ComEd

New Construction – Small Buildings Evaluation Report

FINAL
Energy Efficiency / Demand Response Plan:
Plan Year 8 (PY8)
(6/1/2015-5/31/2016)

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E. EXECUTIVE SUMMARY

This report presents a summary of the findings and results from the Net Energy Optimizer (NEO) tool review, and impact and process evaluation of the PY8 [1] New Construction – Small Buildings program. We focused our evaluation on the NEO tool review to determine the validity of using NEO to calculate each project's savings. The NEO tool review was conducted by examining three case studies of different building types, multifamily, grocery and restaurant. The impact study was limited since only one project was completed in PY8, and the process evaluation was limited to interviewing staff at ComEd and contractors implementing the program. Net to gross (NTG) was not studied, and a deemed NTG value is used.

In PY8, The Weidt Group (TWG) implemented an energy efficiency Illinois Power Agency (IPA) program for new construction projects of commercial and industrial buildings from 5,000 to 20,000 square feet (SF) and multifamily buildings from 5,000 to 100,000 SF. The program was centered on a tool developed by TWG called Net Energy Optimizer (NEO). NEO is a building energy simulation tool built on a DOE2 platform that analyzed the building's energy use for each hour of the year. Analysis included lighting, loads on the building due to weather, the performance of thermal shell, HVAC system, plug loads, internal loads, and occupancy schedules. NEO aimed to unlock the power of building energy simulation models while avoiding the cost and extensive timeline of existing energy model platforms such as eQUEST, Trane Trace, Carrier Hourly Analysis Program (Carrier HAP) and others. The NEO tool also had the ability to run quickly, provided economic analysis of an efficiency measure bundle and displayed up to three different efficiency bundle options, allowing for real-time iterations with a participant design team.

For every project there are two NEO models, one for the baseline building and one for the proposed, more efficient building. For both the NEO tool review and for the impact study Navigant built comparison eQUEST models, both a baseline and proposed, to help examine the validity of the NEO models. eQUEST was chosen as a well-established building energy simulation tool built on the DOE2 platform.

Prior to PY8, there was no ComEd New Construction program for commercial buildings below 20,000 SF and multifamily buildings below 100,000 SF. Larger buildings are handled by the historical new construction program implemented by Seventhwave, which is addressed in a separate report.

E.1. Program Savings

Table E-1 summarizes the electricity savings from the New Construction – Small Buildings program.

Table E-1. PY8 Total Program Electric Savings

Savings Category	Energy Savings (MWh)	Peak Demand Savings (MW)
Ex Ante Gross Savings	45.50	0.0078
Verified Gross Savings	41.85	0.0062
Verified Net Savings	41.85	0.0062

Source: ComEd tracking data and Navigant team analysis.

[1] The PY8 program year began June 1, 2015 and ended May 31, 2016.

E.2. Key Findings and Recommendations

The program offers quick and interactive building modeling, with all modeling costs provided by ComEd and its contractors. The modeling tool used in small buildings, NEO, was capable of estimating energy savings of various measures and the overall process delivers best-in-class services to participants. The primary issue was the lack of participation in PY8 with only one completed project. Participation was primarily limited by the long lead times on new construction programs and the short timeline of the IPA program.

The following provides insight into key program findings and recommendations.[2]

Finding 3. The kitchen[3] did not include economizers in either the baseline or proposed NEO model, even though ASHRAE 90.1 requires an economizer in the baseline and the physical building has an economizer in the kitchen.
Recommendation 3. Ensure economizers are included when required by the energy code or when physically installed.

Finding 6. The lighting power density (LPD) incorrectly applied a space-by-space number to a building area calculation. The building area LPD allowance for dining: cafeteria/fast-food, which is 0.9 watts/SF, should be used for the entire building.
Recommendation 6. Use either the building area method for the entire building or the space-by-space method for the entire building when calculating LPD baselines. When using space-by-space, every single space enclosed by walls including each closet, bathroom, hallway, etc. needs its own individual space LPD.

Finding 7. The controls for the baseline economizers should be single-point dry-bulb, rather than enthalpy controlled.
Recommendation 7. The baseline economizer control should always be single-point dry-bulb where economizers are required.

Finding 11. The primary factor for low participation in PY8 was the long lead times on new construction programs and the short timeline of the IPA program. The program was somewhat out of sync with the IPA cycle.
Recommendation 11. If the small buildings program will be continued beyond the end of the two-year IPA program, Navigant suggests allowing for a full year of startup before completed projects are expected, and that the first year goals be focused on developing a pipeline for the following year.

Finding 14. Print materials consist of a few one-page documents that explained the process of the program or the NEO tool, but it appeared there are no materials focused on the value to participants and trade allies.
Recommendation 15. Investigate which factors most motivate both participants and small construction professionals so that the print materials can highlight those areas.
Recommendation 16. Develop case studies focusing on the small buildings IPA program.

Finding 15. While there was only one completed project in PY8, there was no formal recognition of completed projects nor awards for the best designs.
Recommendation 17. With a pool of more completed projects, consider recognizing successful projects in the form of web site highlights, plaques for building lobbies and contractor lists. Contractor lists can be published in ComEd's website and include contractors meeting

[2] Numbered findings and recommendations in this section are the same as those found in the Findings and Recommendations section of the evaluation report for ease of reference between each section.
[3] There was only one project completed which was a restaurant with a kitchen and dining room.

minimum objective criteria and who have participated in a completed New Construction – Small Buildings project.

1. INTRODUCTION

1.1 Program Description

In PY8[4], the Weidt Group (TWG) implemented the New Construction – Small Buildings (NC-SB) program, an energy efficiency Illinois Power Agency (IPA) program for new construction projects of commercial and industrial buildings from 5,000 to 20,000 square feet (SF) and multifamily buildings from 5,000 to 100,000 SF. The NC-SB program was centered on a tool developed by TWG called Net Energy Optimizer (NEO). NEO aimed to unlock the power of building energy simulation models while avoiding the cost and extensive timeline of existing energy model platforms such as eQUEST, Trane Trace, Carrier Hourly Analysis Program (Carrier HAP) and others. The NEO tool also had the ability to run quickly, provided economic analysis of an efficiency measure bundle and displayed up to three different efficiency bundle options, which allowed for real-time iterations with a participant design team.

Unlike traditional energy modeling where a participant contracted with a professional modeler outside of a utility's program, in this program, TWG conducted the energy modeling. TWG collected information from the participant's design team in order to build a model within a few weeks. TWG then met with their design team and presented a NEO baseline simulation as well as several enhanced efficiency options. Once an efficiency bundle was selected, TWG sent a Bundle Requirements Document to the participant which outlined the agreed measures, documentation required and the incentive. Upon completion of the project, TWG verified the measures so that the incentive could be paid to the participant.

1.2 Evaluation Objectives

The evaluation team focused on reviewing the NEO tool review by determining the validity of using NEO to calculate each project's savings. The evaluation team examined three case studies of different building types, multifamily, grocery and restaurant. The impact evaluation was limited since there was only one project completed in PY8. The process evaluation was limited to interviewing staff at ComEd and TWG. Net to gross (NTG) was not studied, and a deemed NTG value was used.

For every project, there were two NEO models, one for the baseline building and one for the proposed, more efficient building. For both the NEO tool review and for the impact study, Navigant built comparison eQUEST models since eQUEST is a well-established building energy simulation tool that is also built on the DOE2 platform. These baseline and proposed models helped examine the validity of the NEO models.

The evaluation team identified the following key researchable questions for PY8.

1.2.1 Impact Questions

1. What are the energy and summer peak demand savings impacts from the program?
    a. Are the assumptions used in the NEO tool consistent with the best available data sources and, where applicable, the Illinois TRM?
    b. Did the NEO model follow ASHRAE 90.1 – 2010, Appendix G which defines the building modeling method?
2. Is the NEO tool energy modeling outputs appropriate for estimating ex ante savings of small buildings?
    a. Is there sufficient flexibility in the tool to enable accurate estimates of key inputs?
    b. Does the NEO tool over simplify, leading to an unacceptably wide error margin?

[4] The PY8 program year began June 1, 2015 and ended May 31, 2016.

c. Will future evaluations be able to use the NEO models as a starting point for higher rigor evaluation modeling?

1.2.2 Process Questions

1. What administrative processes are in place including application, intake, processing and incentive payment?
2. How does the program pursue participation?
3. What outreach and marketing activities are conducted?
4. What is the process for completing a project from the participant's perspective?
5. What technical assistance is provided to the participant and the participant design team?

2. EVALUATION APPROACH

The impact analysis for the project completed in PY8 included the following steps:

1. Checked the baseline NEO model for compliance with ASHRAE 90.1-2010 code minimum requirements, the modeling method specified in ASHRAE Appendix G and appropriate weather files and schedules.
2. Compared the as-built or efficient NEO model to design drawings located in the project file.
3. Incorporated a NEO tool review to the impact evaluation to discover features of the NEO tool which may need impact adjustment.
4. Constructed Navigant models using eQUEST v3.5 for the baseline and efficient case using many of the inputs from the NEO models except for those that violate energy code or do not comply with the design drawings.
5. Compared the energy outputs between the NEO models and Navigant models for both the baseline and the efficient cases. Where energy outputs significantly differed, we investigated further.

2.1 Overview of Data Collection Activities

The core data collection activities included in-depth process interviews with program staff and implementation contractors, a thorough analysis of the NEO tool with evaluation-level access, and an engineering file review of the project file. The full set of data collection activities is shown in Table 2-1 and Table 2-2.

Table 2-1. Primary Data Collection Activities

What	Who	Target Completes	Completes Achieved	When	Comments
In Depth Interviews	Program Manager/Implementer Staff	4	4	September – October 2016	ComEd, TWG, Seventhwave
NEO Tool Review	Typical Building Types	2 Prototypical Building Types	3 Prototypical Building Types	July – September 2016	Multifamily, Grocery, Restaurant
Engineering File Review	Participating Customer	1	1	September – October 2016	Only One PY8 Participant

Table 2-2. Additional Resources

Reference Source	Author	Purpose	Gross Impacts	Process
Illinois Technical Reference Manual	Illinois Energy Efficiency Stakeholder Advisory Group	Establishing Baseline	X	
ASHRAE 90.1 - 2010	American Society of Heating, Refrigerating and Air-Conditioning Engineers	Establishing Baseline	X	
International Energy Conservation Code 2012	International Code Council	Establishing Baseline	X	
Net Energy Optimizer tool – Evaluation Level Access	TWG	Ex-Ante Model	X	X
eQUEST	eQUEST	Ex-Post Model	X	

2.2 Verified Savings Parameters

The evaluation team calculated the verified gross and net savings (energy and coincident peak demand) resulting from the PY8 program by constructing a Navigant baseline and proposed building model using eQUEST. Savings was the difference in annual energy usage between the two models. The Navigant models used inputs, where appropriate, from the ex ante NEO models. NTG was deemed to be 1.0 in PY8.

2.3 Process Evaluation

The limited process evaluation consisted of in-depth interviews with the ComEd Program Manager, TWG Program Manager and Lead Modeler, and the Seventhwave Program Manager. Questions focused on key topics including:

- Participation, Marketing Efforts and Outreach
- Administrative Processes
- Customer Experience
- Verification and Due Diligence

3. GROSS IMPACT EVALUATION

Navigant conducted an impact analysis for the completed restaurant project in the NC-SB program. Navigant reviewed the restaurant project and compared the NEO tool findings to a Navigant model built in eQUEST. Ex ante savings were 45.50 MWh of electrical energy with 7.79 kW of coincident demand savings. Ex post savings were 41.85 MWh and 6.22 kW of coincident demand reduction. The realization rates were 92 percent and 80 percent respectively for energy and demand savings.

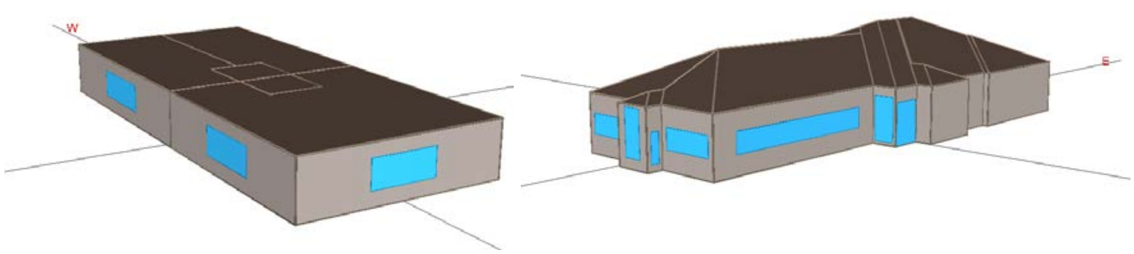
The lifetime of the PY8 program savings was 14.78 years. In the completed project, vacancy controls had an eight-year lifetime and all other measures had a 15-year lifetime. Incremental measure cost was $1,031.

There were two NEO models for the restaurant building, one for the baseline building and one for the proposed, more efficient building. For the impact study, Navigant built comparison eQUEST models, both a baseline and proposed, to help examine the validity of the NEO models. eQUEST is a well-established building energy simulation tool built on the DOE2 platform.

3.1 Building Model Comparisons

The completed PY8 project is a 4,560 square foot (sq.ft) restaurant. Figure 3-1 shows the model's exterior surfaces with the NEO tool version on the left and Navigant's eQUEST model on the right.

Figure 3-1. Exterior Surface of Restaurant for both NEO Model and Navigant Model



NEO Tool Model

Navigant's eQUEST Model

Table 3-1 summarizes the model inputs for both the NEO models and the Navigant models. The baseline case contained a packaged single-zone, gas-powered HVAC system serving 12 perimeter zones and four core zones. The zones were divided into dining and kitchen areas with an economizer in the dining area. Supply fans were modeled using constant fan speed. The efficient case consisted of lighting power density reduction, the addition of occupancy sensors, and a high efficiency unitary cooling system. Most of the savings were attributed to fan energy savings.

Table 3-1. Inputs for the Restaurant Building

Item	Baseline Model	Efficient Model
Wall Assembly U-values	U = 0.064	No change
Roof Assembly U-value	U = 0.048	No change
Window U-value	U = 0.55	No change
Floor U-value	U = 0.142	No change
Interior Lighting Power Density (LPD)	0.90 W/sqft (dining) 0.99 W/sqft (kitchen)	0.63 W/sqft (dining) 0.59 W/sqft (kitchen) With occ sensor installed in kitchen area
Equipment power density	1.53 W/sqft (dining) 1.50 W/sqft (kitchen)	No change
Infiltration (Air-Change)	0.1 ACH (perimeter) 0 ACH (core)	No change
HVAC System	Packaged single-zone with gas furnace and DX cooling Economizers (enthalpy control in dining area), constant speed supply fans, and fan static pressure reduction	No change
Supply Fan	Constant speed fan Total of 6,713 CFM Supply Static Pressure: avg of 2.325 Supply-Eff: 0.2596	No change other than Supply Static Pressure: avg of 0.6447 Supply-Eff: 0.2522
Outside Air (OA)	Flow rate: 2,562 CFM	No change
Cooling Electrical Input Ratio (EIA)	Cooling EIR: 0.286	No change
Furnace Heat Input Ratio (HIR)	*Furnace HIR: 1.25*	*No change*

Source: Navigant analysis and TWG analysis

3.2 Verified Gross Program Impact Results

The completed PY8 project measures included:

- Higher efficiency rooftop cooling units (RTUs) with gas heat,
- Reducing lighting power as compared to the lighting power density code allowance, and,
- Adding vacancy sensors in the kitchen.

The improved RTUs represented the majority of the savings. However, all aspects of the NEO model needed to be investigated since any changes affected the HVAC load on the building and affected the overall savings.

The evaluation team found that the following items needed adjustment in both the baseline and efficient models:

- Miscellaneous loads increased to six watt/sq.ft.
- HVAC zones should have been two instead of eight zones.
- Both the dining room and the kitchen need an economizer instead of just in the dining room.

- Schedules for lighting, plug loads and infiltration did not match ASHRAE 90.1-2010 Addendum AN: Building Envelope Trade-Off Schedules and Loads (Addendum AN).
- Kitchen equipment schedules followed plug load schedules; however, Navigant believes the lighting schedules are a better fit for commercial kitchen equipment in a restaurant.
- Exterior wall area was 27 percent larger than the calculated wall area.

Additionally, the baseline NEO model required these adjustments:

- The lighting power density (LPD) incorrectly applied a space-by-space number to a building area calculation; the dining: cafeteria/fast-food LPD allowance of 0.9 watts/sq.ft should be used for the entire building.
- The controls for the baseline economizers should be single-point dry-bulb rather than enthalpy controlled.
- HVAC capacity recalculation using auto-sizing with 15 percent sizing ratio for cooling and 25 percent sizing ratio for heating.

Navigant accounted for these adjustments in our eQUEST baseline and efficient model. Navigant ran the eQUEST models using the same weather files NEO used and calculated the ex post savings values from their eQUEST model outputs.

Table 3-2 and Figure 3-2 compare the NEO models with the Navigant models built in eQUEST by major internal electrical end uses. The improved RTUs comprise the majority of the savings through both the space cooling and the ventilation fan end uses. The ventilation savings in Navigant's eQUEST analysis is almost identical to the NEO tool; however, there are significant differences in the space cooling savings. Further investigation showed the difference in space cooling savings, while affected by many of Navigant's adjustments, was primarily driven by the addition of the dry-bulb economizer to the kitchen in both the baseline and proposed NEO models.

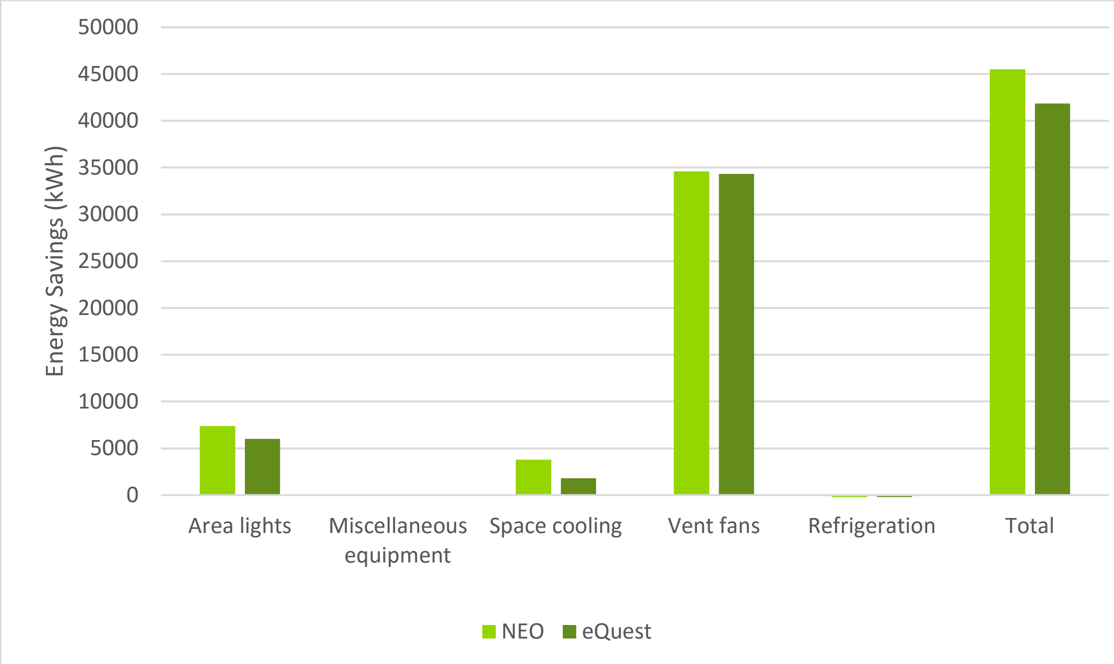
The difference in area lights savings was due to the adjustment of the kitchen LPD allowance from 0.99 to 0.90 watts/sq.ft. Note that miscellaneous equipment, while showing no savings, was much higher in the Navigant model than in the NEO model. This increase was attributed to the schedule change for kitchen equipment from the plug loads to the lighting schedule. An increase in heat output from the kitchen required the overall sizing of baseline cooling equipment. While Navigant is not sure of the method used to size the baseline equipment in the NEO model, the capacity used in Navigant's eQUEST simulation almost exactly matched the NEO cooling equipment sizing.

Table 3-2. NEO Model and Navigant's eQUEST Model by Interior Electrical End Use

End Use	NEO		Navigant		Savings		
	Base	Proposed	Base	Proposed	NEO	Navigant	RR
Area lights	19,573	12,200	18,393	12,395	7,373	5,998	81%
Miscellaneous equipment	9,940	9,940	38,551	38,551	0	0	NA
Space cooling	16,478	12,696	16,707	14,905	3,782	1,802	48%
Vent fans	48,464	13,869	48,411	14,074	34,595	34,337	99%
Refrigeration	44,060	44,306	35,516	35,799	-246	-283	115%
Total	138,515	93,011	157,578	115,724	45,504	41,854	92%

Source: Navigant analysis and TWG analysis

Figure 3-2. Ex Ante (NEO) vs. Ex Post (Navigant eQUEST) Electrical Energy Savings by End Use



Source: Navigant analysis and TWG analysis

3.3 NEO Tool Review

As part of our evaluation, Navigant investigated the accuracy of the NEO tool energy analysis when applied to small commercial buildings. The energy analysis focused on annual electrical energy use in kWh as well as electrical peak demand in kW.

Navigant's review of the NEO tool was limited to case studies of three building types—multifamily, grocery, and restaurant, which were selected because of the project pipeline in PY9. The NEO tool did meet the criteria of providing adequate energy consumption models of baseline code minimum buildings and energy efficiency enhanced buildings when applied to small commercial buildings. Navigant recommends enhancing the NEO tool to minimize realization rate corrections. Recommended enhancements include:

- Matching the baseline HVAC zones to the building design
- Matching schedules for occupancy, lighting power, plug loads, infiltration and HVAC set points with ASHRAE 90.1-2010 Addendum AN: Building Envelope Trade-Off Schedules and Loads (Addendum AN)
- Correcting the exterior wall and window surface area calculations
- Ensuring in all cases that the interior loads match ASHRAE 90.1-2010 Addendum AN
- Baseline economizers should be changed to single point, dry-bulb control

The Appendix contains details of Navigant's review of the NEO tool. The evaluation team recommends further study of other building types in future years to ensure that nuances in modeling simulations are fully investigated.

4. PROCESS EVALUATION

The process evaluation determined that while the program had significantly missed the PY8 energy savings target, the NC-SB was a well-run program that provided valuable services to participants. Based on Navigant's experience with new construction program best-practices and interviews with the program implementer, the program processes appeared to be easy for customers to access and well accepted by participants. Of note is the program's ability to engage with small new construction teams holistically by taking an easy and expedited modeling approach that few small new construction projects would have considered. Further, the program appeared to be successful in convincing the new construction design teams to seek out more cost effective efficiency measures than they would have without the assistance of the NEO tool and the analysis of TWG. A number of recommendations for continued program improvement are in each of the following subsections.

The remainder of this section presents these findings in more detail, including:

- Participation, Marketing Efforts and Outreach
- Administrative Processes
- Customer Experience
- Verification and Due Diligence

4.1 Participation, Marketing Efforts and Outreach

The SB-NC program did not have significant participation in PY8 with only one completed project. While there were many contributing factors (discussed below), the primary factor was the long lead times on new construction projects combined with the short timeline of the IPA program. TWG was limited in that it could not begin marketing and outreach until the beginning of PY8 in June 2015. Due to the seasonality of new construction projects with most design work occurring in the winter and spring, the timeline made it difficult to capture any projects built in 2015. TWG was successful in capturing projects being constructed in 2016, but most will not be completed until PY9 begins. In September 2016 there was 1,703 MWh in the pipeline for PY9. If the NC-SB program will be continued beyond the end of the two-year IPA program, Navigant suggests allowing for a full year of startup before completed projects are expected, and that the first year goals be focused on developing a pipeline for the following year.

One participant with four projects dropped out of the program in PY8. Savings estimates were only 50,000 to 70,000 kWh. Due to the amount of information required to enroll all four buildings and the relatively small incentive, the customer was hesitant to participate. TWG appeared to have diligently followed up with the customer on numerous occasions and tried to streamline the process as much as possible, but the customer decided against participating. Navigant did not view this customer's decision to not participate as an indication of a program problem, but suggests future monitoring of such customers and interviewing them to determine if there is reason for concern.

ComEd wanted to make the two different new construction programs, for large and small buildings, appear as one program to their customers. A consequence was that the SB-NC program was not specifically marketed and the program relied on marketing of ComEd's overall new construction program. Navigant's new construction experience indicated that both participants and trade allies for small buildings are different populations than larger buildings, and that many small construction actors will assume the program is focused on larger buildings without better awareness. Navigant recommends that a dedicated marketing effort be considered to boost program awareness. Navigant also suggests that a standard response be formulated to address trade allies that are confused by the different processes for small and large new construction projects.

TWG had a dedicated outreach person that focused on in-person outreach, searched construction web sites, and went to various conferences where small construction professionals were prevalent. Once potential projects were identified, cold calling was initiated to explain the program to participants. Navigant's experience indicates this in-person outreach focused on trade allies is the most effective way to gain participants in new construction programs and suggests that this practice be continued into the future. Another strategy would be to invest in a listing of permitted construction projects such as the lists that Dodge Data and Analytics collects.

Print materials consisted of a few one-page documents that explained the process of the program or the NEO tool, but it appeared there were no materials focused on the value to participants and trade allies. Navigant recommends investigating which factors most motivate both participants and small construction professionals so that the print materials can highlight those areas. While it may be evident that there are participation benefits to the building owner, less obvious are the benefits to trade allies, and trade allies' opinions often have the greatest influence on the building owner's participation decision. Finally, case studies can also be an effective method of demonstrating the value of the program and Navigant recommends the development of case studies focusing on the NC-SB program.

Navigant notes that there was no formal recognition of completed projects nor awards for the best designs. Recognition in the form of web site highlights, plaques for building lobbies and contractor lists of those who have successfully completed projects can be highly motivating for participation of both the building owner and the design teams.

4.2 Administrative Processes

The administrative processes included tracking data, applications, intake, and incentive payments.

TWG used their tracking system called WeidtSpace and then uploaded information into Frontier, ComEd's tracking system. WeidtSpace appeared to have more functionality including the ability to run NEO from WeidtSpace. WeidtSpace had a dashboard that provided all the basic information of the project such as all the players in the project, critical correspondence, milestones, maps, and can store project files. Additionally, each player had their own dashboard that gave an overview of all the projects they had completed and other historical information. While Navigant did not see the database firsthand, it appeared to contain all the critical components needed for a new construction program where robust details can easily be obtained by TWG team. TWG indicated that a portal to WeidtSpace could be made available to ComEd if they would find the enhanced information useful.

The NC-SB program used the same application as the large buildings application. TWG's outreach specialist assisted participants in filling out the application and reviewed the application and supporting materials for completeness and accuracy. Once the project was vetted through the application process, it was then handed off to a TWG project manager. Navigant's experience suggests applications can be a barrier to participation and is pleased to find that the application itself is simple. In the application, the participant only filled out basic information about the project such as participant contact information, estimated square feet, and building type (office, multifamily, etc.). The outreach specialist then conducted a telephone meeting to retrieve the rest of the information needed. This process minimized the barriers to apply and allowed for a robust transfer of information.

The participant incentive for the NC-SB program is fixed at $0.10 per kWh saved, while the large building program is using a sliding scale in PY9 depending on which point in the design process the project was enrolled. Navigant recommends aligning the incentive between the two programs or even providing a slightly higher incentive since small buildings may need more incentive to induce participation. The NC-SB program also provided a design incentive to help cover the costs of participating at meetings with TWG, providing building design information to TWG, and development of incremental costs for potential efficiency measures. Navigant approves of the design incentive as a useful tool in developing cooperation from the participant's design team.

4.3 Customer Experience

Once a project was enrolled, TWG assigned a project manager and a modeler to interact with the participant design team. TWG reached out to set up a 15 to 20 minute discussion of the project and set up an introductory call. The introductory call served for TWG to meet with all the players affecting design and construction. The introductory call also allowed TWG to investigate the current state of the building design and collect any information not provided during the application process such as the lighting design intent if preliminary drawings had not yet been drafted. TWG then was able to construct a NEO model and schedule a results meeting. Minutes of the introductory call were circulated to all participants of the meeting.

The results meeting was held seven to ten business days after the introductory meeting via telephone and WebEx. A PDF file was circulated to the design team with NEO tool results and three efficiency bundles were proposed. During the meeting, TWG reviewed the NEO model and the proposed efficiency bundles. The NEO tool was launched and changes to the efficiency bundles were made in real time at the meeting at the discretion of the participant design team. Action items were identified and assigned, such as further considering efficiency bundles or investigating pricing. Meeting minutes were recorded including point people for action items and the revised efficiency bundles reviewed at the results meeting.

TWG followed up with the participant design team periodically until an efficiency bundle was selected, at which point a bundle requirements document was generated by TWG. The bundle requirements document reintroduced the measures to the design team, reviewed what documentation would be required from the design team (design drawings, specifications, etc.), reviewed the incentive for the selected bundle, and reviewed the measurement and verification plan. The bundle requirements document was followed up with a submittal request e-mail that asked for specific documentation.

TWG periodically checked in with the participant design team to make sure everything continued on the agreed plan and that efficiency measures were not “value engineered” out of the design. Once the building was sufficiently complete, verification of the measures was performed. A verification report was issued with the final verified savings and the final verified incentive calculated. The design team was given a chance to correct any errors in the verification report before the incentive processing began.

Navigant determined the above described customer experience is a best-in-class process. The NC-SB program brought in the power of building energy modeling at no cost to the participants other than some design time that was partially covered by a design team incentive. The process was highly interactive getting involvement and buy-in from the participant design team. The turn-around time on modeling was extremely fast and was sensitive to the design team’s timeline. The design team was encouraged to pursue efficiency measures that they would not have considered had it not been for the NC-SB program. Project management was professionally done, documenting suggestions and meeting discussions as well as timely follow-up between meetings.

Incremental suggestions for improvement include a code compliance review and a focus on energy efficiency measures not covered by energy modeling, such as kitchen equipment[5]. TWG expressed reluctance in reviewing energy code deficiencies as they do not want to become “the code police.” Navigant agrees that reviewing code compliance is a delicate matter. Code reviews can be done tactfully, especially if they are discussed at the introductory meeting. Reviewing code adds value to the building owner and can be achieved with minimal effort since energy code is reviewed when models are being generated.

[5] Kitchen equipment is usually input as a miscellaneous heat and electricity consumer. All generally used building simulation models do not allow for a direct input of high efficiency kitchen equipment, such as a high efficiency dishwasher. Therefore, more traditional methods used in new construction programs without modeling need to be applied if kitchen equipment efficiency is to be considered.

In the restaurant project completed in PY8, there was no discussion of whether the kitchen equipment (stoves, fryers, griddle, dishwasher, etc.) would be renovated in any of the documents produced by TWG or any of the meeting minutes, with the exception of kitchen hood ventilation. This may have been because kitchen equipment design was not slated for discussion, or it may have been because the NEO tool, like any building energy model, does not look at kitchen equipment efficiency. If there was a possibility for more efficient cooking equipment, it may not have been discussed. This oversight could have caused a lost opportunity for more savings to the program, as well as added incentive to the participant.

4.4 Verification and Due Diligence

Navigant reviewed verification, due diligence and quality control issues with respect to both the validity of the NEO tool for calculating building energy and the on-site verification of energy savings carried out as part of the program. Administrative procedures were in place to ensure information submitted to the program was processed and recorded in the project tracking database. Application forms were reviewed to ensure that they are eligible. The form was completed and all required documentation provided.

The evaluation team discussed the verification policy with TWG program manager. The policy is that all projects completed in a program year would receive an engineering file review, and 10 percent of the projects also would receive an on-site verification. TWG policy is to selectively sample the larger projects when choosing which projects are to receive the on-site verification. Engineering file reviews are usually sufficient since new construction projects are well documented with construction documents, specifications and invoices for equipment. On-site review would occur after substantial completion of the subject building. Since there was only one project completed in PY8, it did receive an on-site verification. Navigant determined the verification policy is sufficient for this program and was sufficient for PY8.

5. FINDINGS AND RECOMMENDATIONS

This section summarizes the key impact and process findings and recommendations.

The NC-SB program provided support for small building customers building a new facility or undertaking a major renovation to incorporate higher levels of energy efficiency in their building design. The program offered quick and interactive building modeling, with all modeling costs provided by ComEd and its contractors. The modeling tool used in small buildings, NEO, is capable of estimating energy savings of various measures and the overall process delivers best-in-class services to participants. The primary issue was the lack of participation in PY8 with only one completed project. Participation was primarily limited by the long lead times on new construction programs and the short timeline of the IPA program.

5.1 Verified Gross Impacts and Realization Rate

Finding 1. Internal loads did not match ASHRAE 90.1-2010 Addendum AN: Building Envelope Trade-Off Schedules and Loads (Addendum AN)
Recommendation 1. Include consistency checks during verification that ensure a consistent approach for estimating internal loads is used.

Finding 2. The NEO tool modeled eight HVAC zones instead of the two zones used in the physical building. ASHRAE 90.1 Appendix G rules in Table G3.1 No. 7 says that when HVAC zones are defined on drawings, each HVAC zone will be modeled as a separate thermal block. While NEO's automated zoning process increases the speed of NEO and only results in a minor change in efficiency results, technically this process does not follow Appendix G rules.
Recommendation 2. The verification NEO model should match the number of HVAC zones in the physical building, even if this requires reconstructing the NEO model.

Finding 3. The kitchen[6] did not include economizers in either the baseline or purposed NEO model, even though ASHRAE 90.1 requires an economizer in the baseline and the physical building has an economizer in the kitchen.
Recommendation 3. Ensure economizers are included when required by the energy code or when physically installed.

Finding 4. Schedules for lighting, plug loads and infiltration did not match ASHRAE 90.1 Addendum AN.
Recommendation 4. Insure schedules match ASHRAE 90.1 Addendum AN in the verification NEO model.

Finding 5. Kitchen equipment schedules followed plug load schedules in ASHRAE 90.1 Addendum AN, but kitchen equipment does not fall into the definition of a restaurant plug load. While Addendum AN does not cover kitchen equipment schedules, Navigant believes the lighting schedules provided in Addendum AN are reasonable schedules for commercial kitchen equipment in a restaurant.
Recommendation 5. For equipment schedules not specified in ASHRAE 90.1 Addendum AN use professional judgment for a more appropriate schedule. Kitchen equipment is not a plug load and a commercial kitchen is generally on when the lighting equipment is on.

Finding 6. The lighting power density (LPD) incorrectly applied a space-by-space number to a building area calculation. The Building area LPD allowance for dining: cafeteria/fast-food, which is 0.9 watts/SF, should be used for the entire building.

[6] There was only one project completed which was a restaurant with a kitchen and dining room.

Recommendation 6. Always use either the building area method for the entire building or the space-by-space method for the entire building when calculating LPD baselines. When using space-by-space, every single space enclosed by walls including each closet, bathroom, hallway, etc. needs its own individual space LPD.

Finding 7. The controls for the baseline economizers should be single-point dry-bulb, rather than enthalpy controlled.
Recommendation 7. The baseline economizer control should always be single-point dry-bulb where economizers are required.

5.2 NEO Tool Review

Finding 8. Overall the NEO tool is meeting the objective of providing credible simplified modeling of small commercial new construction buildings.
Recommendation 8. Continue to use the NEO tool for the New Construction – Small Buildings program. Consider making incremental improvements to the tool including those recommended by Navigant in this report.

Finding 9. Navigant found that the exterior wall areas and window areas do not match the calculated wall and window area derived from the floor area in each building studied. At the beginning of 2016, NEO was updated to include a simple geometry editor to allow users more control over a building's geometry. The editor is Space Asset Area (SAA) based and gives the user the ability to set the shape of the building (square, "H", "T", "U", etc.) and then cut and drag walls to represent the overall shape of the SAA. Individual walls can be edited to be exterior or shared with adjacent spaces (interior). The user provides the general shape of the area and NEO automatically determines built dimensions based on the floor area for that SAA.
Recommendation 9. Recommend using the 2016 simple geometry editor in future projects so that wall and window areas can be better modeled.

Finding 10. The studied NEO tool is not using the latest DOE2 platform, instead it is using DOE2.1E.
Recommendation 10. TWG is currently developing a version of NEO with an EnergyPlus based simulation engine, expected release in the spring of 2017. Navigant recommends updating the software version as planned.

5.3 Process Evaluation

Finding 11. The primary factors for low participation in PY8 were the long lead times on new construction programs and the short timeline of the IPA program. The program is somewhat out of sync with the IPA cycle.
Recommendation 11. If the NC-SB program continues beyond the end of the two year IPA program, Navigant suggests allowing for a full year of startup before completed projects are expected, and the first year goals be focused on developing a pipeline for the following year.

Finding 12. One customer decided not to participate for valid reasons.
Recommendation 12. Continue to monitor and interview customers who start to participate and then decide to not go through with the program to determine if further action is required.

Finding 13. The NC-SB program is not marketed separately and the program relies on the marketing of ComEd's overall new construction program. While direct person-to-person outreach is more effective than marketing in recruiting participants, marketing may help small building participation.

Recommendation 13. Consider a dedicated marketing effort to boost program awareness.
Recommendation 14 Draft a standard response to address trade allies that are confused by the different processes for small and large new construction projects.

Finding 14. Print materials consist of a few one-page documents that explain the process of the program or the NEO tool, but it appears there are no materials focused on the value to participants and trade allies.
Recommendation 15. Investigate which factors most motivate both participants and small construction professionals so that the print materials can highlight those areas.
Recommendation 16. Develop case studies focusing on the small buildings IPA program.

Finding 15. While there was only one completed project in PY8, there is no formal recognition of completed projects or awards for the best designs.
Recommendation 17. With a pool of more completed projects, consider recognizing successful projects in the form of web site highlights, plaques for building lobbies and contractor lists. Contractor lists can be published in ComEd's website and include contractors meeting minimum objective criteria and who participated in a completed New Construction – Small Buildings project.

Finding 16. The participant incentive for the small building IPA program is fixed at $0.10 per kWh saved, while the large building program has a sliding scale depending on which point in the design process the project was enrolled.
Recommendation 18. Consider aligning the incentives between the two programs.
Recommendation 19. Consider providing a slightly higher incentive since small buildings may need more incentive to induce participation.

Finding 17. The program does not provide any code compliance assistance and TWG has expressed reluctance about reviewing energy code deficiencies.
Recommendation 20. Consider reviewing code as it adds value for the building owner participation and can be achieved with minimal effort since energy code is reviewed when NEO models are being generated.

Finding 18. In the restaurant project completed in PY8, there was no discussion of whether the kitchen equipment (stoves, fryers, griddle, dishwasher, etc.) would be renovated in any of the documents produced by TWG or any of the meeting minutes with the exception of kitchen hood ventilation.
Recommendation 21. Review projects in their entirety, even if building energy models do not explicitly address certain types of energy consuming equipment.

6. APPENDIX

6.1 Detailed NEO Tool Review

6.1.1 Introduction

As part of our evaluation, Navigant is investigating the accuracy of the NEO tool energy analysis of small commercial buildings. Energy analysis focuses on annual electrical energy use in kWh as well as electrical peak demand in kW. This NEO Tool Review section presents Navigant's preliminary findings on the NEO tool's accuracy.

6.1.2 Methodology of NEO Tool Review

Navigant is evaluating the NEO tool as applied to small commercial buildings in ComEd's service territory by examining a series of case studies comparing NEO to eQUEST. The case studies not only validate the unique energy features of these buildings, but also allow Navigant to investigate the inner workings of the NEO tool in a way that a general overview would not be able to provide.

The three case studies selected include: a restaurant building that participated in the program in PY8; a prototypical multifamily building; and prototypical grocery store. These three building types are chosen based on the primary building types that are in the program's PY9 pipeline, as well as buildings that have unique energy profiles worth investigating. For instance, the multifamily building involves both residential and C&I energy codes, as well as different spaces types in one building. The grocery store is energy intensive with significant refrigeration load. The restaurant building allowed Navigant to see the NEO tool applied to an actual building case with real world geometry and specific energy choices.

Navigant reviewed the NEO tool using the following steps:

- NEO baseline model inputs are compared with ASHRAE 90.1 2010 energy code requirements.
- Navigant constructed eQUEST v3.5 models for each baseline and efficient case using precise inputs from the NEO models. This process provides a detailed look at the NEO tool and notable features are examined.
- Energy outputs are compared between NEO and eQUEST for each of the six models (both a baseline and efficient model for each of the three buildings). Where energy outputs significantly differ, further investigation is performed.

Navigant accepts that in order to achieve the goal of time and cost efficient modeling, certain simplifications have to be made as compared to more extensive approaches like eQUEST. In addition, while eQUEST is well established, it is a modeling simulation tool and therefore not 100 percent accurate regarding an actual building's performance. Navigant expected minor differences between NEO and eQUEST. Navigant is focused on whether the NEO tool has large discrepancies (more than 5 percent) as compared to eQUEST or if the addition of an energy efficiency measure significantly over or under estimates the savings resulting from the energy measure.

6.1.3 Building Model Case Studies

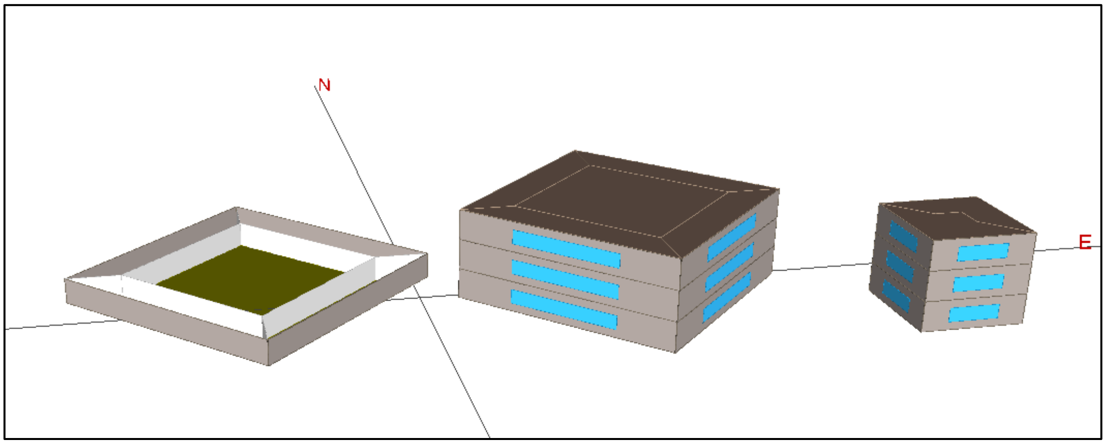
Each of the three case study building types is discussed individually. We provide an overview of each subject building-type followed by a comparison between the baseline NEO model inputs and the efficient building NEO model inputs.

6.1.3.1 Multifamily Building Case Study

TWG provided Navigant with three efficient building cases, each with measure bundles for increasing overall efficiency. Navigant studied HVAC1-Bundle3 which allowed the evaluation team to study the most comprehensive efficiency upgrades.

The multifamily building is a 40,000 square feet (SF) three-story building. The 40,000 SF is divided between 10,000 SF of garage space, 25,000 SF of apartment space, and 5,000 SF of common space. Figure 6-1 shows the NEO model's exterior surfaces.

Figure 6-1. Exterior Surface of Multifamily Building



Source: Navigant analysis and TWG analysis

Table 6-1 summarizes the differences in the baseline and efficient model inputs for both the NEO models and the Navigant models. The baseline case contains packaged single-zone cooling systems for both the garage space and common area and a Packaged Terminal AC (PTAC) system in apartment area serving 35 zones. There is an economizer included in the common space HVAC system. Supply fans are modeled using constant speed fan. Most of the savings are attributed to vent fans (32 percent), lighting energy (25 percent), and heating energy (25 percent) consumption.

Table 6-1. Inputs for the Multifamily Building Case Study

Item	Baseline Model	Efficient Model
Ext Wall Assembly U-values	U = 0.055 (common) U = 0.06 (apartment) U = 0.055 (garage)	U = 0.042 (common) U = 0.042 (apartment) U = 0.055 (garage)
Roof Assembly U-value	U = 0.032 (common) U = 0.026 (apartment) U = n/a (garage)	U = 0.028 (common) U = 0.020 (apartment) U = n/a (garage)
Window U-value	U = 0.5 (common) U = 0.32 (apartment) U = n/a (garage)	U = 0.36 (common) U = 0.16 (apartment) U = n/a (garage)
Floor U-value	U = 0.142	No change
Interior Lighting Power Density (LPD)	0.73 W/sqft (common) 1.54 W/sqft (apartment) 0.21 W/sqft (garage)	0.44 W/sqft (common) 0.92 W/sqft (apartment) 0.13 W/sqft (garage)
Equipment power density	0.5 W/sqft (common) 0.62 W/sqft (apartment) n/a W/sqft (garage)	No change

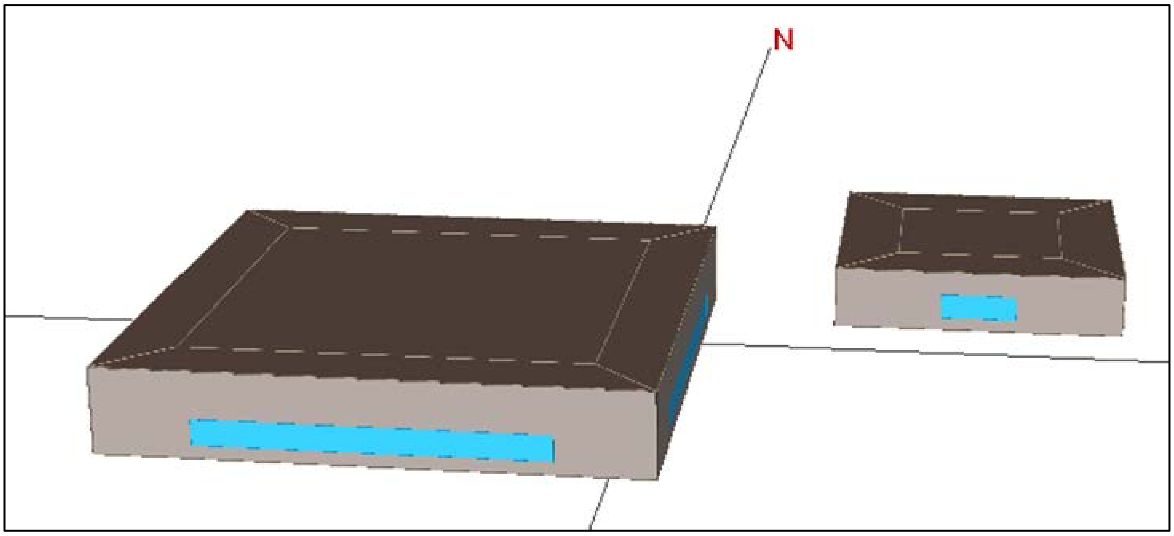
Infiltration (Air-Change)	0.1202 cfm/sqft (perim-common, perim-apartment) 0.02 cfm/sqft (core-common, core-apartment) 0.0167 cfm/sqft (perim-garage, core-garage)	No change except 0.1246 cfm/sqft (perim-apartment) 0.12 cfm/sqft(core-apartment)
HVAC System	Packaged single-zone with gas furnace and DX cooling w Economizers (enthalpy control in common area) w/o Economizer (garage) PTAC (apartment)	Packaged Variable Air Volume (VAV) with gas furnace w Economizers (enthalpy control in common area) VAV w/o Economizer and cooling (garage) PTAC (apartment)
Supply Fan	Constant speed fan Total of 4,824 CFM (common) 19,368 (apartment) 8,693 CFM (garage) Supply Static Pressure: avg of 0.8708 Supply-Eff: avg of 0.3407	No change in CFM but Variable Frequency Drive (VFD) on Common area, Garage area Supply Static Pressure: avg of 0.8677 Supply-Eff: avg of 0.3869
Outside air (OA)	Flow rate: 9,712 CFM	No change
Cooling Electrical Input Ratio (EIR)	0.289 (common) 0.2925 (apartment) n/a (garage)	0.2456 (common) 0.2254 (apartment) n/a (garage)
Furnace Heat Input Ratio (HIR) or EIR for the apartment	1.25 (common) 0.312 (apartment) 1.25 (garage)	1.0526 (common) 0.240 (apartment) 1.00 (garage)

6.1.3.2 Grocery Building Case Study

Similar to the multifamily building, TWG provided Navigant with three efficient building cases for the grocery store building. Each efficient building case has measure bundles for increasing overall efficiency. Navigant studied HVAC1-Bundle3 which allowed the evaluation team to study the most comprehensive efficiency upgrades.

The grocery building is a one-story building with a floor area of 20,000 SF divided between a 15,000 SF retail space and a 5,000 SF refrigerated space. The following figure shows the NEO model’s exterior surfaces.

Figure 6-2. Exterior Surface of Grocery Building



Source: TWG analysis

Table 6-2 summarizes the differences in model inputs for both the NEO models and the Navigant models. The baseline case contains a packaged single-zone cooling system serving ten zones. The zones are divided into the refrigerated and retail areas and an economizer is installed in the retail space HVAC system. Supply fans are modeled using constant speed fans. The efficient case consists of variety of energy efficiency measures, including:

- Mechanical Systems
  - All spaces include constant speed Electrically Commutated Motors (ECM), fan system power at 0.85 BHP/1000cfm, a 30 percent increase in direct expansion (DX) cooling efficiency, a 95 percent efficient gas furnace, and CO2 control of outside air.
  - Retail space includes heat recovery and destratification fans in high bay spaces.

- Architectural Systems
  - All spaces include wall insulation at R 24, roof insulation at R 36, and low-e, high performance aluminum frame glazing

- Lighting Systems
  - All spaces include exterior site lighting reduced to 1.95 kW and a lighting power density of 0.88 W/SF
  - Retail space also has 100% multi-stepped daylighting control and occupancy sensor controls on 25% of the lighting system
  - Refrigerated space includes stepped daylighting controls on 50% of the lighting system
- Refrigeration System only applies to the Refrigerated space and includes LED case/door lighting with occupancy sensors, zero energy doors, anti-sweat heater control based on store humidity, ECM fans, and refrigeration heat reclaim

- Service water heating in all spaces is 95 percent efficient

Table 6-2. Inputs for the Grocery Building Case Study

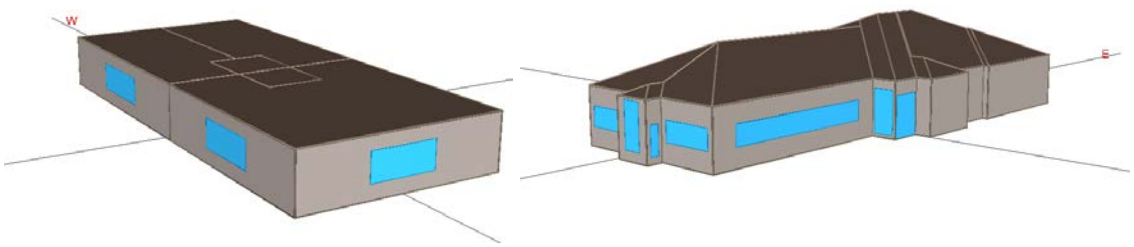
Item	Baseline Model	Efficient Model
Ext Wall Assembly U-values	U = 0.055 (Retail) U = 0.055 (Refrigerated)	U = 0.042 (Retail) U = 0.042 (Refrigerated)
Roof Assembly U-value	U = 0.032 (Retail) U = 0.032 (Refrigerated)	U = 0.028 (Retail) U = 0.028 (Refrigerated)
Window U-value	U = 0.5 (Retail) U = 0.5 (Refrigerated)	U = 0.36 (Retail) U = 0.36 (Refrigerated)
Floor U-value	U = 0.142	No change
Interior LPD	1.26 W/sqft (Retail) 1.26 W/sqft (Refrigerated)	0.882 W/sqft (Retail) 0.882 W/sqft (Refrigerated)
Equipment power density	0.3 W/sqft (Retail) 0.3 W/sqft (Refrigerated)	0.3 W/sqft (Retail) 0.33 W/sqft (Refrigerated)
Infiltration (Air-Change)	0.0336 cfm/sqft (perim-Retail) 0.0333 cfm/sqft (core-Retail) 0.0201 cfm/sqft (perim-Refrigerated) 0.02 cfm/sqft (core-Refrigerated)	No change
HVAC System	Packaged single-zone with gas furnace and DX cooling w Economizers (enthalpy control in retail area) w/o Economizer (Refrigerated)	Packaged single-zone with gas furnace and DX cooling w Economizers (enthalpy control in core-retail area) w/o Economizer (Refrigerated) Packaged VAV system with gas furnace w economizer (perim-retail area)
Supply Fan	Constant speed fan Total of 4,171 CFM (refrigerated) 12,287 CFM (retail) Supply Static Pressure: avg of 0.8604 (refrigerated) avg of 1.2472 (retail) Supply-Eff: avg of 0.3366 (refrigerated) avg of 0.4879 (retail)	Constant speed fan Total of 4,171 CFM (refrigerated) 4,275 CFM (core-retail) Fan with VFD in perim-retail 6,976 CFM Supply Static Pressure: avg of 0.7744 (refrigerated) avg of 1.0885 (retail) Supply-Eff: avg of 0.3847 (refrigerated) avg of 0.5232 (retail)
OA	Flow rate: 4638 CFM	No change
Cooling EIR	0.2615 (refrigerated) 0.2637 (retail)	0.2277 (refrigerated) 0.2076 (retail)
Furnace HIR	1.25 (refrigerated) 1.25 (retail)	1.0526 (refrigerated) 1.0526 (retail)

Most of the savings are attributed to refrigeration consumption which consists of 63 percent of the entire savings. Because of the energy strategies for refrigeration, the load for the refrigeration is reduced by approximately 35 percent.

6.1.3.3 Restaurant Building Case Study

The restaurant building is an actual project completed in PY8 with 4,560 SF of floor space. The efficient NEO model simulates the actual constructed building. Figure 6-3 shows the NEO model's exterior surfaces with the NEO tool version on the left and Navigant's eQUEST model on the right.

Figure 6-3. Exterior Surface of Restaurant for both NEO Model and Navigant Model



Source: Navigant analysis and TWG analysis

Table 6-3 summarizes the model inputs for both the NEO models and the Navigant models. The baseline case contains a packaged single-zone, gas-powered HVAC system serving 12 perimeter zones and four core zones. The zones are divided into dining and kitchen area with an economizer in the dining space. Supply fans are modeled using constant speed fans. The efficient case consists of lighting power density reductions, occupancy sensor reductions, and a high efficiency unitary cooling system. Most of the savings are attributed to fan energy savings.

Table 6-3. Inputs for Restaurant Building

Item	Baseline Model	Efficient Model
Wall Assembly U-values	U = 0.064	No change
Roof Assembly U-value	U = 0.048	No change
Window U-value	U = 0.55	No change
Floor U-value	U = 0.142	No change
Interior LPD	0.90 W/sqft (dining) 0.99 W/sqft (kitchen)	0.63 W/sqft (dining) 0.59 W/sqft (kitchen) With occ sensor installed in kitchen area
Equipment power density	1.53 W/sqft (dining) 1.50 W/sqft (kitchen)	No change
Infiltration (Air-Change)	0.1 ACH (perimeter) 0 ACH (core)	No change
HVAC System	Packaged single-zone with gas furnace and DX cooling Economizers (enthalpy control in dining area), constant speed supply fans, and fan static pressure reduction	No change
Supply Fan	Constant speed fan Total of 6,713 CFM Supply Static Pressure: avg of 2.325 Supply-Eff: 0.2596	No change other than Supply Static Pressure: avg of 0.6447 Supply-Eff: 0.2522
OA	Flow rate: 2,562 CFM	No change
Cooling	Cooling EIR: 0.286	No change
Heating	Furnace HIR: 1.25	No change

6.1.4 NEO Tool Review Findings

Overall the NEO tool is meeting the objective of providing credible simplified modeling of small commercial new construction buildings. Table 6-4, Table 6-5 and Table 6-6 show the model results by end use category for the Multifamily, Grocery and Restaurant case study buildings respectively. In these tables, the Navigant eQUEST model is intended to match the NEO tool with the exception of minor differences in shading, interior wall interaction and wall and window areas. Additionally, in the case of the restaurant building, the number of HVAC systems was different between the two models. In other words, the Navigant model has not made other corrections that we will discuss later in the NEO Tool Review, and the intention of this comparison is to investigate how close the NEO tool is to Navigant's eQUEST simulation.

As shown in Table 6-4Table 6-4, Table 6-5 and Table 6-6, the total realization rate is between 98% and 102%. Further inspection of the Space Cooling, Space Heating and Refrigeration end uses does expose some differences in the NEO tool model and the Navigant eQUEST model. These differences are primarily due to wall area discrepancies in all of the studied buildings and HVAC zoning in the case of the restaurant building. However, the overall conclusion is that the NEO tool is providing an adequate energy model in the studied cases.

Table 6-4. Multifamily Building Case Study Comparison between NEO Model and Navigant's eQUEST Model

End Use	NEO		Navigant		Realization Rate		
	Base	Proposed	Base	Proposed	Base	Proposed	Savings
AREA LIGHTS	54,469	29,877	53,690	29,008	99%	97%	100%
MISC EQUIPMT	85,223	85,223	84,405	84,405	99%	99%	
SPACE HEAT	83,922	59,227	71,312	46,727	85%	79%	100%
SPACE COOL	48,993	31,042	52,759	29,919	108%	96%	127%
VENT FANS	83,103	51,648	79,322	51,007	95%	99%	90%
						Total	102%

Table 6-5. Grocery Store Case Study Comparison between NEO Model and Navigant's eQUEST Model

End Use	NEO		Navigant		Realization Rate		
	Base	Proposed	Base	Proposed	Base	Proposed	Savings
AREA LIGHTS	127,195	73,203	127,101	76,520	100%	105%	94%
MISC EQUIPMT	8,629	9,275	8,628	9,275	100%	100%	100%
SPACE COOL	25,850	16,426	24,194	14,888	94%	91%	99%
VENT FANS	34,852	18,913	34625	16,600	99%	88%	113%
Refrigeration	339,219		324,264		96%		103%
Ext Light	12,100		12,100		100%		100%
						Total	99%

Table 6-6. Restaurant Building Cast Study Comparison between NEO Model and Navigant's eQUEST Model

End Use	NEO		Navigant		Realization Rate		
	Base	Proposed	Base	Proposed	Base	Proposed	Savings
AREA LIGHTS	19,573	12,200	20,541	12,936	105%	106%	103%
MISC EQUIPMT	9,940	9,940	9,935	9,935	100%	100%	100%
SPACE COOL	16,478	12,696	17,279	14,320	105%	113%	78%
VENT FANS	48,464	13,869	48,099	13,827	99%	100%	99%
REFRIGERATN	44,060	44,306	39,001	39,138	89%	88%	56%

EXT LIGHTS	10,695	10,695	10,695	10,695	100%	100%	100%
						Total	98%

6.1.4.1 HVAC Zones

NEO uses sizing runs to determine system capacities and airflows. Capacities are adjusted per ASHRAE and defined explicitly in the final energy model. NEO uses properties for each Space Asset Area (SAA) called 'Min Area per Single Zone' and 'Max Area per Single Zone'. These properties are used to make sure that single zone units in the model do not represent unrealistically large or small systems for a given SAA. When determining minimum requirements for single zone units NEO will use the minimum and maximum allowable size instead of the actual modeled size to determine baseline requirements for unit efficiencies. The intended result is that NEO models single zone units that are thermodynamically similar to expected unit sizes for each SAA.

NEO sizing runs follow common industry practices and ASHRAE 90.1 Appendix G rules in Table G3.1 No. 8, which is intended to be used when HVAC zones are not defined. This includes separating perimeter and core thermal zones (assuming 15' perimeter depth) and separating thermal zones for walls with different orientations. However, ASHRAE 90.1 Appendix G rules in Table G3.1 No. 7 say that when HVAC zones are defined on drawings, each HVAC zone will be modeled as a separate thermal block. Since final verification will be occurring after HVAC zones are defined, and indeed physically built, Navigant maintains that the HVAC zoning should match the physical building at the end of the project.

In the case of the restaurant, we had an actual building, where the number of HVAC zones in the NEO model should have matched the building. While the actual building had two HVAC zones, the NEO model had eight zones. With several smaller HVAC units, both the heating and cooling loads slightly increased, as shown in Table 6-7. A potentially bigger issue that did not occur in the studied buildings is when the baseline requirements are lowered due to smaller systems than reality. NEO limits the zoning issue by setting a typical minimum size for single zone units based on the space usage. Essentially, the single zone units are modeled thermodynamically similar to standard unit sizes. This helps to avoid the potential issue of unrealistically small HVAC units in automatically generated zones.

The NEO tool is generally creating one HVAC zone for every thermal zone prescribed by the ASHRAE 90.1 Appendix C Envelope Trade-off option. While the thermal zones are reasonable model representations of the thermal loads on the building, this method results in an unrealistically large number of very small HVAC units. For example, the 5,000 SF of common space in the multifamily building had 15 HVAC zones.

Navigant recommends that the final NEO models, at verification, match the zoning in the physical building.

Table 6-7.Comparison of Building Loads with different HVAC Zoning

	NEO tool with original zoning		NEO tool with combined zones		
---------------	Elec	Gas	Elec	Gas	Realization Rate
AREA LIGHTS	19,611	0	19,611	0	100%
MISC EQUIPMT	9,940	0	9,940	0	100%
SOURCE USES	0	656	0	656	100%
SPACE HEAT	0	3,832	0	3,948	103%
SPACE COOL	20,160	0	20,381	0	101%
VENT FANS	48,461	0	48,259	0	100%
REFRIGERATN	43,093	0	43,093	0	100%
DOMHOT WATER	0	2,616	0	2,616	100%
EXT LIGHTS	10,695	0	10,695	0	100%

6.1.4.2 Schedules

Schedules for occupancy, lighting power, plug loads, infiltration and HVAC set points are provided by ASHRAE 90.1-2010 Addendum AN: Building Envelope Trade-Off Schedules and Loads (Addendum AN). One exception to the use of Addendum AN in the Small Buildings Program is in residential spaces, such as apartments in multifamily buildings. Residential lighting (per ASHRAE 90.1 Section 9) is outside the scope of 90.1; therefore the process and lighting schedules for the multifamily building do not apply to the residential spaces. In this case, NEO follows the Energy Star Multifamily High Rise Program simulation guidelines.

When comparing the NEO tool schedules to Addendum AN, discrepancies were found in both the grocery and restaurant buildings. In the grocery building, NEO used Addendum AN schedule set 'B' even though ASHRAE maps a retail building to schedule set 'C' due to a judgment call of TWG finding set B more representative of a grocery store's schedule. In the grocery building, the kitchen and dining room reference schedule set 'B' from Addendum AN. Yet again, TWG used judgment to deviate from Addendum AN, instead using plug and process loads from COMNET while occupant densities and ventilation rates are assigned from ASHRAE 62.1.

Navigant maintains that schedules obtained from the participants provide a better representation than any of the aforementioned approaches and is usually available through participant interviews. However, where participant uncertainly exists, Navigant recommends using Addendum AN for commercial spaces and Energy Star Multifamily High Rise Program simulation guidelines for residential apartment spaces.

6.1.4.3 Exterior Wall and Window Area

Navigant found that the exterior wall areas do not match the calculated wall area derived from the floor area in each building studied. In the multifamily building case study, the NEO tool has 19,354 SF of exterior wall area, while the Navigant model with same floor area and wall height has 23,022 SF of wall area. For the grocery store case study, the wall area in NEO is 12,453 SF while the Navigant model has 11,614 SF. Similar issues were found in the restaurant. Decreased wall area underestimates the exterior HVAC loads.

Navigant also found that the window areas do not match. In the multifamily building case study, the window area in NEO is 3,685 SF, while the calculated window area in Navigant's eQUEST model is 4,565 SF.

At the beginning of 2016, NEO was updated to include a simple geometry editor to allow users more control over a building's geometry. The editor is Space Asset Area (SAA) based and gives the user the ability to set the shape of the building (square, "H", "T", "U", etc.) and then cut and drag walls to represent the overall shape of the SAA. Individual walls can be edited to be exterior or shared with adjacent spaces (interior). The user provides the general shape of the area and NEO automatically determines built dimensions based on the floor area for that SAA. Navigant has not reviewed the 2016 geometry editor, but expects this update will resolve all significant geometry issues.

6.1.4.4 Economizer Control

ASHRAE 90.1 Appendix G specifies that commercial spaces that are cooled shall have dry-bulb economizers. While the baseline NEO models have economizers, some of the spaces are enthalpy controlled rather than dry-bulb. This underestimates the savings. Enthalpy control is in the baseline NEO model for the multifamily common spaces, the grocery retail space and the restaurant dining space.

6.1.4.5 Interior Wall interaction and Shading

The NEO tool uses adiabatic interior walls without the Next-to statement which means that the model shows no interaction between interior spaces separated by interior walls. Additionally, exterior walls are set to no shading. These simplifications, while technically incorrect, allow the NEO tool to function quicker and allows for real-time simulations with participants. Navigant did not find these simplifications introduced excessive errors especially when comparing the energy consumption between a baseline building and a proposed building that all share the same simplifications. Therefore, Navigant is not recommending a change relative to interior wall interaction or shading.

6.1.4.6 Software Version

The studied NEO tool is not using the latest DOE2 platform, instead it is using DOE2.1E. While a minor issue, greater accuracy would be achieved by updating the platform version. The TWG Group is currently developing a version of NEO with an EnergyPlus based simulation engine, expected release in the spring of 2017. Navigant recommends updating the software version as planned.

6.1.5 NEO Tool Review Conclusion

Navigant's review of the NEO tool is limited to case studies of three building types—multifamily, grocery, and restaurant. Navigant finds that, while realization rates would not be 100 percent in a formal impact study, the NEO tool does meet the criteria of providing adequate energy consumption models of baseline code minimum buildings and energy efficiency enhanced buildings when applied to small commercial buildings. Navigant recommends enhancing the NEO tool so that realization rate corrections would be minimal. Recommended enhancements include:

- Matching the baseline HVAC zones to the building design
- Matching schedules for occupancy, lighting power, plug loads, infiltration and HVAC set points with ASHRAE 90.1-2010 Addendum AN for commercial spaces and Energy Star Multifamily High Rise Program simulation guidelines for residential apartment spaces
- Correcting the exterior wall and window surface area calculations
- Baseline economizers should be changed to single point, dry-bulb control
- Updating the software version as planned

Further study of other building types is recommended in future years to ensure that nuances in NEO modeling simulations are fully investigated.