**UNIVERSITY OF CALGARY**

# 2019 CLIMATE ACTION PLAN

November 2018

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# EXECUTIVE SUMMARY

Climate change is one of the most pressing and complex challenges facing contemporary society. As a research-intensive university located in a province with deep roots in the energy industry, the University of Calgary can utilize innovative industry partnerships, as well as academic endeavours to address climate action. The university will become a learning lab for deep decarbonization and demonstrate leadership on climate change.

The university's Climate Action Plan (CAP) is an operational planning document that guides short-term and long-term decision making to reduce institutional greenhouse gas (GHG) emissions and the financial and reputational risks associated with institutional GHG emissions. It is an important tool to drive institutional contributions to the Canadian emissions reduction targets, to help the university stay ahead of future regulation, and maintain a leadership role in energy innovation.

The University of Calgary published its first CAP in 2010 with ambitious institutional goals to reduce Scope 1 and Scope 2 GHG emissions. This plan has been fundamental in reaching the significant GHG emission reductions that the university has realized to date. Since 2008, the university has added more than 180,000 square meters of newly built space (22% of growth) and the population of students has increased by approximately 16% over this same period. Despite this growth, and taking into consideration the energy efficiency conservation measures implemented in 2017/18, GHG emissions (Scope 1 and 2) across all campuses are estimated to be approximately 30% lower in 2018/19 than in 2008. This is on par with the current national reduction target set for 2030.

The renewal process for the CAP included consultation with internal and external stakeholders, including focus groups, an experts forum, integrated design process workshops and other opportunities for engagement. The scope of the CAP includes emissions reductions through cleaner energy supply, energy demand reduction and other opportunities such as behavioural change and fleet opportunities. The recommended climate actions include what will be required to achieve significant decarbonization by 2050 with a more detailed focus on actions through to 2030. The CAP focuses primarily on Scope 1 and 2 GHG emissions, of which over 99% are attributed to the built environment.

The CAP outlines short-term (2020 to 2025), medium-term (2025 to 2030) and long-term (2030 to 2050) actions to realize emissions reductions of **35%** below 2008 levels by 2025, **50%** below by 2030, and **97%** below by 2050. These actions include:

- Green Power: Procurement of clean power and installation of onsite renewables.
- Decarbonization of the District Energy System (DES) on main campus: The progressive transformation of the DES on main campus into a next-generation, low-temperature, low-carbon district system. A critical transition point will occur when the existing cogeneration plant reaches the end of its expected useful life (around 2035).
- New Building Innovation: Mitigation of the impact of growth through ultra-energy efficient, net-zero carbon new construction.
- Existing Building Energy Retrofits: Drastic reduction of energy demand through a four-tiered energy retrofit program for existing buildings, as well as continued renewal and repurposing to improve space utilization.
- Behavioural Awareness and other actions not directly related to energy supply and the built environment, but still necessary to engage the university community in helping to achieve emissions reductions.

Transforming the University of Calgary's energy system from a mainly fossil fuel-based system to one that is supplied by minimal fossil fuels requires the support of university leadership, industry partners, and other community stakeholders. The successful implementation of the CAP requires a significant, stable and accessible pool of funds for investment in renewable energy and energy efficiency. Periodic reviews of the CAP will be conducted every five years to update targets and actions.

# INTRODUCTION

## Foreword

According to the United Nations, "Climate change is now affecting every country on every continent. It is disrupting national economies and affecting lives, costing people, communities and countries dearly today and even more tomorrow" (U.N., n.d.). There is a strong scientific consensus that the climate is changing and that human activity contributes significantly to this trend through the creation of greenhouse gases, including carbon dioxide. Given the global nature of this phenomenon, it is not possible for any single nation, locale or organization to halt climate change. However, the opportunity exists for all organizations to engage in climate leadership, thereby providing the necessary collective action to address the climate challenge. Post-secondary institutions are uniquely positioned to lead the way by dramatically reducing their operating emissions, demonstrating innovative technologies and practices, and focusing on the climate challenge within their research and teaching endeavours.

The University of Calgary is recognized today as a Canadian post-secondary leader in sustainability, in its academic and engagement endeavours, operational practices, and through supporting community and industry in their aspirations for leadership in sustainability. The university can, and should, play an integral role in Alberta's climate leadership. As a research-intensive university located in a province with deep roots in the energy industry, the University of Calgary can utilize innovative industry partnerships, as well as our academic endeavours and our operational practices to address the climate challenge. Through these actions, the university can become a learning-lab for deep decarbonization. The university's Climate Action Plan (CAP) is an instrumental and foundational document that will continue to drive us forward and stretch us toward our aspirational target to be a net-carbon neutral institution.

## The University of Calgary Climate Action Plan

### Background

In 2008, the University of Calgary became a signatory to the University and College Presidents' Climate Change Statement of Action for Canada. As part of this commitment, the University of Calgary launched its first CAP in 2010. The University of Calgary's 2010 CAP identified strategies for achieving institutional greenhouse gas (GHG) emission reduction targets that were aligned with leading universities and municipalities across North America.

Since then, the university has attained significant GHG emissions reductions primarily on the main campus through the installation of a cogeneration unit that produces more electricity with lower emissions than the Alberta grid and allows recovery of the waste heat to generate hot water; the mitigation of emissions growth from new buildings through progressive energy and GHG emission performance requirements; and the implementation of energy efficiency programs for existing buildings. Taken together, these initiatives have achieved an approximate 36% reduction of GHG emissions on a per student basis from the 2008 baseline, and approximately 30% in absolute reductions from the 2008 baseline – despite adding more than 180,000 square metres of newly built space and a 16% growth in student population. This progress positions the University of Calgary as one of Canada's post-secondary education leaders in GHG emissions reductions. Further, the university has reached the federal target for a 30% reduction in GHG emission over a decade ahead of the 2030 timeline.

In 2016, the University of Calgary launched its Institutional Sustainability Strategy (ISS), which includes the aspirational goals of striving to attain net carbon neutrality and becoming one of the most energy efficient campuses in Canada. The University of Calgary's actions to date and the rapidly evolving regulation and policy trends call for the renewal of the CAP.

## Purpose of the CAP

The CAP is an operational planning document that guides short-term and long-term decision-making to reduce institutional GHG emissions and the potential financial and reputational risks associated with these emissions. It is a valuable tool to drive institutional contributions to meeting the Canadian GHG emissions reduction targets, remaining ahead of future regulation and to help the university maintain a leadership role in energy innovation. It lays the foundation for the University of Calgary's leadership on climate action.The CAP sits under the Institutional Sustainability Strategy and supporting Framework on Sustainability in Administration and Operations. It directly supports the following aspirational objectives of the operational framework:

- striving to attain net carbon neutrality;
- aiming to be one of the most energy efficient campuses in Canada;
- striving to reduce impacts on the environment and our surrounding communities;
- aiming to be a Canadian leader in high-performance green buildings and sustainable sites practices; and
- aiming to be a zero-waste community.

The CAP will function as a roadmap for the transition to a low-carbon campus and complement the univerisity's research strategy, *Energy Innovations for Today and Tomorrow*. The scope of the CAP includes emissions reductions through energy supply, energy demand and other opportunities (e.g. fleet, IT, waste, etc.). It includes buildings and assets, which the university has operational control over including the main campus, Foothills campus, Spy Hill campus, downtown campus and research stations (1,010,645 $m^2$ total). Given the dynamic nature of the policy environment for climate change, advances in technology and shifts in strategic direction, the CAP will be a living document that can be amended over time.

## Renewal Process

The following principles guided the CAP renewal process:

- data-driven planning and decision-making;
- integrated planning process;
- whole systems design while focusing on energy and emissions;
- build long-range capacity for resiliency and adaptation;
- align with recognized best practice;
- employ a participatory process by engaging students, faculty, staff and industry experts; and
- support Campus as a Learning Lab partnerships where possible.

The renewal process leveraged existing committees including the Operational Sustainability Steering Committee (OSSC), the Energy and Emissions Steering Committee (EESC) and the Sustainability Stewardship Working Groups (SSWG). Consultation included an online survey, web polls, focus group sessions, pop-up sessions, subject matter expert interviews, experts forum and integrated design process (IDP) workshops. Appendix A provides additional detail on each stage of the consultation process.

# PLANNING CONTEXT

The planning context for the CAP includes a variety of external regulatory and policy drivers at different levels of government, emerging technology opportunities, and resiliency and risk mitigation. The current planning context is characterized by a high speed of change and increasing complexity.

## External Regulatory and Policy Drivers

The Conference of the Parties (COP21) climate conference held in Paris in November 2015 brought together tens of thousands of people from 195 countries to tackle the question: How can we keep global temperatures from rising to the point that would result in significant, irreversible impacts to the planet? Countries set their own targets for reducing national GHG emissions and collectively they formed the Paris Agreement on Climate Change, which went into force on November 4, 2016. The new agreement aims to prevent the global average temperature from rising two degrees Celsius above pre-industrial levels. As of November 2017, 195 United Nations Framework Convention on Climate Change (UNFCCC) members, including Canada, have signed the agreement.

In 2015, the Government of Canada held to its commitment made as part of the Copenhagen process, which preceded COP21, the following: an 80% reduction in emissions from 2005 levels by 2050; a 30% reduction in emissions from 2005 levels by 2030; and a 17% reduction by 2020. The 2020 and 2030 pledges set the international foundation for the federal government's climate agreement with provinces. On March 3, 2016, Canada's premiers and prime minister released the Vancouver Declaration on Clean Growth and Climate Change and agreed to take a collaborative approach between provincial, territorial, and federal governments in reducing GHG emissions and enabling sustainable growth.

In December 2016, the Pan-Canadian Framework on Clean Growth and Climate Change was released calling for all jurisdictions in Canada to implement carbon pricing by 2018. Market signals also suggest the potential for mandatory energy disclosure and benchmarking, increasing the stringency of existing energy codes, and a zero-carbon building standard among other new policy directions. Large building portfolio holders such as universities should be preparing for these changes. Further, a new Government of Canada Clean Fuel Standard forecast for release in 2020 is expected to include fuels for transportation, industry and buildings. Proposed amendments to federal coal-fired electricity regulations are expected to impact five coal-fired electricity plants in Alberta.

These rapid changes in policy and regulation are also creating new opportunities. In 2017, the federal government committed $2 billion to the Low Carbon Economy Fund to support the Pan-Canadian Framework on Clean Growth and Climate Change. Combined with carbon levy revenue at both federal and provincial levels, the $2 billion commitment translates into incentive programs to drive down Canadian GHG emissions. This presents an opportunity for the university to align GHG emission reduction strategies with financial incentive programs, but matching funding is likely to be required. Existing building energy efficiency in Canada has the potential to provide more than 50% reduction in Canadian GHG emissions by 2030 with the added benefits of jobs, tax revenue and operational cost savings (Canada Green Building Council, 2018).

As part of its Climate Leadership Plan, the Government of Alberta (n.d.-a) has brought in regulations to eliminate coal-fired electricity in Alberta by 2030. Alberta's carbon levy, which the university is subject to, was introduced in 2017. The carbon levy started at $20 per tonne of carbon dioxide equivalent ($CO_2e$) in 2017 and was increased to $30 per tonne in 2018. The carbon levy under the federal legislation is expected to reach $50 per tonne by 2022. The university partially mitigated the impact of the carbon levy in 2017 by opting into the Specified Gas Emitters Regulation (SGER) and has recently opted into the new Carbon Competitiveness Incentive Regulation (CCIR), which replaced the former SGER. At $50 a tonne, and if mitigation options such as opting into the CCIR to reduce the cost of carbon are not available in the future, the carbon levy impact to the university is projected to be over $4.5 million annually based on current Scope 1 GHG emissions.

The City of Calgary Council approved its climate resilience strategy, *Mitigation & Adaptation Action Plans*, in June 2018. The plan outlines the strategies and actions The City will take to improve energy management, reduce GHG emissions and become more resilient to the extreme events caused by climate change. The Climate Mitigation Action Plan identifies the role and actions of The City to reduce emissions and enable the low-carbon economy. The Climate Adaptation Action Plan identifies the risks and vulnerabilities from severe weather events and involves an iterative process of risk assessment. Finally, The City is part of the 100 Resilient Cities Network.

## Institutional Emissions Considerations as a Result of a Lower Carbon Grid

The Federal Coal Regulation and Alberta's coal phase-out commitment will see the elimination of coal by 2030. Concurrently, the Alberta Renewable Electricity Act requires that at least 30% of electric energy produced in the province come from renewable energy sources by 2030. This will result in a significant drop in grid emissions intensity from purchased electricity. The decarbonization of the Alberta electrical grid means that the total GHG emissions reductions obtained from the displacement of grid electricity, through the use of the university's current cogeneration plant, will progressively erode over time. According to recent projections, the carbon intensity of the Alberta electrical grid could see a drop of 60% from current levels by 2035 (Government of Canada, 2018). Based on these projections, the university's cogeneration plant could become an emissions liability beyond 2030, which somewhat coincides with its expected end of service life in 2035.

## Emerging Technology Opportunities

The emergence of new technologies is creating new possibilities, challenges and uncertainties in the energy market. Four factors in the energy market are transforming the way energy is being distributed and used:

1. new technologies, including renewables and energy storage;
2. distributed generation;
3. smart distribution grid; and
4. the convergence of information technologies with operational technology.

These factors are forecast to play a pivotal role in accelerating the process of electrification of the energy systems that support all economic and human activity. System electrification of end-use services, such as vehicles, is one of the key approaches for transitioning away from natural gas (University of California, 2018). The CAP renewal project considered ways in which these emerging technologies could potentially enable the University of Calgary to advance toward its aspirational goal of net carbon neutrality.

In their report on *Game Changers in the Energy System, Emerging Themes Reshaping the Energy Landscape* the World Economic Forum and McKinsey & Company (2017) highlight the unique planning landscape in which the CAP renewal is taking place. The report highlights, "Now that so many pieces of the ecosystem are in flux, it has become unusually difficult to anticipate what the future holds – and to know what actions are required today to thrive in years ahead. Understanding the urgency and implications of these "game-changing" trends will be critical to businesses…responding to these game-changing trends will require fundamental shifts in how businesses are run, (and) how policies are set…" Responding to this and remaining adaptive to a rapidly changing technology and energy context will be critical.

## Resiliency and Risk Mitigation

Climate change is having a significant impact at local and global scales and we are seeing increasing frequency and magnitude of events. Alberta has experienced significant changes in its climate in recent decades. These climatic changes are leading to increased severity and frequency of extreme weather events including more severe flooding, drought, wind, hail and rainfall events (Figure 1).

Calgary winters are forecast to be shorter and warmer with potential for more substantial snowstorm events, and an emerging hazard of freezing rains and wet snow. Calgary will see rapid changes in temperature that will stress infrastructure and heating and cooling systems within buildings. Calgary is predicted to experience between nine and 34 high-heat days over 28 °C by the 2050s, and 22 to 68 days by the 2080s (City of Calgary, 2018).

These hazards have concerning implications, including impacts on municipal water resources, failures of infrastructure when design assumptions are exceeded by changing conditions, and effects on human health and mortality. Climate action best practices involve taking resiliency and risk mitigation issues into consideration when planning. According to Second Nature (n.d.), Resilience is the ability of a system or community to survive disruption and to anticipate, adapt, and flourish in the face of change.[1]"

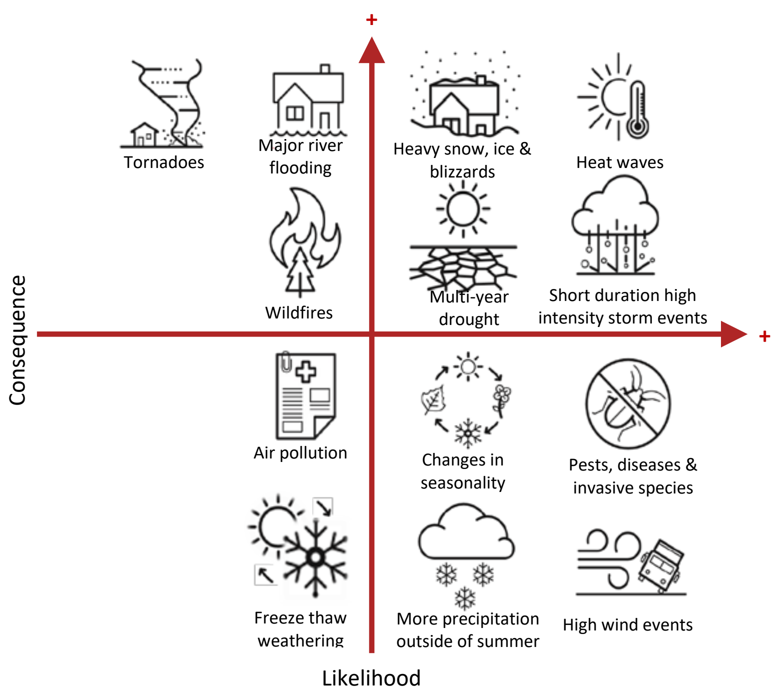


***Figure 1.*** Climate change risk profile for Calgary (City of Calgary, 2018).

[1] Further, the dimensions for campuses and communities to consider in creating resilience include ecosystem services, infrastructure, economic, social equity & governance, and health & wellness. Considering each of these dimensions within the context of climate change will enable campuses to develop a plan that addresses the entire system.

# CURRENT EMISSIONS AND PROGRESS TO DATE

## University of Calgary Emissions Profile

### Current Emissions

This section highlights the University of Calgary's current GHG emissions profile. Globally, GHG emissions are categorized by scope as follows:

- **Scope 1**: Direct GHG emissions from sources that are owned or controlled by an organization, including stationary/mobile combustion of fossil fuels and animal husbandry.
- **Scope 2**: Indirect GHG emissions from sources that an organization does not own or control, but are a direct result of its operation. For the university, this includes emissions associated with electricity and steam purchasing.
- **Scope 3**: Other indirect GHG emissions from sources that an organization does not own or control, including emissions from commuting, transmission and distribution losses, waste, financed travel, paper, and wastewater.

The figures below are based on the fiscal year 2017/18 University of Calgary Greenhouse Gas Inventory. This inventory includes Scope 1 and Scope 2 data across all sites under operational control by the university. In fiscal year 2017/18, the university was responsible for GHG emissions of 182,122 metric tonnes of Scope 1 and Scope 2 carbon dioxide equivalent ($CO_2e$). The following table provides a comparison of 2016/17 GHG emissions with our 2008 baseline year (2008/09):

***Table 1***. Total greenhouse gas emissions

| | 2008/09 | 2017/18 | Change |
|---|---|---|---|
| | metric tonnes $CO_2e$ | | % |
| Scope 1 | 50,133 | 86,931 | 73% |
| Scope 2 | 189,822 | 95,181 | -50% |
| **Total Scope 1 & 2** | **239,955** | **182,112** | **-24%*** |

*Emissions reductions from the Utility Reduction Program (URPr) Years 1 & 2 completed in 2017/18 will be fully realized in 2018/19.

An increase in Scope 1 emissions over the 2008 baseline is primarily due to the increased consumption of natural gas at the cogeneration plant. Combustion of natural gas was the most significant contributor to the university's 2017/18 GHG emissions, releasing 86,931 metric tonnes of $CO_2e$ (47% of total Scope 1 & 2 emissions). The decrease in Scope 2 emissions is due to the production of lower GHG intensity electricity on main campus through cogeneration, thereby lowering the purchase of grid electricity. Electricity produced from cogeneration continues to provide substantially lower GHG emissions intensity over grid electricity. Additional efficiencies are also realized through cogeneration by capturing waste heat for use in building heating.

GHG emissions growth can also be attributed to institutional growth, both in campus population and building area. By comparing the GHG intensity of the university's emissions in 2008/09 and 2017/18, emissions can be assessed on a more comparable basis. Table 2 summarizes GHG intensity with respect to full-time equivalents (FTE)[2] and gross square metres (GSM). It is evident that the university has significantly decreased its GHG emissions under all metric comparators.

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[2] Staff and faculty population is measured in FTE. Student population is measured in full-load equivalents (FLE). The estimated total campus population reported in this table (in FTE) is the sum of the total staff and faculty population (FTE) plus the total student population (FLE).

***Table 2***. Greenhouse gas intensities

| | 2008/09 | 2017/18 | Change (%) |
|---|---|---|---|
| Total Scope 1 & 2 Emissions (metric tonnes $CO_2e$) | 239,955 | 182,112 | -24% |
| Campus Population (FTE) | 29,214 | 34,100 | 16% |
| Building Area (GSM) | 829,938 | 1,010,933 | 23% |
| GHG Intensity (metric tonnes $CO_2e$ / FTE) | 8.21 | 5.34 | -35% |
| GHG Intensity (metric tonnes $CO_2e$ / GSM) | 0.29 | 0.18 | -39% |

Figures 2 and 3 highlight the institutional GHG emissions scope profiles. Scope 1 GHG emissions represent nearly 50% of the University of Calgary emissions footprint as illustrated below. All of the steam purchased by the university is consumed at the Foothills Campus. Natural gas for the central plant on main campus accounts for over 90% of the gas used by the university.

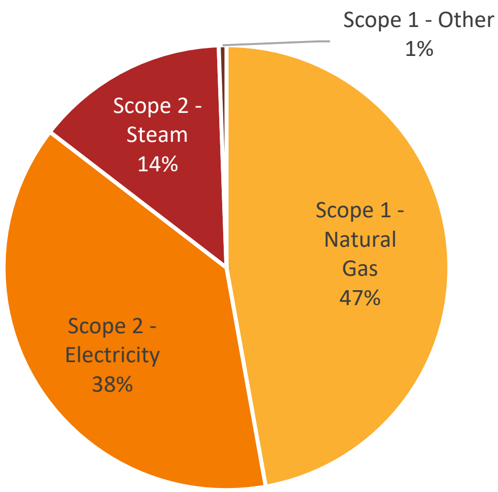


***Figure 2.*** GHG emissions by source (2017/18).

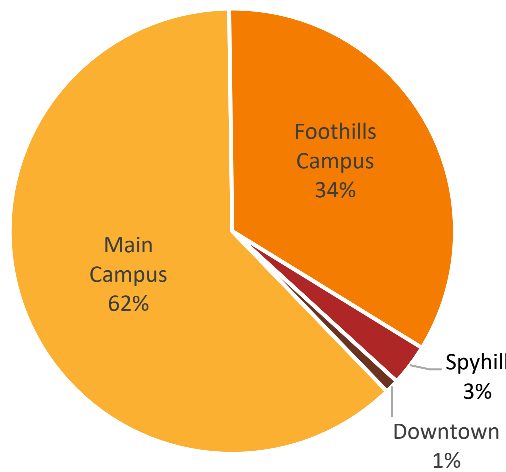


***Figure 3.*** GHG emissions by campus (2017/18).

Main campus and Foothills campus account for over 95% of Scope 1 and Scope 2 emissions (see Figure 3). Emissions from the built environment account for over 99% of total Scope 1 and Scope 2 emissions footprint (electricity, natural gas and steam).

Scope 3 GHG emission inventories cover a broad spectrum of indirect emissions related to commuting, transmission and distribution losses, waste, financed travel, paper and wastewater. In the case of purchasing, reporting is dependent on the capacity of third parties to provide emissions data on their products, which is not yet broadly available. As it is difficult to undertake a true and fair Scope 3 GHG emission inventory, most organizations do not yet publish full Scope 3 inventory. The university will reexamine Scope 3 emission inventories as part of periodic reviews to determine how best to move this element forward in future years.

The university has undertaken a partial Scope 3 GHG inventory with a focus on commuting, transmission and distribution losses, and waste. Since the data is incomplete, these figures are not included in the CAP. The inventory identified opportunities for improving Scope 3 reporting. The CAP consists of strategies to reduce Scope 3 emissions associated with commuting and waste. Procurement strategies are being addressed separately through the implementation plan for the Framework on Sustainability in Administration and Operations.

## Emissions Reductions to Date

The University of Calgary issued its first CAP in 2010 with ambitious goals to reduce Scope 1 and Scope 2 GHG emissions.[3] This plan has been fundamental in guiding the significant climate action that the university has undertaken. Since 2008, the university has added more than 180,000 square metres of newly built space and the population of students has increased by approximately 16%. Despite this growth, over the past eight years institutional climate actions have resulted in a 30% reduction in absolute emissions and close to a 40% reduction in GHG intensity (tonnes $CO_2e$ / GSM). Without the initiatives identified in the original CAP, the University of Calgary GHG footprint would include an additional 125,000 tonnes $CO_2e$, positioning the university as a Canadian post-secondary leader in GHG emission reductions. The annual utility cost avoidance associated with the emission reduction actions delivered since 2010 is approximately $4.8 million, underscoring the effectiveness of institutional action when aligned under an integrated, strategic CAP.

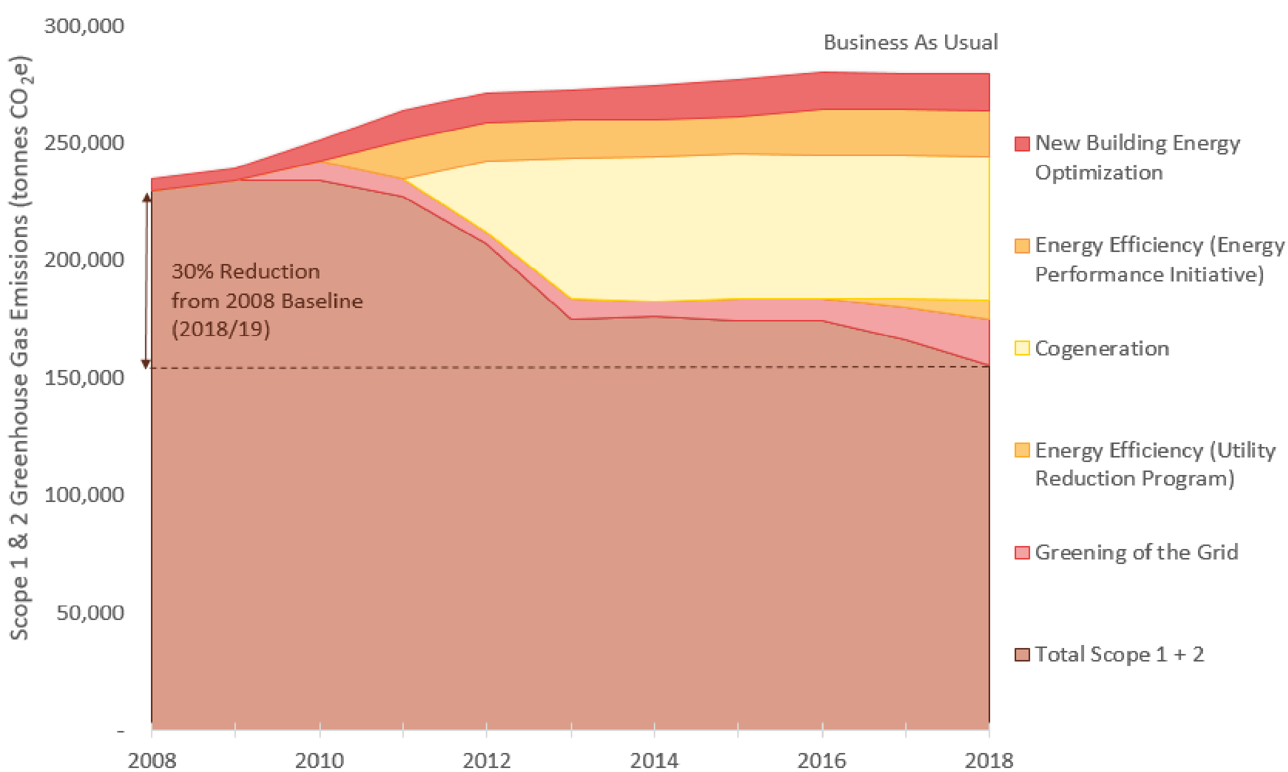


***Figure 4.*** University of Calgary greenhouse gas emissions reductions 2008 through 2018

[3] The 2010 Climate Action Plan aimed to reduce Scope 1 and Scope 2 GHG emissions by approximately 49% by 2015, 56% by 2020 and 80% by 2050.

# RECOMMENDED CLIMATE ACTIONS

## Overall Emissions Reductions Scenario

During the spring and summer of 2018, subject matter experts from among university staff and specialized consultants came together to discuss ideas about how to tackle the challenge of achieving deep decarbonization by 2050; a task aligned with the long-term aspirational goals stated in the University of Calgary's Institutional Sustainability Strategy (2016). Through a series of integrated design process (IDP) sessions, the group explored different decarbonization scenarios for the university and the feasibility of achieving some key milestones for each of these scenarios by specific dates. The actions recommended in this report, as described in the following sections, represent the group's consensus about the most reasonable path towards net carbon neutrality that can be envisioned for the institution at a 2018 point in time. Key milestones and targets along that path are summarized in Figure 5.

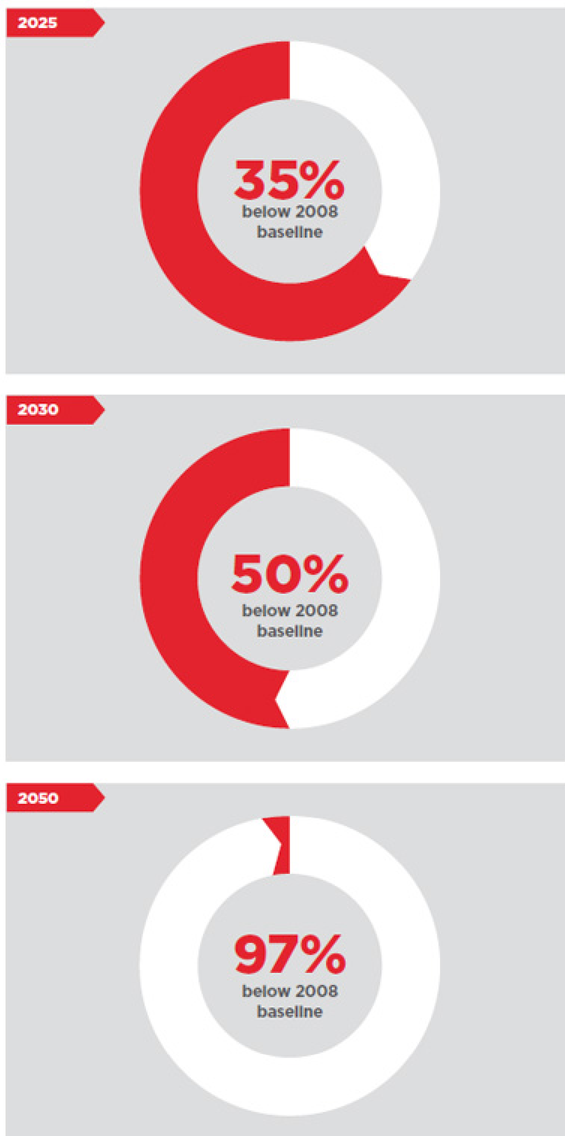


**Figure 5.** University of Calgary 2019 Climate Action Plan GHG emissions reduction targets.

Through the IDP sessions, a number of short-term, medium-term and long-term actions emerged as important steps in the path towards a low-carbon future. These actions are the outcomes of a planning process that took into consideration the university's long-term aspirational goal of net carbon neutrality, but also the emerging trends identified above (e.g., policy, regulations, technology) and the responsibilities associated with long-term stewardship of institutional assets (e.g., buildings and the district energy system). Further analysis will likely be required to determine details related to some of the recommended actions. However, the key areas of focus for climate action were clearly identified through the IDP sessions. Figure 6 shows the relative contributions of these focus areas to the achievement of the 2030 reduction target.

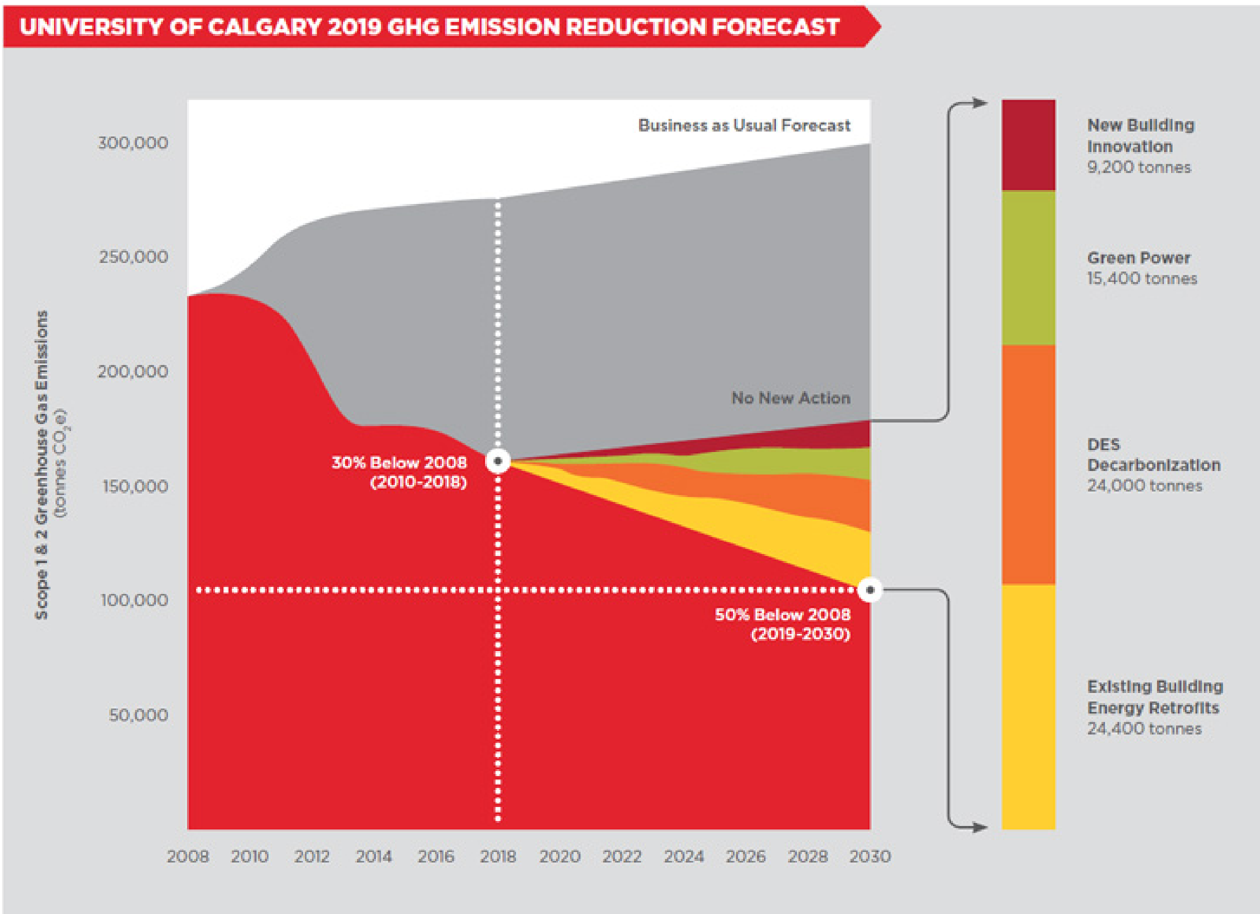


***Figure 6.*** Proposed reductions versus the business as usual (BAU) forecast.

As shown above, the recommended actions of this plan fall into the following major categories:

**Emissions Reductions through Cleaner Energy Supply:**

- Green Power: Procurement of clean power and installation of onsite renewables.
- Decarbonization of the District Energy System (DES) on main campus: The progressive transformation of the DES on main campus into a next-generation low-temperature, low-carbon district system with a critical transition point when the existing cogeneration plant reaches the end of its expected useful life (around 2035-2040).

**Emissions Reductions through Energy Demand Reduction:**

- New Building Innovation: Mitigation of the impact of growth through ultra-energy efficient, net-zero carbon construction.
- Existing Building Energy Retrofits: Substantial reduction of energy demand through a four-tiered energy retrofit program for existing buildings.

Beyond Scope 1 and 2 GHG emissions, the university also has the opportunity to achieve emissions reductions through behavioural change and other opportunities associated with activities that generate Scope 3 emissions.

# Emissions Reductions through Cleaner Energy Supply - Green Power

| 2025 Reductions | 10,500 tonnes | 2030 Reductions | 15,400 tonnes | 2050 Reductions | 25,400 tonnes |
|---|---|---|---|---|---|

As part of its Climate Leadership Plan, the Government of Alberta (n.d.-a) has introduced regulations to eliminate coal-fired electricity in Alberta by 2030. Several coal-fired facilities have entered into agreements with the Alberta Government to end operations or convert to natural gas before the 2030 date. The impact of these decisions is forecast to lead to most plants moving towards shutting down before 2030 regardless of changes in policy. At the same time, through the Renewable Electricity Program (REP), the provincial government is planning to add 5,000 MW of renewable energy to the grid by 2030 to help make up for the loss of coal-fired electricity (Government of Alberta, n.d.-b). Based on current trends, the university anticipates that green power production will be cost competitive with grid electricity in the near term. These trends would provide a low-cost or cost-neutral opportunity for the university to reduce its carbon footprint through the procurement of green power.

Deep decarbonization requires the displacement of electricity generated through fossil fuels and its replacement with clean, carbon-free electricity[4]. The rapid growth in cost-effective renewable energy supply in the province of Alberta will enable the university to procure 100% of purchased electricity from renewable sources in the mid-term time horizon. The University of Calgary has the opportunity to leverage its purchasing power and be an early actor in the shift to 100% green electricity through negotiating power purchase agreements (PPAs) to secure green electricity. Notwithstanding this opportunity, a gradual approach to transition to 100% green electricity supply is modeled in this report over several years. The university must closely monitor these trends and take advantage of emerging opportunities in a timely fashion.

On-site generation will have a smaller impact on the overall carbon reduction goals. Limited open space at the main and Foothills campuses dictates that generation will be limited to solar photovoltaic (PV) and solar thermal installations on buildings and possibly parking lots. Penetration of these technologies will be limited due to higher costs relative to procurement off-site. Nonetheless, on-site renewable energy generation plays a vital role in adding to institutional resiliency and supporting research and learning. Other university properties such as the field stations and Spy Hill campus will permit larger installations and possibly other technologies including wind and biodigesters. Field stations, in particular, have the potential to be 100% off-grid for energy production.

## Near-Term Actions

- **Energy Market Trends Research** – Continuously monitor developments in the Alberta energy market to identify emerging trends, challenges and opportunities.
- **Off-Site Renewable Energy Procurement Strategy**
    a. Initiate a study to confirm the cost impact of procurement of green power, considering varying

[4] Currently, the amount of electricity generated by the university's cogeneration plant is equivalent to approximately 80% of the electricity required by main campus.

percentages up to 100% of the externally purchased electricity, including the possibility of long-term power purchasing agreements (PPAs).
    b. Implement the near-term recommendations of the strategy.

- **On-Site Renewable Generation Strategy**
    a. Develop a strategy including financing model and potential partners for the installation of renewable energy on all campuses.
    b. Develop renewable energy strategies for field stations to enable off-grid operations.
    c. Ensure all new major capital projects include renewable energy.

### Medium-Term Actions

- **Off-Site Renewable Energy Procurement** – Implement the mid-term recommendations of the strategy to increase green power supply to 100%.
- **On-Site Renewable Generation** – Implement the mid-term recommendations of the strategy.

## Emissions Reductions through Cleaner Energy Supply - Decarbonization of District Energy System on Main Campus

| 2025 Reductions | 2,500 tonnes | 2030 Reductions | 24,000 tonnes | 2050 Reductions | 80,000 tonnes |
|---|---|---|---|---|---|

The elimination of natural gas has been identified as “the central challenge to carbon neutrality” (University of California, 2018). The combustion of natural gas at the central plant on main campus generates more than 80,000 tonnes $CO_2e$, which represents over 40% of the institutional GHG emissions (Scope 1 and Scope 2). To achieve the university’s long-term goal of net carbon neutrality with the currently available technology, the DES on main campus would have to be upgraded to a next-generation low-temperature, low carbon district system.

A low-temperature, low-carbon district energy system (DES) distributes heating water at temperatures in the range of 60 degrees Celsius, instead of operating at the higher-heating water temperatures that are typically obtained through the process of combustion. Low-temperature, low-carbon DES typically rely on a variety of energy sources as illustrated in Figure 7. It enables optimum energy performance across the campus through the use of energy exchange and storage technologies. Besides its environmental benefits, this next generation DES can offer higher reliability and flexibility in energy procurement. It provides improved opportunities to incorporate new advanced technologies including smart grid capabilities. By decentralizing elements of the DES, distributed redundancy can be built into it, which would increase the overall resiliency of campus infrastructure. The transition towards a next generation low-temperature system can also reduce some of the risks posed by the high temperatures and pressures associated with the current DES.

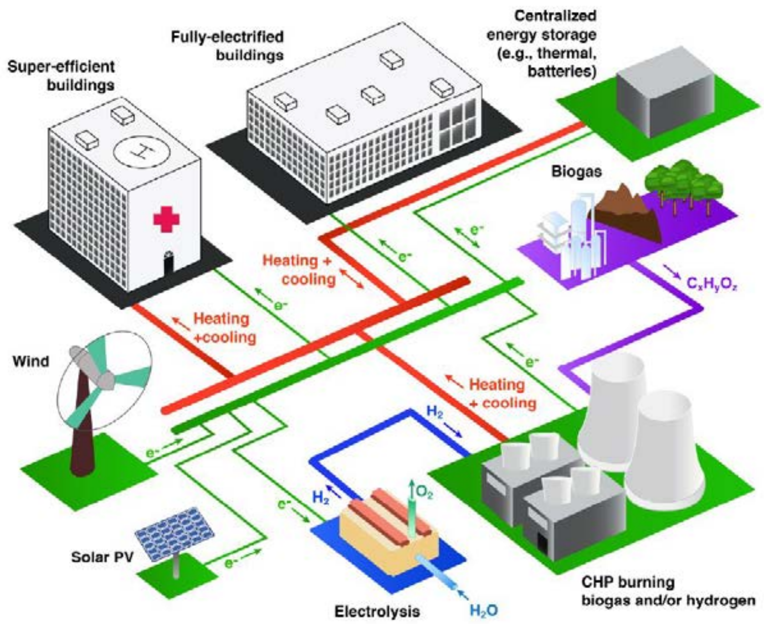


***Figure 7.*** Schematic of a low-temperature, low-carbon district system that would reduce the use of natural gas. (University of California, 2018, February). Strategies for Decarbonization: Replacing Natural Gas. Retrieved from https://www.nceas.ucsb.edu/files/research/projects/UC-TomKat-Replacing-Natural-Gas-Report_2018.pdf

This transition would require a major project that must be implemented over several years, but a critical moment in this process will happen around 2035 when the existing cogeneration plant is expected to reach the end of its expected service life. At that time, major capital investments will be required, and the university will have a unique opportunity to align the renewal and upgrade of critical energy infrastructure with current best practice in DES design and its long-term strategic sustainability goals.

Preliminary engineering analysis has shown that a low-temperature, low-carbon DES that substantially reduces (and could potentially eliminate) the use of natural gas would be technically feasible on main campus, but it will require the following complementary strategies to be implemented concurrently:

- a deep reduction (30% to 60%) in energy demand on campus through a comprehensive energy retrofit program that focuses on deep energy efficiency, waste heat recovery, and optimization of the overall efficiency of the DES;
- the use of clean, carbon-free electricity, instead of natural gas to generate heat on campus using heat pumps and heat recovery chillers (i.e., the electrification of heating that currently depends on natural gas and obtaining electricity from carbon-free energy sources);
- the use of energy storage technologies such as hot/chilled water storage tanks, geothermal fields, and batteries as enablers to optimize energy flows throughout main campus;
- the collection and optimum use of solar radiation available in Calgary as a source of thermal energy;
- implementation of a comprehensive backup power strategy to ensure targeted islanding capacity; and
- the use of renewable fuels such as biomass (BM) or renewable natural gas (RNG) to address peak heating demand only during the coldest months of the year.

Further analysis is required to determine the optimum solution and complimentary strategies for main campus.

The University of Calgary Foothills campus is served by a DES owned and operated by Alberta Health Services. The DES supplies steam and chilled water. Electricity is provided from the grid through the local utility. The primary focus at Foothills campus will be to minimize external energy demands by reducing energy demand within the buildings, along with aggressive implementation of heat recovery. Emissions from electricity can be reduced through the procurement of green power through power purchase agreements (PPA). Alberta Health Services (AHS) is currently developing a cogeneration unit at the Foothills Medical Centre (FMC). The university will continue to collaborate with AHS and explore options to reduce emissions at Foothills campus.

The other campuses (i.e., Spy Hill, field and research stations), do not rely on a central DES. Instead, each building has its own heating and cooling equipment. These facilities would employ demand reduction strategies first and then investigate fuel switching to eliminate emissions from combustion of natural gas and propane. The size and location of these sites would facilitate the development of onsite renewables, in addition to procuring green electricity through PPAs.

**Short-Term Actions**

- **DES Optimization Analysis** – Complete an analysis within the university's Energy Utility Campus Plan to identify energy efficiency opportunities and recommendations for the optimization of the DES on main campus.
- **DES Decarbonization Planning**
    a) Complete a phase one study for a low-carbon, low-temperature, DES with waste heat recovery and energy storage.
    b) Assuming the phase 1 study confirms the low-temperature DES strategy is viable, complete the phase 2 study and develop a phased implementation approach.
    c) Design new buildings and major renovations to be compatible with low-temperature heating systems and where applicable include waste heat recovery.

**Medium-Term Actions**

- **Upgrade the DES** – Begin implementation of the phased transition strategy towards a low-carbon, low-temperature DES on main campus.
- **DES Efficiency** – Improve overall efficiency of the DES on main campus through the implementation of cost-effective energy efficiency measures.
- **Renewable Fuels Procurement** – Explore opportunities to procure renewable fuels (i.e., biomass and sustainable natural gas/biomethane/biogas) and incorporate them into the university's energy portfolio. Continue to monitor energy markets around these opportunities.

**Long-Term Actions**

- **Complete Upgrade of the DES and the Cogeneration Plant** – Implement the remaining phases of the transition strategy towards a low-carbon, low-temperature DES on main campus by 2050.

## Emissions Reductions through Energy Demand Reduction- New Building Innovation

| 2025 Reductions | 3,800 tonnes | 2030 Reductions | 9,200 tonnes | 2050 Reductions | 48,600 tonnes |
|---|---|---|---|---|---|

As the university's teaching and research missions expand, so too will our facilities. To reach the emission reduction targets it is necessary to anticipate growth and plan for mitigation of emissions increases from new buildings. Additionally, growth will include the decommissioning of buildings that are too costly to retrofit to meet current pedagogical and research needs, and to address systemic building systems at or near the end of their service life. These buildings are also likely to be among our highest energy intensity facilities. The university is a recognized leader in developing high-performance, energy-efficient green buildings. For the past ten years, the university has made energy performance a critical component of major capital projects. That commitment has resulted in new buildings demonstrating an estimated 50% reduction in GHG emissions compared to conventional construction. As the building industry is evolving, so are our aspirations – the redevelopment of the MacKimmie Complex is our first major project targeting carbon neutral operations.

High-performance green buildings will continue to be a fundamental part of our climate action strategy as they allow us to mitigate significant GHG emissions associated with growth. Over the next ten years, planned new construction and major renovation projects could add more than 15,500 tonnes of $CO_2e$ to our annual emissions if designed just to meet current building codes[5]. Targeting zero-carbon in new buildings keeps us ahead of potential energy and GHG emissions regulations similar to those observed in other jurisdictions[6]. In addition to avoided emissions, energy efficient new building construction also results in lower operational costs, and improved resiliency to climate change stressors. By design, high-performance green buildings are less affected by extreme weather events and more stable in the event of utilities disruption. A growing body of research also identifies higher cognitive performance in green buildings with advanced indoor environmental conditions (MacNaughton et al., 2017).

New building strategies enable a number of the other key climate actions proposed in this plan. New buildings developed at the university have the opportunity to effectively incorporate on-site renewable energy generation, support the future low-temperature transition of the DES, and through their reduced energy consumption decrease the required investment in renewable power purchase agreements. New building projects also indirectly enable deep building retrofits through decanting and consolidation associated with new projects.

### Short-Term Actions

- **Update Design Standards** – Update the university's design standards for new construction and major retrofits to support ultra-high energy efficiency, and where possible, net-zero carbon construction while maintaining a focus on human health and comfort. Aim to achieve net-zero on all new non-laboratory buildings.
- **Low-Carbon, Low-Temperature DES Transition Preparedness** – Update design standards per recommendations of the DES Decarbonization Plan.

### Medium-Term Actions

- **Implement Net-Zero Buildings** – All new construction is net-zero.

[5] Includes MacKimmie Complex Redevelopment, Mathison Hall, Heritage Science Building Expansion, and Interdisciplinary Science & Innovation Centre.
[6] BC Energy Step Code is a performance based, incremental energy code that will targets all buildings to be net-zero energy ready by 2032.

## Emissions Reductions through Energy Demand Reduction- Existing Building Energy Retrofits

| 2025 Reductions | 16,700 tonnes | 2030 Reductions | 24,400 tonnes | 2050 Reductions | 54,400 tonnes |
|---|---|---|---|---|---|

Achieving a significant energy demand reduction (30% to 60%) from the built environment is critical to reduce the university's GHG emissions and to make the transition to net-zero carbon viable. An important step towards effective management of energy demand is an optimized utilization of existing building space. Further, the university must consider a broader spectrum of options for energy efficiency interventions in existing buildings. More extensive and deeper interventions will not only improve the energy performance of existing buildings, but will also enable the renewal of aging assets that need to keep up with the continual evolution of teaching and research practices. This is even more critical in laboratories and research spaces, which also have the highest energy intensities across the building portfolio. A four-tiered approach to existing building interventions has been proposed (Table 3).

***Table 3***. Planned retrofits for tiers 1-4.

| | | |
|---|---|---|
| Basic Retrofits | Tier 1 | • Low- and no-cost options including retro-commissioning, optimization of controls and systems, and lighting retrofits.<br>• < \$1,000 /t$CO_2$e |
| | Tier 2 | • Retrofits to existing HVAC and controls equipment.<br>• May include high cost to bring building up to current codes and standards.<br>• < \$1,500 / t$CO_2$e |
| Deep Retrofits | Tier 3 | • Deeper retrofits to bring building up to current codes and standards, including heat recovery and low-temperature transition.<br>• Requires holistic approach with other capital renewal programs.<br>• < \$2,500 /t$CO_2$e |
| | Tier 4 | • Complete building redevelopment.<br>• Implementation of net-zero design.<br>• > \$10,000 / t$CO_2$e |

Tier 1 interventions include retro-commissioning, optimization projects and lighting retrofits that have relatively shorter paybacks. Tier 2 interventions include the retrofit of controls and HVAC systems in existing buildings. These projects address base building systems and achieve better energy performance of the buildings over time. However, they usually have longer paybacks than Tier 1 interventions.

Tier 3 interventions involve deep retrofits in existing buildings, especially in energy-intensive spaces such as laboratory facilities. These interventions are critical to achieving significant improvements in energy performance, reducing GHG emissions and realizing utility cost avoidance (UCA). Laboratory and healthcare spaces consume three-to-six times the energy compared to classrooms and offices. The top ten energy-consuming buildings account for about 50% of the energy consumption of the university. Most of these buildings contain laboratory and/or healthcare spaces within them and are also likely to require Tier 3 interventions over the next years.

The installation of waste heat recovery systems, which are critical for the transition to a low-carbon, low-temperature DES in the future, typically fall within Tier 3. These interventions are more intrusive and holistic, addressing major systemic issues throughout the building and achieving significant reductions in energy consumption. Tier 3 projects also tend to have much longer paybacks. Laboratory spaces are the most energy intensive. A deep energy retrofits program for energy-intensive spaces will enable significant GHG emissions reductions and utility cost savings while supporting the much-needed renewal of these spaces. Laboratory swing space will be required for these projects.

The deepest possible intervention, Tier 4, would involve a total redevelopment of an existing building structure. The MacKimmie Complex and Professional Faculties Building Redevelopment project, which is projecting a 90% reduction in energy use, demonstrates the significant potential of net-zero carbon full building retrofits. Tier 4 interventions (and potentially many Tier 3 projects) would be considered as major capital projects rather than as energy efficiency projects and will also require swing space for temporary working environments. To sustain the improved performance achieved through the retrofit program, an Energy Management Plan that will be aligned with ISO 50001 and industry best practices will be developed. The program will feature ongoing monitoring and reporting of building energy performance and the application of key principles of monitoring-based-commissioning (MBx). The implementation of this plan will also require investments in energy data analytics technology.

## Short-Term Actions

- **Basic Retrofits** – Complete the implementation of the current Utility Reduction Program to address Tier 1 and Tier 2 energy efficiency opportunities.
- **Deep Retrofit Strategy**
    - a) Invest in planning for the implementation of a deep energy retrofit strategy with an aim to achieve a 35% reduction in energy consumption by 2030 across the university, and with a focus on waste heat recovery in energy-intensive buildings (large laboratory buildings).
    - b) Align phased capital renewal projects with the identified deep energy retrofit priorities.
- **Low-Temperature Building Transition Strategy** – Develop a strategy to prepare existing buildings on main campus for an eventual transition to a low-carbon, low-temperature DES.
- **Energy Management Plan**
    - a) Develop an Energy Management Plan in alignment with ISO 50001 and industry best practices to sustain improved energy performance.
    - b) Implement recommendations of the energy management master plan including the upgrading of metering and energy analytics technologies.
- **Renovation Energy Design Standards** – Develop energy design standards for renovation projects.

## Medium-Term Actions

- **Deep Retrofit Strategy**
    - a) Invest in planning for the implementation of a deep energy retrofit strategy with an aim to achieve a 50% reduction in energy consumption by 2050 across the university, and with a focus on waste heat recovery in energy-intensive buildings (large laboratory buildings).
    - b) Implement prioritized projects.
- **Energy Management Plan** – Ensure energy management practices are in alignment with ISO 50001.
- **Renovation Energy Design Standards** – Ensure all renovations and operations and maintenance practices are aligned with the renovation energy design standards.

## Long-Term Actions

- **Deep Retrofit Strategy** – Complete implementation of deep energy retrofit program.
- **Low-Temperature Building Transition** – Complete the transition of main campus buildings to the low-carbon, low-temperature DES by 2050.

# Emissions Reductions through Behavioural Change and Other Opportunities

While energy supply and demand represent the most significant potential for Scope 1 and 2 GHG emissions reductions, there are several other important opportunities for emissions reductions, many of which emerged as a high priority for the campus community during the consultation process (Appendix A). This section highlights these opportunities including fleet and IT equipment energy reductions (Scope 1), emissions related to transportation and waste (Scope 3), and behavioural changes from students, faculty and staff. Emissions related to institutional purchasing are addressed separately through the implementation plan for the Framework on Sustainability in Administration and Operations.

## Engagement and Behaviour Change

Building occupants and operators play a crucial role in determining if a building is operated sustainably. Behavioural change is at the root of almost every strategy to reduce emissions. Behavioural change programs that engage building occupants in energy use reductions through actions such as turning off lights and putting computers to sleep have been shown to reduce building energy consumption. At the University of Calgary, there are close to 40,000 potentially engaged occupants. Their understanding of the impacts that their habits and decisions have on emissions reductions is an essential part of the success of the CAP.

### Short-Term Actions

- **Create certification programs to incent behaviour change –** Implement the Sustainable Events, Offices and Labs certification programs to engage students, faculty and staff in actions to reduce GHG emissions.
- **Utilize data and analytics to develop communication and engagement tools –** Utilize information on energy performance to raise awareness and drive behaviour change. Develop tools and programs to assist operational staff with supporting energy efficiency and emissions reductions targets.

## Transportation - Fleet

Fleet vehicles and equipment contribute to campus emission rates. Transitioning fleet away from traditional fossilfuel-based vehicles towards alternative fuel options presents an opportunity to reduce the impact of campus operations.

### Short-Term Actions

- **Fleet Policies** – Develop multi-year fleet strategy and supporting policy for electric vehicle (EV) readiness and adoption, fleet optimization, and implementation of EV charging infrastructure (charging stations).
- **Fleet Transition** – Begin transitioning fleet to zero-emission electric and alternative fuel vehicles and ensure all fleet purchases are EV where EV options are available.
- **Fleet Efficiency Optimization** – Implement maintenance best practices for vehicle performance to optimize fuel efficiency of non-electric vehicles.
- **Fleet Best Practices** – Engage in education and training to improve driving practices, reduce idling and reduce vehicle kilometers travelled.
- **EV Infrastructure** – Create expanded EV infrastructure.

### Medium-Term Actions

- **Fleet Transition** – Complete 75% transition fleet to zero-emission electric and alternative fuel vehicles.
- **EV Infrastructure** – Ensure all parking lots have EV infrastructure.

### Long-Term Actions

- **Fleet Transition** – Complete transition fleet to zero-emission electric and alternative vehicles.

## Transportation - Commuting

It is estimated that commuting represents the most substantial proportion of the University of Calgary's Scope 3 GHG emissions, followed by institutional travel. Commuting to and from campus is generally outside the control of the university, which creates challenges in measuring and reporting on travel-related emissions. The university will continue to monitor its Scope 3 emissions and work to build capacity to understand and measure Scope 3 impacts.

### Short-Term Actions

- **Walking and Cycling** – Complete implementation of phase 1 of the Campus Bike and Pedestrian Network and bike parking plan. Diversify the Sustainable Transportation Working Group to support effective implementation of the Campus Bike and Pedestrian Network and bike parking plan. Work collaboratively with student clubs to promote alternative commuting options (e.g. Winter Cycling Week).
- **Public Transit** – Work collaboratively with external stakeholders to enhance transit service (i.e. frequency, routes, capacity, safety, and comfort) and improve connections to major centres and area amenities. Enhance on-campus public transit nodes to increase the comfort and convenience of public transit.
- **Private Vehicles** – Renew idle-free signage and implement a strategy to enhance compliance. Explore opportunities to incent carpooling and EV vehicles with automated parking technology. Expand outreach and engagement on alternatives to single-occupant vehicle use.
- **Couriers** – Explore a courier drop-off/pick-up strategy to reduce costs and traffic impacts on campus and in surrounding communities.

## Waste

Waste is a minor contributor to GHG emissions at the university. However, waste is an important issue to address for many other reasons. Waste is connected to Scope 3 emissions as it involves transportation and distribution (upstream for shipping goods and services and downstream for waste disposal), purchased goods and services, and waste disposal (World Resources Institute & World Business Council for Sustainable Development, 2013). Waste reduction strategies are popular because they are relatively simple to deliver, and people generally have a good understanding of the positive impact of waste reduction. These strategies also provide substantial opportunities for engagement and behaviour change.

There are numerous waste streams at the University of Calgary, which include: general waste such as paper and plastics; food waste, including packaging and organics; construction waste; landscape waste; supply chain waste, including packaging, equipment, and furniture; and hazardous waste, including chemicals, bio-waste and animal waste. To date, the University of Calgary has reduced the total amount of waste on campus by approximately 20% with diversion rates climbing to 40%. Additional work is required to ensure all waste data is error-free and no sources of waste are missing. The focus for this should be on furniture and equipment reuse and resales, which are not currently captured in waste diversion and reduction data.

### Short-Term Actions

- **Zero Waste Planning** – Renew the multi-year zero-waste strategy.
- **Waste Bin Infrastructure** – Install organics receptacles in all buildings and food locations, expand mixed recycling receptacles.
- **Waste Education** – Implement an education campaign to increase waste diversion and reduction of overall daily waste.

- **Engage with Campus Stakeholders** – Continue working with campus caterers, major event hosts and Facilities to improve diversion rates.

## Information Technology

Information Technology systems including desk-top devices, data centers, and high-performance computing on university campuses are critical to operations. They are also a significant contributor to emissions due to the power it takes to run those systems and the additional energy loads they can place on building HVAC systems. Strategies to reduce the impact of these critical systems include: ensuring computer labs are using energy efficiency programs, such as powering down equipment when not in use; utilizing more efficient cloud-based and co-located servers to reduce energy consumption; and recovering waste heat for building use.

### Short-Term Actions

- **IT Energy Policy** – Develop energy and design standards for IT in new construction, including reducing plug loads, addressing the internet of things (IoT) energy implications, minimizing server closets, and building dedicated cooling systems for IT rooms.
- **High-Performance Computing and Data Center Development**
  a) Design according to North American best practices in energy efficiency and heat recovery with an aim to minimize energy consumption and associated carbon emissions. Consider and pursue options for low-carbon energy supply.
  b) Move existing university data centers into a new high-performance computing center designed for energy efficiency and heat recovery.

### Medium-Term Actions

- To be determined based on emerging information technology opportunities.

## Transportation – Institutionally Financed Travel

Institutionally funded travel is essential to enable academic knowledge dissemination and collaboration and will likely increase as the research capacity of the University of Calgary continues to grow. At the same time, air travel emissions associated with institutionally financed travel are significant. As standards on Scope 3 emissions reporting are maturing, it is important for the university to prepare for future reporting of material Scope 3 emissions.

### Short-Term Actions

- **Scoping and Research** – Advance our understanding of our Scope 3 institutionally financed travel GHG footprint and investigate options to mitigate or offset these emissions.

# IMPLEMENTATION STRATEGY

The recommended climate actions have been presented with consideration of what will be required to achieve significant decarbonization by 2050 by eliminating most emissions due to combustion and powering the university with renewable electricity. The timeline below aims to achieve net carbon neutrality by 2050 but also recognizes the capital renewal timelines for the main campus cogeneration plant. A major cogeneration refit will be due by 2035-40 with likely significant related investments along the way. This presents an opportunity to use these major capital investments to move towards net carbon neutrality. Before this major transition, it will be necessary to achieve significant energy reductions in the university's buildings and ensure that new growth does not increase emissions. These reductions in building demand must be met to influence the planning of energy supply design. The timeline of key actions is summarized in Table 4. Appendix B provides additional detail on the implementation timeline of key actions.

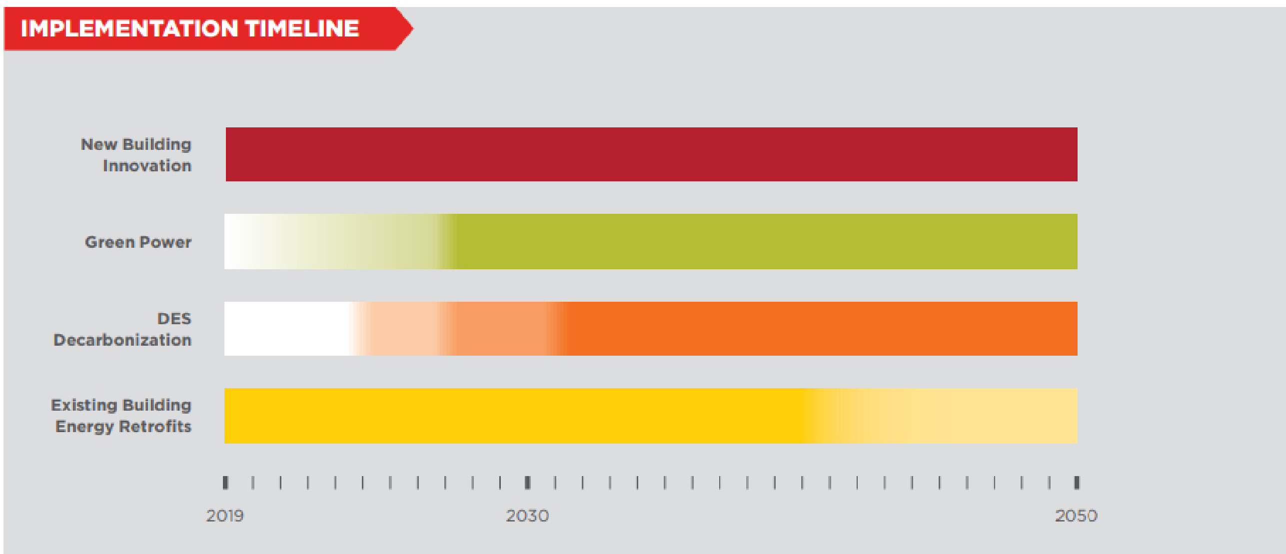


***Table 4***. Implementation timeline of key actions.

## Magnitude of Costs

GHG emissions reductions initiatives often provide both environmental and financial benefits. These benefits are usually quantified in terms of a simple payback (e.g., capital costs, annual utility cost avoidance), the net present value of the project's cash flow, or dollars invested per tonne of GHG emissions reduced by the project. It is important to keep in mind that the consistent selection of projects with more attractive paybacks and/or a lower dollar per tonne of GHG emissions reduced is not always in the best interest of either the institution or to the achievement of its goals. From a long-term strategy perspective, the university must consider the financial performance of energy efficiency projects as one of several criteria to be balanced against others. For example, projects that improve resiliency to climate change impacts may cost more upfront but may substantially reduce future costs and/or reduce the risk of business disruption. To assist in assessing the impact of future actions, an "order of magnitude" cost estimate was utilized. Magnitude cost estimates provide a very general idea of costs and provide some assistance in future capital planning and in exploring potential alternative finance models to enable CAP implementation. Going forward, each major project that stems from the CAP will be individually evaluated based on a project specific business case.

## Partnerships and Financing

Transforming the University of Calgary's energy system from a mostly fossil fuel-based system to one that is supplied by little if any fossil fuels requires the continued investment and support of leadership, stakeholders and partners. Reliable and consistent financial structures and funding sources are critical to achieving widespread change. The successful implementation of the CAP requires a significant, stable, and accessible pool of funds to drive investment in renewable energy and energy efficiency.

As some of the costs involved in the implementation of the CAP strategies will be significant; different funding scenarios and potential business partnership models must be considered to diversify investments and cost-share. Possible avenues include public/private partnerships for large-scale projects, large capital grants through government incentive programs, green bonds, and low-interest loans through the Alberta Capital Finance Authority. Business cases will be developed for major initiatives considering specific opportunities and evaluating projects from a total cost of ownership perspective. Other considerations for investment prioritization will be critical and should include: the anticipation of emerging new regulations, preparedness for emerging technological advancements, the need for renewal of aging assets, emerging institutional needs in support of the teaching and research mission, and building climate change resiliency capabilities.

## Synergies with Campus as a Learning Lab

Campus as a Learning Lab (CLL) is an innovative University of Calgary initiative with a focus on experiential learning and fostering a campus culture rooted in sustainability. CLL provides an opportunity for students, staff and faculty to collaborate on sustainability challenges on the university campus. The CAP strategies include many opportunities to link research and learning to applied emissions reductions on campus and beyond. As projects are individually developed, CLL opportunities will be identified and where viable, included.

## Implementation Oversight

Climate leadership is everyone's responsibility; every department and person on campus has a role to play. A regular review of the CAP will be conducted by Facilities every five years to update targets and actions. Reporting will be completed annually by Facilities and will include an annual emissions inventory[7] and progress report to the Operational Sustainability Stewardship Committee. Updates will occur every five years, with supporting analyses of technologies, protocols and impacts to climate change, along with incorporating changes from the Comprehensive Institutional Plan. Qualitative and quantitative data collection and validation methodologies must also be kept up to date. Regularoptimization of targets, actions and strategies will support the achievement of our goals and ensure we are responsive to a rapidly changing regulatory and technology landscape.

[7] It is anticipated emissions inventories will become reporting mechanisms to meet provincial and federal requirements in the next few years

# GLOSSARY

**Alberta Health Services (AHS)** – Alberta Provincial authority responsible for delivery of healthcare. Owner and operator of the Foothills Medical Centre, and the site's district energy system.

**Biomass (BM)** – Residual wood and plant waste. Typically used for combustion to provide thermal energy.

**Carbon intensity, emissions intensity, GHG intensity** – The rate of the magnitude of emissions relative to a unit of measure. For example, kg $CO_2e$ per user, or per kWh of electricity.

**Clean electricity, carbon-free electricity** – Electricity generated with no $CO_2$ emission during operation, such as solar photovoltaic, micro-hydroelectric. Also includes thermal electric systems operating off of biogas and biomass.

**Cogeneration** – A system that produces power and energy. These systems consist of a thermal combustion unit that can produce motive power, such to turn an electrical generation and heat for use in processes. The University of Calgary uses combustion turbine on main campus to generate electricity; the waste heat is recovered and used to heat the campus.

**Deep energy efficiency retrofits** – Significant energy efficiency retrofits addressing base building systems, building envelope and heat recovery. These types of projects can generate energy savings of 30% to 60%.

**District Energy System (DES)** – A distributed energy system for thermal energy. Typically served by a central plant.

**Geo-exchange field** – A shallow (<1 km deep) field consisting of vertical or horizontal heat exchange loops. A geo-exchange field is used to transfer and store heat underground as part of the geo-exchange heat pump system. These are typically compatible with low-temperature heating loops and operate best with annual balanced loads between heating and cooling. The term geothermal is often inappropriately used to describe a geo-exchange system.

**Heat pumps** – Equipment that utilizes a vapour compression cycle to move heat from the evaporator to the condenser. Can be described as a chiller operating in reverse.

**Heat recovery chiller** – A chiller where the heat of condensing is absorbed by a water loop, which is then used for heating.

**High temperature hot water system** – A hot water distribution system that operates at high pressure and high temperature (150°C to 205°C), allowing the heated water to remain in liquid form.

**High temperature loads** – Process and heating equipment that requires temperatures in excess of 80°C. These are typically steam generators, and glycol pre-heat loops.

**Low-carbon, low-temperature district energy system** – A lower temperature heating water system (typically with a maximum of 80°C), that operates at atmospheric pressure. The lower temperature enables the use of heat pump technology to move heat from the high-temperature loop to the cooling water loop.

**Monitoring-based-commissioning** – Collecting, storing, analyzing and reporting data (collected through metering equipment) to optimize energy performance and efficiency.

**Power Purchase Agreement (PPA)** – A contractual agreement with an electricity generator to obtain energy, rather than procuring energy from the open market to also allow for the procurement of green attributes from the producer.

**Renewable natural gas (RNG)** – Natural gas derived from organic sources such as agricultural waste, landfill gas, or biodigester gas. Renewable natural gas can be supplied into the existing natural gas grid to reduce the overall emissions factor of the natural gas, or more typically the green attributes are sold separately to customers while the gas is supplied into the existing distribution network.

**Waste heat recovery** – Recovering low and mid-grade heat from ventilation and process exhausts such as IT cooling loads and refrigeration loads.

# REFERENCES


Canadian Green Building Council. (2018.) *A roadmap for retrofits in Canada II: Building strong market infrastructure for the retrofit economy*. Retrieved from https://www.cagbc.org/CAGBC/Advocacy/CaGBC_Research/Roadmap_for_Retrofits_in_Canada_II/CAGBC/Advocacy/A_Roadmap_for_Retrofits_in_Canada_II.aspx

City of Calgary. (2018). *Climate Resilience Strategy: Mitigation & Adaptation Action Plans.* Retrieved from http://www.calgary.ca/UEP/ESM/Documents/ESM-Documents/Climate_Resilience_Plan.PDF

Government of Alberta. (n.d.-a). *Phasing out coal pollution.* Retrieved from https://www.alberta.ca/climate-coal-electricity.aspx

Government of Alberta. (n.d.-b). *Renewable Electricity Program.* Retrieved from https://www.alberta.ca/renewable-electricity-program.aspx

Government of Canada. (n.d.). Complementary actions to reduce emissions. Retrieved from https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework/complementary-actions-reduce-emissions.html

Government of Canada. (2018, March). *Low-carbon economy challenge applicant guide.* Retrieved from https://www.canada.ca/content/dam/eccc/documents/pdf/lcef-challenge-applicant-guide.pdf

Green Analytics Corp. & Ontario Centre for Climate Impacts and Adaptation Resources. (2015, May 8). *The Economic Impacts of the Weather Effects of Climate Change on Communities.* Retrieved from http://www.ibc.ca/ns/resources/studies/

MacNaughton, P., Satish, U., Laurent, J.G.C., Flanigan, S., Vallarino, J., Coull, B., Spengler, J.D. & Allen, J.G. (2017). The impact of working in a green certified building on cognitive function and health. *Building and Environment*, *114*, pp.178-186.

University of Calgary. (2010). *The University of Calgary Greenhouse Gas Emission Reduction Plan: 2010 Climate Action Plan Full Report.* Retrieved from https://www.ucalgary.ca/sustainability/

University of Calgary. (2013). *Energy Innovation for Today and Tomorrow: Energy Research Strategy*. Retrieved from https://ucalgary.ca/energy/

University of Calgary. (2016). *Institutional Sustainability Strategy.* Retrieved from https://www.ucalgary.ca/sustainability/files/sustainability/inst_sustainability_strategy_final.pdf

University of Calgary. (2018). *2018-23 Research Plan.* Retrieved from https://www.ucalgary.ca/research/

University of California. (2018, February). *Strategies for Decarbonization: Replacing Natural Gas.* Retrieved from https://www.nceas.ucsb.edu/files/research/projects/UC-TomKat-Replacing-Natural-Gas-Report_2018.pdf

United Nations. (n.d.) *Sustainable Development Goals - Goal 13: Take urgent action to combat climate change and its impacts*. Retrieved from https://www.un.org/sustainabledevelopment/climate-change-2/

World Economic Forum and McKinsey & Company. (2017, January). Game Changers in the Energy System: Emerging Themes Reshaping the Energy Landscape. Retrieved from https://www.mckinsey.com/~/media/mckinsey/industries/oil%20and%20gas/our%20insights/three%20game%20changers%20for%20energy/wef_game_changers_in_the_energy_system.ashx

World Resources Institute & World Business Council for Sustainable Development. (2013). *Technical Guidance for Calculating Scope 3 Emissions (Version1.0): Supplement to the Corporate Value Chain (Scope 3) Accounting & Reporting Standard*. Retrieved from https://ghgprotocol.org/sites/default/files/ghgp/standards/Scope3_Calculation_Guidance_0.pdf

# APPENDICES

# Appendix A: Consultation Summary

## Online Survey

A survey was created and made available to students, faculty and staff via the University of Calgary website. Communications were then circulated to students, faculty and staff through internal channels. Just under 280 people responded to the survey. The purpose of the survey was to reach a large and varied audience and develop awareness of the CAP renewal and gather input on what actions the campus community views as important.

## Web Poll

A poll was posted on the University of Calgary website with a different question each week focused on climate change and the university's role. Visitors to the website would respond directly to the poll by selecting an answer. The purpose of the web poll was to engage a broad audience and build awareness of climate change issues and the CAP renewal.

## Focus Group Sessions

A series of focus groups were conducted that invited participants to provide input on potential actions to help progress towards institutional goals for GHG emission reductions. Five 90-minute focus groups were facilitated on the main, Foothills, and Spyhill campuses for students, faculty and staff.

## Pop-Up Sessions

Pop-up information and outreach sessions were held at two key high-traffic areas on main campus. The sessions were focused on educating passers-by on the CAP. Participants were invited to post ideas on a board and/or complete the online survey. Several sustainability student volunteers and staff provided support in actively engaging passers-by in the pop-up display area to learn about the CAP and provide input.

## Subject Matter Expert Interviews

Subject matter experts were identified among staff who could provide important insights during the information gathering phase of the CAP renewal. More than ten interviews were held with representatives from architecture, planning, operations, energy utilities, engineering, fleet and grounds, project management, residences, risk management, and waste departments at the University of Calgary.

## Experts Forum

The Experts forum provided an opportunity for the university to gather information and ideas from key external and internal experts to be utilized in the integrated design process for the CAP renewal. Participants represented the City of Calgary, the Calgary Board of Education, the Calgary Airport Authority, ATCO, Enmax, the Pembina Institute, Energy Efficiency Alberta, the Canada Green Building Council, the consulting and construction community, and experts from University of Calgary faculty .

## Integrated Design Process (IDP) Workshops

The CAP IDP Workshops engaged senior technical staff and leadership from various internal departments. Facilitated by the CAP consultant team, participants reviewed findings from technical analysis pertaining to energy utility studies and energy efficiency strategies, including scenario modeling. Ultimately, participants agreed upon the direction and strategies to achieve the targets. Additional smaller group workshops were held pertaining to transportation, waste, fleet and Information Technology.

## Appendix B: Implementation Timeline of Key Actions

| | Action | 2020 | 2025 | 2030 | 2035 | 2040 | 2050 |
|---|---|---|---|---|---|---|---|
| Green Power | Energy Market Trends Research | ■ | | | | | |
| | Off-Site Renewable Energy and Procurement Study | ■ | | | | | |
| | On-site Renewable Generation Strategy | ■ | ■ | | | | |
| | Off-Site Renewable Energy Procurement | | ■ | ■ | ■ | ■ | ■ |
| | On-Site Renewable Generation | | ■ | ■ | ■ | ■ | ■ |
| Decarbonization of the DES | DES Opportunity Analysis | ■ | ■ | | | | |
| | DES Decarbonization Planning | ■ | ■ | | | | |
| | Upgrade the DES | | ■ | ■ | | | |
| | District Energy Efficiency | | ■ | ■ | ■ | ■ | ■ |
| | Renewable Fuels Procurement (BM/RNG) | | | ■ | ■ | ■ | ■ |
| | Complete Upgrade of the DES | | | | ■ | ■ | ■ |
| New Building Innovation | Update Design Standards | ■ | | | | | |
| | Low-Carbon, Low-Temperature DES Transition Preparedness | ■ | | | | | |
| | Implement Net-Zero Buildings | ■ | ■ | ■ | ■ | ■ | ■ |
| Existing Building Energy Retrofits | Basic Retrofits | ■ | ■ | ■ | ■ | ■ | ■ |
| | Deep Retrofit Strategy (Planning) | ■ | ■ | | | | |
| | Low-Temperature Building Transition Strategy | | ■ | ■ | ■ | | |
| | Energy Management Master Plan | ■ | ■ | | | | |
| | Renovation Energy Design Standards | ■ | ■ | ■ | ■ | ■ | ■ |
| | Deep Retrofit Strategy (Implementation) | ■ | ■ | ■ | ■ | ■ | |
| | Renovation Energy Design Standards (Implementation) | | | ■ | ■ | ■ | |
| | Low-Temperature Building Transition | | | ■ | ■ | ■ | ■ |

# Appendix C: Acknowledgements

The 2019 CAP would not have been possible without the support of many staff, students and faculty from across the University of Calgary campuses, as well as key external stakeholders. The University of Calgary would like to thank the following contributors for their support and assistance with the renewal of the University of Calgary's CAP:

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