State of the Nuclear Industry – Prospects for the Future

New York Energy Forum

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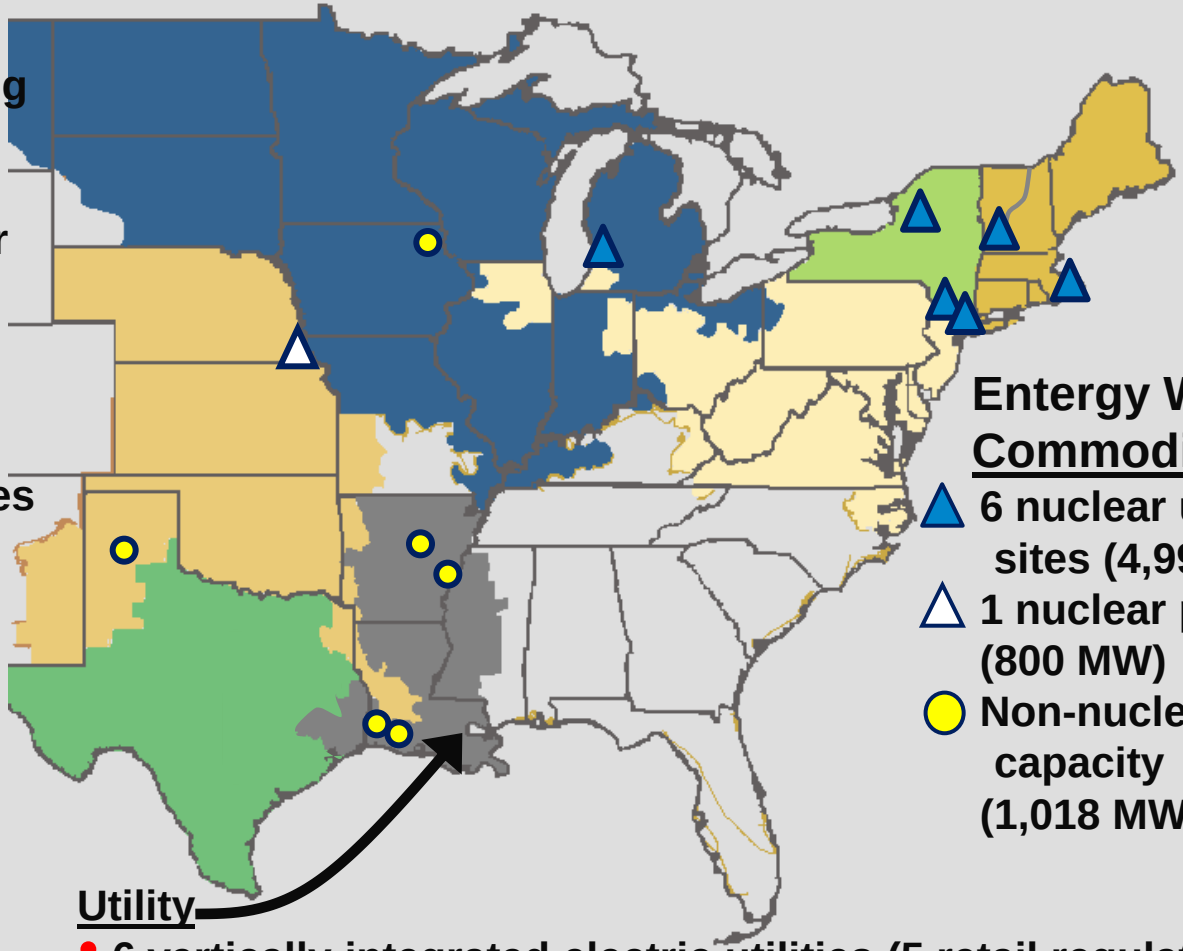
Entergy®

Entergy's Integrated Business

Entergy's Businesses

- 30,000 MW electric generating capacity
- 2nd largest U.S. nuclear generator
- 2.7 million customers
- Over $11 billion revenues
- ~15,000 employees



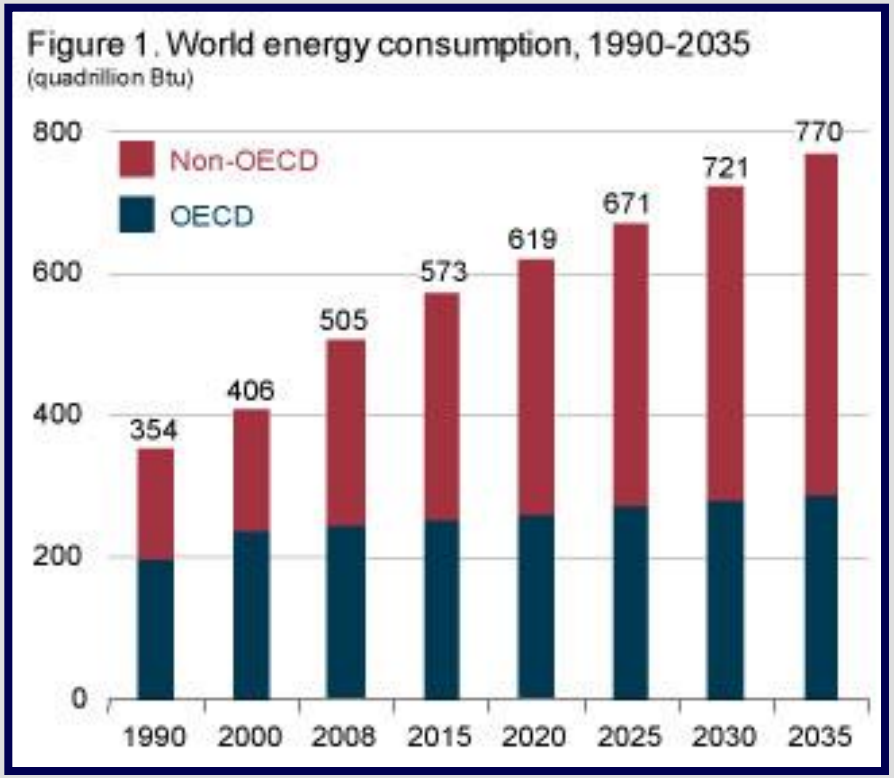
Entergy Wholesale Commodities

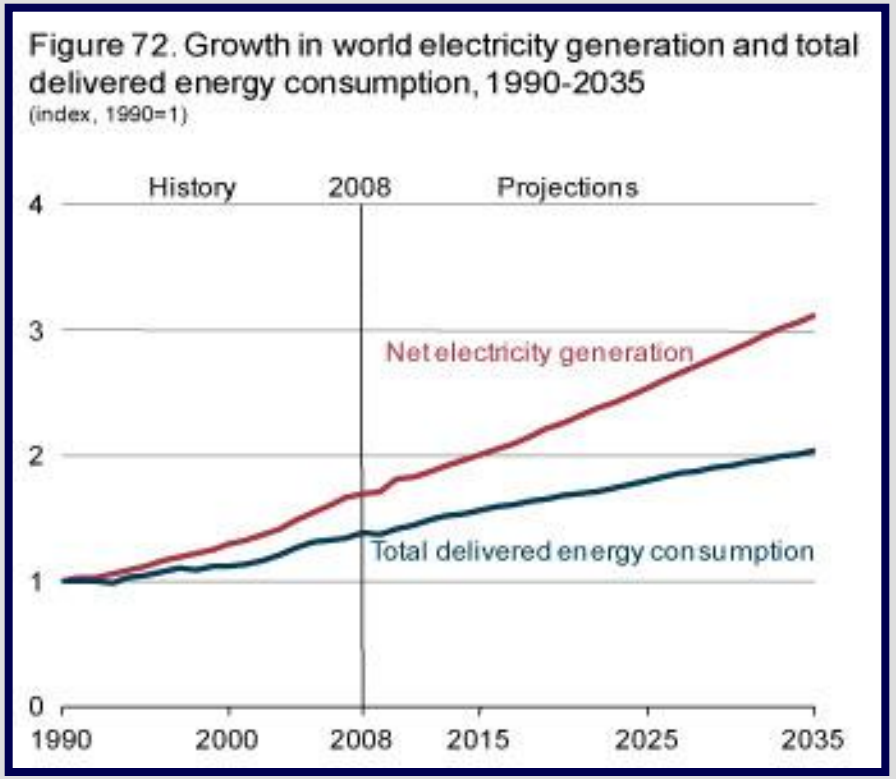
- 6 nuclear units owned at 5 sites (4,998 MW)
- 1 nuclear plant managed (800 MW)
- Non-nuclear wholesale capacity (1,018 MW)

Utility

- 6 vertically integrated electric utilities (5 retail regulators)
- 4 contiguous states – Arkansas, Louisiana, Mississippi, Texas
- 22,000 MW of generating capacity
- More than 15,500 miles of high-voltage transmission lines

Energy Consumption Projected to Continue to Grow





Energy efficiency programs have not delivered the promised results.

Source: U.S. Energy Information Administration, "International Energy Outlook 2011" (rel. Sept. 19, 2011)

New Nuclear – Preserving the Option

- New nuclear construction requires federal and state policy initiatives
- To avoid regulatory uncertainty and encourage utilities to consider new nuclear options, some states have adopted regulatory frameworks that establish a collaborative process among the utilities, the regulator, and other stakeholders

Louisiana, for example, adopted a ***New Nuclear Incentive Rule*** in 2007 that creates incentives for nuclear construction by providing a much greater degree of certainty to the regulator as to the cost of the project and to the utility as to the recovery of that cost as compared to the regulatory approaches used in the previous nuclear construction era

- This greater degree of certainty is provided through three regulatory mechanisms:
  - Three-phase certification procedure:

    siting and licensing - design and development - construction
  - Annual prudence reviews
  - Oversight and reporting process

EWC's Nuclear Portfolio

Palisades – 798 MW
Acquired: April 2007
Licensed Through: March 2031
Power Market: Midwest ISO

FitzPatrick – 838 MW
Acquired: November 2000
Licensed Through: October 2034
Power Market: NYISO Zone A[1]

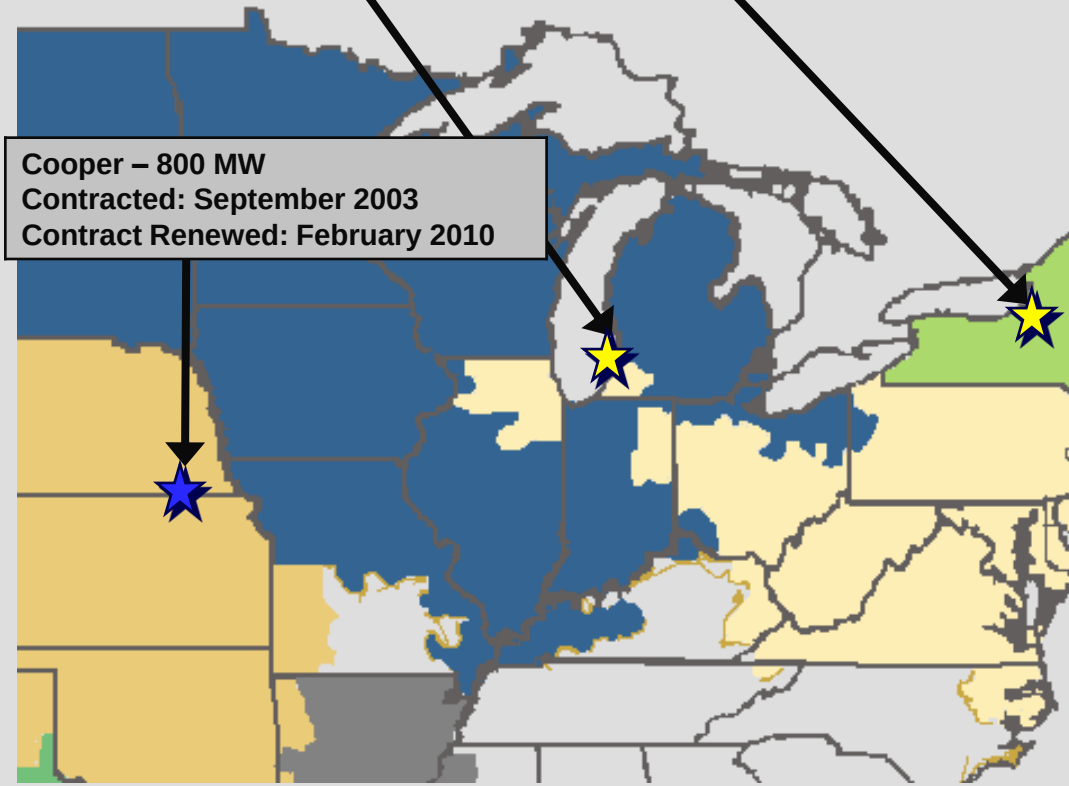
Vermont Yankee – 605 MW
Acquired: July 2002
Licensed Through: March 2032
Power Market: ISO-NE Mass Hub

Pilgrim – 688 MW
Acquired: July 1999
Licensed Through: June 2012
Power Market: ISO-NE Mass Hub

Cooper – 800 MW
Contracted: September 2003
Contract Renewed: February 2010

Indian Point Unit 2 – 1,028 MW
Acquired: September 2001
Licensed Through: Sept.2013
Power Market: NYISO Zone G[1]

Indian Point Unit 3 – 1,041 MW
Acquired: November 2000
Licensed Through: December 2015
Power Market: NYISO Zone G[1]



New England
Independent System Operator "ISO-NE" control area

New York
Independent System Operator "NYISO" control area

Midwest
Independent System Operator "MISO" control area

[1] Represents nearest liquid trading hub; physically located in NYISO Zone C for FitzPatrick and NYISO Zone H for Indian Point

Indian Point

- Indian Point not susceptible to the Japan-level earthquake
- Not susceptible to a tsunami
- A safety margin exists above original design-basis to withstand serious earthquakes

- Plant operators are subject to rigorous training to assure their preparedness in a natural disaster
- Our safety culture requires us to incorporate lessons learned from any accident into our continuous improvement safety programs
- A proven commitment to make the investments needed to assure the presence of adequate backup systems and safety

Defense-in-Depth: Multiple Layers of Backup at Indian Point to Maintain Core Cooling

Multiple layers of backup to handle the loss of power from the grid

Four Separate Systems to Provide Reactor Cooling Using the Steam Generators After Loss of Power to Site or from Grid

- **On-site emergency diesel generators (EDGs)—3 emergency diesel generators per unit (only 2 per unit are required to run the pumps and cooling systems).**
- **Additional redundant and independent diesel generator (Station Blackout diesels)—at each unit the SBO diesels are installed at a different location and electrically isolated from the primary EDGs for each unit, SBO diesels are cross connected so that each can power the pumps and cooling systems at either unit.**
- **Steam Powered Pump—using steam produced by the steam generators from the reactor heat that can be used to cope with a complete loss of AC power from any source.**
- **Diesel Driven Contingency Pump—this pump can be used to supply water to the steam generators and cool the reactor in the event that no other measures are available.**

Charles River Associates Report

The NYC Department of Environmental Protection commissioned a study of the consequences of closing Indian Point. The report was released August 2, 2011:

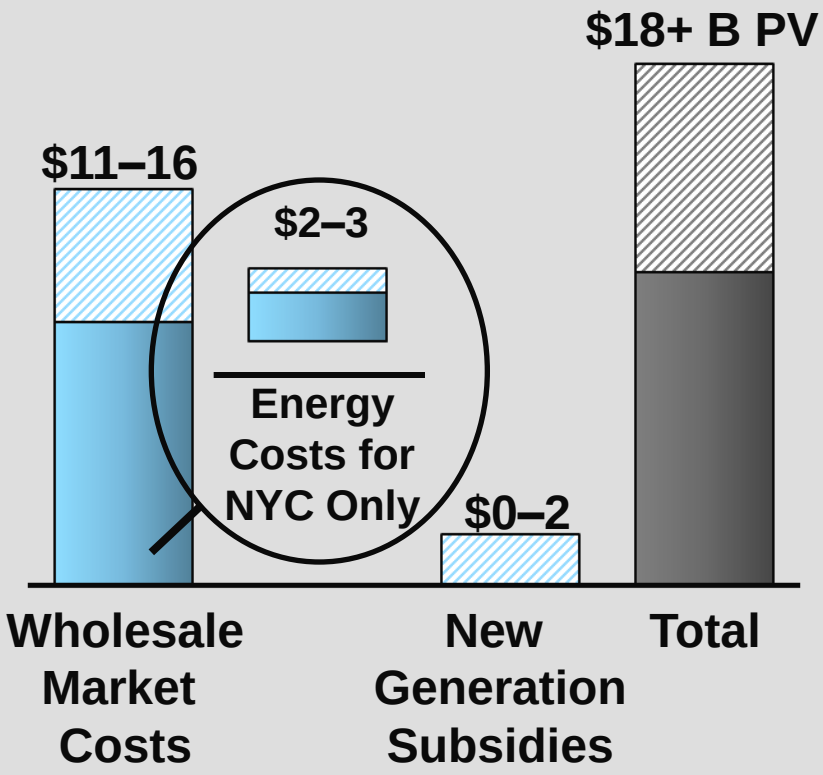
"Any powerplant, including IPEC, can be retired, but not without costs and tradeoffs. It is crucial to understand that the critical question is not whether IPEC can be retired, but rather what the economic, reliability, and environmental impacts of such a decision are. In the case of IPEC's potential retirement, these impacts are sufficiently large to warrant careful consideration."

--CRA Report at 8

CRA Study – Good for Economic Growth

Key Findings

Higher Costs for NY Customers
$B (PV) (all four scenarios)



Source: Charles River Associates

Increased energy cost to New York consumers under every feasible scenario

- Estimated at $10B to $12B through 2030 across the state (for solutions more likely to be feasible from system reliability perspective).
- NYC portion – $2B to $3B.
- Additional economic impacts through indirect and induced economic activity.

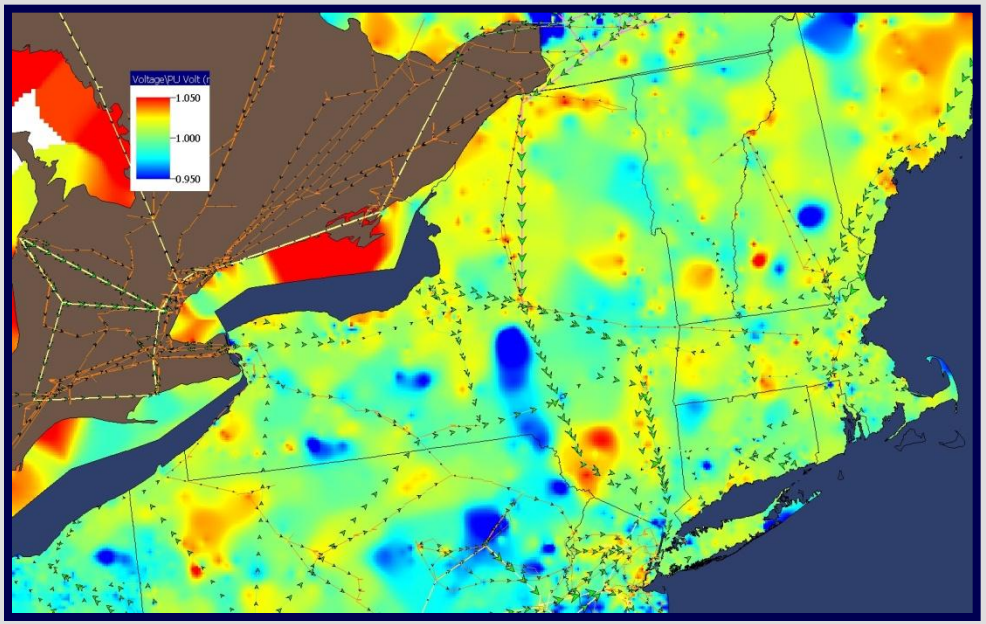
Replacement Options will not be supported by market revenues and will require subsidies

- Subsidies range between $691M for conventional fossil to $2.1B for low carbon.
- Emphasized projects under development in the Lower Hudson Valley (LHV) face significant challenges.
- Not all replacement options may be available upon IPEC's current end of license.
- Significant upgrades of the gas delivery infrastructure will be required for any significant, LHV-based gas fired replacements.

CRA Study – Good for Reliability

Key Findings (continued)

IPEC's retirement without new generation or transmission additions will compromise the reliability of the electric grid



Source: Charles River Associates

- **Resource adequacy impact of IPEC's retirement is highly dependent on the load forecast assumed but, in all cases, LOLE violations result.**
- **CRA used NYISO's 2011 load forecast with an adjustment to energy efficiency assumptions.**
- **Small changes in the assumed future energy consumption can determine whether the system will meet reliability requirements, energy conservation must be considered in a realistic context.**
- **Resource adequacy is only one component of the overall system reliability.**
- **More analysis is needed to determine IPEC retirement impacts on voltage support, stability, etc.**

CRA Study – Good for the Environment

Key Findings (continued)

Each option for replacement of IPEC's capacity would measurably increase air emissions

New York State Incremental Air Emissions Impact

		2016	2017	2018	2019	2021	2023	2025	2027	2030
No New Generation	NO_x	10%	10%	11%	10%	11%	12%	12%	11%	10%
	SO_x	1%	1%	4%	3%	7%	6%	5%	8%	8%
	CO_2	13%	13%	12%	12%	12%	13%	13%	12%	10%
Conv. Thermal[1] – LHV[2] CC[3] Only	NO_x	9%	9%	9%	8%	9%	10%	10%	9%	8%
	SO_x	0%	0%	2%	1%	4%	4%	4%	6%	6%
	CO_2	14%	14%	13%	13%	13%	14%	14%	12%	11%
Conv. Thermal – CCs in LHV & NYC	NO_x	7%	8%	8%	7%	8%	8%	8%	8%	7%
	SO_x	0%	0%	2%	2%	3%	3%	4%	5%	5%
	CO_2	15%	15%	14%	14%	14%	14%	14%	13%	11%
Low Carbon[4]	NO_x	5%	4%	5%	5%	6%	6%	6%	6%	5%
	SO_x	0%	-1%	2%	-1%	4%	1%	5%	1%	2%
	CO_2	7%	7%	6%	6%	7%	7%	7%	7%	5%

Source: Charles River Associates

[1] Conv. Thermal – Conventional thermal power plants

[2] LHV – Lower Hudson Valley

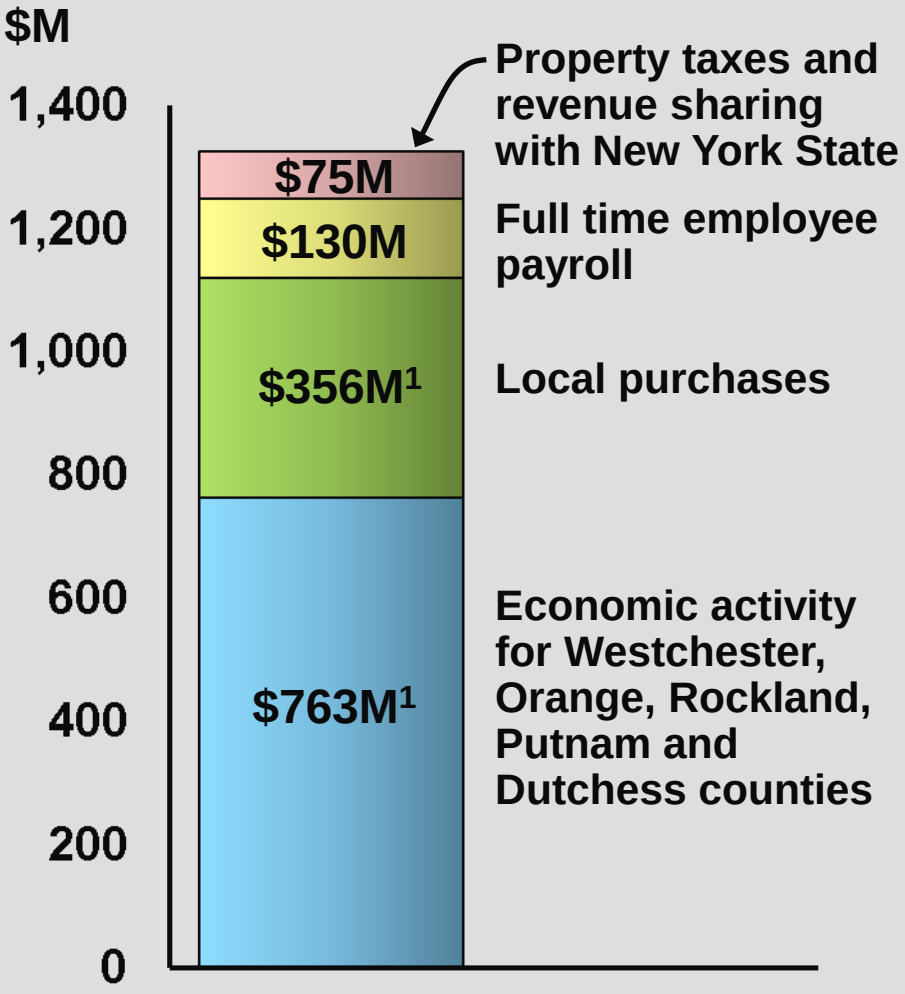
[3] CC – Combined cycle gas-fired plant

[4] Low Carbon – Construction of 1,000 MW HDVC line to NYC coupled with offshore wind energy

- **15% increase in carbon emissions and ~7-8% increase NOx emissions under most conventional replacement scenarios.**
- **CSAPR assumptions used in the final CRA report are subject to change under CSAPR2. Tightening NOx caps could lead to higher prices for NOx emissions increasing the impact of IPEC generation which has no direct air emissions.**

Indian Point Economic Impact

Annual Economic Impact



In addition…

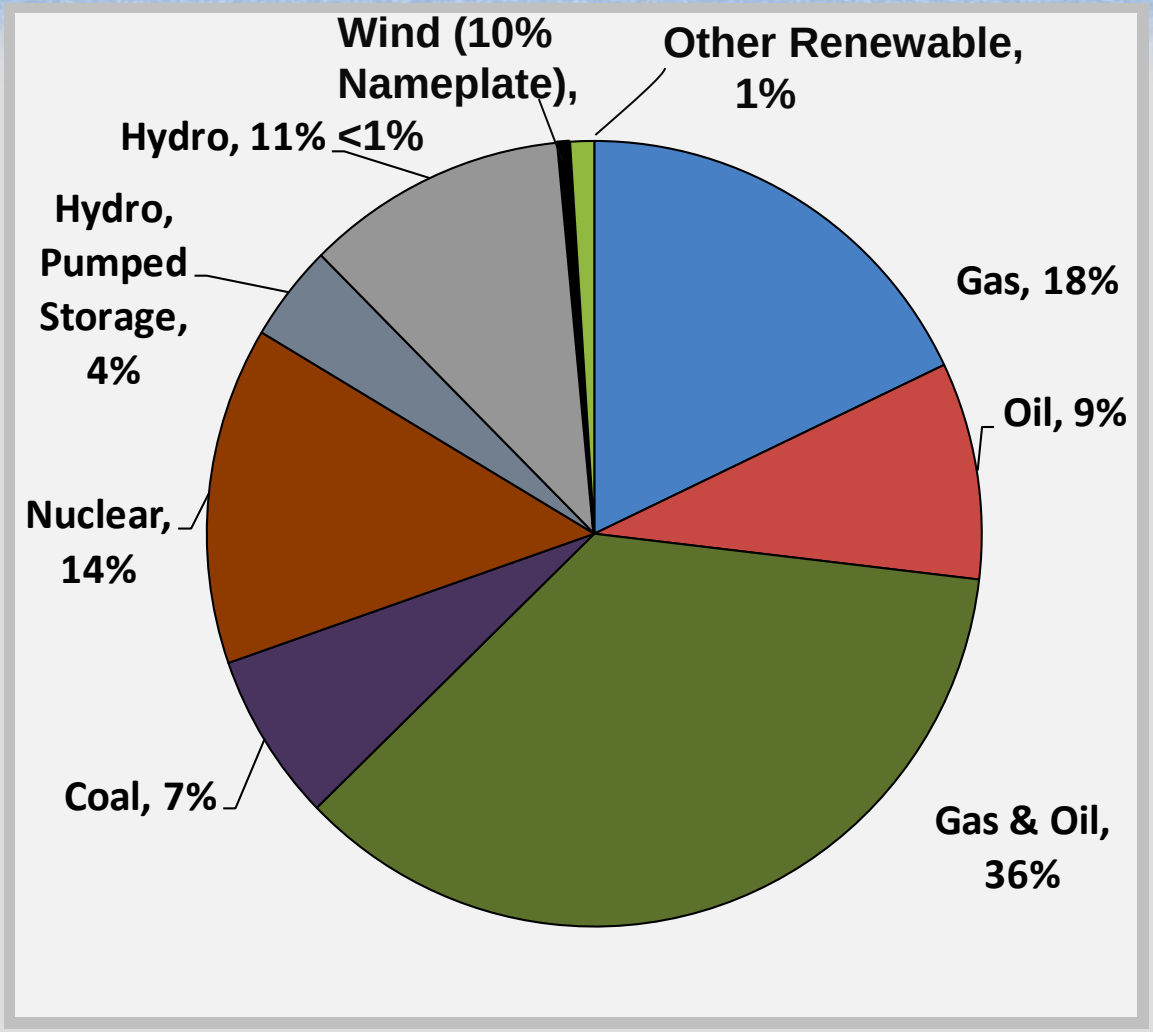
- Entergy employs ~2,000 individuals in New York State
- Over 200 contractors work at the Indian Point and FitzPatrick sites on a daily basis
- $2M annual charitable contributions to organizations such as
  - *Jazz at Lincoln Center*
  - *NY Botanical Gardens*
  - *Paramount Center for the Arts*
  - *American Red Cross*
  - *African-American Men of Westchester*
  - *100 Hispanic Women*
  - *Heartshare-Heat Thy Neighbor*
  - *Hudson Valley Hospital*
  - *Girl Scouts of Westchester and Putnam County*

[1] Based on 2002 study of direct effects including plant output and secondary effects of operations

Nuclear Power in the U.S.

New York City's proximity to Indian Point is not a unique characteristic.
26 of the largest 100 U.S. cities are within 50 miles of a nuclear plant.
More than 116 million people in the U.S. live within 50 miles of a nuclear plant.

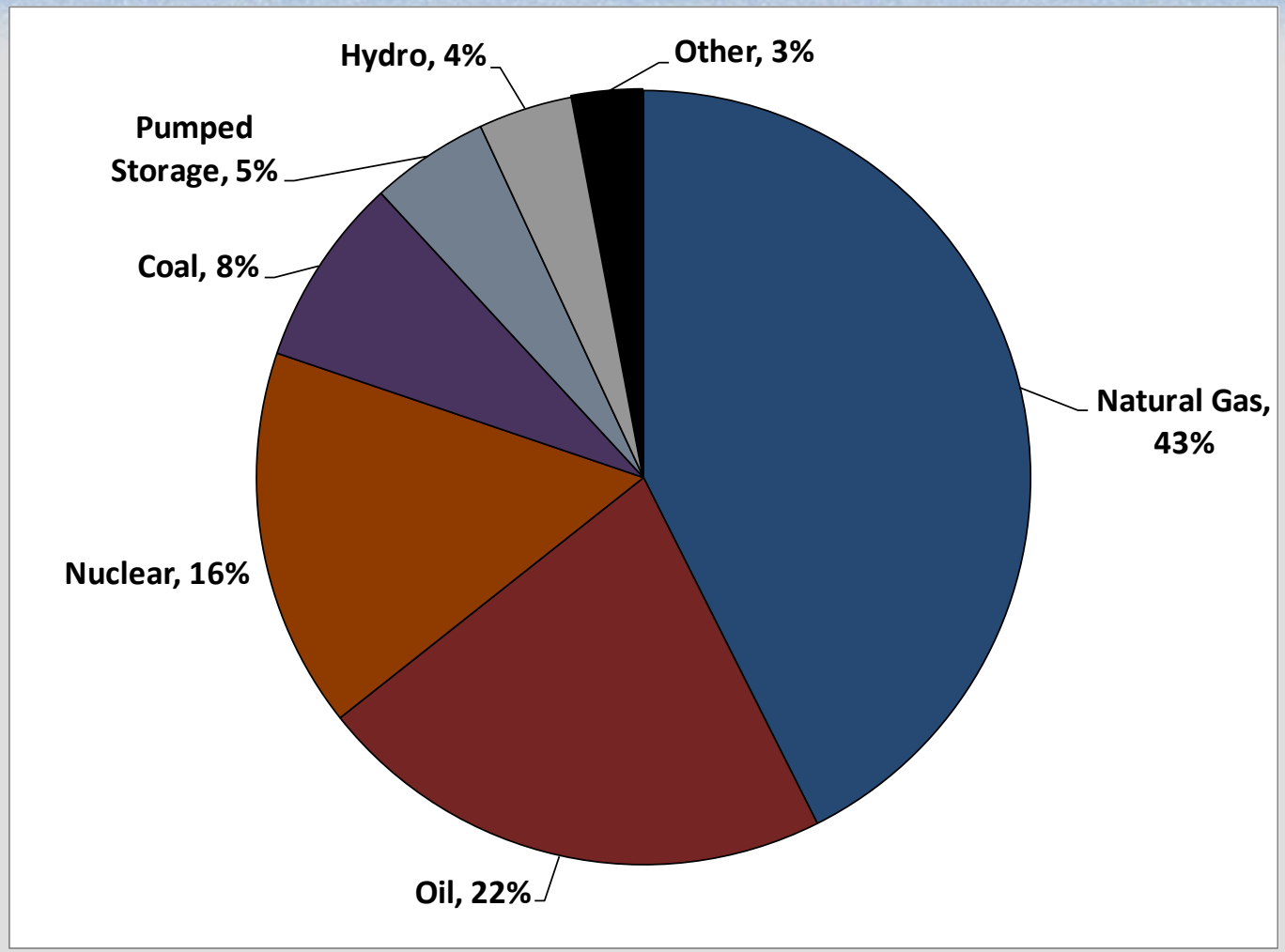
New York State Generation Mix (2010)



What would be the risks and consequences (economic, reliability, environmental, etc.) of increasing New York's dependence on fossil fuel generation?

Source: New York ISO (http://www.nyiso.com/public/about_nyiso/importance_of_reliability/powering_new_york/index.jsp)

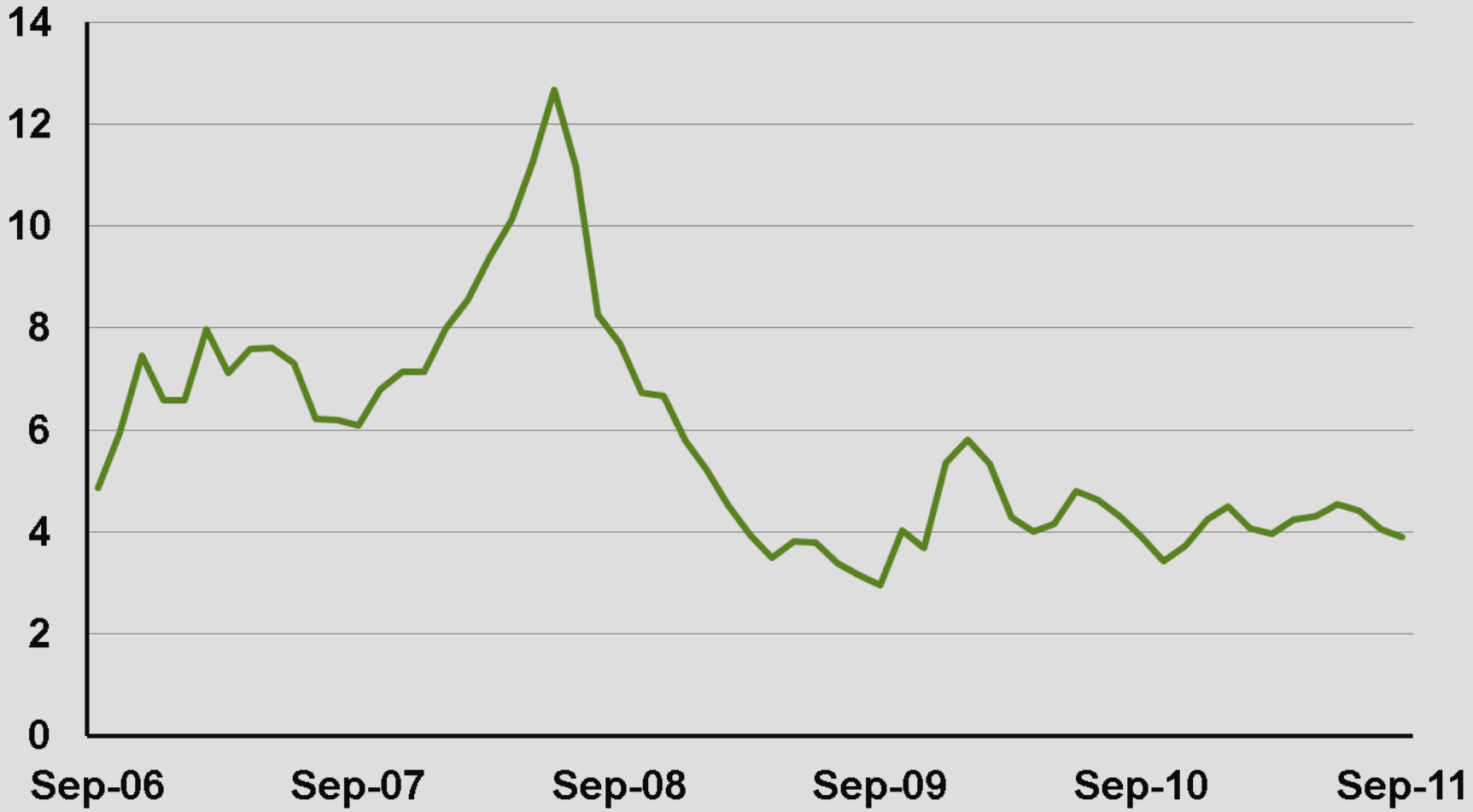
New England Generation Mix (2011)



Source: U.S. EPA (http://www.epa.gov/region1/eco/energy/mitigation-efforts-ne.html)

Historic Volatility of Natural Gas Prices

Monthly U.S. Natural Gas Prices
Sep 2006 – Sep 2011; $/MMBtu

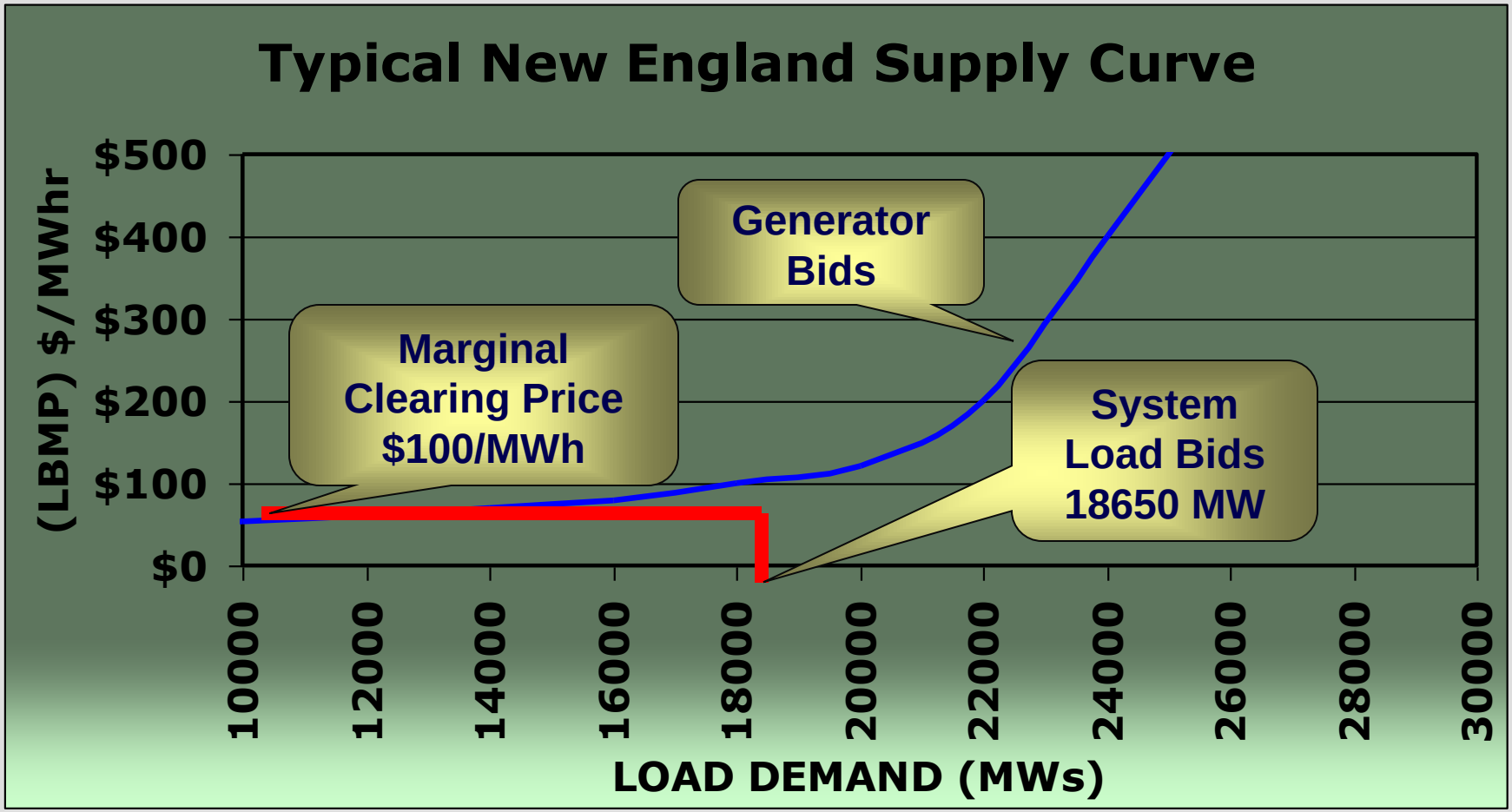


Source: World Bank Commodity Price Data

Locational-Based Marginal Pricing (LBMP)

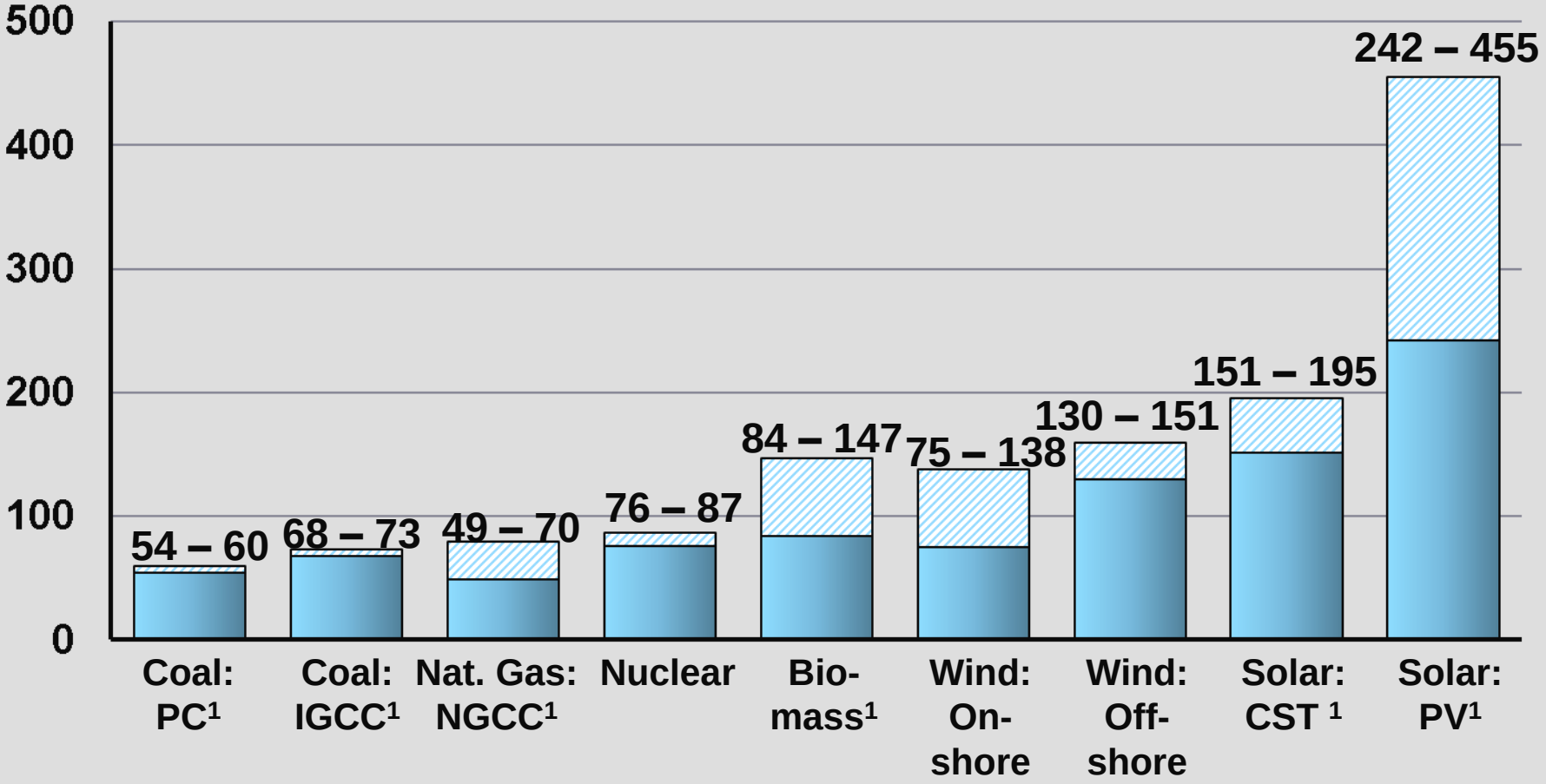
- LBMP is the incremental cost to supply load at a specific location on the grid
- The "Market Clearing Price"
- System is bid-based
  - Bids are confidential
  - LBMPs are determined and published on an hourly basis keeping the market visible

Energy Market Day Ahead Price



Cost of Electricity for New Generation Technologies

Representative Cost and Performance of Power Generation Technologies (2015)
Levelized Cost of Electricity in $/MWh (in 2010$)



[1] *PV = Advanced Pulverized Coal; IGCC = Integrated Coal Gasification Combined Cycle; NGCC = Natural Gas Combustion Turbine; Biomass Bubbling Fluidized Bed; CST = Concentrating* Solar Thermal; *PV = Photovoltaic*

Source: Electric Power Research Institute, "Program on Technology Innovation: Integrated Generation Technology Options" (Public domain reference, June 2011, p.1-11)

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