the Energy Conservation Working Group – a team of goal-orientated student stakeholders and key University decision makers whose mandate was to collaborate and determine which sustainability and campus energy improvement projects would be allocated SERF funding.

This student led incentive opened up the campus sustainability dialog and resulted in our successful Community Energy Plans (CEP), which have been in place since 2004. The CEP was a comprehensive energy and water conservation program achieved through on-going deep retrofit projects and capital renewal projects with large energy components. Over a 10-year period, from 2004/05 to 2014/15, these projects have resulted in the reduction of over 50,000 tonnes of eCO2.

The Green Gryphon Initiative

THE GREEN GRYPHON INITIATIVE

Building on the success of these programs, and the continued engagement of the students and administration personnel, the University set increasingly ambitious goals to improve our Sustainability Plan and in 2015 launched the Green Gryphon Initiative – a $26.2 million investment in sustainability and energy improvements. The project includes many innovative and challenging measures – including a chilled water Thermal Energy Storage system - one of the largest utilities projects ever undertaken at the University.

Alignment with the Climate Change Action Plan

In June 2016 the Ontario Government announced the Climate Change Action Plan (CCAP) to reduce GHG emissions and help move the province towards a prosperous low-carbon economy. In support of the CCAP, The Ministry of Advanced Education and Skills Development (MAESD) announced the new Post-Secondary Greenhouse Gas Campus Retrofits Program (GGRP) to provide the university sector access to funding to reduce their GHG emissions and improve energy efficiency through the use of Cap and Trade auction proceeds.

Aligned with the CCAP and MAESD commitments, the University of Guelph will continue to move forward with energy initiatives that focus on Scope 1 and Scope 2 GHG reductions and support the provincial CCAP GHG emissions reduction targets of 37% by 2030, and 80% by 2050.

Cornerstone Initiatives

The cornerstone initiatives of the University's Environmental Sustainability Plan to meet the GHG reduction targets include:

- **Buildings -** improving energy efficiency of campus buildings, through campus wide energy efficiency upgrades, deep energy retrofits and new construction building performance standards.
- **Central Plant Services -** improving the efficiency of the Central Heating and Cooling Plant, including adding capacity from heat recovery and low carbon electric heating sources.
- **Renewable Energy Supply -** increasing reliance on renewable energy systems, including 'getting to Net Zero' buildings initiatives.

While not targeted in this report, the University recognizes the importance of Scope 3 emissions. Transportation and Carbon inventory management will play a role in meeting the 2050 target. (These initiatives and others as new GHG reductions technologies are developed will be considered in future action plans.)

Scope 1 Emissions – direct emissions from controlled sources of reporting company

Scope 2 Emissions – indirect emissions from purchased energy

Scope 3 Emissions – indirect emissions (included in Scope 2) that occur in the value chain of reporting

Planned Progress

The graph below illustrates the planned progress of the University's Environmental Sustainability Plan to support the CCAP targets.

Conservation measures started in the early 2000s initiated the University's GHG emissions reduction progress and paved the way for the more ambitious Green Gryphon Initiative. GGRP-funded initiatives under the CCAP in 2017-2018 established the Cornerstone Initiatives that will carry the University into the 2018-2030 and 2030-2050 Action Plans.

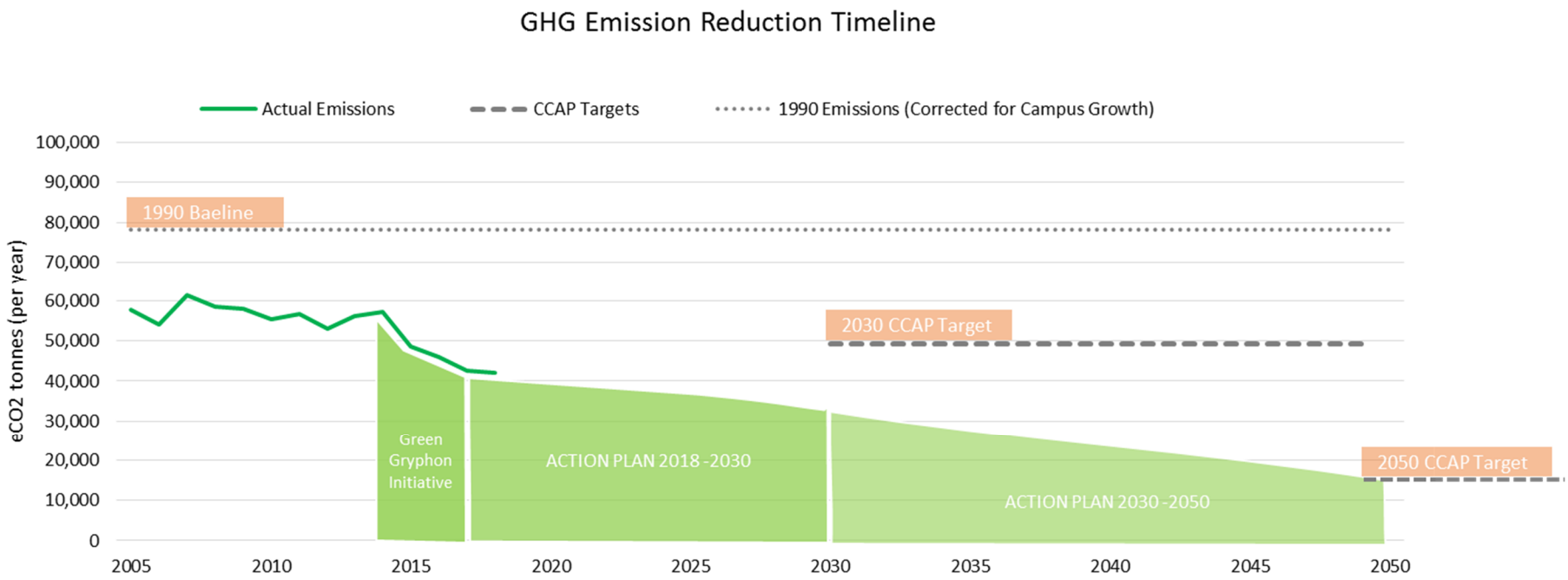

Figure 1 – GHG Emission Reduction Timeline

Baseline Year Identification

The University's Baseline GHG emissions for Scope 1 and Scope 2 emissions are shown in the Table 1.

The Baseline is calculated from the campus' 1990 resource consumption data records (electricity, natural gas, fuel) with standard emission factors applied. The baseline emissions are calculated to current (2018) building area.

The University's current GHG Emissions represent a 45% reduction from Baseline, to 55% of Baseline levels. The current 2018 emissions surpass the CCAP Target Emission Reductions Targets for year 2030.

Table 1 - GHG Emissions

Emission Type	Annual GHG Emissions [Tonnes eCO_2]	Percentage (by Scope)
Base Year GHG Emissions		
Scope 1	49,887	64%
Scope 2	28,264	36%
Total Emissions	**78,151**	**100%**

Emission Type	Annual GHG Emissions [Tonnes eCO_2]	Percentage (of 1990 Baseline)
CCAP Target Emissions		
Year 2030 (37% Reduction)	49,235	63%
Year 2050 (80% Reduction)	15,630	20%
Current GHG Emissions		
2018 (45% Reduction)	42,588	55%

Action Plan 2018 – 2050

The Action Plan for 2018-2050 recognizes the achievement the University has made in reducing emissions to 55% of Baseline levels. The current 2018 emissions surpass the CCAP Target Emission Reductions Targets for year 2030. To continue this trajectory and ready for success to meet the 2050 target of 80%, the University has set the goal is to reduce annual Scope 1 & 2 emissions by 10,000 by year 2030 and a further 15,000 by year 2050 [Tonnes eCO2 per year].

Action Plan Items

(1) **Deep Energy Building HVAC VAV retrofits – Reducing GHG Emissions while improving Buildings Conditions**
The efficiency of many of the University's 1960's and 1970's buildings is burdened from inefficiencies associated with the HVAC systems or re-purposed spaces. The project will improve the energy efficiency of campus buildings with upgrades to HVAC variable air volume (VAV) systems, Buildings targeted include the University Centre, Animal Nutrition and Plant Agriculture. Locations within the identified buildings have been re-purposed from lab and hospitality spaces to student and academic spaces without altering the HVAC systems to reflect these changes. For many years, these spaces have been fully exhausted using 100% fresh air, completely unnecessary and extraordinarily wasteful of energy. They will be upgraded to use heat recovery and recirculated air flows.

(2) **Improving Heating Systems Efficiency – Central Heating Plant – Pilot for Long-term Strategy**
The University Centre, Plant Agriculture, Engineering and South Residence are currently serviced with steam heating from the Central Heating Plant. This project will add capacity to the existing boiler heat recovery system for eventual distribution of hot water (HW) heating to these buildings and displace GHG intensive steam generated heating. To further reduce fossil-fuel heating intensity – the project will include installation of additional electric (near zero GHG) HW heating, both at the building level and within the CUP. Increased reliance on electric boilers in the Central Utility Plant is a long-term strategy to achieve 2050 targets through reduction of Scope 1 emissions, and provides an excellent opportunity for experiential learning related to non-traditional thinking about energy and GHG emissions. Until extremely recently, electrification of heating was largely unheard of.

(3) **Getting to Net Zero Building Operation - Arboretum Centre – Pilot for Experiential Learning**
The Arboretum Centre is a 9,651 SF building located within the 400 acre Arboretum adjacent to the main Guelph campus. The building is a prime candidate for a getting to net-zero initiative: (1) the smaller building size and newer (1973) construction lends itself to a project scale that is not overly ambitious, (2) the availability of interior and exterior space to accommodate the project, (3) its current use for events, and tours allows for experiential learning opportunities through display of technologies and performance (dashboards, information displays). The Arboretum Zero project aims to demonstrate the adoption of current and emerging technologies, toward an awareness and understanding of the potential for retrofits to our existing institutional building stock. While the Arboretum is not a large emitter of GHG gases, the process of improving the energy systems currently in place, vastly renewing the building envelope and doing comparative analysis of the current

and future energy consumptions, makes it an intriguing real life case study for student experiential learning. The process of achieving net zero would be similar regardless of existing energy use. As a free standing self- contained building, it presents an opportunity for experimentation for many educational disciplines. Engineering, Landscape Architecture, Environmental Sciences, Business and Plant Agriculture all have experiential learning opportunities related to this net-zero initiative. The measures will include use of geothermal heating and cooling, native species plantings to protect the building site, solar photovoltaic electrical production, renewed high efficiency windows and roofing materials, active energy conservation window treatments and sophisticated control systems.

(4) **Renewable Energy Supply – Powering Building and Offsetting Emissions**
The University's Action Plan is built on Conversation and Efficiency, including Deep Energy Retrofits, Improved Heating System Efficiency and Low Carbon Building Initiatives. In order to continue the approach on the the goals set for 2050, the University will need to develop new renewable energy sources to power buildings and offset remaining emissions.

(5) **Future Technologies**
The University recognizes that future and emerging technologies are needed to achieve the goals set for 2050.

Action Plan – Key Performance Metrics

The University has set the goal is to reduce annual Scope 1 & 2 emissions by 10,000 by year 2030 and a further 15,000 by year 2050 [Tonnes eCO2 per year].

The cumulative reduction in Scope 1 & 2 emissions is forecasted to be 82,000 tonnes eCO2 by 2050.

Further Key Performance Metrics for the proposed Action Items is presented on Page 13.

Managed Risks:

The University will leverage the Engineering firm engaged for the current Energy Project nearing completion to deliver the work of this application. The assignment of the existing Energy Services Agreement transfers the engineering risk to the firm. As such, the University is able to manage the risk and focus on strategic alignment opportunities, such as curriculum delivery, and student experience. The involvement of the Engineering firm currently engaged is to an extent sufficient to make the project low risk.

(1) VAV retrofits are considered very low risk. They were proven during the implementation of the first phase of the Green Gryphon Initiative. Consideration for ACM and designated substances, impacts on service and scheduling were reviewed during ECM development.

(2) Heating System Efficiency projects are low risk. The university has efficiently operated the existing heat recovery system – this project is an enhancement of that system. Electrification of boiler heating is inherently susceptible to spot market pricing and demand peaks (under the University's Class A rate structure). Controls and prediction services will allow for seamless fuel-switching.

(3) The Arboretum Net Zero retrofit is a medium risk project. Achieving a net zero operation requires a challenging ECM, new technologies, and disciplined operation. Risks will be mitigated though use of industry sponsors for product and in-kind services, extensive use of metering and monitoring, and engagement with our Academic Departments.

Co-Benefits:

(1) **Cost savings.** Carbon reduction initiatives go hand-in-hand with energy efficiency and reduced utility costs. The Action Plan will result in reduced utility spend and de-risk rising energy prices and expected cost of Carbon.

(2) **Automated monitoring and control systems.** Investments in the monitoring and control capability of the systems will result in higher return on system efficiency. Utilizing a greater level of heat recovery, with a higher level of control and monitoring of systems savings will lead to a far greater awareness of energy consumption and savings, than the current model of more gas/more steam. Quantification and re-use of "waste" is often the catalyst of conservation through awareness. Displays via dashboards of the energy consumption and stack heat recovery as a function of weather conditions in very public locations (University Centre, Engineering, Class room complexes) will lead to a greater student and staff understanding of energy use, and quantifying the use will lead to conservation.

(3) **Improved Indoor Air-quality.** Conversion of HVAC systems to suit re-purposed spaces will improve temperature and space conditions.

(4) **Heating redundancy.** Two fold redundancy - 1) In the event the steam distribution lines need to shut-down for service, or emergency repairs, the HHW lines can provide heat to the buildings, 2) in the event the natural gas supply is interrupted, the electric boilers can provide steam heating.

Experiential Learning:

The University of Guelph has a long-standing commitment to teaching and learning, by educating the whole student through meaningful and hands on learning experiences.

Our central campus in Guelph offers our students many opportunities for experiential learning and the implementation of a heat recovery system will allow us to further expand these types of opportunities. Specifically, on our main campus the U of G currently operates three buildings which utilize waste stack heat. The addition of 10 buildings will be used to demonstrate both the scalability of the system, and provide learning opportunities related to low and high-grade heat sources, stretching the limits of both.

In addition, upon completion, we will display interactive and public dashboards in student spaces across our campus. The dashboard systems provide historical data, real time trends and usages and will allow students to use the heat recovery system as a living lab demonstrating the relationships between fuel type usage, efficiencies and greenhouse gas production.

Working with faculty, the Physical Resources department will support the integration of the living lab into classroom based learning by facilitating tour opportunities where students can connect systems with data analysis. Additionally, senior design students will have the opportunity to work on heat recovery based projects as their final design and capstone projects. Using the heat recovery system, students will focus on a component of the system and provide a study, design and final report.

The Arboretum net-zero project provides an excellent case study with before and after data analysis, and evaluation of each improvement done in isolation through modelling and construction stage based data. Understanding the impacts of extreme conditions related to our changing climate, energy use related to extreme temperatures and how these factors alter energy efficiency, supply mixes (i.e. electrical/fossil) and market pricing will provide students with an understanding of how energy is used.

Curriculum Delivery:

The University of Guelph is a leader in curriculum development and the advancement of post-secondary teaching practices. Underpinning our reputation is the intersection of research and teaching; the intentional use of learner-centred technology; and the delivery of varied, flexible and empirically based teaching methods. We were the first Ontario University to develop university-wide learning outcomes and we continue to innovate in tracking and assessing those outcomes as part of a cycle of continuous improvement.

The implementation of this project will have direct benefits to course based and hands on learning for students in U of G's Environmental Sciences, Engineering, Business, Landscape Architecture, Plant Agriculture, and Environmental Governance programs.

Upon project completion, energy usage dashboards will be displayed in various locations on campus, allowing students to gain greater awareness of U of G's energy consumption, implications on sustainability measures and apply course based learning in tangible way. The U of G's physical resources department, has a history of working with academia to implement campus based systems into teaching and will actively partner to offer students a greater understanding of applied concepts.

Finally, our physical resources department regularly employs approximately 10 cooperative education students each term. These co-op students have the opportunity for a number of hands on learning experience which will include the opportunity to work with the proposed heat recovery system.

Alignment with Strategic Mandate Agreement

The University of Guelph understands the delicate balance between the needs of a growing global population and our responsibility to minimize environmental impacts. As outlined in our second Strategic Mandate Agreement and the university's strategic plan, we have an unwavering commitment to environmental stewardship and safeguarding our valued resources.

This is reflected through our academic programs and research expertise in environmental sciences and sustainability, biology and biodiversity, nutrition and health, agriculture and food production, processing and packaging, and food security, management and global policy.

Further supporting these commitments is the ongoing efforts of our central facilities operations. Through the Community Energy Plans (CEP), retrofits and projects have resulted in the reduction of over 50,000 tonnes of eCO2 from 2004/05 to 2014/15. Additionally, our Green Gryphon Initiative (GGI), a $26M campus-wide energy retrofit completed in 2015/16 features a Thermal Energy Storage System (TES), has reduced the university's peak electrical use by 6 megawatts.

The expansion of the central plant heat recovery system will increase the efficiency of district heating natural gas combustion to previously unattainable levels. Further, the addition of electric boilers is the first step towards our long-term strategy to eliminate carbon based heating. The extreme level of efficiency resulting from this project, when combined with other zero carbon measures such as the next step energy storage solutions, will help us reach our 2030 and 2050 targets.

Action Plan – Key Performance Metrics

The Action Plan for 2018-2050 intends to reduce Scope 1 & 2 emissions by 82,000 tonnes eCO2 by 2050.

Table 2 – Action Plan 2018-2050 KPM's

Proposed Strategies/Sustainability Milestone	Cumulative Total GHG Emissions Reductions	GHG Emissions Reduction Achieved by 2030	GHG Emissions Reduction Achieved 2030 - 2050	Total Strategy Cost
	(Tonnes eCO2)	(Tonnes eCO2)	(Tonnes eCO2)	($)
(1) Deep Energy Building HVAC VAV retrofits	12,000	6,000	6,000	15,000,000
(2) Improving Heating Systems Efficiency – Central Heating Plant	28,000	14,000	14,000	15,000,000
(3) Getting to Net Zero Building Operation	2,000	500	1,500	20,000,000
(4) Renewable Energy Supply	20,000	10,000	10,000	10,000,000
(5) Future Technologies	20,000	-	20,000	20,000,000
Total	**82,000**	**30,500**	**51,500**	**90,000,000**

Note: Scope 3 Emissions not included.