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Site Selection/Alternatives

a TerraPower & GE-Hitachi technology

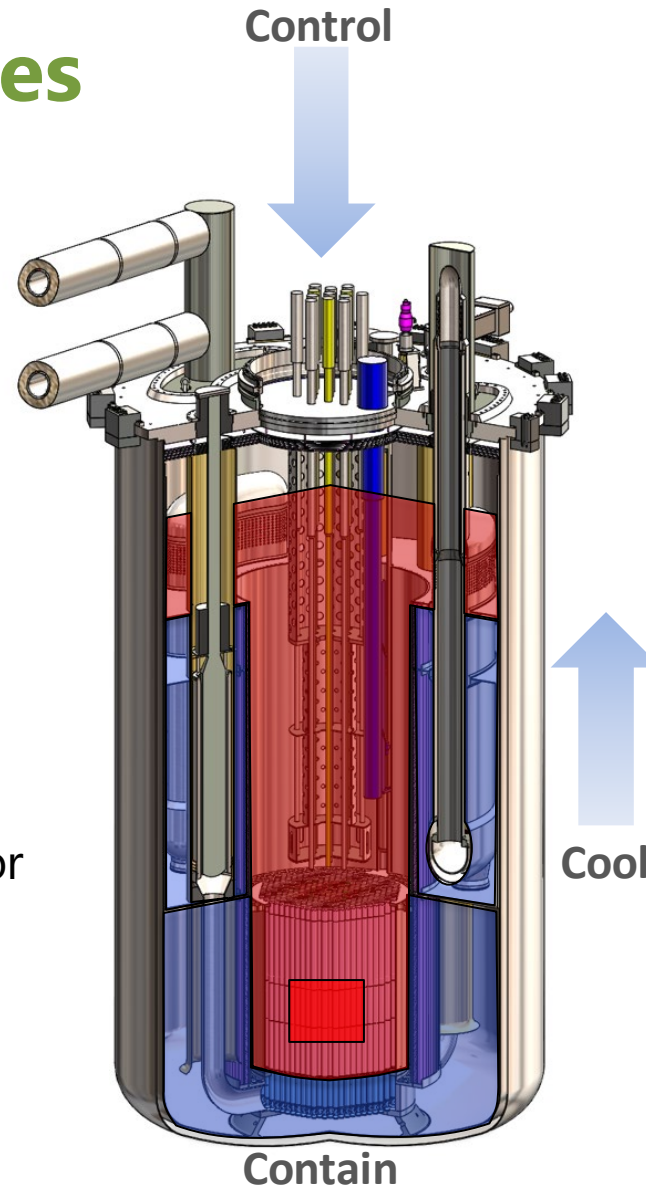
SUBJECT TO DOE COOPERATIVE AGREEMENT NO. DE-NE0009054
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Objectives

- Natrium™ reactor overview
- Review ARDP requisites
- Purpose and need statement and alternative analyses
 - Alternative Sites
 - Alternative Energy Analysis
 - Need for Power
- Site Selection Process
 - Defining the ROI
 - Framework

Sodium Safety Features

- Pool-type Metal Fuel SFR with Molten Salt Energy Island
 - Metallic fuel and sodium have high compatibility
 - No sodium-water reaction in steam generator
 - Large thermal inertia enables simplified response to abnormal events
- Simplified Response to Abnormal Events
 - Reliable reactor shutdown
 - Transition to coolant natural circulation
 - Indefinite passive emergency decay heat removal
 - Low pressure functional containment
 - No reliance on Energy Island for safety functions
- No Safety-Related Control Systems, Operator Actions, or AC power
- Technology Based on U.S. SFR Experience
 - EBR-I, EBR-II, FFTF, TREAT
 - SFR inherent safety characteristics demonstrated through testing in EBR-II and FFTF



Control

- Motor-driven control rod runback
- Gravity-driven control rod scram
- Inherently stable with increased power or temperature

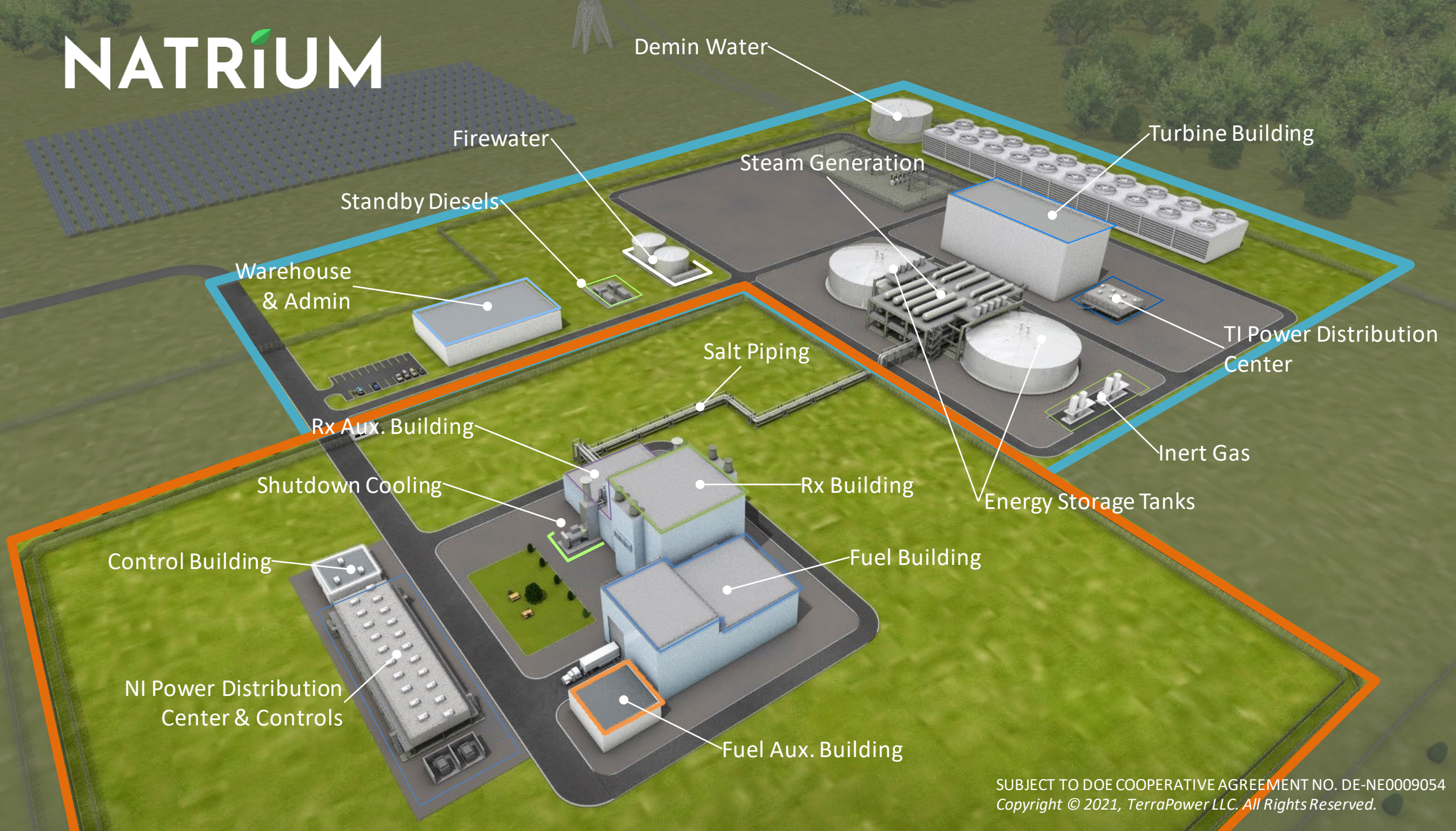
Cool

- In-vessel primary sodium heat transport (limited penetrations)
- Intermediate air cooling natural draft flow
- Reactor air cooling natural draft flow – always on

Contain

- Low primary and secondary pressure
- Sodium affinity for radionuclides
- Multiple radionuclides retention boundaries

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The U.S. Department of Energy ARDP Overview

DOE implements programs, such as the ARDP, in support of its mission to maintain the Nation's technological leadership position in the global nuclear industry and ensure national energy security. (MISSION)

DOE identified that work remains to ensure continued U.S. leadership in the research, design, and development of advanced reactors and to ensure the successful deployment of these reactors in the U.S. and international marketplaces. (NEED)

In support of this mission need, DOE developed the ARDP with funding provided through the FY2020 Consolidation Appropriations Act, (H.R. 1865).

Natrium ARDP Project

Some Key Constraints:

- To demonstrate the advanced reactor design, the Natrium advanced reactor must be designed, sited, licensed, constructed, and operational within the Congressionally mandated 7-year timeframe.
- Therefore, a CPA will be submitted under 10 CFR 50, which will include the requisite submittal of an ER (August 2023).

Alternative Analyses/Site-Selection Development

To support the NEPA process, the ER includes alternative analyses (i.e., Alternative Sites, Energy Alternatives, and System Alternatives).

Alternative Sites (follow-on from the Site Selection Study):

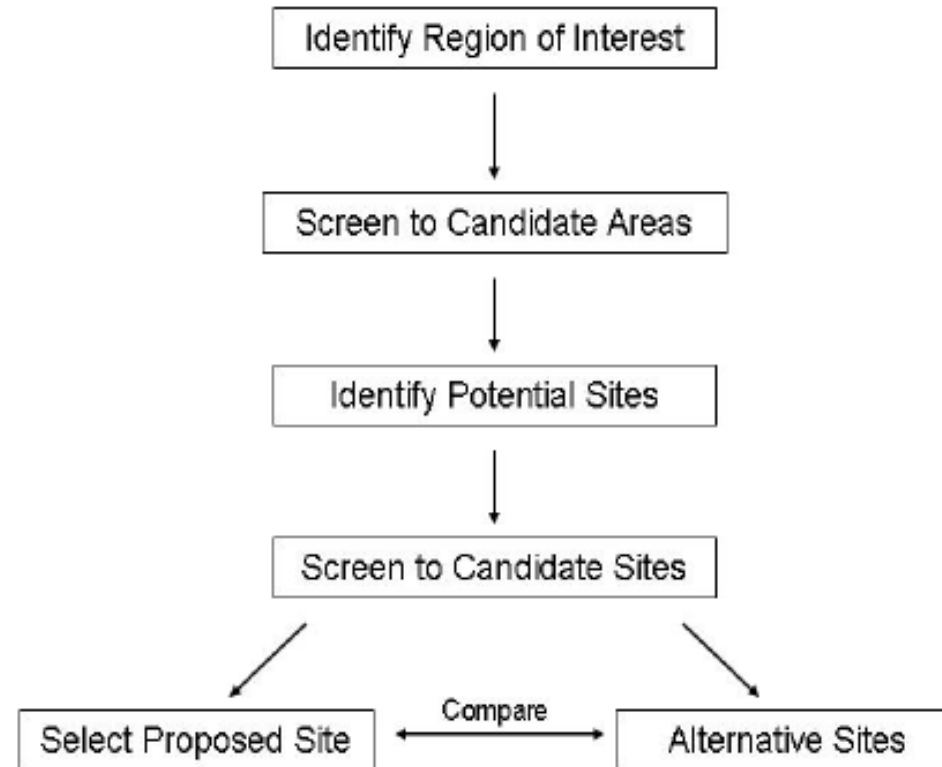
The process developed employs guidance found in:

- NRC Regulatory Guide 4.2, "Preparation of Environmental Reports for Nuclear Power Stations", specifically, Section 9.3, "Site-Selection Process"
- NRC Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations"
- NUREG-1555, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan"

Along with other guidance documents:

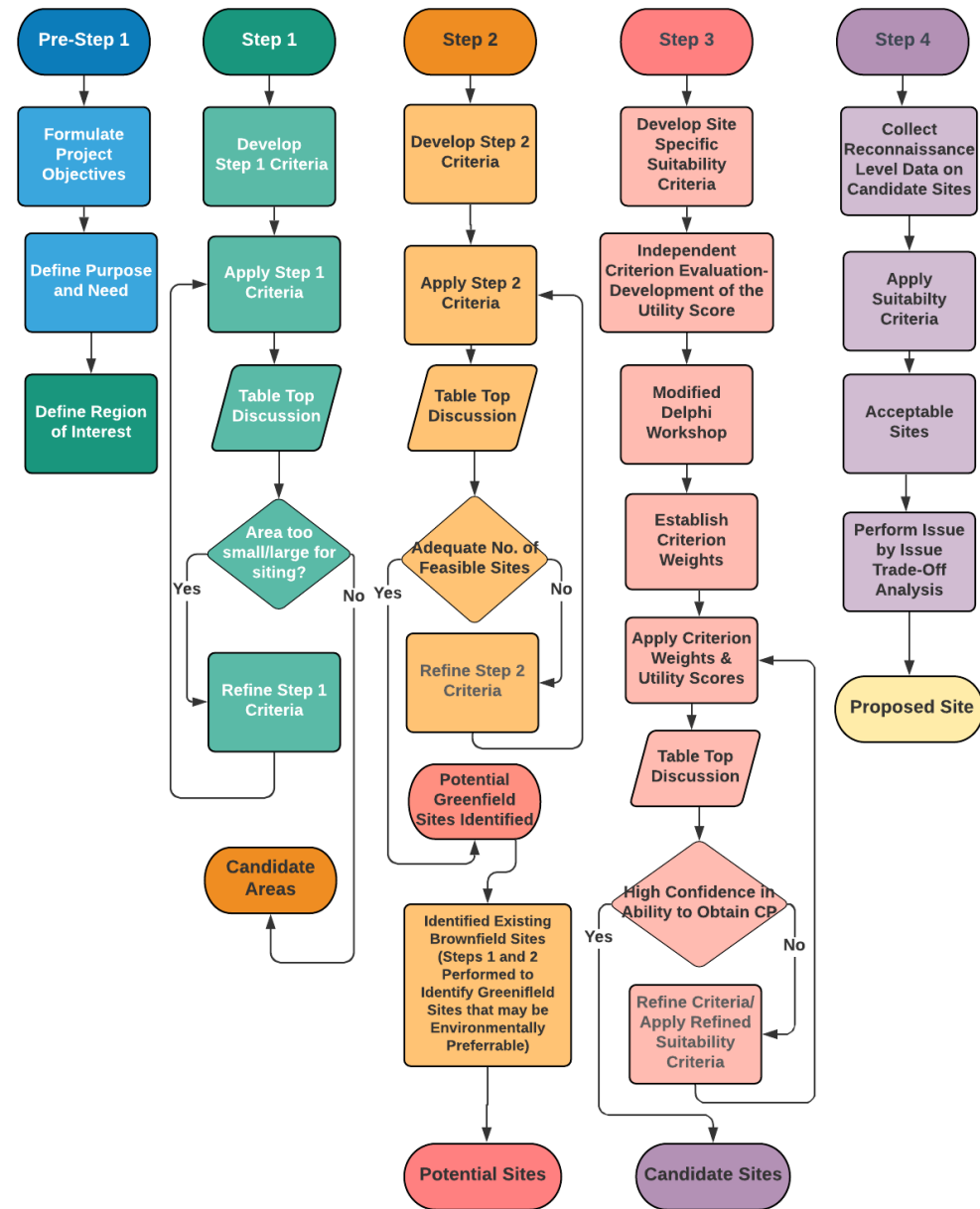
- EPRI, "Advanced Nuclear Technology: Site Selection and Evaluation Criteria for New Nuclear Power Generation Facilities (Siting Guide)"
- NEPA guidance documents

NRC Framework/Outline

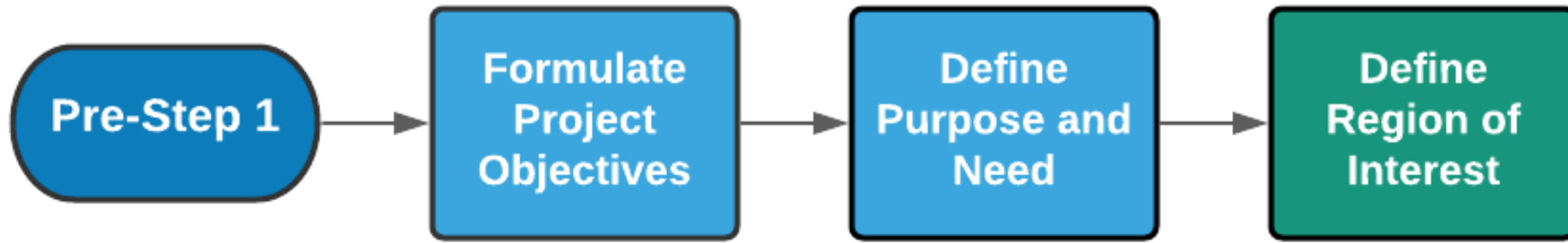


RG 4.2, Preparation of Environmental Reports for Nuclear Power Stations, Rev. 3, Section 9.3, Site-Selection Process, Figure 9-1. Site Selection Process

NATRIUM FRAMEWORK FOR SITE SELECTION



Pre-Step 1



Pre-Step 1: Formulate Project Objectives

ARDP Objectives:

- Demonstrate Advanced Reactor Design: Must be designed, sited, licensed by NRC, constructed, and operational within 7 years.

Sodium Project Objectives:

- Demonstrate the operational flexibility and energy storage capabilities of the Sodium reactor in regions with high penetration of renewables.
- Provide carbon-free energy to areas with retiring or planned closure of power generators and sustain new and increasing energy demand.
- Contribute to the United States Government goals for achieving a 50-52 percent reduction from 2005 levels in economy-wide net greenhouse gas pollution by 2030 and a carbon net-zero or net-negative carbon emission goal by 2050.
- Contribute to a state's carbon net-zero or net-negative carbon emission goal.

Pre-Step 1: Define Purpose and Need

- ISG-026 (Interim Staff Guidance on Environmental Issues Associated with New Reactors): The purpose and need statement is the foundation of the environmental analysis on which the rest of the EIS is built. The purpose and need statement is informed by the applicant's objectives, as stated in Chapter 1 of the applicant's environmental report.
- The purpose and need has typically been described in terms of providing a specific quantity of baseload electricity to a defined service area within a defined time period.
- RG 4.2:
 - The purpose and need statement may address additional needs other than the production of electricity. Additional purposes or needs for the project should provide insight to the benefits of the proposed project and assist the NRC staff in defining reasonable alternatives to the proposed project. However, the purpose and need statement cannot be so restrictive that there are no alternatives, other than the proposed project, that would meet the purpose and need.
 - Additional purposes could include, but are not limited to, the following: greenhouse gas emission goals; replacing existing plants; meeting State or Federal energy policy goals; enhancing energy diversity; consideration of Federal policy not related to environmental quality (10 CFR 51.71(d)).

Pre-Step 1: Define Purpose and Need

A key aspect of the alternatives analyses is that the alternatives presented in the ER should be capable of meeting the purpose and need of the proposed project.

Natrium Project Purpose & Need:

The proposed action is for the NRC to authorize TerraPower to construct and operate the Natrium sodium-cooled advanced reactor in support of TerraPower's participation in the ARDP. In furtherance of the environmental goals of the United States Government for achieving a carbon net-zero or net-negative carbon emission goal by 2050, TerraPower endeavors to demonstrate the Natrium advanced reactor by replacing existing coal plant(s) with a reliable, carbon-free baseload power and enhancing energy diversity.

Pre-Step 1: Define ROI- PacifiCorp Service Area

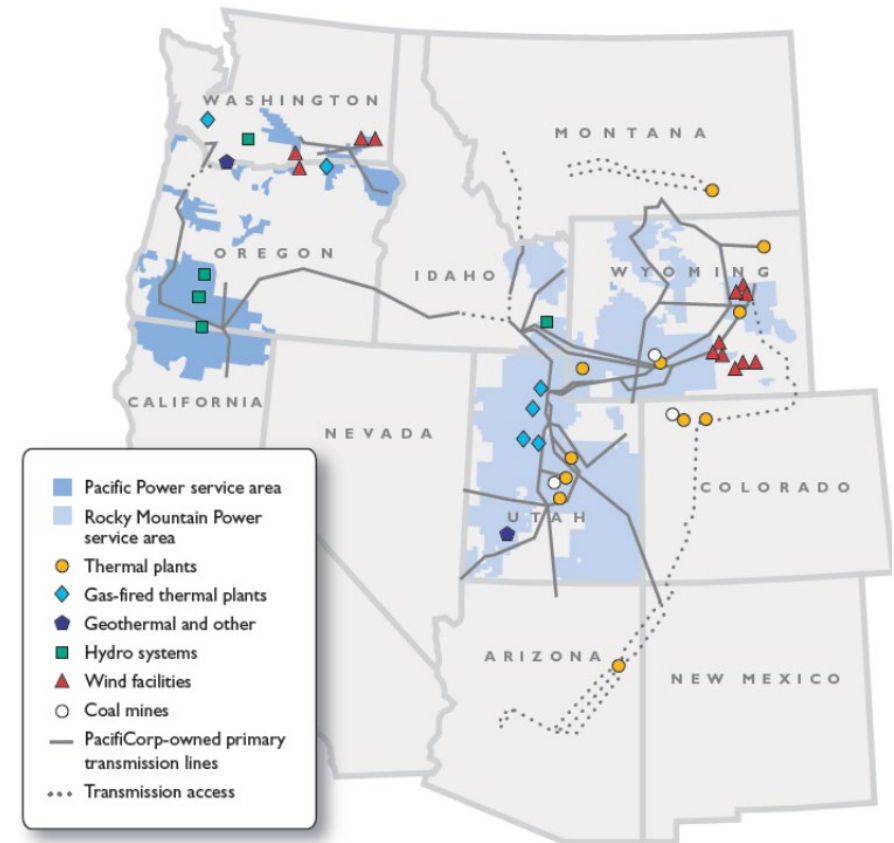
Considerations:

- Ability to meet ARDP schedule (land acquisition)
- Region/service area with retiring coal plants to demonstrate ability to replace a high carbon energy resource with a carbon-free energy.
- Region of high penetration of renewables to demonstrate energy storage capabilities.

Selected PacifiCorp Service Territory

- PacifiCorp is the proposed Owner/Operator of the Natrium reactor.
- PacifiCorp IRP indicates coal plant retirement dates in concert with the ARDP schedule.
- For the portion of the Service territory in Wyoming, in 2020, renewable energy sources generated about 15% of the electricity in the state, with wind power accounting for four-fifths. (Wyoming ranked third, in the amount of wind powered-generating capacity that came online in 2020—with even more large wind, and associated transmission, projects in development or under construction.)
- Wyoming Gov. Mark Gordon, in a March 2021 address, called on the state to transition to net-zero carbon emissions within the next three decades.

Figure 1 PacifiCorp Service Territory



Four Existing “Brownfield Sites” Identified

TerraPower, PacifiCorp, and Wyoming Governor announce efforts to advance a Sodium reactor project at a retiring coal plant in Wyoming¹.

Four potential sites investigated for participation in the ARDP^{2,3}:

1. **Naughton**- Located 4 mi southwest of Kemmerer in Lincoln County. Three-unit plant with total generating capacity of 700 MW (Units 1 and 2 are coal fired and Unit 3 was converted to natural gas in 2019). The 2021 IRP reports the following retirement schedule: Units 1 & 2 2025.
2. **Jim Bridger**- Located 25 mi east of Rock Springs in Point of Rocks, Sweetwater County. Four-unit coal plant with generating capacity of approximately 2110 MW. The 2021 IRP reports the following retirement schedule: Units 1 & 2 converted to natural gas in 2024; and Units 3 & 4 retirement 2037.
3. **Dave Johnston**- Located on the banks of the North Platte River near Glenrock, in Converse County. Four-unit coal plant with a generating capacity of 755 MW. The 2021 IRP reports the following retirement schedule: Units 1–4 retirement 2027.
4. **Wyodak**- Located 5 mi east of Gillette, Campbell County. Air-cooled, plant consisting of one unit with a nameplate capacity of 362 MW.

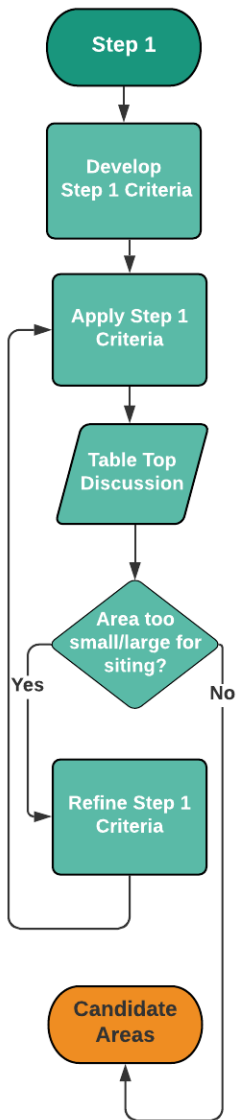
¹ PacifiCorp Press Release, June 2, 2021, *TerraPower, Wyoming Governor and PacifiCorp announce efforts to advance nuclear technology in Wyoming*.
<https://www.pacifiCorp.com/about/newsroom/news-releases/pc-tp-announce-advanced-nuclear-technology-wyoming.html>

² <https://www.wyofile.com/wyoming-to-be-ground-zero-for-advanced-nuclear-plant/>

³ PacifiCorp, 2021 Integrated Resource Plan, September 1, 2021.

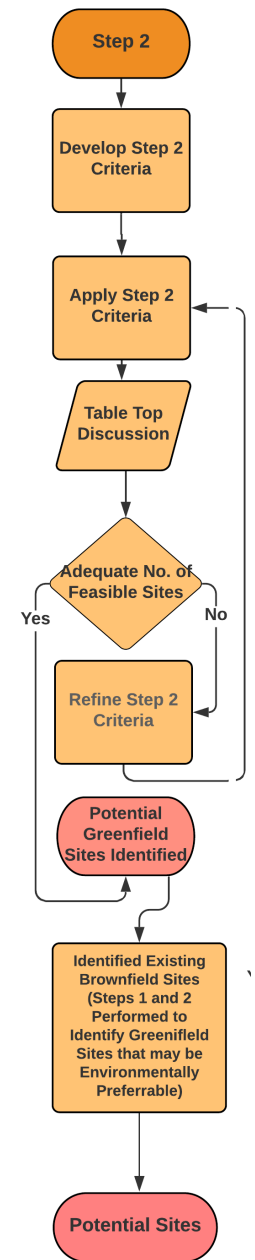
Step 1: Identification of Candidate Areas-Screen ROI

- Given the purpose and need and ARDP constraints, the primary objectives of Steps 1 and 2 are to ensure that the selected candidate sites represent the best that could reasonably have been found within the ROI, i.e., does an environmentally preferable greenfield site exist that meets the purpose and need.
- The selected criteria for Steps 1 and 2 are a compilation of criteria based primarily on guidance documents for larger LWRs, e.g., RG 4.7 and EPRI guidance documents and serve to eliminate areas inconsistent with obtaining a license.
- To accomplish Step 1, the ROI is initially screened by applying the selected criteria using GIS to eliminate areas not meeting these criteria. The different GIS layers are then combined to form an aggregate layer to identify potential candidate areas.



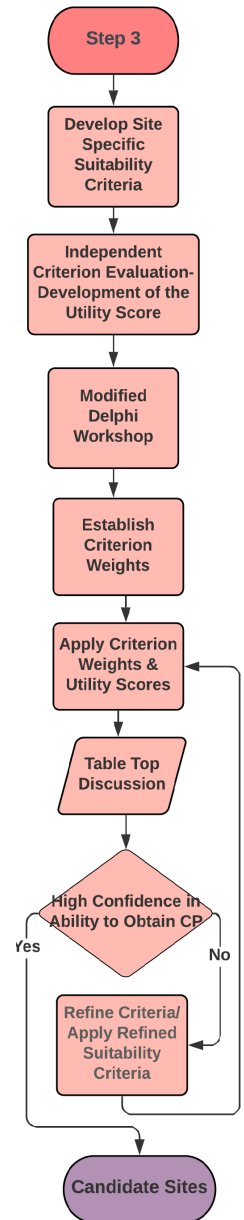
Step 2: Identification of Potential Sites – Screen Candidate Areas from Step 1.

- The Step 2 process continues to eliminate areas inconsistent with requirements for obtaining a license in the ROI and if there exists an environmentally preferable site.
- To accomplish Step 2, the candidate areas are further screened using GIS tools through the application of refined Step 2 criteria. The different GIS layers are then combined to form an aggregate layer to identify additional potential sites to site the Sodium reactor.
- At end of Step 2, potential existing sites are considered.



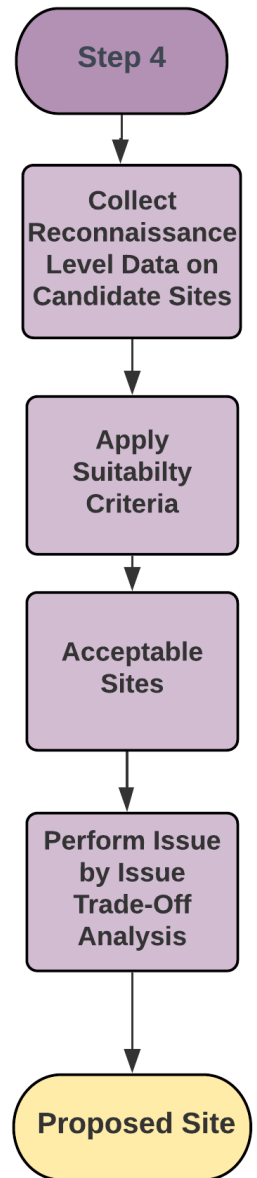
Step 3: Identification of Candidate Sites- Screen Potential Sites Identified in Step 2.

- At this juncture in the site selection process, the application of suitability criteria begins allowing for a more refined analysis where a direct comparison amongst the sites can be completed, i.e., the sites will be compared amongst each other rather than the ability to meet specified criteria some of which are more representative of LWRs.
- To evaluate the suitability of each potential site, each suitability criterion will be evaluated independently by a designated subject matter expert.
- This evaluation will be accomplished by defining a utility function that translates quantifiable site characteristics into a common suitability scale expressing preferences for one site over another. The suitability scale ranges from 1 to 5, where the scale value of 1 is the lowest level of suitability (least preferable) and the scale value of 5 is the highest (most preferable).
- In addition to defining a utility function and associated suitability scale for each suitability criterion, a weighting factor for each suitability criterion will be determined that will reflect the inevitable trade-offs between suitability criteria, that is, a relative importance factor. The Delphi technique will be used to obtain individual and group preferences on the relative importance of criteria.



Step 4: Screen Candidate Sites.

- Generally, as outlined in the EPRI siting guide, the purpose of Step 4 in the site selection process is to select a preferred site from the candidate sites identified in Step 3.
- To accomplish this, Step 4 may involve conducting additional screening using more detailed site-specific data developed from on-site verification surveys, structured specifically to select the “demonstration site” that best meets the ARDP and TerraPower project objectives, e.g., coal plant retirement dates that align with the ARDP schedule.



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A 3D architectural rendering of a large industrial facility, likely a sodium reactor power plant. The facility is situated in a green field with a road and parking lot. It features several large white cylindrical storage tanks, a long white building with many windows, and a complex network of pipes and structural steel. In the background, there is a large solar panel array and a forested area. The word "NATRIUM" is displayed in large white letters in the top left corner.

Questions?

Acronyms

Acronym	Definition
ARDP	Advanced Reactor Demonstration Program
CPA	Construction Permit Application
DOE	U.S. Department of Energy
EPRI	Electric Power Research Institute
ER	Environmental Report
GIS	Geographic Information System
IRP	Integrated Resource Plan
LWR	Light Water Reactor
NEPA	National Environmental Policy Act
RG	Regulatory Guide
ROI	Region of Interest