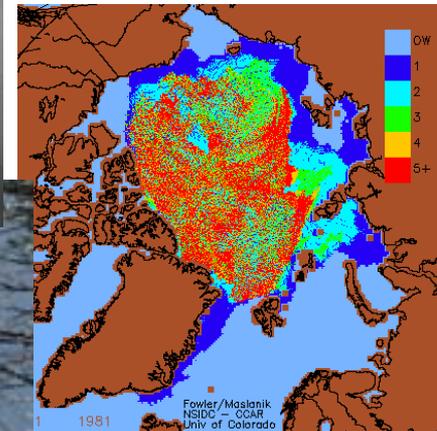


# Nuclear Energy, Nuclear Weapons and Climate Change: Options and Opportunities for the Next Administration



Your Picture Here



The role of the Department of Energy

*An interactive "work in progress"*

Victor Reis  
Senior Advisor  
Department of Energy  
victor.reis@hq.doe.gov

# Some of the Many Briefing (More or Less) Recipients

## **Government**

Sam Bodman  
Arden Bement  
John Marburger  
Don Kerr  
Pete Domenici  
Jim Timbie  
Tony Tether  
Adm. Kirk Donald

## **Former Government**

George Shultz  
Bill Perry  
Jim Schlesinger  
Sam Nunn  
Brent Scowcroft  
Bennett Johnston  
John Deutch  
Rich Mies  
Dick Meserve  
Jim Woolsey

## **Academia**

Princeton  
MIT  
Harvard  
Texas  
U.C. Berkeley  
Vanderbilt  
Oregon State  
Stanford  
Cal Tech  
Utah (Law)

## **Industry**

John Rowe  
John Fuller

## **Foreign Friends**

Philippe Pradel  
Shunsuke Kondo

## **Labs**

Argonne  
Oak Ridge  
Los Alamos  
Livermore  
Berkeley  
Sandia  
SLAC  
JPL(NASA)

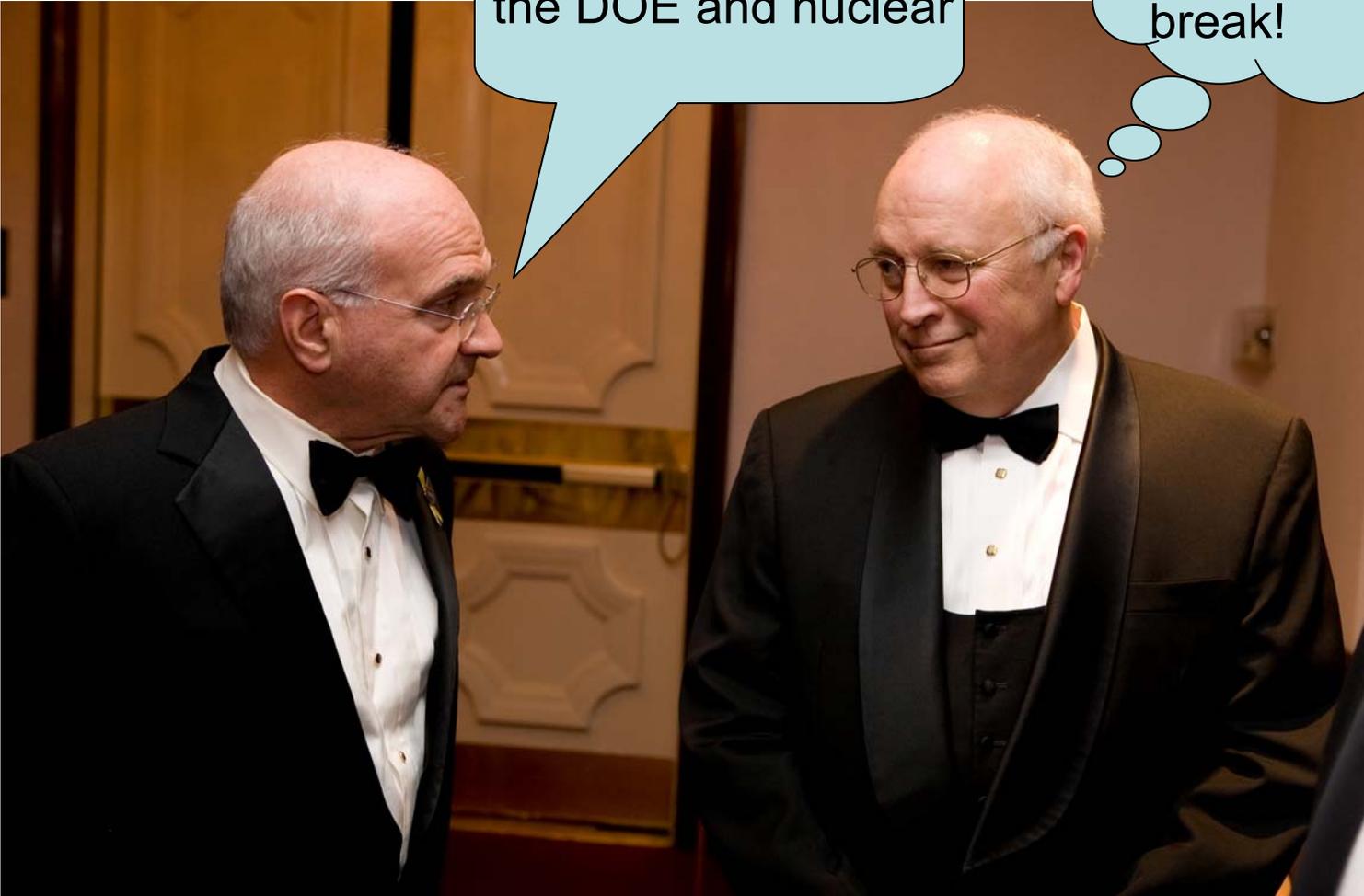
## **Organizations**

Naval Submarine League  
Stratcom SAG  
Council on Foreign Relations  
Center for New American Security  
Center Strategic & Int'l Studies  
AAAS  
DNFSB (Staff)  
Eisenhower Institute  
NAS Nuclear & Rad Studies Board  
NRC (Staff)  
Atomic Testing Museum  
Australian Embassy  
UCOP Asia Pacific Forum  
Ex. Monitor Forum  
DARPA

# A typical encounter:

Let me tell you about  
the DOE and nuclear

Not again, Vic.  
Give me a  
break!



# Theme

Global Development (Electricity/HDI)  
Climate Change (Carbon Emissions)  
National Security  
(Deterrence and Proliferation)



A Nuclear  
“Gesamtkonzept”



An historic leadership opportunity  
for the next administration



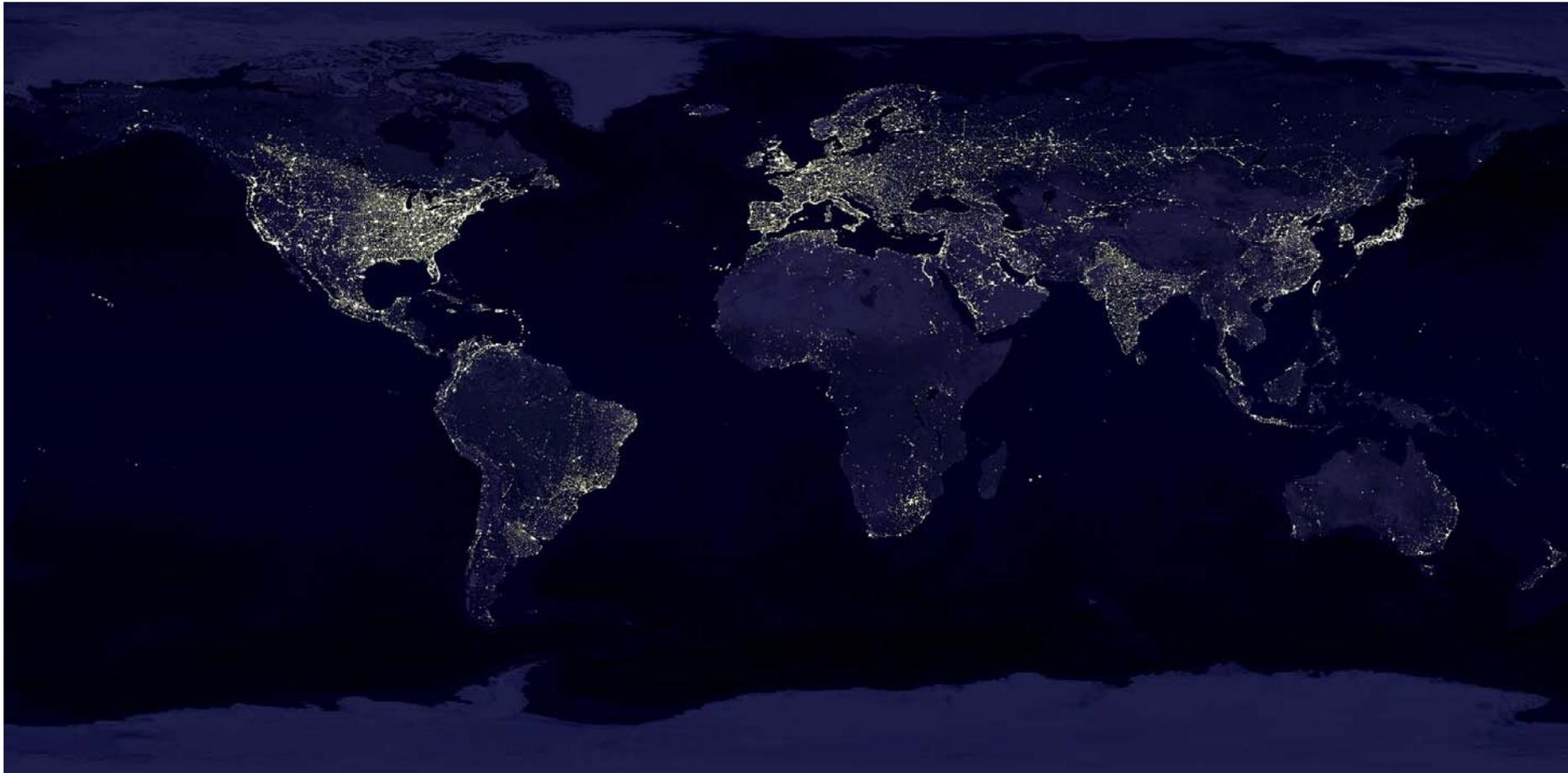
Department of Energy and its labs  
are key to making this happen

# The Development Challenge:

## Security and Development: The Two Sides of Nuclear Technology

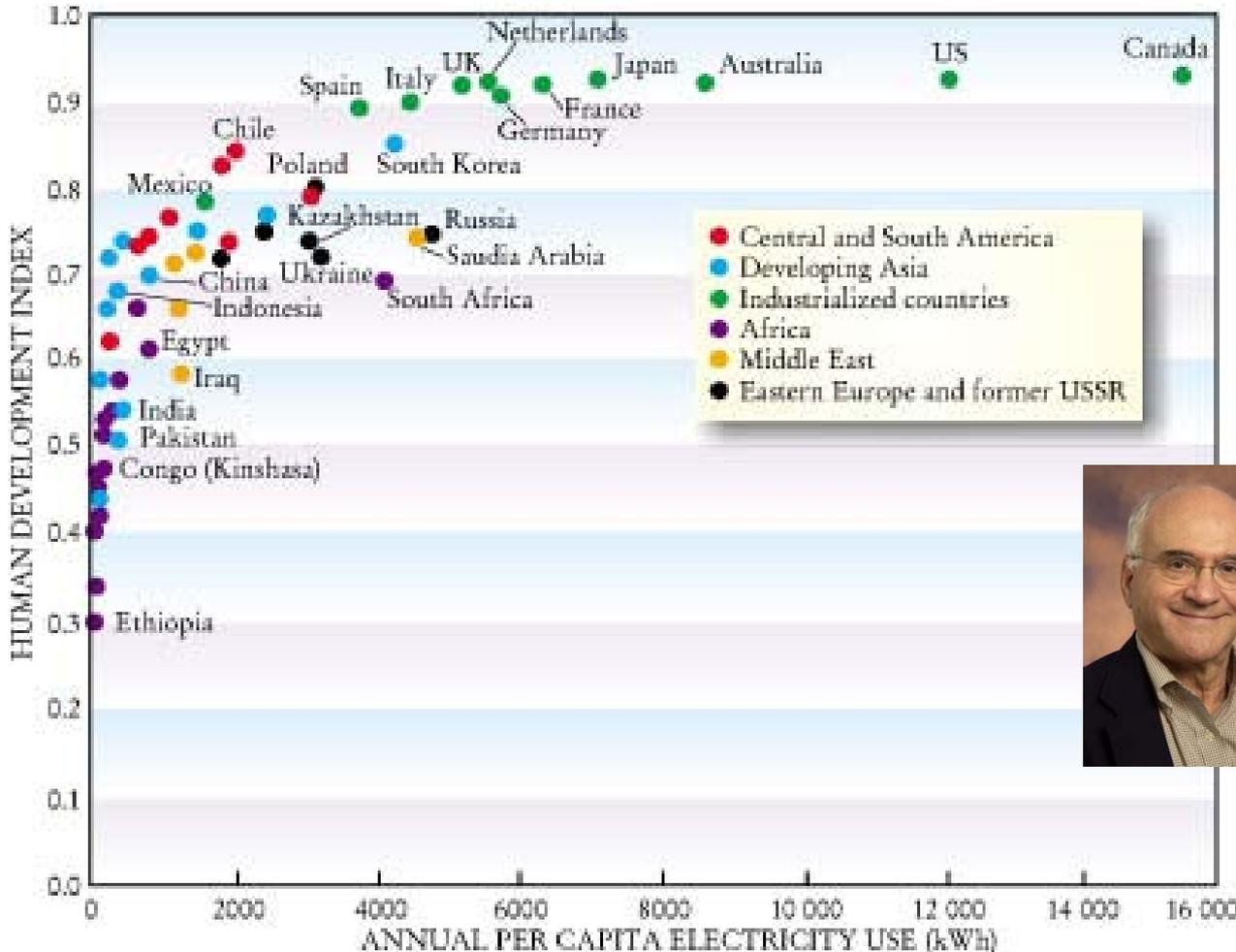
by IAEA Director General Dr. Mohamed ElBaradei

Consider the current global energy imbalance. Roughly **1.6 billion people live without access to electricity**, and **2.4 billion rely on traditional biomass because they have no access to modern fuels**. In some African countries, for example, the per capita electricity consumption is around 50 kilowatt-hours per year.



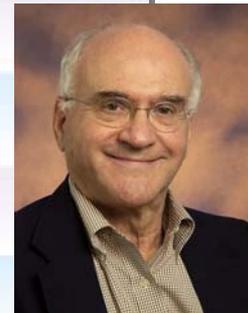
# The Development Vision

The **Human Development Index (HDI)** is an index combining normalized measures of [life expectancy](#), [literacy](#), [educational attainment](#), and [GDP per capita](#) - correlated with electricity



Now – (2000)

Population ~6B  
 Total Electricity ~1600 GWyr  
 80% of population below 0.8 HDI



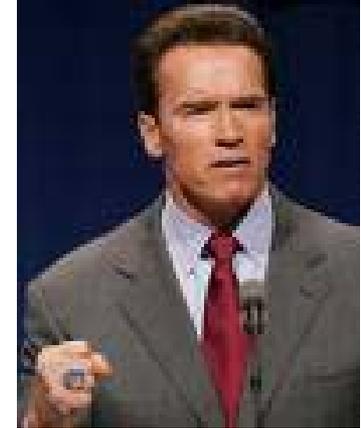
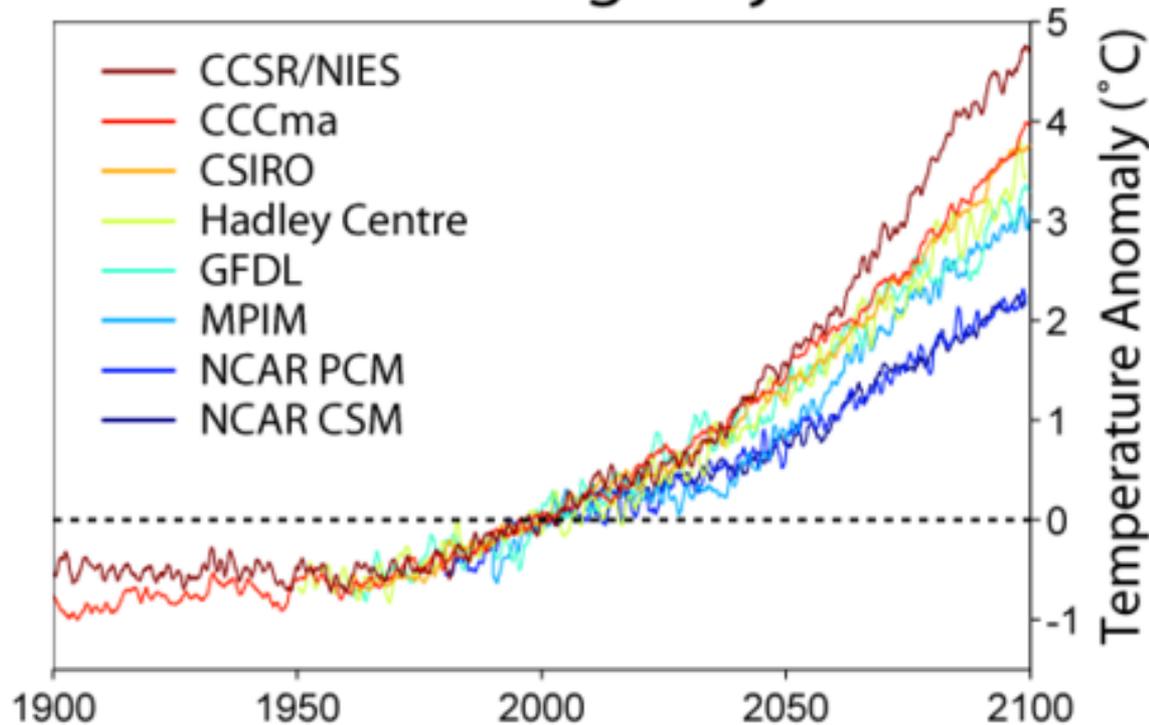
Vision - (2100)

Population ~9B  
 1B @ 8,000 kWh  
 6B @ 4,000 kWh  
 2B @ 2,000 kWh  
 ~ 4100 GWyr

# The Climate Change Challenge:

“The debate is over. We know the science. We see the threat posed by changes in our climate. And we know the time for action is now.”

## Global Warming Projections



Governor  
Schwarzenegger

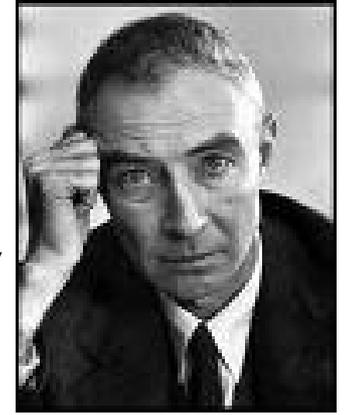


"I will clean up the planet," "I will make global warming a priority."

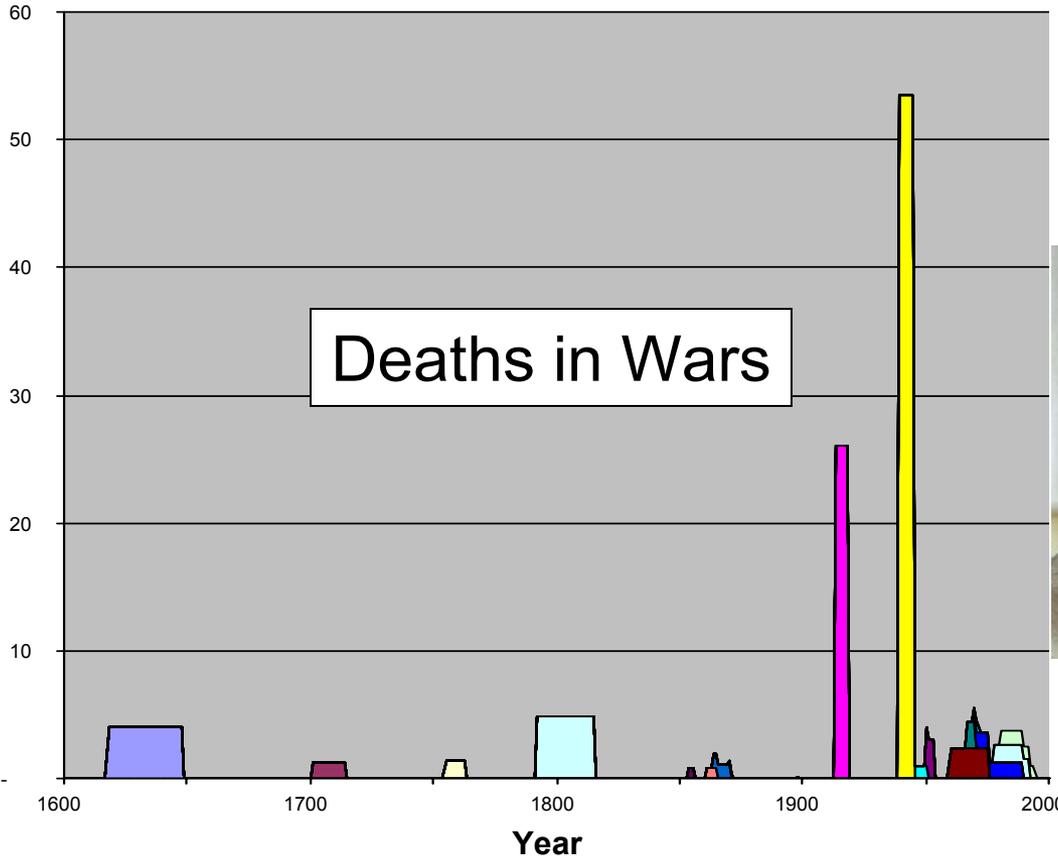
"I believe it's one of the greatest moral challenges of our generation"

# The National Security Challenge:

“The atomic bomb made the prospect of future war unendurable. It has led us up those last few steps to the mountain pass; and beyond there is a different country.”

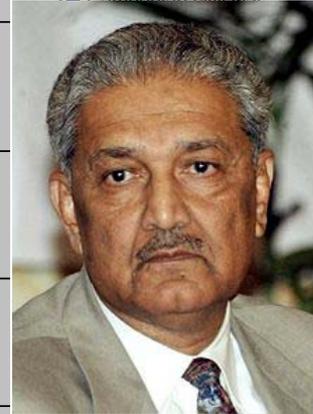


J. Robert Oppenheimer



Deaths in Wars

- Mozambican civil war
- Afghanistan (Soviet intervention)
- Bangladesh secession
- Cambodian civil war



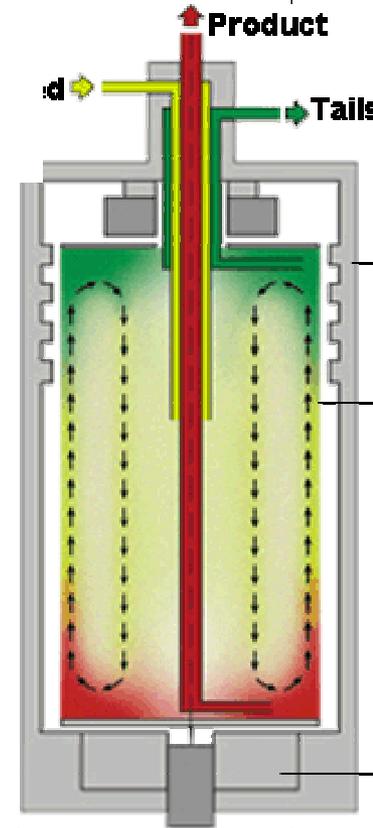
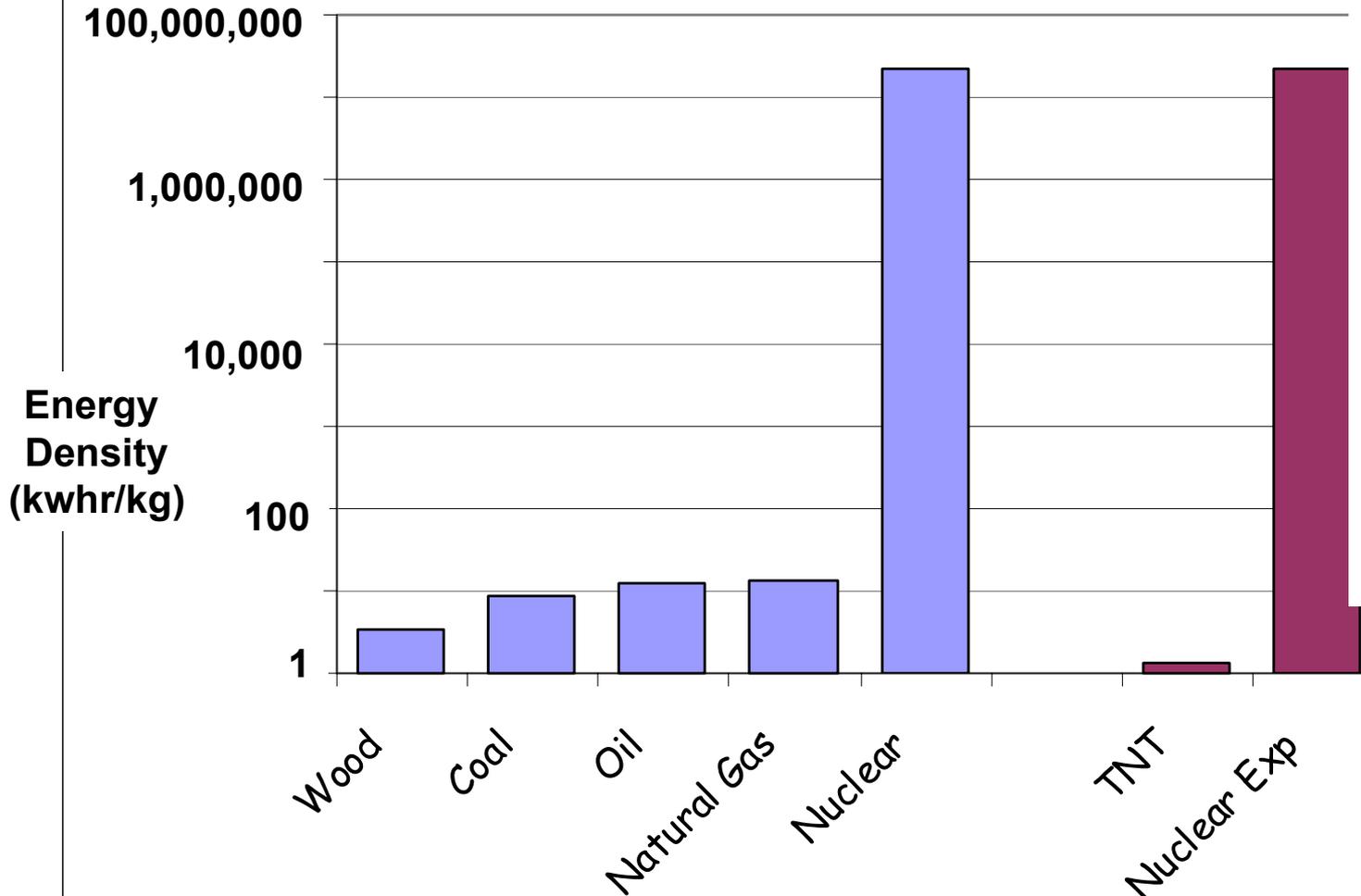
Source: Worldwatch Institute

سامة بن محمد بن عوض بن لادن

Avoid major War - and nuclear proliferation and nuclear terrorism

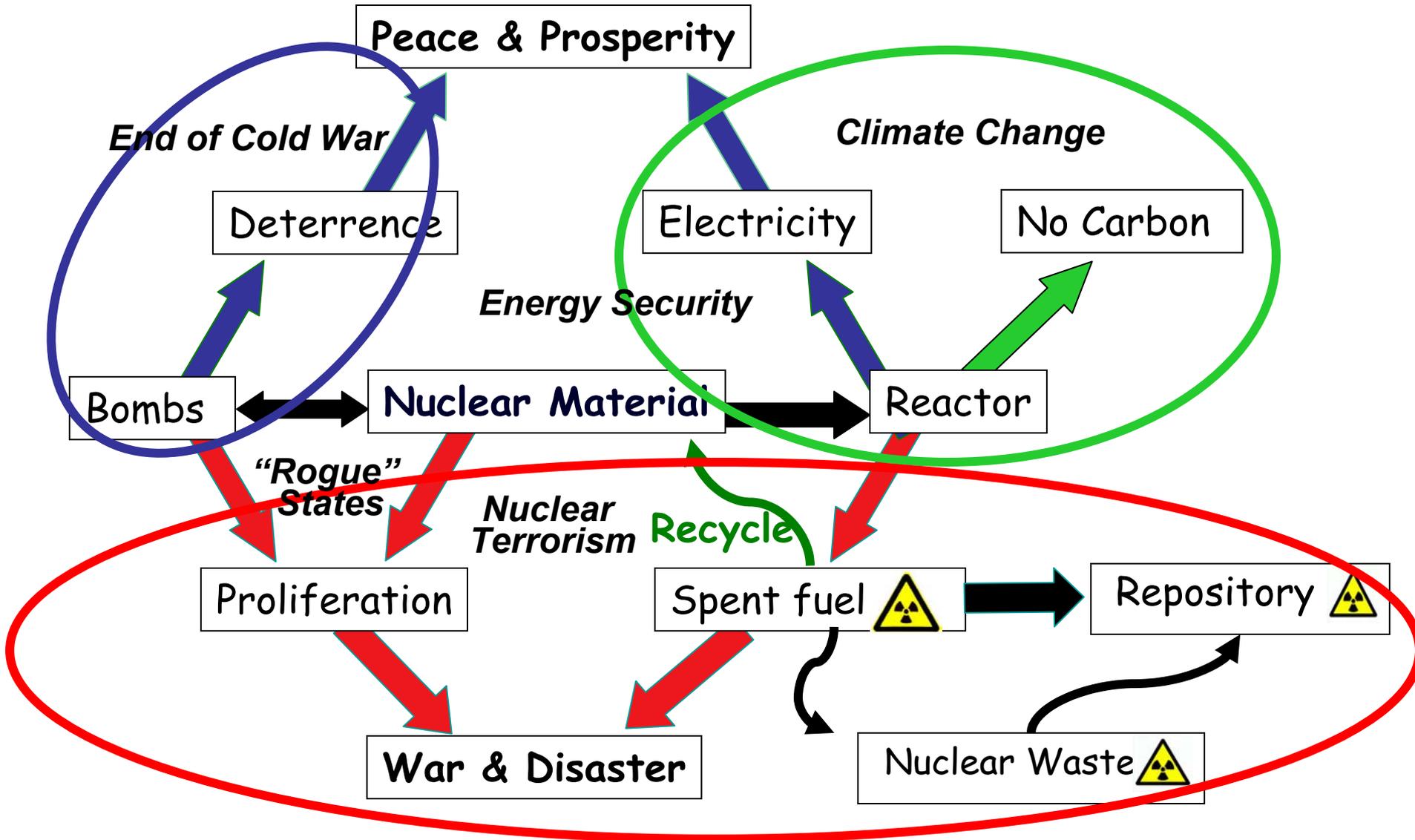
# Nuclear Energy Density > 1,000,000 Chemical Energy Density

**The Atomic Dilemma:** The industrial processes for nuclear material are similar for thermal and explosive uses

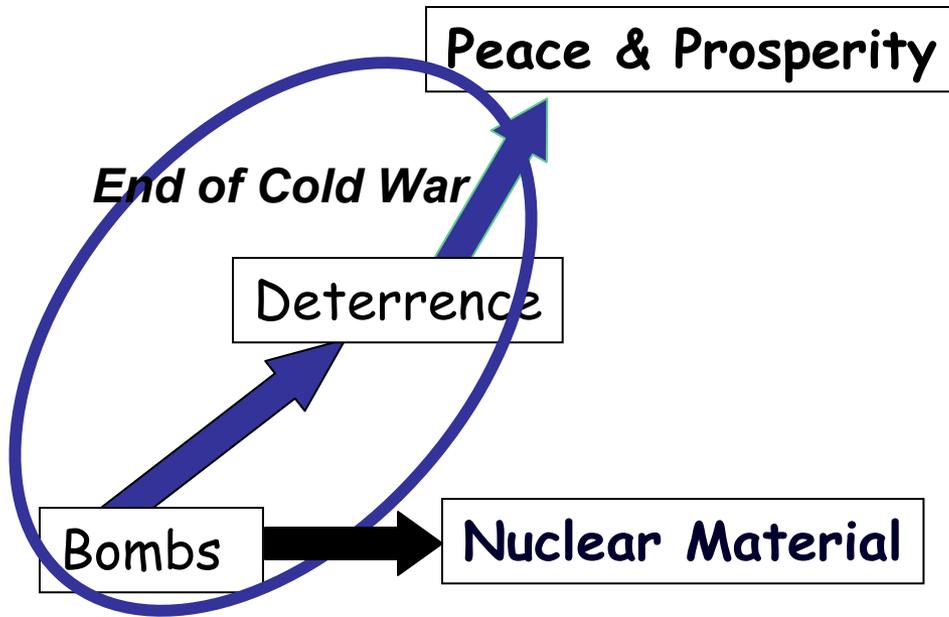


Enrichment centrifuge

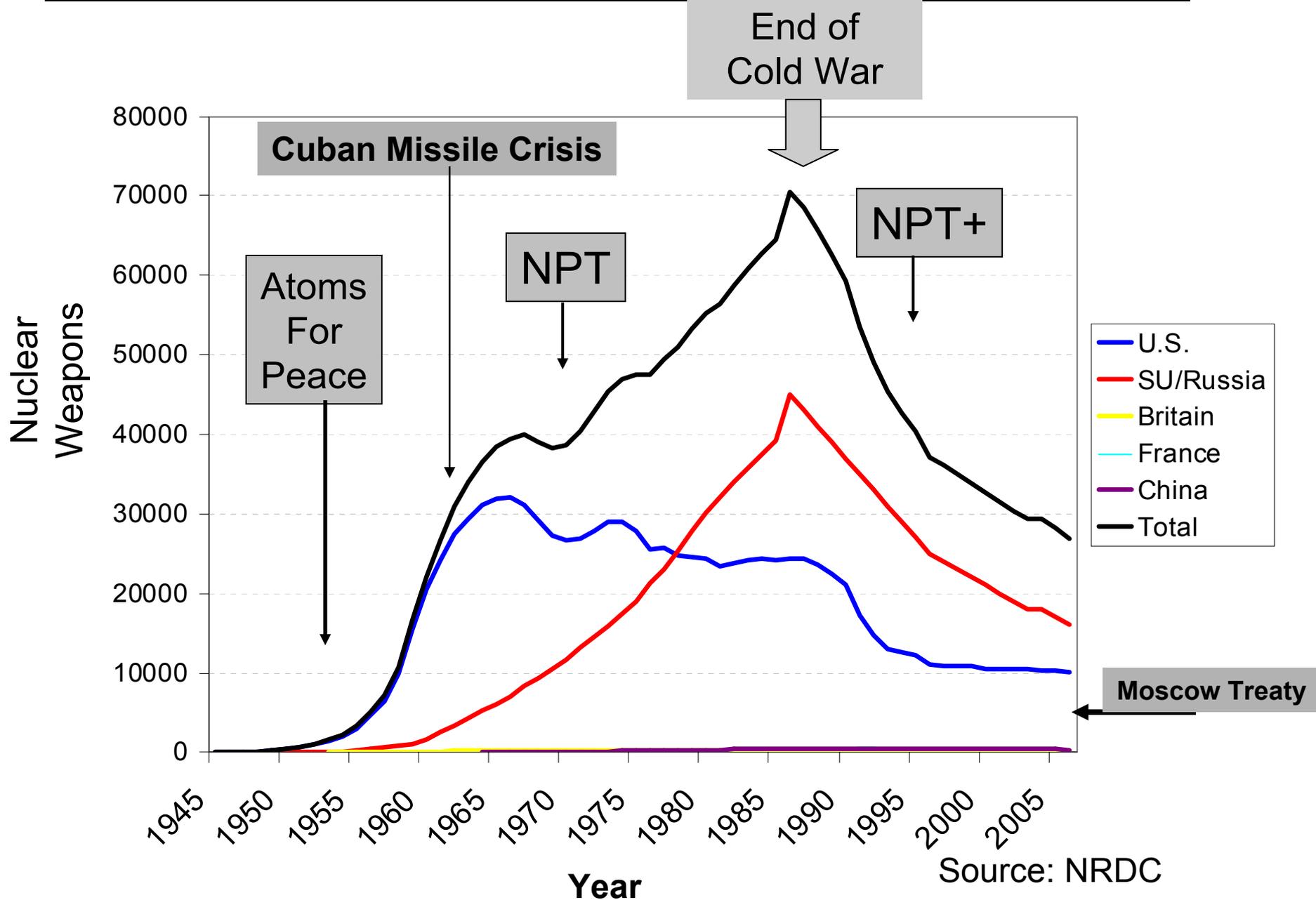
# A Gesamtkonzept of the Global Nuclear System



# Nuclear Weapons Policy



# The Cold War ~ No World War, but a Nuclear Arms Race



# Administration's Policy on Nuclear Weapons



“We can, and will change the size, the composition, and the character of our nuclear forces in a way that reflects the reality that the Cold War is over. I am committed to achieving **a credible deterrent with the lowest-possible number of nuclear weapons** consistent with our national security needs, including our obligations to our allies.”

**President Bush: May 2001**

Each Party shall **reduce and limit** strategic nuclear warheads, ..., so that by December 31, 2012 the aggregate number of such [deployed] warheads does not exceed 1700-2200 for each Party

**Moscow Treaty, May 2002**

The third leg of the New Triad is a responsive defense infrastructure....

Maintaining our ability to respond to large strategic changes can permit us to **reduce our nuclear arsenal** and, at the same time, dissuade adversaries from starting a competition in nuclear armaments.

**Nuclear Posture Review: December 2002**

**Reliable Replacement Warhead (RRW), Complex Transformation**

The President has approved **a significant reduction** in the U.S. nuclear weapons stockpile to take effect by the end of 2007.

The reduction is part of the President's overall strategy to transform the U.S. nuclear weapons stockpile and its supporting infrastructure to better meet the security needs of the 21st Century. It is a comprehensive effort to reduce U.S. reliance on nuclear weapons and streamline and modernize our nuclear infrastructure.

**December 2007**

# Recent Views on Nuclear Weapons

## **A World Free of Nuclear Weapons**

***By George P. Shultz, William J. Perry, Henry A. Kissinger and Sam Nunn.***

***The Wall Street Journal***

***January 4, 2007; Page A15***

“We endorse setting the goal of a world free of nuclear weapons and working energetically on the actions required to achieve that goal, beginning with the measures outlined above”.



## **The Nuclear Disarmament Fantasy** ***By Harold Brown and John Deutch***

***Wall Street Journal***

***November 19, 2007; Page A19***



“However, the goal, even the aspirational goal, of eliminating all nuclear weapons is counterproductive.”

# Recent Views on Nuclear Weapons, Continued

## Toward a Nuclear-Free World

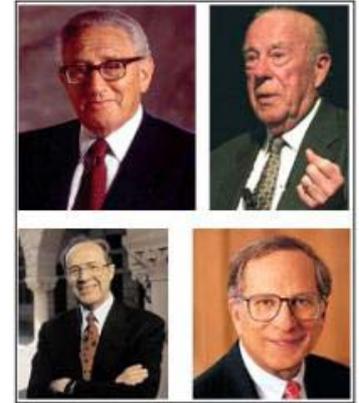
*By George P. Shultz, William J. Perry, Henry A. Kissinger and Sam Nunn*

*Wall Street Journal,*

*January 15, 2008*

“Without the vision of moving toward zero, we will not find the essential cooperation required to stop our downward spiral”.

**They also said:**



“Another subject: **Developing an international system to manage the risks of the nuclear fuel cycle.** With the growing global interest in developing nuclear energy and the potential proliferation of nuclear enrichment capabilities, an international program should be created by advanced nuclear countries and a strengthened IAEA. The purpose should be to **provide for reliable supplies of nuclear fuel, reserves of enriched uranium, infrastructure assistance, financing, and spent fuel management** -- to ensure that the means to make nuclear weapons materials isn't spread around the globe.”

**We'll come back to this**

## Presidential Candidates views on Nuclear Weapons and Deterrence



“Our highest priority must be to reduce the danger that nuclear weapons will ever be used. Such weapons, **while still important to deter an attack with weapons of mass destruction** against us and our allies, represent the most abhorrent and indiscriminate form of warfare known to man. We do, quite literally, possess the means to destroy all of mankind. We must seek to do all we can to ensure that nuclear weapons will never again be used.”



"The danger ... is that we are constantly fighting the last war, responding to the threats that have come to fruition, instead of staying one step ahead of the threats of the 21st century."

"**As long as nuclear weapons exist, we'll retain a strong deterrent.** But we will make the goal of eliminating all nuclear weapons a central element in our nuclear policy,"

# Alternative U.S. Nuclear Weapons Strategies

## Goals:

Fewer Nuclear Weapons (For what purpose?)

- Characteristics ?

– Responsive Infrastructure ? (Nuclear Posture Review –'03)

-Comprehensive Test Ban Treaty (CTBT)?

Congressional "Program"

1. Gradual Reduction of Stockpile
2. Gradual Reduction of Stockpile + RRW
3. Sharp Reduction of Stockpile + RRW
4. Sharp Reduction of Stockpile < 1000, CTBT

Administration

- Russia
- 
- 
- (Japan)



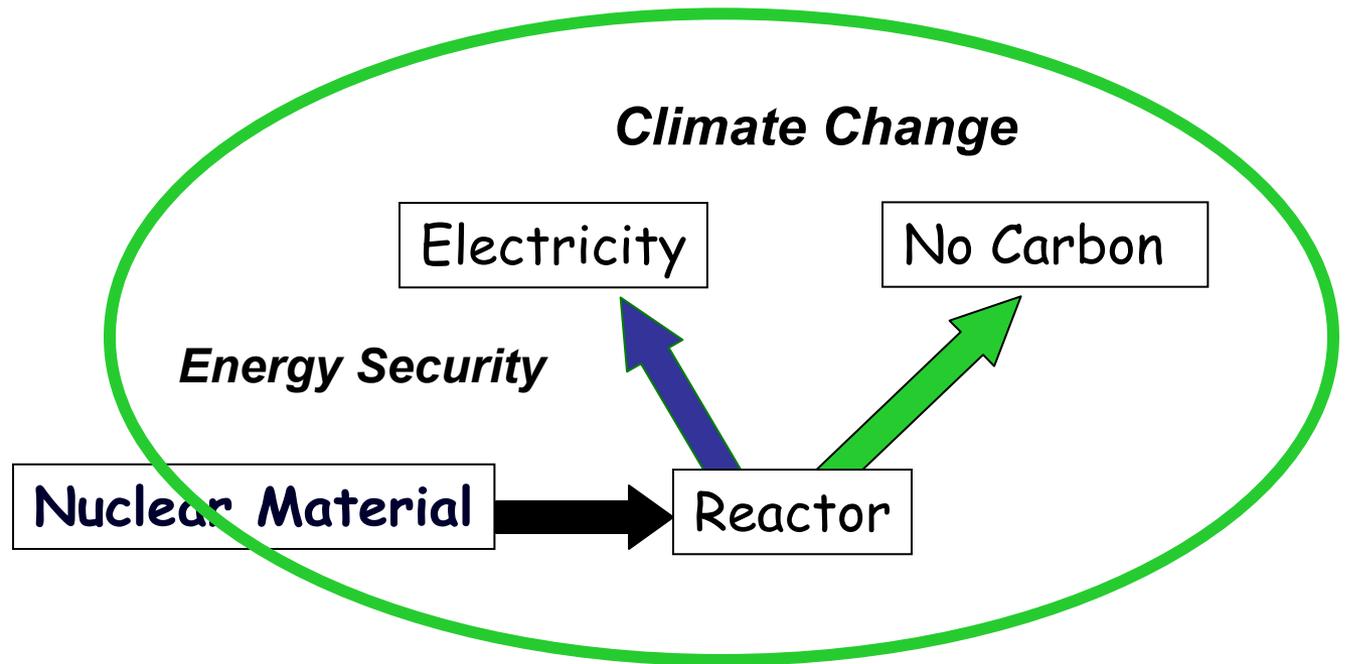
"Scientists Statement on U.S. Nuclear Weapons Policy"

4/17/08

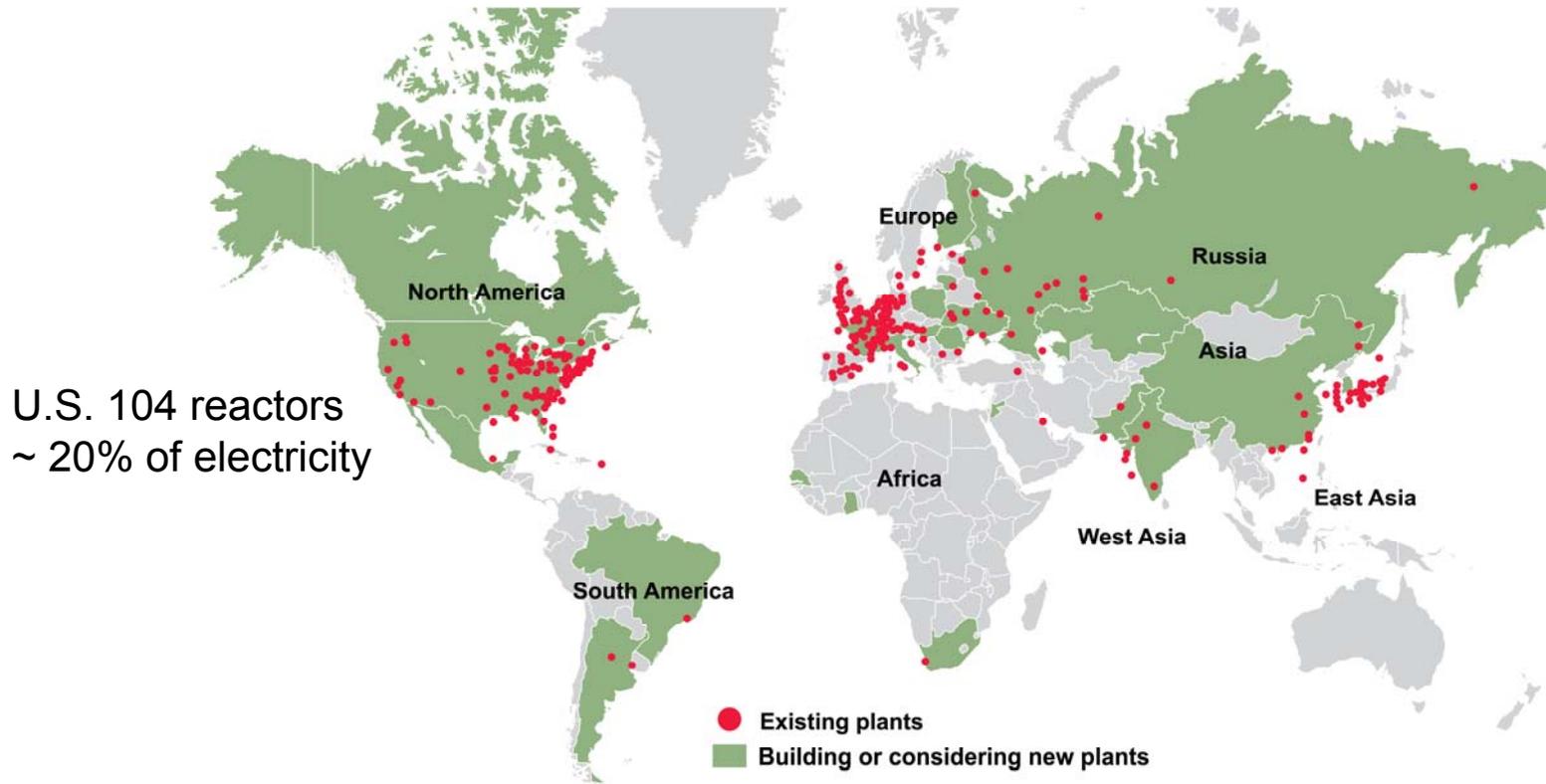


Role of Science Support?

# Nuclear Power and Global Climate Change



There already exists a widespread global nuclear enterprise.



439 reactors operating worldwide in 31 countries providing 16% of electricity

93 units on order or planned

50% of uranium reserves are in developing nations and 30% in Africa

Argentina, Brazil and South Africa have expressed interest in enrichment facilities

Russia, India, Argentina, France, Japan, China and South Korea are, or could become, nuclear suppliers

# Climate, Development & Carbon Scaling



Earth absorbs ~ 3 Billion Tons of Carbon per year

Houghten 2007 *An. Rev. Plane. Science.*

## POWER:

Each 1000 GW year of electricity emits:

Coal: ~ 2 Billion Tons Carbon

Natural Gas: ~ 1.1 Billion Tons Carbon



1,600 → 4000 GW yr

Carbon Capture & Sequestration

Nuclear, Hydro, Wind, Solar

## TRANSPORTATION:

Each 10 Trillion miles traveled at 20 miles per gallon emits ~ 1.4 Billion Tons C

U.S ~ 3 trillion miles per year (2007)

Efficiency, Biofuels, Electrification



## RESIDENTIAL, COMMERCIAL & INDUSTRIAL:

U.S. ~ 0.4 billion tons (2007)

# Modeling Climate Effects, Energy and Economics: A hard problem

We'll use the ObjECTS-MiniCAM Model from the Joint Global Change Research Institute

Integrated Assessment Model that simulates the relationship of key systems pertaining to climate change:

- Carbon Cycle, Atmospheric Chemistry, Radiative Forcing, & Climate
- Fully Integrated Agriculture and Land Use Model
- Energy-Agriculture-Economy Market Equilibrium

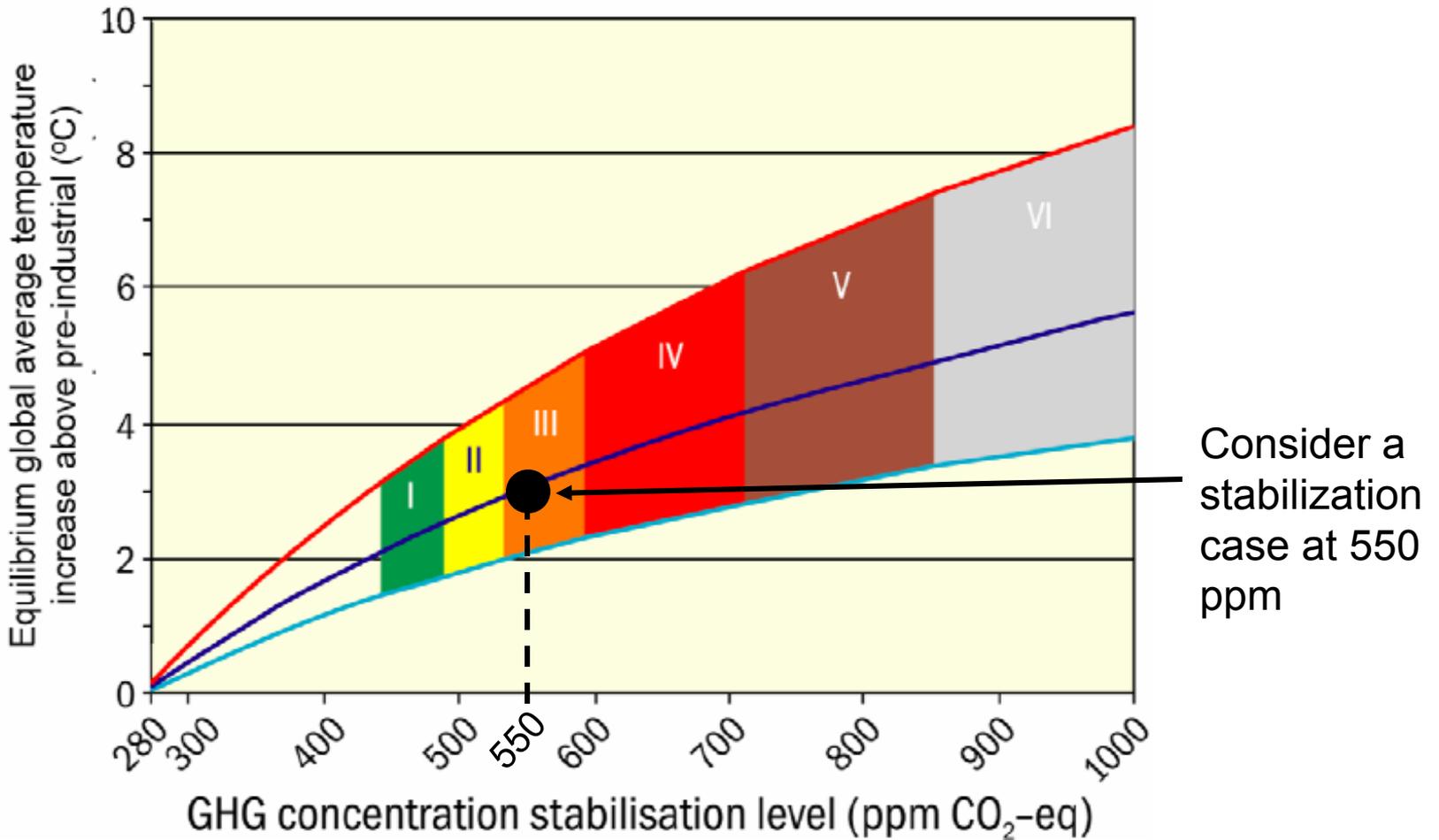
“All models are wrong, some models are useful”

George Box



The image shows the cover of a report titled "Shaping the Global Debate: Technology's Role in Addressing Climate Change". The cover features a blue sky with white clouds as a background. At the top, the title is written in white and yellow text. Below the title, there are several logos of participating organizations: Toyota, NETL (National Energy Technology Laboratory), The Kansai Electric Power Co. Ltd., EPRI (Electric Power Research Institute), ExxonMobil, NRDC (Natural Resources Defense Council), bp, PEMEX, GM, and Environmental Defense. In the center, there is a graphic of the Earth with the text "GLOBAL ENERGY TECHNOLOGY STRATEGY" and "ADDRESSING CLIMATE CHANGE". At the bottom, the report is published by the Joint Global Change Research Institute, which is a collaboration between the University of Maryland and Battelle (Pacific Northwest National Laboratory). The Battelle logo and tagline "The Business of Innovation" are also present.

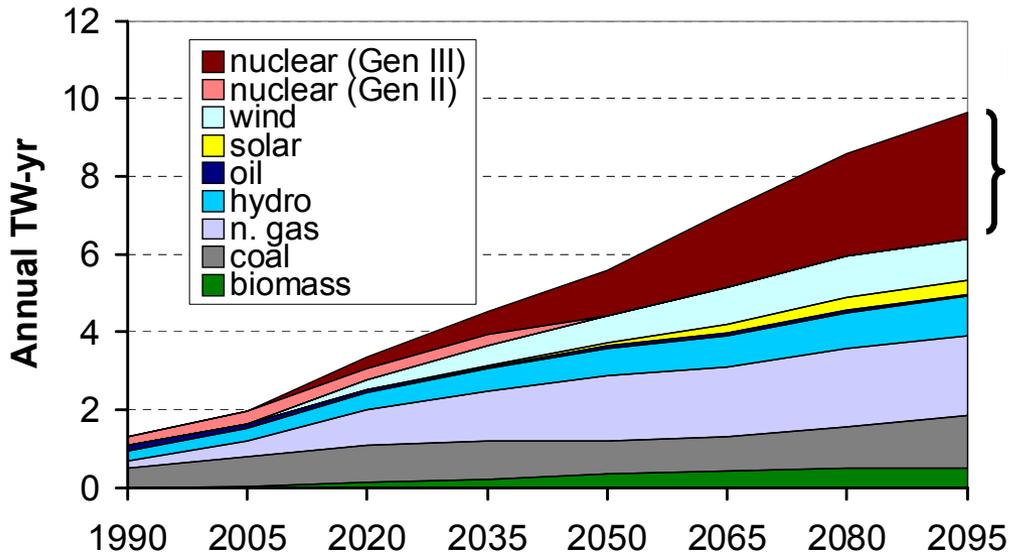
# Estimates of Temperature Increase from Greenhouse Gas Concentration



# Model Results – Stabilize CO<sub>2</sub> at 550 ppm

Conservative goals, optimistic alternative technologies still requires a large increase in nuclear power!!

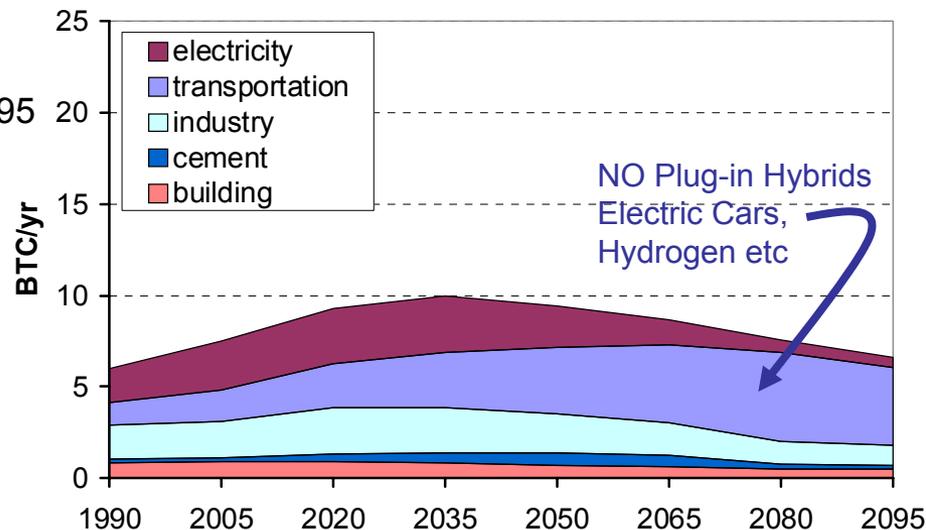
Global Electricity Generation (550 ppm)



} ~ 4000 GW Reactors World-Wide

Sequestration effective \$20/MW hr  
 Hydro x 4  
 Wind ~ 3 Million 1 MW turbines

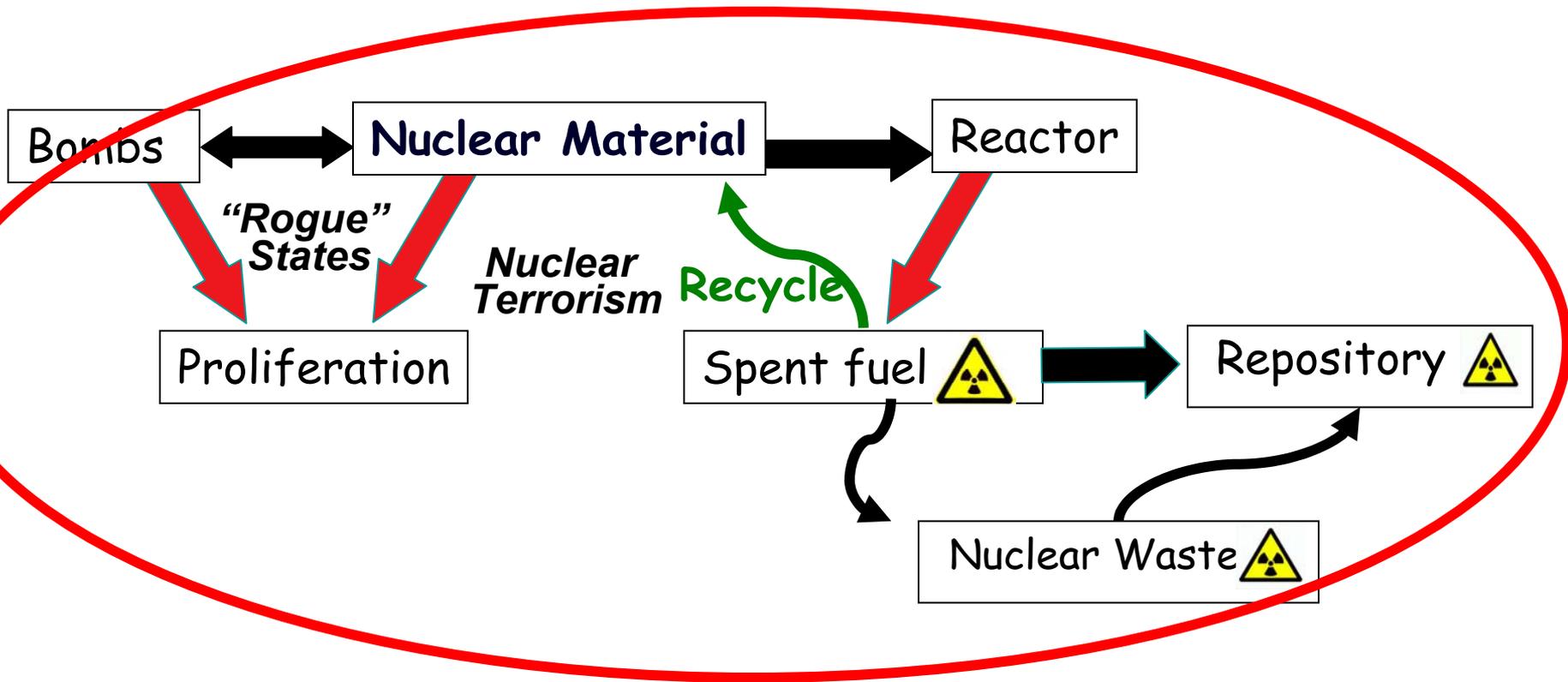
Global CO<sub>2</sub> Emission by Sector (550 ppm)



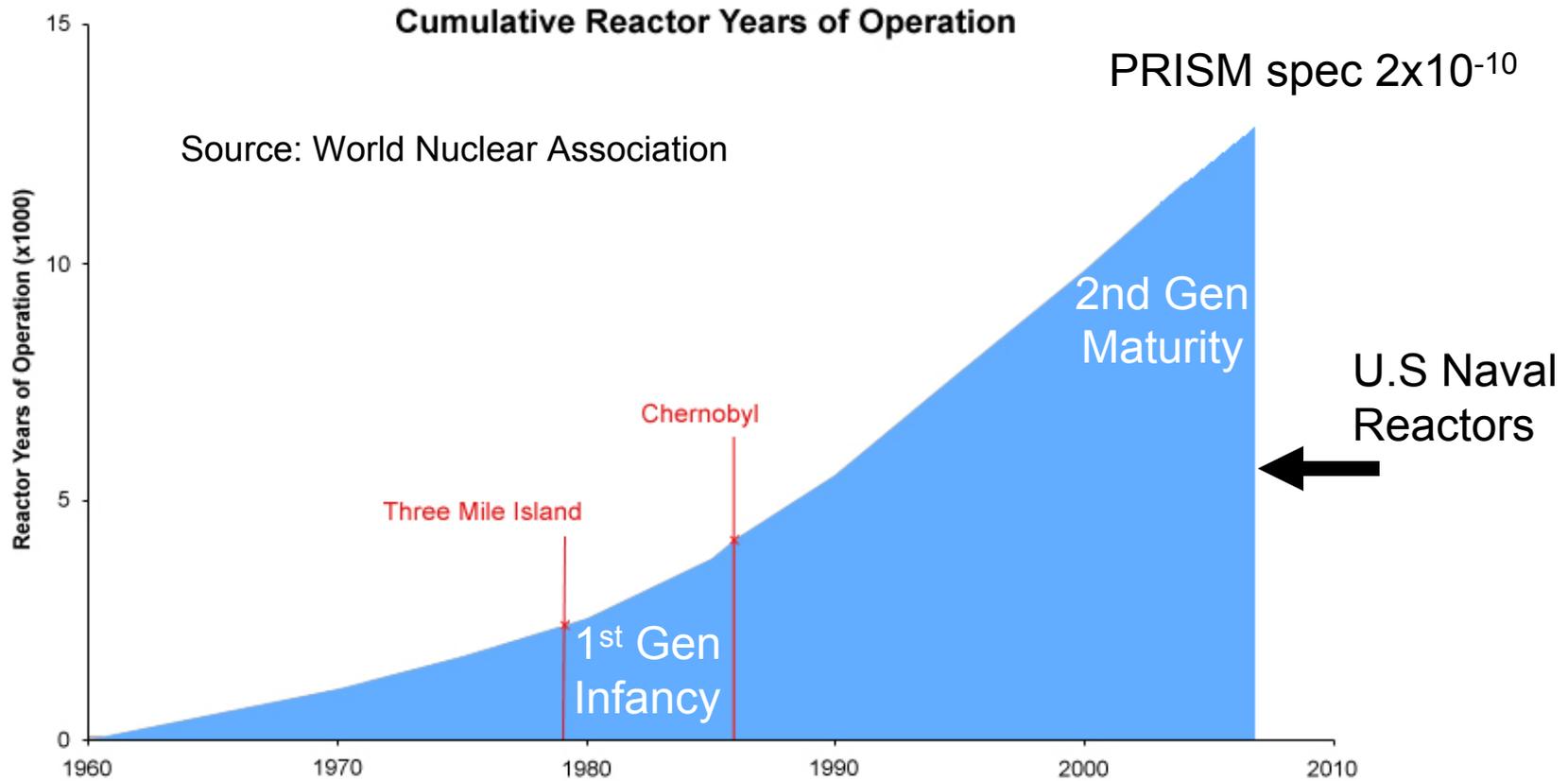
THERE ARE  
CARS ALL OVER  
THE WORLD  
STARVING  
FOR ETHANOL...  
SO FINISH YOUR  
CORN.



# Safety, Waste and Proliferation in a World with Thousands of Reactors



# Safety First!



Design Specs for maximum core damage frequency, plant per year:

ABWR -- $2 \times 10^{-7}$	AP1000 -- $5.09 \times 10^{-7}$	} Modern Reactors
ESBWR -- $3 \times 10^{-8}$	EPR -- $4 \times 10^{-7}$	

For a 1000 reactors,  $10^{-7} \sim 1$  max core damage every 10,000 years.

# A lot of reactors means a lot of nuclear material, moving safely and securely on a global scale

DOE has faced this problem with nuclear weapons and has developed principles for *Surety* – integrating safety, security, and reliability applicable to weapons, facilities, transportation, cyber – the entire system. These principles should be applicable to commercial nuclear power as well ...

Example: Safe, secure transportation of nuclear weapons and transuranic waste

> 100 Million miles



Safe, Secure Trailer



>7 million miles



Transuranic Waste

# Nuclear Waste & Repositories

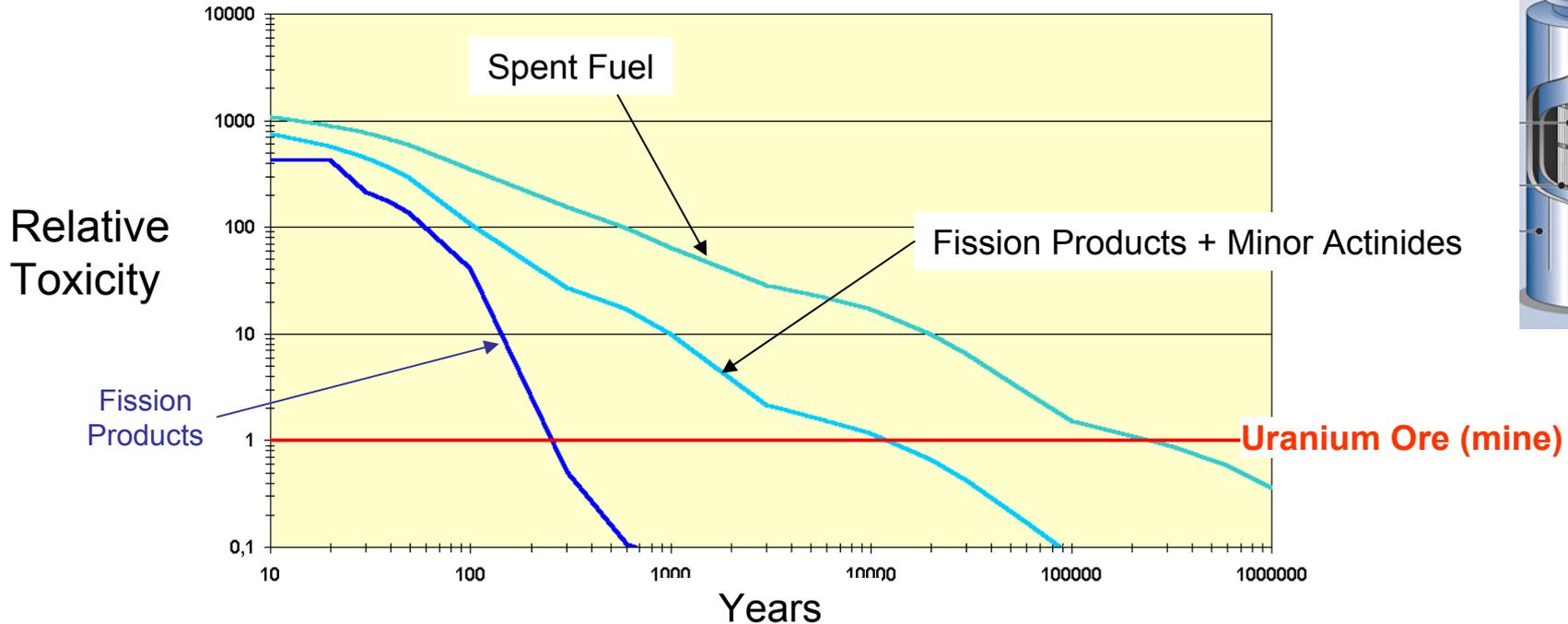
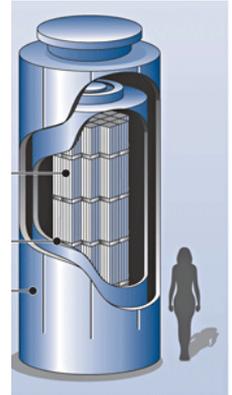
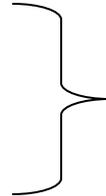
used

Coal: GW-year ~ 7-8 million Tons CO<sub>2</sub>

~ 600,000 tons of solid waste

2 dry cask storage casks  
~ 0.02 ¢/kwhr

Each GW-Year ~ 20 tons of spent fuel  
[~ 19 t Uranium + ~ 0.7 t fission products  
+ 0.2 t Pu + 0.02 t Minor Actinides]



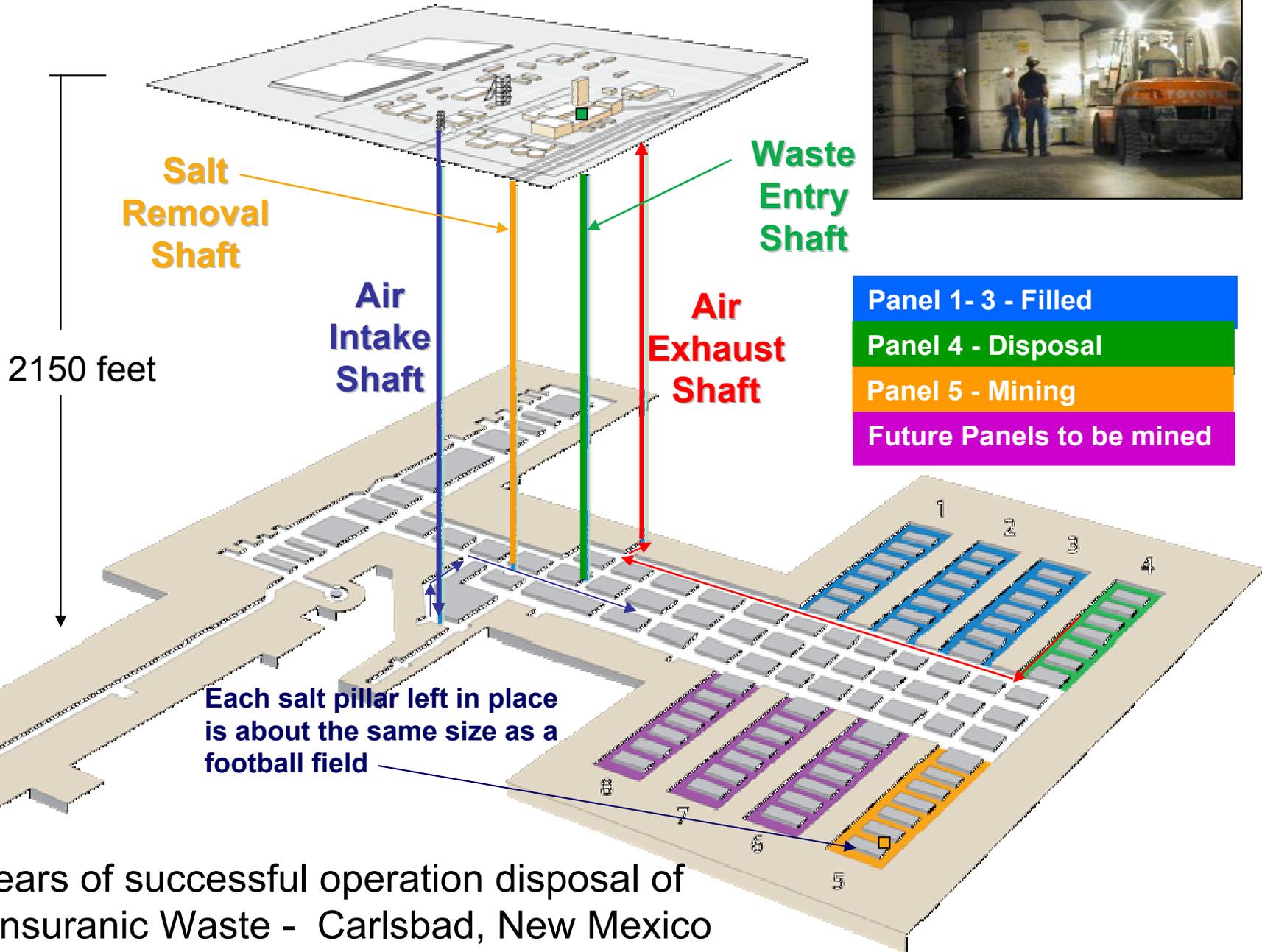
## Waste Strategies: **Intergenerational** (and geographical) **fairness**

On-site Interim Storage → (monitored retrievable → geological) (Yucca Mountain)

On-site Interim Storage → off-site interim storage → geological

On-site Interim Storage → off-site process storage → reprocess + geological

# Waste Isolation Pilot Project (WIPP)



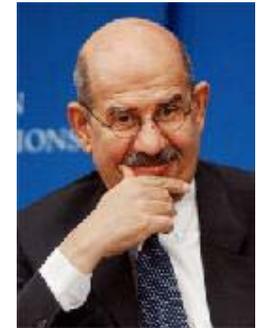
9 years of successful operation disposal of Transuranic Waste - Carlsbad, New Mexico

# Nonproliferation will require strong international cooperation: A new international framework for “nuclear fuel services.”

IAEA Director General El Baradei

10/16/03

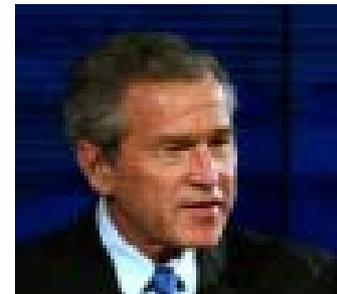
It is time to **limit** ..the production of new material through **reprocessing and enrichment**, by agreeing to restrict these operations exclusively to facilities under multinational control.....



We should consider **multinational approaches** to the management and disposal of spent fuel and radioactive waste

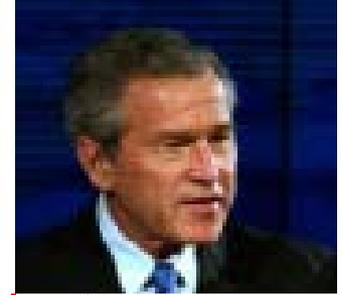
Pres Bush NDU Speech: *New Measures to Counter WMD*, 2/11/04

The **world's leading nuclear exporters** should ensure that states have reliable access at reasonable cost to fuel for civilian reactors, so long as those states **renounce enrichment and reprocessing**



**Limiting enrichment and reprocessing was a driving force for the  
Global Nuclear Energy Partnership (GNEP)**

## Expanding Global Nuclear Power: The Global Nuclear Energy Partnership (GNEP)



“As America and other nations **build more nuclear power plants**, we must work together to address two challenges: We must **dispose of nuclear waste safely**, and we **must keep nuclear technology and material out of the hands of terrorist networks and terrorist states**.

To meet these challenges, my Administration has announced a bold new proposal called the **Global Nuclear Energy Partnership**. Under this partnership, America will work with nations that have advanced civilian nuclear energy programs, such as France, Japan, and Russia. Together, we will **develop and deploy innovative, advanced reactors and new methods to recycle spent nuclear fuel**. This will allow us to produce more energy, while dramatically reducing the amount of nuclear waste and eliminating the nuclear byproducts that unstable regimes or terrorists could use to make weapons.”

President Bush Jan 2006

# Global Nuclear Energy Partnership

## International Principles

- Expand Nuclear Power
  - Safe & effective waste management
- Improve Safeguards
  - IAEA
- **Supply Framework for Fuel Services**
- Fast Reactors
  - Develop, Demonstrate & Deploy
- Appropriate Sized Reactors for Developing Countries
- Develop & Demonstrate Advanced Recycling
  - Eventually eliminate stocks of separated Pu
- Used Best Available Fuel Cycles



IAEA Sept 2007

## GNEP Partners

(As of February 26, 2008)

1. Australia
2. Bulgaria
3. Canada
4. China
5. France
6. Ghana
7. Hungary
8. Italy
9. Japan
10. Jordan
11. Kazakhstan
12. Lithuania
13. Poland
14. Romania
15. Russia
16. Senegal
17. South Korea
18. Slovenia
19. Ukraine
20. United Kingdom
21. United States

## Candidate Partner and Observer Countries

1. Argentina
2. Belgium
3. Brazil
4. Czech Republic
5. Egypt
6. Finland
7. Germany
8. Libya
9. Mexico
10. Morocco
11. Netherlands
12. Slovakia
13. South Africa
14. Spain
15. Sweden
16. Switzerland
17. Turkey

# The global nuclear enterprise is rich with international organizations, e.g.:

International Atomic Energy Agency (144)

- Nonproliferation and Safeguards
- International Project on Innovative Nuclear Reactors and Fuel Cycles (28)



- Generation IV International Forum (11)
  - Next generation of reactors



- World Association of Nuclear Operators (35)
  - Safety and Operations



- Nuclear Suppliers Group (45)
  - Non-proliferation



- Global Nuclear Energy Partnership (21)



- Nuclear Energy Agency (28)

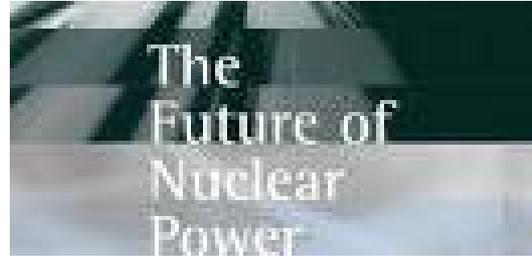


(Number of nation members)

# A Possible Fuel Cycle Regime

High Projections of Nuclear Power in 2050 (1609 GW)

MIT



58 States with nuclear power

## States with over 30 GW Nuclear

United States – 477  
China – 200  
India – 175  
Japan – 91  
France – 68  
Canada – 62  
Russia - 52  
Indonesia – 39  
Germany – 49  
UK – 37  
Brazil – 34

Possible Candidates for  
“Fuel Leasing”

1284/1609 GW, 80% of total

# National Strategies for Nuclear Energy

- 1) Phase out Nuclear Energy : **Former U.S., Germany,**
  - Nuclear Power is too costly, proliferation prone, waste too difficult
  - Maintain safety, discourage international reprocessing, limit repository
  
- 2) Nuclear Energy remains “Part of the Mix” : **Current U.S., Russia, China, .....**
  - Economic Competition with alternatives – Coal, Gas, Hydro, Renewables
  - International arrangements for non-proliferation
  
- 3) Nuclear Energy the primary source of base-load electricity: **France, Japan**
  - Energy Security
  - Carbon Free (Climate Change)
  - International arrangements for non-proliferation

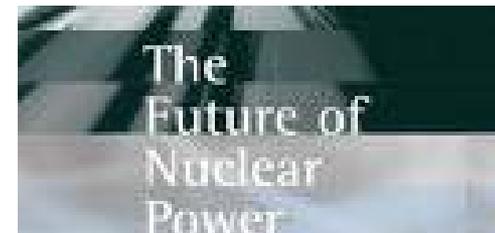
Given that the U.S. has changed its policy, what are alternate pathways for the DOE nuclear program?

# Proposed U.S Nuclear Growth Strategies

- Current DOE Program
  - New Reactor Builds – NP2010, Production Tax Credit, Loan Guarantees, Insurance.
  - Yucca Mountain Repository ?
  - Modest R&D
    - Advanced Systems
    - Industry driven
    - International Partnerships (GNEP)
      - Gen IV International Forum
  - Commercial Business Model for Industrial Recycling
    - Build upon Available Recycling Technology
    - Process Storage of Spent Fuel

Current Congressional Program

- Alternative Program – MIT *Future of Nuclear Power*
  - New Reactor Builds –Production Tax Credit
  - Interim Storage
  - Alternative Repositories (Yucca Mountain+)
  - Strong R&D: Reactor & Fuel Cycle
    - Laboratory, University, Industry
    - Simulation
  - International Partnerships



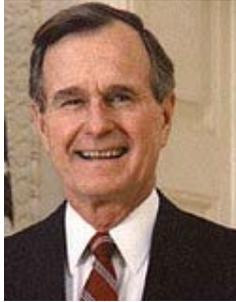
# Closing the Nuclear Policy Circle



"0"

NPT Article 6

Fewer Nuclear Weapons



More Excess Weapons Material



Climate Change  
Energy Security

A lot more Nuclear Power



Effective Non-Proliferation Regime  
Material Control, Fuel Leasing

NPT Article 4

CTBT

More Stable International Political Regime

Atoms for Peace



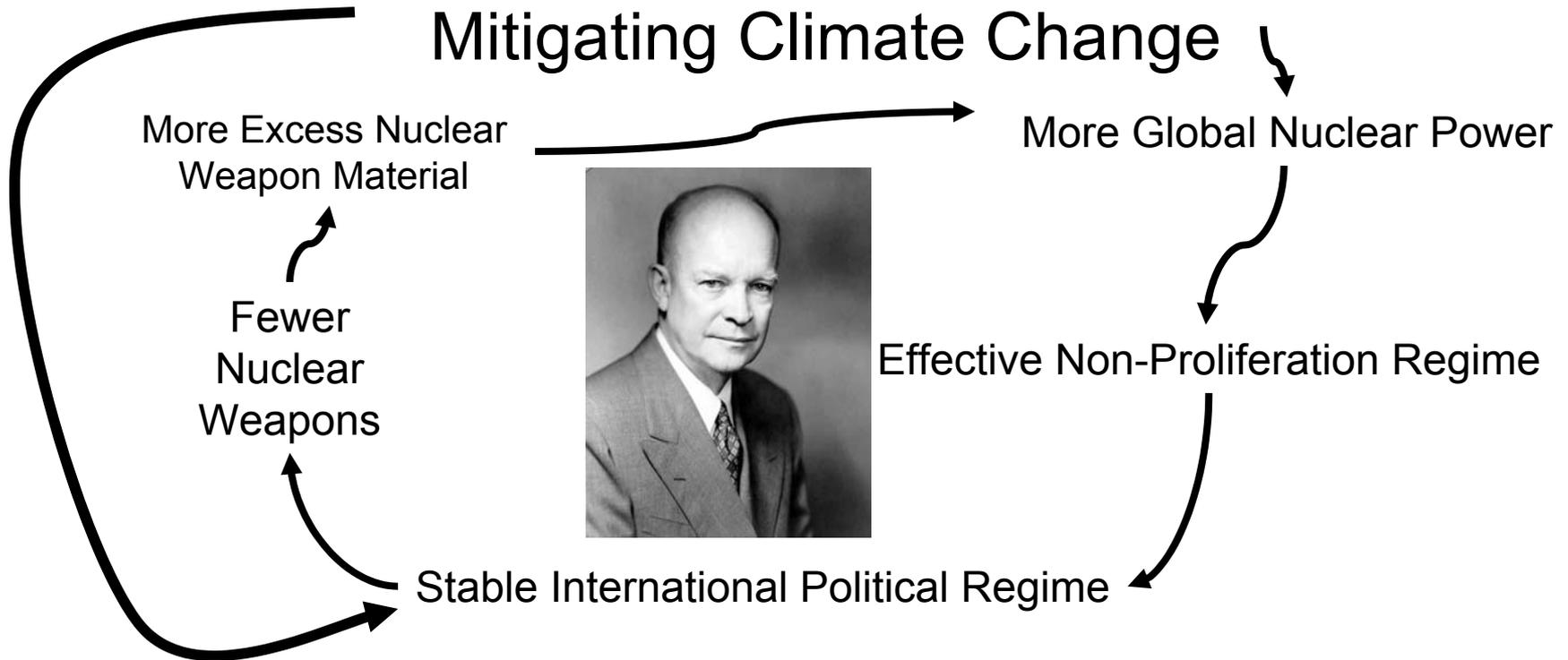
# Closing the Nuclear Policy Cycle - 2

"I will clean up the planet.. I will make global warming a priority."



"I believe it's one of the greatest moral challenges of our generation"

## Mitigating Climate Change



# A (very) Short History of the U.S. Department of Energy



Manhattan Project



Atomic Energy Commission



ERDA

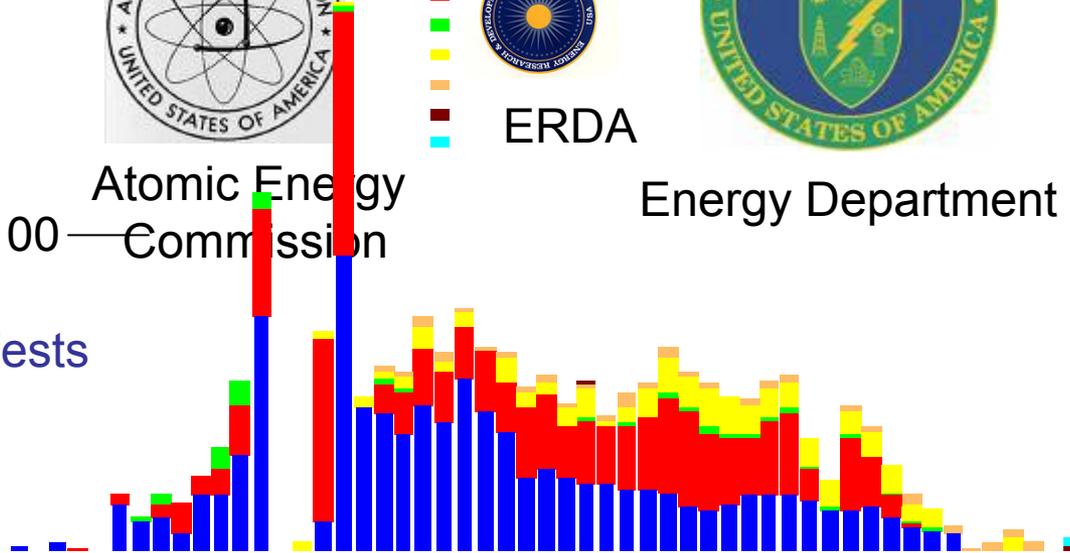


Energy Department



1992 - 94

US Tests



WW 2

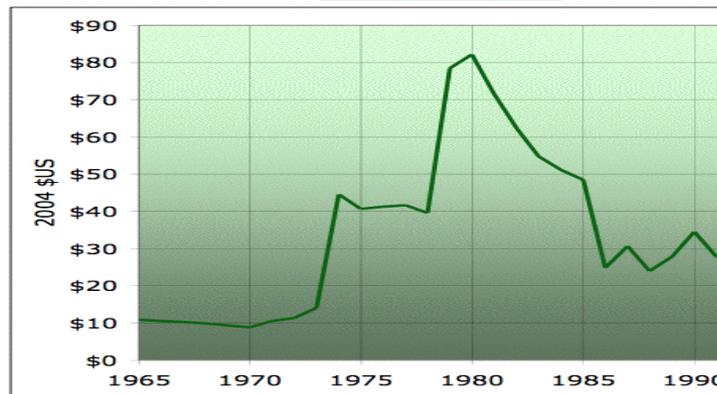
Cold War

Energy Crisis

- No New Weapons
- No Nuke Testing
- Little Nuke Power R&D
- No Waste Repository
- Cancel SSC/ANS
- Little Russian Interaction
- No Energy Policy

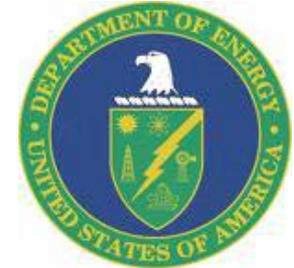
**Defense Clean Up:**  
Hanford, Rocky Flats, etc

\$/bbl



# DOE has done a lot in the last ~ 15 years, for example:

- Major New Science Installations
  - Spallation Neutron Source – **Oak Ridge**
  - Advanced Photon Source - **Argonne**
  - National Ignition Facility - **Livermore**
  - Linac Coherent Light Source - **SLAC**
  - Relativistic Heavy Ion Collider - **Brookhaven**
  - Microsystems and Engineering Sciences Application (**MESA**) - **Sandia**
- Nuclear Weapons - Stockpile Stewardship
  - Much deeper understanding of nuclear explosive process
    - 114 Annual Weapon Certifications without underground testing
    - Simulation has driven High Performance Computing Leadership
    - Stockpile Life Extension (W87, B61)
- Non-Proliferation
  - Russian Weapons and Material Security much improved
  - International Safeguards
  - “Megatons to Megawatts” (330 MTons of Russian HEU eliminated)
- Defense Clean Up
  - Rocky Flats
  - Fernald
  - Mound
- Radioactive Waste Disposition
  - Waste Isolation Pilot Plant (WIPP)
  - Yucca Mountain License Application

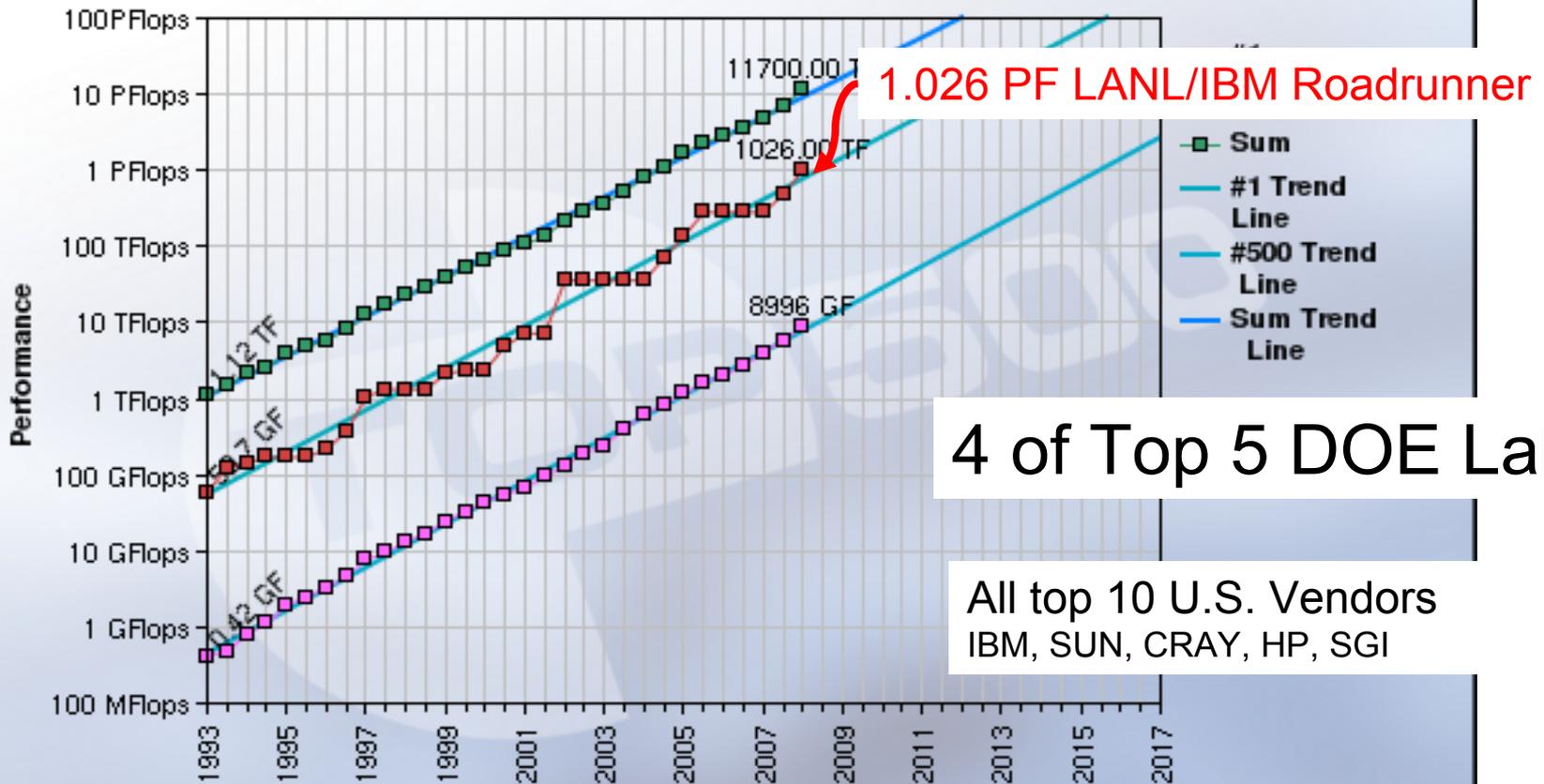


27 Nobel Prizes

# Starting with Stockpile Stewardship, DOE has led the modern Super Computing Industry



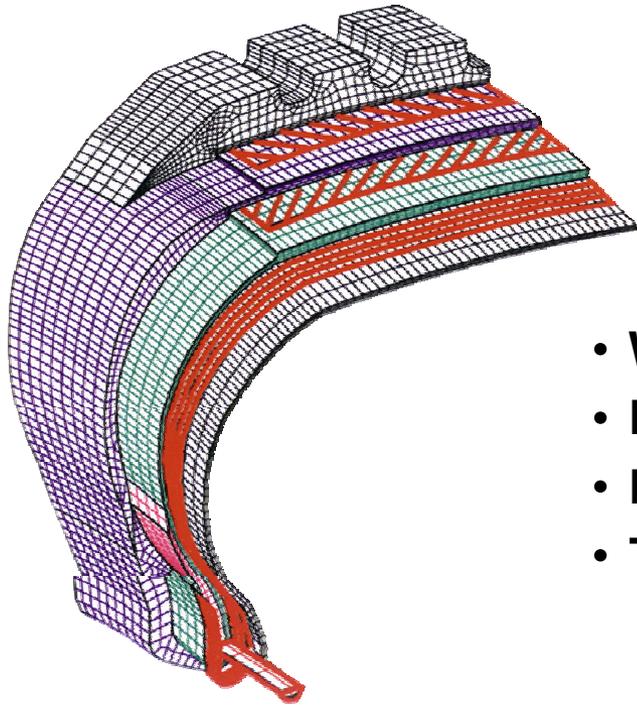
## Projected Performance Development



4 of Top 5 DOE Labs

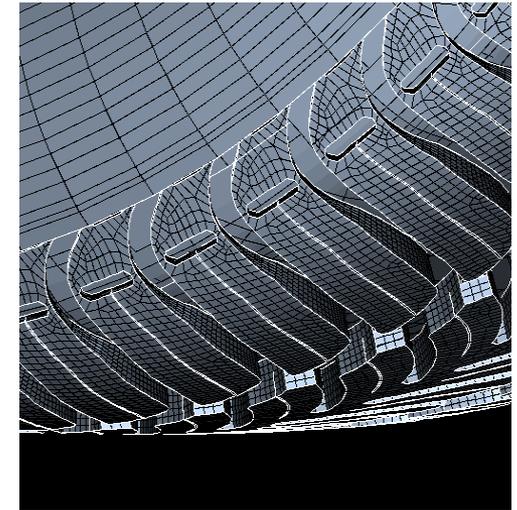
All top 10 U.S. Vendors  
IBM, SUN, CRAY, HP, SGI

# Sandia helped Goodyear use advanced simulation to transform tire design and manufacture.

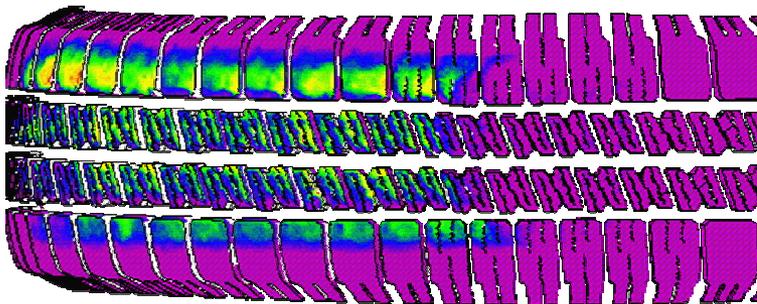


## Challenges

- Wear and failure
- Road handling
- Ride, vibration and noise
- Traction in all weather



Goodyear Assurance w/  
TripleTread Technology



Accumulated slip distribution  
=> wear prediction

# Nuclear Material Protection, Control and Accounting in Former Soviet States



**Rosatom Weapons Complex**

**Russian Navy**

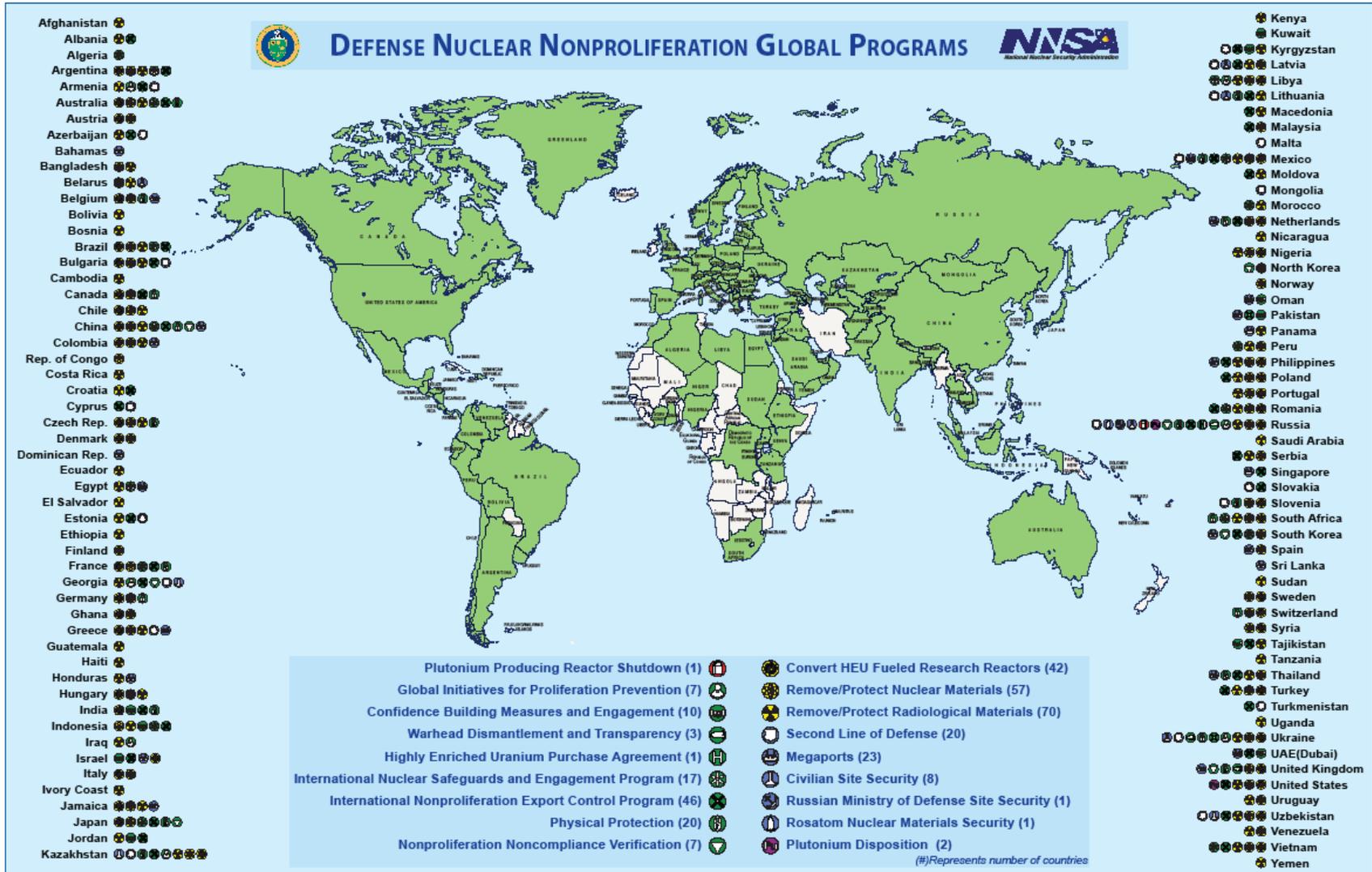
**Rosatom Civilian Complex**

**Strategic Rocket Forces**

**Former Soviet Republics**

**MOD 12<sup>th</sup> GUMO**

# The work on nuclear non-proliferation has been expanded world wide





## Rocky Flats Cleanup

### **DOE's Rocky Flats Cleanup Site Named 2006 Project of the Year By Project Management Institute**

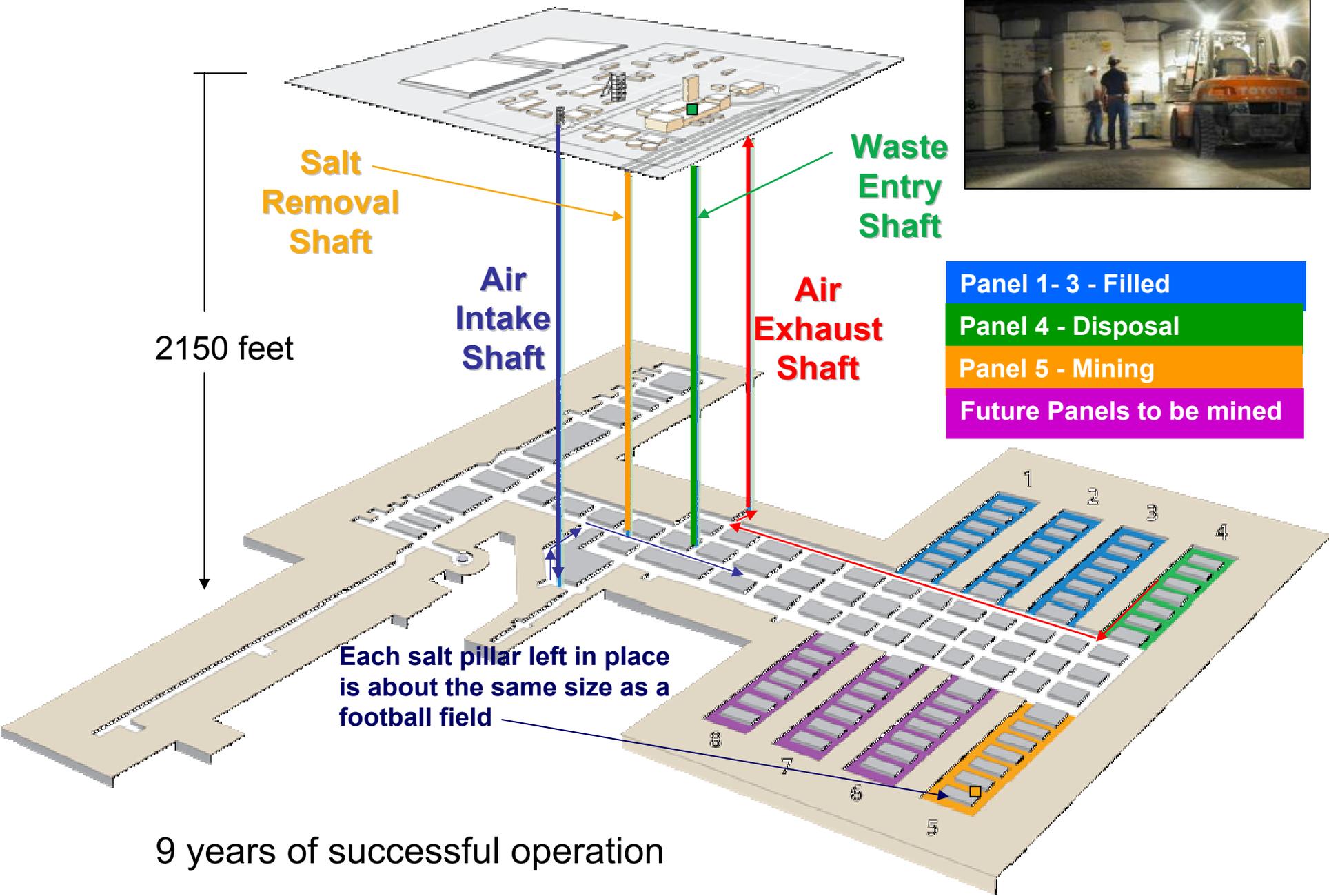
“With the transfer of nearly 4,000 acres from the Department of Energy, the U.S. Fish and Wildlife Service will establish the Rocky Flats National Wildlife Refuge in order to conserve the rare and unique tallgrass prairie found along Colorado’s Front Range,” U.S. Department of Interior’s Director of the Fish and Wildlife Service H. Dale Hall said. “As intended by Congress, the refuge will preserve a lasting wildlife and habitat legacy for future generations.”

July 12, 2007

The 10-year environmental cleanup of the site cost approximately \$7 billion and finished more than 50 years ahead of initial forecasts and for nearly \$30 billion less than estimated in 1994



# WIPP Repository Layout and Operation



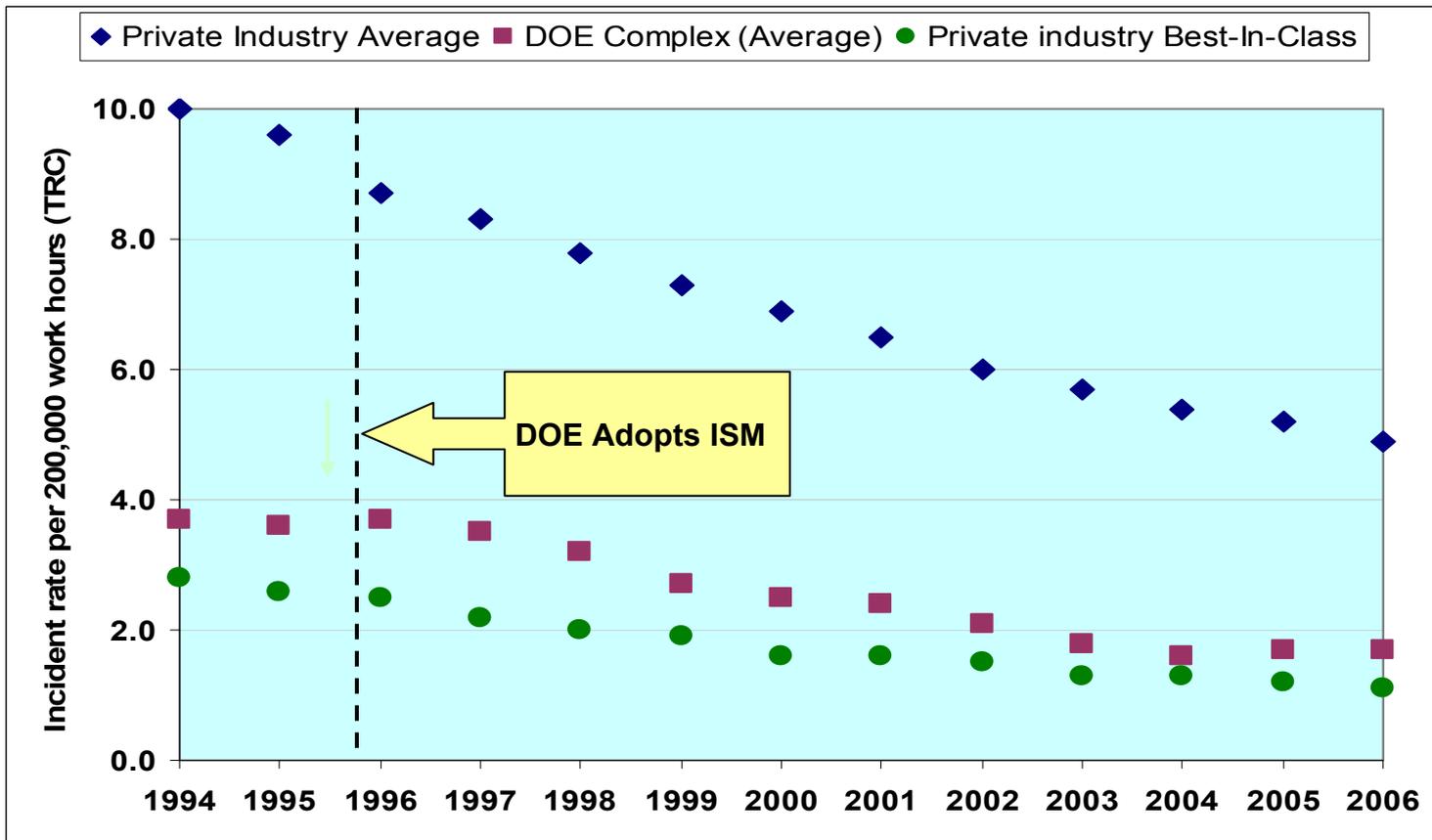


**DOE's License Application  
for a High-Level Waste  
Geologic Repository at  
Yucca Mountain**

**Submitted to NRC**

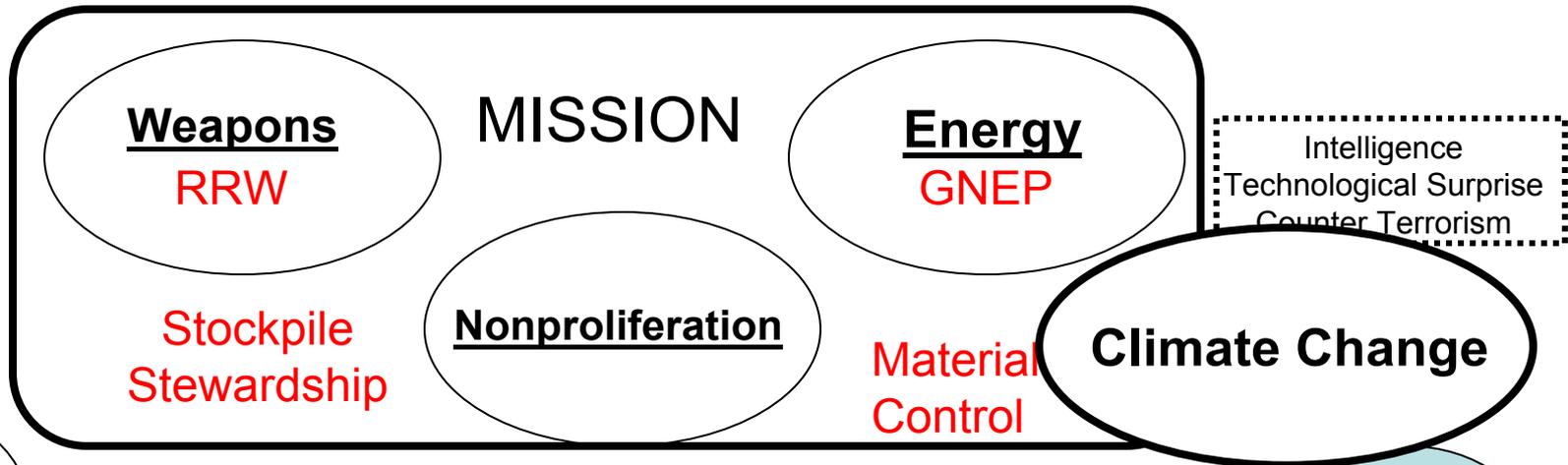
**June 3, 2008**

# Integrated Safety Management cuts DOE safety incidents by half



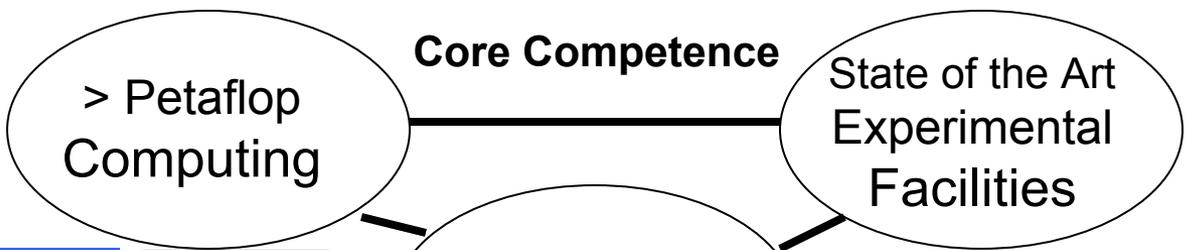
As injury rates decrease, each incremental step requires strong leadership and commitment to achieve additional gains.

# Structuring DOE for the New (and Continuing) Challenge



**Wpns Plants**  
Complex Transform

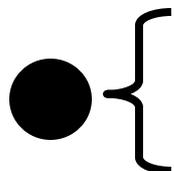
**Industry**



**Labs (Brains)**

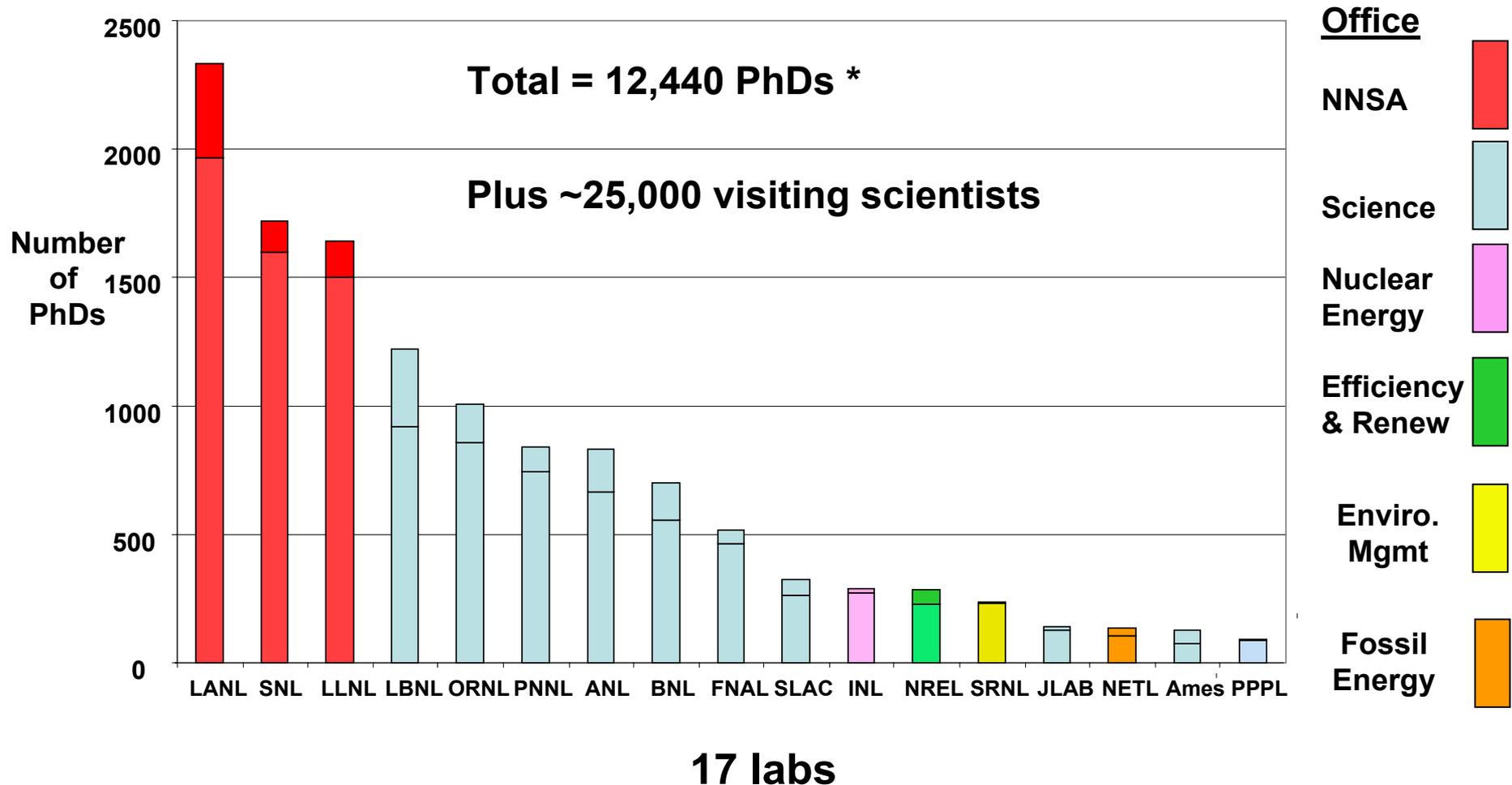
**Material & Radiation Science**

**Academia**



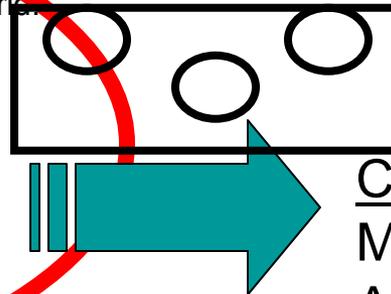
- How to maintain the central DOE asset: it's labs
- How to focus the labs on the major energy, environment and national security challenges

# DOE has a large collection of PhD scientists at 17 labs



# Maintaining DOE Laboratory Core Competence

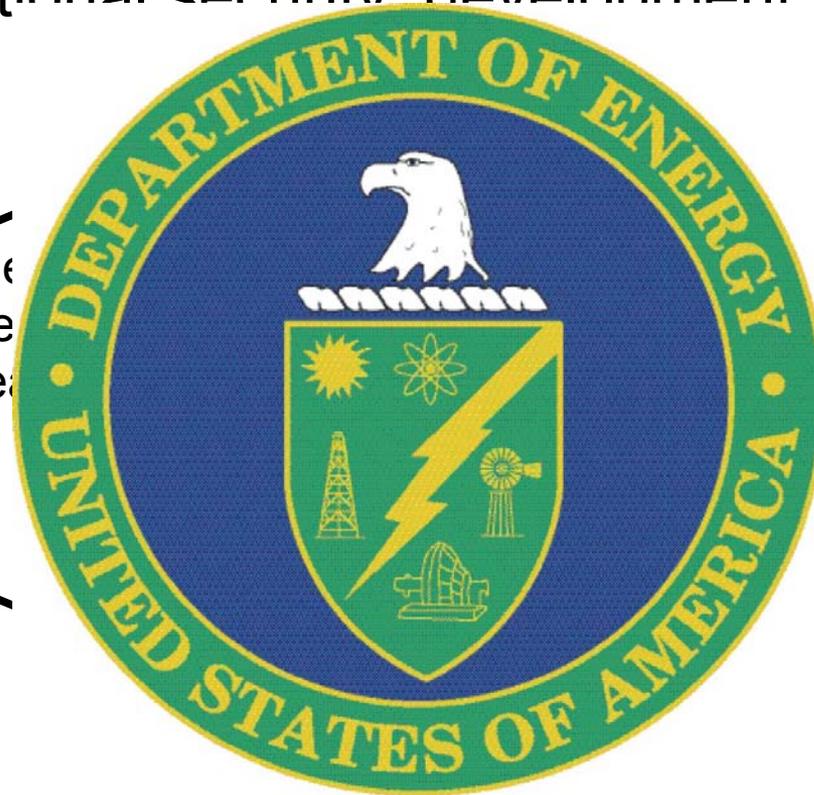
- Balancing Pure and Applied Science
- Maintaining leadership (core competence) in relevant science and technology
  - Challenge Problems
    - Boost Initiative
    - Advanced materials
    - Deep understanding of Environmental Impact
    - ....
  - Signature Facilities
    - SNS, LCLS, NIF, APT, etc
  - Computing & Simulation
- **Creating a DOE System of Labs**
  - Federal & Lab “Team”
    - Control & Governance in a FFRDC/GOCO work
    - Federal technical competence
  - Capacity (user facilities) & Capability (NIF)
  - Competition & collaboration
  - Office Ownership vs Program needs
  - Integrating with Industry & Academia
    - IBM, Goodyear, etc.
  - Classified vs Open Research
    - Foreign interactions



Climate Change  
Measure, Model,  
Analyze & Provide  
Technical Response  
Options ?

**Summary:** The U.S nuclear enterprise (and the DOE and its labs) can provide the next U.S. President the opportunity to effectively attack the interlocking issues of global national security, development and climate change.

Maintain extended  
deterrence while  
number of nuclear



economically  
and expand nuclear

An effective, integrated Department of Energy

# Some Useful Things to Remember

Crisis = 危  
          機

Danger

Opportunity

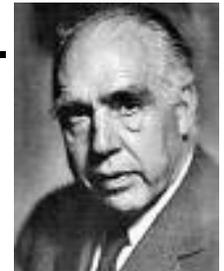
“A crisis is a terrible thing to waste”



Paul Romer

“How wonderful that we have met with a paradox.  
Now we have some hope of making progress.”

- NIELS BOHR



A vision without action is a dream,  
Action without vision is a nightmare

Japanese Proverb



行為のない視野は夢、視野のない行為である不快感である

# “Atoms for Peace”



“To the making of these fateful decisions, the United States pledges before you – and therefore before the world – its determination to help solve the fearful atomic dilemma –to devote its entire heart and mind to find the way by which the miraculous inventiveness of man shall not be dedicated to his death, but consecrated to his life.”

President Eisenhower, December 1953