TRENT UNIVERSITY ENERGY CONSERVATION AND DEMAND MANAGEMENT 2019-2024

Prepared by:
Shelley Strain, CEM, CMVP
sustainability coordinator

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List of Appendicies

As required by O.Reg. 507/18, a printed copy of this plan is available at the Sustainability Office, located at:
Trent University, Blackburn Hall Suite 122.2,
1600 West Bank Drive, Peterborough.

BACKGROUND

In July of 2014, the Sustainability Office (SO) published Trent’s first Energy Conservation and Demand Management Plan (ECDMP) under the former Green Energy Act O.Reg. 397/11. In that plan it was noted that ideas for reducing Trent's energy use were advancing; but were in flux making it a challenging time for planning. Similarly, this 2019 update under new O.Reg 507/18, comes at a time when regulations are changing, programs and incentives are being cut and energy costs are rising.

Part of Trent University's mission, as outlined in the Strategic Mandate Agreement (SMA) with the province (2017-20) is to "foster sustainability, in it's environmental, social and economic dimensions, on our campuses and in all aspects of our work." Ensuring responsible use of energy - both consumption and demand is a key element for Trent to fulfill this commitment.

Advancing our understanding, planning and management of energy at Trent will reduce emissions, protect against rising costs, and provide a buffer to increasing uncertainty in the energy sector. We strive to be flexible and ready to adapt in an informed and methodical manner.

RESULTS

Trent has had a busy five years working toward improved energy efficiency on campus since publishing the 2014 ECDMP. As we look forward to even greater efficiency and improved methods of demand management, we should pause to celebrate our successes.

Energy Conservation

Near the end of 2015, Trent entered into an energy performance contract (EPC) worth $15.5M. This strategically created an opportunity for great conservation results in a short period of time.

Through the EPC Trent is now an all LED campus (with 3 specialty lighting exceptions). We have installed more than 20 high efficiency boilers, improved sub-metering on campus and improved control of Heating Ventilation and Air Conditioning (HVAC). A summary of EPC projects is in Appendix A. Energy Performance Contract Projects. The final projects under this EPC will be completed by the end of 2019.

The model for an EPC is to finance the capital costs of energy efficiency projects and pay that debt with the resulting utility cost savings. Trent's EPC was designed to also offset costs of critical deferred maintenance projects that had low or no energy savings.

The SO produced a series of EPC project profiles called Sustainability in Action @Trent. Look for these on the Trent SO website.

Between 2014-2017 Trent has achieved an overall energy reduction of 8%!

ELECTRICITY

15,700 GJ

8.2%

NATURAL GAS

8,800 GJ

7.4%

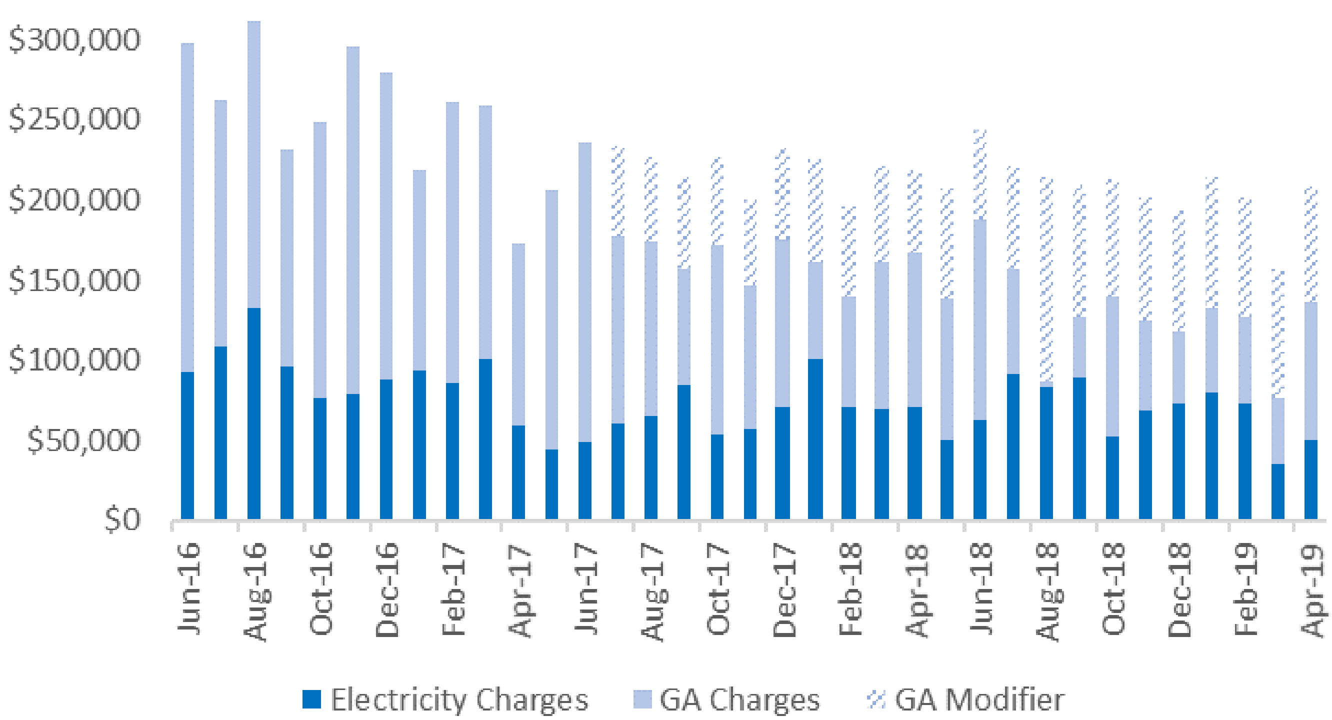
Demand Management

In the summer of 2017 Trent entered into the IESO's ICI demand response program. The IESO charges customers a Global Adjustment (GA) fee that funds the difference between their revenue and the cost of contracts for generation and distribution infrastructure. For Trent, GA is approximately 65% of our charges. The GA fee is a function of the amount electricity Trent uses when the province reaches it's highest demand. If we manage demand, we can manage GA costs.

Trent's participation in the ICI saved over $450,000 so far!

The IESO asks large customers participating in the ICI to reduce electricity use on days of high demand in the province - typically hot, summer days. Graph 1.Global Adjustment impacts on Trent electricity costs demonstrates Trent's success in the ICI. The bars are divided into three sections. The bottom section shows a savings trend related to decreased electricity consumption and the middle shows decreasing GA costs. The top, dashed section of the bar shows the impact of a separate discount called the GA Modifier. This discount has been cut and in the fall of 2019 Trent's costs will be represented by the full height of each bar.

Graph 1. Global Adjustment impacts on Trent electricity costs



INITIATIVES

Trent has reached many milestones since publishing our first ECDMP and strives to keep improving energy performance. Efforts such as sustainability planning, better tools for analysis, increasing transparency of Trent's utility and an energy dashboard providing finer detail on energy use will give staff greater insight on how to best make change while providing students with campus-as-a-lab opportunities to learn.

Utility Data Access

Since 2007 Trent's SO has supported student learning and the work of Facilities Management by tracking, analyzing and providing access to utility data. An on-going SO project is to improve campus metering as a means to provide more and better raw data and analysis to staff and students.

Through the EPC Trent now has sub-metering for electricity and natural gas on most buildings. Staff will assess what opportunities this new system may offer in terms of sharing more detailed data with the Trent community.

As required under O.Reg. 507/18 utility data for 2017 is included in Appendix B Trent University Utility Data, 2017, The SO also offers the last 10 years of utility data for electricity, natural gas, water and fuel oil on our website.

Sustainability Plan

Trent's 2018 Sustainability Plan sets a long-term goal for Trent to move to a low/no carbon campus. The basis of the plan, as it relates to energy, is to strategically work toward eventual campus electrification while balancing costs and emissions in the short term. This means more efficient, and ideally no new, use of natural gas in the short to mid term and a mindful approach that assesses the true cost of projects as Trent moves forward. Project planning will consider the environmental impacts, costs and the replacement cycle of equipment with the intent that all projects will help meet the intent of efficient, environmentally sensitive campus operations. This plan is scheduled for an update in 2019.

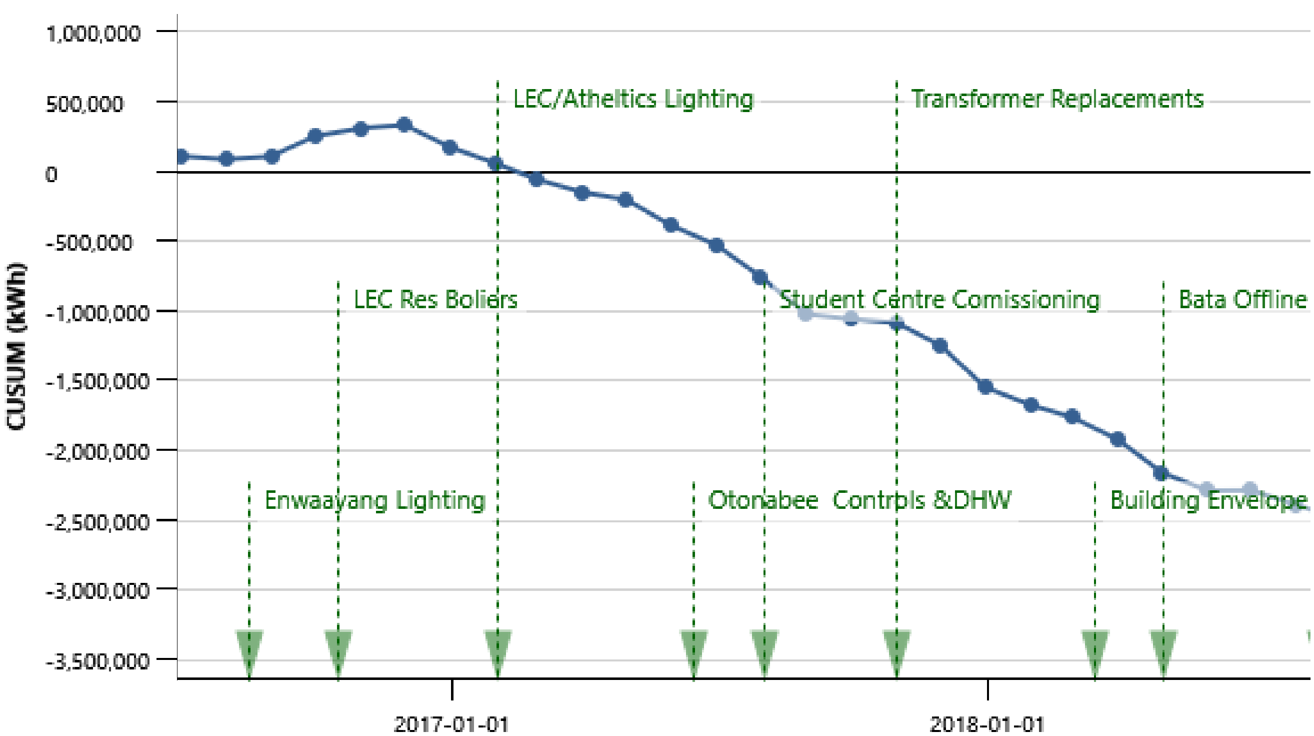
Energy Analysis Tools

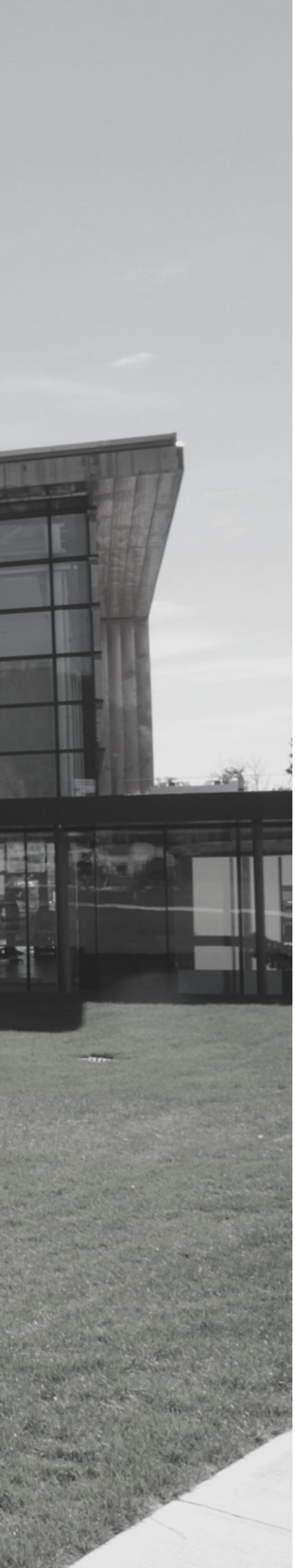
Trent now has access to Natural Resources Canada's RETScreen Expert Software. Originally developed to be a screening tool for renewable energy projects, this dynamic software now provides options for advanced energy analysis, measurement and verification (M&V) of projects, benchmarking between Ontario Universities and even basic energy modelling/forecasting.

While access to the advanced version of this tool is new to Trent staff, it is anticipated to provide ease of analysis for project feasibility and M&V going forward. In the coming months the SO will strive to design an energy monitoring program around the use of this tool.

Below is a sample graph from RETScreen showing the cumulative electricity savings of Trent's EPC (cumulative sum = CUSUM). To more clearly see the impacts of specific projects RETScreen allows us to take a baseline year before project implementation, in this case 2014, to make a model of how our campus uses electricity. That model can then be used to remove the influence of weather and predict over time how much electricity we would have expected to use without the projects. Comparing the difference between that prediction and how much electricity was actually used quantifies how much electricity the project(s) helped us avoid using - the savings!

Graph 2. Impacts of EPC projects on Trent's electricity use (CUSUM)





THE NEXT FIVE YEARS

It is difficult, while in a nationally declared climate crisis, to acknowledge having to work within limitations. Trent is making impressive headway with very limited resources. That said, for the positive impacts of any energy program to persist long-term, changes have to be both physical and cultural.

Trent is striving to be a low/no carbon campus by 2050 with anticipated operating emissions decreasing to ~3,800t by 2030. Ultimately, Trent will wean off of natural gas in a slow, thoughtful manner that will balance stressed budgets and deeply cut Trent's GHGs while strategically aligning all facilities efforts on campus to this common goal.

Goals and Objectives

Since the last ECDMP Trent reduced energy use by approximately 8%. In the next three years Trent will work toward a 10% reduction in overall energy use. This will keep us on track for our 2030 goals and give Facilities Management time to develop internal systems for a coordinated approach to energy. Specifically, areas of focus for this next term are:

- managing Trent’s Global Adjustment rate
- culture shift and training
- operations and maintenance
- continued conservation
- data analysis and management

Recognition of the urgency around climate change is becoming increasingly common and we can expect that opportunities for change, and likely an increase in regulated requirements, will come during the next five years. Facilities Management will establish an energy working group by the fall of 2019 with the intent of helping Trent become as agile as possible to respond effectively and lead in this dynamic time.

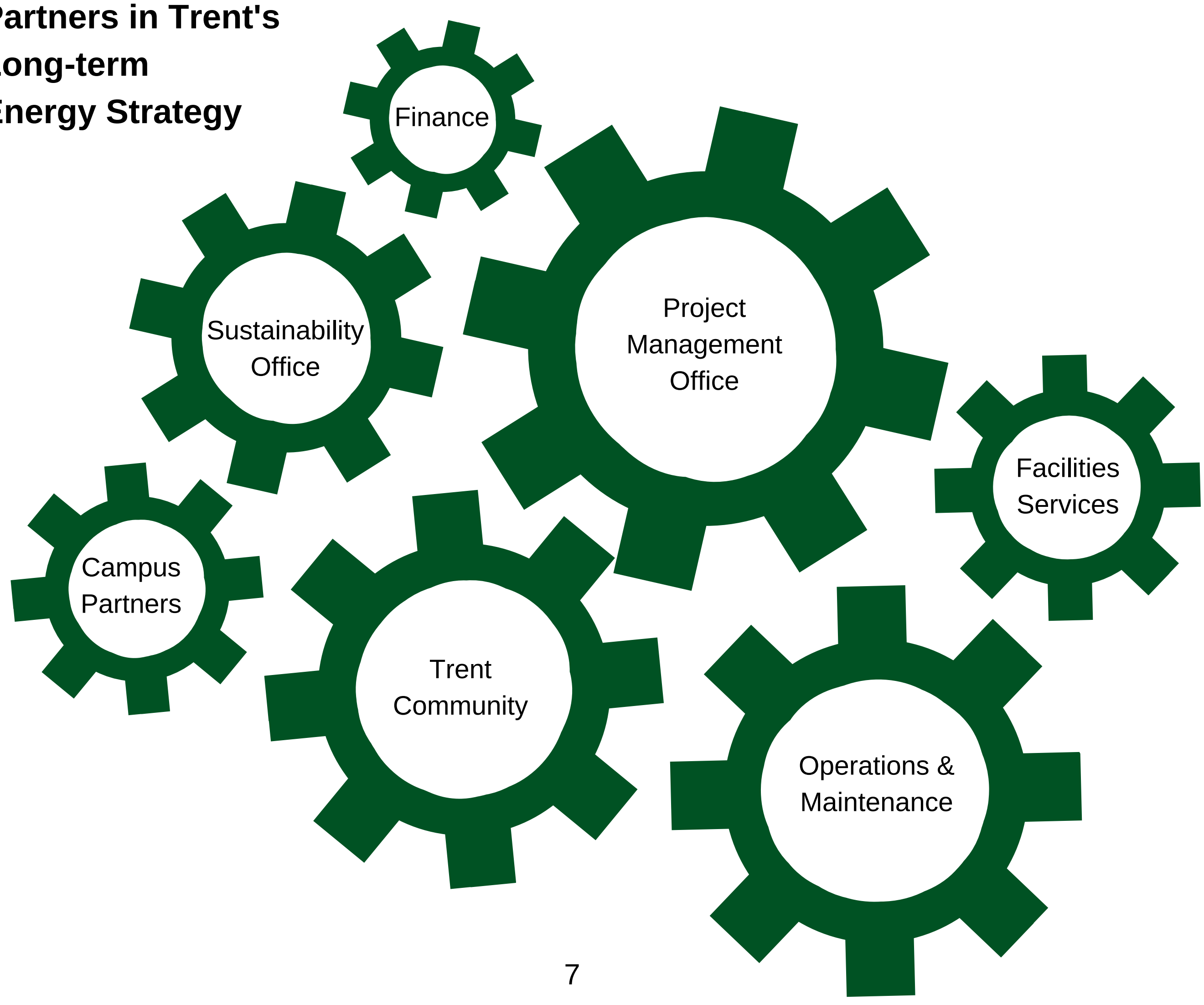
Energy Working Group

The energy working group will be the key to successful energy reduction and management in the next five years. Each of the objectives listed depends on the success of the energy working group. Formation of this group is intended to facilitate an internal culture shift to a shared view of the campus as an energy system with the goal of optimization. How can we work together to optimize the new systems in place and continue to effectively conserve energy and reduce demand?

The first phase of this group will use a facilitated planning process to establish connections and common needs of the various sections in Facilities Management as they relate to energy. It will establish the basis for a collaborative approach to energy management on campus and identify staff training needs. The next phase will identify key campus partners and ways to best engage them in campus conservation efforts.

The knowledge and expertise of this group is deep and varied but in need of a shared alignment to energy goals. Energy management is only one part equipment – there are equal parts culture and operations involved to make it a success.

Partners in Trent's Long-term Energy Strategy

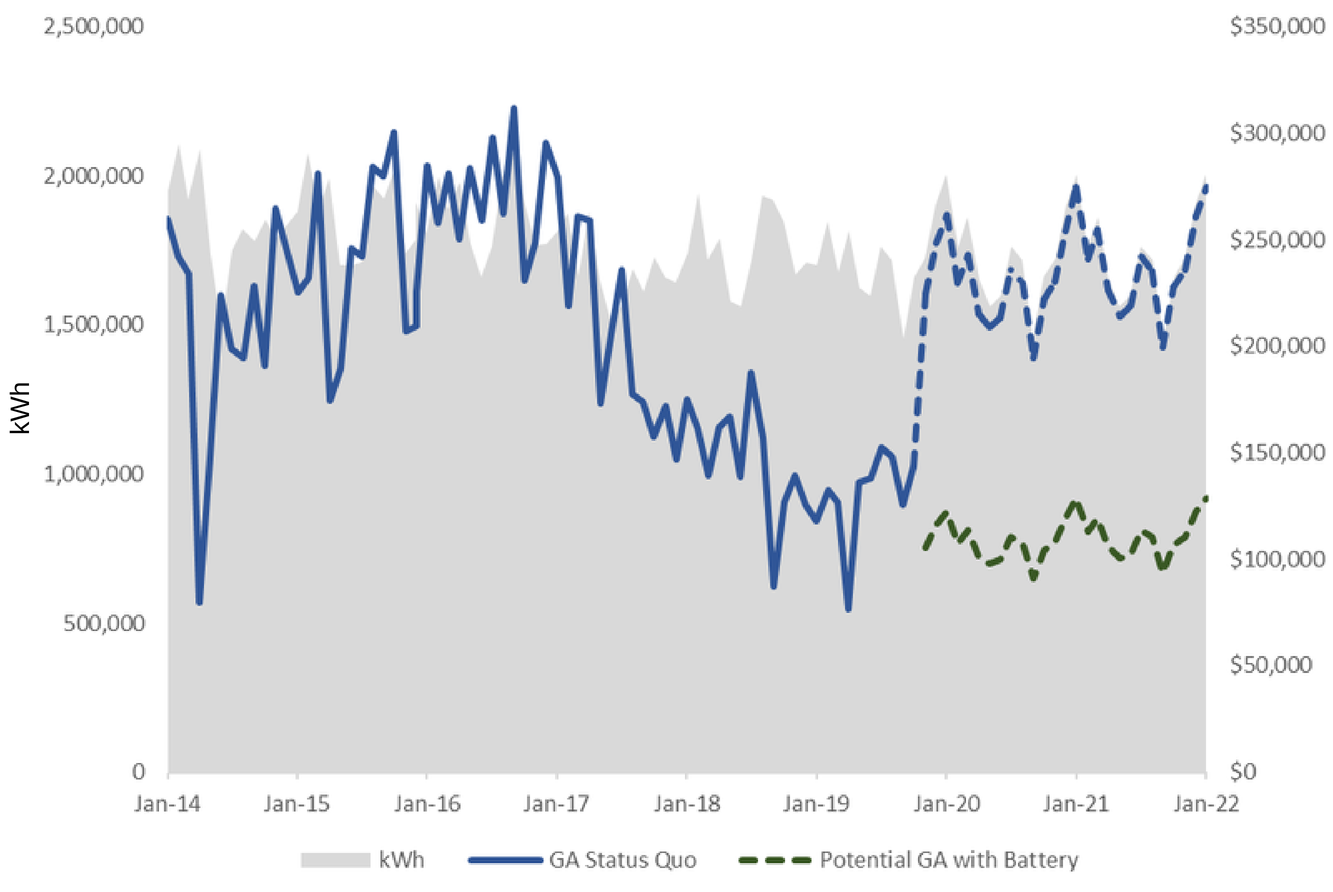


Achieving Full ICI Potential

Currently one of the best opportunities Trent has to manage costs and energy is through the ICI. As the GA modifier is phased out in the fall of 2019, Trent will see a dramatic increase in electricity costs. Graph 3. Projected cost impacts of Global Adjustment programs at Trent shows the anticipated increase of costs. Note that the ICI program affects Trent's main electricity account that represents 87% of our electricity costs.

Graph 3 also shows a dark green line that represents potential for Trent to reduce GA costs by 80% or more by installing a battery storage system. With a battery system Trent could store energy at night when electricity rates are extremely low and discharge this energy from the batteries when the IESO calls on us to reduce demand. A battery system would optimize Trent's success in the ICI, potentially reduce annual costs by more than $1.5M, buffer against the loss of the GA modifier and fund more energy projects on campus.

Graph 3. Projected cost impacts of Global Adjustment programs at Trent



Integrated Approach to Energy Management

The approach to energy at Trent requires several efforts moving forward in parallel and strategically intersecting at the right times to balance opportunities for conservation, energy needs and increasing/decreasing costs.

- a battery storage system will be key to managing costs and starting to close the cost gap between electricity and natural gas
- continued efforts to improve electricity infrastructure on campus starting with renewed electrical switch gear
- new efforts to build a facilities energy team with common energy goals
- continued energy efficiency efforts
- increasing data transparency and sharing

This plan is based on positioning Trent to be adaptable and flexible. It would be difficult to know exactly, at this point in time, what specific needs and solutions our campus may need in 2035 however there are short-term steps that can enable Trent to become more efficient, more independent and more resilient as impacts of energy are changing in our province and the world.

If Trent continues to conserve energy and reduces costs for electricity by adopting a battery storage system, electrification becomes more affordable. Table 1. Projected cost impacts of energy conservation and battery storage at Trent shows the combined impact of an overall conservation reduction of 22% and the benefits of a battery system reducing operating costs while achieving 2030 GHG reduction targets. As savings from the EPC and battery storage project complete their repayment, these funds should be redirected to further energy work on campus. This would position Trent to be successful in the 2030-2050 long-term targets for GHG reductions. With careful planning Trent can realize the full benefit of an integrated approach to energy.

Table 1. Projected cost impacts of energy conservation and battery storage at Trent

	Conservation efforts and fuel source switching (GJ)		Estimated Energy Costs		
	Natural Gas	Electricity	With Battery System	Without Battery System	Potential annual cost savings
2017	118,208	76,601	n/a	$3,494,816	n/a
2022	106,387	68,941	$2,297,580	$3,703,519	$1,405,939
2030	65,232	86,176	$2,814,054	$5,014,539	$2,200,485

APPENDIX A.
ENERGY PERFORMANCE CONTRACT PROJECTS

Please note that this is not an exhaustive list of measures under Trent's EPC. As the EPC enters the final stages this list will be updated when as-built information becomes available. Savings listed are based on engineering calculations, not measured results.

Location	Energy Conservation Measure(ECM)	Date of Substantial Completion	Electricity kWh	Natural Gas m^3	GHGs CO_{2e}
DNA/Life Sciences	Interior Lighting	11/30/2016	244,395	0	5
Blackburn Hall	Interior Lighting	4/7/2017	92,603	0	2
Athletic Centre	Interior Lighting	1/18/2017	193,662	0	4
Lady Eaton College	Interior Lighting	2/1/2017	330,866	0	7
Champlain College	Interior Lighting	10/1/2016	302,098	0	6
Enwaayang	Interior Lighting	8/15/2016	369,923	0	7
OC Residence	Interior Lighting	11/1/2016	122,113	0	2
OCA + Childcare	Interior Lighting	4/7/2017	258,296	0	5
Environmental Science	Interior Lighting	4/7/2017	133,409	0	3
Chemical Science	Interior Lighting	4/7/2017	59,951	0	1
Science Complex	Interior Lighting	4/7/2017	246,240	0	5
Traill	Interior Lighting	8/15/2017	131,368	0	3
Candy Cane Lighting	Exterior Lighting	11/30/2017	103,460	0	2
Durham Campus	Interior & Exterior Lighting	9/15/2017	140,395	0	3
Symons/Traill	Exterior Lighting	4/30/2017	360,903	0	7
Symons	Transformer replacements	10/31/2017	200,979	0	4
Athletic Centre	DHW boilers	11/30/2018	0	14,100	27
Athletics Centre	Pool Filter Replacement	8/30/2017	24,165	6,641	13
Athletic Centre	Therapy Pool variable speed driv	10/31/2018	24,170	0	0
Champlain College	PK Boilers	11/5/2015	0	31,500	60
Champlain College	Res Boilers	8/30/2016	0	20,986	40
Lady Eaton College	LEC Residence boilers	10/15/2016	168,000	6,500	16
Lady Eaton College	DHW for Kitchen Replacement	10/31/2016	0	0	0
DNA/Life Sciences/CSB	Demand Based Ventilation	3/29/2019	1,006,725	257,895	510
Science Complex	Variable Speed Drive Pumping	1/15/2019	68,644	0	1
OC Academics	Controls/VAV & DHW	6/1/2017	375,000	12,300	31
OC Residence	DHW/electric coils	8/31/2018	115,634	-12,820	-22
Symons	Submetering	3/1/2018	0	0	0
Symmons, Traill & Durhar	Building Envelope	3/1/2018	179,464	81,109	158
Total			**5,252,463**	**418,211**	**899**

APPENDIX B.
TRENT UNIVERSITY UTILITY DATA, 2017

Please note that providing 2017 data in this report is a legislated requirement under O.Reg. 507/18. Understanding that more complete and extensive data is of interest to the Trent Community, data from 2007 to the present is available on the Trent SO website. Minor discrepancies between data sets maybe noted and attributed to the exclusion of unconditioned spaces under the regulation and to efforts to correct for the calendar year for the regulation. Data on the SO's website is more comprehensive and is continuous, meaning it is presented 'as-is' without 'corrections' for date.

	Natural Gas (m^3)			Electricity (kWh)				Fuel Oil (L)
	Symons Campus	Durham Campus	Traill College	Symons Campus	Durham Campus	Traill College	Bata Rentals	Symons Campus
Jan	580,090	16,752	8,461	1,712,758	10,529	107,580	10,274	2,434
feb	395,909	10,708	7,946	1,937,951	35,700	161,596	11,161	1,130
Mar	391,617	11,514	6,369	1,699,228	35,700	137,643	11,148	1,025
Apr	281,092	8,148	5,711	1,763,901	39,000	108,200	20,220	539
May	102,537	1,999	1,887	1,557,057	38,700	109,864	11,145	0
Jun	53,683	350	93	1,527,967	33,600	40,830	15,058	0
Jul	48,474	211	27	1,674,937	41,400	30,682	19,786	0
Aug	54,497	225	256	1,891,073	40,500	34,125	18,064	0
Sep	86,939	1,184	355	1,877,842	39,300	30,577	19,490	0
Oct	237,259	4,695	1,675	1,810,672	47,100	36,537	16,336	606
Nov	390,665	11,986	6,002	1,639,178	38,400	51,925	11,594	0
Dec	418,291	15,557	7,286	1,683,005	39,300	96,797	8,354	0
Sub-Total	**3,041,053**	**83,329**	**46,068**	**20,775,568**	**439,229**	**946,356**	**172,630**	**5,733**
Total	***3,170,450***			***22,333,783***				***5,733***

Trent's Energy: 2017 by the numbers

$3,500,000 SPENT ON ELECTRICITY AND NATURAL GAS

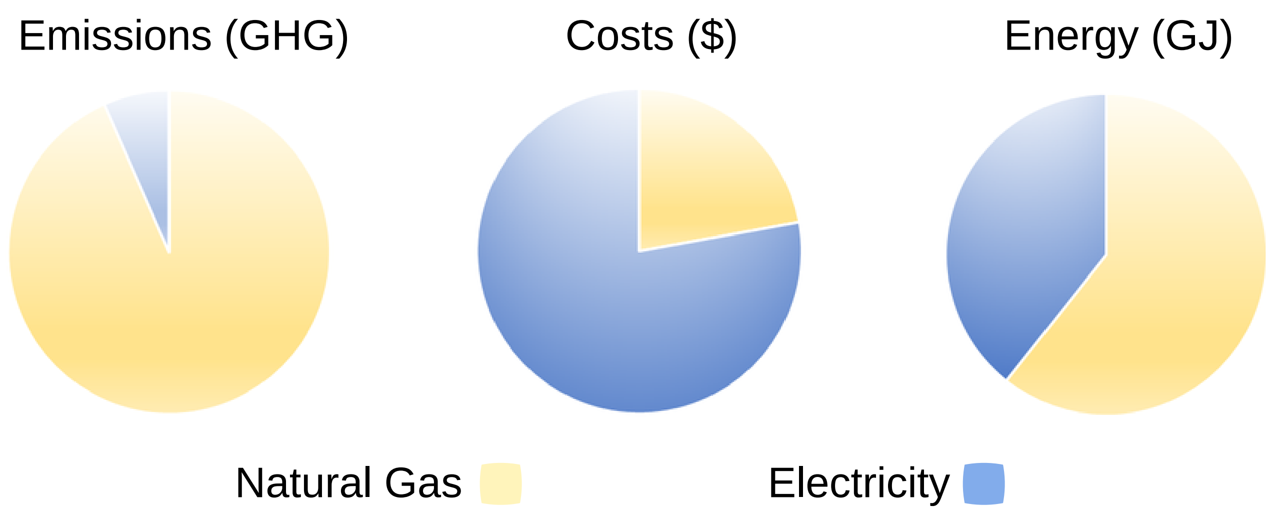
NEARLY 6,500 TONNES OF GHG

195,000GJ OF ENERGY USED TO OPERATE OUR CAMPUS

Giving Context to Trent's Energy Data

It is important to understand the relationship between energy, energy sources and costs for effective planning. Energy conservation and demand management sounds intuitive. Of course we should use energy as efficiently as possible and do our part to lower and balance demand for electricity in the province. And while this is true, straightforward action is challenging because not all energy is equal.

The graphs below are based on Trent's 2017 electricity and natural gas data and show the relationship between cost, useful energy and emissions. An understanding of this dynamic is key when working to balance the energy needs of our campus with strained budgets and achieving Trent's emissions reduction goals.



Trent's 2017 data showed the following relationships for each gigajoule of energy:

- electricity costs 5.4 times more than natural gas
- natural gas emits 9.2 times more greenhouse gases than electricity

In Ontario, electricity is a low-carbon energy source but it is expensive. Natural gas is currently inexpensive but comes at a substantially higher environmental cost.

APPENDIX C.
PROJECTS FOR A LOW/NO CARBON CAMPUS

The following tables are also presented in Trent's Sustainability Plan. The intent of this list of projects is not to be prescriptive but to demonstrate that a low carbon campus can be achieved over time, with planning. It is to highlight that measures taken today will influence the next steps and as such a collaborative strategy is imperative. Lastly, it is to position Trent to take advantage of funding opportunities as they arise by providing thoughtful potential projects.

Short – term GHG Reduction Strategies (all reductions in tonnes)	Annual GHG Reduction	GHG Reduction by 2020	GHG Reduction by 2030	GHG Reduction by 2050	Total Strategy Cost (M$)	Trent Contribution (M$)
DNA/CSB Demand Based Ventilation	515	1,030	6,180	16,480	1.22	0.46 (0.74, GGRP)
Gzowski Occupancy-based ventilation	7	14	84	224	0.16	0 (0.19 GGRP)
Otonabee Residence/Athletics domestic hot water	28	56	336	896	0.71	0.71
Building Envelop Improvements, various buildings	116	232	1,392	3,712	0.3	0 (0.3, GGRP)
Blackburn Boiler Replacement	13	26	156	416	0.38	0.38
Variable Speed Pumping (ESS, CSB, ESC & SC)	10	20	120	320	0.43	0.43
Roadway lighting to LED	4.5	9	54	144	0.4	0.4
Replace Chillers - ESS	7.5	15	180	480	1.5	1.5
Athletics Pool Mechanical	8	16	96	256	0.075	0.075
Air Handler Replacement (SC, LEC & CC)	113	226	1,356	3,616	0.64	0.64
Totals	822	1,644	9,864	26,304	5.8	4.6 Trent, (1.23 GGRP)

Mid-term GHG Reduction Strategies (2020-2030) (all reductions in tonnes)	Annual GHG Reduction	GHG Reduction by 2020	GHG Reduction by 2030	GHG Reduction by 2050	Total Strategy Cost (M$)	Trent Contribution (M$)
Lead Electric Boiler with PV/Battery Generation	138	0	690	3,450	4.3	Funding dependant
Heat Recovery – CC, LEC and OCA	472	0	2,360	11,800	19	Funding dependant
Science Complex Lab/Fume hood Air System	315	0	1,575	7,875	0.8	Funding dependant
Controls Optimization	840	0	4,200	21,000	26.3	Funding dependant
Heat Pump (ground or water sourced heat pump system)	1,467	0	7,335	36,675	26.6	Funding dependant
Totals	3,232	0	16,160	80,800	77	n/a

Long – term GHG Reduction Strategies (2030-2050) (all reductions in tonnes)	**Annual GHG Reduction**	**GHG Reduction by 2020**	**GHG Reduction by 2030**	**GHG Reduction by 2050**	**Total Strategy Cost (M$)**	**Trent Contribution (M$)**
HVAC Redesign using VRF Technology	10	0	0	100	2.1	Funding dependant
Variable Speed Chillers and Heat Recovery Chillers	42	0	0	420	3.4	Funding dependant
Fuel Conversion – NG to electric	1,454	0	0	14,540	15.4	Funding dependant
Domestic Hot Water Reduction	71	0	0	1,775	1.1	Funding dependant
Building Envelope Upgrades	172	0	0	4,300	12.3	Funding dependant
Fuel Optimization Upgrade – replace inefficient NG equipment	46	0	0	1,150	0.9	Funding dependant
Variable Speed Pumping	10	0	0	100	1.1	Funding dependant
Specialized Systems – greenhouse, environmental chambers and Fume hoods	23	0	0	230	0.2	Funding dependant
Kitchen Exhaust	27	0	0	270	1.4	Funding dependant
Totals	1,855	0	0	18,550	37.9	n/a