MIT Future of Nuclear Fuel Cycle Study - principal issues

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History

- **In 2003 MIT issued the study: *The Future of Nuclear Power***
  - Proposed first-mover incentives for new nuclear power plants, helping spur 2005 legislation
  - Generally well received (eventually!)
- **Major changes since 2003**
  - Update Recently Published on the way to new study
- **MIT interdisciplinary study on The Future of the Nuclear Fuel Cycle**
- **Status Report**
  - What has changed
  - Report Objectives
  - Critical questions that must be addressed

Study Sponsors

- Electric Power Research Institute
- Idaho National Laboratory
- AREVA
- General Electric
- Westinghouse
- NAC

Update of MIT 2003 Future of Nuclear Power Study

- Compared to 2003, motivation to make more use of nuclear power is greater
- Public acceptance of nuclear power is greater
- Performance of nuclear plants has been excellent
- Nuclear plants are still more expensive (cost/kwh) than coal or natural gas but removal of risk premium and/or CO2 can make nuclear power competitive
- Government first mover incentives have not been effective to date to make firm nuclear power commitments
- Clear need for a robust long term waste management policy
  - Interim storage
  - Fuel cycle alternatives including reactor technologies
  - Disposal options

Bottom Line Conclusions

- **After 6 years:**
  - No new plants under construction in US
  - Insufficient progress is being made on waste management (some will argue negative progress)
  - Government assistance program not effective and needs to be improved
- **If this is not done:**
  - Nuclear power will diminish as a timely and practical option at a scale where it matters for climate change mitigation

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MIT Future of the
Nuclear Fuel Cycle Study

- **Two Overarching Questions:**

  1. What are the long-term nuclear fuel cycle choices that have desirable features?

  2. What are the implications for near-term policy choices?

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Ground Rules and Assumptions

Range of Cases Analyzed to Understand Sensitivity of Results to Input Assumptions

- **Alternative nuclear growth rates considered**
- **Several fuel cycles analyzed/baseline cases and alternatives**
  - Once through
  - Recycle for fissile fuel recovery
  - Recycle for waste management
  - Evaluate in "modern" context of U resources and LWR staying power
- **Primary emphasis on the United States but within a global context**
- **Emphasize fuel cycle dynamics and value of options for different growth scenarios and technology development**

What are Nuclear Reactor and Fuel Cycle Economics?

(In a World Where the Costs for All Energy Options Are Rising)

- **Update the economic assessment of nuclear reactor costs in the 2003 MIT report considering**
  - Overnight Costs
  - Economics for regulated and unregulated utility markets
  - Implications of federal-government first-user incentives
  - Implications of carbon-credit trading
- **What are the economics of once through and closed fuel cycles?**
- **What is known about fast-reactor economics?**
  - Reactor costs dominate cost of nuclear power

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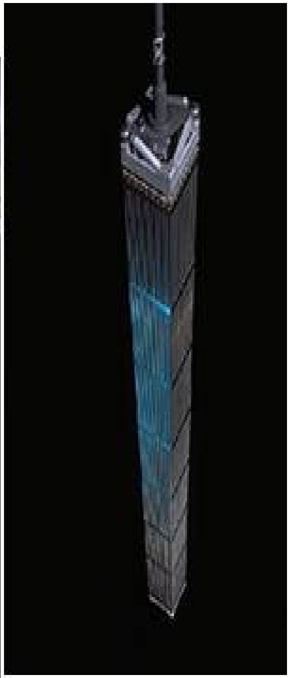
Baseload Electricity Costs (cents/kWh)

	Base case	$25/ton -CO2	same capital cost
Nuclear	8.4		6.6
Coal	6.2	8.3	
Gas ($7/mmBtu)	6.5	7.4	

What Should Be Our Used Nuclear Fuel Storage Strategy?

- Storage can provide time to determine what is more important within the duality of Used Nuclear Fuel
  - Resource
  - Waste
- Storage is a nuclear-chemical process: heat and radioactivity decrease with time
  - Lowers reprocessing costs and risks
  - Lowers transport costs and risks
  - Increases repository capacity
- Approach to storage should be integral to fuel cycle choices/ choice of storage time has major fuel-cycle impacts
- Three classes of storage option
  - At reactor (U.S.)
  - Centralized monitored retrievable storage
  - Combined Storage/Repository



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What Are the Preferred Fuel Cycles for a Sustainable Future?

Compare/Contrast Multiple Cycles To Understand Range of Implications

- What are the implications to the repository and other waste management facilities of alternative fuel cycles?
- What are the uranium resource implications?
- What are the nonproliferation implications to the world of our choices for fuel cycles?
- What are the technical challenges of the alternative fuel cycle options?

What Are the Technical Challenges and Viability of Alternative Fuel Cycle options?

- Must consider the complete fuel cycle
  - Reprocessing
  - Fuel Fabrication
  - Reactors
  - Waste Disposal/Multiple streams from different fuel cycles
    - Separations small part of cost of reprocessing
- Commercial reprocessing is a relatively new enterprise
  - Value for long term waste management?

R&D Recommendations

- Align with reality of next decades
  - Global Uranium Resource Assessment
  - Enhancement and life extension of LWRs
  - New build LWRs/new materials, fuels,…
  - Long term dry storage assessment/engineered barriers
- Alternative disposal options
  - E.g. MA's and deep boreholes

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R&D Recommendations

- Explore long term options
  - Closed fuel cycles and fast reactors
  - Safety and operations analysis of fuel cycle facilities
  - Advanced simulation tool development/reactors and waste management systems
- Nuclear materials security
- Demonstrations?

Summary & Conclusions

- Changes since 2003 indicate the need to rethink fuel-cycle strategies
- There is time to assess alternatives before selecting a path forward/focus on optionality.
- There are major questions that need to be addressed to provide *a durable widely-supported long-term fuel-cycle strategy*
- The goals of the MIT study are to aid in the process to develop such a strategy
- Identification of research, development and demonstration needs aligned with important fuel cycle options.

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