

The Greening of Nuclear Energy



50 years of continuous
operation honored
tonight

18 May 2006

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&

Vice President/President-Elect

American Nuclear Society

Timing is everything

The New York Times
nytimes.com

May 13, 2006

EDITORIAL

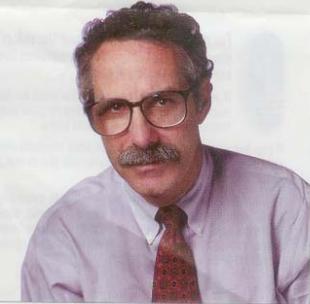
The Greening of Nuclear Power

Not so many years ago, nuclear energy was a hobgoblin to environmentalists, who feared the potential for catastrophic accidents and long-term radiation contamination. But this is a new era, dominated by fears of tight energy supplies and global warming. Suddenly nuclear power is looking better.

"The replacement of Britain's nuclear power stations is "back on the agenda with a vengeance," Tony Blair, May 17, 2006

Am I good?

—ROBERT J. SAMUELSON



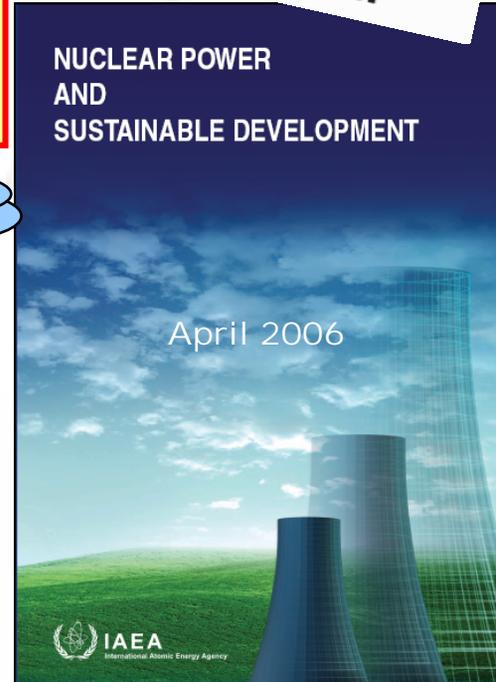
Newsweek
News. Trends. Voices.

“We Americans want it all: endless and secure energy supplies; low prices; no pollution; less global warming; no new power plants (or oil and gas drilling, either) near people or pristine places. This is a wonderful wish list, whose only short-coming is the minor inconvenience of massive inconsistency.”

Feb. 8, 2006
U.S. Must Maintain Nuclear Power Plants to Address Climate Change, Says Pew Center
PRINTER-FRIENDLY
SPONSORED BY

NUCLEAR POWER AND SUSTAINABLE DEVELOPMENT

April 2006



washingtonpost.com

Going Nuclear

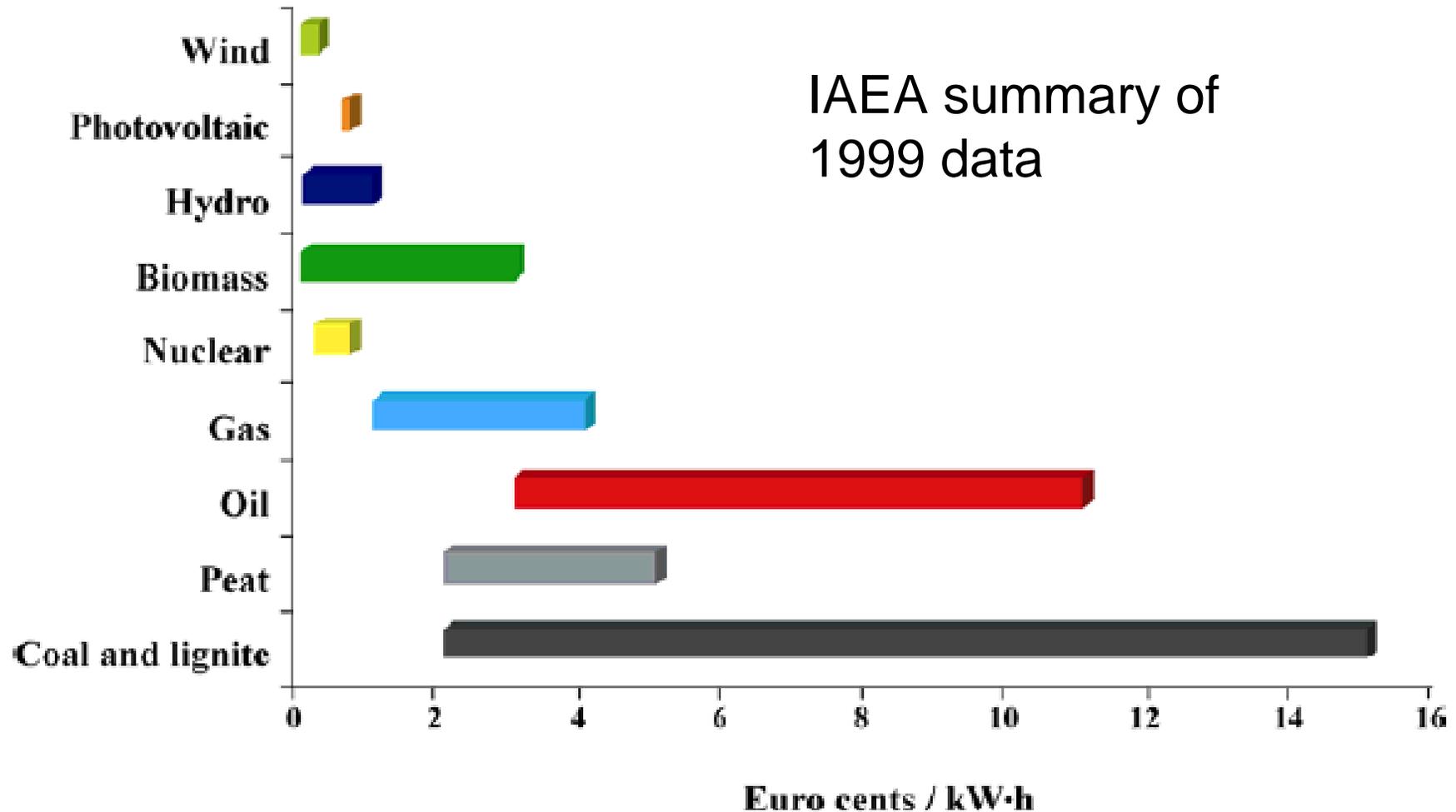
A Green Makes the Case

By Patrick Moore
Sunday, April 16, 2006; B01

In the early 1970s when I helped found Greenpeace, I believed that nuclear energy was synonymous with nuclear holocaust, as did most of my compatriots. That's the conviction that inspired Greenpeace's first voyage up the spectacular rocky northwest coast to protest the testing of U.S. hydrogen bombs in Alaska's Aleutian Islands. Thirty years on, my views have changed, and the rest of the environmental movement needs to update its views, too, because nuclear energy may just be the energy source that can save our planet



External cost of power generation is a measure of “greenness”



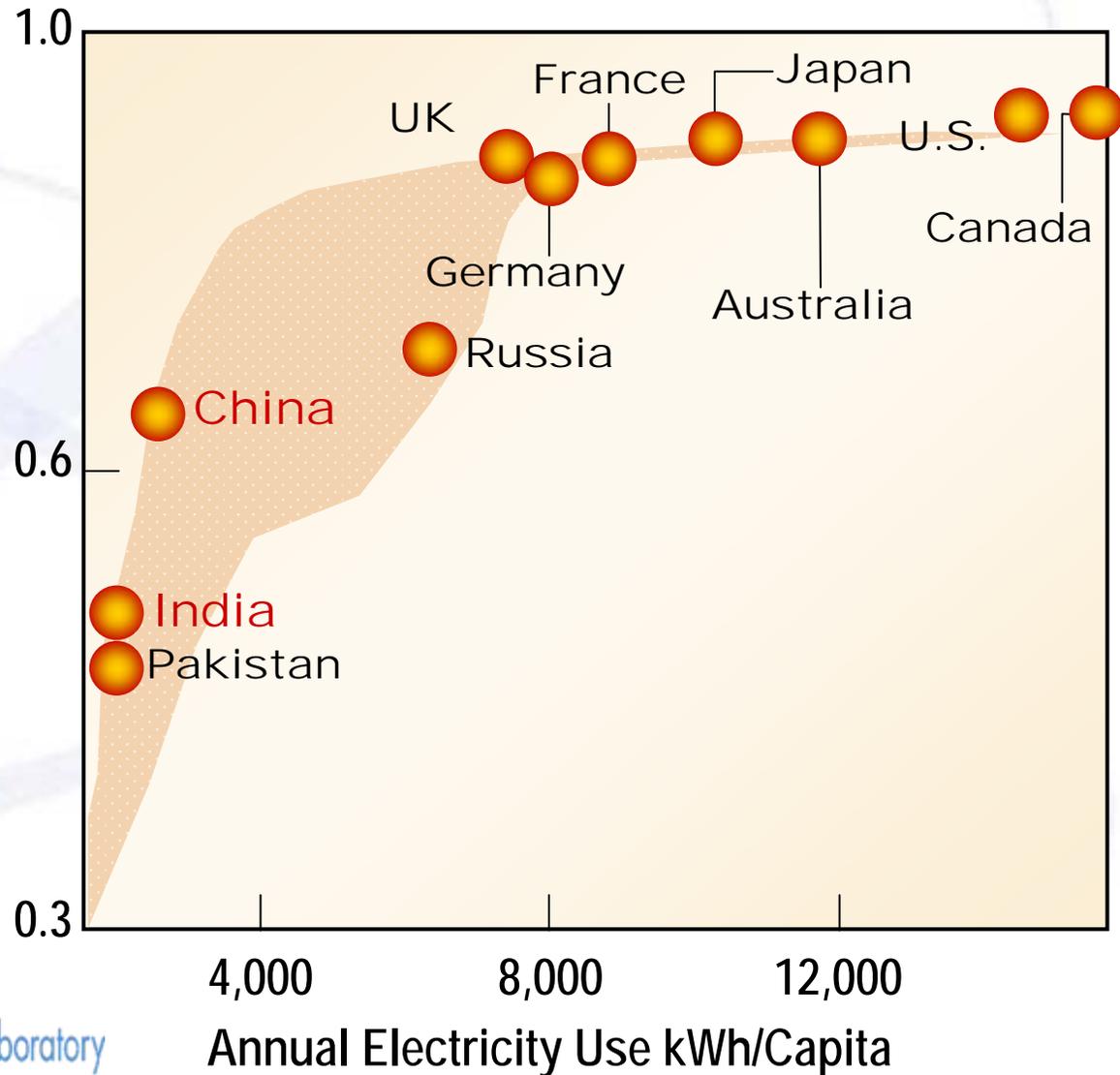
Access to energy essential to quality of life

80% of the world's population is below 0.8 on the UN's Human Development Index (HDI)

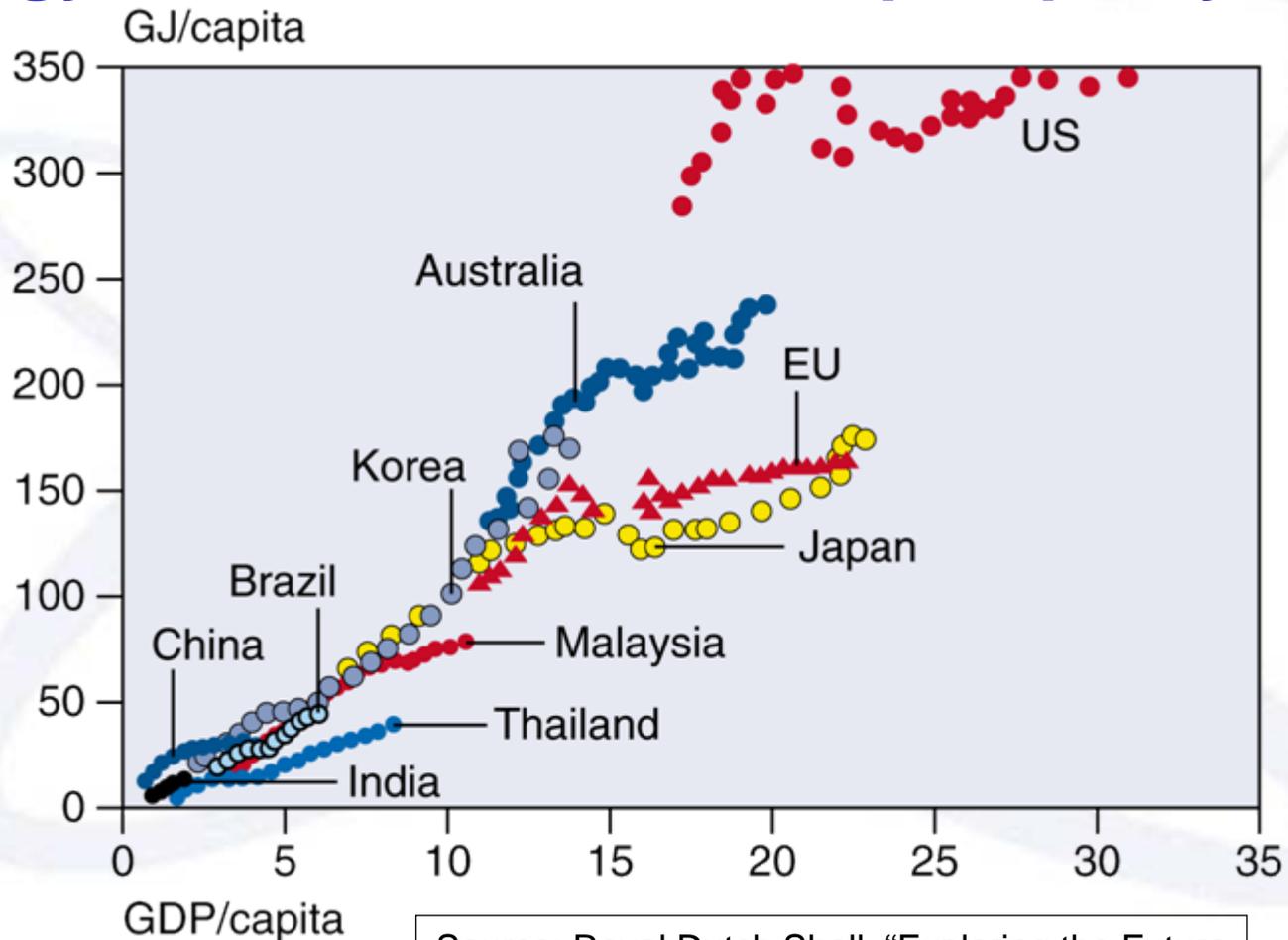
Prosperity

Education

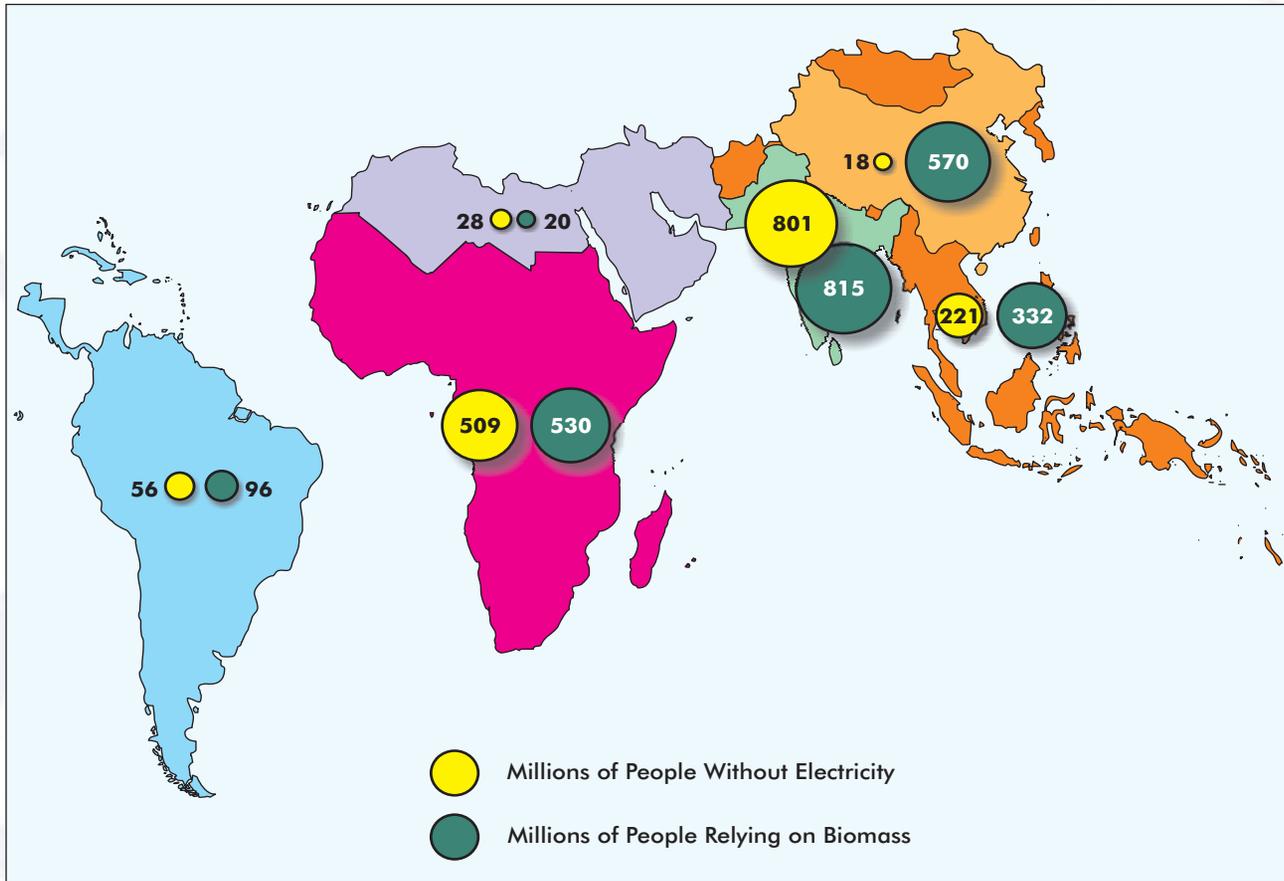
Life span



Energy is the fuel of national prosperity



Map of Global Energy Poverty

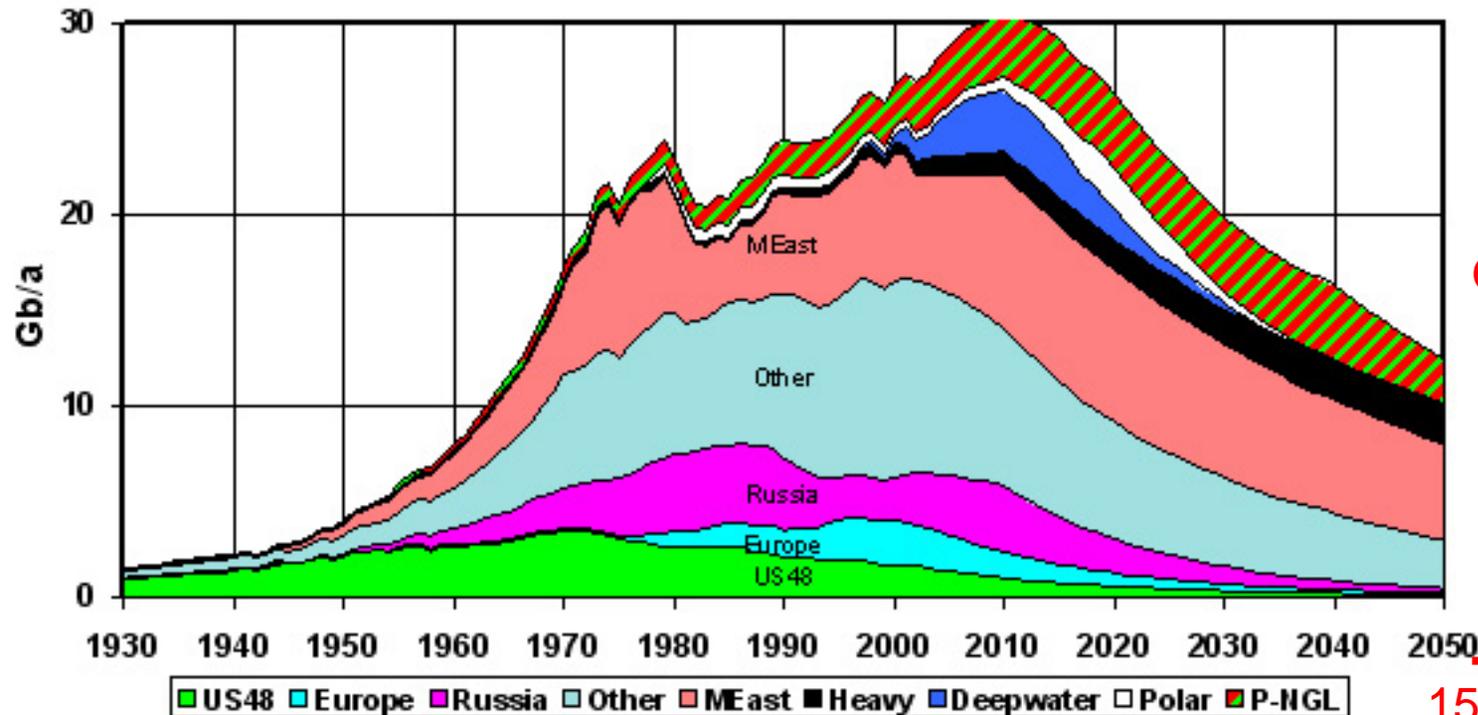


***1.6 billion people have no access to electricity,
80% of them in South Asia and sub-Saharan Africa***

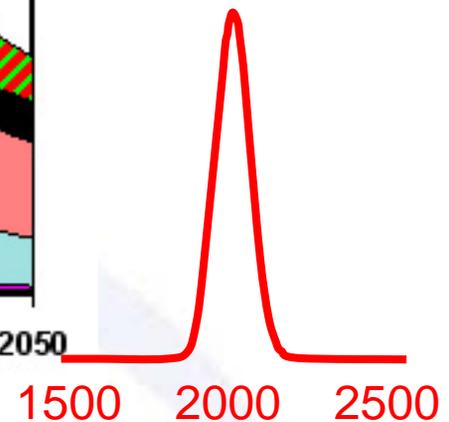
Most oil production in the “Golden Triangle” in the Middle East



Ultimately the geologists have it right: Oil production will peak



Oil in perspective

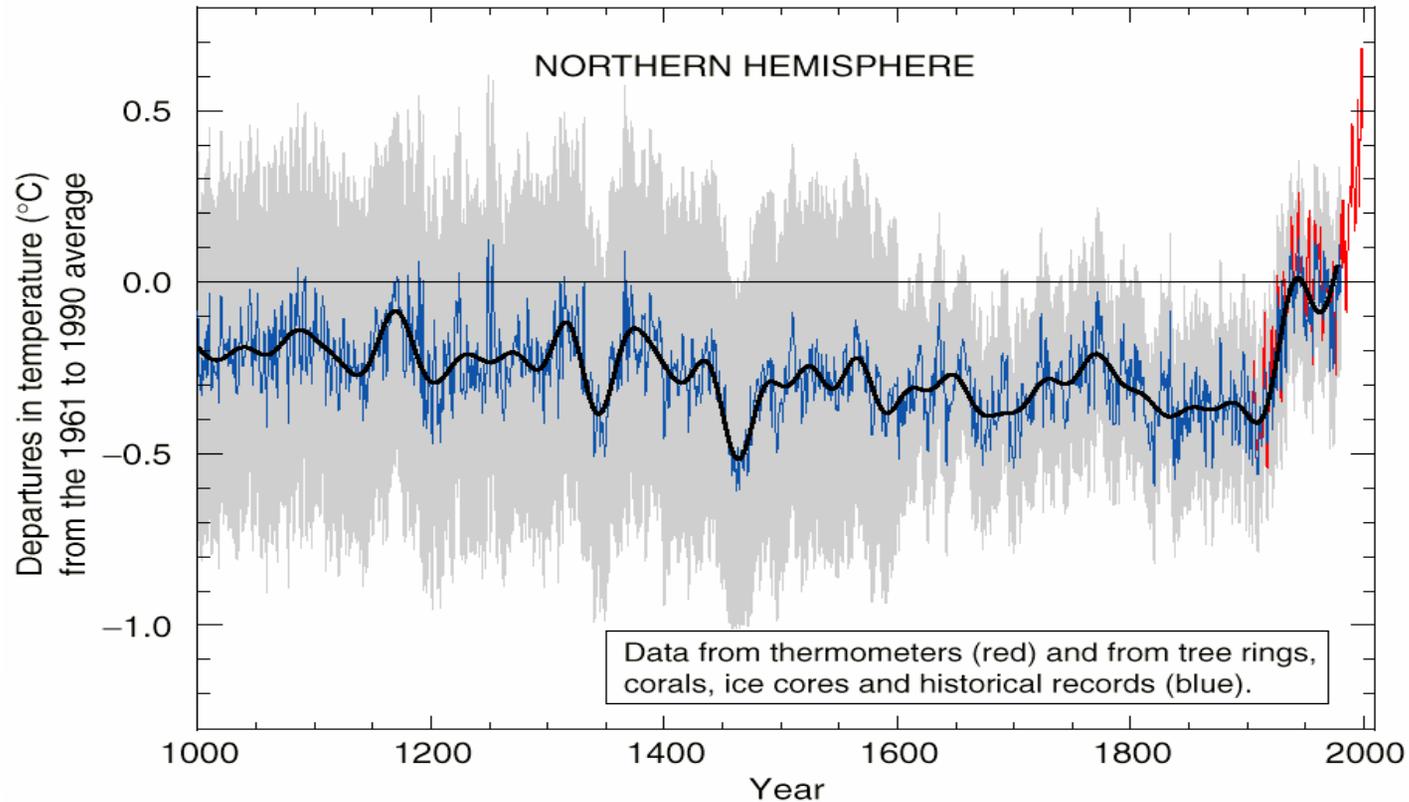


Friday, April 21, 2006, spot oil prices hit \$75/barrel—a new record

Also this week, President Bush complained to President Hu about

China's increasing demand for oil

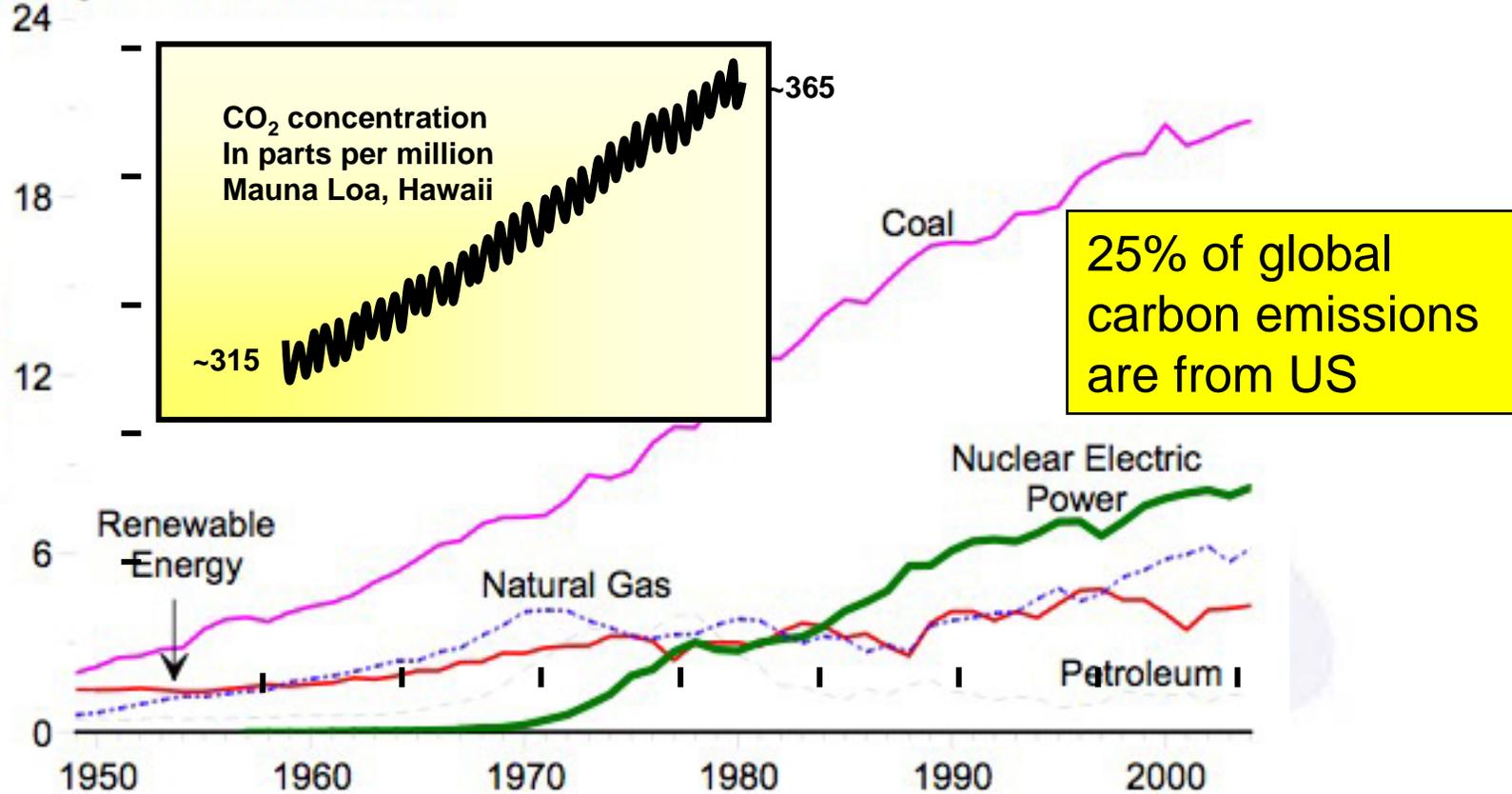
Climate change is taking place



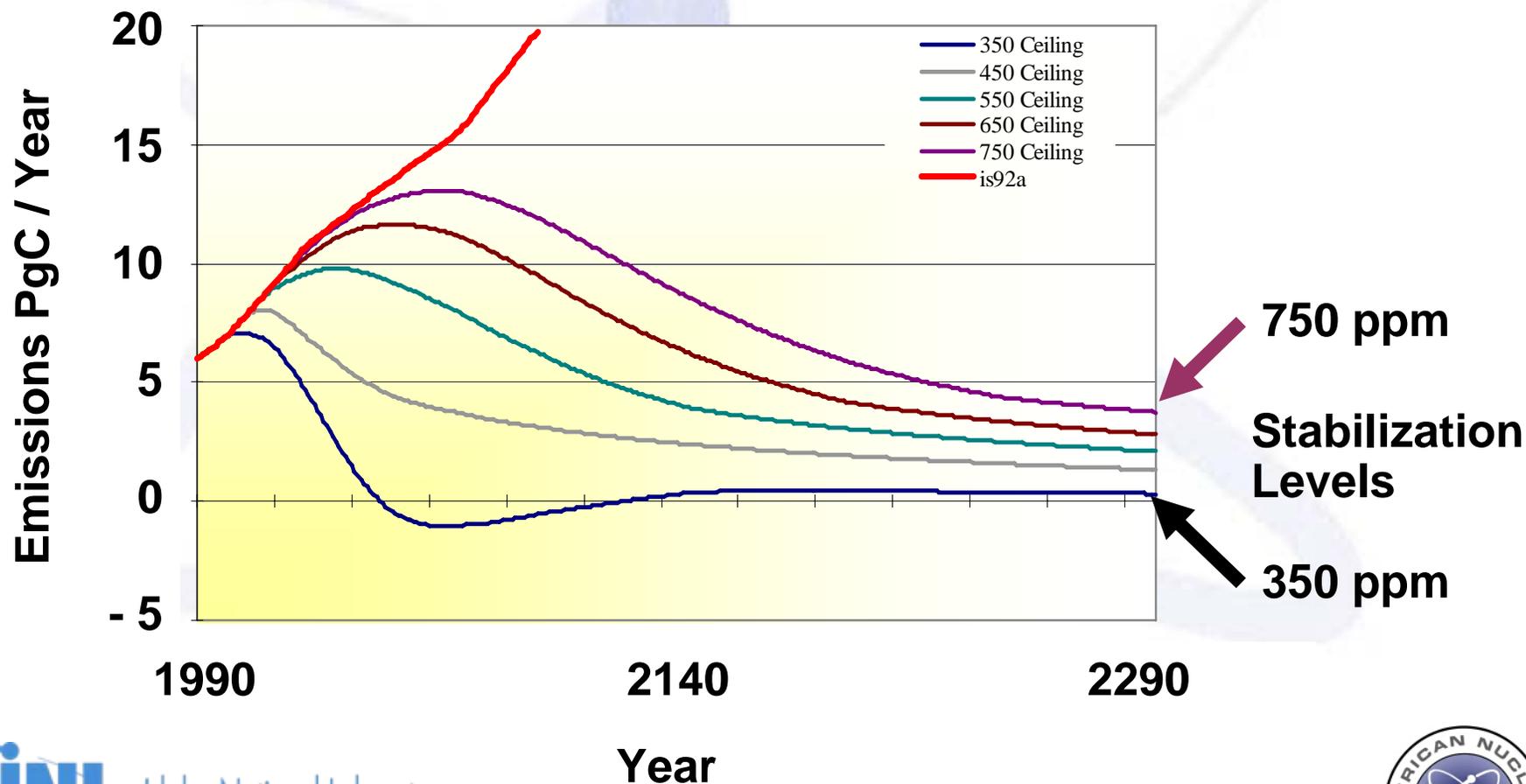
Estimated Change in Northern Hemisphere Temperature Since 1000 AD

Carbon based fuel use is growing

By Major Fuel, 1949-2004



Ultimately, net global CO₂ emissions must sharply decline to achieve stabilization



Why nuclear is green; why it's not green enough

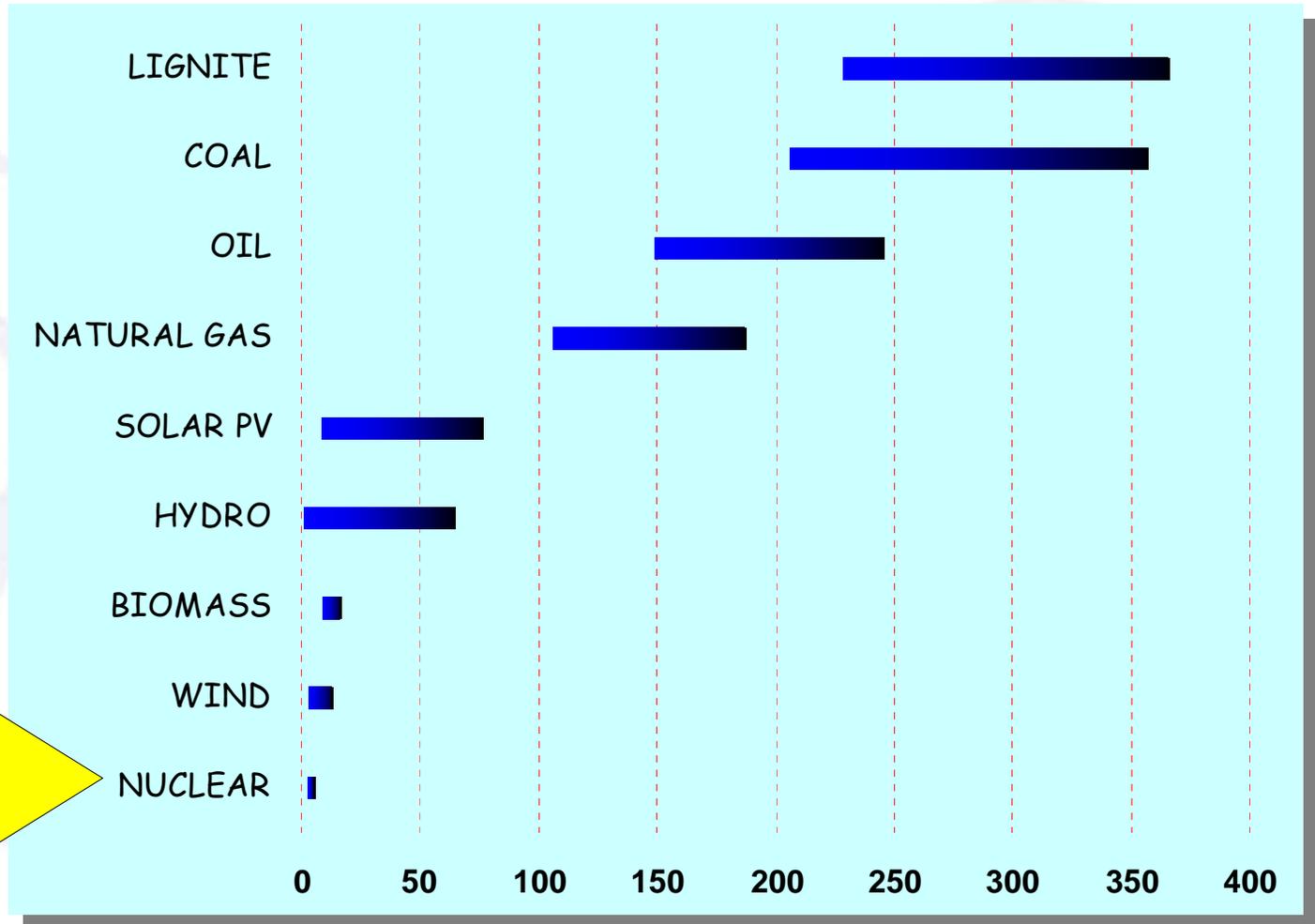
- Safe
- Potentially sustainable
- Minimal air emissions
- Readily expandable
- Minimal solid waste
- It's now a "cool" conversation topic
- Strong environmental endorsements
- Economically competitive
- Extractive industry
- Much remains to be proven
- Much remains to be implemented
- Lingering nonproliferation issues

Conditions for nuclear to be a significant part of the 21st century energy mix

- Low carbon emission technology
- Affordable
- Expandable
- Sustainable
- Safe
- Accepted
- Doesn't leave a mess
- Consistent with national and international policy

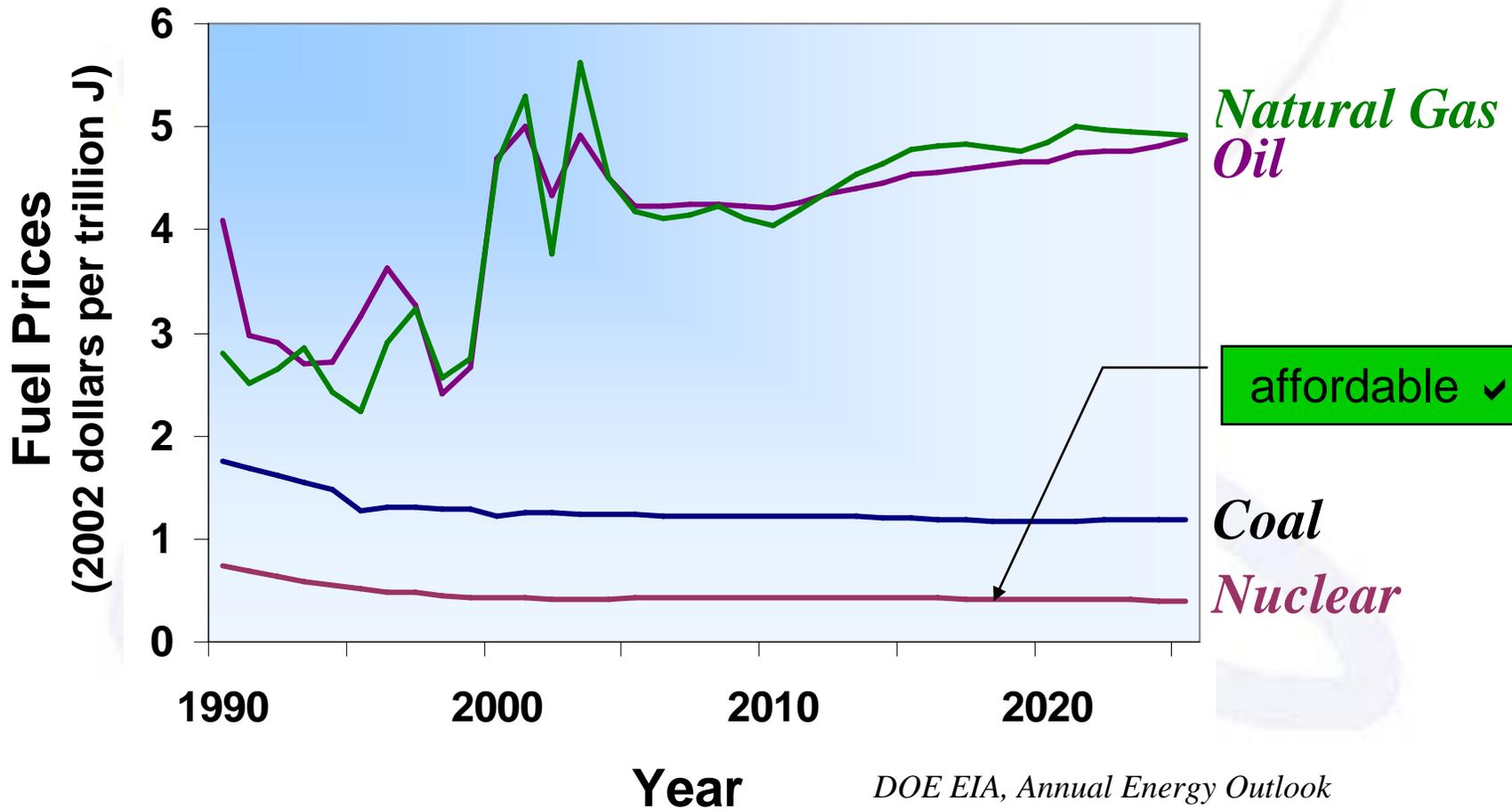
Greenhouse gas (GHG) emissions

GHG
gC_{eq}/kWh



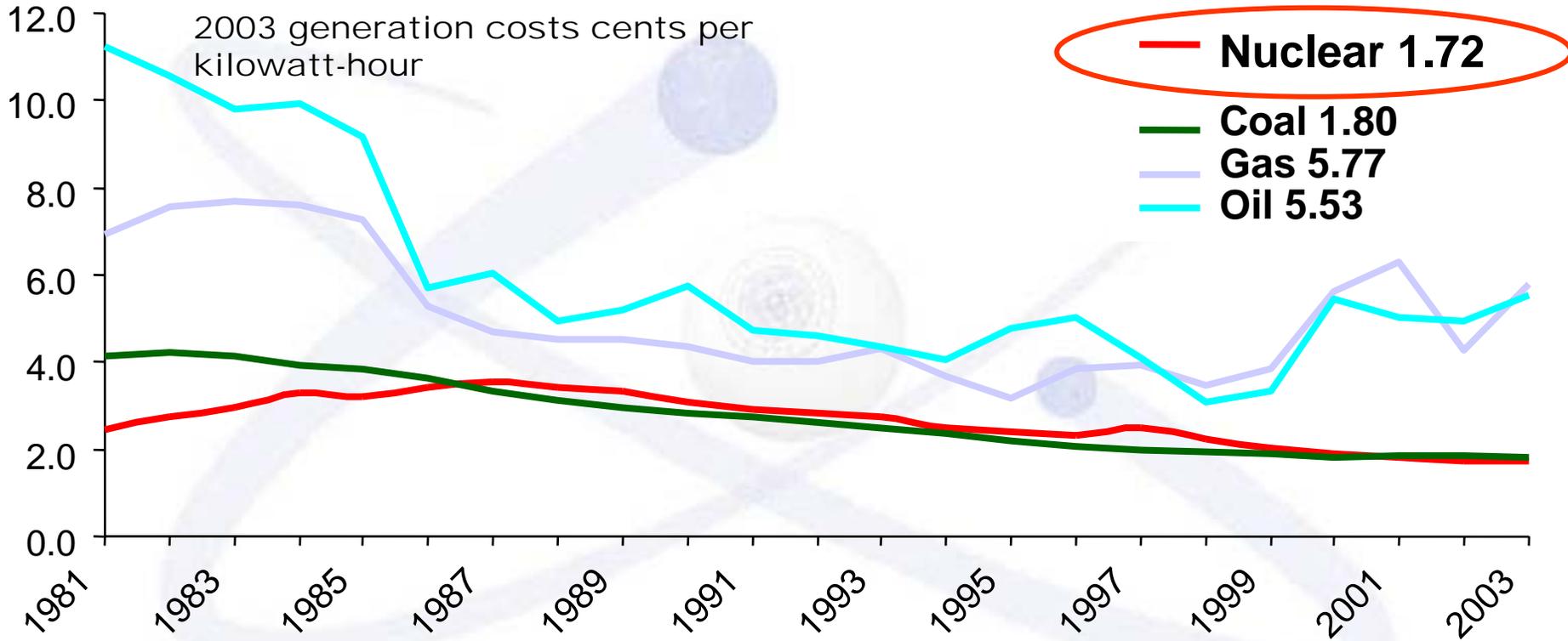
low carbon ✓

U.S. fuel prices to electricity generators



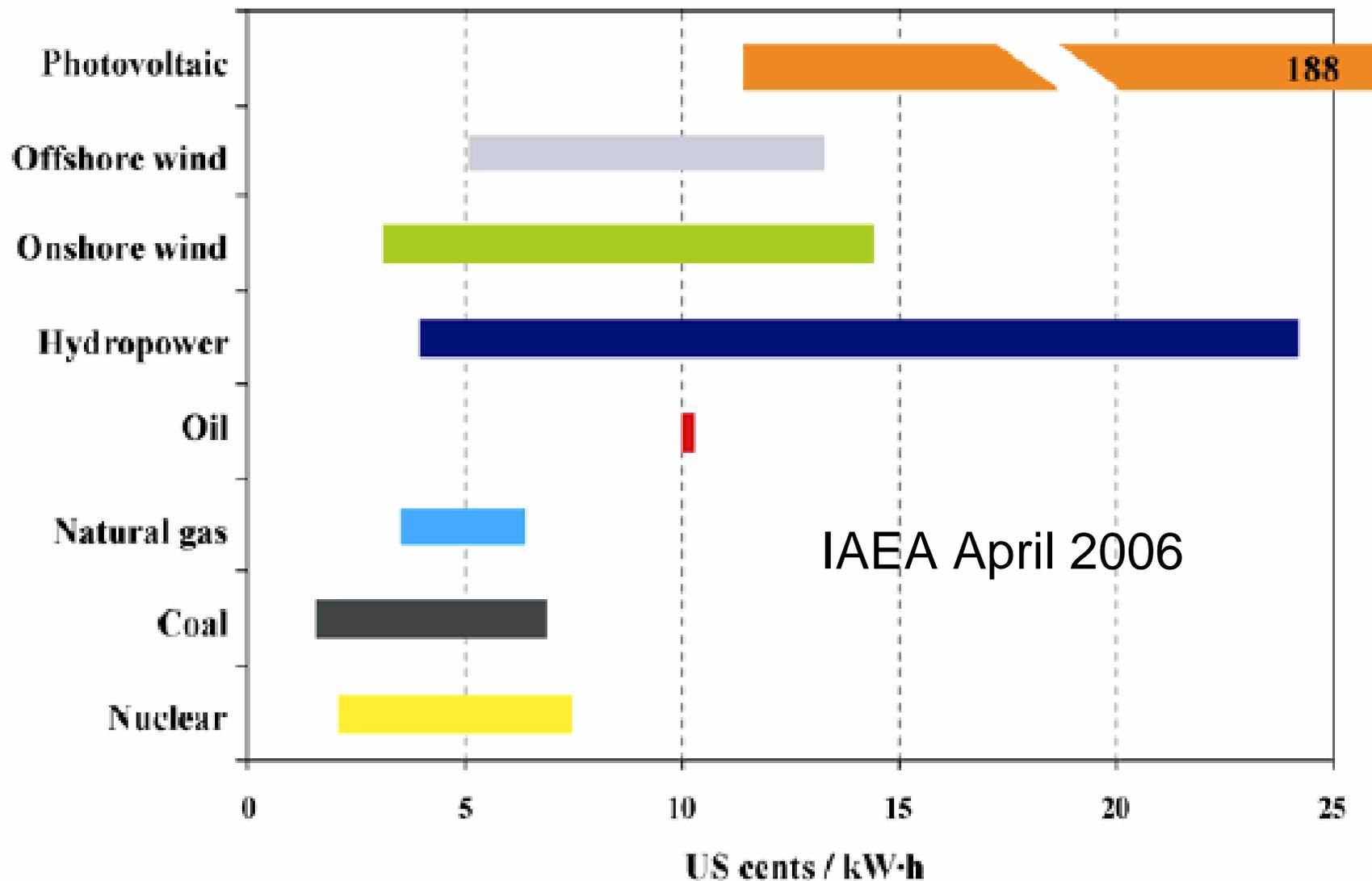
DOE EIA, Annual Energy Outlook
2004, Figure 73

Nuclear energy is competitive



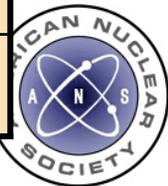
Nuclear is the lowest cost of all (except hydro)

Results of 7 recent forward cost studies



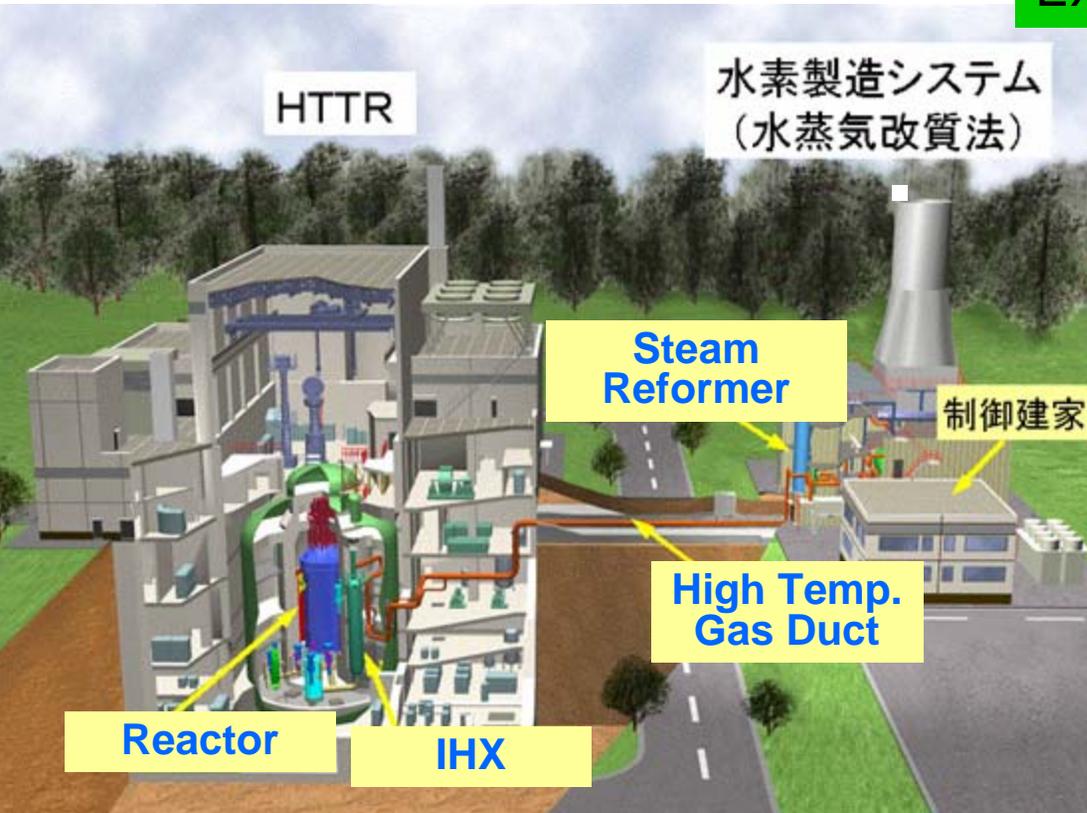
Current Unit Expansion in Asia/Europe

	Country	Operating Units	Number of Units Under Construction	Near-Term Plan (GWe)	By (year)
	India	14	8	29.5	2022
	South Korea	20	6	26.6	2015
	Russia	30	4	40	2020
	Japan	52	3	15	2025
	China	9	2	40	2020
	Ukraine	8	2	22	2030
	Pakistan	2	—	8.5	2030
	Iran	0	1	expandable ✓	
	Romania	1	1		—
	Finland	4	1	—	—

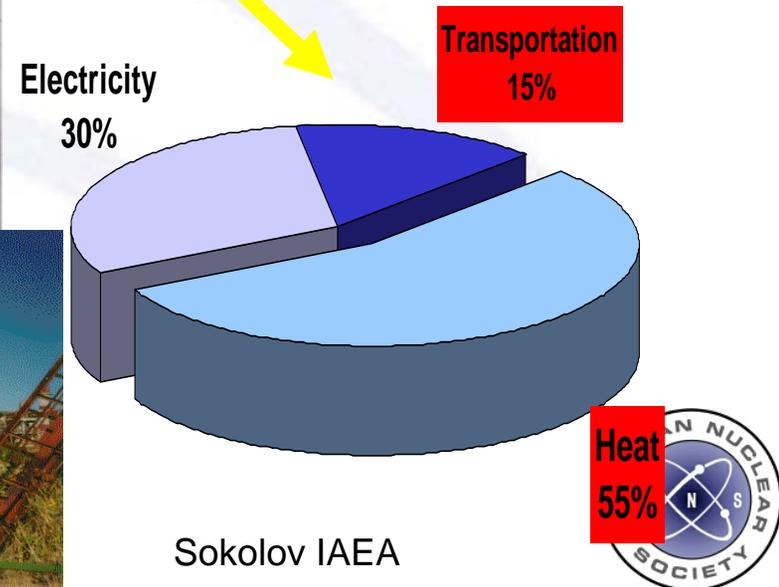


Non-electricity applications of nuclear energy

Expandable to other applications ✓



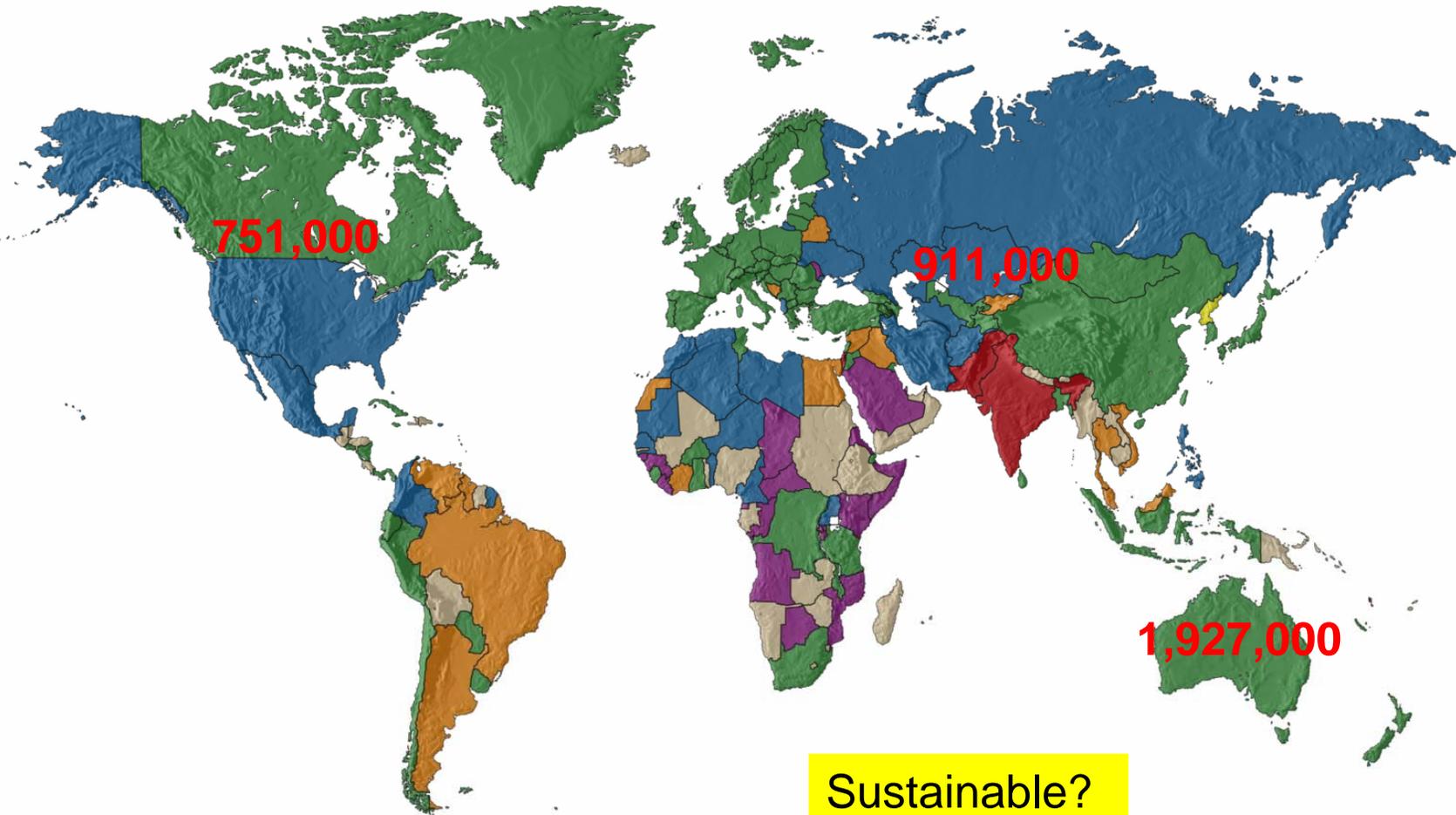
- Sea-water desalination
- Industrial and district heating
- Hydrogen production



Kazakhstan,
BN-350



Uranium resources are ample

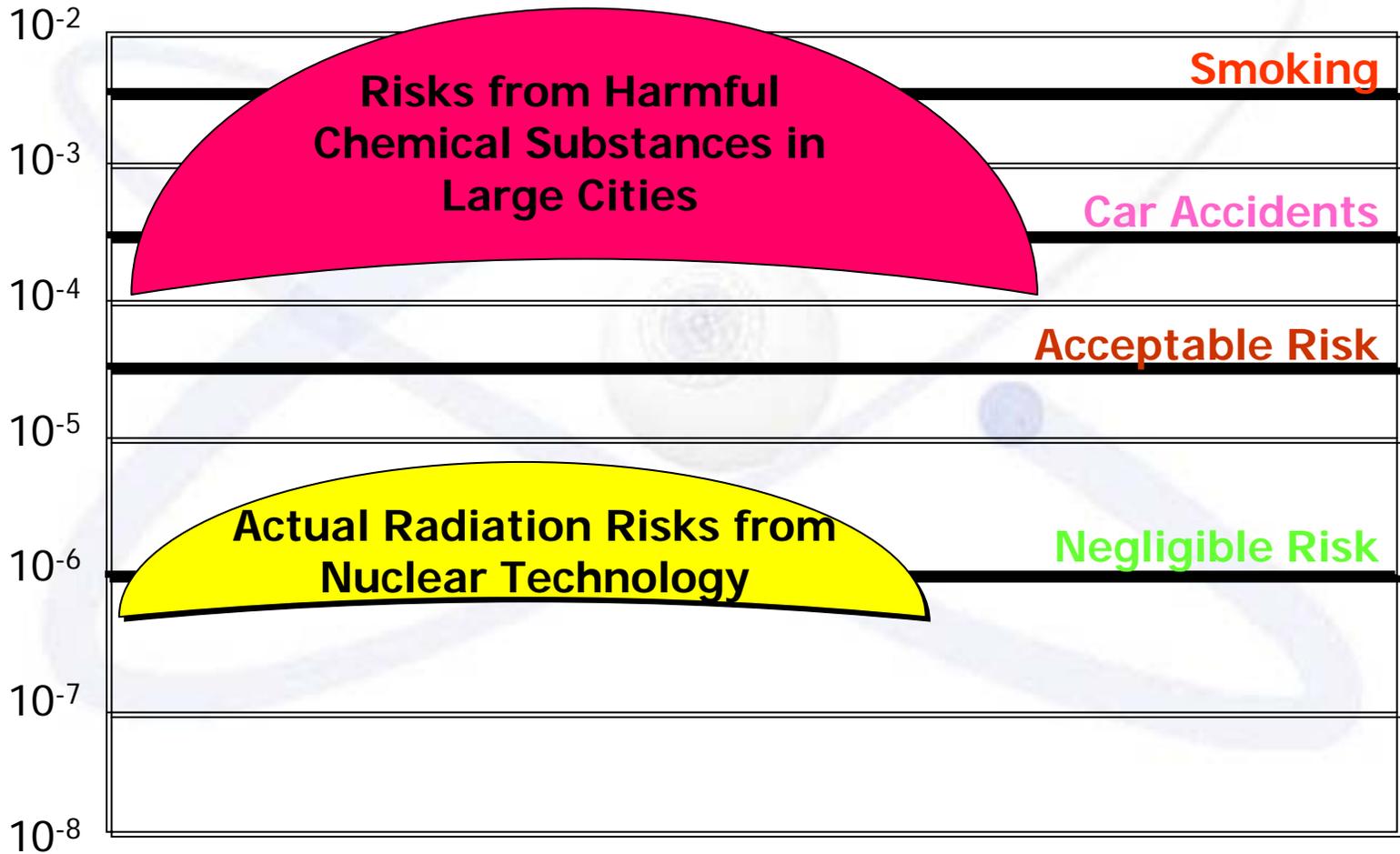


- INFCIRC/153 & AP in force
- INFCIRC/153 & AP signed but not implemented
- INFCIRC/153 Safeguards
- Signed Small Quantity Protocol Declaration
- NPT States without Safeguards Agreements
- Non-NPT States with INFCIRC/66 Safeguards
- "Withdrawn" from NPT (DPRK)



Nuclear technology has low risk

safe ✓

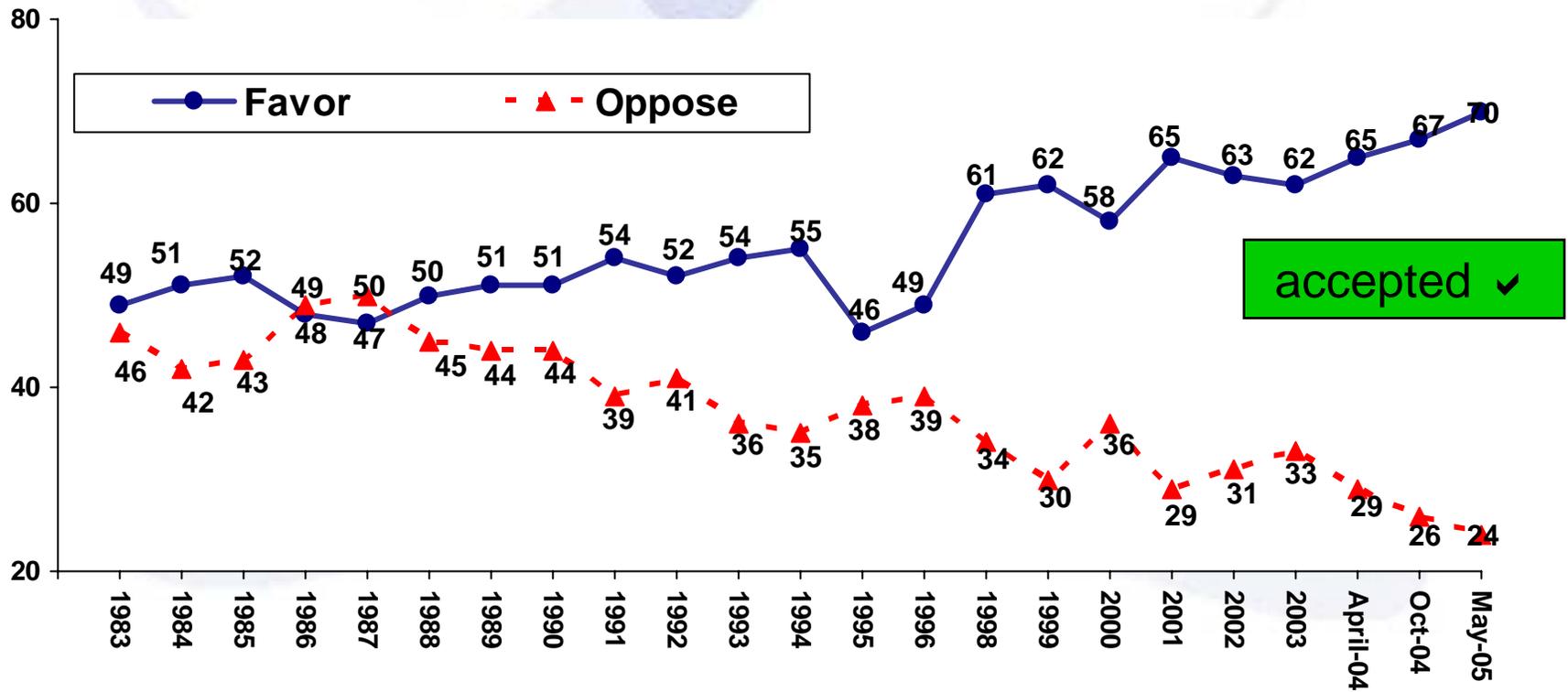


20th Anniversary of Chernobyl

safe ✓

- Impact reports released this year
 - IAEA: 4000 deaths based on World Health Organization study
 - Greenpeace: 95,000 deaths
 - Immediate deaths: 28
 - Most physical impacts were avoidable!
 - No evacuation plan or action
 - No quarantine of milk supply (iodine exposure—virtually all observed cancers are thyroid)
 - Mental health impact for 600,000 people
- 11 more RBMK reactors still in operation

Nuclear Energy widely favored in USA



USA TODAY
Time for Nuclear Power

The New York Times
Nuclear Power's Second Act

Record Gas Prices Breathe Life Into

The Boston Globe

Hot Properties: Nuclear Power Plants



accepted ✓



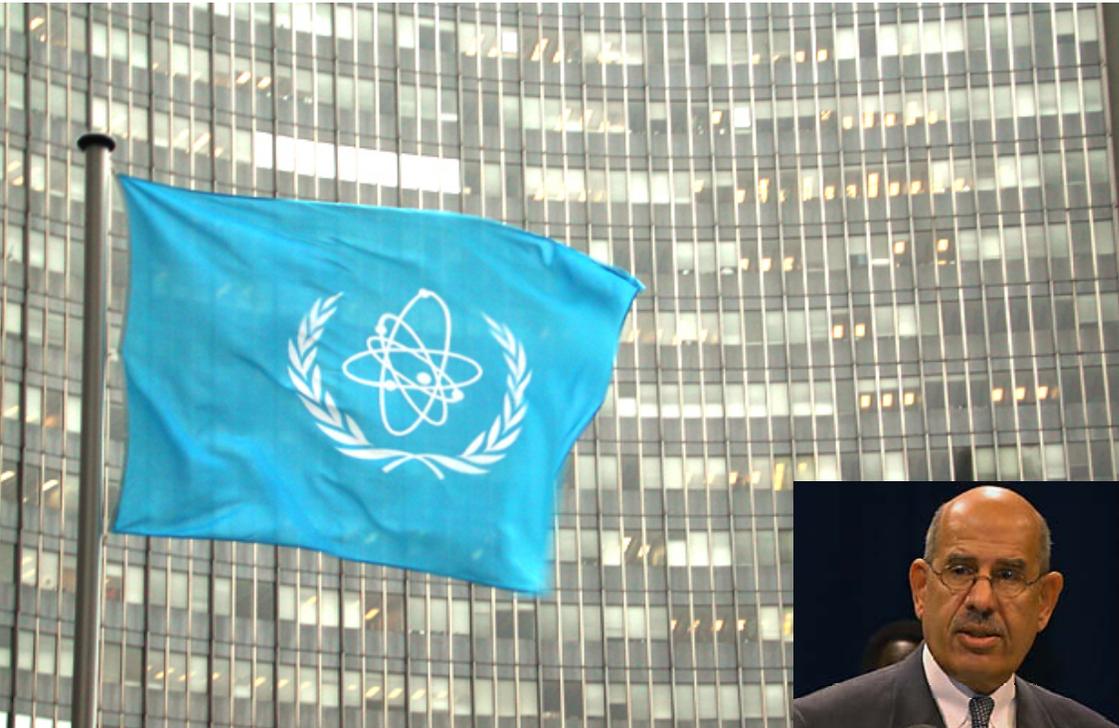
G-8 Ministers Statement

21 March 2006

International Policy ✓

“For those countries that wish, wide-scale development of safe and secure nuclear energy is crucial for long-term environmentally sustainable diversification of energy supply.”

Megatons to Megawatts

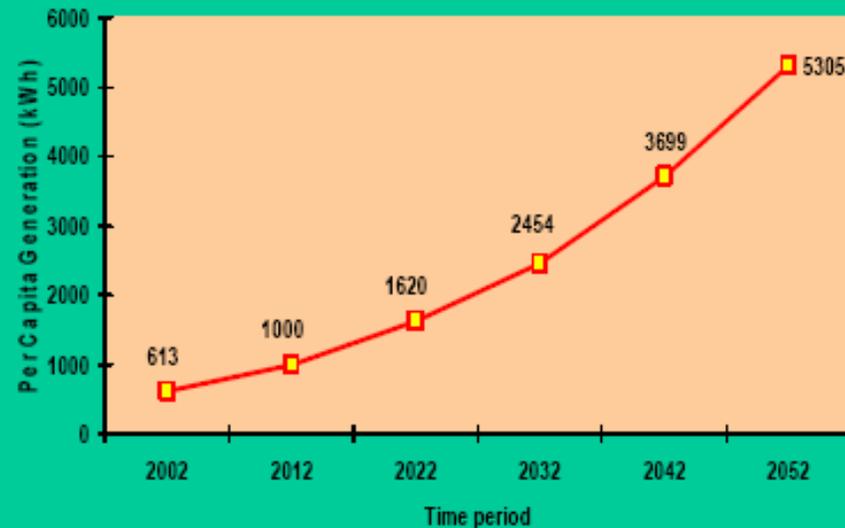
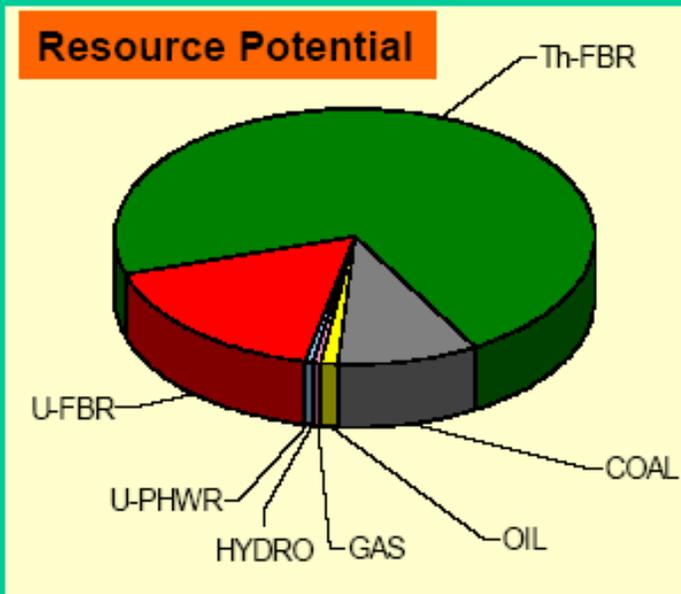


...atoms for peace.
2005 Nobel Peace Prize

- 1 out of 10 US light bulbs is powered by uranium from a former Soviet warhead
 - 6 trillion kW-hr
 - \$12 billion cost
- Cost equivalent energy:
 - \$600 billion in oil
 - \$420 billion in gas
 - \$43 billion in coal
- Energy equivalent:
 - 10 billion barrels of oil
 - 60 trillion cf natural gas
 - 3 billion tons of coal

Indian Energy Growth Scenario

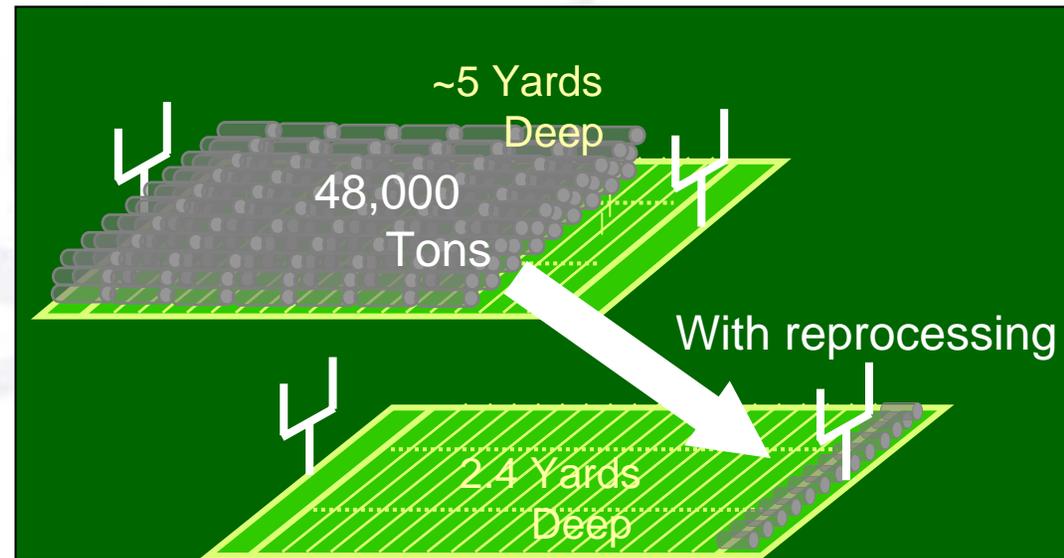
	2003-04	2052
➤ Electricity Generation (GWe)	112.0	~ 1344
➤ Nuclear Energy Share (GWe)	2.72	~ 275
➤ PHWR (GWe)	2.10	~ 0
➤ Faster Growth is needed to reach the target		
➤ FBR with Closed Fuel Cycle is inevitable		



Total amount of used fuel generated is relatively small and readily manageable

Current high-level waste volume after 40 years of operations would fill an area about the size of a football field five yards deep

- ~48,000 metric tons
- ~½ ton per fuel assembly
- ~ 100,000 assemblies
- Only ~5% is waste



No environmental mess

Arms race environmental legacy

- In the US, massive reprocessing preceded planning for management of the environmental effluents
 - 685,000 curies of ^{131}I were released between 1944 and 1947
 - 350,000 m³ of high level liquid waste is stored in steel tanks in the states of Washington, Idaho and South Carolina
- In the USSR, environmental releases from reprocessing in the secret cities of Mayak, Tomsk-7 and Krasnoyarsk-26 resulted in record releases of radioactive material—more than the Chernobyl reactor accident.
 - In 1957 a waste tank explosion ejected 2 million curies up to 1000 feet and contaminated some 23,000 m³ of land
 - Lake Kurachi contained an inventory of 120,000,000 curies in 1995.

- Dust from the receding shoreline contaminated land for 75 miles downwind in 1967

Big environmental mess



Idaho National Laboratory

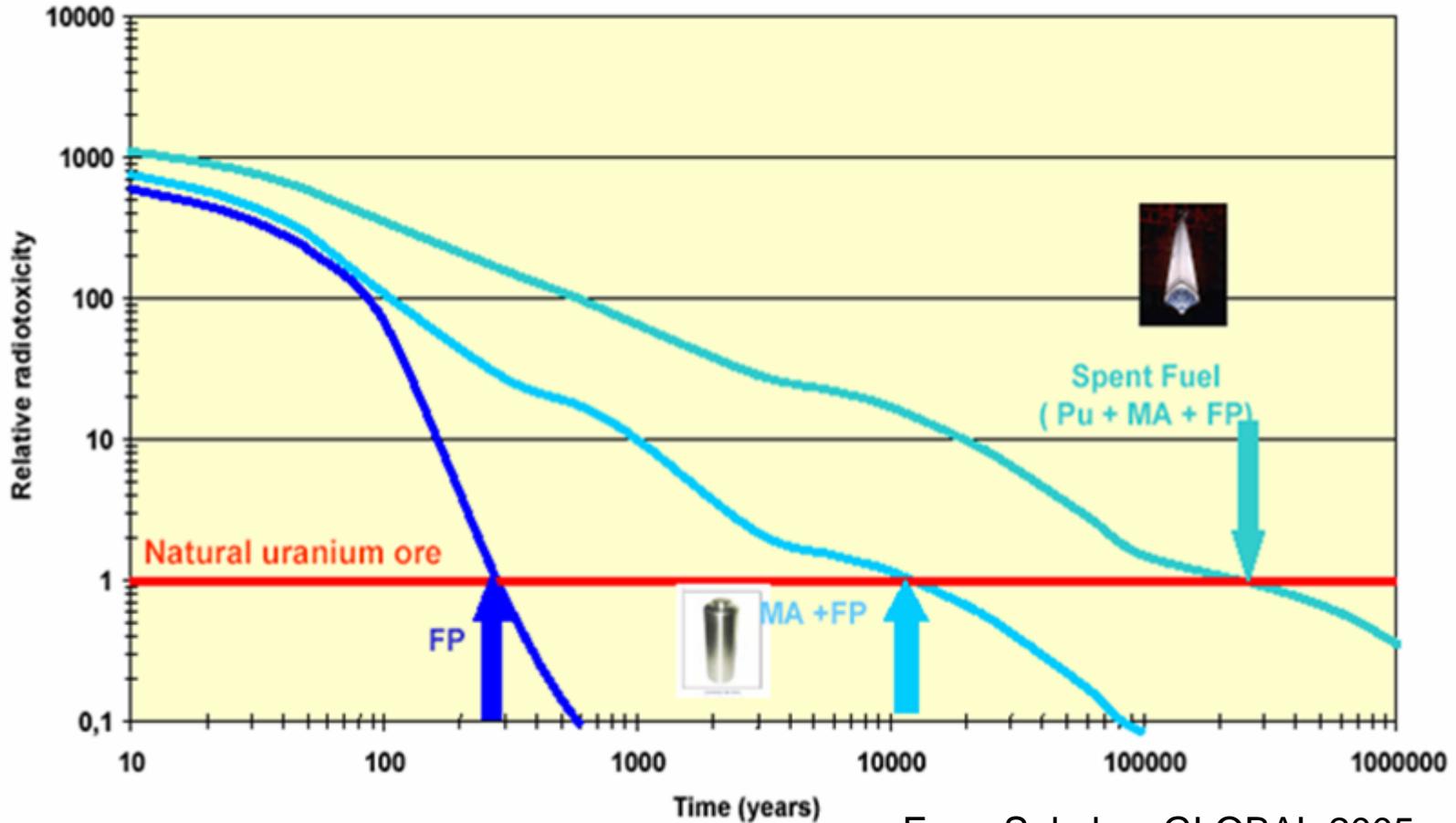


National policies on spent fuel



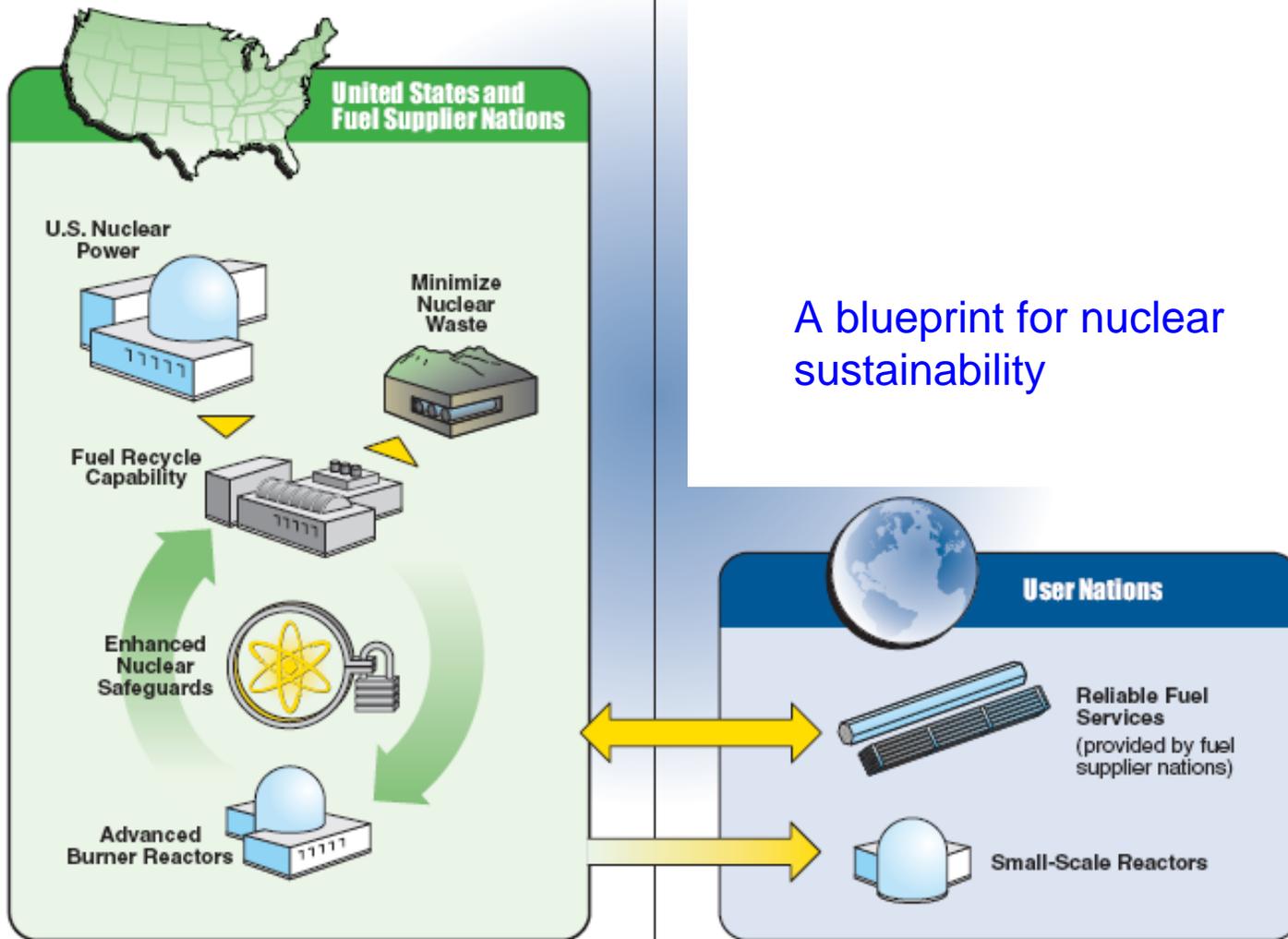
Courtesy Areva

Reprocessing reduces future risk



From Sokolov, GLOBAL 2005

Global Nuclear Energy Partnership (GNEP)



A blueprint for nuclear sustainability

A deep geologic repository is necessary

“We must reconcile Yucca Mountain and the GNEP program. We are not talking about delaying Yucca Mountain beyond its existing uncertain and delayed schedule. In fact, there are legislative actions we can and should take to further the progress of the [Yucca] program.”
Senator Pete Dominici, May 17, 2006

Yucca Mountain

The Energy Policy Act of 2005

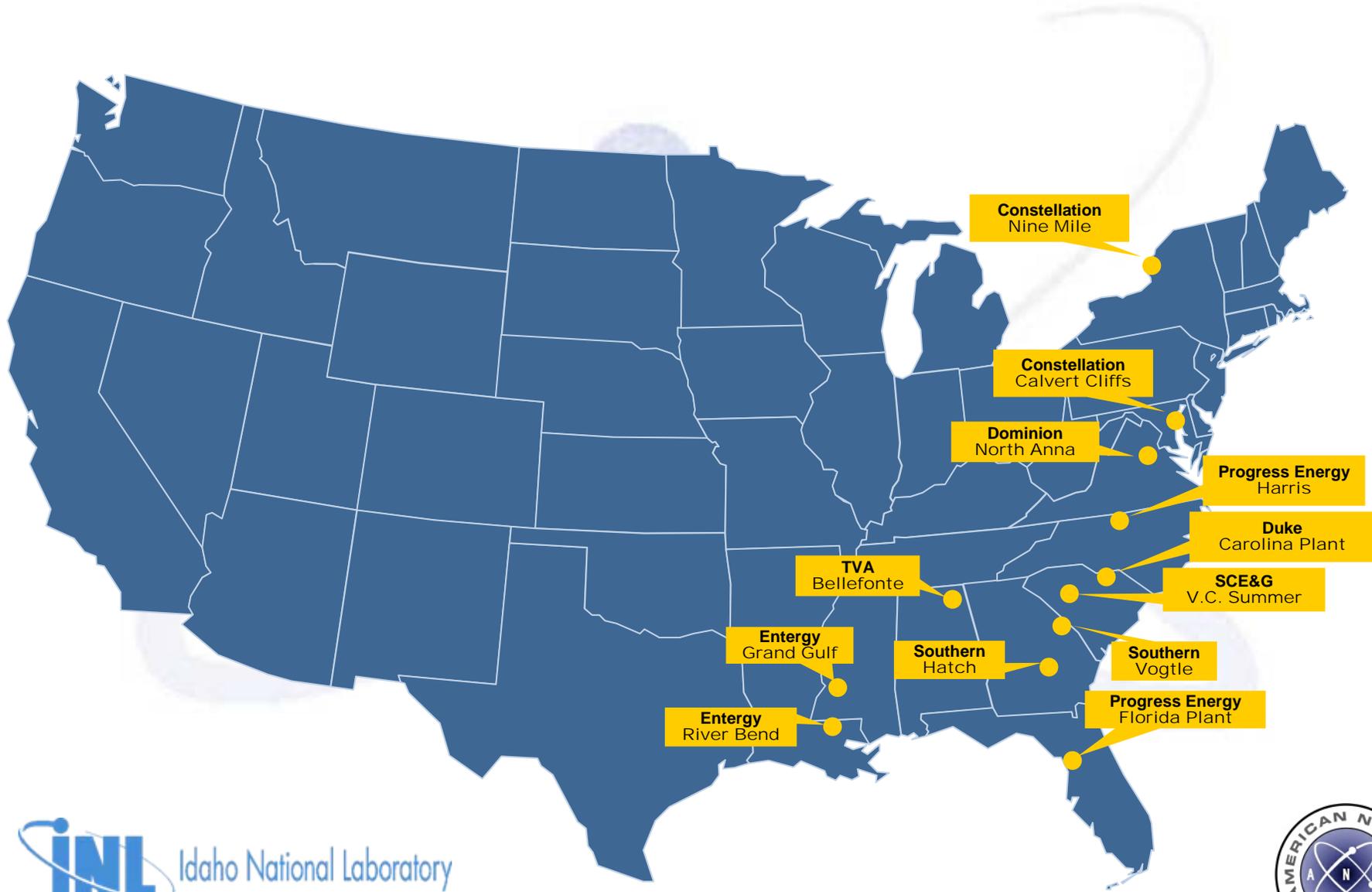


Key provisions for new plant construction

Loan guarantees	80% of project cost	<ul style="list-style-type: none">• Higher leverage• Lower debt cost
Production tax credit	\$18/MW hr	<ul style="list-style-type: none">• Through 2021• \$125M/1000 MW per year• 6,000 MW eligible• IRS rule making: February 2006
Risk assurance	Delay protection	<ul style="list-style-type: none">• \$500M for 1st 2 plants• \$250M for next 4 plants• Final rules: August 2006
Price-Anderson	Liability insurance	<ul style="list-style-type: none">• Reauthorization for 20 years
Decommissioning funds	Updates for treatment	<ul style="list-style-type: none">• Allows companies to establish funds and make contributions• Allows transfer of nonqualified funds to qualified funds



U.S. Nuclear Industry—First Movers



United States new generation



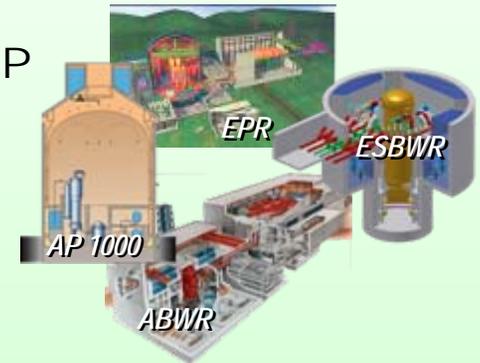
Utilities

Technologies

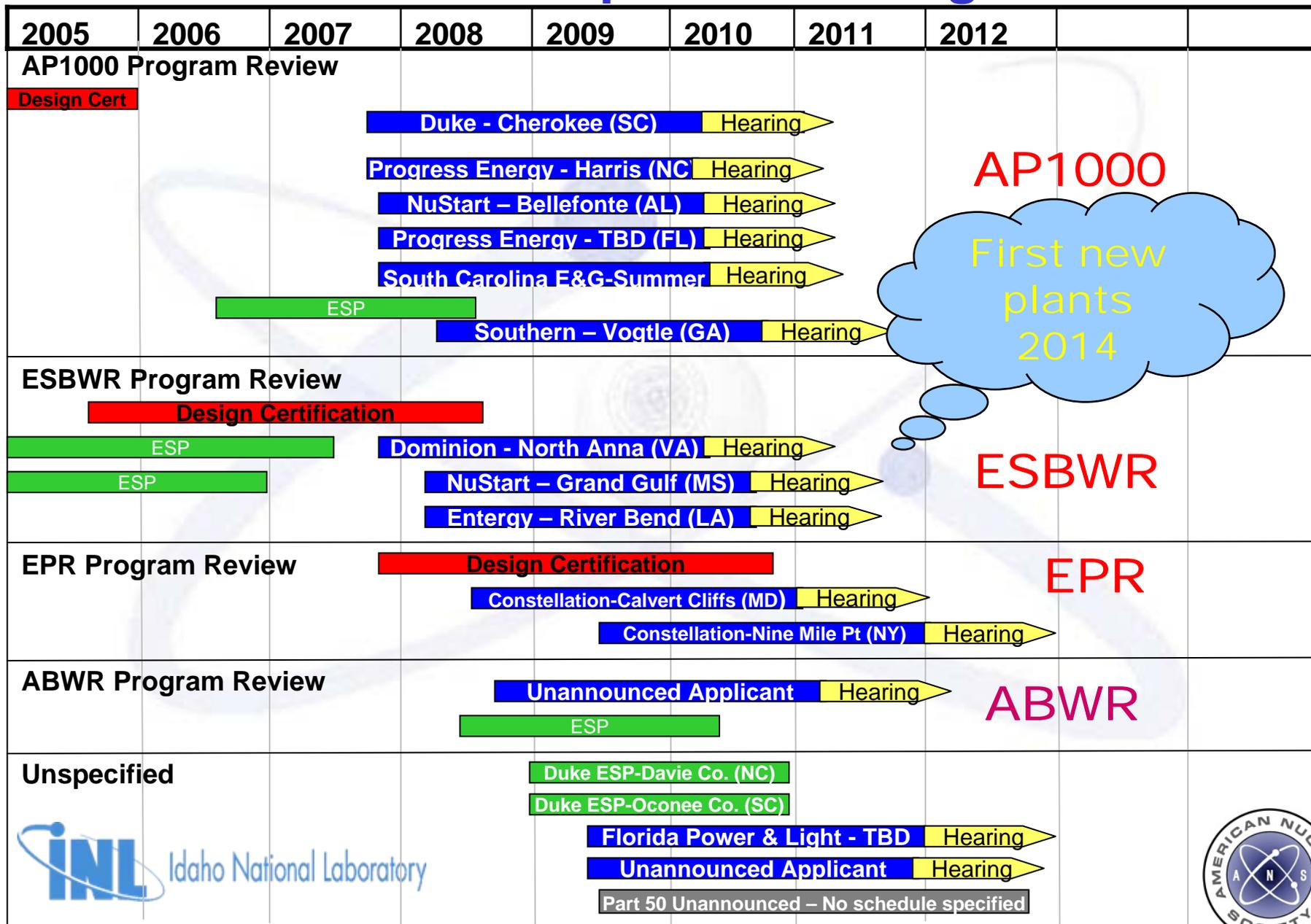
Southern
Constellation
Dominion
SCE&G
Entergy
Duke
Progress Energy
TVA
FPL



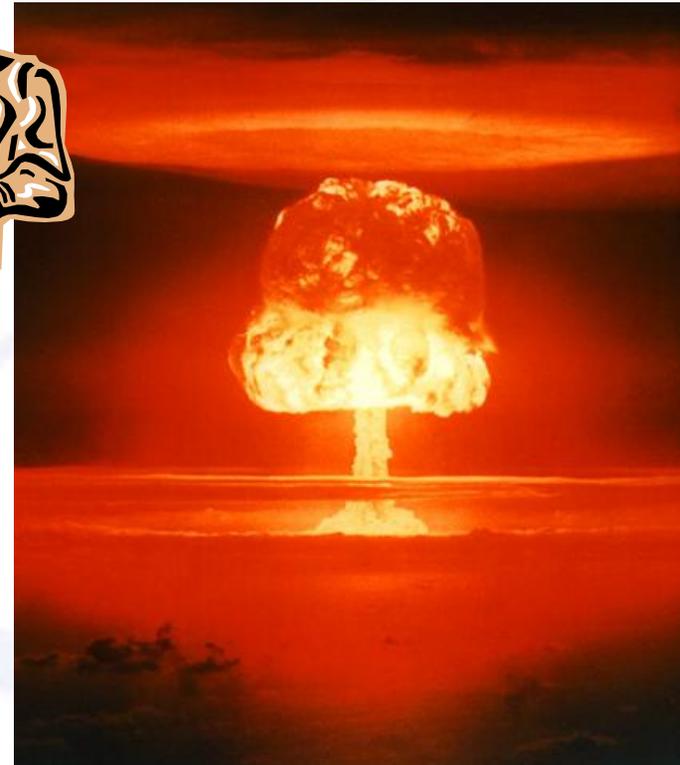
AREVA/Framatome ANP
Westinghouse
General Electric



NRC's estimated new plant licensing schedule



Nuclear energy policy remains in conflict



The leading nations of Europe, working with the United States, are preparing to offer [Iran](#) new assistance in building a light-water nuclear reactor for civilian use in return for Iran's ending activities suspected of being a cover for a weapons program, European and American diplomats said Tuesday [May 17]. New York Times

Role of American Nuclear Society

- Provides forum to develop and apply technology to benefit all humanity
- Serves as credible voice for exchange of nuclear information



Virginia Local Section

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Harold McFarlane
18 May 2006