Nuclear Fuel Cycle Options

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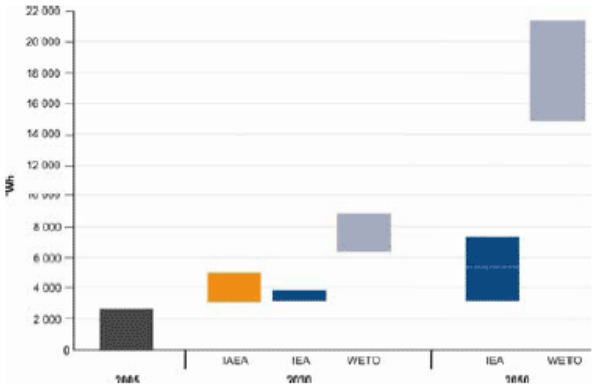
Setting the Stage

- **Expansion of nuclear energy can help the U.S. meet its climate goals while providing energy security**

- **Uncertainties affecting the *Nuclear Renaissance*:**



Timing and scale

Financial Markets

Waste Disposal

- **An effective fuel cycle management strategy must provide options**

Key Elements of Fuel Cycle Strategy

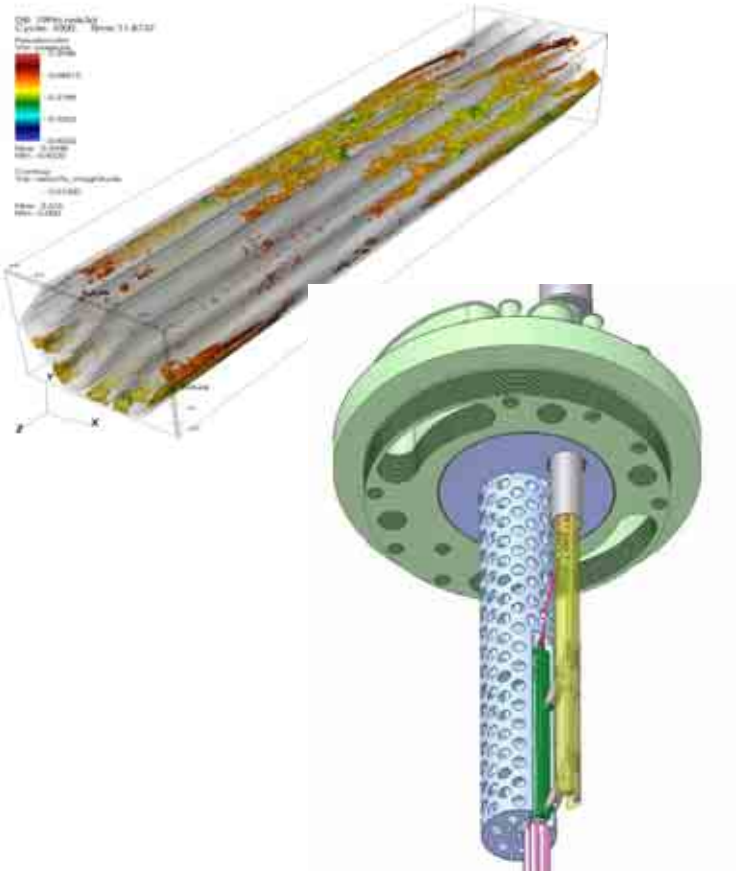
- **Safety**
- **Non-proliferation**
- **Waste management**
- **Resource utilization**
- **Economics**

Fuel Cycle Options – *How & When?*

- **Several options for the future nuclear fuel cycle**
  - Existing “once-through”
  - Other open or closed fuel cycle alternatives
- **We have flexibility on “*How*”**
  - Status quo
  - Evolutionary approach
  - Revolutionary approach
- **We have flexibility on “W*hen”***
  - Near-term, leveraging current technologies and existing reactor fleet
  - Longer-term using “next-generation” technologies
- **Our focus has shifted from accelerated deployment of recycling facilities to a long-term, science-based R&D program**

Leveraging DOE Capabilities to Create Transformational Technologies

- New design tools enabled by modern high-performance computing
- Advanced separations techniques and reactor technologies
- Improved fuel performance and fabrication techniques
- Enhanced safeguards to control and protect nuclear materials
- Robust waste forms tailored to the disposal geology



Science-based R&D to create options for a sustainable fuel cycle

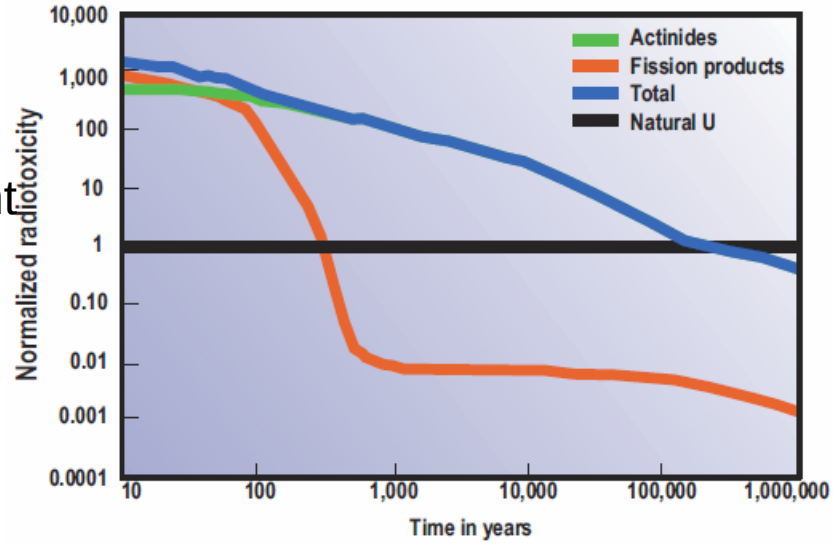
Nonproliferation Objectives

- **Prevent diversion/misuse of nuclear material**
  - Combination of intrinsic and extrinsic factors
- **Improve safeguards technologies and methods**
  - Advanced Instrumentation/real-time process monitoring
  - Safeguards by design
- **Reduce plutonium stockpiles**
  - No separated plutonium
- **Limit the spread of enrichment and reprocessing technologies**
  - Comprehensive fuel services

There is no single technological solution to ensure the peaceful use of nuclear energy – a robust system of safeguards and security is required.

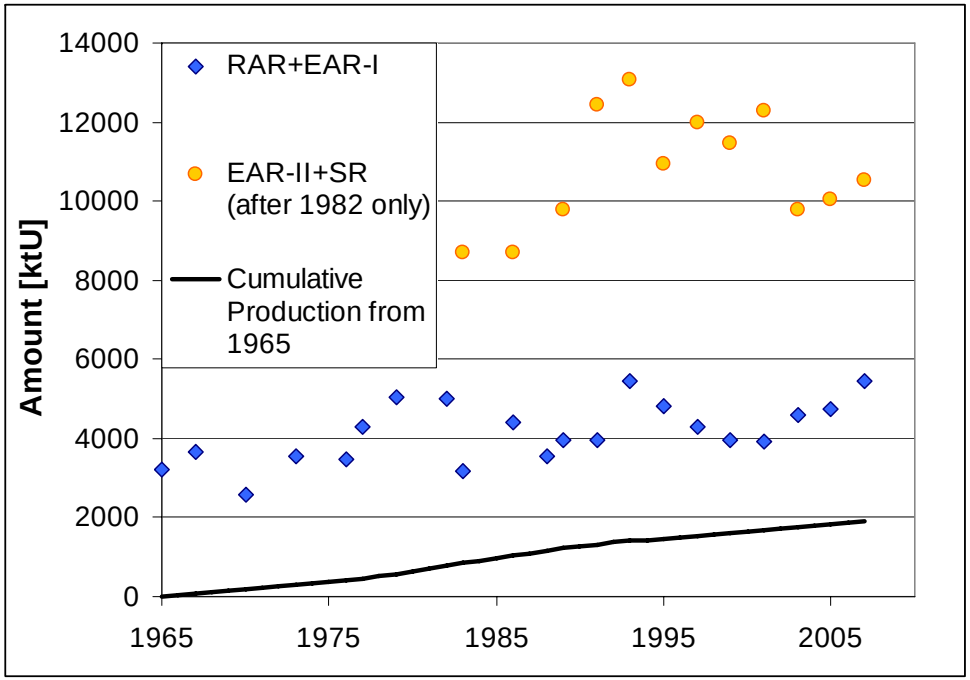
Waste Management

- **Closed fuel cycle options provide opportunities for improved waste management**
  - Does not eliminate the need for a geologic repository
  - Interim storage must be part of the solution
- **Used fuel recycling can reduce the radiotoxicity, heat and volume of nuclear waste byproducts**
- **Recycling will generate large volumes of low level waste**
  - management challenges are different
- **Any future fuel cycle option must safely and effectively deal with nuclear waste**



Uranium Resources

- **Under some nuclear energy growth scenarios, uranium resource demand exceeds supply during this century**
- **Estimates of uranium availability have grown with nuclear use**
- **Investment in uranium exploration has increased as the price has gone up**
- **Future impact of uranium supply is far from certain**
  - It pays to have options



Cost

- **A transition to a closed fuel cycle would be expensive and take several decades**
  - a commercial scale reprocessing plant could cost >$15 billion
- **Business case for an integrated fuel management approach**
  - Industry estimated that a waste fee between $1 - $3/MWh would be needed
- **R&D and innovative technology could significantly reduce costs**
  - Simplified/compact systems, advanced materials
  - Improved design processes, reduced conservatism

Path Forward

- **Establish long-term, science-based fuel cycle R&D program**
  - Pursue breakthrough technologies to address fuel cycle challenges
    - *Safety, proliferation, waste management and cost*
  - Engage end-users and key stakeholders to inform the R&D effort

- **Continue to evaluate a broad suite of fuel cycle options**
  - Comprehensive systems analysis studies to explore deployment alternatives and implications

- **Continue to pursue international collaboration with fuel cycle nations to leverage expertise and resources**
  - Multi-national forums (e.g., Generation IV International Forum – GIF)
  - Bi-lateral and multi-lateral R&D agreements

Conclusion

- Nuclear power is poised to grow in the U.S., but there are uncertainties
- The U.S. fuel cycle management strategy must contain options to provide the flexibility we know we will need
- Uncertainty over the long-term supply of uranium makes it prudent to develop technically viable alternatives
- Innovative, science-driven R&D will enable the safe, secure, economic and sustainable expansion of nuclear energy