

# Energy Economics in a Carbon-Constrained World

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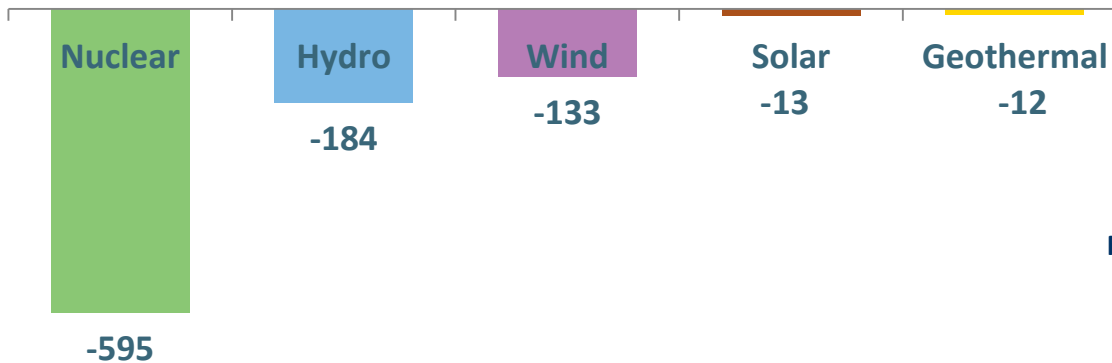


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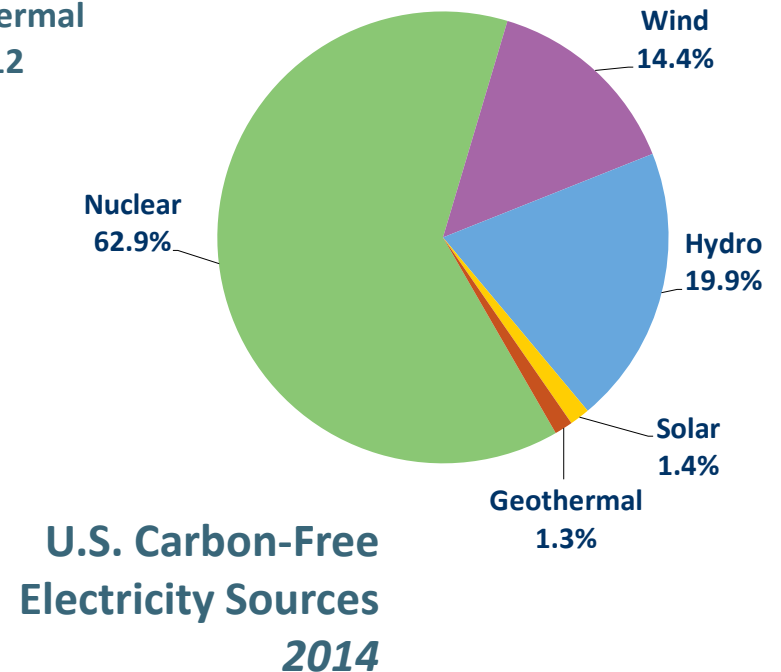
nuclear. clean air energy.

# Recognizing Nuclear Energy's Carbon-Free Value

U.S. Electric Power Industry CO<sub>2</sub> Avoided  
*Million Metric Tons 2014*

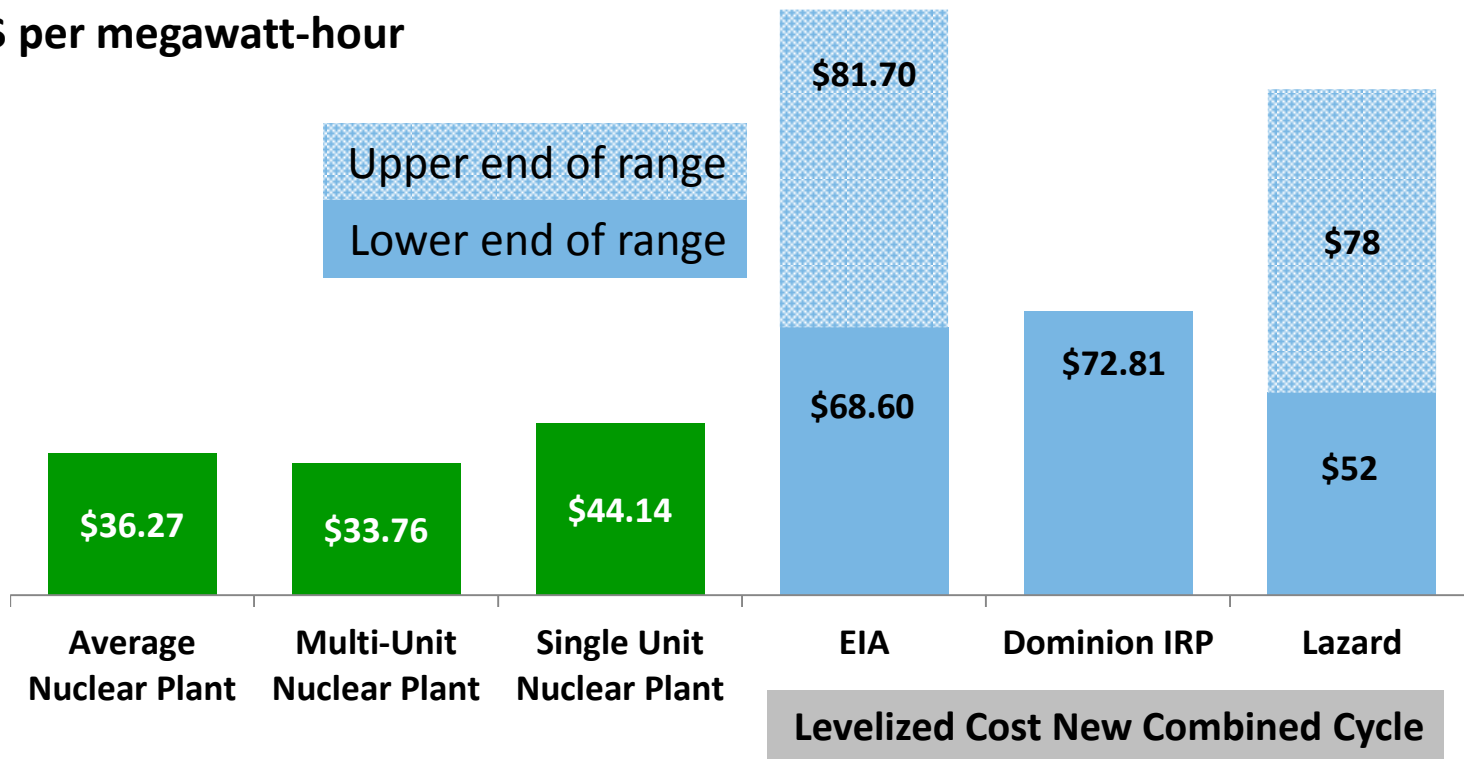


*Sources: Emissions avoided are calculated using regional and national fossil fuel emissions rates from the Environmental Protection Agency and generation data from the Energy Information Administration.*



# Better Deal for Consumers ... Existing Nuclear or New Combined Cycle Gas?

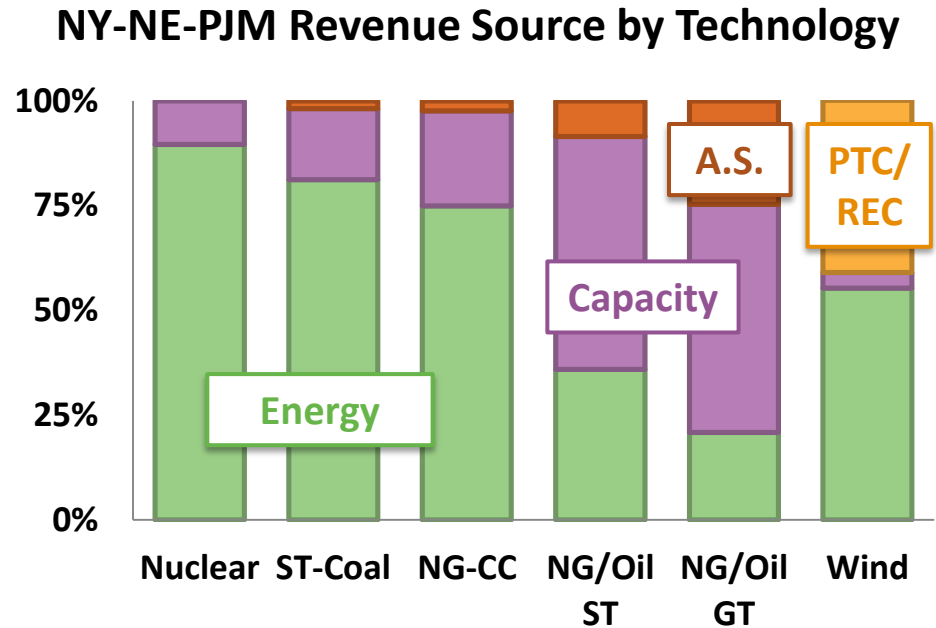
\$ per megawatt-hour



Sources: Existing nuclear costs are 2014 total generating costs (fuel, O&M, capital) from Electric Utility Cost Group. Gas-fired combined cycle costs are levelized costs from (1) Energy Information Administration, *Annual Energy Outlook 2015*; (2) Dominion Virginia Power 2015 Integrated Resource Plan; (3) Lazard, *Levelized Cost of Energy Analysis, 9.0, 2014*.

# Progress in Improving Markets

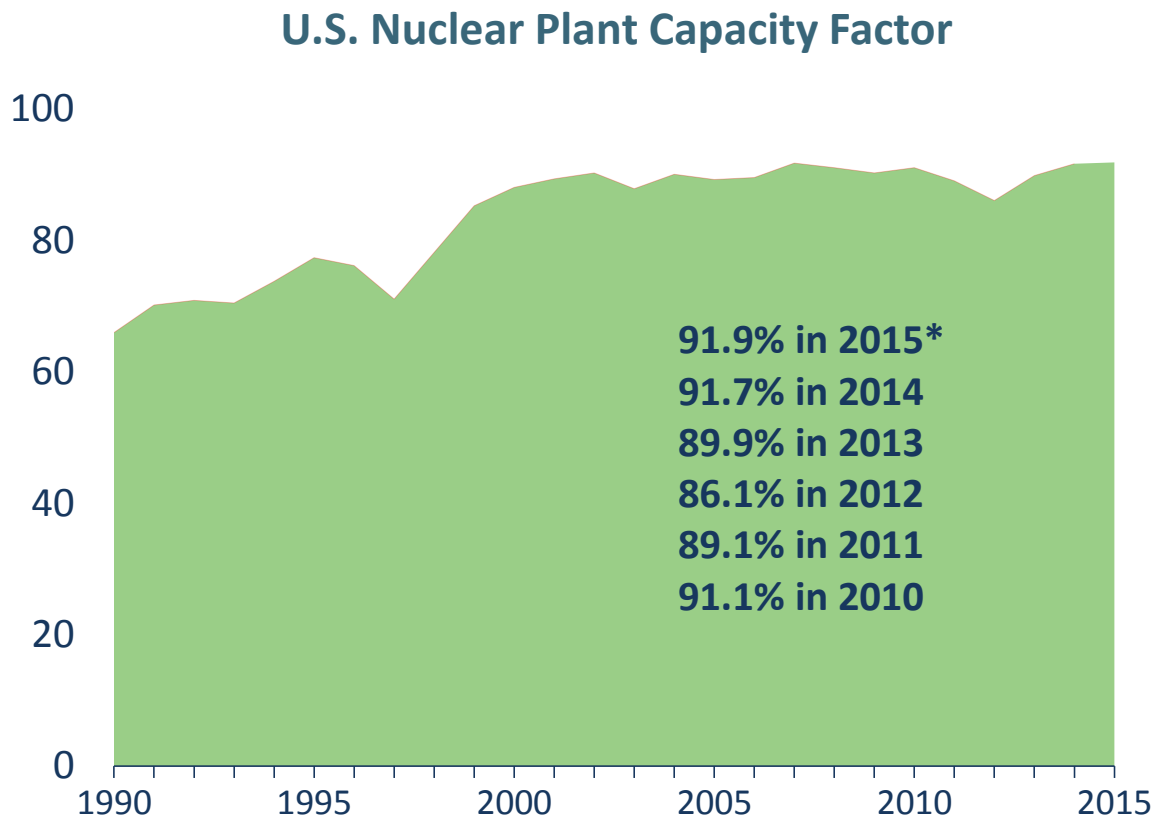
- Capacity market reforms
  - New model in PJM better recognizes important nuclear attribute
  - No benefit in markets that have not taken steps to improve
- Energy market reforms
  - Accurate “day ahead” pricing is the key for nuclear energy



Sources: Velocity Suite; Entergy Research and Analysis  
A.S.: Ancillary Services; PTC: Production Tax Credits;  
REC: Renewable Energy Credits

# Record Capacity Factor in 2015

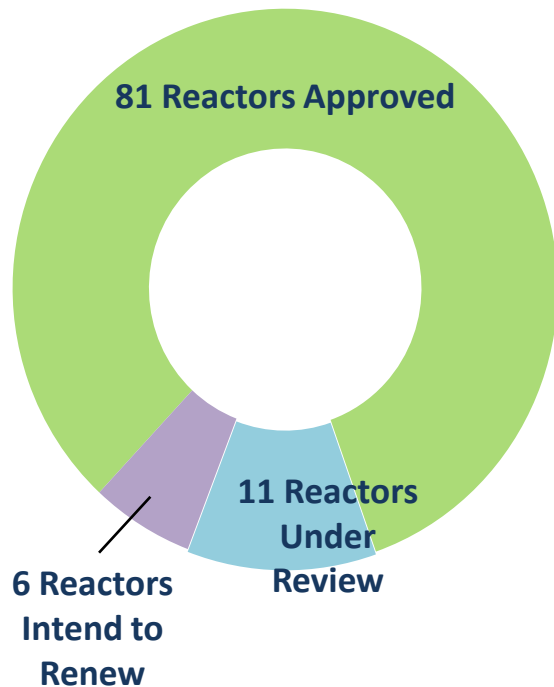
- U.S. reactors set record capacity factor: 91.9%
- Nuclear plants generated 798 billion kWh in 2015
- Average refueling outage duration declined again:
  - 2015: 36 days
  - 2014: 37 days
  - 2013: 41 days



Source: Energy Information Administration  
\* NEI estimate

# Status of First License Renewal

Status of First License Renewal



- Forty reactors have passed 40-year mark
- Approximately 31,000 MW of nuclear capacity will reach 60 years between 2029 and 2035
- Approximately one-half U.S. nuclear capacity will reach 60 years by 2040

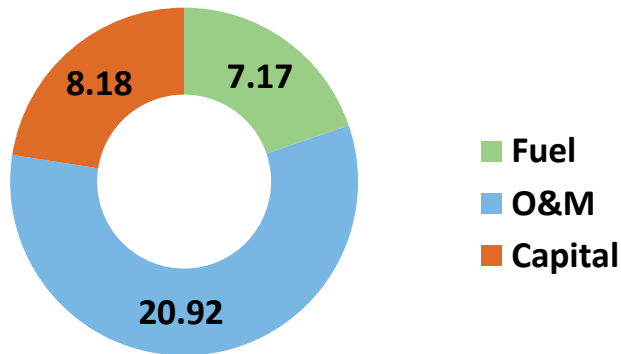
Source: Nuclear Regulatory Commission

# Snapshot of 2014 U.S. Nuclear Plant Costs

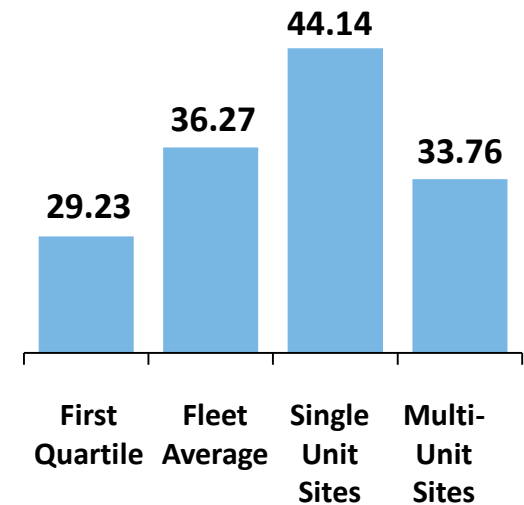
(\$ per MWh)

- Average generating costs have decreased from peak of \$39.70/MWh in 2012 to \$36.27/MWh in 2014
- Fuel costs down slightly in 2014, operating costs flat
- Capital spending down significantly
- \$6.5 billion in 2014 capex, 26% decrease from \$8.7 billion in 2012

2014 Generating Cost



2014 Average Generating Costs

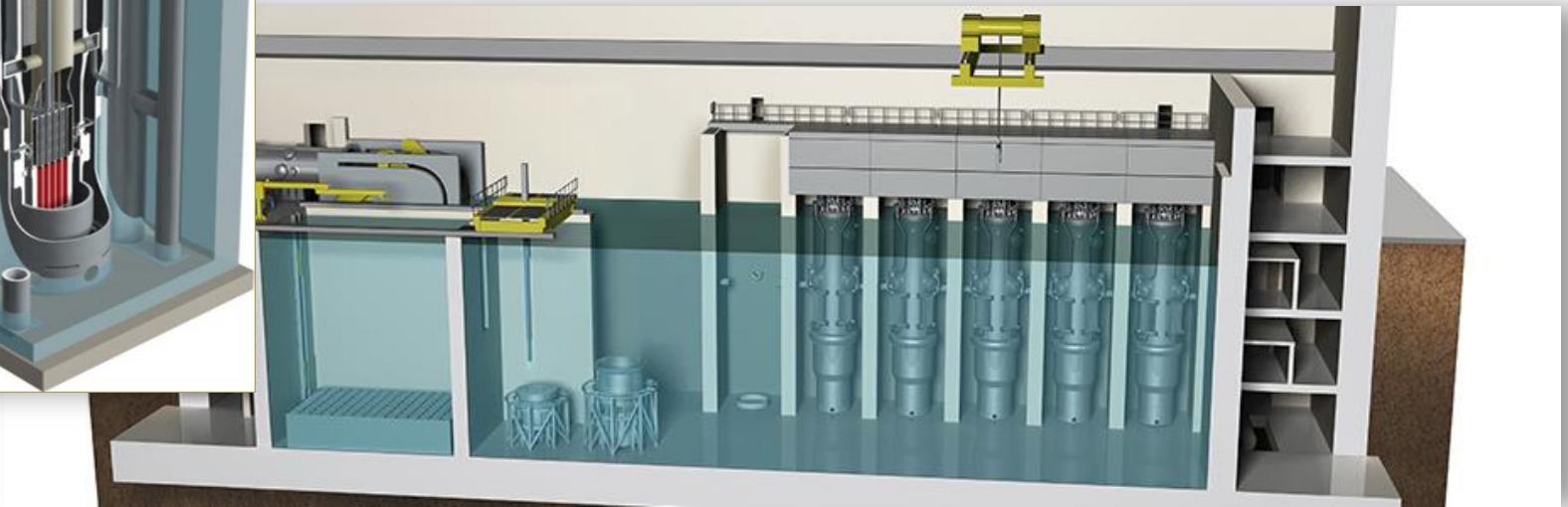


Total generating cost = fuel + capital + operating.  
Source: Electric Utility Cost Group.

# Preserving the Nuclear Option



- NuScale Power expects to file design certification for its small modular reactor in 4th quarter
- Growing interest in GEN-IV reactors





# Global Market Leadership

- Global nuclear market could reach \$750 billion over the next 10 years
- U.S. technology among the most innovative – e.g., the only “passive safety” designs
- U.S. nuclear technology is a strategic instrument of U.S. foreign policy
- Participation in the world market enhances U.S. ability to achieve nonproliferation goals, export safety practices

