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November 8, 2022

### **MEMORANDUM**

**TO: Council Members**

**FROM: Jennifer Light, Power Division Director**

**SUBJECT: Grant PUDs Activities on Small Modular Reactors**

### **BACKGROUND:**

**Presenter:** Kevin Nordt, Chief Resources Officer and CEO Emeritus

**Summary:** Grant PUD's recent Integrated Resource Plan (IRP) identifies a need for future capacity resources to meet potential future resource adequacy requirements (such as those required by the Western Resource Adequacy Program) and energy resources to meet the Clean Energy Transformation Act (CETA) compliance. Grant's IRP identified a proposed mix of new solar, solar plus battery storage, wind, and gas reciprocating internal combustion engines as the most cost-efficient means of meeting future needs. The IRP also recognize that there are alternative or complementary approaches to the portfolio that might best meet future needs. One of these alternative approaches is small modular nuclear reactors (SMR). Kevin will discuss these future needs, Grant's assessment of available technologies, and ultimately their selection of the X-energy Xe-100 as an option for future development.

**Relevance:** The Council's 2021 Power Plan recognized that there are several promising emerging generating resource technologies that might provide value for future resource needs, and it recommended that the region continue to work with developers and manufactures to research and explore these technologies. One of these technologies is SMR and staff

are tracking progress on development efforts to inform the mid-term assessment and future power plan development.

More Info: Grant PUD's 2022 Integrated Resource Plan:  
<https://www.grantpud.org/templates/galaxy/images/images/Downloads/Publications/Exhibit A 2022 Integrated Resource Plan.pdf>

# Grant PUD – SMR Exploration Update

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November 16, 2022

Kevin M. Nordt  
Chief Resource Officer



Powering our way of life.



# Agenda:

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- Motivation for SMR Exploration
- Spectrum of Advanced Reactor Technologies
- Grant's Technology Selection Approach
- Grant's Technology of Choice – Xe-100
- Grant's Deployment & Partnering Plans

# Potential Washington Project

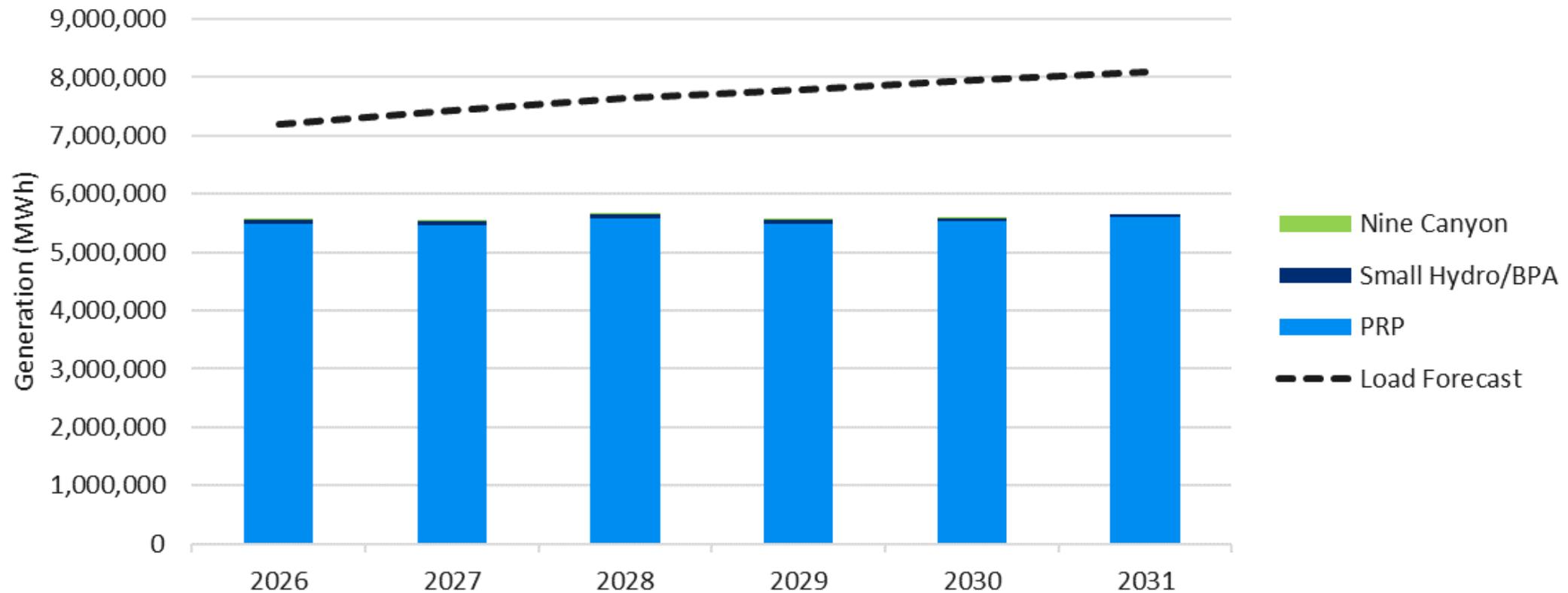
## Grant PUD is considering new resource options to meet growing load:

- Grant continues to experience strong load growth.
- This high capacity factor “new economy” load growth requires clean, firm, dependable, and flexible power resources : ELCC, flex, and cost matter – thus SMR and hydrogen focus.
- Formed SMR Evaluation Team to conduct due diligence and analysis of potential advanced and small modular reactor technologies.
- Evaluation determined X-energy’s Xe-100 design to be the most viable option, due to the design’s:

*“operational, safety, maintenance, and licensing attributes, as well as its technical and economic potential as a firm, dependable energy resource.”*

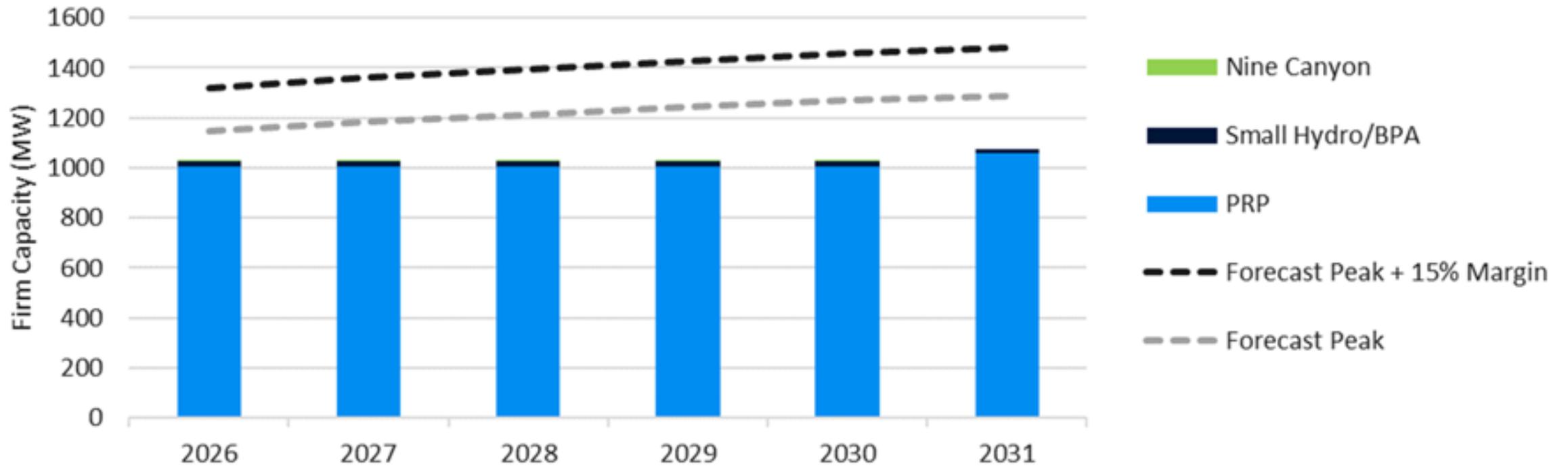
# Grant PUD Load Resource Balance - Energy

Annual energy expectations vs. load forecast, current portfolio



# Grant PUD Load Resource Balance - Capacity

Current portfolio capacity vs potential capacity requirements under WRAP



# Land-use & Energy Density

- Nuclear energy is extremely dense, creating more energy per unit of land than any other resource.
- A 1,000 MW nuclear plant requires just over one square mile (640 acres).
- For comparison:
  - An equivalent amount of wind requires 260 - 360 square miles
  - An equivalent amount of solar requires 50 – 75 square miles
- Advanced and small modular reactors will be the lightest environmental touch – all around including the low volume of spent fuel.
- An Xe-100 reactor, providing 320 MWs, will only require 20-40 acres of land (or .04 square miles!).

# Advanced Small Modular Reactors (SMR)

SMALL MODULAR REACTORS



BEST CHANCE FOR IMMEDIATE CONSTRUCTION

- INCREASED SAFETY
- LESS COST
- SCALING SIZE

## Key Attributes:

- Evolutionary technology
- Small geographic footprint
- Flexible & Dispatchable
- On-line refueling
- Simple, scalable designs
- Passive safety
- Off-the-shelf parts and advanced construction techniques

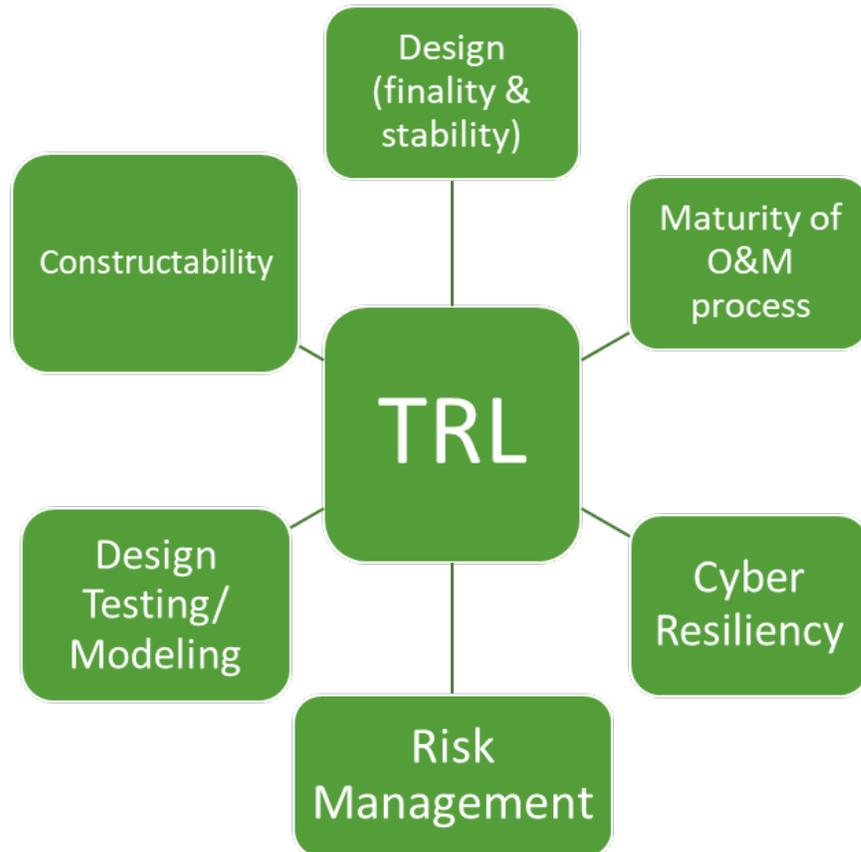
*Image Courtesy of Third Way*

# Wide Variety of SMR Concepts

## Start-up Innovation & Disruptive Technology Climate

- Wide Variety of SMR concepts
  - Water Cooled
  - Gas Cooled
  - Fast Neutron Spectrum
  - Molten Salt - e.g. Sodium or FLiBe
- Vibrant Technology Sector – X-energy, NuScale, TerraPower, GE, Westinghouse, Oklo, Kairos, Copenhagen Atomics, Holtec, U-Battery, Ultra-Safe, Moltex....

# Categories Evaluated



Technology Readiness Level (TRL)

- Technology Readiness Level (TRL)
- Fuel Selection
- Cost (LCOE)
- Safety
- Regulatory & Licensing
- Constructability & Flexibility
- Commercial
- Reactor OEM Capability, Capacity & Engagement
- Good Neighbor
- Used Fuel Storage & Disposal

# XE-100 Adv. Reactor



- Base model consists of four 80 MWe reactors (320 MWe output)
- Design utilizes high temperature gas (Helium) reactor (HTGR) technology
- Dry cooling requires minimal water
- Scalable design expandable up to 12 module plant (960 MWe output)

# XE-100 Design

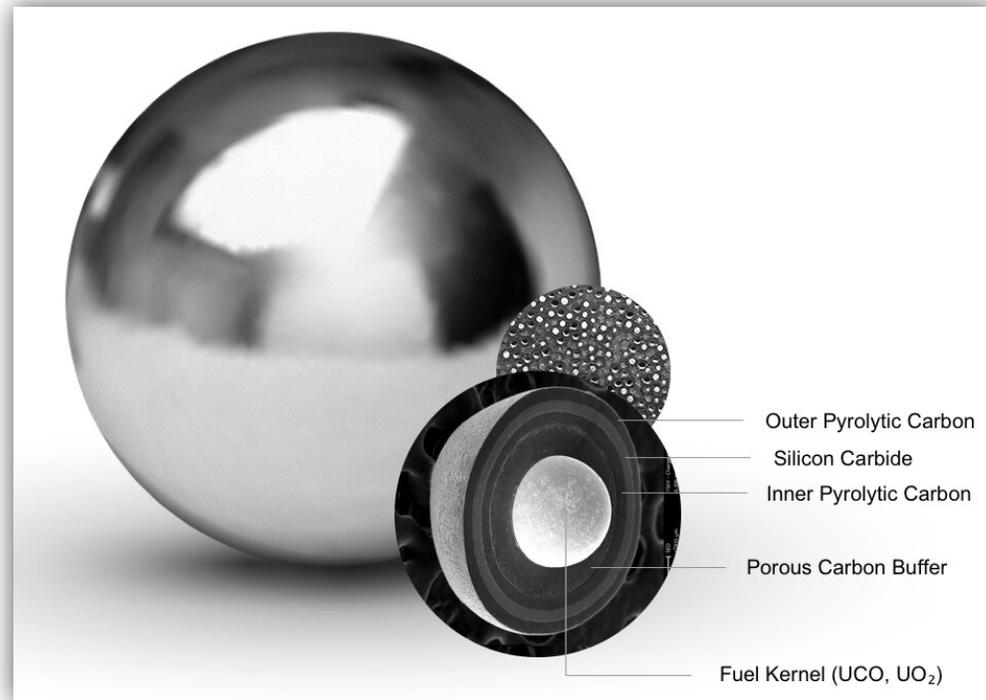
**XE-100 provides clean, carbon-free power at an affordable price and in a scalable package, enabled by:**

- Walk-away safe design
- Variable fuel costs (continuous, online refueling)
- Inherent proliferation resistance
- Higher fuel utilization
- High-temp/high thermal efficiency



# TRISO-X Fuel

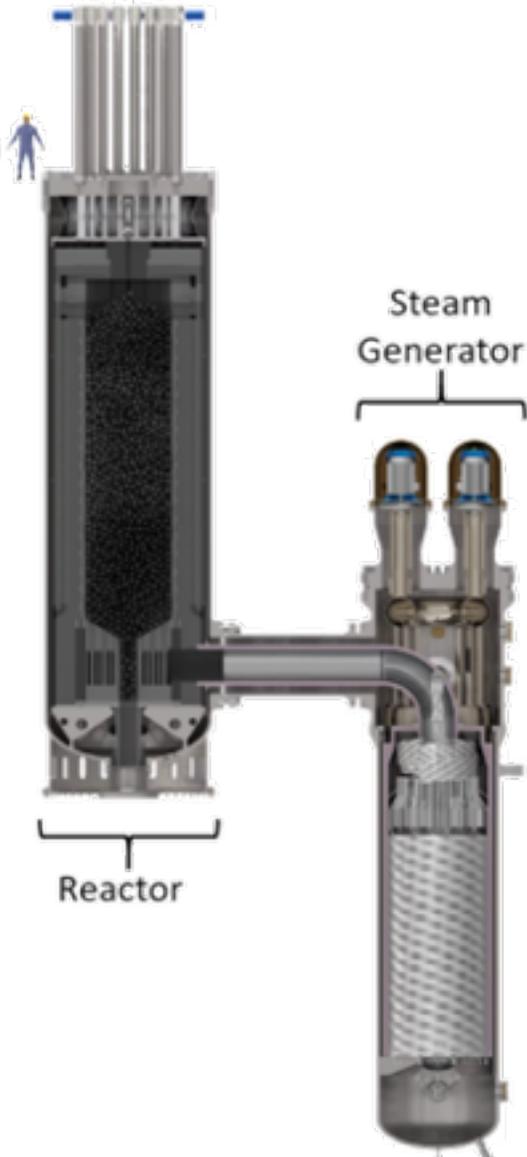
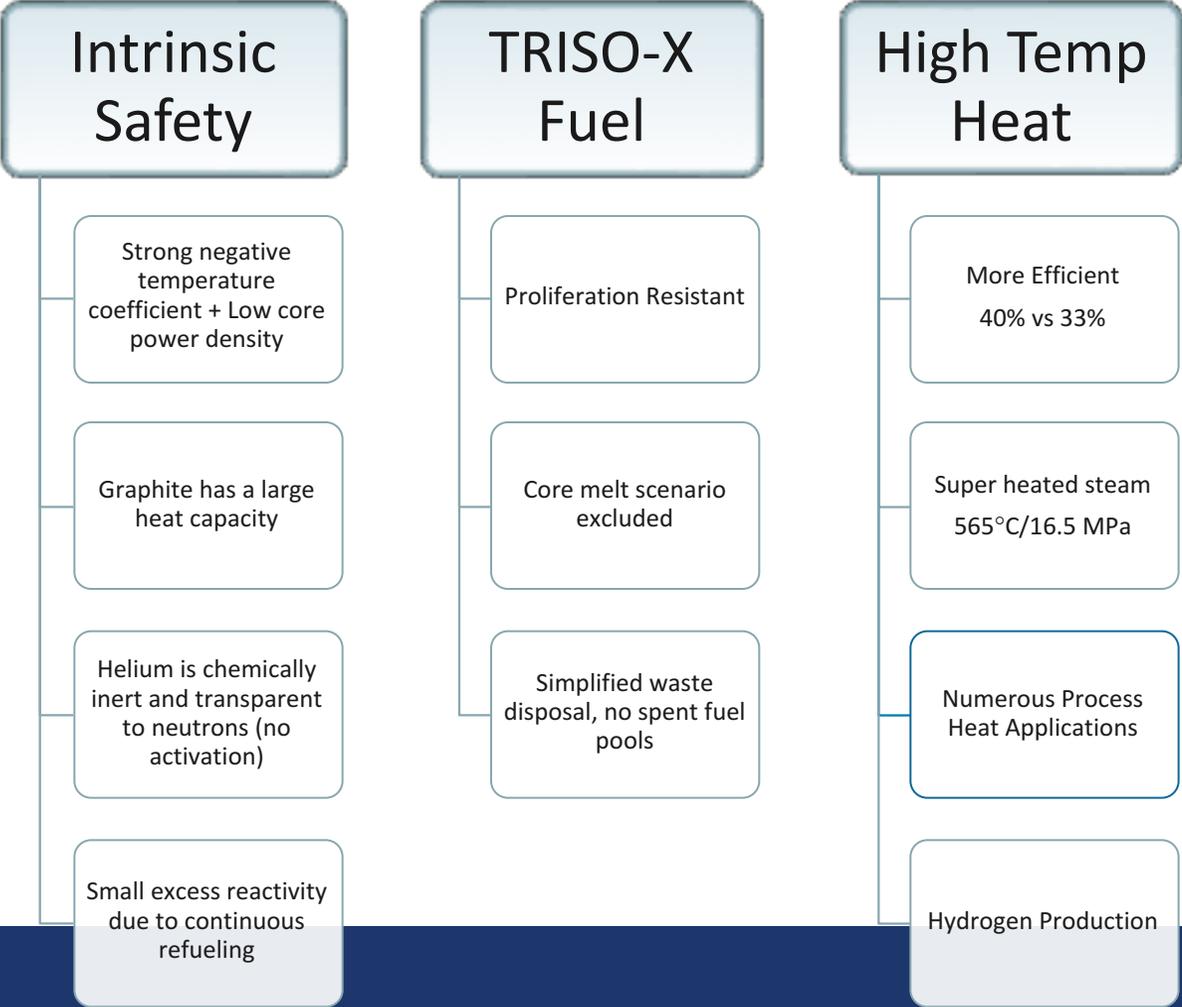
X-energy Reactor is powered by proprietary tri-structural isotropic (TRISO) coated particle field, called TRISO-X, which:



- Is made in a unique coated fuel particle manufacturing process that decreases unusable scrap and ensures quality
- Cannot melt in the Xe-100 reactor... period
- Is the reactor containment, locking in 99.999% of all fission products
- Enables the safety and economic case of the Xe-100 by simplifying the design and operations, while requiring far fewer components

# HTGR vs. Light Water Reactor (LWR)

## Small Modular Reactor



# The Xe-100 Meeting Grant's Requirements

- The Xe-100 is extremely safe and environmentally friendly.
- It brings significant optionality – plant expansion, output product (electricity, industrial process heat, high efficiency H2 production).
- The Xe-100 can be base-load but is flexible – strong contribution to reliability via a high expected ELCC.
- Highly flexible Unit Commitment / Dispatch capability with significant ramping capability.
- Long economic life – 60 year license and very favorable LCOE (mid-\$50's range).

# Grant PUD's Partnering & Deployment Plans

- Grant is partnering with Energy Northwest to leverage PNW nuclear expertise.
- Grant is coordinating with Ontario Power Generation (OPG) to share development experience and knowledge as both pursue Xe-100.
- Both Grant & OPG see great promise not just in nuclear power but clean, high quality industrial process heat – load diversification potential.
- To minimize entity risk and regional opportunities, Grant is working to bring on long term power output wholesale purchasers.
- Significant early progress is being made to support a full plant deployment before the end of the decade.

# Questions?

# Thank You

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