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Non-Energy Impact Literature Review for Ameren Illinois Company

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Opinion Dynamics

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1. Introduction

The AIC evaluation team is assessing non-energy impacts (NEIs) of the utility's 2018-2021 portfolio of residential and commercial energy efficiency programs. NEIs are the impacts that an efficiency program has on its participants, the sponsoring utility, and society at large,[1] in addition to the energy and demand savings it was designed to produce. NEIs can include environmental, economic, public health, and other effects. Importantly, NEIs include both positive and negative outcomes.

Over the past 25 years, NEI researchers and evaluators have been able to qualitatively describe, quantify, or monetize the value of numerous NEIs, resulting in a field of research that is deep and wide-ranging. The evaluation team, in conjunction with the Illinois Stakeholder Advisory Group (SAG) NEI Working Group, plans to leverage this existing knowledge to develop a statewide NEI research approach that is grounded in best-practice, accessible to all Illinois utilities, and customizable to the AIC service area specifically.

In this memo, we summarize findings from our strategic and targeted review of NEI assessment methods and best practices.[2] We designed this review to provide a foundation that will inform and serve our efforts to: (I) develop a long-range plan for assessing NEIs resulting from AIC's 2018-2021 portfolio, and (II) contribute an evaluation perspective to the development of a statewide Illinois NEI research methodology.

In addition to documenting best practices, we comment in this memo on themes our evaluation team will need to consider when leveraging this extensive body of past work. Specifically, our research was guided by the following research questions:

1. What are the most robust and common methods to assess NEIs, and are there NEIs that are particularly well-studied?[3]
2. How can AIC leverage existing research and methodologies in evaluating NEIs associated with its energy efficiency programs?
   - How applicable is the ComEd income qualified NEI assessment method to the AIC service territory? What would be needed to deploy this methodology within AIC's annual program evaluation framework, and are any adaptations needed?
3. What, if any, knowledge gaps could pose barriers to assessing NEIs from AIC initiatives?

[1] We are not investigating NEIs already captured under other frameworks. The Illinois Statewide Technical Reference Manual for Energy Efficiency (IL-TRM) accounts for some NEIs (water savings and some operation and maintenance costs) in its most recent version. In addition, the Future Energy Jobs Act (FEJA) instructs Illinois utilities to include greenhouse gas (GHG) emissions reductions in their cost-effectiveness calculations.

[2] We did not systematically review NEI values (e.g., monetary value/NEI/project) because of Illinois SAG requests that Illinois evaluators develop original estimates of NEIs, rather than transfer values from existing literature. However, Skumatz (2014) provides a general summary of value ranges, and Navigant (2018) summarizes NEI values for residential income qualified programs.

[3] As part of a related task under this scope of work, we are highlighting the specific NEIs that each of AIC's initiatives is likely to produce, based on the types of measures offered and customer populations served.

- What adjustments, data, or additional information are needed to support other types of NEI assessments for AIC? What should the evaluation team consider when developing a strategy to address these barriers?

The remainder of this memo provides additional detail on our literature review methods (Section 2), summarizes key findings (Section 3), provides an annotated bibliography of key studies that we reviewed (Section 4), and discusses conclusions and next steps (Section 5).

2. Methods

To gather best practices but avoid reproducing other researchers' efforts to synthesize NEI studies, the evaluation team conducted a targeted review of nine studies, focusing on those that offered:

1. Frameworks summarizing the history of NEI research nationally;
2. Perspectives on the current and historical NEI policy context in Illinois; and/or,
3. Descriptions of potential NEI assessment methods that are relevant to AIC.

Given Illinois stakeholders' interest in developing common NEI assessment methods for standardization across all utilities, we included Navigant's 2018 review of NEIs from income qualified weatherization programs (prepared for ComEd), as well as several of the technical studies which Navigant referenced as the basis for their proposed income qualified NEI research approach. Table 2-1 contains the studies we reviewed. It should be noted that, though the literature review provides in-depth information for a limited number of studies, the evaluation team reviewed a broader set of research to determine those most applicable to AIC and its 2018-2021 NEI research effects.

Table 2-1. List of Reviewed Non-Energy Impacts Studies

Sponsoring Organization	Author (Year)	Title
IL SAG	Jenkins and Dent (2016)	Documentation of Technical Advisory Committee Review of Non-Energy Benefits
ComEd	Navigant (2018)	Quantifying Non-Energy Benefits from ComEd's Income Eligible Programs: Findings and Recommendations from Secondary Research
The Natural Resources Defense Council	Skumatz (2014)	Non-Energy Benefits / NEIs and Their Role & Values in Cost-effectiveness Tests: State of Maryland
The Natural Resources Defense Council	Skumatz (2015)	Considering the Inclusion of NEBs in IL TRM for Single and Multi-Family Whole Building Retrofit Programs: The Issue of Measure-Based NEBs
DOE WAP	Oak Ridge National Laboratory (2014)	Health and Household-Related Benefits Attributable to the Weatherization Assistance Program
Massachusetts PAs	Tetra Tech and DNV-GL (2018)	Program Administrators of Massachusetts: Non-Energy Impact Framework Study Report
New Hampshire PUC	NEEP (2017)	Non-Energy Impacts Approaches and Values: An Examination of the Northeast, Mid-Atlantic, and Beyond

Sponsoring Organization	Author (Year)	Title
Massachusetts PAs	Three[3] and NMR (2016)	Massachusetts Special and Cross-Cutting Research Area: Low-Income Single Family Health- and Safety-Related Non-Energy Impacts (NEIs) Study
JPB Foundation and the Energy Foundation	Green and Healthy Homes Initiative (not dated)	Achieving Health and Social Equity through Housing: Understanding the Impact of Non-Energy Benefits in the United States

3. Summary of Findings

In this section, we summarize findings from the literature review and explain their importance not only to our efforts to quantify NEIs for AIC but also to help establish a consistent NEI evaluation approach for Illinois. Specifically, we explain industry-standard definitions for NEI categories (utility, participant, and societal); summarize the four most commonly-used NEI assessment methods; and highlight areas where the literature is most robust.

3.1 Background

The energy efficiency industry typically groups NEIs in terms of who receives the added benefit or cost. Table 3-1 is adapted from Skumatz (2014) and briefly explains how NEIs accrue to three types of entities most often discussed in the literature—a program's sponsoring utility, program participants, and society at large. Each entity stands to gain (or incur costs of) many types of NEIs. We have highlighted NEIs that, based on our review, are most frequently researched.

Table 3-1. Common Non-Energy Impacts by Entity

Entity	Definition	Commonly-Discussed NEIs
Utility	Outcomes for the utility sponsoring the energy efficiency program. ▪ Drivers: Providing EE drives changes in utility administrative/ insurance/ distribution efforts and finances ▪ Level of detail: Assessed by program or portfolio depending on NEI	▪ Reduced or avoided utility administrative costs such as arrearages and related costs Administrative cost studies appear limited to customer sectors/segments for which administrative effort and cost was highest in a baseline (e.g., arrearage analyses focus on income-qualified programs) ▪ Line loss reductions, insurance impacts
Participant	Outcomes for program participants from installing and using program-sponsored energy efficiency upgrades at their home or business. Affects both property owners/managers and occupants. ▪ Drivers: EE measures and savings affect building stock, maintenance behavior, and finances ▪ Level of detail: Usually assessed by program; total value can be portioned to measure-specific NEIs in proportion to measure contributions to program savings	▪ Occupant health, safety, comfort, and productivity ▪ Building owner costs, including operations and maintenance, property management impacts (e.g., turnover, satisfaction, marketability) ▪ Impacts related to perceptions about aesthetics, noise, or other features of the upgrade
Societal	Changes in the general population's welfare that spill over from program upgrades ▪ Drivers: Cumulatively, EE measures and savings add up to influence economy, environment, health and safety, and distribution system ▪ Level of detail: Often assessed at portfolio scale; methods determine ability to report by program, customer segment, geography, etc.	▪ Net job creation[4] economic development ▪ Emissions reductions ▪ "Few other societal benefits have been seriously measured" (Skumatz, 2014)

3.2 Non-Energy Impact Assessment Methodologies

This section discusses best practices that other evaluators have used to **(I) inventory** all NEIs which may arise from utility programming, **(II) select** key NEIs for study, and **(III) quantify and monetize** the selected NEIs.

I. Inventorying Potential NEIs across the Utility Portfolio

NEI assessments should, ideally, provide a complete and balanced assessment of all ancillary costs and benefits of an energy efficiency program (Skumatz, 2014; NEEP, 2017; Others). Completeness and balance are critical given that NEIs may be incorporated into program performance assessments, portfolio rebalancing,

[4] The AIC evaluation team outlined a general approach for estimating job impacts of the 2018 portfolio as part of its 2018 evaluation plan.

and/or cost-effectiveness testing, in which it is key to ensure symmetry of the included program costs and benefits (NEEP, 2017).[5] Achieving symmetry is challenging, as leading authors have identified between 35 NEIs (Tetra Tech and NMR, 2018) and 50 NEIs (Skumatz, 2014) that utilities, participants, and society may experience as a result of energy efficiency programs. Given the long list of NEIs one could assess, dedicating time to establish a clear, consistent research framework is a key first step in launching an NEI assessment that is poised to provide complete and symmetrical NEI assessment.

There are two frameworks to achieve a complete and balanced assessment. The first, and simpler, approach is to develop and apply a proxy "adder" that represents a top-down view of the net value of NEIs as a share of program savings.[6] The second approach takes a bottom-up perspective, developing a complete assessment by studying each impact individually and then summing the individual values to demonstrate total NEI costs and benefits. As Illinois stakeholders have previously declined using an NEI adder approach for cost-effectiveness calculations (Jenkins and Dent, 2016), we focused on reviewing best practices for the impact-by-impact approach.

At a high level, best practices for the impact-by-impact approach center around how the evaluator organizes their research efforts. Drawing on methods that Tetra Tech and DNV-GL (2018) used to develop a forward-looking NEI framework for Massachusetts, as well as the U.S. EPA Guidelines for Preparing Economic Analyses[7], we developed a list of methodological best practices for an impact-by-impact approach (Table 3-2), with the end goal of monetizing significant NEIs to the extent possible.

Table 3-2. Methodology for Developing an Impact-by-Impact Portfolio Non-Energy Impacts Assessment

Step	Description
Inventory all impact categories potentially affected by the programs under consideration	1. Develop an initial understanding of each program's services (upgrades, training, etc.). 2. Research how each service may impact participants, utilities, or society beyond saving energy; consider environmental, health, economic, operational, and other outcomes. a. Draw on any past NEI research conducted for the program, expert interviews, secondary literature, and others. 3. Summarize findings in a list or matrix to describe the effects of each program and identify the NEIs associated with these effects. a. For a portfolio-level NEI assessment, be sure to include both commercial and industrial (C&I) and residential programs. b. Consider both positive and negative impacts of a program when inventorying impacts.[8]

[5] As of this memo, the IL SAG stakeholders are discussing whether NEI values should be incorporated into cost-effectiveness calculations.

[6] In the adder approach, evaluators use expert judgement to deem the total value of all NEIs as a share of energy savings, drawing on secondary research to approximate the complete and total value of NEIs. NEEP (2017) summarizes the range of adders used today.

[7] https://www.epa.gov/environmental-economics/guidelines-preparing-economic-analyses

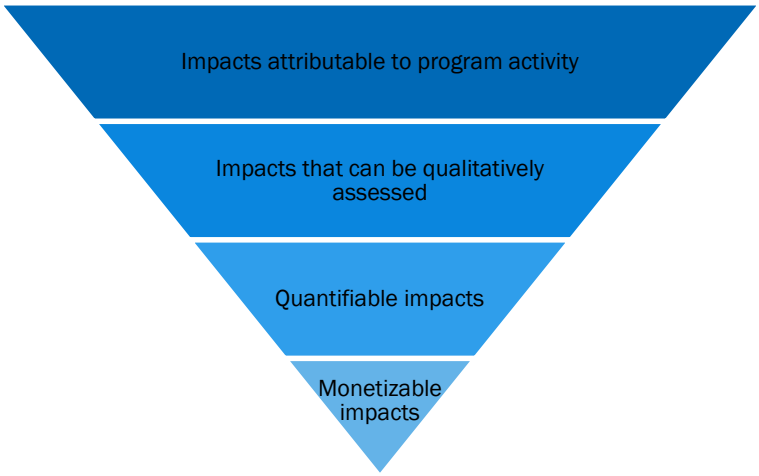
[8] As Illinois stakeholders have pointed out, NEIs comprise both positive and negative impacts of energy efficiency measures. Accordingly, studies reviewed for this effort assert that researchers should measure net impacts. Interestingly, however, few studies have attempted to quantify the negative NEIs of energy efficiency measures. This research is particularly salient with respect to utility and societal impacts. Based on our review, the evaluation team concludes that the field of NEI research to date focused on measuring the positive impacts of NEIs. Measuring negative impacts is a gap in the literature.

Prioritize significant impacts for further study	1. Determine which impacts to include in the overall NEI analysis. Consider asking: a. Which impacts are likely to differ relative to the baseline? b. Which impacts are likely to account for the bulk of the program's total NEI value? c. Which benefit categories are salient for stakeholders (e.g., distributional equity), even if they may not be large in monetary value? d. Are any impacts likely to overlap with others? To have significant data gaps? 2. Recommend a list of NEIs that warrant further investigation.
Quantify significant impacts, to the extent possible	1. Quantify the endpoints related to each impact, focusing on changes attributable to the program relative to the baseline. a. Data are usually needed on the extent and timing of the endpoints.
Estimate the monetary value of quantified impacts	1. Determine whether to conduct original monetization research, or to transfer value estimates from prior research on the same impact.

II. Selecting Evaluable Non-Energy Impacts for Further Research

Although the end goal of the best-practice NEI assessment framework is to quantify and monetize significant NEIs, it may not be possible to express all significant impacts in dollar terms. Some NEIs do not appear readily evaluable due to data gaps, uncertainties, high research costs, and other challenges. Figure 3-1 presents a hierarchy of NEI evaluability.

Figure 3-1. Hierarchy of Qualitative, Quantitative, and Monetized Research



Consistent with the impact-by-impact assessment framework and the hierarchy of NEI evaluability, recent work to quantify NEIs has focused on a handful of impact categories that (a) are clearly linked to program

interventions, (b) have, or are suspected to have, a high monetary value,[9] (c) accrue to disadvantaged populations,[10] and/or (d) are relatively easy to quantify and monetize using industry-accepted methods. These include NEIs from weatherization programs as well as utility NEIs.

- **Weatherization Program NEIs** meet all of these conditions and have received significant recent attention in the literature. These programs offer a measure mix poised to provide significant structural improvements (insulation, air sealing, and potentially, health/safety upgrades). The resulting changes in building stock improve indoor air quality, thermal integrity, and living conditions, while reducing energy bills. These changes impact household finances and customer health, which have been found to offer relatively high benefits relative to total program costs.[11] Moreover, they are designed to reach income qualified customers. And last, well-defined methods exist to assess and monetize participant health and comfort effects.[12]

- **Utility NEIs** also present a clear opportunity for AIC to quantify and monetize NEIs. Because researchers can measure utility NEIs directly from utility records (i.e. occurrences of missed payments), utility NEIs may be quantified and directly monetized without the collection of additional data and without launching research efforts to collect such data.

While the evaluation team has uncovered program types or NEI types that can be reliably studied, other program types will prove challenging for AIC to target in their forthcoming NEI research:

- **Multifamily Programs:** The evaluation team anticipates challenges in measuring non-energy impacts from multifamily programs due to two key issues. First, few multifamily NEI studies have taken place to date, and those which have mostly address small multifamily buildings of four units or fewer. This results in poor foundational information on which to build studies for AIC. Second, teasing apart the effects from property managers versus tenants proves challenging. The literature agrees, qualitatively, that property managers experience NEIs and claim that efficiency measures make the property more attractive; thereby reducing tenant turnover, unit vacancies, and marketing costs. However, our review did not identify any studies that quantify these often-discussed NEIs. Any NEI assessments for this segment that do examine impacts for both tenants and property managers must take care to avoid double-counting benefits across the decision makers (building owners) and the beneficiaries of the upgrades (residents).

- **Commercial and Industrial NEIs:** NEIs exist for C&I programs and appear quantifiable, but most NEI assessments still focus on residential programs and their effects. This limits the range of methods available to inform the long-term research strategy we will develop for AIC. Upon screening several

[9] NEIs with higher per-unit monetary values, relative to program costs and savings, may receive relatively more attention because they have a greater influence on cost-effectiveness assessments.
[10] Disadvantaged customers (e.g., income-qualified customers, multifamily residents) stand to gain relatively more from a given energy efficiency program than the general residential population because they face disproportionately higher health, safety, comfort, and economic concerns related to their housing and energy usage (Oak Ridge National Laboratory, 2014). Capturing these impacts—and notably, the positive outcomes—is a policy priority for environmental justice and income-qualified advocacy groups.
[11] Recent Massachusetts research shows that NEIs comprise 60% of the total program benefits from income qualified programs, compared to about 20% in the market-rate residential and commercial/industrial sectors (Three3 and NMR, 2016).
[12] The cornerstone study for assessing health and safety NEIs from weatherization programs is the Oak Ridge National Laboratory's Weatherization Assistance Program study (2014). This method has already been adapted for at least one state (Massachusetts) and the Navigant team plans to replicate this methodology to assess NEIs associated with ComEd's weatherization program.

C&I methodologies and values for this review, we find that studies and results are geographically limited. The literature tends to cite one key, though robust, study.[13] Information about C&I NEIs in the Midwest, or Illinois specifically, is lacking. Because few studies exist on C&I NEIs, the evaluation team anticipates needing time and effort to ramp up this research effort in AIC territory, should stakeholders wish to pursue it. We suggest that this be a topic for conversation at a future SAG NEI Working Group meeting.

- **Gas vs. Electric Impacts:** AIC serves both gas and electric customers and stakeholders have expressed interest in examining NEIs associated with gas vs. electric initiatives.[14] Confirming research gaps identified in 2014 (Skumatz, 2014), we uncovered little research on the potential for NEIs to differ by properties with gas vs. electric fuel. Researchers have tended to conduct NEI assessments at the program level and as part of broader process evaluations, making it difficult to tease apart gas vs. electric impacts within a program. One unpublished study referenced in the *paper Considering the Inclusion of NEBs in IL TRM for Single and Multi-Family Whole Building Retrofit Programs: The Issue of Measure-Based NEBs* (Skumatz, 2015) did attempt to assign preliminary values to gas vs. electric NEIs and found that they were similar in magnitude; however, authors noted this research as preliminary.

III. Quantifying and Monetizing Selected Non-Energy Impacts

There are four main approaches to quantifying and monetizing NEIs (Table 3-3). These approaches vary in terms of their level of rigor and their suitability to quantify different types of NEIs.

Table 3-3. Summary of Common Methods Used to Quantify Non-Energy Impacts

Approach	Description	Most Applicable to:			Advantages and Disadvantages
		Utility	Participant	Societal	
Compute with primary data	Quantify and monetize change in impact category using pre- and post-program primary data (e.g., utility records). May utilize a treatment/ comparison group for added robustness.	✓	✓		▪ Not subject to error inherent in self-reported data ▪ Primary data may or may not include information required to identify a comparison group ▪ Requires year(s) to collect pre-/post- data (slower than some other methods)
Compute with secondary data (i.e. transfer values)	Estimate change in impact using assumptions from secondary data (e.g. reduction in fire risk from insurance data, or results of other NEI studies). Apply secondary cost data to monetize.	✓	✓	✓	▪ Less robust than primary data ▪ Valid transfers require ensuring source study was high quality and matches well with program (e.g., similar program design, participants…)

[13] Stevens, N., Crossman, K., Rathbun, P., Goldberg, M., Jones, B. (2014) Non-energy impacts of C&I energy efficiency measures provide substantial program benefits above carbon reduction. International Energy Policy & Programme Evaluation Conference, Berlin, Germany.

[14] This topic is on the Punch List for discussion at the IL EE Stakeholder Advisory Group: Non-Energy Impacts Working Group.

					▪ Lower cost approach than primary data
Predictive modeling	Top-down modeling using third-party modeling programs (e.g. IMPLAN, BenMap).			✓	▪ Models take inputs/ produce outputs at scales (e.g., counties) best matched for societal NEIs (e.g., economic, environmental) ▪ Level of effort to model, and scale of model, suggest best used for portfolio-level assessments vs. program-level
Survey methods	Collect self-report data about impacts, often with pre-/post-survey design. Monetize using secondary cost data, self-report cost data, or willingness to pay (WTP) surveys.		✓		▪ Surveys are best way to assess participant impacts ▪ Requires year(s) to field pre-/post- surveys (slower than some other methods) ▪ Still need to obtain secondary (but IL-specific) data to monetize value of reported changes

Source: Approaches and descriptions adapted from Skumatz, 2014. Applicability and commentary from Opinion Dynamics.

Note: Navigant is planning to measure utility and weatherization-related NEIs from ComEd's income qualified programs using survey methods and computation with primary data.

Navigant plans to use a rigorous difference-in-differences design to assess health, safety, and comfort benefits of ComEd's income qualified programs. As detailed in the annotated bibliography, this method involves multiple surveys with participants (pre-treatment and one-year post-treatment) and non-participants (pre-treatment and one-year post-treatment) to determine changes in NEI indicators over time and determine if they are due to program interventions. Commendably, this approach replicates the research design of a large national study of these NEIs from the U.S. Department of Energy's (DOE) National Weatherization Assistance Program (WAP). With unlimited resources, this method represents the gold standard for measuring participant health NEIs and has also been replicated in other states (i.e., Massachusetts). However, this type of study is also a significant undertaking, and this may pose some challenges to AIC and other IL utilities if implemented in the same manner. Key considerations for the AIC team include:

- **Achieving the sample sizes required to detect changes in rare health events.** Navigant has the advantage of collaborating with other researchers (Three[3], Inc. and Seventhwave) who will share data from related research efforts, but no such efforts are underway in AIC territory.[15]

[15] These researchers are using independent funding to measure NEIs in the Midwest and will be collecting data from 70 multifamily buildings in the Chicago area. Navigant plans to leverage this data to supplement other findings from the service territory.

- **Identifying participants before they participate in AIC's Income Qualified and Public Housing initiatives.** Identifying participants before they enter the initiatives allows for the collection of pre-treatment data.

- **Executing a multi-year health-effects study of this scope would limit our ability to conduct a more balanced assessment of NEIs across AIC's portfolio (e.g. studies of negative impacts, impacts from commercial initiatives, etc.).** Given the amount of resources required to conduct portfolio-wide NEI research, AIC and the evaluation team may choose between a more robust, in-depth study of NEIs associated with one or two program types (e.g. income qualified) or conduct research with a greater breadth but less depth. In the case of ComEd, NEI research will utilize pre- and post-surveys, which will require long-range planning in the AIC territory to capture pre- and post- treatment data.

- **Depending on the length and complexity of the NEI survey batteries, they may not be suitable for combination with other survey research efforts (e.g. attribution).** In 2018, the evaluation team leveraged planned attribution surveys to screen for the potential existence of NEIs associated with income qualified programming. However, the actual quantification of NEIs requires more extensive and robust battery of questions that will not lend itself to combining with other types of survey research.

In light of the above considerations, the evaluation team recommends tailoring the scope of research to fit AIC's needs and priorities. For example, AIC may choose to adapt the research scope in terms of sample size, geography covered, number of NEIs quantified in upcoming years, and use of alternative data sources to supplement primary data.

4. Annotated Bibliography

In this section, we provide brief summaries of the studies included in this literature review and their application to AIC.

Jenkins, C. and Dent, S. (2016) Documentation of Technical Advisory Committee Review of Non-Energy Benefits. Illinois. Retrieved from: http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_5

In 2015, the IL Technical Advisory Committee (TAC) reviewed two proposals for the inclusion of NEIs in cost effectiveness calculations. The first proposal was presented by Chris Neme, representing the Natural Resources Defense Council (NRDC) and was based on research by Lisa Skumatz.[16] The second proposal was based on NEI values developed for the state of Massachusetts. In both cases, NEI values would be adapted from existing research for application in the state of Illinois. While the original research was considered robust and defensible, the IL SAG advised against including NEIs in cost effectiveness calculations given uncertainties about the transferability of values to IL, among other key reasons. Feedback on the proposed methodology for

16 Skumatz, L., Ph.D. (2015) Considering the Inclusion of NEBs in IL TRM for Single and Multi-family Whole Building Retrofit Programs: The Issue of Measure-Based NEBs. Skumatz Economic Research Associates, Superior, CO

NEI quantification was collected from a range of stakeholders, including IL utilities, the ICC, and evaluation consultants. Key concerns with the proposed methodology were as follows:

- NEIs are difficult to measure and the robustness of the referenced studies was questioned,
- It is unclear how transferrable MA NEIs are to IL and how values would be adapted to apply to IL customers,
- There needs to be a clear connection between the energy efficiency measure/program and the NEI,
- Higher-cost programs may negatively impact rate payers

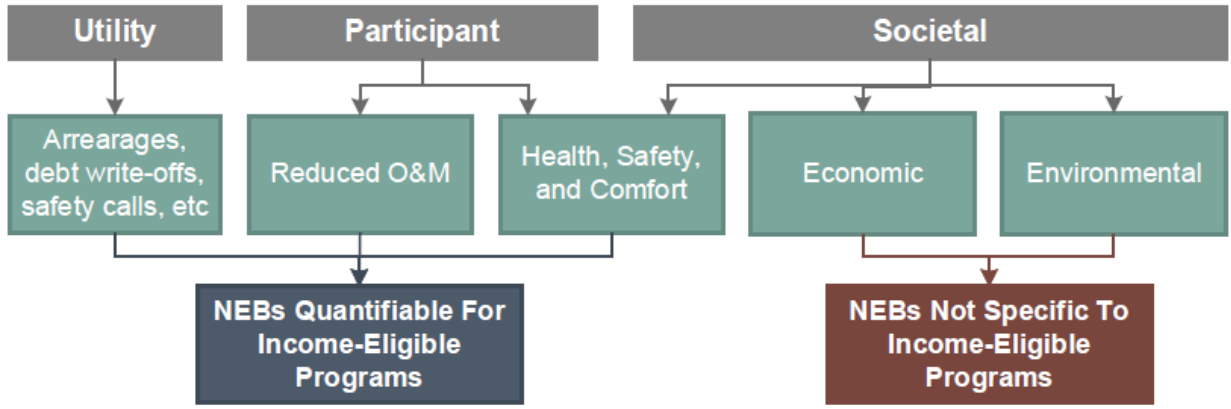
Application for AIC-Specific NEI Assessment

This study provides useful information as to the history of the conversation regarding how and when NEIs should be measured in IL. Inputs and concerns regarding previously-proposed research approaches can be used to shape and improve current research. Planned research in AIC territory already aims to address some of the concerns that were raised by a) conducting primary research across the state, and b) forming a working group that will ensure the most robust and repeatable approaches are employed.

Navigant (March 6, 2018) Quantifying Non-Energy Benefits from ComEd's Income Eligible Programs: Findings and Recommendations from Secondary Research. Chicago, IL. Retrieved from: http://ilsagfiles.org/SAG_files/Evaluation_Documents/Draft%20Reports%20for%20Comment/ComEd_EPY9_Draft_Reports

The report makes recommendations on quantifying NEIs associated with income-eligible EE programs with the aim of including them in future TRC calculations and the IL TRM. The study summarizes research on 32 NEI reports and distills concepts into accessible frameworks. For example, Figure 4-1 synthesizes broad NEI categories, the types of NEIs associated with each category, and recommendations on their eligibility for inclusion in income-eligible program savings. The overarching recommendation of the study is to initially include easily-quantifiable NEIs, such as utility and health, safety, and comfort, as indicated in Figure 4-1.

Figure 4-1. NEI Categories



Source: Navigant

Navigant will monetize utility and health, safety and comfort NEIs through primary research. Common utility NEIs include reductions in arrearages, bad debt-write offs, terminations and reconnections, customer calls, safety calls, and collection notices. As such, these NEIs can be quantified through existing utility administrative and payment data by comparing pre- and post-program statistics for treated and non-treated customers. The study includes a detailed description of the methodology for quantifying utility NEIs. Navigant will utilize participant surveys to monetize health, safety, and comfort benefits. Though there is a wide range of NEIs in this category, the research will initially quantify the following, which have the most direct links to EE and therefore most defensible savings outcomes:

- Reduced asthma-related emergency room (ER) visits, hospitalizations, other direct medical costs, and indirect costs,
- Reduced thermal stress on occupants (hot),
- Reduced thermal stress on occupants (cold), and
- Fewer missed days at work.

Navigant will quantify the metrics through pre- and post- surveys with weatherization program participants. They plan to follow methodology established by the Oak Ridge National Laboratory, which is discussed later in this report.[17] Importantly, Navigant recommends not quantifying NEIs on a measure level but instead accounting for the additive effects of measures by quantifying NEIs at the program or participant level. The study also found that economic and societal NEIs should be quantified at the portfolio level as opposed to the program level. Page 22 of the report includes a detailed appendix of all researched NEIs.

[17] Oak Ridge National Laboratory (2014). Health and Household-Related Benefits Attributable to the Weatherization Assistance Program

Application for AIC-Specific NEI Assessment

To serve AIC, Opinion Dynamics should use this comprehensive study as a foundation to build from. The recommendations on what to include versus exclude and how to approach the research seem sound; however, there are some key considerations and challenges that AIC may face to achieve this level of research in the AIC service territory, which we summarize here:

- Navigant is collaborating with Three[3], Inc. and Seventhwave, who have received independent funding to measure NEIs in the Midwest and who will be collecting data from 70 multifamily buildings in the Chicago area. Navigant plans to leverage this data to supplement other findings from the service territory;[1]
- ComEd NEI research will utilize pre- and post-surveys. Long-range planning will be necessary to capture pre- and post- treatment data in the AIC territory;
- Depending on the length and complexity of the NEI survey batteries, they may not be suitable for combination with other survey research efforts (e.g. attribution);
- In order for AIC to conduct the scale of research made possible in the Chicago area by three institutions (ComEd, Three Cubed, and Seventhwave), the utility would have to invest significant monetary resources and long-term planning to capture a statistically meaningful sample size for both pre- and post-treatment research;
- Resources do not exist to support this level of effort without deprioritizing other important research studies.

Skumatz, L., Ph.D. (2016) Non-Energy Benefits / NEBs - Winning at Cost-Effectiveness Dominos: State Progress and TRMs. Skumatz Economic Research Associates, Superior, CO. Retrieved from: https://aceee.org/files/proceedings/2016/data/papers/6_1147.pdf

This study provides an overview of the 2014 state of research and inclusion of NEIs in benefit-cost (B/C) tests across the country. The study presents typical ranges for NEIs for weatherization and retrofit programs, separated by the three NEI groupings—utility, societal, and participant. Skumatz gives succinct explanations of research progress and gaps in a number of key topic areas: NEB value consistency and transferability, measure-based NEIs, gas vs. electric NEIs, and multifamily. Skumatz reports that for gas vs. electric NEIs, research is "thin," with few foundational studies to offer insights. Generally speaking, research tends to be conducted at the program level as part of broader process evaluations, which makes it difficult to tease apart gas vs. electric impacts. Skumatz did attempt to assign preliminary values to gas vs. electric NEIs and found that they were similar in magnitude; however, authors noted this research as preliminary. In terms of research gaps for multifamily NEIs, Skumatz reports that the limited amount of multifamily research that has taken place has tended to focus on low income properties. Research attempts are complicated given that decision makers (building owners) are different than the beneficiaries of the upgrades (residents), but overall there is a paucity of information and only three studies conducted that Skumatz opted to extrapolate information from. The study gives some generalizable ranges of NEIs as percentages of energy bill savings, but points to a need for more research.

The paper also details methods used for incorporating NEIs into B/C tests, argues that survey-based NEI results are robust enough to include in B/C tests, and discusses existing sources of error in B/C tests. The study defends the inclusion of survey-based NEIs in B/C tests primarily because other critical values that contribute to B/C tests are based on survey research (i.e. NTG), and other inputs to the B/C analysis may not be as well researched as NEIs. Lastly, the paper gives synopses of key efforts made in states and regions across the country. On the Midwest region, Skumatz notes that some NEIs have already been included in B/C tests, but the process to expand inclusion has been stalled.

Application for AIC-Specific NEI Assessment

An important contribution of the paper is a discussion on the transferability of NEIs across programs, participants, measures, and geographies. Given that a central discussion in IL has been questioning the adoption of NEI values developed in other states, a distillation of why and how NEIs are or are not transferrable is helpful. For example, the study offers that NEIs expressed as a percent of energy savings rather than dollar values may be more transferrable across climates. Additionally, Skumatz suggests that some NEIs like arrearages can be transferred across geographies if it is across similar programs and participants. The study weighs in on the pros and cons of making NEIs measure-based in order to make them more transferrable—while measure-based NEIs may transfer more readily, they still face a critical challenge of being double counted if a program delivers more than one measure, which almost certainly creates interactive affects between measures and their associated NEIs. However, Navigant's suggestions to avoid measure-based NEIs to capture additive program effects (or conversely, not double count benefits), likely is a safer and more accurate approach.

Oak Ridge National Laboratory (2014). Health and Household-Related Benefits Attributable to the Weatherization Assistance Program. US Department of Energy, Oak Ridge, Tennessee. Retrieved from: https://weatherization.ornl.gov/wp-content/uploads/pdf/WAPRetroEvalFinalReports/ORNL_TM-2014_345.pdf

The Oak Ridge National Laboratory (ORNL) study comprises an extensive quantitative research effort to monetize health and household NEIs related to weatherization. Though weatherization provides benefits in all of the categories of NEIs, the study measured household expenditure, health and safety, and well-being benefits. Because Navigant will employ methods derived from this study in their efforts to measure NEIs in the ComEd territory, the study may also serve as a touchstone for AIC, and we summarize key aspects here. Specifically, the evaluation team aimed to understand which NEIs have been rigorously quantified through primary data collection. We present the eleven NEIs that the study quantified in Table 4-1, with indication of their reported robustness (Tiers 1, 2, and 3).

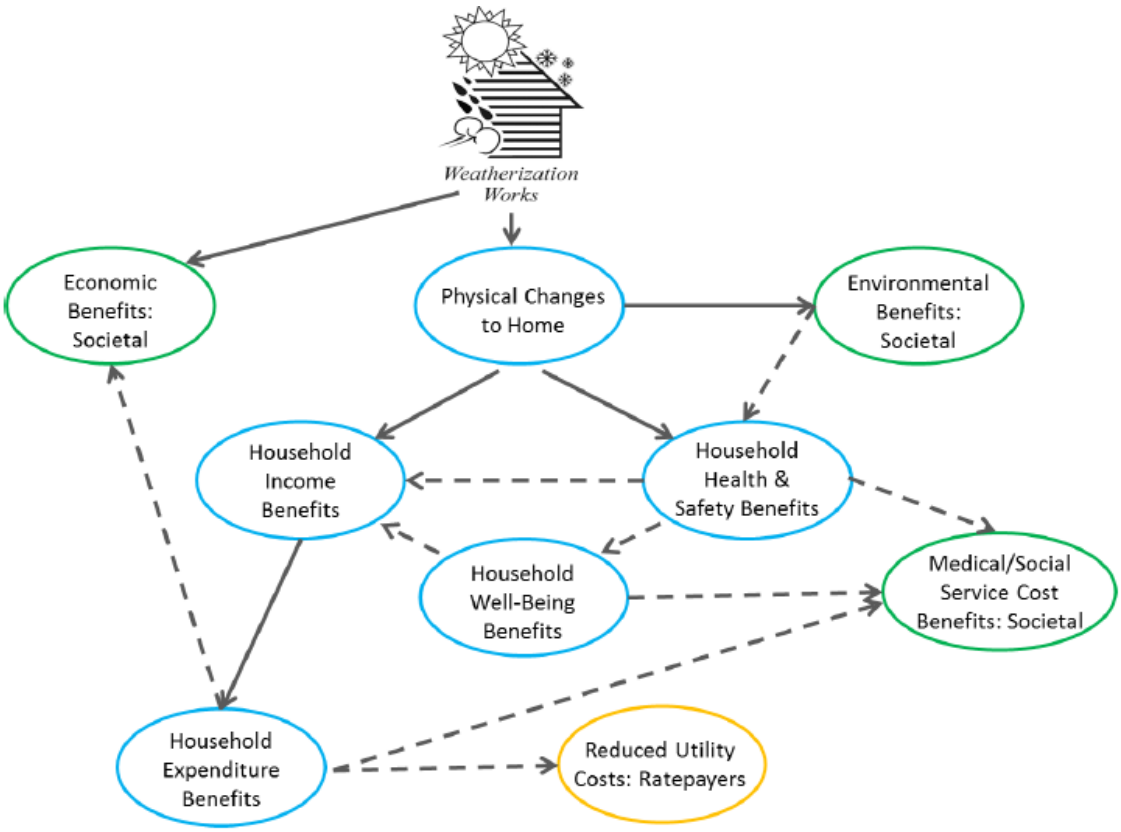
Table 4-1. Non-Energy Impacts of the National Weatherization Assistance Program

Non-Energy Impacts of Weatherization	Tier
Asthma Reduction	1
Thermal Stress-Cold Reduction	1
Thermal Stress-Heat Reduction	1
Food Assistance Reduction	1
Reduction in Missed Days at Work	1
Carbon Monoxide Poising Reduction	2
Improvement in Prescription Drug Adherence	2
Reduction in Use of Short-Term Loans	2
Home Fires	3
Increased Productivity at Work Due to Improved Sleep	3
Increased Productivity at Home Due to Improved Sleep	3
Reduction in Low-Birth Weight Babies from Heat-or-Eat Dilemma	3
Tier 1: *Robust, monetizable outcomes directly attributable to weatherization through pre/post primary research and "highly reliable" cost data.* **Tier 2 and 3:** *Outcomes rely on sound methodologies but may not be supported by direct measurement or may include more assumptions of variable values.*	

Source: Adapted from Oak Ridge National Laboratories, 2014

The report examines NEIs in the context of low-income weatherization and its importance on the health and safety in homes, particularly as global temperatures rise, and pollutants become more pervasive in the human environment. The study offers are framework for understanding the broad-reaching effect of weatherization on quality of life, presented in Figure 4-2.

Figure 4-2. Framework for Understanding Non-Energy Benefits



Source: Oak Ridge National Laboratories, 2014

The study quantified and monetized NEIs in two steps: (a) collecting pre-weatherization and post-weatherization survey data from individuals that participated in a weatherization program, and (b) monetizing eleven key NEIs through secondary research.[18] The weatherization survey included respondents from across the country and was conducted in two phases. In phase one, researchers fielded a survey to pre-weatherization households, along with a comparison group that had received weatherization one year prior. Phase two of the research occurred one year to eighteen months later, when both groups were surveyed again. The approach yielded 398 pre- and post- responses from individuals that received weatherization through the program and 430 responses from the comparison group. Researchers also employed a unique regression approach to

[18] Assumptions, equations, and sources used to monetize NEIs are presented in Section 4.2: Monetary Benefits of Weatherization: Analytical Results. The monetary value of key NEIs are presented in three tiers, representing levels of certainty around the calculations for each.

quantify relationships between weatherization mental health, physical health, and asthma. Survey findings indicated significant differences in pre- and post-weatherization conditions, as follows:

- Homes are more livable;
- The physical condition of homes is improved;
- These and other improvements lead to improved general health;
- Respondents experience fewer 'bad' physical and mental health days;
- Respondents and other household members suffer fewer persistent colds and headaches;
- There are fewer instances of doctor and emergency room visits, and hospitalizations;
- Households are better able to pay energy and medical bills;
- Households are better able to pay for food; and
- Households use of two kinds of short-term, high interest loans (tax refunds and pawn shops) decreases.

Application for AIC-Specific NEI Assessment

The evaluation team may leverage the ORNL study to develop survey questions, which are clearly explained for each of the NEIs studied, explore analytical techniques, and find literature relating to the avoided costs of illness and missed work. Monetization approaches for the study relied, in part, on data from online national databases hosted by entities such as the Department of Health and Human Services and the Agency for Healthcare Research (AHRQ) and Quality. Evaluators may leverage these national databases to monetize NEIs in the AIC territory. The Healthcare Cost and Utilization Project by AHRQ comprises the largest national and state-specific longitudinal healthcare data in the US and may be particularly helpful.[1] Given that Navigant will leverage the ORNL approach to quantifying NEIs in the ComEd territory, the study warrants consideration and in-depth review by others conducting evaluations in IL.

Tetra Tech, NMR, DNV-GL (2018) Program Administrators of Massachusetts: Non-Energy Impact Framework Study Report. Tetra Tech, Inc. Madison, WI. Retrieved from: http://ma-eeac.org/wordpress/wp-content/uploads/NEI-Framework-Study-Report.pdf

The framework study, which was prepared for Massachusetts program administrators, maps a wide range of NEIs to residential and C&I program types. The study offers a clear picture of NEIs that PAs already consider, those that should be added to the research, strategies for not double counting NEIs across different programs, and pathways for future research. Given the detailed focus on NEIs associated with each program type, the evaluation team sought to understand what negative impacts, if any, were anticipated following Massachusetts EE programming. The study calls out blue light associated with LEDs as a potential negative health impact resulting from lighting upgrades.

Application for AIC-Specific NEI Assessment

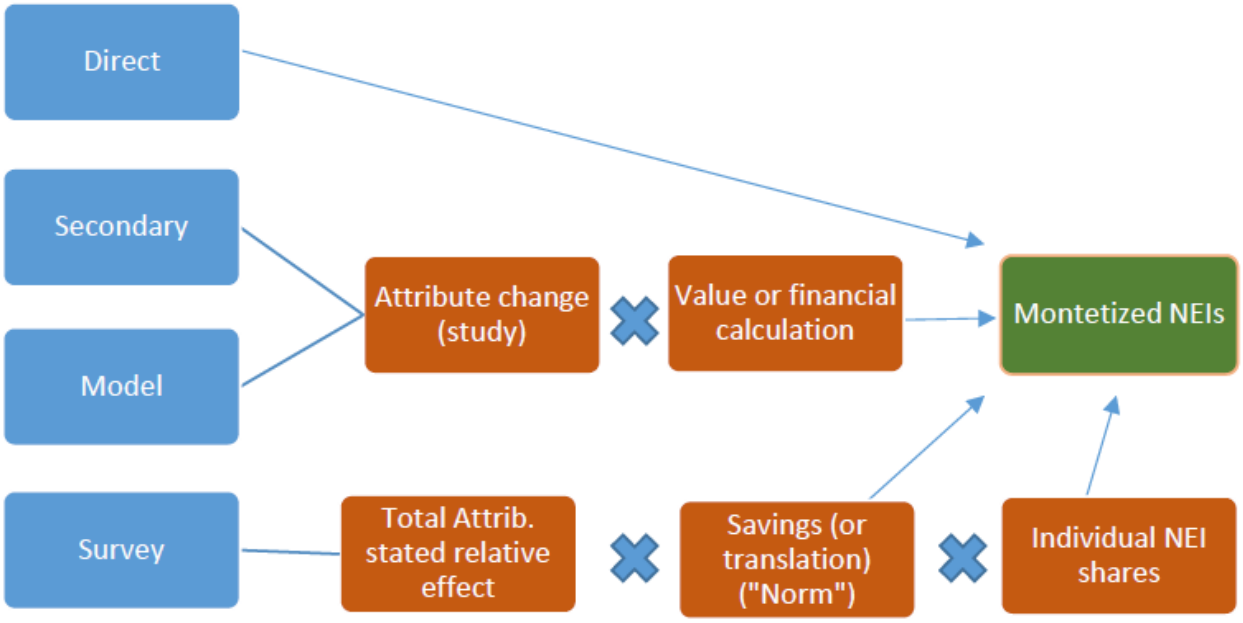
The evaluation team will leverage this study's NEI-to-program mapping when developing a similar matrix for AIC's programs/initiatives, giving consideration to characteristics of AIC's specific initiatives and service area.

NEEP (2017) Non-Energy Impacts Approaches and Values: An Examination of the Northeast, Mid-Atlantic, and Beyond. Northeast Energy Efficiency Partnerships, Inc. Lexington, MA. Retrieved from: https://neep.org/sites/default/files/resources/NEIFinalReport

The NEEP study offers a wide look at approaches to assessing cost effectiveness, ways of quantifying NEIs for inclusion in cost effectiveness analyses and includes conclusions on the state of practice. With respect to the state of research for AIC, key contributions of the NEEP study include a schematic depicting the methodology for how NEIs are monetized, in addition to values for NEIs across major studies and states. The study also includes detailed information on values for C&I NEIs, which relied on data from a previous study conducted by DNV-GL and others.[19] We present key figures from this valuable synthesis here. Figure 4-3 summarizes common cost effectiveness approaches.

[19] DNV GL, National Grid, Tetra Tech (2014) Non-energy impacts of C&I energy efficiency measures provide substantial program benefits above carbon reduction. International Energy Policy & Programme Evaluation Conference, Berlin, GE. Retrieved from: http://www.iea.org/topics/energyefficiency/multiplebenefits/C&I NEIs in Massachusetts.pdf

Figure 4-3. Monetization Approaches for NEIs as Presented by NEEP



Source: As cited in NEEP (2017)

The study offers further useful synthesis of the methodology used to monetize NEIs and which NEI category each approach best serves. For example, surveys best capture participant benefits such as health benefits, satisfaction, and equipment function, while engineering models serve measuring societal impacts such as economic and emissions impacts.

Application for AIC-Specific NEI Assessment

An important contribution of the NEEP study to AIC's NEI research will be the synthesis of applied NEI values across states and major studies (Appendix 1 of study). As the evaluation team develops NEI values for Illinois, we will leverage these existing data points to check the validity of our values.

Three[3], NMR (2016) Massachusetts Special and Cross-Cutting Research Area: Low-Income Single Family Health- and Safety-Related Non-Energy Impacts (NEIs) Study. Retrieved from: http://ma-eeac.org/wordpress/wp-content/uploads/Low-Income-Single-Family-Health-and-Safety-Related-NonEnergy-Impacts-Study.pdf

In 2015, an evaluation of the U.S. DOE's WAP was completed that included the assessment and monetization of twelve health and household-related impacts attributable to the weatherization of income-eligible single-family homes, at a national level, as described above. In this study, a subset of eight household NEIs and four societal NEIs were selected for study in MA. Researchers selected household NEIs based on their evaluability

and hypothesized direct impact on income-eligible homes in the state of MA. The NEIs included in the study, with their measurable proxy indicated in parentheses, were:

1) Reduced asthma (lower medical costs);
2) Reduced cold-related thermal stress (lower medical costs and fewer deaths);
3) Reduced heat-related thermal stress (lower medical costs and fewer deaths);
4) Reduced missed days at work (reduction in lost income);
5) Reduced use of short-term, high interest loans (lower interest payments and loan fees);
6) Increased home productivity due to improvements in sleep (higher productivity for housekeeping);
7) Reduced carbon monoxide (CO) poisoning (lower medical costs and fewer deaths); and
8) Reduced home fires (fewer fire-related injuries, deaths, and property damage).

The methodology employed to measure the NEIs closely followed that of the previously-described WAP study, but some input variables for each of the NEIs were adjusted, as necessary, to reflect actual conditions in MA, and in some cases, the algorithm used was adjusted as well. Overall, the study reports having used a customized, MA-specific approach for each of the NEIs, but relied on input values and approach provided by the WAP study where possible.

The study details the original WAP approach and the subsequent changes made to methodology and inputs for each NEI. We present an example of this accounting in Figure 4-4.

Figure 4-4. Summary of the WAP Survey Approach Use to Measure Total Replaceable CO Monitors, as Presented by NMR and Three[3]

Pre-Weatherization Treatment – National (N=665)					
Fossil Fuels as Heating Source?	No 19.8%				
	Yes → 80.2%	**Have CO Monitor? (N=523)**	No 43.8%		
			Yes → 56.2%	**Functional CO Monitor? (N=287)**	No 7%
					Yes 93%
Total Replaceable CO Monitors = 47.64%					
Pre-Weatherization Treatment – Cold Climate Region (N=318)					
Fossil Fuels as Heating Source?	No 13.2%				
	Yes → 86.8%	**Have CO Monitor? (N=272)**	No 37.9%		
			Yes → 62.1%	**Functional CO Monitor? (N=164)**	No 8.5%
					Yes 91.5%
Total Replaceable CO Monitors = 43.03%					

The MA study methodology then lists all points that were modified to estimate MA-specific benefits, including figures such as the percentage of weatherized homes using fossil fuels for heating, and the percentage of homes below 200% of the federal poverty line, among others.

Application for AIC-Specific NEI Assessment

This work may serve AIC in providing an approach to supplement primary survey data collected across the AIC service territory with nationally-established approaches and values for input variables. The MA study offers a clear picture of how each assumption was modified, creating a traceable and robust record of each data input. Because many household NEIs associated with income eligible households have a low incidence rate and are therefore difficult to measure without a large sample size (i.e. avoided fire risk), AIC may choose to employ methodologies similar to MA in cases where measuring a statistically viable sample is not feasible.

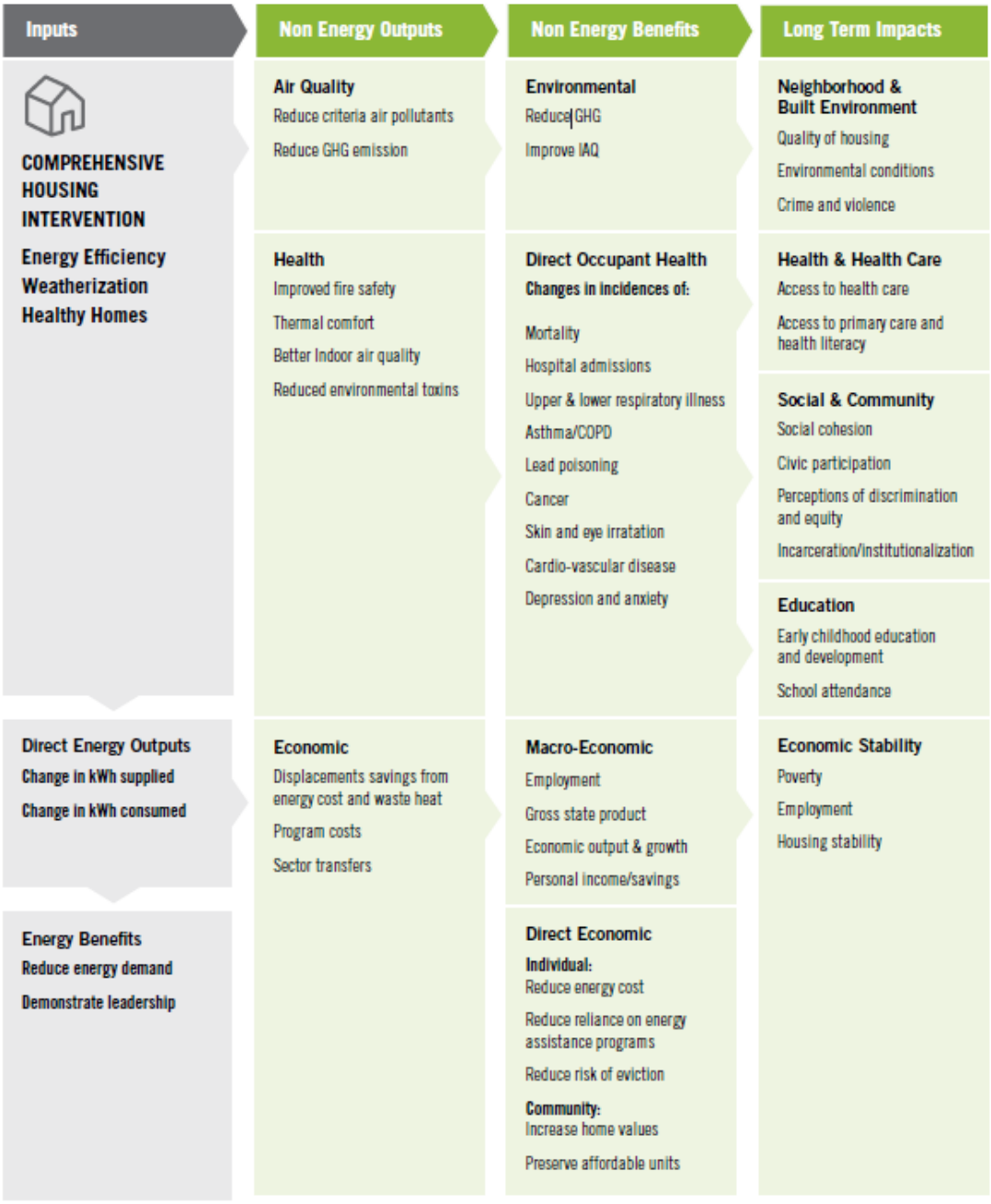
Green and Healthy Homes Initiative. (Not Dated). Achieving Health and Social Equity through Housing: Understanding the Impact of Non-Energy Benefits in the United States. Retrieved from: https://www.greenandhealthyhomes.org/AchievingHealthSocialEquity_final-lo.pdf

This study offers a detailed explanation of how the benefits of EE permeate a range of health indicators for low income populations, creating clear non-energy benefits. The study links EE the discussion of non-energy impacts in terms of social determinants of health (SDOH), which are defined as "the conditions in the environments in which people are born, live, learn, work, play, worship, and age that affect a wide range of health functioning, and quality of life outcomes and risks." Non-energy benefits are tied to social determinants of health in many ways, and because of place-based social inequities that low income families face, these disadvantages communities stand to gain significant improvements in many aspects of life after implementing EE. Figure 4-5 details the connections between non-energy benefits and social determinants of health. Overall, the study makes a strong case for focusing EE improvement efforts on disadvantages communities first, thereby increasing the quality of life for those individuals and spurring greater non-energy benefits.

Application for AIC-Specific NEI Assessment

The evaluation team suggests that AIC can leverage this study to support their focus on disadvantaged communities and income qualified programming.

Figure 4-5. Conceptual Framework of the Connections between Non-Energy Impacts and Social Determinants of Health



5. Conclusions and Next Steps

The studies we reviewed provide (a) a relatively complete summary of the history of NEI consideration in IL and (b) an examination of key studies that can be used to inform the methods for assessment and quantification of NEIs moving forward. Taken together, the studies propose sound and repeatable research approaches that AIC may pursue in quantifying NEIs, though we have identified ways that AIC may adapt their own research plan for feasibility purposes. For example, the AIC research may be adapted in terms of sample size, geography covered, number of NEIs quantified in upcoming years, and use of alternative data sources to supplement primary data. The research presented here also supports AIC's aim in serving income qualified customers, given that EE is a lever for increasing quality of life in those communities.

- **As the evaluation team develops its NEI research framework for 2019-2021, it will continue to follow the framework development best practices identified in this review, building upon the exploratory research conducted in 2018.** Core steps identified in this review include: inventorying all impact categories potentially affected by the programs under consideration; reviewing the inventory to select and prioritize significant impacts for further study; and proposing a plan for quantifying significant impacts and estimating the monetary value of quantified impacts.
  - As next steps, continue to use qualitative and screening-level assessments to identify potential areas for research. Self-report surveys, utility data, etc. are all common methodologies.
- **Impacts from income qualified programs comprise a great value compared to total program value, making them a worthwhile area of initial study.** Moreover, a well-documented national study provides a peer-reviewed methodology. However, the common approach involves significant data collection; the evaluation team may need to adapt the approach and/or be aware that conducting this research involves a trade-off with other potentially important impacts.
  - As next steps, the evaluation team and AIC should further investigate costs of the pre/post treatment/comparison group survey method to quantifying health and comfort NEIs from income-qualified programs. Additionally, AIC may consider less robust, yet sufficient methodologies to arrive at NEI values for some programs. For example, some programs in Massachusetts leverage weatherization NEI values from the "cold" climate region, of which Illinois is part. The study summarized below found it acceptable to use the multi-state region as a proxy for NEIs in Massachusetts. However, it remains to be seen whether customer characteristics, program designs, and other features have a substantial enough effect on NEI values to warrant separate studies.
- **Utility NEIs may be calculated with relative ease compared to other NEIs, given the availability of utility data.**
  - This finding supports the evaluation team prioritizing this type of study in 2019. As next steps, the evaluation team recommends identifying the programs for which utility-based NEIs will be quantified and ensuring the required databases exist. To complete the study, the evaluation team must develop a treatment group (program participants) and a control group (individuals with

similar characteristics to the participants), which will allow for the detection of differences in arrearages and other metrics due to program participation. Because AIC does not track program participation or flag income qualification in its account database, the evaluation team will first have to ensure an approach to identifying such individuals throughout relevant databases. This challenge will comprise the first step of ensuring adequate data to conduct the analysis and will confirm the evaluability of utility NEIs.

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