NUCLEAR POWER

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Nuclear Economics

- Existing nuclear plants can compete favorably with fossil-fueled plant today because of their low operation and maintenance (O&M) and fuel costs.
- New nuclear power plants are uneconomical today because of their high construction costs.
- There have been no successful nuclear plant orders in the U.S. since 1973.

Table 5.1 Costs of Electric Generation Alternatives
Real Levelized Cents/kWe-hr (85% capacity factor)

Base Case	25-YEAR	40-YEAR
Nuclear	7.0	6.7
Coal	4.4	4.2
Gas (low)	3.8	3.8
Gas (moderate)	4.1	4.1
Gas (high)	5.3	5.6
Gas (high) Advanced	4.9	5.1
Reduce Nuclear Costs Cases		
Reduce construction costs (25%).	5.8	5.5
Reduce construction time by 12 months	5.6	5.3
Reduce cost of capital to be equivalent to coal and gas	4.7	4.4

Carbon Tax Cases (25/40 year)	$50/tC	$100/tC	$200/tC
Coal	5.6/5.4	6.8/6.6	9.2/9.0
Gas (low)	4.3/4.3	4.9/4.8	5.9/5.9
Gas (moderate)	4.6/4.7	5.1/5.2	6.2/6.2
Gas (high)	5.8/6.1	6.4/6.7	7.4/7.7
Gas (high) advanced	5.3/5.6	5.8/6.0	6.7/7.0

Source: MIT Study, "The Future of Nuclear Power," 2003, p. 42.

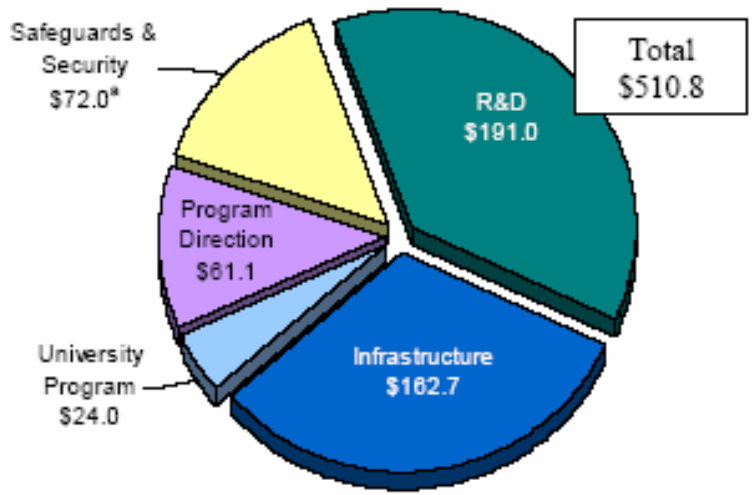
The Nuclear Industry's Solution to its Future

- Have the Federal Government subsidize Nuclear Plants through:
  - DOE Nuclear Power 2010 Program
    - **Early Site Permits** (ASPs)
    - **Construction and Operating Licenses** (COLs)
  - Energy Bill
    - **Reactor Construction Subsidies**

FY 2006 Budget Request
Nuclear Energy, Science and Technology Budget

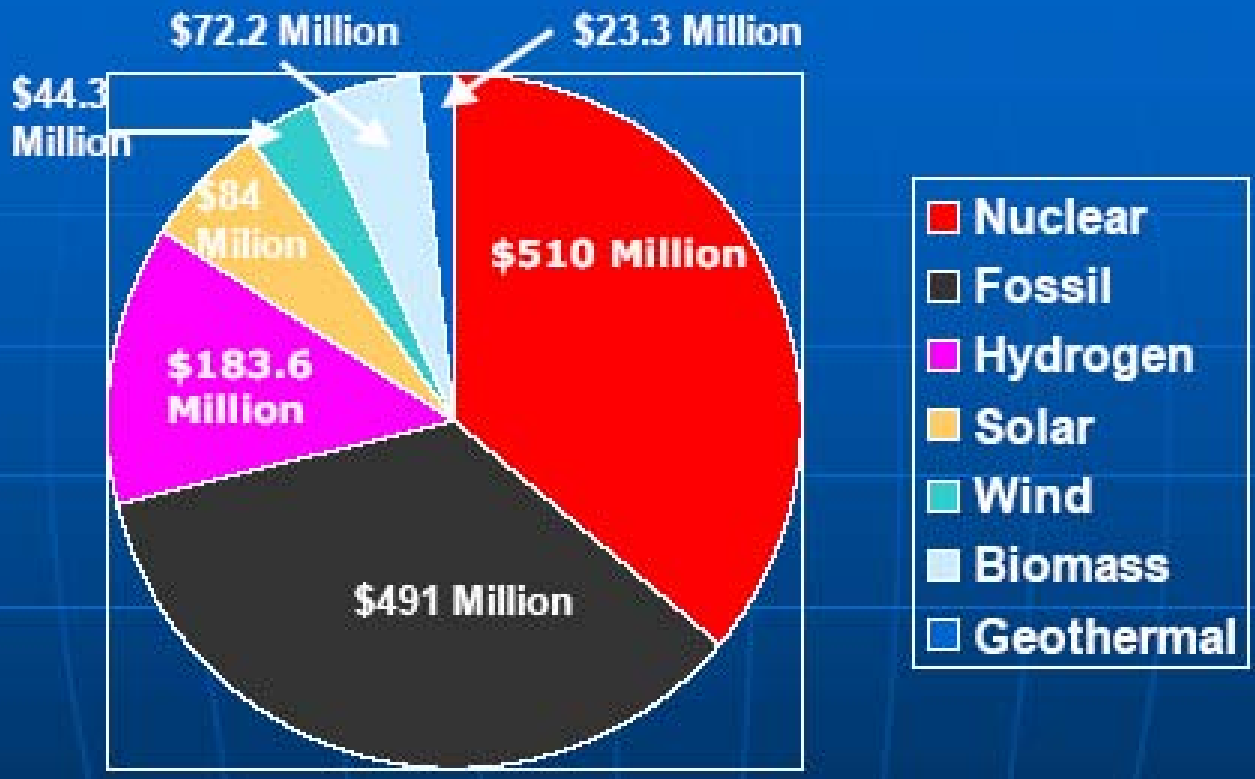
Program	FY 2005 Comparable Approp.[c]	FY 2006 Request[c]
University Reactor Infrastructure and Education Assist.	23,810	24,000
Research and Development:		
Nuclear Energy Plant Optimization	2,480	0
Nuclear Energy Research Initiative	2,481	0
Nuclear Power 2010	49,605	56,000
Generation IV Nuclear Energy Systems Initiative	39,683	45,000
Advanced Fuel Cycle Initiative	67,462	70,000
Nuclear Hydrogen Initiative	8,929	20,000
Infrastructure:		
Radiological Facilities Management	68,563	64,800
Idaho Facilities Management	112,153 [a]	97,862
Idaho Sitewide Safeguards and Security	57,662	75,008
Program Direction	60,035	61,109
Spent Nuclear Fuel Management	1,488 [b]	0
Use of Prior Year/Other Adjustment	-5,717	0
Less Security Charges for Reimbursable Work	-3,003	-3,003
Total Nuclear Energy	**485,631**	**510,776**

[a]Excludes $10M from Naval Reactors
[b]Program returned to the Office of Environmental Management
[c]All values are dollars in thousands



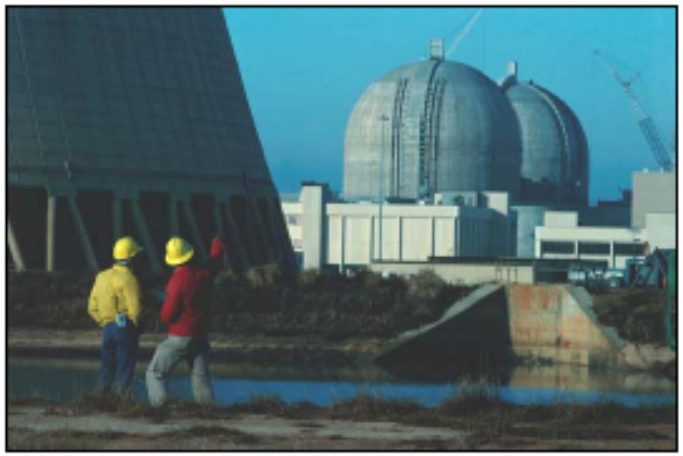
[a]Includes $3.0M reduction for Security Charges for Reimbursable Work

Nuclear Energy gets the single largest R&D subsidy as a fuel source.



As an outcrop of the nuclear weapons program, between 1948 and 1998, 59% of R&D funding ($66 billion in constant 1999 dollars) went to nuclear power. During that time, 23% went to fossil energy ($26 billion), 11% to renewable energy ($12 billion), and 7% to energy efficiency ($8 billion). Source: Sustainable Energy Coalition.

Development & Deployment of Advanced Technologies
A Strong Investment in a Nuclear Energy Future



FY 2006 Request ($ in Millions)	
Nuclear Power 2010	$ 56.0
Generation IV Nuclear Energy Systems Initiative	45.0
Advanced Fuel Cycle Initiative	70.0
Nuclear Hydrogen Initiative	20.0
Total	$191.0

The President's budget supports:

- Cost-shared projects on New Nuclear Plant Licensing Demonstration
- R&D to establish the technical viability of Generation IV technology
- Development and testing of advanced separation and fuel technologies
- Development of thermochemical and high-temperature electrolysis hydrogen production methods

Nuclear Power 2010 Program

(Unveiled by Sec. of Energy on Feb. 14, 2002)

DOE's Stated Goal:

Enable an industry decision in 2005 to proceed with obtaining an NRC license **to construct and operate at least one new nuclear power plant in the United States**. [The original 2005 date has slipped about 5 years.]

- Nuclear Power 2010 is not an R&D Program

- **It is a direct subsidy to the nuclear industry**

Nuclear Power 2010
Federal Subsidies

($ Millions)

FY2005 Funding profile:

---------- Actual ----------				---------- Projected ----------				
FY 2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
7.9	16.6	19.4	10.2	65	75	70	55	55

FY 2006 actual budget request (Feb 2005): $56 m

Actual program extends beyond 2010.

Total subsidy: > $365 million over 9+ years

Early Site Permits and Combined Construction and Operating Licenses

- DOE initiated **cooperative projects** with industry to:
  - Obtain NRC approval of **three sites** for construction of new nuclear power plants under the **Early Site Permit** (ESP) process;
  - Develop application preparation guidance for the combined **Construction & Operating License** (COL) and to resolve generic COL regulatory issues.

Early Site Permits

DOE shared the cost of ESP applications for:

- Dominion Energy's North Anna site (Mineral, VA)
- Exelon Generation Company's Clinton site (Clinton, IL)
- Entergy Corporation's Grand Gulf site (Port Gibson, MS)

Selected Participants Are Receiving Their Federal Subsidies for Early Site Permits

- **Without Any Commitment to Construct a Reactor**
- **Early Site Permits are financial assets that can be banked or sold**

Construction & Operating Licenses (COLs)

- In November 2003, DOE issued a solicitation for licensing demonstration projects intended to lead to successful COLs.

Three consortia responded, two with substantial proposals

- Advanced Candu Reactor (ACR-700) at Dominion Resources North Anna Site; in Jan 2005, Dominion revamped its proposal and dropped Atomic Energy of Canada, Ltd.'s (AECL's) ACR-700 in favor of GE's Economic Simplified Boiling Water Reactor (ESBWR)
- NuStart Energy (Westinghouse Advanced Plant 1000 (AP1000) or GE ESBWR at site to be determined)
- In addition, a $9M cost and feasibility study for a two-unit GE Advanced Boiling Water Reactor (ABWR) at TVA's Bellefonte site

Who are these consortia participants?

Do they need or deserve subsidies from the taxpayer?

Nuclear Plants and Financial Data of Companies Responding to the DOE's Nuclear Energy 2010 Program Solicitation for Licensing Demonstration Projects

U.S. Nuclear Plants Owned or Operated by Energy Generating Companies Responding to the DOE's Nuclear Energy 2010 Program Solicitation for Licensing Demonstration Projects

Dominion -- ESBWR at North Anna Site

Dominion Energy:

6 nuclear plants (5,572 Net MWe); trying to buy 2 more

NuStart Energy

Exelon, Entergy, Constellation Energy, Southern Company, Duke Energy, TVA, EdF International North America, Progress Energy, Florida Power & Light:

60 U.S. nuclear plants (59,855 Net MWe)

ABWR at TVA's Bellefonte Site

TVA: 6 plants (6,701 Net MWe)

Total: : 66 plants (62,978 Net MWe)

63% of the 104 licensed nuclear plants

Financial Data of Companies Associated with the Dominion Resources ESBWR at North Anna Site Proposal

Company	Assets ($ millions)	Revenues ($ Millions)	Net Income ($ millions)	Employees	Date
Dominion Resources	44,186	13,972	1,249	16,700	2004
General Electric	647,482	151,300	16,593	305,000	2004
Bechtel	?	12,700 (new work booked) 11,600 (work off revenue)		47,000	2004

Dominion Resources has been approved to receive $9 million in Nuclear Power 2010 funding, held over from FY 2004

Financial Data of Companies Associated with the NuStart Energy (AP1000 or ESBWR) Proposal

Company	Assets ($ millions)	Revenues ($ Millions)	Net Income ($ millions)	Employees	Date
Exelon	41,941	14,515	1,864	17,300	2004
Entergy	28,554	10,124	933	14,564	2004
Constellation	15,801	12,550	598	9,600	2004
Southern Co.	35,045	11,903	1,531	25,762	2004
Duke	56,203	22,503	1,191	23,800	2004
TVA	34,280	7,533	386	13,379	2004
Progress Energy	26,202	8,743	782	16,000	2003
FPL Group, Inc.	26,935	10,522	887	9,600	2004
EdF Group, Intl. (€)	146,900	44,919	857	167,309	2003
Subtotal	411,861	143,312	9,029	297,314	
BNFL	£ 23,892	£ 2,322	(£ 194)	23,000	2003-2004
General Electric	647,482	151,300	16,593	305,000	2004

Steal from the Middle-Class to Subsidize the Rich

- The generating companies in the NuStart consortium have a combined annual net income that is **25 times** the entire 9 year budget (FY02-FY10) for the Nuclear Power 2010 program.
- But NuStart will be paid by ordinary taxpayers.

Financial Data of Companies Associated with the Two-Unit (ABWR) at TVA's Bellefonte Site Proposal

Company	Assets ($ millions)	Revenues ($ Millions)	Income ($ millions)	Employees	Date
TVA	34,280	7,533	386	13,379	2004
General Electric	647,482	151,300	16,593	305,000	2004
Toshiba	?	?	?	?	
Bechtel	?	12,700 (new work booked) 11,600 (workoff revenue)		47,000	2004
Global Nuclear Fuels-America					
USEC, Inc.					

Selected Participants Will Receive Their Federal Subsidies for COLs

- **Without Any Commitment to Construct a Reactor**
- **Why would they commit at the COL licensing stage; if they did they wouldn't receive the big money which is yet to come**

Public Participation! (or Lack Thereof)

- The Nuclear Regulatory Commission's Early Site Permits (ESPs) will be good for 20 years and can be renewed for an additional 20 years.
- Some 10 to 40 years hence, your children and grandchildren will be unable to challenge siting issues decided under ESPs or design safety issues decided under Construction & Operating Licenses (COLs).

Most of the COL Subsidy Will Go to the Reactor Vendors

- **General Electric Company**

  and/or

- **Westinghouse**

Subsidizing General Electric

- Exxon Mobil Corp. passed General Electric Co. February 18, 2005, to become the largest U.S. corporation by stock market value. . . . That vaulted Exxon Mobil ahead of GE in market capitalization, topping $383 billion compared with about $379 billion for GE.

  --Associated Press, February 18, 2005

- **U.S. Government may subsidize the second largest company in the U.S., with 2004 net income of $16.6 billion!**

General Electric heads for China

Having so far left the Chinese reactor market to others, GE is commending its new reactor designs for the next tranche of orders there. China has had a de facto policy of favoring pressurized water designs, but GE will offer its two boiling water types - the ABWR which is operating in Japan and under construction there and in Taiwan, and the newer ESBWR which features strongly in US plans for new capacity. GE Nuclear and its Japanese partners are in discussion with the China National Nuclear Corporation and provincial governments, who are likely to be influential in technology choice for the next batch of projects.

Nucleonics Week 14/4/05, China Daily 7/4/05.

General Electric's Advanced Boiling Water Reactor (ABWR)

- The ABWR is General Electric's current market offering with two units operating in Japan since 1997, and four additional units under construction in Japan and Taiwan.

General Electric's Economic Simplified Boiling Water Reactor (ESBWR)

- ESBWR is a 4000 MWt (~1390 MWe) General Electric reactor follow-on to the ABWR that had been under design for nine years prior to being submitted to the NRC on April 18, 2002 for pre-application review.

Subsidizing Westinghouse

- **BNFL Westinghouse has already been promised $5 billion in US ExIm-Bank financing for its bid to sell reactors in China.**
- **Westinghouse is owned by BNFL, a British (government) company.**
- **The U.S. Government may again subsidize a British Company!**

Westinghouse's Advanced Plant 1000 (AP1000)

- On Sept. 13, 2004, the NRC granted Final Design Approval (FDA) to Westinghouse Electric Company's AP1000, clearing the way for the company to begin marketing the design internationally.
- "An FDA from the NRC is usually required by plant buyers in other nations seeking bids for new nuclear plants" ...Now that we have a formal FDA, we will be able to offer the AP1000 for forthcoming requests from the People's Republic of China." Quote by Steve Tritch, President and CEO of Westinghouse CEO, on BNFL's web site.
- **The AP1000 "received final design approval last year and is on schedule for certification this year**"

"Nuclear News," Feb 2005, p. 17.

Nuclear Power 2010 Program

DOE's Stated Mission:

- Resolve the regulatory, technical, and institutional uncertainties associated with the licensing and construction of new nuclear power plants.

Nuclear Regulations

- For 25 years the U.S. Nuclear Power Industry has enjoyed a regulatory process of its own design.
- The opportunities for public participation in the licensing process have been significantly reduced.

Nuclear Safety Priorities

- In March 2002, a football-size cavity (created by boric acid corrosion) was discovered in the Davis-Besse reactor vessel head.

- "The fact that (the licensee) sought and the [NRC] staff allowed Davis-Besse to operate past December 31, 2001, without performing these inspections was driven in large part by the desire to lesson the financial impact on (the licensee) that would result in an early shutdown."

  NRC Inspector General, NRC's Regulation of Davis Besse Regarding Damage to the Reactor Vessel Head," Dec. 30, 2002, p. 23.

Integrity of NRC's Licensing Process

NRC Chairman Promotes AP1000 before NRC License Approval

"The top U.S. nuclear regulator vouched for the safety of a new Westinghouse nuclear reactor -- yet to be built anywhere in the world -- in a sales pitch to supply China's growing power industry.

. . . U.S. Nuclear Regulatory Commission Chairman Nils Diaz said the US$1.5 billion (euro 1.2 billion) AP1000 reactor made by Westinghouse Electric Co. is likely to receive regulatory approval in the next few months."

Associated Press, October 19, 2004

Integrity of the NRC (more)

- The NRC permitted the sole owner of a low-level nuclear waste facility -- licensed through an Agreement State -- to continue to own the facility despite knowing that the owner paid the state regulator some $600,000 in cash gold coins and a ski condo to obtain the facility license and amendments to it.

Construction Subsidies Recommended Nuclear Largesse

- **MIT Study (2003): up to ~$2 billion**
  - a production tax credit for up to $200/kilowatt-electric of the plant's construction cost for ten so-called "first mover" plants; $200/kWe = 1.8 cents/kw-h over 1.69 year of production (assuming a 75% capacity factor)

- **DOE, SEAB, Nuclear Energy Task Force (2004/05): up to $3.6 billion**
  - Up to $600 million for vendor "first-of-a-kind engineering" costs--up to $200 m for each of 3 designs; recovered at $12 million/reactor from next 50 reactors; plus
  - Up to $3 billion at $250 million/reactor for first 4 reactors of each of 3 types (through loan guarantees, power purchase agreements, accelerated depreciation, investment tax credit, production tax credit)

Draft Energy Policy Act of 2005: up to $5.7 billion

- Production tax credit of 1.8 cents per kilowatt-hour over 8 years for 6,000 MWe capacity (about 6 plants; assuming a 75% average capacity factor). This was also in HR.6 (2004), first introduced by Sen. Domenici's in S.14 (in April 2003); both of these bills failed to pass. (The 1.8 c/kw-h is in the Hagel Bill introduced February 15, 2005)

But Wait, They Want Even More!

"The bill does not yet give NuStart what it wants most of all: government guarantees of construction loans for new, untested reactor designs.....The utilities also want two fat tax credits--one allowing them to deduct 20% of their spending on new reactors and a second to lop off 1.8 cents for every kilowatt-hour of power produced by the new plants....."

Source:

http://www.forbes.com/home/free_forbes/2005/0131/084_3.html

Proliferation

- Nuclear Power is the only existing energy technology that requires an international safeguards regime.
- As evidenced by Iran and the two Koreas, current IAEA safeguards have major vulnerabilities.
  - The “timely warning criteria” cannot be met if enrichment and reprocessing technologies are operated in non-weapon states.

Yucca Mountain

Yucca's Geologic Media Leaks Like a Sieve

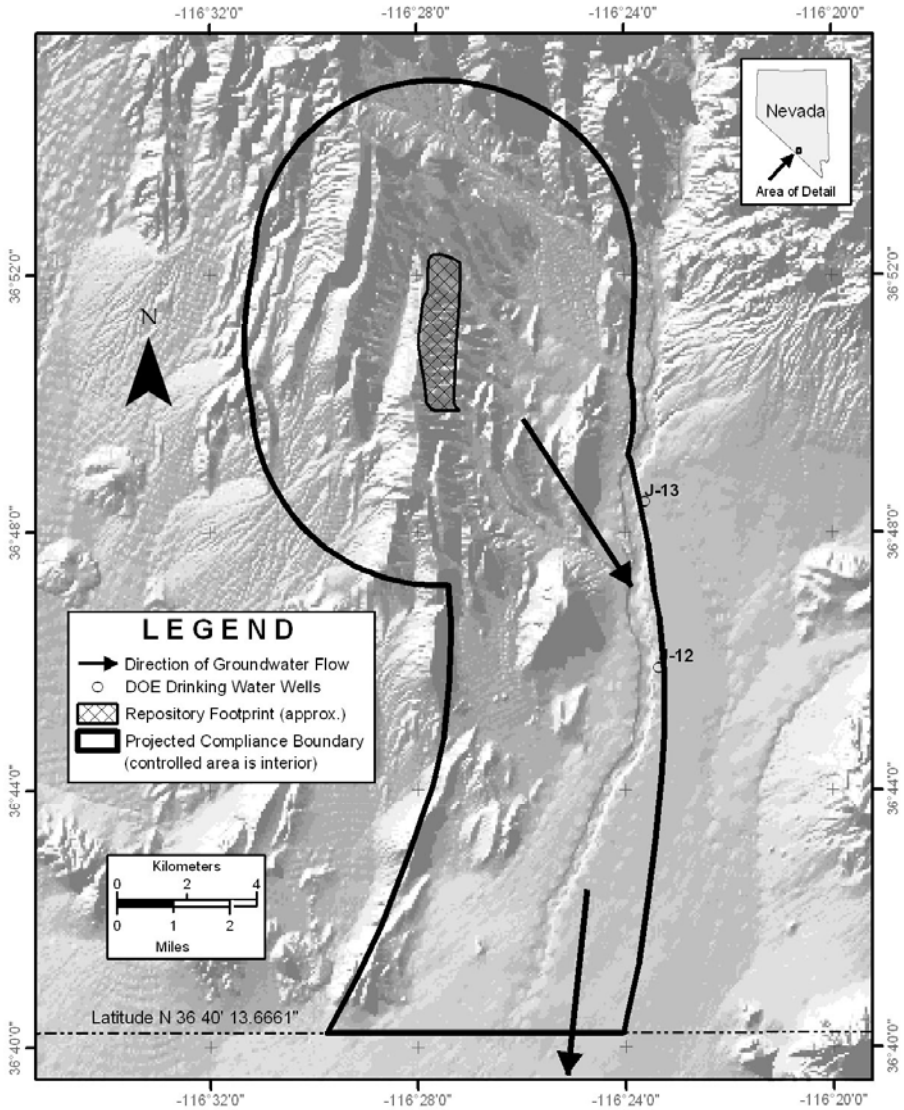
Containment of Radionuclides Relies Primarily on the Engineered Containers

The Government's Solution to a Leaky Repository

- Adjust the EPA licensing criteria to ensure the project can be licensed by:
  - Gerrymandering the control boundary so that dose limits do not have to be met in the radioactive septic field flowing 18 km downstream from the repository; and by
  - Limiting dose calculations to 10,000 years, rather than requiring the geologic site isolate the waste for the length of time it is dangerous.

Projected Groundwater Standards Compliance Boundary for Spread of Radioactive Contamination at the Yucca Mountain Project

Measurement of Radioactive Contamination Takes Place Outside of Controlled Area



NRDC produced this visual representation from the following information:
"The controlled area may extend no more than 5 km in any direction from the repository footprint, except in the direction of groundwater flow. In the direction of groundwater flow, the controlled area may extend no farther south than latitude 36 40' 13.6661" North ... [T]he size of the controlled area may not exceed 300 square km." 66 Fed Reg. at 32117 (June 13, 2001). The direction of groundwater flow is from FEIS (February 2002) at 5-21, Figure 5-3. The repository footprint is from the Yucca Mountain Science and Engineering Report, DOE/RW-0539, at 1-17, Figure 1-3, and the area is approximately 4.27 square km. The area within the projected compliance boundary, as shown in this map, is about 230 square km. The relief image was created from a 1 arc-second Digital Elevation Model from the USGS National Elevation Dataset, April 2002. This map is based on a Nevada State Plane Central projection, North American Datum 1927.

The Nuclear Fuel Reprocessor's Solution to a Leaky Repository

- Use Advanced Technologies for Reprocessing Spent Fuel
- Transmute the Long-Lived Radioisotopes (via neutron bombardment) in Accelerators or Reactors

Nuclear fuel reprocessing and transmutation are a bad alternative to geologic disposal of spent fuel.

Transmutation of Waste

- Using Accelerators
  - Too expensive
  - Requires additional external source of power to run the accelerator
  - Requires reprocessing of irradiated material
- Using Fast Reactors
  - Uneconomical – fast reactor cost is some 1.5 to 2 times the cost of light-water reactors (LWRs), plus higher fuel costs
  - Severe proliferation and potential safety problems
- Using Today's Thermal Reactors
  - Reprocessing is uneconomical --MOX fuel is about 4.5 times the cost of LEU fuel
  - Proliferation and security problems

Thermal Reactors -- Closed Fuel Cycle

- Substitutes uneconomic reprocessing plants for geologic repositories
- Will require Federalization the nuclear fuel cycle

Environmental Costs of Transmutation?

- No evidence that there is a net reduction of health effects –- short-term radioactive releases from the closed fuel cycle may be larger than the long-term releases from the repository

Reprocessing and Transmutation R&D Incurs Serious Proliferation Risks

- Cadres of scientists will be trained in actinide chemistry and plutonium metallurgy for weapons
- Hot cells will provide a breakout capability
- Five non-weapon states participating in DOE's International Gen IV Forum have had clandestine nuclear weapons programs -- South Korea, South Africa, Brazil, Argentina, and Switzerland
- Under DOE's Advanced Fuel Cycle Initiative (AFCI) program, South Koreans are/were invited to ANL to study reprocessing, thus circumventing a U.S. imposed ban on reprocessing in South Korea.

Conclusions

- Nuclear power has been, and continues to be, a specially privileged technology dependent on regulatory shortcuts and public subsidy.
- As a mature power technology, with tens of billions of dollars of public and private capital already behind it, saddled with seemingly irreducible proliferation risks and a costly, unresolved, long-lived hazardous waste burden, nuclear power is a poor candidate for further public subsidies.

Curbing Global Warming is the Objective

- The best policy is to rely on the free market with all pollution costs internalized.
- The economically efficient way to internalize the cost of pollutants is through regulation (or a tax on emissions), e.g. by capping greenhouse gas emissions.
- It is economically inefficient to reduce greenhouse gases by non-R&D subsidization of nuclear power— e.g., paying the current cost difference between nuclear and fossil plants.
- If the Government gives several billion dollars to already profitable energy generating companies to buy 1 to 6 new nuclear plants, without controlling carbon and without other significant market changes, no subsequent nuclear plant orders are likely to follow.
- Under such circumstances, the Nation will buy 1 to 6 costly plants with no meaningful reductions in global warming.