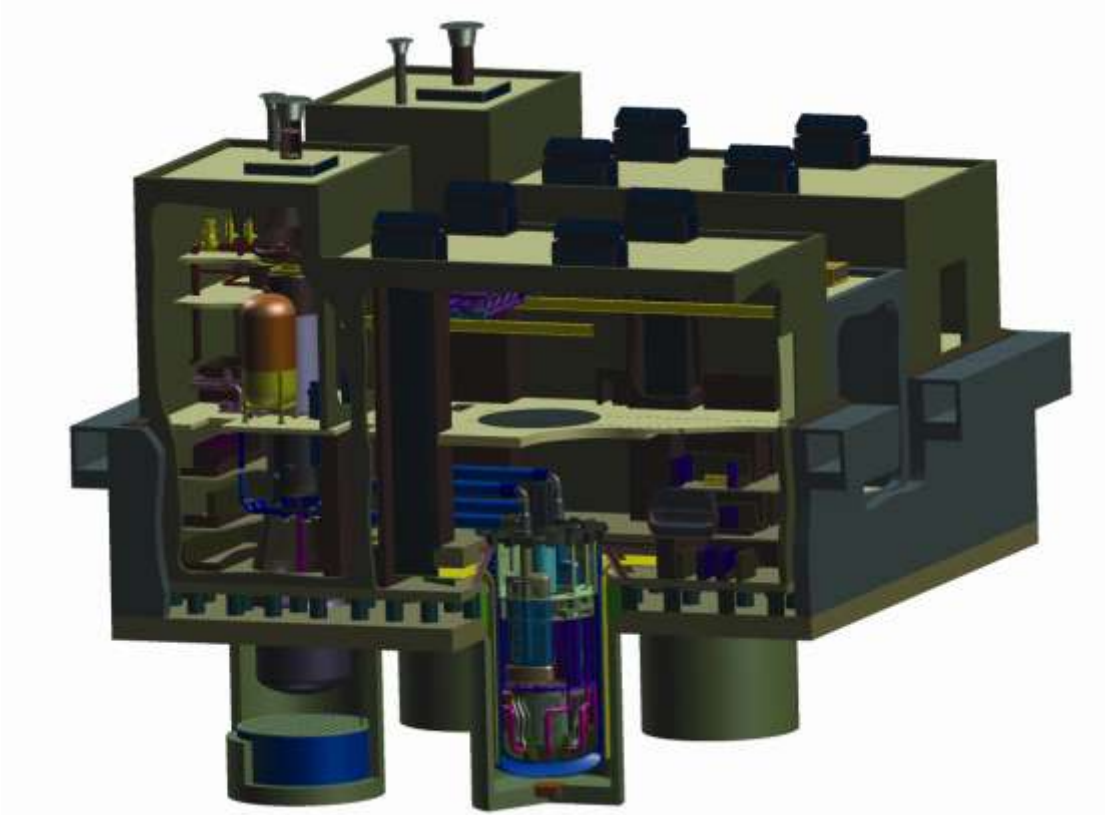
GE Hitachi Nuclear Energy

PRISM

Lighting a new era for reactor safety, energy security, and used nuclear fuel management

David Powell
Vice President Europe region



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European Nuclear Conference 2012
Manchester
9 - 12th December 2012

The Spent Nuclear Fuel Dilemma

We cannot wish Britain's nuclear waste away

Opponents of nuclear power who shout down suggestions of how to use spent waste as fuel will not make the problem disappear

GEORGEMONBIOT'S BLOG

The Guardian, 2 February 2012

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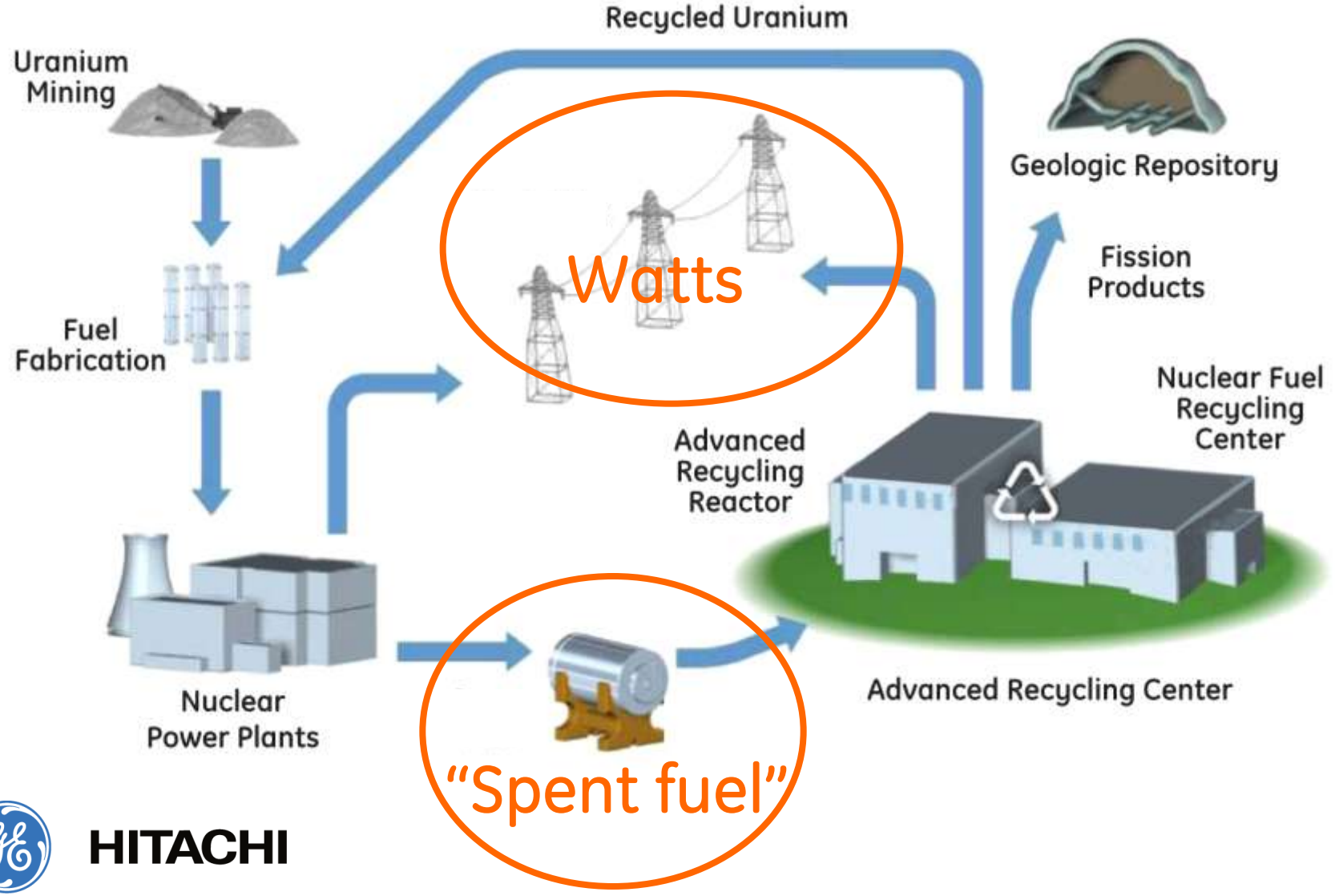
Closing the nuclear fuel cycle
Advanced Recycling Center



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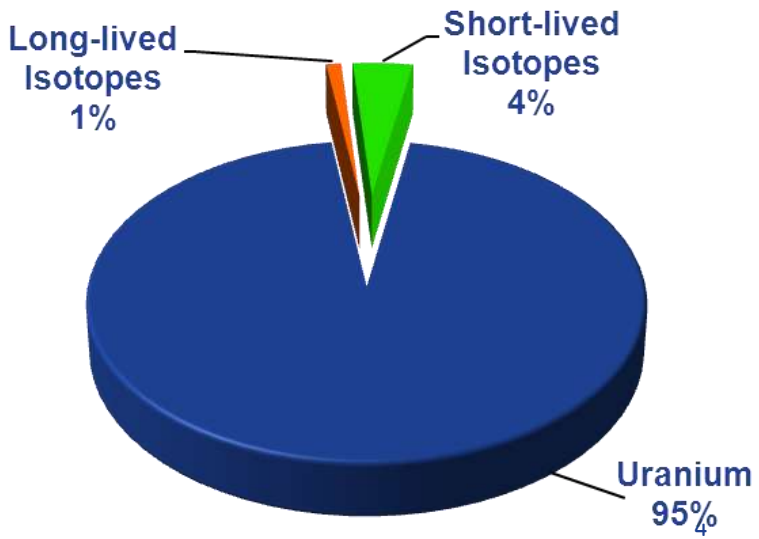
“Spent fuel”- What are we dealing with?

- Current nuclear reactor fuel produces electricity for 4-6 years
- At discharge, only **~1%** of the potential energy has been harnessed
  - Most of the spent fuel is uranium
  - ~1% of the spent fuel is transuranics (long-lived isotopes)
  - ~4-5% are fission products (short-lived isotopes)
- PRISM uses the uranium and transuranics as fuel, leaving the short-lived isotopes for disposal

“Transuranics” = PRISM Fuel



Spent fuel composition

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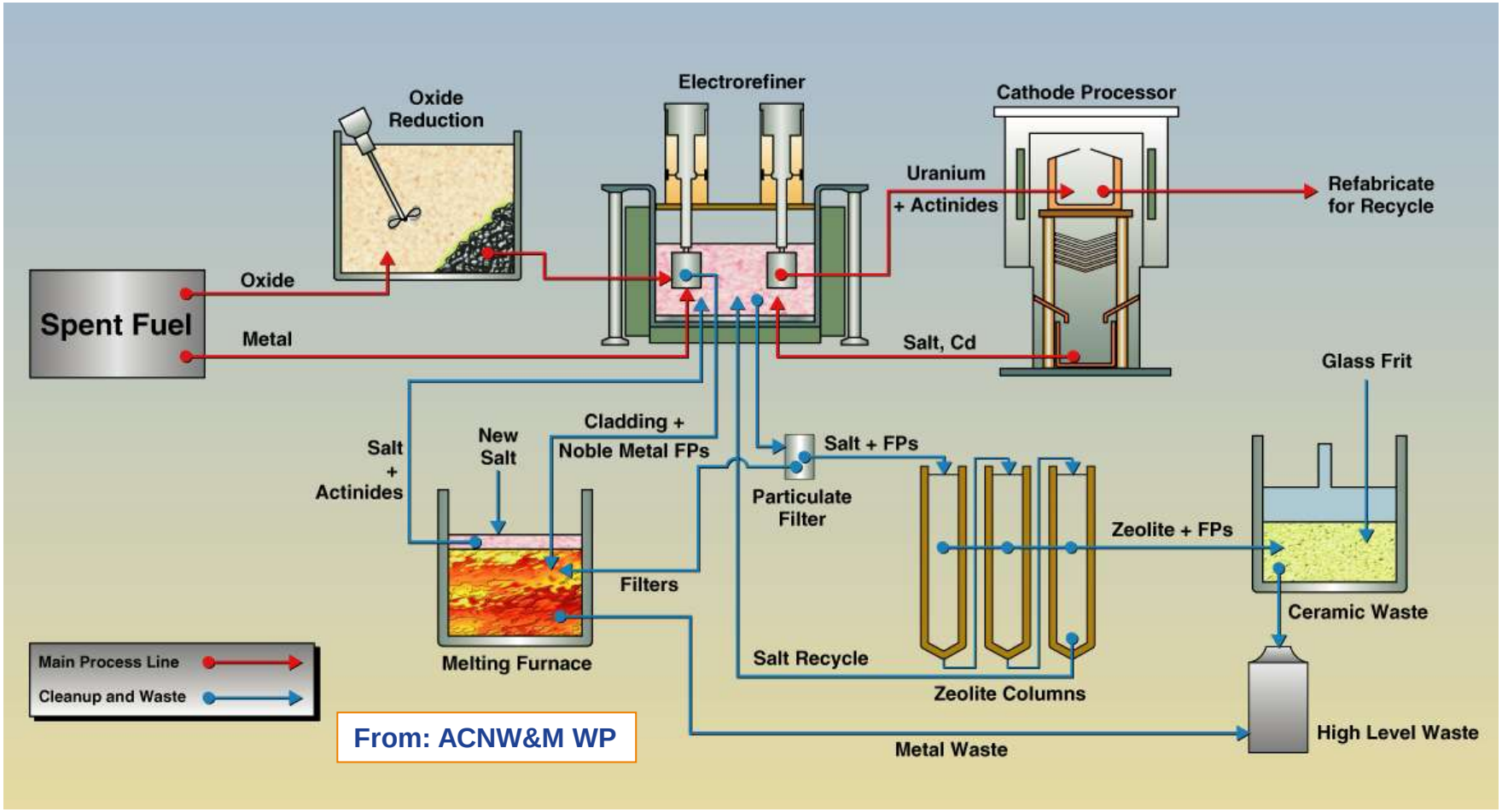
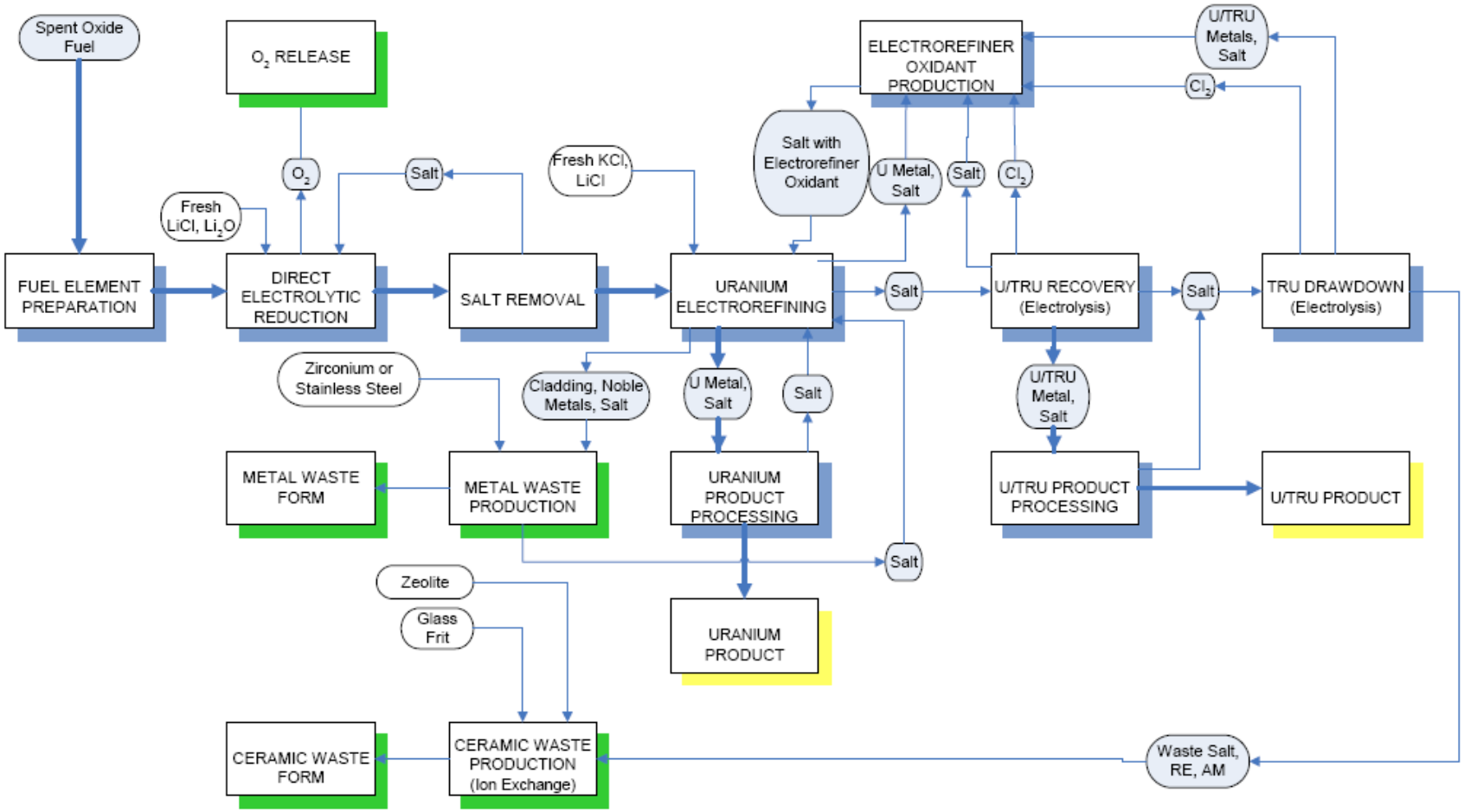
Chemistry

Electrochemistry flowsheet



GEH's oxide fuel processing flowsheet



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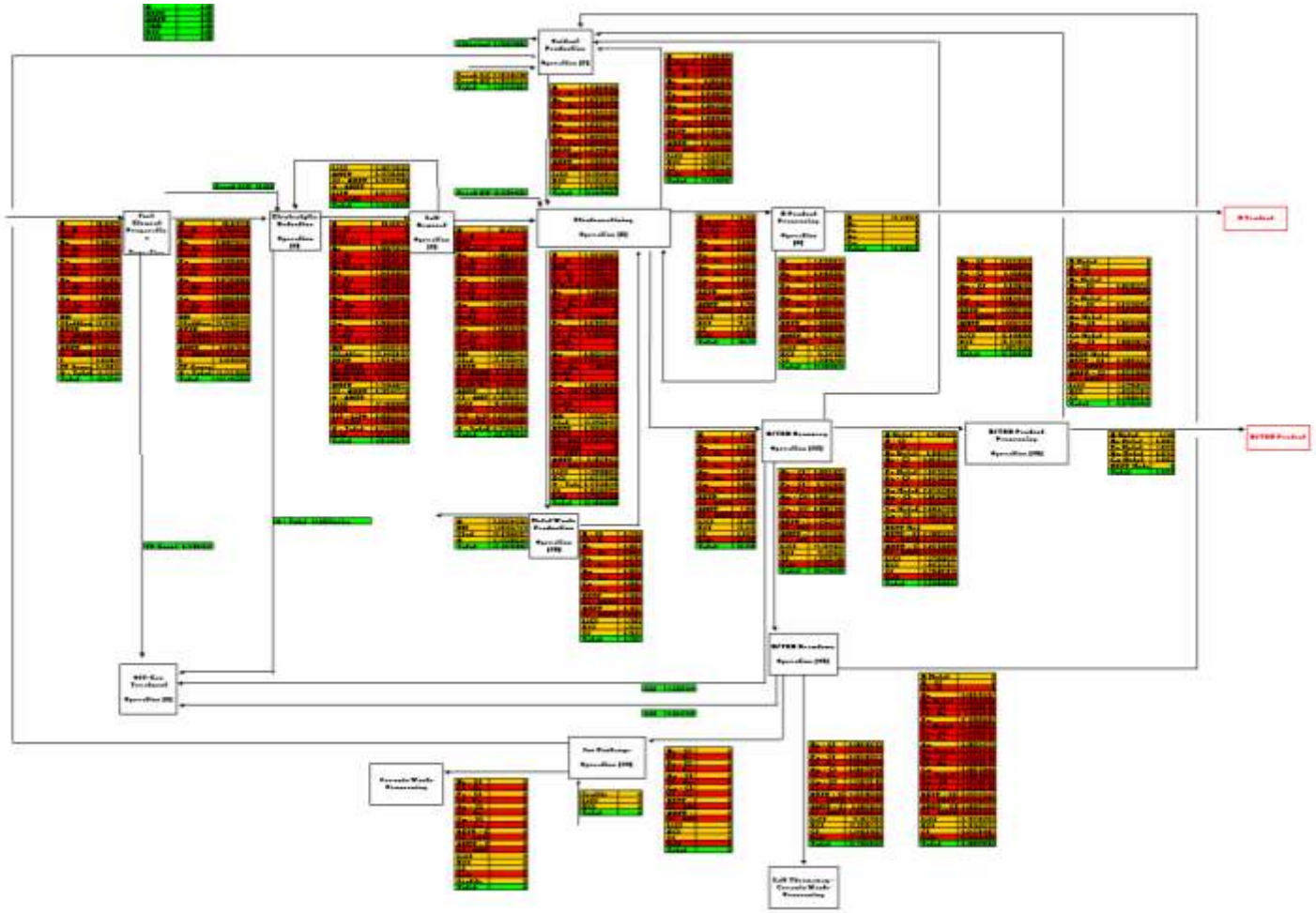
GEH's oxide fuel mass balance model



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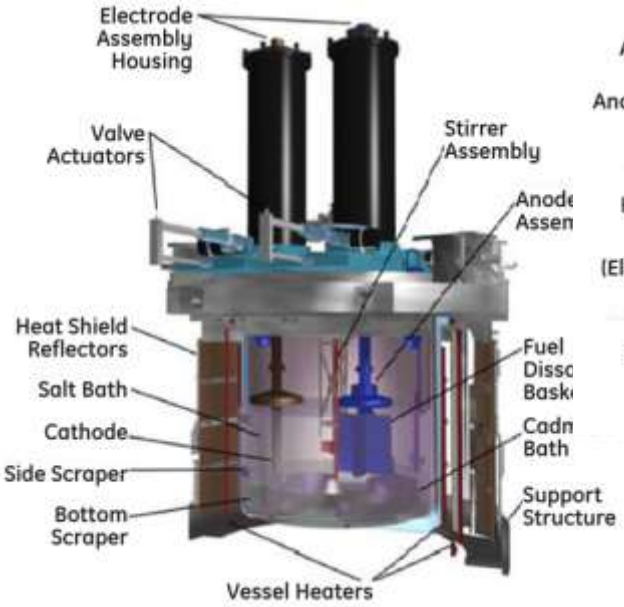
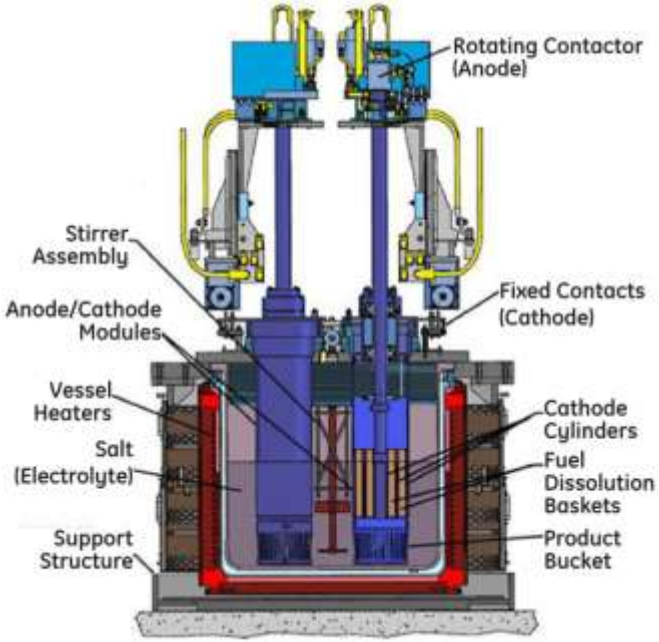
Scale-up issues



Mark IV



Mark V

Commercial Deployment

Process scales on:

- ✓surface area
- ✓current density

The waste forms

Metallic

99Tc is in the metal waste form

Ceramic

Cs and Sr are in the ceramic waste form

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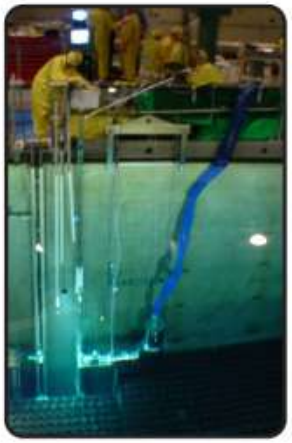
Advanced Recycling Center

Spent Fuel Storage



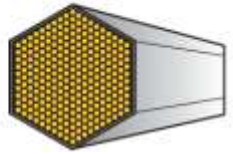
Spent Fuel

NFRC

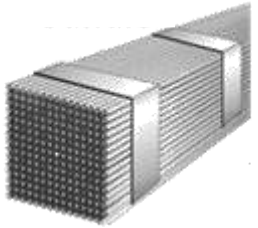
Electrometallurgical Separations

Short-lived Waste

PRISM fuel



Recycled uranium



The NFRC produces PRISM fuel from the recycled uranium and long-lived isotopes. The short-lived isotopes are isolated into stable waste forms.

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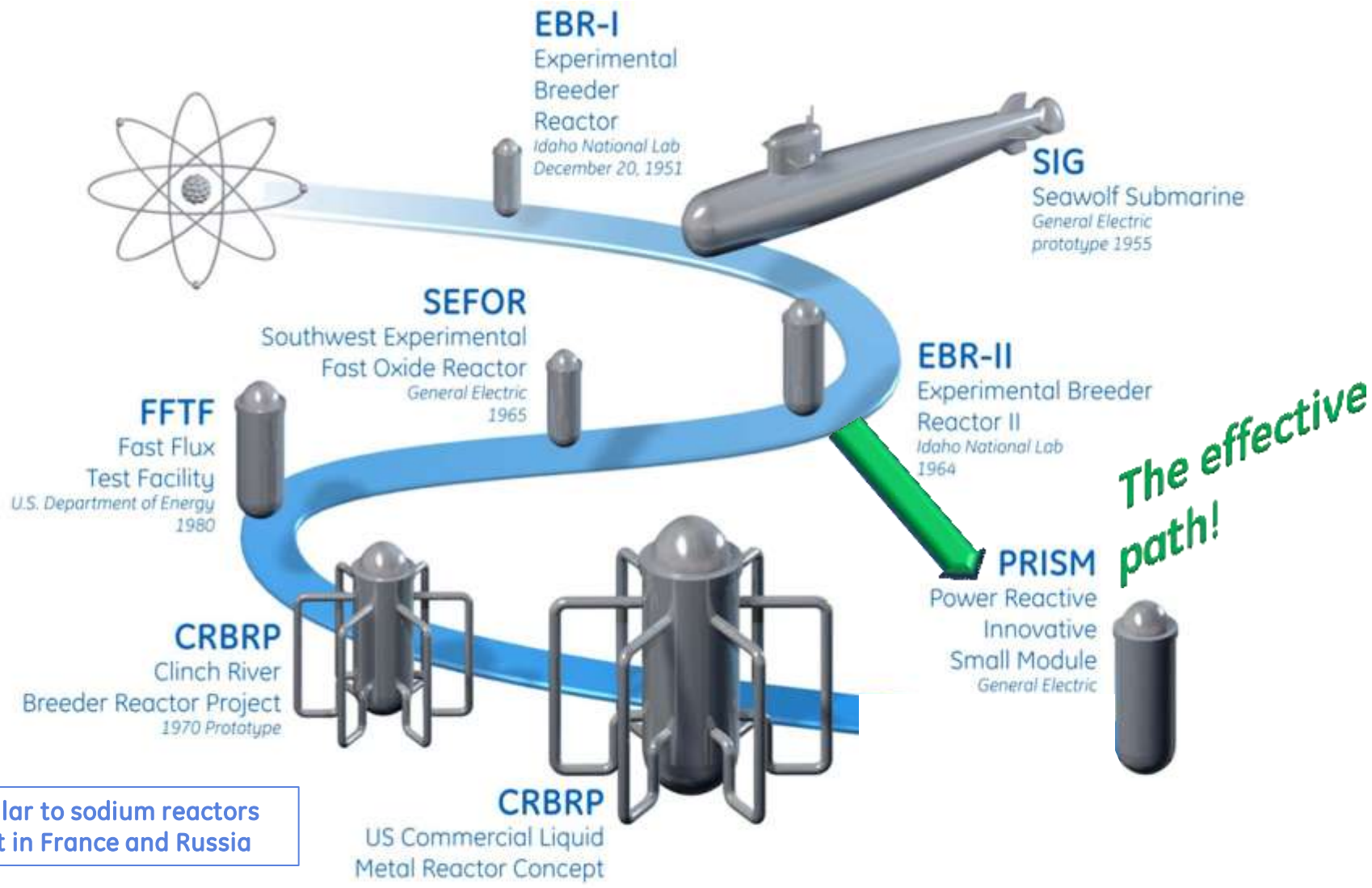
Reactor

Sodium reactor historical evolution



Similar to sodium reactors built in France and Russia

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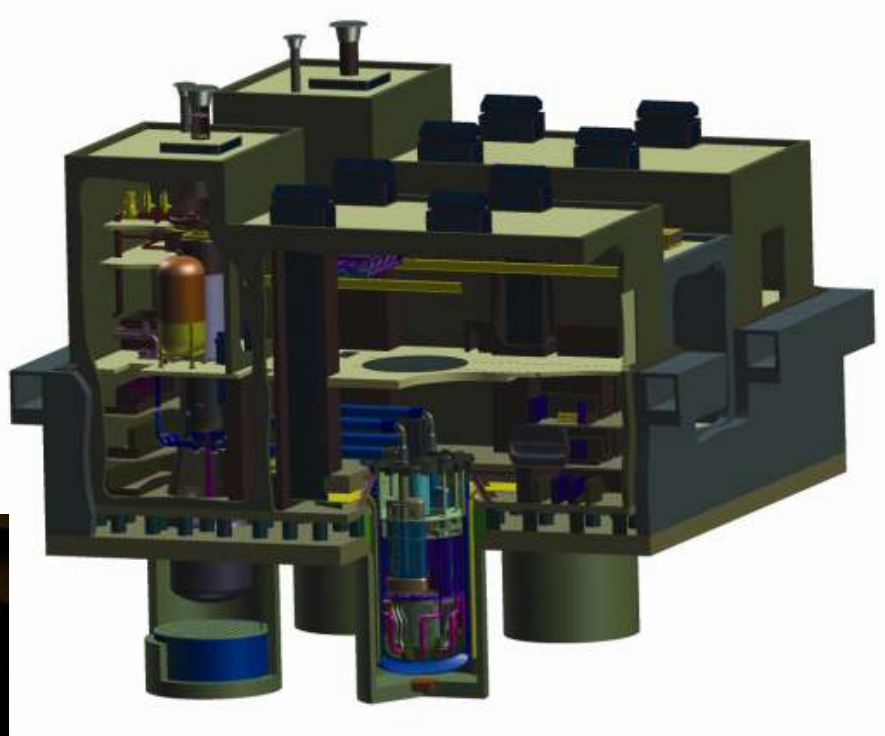
PRISM origins

- ✓ Advanced Conceptual Design
  - Already paid for by USG
  - Available today
- ✓ NRC "…no obvious impediments to licensing…"
  - Prudent starting point



1981-1984 GE Program
- GE funded
- Innovative design approaches

1985-1987 PRISM
- DOE funded $30M
- Competitive LMR concepts

1988 PRDA
- DOE funded $5M
- Continuing trade studies

1989-1995 ALMR
- DOE funded $42M
- Preliminary design
- Regulatory review
- Economics
- Utility advisory board
- Commercialization
- Tech development ($107M additional)

1995-2002 S-PRISM
- GE Funded
- Improved economics
- Actinide burning scenarios

2007-2009 GNEP
- Demo reactor
- Actinide burning
- Commercial
- Best practices
- Advanced power conversion cycle

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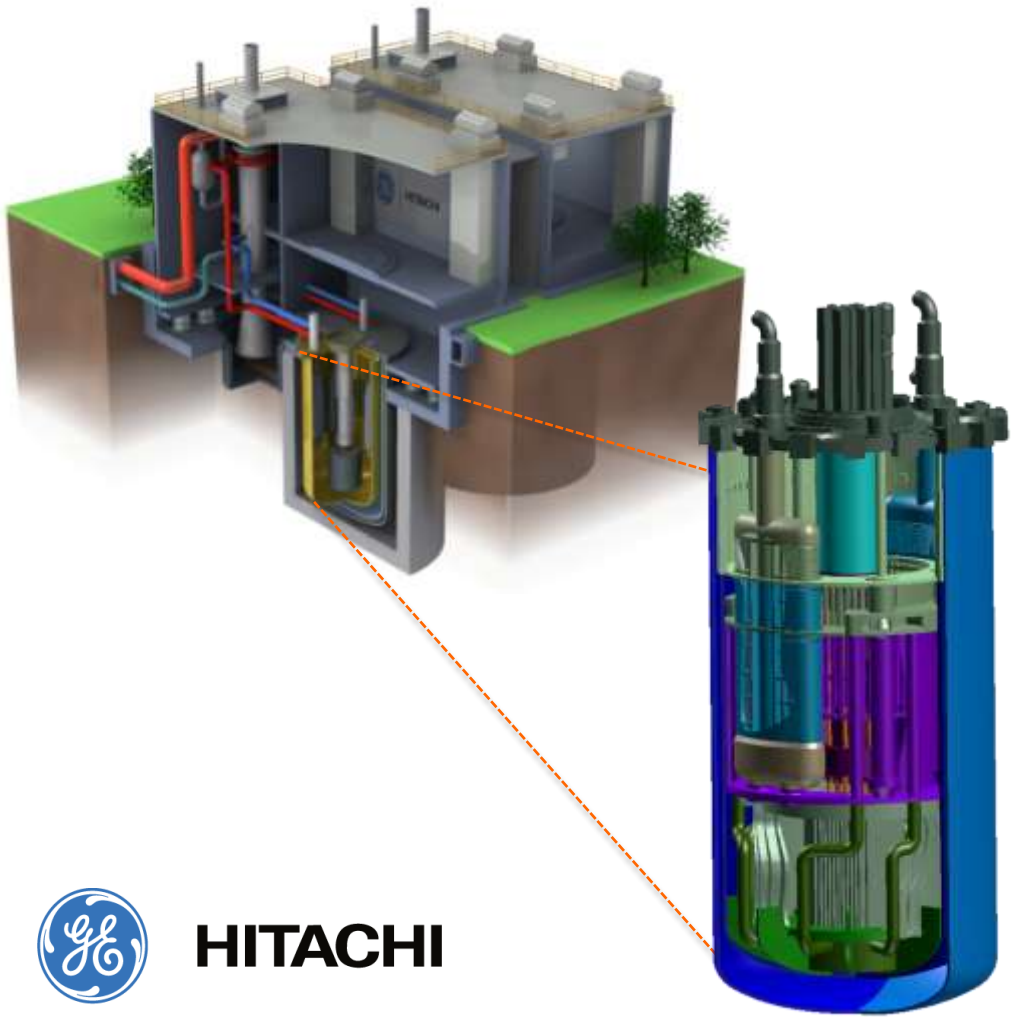
PRISM is Power Reactor Innovative Small Module



- Modular nuclear reactor that uses nuclear waste as fuel
- 311 MWe (840 MWth) per reactor
  - Two reactors per turbine-generator
  - 6 reactors/site -1866 MWe
- Fuel for PRISM fabricated on-site in NFRC
- Features advanced safety and digital control systems
- Modular components allow for factory fabrication

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GEH building and testing key pumping components

Building the EMP

ETEC Testing

2006

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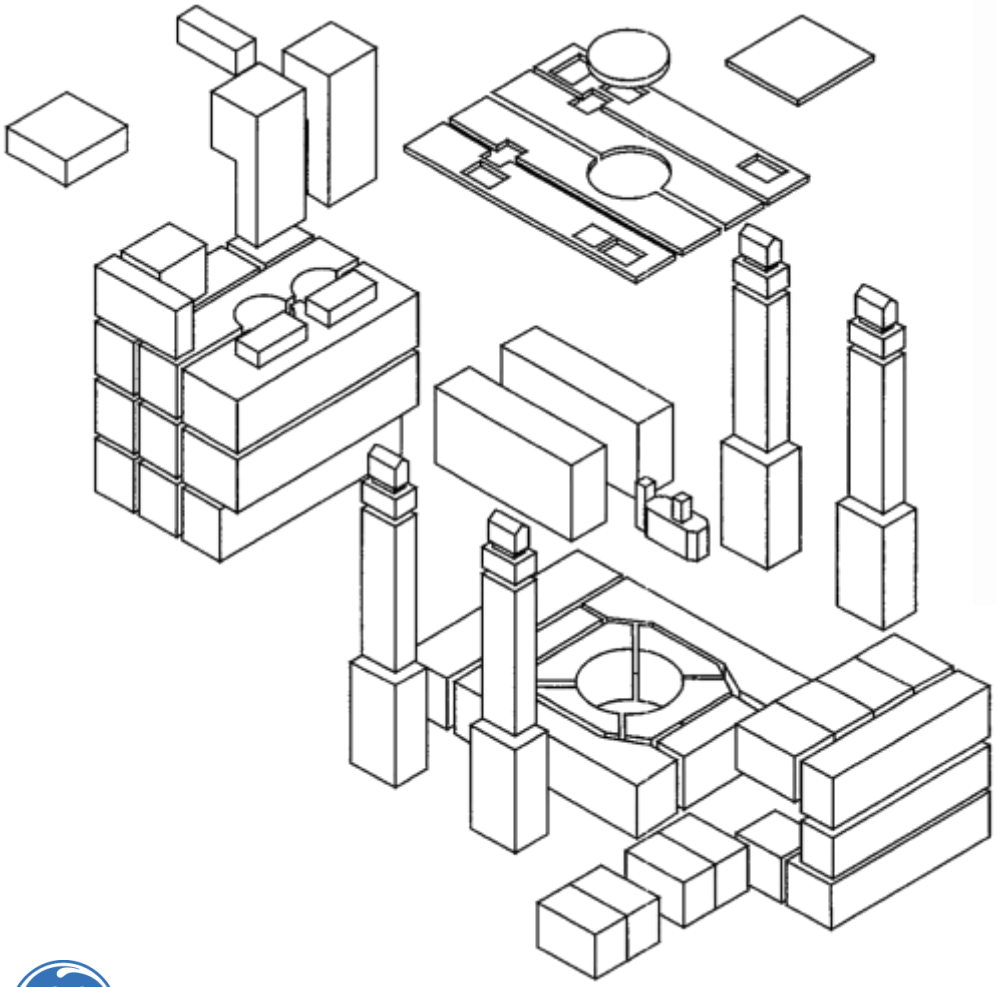
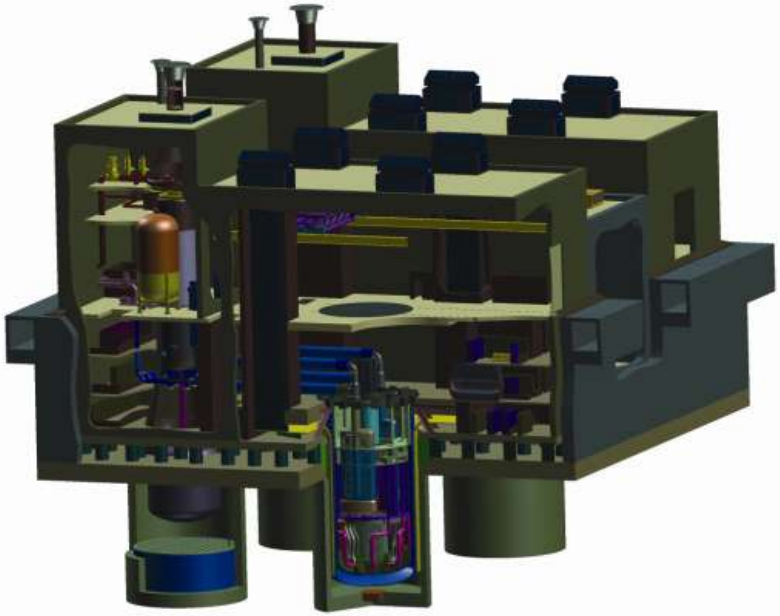
PRISM modular construction





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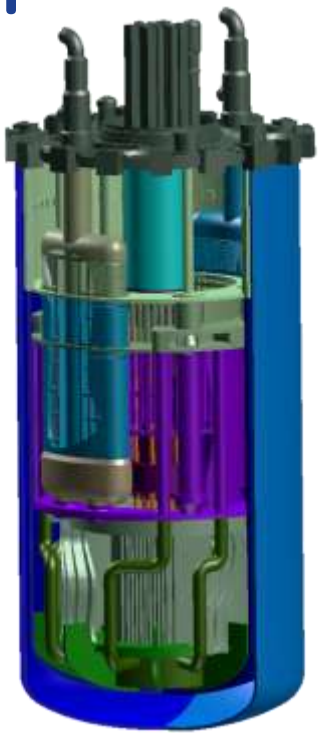
Basic design features of reactor



Simple Conservative Design

- Passive decay heat removal
- Automated safety grade actions

Simplified O&M

- Safety grade envelope small
- Compact primary system

Reduced Capital and Investment Risk

- Factory fabrication of certified design
- Modular construction and seismic isolation
- Small and simple system configuration

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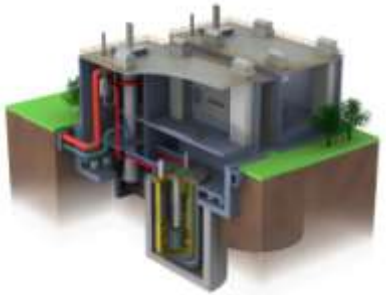
PRISM features allow for low n^{th}-of-a-kind cost of electricity



Feature	Cost Advantage
Pool Type	Eliminates LOCA
Metallic Fuel	Passive reactor shut down
Higher Op Temp	Improved efficiency
Fuel Consumption	Consumes transuranics
Higher Power Density	Better efficiency
Passive Safety	Eliminates active systems
Modular Design	Lower on-site construction costs

X CRBR X Moju X BN600 X ESFR

✓PRISM

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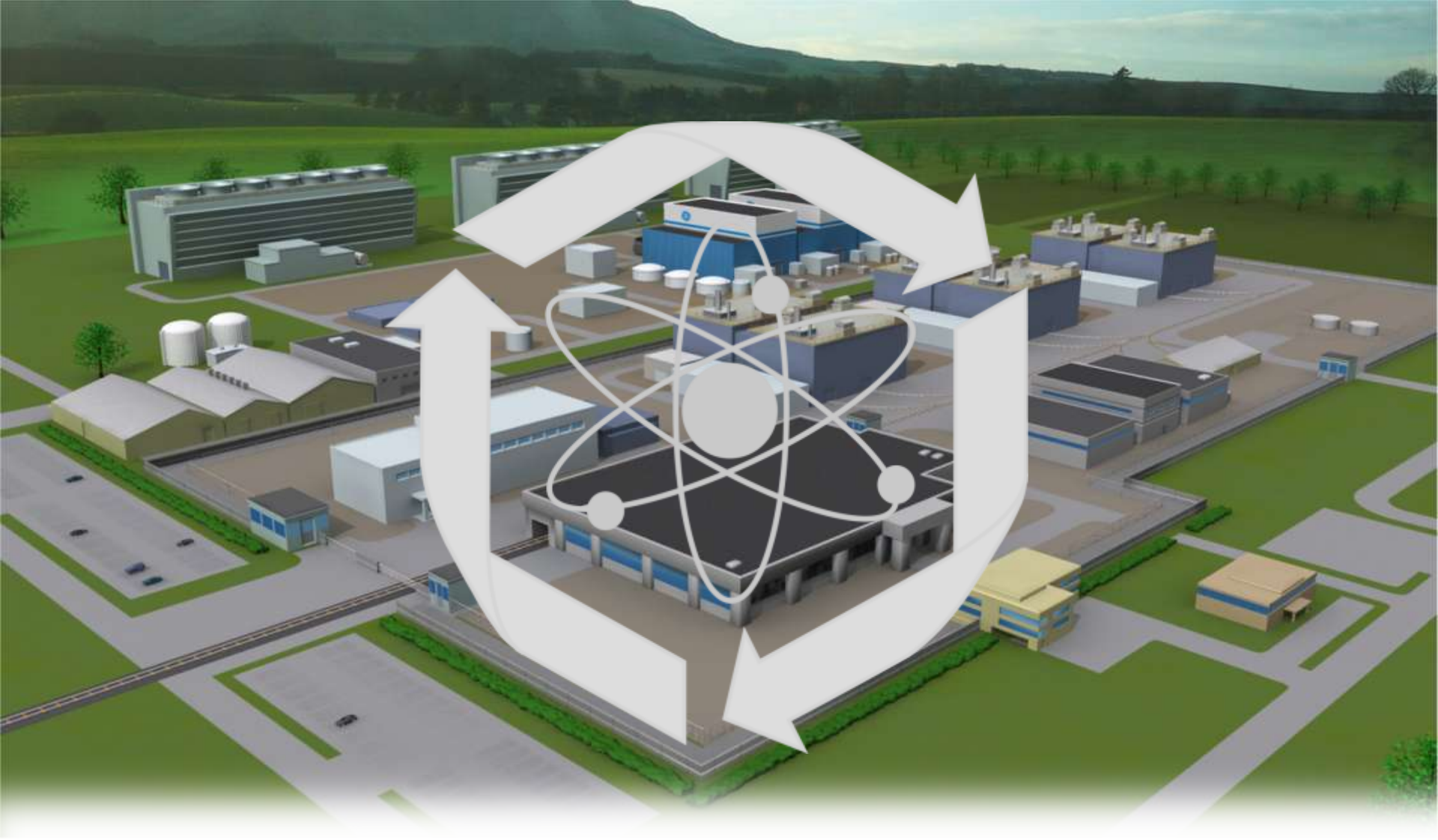

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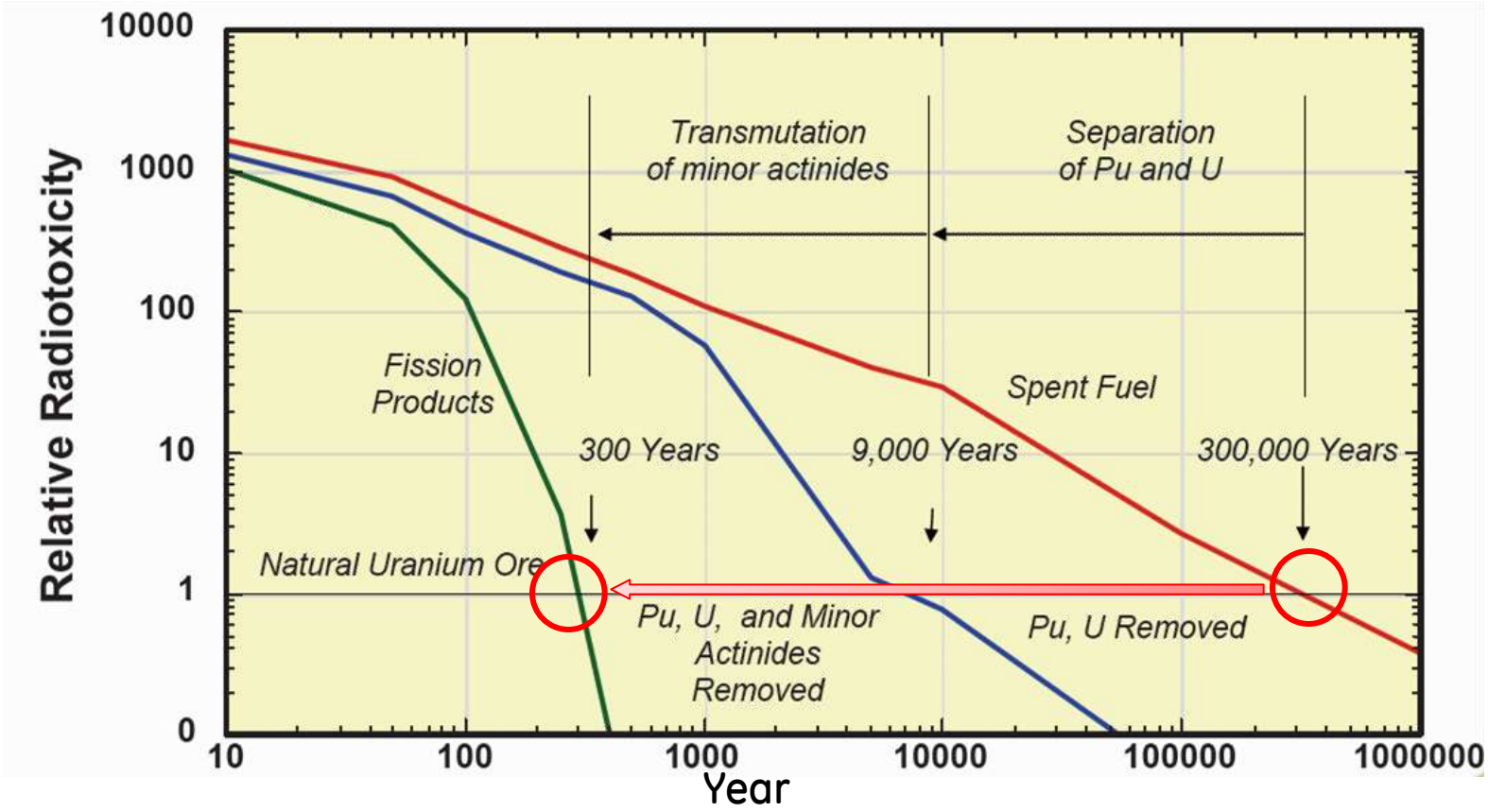
PRISM enables Advanced Recycling Center

Transuranic disposal issues

The 1% transuranic (TRU) content of nuclear fuel is responsible for 99.9% of the disposal time requirement and policy issues



Removal of uranium, plutonium, and transuranics makes a 300,000 year problem a 300 year problem

Benefits to a repository

- Reduction of waste package heat load and volume increases repository capacity
- Dramatic reduction in long-lived constituents in waste packages simplifies repository design
- Dramatic reduction in long-term radiotoxicity of waste makes licensing repository easier and may allow elimination of costly drip shield

Cost of disposal is a function of:
fixed cost, volume, and heat load.
Policy determines the relative value.

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UK plutonium - Potential opportunity

- The UK is storing the world's largest stockpile of civil Pu at 112t and growing.
- The UK Government has taken positive steps and announced its preferred policy of re-use in civil nuclear reactors.
- It "remains open to any alternative proposals for plutonium management that offer better value to the taxpayer"
- The solution needs to meet security and non-proliferation requirements and be affordable, deliverable and offer value for money.
- PRISM provides a unique opportunity.

Innovation for fully closing the fuel cycle

- The **answer to the spent fuel dilemma** – can reduce used nuclear fuel to ~300-year radiotoxicity while providing new electricity generation
- **Passive air-cooling** capability with no operator or mechanical actions needed
- Simplified design **prevents loss of coolant accident**
- Based on over **30 years of safe operation** of EBR-II by the U.S. Government
- Could be designed and deployed in the near-future; could start the path toward licensing **today**

Advanced Recycling Center can reduce nuclear waste radiotoxicity from ~300,000 years to ~300 years

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