OVERVIEW OF THE UNITED STATES P&T PROGRAMME

Carter Savage
AFCI Programme Director, US Department of Energy

The National Energy Policy and nuclear power

"The NEPD Group recommends that the President support the expansion of nuclear energy in the United States as a major component of our national energy policy."

Report of the National Energy Policy Development Group, May 2001

Recommendations:

- Support expansion of nuclear energy in the United States.
- Develop advanced nuclear fuel cycles and next generation technologies.
- Develop advanced reprocessing and fuel treatment technologies.

The United States Department of Energy has a number of initiatives to promote the growth of nuclear energy:

Nuclear power 2010

- Explore new sites.
- Develop business case.
- Develop Generation III+ technologies.
- Demonstrate new licensing process.

Advanced fuel cycle initiative

- Recovery of energy value from SNF.
- Reduce the inventory of civilian Pu.
- Reduce the toxicity & heat of waste.
- More effective use of the repository.

Nuclear hydrogen initiative

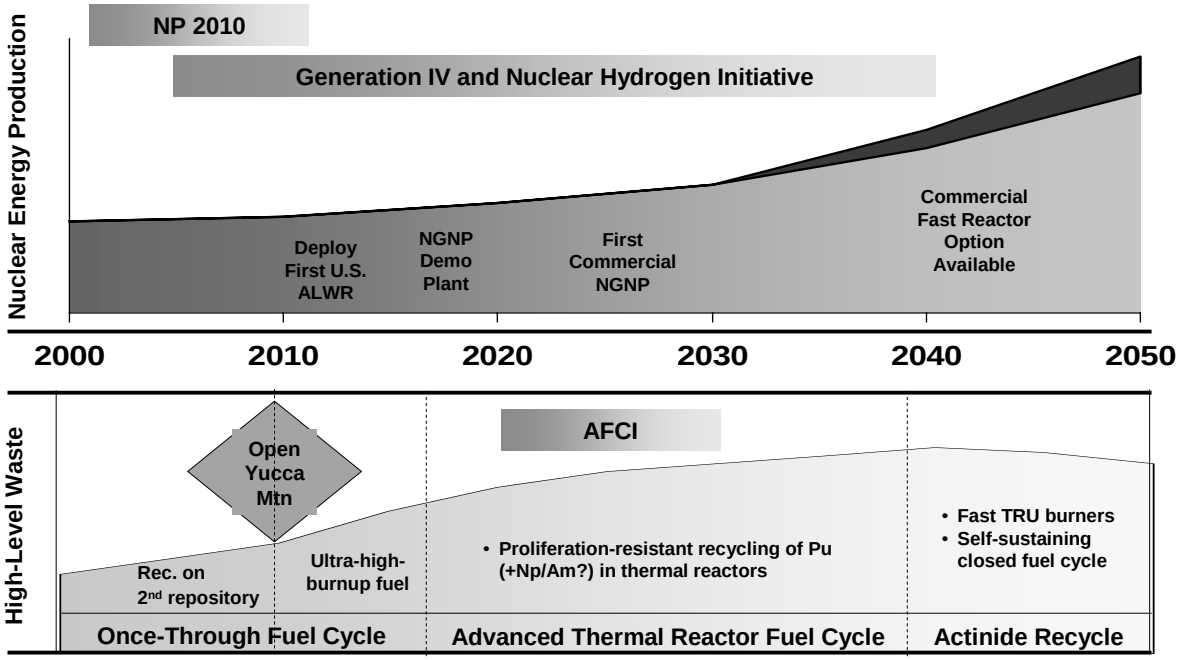
- Develop technologies for economic, commercial-scale generation of hydrogen.

Generation IV

Better, safer, more economic nuclear power plants with improvements in

- safety and reliability;
- proliferation resistance and physical protection;
- economic competitiveness;
- sustainability.

A Long-term U.S. strategy for nuclear energy



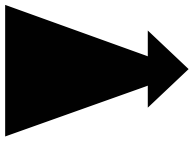
U.S. Generation IV implementation

Generation IV top priority – Next generation Nuclear Plant

- Collaborative with international community.
- Collaborative with industry, especially utilities.
- Demonstrate H_2 and direct-cycle electricity production.
- Result in a commercially viable plant design.

Generation IV second priority

- GFR
- LFR
- SFR



U.S. Fast Reactor

Closely coordinated with

Advanced Fuel Cycle Initiative

Lower priority

- SCWR
- MSR

Advanced fuel cycle initiative ('AFCI')

Mission

- Develop proliferation-resistant spent nuclear fuel treatment, fuel and transmutation technologies to enable the transition from the once-through fuel cycle to a stable, long-term, environmentally, economically, and politically acceptable advanced closed fuel cycle.

Goals

- Develop advanced fuel and fuel cycle technologies for application to current operating commercial reactors and next-generation reactors.
- Develop technologies to reduce the cost of geologic disposal of high level waste from spent fuel, enhancing repository performance.

ACFI Benefits

Achieving AFCI programme goals could:

- Reduce civil plutonium inventories, reducing proliferation risk.
- Extract valuable energy from spent fuel components.
- Retain nuclear energy as a major component of the U.S. energy mix, ensuring energy security in the 21st century.
- Significantly reduce volume, heat load and radiotoxicity of high-level waste from spent fuel, delaying any near-term need for a second geologic repository in the U.S.

History of Department of Energy's Advanced Fuel Cycle Research

- **1999 – Accelerator Transmutation of Waste (ATW) –** roadmap issued by RW, outlined use of high-powered proton accelerators for destruction of all actinides from spent fuel.

- **2000 – ATW –** research programme initiated to explore transmutation technology ($9M).
- **2001 – Advanced Accelerator Applications (AAA) programme launched –** combined ATW with Accelerator Production of Tritium (APT) programme to optimize use of resources ($34M-NE, $34M-DP).
- **2002 – AAA refocused to AFCI –** emphasis on reactor based systems, accelerator transmutation focused on "fuel burn" role to minimize toxicity and support Generation IV (Gen IV) fuel development ($50M).
- **2003 – AFCI establishes new management structure –** National Technical Directors, Technical Integrator, and integrates with Gen IV for fuel cycle development ($58.2M).
- **2004 – AFCI Budget – $68M.**
- **2005 – AFCI Budget Request – $46.3M.**

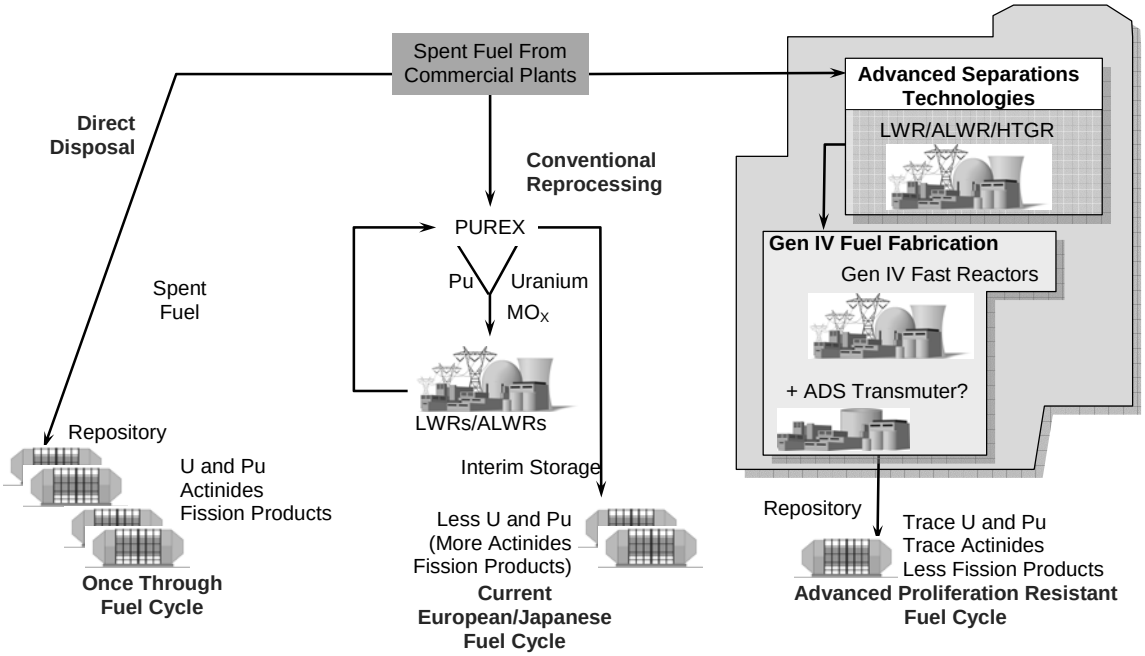
ACFI recent accomplishments

- Successfully demonstrated UREX aqueous process at SRNL, separating uranium from actual spent nuclear fuel with over 99.99 percent purity.
- Demonstrated lab-scale high-purity separation of cesium/strontium, plutonium/neptunium and americium/curium from spent fuel (INEEL, ANL, ORNL).
- Fabricated and irradiated non-fertile and low-fertile metallic, nitride and oxide fuel samples containing plutonium, neptunium and americium (LANL, ANL-W, INEEL). PIE started at ANL-W.
- Built a lead-bismuth test loop at LANL and completed 1000 hour corrosion test.

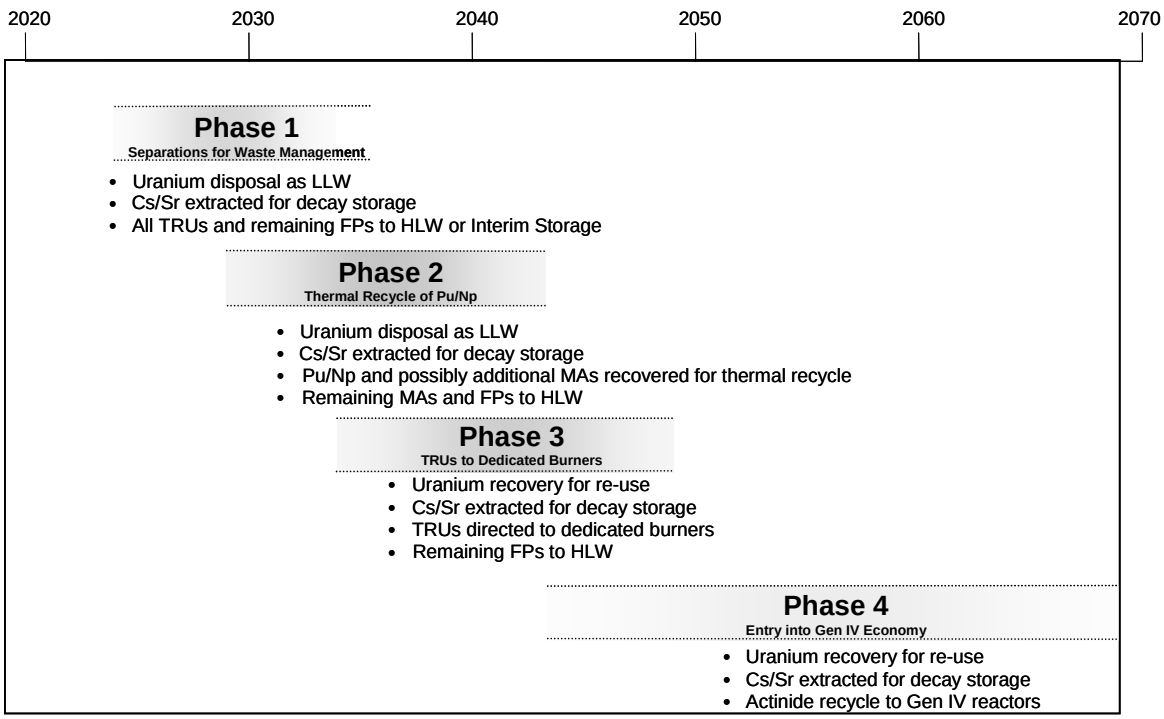
AFCI challenges

- Define, plan and execute the optimal research to inform the 2007-2010 Secretarial recommendation on second repository and meet AFCI/Gen IV programme goals.
- Scale of demonstrations to provide sufficient confidence in 2007-2010 Secretarial recommendation.
- Integration of analysis and modelling with experiments.
- U.S. non-proliferation policy.
- R&D facilities, including pilot-scale demos and fast spectrum irradiation facility.
- Reliable long-term funding.

AFCI approach to spent fuel management



AFCI long-range strategy



Separations – Current approach

- Aqueous separations process development (UREX+1, UREX+2) with laboratory-scale experiments.
- Process technology development (equipment, process integration, process control and instrumentation, safeguards instrumentation, etc.).
- Development of waste forms and storage forms (including performance testing).
- Evaluation of advanced processing methods and validation of promising candidates at laboratory-scale.

Separations technology development in 2005

- Large centrifugal contactor tests.
  - Scale-up issues, remote operation/reliability/maintainability.
  - Process sampling and analysis, process control.
- Dissolution studies.
  - Optimise for most complete dissolution of TRU and compatibility with subsequent separations steps.
- Feed clarification experiments.
  - Efficiency of different methods.
- Alternative head-end process development.
  - Voloxidation process.
  - Off-gas recovery and treatment.
- Uranium crystallization process development.
  - Maximizing purity of separated uranium.
  - Carbonate dissolution process.

Advanced fuels research

- NGNP particle fuel.
  - UCO, SiC coating.
  - High temperature requirement (1 000°C).
- LWR Recycle Fuel.
  - Mixed Oxide.
  - Pu + Np + Am? + Cm?

  - Inert Matrix.
  - Intrinsic proliferation resistance.

- Fast reactor Fuels.
  - Metal, nitride, oxide, dispersion.
  - Optimize transmutation.

Materials research

- Coolants/targets for Generation IV fast reactors and Accelerator Driven Systems.
  - Lead, lead-bismuth for LFR, ADS.
  - Helium, supercritical CO2 for GFR.
- Structural materials for high-temperature, high fast neutron flux performance.
- Fuel matrix materials for very high-burnup fast reactor and transmutation fuels.

AFCI international collaborations

- International Cooperation has provided U.S. with much needed research and experimental data.
- France – CEA: separations, fuels (FUTURIX), physics, systems studies.
- MEGAPIE facility at Paul Sherrer Institute (Switzerland); spallation target technology, physics & engineering support
- Russia – LBE Test target; UNLV cooperation
- OECD/Nuclear Energy Agency
- European Commission
- Japan
- South Korea
- IAEA

Department of Energy approach for international collaborations

- International Nuclear Energy Research Initiative (INERI) changes in FY 2004.
- INERI budget funds completion of ongoing projects only; no new starts.
- New starts of bilateral international collaborations funded by the research programmes (AFCI, Gen IV, Hydrogen).
- INERI bilateral agreements will be main mechanism (France-CEA, S. Korea, OECD/NEA, Euratom, Brazil, Canada); several new agreements close to signing (Japan, South Africa, UK).

- Existing AFCI cooperative agreements and “implementing arrangements” will also be used.
- Collaborations with European community on FUTURIX, MEGAPIE, TRADE expected to continue.
- Trilateral with France and Japan under discussion for use of Monju for transmutation fuel assembly tests.

International collaborations