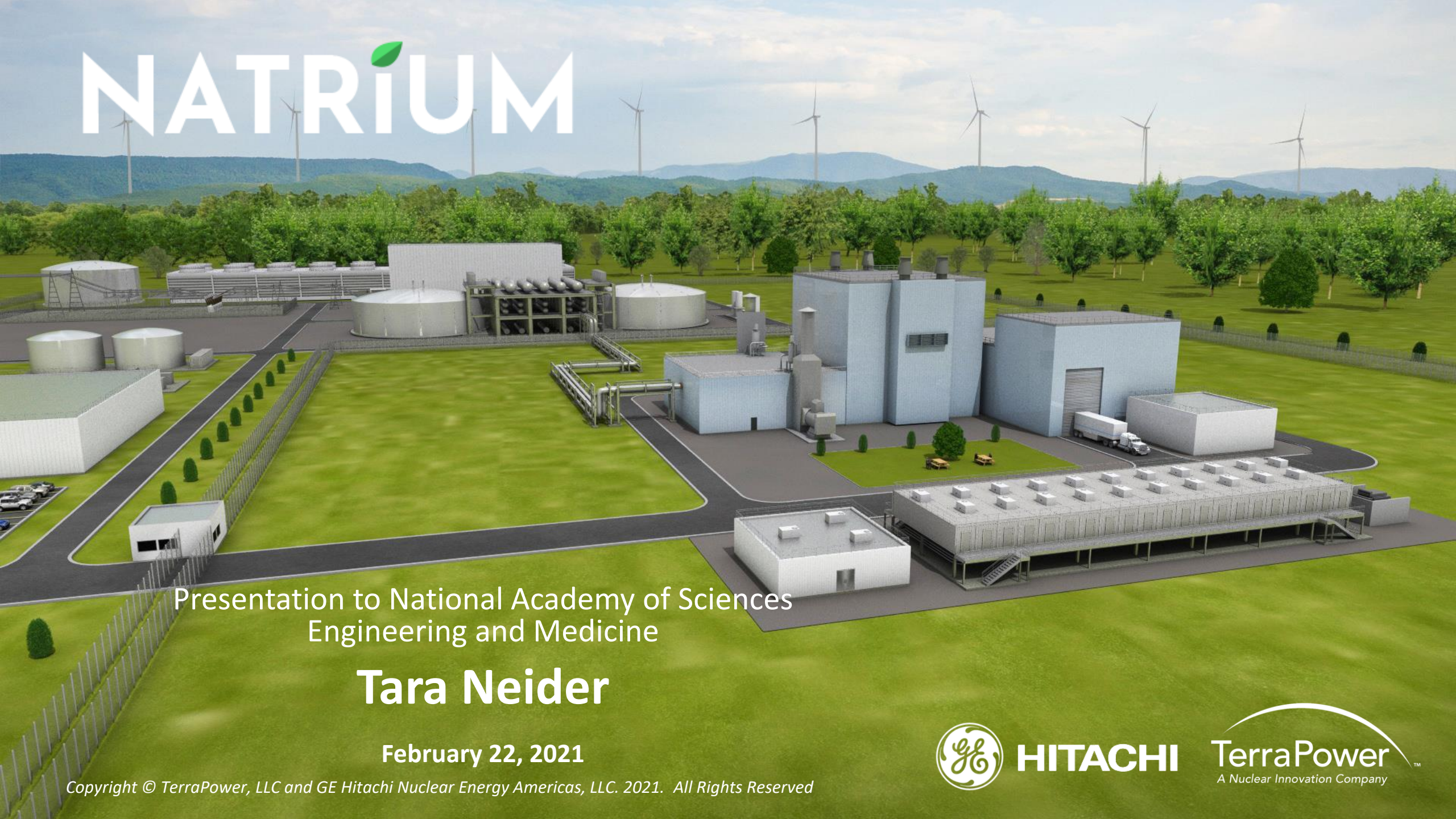


Presentation to National Academy of Sciences Engineering and Medicine

Tara Neider

February 22, 2021

HITACHI

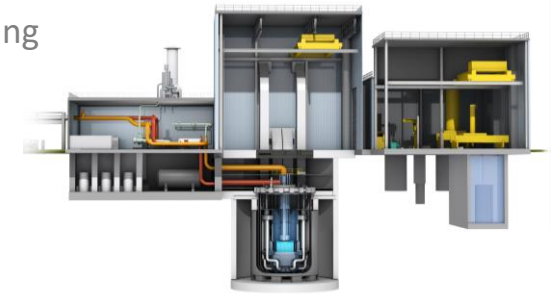
TerraPower
A Nuclear Innovation Company

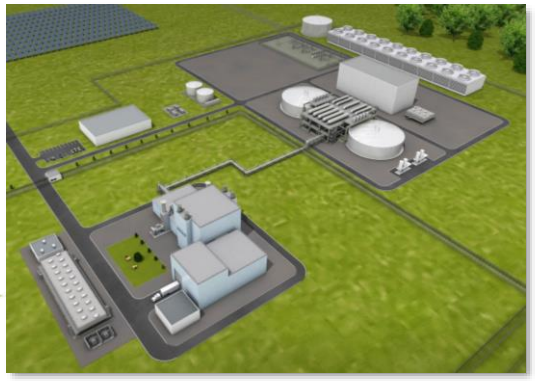
Natrium Roadmap – Ready for Demonstration

Mature commercial plant design
- Further establish compelling commercial case
- Focus on cost and economics
- Refine technology development needs

Develop IES technology & revenue modeling

U.S. NRC engagement





U.S. legacy SFR experience, PRISM and TWR development

1980s-2019

Pre-Demo Phase

Natrium Demonstration Plant (345 MWe → 500 MWe)

Commercial Plant Economics
+Energy Storage & Peaking Capability

2020-2027

Natrium Commercial Series I (345 MWe → 500 MWe)

3 yr. Construction
+Energy Storage & Peaking Capability

2027-2030s

Commercial Series II+ (Up to GWe scale)

Commercial Series I Benefits
+DU Breed-and-Burn
+Potential UNF Recycling
+Potential Pu Disposition
+Zero-Carbon Process Heat

~2040s

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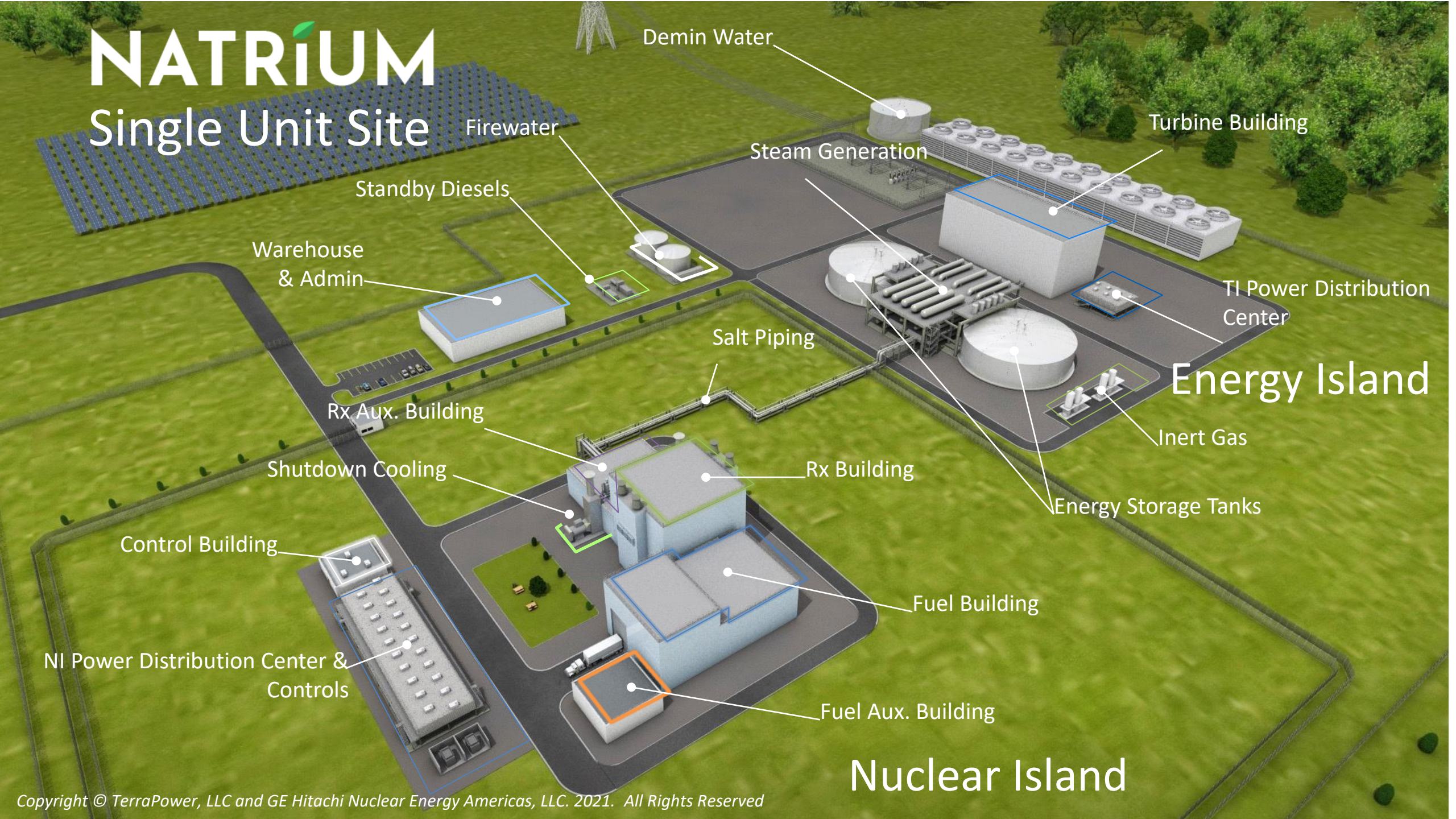
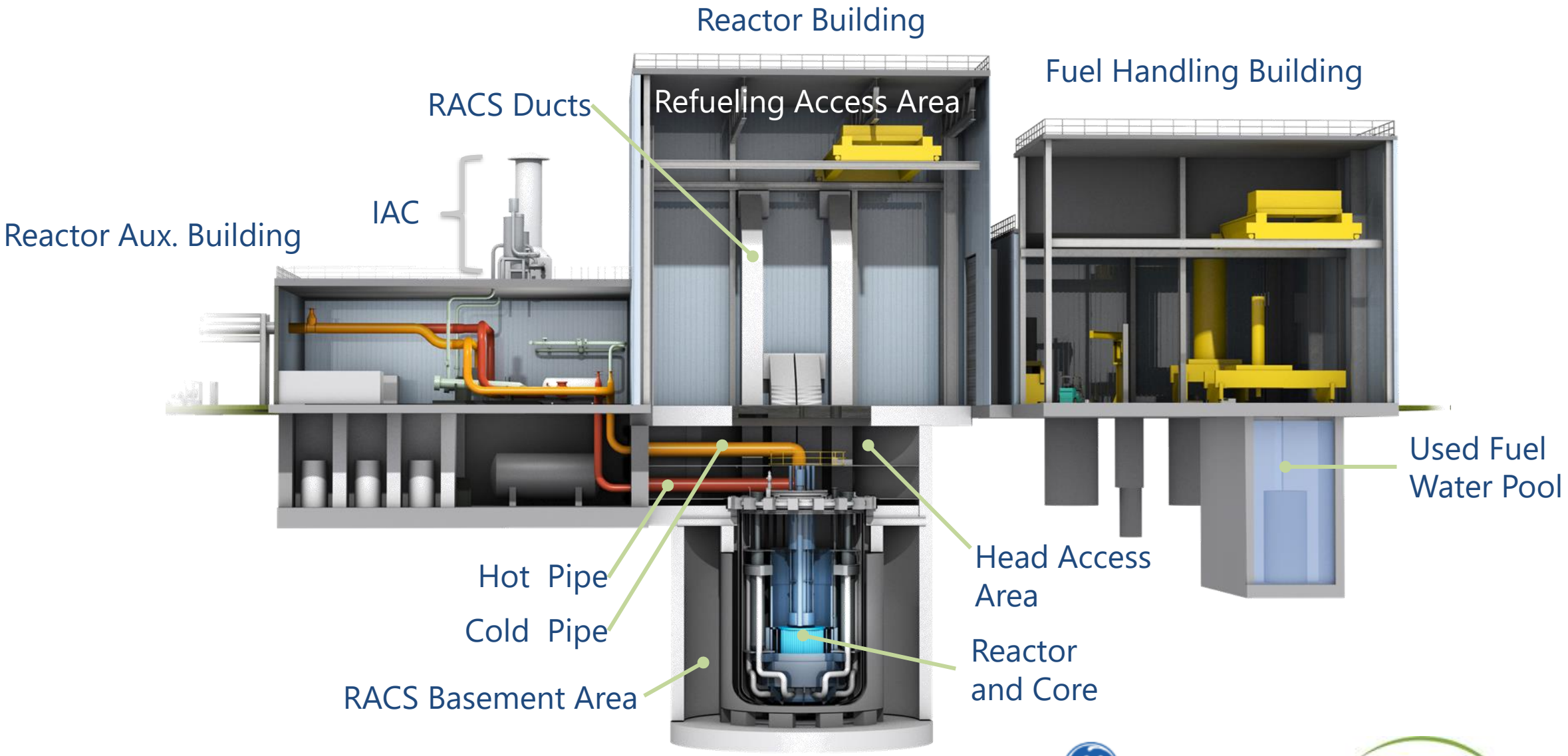
What is Natrium™ Technology?

- A high readiness Sodium-cooled Fast Reactor (SFR) with the following benefits:
  - A ***new plant architecture*** that minimizes cost and construction time
  - ***Simpler, less costly safety systems*** compared to current generation reactors
  - Grid-scale ***energy storage*** to complement renewables
  - ***Fuel cycle flexibility*** that facilitates global export
  - ***Utility-scale decarbonization***



Reactor Building



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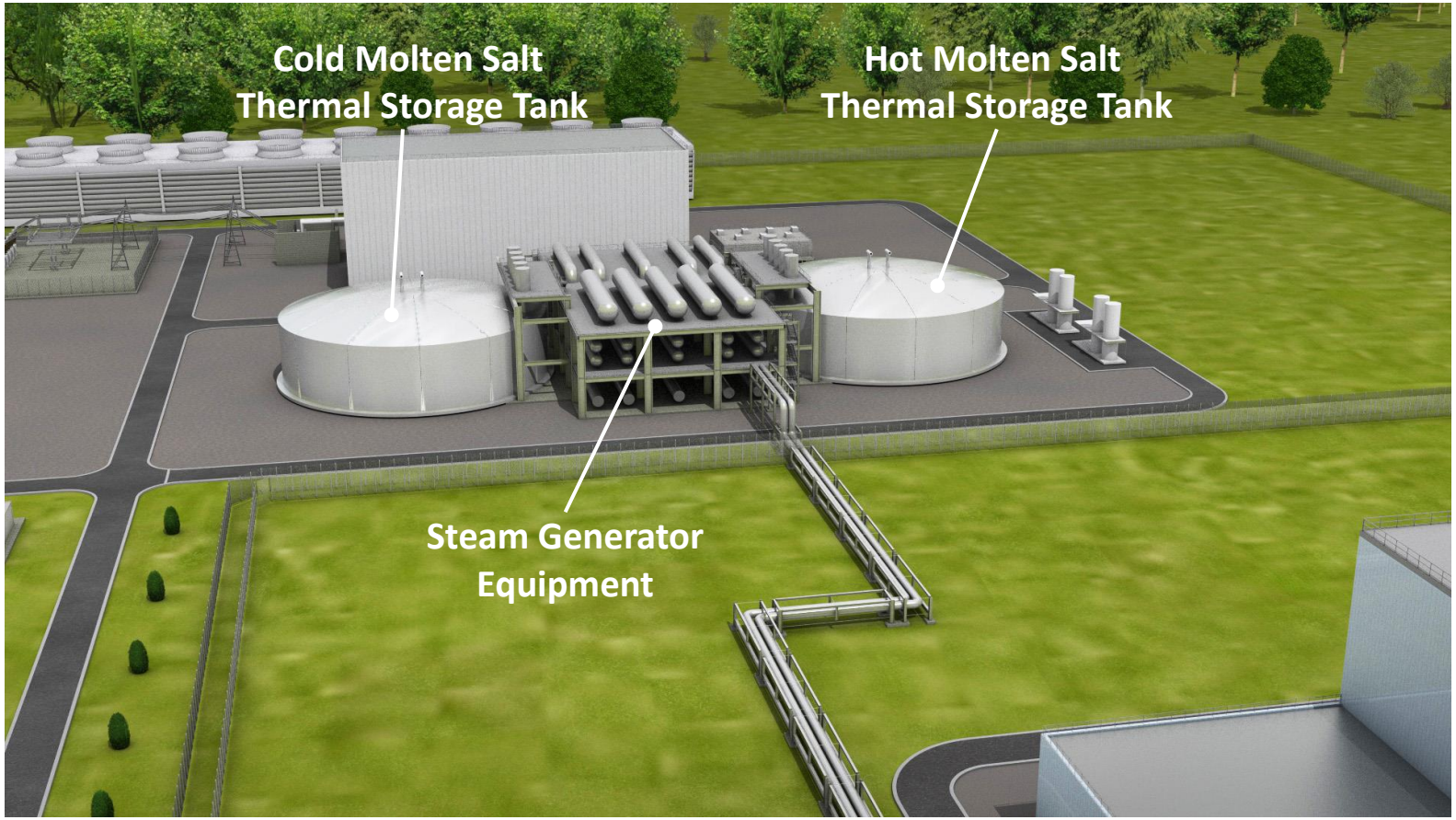
Thermal Storage



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

Sodium Coolant and Molten Salt Properties

- 390-540°C Reactor Coolant Operating temperature
- 880°C Boiling Temperature
- 98°C Melting Temperature
- Sodium inventory -800 m^3 in reactor
- Operates at atmospheric pressure
- Molten Salt used for heat storage is the same as used for solar plants
- Temperature range 238°C – 621°C salt; 60 $NaNO_3$- 40 KNO_3

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What is Different

Inherent Safety

Simple Nuclear Systems
- No sprawling nuclear piping and support equipment
- Exceptional heat transfer
- Passive air cooling
- Low pressure

Dramatic O&M Cost Reduction
- Less equipment to maintain
- Natrium Service Group

Architectural Innovations

Decoupled
- Bulk of plant constructed & operated without nuclear practices

Simple Nuclear Buildings
- 20 vs. 105 $\frac{m^3}{MWe}$ nuclear concrete

Simple Nuclear Construction
- Steel sided buildings
- Below ground reactor
- Minimal engineered backfill

Efficient Construction Layout
- High degree of parallel work

Staffing
- 65 – 125 staff

Flexible
- 8%/min ramp rate

Adjacent Industries

Concentrated Solar Power
- Energy storage in molten salt
- Steam generator & salt pump technology

Argonne Integral Fast Reactor
- 30 years of EBR-II operation
- Proven inherent characteristics

Tunneling
- Vertical cut excavation

Combined Cycle Gas Turbine
- Construction approaches
- Aggressive staffing
- Fast burst power ramping

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Safety

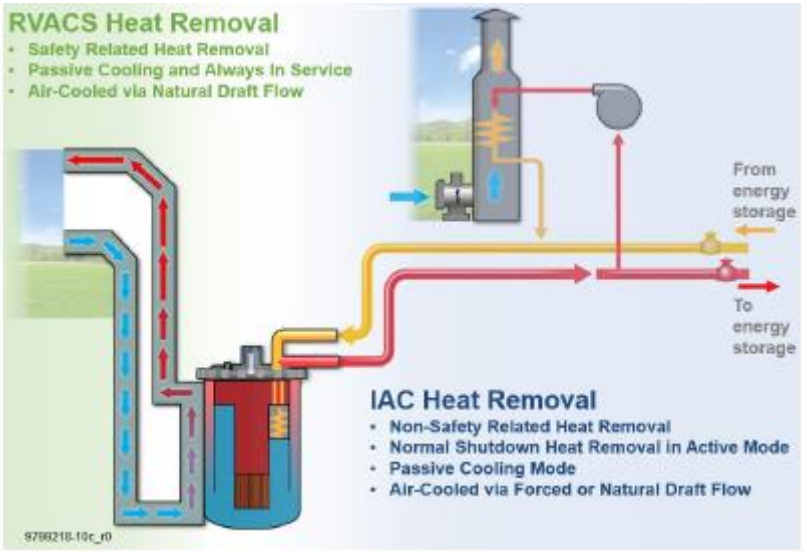
- Low-pressure pool reactor with no piping or fittings below the surface of the pool
- Guard vessel prevents loss of coolant if reactor vessel were to leak
- Fuel material compatible with coolant. Minor fuel cladding breaches are benign where the fuel material is not chemically reactive with the coolant.
- Sodium absorbs many of the released fission products, especially iodine and cesium. Sodium's affinity for fission products also limits the inventory that reaches the cover gas.
- Reactor cover gas operates at essentially atmospheric pressure so there is little to no driving force for a release.
- Intermediate coolant, by static head alone, is at a slightly higher pressure than the primary coolant.
- The only systems connected to the primary coolant boundary, cover gas and sodium cleanup, are automatically isolated by passive fail close valves.

Reactivity Control

- Non-safety related reactor control system acts as a buffer to prevent the need for a scram. It detects abnormal operation and initiates a runback via motor driven insertion of neutron absorbing control rods to achieve a softer shutdown than a scram.
- Safety related reactor protection system exists to initiate a scram should the reactor control system fail or a properly initiated runback fails to prevent the reactor from reaching a scram setpoint. The high reliability scram function is initiated by removing electrical power to an electromagnet, resulting in passive gravity insertion of all control and standby rods into the core.
- The core is designed with a negative temperature and power coefficient that is strong enough such that the reactor can accommodate anticipated transients without scram for events such as a loss of primary flow, loss of heat sink and uncontrolled rod withdrawal. The natural feedbacks are self regulating and will always find a low power level at which the production and heat removal are in balance.

Cooling

- 3 Defense in Depth Features
  - Reactor Air Cooling (Inherent) designed to remove all decay heat (SR)
  - Intermediate Air Cooling Heat Removal
    - Non-Safety Related Heat Removal
    - Normal Shutdown Heat Removal in Active Mode
    - Passive Cooling Mode
    - Air-Cooled via Forced or Natural Draft Flow



Challenging Licensing Issues for Commercialization

- Review Time is biggest issue; We are confident in our design and licensing strategy but guidance on non-LWR licensing is incomplete; Positions being developed now and requirements could change.
- PRISM Pre-licensing Safety Evaluation used as basis for Natrium development; outstanding issues addressed

Technical Challenges for Commercialization

- HALEU Supply
- Development of Supply Chain for critical components
- Our Development program includes significant testing and qualification, particularly in areas of low TRL.
- Ready for demonstration with improvements to lower commercial costs.

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Natrium Team Committed to 7-year Time Frame

PSAR/CPA in 30 months (Phased Approach)

FSAR/OLA by 54 months

First Safety Concrete 48 months

Construction Complete 78 months

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