

# The Future of Nuclear Energy

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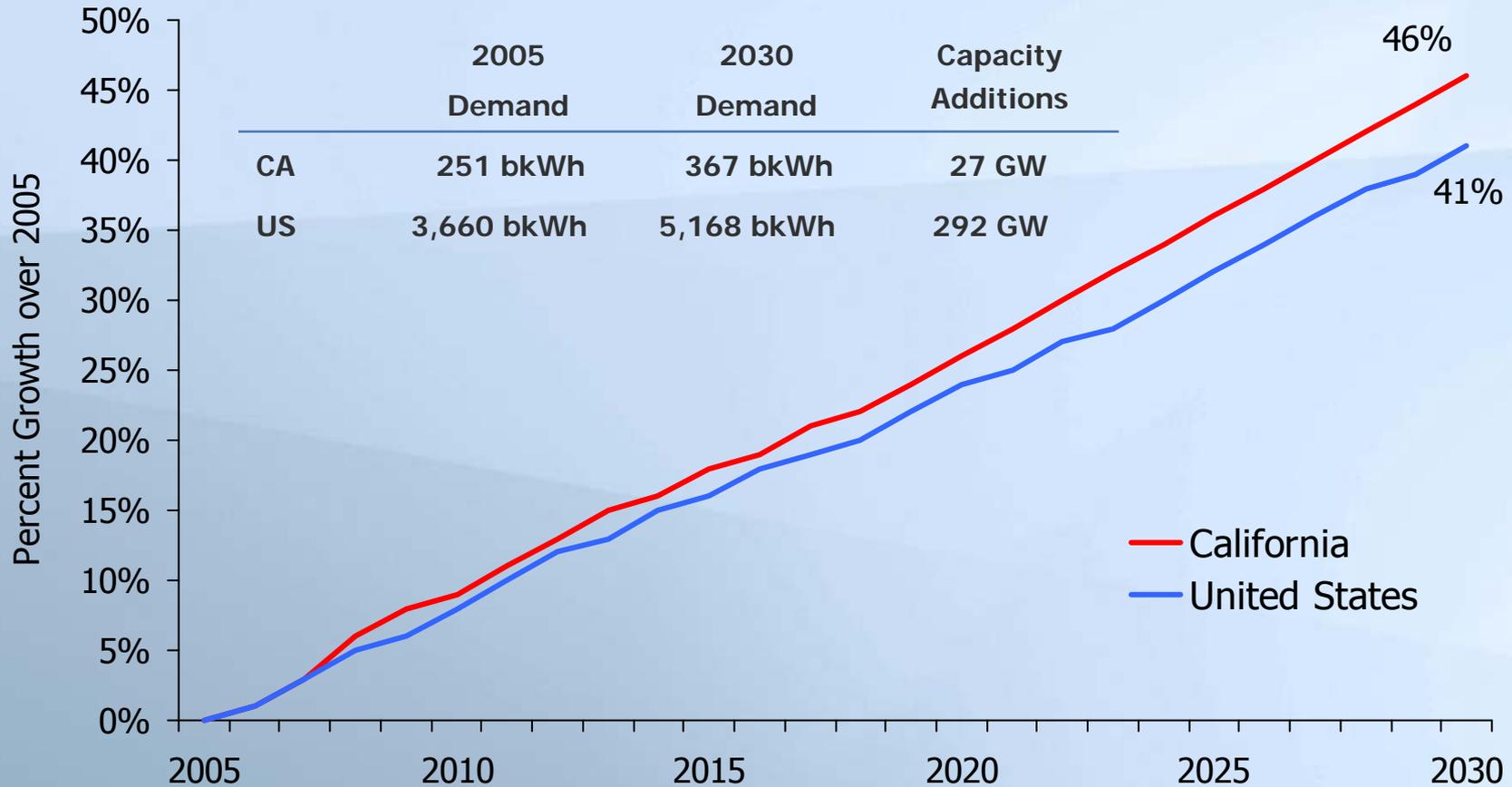
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# Fast Facts About Nuclear Power

- **104 operating nuclear power plants are lowest-cost source of baseload (24-by-7) electricity**
  - Stable fuel costs
  - Higher (90% average) availability than any other source of electricity
- **Nuclear power plants are immune to ...**
  - Volatility in fossil fuel prices
  - Increasingly stringent controls on air pollutants and carbon dioxide emissions
- **New nuclear power plants will be competitive with other sources of clean electricity**
- **All energy sources are subsidized (because energy supply is a public good)**
  - Nuclear energy is not the most heavily subsidized

# Growth in Electricity Demand

## California vs. United States



# **An Energy Policy for An Energy Secure Nation**

- **Implement energy efficiency and conservation in all phases of electricity generation**
- **Employ renewable energy sources to the full extent possible**
- **Rely on proven, large-scale, emission-free energy sources for baseload generation**

**Nuclear power is “an effective greenhouse gas mitigation option, especially through licence extensions of existing plants enabling investments in retro-fitting and upgrading.”**

***UN Intergovernmental Panel on Climate Change  
2007 Fourth Assessment Report***

**“We need every energy resource: oil, gas, coal, hydroelectric, nuclear – and wind, solar and geothermal. We cannot replace 52% of our electricity with technologies that currently provide only 1% of that power (mainly wind). Wind is a supplement, not an alternative.”**

***Roy Innis***

***National Chairman of the Congress of Racial Equality***

***The American Daily, Dec. 6, 2007***

# Sustained Reliability and Productivity

## U.S. Nuclear Capacity Factor

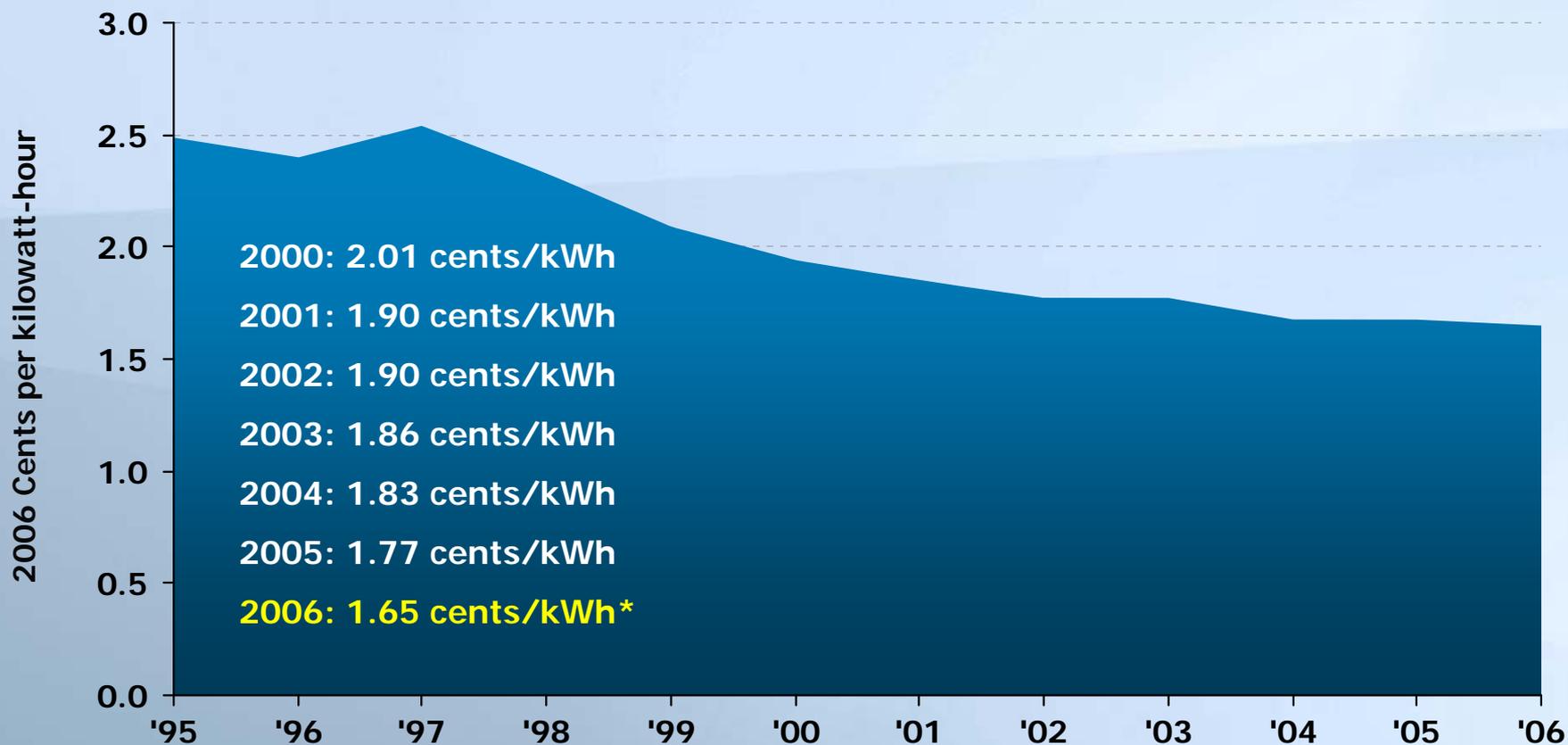


Source: Global Energy Decisions / Energy Information Administration

\* NEI estimate for 2006

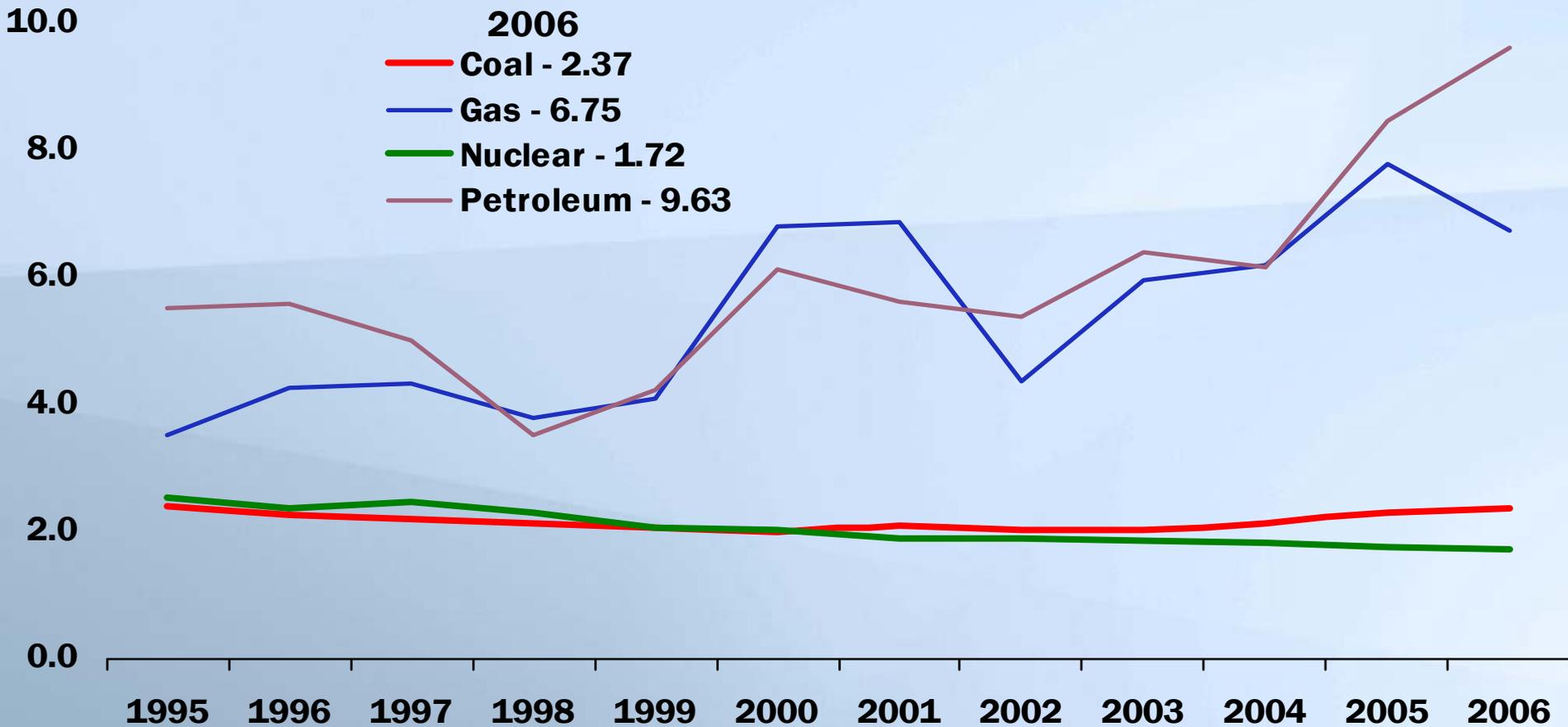
# Solid Economic Performance Continues

## U.S. Nuclear Production Cost



# U.S. Electricity Production Costs

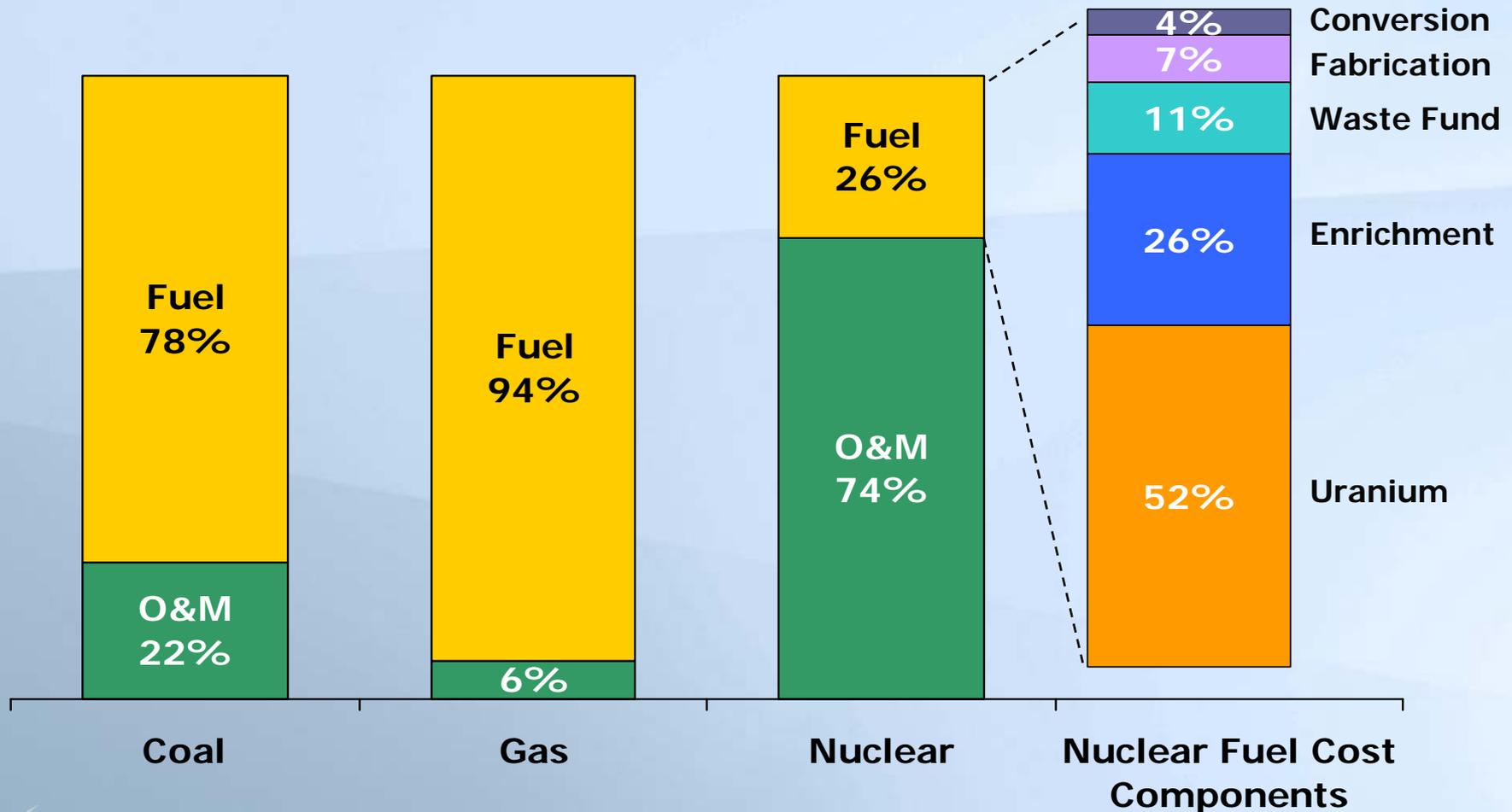
1995-2006, *In 2006 cents per kilowatt-hour*



Production Costs = Operations and Maintenance Costs + Fuel Costs

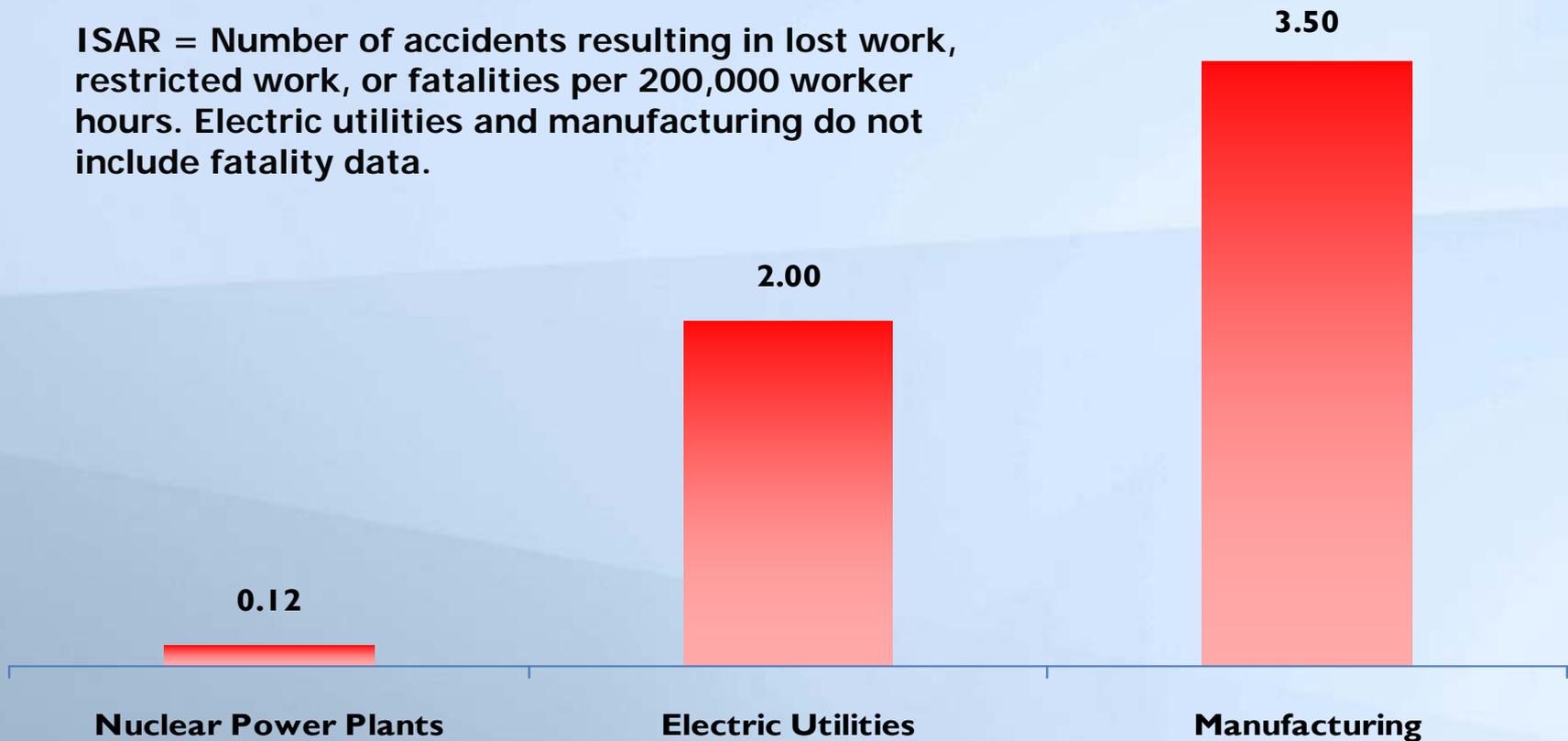
# Fuel as a Percentage of Electric Power Production Costs

2005



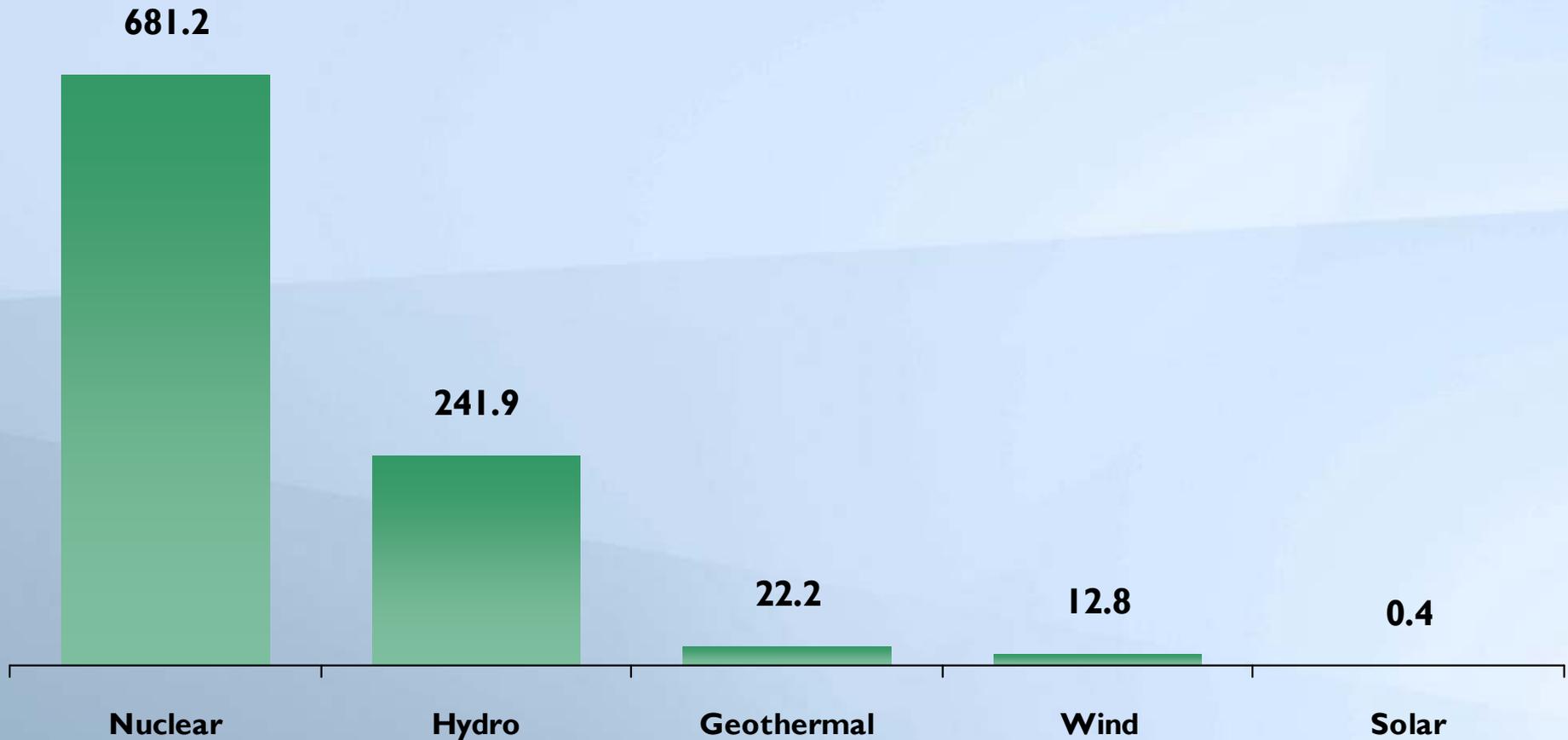
# U.S. Industrial Safety Accident Rate 2006

ISAR = Number of accidents resulting in lost work, restricted work, or fatalities per 200,000 worker hours. Electric utilities and manufacturing do not include fatality data.



# U.S. Electric Power Industry CO<sub>2</sub> Avoided

## Million Metric Tons, 2006



*Source: Emissions avoided are calculated using regional and national fossil fuel emissions rates from the Environmental Protection Agency and plant generation data from the Energy Information Administration.*

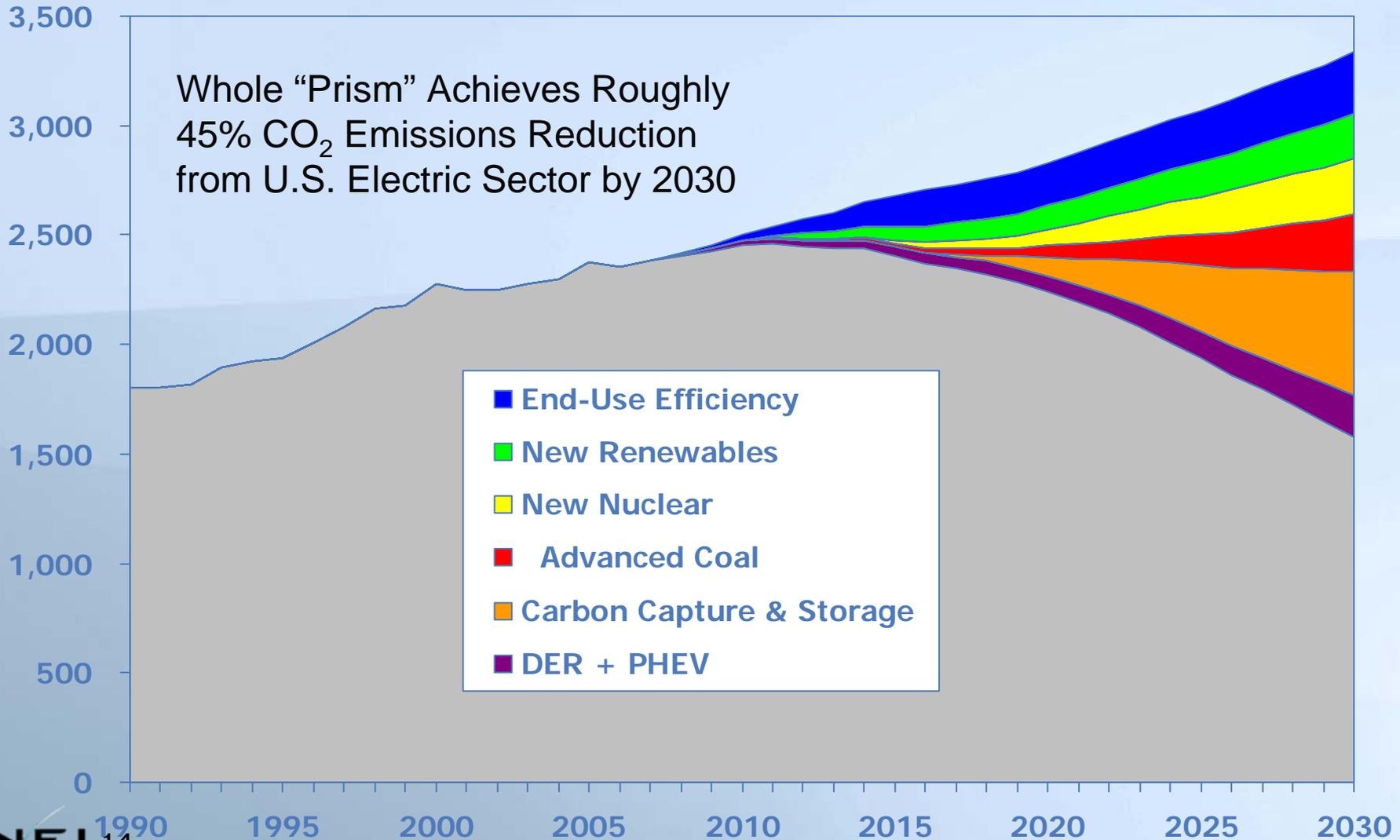
*Updated: 4/07*

# Life-Cycle Emissions: Nuclear Power Is Comparable to Renewables

Electricity generation option	GHG emissions gram equiv CO <sub>2</sub> /kWh	SO <sub>2</sub> emissions mg/kWh	NO <sub>x</sub> emissions mg/kWh	NMVOC mg/kWh	PM mg/kWh
Hydropower	2-48	5-60	3-42	0	5
Nuclear	2-59	3-50	2-100	0	2
Wind	7-124	21-87	14-50	0	5-35
Solar photovoltaic	13-731	24-490	16-340	70	12-190
Biomass/ forestry waste	15-101	12-140	701-1950	0	217-320
Natural gas (combined cycle)	389-511	4-15000+*	13+-1500	72-164	1-10+
Coal (modern plant)	790-1182	700-32321+	700-5273+	18-29	30-663+

\* The sulphur content of natural gas when it comes out of the ground can have a wide range of values. Normally, almost all of the sulphur is removed from the gas and sequestered as solid sulphur before the gas is used to generate electricity. Only in the exceptional case when the hydrogen sulphide is burned would the high values of SO<sub>2</sub> emissions occur.

## CO<sub>2</sub> Reductions Estimated by EPRI "Prism" Analysis

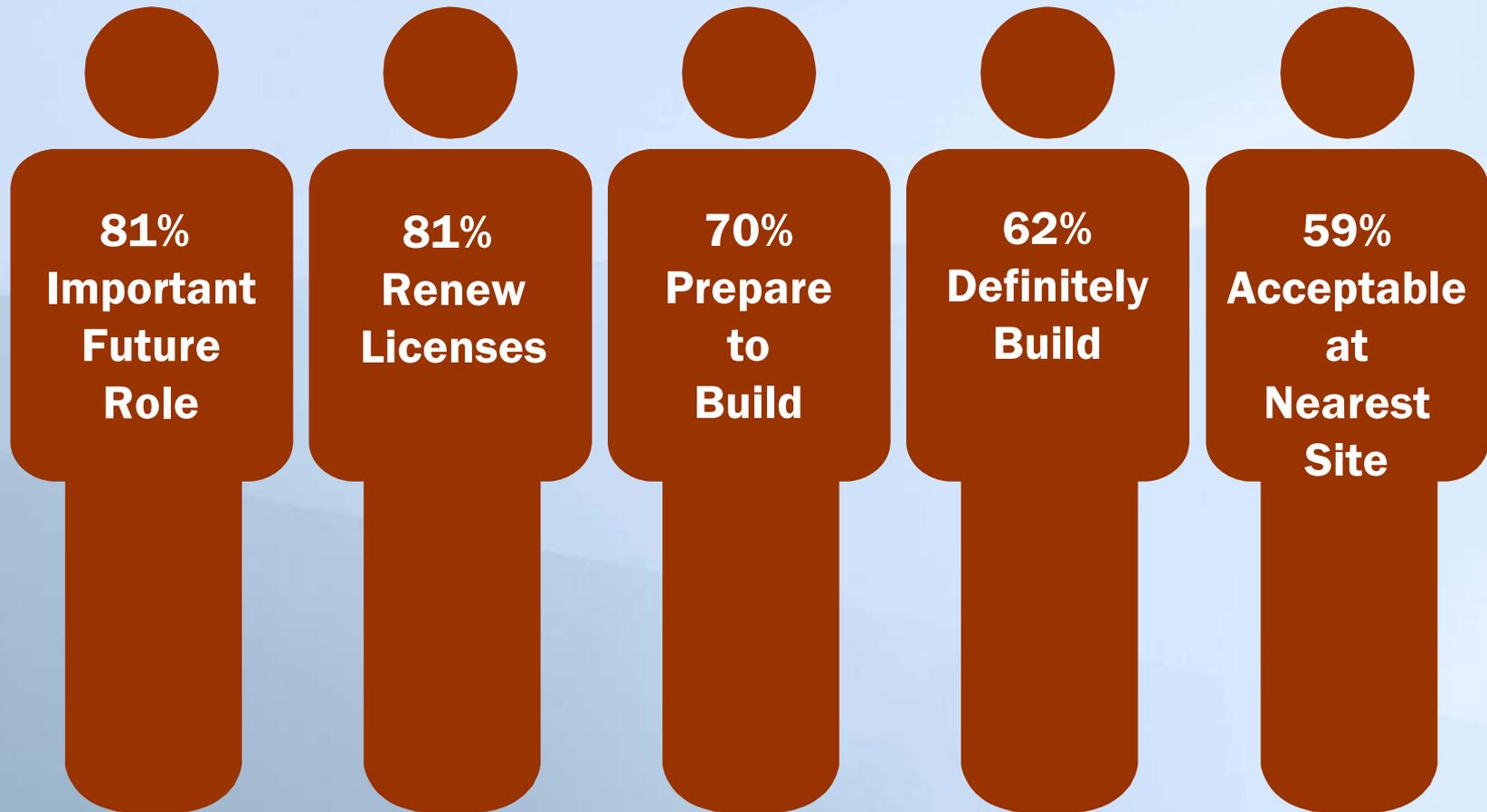


## EPRI “Prism” Technology Deployment Targets

Technology	EIA 2007 Base Case	EPRI Analysis Target *
Efficiency	Load Growth ~ +1.5%/yr (includes historic rate of efficiency improvement)	Load Growth ~ +1.1%/yr (doubles rate of historic efficiency improvements)
Renewables	30 GWe by 2030	70 GWe by 2030
Nuclear Generation	12.5 GWe by 2030	64 GWe by 2030
Advanced Coal Generation	No Existing Plant Upgrades 40% New Plant Efficiency by 2020–2030	150 GWe Plant Upgrades 46% New Plant Efficiency by 2020; 49% in 2030
Carbon Capture and Storage (CCS)	None	Widely Available and Deployed After 2020
Plug-in Hybrid Electric Vehicles (PHEV)	None	10% of New Vehicle Sales by 2017; +2%/yr Thereafter
Distributed Energy Resources (DER) <i>(including distributed solar)</i>	< 0.1% of Base Load in 2030	5% of Base Load in 2030

# Strong Public Support Continues

*October 2007 Survey*



# New October Survey Findings

	Total Agree
<b>Nuclear plants are safe and secure</b>	<b>69%</b>
<b>Nuclear waste/nuclear fuel can be stored safely at plant site</b>	<b>59%</b>
<b>Nuclear waste should be stored in 1 or 2 volunteer sites</b>	<b>73%</b>
<b>Nuclear waste can be shipped safely for storage or disposal</b>	<b>52%</b>

**73% Favor recycling used nuclear fuel rods to produce more electricity and reduce waste to be disposed**

# Simple Facts About Used Nuclear Fuel

- **Uranium is a highly concentrated source of energy:**
  - **After 50 years of nuclear plant operation, only small volume of used nuclear fuel**
  - **Would cover one football field 7 yards deep**
- **Solid, ceramic material: Easy to manage, store, monitor and secure**
- **In 50 years of commercial operation, zero impact on public health or the environment**

# The “Once Through” Fuel Cycle: The Old View of Used Fuel Management



**Nuclear Plant**



**Used Fuel**

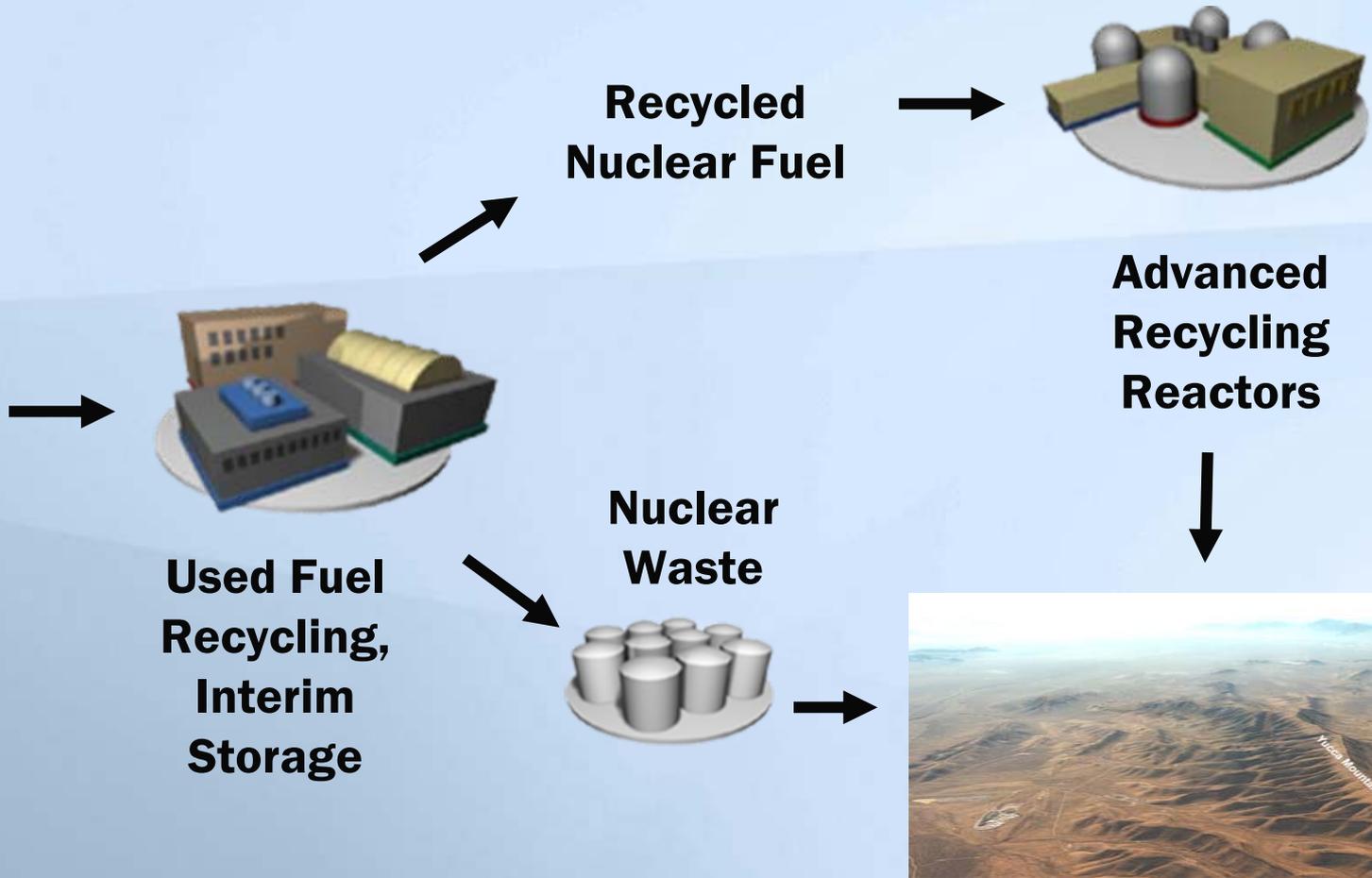


**Yucca Mountain**

# Used Fuel Management: New Strategic Direction



Used Fuel



Used Fuel  
Recycling,  
Interim  
Storage

Recycled  
Nuclear Fuel

Advanced  
Recycling  
Reactors

Nuclear  
Waste

Yucca Mountain

# Used Fuel Management: An Integrated, Phased Program

- **Developing advanced technologies to recycle nuclear fuel provides needed flexibility**
- **Sites for recycling logical candidates for interim storage**
  - **Allows DOE to meet statutory obligation to remove used fuel from operating plants**
  - **Sustains public, political, industry confidence in used fuel management program**
  - **DOE grants to 11 volunteer sites for siting studies**
- **Yucca Mountain still needed long term**

# Why Interim Storage of Used Nuclear Fuel?

- **Consolidate 39 sites into 1 or 2, easier management and security, lower costs**
- **Interim storage provides support for new nuclear plant construction, which is in the best interest of the US**
- **Interim storage also permits utilities to meet their obligation to local communities by completely decommissioning reactor sites at the end of their operating lifetime**

# Horizontal Storage Systems at an ISFSI



Southern California Edison – SONGS Units 1, 2, and 3

# ISFSIs with Vertical Storage Casks



Connecticut Yankee

Yankee Rowe



# A Crawler Moves the Vertical Storage Cask to Storage Pad

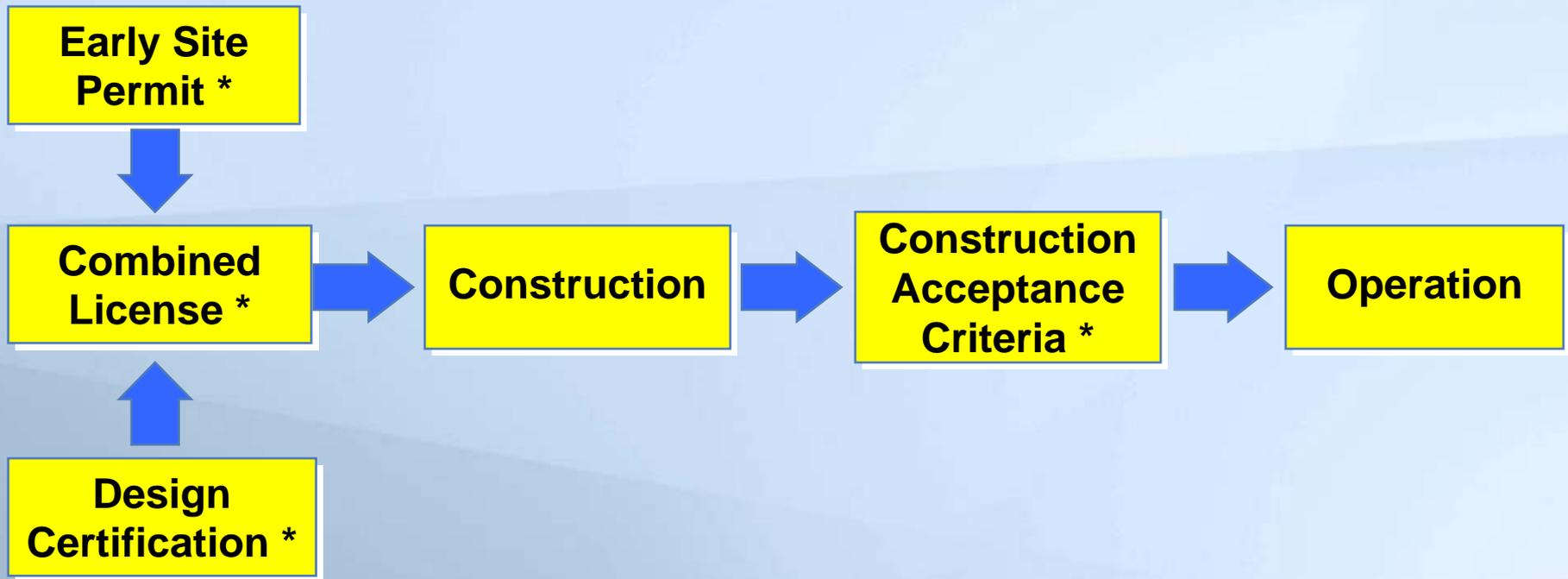


(Note: No special clothing necessary)

# Safely Transporting Used Nuclear Fuel

- **Transported safely for more than 40 years, with more than 3,000 commercial and 800 U.S. Navy shipments across 1.7 million miles of rail or highway**
- **Integrated safety system developed that protects cargo at every step**
- **Robust containers are licensed by the NRC**
- **No public health impact from shipments of used nuclear fuel**

# New NRC Licensing Process (1992 Energy Policy Act)



\* Public Comment Opportunity

# Nuclear Plant Construction: “Then and Now”

Then	Now
<p><b>Changing regulatory standards and requirements</b></p>	<p><b>More stable process: NRC approves site and design, single license to build and operate, before construction begins and significant capital is placed at risk</b></p>
<p><b>Design as you build</b></p>	<p><b>Plant designed before construction begins</b></p>
<p><b>No design standardization</b></p>	<p><b>Standard NRC-certified designs</b></p>
<p><b>Inefficient construction practices</b></p>	<p><b>Lessons learned from nuclear construction projects overseas incorporated, and modular construction practices</b></p>
<p><b>Multiple opportunities to intervene, cause delay</b></p>	<p><b>Opportunities to intervene limited to well-defined points in process, must be based on objective evidence that ITAAC have not been, and will not be, met</b></p>

# Energy Policy Act of 2005: Production Tax Credit

- **\$18/MWh for first 6,000 MW of new nuclear capacity**
- **Distributed on a pro rata basis to all plants that:**
  - **Submit a COL application to the NRC by Dec. 31, 2008**
  - **Begin construction by Jan. 1, 2014**
  - **Start commercial operation by Jan. 1, 2021**
- **Production tax credit**
  - **Enhances financial attractiveness of project after it is built and in commercial operation**
  - **Does not address financing challenges before and during construction**

# Energy Policy Act of 2005: Standby Support

- **Federal insurance coverage for delays caused by licensing or litigation**
- **Covers debt service only**
- **Limitations on coverage reduce value**
  - **First two \$500-million policies: 100% of delay costs, no waiting period for claims**
  - **Second four \$250-million policies: only 50% of delay costs after 6-month delay**

# Energy Policy Act of 2005: Loan Guarantee Program

- **2005 Energy Policy Act authorizes loan guarantees up to 80 percent of project cost**
- **Allows nuclear plant developers to**
  - **Increase leverage**
  - **Reduce financing costs**
  - **Reduce cost of electricity from project**
  - **Non-recourse to project sponsor's balance sheet**
- **Loan guarantee program for all new or improved technologies that reduce, avoid or sequester GHG**

# State Policies Supporting New Nuclear Construction

- **Utilities and policymakers realize need for fuel and technology diversity**
- **Policies being implemented that:**
  - Value diverse generation portfolio
  - Limit retroactive reviews of prudence
  - Allow PUCs to approve new plant costs, set future rate increases before construction
  - Allow investment recovery during construction
  - Provide tax and/or other incentives

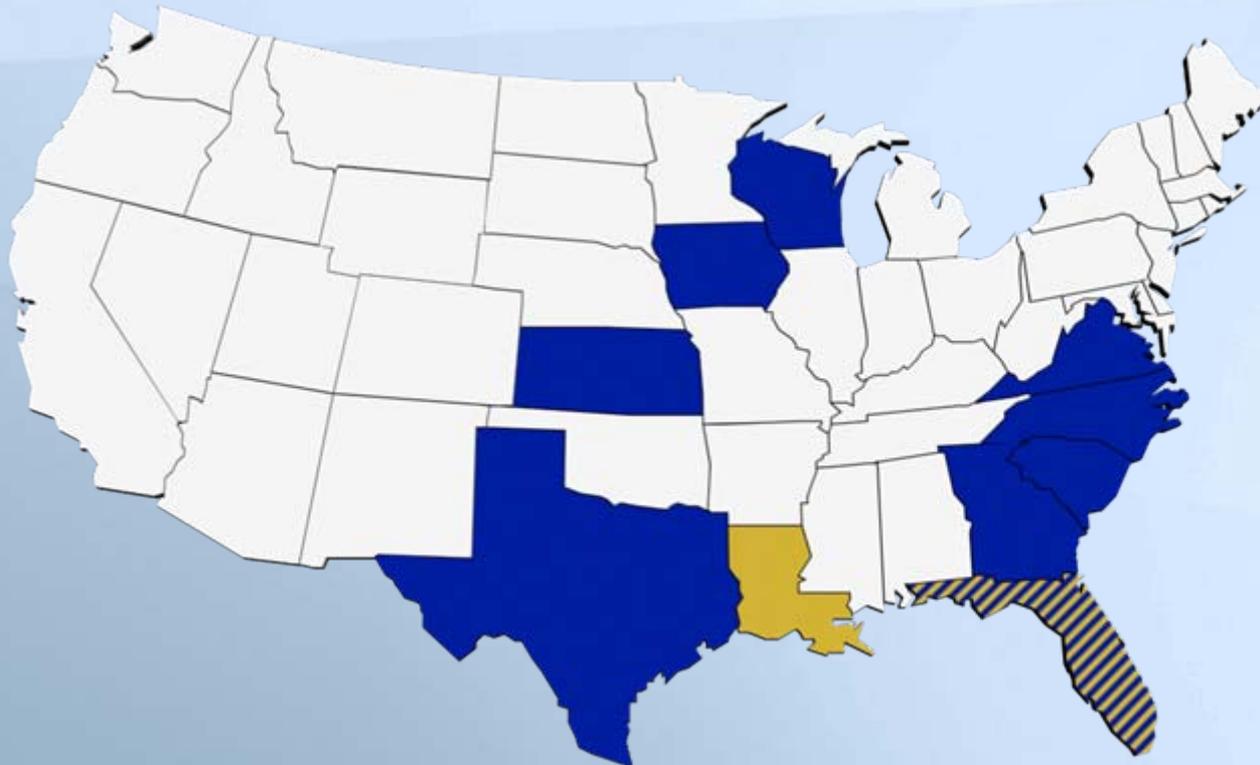
# Financing Support: State Policies

 Legislation in place that helps secure financing

 Regulation in place that helps secure financing

 Legislation under consideration that helps secure financing

 Legislation and regulation in place that help secure financing



# All Energy Sources Are Subsidized

- **Since energy crises of the 1970s (1976-2006), federal government spending on R&D\***

<b>Nuclear</b>	<b>\$4.2 billion</b>
<b>Coal</b>	<b>\$5.9 billion</b>
<b>Renewables</b>	<b>\$7.3 billion</b>

- **Federal expenditures on energy (R&D, tax benefits, etc.) since 1950**

<b>Oil and natural gas</b>	<b>\$435.9 billion</b>
<b>Coal</b>	<b>\$93.4 billion</b>
<b>Hydro</b>	<b>\$80.5 billion</b>
<b>Nuclear</b>	<b>\$64.7 billion</b>
<b>Renewables</b>	<b>\$43.9 billion</b>
<b>Geothermal</b>	<b>\$6.4 billion</b>

# **New Nuclear Power Plants:** *Competitive with Other Sources*

- **All baseload technologies have high capital cost**
- **Capital cost less important than lifetime operating cost**
  - Total nuclear operating cost comparable to advanced coal-based plants and better than gas-fired plants
- **Renewables do not compete with nuclear**
  - Nuclear                      **Baseload 24-by-7 (90% availability)**
  - Wind                              **Intermittent (30% availability)**
- **New nuclear benefits justify use of investment support**
  - Federal government                      **Support for debt financing through loan guarantees**
  - State governments                      **Assurance of investment recovery  
Tax Relief**

*A portfolio of fuels, technologies is essential to meet  
U.S. energy security, environmental goals*

# **“We Are Going to be Seeing New Plants”**

**“I am a pragmatist. The vast majority of the members on my committee support nuclear power, and so do the majority in the Senate ... I don’t think there is any question that we are going to be seeing new plants.”**

***–Sen. Barbara Boxer (D-CA)***

***Chair, Environment and Public Works Committee***

***December 17, 2006***

# **“A More Open Mind”**

**“In the early days of my life in Congress, I was an opponent of nuclear energy because of questions on how to dispose of the waste. Your question is good because the technology has changed, and I bring a more open mind to that subject now because I think we should look at this technology, and compare it to the alternatives. ...It has to be on the table.”**

*–House Speaker Nancy Pelosi (D-CA)*

*February 8, 2006*

# Notable Support

**“Nuclear power generation represents not only a key part of America’s present energy mix, but must be regarded as clean, reliable and jobs-generating option for our nation’s future energy need.”**

***“Nuclear Energy: A Clean and Reliable Choice for America,”  
Building & Construction Trades Department of the AFL-CIO***

**“While global warming is positioned to be a hot issue in the 2008 presidential election, the candidates must face directly the one large-scale means of providing carbon-free electric power: nuclear energy. Candidates in both parties should swallow hard and confess that the United States must take steps that they find difficult.”**

***John Dyson and Matt Bennett  
Third Way (Washington, D.C. strategy center for progressives)  
“Just Say Oui to Nuclear Power,” Boston Globe, Sept. 16, 2007***

**“Nuclear technology is re-emerging as a power generation option in the face of concerns about climate change, energy demand growth and the relative cost of competing technology.”**

***The Keystone Center***

***“Nuclear Power Joint-Fact Finding Report,” June 14, 2007***

**“It is hard to believe simultaneously in energy security and reduction in greenhouse gas emissions without believing in nuclear power. It is just intellectually dishonest.”**

***Jeff Immelt, GE chairman***

***PBS Nightly Business Report, July 9, 2007***

**“I’d push for a reactivation of nuclear power as a viable option. It’s time to stop running scared from Chernobyl and start realizing we now have the systems and technology to build fail-safe nuclear power plants. All over the European Union, they’re investing in building cleaner, safer nuclear power plants. Europe derives about one third of its electricity from nuclear power. ... The U.S. is lagging far behind in nuclear energy, when we should be on the leading edge.”**

***Lee Iacocca, from his latest book,  
“Where Have All the Leaders Gone?”***

***April 2007***

**“The Plumbers and Pipe Fitters Union will only support political candidates who support nuclear power.”**

***Bill Hite, president of United Association of Plumbers and Pipe Fitters***

***Sept. 25, 2007***

# What's in Our Future?

"The future ain't what it used to be." *Yogi Berra*

- **Solid base of political and public support**
- **Nuclear is recognized as essential part of U.S. electricity supply**
- **Industry must address challenges/preconceived ideas**
- **15 to 20 COLs by the end of 2008**
  - 3 COLs already submitted
- **About 5 plants online 2015-2017**
- **Significant new plant construction post 2015**