Appendix C: Natural Gas Sector Strategy Analysis

INTRODUCTION

Chapter 4 (Natural Gas) discusses the economics and emissions reductions for conversion from fuel oil to natural gas. This Appendix provides the methodology and inputs that underpin the numbers in the Chapter. This Appendix covers the following topics:

- Net Present Value (NPV) of conversion
- Economic sensitivity of conversion
- Financing options

NET PRESENT VALUE OF CONVERSION

To calculate the NPV, DEEP took five steps:

1. Define the heating load for fuel oil and natural gas;
2. Calculate oil and natural gas expenditures for the heating load;
3. Identify cost of conversion from oil to natural gas;
4. Determine number of eligible customers; and
5. Calculate NPV of conversion for eligible customers.

1) DEFINE THE HEATING LOAD

Savings from fuel switching will depend on the amount of fuel oil that the customer currently uses. Representative fuel oil use for an average, converting customer in each sector is shown in the first column of Table C-1. These numbers were taken primarily from a report produced by the Department of Economic and Community Development (DECD) in in conjunction with the Connecticut Local Distribution Companies.[1] These numbers are very similar to heating load estimates calculated from U.S. Energy Information Administration data.[2]

As shown in Table C-1, heating load also depends on the efficiency of heating equipment. DEEP assumed 80% efficiency for the current fuel oil boiler/furnace stock. However, DEEP also assumed that when customers convert to natural gas, they invest in new, high efficiency heating equipment (93%). As a result,

heating load is reduced in conjunction with the conversion to natural gas due to the increased efficiency of the new heating equipment. The assumption that converting customers will invest in high efficiency

[1] Connecticut Department of Economic and Community Development, *Expanding Natural Gas*.
[2] Navigant, "Technology Forecast Updates."

equipment is consistent with in the DECD report.[3] DEEP believes this assumption is valid because converting to a higher efficiency furnace provides the customer a higher return from conversion (i.e., higher NPV), and for a financed conversion, lower cost starting from day one.[4]

Table C-1: Heating load for fuel oil and natural gas by sector

	Average delivered Heat for fuel oil Customer (million BTU/year)	Average primary energy consumption at given efficiency (million BTU/year)	
		80%	93%
Residential (Res)	77	96	83
Commercial (Com)	138	173	149
Industrial (Ind)	933	1166	1003

2) CALCULATE OIL AND NATURAL GAS EXPENDITURES FOR THE HEATING LOAD

Fuel expenditures are calculated by multiplying the heating load for a customer by the fuel price for the (heating) fuel that is being used.

For estimating base-case fuel prices for the various fuel options—most notably natural gas and fuel oil—DEEP used fuel price projections from the U.S. Energy Information Administration's (EIA) Annual Energy Outlook (AEO). [5] DEEP used the AEO reference case, and in particular the supplemental tables for the New England region. Several other fuel price scenarios have been examined in addition to the AEO reference case. These scenarios are described under the "Economic Sensitivity of Conversion" section below.

Savings from conversion/fuel switching are determined by comparison of a customer's fuel expenditure before and after conversion, and depend on both the fuel price and the heating load before and after conversion.

3) IDENTIFY COST OF CONVERSION FROM OIL TO NATURAL GAS

The total cost for conversion includes three main components: heating equipment replacement; service and meter; and estimated natural gas main extension. Conversion costs are summarized in Table C-2 and are described in detail below.[6] They vary (or are unnecessary/avoided) depending on sector, if the customer already has gas service, and if not, whether the customer is on-main (defined as within 150 feet of an existing gas main) or off-main (further than 150 feet).

[3] Connecticut Department of Economic and Community Development, *Expanding Natural Gas;* and Navigant, "Technology Forecast Updates."
[4] Using equipment cost numbers from Navigant, "Technology Forecast Updates."
[5] U.S. EIA, "*Annual Energy Outlook 2012*," Available at http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf
[6] Total resource cost (TRC) is the required investment for an energy measure from all involved parties/stakeholders—in this case, the conversion cost to the customer plus the service and meter investment by the local distribution company. The TRC is one of three measures used by Connecticut utilities for their conservation programs.

Table C-2: Conversion cost summary by customer segment and sector

Segment		Home heating conversion	conversions	total cost (HHC)	Service Line and Meter Cost (SLM)	conversions	Total Cost (SLM)	Main extension
On-main								
	Low	$ 7,500	39,000	$ 292,500,000				
	Res	$ 7,500	160,852	$ 1,206,390,000	$4,283	160,852	$688,929,116	*896.5 miles
	Com	$ 20,300	15,585	$ 316,375,500	$7,669	15,585	$119,521,365	of main *
	Ind	$ 40,600	569	$ 23,101,400	$11,504	569	$6,545,492	$1.033M/mile
				$ 1,838,366,900			**$814,995,973**	
Off-main								
	Res	$ 7,500	51,506	$ 386,295,000	$4,283	51,506	$ 220,600,198	
	Com	$ 20,300	37,333	$ 757,859,900	$7,669	37,333	$ 286,306,777	
	Ind	$ 40,600	430	$ 17,458,000	$11,504	430	$ 4,946,505	
				$ 1,161,612,900			**$ 511,853,480**	**$926,383,035**
				HHC costs	**Distribution Costs**		**Total**	
		total on-main cost		$ 1,838,366,900	$814,995,973		$2,653,362,873	
		total off-main cost		$ 1,161,612,900	$ 1,438,236,515		$2,599,849,415	
				$ 2,999,979,800	**$2,253,232,487**		**$5,253,212,287**	

* Not contemplated as part of the DECD study, or Department adjusted.

Heating equipment replacement

Heating equipment replacement cost includes the following: removal and disposal of old heating equipment including fuel oil tank; purchase of new heating equipment (including a furnace or boiler and hot water heater) and labor and installation. These numbers were taken from the DECD report, but are consistent with costs provided by EIA.[7] For residential conversions, DEEP has also verified costs by asking for quotes from local installers (Table C-3). With the exception of firm B, the costs are roughly consistent.

Table C-3: Typical costs of oil-to-natural gas heating system conversions for residential customers*

*Based on a sample of Connecticut-based contractors
**high end of range is the cost of a high efficiency installation

Firm	Location	Price Range
A	East Hartford, CT	$6-12K**
B	South Windsor, CT	$3-5K
C	Plainfield, CT	$5-10K
D	Stonington, CT	$5-8K**
E	Bridgeport, CT	$6-10K

Source: Telephone Interviews with Connecticut based installers, June 2012.

[7] Connecticut Department of Economic and Community Development, *Expanding Natural Gas Expansion*; and Navigant, "Technology Forecast Updates."

4) CALCULATE NET PRESENT VALUE (NPV) FOR ELIGIBLE CUSTOMERS

NPV was calculated for a single customer conversion in each sector and segment, assuming conversion costs are incurred in year 0 and netting them out against 20 years of discounted fuel savings (oil expenditures minus natural gas expenditures). DEEP used a 5% discount rate to bring fuel savings to present value. The selection of this discount rate is explained in Appendix A (Efficiency & Industry). Sensitivity was also examined for a lower (3%) discount rate (Table C-5). NPV for an individual conversion in each sector is shown in Table 5. Multiplying by the number of conversions in each segment gives the NPV for each segment.

Table C-4: Summary of net present value (NPV) analysis

	Number of conversions	Fuel switch savings	Average NPV for a single conversion	Total segment NPV
On-main				
Non-heat	40,000	$22,324	$14,824	$592,974,110
Res	160,851	$22,324	$10,541	$1,695,587,131
Com	15,585	$40,020	$12,051	$187,820,229
Ind	569	$304,727	$252,624	$143,742,894
Off-main				
Res	51,506	$22,324	$3,333	$171,654,801
Com	37,333	$40,020	$(919)	$(34,317,009)
Ind	430	$304,727	$165,248	$71,056,674

For the purpose of the NPV analysis for the base scenario, DEEP evaluated the opportunity as if all conversions were made at once, instead of phasing the conversions over the test period. If phasing were to be considered, a major complication arises around the customer's reaction to a tightening price differential such as a high gas, low oil price scenario. In such a scenario, the incentive to convert could be diminished or eliminated. The effects of a phased natural gas conversion can be seen in the Chapter 1 (Efficiency) and Chapter 2 (Industry). These Chapters include a phased approach so that the natural gas opportunity is presented in a way consistent with what is used to show the effects of efficiency.

ECONOMIC SENSITIVITY OF CONVERSION

Chapter 4 (Natural Gas) discusses how much the NPV of conversion to natural gas changes across three scenarios. These scenarios are higher natural gas prices, reduced heating load due to building envelope energy efficiency, and the combined effect of higher prices and building envelope efficiency. In addition to these scenarios, several others were examined and the results are highlighted in Table C-5.

Table C-5: Results of sensitivity analysis by segment

	Scenario	Sensitivity	Segment A		Segment B	
			Change	NPV	Change	NPV
Base	**Base:** Uses AEO "Reference case" fuel prices for the New England region.[8]	None	None	$2,620	None	$208
Fuel price	**High gas price:** Uses "Low recovery per play" case from 2011 AEO. Applies % changes in prices from 2012–2035 to the AEO 2012 early release "Reference case". The price rise in this scenario is very close to that of the EIA high/rapid liquefied natural gas export scenario.[9]	Medium	-11%	$2,335	-73%	$56
Fuel price	**Low gas price:** Uses "High recovery per play" case from 2011 AEO. Applies percentage changes in prices from 2012–2035 projection to the AEO 2012 early release "Reference case".	Medium	9%	$2,846	58%	$329
Fuel price	**High oil price:** Uses "High oil price" case from EIA AEO 2011. Applies percentage changes in prices from 2012–2035 projection to the AEO 2012 early release "Reference case".	Very high	135%	$6,165	876%	$2,034
Fuel price	**Low oil price:** Uses "Low oil price" case from EIA AEO 2011. Applies percentage changes in prices from 2012–2035 projection to the AEO 2012 early release "Reference case".	Very high	-122%	($567)	-778%	($1,412)
Fuel price	**Today's prices:** Uses current price differential between natural gas and oil (see Table 7 for prices) and holds differential constant in from 2012–2035. Applies differential in prices to the AEO 2012 early release "Reference case".	Medium	16%	$3,026	228%	$684
Misc	**Natural Gas Efficiency**: Assumes lower heating loads are available for conversion because of efficiency investment (20% natural gas demand reduction in residential sector, 15% in commercial and industrial, not including furnace efficiency).	High	-36%	$1,673	-217%	($243)
Misc	**Efficiency + High NG price:** Combines the "Natural gas efficiency" and the "High gas price" scenarios to test sensitivity if both scenarios occur.	High	-45%	$1,443	-277%	($370)
Misc	**Stock turnover:** Uses lower heating equipment replacement capital costs for residential sector. Assumes customer is making a decision between new efficient oil furnace and efficient natural gas furnace, this results in a lower incremental capital cost (capital cost=new gas furnace minus new oil furnace). It also results in lower savings potential because the baseline is a new oil furnace (89% efficient) rather than an existing furnace (80% efficient).[10]	Medium	13% (for on-main residential segment only)			
Misc	**Uptake rate:** Uses 15% lower customer adoption, assumes fixed main extension costs.	Medium	-15%	$2,227	-79%	$43
Misc	**Discount rate:** Uses 3% discount rate instead of 5%.	Medium	38%	$3,616	260%	$747

[8] U.S. EIA, "*Annual Energy Outlook 2012*," Available at http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf
[9] U.S. EIA, *Increased Natural Gas Exports*.
[10] The avoided cost for heating equipment replacement is $2,500 for an oil furnace/boiler and $1,500 for a water heater (Navigant, "Technology Forecast Updates"). Equipment lifetime is assumed to be 25 years for furnace/boiler and 15 years for a water heater. DEEP assumes a 10 year conversion timeframe and 10 out of 25 conversions can be timed perfectly to avoid the full cost of boiler/furnace replacement. For the remaining units, the avoided cost of replacement was discounted back to the time of conversion from the anticipated year of replacement (10–25 years).

Table C-6: Connecticut delivered fuel prices in July 2012

	Natural gas	Fuel oil
Res	$14.51	$30.63
Com	$7.50	$29.63
Ind	$7.96	$29.63

Source: U.S. EIA, "Natural Gas Prices"; and U.S. EIA, "Weekly Heating Oil Prices."

FINANCING

The upfront cost that a customer must pay to convert is one of the most significant barriers for increasing conversion rates. For customers in Segment A, this cost is driven almost entirely by the cost of heating equipment replacement.

For customers in Segment B, the customer will also contribute towards the cost of the main extension. As described in the chapter, Connecticut gas companies can cover the cost of a service line, meter, and main extension up to the NPV of 15 or 20 years of revenue from sales to the new customer(s). Service and meter costs in excess of this amount must be paid by the customer in a one-time, upfront payment called a contribution in aid of construction (CIAC). The maximum amount that can be covered by the gas companies without a CIAC for a typical load in each sector is given in in Table 2 in Chapter 4 (Natural Gas). The upfront cost to the customer is heating equipment replacement cost, plus service, meter, and main extension costs in excess of the amounts shown in Table 2 in Chapter 4 (Natural Gas).

For an initial evaluation of the potential for financing to overcome the upfront cost barrier, it was assumed that this entire amount would be financed over a 10-year period at rates ranging from 0-12%. The required loan payment was then calculated using the Microsoft Excel PMT function for each segment and sector. The payment is then compared to the average fuel bill savings for the customer over the first 10 years after conversion. The net impact of the loan payment and the customer's annual fuel savings is given in the financing tables shown in the chapter for each segment and for the range of interest rates.

For calculating a rough estimate of the incentive required to drive conversion in Segment B, it was assumed that a customer would not convert unless the net effect of the fuel bill savings and the loan payment would be equivalent to a 10% reduction to the customer's fuel expenditure's before conversion. The difference between the actual and the amount for 10% savings was taken as an estimate of the required extra incentive to drive conversion in that segment and sector.