



*BWX Technologies, Inc.
Overview and
Advanced Reactor Development*

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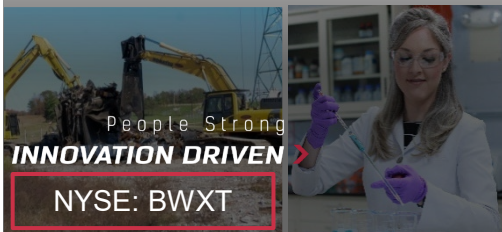
COMPANY OVERVIEW

BWXT[®]
BWX Technologies, Inc.

Company Highlights



BWXT is one of the world's most prolific nuclear technology innovation companies and the sole manufacturer of naval nuclear reactors for U.S. submarines and aircraft carriers.



6,600
highly skilled
employees



**\$2.1 billion
USD**
in 2021 revenues



12
major manufacturing
facilities totaling 3.9
million square feet



60+
years manufacturing naval
nuclear components
and reactors



300+
commercial nuclear
steam generators
manufactured



1.5 million+
Canada Deuterium
Uranium (CANDU)
fuel bundles provided



13
U.S. Department of Energy
laboratories, environmental
cleanup projects and NASA sites



8,000+
fuel elements delivered to U.S.
national laboratories, universities
and international customers

Company Locations



Headquartered in Lynchburg, Virginia, our operations include 12 manufacturing facilities in North America. We also provide management services at more than a dozen U.S. Department of Energy and NASA sites.

Manufacturing Sites

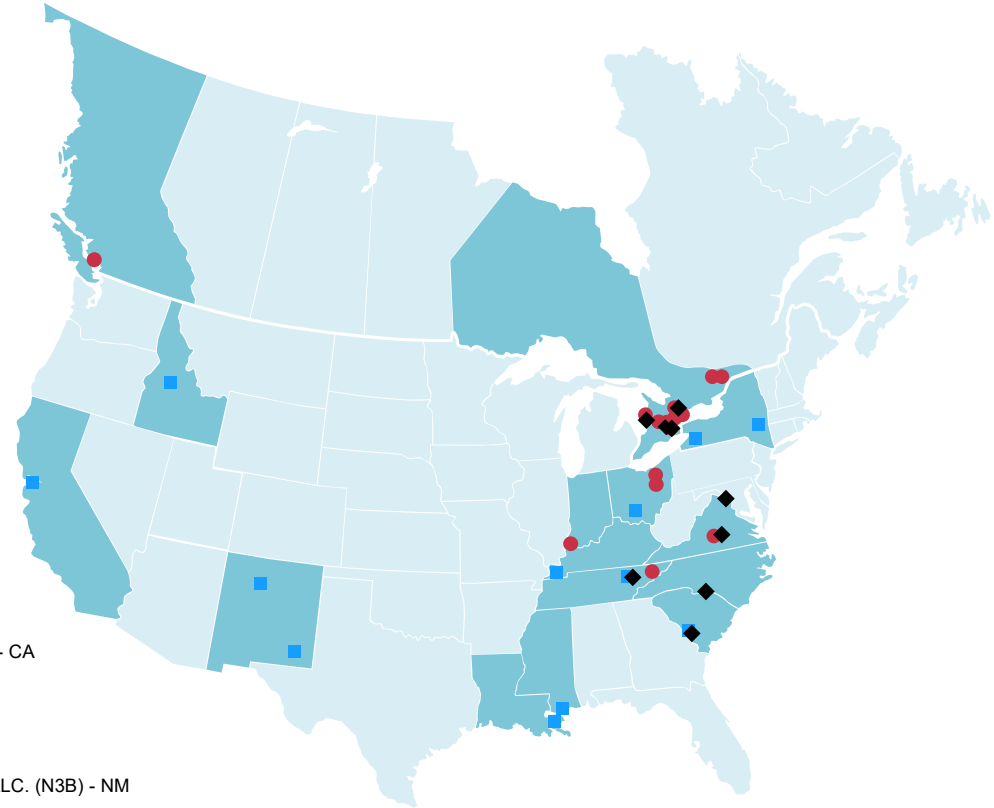
- Lynchburg, VA
- Barberton, OH
- Euclid, OH
- Mount Vernon, IN
- Erwin, TN
- Cambridge, Ontario
- Peterborough, Ontario
- Toronto, Ontario
- Arnprior, Ontario
- Oakville, Ontario
- Ottawa, Ontario
- Vancouver, British Columbia

Key Offices / Operations

- ◆ Lynchburg, VA*
- ◆ Charlotte, NC
- ◆ Oak Ridge, TN
- ◆ Aiken, SC
- ◆ Washington, DC
- ◆ Cambridge, Ontario
- ◆ Dundas, Ontario
- ◆ Peterborough, Ontario
- ◆ Port Elgin, Ontario

Joint Ventures

- Kesselring Site Operations – NY
- CH2M Hill B&W West Valley, LLC. - NY
- Fluor-BWXT Portsmouth, LLC. - OH
- Four Rivers Nuclear Partnership, LLC. - KY
- Naval Reactors Facility - ID
- Battelle Energy Alliance, LLC. - ID
- Lawrence Livermore National Security, LLC. - CA
- UT-Battelle, LLC. - TN
- Isotek Systems, LLC. - TN
- Savannah River Mission Completion - SC
- Syncom Space Services, LLS (S3) – MS, LA
- Nuclear Waste Partnership, LLC. – NM
- Newport News Nuclear BWXT-Los Alamos, LLC. (N3B) - NM



* Corporate headquarters

165-Year History of Innovation

75-Year History of Nuclear Technology

1856

Stephen Wilcox patented the water tube boiler



1907

Teddy Roosevelt's Great White Fleet powered by B&W boilers

1946

Awarded first U.S. Navy contract for propulsion systems



1953

Designed and fabricated components for world's first nuclear powered submarine



1956

Manufactured components for first commercial nuclear power plant in the U.S.

1962

Designed and furnished commercial nuclear reactor systems for Indian Point

1966

Initiated design and fabrication of nuclear components for Nimitz-class aircraft carriers



1994

Awarded first major DOE site management and operating contract at Idaho National Engineering and Environmental Laboratory

1997

Awarded first prime contract from DOE

2015

Selected for design and manufacturing contracts for HPR1000 nuclear plant

2017

Awarded NASA Nuclear Thermal Propulsion Reactor Design contract



2018

Announced disruptive medical isotope manufacturing technology

2019

Introduced FDA-approved medical isotope In-111 generic for diagnostic imaging to the U.S. market



2020

Restarted TRISO advanced nuclear fuel manufacturing for future DoD and NASA missions

2020

Awarded DoD contract for mobile nuclear reactor design

NON-NUCLEAR

NUCLEAR

1856

1946

1994

BWXT ERA

2015



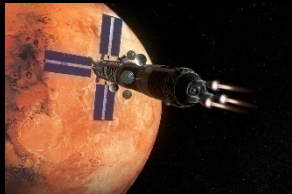
GOVERNMENT



Naval Nuclear Propulsion



Nuclear environmental restoration and site management



Space and defense nuclear power and propulsion

COMMERCIAL



Clean energy demand



Nuclear medical manufacturing



Next generation nuclear reactors



Nuclear Operations

Government Operations

Services & Technologies

Naval nuclear propulsion



Nuclear fuels & uranium processing



Culture of excellence



Experienced leadership

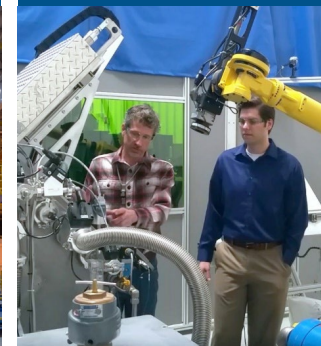


Category 1 licenses

Technical services








Advanced technologies



Government Operations



Nuclear Operations Group (NOG)

	NFS	NOG-E	NOG-L	NOG-B	NOG-MTV
					
Location	Erwin, TN	Euclid, OH	Lynchburg, VA	Barberton, OH	Mount Vernon, IN
Facility (Square Feet)	~271,000	~325,000	~1,000,000	~800,000	~639,000
Employees	760	352	2,261	853	352
Products	<ul style="list-style-type: none"> ○ Fuel Material ○ Downblending 	<ul style="list-style-type: none"> ○ Control Rod Drive Mechanisms 	<ul style="list-style-type: none"> ○ Naval Nuclear Reactors ○ Research Test Reactors ○ Medical Targets 	<ul style="list-style-type: none"> ○ Heavy Components 	<ul style="list-style-type: none"> ○ Heavy Components ○ Missile Tubes ○ Spent Fuel Containers



Services & Technologies

	Advanced Technologies	Technical Services
Location	Lynchburg, VA	13 government facilities in the U.S.
Facility (Square Feet)	61,500	N/A
Employees	180+	248
Products/ Services	<ul style="list-style-type: none"> ○ Engineering Design ○ Microreactor Design ○ Nuclear Thermal Propulsion ○ Ops Support 	<ul style="list-style-type: none"> ○ Management and Operations ○ Nuclear Operations ○ Security ○ Emergency Response ○ Operations and Maintenance ○ ES&H ○ Quality ○ D&D



Commercial Nuclear Power

Nuclear manufacturing



Nuclear fuel



Nuclear services



Commercial Operations



Strong customer relationships



Experienced leadership



Specialized capabilities

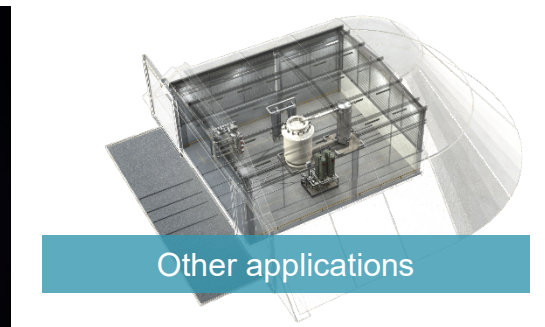
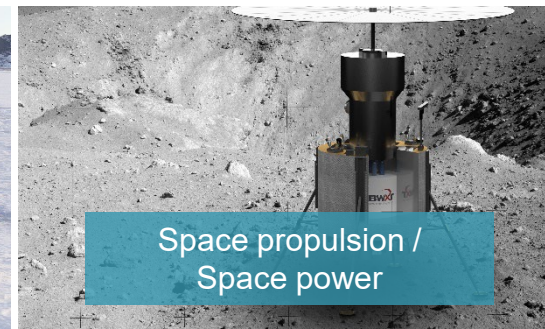
Nuclear Medicine

Medical isotope production





- Space Nuclear
 - Nuclear thermal propulsion
 - Lunar surface power
 - Nuclear electric propulsion
- Terrestrial Reactors
 - Microreactors
- Advanced Technologies
 - Advanced manufacturing
 - Medical isotopes



Cutting-edge, cost-effective, scalable

Advanced Microreactor Deployment



- 1-5 MWe microreactor
- High temperature gas reactor (HTGR) technology
- TRISO fuel
- 2024 – Deployment at Idaho National Laboratory (INL)
- Transportable – within commercially available shipping containers
 - 20ft CONEX Boxes
- Experienced and Capable Team





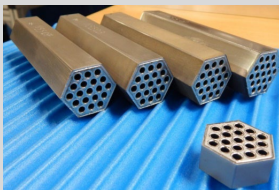
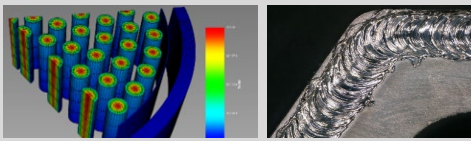
Advanced Nuclear Development

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BWXT Capability: Rapid Product Development

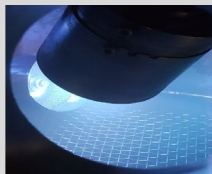


Early R&D



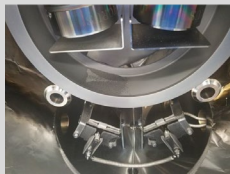
Design, fabrication development; surrogate specimen development

Lab Scale



Sol-Gel kernels and PVD coating

Pilot Scale



Production NRC Cat 1



Reactors and fuel elements for a variety of customers

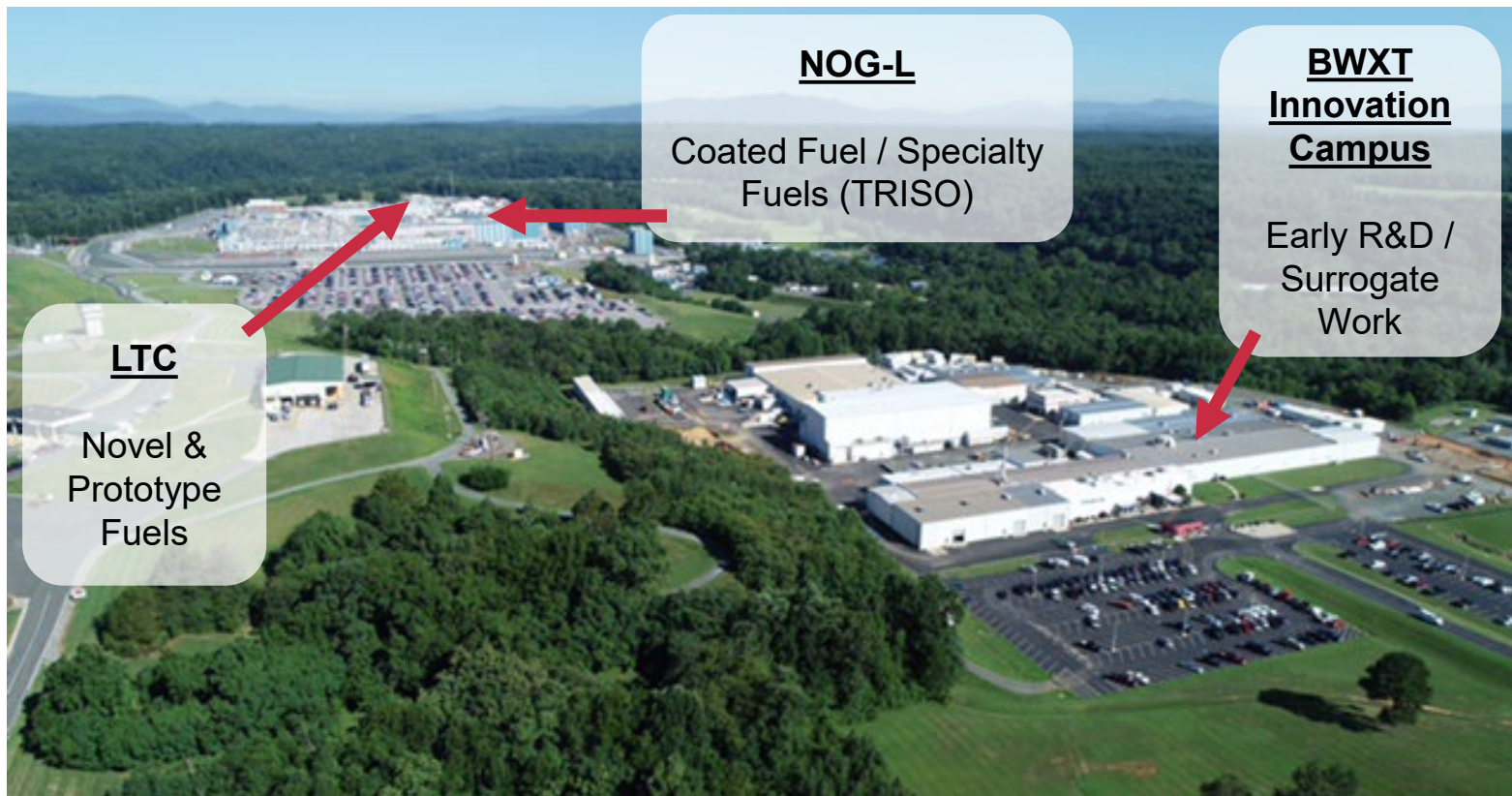
MRL 1
TRL 1

MRL 4
TRL 4

MRL 6
TRL 6

MRL 9
TRL 9

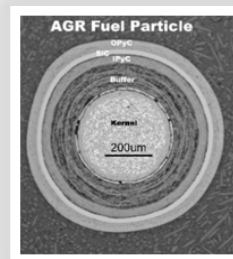
Rapid Fuel Development Infrastructure on Single Peninsula





○ TRISO Fuel

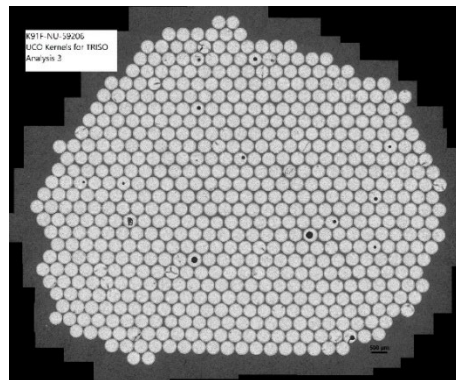
- Uranium Oxycarbide kernel (UCO)
- TRISO coating layers
 - » Buffer
 - » Inner Pyrolytic Carbon (IPyC)
 - » Silicon Carbide (SiC)
 - » Outer Pyrolytic Carbon (OPyC)
- TRISO coated particles consolidated in compacts



TRISO Coated UCO



TRISO Compacts



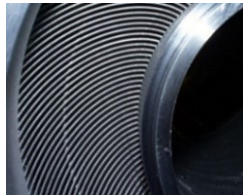


Fuel Production at NOG-L

(all enrichments – HEU, HALEU and LEU)

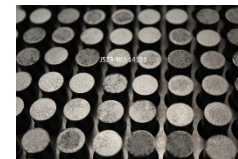
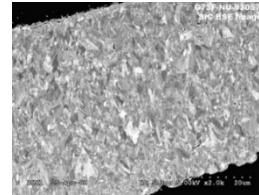
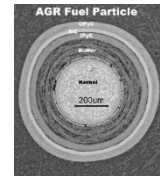
Research Test Reactors and Targets

- ATR, JAEA
- HFIR, NIST, Petten
- Universities of Missouri, Purdue, Florida, Massachusetts (Lowell), MIT



Specialty Fuel Facility (SFF) Capabilities

- Fuel preparation
 - U Metal dissolution & oxidation
 - Powder precipitation & calcining
 - Particle forming & sintering
- Fuel types
 - Enrichments – depleted to HEU
 - Powder, particle, pellet
 - UO₂, UCX, UCO, UN, UZrCX
- Coating types
 - TRISO
 - ZrC
- Compacts
 - Advanced Gas Reactor



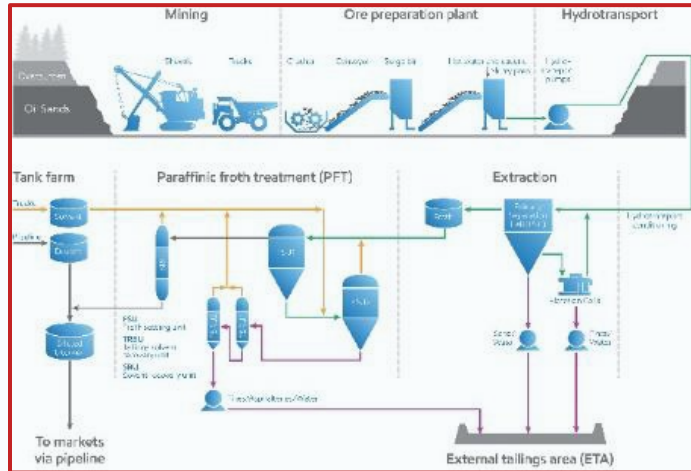


BWXT Advanced Nuclear Reactor (BANR)

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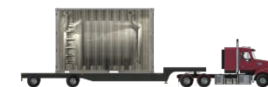
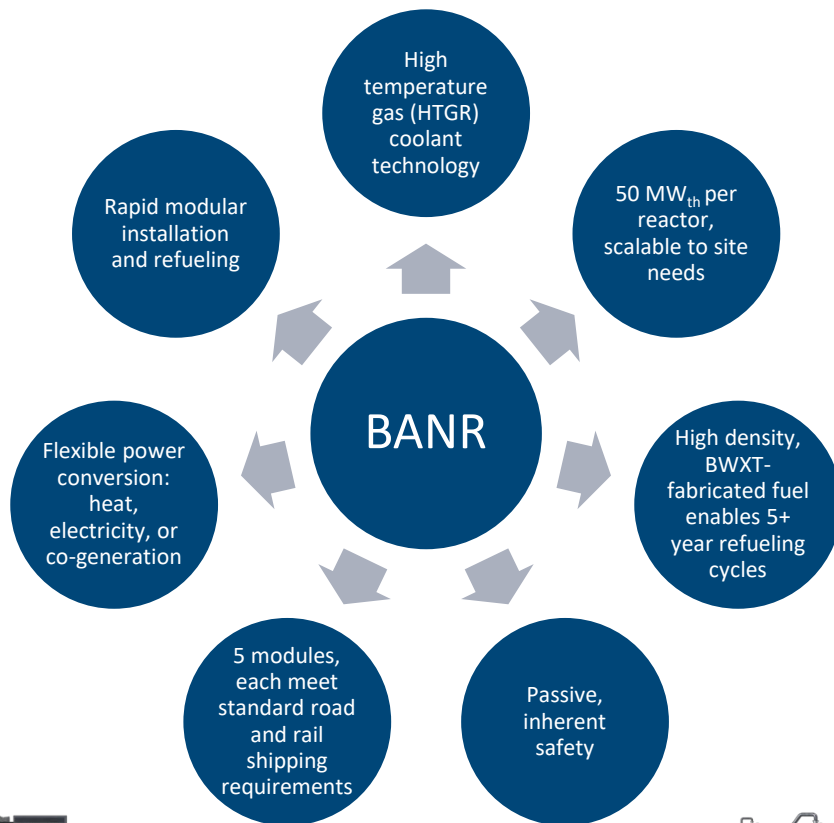
- Nuclear Feasibility Study for Deployment
 - Technical, regulatory and commercial assessment
 - Use cases: process heat, electricity, and co-generation
 - » 8 boilers provide 1200 MWth; 100 MWe from offsite source
 - Motivation: future carbon tax



Top Level Requirements:

- Integrate into existing process systems
- Transportability within existing size and weight limits
- Minimal site preparation and impact on existing site processes
- Maximize regulatory and economic certainty
- No onsite fuel handling

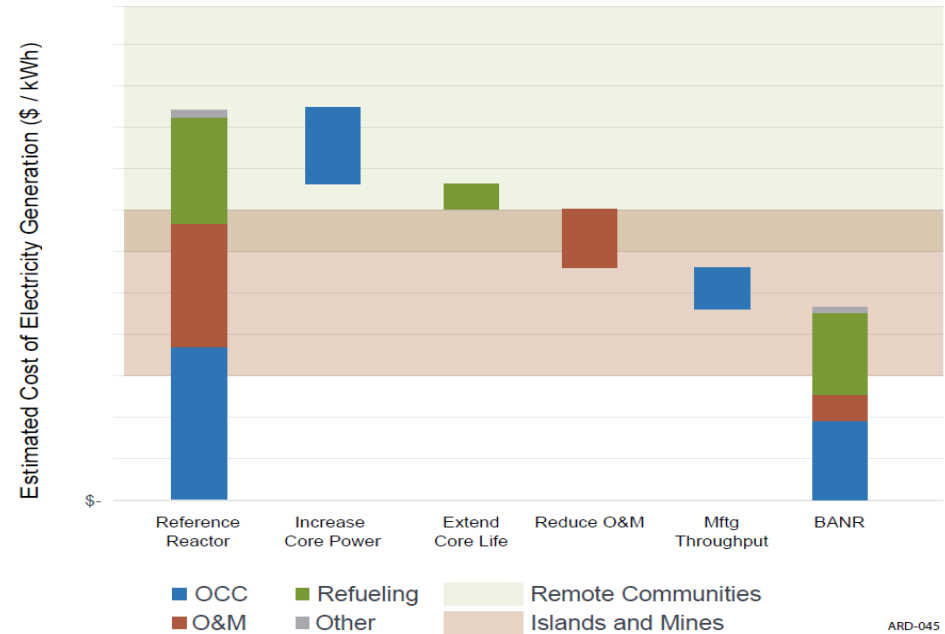
BANR – Technology Overview



Cost Reduction Objectives



- Costs Reduction Points of Emphasis:
 - Increasing core power reduces the number of reactors required
 - Extending core life reduces life time refueling costs
 - Reducing operations and maintain cost directly reduces cost per kWhr
 - Improving manufacturing through-put reduces initial capital cost and refueling cost
- Cost Reduction Expands Target Markets:
 - Mining / Oil sands
 - Remote communities
 - Industrial process heat
 - Secure off-grid power sources



ARD-045

UN TRISO – ARDP for BWXT Advanced Nuclear Reactor (BANR)

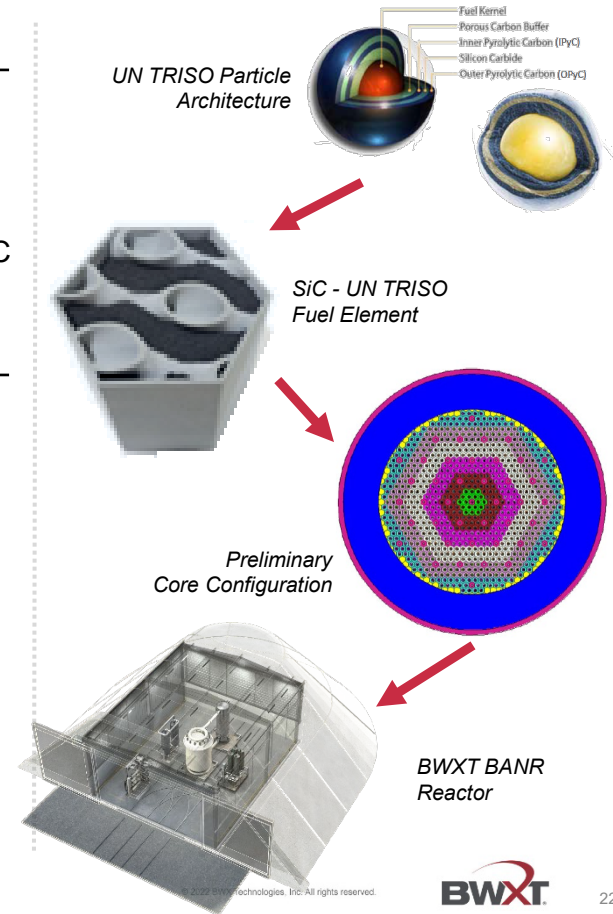
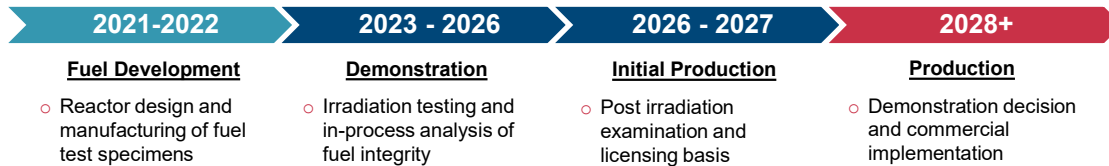


Risk Reduction Program Scope

- Mature design and manufacturing technologies, improving commercial viability
- Demonstrate advanced technology applications to reduce manufacturing costs
- Develop and demonstrate high-power density TRISO fuel form for microreactors
- Focus on reactor skid: fuel system, core design, reactivity control, passive cooling, I&C

Fuel-Specific Scope

- HALEU fuel acquisition; TRISO fuel production
- Knowledge transfer from INL's AGR program and ORNL's TCR program
- Iterative manufacturing and testing of fuel elements, e.g. AM using CVI densification, element testing and characterization
- Irradiation (INL) and examination (ORNL) to advance UN fuel performance
- Licensing activities to advance fuel form regulatory case





Questions

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