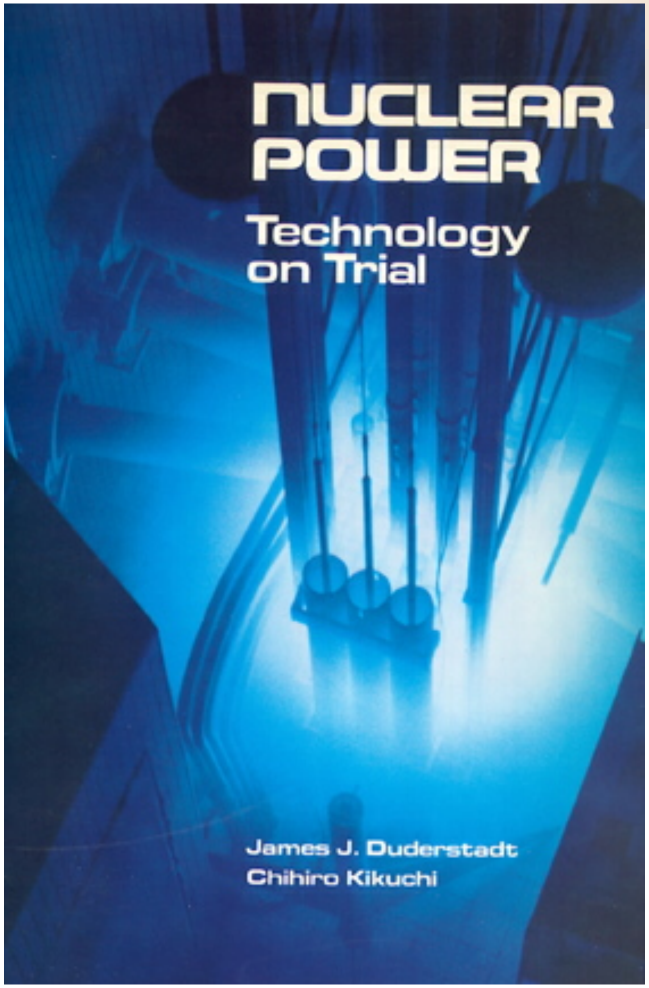
Nuclear Science & Energy R&D

A Strategy for the Nation

The Nuclear Power Wars



Before TMI

- OPEC oil embargo (crude oil > $40/bbl)
- Great concern about future energy sources
- Projections: 1,000 nuclear plants in U.S. by 2000
- Major investment in nuclear power

The Turning Point: 1979

- Early Resistance (Nader, Cherry, Sinclair,…)
- Hollywood ("The China Syndrome")
- AEC --> ERDA –> DOE + NRC
- Three Mile Island II (March 28, 1979)

The Decline and Fall of Nuclear Power in the United States

- Public opinion: TMI --> no new plant orders after 1978
- Far harsher regulatory climate
- Licensing uncertainty and delays (and escalating costs)
- Next generation technologies were strangled
  - Fast breeder reactor (Clinch River)
  - Plutonium recycling (reprocessing)
- Little progress in radioactive waste disposal (NIMBY)
- Deregulation of electrical utility industry

Nuclear Energy R&D

- In 1970s and 1980s most R&D channeled into large projects such as LMFBR, IFR, and ALWR.
- By mid 1990s, Clinton administration had eliminated essentially all civilian nuclear power R&D by (declining from greater than $1 B/year to zero).
- Both the physical and human infrastructure necessary to sustain a U.S. nuclear power option declined quite seriously.

Current Situation

There are currently 103 commercial nuclear power plants in operation in the U.S. supplying 20% of our generated electricity.

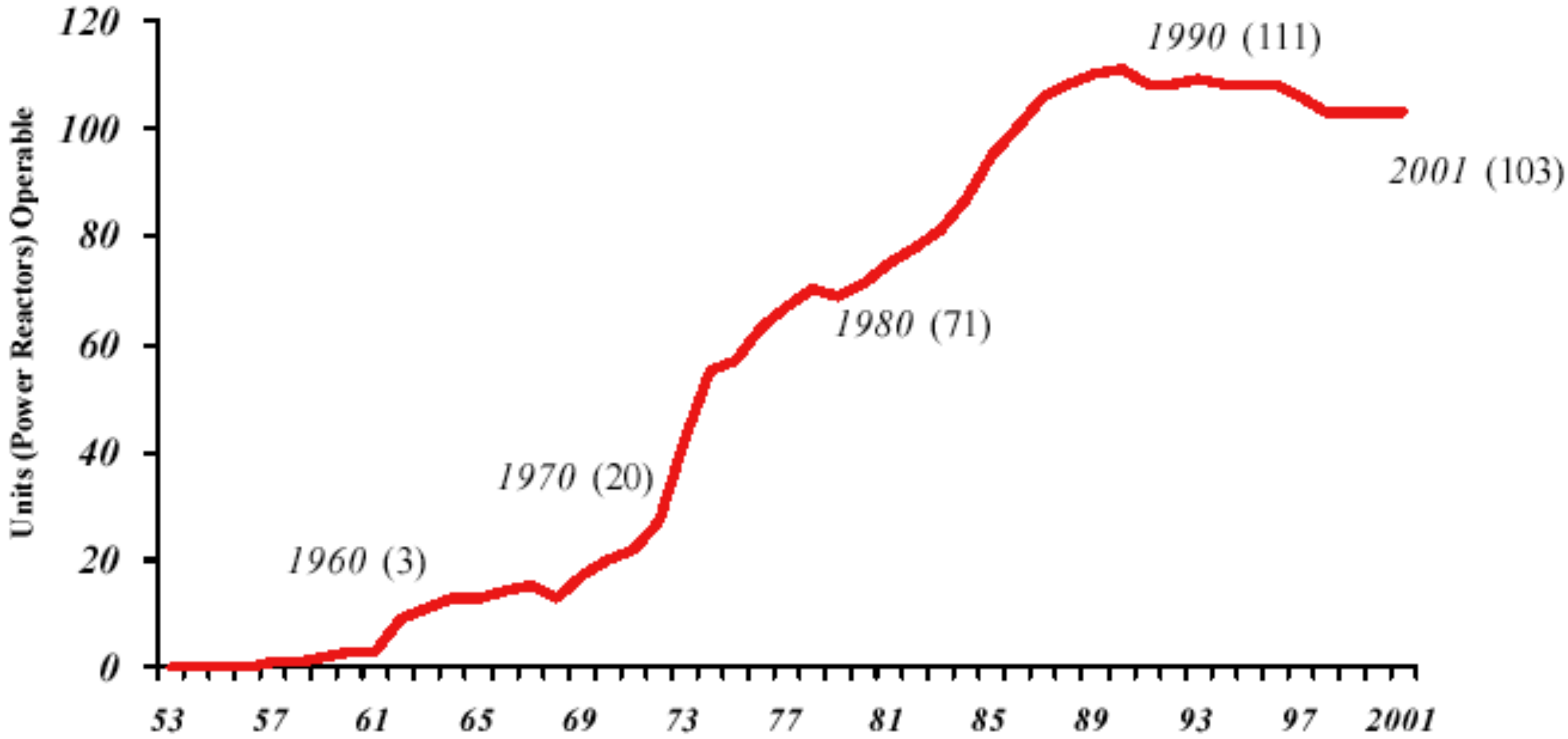
U.S. nuclear plants are licensed by NRC for 40 years and will reach end of license in large numbers by 2010.

Some estimates were that U.S. nuclear generating capacity would drop to 40% of current levels by 2020 (5% of U.S. electircal generating capacity).

U.S. Nuclear Power Plants

103 Nuclear plants with operating licenses

Operable U.S. Nuclear Power Plants (Units) (1953-2001)

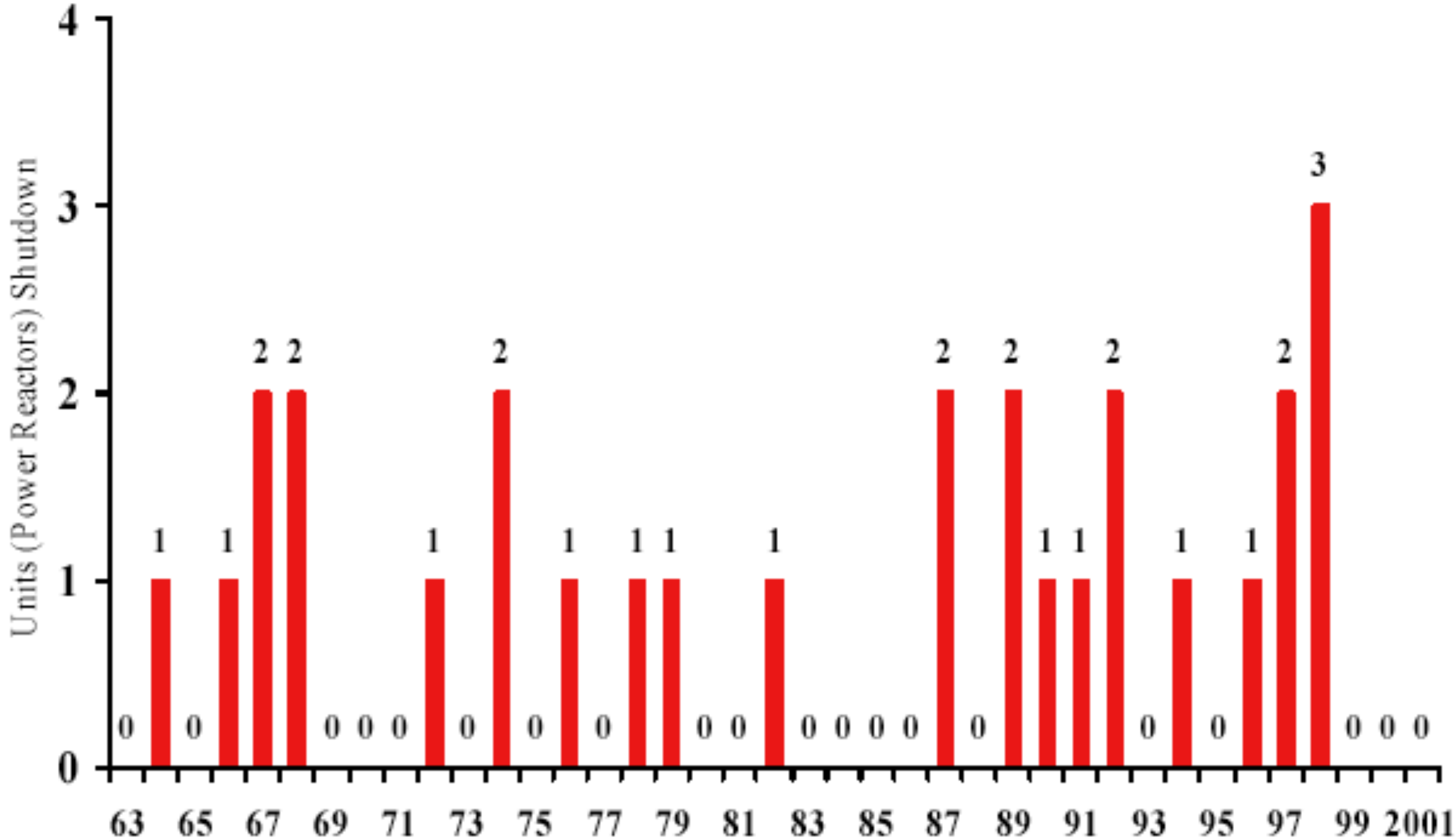


Total of units holding full-power licenses, or equivalent permission to operate, at the end of the year.

Source: EIA

NEI

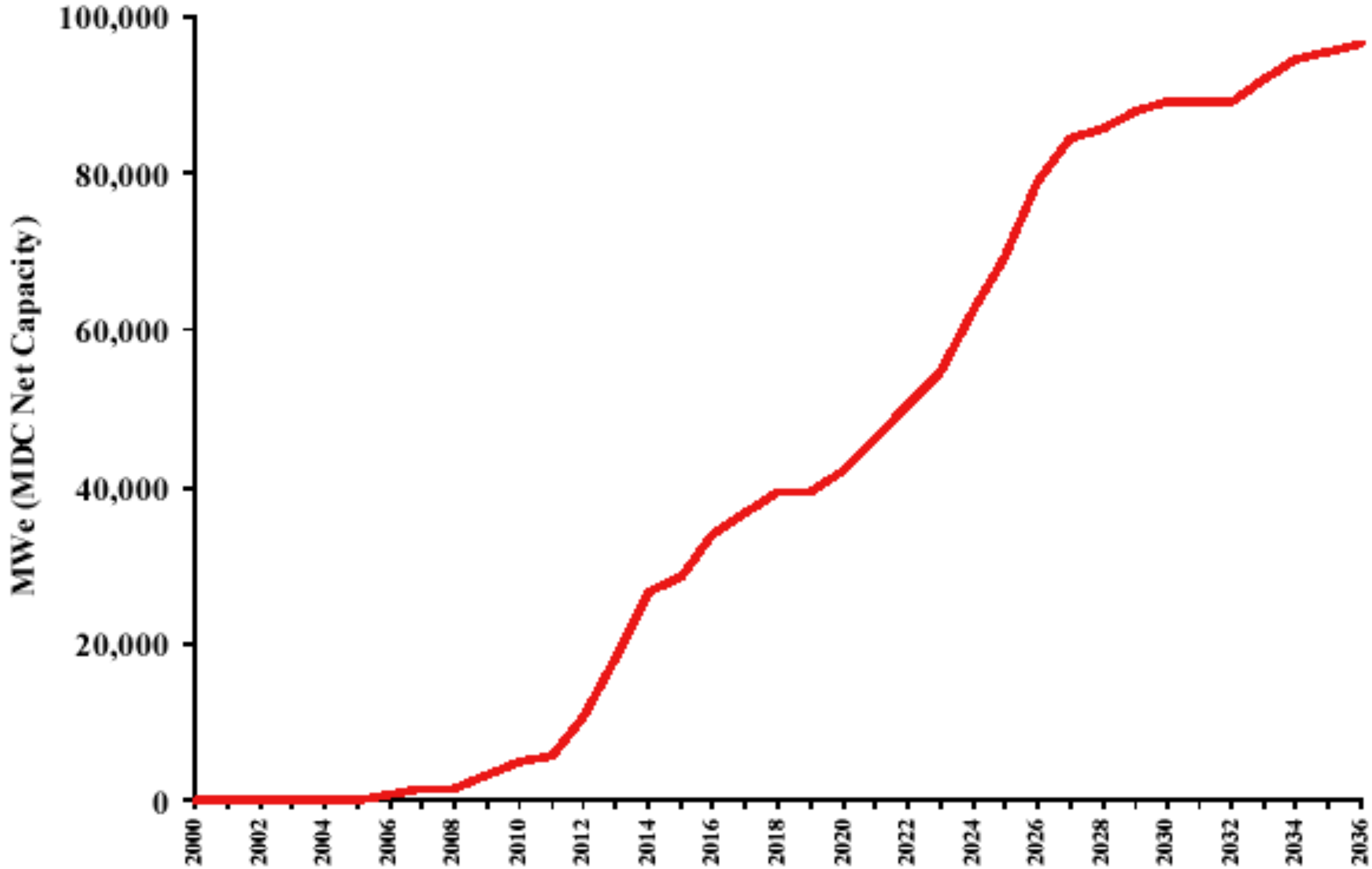
U.S. Nuclear Power Plant Shutdowns



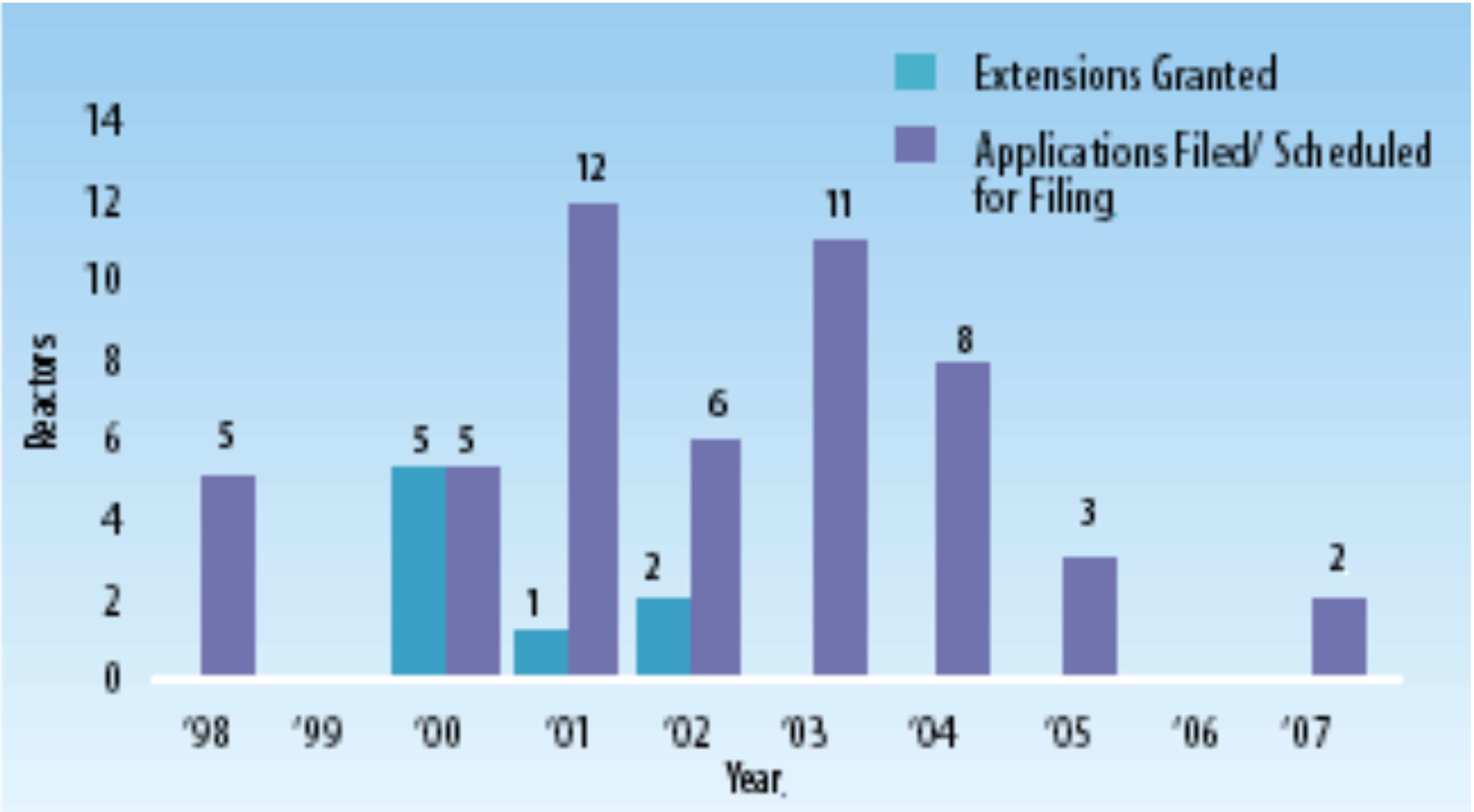
"Shutdown" = removed permanently from service

Source: EIA

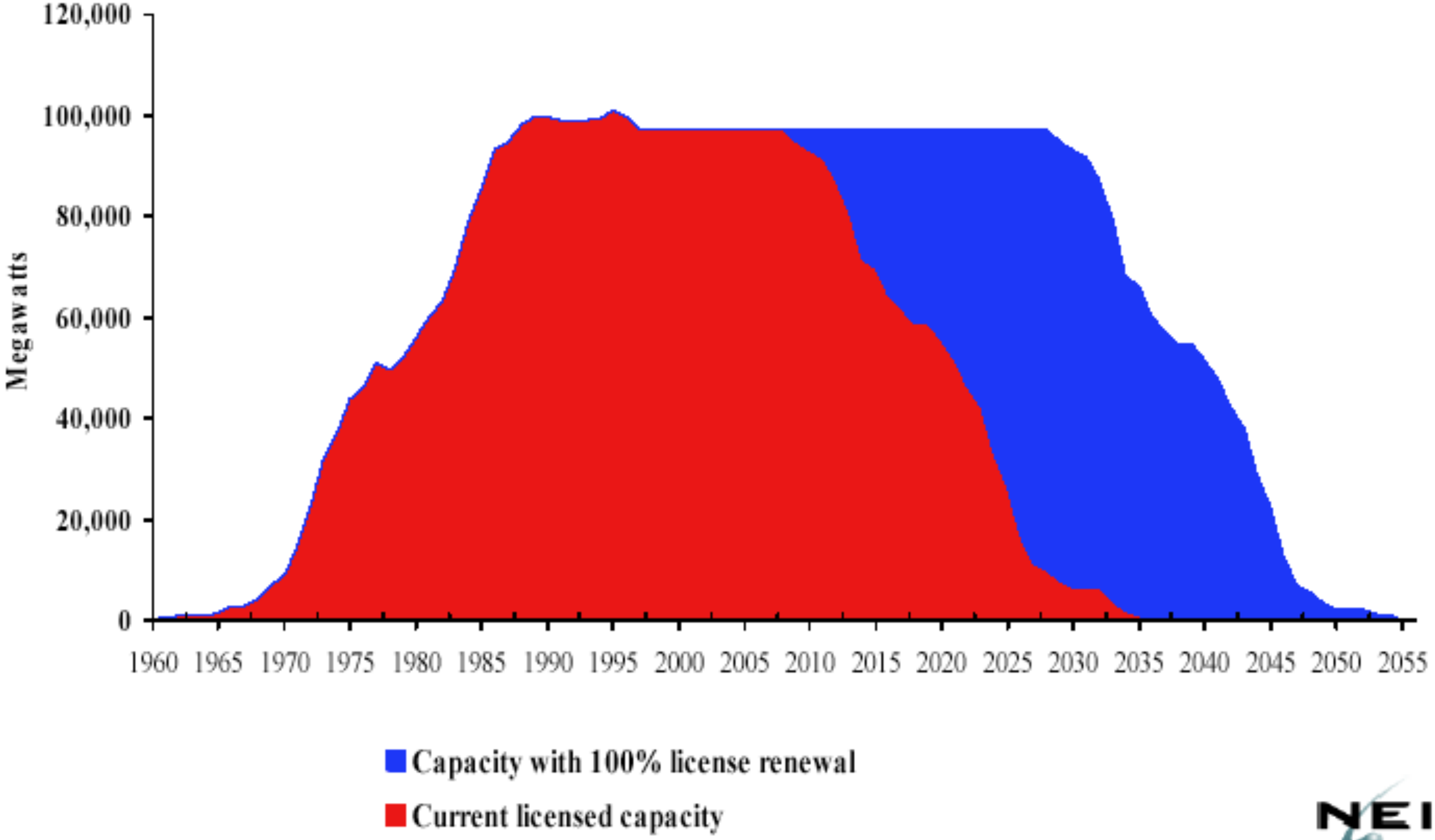
Cumulative Megawatts Lost Due to U.S. Nuclear Plant License Expirations (2000-2036)



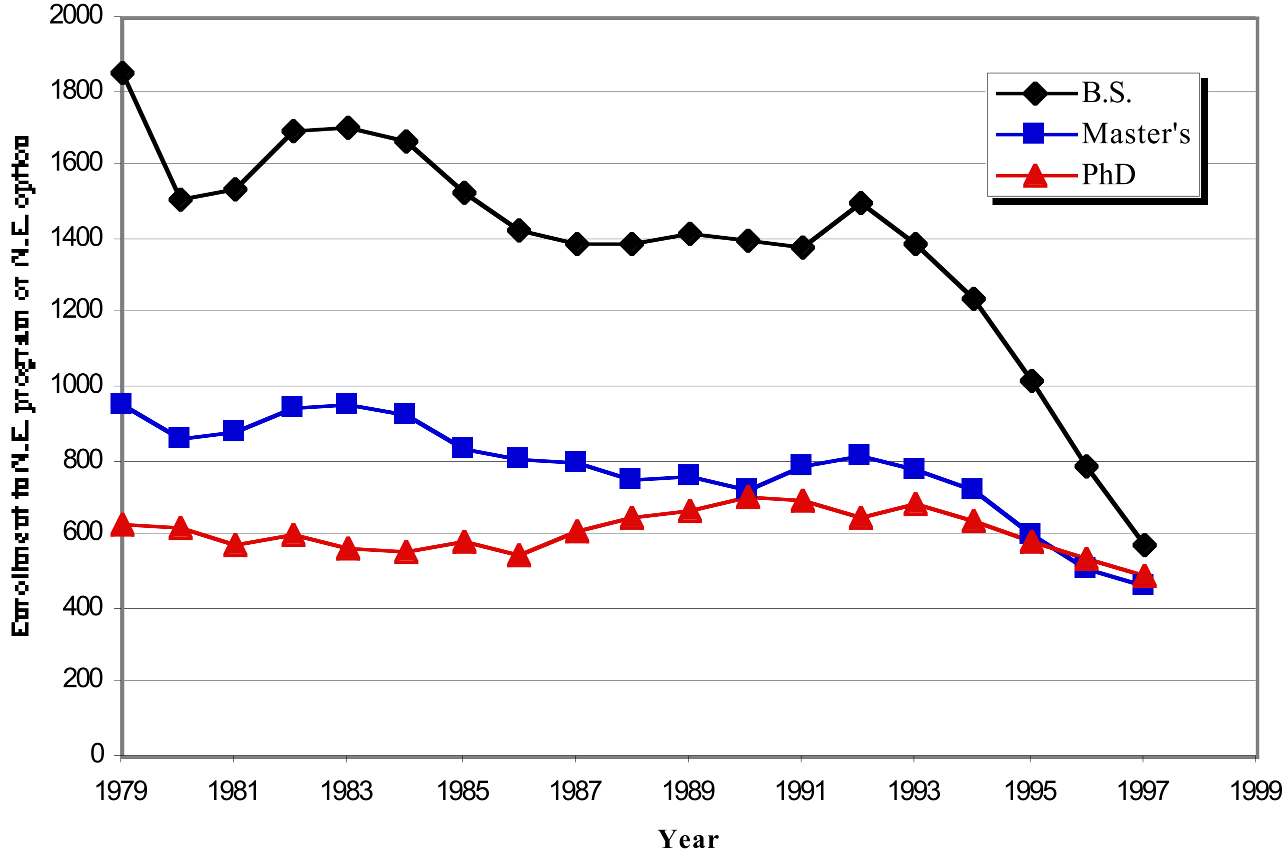
Applications for License Renewal



U.S. Nuclear Generating Capacity With and Without License Renewal



Nuclear Engineering Enrollments in U.S. Universities



Future Challenges

U.S. will need 360,000 MWe of new generating capacity by 2020.

Environmental concerns may rule out major expansion of fossil fuels:

Clean Air Act (SO_2, NO_X, ozone, particulates)

Kyoto Protocol (CO_2)

Nuclear Security (warhead disposal, etc.)

PCAST Energy R&D Panel (1997)

"Fission's future expandability is in doubt in the United States and many other regions of the world because of concerns about high costs, reactor-accident risks, radioactive-waste management, and potential links to the spread of nuclear weapons. We believe that the potential benefits of an expanded contribution from fission in helping address the carbon dioxide challenge warrant the modest research initiative proposed here (NERI and NEPO), in order to find out whether and how improved technology could alleviate the concerns that cloud this energy option's future.

To write off fission now as some have suggested, instead of trying to fix it where it is impaired, would be imprudent in energy terms and would risk losing much U.S. influence over the safety and proliferation resistance of nuclear energy in other countries. Fission belongs in the R&D portfolio."

PCAST Recommendations on Nuclear Energy R&D

- A major extramural research program (investigator-initiated, peer reviewed, long range) (NERI)
- A major research program aimed at extending the life of operating plants (NEPO)
- A high level advisory body to DOE (NERAC)

NERAC

Nuclear Energy Research Advisory Committee

"Provide expert, independent advice on long-range plans, priorities, and strategies in nuclear energy research to the U.S. Department of Energy"

NUCLEAR ENERGY RESEARCH ADVISORY COMMITTEE

Overview

The Nuclear Energy Research Advisory Committee (NERAC) was established on October 1, 1998, to provide independent advice to the Department of Energy (DOE) and Office of Nuclear Energy, Science and Technology (NE) on complex science and technical issues that arise in the planning, managing, and implementation of DOE's nuclear energy program. NERAC will periodically review the elements of the NE program and based on these reviews provide advice and recommendations on long-range plans, priorities, and strategies to effectively address the scientific and engineering aspects of the research and development efforts. In addition, the committee will provide advice on national policy and scientific aspects on nuclear energy research issues as requested by the Secretary of Energy or the Director, NE. The committee includes representatives from universities, industry, and national laboratories. Particular attention was paid to obtaining a diverse membership with a balance of disciplines, interests, experiences, points of view, and geography. NERAC operates in accordance with the Federal Advisory Committee Act (FACA)(Public Law 92-463), 92nd Congress, H.R. 4383' October 6, 1972) and all applicable FACA Amendments, Federal Regulations and Executive Orders.

From the Director
Organization Chart
Program Offices
Press Releases
Public Information
Advisory Committee
Diversity Activities
Job Opportunities
Home Page
Contact Us
NE Strategic Plan
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Privacy & Security Notices

NUCLEAR ENERGY RESEARCH ADVISORY COMMITTEE

- Overview
- Charter
- Organization
- Long-Term R&D Plan
- Meetings
- Reports

Committee Organization

Professor James Duderstadt, Chairman, Nuclear Energy Research Advisory Committee (NERAC), created a subcommittee structure to address various items that the full committee felt should be addressed. The following is a description of the subcommittees and their membership. All of the subcommittees report to the parent committee. The parent committee must approve any recommendations prepared by the subcommittee.

- Subcommittee on Long-Term Planning for Nuclear Energy Research

  This subcommittee will assist in identifying priorities and shaping planning recommendations. In particular, it will have direct responsibility for monitoring the evolution of the Nuclear Energy Research Initiative.

- Nuclear Science and Technology Infrastructure Roadmap

  This subcommittee will review the efforts by the Department of Energy staff to evaluate the Department's current nuclear science facility infrastructure and if that infrastructure is adequate to meet the needs of the nuclear research community for the next 20 years. In addition, the subcommittee will address the human resource needs of the Nation's nuclear energy activities including nuclear science and engineering education.

- Long-Term Isotope Research and Production Plan

  The first activities of this subcommittee will be to review a report on the future demands for medical isotopes prepared by the Medical Isotope Expert Panel. Based on this review and other inputs, the subcommittee will play an important role in developing a long-term plan for the Isotope Program.

- Operating Nuclear Plants Research and Development

  The subcommittee will identify the research necessary to support the operations and optimization of the Nation's existing nuclear power plants and to recommend programs for the conduct of this research. This subcommittee will be actively involved in the coordination of the Department's efforts with those of the Electric Power Research Institute.

- Subcommittee on Advanced Nuclear Transformation Technology

NUCLEAR ENERGY RESEARCH ADVISORY COMMITTEE

Charter

1. **Committee's Official Designation:**
   Nuclear Energy Research Advisory Committee (NERAC)

2. **Committee's Objectives and Scope of Activities and Duties:**
   The activities of the Nuclear Energy Research Advisory Committee include:
   a. Periodic reviews of elements of the nuclear energy research and development Program within the Office of Nuclear Energy, Science and Technology (NE) and recommendations based thereon.

   b. Advice on long-range plans, priorities, and strategies to address more effectively the scientific aspects of nuclear energy research and development and stakeholder aspects of the services of NE.

   c. Advice on appropriate levels of funding to develop those plans, priorities, and strategies and to help maintain appropriate balance between elements of the program.

   d. Advice on national policy and scientific aspects of nuclear energy research issues of concern to the Department of Energy (DOE) as requested by the Secretary or the Director of NE.

5. **Time Period Necessary for the Committee to Carry Out the Purpose:**
   In view of the goals and purposes of the committee, it is expected to be functional for 2 years.

6. **Official to Whom this Committee Reports:**
   The committee will report to the Director of NE.

7. **Agency Responsible for Providing Necessary Support for this Committee:**
   DOE will provide all necessary support for this committee. Within DOE, primary support shall be furnished by NE.

8. **Description of Duties for Which the Committee is Responsible:**
   The duties of the committee are solely advisory and are stated in paragraph 2 above.

NERAC Membership

- John Ahearne, Duke
- Tom Cochran, NRDC
- Allen Croft, Oak Ridge NL
- Marvin Fertel, Nuclear Energy Institute
- Beverly Hartline, LANL
- Bill Kastenberg, UC-Berkeley
- Dale Klein, U Texas - Austin
- Bob Long, Nuclear Stewardship
- Warren Miller, Jr., LANL
- Richard Reba, U. Chicago
- Lynn Rempke, INEEL
- Paul Robinson, Sandia NL
- Robert Socolow, Princeton
- Allen Session, Queens College
- Daniel Sullivan, NIH
- Bruce Tarter, LLNL
- John Taylor, EPRI
- Charles Till, Argonne NL
- Neal Todreas, MIT
- Joseph Comfort, Arizona State
- Maureen Crandall, ICAF
- Jose Luis Cortez, New Mexico M&T
- Tom Boulette, Worcester Polytechnic
- Jim Duderstadt, Michigan, Chair

DOE Office of Nuclear Energy, Science, and Technology

- Address the obstacles to continued operation of existing nuclear power plants and maintain nuclear power as a viable option for the future
  - Nuclear Energy Research Initiative
  - Nuclear Energy Plant Optimization
- Develop DOE mission critical technologies
  - Advanced radioisotope power systems
  - Isotope Support
- Maintain vital nuclear research facilities and education infrastructure
  - Test reactor area
  - University reactor fuel assistance and support
  - Fast Flux Test Facility
- Reduce the life-cycle costs of environmental cleanup
  - Uranium program
  - Termination costs

DOE Nuclear Energy Research Programs

- Nuclear Energy Research Initiative (NERI)
- Nuclear Energy Plant Optimization (NEPO)
- University Nuclear Science and Reactor Support Program
- Nuclear Engineering Education Research (NEER)
- Radioisotope Research Program
- Nuclear Space Power Systems
- Accelerator Transmutation of Waste Program (ATW) (and AAA program)

NERAC Subcommittees

- Long Range Planning (Ahearne)
- Nuclear Science and Technology Infrastructure (D. Klein)
- Operating Nuclear Power Plant R&D (Taylor)
- Isotope Research and Production (Reba)
- Proliferation Resistant Nuclear Technologies (Taylor)
- Transmutation of Radioactive Waste (Richter)
- Blue Ribbon Committee on Nuclear Engineering (Corradini)
- Nuclear Space Propulsion (A. Klein)
- Nuclear Impact on Air Quality (Ahearne)

Early NERAC Activities

- Nuclear S&T Infrastructure Roadmap
- Specific Nuclear Facilities
  - **FFTF**
- Long Range R&D Plan for 21st Century
- Isotope Production
- Human Resource Issues

Fast Flux Test Facility

Long-Range R&D Plan

- Basic Science and Engineering Research
- Nuclear Power
  - Advanced Fuels
  - Instrumentation and Controls
  - Technology and Economics
- Isotopes and Radiation Sources
- Space Nuclear Systems

Nuclear Power 2010

Nuclear Power 2010
is a new R&D initiative announced by Secretary Abraham on February 14, 2002. This initiative is designed to clear the way for the construction of new nuclear power plants by 2010.

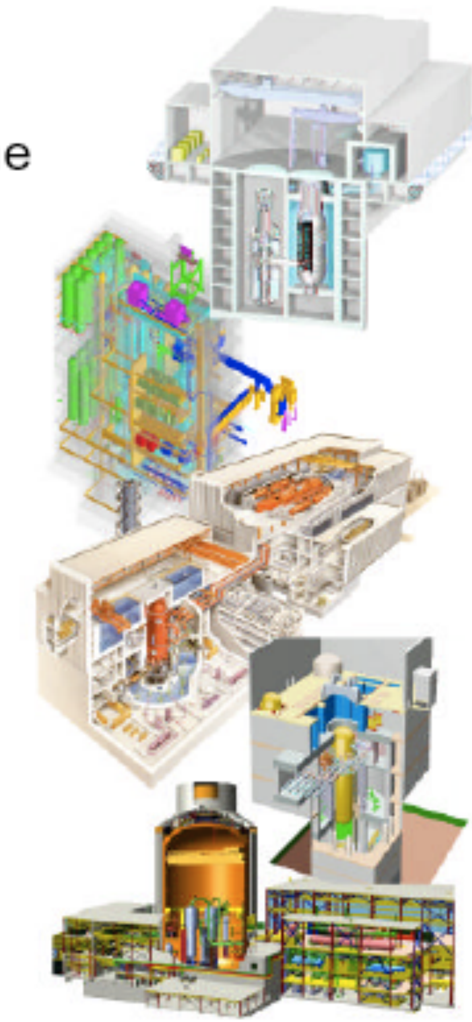
Nuclear Power 2010:
Overview

Goal

- Achieve industry decision by 2005 to deploy at least one new advanced nuclear power plant by 2010

Cooperative Activities

- **Regulatory Demonstration Projects**
  - Early Site Permit (ESP)
  - Combined Construction and Operating License (COL)
- **Reactor Technology Development Projects**
  - NRC Design Certification (DC)
  - First-of-a-kind engineering for a standardized plant
  - Material, component and system testing



Can We Build New U.S. Reactors By 2010? *Yes!*

<u>Can</u> Be Deployed by 2010
- ABWR (General Electric)

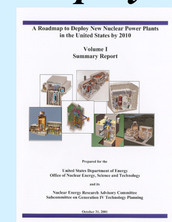
<u>Probably</u> Can Be Deployed by 2010
- AP600 (Westinghouse)
- AP1000 (Westinghouse)
- PBMR (Exelon)

<u>Possibly</u> Can Be Deployed by 2010
- SWR-1000 (Framatone)
- ESBWR (General Electric)
- GT-MHR (General Atomics)

<u>Cannot</u> Be Deployed by 2010
- IRIS (Westinghouse)

2010

Conclusions of the Expert Study: *A Roadmap to Deploy New Nuclear Power Plants in the United States by 2010*


A Roadmap to Deploy New Nuclear Power Plants
in the United States by 2010

Volume I
Summary Report

Prepared for the

United States Department of Energy
Office of Nuclear Energy, Science and Technology

and its

Nuclear Energy Research Advisory Committee
Subcommittee on Generation IV Technology Planning

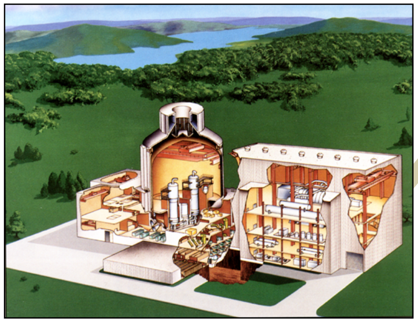
October 31, 2001

But More Work Must Be Done

Early Site Permit Application

- Complete DOE/Industry Scoping Studies
- Launch Cooperative Demonstration of ESP process

Design Certification and Completion of Detailed Design & Engineering



- R&D on First-of-a-Kind Engineering
- Material, Component, and Fuel Testing

Combined Construction and Operating License Application

- Conduct DOE/Industry cost-shared demonstration

Advanced Nuclear Power Systems Online by 2010

- ALWRs
- Gas-cooled reactors

For new U.S. Nuclear Power Plants to be a reality by 2010, DOE must support key R&D and assist industry to demonstrate unproven NRC processes

Generation IV Technology Roadmap

NERAC Meeting: Washington, D.C.
September 30, 2002

Generation IV Technology Roadmap

- Identifies systems deployable by 2030 or earlier
- Specifies six systems that offer significant advances towards:
  - Sustainability
  - Economics
  - Safety and reliability
  - Proliferation resistance and physical protection
- Summarizes R&D activities and priorities for the systems
- Lays the foundation for Generation IV R&D program plans

Generation IV Systems

Gas-Cooled Fast Reactor System	GFR
Lead-Cooled Fast Reactor System	LFR
Molten Salt Reactor System	MSR
Sodium-Cooled Fast Reactor System	SFR
Supercritical-Water-Cooled Reactor System	SCWR
Very-High-Temperature Reactor System	VHTR

- Each system has R&D challenges ahead – none are certain of success

Generation IV International Forum

- **Government-sanctioned organization working together to plan the future of nuclear energy**
  - Chartered in July 2002
  - Conduct joint R&D on next-generation nuclear energy systems
  - Voluntary member participation in specific projects
- **Observer Organizations**
  - OECD-NEA
  - IAEA
  - Euratom

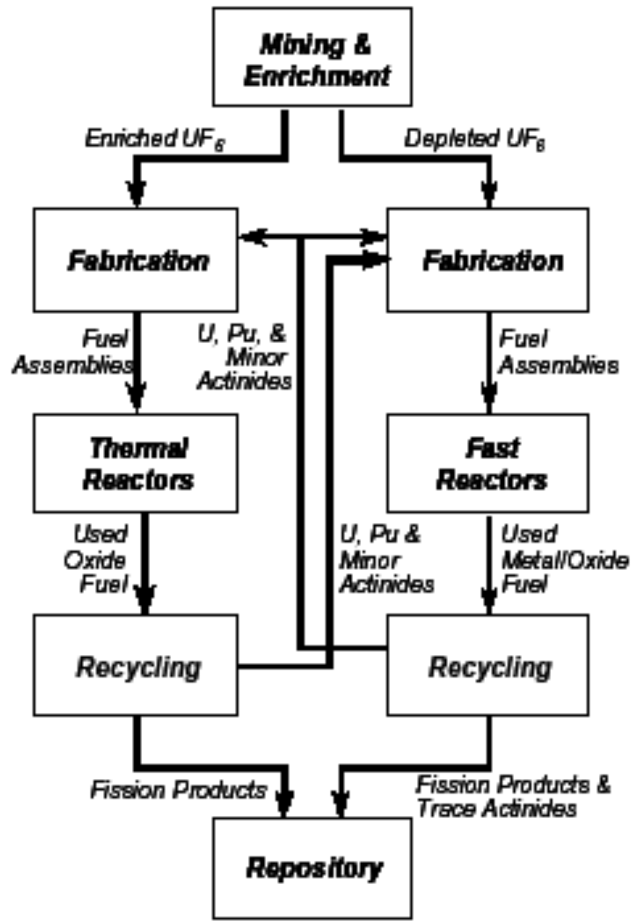
Country Interest in Concept R&D

										
GFR				H	M	L	M	H	H	H
LFR				L	L	L		H		M
MSR				L		L			L	L
SFR				H	H	H			M	M
SCWR			H	M	M	H		H	L	H
VHTR				H	H	M	M	M	H	M

GFR -- Gas-cooled fast reactor
LFR -- Lead-cooled fast reactor
MSR -- Molten salt reactor
SFR -- Sodium-cooled fast reactor
SCWR -- Supercritical water-cooled reactor
VHTR -- Very high temperature reactor

H -- High interest
M -- Medium interest
L -- Low interest
Blank -- No interest
-- Not present in Tokyo

The Portfolio Supports Symbiotic Fuel Cycles



***Disclaimer*:** **This draft report was prepared to help the Department of Energy determine the barriers related to the deployment of new nuclear power plants but does not necessarily represent the views or policy of the Department.**

Business Case for New Nuclear Power Plants

Bringing Public and Private Resources Together for Nuclear Energy

Mitigating Critical Risks on Early Orders for New Reactors

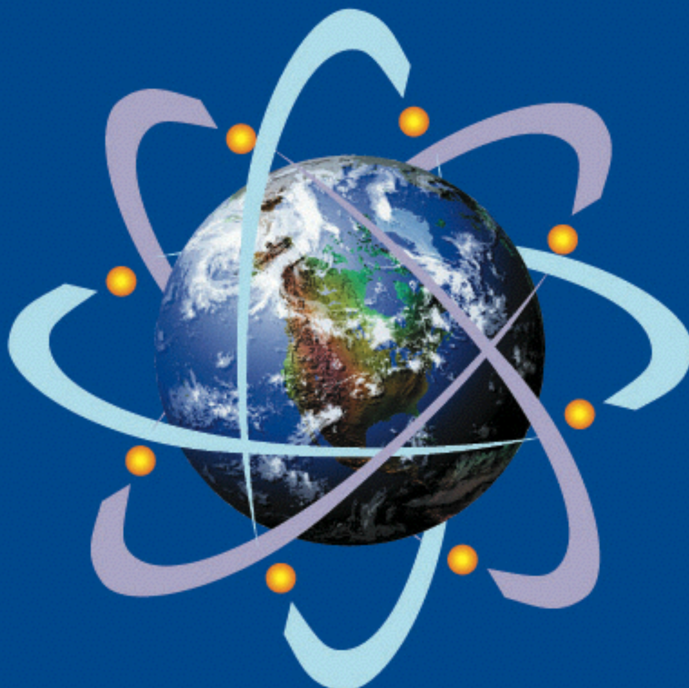
Briefing for NERAC
October 1, 2002

Introduction and Policy Background

- U.S. **National Energy Policy recommended** (NEP, May 2001): **The President should support expansion of nuclear energy** as "a major component of national energy policy", noting that nuclear power offers a low-cost, safe, and environmentally clean source of energy (usually in the form of electricity).
- Energy **Secretary Abraham recommended** (February 2002): **Yucca Mountain should be formally considered for disposal** of nuclear spent fuel.
- **President Bush called** (May 2002): For development of a U.S. strategy to **reduce carbon intensity** in the American economy.
- The current study improved DOE's understanding of the business risks and risk management strategies associated with new nuclear power plants.

Technological Opportunities To Increase the Proliferation Resistance of Global Civilian Nuclear Power Systems (TOPS)

January 2001



Report by the TOPS Task Force of the Nuclear Energy Research Advisory Committee (NERAC)

Nuclear Energy Research Advisory Committee
(NERAC)
Subcommittee on
Long-Term Planning for Nuclear Energy Research

Long-Term Nuclear Technology Research and Development Plan

SUMMARY

June 2000

THE FUTURE of UNVERSITY NUCLEAR ENGINEERING PROGRAMS

and

UNIVERSITY RESEARCH & TRAINING REACTORS

Michael L.Corradini, Chair
Associate Dean, College of Engineering
University of Wiscsonsin, Madison

Marvin L. Adams, Professor
Nuclear Engineering Department
Texas A&M University

Donald E. Dei, Chief Physicist
United States Naval Nuclear Propulsion Program

Tom Isaacs, Senior Scientist
Lawrence Livermore National Laboratory

Glenn Knoll, Professor
Department of Nuclear Engineering and Radiological Sciences
University of Michgan, Ann Arbor

Warren F. Miller
Senior Advisor to the Laboratory Director
Los Alamos National Laboratory

Kenneth C. Rogers, Commissioner (Retired)
United States Nuclear Regulatory Commission

Nuclear Energy Research Advisory Committee (NERAC)

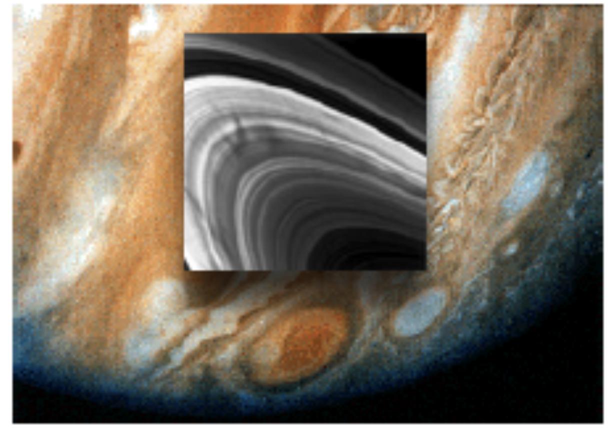
Subcommittee for Isotope Research & Production Planning

Final Report

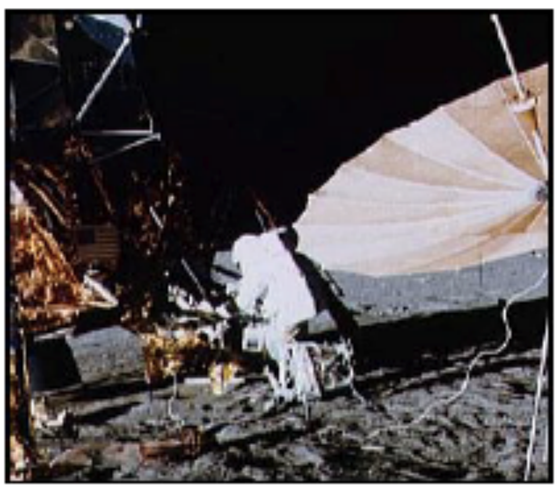
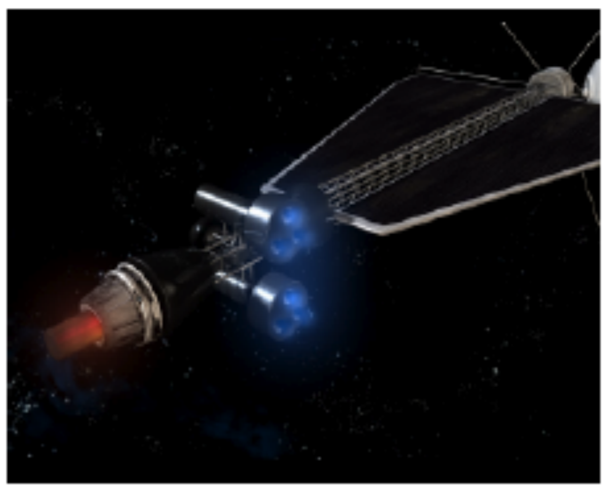
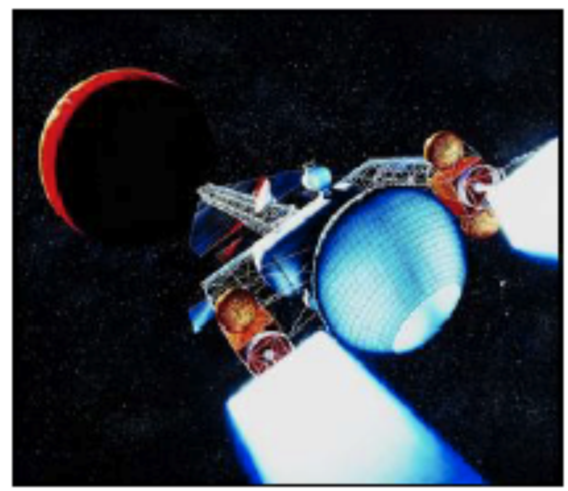
April 2000

Uses of Nuclear Fission in the Civilian Space Program

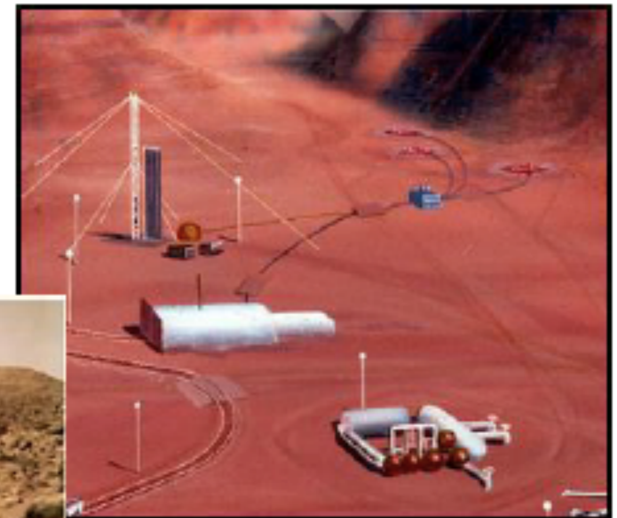
- Outer solar system exploration.
- Planetary or lunar surface missions (robotic or human).
- High-performance propulsion for human missions.
- Advanced applications.

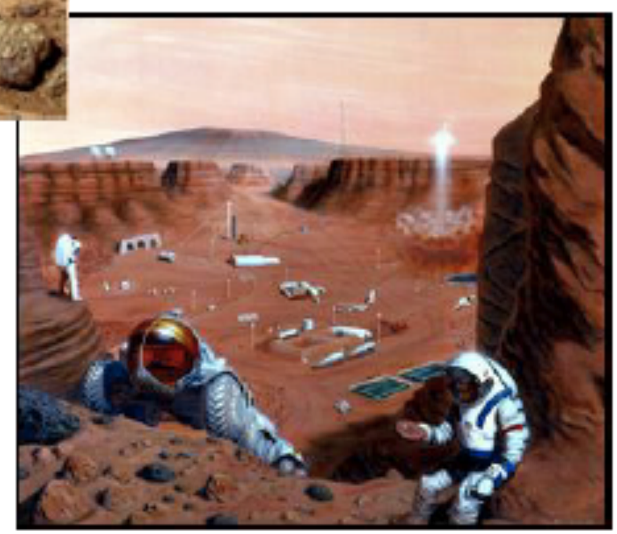



Highly advanced propulsion, extremely high power surface applications.

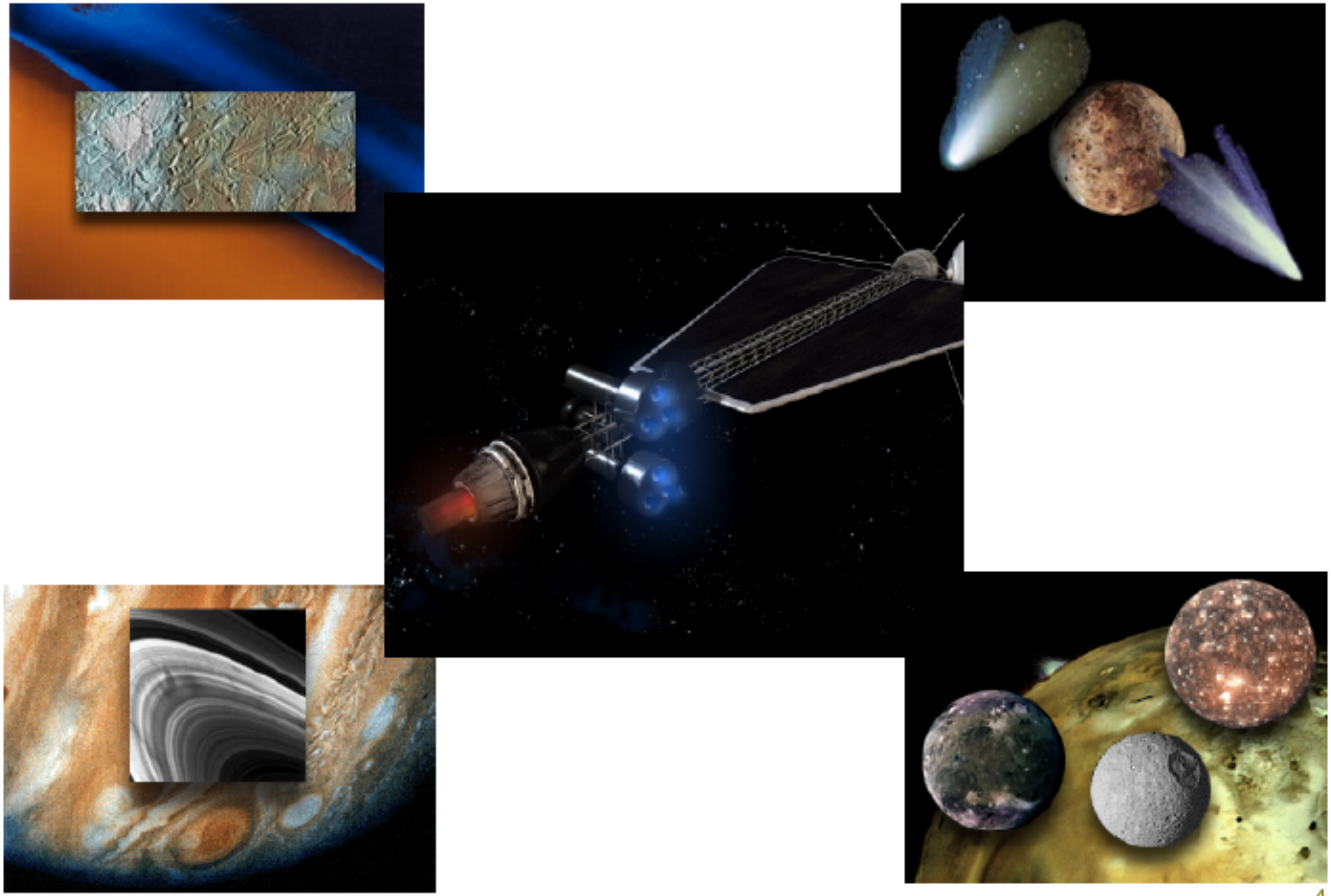




Surface Power Systems

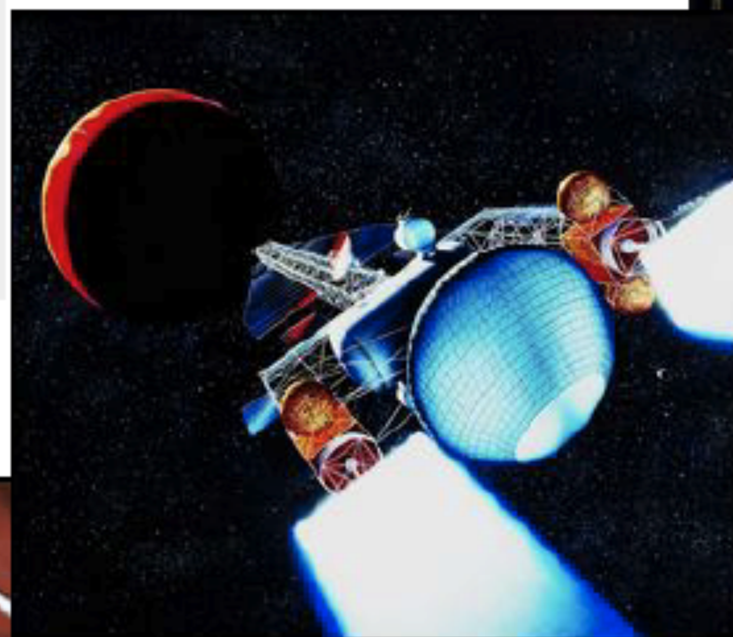




Outer Solar System Exploration



Propulsion for Human Exploration / Advanced



Human Resources

"Perhaps the most important role for DOE/NE in the nuclear energy area is to insure the educational system and facility infrastructure are in good health. It is important that the U.S. maintain a strong commitment to the education and training of nuclear scientists and engineers, to support a wide range of nuclear activities.

In support of these roles, one of DOE/NE's primary responsibilities is to assure the country has the supply of nuclear scientists and engineers that will be needed to provide worldwide leadership in scientific, nonproliferation, commercial, and other uses of nuclear science, technology, and materials. This leads to the need to support undergraduate and graduate students, faculty, and both university and DOE infrastructure as well as to fund long-term nuclear-related R&D that is in the national interest.

Nuclear engineering programs in the US are disappearing. Without concerted action by DOE, supported by OMB and the Congress, most of the existing nuclear engineering programs will soon evaporate or be absorbed and diffused in other engineer disciplines. Direct support to researchers is needed, not only support provided through projects run by industry or the national laboratories, valuable as these last have been and will continue to be."

NERAC Long Range R&D Plan (May, 2000)

Decline in Nuclear Engineering

Over the past two decades, there has been a decline in

Nuclear Engineering Programs: 80 --> 40

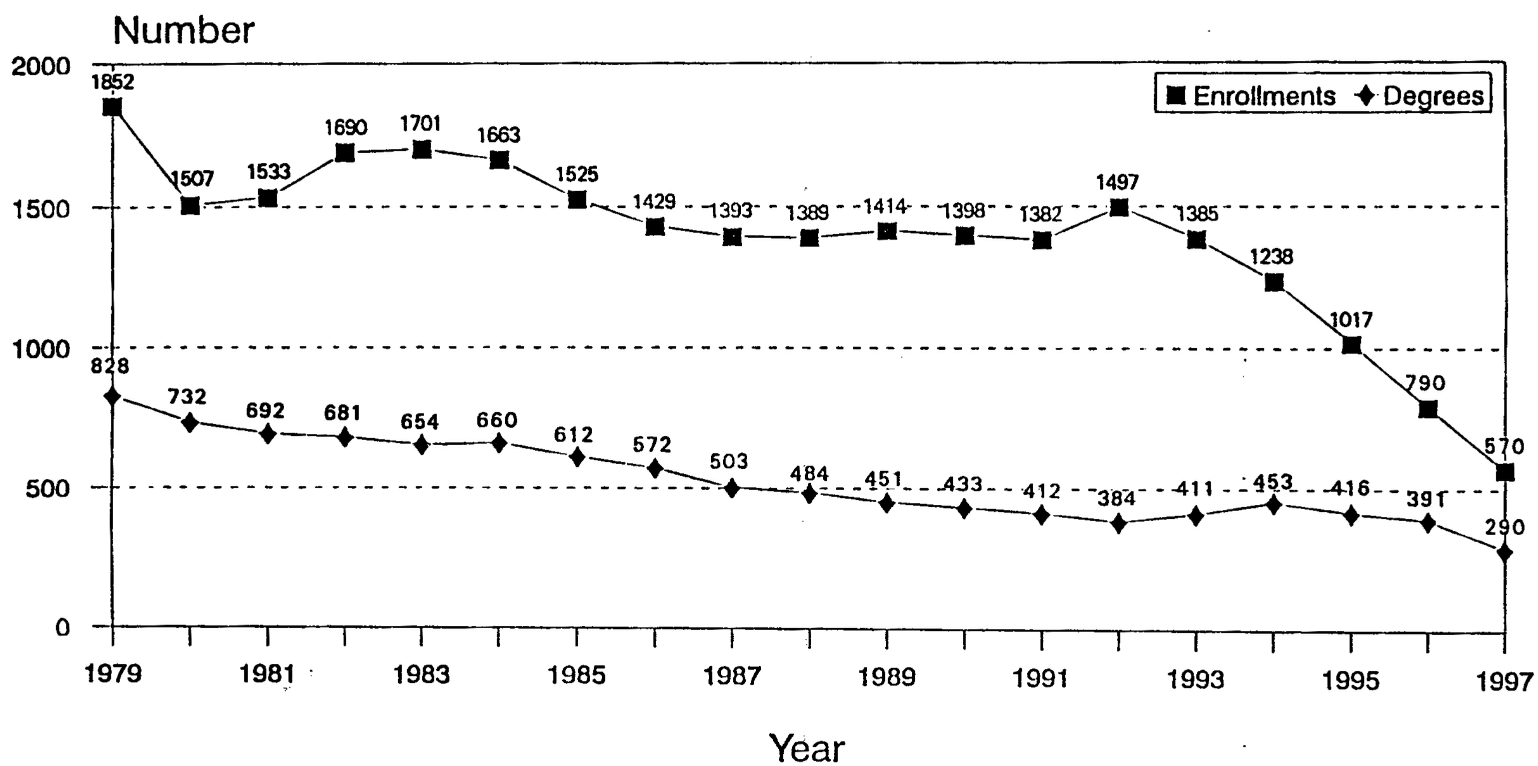
University Research Reactors: 76 --> 28

Undergraduate Enrollments: 1,852 --> 570

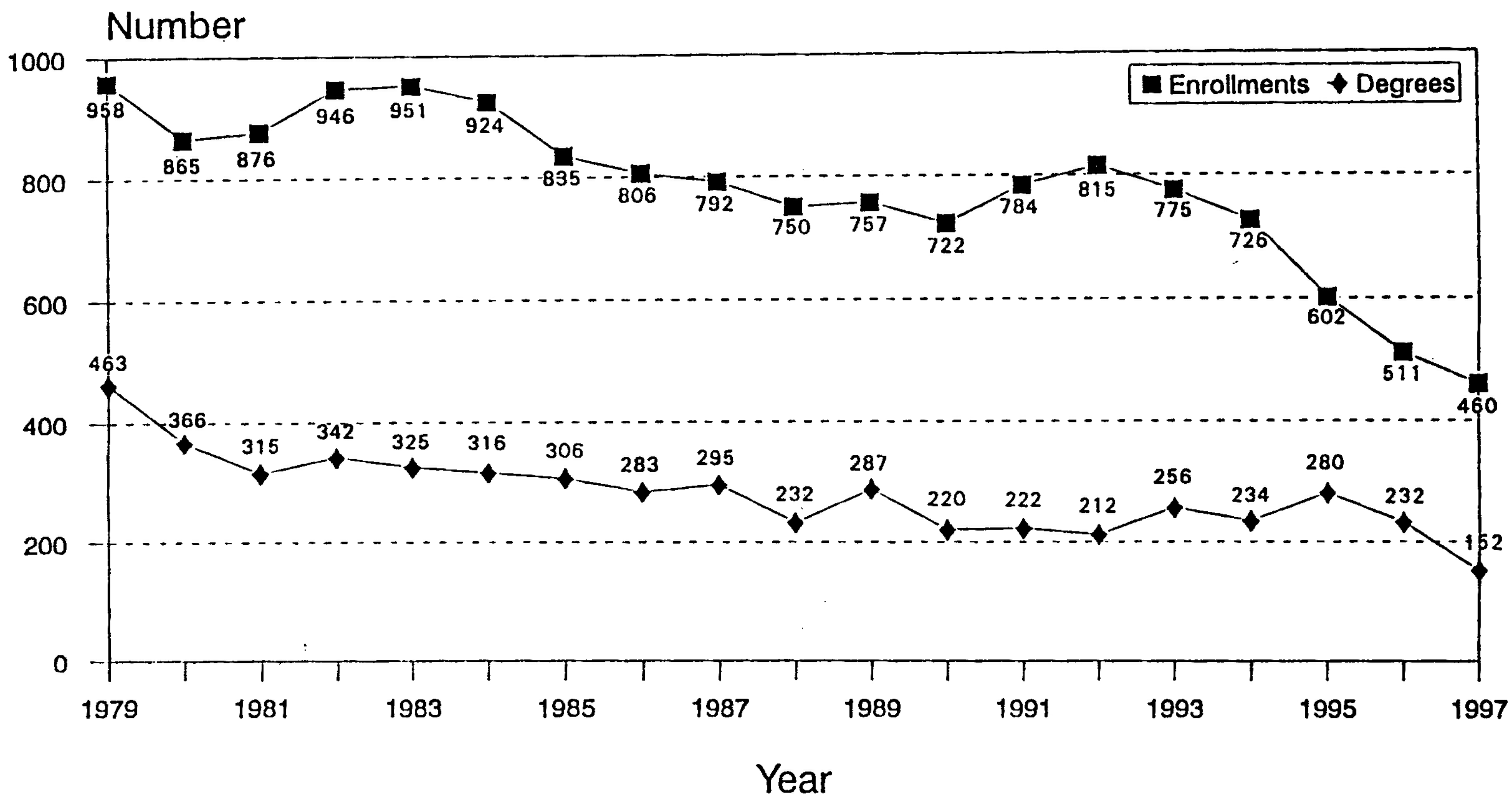
M.S. Enrollments: 958 --> 460

Ph.D. Enrollments: 630 --> 490

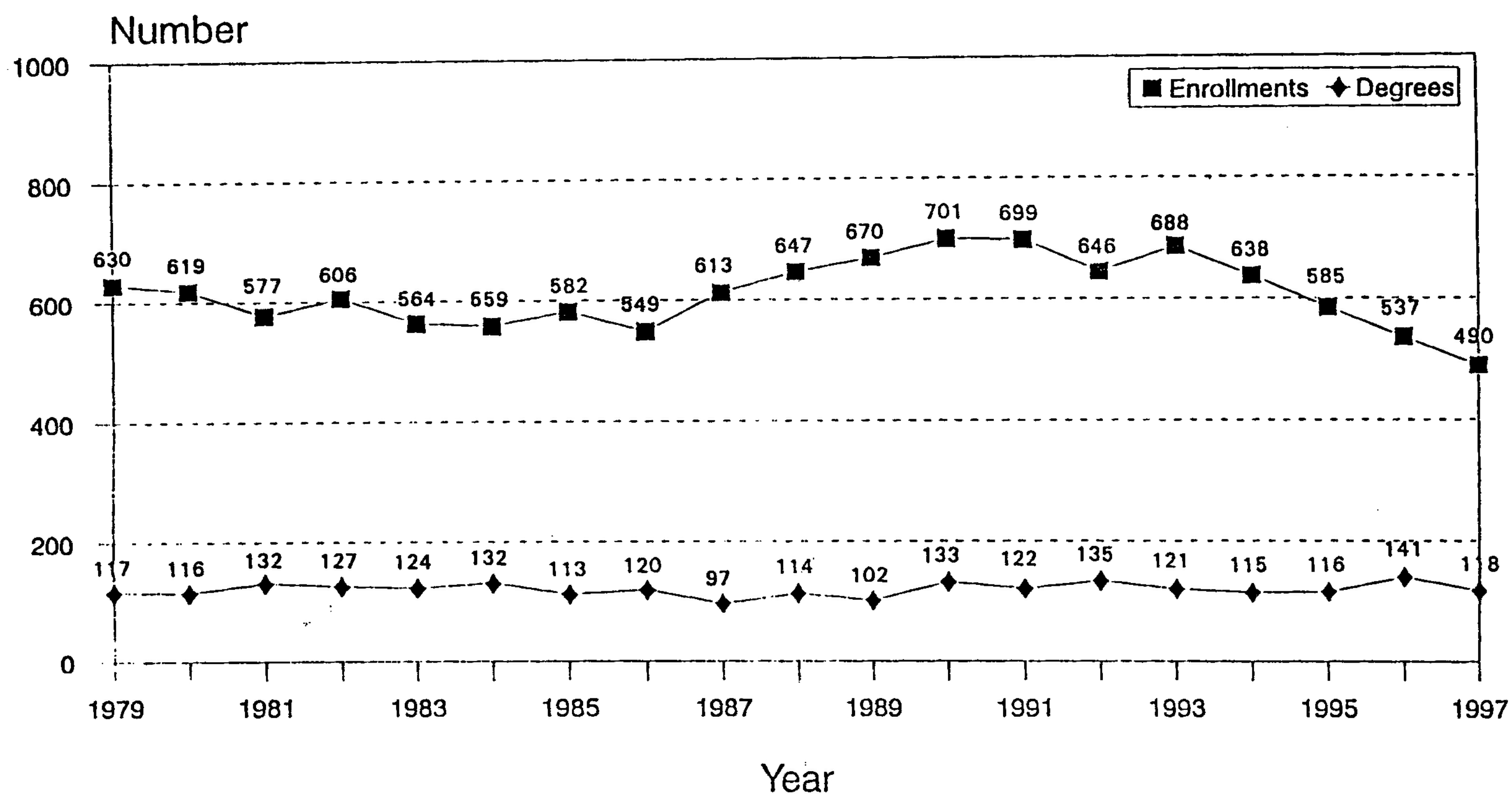
Nuclear Engineering Students (UG)



Nuclear Engineering Students (MS)



Nuclear Engineering Students (PhD)



The Future of Nuclear Engineering

NERAC Blue Ribbon Committee on Nuclear Engineering
(Chair, Mike Corradini, U. Wisconsin)

Charge:

- The intellectual nature of nuclear engineering
- The future of university reactors
- The relationship between university programs and the national laboratories
- The level and nature of federal funding necessary to sustain university nuclear engineering programs.

Intellectual Issues

The most important issue before the blue ribbon committee is the intellectual evolution and “focus” of nuclear engineering programs.

In the past nuclear engineering programs have been distinguished by the way they couple microscopic science with macroscopic engineering (e.g., quantum mechanics with systems design).

Today most programs that have survived have broadened considerably, including nuclear power, radiological science, materials science, medical physics, etc.

University Reactors

Of the 28 remaining campus-based nuclear reactors, how many are capable of significant research? How many can really make contributions in training?

Perhaps we should concentrate limited resources on only a small number of university reactors that would serve as national user facilities.

Perhaps we should make more use of national laboratory facilities through collaboratories for research; perhaps we should use simulators for training.

Relationships between university programs and the national laboratories

There is a long history of mistrust because of the competition between intramural research programs in the labs and the extramural funding of research on the campuses.

Universities also need to more effectively use the resources of the labs for education, e.g., lab facilities for training and lab staff as adjunct faculty.

Although the involvement of universities in programs led by the national labs and industry is important, DOE also needs to provide direct support to university programs.

Federal Funding

Clearly a dramatic increase in funding of university nuclear engineering programs is necessary if we are to sustain the human infrastructure necessary to meet national needs.

Clearly as well the bulk of this funding must come from DOE (since NSF and other mission agencies have long viewed the support of nuclear engineering as the responsibility of DOE).

Federal Funding Options

- Investigator-initiated, peer-reviewed research grants (NEER and NERI)
- Subsidy of university reactors (and other facilities)
- Undergraduate scholarships
- Graduate fellowships and traineeships
- Curriculum development grants

Some interesting comparisons

NSF ITR	$125 M/y
NSF Nanotechnology	$217 M/y
DOE Nuclear Physics	$370 M/y
DOE High Energy Physics	$715 M/y
DOE Nuclear Engineering	$18.5 M/y

Revitalization of Nuclear Research in the U.S.

FY 2004 Nuclear Energy, Science and Technology Budget Request

William D. Magwood, IV, Director
Office of Nuclear Energy, Science and Technology
U.S. Department of Energy

February 3, 2003

FY 2004 Nuclear Energy, Science and Technology Budget Request

(dollars in thousands)

	FY 2002 Comparable Approp.	FY 2003 Comparable Request	FY 2004 Request to Congress	FY 2004 vs. FY 2003	
University Reactor Fuel Assistance and Support..	17,500	17,500	18,500	+1,000	+6%
Research and Development					
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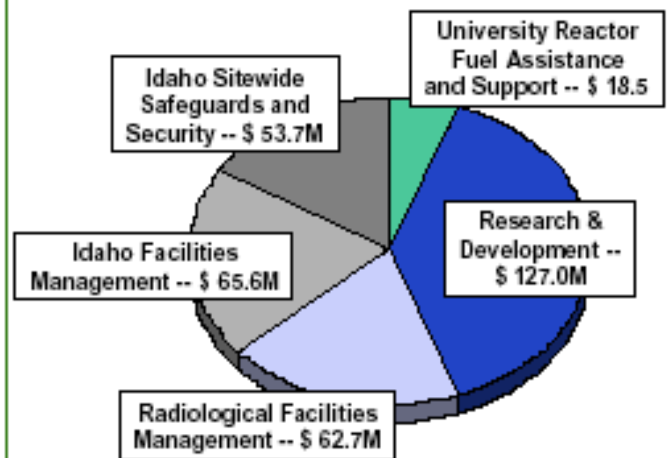

FY 2004 Nuclear Energy, Science and Technology Budget Request

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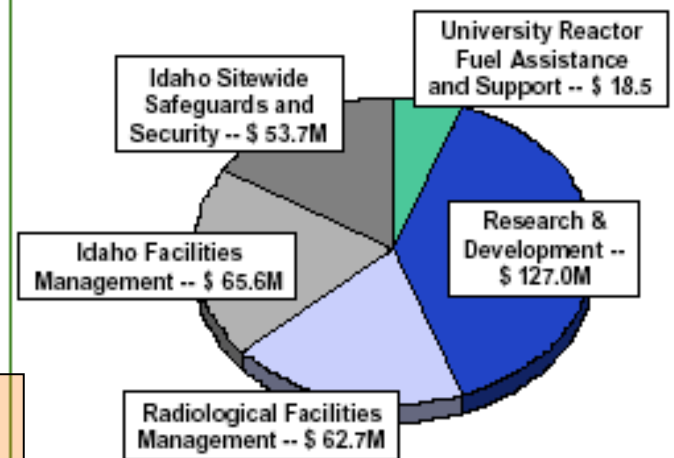
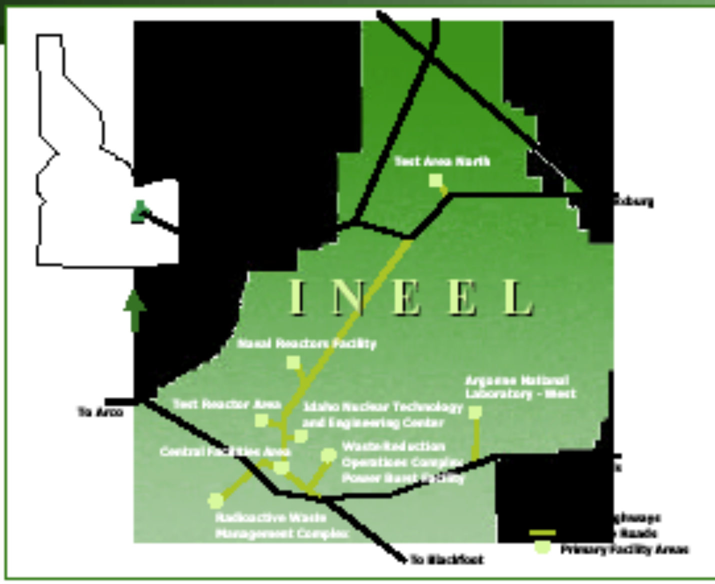
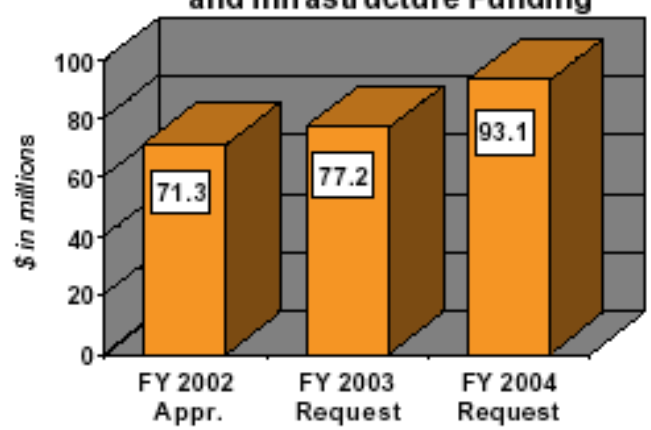


Revitalization of Idaho National Engineering Laboratory





? **On July 15, 2002, Secretary Abraham announced a major mission realignment for INEEL**

? **INEEL will become a world-class nuclear laboratory focusing on R&D such as:**

- Generation IV nuclear energy systems and advanced fuel cycles
- Advanced space nuclear power and propulsion systems

? **Success in environmental cleanup will be essential to the growth in the nuclear program at Idaho**

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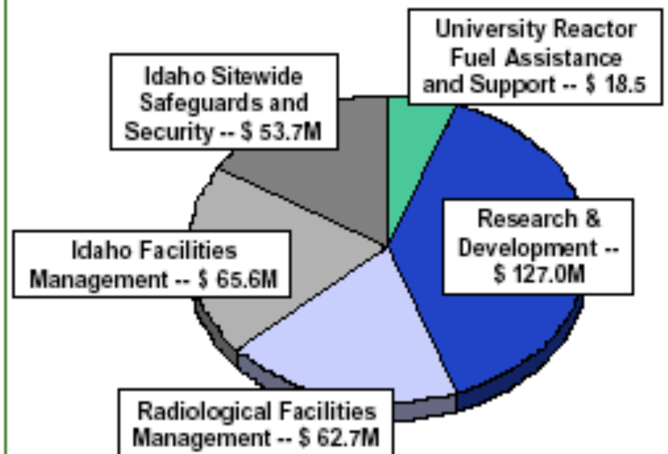

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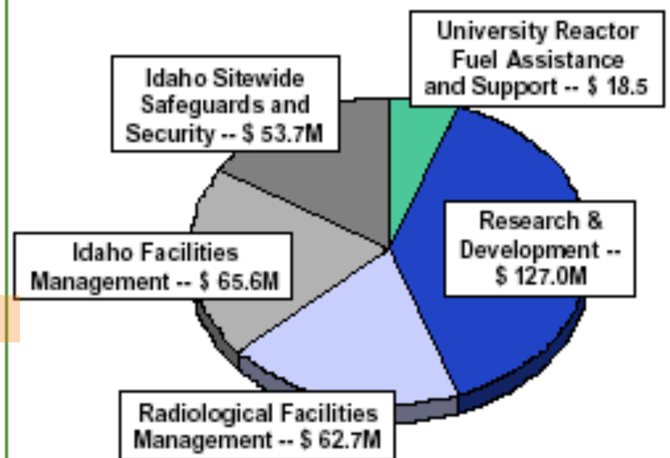
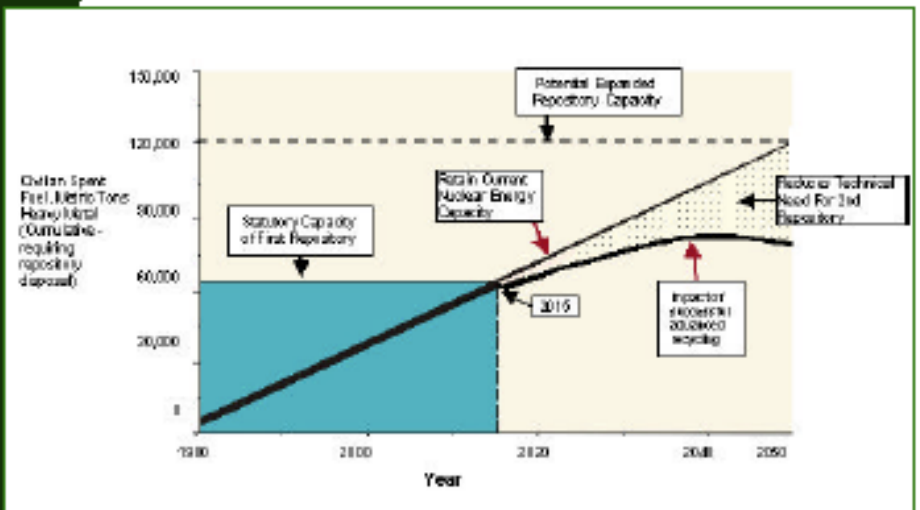


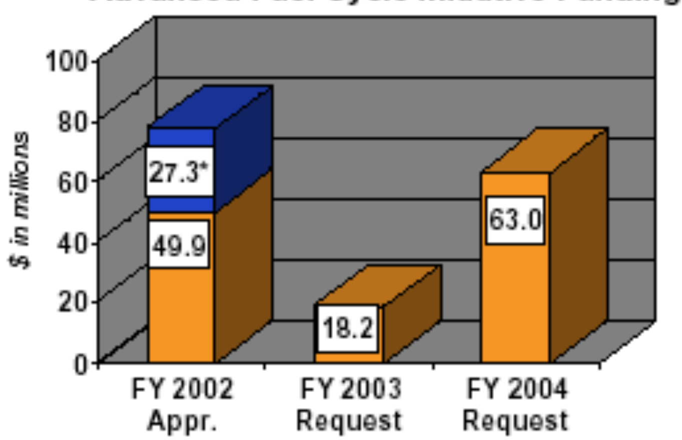
Advanced Fuel Cycle Initiative:
Optimizing Spent Nuclear Fuel Disposition

In cooperation with

OCRWM



Advanced Fuel Cycle Initiative Funding



*Activities related to deactivation of EBR-II.

? Built on international cooperation and collaboration (*e.g.*, France and Russia) and integrated with Generation IV

? *Report to Congress on Advanced Fuel Cycle Initiative: The Future Path of Spent Fuel Treatment and Transmutation Research* issued (January 2003)

Planned Accomplishments -- FY 2004

? Conduct research on proliferation-resistant fuel treatment technologies

? Develop technologies to reduce toxicity and heat load of fuel sent to a geologic repository

? Award additional 10 to 12 transmutation science fellowships to U.S. universities

FY 2004 Nuclear Energy, Science and Technology Budget Request

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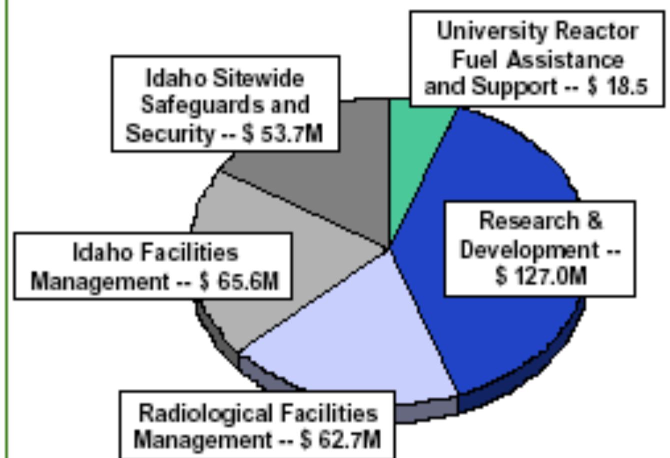

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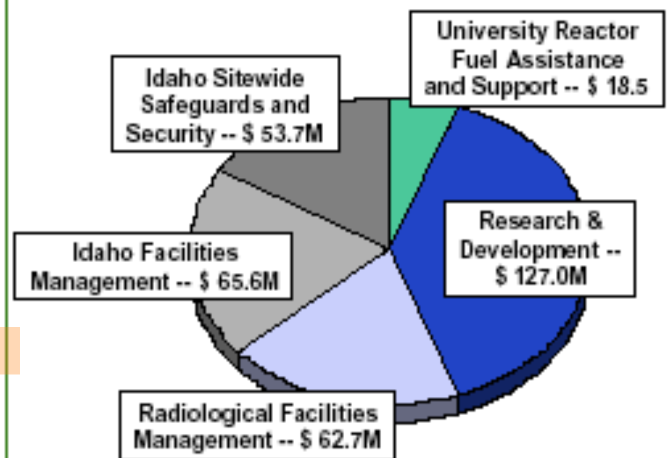
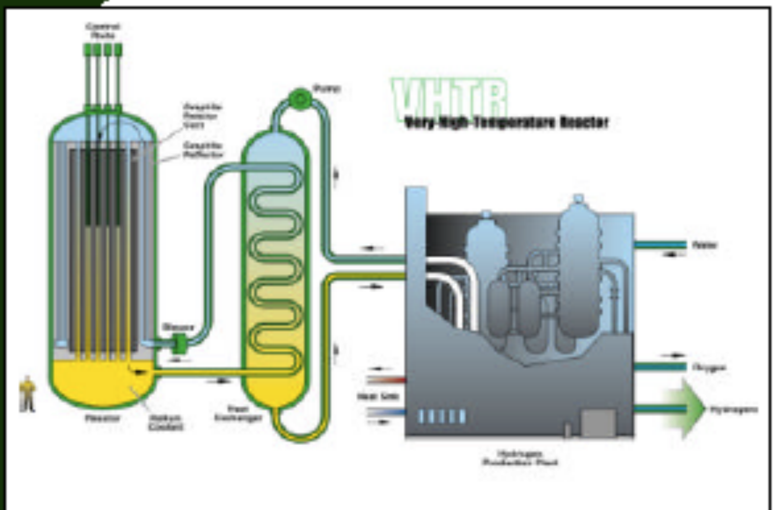
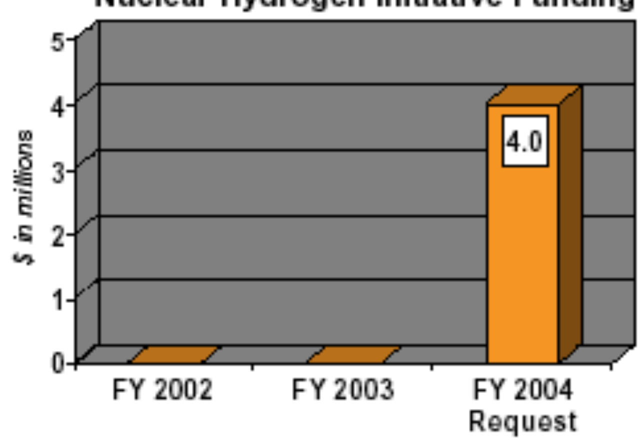


Nuclear Hydrogen Initiative: *Developing Nuclear Energy Systems for Clean and Abundant Hydrogen Production*



Nuclear Hydrogen Initiative Funding



? Nuclear energy systems offer opportunity for economical, clean, and abundant source of hydrogen

Planned Accomplishments in FY 2004

? Complete a Nuclear Hydrogen Technology Roadmap

- Built on National Hydrogen Energy Roadmap and inter-office cooperation
- Define R&D required to develop an integrated nuclear hydrogen production plant

? Develop concept for an integrated nuclear hydrogen production system

? Initiate R&D on high temperature and corrosion resistant materials for thermo-chemical process

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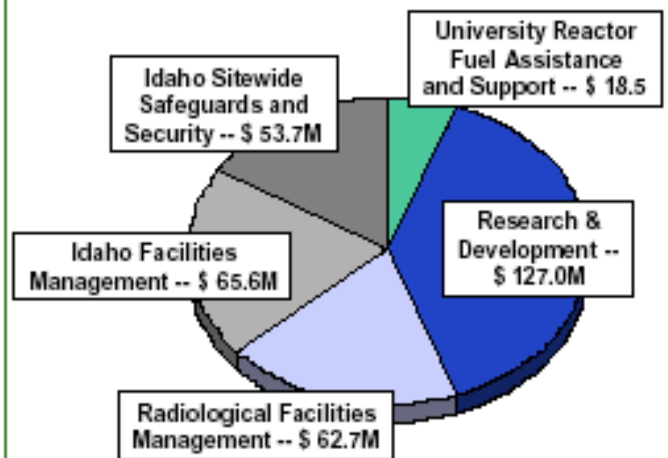

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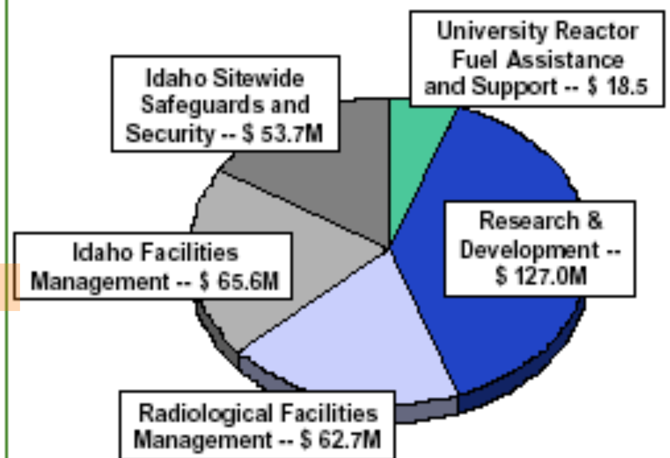
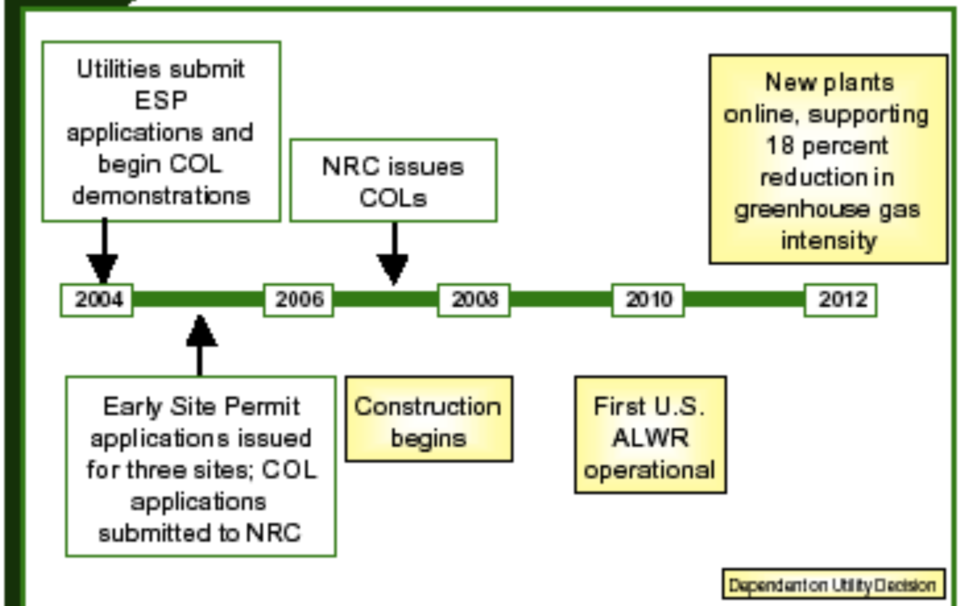
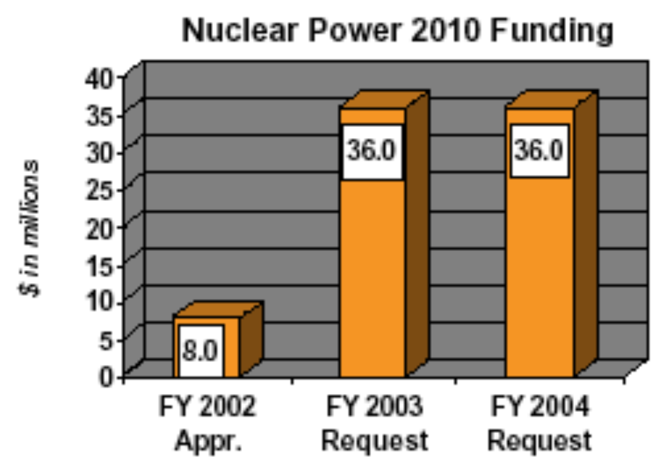


Nuclear Power 2010:
Paving the Way for New Nuclear Power Plants





? U.S. utilities are examining the business cases for new nuclear plants in the U.S.

? Cost-shared regulatory demonstrations and R&D on advanced technologies underway aimed at deploying new plants by 2010

Planned Accomplishments -- FY 2004

? In FY 2003 and FY 2004, DOE will select industry partners for demonstration of Combined and Operating License (COL) processes

? Advanced gas cooled reactor fuel development program continues in FY 2004

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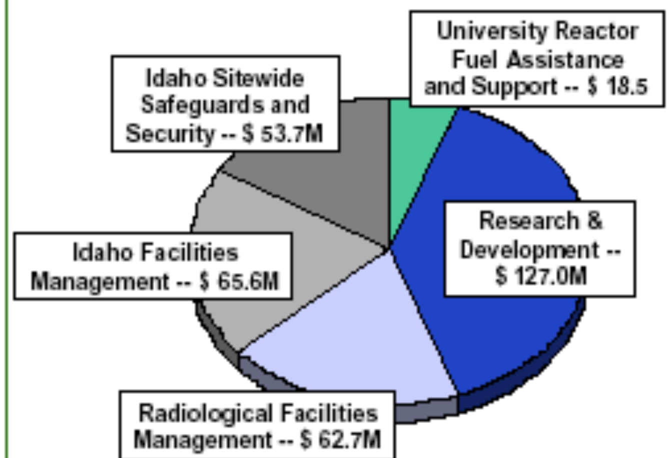

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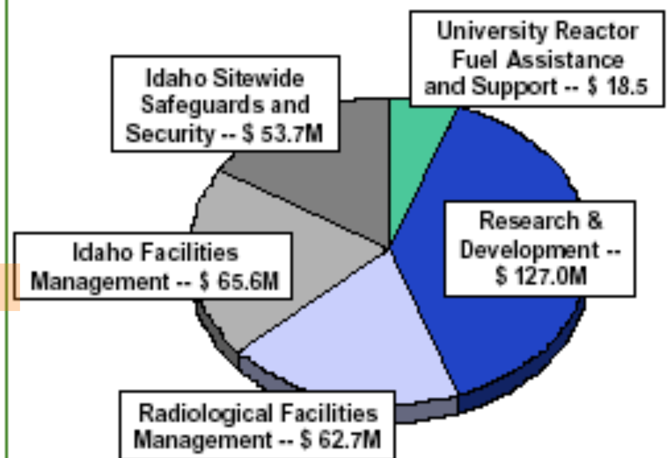
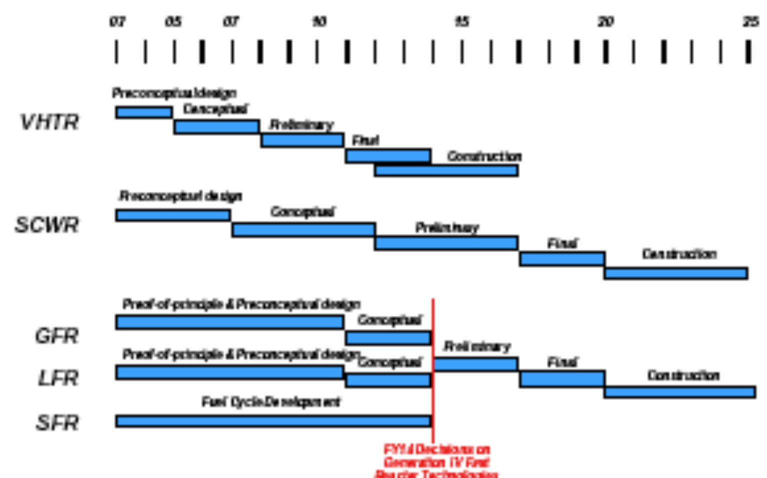
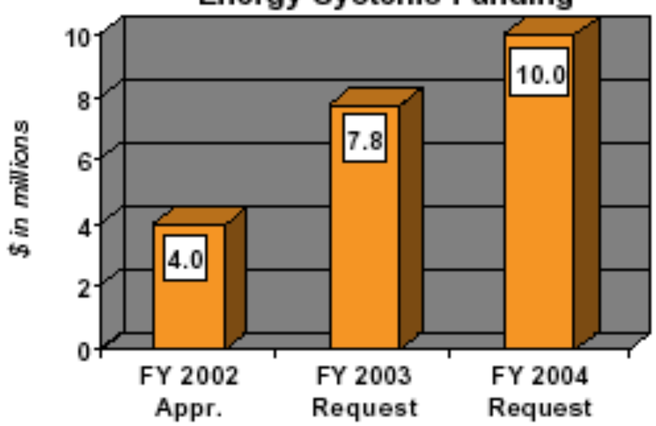


Generation IV Nuclear Energy Systems: *Nuclear Power for a New Century*

Potential Generation IV Timelines



Generation IV Nuclear Energy Systems Funding



- **Developing advanced nuclear energy systems for deployment after 2010 and before 2030**
- **In September 2002, the 10-Nation Generation IV International Forum agreed on 6 advanced technologies, including:**
  - Very High Temperature Reactor (VHTR)
  - Supercritical Water Cooled Reactor (SCWR)
  - Gas Cooled Fast Reactor (GFR)
  - Lead Cooled Fast Reactor (LFR)

Planned Accomplishments -- FY 2004

- **Conduct major VHTR trade studies**
- **Complete feasibility study on GFR fuels studies**
- **Initiate mechanical and irradiation tests on advanced materials**

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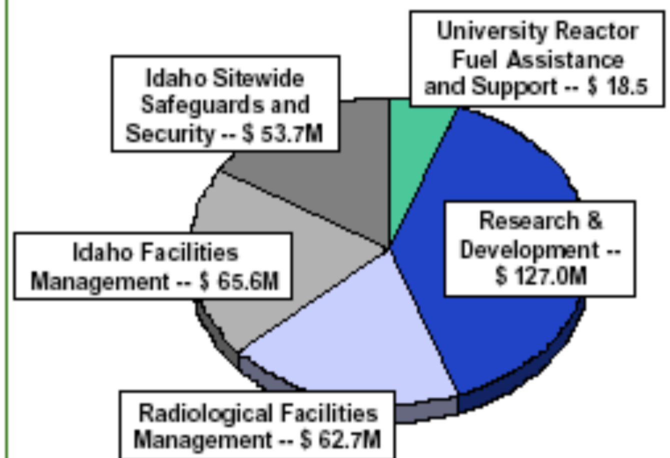

FY 2004 Budget Request

February 3, 2003

New Initiatives:
Building on Our New Vision/Mission

($ in millions)	2004	2004-08 Total
To Understand & Protect Our Home Planet		
Climate Change Research Acceleration	26	72
Aviation Security	21	196
National Airspace System Transition	27	100
Quiet Aircraft Technology	15	100
To Explore the Universe & Search for Life		
Project Prometheus *	93	2,070
Optical Communications	31	233
Beyond Einstein Initiative	59	765
Human Research Initiative	39	347
To Inspire the Next Generation of Explorers		
Education Initiative	26	130
TOTAL for Initiatives	**337**	**4,013**

* Note: Amount shown is in addition to $1 billion from Nuclear Systems Initiative

Project Prometheus:
Pursuing New Capabilities & Revolutionary Science

- **Revolutionary capabilities for nuclear propulsion and power**
  - Much greater ability to power instruments, change speed, and transmit science data
  - No launch constraint to use gravity assists
  - Can orbit multiple objects or moons with vastly greater, persistent observation time
  - Can change target mid-mission (to support change in priorities)

- **First use: Jupiter Icy Moon Orbiter**
  - Search for evidence of global subsurface oceans on Jupiter's three icy Galilean moons: Europa, Ganymede, and Callisto. These oceans may harbor organic material.
  - Nuclear technology will enable unprecedented science data return through high power science instruments and advanced communications tech