THE LOW EMISSIONS COMMUNITY PLAN

Saskatoon's Actions for Climate Change Mitigation

August, 2019.

Official Community Plan
Climate Action Plan
Low Emissions Strategy

City of Saskatoon

Climate CHANGE

saskatoon.ca/**lowemissions**

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MESSAGE FROM THE MAYOR

People in Saskatoon have an undeniable can-do attitude. We are a community with a history of being entrepreneurial, of tackling problems head on, and of knowing the value and the rewards of hard work. People from across the province and across the world come here because of these values—we're a city for people with big dreams and who work to support one another to find success.

These core Saskatoon values are key to helping us address one of the most pressing issues of our time: climate change.

This Low Emissions Community Plan is the result of City of Saskatoon staff taking to heart these values and not shying away from the daunting task of addressing climate change. Our staff have researched the impacts climate change will have on Saskatoon and they have worked with community stakeholders to figure out concrete actions that can be taken to address these risks. This isn't a choice between sustainability and the economy or about deciding between key infrastructures or adapting to extreme weather events. The goal of being a financially strong city with durable infrastructure, a resilient economy, and a strong quality of life for citizens is in line with building a community that is mitigating and adapting to the effects of a changing climate.

The impacts of climate change are being felt now in our community. Our urban forest is under threat due to the heat, our infrastructure is being strained in the cold, and homes and businesses are flooding with more extreme storms. We must work collaboratively with our provincial and federal partners to seek out answers and create action. Additionally, because communities are on the front lines of climate change, this also requires strong leadership at the local level and with community partners to help address it.

Saskatoon's plan is a framework to create a city that is as resilient and strong as the people who call this place home.

Charlie Clark
Mayor

EXECUTIVE SUMMARY

The Low Emissions Community Plan is a toolkit for climate change decision-making which enables the City of Saskatoon (City) to shape our community for the next thirty years. The Low Emissions Community Plan (LEC Plan) describes the co-benefits of action in addition to the costs of inaction, in order to help citizens and decision-makers understand how the choices we make impact our climate, community, economy, and quality of life.

The Low Emissions Community Plan is a long-term roadmap for achieving the City of Saskatoon's established greenhouse gas (GHG) reduction targets through changes to policy and investments in projects, programs, and partnerships.

> ***Our Vision for a Low Emissions Community:*** *Saskatoon is a connected community where every citizen and organization takes pride in prosperous, resilient and low-carbon solutions to realize a clean and healthy city.*
>
> ***Our Mission:*** *To enable a sustainable Saskatoon through an integrated and actionable climate change approach.*

Local & Global Commitments

The City established the need for a Climate Action Plan in the *Strategic Plan: 2018-2021* through the Strategic Goal of Environmental Leadership. Specifically, a key stride includes that "the effects of climate change on civic services are proactively addressed." Consistent with the Strategic Goal of Environmental Leadership, the City signed an agreement with the Global Covenant of Mayors for Climate and Energy in November 2015. This is an international pact that requires the City of Saskatoon to take action on both the causes and effects of climate change by reducing emissions and building resiliency plans for our infrastructure and services.

City of Saskatoon GHG Reduction Targets

On June 26, 2017, City Council set greenhouse gas reduction targets for Saskatoon based on the City's 2014 GHG emissions inventory. They include:

- Reducing the City of Saskatoon's emissions by 40% below 2014 levels by 2023; and 80% by 2050.
- Reducing the community's emissions by 15% below 2014 levels by 2023; and 80% by 2050.

The actions in the Low Emissions Community Plan aim to meet and exceed long term targets.

"The effects of widespread warming are evident in many parts of Canada and are projected to intensify in the future. The rate and magnitude of climate change under high versus low emission scenarios project two very different futures for Canada." - Changing Climate Canada Report 2019

Our Current Emissions

Results from the City of Saskatoon's greenhouse gas inventories show that Saskatoon's emissions have remained relatively consistent since 2014, but are projected to increase over the long term without dedicated action on emissions reduction. Below are Saskatoon's city-wide (corporate and community) emissions over the past 5 years:

- 2014: 3,850,000 tonnes CO_2e
- 2016: 3,690,000 tonnes CO_2e
- 2017: 3,710,000 tonnes CO_2e

Saskatoon's Climate Future

Saskatoon's future is projected to be warmer, wetter, and wilder. If we meet our targets and contribute to meaningful emissions reductions globally, we may be able to mitigate some of the impacts of global climate change.

- **Warmer** temperatures may appear desirable but this means more drought, extreme heat, larger pest populations, and increased risk of heart conditions, diseases, and cancers.
- **Wetter** conditions provide increased opportunity for flooding and freezing rain in winter months.
- **Wilder** trends speak to conditions that create intense storms, such as thunderstorms, blizzards, hail, and tornadoes, occurring more often and causing damage to public and private property on a regular basis.

A warmer, wetter, and wilder future comes at costs that are likely to far outweigh the investments required to create a low emissions community.

The Low Emissions Community Plan

The CityInSight Model was used to forecast the actions required to meet the City's GHG emission reduction targets over the next 30 years, compared to the Business as Planned scenario. The model was used to analyse the GHG and financial impact of each action and follow the principles of:

- **Reduce** – energy load by improving efficiency and conserving energy and water in our homes, buildings, and vehicles;
- **Improve** – operations, land use, and transportation networks to optimize functionality, reduce waste, use land more sustainably; and
- **Switch** – to renewable, low carbon fuel sources

The Low Emissions Community Plan (LEC Plan) proposes forty actions to meet Saskatoon's GHG reduction commitments:

Buildings & Energy Efficiency

Energy Generation

Transportation

Water Conservation

Land Use

Waste Management

Co-Benefits

The plan is a whole-city plan, whose policies and actions achieve multiple community benefits.

- **Our heath is improved** due to more active lifestyles, cleaner air, and improved water and soil quality. These factors can significantly reduce rates of hospitalization, illness and disease, and mortality for everyone in our community.
- **Our economy is diverse and resilient to both local and global changes.** Our community can capitalize on new and existing sectors of business, for example, in the renewable energy, building, construction and Cleantech sectors.
- The Low Emissions Community Plan is estimated to generate approximately 100,000 person years of employment otherwise known as Full Time Equivalents between 2020 and 2050.
- **Reduced expenses for residents, businesses and the municipality.** Investments in technology, conservation and efficiency, and clean energy generation reduces operating and maintenance costs, provides new revenue opportunities, and protects our community from volatile energy and fuel prices.
- **Improved equity and quality of life** is achieved through improved accessibility, housing quality, food security, and poverty alleviation. Destinations become more accessible and all residents have access to healthy food and natural spaces.

Building Resiliency and Modelling Success

This LEC Plan looks to create co-benefits for both emissions reductions (mitigation) and resiliency (adaptation) activities.

High level financial analysis was undertaken for each action in the LEC Plan Scenario to identify the investment required, the net present value, the return on investment, marginal abatement costs, and employment impacts.

While there are significant benefits of adopting the actions set out in the LEC Plan the risks of doing nothing require consideration. In the context of this analysis, risks include the following:

- A slower response to mitigation and therefore more severe impacts of climate change;
- A missed opportunity to transition to low carbon urban systems and therefore an increased burden on the City of Saskatoon, households and the private sector to support the transition;
- A missed opportunity for leadership in the public and private sector; and
- A missed opportunity to acquire co-benefits in improved health outcomes, economic development, a more resilient energy system, and improved quality of living that are synergistic with the LEC Plan energy and emissions outcomes.

To be succesful, the actions require investments now and over time. Starting immediately, implementation would result in savings and, in the case of local energy production, in revenues. Incremental expenditures in buildings, vehicles, and other energy-related equipment and infrastructure increase costs in the short-term but result in long-term savings. Accelerated investments have the added benefit of contributing toward prevention of further degradation of the environment and slowing the degradation-increased cost cycle.

The Low Emissions Community Plan vs. Business as Planned

Lower Energy Costs

The modelled LEC Plan actions results in lower energy costs when compared to the Business as Planned scenario.

Under the LEC Plan total energy use in Saskatoon is 36 million GJ in 2050. This is just over half of what is expected in the Business as Planned (BAP) scenario, where energy climbs from about 38 million GJ in 2016 to almost 70 million GJ in 2050.

***Figure 1**: Total Energy Use, BAP vs. LEC Plan*

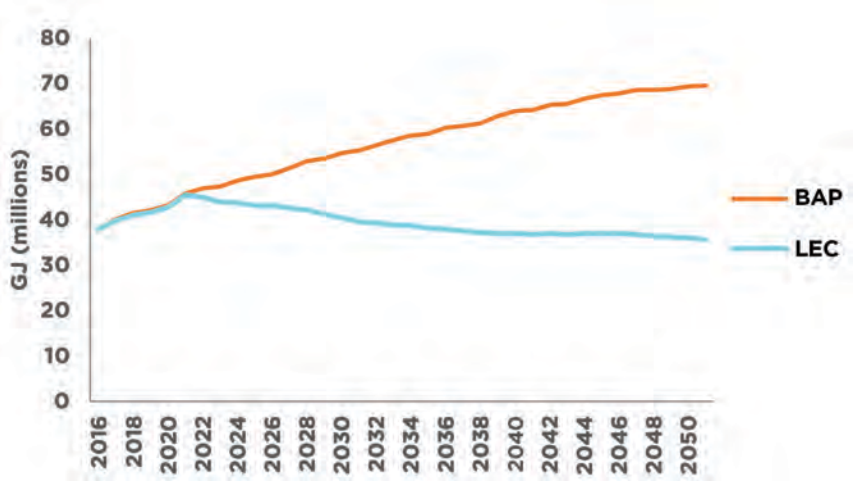


Photo courtesy of Tourism Saskatoon

Meeting Commitments

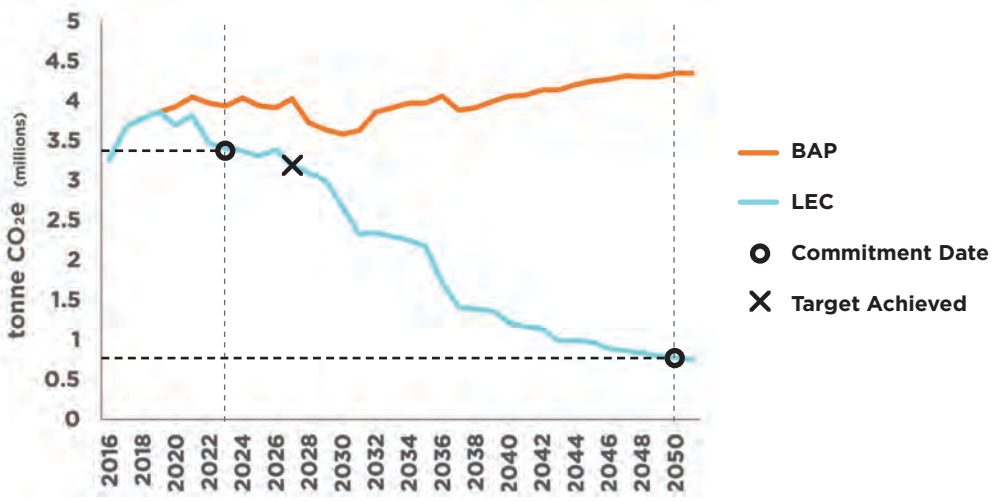
In relation to the emissions reduction targets, implementing the full suite of 40 actions in the recommended timeframe will result in the reductions: Refer to Table 1.

***Table 1**: Target Status and Modelled Projection Summary*

Item	City of Saskatoon	Community	Total
2014			
2014 GHG Baseline (tonnes CO_2e)	106,300	3,743,700	3,850,000
2023			
2023 GHG Reduction Target (%)	40%	15%	
2023 Modelled performance (%)	49.63%	11.61%	
2050			
2050 GHG Reduction Target (%)	80%	80%	
2050 Reduction target (tonnes CO_2e)	85,000	2,995,000	3,080,000
2050 Target Emissions (tonnes CO_2e)	21,300	748,700	779,000
2050 Modelled performance (%)	89.39%	79.71%	
2050 Modelled performance (tonnes CO_2e)	10,630	748,700	759,330

The 40 actions can achieve emissions reductions of 3,080,000 tonnes CO_2e in the year 2050, meeting commitment of the City's total emissions to 779,000 tonnes CO_2e. 3% of emissions reductions is achieved by municipal corporate actions and 97% is achieved by community actions. Corporate reductions are more easily achieved than community wide reduction as the municipality has more control over its own operations, whereas community reductions require broader scale education efforts and behavioural changes over time.

***Figure 2:** Modelled LEC Plan Results in relation to the targets*



The success of the plan lies in the City and the community's ability to follow the roadmap outlined in this report and implement every action. In following this plan, the corporate target of **40% emissions reductions could be met by 2023**. While the Plan begins to move the needle with Community emissions, even with the plan in place the Community target would not be met in 2023, with modelling showing a 12% GHG reduction. The **15% community reduction target** is projected **to be met by 2027**. If fully executed, the LEC Plan actions for both the community and the City as a corporation successfully meet the **80% reduction target by 2050.**

The Path to 80% Reductions by 2050.
Low Emissions Community Actions Summary

	Action	Cumulative Emissions Reductions 2020-2050 (tonnes CO_2e)	Municipal Action (M) Community Action (C)	Action Phase
Buildings & Energy Efficiency				
1	Apply energy efficiency standards (build to Passive House) to all new municipal buildings.	**28,000**	**M**	**P2**
2	Perform deep energy retrofits on municipal buildings.	**175,000**	**M**	**P2**
3	Upgrade plugged appliances and energy conservation behaviours in municipal buildings.	**4,000**	**M**	**P2**
4	Update all municipal building lighting systems.	**5,000**	**M**	**P1**
5	Retrofit municipal heating and cooling systems with ground-source or air source heat pumps.	**204,000**	**M**	**P2**
6	Create an electric and thermal energy consumption cap for new home construction by utilizing a municipal step code.	**1,130,000**	**C**	**P2**
7	Require new homes to include roof solar Photovoltaic (PV) installations in the final year of a municipal step code.	**5,049,000**	**C**	**P4**
8	Create an electric and thermal energy consumption cap for new ICI construction by utilizing a municipal step code.	**6,660,000**	**C**	**P2**
9	Require new ICI buildings to include roof solar PV installations. In the final year of a municipal step code.	**28,000**	**C**	**P4**
10	Incentivize and later mandate homeowners to perform deep energy retrofits.	**2,013,000**	**C**	**P2**
11	Incentivize and later mandate ICI owners and operators to perform deep energy retrofits.	**3,469,000**	**C**	**P2**
12	Require energy efficiency improvements residential and ICI building lighting systems.	**147,000**	**C**	**P3**
13	Incentivize and later mandate homeowners to upgrade household appliances to energy and water efficient models	**582,000**	**C**	**P4**
14	Retrofit home heating and cooling systems with ground-source or air source heat pumps.	**2,120,000**	**C**	**P3**
15	Retrofit ICI heating and cooling systems with ground-source or air source heat pumps.	**658,000**	**C**	**P3**
16	Increase the efficiency of industrial processes.	**232,000**	**C**	**P4**

Action Implementation Timeline Legend	
P1	**Phase 1 Projects:** Action is already in planning or drafted strategy phase
P2	**Phase 2 Projects:** Action planning and implementation to be started in the next 4 years
P3	**Phase 3 Projects:** Action planning and implementation to be started in the next 5-8 years
P4	**Phase 4 Projects:** Action planning and implementation to be started in the next 12+ years

Transportation				
17	Electrify the Municipal fleet over the near-term.	**77,000**	**M**	**P2**
18	Electrify the Municipal transit fleet.	**55,000**	**M**	**P2**
19	Implement a vehicle pollution pricing program in high traffic areas.	**698,000**	**M**	**P3**
20	Increase transit routes and frequency through future updates to the Transit Plan.	**942,000**	**M**	**P1**
21	Electrify personal vehicles through incentive programs, education, and automotive dealer partnerships	**2,756,000**	**C**	**P2**
22	Electrify commercial vehicles through incentive programs, education, and automotive dealer partnerships	**6,860,000**	**C**	**P3**
23	Fund and implement improved cycling and walking infrastructure to encourage active transportation.	**287,000**	**M**	**P1**
Waste				
24	Improve and expand waste management programs and services to increase reduction and diversion.	**1,303,000**	**M**	**P2**
Water Conservation				
25	Decrease water use through efficiency, monitoring, and leak reduction.	**25,000**	**M**	**P2**
26	Reduce residential and ICI water use through education programming and water efficiency incentive programs.	**147,000**	**C**	**P2**
Land Use				
27	Build complete, compact communities through infill development, mixed-use buildings, and compact housing.	**3,353,000**	**M**	**P4**
28	Focus development on densification in previously developed areas, increasing the number of multi-family buildings.	**Included in #27**	**M**	**P4**
Energy Generation				
29	Install solar PV systems on municipal buildings.	**236,000**	**M**	**P2**
30	Install solar PV systems on municipal lands	**Included in #34**	**M**	**P2**
31	Increase Landfill Gas Capture from the Saskatoon Landfill	**1,891,000**	**M**	**P2**
32	Encourage existing residential building owners and mandate new buildings to install solar PV system through programming and bylaw.	**195,000**	**C**	**P2**
33	Encourage existing ICI building owners and mandate new buildings to install solar PV systems through programming and bylaw.	**1,147,000**	**C**	**P3**

Action Implementation Timeline Legend	
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P4	**Phase 4 Projects:** Action planning and implementation to be started in the next 12+ years

34	Install new solar PV utility-scale facilities within or adjacent to city boundaries. With areas within city boundary to be prioritized first.	**1,626,000**	**M**	**P2**
35	Install a CHP facility at St. Paul's Hospital.	**40,000**	**M**	**P2**
36	Implement district energy systems in the downtown and north downtown areas.	**1,079,000**	**M**	**P4**
37	Construct a hydropower plant at the weir.	**218,000**	**M**	**P3**
38	Install renewable energy storage over time.	**3,435,000**	**M**	**P2**
39	Procure renewable electricity from third party producers.	**54,119,000**	**M**	**P4**
40	Procure Renewable Natural Gas from third party producers.	**40,607,000**	**M**	**P4**

Action Implementation Timeline Legend	
P1	**Phase 1 Projects:** Action is already in planning or drafted strategy phase
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INTRODUCTION

What is The Low Emissions Community Plan?

The Low Emissions Community Plan (LEC Plan) is a long-term roadmap that sets out specific actions that the City of Saskatoon (City) and the community need to take in order to achieve GHG reduction targets. The Actions include investments in projects, programs, and partnerships, as well as changes to policy, planning, and regulation that can propel our municipality and community to make meaningful impact. Successful implementation of the LEC Plan could result in reduced energy consumption, low-emission transportation options, effective and sustainable land use, reduced water consumption, waste diversion, and clean, renewable energy.

The actions were informed from a variety of sources including community engagement. See Appendix E for detailed engagement summary

> **Mission:** To enable a sustainable Saskatoon through an integrated and actionable climate change approach.
>
> **Vision:** Saskatoon is a connected community where every citizen and organization takes pride in prosperous, resilient and low-carbon solutions to realize a clean and healthy city.

Pursuing the actions in the LEC Plan is not just about achieving emissions. The vision for Saskatoon as a low emissions community supports community wellbeing and quality of life, developed economic opportunities for residents and businesses, and enables stable livelihoods, equitable growth, and opportunities for all.

The LEC Plan considers a future Saskatoon that has grown to over 500,000 people and compares a Business as Planned scenario to a Low Emissions scenario, focusing primarily on the greenhouse gas and financial implications of both. The 40 Actions outlined for the Low Emissions scenario would enable the City to meet our emissions reduction targets. If any of the actions are not fully implemented, they would need to be replaced with other opportunities or targets will not be achieved.

The LEC Plan includes an implementation plan with timelines and high level requirements for phasing in the actions over the next 30 years. It does not include programmatic details to show how the initiatives will be delivered; and feasibility studies will be required on each of the initiatives. The City's new Triple Bottom Line decision making framework (anticipated to be effective January 1, 2020) will be used to inform the design and evaluate results of each of the 40 actions. However, the tool was not used in the design of the LEC Plan as it is not yet in effect.

The LEC Plan is not just about achieving emissions reductions. The actions support community health and well-being, quality of life, stable livelihoods, equitable growth, and economic development opportunities.

Why a Low Emissions Community?

Environmental Leadership

The City's Climate Action Plan is supported in the *Strategic Plan 2018-2021* through the Strategic Goal of Environmental Leadership. Specifically, a key activity includes "the effects of climate change on civic services are proactively addressed." The Low Emissions Community plan addresses the seven Strategic Goals approved by City Council including:

- **Sustainable Growth**
- **Culture of Continuous Improvement**
- **Asset and Financial Sustainability**
- **Economic Diversity & Prosperity**
- **Moving Around**
- **Quality of Life**
- **Environmental Leadership**

Greenhouse Gas Emissions Targets

On June 26, 2017, City Council set Greenhouse Gas Emissions Targets for Saskatoon as follows:

- 40% reduction in greenhouse gas emissions below 2014 levels for the City as a corporation by 2023; and a reduction of 80% by 2050.
- 15% reduction in greenhouse gas emissions below 2014 levels for the community as a whole by 2023; and a reduction of 80% by 2050.

Our Current Emissions

Results from the City's greenhouse gas inventories show that Saskatoon's emissions have remained relatively consistent since 2014, but are projected to increase over the long term without dedicated action on emissions reduction. Below are Saskatoon's city-wide (corporate and community) emissions over the past 5 years:

- 2014: 3,850,000 tonnes CO_2e
- 2016: 3,690,000 tonnes CO_2e
- 2017: 3,710,000 tonnes CO_2e

In order to reach our GHG reduction targets for Saskatoon, these emissions must stabilize at:

- 3,300,000 tonnes CO_2e by 2023
- 779,000 tonnes CO_2e by 2050

Global Covenant of Mayors

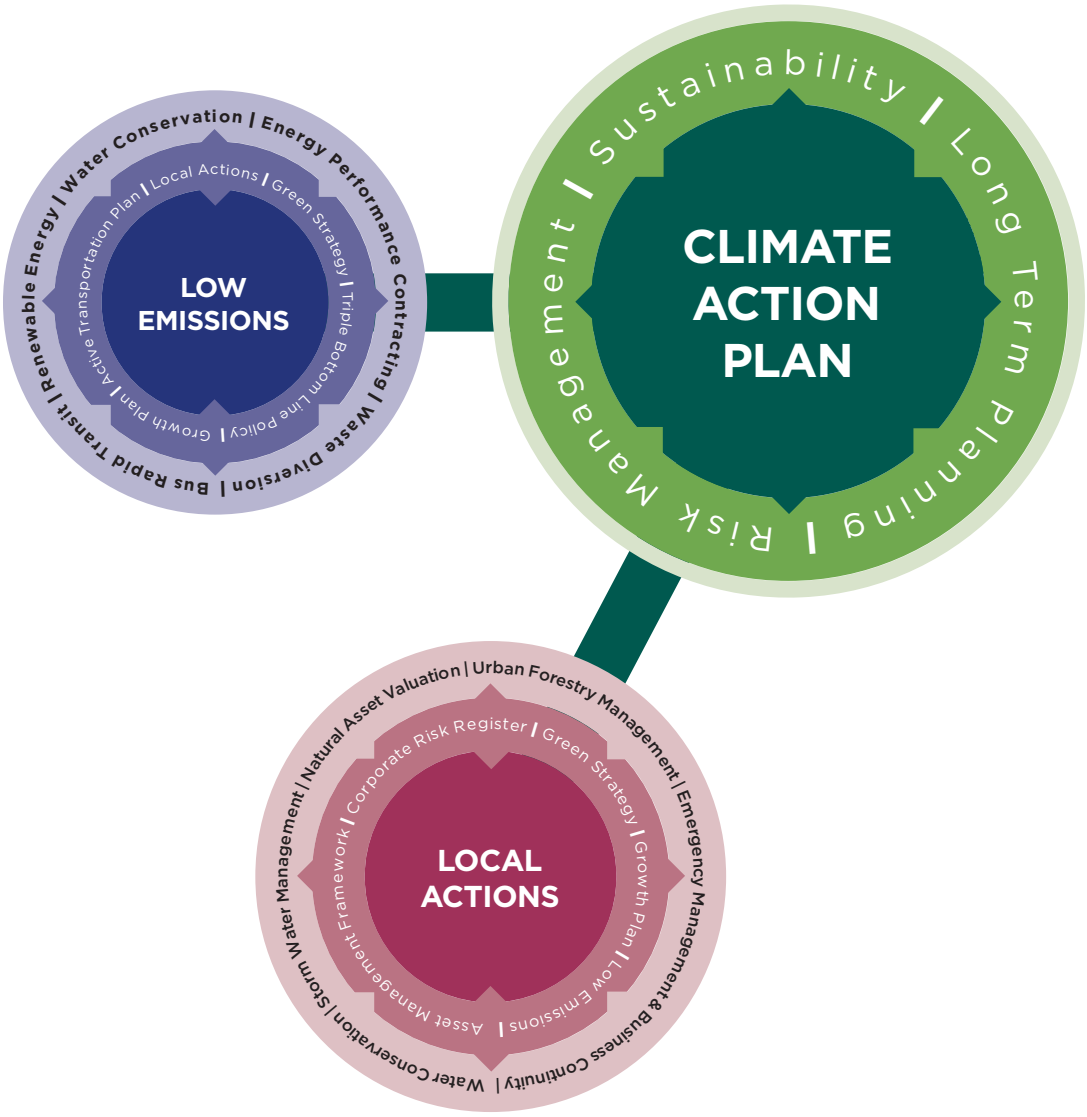
Consistent with our internal commitments, the City signed an agreement with the Global Covenant of Mayors for Climate and Energy in November 2015. This is an international pact and it requires the City to take action on both the causes and effects of climate change by reducing emissions and building resiliency plans for our infrastructure and services. Through this commitment, the City must develop and submit an action plan for demonstrating how we will deliver on our promise to mitigate emissions. Further, the City is required to report back on the plan to show progress on our emissions reductions targets.

A Two-Pronged Approach to The Climate Action Plan

The LEC Plan is part of the dual approach needed to address climate change in the City's Climate Action Plan.

Mitigation: Low Emissions addresses the root cause of climate change by decreasing the rate that we emit heat-trapping greenhouse gases into the atmosphere. Mitigating emissions is expected to slow the effects of climate change, which can decrease the need for adaptive actions.

Adaptation: Local Actions addresses the current and future risks, damages, and impacts of climate change.

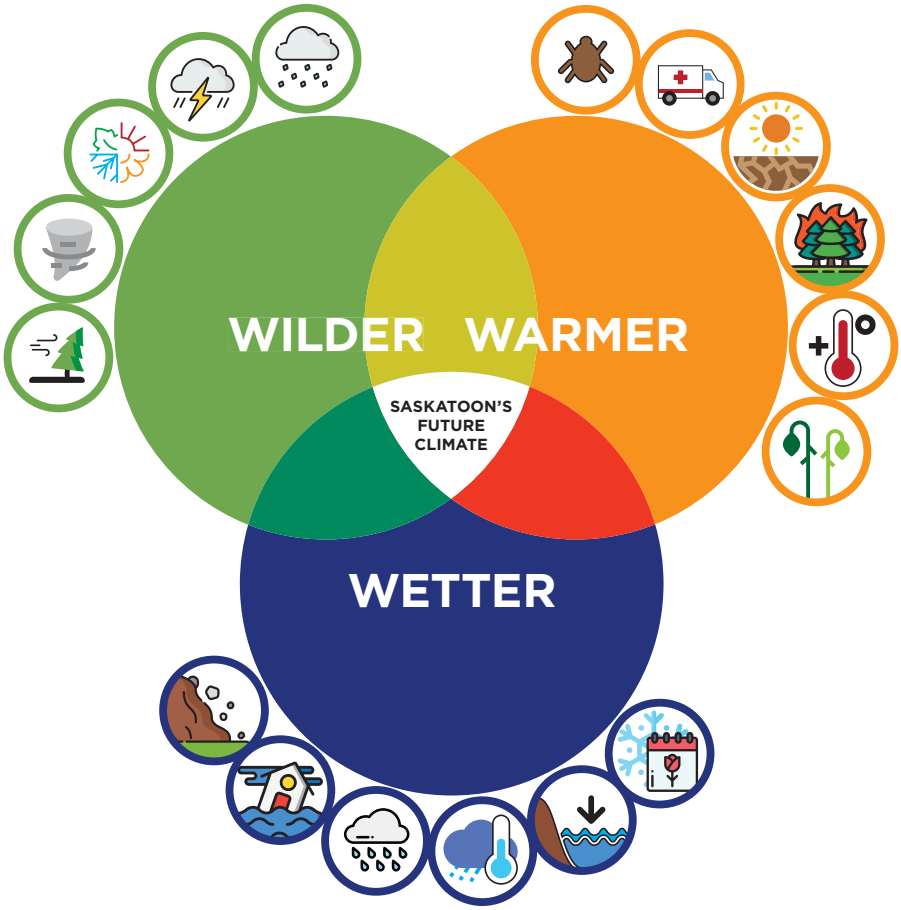


Impacts of Inaction

Global temperature increases greater than 2^{0}C are predicted to cause catastrophic consequences, including increased and more extreme drought in moderate to dry regions, flooding in lowland and coastal areas, crop failure and famine, and extreme stress or collapse of major regional ecosystems.

Canada is warming at double the global average rate[1], as is Saskatoon, with possible increases in average annual temperature of up to four times the global rate by the end of the century. Saskatoon is projected to experience changes in precipitation trends and a likely increase in the frequency of severe weather events. While Saskatoon's weather will continue to experience variability in temperature and precipitation, in general, it is expected to become "Warmer, Wetter, and Wilder":

- **Warmer** conditions may cause more drought, larger pest populations, bush and grass fires, and can worsen public health concerns such as breathing difficulties and heart conditions due to prolonged heat waves and declining air quality.
- **Wetter** conditions mean more freezing rain and less snow fall during winter months, earlier peak river flows, and creating more intense rain events create soil stabilization challenges and the potential for overland flooding. Because of the warmer temperatures, increased overall precipitation won't necessarily result in rainfall during the hottest months.
- **Wilder** conditions include increased risk of thunderstorms, blizzards, hail, and tornados in Saskatoon and surrounding region.



1 Bush, E. and Lemmen, D.S., editors (2019): Canada's Changing Climate Report; Government of Canada, Ottawa, ON. 444 p.

Not investing in the climate actions described in the LEC Plan and the Local Actions Plan may result in increased insurance prices, increased emergency investment into infrastructure and adaptation costs, and increased healthcare costs and social supports for climate refugees or citizens displaced as a result of extreme weather events. These costs are described in Appendix C – The Cost of Inaction.

There is a tendency to postpone transformative actions and investments, as society is often resistant to change. There are two consequences of delay: more drastic and costly emissions reductions will likely be required in the future, and the community will forfeit economic, health and other benefits associated with low-carbon investments and actions.

Benefits of a Low Emissions Community

Investments in climate change initiatives provide financial, environmental, and social benefits across our community. These are realized by:

Improvements to individual and public health

More active lifestyles, more walkable and transit-oriented communities, cleaner air, and improved water and soil quality will lead to improvements to individual and public health, significantly reduce rates of hospitalization, illness, and even mortality. This is particularly relevant for children, seniors, and those facing existing health challenges.

- Chronic exposure to air pollution from the burning of fossil fuels is estimated to result in 7,142 premature deaths per year in Canada[2]
- A shift to utility scale renewables could result in USD$110 billion in savings in annual health costs or nearly 4% of GDP in Canada[2]

Furthermore, reducing transportation emissions (which requires a shift to active and public transportation) improves health through reduced air pollution from vehicles, reduced injuries and deaths from vehicle collisions, and reduced obesity as a result of more active lifestyles.[2]

Innovative local economies and increased employment

A thriving environment and economic prosperity are not mutually exclusive ideals. Climate mitigation investment supports new forms of employment, innovation, and quality jobs. Taking action on climate change has been shown to open up opportunities for new and emerging sectors, particularly those focused on renewable energy, energy efficiency, green buildings, water and waste management, food production, transportation, land use planning, design, and technology. Clean technology is a growing sector, even surpassing the oil sands in terms of proportion of GDP[3].

Financial savings and revenue

Actions that mitigate climate change, commonly result in decreased consumption of fossil fuels, resulting in decreased expenses for fuel and associated saving. It can also encourage revenue opportunities, avoidance of increasing energy costs over the long term, avoidance of carbon levy payments, reduced operating and maintenance costs, and increased asset life.

An example is where the City has seen financial savings is from the switch to LED lighting in civic buildings to conserve energy. In phase one of the project, maintenance costs have been reduced by $45,000 every 2-3 years and annual energy bills have decreased by $142,000.

2 Climate Change toolkit for health professionals, Canadian Association of Physicians for the Environment, 2018

3 Invest in Canada Report, Government of Canada

Decreased utility bills and reduction of energy poverty

Utilizing renewable energy sources would result in lower utility bills for both residents and businesses. This lowers the cost of doing business and reduces the energy poverty burden that impacts many Canadians. 28% (over 117,000) of Saskatchewan households are identified as experiencing energy poverty or that they spend 6% or more of their income on energy bills, which is above the Canadian mean.[4]

Without climate mitigation actions, energy prices are expected to increase by 2% annually which will lead to almost $2 billion in total energy expenditures in Saskatoon by 2050 compared to $880 million in 2016. This is a total increase of approximately 131% over the next 30 years.

Increased social equity and quality of life

Quality of life and social equity is increased through improved accessibility, housing quality, energy and food security, and poverty alleviation. For example:

- Destinations become more accessible (i.e. if dwellings are located in closer proximity to commercial destinations and/or are centered around transit and active transportation networks).
- Building quality is improved (i.e. green buildings can improve indoor air quality, save water, improve energy performance, lower monthly utility costs, and provide comfort through better lighting, insulation, draft proofing, and regulated indoor temperatures).
- Quality housing is created that is affordable, environmentally responsible, and meets the needs of our diverse population.
- All residents have access to healthy food through decreased food costs and local gardening opportunities.
- Better access to natural, recreational, cultural, and educational spaces.
- Quieter environment due to less driving, fewer combustion engines, and better insulation in buildings.

Improved protection and development of natural areas

Utilizing natural infrastructure aids in sequestering carbon and provides other ecological benefits such as enhanced biodiversity, water purification, pollination and pest management, preservation of cultural and natural history, city beautification and improved mental, physical and spiritual health for residents.

Improved land-use planning and development

Sustainable land-use supports the integration and accessibility of transit and active transportation, increases the efficiency of shipping goods and providing services, supports the renewal of historic neighbourhoods, improves the performance of our building stock, integrates greenspace, supports biodiversity and natural areas, and improves access to amenities, businesses, and cultural and recreational opportunities.

Decreased burden on future generations

By acting today to reduce the damage from climate change, this mitigates risks and decreases future costs that will be inflicted on the next generation.

On March 3, 2019 children in over 100 countries walked out of school to rally governments to increase their climate change efforts. In Saskatchewan alone, hundreds of students protested in Regina outside of the legislature and in Saskatoon outside of City Hall.[5] Student protests in Saskatoon proceeded again on March 24, 2019. This highlights the growing concern by youth who understand that acting on climate change now is imperative to their current and future wellbeing.

4 Canadian Urban Sustainability Directors, Local Energy Access Program. A Guidebook on Equitable Clean Energy Program Design for Local Governments and Partners, USDN, 2018

5 Youth March for climate action in front of Saskatchewan Legislature, CBC News, 2019

40 Mitigation Actions: Methodology and Assumptions

In order to prepare the mitigation actions, the CityInSight model was used to project population, energy use and emissions from a baseline year of 2016, established through the City's GHG inventory and projecting to 2050. The model forecasted emissions and costs of a Business as Planned (BAP) scenario and compared it to a LEC Plan scenario.

CityInSight is an integrated energy, emissions, and finance model that uses the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC Protocol) Framework, an international standard for greenhouse gas emissions accounting developed by Sustainability Solutions Group (SSG) and whatIf? Technologies. It has been used in emissions modelling and the development of Climate Action plans in Cities across Canada. For more details on the model, methodology, data inputs, and assumptions see Appendix D.

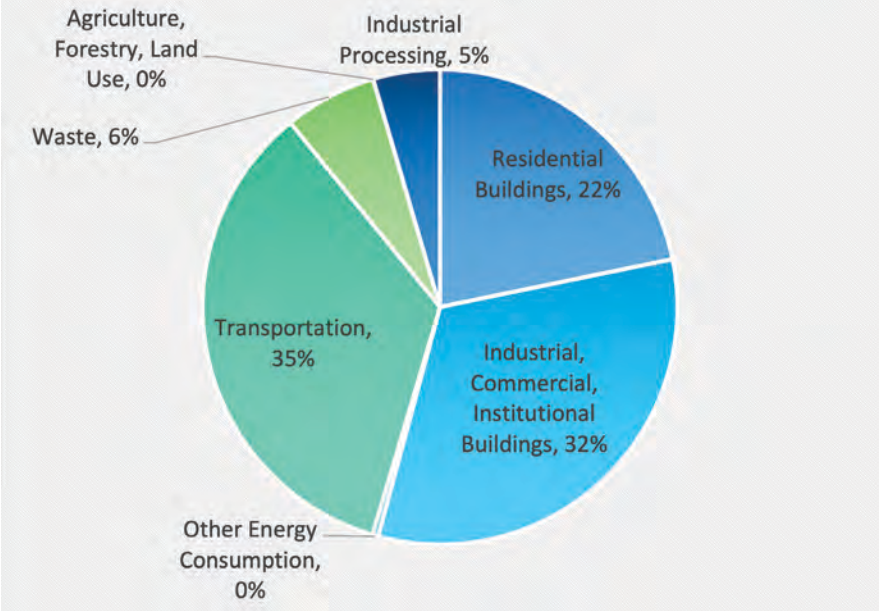
A detailed financial analysis was undertaken by Sustainability Solutions Group & whatIf? Technologies in collaboration with the City for each action in the LEC Plan Scenario to identify the investment required, the net present value, the return on investment, marginal abatement costs, and employment impacts.

OUR CURRENT EMISSIONS

Background

In 2007 the City adopted the Energy and Greenhouse Gas Management Plan[6], over the next 10 years, no inventory was completed and no significant climate action was pursued. In 2014, the City completed an inventory[7] which was repeated in 2016 and 2017. Since then, the City has renewed its commitments to action on climate change and has set a new baseline for emissions reduction targets at 2014 levels.

***Figure 3**: Community emissions by sector 2016 and 2017.*



Community emissions totalled 3,850,000 tonnes CO_2e in 2014, 3,690,000 tonnes CO_2e in 2016, and 3,710,000 tonnes CO_2e in 2017. Between 2014 and 2017, GHG emissions decreased by 4%.

Emissions inventories in Saskatoon will have some variability due to uncontrollable circumstances and weather (such as prolonged heating and/or cooling days). The emissions reductions and fluctuations between 2014 and 2017 are not the result of action on climate change, but are likely due to variability in temperature during those years (e.g. temperature fluctuations can impact energy requirements for heating and cooling systems in buildings). While Saskatoon has realized a slight decrease in the short term, long term emissions for Saskatoon are projected to increase approximately 33% by 2050 if dedicated action to reduce emissions is not taken.

In 2016 and 2017, transportation was responsible for 35% of the community's emissions, with single passenger vehicles being the largest contributor. Within the transportation sector, light trucks (including SUVs) produced 56% of emissions, cars produced 22%, and heavy trucks produced 21%. Residential and commercial buildings are responsible for 22%, and 32% respectively with space heating, plug loading, lighting and water heating emit the highest amount of emissions.

6 Energy and Greenhouse Gas Management Plan, 2007, City of Saskatoon

7 2014 City of Saskatoon Greenhouse Gas Emissions Inventory https://www.saskatoon.ca/sites/default/files/documents/2014_saskatoon_greenhouse_gas_emissions_inventory.pdf

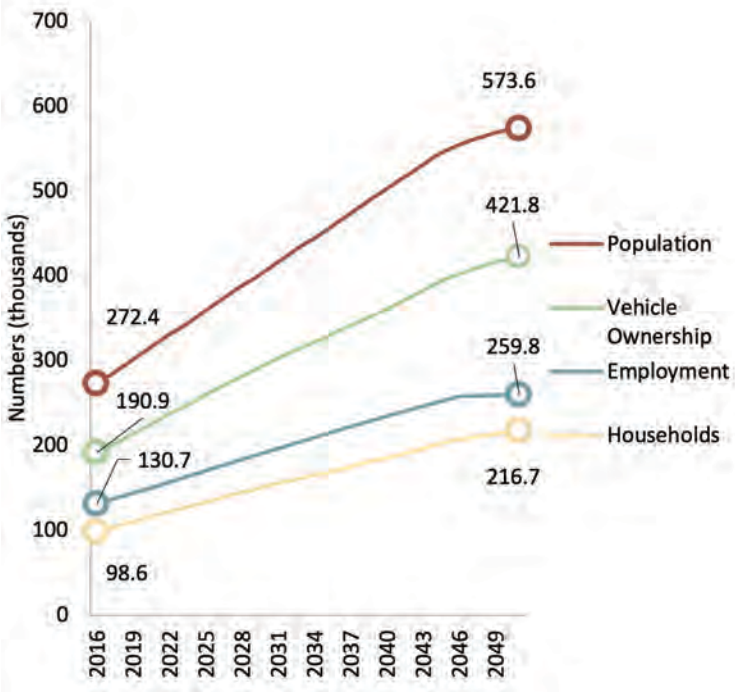
Population and Demographics

Demographics such as population trends, rate of employment, and projected number of households are important elements used in estimating future energy use and emissions and were key assumptions used in modeling. The 2016 National Census, performed every 5 years, provided the baseline information; projections for population and employment were informed by the Growth Plan and various sector plans.

Saskatoon's population has grown rapidly in recent years and is projected to increase by 301,209 people by 2051[8]. Employment is forecasted to scale with population, with 129,144 jobs added between 2016 and 2051. Households are also projected to scale with population growth, with 118,138 added by 2051. Vehicle ownership also scales with population, increasing by 230,900 over the time period.

The following maps outline the population distribution at the neighborhood level in 2016 and what the expected distribution looks like into 2051. The darker areas represent increased density while the lighter areas are less populated.

***Figure 4**: Expected population increases*



Population increase affects building numbers, transportation, energy use, and waste production and these assumptions affect the modelled results of both the business as planned and the low emissions scenarios.

8 Based on Growth Plan projections of 500,000 by 2043, see Appendix D for more details

***Figure 5**: Population distribution by zone 2016*

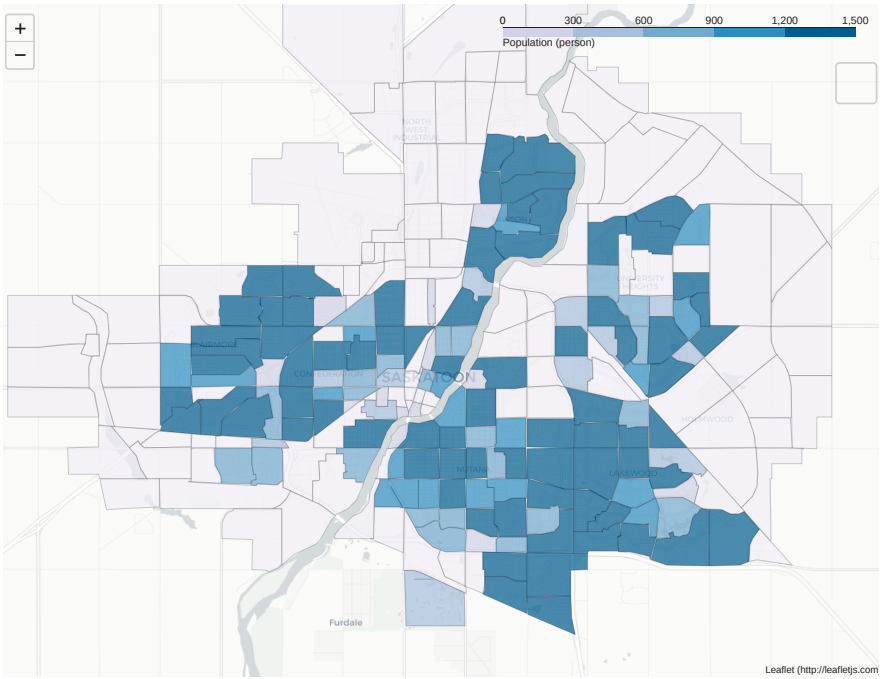
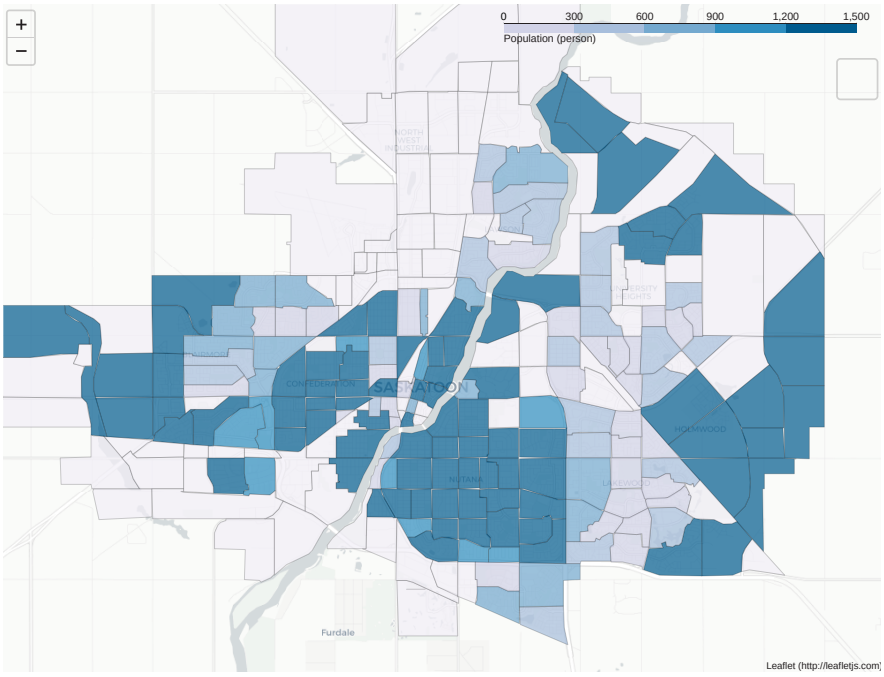


***Figure 6**: Population distribution by zone 2050*




City of
Saskatoon

BUSINESS AS PLANNED SCENARIO

A BAP scenario is akin to a business as usual scenario but it is more realistic to Saskatoon's future state as it takes into account the projects that are in progress or planned but not yet completed. It assumes no additional policies, actions, or strategies are implemented between now and 2050, beyond those that are currently underway.

The BAP scenario was developed by Sustainability Solutions Group and whatIf? technologies with detailed data inputs provided by the City. For a detailed discussion on methodology and modelling assumptions, see appendix D. This provides an analysis of energy, fuel, and emissions if only planned actions are taken over the next 30 years for comparison with a LEC Plan scenario.

The Business as Planned scenario assumes that the City continues to grow, reaching a population of over 500,000 by 2050. With population growth, there are associated increases in employment, number of cars, buildings, and fuel use. While for the most part this results in a similar increase in GHG emissions, there are some notable exceptions:

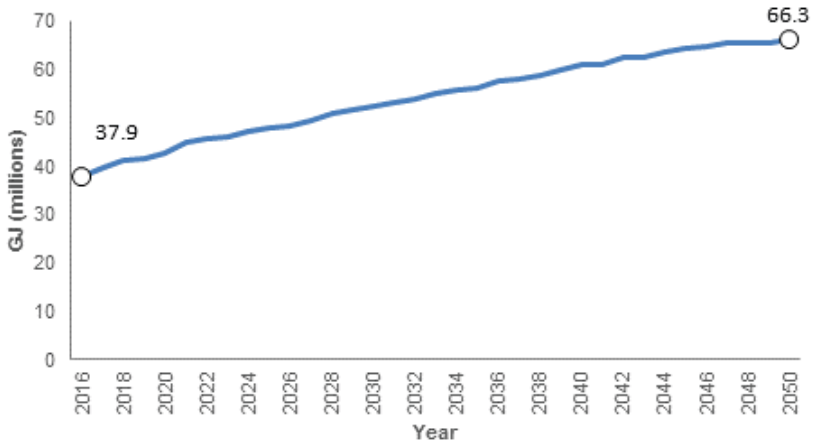
- The Government of Canada will require a full phase out of coal by 2030, causing a significant decrease in electricity emissions. Other fuel emission factors are also expected to decrease as the Environmental Protection Agency (EPA) legislates additional efficiency and Canada follows.
- New buildings will become more efficient to comply with the National Building Code / National Energy Code for Buildings (2017)
- Planned activities such an Environmental Performance Contracting (EPC), LED streetlight replacement, the Active Transportation Plan, Plan for Growth, and a Curbside residential organics programs results in emissions reductions from vehicles, municipal buildings, and waste. These are included in the BAP Scenario

Energy Use

Energy use is projected to increase by over 31.6 million GJ (8,777,778 MWh), or by 83%, by 2050 in the BAP scenario.

However, per capita energy use is projected to decrease by 17 MJ. While the population increases, space heating and water heating demands are projected to decrease due in part to smaller new homes (on average), increased energy efficiency in new buildings, and reduced heating demand days due to warmer winters.

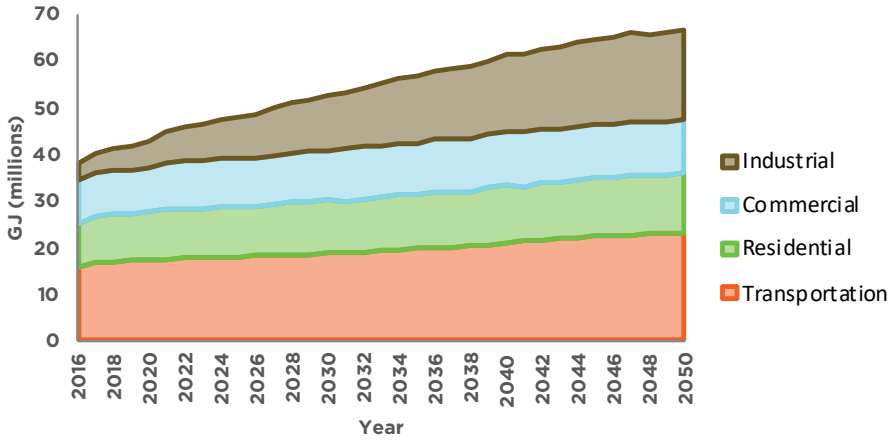
***Figure 7**: Projected Total Energy Use*



Total Energy Use by Sector

The industrial sector sees the greatest change, at almost 440%, due to a large anticipated increase in industrial floor space. Despite slight gains in their energy efficiency, new homes will add substantially to residential energy consumption, increasing by almost 70%. Commercial building energy use increases with its added floor area, changing energy use in that sector by over 26%. Increased vehicle ownership pushes energy consumption up by almost 47% in the transportation sector.

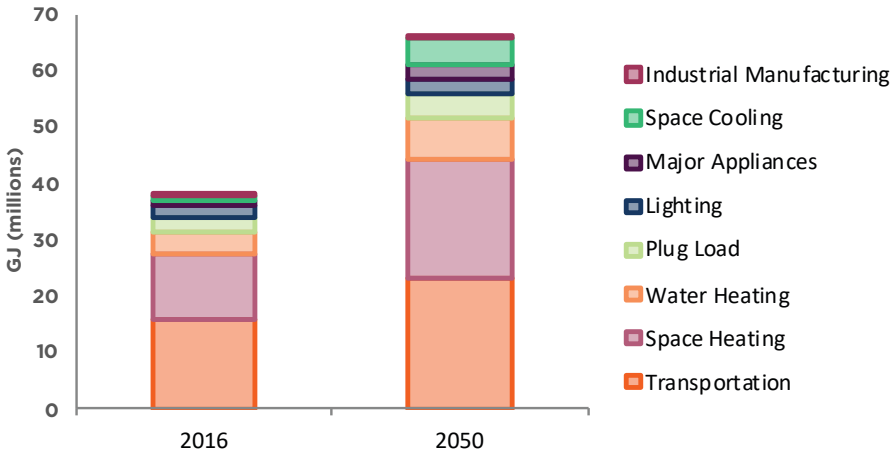
***Figure 8**: Projected total energy use by sector*



Total Energy Use by End Use

Transportation and space heating account for the majority of energy use between 2016 and 2050. Space heating demands are projected to increase by almost 94% over the time period as many new homes are built. Similarly, water heating is projected to use 112% more energy in 2050 than 2016. Plug loads and energy use from major appliances increases with housing as well, increasing by 65% and 163% respectively. Transportation energy consumption increases only moderately through to 2035, due to improved fuel efficiency standards in vehicles and an incremental uptake of electric vehicles (which contributes to increased electricity consumption), and escalates thereafter as projected increases in vehicle kilometres travelled outpace any fuel efficiency gains.

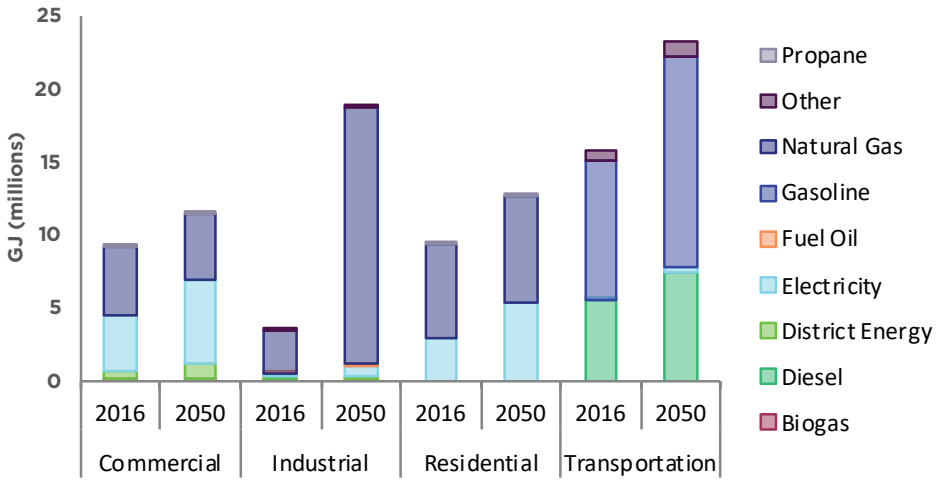
***Figure 9**: Projected total energy use by end use*



Total Energy Use by Fuel Type

Natural gas (space and water heating), electricity (space and water heating, plug loads and appliances) and gasoline (vehicles) make up the majority of fuel use for energy produced between 2016 and 2050. Additional vehicles and homes will increase gasoline use by almost 50% over the time period, while natural gas use is projected to increase by 123%. Electricity use is projected to increase by 95% due to increased plug loads and appliances. The use of all other fuels is expected to increase as well, as elevated population levels drive energy demand.

***Figure 10**: Projected total energy use by sector and fuel type*



Energy Flow and Conversion

The Sankey diagrams below depict the flow of all energy across the entire city, from its source to its end use. Energy sources are on the left-hand side of the diagram, energy use by sector is in the centre, and sums of total energy used and lost are on the right. The height of each energy source bar indicates how much energy is supplied by that source. Similarly, the height of each bar for energy uses indicates the total energy used by each sector. The height of each bar for total energy used and lost is also proportionate. The diagram shows the portions of each energy source that flow to each energy end use. It also shows how much of that energy is successfully used and how much of it is lost in energy conversion and transmission.

The Sankey diagrams below depict Saskatoon's energy flow by fuel and sector in 2016 and 2050. The ratio of useful energy to conversion losses in 2016 is 1.13:1 compared to 1.65:1 in 2050.

***Figure 11**: Sankey diagram for 2016 energy flows*

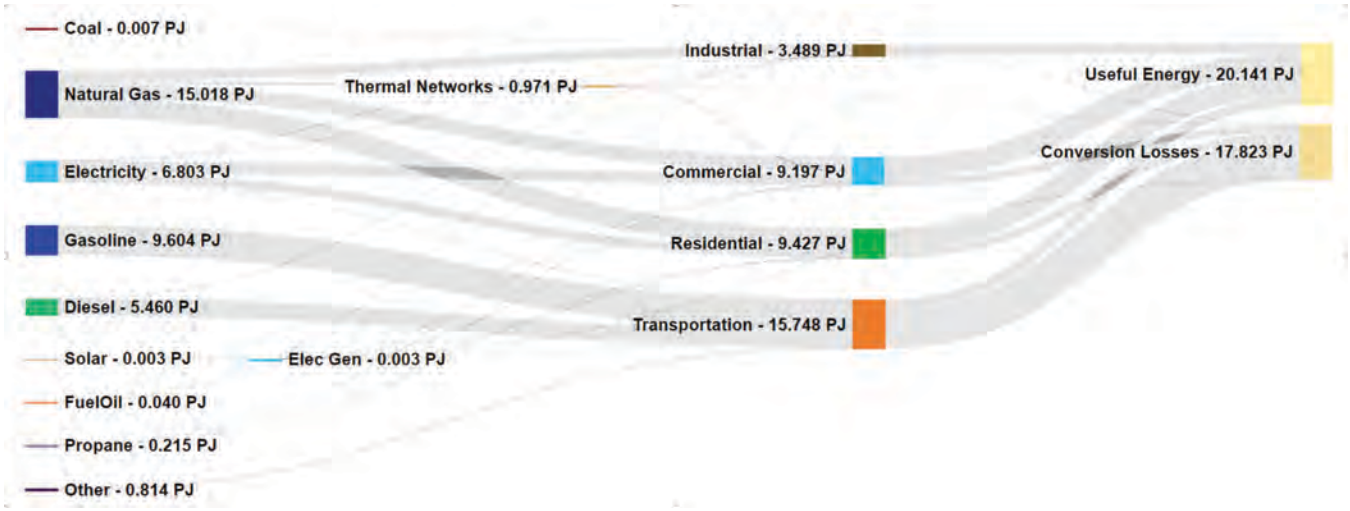
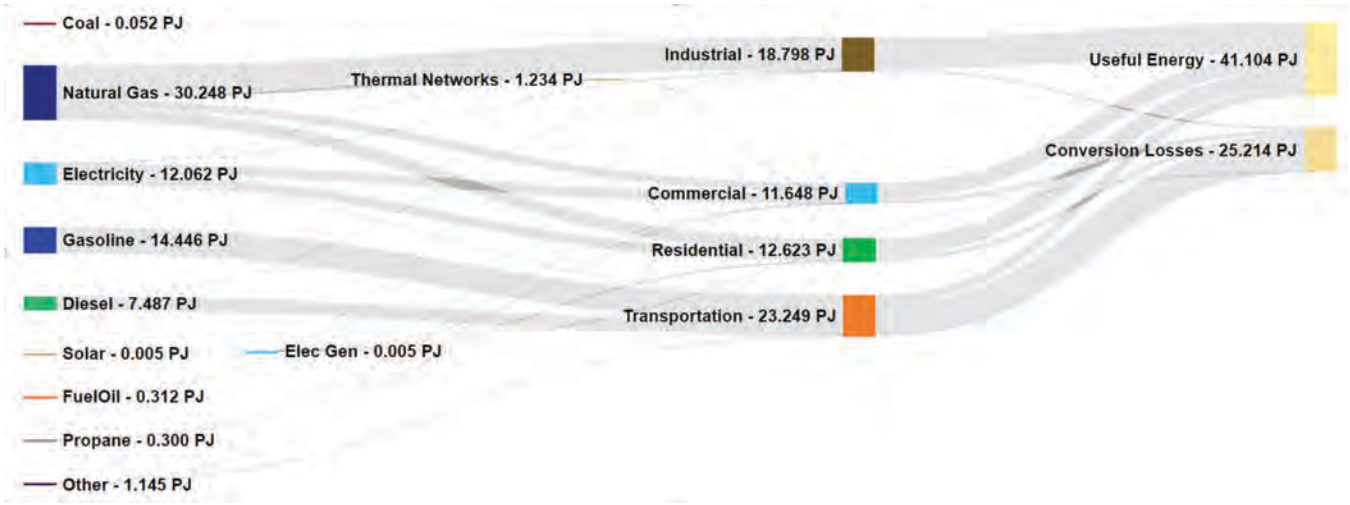


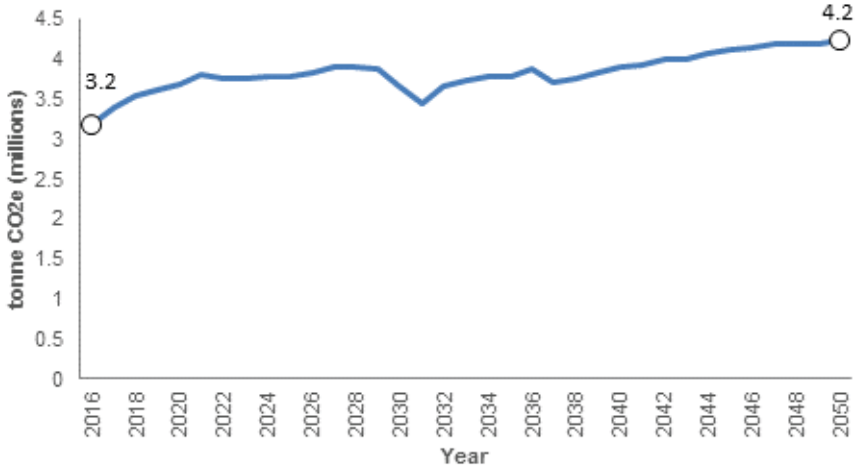
***Figure 12**: Sankey diagram for 2050 energy flows in Business as Planned Scenario*



Projected Total GHG Emissions

Saskatoon's total GHG emissions for the 2014 baseline year is 3,850,000 tonnes CO_2e. Total projected GHG emissions increase to 4,350,000 tonnes CO_2e by 2050 (an increase of 33.4%). A per capita GHG emissions decrease by 4.4 tonnes CO_2e between 2016 and 2050 is projected.

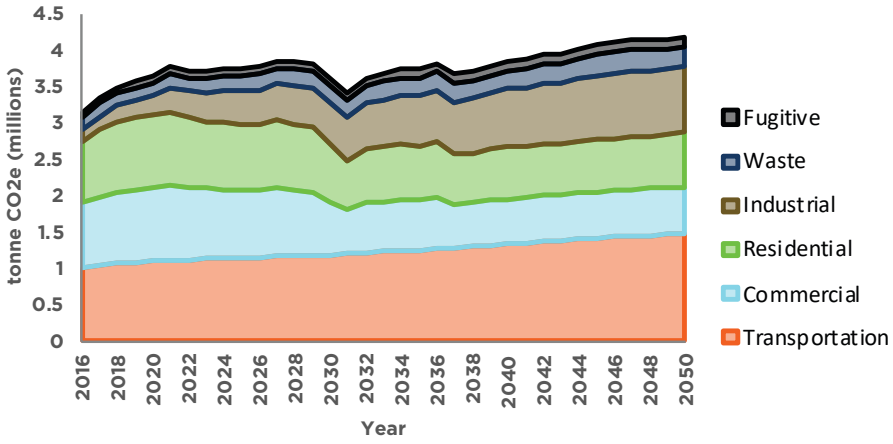
***Figure 13**: Projected total GHG emissions in million tonnes*



Total GHG Emissions by Sector

The transportation, residential, and commercial sectors are responsible for the vast majority of Saskatoon's GHG emissions in 2016, with 32%, 26%, and 28% of total 2016 GHG emissions, respectively. In a BAP scenario it is projected that by 2050 transportation emissions will increase by over 47% as car ownership increases. All building sectors will see significant emissions reductions from the phase out of coal-fired electricity production through the mid-2030s. Commercial building sector emissions will decrease by almost 30% as Heating Degree Days decrease and only moderate floor space is added. The residential sector will see a 10.0% emissions increase, despite significant added housing because of the switch away from coal. The industrial sector is expected to expand its floor space greatly by 2050, adding significantly to its energy use and emissions, which rise by almost 450%.

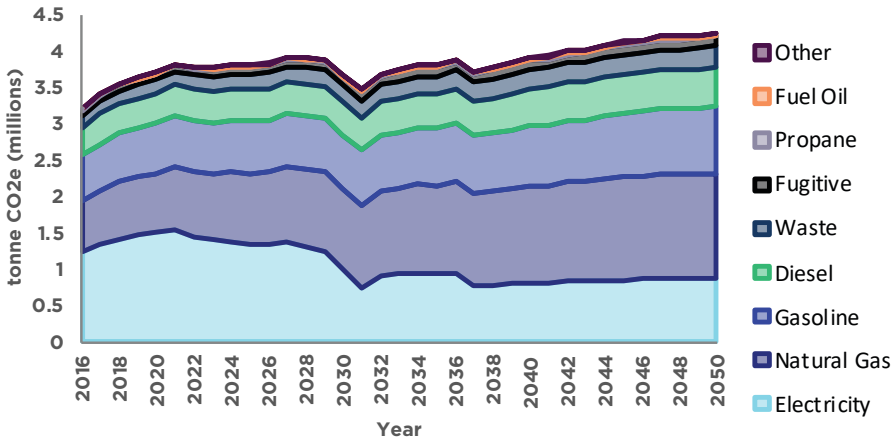
***Figure 14**: Projected total GHG emissions by sector*



Total GHG Emissions by Fuel Source

In 2016, the highest emitter by fuel type was electricity (38.6% of total GHG emissions) followed by natural gas (21.7%) and gasoline (20.3%). Together, they constitute over four-fifths of total fuel emissions. GHG emissions associated with electricity production are projected to decrease by 21.5% over the time period, primarily due to the phase out of coal-fired electricity generation in the province. Much of the electrical generation capacity will switch to natural gas-fired plants, increasing emissions from natural gas by 115% by 2050. Additional vehicles drive gasoline related emissions up by over 50%. As the use of other fossil fuels increases with population, so too do their associated emissions.

***Figure 15**: Projected total GHG emissions by fuel type*



Building Energy & Emissions

As Saskatoon's population increases, its building stock is also projected to increase to accommodate people in homes, offices, commercial spaces, and industrial areas. 12,681,133 m^2 in new residential building area is projected by 2050 (an increase of 131%), with a substantial increase in both apartments and single family homes.

Total non-residential building area is projected to increase by 64.2% by 2050, with a massive planned increase in industrial building floor space.

Building Energy Use

In 2016, buildings used 22.1 million GJ of energy. Their consumption is projected to increase by almost 110% to 46.4 million GJ by 2050. In 2016, the residential building stock consumed 42.6% of total building energy use, commercial consumed 41.6%, and industrial buildings consumed the remaining 15.8%. By 2050, industrial sector energy use is expected to increase by almost 440% to become 40.5% of total building sector energy use. Energy use per home is forecasted to decrease 4.0% by 2050.

Building GHG Emissions

Buildings in Saskatoon emitted 1,935,339 tonnes CO_2e in 2016 and are projected to emit 2,491,091 tonnes CO_2e in 2050—an increase of 28.7%. Residential GHG emissions are projected to increase by 10.0% by 2050, while commercial buildings will decrease emissions by 28.7%. Industrial emissions will increase emissions in step with their increasing floor space and energy use, rising by 448.3%, becoming over one-third of total buildings sector emissions. Total GHG emissions per home is projected to decrease almost 50% between 2016 and 2050.

***Figure 16**: Citywide Building related emissions 2016*

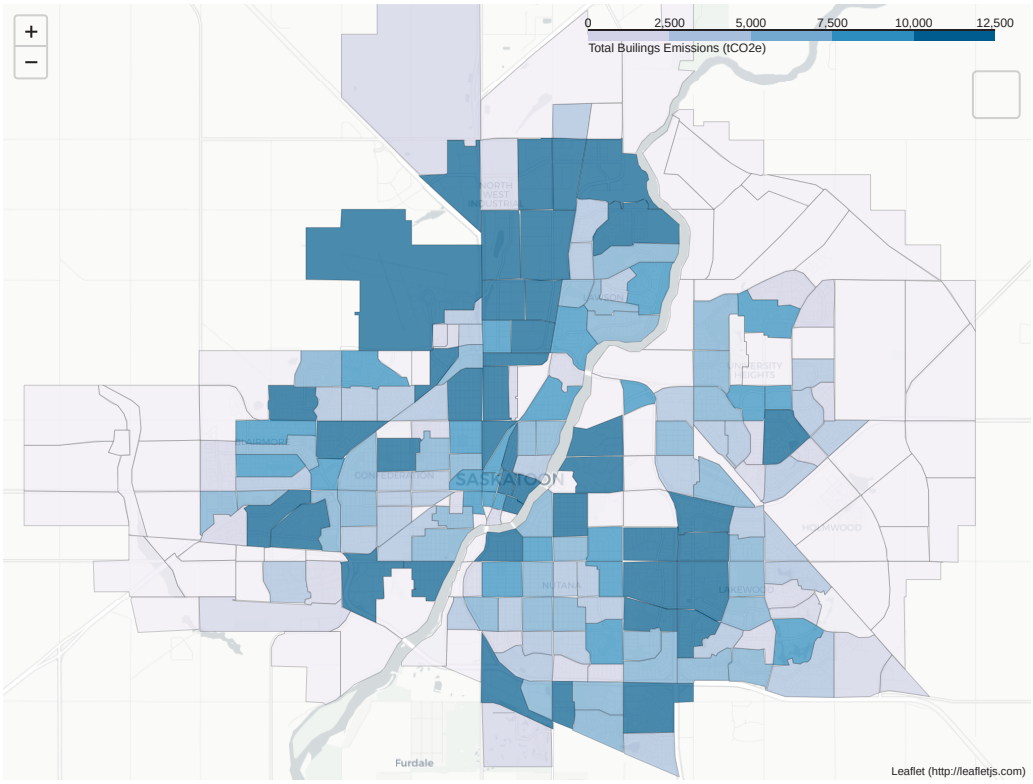
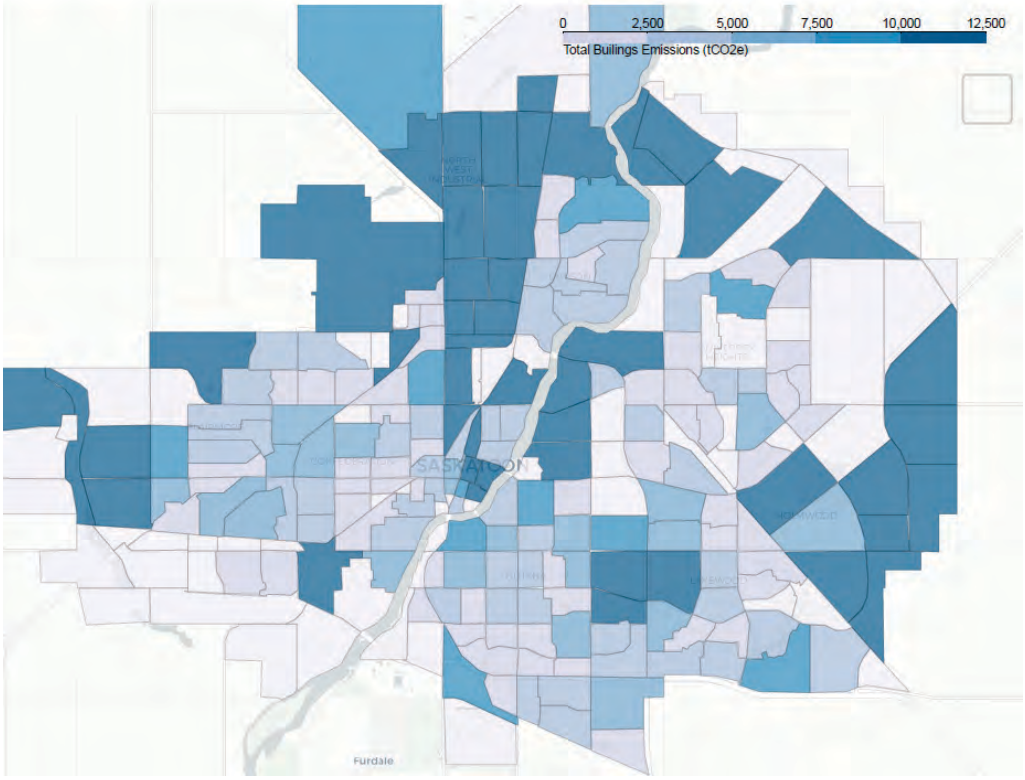


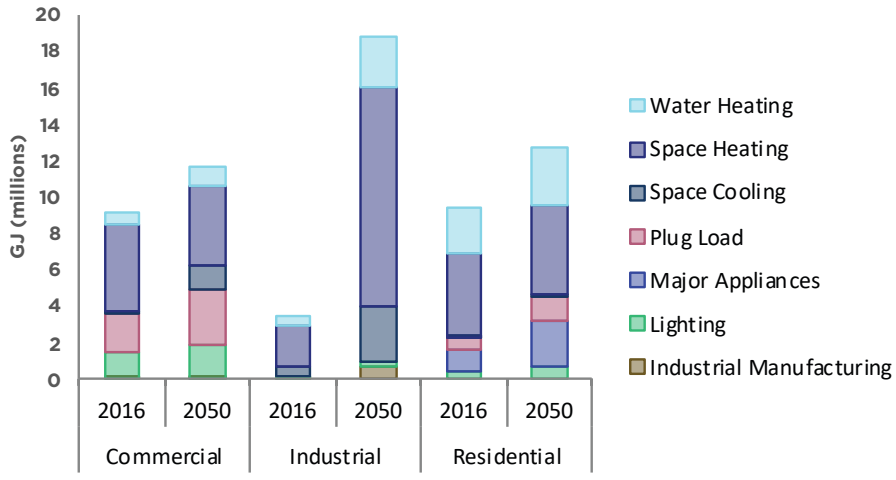
***Figure 17**: Citywide Building related emissions 2050*



Building Energy Use by End Use

With 52.4% of the total energy used in buildings in 2016, space heating is by far the greatest building energy end use. As new buildings become more efficient, homes become smaller on average, and heating degree days decrease, space heating energy demand decreases to 48.4% of total energy consumption by 2050. Water heating is projected to use more energy by 2050, with a 112.1% increase. Increases in population bring additional demand for lighting, appliance energy use and plug loads, whose energy use is projected to experience 59.2%, 163% and 64.8% increases, respectively. Although projected to be only 9.6% of the total energy used in 2050, space cooling energy demand increases significantly (477.7%) from 2016 to cope with increased cooling degree days due to hotter summers.

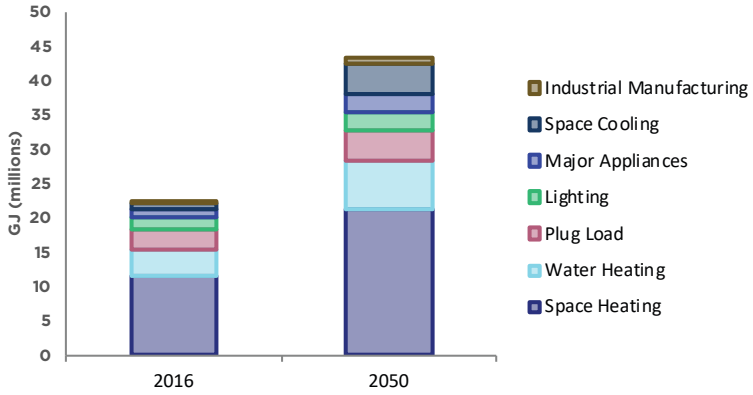
***Figure 18**: Current & projected buildings energy use by sector & end use*



Building GHG Emissions by End Use

The primary energy source for space heating in Saskatoon is supplied by fossil fuels, therefore space heating in 2016 made up almost one-third (31.6%) of total building GHG emissions. Space and water heating GHG emissions are projected to increase in step with population and additional housing. Plug load and lighting related GHG emissions decrease as Saskatchewan phases out coal-fired electricity generation by the mid-2030s. As cooling degree day's increase, space cooling emissions increase significantly (318.7%). As industrial floor space increases significantly, the sector's increased energy use is accompanied by increased emissions, growing by 279.5%.

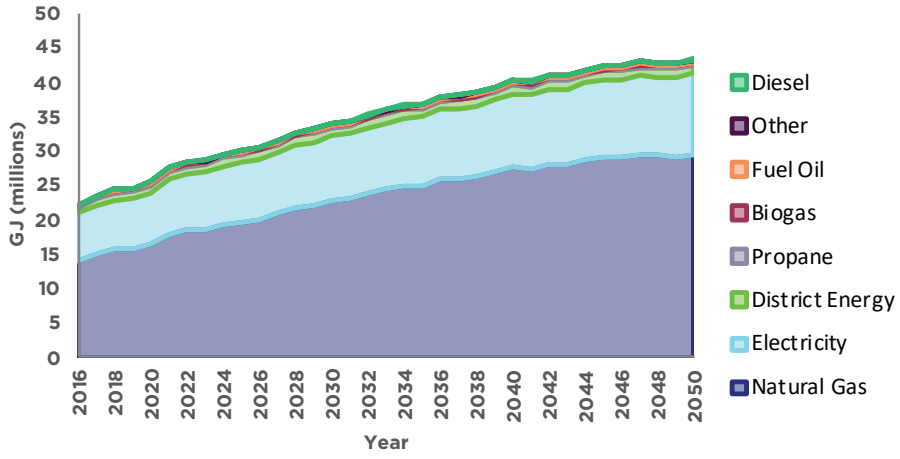
***Figure 19**: Building emissions by end use current & projected*



Building Energy Use by Fuel Type

In 2016, natural gas provided the majority of energy used in buildings (63.6%). Building consumption of natural gas is projected to increase by 123% as residential and non-residential floor spaces increase. Electricity use is 30.7% of total energy use in 2016, increasing 90% by 2050.

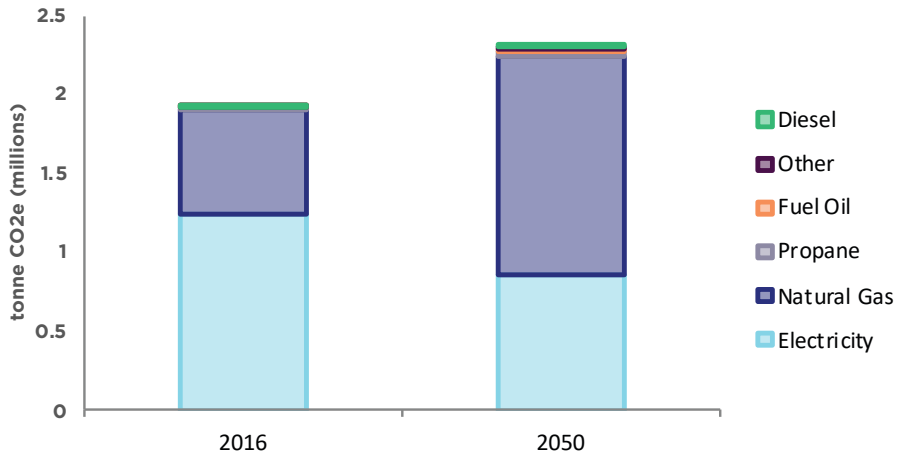
***Figure 20**: Building energy use by fuel type projected*



Building GHG emissions by Fuel Type

Electricity use is responsible for almost 65% of Saskatoon's building emissions in 2016. As coal-fired electricity generation is phased out in the mid-2030's in accordance with federal planning, the grid's emission factor decreases. This would result in a GHG emissions decrease for buildings of 23.4% between 2016 and 2050. Natural gas GHG emissions increase and make up the majority of total building emissions for 2050. Propane stoves, fuel oil furnaces and diesel generators were responsible for the remainder of 2016 building GHG emissions. By 2050, GHG emissions associated with the fuel types increase, but their use in buildings remains small. Overall emissions from buildings will increase by 28.7% in the BAP Scenario.

***Figure 21**: Building GHG emissions by fuel type current & projected*



Transportation Energy & Emissions

At over 15.7 Million GJ, Saskatoon's transportation sector accounted for almost 41.6% of the city's total energy use in 2016. Over half of the transportation energy use was by light trucks (including SUVs), while the majority of the remainder was split almost evenly between cars and heavy trucks. The energy used in the transportation sector increases by 46.7% by 2050. Energy use by light trucks is projected to increase substantially by 2050 compared to small cars, making up over 60% of energy use in the transportation sector.

***Figure 22**: Projected transportation energy use by vehicle type*

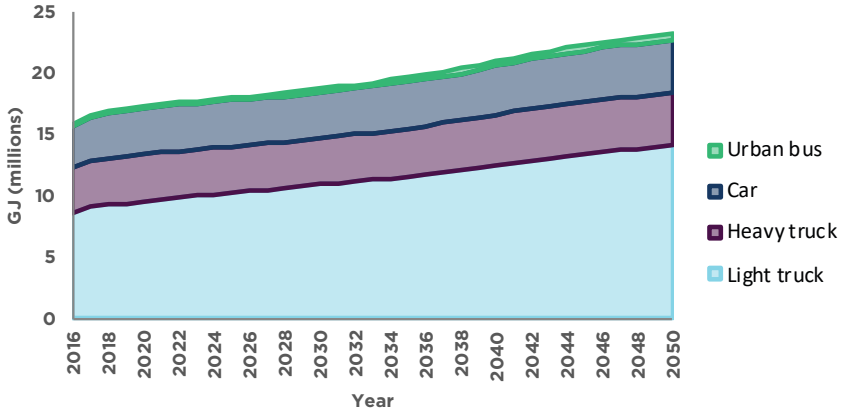


***Figure 23**: Personal Vehicle Use emissions map 2016*

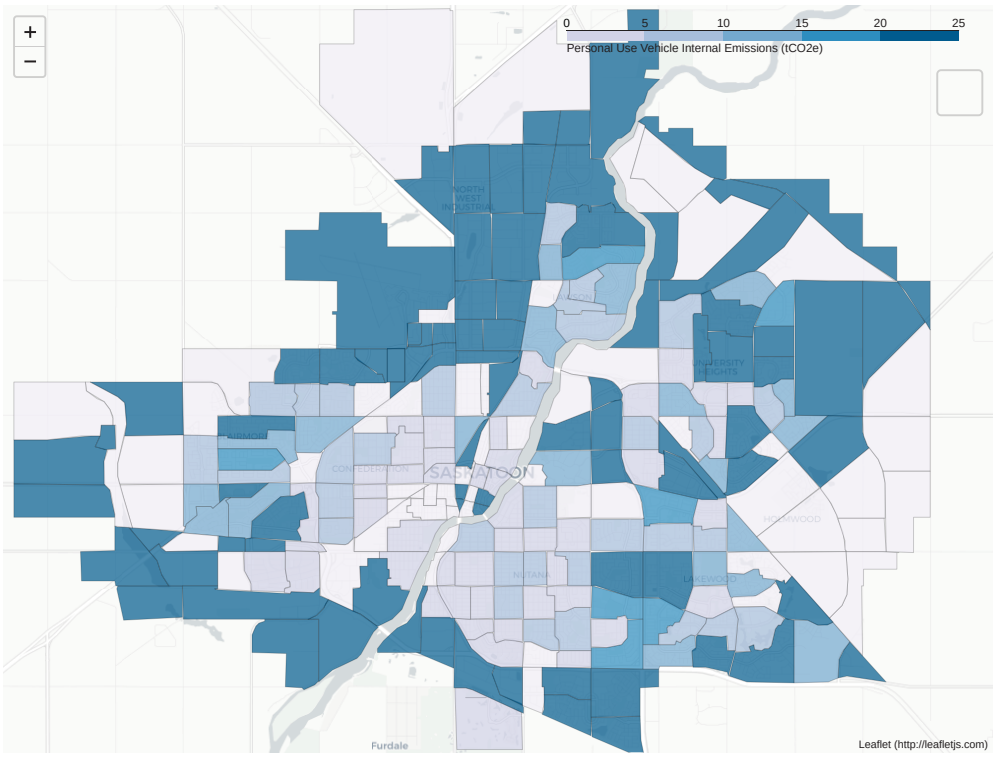
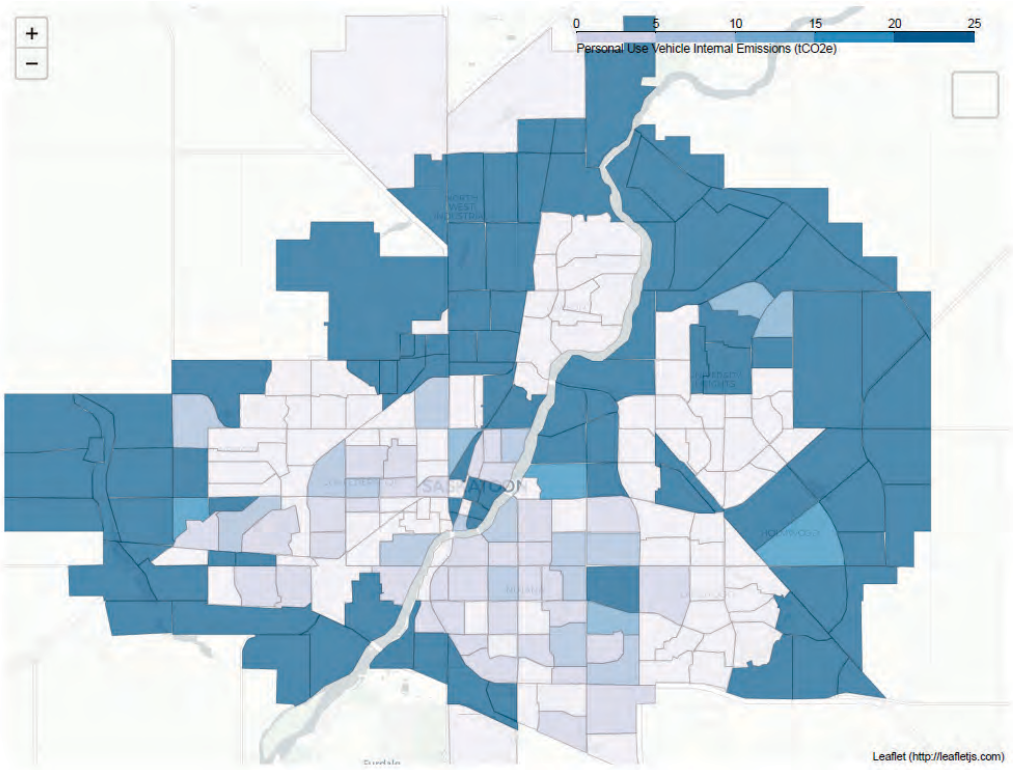


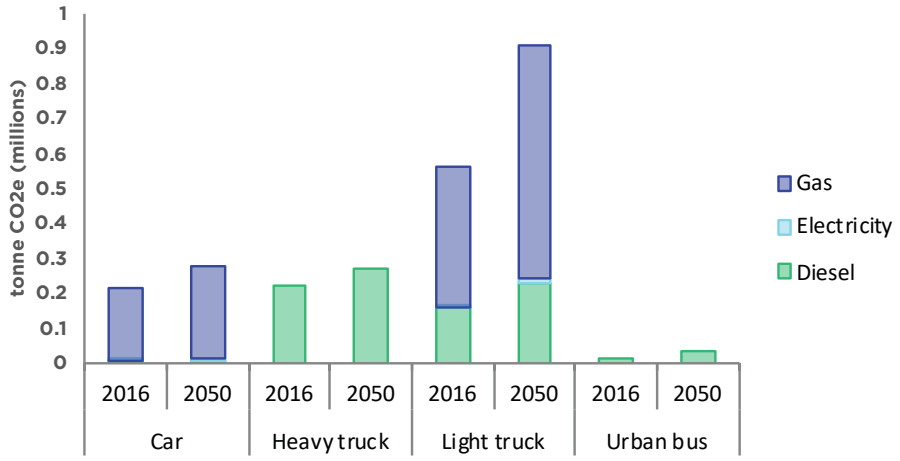
***Figure 24**: Personal Vehicle use emissions map 2050*



City-wide GHG emissions shares by vehicle type align with their energy use. As vehicle ownership shifts to more light trucks, that sector's share of emissions increases by 2050.

The municipality's current fleet vehicle emissions (not including City Transit vehicles) totaled 10,373 tonnes CO_2e in 2016 and 10,441 tonnes CO_2e in 2017. This is approximately 10% of all corporate emissions. Currently, 27% of these emissions are related to light duty gasoline vehicles, 45% are related to larger vehicles and equipment that utilize diesel, 13% are related to police service, 3% are related to fire department services and the remaining 12% are tied to other uses.

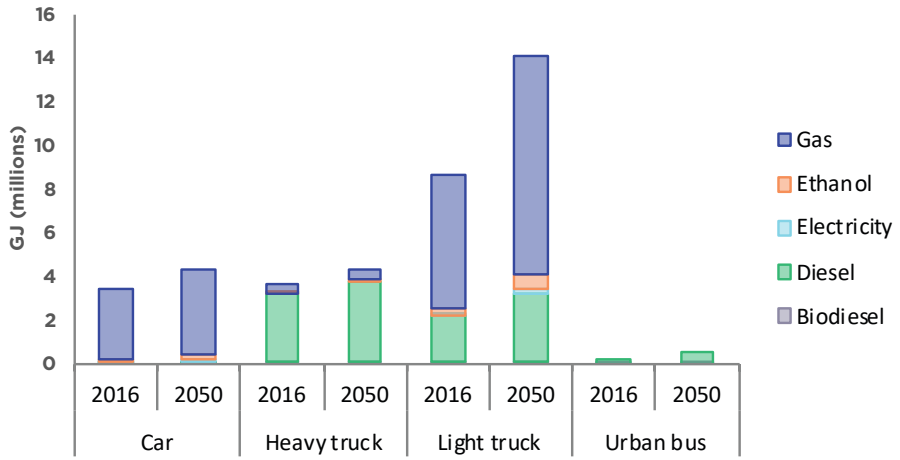
***Figure 25**: GHG emissions by vehicle and fuel type*



Transportation Energy by Fuel Type

As the primary vehicle fuel source in 2016, gasoline consumption is responsible for the majority of transportation GHG emissions at 61.0%, followed by diesel at 34.6%. These shares remain roughly constant through 2050. Electric vehicles increase electricity use over 243,000% by 2050, although as a share of total energy used, electricity use remains minuscule. Gas and diesel still make up over 95% of transportation energy use in 2050

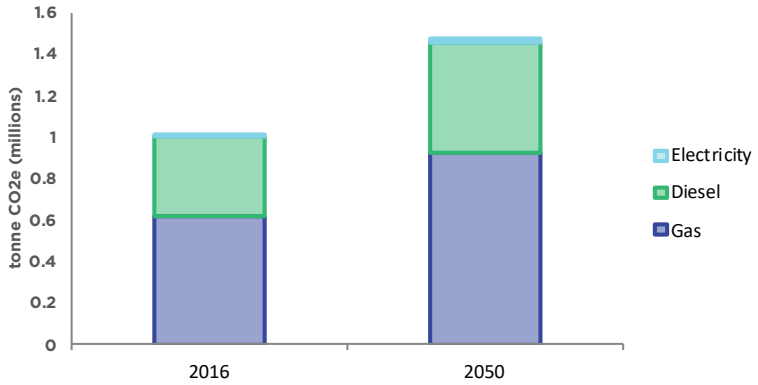
***Figure 26**: Transportation energy use by vehicle & fuel type current & projected*



Transportation GHG Emissions by Fuel Type

As population and total vehicle ownership increase, total transportation GHG emissions are forecasted to increase by almost 50% between 2016 and 2050. Gas accounts for 63.0% of GHG emissions in 2016 while diesel accounts for the remainder. This is expected to change only slightly by 2050. GHG emissions from Electric Vehicles (EVs) increase substantially as more people switch to electric vehicles, but make up a tiny percentage of total transportation GHG emissions.

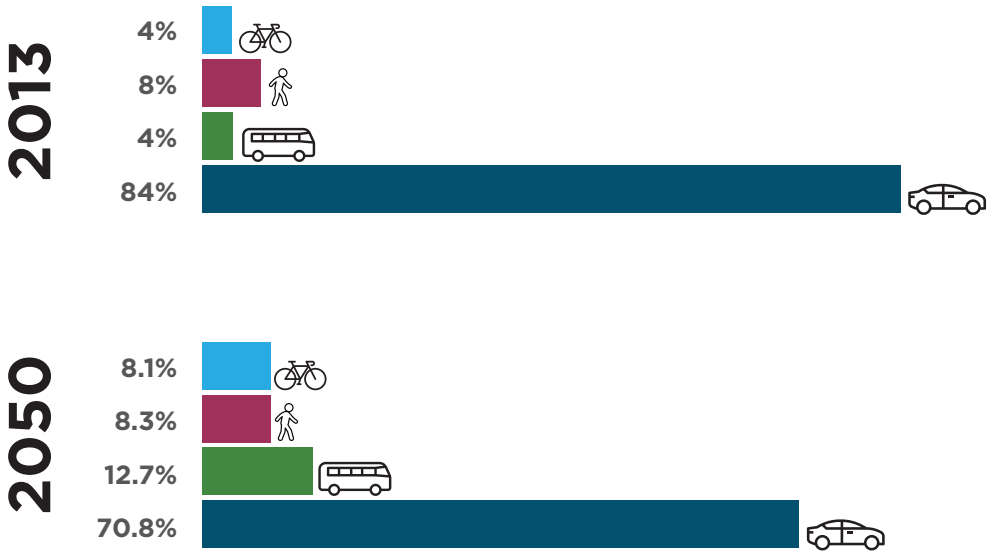
***Figure 27**: Transportation emissions by fuel type current & projected*



Trips and Mode Share

Saskatoon's land-use development has grown the city outward over the years. This urban form is reflected in its transportation patterns, where the most trips are made by personal vehicle. The Active Transportation Plan and the Plan for Growth have mode shift targets for 2045 which see significant increases in walking, biking and transit trips, although personal vehicle travel by 2050 is still expected to make up the vast majority of trips.

***Figure 28**: Mode Share Bar Chart (2013 Household Travel Survey, City of Saskatoon, P. 32)*



Solid Waste Emissions

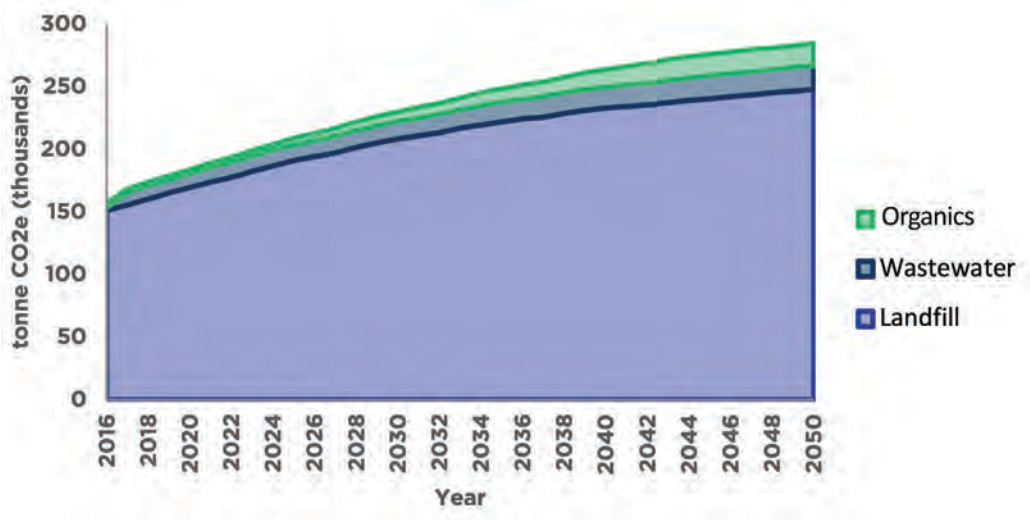
The Waste Diversion Opportunities report estimated that 264,000 tonnes of solid waste was generated in 2016[9]. 36% of it was found to be compostable material (food and yard waste), and 21% recyclable, however, the report estimated that almost 90% of the generated waste went to landfills.

Saskatoon's waste is projected to increase by 85% by 2050, in step with population growth. Organics diversion is expected to increase by 2050 with the introduction of a curbside organics program in 2023. A slight increase in recycling diversion is also likely to occur, as well as voluntary adoption of recycling and organics diversion from the ICI sector.

97% of Saskatoon's waste greenhouse gas emissions were attributable to its landfilled waste in 2016. As the population increases, so too do all waste outputs, contributing to increased emissions. Emissions from landfilled waste are expected to increase 64% by 2050.

The recycling of solid waste is assumed to result in zero waste GHG emissions. Greenhouse gas emissions associated with the energy used at recycling facilities is accounted for in the buildings energy use sector. Similarly, GHG emissions associated with the transportation of waste are accounted for under the transportation sector. Landfill GHG emissions include those from open and closed landfills.

***Figure 29**: Projected waste emissions by sector*



Waste Water

Over 36 million m^3 of wastewater was produced in Saskatoon in 2016, all of which was treated by central treatment facilities. Wastewater production is forecasted to increase in step with population, rising almost 90% by 2050.

Business as Planned Summary

In the long term, community emissions are projected to rise 33% to 4,350,000 tonnes CO_2e by 2050 under a BAP scenario. This projection is far above our reduction target of 80% by 2050 which requires emissions to stabilize at 780,000 tonnes CO_2e in the year 2050.

9 The 2017 Waste Diversion Opportunities Report was completed by Dillon Consulting for the City of Saskatoon and included the results and an analysis of a city-wide waste characterization completed in 2016.

THE LOW EMISSIONS COMMUNITY

Impact Summary

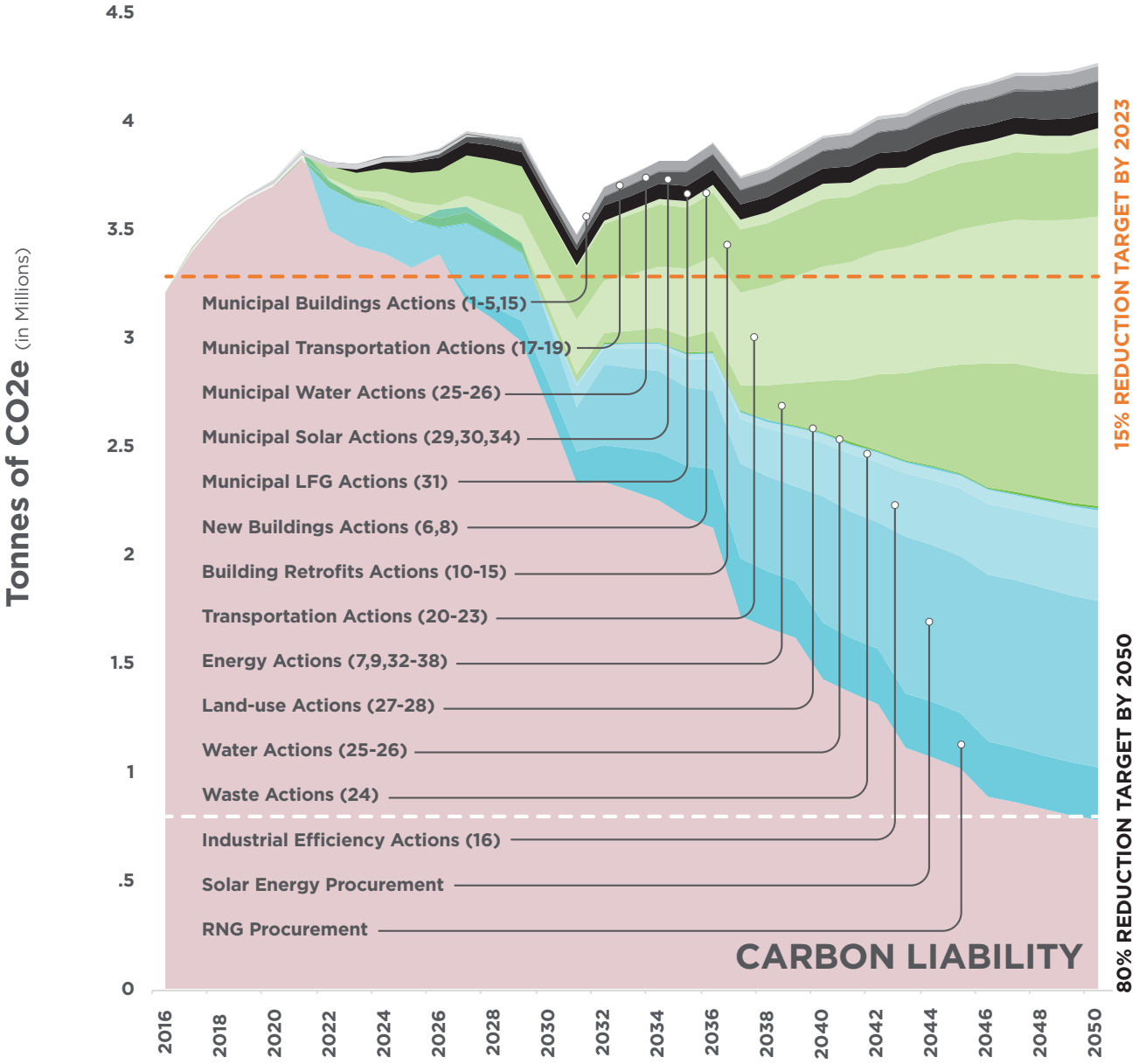
In 2014, Saskatoon's GHG emissions totalled 3,850,000 tonnes CO_2e, these are projected to rise to 4,850,000 tonnes CO_2e, a 13% increase, without action. SSG and whatIf? Technologies used the CityInsight Model to identify 40 actions that would get Saskatoon to its emissions reduction target of 80% by 2050.

The LEC Plan is a whole-city strategy, whose policies and actions achieve multiple community benefits, including increased quality of life, better health outcomes and household energy savings. The LEC Plan models 40 actions through the categories of:

- ***Buildings and Energy;***
- ***Transportation;***
- ***Land Use;***
- ***Renewable Energy;***
- ***Water Conservation; and***
- ***Waste Management.***

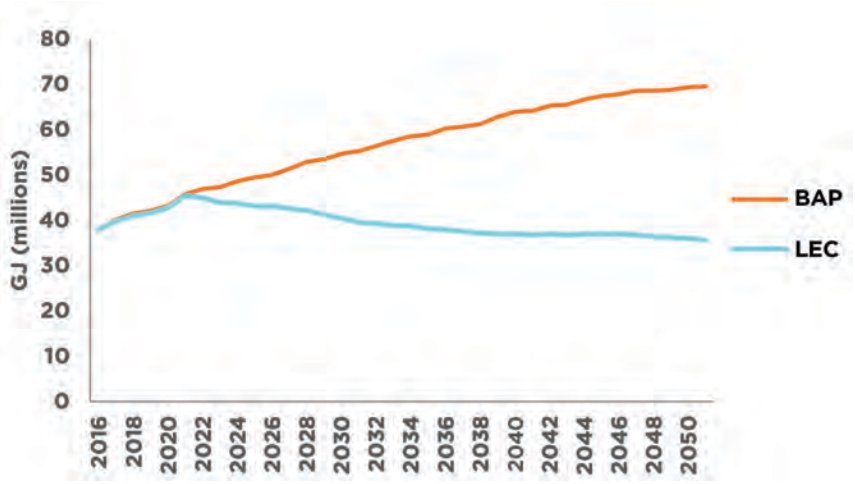
The following section outlines the impact of the collective emissions reduction actions, which then leads to a detailed action by action description. The results that follow are compared to the BAP scenario. Figure 30 demonstrates how each action contributes to reducing emissions to reach the targets.

***Figure 30**: Pathway to a Low Emissions Community*



Total Energy Use

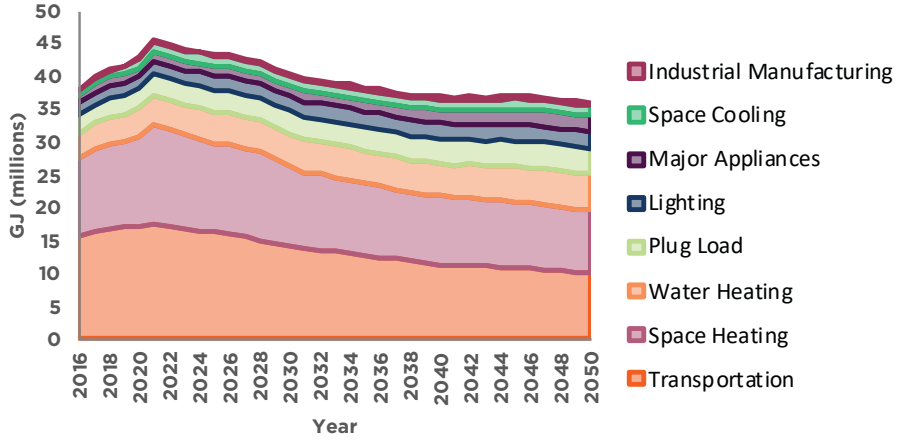
Figure 31: *Total Energy Use, BAP vs. LEC Plan*



The LEC Plan would result in total energy used in Saskatoon to be reduced to 36 million GJ by 2050. This is just over half of what is expected in the BAP scenario, where energy climbs from about 38 million GJ in 2016 to almost 70 million GJ in 2050.

Energy by End Use

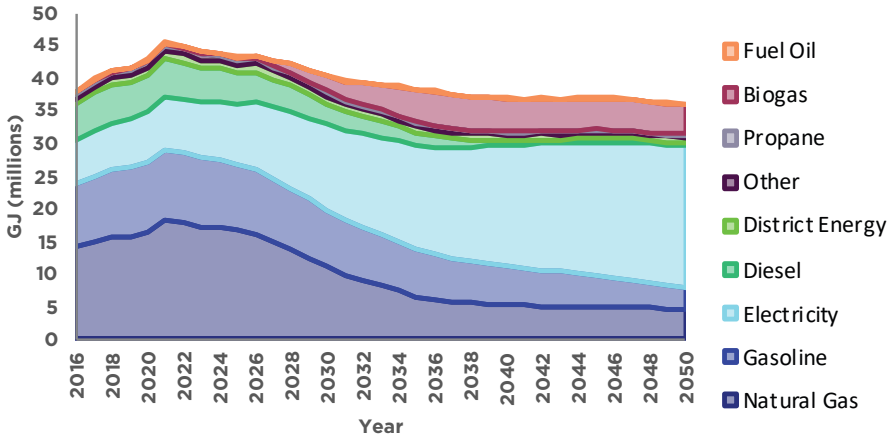
Figure 32: *Energy by end use projected*



Although lighting, appliance, and plug load demand in buildings increase as the population grows and new homes are built, the LEC Plan decreases space heating demand by 19% compared to the BAP in 2050 through increasingly efficient new buildings and retrofits to existing buildings. The transportation sector is the other significant contributor to lowering energy use. Through electrification of personal and commercial vehicles and the municipal fleet, as well as deceasing driving demand with increased transit services and walking and biking infrastructure and programs, energy used by transportation decreases 38% in the LEC Plan compared to the BAP in 2050.

Energy by Fuel Type

Figure 33: *Energy by fuel type*



Energy sources under the LEC Plan shift significantly from 2016 to 2050, as well as compared to the BAP scenario. Diesel, gasoline, and natural gas make up 14%, 25% and 37% of the energy supply in 2016. Under the BAP scenario, they make up 11%, 21% and 45% in 2050. Under the LEC Plan, they dwindle to 1%, 8% and 12%. In place of fossil fuels, LEC Plan energy sources shift to electrification fed by renewable sources (mostly supported by solar PV) and Renewable Natural Gas (RNG) is produced and purchased for use instead of traditional natural gas.

One of the major challenges for Saskatoon to reduce its community wide emissions is the electricity grid - coal and natural gas fired electricity generation makes it difficult for the city to switch to clean energy. The actions related to procurement of renewable electricity and natural gas (actions 39 & 40) make up about 28% of the 40 action's emissions reductions. This is a testament to how challenging emissions reductions are under a fossil fuel-powered electricity grid. The 36 non-procurement actions are ambitious, addressing all City and community sectors. However, they fall short of the 80% emissions reductions by 2050 under 2014 levels target and renewable energy procurement is needed to bridge the gap.

Total Emissions

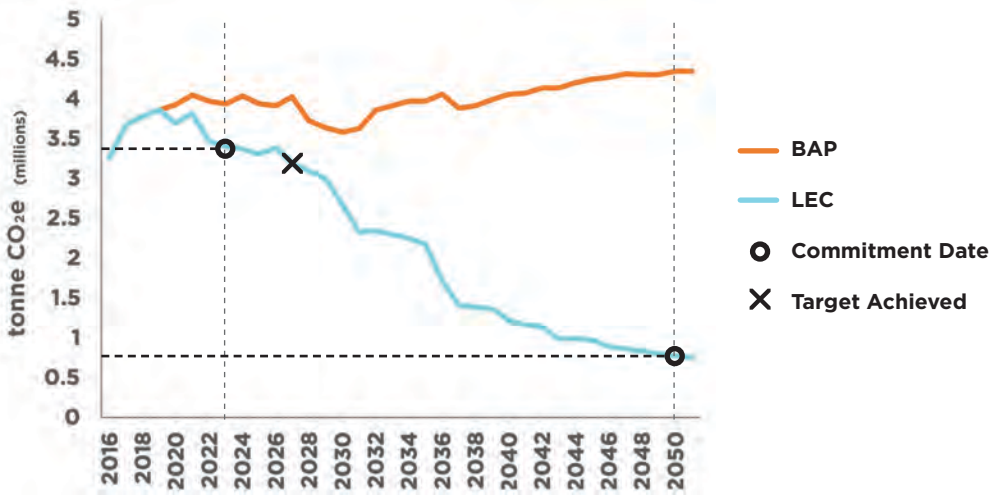
In relation to the emissions reduction targets, implementing the full suite of 40 actions in the recommended timeframe will result in the reductions: Refer to Table 2.

***Table 2**: Target Status and Modelled Projection Summary*

Item	City of Saskatoon	Community	Total
2014			
2014 GHG Baseline (tonnes CO_2e)	106,300	3,743,700	3,850,000
2023			
2023 GHG Reduction Target (%)	40%	15%	
2023 Modelled performance (%)	49.63%	11.61%	
2050			
2050 GHG Reduction Target (%)	80%	80%	
2050 Reduction target (tonnes CO_2e)	85,000	2,995,000	3,080,000
2050 Target Emissions (tonnes CO_2e)	21,300	748,700	779,000
2050 Modelled performance (%)	89.39%	79.71%	
2050 Modelled performance (tonnes CO_2e)	10,630	748,700	759,330

The 40 actions can achieve emissions reductions of 3,080,000 tonnes CO2e in the year 2050, meeting commitment of the City's total emissions to 779,000 tonnes CO2e. 3% of emissions reductions is achieved by municipal corporate actions and 97% is achieved by community actions. Corporate reductions are more easily achieved than community wide reduction as the municipality has more control over its own operations, whereas community reductions require broader scale education efforts and behavioural changes over time.

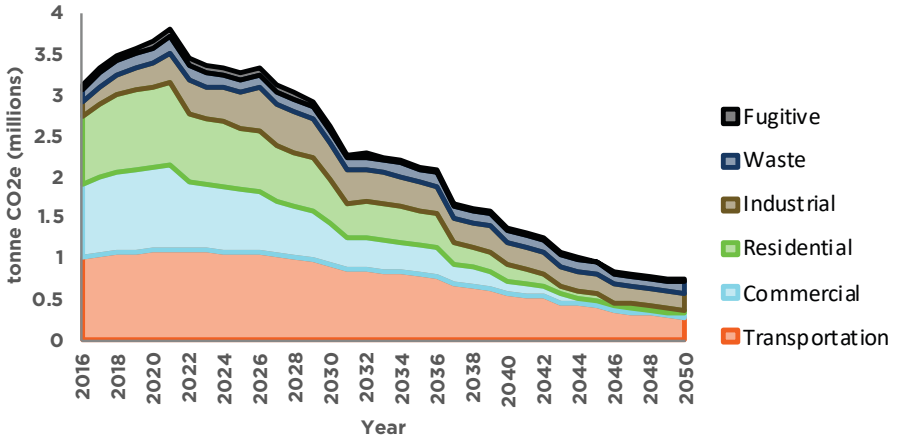
***Figure 34:** Modelled LEC Plan Results in relation to the targets*



The success of the plan lies in the City and the community's ability to follow the roadmap outlined in this report and implement every action. In following this plan, the corporate target of **40% emissions reductions could be met by 2023**. While the Plan begins to move the needle with Community emissions, even with the plan in place the Community target would not be met in 2023, with modelling showing a 12% GHG reduction. The **15% community reduction target** is projected **to be met by 2027**. If fully executed, the LEC Plan actions for both the community and the City as a corporation successfully meet the **80% reduction target by 2050.**

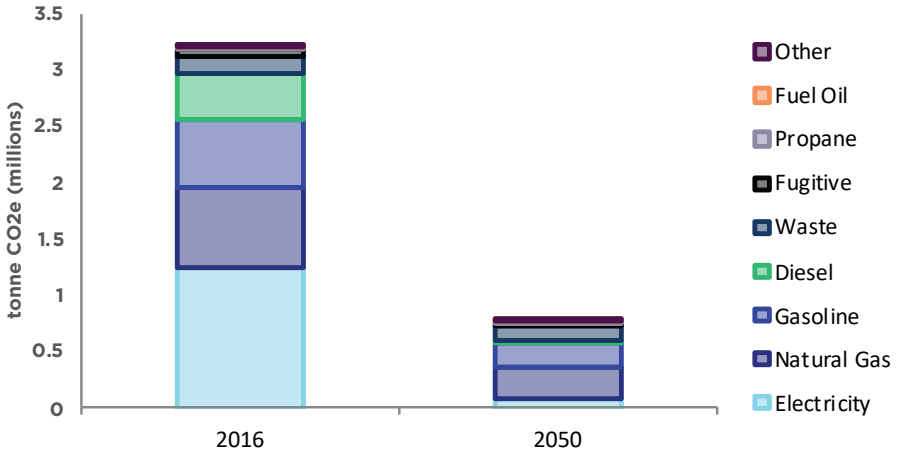
Emissions by Sector

Figure 35: *Emissions by Sector*



Emissions by Fuel Type

Figure 36: *Emissions by fuel type*



Emissions associated with each fuel reduce as the use of those fuels decreases and/or the emissions factors of those fuels decreases. As noted earlier, diesel, gasoline, and natural gas are phased out under the LEC Plan, and with them go their emissions. Electricity's emissions factor is large in 2016 and remains so under the BAP, despite some coal-fired electricity generation phase out. Under the LEC Plan, electricity is almost completely provided by renewable energy sources (supported by solar PV, and procured renewable energy), all but eliminating emissions.

FINANCIAL ANALYSIS AND MARGINAL ABATEMENT COSTS

The actions require investments now and over time to implement. Starting immediately, they result in savings and, in the case of local energy production, in revenues. Incremental expenditures in buildings, vehicles, and other energy-related equipment and infrastructure increase costs in the short-term but result in long-term savings.

Detailed financial analysis was undertaken for each action in the LEC Plan Scenario to identify the investment required, the net present value, the return on investment, marginal abatement costs, and employment impacts.

The marginal abatement cost (MAC) is a measure of the cost or savings of reducing GHG emissions for a particular action. The MAC divides the total costs or savings of the action, as represented by the net present value (NPV), by the total GHG emissions reductions associated with that action over its lifetime. The result is a cost or savings per tonne of GHG emissions reduced. An action with a high cost per tonne is an expensive GHG emissions reduction, whereas an action with a negative marginal abatement cost indicates that money is saved for every tonne of GHG emissions reduced.

The following figure below summarizes the MAC analysis for the LEC Plan. Not all actions modelled in the LEC Plan are included, as some would severely skew the scale of the graph (e.g. the renewable energy procurement action results in massive emissions reductions at massive costs, which would dwarf most actions on the graph). All but nine of the LEC Plan actions result in savings in present dollars, discounted at 3%, over the period from 2020 to 2050.

Note that the wider a bar is, the greater emissions reductions it provides, while the length of the bar depicts the total cost or savings of the action. A taller bar on the right of the graph means an action costs more per tonne, while a taller bar on the left side of the graph means an action has a larger cost savings or return on investment.

According to the model, investment in emissions reducing actions now and in the near future will result in massive energy savings and financial returns for government, industry and households.

The actions with the greatest savings per tonne of emissions reduced include:

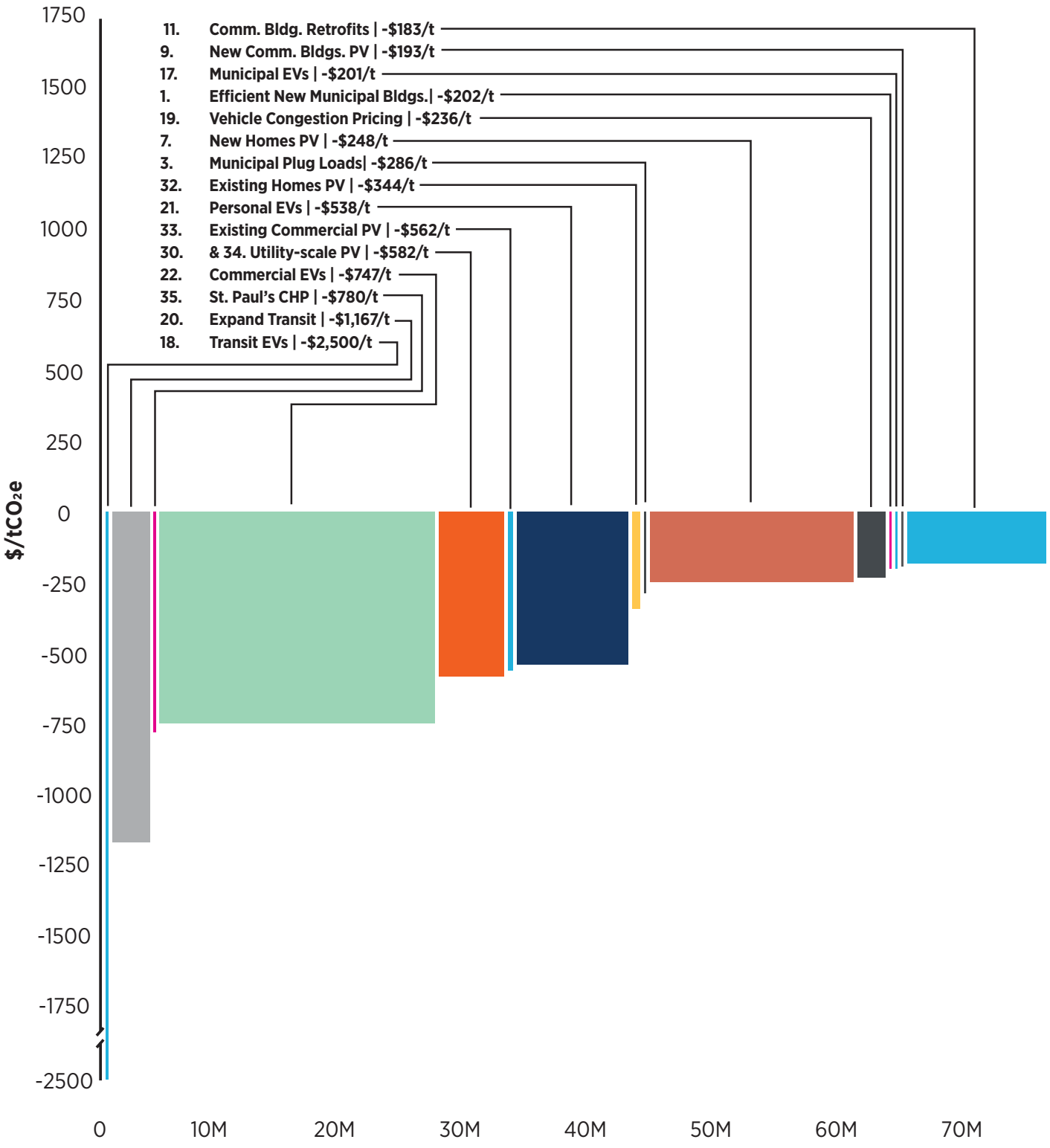
- personal and commercial electric vehicles;
- on-building and utility-scale solar photovoltaic systems;
- efficient new buildings; and
- building retrofits.

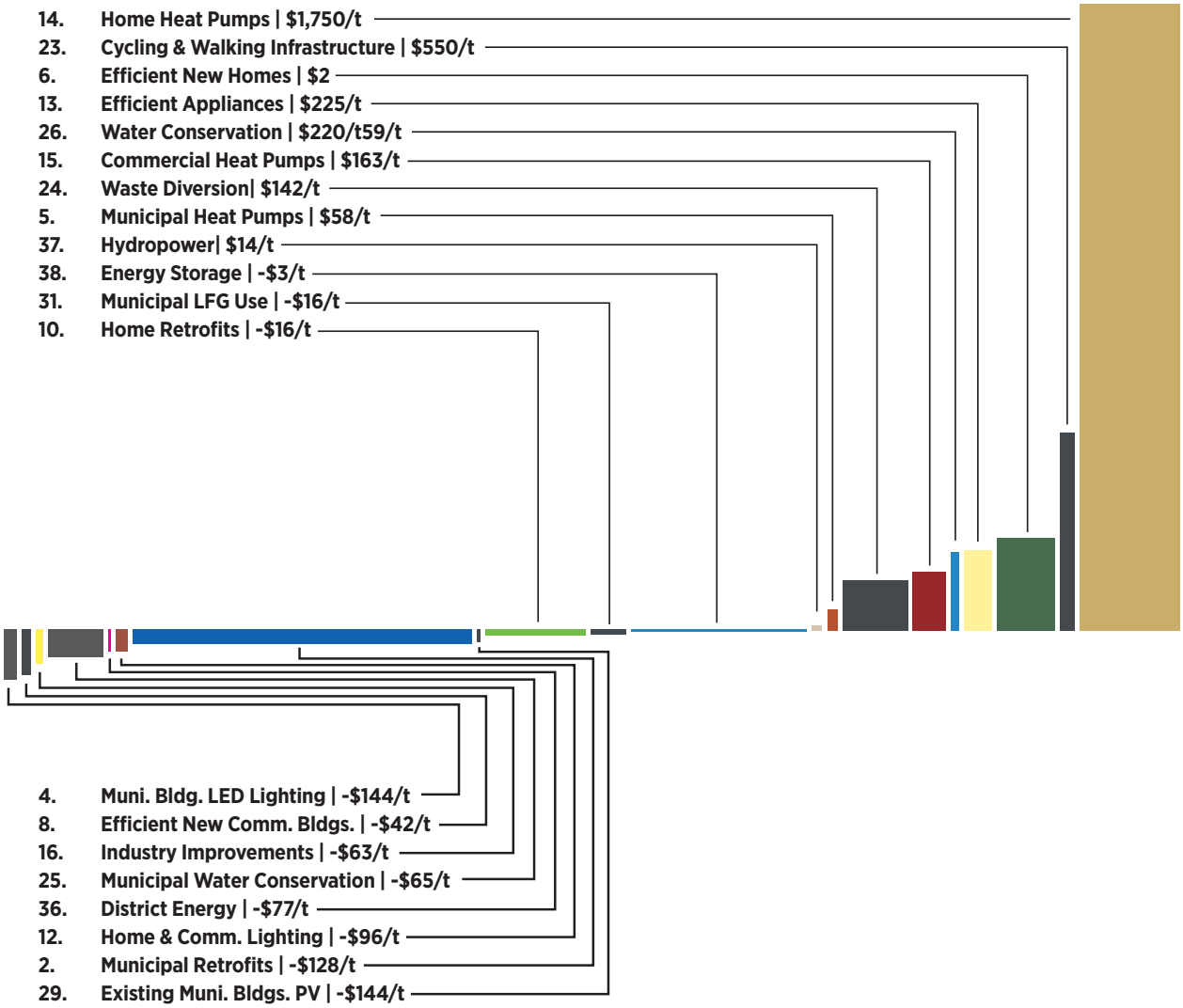
Although there are also considerable emissions savings with installing heat pumps, building efficient new homes, and upgrading appliances, these come at a net cost per tonne of emissions reduced.

Of course, the MAC does not provide the complete justification for whether or not to implement an action, as each of these actions is required in order to meet our GHG reduction targets, but it is a powerful tool to demonstrate the return these investments can have per tonne of GHG reduction and may be used as one of many factors in deciding which actions to take over the short-, medium-, and longer-term.

Saskatoon Energy and Emissions Actions Marginal Abatement Cost Curve

x-axis: tonnes CO_2e reduced by the action (wider bars = greater reductions)
y-axis: net financial return or cost of the action (taller bars = greater return/cost)




14. Home Heat Pumps | $1,750/t
23. Cycling & Walking Infrastructure | $550/t
6. Efficient New Homes | $2
13. Efficient Appliances | $225/t
26. Water Conservation | $220/t59/t
15. Commercial Heat Pumps | $163/t
24. Waste Diversion| $142/t
5. Municipal Heat Pumps | $58/t
37. Hydropower| $14/t
38. Energy Storage | -$3/t
31. Municipal LFG Use | -$16/t
10. Home Retrofits | -$16/t
4. Muni. Bldg. LED Lighting | -$144/t
8. Efficient New Comm. Bldgs. | -$42/t
16. Industry Improvements | -$63/t
25. Municipal Water Conservation | -$65/t
36. District Energy | -$77/t
12. Home & Comm. Lighting | -$96/t
2. Municipal Retrofits | -$128/t
29. Existing Muni. Bldgs. PV | -$144/t
80M
90M
100MT
110MT
120MT
130MT
140MT
tCO2e

Capital Investment & Returns

Total LEC Plan investment and return were evaluated including capital investments, operating costs (including for fuel and electricity), carbon credits, and revenues from investments in local generation. The following table summarizes the categories of investments evaluated.

Table 3: *Categories of investments evaluated.*

Category	Description
Residential buildings	Cost of dwelling construction; operating and maintenance costs (non-fuel)
Residential equipment	Cost of appliances and lighting, heating and cooling equipment
Personal use vehicles	Cost of vehicle purchase; operating and maintenance costs (non-fuel)
Residential fuel	Energy costs for dwellings and residential transportation
Residential emissions	Costs resulting from a carbon price on GHG emissions from dwellings and transportation
Commercial buildings	Cost of building construction; operating and maintenance costs (non-fuel)
Commercial equipment	Cost of lighting, heating and cooling equipment
Commercial vehicles	Cost of vehicle purchase; operating and maintenance costs (non-fuel)
Non-residential fuel	Energy costs for commercial buildings, industry and transport.
Non-residential emissions	Costs resulting from a carbon price on GHG emissions from commercial buildings, production and transportation
Energy production emissions	Costs resulting from a carbon price on GHG emissions for fuel used in the generation of electricity and heating
Energy production fuel	Cost of purchasing fuel for generating local electricity, heating or cooling
Energy production equipment	Cost of the equipment for generating local electricity, heating or cooling
Municipal capital	Cost of the transit system additions (no other forms of municipal capital assessed)
Municipal fuel	Cost of fuel associated with the transit system
Municipal emissions	Costs resulting from a carbon price on GHG emissions from the transit system
Energy production revenue	Revenue derived from the sale of locally generated electricity or heat. This is treated as a negative expenditure in the analysis.

The Plan shows that by 2050 total annual residential energy expenditures are $440 million per year lower than in the business as planned scenario

The following table illustrates the undiscounted and present value of the City and Community investments associated with the low emissions pathway. The negative balance represents initial expenditures and the positive balances represent savings, new revenues or returns.

Table 4: *Summary of financial metrics resulting from the low emissions actions and pathway*

	Low Emissions Community ($ Billions)	
	Cumulative, incremental expenditures and savings to 2050	**Net Present Value** (Discount Rate of 3%)
Capital investments	($19.0)	($11.5)
Operations and Maintenance savings	6.1	3.2
Energy savings	13.2	6.9
Carbon price savings	4.7	2.4
Revenue from local generation	9.6	5.2
Net return of program	**$14.6**	**$6.2**

** In this table, income and savings are positive, expenditures are negative*

By 2050, cumulative City and Community capital investment in the low emissions community actions totals $19 billion with a present value of $11.5 billion, using a discount rate of 3%.The municipality is directly responsible for approximately 32% of these total capital investments and can expect to see approximately 35% of the returns.

Table 5: *Summary of financial metrics directly attributable to City of Saskatoon*

	Low Emissions Community ($ Billions)	
	Cumulative, incremental expenditures and savings to 2050	**Net Present Value** (Discount Rate of 3%)
Capital investments	($6.1)	($3.7)
Savings & New Revenues	11.8	6.2
Net return of program	**$5.7**	**$2.5**
* In this table, income and savings are positive, expenditures are negative		

On the other side of the ledger are operations and maintenance savings (e.g. from electric vehicles requiring less maintenance than internal combustion engine vehicles, from buildings' electrical systems that have lower operating costs), energy (fuel and electricity) cost savings from energy efficiency improvements, the monetary value of the carbon reductions resulting from carbon pricing, and the revenues from locally generated energy. One large contribution to the value of the LEC Plan is lower energy bills; by 2050, total annual residential energy expenditures are $440 million per year lower than in the BAP scenario.

Carbon pricing effectively increases the value of fuel and electricity savings , modestly in the first half of the program but more significantly in the later years as the effective carbon price increases. In 2050, the carbon "premium" from the low emissions scenario reaches $373 million and the cumulative premium over the 2018–2050 period totals $4.7 billion, with a present value of $2.4 billion.

Finally, the LEC Plan includes investments in local energy generation facilities (solar photovoltaics, hydropower, and district energy) that create a steadily growing revenue stream that averages over $300 million over the 2020-2050 time period, reaching over $660 million in 2050. Local generation's cumulative total is $9.6 billion with a present value of $5.2 billion.

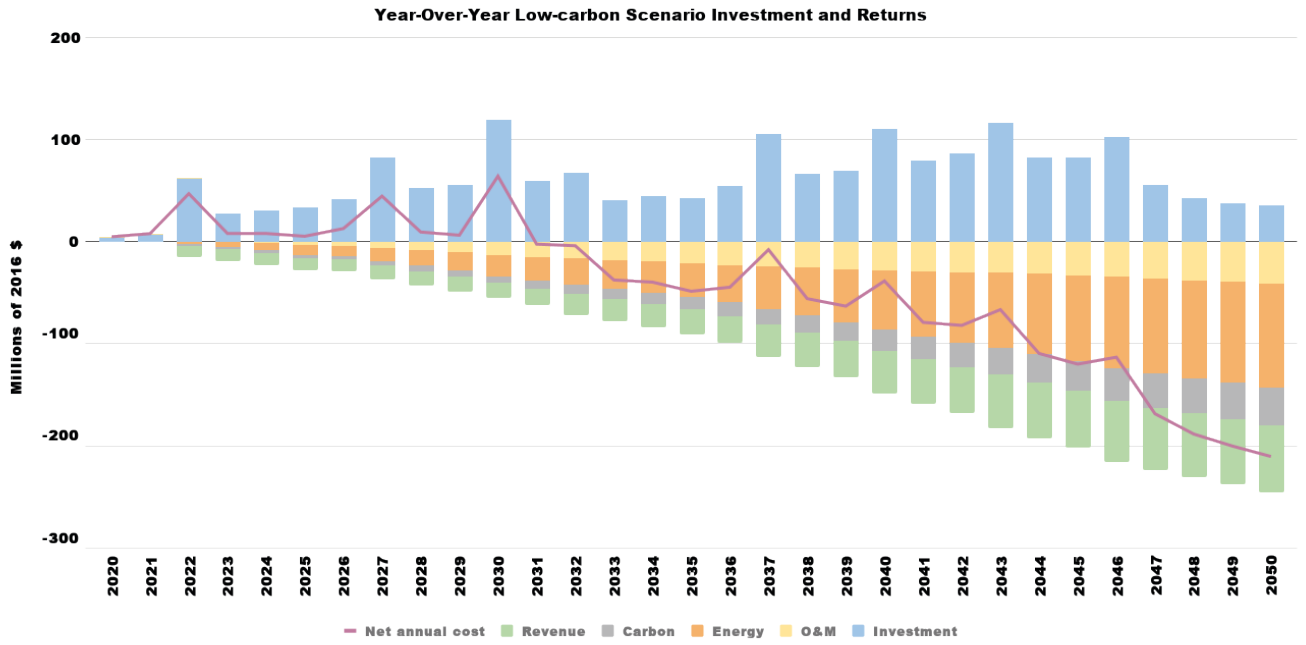
The figure below displays the investment and returns for the low emissions community when compared to the business as planned option. Above the x-axis are investments - the incremental expenditures required to implement the LEC Plan actions over BAP investments. The average annual investment over the 2020-2050 time period is $600M. There are a few years where the investment is notably higher:

- 2027: Downtown district energy expansion and investment in the weir hydropower plant.
- 2030: Purchase of electric public transit buses.
- 2027, 2032, 2037, 2040, 2043, 2046: Lump procurements of external solar PV generated electricity.

Below the x-axis are savings and revenues. Annual total investments exceed total savings and revenues until the breakeven point in 2031, beyond which gains begin to consistently exceed costs. As discussed above, by 2050 the net payback from the plan reaches $14.6 billion.

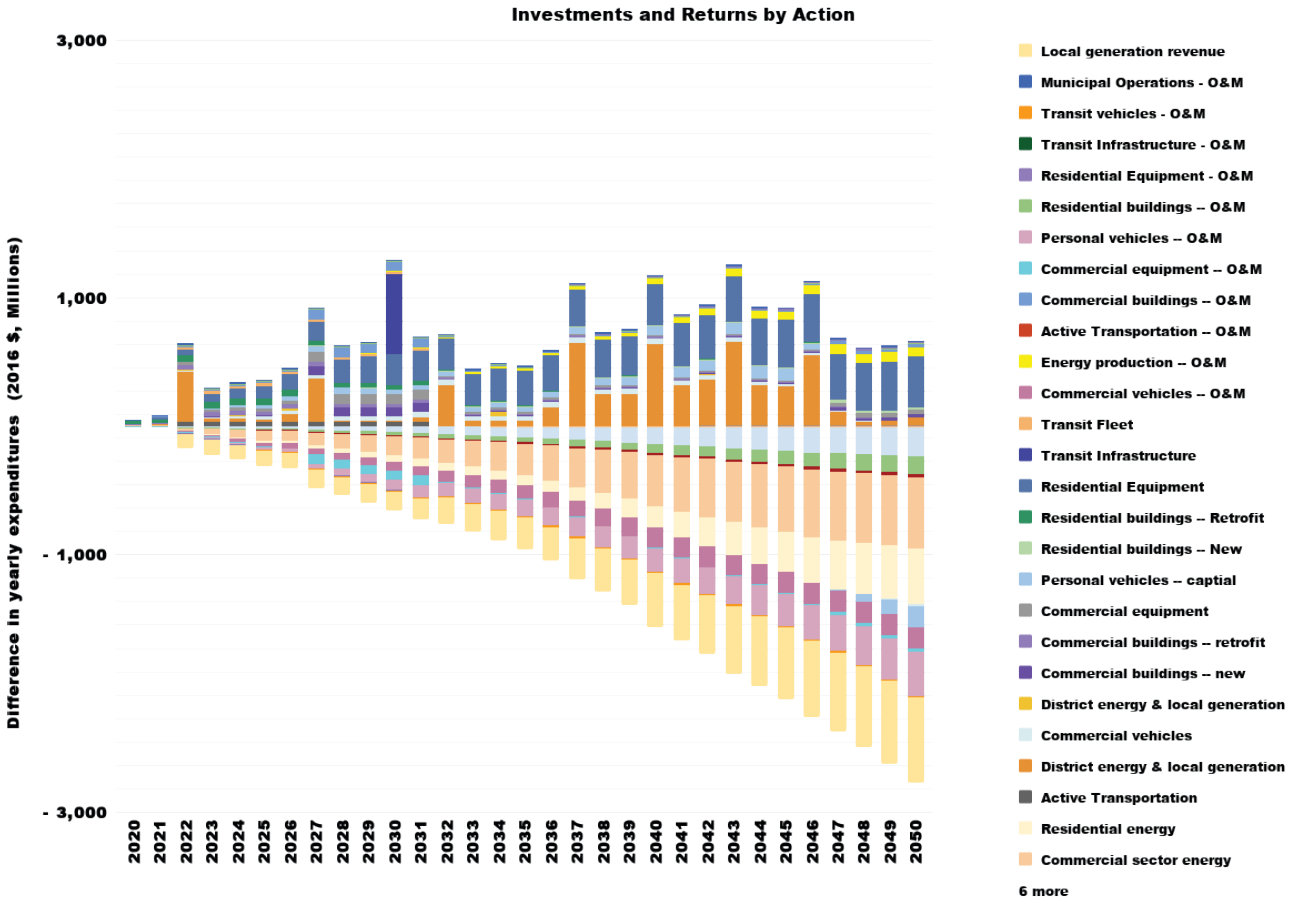
Figure 37: *Expenditures, savings and revenues from the LEC Plan relative to BAP Scenario.*

**Values are presented as costs in this figure, so expenditures are above the x-axis line and savings and revenue are below the x-axis line. Incremental capital costs are shown in the year they are incurred.*



The following figure provides a detailed year-by-year breakdown of the investments, fuel and electricity savings, carbon premiums, and generation revenue in the LEC Plan. The value of the cost savings increases as time progresses.

Figure 38: *LEC Plan annual incremental expenditures over BAP scenario by action.*
**Incremental capital costs are shown in the year they are incurred.*



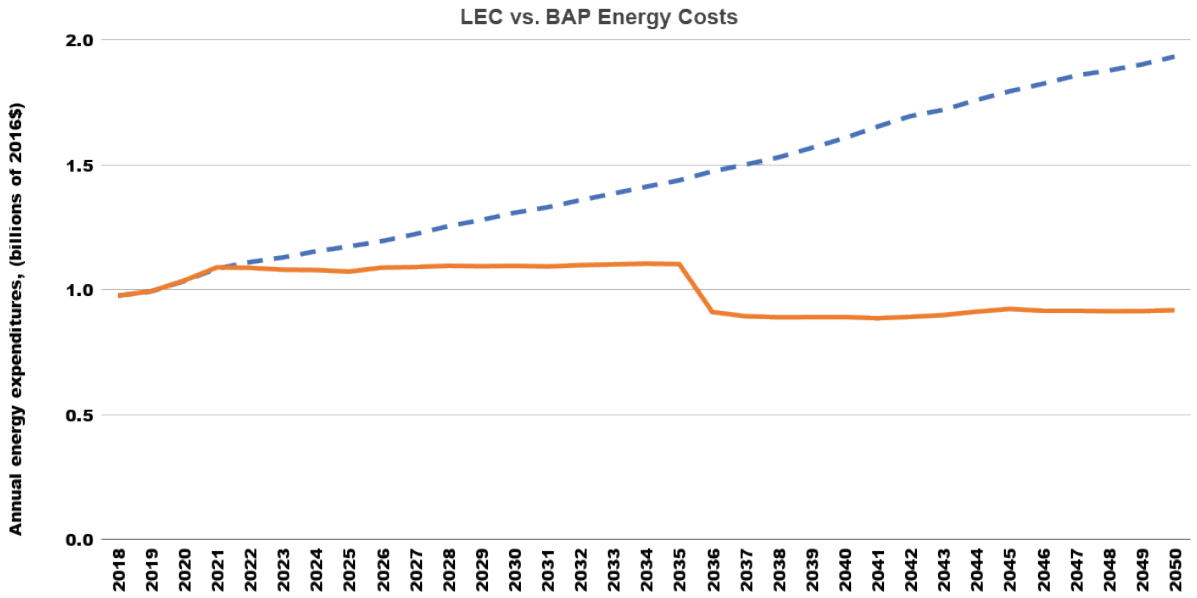
The majority of investments (above the x-axis) are in local energy generation, transit, and residential retrofits and equipment (e.g. heat pumps). The majority of returns (below the x-axis) are in residential and commercial avoided emissions, residential and commercial energy savings, personal and commercial vehicle operating and maintenance costs, and local energy generation.

Energy Costs

The following graph depicts the expected total energy (fuel and electricity) costs for the BAP scenario and LEC Plan.

In the BAP scenario shown with the blue dashed line, costs increase for all types of energy, with gasoline and electricity rising the most, as shown in the following graph.

Figure 39: *Estimated total annual energy expenditures for the BAP scenario (blue) and LEC Plan (orange).*



In 2016, total energy costs paid out by households, businesses and other organizations in Saskatoon totalled $866 million. Electricity accounted for 28%, gasoline sales accounted for 35%, and natural gas use accounted for 10% of expenditures. In the BAP scenario, energy prices are projected to increase, although ongoing improvements in vehicle and building efficiency offsets some of the increase, resulting in a 2% average annual energy spending increase, reaching almost $2 billion in total energy expenditures in 2050.

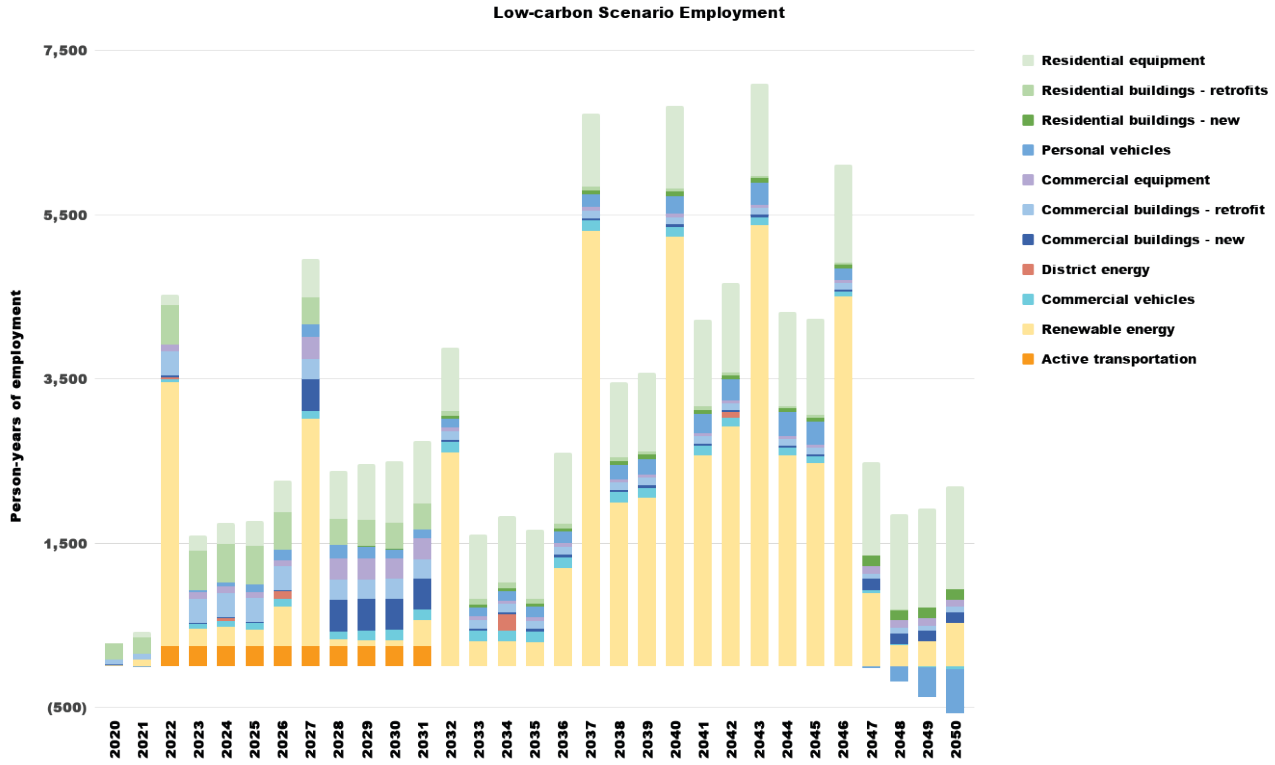
Employment

The LEC Plan capital expenditures are expected to result in increased employment.

Employment factors for each sector were used to translate each million dollars of activity into full-time equivalent jobs. The LEC Plan is estimated to generate over 100,000 person years of employment between 2020 and 2050, or an average of over 3300 per year compared to the BAP scenario. Many jobs are in the energy sector, with solar PV, DE systems, and heat pumps to install. Many are also related to home retrofits and new construction.

The LEC Plan includes investments in local energy generation facilities (solar photovoltaics, hydropower, and district energy) that create a steadily growing revenue stream that averages over $300 million over the 2020-2050 time period, reaching over $660 million in 2050.

Figure 40: *Employment generated by LEC implementation.*



The financial analysis shows there would likely be many economic and employment benefits to implementing the LEC Plan actions. Although significant investments are required by the City, the private sector, industry, and not-for-profits, the long-term cost savings and revenues far outweigh the investments. It is important to note that there is some flexibility in the timing of action implementation. Implementation timelines for the recommended actions can be adjusted slightly depending on funding, public/political desire to complete some actions before others, and advances in technology.

However, the overall recommended timelines should not be disregarded, as delaying the implementation of these impactful actions will undermine our ability to: achieve our GHG reduction targets; reduce negative environmental impacts; and gain the co-benefits that come from taking early action on climate change.

Delaying action also delays (and in some cases, reduces) financial benefits, which could impact our City's and community's ability to achieve the savings, revenues, returns, and employment outcomes as projected in the LEC Plan.

There are significant benefits of adopting the actions set out in the LEC Plan Similarly, the risks of doing nothing are also significant. In the context of this analysis, risks include the following:

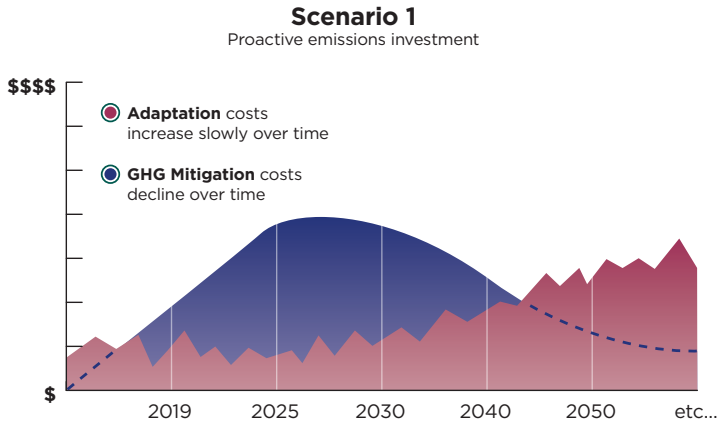
- A slower response to mitigation and therefore more severe impacts of climate change;
- A missed opportunity to transition to low carbon urban systems and therefore an increased burden on the City households and the private sector to support the transition;
- A missed opportunity for leadership in the public and private sector; and
- A missed opportunity to acquire co-benefits in improved health outcomes, economic development, a more resilient energy system, and improved quality of living that are synergistic with the LEC Plan energy and emissions outcomes.

The Link between Mitigation & Adaptation Investment

Investment in emissions reduction activities will impact our adaptation costs over the next 80 years. This is illustrated through reviewing two climate change investment scenarios below.

Scenario 1

Figure 41: *Adaptation and mitigation spending with pro-active investment in mitigation*



In scenario 1, substantial investment is spent for emissions reduction activities such as renewable energy projects, education programs, and financing alternatives within the next 5-10 years. Although this investment is of a higher cost now, it will eventually peak and decline as emissions reduction activities are normalized and technology becomes more accessible and less expensive. This scenario creates co-benefits for both emissions reductions (mitigation) and resiliency (adaptation) activities. An additional benefit is the reduction in the severity of climate change impacts experienced by citizens. For example, as GHG emissions are reduced and previous emissions are mitigated, the severity of changes in annual temperature, precipitation, and extreme weather event patterns is also reduced over time, which limits risk to civic infrastructure, programming and service delivery.

In scenario 1, there is still a need for some adaptation investment, as climate change impacts are already being experienced in Saskatoon and around the world due to emissions previously emitted into the atmosphere. However, this scenario provides time for municipalities to build climate change impact preparedness programming and add adaptation costs to budgets over time as part of their asset management and program planning practices. This creates a more gradual and controlled rise in the cost of adaptation efforts following the principle that $1 of proactive mitigation spending saves $6 of reactive emergency spending.[10]

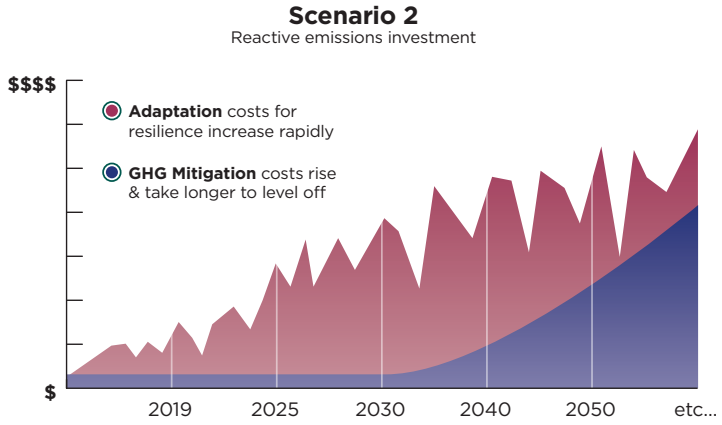
Assuming the time value of money principal, which states the value of money is constantly decreasing over time, investing in emissions reduction projects now will cost less over the long term than investing 20 or 50 years in the future. This is because $1 today is worth more than $1 in 20 years.

Accelerated investments have the added benefit of preventing further degradation of the environment and slowing the degradation-increased cost cycle.

10 National Institute of Building Sciences Issues New Report on the Value of Mitigation, National Institute of Building Sciences, 2018

Scenario 2

Figure 42: *Adaptation and mitigation spending with minimal investment in mitigation.*



In scenario 2, if minimal investment dollars are spent on mitigation (emissions reductions activities) in the immediate future, then climate change impacts such as flooding, drought, and severe storms will increase more rapidly. This will create large spikes in adaptation costs through a reactive approach that cannot be reliably planned or budgeted for, as we will be addressing emergencies as they are occurring. As these large expenditures for repairs or services will be needed on short notice, there is a high likelihood they will create service disruptions to citizens and require debt financing and associated additional costs. At the same time, investment in mitigation will continue to rise as laying the groundwork for projects has not been completed and the time-value of money takes effect.

The National Institute of Building Sciences issued a report that communicates the value of risk reduction spending and cited that for every $1 invested in proactive actions $6 in reactive and unplanned spending is saved.[11] This ratio should be considered when evaluating the amount of funding resources allocated between mitigation and adaptation to the new climate reality.

Investing funds for future benefit is not a new concept; investing in emissions reductions is similar to saving for retirement. Investing for retirement at age 20 results in substantial compounded gains by age 60, and large investment downturns are mitigated over time. In contrast, retirement investment started at age 55 is more vulnerable to large swings in the market and does not have sufficient time to recover before being withdrawn. Similar to retirement investment, there are always alternatives for present day spending such as a new vehicle, a down payment for a home, or a vacation, but those short-term demands do not diminish the importance of investing for the future.

Although significant investments are required by the City, the private sector, industry, and households, the long-term cost savings and revenues far outweigh the investments.

11 National Institute of Building Sciences Issues New Report on the Value of Mitigation, National Institute of Building Sciences, 2018

A Low Emissions Community will help Saskatoon to move the needle, with actions in building efficiency, improving the way we move around, land use, renewable energy, water conservation and waste management.

40 ACTIONS TO IMPLEMENTATION

40 Actions over the next 30 years

The Actions were based on research, best practices review, benchmarking the actions of other cities, and assessing relevance to Saskatoon's context. The final roster represents a viable approach the City and community can take to achieve the City's emissions reduction targets while also leading to co-benefits such as improved health, increased quality of life, and lowered energy costs.

Planning for 3 of the actions has been initiated by the City. In order to meet the emissions target, these 3 would need to be implemented in full with 21 more initiated in the next 4 years, the final 16 actions could be initiated over the next 8-12+ years.

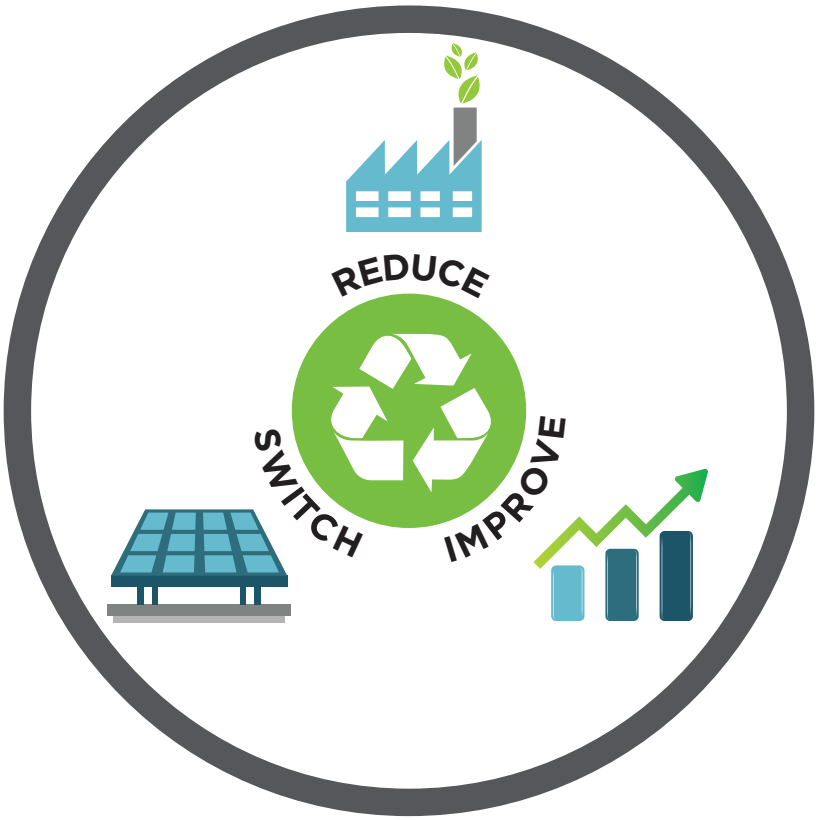
Reduce-Improve-Switch

The 40 Actions are recommended in a sequence of Reduce, Improve, and Switch:

- Reduce energy consumption
- Improve the efficiency of the energy system (supply and demand)
- Switch to low carbon renewable sources of fuel and energy

By avoiding energy consumption (Reduce), our community's need to retrofit infrastructure (Improve) and generate renewable energy (Switch) are both reduced. If Switch occurred first, the capacity of the renewable energy system would need be much greater than if Reduce and Improve actions were implemented first.

Figure 43: *Sample Reduce-Improve-Switch actions*



	Buildings	Transportation	Waste
REDUCE Reduce energy consumption and optimize energy demand.	Build efficient and low-carbon new buildings.	Build compact, complete communities and transit-oriented development.	Implement strategies to prevent the creation of waste.
IMPROVE Increase energy use efficiency.	Upgrade to energy efficient lighting systems. Perform energy retrofits for existing buildings.	Improve fuel efficiency of the vehicle fleet.	Improve the efficiency of waste collection practices.
SWITCH Shift to low carbon energy sources.	Source energy from renewable sources.	Switch to electric vehicles that use renewable energy sources.	Collect fugitive emissions from landfills for use as renewable natural gas.

Community Energy Planning

The actions can be categorized broadly as applying to new infrastructure or existing infrastructure. A key concept of low-carbon community energy planning for new infrastructure is prioritizing actions based on what lasts longest.[12] The first priority is land-use infrastructure—buildings, housing density, mix of land-uses, energy supply infrastructure, and transportation infrastructure—as these elements last several decades or longer. Land-use and energy decisions that create long-lasting infrastructure and systems dedicate us to their use for decades—a phenomenon known as lock-in. The second priority is major production processes, transportation modes, and building design, which includes industrial processes, transportation options, and building and site treatments. The final priority is energy-using equipment such as transit vehicles, motors, appliances and heating, and ventilation and cooling (HVAC) systems.

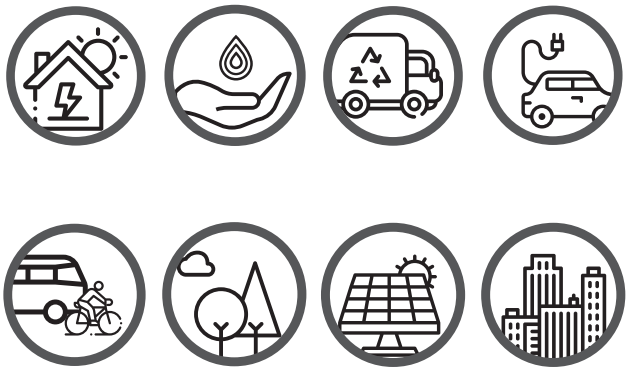
This prioritization approach concentrates actions where the options to intervene in the future will be fewest. For example, currently proposed land-use changes must be carefully considered because, once implemented, there are limited options to modify them in the future.

Actions that apply to existing infrastructure attempt to ameliorate lock-in effects. Changes to transportation infrastructure, existing buildings, waste streams, and existing energy systems often require effort and investment, but in many cases the energy savings, emissions reductions, and co-benefits generated warrant the effort.

Turnover

There are cyclical opportunities to address existing infrastructure, such as the end of serviceable life, between now and 2050. Different types of infrastructure have different degrees of longevity. For example, hot water heaters will turn over three times between now and 2050, providing three opportunities to upgrade their efficiency and/or switch to different fuel types. Residential buildings built today, however, will still be around past 2050. Therefore, decisions on shape, size and energy performance for buildings today have direct implications on long-term GHG emissions and our ability to reduce them in the future. Interventions can be made midway through the lifetime of an investment, but the societal cost, in terms of finances, materials and energy will be higher. Assets which need to be replaced prior to the end of their useful life are defined as stranded assets.

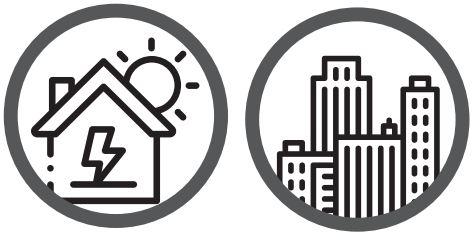
Each action is described in the following sections, organized by sector including municipal and community action categories. Municipal Actions are to be implemented by the municipality and typically apply to municipal infrastructure and operations. Community Actions are those that primarily apply across the city and can be implemented through various bodies and mechanisms, businesses and industry, homeowners, not for profit groups, institutions, etc. Each action description indicates its associated emissions reduction cumulatively from 2020 to 2050 compared to total emissions levels in the Business as Planned scenario from 2020 to 2050.



Every Action Matters in the Low Emissions Community

12 Jaccard, M., Failing, L., & Berry, T. (1997). From equipment to infrastructure: community energy management and greenhouse gas emission reduction. Energy Policy, 25(13), 1065–1074.

Buildings & Energy Efficiency



Buildings account for about 50% of total community energy use and 45% of emissions productions in 2016. Lighting, plug loads, major appliances, space heating and cooling, and water heating all contribute to building emissions (through natural gas use for space heating) or indirect use of fossil fuels (e.g. using electricity from an electricity grid than is primarily reliant on fossil fuels).

We can decrease building emissions to 40% of community energy use and 35% of emissions by 2050, by making future and existing buildings more efficient so that less direct and indirect fossil fuel energy is used.

As fossil fuel-fired electricity is phased out and replaced with renewable energy, building emissions will decrease. However, the current phase out timeline is such that building emissions will continue to be problematic for years to come.

Improving the energy efficiency of our buildings provides benefits for residents and businesses such as reduced spending on energy, which is especially helpful at lower incomes. Quality of life is also improved as spaces are more consistently the right temperature, are quieter, have improved air quality, and can be designed to be more comfortable.

Improving quality of life through efficient more comfortable homes, offices and industrial spaces.

Increase Efficiency in Municipal Buildings

Of all low-carbon actions available, municipalities have the greatest control and likelihood for success in undertaking actions addressing their own buildings. As the city grows, it is expected that the Municipality will increase its floor space over 50% (almost 200,000m^2) by 2050. In addition, the City can save energy and emissions through building retrofits, lighting upgrades, investing in more efficient equipment, and encouraging behaviour changes to save energy used by appliances, computers, and other plug loads. Municipal buildings can also realize energy savings and emissions reductions from heat pump retrofits.

Figure 44: *Improving Efficiency in Municipal Buildings*

Action	Milestone Target & Emissions Reduced 2020-2050 (tonnes CO_2e)
1. Apply energy efficiency standards (build to Passive House) to all new municipal buildings.	All new buildings are designed to target Passive House energy use standards starting immediately. 28,000 tonnes CO_2e
2. Perform deep energy retrofits on municipal buildings.	60% of existing municipal buildings are retrofitted to target Passive House standards by 2031, 100% by 2050. 175,000 tonnes CO_2e
3. Upgrade plugged appliances and improve energy conservation behaviours in municipal buildings.	Achieve 5% plug load energy savings in 100% of buildings by 2023. 4,000 tonnes CO_2e
4. Update all municipal building lighting systems.	Achieve 20% savings in lighting energy use in municipal office buildings by 2026 and 100% of municipal buildings by 2051. 5,000 tonnes CO_2e
5. Retrofit municipal heating and cooling systems with ground-source or air source heat pumps.	Retrofit all municipal buildings with heat pumps and ensure all new municipal buildings have heat pumps, achieving retrofits of 100% of existing municipal buildings by 2026. 204,000 tonnes CO_2e

Going Net Zero with Energy Efficient New Homes

New building energy efficiency is an obvious place to start in easily reducing future emissions. With the expected increase of over 300,000 people by 2050, the housing stock is expected to grow by almost 200,000 homes. Residential building energy use is expected to grow by almost 70% by 2050, increasing emissions by 10%. Committing to reduced energy use in these homes now avoids lock-in effects requiring more costly retrofits in the future. Now and in 2050, about 75% of building energy use is for space heating, space cooling, and water heating. These processes account for 45% of buildings emissions in 2016, rising to over 65% of building emissions, as lighting and plug loads become more efficient.

Using a Building Step Code, like those used in BC, can improve performance of a new building; at Step 4, recommended for Saskatoon to achieve its emissions targets, a new home must achieve Passive House standard levels[13].

Building envelopes (walls, roofs, and windows) of older buildings are also typically leaky, allowing heat to constantly escape the building, with heating and electrical systems that are highly inefficient. Upgrading building insulation, windows, water heaters, and heating, ventilation and air-conditioning systems to highly efficient standards will decrease energy demand on the electrical grid and on natural gas use, leading to significant emissions reductions. Once heating demands are decreased, a city-wide heat pump installation program could be a major contributor to residential emissions reductions.

Lighting upgrades are a relatively simple and effective measure to reduce energy and greenhouse gas emissions. The decreasing costs and longevity of LED bulbs and systems make increasing lighting efficiency "low-hanging fruit." As lighting relies on electrical grid energy, more efficient lighting systems mean less demand on coal and gas-fired electrical generation. It is important to encourage and require building owners and managers to upgrade lighting immediately, instead of waiting until the end-of-life of current systems. In addition to saving considerable energy immediately, LED systems have payback periods that are typically shorter than the end-of-life timeline of existing systems.

Refrigerators, stoves, ovens, dishwashers, clothes washing machines, clothes dryers, and other household appliances have become increasingly efficient over the years. Awareness programs like Energy Star and government incentives have increased the sale of energy and water efficient appliances. These programs and incentives continue to be necessary as inefficient appliances persist in the market and are typically lower cost. Major appliance energy use is anticipated to increase by over 160% by 2050, their emissions increasing more than 10%, as new homes are built.

Adding solar photovoltaic (PV) energy-producing panels further decreases residential reliance on the electricity grid and natural gas use.

13 Passive House levels of performance require energy consumption for space heating to be less than 15kWh/m^2/year, and total primary energy consumption to be less than 120 kWh/m^2/year. Improving the energy use intensity means improving the overall energy efficiency of new homes so they require less energy; TEDI and EUI measures are common in building labelling and Passive House Standards. They are measurements of energy used per square metre or square foot.

Action	Milestone Target & Emissions Reduced 2020-2050 (tonnes CO_2e)	
6. Create an electric and thermal energy consumption cap for new home construction by utilizing a municipal step code.	Improve energy use intensity (EUI) and thermal energy demand intensity (TEDI) for new residential buildings, targeting net-zero ready by 2036. 1,130,000 tonnes CO_2e	
	2021-2025 (Step 1): • 10% EUI improvement • TEDI <= 70 kWh/m^2	**2026-2030 (Step 2):** • 20% EUI improvement • TEDI <= 60 kWh/m2
	2031-2035 (Step 3): • 40% EUI improvement • TEDI <= 50 kWh/m^2	**2036 and later (Step 4):** • 80% EUI improvement • TEDI <=15 kW/m^2
7. Require new homes to include roof solar Photovoltaic (PV) installations in the final year of a municipal step code.	All new homes constructed in 2036 onwards will maximize their roof solar PV coverage, with electricity generation tied into the electricity grid. 5,049,000 tonnes CO_2e	
10. Incentivize and mandate homeowners to perform deep energy retrofits.	Through envelope and mechanical system retrofits and renovations, 50% of existing buildings are 50% more energy efficient by 2030, 90% by 2050. 2,013,000 tonnes CO_2e	
12. Require energy efficiency improvements residential and ICI building lighting systems.	90% of residential and commercial buildings are retrofitted for 5% increased lighting efficiency in addition to regular market-induced lighting efficiency improvements by 2030, 100% by 2050. All existing luminaires are replaced or updated with energy efficient LED bulbs and systems. 147,000 tonnes CO_2e	
13. Incentivize and later mandate homeowners to upgrade household appliances to energy and water efficient models.	Upgraded appliances are 30% more energy efficient and current water heaters are replaced with electric on-demand models in 50% of residential buildings by 2050. 582,000 tonnes CO_2e	
14. Retrofit home heating and cooling systems with ground-source or air source heat pumps.	30% of residential buildings are retrofitted with heat pumps by 2030, 80% by 2050. 2,120,000 tonnes CO_2e	

Getting to Net Zero through Energy Efficiency in New ICI Buildings

Similar to new homes, new industrial, commercial, and institutional buildings can also be made more efficient when designed and built. ICI building energy use is expected to increase over 460% by 2050 in a Business as Planned scenario, with emissions growing almost 450% in the industrial sector. With anticipated floor space increases of 575% for industrial buildings, 46% for commercial buildings, and 123% for institutional, there is great opportunity to avoid emissions by ensuring new ICI buildings are energy efficient.

Commercial retail buildings are often built for short-term and/or flexible uses. Many commercial spaces are built to minimum building standards only, relying on lease tenants to provide the

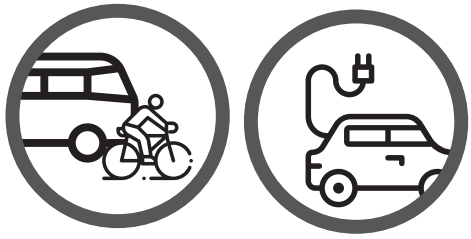
remainder of the fit-up to accommodate the specific requirements of the tenant, which typically involve minimal energy and water saving considerations. Energy efficient fit-up is challenging, as the complete usage details of leased space are not considered in the base building design (pre-tenant), which limits what choices can be made at the fit-up stage (post-tenant).

ICI buildings are typically greater thermal heat users than residential buildings and can achieve even greater benefits from more efficient thermal energy systems.

Industrial activities used about 9% of Saskatoon's total energy use in 2016. With over 1.7 million square metres of new industrial buildings anticipated by 2050, industry's share of total energy use is expected to jump to over 27%. Industrial emissions will climb as well, jumping from 5% of total emissions in 2016 to almost 21% in 2050. Efficiency gains in motors, pumps, and processing technologies will help reduce energy use and emissions.

Shifting activities from fossil fuels (such as natural gas) to electricity will also reduce emissions as the electricity supply decarbonizes due to an increase in renewable energy generation. Renewable natural gas is an important component to achieving emissions reductions in the industrial sector as well.

Action	Milestone Target & Emissions Reduced 2020-2050 (tonnes CO_2e)	
8. Create an electric and thermal energy consumption cap for new Industrial, Commercial and Institutional (ICI) construction by utilizing a municipal step code.	Improve energy use intensity (EUI) and thermal energy demand intensity (TEDI) for new residential buildings, targeting net-zero ready by 2036. 6,660,000 tonnes CO_2e	
	2021-2025 (Step 1): • 10% EUI improvement • TEDI <= 70 kWh/m^2	**2026-2030 (Step 2):** • 20% EUI improvement • TEDI <= 60 kWh/m2
	2031-2035 (Step 3): • 40% EUI improvement • TEDI <= 50 kWh/m^2	**2036 and later (Step 4):** • 80% EUI improvement • TEDI <=15 kW/m^2
9. Require new ICI buildings to include roof solar PV installations. In the final year of a municipal step code.	All new ICI buildings constructed in 2036 onwards will maximize their roof solar PV coverage, with electricity generation tied into the electricity grid. 28,000 tonnes CO_2e	
11. Incentivize and later mandate ICI owners and operators to perform deep energy retrofits.	Through envelope and mechanical system retrofits and renovations, 50% of existing buildings are 50% more energy efficient by 2030, 90% by 2050. 3,469,000 tonnes CO_2e	
15. Retrofit ICI heating and cooling systems with ground-source or air source heat pumps.	30% of commercial building floor space is retrofitted with heat pumps by 2030, 80% by 2050. 658,000 tonnes CO_2e	
16. Increase the efficiency of industrial processes.	Update and retrofit industrial machinery and processes to more efficient models and switch to renewable energy sources to achieve 50% energy savings by 2050. 232,000 tonnes CO_2e	



Transportation

With more energy used in the transportation sector than any other sector, there are major energy efficiency and emissions reduction opportunities. As the city's population increases, so too will the number of vehicles with an expected increase of 230,000 vehicles by 2050.

Although new vehicle sales are increasingly electric, the fossil fuel-fired electricity grid in Saskatchewan presents an emissions challenge for charging electric vehicles (EVs). EVs are typically lower emitting than gasoline and diesel-powered vehicles in the province, although hybrid vehicles tend to be even lower.[14] EVs charged in Saskatchewan emit almost 20 times as much as EVs charged in Ontario, 60 times as much as in BC, and over 450 times as much as in Quebec because these provinces have lower-carbon energy grids than Saskatchewan. However, EVs in Saskatchewan will typically emit 10-20% less than their gasoline counterparts. Phasing out coal-fired power and adding renewable energy to the electricity grid will improve EV emissions over time.

The following 7 actions are needed to reduce transportation emissions for the City.

Expand Transit

Saskatoon's recent Transit Plan improves the city's transit system with the introduction of bus rapid transit. Additional routes and increased frequency are required in order to shift transportation choices from personal vehicles to transit.

Some cities in Canada and globally have piloted free public transit programs, including free transit for youth and seniors to increase ridership. For instance, Calgary and Winnipeg both have free downtown transit areas while Canmore has made all its transit free of charge.

Action	Milestone Target & Emissions Reduced 2020-2050 (tonnes CO_2e)
20. Increase transit routes and frequency through future updates to the Transit Plan.	Shift 5% of personal vehicle trips to transit by 2030, 10% by 2050. The existing goal in Bus Rapid Transit Planning is an 8% mode shift by 2043 942,000 tonnes CO_2e

By 2050, there may be as many as 230,000 more vehicles on the road. Even with Saskatchewan's electrical grid, EV's emit 10-20% less than their gasoline counterparts.

14 National Energy Board Market Snapshot, September 12, 2018: http://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/snpsht/2018/09-01-1hwrnrgprjctsfnncd-eng.html?=undefined&wbdisable=true

Electrify Municipal Fleet, Commercial and Personal Vehicles

With substantial maintenance cost savings and less volatile fuel prices, EVs make a compelling case for use as municipal fleet vehicles as capital investments will be readily paid back through operational savings. Cities in Europe, the US, and Canada are starting to use EVs for all fleet models, including police cruisers, waste collection trucks, field vehicles, bylaw enforcement vehicles, and especially Transit.

The phasing of Municipal EV's would start with small vehicles with larger equipment being considered closer to 2030. Electrifying Saskatoon's bus fleet of about 140 vehicles would take place over the next decade and will be aligned with the phase in for Bus Rapid Transit (BRT).

An increase in EV charging infrastructure for the municipal fleet may also spark further interest and build capacity in the community.

For commercial purposes, a trend toward electrification of long-haul freight trucks and delivery trucks is already occurring. Although currently not widely available, Canada Post, FedEx, UPS, and Purolator have all piloted EV delivery trucks or have small electric fleets. EV models of commercial vehicles are in production and presale numbers are very encouraging. It is expected that the commercial vehicle market will outpace personal electric vehicles once commercial EVs are more widely available. Incentive programs can help encourage this shift.

As light truck, SUV and crossover personal vehicle ownership increases in the city, so too does vehicle energy use and resulting emissions. Although electrifying personal vehicles in the near term will only produce a small decrease in transportation emissions, EVs are a critical step to decreasing community emissions in the long-term as grid electricity becomes cleaner and the City invests in more renewable energy.

Action	Milestone Target & Emissions Reduced 2020-2050 (tonnes CO_2e)
17. Electrify the Municipal fleet over the near-term.	100% of the Municipal fleet is electric by 2030. 77,000 tonnes CO_2e
18. Electrify the Municipal transit fleet.	100% of the Municipal transit fleet are electric by 2030. 55,000 tonnes CO_2e
21. Electrify personal vehicles through incentive programs, education, and automotive dealer partnerships.	30% of all new vehicle sales are electric by 2030, 90% by 2050. 2,756,000 tonnes CO_2e
22. Electrify commercial vehicles through incentive programs, education, and automotive dealer partnerships.	50% of all new heavy trucks are zero emissions by 2030, 100% by 2040. 6,860,000 tonnes CO_2e

Improve Cycling and Walking Infrastructure

Most trips shorter than 2km can usually be made by walking and most trips shorter than 5km by biking. Complete, compact communities and the correct infrastructure such as sidewalks and bike lanes are key components to making trips of these distances possible via active transportation. With investments in pedestrian and cycling infrastructure and programs like bike sharing, active transportation becomes more viable.

Action	Milestone Target & Emissions Reduced 2020-2050 (tonnes CO_2e)
23. Fund and implement improved cycling and walking infrastructure to encourage active transportation.	Achieve a 20% mode shift to active transportation by 2030, 30% by 2050. The existing goal in the active transportation plan is 24% mode shift by 2045. 287,000 tonnes CO_2e

Vehicle Pollution Pricing Program

Vehicle pollution pricing programs are being implemented increasingly in European and American cities in high-traffic areas. They provide a disincentive to use personal vehicles to travel to destinations that are typically well-served by transit. Coordinating a Vehicle Pollution Pricing program with parking pricing in high traffic areas of Saskatoon would decrease personal vehicle use in those areas, alleviate traffic, and increase active transportation.

Action	Milestone Target & Emissions Reduced 2020-2050 (tonnes CO_2e)
19. Implement a vehicle pollution pricing program in high traffic areas.	Achieve a 5% emissions reduction from decreased high traffic area car travel through a pollution charge starting in 2026. 698,000 tonnes CO_2e

Photo courtesy of Tourism Saskatoon

Land Use

The most durable decisions for which a municipality is responsible relate to land-use. From an emissions perspective, the built environment generates both positive and negative feedback cycles.

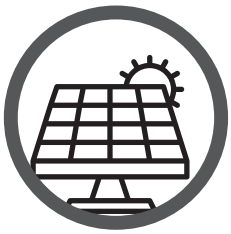
A compact municipality has lower transportation emissions and energy demand as people have more opportunity to walk and cycle. Transit investments are more financially feasible in this context, granting improved access to amenities and increased commuting options. Transit infrastructure attracts further development and the city continues to densify, with carbon emissions declining further and further as a positive feedback loop is created.

By contrast, any future development that results in new residential and commercial development that is not accessible to transit, walking, and cycling increases GHG emissions and energy requirements.

Complete, compact communities increase the feasibility of low-carbon energy systems such as district energy and reduces the financial cost and the GHG impact of providing municipal services such as roads, water and wastewater, fire protection, and transportation, and even provision of home-based health care. Land-use planning can therefore enable, inhibit or prevent attaining a low or zero carbon economy.

Action	Milestone Target & Emissions Reduced 2020-2050 (tonnesCO_2e)
27. Build complete, compact communities through infill development, mixed-use buildings, and compact housing.	Achieve residential energy use reductions with energy efficient, mixed-use multi-family buildings in complete, compact neighbourhoods to achieve 5% less floor area than the current average by 2035 and 25% by 2050. 3,353,000 tonnes CO_2e
28. Focus development on densification in previously developed areas, increasing the number of multi-family buildings.	Increase the housing stock share of multi-family homes by 25% by 2050 for new builds only. Included in previous action.

Build complete, compact communities to make the most of our places and spaces for generations to come.



Energy

With some of the country's highest-emitting grid-supplied electricity, Saskatchewan's emissions reduction efforts need to concentrate on energy efficiency and switching to renewable energy generation and procurement.

Even with the projected phase-out of coal-fire electricity generation, the Province's electricity generation emissions factor will still be over 6 times higher than Ontario's current factor, 22 times higher than BC's current factor, and over 200 times higher than Quebec's current factor by 2050. This eventual, slight decarbonisation of the electrical grid cannot be relied on for reaching Saskatoon's energy use and emissions reduction targets.

As one of the sunniest cities in the country, Saskatoon is a prime candidate for solar energy production. Solar photovoltaic systems are easily installed on existing rooftops of residential and ICI buildings, as canopy structures over parking lots, or as ground-mounted units. A 1kW solar system in Saskatoon produces about 1,350 kWh annually.

Thermal and electrical energy production that currently relies on natural gas can be shifted to Renewable Natural Gas (RNG) sources. RNG is produced from decomposing organic materials like food, agricultural waste, wastewater, and manure. Methane capture from landfills can be upgraded to RNG, and organic materials can be processed in anaerobic digestion facilities to provide gas to upgrade to RNG. Once upgraded, RNG can be used exactly like natural gas.

Landfill Gas Expansion

The Saskatoon landfill has a landfill gas collection and power generation system that captures 50,000 tonnes CO_2e of emissions annually. The captured methane is then either flared or converted to electricity which is sold to SaskPower and used in a local electricity generation facility. The landfill gas collection system could be expanded through drilling more wells into the landfill for increased methane capture. For future organics and wastewater treatment, anaerobic digestion could be used to power treatment facilities through capturing methane similar to the landfill gas system.

Action	Milestone Target & Emissions Reduced 2020-2050 (tonnes CO_2e)
31. Increase Landfill Gas Capture from the Saskatoon Landfill	Increase methane capture and destruction from the landfill to 50%, by 2026. 1,891,000 tonnes CO_2e

Solar Energy: Municipal, Residential, Industrial/Commercial/Institutional (ICI) and Utility Scale

Municipal buildings and lands can host solar Photovoltaic (PV) systems. Municipal purchase and installation of solar PV systems can be coordinated with ICI and residential purchases in a coordinated bulk buy to decrease system costs.

Solar incentive programs for homeowners can subsidize the purchase and installation of grid-tied solar PV arrays on their homes. Many homes in Saskatoon are suitable for solar energy system installations. It is estimated that the average home in Saskatoon can offset its energy use with a 7-10kW solar PV system.[15]

Many ICI buildings have large, flat roofs that are ideal for installing solar arrays at an optimal angle for maximum solar collection.

Although the residential and ICI solar energy contributions are large by 2050, a vast amount of renewable energy is needed to shift away from our existing high-carbon electricity grid. Some of the new renewable energy capacity will have to come from utility-scale installations.

Action	Milestone Target & Emissions Reduced 2020-2050 (tonnes CO_2e)
29. Install solar PV systems on municipal buildings.	Install 24MW of solar capacity by 2026 on municipal buildings. 236,000 tonnes CO_2e
30. Install solar PV systems on municipal lands.	Install a 1MW capacity solar system on Parcel M or similar land area by 2022. Emissions total included in Action #34.
32. Encourage existing residential building owners and mandate new buildings to install solar PV system through programming and bylaw.	Install 10MW of residential solar capacity by 2030, 50MW by 2050. 195,000 tonnes CO_2e
33. Encourage existing ICI building owners and mandate new buildings to install solar PV systems through programming and bylaw.	Install 20MW of ICI solar capacity by 2030, 200MW by 2050. 1,147,000 tonnes CO_2e
34. Install new solar PV utility-scale facilities within or adjacent to city boundaries. With areas within city boundary to be prioritized first.	Install 20MW of solar capacity by 2030, 300MW by 2050. 1,626,000 tonnes CO_2e

15 Energyhub.org calculation: https://energyhub.org/saskatchewan

Other Energy Systems and Storage

Combined heat and power (CHP) systems are efficient producers of thermal and electric energy. They typically use natural gas or biomass, which can be replaced with RNG.Saskatoon Light & Power and the Saskatoon Health Region are studying the feasibility of a CHP plant at St. Paul's Hospital. The thermal energy would be sent to the hospital for its heating requirements, and the electric energy would be sent to the utility's electrical distribution system.

The South Saskatchewan River provides potential for hydropower projects. Saskatoon Light & Power has proposed a hydropower system at the existing weir that would have a 5.5-6.1MW capacity.

District energy (DE) can be an efficient way to produce and distribute thermal energy to clusters of buildings. When built with the possibility of expansion and flexible fuel use, DE systems can change with energy demand and evolved energy technologies.

Renewable energy can be stored for use when needed, using systems such as battery electric storage or pumped hydro storage. Stored renewable energy can be deployed when needed, bridging the temporal gap between when energy is produced (i.e. when it's sunny) and when it is needed (i.e. at night and during peak demand periods). Releasing stored energy decreases reliance on fossil fuel-based peaking plants that operate during peak demand hours (e.g. mornings and evenings). The current cost of battery electric storage is high, but prices are decreasing quickly as battery technologies become increasingly inexpensive to produce.

Action	Milestone Target & Emissions Reduced 2020-2050 (tonnes CO_2e)
35. Install a CHP facility at St. Paul's Hospital.	Install two 540kW CHP units at St. Paul's Hospital. 40,000 tonnes CO_2e
36. Implement district energy systems in the downtown and north downtown areas.	Create district energy systems to serve the downtown and north downtown areas. The systems will add these components over time: • 2026: 37MW RNG boiler • 2034: 37MW RNG boiler and CHP unit (9.6MW thermal, 10.5MW electricity outputs) • 2042: CHP unit (6.4MW thermal, 7MW electricity outputs) 1,079,000 tonnes CO_2e
37. Construct a hydropower plant at the weir.	Complete installation of a 6MW hydropower project at the weir, with an operational efficiency of 55% or greater by 2027. 218,000 tonnes CO_2e
38. Install renewable energy storage over time.	50MW of grid-tied electricity storage is added gradually between 2025 and 2050. 3,435,000 tonnes CO_2e

Putting our sunshine to work for cleaner air and new business opportunity.

Renewable Energy Procurement

Due to our current and projected high emission electricity grid—now and in 2050—all corporate and community energy and emissions actions will not achieve the 80% emissions reductions by 2050 target without purchasing renewable energy from elsewhere. As such, the remaining emissions will need to be reduced by renewable energy procurement. This energy could be procured from third party producers, from additional energy projects undertaken by the City, or from energy projects that are partnerships between the City and private, not for profit, or cooperative energy outfits.

Action	Milestone Target & Emissions Reduced 2020-2050 (tonnes CO_2e)
39. Procure renewable electricity from third party producers.	Procure electricity from 1600 MW of renewable energy capacity installed outside of Saskatoon. 54,119,000 tonnes CO_2e
40. Procure Renewable Natural Gas from third party producers.	Import Renewable Natural Gas to displace 50% of natural gas demand. 40,607,000 tonnes CO_2e

Water Conservation

The Saskatoon water treatment plant draws 120 million litres each day from the South Saskatchewan River for treatment, distribution, and storage. The pumps and treatment processes use electricity and generate emissions in supplying potable water to the city. The less water the system collects, treats, and distributes, the less energy is used.

Like all cities that distribute water through pipes, Saskatoon's system is prone to developing leaks from earth movement, expansion and contraction from seasonal temperature changes, and corrosion. Detecting and repairing system leaks is critical to water and energy conservation. The City is currently updating the distribution system with advanced metering infrastructure (AMI) systems that monitor water use and help with leak detection. Decreasing water use in buildings and in exterior applications like yard maintenance also relieves potable water system demand resulting in lower energy use and fewer emissions.

The City spends around $2.4 million annually irrigating parks, this is expected to increase as the city grows and summers become longer and drier.

The AMI system is expected to be fully deployed by 2022. The improved monitoring provided can help with leak detection in municipal infrastructure and can facilitate behaviour change in municipal, residential, and commercial buildings.

Action	Milestone Target & Emissions Reduced 2020-2050 (tonnes CO_2e)
25. Decrease water use through efficiency, monitoring, and leak reduction.	Utilize AMI system to track city wide consumption, identify and repair leaks, and support conservation and efficiency to enable a 5% reduction in volume pumped by 2026. 25,000 tonnes CO_2e
26. Reduce residential and ICI water use through education programming and water efficiency incentive programs.	Reduce outside water use by 20% and reduce inside water use by 30% in 100% of new builds and retrofits. 147,000 tonnes CO_2e

Protecting our most valuable resource.

Waste Management

Saskatoon's waste tonnage is expected to increase 85% by 2050 as the population grows. More waste will result in an 80% increase in waste-related emissions. Current waste diversion practices include curbside and multi-unit residential recycling, subscription food and yard waste collection, recycling and compost drop-off depots, and Household Hazardous Waste (HHW) drop-off events.

These efforts currently achieve a 22% rate of diversion from the Saskatoon landfill.

The City is targeting 70% diversion by 2023, which will require substantial efforts including city-wide organics collection and processing, disposal bans, increased recycling programming, education and awareness, and usage fees for garbage.

Action	Milestone Target & Emissions Reduced 2020-2050 (tonnes CO_2e)
24. Improve and expand waste management programs and services to increase reduction and diversion	By 2050, achieve reduction and diversion rates of: • 90% for organics • 95% for plastics • 90% for paper The City of Saskatoon's existing target is to divert 70% of waste from the Saskatoon Landfill by 2023. 1,303,000 tonnes CO_2e

FROM SECTOR ACTIONS TO IMPLEMENTATION

The LEC Plan is an umbrella strategy that recommends a suite of actions be implemented over the next 30 years. These actions require strategic phased implementation and funding to change the way we live.

The Actions have been categorized into four phases based on their timeline and readiness for implementation. These include:

Phase 1: Actions already initiated where planning or strategy development has already started

Phase 2: Actions to be started in the next 4 years, but that require further design before initiating

Phase 3: Action planning and implementation to be started in the next 5-8 years

Phase 4: Action planning and implementation to be started in the next 12+ years

The implementation plan lists the different phases for proceeding with the recommended actions, sector, milestone targets, next steps and funding opportunities for each action and shows an aggregate investment and savings total for each phase. Investments include those from the municipality, the private sector, households, and other levels of government.

Savings are also consolidated across the municipality, the private sector, and households, and would be realized in the form of avoided increased energy costs, avoided carbon charge payments, operating and maintenance savings, and new revenue opportunities for government and business. Savings estimates are based on input from City staff, national databases and federal government futures reports, benchmarking against other municipalities, and industry statistics.

These estimates show the high-level, full investment and savings potential of transitioning to a low-emissions community and are not intended to be used in place of a detailed design or feasibility study for each individual project.

The Next steps included in the implementation plan were derived through internal engagement with other city divisions and the timelines described are subject to fluctuate based on City Council approvals and planned allocated funding vs. actual funding. These timelines are high level and feasibility studies or detailed project and program design is factored into the next step timelines. Unless indicated, there is no approved funding for the strategies and feasibility studies.

The funding opportunities for each action are described in more detail in the next section of this report.

As the 40 recommended actions are designed in detail, they will be developed using a Triple Bottom Line assessment. The City of Saskatoon's Triple Bottom Line Decision Making Tool (TBL Tool), which is currently in development and is expected to be in effect by early 2020. The TBL Tool will not only assist in the development and design of LEC Plan actions, but it will also allow completed actions to be reviewed and assessed based on a set of established sustainability criteria.

Phase 1 Implementation

Phase 1 includes 3 projects that could be launched in the next 2-4 years as foundational work in the form of a strategy or detailed design plan has already been developed for them.

Action	Sector	Milestone Targets	Next Steps
4. Update all municipal building lighting systems.	Buildings & Energy Efficiency	Achieve 20% savings in lighting energy use in municipal office buildings by 2026, and 100% of remaining municipal buildings by 2051.	Energy Performance Contracting Project Phase 1-4 Scoping Complete by 2019. 2020-2021: Buildings that are part of the existing Energy Performance contract will have lighting retrofits completed 2021-2026: Request funding and approvel to complete retrofits in remaining buildings
20. Increase transit routes and frequency through future updates to the Transit Plan.	Transportation	Shift 5% of personal vehicle trips to transit by 2030, 10% by 2050. **BRT existing goal is 8% mode shift by 2043**	2022: Federal Funding Received for BRT system construction 2023-2025: Construction of BRT network and further engagement
23. Fund and implement improved cycling and walking infrastructure to encourage active transportation.	Transportation	Achieve a 20% mode shift to active transportation by 2030, 30% by 2050. **ATP existing goal is 24% mode shift by 2045.**	2020-2030: - Downtown AAA cycling network implementation & construction, city-wide cycling network projects implementation and cosntruction, cycling network improvements (enhanced crossings, pavement parking and sinage improvements, - Sidewalk program (sidewalk infill projects, curb ramp program), - Education and promotion program implementation, - Bylaw and policy project implementation

Phase 1 Totals	
Investment Required	**$ 856.9 Million**
Estimated Returns	**$1,798.1 Million**
Cumulative Emissions Reduction from 2020-2050	**1.23 Million tonnes CO_2e**

Phase 2 Implementation

Phase 2 includes 21 projects that need to be planned and implemented within the next four years.

Action	Sector	Milestone Targets	Next Steps
1. Apply energy efficiency standards (build to Passive House) to all new municipal buildings.	Buildings & Energy Efficiency	All new buildings are designed and built to target Passive House energy use standards starting immediately.	2020: A new High Performance Civic Building Policy presented to Council (no requirement for Passive House); a new fire hall (currently being designed) could be built to Passive House Standard 2021/2022: Study of Passive House and policy update to incorporate passive house standard if funding approved
2. Perform deep energy retrofits on municipal buildings.	Buildings & Energy Efficiency	60% of existing municipal buildings are retrofitted to target Passive House standards by 2031, 100% by 2050.	2022: Develop phasing strategy and detailed design for retrofits 2023: Design and strategy complete, request funding and approval from Council on retrofits 2024-2031: 60% of municipal building retrofits completed 2031-2050: Remaining 40% of building retrofits completed
3. Upgrade plugged appliances and energy conservation behaviours in municipal buildings.	Buildings & Energy Efficiency	Achieve 5% plug load energy savings in 100% of buildings by 2023.	2020: Develop phasing strategy and detailed design for appliance upgrades in municipal buildings 2021: Request funding and approval from Council on appliance replacement (as per strategy) 2022-2023: Replace all municipally owned building appliances
5. Retrofit municipal heating and cooling systems with ground-source or air source heat pumps.	Buildings & Energy Efficiency	Retrofit all municipal buildings with heat pumps and ensure all new municipal buildings have heat pumps, achieving retrofits of 100% of existing municipal buildings by 2026.	2020-2021: Secure funding for feasibility study for heatpump retrofits 2022: Pending study results detailed design for retrofitting phasing 2023-2026: Retrofit implementation
6. Create an electric and thermal energy consumption cap for new home construction by utilizing a municipal step code.	Buildings & Energy Efficiency	Improve energy use intensity (EUI) and thermal energy demand intensity (TEDI) for new residential buildings, targeting net-zero ready by 2036.	2020-2021: Complete research and engagement for step code design. Develop step code in consultation with stakeholders. 2023-2025: Step 1 of step code comes into effect and is implemented in new builds 2026-2030: Step 2 of step code comes into effect and is implemented in new builds 2031-2035: Step 3 of step code comes into effect and is implemented in new builds 2036+: Step 4 of step code comes into effect and is implemented in new builds

Action	Sector	Milestone Targets	Next Steps
8. Create an electric and thermal energy consumption cap for new ICI construction by utilizing a municipal step code.	Buildings & Energy Efficiency	Improve energy use intensity (EUI) and thermal energy demand intensity (TEDI) for new ICI buildings, targeting net-zero ready by 2036.	Timelines and programming included in action #6.
10. Incentivize and later mandate homeowners to perform deep energy retrofits.	Buildings & Energy Efficiency	Through envelope and mechanical system retrofits and renovations, 50% of existing buildings are 50% more energy efficient by 2030, 90% by 2050.	2020-2021: Research, engagement, and development of a Property Assessed Clean Energy (PACE) program to be utilized by home owners for energy efficiency and Solar photovoltaic retrofits; request funding and approval from Council on program implementation 2022+: Launch and operate PACE program
11. Incentivize and later mandate ICI owners and operators to perform deep energy retrofits.	Buildings & Energy Efficiency	Through envelope and mechanical system retrofits and renovations, 50% of existing buildings are 50% more energy efficient by 2030, 90% by 2050.	2020-2021: Research, engagement, and development of a PACE program to be utilized by the Industrial, Commercial, and Institutional (ICI) sector for energy efficiency and Solar photovoltaic retrofits; request funding and approval from Council on program implementation 2022+: Launch and operate PACE program
17. Electrify the Municipal fleet over the near-term.	Transportation	100% of the City fleet is electric by 2030.	2020-2021: Develop strategy for electric vehicle (EV) and charging station phase in for fleet. Request funding and council approval 2022: Develop RFP for EVs and Pilot EV models 2023-2030: Phase in Evs to fleet starting with light duty vehicles and progressing to larger equipment as models become more available
18. Electrify the Municipal transit fleet.	Transportation	100% of transit fleet are electric by 2030.	2020-2021: Pilot Leased EV Bus (if funding secured), develop EV bus phase-in Strategy and request funding and approval from Council. Develop RFP for EV buses and select supplier. 2022-2030: Phase in Electric fleet and charging stations
21. Electrify personal vehicles through incentive programs, education, and automotive dealer partnerships	Transportation	30% of all new vehicle sales are electric by 2030, 90% by 2050.	2020-2021: Develop a detailed strategy to increase private EV sales - this will include an EV charging network and education or incentive programs. Request funding and approval for programs and EV chargers 2022-2030: Procure and install EV charging infrastructure network, implement education and communication campaigns

Action	Sector	Milestone Targets	Next Steps
24. Improve and expand waste management programs and services to increase reduction and diversion.	Waste	By 2050, achieve reduction and diversion rates of: • 90% for organics • 95% for plastics • 90% for paper The City of Saskatoon's existing target is to divert 70% of waste from the Saskatoon Landfill by 2023.	2020-2021: Develop strategy for implementation of multi-unit and ICI (including Civic facilities) organic programs and education programs/partnerships on food waste reclamation and reduction. Request Council approval and funding for ICI and Multi-unit programs 2023-2024: Implement curbside organics program for single-family residential (as approved) and bylaws/ programs for multi-unit and ICI (pending approval) 2025-2050: study and implement organics/recyclable bans at civic owned landfill, single use reduction policies & programs, circular economy policies and programs
25. Decrease water use through efficiency, monitoring, and leak reduction.	Water Conservation	Utilize AMI system to track city wide consumption, identify and repair leaks, and support conservation and efficiency to enable a 5% reduction in volume pumped by 2026.	2020-2022: Full deployment of city wide AMI system completed 2022-2026: Identify and repair leaks and reduce system losses
26. Reduce residential and ICI water use through education programming and water efficiency incentive programs.	Water Conservation	Reduce outside water use by 20% and reduce inside water use by 30% in 100% of new builds and retrofits.	2020: Water Conservation Strategy presented to City Council for approval 2021-2030: Education program development and deployment
29. Install solar PV systems on municipal buildings.	Energy Generation	Install 24MW of solar capacity by 2026 on municipal buildings.	2020-2022: Complete a detailed strategy and feasibility study to determine which buildings are capable of handling solar 2022-2026: Pending funding and approval, install solar systems according to results of study
30. Install solar PV systems on municipal lands (Parcel M Project)	Energy Generation	Install a 1MW capacity solar system on Parcel M or similar land area by 2022.	2019: Virtual Net Metering Policy presented to Council for approval 2020-2021: Community engagement, feasibility and detailed design for project. 2022: Build out of site, pending study results
31. Increase Landfill Gas Capture from the Saskatoon Landfill	Energy Generation	Increase methane capture and destruction from the landfill to 50%, by 2026.	2020: Feasibility study and detailed engineering design for additional vertical wells and completion of the perimeter Landfill Gas (LFG) header for tieing into the existing horizontal loop. 2021-2022: Construction of additional vertical wells and tie into the collection facility. 2023-2026:Construction of the perimeter LFG header and tie into the existing horizontal loop on the active cell.

Action	Sector	Milestone Targets	Next Steps
32. Encourage existing residential building owners and mandate new buildings to install solar PV system	Energy Generation	Install 10MW of residential solar capacity by 2030, 50MW by 2050.	2020-2021: Research, engagement, and development of a PACE program to be utilized by home owners for energy efficiency and Solar photovoltaic retrofits; request funding and approval from Council on program implementation 2022+: Launch and operate PACE program
34. Install new solar PV utility-scale facilities within or adjacent to city boundaries.	Energy Generation	Install 20MW of solar capacity by 2030, 300MW by 2050.	2023: Analyze results of 1MW utility scale solar project completed in year prior 2024: Feasibility study and consultations to determine capacity of land within and adjacent to the city 2025-2030: Begin build out further utility scale sites pending study and engagement results
35. Install a CHP facility at St. Paul's Hospital.	Energy Generation	Install two 540kW CHP units at St. Paul's Hospital.	2020-2021: Detailed design for project 2022-2023: Construction of system
38. Install renewable energy storage over time.	Energy Generation	50MW of grid-tied electricity storage is added gradually between 2025 and 2050.	2023-2024: Analysis of technology to date, completion of feasibility study, and phased strategy developed. Funding and approval requested from Council. 2025: Procure storage supplier 2026-2050: Phased construction of storage as outined in strategy

Phase 2 Totals	
Investment Required	**$ 3,746.5 Million**
Estimated Returns	**$ 6,948.3 Million**
Cumulative Emissions Reduction from 2020-2050	**25.4 Million tonnes CO_2e**

Phase 3 Implementation

Phase 3 includes 7 projects that need to planned and implemented within the next 5-8 years.

Action	Sector	Milestone Targets	Next Steps
12. Require energy efficiency improvements residential and ICI building lighting systems.	Buildings & Energy Efficiency	90% of residential and commercial buildings are retrofitted for 5% increased lighting efficiency in addition to regular market-induced lighting efficiency improvements by 2030, 100% by 2050. All existing luminaires are replaced or updated with energy efficient LED bulbs and systems.	2025: Program/Bylaw Development 2026-2030: Program/bylaw comes into effect
14. Retrofit home heating and cooling systems with ground-source or air source heat pumps.	Buildings & Energy Efficiency	30% of residential buildings are retrofitted with heat pumps by 2030, 80% by 2050.	2025: Feasibility study to determine scope of program & assess appetite for program
15. Retrofit ICI heating and cooling systems with ground-source or air source heat pumps..	Buildings & Energy Efficiency	30% of commercial building floorspace is retrofit with heat pumps by 2030, 80% by 2050.	2025: Fesability study to determine scope of program & assess appetite for program
19. Implement a vehicle pollution pricing program in high traffic areas.	Transportation	Achieve a 5% emissions reduction from decreased high traffic area car travel through pollution charges in designated areas starting in 2026.	2024-2025: Begin public engagement and policy or bylaw development, draft and receive approval on new policy. Develop education and enforcement plan and request funding. 2026: policy or bylaw enacted with associated education and enforcement
22. Electrify commercial vehicles through incentive programs, education, and automotive dealer partnerships	Transportation	50% of all new heavy trucks are zero emissions by 2030, 100% by 2040.	2024-2025: Detailed strategy development including engagement and education campaign, begin policy or bylaw development 2026-2030: Develop EV charging infrastructure network, policy or bylaw, continued education and communication campaigns
33. Encourage existing ICI building owners and mandate new buildings to install solar PV systems.	Energy Generation	Install 20MW of ICI solar capacity by 2030, 200MW by 2050.	2025: Expand/update PACE program to be used by ICI facilities 2026-2030: PACE available for ICI buildings
37. Construct a hydropower plant at the weir.	Energy Generation	Install a 6MW hydropower project at the weir, with an operational efficiency of 55% or greater by 2027.	2020-2022: Feasibility and environmental impact assessment; obtain Council and other approvals, secure funding 2023-2027: Pending study results, detailed design and construction of the plant

Phase 3 Totals	
Investment Required	**$ 4,550.4 Million**
Estimated Returns	**$ 6,676.7 Million**
Cumulative Emissions Reduction from 2020-2050	**11.9 Million tonnes CO_2e**

Phase 4 Implementation

Phase 4 includes 9 projects that need to be initiated and/or implemented within the next 12 years and onwards.

Action	Sector	Milestone Targets	Next Steps
7. Require new homes to include roof solar PV installations in the final year of a municipal step code.	Buildings & Energy Efficiency	All new homes constructed in 2036 onwards will maximize their roof solar PV coverage, with electricity generation tied into the electricity grid.	Corresponds with next steps for Action #6, final step of municipal step code. 2036-Onwards: New homes require solar PV
9. Require new ICI buildings to include roof solar PV installations. In the final year of a municipal step code.	Buildings & Energy Efficiency	All new ICI buildings constructed in 2036 onwards will maximize their roof solar PV coverage, with electricity generation tied into the electricity grid.	Corresponds with next steps for Action #6, final step of municipal step code. 2036-Onwards: New ICI buildings require solar PV
13. Incentivize and later mandate homeowners to upgrade household appliances to energy and water efficient models	Buildings & Energy Efficiency	Upgraded appliances are 30% more energy efficient and current water heaters are replaced with electric on-demand models in 50% of residential buildings by 2050.	2040: Detailed design of program to incentivize appliance upgrades
16. Increase the efficiency of industrial processes.	Buildings & Energy Efficiency	Update and retrofit industrial machinery and processes to more efficient models and switch to renewable energy sources to achieve 50% energy savings by 2050.	2040: Detailed design of program and engagement to determine scope of programming
27. Build complete, compact communities through infill development, mixed-use buildings, and compact housing.	Land Use	Achieve residential energy use reductions with energy efficient, mixed-use multi-family buildings in complete, compact neighbourhoods to achieve 5% less floor area than the current average by 2035 and 25% by 2050.	2020: Official Community Plan update presented to city council including variety of policies and plans related to infill development, corridor growth and long term planning. 2020-ongoing: Corridor Plan implementation – segment-specific corridor plans targeting land use designation, rezoning and public realm design as well as necessary transportation and infrastructure plans and improvements to support the growth. 2021-2045: Policy and programming pertaining to growth plan implemented on an ongoing basis.
28. Focus development on densification in previously developed areas, increasing the number of multi-family buildings.	Land Use	Increase the housing stock share of multi-family homes by 25% by 2050 for new builds only.	Included in action #27

Action	Sector	Milestone Targets	Next Steps
36. Implement district energy systems in the downtown and north downtown areas.	Energy Generation	Create district energy systems to serve the downtown and north downtown areas. The systems will add these components over time: 2026: 37MW RNG Boiler, 2034: 37 MW RNG Boiler and CHP Unit (9.6MW thermal, 10.5MW electricity outputs, 2042: CHP unit (6.4 MW Thermal, 7MW electricity output)	2025: Detailed design completed, review of previous completed fesability study and included with detailed design plans for North Downtown 2026-2033: Addition/construction of RNG Boiler 2034-2041: Addition/construction of one CHP unit 2042: Addition/construction of second CHP unit
39. Procure renewable electricity from third party producers.	Energy Generation	Procure electricity from 1600 MW of renewable capacity installed outside of Saskatoon.	2040-2041: Detailed design and feasibility study 2042-2050: Tender and purchase of imported renewable energy
40. Procure renewable natural gas from third party producers.	Energy Generation	Import RNG to displace 50% of natural gas demand.	2040-2041: Detailed design and feasibility study 2042-2050: Tender and purchase of imported RNG

Phase 4 Totals	
Investment Required	**$ 9,811.9 Million**
Estimated Returns	**$ 18,143.5 Million**
Cumulative Emissions Reduction from 2020-2050	**7.9 Million tonnes CO_2e**

FUNDING LOW EMISSIONS

Funding Opportunities

Implementing the LEC Plan recommendations requires substantial investment in initiatives such as renewable energy projects, electrifying transportation systems, improved building standards, improved waste diversion and water conservation efforts, and new service offerings for residents.

Currently, there is minimal funding earmarked by the City for environmental programs, initiatives, and projects. Climate change projects are funded on a case by case basis, which delays projects and programs from being delivered. This model of funding does not allow for long-term planning that enables reaching reduction targets. Additionally, grant funding is heavily relied upon, which is unsustainable as grants are highly competitive, labour intensive, unreliable, and subject to political volatility.

Therefore, in order to reach our community and corporate GHG targets and avoid further delays, it is critical for the LEC Plan recommended actions to have access to reliable and consistent funding sources.

The review of funding & resource allocation opportunities was compiled based on literature review and best practices in other Canadian municipalities.

Funding Models

Green Revolving Funds

A green revolving fund (GRF), also referred to as a sustainability revolving fund, and provides a unique opportunity to pay forward the success of efficiency projects into future projects. A green revolving fund finances projects by tracking utility savings (i.e. from energy and water conservation), fuel savings, and other cost savings and then paying those savings back into a common fund. Any surpluses in the common fund are earmarked for future efficiency or sustainability initiatives that meet the same criteria or are necessary to achieve sustainability outcomes (e.g. educational programs on reduced consumption).

A GRF should meet two criteria:

1. Reduce resource consumption or reduce emissions, and
2. Produce savings from operations.

There are two options for structuring a GRF: a fixed payout model and a loan model.

The **fixed payout model** is most effective when multiple departments or building utilities are paid through one centralized fund. The University of Saskatchewan uses this model for its Sustainability Revolving Fund because all utilities are paid from one fund and the process of tracking savings is less complex. For this program, energy efficiency projects are put through an application process and must have an estimated payback of 15 years or less. The expected payback and emissions estimates for the project are then reviewed for reasonableness and the project is accepted. Repayment is from a central utilities fund where the savings are paid back into the fund on an annual basis once the project is completed. For projects less than $10,000, repayment is made within one year, whereas projects valued at $10,000-$1M see repayment over five years, and projects greater than $1M receive repayment within ten years.[16] The fixed payout model requires an initial capital investment to start the program. Additional capital investment can be contributed

16 University of Saskatchewan, Office of Sustainability, (2018)

during the ongoing life of the revolving fund model if there is incentive to adopt additional sustainability programs and expand the sustainability strategy within the organization.

The **loan model** is most effective when multiple departments or buildings in an organization are paying their own utility costs in house and there is no centralized utility fund. The loan model provides upfront capital for projects similar to the fixed payout model but the project then pays off the loan obtained with tracked efficiency savings. The success of these funds is consistently proven and they are now widely used in 70+ universities and private organizations.[17]

- Harvard has an especially successful loan model Green Revolving Fund of $12M that's been funding sustainability projects for over 26 years since its inception in 1992. The requirements for applications to these loans are that the project must reduce negative environmental impacts, have a positive estimated net present value, and payback within 11 years.[18]
- Edmonton's Energy Management Revolving Fund, created in 1995, and has grown to over $30 Million. This fund is a loan model that is used to retrofit municipally owned buildings for energy efficiency.
- The Federation of Canadian Municipalities' Green Municipal Fund is another successful example of a loan based model revolving fund. This fund loans seed money to Municipalities; then, as municipalities pay back their loans, the repaid amounts are deposited back into the fund and re-loaned to another projects, making the fund self-sustaining.

Seed funding for Revolving Funds can be realized through mill rate contribution, utility funding, grant funding, RCE allocation, or existing reserve funds. The investment criteria for Revolving Funds must be set out during the program or project design phase. Specifically, the project criteria may base the success and savings on financial payback, environmental impact, or social benefit, or a hybrid of all three pillars using the Triple Bottom Line approach.

GRF's do require an accounting or tracking of savings, which may require additional staff or administration costs due to complexity. Complexity is reduced by using a fixed payout model. Capital or seed funding is still required for GRFs in order for renovations or projects to begin. However, once the initial capital investment is made, the fund is designed to be self-sufficient and not dependent on outside funding sources.

Given the need for accounting for cost savings and environmental calculations, having a management plan for a GRF is optimal. The plan should outline how resource consumption will be reduced and how cost savings will be tracked and allocated. Further, the plan should outline how future investments will be made.

Innovation Funds

Innovation funds are similar to capital reserves which are already widely used within the City (e.g. the reserve for capital expenditures or the gas tax capital reserve). They can also operate similar to a revolving fund as described above. The Atmospheric Fund (TAF) is an example of how both a reserve and revolving fund work together to foster innovative solutions and was developed by the City of Toronto in 1991. TAF was initially financed with surplus capital from the sale of city owned land. The fund is strategically managed to invest in innovation programs that reduce greenhouse gas emissions and air pollution. The fund is a self-sufficient endowment and offers a combination of revolving loans and grants without using any city budget resources. Grants are offered to projects related to high performance buildings, clean energy transportation, design and development of low emissions neighborhoods, and education programs focused on low-carbon behaviours.[19]

In February 2018, TAF joined forces with Vancouver, Calgary, Edmonton, Ottawa, Halifax and Montreal to accelerate the fund for low emissions projects. The coalition (referred to as Low Carbon Cities Canada (LC3) raises funds through impact investing, strategic grants, and demonstration projects in order to bring carbon emissions plans to life in Canadian cities. LC3

17 University of Saskatchewan, Office of Sustainability, (2018)
18 Harvard University, Office for Sustainability, (2018)
19 The Atmospheric Fund (2018)

has requested $156 Million of investment from the federal government of which $140 Million will be used for impact investments in local low emissions ventures that generate returns for further climate change actions.

Innovation funds require an initial capital investment. Additional costs are required to manage and administer the fund. Saskatoon is in a unique position to invest in an Innovation fund similarly to the TAF funding strategy as we sell and manage land within city limits and have our own power utility. Parameters for Innovation funds should also be outlined, ideally within a terms of reference. This should strategically guide investment decisions for use of financial resources.

Climate or Green Bonds

Climate Bonds or Green Bonds are bonds available for purchase in capital markets with the proceeds used exclusively for green or climate related projects. Green City bonds are a debt instrument and can used to fund city specific projects such as major transportation infrastructure, low emissions facilities, and renewable energy projects. Green City bonds are widely used in Europe, the US, and at a provincial level in Ontario. Ottawa was the first city in Canada to issue a green City bond for funding a light rail system and this issuance resulted in $102M of capital for the project.[20] The City of Vancouver's issuance of a green City bond (released in September 2018) is expected to raise up to $85M. Some of the approved projects to be funded by Vancouver's bond include waste heat recycling projects, retrofitting a fire hall to LEED Gold Certification, and energy efficient affordable housing construction projects.[21]

Issuing bonds provides access to a growing pool of investors seeking to invest in climate impactful projects. Historically, most green bonds issued have been oversubscribed meaning the demand to invest in them is higher than the supply of notes. Repayment of the bonds can be matched to the life of an asset and stretched to 5, 10, or 20 years and issuance provides access to a substantial amount of capital funding.

Administration costs are required for Green Bonds to ensure the bond is credible and adheres to specific requirements in order to remain accountable to bond holders. In addition, third party verifications or audits of the processes can be involved; this would typically be included in the audit agreement with internal and external auditors. Finally, due to Green Bonds being a debt instrument they do require repayment and are not a source of "free" money.

Public Private Partnerships (P3)

Public Private Partnerships (P3s) are partnerships between government organizations and private business typically used to design, finance, build and/or maintain large infrastructure projects in a time and cost efficient manner. The City of Saskatoon has already had success with this model previously for the North Commuter Parkway, Traffic Bridge, and the Civic Operations Centre.

Communities in the US are beginning to use an evolved model of a P3, referred to as Community Based Public Private Partnerships (CBP3). This model is very similar to a traditional P3 but is focused on funding green infrastructure or storm water management infrastructure for the improvement of water quality and quality of life.[22] Green infrastructure, such as urban forest or significant green space development, relates to climate change as it reduces emissions through carbon sequestration and supports climate adaptation and resiliency efforts.

The Clean Water Partnership in Maryland, US was established in 2015 and is using $100M to invest in 2,000 acres of green infrastructure retrofits on municipal, private, and community land to increase water retention and reduce storm water runoff. The partnership is in its second of three years and is expected to be completed on time and on budget with 87 projects being funded through the partnership.[23]

Community Partnerships

20 City of Ottawa, Budget Details (2017)
21 City Of Vancouver (2018)
22 United States Environmental Protection Agency (2015) Financing Green Infrastructure - Is a Community-Based Public-Private Partnerships (CBP3) Right for You?
23 Prince George's County Clean Water Partnership Progress Report. (2017)

Community Partnerships include anything from Local Business Sponsorship of an item to larger partnerships with the University of Saskatchewan, non-profit organizations, or Indigenous groups.

Saskatoon has experienced success with community partnerships in the past. For example, the Solar Power Demonstration site is a collaboration between Saskatoon Light & Power, the SES Solar Cooperative, Sask Polytechnic, and the Saskatchewan Environmental Society. With this project, funds were provided from the City and the Saskatchewan Environmental Society and sun-tracking equipment arrays were loaned from Sask Polytechnic.

A benefit of a community partnership arrangement is that it engages multiple members of the City and the community and fosters a collaborative environment for approaching climate related issues. It also promotes cost and knowledge sharing among different groups. However, these partnerships may be smaller in nature than a P3 and/or require additional administrative or FTE resources to seek out partnerships and maintain relationships.

Local Improvement Charges (LICs) or PACE Financing for Private Property

A Local Improvement Charge (LIC) is a financing mechanism that allows a municipality to provide up-front financing for private property environmental/energy efficiency retrofits. An LIC is provided over a longer term than a bank loan would be (either 10, 15, or 20 years) and at a fixed interest rate. For these reasons, these loans are more attractive to residents than a traditional line of credit or conventional loan. The financing is then repaid on the resident's property tax bill. These charges remain with the property itself, so when a resident moves the LIC continues to be repaid by the next owner. This reduces financial risk for the individual as they are not stuck with payments for improvements to a house they no longer live in.

The risk of default on LIC payments is low because the payments operate in the same way as property taxes. In other words, financial security is assured for the municipality because any overdue payments can be treated like unpaid taxes and a priority lien could be applied to the property (so the loan is repaid to the municipality before all other creditors can collect). Additionally, through the application process, applicants can be thoroughly screened for any other outstanding debt and/or a cap can be placed on the amount of the loan based on a percentage of the property value.[24]

The City of Halifax offers financing for solar power on private properties using LICs. The Solar City Program is available for residential property owners, non-profit organizations, places of worship, co-operatives, and charities to choose from three solar technologies (solar electric, solar hot air and/or solar hot water). The financing program is voluntary and, after installation, the LIC is billed to the owners annually and displayed separately from property taxes. Payments are made at a fixed interest rate of 4.75% over 10 years. In order to be eligible, the property owner or organization must have their property taxes paid in full on a regular basis. This program was piloted for two years and, in that time, 407 solar permits were issued, indicating a strong appetite for the program. Since the completion of the pilot and implementation of a city wide program, 53 more permits have been issued. In total, $4.5 Million in solar projects have been financed in 2.5 years.[25]

The Home Energy Loan Program (HELP) and Hi-RIS program was launched in Toronto in January 2014. It gives single dwelling home owners and multi-residential unit operators access to energy and water conservation upgrades through a low interest loan that can be repaid within 5, 10, or 15 years. By March 2018, 677 single unit dwellings and 37 multi-unit dwellings had applied for the program with 160 single unit projects completed and 11 multi-unit buildings (1,861 individual units). Between April 2017 and March 2018, the number of HELP applications increased 28% and Hi-RIS increased 60%, indicating the appetite for loans to retrofit properties is steadily increasing.[26]

Implementing LICs will require working with the provincial government to amend the Cities Act. Saskatchewan's Cities Act does not currently include municipal loans but revisions to this

24 Clean Air Partnership, Local Improvement Charge FAQ, 2018
25 Halifax Solar City Program Update (2017)
26 City of Toronto, Home Energy Loan Program and High-rise Retrofit Improvement Support Program Update, 2018

are underway in 2019-2020. The long-term benefits would result in the ability for Saskatoon to implement initiatives outlined in the LEC Plan. The benefits would be recognized in all pillars of the Triple Bottom Line approach through lower consumption, economically affordable programs, and access for all members of the community to environmental financing.

In the 2019 Federal Budget, the federal government proposed Community EcoEfficiency Acceleration funding of $300 Million to provide financing for municipal initiatives (such as PACE financing) to enable cities to provide loans to homeowners for both energy efficiency and renewable energy generation retrofits. This funding is subject to change based on the upcoming federal election, so it is critical that the ground work to amend provincial legislation be completed immediately to ensure this funding opportunity is not missed.

On-Utility-Bill Financing

On-utility-bill financing operates similar to LICs except the loans are repaid through a monthly charge applied to the user's energy or water utility bill instead of to their property taxes. With this model, the repayments remain with the property if there is a change in ownership (similar to an LIC) but failure to repay any loans using this model can result in a cancellation of utility services to a property, making defaulted loans less of a risk.

Manitoba Hydro offers multiple types of on-utility-bill loans for gas and electrical system upgrades, as well as upgrades for insulation, air leakages, EV charging stations, window and doors replacement, space heating upgrades, solar, or geothermal heating systems. Repayments for the loans are paid on the customer's energy bill with a fixed interest rate and maximum repayment terms depend on the type of retrofit being completed. Financing is available to any home owner with an active Manitoba Hydro account in good standing.27 This program has been running since 2009; by 2013, over 89,000 households had utilized the loans.

According to the City of Saskatoon's 2017 Environmental Awareness Survey, 60% of residents surveyed noted that the initial cost of installing solar panels or upgrading to high quality windows and insulation was a barrier to them implementing the technology. LICs, PACE, and On-Utility-Bill Financing programs are powerful tools for reducing community emissions, as they provide the upfront cost of efficiency or renewable energy renovations.

Resource Allocation Options

Regardless of the funding model selected to sustain the LEC Plan investments, these models will require initial seed funds or resource allocation. Options for resourcing the initial models are described in detail below.

Reserves

Reserve funding would recognize a predetermined contribution from a source or multiple sources on an annual basis so the reserve self-generates and ideally increases at a higher rate than inflation. Expenditures from reserve funding should be strategically defined, similarly to other funding models, and could resolve the issue of sustainability initiatives having to request funding from utilities for program and project development. Traditional reserve structures are different than the GRF or Innovation Fund, although the funding model could be combined so savings are invested back into the reserve.

The City has multiple reserves, which are governed by bylaw. An Environmental or Sustainability Reserve would require the same oversight as others within the corporation, and would require bylaw development at the time of request. The sources of funding would be defined prior to inception.

27 Manitoba Hydro, Loans & Savings Programs 2018

Currently, many capital reserves in Bylaw #6774 have a limited scope and do not contain expenditure room for Climate Change Capital project development. Additionally, there is no one dedicated capital reserve in place for environmental sustainability (including climate change) initiatives.

A climate-change reserve would ensure there is a dedicated fund exclusively for related projects. Setting up an additional capital reserve does not require a change in the way business is done at the corporation and can be done quickly with limited additional administrative efforts. This alternative requires an initial capital investment to get the reserve balance in place, as well as annual sources of funds that are adequate to cover the strategic spending plan. This would likely require additional mill-rate funding requests for some cost centres and/or a plan for funding the reserve from utility. Alternatively, the climate-change reserve could be funded through an allocation from new the gas tax fund top up proposed by the federal government in the 2019 Federal Budget. This top up is earmarked for 3 priority areas including: Productivity and Economic Growth, Clean Environment, and Strong Cities and Communities. Under the Clean Environment priority, eligible projects include wastewater, solid waste, community energy systems, and brownfield redevelopment.

In order to avoid the perception that climate-change work is the responsibility of one division (i.e. the division that oversees the Environmental Reserve), the Sustainability Division would work with other divisions to ensure that the funds are utilized to the benefit of the entire corporation, using the Triple Bottom Line approach.

Utility and/or Property Tax Funding

The City's organizational chart places the Sustainability Division within the Environment and Utilities Department. Within the department, three utility divisions are present (Saskatoon Light and Power, Saskatoon Water, and Water & Waste Stream), which charge a rate for the provision of the utility to the community (energy, water, and waste services).

Under the existing city model, utility divisions allocate any revenue surpluses to their own division or anywhere they see fit. Under a consolidated business model, utility services would recognize monetary input to provide utilities to the Saskatoon community to cover their operational costs. Once the operational costs are "covered," the financial surplus for capital improvements and asset management would roll into a consolidated utility fund, which would fund all projects within the Environment and Utility Department on a prioritized basis.

The consolidated business approach would apply to all climate-change projects that affect utilities; climate-change projects affecting non-utility divisions would source funding through other methods.

Grants

Grants for climate change initiatives are available through federal and provincial governments, and non-governmental organizations. Grants present an impactful opportunity as they can be material sums of investment capital and are interest-free ways to finance projects. Grants are an excellent way to launch new programs or services, and build capacity within the municipality. Grants enable the municipality to determine if additional services, programs, or strategies are appropriate for the municipality without relying on the tax base or utility funding.

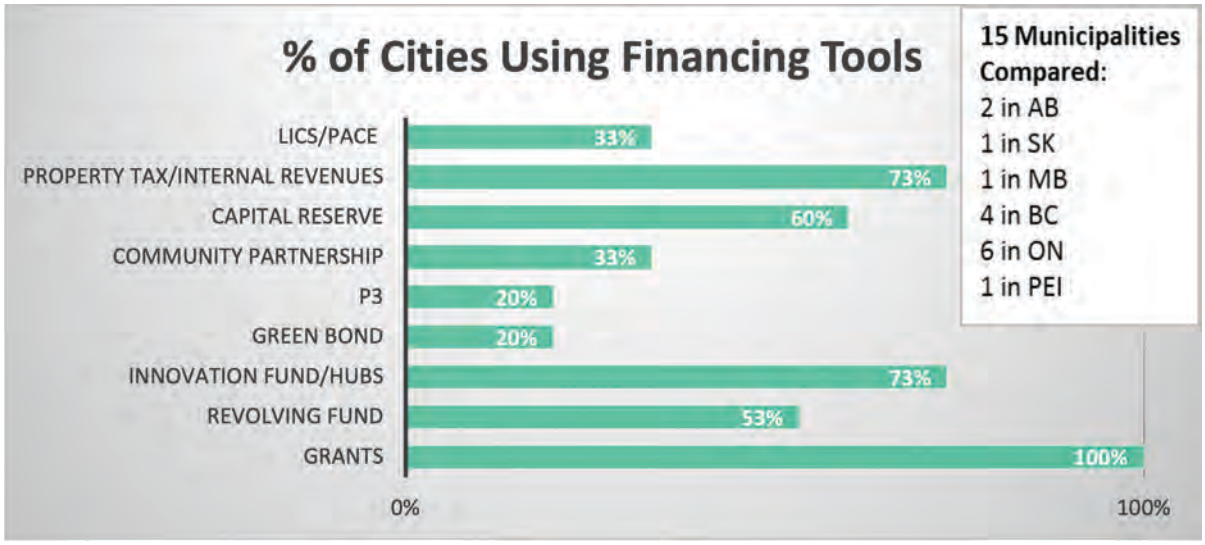
A variety of grant programs produce many options for different activities such as resiliency, emissions reductions, environmental protection, waste diversion, energy programming, green development, and others.

Grants tend to be highly competitive and fairly labour intensive. Grant applications require up-front time and energy, with no guarantee that the effort will translate into funding. Post-project/program reporting is often required and detailed expense reports are required for submission. Upon project completion, there is no guarantee that a project will be transferred into operations through ongoing service delivery. Where ongoing service delivery is required, a budget request is required the year prior to transfer to operations to avoid disruption of service; however, the service

is at risk of not being approved for mill-rate funding if it is not identified as a priority.

Comparison of Funding Tools Used in Other Municipalities

While analyzing the different financing tools available, a review of 15 other Canadian municipalities was performed to determine any trends in financing sustainability projects across Canada. These municipalities ranged in size and location. A listing of findings is below.



Notable trends from the comparison municipalities include:

- A property tax allocation was used most commonly to fund climate change or sustainability department employee salaries.
- Capital reserves were funded through ongoing carbon tax rebates (in all BC municipalities), gas tax rebates, and interest from an endowment fund or grants.
- Green bonds have been issued in Ottawa, Vancouver, and Toronto and are used for major infrastructure or public transportation upgrades.
- Green revolving funds were most commonly used for energy efficiency projects; three cities used them specifically for LED streetlight replacements.
- LICs or PACE financing is exclusively used as an incentive for homeowners or multi-unit

  building owners to install renewable energy or efficiency upgrades to their property years.


lobby
Coworking

CONCLUSION

Communicating Progress and Next Steps

The LEC Plan creates a long-term roadmap to show the City how emissions targets can be achieved. In addition to meeting our GHG goals, the Plan models a path for a resilient, healthy community. Through the plan our community serves to benefit from a resilient economy that is more diverse in time of global economic changes. Our residents, businesses and the municipality are better positioned to benefit from reduced expenses, which leads to improved equity and quality of life.

In moving toward the long-term implementation of the plan, accountability and transparency support the success of the Plan. The progress or shortfalls related to the City's overall GHG reduction targets for both the community and the corporation will be communicated in the annual GHG Inventory report and on the City's website on the Environmental Dashboard.

Furthermore, if our short-term emissions targets are not on track to being reached, the Sustainability Division will report any shortfalls to City Council with a detailed summary of opportunities to reduce these emissions as well as impacts to economic and social outcomes. This report will go out in 2022 (one year before the target date) and be updated post 2023. Over the long term, LEC Plan update reports are anticipated to be provided at 5-year intervals until 2050, which will help us track our progress towards achieving interim targets and actions.

APPENDIX A

The Current State of Climate Action

Federal

The Conference Board of Canada tracks performance of results nationally against 15 other countries in the Canada Performs: Environment report card. The overall assessment is segregated into 4 categories: air pollution, waste, freshwater management, and climate change. In the latest report (2016), Canada received a grade of D and ranked 14 out of the 16 peer nations; only surpassing the US and Australia. Canada reported lowest on the sections of particulate matter (air quality), GHG emissions and energy intensity.[28] The ranking in these areas is closely tied to high usage of fossil fuels for energy which has the highest impact on the environment and magnify climate change impacts.

The federal government, through the Pan-Canadian Framework for Clean Growth and Energy, encourages sustainable development through pricing carbon pollution; sector specific infrastructure development; climate adaptation initiatives; and supporting clean technologies.

Transitioning to a LEC Plan would improve these rankings, as it involves reducing our energy consumption, improving the efficiency of our energy system and our buildings, and switching our energy sources to renewables which have less damaging environmental impacts.

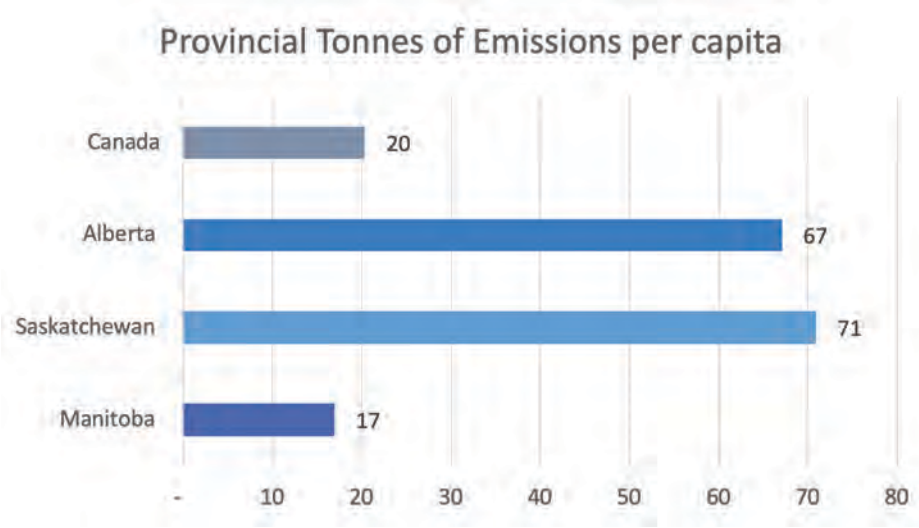
Provincial

In the latest Canada Performs: Environment report card, Saskatchewan remained consistent with prior years, with a D- grade including a D- grade for particulate matter (air quality), GHG emissions and energy intensity. The grade is benchmarked among the other provinces in Canada, and the federal result is compared to 15 other countries. In neighbouring Prairie Provinces, Alberta was ranked with a D- in the same areas as Saskatchewan, and Manitoba received a D- for energy intensity but a D for air quality and C for GHG emissions.

Saskatchewan accounts for 11% of Canada's GHG emissions.

The per capita emissions in Saskatchewan are the highest in Canada at 71 tonnes per person, with the Canadian average being 20 tonnes per person. When benchmarked against other Prairie Provinces with similar economies, the per capita emissions are 4 tonnes higher per person than in Alberta (67 tonnes per capita) and 54 tonnes higher per person than in Manitoba (17 tonnes per capita).

Figure 45: *Provincial and Federal Emissions per Capita*



28 How Canada Performs, Conference board of Canada, 2018

In Alberta, coal-fired electricity generation is scheduled to be eliminated by 2030 which has the potential to reduce their per capita emissions by 49% to 45 tonnes per capita shortly after 2030.[29] Manitoba's per capita emissions are substantially lower, as there is high usage of renewable hydropower for electricity instead of reliance on a coal and gas powered energy grid. Manitoba's per capita emissions are projected to decline approximately 47% to 9 tonnes per capita post 2030.[28] Manitoba is planning to reduce its emissions through a comprehensive plan that includes keystones of expanding renewable generation, reducing electricity and natural gas consumption through energy efficiency building retrofitting and electrifying transportation systems.[30]

The Saskatchewan government has released a climate change strategy referred to as Prairie Resilience. The impactful mitigation activities in Prairie Resilience include:

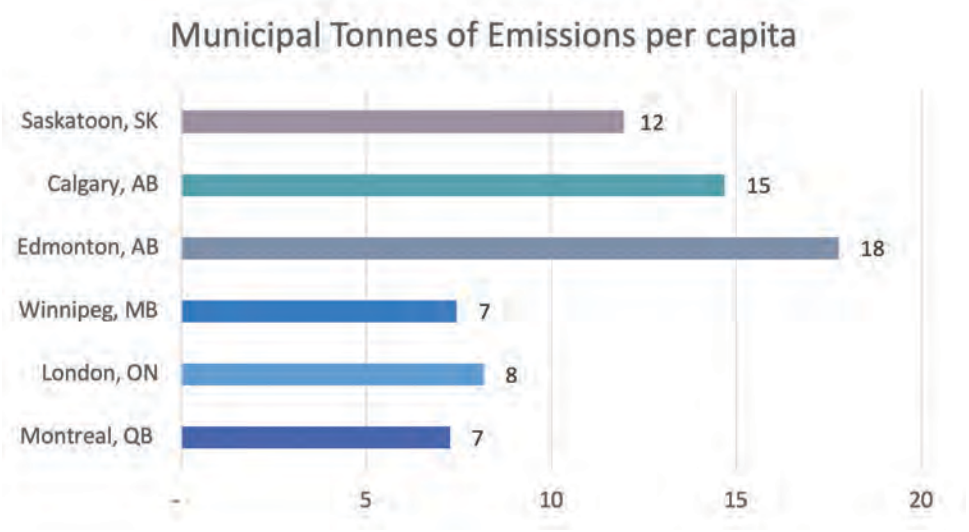
- increasing renewable energy generation capacity up to 50% by 2030;
- reducing energy consumption in provincial government owned buildings to 1.494 GJ/m² by 2020 (which is a 27% reduction from 2007 consumption);
- reducing emissions from the oil & gas sector by 40% by 2025; and
- decreasing the emissions intensity of the economy with no specified reduction target or date.

Currently, renewable energy generation in the province is primarily produced by hydro projects in Athabasca, Island Falls, Nipawin and Coteau Creek. Wind power facilities also exist in southern Saskatchewan, such as Cypress Hills and Swift Current. When combined, these sources account for 25% of total energy generation capacity at present. Prairie Resilience does not outline actions for reducing transportation emissions or building energy consumption for (nongovernmental) residential or commercial buildings.

The City of Saskatoon

In 2016, Saskatoon represented 4% of Saskatchewan's overall provincial emissions, and per capita emissions were 12 tonnes CO_2e. This is lower than the per capita emissions for Calgary and Edmonton in 2016, but significantly higher than Winnipeg, London and Montreal.

Figure 46: *Municipal Emissions per Capita*



29 By the numbers: Canadian GHG Emissions, Ivey Lawrence National Centre for Policy & Management, 2016
30 Climate and Green Plan, Manitoba Sustainable Development, 2017

APPENDIX B

Federal Carbon Pricing Plan Summary

On October 23, 2018, the Government of Canada released additional details on its Pan-Canadian approach to pricing carbon pollution, which includes the federal carbon pricing "backstop." The backstop was established into legislation and applies to those provinces (and territories) who have not met minimum thresholds set by the federal government's coverage benchmark. The benchmark establishes minimum emissions pricing coverage that provinces must achieve. If a province's climate change plan does not meet the benchmark, then the backstop would apply, in whole or in part.

As a result, the Government of Canada announced that the backstop would be in effect as of April 1, 2019 in the provinces of Saskatchewan, Manitoba, Ontario, and New Brunswick because these provinces had not developed plans that met the benchmark thresholds. The application in Saskatchewan is a hybrid version, whereby the carbon price and fuel charge are federally defined, but the Output Based Performance Standard (OBPS) is Saskatchewan-made through the Prairie Resilience strategy.[3] Specifically, the carbon price framework includes two main components that became effective April 1, 2019:

1. A carbon levy applied to fossil fuels, which includes gasoline, diesel fuel, natural gas, light fuel oil, propane, and other fuel sources (this is federally defined in Saskatchewan).
2. An Output-Based Performance Standard (OBPS) that applies to industrial facilities that emit above a 10,000 tonnes CO_2e threshold (this is provincially defined in Saskatchewan).

Both the carbon levy and output-based pricing system will price carbon based on carbon dioxide equivalents (known as CO_2e). The price per tonne of carbon will gradually increase over a period of five years. The price started at $10 per tonne in 2018, increased to $20 per tonne in 2019, and will continue to increase by $10 per tonne until 2022 (when it will reach $50 per tonne).

Implications for the City of Saskatoon Operations

The City consumes gasoline and diesel fuel to operate its equipment and fleet, and uses natural gas to heat City-owned buildings. Our provincial electrical grid that is produced and managed by SaskPower is based on coal, which creates a higher emissions level for Saskatoon than might be realized in other regions of Canada that have a different grid base (such as hydro power). The application of the backstop on the Saskatoon utility rate was reported to Council on March 25, 2019. The increased cost for SaskPower to provide energy to the community using its current energy mix (as a result of the output based pricing model) is estimated at $18 per year per household in 2019, with an expected $50 per year per household by 2021.

Table 6: "Estimated carbon price expense for the City of Saskatoon" shows the estimated gross cost increases to the City for its's own operations by fuel source. Based on the federal carbon levy referred to above of $20/tonne in 2019, $30/tonne in 2020, $40/tonne in 2021and $50/tonne in 2022. Consumption estimates and the potential increase in fuel prices from the carbon levy on fossil fuels is shown below. Total gross cost increases to the City are estimated to be $2.07 million by 2022 (on annual basis) under a BAP Scenario

Table 6: *Estimated carbon price expense for the City of Saskatoon*

Fuel Source	2019*	2020*	2021*	2022*
Gasoline	$ 92,095	$ 141,006	$ 191,631	$ 244,435
Diesel	$ 106,684	$ 159,832	$ 213,174	$ 266,516
Natural Gas	$ 523,727	$ 833,436	$ 1,178,425	$ 1,561,812
Total	**722,506**	**1,134,274**	**1,583,230**	**2,072,762**

**means marginal increase in fuel consumption estimated based on historical usage averages*

Based on an internal analysis of fuel consumption across the City's operations, approximately 35% of the fuel related expenses could be recovered through planned utility rate increases. The remaining 75% of carbon pricing expenses related to gas and diesel specifically can be reduced by reducing fleet emissions, for example, through a conversion to EVs route optimization, and rightsizing (i.e., making sure the right sized vehicle is used for the right activity, such as smart cars for commuting rather than half tonne trucks).

Return of Proceeds to the Province of Origin

One of the fundamental features of the carbon pricing mechanism is the intent of the Government of Canada to return all the revenues generated from the backstop to the province/territory of origin.[31] This is known as revenue recycling.

In Saskatchewan, 90% of the revenues generated from the regulatory charge on fuel is currently being returned to individuals and families through what Canada calls "Climate Action Incentive" payments. The Climate Action Incentive can be claimed on personal income tax returns annually starting in the 2018 income tax year. The remaining 10% (an estimated return of $445 million in fuel charge revenues over the next five fiscal years) will be dedicated to provide support for small to medium-sized businesses, not-for-profits, Indigenous communities, municipalities, universities, schools, and hospitals (summarized in Table 8 - "Estimated Annual Support for Saskatchewan Non-households").

Table 7: *Estimated Annual Support for Saskatchewan Non-households*

Estimated Annual Support for Saskatchewan Non-Households ($ Millions)						
	2019/20	**2020/21**	**2021/2022**	**2022/23**	**2023/24**	**Total**
Institutional* Support	15	25	30	40	40	150
Small & Medium Business Support	30	45	60	80	80	295
Total Support	**45**	**70**	**90**	**120**	**120**	**445**

**Institutional refers to municipalities, universities, schools, hospitals, indigenous communities and not-for-profit organizations*[12]

The Saskatchewan government is currently working on the details as to how this support will be provided to these organizations. This support could help the City reduce its potential cost implications from the implementation of the backstop's fuel levy and be reinvested into emissions reduction initiatives. Similarly, the proceeds from the OBPS that are paid by registered emitters are expected to be reinvested in the province or territory of origin. Further details on how this money is to be received have not yet been defined by the federal and provincial government.

31 The federal Goods and Services Tax (GST) or in some provinces the Harmonized Sales Tax (HST), will be applied to the fuel price after the carbon price backstop is levied. However, any increased revenues in the GST/HST resulting from the backstop are not applicable to this policy.

APPENDIX C

The Cost of Inaction

The benefits of investing in climate change mitigation are explored throughout the LEC Plan and include everything from direct financial returns, increased employment, improvements to health, and higher quality of life.

If no global action on climate change is not taken, and the climate is allowed to change, there will be numerous costs beyond the missed benefits already explored. These include increased insurance prices, increased emergency investment into infrastructure and adaptation costs, and increased healthcare costs and social supports for climate refugees or citizens displaced as a result of extreme weather events.

Insurance

As the state of our climate changes, and the types and frequency of extreme weather events increase, insurance companies are called upon to cover the cost of damaged property. In recent years, the Insurance Bureau of Canada has spent $1 Billion on claims related to extreme fires, flooding, and similar extreme weather annually.[32] Historically in the previous decade, claims related to extreme events were approximately $400 million annually, indicating the enhanced frequency of these events has already increased costs by an estimated $600 million or 40%.[30] As insurance companies spend more, the premiums for their services must keep pace–increasing the cost of doing business for all insurance purchasers.

Infrastructure

According to the 2016 Canadian Infrastructure Report card, "One-third of our municipal infrastructure is in fair, poor or very poor condition." Replacement costs for Canadian infrastructure that is in very poor and poor condition is estimated at $141 billion.[33] Over 56.8% of this infrastructure is municipally owned, meaning $80.1 billion of these costs fall to municipal governments. Further, these replacement costs assume a business as planned environment which allows municipalities to budget and plan ahead for maintenance, but as extreme weather events become more severe and more frequent, the ability to plan and fund these replacements deteriorates over time.

For example, the City of Calgary incurred $6 billion in property damage and financial loss as a result of flooding in 2013.[34] This can lead to a direct increase in debt and taxes to residents and businesses as infrastructure repairs or replacements are expedited, and due to an increased need for emergent funding for unexpected asset failure.

Health Care

Climate change poses a threat to human health in a variety of ways. Most notably, this is felt through extreme temperatures, decreased air quality, food insecurity, and an increase in the spread of diseases such as Lyme disease and West Nile.[35] These changes and activities affect public health in Canada through the following health issues:

- Increased cardiovascular illnesses such as strokes and heart attacks;
- Increased respiratory diseases and cancers due to poor air quality; and
- Skin damage and skin cancer due to overexposure to ultraviolet rays.

32 The costs of climate change are rising, Hodgson, N. (2018)
33 Canadian Infrastructure Report Card (2016)
34 The Flood of 2013, City of Calgary (2019)
35 Government of Canada (2018) Climate change and health: Health effects

Increased rates of diseases result in direct increased costs to the healthcare system. For example, patients admitted to hospitals with heart failure cost the Canadian Health Care system $482 million in 2013. By 2030, it is anticipated that the volume of patients with heart failure will increase by 33%, leading to $720 million in annual health care costs.[36] According to the Canadian Centre for Disease Control, the number of confirmed cases of Lyme disease have increased by 71% from 2009-2015.[37] This increase has resulted in the federal government spending $4 million on research into detection and treatment options related to Lyme disease.[38] These values only consider the cost to treat or care for patients and do not capture the wider financial implications to the economy for lost time off work as employees and business owners are in hospital, at appointments, recovering at home, or providing care to family members and dependents.

Social Supports & Climate Refugees

The impacts of climate change are inevitably linked to social inequities. A study by the United Nations (UN) drew these links by highlighting that the effects of climate change create a vicious cycle in which marginalized groups are more exposed to negative effects and are severely disadvantaged when it comes to coping or recovering from damage as a result of a changing climate.[39] These effects are not only damaging on a global scale but can be felt within Canada and Saskatchewan as well.

On a global perspective, many countries are impacted by rising sea levels, crop failure, and natural disasters. This has resulted in an influx of climate related immigration (also known as "climate refugees") to countries that are currently less impacted by climate change and/or have higher levels of resiliency planning underway, such as Canada and the US. The World Bank cites that by 2050, 143 Million people will be displaced as a result of climate change.[40] Similarly, the United Nations indicated that by 2050 between 200 Million to 1 Billion people will be displaced as a result of climate change and climate-related conflict.[41] Another estimate from the UN cites that, since 2009, someone is displaced due to disaster every second. This indicates that more social supports are needed from all levels of government, community organizations, institutions, and businesses to support our global community and to provide services for new Canadians and refugees (such as affordable housing, food, employment opportunities, and educational, cultural, and language programs).

Energy Poverty & Social Equity

Energy poverty occurs when a household has difficulty meeting energy needs. In 2013, most Canadians spent three per cent or less of their income on energy. When household expenditures for energy exceed 6%[42]-10%[43], these households are said to be living in energy poverty. In 2013, nearly 8% of Canadian households were experiencing energy poverty, based on their expenses for the energy used within the home. When gasoline expenses were included, the number of households in energy poverty more than doubled to almost 20% of Canadian households.[44] Additionally, energy poverty rates in Saskatchewan are among the highest in the nation: 28% (over 117,000) of Saskatchewan households are identified as experiencing energy poverty, which is above the Canadian mean.[45]

Energy poverty is regressive, as it disproportionately affects lower-income Canadian households. In 2013, 30% of households earning $27,000 or less, and almost 28% of households earning between $27,000 and $47,700, had to devote 10% or more of their expenditures to energy. That's a costly burden for many lower-income families.

36 Tran, D. T., Ohinmaa, A. (2016) The current and future financial burden of hospital admissions for heart failure in Canada: A cost analysis. CMAJ Open, 4(3)
37 Government of Canada, CCDR (2017) Lyme disease in Canada: 2009-2015
38 Harris, K. (2017) Federal government spends $4M to fight Lyme disease
39 Nazrul, S., Winkel, J. (2017) Climate Change and Social Inequality
40 Barron, L. (2018) 143 Million People Could Soon Be Displaced Because of Climate Change, World Bank Says
41 Turn and Face the Strange, The Brookfield Institute, 2019
42 A Guidebook on Equitable Clean Energy Program Design for Local Governments and Partners, USDN, 2018
43 Energy Costs and Canadian Households: How Much Are We Spending? The Fraser Institute, 2016
44 Energy Costs and Canadian Households: How Much Are We Spending? The Fraser Institute, 2016
45 Canadian Urban Sustainability Network, Local Energy Access Program, 2019

Correspondingly, historical trends showcase an unequal divide when it comes to low and medium income (LMI) household's ability to access and benefit from clean energy technologies.[46] Therefore, policies and initiatives need to be inclusive of LMI households in order to promote clean and healthy energy access for all populations within the Saskatoon Community.

Canadian energy prices included in the consumer price index (CPI) grew by 103% between 1994 and 2013, while the prices of the rest of the CPI basket grew by 39% over the same period. Meanwhile, nominal disposable income per person grew by 87%, considerably slower than the increase in energy prices. While energy efficiency gains have been realized in new homes and cars, increasingly, energy costs are a more significant proportion of household spend because price increases are outstripping these efficiency gains.

46 A Guidebook on Equitable Clean Energy Program Design for Local Governments and Partners, USDN, 2018

APPENDIX D

Modelling Methodology & Assumptions

Business as Planned

The Business as Planned (BAP) BAP scenario assumes that no additional policies, actions or strategies will be implemented by 2050 beyond those that are currently underway. SSG and whatIf? Technologies used the CityInsight model to project Saskatoon's energy use and GHG emission production from a baseline year of 2016 (data informed) through to the year 2050 (modelled).

Two steps were taken to develop and quantify the BAP:

- Data collection: A data request was compiled and data collected from various sources. Assumptions were identified to supplement any gaps in observed data. A data, methods, and assumptions manual was provided to the City to ensure transparency of data and assumptions used.
- Model calibration and baseline: The model was custom built for the Saskatoon context and incorporates data for population, population assignment to dwellings, jobs assignment to buildings, a surface model of buildings, transportation, waste, industry, and land-use. An energy and GHG emissions inventory baseline year is established (2016) and at each modelling stage the model is calibrated against observed data.

Population and demographic information is presented in 5-year increments from 2016 to 2051 for consistency with census years. For ease of reporting, energy and GHG emissions data for 2050 and 2051 are often considered equal in this report.

CityInSight uses the GPC Protocol Framework, an international standard for greenhouse gas emissions accounting.

This report uses a GPC BASIC inventory approach, which includes GHG inventories and modelling of the following elements:

- Residential buildings;
- Commercial and institutional buildings and facilities;
- Manufacturing industries and construction;
- Energy industries;
- Fugitive emissions from oil and natural gas systems;
- On-road transportation;
- Solid waste disposal; and
- Wastewater treatment.

Modelling Assumptions

BAP scenario modelling accounts for population and demographics trends and estimates, and uses energy and GHG emissions related information from local, provincial, and federal governments to inform modelling assumptions.

Table 8: *Central BAP assumptions*

	2016				2051				Units
Population	272,403				573,612				people
Residential building area per person	35.53				38.98				m2/person
Annual vehicle kilometres travelled (int. and ext. trips)	2,126,045,485				5,993,678,606				km
Transportation mode split*	v	t	w	b	v	t	w	b	%
Internal trips	83	6	8	3	71	8	13	8	v = vehicle
External outbound trips	100	-	-	-	100	-	-	-	t = transit
External inbound trips	100	-	-	-	100	-	-	-	w = walking b = bicycling
Electric vehicle uptake rate	5% of personal vehicles are EVs by 2050.								%/year
Electricity emissions factor	CO2: 621 CH4: 0.0435 N2O: 0.0156				CO2: 248 CH4: 0.05 N2O: 0.01				g/kWh
Average building efficiency	Follows the National Energy Code of Canada for Buildings (2017)								%/year
Fuels GHG intensity	CO2e		CH4		N20				
Gasoline	49.87		0.0010		0.0009				kg/GJ
Natural Gas	49								kgCO2e/GJ
Diesel	70.62		0.0035		0.0104				kg/GJ
Fuel Oil (light)	68.37		0.0007		0.0008				kg/GJ
Fuel Oil (Heavy)	74.74		0.0013		0.0015				kg/GJ

Detailed Assumptions for the BAP in their respective sectors is as follows:

	DATA/ASSUMPTION	SOURCE	SUMMARY OF APPROACH
DEMOGRAPHICS			
Population & employment			
Population & employment	total projected population = 500,000 by 2043 78,000 new jobs by 2041	mid-range projection from Growth Plan (Section 2.1.4) employment estimates from various sector plans	additional population will be allocated to neighborhoods according to various Sector Plans and Neighbourhood Concept Plans new employment will be allocated to employment sectors based on regional (CMA) shares in employment data projections from the Conference Board of Canada except for Riel in which all new employment will go to the industrial sector
BUILDINGS			
New buildings growth			
Building growth projections	122,778 dwelling units to be added by 2046 2,861 non-residential buildings to be added by 2051	Sector Plans Neighbourhood Concept Plans Input from Regional & Long Range Planning and Planning Project Services	new dwelling units will be allocated to dwelling types according to various Sector Plans, Neighbourhood Concept Plans, and input from Regional & Long Range Planning and Planning Project Services new non-residential floor space is based on additional jobs Growth plan estimates new growth will be 35% infill and 65% greenfield
New buildings energy performance			
Residential **Multi-residential** **Commercial & Institutional** **Industrial**	New builds to follow National Building Code / National Energy Code for Buildings (2017).	City (2018). Energy Requirements for Buildings. Retrieved from: https://www.saskatoon.ca/services-residents/building-renovations-permits/energy-requirements-buildings	
Existing buildings energy performance			
Residential **Multi-residential** **Commercial & Institutional**	Hold energy performance constant		Baseline efficiencies for each building type are derived in the model through calibration with observed data; for existing buildings, no improvements in efficiency are applied.
Energy performance contracting - building retrofits with equipment focus (LED lighting, toilets, boilers replacement etc)	New savings per year: 2018: electricity: 3,744,303 kwh NG: -188,484 m3 2019: elec: 1,848,284 kwh NG: 313,926 m3 2020: elec: 5,544,853 kwh NG: 941,779.8 m3 2021: elec: 8,317280 kwh NG: 1,412,670 m3	EPC Measures 2018 and EPC calculation email	

LED streetlight replacement (citywide)	all streetlights replaced by 2026 average savings of 74%	Economic Analysis Streetlight Replacement version 2.xlsx	
Industrial	Hold energy performance constant		
End use			
Space heating	Fuel shares for end use unchanged; held from 2016-2050.	Canadian Energy Systems Analysis Research. Canadian Energy System Simulator. http://www.cesarnet.ca/research/caness-model	Within the model, the starting point for fuel shares by end use is an Ontario average value for the given building type, which comes from CanESS. From there, the fuel shares are calibrated to track on observed natural gas and electricity use. Once calibrated, end use shares are held constant through the BAU.
Water heating			
Space cooling			
Projected climate impacts			
Heating & cooling degree days	HDD decrease and CDD increase to 2050	Climate Atlas of Canada, version 1 (4 April 2018), using BCSD climate model data. Retrieved from: https://climateatlas.ca/data/city/445/hdd_2060_85	Average HDD and CDD values across all models for Saskatoon in the RCP4.5 scenario is used
Grid electricity emissions			
Grid electricity emissions factor	2016: CO2: 621 g/kWh CH4: 0.0435 g/kWh N2O: 0.0156 g/kWh 2050: CO2: 248 g/kWh CH4: 0.05 g/kWh N2O: 0.01 g/kWh	2016 data from SaskPower 2050 data based on National Energy Board. (2016). Canada's Energy Future 2016. Government of Canada. Retrieved from https://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2016pt/nrgyftrs_rprt-2016-eng.pdf	Electricity generation input variables are sourced from CanESS and are set on the basis of a combination of NEB's Energy Future 2016 projected electricity generation capacity for Saskatchewan see "Grid emissions factors" tab for time series of values
ENERGY GENERATION			
Local energy generation			
Solar PV	Additional 30.66 kw in 2017	Sask Light and Power (2017). 2017 Annual Report	
Hydropower			
District Energy			
TRANSPORTATION			
Mode Shares	baseline mode share: transit: 4% mode share active: 12% mode share (bike: 4%; walk: 8%) vehicle: 82% mode share 2045 target mode share transit: 8% Bike: 8% walk: 16% vehicle: 68%	baseline: Active Transportation Plan p.21 (from Ipsos Reid Household Travel Survey 2013) 2045: Active transit Growth Plan p.34 (from Ipsos Reid Household Travel Survey 2013	Growth plan also includes work trips share (p.21 of active transit)
Electrify municipal fleet	no planned municipal fleet electrification		
Fleet GPS system installation. Will enable right sizing, route optimizations and fuel consumption reductions	1% reduction in fleet fuel use by 2021	Decision Matrix	

Transit			
Expansion of transit	Transit expansion to support 8% mode share increase by 2045	City, Plan for Growth	
Electric vehicle transit fleet	No planned transit electrification		
Active			
Cycling & walking infrastructure	Active transportation infrastructure expansion to support active mode share increase of 12% by 2045	Active Transportation Plan p.34 (from Ipsos Reid Household Travel Survey 2013)	
Private & commercial vehicles			
Vehicle kilometers travelled	No data from City or other. Derived by the model.		Vehicle kilometres travelled projections are driven by buildings projections. The number and location of dwellings and non-residential buildings over time in the BAU drive the total number of internal and external person trips. Person trips are converted to vehicle trips using the baseline vehicle occupancy. Vehicle kilometres travelled is calculated from vehicle trips using the baseline distances between zones and average external trip distances.
Vehicle fuel efficiencies	Vehicle fuel consumption rates reflect the implementation of the U.S. Corporate Average Fuel Economy (CAFE) Fuel Standard for Light-Duty Vehicles, and Phase 1 and Phase 2 of EPA HDV Fuel Standards for Medium- and Heavy-Duty Vehicles.	EPA. (2012). EPA and NHTSA set standards to reduce GHGs and improve fuel economy for model years 2017-2025 cars and light trucks. Retrieved from https://www3.epa.gov/otaq/climate/documents/420f12050.pdf http://www.nhtsa.gov/fuel-economy	Fuel efficiency standards are applied to all new vehicle stocks starting in 2016.
Vehicle share	Personal vehicle stock share changes between 2016-2050. Commerical vehicle stock unchanged 2016-2050.	CANSIM and Natural Resources Canada's Demand and Policy Analysis Division.	The total number of personal use and corporate vehicles is proportional to the projected number of households in the BAU.
Electric vehicles	No planned increase in electric vehicle stock		

WASTE			
Waste generation	Waste generation rate constant to baseline		
Waste diversion	Adjust rates to meet 70% waste diversion by 2023		
City Wide organics program for single unit dwellings	2020: 51% capture 2024: 52% capture 2029: 54% capture 2044: 63% capture	Unified waste utility steering committee. (Oct 27, 2018). Organics Processing RFP - Tonnage for Pricing Evaluation and Planning	
LT landfill strategy	2016: 21.8% waste diversion rate target = divert 70% of waste from the landfill by 2023.	City"Waste Diverted from Landfill." Retrieved from: https://www.saskatoon.ca/city-hall/our-performance/performance-dashboard/environmental-leadership/waste-diverted-landfill	
Waste treatment	Waste treatment is unchanged		
Wastewater	Wastewater treatment is unchanged		
INDUSTRY			
Industrial Process Energy			
Industrial efficiencies	Hold baseline efficiency rates held to baseline		
FINANCIAL			
Energy costs		Canada's Energy Futures 2016	

APPENDIX E

Engagement Summary

Engagement was completed to ensure that the LEC Plan (and subsequent initiatives) was shaped by the ideas, interests, expertise and realities of community members, businesses, non-profits, community organizations, institutions, and other key stakeholders.

Engagement opportunities were delivered to the broader community through public engagement in the form of focus groups, surveys, pop-up events, workshops, meetings, presentations and letter writing. These events involved approximately 1,700 participants and approximately 64 organizations or businesses. Engagement with 14 internal divisions and 40+ employees was also completed.

Environmental Awareness Survey

In 2017, the City hired Environics Research to conduct a survey to better understand environmental attitudes and behaviours, perceived barriers to taking environmental actions, and perceptions of the City's environmental performance of both Saskatoon residents[47] and the Industrial, Commercial and Institutional (ICI) sector[48].

A summary of results include:

- Almost six in ten residents believe that the science on climate change is conclusive, while three in ten believe in climate change but are not completely convinced that humans are causing it. Only one in ten believe the science around climate change is inconclusive. These perceptions about climate change are similar to those of other Canadians.
- One in three residents believe climate change is negatively affecting Saskatoon today, with younger and more environmentally-conscientious residents more likely to agree that this challenge is facing the City right now. More than half believe that it will do so in the future, with only one in ten believe that climate change will have no impact now or in the future.
- Three in ten of the businesses and organizations surveyed believed that climate change will significantly impact their operations, with larger businesses/organizations most likely to expect this. Primary concerns about climate change included higher costs for energy, insurance, and public services.
- Six in ten business/organization representatives say protecting the environment is a major issue, with this sentiment more likely to be shared by larger organizations.
- In terms of how climate change may impact them personally, residents are most concerned about how this issue will affect them financially. More than four in five say they are very or somewhat concerned about how climate change will affect the cost of food, energy, public services, and insurance. Health issues and the possibility of evacuations are the lowest-rated concerns among Saskatoon residents.
- 84% of residents totally agree or somewhat agree that more restrictions on industry are needed to stop pollution.
- 69% of residents totally agree or somewhat agree that the way we consume and live is leading to the complete destruction of the planet.
- 69% of residents totally disagree or somewhat disagree that the environment can recover on its own from problems caused by humans.
- 66% of residents totally disagree or somewhat disagree that growing the economy should take priority over protecting the environment.

The full results can be viewed on the City's Environmental Dashboard webpage:

www.saskatoon.ca/envirodashboard

47 A total of 817 residents completed the survey between June 28th and July 22nd, 2017. Quotas by area of Saskatoon (Suburban Development Area, or SDA), gender and age were applied to the sample, with minor statistical weighting by these variables to ensure the sample reflected the known characteristics of the City's population (based on StatsCan data). Because this was an online survey with a non-probability sample, no margin-of-error can be ascribed to these survey results. For the purposes of comparison, a margin-of-error with a probability sample of n=817 is +/- 3.4%, 19 times out of 20.

48 Environics conducted a telephone survey with representatives of ICI organizations operating in Saskatoon. This included businesses, not-for-profit organizations, and health and educational sector representatives. A total of 151 respondents were interviewed by telephone between June 29th and July 19th, 2017 (108 businesses, 31 non-profits, and 12 institutions). The margin of error for a sample size of n=151 is +/- 7.98%, 19 times out of 20.

Phase 1 – Public Engagement

This phase consisted of broad community engagement with the community as whole including residents, industrial, commercial, and institutional sectors and other stakeholders, with the goals to:

1. Get a sense of the community's readiness to take on and/or support specific mitigation initiatives.
2. Understand the community's expectations about the role of various groups and stakeholders in supporting and/or facilitating community-led action on climate change.
3. Use feedback from the community to identify and prioritize mitigation opportunities for the Plan.

Public engagement sessions and workshops were delivered from January to November 2018. Activities included:

Techniques	Results
Focus Groups x 2 - Businesses	7 participants (morning) 8 participants (afternoon)
Focus Group x 1 - Non-Profits and Community Organizations	8 organizations represented
Online Surveys x 3 - Residents - Business Leaders and Representatives - Non-Profit, Community Organization, and Institutional Leaders and Representatives	1197 responses (residents) 32 responses (businesses) 22 responses (non-profits, community orgs, institutions)
Pop Up Events x 5	31 participants + 16 who took materials (Market Mall) 80 participants + 38 who took materials (Field House) 14 participants + 1 who took materials (Freda Ahenakew library) 40 participants (Place Riel) 143 participants + 3 who took materials (Wintershines)
Workshop + Survey - Community Subject Matter Experts	99 workshop participants 76 survey responses
Relationship Building - Business Associations - Institutions - Other	Meetings with the: North Saskatoon Business Association, Downtown Business Group, and Chamber of Commerce Presentations to: the Energy Management Task Force; Innovation Place
Letter Writing	9 public letters submitted
NSBA Workshop	Workshop with NSBA members to review low emissions initiatives and communicate which ones will affect the ICI sector
Sustainability Division Workshop	Half day session for all employees in the sustainability division to comment on 270+ initiatives and provide feedback/add to list of items pursued
Presentation to SASF Teacher Group	Update on Low Emissions Plan to elementary school teachers involved in SASF program

In the 2018 climate change engagement survey, residents were asked: "How should our City invest in initiatives that slow down or prevent the negative impacts of climate change?"

- 50% of respondents said they support spending on initiatives that reduce greenhouse gas emissions, whether or not future financial savings can be expected.
- 11% of respondents said they do not support spending on initiatives that reduce greenhouse gas emissions.
- Other respondents said they support spending on initiatives that reduce greenhouse gas emissions, as long as investments:
    - Lead to community benefits, such as improved health, safety, and quality of life outcomes;
    - Demonstrate financial savings; or
    - Generate economic activity and employment opportunities in our community.

Phase 2 – Internal Engagement

Phase 2 Engagement was focused on internal communication and feedback on corporate-specific initiatives. It also included a workshop to develop a mission and vision for the LEC Plan. This phase took place from December-March 2019.

Overall, 14 divisions were engaged on specific initiatives that relate to the LEC Plan and have an impact on their business. These engagements consisted of formal meetings, phone calls and email streams (otherwise known as "interactions"). In total, there were 50+ interactions with other divisions. Over 45 staff members participated, including managers, directors and the administrative leadership team.

In addition to engaging with divisions on specific initiatives, two workshops were conducted in December 2018 with representatives from a variety of divisions in order to develop a mission and vision statement for the LEC Plan.

Phases 2 communications and marketing was limited to website updates.

Engagement Phase 3

Phase 3 engagement was focused on presenting specific initiatives and business plans to directly affected stakeholder groups in order to obtain feedback. Phase 3 included presentations on request to:

1. The Energy Management Task Force (community organization)
2. The Saskatoon & Region Home Builders' Association and members
3. Conference delegates at the Canadian Network for Environmental Education and Communication (EECOM) conference

Presentations to a variety of community groups continue on request and will be ongoing to demonstrate the city's efforts to reduce emissions after the plan is released.

Phases 3 communications and marketing was limited to website updates.

Future Engagement

Community engagement for specific climate change and sustainability initiatives will be ongoing at regular intervals throughout the next 5 years. For example, an environmental awareness survey will be conducted with the public which will include questions related to the LEC Plan

After 5 years, it is anticipated that climate mitigation work will be part of regular business planning at the City and that climate change programming will be more normalized. As such, public engagement may not be required as frequently and could be conducted every 4 years to align with the budgeting cycle.

APPENDIX E

Measuring Success

Measurement is a critical and challenging component of determining if a project was successful and if it should be expanded on, scaled up, re-designed, or not pursued any further. The TBL Decision Making Principles will be used for Reporting:

Principle: Environmental Health and Integrity

Indicators:

- Renewable Energy
- Conservation of Resources
- Climate Change Mitigation and Adaptation
- Green Buildings, Infrastructure and Land Use
- Sustainable Transportation
- Healthy Ecosystems
- Clean Air, Water, and Land
- Waste Reduction and Diversion
- Storm Water Management
- Sustainable Food System

Principle: Social Equity and Cultural Wellbeing

- Indicators:
- Equity and Opportunity
- Diversity, Accessibility, and Inclusion
- Heritage and Culture
- Self Sufficiency and Living with Dignity
- Health and Wellbeing
- Safety and Resiliency
- Public Participation
- Recreation

Principle: Economic Prosperity and Fiscal Responsibility

Indicators:

- Innovation and Technology
- Sustainable Procurement
- Fiscal Responsibility
- Support the Local Economy
- Asset Management
- Skills and Training
- Labour Rights and Employment
- Affordability

Principle: Good Governance

Indicators:

- Ethical and Democratic Governance
- Effective Service Delivery
- Education, Communication, Engagement and Capacity Building
- Monitoring, Reporting and Compliance
- Remain Agile and Adaptive
- Roles, Responsibilities and Rewards

The Triple Bottom Line outcomes of the LEC Plan actions will be tracked and reported on to City Council and through the City's SSS report, which focuses on Service, Savings, and Sustainability of City services and initiatives.

Annual GHG emissions reductions will also be reported on at a collective level through the City's GHG Inventory report, which will be presented annually each spring.

Each of the 40 actions includes a milestone or target to be met at different timelines. After a project is completed, the project results will be compared against the action specific targets.

Communicating Progress

The success or shortfalls related to the City's overall GHG reduction targets for both the community and the corporation will be communicated in the annual GHG Inventory report and on the City's website on the Environmental Dashboard.

If our short-term emissions targets are not on track to being reached, the Sustainability Division will report any shortfalls to City Council with a detailed summary of opportunities to reduce these emissions. This report will go out in 2022 (one year before the target date) and be updated post 2023. Over the long term, LEC Plan update reports are anticipated to be provided at 5-year intervals until 2050, which will help us track our progress towards achieving interim targets and actions.

Budget deliberations will also provide an opportunity to have meaningful conversations about investing in the LEC Plan. The investments required to stay on track to achieve the emissions reductions targets will be presented to council through operational and capital budget requests.

APPENDIX G

Glossary

Acronym	Term	Definition
AMI	Advanced Metering Infrastructure	An integrated system of smart meters, communications networks, and data management systems that enables two-way communication between utilities and customers.
CHP	Combined Heat & Power	A suite of technologies that can use a variety of fuels to generate electricity or power at the point of use, allowing the heat that would normally be lost in the power generation process to be recovered to provide needed heating and/or cooling.
CO_2e	Carbon Dioxide Equivalent	Provides a standard unit to indicated the global warming potential of greenhouse gases. Each gas (like methane or nitrous oxide) is converted to $C0_2e$, using accepted factors.
DE	District Energy	District energy systems produce hot water, steam or chilled water at a central plant and then distribute the energy through underground pipes to buildings connected to the system.
EV	Electric Vehicle	A vehicle which uses one or more electric motors for propulsion
GHG	Greenhouse Gas	A gas that absorbs and emits radiant energy within the thermal infrared range. Greenhouse gases cause the greenhouse effect. The primary greenhouse gases in Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide and ozone.
GRF	Green Revolving Fund	Is an internal capital pool that is dedicated to funding energy efficiency, renewable energy, and/or sustainability projects that generate cost savings.
ICI	Institutional, Commercial, Industrial	Buildings that are commercial in their usage and not used for residential purposes. For example: facilities comprised of the building of business and commercial facilities such as, medical buildings and hospitals, universities, correctional facilities, industrial and manufacturing facilities, professional office buildings, government office buildings, municipal buildings, hotels, etc.
LFG	Landfill Gas	Biogas generated from the capture of methane in a landfill.
LIC	Local Improvement Charge	A fixed annual charge levied against specific real property for a specific period by a municipality which amortizes the capital costs of local improvements such as sewers, paved roads, etc. This charge is in addition to real estate taxes.
PACE	Property Assessed Clean Energy	A means of financing energy efficiency upgrades or renewable energy installations of residential, commercial, and industrial property owners.
RNG	Renewable Natural Gas	A biogas which has been upgraded to a quality similar to fossil natural gas and having a methane concentration of 90% or greater. A biogas is a gaseous form of methane obtained from biomass.
Solar PV	Solar Photovoltaic	Solar Photovoltaic (PV) is a technology that converts sunlight (solar radiation) into direct current electricity by using semiconductors.
TBL	Triple Bottom Line	A decision making a framework that recommends that organizations commit to focus on social and environmental concerns just as they do on profits.
VNM	Virtual Net Metering	A bill crediting system for solar projects. If more power is generated than required by a solar site, bill credits are banked and tracked then paid out when power is used.
	Passive House	Passive house (German: Passivhaus) is a rigorous, voluntary standard for energy efficiency in a building, reducing its ecological footprint. It results in ultra-low energy buildings that require little energy for space heating or cooling.
	Person-year of employment	A full year of employment for one person. Sometimes referred to as an FTE (full time equivalent) in organizations. Example: a job that employs 1,000 people for 10 years = 10,000 person years of employment.
	Municipal Step Code	A building code regulation (either mandated or incentivized) that sets performance targets for new construction and groups them into "steps" that apply across various building types and regions.

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