Energy Conservation and Demand Management Plan

Ryerson University

July 1st, 2019

Ryerson University

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Introduction and Background

Ontario Regulation 507/18, made under the Electricity Act of 1998, directs all public agencies in Ontario to prepare, publicly report, and implement Energy and Conservation Demand Plans (also referred to as 'ECDM Plan') on or before July 1, 2019, and every fifth anniversary thereafter. Ryerson University ('Ryerson') previously issued an ECDM Plan on July 1, 2014 under Ontario Regulation 397/11, which has since been revoked.

Figure 1- Ryerson's campus situated in the heart of downtown Toronto

Purpose of the Energy Conservation and Demand Management Plan

Ryerson's campus is located in the heart of downtown Toronto. Operating more than 40 buildings to cater to approximately 40,000 students and 2,700 faculty and staff, Ryerson has a significant energy footprint. A combination of rising energy costs, aging infrastructure, and the ever-increasing need to commit to sustainable operations highlight the importance of reviewing energy conservation initiatives, setting benchmarks, and developing a strategy for the future. The purpose of Ryerson's 2019 ECDM Plan is threefold, as follows:

1. Review the progress made by conservation initiatives that have been undertaken since the issue of the previous ECDM Plan in 2014
2. Report on Ryerson's existing energy consumption profile
3. Benchmark Ryerson's energy consumption, and communicate the conservation strategy framework for the short and long-term future

Ryerson University Profile

Ryerson began operations as Ryerson Polytechnic Institute in 1948, and has rapidly evolved since then. Having been granted full university status in 1993, Ryerson continues to expand its operations and services for students, faculty, and staff.

Figure 2- Oakham House, built in 1948, is the oldest building on Ryerson's campus

While Ryerson has expanded by constructing state-of-the-art LEED-certified buildings such as the Sheldon and Tracy Levy Student Learning Center, Daphne Cockwell Complex, and Centre of Urban Innovation over the past five years, more than 50% of the buildings on campus are over 30 years old and in need of infrastructure renewal. Furthermore, as an urban university located in a high-density urban area, Ryerson's ability to expand the borders of its campus are limited. Management of energy use at Ryerson certainly presents unique challenges, but also the opportunity to intelligently and innovatively pursue creative energy solutions.

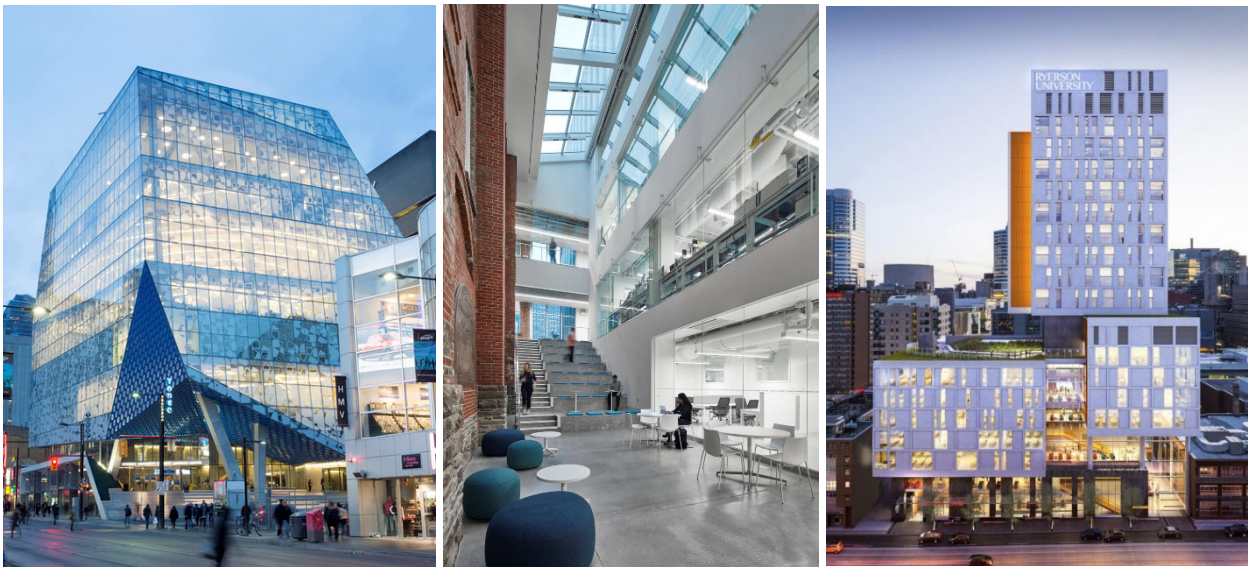

Figure 3- Recent additions to Ryerson's campus include the Sheldon and Tracy Student Learning Centre in 2015 (left), the Centre for Urban Innovation in 2018 (centre), and the Daphne Cockwell Complex, entering service in 2019 (right)

Campus Summary

Ryerson offers more than 100 undergraduate, masters and PhD programs across 7 faculties. It is also home to Canada's largest continuing education program with 78 career-related certificate programs. In addition to full-time equivalent students, the continuing education program caters to 70,000 students each year. Ryerson operates year-round but is at its busiest from September through to April during the fall and winter academic semesters.

Table 1 – Buildings currently owned and operated by Ryerson

Building Code	Building Name	Building Address	Conditioned Floor Area (ft^2)	Date Acquired by Ryerson	Building Category
BND	114 Bond	114 Bond St.	3,231	1860	Administrative
PRO	112 Bond	112 Bond St.	2,753	1860	Administrative
OKF	O'Keefe House	137 Bond St.	7,380	1880	Formerly residence; being re-purposed
SID	School of Interior Design	302 Church St.	32,524	1900	Academic
MON	Monetary Times	341 Church St.	21,141	1929	Academic
VIC	Victoria Building	285 Victoria St.	114,419	1930	Academic and administrative
CUI	Centre for Urban Innovation	44 Gerrard St. E	62,500	1941, renovated in 2018	Academic
OAK	Oakham House	63 Gould St.	18,444	1948	Community events
COP	Co-operative Education	101 Gerrard St. E	6,870	1950	Academic
GER	Research and Graduate Studies	111 Gerrard St. E	27,605	1950	Academic
BON*	Capital Projects & Real State, Security	111 Bond St.	7,127	1960	To be demolished
KHE	Kerr Hall East	340 Church St.	121,290	1960	Academic
KHN	Kerr Hall North	43 Gerrard St. East	99,189	1960	Academic
KHS	Kerr Hall South	50 Gould St.	105,238	1960	Academic
KHW	Kerr Hall West	379 Victoria St.	145,286	1960	Academic
JOR	Jorgenson Hall	380 Victoria St.	97,549	1971	Administrative
POD	Podium	350 Victoria St.	192,003	1971	Administrative
LIB	Library Building	350 Victoria St.	209,547	1974	Academic

Building Code	Building Name	Building Address	Conditioned Floor Area (ft^2)	Date Acquired by Ryerson	Building Category
ARC	Architecture Building	325 Church St.	71,773	1981	Academic
EPH/SHE	Eric Palin Hall/ Sally Horsfall Eaton Centre for Studies in Community Health	87 Gerrard St. E/99 Gerrard St. E	191,065	EPH-1984 SHE- 2002	Academic
ILC	International Living/Learning Centre	133 Mutual St.	125,670	1987	Residence
RAC	Recreation and Athletics Centre	40 Gould St.	44,807	1987	Athletic
BKS	Bookstore	17 Gould St.	14,021	1988	Bookstore
PIT	Pitman Hall	160 Mutual St.	221,056	1991	Residence
PKG	Parking Garage	300 Victoria St.	120,324	1991	Parking garage
RCC	Rogers Communications Centre	80 Gould St.	118,638	1991	Academic
HEI	Heidelberg Centre-School of Graphics Communications Management	125 Bond St.	26,640	2002	Academic
ENG	George Vari Engineering and Computing Centre	245 Church St.	209,165	2004	Academic
CED	G. Raymond Chang School of Continuing Education	297 Victoria St.	34,242	2005	Academic
SCC	Student Campus Centre	55 Gould St.	35,279	2005	Community events
TRS	Ted Rogers School of Management	575 Bay St.	186,694	2006	Academic
SBB	South Bond Building	105 Bond St.	58,679	2007	Academic
BKE	110 Bond	110 Bond St.	8,334	2008	Administrative
IMA	School of Image Arts	122 Bond St.	100,401	2012	Academic
MAC	Mattamy Athletic Centre	50 Carlton St.	225,632	2012	Athletics
SLC	Student Learning Centre	341 Yonge St.	138,790	2015	Academic and community events
DCC	Daphne Cockwell Health Sciences Complex	288 Church St.	409,117	2019	Academic, residential, parking garage

Table 2 presents a summary of all Ryerson-owned facilities by primary building use category.

Table 2- Overview of campus facilities, categorized by primary building use type

Primary Building Use Type	Total Floor Area (sq.ft.)	Number of Buildings	Percentage of Total Area
Administrative Offices and Related Facilities	303,870	5	8.2%
Academic Facilities	2,033,046	21	55.0%
Libraries	209,547	1	5.7%
Student Recreational and Athletic Facilities	270,439	2	7.3%
Bookstores	14,021	1	0.4%
Student Residences	551,285	3	14.9%
Parking Garages	120,324	1	3.3%
Student Community Spaces	192,513	3	5.2%

The age of construction varies widely within the facility portfolio, with the oldest building dated before 1900 and three newly constructed buildings added since 2015. The following figure and table present a summary of the age distribution of Ryerson's facilities.

Table 3 – Building Age Portfolio

Age (Years)	Number of Facilities	Gross Floor Area (ft^2)
>50	13	705,370
25-50	11	1,406,453
10-25	7	559,033
<10	5	936,440

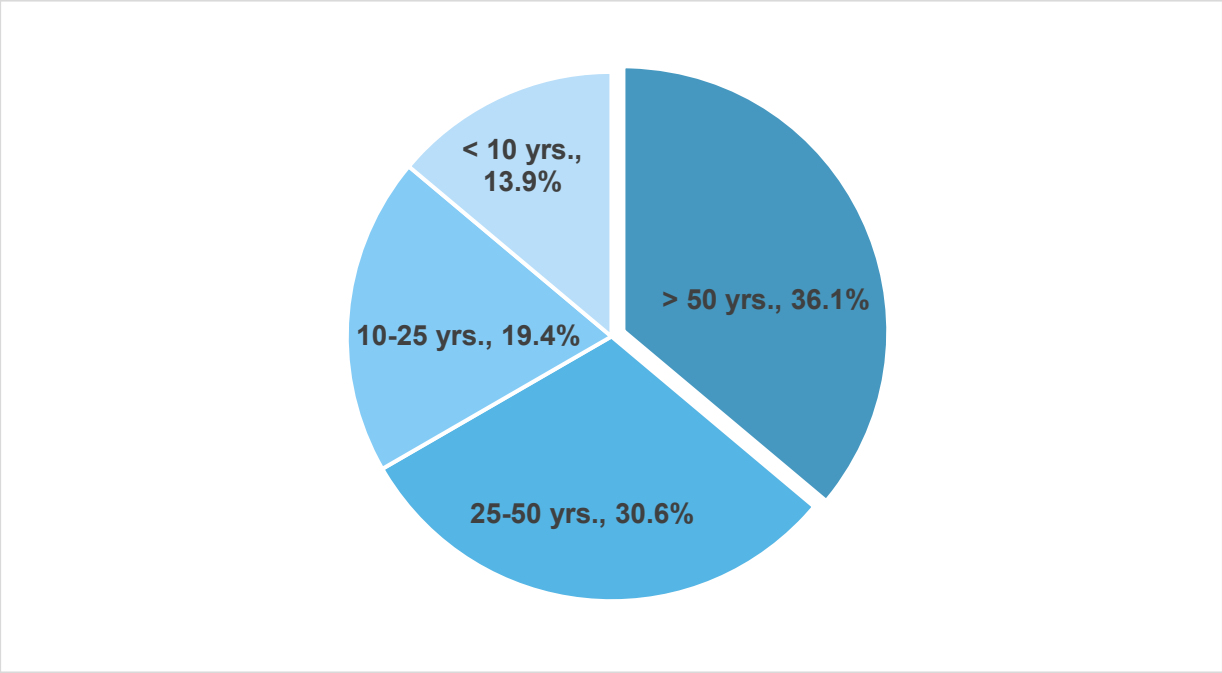

Figure 4- Building Age by Percentage

As shown in Table 3 and Figure 4, the category of "over 50 years old" holds the largest number of buildings on campus. It can also be seen that a majority of Ryerson's buildings are over 25 years old; in most such cases, base building systems are in need of renewal, with work toward the improvement of mechanical, HVAC, electrical and envelope systems required in the near future. It is essential that the energy performance of the base building systems be improved during the revitalization process as well. This will not only reduce energy consumption and operational costs, but also increase user comfort.

Ryerson is in the process of the largest expansion in its history, with seven newly constructed and five fully renovated buildings since 2000. This expansion is expected to continue into the coming decade. The continued growth of Ryerson's building inventory puts increasing demands onto campus energy systems. The design and building standards applied during expansion shall have a large impact on the long-term energy performance of the campus. As highlighted in Figures 5 and 6, the increase in campus floor area is matched with an increase in student enrollment. Minimizing the impact of this growth on Ryerson's overall energy consumption is essential toward serving as an example of responsible, sustainable expansion in operations.

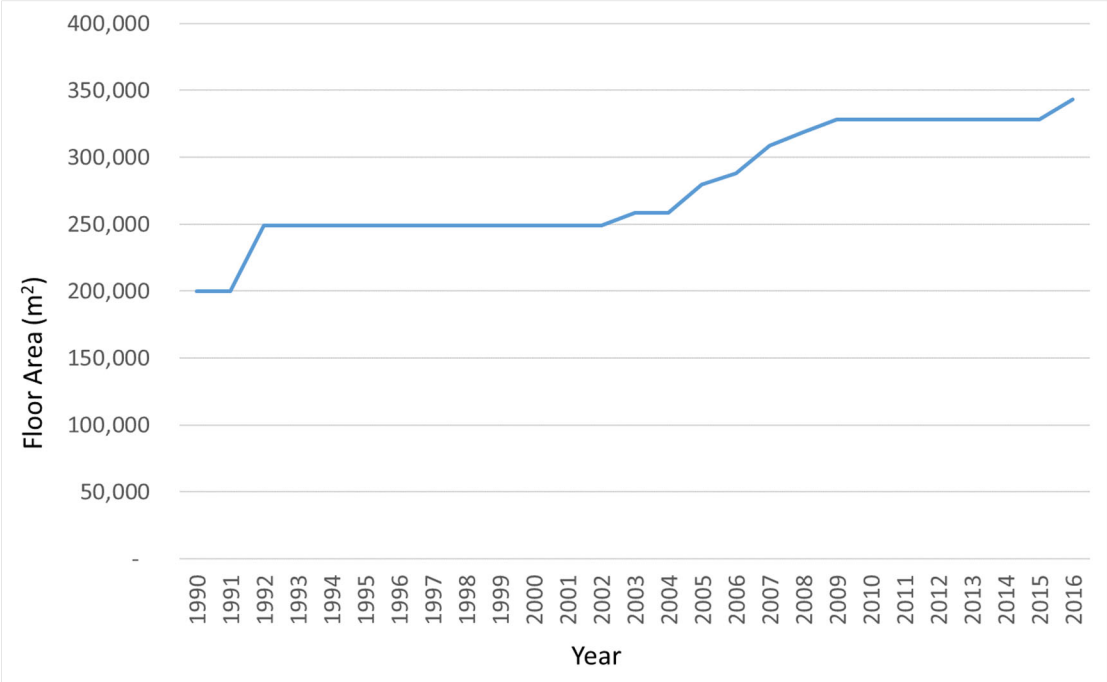

Figure 5 - Ryerson Building Footprint Portfolio 1990-2016

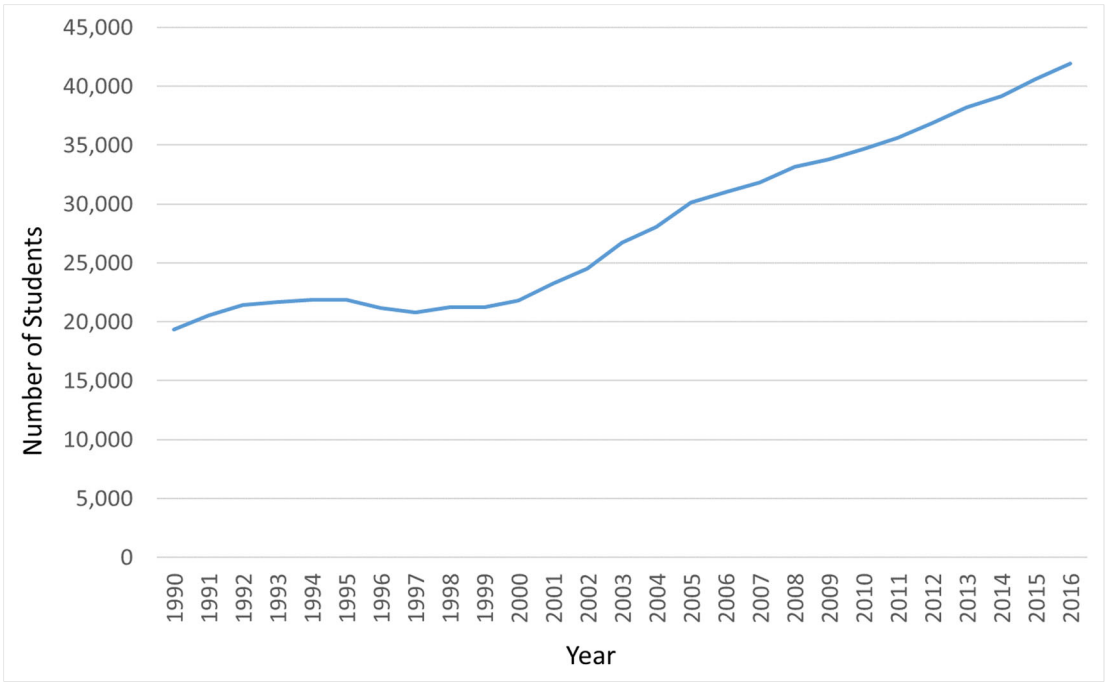

Figure 6 - Ryerson Student Enrollment from 1990-2016

Ryerson's Energy Consumption

Quantifying campus energy consumption is a key first step in developing an energy management strategy. Ryerson makes use of Prism Engineering's PUMA software to maintain and manage a utilities database. The software has been in service since August 2018, and supplements the use of Microsoft Access for utility management. PUMA is an online energy management software and service that helps clients analyze and manage their energy consumption and GHG emissions. It also offers features such as benchmarking consumption with other similar buildings in Canada. Ryerson is also in the process of installing electrical, steam/natural gas, chilled water, and domestic water sub-meters for all buildings on campus. This initiative shall allow for more timely and granular energy data to be available for analysis, and will be discussed further in later sections of this report.

Historical Trends (1990-2017)

Figure 7 shows a gradual increase in Ryerson's energy use over time. A significant drop in energy consumption can be seen in 1997. This can be attributed primarily to the implementation of a comprehensive energy services contract with MCW Custom Energy Solutions between 1994 and 1996, as well as the introduction of the Enwave district steam system, which improved the efficiency of the campus-wide heating system. The gradual increase in energy consumption over time is an expected trend that can be accounted for by Ryerson's growing footprint and student enrollment. Despite the gradual increase in absolute energy consumption, the energy usage intensity per unit floor area as well as per full-time student enrollment has remained constant throughout the years, as shown in Figure 8.

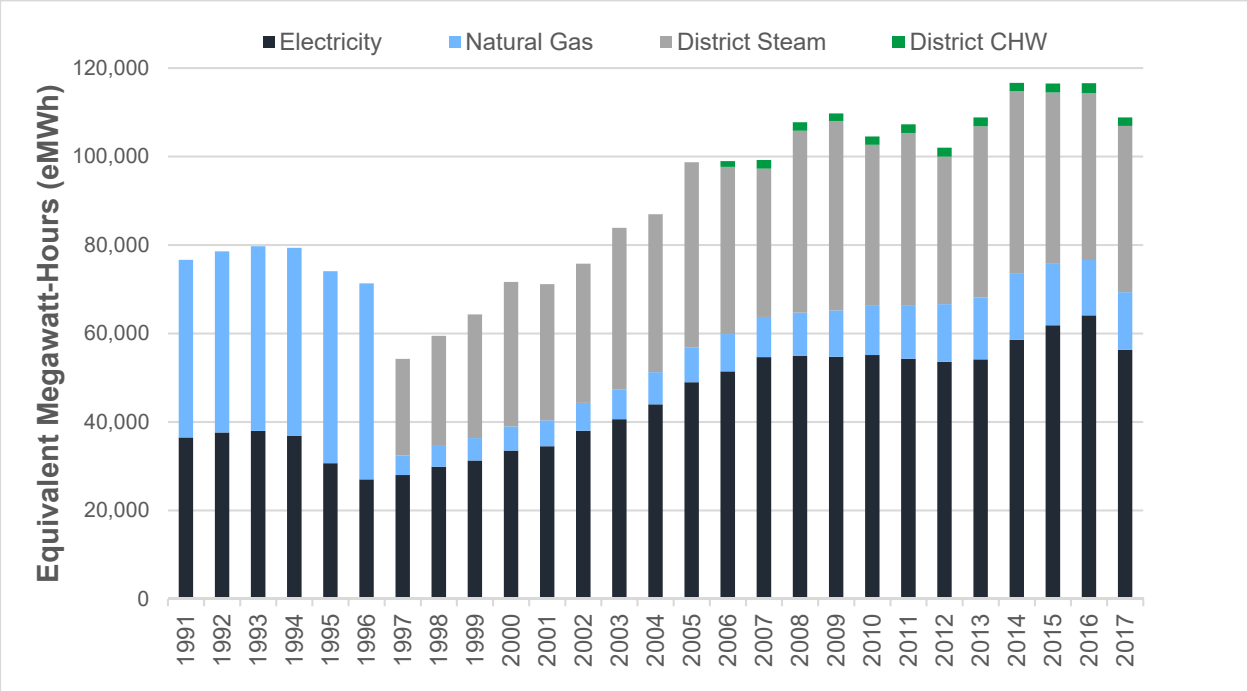

Figure 7 - Ryerson Energy Consumption from 1990-2017

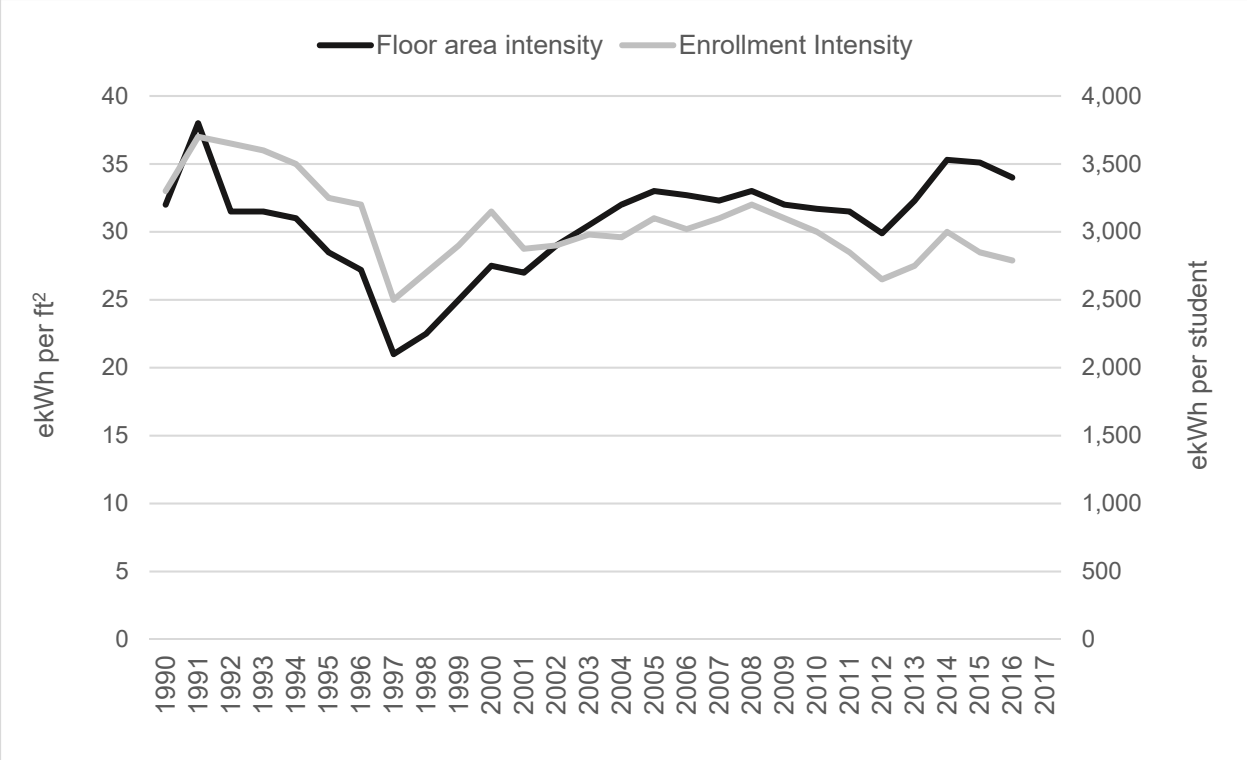

Figure 8 – Ryerson's energy usage intensity (EUI) from 1990-2017

Current State of Energy Consumption (2017)

Ryerson makes use of electricity, district steam, natural gas, and district chilled water to meet its energy needs. Many of Ryerson's buildings share electrical and steam meters; a map of the existing metering layout on campus can be seen in the Appendix of this report. The ongoing campus-wide sub-metering project shall enable utility consumption data to be collected at the individual building level.

Utility Consumption and Cost Breakdown

In 2017, Ryerson's total cost for all utilities, including domestic water, was $14,194,227. Table 4 provides a breakdown of the energy commodity, consumption and costs for 2017. An increase in year-to-year utility cost is driven by increasing energy use as well as rising utility costs.

Table 4 - Utility Consumption and Cost (2017)

Utility	Consumption	Cost	Average Blended Rate
Electricity	57,590,453 kWh	$9,800,261	$0.170/kWh
District Steam	107,388,605 lbs	$2,813,614	$0.026/lb
District Chilled Water	542,998 TH	$207,530	$0.382/TH
Natural Gas	1,266,946 m^3	$202,523	$0.160/$m^3$
Domestic Water	302,715 m^3	$1,170,298	$3.866/$m^3$

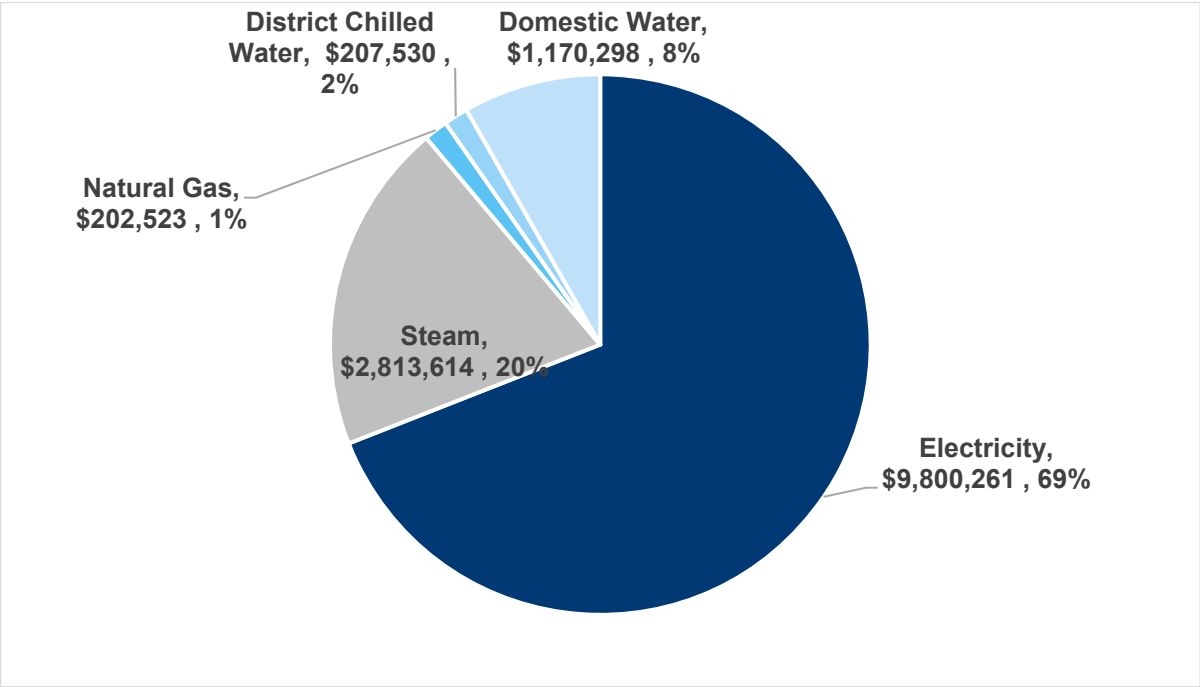

Figure 9- Breakdown of annual utility cost, by utility type (2017)

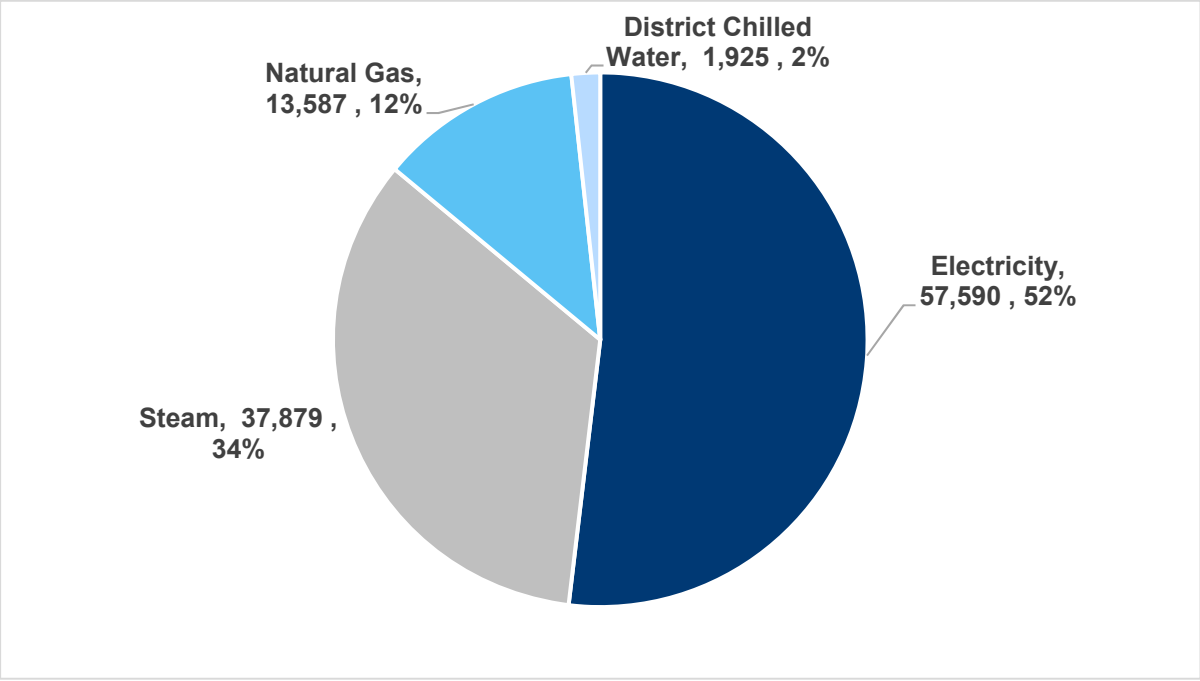

Figure 10- Breakdown of annual energy consumption in eMWh, by utility type (2017)

Ryerson's primary heat source is district steam, which is supplied by Enwave. Approximately 70% of the overall square footage on campus is heated using district steam, with majority of the remaining area heated by natural gas. Only the Campus Bookstore and the residential suites within the International Living and Learning Centre make use of electric heating.

Most buildings on campus are cooled by means of district cooling system using chilled water generated in Ryerson's central chiller plant located in the basement of the Library Building (LIB). Another chiller plant services Pitman Hall (PIT) and Rogers Communication Centre (RCC). The remaining buildings, with the exception of the Ted Rogers School of Business (TRS), have a standalone cooling plant. In order to meet the demands of a growing campus, the existing central chiller plant's capacity is being expanded through addition of a new chiller plant that shall be located in Kerr Hall East (KHE). This new plant shall feed into part of the existing central chiller plant's distribution network.

TRS utilizes deep lake water cooling, which is also supplied by Enwave. This innovative technique cools air with cold water taken from the depths of Lake Ontario. Pipes reaching 5km into Lake Ontario bring cold water at 4°C from 83 meters below the surface of the lake, to the Toronto Island Filtration Plant, and then to the John Street pumping station. It is here that the cooling capacity of the lake water is transferred through heat exchangers to Enwave's closed-loop chilled water distribution network. This network is used to cool several buildings located within Toronto's downtown core, as well as Ryerson's TRS building.

Electricity is provided by Toronto Hydro Electric System and comes to each building on campus from a variety of distribution points. Larger campus buildings have multiple entry points and a dedicated switchgear.

Estimated End-Use Energy Breakdown

Estimating energy end-use in the buildings is important in determining areas where energy savings can be obtained. This breakup of the energy consumption highlights area where measures can be implemented. The energy end-use analysis produced the following average breakdown between Ryerson's building portfolio:

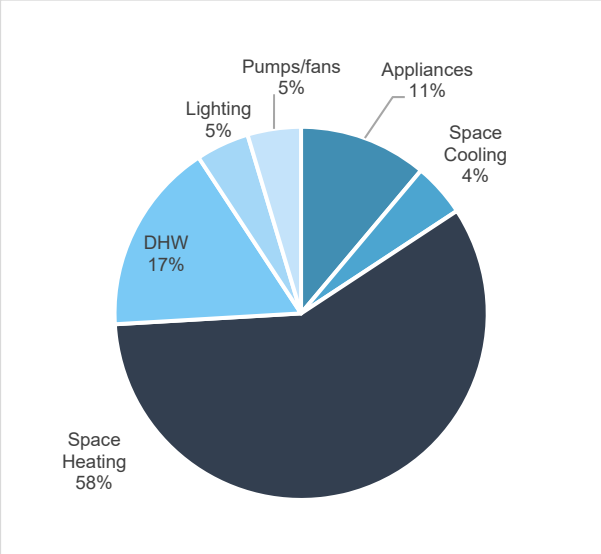

Figure 11 – Typical residential end-use breakdown

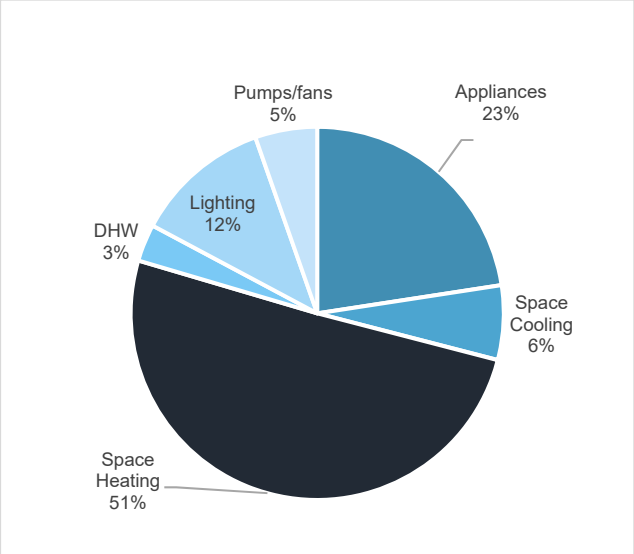

Figure 12 – Typical classroom/office end-use breakdown

The end-use breakdowns shown in Figures 11 and 12 were estimated using historical utility data in conjunction with linear regression analyses using RETScreen Expert Software, with weather-dependent variables (heating and cooling degree days) taken into account as well. A comparison of the actual natural gas consumption of Pitman Hall (PIT), plotted alongside its predicted consumption as derived through RETScreen, can be found in the Appendix. This plot highlights the expected accuracy of the linear regression analyses that were conducted.

The on-going campus-wide sub-metering project shall allow for more accurate real-time analysis of end-use energy breakdown within Ryerson's buildings as well. Metering the district chilled water and steam systems for each building will allow for the isolation of heating and cooling loads for more in-depth analysis of potential savings opportunities.

Energy Conservation Targets

Setting energy conservation targets fulfils some key functions for Ryerson's commitment toward a sustainable future, including the following:

1. Targets provide a guiding principle for strategic decisions related to all aspects of operations, including construction of new facilities and modifications being considered for existing ones
2. Targets also serve as an essential benchmarking tool to evaluate the annual performance of initiatives geared toward promoting and practising energy conservation

Ryerson's targets have been categorized as either quantitative or qualitative.

Quantitative Targets

Quantitative targets should be measureable and verifiable. Instead of basing targets around absolute energy consumption values, it was determined that Ryerson's targets for the upcoming ECDM Plan cycle should be based on energy usage intensity. This would allow for the targets to account for Ryerson's continually evolving campus, with buildings likely to be added to the existing portfolio over the next five years.

Two metrics were considered for measuring energy usage intensity (EUI); energy consumption per full-time equivalent (FTE) students, faculty and staff, and energy consumption per square foot. The energy consumption per FTE student, faculty and staff is an approximate indicator of how efficiently energy is being utilized to serve Ryerson's population. However, several factors skew the accuracy of this metric's intended use. The ever-changing nature of how education is delivered offers students many unique choices about how much time they spend on campus, and how they utilize campus facilities. Such factors have considerable influence on the energy consumption per FTE student, faculty and staff, and may not provide an accurate indication of changes in energy efficiency.

Energy consumption per square foot was noted to be a much more applicable metric for setting targets. This metric is already widely used across several agencies and institutions, and allows for simple comparisons of energy usage intensities to be made. Furthermore, this metric shall more accurately indicate the effectiveness of energy conservation initiatives, as it has a more direct correlation to the performance of buildings on campus; a vast majority of energy

consumption at Ryerson can be attributed to the use of buildings. Once the campus-wide sub-metering program is complete, further segmentation of EUI will be possible. Segmentation can be based on building age, size, and type of use.

As shown in Figure 8 earlier in the report, the EUI at Ryerson has increased over the last two decades. This has occurred in spite of the emergence of new technologies such as LED lighting and variable frequency drives (VFDs), which allow for building operations to be conducted with reduced energy consumption. The increase in EUI can primarily be attributed to increased student enrollment and aging building systems. Furthermore, the high EUI of existing buildings has not been sufficiently offset by the reduced EUI of major renovations and new construction buildings.

The baseline data used for setting targets in this ECDM Plan shall be from 2017, as presented in Tables 3 and 4. Ryerson's energy conservation target for the coming ECDM cycle from 2019 to 2024 is a 10% reduction in EUI from the baseline value, with an average of 2% annual reduction per year for the next 5 years. Progress toward this target shall be reviewed on an annual basis. Table 5 outlines the baseline and target EUIs.

The target shall be attained through a combination of electrical, natural gas, and district heating/cooling system energy savings. Strategies for energy conservation shall be discussed in further detail later in the report.

Table 5- Overall quantitative energy conservation target for the period of 2019-2024

2019-2024 Energy Conservation Target	
2017 EUI (ekWh/ft^2)	30.83 ekWh/ft^2
2024 Target EUI (ekWh/ft^2)	27.75 ekWh/ft^2 10% reduction from 2017 baseline
Total 5-year EUI Reduction Target (ekWh/ft^2)	3.08 ekWh/ft^2
Average annual EUI reduction (ekWh/ft^2)	0.62 ekWh/ft^2

Qualitative Goals

In addition to the quantifiable goals around EUI, this ECDM Plan also incorporates qualitative goals that have been set in order to foster a culture of sustainability across all aspects of the university's operations, from student engagement to collaboration with external stakeholders. Being located in a highly dense urban campus, Ryerson can serve as a valuable 'Living Lab' to highlight the possibilities that can be brought to light when conservation initiatives are undertaken in urban areas.

Table 6 provides a summary of Ryerson's qualitative targets for this ECDM plan's period.

Table 6- Ryerson's qualitative goals for the period of 2019-2024

Goal	Planned and ongoing actions to achieve goal
Encourage sustainable practices across various departments at Ryerson	Ryerson's Sustainability Certificate Program, which shall be administered by the Sustainability Office, shall be offered to any interested department within the university that wishes to adopt a more sustainable approach to conducting their operations. Attaining the certification shall require an internal audit of the department's practices, with energy conservation being a key component of the scoring system. Continuous improvement is encouraged by offering different levels of certification. This program shall be launched in September 2019.
Engage the Ryerson community to spread awareness of need for conservation and sustainability	Campaigns related to conservation and sustainability are held throughout the year. Examples include Healthy Commute Week and 12 Days of Sustainable Christmas. Seasonal communication encouraging conservation practices are also distributed throughout the Ryerson community. For example, the community is encouraged to turn off unnecessary appliances before extended university shutdowns, such as during the Christmas break. Ryerson aims to increase data collection around assessing the effectiveness of such campaigns in the near future, so as to increase their impact over time. Ryerson's Sustainability Office also engages with the university's community by periodically serving as guest speakers for academic programs related to sustainability.
Support emerging talent toward careers in the sustainability sector	The Sustainability Office employs part-time interns from a wide range of Ryerson's academic programs throughout the year. This includes an Energy Intern position. The aim of such internships, apart from harnessing the talent of Ryerson's students, is to set up future leaders for a career in the sustainability and conservation fields.
Serve as a Living Lab for other institutions and facilities on a municipal, national, and international level	Ryerson maintains active relationships with other universities and colleges, as well as key stakeholders such as utility providers, NRCan, and the City of Toronto. Relationships are maintained by sharing ideas and lessons learned from past initiatives, as well as checking in with NRCan and City officials to gauge how Ryerson can contribute to, and eventually play a leading role, toward local and national conservation goals.
Ensure all future and ongoing modifications on campus prioritize energy conservation and sustainability	Ryerson's design standards require all new construction and major renovation buildings to achieve a minimum of LEED Silver certification. Furthermore, the Sustainability Office is also working toward creating a Green Leasing Checklist, which aims to ensure that spaces leased by Ryerson are as energy efficient as possible.

Energy Reduction Strategies

This section shall review past energy conservation initiatives that have taken place, including those that have been implemented since the previous ECDM Plan was issued in July 2014. Ongoing initiatives, as well as near and long term strategies toward Ryerson's push for conservation shall also be discussed in this section of the report.

Apart from improvement measures, long-term, sustained energy conservation also involves collaborating with key internal and external stakeholders. Such partnerships allows for opportunities to adopt best practices and replicate measures that have delivered proven results. Ryerson's collaboration with such stakeholders shall also be discussed in this section.

Past Initiatives

Ryerson has undertaken several initiatives in the past in an effort to reduce its energy consumption and carbon footprint. Table 7 highlights some of these past initiatives. With the exception of the MCW Energy Service Contract, all these measures have been implemented after issuance of the 2014 ECDM plan.

Table 7- Past energy conservation initiatives implemented by Ryerson

Conservation Initiative	Description
MCW Energy Service Contract ***1994-1996***	Between 1994 and 1996, Ryerson undertook an extensive, campus-wide effort to reduce its energy consumption. This effort involved an Energy Service Contract (ESCo) in partnership with MCW Custom Energy Solutions, and include measures such as campus-wide lighting retrofits, upgrading heating and cooling systems, and extending district energy piping to include five additional buildings to be incorporated into the central heating and cooling plants that were in use at the time. This measure led to a significant reduction in energy consumption, as shown in the dip in total annual consumption between 1996 and 1997 in Figure 7.
Central Chiller Plant Metering and Efficiency Study *2015*	2015, Ryerson installed a sub-metering system in the two primary chiller plants used on campus- the 4,000 ton Central Chiller Plant, as well as the 500 ton RCC Chiller Plant. The sub-metering system is able to capture live energy consumption and power draw data pertaining all equipment in use within each plant, including the chiller compressors, distribution pumps, and cooling tower fans. This allows Ryerson's facility managers to analyze the energy consumption of the plant, and identify any issues with equipment as well as sources of energy inefficiency. The metred data was also used to conduct an energy efficiency study of the Central Chiller Plant, allowing its energy consumption to be benchmarked.

Conservation Initiative	Description
LEED Certifications of New Buildings *2015-2019*	Construction of the Sheldon and Tracy Levy Student Learning Centre (SLC) was completed in 2015. Energy efficiency was at the forefront of this building's design considerations, resulting in a LEED Gold certification. The Centre of Urban Innovation came into service in 2018, and was designed in accordance with LEED Silver Standards. This newly constructed building is currently undergoing the LEED certification process. The Daphne Cockwell Centre (DCC), which is scheduled to come into service in the fall of 2019, has been designed in accordance with LEED Silver standards. Certification for this standard is currently in process.
Laboratory Upgrades within Kerr Hall North ***2017***	Several laboratories in Kerr Hall North were renovated in 2017. These labs were outfitted with energy efficient equipment, including LED ceiling panels and efficient fume hoods.
Monetary Times Comprehensive Energy Retrofit ***2017****-2018*	The Monetary Times Building (MON) underwent a comprehensive full-building energy retrofit from 2017 to 2018. This project included LED lighting retrofits as well as a building envelope upgrade. The building was also sub-metered, allowing for consumption patterns related to heating, cooling, lighting, air distribution, and plug loads to be monitored in detail.
Cooling Tower Water Metering *2018*	In 2018, Ryerson received the SUEZ Proof Not Promises Award, along with a $30,000 evaporation credit from the City of Toronto. This was due to the installation of a metering system that allows Ryerson's facility managers to track how much water is lost due to evaporation from the chiller plant cooling towers instead of going into the sewage system.
Prism PUMA Energy Management Software ***2018***	Ryerson previously used Microsoft Access to maintain and manage a utilities database. The management software has recently been converted to Prism Engineering's PUMA (Prism Utility Monitoring and Analysis) software. This software, in addition to acting as a utility bill database, also provides analytical tools to monitor billing data and highlight any anomalies. Some features in PUMA include energy benchmarking and comparison with other buildings in Canada.
Building Retro-Commissioning Projects *2018-2019*	Retro-commissioning plays a crucial role in maintaining or improving the performance of building systems. Energy reduction is achieved through a systematic evaluation of all building systems and equipment to identify potential conservation measures. Between 2018 and 2019, Ryerson retro-commissioned the following buildings: • George Vari Engineering and Computing Centre (ENG) • Mattamy Athletic Centre (MAC) • Victoria Building (VIC) The savings obtained as a result of this round of retro-commissioning is in the process of being verified.

Conservation Initiative	Description
LED Lighting Retrofits ***2014-2019***	LED lighting retrofits are a highly effective method to achieve significant energy savings and improve a building's existing conditions. Apart from reducing electricity consumption, LED lighting upgrades also improve a user's experience within the building by providing a vastly improved quality of light. Between 2014 and 2019, Ryerson has conducted LED lighting retrofits within the following buildings: • Library (LIB) • Pitman Hall parking garage (PIT) • Monetary Times Building (MON) • Recreation and Athletics Centre (RAC) • Eric Palin Hall (EPH) LED retrofits within more buildings are planned in the coming years.

Figure 13- The George Vari Engineering and Computing Centre (ENG), constructed in 2004, underwent retro-commissioning between 2018 and 2019

Ongoing Initiatives

At the time of issue of this report in July 2019, Ryerson is in the process of reviewing the results from the previous round of energy conservation initiatives, as well as planning the next round of projects. In the midst of this, there are some ongoing projects underway. These are outlined in Table 8 below.

Table 8- List of ongoing energy initiatives at Ryerson as of July 2019

Ongoing Initiative	Description
Campus-Wide Sub-Metering Project	Ryerson's existing utility metering layout map can be found in the Appendix of this report. As per the map, Ryerson has, in many key cases, multiple buildings connected to a single feed for electricity and/or steam. This is especially true in the case of steam, where a total of seventeen buildings are fed using just three district steam feeds. This existing system makes it difficult to isolate energy consumption and GHG emissions down to the individual-building level, which would otherwise be a crucial step in prioritizing future initiatives. The Campus-Wide Sub-Metering project involves sub-metering all utilities for each building and consolidating the resulting interval data obtained. This data will allow for accurate live as well as historical energy consumption data for all buildings on campus. This information will be used to: 1. Prioritize future energy conservation initiatives through more informed, data-driven decision-making processes 2. Quantify actual savings to continually improve the performance of Ryerson's facilities, and 3. Drive a real-time energy monitoring dashboard, which will serve to engage the broader Ryerson community. The Campus-Wide Sub-Metering Project will therefore serve as a backbone for future energy efficiency measures. The project is being implemented in three phases. Phase 1 is scheduled for completion in the fall of 2019, with Phases 2 and 3 currently in the design stage.
Annual Steam Trap Audits	Optimal operation of steam traps is crucial for a site like Ryerson, which makes use of district steam for most of its heating requirements. Improper functioning of steam traps can lead to significant losses in energy efficiency due to steam leaks. This often leads to comfort issues within the building as well. As part of a collaborative effort with Enwave, Ryerson's supplier for district steam, an audit of key steam traps are conducted throughout the campus on an annual basis, which an audit report that provides recommendations for traps that require maintenance or replacement. The report includes estimates of energy savings that can be achieved by conducting maintenance on the identified traps with issues.

Future Initiatives

Future initiatives at Ryerson have been categorized to fit into short/mid-term plans, and long-term plans. The overall framework and intent of these plans, along with the initiatives that are encompassed within them, are elaborated on in this section of the report.

Short and Mid-Term Plans

The short and mid-term plans are intended to be implemented over the next ten to fifteen years. The primary intent of these plans is bring each individual building on campus to operate as efficiently as possible. This can be achieved by adhering to high efficiency design standards for new construction buildings, by implementing comprehensive full-scale renovations of existing ageing buildings, or by retrofitting individual building systems (such as lighting or HVAC) within a building. Upgrades to the central district heating and cooling systems would also aid Ryerson in fulfilling its short and mid-term plans.

Table 9 outlines measures that are to be implemented as part of the the short and mid-term plans.

Table 9- Measures to be implemented as part of Ryerson's short and mid-term energy conservation plans

Measure	Description
LED Lighting Retrofits	While LED retrofits have already taken place in a number of buildings on campus over the last five years, significant savings potential lies in conducting more retrofits on campus buildings. LED retrofits are especially applicable to buildings that have been constructed recently enough to not warrant a full-scale renovation, but were constructed before the prevalence of LED lighting technology. Examples of such buildings include the Sheldon and Tracy Levy Student Learning Centre, and the School of Image Arts. The intent of the mid-term plan is to eliminate all non-LED lighting on campus over the coming years.
Upgrading Outdated Equipment	Aside from lighting, other building systems, including HVAC and domestic hot water supply, are also major sources of energy consumption and inefficiency. As part of the effort to improve the energy performance of each individual building on campus, this segment of the plan involves identifying inefficient fans, pumps, boilers, heat exchanger, and other building components, and replacing them with more modern alternatives that incorporate technology such as well-commissioned variable frequency drives (VFDs). This part of the plan also involves replacing malfunctioning valves, steam traps, and other components related to the HVAC systems as needed.

Measure	Description
Building Retro-Commissioning and Improvement of Controls	The savings associated with upgrading individual building components are not maximized if their controls and sequence of operations are not programmed and integrated well. Building retro-commissioning aids in eliminating this issue by re-assessing a building's control system and sequence of operations in order to make sure that all building components are interacting in a manner that maximizes occupant comfort and eliminates energy waste. The advent of wireless technology and Internet of Things (IoT) also allows for more comprehensive feedback systems that can fine-tune a building's performance characteristics based on parameters such as level of occupancy. Building controls upgrades can incorporate such technology, such as wireless CO_2 sensors, into existing systems to better control the output of the building's ventilation system.
Full-Scale Building Renovations and Building Envelope Upgrades	Figure 14 shows the School of Image Arts building before and after a complete building renovation. The building was originally built in 1953, and completed a full-scale renovation in 2012. The implementation of a full-scale renovation provides a valuable opportunity to vastly enhance a building's energy performance. As mentioned previously, Ryerson's design standards require all new construction builds or major renovations to adhere to a minimum of LEED Silver standards. In lieu of a full-scale renovation, older buildings can also be upgraded through a comprehensive energy retrofit that includes a building envelope upgrade. Such measures involve sealing gaps and minimizing air infiltration across the building envelope.
District Heating Systems Upgrades	Ryerson makes use of district systems to meet most of its heating as well as cooling loads. One key difference to note is that while Ryerson produces it's own district chilled water, the steam in the district heating system is provided by Enwave. Each individual building is outfitted with heat exchangers that transfer heat from the steam to a hot water loop within the building. Since Ryerson has no control over the efficiency by which steam is generated, focus must be placed on the distribution network on campus, the heat exchangers, and the hydronic networks of the buildings. Efficiency upgrades of the district system would involve 1) steam distribution losses are minimized by having sufficient insulation on the distribution pipes, 2) maximizing heat recovery and utilization from the steam condensate wherever possible and 3) ensuring that the heat exchangers are operating as efficiently as possible.

Measure	Description
District Cooling System Upgrades	As in the case of the district heating system, efficiency of the district cooling system can be improved by ensuring sufficient levels of insulation around the distribution pipes. As the district chilled water is produced mostly within Ryerson's Central Chiller Plant, Ryerson has more control and ownership over potential savings. Improvement measures with regards to the district system involve 1) increasing the overall efficiency of individual components of the system, including pumps, fan motors, and chiller compressors 2) reviewing and modifying the sequence of operations of the control system of the plant as part of a retro-commissioning project to ensure that equipment are not operating at higher capacities than required. This is especially applicable in the coming year, as Ryerson installs a new chiller plant in Kerr Hall South to add to the existing district system's capacity.
Community Engagement	Student and staff engagement is an important component in any sustainability strategy. They have shown to be effective, particularly when students and staff see their peers engaged, when incentives are offered, and when marketing messages are tailored based upon the values and interests of the building users. Properly designed and delivered engagement strategies can go a long way in ensuring that building users realize the desired benefits of energy efficiency retrofits. It also offers one of the best chances for long lasting sustainable behavior on the part of new or older students and staff. A consistent and diverse engagement strategy, implemented by the Sustainability Office, shall lay the foundation of a culture of conservation on campus, which shall lead into Ryerson's long-term conservation plan.

Figure 14- The School of Image Arts Building (IMA), originally constructed in 1953, before (right) and after (left) undergoing full-scale building renovations in 2012

Long-Term Plans

Whereas the short and mid-term plans aim to reduce the energy consumption of individual buildings on campus, the long-term plan shall focus on finding synergies in energy efficiency by assessing the campus, and the operations within it, as a whole.

Measures to be considered as part of the long-term plan are outlined in Table 10. Although initiatives in the long-term plan are to be the main area of focus after approximately ten to fifteen years, the foundational steps that precede them shall take place in conjunction with short and mid-term initiatives. These foundational steps shall mostly involve reviewing case studies, implementing feasibility studies, and conducting pilot projects. Implementation of the long-term plan also requires up-to-date knowledge of new technologies and solutions being offered in the market.

Table 10- Measures for consideration as part of Ryerson's long-term energy conservation strategy.

Measure	Description
Smart, Integrated Scheduling of Building Use: Ryerson as a Smart Campus	The goal of this initiative is to switch from static to dynamic scheduling, in order to avoid the under-utilization of buildings and their base loads. As a basic example, it would be more energy efficient to operate a single building at full utilization than it would be to operate two buildings at half their utilization. Smart scheduling would eventually allow for whole buildings to be shut down or significantly ramped down on certain times and days, in the event that they are not expected to be heavily occupied. In such situations, their operations would be transferred to another building within campus. Smart scheduling is made especially possible with the rise of predictive analytics and machine learning. Using such tools, which are being developed at a rapid pace, Ryerson's expected campus occupancy could be determined ahead of time, and classes and other operations scheduled accordingly. It should be noted that this measure is not without its challenges, as it cannot be implemented in specialized buildings with laboratories, but is rather more well-suited for buildings primarily used for general classrooms and lectures. However, this measure still holds significant energy and utility cost savings potential, especially when considering Ryerson's comprehensive continuing education program, where classes mostly take place in the evenings, when occupancy on campus is significantly reduced.

Measure	Description
Increased Use of Renewable Energy	Ryerson's long-term energy conservation strategy shall also place a renewed focus on renewable energy. This shall primarily focus on roof-mounted photovoltaic (PV) panels. Ryerson procured the services of Internat Energy Solutions to conduct estimations of the power and annual energy potentially available through such systems on campus, based on existing conditions. These estimates have been listed in Table 11. Only buildings with sufficient roof space have been considered for such future measures. These buildings include the School of Image Arts (IMA), Rogers Communication Centre (RCC), and Pitman Hall (PIT). While Table 11 also lists Kerr Hall North and West in its estimates, it is quite likely that Kerr Hall shall undergo extensive renovations within the next ten to fifteen years. Ryerson currently has a small number of PV panels currently mounted on the roof of the Student Campus Centre (SCC). While a feasibility study shall also be conducted to install a geothermal system on campus, it should be noted that owing to Ryerson's location within a densely-populated urban centre, installation of such a system may involve re-organization of the City's as well as Ryerson's underground infrastructure, including utility piping. This could render such an initiative ineffective from a cost/savings standpoint.

Table 11- Estimates of energy available through the installation of roof-mounted PV panels on campus

Building	Size of System (kW)	Annual Electricity Generation (kWh)
IMA	99.4	118,519
KHN/KHW	386.4	346,964
RCC	102.1	125,424
PIT	40	43,490

Key Partnerships

As a place of discovery and learning, Ryerson plays a pivotal role within its community on a municipal, provincial, national, and international level. As such, any efforts geared around conservation and sustainability are rendered significantly more effective when they are conducted with the buy-in of the broader community. The role of internal and external stakeholders play a key role towards all aspects of conservation on campus.

External stakeholders include all utility providers to Ryerson's campus, as well as energy, sustainability, and conservation organizations and associations. Examples of such organizations include the following:

- Canadian Green Building Council (CaGBC)
- Ontario Association of Physical Plant Administrators (OAPPA)
- Natural Resources Canada (NRCan)
- Ontario College and University Sustainability Professional (OCUSP)
- Ministry of Training, Colleges, and Universities (MTCU)
- The City of Toronto

External stakeholders, including other universities and colleges, provide Ryerson with a wealth of information around conservation efforts and best practices. Apart from being valuable sources of information and knowledge-sharing, organizations such as utility providers and NRCan can also serve as potential sources of funding that act as catalysts towards conservation efforts.

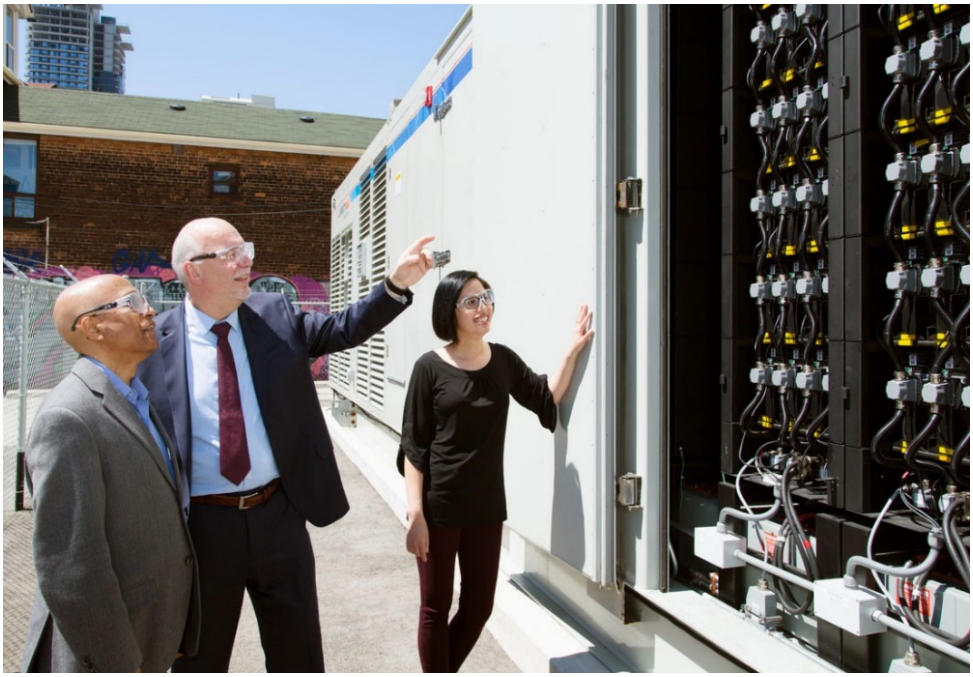

Figure 15- The Centre for Urban Energy (CUE) joined with Toronto Hydro to test a homegrown utility-scale battery system in the heart of the city

Internal stakeholders involve all operational and academic departments or teams that are geared around conservation and sustainability. Internal organizations focused on research around energy and water conservation include the Centre for Urban Energy (CUE) and Ryerson Urban Water (RUW). Both teams are located within the Centre for Urban Innovation (CUI), which came into service in 2018. The CUI is a research, incubation, and commercialization hub that is focussed on finding solutions to urban infrastructure issues. Figure 15 highlights collaboration between

Ryerson's internal and external stakeholders; in 2017, the CUE joined with Toronto Hydro to test a homegrown utility-scale battery system in the heart of Toronto.

Water Conservation

While this ECDM Plan has focussed primarily on energy conservation, Ryerson also recognizes the need for water conservation, from both an environmental and operational cost perspective. By adhering to LEED Silver standards, new construction and major renovation buildings are contributing to water conservation on campus. However, more can be done to conserve water on campus, including the following:

Figure 16- Ryerson received the Proof Not Promises Award from SUEZ in 2018

- Refit existing buildings with low flow alternatives to outdated faucets, toilets, and showerheads
- Building on partnership with Ryerson Urban Water to launch water conservation initiatives on campus
- Consider the feasibility of increasing use of grey water for purposes such as irrigation. Currently, grey water is collected at the Sheldon and Tracy Levy Student Learning Centre (SLC) and used to irrigate the green roof of the building

As mentioned previously, Ryerson received the SUEZ Proof Not Promises Award in 2018, in addition to a water charge credit from the City of Toronto, for tracking the amount of water being lost due to evaporation from the cooling towers.

Appendix

Campus Utility Metering Map

Campus Metering Map
Electricity

Rev 1 - May 2nd, 2016
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Ryerson University

Ryerson Operated - No Utility Steam

Ryerson Operated - Fed from Kerr Hall Steam

Ryerson Operated - Fed from LIB Absorption Chiller Steam

SLC is fed from the meter used for the absorption chillers in the main cooling plant located in LIB. These chillers do not operate nor does CF&S have plans to operate them in the future.

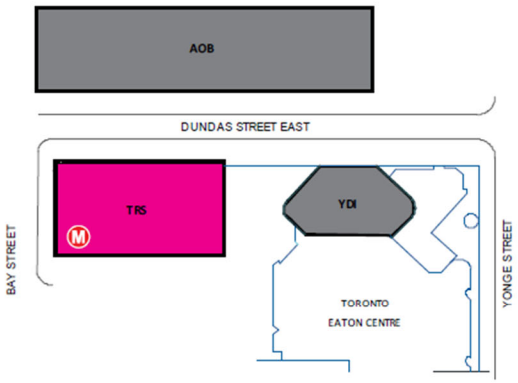
Ryerson Operated - Fed from ENG

Ryerson Operated - Fed from TRS

Not Operated by CF&S

Meter

Sub Meter



Campus Metering Map
Steam

Rev 1 - May 2nd, 2016

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Ryerson University

Ryerson Operated - Standalone

Ryerson Operated - Fed from Kerr Hall
KHN, KHE, KHS, KHW and RAC are all fed from 4 meters located in the North West, North East, South West and South East of Kerr Hall. Theses feeds are only partially integrated.

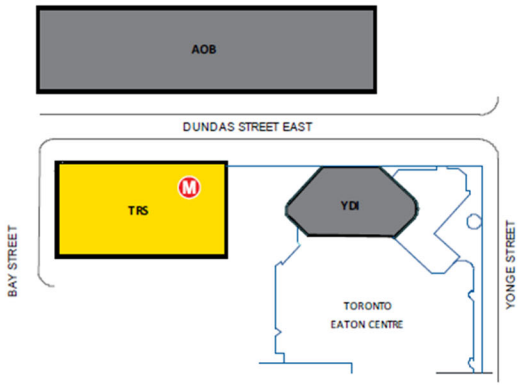
Ryerson Operated - Fed from JOR and LIB
JOR, POD and LIB are all fed from two meters, one in JOR and one in LIB.

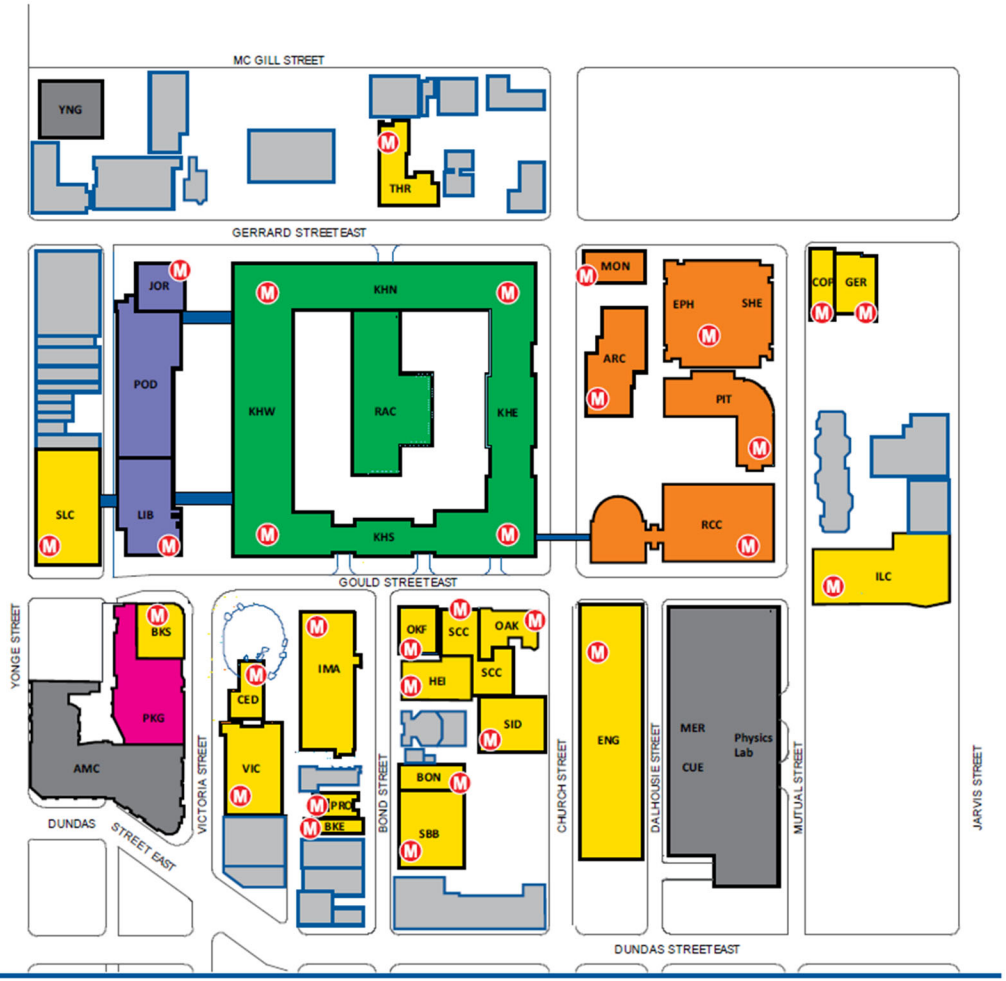
Ryerson Operated - Standalone Billed to 87 Gerrard
MON, EPH/SHE, ARC, PIT, and RCC are all addressed to 87 Gerrard st. but all meters are located in the respective buildings and the feeds are standalone.

Ryerson Operated - No Utility Water Billing

Not Operated by CF&S

Meter





Campus Metering Map
Domestic Water

Ryerson Operated - Standalone
Note: While we know the TRS has gas and corresponding meter, we have never received a bill for this gas.

Ryerson Operated - Fed from Kerr Hall
Kerr hall has three gas meters which serve KHN, KHE, KHS, KHW, and RAC. These gas feeds are only partially integrated.

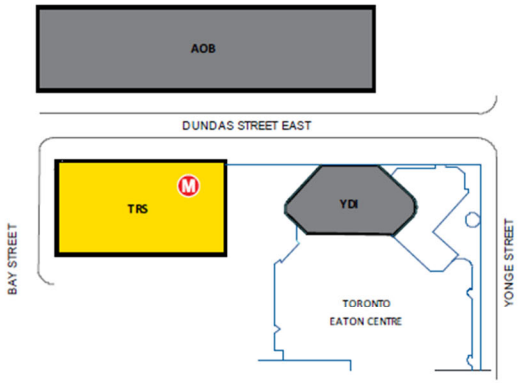
Ryerson Operated - Fed from JOR and LIB

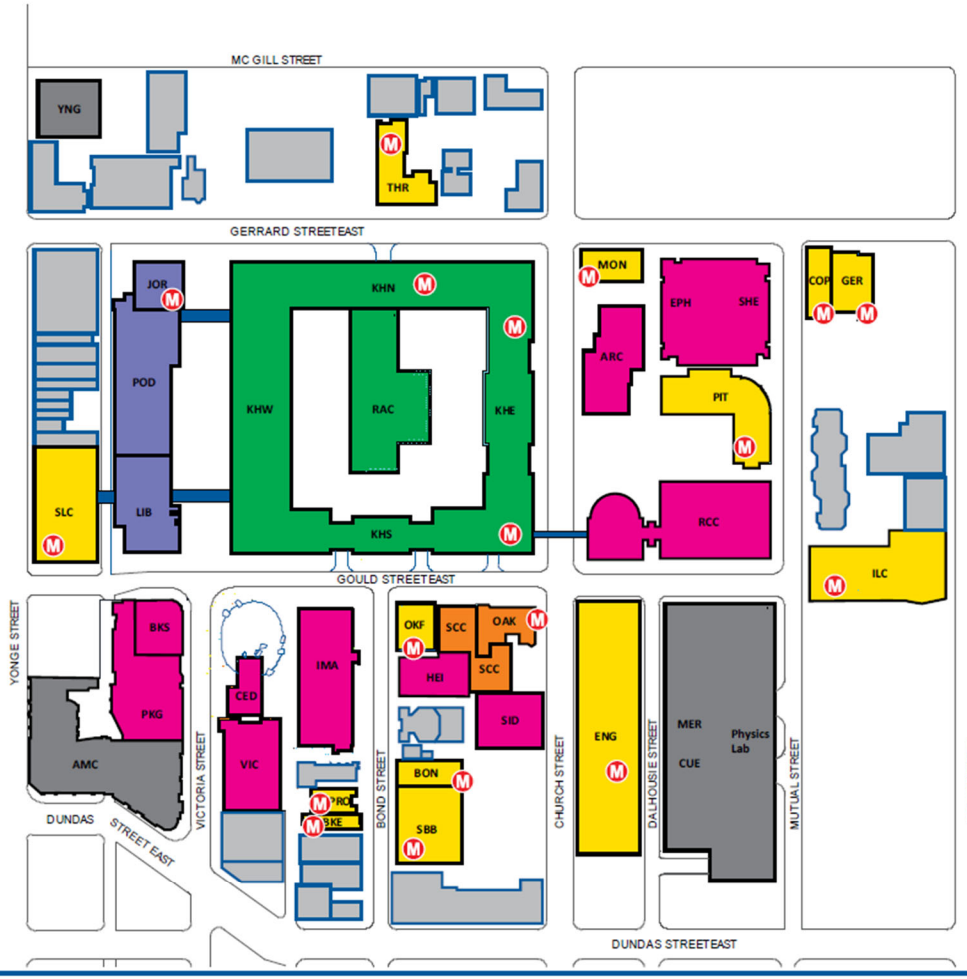
Ryerson Operated - Fed from OAK

Ryerson Operated - No Gas Supply

Not Operated by CF&S

Meter





Campus Metering Map
Gas

RETScreen Regression Sample for Estimated End-Use Breakdown