The Global Nuclear Energy Partnership

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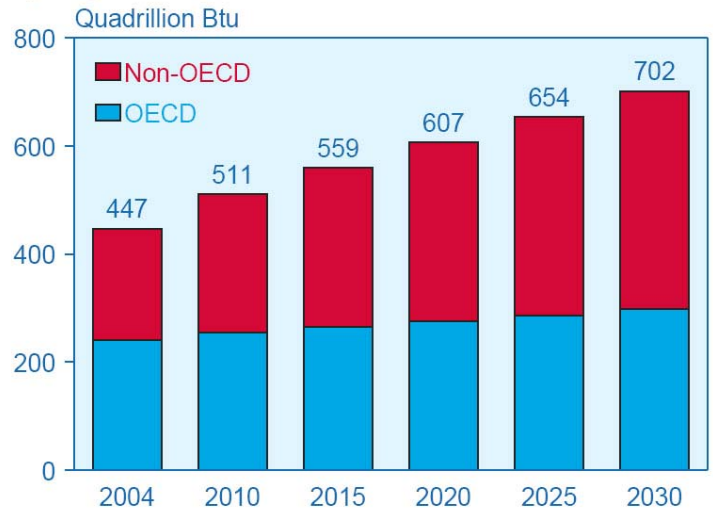
Outline

- Global Energy Demand and GNEP
- GNEP
- gNEP
- Approach

World energy demand is growing substantially

- **World energy consumption is predicted to increase by 57 percent through 2030.**
- **Total energy consumption in non-OECD countries will increase by 95 percent compared to 24% in OECD.**
- **Supply and price of natural gas and volatility of oil prices add uncertainty to their use.**
- **Mitigating global climate change requires lowering greenhouse gas emissions.**

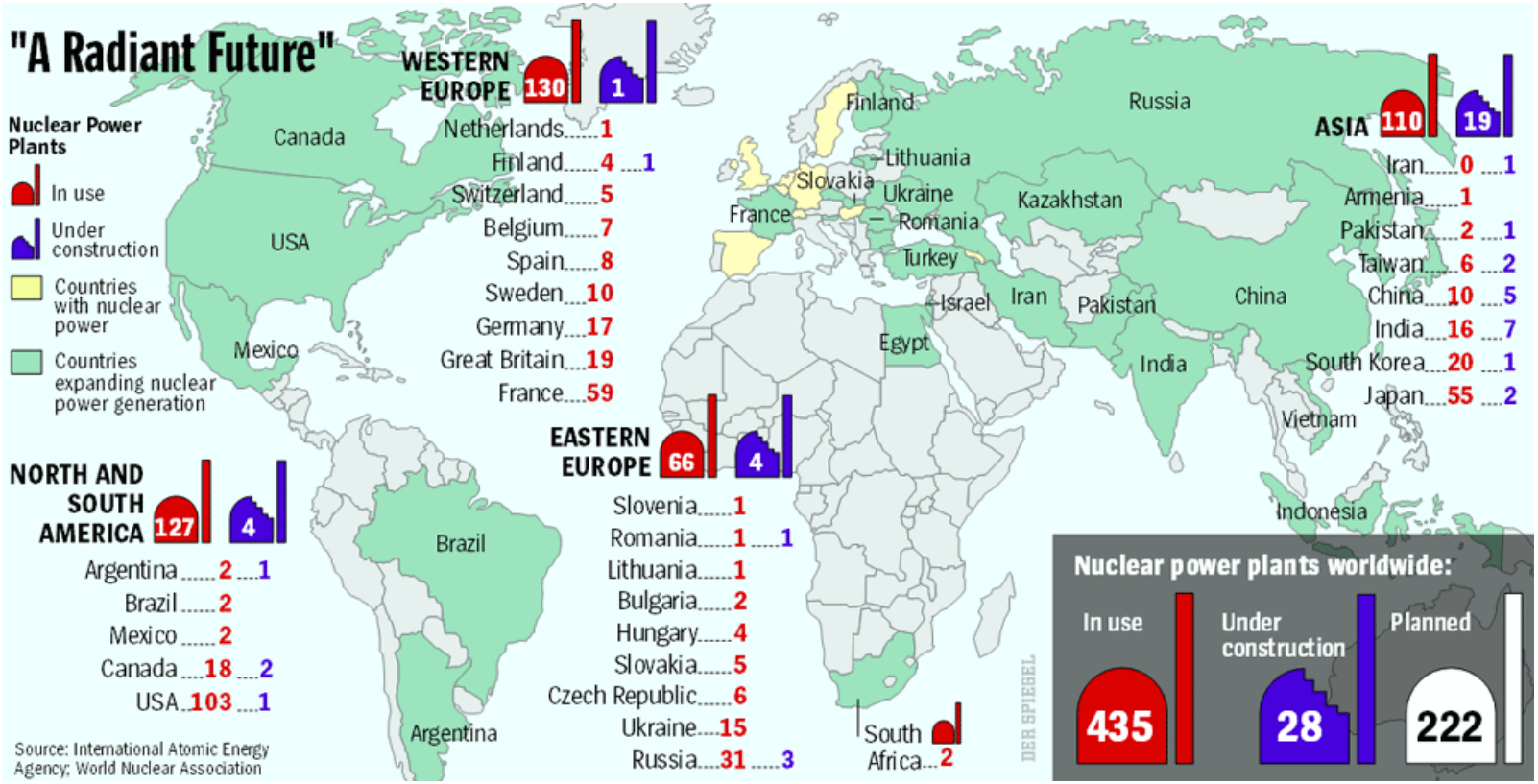
World Marketed Energy Consumption by Region, 2004-2030



Sources: **2004:** Energy Information Administration (EIA), *International Energy Annual 2004* (May-July 2006), web site www.eia.doe.gov/iea. **Projections:** EIA, System for the Analysis of Global Energy Markets (2007).

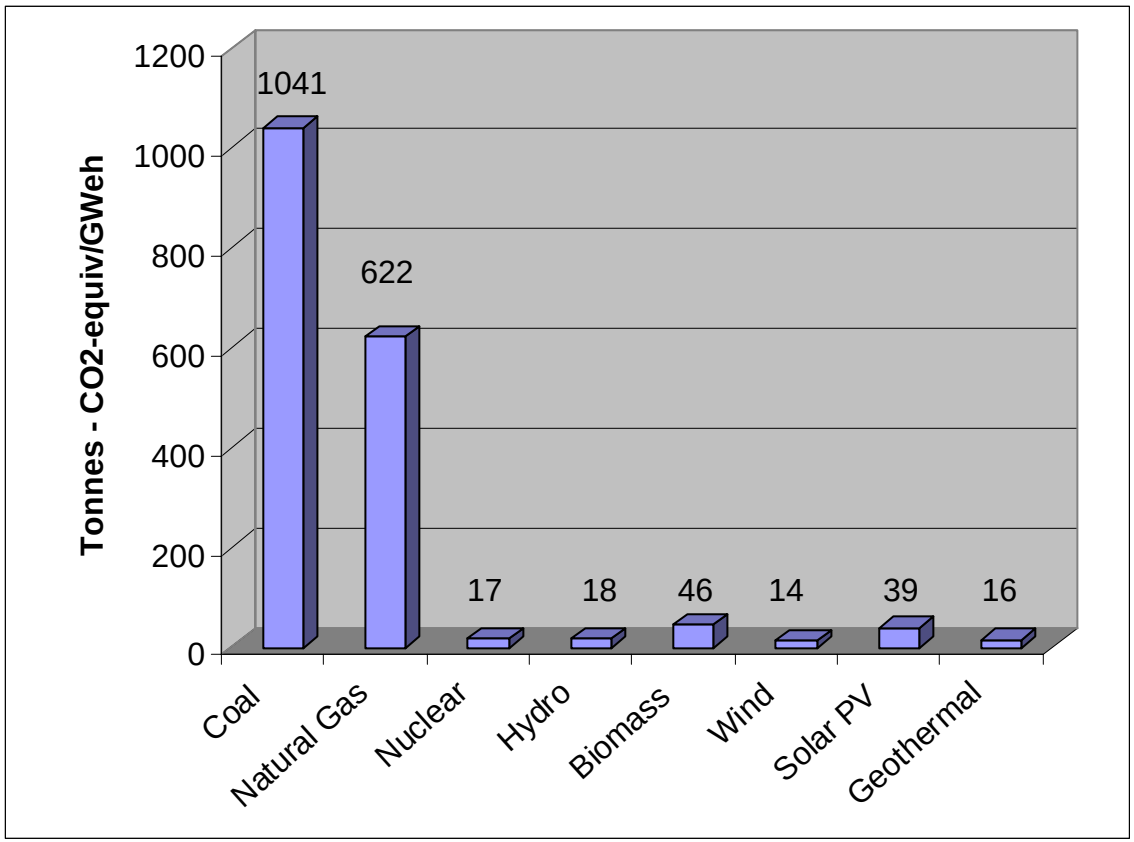
The world is turning increasingly to nuclear energy for sustainable development

Nuclear power is expanding internationally to help meet the growing demand



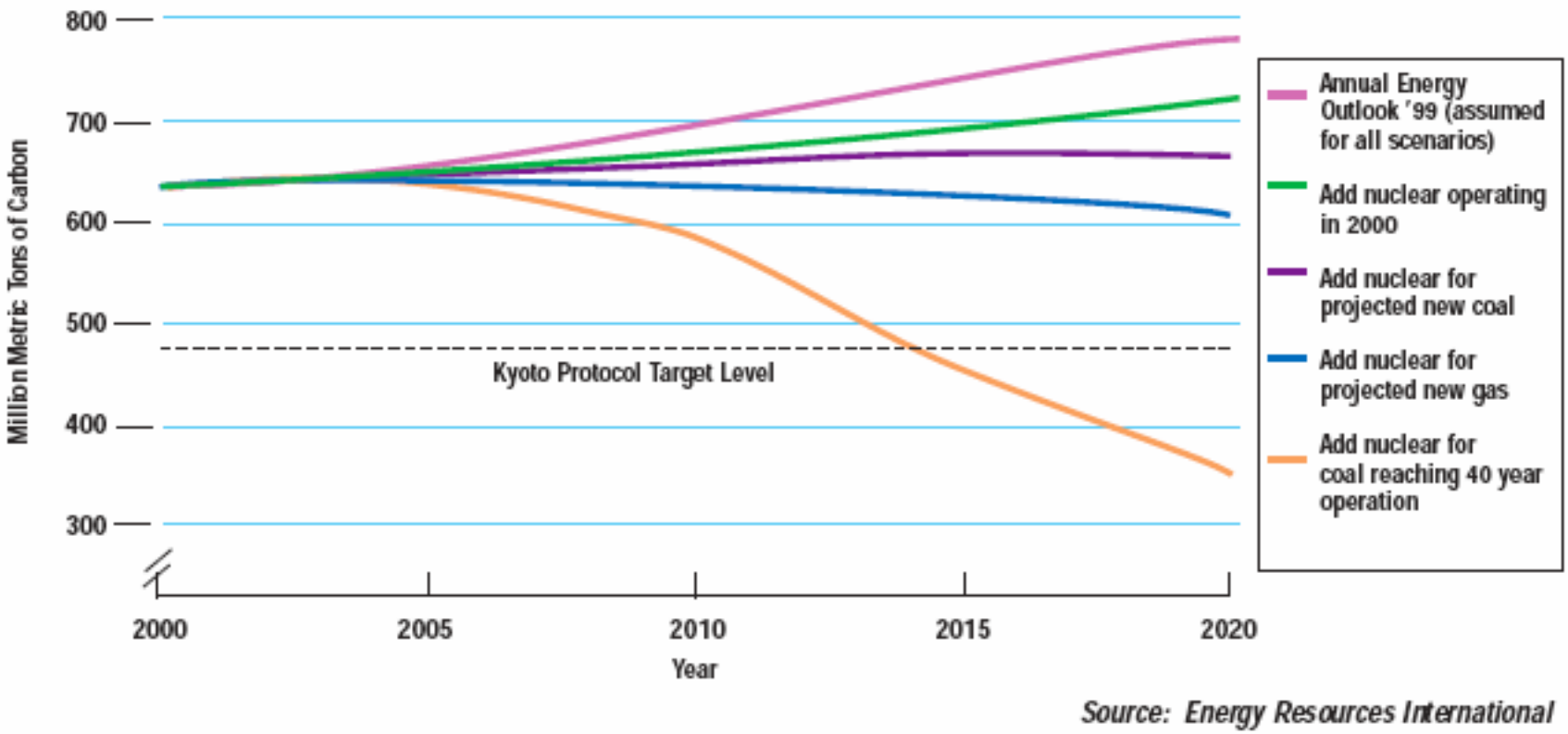
http://www.spiegel.de/international/spiegel/0,1518,460011,00.html

Nuclear energy is among the lowest greenhouse gas sources of electricity



Source: "Life-Cycle Assessment of Electricity Generation Systems and Applications for Climate Change Policy Analysis," Paul J. Meier, University of Wisconsin-Madison, August, 2002.

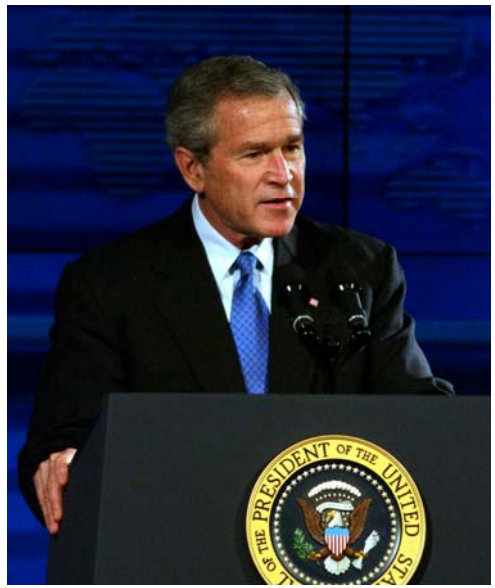
The expansion of nuclear energy is key to reducing greenhouse gases



From: Meeting Our Clean Air Needs with Emission-Free Generation, from the Nuclear Energy Institute

The Global Nuclear Energy Partnership was launched in February 2006 as part of the President's Advanced Energy Initiative

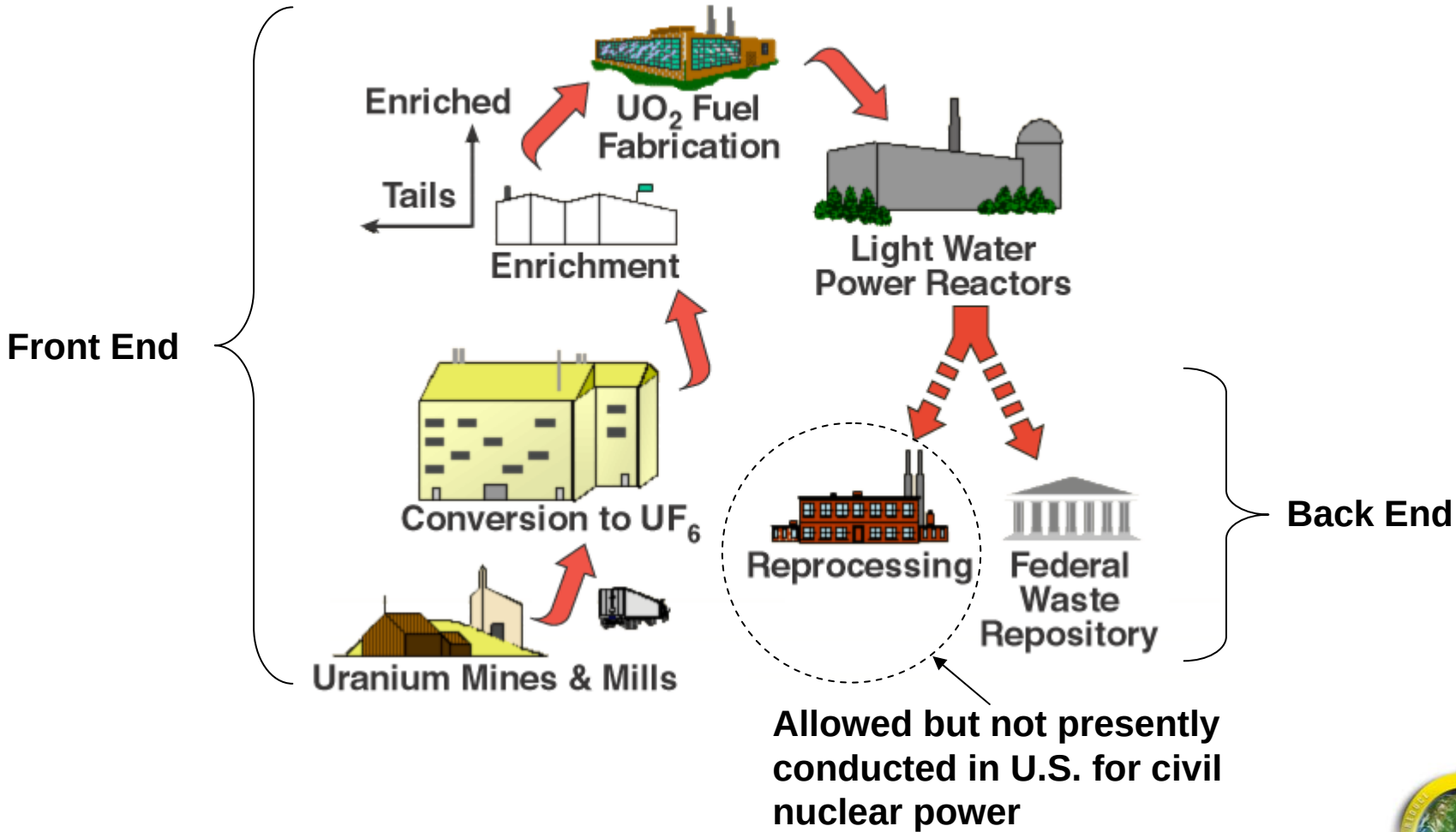
- **GNEP proposed to establish the foundation for safe and secure expansion of nuclear energy in the U.S. and worldwide**
- **FY 2007 funding of $167.5M**
- **FY 2008 budget proposes $405M, including $10M for safeguards technologies**



"…my Administration has announced a bold new proposal called the Global Nuclear Energy Partnership…we will develop and deploy innovative, advanced reactors and new methods to recycle spent nuclear fuel."

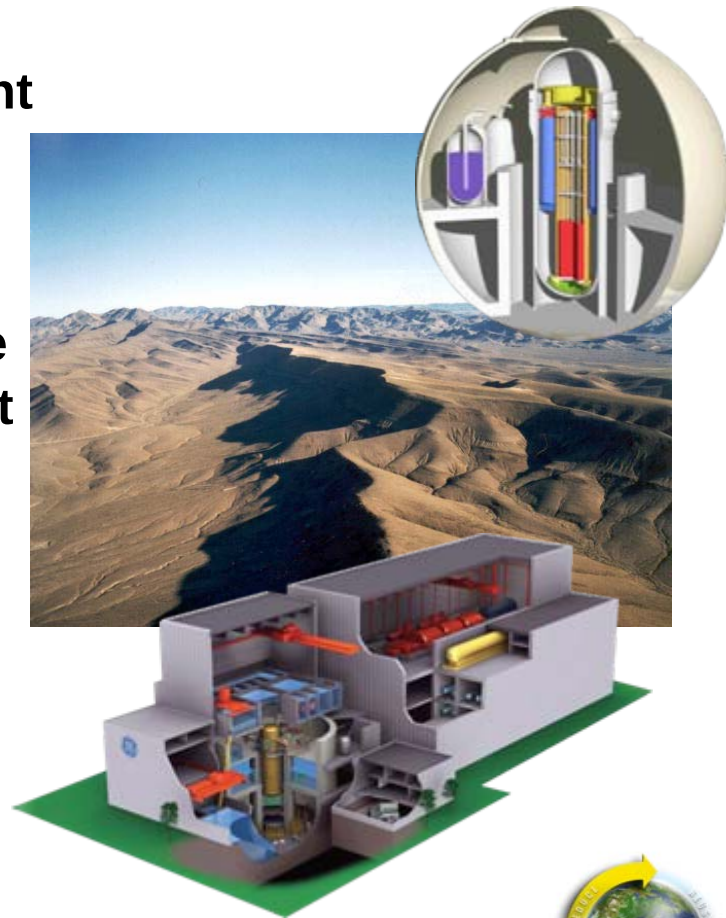
The Nuclear Fuel Cycle Refers to the Collection of Activities Necessary for Nuclear Energy

Once-Through or Open Nuclear Fuel Cycle



GNEP enables safe and secure expansion of nuclear power worldwide by:

- Facilitating global deployment of nuclear power through responsible stewardship
- Developing advanced proliferation-resistant spent nuclear fuel recycling technologies
- Improving nuclear waste management
- Developing advanced reactors to consume transuranic elements separated from spent fuel.
- Establishing reliable international fuel services
- Developing enhanced nuclear safeguards
- Supporting grid-appropriate exportable reactor development and deployment



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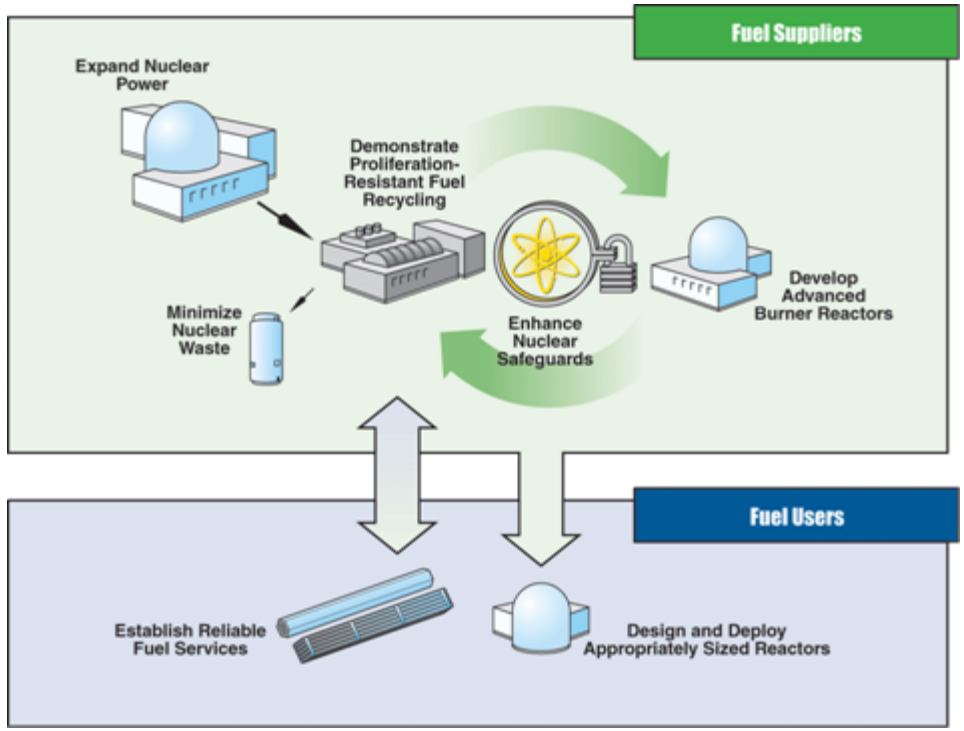
Key international elements of GNEP augment and support nonproliferation efforts

- **Fuel Suppliers:** Operate reactors and fuel cycle facilities, including fast reactors to transmute the actinides from spent fuel into less toxic materials
- **Fuel Users:** Operate reactors, lease and return fuel
- **IAEA:** Provide safeguards and fuel assurances, backed up with a reserve of nuclear fuel for states that do not pursue enrichment and reprocessing



GNEP makes diversion and misuse of fissile materials more difficult, more costly, and acquisition of sensitive fuel cycle technologies more difficult to justify as part of a peaceful nuclear program

GNEP has three international engagement pathways

- **Policy Engagement**
  - Establish bilateral and multilateral partnerships based on GNEP principles, including fuel supplier, fuel recipient and prospective recipient countries
- **Framework Development**
  - International fuel assurance system that includes:
    - *Reliable fuel leasing mechanisms between fuel suppliers and users;*
    - *Emergency fuel banks/reserves in the event of an interruption in supply.*
- **Technical Collaboration**
  - Advanced fuel cycle cooperation (only with established fuel cycle countries)
  - Grid-Appropriate Reactors (small and medium size, 10-350 Mwe);
  - Infrastructure development for countries interested in nuclear power

GNEP has strong International support

- **GNEP has engaged with advanced fuel cycle countries, reactor and candidate reactor countries since the February 2006 announcement**
  - (e.g., Russia, China, France, UK, Japan, South Korea, Canada, Australia, Germany, Argentina, Brazil, Indonesia, Philippines, Ukraine, Nigeria, Ghana, South Africa, Vietnam, Malaysia, Poland, Bahrain, Jordan, and Mexico)
- **US and 5 other supplier nations proposed a reliable fuel supply initiative at the IAEA in September 2006**
- **Co-Sponsored IAEA Workshop on Infrastructure Needs for Developing Countries in December 2006**
- **Bi-Lateral Civil Nuclear Cooperation Agreements in place with Russia and Japan**

The global partnership is taking shape

- **France, Japan, China, and Russia, with UK and IAEA observers held a Ministerial meeting with the U.S. Secretary of Energy on May 21, 2007 in Washington, DC to state support for GNEP**

- **In a joint statement in May, the Partnership pledged to broaden the participation to other nations. Plans for that are underway.**

Energy Ministers at May 21, 2007 GNEP Meeting in Washington DC

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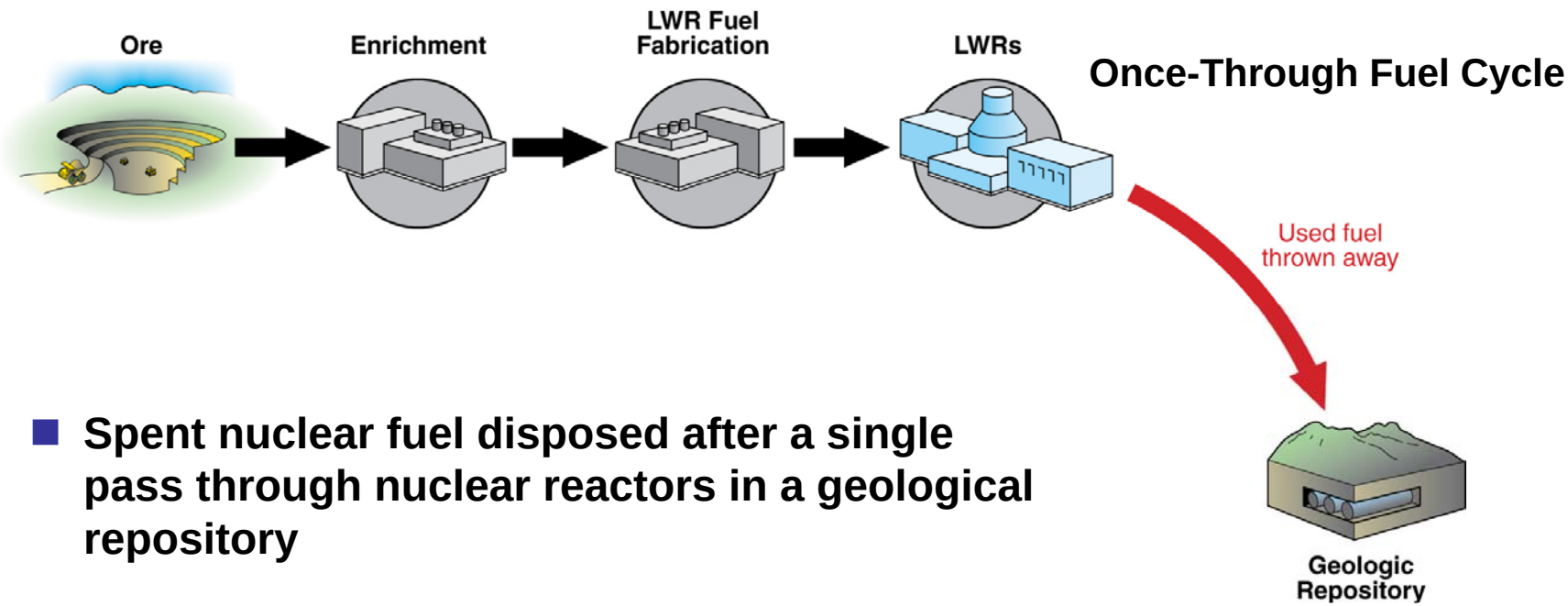
The domestic elements of GNEP and NP2010 advance nuclear energy in the U.S. through work to:

- **Expand nuclear power to help meet growing energy demand in an environmentally sustainable manner.**

- **Develop, demonstrate, and deploy advanced technologies for recycling spent nuclear fuel that**
  - *Do not separate plutonium, and*
  - *Simplify the disposition of nuclear waste, thereby helping to minimize the number of geologic repositories in the United States through the end of this century.*

- **Develop, demonstrate, and deploy fast reactors that consume transuranic elements (TRU) from recycled spent fuel.**

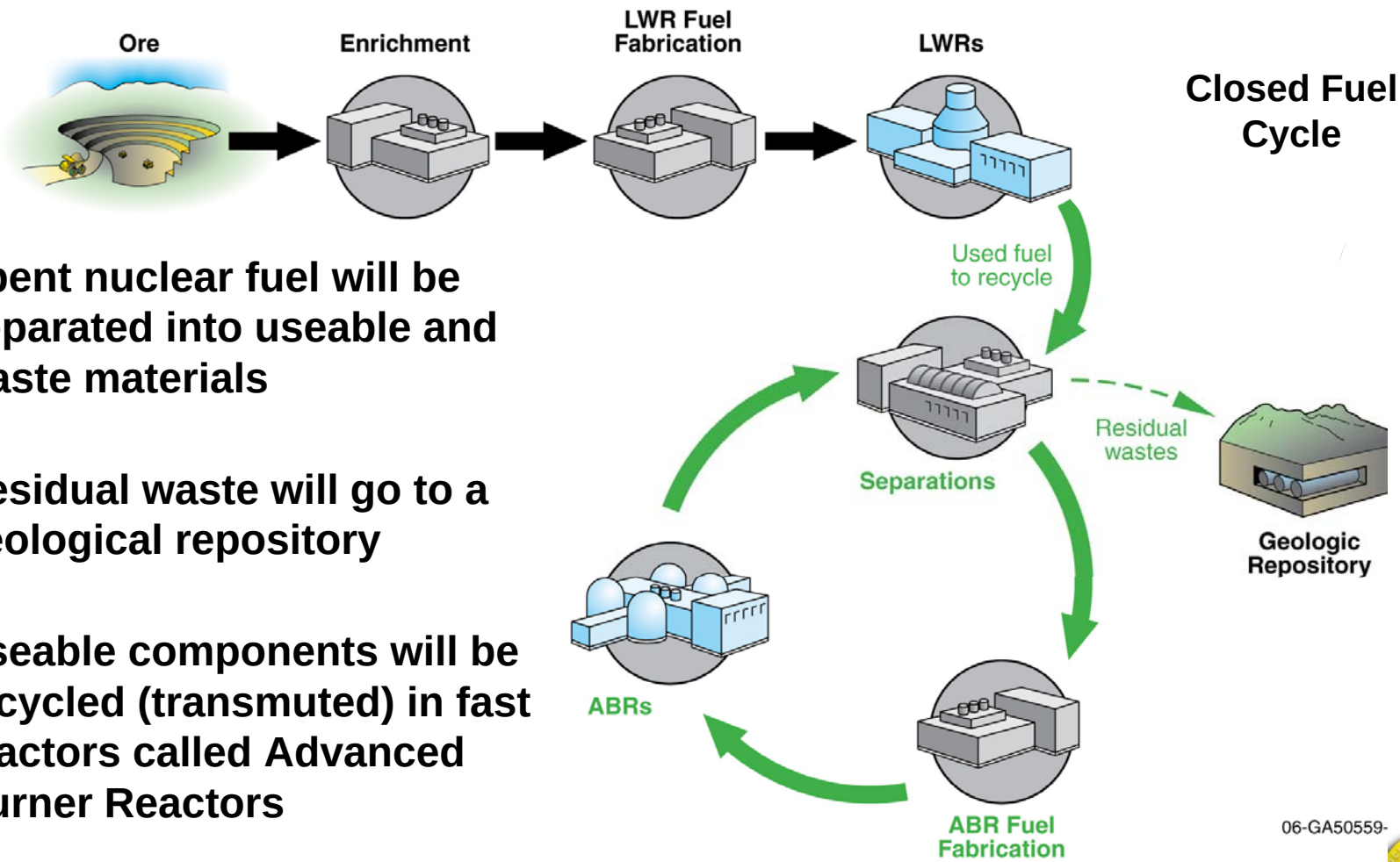
At Present the U.S. Has a Once-Through Fuel Cycle



- Spent nuclear fuel disposed after a single pass through nuclear reactors in a geological repository
- If nuclear power increases as predicted, the U.S. will need multiple repositories by the end of the century with the once-through fuel cycle

06-GA50559-02

GNEP will move the U.S. from a once through to a closed or recycling fuel cycle

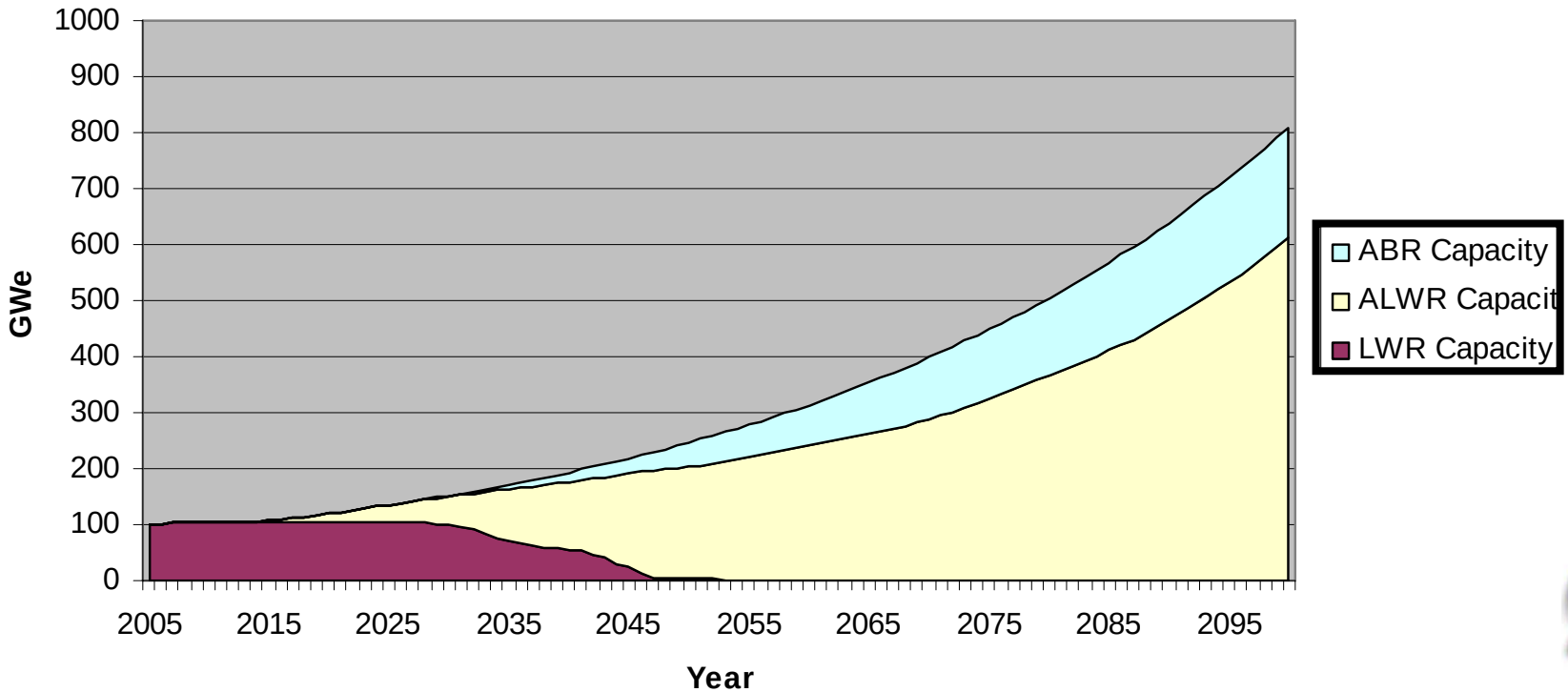


- Spent nuclear fuel will be separated into useable and waste materials
- Residual waste will go to a geological repository
- Useable components will be recycled (transmuted) in fast reactors called Advanced Burner Reactors

At equilibrium, there must be multiple fast recycling reactors supporting the LWR or ALWR fleet

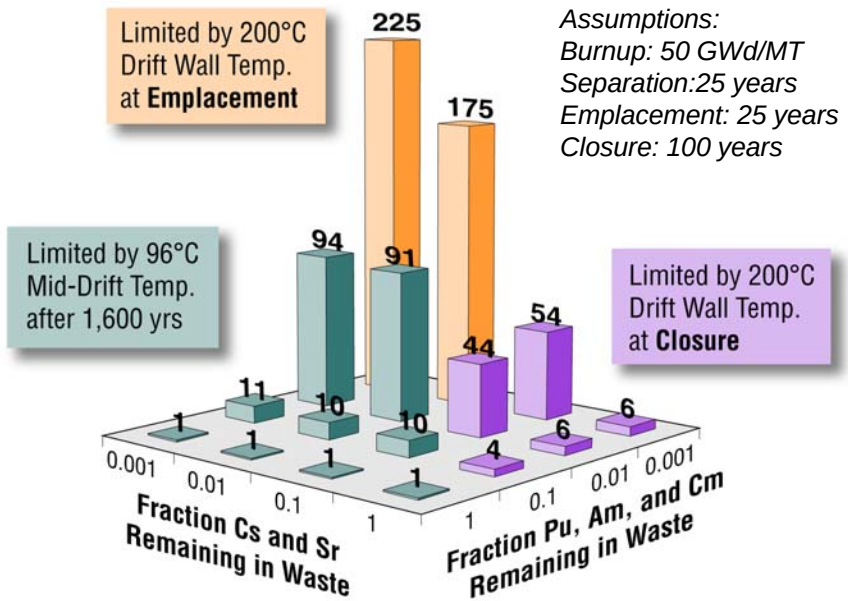
- **GNEP has performed systems analyses of various deployment scenarios, including single and multiple tier LWR Pu + U (MOX) with FR systems.**

- **In this example, nuclear energy is assumed to increase by 2.4%/year, requiring roughly 1/4 of the nuclear generating capacity from ABRs in 2100.**



Potential benefits of closed fuel cycle include improved waste management

- **Spent nuclear fuel separated into reuseable materials and waste, allows potentially large gains in repository loading**
  - Uranium can be re-enriched
  - Plutonium, americium and curium can be recycled using fast reactors
  - Cesium and strontium removed before geologic disposal



Potential Drift Loading Increase Factor for Spent LWR Fuel

- **Yucca Mountain needed regardless of fuel cycle scenario**

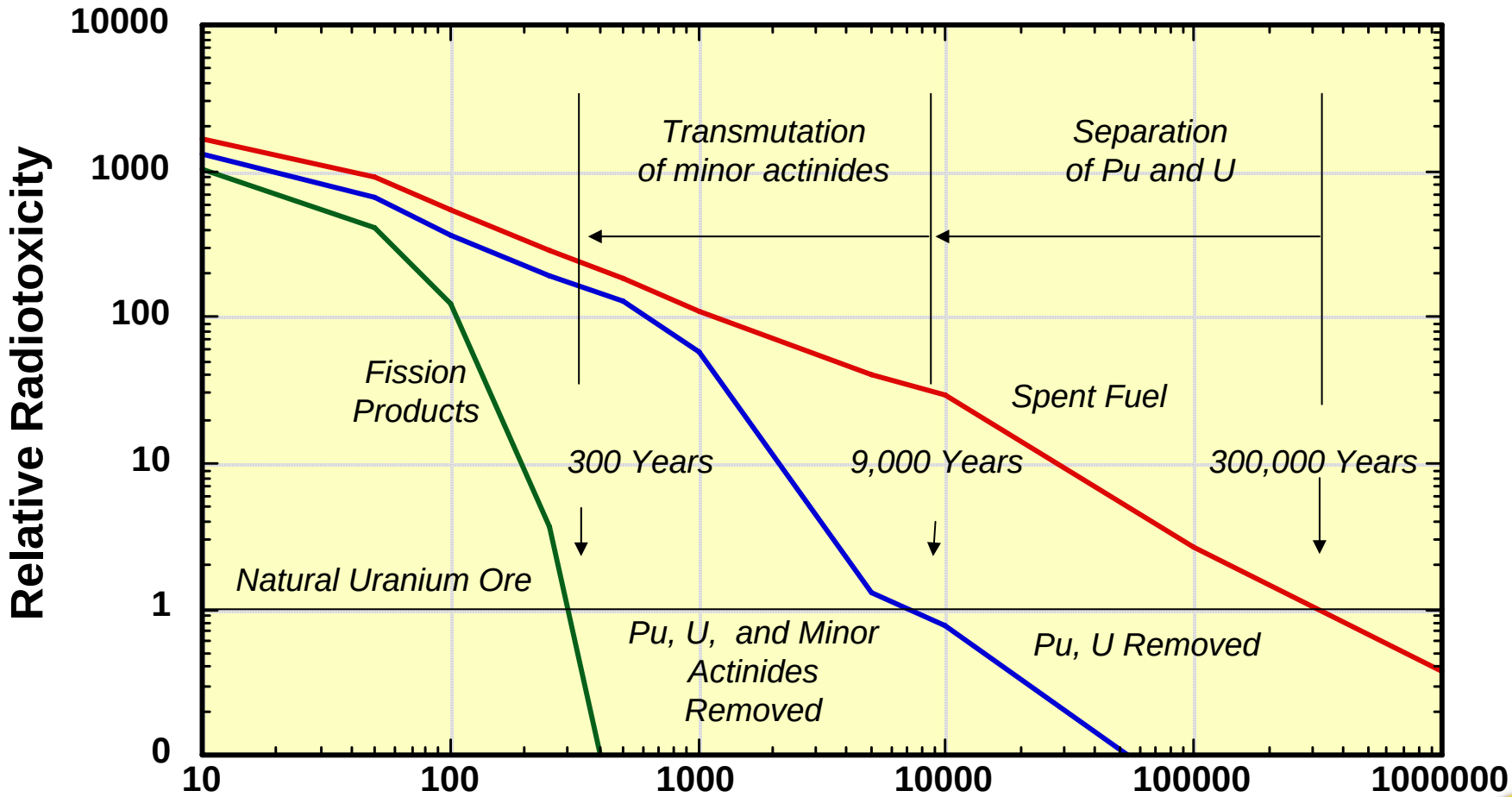
GNEP strategy will also enable greater utilization of energy content contained in nuclear fuel

GNEP requires an integrated waste management strategy

- **Aimed at determining and optimizing the waste management benefit of GNEP**
- **To be applied to all GNEP facilities for maximum waste reduction**
- **Determine the appropriate waste form and disposition pathway, including:**
  - Best existing technical approaches and need for further R&D
  - Similar approaches for identical or similar waste streams
  - Input to process and facility designs
- **Transportation issues also addressed – advanced remote tracking and monitoring technology development**

Our goal is for all waste to have a pathway for permanent disposal with no long-term storage of liquid wastes.

Separation and transmutation can greatly reduce long-term radiotoxicity of waste material



LWR Fuel 50 GWd/MT, 5 Years Cooling

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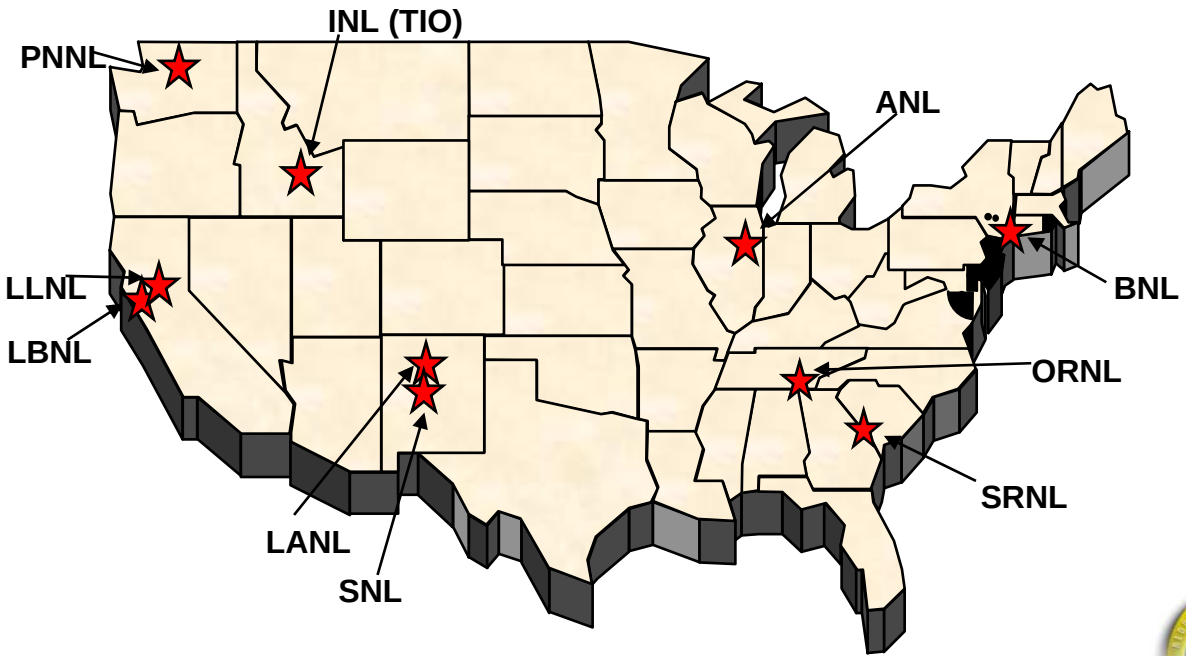
GNEP is taking specific near term actions

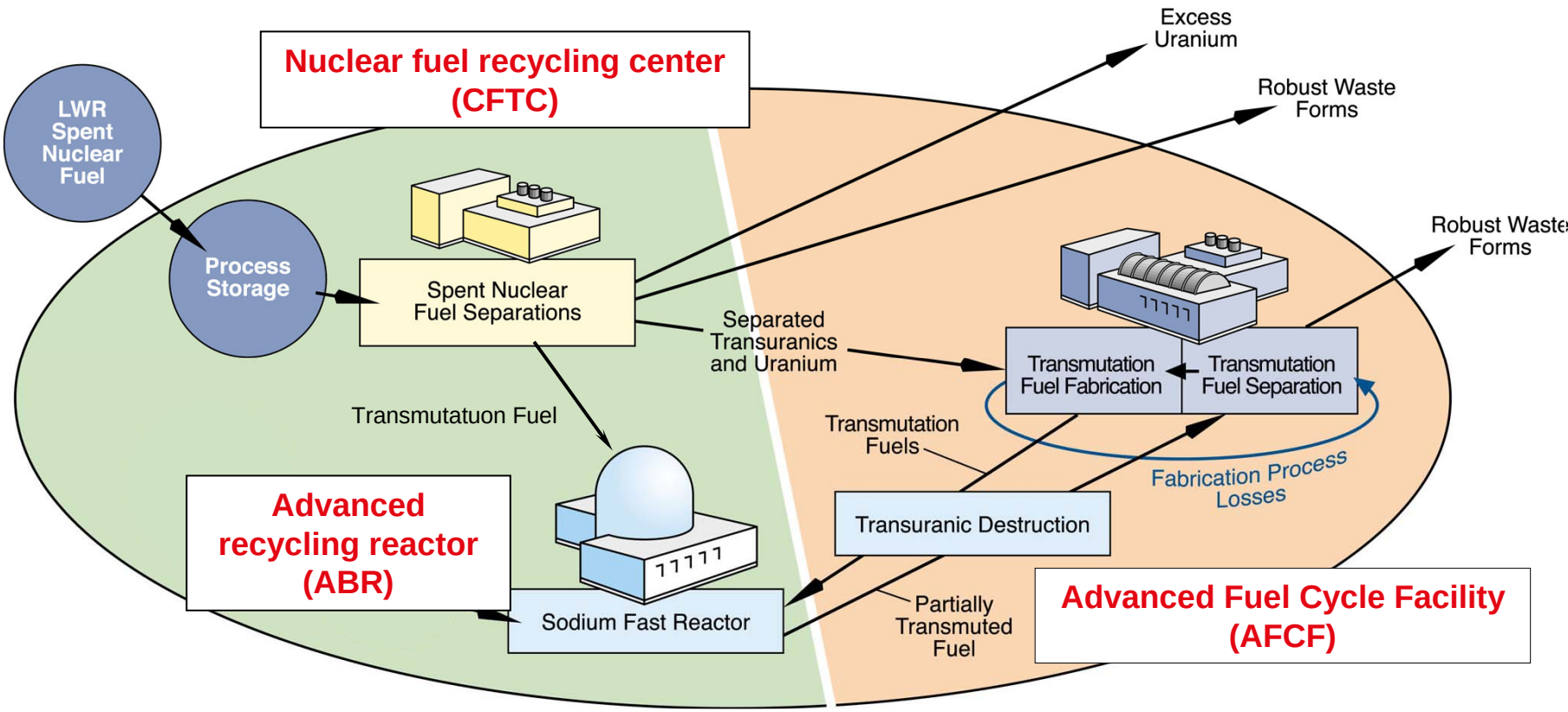
- Obtain input from U.S. and international industries and governments on how best to bring the needed GNEP facilities into being, what technology and policy issues must be resolved, and what business obstacles must be overcome.
- Pursue industry participation in the development of conceptual design studies and economic studies that support the nuclear fuel recycling center and advanced recycling reactor implementation for GNEP
- Develop a detailed GNEP technology roadmap for demonstrating solutions to the remaining technical issues in order to support commercial GNEP facilities.
- Prepare a programmatic GNEP Environmental Impact Statement.
- Prepare a decision package for the Secretary of Energy for a 2008 decision

The GNEP R&D Program Uses Resources Across the Nation

- **R&D mission**
  - Support for technology development needs of GNEP facilities
  - Long-term development of advanced separations, transmutation fuel and recycle technologies along with validated simulation and computational techniques to advance the development and approval of fuel cycle technology.
- **Ten national laboratories are engaged in the GNEP R&D program**
- **A university supporting research program started in FY07**



Initially GNEP envisions three facilities

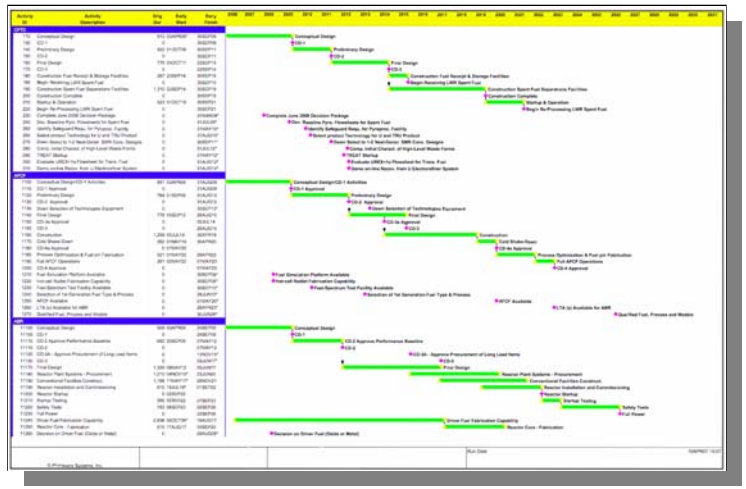


Industry led with national laboratory, university and international participation

National laboratory led with NRC, industry, university and international participation

R&D work underway is addressing advanced recycling technical issues

- **Integrated waste management strategy**
  - Design and manage all waste streams to greatly reduce the environmental impact associated with SNF
    - *Well defined waste streams*
    - *Destruction of key isotopes*
    - *Robust waste forms*
- **Separations technologies that support integrated waste management strategy**
  - Very high recovery factors and product purity
  - Partition spent fuel constituents into elements for recycling, decay, and disposal
  - Scale-up to large throughputs



GNEP Integrated Technology Development Schedule

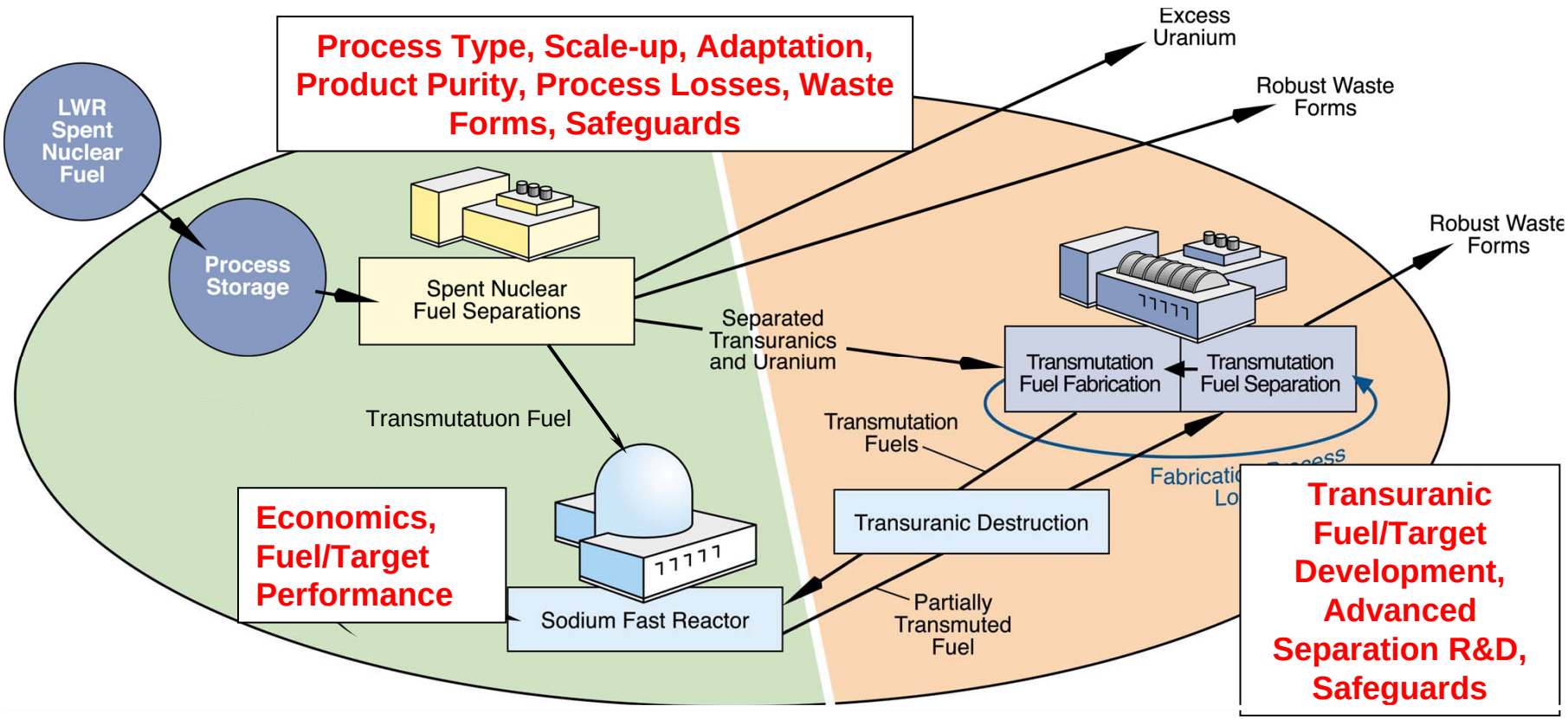
R&D work underway is addressing advanced recycling technical issues

- **Fuel forms or targets that enable destruction of transuranics in fast reactors**
  - Remote fabrication
  - Performance under irradiation
- **Reactors that also enable the destruction of transuranics**
  - Sodium cooled fast reactors designed for that purpose
  - Focus on cost reduction
- **Safeguards technologies that provide for enhanced proliferation resistance**
  - Detection and control technologies
  - Safeguards by design

Advanced Experimental Fuel Counter- MTR/IRT fresh/spent Active and passive mode

Technology challenges can be addressed through innovative design features, design simplification and the use of advanced simulation and modeling techniques

Future recycling technology work will be greatly enhanced using the planned facilities



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A National Environmental Policy Act analysis is underway for GNEP

- **GNEP Programmatic Environmental Impact Statement (PEIS)**
  - assess reasonable alternatives
  - analyze potential environmental impacts
  - assist DOE decision-making
- **GNEP Siting Studies**
  - Stakeholder interest in hosting one or both commercial-scale facilities
  - 11 grant applications funded
  - 9 states (ID, IL, KY, NM, OH, SC, TN, UT, WA)
  - Both DOE and non-DOE sites proposed

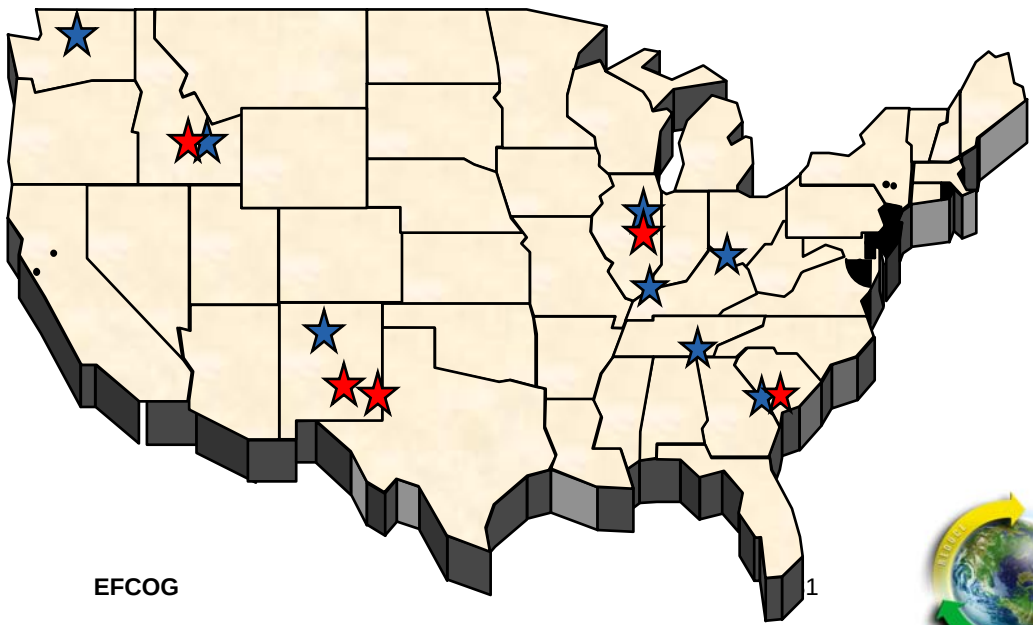
Thirteen site alternatives are under examination

DOE Sites

- Argonne National Laboratory (IL)
- Hanford (WA)
- Idaho National Laboratory (ID)
- Los Alamos National Laboratory (NM)
- Oak Ridge Reservation (TN)
- Paducah (KY)
- Portsmouth (OH)
- Savannah River National Laboratory (SC)

Non-DOE Sites

- Atomic City, ID
- Barnwell, SC
- Hobbs, NM
- Morris, IL
- Roswell, NM

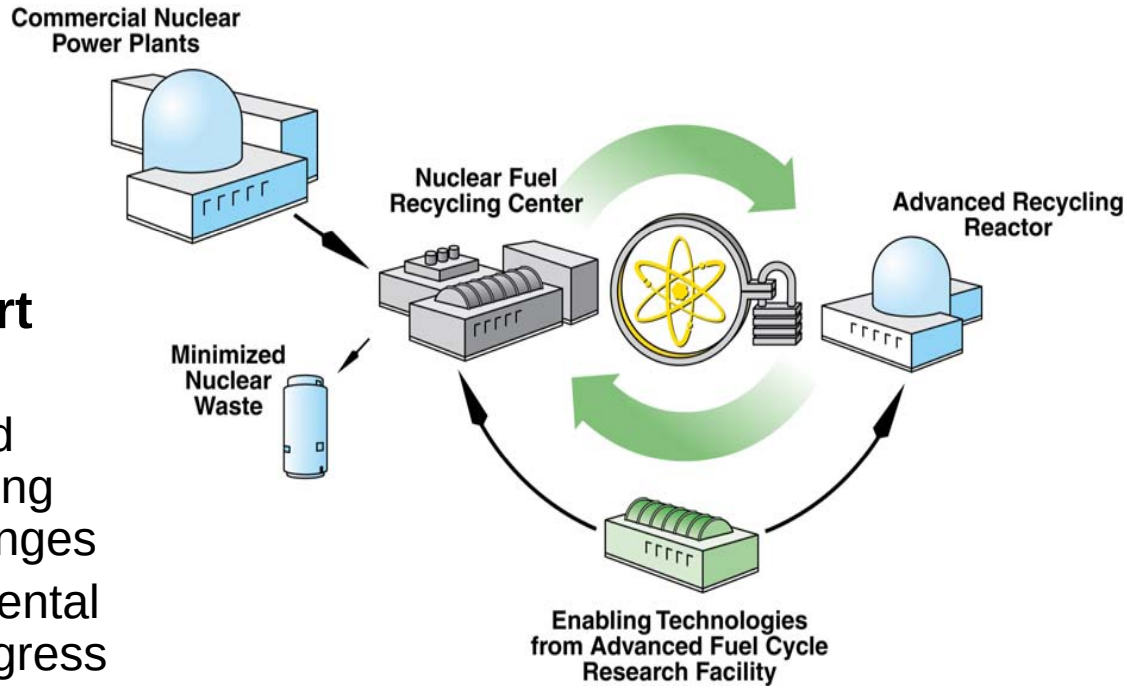


Industry will lead GNEP technology deployment studies

- **Scoping studies were completed last year as part of an Expression of Interest process**
- **Deployment studies will be funded through a Funding Opportunity Announcement to address:**
  - Business plan
  - Technology development roadmap
  - Conceptual design studies
  - Communications plan
- **4 awards anticipated by September 2007**
  - AREVA Federal Services, LLC,
  - EnergySolutions, LLC
  - GE-Hitachi Nuclear Americas, LLC, and
  - General Atomics

Summary

- **International support for GNEP is strong and moving forward**
- **There is significant effort underway**
  - National laboratories and universities are responding to key technology challenges
  - Programmatic Environmental Impact Statement in progress
  - Industry-led deployment studies soon to be launched



- **GNEP is addressing the challenges needed to ensure sustainability of the nuclear power renaissance**