# The Global Nuclear Energy Partnership – The Technology Demonstration Program

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# *What is GNEP?*

The Global Nuclear Energy partnership is a comprehensive strategy to:

- Increase U.S. and global energy security
- Encourage clean development around the world & improve the environment
- Reduce the risk of nuclear proliferation

# *Key Elements*

- Expand Nuclear Energy
- Recycle Nuclear Fuel & Reduce Nuclear Waste
- Enhance Nonproliferation Arrangements

# GNEP Strategy

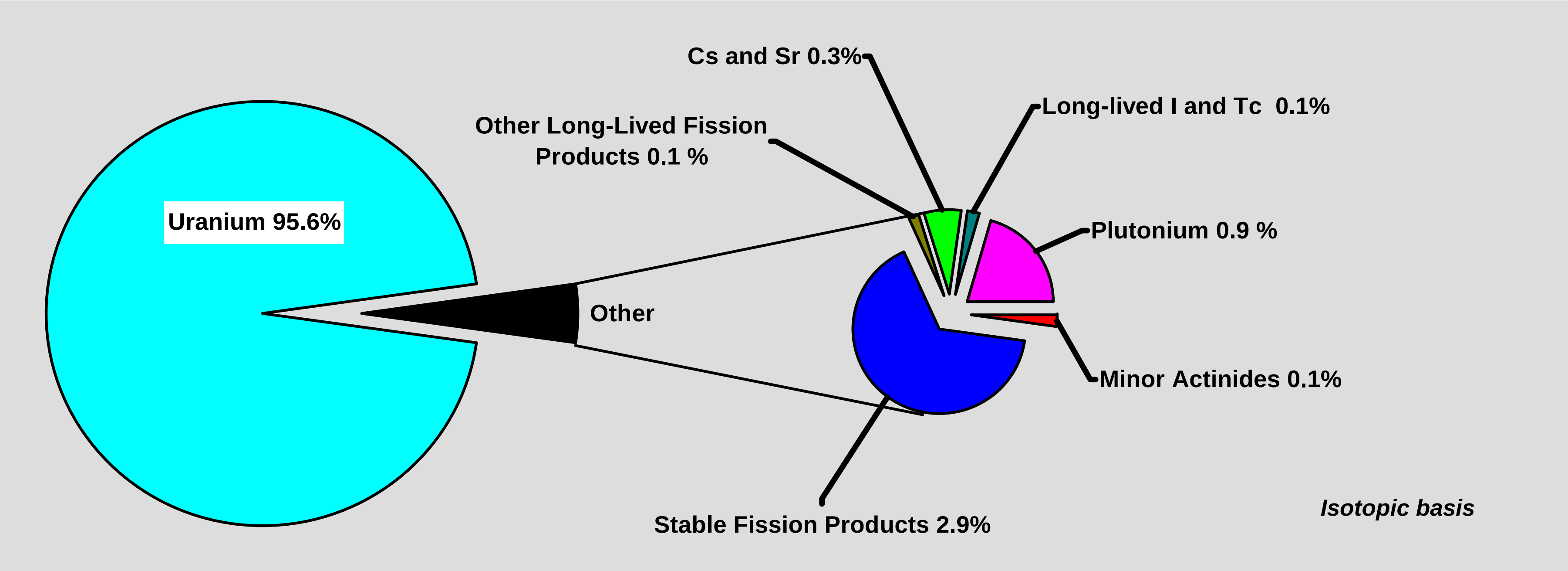
- Build a new generation of nuclear power plants in the United States.
- Open the federal geologic repository
- Develop and deploy new nuclear recycling technologies.
- Design Advance Burner Reactors that would produce energy from recycled nuclear fuel.
- Establish a fuel services program that would allow developing nations to acquire and use nuclear energy economically while minimizing the risk of nuclear proliferation.
- Develop and construct small scale reactors designed for the needs of developing countries.
- Improve nuclear safeguards to enhance the proliferation-resistance and safety of expanded nuclear power.

# Why Recycle?

- *National Motivations:*
  - *Optimal use of repository (ies)*
  - *Near-term management of spent nuclear fuel*
  - *Recovery of energy value in SNF (natural resource utilization)*

- *International Motivations:*
  - *Global nuclear-materials management options*
  - *Guidance for policy decisions on governance regimes*
  - *Leadership in defining advanced systems for proliferation resistance*

# Used Nuclear Fuel (less cladding)



# Potential Repository Needs

| Nuclear Futures | | Existing License Completion | Extended License Completion | Continuing Level Energy Generation | Continuing Market Share Generation | Growing Market Share Generation |
|---|---|---|---|---|---|---|
| Cumulative discharged fuel in the year 2100 (metric ton) | | 100,000 | 120,000 | 250,000 | 600,000 | 1,400,000 |
| | | Existing Reactors Only | | Existing and New Reactors | | |
| Fuel Management Approach | | Number of Repositories Needed at 70,000 Metric Ton Each | | | | |
| No Recycle | Once-Through | 2 | 2 | 4 | 9 | 20 |
| No Recycle | Once-Through, High Burnup Fuels | 2 | 2 | 3 | 7 | 17 |
| Reprocess & Recycle | Limited Recycle, High Burnup Fuels | Recycle not Recommended | | 2 | 5 | 10 |
| Reprocess & Recycle | Transitional and Sustained Recycle | | | 1 | 1 | 1 |

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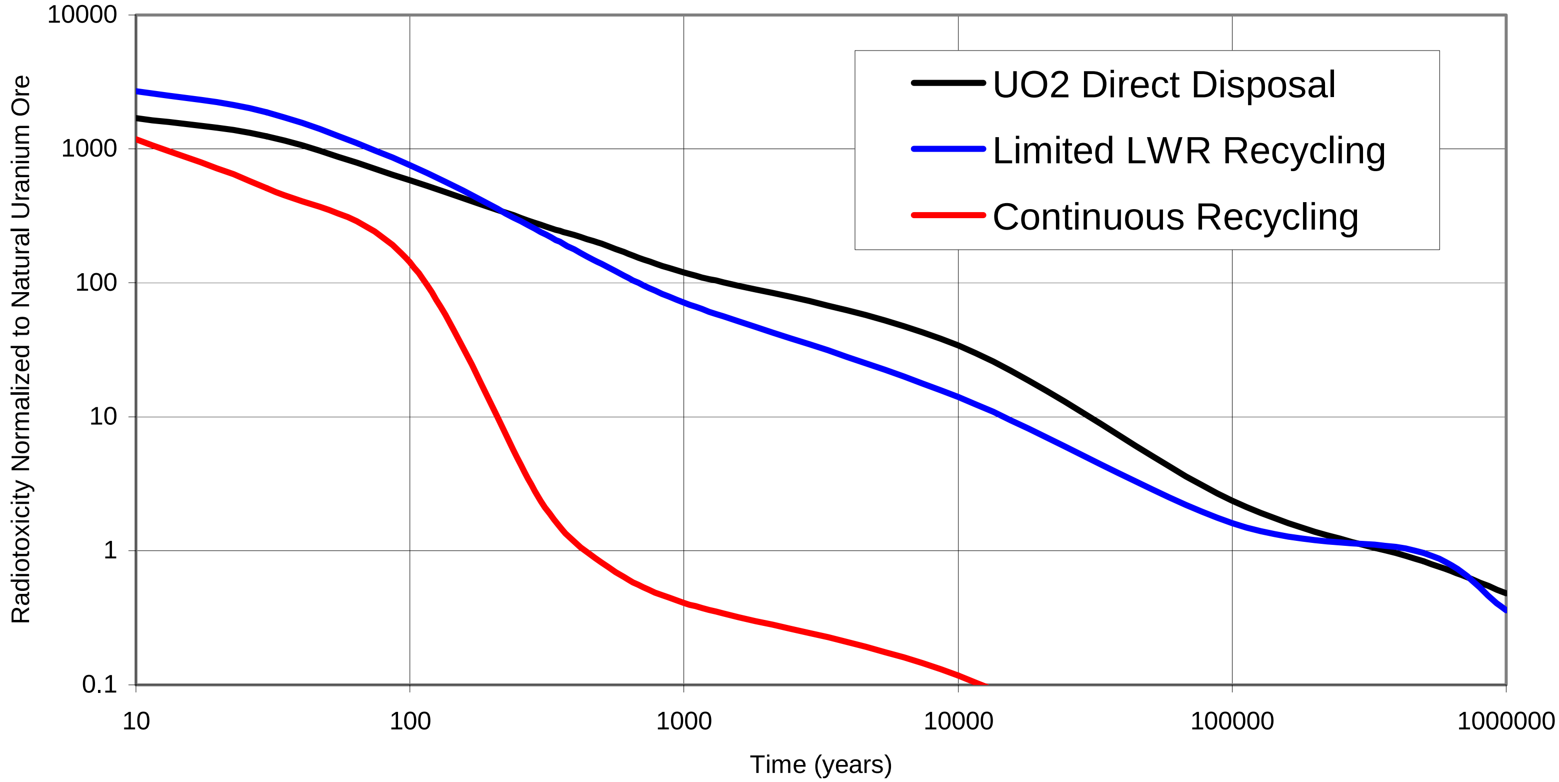
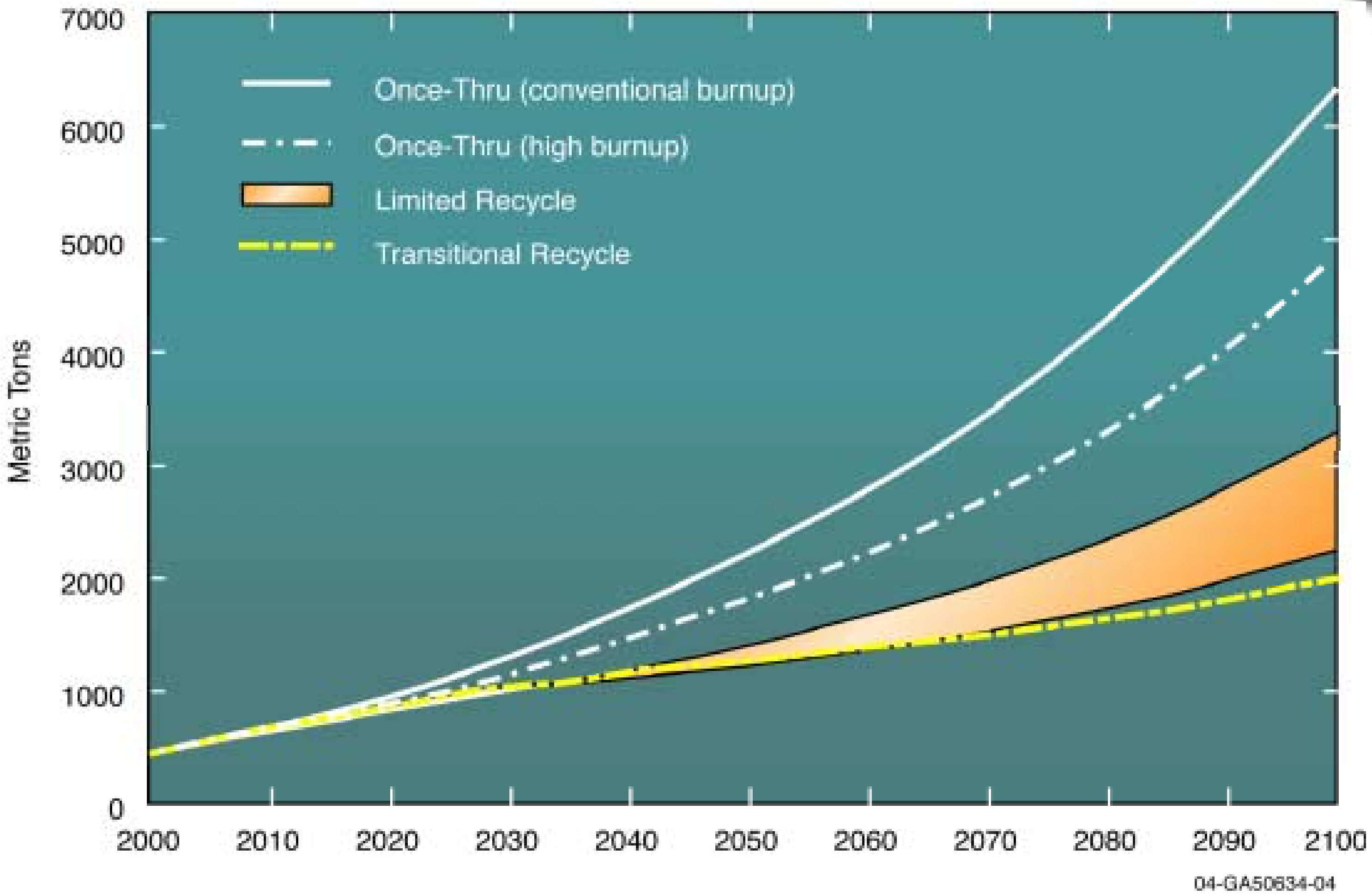
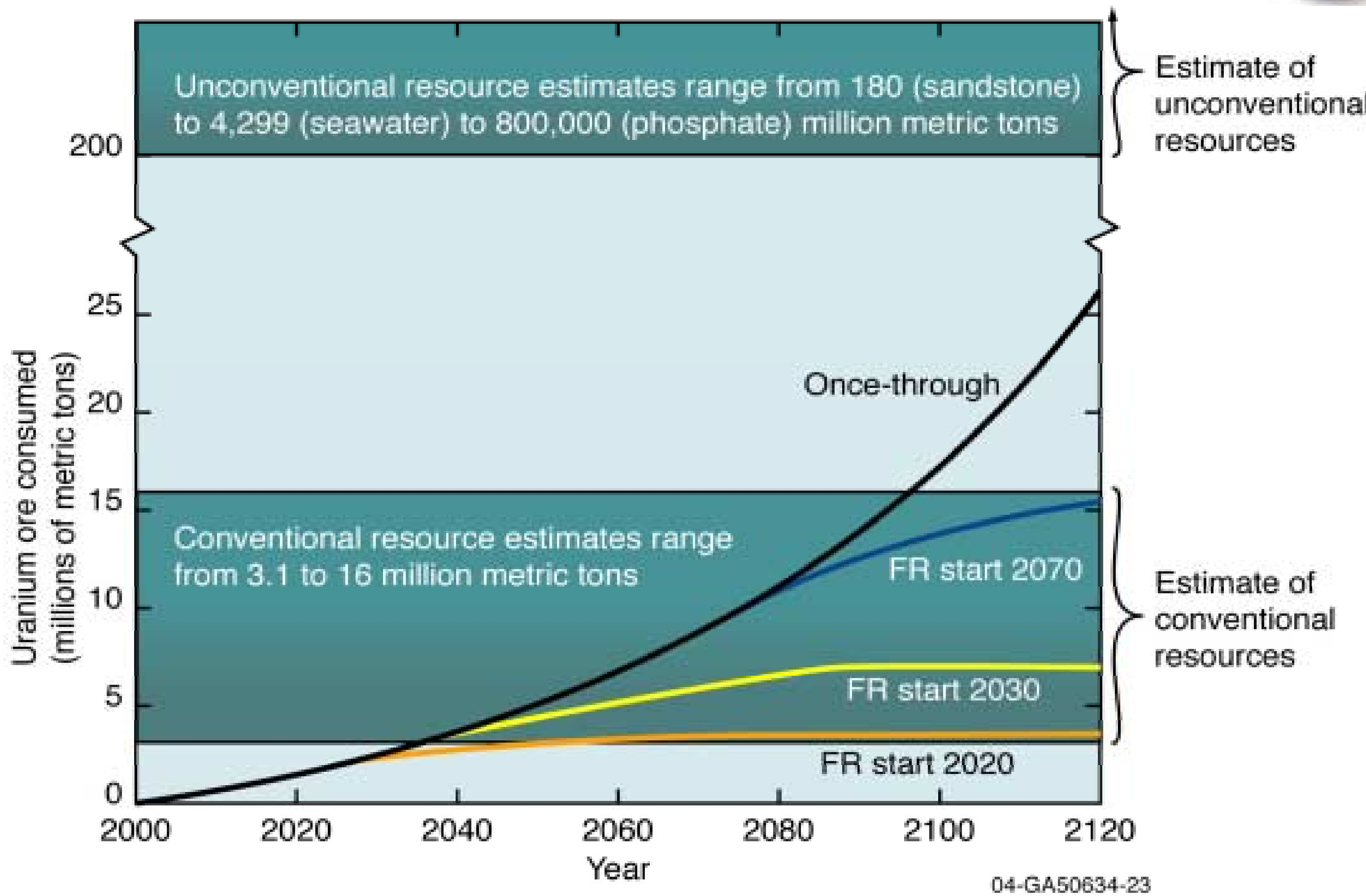
## *Repository Benefits*
## *Radiotoxicity for Limited/Continuous Recycle*



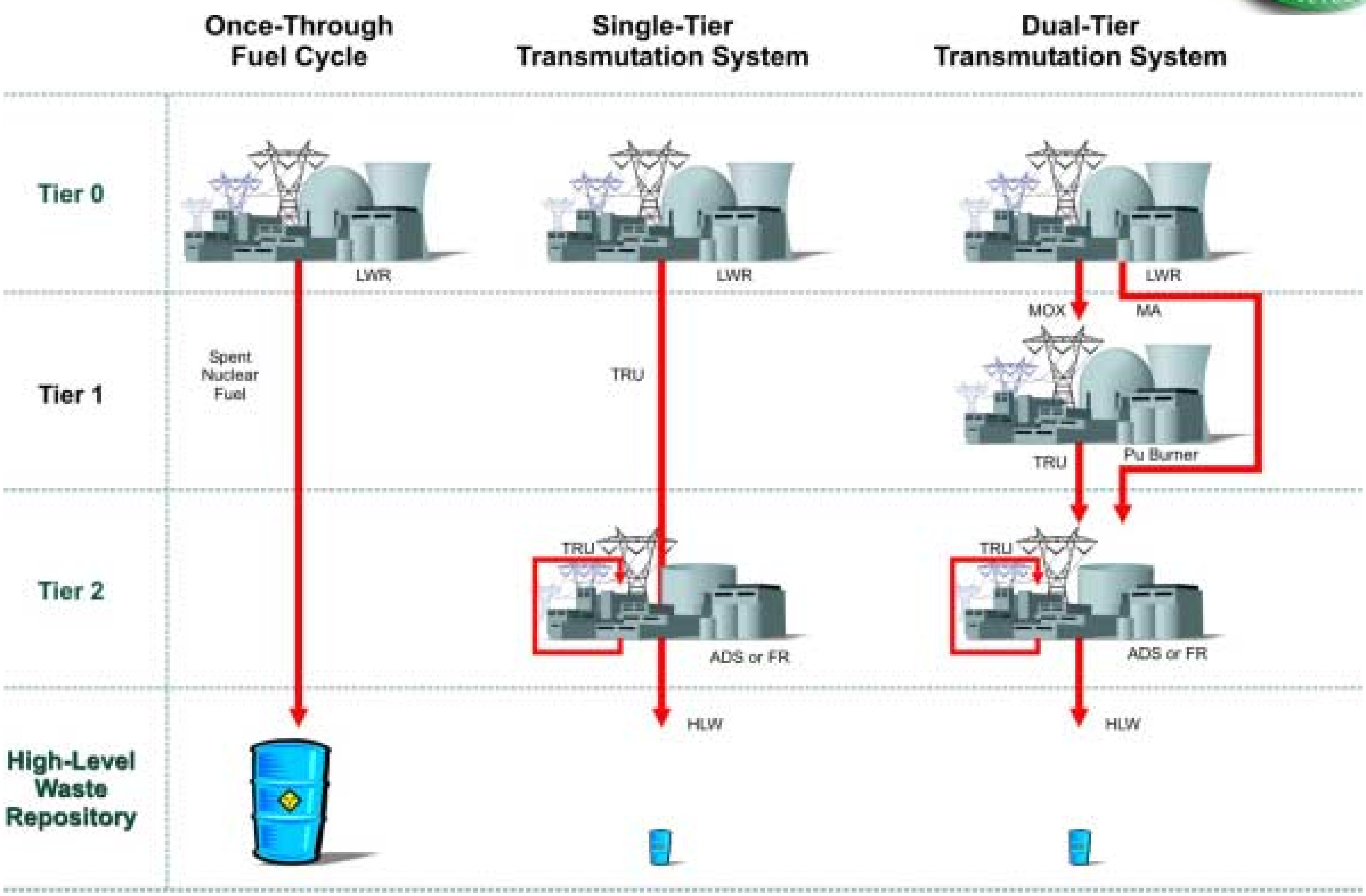
# Plutonium Management



# Impact of FR Deployment on Uranium Resource Needs



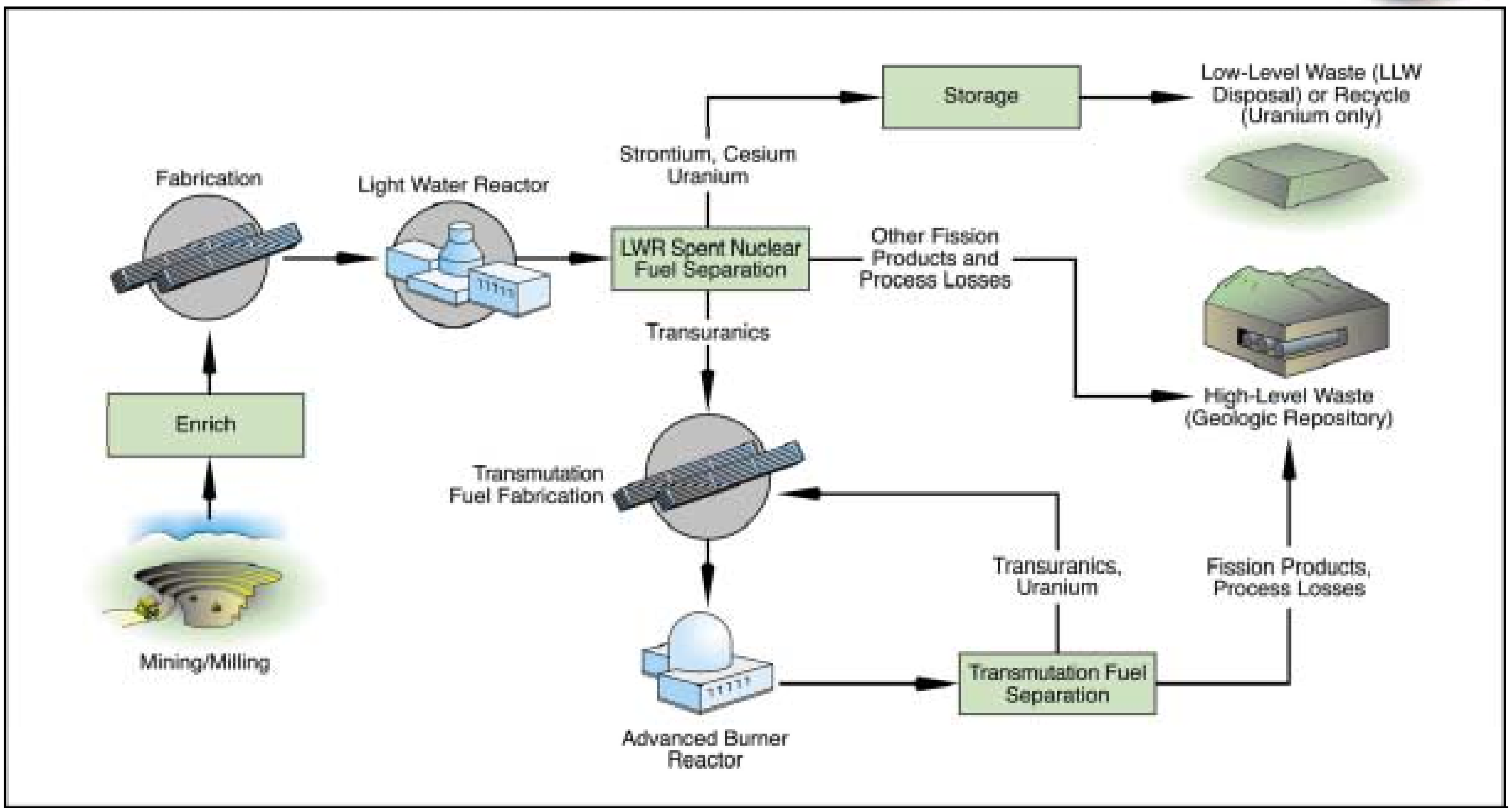
# *Transmutation System Approaches*



# GNEP Deployment Systems Requirements

- *The system must result in a significant improvement in repository utilization, preferably avoiding the need for a second geologic repository this century*
- *The system must optimize waste management including minimizing waste that needs to be handled or stored, and producing only solid waste with robust waste forms*
- *The system must make available the energy value of separated materials for future use*
- *The system must reduce proliferation risk*
- *The system must be deployable in a timeframe so as to reassert U.S. leadership, and influence fuel cycle development worldwide (20 years)*
- *The system must remain as economical as possible*
- *The system must be environmentally sound*

# GNEP Deployment System



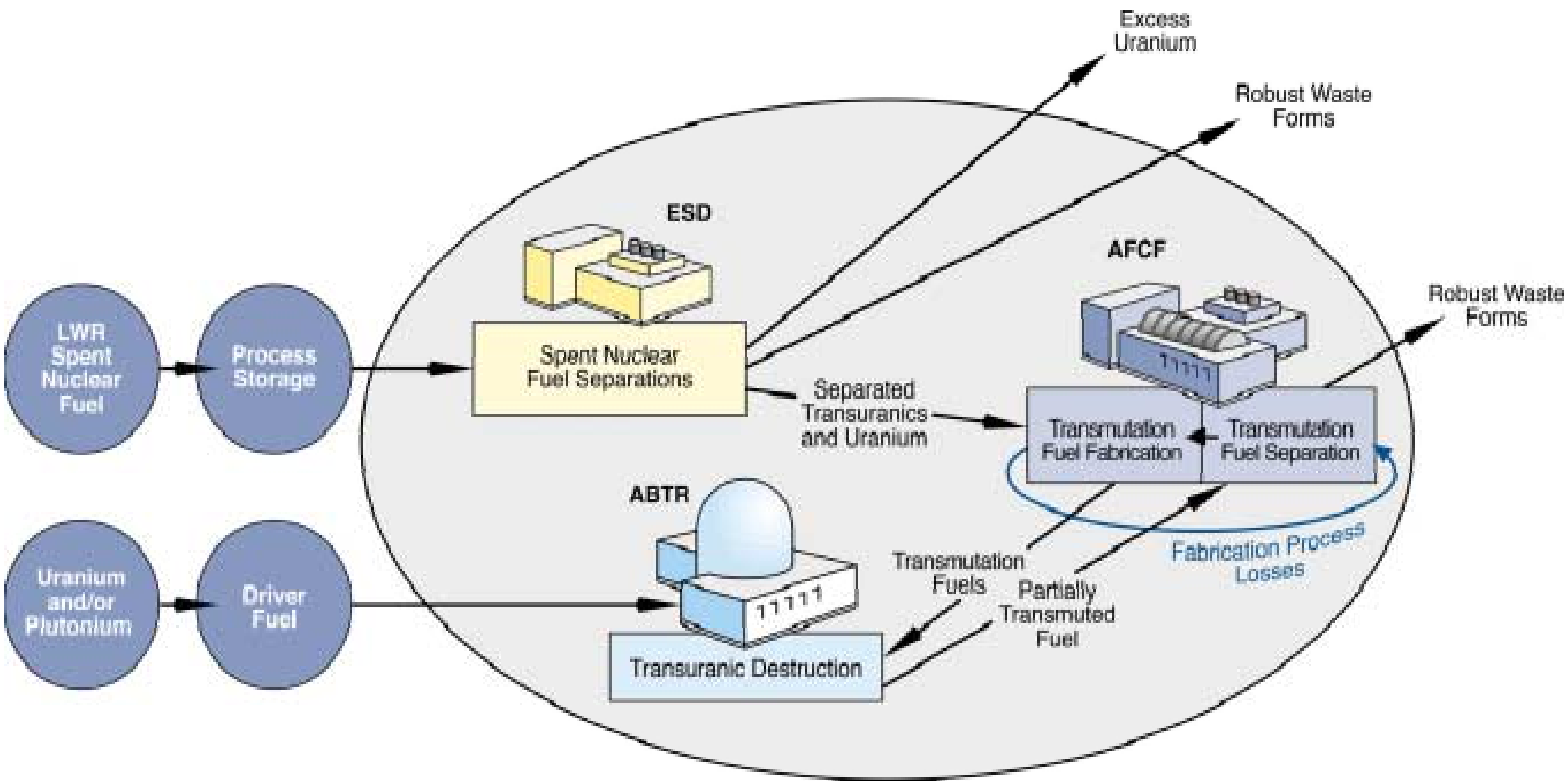
## Global Nuclear Energy Partnership Technology Demonstration (GNEP-TD)

- *GNEP Technology Demonstration Program*
  - *Focus on domestic demonstration of key technologies*
  - *International partnerships in technology development*
  - *Embedded university program*
- *5-year technology plan under development*
  - *10 labs involved*
- *Provision of intellectual basis for GNEP-TD decisions*
  - *Basis studies*

# *Technology Demonstration Program Approach*

- *Systems Integration*
- *LWR Spent Nuclear Fuel Separation Technologies*
- *Transmutation Technologies*
- *Transmutation Fuels and Separations Technologies*
- *Modeling and Simulation*
- *International Safeguards and Proliferation Risk Reduction*

# GNEP Technology Demonstration Facilities



# GNEP-TD Facilities

- ***Engineering-Scale Demonstration (ESD)***
  - *Demonstration of the UREX+1a process*
  - *Source of supply of transuranic elements for Advanced Burner Test Reactor*
  - *Suitable for process optimization*
  - *Size is to be determined from performance requirements*

- ***Advanced Fuel Cycle Facility (AFCF)***
  - *Demonstration of transmutation fuel fabrication and processing*
  - *Modular research laboratory*
    - Aqueous separations demonstration at up to 25 metric tons per year
    - Pyrochemical separations demonstration at >1 metric ton per year
    - Recycle fuel fabrication development and demonstration
    - Supporting R&D laboratories

- ***Advanced Burner Test Reactor (ABTR)***
  - *Demonstrate performance of transmutation fuel*
  - *Size is to be determined from performance requirements*

# Suite of UREX+ Processes

| *Process* | *Prod #1* | *Prod #2* | *Prod #3* | *Prod #4* | *Prod #5* | *Prod #6* | *Prod #7* |
|---|---|---|---|---|---|---|---|
| **UREX+1** | **U** | **Tc** | **Cs/Sr** | **TRU+Ln** | **FP** | | |
| **UREX+1a** | **U** | **Tc** | **Cs/Sr** | **TRU** | **All FP** | | |
| **UREX+2** | **U** | **Tc** | **Cs/Sr** | **Pu+Np** | **Am+Cm+Ln** | **FP** | |
| **UREX+3** | **U** | **Tc** | **Cs/Sr** | **Pu+Np** | **Am+Cm** | **All FP** | |
| **UREX+4** | **U** | **Tc** | **Cs/Sr** | **Pu+Np** | **Am** | **Cm** | **All FP** |

**Notes: (1) in all cases, iodine is removed as an off-gas from the dissolution process.**
**(2) processes are designed for the generation of no liquid high-level wastes**

**U: uranium (removed in order to reduce the mass and volume of high-level waste)**
**Tc: technetium (long-lived fission product, prime contributor to long-term dose at Yucca Mountain)**
**Cs/Sr: cesium and strontium (primary short-term heat generators; repository impact)**
**TRU: transuranic elements (Pu: plutonium, Np: neptunium, Am: americium, Cm: curium)**
**Ln: lanthanide (rare earth) fission products**
**FP: fission products other than cesium, strontium, technetium, iodine, and the lanthanides**

## Advanced Fuel Cycle Facility (AFCF) main mission is to develop and demonstrate advanced fuel recycling technologies

- *Cost effective alternatives for high level nuclear waste management in the form of advanced closed fuel cycles.*
- *Advanced proliferation-resistant fuel recycling technologies including chemical processing and fuel fabrication.*
- *Advanced safeguards including advanced instrumentation for materials protection, control and accountability (MC&A), and advanced control and monitoring systems.*

## Advanced Burner Test Reactor: A Key Component of GNEP-TD

- *Thermal reactors only suited for limited transmutation*
- *The role of thermal reactors for transmutation in the US is strongly reduced by the policy that avoids separation of pure plutonium, and the lack of a specific US infrastructure*
- *Fast reactors can effectively destroy all transuranics*
  - *Proliferation issue*
  - *Waste issue*
- *GNEP-TD will focus on fast reactor recycling*
- *Major challenges*
  - *TRU fuels and reprocessing*
  - *Cost reduction*
  - *Demonstration of passive safety*

# GNEP-TD Key Milestones and Planning Dates

- *EIS Record of Decision (6/08)*
- *Secretarial Decision on proceeding with demonstration (6/08)*
- *ESD operational (2011-2015)*
- *ABTR operational (2014-2019)*
- *AFCF operational (2016-2019)*

*DATES PROVISIONAL—To be determined through Technology Development plan*

# *The Global Partnership is Under Development*

Countries Approached by U.S. to be possible Fuel Cycle States

Japan – active follow-up
France – active follow -up
Russia – active follow - up
United Kingdom (In midst of Government Energy Study)
China (Follow-up being arranged)

~ 40 Countries briefed at International Atomic Energy Agency

Science Attaches briefed in DC

Detailed Discussion with Canada, South Korea

International Response Positive

# Summary

- *The GNEP Technology Demonstration Program*
  - *LWR spent fuel separations*
  - *Transmutation*
  - *Transmutation fuel separations and fabrication*
- *Key challenges exist for each technology demonstration*
  - *Separations efficiencies*
  - *Acceptable costs for fast reactors*
  - *Transmutation fuels*
- *A successful GNEP Technology Demonstration Program will require the expertise at national laboratories, universities, and industry*
- *GNEP will develop and demonstrate technologies that enable the transition to a stable, long-term, environmentally, economically, and politically acceptable advanced fuel cycle*