Westinghouse eVinci™ Micro-Reactor

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eVinci Micro Reactor Development
May 2021

Westinghouse

Westinghouse Electric Company

GLOBAL HEADQUARTERS

Cranberry Township, Pennsylvania, United States

Westinghouse established **59** other companies

He received over **360** patents for his work

Approximately **9,000** Employees

Comprised of **5** Business Units

Locations in **19** Countries

Deployed many of the world's greatest advances in energy technology

- Air brakes for rail cars
- 1st Commercial radio broadcast
- Camera that captured the image of the first man on the moon
- USS Nautilus propulsion (S1W)
- World's first commercial Pressurized Water Reactor

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eVinci Micro Reactor

Capability

Nuclear battery designed for safe and reliable electricity and heat generation

Technical Capabilities

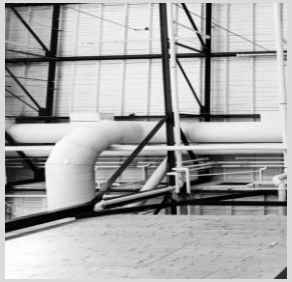
- ✓4.5 MW – net electric power output
- ✓Transportable for ease of installation and elimination of spent fuel storage on site
- ✓Cost-competitive plant lifecycle
- ✓Minimal onsite personnel
- ✓Mature technology, manufacturing, and regulatory readiness
- ✓Cogeneration and load following capability

eVinci Micro Reactor

Prospective Markets/End Uses

Remote mining operations

Industrial process heat



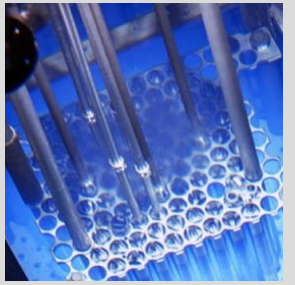
District heating

Remote communities

Hydrogen Generation

Critical Infrastructure Installations

Disaster relief



Research Reactors

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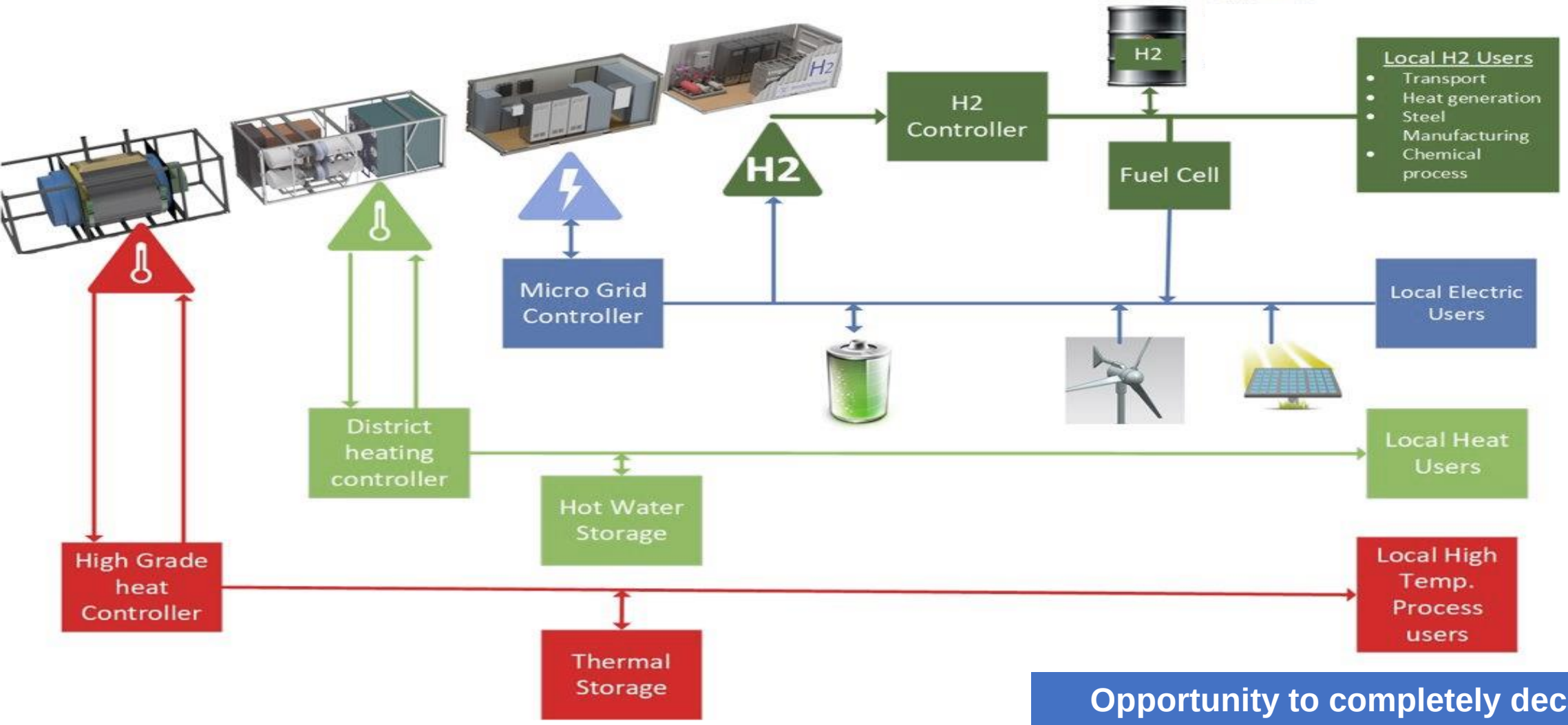
eVinci Products

Total Energy Solution



Opportunity to completely decarbonize communities and industrial sites

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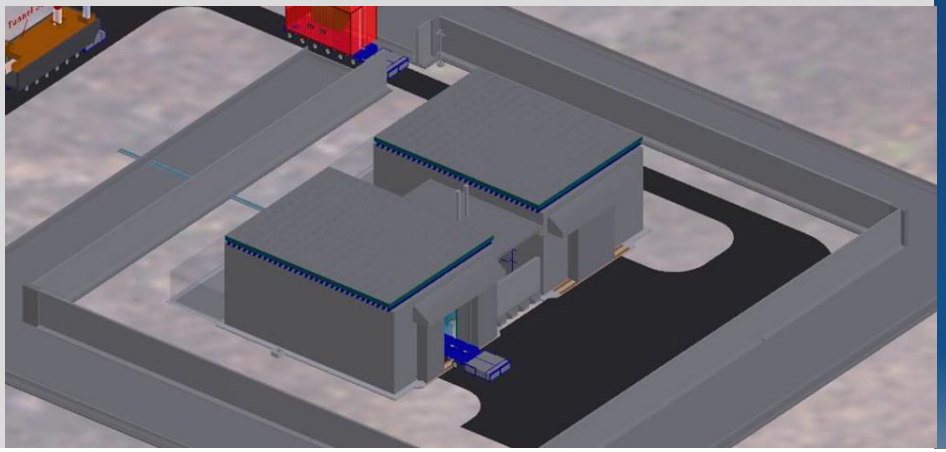
Positive Environmental Impact

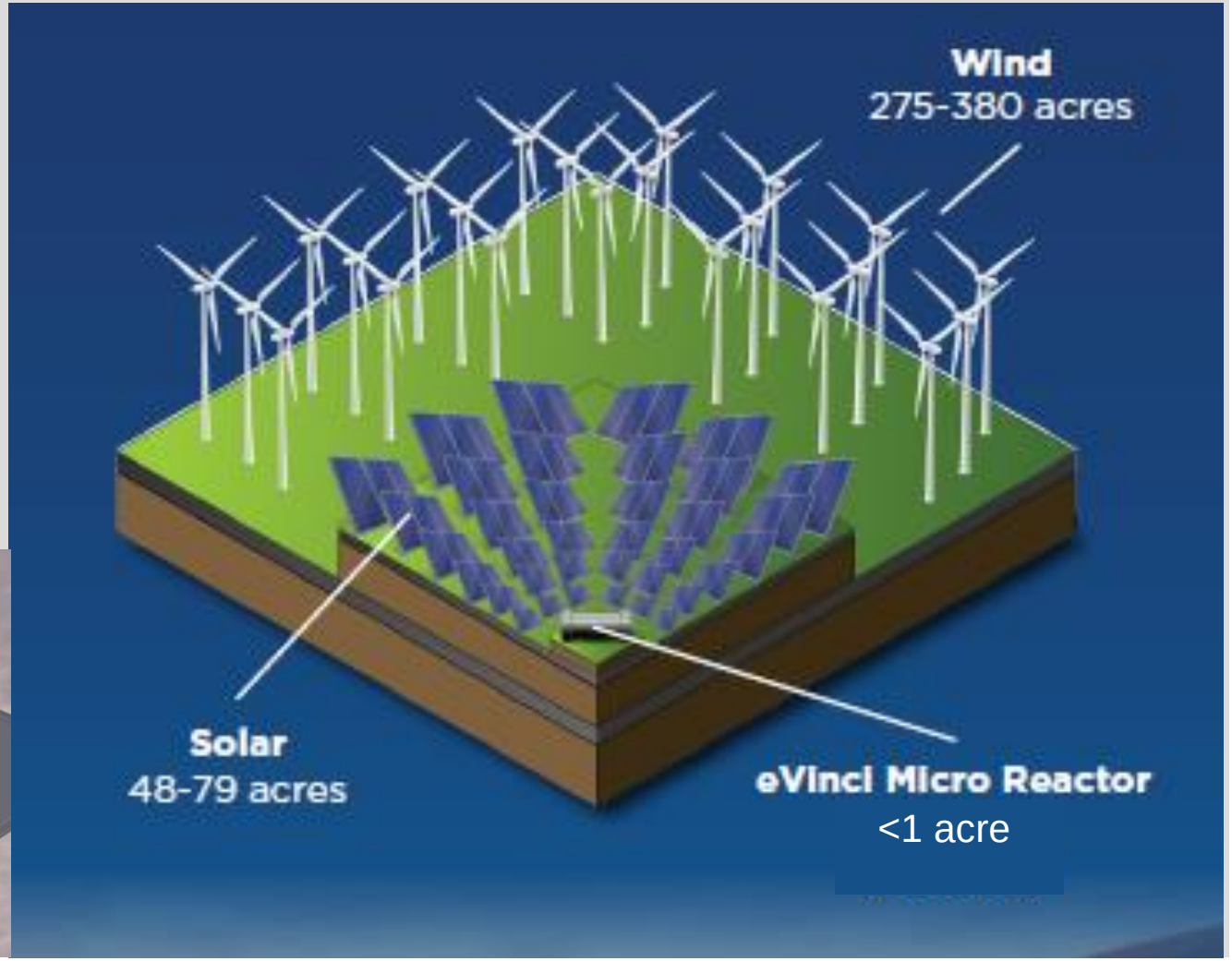
eVinci Benefits		Current State Factors/Risks
Emissions free	✓	Carbon, particulate and other pollutant emissions
Eliminates risk of fuel spills or leaks	✓	Risk of fuel spills/leaks from storage and transport
Minimal maintenance	✓	Frequent maintenance and machine rebuilds
No oil lubrication or water necessary	✓	Risk of oil leakage/spills, water for cooling
Reliable in all weather conditions and temperatures	✓	Weather conditions may inhibit fuel stability
Excess heat may be captured for building heat, H2 generation, water purification	✓	High cost of fuel limits economics of additional energy opportunities

>31,000 Metric Tons of CO_2 Emissions Reductions Per Year – Per eVinci

eVinci Micro Reactor
Footprint

- Near 100% capacity factor versus intermittent renewable supply
- Building shields radiation
- All construction above ground
- Site footprint: **0.8 acres**
- Building footprint: **0.25 acres**





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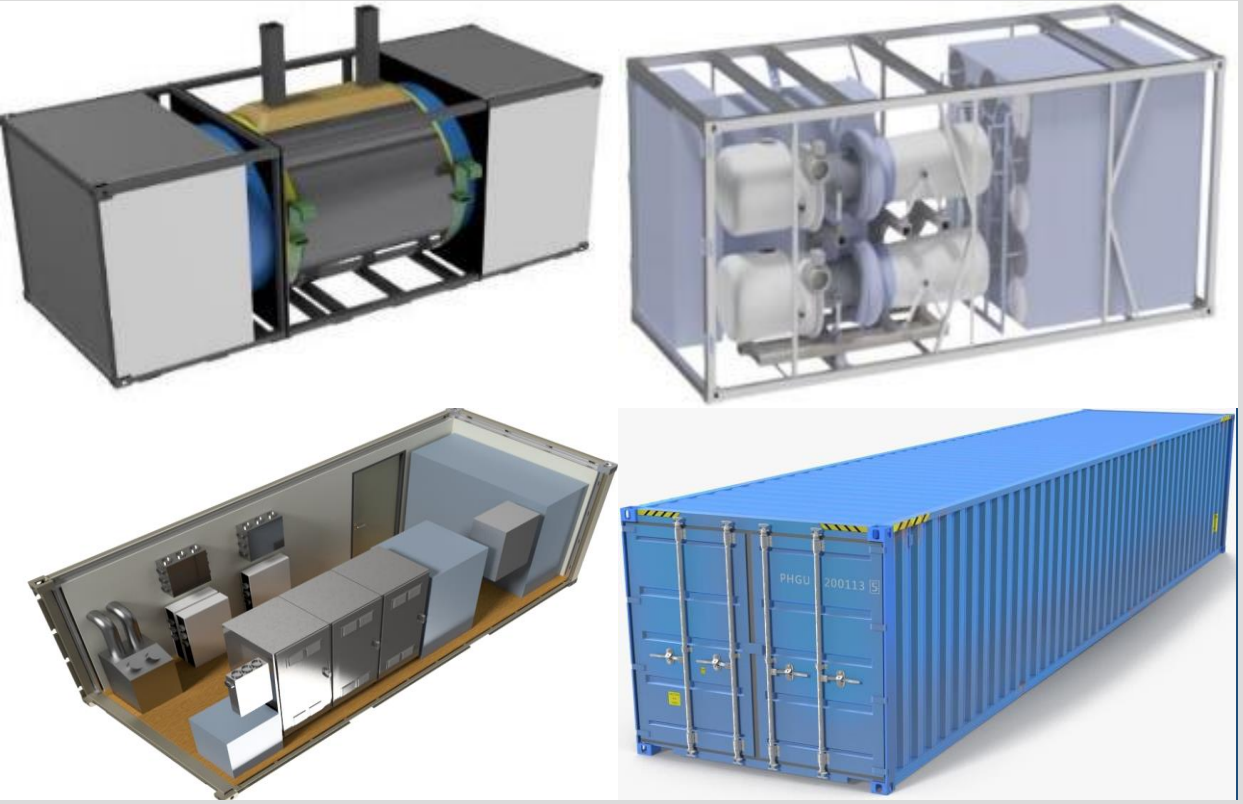
eVinci Micro Reactor Deployment

Transportability Advantages



Minimizes construction cost and labor

Installation to operation in less than 30 days

- ❑ **Entire plant delivered in four truckload size containers (40’ x 14’ x 14’)**
  - Reactor container
  - Power conversion unit
  - Instrument and controls
  - Miscellaneous support equipment

- ✓ **Weights and sizes allow for deployment in remote areas (truck/rail/barge)**
- ✓ **Allows for rapid scaling to meet demand**
- ✓ **No spent fuel or waste storage on site**
- ✓ **Minimizes decommissioning and effort to return site to green field**

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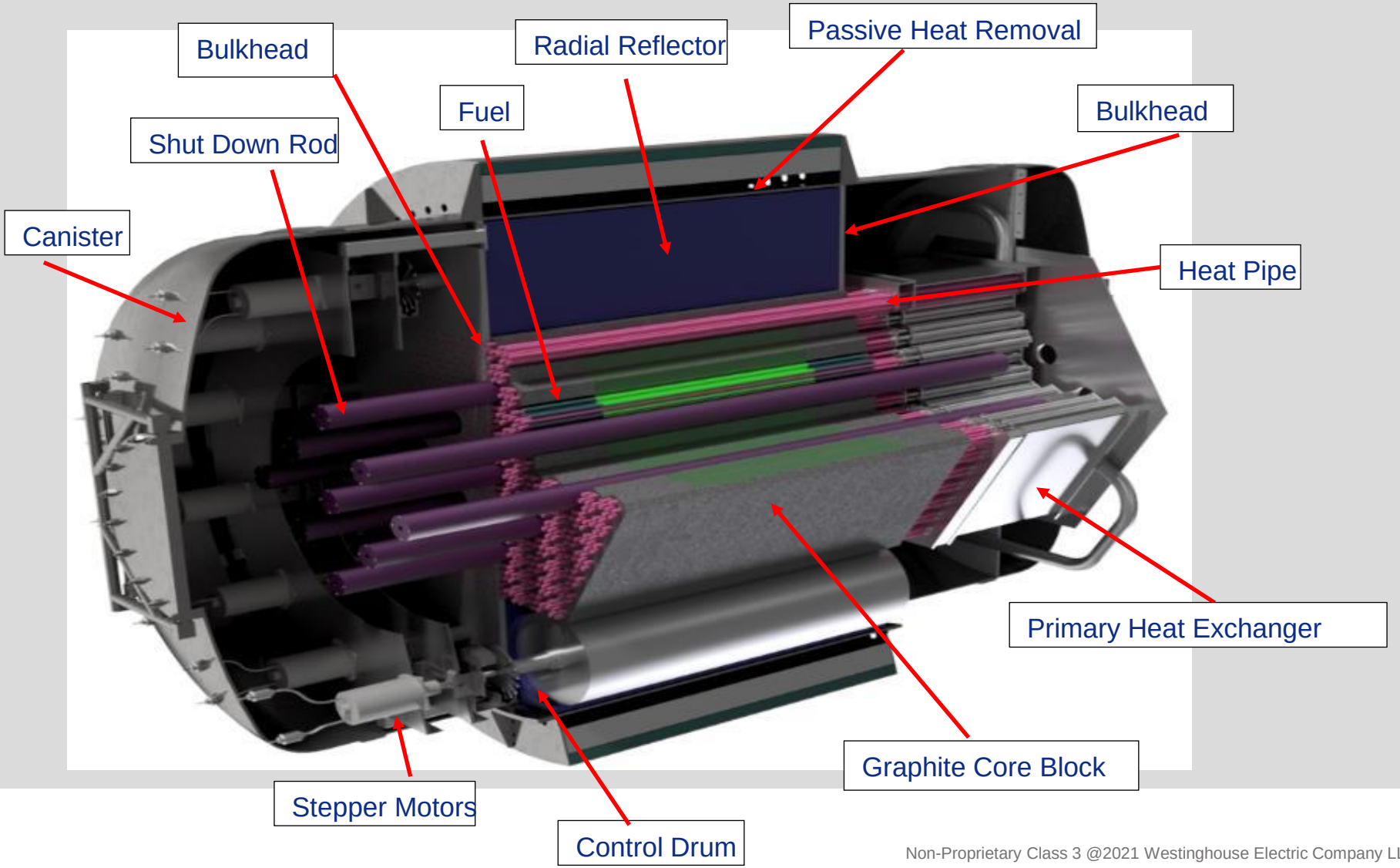
eVinci Micro Reactor

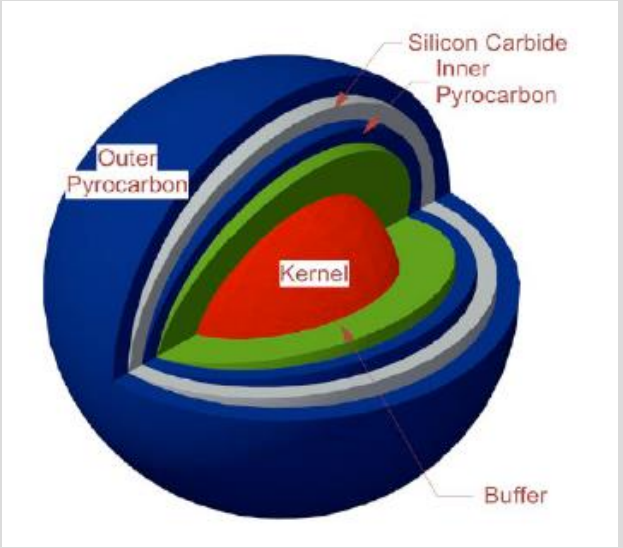
Main Components



eVinci Micro Reactor

TRISO Fuel Design

- Uranium Oxycarbide (UCO) in a tri-structural isotropic (TRISO) fuel form
- UCO limits oxygen activity, reducing CO and CO2 generation and gas pressure
- HALEU (<19.75wt% ^{235}U) fuel
- Buffer: low-density porous pyrolytic carbon (PyC) coating layer
- IPyC: high-density first load-bearing layer against the pressure exerted by the Fission Product (FP)
  - Retains gaseous FPs but loses effectiveness at high temperatures to retain metallic FPs
- SiC: structural skeleton of the TRISO particle
  - Third layer for FP retention, including metallic FPs at high temperatures
  - Sufficient strength to withstand internal pressure during irradiation
- OPyC: the final barrier for FPs
  - Mechanical protection for the SiC layer
  - Both OpyC and IPyC shrink initially during irradiation leading to compression of the SiC layer, reducing tensile stress on this layer



TRISO Fuel is only High temperature fuel that has regulatory acceptance and extensive qualification basis

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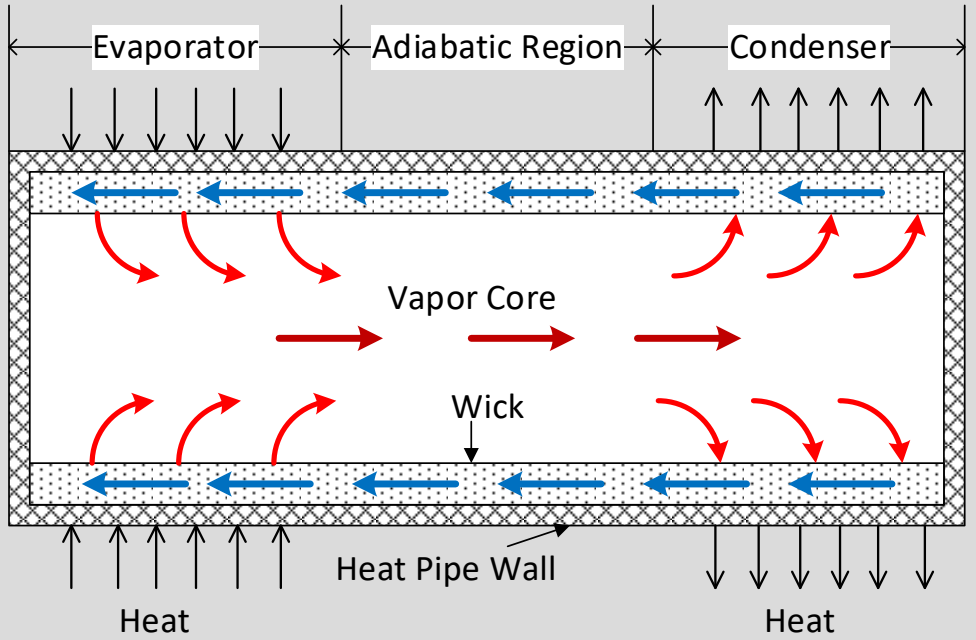
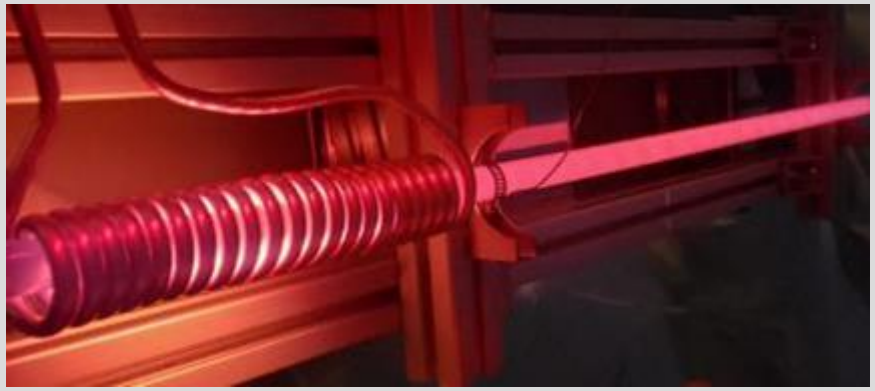
Why Heat Pipes?

- ❑ Heat pipes (HPs) are passive heat transport devices
- ❑ HPs eliminate need for reactor coolant pumps, RCS, primary coolant chemistry control and all associated auxiliary systems
- ❑ No cooling water required
- ❑ HPs are self regulating
- ❑ Technology readiness level is very high (8/9)

Westinghouse has developed industry leading heat pipe manufacturing and testing processes





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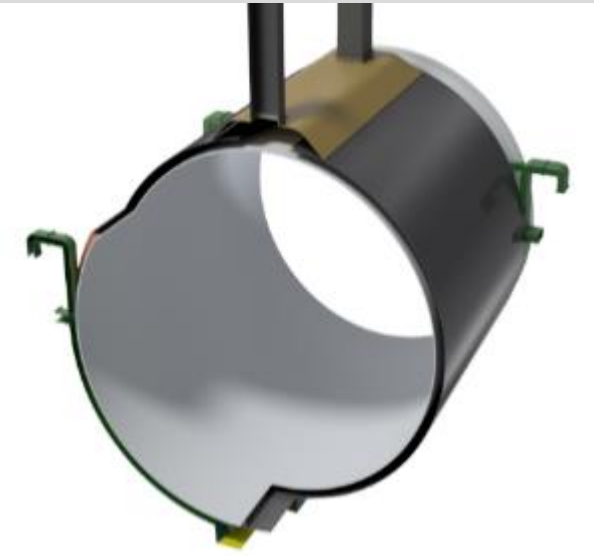
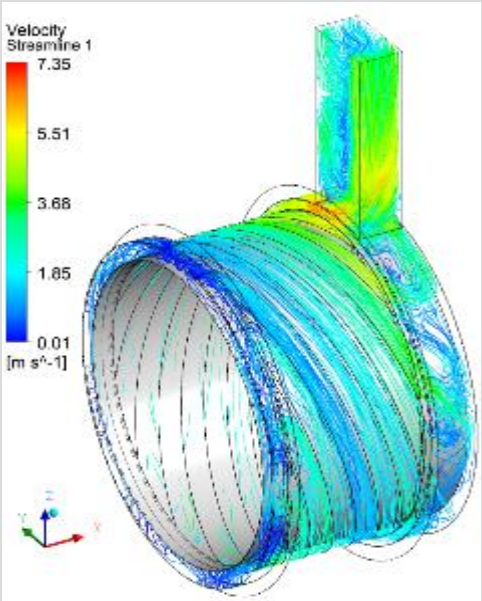
Inherent Safety





eVinci has multiple layers of defenses to ensure accident proof operation

- ❑ Passive heat pipe technology
- ❑ Passive heat removal system to remove decay heat without moving parts or operator action
- ❑ Not susceptible to Loss of Coolant Accident (LOCA)
- ❑ Minimal pressure differentials
- ❑ No operator action required
- ❑ Self-contained fuel
- ❑ Redundant and diverse shutdown systems
- ❑ Self regulating reactivity

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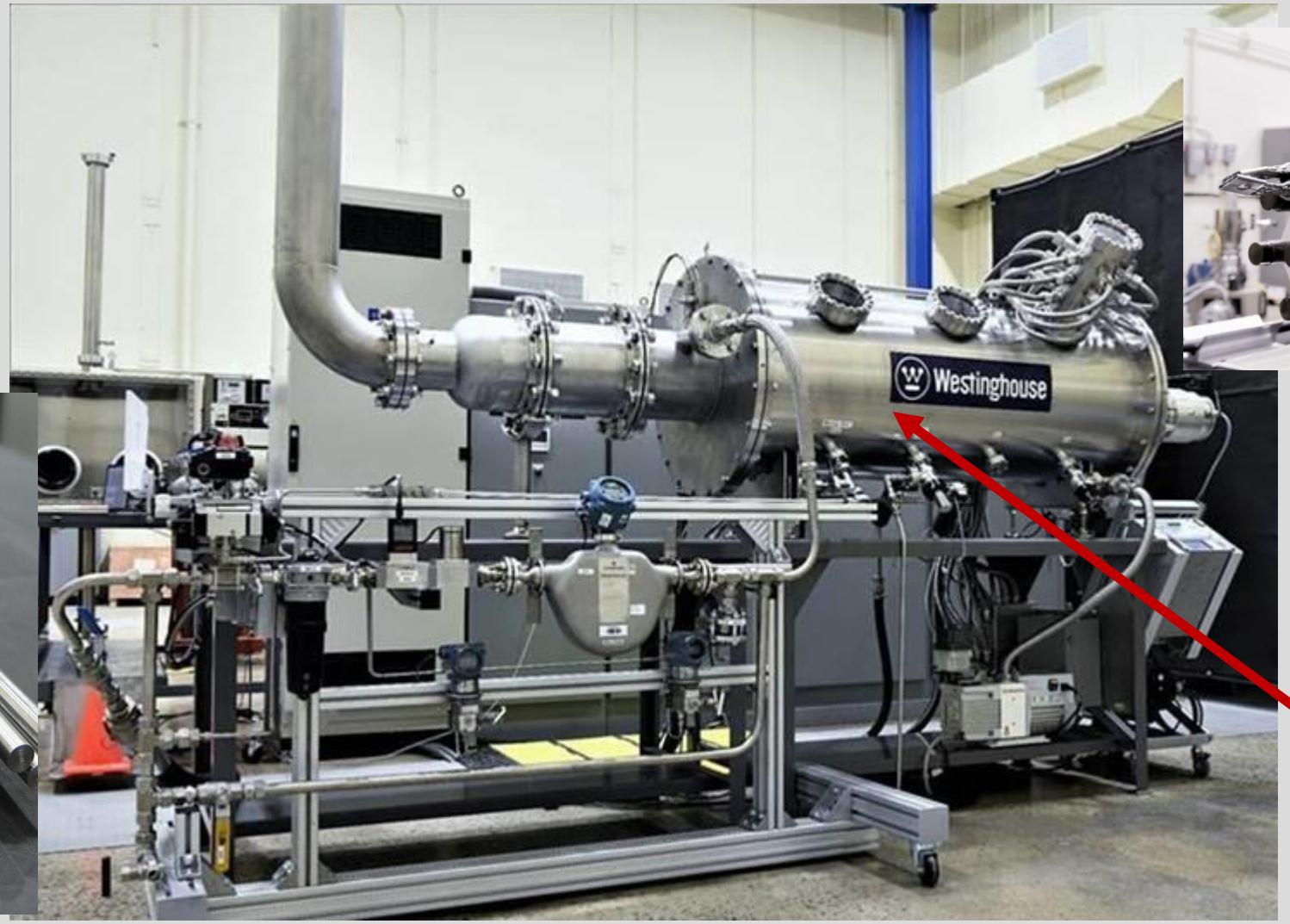
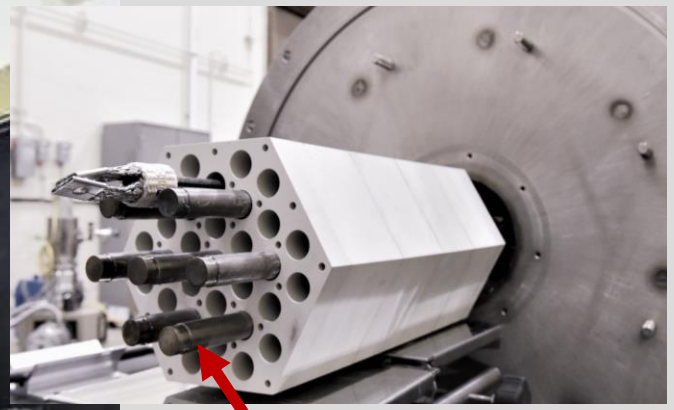
Testing Program

Heat Pipes





Heat Pipes

Test Chamber

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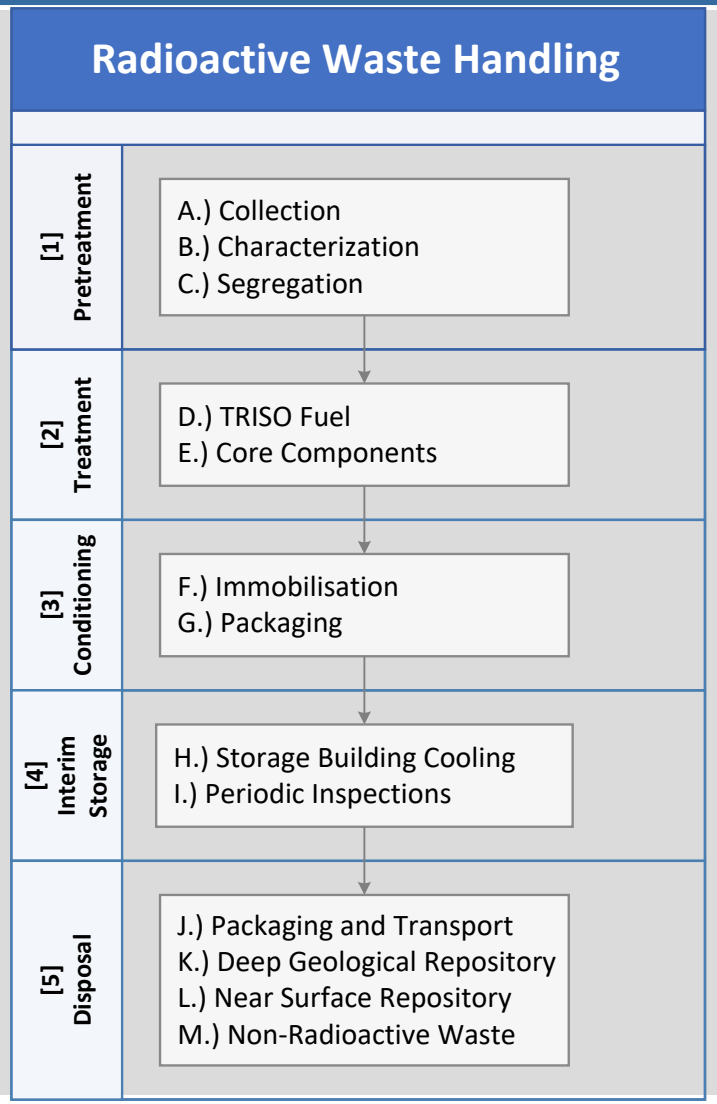
Fuel Management Strategy



- Once-through fuel cycle and waste management
  - CX-1 container returned to the manufacturing facility
  - Refurbishment and reuse option for core components
- No on-site waste storage (only for cool-down)
- High- and Low-Level waste streams
  - Spent TRISO fuel to be removed and consolidated (volume reduction)
  - Decontamination where possible from ILW to LLW (e.g., graphite core block)
  - Interim Storage to last as long as necessary until final repository becomes available

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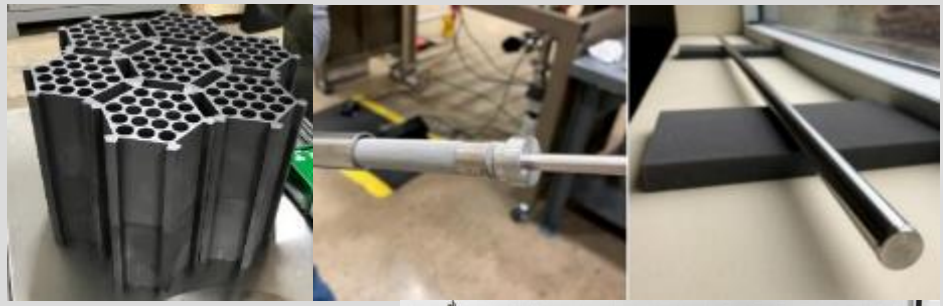
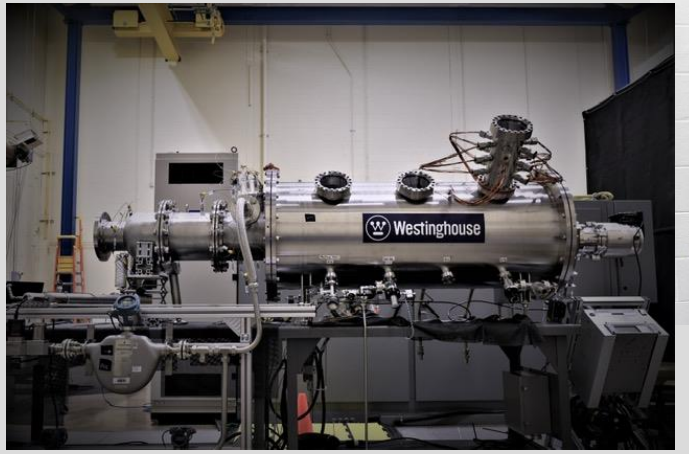
Safety, Reliability and Cost

- ✓ **Safety – "Walk away safe"**
  - ❑ Passive core cooling
  - ❑ Self contained fuel
- ✓ **Reliability**
  - ❑ Qualification testing and manufacturing development in an advanced state
  - ❑ Minimal moving parts
- ✓ **Cost**
  - ❑ FOAK unit LCOE competitive with transported diesel
  - ❑ Minimal construction cost and effort to return site to green field





2020	2021	2025	2026
Electrical Demonstration	Component Development / Nuclear Demonstration	Commercial Unit	

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