Title
The potential impact of renewable energy deployment on natural gas prices in New England

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Subject The Potential Impact of Renewable Energy Deployment on Natural Gas Prices in New England

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INTRODUCTION

Concerns about the price and supply of natural gas have deepened in recent years both nationally and in New England. Renewable energy (RE) technologies can directly hedge natural gas price risk by reducing the need to purchase variable-price natural gas-fired electricity generation, and replacing that generation with fixed-price renewable electricity supply.

In addition to its direct contribution to price stability, an increasing number of studies show that renewable energy deployment can also put downward pressure on natural gas prices by reducing demand for gas among gas-fired generators. These gas price reductions are, in turn, expected to reduce electricity prices and – more importantly – directly reduce consumer natural gas bills. Many recent studies have found that this effect may be significant, substantially benefiting consumers. These studies are reviewed in the attached paper, published in the proceedings of a recent national energy conference.

An important consideration is that – strictly speaking – this price reduction represents a consumer benefit that comes at the expense of producers; it therefore represents a wealth transfer, not a net gain in social welfare. That said, current concerns about the price and supply of natural gas suggest that policymakers may want to pursue actions that reduce the strain of high prices on consumer energy bills.

Using previous studies as a guide, this memorandum focuses on New England, and calculates the potential impact of increased deployment of renewable energy on regional natural gas prices, as well as consumer benefits associated with those price reductions. We do this by extrapolating the findings of previous studies to the New England region. Pertinent caveats are noted, though we direct the reader to the attached paper for further discussion of our general methods and the limitations to current research in this area. Below, we first estimate the potential long-term consumer gas savings that derive from increased renewable energy deployment in New England, based primarily on extrapolation from national studies. Subsequently, we extrapolate the results of an ACEEE/EEA study that, arguably, may do a better job at representing the regional, near-term impacts of renewable energy on natural gas prices. The renewable energy additions included in this analysis reflect the projected impact of renewables portfolio standards (RPS) in both Massachusetts and Connecticut through 2009.

LONG-TERM BENEFITS OF INCREASED RE DEPLOYMENT IN NEW ENGLAND

Most of the studies summarized in the attached paper look at the *national* impacts of *national* renewable energy deployment. As shown in the attached paper, the majority of the modeling studies that have been conducted (typically, though not always, using the EIA's National Energy Modeling System - NEMS) show that each 1 percent reduction in national natural gas demand may reduce the long-term wellhead price of natural gas by 0.75 percent to 2.5 percent. Some models predict even more significant national price reductions (e.g., the recent National Petroleum Council assessment shows an approximate 4 percent reduction in price from a 1 percent decrease in national gas demand). This estimate of the "inverse price elasticity of supply" for natural gas is somewhat consistent with the output of other national energy models, and with a very limited empirical economics literature on natural gas supply elasticities.

We therefore conclude that – while additional research and validation is important – a reasonable initial estimate is that a 1 percent reduction in national natural gas demand may lead to a long-term wellhead price reduction of 0.75 to 2.5 percent. This wellhead price reduction (in $/MMBtu terms) is expected to translate roughly one-for-one into retail natural gas prices.

Though the models used to create this estimate are arguably best-suited for long-term, national analysis, we have also sought to understand impacts of short-term, regional renewable energy deployment scenarios. Given that natural gas supply is generally constrained in the short-term, but better able to adjust over the long-term, one would expect deployment of renewable energy to cause a reduction in natural gas prices that is larger in the near-term than over the long-term. Similarly, a region that is transportation-constrained could experience regional price impacts that exceed average, national price impacts. Based on a number of modeling runs conducted in the EIA's National Energy Modeling System (not shown in the attached paper), we have found that NEMS generally predicts that regional penetration of renewable generation can lead to an initial regional gas price reduction that is 3 - 5 times as large as the national change in average wellhead prices. For example, a $0.1/MMBtu reduction in national wellhead prices can initially translate into a $0.3-0.5/MMBtu reduction in retail gas prices in the region in which the renewables deployment occurs. Over the ensuing 20 years, this regional multiplier dissipates and the regional impact is predicted to be virtually the same as the national impact.

Given the above findings, most of which are described in more detail in the attached paper (note that the regional results presented above are not highlighted in the attached paper), one can calculate the potential impacts of increased renewable energy deployment in New England. To do so, we assume the following:

- An increase in renewable energy supply in New England of roughly 402 MW (generating 1,854 GWh per year) by 2006 and 721 MW (generating 3,357 GWh per year) by 2009. These additions reflect the projected impact of renewables portfolio standards (RPS) in both Massachusetts and Connecticut through 2009, as calculated by LaCapra Associates for the MTC. As a result of these additions, natural gas demand among New England generators is projected to fall by 6,312 GBtu in 2006 (i.e., from 485,110 to 478,798 GBtu) and 11,859 GBtu in 2009 (i.e., from 467,118 to 455,259 GBtu).[1] We assume that gas demand reductions in the years between 2006 and 2009 can be interpolated linearly from the 2006 and 2009 reductions, and that annual reductions after 2009 are fixed at 11,859 GBtu. Thus, in effect, we are only modeling the impact of the Massachusetts and Connecticut RPS through 2009, and then assuming that the impact remains constant through 2025.[2]

- We translate these gas savings into percentage reductions in national natural gas demand using forecasts of national natural gas demand for 2006-2025 from the latest EIA Annual Energy Outlook.

- We estimate the national average wellhead price reduction by applying inverse elasticity estimates of 0.75, 1.5, and 3, consistent with the studies summarized in the attached paper. On a national basis, we assume that reductions in wellhead prices translate directly, on a one-for-one basis, into reductions in retail gas prices.

- To estimate New England retail price reductions, we assume a regional multiplier of 3 in the initial year of our analysis (2006), declining linearly to 1 by 2025, the final year of our analysis. In other words, we assume that reductions in New England retail natural gas prices will, in 2006, be 3 times as large as reductions in national average wellhead prices in that year. This is consistent with previous analysis that we have conducted with NEMS, as reported earlier. This regional multiplier reflects the fact that New England has little native natural gas supply, and is therefore highly dependent on transportation from other regions – transportation that is, at times, tightly constrained, resulting in price effects that are amplified relative to changes in average wellhead prices. Particularly at such times, a reduction in natural gas demand resulting from renewables penetration in New England may have a large impact on regional gas prices.

- We estimate national and New England consumer gas bill savings by applying the resulting retail price reductions to total estimated gas demand as presented in the latest EIA Annual Energy Outlook nationally and for New England, respectively. This assumes that retail gas

[1] These numbers stem from a LaCapra Associates, Inc. analysis of the New England electricity market. It should be noted that this reduction in gas demand within the electricity sector – and more importantly the corresponding decline in natural gas prices – should ultimately induce at least some resurgence of demand among all gas-consuming sectors of the economy (i.e., with a downward-sloping demand curve, more natural gas is demanded at lower prices). We assume that LaCapra's analysis, which focused solely on the electricity sector, does not capture this "rebound effect" in its entirety. As such, the reductions in natural gas demand in New England presented here may be somewhat over-stated.

[2] This is a conservative assumption, given that the Connecticut RPS extends through 2010, and the Massachusetts standard is likely to increase beyond 2009. Even in the absence of further policy stimulus beyond 2009, the "learning effect" from adding 721 MW of new renewables capacity in New England by 2009 could reasonably be expected to result in additional renewables development in the years after 2009.

price reductions translate directly into consumer bill savings (both directly through gas bills and indirectly through electric bills).[3]

- Finally, by allocating the resulting consumer gas bill savings to the projected MWh of renewable energy supply, we estimate the natural gas-related consumer benefits that derive from each increment of renewable generation.

Though all of these assumptions are subject to uncertainty, we believe that the results can be used to estimate a plausible range of impacts, especially over the long-term, that are, at a minimum, consistent with those predicted by integrated energy models. The results of the analysis are presented below in Tables 1 through 3 (each presenting results for a different inverse supply elasticity), and Figures 1 and 2.

Table 1. Analysis Results (Inverse Elasticity = 0.75)

	Gas Demand Reduction	Reduction in Retail Gas Price		Consumer Gas Savings		Savings Per-MWh RE	
	New England	New England	National	New England	National	New England	National
	(MMBtu)	(2002 $/MMBtu)		(2002 $)		(2002 $/MWh RE)	
2006	6,311,850	$0.0020	$0.0007	$1,727,034	$16,030,719	$0.93	$8.65
2007	8,161,022	$0.0024	$0.0008	$2,162,953	$21,025,771	$0.92	$8.93
2008	10,010,194	$0.0029	$0.0010	$2,619,228	$26,613,764	$0.92	$9.32
2009	11,859,367	$0.0031	$0.0012	$2,835,566	$29,995,945	$0.84	$8.94
2010	11,859,367	$0.0028	$0.0011	$2,622,574	$29,414,246	$0.78	$8.76
2011	11,859,367	$0.0028	$0.0011	$2,611,470	$30,831,508	$0.78	$9.18
2012	11,859,367	$0.0028	$0.0012	$2,635,071	$32,468,479	$0.78	$9.67
2013	11,859,367	$0.0027	$0.0012	$2,563,291	$34,012,830	$0.76	$10.13
2014	11,859,367	$0.0026	$0.0012	$2,434,905	$34,738,514	$0.73	$10.35
2015	11,859,367	$0.0026	$0.0013	$2,423,511	$36,284,015	$0.72	$10.81
2016	11,859,367	$0.0024	$0.0013	$2,314,340	$36,557,676	$0.69	$10.89
2017	11,859,367	$0.0023	$0.0012	$2,190,982	$36,645,736	$0.65	$10.92
2018	11,859,367	$0.0021	$0.0012	$2,078,679	$36,122,937	$0.62	$10.76
2019	11,859,367	$0.0019	$0.0012	$1,974,568	$35,732,550	$0.59	$10.64
2020	11,859,367	$0.0018	$0.0012	$1,943,860	$37,066,205	$0.58	$11.04
2021	11,859,367	$0.0018	$0.0012	$1,917,084	$38,552,418	$0.57	$11.48
2022	11,859,367	$0.0016	$0.0012	$1,766,749	$38,280,457	$0.53	$11.40
2023	11,859,367	$0.0015	$0.0012	$1,675,214	$38,306,107	$0.50	$11.41
2024	11,859,367	$0.0013	$0.0012	$1,520,441	$38,249,579	$0.45	$11.39
2025	11,859,367	$0.0012	$0.0012	$1,376,784	$38,133,606	$0.41	$11.36
NPV Consumer Savings and Levelized $/MWh:				**$27,944,256**	**$395,426,364**	**$0.73**	**$10.04**

[3] Again, there is likely some "rebound effect" that we are not capturing, given that the LaCapra Analysis was limited to the electricity sector. In other words, lower gas prices (and gas bills) should cause consumers in all sectors to demand more gas. Integrated models such as the EIA's National Energy Modeling System, which models energy consumption in all sectors of the economy, are better able to capture this rebound effect.

Table 2. Analysis Results (Inverse Elasticity = 1.50)

	Gas Demand Reduction	Reduction in Retail Gas Price		Consumer Gas Savings		Savings Per-MWh RE	
	New England	New England	National	New England	National	New England	National
	(MMBtu)	(2002 $/MMBtu)		(2002 $)		(2002 $/MWh RE)	
2006	6,311,850	$0.0039	$0.0013	$3,454,067	$32,061,437	$1.86	$17.29
2007	8,161,022	$0.0048	$0.0017	$4,325,906	$42,051,542	$1.84	$17.86
2008	10,010,194	$0.0058	$0.0021	$5,238,456	$53,227,527	$1.83	$18.64
2009	11,859,367	$0.0062	$0.0023	$5,671,132	$59,991,889	$1.69	$17.87
2010	11,859,367	$0.0057	$0.0022	$5,245,148	$58,828,492	$1.56	$17.52
2011	11,859,367	$0.0056	$0.0023	$5,222,939	$61,663,016	$1.56	$18.37
2012	11,859,367	$0.0055	$0.0023	$5,270,142	$64,936,957	$1.57	$19.34
2013	11,859,367	$0.0055	$0.0024	$5,126,581	$68,025,660	$1.53	$20.26
2014	11,859,367	$0.0053	$0.0024	$4,869,809	$69,477,028	$1.45	$20.70
2015	11,859,367	$0.0052	$0.0025	$4,847,022	$72,568,029	$1.44	$21.62
2016	11,859,367	$0.0049	$0.0025	$4,628,680	$73,115,352	$1.38	$21.78
2017	11,859,367	$0.0045	$0.0025	$4,381,963	$73,291,472	$1.31	$21.83
2018	11,859,367	$0.0041	$0.0024	$4,157,357	$72,245,875	$1.24	$21.52
2019	11,859,367	$0.0038	$0.0023	$3,949,136	$71,465,100	$1.18	$21.29
2020	11,859,367	$0.0036	$0.0024	$3,887,720	$74,132,411	$1.16	$22.08
2021	11,859,367	$0.0035	$0.0025	$3,834,169	$77,104,836	$1.14	$22.97
2022	11,859,367	$0.0032	$0.0024	$3,533,499	$76,560,914	$1.05	$22.81
2023	11,859,367	$0.0029	$0.0024	$3,350,427	$76,612,214	$1.00	$22.82
2024	11,859,367	$0.0026	$0.0024	$3,040,882	$76,499,158	$0.91	$22.79
2025	11,859,367	$0.0024	$0.0024	$2,753,569	$76,267,211	$0.82	$22.72
NPV Consumer Savings and Levelized $/MWh:				**$55,888,513**	**$790,852,727**	**$1.46**	**$20.08**

Table 3. Analysis Results (Inverse Elasticity = 3.00)

	Gas Demand Reduction	Reduction in Retail Gas Price		Consumer Gas Savings		Savings Per-MWh RE	
	New England	New England	National	New England	National	New England	National
	(MMBtu)	(2002 $/MMBtu)		(2002 $)		(2002 $/MWh)	
2006	6,311,850	$0.0078	$0.0026	$6,908,135	$64,122,875	$3.73	$34.59
2007	8,161,022	$0.0097	$0.0033	$8,651,813	$84,103,083	$3.67	$35.71
2008	10,010,194	$0.0115	$0.0041	$10,476,912	$106,455,054	$3.67	$37.27
2009	11,859,367	$0.0124	$0.0046	$11,342,264	$119,983,779	$3.38	$35.74
2010	11,859,367	$0.0113	$0.0044	$10,490,296	$117,656,984	$3.12	$35.05
2011	11,859,367	$0.0111	$0.0045	$10,445,879	$123,326,032	$3.11	$36.74
2012	11,859,367	$0.0110	$0.0047	$10,540,283	$129,873,914	$3.14	$38.69
2013	11,859,367	$0.0109	$0.0048	$10,253,162	$136,051,320	$3.05	$40.53
2014	11,859,367	$0.0105	$0.0049	$9,739,618	$138,954,057	$2.90	$41.39
2015	11,859,367	$0.0104	$0.0051	$9,694,043	$145,136,058	$2.89	$43.23
2016	11,859,367	$0.0097	$0.0050	$9,257,359	$146,230,704	$2.76	$43.56
2017	11,859,367	$0.0091	$0.0049	$8,763,927	$146,582,944	$2.61	$43.66
2018	11,859,367	$0.0083	$0.0048	$8,314,715	$144,491,750	$2.48	$43.04
2019	11,859,367	$0.0075	$0.0046	$7,898,272	$142,930,199	$2.35	$42.58
2020	11,859,367	$0.0073	$0.0048	$7,775,439	$148,264,821	$2.32	$44.17
2021	11,859,367	$0.0070	$0.0049	$7,668,338	$154,209,671	$2.28	$45.94
2022	11,859,367	$0.0064	$0.0049	$7,066,997	$153,121,828	$2.11	$45.61
2023	11,859,367	$0.0059	$0.0049	$6,700,855	$153,224,429	$2.00	$45.64
2024	11,859,367	$0.0053	$0.0048	$6,081,764	$152,998,316	$1.81	$45.58
2025	11,859,367	$0.0047	$0.0047	$5,507,138	$152,534,422	$1.64	$45.44
NPV Consumer Savings and Levelized $/MWh:				**$111,777,025**	**$1,581,705,454**	**$2.92**	**$40.15**

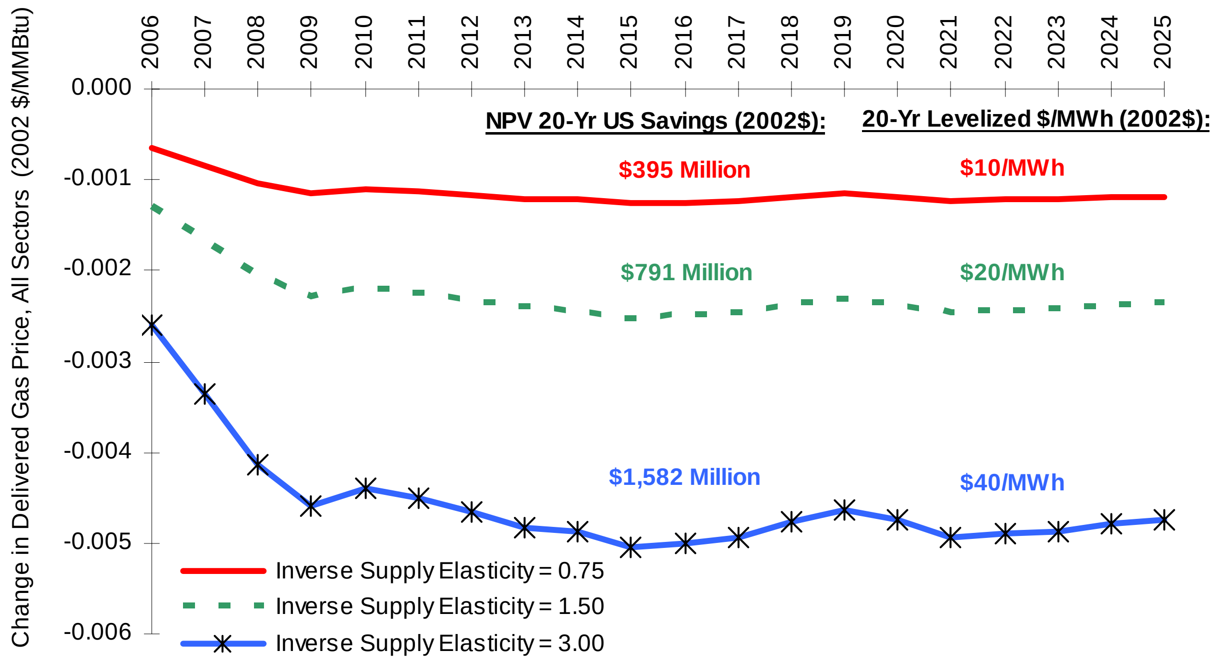

Figure 1. Aggregate Impact on National Delivered Gas Prices

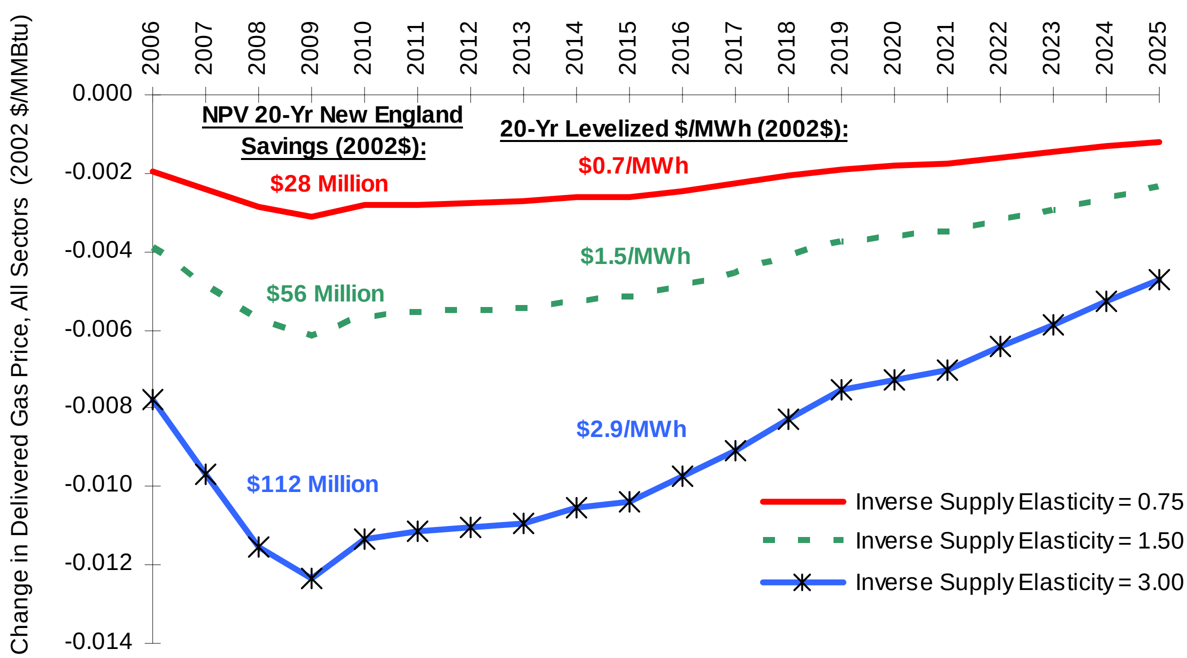

Figure 2. Aggregate Impact on New England Delivered Gas Prices

EXTRAPOLATING NEAR-TERM REGIONAL IMPACTS FROM ACEEE/EEA

One would expect that regional penetration of renewable energy would have a larger near-term, regional impact on gas prices than predicted over the longer-term, on a national basis. This is due to both regional transportation constraints that exist in many regions, and because the supply of natural gas in the near-term is heavily constrained.

The regional multiplier used in the previous analysis seeks to approximate this effect, in a way consistent with its apparent treatment within NEMS. Because of the perceived limitations of NEMS and many other national energy models in predicting near-term, regional impacts of altered gas demand scenarios, however, in December 2003 ACEEE published a study using the EEA model. The EEA model is a full supply/demand equilibrium model of the North American gas market, most recently used as part of the influential National Petroleum Council assessment of natural gas supply and demand. The EEA model contains a great deal of regional representation, and allows for small changes in natural gas demand to have a disproportionately large impact on gas prices because they reduce prices on the margin, where they are the highest. In some regions, demand for gas can at times exceed the ability of the current transportation infrastructure, creating even greater price pressure that small savings can relieve.

The ACEEE study evaluated the potential impact of renewable energy and energy efficiency deployment on natural gas prices, both nationally and regionally. One of those scenarios involved renewable energy and energy efficiency deployment in the Northeast (New England, NY, and portions of PJM). While we recommend that MTC contact ACEEE and EEA directly to seek a specific analysis of increased RE deployment in New England, results from the 2003 ACEEE modeling run can be extrapolated to roughly estimate the potential impact of increased renewable energy deployment on New England gas prices. Results from this extrapolation are presented here.

Some of the most pertinent ACEEE/EEA results are presented in Table 4.

Table 4. Key Results from the ACEEE Analysis of Increased RE and EE in the Northeast

	2004	2005	2006	2007	2008
Ref: New England hub price (2002$/MMBtu)	4.91	6.02	4.22	4.54	3.82
EERE: New England hub price (2002$/MMBtu)	4.57	5.55	3.83	4.35	3.46
change in hub price (2002$/MMBtu)	-0.34	-0.47	-0.39	-0.19	-0.36
change in hub price (%)	-6.92%	-7.81%	-9.24%	-4.19%	-9.42%
Ref: Consumption all Northeast/PJM States (Bcf)	3,598	3,608	3,757	3,868	4,038
EERE: Consumption all Northeast/PJM States (Bcf)	3,480	3,449	3,525	3,557	3,640
change in consumption (Bcf)	-118	-159	-232	-311	-398
change in consumption (%)	-3.28%	-4.41%	-6.18%	-8.04%	-9.86%

As shown in Table 4, by the year 2008, a reduction in Northeastern gas consumption of 398 Bcf (408,746,000 MMBtu) is expected to lead to a reduction in New England hub prices of $0.36/MMBtu. Though not shown here, the detailed ACEEE/EEA results suggest that New England hub price reductions may not flow one-for-one to retail gas price reductions. Instead, on average, approximately 80% of the hub price reduction flows to a reduction in the weighted average retail gas price (considering the residential, commercial, industrial, and power sectors).[4]

The New England renewables scenario provided by MTC shows a reduction in gas consumption of 11,859,367 MMBtu in 2009. Extrapolating the 2008 ACEEE ratio from Table 4 (i.e., $0.36/MMBtu / 408,746,000 MMBtu) to MTC's 2009 projected reduction in gas demand (11,859,367 MMBtu) yields an expected price reduction at the New England hub of $0.01/MMBtu. With approximately 80% of price changes at the New England hub price flowing through to changes in New England delivered prices, consumers see a price reduction of $0.008/MMBtu.

Applying this price change to the EIA's total (i.e., among all sectors) projected New England demand for natural gas in 2009 (after netting out the RPS-induced reduction in demand) yields total consumer savings of $7,673,265 (in 2002 $). Spreading those savings over the total projected RPS-induced renewable generation in 2009 (3357 GWh) yields savings of $2.3/MWh of renewable generation.[5] These results – consumer savings of $7,673,265, or $2.3/MWh, in 2009 – are slightly larger than results for that same year from the EIA/NEMS analysis, assuming an inverse supply elasticity of 1.5 (i.e., to arrive at similar results using our EIA/NEMS simplified method, one would need to assume an inverse supply elasticity of about 2.0).

CONCLUSIONS

Due to the uncertainty inherent in the shape of the supply curve for natural gas in the short- and long-term, one must be cautious in estimating the impact of increased RE deployment on natural gas prices in the New England region. Nonetheless, the two approaches to estimating this effect applied in this memo come to similar results. Specifically, the consumer gas savings benefits in New England associated with increased RE deployment equal approximately $1-3/MWh on a 20-year levelized basis, with a most-likely outcome of perhaps ~$2/MWh. The benefits of deployment of renewable energy in New England also flow to the remainder of the nation, however, in the form of lower wellhead gas prices. On a national basis, 20-year levelized consumer savings of $10-40/MWh might be expected, with a most-likely outcome of perhaps ~$20/MWh. National savings are so much larger than New England savings because the wellhead (and delivered) price reductions – though more muted than in New England – are applied to a much larger quantity of natural gas demand. The NPV of consumer gas savings in New England are calculated to be ~$30 - $110 million, with perhaps $50 million as a central value estimate. National consumer gas savings are much higher, with a range of $400 - $1600 million, and a central estimate of ~$800 million.

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[4] While we can only speculate as to the actual cause of this apparent retail price dampening, one potential reason could be that retail prices tend to be more "sticky" than hub prices, since retailers presumably lock in at least some portion of their supply through short-term (and perhaps even long-term) contracts. Also note that we generally did not observe this dampening effect in NEMS, which could reflect the fact that NEMS is more of a long-term model, and one would expect changes in wholesale prices to completely flow through to retail prices over longer terms.

[5] Because significantly higher inverse supply elasticities are employed in the first few years of the EEA model, our decision to look only at 2008 – the last year of the EEA analysis – is somewhat conservative. On the other hand, we assume that the 2008 EEA relationship also holds for 2009; this extrapolation ignores the idea that initial reductions in gas demand – i.e., those that are on the margin – are likely to have a more sizable impact on gas prices (e.g., due to short-term pipeline constraints).