Pre-Feasibility Study: Integration of an MMR® Plant into the CVEA Energy Supply System

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SYNOPSIS

This document was prepared for Copper Valley Electric Association (CVEA) and serves as a preliminary feasibility study for deploying a Micro-Modular Reactor (MMR®) for meeting CVEA energy load. The MMR technology is presented. Several sites are discussed, and Tsunami, Seismic, and Civil reviews are provided. An assessment of the MMR economics was performed. Discussions with key community and state stakeholders were conducted and detailed in the report.

Document Change History

Rel.	Date	Preparer	Changes
00	2022/09/09	USNC	New document created and populated.
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Document Approval

Action	Designation	Name	Signature	Date
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EXECUTIVE SUMMARY

This document has been prepared as a preliminary assessment of building a micro nuclear reactor to meet the needs of the Copper Valley Electric Association and its customers. The Micro-Modular Reactor (MMR®) technology, a 15 to 30 MW_{th} reactor developed by Ultra Safe Nuclear Corporation (USNC), is detailed in this report and an overview of the licensing process is provided.

Several options have been considered to analyze the cost of electricity that CVEA would incur if MMR technology is pursued. From this sensitivity analysis, it was found that three parameters drive the cost of electricity—capacity factor, heat price, and tax credits.

The capacity factor is driven by the ability to sell heat. Identifying an off taker for heat from the MMR improves the capacity factor which reduces the cost of electricity.

The following most crucial parameter is the ownership and, therefore, the cost of sourcing the capital and tax burden. Furthermore, the recently approved Inflation Reduction Act provides an Investment Tax Credit (ITC), for which this project would qualify, that can range from 30% to 50% of the capital investment.

The financial analysis in this report involved the completion of several scenarios and concludes that CVEA ownership with maximum heat sales and the highest ITC available provides for the most economic deployment of MMR technology for CVEA. Other scenarios (e.g., other ownership models, reduced heat sales) can provide economic deployments albeit at less favorable conditions than the optimal deployment scenario.

Preliminary siting work was performed for Valdez and Glenallen locations. The tsunami and seismic activity of the Valdez region, as well as a civil review of the specific mountain site are provided. The Tsunami report found that water ingress at the site is unlikely as it's elevation places it above water ingress zones. The civil review found the site composition and size suitable for construction.

Ongoing conversations with local and state stakeholders found that there is broad and deep support for integrating micronuclear reactors in this region of Alaska. Neither USNC nor CVEA heard significant opposition to the idea of siting an MMR in CVEA's service area, in fact most all were encouraged by it. Most people that had questions about the safety of the endeavor seemed to understand the safety features designed to mitigate any potential risks to the community and the environment. It was important to begin engagement at this early stage, so that people are assured that there will be no decisions to proceed to any next stage without an understanding how the public feels about the reactor technology. Community engagement will be a critical component of the next phase if the project is to move forward.

CONTENTS

EXHIBITS

ABBREVIATIONS

This list contains the abbreviations used in this document.

Abbreviation or Acronym	Definition
ANCSA	Alaska Native Claims Settlement Act
BTU	British thermal units
CFR	Code of Federal Regulations
CVEA	Copper Valley Electric Association
DNR	Alaska Department of Natural Resources
DOE	US Department of Energy
EPA	US Environmental Protection Agency
EPS	Electric Power Services inc.
FCM	Fully Ceramic Microencapsulated Fuel
FEIS	Final Environmental Impact Statement
GWP	Global warming potential
IRA	Inflation Reduction Act
ITC	Investment tax credit
kPa	Kilopascal
kV	Kilovolt
lb	Pound
LSR	Light straight run
MBH	Thousand BTU per hour
MMR	Micro-Modular Reactor
MVA	Mega Volt-Amp
MW_e	Megawatt on an electric basis
kWh_e	kilowatt-hour on an electric basis
kWh_{th}	kilowatt-hour on a thermal basis
NEPA	National Environmental Policy Act
NRC	Nuclear Regulatory Commission

Abbreviation or Acronym	Definition
Psia	Pounds per square inch, absolute
Psig	Pounds per square inch, gauge
PTC	Production tax credit
ROM	Rough order of magnitude
TAPS	Trans-Alaska Pipeline System
USNC	Ultra Safe Nuclear Corporation LLC
VMT	Valdez Marine Terminal

1. INTRODUCTION

1.1 SCOPE AND PURPOSE

The purpose of this document is to assess the feasibility of integrating a Micro Modular Reactor™ (MMR) into the Copper Valley Electricity Authority (CVEA) system. The document describes the technology, stakeholder assessment, surveys CVEA plants and possible replacements or additions, economics of MMR deployment and utilization, and MMR site scoping. This document was prepared as a pre-feasibility study between CVEA and Ultra Safe Nuclear Corp (USNC).

1.2 KEY FEATURES OF MMR® TECHNOLOGY

The MMR is a high temperature nuclear reactor being developed by USNC. The MMR is a microreactor with a capacity of 15 to 30 MW_{th} per reactor. Early deployments focus on the 15 MW_{th} version. Multiple reactors can be housed at a single site.

An MMR facility typically consists of a modularized Nuclear Plant, coupled to an application specific Adjacent Plant. This allows the heat output from the Nuclear Plant to scale by adding standard MMR units. The Adjacent Plant is a normal industrial facility with thermal energy storage on site and can be used to produce electricity, process heat, or hydrogen.

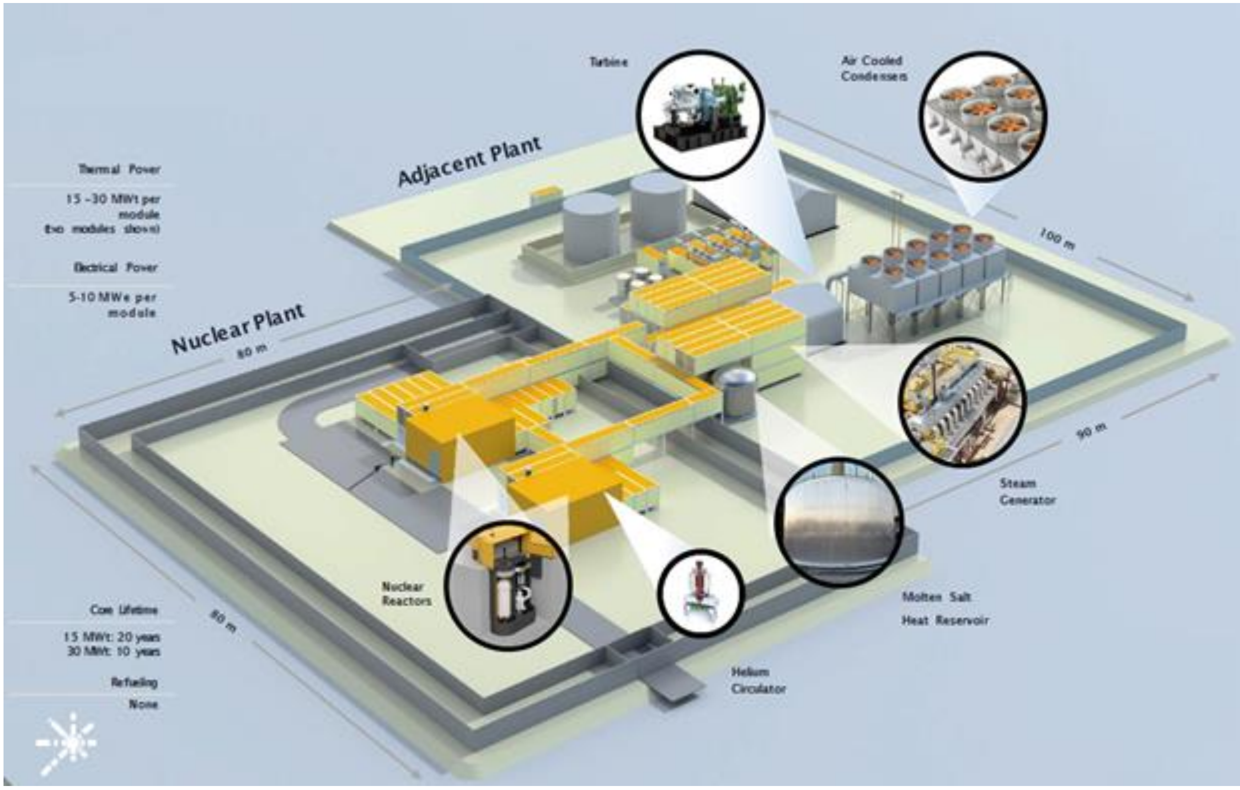

Exhibit 1-1: Schematic of a typical MMR site

The standard MMR units will be factory produced and the balance of the Nuclear Plant is modularized and tested off-site, ready for transportation and installation on each deployment site once the necessary licenses and permits are obtained, which is similar to a wind turbine.

As the MMR is factory fabricated, requires infrequent refueling, and has high safety margins, it is a candidate for energy generation in harsh Alaskan environments.

2. CVEA ENERGY SUPPLY PORTFOLIO

2.1 CVEA PORTFOLIO OVERVIEW

CVEA owns and operates a diverse mix of power plants that includes two hydroelectric plants, a cogeneration plant, and two diesel plants. The sections below serve as an overview of CVEA's generation portfolio and help understand what unit(s) the MMR facility might replace. The majority of CVEA's generation comes from the Solomon Gulch and Allison Creek Hydroelectric facilities. Those two units are omitted from this section as it is intended the MMR facility will replace fossil generation. There are transmission assets surrounding these dams that may be of use in this project.

2.1.1 CVEA Cogeneration Project

The Cogeneration Plant (Cogen) is located at the Petro Star Refinery in Valdez, Alaska. The plant was constructed as a mutual effort between CVEA and Petro Star. Commissioned in 2000, the plant has a 5.2-megawatt Solar Taurus 60 turbine which is fueled by Light Straight Run (LSR), a naptha type product that is supplied by the refinery. LSR is a byproduct of the refinery distillation process. The unit is operated during the winter months, typically from December through April. During these months, it is the primary source of power to the CVEA system. The 850°F (454°C) exhaust heat from the turbine is sent to the refinery's crude heater to increase the efficiency of the refining process. The refinery pays CVEA for this heat. CVEA members receive the benefit of this heat revenue as a heat revenue credit on their electric bill. The credit is applied to each members' bill during the months the unit operates on a per kilowatt-hour basis.

2.1.2 Glennallen Diesel Plant

The Glennallen Diesel Plant is the oldest CVEA power plant. The plant was constructed in the mid-1950s, expanded in the 1970s, and upgraded multiple times since. The total plant capacity of 8 megawatts is generated with two Enterprise DSR46 diesel generators, one Caterpillar 3516B diesel generator, and one Electro Motive Diesel 16-710 diesel generator. These diesel generators are almost entirely run in the winter.

2.1.3 Valdez Diesel Plant

The Valdez Diesel Plant was constructed after the 1964 Good Friday Earthquake and upgraded in the years since. The total plant capacity of 8 megawatts is generated with three Enterprise DSR46 diesel generator sets and two Caterpillar 3516B diesel generator sets. The caterpillars were commissioned in 2017. Like Glennallen, these diesel plants are typically run very little in the summer months.

2.1.4 Transmission Infrastructure

CVEA's service areas are tied together with a 106-mile, 138-kilovolt transmission line that is owned and operated by CVEA. The transmission line provides the link to all five generating plants. Power can flow from any of the generating plants to the end consumers. Historically, power flows from Valdez to the Copper Basin in the summer months, as nearly all the power requirements are met with the two hydroelectric plants. The transmission line traverses severe terrain between the two districts, such as the Thompson Pass area, which is known for being one of the snowiest places in North America.

2.1.5 Alyeska Pipeline and Valdez Marine Terminal

The Trans Alaska Pipeline System (TAPS) moves crude oil from Alaska's north slope to the southern terminus at the Valdez Marine Terminal (VMT). The Alyeska Pipeline Service Company operates the VMT, where crude is loaded onto tanker ships for distribution to refining and downstream processes.

A portion of the power consumed at VMT is produced by burning the pipeline and storage tank off-gas. When the power vapor facility generates more energy than is necessary for VMT, the power is sold to CVEA. When there is not enough power for the VMT facility, power is bought from CVEA. The power vapor facility is a net seller of electricity to CVEA over the year.

Yearly electricity generation from the power vapor facility has grown by 60% from 2017 to 2019, and it is expected to increase further as capacity at VMT grows. CVEA would receive more electricity, meaning less energy is required from Cogen or the Salmon Gulch dam.

2.2 REPLACING FOSSIL FUELS WITH NUCLEAR

As fossil generators age and the world looks to transition away from carbon emitting sources, nuclear power offers a reliable and economical replacement. Within CVEA, a microreactor would be able to replace fossil fuel generation directly without much change to how the system is operated. While the diesel units would likely remain for reliability and peaking power, a nuclear reactor could replace Cogen within CVEA's portfolio.

For a nuclear technology to be successful in CVEA's area and replace Cogen, the reactor would need to:

- Be an appropriate size, ~5 MW_e to replace the winter generation from Cogen,
- Have flexible operations capability, allowing for power levels that fluctuate over hourly, daily, and seasonal timescales,
- Be able to operate effectively and reliably in a harsh environment and handle the disruptions, such as cold events, seismic activity or Tsunamis, that might come from such a location,
- Be a passively safe design, meaning that the reactor takes advantage of fundamental physical laws to ensure safety, in addition to other engineered safety controls.

The unique design of the high temperature MMR with Fully Ceramic Micro-Encapsulated Fuel (FCM®), detailed in Section 3, meets all the criteria outlined above.

3. MMR® TECHNOLOGY DESCRIPTION

The project will consist of two major parts, the Nuclear Plant and the Adjacent Plant that are referred to as the "MMR facility." The Nuclear Plant includes an MMR High Temperature Gas-cooled Reactor, which provides process heat to the Adjacent Plant via a molten salt thermal exchange system, as well as the equipment required to transport the heat from the reactor and support the operation of the plant and ensure the safety of the facility. The Nuclear Plant is independent from the Adjacent Plant, requiring no supporting services from the Adjacent Plant for safe operation.

The Adjacent Plant consists of the equipment and systems that convert the heat to electrical power or other forms of energy as per client requirements, such as steam. The Adjacent Plant consists of electricity generation equipment or processing equipment to send heat directly to customers over the lifetime of the plant.

The MMR technology has been developed by USNC and is largely based on proven designs with inherent safety features, further augmented with specific novel safety features. The degree of such proven inherent safety design features confers confidence in the operability and safety of the facility. The novel safety features further enhance the confidence in the safety of the technology. One such feature is the use of the FCM fuel that ensures containment of radioactivity during operations and accident conditions, which means that almost no fission products are released out of the fuel. Current reactors require complex safety systems, such as large containment domes, to contain fission products in the case of an event. The MMR's FCM fuel itself already performs the function of containing fission products during such events.

The MMR facility also provides the flexibility of producing electrical power and/or heat. In addition, the MMR design has load-follow capability, which means that it can accommodate periods of lower power demands during its operation.

The MMR technology does not produce greenhouse gas emissions during its operation.

3.1 MMR PROCESS

The MMR facility includes a Nuclear Plant containing an MMR reactor and an Adjacent Plant, which are the main physical works related to the project. The Nuclear Plant provides process heat to the Adjacent Plant where it is converted to electrical power and/or heat as per client requirements. There are no services from the Adjacent Plant required for the safe shutdown of the Nuclear Plant. The description provided below is for a single reactor plant, which will likely be the case to meet CVEA's needs. If more energy is needed, multiple reactors can be placed in a single Nuclear Plant site and share the Adjacent Plant.

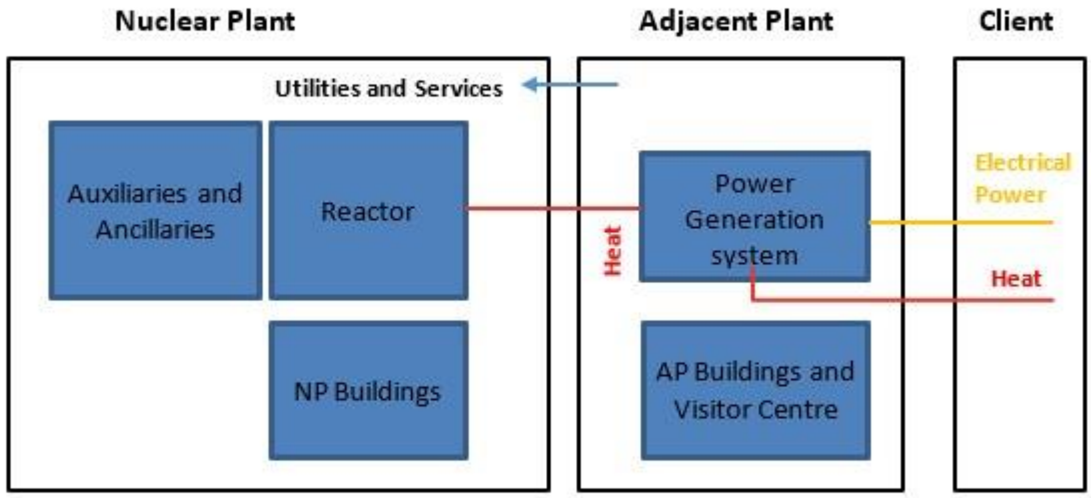

Exhibit 3-1: MMR facility block flow diagram

The Nuclear Plant uses a closed helium cycle that is contained within the reactor vessel assembly. The helium removes the heat generated by the nuclear reactor during normal operation. Helium passes through the nuclear core and is heated by the controlled nuclear fission process.

The selection of helium as the heat transport choice for the MMR presents several advantages. Helium is an inert, radiologically transparent, single-phase gaseous coolant with no flashing or boiling possible. There are no reactivity effects associated with helium. Helium has no chemical reactions with the interfacing components such as the fuel or reactor core components. Pressure measurements used for helium are accurate and pump cavitation cannot occur.

The heated helium passes through the Intermediate Heat Exchanger (IHX) and heat is transferred into the molten salt within the Nuclear Plant Molten Salt System. The cooled helium is recirculated back through the reactor core using an electrically powered circulator. Cold molten salt entering the Nuclear Plant passes through the Intermediate Heat Exchanger and is heated up by the helium. The hot molten salt is then transported from the Nuclear Plant to the non-nuclear facility, the Adjacent Plant. The Adjacent Plant uses the heated molten salt heat and then returns cooled molten salt to the Nuclear Plant. Exhibit 3-2 provides a simplified process diagram within the Nuclear Plant.

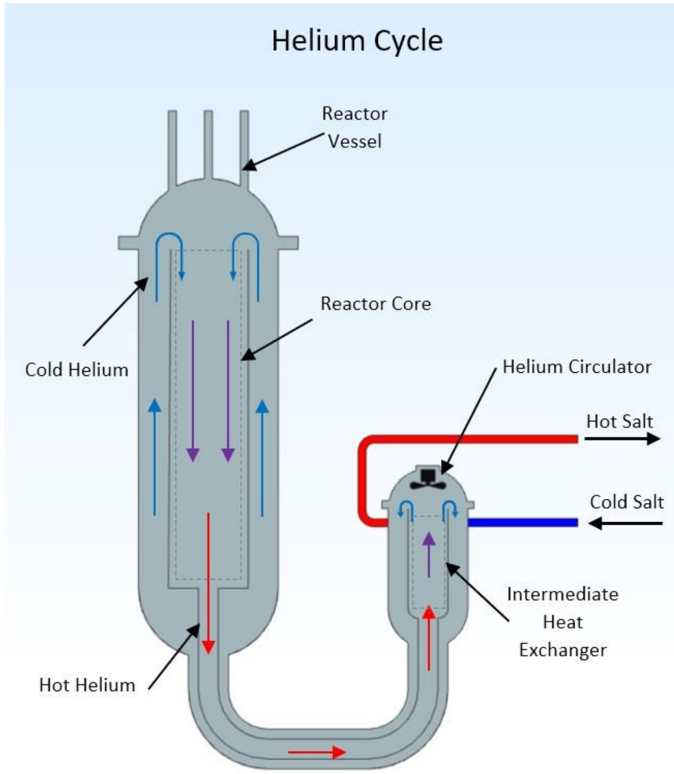

Exhibit 3-2: Nuclear plant, simplified diagram

The Adjacent Plant is a power plant generating power from the heat supplied by the Nuclear Plant. The Adjacent Plant contains all the equipment to generate electrical power and supply it to the customer. The Adjacent Plant can also supply process heat to customer applications as required. A simplified diagram is provided in Exhibit 3-3.

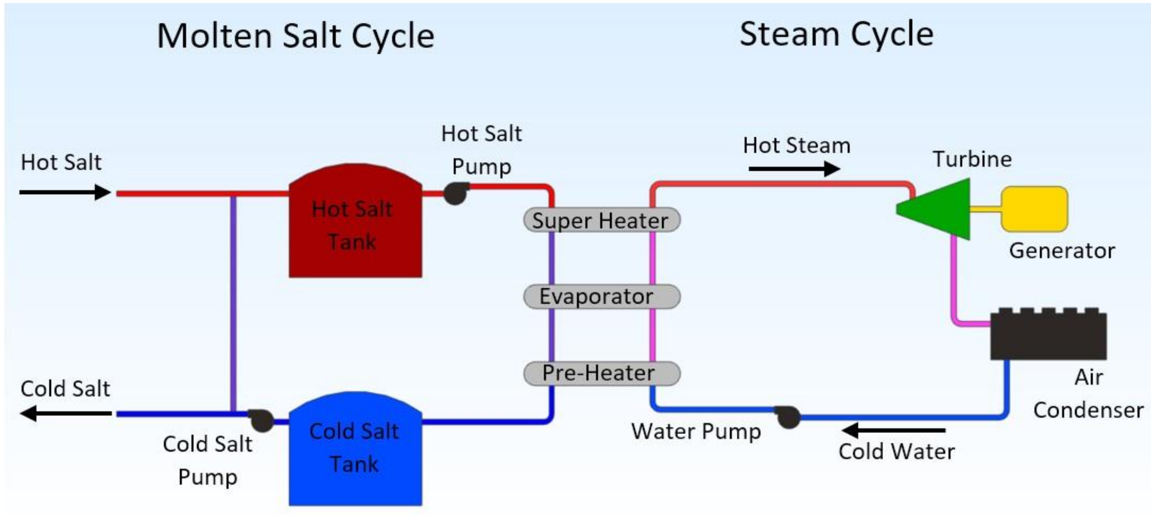

Exhibit 3-3: Adjacent plant, simplified diagram

3.2 NUCLEAR PLANT

The Nuclear Plant contains the Nuclear Building and the Citadel Building which houses the MMR reactor and its associated Nuclear Heat Supply System. A secure perimeter is established around the entire Nuclear Plant. The fence around the Nuclear Plant marks the site boundary. Access to the site would be controlled and monitored.

3.2.1 Nuclear Heat Supply

The main function of the Nuclear Heat Supply System is to remove heat generated by the reactor core and transfer it to a secondary loop by means of the Intermediate Heat Exchanger. The Nuclear Heat Supply System also provides reactivity control in the reactor core, long-term burnup compensation and low power control during startup through the operation of the control rods. The Nuclear Heat Supply System allows for passive removal of residual heat from the core. The Nuclear Heat Supply System includes the reactor, the hot gas duct, the Helium Circulator, and the Intermediate Heat Exchanger. It also forms the pressure boundary for the helium coolant. An illustration of the Nuclear Heat Supply System is provided in Exhibit 3-4. High temperature molten salt is used in the secondary loop.

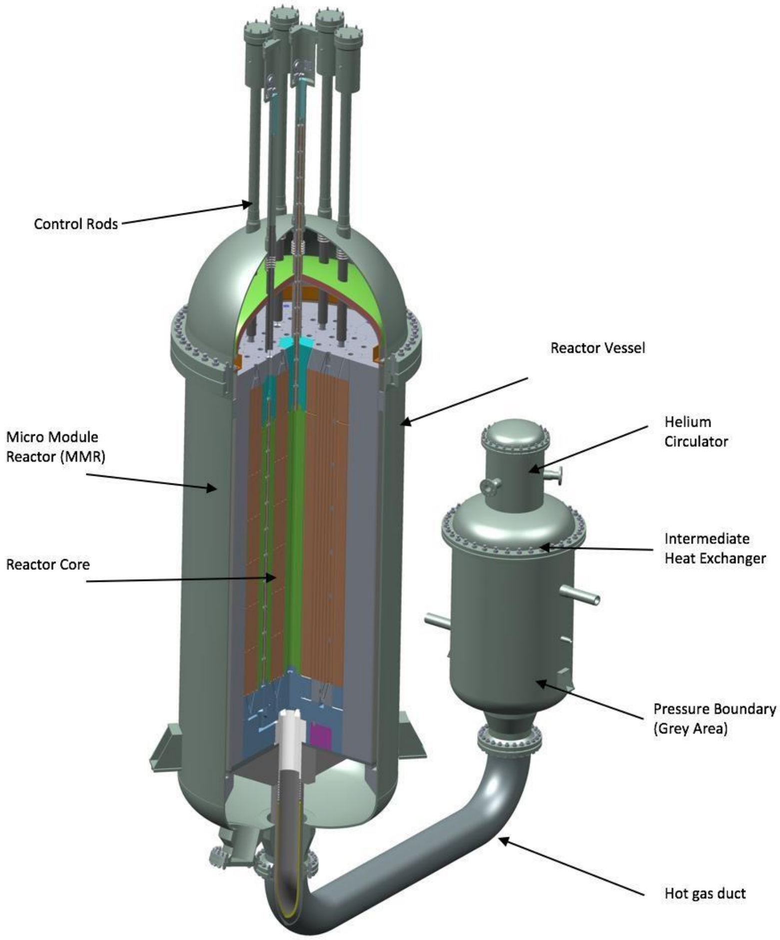

Exhibit 3-4: Schematic of the nuclear heat supply system

3.2.2 Reactor Fuel

The MMR fuel, referred to as FCM fuel, contains low-enriched uranium. The fuel is manufactured with Tri-structural Isotropic (TRISO) fuel particles whose primary purpose is to retain fission products. The TRISO is bonded together in a Silicon Carbide matrix to form FCM fuel pellets. FCM is an extension of a reliable and historically proven technology resulting in two extra and very strong barriers against radioactivity release. FCM provides containment of radioactive materials during operations and accident conditions. It is highly proliferation resistant and provides environmental protection during and after operations. Exhibit 3-5 illustrates the FCM fuel concept.

The FCM fuel will be fabricated in a separate fuel fabrication facility.

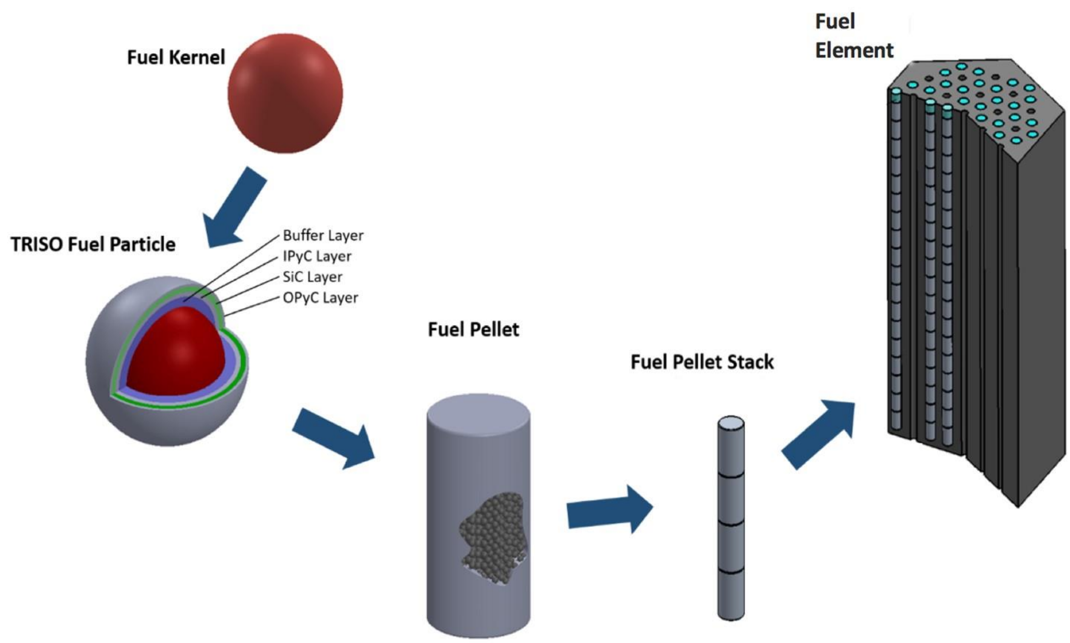

Exhibit 3-5: The FCM and fuel elements

3.2.3 Reactor Core

The Reactor Core consists of hexagonal graphite blocks containing stacks of fuel pellets and full-length channels for helium flow, together called fuel elements (Exhibit 3-5). The hexagonal fuel elements are stacked to form columns, which rest on support structures in the reactor.

The core provides adequate coolant flow paths for heat removal and the graphite material itself assists with further heat removal. The graphite core provides a neutron moderation and reflection function. The core also provides for areas for insertion of control rods. The MMR reactor core has a low power density and a high heat capacity resulting in very slow and predictable temperature transients.

3.2.4 Citadel Building

The Nuclear Heat Supply System (including the reactor core) is housed in a vertical cylindrical concrete structure, named the Citadel Building (Exhibit 3-6). The Citadel Building protects the reactor and the Intermediate Heat Exchanger from hazards (both external and internal to the Citadel Building) and the Citadel Building wall provides biological shielding which mitigates against possible radiation exposure from the reactor.

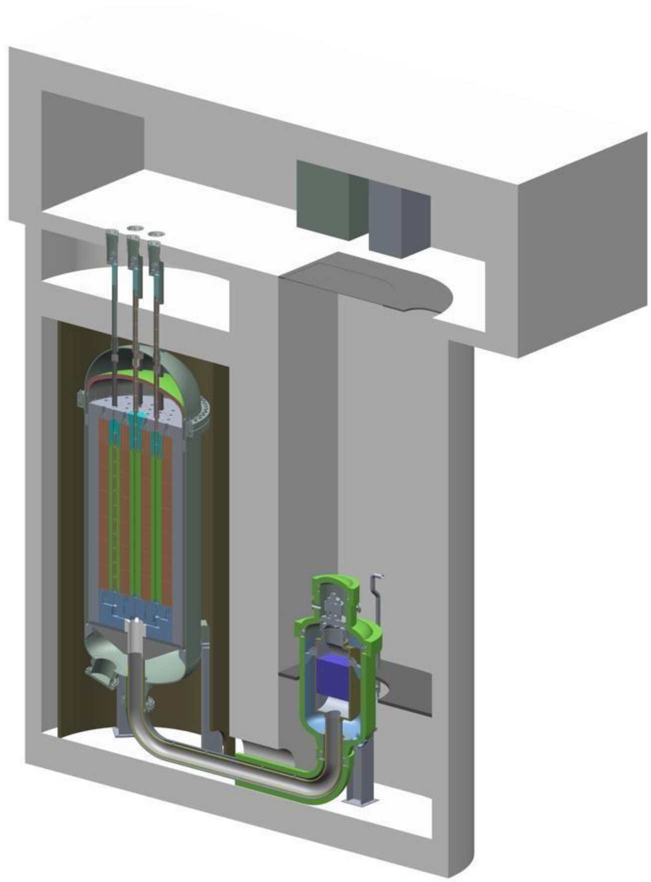

Exhibit 3-6: A typical citadel building

3.2.5 Nuclear Building

The Nuclear Building is constructed on top of the Citadel Building and contains supporting equipment to operate the plant.

3.2.6 Molten Salt System

The Nuclear Plant Molten Salt System is a system of pumps and pipes that connects to the Nuclear Heat Supply System and transfers heat through circulating molten salt to the Adjacent Plant Molten Salt System (discussed in Section 3.3.1). The Nuclear Plant Molten Salt System can be isolated/disconnected from the Adjacent Plant, if required.

3.2.7 Waste Handling and Storage Area

The Waste Handling and Storage area within the Nuclear Plant includes provision for the processing, packaging and storage of Low-Level Waste and Intermediate Level Waste. Low and Intermediate-Level Waste will be packaged and stored on site or periodically transported off-site to be managed at an appropriately licensed facility and, where required, would be transferred for long-term management and storage. Waste management plans will be developed to provide estimates of the waste volumes, characteristics and further assess suitability for on-site disposition.

3.3 ADJACENT PLANT

The Adjacent Plant buildings contain the equipment required for the generation of electricity from the heat supplied by the Nuclear Plant and to interface with any customer end use facilities. Access to the site would be controlled and monitored. The buildings are enclosed within a dedicated fence.

3.3.1 Adjacent Plant Molten Salt

The Adjacent Plant Molten Salt System acts as an intermediary to transport the heat generated in the Nuclear Plant and transfer it through heat exchangers to a Steam Cycle for the purpose of generating power and the supply of heat for customer applications.

The Adjacent Plant Molten Salt System consists of pumps and pipes containing molten salt as well as hot and cold storage tanks. These tanks serve as an energy storage system and help to regulate the flow of molten salt. The molten salt is pumped to the hot storage tank from where it can be pumped to a steam generator. The steam generator to be used is standard commercial off-the-shelf plant equipment identical to that used within a Concentrated Solar Plant. The molten salt is then transferred to a cold storage tank before it returns to the Nuclear Plant for reheating.

The Adjacent Plant Molten Salt System can be disconnected/isolated from the Nuclear Plant, if required.

3.3.2 Steam Turbine Generator

The function of this system is to generate electricity from the heat supplied from the Nuclear Plant via the molten salt. The Power Generation System consists of the turbine generator and supporting infrastructure. The Adjacent Plant will have a main electrical grid connection for export of the electrical power generated via transmission infrastructure, which will be confirmed once the site location has been finalized. Additionally, there will be an auxiliary grid connection to provide station power when the main connection is not available.

3.3.3 Air Cooled Condenser System

In the operation of the steam turbine, water is heated to steam from the heat received from the molten salt. The steam is then used to power the turbines that generate electricity. The steam within the power plant is condensed to a liquid state before it can be re-used in a closed loop arrangement. The excess heat that is removed during steam condensation is dissipated to the atmosphere via air cooled condensers or dry cooling towers that do not use any form of external water source for operation, such as a lake or river system. The cooled condensate is then returned to be heated again by the molten salt.

3.4 MODULARIZATION

The MMR facility uses standardized modules which will be to the extent possible assembled, commissioned and tested off-site, prior to transport, and then installed at site. Piping, cabling, lighting, etc., will be included in the modules with specific interfaces for ease of connection during installation. Minimum work is foreseen for assembling the modules at site.

Similarly, pre-cast concrete structures may be used, which reduces the need of on-site pouring of concrete, thus reducing the number of cement transport vehicles and their associated greenhouse gas emissions.

The modules will be sized to allow usage of standard International Standards Organization shipping containers to expedite transport and site installation. This sizing of the modules is the same as what is used for regular road transport and thus minimizes the impact to traffic on local roads during transport to site.

4. LICENSING FRAMEWORK AND STRATEGY

For a nuclear plant to be sited, permitted, and obtain regulatory approval, it will require the alignment of multiple approvals, and state and federal regulatory requirements. There is no fast path, workaround, nor total assurance in securing any of these. However, the odds of achieving them can be more successfully realized with thoughtful planning and execution.

This section provides an overview of the licenses required from the U.S. Nuclear Regulatory Commission (NRC) and state and local level approvals.

4.1 NATIONAL LICENSING

The NRC is the federal government entity that regulates commercial nuclear power plants, including the licensing of new nuclear plants. The process to license a nuclear reactor is described in code 10 of federal regulations (CFR) Part 50. It is a two-step process that consists of applying for a construction permit and then applying for an operating license. The licensing process is a lengthy and complex process, spanning years with many document submittals and public meetings. Efficiently navigating the NRC licensing process is key to the schedule for deploying a new nuclear plant. A detailed federal licensing strategy would be developed during future phases of this project.

4.2 ALASKA LICENSING BACKGROUND

In addition to the NRC, Alaskan state and local licenses must be understood and obtained. Alaskan Statutory Authority on Nuclear DEC Permit Requirement A from the Department of Environmental Conservation (DEC) is needed prior to the development of a nuclear facility or nuclear fuel under AS 18.45.025(a). In this portion of the law the DEC is required by this statute to adopt regulations for governing the issuance of permits. Permits may not be issued until the municipality with jurisdiction over the proposed facility site has approved the permit.

The DEC currently does not have a nuclear division and so obtaining appropriations to develop a nuclear department within the DEC will be a barrier to deployment if Alaska statute is not amended. The DEC has interpreted their responsibility to develop a nuclear department as contingent on 1) an Alaskan nuclear developer's successful completion of the NRC permitting process, and 2) legislative appropriation of funding for the program. The elimination of this permit requirement could save the state funding. Such a change would be in line with the majority of the lower 48 as only 14 other states expressly limit nuclear construction in the state rather than leave safety and the environmental considerations to the NRC to address during the licensing process.

Alternatively, if the requirement is not eliminated, it would be advantageous to appropriate funding for a DEC nuclear department prior to the completion of the NRC permitting process to avoid excessive delays between completing federal licensure requirements and defining the standards for state compliance. Under the current law, DEC would not begin the process of developing a nuclear department until a license has been awarded by the NRC. The process to obtain legislative approval of appropriations for a nuclear department, develop the nuclear department, and then process a request within the department would likely be lengthy and would add significant development delays. Such a protracted process should be avoided if possible.

AS 18.45.025(b) requires a law to be passed by the legislature for the specific site where a nuclear reactor will be located. This statute was amended and signed into law in May 2022 by the Governor of Alaska. The Senate Bill 177 is entitled "An Act relating to nuclear facility siting permits; and relating to microreactors." This previous portion of AS 18.45.025 (b) required legislative approval to "designate by law the land in the state on which a nuclear fuel production, nuclear utilization, nuclear reprocessing, or nuclear waste disposal facility may be located.[1]

With the amendment through SB 177 an exemption was created for microreactors (defined as less than 50 MW_e) from the requirement that the legislature approve of each microreactor site. The bill in no way provides any assurance for the siting, construction and operation of a microreactor, but it eliminates barriers for an interested community to be able to explore the feasibility of having a microreactor. The portion of AS 18.45.025 remains that the municipality that has jurisdiction over the proposed site must give its approval before any project can be permitted thus ensuring that any projects that come to the Department of Environmental Conservation for siting will be community driven.

4.2.1 Tribal Policies that May Affect an MMR Project

Unlike the lower 48 states, there have been few historic attempts to isolate Alaskan Native populations onto reservations in Alaska. Rather than a reservation system, the Alaska Native Claims Settlement Act ("ANCSA") addressed the distribution of land to Native Alaskans in 1971. The ANCSA created Native Corporations and

[1] Alaska Statutes: AS 18.45.025. Facilities Siting Permit Required. (touchngo.com)

transferred federal funds and approximately 44 million acres in Alaska to Native Corporations. Native Corporations were broken down into regional Native Corporations and village Native Corporations. Under this arrangement, village corporations were granted the surface rights to the lands they selected and regional corporations were granted the subsurface rights of both their own selections and of those of the village corporations. Alaska Native village corporations are owned by Alaska Native shareholders and hold title to nearly 17 million acres of land across Alaska. Alaska Native village corporations manage the land for the benefit of their shareholders. There are 174 Alaska Native village corporations in Alaska, which are separate entities from Federally Recognized Tribes.

Native Corporations do not possess sovereign immunity because they do not fulfill key attributes of an independent and self-governing Indian tribe. Lands that have gone through the Alaska Native Claims Settlement Act are likewise not considered “Indian country” over which a tribe has jurisdiction. Land owned by Native Corporations may be regulated by the state because it is not categorized as “Indian country”.

Native Corporations have significant political and financial sway. Native Corporations account for a third of Alaska’s 50 largest companies and have the ability to generate significant financial and political support. Native Corporations are also considered tribes for limited purposes including certain federal tax benefits. Native Corporations may be pursued as joint venture partners, and local Native Corporations should be contacted early in the process of determining a demonstration location to gauge interest in nuclear development and address any concerns. Early involvement is important to ensure local stakeholders are appropriately engaged in the project.

5. SCENARIOS FOR MMR APPLICATIONS WITHIN CVEA

Building an MMR to replace one of CVEA's fossil generators could significantly reduce carbon emissions in the winter months. The Cogen facility would be a good candidate for replacement because of the MMR's similar size and ability to supply higher temperature heat.

The Cogen plant is rated at 5.2 MW_e. A Solar Taurus 60 turbine produces electricity via burning LSR (also called naptha). The waste heat exits the turbine at 850°F and is sent to an industrial heat user.

With the existing electric and thermal load, there is some excess MMR capacity that could be utilized. Assuming a thermal efficiency of 33%, the electric load requires 15 MW_{th}. Considering the existing industrial heat load means that the MMR must have a capacity of at least 25 $MW_{th.}$ The MMR facility would require two 15 MW_{th} reactors.

5.1 CONSIDERATIONS FOR REPLACEMENT OF COGEN

Several parameters need to be accounted for to create a holistic understanding of where the MMR might be sited and how it might be used.

First, the area electric load is small relative to MMR size. Cogen is currently not needed in the summer months and rarely runs at full power. The MMR facility would also have a low utilization rate if it were to step in as a replacement for Cogen. As such, finding users for energy to increase the MMR facility utilization would improve the economics of the system.

Other solutions for economic improvements would be to connect to a larger transmission network, such as the Road Belt tie.

Another consideration is that the Alyeska Pipeline Service Company expects to continue historical trends and increase electricity generation at the vapor power plant within the VMT. If this power increase is realized, there will be even less electric load for the MMR. Alternative energy buyers would introduce an extra revenue stream further decreasing the electricity cost for end users.

5.2 POTENTIAL MMR FACILITY LOCATIONS

Potential MMR sites were evaluated in two locations: one in Valdez and one in Glenallen.

This section incorporates work done by Electric Power Systems Inc. (EPS) and subcontractors under EPS' supervision.

5.2.1 Valdez Site

Valdez presents as an ideal location because much of the infrastructure already exists, and a potential heat off-take customer is in close proximity to the area.

Within Valdez, there were three proposed sites. The site locations (provided by CVEA) coupled with EPS Tsunami hazard map is shown in Exhibit 5-1. These include the Richardson, Harris, and Mountain sites. The Mountain site shows the most promise due to the absence of obvious geohazards. The Harris and Richardson sites are both within the tsunami hazard zone and the Lowe River floodplain based on hazard maps published by the State of Alaska. Acquisition of each of these sites would need to be considered when selecting the optimal site.

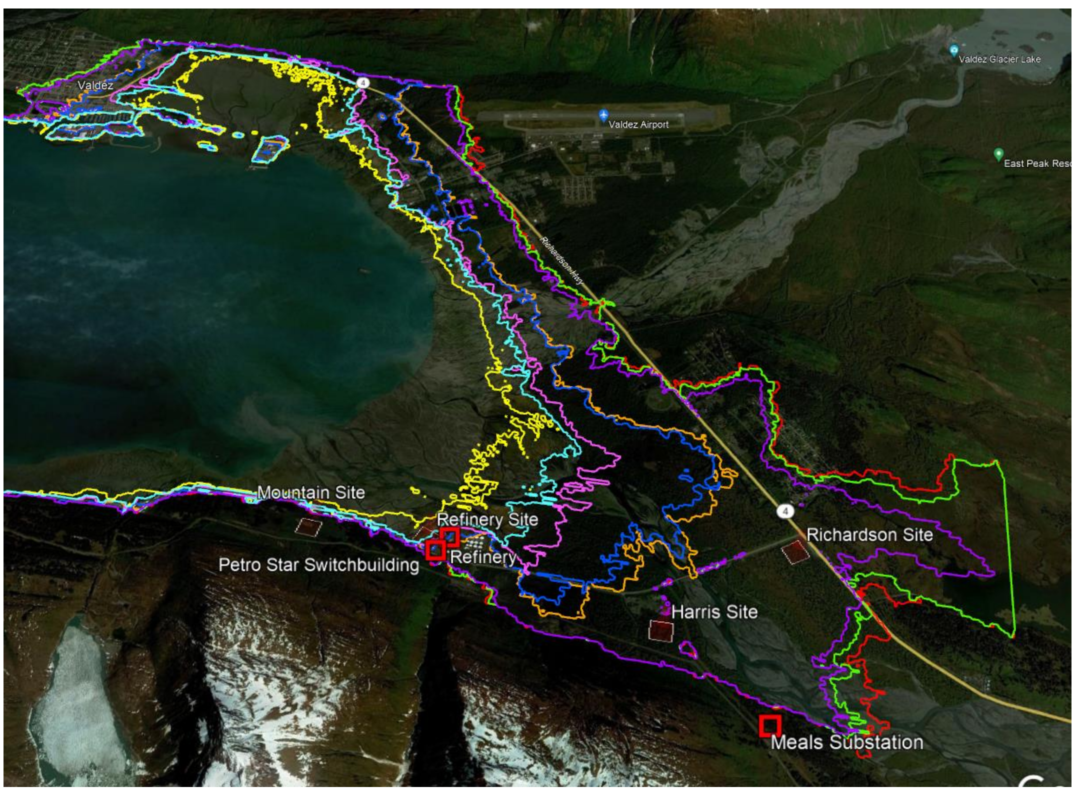

Exhibit 5-1: Valdez area tsunami map with the three sites (Mountain, Richardson, and Harris). Lines show tsunami ingress from different studies.

5.2.1.1 Tsunami Report

The following is a summary of a report produced by Northern Geotechnical Engineering, Inc. titled "Preliminary Review of Tsunami Hazards for Port Valdez, Alaska" and dated 23 Aug 2022, referred to as "The Report" in this section. The complete document is presented as a companion to this document.

The Report was commissioned by EPS and is specific to the tsunami hazards expected in the near vicinity of Port Valdez. The Report is intended to assist in the preliminary selection of a potential microreactor power generation site(s).

In The Report, Northern Geotechnical Engineering specifically noted a well-established pattern of seismicity in the region, primarily due to the well-known Alaska-Aleutian Subduction Zone. In addition, the Prince William Sound area in which Valdez is located is known for geotechnical conditions that may lead to large scale submarine or subaerial landslides. All these events may generate tsunami waves that can affect the Valdez area.

Since 1899, a total of seven tsunami events were found to have been recorded in the Valdez arm, including the 1964 event that destroyed the entirety of the town. This Mw9.2 earthquake resulted in substantial subsidence and lateral shifting of the port and multiple tsunamis were generated, including two from nearby submarine landslides and several others from the deformation of the ocean bed. Damage from the event was noted as high as 220 ft elevation at one location in the Valdez Arm and large-scale flooding occurred throughout the low-lying areas.

Based on the local and regional geology, further tsunami events are considered likely to occur during the lifespan of any substantial infrastructure project in the Port Valdez area. Because it is difficult to accurately predict the size and frequency of these events, the authors recommend using a "worst case scenario" based on the numerically modeled water inundation distance maps completed by others (Nicolsky, et.al., 2013). An extensive appendix of various water inundation maps from modeling are included in The Report. The maps include the potential effects of a variety of scenarios based on risks of both seismic activity and large submarine landslides that may occur in the near area.

The conclusion of the authors is that any location suitable for further studies must be located outside of predicted water inundation zones as shown in the map included as Appendix F15 in The Report. This map includes the maximum predicted extent of the currently predicted tsunami risks in a combined format. It is specifically noted that most of the land outside the inundation zones is currently built up with varying levels of well-developed infrastructure, including the town site, airport and oil terminal.

5.2.1.2 Seismic Report

The Gulf of Alaska, where Valdez is situated, is known for high seismic activity. USGS probability estimates are in the highest category on their published mapping, showing a potential for greater than 250 damaging earthquakes in a 10,000-year period. Design short term ASCE-7 (Ss) and 1-second (S1) accelerations are comparable to San Francisco, an area similarly known for high seismic activity (see Table 1 and Exhibit 5-2). Valdez experienced extreme regional damage during the 1964 earthquake and following tsunami.

Further development of the project site would require development of site-specific horizontal and vertical response spectra following onsite geotechnical analysis. ASCE design category IV, the highest classification provided for critical public infrastructure, would be the basis for non-essential systems such as the molten salt storage system, the steam generator, and personnel working areas. NRC regulated sections of the facility would require adherence to NRC Regulatory Guide (RG) 1.29, *Seismic Design Classification for Nuclear Power Plants* and other applicable standards[2]. These standards typically lead to a reduction or elimination of ductility factors used in seismic design calculations. Stiff, compact structures are favorable for designs with reduced ductility factors to avoid extreme local accelerations within structures.

Table 1 Seismic Activity in Valdez, AK compared to San Francisco, CA

ASCE-7 Design Values*	Valdez, Alaska	San Francisco, CA (Comparative)
S_S (short term acceleration)	1.57	1.57
S_1 (1-second acceleration)	0.74	0.6

[2] https://www.federalregister.gov/documents/2021/08/02/2021-16343/seismic-design-classification-for-nuclear-power-plants

S_{MS}	1.65	1.74
S_{M1}	1.97	1.76
S_{DS}	1.1	1.16
S_{D1}	1.32	1.17
T_L	16	12
PGA_M	0.53	0.59
V_{S30}	260	260

*Assumed seismic design category IV, Soil class D for comparative purposes.

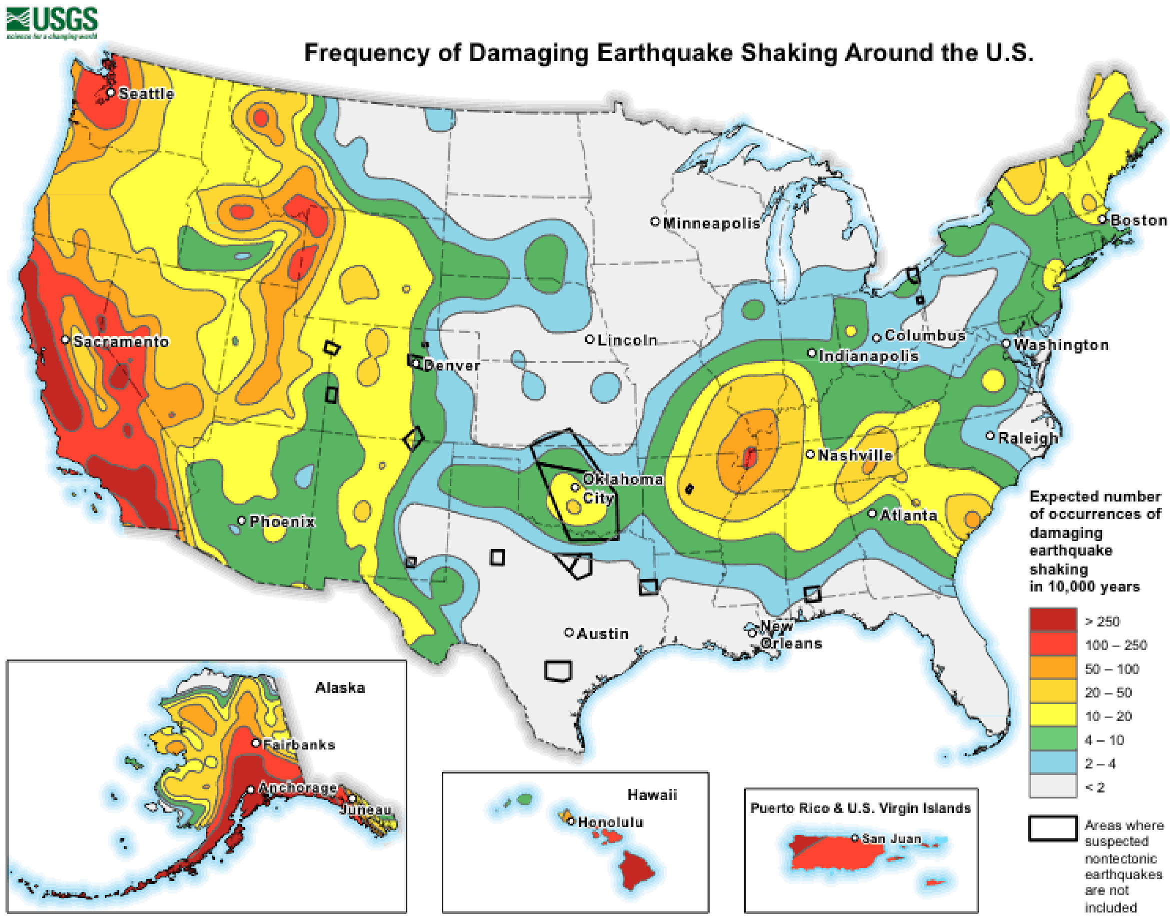

Exhibit 5-2 Seismic activity in the U.S.

5.2.1.3 Civil Review of Valdez Mountain site

RECON LLC, under subcontract with EPS, completed an initial evaluation of five specific sites provided by EPS for review. The following summarizes the findings.

Although the report is focused on an initial assessment of site constructability, it also addresses potential geohazards that may need to be further evaluated. Based on currently available information regarding tsunami inundation and flooding, the three sites located within the mapped area of potential impacts by these known geohazards have been eliminated from further review. These “at risk” sites are identified as the following:

- Richardson Site
- Harris Site
- Refinery Site.

The sites remaining are the Mountain Site and the Meals Substation Site. Although the Meals Substation Site was not specifically identified for consideration, it has been included due to RECON's determination of its potential suitability and desirable location.

The two sites evaluated are located southeast of the Port of Valdez at the head of Valdez Arm. Access is via Dayville Road. Both sites are within the city limits of Valdez in areas either zoned Public Use or Heavy Industrial.

5.2.1.3.1. Mountain Site

This site is located at approximately Mile 3 of Dayville Road. The site is on a bedrock bench at the toe of Sugarloaf Mountain, and is situated between Dayville Road, which is located in the upper intertidal zone, and the Trans Alaska Pipeline, which is located approximately 600 feet upslope from the site. Elevation of a potential development footprint is approximately 150 feet above sea level. The site is partially forested but mostly has a dense cover of alder brush. A small wetland area is located on the bench. Bedrock of moderate competence can be expected at shallow depths with a cover of mixed soils that may include colluvium and glacial till.

Development of an access road from the highway to the development site will require a new approach on the highway, and approximately 1500 feet of access road that would be benched and/or cut into the bedrock slope. Site preparation will likely require blasting to create a development area in the sloping and uneven bedrock terrain. Groundwater may be shallow, but sporadic due to the high rainfall and runoff from the mountain slope.

5.2.1.3.2. Meals Substation Site

This site is located approximately one mile southwest of Mile 1 Dayville Road. The site is on a bedrock bench at the toe of Sugarloaf Mountain and roughly 800 feet from the Lowe River floodplain. The site is adjacent to the Trans Alaska Pipeline and the CVEA intertie. The Meals Substation in located in the immediate vicinity of the site and at roughly the same elevation of approximately 300 feet above sea level. The site is mostly forested with mature conifers. A natural drainage and small wetland area are situated immediately adjacent to the site but may be avoided. Bedrock of moderate competence can be expected at shallow depths with a cover of mixed soils that may include colluvium and glacial till. There is presently access to the site via a 0.3-mile gravel road from the highway to the pipeline service road and thence on the pipeline service road for 0.8 miles to Meals Substation. From the substation, access to the site may include an additional 0.2 miles of road construction. Given the pipeline service road has a section with grades exceeding 15%, it may be necessary to construct approximately 3000 feet of new access road that would be benched and/or cut into the bedrock slope. Site preparation will likely require blasting to create a development area in the sloping and uneven bedrock terrain. Groundwater may be shallow, but sporadic due to the high rainfall and runoff from the mountain slope.

5.2.1.3.3. Civil Work Conclusion

The primary purpose of this initial site evaluation is to assess project area conditions and determine constructability for the intended site development. Both the Mountain Site and the Meals Substation Site appear to be suitable from a constructability standpoint. The few potential geohazards are similar for each site and will require further investigation as the project advances.

5.2.1.4 Electric Transmission from Mountain Site

For the evaluation, it is assumed the electrical interconnection point will be at the Meals Substation. The following electrical components will be required:

- Plant Substation
- Distribution Line from Plant to Meals
- Tie Breaker at Meals Substation.

The plant substation will consist of a 10 MVA step-up transformer to convert the plant's generation voltage to the CVEA 24.9kV distribution voltage. There will also be a low side breaker/disconnect switch and high side transformer breaker.

A new express line will be constructed from the plant location to the Meals Substation. The line will be constructed similar to the existing Meals to Solomon distribution line, with the final distance to be determined by the location of the new plant.

A new feeder break will be added at the Meals Substation to provide for a dedicated USNC electrical tie point.

The load flow analysis in Exhibit 5-3 shows the MMR facility operating at 10 MW_e electrical load, interconnected at the Meals Substation. Generation and loads are based on the model's existing loading scenarios as provided to EPS from CVEA. The location of the plant will offset existing generation on the distribution and transmission lines and will have no adverse effects on the system.

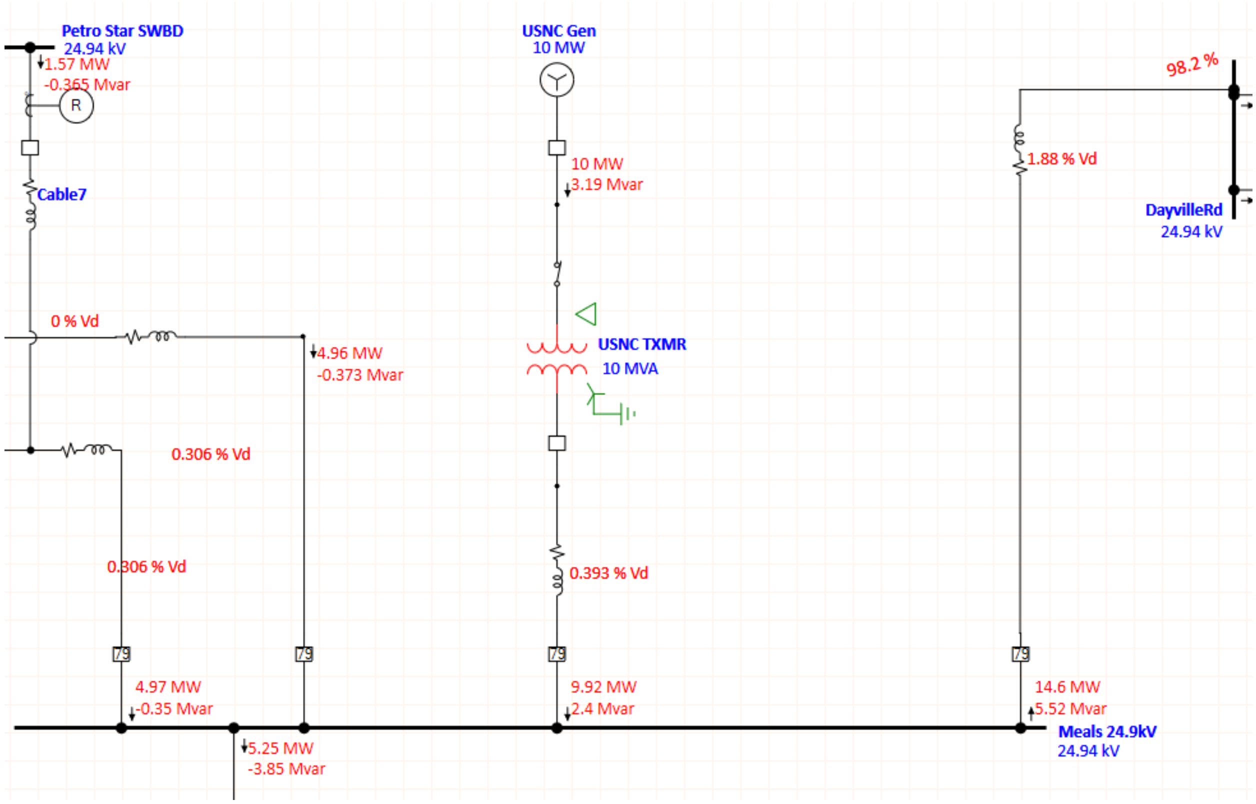

Exhibit 5-3: Transmission design from MMR to Meals Substation

5.2.2 Glenallen Site

A preliminary evaluation was also performed for a site near Glenallen. The general site, a substation along TAPS south of the Glenn highway, is shown in Exhibit 5-4. Land ownership was investigated, and it was found that several private lots were located between the proposed site and the Richardson highway, as shown in Exhibit 5-5.

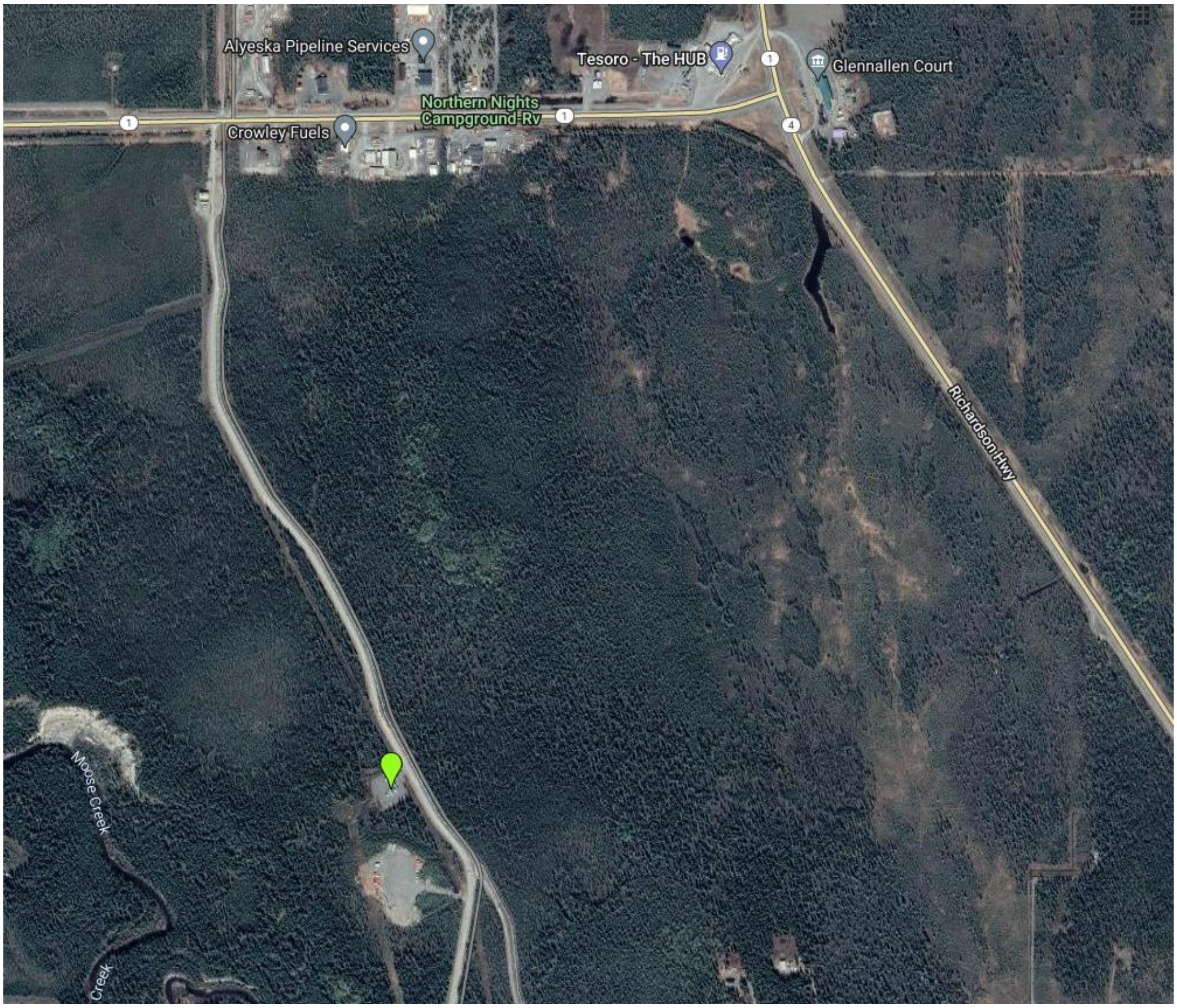

Exhibit 5-4: General Glenallen site location, general view

Exhibit 5-5: Glenallen site location, in red box, with private lines drawn. Immediately surrounding the site is federal land.

The Glenallen site was not investigated in as much detail because an off taker of heat was not identified. If a heat off-taker can be identified near this site, additional site investigation is recommended. See the economic evaluation of the Glenallen site for more detail.

To site an MMR at the Glenallen location, it would be necessary to investigate the covenants, access, and easements associated with the private lots highlighted in Exhibit 5-5. Understanding if one of the private lots could be acquired for utility/power plant use and if transmission infrastructure across federal land to the TAPS substation would need to be investigated further.

6. FINANCIAL ASSESMENT OF THE MMR FACILITY

The financial fitness of each site was evaluated under several economic sensitivities was evaluated to understand the economic options for adding an MMR. This includes different plant operating modes, various tax credits the project might be eligible for, and different ownership structures.

The MMR facility evaluated in this section had two 15 MW_{th} reactors at the site. The cost of a 5 MW_e adjacent plant was used. Two units were needed to match the heat and electricity generation that Cogen currently provides.

6.1 MMR FACILITY OWNERSHIP STRUCTURE

There are two options for owning an MMR that serves CVEA customers:

- USNC (and potential investment partners) own the plant in a special purpose vehicle that contracts with CVEA,
- CVEA owns and operates the plant.

Under USNC ownership, a power purchase agreement (PPA) would be negotiated between CVEA and the USNC ownership entity. This ownership would mean that CVEA does not need to furnish the capital expenses to build the MMR facility. The disadvantage is that the USNC ownership entity would not be tax exempt and would likely not be eligible for some of the government incentives and grants that CVEA would be eligible for. This means a higher PPA price for electricity relative to CVEA ownership.

The second ownership structure, in which CVEA owns the MMR facility, would take advantage of CVEA's tax exempt status on revenue and reduce the overall electricity cost relative to USNC ownership. In this structure, CVEA would purchase the reactor, own it, and could contact the operating and maintenance services with USNC. It is possible that CVEA ownership advantages could be realized with a CVEA subsidiary.

6.2 INFLATION REDUCTION ACT TAX CREDIT ELIGIBILITY

The Inflation Reduction Act (IRA)[3], which was recently signed into law, has several tax incentives that this project will be eligible for. The IRA extends tax credits to

[3] https://www.congress.gov/bill/117th-congress/house-bill/5376/text

include all electricity generating technologies that do not directly emit CO_2 emissions. A nuclear facility would qualify under this definition.

The clean electricity investment tax credit (ITC) starts at a tax credit of 6% of capital expenditure with increasing rates for meeting certain incentives. The rate is increased to 30% when regional prevailing wages are met for workers during construction of the facility, as well as a percentage of construction labor coming from apprenticeships.

The tax credit can be increased further by two bonus criteria: building in an energy community and utilizing domestically produced content during construction of the facility. The U.S. government defines an energy community as locales that have historically had a high reliance on oil and gas jobs. The non-metro Alaska census area is designated as an energy community[4]. To meet the energy community requirement the unemployment in the region must be higher than the national average. If energy community conditions are met, the project is eligible for an additional 10% tax credit.

The IRA also offers a bonus for using domestically produced content in the construction of the facility. To earn this credit the facility must use U.S. produced steel, iron, or other manufactured goods. There is an exemption when domestic goods are 25% more expensive than non-domestic alternatives. Qualifying for the domestic content adds an additional 10% bonus credit. If all the bonuses are met, the project would be eligible for up to 50% of the capital cost.

For tax exempt organizations, such as CVEA, there is an option to take the tax credit as a direct payment. The IRA defines entities that may take direct payment as only "only tax-exempt organizations, a State or political subdivision thereof, the Tennessee Valley Authority, Indian tribal governments (as defined in Section 30D(g)(9)), any Alaska Native Corporation (as defined in Section 3 of the Alaska Native Claims Settlement Act), or any corporation operating on a cooperative basis which is engaged in furnishing electric energy to persons in rural areas."

To receive the direct payment for a project larger than 1 MW after 2026, the domestic production content bonus must be met. Direct pay credits are transferrable.

The IRA allows the owner/operator to take either an ITC, or a production tax credit (PTC). If wage and apprenticeship requirements are met, the PTC starts at 2.6c/kWh_e indexed for inflation. The PTC is also eligible for domestic content and

[4]https://energycommunities.gov/priority-energy-communities/

energy community bonuses. The PTC can be claimed for 10 years. To be eligible for the ITC or PTC, the project would need to commence prior to 2032 or "the calendar year in which Treasury determines that the annual greenhouse gas emissions from the production of electricity in the United States are equal to or less than 25% of those emissions for calendar year 2022," whichever is later.

This analysis includes an ITC sensitivity with 0%, 30%, 40%, and 50% reductions in capital cost.

6.3 ECONOMIC EVALUATION OF COGEN REPLACEMENT

Economic analysis was conducted for each of the replacement scenarios outlined in this section. Each scenario was run with a USNC and CVEA ownership and for ITC allowances ranging from 0% to 50%.

The economics of deploying MMRs at each of the evaluated sites is strongly driven by the ability to sell heat and electricity for the highest portions of the year, as well as the distance the heat needs to be transported to the consumer. That is, year-round off take of all the heat and electricity generated by the MMR facility by a consumer near the MMR facility would provide the most economic deployment. For example, increasing interest in mariculture activities could develop into a heat off taker. The Alaska Mariculture Cluster, which has received support from Valdez, the State of Alaska, and US DOE, could benefit from the energy an MMR would provide year-round. In contrast, seasonal off take of only a portion of the heat or electricity generated from the facility would provide less favorable project economics.

CVEA ownership provides lower delivered electricity costs due to the favorable tax status as compared to ownership by a third party. The Investment Tax Credit has the potential to dramatically reduce the delivered electricity cost for either ownership model.

6.3.1 Comment on Impacts of VMT Power Export

The Alyeska Pipeline Services Company anticipates larger exports of energy from the power vapor facility at VMT. Using this electricity would lower the electricity utilization rates at the MMR facility. If power export does increase from VMT, selling heat would reduce the risk associated with increasing generation from VMT and stagnating load.

For the MMR facility, selling heat is generally advantageous. The reactor produces a large amount of high temperature heat very efficiently and selling heat avoids the losses associated with converting thermal energy to electricity. The economic analysis in this report was performed using a 5 MW_e turbine, but the same plant could be sized with an even smaller turbine if necessary.

7. CARBON EMISSION CONSIDERATIONS

7.1 AVOIDED EMISSIONS IN ALASKA

CVEA currently generates approximately 70% of its electricity from carbon-free hydro power with fossil fuels accounting for the other 30% of generation. The Cogen and Valdez and Glenallen diesel plants account for the entirety of CVEA's direct greenhouse gas emissions. Collectively, the plants produce approximately 17,640 tons per year. The MMR would replace Cogen, which accounts for 88% of CVEA's yearly CO_2 emissions. Additionally, selling carbon-free heat from the MMR to a consumer could help that off-taker reduce carbon emissions.

7.2 MMR LIFECYCLE EMISSIONS

Nuclear plants have no direct CO_2 emissions because they use nuclear fission to produce electricity via steam rather than burning fossil fuels like traditional generators. The lifecycle emissions, or carbon emissions from all the materials, construction, and operation, for nuclear plants are generally very low.

A lifecycle analysis was performed that accounts for the emissions associated with uranium mining and enrichment, and fuel fabrication as well as inputs to build the MMR such as steel, concrete, and energy used during construction.

The emissions analysis found that the MMR had lifecycle emissions similar to wind and solar and well below fossil fuel levels. See Exhibit 7-1 for a comparison of lifecycle emissions for the MMR and existing technologies.[5]

[5] Lifecycle emissions from existing technologies come from an analysis by the National Renewable Energy Laboratory: https://www.nrel.gov/docs/fy21osti/80580.pdf

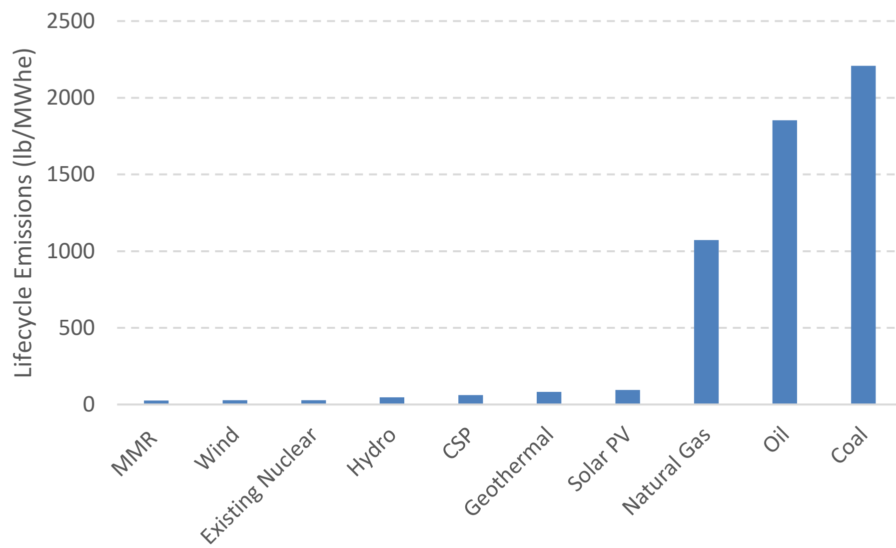

Exhibit 7-1: Lifecycle emissions of the MMR and other electricity generation sources

8. STAKEHOLDER ENGAGEMENT AND PUBLIC ACCEPTANCE

Siting a nuclear reactor, or any nuclear facility, is a challenging and complex enterprise. Over the decades, stakeholder views and values have carried significant weight in decisions around siting these types of facilities,[6] although many companies and government agencies generally prioritized technical readiness over stakeholder engagement.[7] USNC understands these complexities and assigns primary importance to the process of conducting meaningful stakeholder engagement in the planning and decision-making of siting an MMR.

USNC's corporate commitment to stakeholder engagement extends beyond gaining consensus or project buy-in, one-way sharing of information, or 'checking a box'. USNC aims to create a participatory space that allows opportunity for the expression of diverse perspectives and for the development of creative solutions to emerge. In this initial phase, USNC has reached out to interested and potentially impacted parties and begun a process intended to create familiarity and build trust and support. This has been done through a process characterized by information sharing, active listening, and two-way dialogue.

The range of stakeholders and communities of interest that were identified for this pre-feasibility study were selected both for regional proximity to the location of the proposed microreactor, as well as their affiliation with key state agencies, elected officials and Native Community affiliation. Of special interest to us at USNC was to ensure that our engagement was inclusive of all key interests, not just those who are easiest to reach. USNC's engagement activities focused on building relationships, actively listening to stakeholder and Alaska Natives' views, perspectives, and concerns, and providing information about the proposed project. Staff spoke with numerous individuals and organizations and attended multiple events to answer questions and provide answers on the project, technology, and feasibility study. We shared information, encouraged questions, and provided answers from November 2021 through August 2022. The engagement activities undertaken are in no way exhaustive; if CVEA's board votes to move forward with

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[6] Examples of this include opposition to the federal government's attempt to site the Yucca Mountain Repository for disposing of high-level radioactive waste and spent nuclear fuel in Nevada and the multiple attempts to site a consolidated interim storage site for spent nuclear fuel.

[7] Stakeholders are any individual, group of individuals, organizations, or political entity with a stake in the outcome of a decision. The public are those stakeholders who are not part of the decision-making entity or entities. Public participation is the process that involves the public in problem-solving or decision-making and that uses public input to make better decisions. https://www.iap2.org/page/ethics

the project, engagement activities will build upon these efforts and expand (see Section 8.2.2, for further discussion).

This chapter presents an overview of Alaska's unique history with nuclear issues, describes USNC's engagement activities, summarizes who USNC spoke with and what we heard, and discusses future opportunities for engagement, should the work continue past the pre-feasibility study stage.

8.1 UNIQUE ASPECTS OF ALASKA HISTORY AND ENGAGEMENT

Despite the enormous physical size of the state, the population is relatively small, and a culture of familiarity makes building trust and credibility a lengthy and earned process. Additionally, engagement work must respect Alaska Natives and their autonomy, as well as their unique cultural and historical perspective.

Alaska Natives have a unique relationship with the U.S. government that is different from the reservation system for federally recognized Native Americans in the lower 48. The 1971 Alaska Native Claims Settlement Act (ANCSA) required the creation of tribal corporations to be organized under Alaska law. ANCSA divided Alaska into 12 geographic regions. Congress enacted ANCSA in order to provide a means by which Alaska Natives could derive economic benefits from the resources around them.

ANCSA corporations are the largest private landowners in Alaska, with title to 44 million acres of selected land throughout the state. Development of the resources beneath their lands provides an opportunity to generate jobs and economic benefits for their Native shareholders and fulfil the implicit promise Congress made to Alaska Natives in exchange for extinguishment of their aboriginal claims. As such, it is critically important to connect with Alaska Native communities and to understand their unique history, context, and cultural landscape.

Ahtna, Inc. and Chugach Alaska Corporation are the two Alaska Native Regional Corporations closest to the proposed CVEA project. USNC focused efforts on reaching out to Ahtna and Chugach regional and village corporations, Alaska Native villages, Alaska Native regional non-profit organizations and other affiliated entities, since this project would occur on their lands.

In addition to the Alaska Native outreach, another key factor that must be accounted for when considering a nuclear project in Alaska is the state's history with nuclear weapons, nuclear power, and its impacts on Alaska Natives and local communities where the projects occurred. This history informs people's perception of nuclear energy and may influence views of the project under consideration. To better inform USNC's pre-feasibility study stakeholder engagement, the team conducted interviews with groups and individuals who bring a range of backgrounds and perspectives. The team also did extensive research on energy projects in the state, paying particular attention to four case studies selected for lessons learned and for impacts that may result from them. These are: Amchitka Island weapons testing, the Galena nuclear power plant, Project Chariot, and the Fort Greely Military Installation.

- **Amchitka Island Nuclear Weapons Testing**: Amchitka Island, located 1,340 miles west-southwest of Anchorage, was the site of three underground nuclear tests conducted in the island's deep subsurface in 1965, 1969 and 1971. Initial tests did not reveal significant radioactive contamination, but the site is now part of the U.S. Department of Energy (DOE) Legacy Management program, and DOE has conducted risk assessments for potential radionuclide releases into the marine environment. Of key concern was whether possible releases of radionuclides at the ocean floor posed risks to Alaska Natives through consumption of marine subsistence species. DOE's screening concluded that potential risk levels were "well below" the Environmental Protection Agency's most conservative risk threshold for both subsistence users and commercial catch consumers. Regardless of this finding of no significant impact, lingering trust and credibility issues and perceived lack of transparency with the federal government continue to impact people's perceptions of nuclear projects.
- **Galena Nuclear Power Plant:** The attempted 2008 siting of a nuclear reactor in Galena, located 550 miles northwest of Anchorage, provides another case study informing how nuclear in Alaska is contextualized. The Japanese company Toshiba offered the town of Galena a "free reactor" if the town paid operating costs estimated at 10 cents kw/hr. Toshiba tabled the project when it was unable to financially commit to the licensing process required by the NRC. While original costs of the reactor would have been minimal to Galena, had Toshiba donated the reactor, as permitting costs became clear (about $600 million), Toshiba raised the price of the reactor to $25 million and then subsequently raised it to $200 million. The town and Toshiba were unable to reach agreement and Toshiba eventually ended the project.
- **Project Chariot:** Project Chariot was an effort by the U.S. government to construct an artificial harbor at Cape Thompson, on Alaska's North Slope, by burying and detonating several nuclear devices. Although detonation never occurred, the site was used in a series of experiments to study the economic and environmental impacts of nuclear contamination. Radioactively contaminated soil from the Nevada Test Site (now the Nevada National Security Site) was buried in unmarked locations around the nearby Inupiaq Alaska Native village of Point Hope to study the movement of radioactivity through soil and

water.[8] Years later, a partial set of project documents was declassified, and a University of Alaska researcher helped discover that contamination remained. After pressure from the State of Alaska and the local population, DOE led a cleanup of the contaminated soil and water. Cancer remains the leading cause of death in Point Hope.[9]

- **Fort Greely Military Installation:** Located in central Alaska, this military installation housed a nuclear power plant which operated from 1962 until 1968 to supply electrical power and heating steam to the Fort. The plant also provided data on the economics of operating a nuclear power plant compared to conventional oil-fires systems in remote areas, where fuel costs are high and supplies frequently interrupted by weather. The U.S. Army Corps of Engineers (USACE) issued its Final Environmental Assessment and Finding of No Significant Impact in June 2021 for the decommissioning and dismantlement of the facility. In July 2022, the USACE awarded a contract to Westinghouse Government Services for decommissioning, dismantling, and disposal of the nuclear power plant over the next six years.

This history has fostered a lack of trust between Alaskans and the U.S. government and industry, which influences views on the risks and benefits of nuclear power. USNC is acutely aware of this history and seeks a different approach that does not damage the social, economic, or environmental health and safety of the communities impacted by this project.

8.2 ENGAGEMENT AND FINDINGS

8.2.1 Engagement Overview and Who We Wave Talked To

From November 2021 through August 2022, USNC and CVEA conducted one-on-one and group meetings, both virtually and in-person, engaged in numerous informal conversations, held public meetings and attended conferences and local events/meetings with stakeholders and Alaska Natives. USNC traveled to Alaska to meet with stakeholders and Alaska Natives on numerous occasions during this period.

Direct outreach was conducted to a broad range of stakeholders, including federal and state officials, ANCSA corporations, Alaska Natives, utility staff, university

[8] https://nuclearprinceton.princeton.edu/project-chariot

[9] "Inside the Government's Secret Plan To Nuke Alaska," All That's Interesting, January 3, 2018, https://allthatsinteresting.com/project-chariot

researchers, non-governmental organizations (NGOs), state level agencies, and others. Stakeholders and Alaska Natives that USNC and CVEA engaged with thus far are depicted in Table 2 below. Appendix A shows a complete list of stakeholders and Alaska Natives with whom both USNC and CVEA met as of August 2022. As noted earlier, the engagement activities that have occurred are a first step and should not be viewed as exhaustive.

Table 2: USNC and CVEA Stakeholder Engagement

Stakeholder Categories	Representative Organizations and Gatherings
Academia	Universities Community Colleges
Business/Industry	Business Associations Economic Development Organizations Utilities & Cooperatives Fishing, seafood, mariculture
Government – Elected Officials	- Congressional Delegation - Governor - Mayors - City Councils
Government – Agencies	State Departments (energy, conservation, etc.) Councils Federal Agencies National Labs
ANCSA Corporations	Regional Corporations Village Corporations ANCSA Regional Non-Profits
Alaska Native Villages	Tribal Councils and individuals in Chugach region Tribal Councils and individuals in Ahtna region
Non-Governmental Organizations	- Environmental - Tribal - Science centers
Media	- Radio stations - Newspapers

General Public	- Public Meetings - Conferences - Chambers of Commerce

8.2.2 What We Heard

From the initial conversations USNC and CVEA conducted, stakeholders were generally supportive of pursuing MMR development to lower energy costs for Alaskans. Of paramount interest was deploying creative solutions to solving Alaska's energy needs. A common question that arose was whether MMRs would lower community electricity pricing and if so when those lower costs could be expected. Other stakeholders and Alaska Natives cautioned that the unique history of nuclear in Alaska would present a hurdle, as some communities are unlikely to trust a company to protect their health and safety and the environment in a future nuclear project.

Stakeholders were curious to learn more about MMR technology, the safety features of the advanced reactor, and the overall project. The issues of safety are very important to address with nuclear reactors, however many were expressed with the reference being the larger commercial light water reactors in operation today. As such it was necessary to explain the ways in which the microreactor technology is starkly different from traditional reactors and explain the safety features inherent to the reactor design. However, all risks whether real or perceived were addressed and given utmost respect. Mitigations to existing risk factors were also explained and additional reference points (e.g., NRC) were provided for independent verification.

Stakeholders wanted to know about the timeframe of the project, when CVEA would expect a facility to be in operation, and how much it would cost to license, site, and construct a facility. Most stakeholders with whom USNC met were interested in learning about potential benefits, such as job creation, or risks associated with siting a facility. Stakeholders commented that they needed additional information in order to make an informed decision and encouraged USNC to do a better job describing the technology in ways that people can better understand both the benefits and risks it may provide. Some stakeholders were interested in learning about the possibility of hosting an MMR in their own communities and were curious whether USNC was speaking with utilities and communities outside of the CVEA service territory.

Stakeholders and Alaska Natives had a variety of questions about the project, ranging from why the pre-feasibility study only examined siting an MMR in Valdez to whether Alaska was being used as a "trial run" for other future USNC projects.[10] Others cautioned that the history of nuclear was one of assuring the public of its safety, only for an accident to occur or for a company or the U.S. government to misrepresent impacts on a community.

Some Alaska Natives expressed concerns regarding potential accidents and how this could impact subsistence living. Others wanted to know more about the safety of the MMR facility, the technology, and its systems. Additional concerns included those tied to safety of the fuel and storing spent nuclear fuel, facility safety, concerns with the unique environmental conditions of Alaska, and concerns with transporting spent fuel (see Table 3 below for additional details).

Stakeholders also wanted to know about the capacity of MMRs, whether the number of MMRs could be augmented in a community, and whether communities with larger energy needs than an MMR could provide could still develop an MMR project. Individuals also sought to understand the specifics of MMRs, the fuel used, USNC's technology, and site specifications. Stakeholders sought additional information on MMRs and how they differed from Small Modular Reactors (SMRs), how or if MMRs integrated with existing electricity systems, and if MMRs could be used for purposes other than electricity generation. In these discussions there were repeated requests for and questions about the ability of the reactor to produce heat and steam. Many noted that if there were additional or surplus energy available that it could grow opportunities for future businesses. One example of this which had repeated reference was the need for process heat for the fish processing industry. Stakeholders and Alaska Natives wanted additional details on the site footprint, layout, and where MMRs would be made (and if fabricated off-site, how MMRs and materials would be transported to the site). Furthermore, a variety of fuel questions arose among stakeholders, including what type of fuel would be used, how USNC's technology and design impacted fuel safety, how often fuel would be reloaded, what happens with the fuel after it has been unloaded from the reactor, and where USNC would source the enriched fuel, and sources of helium. Many stakeholders voiced concern for the overall nuclear fuel cycle and uranium mining impacts and expressed the need to consider the totality of the fuel cycle.

Stakeholders and Alaska Natives requested clarity on USNC's decommissioning plans and where spent nuclear fuel generated during the lifecycle of the MMR

[10] USNC has other projects in the US and Canada, so Alaska is not the first location to be considering an MMR.

facility would be stored. Numerous people expressed concern that the spent fuel might be stored indefinitely on-site, who paid for storage, and what USNC's plans were in the face of continued inaction by the federal government to locate and site an interim storage facility or a permanent geologic repository for spent nuclear fuel.

Table 3: Common Questions and Issues Raised

Spent Nuclear Fuel	Facility	Technology	Workforce	Transportation	Economics
How often for refueling	Size of plant facility	Prior demonstration of proof of concept	Number of workers needed for construction	Transportation safety	Cost per kw average and availability of heat and steam
Volume of spent fuel created	Siting in seismic or permafrost conditions	Potential for meltdown of fuel	Number of workers needed for operation	Ability to transport reactors, fuel and spent fuel on remote roads	How expensive is reactor per unit and cost of total facility
Length of time stored on-site	Length of assembly time	Potential for leakage of contaminants	Special training required for operators	How to transport to communities that are only accessed by sea or air	Ownership of facility and liability
Safety of on-site storage	Decommissioning process	Potential for accident or explosion	Security requirements	Government or private company transport	Community benefits
Ownership of spent fuel	Site restoration	Emergency Planning Zone size	Union or Alaska Native Workforce	Type of casks for storage and transport	Eligibility for available Govt grants or loans

Should this project proceed, there will be extensive and on-going engagement with stakeholders and Alaska Natives. The opportunities for future engagement include both required public involvement and tribal consultations through the NRC licensing process, and company engagements through USNC's on-going conversations with the communities in the CVEA service area and throughout Alaska.

Since the NRC licenses and regulates nuclear power plants throughout the U.S., the agency follows federally required public engagement and tribal consultation practices.[11] The process provides many opportunities for public engagement. These include public meetings and comment periods during the development of the Safety Evaluation Report. As required under the National Environmental Policy Act (NEPA), the NRC also holds public scoping meetings to help determine the scope of the environmental review, public meetings and comment period upon release of the draft Environmental Impact Statement, and finally an NRC hearing with a public component that helps determine the NRC's final decision regarding the license application.

As a federal agency, NRC must also conduct formal tribal consultations when considering the license application, as required by Section 106 of the National Historic Preservation Act. Federal agencies must follow the Section 106 process in consultation with State Historic Preservation Officer, Tribal Historic Preservation Officer, tribal governments, state and local governments, any consulting parties, and the public. This requires meeting with the tribal leaders for both Ahtna and Chugach regions, considering a project's potential impacts and benefits, and considering tribal values and priorities in their decision-making. The NRC also follows established principles in its *Tribal Policy Statement*, as well as its *Tribal Protocol Manual*, to promote government-to-government interactions with federally recognized Native American tribes and to facilitate tribal involvement.

USNC also commits to continued engagement with the communities and Alaska Native regional corporations, village corporations, Alaska Native villages and regional and state stakeholders impacted by this project. This will include opening a local office in Valdez and hiring a local person(s) who will make themselves available to interested parties. This will include regular community meetings, participating in local events, working with local schools, and generally providing outreach and communications support to CVEA as needed. A local presence can also help feed information back to USNC and CVEA which contributes to their

[11] https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/licensing-process-fs.html

efforts to design the project with the priorities, concerns, and needs of the local population in mind.

8.3 STAKEHOLDER ENGAGEMENT CONCLUSIONS

A preliminary conclusion based on the conversations we have had is that there is broad and deep support for integrating micronuclear reactors in this region of Alaska. Neither USNC nor CVEA heard significant opposition to the idea of siting an MMR in CVEA's service area, in fact most all were encouraged by it. This was a surprising but consistent feature of these discussions and interactions with Alaskans. This is not to say or infer that people did not have safety concerns or other issues they felt important to understand—they did, and, in this report, we have tried to reflect those back. Most people that had questions about the safety of the endeavor seemed to understand the safety features designed to mitigate any potential risks to the community and the environment. Considering the high safety threshold of the reactor, people were mostly focused on the benefits of micronuclear for a more cost effective, reliable, and carbon-free source of heat and power.

We believe it was important to begin engagement at this early stage so that people are assured that there will be no decisions to proceed to any next stage without an understanding how the public feels about the reactor technology. When CVEA decides whether to proceed or not, it will be in great part based upon what people want to see for their future in this area of Alaska. If there is a decision to proceed, we will be grateful to continue this work we have begun, and to reconnect to those we have had the pleasure of meeting and learning from.

9. CONCLUSIONS AND RECOMMENDATIONS

This report discusses the Micro-Modular Reactor and its potential for generating power in the CVEA service area. At 15 MW_{th} per unit, and with the ability to place multiple units at one site, the MMR is a match for CVEA's needs. Replacing the existing Cogeneration unit would reduce CVEA emissions, cut reliance on external fuels, and can supply high temperature heat to consumers in the area.

Several sites were evaluated in Valdez and a Mountain Site southeast of Valdez off of Dayville road was focused on. It was found that this site would have the lowest risk of water ingress from Tsunami. The seismic activity in the region was evaluated and found that activity is higher than the rest of the country and stiff designs should be incorporated. The MMR is currently designed to withstand seismic oscillation and demonstrating this will be a significant portion of the NRC licensing process. The Mountain Site Civil review found that the Mountain site was suitable for construction. Preliminary work also found a potential site near Glenallen, although limited investigations were completed for this site due to the lack of an identified heat off-taker in close proximity to the site.

The economics of replacing Cogen with two 15 MW_{th} MMRs at a single facility were evaluated under two ownership structures, various tax incentive scenarios, various operating modes, and for both the Valdez and Glenallen sites. Scenarios where the MMR facility ran at a lower capacity factor, such as only producing and selling energy in the winter months, were less economical. Augmenting electricity sale with heat sale to a heat consumer would greatly improve the economics. Year-round heat sales would have the most positive economic impact.

The MMR facility would be eligible for the clean electricity credits ratified in the Inflation Reduction Act. The base ITC (assuming prevailing wage and apprenticeship requirements are met) would start at a reduction of tax burden by 30% of the project's capital investment. Bonuses for locating the project in an energy community, which likely includes the non-metro Alaska census region, and using domestic steel and manufactured content could be realized for this project. Each bonus is an additional 10%, meaning this project could be eligible for up to 50% ITC. In lieu of the ITC, the tax credit could be taken as a PTC that is based on the facility's energy output. A tax-exempt organization can qualify for direct payment of these credits rather than standard tax deduction.

Two ownership structures were investigated; the MMR facility owned by USNC (and partners) or by CVEA. The CVEA ownership model provided the most economic deployment strategy. The MMR facility under USNC ownership was more expensive but could still provide electricity at or lower than current electricity costs when sufficient heat is sold, and tax incentives are realized.

This study concludes that there is value for CVEA in using an MMR to provide energy to local consumers. Preliminary analysis of sites has found that there are potential locations that warrant further study. Discussions with the community have found public reaction to be generally positive and should be continued if the project is to continue.

APPENDIX A: DETAILED STAKEHOLDER ENGAGEMENT INFORMATION

1. Academia

University of Alaska-Anchorage – Center for Economic Development

University of Alaska-Fairbanks – Alaska Blue Economy Center

University of Alaska-Fairbanks – Alaska Center for Energy and Power

2. Alaska Native Corporations and Alaska Natives

Ahtna

Alaska Native Regional Corporations

- Ahtna, Incorporated

Alaska Native Village Corporations

- Chitina Native Corporation

Alaska Native Regional Non-Profit Organizations

- Copper River Native Association

Chugach

Alaska Native Regional Corporations

- Chugach Alaska Corporation

Alaska Native Village Corporations

- Tatitlek Corporation

Alaska Native Villages

- Valdez Native Tribe

3. Business/Industry

Business Associations & Economic Development Organizations

- Alaska Chamber
- Copper Valley Chamber of Commerce
- Copper Valley Development Association
- Resource Development Council

Utilities & Cooperatives

- Cordova Electric Cooperative
- Golden Valley Electric Association
- Alaska Village Electric Cooperative

Fishing, Seafood, Mariculture

- Pacific Seafood Processors Association
- Peter Pan Seafood

4. Government – Elected Officials

Federal

- Congressional Delegation- Murkowski, Sullivan, and Young

State

- Governor Dunleavy
- Senators Bishop, Hoffman, Hughes, Kawasaki, Kiehl, Micciche, Revak, and Shower
- Representatives Cronk, Fields, McCabe, Rauscher, Schrage, Thompson, and Zulkowlsky

Local

- Mayor of Valdez
- Valdez City Council
- Cordova City Manager
- Cordova Chamber
- Mayor of Cordova

5. Government – Agencies

Federal

- Department of Energy (DOE) Arctic Energy Office
- DOE Office of Clean Energy Demonstrations
- DOE Office of Nuclear Energy

- National Renewable Energy Laboratory

State

- Alaska Energy Authority
- Denali Commission
- Department of Environmental Conservation
- Exxon Valdez Oil Spill Trustee Council

Local

- Valdez Ports and Harbor
- Valdez Public Works
- Valdez Planning Commission
- Valdez Parks, Recreation and Cultural Resources
- Valdez Police Department

Media

- Alaska Business Magazine
- Alaska Journal of Commerce
- Anchorage Daily News
- Copper River Country Journal
- Copper River Record
- KUAC Alaska Public Media
- KVAK Radio
- North of 60 Mining News

6. Non-Governmental Organizations

Tribal

- Alaska Federation of Natives
- ANCSA Regional Association
- Alaska Native Village Corporation Association
- Native Conservancy

Local

- Chugach Mountain Institute
- Copper Country Alliance
- Copper River Watershed Project
- Prince William Sound Science Center

7. General Public

Public Meetings/Conferences

- Member of Alaska Center for Energy and Power Nuclear Stakeholder Working Group- Presented to Working Group at University Alaska-Fairbanks, Fairbanks, AK, June 2021
- Cordova Chamber Event – Cordova, AK, March 2022
- CVEA/USNC Public Meetings – Glennallen and Valdez, AK, April 2022
- CVEA Annual Member Meetings – Glennallen and Valdez, AK, May 2022
- Alaska Sustainability Energy Conference – Anchorage, May 2022
- Alaska Native Village Corporation Association Annual Meeting and Business Conference – Anchorage, AK, May 2022
- Alaska Nuclear Energy Roadmap/Alaska NRIC, Anchorage, AK, May 2022