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SUBJECT:	Massachusetts Residential Non-Energy Impacts (NEIs): Deemed NEI Values Addressing Differences in NEIs for Heating, Cooling, and Water Heating Equipment that is Early Replacement Compared to Replace on Failure
DATE:	July 15, 2013

1 Introduction

Non-Energy Impacts (NEIs) associated with heating, cooling, and water heating equipment may differ according to whether the program-sponsored equipment is an early replacement measure, a measure that is replacing failed equipment, or equipment that was scheduled to be replaced. As explained in the C&I NEI report, if NEIs have resulted from measures that either replaced a failed existing measure or replaced a functioning measure that was scheduled to be replaced immediately, the entire NEI is not attributable to the Program Administrators' (PAs) programs.[1] Instead, only the portion of the NEI that is associated with the measure's energy efficiency is attributable to the PAs' programs, and the portion of the NEI associated with a measure's "newness" is not applicable to the program, because the participant would have incurred that benefit or cost without the program.

This memorandum provides adjusted deemed NEI values that address the differences in NEIs for residential heating, cooling, and water heating equipment that is early replacement compared to replace on failure. These deemed NEIs update the NEIs provided in the residential NEI report submitted to the PAs on August 15, 2011[2].

[1] DNV KEMA and TetraTech. 2012. Massachusetts Program Administrators Final Report – Commercial and Industrial Non-Energy Impacts Study. June 29, 2012. http://www.ma-eeac.org/docs/2011%20to%202012%20EMV/Cross%20Cutting_General/DNV%20KEMA%20Final%20MA%20NEI%20REPORT%20June%2029%202012.pdf.

[2] NMR Group, Inc. (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation. Prepared for the Electric and Gas Program Administrators of Massachusetts. (http://www.ma-eeac.org/Docs/8.1_EMV%20Page/2011/2011%20Residential%20Studies/Mass%20Crosscutting%20NEIs%20Final%20Report%20081511.pdf)

We took several steps to adjust NEI estimates for residential heating, cooling, and water heating measures that replaced failed equipment. First, we used professional judgment and the NEI literature to attribute a portion of the NEIs associated with heating, cooling, and water heating systems to the measure's "newness" and a portion to the measure being energy efficient. We assigned NEI attribution factors according to the following broad categories of attribution:

- The entire NEI is attributable to the measure being energy efficient: 0% attributable to "newness" and 100% attributable to being energy efficient
- The NEI is predominantly attributable to the measure being energy efficient: 33% attributable to "newness" and 67% attributable to being energy efficient
- The NEI is equally attributable to the measure being energy efficient and being new: 50% attributable to "newness" and 50% attributable to being energy efficient
- The NEI is predominantly attributable to the measure being new: 67% attributable to "newness" and 33% attributable to being energy efficient
- The entire NEI is attributable to the measure being new: 100% attributable to "newness" and 0% attributable to being energy efficient.

Second, using the attribution factors, we estimated the value of the portion of NEIs for heating, cooling, and water heating measures associated with the energy efficiency of the measure for systems that are replaced on failure. Then, using data from the current HEHE and Cool Smart evaluation,[3] we determined the percentage of program participants that replaced failed systems and assigned the adjusted NEI values to these participants.

[3] Cadmus. 2013. 2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing (Draft Final Report). June 2013. Prepared for The Electric and Gas Program Administrators of Massachusetts.

2 NEI Attribution Factors

Table 1 displays the residential NEIs associated with heating, cooling, and water heating equipment for which the value may differ according to whether the equipment is early replacement or replacement on failure (ROF), the portion of the NEI attributable to the measure's "newness," and the portion attributable to the measure being energy efficient. Table 1 includes the residential NEIs listed in Appendix C: Non-Resource Impacts of the Massachusetts Technical Reference Manual that are either (1) applied on a per participant basis with heating, cooling, or water heating equipment listed as the measure category, or (2) applied on a per measure basis with HVAC listed as the end use.[4] Excluded from Table 1 are residential NEIs that are derived exclusively from low-income programs, since low-income programs are described in the current HEHE and Cool Smart evaluation as early replacement efforts.[5] The residential NEI of equipment maintenance is also excluded from Table 1 because the PAs determined that this NEI should only be applied to non-oil-to-gas early replacement heating, cooling, or heating and hot water system measures. A discussion of how we determined the portion of each NEI attributable to the measure's "newness" and the portion attributable to the measure being energy efficient follows Table 1.

[4] Massachusetts Electric and Gas Energy Efficiency Program Administrators. 2012. Massachusetts Technical Reference Manual for Estimating Savings from Energy Efficiency Measures 2013-2015 Program Years – Plan Version. (http://www.ma-eeac.org/Docs/8.3_TRMs/1MATRM_2013-15%20PLAN_FINAL.pdf).

[5] Cadmus. 2013. 2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing (Draft Final Report). June 2013. Prepared for The Electric and Gas Program Administrators of Massachusetts.

Table 1. NEI Attribution Factors

NEI	Measure Category/ End Use	Percent Attributable to Newness	Percent Attributable to Energy Efficiency
Thermal Comfort	Heating System	0%	100%
	Cooling System		
	Heating and Cooling System		
Health Benefits	Heating System	0%	100%
	Cooling System		
	Heating and Cooling System		
	Heating and Hot Water System[1]		
Property Value Increase	Heating System	50%	50%
	Cooling System		
	Heating and Cooling System		
	Hot Water System		
	Heating and Hot Water System		
Home Durability	Heating System	67%	33%
	Cooling System		
	Heating and Cooling System		
	Hot Water System		
	Heating and Hot Water System		
Noise Reduction	Cooling System	33%	67%
	Heating and Cooling System		

[1] "Heating and hot water system" values are applied to integrated water heater/condensing boilers.

2.1 Thermal Comfort

Participants in energy efficiency programs that include HVAC components and shell measures commonly experience greater perceived comfort, due to fewer drafts and more even temperatures throughout the home. Where the NEI of thermal comfort has been investigated in the literature, it has most often been valued at the whole-house level in conjunction with programs that include both HVAC equipment and shell measures. In California, the low-income energy-efficiency programs improved household comfort by making the house warmer, making it more affordable to keep warm, and reducing draftiness (TecMarket Works, SERA, and Megdal Associates, 2001). Shell measures, such as air sealing and insulation, help maintain internal temperatures and reduce draftiness by restricting heat and air flow between the interior and exterior of the home. Heating and cooling equipment that is energy efficient makes it less expensive to maintain a comfortable temperature in the home than less energy efficient equipment.

We have found no reports or analyses which have attempted to directly measure the relative contribution of individual measures to improvements in thermal comfort, though shell measures may have a more direct impact by reducing draftiness and thus be responsible for a disproportionate amount of the thermal comfort NEI. However, the *2001 California Low Income Public Purpose Test (LIPPT) Report* (TecMarket Works, SERA, and Megdal Associates, 2001) assigned a portion of a given NEI value to an individual measure based on the average energy bill savings for which the measure is responsible.

Like the 2001 California LIPPT Report, the NEIs provided in the residential NEI report submitted to the PAs on August 15, 2011[6] were estimated at the measure level. To estimate NEIs at the measure level, NMR assigned a portion of a given NEI value, such as the value of thermal comfort, to an individual measure based on the average energy bill savings for which the measure is responsible. As a result, there are separate thermal comfort NEI values for shell measures (air sealing, insulation, windows) and HVAC measures (cooling systems, heating systems, heating and cooling systems).

Because heating and cooling equipment that is energy efficient makes it less expensive to maintain a comfortable temperature in the home, we attribute the entire value of thermal comfort derived from heating and cooling equipment to the measure being energy efficient (i.e. 0% attributable to "newness"). However, this inherently implies some level of snapback, or increased usage resulting in reduced energy savings. The NEI literature we reviewed for the residential NEI report did not address the phenomenon of snapback. We reviewed several recent reports on the topic of snapback, including an American Council for an Energy-Efficient Economy white paper summarizing snapback findings in various reports (Nadel, 2012). This white paper reports that direct rebound effects (snapback) associated with space heating ranging from 10-30%, and that a likely range of direct rebound associated with space heating for the majority of U.S. households is 1-12%. In terms of space cooling, the white paper reports that while some studies have found evidence of snapback for air conditioning, others have not or were inconclusive.

For the residential NEI report, the NEI value of comfort was estimated via a relative valuation survey method, wherein respondents valued each NEI in relation to an estimate of their annual energy bill savings. Since the estimated annual energy bill savings was not adjusted for snapback, the NEI value for thermal comfort may be inflated. In addition, shell measures may be responsible for a disproportionate amount of the thermal comfort NEI, Given the uncertainty of the amount of snapback, the possibility that the original value is inflated as a result of snapback, and the possibility that shell measures are responsible for a disproportionate amount of the thermal comfort, we believe that a conservative approach is to discount the value of this NEI by one-half.

2.2 Health Benefits

Heating and cooling equipment that is energy efficient makes it less expensive to maintain a healthy temperature in the home than less energy efficient equipment. Adverse health outcomes are associated with excessive hot and cold weather, and with increased prevalence of deaths and hospitalizations on excessively hot and cold days (Knowlton et al., 2009; O'Neil et al., 2005; Ostro et al., 2010; Snyder and Baker, 2010). In a review of housing and energy within the World Health Organization (WHO) European Region that investigated fuel poverty, the WHO recommended a safe indoor temperature range of 65°F–70°F (WHO, 2007). A number of recent studies have found links between temperatures in the home and health outcomes. For example, in a study of the effect of temperature on mortality in California, Ostro et al. (2010) observed (1) significant associations between heat and several disease-specific types of hospital admissions in California and (2) that the use of central AC appeared to significantly reduce the risk from higher temperatures. In a randomized community trial in New Zealand involving installation of energy efficient heaters, Preval et al. (2010) found that the installation of new heaters raised the indoor temperatures, and that the increase in temperatures likely improved occupant health. A study of heating and insulation retrofits in the United Kingdom found that program participants who, after the retrofits, increased their indoor air temperature to temperatures recommended by the WHO, increased their life expectancy (Liddell, 2009).

These findings from the health literature suggest that health benefits are derived from maintaining healthy temperatures in the home, which is dependent upon the ability to afford the fuel. Energy efficient heating and cooling equipment is more affordable to operate due to its energy efficiency and not its "newness." Therefore, we attribute the entire value of health benefits derived from heating and cooling equipment to the measure being energy efficient (i.e. 0% attributable to "newness"). However, this inherently implies

[6] NMR Group, Inc. (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation. Prepared for the Electric and Gas Program Administrators of Massachusetts. (http://www.ma-eeac.org/Docs/8.1_EMV%20Page/2011/2011%20Residential%20Studies/Mass%20Crosscutting%20NEIs%20Final%20Report%20081511.pdf)

some level of snapback, or increased usage resulting in reduced energy savings. Since the estimated annual energy bill savings on which respondents based the value of NEIs was not adjusted for snapback, the NEI value for health benefits may be inflated. Given the uncertainty of the amount of snapback and the possibility that the original value is inflated, we believe that a conservative approach is to discount the value of this NEI by one-half.

2.3 Property Value Increase

All other things equal, a new heating, cooling, or hot water system is more valuable than an older one because it has more years of useful life. An energy efficient heating, cooling, or hot water system is more valuable than a less efficient system because it has lower operating costs. Several studies have linked energy efficiency with higher property selling prices, including Drakos et al. (2011), Griffin et al. (2009), Berry et al. (2008), and Nevin and Watson (1998). While Nevin and Watson (1998) controlled for the age of the home in their analysis, none of these studies specifically addressed the age of the heating, cooling, or hot water equipment in the homes. We think it is reasonable to attribute the value of this NEI equally to the measure being energy efficient and being new.

2.4 Home Durability

Homes built with better-quality heating, cooling, and structural materials are potentially more durable, therefore requiring less maintenance. At the same time, new heating, cooling, and water heating systems require less maintenance than older ones. To the extent that energy efficiency programs install better quality heating, cooling, and hot water systems than would have been installed in the absence of the program, they provide value to participants in the form of avoided maintenance costs and transaction costs. Only one study in the NEI literature examined participant valuation of home durability. The 2006 Non-Energy Impact Evaluation for the NY ENERGY STAR Labeled Homes program found that 42% of program participants believed that their new ENERGY STAR-labeled home was more durable than their old home. Conjoint analysis questions asked at the end of the survey revealed that respondents were willing to pay a premium of $5,648 in the upfront cost of the home to have a home that is “built following best practices in installation, so that the heating and cooling and structural materials are less prone to failure and may exceed their expected lifetimes.” In the absence of further studies linking energy-efficient heating, cooling, and hot water equipment with home durability, we attribute the value of this NEI predominantly to its being new.

2.5 Noise Reduction

Cooling systems and heat pumps that operate quietly can benefit participants in the form of reduced noise in the home. A recent report found that energy-efficient residential central air conditioning (CAC) systems are packaged with a variety of premium, non-energy features, including noise reduction. Through interviews with installers of CAC systems in Massachusetts, the study found that “manufacturers often reserve premium features for higher efficiency units to differentiate their product offerings” (Navigant Consulting Inc., 2013). In light of these findings, we think it is reasonable to attribute the value of noise reduction associated with cooling equipment predominantly to the measure being energy efficient.

3 Adjusted NEI Values

A recent evaluation of the Massachusetts Cool Smart and High-Efficiency Heating and Water Heating Equipment (HEHE) programs investigated the timing of equipment replacement for residential heating and cooling equipment. The Cool Smart program offers rebates for residential CAC, air-source heat pumps, and ductless mini-splits, while the HEHE program offers rebates for residential gas furnaces, boilers, integrated boilers and water heaters, indirect water heaters, storage water heaters, tankless water heaters, and stand-alone gas water heater equipment. In the evaluation, participants were classified as either: (1) early replacement (4 or more years of remaining life), (2) replace-on-failure (ROF), (3) new units, or (4) in-between (units that are neither clearly early, new, nor ROF). Table 2 displays the equipment replacement timing findings from the evaluation.

Table 2: Equipment Replacement Timing in HEHE and Cool Smart Programs

Measure	Equipment Replacement Timing Shares			
	Early	New	ROF	In-Between
Boiler	30.6%	0.0%	44.9%	24.5%
Furnace	23.1%	0.0%	61.5%	15.4%
Central Air Conditioner / Heat Pump	8.0%	50.4%	29.2%	12.4%
Ductless Mini-Split	2.5%	95.1%	0.0%	2.5%
Integrated Boiler / Water Heater	20.0%	0.0%	55.7%	24.3%
Storage Water Heater	33.3%	0.0%	50.0%	16.7%
Tankless Water Heater	28.0%	0.0%	54.8%	17.2%

The evaluation further explored the rate of oil-to-gas conversions for boiler and furnace replacements. Table 3 displays the equipment replacement timing findings by oil-to-gas conversion status.

Table 3: Boiler and Furnace Replacement Timing by Oil-to-Gas Conversion Status

Measure	Oil to Gas Conversion?	Equipment Replacement Timing Shares			
		Early	ROF	In-Between	All
Boilers between 90 and 96% AFUE	No	6.8%	23.0%	13.5%	100%
	Yes	27.0%	18.9%	10.8%	
Boilers greater than or equal to 96% AFUE	No	6.9%	20.8%	12.5%	100%
	Yes	20.8%	26.4%	12.5%	
Furnaces greater than or equal to 95% AFUE	No	9.1%	45.5%	5.2%	100%
	Yes	14.3%	15.6%	10.4%	

In light of the equipment replacement timing and oil-to-gas conversion findings from the evaluation of the Cool Smart and HEHE programs, the PAs have claimed all oil-to-gas conversions in Table 3 as ROF, and have claimed half of the "in-between" replacements in Table 2 as early and the other half as ROF. Table 4 displays the ROF rates the PAs have claimed.

Table 4: ROF Equipment Replacement Timing Shares for Adjusted NEI Values

Measure	ROF
Boilers between 90 and 96% AFUE	86.5%
Boilers greater than or equal to 96% AFUE	86.8%
Furnaces greater than or equal to 95% AFUE	88.4%
Central Air Conditioner / Heat Pump	35.4%
Ductless Mini-Split	1.3%
Integrated Boiler / Water Heater	67.9%
Storage Water Heater	58.4%
Tankless Water Heater	63.4%

We utilized the ROF rates from Table 4 along with the attribution factors from Table 1 to adjust the annual NEI estimates for heating, cooling, and water heating measures that replaced failed equipment. We calculated the value of NEIs for ROF equipment by multiplying the percent attributable to the measure being energy efficient by the full NEI value. These values are labeled 'ROF NEI Value' in Table 5 and Table 6. We multiplied the new ROF NEI value by the ROF rate from Table 4 to derive the ROF portion of the NEI estimate. Next, we multiplied the full NEI value by one minus the ROF rate, representing the non-ROF portion of the NEI estimate. Finally, we derived an overall NEI value by adding the ROF portion of the NEI estimate to the non-ROF portion of the NEI estimate. Equation 1 shows the formula for this process. Because the NEI values reported in Table 5 and Table 6 are annual values, they should be applied only once for NEIs with a duration of 'one time,' and annually for the remaining useful life (RUL) of measures for NEIs with an 'annual' duration.

The NEIs of thermal comfort and health benefits in Table 6 are separated from noise reduction, home durability, and property value increase in Table 5 for two reasons. First, since we attribute 100% of thermal comfort and health benefits to energy efficiency, there is no difference between the ROF NEI value and the full NEI value. Second, there is the additional adjustment of discounting the values of these two particular NEIs by one-half, due to the uncertainty associated with the level of snapback and the potentially inflated initial estimates that did not account for snapback.[7]

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Equation 1: Overall NEI Value Adjusted for ROF Measures

$$Overall\ NEI\ Value = [(EE\ Portion\ of\ NEI * Full\ NEI\ Value) * ROF\%] + [Full\ NEI\ Value * (1 - ROF\%)]$$

[7] In addition, shell measures may be responsible for a disproportionate amount of the thermal comfort NEI,

Table 5: Adjusted NEI Values for Noise Reduction, Home Durability, and Property Value Increase

Measure Category	Measure	NEI	Duration	Full NEI Value ($/Year)	EE Portion of NEI	ROF NEI Value ($/Year)	Percent ROF	Overall NEI Value ($/Year)
Cooling System	Central Air Conditioner/ Heat Pump	Noise Reduction	Annual	$2.83	67%	$1.90	35.4%	$2.50
		Home Durability	Annual	$1.54	33%	$0.51		$1.17
		Property Value Increase	One Time	$62.65	50%	$31.33		$51.56
Heating and Cooling System	Ductless Mini-Split	Noise Reduction	Annual	$1.42	67%	$0.95	1.3%	$1.41
		Home Durability	Annual	$1.98	33%	$0.65		$1.96
		Property Value Increase	One Time	$80.69	50%	$40.35		$80.19
Heating System	Boilers between 90 and 96% AFUE	Home Durability	Annual	$17.42	33%	$5.75	86.5%	$7.33
		Property Value Increase	One Time	$678.52	50%	$339.26		$385.23
	Boilers greater than or equal to 96% AFUE	Home Durability	Annual	$17.42	33%	$5.75	86.8%	$7.30
		Property Value Increase	One Time	$678.52	50%	$339.26		$384.21
	Furnaces greater than or equal to 95% AFUE	Home Durability	Annual	$17.42	33%	$5.75	88.4%	$7.10
		Property Value Increase	One Time	$678.52	50%	$339.26		$378.61
Heating and Hot Water System	Integrated Boiler / Water Heater	Home Durability	Annual	$0.72	33%	$0.24	67.9%	$0.39
		Property Value Increase	One Time	$29.17	50%	$14.59		$19.27
Hot Water System	Storage Water Heater	Home Durability	Annual	$2.13	33%	$0.70	58.4%	$1.30
		Property Value Increase	One Time	$82.56	50%	$41.28		$58.47
	Tankless Water	Home Durability	Annual	$2.13	33%	$0.70	63.4%	$1.23

Measure Category	Measure	NEI	Duration	Full NEI Value ($/Year)	EE Portion of NEI	ROF NEI Value ($/Year)	Percent ROF	Overall NEI Value ($/Year)
	Heater	Property Value Increase	One Time	$82.56	50%	$41.28		$56.39

Table 6: Adjusted NEI Values for Thermal Comfort and Health Benefits

Measure Category	Measure	NEI	Duration	Full NEI Value ($/Year)	EE Portion of NEI	ROF NEI Value ($/Year)	Final Adjust-ment	Adjusted NEI Value ($/Year)
Cooling System	Central Air Conditioner / Heat Pump	Thermal Comfort	Annual	$3.92	100%	$3.92	÷ 2	$1.96
		Health Benefits		$0.13		$0.13		$0.07
Heating and Cooling System	Ductless Mini-Split	Thermal Comfort	Annual	$5.05	100%	$5.05	÷ 2	$2.53
		Health Benefits		$0.16		$0.16		$0.08
Heating System	Boilers between 90 and 96% AFUE	Thermal Comfort	Annual	$48.63	100%	$48.63	÷ 2	$24.32
		Health Benefits		$1.56		$1.56		$0.78
	Boilers greater than or equal to 96% AFUE	Thermal Comfort	Annual	$48.63	100%	$48.63	÷ 2	$24.32
		Health Benefits		$1.56		$1.56		$0.78
	Furnaces greater than or equal to 95% AFUE	Thermal Comfort	Annual	$48.63	100%	$48.63	÷ 2	$24.32
		Health Benefits		$1.56		$1.56		$0.78
Heating and Hot Water System	Integrated Boiler / Water Heater	Thermal Comfort	Annual	$1.83	100%	$1.83	÷ 2	$0.92
		Health Benefits		$0.06		$0.06		$0.03

4 References

Berry, Stephen, Tony Marker, and Tom Chevalier. (2008). Modeling the Relationship between Energy Efficiency Attributes and House Price: The Case of Detached Houses Sold in the Australian Capital Territory in 2005 and 2006. 2008 American Council for an Energy-Efficient Economy Summer Study Conference. Pacific Grove: American Council for an Energy-Efficient Economy.

The Cadmus Group, Inc. (2013). 2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing Volume I. Prepared for the Electric and Gas Program Administrators of Massachusetts.

The Cadmus Group, Inc. (2013). 2012 Residential Heating, Water Heating, and Cooling Equipment Evaluation: Net-to-Gross, Market Effects, and Equipment Replacement Timing Volume II: Appendices. Prepared for the Electric and Gas Program Administrators of Massachusetts.

Drakos et al. (2011). Increasing Property Values and Decreasing Forced Mobility: Analysis of Nonenergy Benefits for Low-Income Programs. International Energy Program Evaluation Conference. Boston: International Energy Program Evaluation Conference.

Griffin, Ann, Ben Kaufman, and Sterling Hamilton. (2009). Certified Home Performance: Assessing the Market Impacts of Third Party Certification on Residential Properties.

Knowlton, Kim, Paul English, Galatea King, Helene G. Margolis, Daniel Smith, and Gina Solomon. (2009). The 2006 California Heat Wave: Impacts on Hospitalizations and Emergency Department Visits. Environmental Health Perspectives. 117:61-67.

Liddell, Christine. (2009). Tackling Fuel Poverty and Impacts on Human Health: A Review of Recent Evidence. Ulster.

Massachusetts Electric and Gas Energy Efficiency Program Administrators. (2012). Massachusetts Technical Reference Manual for Estimating Savings from Energy Efficiency Measures: 2013-2015 Program Years – Plan Version.

Michaels, Robert. (2012). Energy Efficiency and Climate Policy: The Rebound Dilemma. Washington, DC: Institute for Energy Research.

Nadel, Steven. (2012). The Rebound Effect: Large or Small? Washington, D.C.: American Council for an Energy-Efficient Economy.

Navigant Consulting, Inc. (2013). Incremental Cost Study Phase Two Final Report: A Report on 12 Energy Efficiency Measure Incremental Costs in Six Northeast and Mid-Atlantic Markets. Prepared for Prepared for the Evaluation, Measurement and Verification Forum Chaired by the Northeast Energy Efficiency Partnerships.

Nevins, Rick and Gregory Watson. (1998). Evidence of Rational Market Valuation for Home Energy Efficiency. The Appraisal Journal Oct (1998):401-409.

NMR Group, Inc. (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation. Prepared for the Electric and Gas Program Administrators of Massachusetts.

O'Neill, Marie, Shakoor Hajat, Matiana Ramirez-Aguilar, Joel Schwartz, Antonella Zanobetti. (2005). Impact of control for air pollution and respiratory epidemics on the estimated associations of temperature and daily mortality. International Journal of Biometeorology. 50:121-129.

Ostro, Bart, Stephen Rauch, Rochelle Green, Brian Malig, and Rupa Basu. (2010). The Effects of Temperature and Use of Air Conditioning on Hospitalizations. American Journal of Epidemiology. 10:1-9.

Preval, Nick, Ralph Chapman, and Philippa Howard-Chapman. (2010). Evaluating energy, health and carbon co-benefits from improved domestic space heating: A randomized community trial. Energy Policy. 38:3965-3972.

Ryan, Lisa and Nina Campbell. (2012). Spreading the Net: The Multiple Benefits of Energy Efficiency Improvements. Paris: International Energy Agency.

TecMarket Works, Skumatz Economic Research Inc (SERA), and Megdal Associates. (2001). The Low income Public Purpose Test (LIPPT).

WHO (2007). Housing, Energy and Thermal Comfort. Copenhagen:World Health Organization.