Global Nuclear Energy Partnership

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Presentation to Workshop on Fuel Cycle Safety
Outline

- Global Energy Demand and GNEP
- GNEP
- GNEP
- Approach
  - Importance of safety to GNEP mission
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.

The world is turning increasingly to nuclear energy for sustainable development

World Marketed Energy Consumption by Region, 2004-2030

GNEP is a Strategy to Support Safe Secure Civilian Nuclear Power Expansion Worldwide

- Expand use of nuclear power
- Establish reliable fuel services
- Support grid-appropriate exportable reactors
- Enhance nuclear safeguards technology
- Develop and deploy recycle technology
- Develop and deploy advanced recycle reactors
- Minimize nuclear waste

_The goal of the Global Nuclear Energy Partnership (GNEP) is the expansion of nuclear energy for peaceful purposes worldwide in a safe and secure manner that supports clean development without air pollution or greenhouse gases, while reducing the risk of nuclear proliferation._ - GNEP Statement of Principles
GNEP is part of the President’s Advanced Energy Initiative, launched in February 2006

- 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.”
Within DOE, the GNEP program structure is arranged to cover both international and domestic activities.

- **GNEP Program Manager**
  - Asst. Sec. Spurgeon

- **Deputy GNEP Program Manager**
  - Lisowski
  - Savage Deputy (actg.)

- **International Programs**
  - McGinnis

- **Advanced Fuel Cycle R & D**
  - Price (actg)

- **Computing and Simulation**
  - Levedahl

- **Advanced Burner Reactor**
  - Sal Golub

- **Consolidated Fuel Treatment Center**
  - Dan Stout

- **Advanced Fuel Cycle Facility**
  - Andy Griffith (actg)

- **Science and Engineering Council**
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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 international engagement and partnership development activities

- GNEP has engaged with advanced fuel cycle countries, reactor and candidate reactor countries since the February 2006 announcement, among those are:
  - 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

- Japan, France, Russia, and China, 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
A second Ministerial meeting held in Vienna on Sep. 16, 2007 had 35 countries participating:

- Added 11 countries to the original 5 Partner countries, more than tripling the Partnership.
- All 16 publicly signed the GNEP Statement of Principles.
- Nineteen additional Countries attended as Observers and most are seriously considering GNEP membership.
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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
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
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 ultimately be recycled (transmuted) in fast reactors called Advanced Burner Reactors
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GNEP envisions three domestic facilities supported by research and development activities, initially:

- **Nuclear fuel recycling center (CFTC)**
- **Advanced Fuel Cycle Facility (AFCF)**
- **Advanced recycling reactor (ABR)**

*Industries led with national laboratory, university and international participation*

*National laboratory led with NRC, industry, university and international participation*
The nuclear fuel recycling center (CFTC) will recover additional energy from spent nuclear fuel

- The nuclear fuel recycling center will separate SNF discharged from power reactors into reusable components and waste streams.
- The CFTC will be industry led, utilizing demonstrated technologies and likely operated under an NRC license.
- Both Electrochemical Processing and Aqueous Separation are being considered.

- The CFTC will initially process as much as 800MTHM/yr and may occupy or order 500 acres.
- The project includes facilities to store and process spent nuclear fuel, fabricate fuel from reusable components, and capture waste products in a form suitable for disposal.
- National Labs will conduct technology development activities defined by industry for the initial prototype and long term research and development.
ABR is an advanced recycling reactor that will destroy transuranics while generating electricity.

- A 1000 MWt (ref.) plant occupies roughly 150 acres in facilities and has a 1000 acre site footprint.
- The ABR plant will:
  - demonstrate transmutation
  - demonstrate cost reduction design features
  - demonstrate fast reactor safety
  - Qualify fuels and materials

The ABR prototype will pave the way for cost and performance improvements needed for commercialization.

The ABR project design will be led by the private sector and include substantial international collaboration. The National Labs will conduct technology development activities defined by industry for the initial prototype and long term research and development to make future commercial plants competitive with advanced light water reactor designs.
AFCF is a research, development, and demonstration facility for advanced recycling technologies.

- 170 acre (50 acre within PIDAS) integrated facility for advanced technologies
  - Aqueous Process
  - Electrochemical Process
  - Transmutation Fuel
  - Waste Forms
- Operational support for commercial used fuel recycling center
- Demonstration bed for advanced safeguards. Being designed as eligible for IAEA safeguards.

- When completed, AFCF will be a world class facility for developing advanced nuclear fuel recycling technologies for commercialization.

- AFCF will be led by National Laboratories. Technology development activities will be designed and carried out by the DOE National Laboratories in collaboration with universities, industry, regulatory and International partners.
GNEP Advanced Fuel Cycle R&D is Being Executed Through Campaigns

- Campaigns are integrated experimental and simulation efforts focused on developing key capabilities or products required for GNEP.
  - Organized around national laboratories + universities + industry + international cooperation
  - Work is planned and executed to clearly stated goals, objectives and milestones

- Campaigns combine direct and supporting activities
  - Transmutation Fuels
  - Separations Technologies
  - Fast Reactor Design and Analysis
  - Safeguards
  - Waste Management and Advanced Waste Forms
  - Systems Analysis
  - Grid-appropriate reactors

- Campaign activities managed by DOE/NE, integrated by the Technical Integration Office and performed by national laboratories
  - INL supports execution via technical integration office
  - Other national laboratories support with unique capabilities
GNEP technical program organizational structure

**PROJECTS**

- **Advanced Burner Reactor**
  - Sal Golub

- **Consolidated Fuel Treatment Center**
  - Dan Stout

- **Advanced Fuel Cycle Facility**
  - Andy Griffith (actg)

**R & D**

- **Advanced Fuel Cycle R & D**
  - Price (acting)

- **Design Data Needs**

- **Technology**

- **Technical Integration**
  - Finck (INL)
  - Cappiello (LANL)
  - Marra (SRNL)

- **Cross Cut Coordination**
  - Modeling/Simulation (Nowak-ANL)
  - Safety and Regulatory (Kelly-SNL)

- **Fuels**
  - Pasamehmetoglu (INL)

- **Separations**
  - Laidler (ANL)

- **Systems Analysis**
  - McCarthy (INL)

- **Safeguards**
  - Miller (LANL)

- **Waste**
  - Peters (ANL)

- **Reactor**
  - Hill (ANL)

- **Grid Appropriate Reactors**
  - Ingersoll (ORNL)
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The GNEP Strategic Plan requires specific near-term actions

- Obtain input from industries and governments
  - *How best to bring the needed GNEP facilities into being?*
  - *What technology and policy issues must be resolved?*
  - *What business obstacles must be overcome?*

- Develop a detailed GNEP technology roadmap for demonstrating solutions to the remaining technical issues

- Pursue industry engagement to develop conceptual designs and other engineering studies that support a nuclear fuel recycling center and an advanced recycling reactor

- Prepare a programmatic GNEP Environmental Impact Statement

- In 2008, prepare a decision package for the Secretary of Energy
Initial Industry engagement for ABR and CFTC projects will be through Cooperative Agreements

- Awards to 4 Industry Teams were made September 29, 2007
- Deliverables Include
  - Business Plan
  - Conceptual Design Studies
  - Technology Development Roadmap
  - Communications Plan
- Three separate Project Performance Periods
  - From initial award (FY2007) through FY2009
  - Phase 2 and 3 awards based on industry performance
- Anticipated Funding (~ $60M)
  - FY2007 ~$16M
  - FY2008 ~$20M (subject to appropriations)
  - FY2009 ~$24M (subject to appropriations)
Four industry teams were selected and awarded

- **Energy Solutions**
  - Westinghouse Electric Company, Shaw, Toshiba, BoozAllenHamilton, Nexia, NFS, AECL

- **International Nuclear Recycling Alliance**
  - AREVA, Mitsubishi Heavy Industries (MHI), Battelle Memorial Institute, BWXT, Japan Nuclear Fuel Limited (JNFL), Washington Group

- **GE-Hitachi Nuclear Americas**
  - Burns and Roe, Fluor, IBM, KAERI, Lockheed Martin, NuVision (part of Vision Capital), GEH Canada and HGE Japan, plus another upon agreement signing

- **General Atomics**
  - United Technologies, Hamilton-Sundstrand, Rocketdyne, CH2M Hill, OKB Mechanical Engineering (OKBM)
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

**Timeline**

- **Advance Notice of Intent (ANOI)**
  - 3/2006

- **Notice of Intent (NOI)**
  - 1/2007

- **Public Scoping Process**

- **Draft PEIS**
  - Summer 2007

- **Public Comment on Draft PEIS**
  - Fall 2007

- **Final PEIS**
  - Late Spring 2008

- **Record of Decision (ROD)**
  - Summer 2008
To assure safety for the worker, the public and the environment through demonstrably-safe facility design and planning

- Incorporate a Integrated Safety Management Process (ISMS) based safety culture into the design effort at the earliest phase of conceptual design.

- Develop a Safety-in-Design (SID) process under the guidance of DOE-STD-1189.

- Provide and maintain SID training and oversight to technical and design personnel involved in the facility development and design.

- Maintain the Safety-in-Design process throughout the design conceptual, preliminary, and final phases.
Safety-in-Design process is at work supporting the Advance Fuel Cycle Facility

- **Historical Model:**
  - Facility designed by technical engineering team.
  - Safety documented by separate safety team after the fact.

- **Implementation of SID for AFCF (in compliance with Draft DOE-STD-1189):**
  - Safety and safety integration – a project responsibility.
  - Technical and safety teams work together to incorporate safety into design
  - Integration of design/safety expertise all levels of project design
Summary

- The International partnership shows enormous, unprecedented promise for supporting the expansion of nuclear power
  - ElBaradei: “GNEP is … comprehensive because it deals with all aspects of the fuel cycle, both the front end and the back end. GNEP also aims to establish a global partnership, which is the way to go. I think nuclear energy is an international concern and if we need to man it we need to man it on an international basis.”

- FY2007 and FY2008 activities continue advanced fuel cycle R&D and support the Secretary’s 2008 Record of Decision on the path forward for GNEP
  - GNEP will further relevant advanced fuel cycle research and development using national laboratories, international collaborations, universities, and industry

- GNEP is placing the cornerstone for nuclear power through a program that will develop and foster
  - A successful global partnership to address the expansion of nuclear power and nuclear weapons proliferation
  - A sustainable domestic nuclear electrical generation industry with adequate paths to deal with the spent nuclear fuel and, over time, close the fuel cycle
  - Safety is the foundation of this cornerstone