APPENDIX 1

Building A Better Electric Utility:
An Asset Management Plan for Saskatoon Light & Power

City of Saskatoon

MARCH 2018

Saskatoon Light & Power

INTRODUCTION

In 2011, it was identified that a strategic change would need to be made to address Saskatoon Light & Power's (SL&P) aging infrastructure.

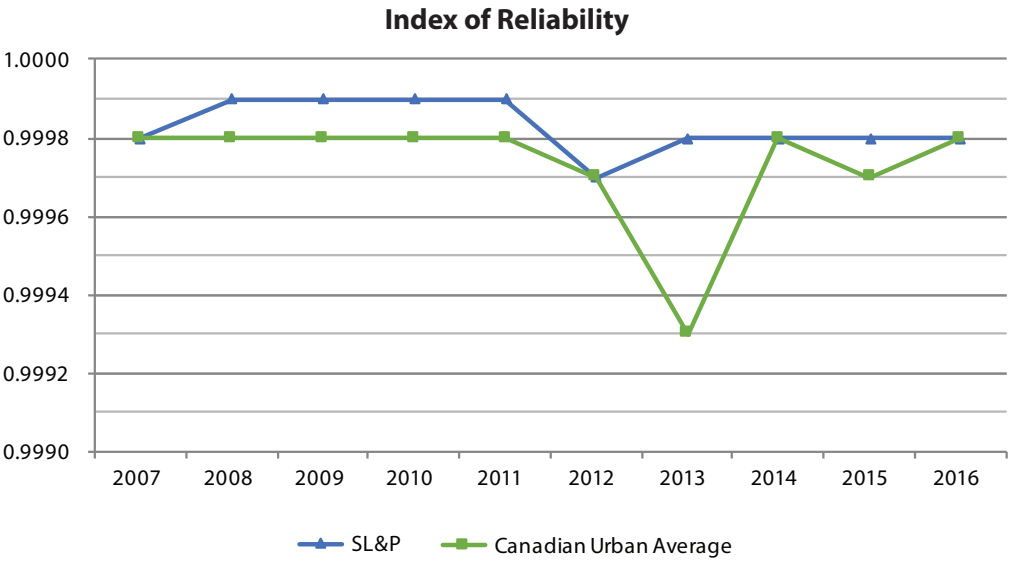
A consulting firm was hired and they produced a report in June 2012 providing an independent Capital Development Planning Study. The purpose of the report was to identify the long-term capital funding requirements necessary to achieve or exceed industry reliability standards while maximizing the return on these investments.

The consultant reported that SL&P would need to respond to concerns about their aging infrastructure and the demands being placed on that infrastructure from growth by significantly increasing their capital spending from previous levels.

SL&P has been able to increase its capital investment by $5.3 million over a six-year period (2013-2018) increasing the capital contribution from $10.8 million to $16.1 million. Although SL&P has made some progress, more attention is required in order to maintain SL&P's assets at an acceptable level now and into the future.

It is important to note that the consultant also observed that SL&P has been able to either meet or exceed reliability statistics in relation to comparable utilities across Canada, as shown in Table 1 below. The need to adjust capital provision funding levels is therefore aimed at maintaining the performance of the utility into the future.

Table 1 – SL&P Index of Reliability



CURRENT INVENTORY

The current inventory of SL&P assets is valued at over $702 million as detailed in Table 2 below:

Table 2 – SL&P Inventory Summary (in Millions of $)

Asset Class	Replacement Cost	% of Asset
Transmission	$19.20	3%
Substation	$202.40	29%
Overhead/Underground Distribution	$261.00	37%
Downtown Network System	$69.00	10%
Street Light System	$127.80	18%
Generation	$12.50	2%
Metering	$10.90	1%
Total	**$702.80**	

Transmission – Transmission assets include lines and equipment that deliver bulk power from SaskPower supply points to SL&P lines and substations.

Transmission Tower (Lattice Structure)

138 kV Transmission Entering Bulk Power Substation

Substations – The utility is served by 21 substations located in various areas of the city. Inside each substation are a number of transformers. These transformers are key assets owned by the utility.

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Overhead Distribution – Approximately 60% of the utility's distribution system consists of overhead lines (400 km) with the rest being buried underground.

The majority of the overhead system is supported using wooden poles, with the balance of the poles being made of steel.

Underground Distribution – The underground distribution system consists of 265 km of cable which was largely installed in the 1960's and 1970's.

Downtown Network System – SL&P operates a distribution network in the downtown area consisting of underground concrete vaults and duct banks. These vaults are large "rooms" built under the sidewalk to house transformers and place these systems underground and out-of-sight. There are 20 vaults and 50 transformers in the system.

Network Vault under Construction – Floor and Walls

Crews working on Overhead Distribution

Street Light System – SL&P operates 79.5% of the city's street light network (approximately 25,000 fixtures) with SaskPower operating the balance.

PHYSICAL CONDITION OF ASSETS

The condition of assets and how they are assessed varies with construction materials, components, operational environment, and specific external inputs. In general, components degrade with age and time in service. More demanding environments and overload events shorten the expected life of equipment. Ongoing maintenance can extend the life of the asset but is not always cost effective. The majority of the electrical assets need to be capable of surviving overload conditions and have excess capacity for contingency situations. The system as a whole is designed to take advantage of this capacity and so demands a high degree of confidence in the performance and condition of most assets. Also given the nature of electricity, consequences from asset failures can vary widely, from little to no effect to widely catastrophic. Table 3 as follows, provides a summary of general condition ratings and descriptions which have been applied to each asset category.

Table 3 – SL&P Structural Condition Rating Summary

Physical Condition	Description & Action
Very Good	Like new condition.
Good	Minor deficiencies noted, monitoring and minor maintenance required.
Fair	Signs of deterioration are evident. Some potential for failure, monitoring and planning for rehabilitation required.
Poor	Advanced deterioration and high potential for failure evident. Rehabilitation required.
Very Poor	Structure no longer capable of providing required reliability standards.

Below are examples of assets in various states of condition:

Transmission Tower Base in Good Condition

Transmission Tower Base in Poor Condition

Transmission tower structures have a special protective coating to inhibit rust. Damage or degradation of this coating allows rust to form, thus weakening the structure.

Substation Transformer Oil Leak (1st Ave)

Substation Transformer Oil Leak (College Park)

The mineral oil contained in a substation transformer is essential for electrical insulation and cooling. Over time leaks can develop into dangerously low oil levels, cause issues with auxiliary equipment, and be harmful to the environment.

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Dirt and Contamination Inside Switchgear

Switchgear Failure from Contamination

The build-up of dust, dirt, and other contaminants inside switchgear can compromise the integrity of insulating components, which can result in catastrophic failures.

Network Vault Roof in Good Condition

Network Vault Roof in Poor Condition

The roof structures in the downtown network vaults have removable sidewalk panels to permit installation and removal of large equipment. The steel components can rust over time, making removal of the panels difficult. If there is significant rust build-up, the concrete sidewalk panels can crack or break, collapsing on the equipment below.

Network Vault Grate in Good Condition

Network Vault Grate in Poor Condition

The downtown network vaults also have steel grates used for access to the vault and to provide cooling/venting for the equipment below. Over time these grates can rust, warp, and plug with debris. This can make access difficult, compromise the venting systems, and create tripping hazards on the sidewalk.

New Overhead Distribution Transformer

Leaking Overhead Distribution Transformer

Similar to substation power transformers, oil-filled distribution transformers can develop leaks with similar impacts on operation and the environment. While the units themselves are much smaller with fewer affected customers, there are more than 4,000 in service.

Wood Distribution Pole - New

Wood Distribution Pole - Good Condition

Wood Distribution Pole - Poor Condition

With approximately 13,000 wood distribution poles in service, condition varies widely. Poles can rot, crack, and weaken over time, and the degradation may not be visible (below the ground line or internal to the pole). Poles in poor condition are unsafe for workers to climb, and are more prone to failure from stresses due to wind or equipment loads and tensions.

Street Light Pole in Good Condition

Street Light Pole in Poor Condition

Street light poles are prone to rusting, but the condition is not always readily visible since the rust may start from the inside of the pole. Rusting may also occur behind decorative bases, inside shrouds or beneath mounting plates.

EXPENDITURE LEVELS

The Administration evaluates the condition of the City's assets in order to develop annual programs that will maintain the assets at the desired target condition for the least cost. Condition assessments are conducted to develop annual capital improvement plans.

The level of service for each type of asset is defined; however, as the level of service increases for the asset, so does the maintenance cost. In order to be able to compare the level of investment for all assets corporate-wide, five levels of expenditures are identified below. It should be noted that expenditure levels are not condition assessments, but lead to a change in the asset condition over time. "A" represents the highest level of expenditure and "F" represents no expenditure.

Table 4: Expenditure Levels

Expenditure Level	Asset Condition	Description
A	Getting Better Quickly	Sufficient expenditures to keep assets in the desired condition and to increase asset condition/value quickly over time.
B	Getting Better	Sufficient expenditures to keep assets in the desired condition and to increase asset condition/value slowly over time.
C	Maintain Assets in current condition	Sufficient expenditures to keep asset in constant condition over time.
D	Getting Worse	Insufficient expenditures to maintain asset condition. Over time asset condition will deteriorate.
F	Getting Worse Quickly	No expenditures. Asset condition/value decreased rapidly.

There are two questions that should be asked prior to proceeding with an asset management plan:

1. What is the desired asset condition level?

2. How quickly would City Council like to reach their desired asset condition level, and corresponding expenditure level?

Table 5 aligns the desired condition and expenditure level. The table also shows the required funding to meet a level "B" expenditure level and associated funding gap.

Table 5: Funding Gap 2018 (in Millions of $)

Asset	Physical Condition **Actual**	Physical Condition **Desired**	Desired Expenditure Level	Required Average 10-Year Funding
Transmission	0% Very Good 100% Good 0% Fair 0% Poor 0% Very Poor	61% Very Good 39% Good 0% Fair 0% Poor 0% Very Poor	Level B	2.19
Substations	0% Very Good 72% Good 28% Fair 0% Poor 0% Very Poor	0% Very Good 100% Good 0% Fair 0% Poor 0% Very Poor	Level B	5.5
Downtown Network	0% Very Good 30% Good 64% Fair 6% Poor 0% Very Poor	30% Very Good 70% Good 0% Fair 0% Poor 0% Very Poor	Level B	2.17
Distribution	0% Very Good 90% Good 0% Fair 10% Poor 0% Very Poor	100% Very Good 0% Good 0% Fair 0% Poor 0% Very Poor	Level B	6.47
Metering	80% Very Good 10% Good 0% Fair 10% Poor 0% Very Poor	100% Very Good 0% Good 0% Fair 0% Poor 0% Very Poor	Level B	0.59
Lighting	10% Very Good 47% Good 37% Fair 5% Poor 1% Very Poor	0% Very Good 78% Good 22% Fair 0% Poor 0% Very Poor	Level B	3.15
Generation	16% Very Good 84% Good 0% Fair 0% Poor 0% Very Poor	0% Very Good 100% Good 0% Fair 0% Poor 0% Very Poor	Level B	0.3
Other Projects	N/A	N/A		4.06
Total Funding Required				24.43
Less: External Funding				1.33
Sub Total				**23.1**
2018 Capital Contribution				16.1
Funding Gap				**7.0**

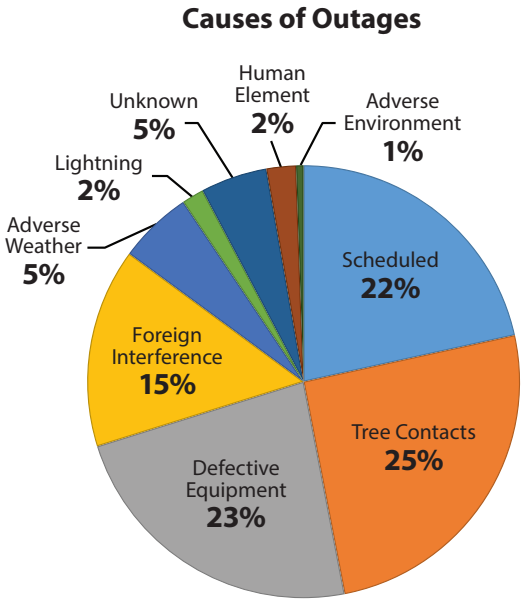
As outlined in this report, expenditure levels are below the desired levels, and this has led to a general decline in the overall condition of our assets. This needs to be addressed. As shown in Table 5 (page 9), the current funding for capital contribution is $7.0 million below the required annual funding based on the average 10-year capital plan to meet desired condition levels.

PRESERVATION PROGRAMS

When SL&P develops its capital budget each year, it takes into account the performance of the electrical grid over the past year and targets spending to prevent future power outages.

The four primary causes of power outages in 2016 were:

1. Trees contacting overhead power lines (25%);
2. Defective equipment (23%);
3. Scheduled outages for maintenance work (22%);
4. Interference by a third party such as damage from a vehicle collision, bird contacts with overhead power lines, contractor dig-ins with underground cables, etc. (15%).



A study was conducted in 2012 to review SL&P preventative maintenance (PM) practices for energy delivery equipment. The type, frequency and level of PM can have a significant impact on capital spending. For example, if PM declines over time, equipment deterioration and failures can accelerate. Enhanced maintenance is often a cost-effective alternative to capital replacements. Moreover, certain PM extends the life of critical assets.

Transmission

Most of SL&P's transmission lines are steel poles requiring little maintenance. The majority of these lines are located in areas where minimal tree trimming is needed; however, some lines are susceptible to damage from particularly large trees located outside of the right-

of-way. Tree trimming of both public and private trees is necessary, but even with adequate trimming there are still chances for uprooted trees or large branches to fall onto the lines and create power outages.

In 2005, SL&P performed a comprehensive electrical inspection of its entire transmission system. The inspection and analysis identified the susceptibility of certain equipment, particularly insulators, to corona-related deterioration. Three categories of deterioration were identified, and corona rings were installed on line insulators within the areas with the most severe readings. SL&P has performed two subsequent inspections and lines with moderate readings have been addressed to avoid insulator failure.

Substations

SL&P performs a monthly inspection of every substation, which includes the recording of equipment operations, observable problems, and any items requiring immediate resolution. Annual oil samples are taken from each power transformer and analyzed for indication of any internal degradation. SL&P also recently completed the final year of a three-year electrical testing program for all substation transformers. These tests indicate any immediate condition issues and establish a baseline for the future testing program. Some transformers also have some monitoring equipment that provide continuous online feedback on various parameters of operation.

Substation equipment typically requires periodic maintenance, particularly those with moving parts or large and expensive equipment where a loss of the device would result in major outages (such as transformers).

Substation Transformer

Substation Switchgear

Substation Control Cabinet

OVERHEAD LINE MAINTENANCE

Reliability statistics indicate that tree-related outages are one of the leading causes of power outages. This is a common concern for urban electrical utilities.

SL&P undertakes a significant annual tree trimming program. The utility works with the Parks division to trim City-owned trees interfering with street lights and power lines in front of properties. The utility also patrols rear lanes and trims trees away from the lines.

Work is also done regularly on overhead lines to upgrade feeders to meet increased demand. Infill development increases urban density and drives the need for additional electrical capacity. Whenever possible, these projects are scheduled to replace older lines that are weathered and needing to be replaced.

Wood Poles

There are a variety of ways in which poles are identified for replacement. Through large-scale voltage conversion projects or opportunities involving other companies requiring access to a pole, the pole may be replaced. Also when other types of work are being performed, a pole or series of poles may be identified for replacement. The long-term plan is to identify poles in critical locations and perform systematic inspections for these poles. A system-wide inspection may be performed once an asset management system is implemented.

Street Lights

SL&P does not have a complete database of street light pole condition, but has established an inspection program. About 1,400 poles are inspected annually, with areas of high traffic (pedestrian and vehicle) being targeted first. Issues with street lights are generally easier to detect, as corroded poles, deteriorated bases, and broken fixtures are more observable and do not require extensive tests. Street light maintenance mostly includes the replacement of bulbs or broken fixtures.

Cables and Padmount Equipment (Radial)

SL&P inspects padmount equipment annually for external wear, base deterioration, or obvious damage. SL&P has identified padmount transformers using live-front termination, proposing to replace these devices with dead-front terminations. Some cables have been injected with silicon to extend their service lives. Cable testing is very labour intensive and requires power interruptions (offline tests) in order to be effective. New methods are being developed that may allow for reliable testing of cable with less effort and no power interruption.

Secondary Networks

SL&P has established an annual inspection program that started with an extensive assessment of existing assets. Additionally, control devices are being upgraded to include on-line monitoring capability. Network transformers have also been added to the annual oil inspection program. SL&P has also installed primary protective devices that minimize the impact of faults, as these will be cleared rapidly.

POTENTIAL PLAN TO ADDRESS THE FUNDING GAP

There is currently a $7.0 million annual funding gap between the contribution to the capital reserves and the amount necessary to achieve the desired physical condition. In 2018, SL&P plans to contribute $16.1 million to capital reserves which in time will need to increase to $23.1 million (in 2018 dollars) as outlined in Table 5.

Due to the size of the gap, it is recognized that any potential plan to address this situation will need to be developed over a number of years. The goal would be to maintain a healthy Return on Investment (ROI) for the City while increasing investments into the capital reserve as electricity rates increase over time.

SaskPower sets electricity rates on a periodic basis. It has been the practice of SL&P to match those increases to provide rate consistency for all customers within the city's boundaries. Therefore, it is not practical to set higher or lower electricity rates than SaskPower's in order to adjust the amount of funding SL&P can provide to capital reserves.

A rate model has been developed to project the impact that various factors would have on both the ROI and capital provisions over time.

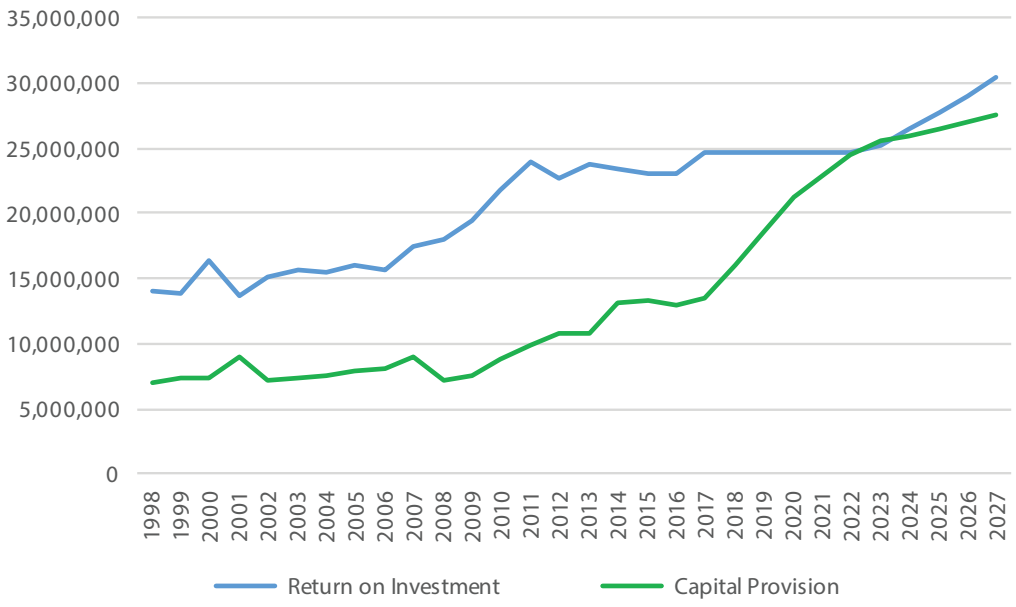
Key assumptions include:

- Electricity rates will increase 5% annually from 2018 to 2020 and then 3% thereafter;
- Bulk power charges from SaskPower will increase at the same rate;
- The target capital provision of $23.1 million (in 2018 dollars) will increase at a rate of 2% annually;
- ROI will remain constant until capital provisions meet the desired funding level and will then increase; and
- Grant-in-Lieu (GIL) will continue to grow annually based on rate increases.

The model shows that capital provisions will achieve the target goal by 2023 (six years). ROI will remain at the current level of $24.66 million from 2018 to 2022. Beginning in 2023, ROI will continue to grow. A new Capital Development Planning Study will be required at that time to project future capital spending requirements and an updated rate model will be developed to guide future ROI increases.

The following chart shows the total financial benefit achieved over the past 20 years and the resulting benefit over the next 10 years based on the potential plan for 2018 to 2027.

Return on Investment & Capital Provision
(20 Year History Plus 10 Year Projection)



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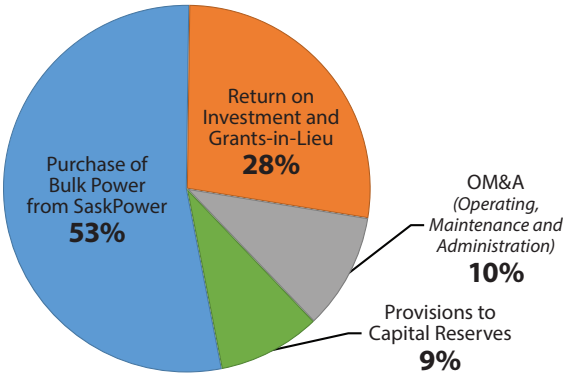
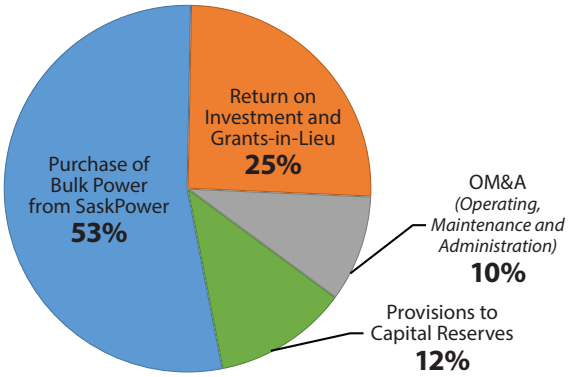
The end result of this plan would be to gradually adjust the percentage allocated in the four main categories of expenses in order to better balance investments in capital provisions with total financial benefit to the City. The following two pie charts show the allocation of funds based on current levels (2018) and the projected allocation (2022).

Summary of Expenses (2018)



Summary of Expenses (2022)



As part of this plan, the utility intends to reduce overall renewal costs and extend the life expectancy of assets. This will be accomplished through the implementation of an asset management system. Currently, asset data and maintenance history resides in separate systems and databases. As a result, it is difficult to query and analyze the data. As well, current work management and project reporting systems are not designed to easily capture and report the necessary data. By implementing an asset management system, the utility will be able to improve efficiency in the utility's maintenance efforts by targeting the maintenance on the most critical elements of the system.

The Asset & Financial Management department has a project budgeted in 2017-2021 to implement an Enterprise Resource Planning system, which includes implementing a corporate-wide Asset Management System.

CLIMATE ADAPTION STRATEGY

One of the key impacts for SL&P from climate change will be the potential for more frequent and severe storms. Strong winds combined with rain or snow create conditions for trees to bend and snap, sometimes falling onto overhead power lines and creating power outages. As these types of storms become more frequent, it will become increasingly important to trim trees away from power lines. Therefore, the potential funding plan has maintained operating budget funding at a level that will allow trees to be trimmed on a seven-year cycle.

Increased lightning strikes on the electrical grid is another significant concern. The utility has installed protection systems to reduce the impact of electrical surges on the utility's assets, but these protection systems will need to be replaced and upgraded in the future.

It is not practical to eliminate all future power outages from occurring, so SL&P has designed its grid to be resilient and have built-in redundancy in accordance with industry standards. For example, if a certain segment of the power grid is affected by a power outage, that segment can often be isolated and have power rerouted around the area to continue serving customers beyond the damaged area. New smart grid technology is being implemented to help identify the location of outages faster and reroute power more easily.

Climate change mitigation may also have an impact on our customers' reliance on electricity. It is expected that electric vehicles will become more popular in the near future as environmentally concerned customers move away from gasoline powered vehicles. This may increase demand on the power grid. Over time, it is likely that electric vehicles will have a significant share of the vehicle market.

Customers have also been investing in solar photovoltaic cells for their homes and businesses in recent years through the utility's Net Metering Program. While the total amount of electricity generated remains very small (0.04% of the annual electricity sold to customers), the number of connected customers generating their own power is doubling every two years. Distributed generation systems typically do not meet the full needs of the customer, so customers still rely on the utility for a portion of their power and for a backup supply when their system fails. The reduced amounts collected from these customers do not provide sufficient funding to maintain the extensive distribution system that is necessary to serve all customers. Therefore, SL&P will continue to explore solutions to this issue in collaboration with SaskPower.

The utility has also recently invested in sustainable electricity generating projects including the development of the Landfill Gas Power Generation Station and a Solar Power Demonstration project. Other projects under consideration include a hydropower project at the weir, a combined heat and power project at St. Paul's Hospital, and a utility-scale solar plant. Generating clean energy meets the corporate direction to reduce greenhouse gas emissions while providing benefits to our customers, the environment, and the City.

Visit **saskatoon.ca** for more information on the City's overarching Climate Adaptation Strategy, and Corporate Asset Management Plan.

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