'Powering Up' A Green Saskatchewan: Exploring Possible Sustainable Solutions for Saskatchewan's Electricity Market

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Summary

The electrical market in Saskatchewan is embarking on an exciting journey to both increase its generating capacity and reduce greenhouse gas (GHG) emissions to promote a more sustainable future. SaskPower is the centralized generation and transmission crown corporation for the province and has the ability to implement the necessary actions to create a sustainable electrical system. There are many paths that Saskatchewan can take for a more sustainable future. Currently, the future of Saskatchewan's electrical market depends on results from the Boundary Dam Carbon Capture and Storage (CCS) Demonstration Plant. This project proposes electrical capacity models for SaskPower in the event their current CCS project is not a feasible option.

1. Introduction

Electricity production in Saskatchewan is meeting new challenges over the next 20 years. Greenhouse gas emissions (GHG) are a large concern in today's environmental and climate change-concerned society. As the highest GHG emitter per capita within Canada (69.8 tonnes CO2 equivalent per capita per year in 2010 [2]), more than three times the national average (20.3 tonnes CO2 equivalent per capita per year) it will be a significant challenge for Saskatchewan to reduce their GHG emissions while meeting electricity demands. Saskatchewan depends heavily on coal and natural gas to provide 74% of the province's electricity capacity [3]. Saskatchewan's electricity demands will continue to increase by approximately 1.8% over the next 20 years similar to the rest of the country [3]. Most of Saskatchewan's aging power plants will be nearing the end of their projected operational life, and will be either refurbished and upgraded to higher environmental standards, or retired and replaced with renewable, sustainable, or more efficient forms of power generation. Currently, Saskatchewan's electrical power market is controlled and operated by the crown corporation SaskPower, originally founded as the Saskatchewan Power Corporation in 1929 [1]. With the need for additional electricity production, and a governing party that has the ability to initiate plans efficiently for the entire province, Saskatchewan has a considerable opportunity to improve their electricity market and drastically reduce their GHG emissions.

Numerous power plants within Saskatchewan are reaching the end of their operational life within the next 20 years and require either refurbishment or retirement of existing facilities. In both cases, these power stations will be required to meet environmental and emission standards as proposed by Environment Canada. By mid-2015, performance standards of electricity generating facilities would be set at intensity levels similar to that of a Natural Gas Combined Cycle (NGCC) turbine

ranging from 360 to 420 tonnes/GWh [6]. These numbers would be comparable to a coal-fired power plant implementing carbon capture and storage (CCS) technology that is able to capture 70% of the emissions released by the facility. A large number of these power stations coming to the end of their operation lifetime include coal-fired or natural gas power stations and will therefore require major refurbishment or replacement with more efficient, more sustainable, and renewable facilities.

The overall goal of this project was to analyze Saskatchewan's currently electricity market and propose alternative electricity capacity models that would take into account Saskatchewan's electricity requirements for the next 20 years. These models would consider the GHG emissions of each electricity source, and the feasibility of each source within the province. Each model represents a more "green" option for electricity production ("green" meaning the use of renewable and sustainable electricity production where suitable). Renewable forms of electricity, as defined by our group, are the forms of electricity generation that are not depleted by use (e.g. wind, solar, geothermal and hydropower generation). Sustainable forms of electricity, are the kinds of electricity generation that attempt to achieve an ecological balance by avoiding the depletion of the province's natural resources, either by increasing operational efficiencies or reducing fuel consumption. Clean coal (i.e. Coal power stations that utilize CCS), natural gas cogeneration (Co-gen), and nuclear are some examples of sustainable power generation.

Three final models were developed for Saskatchewan's future electricity market.

- The Conservative Model primarily utilizes natural gas power and introduces nuclear power. The least amount of GHG reductions occurs in this model.

- The Moderate Model increases the amount of nuclear power being utilized in order to offset a dependency on natural gas.

- The Progressive Model focuses on maximizing renewable energy and provides the highest reduction in GHG emissions. This model also introduces the utilization of large-scale solar power.

The combination of economic growth and increased future electrical demand puts Saskatchewan in a unique position to be able to explore all options of electricity generation. Saskatchewan has an abundance of natural resources, giving Saskatchewan the option to explore many sustainable forms of power generation technologies. By moving towards renewable and sustainable forms of electricity generation, SaskPower and ultimately Saskatchewan will be able to decrease their "carbon footprint" as well as reduce their output of all other GHGs..

2. Saskatchewan's Current Electricity Market

Saskatchewan takes full advantage of its large supply of coal. Being the dominant electricity generation fuel, coal makes up 41% of the total electrical capacity for the province in 2011 [5]. The second greatest source of electrical capacity comes from natural gas at 32%, totaling the reliance on fossil fuels to be 73% [5]. The remainder comes from wind power, hydro and some heat recovery, as presented in Figure 1. Figure 1 emphasizes Saskatchewan's heavy reliance on fossil fuel-

generated electricity, and shows the capacity for improvement to a more responsible and "green" electrical generating future.

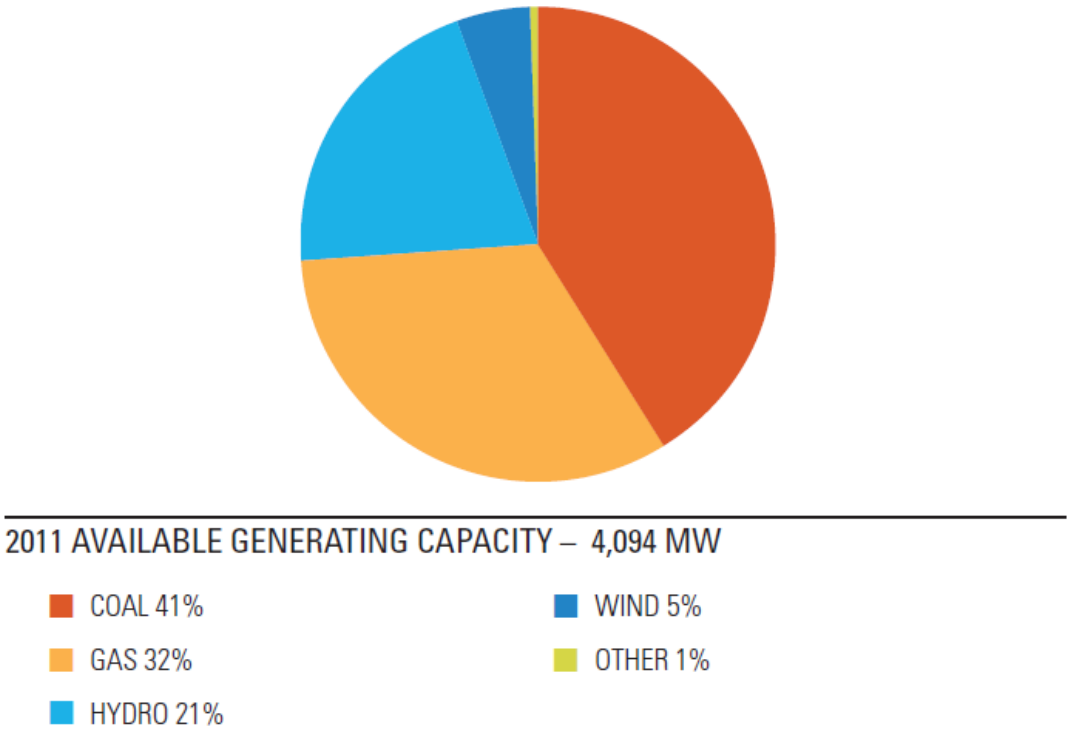

Figure 1: Available Generating Capacity in Saskatchewan for 2011 [5]

If one were to sum the present electrical situation in Saskatchewan in one word, it would be opportunity. The province has the ability to shift gears to become a more sustainable power producer, and a leader in emission reduction. It is time to take advantage of the situation in Saskatchewan and move forward, no longer as the leading emission producer, but an example for every region (i.e. province, state, and country), which wants to improve their sustainable practices.

Coal is currently the largest electrical production method implemented by SaskPower. Conventional burning of this fossil fuel is inexpensive, however , due to government mandates, conventional methods of coal-power will have to be phased out by 2035 [4]. Saskatchewan is the first in the world to experimentally run a full scale investigation of a "clean coal" practice at one of units in their Boundary Dam coal fired stations. In partnership with the Federal Government, $1.24 billion [3] has been allocated to CCS technology research, where captured carbon (CC) waste products may be used for oil recovery and other uses like carbon assisted geothermal capture [4]. Unit 3 will undergo refurbishment to produce 100 MW [3] – 150 MW [4] of base load electrical power to the grid, and is expected to be operational by 2015.

3. Electricity Models

These proposed electricity production models assume that CCS is not feasible. The models also share three unchanging traits for electricity capacity. First, hydro will be maxed out and contribute to 17% (1.05 GW); second, wind power will contribute to 15% (0.91 GW); third, coal plants not at the end of their lifetime will contribute 4% (0.24 GW) of electricity capacity. The models we have generated only look at overall capacity of the province. The electricity production from the individual sector type was not explored as it would be difficult to predict power production and usage for the future.

3.1 Conservative Electricity Model

In the conservative model we introduce a number of trends for our three recommended models for Saskatchewan. The first of which assumes the implementation of carbon capture on coal production is unsuccessful. As each coal power producing facility reaches its expected lifetime, the facility is retired and replaced by a more sustainable technology. The hydro-electric power production uses all available sites, and contributes a maximum of 1045 MW of power. Wind power also will have a drastic increase in all models, achieving between 15% and 17% of total capacity. The main focus of the conservative model lies in natural gas, with the addition of a small amount of nuclear power.

3.2 Moderate Electricity Model

As in the conservative model, this moderate plan takes into account that CCS is not viable for the future use in the province. As well this plan takes advantage of every potential hydropower facility with the province's basin. Wind power is also fully utilized to the desired 17%. Newly introduced in this model are the nuclear power aspirations of the province for use of the ACR-1000. This model features power production facilities that have the base load reliabilities provided by Natural Gas Cogeneration and a large-scale nuclear facility.

3.3 Progressive Electricity Model

The progressive model proposes the "greenest" option of the three models with the highest contributions from renewable and sustainable sources. Similar to the conservative and moderate model, hydropower and wind power will each provide 17% of Saskatchewan's electricity capacity. With conventional coal significantly phased out, natural gas and nuclear power will help replace this resource's contribution. Unlike the other two models, solar power is proposed to contribute 5% electricity capacity by 2033. With solar power technology becoming more inexpensive and increasingly competitive with other energy sources, it can be seen as an option for future large scale production.

4. Conclusion

Saskatchewan has the opportunity to make significant changes towards a more sustainable electrical grid in the next 20 years. It is important for Saskatchewan to make these changes because they have the highest GHG emissions per capita in Canada, a significant amount of power plants that need refurbishment or retirement in the near future, and growing electricity demands. The idea behind creating three energy models was to give Saskatchewan some feasible options to make those changes. Overall, we would like to recommend the following options:

- Apply CCS technology to coal or replace those stations with a more sustainable practice.
- Maximize the use of Saskatchewan's available hydropower resources.
- Exploit the availability of wind power across the province.
- Utilize Saskatchewan's uranium resources and implement nuclear power.
- Explore the potential of solar power in Saskatchewan.

Saskatchewan already has a huge amount of effort going into future electrical grid planning. No matter what energy model is applied, the overall goal to reduce GHG emissions will be achieved.

5. References

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