USING ENERGY EFFICIENCY TO HEDGE NATURAL GAS PRICE UNCERTAINTY

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The U.S. electricity sector faces significant uncertainty as it makes large capital investments to replace aging infrastructure and to comply with forthcoming environmental regulations.[1] Near- and long-term uncertainties include fuel prices, demand growth, and environmental and climate policy. Utilities and regulators must manage these risks[2] in order to maintain reliable electricity at affordable prices. Energy efficiency investments can provide an important tool for managing risk by reducing exposure to uncertain costs (e.g., fossil fuels), deferring major generation investments, and reducing environmental emissions. Here we explore the potential for energy efficiency to hedge against uncertainty in natural gas prices. The example presented illustrates a method to quantify the value of energy efficiency as a hedge against a variety of risks.

Our analysis of an investment in a 540-megawatt (MW) natural gas plant shows cost savings for consumers from energy efficiency for all natural gas forecasts analyzed. In the event of a significant price increase, consumers realize large savings—on the order of $100 million.

Background

Uncertainty regarding natural gas prices is a particular concern to utilities[3] and utility regulators.[4] In the last four years, increased availability of unconventional natural gas supplies and consequent low natural gas prices have led to widespread changes in the U.S. electricity sector. In 2012, low natural gas prices caused a reduction in electricity generation from coal-fired power plants and a simultaneous increase in generation from natural gas combined cycle units.[5] Projections by the Energy Information Administration[6] and others[7] indicate this trend is likely to continue. Since the beginning of significant shale gas drilling around 2008, the Energy Information Administration's (EIA) natural gas price projections have fallen while natural gas generation projections have increased. The 2012 Annual Energy Outlook (AEO) 2020 reference scenario Henry Hub price forecasts is over $2 per million British thermal units (MMBtu) less than the 2010 AEO reference scenario (see fig. 1). If EIA's forecasts are accurate, natural gas combined cycle plants will be the least-cost option for new baseload and intermediate-load generation in most of the country.[8] Despite low price forecasts, historical natural gas prices show significant price volatility, and a return to past price volatility, coupled with increased natural gas dependence, could cause spikes in electricity rates for consumers.

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[1] Ron Binz, Richard Sedano, Denise Furey, and Dan Mullen, "Practicing Risk-Aware Electricity Regulation: What Every State Regulator Needs to Know" (Boston: CERES, 2012).

[2] Fuel prices, demand growth, and environmental and climate policy uncertainty create cost risk for utilities and electricity customers.

[3] Brian Wingfield, "Duke Energy Chief Urges U.S. Caution in Relying on Natural Gas," *Bloomberg*, May 19, 2011.

[4] Phyllis Reha, "The Role of Natural Gas in Minnesota's Energy Future" (presentation at the Environmental Initiative Policy Conference, Concordia University, September 21, 2012), http://www.slideshare.net/Environmental-Initiative/policy-forum-series-reha-the-role-of-natural-gas-in-minnesotas-energy-future.

[5] U.S. Energy Information Administration (EIA), Today in Energy, "Competition among fuels for power generation driven by changes in fuel prices," http://www.eia.gov/todayinenergy/detail.cfm?id=7090; U.S. EIA, Today in Energy, "Cheaper natural gas alters generation dispatch in Southeast," http://www.eia.gov/todayinenergy/detail.cfm?id=9090#tabs_SpotPriceSlider-1.

[6] U.S. EIA, *Annual Energy Outlook 2012* (Washington, D.C.: U.S. EIA, 2012).

[7] ExxonMobil, The Outlook for Energy: A View to 2040 (2013), http://www.exxonmobil.com/Corporate/files/news_pub_eo.pdf.

[8] U.S. EIA, "Levelized Cost of New Generation Resources in Annual Energy Outlook 2012," http://www.eia.gov/forecasts/aeo/electricity_generation.cfm.

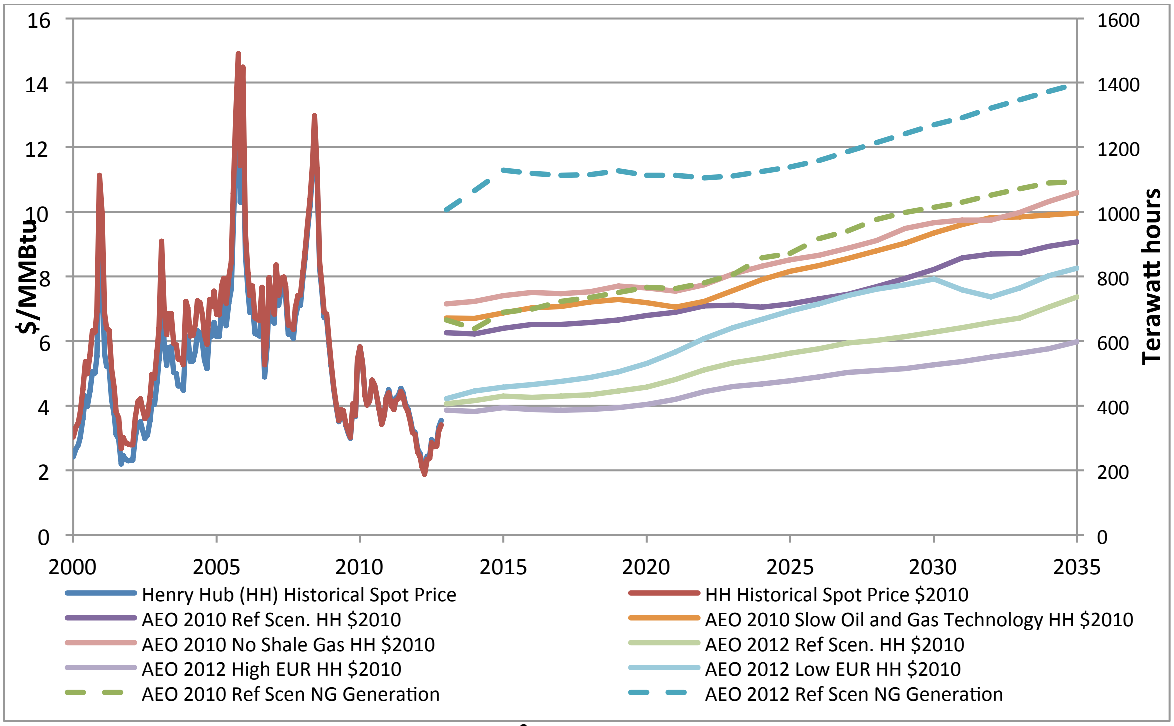

Figure 1. Historical Henry Hub spot prices (EIA)[9] and EIA 2010 and 2012 AEO Henry Hub natural gas price and generation forecasts[10]

Energy efficiency is well established as a low-cost resource for consumers.[11] Perhaps equally important, energy efficiency can also act as a hedging investment against fuel price volatility and other uncertainties.[12]

Analysis

In this example analysis, we look at the economics of investing in a new natural gas combined cycle (NGCC) plant with and without energy efficiency investments under natural gas price uncertainty. We use the PowerOptInvest model[13] to represent a profit-maximizing investor considering replacing a portion of the generation capacity of a new 540 MW NGCC plant with one of three alternative energy efficiency investments. Each of the energy efficiency alternatives yields different reductions in demand and capacity requirements at different costs:

1. A 2% reduction in demand and capacity requirements at 3 cents/kilowatt hour (kWh)
2. A 4% reduction in demand and capacity requirements at 4.5 cents/kWh
3. A 6% reduction in demand and capacity requirements at 6 cents/kWh

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[9] U.S. EIA, Henry Hub Gulf Coast Natural Gas Spot Price, http://www.eia.gov/dnav/ng/hist/rngwhhdm.htm.
[10] U.S. EIA, Annual Energy Outlook Table Browser, http://www.eia.gov/oiaf/aeo/tablebrowser/.
[11] U.S. Environmental Protection Agency, "National Action Plan for Energy Efficiency" (2006); see figure 4 in "Saving Energy Cost-Effectively: A National Review of the Cost of Energy Saved Through Utility-Sector Energy Efficiency Programs," American Council for an Energy-Efficient Economy (Washington, D.C.: ACEEE, 2009).
[12] U.S. EPA, "National Action Plan for Energy Efficiency"; Umair Irfan, "U.S. Efficiency Spending Projected to Double, Offset Most Demand Increases," *ClimateWire*, January 18, 2013.
[13] PowerOptInvest is a publicly available investment decision model from Duke University and the Nicholas Institute for Environmental Policy Solutions that determines the least-cost investment and operating strategies for electric power generation facilities. The beta version of the model is available at http://www.nicholasinstitute.duke.edu/climate/poweroptinvest.

Our analysis uses default AEO 2012 cost and emissions assumptions and AEO 2012 forecasts to estimate the 30-year net present value (NPV) of costs for ratepayers.[14] Each energy efficiency alternative investment is coupled with a reduced NGCC investment that meets the same load as the standalone 540 MW NGCC investment, resulting in a lower capital cost for the energy-efficiency-coupled NGCC plant. The investor is assumed to be indifferent to energy efficiency and generation investments (i.e., there is no throughput incentive).[15] Energy efficiency costs are included in the model on an annualized basis, similar to operating costs.

Using PowerOptInvest, we determine the least-cost investment decision for ratepayers[16] under three natural gas price scenarios: 1) AEO 2012 reference scenario; 2) the low estimated ultimate recovery (EUR) scenario, a low natural gas supply and technology development scenario that yields high natural gas prices; and 3) the high EUR scenario, with greater supply and technology development that yields low natural gas prices. We then determine 30-year NPV costs for ratepayers in each scenario.

In all scenarios, the model determined it is least cost to invest in a 4% energy efficiency demand reduction with a 518.4 MW NGCC plant. The tables below present 30-year NPV costs for each natural gas price scenario for 1) the investment in 4% energy efficiency complementing a 518.4 MW NGCC plant, and 2) an investment in a 540 MW NGCC plant. A comparison of the NPVs shows that investing in energy efficiency combined with an NGCC saves ratepayers 6 to 20 million dollars relative to only investing in an NGCC plant, depending on the scenario.

Tables 1 and 2. 30 NPV of capital, fuel, and annual operating and efficiency costs by scenario, $2010

4% Energy Efficiency & NGCC Investment

AEO 2012 scenario	30 NPV capital costs	30 NPV fuel costs	30 NPV O&M + EE costs	Sum millions $2010
Reference scenario	$821	$1,378	$267	**$2,466**
Low EUR - high NG price	$821	$1,559	$267	**$2,647**
High EUR - low NG price	$821	$1,215	$267	**$2,303**

540 MW NGCC Investment

AEO 2012 scenario	30 NPV capital costs	30 NPV fuel costs	30 NPV O&M costs	Sum millions $2010
Reference scenario	$855	$1,435	$188	**$2,479**
Low EUR - high NG price	$855	$1,624	$188	**$2,667**
High EUR - low NG price	$855	$1,265	$188	**$2,309**

Natural Gas Price Shock

As noted prior, the high natural gas price forecasts (low EUR scenario) in the AEO 2012 are low relative to historical price spikes and may not capture the full range of natural gas price uncertainty. To capture the risk of a sudden and significant jump in natural gas prices, we modeled an unanticipated increase in natural gas prices from the reference scenario to the high natural gas price scenario (low EUR) with a $3/MMBtu price adder beginning in 2016.[17] PowerOptInvest allows us to represent an investor who does

[14] 2012 investment in a 540 MW NGCC plant with a 75% capacity factor. Assume a 7% discount rate and a pretax cost of capital of 12.7% (from NERC 2010 Special Reliability Scenario Assessment: Resource Adequacy Impacts of Potential U.S. Environmental Regulations). 540 MW is the default size for a new NGCC in the 2012 AEO. AEO 2012 does not include NO_x or SO_2 emissions allowance price projections. Based on this, all emissions allowance costs for all of the investments were set to zero. We assume it takes 3 years to engineer and construct a new NGCC plant, with operations beginning in 2015.

[15] We assume the investor receives the same revenues regardless of the investment alternative. The investor responds by minimizing costs to maximize profits. If a utility faces reduced revenues from increased demand-side energy efficiency, there is a disincentive to reducing demand through energy efficiency. This is referred to as the throughput incentive. Policies such as decoupling and revenue recovery mechanisms can be used to counter the throughput incentive.

[16] Without the throughput incentive, the least-cost investment option for ratepayers maximizes profit for the investor.

[17] To estimate wholesale electricity price forecasts for the high natural gas price scenario (Low EUR) with the $3/MMBtu price adder we used average price differentials and ratios between the delivered natural gas prices for the electricity sector and

not anticipate this price shock and therefore chooses the least-cost investment decision in 2012 based on the reference scenario forecasts but then faces an unexpected jump to higher prices beginning in 2016.

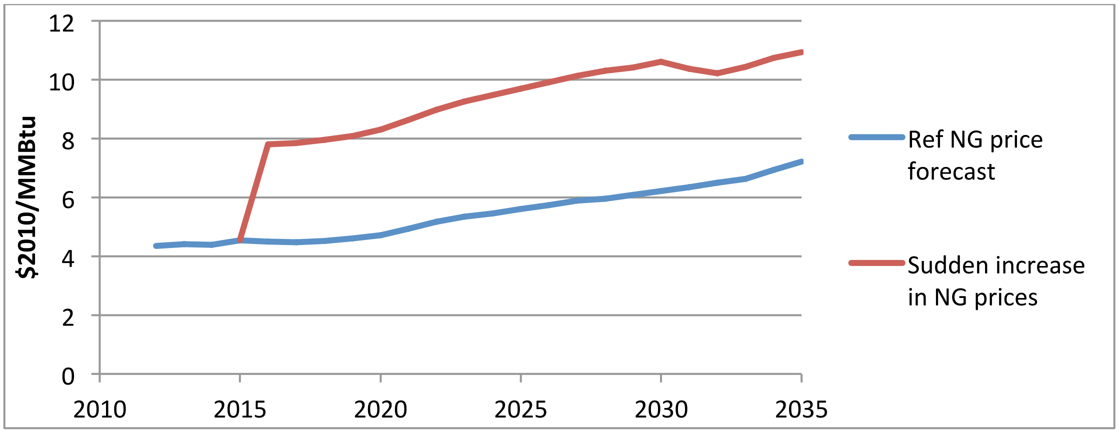

Figure 2. Sudden increase in natural gas prices

Using PowerOptInvest, we run the model three times with the sudden, unanticipated increase in natural gas prices for

1. A 540 MW NGCC plant without energy efficiency options
2. Three efficiency investment options coupled with NGCC and the base 540 MW NGCC plant
3. Only the 6 cent/kWh, 6% energy efficiency investment option coupled with a 507.6 MW NGCC plant

The results of these three analyses are presented in the table below. Similar to the earlier results, when allowed to choose between the three energy efficiency options and the base 540 MW plant (modeling run 2 above), the model determines it is least cost to invest in the 4.5 cent, 4% demand and capacity reduction investment in 2012.

When we force the model to invest in the maximum amount of energy efficiency, ratepayers save approximately $1 million for a sudden jump in natural gas prices over the 4% energy efficiency investment. Savings for both energy efficiency investments result in over $110 million in savings for ratepayers relative to the base 540 MW NGCC investment for this price jump.

Table 3. 30 NPV of capital, fuel, and annual operating and efficiency costs for sudden unanticipated jump in natural gas prices in 2016

	30 NPV capital costs	30 NPV fuel costs	30 NPV O&M + EE costs	Sum millions $2010
540 MW NGCC	$855	$2,409	$188	**$3,453**
4.5 cent/kWh EE - 4% EE & 507.6 MW NGCC	$821	$2,250	$267	**$3,338**
6 cent/kWh EE - 6% EE & 507.6 MW NGCC	$804	$2,203	$330	**$3,337**

wholesale electricity prices for the Reference scenario, Low EUR, and High EUR scenarios. All other forecast for the Low EUR + $3/MMBtu scenario were set equal to the Low EUR scenario.

Discussion

Energy efficiency investments have inherent risk benefits because they reduce exposure to uncertain costs, such as fossil fuel prices, can defer major generation investments, and reduce environmental emissions. For the AEO 2012 scenarios modeled here, energy efficiency investments minimize the expected value of future costs (i.e., are least cost) and protect ratepayers from sudden increases in natural gas prices, demonstrating the fuel price risk benefits of energy efficiency. The savings that we calculated from choosing the maximum energy efficiency alternative as a way to protect ratepayers from a natural gas price shock are minor relative to the costs of the energy efficiency investment. However these results are likely a consequence of limiting the analysis to natural gas price uncertainty. Including additional uncertainties such as cooling water scarcity, future environmental regulations, and federal climate policy would likely further incentivize investment in additional energy efficiency as a hedging option. It is also important to note that we have shown that energy efficiency can be part of a portfolio that minimizes expected costs. Hedging investments can include additional costs that protect investors from risk. Similar to purchasing natural gas futures contracts and incurring a price premium, utilities and utility regulators can invest in additional energy efficiency, beyond what is least-cost under baseline forecasts to protect against the risk of a significant unanticipated increase in natural gas prices.

Hedging options and risks will vary by utility and region but modeling exercises similar to this can demonstrate the potential cost of fuel price volatility and other uncertainties and better capture the value of risk hedging investments such as energy efficiency. Utility regulators and ratepayers advocates similarly can require analysis of uncertainties and shocks during regulatory proceedings to protect ratepayers from undue risk and determine investment options that guard against foreseeable risk.