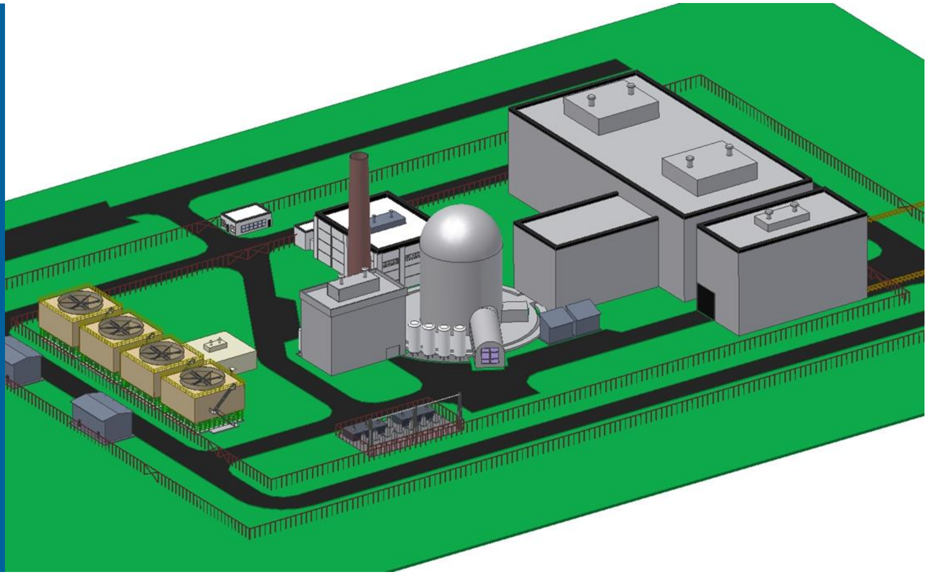
PRESENTATION 4

A SUSTAINABLE NUCLEAR ENERGY SYSTEM



MARK A. WILLIAMSON
Nuclear Engineering Division

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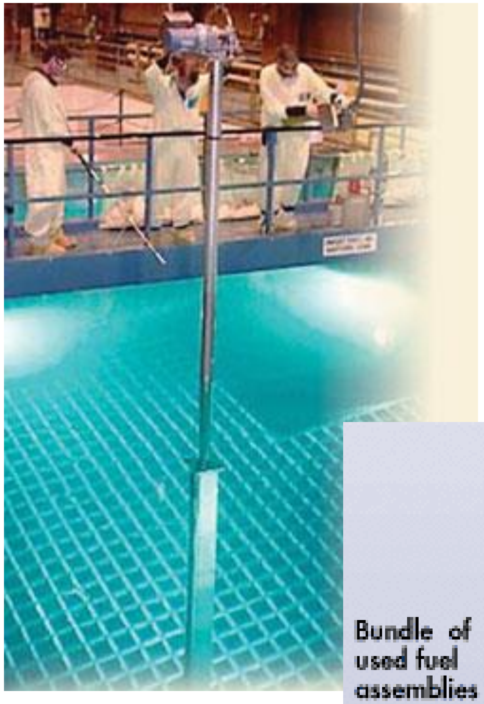
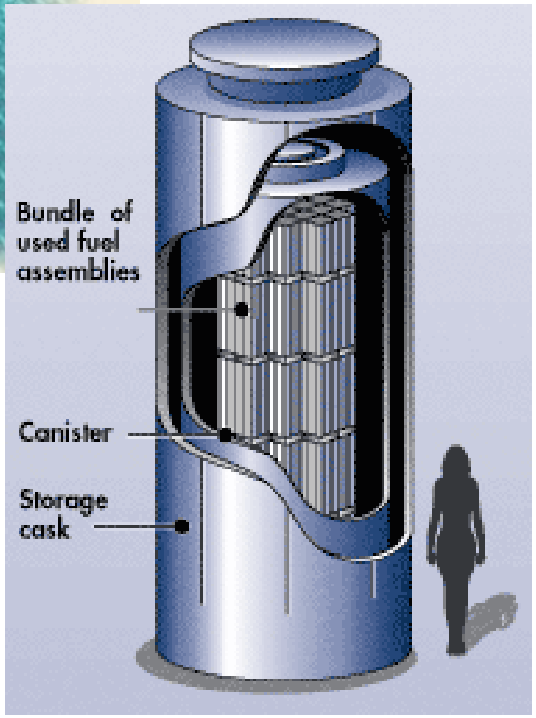
USED FUEL GENERATION IN THE U.S.

- Each year, U.S. nuclear power plants generate about 2,000 metric tons of used fuel
  - Each commercial reactor is provided with water basin storage capacity for about 40 years' worth of used fuel generation
  - Most utilities have added dry cask storage capacity because there is no pathway at present to ultimate disposal of the used fuel

- All of the used fuel generated by these plants is currently scheduled for geologic disposal
  - On March 5, 2009 DOE Secretary Chu announced that Yucca Mountain Repository was no longer an option for long-term storage of used nuclear fuel
  - In March 2010, DOE filed a motion with NRC to withdraw the license application, which resulted in multiple lawsuits from states and utilities





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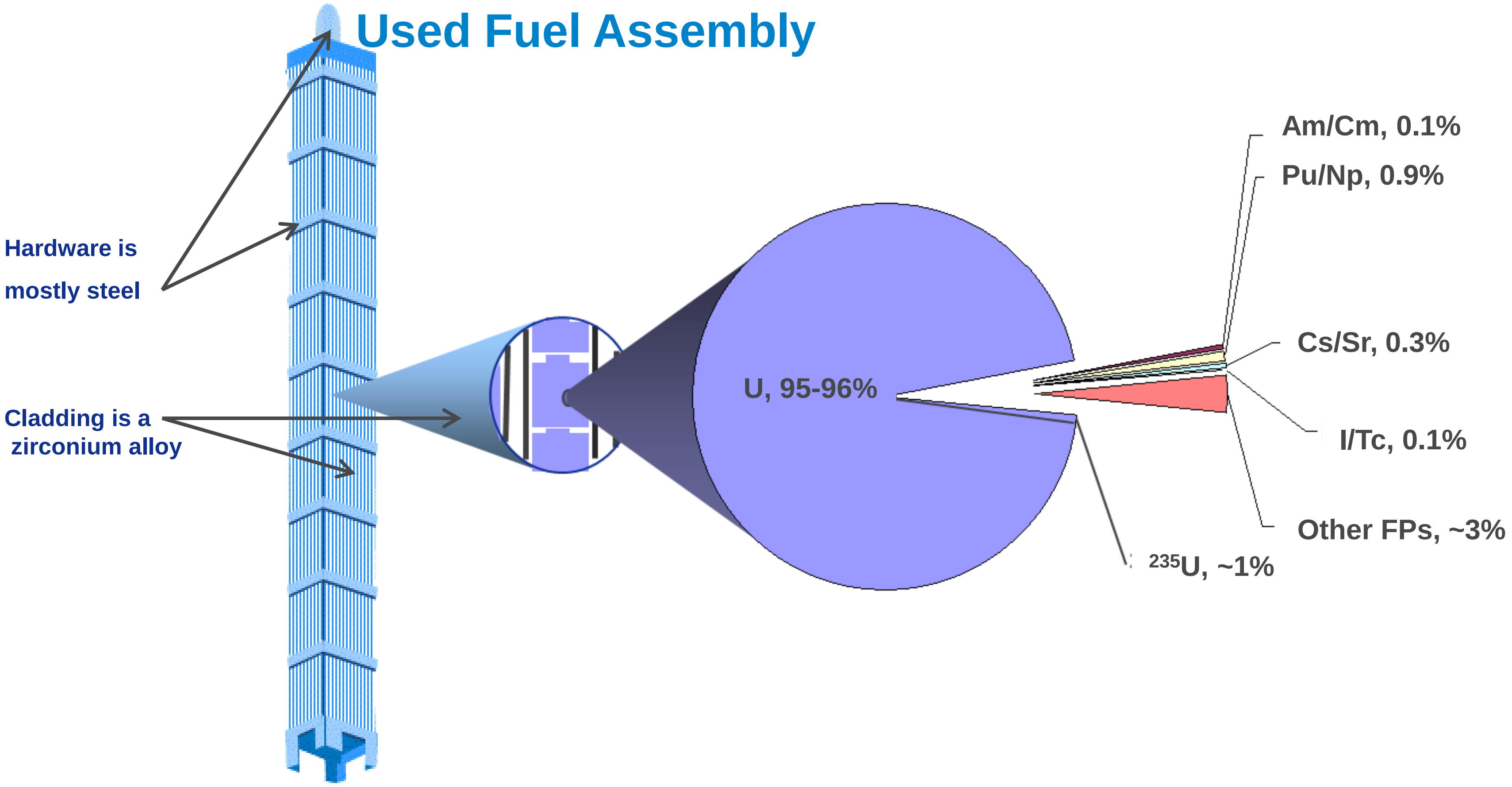
USED NUCLEAR FUEL CHARACTERISTICS

96% of the metals in used nuclear fuel can be recovered and recycled for energy production, with only a small fraction sent to the geologic repository



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FUEL CYCLE OPTIONS STUDY

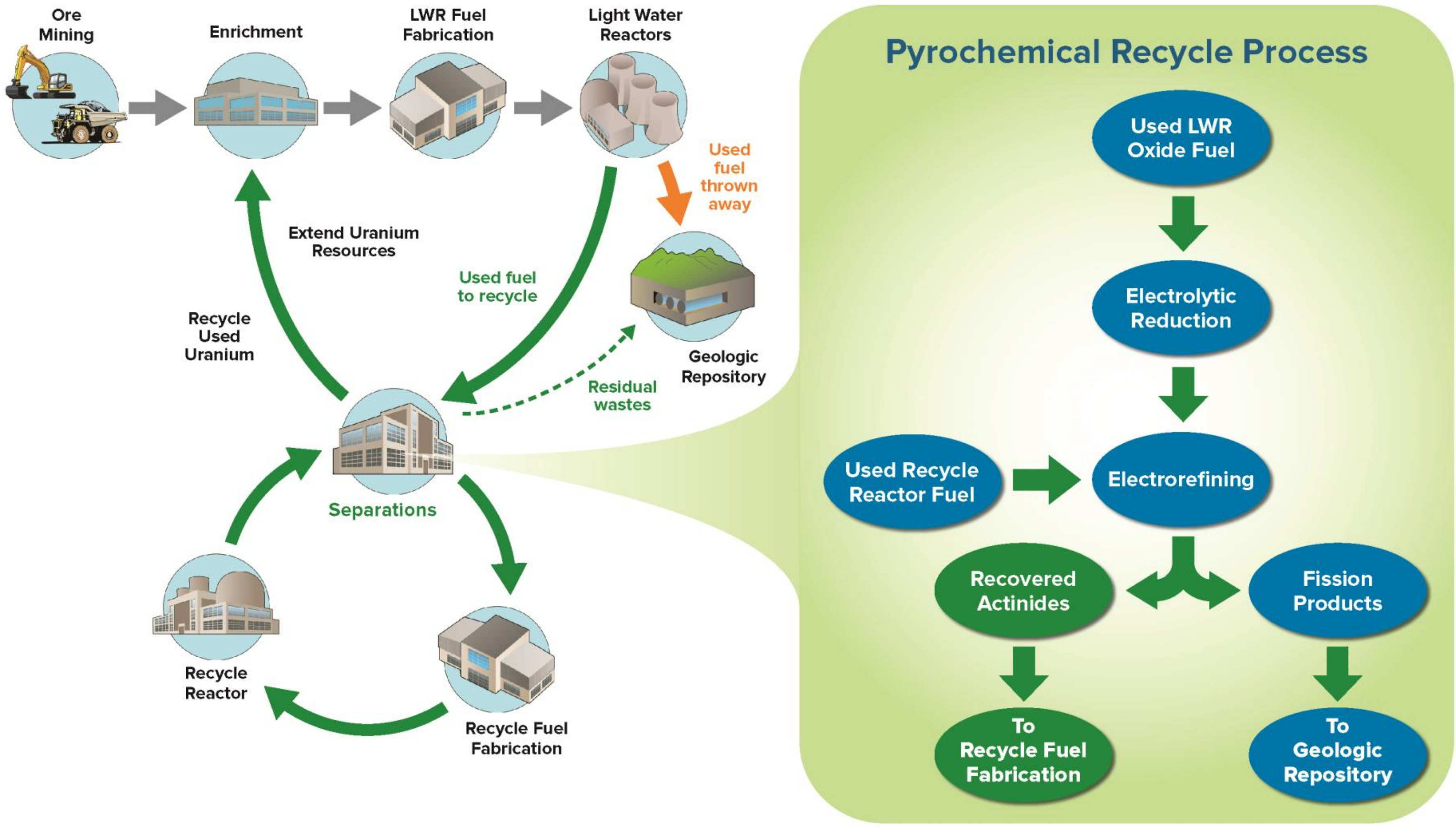
- In 2011, U.S. DOE chartered a Fuel Cycle Evaluation and Screening Study to strengthen the basis for U.S. nuclear energy R&D decisions
  - Identify promising fuel cycles with potential to provide substantial improvements, as compared to the current U.S. fuel cycle
  - Provide information about potential benefits and challenges of nuclear fuel cycle options
  - Identify characteristics of and R&D needs for promising fuel cycles
  - https://fuelcycleevaluation.inl.gov/SitePages/Home.aspx

- Nine criteria identified for evaluation
  - Safety, environmental impact, nuclear waste management, resource utilization, proliferation risk, nuclear material security risk,
  - Development and deployment risk, financial risk, institutional issues

- Over 4000 fuel cycle options identified
  - Cataloged into 40 groups for evaluation

- Among all options, three groups of fuel cycles consistently provided the highest improvements compared to the current U.S. fuel cycle, each group included
  - Generation IV fast reactor
  - Continuous recycle of actinides in Gen IV fast reactor

A SUSTAINABLE NUCLEAR ENERGY SYSTEM



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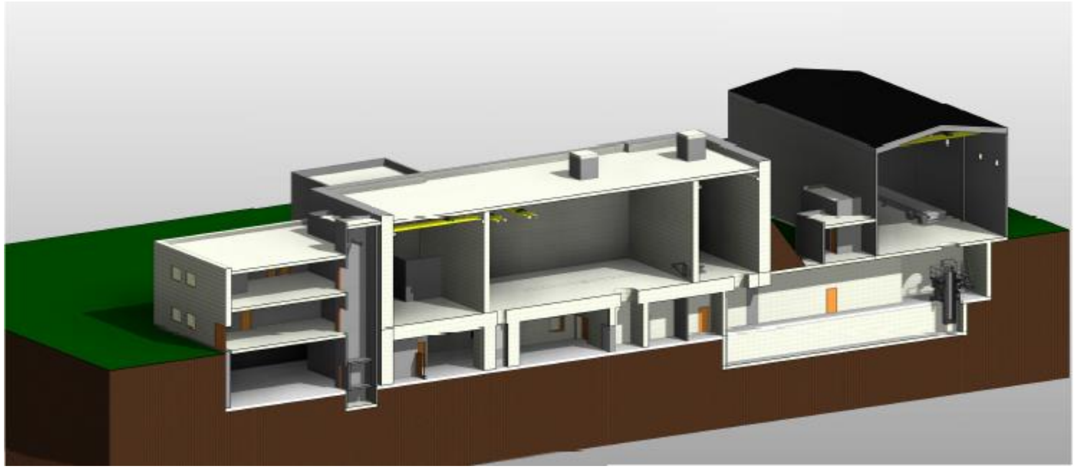
PYROCHEMICAL RECYCLE FACILITY

- Conceptual design of 100 MT/yr LWR fuel treatment pilot plant completed
  - Integrated process flowsheet and operational model for entire facility
  - Conceptual design for all process equipment
  - Worked with A&E firm to complete facility design and balance of plant systems

- Design provides launching point for detailed plant design

- Identified technology gaps requiring additional validation or supporting R&D
  - No showstoppers identified

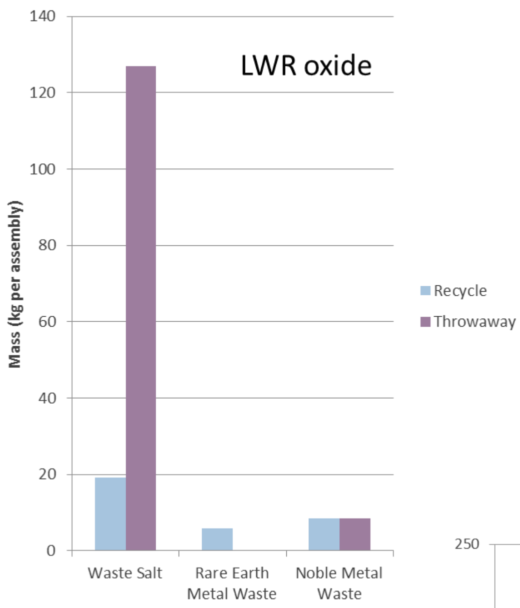


FUEL RECYCLING FACILITY FEATURES

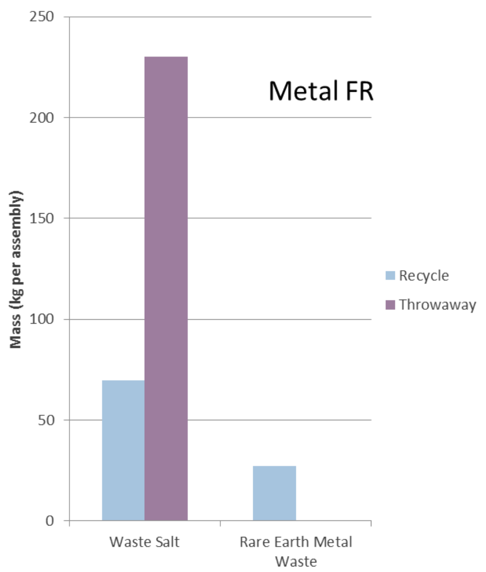
- Maximize actinide recovery
  - Crucial to reducing long-term radioactivity and heat load of high-level waste destined for a geologic repository
  - Recovered actinides recycled as fuel for GEN IV fast reactor

- Recover fission products from process salt to achieve fuel product quality and minimize waste destined for repository
  - No need to produce high purity salt for recycle so some fission product contamination remaining in salt is ok
  - Salt recycle optimized to limit high-level waste production
  - Recovered fission products encapsulated in durable waste forms

- Design based on experimental results of U.S. DOE funded engineering- and lab-scale technology development activities
  - Main operations demonstrated
  - Experimental work to validate technology gaps



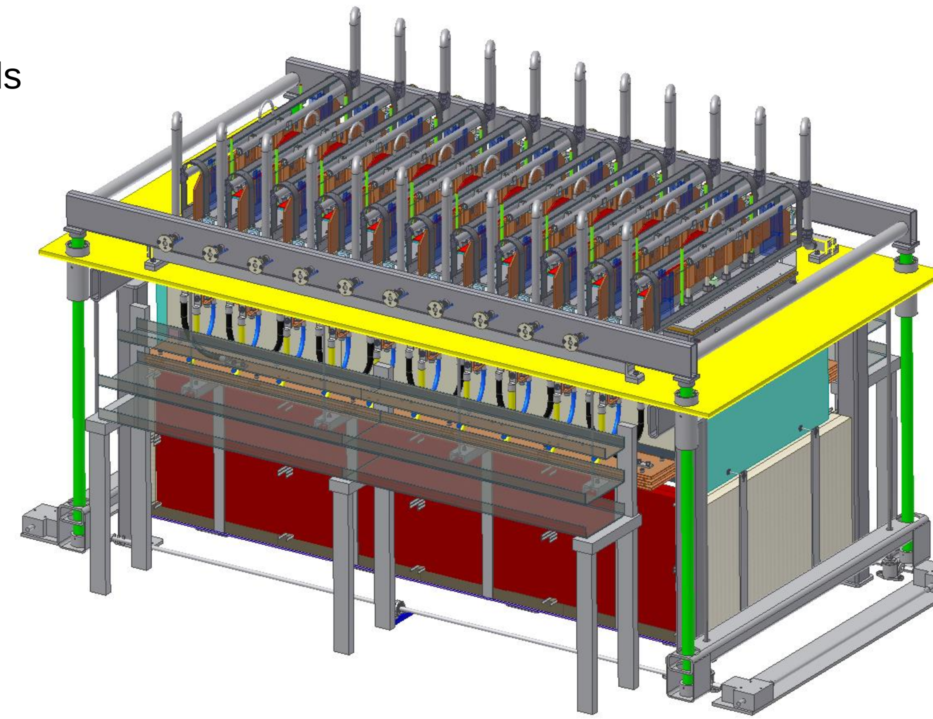
Salt waste produced per assembly for the pyrochemical processing of used fuel with and without salt recycle



ELECTROREDUCTION: FROM LIGHT WATER TO FAST REACTOR FUEL CYCLE

- Electroreduction converts used fuel oxides to base metals for treatment in electrorefiner
  - Modular design
    - Scalable process to meet throughput needs
    - Ease of maintenance and repair
    - Ease of remote operation
    - Minimize footprint to reduce costs
  - High capacity factor

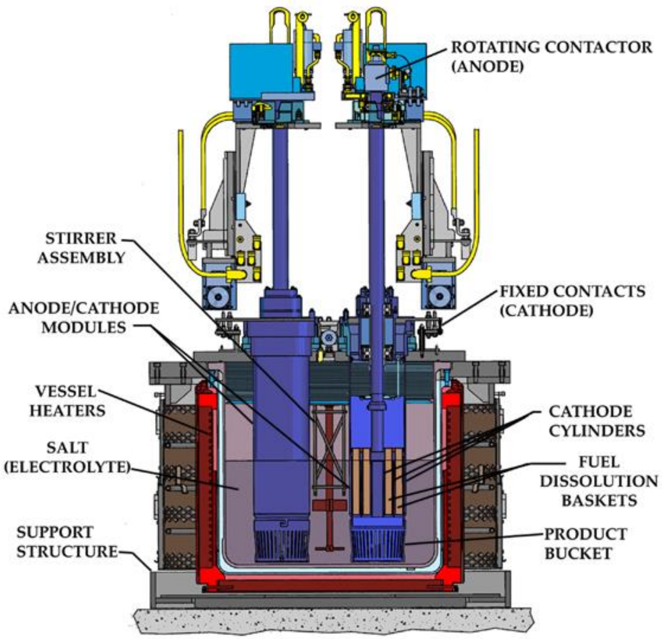
- Process demonstrated at multiple scales with simulated and irradiated fuels



General Electric - Hitachi Nuclear
US Patent: 9,017,527

NEXT-GENERATION ELECTROREFINER

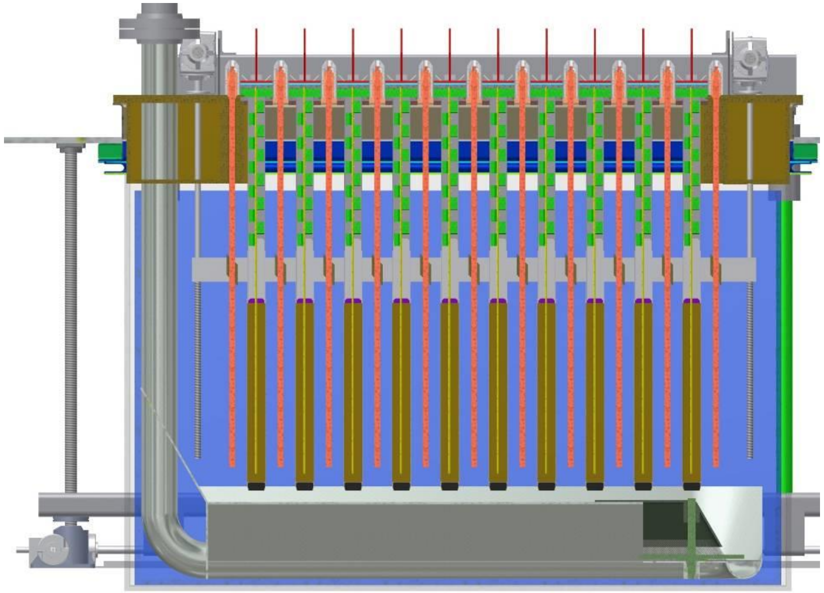
Mk V



Demonstrated sustained treatment of irradiated fuel from Experimental Breeder Reactor II (EBR II)

PEER prototype module

Advanced design eliminates inefficiencies in Mk V system



General Electric - Hitachi Nuclear
US Patent: 9,150,975

PYROCHEMICAL PROCESSES IDEALLY SUITED FOR FAST REACTOR FUEL RECYCLE

GEN IV FAST REACTORS HAVE UNIQUE FEATURES IMPACTING CHOICE OF REPROCESSING TECHNOLOGY

- High concentration of transuranic elements in fuel (e.g., 20 wt%)
- Short cooling time to allow for in-vessel storage of used fuel prior to reprocessing
  - No extensive out-of-reactor used fuel storage system required
  - Eliminates large out-of-reactor inventory of transuranic elements
- Sodium used for bonding metal fuel with cladding material for improved heat transfer
    - Reacts to form sodium chloride that is soluble in molten salt

ADVANTAGES OF PYROCHEMICAL PROCESSES

- High solubility for actinides yield compact process operations
- Resistant to high radiation fields thus allowing treatment of short-cooled fuel
- High actinide concentrations in the salt are critically safe
- Wide electrochemical potential (i.e., voltage) window allows for recovery of actinides as metals
- Low melting point salt permits use of low-cost containment vessels

SUMMARY

Nuclear energy is the only near carbon-free source that offers reliable 24/7, large-scale energy production

Generation IV fast reactor and closed fuel cycle specifically designed to address

- Sustainability
  - Maximize resource utilization
  - Major role in waste management
- Competitive economics
  - Industrially practicable
  - High capacity factor
  - Modular systems to meet throughput needs and facilitate maintenance and repair
- Safety and safeguards assurance
  - Inherently safe operations
  - Designed to meet non-proliferation standards
- Waste minimization
  - Encapsulate fission products in engineered waste forms that can be disposed in an environmentally responsible manner

ACKNOWLEDGEMENT

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