The Impact of Changing Natural Gas Prices on Renewables and Energy Efficiency

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Summary and Take Away

- **New natural gas supply availability is having considerable impacts on all energy markets today and on longer term, forward-looking basis.**
- **Given the prevalence of natural gas at the margin, this impacts not just retail gas usage, but also power, renewables and environmental valuations.**
- **Lower gas commodity will also drive down gas as a share of total bill and start to move base rate/commodity cost relationships to longer-run averages.**
- **If avoided costs (future looking costs) are not re-calibrated to reflect these market changes, it could result in higher-than-cost effective energy efficiency and renewable energy being adopted.**

Marginal Costs/Avoided Costs

Marginal cost – the change in total cost resulting from an extremely small change in output. Typically thought of in the short run, although long run marginal costs can be important for planning purposes.

Avoided costs – the real world estimate of long run marginal costs where all factors of production (or inputs such as capital/capacity and other variable costs) are variable.

Important in long run resource planning evaluation as well as evaluation of renewable energy resources and energy efficiency measures.

Avoided Cost Estimation

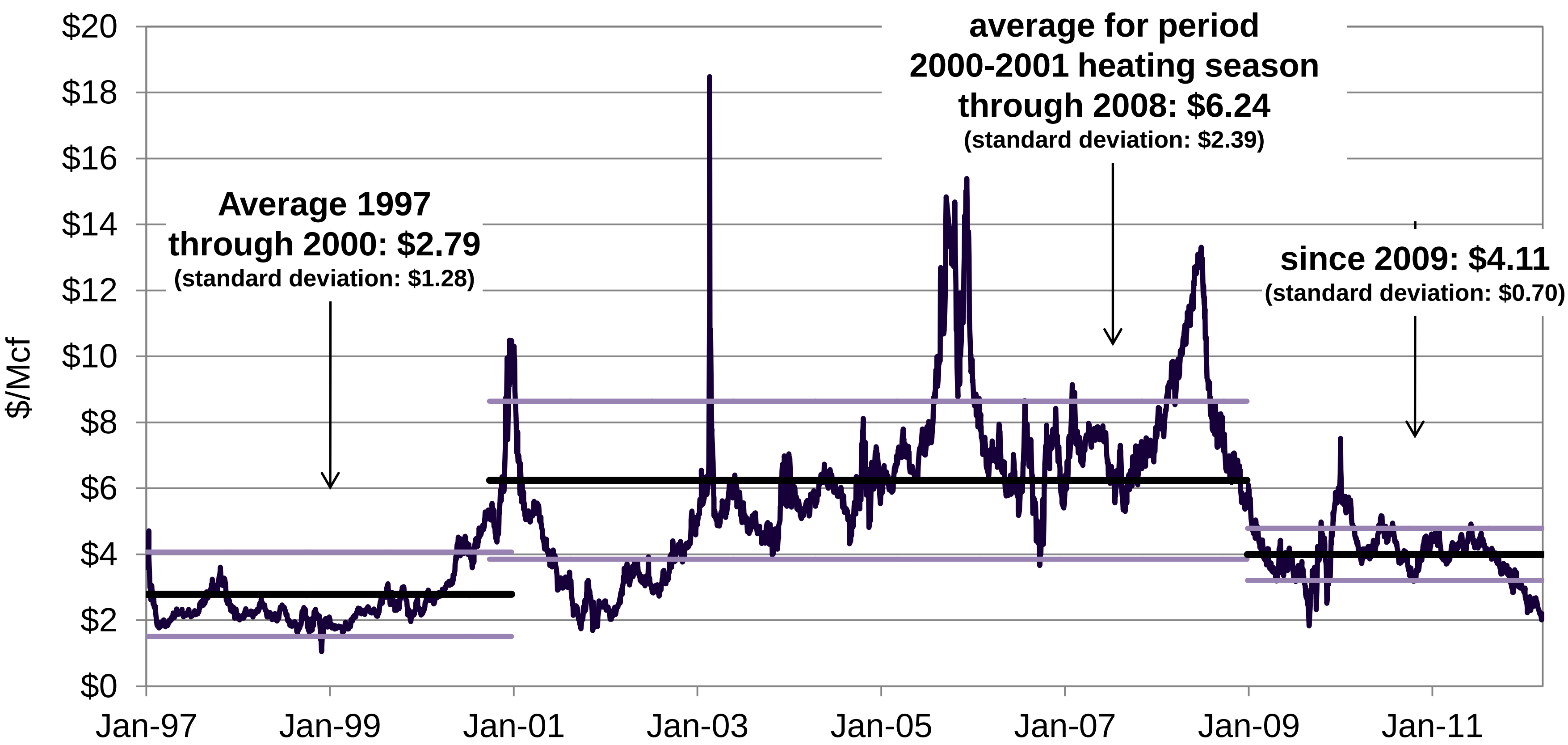
Avoided cost estimates are often a function of:

1. **Future energy costs**
2. **Future capacity costs**
3. **Future natural gas commodity costs (LDC)**
4. **Future environmental costs**
5. **Future renewable costs**
6. **Zero dispatch benefits (use/application varies by state)**

Natural Gas Prices

Natural Gas Price Variability

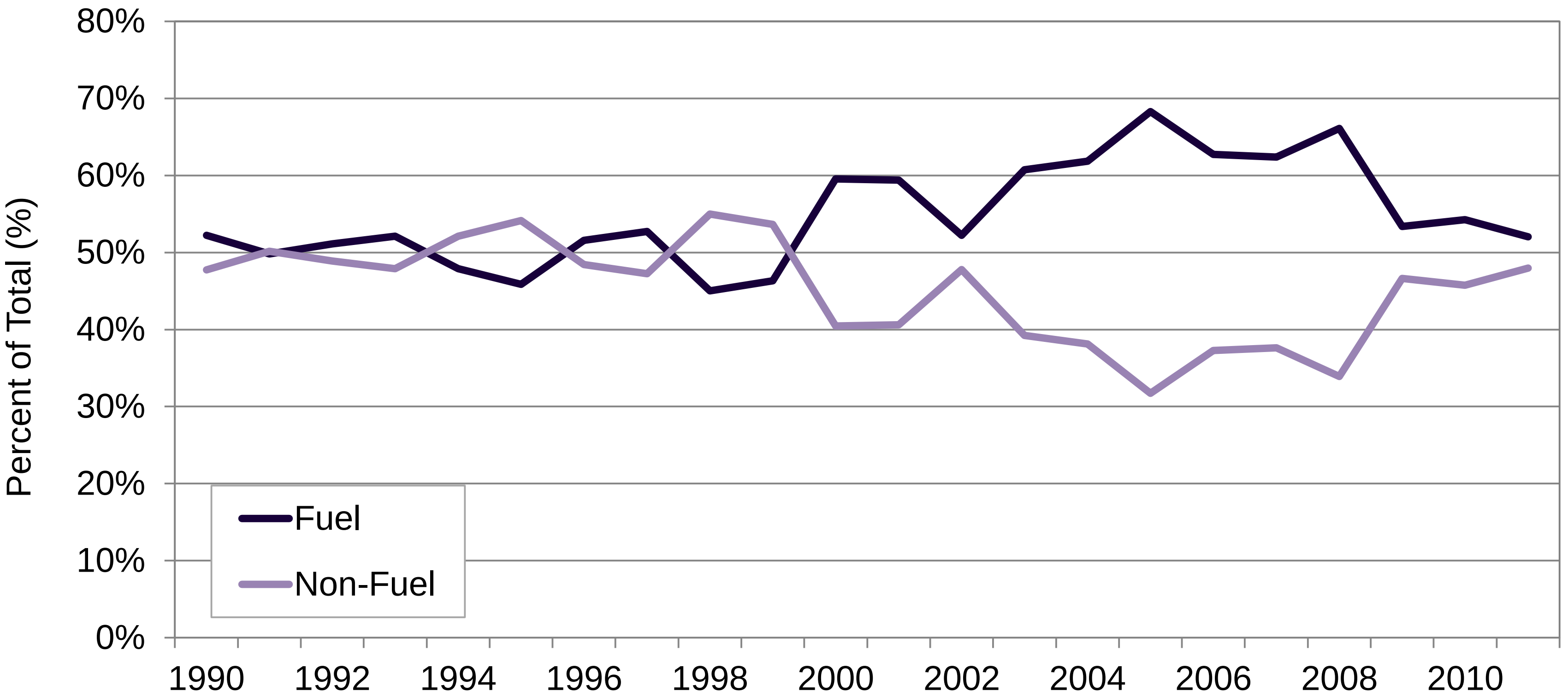
The 2001 to 2009 market trend of higher average prices coupled with high volatility is reversing itself and post 2009 prices are significantly lower.



Source: Energy Information Administration, U.S. Department of Energy.

Estimated Gas and Non-Gas Costs in U.S. Distribution Rates

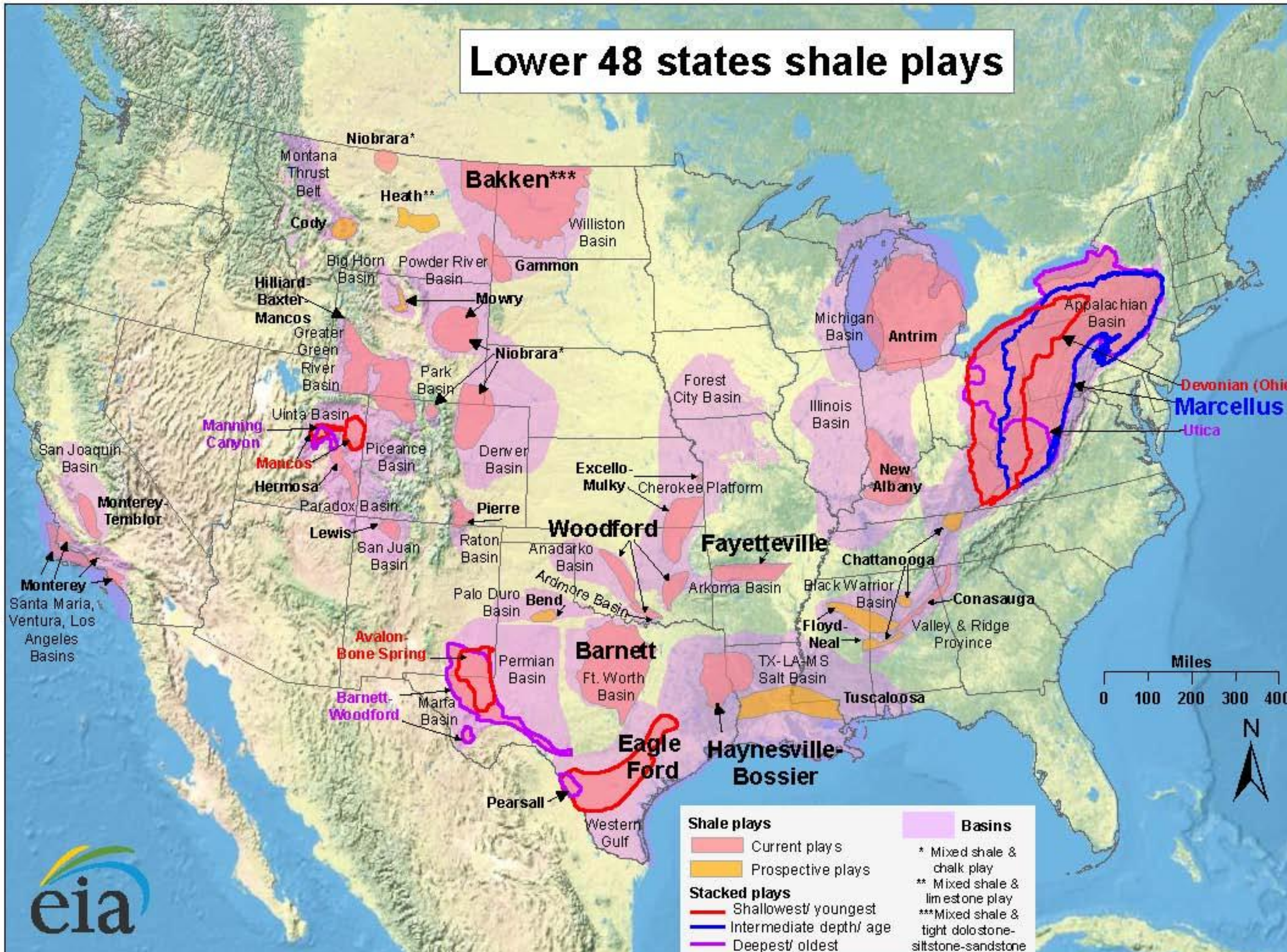
The commodity share of total bills are closer to percentages observed in the 1990s rather than the early 2000s.



Source: Energy Information Administration, U.S. Department of Energy

Domestic Shale Gas Basins and Plays

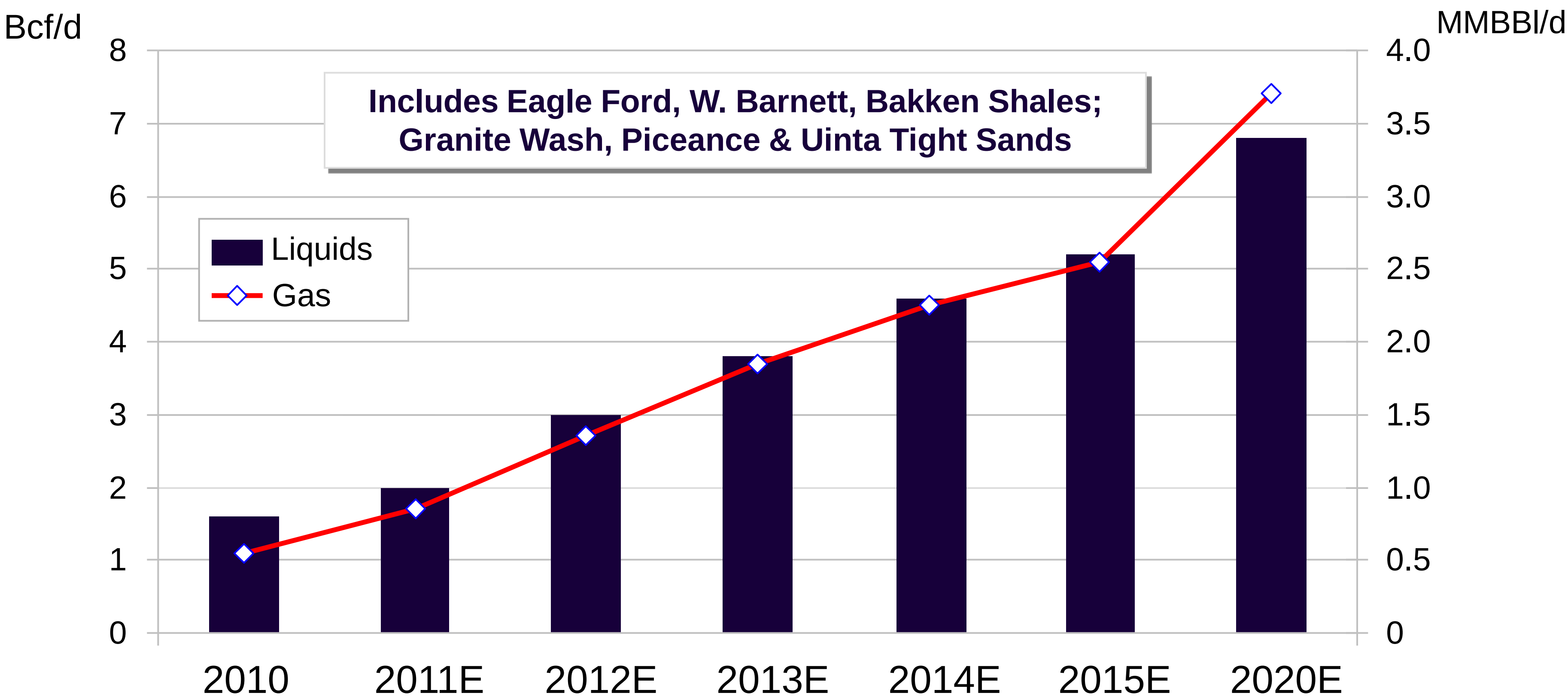
Unlike conventional resources, shale plays (natural gas, liquids, and crudes) are located almost ubiquitously throughout the U.S. and are the primary reason for the decrease in overall and regional natural gas prices.



Source: Energy Information Administration, U.S. Department of Energy

Annual Production, Unconventional Resources

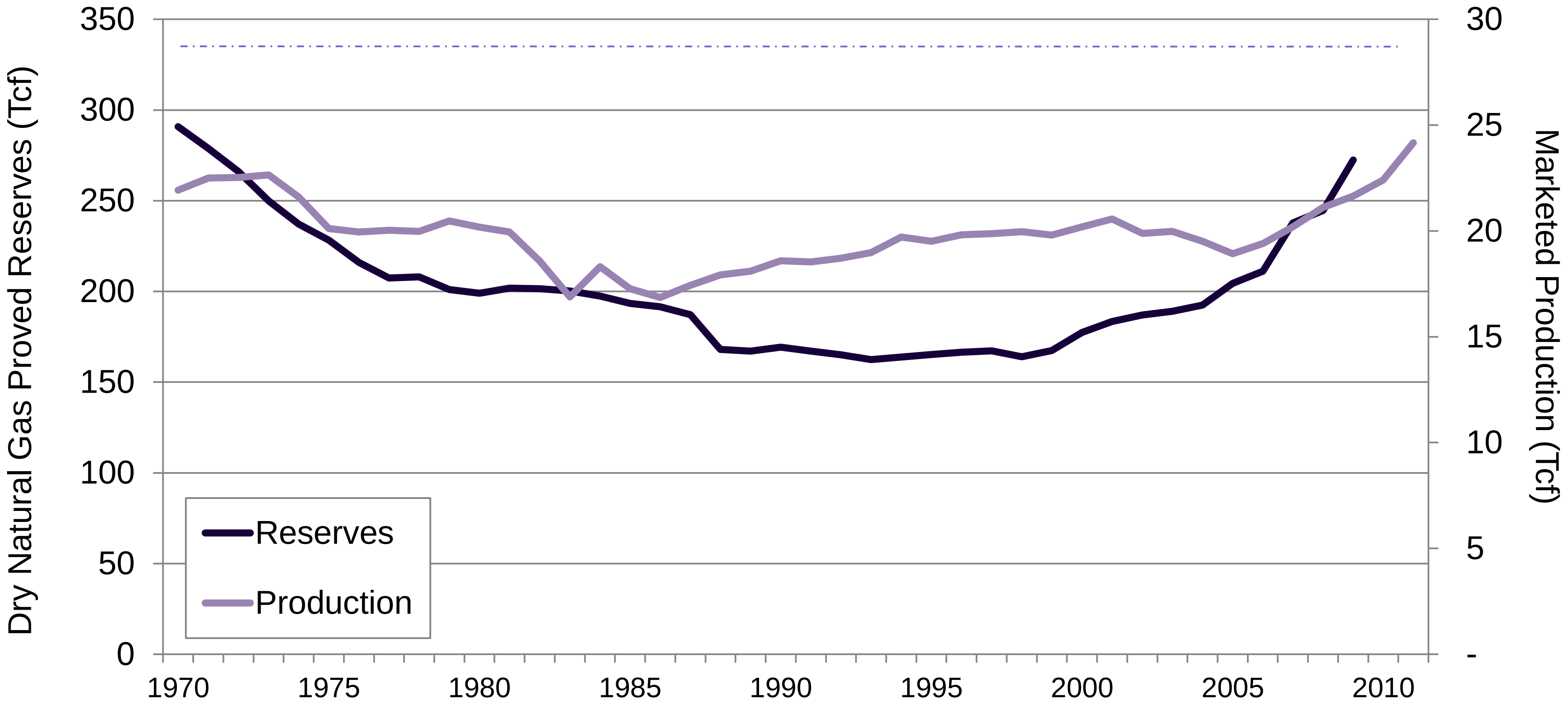
Liquids production from shale plays > 3 million barrels per day by 2020
Associated natural gas > 7 Bcf/d of "costless" supply (or about 2.3 Bcf/d per every 1.0 MMBbls/d of shale-based liquids production).



Source: Advanced Resource Intl; presentation to Cheniere Board, March 2011; Cheniere Research

Natural Gas Proved Reserves and Production

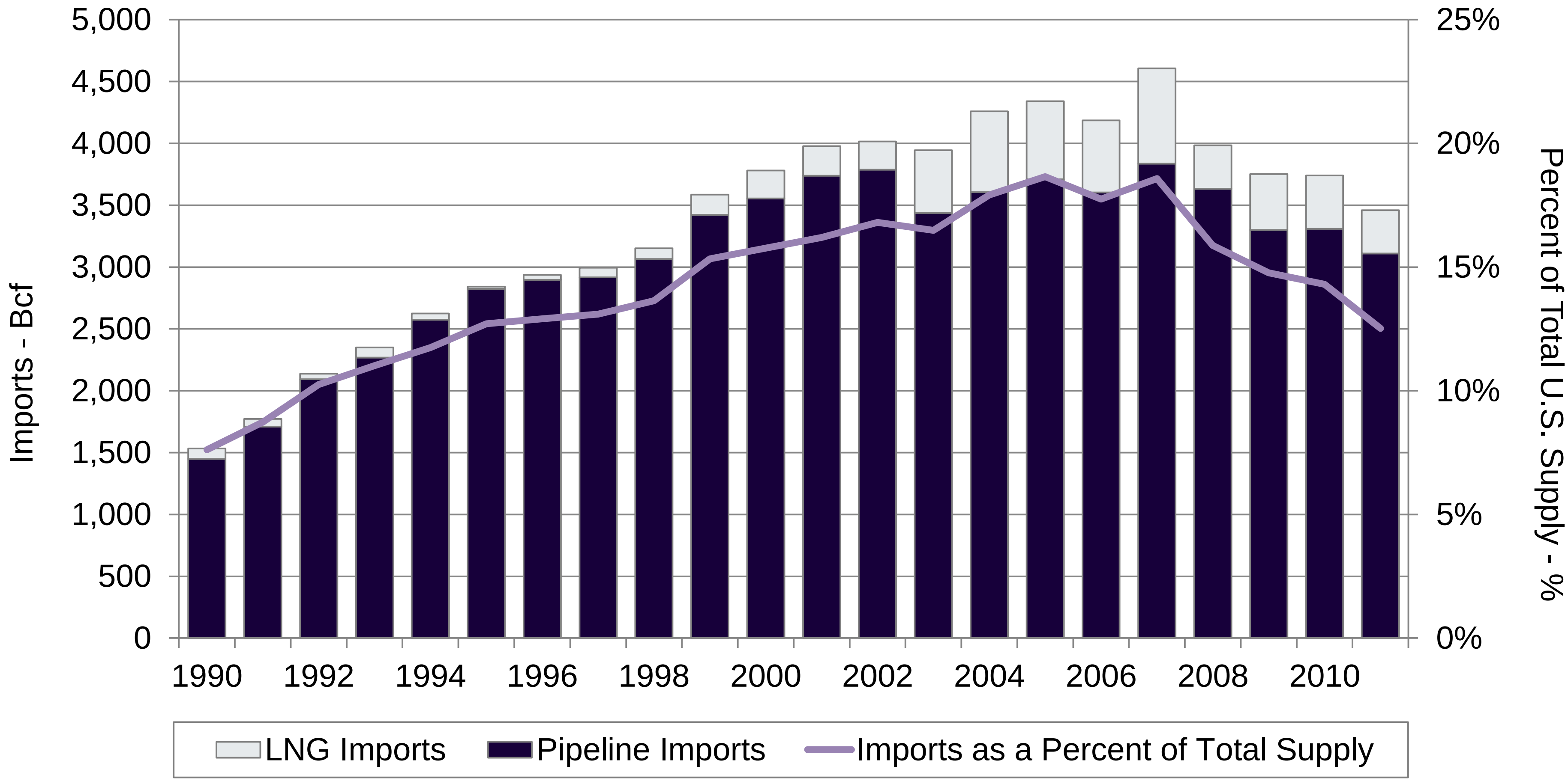
Current U.S. natural gas reserves are approaching record levels not seen since 1970. Natural gas production is at levels that surpass historic peaks.



Source: Energy Information Administration, U.S. Department of Energy

Natural Gas Imports

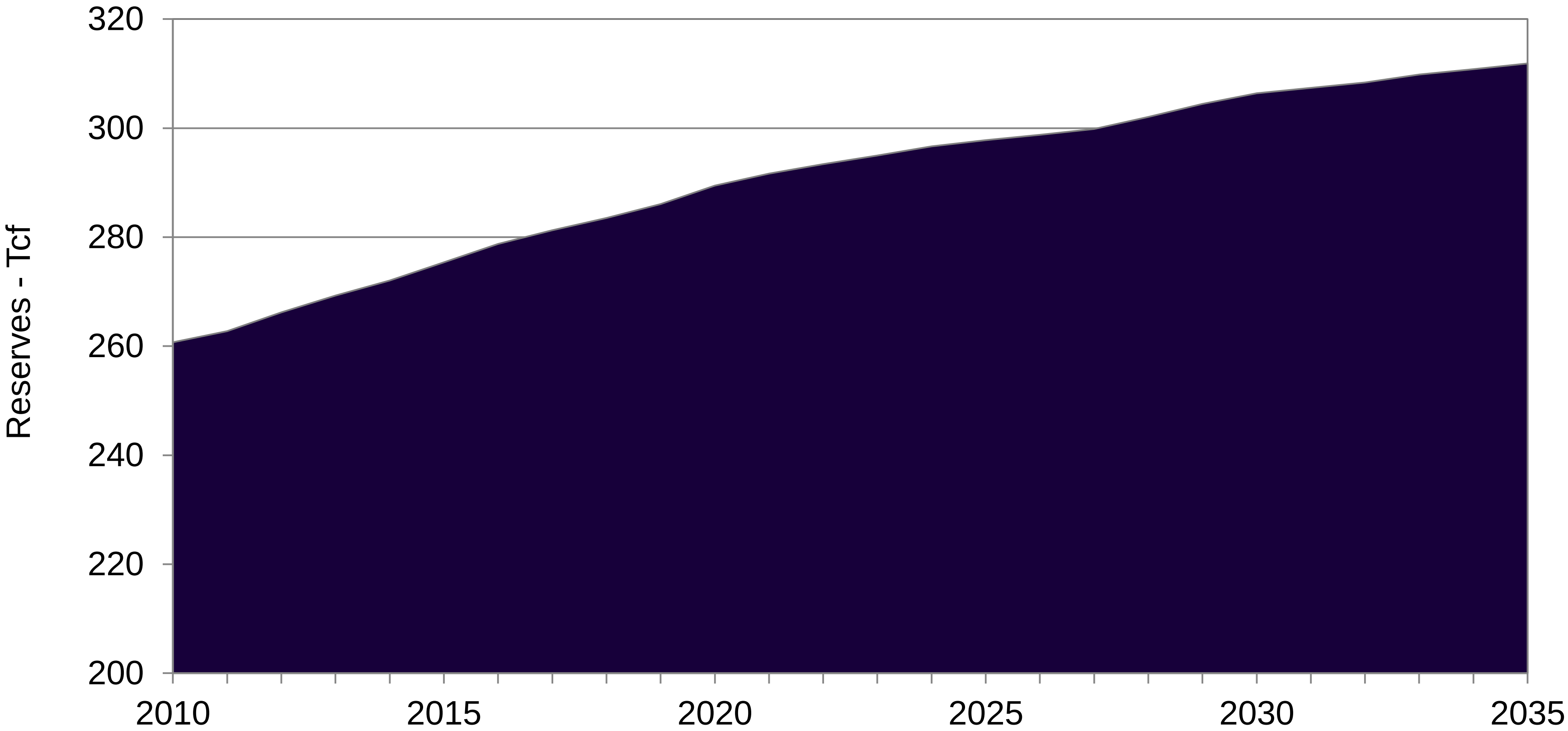
Natural gas imports, once thought the be the supply remedy for meeting future gas needs are falling to levels also not seen since the 1990s.



Source: Energy Information Administration, U.S. Department of Energy

Annual Energy Outlook, Natural Gas Reserves

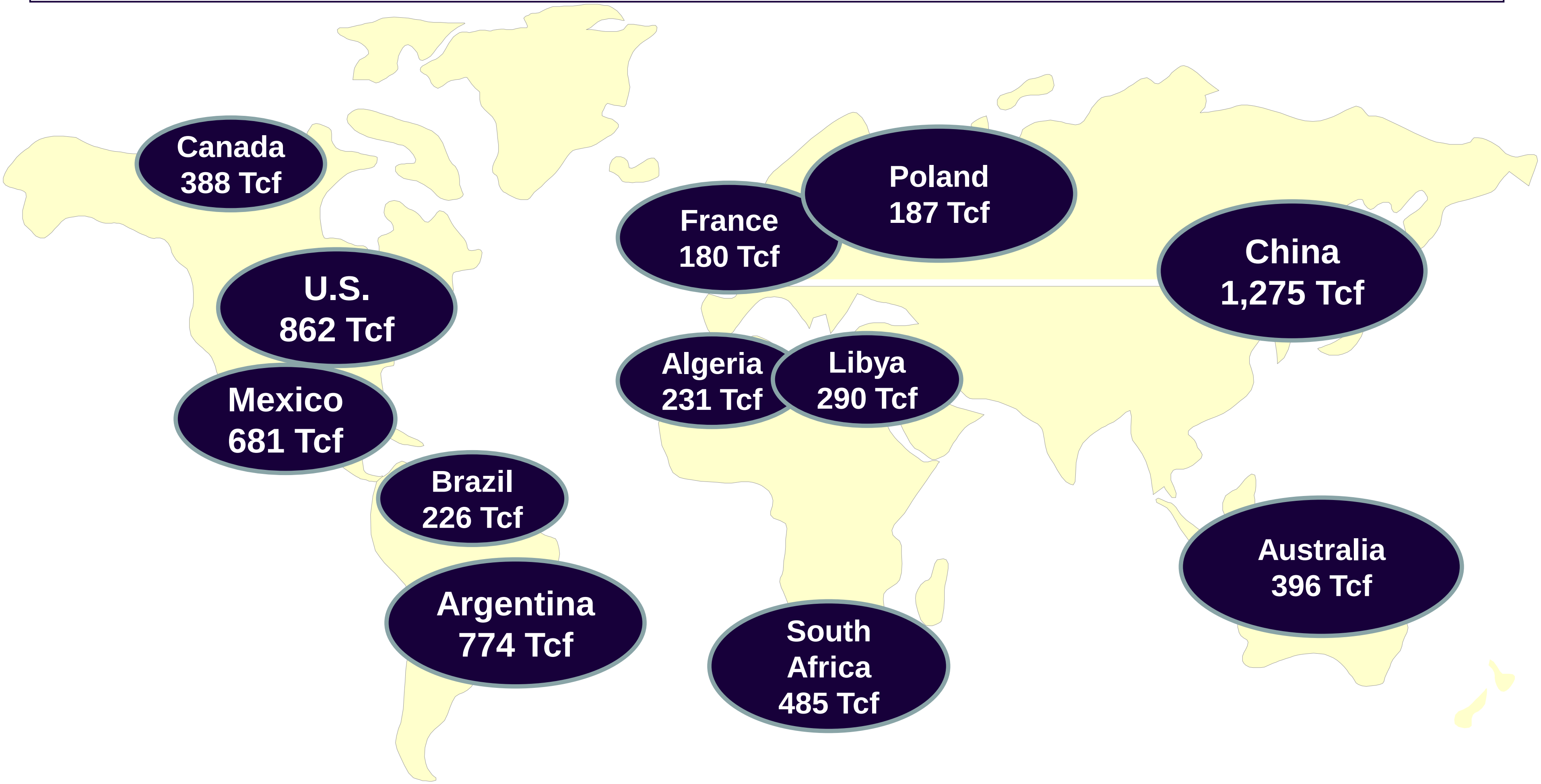
Unconventional resources are not a “flash in the pan” and are anticipated to continue to increase over the next two decades or more.



Source: Energy Information Administration, U.S. Department of Energy

Basin Competition

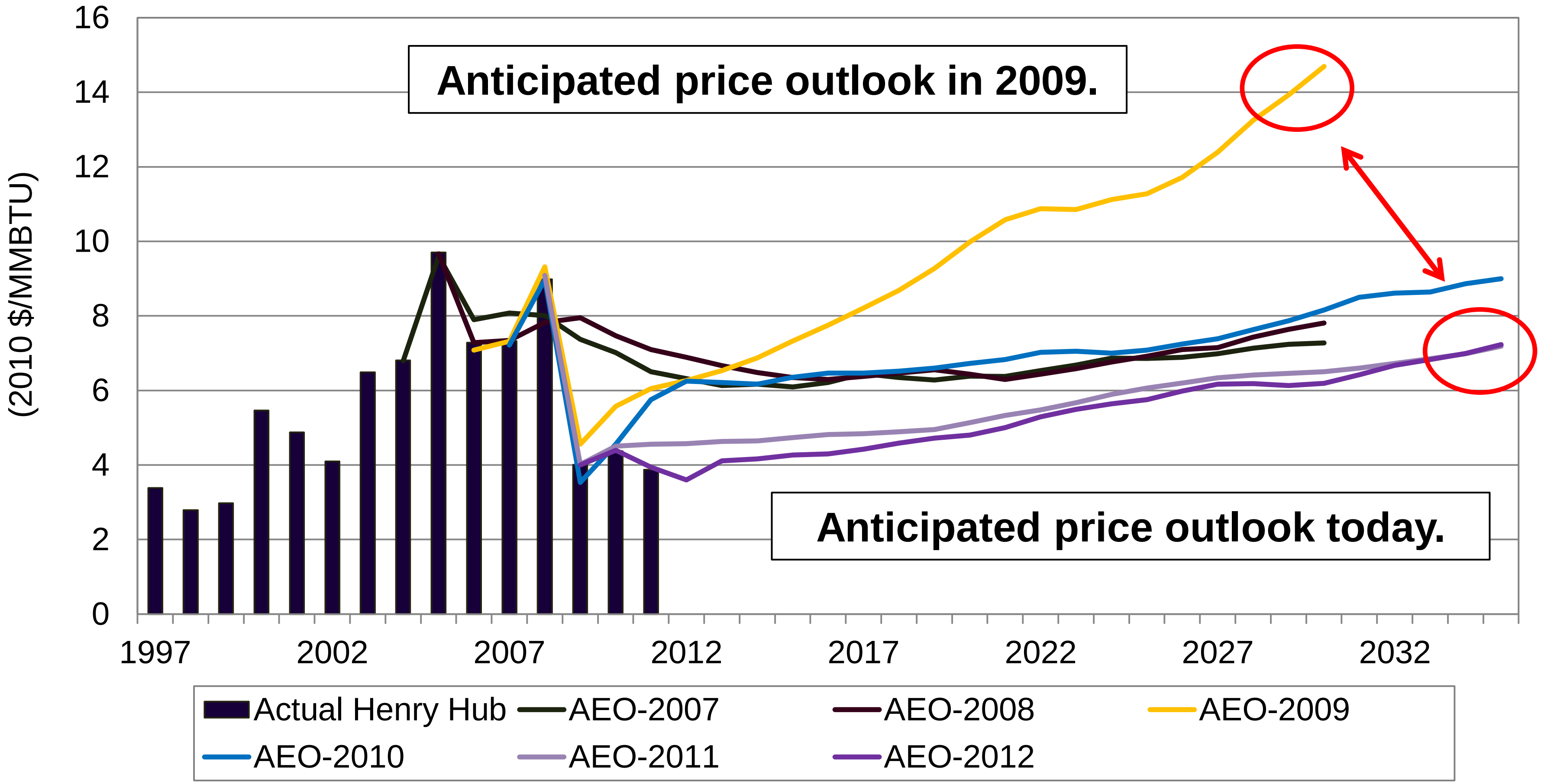
Close to 6,000 TCF of shale gas opportunities around the world. Coupled with 9,000 Tcf in conventional suggest a potentially solid resource base for many decades.



Source: MIT Energy Initiative.

Choosing Most Current Natural Gas Price Forecasts: AEO-2007 to AEO-2012

Shale availability has significant impact on future price outlook.



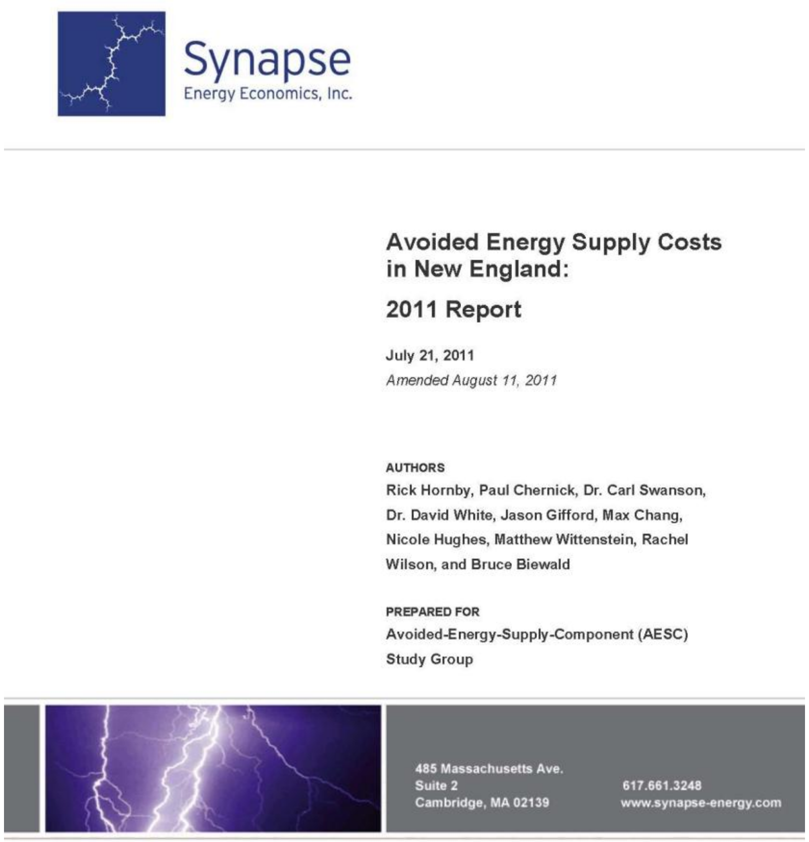
Source: Energy Information Administration, U.S. Department of Energy

Varying Industry Natural Gas Forecasts

Note: [1] As of May 31, 2012.
Source: Foster Natural Gas/Oil Report. Barclays Capital analysts: producer expectations of "very weak" gas prices in 2012, yet gas production will still manage to grow. March 9, 2012; Hargreaves, S. 2012. Heating homes with gas gets cheaper. CNNMoney.com. January 12, 2012; Holland, B. 2012. Pritchard cuts 2012 gas price forecast 25%. Electric Power Daily. January 19, 2012; and Natural Gas Week. Treadmill: little hope seen for corralling burgeoning gas supply. February 13, 2012 .

Natural Gas & Energy Costs

Choosing Most Current Natural Gas Price Forecasts


Synapse
Energy Economics, Inc.

Avoided Energy Supply Costs in New England:

2011 Report

July 21, 2011

Amended August 11, 2011

AUTHORS

Rick Hornby, Paul Chernick, Dr. Carl Swanson, Dr. David White, Jason Gifford, Max Chang, Nicole Hughes, Matthew Wittenstein, Rachel Wilson, and Bruce Biewald

PREPARED FOR

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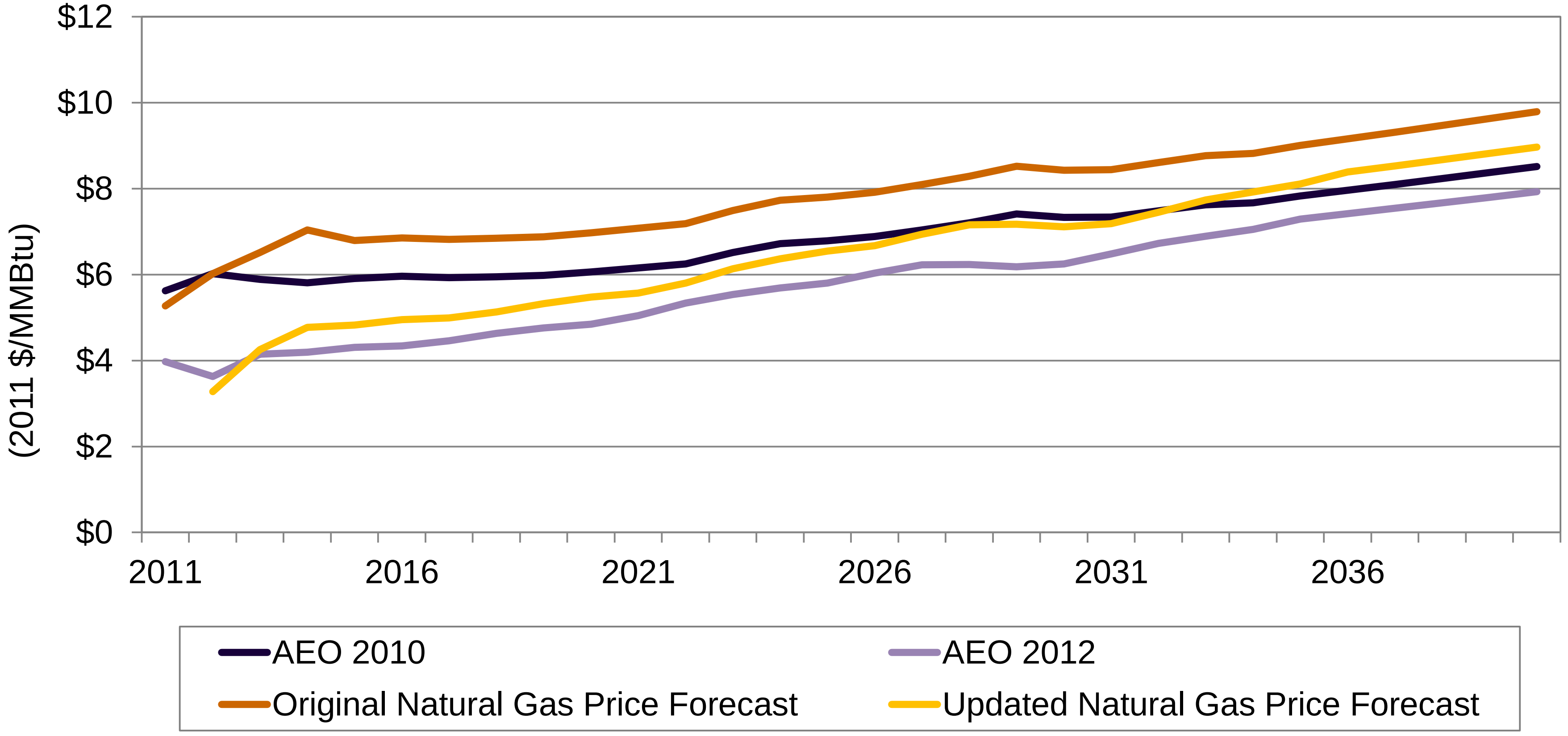
- 2011 Avoided Energy Supply Costs ("AESC")
  - Conducted on behalf of energy efficiency program administrators in New England.
- Assumes that EIA's AEO 2011 is "too optimistic" regarding shale gas production and utilizes "more conservative" numbers from AEO 2010.

Effect of Changing Realities on Forecasted Natural Gas Prices

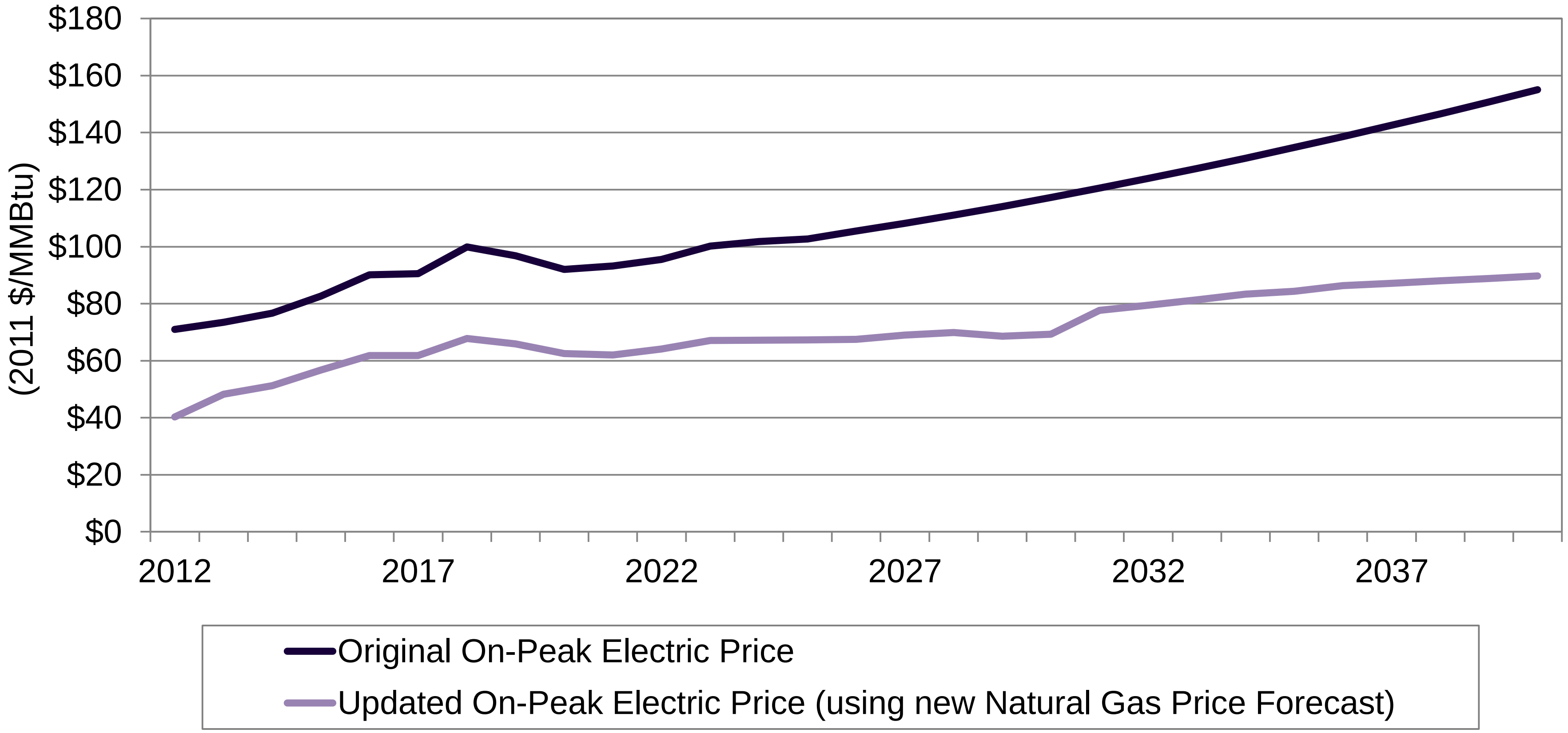
AESC uses "high cost" shale outlook (original fcst) and even update of this shows a wide near-term difference. 2016-2020 prices under "original forecast' are as much as 75 percent above AEO baseline.



Source: Avoided Energy Supply Cost, 2011 Report

Changing Forecasted Natural Gas Prices Impact on Electric Price

Updated forecasts can have a considerable impact on the forecasted avoided cost. Energy costs often account for a sizable share of overall avoided cost.



Source: Avoided Energy Supply Cost, 2011 Report

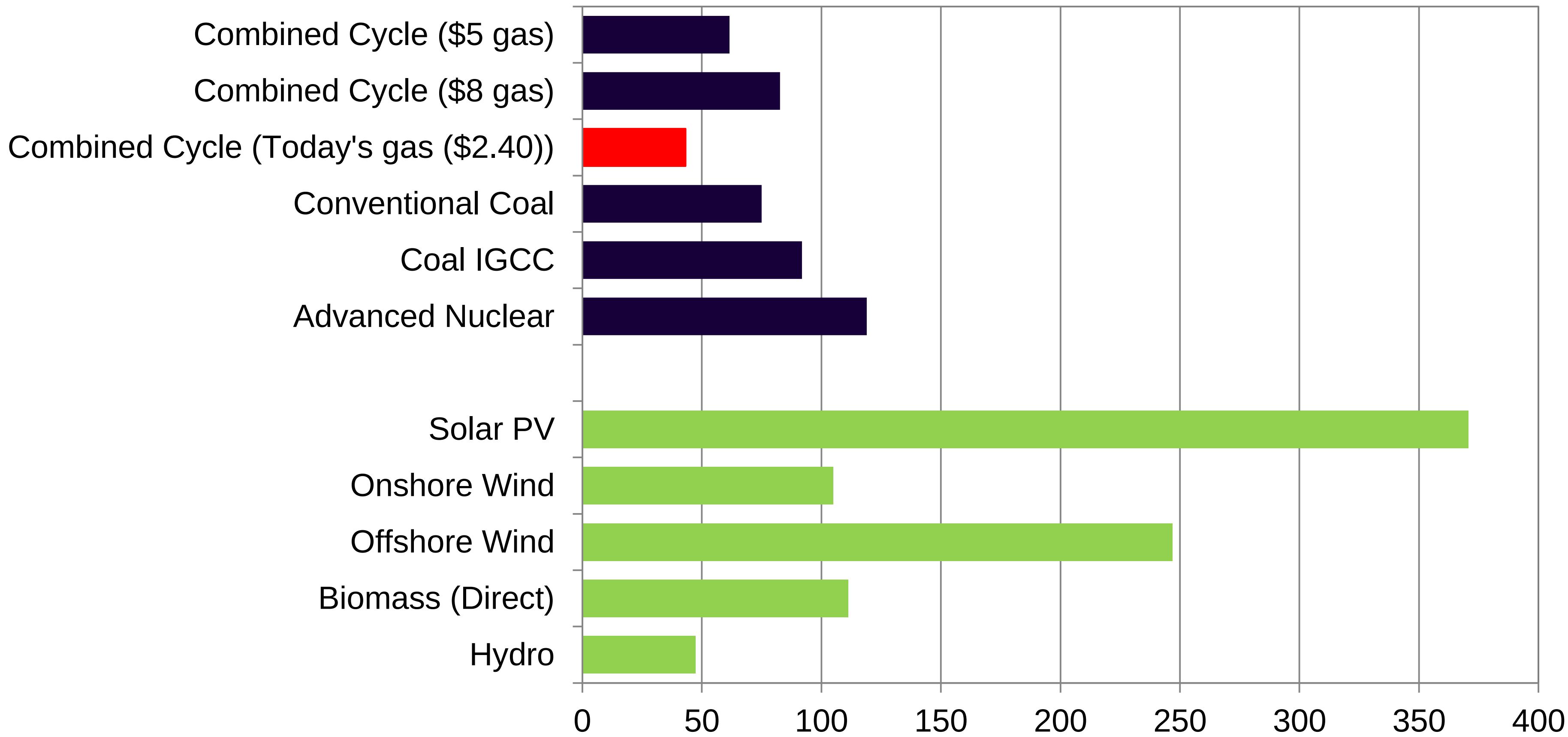
Capacity Prices

Estimation of Capacity Costs

- **Future capacity costs are a function of needed capacity.**
- **The tighter the (capacity) market, the more likely capacity prices will rise to incent the development of new capacity.**
- **Can be incentives to understate capacity requirements that would/could arise from (1) load growth (2) EPA-induced retirements (3) below-expected renewable capacity development.**
- **Natural gas price decreases drive down an already lower-capital cost investment, with higher operating efficiencies and lower emissions. This creates a large cost differential between natural gas based generation and all other generation technologies (renewables AND other fossil/nuclear).**

Levelized Cost of Generation

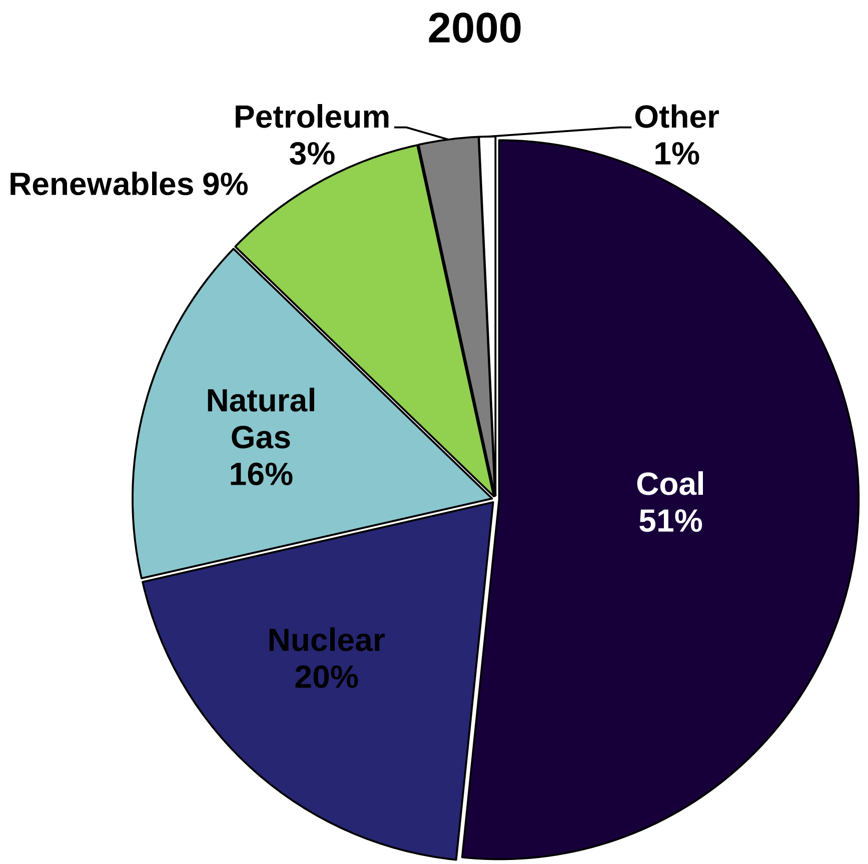
Lower gas prices move the levelized cost (and capacity cost) of the development of new, incremental capacity even lower.

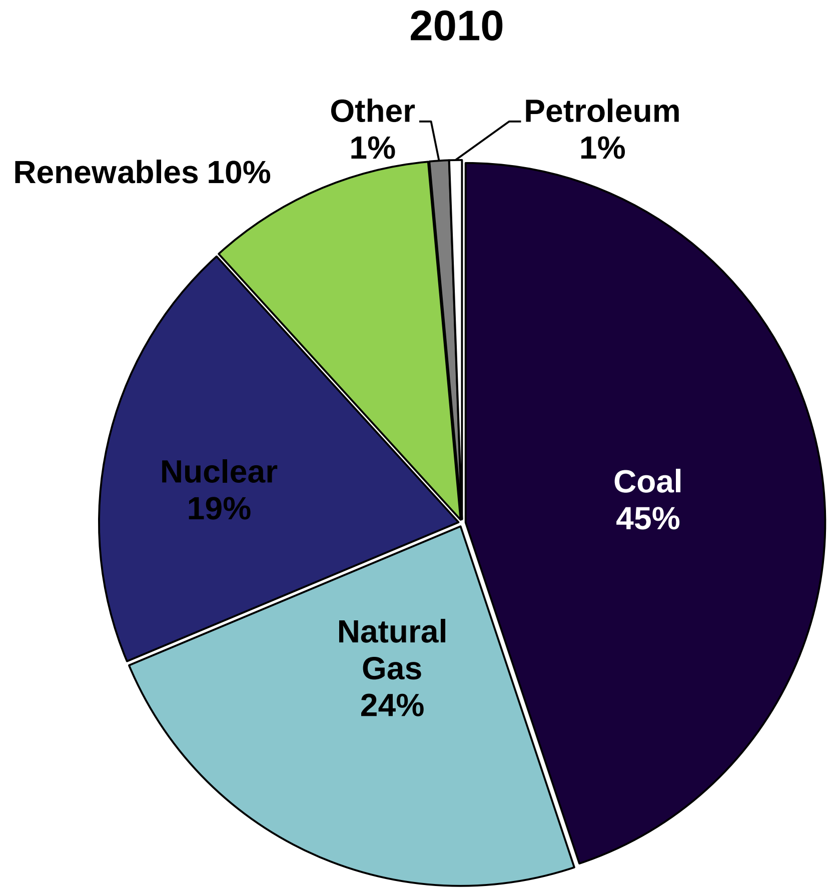


Source: U.S. Department of Energy, Energy Information Administration.

U.S. Power Generation – Fuel Mix

Over 250,000 MWs of natural gas power generation capacity has been added over the past decade at the expense of coal and nuclear. Gas will continue to be the marginal technology for a variety of reasons.





Source: Energy Information Administration, U.S. Department of Energy

Electric Industry Environmental Regulations Create Uncertainty for Coal

National Ambient Air Quality Standards (NAAQS)

- Sets acceptable levels for six criteria pollutants (carbon monoxide, lead, nitrogen dioxide, particulate matter, ozone, sulfur dioxide).
- A network of 4,000 State and Local Air Monitoring Stations is used to determine if geographic areas are meeting or exceeding the NAAQS.

Transport Rule (now CSAPR) [proposed]

- Issued to replace the Clean Air Interstate Rule (CAIR) and its predecessor the Clean Air Transport Rule ("CATR"). Requires 31 states (and D.C.) to improve air quality by reducing power plant emissions (SO2 and NOX) that contribute to ozone and fine particulate pollution in other states (some annual, some on ozone season only).
- By 2014, the rule and other state and EPA actions would reduce power plant SO2 emissions by 80% over 2005 levels. Power plant NOx emissions would drop by 58%.

Utility Maximum Achievable Control Technology (MACT) [to be proposed]

- EPA must set emission limits for hazardous air pollutants. The rule is expected to replace the Clean Air Mercury Rule (CAMR) and add standards for lead, arsenic, acid gases, dioxins and furans.

Coal Combustion Residuals (CCR) [proposed]

- Would establish, for the first time under the Resource Conservation and Recovery Act (RCRA) requirements for the proper disposal of coal ash generated by coal combustion at electric power plants.

Power Plant Cooling Water Intake Structures Rule

- Section 316(b) of the Clean Water Act is intended to address environmental impacts from cooling water intake to and discharge from power plant cooling systems. Requires that the location, design, construction and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact.

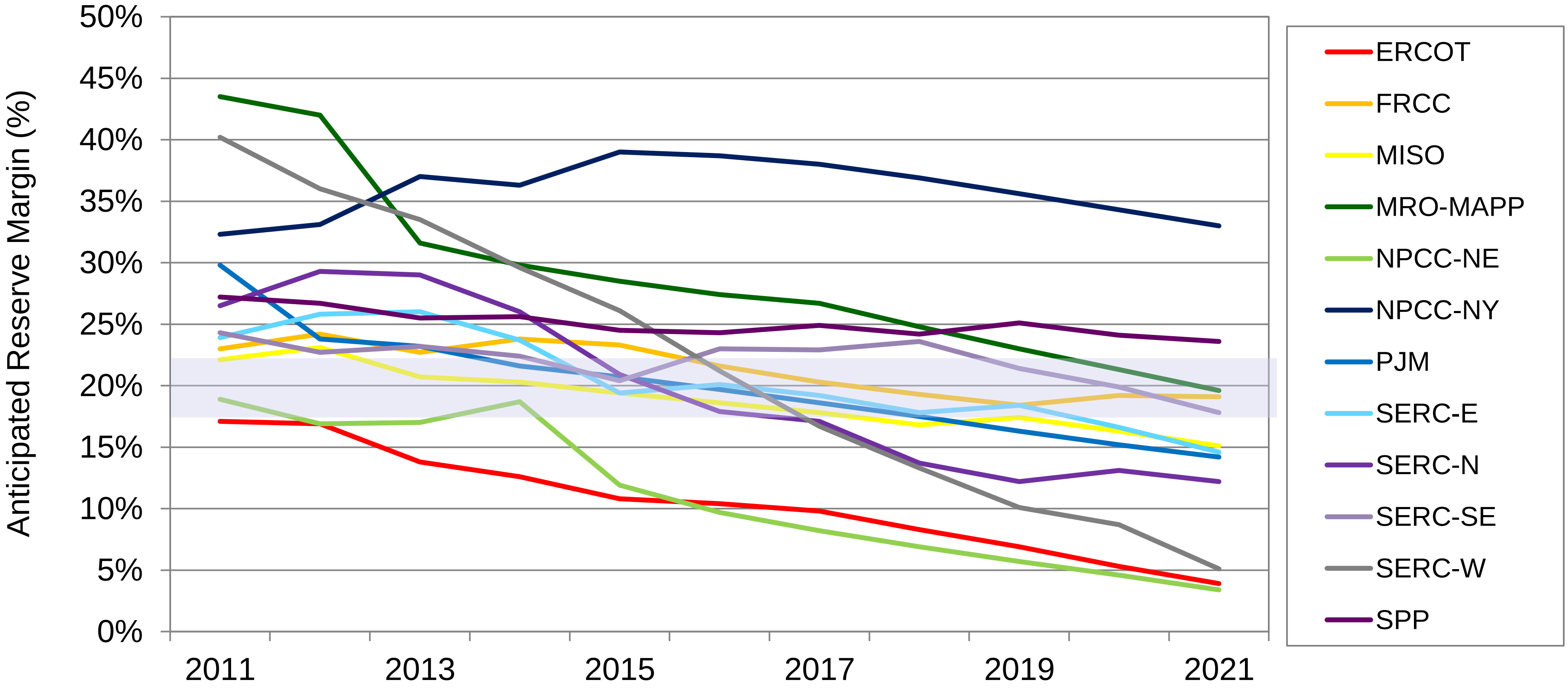
Summary of Retirement Studies Related to EPA Rules

Study	Retired Capacity	Regulation Requirements
NERC (October 2010)	47 to 76 GW by 2018 (total fossil fuel capacity, including oil and gas)	Levelized costs (@2008 CF) after retrofitting each unit for the environmental regulations compared to the cost of a new gas-fired unit. Scenario 1 - Transport Rule Scenario 2 - Transport Rule, MACT Scenario 3 - Transport Rule, MACT, 316(b) Cooling Water, Coal Ash
ICF/IEE (May 2010)	25 to 60 GW by 2015	Cost of retrofitting coal plant compared to cost of new gas CC Scenario 1 - Transport Rule, MACT Scenario 2 - Transport Rule, MACT, CWA 316(b)
Brattle Group (December 2010)	50 to 65 GW by 2020	Regulated Units - 15-year present value of costs > replacement power from a CC or CT. Merchant unit - 15-year present value of cost > revenues from energy and capacity markets. Transport Rule, MACT, 316(b) Cooling Water, Coal Ash
Credit Suisse (September 2010)	60 GW	Size and existing controls Transport Rule, MACT
Charles River Associates (December 2010)	39 GW by 2015	In-house model (NEEMS) optimizing costs of existing capacity and costs of potential new capacity. Transport Rule, MACT
MJ Bradley (August 2010)	30 to 40 GW	Switch to lower sulfur coal, install emission controls, or retire Transport Rule, MACT
Bernstein Research (October 2010)	51 GW	FGS + emissions on all coal fired units by 2015 Transport Rule, MACT

Source: Synapse Energy Economics, Inc., “Public Policy Impacts on Transmission Planning, Prepared for Earthjustice”, December 10, 2010; and “Miller, P. A Primer on Pending Environmental Regulations and their Potential Impacts on Electric System Reliability. Working Draft, JD Northeast States for Coordinated Air Use Management. January 24, 2011.

Anticipated Planning Reserve Margins

Most areas of the country are anticipated future reserve margins blow those typically utilized for planning purposes.



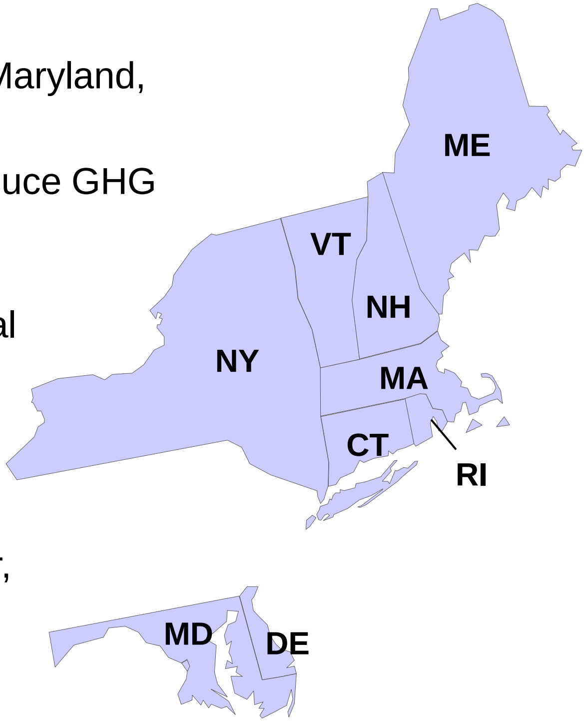
Source: NERC 2011 Long-Term Reliability Assessment

Changes in Environmental and Renewable Energy Costs

CO_2 Emissions in RGGI States

Regional Greenhouse Gas Initiative, Inc. (RGGI, Inc.) is a 501(c)(3) non-profit corporation created to support development and implementation of the Regional Greenhouse Gas Initiative (RGGI).

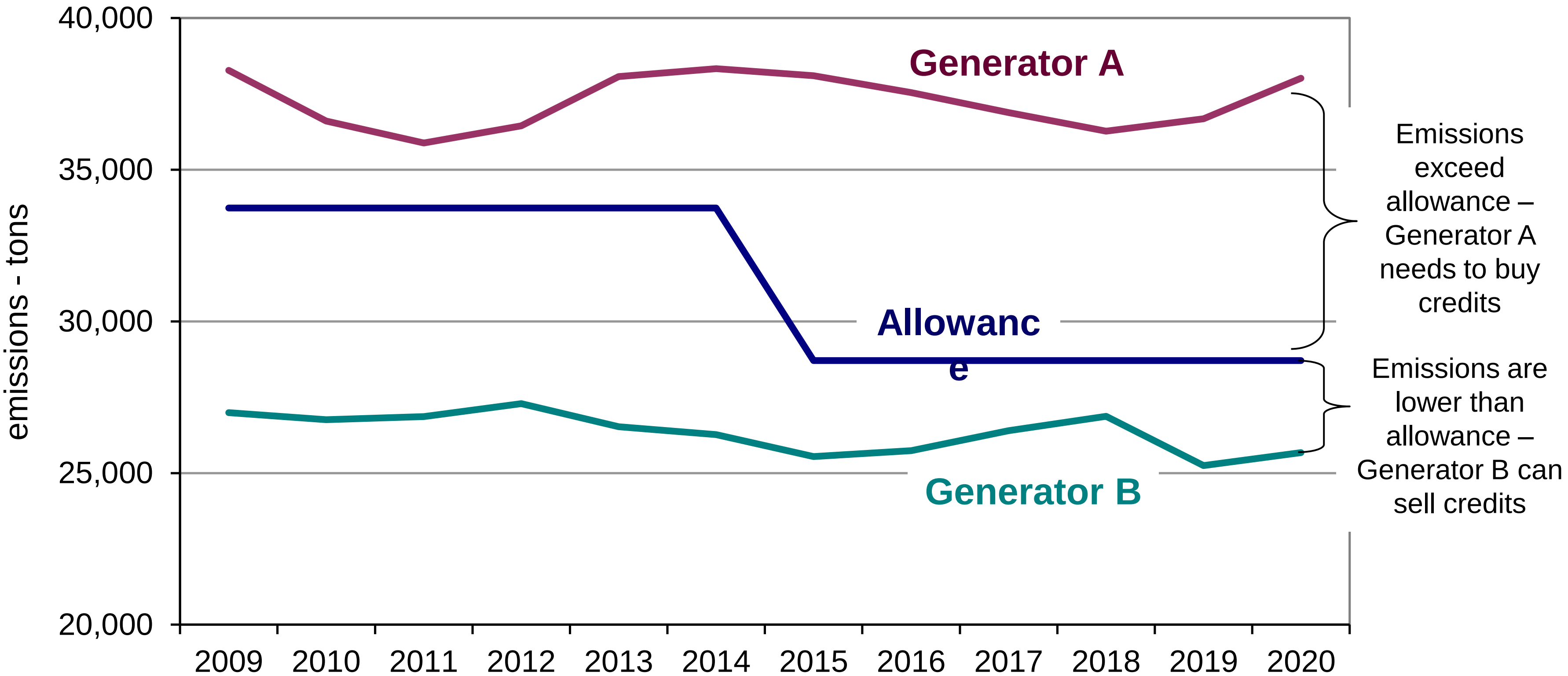
- A cooperative effort among nine states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island and Vermont.[1]
- Started in 2008 and was the first market-based regulatory program to reduce GHG emissions in the U.S.
- Establishes a regional cap on carbon dioxide (CO_2) emissions from the power sector and requires power plants to possess CO_2 allowances equal to their CO_2 emissions over each three-year control period..
- The regional CO_2 emission cap comprises the sum of each RGGI participating state's annual CO_2 allowance budget. For the first six years of the program (2009-2014) the emission cap is 188 million short tons of CO_2 per year. Beginning in 2015, the cap will decrease by 2.5% per year, such that it will be 10% lower by the end of 2018.
- Recent reports have deemed the program a success and estimate that the program has already created $1.6 billion in economic value, could lead to $1.1 billion in ratepayer savings, and states participating in the program have seen a 20 percent greater reduction in per-capita CO_2 emissions than non-RGGI states.



Note: [1] New Jersey was also an original member state but withdrew from the RGGI program in 2011.
Source: RGGI.org

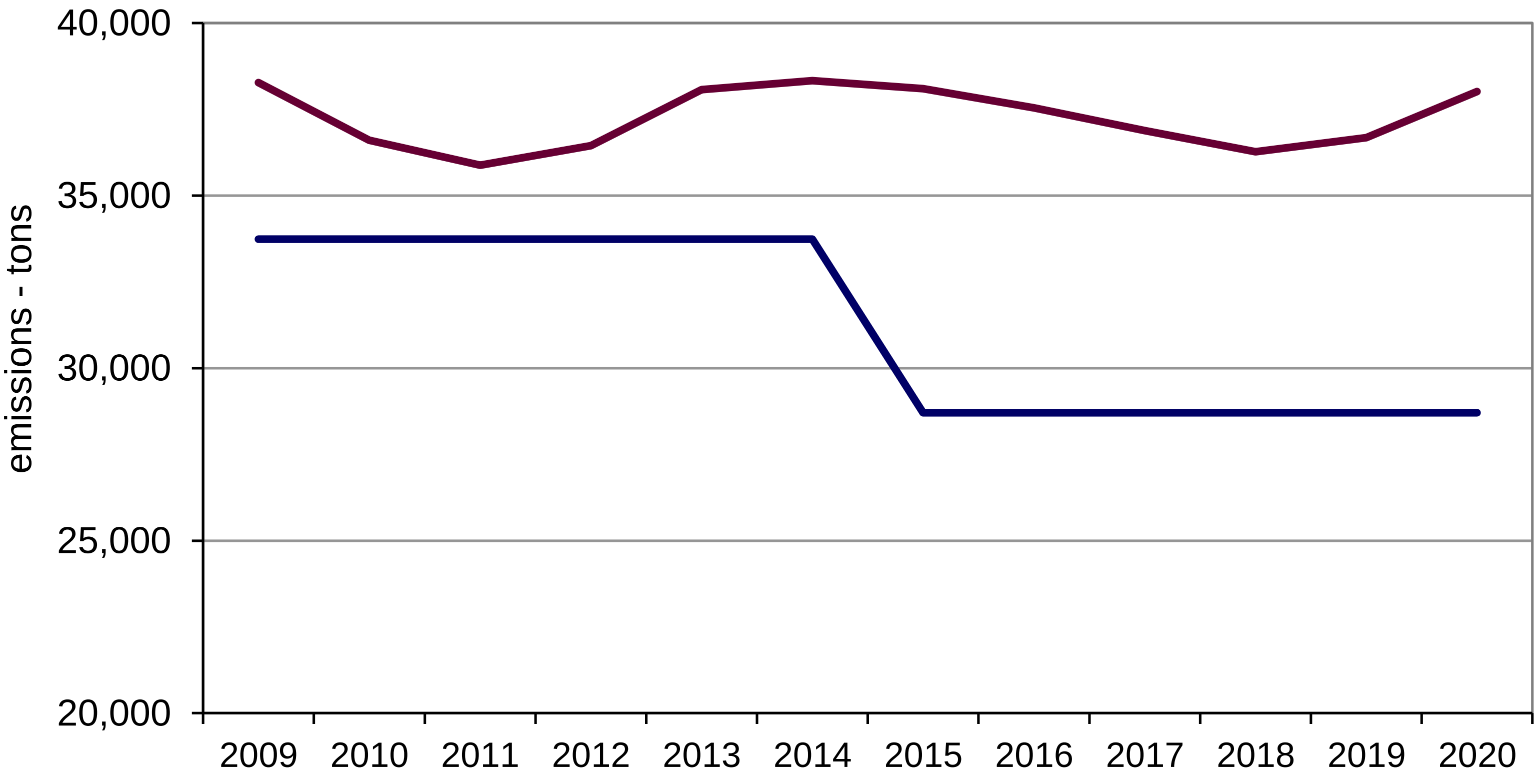
How Does Cap & Trade Work?

Simply speaking, sources "long" on credits will trade with those that are "short."



How Does Cap & Trade Improve Overall Emissions?

Framework creates "scarcity" because the initial regulatory "design" is intentionally "short" in the aggregate. More stringent caps result in more expensive mitigation costs (higher marginal credit prices), other things equal.



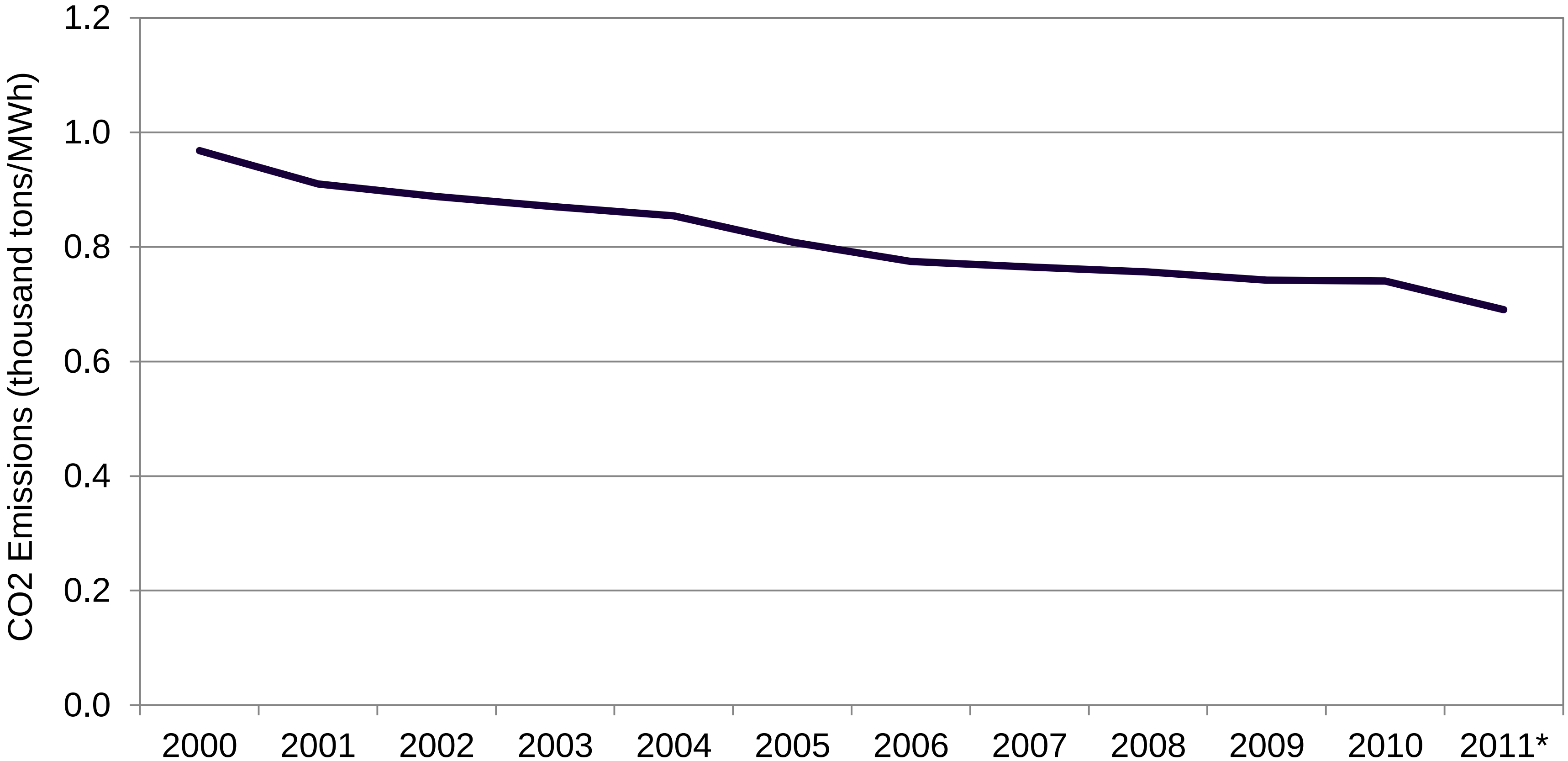
Emissions exceed allowance – Shortfall must be made up from:

(1) credit purchases from those facilities individually long ; and/or

(2) capital investments to lower emissions profile.

CO_2 Emissions in RGGI States

RGGI states have seen dramatic decreases in carbon emissions since 2000. Today, the CO2 emissions rate is about 29 percent lower than a decade ago.



Source: U.S. Environmental Protection Agency, Accessed at: http://camddataandmaps.epa.gov/gdm/.

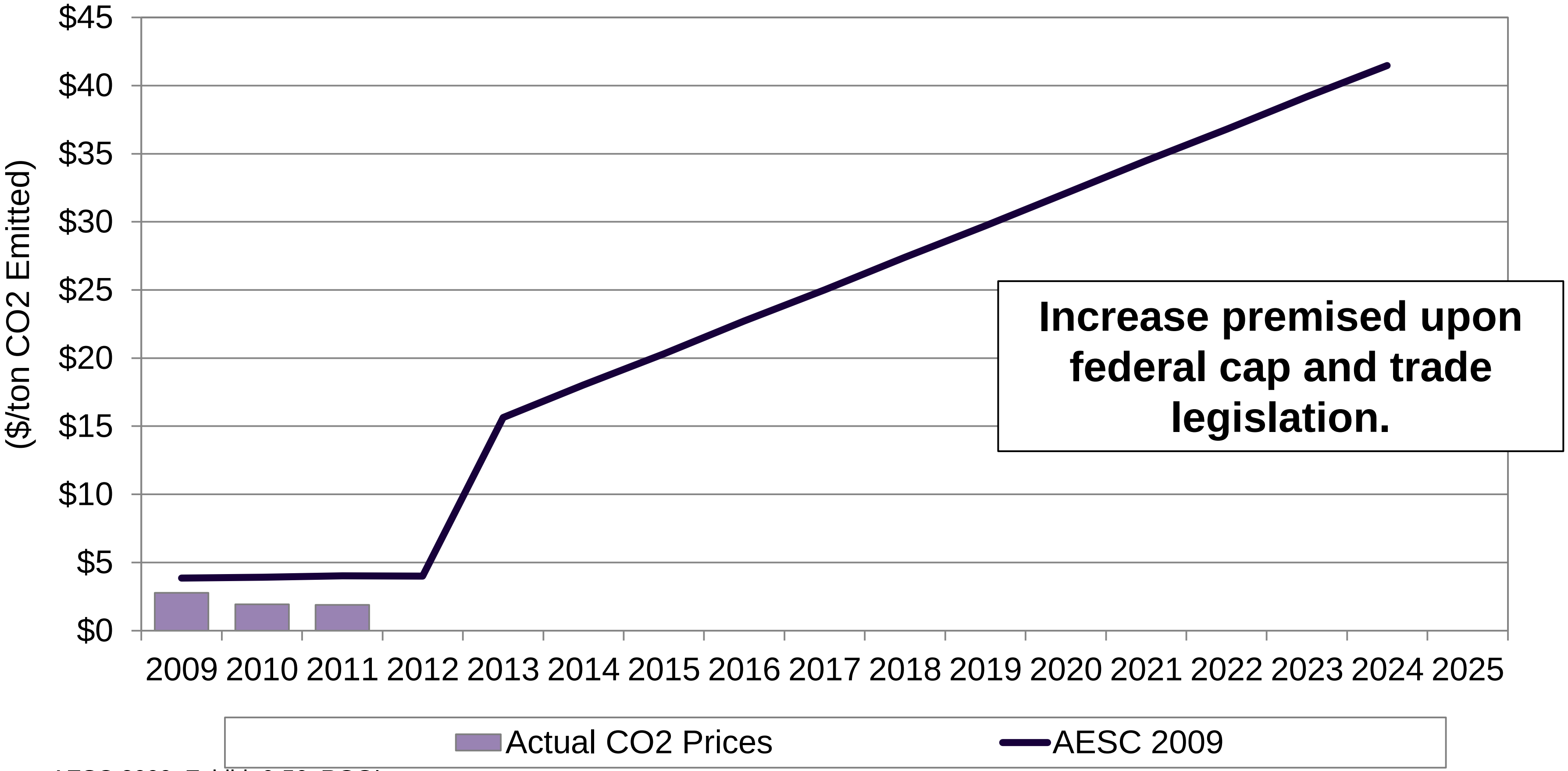
RGGI Auction Results, Quantities and Price

The Regional Greenhouse Gas Initiative is the only existing cap and trade market for CO_2 in North America. Prices have been stable, but recent auctions have seen falling volumes.

Source: Regional Greenhouse Gas Initiative, Inc., Accessed at: http://www.rggi.org/market/co2_auctions/results.

CO_2 Prices – AESC 2009 and RGGI Actual

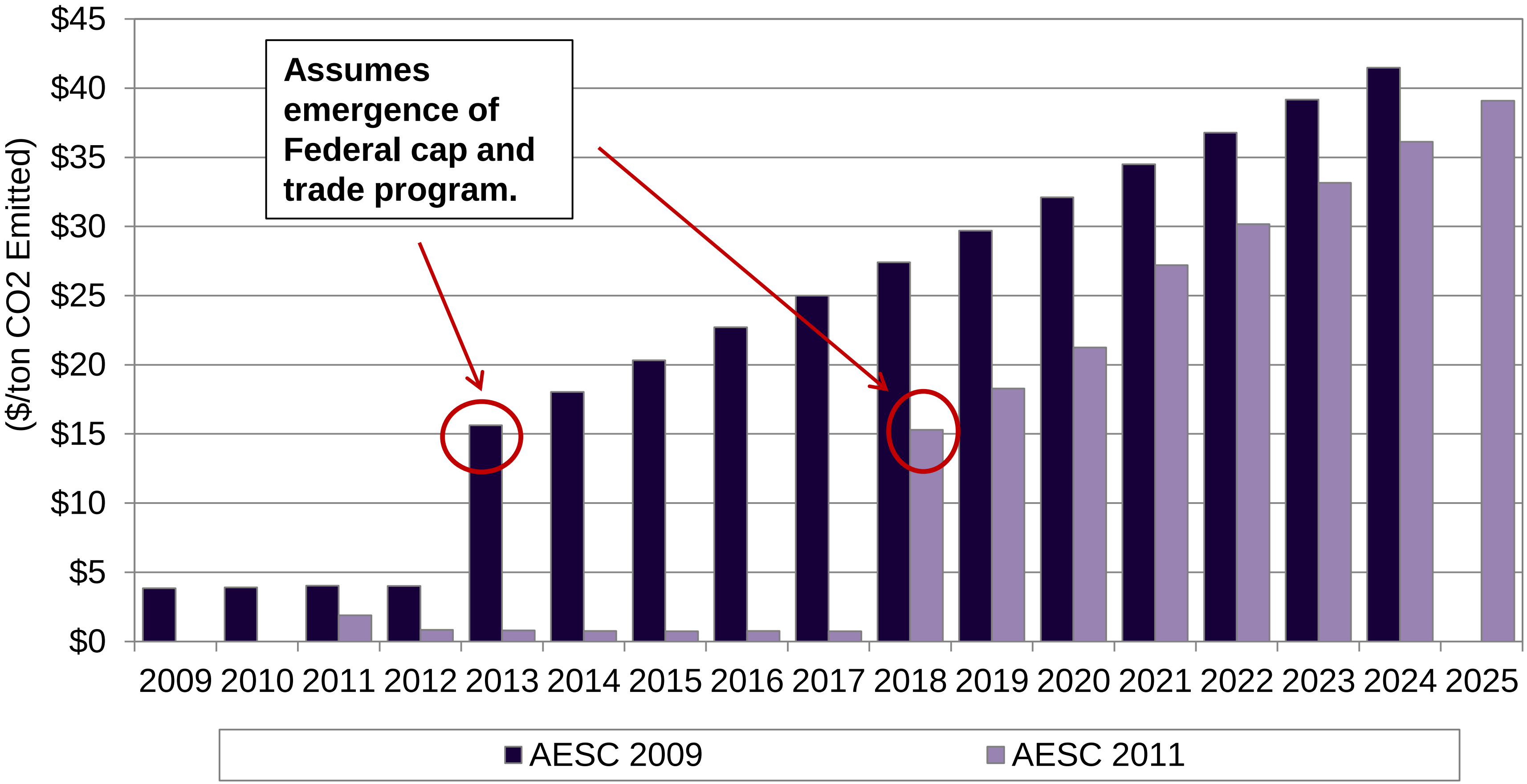
Important to tie projected environmental cost to reality. The AESC here assumes a significant increase in future carbon prices from levels currently at $5 per ton, to over $40 per ton. NOTE: this is on a tradable market basis – is not an "externality" since it is an internal cost – "externalities" would be in addition to these "known" credit prices.



Source: AESC 2009, Exhibit 6-56; RGGI.

CO_2 Externality Value – AESC 2009 and AESC 2011

Comparing prior to current AESC shows impact and timing of federal carbon regulation assumptions.



Source: AESC 2009, Exhibit 6-56; AESC 2011, Exhibit 6-57.

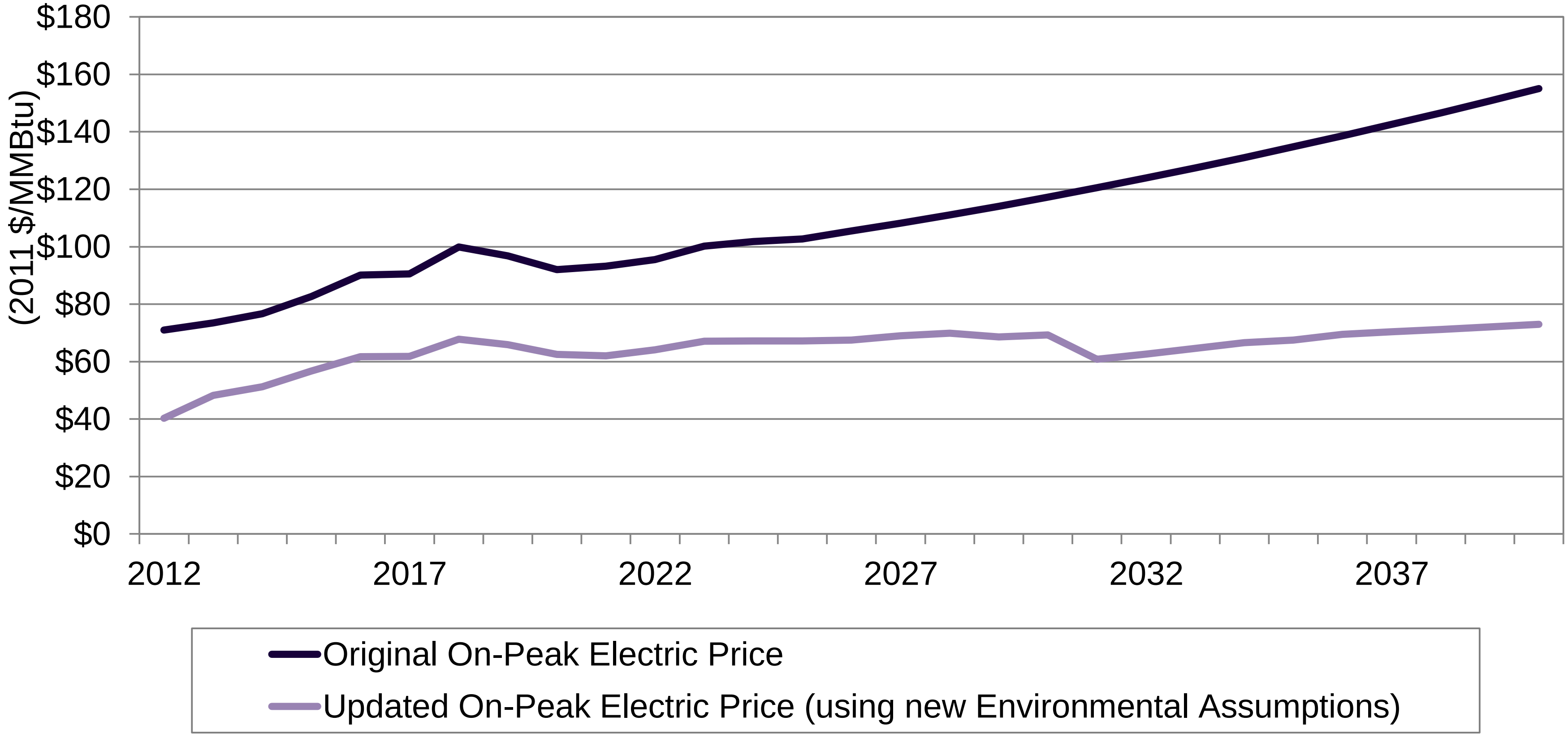
Federal CO_2 Cap and Trade Legislation

	Bill No.	Legislation Name	Sponsers	Date Introduced	Result
111th Congress (2008-2010)	-	American Power Act (APA)	Senators Kerry and Lieberman	May 12, 2010	No Finalized Bill Drafted
	H.R. 2454	American Clean Energy and Security (ACES) Act	Representative Waxman and Markey	March 1, 2009	Died After Passing House of Representatives
110th Congress (2006-2008)	S. 3036	Lieberman-Warner Climate Security Act of 2008	Senators Boxer, Lieberman, and Warner		Did not pass Full Senate vote
	S. 1176	Low Carbon Economy Act	Senators Bingaman and Spector	July 11, 2007	Died without vote
	S. 485	Global Warming Reduction Act	Senators Kerry and Snowe	February 1, 2007	Died without vote
	S. 309	Global Warming Pollution Reduction Act	Senators Sanders and Boxer	January 16, 2007	Died without vote
	S. 280	Climate Stewardship and Innovation Act	Senators McCain and Lieberman	January 12, 2007	Died without vote
	H.R. 6316	Climate Matters Act of 2008	Representative Doggett	June 19, 2008	Died without vote
	H.R. 6186	Investing in Climate Action and Protection Act (iCAP Act)	Representative Markey	June 4, 2008	Died without vote
	H.R. 1590	Safe Climate Act of 2007	Representative Waxman	March 20, 2007	Died without vote
	H.R. 620	Climate Stewardship Act	Representatives Olver and Gilchrest	January 22, 2007	Died without vote

Source: Pew Center on Global Climate Change

Changing Forecasted Environmental Costs Impact on Electric Price

Below updates avoided cost estimate for changing outlook for natural gas prices AND tradable environmental credits. Overall, the impact of tradable allowances on total costs are not sizable, unless, some additional "externality" value is added.

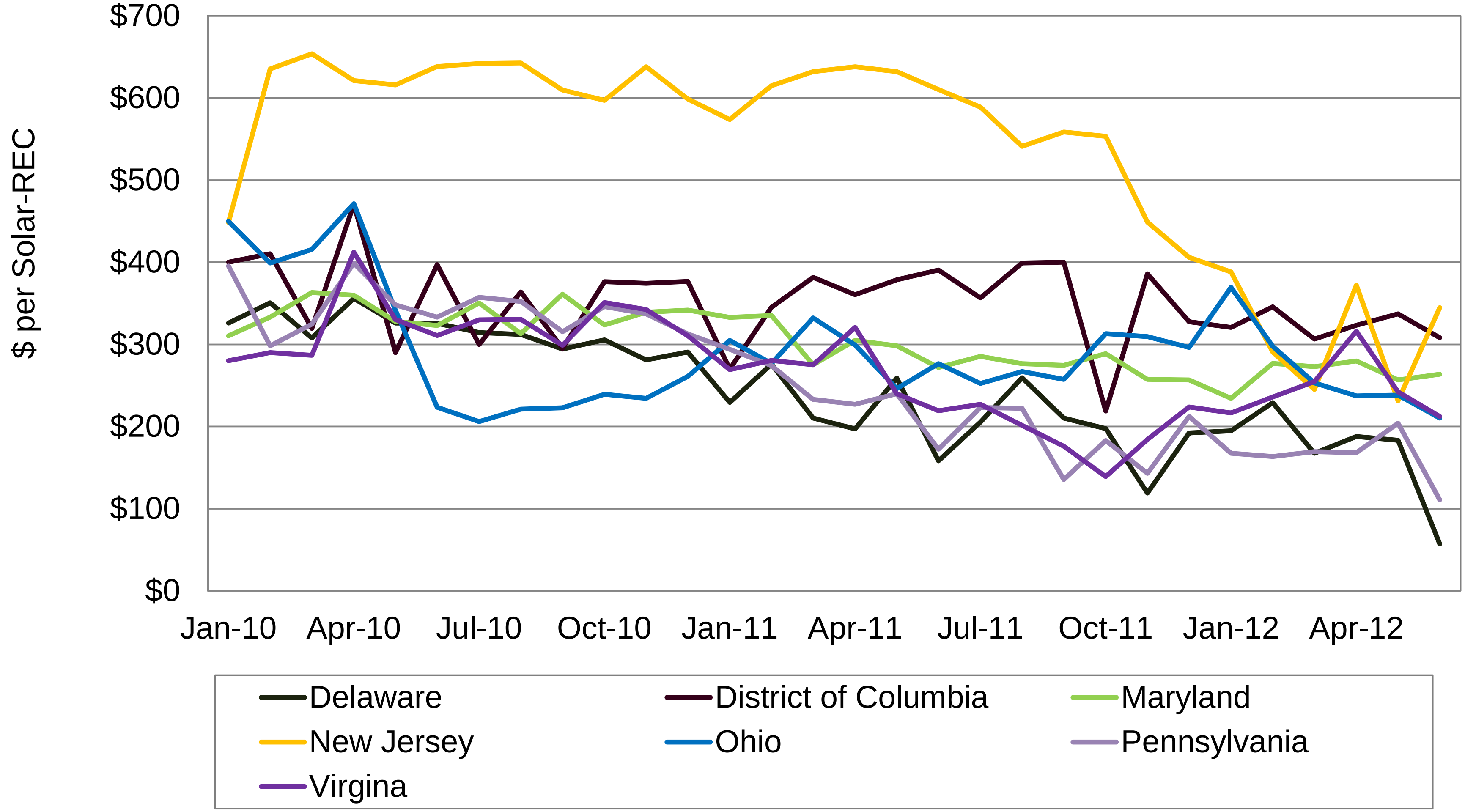


Source: Avoided Energy Supply Cost, 2011 Report

Renewables

Cost of Solar Renewable Energy Credits through PJM-GATS

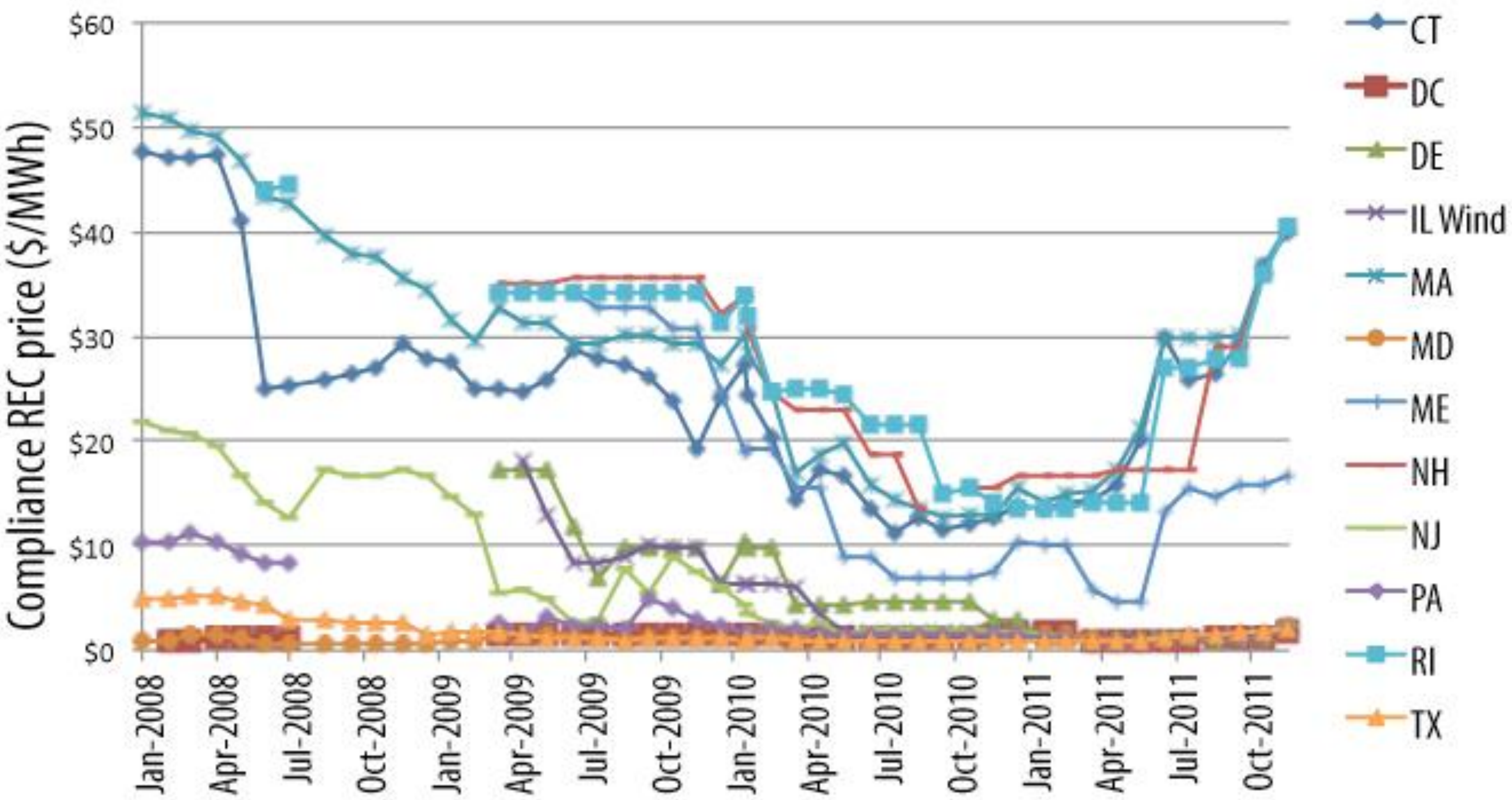
Solar energy costs (SRECs) have decreased considerably over the past year, even in high priced states such as New Jersey.



Source: PJM-GATS

Cost of Non-Solar Renewable Energy Credits

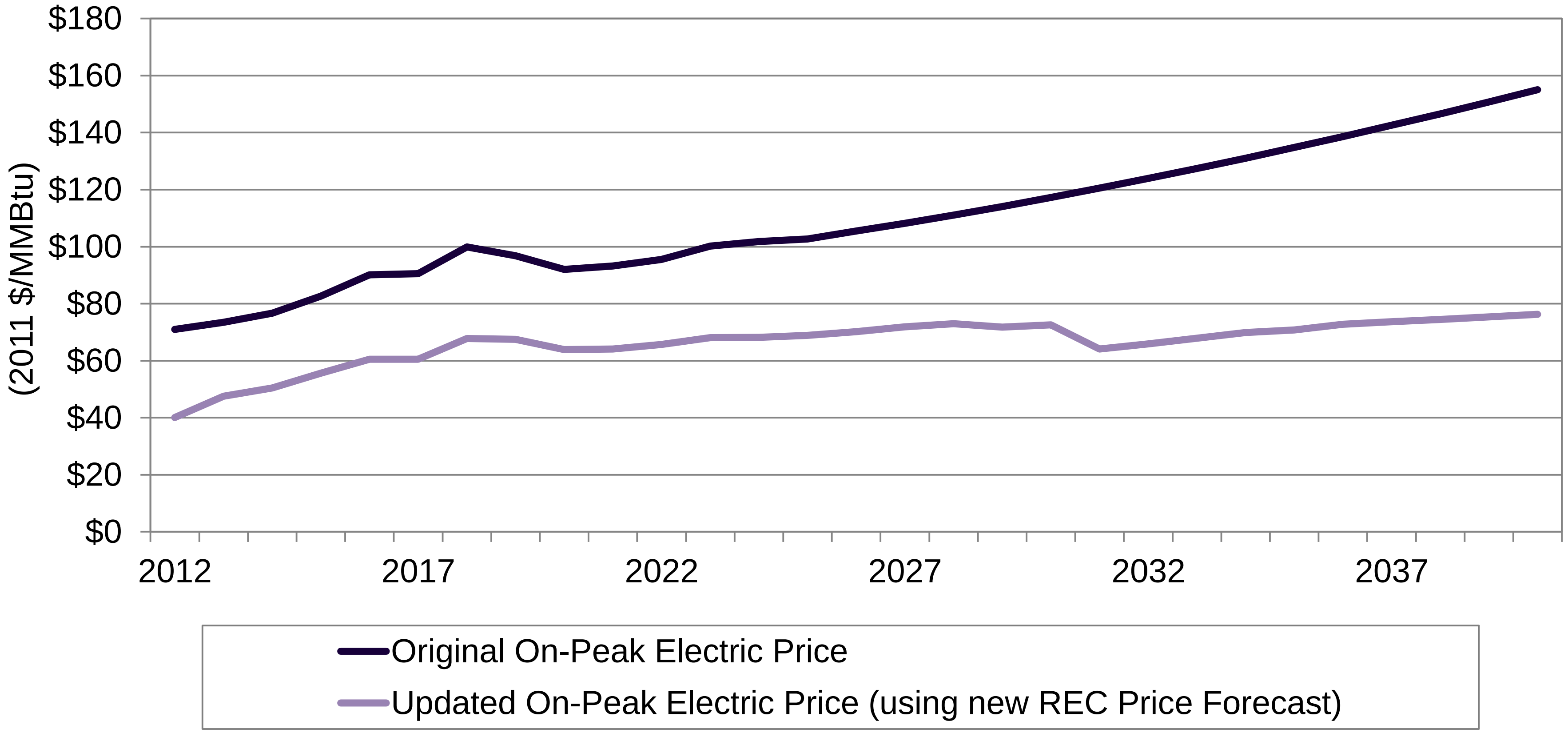
Class 1 RECs have also seen considerable price decreases although there has been some rebounding in the past year.



Source: Energy Efficiency & Renewable Energy Division, U.S. Department of Energy; Citing Spectron Group
Accessed at: http://apps3.eere.energy.gov/greenpower/markets/certificates.shtml?page=5

Changing Forecasted REC Prices Impact on Electric Price

REC prices are avoidable costs that can be credited to avoided cost if used for energy efficiency cost effectiveness analysis.



Source: Avoided Energy Supply Cost, 2011 Report

Conclusion

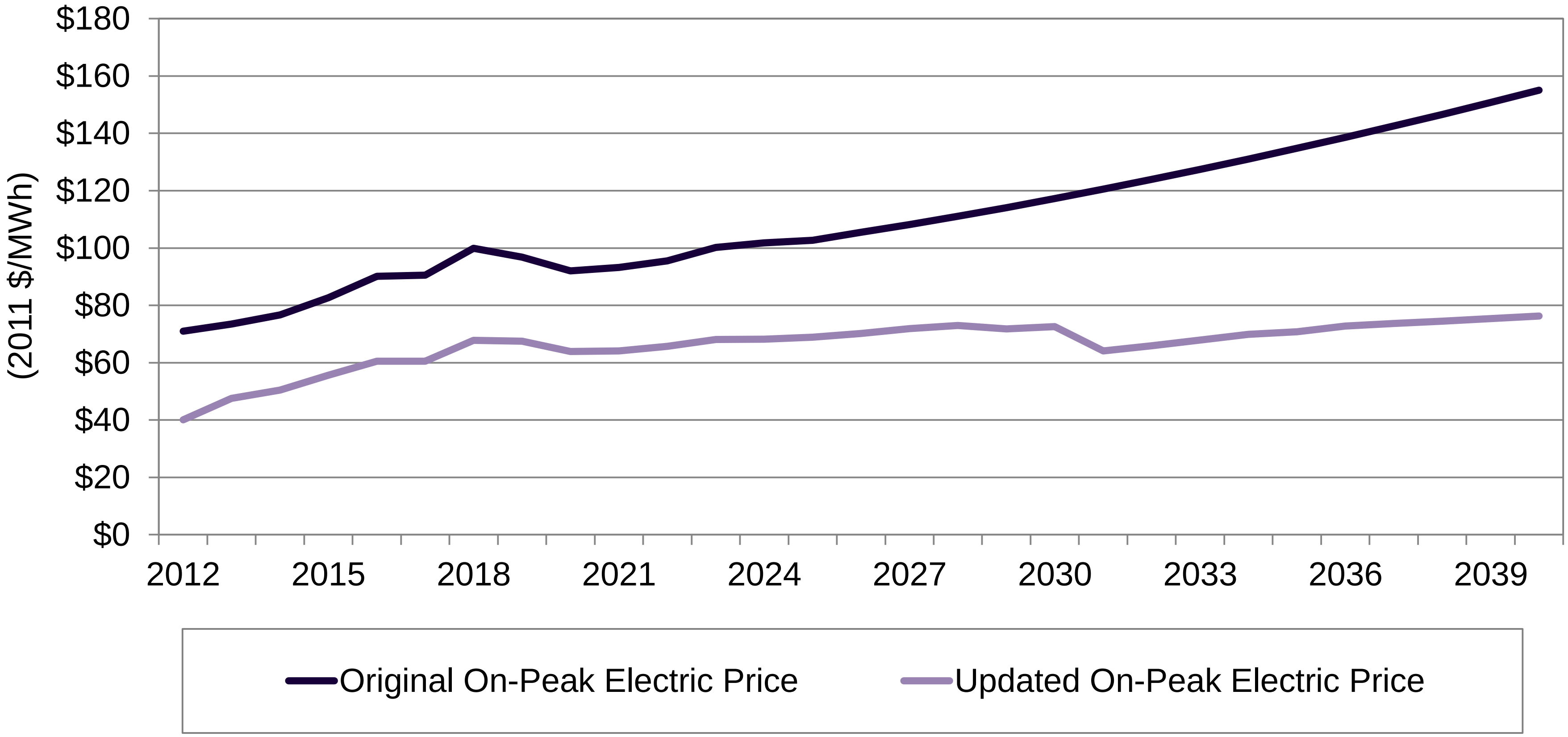
Effect of Changing Realities on Estimates of Avoided Electrical Prices

		Winter		Summer	
		Estimated 2040 On-Peak Electric Price ($2011/MWh)	Estimated 2040 Off-Peak Electric Price ($2011/MWh)	Estimated 2040 On-Peak Electric Price ($2011/MWh)	Estimated 2040 Off-Peak Electric Price ($2011/MWh)
Original AESC 2011 Estimate	**(A)**	$141	$115	$155	$120
'A' with Natural Gas Price Forecasts Updated to Reflect More Recent AEO Projections	**(B)**	$82	$69	$90	$71
'B' Modified to Reflect Current Environmental Policy Understanding	**(C)**	$66	$52	$73	$55
'C' Modified to Reflect Current REC Prices	**(D)**	$69	$56	$76	$58
Total Effect 'A' to 'D'		**-51.08%**	**-51.67%**	**-50.83%**	**-51.55%**

Source: Avoided Energy Supply Cost, 2011 Report

Effect of Changing Realities on Estimates of Avoided Electrical Prices

Updated forecasts can result in differences of up to 50 percent.



Source: Avoided Energy Supply Cost, 2011 Report

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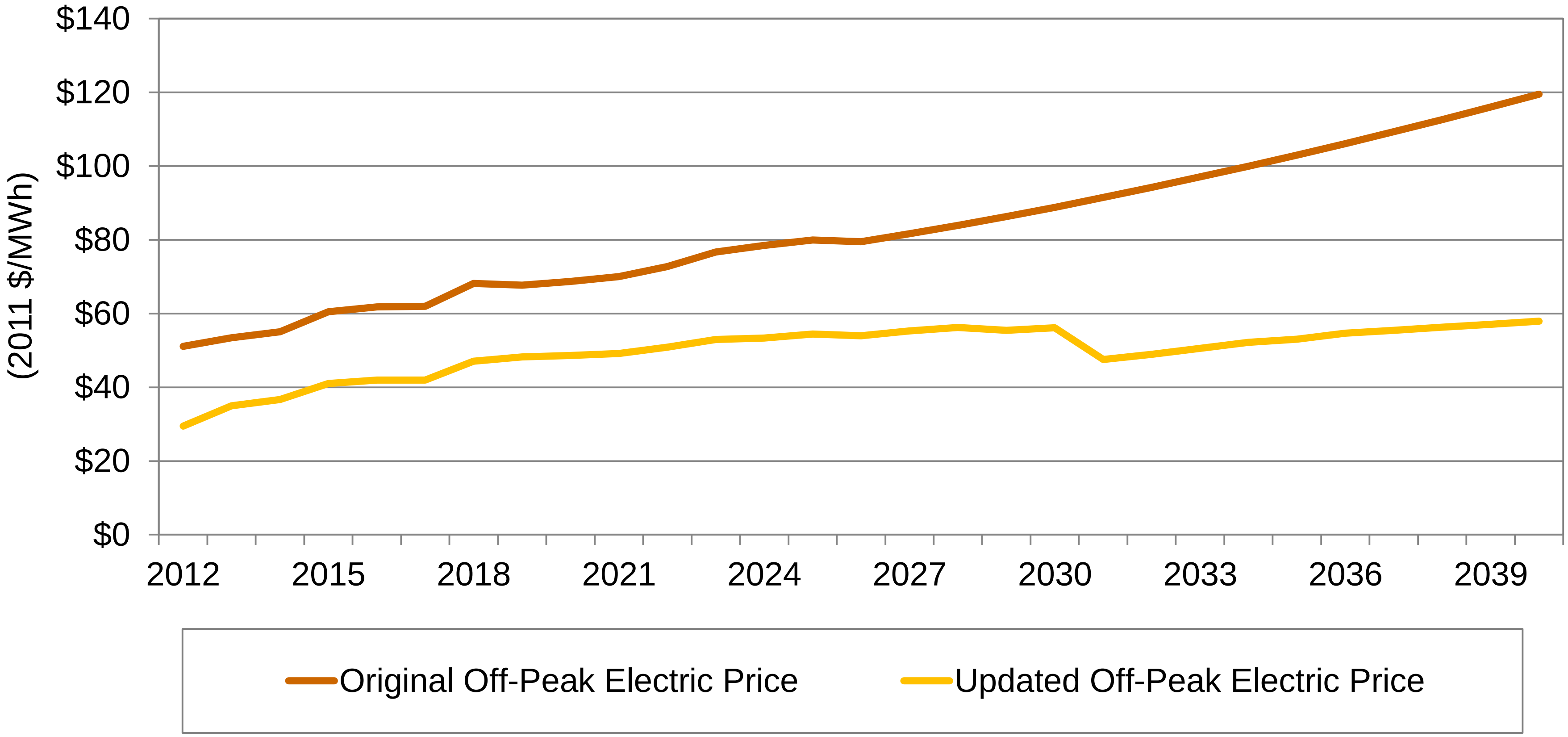

Source: Avoided Energy Supply Cost, 2011 Report

Questions, Comments and Discussion

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