Rook I Project

Environmental Impact Statement

TSD XII: Net-Zero Framework

NET-ZERO FRAMEWORK TECHNICAL SUPPORT DOCUMENT FOR THE ROOK I PROJECT

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Abbreviations and Units of Measure

Abbreviation	Definition
GHG	greenhouse gas
IMS	Integrated Management System
NB	New Brunswick
NexGen	NexGen Energy Ltd.
Project	Rook I Project
SACC	Strategic Assessment of Climate Change
SMR	small modular reactor

Unit	Definition
%	percent
km	kilometre
MW	megawatt

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TABLES

1 INTRODUCTION

NexGen Energy Ltd. (NexGen) is proposing to develop a new uranium mining and milling operation in northwestern Saskatchewan called the Rook I Project (Project). The Project would be located approximately 40 km east of the Saskatchewan-Alberta border, 130 km north of the town of La Loche, and 640 km northwest of the city of Saskatoon. The Project would reside within Treaty 8 territory and the Métis Homeland. At a regional scale, the Project would be situated within the southern Athabasca Basin adjacent to Patterson Lake, along the upper Clearwater River system. Access to the Project would be from an existing road off Highway 955.

NexGen has a vision to help deliver the clean energy fuel needs of current and future generations. The proposed Project would provide a source of uranium that could be used in small modular reactor technology. If used in Saskatchewan, this technology could reduce carbon emissions in electricity production, and therefore contribute to the Government of Government of Canada's ability to meet its environmental obligations and commitments with respect to climate change by displacing higher greenhouse gas (GHG) intensity, fossil fuel (e.g., coal) electrical generation. With the proposed Project, NexGen is advancing the world's largest uranium project under development, with a commitment to protecting and promoting the health, safety, and well-being of people and the environment. As part of its vision and values, NexGen is committed to protecting and preserving the environment through the lifespan of the Project and to responsibly managing energy use and GHG emissions as outlined in the Integrated Management System (IMS) Policy.

Notwithstanding its potential for net GHG reductions, the Project has the potential to affect climate change through the emissions of GHGs associated with different Project activities during the Construction, Operations, and Decommissioning and Reclamation (i.e., Closure) phases. As part of the Environmental Impact Statement (EIS), a detailed assessment of the potential effects of the Project on climate change was undertaken (EIS Section 7.4, Climate Change). This included preparation of a GHG emissions inventory and identification of the main sources of GHG emissions for the proposed Project. With a 4-year Construction duration and 24-year Operations duration, the operational lifespan of the Project is planned to extend until the early 2050s.

This net-zero framework has been developed based on the guidance provided in the *Draft Technical Guide Related to the Strategic Assessment of Climate Change* (SACC; SACC Technical Guide; Government of Canada 2021). Considering the early stage of Project development, the net-zero framework provides a preliminary assessment of potential alternative technologies and practices that could be used to reduce Project GHG emissions during the lifespan of the Project. Considerations for future decision making on the implementation of alternative technologies and practices have been identified, and it is expected that the framework would evolve as the Project design advances.

Finally, the framework outlines key barriers to implementing the technologies and discusses required support from Government to facilitate the implementation.

2 CONTEXT

The Project falls under the *Canadian Environmental Assessment Act,* 2012 (CEAA 2012). Under the CEAA 2012, there is no requirement to develop a net-zero plan or demonstrate how the Project plans to reduce emissions over the course of the Project lifespan. However, there is new guidance called the *Strategic Assessment of Climate Change (SACC) 2020* (Government of Canada 2020a) and the accompanying SACC Technical Guide that applies to Projects falling under the *Impact Assessment Act,* 2019 (IAA 2019). Although the Project is not required to develop a net-zero plan, NexGen has commenced the process of planning for future reduction in GHG emissions at the proposed Project. To that end, this net-zero framework would be used as a roadmap for fulfilling NexGen's commitment to protecting and preserving the environment through the Project lifespan and to responsibly managing energy use and GHG emissions, as outlined in the IMS Policy. Further discussion of the IMS is found in the Technical Support Document XIII, Upstream Greenhouse Gas Emissions and Carbon Intensity Discussion.

The SACC (Government of Canada 2021) and accompanying draft SACC Technical Guide outline the approach to developing a net-zero plan and requires that both direct emissions (Scope 1) and acquired energy GHG emissions such as grid electricity (Scope 2) are considered. There are no Scope 2 emissions for the Project, so the net-zero framework focusses on Scope 1 emissions. The development of a net-zero plan is guided by the best available technologies / best environmental practices determination process, which includes identification of GHG mitigation measures. The net-zero plan process as outlined in the SACC is summarized in a series of steps shown in Table 1. This process would be used as a guide for developing the net-zero framework for the Project.

Table 1: Strategic Assessment of Climate Change Steps of the Best Available Technologies / Best Environmental Practices Determination Process to Support a Net-Zero Plan

Step	Description
Step 1: Listing of technologies and practices	Projects identify all available technologies and practices based on the identified main sources of emissions for each project phase.
Step 2: Technical feasibility assessment	Projects identify whether the identified technologies and practices are feasible for implementation under specific circumstances of the project.
Step 3: GHG reduction potential assessment	Projects identify the GHG effects of each identified technology/practice on the main sources of emissions for the project.
Step 4A: Economic feasibility assessment	Projects eliminate technologies and practices that may not be economically feasible for implementation during the project lifespan.
Step 4B: Additional considerations	Projects identify the social, health, and environmental effects of the alternative technologies and practices, through stakeholder engagement.
Step 5: Selection of best available technologies / best environmental practices	Projects combine technologies and practices and develop scenarios at the project level by considering emission sources and potential interactions between the mitigation measures.
Step 6: Review by the Government of Canada	This step includes review which is undertaken by the Impact Assessment Agency of Canada or life cycle regulators, with the support of expert federal authorities.

GHG = greenhouse gas.

3 PROJECT GREENHOUSE GAS EMISSIONS PROFILE

Based on the GHG inventory described in Section 7.4 of the Environmental Impact Statement, the Project's main sources of Scope 1 GHG emissions are summarized in Table 2. This emission profile is the average annual emissions over the Project's lifespan by source. On-site electricity generation, on-site mobile equipment, and mine and building heating have the highest emissions compared to others, and hence they have been considered for the net-zero framework. Emissions associated with land use change, stationary combustion, waste incineration, industrial processes, and explosives have a relatively small combined contribution of 12.6% of annual emissions, and therefore have not been evaluated in the net-zero framework at this early stage.

Table 2: Project Main Greenhouse Gas Emission Sources

GHG Emission Source	Total % of Average Annual GHG Emissions	Description
On-site electricity generation	59.3%	Emissions from natural gas and diesel combustion from the generators used to produce electricity.
On-site mobile equipment	14.7%	Emissions from diesel combustion of surface and underground mobile equipment that would be used for construction, mine operations, road maintenance, material management, and personnel movement.
Mine and building heating	13.4%	Emissions from natural gas combustion within the mine and building heaters used for underground and surface operations.
Land use change, stationary combustion, waste incineration, industrial processes, and explosives	12.6%	Emissions from land use change includes emissions from the lost carbon sink annually due to removed vegetation and the one-time total carbon losses in biomass due to disturbances. Emissions from stationary combustion includes emissions from the natural gas and diesel combustion from the burner that would heat the calciner to remove impurities from the processed ore and fossil fuel use in the incinerator. Emissions from waste incineration includes the emissions released through the incineration of domestic and low-level radiological waste. Emissions from industrial processes includes the emissions from the sulphuric acid production plant and the acidification of ore material. Emissions from explosives includes emissions associated with blasting.

GHG = greenhouse gas.

4 NET-ZERO FRAMEWORK

The net-zero framework provides early identification of potential technologies and practices that could be used to reduce future GHG emissions from the Project.

Considering that the Project is still in an early phase, this document provides the net-zero framework that was guided by steps 1 through 3 of the best available technologies / best environmental practices determination process from the SACC (Table 1).

Project-specific considerations at each step are described in the following:

Step 1: Listing of technologies and practices

- A preliminary list of available and emerging technologies and practices for the main sources of Project GHG emissions was developed.
- A brief description was developed for each technology/practice that outlines how the technology could be applied to the Project, and any Project-specific studies undertaken to date to evaluate the feasibility of the technology/practice option.

Step 2: Technical feasibility assessment

For each identified technology/practice from Step 1, the current status of the technology/practice was identified using the categories summarized in Table 3.

Table 3: Technology/Practice Status Categories

Category	Description
Established	Commercially available and wide adoption in the mining sector
Available	Commercially available and limited adoption in the mining sector
Emerging	Not in wide commercial use, pilot project level
Research and development	Theoretical and planned pilot

Step 3: GHG reduction potential assessment

For each technology/practice from Step 1, the GHG reduction potential was identified using the categories summarized in Table 4.

Table 4: Greenhouse Gas Emissions Reduction Potential Categories

Category	Description
Low	<10% reduction potential in site-wide absolute emissions
Moderate	10%-50% reduction potential in site-wide absolute emissions
High	>50% reduction potential in site-wide absolute emissions

< = less than; > = more than.

5 ALTERNATIVE TECHNOLOGIES AND PRACTICES ASSESSMENT

Based on the approach provided in Section 4 of this document, a preliminary alternative technologies and practices assessment was conducted for the Project, which is summarized in Table 5. The assessment focussed on the activities that are the largest GHG emission sources, including on-site electricity generation, on-site mobile equipment, and mine building and heating. For on-site electricity generation, feasibility studies have been undertaken on alternative energy sources such as solar, wind and grid connection (Stantec 2019 and SLR 2021). Solar energy was eliminated from project design as it was identified that it is not technically feasible to implement solar panels compared to wind energy, as summarized in Table 5. Connection to the grid was also eliminated as a feasible option because of the high costs associated with installing a powerline. If the emissions intensity of Saskatchewan grid is reduced, the costs associated with grid connection could be revisited and re-evaluated against the costs associated with other alternative technologies for onsite electricity generation.

Based on the Project's development timelines, the EIS has been based on power generation using natural gas from Liquified Natural Gas (LNG). As the Project design progresses, and in consideration that on-site electricity generation is the largest Project GHG emission source, future work is expected to further assess and refine power generation options.

The alternative technologies and practices have been grouped by opportunity category by which the emissions could be reduced (e.g., fuel switching, electrification). For the identified technologies and practices, the current technology status and the GHG emissions reduction potential were identified based on the categories summarized in Table 3 and Table 4, respectively. The preliminary list of technologies and practices represents the available options at the time of this report. The available technology and practices would likely evolve and need to be re-evaluated, as discussed in Section 6, Decision Making.

Table 5: Alternative Technology and Practices Assessment

Opportunity Category	Technology Option	Technology Description	Current Technology Status	Preliminary GHG Reduction Potential
On-Site Electricity Generation				
On-site electricity generation	Hybrid System	A hybrid system is a combination of two or more methods of electricity generation to supply power. It is commonly used to integrate renewable energy sources such as solar photovoltaic (PV) or wind turbines so that they become a portion of the overall power supply. A hybrid system could be used for on-site electricity generation, which includes incorporating an on-site power plant combined with renewable energy alternatives (e.g., solar PV arrays, wind turbines) and batteries. A renewable energy scoping study was conducted for the Project to investigate the technical and commercial potential of including renewable energy generation at the Project (SLR 2021). Results of the scoping study indicated that a hybrid system including combination of natural gas generators and wind turbines along with a battery energy storage system are a feasible proposition for the Project, and recommended the proposition could be included in future design phases, as they are advanced. To produce approximately 50% of electricity through wind turbines, 12 wind turbines with a rated power of 3.465 MW plus 13 MWh battery energy storage was considered in the study (SLR 2021). Generating electricity utilizing solar PV technology was not found to be feasible for the Project due to the variance in solar radiation available between the summer and winter months (SLR 2021).	**Established:** This technology is commercially available and widely adopted in the mining sector. Some examples where this technology has been implemented at mine sites that are located in Northern Canada include: ▪ Diavik Mine (Diavik Diamond Mines Inc.) in the Northwest Territories have installed four 2.3 MW E70 Enercon turbines, that have been operational since 2012. ▪ Raglan Mine (Glencore) in Northern Quebec have installed two 3 MW E82 Enercon turbines (2014 & 2018). Glencore has committed to installing two more turbines as of 2021. The wind turbine generation is integrated into the mine diesel grid, supported by energy storage, as part of their micro grid pilot project. ▪ Meliadine Mine (Agnico Eagle) in Nunavut is pursuing a wind farm project at their operations.	**Low to Moderate:** Reduction potential would depend on the percentage of power source coming from natural gas versus wind. With 50% of power from renewables, this would result in a moderate classification Having 50% of power come from renewables would lead to an approximate 30% reduction potential in site-wide emissions, as on-site electricity generation is responsible for 59.3% of total Project emissions.
On-site electricity generation	SMR	An SMR is a nuclear reactor facility that is smaller than a traditional nuclear power plant, and it may employ novel technologies such as passive/inherent safety features, and extensive use of factory-built modules (CNSC 2020). For remote mine sites with electricity demands between 10 and 20 MV, SMRs could potentially reduce energy costs	**Research and development:** Currently, this technology is in the research and development phase and not available commercially. In 2021, four power companies (Ontario Power Generation, Bruce Power, Energie NB Power, and SaskPower) published a report that provided a feasibility assessment of SMR development and deployment and provided the power companies' business case	**High:** The Project has a nominal electricity demand of 24.1 MW, based on the power requirements from the mine feasibility study, which was nine 3.329 MW natural-gas fired generation units to meet nominal demand of 24.1 MW (SLR 2021). Deployment of two, 10-MW unit SMRs could help meet 20 MW (83%) of this

Table 5: Alternative Technology and Practices Assessment

Opportunity Category	Technology Option	Technology Description	Current Technology Status	Preliminary GHG Reduction Potential
		(Ontario Power Generation et al. 2021). Currently, four utilities (SaskPower, Ontario Power Generation, Bruce Power, and NB Power) are working on developing three streams of SMRs. One of those streams (i.e., Stream 3) includes bringing affordable, clean energy to remote mine sites (Ontario Power Generation et al. 2021).	for implementation of SMRs in the provinces of Saskatchewan, New Brunswick, and Ontario (Ontario Power Generation et al. 2021). Stream 3 of this study proposed a new class of micro-SMRs that would be suitable for mine sites. To advance the technology, a 5 MW gas-cooled reactor project is underway at the Chalk River site in Ontario. The project is being undertaken by the Ultra Safe Nuclear Corporation (USNC) and is expected to be operational by 2026 (Ontario Power Generation et al. 2021).	electricity demand, which would lead to an approximate 50% reduction in site-wide absolute emissions, as on-site electricity generation is responsible for 59.3% of total Project emissions.
On-Site Mobile Equipment				
Fuel switching	Diesel to biodiesel	Biodiesel is a diesel fuel substitute that is used in diesel engines and is made from renewable materials such as plant oils, waste cooking oils, and animal fats (Government of Canada 2020b). Biodiesel is blended with petroleum diesel and blends of 20% biodiesel (B20) are commonly approved for use in equipment. The higher biodiesel blends can gel in colder conditions, so it is best suited for underground work or seasonal use in the warmer months.	**Available:** Biodiesel is available for implementation; however, blends are generally a low percentage and limited to warmer months for surface equipment. Barriers to wider adoption of higher blends relate to varying performance feedback. While some operations have been able to operate at higher blends, such as Hutchinson Salt Company in Kansas having used 100% biodiesel in their underground equipment since 2003 (Biodiesel Sustainability Now, 2020), other mines have reported operational issues relating to additional maintenance requirements and lower equipment performance, with blends closer to B20 (Carmeuse, 2019).	**Low:** The GHG emissions reduction would depend on the biodiesel blend used. Assuming all diesel use in the mobile fleet is replaced with a B20 blend, it would lead to an approximate 20% reduction of GHGs from mobile equipment (14.7% of Project emissions), and would reduce total Project emissions by almost 3%.
	Diesel to renewable diesel	Renewable diesel is produced through various processes such as hydrotreating, gasification, pyrolysis, and other biochemical and thermochemical technologies. It is chemically the same as diesel and can be used directly as a diesel substitute year-round (US Department of Energy 2021).	**Emerging:** This technology is not in wide commercial use in the mining sector in Canada. There is currently a limited supply of renewable diesel, although this is expected to change in the future as more production is planned. For example, the Strathcona refinery in Alberta could produce about 3 million litres of renewable diesel per day in 2024 (Imperial Oil 2022).	**Moderate:** Assuming all diesel use in the mobile fleet is replaced, it would lead to 100% reduction of GHGs from mobile equipment, and would reduce total Project emissions by 14.7%.
	Diesel to Hydrogen (Hydrogen Fuel Cell Equipment)	Hydrogen fuel cells convert hydrogen and oxygen into electricity onboard, while producing no tailpipe emissions. This electricity can be utilized to	**Emerging:** This technology is expected to be piloted in 2022 at the Mogalakwena (Anglo American) platinum mine in South Africa,	**Moderate:** Assuming all diesel use in the mobile fleet is replaced, it would lead to 100% reduction of GHGs from mobile equipment, and

Table 5: Alternative Technology and Practices Assessment

Opportunity Category	Technology Option	Technology Description	Current Technology Status	Preliminary GHG Reduction Potential
		power an electric drivetrain of any piece of equipment. The total lifecycle GHG emissions depend on the carbon intensity of the hydrogen production.	powering a Komatsu 930E (291-ton capacity) haul truck. A 3.5 MW electrolyser will be constructed on site for the hydrogen fuel production (Anglo, n.d.). Development of an underground fuel cell loader was carried out almost 20 years ago; however, due to the smaller market, as well as safety concerns with storing and operating hydrogen underground, commercialisation for surface equipment has made further advances (Vehicle Projects Inc., 2009).	would reduce total Project emissions by 14.7%.
Electrification	Battery-powered haul truck	Battery electric haul trucks are powered by energy stored in batteries, and do not have a conventional gasoline or diesel engine.	**Available:** This technology is being planned/implemented at Canadian underground mines including: ▪ Brucejack Mine (Pretivm) have undertaken a successful trial and have purchased 50-tonne haul trucks (Sandvik Z50s) to replace their existing diesel haul trucks (Sandvik 2021). ▪ Borden Mine (Goldcorp) is planned to be all electric mine fleet. ▪ Glencore's Onaping Depth Project (in construction) will be an all-electric fleet deep mine operation (Mining News North 2021).	**Low:** Assuming all diesel use in the mobile fleet is replaced with electric, and assuming the on-site electricity generation is the hybrid system described above with 50% of power from renewables, this would lead to an approximate 7% reduction potential of total Project emissions, as mobile fleet emissions are responsible for 14.7% of total Project emissions. The reductions due to electrification of haul trucks only would be less than 7% of total Project emissions, because haul truck are only a portion of the mobile fleet.

Table 5: Alternative Technology and Practices Assessment

Opportunity Category	Technology Option	Technology Description	Current Technology Status	Preliminary GHG Reduction Potential
	Battery-powered loaders and utility/light vehicle trucks	Battery electric vehicles and loaders are powered by energy stored in batteries, and do not have a conventional gasoline or diesel engine.	**Available:** This technology is being planned/implemented at Canadian Mine sites including: ▪ The Onaping Depth Project (Glencore) have two battery electric flat decks, with one serving as the water truck for ramp maintenance to support the mine construction. In addition, two electric utility vehicles are used for personnel movement throughout the mine (Glencore 2020).	**Low:** Assuming all diesel use in the mobile fleet is replaced with electric, and assuming the on-site electricity generation is the hybrid system described above with 50% of power from renewables, this would lead to an approximate 7% reduction potential in total Project emissions, as mobile fleet emissions are responsible for 14.7% of total Project emissions. The reductions due to electrification of battery powered loaders and utility/light vehicle trucks would be less than 7% because they are only a portion of the mobile fleet.
	Conveyors	A conveyor system can be used as a transportation system to move ore instead of hauling with a mobile fleet. The most common conveyor system is a belt system.	**Established:** This technology is available and has been implemented by various mining operations. This technology is being planned/implemented at mine sites including: ▪ Goldex Mine (Agnico Eagle) has a 3 km underground railveyor system with electric motors which are powered by hydroelectric power source (Railveyor, n.d.).	**Low:** Conveyors would only replace a portion of the mobile fleet used on the site. Mobile fleet emissions comprise 14.7% of total Project emissions, and use of conveyors would only reduce part of these emissions. Hence, use of conveyors would help in reduction of less than 10% of total Project emissions.
	Tethered electric mining equipment	Tethered electric mining equipment have a hybrid diesel/electric powertrain. The diesel power allows the equipment to move around the mine. When in operation, the equipment tether to an electrical source.	**Established:** This technology is available for equipment such as loaders, shovels and drills. This technology is being planned/implemented at mine sites including: ▪ The Zielitz Potash mine is testing a tethered electric LHD (Load Haul Dump) with onboard battery capability for mobility for it's underground mine (International Mining 2021). ▪ The Borden Gold Mine (Goldcorp) located in Sudbury, Ontario will be using tethered equipment (such as tethered scoops) for underground mining operations. The mine plans to use tethered scoops until quick-charge battery is viable (Goldcorp 2016, Pollon 2016)	**Low:** Assuming all diesel use in mobile fleet is replaced with electric, and assuming the on-site electricity generation is the hybrid system described above with 50% of power from renewables, this would lead to an approximate 7% reduction potential in total Project emissions, as mobile fleet emissions are responsible for 14.7% of total Project emissions. The reductions due to tethered electric mining equipment only would be less than 7% of total Project emissions because the tethered equipment are only a portion of the mobile fleet.

Table 5: Alternative Technology and Practices Assessment

Opportunity Category	Technology Option	Technology Description	Current Technology Status	Preliminary GHG Reduction Potential
Fleet management and autonomous haul trucks	Fleet management and tracking tools	Fleet management systems and tracking tools include computer-based dispatching tools, which optimize haulage and vehicle routes and reduce truck idling time. Properly maintaining equipment prevents failures and lowers overall operational costs (Mining Technology 2018).	**Established:** This technology is available for near-term implementation with a range of vendors providing services for fleet management. More traditionally seen in open pit operations, fleet management is being adopted underground with communication system improvements. Myra Falls (Nystar) in British Columbia adopted an underground fleet management system in 2020, increasing production by about 15% on average (Outliers Mining Solutions, n.d.).	**Low:** Increasing equipment utilization, while eliminating unnecessary idling time is estimated to reduce mobile fleet emissions by about 3% (Teck, 2014), which would result in the total Project emission reduction of less than 1%.
	Autonomous haul trucks	Autonomous haul trucks use technology to drive the vehicle instead of an operator. Operation of the truck can be optimized reducing fuel consumption and maintenance.	**Emerging:** Though this technology is available for implementation for open pit mines, it is in a development stage for underground mines: ▪ The Brucutu iron ore open pit mine (Vale) in Brazil has become the first mine with 100% autonomous haulage (Jamasmie 2021). ▪ Volvo Group is developing autonomous trucks for underground mines which were tested at the Kristineberg mine in Sweden (1,300 m underground) (Mining Technology 2021). ▪ Sandvik has launched AutoMine for Trucks in March 2020 for autonomous truck haulage for underground mines (Mining Technology 2021).	**Low:** GHG reduction would be a result of reduced fuel consumption and increased operational efficiency. Based on various studies, autonomous vehicles are estimated to reduce GHG emissions by about 10% (Engholm et al., 2020), which would reduce the total Project emissions by 1.5%.

Table 5: Alternative Technology and Practices Assessment

Opportunity Category	Technology Option	Technology Description	Current Technology Status	Preliminary GHG Reduction Potential
Mine and Building Heating				
Efficient technologies	Heat recovery / heat exchangers	Heat recovery captures waste heat from process water, process plant exhaust, ventilation exhaust and/or compressors via a preheater / heat exchanger.	**Available:** This technology is available and has been implemented in the global mining sector: ▪ Zinkgruvan mine (Lundin) installed a plate heat exchanger for their mine ventilation heating system, using the heat in the return air to preheat incoming air (Holmund, 2015). ▪ Line Creek Coal mine (Teck) installed a heat exchanger unit between the exhaust and intake air to recover waste heat (Government of BC, n.d.).	**Low:** Potential energy reduction depends on the technology application and varies based on the amount of heat energy recovered. The largest heating load is expected to be heating ventilation air, and according to Holmund (2015), the fuel consumption for heating can be reduced by up to 90%. Assuming ventilation accounts for about half of the mine and building heating emissions (13.4%), it may reduce total Project emissions by up to 6%.
Energy supply	Air to air heat pumps	Heat transfer from ambient air via heat exchanger, which is then brought up to design temperature through a heat pump. These systems are typically integrated into heating, ventilation, and air conditioning (HVAC) systems for building heating.	**Available:** This technology is widely available and has been successfully installed in various HVAC applications for residential, commercial or industrial buildings. Though specific case studies to the mining sector were not available, this technology is being implemented by the Vancouver City Hall: ▪ Vancouver City Hall is implementing Air Source Heat Recovery unit which is more efficient and can meet the requirements of cooling, heating, and domestic hot water (City of Vancouver, n.d.).	**Low:** In terms of site-wide absolute emission reduction, the GHG reduction potential is low (<5%), as space heating loads are generally small at mine sites.

GHG = greenhouse gas; HVAC = heating, ventilation, and air conditioning; MW = megawatt; MWh = megawatt hour; NB = New Brunswick; SMR = small modular reactor.

6 DECISION MAKING

The technologies and practices identified in Section 5, Alternative Technologies and Practices, provide alternatives that could help the Project reduce GHG emissions from on-site electricity generation, on-site mobile equipment, and mine and building heating in the future. However, for future decision making on selection of which GHG reduction technologies and practices to implement, a range of factors have been identified that need to be considered including: Indigenous, public, and regulatory engagement; technologies and practices interdependencies; and economic feasibility assessment. More detailed decision making would consider barriers to the implementation and solutions required to overcome those barriers, which could include Government support. Future decision making would revisit and build upon the alternatives technologies and practices identified, as a part of NexGen’s continual improvement process. This approach of re-assessing technologies and practices aligns with NexGen’s commitment to manage energy use and reduce GHG emissions.

Indigenous and Stakeholder Engagement:

Indigenous, public, and regulatory engagement is a key consideration in making decisions on which future technologies and practices could be implemented. The Project could consider undertaking engagement as a part of the continual improvement process to identify whether:

- a technology or practice could have social or health effects that could affect local Indigenous Groups and communities, including their quality of life, employment, demographics, and Indigenous rights; and
- a technology or practice could have adverse effects such as release of air pollutants or affect carbon sinks.

Technologies and Practices Interdependencies:

The technologies and practices listed in Section 5 could be interdependent, and it is necessary to identify those interdependencies as a part of decision making. For example, the alternatives technologies and practices assessment identified that SMRs have the highest emission reduction potential. Integration of an SMR has the potential to provide a clean source of electricity, which would change the profile of GHG emissions at the Project. Under this scenario, the GHG emission reduction potential of other technologies would have to be reviewed again, as an SMR would likely facilitate electrification of other sources such as mobile fleet and increase the emissions reduction potential as compared to the base case assumption of LNG as the primary fuel source for on-site electricity generation.

Economic Feasibility Assessment:

Economic feasibility is a key consideration in identifying whether a technology or practice could be implemented. The Project could consider the following for an economic feasibility assessment:

- if the technology or practice is feasible based on implementation costs, profits, and price of carbon;
- if the costs and uncertainty are high for a technology or practice that has not been used or tested on mine sites, under similar conditions; and
- if there are any other economic risks associated with the technology or practice.

For example, a feasibility study was conducted for the Project to assess the economic viability of alternative energy options (SLR 2021). In that study, economically viable combinations of numbers and sizes of generators, wind turbines, solar cells, and batteries were identified, and evaluated in terms of net present cost. Results of the study indicated that a hybrid system would be more economically attractive than connecting to the existing power grid (SLR 2021).

7 REQUIRED GOVERNMENT SUPPORT TO OVERCOME BARRIERS TO SMALL MODULAR REACTORS

The alternative technologies and practices assessment (Section 5) identified a range of measures that could be implemented by the Project to reduce GHG emissions. Of the technologies and practices considered, SMRs have the highest emission reduction potentials. However, implementation of SMRs currently has a range of barriers including:

- working prototypes for the industry, as they are not commercially available at this time;
- regulatory, licensing, and permitting uncertainty, both at provincial and federal levels;
- large capital investments; and
- potential Indigenous and public perception and acceptance of the technology.

Federal and provincial government support would be required to overcome the barriers associated with implementation of SMRs, specifically the following:

- increasing public awareness and acceptance for implementation of SMRs;
- increasing the investment and innovation in the SMR technology and infrastructure;
- defining regulatory requirements (e.g., permitting and licensing) and ensuring the regulatory processes are efficient for implementation of the technology;
- conducting a detailed, sector-wide study that could help define the strategies and/or incentives for implementation of SMRs on the provincial scale; and
- aligning with the emission reduction potentials outlined in the Made-in-Saskatchewan Climate Change Strategy (Government of Saskatchewan 2017), by implementation of SMRs on remote mine sites.

Currently, the Project design includes on-site power generation through natural gas. Providing Project-level support for implementation of SMRs aligns with the *Saskatchewan Growth Plan* (Government of Saskatchewan 2015) that aims to reduce GHG emissions from electricity generation by 40% by 2030 from 2005 levels. In its Made-in-Saskatchewan Climate Change Strategy (Government of Saskatchewan 2017), the Government of Saskatchewan has identified that SaskPower has committed to increase renewable power generation to 40% of it's total generating capacity by 2030. SaskPower also anticipates that there could be an increase in the demand for zero emissions electricity to support the electrification of transportation and other sectors and there could be more stringent regulations to reduce carbon dioxide emissions from power generation post-2030. Hence, SaskPower is evaluating potential alternatives to reduce their GHG emissions, including implementation of SMRs (Ontario Power Generation et al. 2021). The Government of Saskatchewan is also evaluating options to fuel the provincial SMRs with provincially mined uranium (Ontario Power Generation et al. 2021).

An economic and technical feasibility study is being conducted by SaskPower for deployment of a 300 megawatt (MW) nuclear power plant by 2032. SaskPower is also evaluating potential deployment of an additional 900 MW of power generating capacity from SMRs between 2035 and 2042. The Government of Saskatchewan aims to investigate the possibility of creating commercial contracts in the heavy industry and mining industry for implementation of SMRs (Ontario Power Generation et al. 2021). Hence, the remote mine sites in Saskatchewan have an opportunity to collaborate with the provincial government to implement SMRs and reduce their GHG emissions. By providing support to the Project for implementation of SMRs fuelled by provincial uranium, the Project would be able to reduce its GHG emissions considerably and contribute towards the ongoing emission reduction targets set by the Government of Saskatchewan. Implementation of SMRs also supports achieving Federal Government targets of phasing out coal by 2030 and achieving net-zero GHG emissions by 2050.To support the implementation of SMRs, the Federal Government would need to define efficient regulatory processes, including permitting and licensing of SMRs and management of waste.

8 SUMMARY

Based on the requirements stated in the *Canadian Environmental Assessment Act*, 2012, and the SACC, a net-zero plan is not required for the proposed Project. However, the Project has a potential to affect climate change through the emission of GHG. As a part of its vision and values, NexGen is committed to protecting and preserving the environment through the lifespan of the Project and to responsibly managing energy use and GHG emissions. In alignment with NexGen's vision and values, a net-zero framework has been developed for the Project which has considered guidance provided in the SACC Technical Guide.

The net-zero framework identifies a range of alternative technologies and practices that could be implemented by the Project to reduce GHG emissions. Considering the early stage of Project development, the framework is guided on the first three steps of the draft SACC Technical Guide, which includes listing of technologies and practices, a technical feasibility assessment, and a GHG reduction potential assessment.

Following that, the proposed net-zero framework identifies that, for future decision making on implementation of GHG reduction technologies and practices, a range of factors need to be considered including: Indigenous, public, and regulatory engagement; technologies and practices interdependencies; and economic feasibility assessment. The framework is expected to evolve to incorporate these decision-making considerations as the Project design advances.

Given the interdependency of potential GHG reduction opportunities, if any technology or practices are selected for implementation, it could modify the feasibility of implementation of other technologies and practices. Hence, as a part of the continual improvement process, the alternative technologies or practices would need to be re-assessed based on implementation of any new technologies and practices as part of the continual improvement process described in the IMS Manual and Environmental Protection Program.

CLOSING

Golder is pleased to submit this report to NexGen in support of the environmental assessment for the Rook I Project. For details on the limitations and use of information presented in this report, please refer to the Study Limitations section following this page. If you have any questions or require additional details related to this study, please contact the undersigned.

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