

The Global Nuclear Energy Partnership – Challenges and Opportunities for Nonproliferation and International Security

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Technology for the Future Nuclear Fuel Cycle
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Outline

- **Global Energy Demand and GNEP**
- **Existing International Nonproliferation R&D Program**
- **Safeguards Campaign**
- **Research and Technology Development Needs**
- **Summary**

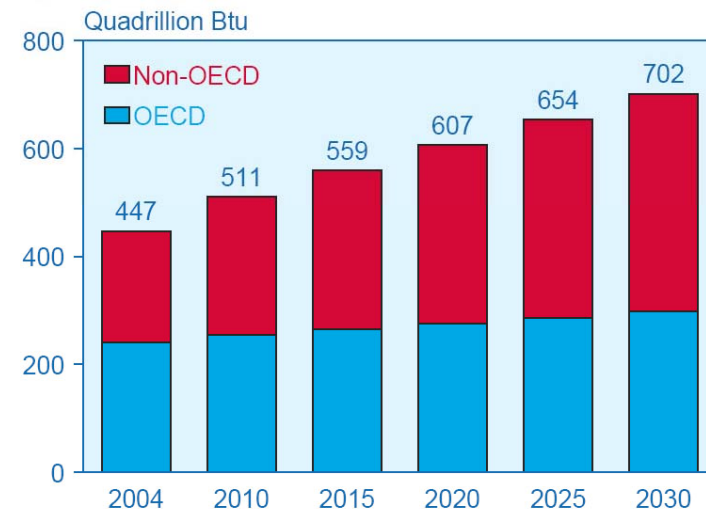




World energy demand is growing substantially

- 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).

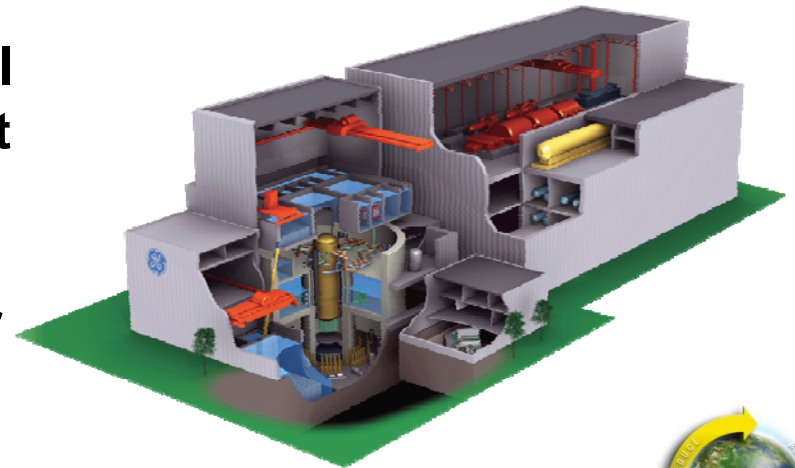
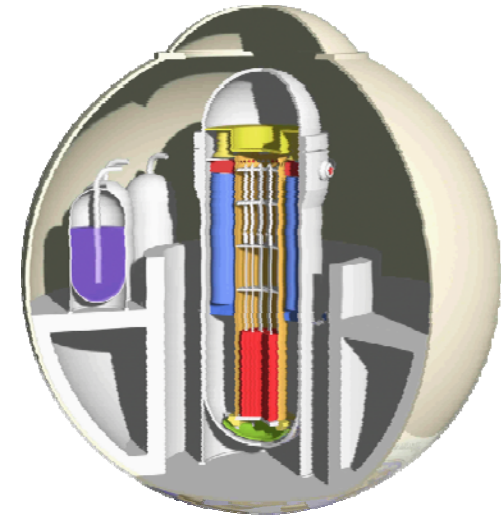
The world is turning increasingly to nuclear energy for sustainable development





GNEP will support safe and secure expansion of nuclear power worldwide through working to:

- Facilitate the global deployment of commercial-scale light water nuclear power reactors through responsible stewardship arrangements.
- Develop and deploy grid-appropriate reactors for States that individually or regionally cannot incorporate or support commercial-scale reactors.
- Establish a framework for reliable fuel supply and spent fuel disposition that provides a way for States to implement nuclear power without developing indigenous enrichment or reprocessing capabilities.





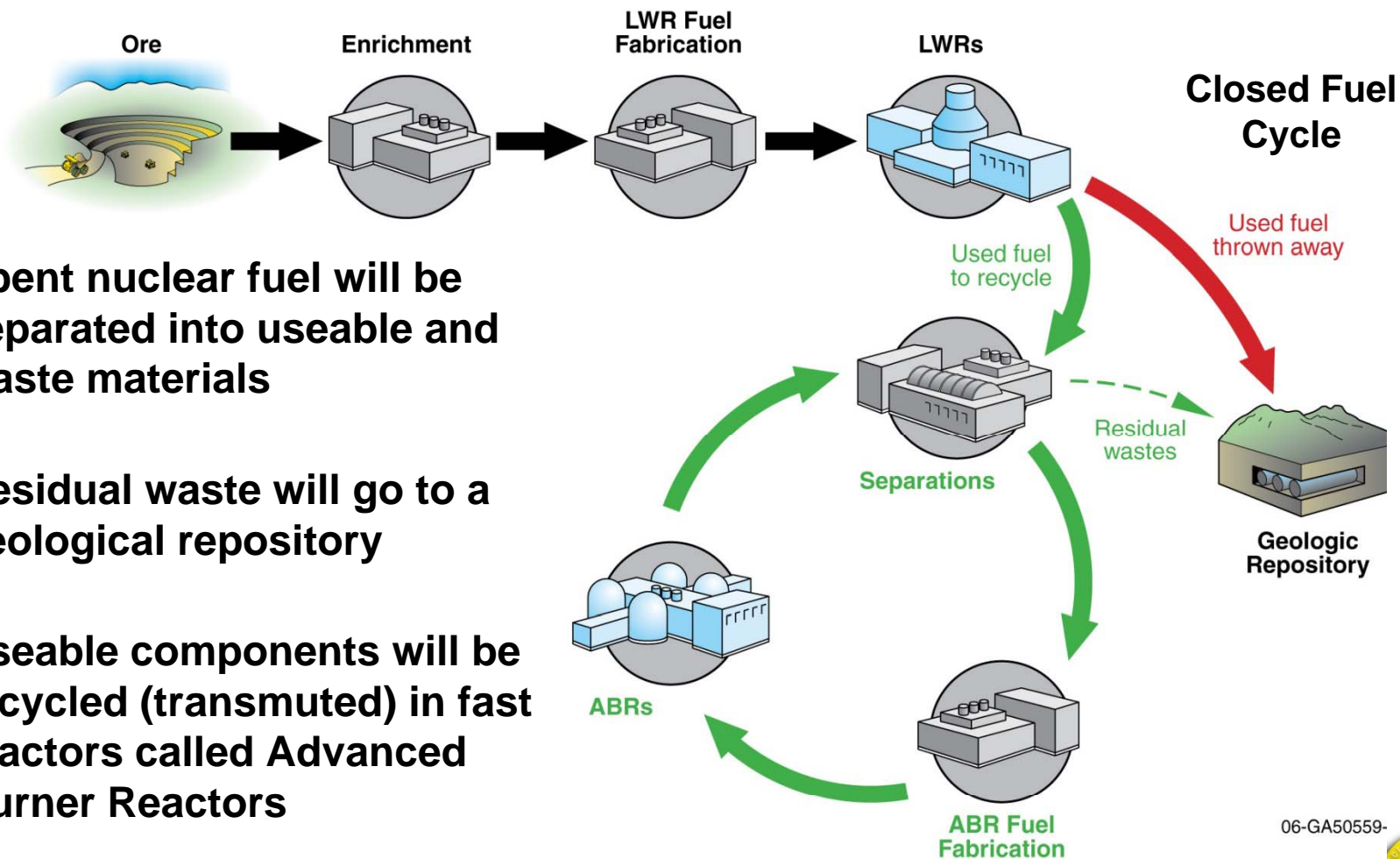
GNEP will accomplish its objectives by developing institutional arrangements and advancing fuel cycle technologies to:

- **Provide efficient uranium recycling, consumption of transuranics and reduced generation of nuclear waste.**
- **Provide spent fuel disposition through interim storage, recycle, and repository storage of final waste products.**
- **Ensure that utilities will be able to operate their reactors and be relieved of their spent fuel legacy.**
- **Encourage suppliers to offer fuel leasing and take-back arrangements to relieve others of the burden of spent fuel disposition.**





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





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 other international enrichment suppliers proposed a reliable fuel supply initiative at the IAEA in September 2006**
- **Co-Sponsored IAEA Workshop on Issues for the Introduction of Nuclear Power in December 2006**
- **Bi-Lateral Civil Nuclear Cooperation Agreements in place with Russia, Japan, China, Australia, MOU with Jordan**
- **As of September 16, 2007, 16 nations have signed the GNEP Statement of Principles**





Office of Nonproliferation and International Security objectives related to GNEP

- Reduce proliferation and security risks from spent fuel recycle,
- Discourage spread of enrichment and reprocessing technology,
- Reduce stocks of excess separated civil plutonium,
- Develop *Advanced Safeguards* and *Safeguards by Design*, and
- Promote development of proliferation resistant reactors and infrastructure suitable for developing countries





Current Office of Nonproliferation and International Security activities include

■ Proliferation Risk Assessments

- Refine PR/PP methodology
- Produce NPIA to support PEIS
- Incorporate nonproliferation concepts in modeling & simulation

■ Advanced Safeguards

- Promote Safeguards by Design for new facilities
- Develop safeguards approaches for new facility types
- Engage internationally on Advanced Safeguards

■ Fuel Services

- Promote cost-effective, reliable fuel supply
- Develop technical/policy options for spent fuel take back & waste by-products

■ Regulatory Controls

- Assess for additions to nuclear suppliers group control lists
- Review international cooperation on sensitive separations technologies

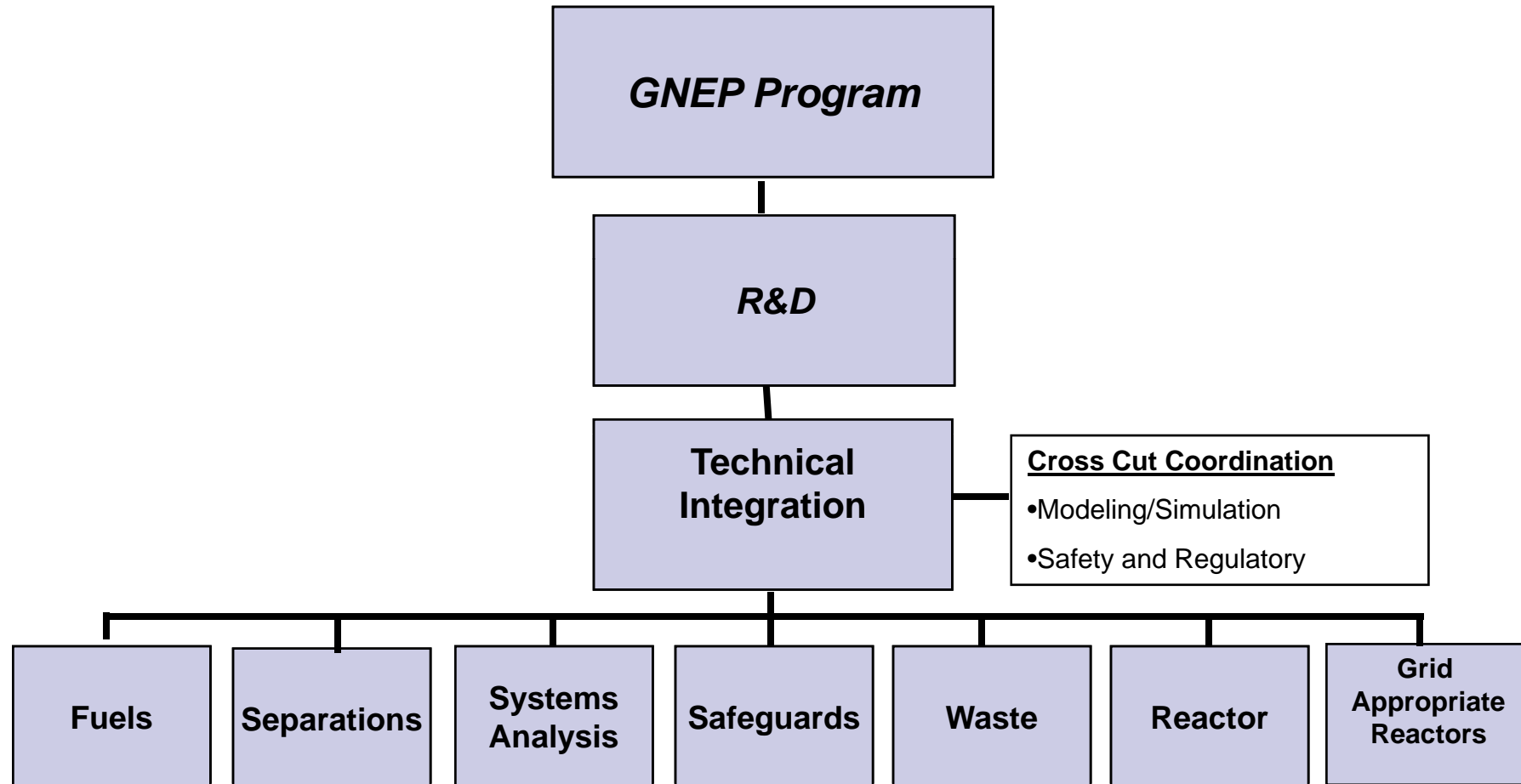
■ International Engagement

- Support nonproliferation objectives in bilateral and multilateral discussions



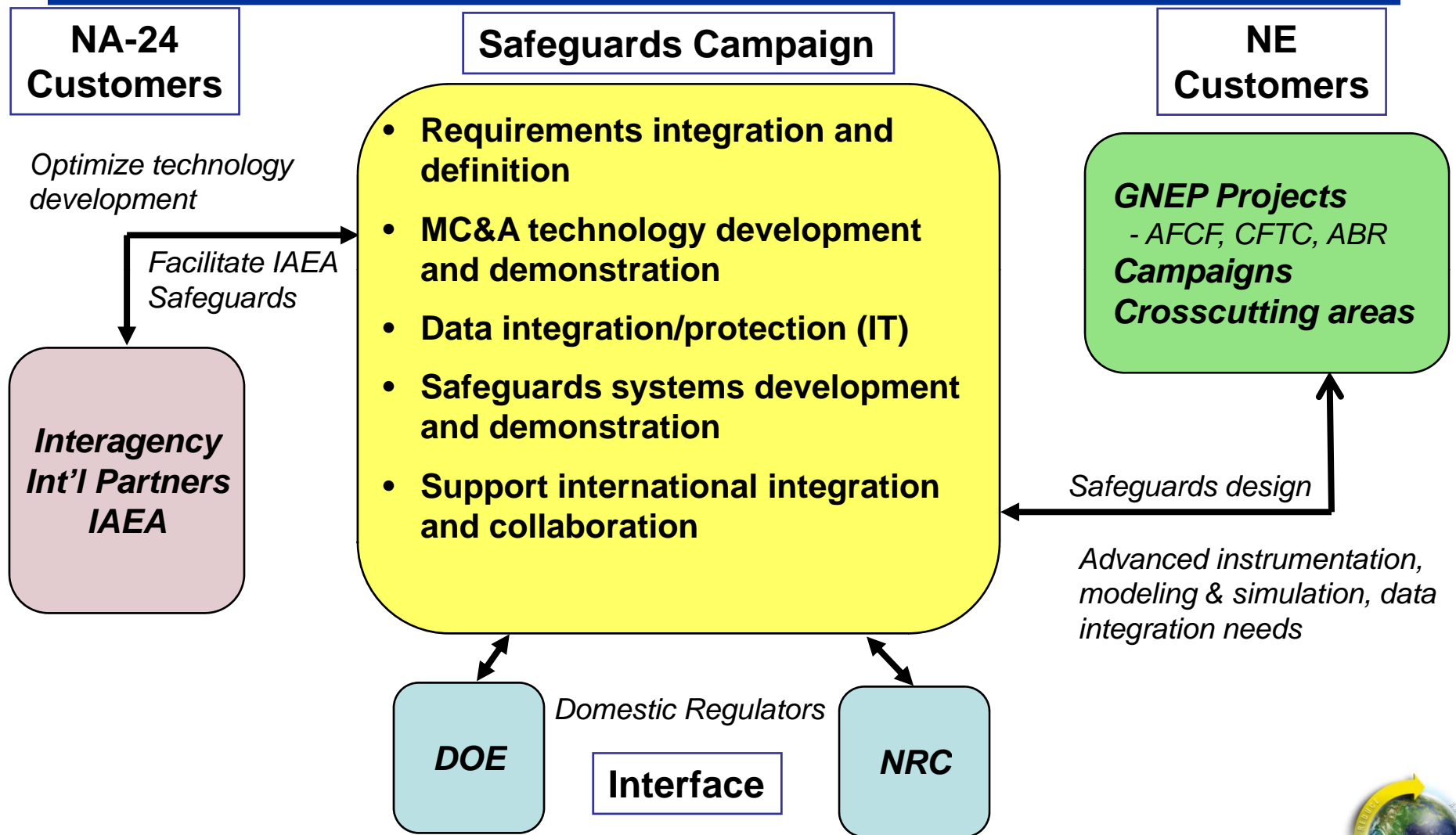


GNEP campaign organization for R&D in Office of Nuclear Energy Programs





Safeguards campaign structure and interface to the Office of Nonproliferation and International Security





International and domestic safeguards challenges

- **Nondestructive measurement of mixed actinide materials**
- **Quantitative measurement of spent nuclear fuel**
- **Continuity of knowledge for fast reactor fuels in liquid metal**
- **Safeguards for electrochemical processing**
- **Safeguards for new aqueous processing methods**
- **Process monitoring, including flows of cold materials**
- **Design information verification for larger flexible facilities while protecting proprietary interests**
- **Improved safeguards efficiency; more facilities with fewer resources**





Safeguards work is critical to help achieve GNEP nonproliferation vision

- Provide experts to GNEP facility design teams
- Integrate domestic and international safeguards requirements
- Provide research and technology development in support of both industry and laboratory led facilities
- Facilitate communication with domestic regulators (DOE, NRC) and with IAEA to enhance safeguards effectiveness
- Cooperation with partner states to advance state of the art in safeguards technology
- Strong university participation to help train next generation of safeguards and nonproliferation professionals

The safeguards effort will add to the technical foundation of the GNEP vision of reducing proliferation risk as an integral part of the global expansion of nuclear energy





Next generation safeguards require a sustained research and technology development effort

- **Advanced measurement techniques – large throughput facilities challenge current international and domestic safeguards goals, necessitating additional measures**
- **Safeguards by Design – include safeguards and physical protection as key design criteria in the design process**
- **Process monitoring – integrate nuclear and non-nuclear operational data to provide rigorous quantitative measures of enhanced safeguards effectiveness, providing authentication and protecting sensitive information**
- **Use of modeling and simulation in the design and evaluation of safeguards approaches and in evaluation of safeguards operational data**
- **Advanced tools – assess safeguards performance, optimize safeguards design, evaluate proliferation risk reduction from facility, site, and international systems perspective**

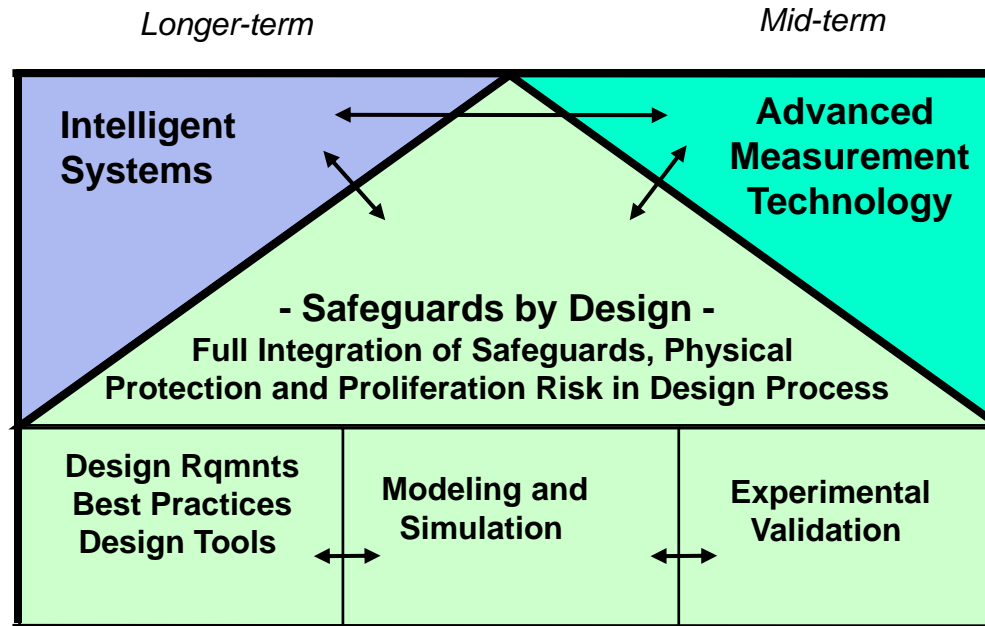




Building on safeguards by design – enabling real time knowledge extraction of facility operations

Transformational:

- Integration of Systems
- Modern Decision Tools
- Latest IT Technology
- Cyber Security
- Data Authentication
- New Measurements



Improved:

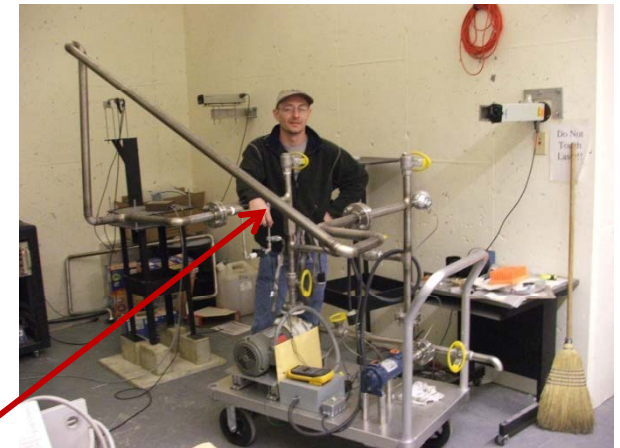
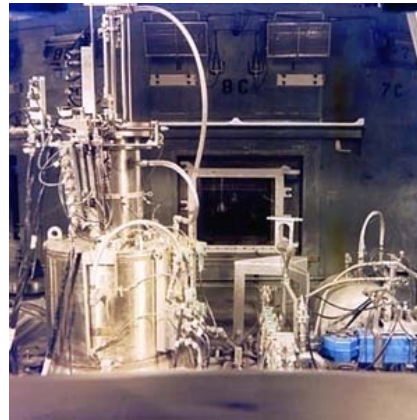
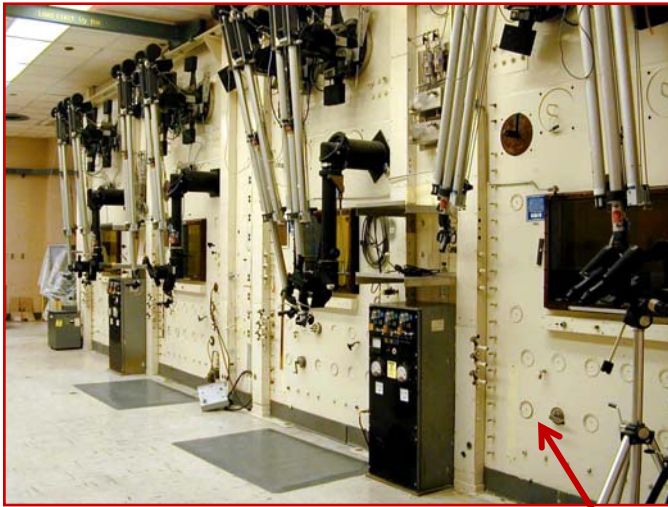
- Precision
- Speed
- Sampling
- Methods
- Scope

Integration of all available data can enable a higher level of confidence that facility operations are normal, increasing safeguards effectiveness and efficiency





Experimental program is vital to success



FCF - Electrochemical
CETE - Radiochemical
CMR - Retrievable
CETE - Head End
IAC - Flow Loop





GNEP is taking specific near term actions

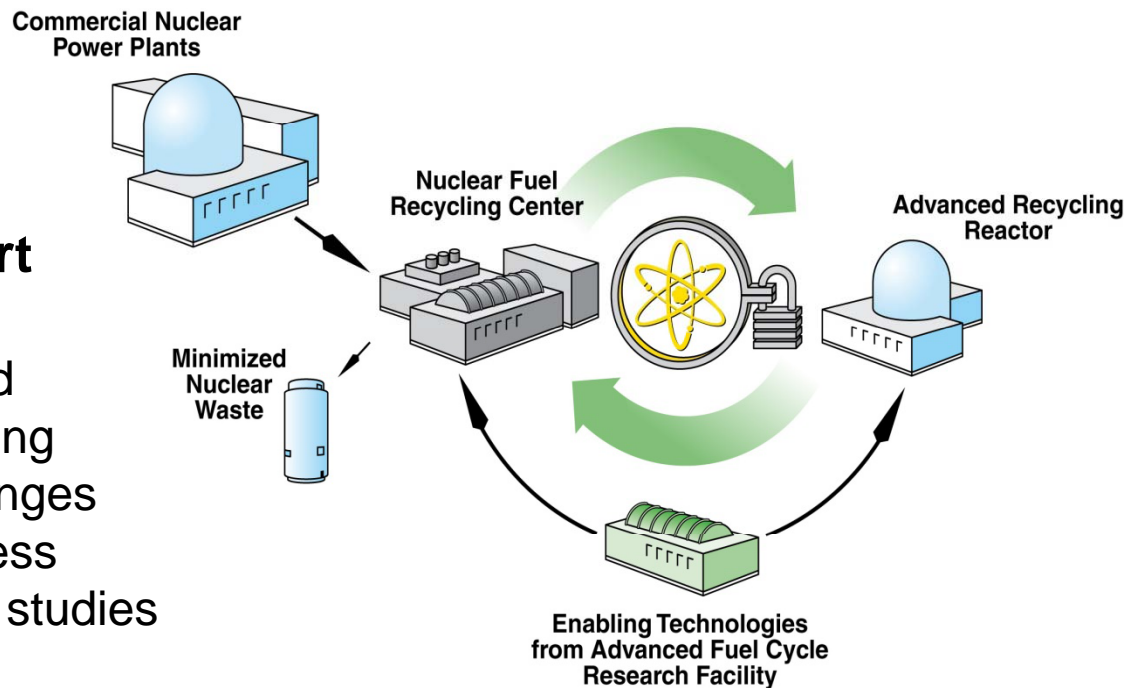
- **Obtain input from U.S. and international industries and governments on how to bring the needed GNEP facilities into being, what technology and policy issues must be resolved, and what business obstacles must be overcome.**
- **Pursue industry participation in the development of conceptual design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





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
 - PEIS and NPIA in progress
 - Industry-led deployment studies recently launched
- **GNEP is addressing the challenges needed to ensure sustainability of the nuclear power renaissance**



Nonproliferation and advanced safeguards are a cornerstone of the GNEP vision

