Guidehouse

Memorandum

To: Randy Opdyke, Bruce Liu, Jim Jerozal, Nicor Gas; Scott Dimetrosky, Katie Parkinson, Jane Colby, Apex Analytics; Ted Weaver, First Tracks Consulting; Jennifer Morris, David Brightwell, ICC Staff; Celia Johnson, Illinois SAG

From: Kevin Grabner, Laura Agapay-Read, Sophie Gunderson, Ethan Young, Patricia Plympton, Guidehouse

Cc: Stu Slote, Guidehouse

Date: February 19, 2021

Re: Recommended Non-Energy Impacts for Nicor Gas' Cost-Effectiveness Tests

INTRODUCTION

In December 2016, the Illinois General Assembly passed the Future Energy Jobs Act, which contains language on including additional non-energy benefits (now described as non-energy impacts (NEIs)) in energy efficiency programs' total resource cost (TRC) tests[1].

Electric

> *"A total resource cost test compares the sum of avoided electric utility costs, representing the benefits that accrue to the system and participant in the delivery of those efficiency measures and including avoided costs associated with reduced use of natural gas or other fuels, avoided costs associated with reduced water consumption, and avoided costs associated with reduced operation and maintenance costs, as well as other quantifiable social benefits…".*

Natural Gas

> *"The total resource cost test compares the sum of avoided natural gas utility costs, representing the benefits that accrue to the system and the participant in the delivery of those efficiency measures, as well as other quantifiable societal benefits, including avoided electric utility costs…"*

FEJA also contains language regarding not requiring income eligible programs to meet the TRC test:

[1] FEJA (Illinois Future Energy Jobs Act). Public Act 099-0906. www.ilga.gov/legislation/publicacts/99/PDF/099-0906.pdf. (passed December 7, 2016).

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Electric

> *Demonstrate that its overall portfolio of measures, not including low-income programs described in subsection (c) of this Section, is cost-effective using the total resource cost test.*

Natural Gas

> *The low-income programs described in item (4) of subsection (f) of this Section shall not be required to meet the total resource cost test.*

Currently, the Illinois Technical Reference Manual[2] (TRM) includes deemed monetized values for societal and participant NEIs. The TRM quantifies the following NEIs to include in TRC tests:

- **Societal: Avoided use of water (water savings) from energy efficiency programs:** Water savings are based on measurements consistent with federal standards. The value of the savings is determined by what Illinois customers would have paid for the water saved.

- **Participant: Reduced or increased O&M costs:** This is a deemed value based on the estimated impact from reduced or increased labor and materials that occur once a building has received energy efficiency improvements. For example, a heat recovery grease trap filter may result in reduced cleaning frequencies, while new equipment such as adding controls or tankless water heaters may increase O&M costs.

Nicor Gas cost-effectiveness modeling includes two additional NEI values that were estimated from secondary sources.

- **Utility: Avoided environmental costs from reduced carbon emissions:** Environmental costs are the dollar per therm ($/therm) quantification of the benefits Nicor Gas has achieved by reduced carbon emissions associated with reducing gas use through energy efficiency programs. A carbon reduction adder of $0.134 per therm (based on a carbon adder of $25/metric ton) is included starting in 2020 for the TRC analysis.

- **Non-Energy Benefits Adder:** A Non-Energy Benefits adder of 7.5 percent is included in Nicor Gas TRC modeling to account for the value of all NEIs except carbon emissions, water savings, and participant O&M costs. The value is based on secondary research.

NEIs Applicable to Natural Gas Utilities' Cost-Effectiveness Tests

Guidehouse conducted a literature search to determine which states or natural gas utilities use quantified and monetized NEIs for cost-effectiveness tests. The research included identifying methodologies previously used by states or natural gas utilities to evaluate NEIs. This gas-focused research leveraged and builds upon the extensive research conducted by Guidehouse for ComEd.[3][4]

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[2] IL SAG. Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 8.0. Illinois Commerce Commission. Springfield: IL. s3.amazonaws.com/ilsag/2020_IL-TRM_Version_8.0_dated_October-17-2019_Final_Volumes_1-4_Compiled.pdf.

[3] Guidehouse report "Quantifying Non-Energy Benefits from ComEd's Income Eligible Programs: Findings and Recommendations from Secondary Research," March 6, 2018. https://s3.amazonaws.com/ilsag/ComEd_Income_Eligible_Programs_NEBs_Secondary_Research_Report_2018-03-06.pdf

[4] Guidehouse memo "Review of States' Methodologies to include Monetized Non-Energy Impacts in Cost-Effectiveness Tests," April 30, 2020. : https://s3.amazonaws.com/ilsag/ComEd-Memo-Methods-to-Include-NEIs-in-C-E-Tests_Draft_2020-04-30.docx

For societal NEI estimates, Guidehouse conducted an analysis on programs expected to be implemented by Nicor Gas in CY2022 through CY2025 using the methodology developed for ComEd and adjusted for gas utilities. Under this approach, the analysis team used the lifetime stream of net savings achieved in the CY2019 portfolio as a representation of the lifetime stream of savings achieved under programs that may be implemented in CY2022-2025, as this represents the most recent set of savings vetted by the evaluation team.

For participant NEI estimates, Guidehouse recommends proxy values for monetized NEIs associated with Nicor Gas' implemented programs. Guidehouse determined these proxy values using NEI research conducted for Massachusetts to quantify and monetize participant NEIs. Massachusetts used monetized participant NEI values in their cost-effectiveness tests.

The following describes Guidehouse's approach to evaluating societal NEIs, as well as Massachusetts's methodologies and proxy values used for participant NEIs.

Societal NEIs

Nicor Gas' energy efficiency (EE) programs lead to substantial savings of natural gas across both the residential and non-residential sectors, with these savings projected to persist for as long as 25 years into the future, depending on the measures implemented. In turn, over the same period, substantial reductions in the emissions of $PM_{2.5}$, NOx, SO_2, NH3, and volatile organic compounds (VOCs) are expected.

Human health is significantly impacted by exposure to pollutants such as PM2.5, SO2, and NOx. Premature infant and adult mortality has been linked to increased exposure to ambient air pollution.[5] Further, increased exposure to pollutants such as PM2.5 can lead to the development or exacerbation of respiratory and cardiovascular conditions. Each of the health outcomes from ambient pollution exposure, particularly exposure to PM2.5,[6] come at a substantial economic cost.[7] The reduction in emissions of these pollutants attributed to Nicor Gas' EE programs and their lifetime savings also realized benefits associated with avoided adverse health outcomes.

The EPA developed a tool that estimates the health benefits of reduced emissions from power generation: CO-Benefits Risk Assessment (COBRA). Updated in June 2020, COBRA is a peer reviewed screening tool that establishes the human health benefits and associated economic impacts of emission reduction scenarios.[8] The COBRA model uses county-level emission reductions to estimate changes in health outcomes.

Guidehouse generated four sets of Societal NEI estimates to be included in Nicor's TRC tests of CY2022-2025 programs, based on CY2019 data. To generate these estimates, Guidehouse repeated an annual six-step modeling approach four times. Guidehouse first worked to ensure that all lifetime energy savings were accounted for, as Nicor's programs cover a variety of measures with measure lives ranging from one to 25 years. In the case of 2022 Societal NEIs, Guidehouse took program savings for CY2019 programs, which spanned 2019 through 2042, then assumed these savings will occur from 2022 through 2046. Guidehouse then estimated the emissions reductions and health benefits associated with these savings for each year from 2022 through 2046, discounting each

[5] On an annual basis, the World Health Organization (WHO) estimates around 4.2 million premature deaths globally are linked to ambient air pollution, with the most harmful culprits being PM2.5, SO2, NO2, and Ozone https://www.who.int/airpollution/ambient/health-impacts/en/ Accessed: August 17, 2020.
[6] https://www.epa.gov/clean-air-act-overview/air-pollution-current-and-future-challenges Accessed: August 17, 2020.
[7] https://www.epa.gov/environmental-economics/mortality-risk-valuation Accessed: August 17, 2020.
[8] https://www.epa.gov/statelocalenergy/how-cobra-works. Accessed: July 15, 2020.

year's health benefits estimates back to 2022, then summed the stream of discounted health benefits. This process was repeated for 2023, 2024, and 2025 Societal NEI estimation. The annual, six-step approach and an example of how to apply these values is detailed further in Appendix A.

To facilitate the measurement of reductions in emissions of pollutants due to Nicor Gas' CY2019 programs, the U.S. Environmental Protection Agency (EPA) provided Guidehouse with natural gas emissions factors. **Error! Reference source not found.** below shows the emissions factors provided, grouped by sector and pollutant type.[9,10,11]

Table 1. Emission Factors

Pollutant	Non-Residential Factors (lb/MMCF)	Residential Factors (lb/MMCF)
$PM_{2.5}$	0.43	0.43
NOx	100	94
SO2	0.6	0.6
NH3	0.49	20
VOC	5.5	5.5

Source: U.S. EPA reports AP-42, EIIP, and NEI.

Using emissions factors illustrated above, Guidehouse calculated the emissions reductions associated with verified savings across the residential and non-residential sectors. As Nicor Gas' CY2019 measures can accrue savings for up to 25 years, emissions reductions were calculated for each year the portfolio claimed savings via multiplication of each year's natural gas savings with emissions factors. Table 2 below provides the total calculated emissions reductions associated with Nicor Gas' CY2019 sectors.

Table 2. Emission Changes

Pollutant	Non-Residential Sector (tons)	Residential Sector (tons)
$PM_{2.5}$	6.67	1.90
NOx	1,550.71	416.11
SO2	9.30	2.66
NH3	7.60	88.53
VOC	85.29	24.35

Source: Nicor Gas CY2019 Data; Guidehouse Analysis.

[9] U.S. Environmental Protection Agency. 1996. Compilation of Air Pollutant Emission Factors, 5th Edition, (AP-42), Volume I: Stationary Point and Area Sources. Research Triangle Park, NC. https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emission-factors#5thed

[10] U.S. Environmental Protection Agency. 2004. Emission Inventory Improvement Program (EIIP). Estimating Ammonia Emissions from Anthropogenic Sources, Draft Final Report. Prepared by E.H. Pechan and Associates, Inc. Research Triangle Park, NC. https://www.epa.gov/sites/production/files/2015-08/documents/eiip_areasourcesnh3.pdf

[11] U.S. Environmental Protection Agency. 2020. 2017 National Emissions Inventory Complete Release: Technical Support Document. Research Triangle Park, NC. (NEI) https://www.epa.gov/sites/production/files/2020-04/documents/nei2017_tsd_full_30apr2020.pdf

The COBRA model has three baseline emission data frames pre-loaded into the software – 2016, 2023 and 2028, and the EPA has estimated population changes and resulting health responses to emission changes in each of these baseline years. Guidehouse conducted the COBRA analysis on an annual basis by inputting the estimated savings from what we expect will be Nicor Gas's CY2022-2025 program measures for each year ranging from 2022 to 2049. COBRA also accounts for the changes in baseline population and health responses to emissions over time. During this process, Guidehouse carefully aligned the nearest COBRA baseline year to each portfolio year, as shown in **Error! Reference source not found.**.

Table 3. COBRA Baseline and Portfolio Years

COBRA Baseline Used	Portfolio Years
2016	2022
2023	2023-2027
2028	2028-2049

Source: Guidehouse.

The COBRA model also allows the user to choose the location of emissions and energy mix. Guidehouse selected the Nicor Gas territory's counties for the emissions location and selected residential and non-residential natural gas emissions tiers. As natural gas emissions are created on a local scale relative to electricity, the distinction between residential and non-residential emissions is essential. Guidehouse evaluated the benefits resulting from these portfolio sectors separately and applied the discounted benefits per therm values annually to each program encompassed in the sectors in CY2019.

Furthermore, COBRA has an option to input a preferred discount rate. The EPA provided Guidehouse a custom valuation file using a 2.40 percent discount rate, a discount rate deemed by the Illinois Technical Reference Manual (IL TRM) beginning in v9.0.[12] Guidehouse applied this discount rate to evaluate the economic benefits resulting from emissions reductions attributed to Nicor Gas' CY2019 programs.

Table 4**Error! Reference source not found.** shows the estimated benefits per therm for the residential and non-residential sectors for modeled CY2022-2025 portfolios. Guidehouse discounted these values back to the program year's dollar value. So, in this case, CY2025 societal NEI estimates are presented in 2025 dollars. The values encompass all monetized health benefit categories within COBRA and cover all years between 2019 and 2042.[13] Appendix A provides program-level and annual benefits per therm estimates for the four program years evaluated from the CY2019 portfolio.

[12] Illinois Statewide Technical Reference Manual for Energy Efficiency Version 9.0, final available at: http://www.ilsag.info/technical-reference-manual.html

[13] All estimated health benefits for the years 2019 through 2042 were discounted to 2022-2025 dollars according to program year.

Table 4. CY2022-2025 Societal NEI Estimates - By Portfolio

Sector	CY2019 Verified Net Lifetime Savings (Therms)	Program Year	$ Total Health Benefits	$ Total Health Benefits per Net Therm (Average)
Residential	91,809,346	CY2022	$15,174,568	$0.1654
		CY2023	$15,238,471	$0.1661
		CY2024	$15,280,818	$0.1666
		CY2025	$15,323,343	$0.1671
Non-Residential	321,616,716	CY2022	$56,552,026	$0.1761
		CY2023	$56,785,415	$0.1772
		CY2024	$56,950,914	$0.1781
		CY2025	$57,117,146	$0.1790

Source: Guidehouse CY2019 Nicor Gas Program Savings data and COBRA model. Values shown for CY2019 lifetime net therms may have minor rounding differences for some measures compared with end of year summary reports, related to partial year measure lives.

Please note that the dollar per therm benefits shown in Table 4 should only be applied to the lifetime therms saved from a given implementation year. For example, if a measure was installed in CY2022 and has not reached its end of useful life by 2025, the therms saved from that measure in 2025 should not be incorporated in the CY2025 cost-effectiveness tests. This recommended application of dollars per therm benefits would avoid double-counting benefits year after year.

Sources of Values for Participant NEIs

Guidehouse used studies from Massachusetts to produce recommended values for Nicor Gas' participant NEIs. The table below lists the NEI types and the sources we used to produce recommendations for Nicor Gas' NEI values.

Table 5. NEI Types and Sources

NEI Type	State	Research Study	Authors
Participant	Massachusetts	Massachusetts Special and Cross-Cutting Research Area: Low-Income Single-Family Health- and Safety-Related Non-Energy Impacts (NEIs) Study (2016)	Three[3] Inc. and NMG Group, Inc.
Participant	Massachusetts	Low-Income Multifamily Health- and Safety-Related NEIs Study (TXC 50) Preliminary Findings Report (2018)	Three[3] Inc. and NMG Group, Inc.

Source: Guidehouse

Participant NEIs

Participant NEIs quantify health and safety impacts of energy efficiency programs to participants and their household. These impacts include reduced medical costs associated with reduced asthma symptoms and thermal stress, as well as reduced missed days of work.

In 2014, the U.S. Department of Energy's (DOE) conducted a national assessment of the participant NEIs associated with its Weatherization Assistance Program (WAP). The DOE WAP assessment included a comprehensive participant survey which participants completed before participation and one year following participation.[14]

Massachusetts used the same methodology to conduct participant NEI studies which quantified and monetized values used in cost-effectiveness tests.**Error! Bookmark not defined.**, **Error! Bookmark not defined.** The state performed studies in varying years and the reported values do not represent the current value of the dollar.

Guidehouse compiled the participant NEI values from these studies to determine estimates in 2022 to 2025 dollars, shown in Table 6. Multifamily and single-family building types are shown separately in the below tables to reflect the differing measure mixes and resulting impacts on the participants in those households. Appendix C provides the unadjusted values from the state's studies.

Table 6. Multifamily Monetized Participant NEI Proxys – Per Household Annually

Participant NEI type	Guidehouse Adjusted Values ($2022)	Guidehouse Adjusted Values ($2023)	Guidehouse Adjusted Values ($2024)	Guidehouse Adjusted Values ($2025)
Thermal Comfort	29.20	29.80	30.39	30.96
Health & Safety (including Asthma Reduction)	38.17	38.96	39.74	40.49
Reduced missed days of work	67.79	69.18	70.57	71.89
Total	135.16	137.94	140.70	143.34

Sources: Skumatz, 2014; Three[3] and NMR Group 2018; Guidehouse analysis.

Table 7. Single-family Monetized Participant NEI Proxys – Per Household Annually

Participant NEI type	Guidehouse Adjusted Values ($2022)	Guidehouse Adjusted Values ($2023)	Guidehouse Adjusted Values ($2024)	Guidehouse Adjusted Values ($2025)
Thermal Comfort	82.64	84.26	85.88	87.43
Health & Safety (including Asthma Reduction)	11.20	11.42	11.64	11.85
Reduced missed days of work	209.52	213.63	217.74	221.66
Total	303.36	309.31	315.26	320.94

Sources: Skumatz, 2014; Three[3] and NMR Group 2016; Guidehouse analysis.

[14] Oak Ridge National Laboratory 2014., "*Weatherization Works- Summary of Findings from the Retrospective Evaluation of the Department of Energy's Weatherization Assistance Program, Managed by UT-Battelle for the US Department of Energy.*" (DOE WAP Study 2014) September. https://www.energy.gov/eere/wap/downloads/weatherization-assistance-program-national-evaluation. Accessed: April 24, 2020.

RECOMMENDATIONS

Based on our review of the current practices that other states use to include monetized NEIs in cost-effectiveness tests, and the current state of relevant data to Nicor Gas, we submit the following recommendations for Nicor Gas consideration:

Recommendation #1: Include monetized nationwide Societal NEI benefits in the Nicor Gas portfolio programs' TRC tests. Please note that the dollar per therm benefits should only be applied to the therms saved from a given implementation year and should not include therms saved from measures installed in previous program years.

Application Process #1: Multiply the averaged sector-level discounted dollar per therm estimates by the lifetime therms savings of the program in the respective sector.

Application Process #2: Given that program measures and mix change with each implementation year, Guidehouse provided non-discounted and non-inflated annual sector-level dollar per therm benefits for CY2022-25 in Appendix A. Multiply these values by program-level annual therm savings of the respective sector from each year of implementation. The resulting savings must be discounted back to the year of implementation using a real discount rate.

Recommendation #2: Include monetized proxy Participant NEI values associated with the Nicor Gas Income Eligible programs in these programs' TRC tests. When available and if statistically significant, use the primary monetized values from ComEd Participant NEI research focused on the joint utility Income Eligible Multifamily, Single-Family and Public Housing programs in these programs' TRC tests.

Application Process: Proportion annual NEI benefits between electric and gas utilities according to utility investment in the program. After apportioning, calculate the lifetime net present value of benefits per household using the program's weighted average measure life and a real discount rate of 0.42 percent, as deemed by the IL TRM v9.0.

APPENDIX A. SOCIETAL NEIS - COBRA ESTIMATED HEALTH BENEFITS

Societal NEI Methodology

The annual, six-step approach described below is an illustration in Table 8**Error! Reference source not found.** below. The example used in the table below focuses on estimation of Societal NEIs for 2032 assuming CY2019 program savings begin in 2022. Additional detail providing context for each step in the analysis is provided in the following paragraphs.

Table 8. Stepwise Summary of Annual Estimation of CY2022 Health Benefits: Year 2032

Step	Description
1. Year 2032 Portfolio-Level CPAS	Assuming CY2019 programs are implemented in CY2022, gather and aggregate all sector-level therm savings to construct a portfolio-level annual timeline of residential and non-residential savings spanning 2022 through 2046, then extract sector-level therm savings for 2032.
2. Evaluate Emission Reductions	Use the emission factors provided by the EPA (shown in **Error! Reference source not found.**) to estimate the tons of emissions reduced by sector for 2032.
3. Execute COBRA Model	Use COBRA to estimate 2032 health benefits from emissions reductions.
4. Discount Benefits to CY2022	Discount 2032 COBRA-estimated sector-level health benefit to CY2022 for TRC tests.
5. Divide Discounted Benefits by Year 2032 CPAS	Divide discounted 2032 COBRA-estimated sector-level health benefit by sector-level savings to generate a discounted health benefit per therm.
6. Multiply by Program-Level Year 2032 CPAS	Multiply discounted 2032 health benefit per therm by program-level savings to calculate 2032 program-level health benefit.

Step 1: Year 2032 Portfolio-Level CPAS
For this summary we focus on estimation of societal health benefits for the Non-Residential Small Business program in 2032 assuming CY2019 programs and the stream of associated savings begin in CY2022. In this first step, gather and aggregate the Nicor Gas CY2019 programs' savings data and measure lives to construct an annual savings table. Assuming CY2019 savings begin in 2022, extract the total Non-Residential savings for year 2032 equal to 12,626,174 Therms for use in Step 2.

Step 2: Evaluate Emission Reductions
To facilitate the measurement of reductions in emissions of pollutants due to Nicor Gas' CY2019 programs, the U.S. Environmental Protection Agency (EPA) provided Guidehouse with natural gas

emissions factors.**Error! Reference source not found.Error! Reference source not found.** Table 9 below shows the emissions factors provided, grouped by sector and pollutant type.[15,16,17]

Table 9. Emission Factors

Pollutant	Non-Residential Factors (lb/MMCF)	Residential Factors (lb/MMCF)
$PM_{2.5}$	0.43	0.43
NOx	100	94
SO2	0.6	0.6
NH3	0.49	20
VOC	5.5	5.5

Source: U.S. EPA reports AP-42, EIIP, and NEI.

Using emissions factors illustrated above, calculate the emissions reductions associated with verified savings across the non-residential sector in 2032.

Step 3: Execute COBRA model
Following estimation of saved emissions estimates, COBRA estimation was conducted using adjusted county-level emissions reductions estimates. COBRA uses emissions reductions to estimate county-level changes in air quality, then estimates the resulting county-level health outcomes and economic costs. The COBRA model has three sets of baseline years included in its current build – 2016, 2023 and 2028. Guidehouse conducted the COBRA analysis on an annual basis by inputting the estimated savings from what we expect will be Nicor Gas's CY2022-2025 program measures for each year ranging from 2022 to 2049. During this process, Guidehouse carefully aligned the nearest COBRA baseline year to each portfolio year, as shown in Table 10 below**Error! Reference source not found.**.

Table 10. COBRA Baseline and Portfolio Years

COBRA Baseline Used	Portfolio Years
2016	2022
2023	2023-2027
2028	2028-2049

Source: Guidehouse.

The COBRA model also allows the user to choose the location of emissions and energy mix. Guidehouse selected the Nicor Gas territory's counties for the emissions location and selected residential and non-residential natural gas emissions tiers. As natural gas emissions are created on a local scale relative to electricity, the distinction between residential and non-residential emissions is essential. Guidehouse evaluated the benefits resulting from these portfolio sectors separately and

[15] U.S. Environmental Protection Agency. 1996. Compilation of Air Pollutant Emission Factors, 5th Edition, (AP-42), Volume I: Stationary Point and Area Sources. Research Triangle Park, NC. https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emission-factors#5thed
[16] U.S. Environmental Protection Agency. 2004. Emission Inventory Improvement Program (EIIP). Estimating Ammonia Emissions from Anthropogenic Sources, Draft Final Report. Prepared by E.H. Pechan and Associates, Inc. Research Triangle Park, NC. https://www.epa.gov/sites/production/files/2015-08/documents/eiip_areasourcesnh3.pdf
[17] U.S. Environmental Protection Agency. 2020. 2017 National Emissions Inventory Complete Release: Technical Support Document. Research Triangle Park, NC. (NEI) https://www.epa.gov/sites/production/files/2020-04/documents/nei2017_tsd_full_30apr2020.pdf

applied the discounted benefits per therm values annually to each program encompassed in the sectors in CY2019.

The EPA provided Guidehouse a custom valuation file using a 2.40 percent discount rate, as will be deemed by the Illinois Technical Reference Manual (IL TRM) beginning in v9.0[18]. COBRA currently estimates the low- and high-sensitivity health impacts of reduced pollution exposure over a 20 year period, as reduced exposure to emissions in one year reduces acute morbidity in the year of analysis and reduces the incidence of premature mortality for up to 20 years.[19] COBRA then discounts this stream of health benefits back to the year in which savings are realized, which in this example is 2032.[20] Guidehouse applied the custom valuation file with a 2.40 percent discount rate to evaluate the low- and high-sensitivity economic benefits resulting from emissions reductions attributed to 2032 savings. The mean of national low- and high-sensitivity estimates was used as the health benefit estimate for 2032.

Step 4: Discount results to CY2022
Under the annual analysis methodology employed in steps two and three, health benefits estimates are expressed in terms of dollars in the analysis year of interest. In the case of 2022 implementation of CY2019 programs, Societal NEIs are being used to inform TRC tests of the 2022 implementation of programs, which use cost and benefit inputs expressed in terms of 2022 dollars. To remain consistent with other inputs to TRC tests, Guidehouse discounted each year's county-level COBRA results back to 2022 using a 0.42 percent discount rate.

Step 5: Divide by analysis year sector-wide savings
After discounting each year's sector-level health benefits to 2022, discounted health benefits were divided by the sector-level's yearly savings. In the case of 2032 estimation of health benefits, the discounted health benefits of approximately $2.29 million dollars from Step 3 were divided by 2032's 12,816,982 therms of non-residential sector-level savings, generating an estimate of 0.18 cents in discounted health benefits per therm (BPT) of energy saved in 2032.

Step 6: Multiply by program-level savings
The final step in generating a program-level Societal NEI estimate for a specific year is multiplying the sector-level BPT value resulting from Step 4 by the program-level savings. The result is a total estimated benefit of approximately $1.39 million dollars for the Small Business program.

Annual Sector-Level Benefits per Therm Estimates

[18] Illinois Statewide Technical Reference Manual for Energy Efficiency Version 9.0, draft available at: http://www.ilsag.info/technical-reference-manual.html
[19] COBRA assumes that the incidences of premature mortality attributed to pollution exposure occurs over a 20 year period following exposure. COBRA currently assumes that 30 percent of premature deaths occur in the first year, 50 percent of deaths occur in years two through five, and the remaining 20 percent of deaths occur in years six through twenty. For more information, see page F-8 of the COBRA user manual: https://www.epa.gov/sites/production/files/2020-06/documents/cobra_user_manual_june_2020.pdf
[20] In the case of analysis of emissions reductions in the year 2032, COBRA models the associated reductions in morbidity and mortality that can be expected to occur over a 20 year period between 2032 and 2051. This 20 year stream of health benefits is then discounted back to the analysis year, which in this case is 2032.

Table 11 through Table 14 show the sector level dollar per therm estimates by program year, based on the CY2019 portfolio. The values provided have not been adjusted for inflation or discounted following the COBRA model runs. Thus, these values are presented in real dollars.

Please note the dollar per therm values should only be applied to annual therms saved from measures installed in the respective year's implementation. This method avoids double counting benefits.

Table 11. Sector Level Dollars per Therms Savings – CY2022 (Real Dollars)

Year	Therms Savings (Residential)	$ Total Health Benefits (average)	$Total Health Benefits per Therm (average)	Therms Savings (Non-Residential)	$ Total Health Benefits (average)	$Total Health Benefits per Therm (average)
2022	5,743,078	$934,709	$0.16275	21,360,409	$3,717,609.03	$0.17404
2023	5,743,078	$956,442	$0.16654	21,360,409	$3,802,811.62	$0.17803
2024	5,482,150	$912,805	$0.16650	21,360,409	$3,802,811.62	$0.17803
2025	5,441,519	$905,826	$0.16647	20,950,726	$3,729,502.93	$0.17801
2026	5,441,519	$905,826	$0.16647	20,950,726	$3,729,502.93	$0.17801
2027	5,441,519	$905,826	$0.16647	18,129,622	$3,221,977.40	$0.17772
2028	5,431,621	$947,350	$0.17441	13,181,921	$2,452,381.88	$0.18604
2029	5,431,621	$947,350	$0.17441	13,181,921	$2,452,381.88	$0.18604
2030	5,262,118	$917,431	$0.17435	13,176,077	$2,451,414.93	$0.18605
2031	5,262,118	$917,431	$0.17435	12,856,974	$2,392,524.50	$0.18609
2032	4,461,465	$777,547	$0.17428	12,816,982	$2,386,506.78	$0.18620
2033	3,702,953	$645,812	$0.17440	12,816,982	$2,386,506.78	$0.18620
2034	3,702,953	$645,812	$0.17440	12,767,394	$2,375,690.68	$0.18607
2035	3,684,869	$642,269	$0.17430	12,626,174	$2,349,368.78	$0.18607
2036	3,684,763	$642,381	$0.17433	12,626,174	$2,349,368.78	$0.18607
2037	3,608,102	$629,151	$0.17437	11,840,980	$2,202,824.47	$0.18603
2038	3,608,102	$629,151	$0.17437	11,749,962	$2,186,538.21	$0.18609
2039	3,608,102	$629,151	$0.17437	11,709,239	$2,178,845.53	$0.18608
2040	3,432,948	$598,401	$0.17431	11,709,239	$2,178,845.53	$0.18608
2041	3,423,707	$596,965	$0.17436	11,709,239	$2,178,845.53	$0.18608
2042	42,207	$7,411	$0.17558	11,342,830	$2,110,335.38	$0.18605
2043	42,207	$7,411	$0.17558	11,232,877	$2,090,083.76	$0.18607
2044	42,207	$7,411	$0.17558	53,150	$9,866.10	$0.18563
2045	42,207	$7,411	$0.17558	53,150	$9,866.10	$0.18563
2046	42,207	$7,411	$0.17558	53,150	$9,866.10	$0.18563
Lifetime	**74,031,858**	**$12,645,926**	**$0.17082**	**256,160,378**	**$46,656,201**	**$0.18214**

Source: Guidehouse CY2019 Nicor Gas Program Savings Analysis data and COBRA model.

Table 12. Sector Level Dollars per Therms Savings – CY2023 (Real Dollars)

Year	Therms Savings (Residential)	$ Total Health Benefits (average)	$Total Health Benefits per Therm (average)	Therms Savings (Non-Residential)	$ Total Health Benefits (average)	$Total Health Benefits per Therm (average)
2023	5,743,078	$956,442	$0.16654	21,360,409	$3,802,811.62	$0.17803
2024	5,743,078	$956,442	$0.16654	21,360,409	$3,802,811.62	$0.17803

Year	Therms Savings (Residential)	$ Total Health Benefits (average)	$Total Health Benefits per Therm (average)	Therms Savings (Non-Residential)	$ Total Health Benefits (average)	$Total Health Benefits per Therm (average)
2025	5,482,150	$912,805	$0.16650	21,360,409	$3,802,811.62	$0.17803
2026	5,441,519	$905,826	$0.16647	20,950,726	$3,729,502.93	$0.17801
2027	5,441,519	$905,826	$0.16647	20,950,726	$3,729,502.93	$0.17801
2028	5,441,519	$948,889	$0.17438	18,129,622	$3,373,263.55	$0.18606
2029	5,431,621	$947,350	$0.17441	13,181,921	$2,452,381.88	$0.18604
2030	5,431,621	$947,350	$0.17441	13,181,921	$2,452,381.88	$0.18604
2031	5,262,118	$917,431	$0.17435	13,176,077	$2,451,414.93	$0.18605
2032	5,262,118	$917,431	$0.17435	12,856,974	$2,392,524.50	$0.18609
2033	4,461,465	$777,547	$0.17428	12,816,982	$2,386,506.78	$0.18620
2034	3,702,953	$645,812	$0.17440	12,816,982	$2,386,506.78	$0.18620
2035	3,702,953	$645,812	$0.17440	12,767,394	$2,375,690.68	$0.18607
2036	3,684,869	$642,269	$0.17430	12,626,174	$2,349,368.78	$0.18607
2037	3,684,763	$642,381	$0.17433	12,626,174	$2,349,368.78	$0.18607
2038	3,608,102	$629,151	$0.17437	11,840,980	$2,202,824.47	$0.18603
2039	3,608,102	$629,151	$0.17437	11,749,962	$2,186,538.21	$0.18609
2040	3,608,102	$629,151	$0.17437	11,709,239	$2,178,845.53	$0.18608
2041	3,432,948	$598,401	$0.17431	11,709,239	$2,178,845.53	$0.18608
2042	3,423,707	$596,965	$0.17436	11,709,239	$2,178,845.53	$0.18608
2043	42,207	$7,411	$0.17558	11,342,830	$2,110,335.38	$0.18605
2044	42,207	$7,411	$0.17558	11,232,877	$2,090,083.76	$0.18607
2045	42,207	$7,411	$0.17558	53,150	$9,866.10	$0.18563
2046	42,207	$7,411	$0.17558	53,150	$9,866.10	$0.18563
2047	42,207	$7,411	$0.17558	53,150	$9,866.10	$0.18563
Lifetime	**74,031,858**	**$12,704,500**	**$0.17161**	**256,160,378**	**$46,870,627**	**$0.18297**

Source: Guidehouse CY2019 Nicor Gas Program Savings Analysis data and COBRA model.

Table 13.Sector Level Dollars per Therms Savings – CY2024 (Real Dollars)

Year	Therms Savings (Residential)	$ Total Health Benefits (average)	$Total Health Benefits per Therm (average)	Therms Savings (Non-Residential)	$ Total Health Benefits (average)	$Total Health Benefits per Therm (average)
2024	5,743,078	$956,442	$0.16654	21,360,409	$3,802,811.62	$0.17803
2025	5,743,078	$956,442	$0.16654	21,360,409	$3,802,811.62	$0.17803
2026	5,482,150	$912,805	$0.16650	21,360,409	$3,802,811.62	$0.17803
2027	5,441,519	$905,826	$0.16647	20,950,726	$3,729,502.93	$0.17801
2028	5,441,519	$948,889	$0.17438	20,950,726	$3,897,837.86	$0.18605
2029	5,441,519	$948,889	$0.17438	18,129,622	$3,373,263.55	$0.18606
2030	5,431,621	$947,350	$0.17441	13,181,921	$2,452,381.88	$0.18604
2031	5,431,621	$947,350	$0.17441	13,181,921	$2,452,381.88	$0.18604
2032	5,262,118	$917,431	$0.17435	13,176,077	$2,451,414.93	$0.18605
2033	5,262,118	$917,431	$0.17435	12,856,974	$2,392,524.50	$0.18609
2034	4,461,465	$777,547	$0.17428	12,816,982	$2,386,506.78	$0.18620
2035	3,702,953	$645,812	$0.17440	12,816,982	$2,386,506.78	$0.18620
2036	3,702,953	$645,812	$0.17440	12,767,394	$2,375,690.68	$0.18607
2037	3,684,869	$642,269	$0.17430	12,626,174	$2,349,368.78	$0.18607

Year	Therms Savings (Residential)	$ Total Health Benefits (average)	$Total Health Benefits per Therm (average)	Therms Savings (Non-Residential)	$ Total Health Benefits (average)	$Total Health Benefits per Therm (average)
2038	3,684,763	$642,381	$0.17433	12,626,174	$2,349,368.78	$0.18607
2039	3,608,102	$629,151	$0.17437	11,840,980	$2,202,824.47	$0.18603
2040	3,608,102	$629,151	$0.17437	11,749,962	$2,186,538.21	$0.18609
2041	3,608,102	$629,151	$0.17437	11,709,239	$2,178,845.53	$0.18608
2042	3,432,948	$598,401	$0.17431	11,709,239	$2,178,845.53	$0.18608
2043	3,423,707	$596,965	$0.17436	11,709,239	$2,178,845.53	$0.18608
2044	42,207	$7,411	$0.17558	11,342,830	$2,110,335.38	$0.18605
2045	42,207	$7,411	$0.17558	11,232,877	$2,090,083.76	$0.18607
2046	42,207	$7,411	$0.17558	53,150	$9,866.10	$0.18563
2047	42,207	$7,411	$0.17558	53,150	$9,866.10	$0.18563
2048	42,207	$7,411	$0.17558	53,150	$9,866.10	$0.18563
Lifetime	**74,031,858**	**$12,742,748**	**$0.17213**	**256,160,378**	**$47,020,138**	**$0.18356**

Source: Guidehouse CY2019 Nicor Gas Program Savings Analysis data and COBRA model.

Table 14. Sector Level Dollars per Therms Savings – CY2025 (Real Dollars)

Year	Therms Savings (Residential)	$ Total Health Benefits (average)	$Total Health Benefits per Therm (average)	Therms Savings (Non-Residential)	$ Total Health Benefits (average)	$Total Health Benefits per Therm (average)
2025	5,743,078	$956,442	$0.16654	21,360,409	$3,802,811.62	$0.17803
2026	5,743,078	$956,442	$0.16654	21,360,409	$3,802,811.62	$0.17803
2027	5,482,150	$912,805	$0.16650	21,360,409	$3,802,811.62	$0.17803
2028	5,441,519	$948,889	$0.17438	20,950,726	$3,897,837.86	$0.18605
2029	5,441,519	$948,889	$0.17438	20,950,726	$3,897,837.86	$0.18605
2030	5,441,519	$948,889	$0.17438	18,129,622	$3,373,263.55	$0.18606
2031	5,431,621	$947,350	$0.17441	13,181,921	$2,452,381.88	$0.18604
2032	5,431,621	$947,350	$0.17441	13,181,921	$2,452,381.88	$0.18604
2033	5,262,118	$917,431	$0.17435	13,176,077	$2,451,414.93	$0.18605
2034	5,262,118	$917,431	$0.17435	12,856,974	$2,392,524.50	$0.18609
2035	4,461,465	$777,547	$0.17428	12,816,982	$2,386,506.78	$0.18620
2036	3,702,953	$645,812	$0.17440	12,816,982	$2,386,506.78	$0.18620
2037	3,702,953	$645,812	$0.17440	12,767,394	$2,375,690.68	$0.18607
2038	3,684,869	$642,269	$0.17430	12,626,174	$2,349,368.78	$0.18607
2039	3,684,763	$642,381	$0.17433	12,626,174	$2,349,368.78	$0.18607
2040	3,608,102	$629,151	$0.17437	11,840,980	$2,202,824.47	$0.18603
2041	3,608,102	$629,151	$0.17437	11,749,962	$2,186,538.21	$0.18609
2042	3,608,102	$629,151	$0.17437	11,709,239	$2,178,845.53	$0.18608
2043	3,432,948	$598,401	$0.17431	11,709,239	$2,178,845.53	$0.18608
2044	3,423,707	$596,965	$0.17436	11,709,239	$2,178,845.53	$0.18608
2045	42,207	$7,411	$0.17558	11,342,830	$2,110,335.38	$0.18605
2046	42,207	$7,411	$0.17558	11,232,877	$2,090,083.76	$0.18607
2047	42,207	$7,411	$0.17558	53,150	$9,866.10	$0.18563
2048	42,207	$7,411	$0.17558	53,150	$9,866.10	$0.18563
2049	42,207	$7,411	$0.17558	53,150	$9,866.10	$0.18563

Year	Therms Savings (Residential)	$ Total Health Benefits (average)	$Total Health Benefits per Therm (average)	Therms Savings (Non-Residential)	$ Total Health Benefits (average)	$Total Health Benefits per Therm (average)
Lifetime	**74,031,858**	**$12,781,914**	**$0.17265**	**256,160,378**	**$47,173,238**	**$0.18416**

Source: Guidehouse CY2019 Nicor Gas Program Savings Analysis data and COBRA model.

APPENDIX B. PARTICIPANT NEIS – SOURCE VALUES

Three[3] and NMR Group conducted a primary research study for Massachusetts to determine the participant NEIs associated with income eligible programs including reduced effects of asthma, cold- and heat-related thermal stress, missed days of work, deaths, and fire damage.**Error! Bookmark not defined.** These monetized values are provided in the statewide TRM. Massachusetts utilities include these monetized values in their programs' TRC tests.[21]

The 2018 Massachusetts study is specific to Low-Income Multi-family (LIMF) Health and Safety-Related NEIs**Error! Bookmark not defined.**. Three[3] and NMR Group conducted a similar study in 2016 for Low-Income Single Family (LISF) NEIs.[22] The 2018 report complements the past values and recommendations provided in the 2016 study. Variabilities in the values from the two studies are due to differences in installed measures and household types.

Guidehouse adjusted Massachusetts NEI recommended values from 2016 and 2018 to 2022 through 2025-dollars using a conservative inflation forecast of approximately 2 percent annually following 2020. Table 15 provides the original recommended values, prior to inflation.

Table 15. Massachusetts Participant NEI Recommendations – Per Household Annually

Participant NEI type	Massachusetts LISF Program Values ($2016)	Massachusetts LIMF Program Value ($2018)
Total Thermal Comfort	12.95	5.95
Health & Safety (Asthma Reduction)	9.99	35.55
Reduced missed days of work	149.45	48.61

Sources: Three[3] and NMR Group, 2016; Three[3] and NMR Group, 2018; Guidehouse.

[21] Database of State Efficiency Screening Practices (DSESP), 2020. "National Energy Efficiency Screening Project, https://nationalefficiencyscreening.org/ Accessed: July 5, 2020.
[22] Three[3] and NMR Group, 2016. "Low-Income Single-Family Health- and Safety-Related NEIs Study." Massachusetts Program Administrators August 5.