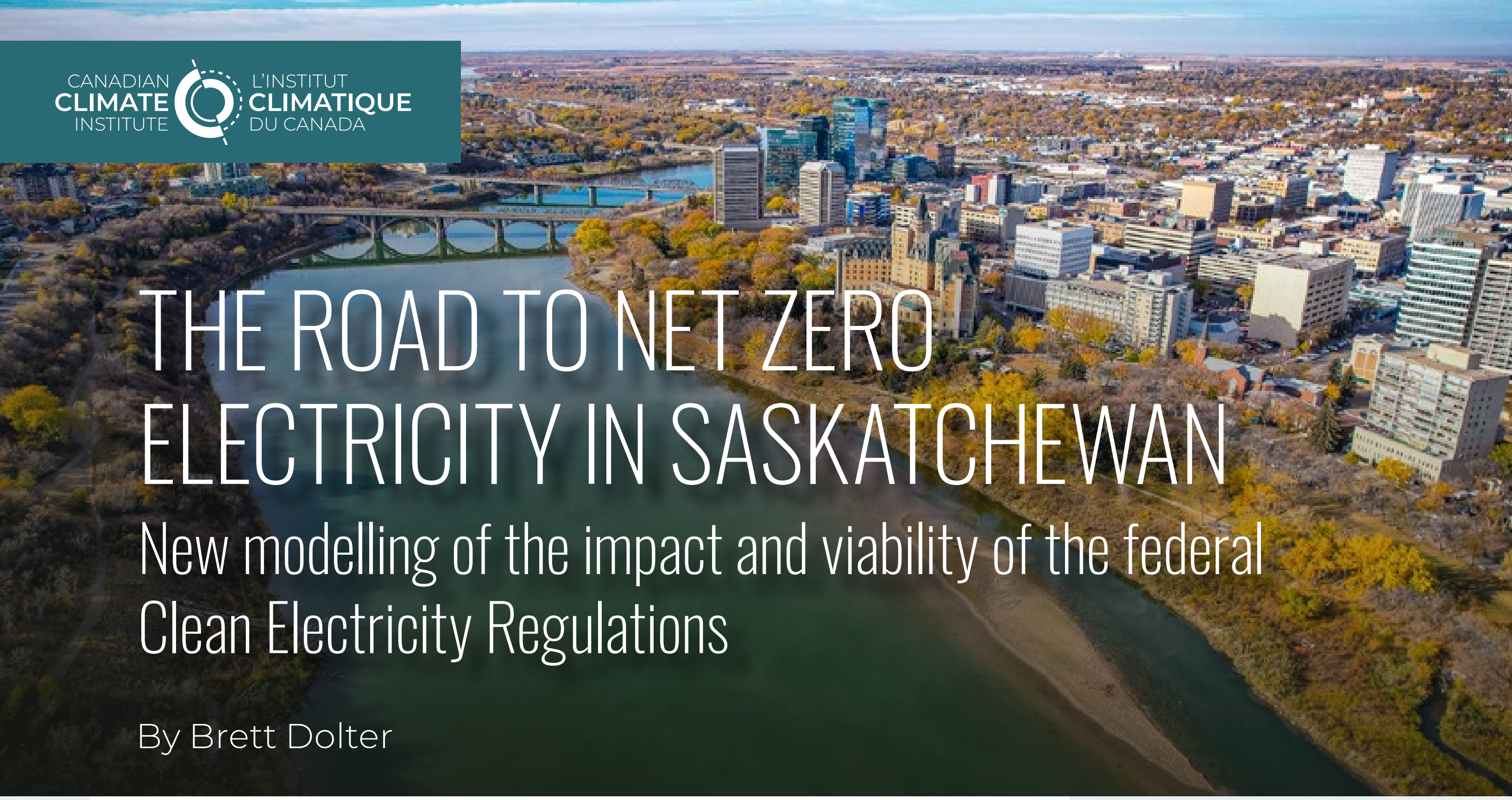

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THE ROAD TO NET ZERO ELECTRICITY IN SASKATCHEWAN

New modelling of the impact and viability of the federal Clean Electricity Regulations

By Brett Dolter

SUMMARY

Saskatchewan is working towards a net zero electricity system, with the electricity utility SaskPower expecting to achieve this goal by 2050 or sooner. The province has, however, expressed concern about the proposed federal Clean Electricity Regulations, which seek to accelerate net zero electricity across the country. This paper presents new modelling that shows the impact of adopting revised Clean Electricity Regulations that address the concerns of SaskPower. This analysis finds that revised Clean Electricity Regulations would change electricity rates only marginally as compared to rates under a baseline scenario.

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Acknowledgments

This work was supported by staff and researchers at the Energy Modelling Hub, including Jacob Monroe, Cristiano Fernandes, Mahdis Bayani, and Edouard Clement.

Expert reviewers

Tim Eckel, Energy Transition and Asset Management Senior Advisor

John Wright, Former President and CEO SaskPower

We have made efforts to respond to comments made by reviewers but all errors and omissions are the responsibility of the author. Review does not imply endorsement of the findings and recommendations in the paper.

September 2024

INTRODUCTION

Across Canada, in response to accelerating climate change, electricity utilities are working to reduce their pollution from the burning of coal and natural gas. The timing of when a given utility plans to reach net zero emissions varies, but most are planning to achieve it by 2050 or sooner.

In Saskatchewan, the publicly owned power utility SaskPower is responsible for electricity generation, transmission, and distribution throughout the province.[1] They write in their 2022–23 Annual Report, “our electricity system is on track to achieve net zero greenhouse gas emissions by 2050 or earlier” (SaskPower 2023a). As a Crown Corporation owned by the Province of Saskatchewan, SaskPower must align its plans with direction from the provincial cabinet and Crown Investments Corporation (CIC), which oversees all Crown Corporations in the province.

To meet its international climate commitments, the Canadian government has also promised to reach net zero emissions. It has recognized that widespread electrification powered by clean electricity will need to be the backbone of Canada’s energy transition. To achieve these goals, the Canadian government has introduced several policies aimed at accelerating the build-out of bigger, cleaner, smarter electricity grids across the country, including coal-fired regulations, industrial carbon pricing, and a Clean Electricity Investment Tax Credit.

In August 2023, the Canadian government introduced draft Clean Electricity Regulations (CER) that would require natural gas plants built after 2025 to meet a greenhouse gas emissions intensity standard as of 2035. The draft regulations also set limits on the operation of plants built before 2025 (Canada Gazette 2023). SaskPower and CIC responded to the proposed regulations with written feedback in November 2023 (SaskPower 2023b; CIC 2023). SaskPower and CIC’s position was that the utility cannot achieve compliance with the Clean Electricity Regulations as drafted.

In February 2024, Environment and Climate Change Canada (ECCC) shared a summary of feedback their proposed Clean Electricity Regulations had received. ECCC also proposed some changes to the regulations that added flexibilities to address stakeholders’ concerns (ECCC 2024). To date, there has been no analysis of how the suggested flexibilities might address or alleviate SaskPower’s concerns or how it might reduce electricity rate impacts.

In this analysis, I seek to fill this gap by assessing potential pathways for SaskPower to comply with the Clean Electricity Regulations, including with the additional flexibility measures proposed by ECCC

1 The exceptions are two distribution regions within Saskatoon (Saskatoon Light & Power) and Swift Current (Swift Current Light & Power).

in February 2024.[2] I then compare the cost of complying with the Clean Electricity Regulations to the cost of SaskPower's proposed greenhouse gas emissions reduction pathways.

This work is carried out in collaboration with the Energy Modelling Hub and makes use of the COPPER model (SESIT 2024). This capacity-growth model allows for electricity investment pathways to be modelled from 2025 to 2050. The model outputs include details of the capacity and generation mix, costs, and greenhouse gas emissions for each scenario.

I find that compliance with the Clean Electricity Regulations, designed with the flexibilities proposed by ECCC in February 2024, is achievable within the technical and logistic constraints SaskPower has outlined. Complying with the revised Clean Electricity Regulations is possible without jeopardizing electricity reliability. Compliance would require only modest residential electricity rate increases of 6–9 per cent by 2035 relative to the supply scenarios being contemplated by SaskPower, while reducing greenhouse gas emissions below what SaskPower's Supply Plan would achieve.

This is not to say that achieving the Clean Electricity Regulations is without cost or risk. The electricity options being considered in Saskatchewan include gas plants with carbon capture and storage, as well as small modular nuclear reactors. Both of these technologies are in the early stages of commercialization (Dion et al. 2021). Saskatchewan is also a high-cost electricity jurisdiction and has further to go to decarbonize its electricity grid than some other Canadian provinces (Canadian Electricity Advisory Council 2024). Complementary policies like the federal Investment Tax Credits will be important to support Saskatchewan's investments in clean electricity and keep rates affordable in the province.

> I find that compliance with the Clean Electricity Regulations . . . is achievable within the technical and logistic constraints SaskPower has outlined.

2 Because the final Clean Electricity Regulations have yet to be released, I use two scenarios to represent more flexible or more stringent modified regulations.

2 SASKATCHEWAN'S CLEAN ELECTRICITY PROGRESS TO DATE

Figure 1 below summarizes SaskPower's electricity generation mix from 1954 to 2023. Coal was the main source of electricity for most of SaskPower's history, but natural gas became the main source of electricity generation in 2019.

SaskPower built hydroelectric dams in the 1960s, 1970s, and 1980s, but the province has limited hydroelectric potential due to its flat geography. The province has some remaining hydroelectric potential on the Churchill River and Saskatchewan River. It also has the potential for small hydroelectric projects of less than 100 megawatts in locations in northern Saskatchewan. Saskatchewan will never be one of Canada's hydroelectric powerhouses, however.

Wind power was first developed in Saskatchewan in 2002, and by 2023–24 was generating 7.5 per cent of SaskPower's electricity. Solar photovoltaics currently play a minor role on the SaskPower grid, and provided only 0.26 per cent of electricity generation in 2023–24, or 71 gigawatt hours (SaskPower 2024a).

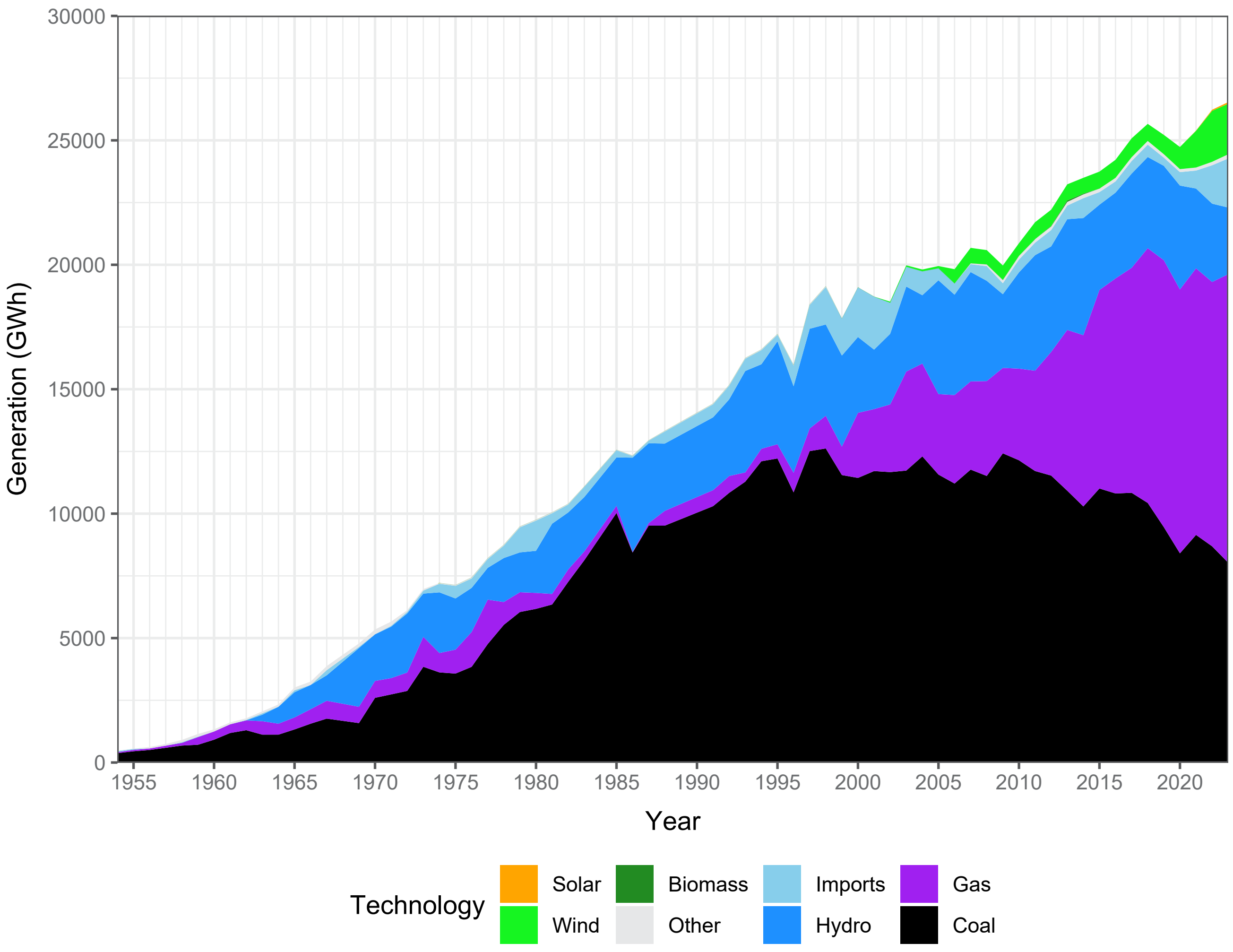
SaskPower pioneered the use of carbon capture and storage (CCS) in the Boundary Dam project. The 115-megawatt Boundary Dam Unit 3 facility is a coal-fired power plant equipped with carbon capture and storage, and it was commissioned in 2014.

SaskPower Boundary Dam GS, CC BY-SA 3.0

Figure 1:

SaskPower electricity generation history, 1954–2024

(Dolter 2015; SaskPower Annual Reports)[3]



3 SaskPower began reporting generation totals by fiscal year beginning in 2015–16. Totals from 2016 to 2023 are a weighted sum of totals from adjoining fiscal years. For example, the totals for 2016 give three-quarters weight to the 2016–17 totals and one-quarter weight to the 2015–16 totals.

The Gardiner Dam on the South Saskatchewan River.

3 SASKPOWER SUPPLY OPTIONS

SaskPower distinguishes between the supply options available to it before 2030 and those only available after 2030. Table 1 summarizes these available options.

Table 1:

SaskPower's available supply options

(SaskPower 2023c)

Before 2030	Additional after 2030
Natural gas	Saskatchewan hydro
Imports	Small modular nuclear reactors
Wind and solar	Natural gas with carbon capture
Biomass	Hydrogen
Geothermal	
Flare gas	
Distributed energy resources	
Battery energy storage	
Demand-side management	

According to SaskPower, new hydroelectric developments, small modular nuclear reactors, natural gas with carbon capture and storage, and hydrogen-fuelled turbines are technologies that will only be available after 2030. SaskPower's concerns with the draft Clean Electricity Regulations are partially rooted in the assumption that decarbonizing Saskatchewan's grid will only be possible with technologies that are not yet commercially available.

Because the regulations would not allow unabated natural gas to be built after 2025, SaskPower's options for non-emitting dispatchable capacity prior to 2030 would be limited to biomass, geothermal, grid-scale battery storage, distributed energy resources, certain types of demand-side management, and imports.

SaskPower is also in the planning stages for a new 370-megawatt combined-cycle natural gas plant that will be built near Lanigan, Saskatchewan (SaskPower 2024b). The utility has expressed concern that this plant would not comply with the Clean Electricity Regulations because it is not being built with carbon capture.

SaskPower is currently developing its future supply plan. As part of this process, SaskPower has carried out significant public engagement around the province (SaskPower 2023c). In public information sessions, SaskPower has provided four possible futures for Saskatchewan's electricity system (SaskPower 2023c).

All four scenarios include significant investment in wind and solar energy. SaskPower's Diverse Mix 2035 scenario would comply with the original draft of the Clean Electricity Regulations, but SaskPower deems it to be infeasible due to risk related to supply chain constraints and the lack of commercial availability of technologies like combined- cycle gas plants with carbon capture and small modular nuclear reactors before 2030–2035. SaskPower states that realizing this scenario "leaves no room for error." SaskPower has not yet commented publicly on the feasibility of complying with revised Clean Electricity Regulations that provide additional flexibilities.

The other three scenarios would achieve close to net zero electricity in Saskatchewan by 2050. The Diverse Mix 2050 scenario would include imports of electricity from Manitoba Hydro and the Southwest Power Pool (a regional transmission organization operating to the province's south and east), natural gas combined-cycle plants with carbon capture, and investment in small modular nuclear reactors, along with an expansion of wind and solar energy. The Renewables 2035 scenario includes slightly more wind and solar investment, substantially more imports, and would not include investment in small modular nuclear reactors. The Low Imports 2035 scenario reduces the amount of imports coming from Manitoba Hydro and the Southwest Power Pool relative to the Diverse Mix 2050 and Renewables 2035 scenarios, and does so through greater investment in small modular nuclear reactors.

The required investment from 2024–2050 for all four scenarios is similar, ranging from $53 billion in the Diverse Mix 2050 scenario to $57 billion in the Low Imports 2035 and Renewables 2035 scenario, and $56 billion in the Diverse Mix 2035 scenario. The timing of the investments differs, however, and capital costs would be incurred sooner in the Diverse Mix 2035 scenario to comply with the original draft of the Clean Electricity Regulations (SaskPower 2023c).

4 THE SASKATCHEWAN ELECTRICITY SECTOR'S GENERATION MIX AND POLICY LANDSCAPE

SaskPower is subject to coal-fired power regulations and an output-based carbon pricing system for large emitters. In 2012, the Conservative federal government passed coal-fired regulations that required coal plants to be phased out 50 years after commissioning (Canada Gazette 2012). Saskatchewan has three coal-fired power stations that must follow these rules: Boundary Dam at Estevan, Shand at Estevan, and Poplar River at Coronach.

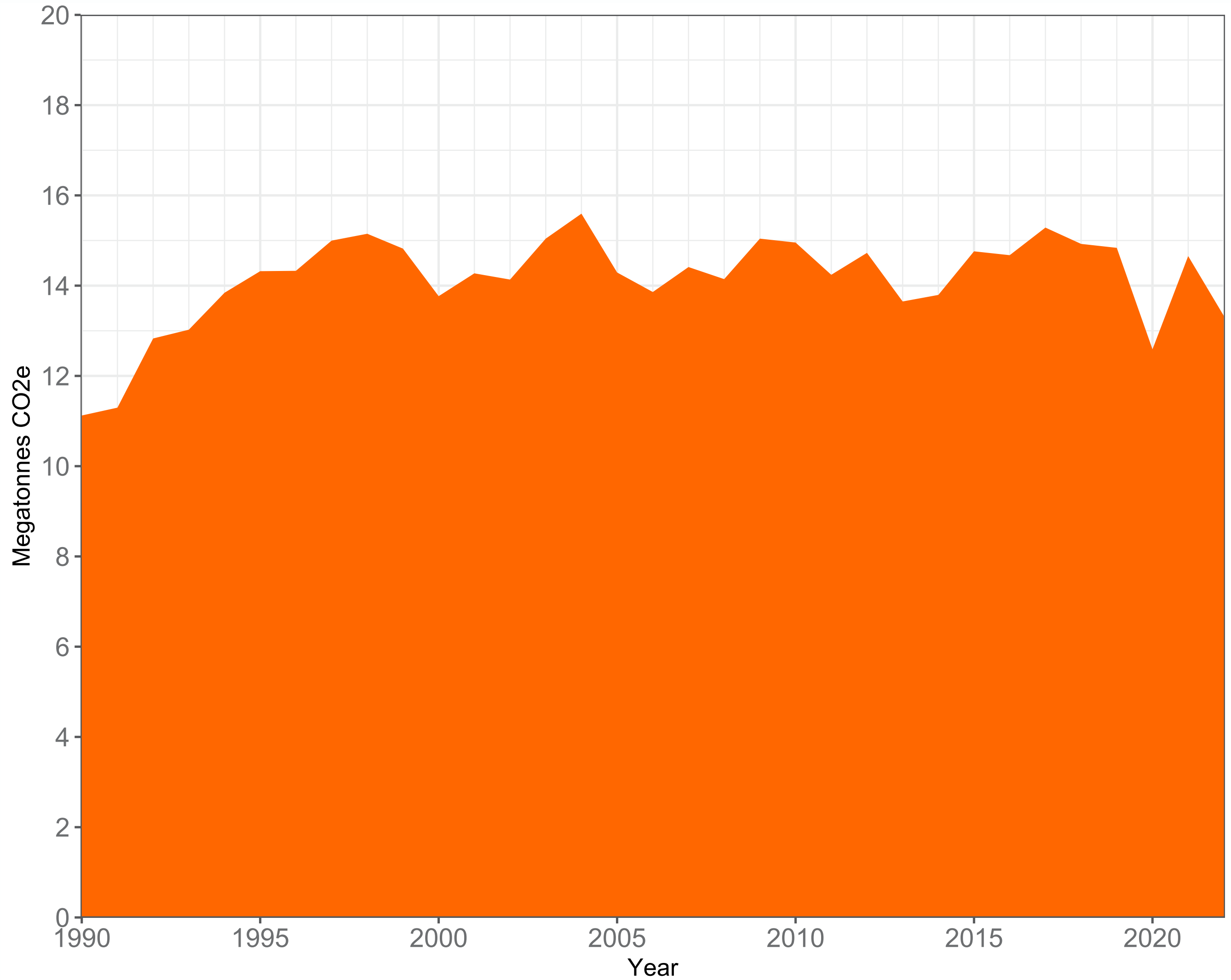
In 2018, the Liberal federal government changed the coal-fired rule to require that coal-fired power plants retire by 2030, or 50 years after they started working, whichever was sooner (Canada Gazette 2018). The 2018 update to the regulation only affected the 276-megawatt Shand coal-fired power plant. It must now retire by the year 2030 rather than 2042, when it would have reached 50 years of life.

The Saskatchewan and Canadian governments signed an equivalency agreement in 2020, allowing SaskPower to run some of its coal-fired power plants longer than would otherwise be allowed under the coal-fired regulation, in exchange for commitments to meet greenhouse gas emissions reduction and non-emitting generation targets (Government of Canada and Government of Saskatchewan 2020). Under this agreement, the Saskatchewan electricity sector must not release more than 175 megatonnes (million tonnes) of carbon dioxide equivalent "for the period January 1, 2018, to December 31, 2029," and interim targets are set for years before 2030 (Government of Canada and Government of Saskatchewan 2020).

SaskPower is on track to comply with the Equivalency Agreement. Over the period 2018–2022, greenhouse gas emissions from the Saskatchewan electricity sector were 70.3 megatonnes of carbon dioxide equivalent for an average of just over 14 megatonnes per year (ECCC 2024, see Figure 2), and SaskPower reports that an additional 13.6 megatonnes of carbon dioxide equivalent were released in 2023 (SaskPower 2024a). This means that over six years, SaskPower has emitted 90.8 megatonnes of carbon dioxide equivalent, which is 52 per cent of the 175 megatonnes allowable in the twelve years from 2018 to 2029. As long as its annual emissions remain below 14 megatonnes of carbon dioxide equivalent per year, on average, for the rest of the decade, SaskPower will be in compliance.

Figure 2:

Saskatchewan electricity sector greenhouse gas emissions, 1990–2022 (ECCC 2024)—figure by Brett Dolter



As part of the equivalency agreement, Saskatchewan also committed "to have at least 40 per cent of the province's electricity capacity be from non-emitting energy sources by 2030" (Government of Canada and Government of Saskatchewan 2020). The 40 per cent threshold is a minimum, with SaskPower aiming to achieve 40–50 per cent non-emitting capacity by the end of 2030. According to its 2022–23 annual report, "SaskPower's total renewable generation capacity as [of] March 31, 2023, was 1,888 megawatts (MW), or 34.7 per cent, of our company's total available generating capacity of 5,437 MW" (SaskPower 2023a). These totals include a 191-megawatt import agreement from Manitoba Hydro, as well as generation from flare gas and landfill gas. SaskPower's progress toward its 2030 renewable capacity goal is laudable and demonstrates the utility's capacity for building out clean energy.

Table 2 summarizes the generation capacity available on the Saskatchewan electricity system. The hydro category includes the Manitoba Hydro import agreement.

Table 2:

SaskPower generation capacity mix in megawatts

(SaskPower 2023a; 2024a)

Available generating capacity (net MW)	2023–24	2022–23	2021–22	2020–21	2019–20	2018–19
Gas	2,065	2,160	2,160	2,160	2,172	1,839
Coal	1,389	1,389	1,389	1,530	1,530	1,530
Hydro	1,155	1,154	989	989	889	889
Wind	617	617	626	241	241	241
Solar	95	83	54	39	34	4
Other	34	34	28	28	27	28
Total	5,355	5,437	5,246	4,987	4,893	4,531

SaskPower also pays carbon pricing charges for emissions from its coal-fired plants and natural gas plants. Effective January 1, 2023, the electricity sector is regulated by the Saskatchewan output-based performance standards program. In this system, SaskPower must meet an emissions intensity target for each facility. This intensity varies by plant type (gas or coal) and year. SaskPower must then pay a carbon price for any emissions above the emissions intensity standard (Canada Gazette 2020). All carbon pricing revenues from the electricity sector are sent to the Province of Saskatchewan's General Revenue Fund. In the 2024–25 budget, the Saskatchewan government estimated that carbon pricing revenues from the electricity sector would total $326.3 million from January 1, 2023, to March 31, 2024, and another $280.9 million in the 2024–25 fiscal year (Government of Saskatchewan 2024). The province plans to use these funds to lower the cost of installing small modular nuclear reactors and renewable energy sources like wind and solar (Salloum 2024).

Two new federal policies will also affect Saskatchewan's electricity sector: the Clean Electricity Investment Tax Credit and, as discussed, the forthcoming Clean Electricity Regulations. The Clean Electricity Investment Tax Credit is still being finalized, but is expected to offer a 15–30 per cent tax credit for most types of non-emitting generation. It may also have conditions attached to its uptake by Crown utilities—conditions that are still being decided.

3 SASKPOWER AND CIC CONCERNS WITH THE ORIGINAL DRAFT OF THE CLEAN ELECTRICITY REGULATIONS

SaskPower (2023) and CIC (2023)'s main concerns with the Clean Electricity Regulations are summarized in Table 3, along with related responses from ECCC outlined in their 'What We Heard' public engagement summary (ECCC 2024). If ECCC implements the proposed changes in the final Clean Electricity Regulations, it could address many of these concerns.

Table 3:

Key concerns from SaskPower and CIC, and ECCC response

Clean Electricity Regulations' design criteria in the original draft	SaskPower/CIC concern	ECCC response
Performance intensity standard is set at 30 tonnes CO_2eq/GWh.	No gas plants with CCS have met the proposed performance standard of 30–40 tonnes CO_2eq/GWh.	Considering "slightly" increasing the performance standard used to calculate emissions limits.
Prescribed life: the performance standard applies at the "End of Prescribed Life" (EoPL) which is deemed to be 20 years after commissioning.	A prescribed life of 20 years will lead to early retirement of gas plants.	Considering extending the "End of Prescribed Life" to be "slightly" higher than 20 years.
Performance-intensity regulation applies to all units commissioned after January 1, 2025.	Planning has been underway for the Aspen natural gas plant near Lanigan, and it does not include carbon capture and storage (CCS). Aspen will not be commissioned before January 1, 2025.	Considering treating a gas plant that is substantially underway but not commissioned by January 1, 2025, to be treated equivalent to a unit that is commissioned by January 1, 2025.
Peaker facilities that operate for 450 hours per year or less do not need to meet the performance intensity standard.	The 450-hour operating limit for conventional gas plants is too short and could have the unintended consequence of keeping a greater number of old, inefficient gas plants running.	Considering changing to a pooled emissions limit that allows a responsible party to combine emissions limits of individual existing units to create a pooled emissions limit for a fleet.
The performance standards apply to any facility that is a net exporter to the grid. As drafted, this would include natural gas cogeneration plants.	Cogeneration will be deterred, leading to less efficient use of natural gas for industrial heating.	Considering distinguishing treatment of emissions associated with "behind the fence" generation from generation exported to the grid.
Emergency provision: the Minister of Environment can provide an exemption to allow a plant to operate outside of the performance standard in emergency circumstances.	Requiring federal ministerial authorization for emergency exemptions can create legal liability and hurt the reliability of the grid by delaying grid response.	Considering an exemption period for emergencies, within which utilities can operate outside annual emissions limits without federal ministerial approval.

Clean Electricity Regulations' design criteria in the original draft	SaskPower/CIC concern	ECCC response
The performance intensity standard must be met by January 1st, 2035.	Non-emitting baseload technologies are not available in Saskatchewan before 2034.	No response
N/A	Saskatchewan's electricity rates will go up, putting the province at a competitive disadvantage relative to other jurisdictions with lower-cost electricity (e.g. hydro-abundant provinces)	No response
N/A	The timeline of meeting the CER will increase pressure on the supply chain.	No response

Gas plants commissioned before January 1, 2025, must meet the Clean Electricity Regulations' emissions performance targets at the end of their prescribed life. ECCC has indicated a willingness to make the regulations more flexible by increasing the prescribed end-of-life of gas plants beyond 20 years. Extending the prescribed life would allow extant gas capacity to operate longer before meeting the regulation by retiring, scaling down operations, or being equipped with carbon capture and storage. This would help address SaskPower's concern that the regulations will lead to early retirement of power plants.

ECCC is considering allowing plants in the planning and development stages to be treated equivalent to a unit commissioned by January 1, 2025. This is relevant to SaskPower's planned 370-megawatt Aspen gas plant near Lanigan, Saskatchewan. Construction on the Aspen plant began in April 2024, but the plant won't be commissioned before January 1, 2025. Allowing this plant to be treated equivalent to a unit commissioned by January 1, 2025, would mean Aspen would not need to meet an emissions intensity target until it reaches the "prescribed end of life" period of 20 years or more after January 1, 2025. This recognizes SaskPower's point that planning new generation assets takes substantial lead time, and incorporating carbon capture into the planned Aspen facility is not possible before commissioning. SaskPower could add carbon capture to the Aspen power plant in the future to make the plant compliant with the regulations.

A bigger revision to the Clean Electricity Regulations is proposed to address concerns about the technical feasibility of meeting an intensity standard of 30–40 tonnes of carbon dioxide equivalent per gigawatt-hour (CO_2eq/GWh) and the unintended consequence of having unit-level emissions constraints. SaskPower and others (for example, Electricity Canada) have argued that a performance target of 30–40 tonnes of CO_2eq/GWh is not technically feasible for a gas plant with carbon capture and storage. As well, SaskPower argued that setting emissions caps unit by unit would result in inefficient use of its gas plants; instead of retiring old, inefficient units, it would keep them operating so they could qualify for the 450-hour operating limit for peaking plants. ECCC plans to address both of these concerns by moving to a pooled emissions limit. A performance target will be set at a level of 30 tonnes of CO_2eq/GWh or higher, and an allowable emissions limit will be calculated for the entire fleet of gas plants owned by a utility like SaskPower. This pooled target gives SaskPower the flexibility to run its newest plants efficiently, while retaining older plants for infrequent and less-efficient back-up usage.

If ECCC moves to a pooled emissions limit, they would also remove the provisions for peaker plants. In the draft Clean Electricity Regulations, peaker plants could operate at emissions intensities higher than the standard as long as they operated for 450 hours or less per year. Under the revised regulations, these plants would instead operate within the emissions cap. One unintended consequence of this revision is the possibility that utilities will delay retirement of old gas plants to boost the size of their pooled emissions cap. ECCC will need to consider supplemental policy to avoid that outcome.

ECCC has also expressed a willingness to explore flexibility for cogeneration units. This is relevant for plants like the Cory cogeneration facility, which is linked to a Nutrien potash site. Steam from the Cory gas plant is used in the mining of potash, which makes more efficient use of the natural gas burned at the facility. It is not clear if the proposed revisions will be enough to avoid deterring Saskatchewan's cogeneration facilities from exporting power to the grid.

Lastly, the draft Clean Electricity Regulations required utilities to seek approval from a federal Minister in order to exceed annual emissions limits in the case of an emergency or a threat to power reliability. The proposed revisions would let grid operators go over annual emissions limits for a short period of time before requiring ministerial approval. This reduces the risk of outages, but may not extinguish calls for less federal oversight of the power system.

If ECCC were to implement all of the above changes, three unresolved concerns would remain.

First, SaskPower is concerned that 2035 is too soon for the regulations to come into effect. As noted above, SaskPower does not think small nuclear reactors will be able to be built before that date, and has indicated that only one gas plant equipped with carbon capture could likely be built before 2035. Small nuclear reactors and gas plants fitted with carbon capture are both considered "wild-card" technologies, not yet commercially viable and still facing significant technical and financial hurdles (Dion et al. 2021). ECCC has not proposed extending the compliance date beyond 2035.

Second, SaskPower and CIC are concerned that the Clean Electricity Regulations will unduly increase electricity rates. Saskatchewan's electricity rates, like other provinces relying mostly on thermal electricity such as Alberta and Nova Scotia, are high relative to hydroelectric provinces like Quebec, British

Jordie Braun (https://commons.wikimedia.org/wiki/File:Centennial_Wind_Power_Facility_Sunrise.jpg), https://creativecommons.org/licenses/by-sa/4.0/legalcode

Columbia, Manitoba, and Newfoundland and Labrador. A residential household using 1,000 kilowatt-hours of electricity in a month faced a bill of $178.94 in Regina, Saskatchewan, in 2023, while a household in Winnipeg, Manitoba, faced an electricity bill of only $102.44 for the same amount of electricity (Hydro Quebec 2023). Saskatchewan is concerned that further electricity rate increases will act as a disincentive for industry to locate in the province and create inequity across Canada.

To assess the economic impact of the Clean Electricity Regulations, the Saskatchewan government convened an Economic Impact Assessment Tribunal (EIAT 2024). The EIAT hired climate change policy research firm Navius to compare a portfolio of federal climate policies against a portfolio of policies they called the Saskatchewan Affordable Power Plan. The Saskatchewan Affordable Power Plan policy package includes cancelling the Clean Electricity Regulations, freezing carbon pricing at $65 per tonne, exempting electricity from carbon pricing, extending the life of coal plants past the federal phase-out date of 2030, and receiving generous federal funding for electricity projects in Saskatchewan: 75 per cent of the cost of small nuclear reactors and 50 per cent of the cost of renewables like wind and solar. Each of these policy changes would have to be made by the federal government; none, in spite of the plan's name, are within the power of the provincial government to enact.

Isolating the impact of the Clean Electricity Regulations, Navius found that it would increase residential electricity prices by 1.3 cents/kwh by 2035 relative to the list of policies the panel chose for comparison. This is higher than the 0.9 cents/kwh residential rate impact the Clean Electricity Regulations would create in Saskatchewan by 2040, as estimated in the Regulatory Impact Analysis Statement released as part of the draft Clean Electricity Regulations (Canada Gazette 2023). It is, however, a far cry from the Province of Saskatchewan's claim in November 2023 that electricity rates would double by 2035 as a consequence of the Clean Electricity Regulations and coal-fired electricity regulations (Government of Saskatchewan 2023).[4]


A solar array installation at Cowessess First Nation. © Stephen Hall

4 SaskPower estimates that families, communities, businesses and industries will see electricity rates more than double by 2035 to cover the costs associated with the Clean Electricity Regulations and federal coal regulations. The federal net zero power system plan is expected to cost Saskatchewan about $40 billion from now until 2035" (Government of Saskatchewan 2023).

Also notable is that Navius was comissioned by Saskatchewan's Economic Impact Assessment Tribunal to model the Draft Regulations as proposed in August 2023, rather than include the additional flexibilities ECCC had indicated they are considering (Dolter 2024). The modelling in this paper, on the contrary, looks at two potential revised versions of the Clean Electricity Regulations, to understand the rate impacts and whether they differ from the impact of the original regulations as variously estimated by Navius and ECCC.

The third concern that remains unanswered in Table 3 is the concern that demand for higher investments in electricity generation would stress supply chains and could encounter labour shortages. Saskatchewan is small relative to the global electricity sector, so demand from our province is inconsequential from a supply-chain perspective. Any equipment shortages experienced in Saskatchewan are indicative of larger supply-chain issues that are present throughout the North American electricity sector (APPA 2024; US DoE 2023).

These shortages arose during the Covid-19 pandemic and impacted production of crucial components such as distribution transformers. It remains an open question whether investment in electricity pathways that comply with revised Clean Electricity Regulations would require a significantly greater supply of materials than pathways that do not comply. There may, however, be a role for the federal government to boost Canadian manufacturing of crucial components for the electricity sector in the same manner they have supported investments in the electric vehicle value chain.

Finding enough workers to build and operate new electricity generation, transmission, and storage facilities may indeed be a challenge, but this is also not a challenge that is unique to Saskatchewan. Electricity Human Resources Canada (EHRC) estimates that there will be between 17,000 and 28,000 job openings in the Canadian electricity sector between 2023 and 2028 (EHRC 2023). To ensure these job openings are filled, the EHRC recommends actions such as providing more flexible work arrangements to retain employees reaching retirement age, creating a targeted immigration stream to attract newcomers with skills relevant to the electricity sector, and increasing recognition of foreign credentials (EHRC 2023). Collaboration across provincial and federal governments could help to ensure qualified labour is available for any and all electricity pathways being contemplated in Saskatchewan and across Canada.

6 NEW MODELLING OF THE CLEAN ELECTRICITY REGULATIONS' IMPACTS ON SASKATCHEWAN

The debate over the Clean Electricity Regulations has, to date, focused on the draft regulations released in August 2023. However, ECCC has expressed a willingness to revise those regulations to respond to concerns made by utilities like SaskPower. In this report, I evaluate the impact of revised Clean Electricity Regulations that incorporate the flexibilities proposed by ECCC. This is the first analysis of its kind. It differs from the work Navius conducted for the Saskatchewan Economic Assessment Tribunal, which still focused on the original August 2023 draft of the Clean Electricity Regulations.

To understand the cost and rate implications of revised Clean Electricity Regulations, I've worked with the Energy Modelling Hub to model three scenarios for Saskatchewan's electricity future: a baseline scenario based on SaskPower's public engagement presentations, a flexible version of the Clean Electricity Regulations, and a more stringent version of the Clean Electricity Regulations. Each of these scenarios is modelled using a customized version of the COPPER model (Arjmand and McPherson 2022).

COPPER models electricity generation in Canada and is divided into 13 regions (SESIT 2024). COPPER can be used to estimate the costs of competing electricity sector investment pathways under different policy assumptions. The version of the model I use is constructed to co-optimize across Saskatchewan and Manitoba to allow electricity trade between these provinces.[5] This Saskatchewan/Manitoba COPPER model selects investments in electricity generation, transmission, and storage in five-year time-steps beginning in 2025. It also selects hourly dispatch for available technologies so as to reliably meet demand for 26 different kinds of representative days in each time-step, and accounts for the temporal and spatial variability of wind and solar output. Cost assumptions used in the modelling are summarized in Appendix A.

The upshot is that the revised Clean Electricity Regulations appear feasible in Saskatchewan, and they change electricity rates only marginally as compared to rates under a baseline scenario.

"The revised Clean Electricity Regulations appear feasible in Saskatchewan, and they change electricity rates only marginally as compared to rates under a baseline scenario.

5 The COPPER model does not allow endogenous electricity trade with the United States, and so the future potential for trade within the Southwest Power Pool is not represented in these scenarios.

Baseline scenario

In the baseline scenario, SaskPower builds out its capacity in a manner consistent with the scenarios presented in its 2023 public engagement sessions. SaskPower's modelling generally assumes that no unabated natural gas plants are built after 2030. In this baseline scenario, SaskPower brings online its first 315-megawatt small modular nuclear reactor in 2035. This scenario assumes increasing viability for gas plants equipped with carbon capture and storage, such that SaskPower can build one 350-megawatt plant in the 2030 time-step and more afterwards.

In SaskPower's supply scenarios, annual greenhouse gas emissions decline by more than 50 per cent relative to 2005 by 2030, when all unabated coal-fired power plants retire, and then emissions continue to decrease, reaching between 10,000 and 300,000 tonnes of CO_2 eq per year by 2050. I model SaskPower's least stringent greenhouse gas emissions outcome of 300,000 tonnes/year to avoid unduly increasing the cost of the baseline scenario and skewing the comparison. Natural gas combined-cycle plants in this baseline scenario operate with a 30-year life expectancy. In line with SaskPower's supply plans, I constrain new combined-cycle gas plants to be limited to 370 megawatts in 2025, 500 megawatts in 2030, and then zero megawatts after that. New, simple-cycle gas is constrained to 100 megawatts in 2025 and zero megawatts in all periods afterwards.

Flexible Clean Electricity Regulations

In this policy scenario, I assume that ECCC implements the proposed changes to the Clean Electricity Regulations spelled out in their 'What We Heard' document and sets key policy criteria at lenient and flexible levels (ECCC 2024). These changes include:

- Allowing capacity and greenhouse gas emissions from natural gas plants to be pooled when calculating allowable emissions;
- Setting the allowable emissions cap at 50 tonnes CO_2eq/GWh for all gas plants built after 2025;
- Allowing a 25-year life expectancy for existing gas plants built before 2025;
- Allowing construction of the Aspen unabated natural gas combined cycle power plant to proceed because it is already in the planning stages, and requiring it to comply with the regulations' intensity standard or retire by 2050.

Stringent Clean Electricity Regulations

In this policy scenario, I assume that ECCC implements the proposed changes to the Clean Electricity Regulations spelled out in their 'What We Heard' document and sets key policy criteria at more stringent levels (ECCC 2024). These changes include:

- Allowing capacity and greenhouse gas emissions from natural gas plants to be pooled when calculating allowable emissions;
- Setting the allowable emissions cap using an intensity of 35 tonnes of CO_2eq/GWh for all gas plants built after 2025;

- Allowing a 20-year life expectancy for existing gas plants built before 2025;
- Allowing construction of the Aspen natural gas combined-cycle power plant to proceed because it is already in the planning stages, and requiring it to comply with the intensity standard or retire by 2045.

Settings common to all scenarios

All of the scenarios have the following common constraints, which are summarized by time-step in Table 4. These settings align all of the scenarios with the constraints SaskPower has outlined in their supply planning communications. For example, SaskPower believes it can develop one 350-megawatt gas plant with carbon capture between 2030 and 2035, and that an initial 315-megawatt small modular nuclear reactor could be built and operational by 2035.

- Wind and solar capacity maximum limits: Wind and solar are constrained to reflect SaskPower's generally cautious pace with developing renewables. The allowable capacity increases in each 5-year time-step of the model.
- Solar minimum capacity limits: SaskPower has outlined plans for investing in expansion of solar. All scenarios assume solar expands to at least 800 megawatts by 2035 and at a minimum expands by 25 megawatts in future time-steps.
- Gas-with-carbon-capture constraints: No gas with carbon capture before 2030. Limit gas with carbon capture expansion to 350 megawatts in the 2030 time-step. No limits on gas with carbon capture for the 2035 time-step and afterwards.
- Small nuclear reactor maximum capacity limits: No reactors before 2035. Limit nuclear capacity to 315 megawatts in 2035. No upper limits for 2040 time-step and afterwards.
- Small nuclear reactor minimum capacity limits: Reflecting SaskPower's 'Diverse Mix 2050' scenario plan for building out small nuclear reactors between 2035 and 2050, the model requires a minimum of one 315-megawatt reactor to be built in each time-step beginning in 2035 and continuing to 2050.

Table 4:

Constraints common to all scenarios

Constraints	2025	2030	2035	2040	2045	2050
Solar maximum capacity (MW)	100	800	900	900	900	900
Wind maximum capacity (MW)	800	1,800	2,800	3,200	4,000	4,100
Solar minimum capacity (MW)	100	400	800	825	850	875
Gas-with-carbon-capture maximum capacity (MW)	0	350	Unlimited	Unlimited	Unlimited	Unlimited
Small nuclear maximum capacity (MW)	0	0	320	Unlimited	Unlimited	Unlimited
Small nuclear minimum capacity (MW)	0	0	315	630	945	1,260

These common scenario settings ensure greater comparability between scenarios, and greater concordance with SaskPower's supply plans.

7 MODELLING RESULTS

In this section, I present the COPPER modelling results, beginning with a description of electricity capacity and generation in each of the three scenarios: a “SaskPower Supply Plan” scenario that is consistent with SaskPower’s potential supply plans; a “Flexible Clean Electricity Regulations” scenario with the regulations set at the more lenient values being considered by ECCC; and a “Strict Clean Electricity Regulations” scenario with the regulations set at the more demanding values being considered by ECCC. I then outline the greenhouse gas emissions and emissions intensity that result from these scenarios.

Following this, I outline the capital investment costs required for each scenario, along with their timing. I then provide estimates of the impact of revised Clean Electricity Regulations on the average cost of generation for SaskPower and resulting residential rates. In general, I find that the Clean Electricity Regulations as revised would lead to much greater greenhouse gas emissions reductions, at a modest increase for residential rates of 6 to 9 percent in 2035.

Electricity capacity mix

The results of the modelling are summarized in the figures below. Figure 3 shows the capacity mix in megawatts by scenario (see Appendix B for a table summarizing the data in the figure). Common to all scenarios is a rapid expansion of wind energy, which aligns with SaskPower’s internal plans to achieve up to 50 per cent renewable capacity by 2030. Wind is selected in the model due to its competitive levelized cost.

The biggest differences between the scenarios lie in the combined-cycle natural gas units (“CC Gas” and “CC Gas Backup”). In the CER scenarios, some of the combined-cycle natural gas plants fall under the Clean Electricity Regulations and must meet the regulated, pooled emissions targets. This natural gas capacity is shown in a lighter shade of pink/purple (“CC Gas Backup”). As gas plants reach their “prescribed end of life” according to the regulations, their capacity can shift from unregulated (“CC Gas” shown in purple) to regulated (“CC Gas Backup” shown in lighter pink/purple). Without the Clean Electricity Regulations, SaskPower could operate its natural gas capacity without restriction until the economic end of life of these plants, which we model as being 30 years.

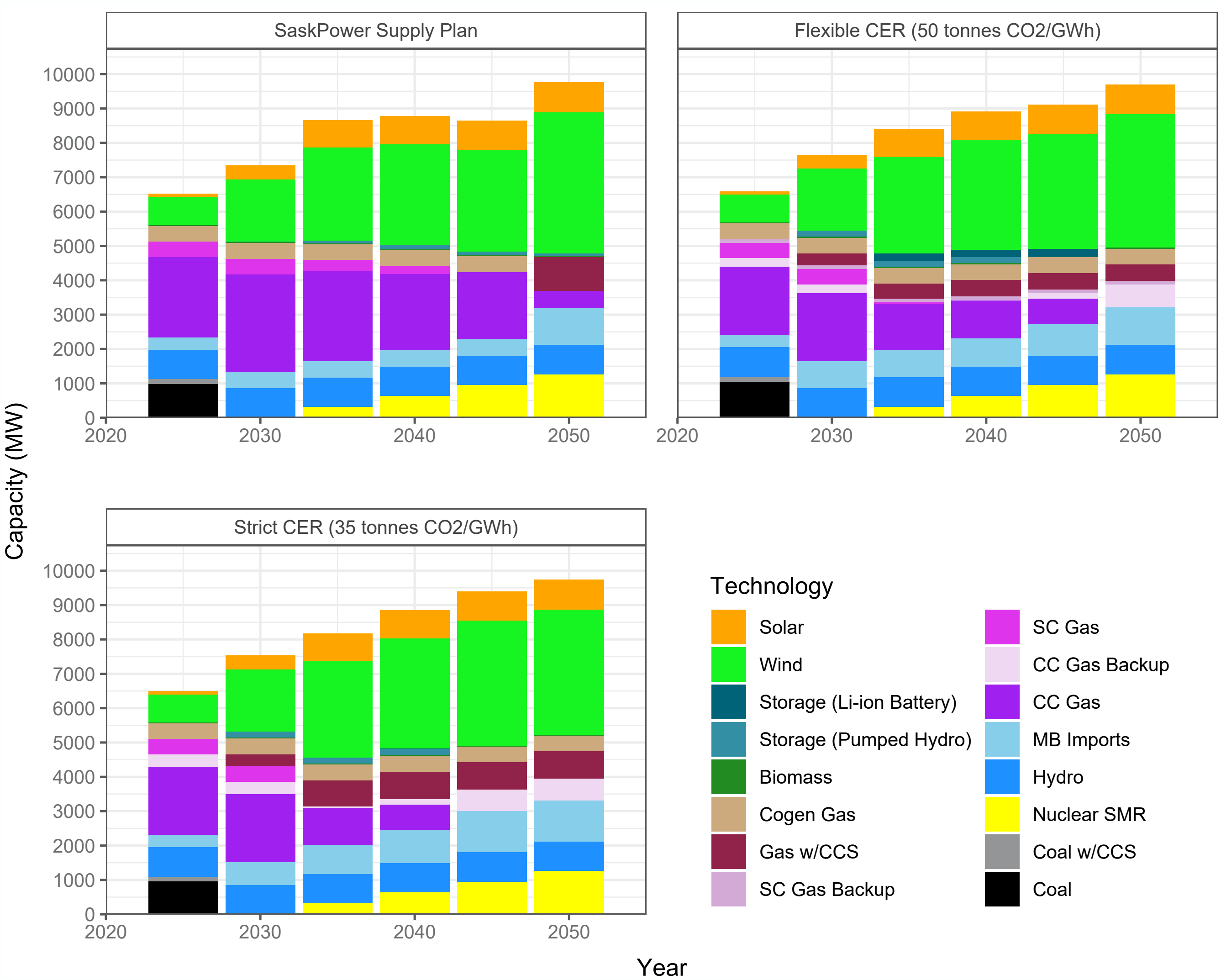
The “SaskPower Supply Plan” scenario includes only unregulated combined-cycle gas plants (“CC Gas” in purple) because this scenario assumes no Clean Electricity Regulations. In the SaskPower supply plan scenario, a 370-megawatt plant is built in the 2025 time-step and a 500-megawatt combined-cycle plant is built in the 2030 time-step. In the CER scenarios, 370 megawatts of natural gas plants are built in the 2025 time-step, and these are treated as regulated plants that must adhere to the pooled emissions caps in 2035. This means, in practice, that the SaskPower Supply Plan assumes the 2025 Aspen power plant is built and operates unregulated, while the CER scenarios assume the 2025 Aspen power plant is built and operates as a regulated plant beginning in 2035.

The Clean Electricity Regulations scenarios also include combined-cycle gas plants with carbon capture and storage (Gas w/CCS) beginning in 2035. The SaskPower Supply Plan only sees the first gas plant built with carbon capture coming online in 2050. In the 2050 time-step, the SaskPower Supply Plan must meet a greenhouse gas emissions target of 300,000 tonnes of CO_2 equivalent, which requires the construction of gas capacity with carbon capture.

Nuclear capacity is the same across all three scenarios, increasing by 315 megawatts in every time-step beginning in 2035. Additional nuclear capacity is not selected in any of the scenarios, due to the high cost of small modular nuclear reactors (SMR).

Figure 3:

Saskatchewan electricity capacity mix by scenario



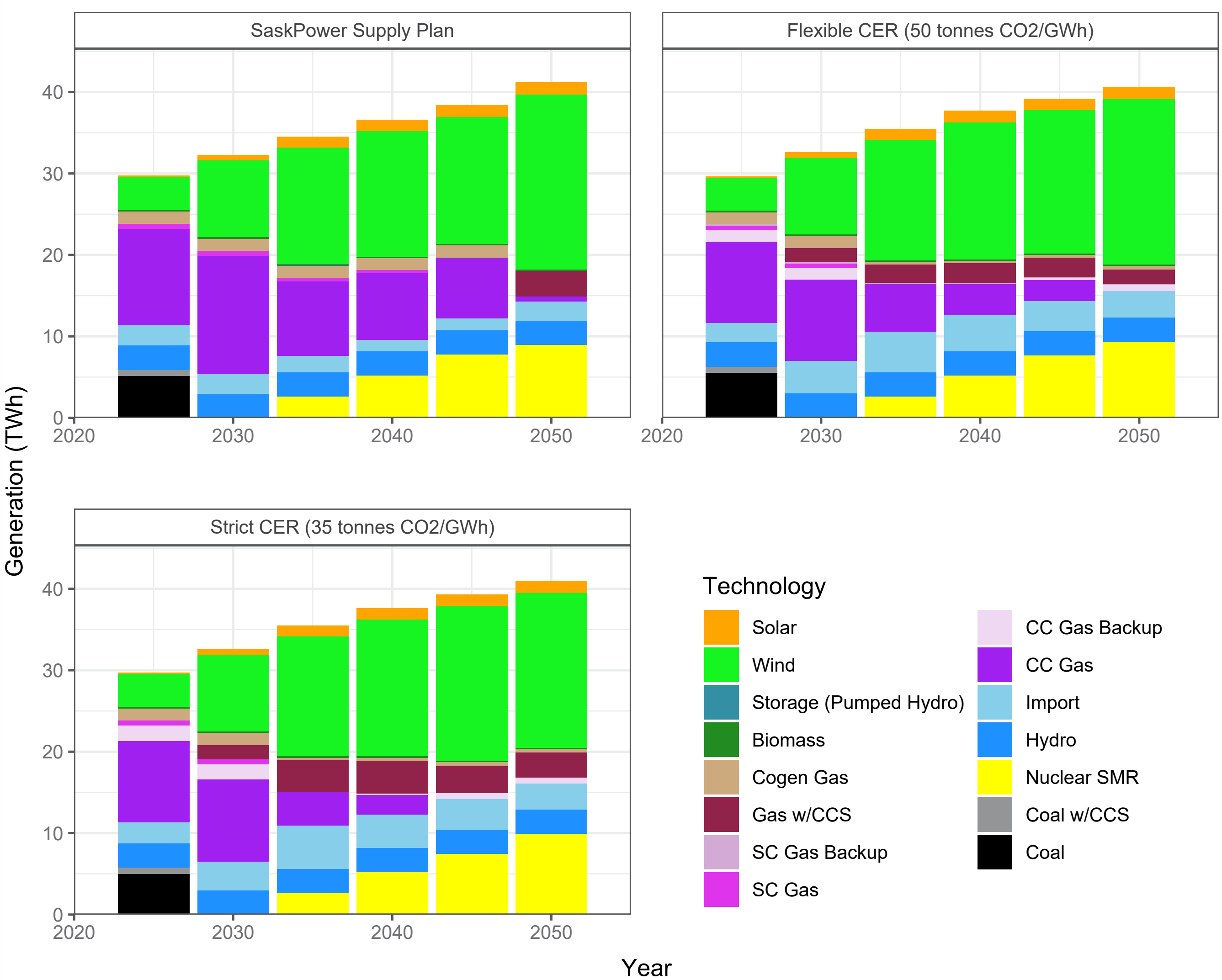
Electricity generation mix

The electricity generation mix that results in each scenario is shown in Figure 4 (see Appendix B for a table summarizing the data in the figure). The scenarios differ in two main ways. The CER scenarios include more imports from Manitoba (shown in light blue). The SaskPower Supply Plan, in turn, relies on greater use of combined-cycle natural gas plants. The regulated gas plants in the CER scenarios are available as back-up to meet peak demand and to back-up the variability of wind and solar energy. These regulated back-up plants do not provide large shares of electricity in order to operate within the emissions limits set out by the Clean Electricity Regulations.

Note, also, that the Strict CER scenario includes unregulated gas plants up to and including the 2040 time-step, and the Flexible CER scenario includes unregulated gas plants up to and including the 2045 time-step. This reflects the time when existing gas plants would meet their prescribed end of life under the Strict CER (20 years) and the Flexible CER (25 years). Coal-fired electricity is phased out in 2030 in all scenarios, in accordance with federal coal-fired electricity regulations.

Figure 4:

Saskatchewan electricity generation mix by scenario



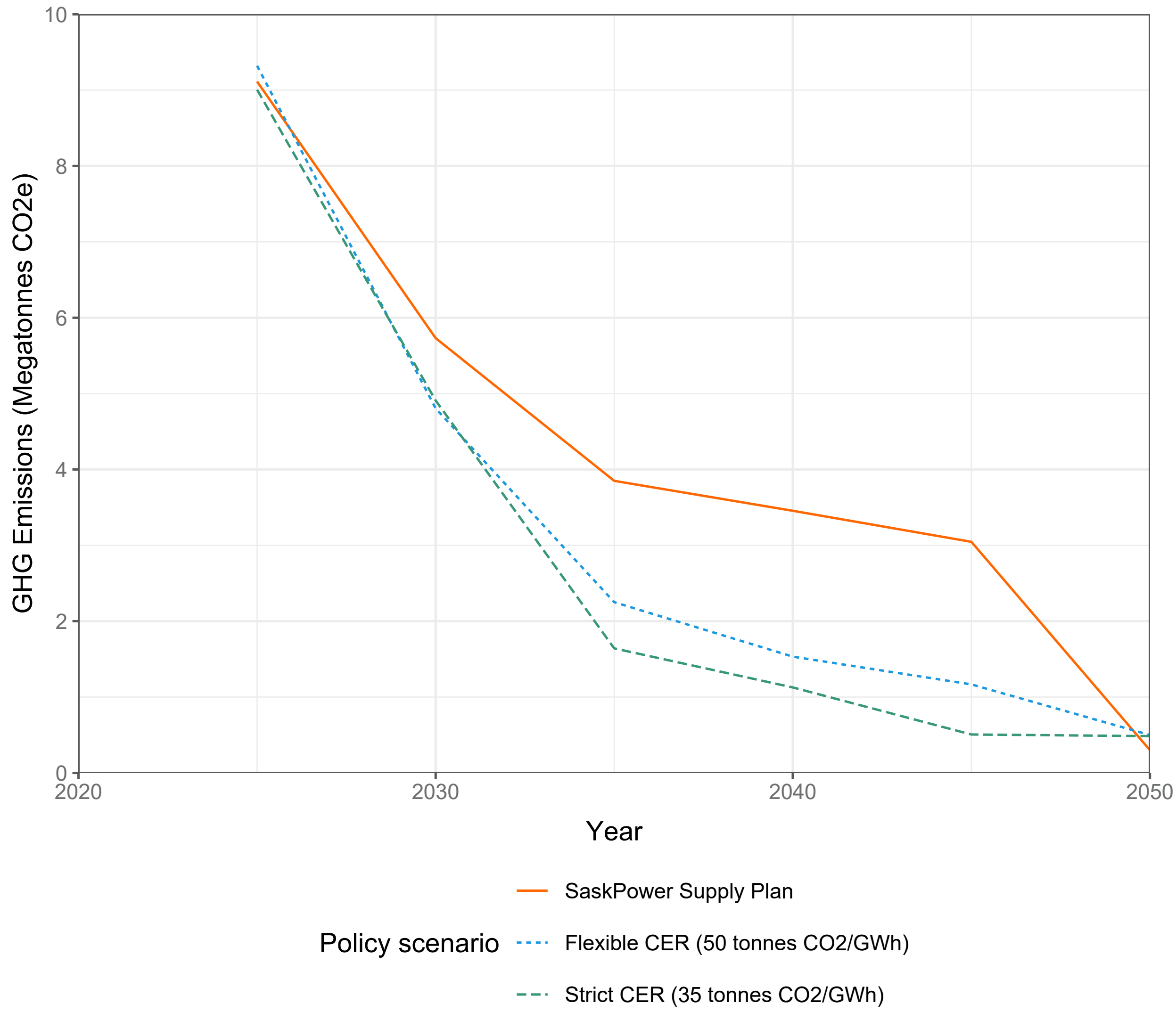
Greenhouse gas emissions

The climate benefits of the Clean Electricity Regulations are apparent in Figure 5. Greenhouse gas emissions from Saskatchewan's electricity sector were 13.6 megatonnes of carbon dioxide equivalent (CO_2eq) in 2023 (SaskPower 2024a). In the modelling scenarios, greenhouse gas emissions are reduced to about 9 megatonnes of carbon dioxide equivalent in 2025 across all three scenarios, and then fall by 3–4 megatonnes in 2030, driven largely by the retirement of all remaining coal plants.

In the 2035 time-step, we can see the biggest difference between the CER scenarios and the SaskPower supply scenario. The SaskPower Supply Plan would see annual emissions of 3.83 megatonnes of carbon dioxide equivalent in 2035, while the Flexible CER would reduce emissions to 2.25 megatonnes, and the Strict CER would achieve emissions of 1.64 megatonnes. Note that none of the scenarios achieve "net zero emissions" by 2035, but the CER scenarios get closer to that target.

Figure 5:

Greenhouse gas emissions by scenario



Without further policy, the SaskPower Supply Plan achieves lower emissions in 2050, when greenhouse gas emissions are constrained to 300,000 tonnes (0.3 megatonnes) of carbon dioxide equivalent. Emissions under the Strict CER would be 480,000 tonnes of carbon dioxide equivalent in 2050 and under the Flexible CER would be 500,000 tonnes of carbon dioxide equivalent in 2050. Remaining emissions are mostly emissions from gas plants with carbon capture, which operate at an emissions intensity of 38 tonnes of CO_2eq/GWh in the model. Additional policy would be needed to achieve true net zero by 2050, and could potentially include investment in biomass energy with carbon capture and storage (BECCS), which can sequester carbon dioxide from the atmosphere and could count as negative emissions in SaskPower's greenhouse gas emissions totals (Maenz 2024). The modelling for the analysis presented in this report does not include BECCS as a supply option.

Part of the differences in pollution could be attributed to higher levels of imported electricity in the Clean Electricity Regulations scenarios. The emissions shown in Figure 5 are provincial emissions released within Saskatchewan and do not include emissions related to imported electricity. Figure 6 and Table 5 display the domestic emissions intensity of each scenario. To calculate this emissions intensity, I divide the greenhouse gas emissions released within Saskatchewan by the electricity generated within Saskatchewan. The result is a calculation of the emissions intensity of Saskatchewan-produced electricity, measured in tonnes of carbon dioxide equivalent per gigawatt-hour (CO_2eq/GWh) of electricity generation. The Clean Electricity Regulations scenarios achieve reductions in this domestic emissions intensity, indicating that emissions reductions are occurring within Saskatchewan, and are not just the result of carbon leakage to other regions.

It is also noteworthy that imports of electricity from Manitoba have low emissions intensity. In the modelling scenarios in this paper, Manitoba's domestic emissions intensity is between 20 and 23 tonnes of CO_2eq/GWh in 2025 and decreases to between 4.8 and seven tonnes of CO_2eq/GWh by 2050.

As a caveat, I do not explicitly model imports from the Southwest Power Pool, the regional transmission organization serving much of the central United States. Southwest Power Pool's generation mix is currently more emissions-intensive than Manitoba Hydro electricity and consisted of 37.5 per cent wind, 33.3 per cent coal, 20.9 per cent natural gas, 5.1 per cent nuclear, 2.9 per cent hydroelectric, 0.2 per cent solar, and 0.1 per cent other in 2022 (SPP 2023).

Figure 6:

Saskatchewan greenhouse gas emissions intensity by scenario

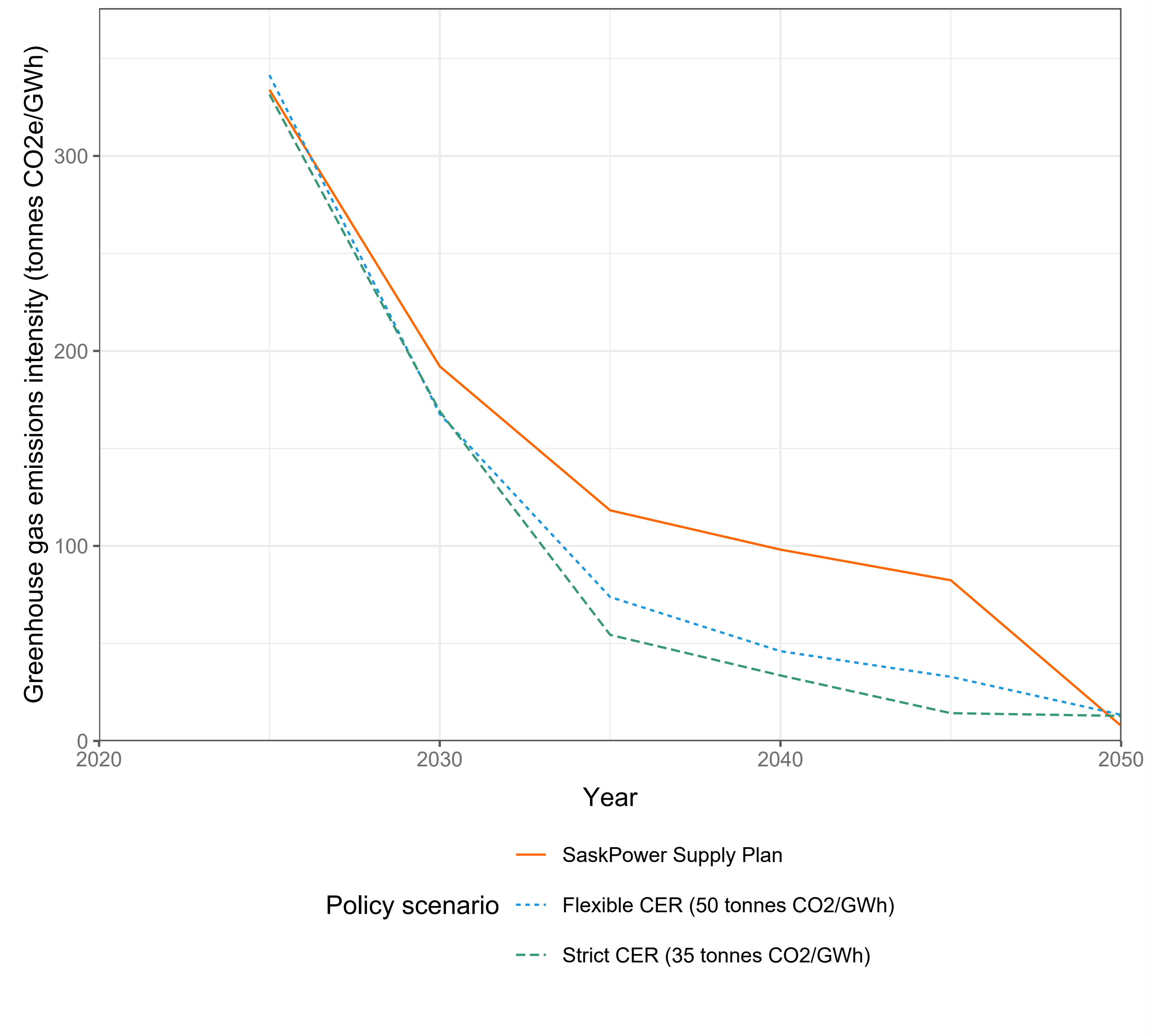


Table 5:

Saskatchewan's greenhouse gas emissions intensity by scenario

Year	SaskPower Supply Plan	Flexible CER (50 tonnes CO_2eq/GWh)	Strict CER (35 tonnes CO_2eq/GWh)
2025	334	341	332
2030	192	168	169
2035	118	74	54
2040	98	46	34
2045	82	33	14
2050	8	13	13

Investment costs

To achieve the greenhouse gas emissions reductions by 2035 shown in Figure 5, additional investment would be needed in the SaskPower electricity system. Figure 7 and Table 6 summarize the capital investments needed in each scenario. Figure 7 displays capital investments in each time-step, while Table 6 displays the cumulative sums of capital investments. By 2035, the Flexible Clean Electricity Regulations scenario would require an additional $4 billion in capital investment in Saskatchewan, and the Strict Clean Electricity Regulations scenario would require an additional $6.5 billion in capital investment relative to the SaskPower Supply Plan.

By 2050, however, the SaskPower Supply Plan will require higher capital expenditures. Much of the difference occurs in the final 2050 time-step to allow SaskPower to meet the utility's 2050 emissions target of 300,000 tonnes of carbon dioxide equivalent. Waiting until 2050 to achieve this target may itself create supply chain pressures and labour shortages that could be avoided by early and continual action. The supply planning scenarios SaskPower has shared publicly do involve more consistent investment into low-emissions generation over time than the baseline scenario, which resulted from optimizing the COPPER model.

Figure 7:

Investment cost by scenario and time-step

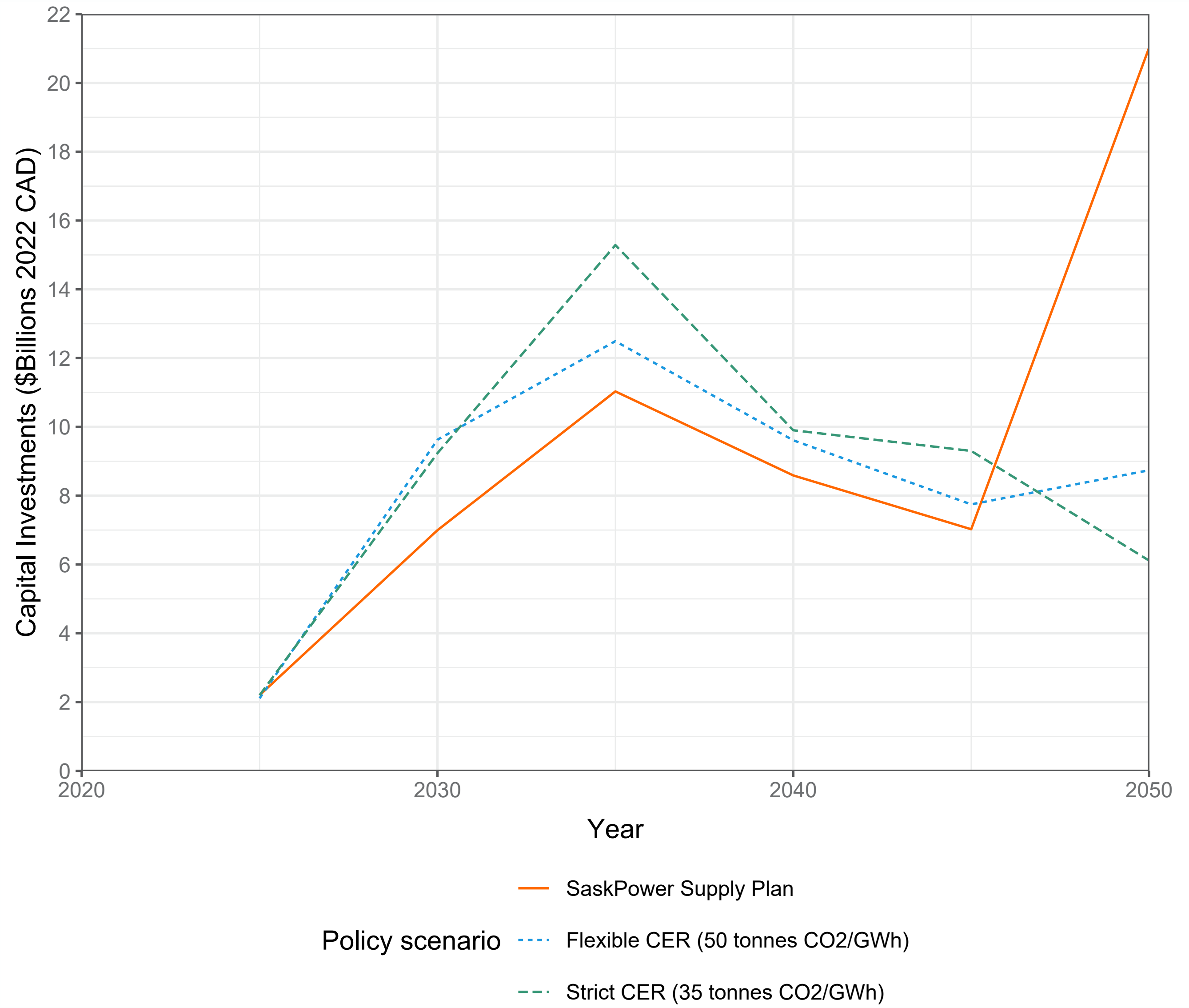


Table 6:

Saskatchewan investment cost, cumulative totals by time-step

(2022 C$billions)

Year	SaskPower Supply Plan	Flexible CER (50 tonnes CO_2eq/GWh)	Strict CER (35 tonnes CO_2eq/GWh)
2025	2.199	2.109	2.199
2030	9.196	11.737	11.435
2035	20.227	24.229	26.722
2040	28.816	33.839	36.624
2045	35.84	41.586	45.925
2050	56.865	50.325	52.038

Average cost of generation

Capital investments are not the only cost of the electricity system. Other costs include fixed and variable operations and maintenance costs, fuel costs, and carbon pricing costs. Figure 8 displays these annual costs for each scenario and time-step (see Appendix B for a breakdown of these costs). The cost of servicing SaskPower's existing debt is also included in Figure 8. At the end of fiscal year 2023–24, SaskPower had a total debt of $9.4 billion (SaskPower 2024). This debt is amortized over 25 years at a financing rate of 6 per cent per year and is shown in black at the base of the columns in Figure 8.

Capital expenditures are amortized over the entirety of their economic life, at financing rates of 6 per cent for investments in thermal technologies and transmission, and 9 per cent for storage and renewable energy. We assume a carbon price of $170 per tonne of carbon dioxide equivalent by 2030 (C$2022), which is maintained at a real value of $170 per tonne of carbon dioxide equivalent until 2050 (C$2022). The output-based pricing system (OBPS) for electricity does not provide free offset allowances for natural gas plants after 2030, and so emissions from gas plants are fully priced in 2030 and beyond. The SaskPower Supply Plan involves higher emissions from natural gas plants and incurs higher carbon pricing charges.

Aerial view of the South West Industrial neighbourhood of Saskatoon looking south at the Queen Elizabeth Power Station.

Figure 8:

Cost by scenario, cost type, and time-step

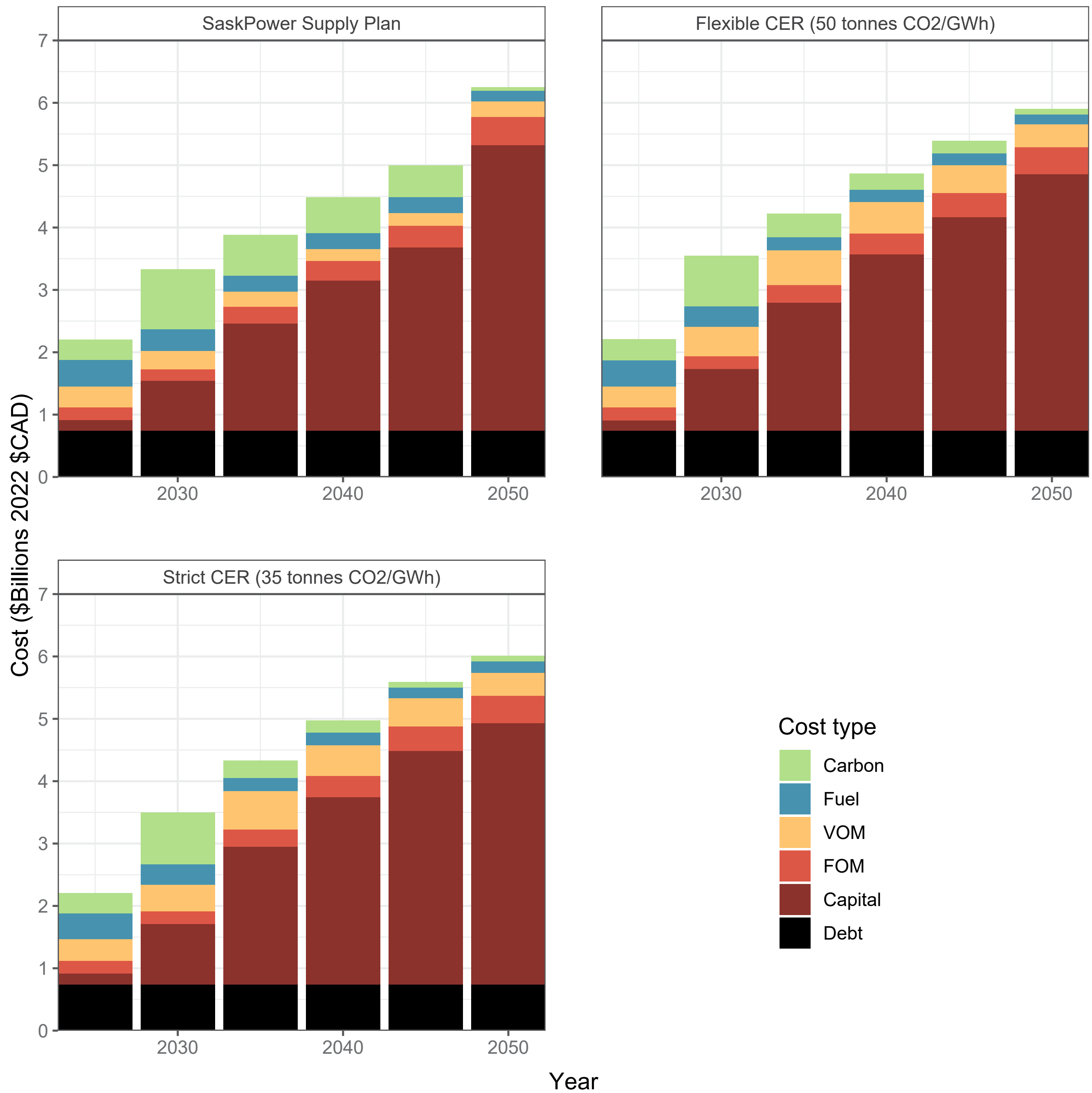
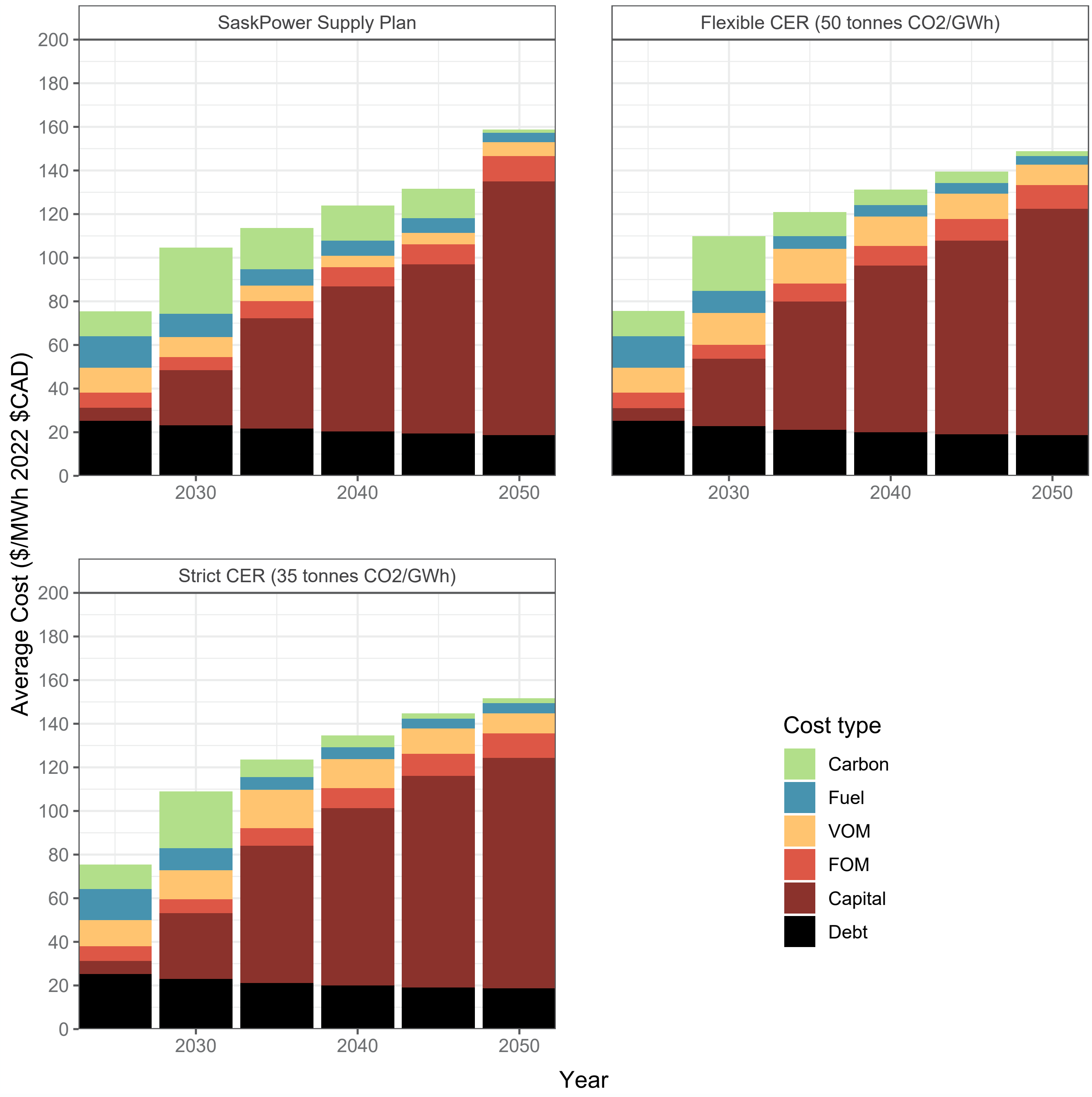


Figure 9:

Average cost by scenario, cost type, and time-step ($/MWh C$2022)



As costs increase with each time-step, so does the supply of electricity. Figure 9 shows the average cost of each cost-type by scenario and time-step. To calculate average cost, the annual costs are divided by electricity supply and presented in dollars per megawatt-hour ($/MWh) (C$2022). Figure 10 presents the total levelized cost of electricity generation in one plot for ease of comparison, and Table 7 provides the numeric summary of the data underlying the table. The Strict CER scenario has a levelized cost of about $10/MWh higher than the SaskPower Supply Plan in 2035 ($9.88/MWh), while the Flexible CER scenario has an average cost that is $7.22/MWh higher.

Figure 10:

Average cost summary ($/MWh C$2022)

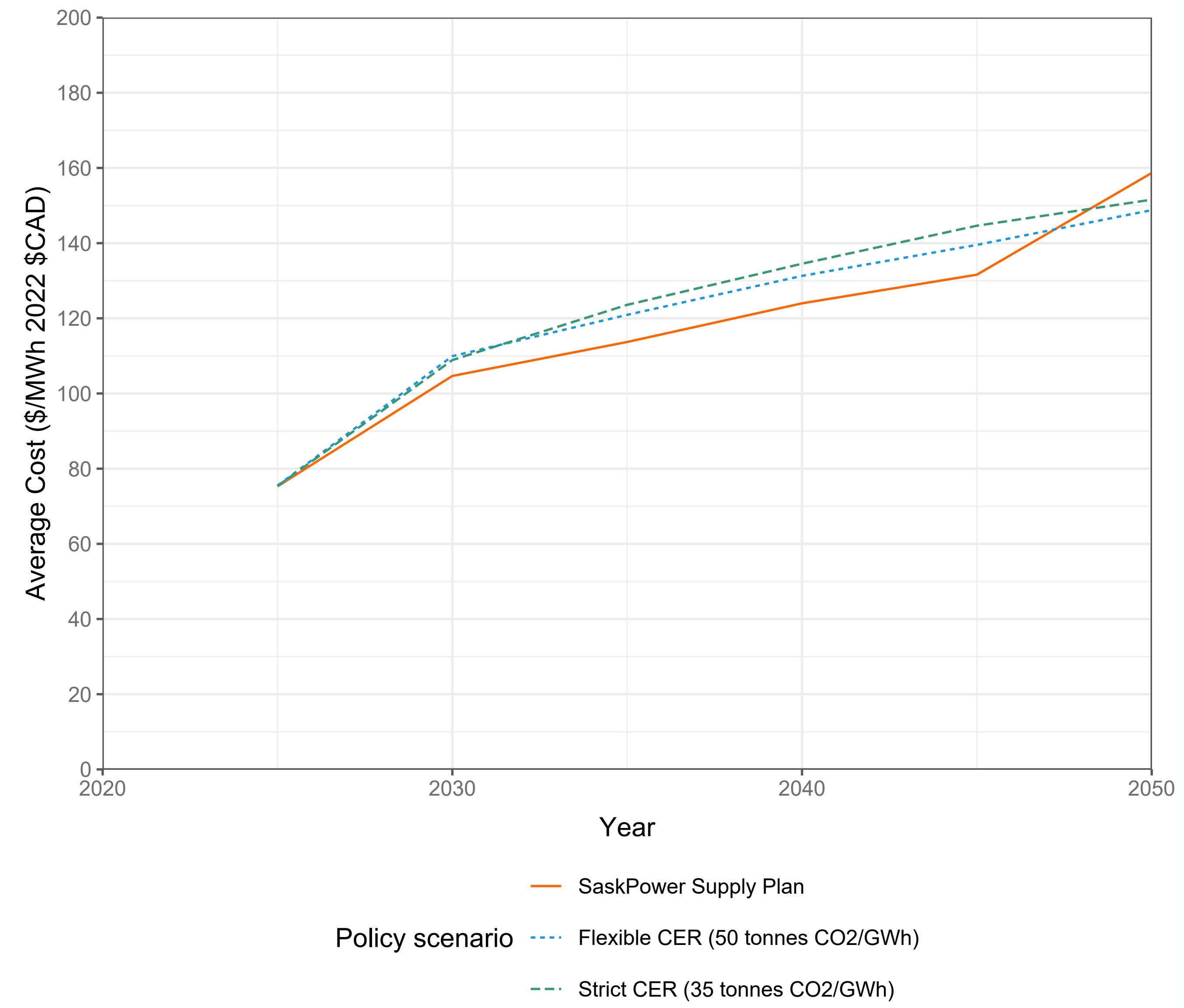


Table 7:

Saskatchewan average cost summary ($/MWh C$2022)

Year	SaskPower Supply Plan	Flexible CER (50 tonnes CO_2eq/GWh)	Strict CER (35 tonnes CO_2eq/GWh)
2025	75.29	75.49	75.37
2030	104.67	109.93	108.90
2035	113.70	120.92	123.58
2040	123.99	131.28	134.52
2045	131.61	139.53	144.64
2050	158.67	148.78	151.57

Residential electricity rate impacts

The average costs in each scenario are converted to residential electricity rates using a mark-up approach. First, I compare SaskPower's electricity rates in 2024 to the average costs calculated in the modelling scenarios in the 2025 time-step. I then determine the "mark-up" ratio for each scenario by dividing residential rates by the average cost in each scenario. The average mark-up in the three scenarios is 2.17. I use this ratio of average cost to residential rate to impute residential rates in each of the scenarios and time-steps. These imputed rates are presented in Figure 11 and Table 8.

In the 2035 time-step, the Flexible Clean Electricity Regulations scenario would result in residential electricity rates 6 per cent higher than the SaskPower Supply Plan scenario (1.5 cents/kilowatt-hour), while the Strict CER scenario would result in rates 9 per cent higher (2.1 cents/kWh). These findings are comparable to the modelling work Navius conducted for the Economic Assessment Tribunal (Navius Research 2024). Navius estimated that rates would be 1.7 cents/kWh higher for residential customers in 2035 under the Clean Electricity Regulations due to the regulatory requirements. My estimates of the costs of the Flexible Clean Electricity Regulations scenario are slightly lower, which points to the cost savings that could occur if ECCC adopts the most flexible version of the changes proposed in February 2024 (ECCC 2024).

In the original Regulatory Impact Analysis Statement of the draft Clean Electricity Regulations, ECCC estimated that residential electricity rates would be 0.9 cents/kWh higher under the Clean Electricity Regulations than in the base case in 2040 (Canada Gazette 2023). My analysis in this report puts the difference at 1.5 cents per kWh in 2040 under the Flexible Clean Electricity Regulations and 2.2 cents per kWh under the Strict Clean Electricity Regulations. This is slightly higher than the ECCC estimates and in part reflects the cost premium of constructing power plants in Saskatchewan, which we assume is 40 per cent higher than the United States Energy Information Administration's 2023 Annual Energy Outlook costs for thermal plants and 18 per cent higher than these numbers for wind, solar, and storage facilities (US EIA 2023).

As Figure 11 displays, residential electricity rates are set to rise in Saskatchewan across all scenarios, even without the Clean Electricity Regulations. This is similar to the finding of other national studies such as the Canadian Climate Institute's *Big Switch* (Dion et al. 2022) and *Clean Electricity, Affordable Energy* (Harland et al. 2023) reports.

Governments have tools to mitigate electricity rate increases and are beginning to use them. In Saskatchewan, using carbon pricing revenues from the electricity sector to fund capital investments in small modular nuclear reactors, wind, solar, and storage, will reduce rate pressures. The federal Investment Tax Credits will similarly lower rate pressures by reducing the cost of capital investments. Shifting the cost of electricity investments from the rate-base to the tax-base does not make the costs disappear, but it does ensure more equitable outcomes as low-income households see their electricity costs reduced to a greater extent than any countervailing income tax increases (Dolter and Winter 2022). The federal government has finalized Clean Technology Investment Tax Credits that offer a 30 per cent refundable tax credit for taxable corporations and mutual fund trusts. Crown Corporations such as SaskPower are not eligible for this tax credit. Federal Budget 2024 proposed a refundable tax credit of 15 per cent for Crown Corporations that would be subject to conditions such as "the government of that province or territory would need to publicly commit to work towards a net-zero electricity grid by 2035" (Canada 2024). This electricity investment tax credit would open an avenue for SaskPower to access investment tax credits for projects that it owns. Both the Clean Technology and Clean Electricity Investment Tax Credits would help reduce rate pressures in Saskatchewan.

From an affordability perspective, an increase in electricity rates may not mean an increase in energy expenditures for households. Electric vehicles offer significant operation and maintenance savings relative to gasoline vehicles and should soon reach purchase cost parity (Randall 2024). As Canadians transition to zero-emission technologies like electric vehicles, increases in electricity rates and usage may be offset by a decrease in the overall energy expenditure wallet due to a reduction of gasoline expenditures (Canada Electricity Advisory Council 2024).

Figure 11:

Residential electricity rates by scenario ($/MWh C$2022)

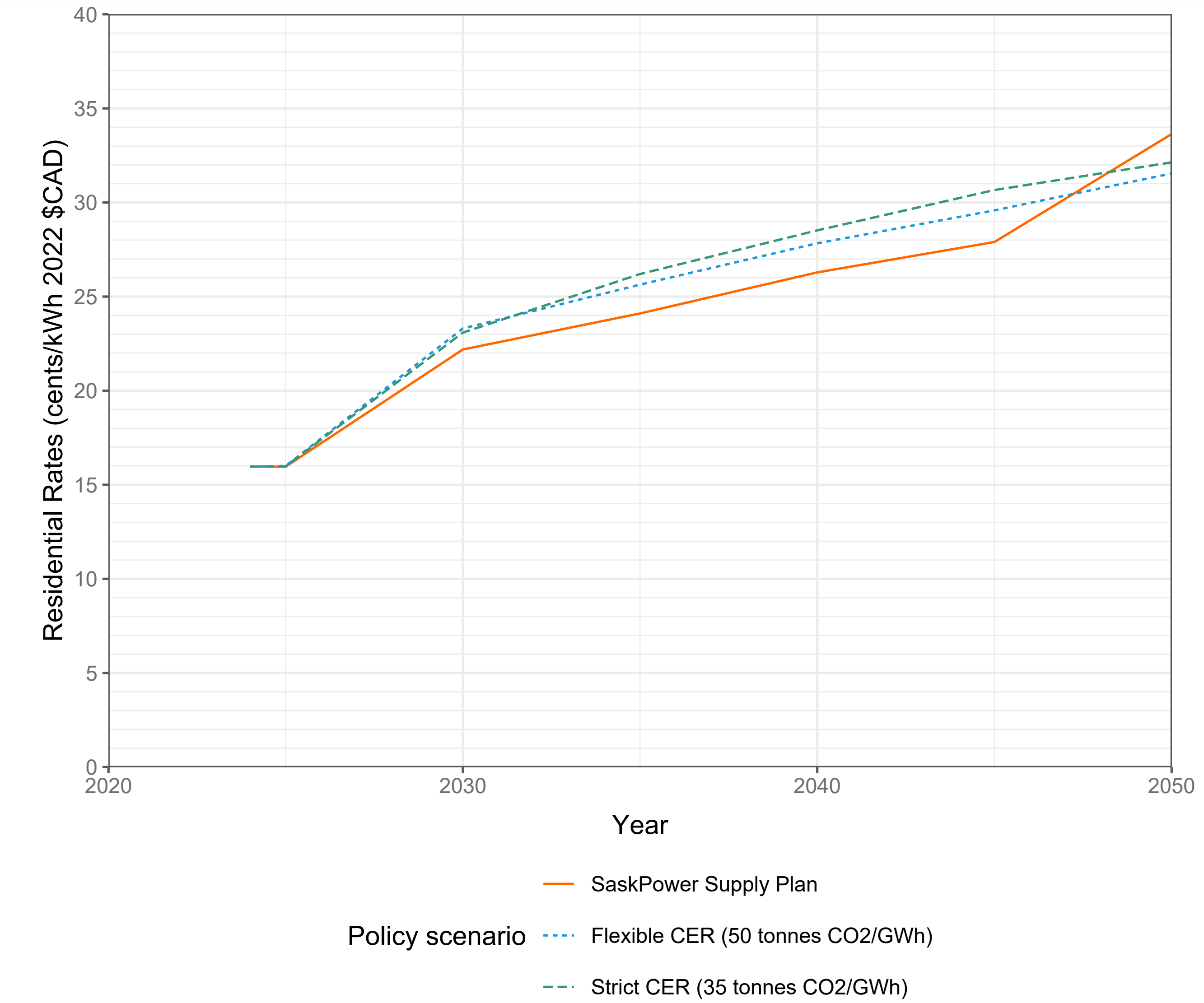


Table 8:

Residential electricity rates by scenario

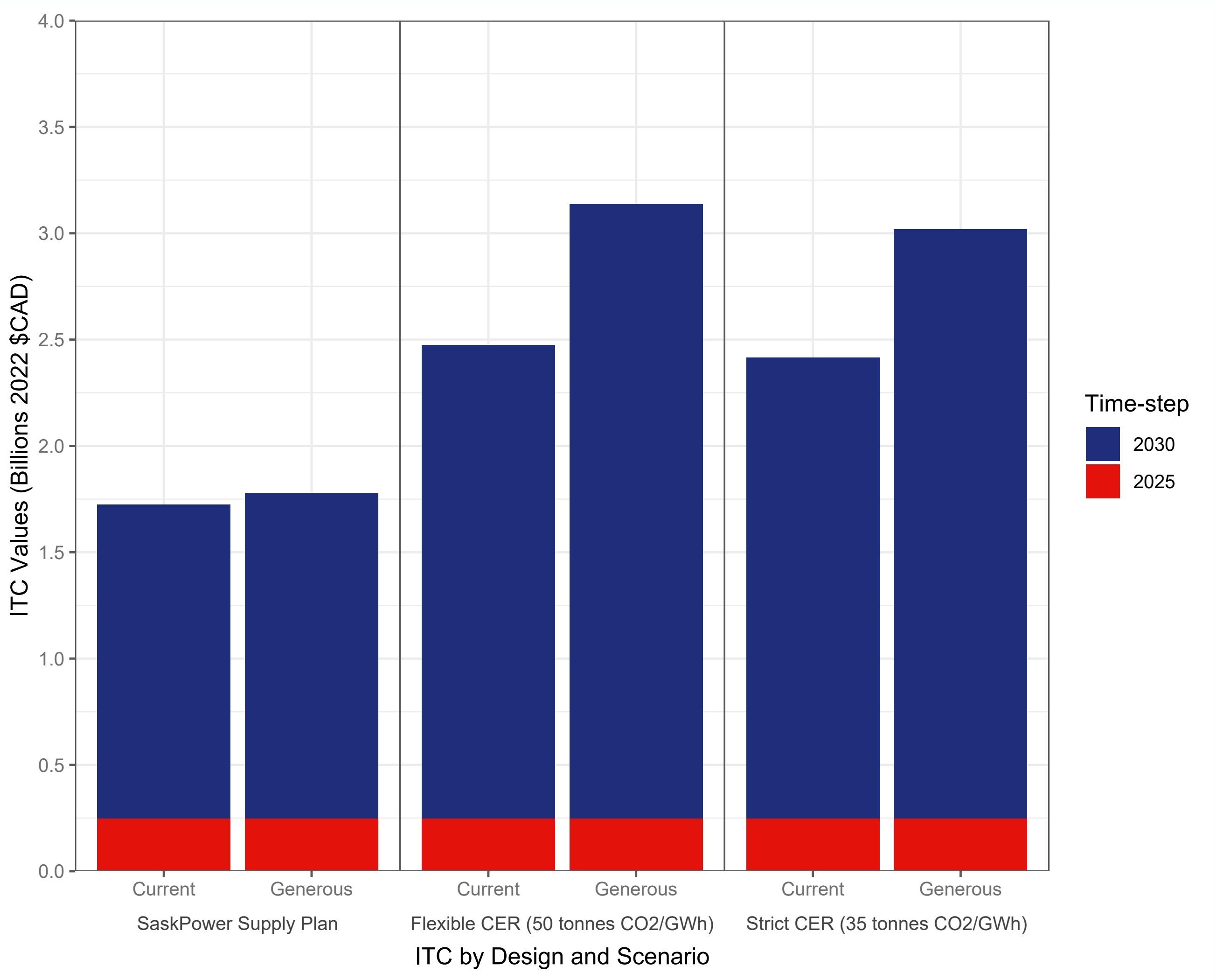
(cents/kWh C$2022)

Year	SaskPower Supply Plan	Flexible CER (50 tonnes CO_2eq/GWh)	Strict CER (35 tonnes CO_2eq/GWh)
2024	16.00	16.00	16.00
2025	16.00	16.00	16.00
2030	22.20	23.30	23.10
2035	24.10	25.60	26.20
2040	26.30	27.80	28.50
2045	27.90	29.60	30.70
2050	33.60	31.50	32.10

The final design of the Clean Electricity Investment Tax Credits will play an important role in mitigating rate increases. Figure 12 summarizes the differences between Investment Tax Credit values in a scenario where the Clean Electricity Investment Tax Credit for Crown Corporations is kept to 15 per cent ("Current" design), and where the Clean Electricity Investment Tax Credit for Crown Corporations is increased to 30 per cent to match tax credits for private entities ("Generous"). Both tax credit scenarios assume that solar, wind, and storage technologies are owned by private companies, while carbon capture and storage projects and inter-provincial transmission projects are owned by SaskPower. The more generous Clean Electricity Investment Tax Credit would increase federal support in Saskatchewan by between $600 million and $662 million dollars relative to the current proposed design.

Figure 12:

Investment tax credits by design and scenario (Billions C$2022)



8 SUMMARY OF FINDINGS

Below, I summarize the key takeaways from this modelling exercise.

1. CLEAN ELECTRICITY REGULATIONS INCREASE RATES SLIGHTLY—MUCH LESS THAN ESTIMATED BY THE GOVERNMENT OF SASKATCHEWAN

Both the Navius analysis and the analysis in this report offer a much different take on the rate impact of the Clean Electricity Regulations than was originally expressed by the Saskatchewan government. In a November 2023 press release, the Saskatchewan government claimed, "SaskPower estimates that families, communities, businesses and industries will see electricity rates more than double by 2035 to cover the costs associated with the Clean Electricity Regulations and federal coal regulations. The federal net zero power system plan is expected to cost Saskatchewan about $40 billion from now until 2035" (Government of Saskatchewan 2023). In this analysis, I find that by 2035, additional capital expenditures will be only $4–6 billion higher (not including federal supports through the investment tax credit), and rate impacts will be 1.5–2.1 cents/kWh higher. This is a rate increase of 6–9 per cent relative to a baseline case, not a 100 per cent increase as claimed by the Government of Saskatchewan.

2. SASKPOWER COULD MAKE THE CASE FOR MORE FLEXIBLE CLEAN ELECTRICITY REGULATIONS AND A MORE GENEROUS FEDERAL INVESTMENT TAX CREDIT

Saskatchewan and SaskPower could argue for the more flexible version of the Clean Electricity Regulations modelled in this paper to reduce the cost of compliance to the lower end of the ranges noted above. A flexible version of the proposed Clean Electricity Regulations is not vastly out of line with the energy mix SaskPower is already planning for.

A case can also be made that additional funding from the federal government would be useful and justified. A tax credit that provides 30 per cent of capital costs in direct funding for Crown Corporation projects would help to keep electricity rates affordable in Saskatchewan.

3. NO MATTER WHAT, WIND ENERGY WILL GROW SIGNIFICANTLY IN SASKATCHEWAN

All scenarios modelled in this paper show significant investments in wind energy. Saskatchewan has one of the best onshore wind resources in Canada. SaskPower has recognized this natural advantage with its own plans to expand wind energy in the province and achieve up to 50 per cent renewable capacity by 2030. Wind energy is also cost-competitive as a source of electrons on the Saskatchewan electricity system. When wind energy is available, it allows SaskPower to ramp down electricity generation from other sources like gas plants. This saves on fuel and carbon pricing charges, and it reduces greenhouse gas emissions. COPPER represents wind in a detailed way, providing hourly wind generation estimates for 290 locations in Saskatchewan. Even with the variability of wind accounted for in the COPPER model, the model selects wind investments of between 3,633 megawatts and 4,100 megawatts by 2050, leading wind to represent between 42.5 per cent and 47 per cent of total system capacity by 2050.

4. CUMULATIVE EMISSIONS WOULD BE SIGNIFICANTLY HIGHER IN THE ABSENCE OF THE CLEAN ELECTRICITY REGULATIONS

SaskPower's supply planning process outlines alternate pathways to achieve close to net zero electricity by 2050. Since greenhouse gas emissions accumulate in the atmosphere, the road to net zero electricity is as important as the eventual destination. The baseline scenario in this report aligns with SaskPower's supply plans and generates cumulative greenhouse gas emissions of 126.3 megatonnes of carbon dioxide equivalent from 2025 to 2050.

The two versions of the Clean Electricity Regulations modelled in this report reduce cumulative emissions significantly. The flexible version of the Clean Electricity Regulations generates cumulative emissions of 95.9 Mt CO_2 eq between 2025 and 2050, and the more stringent version generates cumulative emissions of only 86.4 Mt CO2 eq. Savings of 30–40 Mt CO_2 eq are equivalent to a year of emissions from 9–12 million gasoline cars (NRCAN 2024).

The Clean Electricity Regulations achieve these lower levels of pollution by driving a reduction in the use of gas plants, and earlier and more widespread use of carbon capture on Saskatchewan gas plants. While the Clean Electricity Regulations motivate higher imports from Manitoba in these scenarios, those imports are relatively clean. Saskatchewan's domestic electricity emissions intensity is also lower in the Clean Electricity Regulations scenario. This clean electricity can play an important role in decarbonizing other sectors within Saskatchewan.

Importantly, none of the scenarios require or achieve net zero greenhouse gas emissions by 2035. The conversation in Saskatchewan would be clearer if all parties recognized that the Clean Electricity Regulations reduce emissions, but do not require elimination of all emissions by 2035. Achieving net zero emissions in electricity by 2035 would be difficult, if not impossible. The Clean Electricity Regulations do not require SaskPower to meet this goal, but instead ensure that new gas plants are built with carbon capture and storage. Achieving this objective should be much more technically feasible for the utility than meeting a net-zero emissions target by 2035.

5. FEDERAL-PROVINCIAL COLLABORATION SHOULD BE POSSIBLE TO ACHIEVE NET ZERO ELECTRICITY

If SaskPower is to achieve its net zero commitments by 2050, it does not appear that the Clean Electricity Regulations create undue costs or barriers to achieving that commitment. Rather, revised Clean Electricity Regulations would lead to only modest electricity rate increases by 2035 relative to SaskPower's supply plans, while achieving significant reductions in annual and cumulative greenhouse gas emissions.

The release of the final Clean Electricity Regulations is expected in Fall 2024. At that time, based on the encouraging findings of this analysis, it is my hope that the Government of Saskatchewan and Government of Canada can work collaboratively to achieve their shared commitment to net zero electricity. Saskatchewan is home to some of Canada's best wind and solar resources, is building new transmission links to markets in the United States, has pioneered the use of carbon capture and storage in the electricity sector, and is exploring the potential for nuclear generation. Collaboration between the Saskatchewan and Canadian governments could unlock SaskPower's potential and make the utility a leading provider of zero-emissions electricity in North America.

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Appendix A: Modelling Assumptions

Table A1:

Cost and performance assumptions used in the COPPER model

Technology	SK capital costs (C$/ kW)	Total project costs (2022) (C$/ kW)	Life (years)	Financing cost %	Annualized capital cost (C$/ MW-year)	Fixed O&M costs (C$/ MW-year)	Variable O&M costs (C$/ MWh)	Average fuel price (C$/ GJ)	Carbon emissions (tCO_2eq/ MWh)	Efficiency (%)
Biomass	9,096	11,007	30	6%	799,671	183,950	7.07	2.87	0.000	25%
Coal	8,203	9,942	30	6%	722,241	59,384	6.58	2.37	0.809	40%
Coal w/CCS	13,321	16,033	30	6%	1,164,766	87,126	25.16	2.37	0.103	32%
Geothermal	6,193	7,540	40	6%	501,138	200,174	1.70	0.00	0.000	38%
Hydroelectric (daily storage)	5,611	6,843	40	6%	454,776	115,196	5.00	0.00	0.000	
Hydroelectric (large reservoir)	12,194	16,255	70	6%	992,112	16,009	2.00	0.00	0.000	
Run-of-river hydroelectric	6,226	7,579	40	6%	503,744	55,655	1.00	0.00	0.000	
Hydrogen	2,599	3,064	35	6%	211,318	58,000	4.69	15.60	0.030	34%
Green Hydrogen	2,599	3,064	35	6%	211,318	58,000	4.69	56.40	0.000	34%
CC Gas	3,120	3,754	30	6%	272,717	20,631	3.73	2.94	0.338	54%
Gas w/CCS	7,366	8,724	30	6%	633,817	40,378	17.64	2.94	0.038	48%
Cogen Gas	5,178	6,169	30	6%	448,201	40,378	8.54	2.94	0.338	48%
SC Gas	2,421	2,858	30	6%	207,632	23,855	6.88	2.94	0.516	35%
Nuclear (large)	14,154	17,897	30	6%	1,300,225	177,983	3.47	0.81	0.000	33%
Nuclear SMR	15,195	19,196	30	6%	1,394,603	138,996	4.39	0.81	0.000	33%
Solar	2,221	2,628	30	9%	255,779	22,308	0.00	0.00	0.000	
Storage (li-ion)	1,948	2,257	15	9%	279,985	59,488	0.00	0.00	0.000	
Storage (Pumped Hydro)	2,301	3,157	70	9%	284,781	14,040	1.00	0.00	0.000	
Wind	3,218	3,870	30	9%	376,666	38,532	0.00	0.00	0.000	
Imports	2,769	3,182	30	6%	231,159	25,000	100.00	0.00	0.000	
Exports							50.00			

Table A2:

Annual electricity growth rates in the COPPER model by time-step and province

Province	2025	2030	2035	2040	2045	2050
Manitoba	3.43%	1.84%	1.57%	1.36%	1.08%	0.80%
Saskatchewan	4.48%	1.73%	1.50%	1.32%	0.97%	0.60%

Appendix B: Modelling Outputs

Table B1:

Modelled capacity in megawatts (MW) by time-step and technology in the SaskPower Supply Plan scenario

SCENARIO: SaskPower Supply Plan						
Technology	2025	2030	2035	2040	2045	2050
Coal	982	0	0	0	0	0
Coal w/CCS	139	0	0	0	0	0
Nuclear SMR	0	0	315	630	945	1,260
Hydro	863	863	863	863	863	863
Imports	350	466	466	466	466	1,052
CC Gas	2,348	2,853	2,630	2,230	1,970	519
SC Gas	439	439	316	224	0	0
Gas w/CCS	0	0	0	0	0	975
Cogen Gas	456	456	456	456	456	0
Biomass	40	37	37	37	37	40
Storage (Pumped Hydro)	0	23	69	127	103	80
Wind	800	1,800	2,709	2,921	2,954	4,100
Solar	100	400	800	825	850	875
Total	**6,517**	**7,337**	**8,661**	**8,779**	**8,644**	**9,764**

Table B2:

Modelled capacity in megawatts (MW) by time-step and technology in the Flexible CER scenario

SCENARIO: Flexible CER (50 tonnes CO_2/GWh)						
Technology	2025	2030	2035	2040	2045	2050
Coal	1,056	0	0	0	0	0
Coal w/CCS	139	0	0	0	0	0
Nuclear SMR	0	0	315	630	945	1,260
Hydro	863	863	863	863	863	863
Imports	350	778	778	821	912	1,089
CC Gas	1,983	1,983	1,360	1,100	747	0
CC Gas Backup	265	265	0	15	165	671
SC Gas	439	439	48	0	0	0
SC Gas Backup	100	100	100	100	100	100
Gas w/CCS	0	350	438	477	477	477
Cogen Gas	456	456	456	456	456	456
Biomass	40	37	37	37	37	37
Storage (Pumped Hydro)	0	170	170	170	0	0
Storage (Li-ion Battery)	0	8	221	221	213	0
Wind	800	1,800	2,800	3,200	3,344	3,877
Solar	100	400	800	825	850	875
Total	**6,591**	**7,649**	**8,386**	**8,915**	**9,109**	**9,705**

Table B3:

Modelled capacity in megawatts (MW) by time-step and technology in the Strict CER scenario

SCENARIO: STRICT CER (35 TONNES CO_2/GWH)						
Technology	2025	2030	2035	2040	2045	2050
Coal	957	0	0	0	0	0
Coal w/CCS	139	0	0	0	0	0
Nuclear SMR	0	0	315	630	945	1,260
Hydro	863	863	863	863	863	863
Imports	350	655	826	960	1,188	1,188
CC Gas	1,983	1,983	1,100	747	0	0
CC Gas Backup	365	365	39	160	636	636
SC Gas	439	439	0	0	0	0
Gas w/CCS	0	350	751	791	791	791
Cogen Gas	456	456	456	456	456	456
Biomass	40	37	37	37	37	37
Storage (Pumped Hydro)	0	170	170	170	0	0
Storage (Li-ion Battery)	0	8	8	8	0	0
Wind	800	1,800	2,800	3,200	3,634	3,634
Solar	100	400	800	825	850	875
Total	**6,492**	**7,526**	**8,165**	**8,847**	**9,400**	**9,740**

Table B4:

Modelled generation in gigawatt-hours (GWh) by time-step and technology in the SaskPower Supply Plan scenario

SCENARIO: SASKPOWER SUPPLY PLAN						
Technology	2025	2030	2035	2040	2045	2050
Coal	5,162	0	0	0	0	0
Coal w/CCS	731	0	0	0	0	0
Nuclear SMR	0	0	2,594	5,188	7,782	8,961
Hydro	2,990	2,990	2,990	2,990	2,990	2,981
Import	2,427	2,425	1,972	1,396	1,430	2,339
CC Gas	11,932	14,496	9,210	8,234	7,481	626
SC Gas	577	577	415	294	0	0
Gas w/CCS	0	0	0	0	0	3,114
Cogen Gas	1,478	1,478	1,478	1,478	1,478	0
Biomass	228	211	211	211	211	198
Storage (Pumped Hydro)	0	0	1	1	0	0
Wind	4,023	9,391	14,268	15,392	15,560	21,481
Solar	170	693	1,387	1,429	1,471	1,513
Total	**29,718**	**32,261**	**34,526**	**36,613**	**38,403**	**41,213**

Table B5:

Modelled generation in gigawatt-hours (GWh) by time-step and technology in the Flexible CER scenario

SCENARIO: FLEXIBLE CER (50 TONNES CO_2/GWH)						
Technology	2025	2030	2035	2040	2045	2050
Coal	5,548	0	0	0	0	0
Coal w/CCS	731	0	0	0	0	0
Nuclear SMR	0	0	2,594	5,188	7,664	9,339
Hydro	2,990	2,990	2,990	2,990	2,990	2,990
Import	2,328	3,949	4,965	4,376	3,698	3,245
CC Gas	10,075	10,075	5,896	3,881	2,595	0
CC Gas Backup	1,348	1,348	0	17	188	761
SC Gas	577	577	63	0	0	0
SC Gas Backup	131	131	74	74	74	74
Gas w/CCS	0	1,778	2,226	2,425	2,425	1,781
Cogen Gas	1,478	1,478	331	297	336	448
Biomass	228	211	211	211	211	157
Storage (Pumped Hydro)	0	2	0	0	0	0
Wind	4,023	9,391	14,743	16,819	17,568	20,303
Solar	170	682	1,362	1,404	1,445	1,487
Total	**29,627**	**32,612**	**35,455**	**37,682**	**39,194**	**40,585**

Table B6:

Modelled generation in gigawatt-hours (GWh) by time-step and technology in the Strict CER scenario

SCENARIO: STRICT CER (35 TONNES CO_2/GWH)						
Technology	2025	2030	2035	2040	2045	2050
Technology	2025	2030	2035	2040	2045	2050
Coal	5,029	0	0	0	0	0
Coal w/CCS	731	0	0	0	0	0
Nuclear SMR	0	0	2,594	5,188	7,444	9,929
Hydro	2,990	2,990	2,990	2,990	2,990	2,990
Import	2,532	3,530	5,321	4,053	3,750	3,180
CC Gas	10,075	10,075	4,173	2,463	0	0
CC Gas Backup	1,856	1,856	44	182	721	721
SC Gas	577	577	0	0	0	0
Gas w/CCS	0	1,778	3,817	4,017	3,304	3,052
Cogen Gas	1,478	1,478	297	338	497	454
Biomass	228	211	211	211	166	154
Storage (Pumped Hydro)	0	2	0	0	0	0
Wind	4,023	9,391	14,686	16,762	19,003	19,003
Solar	170	681	1,363	1,402	1,444	1,486
Total	**29,689**	**32,569**	**35,496**	**37,606**	**39,319**	**40,969**

Table B7:

Modelled annual costs (millions C$2022) by time-step and technology in the SaskPower Supply Plan scenario

SCENARIO: SASKPOWER SUPPLY PLAN						
Cost type	2025	2030	2035	2040	2045	2050
Carbon	331	967	650	583	514	56
Fuel	421	342	256	256	255	170
VOM	334	292	238	188	198	249
FOM	202	190	270	313	348	451
Capital	180	805	1,728	2,414	2,948	4,588
Debt	736	736	736	736	736	736
Total	**2,204**	**3,332**	**3,878**	**4,490**	**4,999**	**6,250**

Table B8:

Modelled annual costs (millions C$2022) by time-step and technology in the Flexible CER scenario

SCENARIO: FLEXIBLE CER (50 TONNES CO_2/GWH)						
Cost type	2025	2030	2035	2040	2045	2050
Carbon	340	814	384	263	201	87
Fuel	423	325	209	194	195	156
VOM	329	469	555	499	442	365
FOM	206	204	284	340	385	437
Capital	174	998	2,059	2,833	3,431	4,118
Debt	736	736	736	736	736	736
Total	**2,208**	**3,546**	**4,227**	**4,865**	**5,390**	**5,899**

Table B9:

Modelled annual costs (millions C$2022) by time-step and technology in the Strict CER scenario

SCENARIO: STRICT CER (35 TONNES CO_2/GWH)						
Cost type	2025	2030	2035	2040	2045	2050
Carbon	327	831	284	197	91	87
Fuel	418	331	206	203	171	186
VOM	347	424	614	488	447	363
FOM	200	201	277	337	395	439
Capital	180	977	2,215	3,011	3,749	4,195
Debt	736	736	736	736	736	736
Total	**2,208**	**3,500**	**4,332**	**4,972**	**5,589**	**6,006**

Appendix C: Navius Modelling Outcomes

Table C1:

Table C1 – Electricity Price Impacts of SK-CER estimated by Navius

(cents/kWh 2022 C$) (Navius Research 2024)

Electricity price impacts of SK-CER relative to SAPP in 2035 (C$2022)					
2025 Electricity Prices (c/kWh)		2035 Electricity Prices (c/kWh)		Net increase (CER vs SAPP)	
Consumer type	**All scenarios**	**SAPP**	**SK-CER**	**Rate change (c/kWh)**	**Annual cost per consumer ($)**
Generator	7.4	7.6	10.3	2.7	
Residential	22.6	22.6	25.7	3.1	$241
Commercial	16.3	16.5	19.4	3.0	$888
Industrial	12.7	12.9	15.8	2.9	$1,429

Figure C1 – Electricity Price Impacts of SK-CER estimated by Navius

(cents/kWh 2022 C$) (Navius Research 2024)

navius research

Figure 3: Impact of policy on household electricity prices in 2035