ULTRA SAFE NUCLEAR

Ultra Safe Nuclear Corporation

Presentation to NH Nuclear Study Commission

Donald “Gus” Gustavson | Business Operations Manager, Core Group

October 2, 2024

RELIABLE ENERGY ANYWHERE

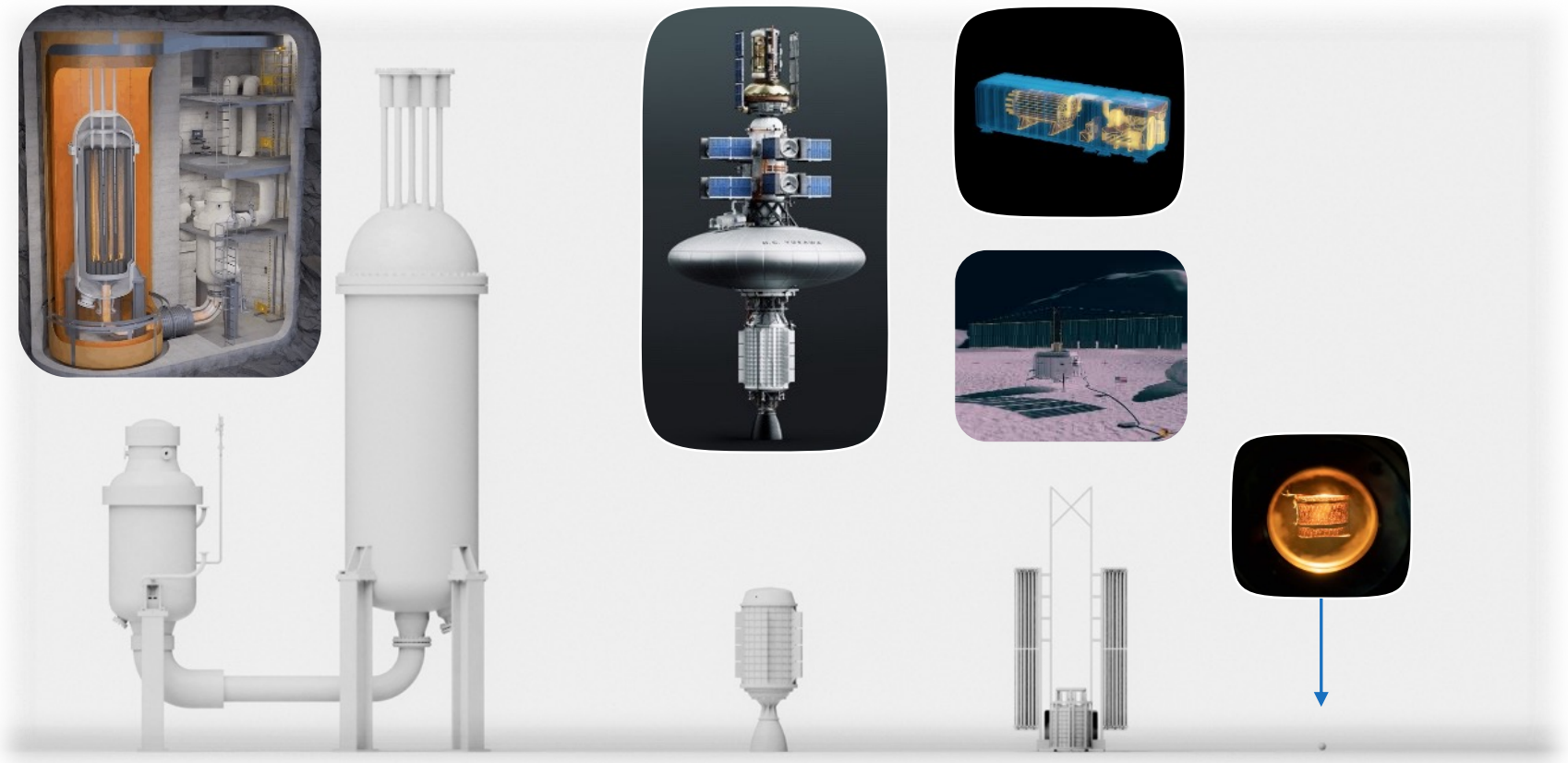
Agenda

USNC & Core Overview	**10 mins**
– Our Commercial offering	
– Our Company Profile	
– Our Fuel	
Nuclear Fuel Cycle for Advanced Reactors	**15 mins**
– Fuel Cycle Overview	
– Key Issues for Advanced Reactors	
– USNC Strategy	
Q&A	**5 mins**

Ultra Safe Nuclear – Reliable Zero-Carbon Energy Anywhere

EARTH to SPACE

- Family of nuclear energy products and services
- Zero-carbon power with minimal infrastructure required
- From Watts to Megawatts
- All based on Ultra Safe principles & technologies
- Shared design and fabrication resources



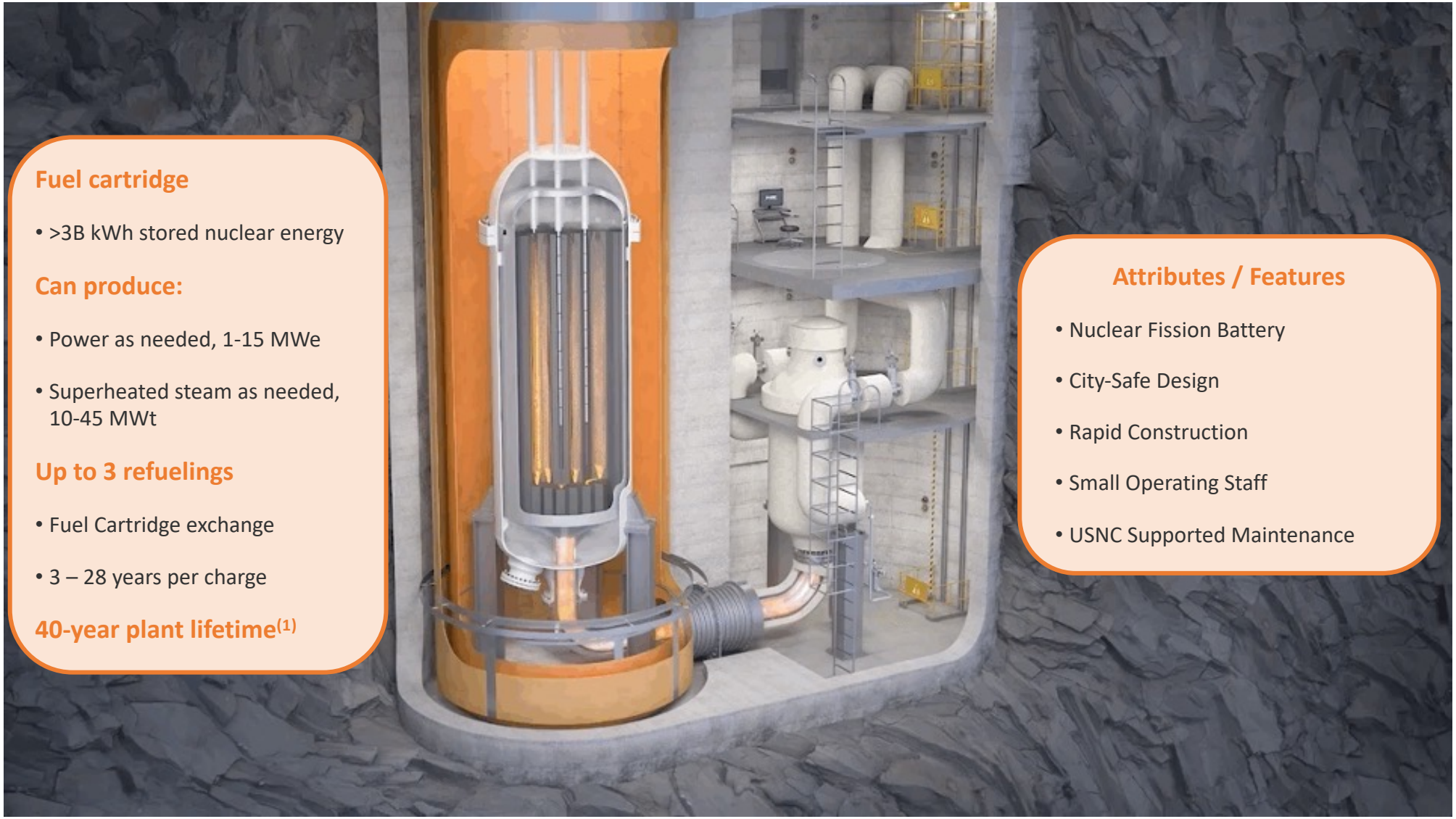
MMR
Earth
5MWe+ & GW scaled
Industrial
Micro-grid
Off-grid

NTP
Space
Propulsion Engine

PYLON
Earth & Space
10kWe to MWe

EmberCore
Earth & Space
1mW and up

Micro-Modular™ Reactor (MMR®) Unit or "Nuclear Battery"



Fuel cartridge

- >3B kWh stored nuclear energy

Can produce:

- Power as needed, 1-15 MWe
- Superheated steam as needed, 10-45 MWt

Up to 3 refuelings

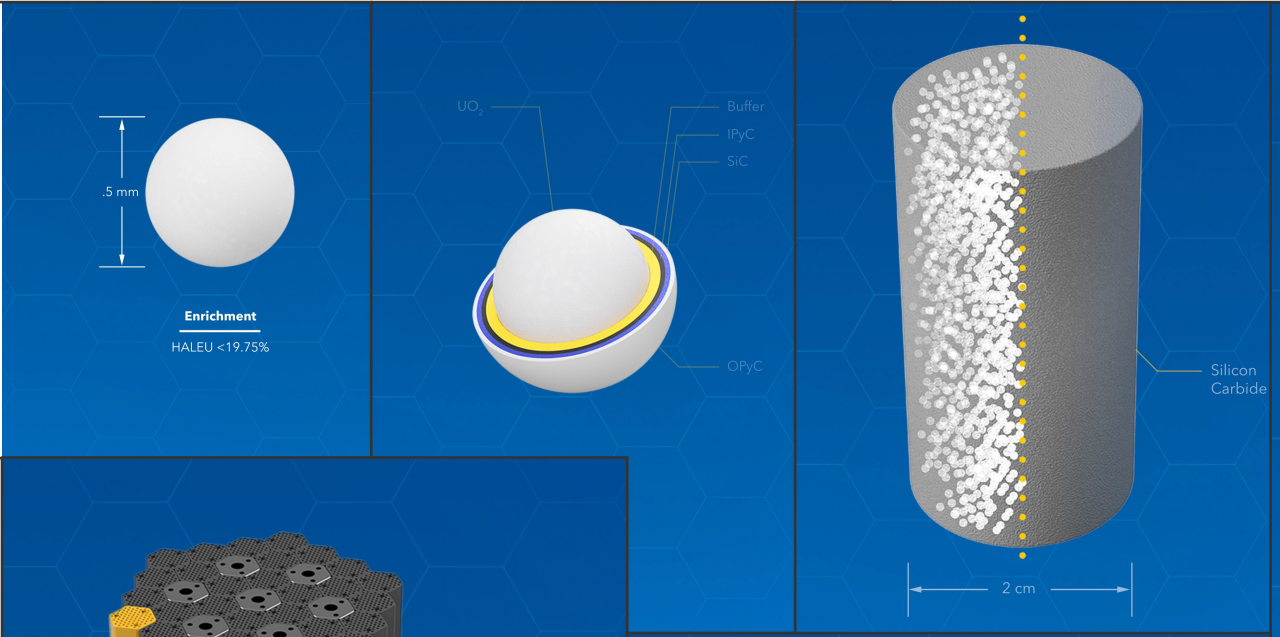
- Fuel Cartridge exchange
- 3 – 28 years per charge

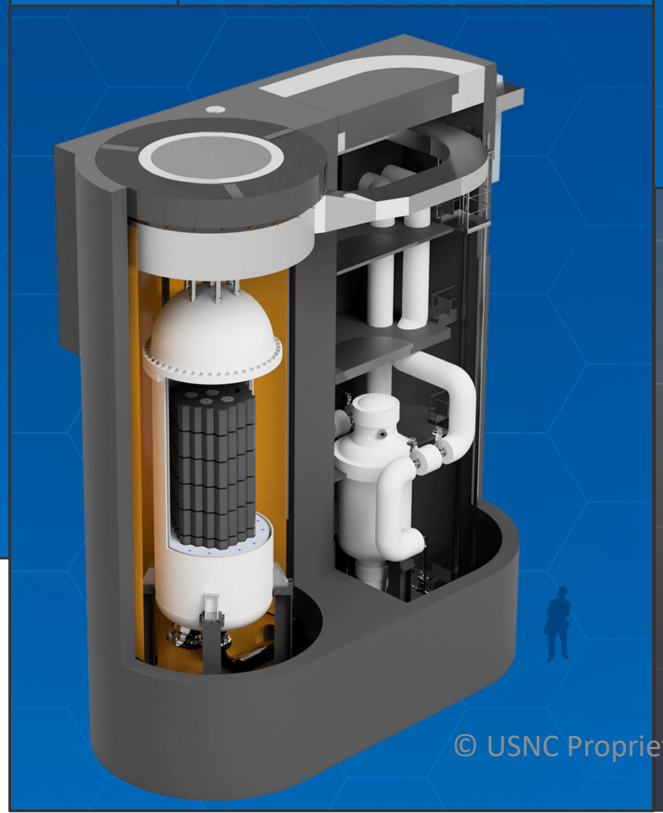
40-year plant lifetime(1)

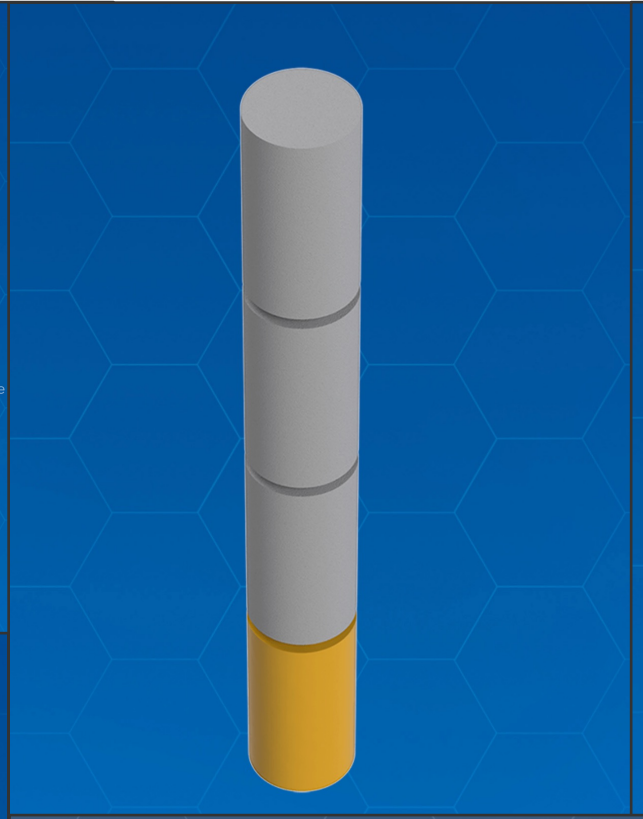
Attributes / Features

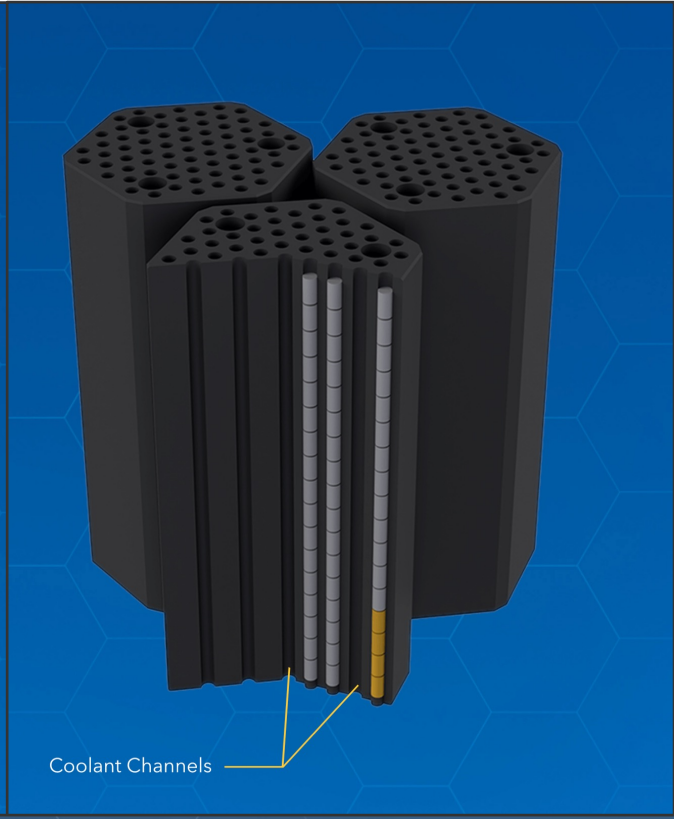
- Nuclear Fission Battery
- City-Safe Design
- Rapid Construction
- Small Operating Staff
- USNC Supported Maintenance

Source: Management Information.
(1) Neglecting potential for future service life extensions.









MMR Micro Reactor Unit
3B KWh (heat)

USNC
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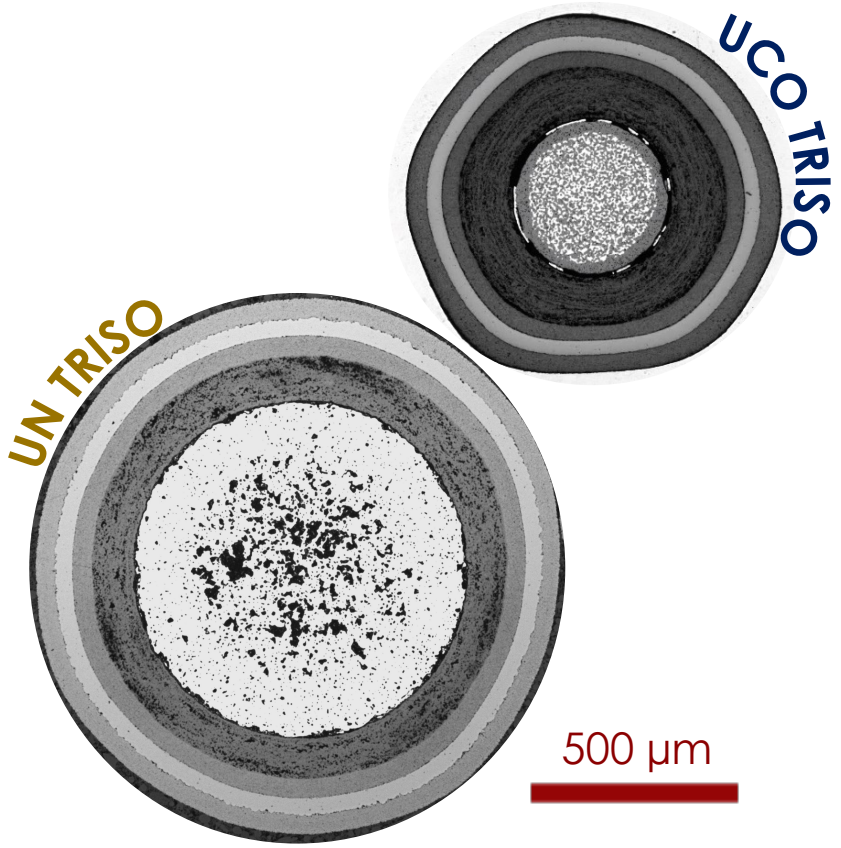
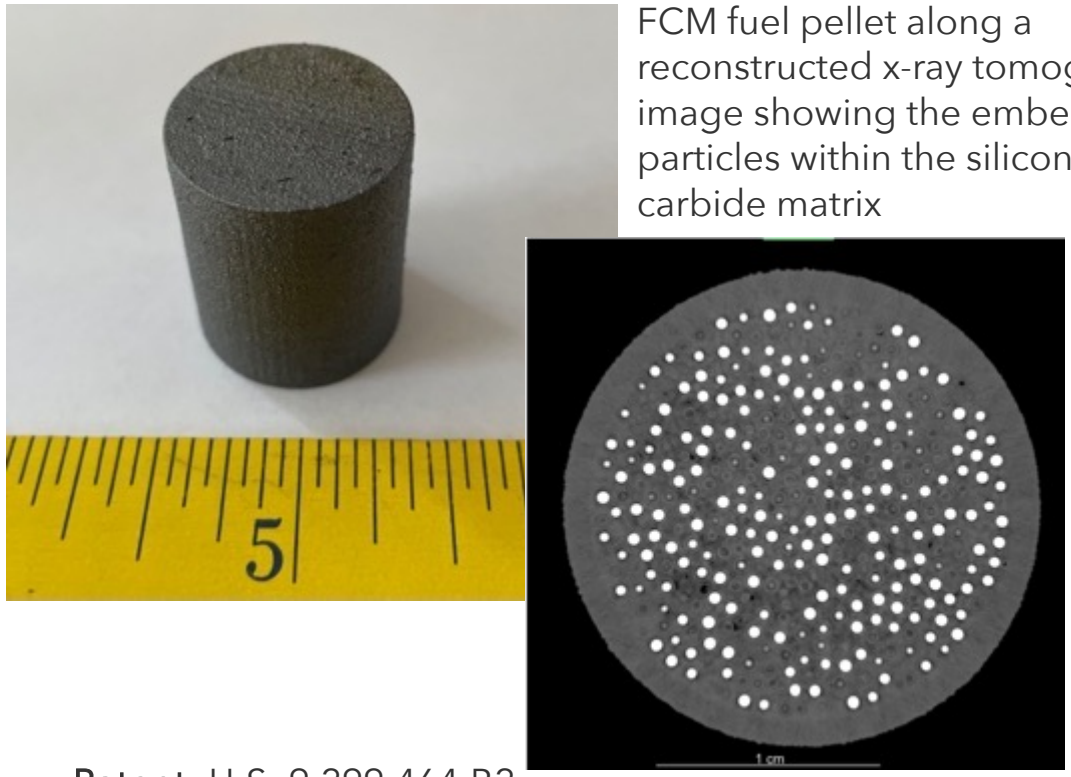
MMR Micro Reactor
"Nuclear Battery"

USNC | FCM™ fuel technology for MMRs comprises TRISO coated fuel particles embedded in silicon carbide



TRISO fuel particles with various uranium bearing kernels

Terrani et al., *JNM* **547** (2021) 152781



FCM fuel pellet along a reconstructed x-ray tomograph image showing the embedded particles within the silicon carbide matrix

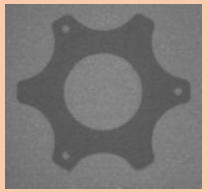
Patent: U.S. 9.299.464 B2
Patent application: U.S. 2020/0156282 A1

USNC | Fuel Manufacturing Today

Pilot Fuel Manufacturing Facility (FCM® and TRISO Particle Fuel Production)

- Pilot Fuel Manufacturing Facility – Oak Ridge, Tennessee
- First private sector advanced fuel factory in the U.S. – Online September 2022
- Fully Ceramic Microencapsulated ("FCM") fuel currently in production
- Proprietary additive manufacturing process capable of multiple geometrics

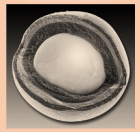
SiC Shells



Binderjet Printing

Partial Densification

TRISO



Chemical Vapor Deposition ("CVD")

SiC Powder & Fuel

** Click the image above to view video clip*

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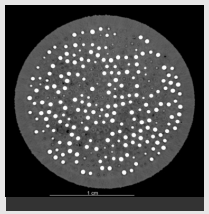
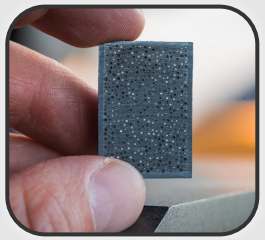




FCM Compact – MMR(1) Fuel

- Simple geometry
- Commercial application

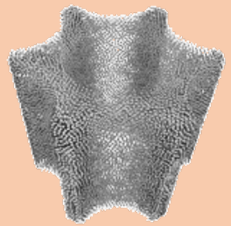
FCM Compact – (Advanced Fuel)

- Complex geometry
- Advanced space & terrestrial applications

** Click the image above to view video clip*

Final Densification

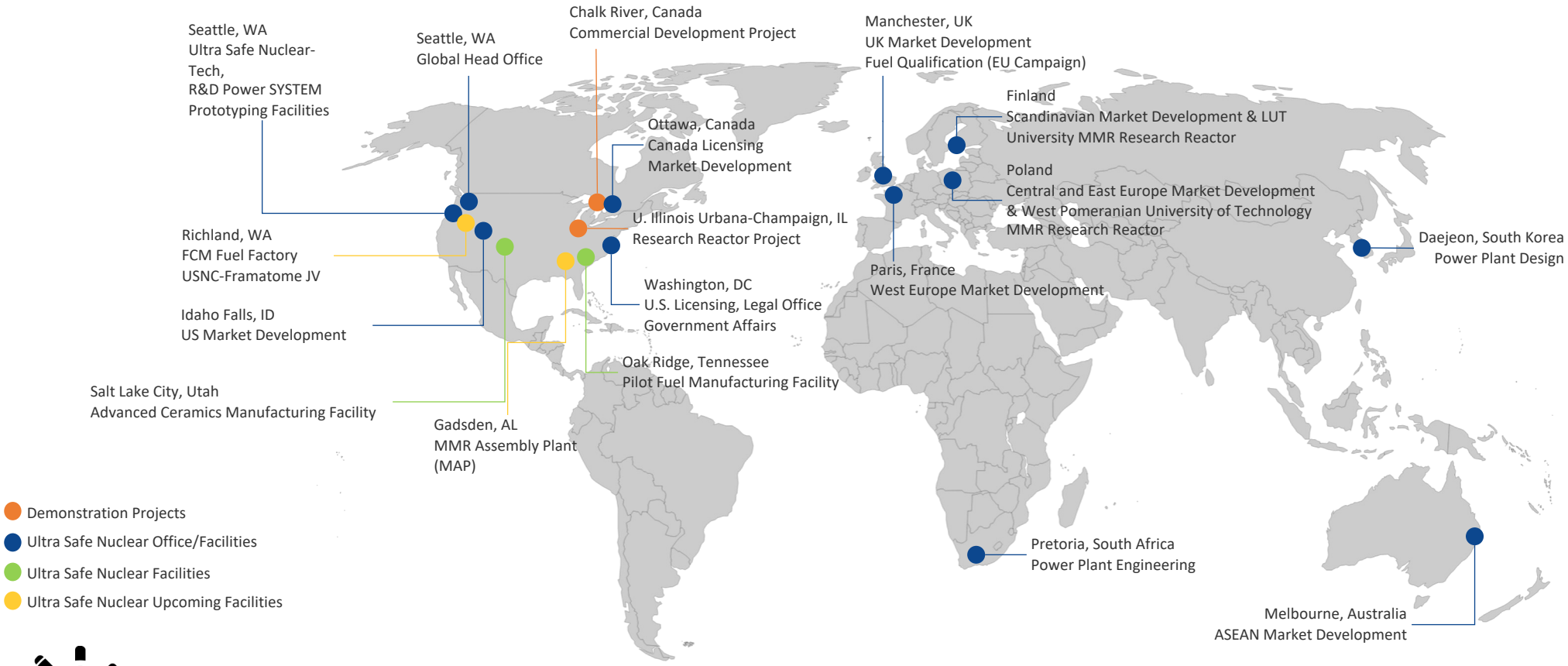
Quality Control



Non-Destructive Analysis

USNC | Business Operations

Ultra Safe Nuclear is supported by 300+ employees in multiple countries, including South Africa, South Korea, Canada, UK, France, Poland, and Australia.



Front End of the Fuel Cycle | Background

There are lots of terms used to describe nuclear reactors in development today that are evolutions from the traditional fleet of Boiling Water Reactors (BWRs) and Pressurized Water Reactors (PWRs), e.g. Advanced Reactors, Generation III+/IV reactors, Small Modular Reactors, etc.

- **Advanced Reactors**: a not strictly defined term that can include anything from modernization of existing designs up to theoretical reactors, including new "modular" reactors due to the nature of their design and resultant construction complexity
    - **Small Modular Reactors**: also not strictly defined, generally accepted to be advanced reactors of ~300MWe or less
    - **Micro Reactors**: generally accepted to be ~20MWe or less

USA NEIMA's definition of *advanced*

The term *advanced nuclear reactor* means a nuclear fission or fusion reactor, including a prototype plant (as defined in sections 50.2 and 52.1 of title 10, Code of Federal Regulations (as in effect on the date of enactment of this Act)), with significant improvements compared to commercial nuclear reactors under construction as of the date of enactment of this Act, including improvements such as

- additional inherent safety features;
- significantly lower levelized cost of electricity;
- lower waste yields;
- greater fuel utilization;
- enhanced reliability;
- increased proliferation resistance;
- increased thermal efficiency; or
- ability to integrate into electric and nonelectric applications.

Many of these new designs being discussed today as "advanced reactors" have much more robust and advanced nuclear fuel forms that improve the safety of the overall design and reduce the safety burden placed on the rest of the reactor

Front End of the Fuel Cycle | Today

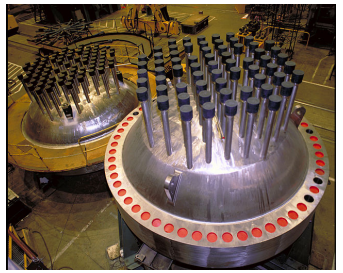
Mining & Milling → **Conversion** → **Enrichment** → **Deconversion** → **Fabrication** → **Reactor**

Uranium Ore → U_3O_8

U_3O_8→UF_6

UF_6 (~0.7% ^{235}U) → UF_6 (3-5% ^{235}U)

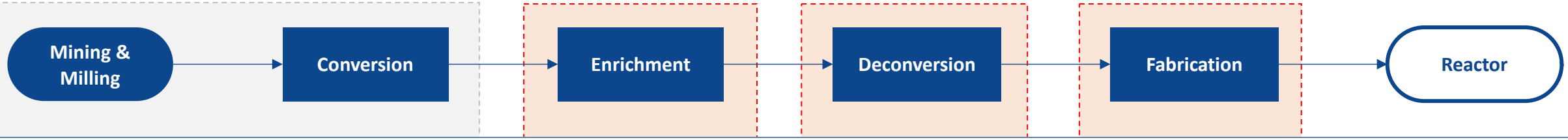
UF_6 (3-5% U_{235}) → UO_2



UO_2→ Sintered UO_2 ceramic pellets in metal cladding (fuel assembly)

Fuel assembly loaded into reactor core

Front End of the Fuel Cycle | Issues For Advanced Reactor Deployment



In general, when we speak of the front end of the fuel cycle for Advanced nuclear, we are looking at

- **Higher Enrichment**: many require "HALEU," or <20% EUP (our design is flexible and preliminary projects are underway for <10%, AKA LEU+)
- **Deployment of fuel forms and technology not used in our commercial fleet:** such as TRISO; this requires the deployment and licensing of commercial-scale production

There is no change to this part of the fuel cycle relative to today's market

No commercial licensed facility in US to deconvert enriched UF6 to Uranium Oxide

HALEU (<20%)

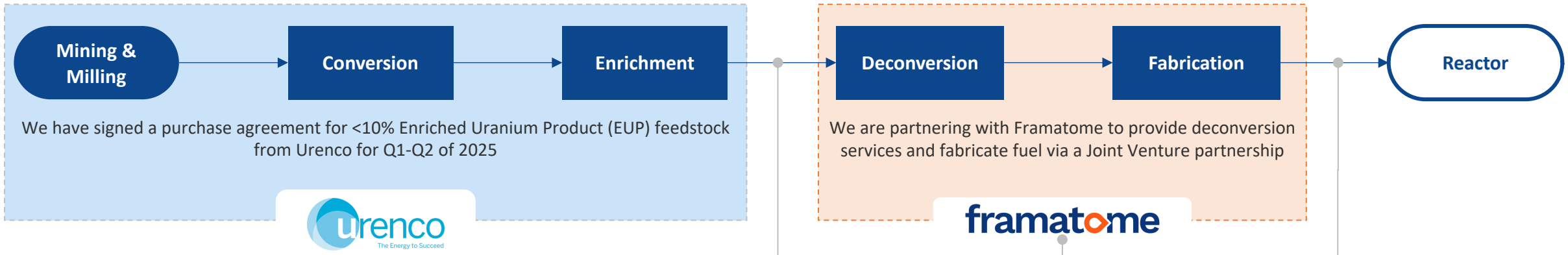
- Produced in Russia but not available to obvious geopolitical situation
- No capacity exists in US, excepting small pilot production (Centrus) unable to discharge
- Urenco predicts licensed capacity in 2029 timeframe

LEU+ (<10%)

- Urenco capacity online starting in first half of 2025 at their facility in Eunice, NM

- No commercial fuel fabrication facilities licensed for higher enrichments (> 6.5-8%)
- No commercial deployment of production capabilities for advanced fuel forms (e.g, TRISO)

Front End of the Fuel Cycle | USNC Strategy



Existing 30B cylinders (and the upcoming 30BX) with UF6 enriched up to 10 wt.% 235U are expected to be able to be proven safe to store and ship with some configuration control, Urenco is pursuing this course of action and perceives little risk

We have a joint contract with Paragon & SRNL to fabricate, test, and license a shipping container. We have selected a design (existing, license package) and prototype fabrication is underway

Partnership: USNC is forming a joint venture partnership with Framatome to manufacture our MMR fuel at their licensed fuel facility in Richland, WA. A partner:

- Accelerates our timeline (~4 years) to first product by utilizing a fuel manufacturing site under active NRC license
- De-risks our execution timeline by bringing invaluable expertise in the economical and safe manufacturing nuclear fuel assemblies at commercial scale
- Exploits existing deconversion capabilities and avoids the need for a new transportation solution
- Provides the ideal business incentive arrangement, e.g, the sharing of costs, risks, and opportunities

https://world-nuclear-news.org/Articles/Urenco-USA,-USNC-in-advanced-reactor-uranium-suppl

world nuclear news

Energy & Environment | New Nuclear | Regulation & Safety | Nuclear Policies | Corporate | Uranium

Urenco USA, USNC in advanced reactor uranium supply 'first'

02 March 2023

Share

A newly announced agreement under which Urenco USA will supply enriched uranium to Ultra Safe Nuclear Corporation to manufacture fuel for its Micro-Modular Reactor (MMR) has been described by the companies as the first commercial supply of enriched uranium product (EUP) for use in an advanced nuclear reactor anywhere in the world.

(Image: Urenco USA/USNC)

https://www.world-nuclear-news.org/Articles/Companies-pool-resources-to-manufacture-TRISO-fuel

world nuclear news

Energy & Environment | New Nuclear | Regulation & Safety | Nuclear Policies | Corporate | Uranium

Companies pool resources to manufacture TRISO fuel

27 January 2023

Share

A joint venture between Framatome and Ultra Safe Nuclear Corporation (USNC) plans to manufacture commercial quantities of TRISO fuel particles and fuel for advanced reactor designs.

FCM fuel pellet (Image: USNC)