Nuclear: A Critical Role in Our 21st Century Energy Portfolio

38th Annual PURC Conference

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Director, Policy Development
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Overview

- Nuclear Plant performance
- License Renewal / Long-Term Operation
- Used Fuel Management / Blue Ribbon Com.
- Recognition of Environmental Benefits
- Public Opinion
- Status of New Plant Developments
- Current Political Support
U.S. Electricity Production Costs
1995-2009, In 2009 cents per kilowatt-hour

Production Costs = Operations and Maintenance Costs + Fuel Costs. Production costs do not include indirect costs and are based on FERC Form 1 filings submitted by regulated utilities. Production costs are modeled for utilities that are not regulated.

Source: Ventyx Velocity Suite
Updated: 5/10
# U.S. Capacity Factors by Fuel Type

## 2009

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Average Capacity Factors (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear</td>
<td>90.5</td>
</tr>
<tr>
<td>Geothermal</td>
<td>71.5</td>
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<tr>
<td>Biomass</td>
<td>66.0</td>
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<tr>
<td>Coal (Steam Turbine)</td>
<td>63.1</td>
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<tr>
<td>Gas (Combined Cycle)</td>
<td>44.7</td>
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<tr>
<td>Hydro</td>
<td>29.4</td>
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<tr>
<td>Wind</td>
<td>27.8</td>
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<td>Solar</td>
<td>23.5</td>
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<tr>
<td>Gas (Steam Turbine)</td>
<td>13.3</td>
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<tr>
<td>Oil (Steam Turbine)</td>
<td>7.4</td>
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</tbody>
</table>

Source: Ventyx Velocity Suite / Energy Information Administration

Updated: 5/10
U.S. Nuclear Plant Output Growth
Billion kWh

Equivalent to 28 new 1,000-megawatt power plants

Source: Energy Information Administration
Updated: 4/10
Cumulative Capacity Additions at U.S. Nuclear Facilities 1977-2014

Under Review and Expected - 3,524 MWe by 2014

Approved - 5,810 MWe

Source: Nuclear Regulatory Commission
Updated: 10/10
Applications for License Renewal

- 59 Units Granted
- 23 Units Under Review
- 16 Units Intend to Renew
- 6 Units Unannounced

Source: Nuclear Regulatory Commission
Updated: 11/10
Environmental
U.S. Electricity Sources Which Do Not Emit Greenhouse Gases During Operation 2009

- Nuclear: 69.3%
- Wind: 6.1%
- Hydro: 23.2%
- Solar: 0.1%
- Geothermal: 1.3%

Source: Energy Information Administration
Updated: 4/10
U.S. Electric Power Industry CO₂ Avoided
Million Metric Tons, 2009

- Nuclear: 647.2
- Hydro: 219.0
- Wind: 57.9
- Geothermal: 12.4
- Solar: 0.7

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: 5/10
Perspective on CO₂ Emissions Prevented By U.S. Nuclear Plants

Million Metric Tons, 2009

CO₂ emissions prevented by U.S. nuclear power plants (2009) = 647.2

equals CO₂ from 125 million cars

CO₂ emitted by all 137 million U.S. passenger cars (2008) = 711.9

Source: Emissions avoided by nuclear power are calculated using regional fossil fuel emission rates from the Environmental Protection Agency and plant generation data from the Energy Information Administration. Car emissions from EPA, Office of Transportation and Air Quality Emissions Facts (April 2000).

Updated: 5/10
Comparison of Life-Cycle Emissions
Tons of Carbon Dioxide Equivalent per Gigawatt-Hour

Coal: 1,041
Natural Gas: 622
Biomass: 46
Solar PV: 39
Hydro: 18
Nuclear: 17
Geothermal: 15
Wind: 14

# Summary of Studies on Climate Change Mitigation

## New Nuclear Generation Capacity Required

<table>
<thead>
<tr>
<th>Source</th>
<th>Study/Analysis</th>
<th>Number of new reactors*</th>
<th>Gigawatts</th>
<th>Timeframe</th>
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<tbody>
<tr>
<td>Energy Information Administration</td>
<td>Annual Energy Outlook 2010</td>
<td>6</td>
<td>8</td>
<td>2035</td>
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<td>Kerry/Lieberman, American Power Act (2010)</td>
<td>52</td>
<td>72</td>
<td>2035</td>
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<td></td>
<td>Waxman/Markey (2009)</td>
<td>69</td>
<td>96</td>
<td>2030</td>
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<td>Environmental Protection Agency</td>
<td>Kerry/Lieberman, American Power Act (2010)</td>
<td>181</td>
<td>253</td>
<td>2050</td>
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<td>Waxman/Markey (2009)</td>
<td>187</td>
<td>262</td>
<td>2050</td>
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<td>Lieberman/Warner (2008)</td>
<td>179</td>
<td>250</td>
<td>2050</td>
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<tr>
<td>Electric Power Research Institute</td>
<td>Prism/Merge Analyses: 2009 Update</td>
<td>46</td>
<td>64</td>
<td>2030</td>
</tr>
</tbody>
</table>

*Based on a 1,400 MW average nuclear plant.
Safety
Significant Events are those events that the NRC staff identifies for the Performance Indicator Program as meeting one or more of the following criteria:

- A Yellow or Red Reactor Oversight Process (ROP) finding or performance indicator
- An event with a Conditional Core Damage Probability (CCDP) or increase in core damage probability (ΔCDP) of $1 \times 10^{-5}$ or higher
- An Abnormal Occurrence as defined by Management Directive 8.1, “Abnormal Occurrence Reporting Procedure”
- An event rated two or higher on the International Nuclear Event Scale

Source: NRC Information Digest, 1988 is the earliest year data is available.
Updated: 4/10
U.S. Industrial Safety Accident Rate
2009

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

Updated: 6/10
Average Collective Dose Per Reactor
1973-2008, Person-rem

Source: Nuclear Regulatory Commission - Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities, Energy Information Administration
Updated: 6/10
Used Nuclear Fuel
Used Nuclear Fuel: The New Reality

- Administration terminating the Yucca Mountain project
  - Blue ribbon commission to develop recommendations on used fuel management
- Interim storage safe, secure for indefinite period of time
- Used fuel issues not an impediment to operating reactors or new plant development

Dry cask storage for used fuel at the Surry station in Virginia
Recognition of Environmental Benefits
“I have never seen a credible scenario for reducing emissions that did not include nuclear energy”

June 2007
“[I]f we encourage it in the right way, nuclear energy growing well . . . minimizes humanity’s carbon-loading of the atmosphere . . . collaborates well with other carbon-free or superefficient energy forms . . . helps generate other Green services such as desalination or hydrogen . . . helps eliminate nuclear weapons . . . securely energizes cities and thereby helps to reduce world poverty . . .”

Stewart Brand
Whole Earth Discipline,
an Ecopragmatist Manifesto
October 2009
“I think that next-generation, safe nuclear power is an option which we need to develop. And it is being developed in many countries around the world. So if the United States declines to do that, we're just going to suffer economically because other countries will take the lead in that technology.”

Dr. James E. Hansen, Director
NASA Goddard Institute for Space Studies
January 26, 2010
Public Opinion
U.S. Public Opinion 1983 – 2010:
Favorability to the Use of Nuclear Energy for Electricity

Annual Averages Until 2010, Percentages

Bisconti Research, Inc. March 2010 survey of 1,000 U.S. adults; margin of error +/- 3 percentage points
Strong Public Support Continues

- 74% Favor Use of Nuclear Energy
- 87% Favor Renewing Licenses
- 87% Important for Our Energy Future
- 70% Definitely Build New Reactors
- 77% Acceptable at Nearest Site

Source: Bisconti Research Inc./Gfk Ropper
March 2010 poll of 1,000 U.S. adults; margin of error is +/- 3%
New Plant Information
U.S. Needs 28 Percent More Electricity by 2035 BkWh

Net Generation to the Grid

2009: 3,830
2035: 4,898

Source: Energy Information Administration’s Annual Energy Outlook 2010
Updated: 2/10
Capacity Brought Online by Fuel Type
1950-2009 (Nameplate Capacity, MW)

Source: Ventyx Velocity Suite
Updated: 2/10
### Nuclear Units Under Construction and Planned Worldwide

<table>
<thead>
<tr>
<th>Country</th>
<th>Under Construction</th>
<th>Planned</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>24</td>
<td>33</td>
</tr>
<tr>
<td>Russia</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>India</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Japan</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>S. Korea</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>US</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>China, Taiwan</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Ukraine</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Argentina</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Iran</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Pakistan</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>France</td>
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<td>1</td>
</tr>
<tr>
<td>Slovakia</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**Totals:**
- 61 units under construction*
- 149 units on order or planned**

*Chart includes only countries with units under construction. **Countries planning new units are not all included in the chart.

Planned units = Approvals, funding or major commitment in place, mostly expected in operation within 8-10 years.

Updated: 10/10
Near-Term Fundamentals Negative, Long-Term Fundamentals Have Not Changed

- North American electricity demand will not recover to pre-recession levels until 2012 or so
- Most regional power markets likely to remain oversupplied for at least the next five years
- Spot power prices projected to remain soft in 2010-2011 at least
- Low natural gas prices likely to persist in near term
Part 52 Licensing Process Working as Planned

- Technical questions are being addressed before construction begins
  - Process is transparent and readily available to the public
  - Hearing process is proceeding as scheduled where applicable
- Construction inspection in progress
- First facility start-up for combined license will occur in 2010 for LES’ National Enrichment Facility

Photo courtesy Louisiana Energy Services
### Review Status

#### DESIGN CERTIFICATIONS
- AP1000
- ABWR
- ESBWR
- USAPWR
- EPR

#### COMBINED OPERATING LICENSES
- Vogtle
- Comanche Peak
- North Anna
- Bellefonte
- Summer
- Harris
- Levy
- STP
- Turkey Point*
  - Calvert Cliffs
  - Bell Bend
  - Fermi
  - Lee

* Official review schedule not issued by the NRC yet.
State Policies Supporting New Nuclear

Legislation

Regulation

Both legislation and regulation

Potential location for new nuclear facility
Site Preparations Are Underway
Vogtle Units 3 and 4

Photo Courtesy Southern Company
Work Force: Training the Industry’s Next Generation

- 52 community college nuclear partnership programs
- 28 state energy work force consortia
- More than $90 million in federal grants to support nuclear career and work force development activities
Growth in Nuclear Supply Chain Continues

- Shaw Group near completion of new nuclear component manufacturing facility in Lake Charles, La.
- Global Laser Enrichment started test loop in Wilmington, N.C., in July 2009
- AREVA and Northrop Grumman broke ground in July 2009 in Newport News, Va., on nuclear components manufacturing facility
- 10 percent increase in number of domestic “N-stamps”
Economic Benefits of Nuclear Power

**Job Creation**

- 1,400 – 1,800 jobs during construction, peak employment up to 2,400 jobs
- 700 permanent operating jobs: These jobs pay 36% more than average local salaries
- 700 equivalent additional jobs in local area to support the plant workforce & families

**Suppliers**

- 400,000 cubic yards of concrete—five times as much the 100-story Sears Tower
- 66,000 tons of steel
- 44 miles of piping and 300 miles of electric wiring
- 130,000 electrical components.

**Local Economy**

- $430 million a year in total output for the local community
- $40 million per year in total labor income.
- Every $1 spent by the average nuclear plant results in the creation of $1.07 in the local community.
- $20 million per year in state and local taxes. These tax payments support schools, roads and other state and local infrastructure.
- $75 million per year in federal taxes
# New Nuclear Will Be Competitive

Levelized Cost of Electricity (2007 cents per kilowatt-hour)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Cost Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined cycle (low gas price)</td>
<td>4-7</td>
</tr>
<tr>
<td>Wind (onshore)</td>
<td>4-10</td>
</tr>
<tr>
<td>Coal</td>
<td>5-9</td>
</tr>
<tr>
<td>Wind (offshore)</td>
<td>5-18</td>
</tr>
<tr>
<td>Nuclear</td>
<td>6-13</td>
</tr>
<tr>
<td>Combined cycle with CCS (low gas price)</td>
<td>7-10</td>
</tr>
<tr>
<td>Biopower</td>
<td>8-10</td>
</tr>
<tr>
<td>Solar CSP</td>
<td>8-20</td>
</tr>
<tr>
<td>Coal with CCS</td>
<td>9-15</td>
</tr>
<tr>
<td>Geothermal</td>
<td>10</td>
</tr>
<tr>
<td>Combined cycle (high gas price)</td>
<td>10-16</td>
</tr>
<tr>
<td>Combined cycle with CCS (high gas price)</td>
<td>14-21</td>
</tr>
<tr>
<td>Solar PV</td>
<td>14-30</td>
</tr>
</tbody>
</table>

Source: National Research Council of the National Academies, *America’s Energy Future: Technology and Transformation*
Current Political Support
“But to create more of these clean energy jobs, we need more production, more efficiency, more incentives. And that means building a new generation of safe, clean nuclear power plants in this country.”

President Barack Obama
State of the Union
January 27, 2010
We're going to have to build a new generation of safe, clean nuclear power plants in America. This is only the beginning. My budget proposes tripling the loan guarantees we provide to help finance safe, clean nuclear facilities.

President Barack Obama
Lanham, Maryland
February 16, 2010
“There's been discussion about how we can restart our nuclear industry as a means of reducing our dependence on foreign oil and reducing greenhouse gases.”

President Barack Obama
White House press conference
November 3, 2010
“investing in nuclear energy will position America to lead in a growing industry. If we are serious about cutting carbon pollution then nuclear power must be part of the solution.”

Dr. Steven Chu
Wall Street Journal
March 3, 2010
“So tonight, I challenge you to join me in setting a new goal: By 2035, 80 percent of America’s electricity will come from clean energy sources.”

“Some folks want wind and solar. Others want nuclear, clean coal and natural gas. To meet this goal, we will need them all.”
One More Perspective
Just for Fun!
“I love nuclear.”

Bill Gates
Remarks at MIT
April 21, 2010