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Advanced Reactor Demonstration Project Overview

a TerraPower & GE-Hitachi technology

Advanced Reactor Demonstration Program (ARDP) demonstration goals

- Demonstrate the ability to design, license, construct, startup and operate our Natrium™ Advanced Reactor
- Build the supply chain for sodium fast reactors in the United States
- Lower emissions by initiating the deployment of a fleet of Natrium reactors – Demo will show that we can build these plants economically and that they will be attractive for future owner/operators
- Development of new jobs and a stronger economy

Elements of the Natrium™ ARDP Offering

- Strong private financial backing
- Design, NRC Part 50 licensing, Procurement, Construction and Startup of Natrium Demonstration reactor 840 MWt through fuel loading within 7 years
- Support Development of HALEU metal fuel supply chain
  - Providing funding for first year of development in two cascades of 120 AC100M centrifuges that would add 12 MTU/year of capacity at 19.75 wt. % U^{235}.
  - Design, license and construct a fuel fabrication facility for HALEU metallic fuel
- Continue development of TP advanced fuel and material development and qualification program

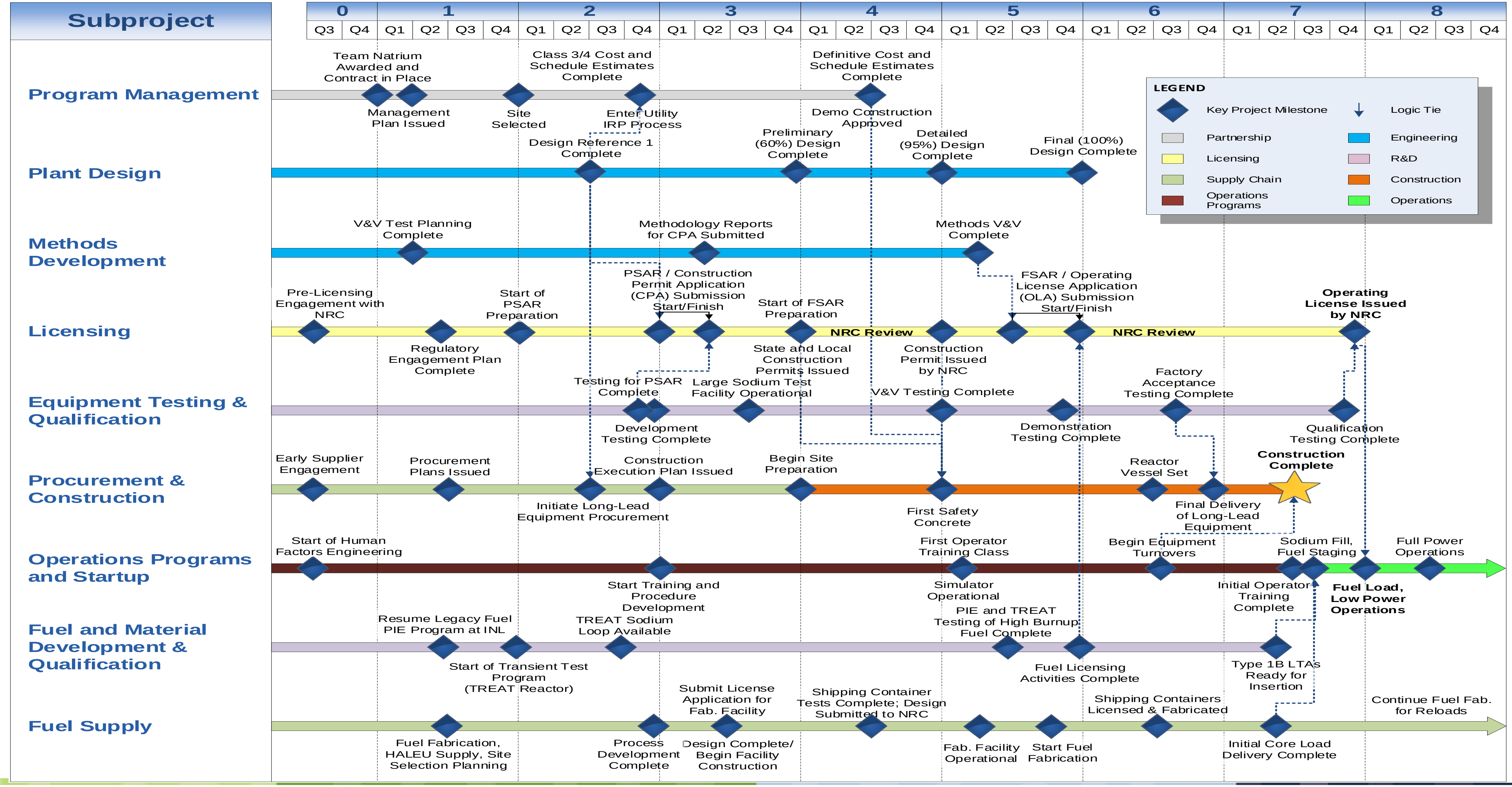
Team Members

Why Natrium™ technology?

It is the best option for deploying advanced nuclear power given increasing demand for carbon-free energy and a growing mix of renewable sources because it:

- Simplifies construction and architecture compared to previous reactor types
- Offers a cost-competitive, flexible technology that supports load following, energy storage and industrial process heat applications
- Brings step-change improvements in capital and operational costs
- Provides a utility-scale decarbonization solution that can make a meaningful impact on efforts to mitigate climate change

Team Natrium
ARDP Natrium Demonstration Project Level 1 Schedule



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Schedule and Cost Estimate Methodology

- Assumes a defined spending plan with consistent source of funds
- Jointly developed by TP, GEH and Bechtel based on past experiences
- Licensing schedule has been discussed several times with NRC "aggressive but achievable"
- Design to minimize construction time
- AACE Class 3 / 4 cost estimate and schedule by end of budget period 2
- AACE Definitive cost estimate and schedule for construction will be provided in 4^{th} budget period

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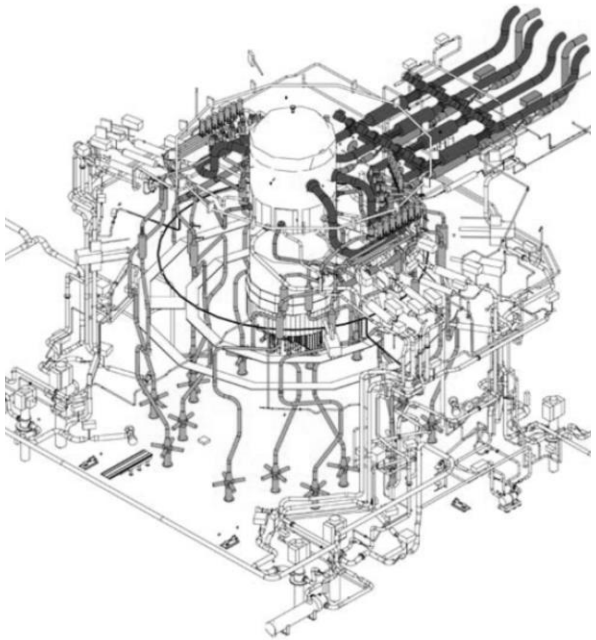
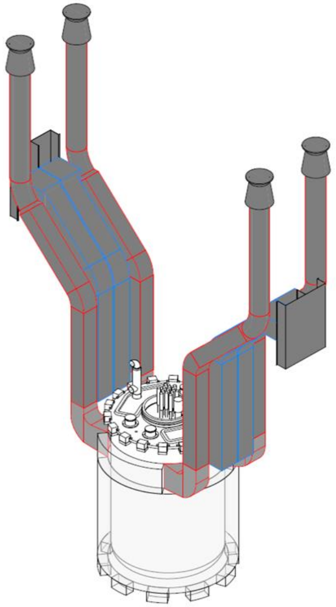
Simple Nuclear Systems





LWR Emergency Core Cooling	Natrium Radiant Vessel Cooling
• 2600+ ASME Sect. III Pipe Welds • High Pressure Injection (1000+ PSI) • Large Water Inventory Requirements • Active Valve and Pump Operation • Multiple Trains and Sub-systems	• Zero ASME Sect. III Pipe Welds • Atmospheric Pressure (<1 PSI) • Unlimited Air-Cooled Heat Sink Supply • Fully Passive (Always in Operation) • Singular Rugged System

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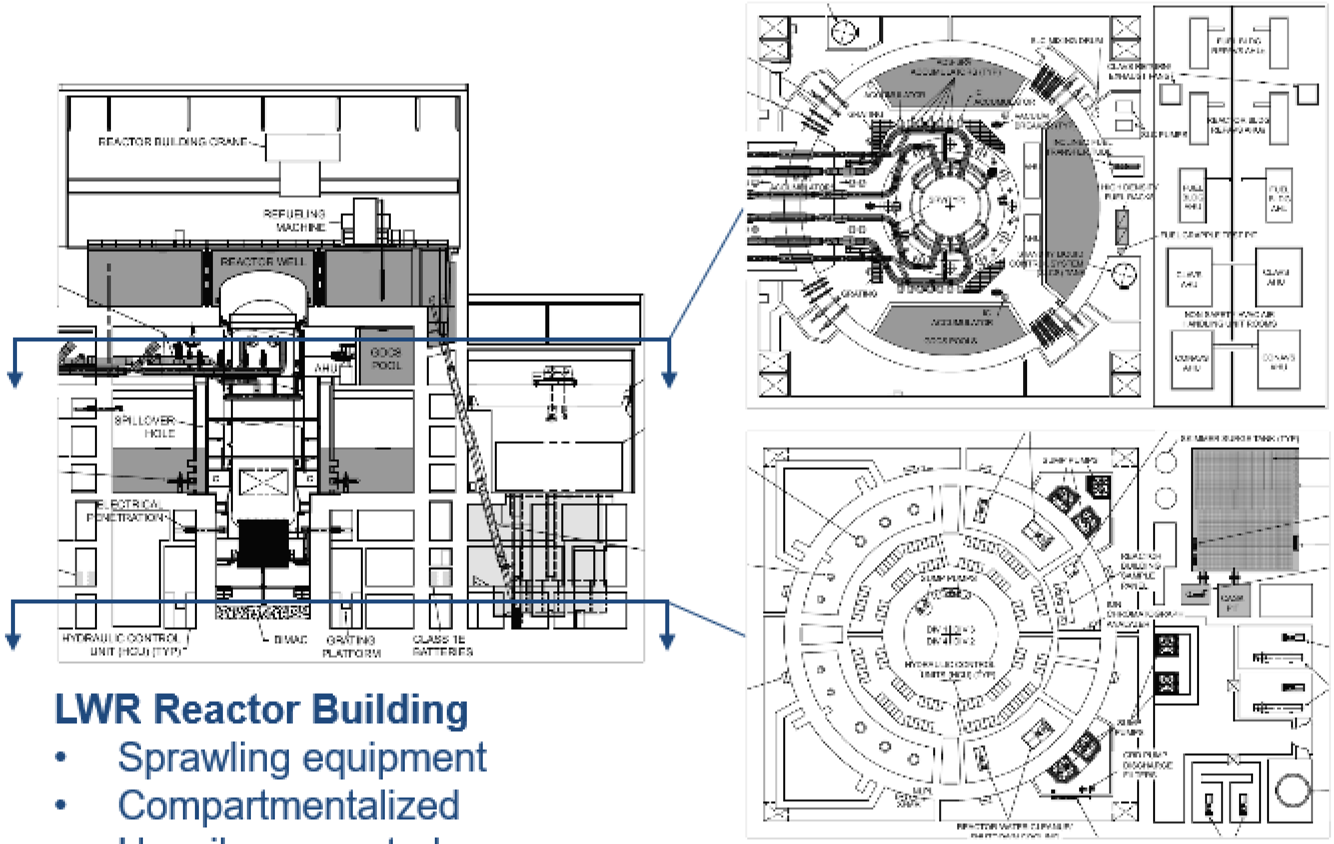
Simple Nuclear Buildings

Light Water Reactor (LWR)

~105 m³/MWe total nuclear concrete

Natrium

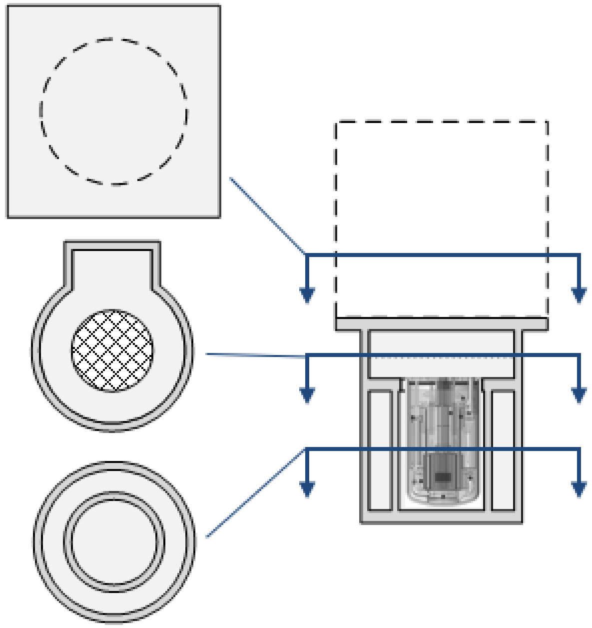
~20 m³/MWe total nuclear concrete



LWR Reactor Building

- Sprawling equipment
- Compartmentalized
- Heavily congested

Shown to Scale

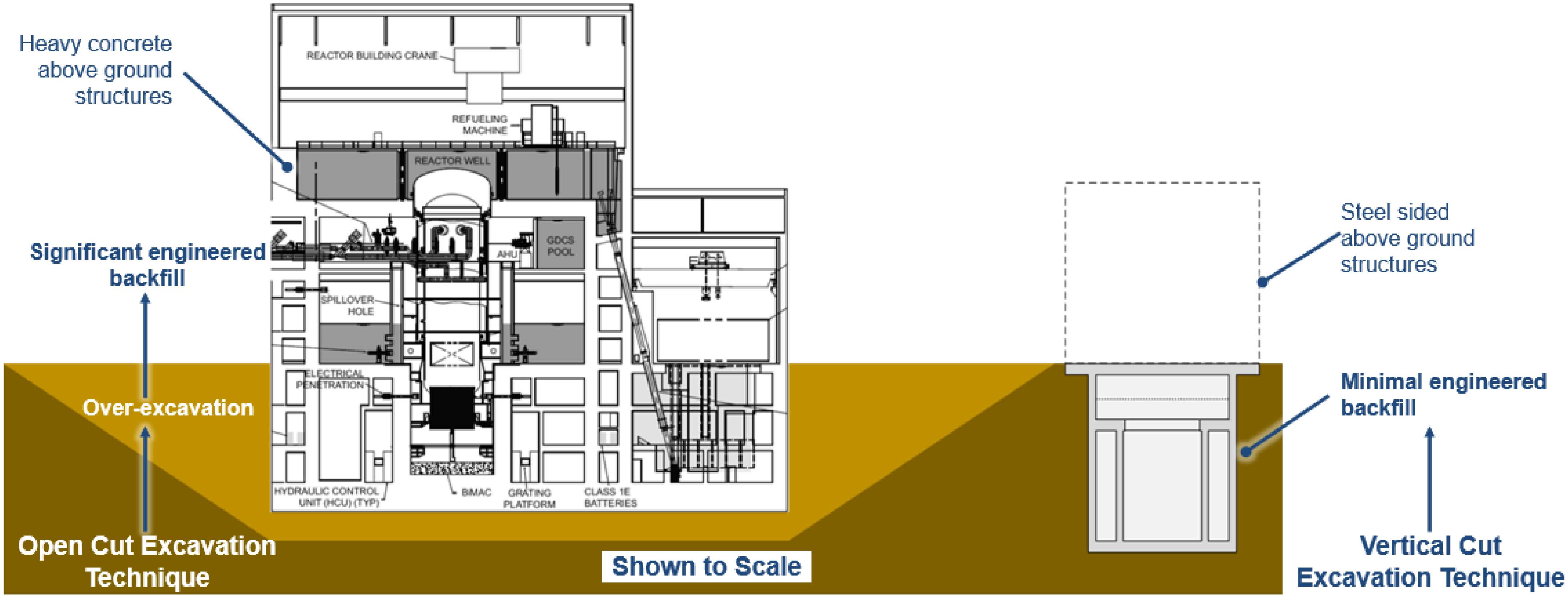


Natrium Reactor Building

- Compact pool reactor equipment
- Few internal walls
- Open floor plan

Simple Nuclear Construction

Light Water Reactor (LWR)	Natrium



Customers?

- Marketing to US Utilities
- About 10 US Utilities have joined our Utility Advisory Board
- In discussions with a potential owner/operators for the demonstration plant
- Key success criteria –
  – Natrium can be located anywhere that meets the NRC criteria, but has added value in markets that have a high penetration of renewables, that both need a stable baseload and need power on demand when solar and wind are not available.
  – Strong political support, especially at the state and local levels
  – Strong workforce
  – EPRI Siting Guide

Licensing Strategy

- Team Natrium selected the 10 CFR 50 licensing process due to the time requirements on the program. 10 CFR 50 allows you to start construction earlier.
- The Preliminary Safety Analysis Report will be submitted with a Part 50 Construction Permit Application (CPA). The PSAR is currently organized consistent with the draft PSAR/FSAR outline and guidance provided by an NRC letter dated April 15, 2020, titled "Updated Draft Outline for Licensing Modernization Project Advanced Reactor License Applications"
- The Final Safety Analysis Report will be submitted with the Operating License Application

Natrium Reactor Planned NRC Interactions Environmental (2021-2022)

- Site Selection Process
- Environmental Coordination State and Federal
- Environmental Need for Power and Alternate Analysis
- Severe Accident Mitigation Analysis
- Environmental – Fuel Cycle Impacts

Planned NRC Interactions Safety/Programs (2021-2027)

- Quality Assurance – NRC currently reviewing
- Safeguards Information (SGI) Plan
- Probabilistic Risk Assessment (PRA)
- Natrium Demo Plant
- Applicability of Regulations
- Engineering Computer Codes for Natrium
- M++ (Mongoose sub channel code) Thermal Hydraulic Topical
- Risk Informed Performance Based Preliminary Design Criteria
- Plant-Level Risk-Informed Performance-Based SSC's Classification
- Energy Island Decoupling
- Consensus Codes and Standards
- Source Term Methodology
- Design Basis Accident Methodology
- PSAR Chapter 1 – Plant and site overview
- Licensing Basis Events with and without releases
- Emergency Preparedness
- Metal Fuel Operating Experience
- Radiological Release Consequences Methodology
- Reactor Stability Methodology
- Partial Flow Blockage Methodology
- Regulatory Exemptions
- Fuel Methodology

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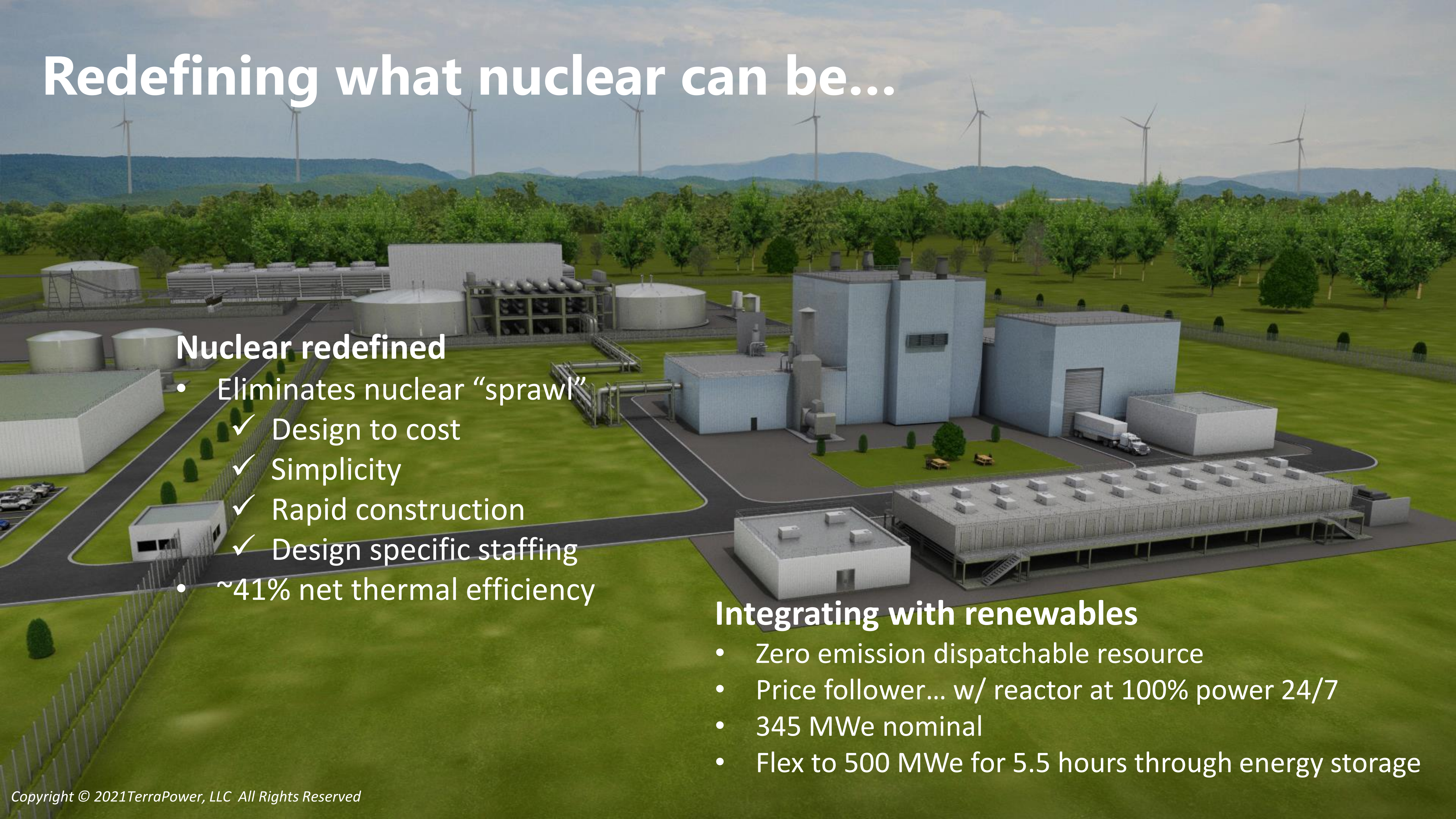
Key Licensing Milestones (2023 – 2028)

- Construction Permit Application and PSAR Submittal – August 2023
- License to Construct – March 2025
- Operating License Application and FSAR Submittal – March 2026
- License of Operate – March 2028

Redefining what nuclear can be…

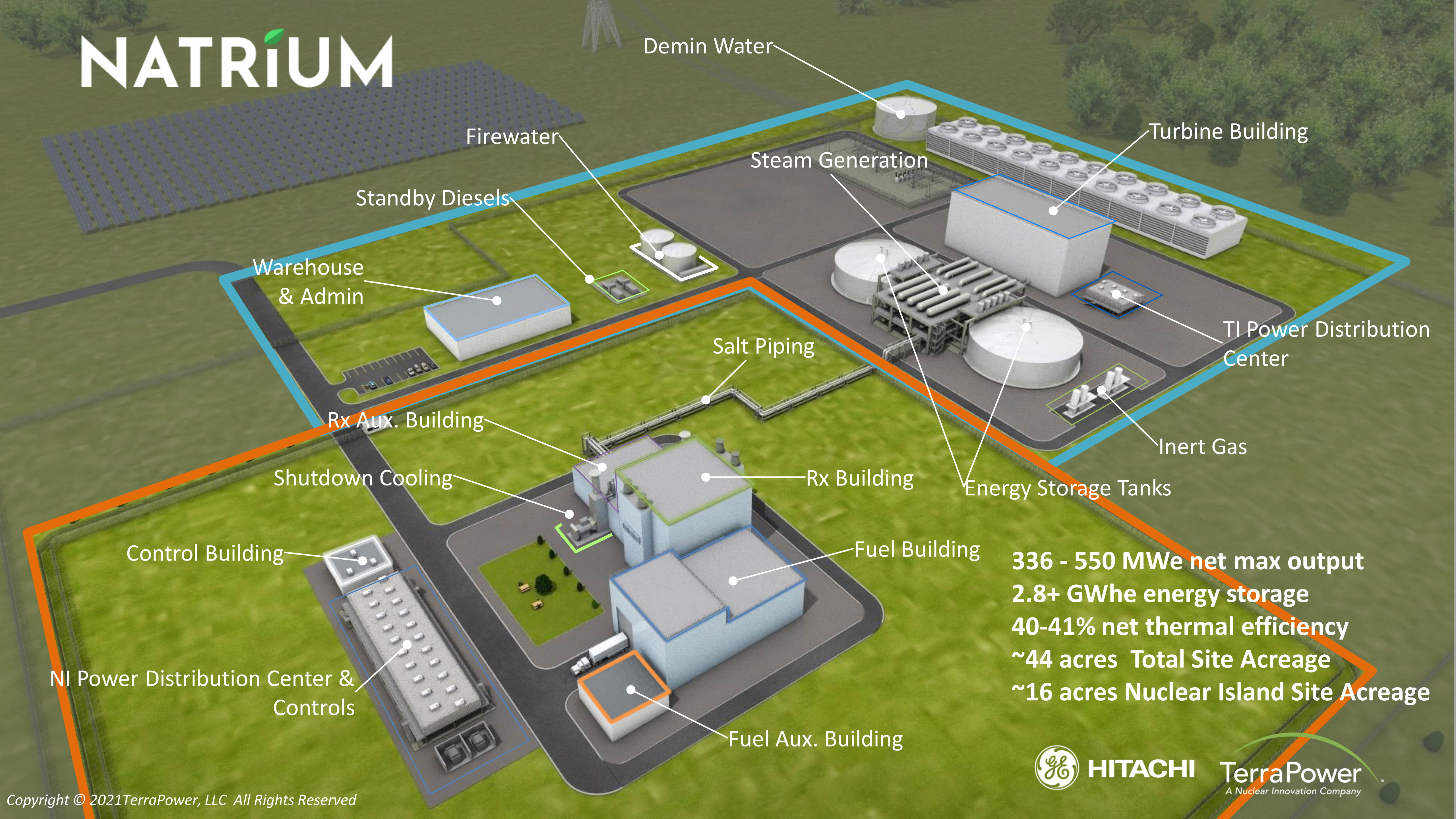


Nuclear redefined

- Eliminates nuclear "sprawl"
  - ✓ Design to cost
  - ✓ Simplicity
  - ✓ Rapid construction
  - ✓ Design specific staffing
- ~41% net thermal efficiency

Integrating with renewables

- Zero emission dispatchable resource
- Price follower… w/ reactor at 100% power 24/7
- 345 MWe nominal
- Flex to 500 MWe for 5.5 hours through energy storage


NATRIUM
Demin Water
Firewater
Turbine Building
Steam Generation
Standby Diesels
Warehouse & Admin
TI Power Distribution Center
Salt Piping
Rx Aux. Building
Inert Gas
Shutdown Cooling
Rx Building
Energy Storage Tanks
Control Building
Fuel Building
336 - 550 MWe net max output
2.8+ GWhe energy storage
40-41% net thermal efficiency
~44 acres Total Site Acreage
~16 acres Nuclear Island Site Acreage
NI Power Distribution Center & Controls
Fuel Aux. Building
HITACHI
TerraPower
A Nuclear Innovation Company

Heat Transport Architecture
It's all about the tanks.

How Energy Storage Works

Basic Operation

Charging: Low Price $\dot{W}_T < \eta_T \dot{Q}_{Rx}$

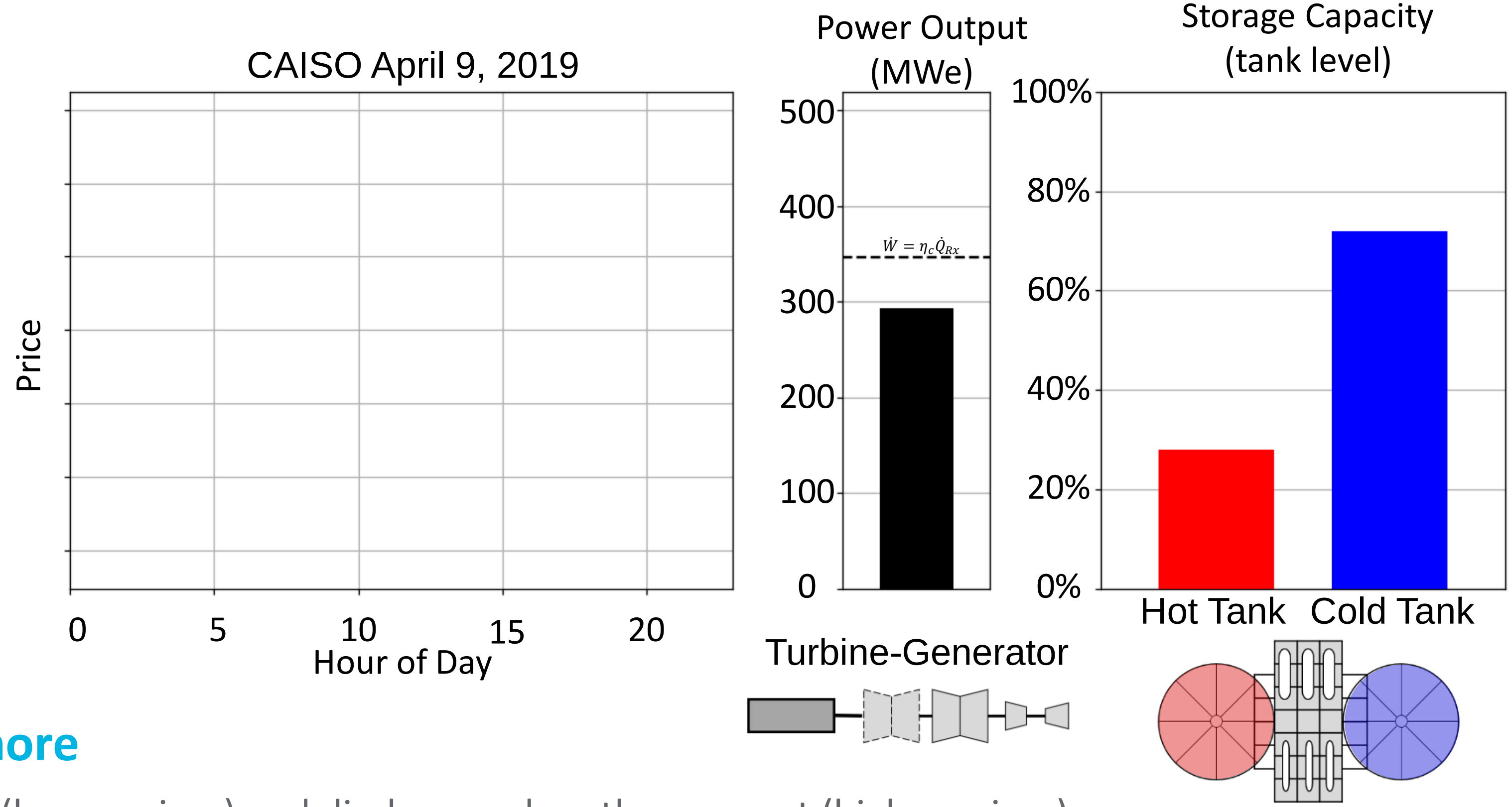
- Hot salt tank level increases
- Cold salt tank level decreases

Discharging: High Price $\dot{W}_T > \eta_T \dot{Q}_{Rx}$

- Hot tank salt level decreases
- Cold tank salt level increases

Even: $\dot{W}_T = \eta_T \dot{Q}_{Rx}$

- Steady holt tank salt level
- Steady cold tank salt level

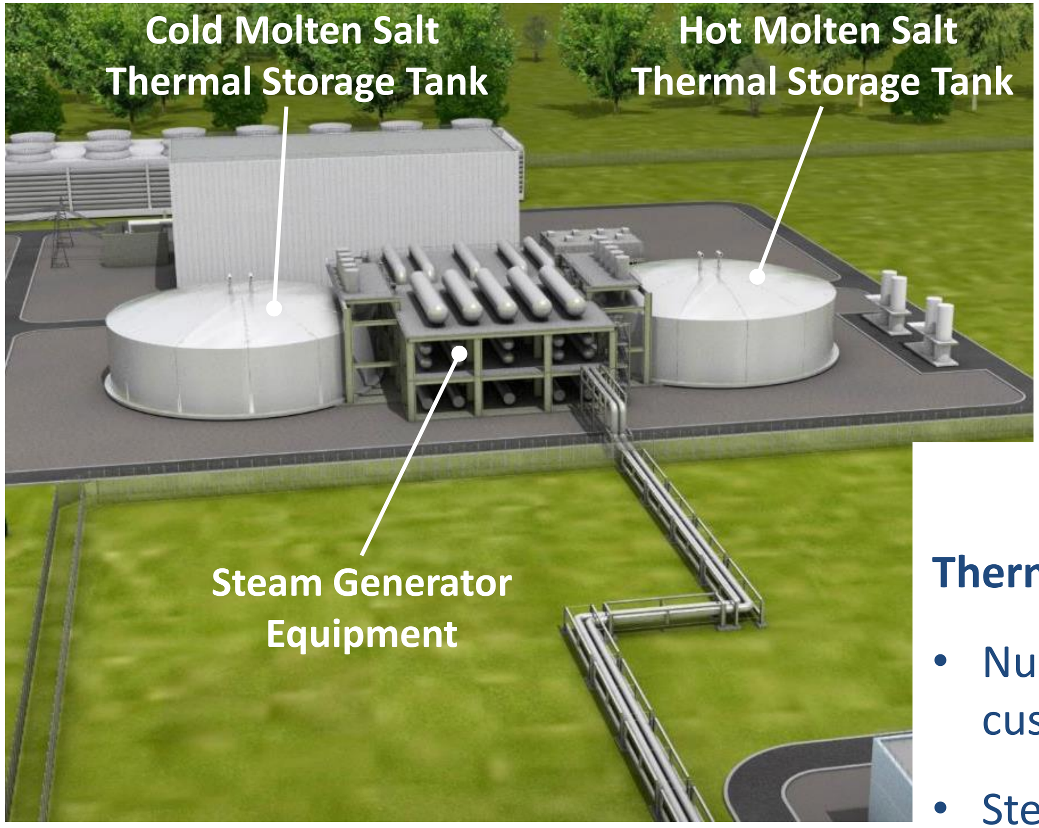


Low price - sell less, high price – sell more

- Store when renewables producing power (lower prices) and discharge when they are not (higher prices)
- Natrium is different from LWRs because the outlet temperature is high enough to support storage.
- Reactor output is steady … minimize cycling of reactor
- Price following above and below 100% reactor power

$$\text{Full Power Turbine Hours} = \frac{(\rho V_{working})_{hot}(C_{hot}T_{hot} - C_{cold}T_{cold})}{\frac{\dot{Q}_T}{\eta_T} - \dot{Q}_{Rx}}$$

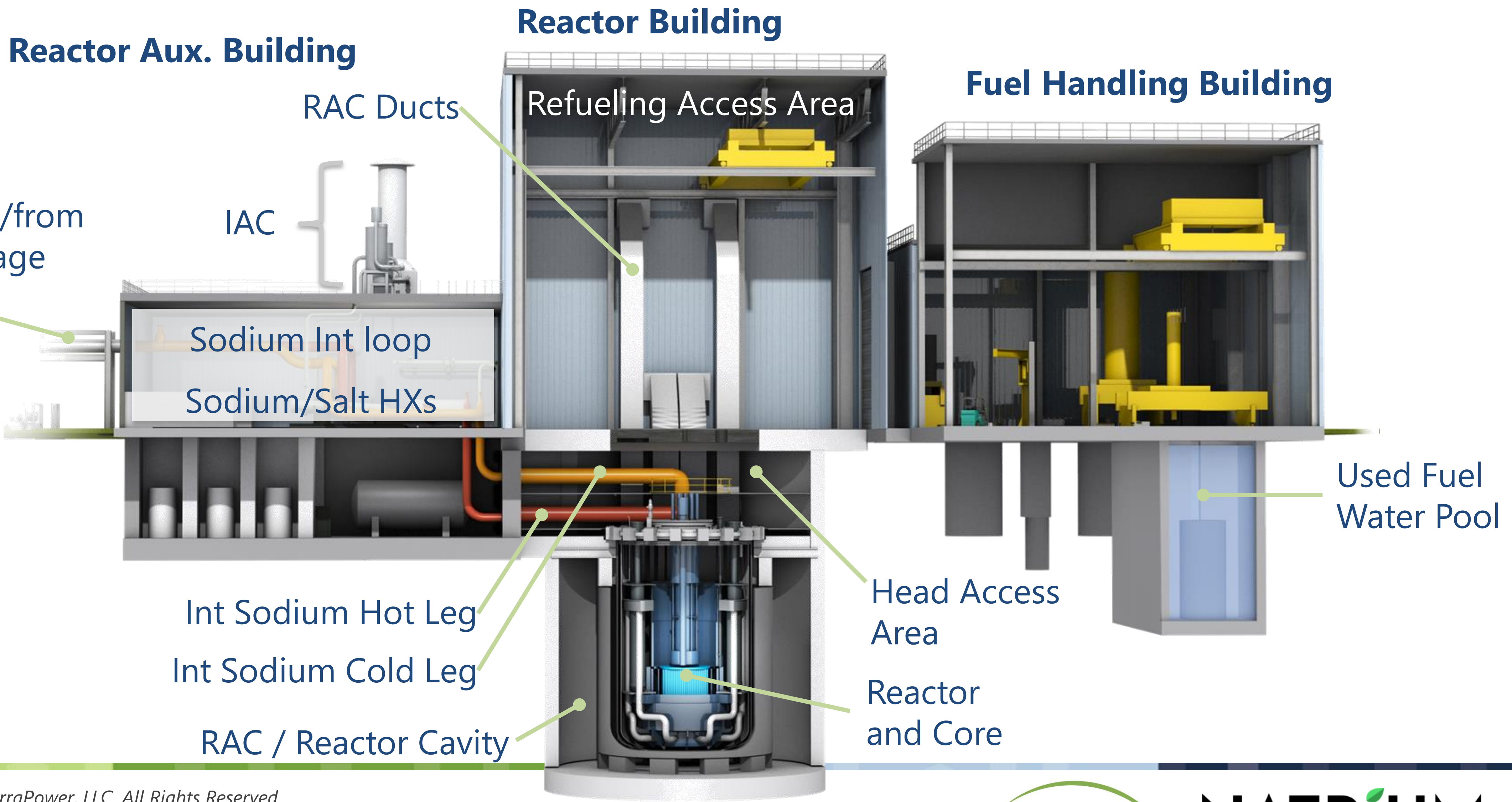
Thermal Storage



Thermal Storage

- Number of tanks based on customer’s energy need
- Steam generator trains based on size of turbines
- Turbine size based on customer’s power need

Key Technical Features of Natrium Reactor Buildings



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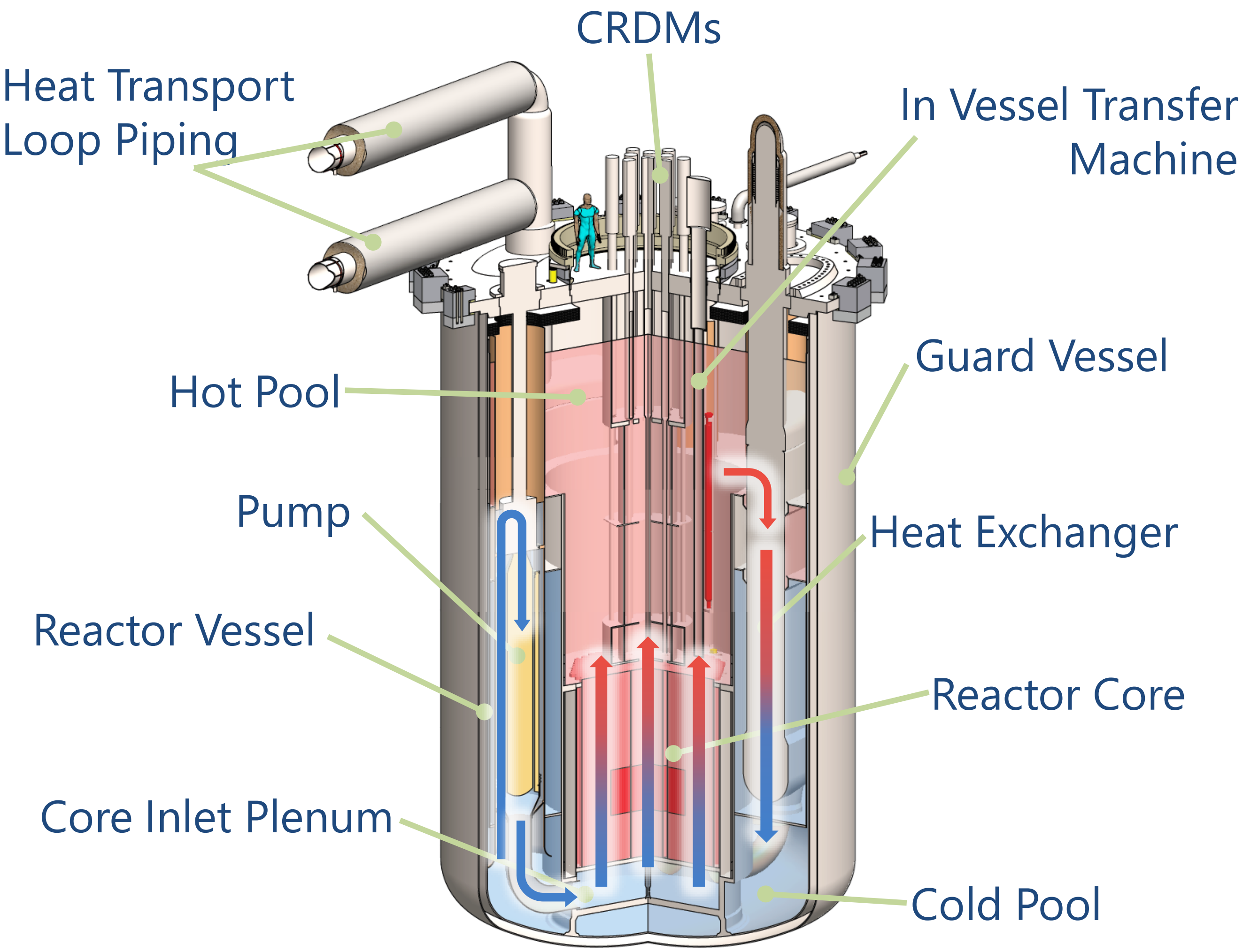
Key Technical Features of Reactor Equipment Design



- Advanced Fuel System
  - long lived, once through, lower cost fuel
- Efficient Transport Architecture
  - Molten Salt Loop transports heat to Energy Island
- Simple Reactor Structures
  - Safety related / nuclear seismic sub-structures
  - Open floor plan: few internal walls
- Compact Reactor Equipment
  - Pantograph In-Vessel Fuel Handling Machine
  - Space efficient internals design for easy fabrication
- Natural Circulation (Air) based safety cooling
  - RAC simplifies safety analysis & defense
- Local Loop Cooling for Refueling (non safety)
  - Na to air heat exchangers on Intermediate Loop

NATRIUM

Competitive
Clean Energy

Simple Nuclear System
- Exceptional heat transfer
- Passive air cooling
- Low pressure
- Optimized layout

Flexible
- Dispatchable power
- Energy storage… price follow
- Integrate with renewables
- Process heat

Adjacent innovations
- Concentrated solar power industry
- Tunneling industry… vertical cut
- Combined cycle gas turbine industry

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