ECOVENTURE

Alberta Utilities Commission

Inquiry Into the Ongoing Economic, Orderly, and Efficient Development of Electricity Generation in Alberta

Proceeding 28501

Consideration of Implementing Mandatory Reclamation Security Requirements for Power Plants

November 8, 2023

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APPENDICES

LIST OF ACRYONMS

AACE – Association for Advancement of Cost Engineering

AEP – Alberta Environment and Parks

AEPA – Alberta Environment and Protected Areas

AER – Alberta Energy Regulator

AESO – Alberta Electric System Operator

AGL – Above ground level

ARO – Asset retirement obligation

AUC – Alberta Utilities Commission

AUD – Australian Dollar

BCER – British Columbia Energy Regulator

BEIS – United Kingdom Department of Business, Energy, and Industrial Strategy

BLM – United States Department of the Interior's Bureau of Land Management

CAD – Canadian Dollars

CEC – California Energy Commission

CER – Canada Energy Regulator

CIRNAC – Crown-Indigenous Relations and Northern Affairs Canada

CPI – Consumer Price Index

DLAs – Designated leasing areas

EDF Energy - EDF Energy Nuclear Generation Limited

EPEA – Environmental Protection and Enhancement Act

EOR – Engineer of Record

ESA – Environmental Site Assessment

EU – European Union

FCSAP – Federal Contaminated Sites Action Plan

Gov. of Sask's ARO - Government of Saskatchewan's Acknowledgement of Reclamation

ha – hectare

IOGC – Indian Oil and Gas Canada

IOL – Indian Owned Land

LCA – Licensee Capability Assessment

LFP – Large Facility Liability Management Program

LLR – Licensee Liability Rating

LMP – Licensee Management Program

LMR – Liability Management Rating

MFSP – Mine Financial Security Program

MITECO – Ministry of Ecological Transition and Demographic Challenge

MOECC – Ontario Ministry of the Environment and Climate Change

MW – megawatt

ORB – Office of Budget Responsibility

OWA – Orphan Well Association

OWL – Oilfield Waste Liability Program

PCBs – Polychlorinated biphenyls

PV - Photovoltaic

RCA – Reclamation certificate application

REDA – Responsible Energy Development Act

REO - Renewable Energy Operation

RIA – Regional Inuit Association

SEK – Swedish Krona

SRP – Site Rehabilitation Program

SSLAs – Site-Specific Liability Assessments

SOGOF – Saskatchewan Oil and Gas Orphan Fund

WEEE - Waste Electrical and Electronic Equipment

USD – American Dollars

£ - Pound

€ - Euro

GLOSSARY

Aboveground and below ground mounts - stabilize and hold frame structures and panels in place

Access road - road to access wind turbine and associated facilities

Agricultural lands - lands that are managed under conventional, minimal or zero till practices for agricultural purposes, which include cereal or small seeded, crops, tame forages, tame pastures, hay lands, agroforestry or specialty crops that require management

Alberta Environment and Protected Areas (AEPA) - oversees legislation applicable to Alberta's environment and ecosystems

Alberta Energy Regulator (AER) - regulator of energy development in Alberta, specifically for upstream oil and gas, oil sands and coal projects, and provides regulatory oversight for all stages from application to end of life closure and reclamation

Alberta Electric System Operator (AESO) - responsible for providing for the safe, reliable and economic operation of the Alberta interconnected electric system and for promoting fair, efficient and openly competitive markets for electricity, in accordance with applicable legislation

Alberta Utilities Commission (AUC) - regulates the utilities sector, natural gas and electricity markets to protect social, economic and environmental interests of Alberta where competitive market forces do not

Area Based Closure Program – three- year program in Alberta to incentivize oil and gas companies to permanently close inactive or marginally productive oil and gas wells

Biomass – conversion of chemical energy from plants and animals

Brownfield lands - a commercial or industrial property which is: contaminated or possibly contaminated. vacant, derelict or underutilized. suitable for development or redevelopment

Canada Energy Regulator (CER) - regulate pipelines, energy development and trade in the Canadian public interest

Closure quotas - specify the minimum amount of money that licensees are required to spend on oil and gas closure work each year and encourages oil and gas companies to collaborate to increase efficiency of projects and complete more closure work

Collection system – collects energy from solar panels or wind turbines and transmits it to substation

Crown Land - lands that are classified as public lands that are managed by the provincial government on behalf of the King of England

Directive – an official or authoritative instruction

Decommissioning - the permanent closure of all or part of a facility followed by removal of process equipment, buildings and other structures

End-of-life – end of the useful life of equipment or facility, specified date after which it will no longer be used for its specified purpose

Environmental Protection and Enhancement Act (EPEA) - a Provincial act established to protect air, land, and water. The EPEA is one of the two main regulations governing environmental issues in Alberta.

Equivalent land capability - the ability of the land to support various land uses after conservation and reclamation is similar to the ability that existed prior to a specified land activity being conducted on the land, but that the individual land uses will not necessarily be identical

Environmental impairment liability insurance – pollution policies at specific locations; interchangeable with site-specific pollution coverage

Environmental site assessment (ESA) - an investigation to determine the environmental condition of a given land area

Financial assurance - financial security (cash and non-cash) to guarantee you can cover the cost of complying with environmental objectives

Forested lands - areas dominated by trees and forested vegetation, whether the area is utilized for commercial purposes or not

Foundations - structural support for solar panels, wind turbines and associated facilities

Geothermal – conversion of heat derived from the earth's core to heat water or another working fluid to spin a generator's turbine that then outputs electricity

Holistic assessment - framework that assesses multiple factors to provide insight into a company's ability to manage their regulatory and liability obligations, including cleaning up their sites

Hydro – use of water pressure and the movement of water to turn a turbine that then outputs electricity

Industrial lands - lands used for commercial establishments such as manufacturing, distribution centers, warehousing, shipping, storage, shipping and repair and maintenance of equipment

Infrastructure – any underground or aboveground structures, equipment and facilities developed for operations

Inventory Reduction Program – program to increase the amount of closure work occurring in Alberta, reduce liability, and to increase the amount of land being returned to equivalent capabilities, or to a state similar to what it was in before development took place

Laydown area - areas for equipment storage during construction/decommissioning

Levy – an amount of money that you have to pay to a government or organization

Liability assessment - assessment conducted by a licensee or approval holder to estimate the costs to suspend, abandon, remediate, and reclaim a site, as well as provide care and custody from shutdown of operations through to site reclamation

Licensee – holder of the license to construct or operate

Meteorological tower - tower to monitor wind conditions

Micro-generation – small-scale generation that is generally close to or at the point of consumption

Mine Financial Security Program – program used by the Government of Alberta and the AER to strike a responsible balance between protecting Albertans from oil sands and coal mine closure costs, and maximizing industry's opportunities for responsible and sustainable resource development

Native grasslands - naturally occurring ecosystems where the vegetation community is dominated by native herbaceous species

Natural Gas - flammable gas, consisting largely of methane and other hydrocarbons, occurring naturally underground (often in association with petroleum) and used as fuel

Non-renewable - energy resource that cannot be replenished or renewed, including, but not limited to coal, natural gas, oil, and nuclear

Nuclear – nuclear reactions used to produce electricity

Offshore wind - conversion of kinetic energy into electrical power through wind farms that are located in bodies of water (usually in oceans)

Orphan fund levy - covered by the licensees in the LLR Program and OWL Program, is used in cases when licensees become defunct

Orphaned oil and gas wells - protecting public safety and managing the environmental risks of oil and gas properties that do not have a legally or financially responsible party that can be held accountable. These properties are known as "orphans."

Peatlands - boreal wetlands defined with a peat depth of a minimum of 40 cm which include functioning bogs and fens

Phase 1 Environmental Site Assessment – non-intrusive assessment to identify areas of potential environmental concern

Phase 2 Environmental Site Assessment - intrusive investigation to identify or confirm impacts at a site

Powerlines – Defined as transmission line right-of-ways on private land, transmission line right-of-ways on public land, and distribution line right-of-ways on public land

Power plant - power plant means the facilities for the generation and gathering of electric energy from any source

Reclamation – defined by an or all of the following: the removal of equipment or buildings or other structures or appurtenances; the decontamination of buildings or other structures or other appurtenances, or land or water; the stabilization, contouring, maintenance, conditioning or reconstruction of the surface of land, or any other procedure, operation or requirement specified in the regulation

Reclamation certificate application – issued when it can be demonstrated that a site is functioning similarly to how it did before it was disturbed, and no longer needs intervention

Remediation - managing and cleaning up any contamination from licensed activities or from approved facilities

Renewable - an energy resource that occurs naturally and that can be replenished or renewed within a human lifespan, including, but not limited to (i) moving water, (ii) wind, (iii) geothermal or heat from the earth, (iv) solar or sunlight, and (v) sustainable biomass

Renewable Energy Operations (REOs) – Site or plant generating renewable electricity from a renewable energy resource

Retrofitting/Re-Energization - to update the power generation facility to extend its useful life

Salvaging - dismantling or removing any works or installations forming part of a power plant

Site-Specific Liability Assessments (SSLAs) - assessment to estimate the cost to suspend, abandon, remediate, or reclaim a specific site

Site-specific pollution – pollution policies at specific locations; interchangeable with environmental impairment liability insurance

Solar – conversion of sun’s light and heat energy into electricity

Solar photovoltaic modules – solar panels for capturing solar energy

Solar thermal system - includes lenses, mirrors, tracking systems, and turbines

Substation - part of a transmission line that is not a transmission circuit and includes equipment for transforming, compensating, switching, rectifying or inverting of electric energy flowing to, over or from the transmission line

Transformers - where voltage of energy generated is altered for distribution

Wind – conversion of kinetic energy into electrical power

Wind turbine - structure intended for the production of electrical power; comprising a support mast on which is installed a nacelle containing a generator unit and which supports rotor blades that are caused to rotate by the wind. The total height of the obstruction is the height of the nacelle, above ground level (AGL), plus the length of one of the blades held in a vertical position

1.0 INTRODUCTION

On July 21, 2023, a letter submitted by the Alberta Utilities Commission (AUC) to the Minister of Affordability and Utilities flagged two policy issues related to the approvals of renewable (solar and wind) and thermal power plant applications. This included the following:

- Development of renewable power plants on high-value agricultural land.
- Lack of mandatory reclamation security requirements for the renewable power plants.

In response, on August 3, 2023, the Government of Alberta placed a pause on the approval(s) of renewable generation projects and ordered the AUC to host an inquiry into the ongoing economic, orderly, and efficient development of electricity generation in Alberta. Ecoventure Inc. (Ecoventure) was retained by AUC to prepare an expert report in support of the inquiry related to land impact issues.

1.1 Objectives

The objective of the inquiry is to allow the AUC to review and identify the criteria for developing a regulatory framework for electricity generation that takes into account the long-term public interest of Albertans. As part of the inquiry, the AUC has been directed to report on the following:

- Considerations on development of power plants on specific types or classes of agricultural or environmental land.
- Considerations of the impact of power plant development on Alberta's pristine viewscapes.
- Considerations of implementing mandatory reclamation security requirements for power plants.
- Considerations for development of power plants on lands held by the Crown in "Right of Alberta".
- Considerations of the impact with the increasing growth of renewables that have has on both generation supply mix and electricity system reliability.

To facilitate with collecting information related to the above points, subject matter experts were retained to prepare reports. As a result, Ecoventure was contracted by the AUC to provide subject matter expertise in the consideration of implementing mandatory reclamation security requirements for power plants.

1.2 Scope of Work

The scope of work, as agreed upon by the AUC and Ecoventure, was specific to the determination of end-of-life decommissioning and reclamation and associated security deposit requirements including:

- Literature reviews of decommissioning and reclamation practices and costs from completed projects in Alberta and other jurisdictions, by generation type;
- Literature reviews of models for liability management and end-of-life security programs from Alberta (AER Large Facility Management, Licensee Life-Cycle Management, Mine Financial Security Program [MFSP] and associated directives, etc.) and other jurisdictions (Canada Federal Contaminated Site Action Plan, etc.); and
- Comment on the common/best practices currently in use related to end-of-life security for power plants (by type if there are differences) and discussion of their pros and cons.
- Review closure requirements for power generation sites (Alberta and Canadian reclamation criteria, reclamation certificate process, reclamation practices and criteria endpoints for power lines, etc.) and then provide recommendations and framework for closure endpoints.
- Apply expertise in decommissioning and reclamation processes to develop estimated costs based on metrics such as land use, location, area, type of disturbance, etc.
- Develop an estimate of reclamation costs (or range) based on a standard unit of measure, for example: reclamation cost per megawatt (MW), or a cost per turbine for wind generation projects or cost per hectare of installed panels for solar generation.

1.3 Terms of Reference

For the purposes of this report, the following definitions are presented:

As defined in the *Hydro and Electric Energy Act* (AEP, 2022c), the following definitions will be utilized in this report.

- Power plant: “power plant means the facilities for the generation and gathering of electric energy from any source”.
- Substation: “substation” means a part of a transmission line that is not a transmission circuit and includes equipment for transforming, compensating, switching, rectifying or inverting of electric energy flowing to, over or from the transmission line”.

Power generation can occur from a wide range of sources, however, the power generation sources that are referenced in this report are natural gas, coal, wind, solar, biogas, geothermal, nuclear, and hydro. In Alberta specifically, typical power generation sources include natural gas, coal, wind and solar. Coal power generation is currently being phased out in the Province with associated emissions to be eliminated by the end of 2023 (Gov. of AB, 2023b). Additional emerging potential sources of power generation that are not currently in widespread use in Alberta are excluded from the review. The review also excludes all micro-generation as defined by the *Micro-generation Regulation* (Gov. of AB, 2018).

While there are several types of renewable energy sources, the evaluation of end-of-life processes and security requirements will be focused towards solar and wind power generations as these are the predominant types of renewable energy to be developed on agricultural lands in Alberta.

For solar and wind generated power plants that do not connect directly to the distribution system, substations are typically installed as part of the power generator, thus included in the definition of a power plant. It is assumed that systems that connect directly to the distribution network system do not include the use of a substation. As the scope of work for this report is decommissioning and reclamation, the potential for re-powering a site was not considered in the framework recommendations for closure and estimated costs provided.

While current reclamation practices distinguish between private (freehold) Land, Crown Land and Federally Regulated Land, the scope of this work will not distinguish the Landowner, as a higher focus will be placed on the type of disturbance and surrounding land use.

For the purposes of understanding, the following definitions for the various landowner types will be used for lands within Alberta:

- Freehold Land refers to land privately owned and managed.
- Crown Land refers to the lands that are classified as public lands that are managed by the Provincial Government. Depending on the use of the land, legislation divides these lands into two categories (AEP, 2018):
    - Public Lands that are administered by Alberta Environment and Protected Areas (AEPA) under the *Public Lands Act* (Gov. of AB, 2000a) *and Public Lands Administration Regulation* (Gov. of AB, 2017).
    - Public Lands that are administered by other legislation, such as "Parks" under the *Provincial Parks Act* (AEP, 2023e), Wilderness Areas, Ecological Reserves, or administered by other Provincial Departments.

  The Public Lands that are not managed by the Provincial Government do not fall under either category, thus are considered Federally Regulated Land entities.

- Federally Regulated Land refers to land managed by the Government of Canada, and includes First Nations Reserves, the Department of National Defence lands, and the National Parks.
- Lands that fall under Métis Settlements are Provincially Regulated.

For reclamation certificate applications (RCAs), the applications for future projects will be required to follow the applicable regulatory framework at the time of reclamation.

2.0 OVERVIEW OF POWER GENERATION FROM APPLICATION TO END OF LIFE

Energy sources considered for power generation within the context of this report include coal, natural gas, solar, wind, hydro, and nuclear. They can be divided into non-renewable and renewable energy sources, defined as:

- Non-renewable energy source is defined as an energy resource that cannot be replenished or renewed, including, but not limited to coal, natural gas, oil, and nuclear power.
- Renewable energy is defined as "an energy resource that occurs naturally and that can be replenished or renewed within a human lifespan, including, but not limited to (i) moving water, (ii) wind, (iii) geothermal or heat from the earth, (iv) solar or sunlight, and (v) sustainable biomass (AEP, 2018).

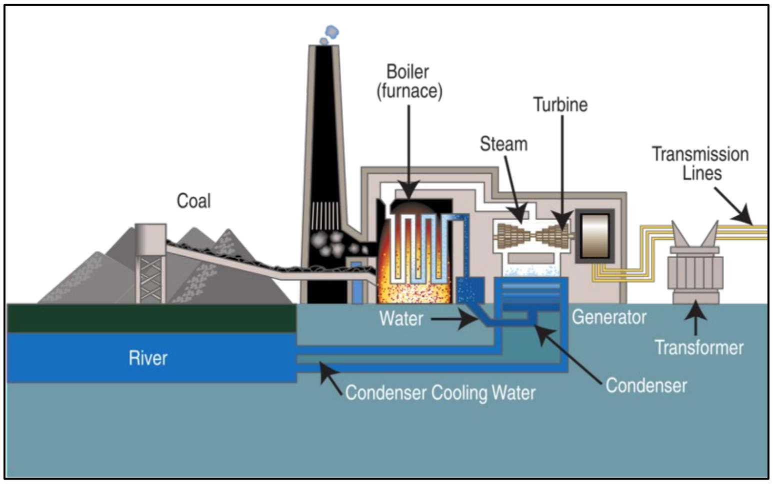
2.1 Non-Renewable Energy

There are several types of non-renewable energy sources, however, the main sources used in Alberta are coal and natural gas.

Coal Energy

Coal-fired power plants operate by burning coal to make steam that in turn generates electricity. They are considered non-renewable sources, as coal is a finite resource. While plants do not need to be located adjacent to a mine, it is preferrable to be within proximity to reduce the need to transport coal to the plant. Therefore, in many cases, plants are generally located within proximity to a mine. Figure 2-1 is a schematic of the typical process coal-fired power plants undergo to use coal for electricity generation.

Figure 2-1. Schematic of a coal-fired power plant (Energy Education, 2023).



Below are the specific main components required for coal power generation.

Table 2-1 Components of coal power generation.

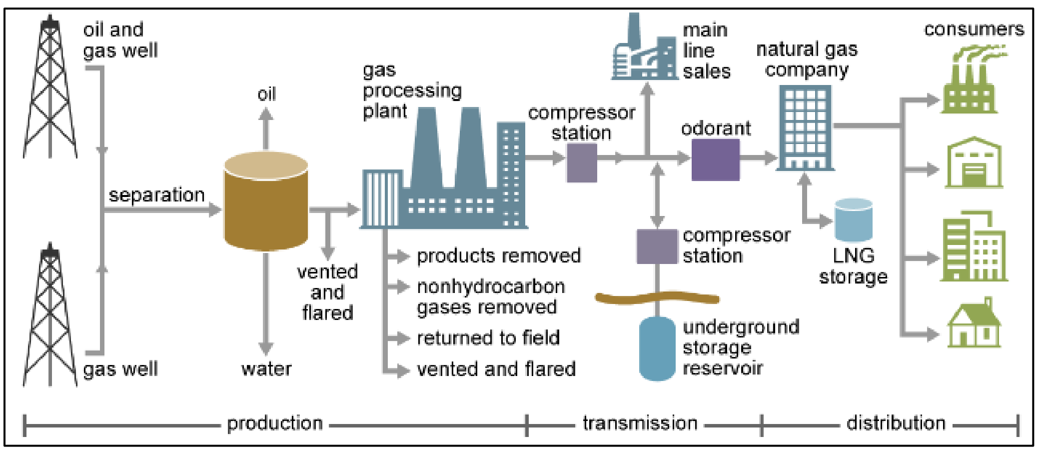
Purpose	Component	Surface or Subsurface Infrastructure	Description
Energy Collection, Storage and Transformation	Coal pulverizer	Surface	Used to dry, grind and classify coal.
	Conveyors	Surface	Transports coal from coal yard to the power stations.
	Powerhouse	Surface	Includes boilers (watertube and firetube), turbines, and pumps.
	Cooling tower	Surface	Circulates water throughout the power plant.
	Gas removal system	Surface	Removal of gases.
	Generator	Surface	Converts current.
	Transformer	Surface	Increases output voltage.
	Transmission line	Surface	Includes lines for transmission.
Associated Facilities	Mine	Surface and Subsurface	Source of coal.
	Access Road	Surface	Road to access mine, plant and associated facilities.

Purpose	Component	Surface or Subsurface Infrastructure	Description
	Laydown Areas	Surface	Areas for equipment storage during construction/decommissioning.

Natural Gas

Electricity generation from natural gas is completed in a similar way to coal energy. Natural gas withdrawn from natural gas or crude oil wells is then processed to remove water vapour and non-hydrocarbon components in addition with separating natural gas liquids (EIA, 2022a). Natural gas is transported to a compressor station where fuel and compressed air mix in the combustion chamber and is burned resulting in the spinning of a turbine to drive the generator (EIA, 2022a). The electrical current that is formed is passed through a transformer to alter the voltage to a form suitable for transmission (EIA, 2022a). Figure 2-2 is a schematic of the production to distribution process for generating electricity from natural gas.

Figure 2-2. Schematic of electricity generation from natural gas/oil (EIA, 2022a).



Below are the specific main components required for natural gas power generation.

Table 2-2 Components of natural gas power generation.

Purpose	Component	Surface or Subsurface Infrastructure	Description
Energy Collection, Storage and Transformation	Gas processing plant	Surface	Includes turbines, pumps, compressor stations and combustors.
	Cooling tower	Surface	Circulates water throughout the power plant.
	Heat recovery steam generator	Surface	Recovers heat from a hot gas stream.

Purpose	Component	Surface or Subsurface Infrastructure	Description
	Gas removal system	Surface	Removal of gases.
	Transformer	Surface	Increases output voltage.
	Generator	Surface	Converts current.
	Transmission line	Surface	Includes lines for transmission.
Associated Facilities	Oil and gas wells	Surface and Subsurface	Source of natural gas.
	Storage reservoir	Subsurface	Storage of natural gas.
	Pipelines	Surface and Subsurface	For transport of natural gas from wells to power plant.
	Access Road	Surface	Road to access oil and gas wells, plant and associated facilities.
	Laydown Areas	Surface	Areas for equipment storage during construction/decommissioning.

2.2 Renewable Energy

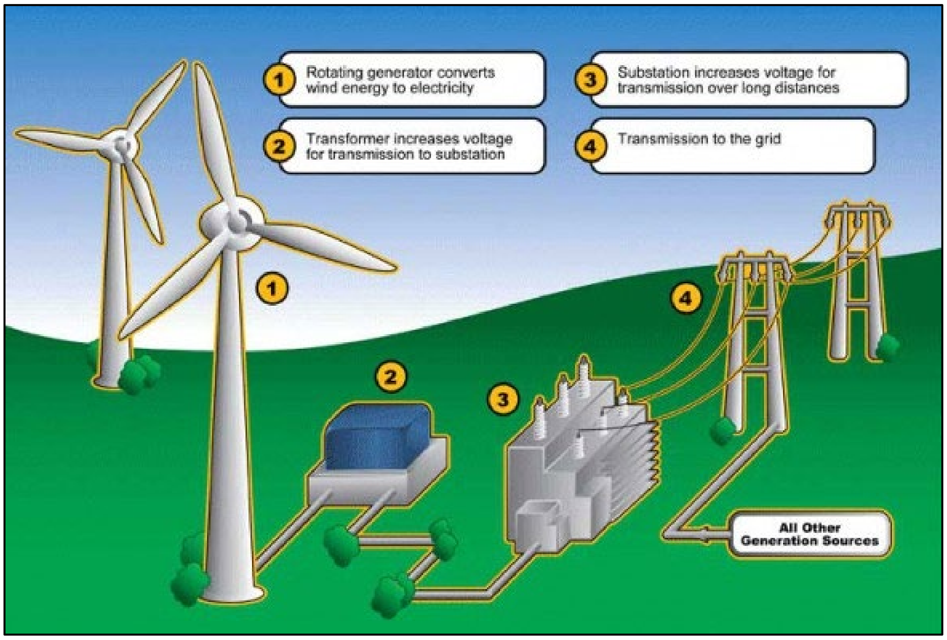
There are several types of renewable energy sources, however, this report will focus on solar and wind as the main renewable sources of interest (as the most applicable to Alberta). For wind and solar, wind turbines and solar panels capture energy (through wind and sunlight, respectively). This energy is converted in the inverter to a form that is usable for the electric grid (converting from direct current to alternating current). Substations are used to convert the voltage level(s) for distribution and transmission. From the substation, the electricity can be directed towards a battery for storage, or to the electric grid for consumption.

Wind Energy

By definition, wind turbines are "structures intended for the production of electrical power; comprising a support mast on which is installed a nacelle containing a generator unit and which supports rotor blades that are caused to rotate by the wind. The total height of the obstruction is the height of the nacelle, above ground level (AGL), plus the length of one of the blades held in a vertical position" (Gov. of Canada, 2023). Wind turbines work by collecting kinetic energy from wind and transforming it into electricity. Rotation of a drive shaft to turn the turbine helps to generate the electrical current (AUC, 2023c).

Figure 2-3 shows the typical set up required for wind farms to provide electricity to the grid.

Figure 2-3. Schematic of typical wind farm set up (Loriesfontein Wind Farms, 2023).



Below are the specific main components required for wind power generation.

Table 2-3 Components of wind farm construction (Power Company of Wyoming LLC, 2015).

Purpose	Component	Surface or Subsurface Infrastructure	Description
Energy Collection, Storage and Transformation	Wind Turbine	Surface	Includes blades, nacelle and tower.
	Foundations	Subsurface	Structural support for turbines and associated facilities.
	Meteorological Tower	Surface	Tower to monitor wind conditions.
	Aboveground and Underground Lines	Surface and Subsurface	Includes lines for transmission.
	Collection System	Surface	Collects energy from turbines and transmits it to substation.
	Substation	Surface	Gathering point for energy produced.

Purpose	Component	Surface or Subsurface Infrastructure	Description
	Transformers	Surface	Where voltage of energy generated is altered for distribution.
Associated Facilities	Access Road	Surface	Road to access wind turbine and associated facilities.
	Laydown Areas	Surface	Areas for equipment storage during construction/decommissioning, including crane pads.

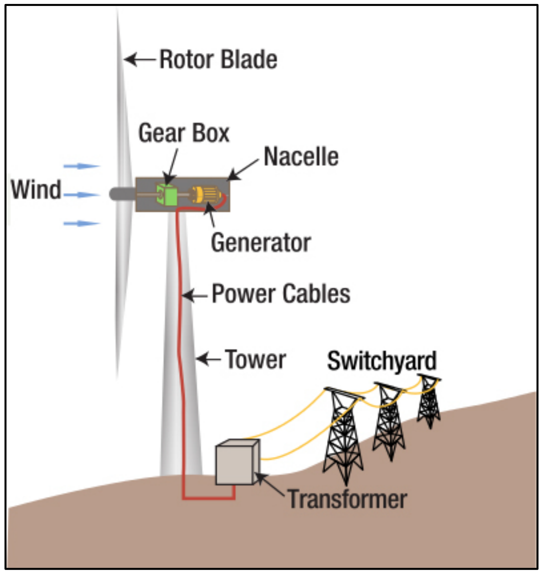
Some specifications for wind turbine set up include the following (Alberta Culture and Tourism, 2023; Gov. of Canada, 2023):

- Minimum average height of turbine: 60 to 90 meters to the maximum average height of turbine: 152 meters (This is due to aviation regulations; however, this can be amended upon notice filing with NAV CANADA).
- Minimum average length of blade: 40 to 60 meters to the maximum 107 meters dependant on permitting of area and location.
- Minimum average rotation speed: 161 kilometers to the maximum 290 kilometers per hour with heavy blades.

With development of new technology, there is potential for the average height and rotor diameter to increase.

To achieve electricity generation from wind, turbines need to spin a minimum of 12.8 km per hour and reach speeds of 40 to 88 km per hour (Alberta Culture and Tourism, 2023). Blades that can cover a larger area are able to produce more power. Additionally, the height of the tower can increase efficiency by extending into areas in the sky that have a greater wind velocity accumulation. Optimum kinetic wind energy can be captured starting at heights of 30 meters AGL (Alberta Culture and Tourism, 2023). Figure 2-4 shows the typical components of a wind turbine.

Figure 2-4. Components of a wind turbine (Alberta Culture and Tourism, 2023).



Materials utilized in the construction of wind farms include steel, pilings, concrete, fibreglass, reinforced polyester, and woody epoxy (Loriesfontein Wind Farms, 2023). Wind farms can be constructed on land as well as offshore, though offshore wind farms are not physically possible in Alberta. Despite the lack of relevance of offshore wind farm construction in the province, the regulatory schematics of such farms can help for the purposes of identifying regulatory frameworks for decommissioning and reclamation.

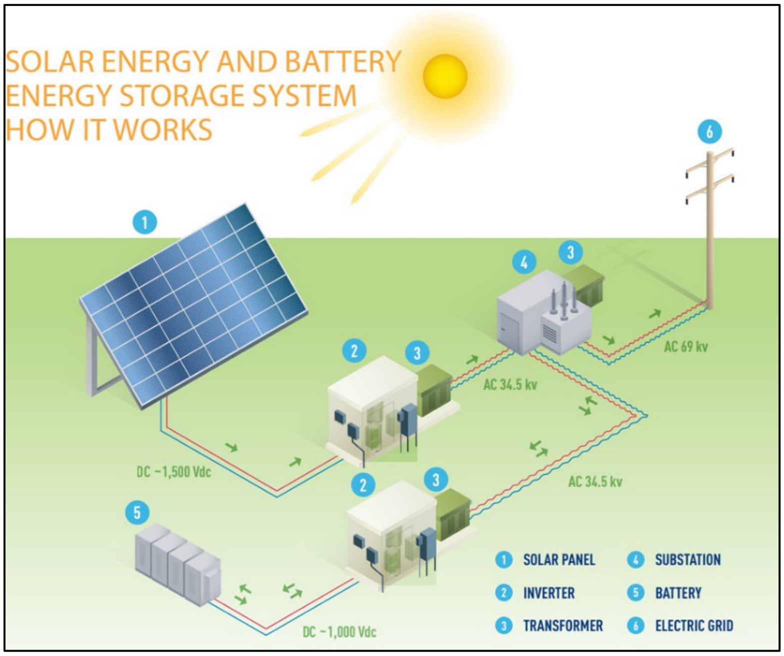
Solar Energy

For power from solar energy, sunlight is captured and converted into heat energy for electricity generation. This can occur through one of the following methods (AUC, 2023c):

- Use of photovoltaic (PV) panels that convert light into an electrical current; or
- Through concentrated solar thermal systems that utilize lenses, mirrors and tracking systems to focus sunlight into a beam for steam creation. The generated steam will turn a turbine that will produces electricity.

Figure 2-5 depicts the typical set up of a solar system and the process it undertakes to capture and transform solar energy into electricity from PV panels.

Figure 2-5. Schematic of typical solar energy set up (Innergex, 2020).



The table below lists the specific main components required for solar production.

Table 2-4 Components of solar farm construction.

Purpose	Component	Surface or Subsurface Infrastructure	Description
Energy Collection, Storage and Transformation	Solar PV Modules	Surface	Solar panels for capturing solar energy.
	Solar thermal system	Surface	Includes lenses, mirrors, tracking systems, and solar panels.
	Foundations	Subsurface	Structural support for solar panels and associated facilities.
	Aboveground and below ground mounts	Surface and Subsurface	Stabilize and hold frame structures and panels in place.
	Aboveground and underground lines	Surface and Subsurface	Includes lines for transmission.
	Collection System	Surface	Collects energy from solar panels and transmits it to substation.
	Substation	Surface	Gathering point for energy produced.
	Transformers	Surface	Where voltage of energy generated is altered for distribution.

Purpose	Component	Surface or Subsurface Infrastructure	Description
Associated Facilities	Access Road	Surface	Road to access solar panels and associated facilities.
	Laydown Areas	Surface	Areas for equipment storage during construction/decommissioning.

The efficiency of solar panel set up(s) is dictated by airflow, which can be optimized through factors such as the space between panels and height off the ground (NREL, 2022). Additionally, row spacing is dependent on (IRENA, 2014):

- Latitude (sun path);
- Inclination of panels;
- Set up of panels on mounting system; and
- Minimum space required for operations and maintenance.

Knowing the optimal configuration for efficiency can assist with knowing the area of land required for construction.

Salvageable materials from solar installations include (EPA, 2023):

- Aluminium
- Tin
- Tellurium
- Antimony
- Gallium
- Indium

Inverters, mounting systems, and batteries are components that can be recycled lessening the overall carbon footprint (EPA, 2023).

Solar and wind generation systems typically have a lifespan of 25-30 years before they are required to be replaced, or decommissioned. Understanding the components required for construction will be useful to understanding what needs to be decommissioned at the end of life.

Geothermal Energy

Geothermal energy is derived from rocks and fluids deep within the Earth's crust. Thermal energy can be created by (AER, 2023j):

- Residual heat from the earth's formation
- Heat from the decay of radioactive elements
- Friction between rock formations
- Solar absorption in the shallow subsurface

There are two types of geothermal resources (AER, 2023j):

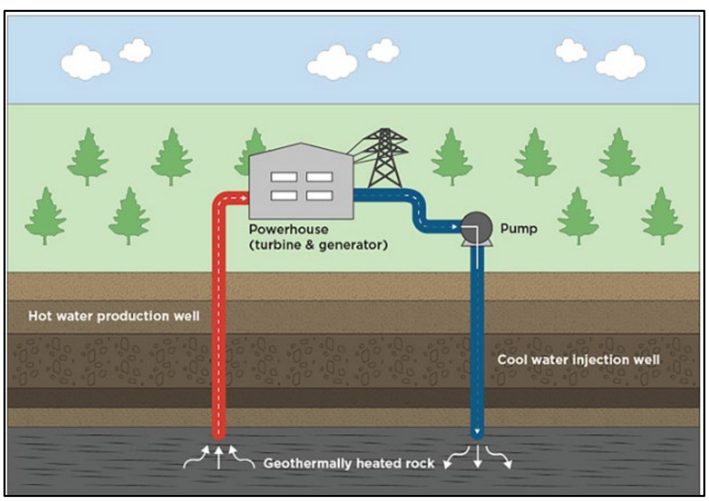
- Deep geothermal: Rock formations and fluids are at a depth below the base of groundwater protection (base of the deepest formation that is likely to contain non-saline groundwater). Temperatures in this region exceed 120°C.
- Shallow geothermal (ground source heat exchange or geo-exchange systems): Found close to the surface. Overall temperatures in this region are generally less than 40°C.

A geothermal system consists of three main components – a heat source, a reservoir and a fluid that acts as a carrier to transfer the heat (AER, 2023i).

Additionally, there are two types of configurations:

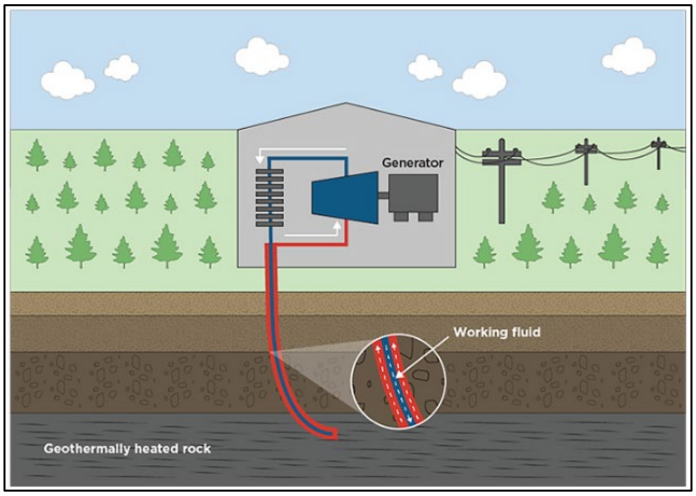
- Open loop systems: Where water is circulated from a porous rock formation through engineered wells that are drilled into the formation. Hot water collected in the wellbore is lifted to a facility that extracts the heat from the water. Once cooled, the water is injected back into the formation where it is naturally re-heated (AER, 2023j).

Figure 2-6. Schematic of open loop geothermal system (AER, 2023j).



- Closed loop systems: Fluids other than water are used to carry heat from a formation within a contained system. Wells are interconnected to circulate fluid. Cool fluids are pumped down the wellbore and heated by the formation. Heated fluids are lifted to a facility to extract the heat from the fluid. Once cooled, the water is re-circulated through the network.

Figure 2-7. Schematic of closed loop geothermal system (AER, 2023j).



The table below lists the specific main components required for geothermal power production.

Table 2-5 Components of geothermal power generation.

Purpose	Component	Surface or Subsurface Infrastructure	Description
Energy Collection, Storage and Transformation	Cooling tower	Surface	Circulates water throughout the facility.
	Powerhouse	Surface	Includes steam turbines, pumps, generators and condensers.
	Gas removal system	Surface	Removal of gases.
	Transformer	Surface	Increases output voltage.
	Generator	Surface	Converts current.
	Transmission line	Surface	Includes lines for transmission.
Associated Facilities	Wells	Surface and Subsurface	Source of thermal energy. Includes hot water production and injection wells.

Purpose	Component	Surface or Subsurface Infrastructure	Description
	Pipelines	Surface and Subsurface	For transport of thermal energy from wells to the power plant.
	Access Road	Surface	Road to access oil and gas wells, plant and associated facilities.
	Laydown Areas	Surface	Areas for equipment storage during construction/decommissioning.

Biomass Energy

Biomass is the conversion of chemical energy from plants and animals (EIA, 2023a). Sources that can be utilized include:

- Wood and wood processing waste.
- Agricultural crops and waste materials.
- Biogenic materials.
- Animal manure and raw sewage.

The conversion of biomass can be completed through multiple processes (EIA, 2023a):

- Direct combustion for heat production: This is the most common process utilized.
- Thermochemical conversion to produce solid, gaseous and liquid fuels. This involves pyrolysis, hydrotreating and gasification processes.
- Chemical conversion to produce liquid fuels. Transesterification (converting one carboxylic acid into another) is a chemical conversion process that produces biodiesel.
- Biological conversion to produce liquid and gaseous fuels. This involves the fermentation to make ethanol and anaerobic digestion to produce biogas. Anaerobic digestion is a process in which organic material is broken down by bacteria in the absence of oxygen. Biogas, which consists of methane and carbon dioxide, is produced from anaerobic digestion and can be burned directly as fuel or treated to remove the carbon dioxide (EIA, 2022b).

The table below lists the specific main components required for biomass power production.

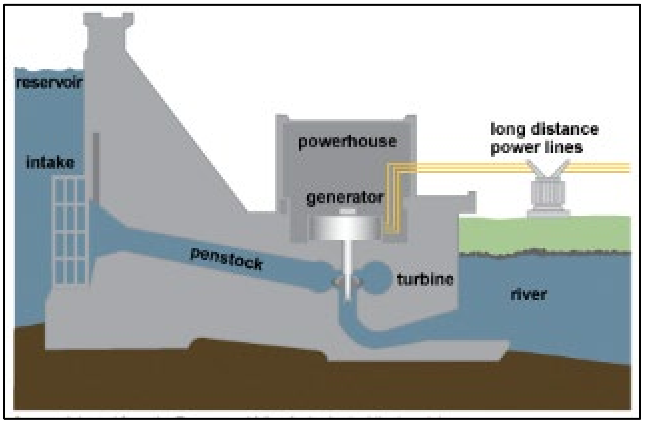
Table 2-6 Components of biomass power generation.

Purpose	Component	Surface or Subsurface Infrastructure	Description
Energy Collection, Storage and Transformation	Conveyors	Surface	Transports biomass from storage area to the power stations.
	Power station	Surface	Includes dryer, boiler, combustion chamber, heat exchanger, turbines and generators.
	Gas removal system	Surface	Removal of gases.
	Transformer	Surface	Increases output voltage.
	Generator	Surface	Converts current.
	Transmission line	Surface	Includes lines for transmission.
Associated Facilities	Storage area	Surface	Storage of biomass.
	Access Road	Surface	Road to access oil and gas wells, plant and associated facilities.
	Laydown Areas	Surface	Areas for equipment storage during construction/decommissioning.

Hydro Energy

Hydro systems depend on moving water to produce energy. Therefore, these systems are constructed near a large water source. The capacity of the hydro power plant is largely dependent on the water flow speed. Water that flows through the penstock within the plant turns blades on a turbine that in turn spin to power a generator. Two common systems include usage of a river’s current to turn the turbine, or the accumulation of water in a reservoir created by dams that is released to turn the turbines (EIA, 2023b). Figure 2-8 demonstrates the components of a hydro power system for electricity generation.

Figure 2-8. Schematic of a hydro power system (EIA, 2023b).



While geothermal, biomass and hydro energy are renewable energy sources that have been developed in Alberta, the focus of this report will be on solar and wind energy as the predominant energy sources on agricultural lands in Alberta.

The table below lists the specific main components required for hydro power production.

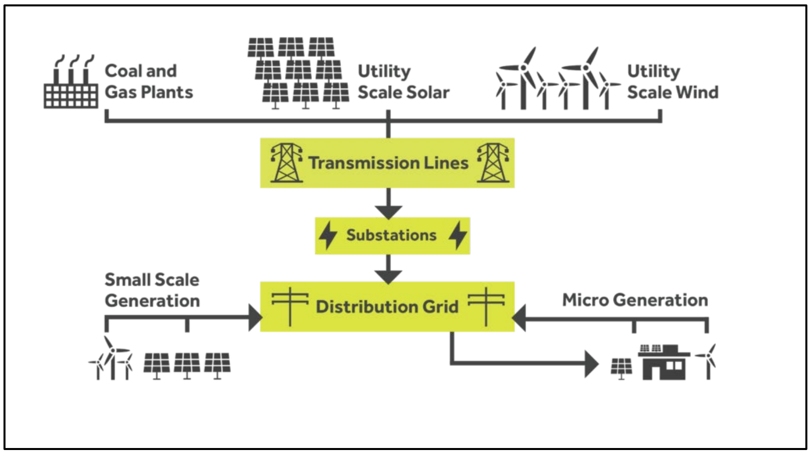
Table 2-7 Components of hydro power generation.

Purpose	Component	Surface or Subsurface Infrastructure	Description
Energy Collection, Storage and Transformation	Powerhouse	Surface	Includes turbines, generators, and transformers.
	Transformer	Surface	Increases output voltage.
	Generator	Surface	Converts current.
	Transmission line	Surface	Includes lines for transmission.
Associated Facilities	Reservoir/Dam	Surface and Subsurface	Source of water. Dam used to store water within the reservoir.
	Penstock	Surface and Subsurface	For transport of pressurized water from reservoir to the power plant.
	Access Road	Surface	Road to access oil and gas wells, plant and associated facilities.
	Laydown Areas	Surface	Areas for equipment storage during construction/decommissioning.

2.3 Energy Connection to Distribution Grid

Energy produced at large facilities (through non-renewable and renewable sources) are connected to the distribution grid through transmission lines and substations (as shown in Figure 2-9). Smaller scale generation systems, such as small-scale generation and micro generation systems, can connect directly to the distribution grid and operate on a smaller scale than the larger facilities. Micro generation systems in particular supply electricity for on-site usage before feeding excess electricity to the grid (MCCAC, 2020). For the purposes of establishing end-of-life security requirements, only power generation up to the point of entering the transmission/distribution system is included for consideration.

Figure 2-9. Schematic of electricity generation in Alberta (MCCAC, 2020).

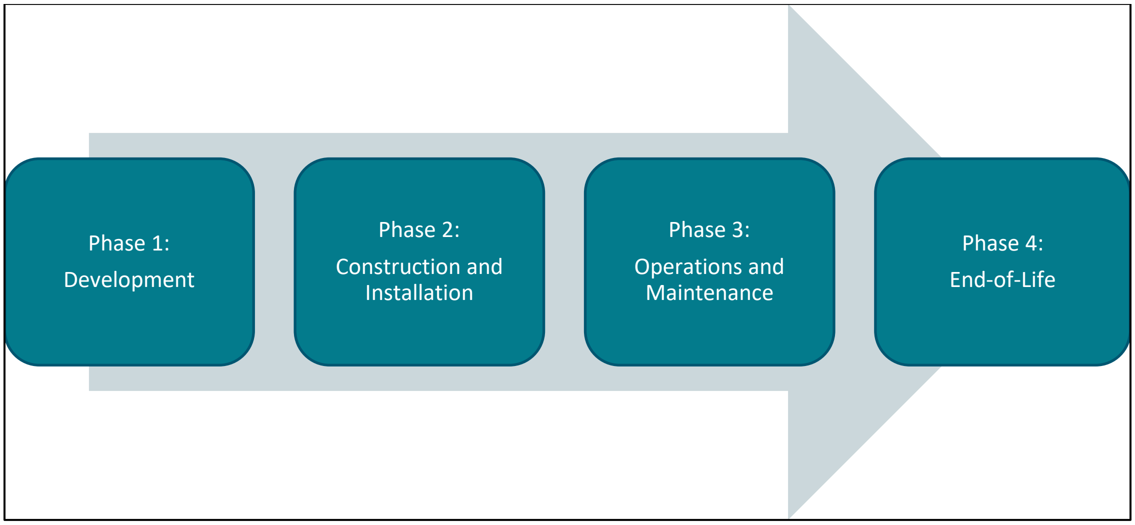


Power generation has historically been dominated by coal and natural gas sources. However, with the worldwide push towards "cleaner energy" and achieving net zero emissions, solar and wind energy is becoming more prevalent in the province, and decommissioning of coal power plants has increased. To understand power generation and the steps it entails to develop, it is important that the stages of power plants are understood.

2.4 Life Cycle of Power Generation

There are several project stages involved with power generation. Listed below are the general stages required for each facility and some considerations for development.

Figure 2-10. Flowchart of the stages required for power plant development.



Phase 1: Development

Identify a Location

Oil, Gas, and Coal facility locations that have been constructed are highly dependent on reservoir access. Coal-fire power plants depend on a source of coal, thus are generally located near a mine.

For large scale solar and wind systems, agricultural land is generally deemed most suitable due to the physical characteristics of the land, including (NYSERDA, 2023):

- Relatively flat topography.
- Maximum sun exposure.
- Cleared vegetation (ex. minimal trees to block the sun).
- Close in proximity to the electrical grid.
- Social and economic considerations, such as being accessible for inspection, repairs etc.
- Large areas of land where available.

Based on these factors, it is not surprising that the majority of solar and wind farms are proposed where land use is primarily agricultural and there is space to accommodate the footprint of small, medium, and large facilities.

Table 2-3 describes the average acres of land required to produce a megawatt of electricity (Strata, 2017). As observed, non-renewable sources generally require less surface land area to achieve a megawatt of produced electricity. On the other hand, a dam constructed to produce hydroelectricity requires a significant amount more surface land area.

When comparing the land area required for solar and wind projects, wind energy appears to require more land per megawatt produced. However, the permanently disturbed area of a wind farm compared to the area required to allow for appropriate turbine clearance must be considered as this can drastically alter the land area required. Generally, wind turbines require a smaller disturbed area than solar farms, and agricultural practices can continue to commence around the turbines.

Table 2-8 Land Use by Electricity Source in Acres/MW Produced (Stata, 2017).

Electricity Source	Acres per Megawatt Produced
Coal	12.21
Natural Gas	12.41
Nuclear	12.71
Solar	43.50
Wind	70.64
Hydro	315.22

Figures 2-11 to 2-13 show how solar and wind project location boundaries can be determined based on the type of infrastructure required (MOECC, 2023).

Figure 2-11. Project location boundary for solar facility (MOEC, 2023).

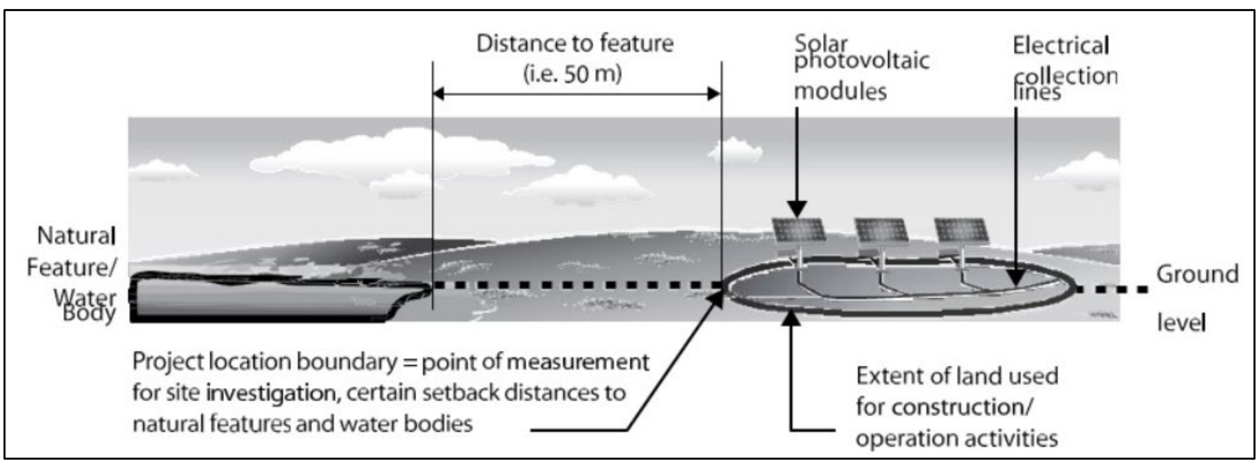


Figure 2-12. Project location boundary where the construction area is furthest (MOECC, 2023).

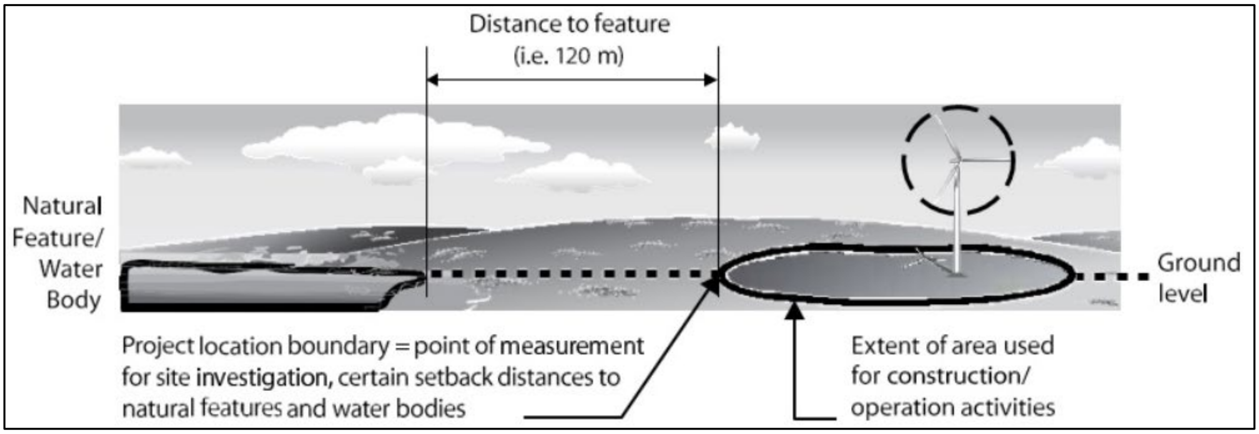
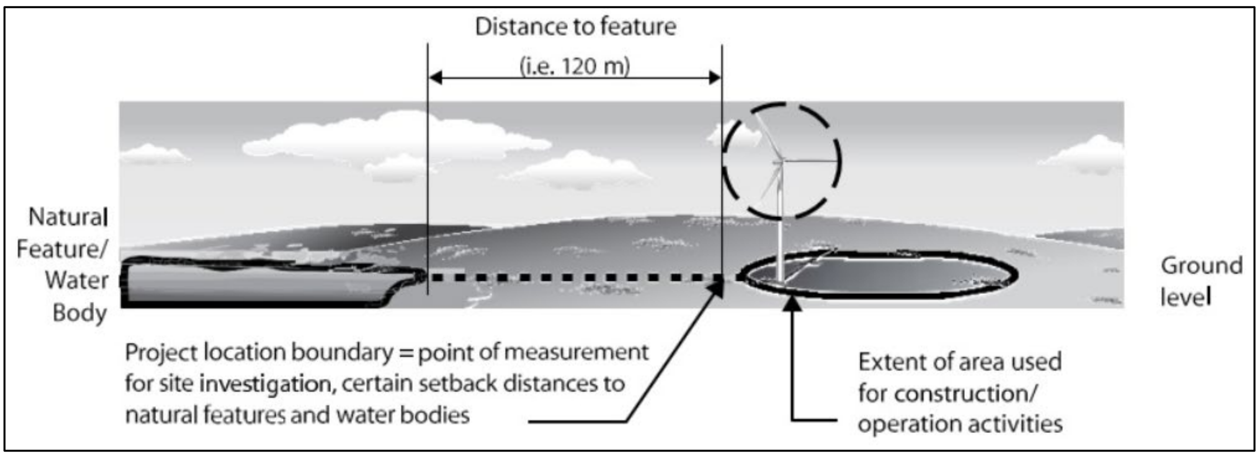


Figure 2-13. Project location boundary where the turbine blade tip is furthest (MOECC, 2023).



While renewable energy generates “clean energy”, and the power supply is infinite, the required area of disturbed land is an important consideration that should be taken into account for approval of renewable energy power plants.

Approvals and Permitting

As part of the application process, there are several environmental compliance provisions that are essential; there are variations to the requirements based on the regulatory body and the type of facility being permitted.

During the approval stage for power plants, governing bodies often require financial assurance to ensure adequate funds are available on behalf of the proponent. Financial assurance can be required for the following reasons:

- To ensure environmental compliance is met;
- To ensure that required components are achieved by a specified date; or

- To ensure that funds are available for future decommissioning and reclamation activities.

There are several types of financial and non-financial mechanisms utilized for project approvals, and the acceptable form of financial assurance is dependent on the jurisdiction. A summary of common types of financial mechanisms is included in Table 2-4, and non-financial mechanisms in Table 2-5. Mechanisms such as decommissioning provisions in land-lease agreements, have the potential to be either a financial or non-financial mechanism. For these mechanisms, they are presented based on the pre-dominant type of mechanism. Further discussion and evaluation of each mechanism is presented in subsequent sections and in Appendix A.

Table 2-9 Common types of financial mechanisms used in decommissioning cost provisions.

Type of Mechanism	Description
Cash	Cash, in the amount of the estimated decommissioning costs can be set aside and utilized once decommissioning activities commence (Department of Energy & Climate Change, 2023).
Decommissioning or “Hold Back” Provisions in Land-Lease Agreements	Within the land lease agreement between the licensee and the landowner, decommissioning provisions and/or “Holdback” percentage can be added based on the preferences of the two parties. The clause could include complete removal of the equipment and reclamation of land back to equivalent land capability, or could include a buy out option for the landowner should the landowner wish to keep the equipment (NYSERDA, 2023).
Decommissioning Trusts	Trust funds can be established specifically for decommissioning. Assets sufficient to cover the estimated cost is transferred to a trust that is held and administered by a financial institution (Cox, 2022; NYSERDA, 2023). If the value of the trust exceeds the decommissioning costs, excess funds will be released back to the licensee (Cox, 2022).
Escrow Accounts	This account operates by the licensee making payments to an account at a federally insured financial institution. Scheduled payments can be made during the life cycle of the project until the fund reaches the estimated cost of decommissioning, rather than an upfront payment (Cox, 2022; NYSERDA, 2023).
Surety Bonds	Surety bonds are legally binding contracts typically issued by the government or financial institutions (the surety) indicating they will assume responsibility should the principal (the licensee) fail to perform their obligations. This protects the oblige (the third party) from assuming costs. The bond required is usually based on both the cost of decommissioning and reclamation. Changes In end-of-life costs would result in a change in the bond (NYSERDA, 2023). A performance bond is a type of surety bond where the surety requires security that a task is completed in a satisfactory manner. Funds may be paid out to a standby trust fund or to hire a contractor to complete decommissioning (Cox, 2022). A decommissioning bond, which is more specific to the decommissioning and reclamation processes, is another type of surety bond that guarantees the proper removal of equipment.

Type of Mechanism	Description
Letters of Credit	Letters of credit can be issued by a financial institution as an assurance to a beneficiary (government entity or landowner) that they will receive payment up to a certain amount should the licensee fail to decommission and reclaim a site. The letter will state the conditions for payment, supporting documentation and an expiration date (NYSERDA, 2023). In some cases, irrevocable letters of credit can be required, which means the financial institution can alter the payout amount only with the consent of the bank, locality, and licensee (Cox, 2022).
Early/Mid-Life and Continuous Accrual Decommissioning Funds	A fund that accrues in the early and mid-life stages of operations can be set up given enough is projected to be funded by the facility's end of life. Earlier payments reduce the risk to the governing body and liability of the facility (Department of Energy & Climate Change, 2023). In the event the licensee defuncts, the governing body will need to ensure adequate funds are available. This can be done through a joint trust arrangement.
Insurance	Insurer is paid the net present day value of the expected decommissioning liability. The insurer can only cancel the policy if the licensee does not pay premiums (Cox, 2022).
Parent Guarantee	Parent company of the licensee proves financial solvency and agrees to pay decommissioning obligations (Cox, 2022).

Table 2-10 Common types of non-financial mechanisms used in decommissioning cost provisions.

Type of Mechanism	Description
Abandonment and Removal Clause	Clauses can be included in local bylaws or approvals to mandate removal of equipment upon abandonment or face civil penalties, fines and/or imposing a lien on the property to recover costs. Within these clauses, the period of abandonment before enforcement is taken should be defined (NYSERDA, 2023).
Special Permit Application	Similar to including abandonment and removal clauses in local bylaws, it can be mandated to include decommissioning plans as part of the permit approval process. This allows the local government to put a lien on the property to assist with the cost of decommissioning and reclamation (NYSERDA, 2023).
Temporary Variance/Special Permit Process	Temporary variance/special permits acts in a manner that allows the local government to re-licence the specified area of land for the purpose of the energy facility. The permit would have a specific term that covers the life span of the facility, and if it is not renewed, the site would no longer be in compliance with local zoning regulations, in which case the local government could enforce removal of the facility (NYSERDA, 2023).
Corporate Financial Test	Licensee self-insures the cost of decommissioning by providing a large and stable net worth. In this case, security is not posted (Cox, 2022).

In addition to the above mentioned financial and non-financial mechanisms that are commonly practiced, legislation can be implemented for liability management programs for specific industries that act as security programs for the specific type of facilities that belong to the industry. Liability management is used to manage assets to minimize risk and drive projects to closure with minimal expenditure from internal and external resources.

Phase 2. Construction and Installation

Infrastructure or installations can differ depending on the type(s) of facilities to be constructed. However, regardless of the type of power source, power generation will require surface and subsurface components. For renewable energy, surface components can include energy capture infrastructure (such as wind turbines or solar PV modules), transformers, inverters, substations, cables, fencing, and transmission/distribution lines. Subsurface components can include foundations or underground pilings, mounts and underground electrical lines. Associated facilities such as laydown areas and access roads are often required to assist with construction flow, as well as to access the site over the course of its lifespan. The materials used for solar and wind power generation are often recoverable and considered in the salvage value of facilities. Additionally, the configuration of infrastructure can impact the footprint and whether activities can take place on land surrounding the facility.

Phase 3. Operations and Maintenance

Power generation facilities from non-renewable sources generally have an active operational lifespan until all easily extractable resources are recovered. Facilities from renewable sources, such as solar or wind energy, have an active operational lifespan of 25-30 years. However, as ideas and technology evolve the life cycles will lengthen.

Upon the end of the operational lifespan, end-of-life closure options should be considered and planned. For non-renewable energy sources, end-of-life cycles usually results in the decommissioning and reclamation of land. For renewable energy sources, end-of-life options include:

- Extending the performance period.
- Refurbishing the system.
- Re-powering the system.
- Decommissioning and reclamation.

Phase 4. End of Life Cycle

There are several end-of-life cycle options for power generation sites, including decommissioning and reclamation, re-use, or re-powering. Decommissioning and reclamation will be the focus of this report.

Decommissioning as defined in AUC's Rule 007, is "the permanent closure of all or part of a facility followed by removal of process equipment, buildings and other structures" (AUC, 2022). This generally includes all surface and subsurface infrastructure associated with the facility.

Decommissioning plans are often required in the initial approval for construction and operation, in addition continually updated throughout the facility life cycle, however, this can be dependent on jurisdiction and the regulatory body.

At the decommissioning stage, there are several options for how infrastructure is handled, including landfill disposal, re-use, re-furbish or salvage at market price. As defined by AUC in Rule 007, salvaging is the "Dismantling or removing any works or installations forming part of a power plant" *(*AUC, 2022). Salvaging is commonly incorporated into estimated decommissioning costs to help offset costs. Further details on the decommissioning stage of various power plant operations will be discussed throughout this report.

Following the decommissioning stage, reclamation can proceed. According to the *Environmental Protection and Enhancement Act* (EPEA; AEP, 2023c*),* reclamation is defined by any or all of the following:

- "the removal of equipment or buildings or other structures or appurtenances;
- the decontamination of buildings or other structures or other appurtenances, or land or water;
- the stabilization, contouring, maintenance, conditioning or reconstruction of the surface of land
- any other procedure, operation or requirement specified in the regulation".

Though the above definition of reclamation includes infrastructure removal, industry practice generally separates them into two stages, however, the end goal of closure remains the same. The reclamation process also includes the return of land to equivalent land capability based on existing and surrounding land use. Equivalent land capability is defined as "the ability of the land to support various land uses after conservation and reclamation is similar to the ability that existed prior to a specified land activity being conducted on the land, but that the individual land uses will not necessarily be identical" (AEP, 2019).

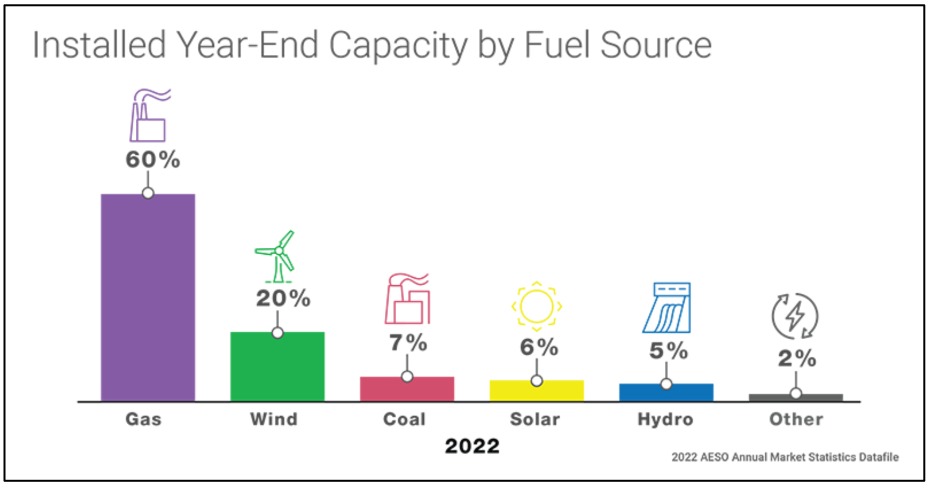
In some cases, a change in land use can be supported based on the perceived impacts to the environment, and landowner preferences.

In subsequent sections, the application for end-of-life process will be described for the main energy sources utilized in Alberta, however, decommissioning and reclamation will be the main focus of the report.

3.0 SUMMARY OF POWER GENERATION IN ALBERTA

Power generation in Alberta is still dominated by natural gas, followed by wind, as shown by AESO's 2022 breakdown (AESO, 2023).

Figure 3-1 Breakdown of electricity generation in 2022 in Alberta (AESO, 2023).



Power plant approval in Alberta falls under the jurisdiction of AUC, and decisions are based on grouping applications by energy source (AUC, 2023b). The categories utilized are (AUC, 2023b):

- Thermal energy (coal and natural gas);
- Wind energy;
- Solar energy;
- Hydro energy; and
- Other, including biomass and waste heat.

At the application stage for power plants, factors that are considered by the AUC for approval include (AUC, 2023a):

- Environmental impacts, including impacts to wildlife;
- Property values;
- Noise;
- Visual impacts;
- Land-use considerations;
- Economic benefits; and

- Other concerns raised by other parties.

Currently, the cost of projects and the financial viability is not considered at the approval stage since the market is deregulated and investment is at the risk of the applicant (AUC, 2023a). Decision making is focused on the technical aspects of the proposed plant and a review to determine the impact on nearby communities (AUC, 2023a).

3.1 Non-Renewable Energy

In 2015, the Alberta government announced that emissions from coal power generation would be eliminated by 2030 (Gov. of AB, 2023b). Furthermore, the *Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations* (Gov. of Canada, 2018) was amended in 2018 by the Government of Canada to accelerate the phaseout of coal-fire power generation (AER, 2023d). In Alberta, the following coal-fired power generators were phased out:

- In 2021, TransAlta phased out its generator which resulted in the closure of the Highvale Mine.
- In 2021, Heartland Generation phased out its generator which resulted in the closure of the Sheerness and Paintearth Mines.
- Capital Power is currently in the process of converting the Genesee Site to natural gas. Completion of the conversion will likely result in the closure of the Genesee Coal Mine. The targeted completion date is the end of 2023.

Effectively, by the end of 2023, electricity generation from coal power will be phased out across the province (Gov. of AB, 2023b). Table 3-1 provides a more detailed description of the application to decommissioning and reclamation process for non-renewable energy in Alberta.

Table 3-1 Application to decommissioning and reclamation of non-renewable energy in Alberta.

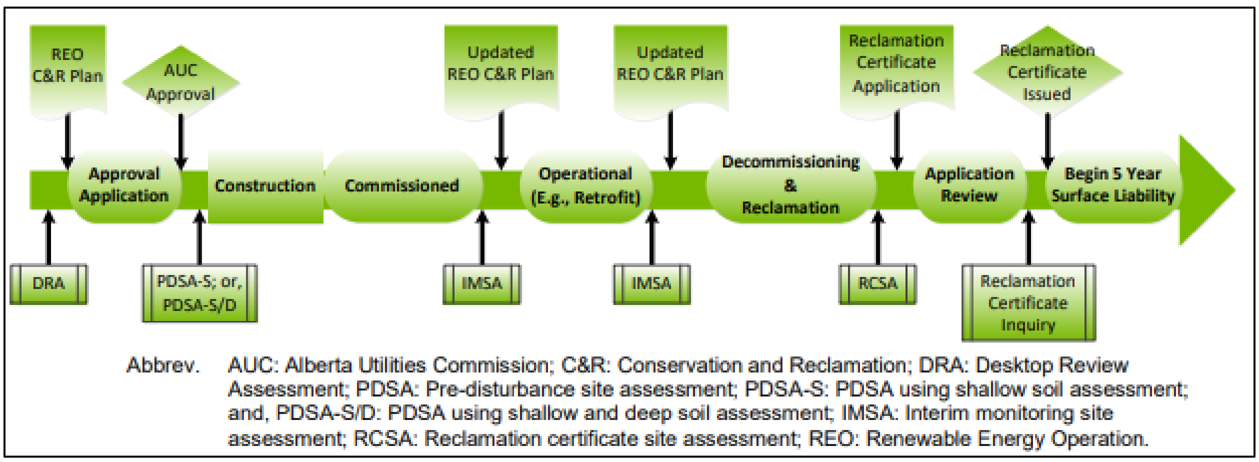
Phase	Coal	Natural Gas
Application Process	Based on the phase out announcement of coal-fired power plants, the application process for coal-fired power plants in Alberta is no longer relevant.	For power generation from natural gas, the AUC oversees the process. Power plant decisions are grouped based on generation source. Natural gas would fall under the thermal energy category, which is treated in a similar way to coal (AUC, 2023b).
Operations	Any operational power plants in the province are now in their last years of their operational lifespan. With 2030 as the target to phase out coal power, decommissioning and reclamation of these facilities will be the main focus for the province.	Operations and maintenance regulations are followed as per AUC's direction.

Phase	Coal	Natural Gas
Decommissioning and Reclamation	The footprint of the plant must be considered as well as the mine itself. Mine reclamation included as part of the MFSP, detailed in Section 5.2.	The footprint of the plant must be considered as well as the wells supplying the plant. Oil and gas reclamation is detailed in Section 4.3.1.

3.2 Renewable Energy

The application for end-of-life process for renewable resources is still a relatively new development. Underlying regulatory frameworks in the province are still evolving and are not as well established as non-renewable resources. Though this is the case, the Figure 3-2 outlines the approval to end-of-life stages for renewable energy operations (REOs) in Alberta.

Figure 3-2. Flowchart of the approval to end-of-life stages for REOs in Alberta (AEP, 2018).



Based on the physical characteristics that make agricultural land more desirable for renewable set ups, and the solar and wind resources in Alberta, it is understandable why most of solar and wind projects in Alberta are located in the southern half of the Province. Figures 3-3 and 3-4 depicts the solar and wind resource across the Province.

Figure 3-3. Map of solar resource across Alberta (AESO, 2020).

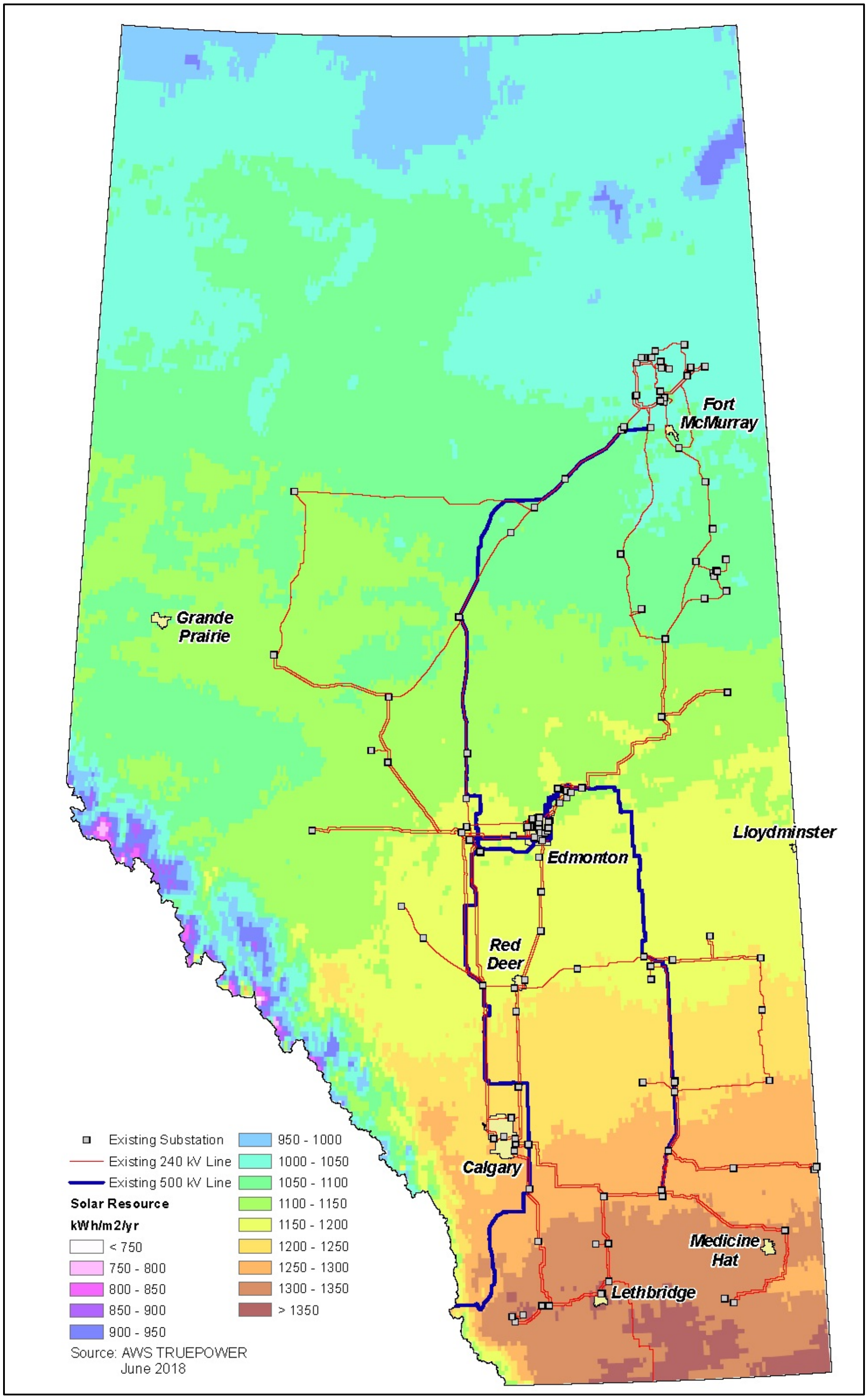


Figure 3-4. Map of wind resource across Alberta (AESO, 2020).

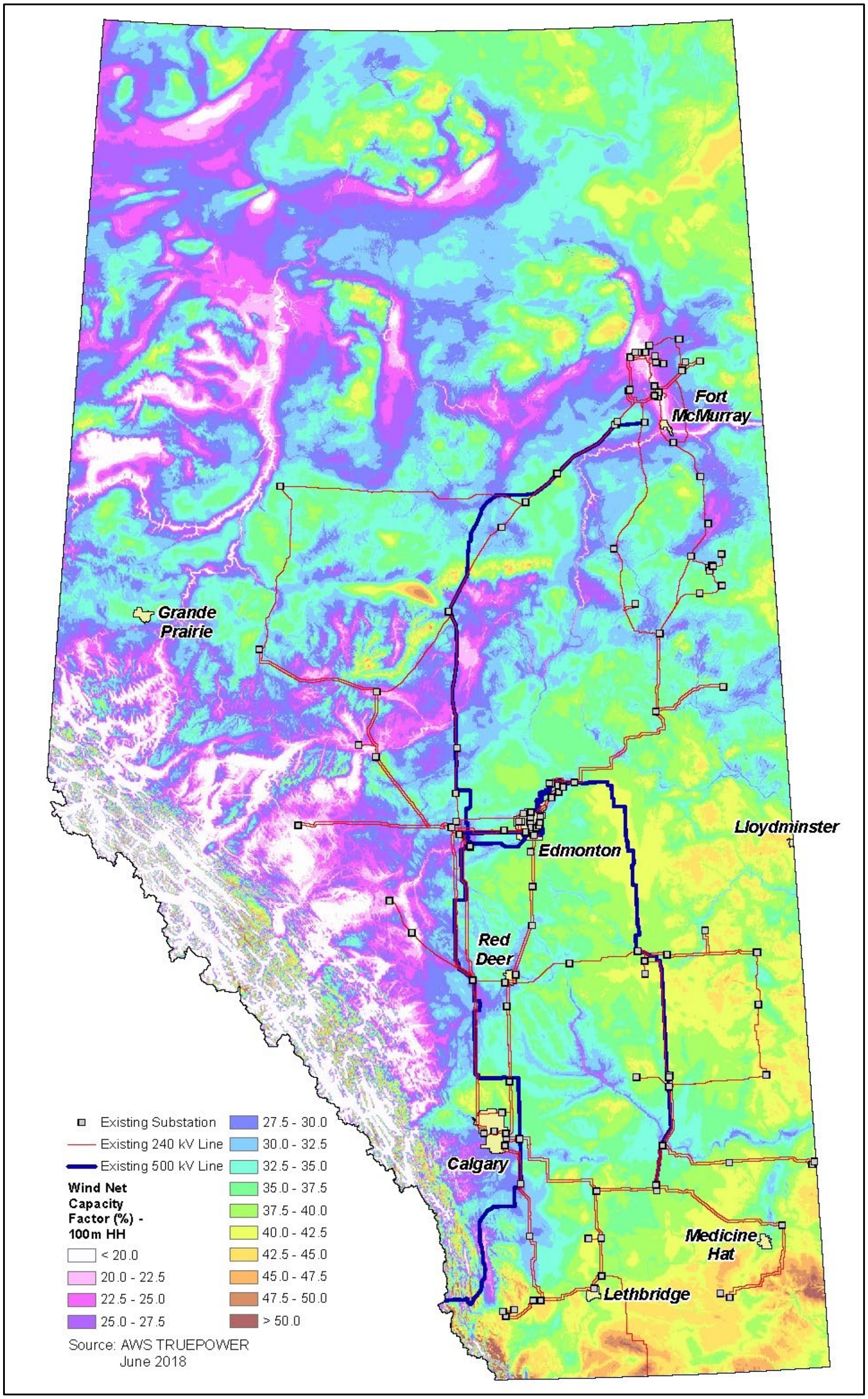


Table 3-2 provides a detailed description of the application to decommissioning and reclamation process for renewable energy in Alberta.

Table 3-2 Application to decommissioning and reclamation of renewable energy in Alberta.

Phase	Renewables
Application Process	The *Hydro and Electric Energy Act* describes the requirements for development and operation of hydro and electric energy in Alberta (AEP, 2022c). The required components for applications to develop power plants, substations, transmission lines, industrial system designations, and hydro development are outlined in AUC Rule 007 *Applications for Power Plants, Substations, Transmission Lines, Industrial System Designations, Hydro Developments and Gas Utility Pipelines* (Rule 007; AUC, 2022). Other Rules that are applicable to the approval process for power plants include AUC Rule 012: *Noise Control* (AUC, 2021); AUC Rule 033: *Post-Approval Monitoring for Wind and Solar Power Plants* (AUC, 2019a); and AUC Rule 024: *Rules Regarding Micro-Generation* (AUC, 2019b). While the *Hydro and Electric Act* does not specifically refer to solar energy, AUC Rule 007 applies to power plants, which includes solar energy plants. As part of the application process, specifically for wind power plants, an environmental evaluation that follows the Wildlife Directive, a directive that provides best management practices to identify risk to wildlife, must be signed off by a professional from Alberta Environment and Parks (AEP, 2018). Under AUC Rule 007, applicants are also required to provide an analysis of how the operator will ensure the project has sufficient funds to address decommissioning and reclamation costs and a renewable referral report from AEP (AUC, 2022). AUC Rule 007 currently does not specify how the decommissioning of renewable power plants needs to be completed.
Operations	Operations and maintenance regulations are followed as per the AUC's direction.
Decommissioning and Reclamation	The reclamation requirements for renewable resources in Alberta are outlined in Section 4.3.4.

Why Decommissioning and Reclamation Should be Considered?

While there are several end-of-life options, advantages of decommissioning and reclamation include:

- Land can be reclaimed and become available for productivity;
- Expenses associated with operations will cease; and
- Scrap materials can be salvaged.

The costs of decommissioning and reclamation can be expensive, thus can be difficult to financially achieve without appropriate financial mechanisms in place. The following sections of the report will outline the current decommissioning and reclamation framework and the liability models in place in Alberta. That knowledge along with a review of other jurisdictions will act as a guide to considering the need for implementing mandatory reclamation security.

4.0 REGULATORY OVERSIGHT OF DECOMMISSIONING AND RECLAMATION IN ALBERTA

4.1 LEGISLATION

Environmental Protection and Enhancement Act

The *EPEA* is the primary Act in Alberta to regulate the management of air, water, land and biodiversity (AEP, 2023c). The Act was modified in 2017 to include details pertaining to thermal, hydro-electric, wind and solar power electrical generation.

Responsible Energy Development Act

The *Responsible Energy Development Act (REDA)* was proclaimed in 2013 to mandate that AER would become the regulator of energy resource(s) development in Alberta (AEP, 2023g).

Conservation and Reclamation Regulation

The *Conservation and Reclamation Regulation* acts to outline the reclamation requirements for specified disturbed land and returning the land to an equivalent land capability as mandated by the *EPEA* (AEP, 2023b).

4.2 REGULATORY BODIES

Alberta Environment and Parks

Alberta Environment and Protected Areas, formerly Alberta Environment and Parks or simply Alberta Environment (AEP) oversees legislation applicable to Alberta's Environment and Ecosystems. They are responsible for policy and legislation to support AUC and the AER with energy development impacts on the environment. In terms of renewable energy, AEP provides support at the approval and construction and operational stages by reviewing plans submitted with applications (after January 1, 2020), ensuring construction and operational requirements meet approval requirements and legislation, which ensures plan aligns with wildlife reviews (AEP, 2018; 2019). At the closure and certification phase, AEP is responsible for issuing reclamation certificates and cancelling dispositions on public land as needed (AEP, 2018; 2019).

Alberta Energy Regulator

Under the direction of *REDA*, the AER is the regulator of energy development in Alberta, specifically for upstream oil, gas, oil sands and coal projects, which provides regulatory oversight for all stages from application to end-of-life closure and reclamation. Specific reclamation requirements have been developed for oil and gas sites, mines, along with in situ operations.

The AER does not have regulatory oversight of the renewable energy sector, however, AER's mandate has been expanded to include oversight of deep geothermal development, hydrogen, helium, and lithium practices in the Province. Additionally, the AER does not have jurisdiction over federal land in the province. For reclamation on First Nations Reserves in Alberta, the Indian Oil and Gas Canada (IOGC) within the Aboriginal Affairs and Northern Development Canada that oversees the issuing of reclamation certificates (AER, 2023t).

Alberta Utilities Commission

The AUC is responsible for issuing approvals for electricity generating systems, including wind and solar facilities, regulating the operational processes of electricity generation, and responsible for cancellation of the approval once the reclamation certificate has been issued by the appropriate governing body (AEP, 2018). They are responsible for ensuring the delivery of Alberta's utility service occuring in a responsible manner and is in the best interest of the public (AEP, 2019).

Alberta Electrics System Operator

The Alberta Electric System Operator (AESO) is responsible for determining the needs and operations of the electric grid, with the notification process for decommissioning (AEP, 2018). As a larger role is played in the transmission and distribution of electricity, the AESO only plays a minor role in the decommissioning and reclamation stages.

4.3 Specific Reclamation Requirements – By Sector

4.3.1 Extractable Resource Reclamation Requirements

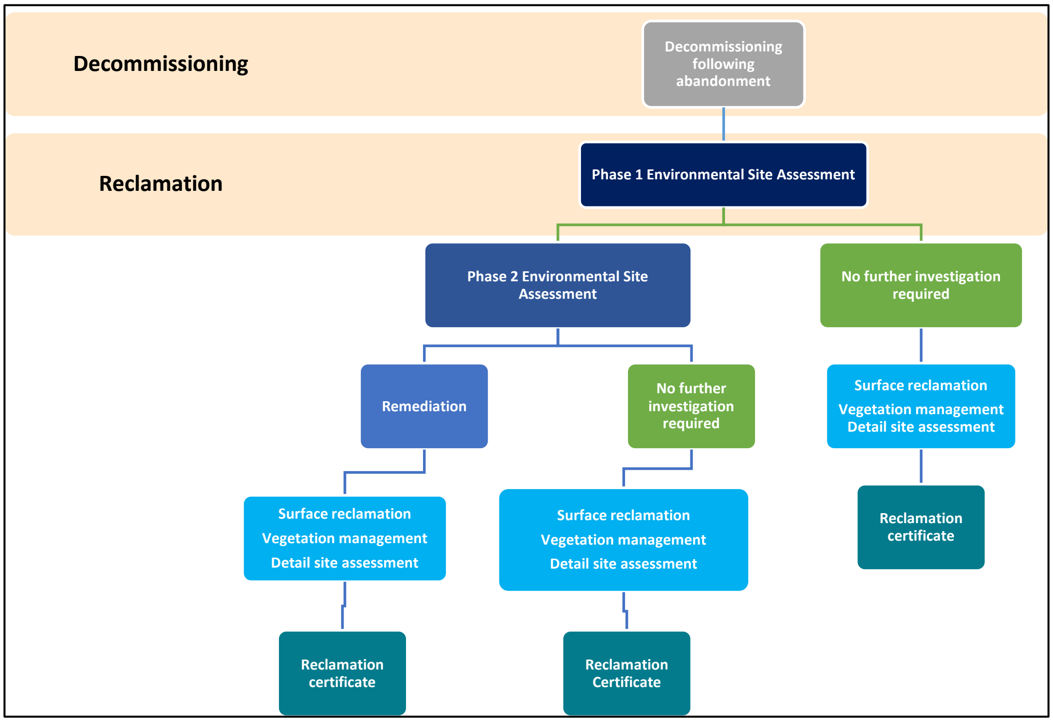
Reclamation guidelines of upstream oil and gas, sweet or sour gas plants and pipelines in Alberta are outlined in the *2010 Reclamation Criteria for Wellsites and Associated Facilities*. The reclamation requirements are dependent on end land use, define as:

- Cultivated lands (ESRD, 2013a);
- Forested lands (ESRD, 2013b);
- Native grasslands (ESRD, 2013c); and
- Peatlands (AEP, 2017).

The reclamation requirements are applicable to wellsite's and all associated facilities, including access roads, remote sumps, campsites, borrow pits, etc. Any infrastructure or facilities that are left in place at the reclamation stage require acceptance and sign off by the landowner.

The steps of the reclamation process for the oil and gas industry in Alberta can be visualized with Figure 4-1.

Figure 4-1. Flowchart of the reclamation process from decommissioning to reclamation certificate.



Landowners will also receive a copy of the reclamation certificate and can submit a statement of concern to AER should concerns not be addressed by the licensee within 30 days of receiving the application.

Currently, there are no regulatory or legislative triggers for reclamation in Alberta. Licensees may leave a site suspended and abandoned indefinitely; however, this will impact their liability rating which could trigger the need to submit a security deposit (Farmer's Advocate Office, 2022). More information on the liability management programs in Alberta are described in Section 5.0. For sites that have an adverse impact to the environment, water or groundwater, Environmental Protection Orders can be issued to speed up the remediation and reclamation processes. The licensee remains responsible for any surface issues within 25 years of the reclamation certificate being issued, and is responsible for life for any contamination concerns (AER, 2023s).

In situ projects in Alberta include enhanced recovery in situ oil sands operations, heavy oil processing plants and oil production sites. Reclamation of these types of facilities are described in *Specified Enactment Direction 001: Direction for Conservation and Reclamation Submissions Under an Environmental Protection and Enhancement Act Approval for Enhanced Recovery In Situ Oil Sands and Heavy Oil Processing Plants and Oil Production Sites* (AER, 2016c). Within six months of ceasing operations of these facilities, licensees must apply for an amendment to their

EPEA approval to decommission and reclaim, and site-specific decommissioning and reclamation requirements must be included. Pilot projects, which are facilities that produce 2,000 m^3 per day or less, are to follow the standard *2010 Reclamation Criteria and Wellsites and Associated Facilities* requirements. For commercial projects, which are facilities that produce over 2,000 m^3 per day, the EPEA approval will cover decommissioning and reclamation requirements (AER, 2023l).

4.3.2 Mine Reclamation Requirements

Reclamation guidelines of coal mines plus processing plants, oil sands mines in addition their processing plants, coal and oil sands exploration programs are outlined in EPEA, furthermore to other legislation such as the *Coal Conservation Act*, or the *Public Lands Act* (Gov. of AB, 2000a), depending on the development type. Site-specific requirements for reclamation, including soil salvage and storage are outlined for an EPEA approval.

For coal mines, oil sands mines and processing plants, the company that owns the mine is responsible for removal of all infrastructure, abandonment, and reclamation. The MFSP (outlined in Section 5.2) was established by the Government of Alberta to manage liability associated with reclamation of coal mines and processing plants. Multiple reclamation plans are typically prepared throughout the life cycle of the facility. As coal mines and processing plants are approved through EPEA, the required components to be submitted for an RCA differ from the standard oil and gas wellsite (AER, 2019).

For coal and oil sands exploration programs, approved projects can operate for a maximum of five years (two years for operations and three years for reclamation), however it is highly encouraged that reclamation is completed within one year of surface disturbance. For areas that are not reclaimed within the five-year time frame, a miscellaneous lease application can be submitted and a reclamation certificate can be applied for on other reclaimed areas (AER, 2023r).

4.3.3 Powerline Reclamation Requirements

The reclamation requirements for powerlines are outlined in the *AEP Reclamation Practices and Criteria for Powerlines* document (AEP, 2020). Powerlines are defined as follows (AEP, 2020):

- "Transmission line right-of-ways on private land;
- Transmission line right-of-ways on public land;
- Distribution line right-of-ways on public land."

Powerline decommissioning involves the removal of conductor wires and support structures. Often, the entire support structure is removed and backfilled, however, if it is to remain in place, it must be removed to a minimum of 1.2 metres below ground surface and must not have an adverse effect on surrounding land (AEP, 2020). The *2010 Reclamation Criteria and Wellsites and Associated Facilities* will be followed for reclamation based on type of land.

4.3.4 Renewable Energy Operations Reclamation Requirements

The *Conservation and Reclamation Directive for Renewable Energy Operations* describes the reclamation requirement for renewable energy options, including solar and wind power generation (AEP, 2018). As defined in the directive, REO is “a site or plant generating renewable electricity from a renewable energy source” (AEP, 2018).

Section 6.2 of the *Conservation and Reclamation Directive for REOs* includes the considerations that must be made in the reclamation planning process (AEP, 2018). The general steps required for REOs include completing a pre-disturbance site assessment; completing interim monitoring site assessment, including a weed management plan; monitoring disturbances; submitting a conservation and reclamation plan; and completing a reclamation certificate site assessment to obtain a certificate (AEP, 2018). Appendix D of the *Conservation and Reclamation Directive for REOs* includes a checklist of required components and information to submit for an RCA (AEP, 2018).

Throughout the process of reviewing and reclamation planning, the AEP will provide support to the AUC as required, however, AEP will accept and approve RCAs for all REOs. For REOs, a reclamation certificate site assessment is required as part of the application and must be completed by an environmental professional. At the very least, the *2010 Reclamation Criteria for Wellsites and Associated Facilities* (AEP, 207; ERSD, 2013a; 2013b; 2013c) must be followed for the assessment.

Following issuance of the reclamation certificate, REOs have a five-year liability period for surface reclamation issues and lifetime liability for contamination (AEP, 2018).

The *Conservation and Reclamation Directive for REOs* does not include information on who assumes liability and responsibility for reclamation of abandoned operations. It is also not applicable to operations that were reclaimed prior to July 1, 2018, facilities that generate five megawatts or less and the total footprint is under one hectare (2.47 acres), or facilities located within the boundary of federal lands (ex. Indigenous reserves, military bases and national parks; AEP, 2019).

5.0 MODELS FOR LIABILITY MANAGEMENT AND END-OF-LIFE SECURITY PROGRAMS IN ALBERTA

Liability management in Alberta for energy development has historically focused on the reduction of inactive sites, including wells, facilities and pipelines, over time (AER, 2023n). In Alberta’s oil and gas industry, there has been an increasing number of inactive wells, however, closure work has not been on pace to keep up (AER, 2023n). As a result, there are several liability management frameworks and security programs which have been implemented in Alberta to manage a Company's liability and ability to meet regulatory obligations, in addition to reducing the potential need for taxpayers to fund decommissioning and reclamation requirements.

With relation to liability management, the Government of Alberta's role is to "set policy direction for how liability is managed and provides general oversight, with the goal of reclaiming land for other uses" (AER, 2023n), whereas, the role of AER includes being "responsible for implementing policy, monitoring progress, and providing enforcement when needed" (AER, 2023n).

5.1 Oil and Gas Sector

The AER has developed a liability management framework for the life cycle of oil and gas to assist with the identification of potential issues, develop timely solutions and increase closure work (AER, 2023n).

The **Licensee Liability Rating (LLR) Program** helps alleviate the burden of decommissioning and reclamation costs on Albertans by requiring licensees to provide financial security when their liabilities outweigh their assets (AER, 2023o). This ensures the licensees have a plan and the financial means to meet their closure requirements. The amount of financial security is based on the difference. The details of the program are listed in *Directive 006: Licensee Liability Rating Program* (AER, 2021b) and *Directive 011: Licensee Liability Rating Program: Updated Industry Parameters and Liability Costs* (AER, 2015). *Directive 068: Security Deposits* provides information and direction regarding the cash and letters of credit provided to the AER to satisfy security deposit requirements under the energy resource enactments (AER, 2022a). This directive does not apply to security programs, which will be described in detail in later sections.

The LLR contributes to the licensee's **Liability Management Rating (LMR**), which is a measure of the ratio of a company's liabilities and assets, that has been a large part in the determination of liability for the oil and gas sector (AER, 2023o). LMR is calculated on a monthly basis, and the rating system is as presented in Table 5-1.

Table 5-1 Defining LMR ratios and security implications for closure in Alberta (AER, 2023o).

LMR	Defining the Ratio	Security Implications for Closure
Equals 1.0	Company has the same amount of assets as liabilities	AER did not require security to be posted
Less than 1.0	Company has more liabilities than assets	AER would require security to be posted

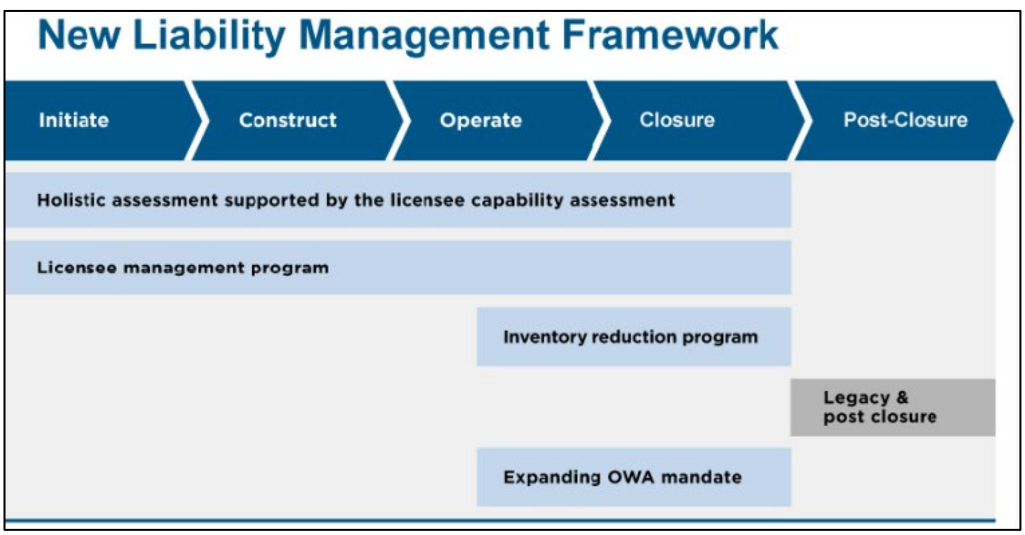
A main issue with LMR is that when companies have a rating below 1.0, there is potential the company is already in financial distress and security cannot be posted. For assets where the licensee goes through the bankruptcy process, the liabilities would eventually be transferred to the Orphan Well Association (OWA) program. As a result, the LMR has been deemed an unsuitable measure to evaluate the full life cycle of energy development. However, the LMR is currently integrated into three of AER's liability management programs – Licensee Liability Rating (LLR) Program, Large Facility Liability Management Program (LFP) and Oilfield Waste Liability (OWL) Program, in addition to several directives and the *Oil and Gas Conservation Rules* (AEP, 2023f). Thus, replacement of the LMR is not a simple task without careful consideration of how other regulations are impacted.

In 2020, a new liability management framework was developed. This framework is outlined in *Directive 088: Licensee Life-Cycle Management* (AER, 2023h), and *Manual 023: Licensee Life-Cycle Management* (AER, 2023q), and includes information pertaining to the following (AER, 2023n):

- the holistic assessment and licensee capability assessment (LCA);
- the licensee management program (LMP);
- the inventory reduction program;
- an updated licence transfer process; and
- and changes to security collection.

Furthermore, the new liability management framework can be visualized as per Figure 5-1.

Figure 5-1. Programs involved in the liability management framework for Alberta's energy development (AER, 2023n)



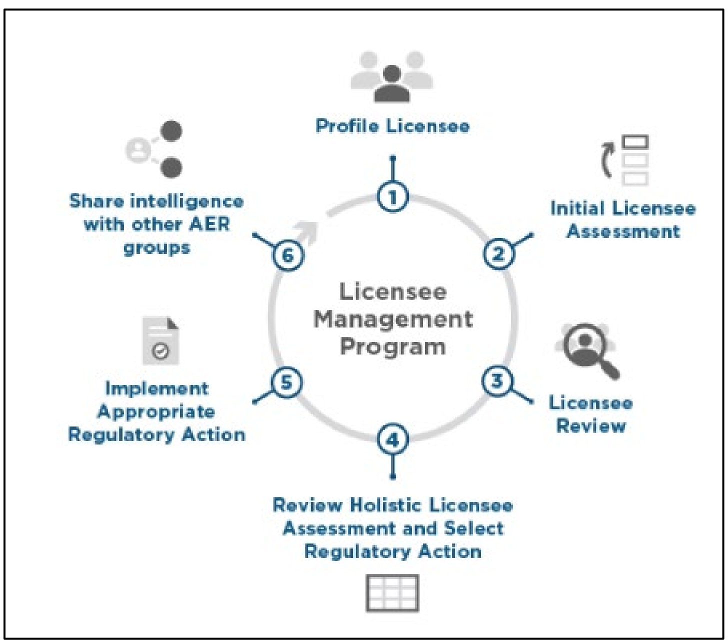
The **holistic assessment** is a framework that assesses multiple factors to provide insight into a company's ability to manage their regulatory and liability obligations, including cleaning up their sites (AER, 2023k). The factors that are considered are listed in Section 4.5 of *Directive 067: Eligibility Requirements for Acquiring and Holding Energy Licences and Approvals* (AER, 2023g). With these factors, the company's financial and liability risk, performance and operations, and closure and administrative factors are evaluated as part of the LCA, which makes up the backbone for the evaluation of the energy life cycle, particularly for oil and gas operations. The results of the assessment, which are confidential and not available to the public (AER, 2023k), will dictate if a licensee is capable of meeting their regulatory and liability obligations across the energy development life cycle (AER, 2023g).

Over time, the intention is to replace the LMR with the LCA. To date, the holistic assessment has replaced LMR for licence transfers and security collection for licence transfers (AER, 2023k).

Once the holistic assessment has been completed, the **Licensee Management Program (LMP)** will be utilized to identify the licensees that are or likely to be at risk of not meeting their regulatory and liability obligations (AER, 2023o). The AER will act to provide education or recommendations to follow best practices, and initiate regulatory action as needed. As the holistic assessment and LCA are slowly being introduced, the LMP will also be implemented in phases, with the first phase consisting of a holistic assessment to prioritize and review licensees (AER, 2023o). Once similar licensees have been appropriately grouped and additional reviews completed, the AER will use a risk matrix approach to determine the suitable regulatory actions required and monitor the licensees to ensure management of risk and liability are being accounted for.

As presented by the AER, Figure 5-2 depicts the steps of the LMP.

Figure 5-2. Flowchart of Steps in the Licensee Management Program (AER, 2023o).



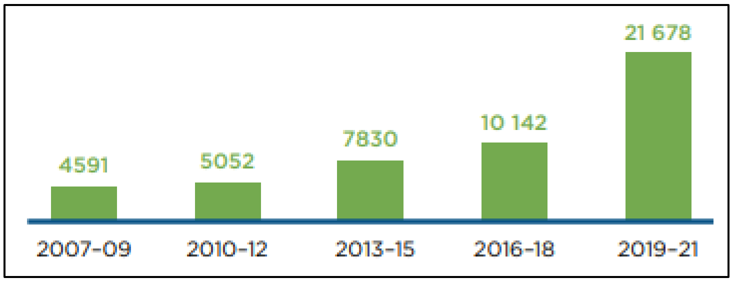
The three main outcomes of the LMP are as follows (AER, 2023o):

- Proactively conduct timely closure work and reduce liability;

- Maintain integrity of infrastructure and site; and
- Manage infrastructure to minimize the risk to the public and environment.

From 2019 to 2021, the **Area Based Closure Program** was implemented as a step gap to assist with the transition into the new liability management framework. The goal was to help reduce the cost of closure through the Inventory Reduction Program. Licensees were able to focus their closure spend on work that fit their liability reduction goals in a more effective and efficient way, rather than the AER mandating specific closure work. The figure below shows the number of abandoned wells in three-year increments between 2007 and 2021:

Figure 5-3. Number of abandoned wells in three-year increments from 2007 to 2021 (AER, 2021a).



In 2020, the Federal Government provided approximately $1 billion in grant funding to be administered by the Government Alberta as part of the **Site Rehabilitation Program (SRP)** to encourage the proper closure and reclamation of oil and gas sites in Alberta. While licensees in the ABC program still had to provide funds to meet their closure targets, SRP contributed to the increased closure spending. In 2020, individual spend targets were suspended, and for licensees in the ABC program in 2020 and 2021, the spend amount from 2020 counted towards 2021 (AER, 2021a). Overall, the grant program was set up to assist licensees to meet their regulatory obligations. While the AER oversaw the regulatory requirements for closure, the funding provided was not part of AER's liability management framework. Funding was awarded when a contract between a licensee and contractor were submitted. The grant program ended in 2022 (AEP, 2023h).

The **Inventory Reduction Program** was implemented in 2022 to assist with improving closure work and reducing liability as outlined as a main outcome of the LMP, as well as increasing the amount of land being returned to equivalent capabilities. The program consists of closure quotas and closure nomination.

Closure quotas "specify the minimum amount of money that licensees are required to spend on oil and gas closure work each year and encourages oil and gas companies to collaborate towards increased efficiency of projects and complete more closure work" (AER, 2023m). There are two types of quotas – mandatory closure spend quotas and supplemental closure spend quotas.

Mandatory closure spend quotas are based on the industry-wide closure spend requirement set by AER. It is determined by several factors, including change in number of inactive sites, commodity pricing, and closure work completed in the previous year. In 2022, also the first year the program was implemented, the industry-wide closure spend for the oil and gas industry was $422 million. For 2023 and 2024, the quotas are $700 million each year (AER, 2023e). Licensees are provided licensee-specific quotas based on the Province's closure spend requirement. The financial distress of a licensee as determined by the LCA in conjunction with the licensee's proportion of the industry's inactive liability are used to calculate the licensee-specific spend rate. Licensees with a high level of financial distress, determined by having approximately 10% of the industry's inactive liability will be presented with a lower required spend rate. For reference, in 2022, a higher spend rate was 4.0%, and lower spend rate was 3.3%. In 2023, a higher spend rate was 6.7%, and a lower spend rate was 3.6% AER, 2023e). The mandatory closure spend is calculated as follows:

Mandatory closure spend = Value of total inactive liability x spend rate

Supplemental closure spend is a higher, optional quota with incentives should licensees decide to meet that target. Incentives include access to surface equipment removal extensions and mineral lease expiry extensions (AER, 2023e).

For sites that have been inactive or abandoned for five or more years, with the exception of pipelines and pipeline risers, a closure nomination can be submitted to the AER (AER, 2023m).

The **Large Facility Liability Management Program (LFP)** is a program to protect Albertans from the decommissioning and reclamation costs of large facilities, including sulphur recovery gas plants, standalone straddle plants and in situ oil sands central processing facilities with a minimum production capacity of 5,000 m^3/day of bitumen (AER, 2023p). *Directive 024: Large Facility Liability Management Program* outlines the liability management requirements related to these facilities (AER, 2016a). The LFP is applicable to historic, current, and future licensed facilities. The working interest parties are required to pay a proportionate share of the cost to cover the expenses for end of life (from suspension to reclamation).

Security associated with facilities within the LFP is determined by a licensee's security-adjusted LMR, which is calculated monthly (AER, 2016a). In the case a licensee in the LFP becomes defunct, the following situations will occur (AER, 2016a):

- "Any non-facility-specific LMR security deposit held by the AER will be allocated to address its unfunded suspension, abandonment, remediation, or reclamation liability in each program in which it had liability in proportion to its deemed liability in each program; and

- Any facility-specific security deposit held by the AER will be applied first to the facility for which it was collected, with any surplus being available for any unfunded liability held by the licensee."

The *Oil and Gas Conservation Rules* (AEP, 2023e) *and Geothermal Resource Development Rules* (AEP, 2023d) allows AER to collect security deposits as required. *Directive 068: Security Deposits* outlines the information regarding submitting cash and letters of credit to the AER (AER, 2022a). The directive is not applicable to security programs that fall under the specified enactments, such as the MFSP.

A levy is issued to licensees with facilities in the LFP as a contingency in the event other licensees become defunct, and their facilities become orphaned. The levy amount is dependent on a licensee's share of liabilities within the LFP. The Orphan Fund Levy is further detailed below.

The **Oilfield Waste Liability (OWL) Program** is a program to protect Albertans from being responsible for the end-of-life costs of AER-approved oilfield waste management facilities, and to minimize the risk to the Orphan Fund should the licensee becomes defunct. Similar to the LFP, licensees must provide a security deposit that is calculated based on the LMR assessment.

LMR for non-producing licensees and eligible licensees (AER, 2016b):

$$\mathrm{LMR} = \frac{\mathrm{DA\ in\ OWL} + \mathrm{DA\ in\ LLR\ (if\ any)} + \mathrm{DA\ in\ LFP\ (if\ any)}}{\mathrm{DL\ in\ OWL} + \mathrm{DL\ in\ LLR\ (if\ any)} + \mathrm{DL\ in\ LFP\ (if\ any)}}$$

LMR for producer licenses (AER, 2016b):

$$\mathrm{LMR} = \frac{\mathrm{DA\ in\ LLR}}{\mathrm{DL\ in\ OWL} + \mathrm{DL\ in\ LLR} + \mathrm{DL\ in\ LFP\ (if\ any)}}$$

where, DA is the deemed assets and DL is the deemed liability.

The deemed assets are determined with the Facility Netback Calculation Form in Directive 075 (AER, 2016b) for each licensee's facility within the program, and the non-producing licensee volumes. The deemed liabilities are based on the Facility Liability Declaration form, current cost for end-of-life activities, site-specific liability assessment and meeting the AER closure requirements. Licensees that cannot provide financial information to verify the netback calculation is required to submit a security deposit for 100 percent of the deemed liability of the facility (AER, 2016b).

Under the OWL program, facility-specific security deposits are also required for the amount by which the deemed liabilities of an oilfield waste management facility exceed its deemed assets regardless of the LMR assessment (AER, 2016b). This is determined by the facility-specific liability rating (AER, 2016b):

$$\text{Facility-Specific Liability Rating} = \frac{\text{Deemed asset of facility (determined by appendix 4)}}{\text{Deemed liability of facility (determined by appendix 5)}}$$

Refunds of facility-specific security deposits can be issued once a facility has reported 12 calendar months of throughput and the deemed assets are equal or exceed the deemed liabilities.

The **Orphan Fund Levy**, which is covered by the licensees in the LLR Program and OWL Program, is used in cases when licensees become defunct. Facilities within the OWL Program are eligible to be declared orphaned. The orphan levy is calculated as follows:

$$Licensee's\ share\ of\ levy = \frac{A}{B} \times required\ levy\ amount$$

where, A is the licensee's deemed liability in the LLR and OWL programs and B is the deemed liability of all licensees in the LLR and OWL programs.

If a non-producing licensee becomes defunct within five years of being in the OWL program, the remaining non-producing licensees will be subject to a separate levy to address the first $2 million of decommissioning and reclamation costs of the defunct licensee's assets. For licensees with end-of-life costs that exceed $2 million, the additional costs over $2 million will be an expense of the Orphan Fund.

Under the *Oil and Gas Conservation Act*, the **Orphan Well Association (OWA)** operates through the Orphan Fund Delegated Administration Regulation with authorization from AER to manage closure of orphaned oil and gas wells, pipelines and facilities and reclamation of sites. The OWA operates from the funds collected through the annual orphan fund levy as discussed above. The holistic assessment and LCA do not impact the levy calculation.

To estimate the cost of closure, **Site-Specific Liability Assessments (SSLAs)** are completed at specified intervals throughout the life cycle of the facility (typically 5 years or 3 years for designated problem sites or upon AER direction such as in the event of a license transfer request). As defined in *Directive 001: Requirements for Site-Specific Liability Assessments Facilities*, a liability assessment is an "assessment conducted by a licensee or approval holder to estimate the costs to suspend, abandon, remediate, and reclaim a site, as well as provide care and custody from shutdown of operations through to site reclamation" (AER, 2023f). Facilities that require these types of assessments include (AER, 2023p):

- "Facilities in the LFP;
- Facilities in the OWL program;
- Gas processing and gas fractioning plants in the LLR program;
- A request for LLR variation; and

- Potential problem sites in the LLR Program defined by AER."

Directive 001 is applicable to all liability management programs under the *Oil and Gas Conservation Rules* (AEP, 2023g), *Brine-Hosed Mineral Resource Development Rules* (AEP, 2023d), and *Geothermal Resource Development Rules* (AEP, 2023g). Sites that fall under the specified enactments of *EPEA* are not required to follow Directive 001. The components to be included in the SSLA are detailed in Directive 001 and are only required when deemed necessary by AER.

Other measures the AER is taking with managing liability is reviewing unpaid municipal taxes and surface lease payments. Applications for new well licences or well transfers will be reviewed to confirm the licensee does not have any unpaid municipal taxes over $20,000 (AER, 2023n). Unless evidence is provided that the unpaid taxes have been covered or a payment plan has been accepted, the applications will be classified as incomplete. While the AER can deem applications incomplete, they do not have jurisdiction to take compliance or enforcement action(s) and are not involved with collection of taxes (AER, 2023n).

Additionally, licensees must disclose surface lease payment information as requested by AER. Any unpaid surface lease payments will assist the AER in determining if a licensee can meet their regulatory and liability obligations (AER, 2023n).

5.2 Mines

To manage the liabilities of coal mines and oil sands, the Government of Alberta and AER have implemented the **MFSP**. As with the oil and gas liability management programs, the MFSP aims to reduce the burden of end-of-life closure activities on Albertans. Under MFSP, there are four types of financial security deposits (AEP, 2021; AER, 2022b):

1. Base security deposit.

   The base security deposit provides funds to the government to maintain security and safety of the site until the site is taken over or infrastructure is removed, and site is reclaimed. Should a new approval holder not take over, the deposit will be used to cover closure costs. The deposit is based on industry standards as follows:

   - $2 million for mine-mouth coal mine approval.
   - $7 million for export coal mine or plant approval.
   - $30 million for oil sands mine with no EPEA approval as of January 1, 2011.
   - $60 million for oil sands mine and upgrader with no EPEA approval as of January 1, 2011.

2. Operating life deposit.

When there remains less than 15 years of reserves remaining, the operating life deposit is required to address the risks at the end of the mine's life to ensure that the closure costs are covered by the time there are six years or less of reserves remaining. This deposit is the difference in closure costs and the base security deposit.

3. Asset safety factor deposit.

   If the asset reduces up to three times the cost of the liability, and the liability cannot be fully funded, an asset safety factor deposit requirement should be guaranteed. For instances where the threshold for the risk is far too great, a deposit is necessary when the asset to liability ratio falls below 3.00. Financial security will assist in bringing the ratio back to 3.00. This deposit is intended to operate as a long-term incentive to prevent deferring reclamation activities.

4. Outstanding reclamation deposit.

   This deposit addresses the risk that results from a licensee deferring reclamation which operates as an immediate and continuous incentive. Security is posted when liability is not reduced according to an AER approved reclamation plan, and the cost of deferring reclamation is greater than reclaiming.

6.0 REGULATORY OVERSIGHT OF DECOMMISSIONING AND RECLAMATION PRACTICES ACROSS CANADA

Across Canda, there are well-established frameworks for the oil and gas industry, with frameworks for renewable energy that are becoming more prevalent.

At the Federal level, the Government of Canada is responsible for management of sites under custody of Federal Departments or Crown Corporations such as Department of National Defence, Transport Canada, Parks Canada, sites on Federal land, and additional sites where the Government of Canada has accepted some or all financial responsibility.

Additionally, while some Provincial Regulators collaborate on the framework approaches, ultimately, each Province has their own regulations and liability management programs for each energy sector. Below, Federal frameworks and Provincial frameworks in British Columbia, Saskatchewan and Ontario will be discussed.

6.1 FEDERAL

Canada Federal Contaminated Site Action Plan

The FCSAP was established in 2005 by the Government of Canada to provide a framework to address identified contaminated sites. Through the plan, funding is provided to assist with managing contaminated sites that fall under the responsibility of federal departments, agencies and consolidated Crown Corporations (ECCC, 2021). The objectives of the plan include reducing the environmental and human health risks from known Federal contaminated sites and the financial liabilities. The fund does not provide funding for all Federal contaminated sites, and sites must meet the eligibility criteria.

In 2005 when the program started, $4.54 billion CAD was provided by the government to operate a 15-year program (Gov. of Canada, 2019). The program was renewed for another 15 years in which $1.16 billion CAD would be invested for 2020 to 2024 (Gov. of Canada, 2019).

The Government of Canada has identified sites where assessment, remediation and/or risk management and monitoring are required. Of these sites, site assessments completed by professionals are used to determine the liability estimate of these sites (ECCC, 2021). A statistical model is used to estimate the liability of unassessed sites, based on a projection of how many sites will proceed to remediation and the current and historical costs (ECCC, 2021). When combining the estimates of the assessed and unassessed sites, the cost is the best estimate of the cost to remediate the sites.

- Eligibility to receive funding through the program was set up as follows (Gov. of Canada, 2019): Phase III (2016 to 2019):
    - Meet the definition of contaminated site as set by the Treasury Board.
    - Activities prior to April 1, 1998, are the source of contamination.
    - On lands owned or leased by the federal government, or on non-federal lands that the federal government is responsible for.
    - Classified as Class 1 (high priority) or Clase 2 (medium priority) where remediation began prior to 2011.
    - Financial liability is reported in the Public Accounts of Canada and in the Treasury Board Secretariat’s FCSI.
- Phase IV (2020 to 2024) – in addition to the criteria described in Phase III, the following is now eligible for funding:
    - Sites can be bundled with a Class 1 or ongoing Class 2 site. In this case, a group of sites can be remediated if they are in close proximity regardless of the classification.
    - Located on First Nations reserves or impacting Indigenous communities in the north, overseen by Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC).

Additionally, sites that were contaminated post 1998 can be eligible if they are located on First Nations Reserves or impacting Indigenous communities in the north, overseen by CIRNAC, are being transferred to CIRNAC, or have been/will be inherited by the government (Gov. of Canada, 2019).

The classification of sites is based on the Canadian Council of Ministers of the Environment National Classification System for Contaminated Sites and the Aquatic Site Classification System developed by FCSAP, which scores sites based on their potential impacts to human health and the environment (Gov. of Canada, 2019).

The FCSAP operates on a cost sharing basis, where portions of the activities are to be covered by the responsible party. Since the program started in 2005, approximately $387.8 million CAD of funding from responsible parties has been spent on remediation activities (Gov. of Canada, 2019).

Canada Energy Regulator Decommissioning Requirements

The Canada Energy Regulator (CER) provides a framework for the parts of Canada's energy industry that fall under their jurisdiction. This includes pipelines, power lines, and offshore renewable sources.

To decommission a pipeline, an application must be submitted to the Commission for review indicating the reasons for decommissioning and procedures that will be followed (CER, 2023a).

Decommissioning of pipelines involves removing the product from the pipeline, cleaning the interior, disconnecting the pipeline from facilities, creating barriers that prevent anything from entering or exiting the pipeline, and returning the land to a comparable state as the surrounding area (CER, 2023b).

Cost estimates of the decommissioning process must be provided along with the application to decommission. Additionally, costs for post-decommissioning activities must also be provided as decommissioning is not at the end of the life cycle. These estimates, which are based on present day costs, must include the future costs associated with maintaining the facilities in a decommissioned state until final abandonment, as well as the costs to complete abandonment, including any remediation and reclamation work required (CER, 2023a).

Liabilities detailed should include the type of liability and estimated associated cost of facilities, as well as a statement that describes which decommissioning work is associated with a legal obligation (CER, 2023a).

Confirmation of available funds for the decommissioning work is required and must be available for future abandonment work (CER, 2023a).

Mine Closure Requirements

The Mine Site Reclamation Policy for Nunavut was released in July 2022 by the Department of Indian Affairs and Northern Development (Gov. of Canada, 2022). It applies to operating of closed mines in Nunavut. The reclamation plan must indicate the owner and/or operator of the mine is responsible for the closure costs.

Financial security for these projects are set at the time of the licence or lease approval and is held by the Minister of Northern Affairs. If the project overlaps on Indian Owned Land (IOL), part of the security may be assigned to the appropriate Regional Inuit Association (RIA) under a security management agreement, which are prepared on a case-by-case basis. Terms that can be included in these agreements include the following (Gov. of Canada, 2022):

- Amount of security held by each organization.
- Justification for division of security (if divided between organizations).
- Conditions under which security funds will be released.

Larger projects may be able to post security in phases, however, this is on a case-by-case basis.

The amount of security required is to be equal to the total reclamation liability for all lands and water bodies that are impacted by the mine(s). Costs are to be based on the reclamation work that would be completed by a third-party contractor. The standard model for estimating security costs is the RECLAIM 7.0 model, which was developed by CIRNAC, the Government of the Northwest Territories, and the Lands and Waters Boards of the Mackenzie Valley (Gov. of Canada, 2022).

An interim abandonment and restoration plan must be submitted at the application stage and essentially will include the detailed cost estimate using the RECLAIM 7.0 model (Gov. of Canada, 2022). The water licence will detail a schedule for submitting interim and final plans. With these plans, it is encouraged to follow a progressive reclamation and abandonment plan and a phased-in approach to accommodate new technology. Updated costs are to be provided on a regular basis throughout the operational period. A monitoring program proposal is also required and an obligation to be implemented by operators for the length of time specified after operations is complete. The post-closure monitoring will determine the effectiveness of the reclamation work completed to date on the site (Gov. of Canada, 2022).

A certified final plan of land use must be submitted to CIRNAC a minimum of 60 days before the completion of the land use operation and/or the expiry of a land use permit (Gov. of Canada, 2022).

Release of financial security can only be done when the items listed on the abandonment and restoration plan are addressed following mine closure (Gov. of Canada, 2022).

For orphaned or abandoned mine sites, the closure requirements would fall under the Federal Government's Contaminated Sites Policy Framework (Gov. of Canada, 2022).

6.2 British Columbia

Oil and Gas Sector

The BC Energy Regulator's (BCER) Liability Management Program manages the financial risks for oil and gas operations in British Columbia. The program is used to determine the security deposits required by licensees. The Comprehensive Liability Management Plan was introduced in 2019 and addresses three main components to ensure the liability does not fall onto the public (BCER, 2023; BC Oil and Gas Commission, 2020). These three components include (BCER, 2023):

- Liability management: The Permittee Capability Assessment program, which replaced the LMR program in British Columbia in 2022, completes a holistic assessment to determine the financial health of licensees and evaluate their ability to meet regulatory obligations.
- Improving rate of inactive site restoration: *The Dormancy & Shutdown Regulation* (BC OGC, 2023) implements a timeline in which licensees must decommission and reclaim inactive sites.
- Addressing orphan sites: Previously, the levy imposed on licensees was a fixed tax based on production. However, the levy is now based on liability and is used to fund the Orphan Site Reclamation Fund. The levy is calculated in a similar model to Alberta. This ensures that decommissioning and reclamation work is solely funded by industry.

Renewable Energy Sector

The *Clean Energy Guidebook* indicates decommissioning is the responsibility of the licensee, and terms and conditions are generally outlined in the tenure document. Five years prior to the termination of the facility licence, the licensee must apply for an extension or prepare a decommissioning plan. The time in which decommissioning must occur is project specific (Gov. of BC, 2016).

For leases on Crown land that fall under the *Land Act*, financial security is required (MoFLNRO, 2019). The amount required is based on a risk assessment of the likelihood of the security being used and the decommissioning costs (Figure 6-1). The likelihood of security being used is defined by the likelihood of a default event occurring and the responsible party not being able to meet their required decommissioning obligations. If a licensee cannot or will not meeting their end-of-life closure requirements with corporate funds, then security is utilized to fun activities. If closure obligations are met, the security is returned to the licensee. The higher the decommissioning cost, the more likely the need for the security to be used to finance the process.

The decommissioning cost will be more heavily weighted in the risk assessment as financial information of the licensee may not be readily available during the review process (MoFLNRO, 2022). The estimated cost of removing a remote meteorological tower is approximately $15,000 CAD. For wind projects, the required minimum amount of financial security will be project dependent based on details discussed below. Requirements for solar projects were not included in the land procedure. Figure 6-1 shows the risk matrix used to determine security amounts.

Figure 6-1. Risk matrix to determine security amounts (MoFLNRO, 2022).

Clean-up cost class	Likelihood of security being used			
	N	L	M	H
N (<$1k)	Neg	Neg	Low	Low
L ($1k – $10k)	Neg	Low	Low	Med
M ($10k – $50k)	Low	Low	Med	High
H ($50k +)	Low	Med	Med	High

Based on the results of the risk matrix, the security funding requirements for decommissioning can be determined. Table 6-1 outlines the funds for security based on the risk level.

Table 6-1 Security amounts required based on licensee risk assessment (MoFLNRO, 2022).

	Negligible	Low Risk	Moderate Risk	High Risk
Decommissioning Cost	Less than $1,000 CAD.	$1,000 CAD to $10,000 CAD.	$10,000 CAD to $50,000 CAD.	Greater than $50,000 CAD.
Basis for Security Amount	Consider using minimum amount.	Consider using a minimum amount or up to 30% of estimated costs.	Consider using 30 to 60% of estimated costs.	Consider using 60 to 100% of estimated costs.
Security Required	Minimum security amount may be used.	Minimum security amount may be used.	Security amount based on the estimated decommissioning and reclamation costs.	Security amount based on the estimated decommissioning and reclamation costs.

Phased in financial assurance methods can be used for large projects to account for the change in risk that a project may undergo during each step of the project. The cost estimate should be based on present day information, and not on future costs, thus periodic reviews are completed. The acceptable and non-acceptable forms of security are shown in Table 6-2.

Table 6-2 Acceptable and Non-acceptable forms of security for approvals under Land Act in British Columbia (MoFLNRO, 2022).

Acceptable Forms	Not Acceptable Forms
▪ Irrevocable letter of credit (preferred form for approvals under the Land Act). ▪ Cash (physical cash, cheques, bank drafts, online banking bill payments, interac debit card payments, wire transfers, or money orders). ▪ Surety bonds.	▪ Credit card payments. ▪ Electronic fund transfers and e-transfers. ▪ Safe keeping agreements.

Blanket securities can also be arranged if a licensee has multiple projects, instead of posting security for each individual project (MoFLNRO, 2022).

6.3 SASKATCHEWAN

Oil and Gas Sector

The Government of Saskatchewan's Acknowledgement of Reclamation (Gov. of Sask AOR) Program is a program specific to the oil and gas sector for sites that fall under *the Oil and Gas Conservation Regulations, 2012*. The Gov. of Sask's AOR program is regulated by the Government of Saskatchewan's Ministry of Energy and Resources (Gov. of Sask, 2023a).

The Licensee Liability Rating Program in Saskatchewan manages the risk to the Saskatchewan Oil and Gas Orphan Fund (SOGOF) and operates in a similar manner as the programs in Alberta and British Columbia that help prevent the end-of-life costs from falling onto the public. The *Financial Security & Site Closure Requirements* (Gov of Sask, 2023c) and *Directive PNG025: Financial Security Requirements* (Gov. of Sask, 2023a) outlines information on liability calculations and security deposits. Security deposits are required by all licensees with oil and gas operations in Saskatchewan. Facilities that are non-oil and gas, such as potash mining, storage facilities, waste facilities etc., are exempt from the required security deposit framework.

The Inactive Liability Reduction Program is a new program in Saskatchewan that requires licensees to annually retire a certain percentage of their inactive liabilities. Similar to Alberta's Inventory Reduction Program, this program aims to prevent an increase in orphaned wells and facilities, ensure end-of-life regulatory obligations are being met and ensure licensees are managing liabilities proactively (Gov. of Sask, 2023b).

Saskatchewan also has an Orphan Fund Procurement Program that is responsible for identifying orphaned upstream oil and gas and wellsites. Funds within SOGOF, which is funded by Saskatchewan oil and gas producers are used to assist with closure of sites operated by defunct licensees. Any licensee with abandonment and reclamation liability for their oil and gas assets are required to annually pay into the Orphan Fund Levy. The levy is determined through the LLR program and considers the licensees' deemed liability, industry deemed liability and annual budget set by the Ministry of Energy and Resources. In 2023, the total levy was determined to be $10 million CAD (Gov. of Sask, 2023b).

Renewables Sector

At this time, there are no specific guidelines for the decommissioning and reclamation processes of renewable energy in Saskatchewan.

6.4 Ontario

Oil and Gas Sector

The oil and gas industry in Ontario is regulated by the Ontario Ministry of Natural Resources and Forestry who follow the *Ontario Regulation 245/97* and Provincial Operating Standards.

Unlike the Western Provinces, Ontario currently does not have a security plan or requirement for end-of-life activities. Oil and gas licensees are responsible for plugging inactive wells. If the licensee is defunct and an operator responsible for the well cannot be located, the landowner is responsible for plugging the well.

Oil and gas wells that were drilled before 1963, haven't been used or tampered with, are visible from the surface and does not have an operator qualify for the Abandoned Works Program, which assists landowners with plugging wells on their property. The Abandoned Works Program which is regulated by the Ministry of Natural Resources and Forestry is funded by the Ontario Government and $23.6 million CAD has been invested into the program (Natural Resources and Forestry, 2023).

Renewables Sector

The *Technical Guide to Renewable Energy Approvals* outlines the approval process for renewable energy in Ontario, including details on decommissioning (MOECC, 2023). The Renewable Energy Approval Regulation (O.Reg 359/09) indicates a Decommissioning Plan Report is required as part of the application that is sent to the Ministry of the Environment and Climate Change (MOECC) for approval of renewable energy projects (MOECC, 2023). The approval requirements apply to the following types of facilities (MOECC, 2022; 2023):

- Solar projects:

    - Class 3 ground-mounted solar facilities with a name plate capacity greater than 10 kW.
- Wind projects:
    - Class 2 facilities with a name plate capacity over 3 kW but less than 50 kW.
    - Class 3 facilities with a name plate capacity equal or greater than 50 kW with sound power level less than 102 dBA.
    - Class 4 facilities with a name plate capacity equal to or greater than 50 kW with sound power level greater than or equal to 102 dBA.

In many cases, for approved projects, the applicant will be required to submit an updated and comprehensive decommissioning plan within six months of commencing decommissioning activities. This updated plan will contain more detail as to the exact activities that will take place, however, the initial plan should be detailed enough to highlight the negative impacts to the environment that need to be considered at the decommissioning/reclamation stage (MOECC, 2022).

Information required for the decommissioning plan include (MOECC, 2022):

- Procedures for infrastructure removal:
    - Includes all structures, foundations and aboveground and belowground infrastructure.
    - Infrastructure or improvements remaining in place must be justified.
- Reclamation activities to bring the affected land to equivalent land capability.
- Procedures for managing excess materials and waste.
    - Describe what type of waste will be generated and how the excess materials and waste will be managed, including whether it is transported off-site.

Within the plan, details on decommissioning plans in the event that the project is abandoned during construction should be provided. Additionally, practices that limit the need for additional clearings are preferred (MOECC, 2022).

Financial assurance is required for most solar, wind or bio-energy projects in Ontario. The amount of financial assurance required is determined on a project specific basis (MOECC, 2022). Table 6-3 outlines the types of financial instruments that are acceptable and not acceptable (MOECC, 2023).

Table 6-3 Acceptable, non-standard and not acceptable forms of financial instruments in Ontario (MOECC, 2023).

Acceptable Forms	Non-Standard Forms (forms not generally recommended, but may be accepted)	Not Acceptable Forms
▪ Cash. ▪ Irrevocable letter of credit. ▪ Surety bond.	▪ Any security or collateral accepted by the Program Director. ▪ Agreements, contracts or other non-standard forms of financial assurance with conditions stated in the order or approval. ▪ Insurance policies. ▪ GICs reissued payable to the Ontario Minister of Finance. ▪ Marketable securities (apart from the acceptable forms) or other negotiable securities. ▪ Indemnification Agreements. ▪ Letters of guarantee. ▪ Qualified Environmental Trust accompanied by letter of credit, cash or bond. This form is an agreement made between two parties for the purpose of a tax benefit to the regulated party.	▪ GICs which are not transferable. ▪ All bonds which are not transferable. ▪ Bank accounts held by the regulated party or joint bank accounts held by the Ministry and the regulated party. ▪ Insurance policies for long-term projects or landfill sites. ▪ Guarantees from out-of-province, off-shore firms.

7.0 REGULATORY OVERSIGHT OF DECOMMISSIONING AND RECLAMATION PRACTICES – OTHER JURISDICTIONS

Worldwide, there are several jurisdictions that have well-established frameworks for both non-renewable and renewable energy that utilize financial and non-financial mechanisms for liability management related to decommissioning and reclamation. Below some of the frameworks that have been implemented across the United States, Australia and Europe will be discussed.

7.1 UNITED STATES

There are multiple frameworks in the United States for decommissioning of solar and wind facilities, thus, the degree to which policies have been developed across the country vary. Various types of frameworks implemented include the following (NREL, 2021):

- Department of the Interior's Bureau of Land Management (BLM): A federal agency that oversees the country's public lands. It has policies in place for the application, approval and decommissioning practices for solar and wind power. Decommissioning plans and proof of security must be provided by the holder of the facility right-of-way (BLM, 2015). Majority of the public lands within the United States are within 12 Western States (Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming).

- State-level framework: Mandatory decommissioning requirements are overseen by state regulatory bodies. In many cases, a decommissioning plan and proof of financial assurance must be submitted. Louisiana, Minnesota, Montana, New Hampshire, North Dakota and Vermont are examples of States that follow this.

- Hybrid framework: Mandatory decommissioning requirements overseen by State and/or local bodies. While the State requirements must be followed, local bodies may have additional requirements that make the framework more stringent than the State regulations. In many cases, a decommissioning plan and proof of financial assurance must be submitted. California, Hawaii, Illinois, New Jersey and Wyoming are examples of States that follow this.

- Optional State-level decommissioning program: In this type of program, projects can comply with an optional state certification process. In this scheme, decommissioning plans and financial assurance are submitted to State entities in lieu of obtaining government permits and approvals. Washington is an example of a State that follows this.

In addition to the regulatory framework in place, landowners can also request certain requirements as a condition in the agreement. In the subsequent sections, more information will be provided on the federal framework through the BLM, as well as select jurisdictions to highlight the State-level framework, hybrid framework and optional State-level decommissioning program.

Bureau of Land Management

The Solar and Wind Rule, as described in the document published in 2016, "*Competitive Processes, Terms, and Conditions for Leasing Public Lands for Solar and Wind Energy Development and Technical Changes and Corrections for 43 CFR Parts 2800 and 2880*", guides the BLM in managing solar and wind development projects on public lands. The BLM can issue leases and grants as forms of right-of-way approvals. Leases are authorizations within the designated leasing areas (DLAs) and grants are authorizations for development outside the DLAs. This rule also incentivizes development on DLAs by allowing the following:

- Financial incentives including less frequent adjustments to rent and longer phase-ins for other fees;
- Accepting standard bonds over bonds based on full reclamation costs;
- Awarding leases through competitive processes, such as bidding; and
- Streamlining leasing process.

The application, approval and bonding requirements for lease and grant authorizations by the BLM are summarized in Table 7-1.

Table 7-1 United States Bureau of Land Management approval and bonding requirements.

	Leases	Grants
Land Area	Within DLAs.	Outside DLAs.
Application Process	No requirements of the competitive process.	Two preliminary application review meetings and one public meeting required within six months of submitting application. Meetings can be waived at the discretion of the BLM.
Approval Process	No specific approval requirements. Project-dependent.	Site-specific surveys, studies and inventories must be completed for National Environmental Policy Act review.
Bonding	**Basis:** Based on standard bond amount specified by regulations. No reclamation cost estimate required. Lesser bond amount can be approved at discretion of BLM. **Salvage:** A reclamation cost estimate is not required to be provided, therefore, salvage value does not need to be calculated. **For solar:** Bond amount is $10,000 USD per acre of land disturbance (BLM, 2023a). **For wind:** $2,000 USD per meteorological tower; $10,000 USD per wind turbine (BLM, 2023c).	**Basis:** Based on reclamation cost estimates. Lesser bond amount can be approved at discretion of BLM. **Salvage:** Salvage and recycling can be considered. **Must include**: Bond must also cover estimated costs of cultural resource and Indian culture resource identification, protection and mitigation for project impacts. The cost for BLM administration processes must also be included. **For solar:** Based on reclamation cost estimate, however, bond amount must be no less than $10,000 USD per acre of land disturbance (BLM, 2023b, 2023c). **For wind:** Based on reclamation cost estimate, however, bond amount must be no less than $10,000 USD per authorized turbine less than 1 MW in nameplate capacity or $20,000 USD

	Leases	Grants
		per authorized turbine equal or greater than 1 MW in nameplate capacity (BLM, 2023c).

For short term grants for solar energy sites or project area testing, a bond amount of no less than $2,000 USD per meteorological tower or instrumental facility must be posted prior to ground disturbance activities (BLM, 2023c).

The following lists the types of acceptable bond instruments by the BLM (BLM, 2023b):

- Cash.
- Cashier's or certified cheque.
- Certificate or book entry deposits.
- Negotiable U.S. Treasury securities.
- Surety bond.
- Irrevocable letters of credit.
- Insurance policy; BLM must be named a beneficiary of the policy.

The rule indicates that corporate guarantees are not acceptable forms of bonds as they are too risky due to the constant requirement to confirm the quality of corporate guarantee (BLM, 2023b). Bonds in lesser amounts than required generally are not approved until closer to the decommissioning stage as the BLM does not want to bear responsibility of company that is not financially stable.

Bonds must be posted prior to the approval of projects and land disturbance cannot commence until a Notice to Proceed is obtained (BLM, 2023c). This notice will not be issued until the bond is posted and accepted by the BLM. Grant holders who do not have a bond in place during the BLM review process will be issued a letter of non-compliance indicating the holder has 60 days to submit a bond instrument (BLM, 2023c).

To determine the bond amount for grants, the BLM requires reclamation cost estimates to be submitted within 90 days. These estimates must include the following components (BLM, 2023c):

- "Environmental liabilities, such as the securing, removal or use of hazardous materials and substances, hazardous waste, herbicide, petroleum-based fluids, and dust control or soil stabilization materials;
- The decommissioning, removal, and proper disposal, as appropriate, of any improvements and facilities; and

- Interim and final reclamation, revegetation, recontouring, and soil stabilization. This includes the potential for flood events and downstream sedimentation from the site that may result in off-site impacts; the area and acreage of disturbance; and the resources affected by the project."

The mining operation guidance, IM2009-153, will be used to assist in calculating the bond amount (BLM, 2015).

Salvage values should not be included in the reclamation estimate as these values are generally based on a transient market value (BLM, 2015; 2023c). However, addendums to the reclamation cost can be included to include salvage values and recycling of materials. The values in the addendum will only be considered by the BLM if adequate third-party documentation and justification for salvage are provided, or special circumstances that need to be considered (ex. a jurisdiction mandate that infrastructure must be recycled; BLM, 2015). The values presented must also be representative of current local market value.

For solar energy projects, the bonds will be reviewed on an annual basis. For wind energy projects, the bonds will be reviewed at least every five years. Every 10 years, the bond amounts will be adjusted using the change in the Implicit Price Deflator-Gross Domestic Product Index (BLM, 2023a).

BLM Manual 1372 – Collections and Manual 1270 – Records Administration outline how financial instruments for bond payment is handled. Cash, performance, and compliance bonds are to be safeguarded in a fireproof safe or file with locks that are only accessible to a select number of individuals before being deposited into the BLM suspense account. Other non-negotiable bond instruments are to be stored in secure BLM records room or secured file cabinet in a project case file that is properly safeguarded and documented. The public is not able to view information pertaining to the bond instruments (BLM, 2015).

Texas

Texas is currently one of the top electricity producing states in the United States, with the dominant power generating sources being natural gas, wind and solar. With oil and gas historically dominating the energy industry in this state, the recent approval of legislation has allowed for increased regulation of renewable energy sources, specifically wind and solar.

The Wind Power Facility Agreement provision, and Senate Bill 760, in the Texas Utilities Code (Chapter 301 and Chapter 302, respectively, in Title 6), became effective in 2019 and 2021 and outline the decommissioning requirements of wind and solar facilities (Texas Legislative Council, 2023).

The agreement and bill indicate the grantee is responsible for the decommissioning and reclamation process, and provisions for these processes must be detailed in an agreement between the grantee and landowner, including providing evidence. Grantees are required to provide evidence of financial assurance that reclamation obligations can be met. The financial assurance is dependent on several factors, including the cost of the facility, the cost to decommission and reclaim, and the salvage value, and must be estimated by a third-party professional engineer practicing in Texas.

Table 7-2 outlines the requirements for solar and wind facilities in Texas.

Table 7-2 Texas solar and wind power reclamation and financial assurance requirements (Texas Legislative Council, 2023).

	Solar	Wind
Policy	Senate Bill 760 – Texas Utilities Code, Title 6, Chapter 302.	Wind Power Facility Agreement – Texas Utilities Code, Title 6, Chapter 301.
Reclamation	Reclamation of solar power facilities includes removal of all solar energy devices, transformer, substations and overhead lines, foundations, and buried cables to a depth of at least 3 metres below ground, access roads and rocks.	Reclamation of wind facilities includes the wind turbine generator, including the towers and pad-mount transformers, substations, and buried cables.
Financial Assurance	**Requirements:** Evidence of financial assurance must be provided to the landowner. **Acceptable forms:** A parent company guarantee with a minimum investment grade credit rating for the parent company issued by a major domestic credit rating agency, a letter of credit, a bond, or another form of financial assurance reasonably acceptable to the landowner. **Amount:** Must equal at least the cost of decommissioning and reclamation that exceeds the salvage value and less any portion of the value pledged to secure outstanding debt. Amount can change based on updated costs that must be periodically re-evaluated throughout its operational lifespan.	**Requirements:** Evidence of financial assurance must be provided to the landowner. **Acceptable forms:** A parent company guarantee with a minimum investment grade credit rating for the parent company issued by a major domestic credit rating agency, a letter of credit, a bond, or another form of financial assurance reasonably acceptable to the landowner. **Amount:** Must equal at least the cost of decommissioning and reclamation that exceeds the salvage value and less any portion of the value pledged to secure outstanding debt. Amount can change based on updated costs that must be periodically re-evaluated throughout its operational lifespan.
Agreement Provisions	Agreement must include: - Estimated cost to remove facilities and reclaim land to pre-disturbance conditions; salvage value must be determined by a professional engineer licensed to practice in Texas. - Updated reclamation costs including updated salvage costs must be determined by a professional engineer	Agreement must include: - Estimated cost to remove facilities and reclaim land to pre-disturbance conditions; salvage value must be determined by a professional engineer licensed to practice in Texas. - Updated reclamation costs including updated salvage costs must be determined by a professional engineer and provided to the landowner at

	Solar	Wind
	and provided to the landowner based on the following timeline: - On or before the 10th anniversary of operations - At least once every five years for term of agreement. - Licensee must ensure financial assurance is updated as required. - Agreement must indicate that financial assurance will be delivered no later than the date the agreement is terminated, or the 20th anniversary of operations (whichever is earlier).	least once every five years for term of agreement. - Licensee must ensure financial assurance is updated as required. - Agreement must indicate that financial assurance will be delivered no later than the date the agreement is terminated, or the 10th anniversary of operations (whichever is earlier).

For reclamation activities to occur, the landowner must request reclamation to occur no later than 180 days following inactivity from the facility. At this time, the end point for reclamation is defined as satisfaction that the provisions in the agreement were met.

Senate Bill 760 does not appear to apply to Facility Agreements executed prior to September 1, 2021, and only applies to Facilities classified as generation assets, which is defined in Section 39.251 of the Texas Utilities Code (Texas Legislative Council, 2023) as "assets associated with the production of electricity, including generation plants, electrical interconnections of the generation plant to the transmission system, fuel contracts, fuel transportation contracts, water contracts, lands, surface or subsurface water rights, emissions-related allowances, and gas pipeline interconnections". Similarly, The Wind Power Facility Agreement only applies to agreements executed on or after September 1, 2019.

Senate Bill 1372 was proposed in 2019 to provide standards for decommissioning wind facilities, however, it appears there has been no movement on the bill (Tex. S.B. 1372, 2019).

California

The California Energy Commission (CEC) is the state's regulatory body for energy policy and planning. They are responsible for forecasting future energy needs and keeping historical data, siting and licencing power plants, promoting energy efficiency through the development of standards, developing technology and supporting renewable energy, and planning for response to energy emergencies (California ISO, 2023).

Solar

For the approval of solar power plants, a management plan is required according to State policy. The management plan must include a soil management and site restoration plan, including the removal of infrastructure. In some cases, the CEC may be required to approve decommissioning plans (Lewis Roca, 2023).

While a cost estimate for reclamation is not required to be submitted to the State, a restoration security instrument must be posted in the amount specified by the local jurisdiction to cover reclamation costs, and must be posted prior to construction. The restoration security instrument is in effect at the commencement of the project until released by the regulating body. As stated in the California Code of Regulations published by the California Office of Administrative Law, the reclamation costs include the following (Cal. Code Regs., 2023):

- Re-grading;
- Re-vegetation (including monitoring);
- Labor and supervision;
- Equipment;
- Mobilization and transportation;
- Removal and disposal of buildings, structures, and equipment;
- Soil testing;
- Fencing;
- Liability insurance; and
- Any other required procedures to complete reclamation.

The reclamation costs should not include the cost of construction or operations. The amount and validity of the security instrument will be reviewed by the licensee no less than once every five years, with the review submitted to the regulatory body for approval.

In addition to the amount required, local jurisdictions may have specific requirements regarding the type of financial instrument provided; however, acceptable forms include (Cal. Code Regs., 2023):

- Performance bonds;
- Surety bonds;
- Irrevocable letters of credit;
- Trust funds;
- Corporate guarantee; or

- Any other form approved by local jurisdiction.

The regulatory body may deem the licensee financially incapable of fulfilling reclamation obligations if the restoration security in the amount required is not posted or has not provided a security instrument that has been approved (Cal. Code Regs., 2023). The regulations do not mention the inclusion of salvage value in decommissioning estimates.

Wind

At this time, California does not have any decommissioning requirements for wind facilities, however, the State has voluntary guidelines for the decommissioning process (EMC, 2021).

Hawaii

Energy sources that are dominant in Hawaii are natural gas, solar and wind power. Due to the island's isolation from the mainland, petroleum is generally imported, which makes renewable energy an attractive venture for sustainability.

Solar

Decommissioning requirements in Hawaii for solar facilities on agricultural land are dependent on land classification, specifically on soil productivity as classified with the University of Hawaii Land Study Bureau's Overall Productivity Rating system (DBEDT, 2015; Lewis Roca, 2023). A summary of decommissioning requirements is presented in Table 7-3.

Table 7-3 Hawaii decommissioning requirements for solar facilities (DBEDT, 2015; Lewis Roca, 2023).

Classification	Productivity Rating	Decommissioning Requirements	Solar Facilities Permitted
Class A	High	No decommissioning requirements listed.	Permitted in limited circumstances.
Class B or C	Moderate	Financial security is required prior to operations, and decommissioning must occur within 12 months of inactivity. The type of financial instrument used and the amount in which is required are not listed in state regulations and are dependent on local jurisdictions. While decommissioning and financial security must be posted, the preparation of a decommissioning plan at the approval stage is not required.	Permitted on up to 20 acres of land, or an area equal to 10% of the acreage of the subject parcel (whichever is less) without state Special Use Permit (SUP; DBEDT, 2015). For projects that exceed the above-mentioned criteria, a SUP can be obtained if the following criteria are met (DBEDT, 2015): - Area occupied needs to be made available for agricultural activities at a lease rate at least 50% below fair market value; and

Classification	Productivity Rating	Decommissioning Requirements	Solar Facilities Permitted
			- Financial security for decommissioning must be provided. Decommissioning must occur within 12 months of facility's end of life, and operator is responsible.
Class D or E	Low	No decommissioning requirements listed.	Permitted.

Hawaii currently does not have any requirements to submit a decommissioning plan (DBEDT, 2015; Lewis Roca, 2023).

Wind

At this time, Hawaii does not have any decommissioning requirements for wind facilities.

North Dakota

The main energy sources in North Dakota consist of coal, wind and hydroelectric. Decommissioning plans and financial assurance are required as part of the approval process for solar and wind facilities and must be submitted to the North Dakota Public Service Commission. The decommissioning plan must outline the decommissioning process, the environmental effects, and the facility cost(s). This plan must be updated 10 years after the initial approval, and then every five years following approvals. Financial assurance in the form of a performance bond, cash escrow, surety bond or a guarantee are acceptable forms, and must equate to 5% of the estimated decommissioning cost. Unlike other States, North Dakota mandates that decommissioning must be completed within 12 months of abandonment or within 24 months of the end of facility's useful life (Lewis Roca, 2023).

New York

Approximately 27.4% of New York's electricity generation in 2020 was achieved through renewable energy.

Solar

Details regarding the solar industry in New York can be found in the New York State Solar Guidebook (NYSERDA, 2023).

A Final Decommissioning and Site Restoration Plan must be provided as part of the approval process. The decommissioning plan should address the safety and removal of hazardous materials, environmental impacts, aesthetics, salvage and recycling, potential future uses of the site and the expected end of the facility's useful life. Within the plan, letters of credit must also be provided to the Office of Renewable Energy Siting after a year of operation and updated every five years (NYSERDA, 2023).

For facilities on land that are not owned by the operator, a guarantee or security agreement between the applicant and landowner must be included (NYSERDA, 2023).

Wind

At this time, New York decommissioning requirements for wind facilities includes the removal of equipment, reclamation and providing a reclamation cost estimate (EMC, 2021).

Illinois

Solar

A decommissioning plan that is prepared by a Professional Engineer, must be submitted to the local jurisdiction and include the following information (Illinois Department of Agriculture, 2019):

- Estimated deconstruction cost, in current dollars at the time of filing, including:
    - The number of solar panels, racking, and related facilities involved;
    - The original construction costs;
    - The size and capacity (in megawatts);
    - The salvage value of the facilities (if all interests in salvage value are subordinate to that of the financial assurance holder if abandonment occurs); and
    - The construction method and techniques for the facility and for other similar facilities.
- A comprehensive detailed description of how the facility owner plans to pay for the deconstruction of the facility.

Financial assurance is to be provided to cover the costs of deconstruction. The Agreement defines deconstruction as "the removal of a facility from the property of a landowner and the restoration of that property as provided in the Agricultural Impact Mitigation Agreement" (Illinois Department of Agriculture, 2019).

Financial assurance is phased in over the first 11 years of operations as shown in Table 7-4.

Table 7-4 Financial assurance schedule for solar facilities in Illinois (Illinois Department of Agriculture, 2019).

Milestone	Financial Assurance Requirement
On or before 1st anniversary of operations	Financial assurance to cover 10% of estimated costs.

On or before 6th anniversary of operations	Financial assurance to cover 50% of estimated costs.
On or before 11th anniversary of operations	Financial assurance to cover 100% of estimated costs.

The County may re-evaluate the estimated costs following the 10th anniversary of operations and every five years following but is not required to do so. If financial assurance is re-evaluated, the amount that must be posted may also change.

Decommissioning must occur within 12 months of end of operational life, and include removal of the following (Illinois Department of Agriculture, 2019):

- Solar panels, cells and modules;
- Solar panel mounts and racking, including any helical piles, ground screws, ballasts, or other anchoring systems;
- Solar panel foundations, if used (to depth of 5 feet);
- Transformers, inverters, energy storage facilities, or substations, including all components and foundations; however, underground cables at a depth of 5 feet or greater may be left in place;
- Overhead collection system components;
- Operations/maintenance buildings, spare parts buildings and substation/switching gear buildings unless otherwise agreed to by the landowner;
- Access road(s) unless Landowner requests in writing that the access road is to remain;
- Operation/maintenance yard/staging area unless otherwise agreed to by the landowner; and
- Debris and litter generated by deconstruction and deconstruction crews.

Virginia

Solar

The State of Virgina requires licensees to enter into a decommissioning agreement with the local jurisdiction, however, it is up to each jurisdiction to codify specific decommissioning standards. In July 2022, approximately 25% of the counties and cities in Virginia implemented jurisdiction specific decommissioning requirements for solar energy (Cox, 2022). A decommissioning ordinance requires the licensee to prepare a decommissioning plan prior to approval and construction. Specific terms and conditions that can be found in some decommissioning ordinances include (Cox, 2022):

- May require the licensee to notify them that the facility has reached its end of life.
- The definition of decommissioning may differ between localities. An example would be the specification that associated facilities, such as an access road would be required to be reclaimed.
- Abandonment and end-of-life clauses may include a specific timeline in which decommissioning and reclamation must occur following end of life.
- The types of financial assurance that are accepted can differ between localities and requirements generally specify that security in the full amount of decommissioning costs are required.
- The inclusion of salvage values are also dependent on the locality. While the state allows for the optional inclusion of these values, localities may have more stringent guidelines.

The decommissioning plan, which should be reviewed by a Professional Engineer or Engineer of Record (EOR) prior to submission to the governing body, should be updated no less than every five years following initial approval. Components required for the decommissioning plan include (Cox, 2022):

- Contact information of all stakeholders.
- Anticipated project life.
- Cost estimate for decommissioning using present day values and including the financial assurance that will be posted.
- Decommissioning details, such as procedure, duration, and methods for waste disposal
- Salvage plan.
- Reclamation plan.

Within the decommissioning plan, the details of infrastructure removal are also included. All above ground infrastructure should be removed as well as below ground infrastructure. Below ground infrastructure must be removed to 36 inches below the finished grade or down to bedrock, whichever is less (Cox, 2022). Components can remain in place with landowner authorization. Any component that can be recycled should be, though recycling programs are still being established.

Non-financial mechanisms that are used by localities include (Cox, 2022):

- Abandonment and removal clauses.
- Special permit applications.

- Temporary variance process.

Financial assurance in the full amount of the estimated decommissioning costs is required. The amount, type and posting times of security are dependent on the size, complexity and lifespan of the facility, thus the requirement varies on a case-by-case basis. Types of financial assurance generally accepted include (Cox, 2022):

- Trust funds.
- Cash escrow.
- Letter of credit.
- Surety bond.
- Insurance.
- Guarantee by an investment-grade entity.
- Parent guarantee.
- Promissory note.

In some cases, localities may also accept a corporate financial test for a company to self-insure the estimated decommissioning costs. The procedure for security evaluation is based on EPA's guiding practices on decommissioning security for end-of-life Resource Conservation and Recovery Act of 1976 Subtitle C facilities (such as deactivated nuclear power plants and municipal solid waste landfills; Cox, 2022).

The schedule in which financial security must be posted is also dependent on the locality. An example of the schedule for the approval of Twitty's Creek Solar in Charlotte County, Virgina is Figure 7-1 (Cox, 2022).

Figure 7-1 Financial security schedule for Twitty's Creek Solar (Cox, 2022).

Operating Year	Deposit	Cumulative Fund	Percent of Decommissioning Cost Posted
1	$40,900	$40,900	6.79%
2	$39,600	$80,500	13.37%
3	$37,400	$117,900	19.57%
4	$36,600	$154,500	25.65%
5	$37,400	$191,900	31.86%
6	$36,100	$228,000	37.85%
7	$35,300	$263,300	43.72%
8	$32,700	$296,000	49.14%
9	$30,000	$326,000	54.13%
10	$27,000	$353,000	58.61%
11	$23,500	$376,500	62.51%
12	$20,500	$397,000	65.91%
13	$17,000	$414,000	68.74%
14	$13,900	$427,900	71.04%
15 to 30	$10,900 per annum	$602,300 by Year 30	100% by Year 30

The State allows the annual application of an inflation factor to the original cost estimate (Cox, 2022). However, best practice requires the re-evaluation of the cost estimate by a Professional Engineer every five years. If the locality requires re-evaluation of costs to present day value, the adjustment with the inflation factor is redundant.

Salvage credit is generally included in decommissioning plans, however, the value is variable based on the market. As a result, many localities do not accept salvage values alone when the value exceeds decommissioning costs (Cox, 2022).

Washington

Solar

Washington has a voluntary policy for decommissioning and financial security through the use of certificates. Solar energy projects can receive certification from the Energy Facility Site Evaluation Council (EFSEC, 2023) in lieu of obtaining permits and approvals. The certification process involves the following steps (EFSEC, 2023):

1. Application Submittal: At the application stage, there are multiple areas related to the project that must be addressed. Within the application, the financial assurance must be discussed, and the commitment to site restoration and preservation must be described.
2. Application Review.
3. Initial Public Meeting.
4. Land Use Consistency Hearing.
5. Environmental Impact Statement.
6. Adjudicative Proceedings and Permits Review.
7. Recommendation to the Governor.

At least 90 days prior to the start of site activities, an initial site restoration plan must be provided that details the plan at the facility's end of life. The plan must also include an economic discussion that includes proof of the financial instrument to be posted. The financial security must show that the licensee is able to manage the restoration of the site, and have evidence of pollution liability insurance coverage, a site closure bond, sinking fund, or other instrument. The amount must also be justified to show the funds will be sufficient for decommissioning and reclamation activities. Along with the site restoration plan, a decommissioning plan must also be prepared (WAC, 2023). Following end of life, a detailed site restoration plan must be submitted within 90 days. The site restoration plan should be reviewed and updated at least every five years (WAC, 2023).

Other States

The States that currently do not have well established end-of-life closure regulations for renewable energy facilities include Oregon, Colorado, Nebraska, Nevada, Oklahoma, and New Mexico (Lewis Roca, 2023; NREL, 2021). Iowa and Kansas, who generate a great amount of the State's electricity from wind power, also do not have any decommissioning regulations currently in place (Lewis Roca, 2023). Some states that reportedly have specific state policies, such as New Jersey and Wyoming, require decommissioning plans, but do not require financial assurance.

7.2 Australia

The drive to ramp up the renewable energy market in Australia is largely driven by the goal for zero net emissions by 2050 (Australian Trade and Investment Commission, 2023).

With that target in mind, decommissioning of coal-fired power stations is underway in the country, including:

- Nine coal fired power stations decommissioned between 2010 to 2016 (Parliament of Australia, 2023).
- Hazelwood Power Station in Victoria was decommissioned in March 2017. The decommissioning cost was reportedly estimated at $734 million AUD. In 2022, a large-scale battery energy storage system was brought online at the former power station site (Asher, 2017).
- Liddell Power Station in New South Wales was decommissioned in May 2023. The decommissioning cost was reportedly estimated at $687 million based on 2022 reports (Hannam, 2023). AGL Energy reportedly set aside $1.5 billion for clean up efforts of their four large generators, including Liddell Power Station, Bayswater Power Station, Torrens Island Power Station and Loy Yang A Power Station (AGL, 2022; Hannam, 2023). It is unknown what the exact cost to decommission Liddel Power Station is at this time of the report.

While coal-fire production is on the decline in Australia, oil and gas operations still commence across the country. With the country being surrounded by water, offshore oil rigs are far more common. The North Endeavour is a floating production storage and offtake facility between the Laminaria and Corallina oil fields in the Timor Sea, that was taken over by the Australian Government as the previous owner Northern Oil & Gas Australia went into liquidation. At the time of liquidation, funds to complete decommissioning were not available. As a result, the Laminaria and Corallina Decommissioning Cost Recovery Levy, a temporary cost recovery levy, was implemented to ensure that the public would not be responsible for the cost of the facility (DISR, 2023). A $325 million AUD contract was awarded by the Australian government to commence Phase 1 of the decommissioning process; a process that will be completed in three phases and now funded by offshore oil and gas companies through the levy program (DISR, 2023). The North Endeavour is an example of the impacts that are faced when scenarios such as licensees undergoing liquation occur, and a strong encompassing security program is not implemented for large facilities that accept high decommissioning and reclamation costs. Since then, the Australian Government has been working to add more stringent regulations that dictate the process should licensees become defunct.

The Petroleum and Geothermal Energy Act 2000 outlines the policy for liability management for oil and gas operations with regulatory obligations falling on the licensee. The Environmental Liability Management Policy is a risk-based approach to manage liabilities by working to reduce the proportion of inactive wells and ensuring financial security is available. Under this policy, financial assurance that is acceptable by the Minister is required for petroleum, gas storage and geothermal activities in South Australia. The financial assurance required is based on the rehabilitation liability estimate, which must be submitted annually and includes the costs to decommission facilities. Based on the deemed assets and financial performance of licensees, the portion of the rehabilitation liability estimate that licensees must post for financial assurance will be determined (Gov. of South Australia, 2020).

On the other hand, aggressive clean energy targets set by the government have turned the focus to renewable energy generation. The Australian Energy Market Agreement outlines the legislative and regulatory framework for the country's energy market. The Australian Energy Regulator regulates, monitors and enforces energy legislation (Australian Energy Regulator, 2023).

Two federal policies related to the electricity sector are responsible for the increase in renewables and decommissioning of current coal powered plants:

1. Renewable Energy Target.

   The target is designed to reduce greenhouse gas emissions and encourage electricity generation from renewable sources. The target is divided into two targets based on size of project – large-scale renewable energy scheme target of 33,000 GW hrs of renewable energy by 2020; and small-scale renewable energy scheme, which supports small scale projects (Clean Energy Regulator, 2023).

   Under the large-scale renewable energy scheme and the Renewable Energy (Electricity) Act 2000, power plants can become accredited to achieve certificates based on energy production and can be sold and traded to off-set the cost of the plant. Certificates are regulated by the Clean Energy Regulator, who administer emission reduction schemes. The certificates are created per MWh of eligible electricity generated by a power plant. The large-scale renewable energy target requires liable parties to annually buy and surrender certificates. The small-scale technology percentage and renewable power percentage are used determine the amount of certificates the liable parties are required to surrender to meet legal obligations (Clean Energy Regulator, 2023).

2. Emissions Reduction Fund.

   Designed to provide incentives for organizations and individuals to adopt new practices and technologies to reduce emissions.

The majority of renewable projects in Australia have been constructed in the east portion of the country in Queensland, Victoria, and New South Wales.

Solar

Based on the solar energy facility guidelines published by the Queensland Department of Natural Sources, Mines and Energy (Queensland Government, 2018), the New South Wales Department of Planning and Environment (NSW Government, 2016, 2022), and the Victoria State Government (Victoria State Government, 2022), decommissioning of solar and wind energy facilities in these

States is the responsibility of the licensee, and while there are some guidelines based on State, it appears as though decommissioning and reclamation activities are up to the licensee and landowner to agree upon.

A decommissioning plan is generally prepared when the lease is signed between the licensee and landowner. For each facility, the licensee must consult with the landowner to determine which infrastructure should remain in place (CEC, 2023). Within the agreement between the licensee and landowner, which act similar to commercial leases, clauses are often included to describe the responsibilities and funding arrangements for decommissioning and reclamation, as well as indicate the time period in which decommissioning must occur following site inactivity (Australian Energy Infrastructure Commissioner, 2023). In the event where the licensee is unable to remain responsible for the facility, the liability may fall on the landowner (Australian Energy Infrastructure Commissioner, 2023).

Financial security, through a bank guarantee, sinking fund, trust fund, or a security bond deposit, must be prepared by the licensee to cover the cost of decommissioning as agreed upon with the landowner and as per the plan (CEC, 2023), and provided to the landowner as requested (Australian Energy Infrastructure Commissioner, 2023).

The decommissioning plan is often revisited in the final years of the lease and revised as needed (CEC, 2023). If decommissioning does not occur within 12 months of inactivity, the financial mechanisms in place will be handed to the landowner or administrator that was originally agreed upon in the plan to complete decommissioning (CEC, 2023).

Offshore Wind

On the other hand, in 2022, under the *Offshore Electricity Infrastructure Act 2021* (Australian Government, 2022a), the Australian government released regulations (*Offshore Electricity Infrastructure Regulations 2022 [Australian Government, 2022b]) and* a cost recovery implementation scheme (*Offshore Electricity Infrastructure (Regulatory Levies) Regulations 2022 [Australian Government, 2022c]) to* expand the framework for offshore wind energy. Within the framework, a management plan for offshore infrastructure would need to be submitted to the regulator, which includes a decommissioning cost estimate. The financial security required to be submitted to the regulator would be the full cost of decommissioning installed infrastructure, and timing and acceptable form would be agreed upon with the regulator (OIR, 2023). The plan is to be updated every five years, or sooner if there is a proposed change or change in circumstances or operations (OIR, 2023). Further details regarding the requirements of the management plan are still being developed (OIR, 2023).

As part of the *Offshore Electricity Infrastructure Act 2021* (Australian Government, 2022a), a cost recovery implementation scheme in the form of a regulatory levy has been proposed, which would be applicable to licensees that have offshore assets. There are three components to the cost recovery levy (OIR, 2022), which will assist with ensuring the regulator can operate:

1. Annual licence levy: Dependent on licence type and size.
2. Annual Commonwealth levy: Set amount.
3. Annual compliance levy: Dependent on licence type and size.

7.3 Europe

The European Union has a target of cutting net greenhouse gas emissions by 55% by 2030, with a goal of net zero emissions by 2050 (European Environment Agency, 2023). Several types of regulatory frameworks and funds have been set up for varying power generation types across Europe.

Nuclear Power

Europe has been a leader in nuclear energy; however, with the improvement of renewable energy sources, the difficulty of maintaining nuclear energy, and the lengthy process to decommission, the rate of decommissioning of nuclear power plants has increased. Additionally, the consideration of how to dispose of nuclear waste is a difficult process to undergo. The estimated cost to decommission a nuclear power plant ranges from $280 to $612 million USD (U.S.NRC, 2023).

In the **United Kingdom**, the Nuclear Liabilities Fund Limited was established to receive, hold, and invest assets to secure funding for decommissioning (Nuclear Liabilities Fund, 2023). This is done through the Nuclear Trust that is meant to cover the decommissioning costs of eight nuclear power stations operated by EDF Energy Nuclear Generation Limited (EDF Energy). The trust received an initial endowment of £260 million (equivalent to approximately $434 million CAD; Nuclear Liabilities Fund, 2023). At the time of set up, it was assumed that contributions from British Energy and the growth of the fund would cover the decommissioning costs. British Energy would then be responsible for meeting the shortfall of the fund and funding removal and storage of spent fuel as these were not within the scope of the fund. However, the UK government assumed responsibility of the nuclear liabilities as British Energy could not financially handle it (Nuclear Liabilities Fund, 2023). Further funds were given to the trust upon the sale of British Energy and EDF Energy is also required to submit regular payments to the fund. With new agreements in place, annual funding reviews are completed to determine if funds in the trust are sufficient to cover costs, and additional contributions are required should there be a shortfall (Nuclear Liabilities Fund, 2023). The Department for Business, Energy & Industrial Strategy have also provided financial incentives to EDF Energy to speed up the defueling process (House of Commons Committee of Public Accounts, 2022). The estimated cost of decommissioning appears to be rising over time. Once complete, ownership of the power plants will be transferred to the

Nuclear Decommissioning Agency to decommission. In 2021, the estimated cost to decommission was estimated at £23.5 billion (equivalent to approximately $39.2 billion CAD), and at the time the fund was valued at £14.8 billion (equivalent to approximately $24.7 billion CAD; House of Commons Committee of Public Accounts, 2022). Additionally, 80% of the trust is invested in the National Loans Fund, which historically has been low risk, but the returns are also low and not sufficient to cover the estimated costs (House of Commons Committee of Public Accounts, 2022). As a result of the low performance of the fund, requests have been made that taxpayer funds be invested in the National Loans Fund to assist with increasing decommissioning costs. The nature of the investment strategy and the long-term decommissioning plan has resulted in a high amount of uncertainty as to how the financial costs will be covered and to what extent the taxpayers will be responsible for costs.

In **Sweden**, approximately 40% of the electricity generated is through nuclear power (Riksgalden Swedish National Debt Office, 2022). Swedish regulations indicate operators are responsible for the decommissioning costs. A nuclear waste fee has been implemented for all nuclear power operators and will be used to fund the Nuclear Waste Fund, which is expected to cover the costs of nuclear waste management and decommissioning of nuclear power plants in Sweden as well as the costs to manage the fund and supervise activities. Two security measures are implemented with the fund (Riksgalden Swedish National Debt Office, 2022):

- Credit risk amounts: Covers the credit risk on future fees, which will decrease over time as electricity production from the plant decreases and the fund increases in size.
- Risk margins: Based on the Financing Act, the risk margin considers both the liabilities and assets of licensees, not just the liability.

With these two security measures in place, the risk that taxpayers will have to contribute to nuclear waste management costs decreases. The calculated future costs are submitted to the Swedish National Debt Office every three years, and based on these numbers, a new surcharge is proposed (Riksgalden Swedish National Debt Office, 2022). As of 2022, the total cost of the nuclear waste programme in Sweden is estimated to be about SEK 171 billion (equivalent to approximately $21.2 billion CAD; SKB, 2023).

Wind

Offshore wind farms are a common occurrence across Europe due to its accessibility to the ocean and its limited available land area. Decommissioning costs vary depending on the size of the farm, and the window in which decommissioning activities occurs can be small based on weather constraints (Renewables Consulting Group, 2015).

In the **United Kingdom (UK)**, the *Energy Act 2004* indicates the Department of Business, Energy and Industrial Strategy (BEIS) can request decommissioning programs and financial securities for offshore installations (BEIS, 2011). A decommissioning plan must be submitted prior to project approval, along with the decommissioning cost estimated following a standard template, Annex E. Costs are based on present day values of methods and technologies and will be used by the BEIS to determine the level of financial security required. These plans are to be updated during the operational life to reflect best practices at the time (Renewables Consulting Group, 2015). Security must be submitted by the licensee, and there are a wide range of forms accepted including the following (BEIS, 2011):

- Upfront cash.
- Cash reserving.
- Letters of credit.
- Bank guarantees.
- Performance bonds.

Types of security that are not accepted include parent company guarantees and insurance schemes (BEIS, 2011).

Inflation is accounted for as follows (BEIS, 2011):

- Present day values are to be used in cost estimates.
- When submitting pre-construction plans, inflation should also be forecasted up to the end of any subsidy period using the Consumer Prince Index (CPI) inflation rate.
- If the current Office of Budget Responsibility's (OBR) forecast for inflation (as determined by the CPI) does not reach the expected point of decommissioning, then an average inflation value (calculated by the average over the years published by the OBR starting from the current financial year) would be assumed for the years not yet covered by the forecast.
- Decommissioning costs are to be reviewed annually and updated accordingly. This may result in changes to financial security as the financial instrument amount must match estimated costs.

The decommissioning cost estimates cannot include salvage values as the value can fluctuate and BEIS does not have any governing powers over the salvage market, thus is not a reliable estimate. Additionally, the cost estimates should include the recycling and disposal costs of infrastructure (Department for Business, Energy & Industrial Strategy, 2019).

In **Scotland**, the decommissioning of offshore renewable energy is guided by the *Offshore renewable energy: decommissioning guidance for Scottish waters* document also under the

Energy Act 2004 (Scottish Government, 2022). Therefore, the decommissioning requirements are comparable to the requirements in the UK.

The decommissioning provisions indicate that the licensee must be responsible for decommissioning costs, and the cost estimate provided must follow the standard template in Annex C Decommissioning programme template (Scottish Government, 2022). Present day values for current methods and technologies are required for the estimates (see below for details on inflation) and are the costs that the Scottish Ministers would have to pay should they become responsible for the facility (Scottish Government, 2022). Based on the decommissioning cost estimate, the Scottish Ministers will determine the level of financial security required (Scottish Government, 2022).

Inflation is accounted for in a similar way to how the UK accounts for inflation, which is as follows (Scottish Government, 2022):

- Present day values are to be used in cost estimates.
- When submitting pre-construction plans, inflation should also be forecasted to the expected point of decommissioning using the CPI inflation rate.
- If the current OBR forecast for inflation (as determined by the CPI) does not reach the expected point of decommissioning, then an average inflation value (calculated by the average over the years published by the OBR starting from the current financial year) would be assumed for the years not yet covered by the forecast.
- Decommissioning costs are to be reviewed annually and updated accordingly. This may result in changes to financial security as the financial instrument amount must match estimated costs.

Similarly to the broader UK, the decommissioning cost estimates cannot include salvage values as the value can fluctuate and the Scottish Minister does not have any governing powers over the salvage market, thus is not a reliable estimate (Scottish Government, 2022).

The plan should also outline how the facility decommissioning will be financed and put into place appropriate security arrangements. There are no prescriptive forms of security that is required; however, acceptable types include the following (Scottish Government, 2022):

- Upfront cash deposit (paid into an escrow account or direct to a Scottish government account).
- Cash accrual.
- Irrevocable draw down letters of credit.
- Bank guarantees.

- Performance bonds.

Unacceptable forms of security include parent company guarantees and insurance schemes (Scottish Government, 2022). The Scottish Ministers must be able to have access to the funds in the event the facility falls on the government to decommission (Scottish Government, 2022).

The financial security is expected to be put in place at the commencement of construction, unless an arrangement that has a set timeline for fund accrual is approved. However, projects will be assessed on a case-by-case basis to determine the requirements (Scottish Government, 2022).

In the **Netherlands**, the Water Act is utilized to govern the regulations regarding decommissioning of offshore wind farms. Decommissioning is required once the facility is no longer in use, and must be started within two years of inactivity (CMS, 2018). For equipment to be left in place, approval from the governing body is required. Bank guarantees of €120,000/MW (equivalent to approximately $175K CAD) is required for the permit to be issued (prior to construction starting) and is to be managed by the Netherlands Enterprise Agency (CMS, 2018). The amount of the bank guarantee will be re-assessed at least 12 years after the start of operations. The decommissioning plan is required to be submitted a few months prior to commencing decommissioning activities.

In **France**, decommissioning of wind facilities includes infrastructure removal, reclamation and that demolition waste is recovered or disposed of by authorized entities (EMC, 2021), and is required to be completed by the licensee upon termination of operations (Légifrance, 2023).

Financial assurance must be provided at the start of operations and is re-assessed periodically to account for inflation (Légifrance, 2023). Financial assurance for wind facilities is €50,000 (approximately $73K CAD per wind turbine) for 2 MW turbine and €10,000 (approximately $15K CAD) per additional MW (EMC, 2021). Acceptable forms of security include:

- Written commitment of credit institution, a financing company, an insurance company or a mutual guaranteed company.
- Deposit to the Caisse des Dépôts et Consignations.
- Private guarantee fund.

Financial assurance can be pooled if the licensee has multiple assets requiring security (Légifrance, 2023).

Environmental monitoring must begin within twelve months after commissioning. For any impacts requiring remedial action, the monitoring must be completed within twelve months, otherwise, must be completed at least every 10 years (EMC, 2021).

Reclamation includes removal of the foundation (except where the environmental balance is unfavourable; and the remaining infrastructure cannot be less than 2 metres below ground). Crane areas and access roads must be excavated to a depth of 40 cm and replaced with land that is representative of surrounding land (Légifrance, 2020). As of July 1, 2022, 90% of the total mass of wind turbines must be re-used or recycled for turbines that are authorized after January 1, 2023, when all foundations are excavated, or 85% when the excavation of the foundations is subject to exemption (Légifrance, 2020). Additionally, at least 35% of the mass of the motors must be re-used or recycled (Légifrance, 2020). Therefore, the licensee must know the composition of the wind turbine.

Solar

In the **United Kingdom (UK)**, for solar farms, the National Planning Policy Framework outlines the policy for planning and approval. For solar projects, decommissioning bonds (also referred to as reinstatement bonds) can be put in place to ensure decommissioning and reclamation costs can be covered. These bonds can work in two ways (House of Commons Library, 2015):

1. Funds can be put into an account at the beginning of development and remains in the account for the lifespan of the project. The funds are only accessed at the end of life.
2. Funds can be put aside throughout the project lifetime.

Set up of these bonds is usually between the project owner and landowner, and generally do not have government involvement (House of Commons Library, 2015).

In some cases, local jurisdiction can dictate what is required within their jurisdiction. In planning policy documents specifically set up by the Cornwall Council, it indicates that solar farms are to be decommissioned after their lifetime and that a decommissioning bond is not required (House of Commons Library, 2015).

In **Spain**, the Ministry for Ecological Transition and Demographic Challenge (MITECO) is the governing body in relation to energy (Olivera and Artes, 2023). For renewable energy in Spain, the licensee of the facility is responsible for decommissioning after closure (Ministry of Economy, 2020). Administrative authorization to decommission must be requested before doing so. A closure plan detailing the technical, economic, and environmental circumstances must be detailed and submitted with the request (Ministry of Economy, 2020; Olivera and Artes, 2023). Currently, the Royal Decree 1955/2000 (document that develops the regulatory framework in Spain) does not have any financial security requirements for decommissioning (Olivera and Artes, 2023).

Through the Waste Electrical and Electronic Equipment (WEEE) Directive, the **European Union (EU)** has implemented regulations that mandate the reuse, recycling and recovery of decommissioned PV modules. The WEEE Directive has been incorporated into national policies of the countries who are a part of the EU, and each country has the ability to incorporate it into their legislation as they see fit (Smart Prosperity Institute, 2021). As a result, countries may have slightly different guidelines. For example, how solar PV is defined may differ, thus resulting in a different method of end-of-life management. As part of the directive, licensees are responsible for the costs of collecting and recycling products (Smart Prosperity Institute, 2021).

8.0 SUMMARY AND EVALUATION OF PRACTICES FOR END-OF-LIFE SECURITY

Based on the results of the literature review above, a summary of financial and non-financial mechanisms for end-of-life security, examples of implementation, and positive and negative attributes of each mechanism are presented in Appendix A. Further commentary and evaluation relevant to the specific context of recommended best practices for power generation in Alberta is detailed within this section.

8.1 Up Front Security

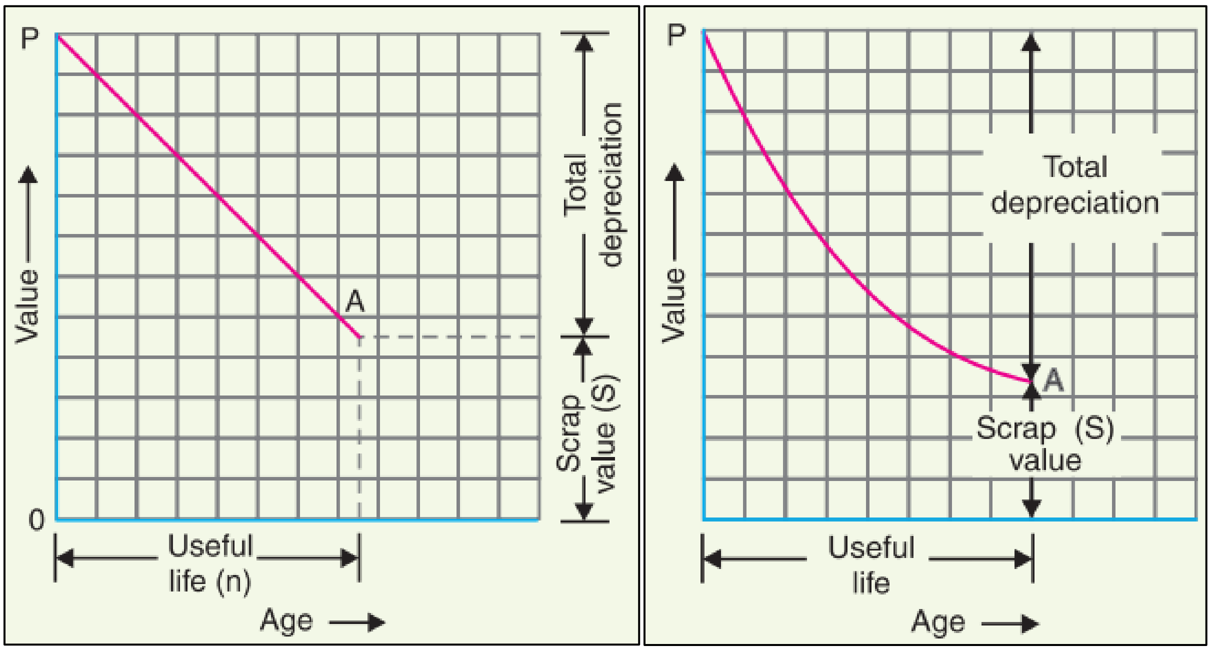
A Survey of Federal and State-Level Solar System Decommissioning Policies in the United States for solar facilities suggested that compliance with end-of life financial security requirements had an impact on construction timelines, project economics and overall project viability. Of the states that were reviewed, jurisdictions that required financial assurance for decommissioning costs prior to construction and operation had increased capital costs, which resulted in delayed construction and project development. On the other hand, policies that allowed for financial assurance to be scheduled throughout the stages of the project allowed for financial assurance to be incurred as an operating cost instead of a capital cost (NREL, 2021).

The collection of up-front security must balance economic impact to the licensee and deterring investment with ensuring sufficient funds. As per Appendix A, several forms of financial mechanisms for collection of up-front security are used in Alberta and other jurisdictions. Each mechanism has its own merits and drawbacks with no one form being the predominant method or consistent ‘best practice’. Ecoventure has not analyzed the specific accounting policies and legal standing of each mechanism in relation to Canadian and Albertan frameworks. As such, no commentary regarding the form of security to be held (e.g. cash versus bonds versus trust accounts, etc.) is provided. However, it is generally accepted that the higher proportion of security that is held up front and the more secure form that it is held in, reduces the risk to government and landowners in the event a licensee does not uphold their decommissioning requirements; however, negatively impacts project economics and decreases investment.

8.2 Accrued Security

The concept of accrued security is that the licensee puts aside funds over the lifecycle of the project to allow operations to fund end-of-life closure activities. Although accrual of funds does not provide the same level of security as up-front collection, it allows the licensee to spread out costs, reducing the initial economic burden of development. It also correlates asset value with liabilities throughout the project lifecycle. Timing and security amount must correlate with the estimated required reclamation costs, keeping in mind the asset value to ensure adequate funds are available at any point in the project lifespan to cover associated liabilities. Accrued security valuations should include multiple depreciation analysis predictions.

Figure 8-1 Example power plant depreciation curves (Saad, 2016).



8.3 Non-Financial Instruments

In general, non-financial instruments such as permits, targeted lease agreements, decommissioning clause requirements at approval of project, etc. are inferior forms of security to financial instruments. They typically rely on compliance enforcement by government/regulators or legal action by the landowner. Available leverage to enforce compliance is reduced based on the relative portfolio of assets the licensee holds. In other words, impairment of assets or income/profit generation is typically required for effective compliance enforcement and as asset value declines in relation to liabilities near end of life, the effectiveness of enforcement action is decreased. If a licensee or operator does not have additional assets that can be leveraged as part of compliance enforcement, the risk of defaulting on decommissioning obligations is high.

8.4 Corporate Financial Test

A corporate financial test includes an evaluation of a company's financial health as a means of determining whether they have sufficient means to cover expected end-of-life liabilities. An example of this is the AER's Licensee Capability Assessment. Licensees are required to submit financial information and a capability assessment is utilized to determine the licensee's ability to fund end-of-life decommissioning and reclamation activities. The challenge with such a framework is when licensees do not meet corporate financial thresholds, there is an inherent challenge in enforcing compliance with administrative penalties and producing required security deposits; essentially adding a financial penalty onto an already struggling organization. This is evidenced by recent AER notices wherein multiple licensee's were not in compliance with closure or other compliance obligations, and have had multiple orders issued against them with select assets assigned to the OWA for care and maintenance and closure obligations (AER, 2021c; 2023a; 2023b; 2023c;). Corporate financial tests ultimately need to be incorporated with additional financial and regulatory mechanisms as part of a broader liability management framework.

8.5 Industry Levy

In the event of a default resulting in a shortfall of funds for decommissioning obligations, the unfunded liability must be underpinned by government or an industry funded levy. In Alberta's oil and gas industry, the OWA is funded by industry as a levy based on a licensee's proportion of the overall industry's liability. Established in 2002, OWA is an industry funded collaboration among the Alberta Government, provincial regulators and oil and gas producers, that operates with an annual levy collected from industry to fund ongoing decommissioning and reclamation of orphaned oil and gas wells, facilities, and pipelines. In recent years, interest-free government loans totalling $535 million have been provided to the OWA to expedite cleanup work due to an increased inventory and to support industry activity during an economic downturn (OWA, 2023). Other industry levy models include one-time or limited period levies to fund specific activities or shortfalls such as in the example of the Laminaria and Corallina Decommissioning Cost Recovery Levy in Australia (DSIR, 2023).

8.6 Liability Management Frameworks

A combination of financial and non-financial mechanisms can be combined into a liability management framework. An example of this is the AER's updated Liability Management Framework which was introduced in 2020. The framework includes a financial component in the form of security deposits along with corporate financial tests, underpinned by an industry levy. Licensees are required to submit financial information and a capability assessment is utilized to determine the corporation's ability to fund end-of-life decommissioning and reclamation activities. If a licensee does not meet certain decommissioning or reclamation or spend thresholds, financial or target based, administrative penalties are applied and/or a security deposit is required to reduce the risk of underfunded liabilities.

The framework requires regulatory oversight on transfers or changes in ownership to ensure licenses aren't transferred to companies with insufficient corporate strength to fund closure activities and regulatory obligations.

Liability management and regulatory oversight of oil and gas in comparison to power generation differs in the province in that the AER regulates a higher volume of operators with a higher quantity and variety of assets; income or profit is generated at different stages from resource extraction to movement of product to refining or processing of product. A non-renewable energy source will have a diminishing rate of return, as the resource is depleted and requires ongoing development or extraction of the resource, whereas a renewable energy source can only be limited by the capacity of the infrastructure to capture and convert the energy. The requirement for oil and gas licensees to consistently be developing and exploiting more resource allows for opportunities for regulatory approval of projects or development and compliance enforcement. As an example, a company that is not meeting their mandatory closure spend requirements can be denied new well licenses and/or prevented from license transfers from other operators. Conversely, power generation typically has one source of profit or income – capturing energy from a specific source and converting it for distribution to the power grid. After initial construction and energizing of the power plant, there are limited opportunities to enforce regulatory requirements other than in relation to other projects an applicant may be pursuing. Initiating a financial levy or obligation prior to or at the start of potential profit generation would therefore have a higher percentage of compliance.

8.7 Additional Considerations

Project Life Cycle

Where licensee or operator capital expenditure is highest at pre-construction and onset of construction, there is a higher risk to a project not being completed as proposed, and other operators, regulators or government taking on completion or reclamation requirements should a company not hold the required assets or funds to complete construction of a project. Once an asset or project is constructed, and ready for initiation, value and income or profit potential increase. As the project moves into operational status, the operator's ability to fund regulatory and security requirements expands.

Providing interim targets for reclamation and a phased approach for liability reduction or closure spend means that an operator can spread the costs or obligations over the lifespan of a project. With respect to wind and solar, reclamation of the surface disturbance associated with construction is a cost that could be born at the onset of production. Reclamation of the extensive road and pad system required for construction should be considered as a prerequisite to startup.

Approval of a conceptual decommissioning and reclamation plan at the project initiation stage would ensure that end-of-life considerations and associated costs are considered at the onset of planning. Updating of plans on a regular basis, as new information becomes available and prior to initiating decommissioning and reclamation activities, would ensure that site-specific considerations and changes in requirements or practices are incorporated prior to actual decommissioning. Regulatory oversight and approval of plans on an on-going and predetermined basis (every 5 years) would ensure that operators and regulators have a common understanding and agreement on the requirements. A final decommissioning and reclamation plan should be approved prior to facility end of life, and associated decommissioning activities commenced within 12 months of discontinuation of power generation.

Retrofitting/Re-Energization

The opportunity to retrofit, re-energize, or otherwise update the power generation facility to extend its useful lifespan should be a priority to reduce the need for further disturbance of land but also to reuse components where applicable. Allowing for retrofitting to be proposed in lieu of an end-of-life decommissioning and reclamation plan is not always the best practice; instead, as final site closure nears it could be proposed as an alternative, and similar to decommissioning activities, should be initiated within 12 months of the facilities' end of life cycle.

9.0 DECOMMISSIONING AND RECLAMATION CLOSURE ENDPOINTS

The installation and development of power generation facilities, as with most large infrastructure projects, requires disturbance to the landscape. Site preparation, soil stripping, grading, road development, pilings, footings and underground infrastructure are needed to support power generation facilities. After installation, it is recommended to complete interim reclamation to accommodate landowner agricultural practices, landscape and drainage patterns and establish vegetation that is compatible with the adjacent area. However, the end-of-life expectation for final decommissioning and reclamation is recommended to follow the governance of the *EPEA* were the final objective is to meet "*Equivalent land capability, where the ability of the land is to support various land uses after conservation and reclamation that is similar to the ability that existed prior to an activity being conducted on the land, but that the individual land uses will not be necessarily be identica*l" (AEP, 2023b).

The majority of power generation occurs on agricultural land within Alberta; the objective for reclamation endpoints is typically agricultural land. However, consideration must also be given to development on industrial lands which is increasingly common for solar facilities and potential development on crown land, First Nation's land, Métis Settlements, etc. where the land use is not specifically agricultural.

At the end of life, when a facility is no longer generating power, or efficiency of power generation has declined, or cannot be retrofitted for extended use, the power generation facilities are to be fully decommissioned with reclamation completed to equivalent land capability. The desired outcomes of "equivalent land capability" for reclamation on oil and gas facilities is outlined within the *2010 Reclamation Criteria for Wellsites and Associated Facilities for Cultivated lands* (ESRD, 2013a). This criterion has been developed to address the ecological health and function of land operability. Key consideration of the criteria development includes a science-based approach that is reproducible and desirable to address ecosystem and management function, workable as the criteria offers alternative or options to promote efficiency and recognize constraints and enforceable as outcomes are addressed through performance measures evaluated by the Government of Alberta. The reclamation criteria focus on the soil, landscape and vegetation parameters to evaluate the success of reclamation efforts and targets that are evaluated against equivalent land use capability parameters. By adopting already existing criteria in evaluating reclamation of power generation facilities, reclamation outcomes can be consistent throughout the province of Alberta. Alberta has well established reclamation criteria for the following land-use categories as endpoints:

- Cultivated lands (ESRD, 2013a);
- Forested lands (ESRD, 2013b);
- Native grasslands (ESRD, 2013c); and
- Peatlands (AEP, 2017).

In comparison to oil and gas development, which must be sited in proximity to an available and accessible resource which could occur in peatlands, power generation development on peatland sites should be discouraged due to the ecosystem value of a peatland and the time required to regenerate to a productive peatland ecosystem (Bullock, Collier & Convery, 2012).

While development on disturbed or industrial (Brownfields) lands should be considered as a best practice, end-of-life closure requirements for industrial lands should be detailed at the on-set, particularly where a potential change in end land use may occur. General considerations and specific conditions for each land use are discussed below.

9.1 General Considerations

Resource extraction, including renewable resource facilities have extensive underground infrastructure vital to the generation of power. Traditional oil and gas extraction activities can include, but are not limited to, underground piping, concrete vaults, wellbores, underground tankage and pilings. Typically, underground infrastructure is left in place at depths if it will not impede reclamation outcomes for the site. Infrastructure left in place may impede root or vegetation growth, water infiltration, or create physical barriers within the subsurface. Impediment to future use of the site should be avoided for solar and wind subsurface infrastructure. Buried concrete footings, pilings and electrical cabling should only be left at depths that would not interfere with future use of the site. Landowner agreement and signoff with regards to leaving subsurface or surface infrastructure, should be agreed upon at project start and updated on a regular basis or as new information becomes available. Change in landowner or change in land use may affect the reclamation outcomes and agreements should be updated on a regular basis.

As with the established reclamation criteria within the Province, regulatory oversight should include a staged approach to ensure the site is ready to meet reclamation outcomes. At a minimum, a Phase 1 Environmental Site Assessment (ESA), a non-intrusive assessment to identify areas of potential environmental concern, is required. Should the potential for impacts be found, a Phase 2 ESA (intrusive investigation) to identify or confirm impacts at the site, should be completed. Should impacts be identified, remediation to applicable guidelines may be required prior to reclamation activities being completed.

9.2 Agricultural/Cultivated Lands

Agricultral and cultivated lands include lands that are managed under conventional, minimal or “zero till” practices for agricultural purposes. These lands include cereal or small seeded crops, tame forages, tame pastures, hay lands, agroforestry or specialty crops that require additional management practices. The primary purpose of agricultural and cultivated lands is the systematic management for the rearing of livestock and or the production of crops for consumption. The equivalent land capability for agricultural and cultivated lands is a comparable landscape where soils (topsoil, depths, color, texture structure), landscape (drainage, erosion, stability, operability and debris) and vegetation (crop type, growth stage, height, density, plant health and seed development) parameters are comparable to the off-site adjacent areas or comparable to the pre-existing landscape prior to the construction activities.

9.3 Forested Lands

Forested lands are areas dominated by trees and forested vegetation, whether the area is utilized for commercial forestry purposes or not. Forested locations are comprised of trees, shrubs and herbaceous species based on the nutrient and moisture regime of a given area. The desired forested reclamation outcomes are to establish a site with a diverse and healthy vegetation community, dominated by the desired forested species and on a growth and establishment trajectory of meeting the off-site forested community. Majority of forested lands are located in the northern portion of the Province.

9.4 Grasslands

Native grasslands are naturally occurring ecosystems with a vegetation community dominated by native herbaceous species. Native grasslands have a mixture of native grass species, forbs, shrubs and tree species, with limited agronomic or introduced species. Native grasslands are found primarily in the Grassland Natural Regions predominantly in southern Alberta, however they can be found within the Parkland, Rocky Mountain and Foothills Natural Regions of central and western Alberta (NRC, 2006). The desired reclamation outcome is to establish a healthy and diverse native grassland community that seamlessly blends with the adjacent area and dominate by native grassland species.

9.5 Peatlands

Peatlands are boreal wetlands defined with a peat depth of a minimum of 40 cm and include functioning bogs and fens. For the purpose of criteria, peat forming wetlands with less than 40 cm of peat are to be assessed using the peatland criteria. The expectation of peatland reclamation outcomes is to restore peatlands to facilitate a functional boreal wetland where hydrology across the landscape is maintained with no excessive pooling or drying, with a diverse peat forming vegetation composition dominated by woody and vascular species and bryophytes.

9.6 Industrial Lands

Industrial land use is defined as lands used for commercial establishments such as manufacturing, distribution centers, warehousing, shipping, storage, shipping and repair and maintenance of equipment. As industrial land has typically been disturbed during the development, the desired outcome is to establish an area that can continually be utilized for industrial purposes which is safe and clean for further activity.

10.0 ESTIMATED COSTS FOR DECOMMISSIONING AND RECLAMATION

10.1 Review of Published Decommissioning Plans and Cost Estimates

A previously published report of U.S. decommissioning costs for power generation sites identified the following costs per megawatt of capacity.

Figure 9-1 Reported decommissioning cost estimates per megawatt of capacity in $USD (RFF, 2017).

Fuel type	No. of estimates	2016$ (thousands) Minimum	Mean	Maximum
Offshore wind	7	$123	$212	$342
Coal	28	$21	$117	$466
Concentrated solar power (CSP)	5	$24	$94	$138
Solar photovoltaic (PV)	22	–$89*	$57	$179
Onshore wind	18	$2	$51	$222
Petroleum/petroleum + gas	19	$2	$31	$103
Gas (various types)	28	$1	$15	$50

*Negative cost estimates indicate that the salvage value of plant materials exceeds decommissioning costs.

A review of decommissioning cost estimates and actual costs for completed decommissioning and reclamation projects was completed with results summarized in Appendix B.

10.2 Decommissioning and Reclamation Costs in Alberta

Based on the significant history of natural resource extraction throughout Alberta, a robust decommissioning and reclamation industry is present in the province, with well defined industry standard practices for decommissioning and reclamation. For the purposes of defining end-of-life closure activities and associated costs, decommissioning and reclamation are defined as:

- Decommissioning: removal of all surface and subsurface infrastructure.
- Reclamation: all levels of phased ESAs, remediation of any identified impacts to an acceptable standard, and returning the surface to equivalent land capability based on landscape, soils, and vegetation criteria.

10.2.1 Decommissioning

The general principles of decommissioning for power generating facilities are the same regardless of land use and is dictated by the type of facility, infrastructure present and required footprint. As such, the decommissioning requirements in Alberta are discussed in context of the type of power generation instead of the land use.

Coal/Natural Gas

Suspension, abandonment, and decommissioning costs are estimated based on generic expected site conditions and industry standard costs. The decommissioning and liability costs are limited to surface and subsurface infrastructure associated with power generation only and do not include any transmission related infrastructure. It is recognized that decommissioning of natural gas power plants is less effort than coal power generation although the general methodology is effectively the same. Where a coal power plant has been converted to natural gas, the methods and associated costs associated with coal power generation should be followed. The general methodology of the work to be done during the decommissioning and abandonment is described as follows:

- Development of a decommissioning plan and coordination of required resources.
- Underground utility locates, disconnect electrical power, purge all equipment on site, and remove fluids for off-site disposal, based on the following assumptions and methodology as per industry standards:
    - Locate all buried utilities via direct connection and 3-way sweep. Hydrovac to expose all utilities at connections as per industry standards.
    - Assume all power coming into the site is shut off and locked out by the utility company. Electrical disconnect confirmation only.
    - Assume all tanks and lines previously drained but not purged.

  - All sources of gas and pressure into the site are eliminated/blinded.
  - Vacuum/steam truck combo units to be used to depressurize and remove all free liquids from piping, pumps, equipment, aboveground storage tanks, and septic tanks.
  - Transfer fluid to tanker style vacuum truck for transport of all waste liquids and sludge to an appropriate disposal facility.
  - Gas test all vessels, tanks, and confined spaces for LEL levels and, where required, purge out all equipment, tanks, pumps and piping with nitrogen.
  - Safety coordination, site care and custody throughout this Phase.
- Demolition of site structures and cut/cap buried facilities at appropriate depth on site. The following assumptions and methodology are applicable as per industry standards:
  - Mobilization of heavy equipment to site suitable for demolition activities including excavators with appropriate shears, hammers, and material handling attachments.
  - Setup field office and laydown areas for site management.
  - Excavate and remove cables on site and excavate buried facilities to trench depth and cut/cap where applicable.
  - Demolish buildings, tanks, vessels, piping. Remove insulation where possible and shear metal into transportable sizes. Separate materials into stockpiles/bins based on material type.
    - Majority of buildings to be demolished by progressive removal of cladding and structural members by demolition equipment from top down and bay to bay.
    - Select facilities such as main powerhouse to be demolished by controlled blast pending preparation of a detailed demolition plan by a qualified engineer.
  - Pull all pilings less than 30 cm diameter and cut all larger pilings at appropriate depth below ground.
  - Safety coordination, site care and custody throughout this Phase.
- Drain, dredge, and decommission ponds/lagoons/septic fields. The following assumptions and methodology are applicable:

    - Cooling ponds/lagoons to be dewatered and dredged with sludge stabilized for use as reclamation material.
    - Cooling water to be pumped off to surroundings after confirmation of suitability.
    - Ponds assumed to be at half capacity at time of decommissioning.
    - Where applicable, HDPE liners to be removed, ripped up into transportable pieces, and hauled for off-site disposal.
    - Septic fields to have piping excavated and hauled for disposal.
- Load, transport, and dispose of solid waste to the appropriate facility. The following assumptions and methodology are applicable as per industry standards:
    - Load and haul all equipment and skids with potential salvage potential.
    - Load and haul concrete to landfill.
    - Load and haul insulation and garbage to landfill.
    - Load and haul all salvageable metal for recycling and non-salvageable for disposal.
    - Demobilization of equipment and trucks.
    - Safety coordination, site care and custody throughout this Phase.
- Ongoing project management, site supervision, security, care and custody of the site for a period of 3 years.

Wind

Suspension, abandonment, and decommissioning costs are estimated by Ecoventure based on generic expected site conditions for a wind generated power facility utilizing turbines and industry standard costs. The decommissioning and liability costs are limited to surface and subsurface infrastructure associated with power generation only and do not include any transmission related infrastructure. The general methodology of the work to be done during the decommissioning and abandonment is described as follows:

- Development of a decommissioning plan and coordination of required resources.
- Underground utility locates, disconnect electrical, drain equipment on-site, and remove fluids for off-site disposal, based on the following assumptions and methodology as per industry standards:

    - Locate all buried utilities via direct connection and 3-way sweep. Hydrovac to expose all utilities at connections as per industry standards.
    - Assume all power coming into the site is shut off and locked out by the utility company. Electrical disconnect confirmation only.
    - Drain oil and fluids from equipment and turbines.
    - Transfer fluids to truck for transport of all waste liquids to an appropriate disposal facility.
    - Safety coordination, site care and custody throughout this Phase.
- Removal/demolition of turbines and related infrastructures and cut/cap or remove buried facilities to an appropriate depth on site. The following assumptions and methodology are applicable as per industry standards:
    - Setup field office and laydown areas for site management. Upgrade and where necessary build access suitable for required heavy equipment and cranes.
    - Mobilization of heavy equipment to site suitable for demolition activities including excavators with appropriate demolition attachments and cranes.
    - Excavate and remove cables on site to trench depth and cut.
    - Remove blades via crane and place in laydown area. Disassemble tower and place and laydown area for processing.
    - Shear blades, turbines, and related infrastructure into transportable sizes and segregate for recycle/salvage where applicable.
    - Excavate turbine concrete foundations and break up to allow water infiltration. Remove concrete to a depth of at least 1.2 m below ground.
    - Safety coordination, site care and custody throughout this Phase.
- Load, transport, and dispose of solid waste. The following assumptions and methodology are applicable as per industry standards:
    - Load and haul concrete and garbage to landfill.
    - Load and haul all salvageable metal for recycling and non-salvageable for disposal.
    - Demobilization of equipment and trucks.

    - Safety coordination, site care and custody throughout this Close-Out Phase.
- Ongoing project management, site supervision, security, care and custody of the site for a period of 1 year.

Solar

Suspension, abandonment, and decommissioning costs are estimated based on generic expected site conditions for a solar generated power facility utilizing PV panels mounted on pilings and industry standard costs. The process for decommissioning follows a similar process as other facility types, including:

- Development of a decommissioning plan and coordination of required resources.
- Underground utility locates and disconnect electrical based on the following assumptions and methodology as per industry standards:
    - Locate all buried utilities via direct connection and 3-way sweep. Hydrovac to expose all utilities at connections as per industry standards.
    - Assume all power coming into the site is shut off and locked out by the utility company. Electrical disconnect confirmation only.
    - Safety coordination, site care and custody throughout this Phase.
- Removal/demolition of solar panels and related infrastructures and cut/cap or remove buried facilities to an appropriate depth on site. The following assumptions and methodology are applicable as per industry standards:
    - Setup field office and laydown areas for site management. Upgrade access suitable for required equipment and trucks.
    - Mobilization of heavy equipment to site suitable for demolition activities including excavators with appropriate demolition attachments.
    - Excavate and remove cables on site to trench depth and cut.
    - Dismantle panels, racking, and frames. Segregate materials and cut into transportable sizes.
    - Pull all pilings, or reverse out screw pilings, less than 30 cm diameter and cut all larger pilings at appropriate depth below ground. Where required, remove concrete to a depth to not impede future land use at the site.
    - Safety coordination, site care and custody throughout this Phase.

- Load, transport, and dispose of solid waste. The following assumptions and methodology are applicable as per industry standards:
    - Load and haul concrete and garbage to landfill.
    - Load and haul all salvageable metal for recycling and non-salvageable material for disposal.
    - Demobilization of equipment and trucks.
    - Safety coordination, site care and custody throughout this Phase.
- Ongoing project management, site supervision, security, care and custody of the site for a period of one year.

General Assumptions and Cost Summary

The following general assumptions and limitations were utilized in determining estimated decommissioning costs for power generation facilities:

- Labour and equipment can be sourced within the province with nominal costs for subsistence and initial mobilization to the project location.
- Hazardous materials such as asbestos and polychlorinated biphenyl (PCBs) are potentially present at older coal facilities but are no longer in use for recent installations. Abatement costs have been factored in for coal power plants but not for other power generation types.
- Disposal facilities for liquid and solid waste are located within 200 km of the subject site.
- Subsurface infrastructure to be removed to a minimum of 1.2 m below ground level; however, any buried material must not impact future land use and may require landowner approval in writing for buried infrastructure to remain in place.
- Estimates presented are an expected average cost per megawatt of power generation. A significant range in low and high costs is expected and site-specific decommissioning and reclamation plans (with associated cost estimates) is recommended where possible.
- All estimates below are presented as gross decommissioning costs without any cost recovery from sale of salvaged equipment or materials.
- All estimated costs are presented in equivalent present day Canadian Dollars (CAD).

Estimated decommissioning costs for each type of power generation evaluated, based on review of estimates for similar facilities and Ecoventure's experience in liability estimation within Alberta, are summarized in the table below as well as in Appendix C.

Table 10-1 Estimated average decommissioning costs by power generation type.

Power Generation Type	Estimated $/MW	Comments
Coal	75,000	High variability (-50% to + 300%) in expected costs due to typical age of coal power plants, variations in construction, hazardous material abatement, contamination levels, and cooling pond area. Excludes mine related infrastructure and equipment.
Natural Gas	35,000	Moderate variability (-50% to +100%) in expected costs. Where natural gas plants have been retrofitted from existing coal facilities, use coal power plant estimate.
Wind	95,000	Estimated $185,000 per turbine. Moderate variability (-25% to +75%) in expected costs. Costs influenced by location/proximity to services and significant increase in $/turbine for smaller wind farms.
Solar	70,000	Moderate variability (-50% to +100%) in expected costs. Costs influenced by type of installation/racking (stationary vs. tracking, etc.) and pilings used.

10.2.2 Reclamation

Once decommissioning is complete, sites progress through to reclamation, including a Phase 1 ESA, Phase 2 ESA and remediation, if required, and final surface reclamation and revegetation. Unlike decommissioning, reclamation requirements are generally dictated by land use instead of type of power generation.

Common Reclamation Requirements

The decommissioning and reclamation of power generation facilities in the province of Alberta is recommended to follow similar standards and expectations as similar industries. A typical approach to reclamation is outlined below. Site-specific planning and reclamation consideration will need to be adopted based on the area, however listed below is a typical approach.

- Consultation and discussion with landowner, stakeholders and regulators to discuss site specifics, reclamation considerations and desired outcomes. Furthermore, a review of regulatory oversight will be completed prior to activity to ensure compliance with appropriate legislation (i.e. *Public Lands Act* [Gov. of AB, 2000a], *Water Act* [Gov. of AB, 2000b], and *Wildlife Act* [Gov. of AB., 2000c]).

- Prior to any surface reclamation activities, completion of a non-intrusive Phase 1 ESA including background information review, stakeholder interviews and a site visit in accordance with Alberta Environmental Site Assessment Standard (AEP, 2016).
- If required, based on the results of the Phase 1 ESA, completion of a Phase 2 ESA including intrusive sampling in accordance with Alberta Environmental Site Assessment Standard (AEP, 2016).
- If contamination is identified, completion of remediation to appropriate soil and groundwater guidelines such as Alberta Tier 1 and Tier 2 Soil and Groundwater Remediation Guidelines (AEP, 2022a and 2022b).
- Coordinatization with all parties for land agreements, road use and any crossing and proximity agreements.
- Completion of a comprehensive ground disturbance review, including Alberta OneCalls, independent line locates, exposure of underground infrastructure and any other mitigation measures that may be required.
- Mobilization of equipment to the project area. All equipment is to be cleaned prior to entry to avoid the spread of invasive vegetation species and potential soil pathogens.
- Where necessary, soil stripping and salvage of topsoil and subsoil is to be completed to allow for adequate workspace during the reclamation process. Soils are to be stripped based on soil horizon and classification and stored with a minimal of 1 m separation to avoid admixing.
- Complete the removal of surface gravel associated with access roads and supporting infrastructure.
- Where and if necessary, backfilling of areas with subsoil. Backfill material is to be tested (pH, salinity, and texture) prior to importing to site with landowner notification and approval for importation of backfill.
- Subsoil will be de-compacted, via deep ripping, paratilling or disking. Once de-compacted, subsoil is to be contoured to match the surrounding area to support landscape operability of the area.
- Once the grading of subsoil has been completed, topsoil will be replaced (where applicable) across the project area. Topsoil texture, depths and quality are intended to be comparable to adjacent or pre-existing conditions to support comparable vegetation establishment.

- Where required, erosion and sediment control measures are to be utilized, to mitigate potential erosion issues, limit soil loss and reduce sedimentation in adjacent watercourses.
- Vegetation establishment is to be completed in conjunction with reclamation efforts. In some cases, that may include integration of landowner practices (annual crop rotation). In other applications, further seeding and vegetation establishment is required based on the land use and desired outcomes.

Post reclamation monitoring is to be completed following reclamation and throughout the growing season. The *2010 Reclamation Criteria for Wellsite and Associated Facilities for Cultivated Lands* (ESRD, 2013a) is to be utilized as the guidance document to address post reclamation conditions regarding soil health, landscape operability and vegetation establishment. Where deficiencies are noted, additional mitigation is to be competed (i.e. further site contour, soil additions or amendments, vegetation control or additional seeding).

Agricultural/Cultivated Lands

An acceptable reclamation plan should be consistent with industry and established standards, such as *2010 Reclamation Criteria for Wellsites and Associated Facilities for Cultivated Lands* (ESRD, 2013a), following decommissioning:

- Prior to commencing reclamation activities, the site will require Alberta One Call and Third-Party Line Locates to be completed.
- The gravel present will be removed and hauled away. This cost is included in the decompaction cost estimate.
- The area will be deep ripped to relieve compaction prior to the replacement of subsoil. The site will be re-contoured to establish appropriate surface drainage across the site and to blend with the adjacent landscape.
- Salvaged and select imported topsoil material will be replaced evenly across the area as required to meet equivalent land capability and to promote vegetation growth.
- Final seeding and vegetation establishment will be incorporated based on final agricultural land use and/or forested (based on landowner request).
- Ongoing monitoring will be conducted to assess vegetation, soils, and terrain. Weed control and general site maintenance (e.g., erosion control, fertilizer applications, etc.) will be required, for at least three years to five years, until a RCA is submitted to the appropriate regulatory agency.

- The cost of reclamation will include costs for site preparation, supervision of reclamation work, monitoring and maintenance, and preparation and submission of an RCA.
- After completion of all reclamation activities, complete a detailed site assessment, update all applicable reclamation certificate schedules (includes updating Schedule 2, Phase 1 ESA), compile and submit RCA.

Forested Lands

The proposed reclamation plan should be consistent with industry and established standards for *2010 Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands* (ESRD, 2013b) following decommissioning:

- Gravel and coarse stony material that are present will be removed and hauled away.
- Active facility areas will be deep ripped to relieve compaction prior to the replacement of subsoil. The site will be re-contoured to establish appropriate surface drainage across the site and to blend with the adjacent landscape.
- Salvaged topsoil and peat material will be replaced evenly across the area as required to meet equivalent land capability and to promote vegetation growth.
- Once the soils are replaced, soils will be shallow ripped to alleviate any compaction and establish micro-contours to support vegetation establishment.
- Approximately 2,000 spruce and poplar seedlings will be planted per hectare on the reclaimed area.
- Ongoing monitoring will be conducted to assess vegetation, soils, and terrain. Weed control and general site maintenance (e.g., erosion control, fertilizer applications, etc.) will be required, for at least three years to five years. Once the Site meets forestry reclamation criteria, a detailed site assessment will be completed, and a reclamation certificate application will be submitted to the appropriate regulatory agency.
- The cost of reclamation will include costs for site preparation, supervision of reclamation work, monitoring and maintenance, and preparation and submission of a reclamation certificate application.
- After completion of all reclamation activities, complete a detailed site assessment, update all applicable reclamation certificate schedules (includes updating Schedule 2, Phase 1 ESA), compile and submit reclamation certificate application.

Grasslands

The proposed reclamation plan should be consistent with industry and AER standards for *2010 Reclamation Criteria for Wellsites and Associated Facilities for Native Grasslands (July 2013 Update;* ESRD, 2013c), following decommissioning:

- The gravel present will be removed and hauled away.
- Active facility areas will be deep ripped to relieve compaction prior to the replacement of subsoil. The site will be re-contoured to establish appropriate surface drainage across the site and to blend with the adjacent landscape.
- Salvaged and select imported topsoil material will be replaced evenly across the area as required to meet equivalent land capability and to promote vegetation growth.
- Once the soils are replaced, soils will be shallow ripped to alleviate any compaction in preparation for seeding.
- Ongoing monitoring will be conducted to assess vegetation, soils, and terrain. Weed control and general site maintenance (e.g., erosion control, fertilizer applications, etc.) will be required, for at least three years to five years, until a reclamation certificate application is submitted to the appropriate regulatory agency.
- The cost of reclamation will include costs for site preparation, supervision of reclamation work, monitoring and maintenance, and preparation and submission of a reclamation certificate application.
- After completion of all reclamation activities, complete a detailed site assessment, update all applicable reclamation certificate schedules (includes updating Schedule 2, Phase 1 ESA), compile and submit reclamation certificate application.

Industrial Lands

The proposed reclamation plan is consistent with industry and Brownfield Development policy (Gov. of AB, 2012; 2023a) in industrial settings, following decommissioning:

- Post decommissioning with impacted or contaminated material(s) that may remain on a Site will be remediated to the appropriate soil and groundwater guidelines such as Alberta Tier 1 or Tier 2 (AEP, 2022a and 2022b) as per the Contaminated Site Policy Framework (ESRD, 2014). It is expected that the Facility Owners will repair the earthwork environment better than the minimal requirements outlined by the Act.
- Removal of any remaining industrial debris, to accommodate the future industrial development and use of the Site.

- Areas not necessary to accommodate future industrial use will be deep ripped to relieve compaction and re-contoured to establish surface drainage across the site prior to replacement of soil reclamation material.
- Areas of the future industrial land use are to be re-developed to accommodate approved zoning based on municipal planning and proposed industrial activities.

General Assumptions and Cost Summary

The following general assumptions and limitations were utilized in determining estimated reclamation costs for power generation facilities:

- Labour and equipment can be sourced within the province with nominal costs for subsistence and initial mobilization to the project location.
- The Phase 1 ESA is included within the estimated reclamation cost, however, subsequent Phase 2 ESA and remediation costs have not been included as the requirement is subject to the findings of the Phase 1 ESA.
- For wind farms, a per turbine reclamation cost roughly equivalent to 1 hectare is estimated for the turbine footprint. Additional evaluation of the disturbed area for access roads would be required to compare overall cost/ha to cost/turbine.

Estimated reclamation costs for each land use on a per hectare basis based on review of estimates for similar facilities and Ecoventure's experience in liability estimation within Alberta are summarized in Table 10-2 as well as in Appendix C.

Table 10-2 Estimated reclamation costs based on land use on a per hectare basis.

Land Use	Estimated $/ha	Comments
Cultivated	43,800	Cost associated to final reclamation.
Forested	59,000	Cost associated to final reclamation.
Grassland	55,000	Cost associated to final reclamation. Additional costs associated with vegetation establishment and control.
Industrial	25,000	Cost associated to final reclamation.

10.3 METHODS FOR DETERMINATION OF DECOMMISSIONING AND RECLAMATION COSTS

Site Specific Liability Estimates

Average costs for decommissioning and reclamation on a per megawatt and per hectare basis have been presented above; however, due to the variability in costs it is recommended that SSLAs be prepared for each facility. As each facility is required to submit a decommissioning and reclamation plan as part of the application process (AEP, 2018), plans should be fully cost estimated based on present day estimates. Industry standard methods for asset retirement obligation (ARO) and liability determination should be followed. AER Directive 001 (AER, 2023f) outlines requirements for SSLAs related to oil and gas facilities with a prescriptive process to be used as a guide or reference. In general, SSLAs should be completed by an independent third-party consultant experienced in liability estimating in general accordance with Association for Advancement of Cost Engineering (AACE) practices with a minimum Class 3 confidence level.

Due to changing market conditions, SSLAs should be reviewed and updated on a regular basis. Standard practice typically requires updated SSLAs be prepared every five years during a project lifespan or upon specific triggers such as prior to a change in ownership or material changes to the site or end-of-life closure requirements.

Salvage Value

The estimation of salvage value and to what extent it should be included within liability estimates varies significantly. Salvage value is increasingly significant when evaluating end-of-life costs for wind and solar facilities, where materials used have higher recoverable value than traditional thermal power plants. As summarized in prior sections, the inclusion of salvage value in decommissioning estimates for the purposes of establishing end-of-life security is variable by jurisdiction based on the high variability in market conditions over time. Where it is allowed to be included, the confidence level in associated estimates is generally reduced or additional documentation and justification is required. As with labour and equipment rates, the closer to the end of a project life cycle, confidence in accuracy of estimated salvage values increases.

Inflation/Time Value

Allowance for including inflationary factors in estimating future decommissioning and reclamation costs is also variable by jurisdiction. In general, liability estimates are completed based on work being undertaken at present with current labour, equipment, and material rates. In certain jurisdictions, the future cost at the anticipated end of life for the facility is calculated to include economic factors such as inflation. With the inherent challenges in accurately predicting changes in economic conditions, inflationary adjustments should be viewed with low confidence. Where inflation is allowed to be included in determination of expected end-of-life costs, a prescribed method of determination such as the trailing CPI is recommended to standardize approaches.

11.0 RECOMMENDATIONS AND FRAMEWORK FOR END-OF-LIFE SECURITY

After review and evaluation of liability management frameworks and end-of-life cycle security programs from various jurisdictions and other resource extraction or power generation industries, it is clear no single mechanism for end-of-life security can satisfy all requirements. As a result, a fully formed Liability Management Framework which incorporates multiple financial and non-financial mechanisms is recommended to be developed. Ecoventure's recommendations for components of the framework include:

- An Energy Installation approval, issued by the regulator, to act as an agreement between all parties involved including landowner, government agencies, regulator, and proponent. An approval to construct, operate and reclaim is an effective regulatory oversight tool to ensure an energy installation is implemented, managed, and reclaimed as per legislation and regulations. It is recommended to require end-of-life commitments at the outset of a project to act as an agreement to undertake end of life commitments, acceptable and agreed upon by landowners, regulators, and proponents. A decommissioning and reclamation plan should include, at a minimum, a commitment to reclaim to the equivalent land capability and any exceptions to removal of surface or subsurface infrastructure to be agreed upon by the landowner and proponent.
- As part of the application and approval process, a liability cost estimate to complete decommissioning and reclamation should be established. The decommissioning and reclamation plan should have two fully-costed components; interim reclamation to be completed after construction or installation to return as much of the disturbed land back to productive use, and end-of-life reclamation to return the entire site to equivalent land capability.
    - At a minimum, an updated decommissioning and reclamation plan and associated costs should be completed and agreed upon by all three parties every five years.
    - A current liability estimate should be requested upon any material change to site conditions or upon request for a change in licensee ownership.
    - A final decommissioning and reclamation plan or a plan to retrofit and extend the operational lifespan should be submitted within the 12th month prior to of the end of the project's operational lifespan.
    - In determination of end-of-life closure costs, expected salvage value should be calculated and a prescribed inflationary model should be

applied; however, both salvage values and inflation should be given reduced weighting in determination of associated security requirements.

- At each scheduled review period, as presented above, proof of acceptable pollution insurance as applicable, and current property tax and lease payments should be provided.
  - Pollution insurance requirements will vary by power generation type and age of facility for existing plants but is generally recommended to include site-specific pollution or environmental impairment liability insurance covering off-site pollutants.
- With initial reclamation and end-of-life costs determined based on the accepted decommissioning and reclamation plan, security requirements can be calculated. A phased approach to requiring security, at the pre-construction phase of the project and throughout the power generation timeline, would spread the obligation over the operational life of the facility.
  - Requiring upfront security commensurate with initial reclamation costs would cover costs associated with incomplete construction of facilities, or a proponent entering into bankruptcy during the construction phase. This would allow the land to be reclaimed if disturbed but not fully constructed while still reducing the burden on the proponent to not have to put up security for full end-of-life costs at the project outset. It is recommended that if interim reclamation targets are met, a percentage of the security could be returned.
  - Once initial reclamation has been completed and approved by the regulator and landowner, an accrued security program should be established to allow for security to be collected over the lifecycle of the project while operational. Regular SSLAs should be used to inform and update expected end-of-life costs and ensure sufficient security is being accrued to meet final closure costs.
  - The form in which to collect security should be further evaluated to ensure funds are protected in the event of bankruptcy while not overly burdening the proponent and deterring investment. A corporate financial test and consideration of a licensee’s overall portfolio of power generation assets in Alberta should be considered with potential to offset security guarantees.

- A corporate financial test and consideration of a licensee's record of regulatory compliance and financial obligations to landowners and municipalities should be conducted as part of any request for license transfer from one licensee to another.
- At this time, it is not recommended to establish an ongoing industry levy or association to manage facilities when a licensee is unable to meet end-of-life closure requirements. However, it is recommended that regulatory mechanisms be established to allow for collection of an industry levy in the event of underfunded liability resulting from bankruptcy of a proponent. If a facility requires decommissioning and/or reclamation, and collection of required funds from the licensee cannot be completed, a bid process should be conducted to establish a prime contractor to complete the required decommissioning and reclamation work and a one-time or short duration industry levy should be raised to fund required closure work.

12.0 QUALIFICATIONS OF THE PROJECT TEAM

A summary of qualifications of the project team and their role in preparation of the report is presented in Table 12-1, below. Complete curriculum vitas (CVs) are included in Appendix D.

Table 12-1 Summary of project team roles and qualifications.

Brett Nichols, B.Sc., P.Eng. **Project Director**	Mr. Nichols is a Senior Professional Engineer and President and Chief Executive Officer (CEO) of Ecoventure. He is experienced in executing and managing liability and acquisition assessments, Risk Management Plans, Environmental Site Assessments (ESAs), and soil and groundwater monitoring and remediation programs throughout Western Canada. Mr. Nichols has led numerous multi-disciplinary liability assessments, site-specific risk assessments, risk management plans, and environmental management programs with liabilities more than $500MM. With over 15 years of experience in environmental management, Mr. Nichols employs his experience in environmental and business management to work closely with clients and stakeholders to effectively manage programs and budgets with a specific focus in applying risk-based analysis to liability reduction. Brett excels in working with a wide range of federal (Department of National Defence, Parks Canada), provincial (Alberta Transportation and Alberta Utility Commission), municipal (City of Edmonton and Regional Municipality of Wood Buffalo) government agencies, First Nations, private industry, and non-governmental stakeholders.
Margo Metcalfe, B.Sc., P.Ag. **Project Lead**	Ms. Metcalfe is a Senior Professional Agrologist with over 20 years experience in Western and Northern Canada in oil and gas, power generation and distribution, commercial, and industrial industries leading assessment, remediation, and decommissioning/reclamation programs. Her work experience has included Regulatory oversight of energy development and closure projects, provided expert scientific and technical advice on complex environmental issues and project/portfolio management of complex programs from scope development to closure. Ms.Metcalfe has successfully overseen and managed projects for monitoring and closure of electrical generation, distribution and transmission facilities in Alberta and British Columbia as well as working for the Alberta Energy

	Regulator as a senior specialist in the large facility decommissioning, closure, and liability management division.
Carlos Arregoces M.Sc., P.Ag. **Senior Project Support**	Mr. Arregoces has over 20 years of experience in environmental management in Western Canada. He has extensive experience working with regulatory agencies, industry personnel, agricultural landowners, and stakeholders for all aspects of pre-disturbance planning and assessment, soil classification, inventories, mapping and evaluations, soils research, baseline surveys and environmental impact assessment, conservation and reclamation plan development, biophysical assessments, decommissioning and reclamation program development and liability management, detailed site assessments, reclamation certificate application process, among other performances related to environmental services. Mr. Arregoces has extensive experience in soil and land capability classification including having performed land irrigation classification of an estimated 50,000 acres throughout Alberta.
Chris Newton, M.Sc., P.Biol., RPBio. **Senior Project Support**	Mr. Newton has over 15 years' experience in the environmental management field and is currently Manager of the Conservation and Reclamation group with Ecoventure Inc. Mr. Newton currently works on a variety of projects ranging from wetland and biophysical assessments, environmental pre-planning, Phase 1 and 2 ESAs, reclamation management and detailed site assessments throughout Western Canada. Mr. Newton also has experience with wildlife, vegetation and wetland assessments, and environmental monitoring of seismic and pipeline projects.
Rachel Yee, M.Sc., P.Biol. **Project Support**	Ms. Yee is a Professional Biologist with over 4 years' experience in reclamation programs and environmental management. Ms. Yee's experience includes Phase 1, 2 and 3 ESA programs, detailed site assessments, reclamation certificate applications, and acquisition assessments throughout Western Canada for various oil and gas, commercial and industrial operations. Additionally, Ms. Yee manages multiple reclamation and programs and portfolios.

13.0 LIMITATIONS

This report is an instrument of service of Ecoventure Inc. The report has been prepared for the use of Alberta Utilities Commission for the specific application to the Power Generation Inquiry including public distribution as part of inquiry proceedings. The report reflects the professional opinion of Ecoventure based on information provided to it by Alberta Utilities Commission and otherwise available at the time of writing. This report is not to be reproduced or used for any purpose other than the context of the inquiry without the prior written consent of Ecoventure. Ecoventure makes no other warranty, expressed or implied, and will not assume or otherwise accept responsibility or liability for losses incurred because of the circulation, publication, reproduction, use of or reliance on this report contrary to the provisions discussed in this paragraph.

14.0 REFERENCES

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15.0 CLOSURE

Ecoventure would like to thank Alberta Utilities Commission for the opportunity to work on this project and trusts that the present report satisfies your immediate needs.

Sincerely,

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APPENDIX A
Summary of End-Of-Life Security Mechanisms

APPENDIX A: Summary of End-of-Life Security Mechanisms

Mechanism	Type	Description	Examples/Jurisdictions	Pros	Cons	Comments
Cash	Financial	Cash, in the amount of the estimated decommissioning costs can be set aside and utilized once decommissioning activities commence (Department of Energy & Climate Change, 2023).	BC and Ontario - Renewables Sector; United States - BLM; United Kingdom; France	Firmest form of security as held by regulator or landowner until decommissioning commences. If licensee goes bankrupt, cash is available to fund decommissioning activities.	Requires up front cash payment by licensee increasing capital cost of development, could deter investment and slow development. Cash required at project development may not be sufficient to fund decommissioning at project closure. Need to regularly review end of life costs and adjust security amount based on current estimates. Who to hold cash and how will it be invested to ensure sufficient funds available.	Not typically feasible from a licensee standpoint, may deter investment
Decommissioning Provisions in Land-Lease Agreements	Financial or Non-Financial	Within the land lease agreement between the licensee and the landowner, decommissioning provisions can be added based on the preferences of the two parties. The clause could include complete removal of the equipment and reclamation of land back to equivalent land capability, or could include a buy out option for the landowner should the landowner wish to keep the equipment (NYSERDA, 2023).	All jurisdictions reviewed	Direct agreement between licensee and landowner. Allows for flexibility and agreement to suit landowners requirements	Potential for unfair agreements between licensees and landowners. Potential for landowners to be responsible for reclamation if agreements aren't upheld. Sale or transfer of land or leases can result in challenges with agreements previously negotiated.	Could be a component of agreements in Alberta but likely needs to be backstopped by regulatory requirements
Decommissioning Trusts	Financial	Trust funds can be established specifically for decommissioning. Assets sufficient to cover the estimated cost is transferred to a trust that is held and administered by a financial institution (NYSERDA, 2023; Cox, 2022). If the value of the trust exceeds the decommissioning costs, excess funds will be released back to the licensee (Cox, 2022).	United States - California, Virginia; Australia; United Kingdom (Nuclear Liabilities Fund)	Firm security held until decommissioning commences. Full security is held from the project outset in the event of bankruptcy during the project lifecycle.	Requires up front investment by licensee increasing capital cost of development, could deter investment and slow development. Trust amount required at project development may not be sufficient to fund decommissioning at project closure. Need to regularly review end of life costs and adjust security amount based on current estimates. Potential legal challenges in the event of bankruptcy.	Setup and administration of trust can vary with requirements to be laid out in regulations. Needs to be protected from claim by other security holders in the event of bankruptcy.
Escrow Accounts	Financial	This account operates by the licensee making payments to an account at a federally insured financial institution. Scheduled payments can be made during the life cycle of the project until the fund reaches the estimated cost of decommissioning, rather than an upfront payment (NYSERDA, 2023; Cox, 2022).	United States - North Dakota, Virginia; Scotland	Allows the licensee to spread out payments and accrue funds during lifecycle of the project. Operations can fund payments instead of requiring full outlay of capital up front.	Bankruptcy of licensee during construction or prior to full decommissioning payments results in underfunded liability. Need to regularly review end of life costs and adjust security amount based on current estimates. Potential legal challenges in the event of bankruptcy.	Setup and administration of accounts can vary with requirements to be laid out in regulations. Needs to be protected from claim by other security holders in the event of bankruptcy.
Surety Bonds	Financial	Surety bonds are legally binding contracts typically issued by the government or financial institutions (the surety) indicating they will assume responsibility should the principal (the licensee) fail to perform their obligations. This protects the oblige (the third party) from assuming costs. The bond required is usually based on both the cost of decommissioning and reclamation. Changes In end-of-life costs would result in a change in the bond (NYSERDA, 2023). A performance bond is a type of surety bond where the surety requires security that a task is completed in a satisfactory manner. Funds may be paid out to a standby trust fund or to hire a contractor to complete decommissioning (Cox, 2022). A decommissioning bond, which is more specific to the decommissioning and reclamation processes, is another type of surety bond that guarantees the proper removal of equipment.	BC and Ontario - Renewables Sector; United States - BLM, Texas, California, North Dakota, Washington; Australia; United Kingdom; Scotland	Contractual agreement to protect landowner from end-of-life costs. Multiple structures available, can be tailored to project requirements.	Requires backstopper/surety entity in the event licensee can't fulfil obligations. Need to regularly review end of life costs and adjust bond amount based on current estimates. Potential legal challenges in the event of bankruptcy.	Setup and administration of bonds can vary with requirements to be laid out in regulations. Needs to be protected from claim by other security holders in the event of bankruptcy.
Letters of Credit	Financial	Letters of credit can be issued by a financial institution as an assurance to a beneficiary (government entity or landowner) that they will receive payment up to a certain amount should the licensee fail to decommission and reclaim a site. The letter will state the conditions for payment, supporting documentation and an expiration date (NYSERDA, 2023). In some cases, irrevocable letters of credit can be required, which means the financial institution can alter the payout amount only with the consent of the bank, locality, and licensee (Cox, 2022).	BC and Ontario - Renewables Sector; United States - BLM, Texas, California, New York (solar), Virgina; United Kingdom; Scotland	Financial security held until decommissioning commences. Full security is held from the project outset in the event of bankruptcy during the project lifecycle. Less up front costs to licensees than cash trust funds.	Increases up front capital requirements, could deter investment and slow development. Trust amount required at project development may not be sufficient to fund decommissioning at project closure. Need to regularly review end of life costs and adjust security amount based on current estimates. Potential legal challenges in the event of bankruptcy.	Needs to be protected from claim by other security holders in the event of bankruptcy.
Early/Mid-Life and Continuous Accrual Decommissioning Funds	Financial	A fund that accrues in the early and mid-life stages of operations can be set up given enough is projected to be funded by the facility's end of life. Earlier payments reduce the risk to the governing body and liability of the facility (Department of Energy & Climate Change, 2023). In the event the licensee defuncts, the governing body will need to ensure adequate funds are available. This can be done through a joint trust arrangement.	United Kingdom	Collection of a certain proportion of funds up front provides some certainty while not overly burdening licensee. Allows the licensee to spread out payments and accrue funds during lifecycle of the project. Operations can fund payments instead of requiring full outlay of capital up front.	Bankruptcy of licensee during construction or prior to full decommissioning payments results in underfunded liability. Need to regularly review end of life costs and adjust security amount based on current estimates. Depending on fund setup, can be less secure than other forms with potential legal challenges in the event of bankruptcy.	Structure and setup of fund to ensure adequate funds are collected and protected in the event of bankruptcy required.
Insurance	Financial	Insurer is paid the net present day value of the expected decommissioning liability. The insurer can only cancel the policy if the licensee does not pay premiums (Cox, 2022).	United States - BLM, Virginia	Reduces up front cost to licensee and allows insurance premiums to be part of operational costs during project lifecycle. Third party insurer provides security.	Insurance policy requirements and premium payments need to be met to trigger payout. Need to insure decommissioning costs can be covered by available proceeds throughout project lifecycle.	
Parent Guarantee	Financial	Parent company of the licensee proves financial solvency and agrees to pay decommissioning obligations (Cox, 2022).	United States - Texas, California, North Dakota, Virginia	Reduces up front cost to licensee and allows for favourable corporate structures to be established to spur development.	Exposed to risk based on strength of parent company. Subject to change in the event of sale of subsidiaries.	Generally not an acceptable form of security in other jurisdictions

APPENDIX A: Summary of End-of-Life Security Mechanisms

Mechanism	Type	Description	Examples/Jurisdictions	Pros	Cons	Comments
Abandonment and Removal Clause	Non-Financial	Clauses can be included in the local bylaws to mandate removal of equipment upon abandonment or face civil penalties, fines and/or imposing a lien on the property to recover costs. Within these clauses, the period of abandonment before enforcement is taken should be defined (NYSERDA, 2023).	United States - New York, Virginia	No up front costs to licensees. Clauses can be flexible and tailored to specific project and landowner requests.	No financial security held to ensure licensees meet obligations under the clauses. Risk of liability being transferred to government or landowner in the event of bankruptcy.	
Special Permit Application	Non-Financial	Similar to including abandonment and removal clauses in local bylaws, it can be mandated to include decommissioning plans as part of the permit approval process. This allows the local government to put a lien on the property to assist with the cost of decommissioning and reclamation (NYSERDA, 2023).	United States - New York, Virginia	No up front costs to licensees. Permits can be flexible and tailored to specific project and landowner requests. Allows for security to be held as lien on property where licensee owns the land being constructed on.	No financial security held to ensure licensees meet obligations under the clauses. Risk of liability being transferred to government or landowner in the event of bankruptcy where property value does not exceed decommissioning costs. Limited effectiveness when licensee does not own property.	
Temporary Variance/Special Permit Process	Non-Financial	Temporary variance/special permits acts in a manner that allows the local government to re-licence the specified area of land for the purpose of the energy facility. The permit would have a specific term that covers the life span of the facility, and if it is not renewed, the site would no longer be in compliance with local zoning regulations, in which case the local government could enforce removal of the facility (NYSERDA, 2023).	United States - New York, Virginia, Hawaii	No up front costs to licensees. Permits can be flexible and tailored to specific project and landowner requests. Compliance enforcement measures used to ensure timely decommissioning at end of life.	No financial security held to ensure licensees meet obligations under the clauses. Risk of liability being transferred to government or landowner in the event of bankruptcy. Local governments have limited compliance enforcement measures available.	
Corporate Financial Test	Non-Financial	Licensee self-insures the cost of decommissioning by providing a large and stable net worth. In this case, security is not posted (Cox, 2022).	AER Licensee Capability Assessment	No up front costs to licensees if they meet corporate financial threshholds. Reduces potential for high risk licensees. Can request security from licensees who do not meet threshholds.	No financial security held until licensee falls below specific threshhold at which point they may be unable to provide security. Risk of licensee selling project to less stable entity if not subject to regualtory review.	
Industry Levy	Financial	A levy is issued to all licensees in the industry, typically based on their proportion of the overall industry. Funds collected are utilized to cover the costs of underfunded liability in the event a licensee does not meet their decommissioing obligations. Can be an ongoing levy/association or one-time or limited timeframe levies.	Alberta Orphan Fund Levy/Orphan Well Association; Saskatchewan Orphan Fund Levy; Australia Laminaria and Corallina Decommissioning Cost Recovery Levy; Australia (offshore wind); Sweden (nuclear waste fee)	Reduced up front costs to licensees, can spread out over operational lifespan. Costs are born by industry and not government or landowners.	Requires an organization to collect, administer, and manage collected funds as well as complete required decommissioing work. Need to ensure industry levy keeps pace with required funds. Places cost burden on other licensees and does not align with 'polluter pay' principle. Assumes some licensees will default on responsibilities.	

Notes:

- References included in body of report

APPENDIX B:
Decommissioning Cost Estimates

Appendix B: Example Decommissioning Plans - Natural Gas and Coal

Site	Location	Year Plan Created	Estimate Type	Nameplate Capacity (MW)	Area (ha)	MW/ha - Production	Estimated Decommissioning Cost	Decommissioning Cost/MW	Salvage	Net Decommissioning Cost	Estimated Reclamation Cost	Estimated Reclamation Cost/ha	Estimate Details	Financial Assurance	Reference
Rainbow Lake Generating System	Rainbow Lake, Alberta, Canada	2006	Application	97	Not specified	---	$4,850,000	$50,000	Not specified	$4,850,000	$370,000	---	Decommissioning estimate is for decommissioning Units 1, 2, and 3. Reclamation cost estimate is for remediation only. Costs for the other components of reclamation were not available.	Not specified	Alberta Power (2000) Ltd., 2006
Hazelwood Power Station	Victoria, Australia	2017	Post-decommissioning Estimate	1,600	3,554	0.45	$734,000,000	$458,750	Not specified	$734,000,000	Reclamation cost is not available	---	It could not be determined if the estimated cost includes reclamation.	Not specified	Asher, 2017
Lidell Power Station	New South Wales, Australia	2023	Post-decommissioning Estimate	2,000	Not specified	---	$687,000,000	$343,500	Not specified	$687,000,000	Reclamation cost is not available	---	AGL Energy reportedly set aside $1.5 billion for decommissioning of four power stations. It could not be determined if the estimated cost includes reclamation.	Not specified	AGL, 2022; Hannam, 2023
Colstrip Power Plant (Units 1-4)	Colstrip, Montana, United States	2019/2020	Draft Report	2,094	Not specified	---	$49,700,000 for Units 1 & 2	$80,945	Not specified	Not specified	$85 to $142.7 million		Noted that decommissioning cost for typical 500 MW coal-fired power plant ranges from $5 to $15 million. Decommissioning cost is estimated to be approximately $21,000 to $466,000 per MW. Estimated reclamation cost provided is for remediation of Colstrip Units 1 & 2. Estimated overall decommissioning and reclamation cost of Units 1 to 4 is $400 to $700 million.	Financial assurance provided for remediation and closure; total financial assurance provided as of July 1, 2020 was $243.1 million	LEPO, 2019; Legislative Services Division, 2020

Notes:

- Full references included in body of report
- All costs expressed in currency of the associated locality unless otherwise specified

Example Decommissioning Plans - Solar

Site	Location	Year Plan Created	Estimate Type	Nameplate Capacity (MW)	Project Area (ha)	Permanent Disturbed Area (ha)	MW/ha - Production	Estimated Decommissioning Cost	Decommissioning Cost/MW	Salvage	Net Decommissioning Cost	Estimated Reclamation Cost	Estimated Reclamation Cost/ha	Estimate Details	Financial Assurance	Reference
Travers Solar Project	Vulcan County, Alberta, Canada	2019	Application	465	1,614	Not specified	0.29	Not specified	---	Not specified	Not specified	Not specified	---	---	Not specified	Greengate, 2019
Big Sky Solar Project	Acadia, Alberta	2023	Application	140	420.5	420.5	0.33	Not specified	---	Not specified	Not specified	Not specified	---	Decommissioning and reclamation activities described in plan, however, cost estimate was not available.	Not specified	Big Sky Solar LP., 2023; WSP Golder, 2022
White Tail Solar	Washtenaw County, Michigan, United States	2020	Proponent Application Estimate	72.6	269	190	0.27	$4,145,489	$57,100	$1,952,365	$2,785,921	$592,797	$3,120	Reclamation costs include access road excavation and removal, and topsoil replacement and rehabilitation of site.	Financial assurance was calculated from the decommsissioning funding risk times the net estimated cost. Security will be provided in a decommissioning agreement.	Stantec, 2020
Three Rivers Solar Power	Hancock County, Maine, United States	2019	Proponent Application Estimate	100	451	188	0.22	$2,205,450	$22,055	Not specified	$2,230,450	$25,000	$133	Reclamation costs include grading and seeding disturbed areas.	Performance bond, surety bond, or letter of credit must be provided prior to construction. Costs are to be re-assessed every 5 years and financial assurance updated accordingly.	Acheron Engineering Services, 2019
Solar Energy Generating System (SEGS) III-VII (87-AFC-01C)	San Bernadino County, California, United States	2021	Proponent Application Estimate	150	405	Not specified	---	Not specified	---	Not specified	Not specified	---	---	Decommissioning plan does not include cost estimates.	Not specified	Nextera, 2021
Gemini Solar Project	Clark County, Nevada, United States	2019	Proponent Application Estimate	690	2,873	Not specified	---	Not specified	---	Not specified	Not specified	---	---	Decommissioning and reclamation plan indicates materials can be salvaged to offset costs, however, decommissioning and reclamation cost estimates are not provided. Final Closure Plan to be prepared prior to facility closure.	Performance bond, issued by insurance company or financial institution prior to the start of construction, and to be structured so funds would be returned upon completion of decommissioning and reclamation.	EPD Solutions Inc., 2019

Notes:

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Example Decommissioning Plans - Wind

Site	Location	Year Plan Created	Estimate Type	Nameplate Capacity (MW)	Project Area (ha)	Permanent Distrubed Area (ha)	MW/ha - Production	# of turbines	MW/Turbine	Estimated Decommissioning Cost	Estimated Salvage	Net Decommissioning Cost	Estimated Reclamation Cost	Estimated Reclamation Cost/Turbine	Estimate Details	Financial Assurance	Reference
Buffalo Ridge Wind Energy Facility	Lincoln and Pipestone County, Minnesota, United States	2020	Proponent Application Estimate	109	7,100	Not specified	0.02	40	2.725	$4,290,718	Not specified	$4,290,718	$405,000	$10,125	Reclamation costs include reclamation of access roads, substation and 0.5 acres/turbine site.	Performance bonds for the total amount of infrastructure.	Buffalo Ridge Wind, LLC, 2020
Buffalo Ridge II Wind Energy Facility	Brookings and Deuel County, South Dakota, United States	2021	Proponent Application Estimate	210	49,000	Not specified	0.00	105	2	$16,409,462	$7,063,339	$9,346,123	$1,524,400	$14,518	Decommissioning plan indicates the decommissioning cost per tubine is $103,529. Reclamation cost estimate includes recalmation of roads, turbine sitse and aux sites.	Specific mechanism not specified, but indicates that decommissioning funds will be available.	BARR, 2021a
PraireWinds SD1 (Crow Lake Wind Project)	Jerauld, Brule and Aurora County, South Dakota, United States	2021	Proponent Application Estimate	162	14,568	Not specified	0.01	108	1.5	$18,615,142	$5,953,251	$12,661,891	$2,450,341	$22,688	Decommissioning plan indicates the decommissioning cost per tubine is $139,928. Reclamation cost estimate includes recalmation of roads, turbine sitse and aux sites.	Specific mechanism not specified, but indicates that decommissioning funds will be available.	BARR, 2021b
Suncor Energy Adelaide Wind Power Project	Strathroy, Ontario, Canada	2012	Specifications Report	40	Not specified	Not specified	Cannot be calculated	18	2.2	Not specified	Not specified	Not specified	Not specified	---	Report provides the specifications of the wind turbines.	Not specified	Stantec, 2012
Dakota Range III Wind Project	South Dakota, United States	2018	Proponent Application Estimate	151.2	7,689	Not specified	0.01966446	36	4.2	$11,214,900	$7,563,900	$3,651,000	Reclamation costs are included in decommissioning costs	---	Decommissioning cost is based on no resale of components. Decommissioning cost per turbine is $101,420. Net estimated decommissioning cost for 2050 based on 2% inflation is $183,710 per turbine and $6,613,280 for entire project.	Not specified	DNV GL, 2018
										$11,214,900	$9,306,900	$1,908,000	Reclamation costs are included in decommissioning costs	---	Decommissioning cost is based on partial resale of components. Decommissioning cost per turbine is $53,000. Net estimated decommissioning cost for 2050 based on 2% inflation is $96,000 per turbine and $3,456,080 for entire project.		
Rail Tie Wind Project	Albany County, Wyoming, United States	2021	Proponent Application Estimate	504	26,000	Not specified	0.01938462	120	4.2	$12,588,883	$8,665,802	$3,923,081	$4,970,938	$41,424	Estimated decommissioning costs includes the removal of infrastrcuture. Estimated reclamation costs include the hauling and disposal of gravel, culverts and low water crossing materials, decompaction, grading, erosion and sediment control, re-vegetation and toposil additions. Estimated decommissioning cost per turbine (minus salvage and land sales) is $74,033.	Financial assurance is based soley on direct and indirect costs of decommissioning (salvage and land sale information is provided, but not included)	Westwood, 2021

Palmer's Creek Wind Farm	Chippewa County, Minnesota, United States	2017	Proponent Application Estimate	44.6	2,500	5	9.10204082	18	2.48	$7,385,822	$445,500	$6,940,322	Reclamation costs are included in decommissioning costs	---	Estiamted decommissioning cost includes removal of aboveground and below ground infrastructure and topsoil restoration. Separate decommissioning and reclamation costs were not available.	Not specified	Wenck Associates, 2017
Paintearth Wind Power Project	Stettler, Alberta	2020	Application	151.2	Not specified	Not specified	---	42	3.6	Not specified	Not specified	Not specified	Not specified	---	A decommissioning plan and estimated reclamation costs were not available for review.	Not specified	AUC, 2020

Notes:

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APPENDIX C
Framework of End-of-Life Costs in Alberta

APPENDIX C: Framework of End-of-Life Costs in Alberta

Power Generation Type	Estimated Decommissioning Cost $/MW	Land Use	Estimated Reclamation Cost/ha	Estimated Decommissioning Cost/Turbine	Estimated Reclamation Cost/Turbine	Comments
Coal	$75,000	Cultivated	$43,800	N/A	N/A	
		Forested	$59,000		N/A	
		Grassland	$55,000		N/A	
		Industrial	$25,000		N/A	
Natural Gas	$35,000	Cultivated	$43,800	N/A	N/A	
		Forested	$59,000		N/A	
		Grassland	$55,000		N/A	
		Industrial	$25,000		N/A	
Wind	$95,000	Cultivated	$43,800	$185,000	$43,800	
		Forested	$59,000		$59,000	
		Grassland	$55,000		$55,000	
		Industrial	$25,000		$25,000	
Solar	$70,000	Cultivated	$43,800	N/A	N/A	
		Forested	$59,000		N/A	
		Grassland	$55,000		N/A	
		Industrial	$25,000		N/A	

Notes:

- See body of report for decommissioning and reclamation definitions
- All costs presented as average estimates in $CAD

N/A - Not Applicable

APPENDIX D
Curriculum Vitas

Brett Nichols, P.Eng

PRESIDENT AND CEO

SENIOR PROFESSIONAL ENGINEER

EDUCATION

B.Sc. Environmental Engineering, University of Alberta

PROFESSIONAL REGISTRATIONS

Professional Engineer, Association of Professional Engineers and Geoscientists of Alberta and Engineers and Geoscientists BC

CERTIFICATES

Project Management Fundamentals
Spill Responder
Tier 2 Assessment

PROFESSIONAL HISTORY

Ecoventure Inc.

PRESIDENT AND CEO, 2015-PRESENT
SENIOR MANAGER, OPERATIONS, 2010-2015
MANAGER, CORPORATE AND REGULATORY COMPLIANCE, 2009-2010
PROJECT MANAGER, ASSESSMENT AND REMEDIATION, 2007-2009

Shelby Engineering Ltd.

CIVIL ENGINEERING TECHNICIAN, 2006-2007

HIGHLIGHTS OF EXPERIENCE

- Client and stakeholder liaison
- Project/program management
- Business management
- Senior review
- Tier 2/SST
- Risk assessment and risk management plans
- Environmental due diligence/acquisitions and divestitures
- Site Specific Liability Assessment
- Facility abandonment and decommissioning estimates
- Phase 1/2/3 ESAs and site investigations
- Groundwater monitoring/assessments
- EPEA soil and groundwater monitoring proposals/programs
- Spill response and incident Command
- Ecological Network Reports and Site Location Studies

Mr. Nichols is a Senior Professional Engineer and President and Chief Executive Officer (CEO) of Ecoventure. During his tenure at Ecoventure, Mr. Nichols has gained experience executing and managing liability and acquisition assessments, Risk Management Plans, Phase 1, Phase 2, and Environmental Site Assessments (ESAs), and soil and groundwater monitoring and remediation programs throughout Western Canada. Mr. Nichols has led numerous multi-disciplinary liability assessments, site-specific risk assessments, risk management plans, and environmental management programs with liabilities more than $500MM. With over 15 years of experience in environmental management, Mr. Nichols employs his experience in environmental and business management to work closely with clients and stakeholders to effectively manage programs and budgets with a specific focus in applying risk-based analysis to liability reduction. Brett excels in working with a wide range of federal (Department of National Defence, Parks Canada), provincial (Alberta Transportation and Alberta Utility Commission), municipal (City of Edmonton and Regional Municipality of Wood Buffalo) government agencies and private industry to provide senior program management, expert review and technical sign off, and risk assessment/management expertise.

KEY PROJECT EXPERIENCE

Alberta Utility Commission

CONFIDENTIAL, 2019-PRESENT

Senior liability assessor for evaluation of appropriate demolition, remediation, and reclamation costs associated with a coal-fired power plant and mine site. Contracted to act as client representative for review of funding application from proponent, preparation of supplemental information requests, supporting legal arguments during adjudication hearing, and assist in determination of appropriate funding agreement. Two scenarios, immediate partial and postponed complete decommissioning evaluated with consideration for impacts on site operations if immediately decommissioned and time-value and economic impacts of changing government and environmental regulations on the postponement scenario.

Gibson Energy Partnership

EDMONTON, ALBERTA, 2018-PRESENT

Senior technical review for detailed risk analysis and risk management plan for on- and off-site MTBE concentrations. Site-specific, risk-based guidelines and management plan developed for soil vapour inhalation, domestic use aquifer, and freshwater aquatic life exposure pathways. A 3-D conceptual site model was developed incorporating proximity to the North Saskatchewan River and an unnamed tributary as well as a downgradient rail line and former landfill site (current park) within the MTBE plume. Literature review and a predictive MTBE fate and transport model were iteratively compared to observed contaminant migration to refine a site-specific model with incorporation of movement through unlined and unconsolidated historic landfill cells.

NuVista Energy

HAY-ZAMA LAKES, ALBERTA, 2007-2019

Senior project manager and risk assessor for site-specific risk assessment and development of comprehensive RAP, long term monitoring program, and risk management plan for 1960s era oil battery within a provincial park and internationally recognized wetland complex.

Completed data gap analysis, developed, and implemented soil and groundwater sampling plan and aquatics/benthic invertebrate assessment. Completed DUA exclusion, detailed risk analysis for fate, transport, and receptors for chlorides, metals, glycols, methanol, PAHs, and PHCs. Completed remedial measures to control exposure pathways on-site and to stabilize impacts for long term management.

LIABILITY ASSESSMENT AND MANAGEMENT

Athabasca Oil Corp., Site-Specific Liability Assessments, 2021-2022

NORTHEAST, ALBERTA

Program manager and senior liability assessor for SSLAs of all company facilities meeting regulatory reporting requirements including multiple large SAGD facilities, legacy gas plants, and an aerodrome. Complete evaluation of all decommissioning/abandonment, remediation, and reclamation costs with reporting for internal ARO and external liability estimation according to AER directives.

Crescent Point Energy Corp., Multiple Acquisitions, 2012 to Present

THROUGHOUT AB, SK, MB, BC, ND

Client liaison, program manager and senior liability assessor for environmental due diligence and liability evaluation for numerous acquisitions throughout western Canada. Review of background information and divesting company files, completion of site inspections, and reporting of abandonment/decommissioning, remediation, and reclamation liability estimates.

Recent projects include Spartan Delta (2023), Paramount (2022), Shell Canada (2021), Hammerhead (2023).

Canadian Natural Resources Ltd., Decommissioning Liability Assessments, 2022

THROUGHOUT ALBERTA

Program manager and senior liability assessor for evaluation of suspension, abandonment, and decommissioning estimates for six large facilities ranging from gas plants to heavy oil batteries. Development of liability estimates and preparation of all associated regulatory submissions according to AER requirements.

LIABILITY ASSESSMENT AND MANAGEMENT (CONT'D)

Confidential Client, Expert Review, 2018-2020

MANITOBA

Senior reviewer for expert opinion and rebuttal reports associated with legal proceedings for a pipeline failure and associated spill response and remediation. Review and professional sign-off on two expert opinion reports, for mediation and subsequent trial-ready report, and one rebuttal report evaluating the timeframe the spill began, the date a prudent operator would have been aware of the spill, the steps taken when aware of the spill, determination of reasonable project costs and comparison of actions of the pipeline company with those of a reasonably prudent operator.

Confidential Client

ALBERTA

Senior liability assessor for transactional due diligence for purchase/sale of a polystyrene plant in central Alberta. Review of historical reports and development of remedial action plans and associated liability estimates for cleanup of styrene contamination in soil and groundwater.

Paramount Resources Ltd., Acquisition of Apache Canada, 2017

NW AB, NE BC, YK, NT

Senior project manager and liability assessor for evaluation of all Apache assets considered for purchase in NW Alberta, NE British Columbia, Yukon, and Northwest Territories. Coordinate review of all publicly available information, divesting company environmental files, and disclosed liabilities. Prepared list of sites recommended for inspection and completed site visits on facilities including multiple legacy oilfields in the vicinity of the Liard River within NE BC, YK, and NWT. Detailed site inspection and evaluation of costs associated with abandonment, decommissioning, remediation, and reclamation of the Kotaneelee oil field, including multiple well sites and pipelines, a central processing facility, and Liard River barge loading/unloading locations.

Assignation of liability and Asset Retirement Obligation (ARO) costs for abandonment, decommissioning, remediation, and reclamation of all assets. Presentation of findings to purchasing and divesting companies and additional stakeholders.

Gibson Energy, Fractionation Plant and Oil Terminal, 2017and 2022

HARDISTY, ALBERTA

Senior liability assessor for Site Specific Liability Assessment of fractionation plant and oil terminal including review of background information, site inspection, and development of decommissioning/ abandonment, reclamation, and remediation cost estimates according to AER Directive 001 requirements. Update estimates in 2022 after facility expansion and as per AER reporting requirements.

Crescent Point Energy Corp., Corporate Acquisition – Legacy Oil & Gas, 2015

ALBERTA, SASKATCHEWAN, B.C., MANITOBA, NORTH DAKOTA

Client liaison, program manager, and senior liability assessor for environmental due diligence assessments in acquisitions for Crescent Point from 2012 to present. Over 10 acquisition assessments have been completed which resulted in the successful purchase of over half the asset packages reviewed. Post purchase applicable sites have been entered into the reclamation program.

Corporate acquisition of Legacy Oil & Gas package entailed over 2000 properties for purchase. Designed project team, scope of work, review and analysis of all production and thousands of environmental and regulatory documents, coordination of site visits to high liability sites, including 3 days in the Turner Valley (TV) field, application of LLR within Alberta and Saskatchewan and review and application of interprovincial regulations. Review of TV field included liability assessment of all facilities, and high liability well sites, including historical facilities dating to the 1920s with minimal historical data, EPEA sites, assessment of water treatment plant, bio-pile remedial sites and corporate landfill, eroded historical pipeline resurfacing sites, sites located on waterbodies/rivers, sites affected by 2013 flood, contaminated sites discovered during urban development within the towns of TV, Black Diamond and Longview, GWM sites with anomalously large contaminant plumes, remediation sites, well sites residing on hill side slopes etc., Review of final acquisition spreadsheet and assessment of reclamation, remediation and immediate liability costs for all Legacy assets.

PROGRAM AND PROJECT MANAGEMENT

Alberta Transportation, 2018-2019

MULTIPLE LOCATIONS, ALBERTA

Client liaison and senior technical review for Baseline ESAs of 21 legacy highway maintenance yards include Phase 1 ESA, EM/ERT surveys, Phase 2 ESA, GWM, and reporting for each site. Worked with the Project Manager to oversee development of work plans, resourcing, execution of field work, and budget tracking. Senior technical review of associated reports. Program executed in a compressed timeline (4 months) and under budget.

Defence Construction Canada/Department of National Defence, Cold Lake Air Force Base and CFB Edmonton, 2009-2017

COLD LAKE AND EDMONTON, ALBERTA

Client liaison and senior program manager for environmental assessment, monitoring, and remediation activities at multiple active bases. Authorized/registered company security officer for applicable project scopes.

Applicable projects executed include groundwater monitoring and development of remedial options for active and inactive jet-refueling tank farms, distribution lines, and pumping stations at Cold Lake (active) and Edmonton (inactive) air bases. Soil and groundwater investigation of Building 174 at CFB Edmonton, a historic refueling/storage facility. Development and implementation of remedial action plan to allow for redevelopment at the site.

Senior technical review of soil and groundwater reports according to federal guidelines including completion of FCSAP and NCSCS data sheets.

Parks Canada, Mud Lake Abattoir and Landfill and Jasper Highway Maintenance Yard, 2017-2018

ELK ISLAND AND JASPER NATIONAL PARKS

Senior program manager and client liaison for Phase 2 ESA, groundwater monitoring, and preliminary quantitative human health and ecological risk assessment (PQHHERA) of the former Mud Lake abattoir (tannery) and landfill site located within Elk Island National Park. Development of remedial and risk management options and completion of associated FCSAP and NSCS data sheets.

Phase 2 ESA of highway maintenance yard located in Jasper National Park. Development of a conceptual site model and remedial options analysis.

Nuvista Energy Ltd., Multiple Well Sites and Facilities, 2011-2015

NEAR RAINBOW LAKE, ALBERTA

Senior project/program manager for abandonment, decommissioning, assessment, remediation, and reclamation of 49 well sites and facilities in a remote winter access area within a single winter season. Completion of 21 Phase 2 ESAs. Senior review of initial Phase 2 ESA results and coordinate remediation of 7 sites and Tier 2 and/or SST to address exceedances at 5 sites. All remediation and additional assessment executed within the same winter access period.

Over 4 similar winter programs, over 230 wellsites and facilities have been successfully cleaned up with over 180 reclamation certificates achieved to date and using risk-based justifications over 15,000 tonnes of soil were diverted from landfill.

Regional Municipality of Wood Buffalo, Janvier Site 18 Remediation, 2017

NEAR FORT MCMURRAY, ALBERTA

Senior project manager for remediation of a former dump site and nuisance ground managed by the municipality. Local, First Nations, contractors utilized throughout the project. As a result of strong project management, project was completed ahead of schedule and under budget.

Nuvista Energy Ltd., Hay-Zama Pipeline Break, 2015

HAY LAKE INDIAN RESERVE

Senior technical review and client liaison for spill response activities related to a >100 m^3 release of PHCs and produced water into a sensitive wetland ecosystem. Utilized Alberta and Federal (CCME) guidelines due to being located on a First Nations reserve and where possible established site-specific risk management guidelines to compare and manage site impacts.

Upon completion of delineation, source control, and wildlife mitigation measures, a recovery system and monitoring program was implemented. Local, First Nations, monitors were trained to complete routine monitoring including sample collection, field screening, and preparation for sample submission as well as maintaining the recovery system and wildlife control measures.

Enerplus Corporation, 2008-2012

NEAR TRUTCH, BC

Project manager for assessment and remediation of two historical soil treatment sites managed under the BC Ministry of Environment's (MoE) Contaminated Sites Regulation (CSR); one landfarm and one biopile site for treatment of historical drilling waste.
Completed preliminary site investigations of soil and groundwater at each site along with barite site determination. Sites are located in remote, mountainous terrain accessible by ATV or constructed ice roads limiting remedial options. Developed and executed remedial action plans and successfully removed MoE contaminated sites designation.

Perpetual Energy Inc., 2013-2015

NEAR FORT NELSON, BC

Client liaison and senior program manager for soil and groundwater investigation of a former well site and compressor facility in a remote area near the Yukon border. Site accessible only by ATV or lengthy constructed ice road. After initial investigation, risk-based guidelines were developed and a remedial action plan was executed to leave the maximum amount of material on site with risk justifications due to significant logistical challenges accessing location. Successfully received regulatory approval for unique risk-based justifications.

Jubavi Investment Corp., 2008-2018

EDMONTON, ALBERTA

Project manager for Phase 1 ESA, Phase 2 ESA, and remediation of former gas station/welding shop, motel, and farmyard/residence located along a major transportation corridor. Responsible for coordinating all reporting and field work and prime contractor requirements for the Alberta Tank Site Remediation Program, City of Edmonton contracts and on street construction and maintenance (OSCAM) permits. Petroleum hydrocarbon impacted soil excavated and treated on site with risk management of off-site impacts through installation of a geomembrane on the property boundary and monitoring program implemented across three roadways/utility corridors. Monitored natural attenuation implemented for off-site plume.

REGULATORY MONITORING AND COMPLIANCE

ATCO Pipelines and Liquids – Legacy Well Site, 2016-2020

NEAR VERMILLION, AB

Senior technical review for conceptual site model and risk assessment for a 1940s era legacy well site. The project is managed by the Alberta Energy Regulator's (AER's) Contaminated Sites Policy Framework with remedial progress and monitoring requirements associated with the CSU file.

A review of historical soil and groundwater investigations and remedial activities was completed and supplemented through wetland classification, mapping, and bathometric surveys, surface water and sediment sampling, and detailed vegetation assessment. The site CSM was revised and observed and predicted fate and transport calculations were completed to evaluate the risk to receptors associated with a widespread off-site chloride plume. Based on the results of the risk assessment, a significantly reduced monitoring program will be implemented at the site.

C Group Energy Inc., Skaro Oil Battery and Injection Facility, 2007-Present

NEAR VEGREVILLE, ALBERTA

Senior program manager and liability assessor for regulatory CSU and deemed 'Potential Problem Site' by AER. The site is a 1960s era oil battery and produced water disposal site with multiple historical spills. Supervised completion of multiple geophysical investigations including EM 38/31 surveys, vertical conductivity profiling, and ERT to map salt plumes, track remedial progress of a groundwater recovery network installed by Ecoventure at the site and optimize recovery network operation.

Completed supplemental soil, groundwater, and surface water monitoring and updated Site-Specific Liability Assessment (SSLA) for the site. Corresponded with AER's Liability Management Group and based on the SSLA and justifications accepted by the regulator, the Problem Site designation was removed from the site.

Husky Oil Operations Ltd., Gas Processing Plant, 2007-2010

NEAR RAINBOW LAKE, ALBERTA

Responsible for preparation of Soil and Groundwater Monitoring and Management Proposals according to the *EPEA* Approval requirements for the facility. Correspond and liaise with applicable regulatory bodies regarding approval conditions and monitoring/management commitments.

Coordinate and supervise completion of soil and groundwater monitoring programs including all aspects of field work, sampling, laboratory analysis interpretation, and preparation of final reports. Develop and implement sampling program based on air dispersion modelling for airborne sulphur deposition. Preparation of Remedial Action Plans for various areas for the plant site as part of ongoing soil management program and coordinate preparation of a Risk Management Plan to address extreme acidic conditions surrounding and downgradient of the sulphur block on site.

RISK ASSESSMENT AND RISK MANAGEMENT PLANNING

Confidential Client, 2022 to Present

EDMONTON, ALBERTA

Senior technical support for site assessment and risk management plan development and implementation for a former sand and gravel pit (xx hectares) in response to an Enforcement Order issued by regulatory body. Site located beside a transportation utility corridor and a heavily industrialized area. Soil and groundwater assessment completed to identify any potential buried debris or waste material at the site and assess the quality of backfill/alternative reclamation material used. Challenges included adequately interpreting regulatory requirements and short timeline required to complete submissions. Clear and concise communication with governing regulatory body to ensure timelines and targets and acceptance of assessment and risk management plan required for acceptance of the RMP and removal of the enforcement order.

Carstar Collision – Gateway Boulevard, 2016-2017

EDMONTON, ALBERTA

Senior project manager for assessment of impacts to soil and groundwater related to historical activities at the location as well as adjacent former gas station and rail line. Developed and implemented a remedial action and risk management plan including selective excavation and disposal, Tier 2 guideline adjustment for DUA and soil vapour exposure pathways, engineered barrier installation on site boundary, and exposure control/risk management calculations to allow for refinancing and continued use of the property.

ATCO Pipelines and Liquids, 2016-2020

NEAR DRAYTON VALLEY, AB

Senior technical review for conceptual site model and risk assessment for an active compressor station. Project included evaluation of soil and groundwater data related to sterilants (bromacil and tebuthiuron) and PHC impacts and development of a CSM and site-specific guidelines. CSM and fate and transport models incorporated multiple preferential flow paths related to historical and newly installed pipelines through the impact zone and research of chemical properties and mobility of bromacil and tebuthiuron in the environment. Research included completion of bench scale testing of trap and treat remediation system for sterilant impacted groundwater and design of field scale treatment system. Successfully risk assessment resulted in significantly reduced regulatory monitoring requirements and remediation liability at the site.

ENVIRONMENTAL IMPACT ASSESSMENT

Consortium of Developers and City of Edmonton, 2011-2014

EDMONTON, ALBERTA

Project Manager for Ecological Network Reports (ENRs) for two proposed area structure plans (ASPs) within the City of Edmonton; Horse Hills and Riverview. Coordinate team for background information review, GIS mapping and analysis, field surveys, and development of proposed ecological networks for the two ASP areas encompassing over 4,000 ha of the City of Edmonton

Walton Development and Management LP., 2011-2017

EDMONTON, ALBERTA

Project Manager for Environmental Impact Assessment (EIA) and Site Location Study (SLS) for approval of three stormwater constructed wetlands and naturalized drainage channel. Project involved removal of two pre-existing drainage channels connecting a forest-wetland complex to Big Lake/Lois Hole Provincial Park and replacement with a centralized drainage channel tied into three stormwater facilities. Coordinated multi-discipline team and provided senior technical support for EIA/SLS reports and regulatory approval applications according to municipal river valley bylaw and provincial water act and public lands act. Collaborate and present to multiple stakeholders including municipal and provincial regulators, developers, and numerous NGOs including Big Lake Environmental Support Society (BLESS) and Sierra Group; received development support from both groups. Providing hearing support for public hearing and City Council debate, receiving council approval without amendments.

Margo Metcalfe, P.Ag.

PROFESSIONAL AGROLOGIST

MANAGER ASSESSMENT AND REMEDIATION – TECHNICAL LEAD

Ms. Metcalfe is a Senior Professional Agrologist with 20 years of experience in Western and Northern Canada in upstream, midstream, downstream, commercial, and industrial industries leading assessment, remediation, and reclamation programs. Her work experience has included Regulatory oversight of energy development and closure projects, providing expert scientific and technical advice on complex environmental issues and project/ portfolio management of complex programs from scope development to closure and post-mortem with liabilities up to $10MM. Ms. Metcalfe has successfully overseen and managed projects for electrical generation, distribution and transmission in Alberta and British Columbia, projects for downstream, pipeline, commercial, industrial and upstream facilities across Western and Northern Canada. Margo has technically reviewed all stages of environmental work from assessment reports to reclamation application including Phase 1, Phase 2 and Phase 3 Environmental Site Assessments (ESAs), risk assessments, risk management plans, regulatory soil and groundwater monitoring, and remedial and reclamation programs.

KEY PROJECT EXPERIENCE

ENVIRONMENTAL SITE ASSESSMENTS

Various Oil and Gas Operators

MULTIPLE LOCATIONS, ALBERTA

Technical review and regulatory acceptance of environmental site assessment reports for approximately 300+ surface oil and gas locations (wellsite, pipelines, batteries, facilities). As part of the remediation and contamination management team at the AER, routine work included reviewing environmental site assessment reports against criteria for regulatory acceptance, from both a technical and regulatory compliance perspective. Technical review and acceptance of appropriate guidelines, including SST, Tier 2 and site-specific risk assessment guidelines.

EDUCATION

B.Sc. Environmental and Conservation Sciences, University of Alberta

PROFESSIONAL REGISTRATIONS

Professional Agrologist, Alberta Institute of Agrologists

CERTIFICATES

Project Management Fundamentals
SST
Tier 2 Assessment

PROFESSIONAL HISTORY

Ecoventure Inc.
TECHNICAL LEAD - PRESENT

Chemistry Matters Inc.
SENIOR TECHNICAL SUPPORT, 2021-2022

Alberta Energy Regulator
SENIOR SPECIALIST, REMEDIATION AND CONTAMINATION, 2015-2021

WorleyParsons
PROJECT MANAGER / SENIOR ENVIRONMENTAL SCIENTIST, 2010-2015

SNC Lavalin Environment
PROJECT MANAGER, 2009-2010

Solstice Canada Corp
PROJECT MANAGER / ENVIRONMENTAL SCIENTIST, 2004-2009

Delnor Construction Ltd.
PROJECT MANAGEMENT ASSISTANT, 2001-2004

HIGHLIGHTS OF EXPERIENCE

- Project/program management
- Senior / technical review
- Tier 2/SST
- Risk assessment and risk management plans
- Regulatory oversight of Energy development and Closure Projects
- Environmental due diligence/acquisitions and divestitures
- Site Specific Liability Assessment
- Phase 1/2/3 ESAs and site investigations
- Groundwater monitoring/assessments
- Specialization in regulating large facility decommissioning
- Spill response and incident Command

ENVIRONMENTAL SITE ASSESSMENTS (CONT'D)

Devon Canada

SWAN HILLS AREA, ALBERTA, 2010 -2015

Senior technical review for environmental site assessment program for upstream oil and gas environmental due diligence program located in Swan Hills area of Alberta. Work reviewed included Data Gap Analysis, Phase 1, Phase 2 and Phase 3 assessment program for approximately 100+ wellsite, battery and large facilities. Data gathered during assessment program was used to generate regional background database for future remedial / closure work.

Shell Canada Ltd.

MULTIPLE LOCATIONS, AB, SK, YK, NWT, 2009-2010

Project Manager for environmental site assessment program for 40+ bulk fuel and service station locations across Alberta, Saskatoon, Yukon and Northwest Territory. Scope of the program was to assess sites for liability / due diligence and property transfers. Data gap analysis, Phase 1, 2 and 3 ESAs conducted in a shortened timeframe for each Site. Senior technical review of all assessment reports.

ATCO Electric Ltd.

MULTIPLE LOCATIONS, ALBERTA, 2010-2015

Senior technical review for assessment program of non-active power generation stations across Alberta. Project work included data gap analysis, development of work plans, resourcing, execution of field work, and technical review of all assessment reports. Scope of the program was to assess for applicability of regulatory closure through remediation or reclamation certification.

Alberta Environment and Parks

SASKATOON MOUNTAIN PROVINCIAL RECREATION AREA, ALBERTA

Senior technical review for Phase 2 ESA and risk assessment associated with a former military base and landfill currently located within a provincial park. Established site-specific guidelines and associated risk for variety of contaminants and sources including petroleum hydrocarbons, volatile organic compounds, polycyclic aromatic compounds, metals, and salinity in soil and sediment at the site. Evaluated risk at the site for future park development and provided recommendations for future assessment and/or remediation.

REMEDIATION AND REMEDIAL ACTION PLANS

Various Oil and Gas Operators

MULTIPLE LOCATIONS, ALBERTA

Technical review and regulatory acceptance of remedial action plans and remediation reports for approximately 150+ surface oil and gas locations (wellsite, pipelines, batteries, facilities). As a Senior Specialist with the Remediation and Contamination Management team at the AER, routine work included reviewing remedial action plans and remediation reports against criteria for regulatory acceptance, from both a technical and regulatory compliance perspective. Sites ranged in complexity from single contaminant routine remediation to multi-contaminant large scale and multi-year remediation programs.

REMEDIATION AND REMEDIAL ACTION PLANS (CONT'D)

Various Oil and Gas Operators

MULTIPLE LOCATIONS, ALBERTA, 2010-2015

Project manager and/or Senior technical review for remedial action plans and remediation programs for various upstream oil and gas sites (200+) across Alberta. Remediation projects included excavation and landfill disposal, ex situ and in-situ treatment and soil and groundwater chemical amendment.

Apache Canada Ltd.

EAST CENTRAL ALBERTA, ALBERTA, 2006-2008

Project manager for field-wide remediation program for wellsite Underground Storage Tank removal program. Approximately 100 USTs decommissioned, removed and impacted material excavated for environmental due diligence purposes. Program completion achieved on time and on budget.

RISK ASSESSMENT AND RISK MANAGEMENT

Various Oil and Gas Operators

MULTIPLE LOCATIONS, ALBERTA

Technical review and regulatory acceptance of Risk Assessment and Risk Management Plans for approximately 100+ complex contaminated sites. As a Senior Specialist with the Remediation and Contamination Management team at the AER, work included reviewing Risk Assessments and Risk Management Plans against criteria for regulatory acceptance, from both a technical and regulatory compliance perspective. Sites were typically at end of life and complex contaminant situations.

Atco Electric Ltd.

MULTIPLE LOCATIONS, ALBERTA, 2010-2015

Project manager and senior technical review for risk assessment and risk management plan development for 4 diesel generated power plants at end of life. All risk assessments and risk management plans accepted by regulatory authority (AEP and Parks Canada).

LIABILITY ASSESSMENT AND MANAGEMENT

Various Oil and Gas Operators

MULTIPLE LOCATIONS, ALBERTA

Senior technical support for Liability Assessments for complex sites. As a Senior Specialist with the Remediation and Contamination Management team at the AER, work included providing support to the liability management team on complex contaminated sites. Supported review and approval on approximately 30+ sites.

Apache Canada Ltd.

MULTIPLE LOCATIONS, ALBERTA, 2006-2008

Project manager for corporate liability assessment and management program for 35 large facilities. Decommissioning, remediation and reclamation costs generated as per Directives from available information and site visits. Operator required additional assessment of all facilities subsequently for confirmation of costs and environmental due diligence program.

Pengrowth Corporation

MULTIPLE LOCATIONS, ALBERTA, 2009-2015

Liability assessment of an oilfield for environmental due diligence and legacy funding updates. Approximately 400 upstream oil and gas sites were reviewed for liability value on a bi-annual basis. Costs generated for decommissioning, remediation and reclamation.

SUBJECT MATTER EXPERT

Various government bodies and law firms

EDMONTON, ALBERTA

Provide technical subject matter expert opinion to various law firms and government entities on regulatory matters including liability management, risk management and contaminated sites management. Participated in mediation as a subject matter expert on various risk assessment and contaminated sites.

Carlos Arregoces, M.Sc., P.Ag.

SENIOR PROFESSIONAL AGROLOGIST

SENIOR MANAGER

Mr. Carlos Arregoces is a Senior Manager with Ecoventure Inc. and has over 18 years of experience in environmental management in Western Canada. Mr. Arregoces oversees all business units of Ecoventure Inc.

Mr. Arregoces has extensive experience working with regulatory agencies, industry personnel, and stakeholders on the development of customized strategies to prioritize their LMR/LLR obligations based on available budgets; extensive program and project experience in planning and coordination, supervision, management, senior review, and execution of all aspects of pre-disturbance planning and assessment, soil classification, inventories, mapping and evaluations, soils research, baseline surveys and environmental impact assessment, conservation and reclamation plan development, environmental site assessment and remediation, spill response, biological assessments, decommissioning and reclamation program development and liability management, erosion and sediment control plans, vegetation management programs, habitat restoration, detailed site assessments, reclamation certificate application process, among other performances related to environmental services.

He maintains current knowledge of applicable legislation to proactively manage regulatory risks and ensure dissemination of relevant information to clients as required.

KEY PROJECT EXPERIENCE

Expert Review

Confidential Client, Compilation and Evaluation of Background Information

East Central Alberta

Aided on the compilation of third party data and information. Based on available information, provided initial evaluation and discussion of work executed and methods implemented on a contaminated site.

The compiled information provided to the senior personnel was utilized to determine efficiency of work completed and liability associated to the location.

The compiled information provided to the senior personnel was utilized to determine efficiency of work completed and liability associated to the location.

EDUCATION

M.Sc. in Environment and Management Royal Roads University, Victoria, BC, 2009
Environmental Resources Management Certificate, University of Alberta, 2002
MBA in Agriculture Enterprises, University of Popayan, Colombia, 1996
B.Sc. in Agriculture, University of Popayan, Colombia, 1993

PROFESSIONAL REGISTRATIONS

Professional Agrologist, Alberta Institute of Agrologists (AIA), British Columbia Institute of Agrologists

PROFESSIONAL HISTORY

Ecoventure Inc.
Senior Manager, 2009-Present

Paragon Soil and Environmental Consulting
Soil Scientist/Soil Reclamation Specialist, 2002-2009

Prodeco Group (Colombia)
Land Reclamation Supervisor, 1998

Coolechera (Colombia)
Junior Financial Analyst, 1997

Reforestadora de la Costa S.A. (Colombia)
Assistant Planning Forester, 1994

HIGHLIGHTS OF EXPERIENCE

- Project/Program Management
- Business Development,
- Client Liaison
- Senior Review
- Pre-Disturbance/Pre-Construction Assessments
- Soil Classification, Inventories, Mapping and Evaluations
- Soil Research and Literature Reviews
- Baseline Survey/Environmental Impact Assessment
- Conservation and Reclamation Planning and Annual Reporting
- Phase 1, 2, and 3 Environmental Site Assessments/Site Investigations
- Pipeline Integrity Risk Assessments
- Major and Minor Reclamation
- Erosion & Sediment Control Plans
- Vegetation Management Programs
- Detailed Site Assessments
- Reclamation Certificate Application, Acknowledgement of Reclamation and Certificate of Restoration
- Due diligence and liability assessments

PORTFOLIO AND PROGRAM MANAGEMENT

Perpetual Energy Operating Corp. Projects

ALBERTA

Managed upstream environmental projects on abandoned and active facilities throughout Alberta. Developed yearly reclamation programs including cost estimates for reclamation and remediation projects, client liaison, senior technical review and professional sign off for Environmental Site Assessments reports, coordinate initial spill response, implementation of innovated remediation techniques, erosion and sediment controls, project manager, Reclamation Certificate Application compilation and submissions, budget management. Performed senior review of company's Pre-Construction and Pre-Site Assessment Standard, conducted environmental audits on two of Perpetual's core areas and developed the best management practices for reclamation and integration of pre-disturbance assessment data with construction and reclamation practices. Participated in meetings with upper management of the company to develop customized strategies prioritizing environmental liabilities and risks reduction.

West Lake Energy Corp (Formerly Twin Butte Energy) Environmental Program

WESTERN CANADA

Acted as portfolio manager and client liaison for the reclamation program, including Phase I and II ESA's and Remediation, spill response, groundwater monitoring programs, reclamation, vegetation management, detailed site assessments, Reclamation Certificate Applications and Acknowledgement of Reclamation compilations and submissions. Performed the portfolio management efficiently in fast paced and changing work environments with critical timelines.

Zargon Oil and Gas

WESTERN CANADA

Performed client liaison role for the company's environmental portfolio management including program development and management for reclamation and remediation activities. Provide technical support and report reviews, project manager, budget management and accruals reporting, and environmental support for operations related activities.

RECLAMATION

Various Clients

WESTERN CANADA

Acted as senior program manager of reclamation, erosion and sediment control and vegetation management including proposals and scope of work development and submission, conservation and reclamation plans development and execution, scheduling, prioritization, crew leader, supervision of field activities, reporting, client liaison, safety coordination, cost control, and professional sign-off.

Crescent Point Energy Corp., Reclamation Program

ALLIANCE, ALBERTA, 2016

Development of scope of works and execution plans, including cost estimates, for minor and major reclamation of over 20 oil and gas locations. Responsible for providing directions on best management practices for reclamation executions on leases and associated facilities. Senior review of daily progress reports and total budget management for the program.

RECLAMATION (CONT'D)

Albian Sands, Shell Canada, Muskeg River Mine Tailings Pond Dike Reclamation

FORT MCMURRAY, ALBERTA

Acted as soil reclamation specialist on the development, execution and supervision of a conservation and *reclamation* plan of approximately 180 hectares along the dike of tailings pond east. Reclamation soil prescriptions were developed based on reclamation materials available, topographical positions and desire vegetation communities to target ecosites phases in response to management practices with emphasis on tree productivity, biodiversity and wildlife habitat quality.

SPILL RESPONSE AND ASSESSMENT

Sinopec Daylight Energy Ltd, Pipeline Break

DRAYTON VALLEY, ALBERTA

Assisted on the management and execution of a pipeline break assessment and remediation of approximately 30 m3 of light crude oil. Fluid and impacted material recovered during the initial spill response was disposed of at a Class I landfill facility. Petroleum hydrocarbons impacts were observed at depths of 0.0-9.5 m. Remediation implemented on this project included on-site ex-situ and off-site ex-situ treatment, and excavation and landfill disposal. Approximately 15,400 m^3 of hydrocarbon-impacted soil was removed from the area affected by the pipeline break. Approximately 85% of hydrocarbon-impacted soil was accepted for disposal at the Aspen Regional Landfill in Drayton Valley. The remaining 15% of hydrocarbon-impacted soil was successfully treated on site using an excavator equipped with an Allu bucket. The excavation was backfilled with remediated soil, stockpiled overburden, and material provided by the landowner. Following backfill activities, a one year waiting period was implemented for proper ground settling; at that time, the landscape and surface drainage was restored to its natural conditions and disturbed areas were seeded as per landowners' seed-mixture preference.

REMEDIATION AND REMEDIAL ACTION PLANNING

Phase III Environmental Site Assessments/Remediation, Various Clients

THROUGHOUT ALBERTA

Senior reviewed, managed and participated in several Phase III remediation projects including excavation and disposal at landfill and on-site remedial treatment options.

ENVIRONMENTAL SITE ASSESSMENTS

Phase I Environmental Site Assessments, Various Clients

VARIOUS LOCATIONS IN ALBERTA

Managed the completion of over 500 Phase I Environmental Site Assessments within Alberta and recommended necessary future environmental work with respect to current regulatory guidelines in the upstream sector.

ENVIRONMENTAL SITE ASSESSMENTS (CONT'D)

West Lake Energy Corp, Phase I ESA

ALBERTA, 2017 PROGRAM

Senior management of a Phase 1 ESA program for over 90 upstream oil and gas sites. Planning and supervision of the program to confirm that all objectives were met following client goals and regulatory requirements.

Phase II Environmental Site Assessments, Various Clients

VARIOUS LOCATIONS, ALBERTA

Managed Phase II Environmental Site Assessments programs for over 150 Phase II assessments at upstream wellsites in Alberta. Completed phased intrusive investigations at contaminated operating and former activity locations to assess the potential for contamination presence. Ensure that project scopes were consistent with work plans, report conclusions were supported by the work results, potential work results implications were documented, recommendations were supported by the reported information, reporting QC expectations were met, and the deliverables met company, client, and regulator quality objectives.

NuVista Energy Ltd, Phase II ESA

HAY-ZAMA LAKES/FONTAS, ALBERTA, 2010-2012

Management of Phase II Environmental Site Assessment program on over 25 locations including scope of work and cost estimate development, project tracking, senior support to field personnel, report writing, and professional sign off.

Black Pearl Resources Inc, Mooney Gas Processing Plant Facility, Liability Assessment

LESSER SLAVE RIVER, ALBERTA

Reviewed and assisted on a Type A Site-Specific Liability Assessment for the Mooney Gas Processing Plant Facility. The Type A Liability Assessment was prepared in accordance with the AER Directives 001

SOIL SURVEYS AND EVALUATIONS

Various Clients

ALBERTA AND BRITISH COLUMBIA

Soil classification, inventories, mapping and evaluation for pipeline and transportation corridors, oil sands, coal and uranium mines, conventional oil and gas and SAGD well sites and associated facilities, pipeline integrity risk assessments/stress corrosion and cracking, gravel and borrow pits, damage assessments on disturbed railways sites caused by maintenance or derailments, land classification for irrigation, among other lands assessments and evaluations.

BP Canada, Pipeline Integrity Risk Assessment

COCHIN PIPELINE SYSTEM, CANADA AND USA

Performed an investigation of stress corrosion and cracking (SCC) for the entire pipeline corridor, over 3,000 km, in Canada and United States to determine low, medium and high risk locations along the pipeline. Conducted field assessments describing landscape, parent material and soil parameters on high risk locations and supervised the integrity dig assessments for several locations providing detailed field description information and recommendations to senior advisors.

SOIL SURVEYS AND EVALUATIONS (CONT'D)

Land Irrigability Classification

VARIOUS CLIENTS AND IRRIGATION DISTRICTS IN ALBERTA

Performed Level I and II investigations for land irrigation classification of approximately 28,000 acres. The assessments included scope of work and cost estimates development and submission, project planning and coordination, safety coordination, preliminary air photo interpretation, review of available soil and geological survey reports, performance of a detailed landscape and soil profile assessments for irrigation suitability, soil samples collection, data entry, analysis, evaluation, interpretation, reporting, mapping, and completion of agricultural feasibility reports to determine annual volume of water requirements for irrigation.

ENVIRONMENTAL IMPACT ASSESSMENT

Various Clients

VARIOUS LOCATIONS IN ALBERTA

Managed and conducted baseline soil, terrain and vegetation survey utilized to provide information for soil conservation and reclamation and mine closure planning, pipeline construction monitoring, soils input to environmental impact assessments and pre-disturbance assessments, and post-construction monitoring and audits.

Imperial Oil, Kearl Oil Sands Project

FORT MCMURRAY, ALBERTA

Managed and supervised the baseline Soils and Terrain Survey field program including soil and landscape conditions characterization in the local study area, completion of supplemental field program as required based on previous surveys and existing data, integration of data with vegetation and wetlands component, ecosite classification and site index to ground-truth AVI and AWI mapping, peat depths and notation of underlying mineral material taken to aid mine planning and reclamation, QA/QC procedures for mapping and lab analysis. Participated on the preparation of the Conservation, Reclamation and Closure Plan, and completed the soils component of the Environmental Impact Assessment for this project. Following the submission of the Application and the Project Development Plan, provided all necessary supporting background information to senior advisors to respond questions from public interest groups as well as for their preparation to attend the Public Hearings as a Panel member for the Client.

TransCanada Pipelines, Keystone Mainline

ALBERTA AND SOUTHWEST SASKATCHEWAN

Conducted a baseline environmental inventory and provided input the Conservation, Reclamation and Closure Plan and Environmental Impact Assessment for the proposed pipeline route for the TransCanada's Keystone pipeline corridor. The performance of the work completed included: background review of existing soil surveys and surface geological reports, preliminary air photo interpretations, field evaluations and field mapping of the soil resources, supervision of field crew soils assessors, safety coordination, QA/QC of field data collected, providing baseline data, mapping present land use and sampling soils to identify areas of alternate soil material handling and best management practices to be implemented during pipeline construction and reclamation activities. Provided technical support on the development of the Environmental Protection Plan for this project.

RESEARCH AND INNOVATION

Various Clients

ALBERTA

Conducted and assisted in several soils research and investigation projects for Alberta Agriculture and Rural Development, Agriculture Canada, the Cumulative Environmental Management Association (CEMA) and Canadian Oil Sands Network for Research and Development (CONRAD) in conjunction with the University of Alberta, University of Saskatchewan and University of Waterloo. Conducted research and investigations including soil moisture study on natural and reclaimed sandy soils in the Athabasca oil sands region; investigation of water repellency and water content in undisturbed and reclaimed soils from the Athabasca oil sands region; inventory of hydrocarbon affected natural soils in the Athabasca oil sands region; evaluation of soil water dynamics to determine land capability of coarse textured, hydrocarbon affected reclamation soils; nitrogen availability in salvaged LFH versus peat-mineral mixtures; assisting on the development of a national measurement protocol for carbon sequestration in soils, for Agriculture Canada; selection and establishment of bench-mark soil plots on agricultural land, including reporting, for Alberta Agriculture - Assessment of Environmental Sustainability in Alberta Soil Quality Monitoring Project; provided technical support on the review of the Alberta 2007 Reclamation Criteria for Wellsites and Associated Facilities; among others.

Cumulative Environmental Management Association (CEMA)

FORT MCMURRAY, ALBERTA

Established and monitored over 100 long term soil and vegetation monitoring plots in the oil sands region. This work included plot selection, initial and subsequent soil description and sampling, analysis and interpretation, annual reporting and data base maintenance. Each year a number of plots were re-sampled to track changes over time and determine whether any problems might arise that could jeopardize reclamation success. The results were a primary source of information in the refinement of the "Land Capability Classification System for Forest Ecosystems in the Oil Sands Region (2006)" and for the CEMA Soil and Vegetation Working Group

Chris Newton, P.Biol., RPBio

PROFESSIONAL BIOLOGIST

TECHNICAL LEAD – CONSERVATION AND RECLAMATION

Ecoventure Inc.'s Chris Newton is a Professional Biologist and Technical Lead for the Conservation and Reclamation group. The University of Calgary awarded him a Bachelor's degree in Biological Sciences, while Royal Roads University awarded him a Master's degree in Environmental Management. His memberships with the Alberta Society of Professional Biologists (ASPB) and the College of Applied Biology (BC) are in good standing. His career in Environmental Management dates back to 2006 and he currently works on a wide variety of projects involving wetland and biophysical assessments, environmental planning, Phase I and Phase II Environmental Site Assessments, Reclamation Management, and Detailed Site Assessments in Western Canada. Additionally, Chris is certified as an Authenticating Wetland Practitioner, and has experience with Wildlife, Vegetation, and Wetland Assessments, and Environmental Monitoring of seismic and pipeline projects.

KEY PROJECT EXPERIENCE

RECLAMATION

Various Clients

WESTERN CANADA

Developed proposals and scopes of work for reclamation, erosion control, and vegetation management, as well as coordinated proposals and scopes of work. Development and implementation of conservation and reclamation plans, scheduling, prioritizing, leading crews, overseeing field activities, reporting, liaison with clients, coordination of safety, and cost control.

Perpetual Energy Operating Corp.

EAST CENTRAL ALBERTA

Completed Phase 1 ESA/reclamation site inspections of oil and gas facilities to identify vegetation, soil and landscape parameters. Coordinated and implemented reclamation activities for oil and gas facilities to meet reclamation criteria.

EDUCATION

B.Sc, in Biological Sciences
University of Calgary, 2006
M.Sc., in Environmental Management
Royal Roads University, 2020

PROFESSIONAL REGISTRATIONS

Alberta Society of Professional Biologists
College of Applied Biology British Columbia

CERTIFICATES

Ground Disturbance Level II
H_2S Alive
Standard First Aid
Transportation of Dangerous Goods (TDG)
WHMIS
ATV Training
Class 5 Drivers Licence

PROFESSIONAL HISTORY

Ecoventure Inc.
CONSERVATION & RECLAMATION, 2013-PRESENT

Greenlight Environmental Consulting Inc.
ENVIRONMENTAL SCIENTIST, 2007-2013

Alliance Environmental Solutions
ENVIRONMENTAL SCIENTIST, 2006

HIGHLIGHTS OF EXPERIENCE

- Project / program management
- Office management / leadership
- Senior Review
- Client relations
- Wetland / biophysical assessments
- Pre-disturbance / Pre-construction planning
- Reclamation / Detailed Site Assessments
- Reclamation Certificate Application (Ab), Acknowledgement of Reclamation (Sask) and Certificate of Restoration (BC)
- Phase 1, 2, and 3 Environmental site Assessments
- Environmental monitoring
- Conservation & Reclamation planning
- Vegetation Management program
- Due diligence and liability assessments

RECLAMATION (CONT'D)

Nuvista Energy Ltd.

RAINBOW LAKE

Project manager and team lead for the 2016 and 2017 Abandonment program where over 100 wellsite and facility locations were abandoned, remediated and reclaimed within Northwestern Alberta. Reclamation and re-vegetation planning and execution along with wetland establishment and vegetation monitoring have been ongoing to reach Alberta 2010 reclamation criteria and achieve reclamation certificates. Completion of detailed site assessment and the technical review of and professional sign off reclamation certificates associated with this project.

Shiningstar Energy

NORTHEAST BRITISH COLUMBIA

Completed over 30 reclamation site inspections within Northeast British Columbia as part of an initial liability and reclamation program set up. Site conditions and next step recommendations and cost estimates were provided.

PRE-DISTURBANCE ASSESSMENTS

IPC Canada Ltd.

BLACKROD

Provide field and regulatory support for the expansion and development of the Blackrod SAG-D facility. Completion of Pre-Disturbance Assessments, Water Act Applications, land management and the development of EPEA environmental monitoring proposals.

Blackspur Oil Corp.

THORSBY & BROOKS

Coordinate pre-construction planning and assessment with field operations to assess proposed wellsites, access and pipeline routes and identify environmental concerns and necessary mitigation. Completion of necessary environmental regulatory requirements included pipeline code of practice notifications, Water Act application, Temporary Field authorization, and historical approval (HRA).

Crestwynd Exploration Ltd.

NEWBROOK & RED EARTH CREEK

Coordinate pre-construction planning and assessment with field operations to assess proposed well sites, access and pipeline routes and identify environmental concerns and necessary mitigation in order to obtain well licences.

Pearl Exploration and Production Ltd.

SLAVE LAKE

Completed over fifteen Pre-Construction Assessments and Environmental Field Reports for well sites and access road within Northern Alberta. Each Environmental Field Report included a soil and vegetation survey, timber assessment and construction and mitigation planning.

ENVIRONMENTAL MONITORING

ATCO Pipelines Ltd.

REDWATER

On-site environmental monitor for the Opal Valve assembly upgrade within a seasonal wetland. Pre-construction wildlife assessments were completed to ensure operations did not impact migratory bird species. Monitoring of soil stripping and salvaging within a wetland during the valve upgrade and final reclamation of the area.

TransNorthern Pipeline Inc.

CENTRAL ALBERTA

Environmental monitoring of pipeline integrity digs (2010-2013) to ensure proper soil salvage and replacement and best management practices along with regulatory approval (Historical clearance, Water Act Code of Practice and Temporary Field Authorizations).

Various Geophysical Exploration Clients

WESTERN CANADA

Completed environmental surveys and project proposals for oil and gas exploration throughout Western Canada. Environmental surveys focused on species at risk and provincial sensitive species and wetland. Supervised as an environmental monitor of on-site activities to ensure operations met compliance, provide mitigation options and identify environmental concerns.

BIOPHYSICAL ASSESSMENTS

Gibson Energy and Infrastructure Partnership

FORT SASKATCHEWAN, ALBERTA

Gibson is the owner of the Heartland Sulfur Terminal located east of Fort Saskatchewan, Alberta which is a rail loading facility of sulfur products. The facility was recently constructed with wetland present which were assessed and compensated under the Alberta Wetland Policy. An evaporation pond was built as part of the compensation process, however during the spring of 2020 due to rapid snowmelt the evaporation pond breached and flowed into adjacent seasonal wetlands resulting in flooding and non-compliance issues. Ecoventure completed a Wetland Impact Assessment Report with mitigation planning to assess the area and develop a mitigation strategy which included berm and wetland enhancement. The assessment and mitigation strategy were submitted as part of a Water Act Application for wetland activities in accordance with the Alberta Wetland Policy and Water Act.

ATCO Pipelines Ltd.

VARIOUS SITES, ALBERTA

Project management and technical supervision of wetland and water body assessment for pipeline related activities and preparation of pipeline Code of Practice Notification and Wetland Impact Assessment Forms (WIAF), Environmental Protection Plans (EPP) and necessary mitigation. Project included pipeline integrity programs, pipeline replacement, facility upgrades and pipeline removals throughout the province of Alberta.

BIOPHYSICAL ASSESSMENTS (CONT'D)

Mattamy Homes Ltd.

EDMONTON & SHERWOOD PARK

Completed numerous wetland assessments and biophysical reviews of urban development projects within the City of Edmonton and Strathcona County and prepared wetland impact assessments, mitigation/compensation planning, and acquired approvals under Water Act and Public Lands Act.

Rachel Yee, M.Sc., P.Biol.

PROFESSIONAL BIOLOGIST

PROJECT COORDINATOR – REGULATORY AND LIABILITY

EDUCATION

M.Sc. in Environmental Engineering, University of Alberta, 2018
B.Sc. in Biological Sciences, University of Calgary, 2015

PROFESSIONAL REGISTRATIONS

Professional Biologist - Alberta Society of Professional Biologists

CERTIFICATES

Common Safety Orientation
Standard First Aid – Level C, CPR/AED
WHMIS
Transportation of Dangerous Goods
Class 5 Drivers' Licence

PROFESSIONAL HISTORY

Ecoventure Inc.

PROJECT COORDINATOR
REGULATORY AND LIABILITY
EDMONTON, ALBERTA
2022 - PRESENT

Vertex Professional Services Ltd.

REPORTING COORDINATOR
ASSESSMENT AND REMEDIATION
SHERWOOD PARK, ALBERTA
2018 - 2022

HIGHLIGHTS OF EXPERIENCE

- Client liaison
- Program management
- Project coordination
- Technical reporting for Phase 1 and 2 ESAs (Oil and Gas, Commercial and Industrial)
- Initial review of reports
- Site inspections for Phase 1 ESAs (Oil and Gas, Commercial and Industrial)
- Environmental Due Diligence/ Acquisitions and Divestitures
- Strong usage of Alberta Energy Regulator OneStop: Reclamation Certificate Application Program
- Updating and project tracking with client's SiteView system
- Data management for detailed site assessments

Rachel Yee is an environmental consultant in the Regulatory and Liability group with Ecoventure Inc. and is a Professional Biologist in good standing with the Alberta Society of Professional Biologists. Rachel holds a Bachelor of Science degree in Biological Sciences from the University of Calgary and a Master of Science degree in Environmental Engineering from the University of Alberta.

Rachel has been working in the field of environmental management since 2018, primarily focused on Regulatory Compliance and Liability, and Assessment and Remediation projects. Her experience includes technical reporting and project coordination of Phase 1 and 2 Environmental Site Assessments for oil and gas, commercial and industrial clients within Alberta, Saskatchewan and British Columbia, Acquisitions/Divestitures, Reclamation Certificate Applications, data management, and proposal development. Additionally, she currently manages the reclamation program for various clients.

KEY PROJECT EXPERIENCE

ENVIRONMENTAL SITE ASSESSMENTS

Phase 1 Environmental Site Assessments, Various Clients

ALBERTA, SASKATCHEWAN, BRITISH COLUMBIA, ONTARIO, 2018 TO PRESENT

Technical reporting and completing site assessments for Phase 1 ESAs for upstream oil and gas and commercial clients. Phase 1 responsibilities included the collection and organization of data, completing site inspections, conducting aerial photograph interpretation, conducting interviews with stakeholders, uploading information to Alberta Energy Regulator's OneStop system (where applicable) and providing recommendations for next steps.

Phase 2 Environmental Site Assessments, Various Clients

ALBERTA, SASKATCHEWAN, 2018 TO PRESENT

Technical reporting for various Phase 2 ESA programs for upstream oil and gas and commercial clients. Responsibilities include preparing reports, uploading information to Alberta Energy Regulator's OneStop system (where applicable) and peer reviewing Phase 2 ESA reports.

PORTFOLIO AND PROJECT MANAGEMENT

Reclamation Program, Crescent Point Energy Corp. and Advantage Energy Ltd.

ALBERTA, 2023

Client liaison and program manager of client's reclamation program, which included Phase 1 and 2 ESAs, remediations, groundwater monitoring, surface reclamation, DSAs and RCAs. Responsibilities include acting as client liaison, setting up projects, updating budgets and status page in Ecomanager system, invoicing, and providing updates to client through SiteView where applicable.

Phase 1 Environmental Site Assessments, Orphan Well Association and Crescent Point Energy Corp.

ALBERTA, 2023

Coordinating and assisting in overseeing Phase 1 ESA program. Responsibilities include coordination of work, managing reporting team, maintaining budgets and timelines, ensuring deliverables are completed professionally and accurately, and invoicing.

Phase 1 Environmental Site Assessments, Various Clients

ALBERTA, SASKATCHEWAN, 2018 TO PRESENT

Coordinating and assisting in overseeing Phase 1 ESA programs consisting of 20 to 150 wells. Responsibilities include coordination of work, managing field and reporting team, maintaining timelines and ensuring deliverables are completed professionally and accurately. Additional tasks involved preparing proposals and cost estimates for potential Phase 1 ESA work, training junior staff, and completing initial reviews of reports.

ACQUISITIONS AND DIVESTITURES

Acquisition Assessment, Confidential Client

ALBERTA, 2022

Assisted in the completion of environmental due diligence and ARO assessment for a Vermilion Energy package entailing over 4000 wells and 200 facilities. The assessment was completed within three weeks and involved reviewing and analyzing relevant well and facility information, establishing liability risks, establishing decommissioning, reclamation and remediation costs and finalization of the spreadsheet and report.

Acquisition Assessment, Crescent Point Energy Corp.

ALBERTA, 2022

Assisted in the completion of environmental due diligence and ARO assessment in Crescent Point's successful acquisition of Paramount's Canadian assets. Package entailed over 100 wells and facilities and was completed within three weeks. Responsibilities included reviewing and analyzing relevant well and facility information, establishing liability risks, establishing decommissioning, reclamation and remediation costs and finalization of the spreadsheet and report.

LIABILITY ASSESSMENT AND MANAGEMENT

Alberta Utilities Commission

ALBERTA, 2023

Completed literature review and prepared report on the consideration of implementing mandatory reclamation security requirements for power plants as part of the renewable electricity generation inquiry.

RECLAMATION

Reclamation Certificate Applications, Various Clients

ALBERTA, 2018 TO PRESENT

Completed components and submission of components for reclamation certificate applications for various clients in Alberta through Alberta Energy Regulator's OneStop system.

Detailed Site Assessment Data Management

Various Clients

ALBERTA, 2018 TO 2021

Managed the field data for detailed site assessments for programs with over 150 wells and Oil Sand Exploration Programs.