FINAL IMPACT EVALUATION REPORT

High Performance New Construction and Residential New Construction Programs

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PREPARED BY:

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PREPARED FOR:

The Independent Electricity System Operator

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Frontier Associates would also like to thank the staff at the Local Distribution Companies (LDCs) for providing their insight on the HPNC and RNC Programs.

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1. EXECUTIVE SUMMARY

The Independent Electricity System Operator (IESO) hired Frontier Associates to conduct an impact evaluation for IESO's 2015 High Performance New Construction (HPNC) and Residential New Construction (RNC) programs.

The goal of the evaluation is to verify net energy and demand savings attributed to the programs.

1.1 High Performance New Construction (HPNC)

The evaluation team was tasked to review HPNC savings for projects completed in 2015, as well as evaluate additional 2011-2014 projects that were provided during this review cycle. Table 1 provides the summary of the impact evaluation results for 2015 as compared to 2014.

Table 1: HPNC Impact Evaluation Results (2014 vs 2015)

Program Metric - HPNC	2014*	2015
Number of Buildings	315	168
Program Realization Rate (% kWh)	79%	98%
Program Realization Rate (% kW)	71%	92%
Gross Verified Annual Energy Savings (GWh)	45.030	40.729
Gross Verified Lifetime Energy Savings (GWh)	646.712	584.977
Gross Verified Demand Savings (MW)	13.849	9.656
Net to Gross Ratio (Energy)	0.54	0.54
Net to Gross Ratio (Demand)	0.54	0.54
Net Annual Energy Savings (GWh)	**24.316**	**22.022**
Net Lifetime Energy Savings (GWh)	**349.224**	**317.191**
Net Annual Energy Savings at 2020 (GWh)	**-**	**21.793**
Net Peak Demand Savings (MW)	**7.479**	**5.222**
Net Peak Demand Savings at 2020 (MW)	**-**	**5.188**

* True-ups included.

Table 2 provides the net demand and energy savings attributed to each track in the program.

Table 2: HPNC Savings by Track (2014 vs 2015)

	2014 Verified*				2015 Verified			
Track	Net Energy Savings (kWh)	kWh %	Net Demand Savings (kW)	kW %	Net Energy Savings (kWh)	kWh %	Net Demand Savings (kW)	kW %
Prescriptive	4,387,861	18.0%	1,187	15.9%	2,758,023	12.5%	720	13.8%
Engineered	1,489,815	6.1%	234	3.1%	2,415,950	11.0%	414	7.9%
Custom	14,503,528	59.6%	5,011	67.0%	13,932,582	63.3%	3,214	61.5%
Unidentified	3,935,246*	16.2%	1,047	14.0%	2,915,829	13.2%	874	16.7%
Totals	**24,316,450**	**100%**	**7,479**	**100%**	**22,022,384**	**100%**	**5,222**	**100%**

* True-up projects included

The custom track provided the greatest net demand (kW) and energy (kWh) savings for the HPNC program, followed by the prescriptive track then the engineered track. Many projects were submitted without sufficient documentation required to enable identification of a track. Those projects are defined here as unidentified projects. Unidentified projects accounted for a significant portion of net demand and energy savings but could not be attributed to any specific track.

Within the prescriptive and engineered tracks, lighting, HVAC controls, high-volume low-speed (HVLS) fans, and ENERGY STAR® appliances provided the greatest contribution to kW savings. Lighting and ENERGY STAR appliances contributed most to kWh savings.

Table 3 shows the breakdown of realization rates for each track within the HPNC program.

Table 3: HPNC Realization Rates, 2015

Realization Rates by Program Track	% kWh	% kW
Prescriptive	85%	68%
Engineered	111%	89%
Custom[1]	98%	100%
Unidentified[2]	100%	100%

The HPNC program passed both the PAC and TRC cost effectiveness tests for 2015, showing improvements over past years' performance. Even though 2015 had a decrease in participation, net program benefits did not decrease significantly enough to have a negative effect on the cost effectiveness. Additionally, administrative costs were adjusted appropriately for the decrease in projects. Administrative cost increased to 40.7% of total program cost, up from 33.9% for 2014. This will have less of a negative effect on the benefit-cost ratio as long as the benefit per project remains high, as seen in 2015.

Table 4: HPNC Cost Effectiveness Results

2015 Results		
PAC	Benefit	$20,909,487
	Cost	$8,316,839
	Net Benefit	$12,592,647
	Net Benefit Ratio	2.51
TRC	Benefit	$24,045,910
	Cost	$10,609,747
	Net Benefit	$13,436,163
	Net Benefit Ratio	2.27
Levelized Delivery Cost	$/MWh	$36.73
	$/MW	$154,557

[1] Demand realization rate capped at 100%.
[2] Energy and demand realization rates capped at 100%.

1.2 Residential New Construction (RNC)

The evaluation team was tasked to review RNC savings for projects completed in 2015, as well as evaluated 2011-2014 projects that were reported in 2015. Table 5 provides the summary of the impact evaluation results for 2015 as compared to 2014 evaluation results.

Table 5: RNC Impact Evaluation Results (2014-2015

Program Metric – RNC	2014*	2015
Number of Homes	3,124	4,012
Program Realization Rate – Energy (% kWh)	67%	76%
Program Realization Rate – Demand (% kW)	100%	187%
Gross Verified Annual Energy Savings (GWh)	5.375	12.752
Gross Verified Lifetime Energy Savings (GWh)	98.005	275.747
Gross Verified Demand Savings (MW)	0.858	2.263
Net to Gross Ratio (Energy)	0.63	0.49
Net to Gross Ratio (Demand)	0.63	0.49
Net Annual Energy Savings (GWh)	**3.386**	**6.305**
Net Lifetime Energy Savings (GWh)	**61.743**	**136.246**
Net Annual Energy Savings at 2020 (GWh)	**-**	**6.305**
Net Peak Demand Savings (MW)	**0.541**	**1.113**
Net Peak Demand Savings at 2020 (MW)	**-**	**1.113**

* True-ups included.

Program year 2015 saw more participation than 2014. In 2011-2013, the performance track dominated energy and demand savings, while in 2014 the prescriptive track dominated. Program year 2015 saw a return to performance dominated savings.

Table 6 provides the net demand and energy savings attributed to each track in the RNC program. Demand and energy savings are dominated by the prescriptive track. Performance track projects were the largest contributor to total RNC energy and demand savings in 2015, followed by prescriptive track projects and finally custom track projects. There were no custom track projects reported in 2015.

Table 6: RNC Savings by Track, 2014-2015

	2014 Verified*				2015 Verified			
Track	Net Energy Savings (kWh)	kWh %	Net Demand Savings (kW)	kW %	Net Energy Savings (kWh)	kWh %	Net Demand Savings (kW)	kW %
Prescriptive	1,948,792	58%	446	82%	2,838,248	45%	190	17%
Performance	985,688	29%	58	11%	3,467,033	55%	923	83%
Custom	451,655	13%	37	7%	0	0%	0	0%
Totals	**3,386,135**	**100%**	**541**	**100%**	**6,305,281**	**100%**	**1113**	**100%**

* True-ups included.

ENERGY STAR New Homes were the most popular performance measure implemented in 2015. At the end of the year, the program had 124 ENERGY STAR New Homes projects with 1,778 homes. These ENERGY STAR New Homes provided 45% of the net kW savings and 65% of the verified net kWh savings for the RNC program.

ENERGY STAR Qualified LEDs were the most popular program-wide measure implemented, with 37% of all RNC projects implementing this measure.

Table 7 shows a breakdown of realization rates for each track within the RNC program. Performance track projects had very high demand realization rates due to improvements to the peak savings methodology. In 2015, no savings were allowed for the prescriptive measure gas furnace ECM. This resulted in a realization rate of 0% for that measure and reduced overall prescriptive track realization rates.

Table 7: RNC Realization Rates by Track, 2015

Realization Rates by Program Track	% kWh	% kW
Prescriptive	55%	38%
Performance	109%	921%
Custom	No projects	

The RNC program passed both the PAC and TRC cost effectiveness tests. RNC was able to benefit from a substantial increase in participation for the 2015 program year. With the increase in participation, more money was spent on incentive costs. For 2015, incentives were the majority portion of program cost at 63% of the total. This is a vital program characteristic for successful PAC results since more of the cost associated with the program is going directly to potentially beneficial projects.

Table 8: RNC Cost Effectiveness Results

2015 Results		
PAC	Benefit	$6,461,767
	Cost	$3,434,451
	Net Benefit	$3,027,316
	Net Benefit Ratio	1.88
TRC	Benefit	$7,431,032
	Cost	$5,911,717
	Net Benefit	$1,519,315
	Net Benefit Ratio	1.26
Levelized Delivery Cost	$/MWh	$42.12
	$/MW	$233,897

1.3 Key Findings and Recommendations

1.3.1 High Performance New Construction

This section presents a summary of key findings resulting from the 2015 HPNC impact evaluation.

The custom track provided the greatest net demand (kW) and energy (kWh) savings for the HPNC program, followed by the prescriptive track then the engineered track. Unidentified projects accounted for a significant portion of net demand and energy savings but could not be attributed to any specific track due to insufficient project documentation.

Within the prescriptive and engineered tracks, lighting, HVAC controls, HVLS fans, and ENERGY STAR appliances provided the greatest contribution to kW savings. Lighting and ENERGY STAR appliances contributed most to kWh savings.

Below are the recommendations resulting from the 2015 HPNC impact evaluation.

1.3.1.1 Data Reporting & Tracking Requirements

- Develop a consistent methodology across the province for capturing key data points for savings calculations. This may be either a centralized database or a list of requirements for each LDC's own database.
- Ensure complete submittal of project documentation to facilitate savings evaluation. Specifically for the custom track, add the Final Commissioning Report to the list of requirements for custom projects. This document would be submitted when the project is complete and would allow reviewers or evaluators to confirm that the facility was operating as designed.
- Assign projects a unique ID to assist with identifying project evaluation status for impact evaluations and true-ups. If unique IDs already exist, include them in project reporting documentation.
- For projects that include multiple measure types, prescriptive and engineered track savings should be reported by measure similar to the way they are in the RNC program and in other programs. Currently, savings are only reported to the evaluation team as either custom or prescriptive.
- Consider adding the Final Commissioning Report to the list of requirements for custom projects. This document would be submitted when the project is complete and would allow reviewers or evaluators to confirm that the facility was operating as designed.

1.3.1.2 Prescriptive Assumptions

- The Measures and Assumptions List (MAL) should incorporate baseline adjustments to the Unitary AC and Agribusiness HVLS measures as outlined in this and previous evaluation reports.
- Prescriptive assumptions should be updated to take building type into account. At a minimum, it is recommended that the existing prescriptive assumptions (using Office as the default building type) be expanded to include the Retail building type.
- No demand savings should be claimed for exterior lighting projects.

1.3.1.3 Savings Calculation Tools

- For engineered track workbooks, operating schedules should not exceed 8,760 hours.
- Provide additional functionality for engineered track lighting worksheets to individually report savings for each lamp/fixture type.
- Consider adding EnergyPlus (United States Department of Energy-sponsored modelling engine) as an approved modelling software. This is a free software that is continually being improved by the United States Department of Energy.

1.3.2 Residential New Construction

Below is a summary of key findings resulting from the 2015 RNC Impact Evaluation.

ENERGY STAR New Homes were the most popular performance measure implemented in 2015. At the end of the year, the program had 124 ENERGY STAR New Homes projects with 1,778 homes. These ENERGY STAR New Homes provided 45% of the net kW savings and 65% of the verified net kWh savings for the RNC program.

Program-wide, ENERGY STAR Qualified LEDs were the most popular measure implemented, with 37% of all RNC projects implementing this measure.

Below are the recommendations resulting from the 2015 RNC Impact Evaluation.

1.3.2.1 Data Reporting & Tracking Requirements

- It is recommended that the LDCs and the IESO capture key data points for savings calculations. Most of these are related to product specifications, while a few others are related to general characteristics of the home such as control setpoint and cooling/heating types of the homes:
    - Lamp counts tied to indoor lighting timers, outdoor lighting timers, dimmer switches, outdoor motion sensors, and indoor motion sensors;
    - Program settings for lighting controls;
    - Lumens and wattages for all installed lighting;
    - Cooling capacity, Seasonal Energy Efficiency Ratings (SEER), and full-load cooling hours for all HVAC measures; and
    - Cooling and heating-types of the residences.
- Develop a consistent methodology across the province for capturing key data points for savings calculations. This may be either a centralized database or a list of requirements for each LDC's own database.
- For many project sites, subdivision names or street names are given with no unique identifier provided. Unique project IDs can go a long way toward helping the evaluation team track documentation and identify duplicates.
- For project sites that participated in both performance and prescriptive tracks, more detailed modelling inputs/design parameters for EnerGuide and ENERGY STAR should be provided to enable the evaluation team to discern between savings attributable to performance track measure and prescriptive measures.

2. INTRODUCTION

2.1 Evaluation Goals and Objectives

The overall goals of the Impact Evaluation are to verify the demand and energy savings and cost effectiveness of the Independent Electricity System Operator (IESO)'s High Performance New Construction (HPNC) and Residential New Construction (RNC) programs.

2.2 Program Descriptions

The following sections provide a brief overview of the programs.

2.2.1 High Performance New Construction

The HPNC program is designed to encourage construction of energy efficient buildings that are more efficient than the Ontario Building Code (OBC) by allowing commercial customers to participate in three incentive tracks: Prescriptive, Engineered, and Custom. Prescriptive incentives are set for pre-approved technologies. Engineered incentives must be calculated with the use of pre-set worksheets for a variety of measures. The custom track provides incentives to participants (facility managers and owners) who calculate energy and demand savings using approved modelling software.

2.2.2 Residential New Construction

The RNC program is designed to encourage residential homebuilders to construct energy efficient new homes by participating in one of three tracks: Prescriptive, Performance, and Custom. The prescriptive track offers set incentive amounts for pre-approved technologies. The performance track provides pre-set incentives to homebuilders who build homes to reach EnerGuide 83 or better, or qualify for ENERGY STAR certification. The custom track requires the use of pre-set calculation worksheets for a variety of measures. Custom track incentives are based on the level of energy performance improvement over code. Participants in this program are homebuilders.

2.3 Report Overview

The executive summary (section 1) outlines the key impacts and findings from the evaluation. This introduction (section 2) includes the program descriptions and report overview. Section 3 describes the impact evaluation of program year 2015, cost effectiveness analysis, and detailed findings and recommendations. The appendices to this report include a glossary of terms, updated prescriptive assumptions, suggested adjustments to measures, and inspection checklists.

3. IMPACT EVALUATION

This section describes the methodologies used to estimate average per project reduction in electricity demand as well as overall gross and net energy and demand savings delivered through the High Performance New Construction (HPNC) and Residential New Construction (RNC) programs.

3.1 High Performance New Construction

3.1.1 Methodology

Listed below are the steps taken by the evaluation team in assessing the impacts of the HPNC, with specific details of the methodologies used for each track (prescriptive, engineered, or custom).

1. The evaluation team received project information from the IESO.
2. A desk review was completed for each project with partial or complete documentation.
3. Projects were selected for post-inspection using a 90% +/- 10% confidence interval. Projects were selected randomly among 2015 projects with complete documentation. Inspection results were used to verify measure type and product counts. Reported project data, as verified by inspection results, were not significant enough to merit any program-wide adjustments to projects that were not inspected.
4. For HPNC prescriptive and engineered projects, savings were validated against the Measures and Assumptions List (MAL) savings assumptions (prescriptive) and savings worksheets (engineered). Baseline and saving calculation recommendations from previous evaluations reports were applied where appropriate.
5. For HPNC custom projects, computer modelling summary reports were reviewed primarily for reasonableness of the modelling rationale and the calculated reductions in demand and consumption for the reference design versus proposed design.
6. The IESO's definition of peak demand savings[3] and IESO's latest load profiles were used to estimate peak demand savings.
7. Projects with insufficient or no documentation were assigned savings calculated by multiplying claimed savings against weighted average realization rates for desk reviewed projects. For projects where the measure type was known, claimed savings were applied against measure-specific weighted average realization rates. For projects where the measure type was unknown, claimed savings were applied against overall program weighted average realization rates.
8. For projects where the track was unknown, savings were attributed to a new "Unidentified" track.
9. Net energy and demand savings were calculated using a self-report survey as used in previous evaluations and specified by track.

[3] The evaluation team followed the IESO's EMV Protocols and Requirements, 2011-2014 definition of peak. This definition of peak is 1pm-7pm, weekdays, June-August.

3.1.2 Review of Inputs Assumptions and Algorithms

This section provides an overview of major discussion points regarding measures within the prescriptive, engineered, and custom tracks.

3.1.2.1 Prescriptive Track

Available documents for prescriptive measures in the HPNC program were reviewed. Most references and assumptions that underlie the savings verification process were the same as those used for the 2011-2014 evaluations. To see these references and assumptions, refer to Appendix B: Updated Prescriptive Assumptions.

3.1.2.2 Engineered Track

3.1.2.2.1 Lighting

Savings were validated against savings assumptions specified in the following engineered track lighting worksheets:

- Commercial Interior Lighting Engineering Worksheet
- Commercial Directional Lighting Engineering Worksheet
- Commercial High Bay Lighting Engineering Worksheet
- Commercial Exterior Lighting Engineering Worksheet

Demand savings and effective useful life (EUL) values were assigned as specified for prescriptive lighting measures. See Appendix B for applicable assumptions and references.

Baseline and efficiency case wattages and reported run hours were reviewed for each project. Reported wattages and run hours were largely reasonable and accepted in most cases. In some cases, engineered worksheets were updated to align with project completion reports or inspection results (where available).

3.1.2.2.2 Unitary AC Equipment

Savings were validated against savings assumptions specified in the following unitary AC engineered track HVAC worksheet:

- Unitary A/C Engineering Worksheet

Demand savings and EULs were assigned as specified for prescriptive unitary AC Equipment. See Appendix B for applicable assumptions and references.

3.1.2.3 Custom Track

For custom track projects, computer modelling and associated backup files were reviewed for compliance with program requirements and for overall reasonableness of claimed reductions in demand and consumption for the reference (Ontario Building Code [OBC] compliant) design versus the proposed design.

Custom projects require computer simulation modelling utilizing approved software to demonstrate the difference in annual energy consumption between the OBC-compliant reference building design and the proposed design with energy efficiency improvements. Certain project documents are required to be submitted by the project participants. However, this documentation was not available in all cases.

The following project documents, compiled by IESO, were most utilized in the review:

1. Pre- and Post-Project Submission Forms
2. Custom Project Worksheet
3. Simulation Summary Report (with most important appendices listed below)
    a. Summary compliance report
    b. Code compliance checklists
    c. Reference building modelling information
    d. Notes on inputs (building, plant, system)
4. Working energy simulation files and hourly output files
5. Energy & Demand Savings Summary
6. Project evaluator review reports (sometimes provided; not required but very useful)
7. Drawings, specs, product data
8. Backup for incremental cost entered on Custom Project Worksheet (required but often NOT provided)
    a. Incremental cost backup was provided for some projects in the form of an equipment/system breakdown in a separate file or email from the architect/engineer, estimator, or other consultant. For the remaining projects, the evaluation team used incremental costs provided on the custom project worksheet or completion report. In these cases, no supplemental breakdown of incremental equipment and labour costs by measure (e.g. HVAC, lighting, envelope, etc.) were provided.

One area of concern was the submittal of outdated model files. These files are refined as the project is carried out, often as a result of reviewer comments, design evolution, final selection of major equipment, and approved supplier submittals. Participants should be instructed to always submit the ‘final’ model files at project completion.

3.1.3 High Performance New Construction Inspections

The main objective of the inspections was to compare information submitted on the Save on Energy application worksheets for each participant to the in-situ data observed by the inspector. These reported application values and observed in-situ values were then compiled across all participants for each individual measure.

Within the High Performance New Construction (HPNC) program, projects were selected for site visits in order to validate reported savings and measure assumptions at a 90% +/- 10% confidence interval at the track level. Due to scheduling constraints, projects were selected based on the initial data release from the IESO.

Sample size was calculated as:

$$n = \frac{Nz^2 pq}{d^2(N \quad 1) + z^2 pq}$$

Where:

$n = sample\ size$

$p = response\ variable,\ ranges\ from\ less\ than\ 0.1\ to\ 0.5$

$N = Population$

$q = 1 - p$

$d = precision$

$z = Reliability\ factor$

Using:

$p = 0.5$

$N = 48$

$q = 1 - p$

$d = 10\%$

$z(90\%) = 1.645$

For the prescriptive track, a sample size of 29 was needed to achieve the 90% +/- 10% confidence interval. Projects were randomly selected for inspection. Prescriptive projects were organized by measure type and compared based on contribution to total energy savings. An additional 15% was

added to the sample size in case of difficulties accessing the selected sites. This resulted in a total of 33 projects that were randomly selected for site visits.

For the custom track, all sites with available documentation were selected.

In the first PY 2015 data release from the IESO, nine projects were identified as custom. Of the nine custom track projects, documentation was available for only six, four of which also were participating in the prescriptive track.

The full sample size for the prescriptive track was achieved with 29 sites visited. With a reduced population of participants in the custom track (only six of the nine providing documentation), only five of those sites have provided access to the inspector.

Table 9: HPNC Overview of Site Visit Sample Sizes

Track	Total Number of Projects	Sample Size (90% +/-10%)	Total Sample Size (+15%)
Custom	9	6	6
Prescriptive	48	29	33
Total Inspections	52	33	37

Overall, the in-situ data showed a high degree of concordance with the application worksheets. Of 91 surveyed measures, 59 (65%) had absolutely no variation from the participants' worksheets. Where discrepancies did occur, they generally were small.

Within the HPNC appliance measures for multi-residential projects, although there were small discrepancies between the application worksheets and the observed installations (none greater than 2%), on balance the sum of reported appliances matched the observed sum to within less than 1%.

The number of inspected installed lighting measures was within 4% of the application reported number, with reported wattages within 1% of what was observed.

The number of lighting controls measures observed in-situ was 3% more than the claimed amount.

The inspector did not find any discrepancy for the high-volume low-speed recirculation fans (HVLS) measure after visiting nine farms.

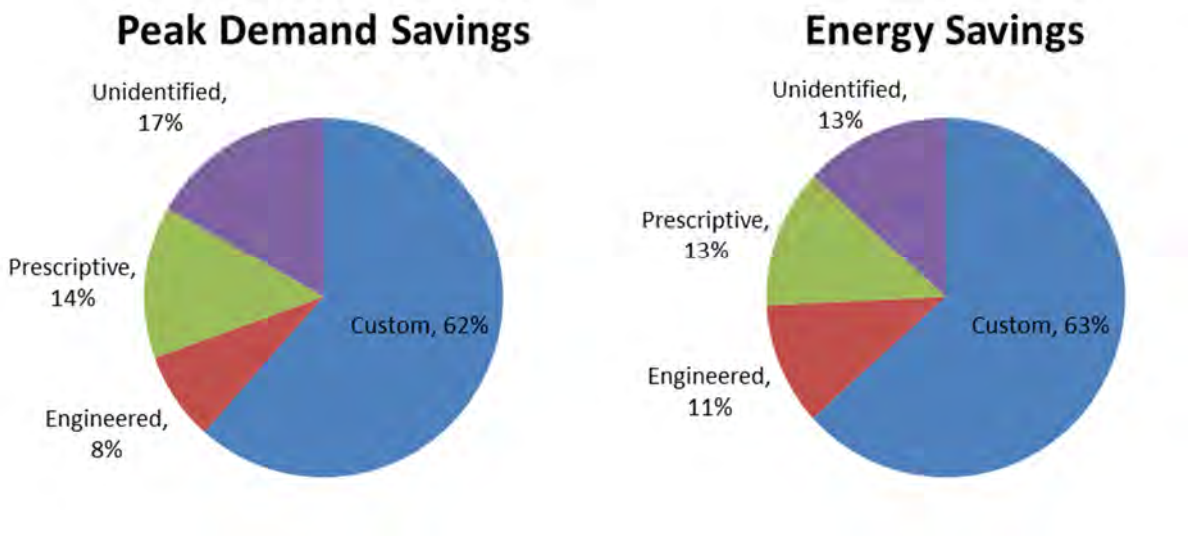
Unitary air conditioning equipment matched the applications on all but one of the seven sites visited.

Participants were generally very cooperative with the inspection process, and many expressed appreciation for the program.

3.1.4 Impact Evaluation Results

Figure 1 shows the breakdown of net demand and energy savings for the HPNC program by track. Custom projects contributed the majority of the savings in the HPNC program.

Figure 1: HPNC Percentage of Total Savings by Track



3.1.4.1 Prescriptive Track

Among identified projects within the prescriptive track, the majority of energy and demand savings were provided by lighting, appliance, and agribusiness measures as shown in Figure 2 and Table 10. There were a significant number of projects that did not have sufficient documentation to determine the measure.

Figure 2: HPNC Prescriptive Net Demand and Energy Savings by Measure

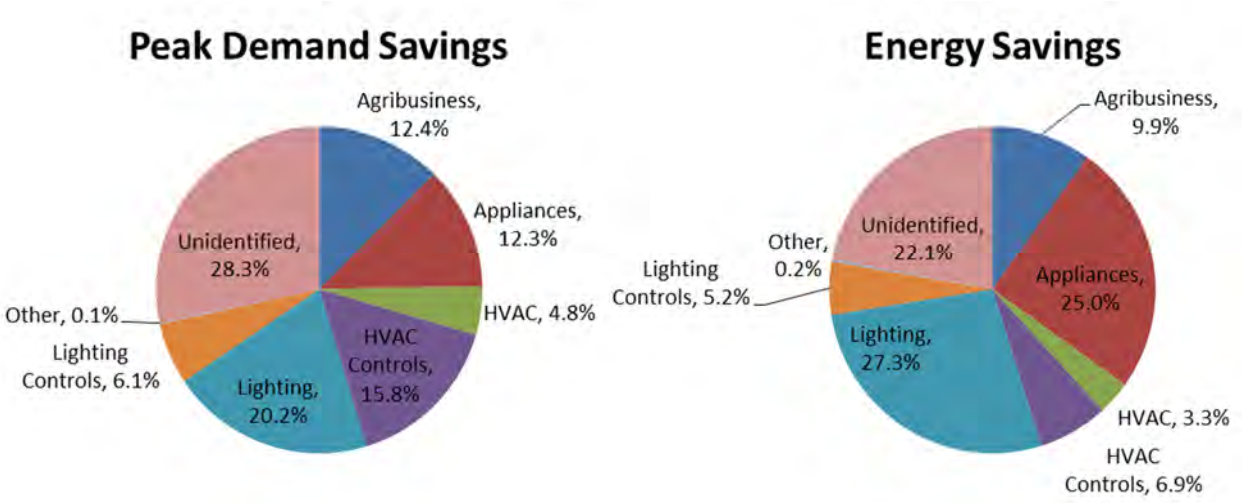


Table 10: HPNC Prescriptive Net Energy and Demand Savings by Measure, 2015

Measure	Net Energy Savings (kWh)	% of Total kWh Savings	Net Demand Savings (kW)	% of Total kW Savings
Agribusiness	272,385	9.9%	89.64	12.4%
Appliances	690,767	25.0%	88.40	12.3%
Belts	1,730	0.1%	0.22	0.03%
HVAC	91,381	3.3%	34.48	4.8%
HVAC Controls	191,091	6.9%	113.92	15.8%
Lighting	753,551	27.3%	145.46	20.2%
Lighting Controls	144,072	5.2%	43.59	6.1%
Motors	1,232	0.04%	0.15	0.02%
Variable Frequency Drives	2,728	0.1%	0.34	0.05%
Unidentified	609,085	22.1%	204.00	28.3%
Total	**2,758,023**	**100.0%**	**720.21**	**100.0%**

Among lighting measures, fluorescent-type fixtures contributed most to the overall savings. The most common fluorescent measures installed were high performance and reduced wattage T8s and T5s. No savings were awarded for pin-socket CFLs. The most common LED measures were recessed downlights, PAR lamps, and MR 16 lamps.

Among ENERGY STAR appliances, the ENERGY STAR clothes washer was the most popular measure installed and provided the most savings, followed by dishwashers then refrigerators.

Agribusiness measures also continued to be a key contributor to overall savings, but savings from those measures have decreased compared to previous evaluations. All agribusiness savings in PY 2015 came from the recirculation ventilation high-volume low-speed (HVLS) fans measure.

3.1.4.2 Engineered Track

Savings from the engineered track resulted primarily from lighting measures, as shown in Figure 3 and Table 11.

Figure 3: HPNC Engineered Net Demand and Energy Savings by Measure

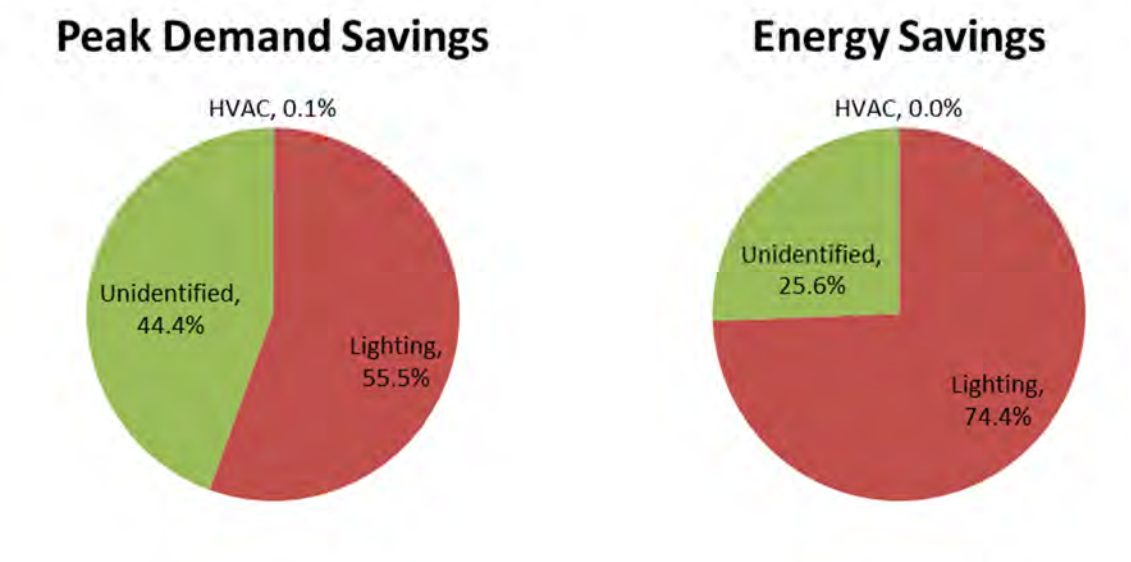


Table 11: HPNC Engineered Net Energy and Demand Savings by Measure, 2015

Measure	Net Energy Savings (kWh)	% of Total kWh Savings	Net Demand Savings (kW)	% of Total kW Savings
HVAC	689	0.0%*	0.41	0.1%
Lighting	1,796,311	74.4%	229.68	55.5%
Unidentified	618,949	25.6%	184.11	44.4%
Total	**2,415,950**	**100.0%**	**414.20**	**100.0%**

*This value is not actually zero, but is displayed as zero when rounded to one decimal place.

Among identified measures, most of the demand and energy savings within the engineered track came from lighting measures. The most popular measure types were LED lamps and fixtures. T8 fluorescent fixtures contributed to a lesser degree.

3.1.4.3 Custom Track

Table 12 shows the verified net demand and energy savings calculated for the custom track.

Table 12: HPNC Custom Net Energy and Demand Savings, 2015

Track	Net Energy Savings (kWh)	Net Demand Savings (kW)
Custom	13,932,582	3,214.01

Energy and demand savings for custom track projects are determined by the difference in energy consumption reported from computer simulation (using approved software) of a minimally code-compliant design versus the proposed energy efficient design. All modelling was done in EE4 and eQuest. The projects covered a wide range of types of buildings. Although the savings estimations (simulations) were not required to identify individual measure savings impacts, HVAC-related upgrades and high efficiency boilers were the most common measures included and likely had the most impact as the simulations took full advantage of high efficiency equipment and advanced control features (condensing boilers, HVAC scheduling and setbacks, variable speed drives).

3.1.4.4 Unidentified Projects

Table 13 shows the verified net demand and energy savings calculated for unidentified projects which were submitted with limited or no documentation.

Table 13: HPNC Unidentified Net Energy and Demand Savings, 2015

Track	Net Energy Savings (kWh)	Net Demand Savings (kW)
Unidentified	2,915,829	873.61

3.1.4.5 Comparison of 2014 and 2015 Impact Evaluation Results

The following figures provide a comparison of the 2014 and 2015 HPNC program years. Savings totals decreased in 2015 primarily due to a 25% decrease in participation.

Figure 4: HPNC Savings (2014 vs 2015)

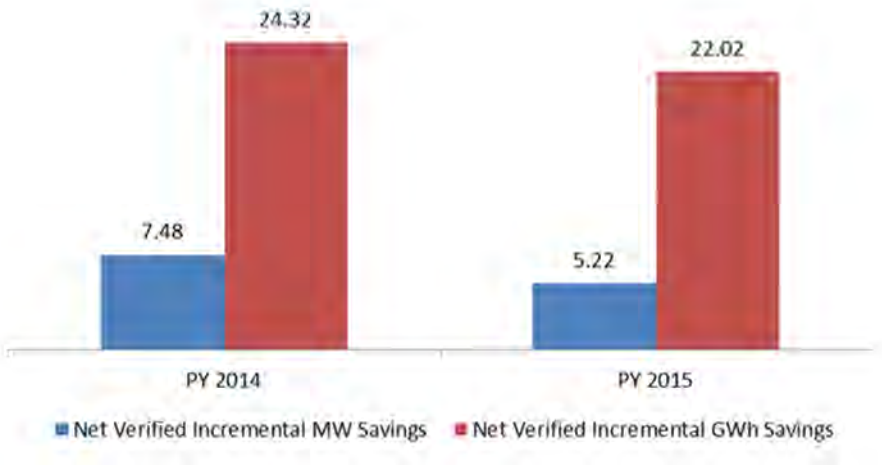


Figure 5: HPNC Net Verified Incremental MW Savings by Track (2014 vs 2015)

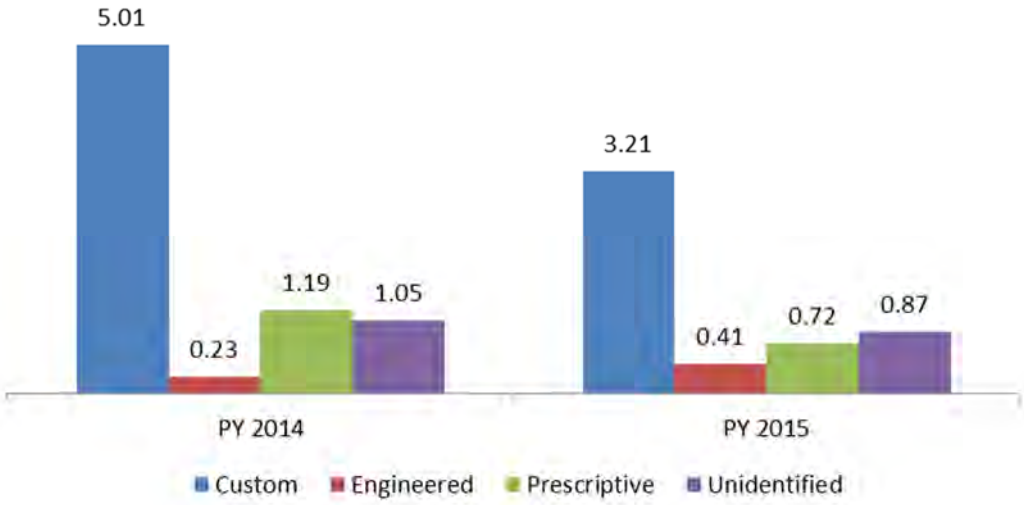
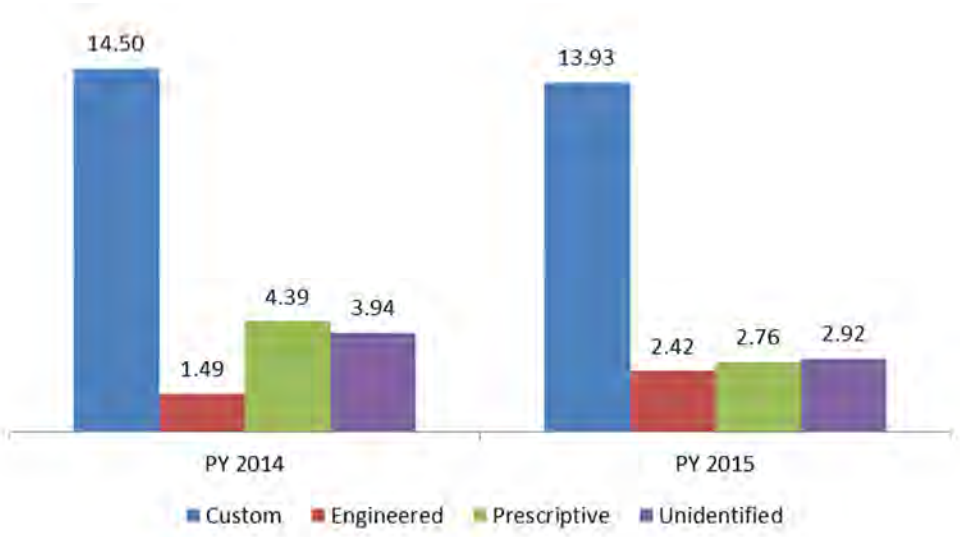


Figure 6: HPNC Net Verified Incremental GWh Savings by Track (2014 vs 2015)



In both years of the program, most savings came from the custom track. Excluding unidentified projects, the prescriptive track contributed the next highest savings totals, followed by the engineered track.

3.1.4.5.1 Prescriptive Track

Among identified projects within the prescriptive track, the majority of energy and demand savings were provided by lighting, appliance, and agribusiness measures. A significant number of the projects did not have sufficient documentation to determine the measure installed and were tagged as "unidentified savings." Lighting savings remained fairly consistent in contributing the highest savings in 2014 and 2015 but savings decreased due to a 25% decrease in program participation.

Figure 7: HPNC Net Incremental GWh Savings from Prescriptive Measure Trends (2014 vs 2015)

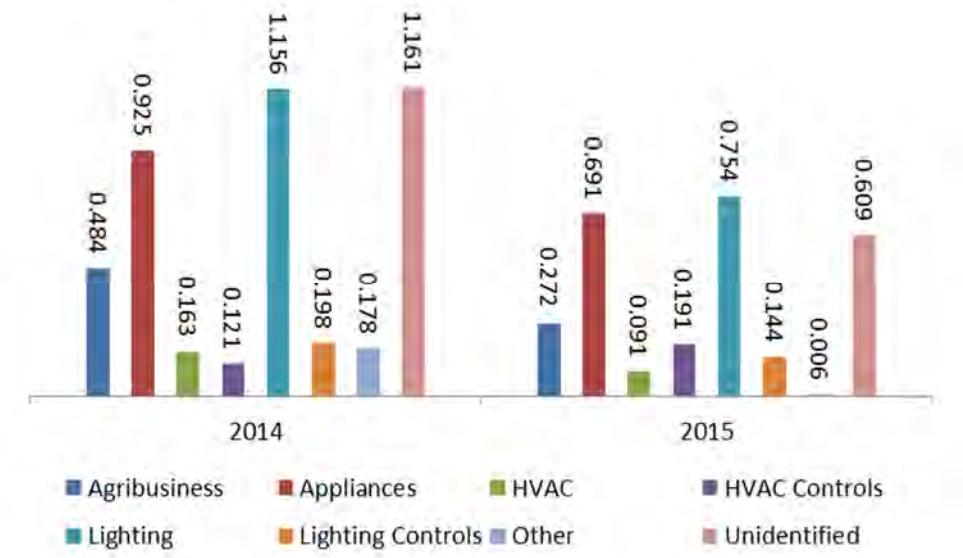
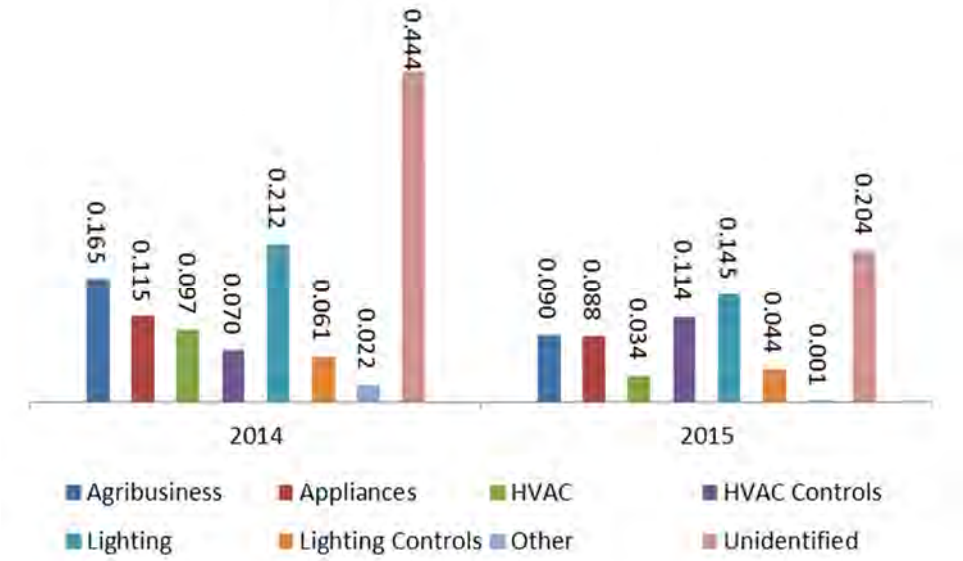


Figure 8: HPNC Net Incremental MW Savings from Prescriptive Measure Trends (2014 vs 2015)



Among lighting measures, fluorescent-type fixtures contributed most to the overall savings. The most common fluorescent measures installed were high performance and reduced wattage T8s and T5s. The most common LED measures were recessed downlights, PAR lamps, and MR 16 lamps.

Among ENERGY STAR appliances, the ENERGY STAR clothes washer was the most popular measure installed and provided the most savings, followed by dishwashers then refrigerators.

Agribusiness measures also continued to be a key contributor to overall savings, but savings from those measures have decreased compared to previous evaluations. All agribusiness savings in PY 2015 came from recirculation ventilation high-volume low-speed (HVLS) fans measure.

3.1.4.5.2 Engineered Track

Savings from the Engineered track resulted primarily from lighting measures. Similar to the Prescriptive track, a significant number of the projects do not have sufficient documentation to determine the measure.

Savings decreased for HVAC measures but increased for lighting measures. Overall engineered track savings increased from 2014 to 2015. Lighting savings remained fairly consistent, contributing the highest savings in 2014 and 2015 and showing increase in savings from 2014 to 2015. On the other hand, HVAC savings decreased in 2015 primarily due to a 25% decrease in program participation. Engineered track savings for unidentified measures increased in 2015 due to projects with insufficient project documentation.

Figure 9: HPNC Net Incremental GWh Savings from Engineered Measure Trends (2014 vs2015)

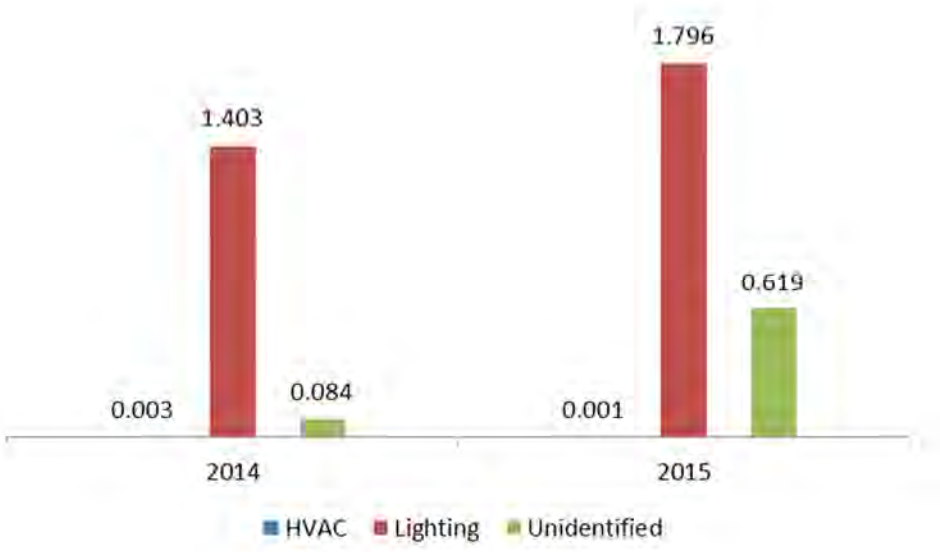
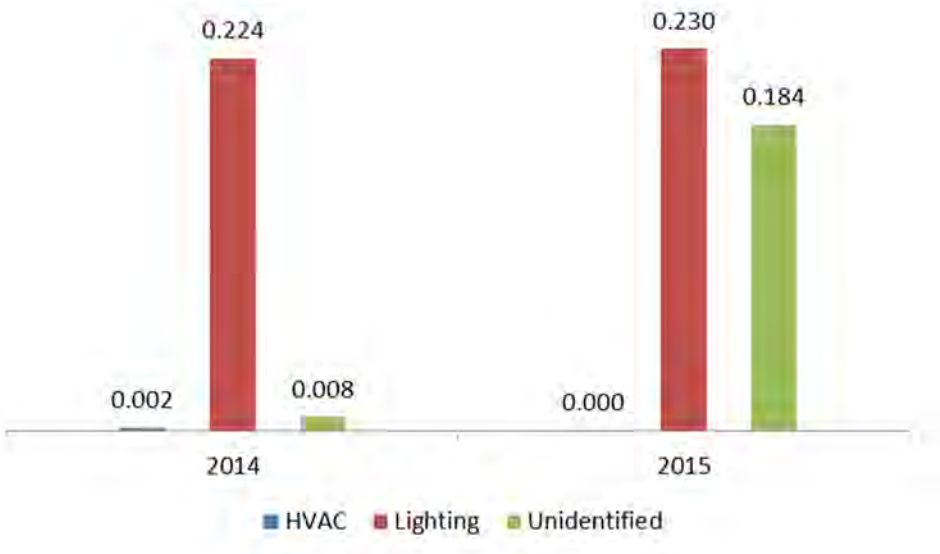


Figure 10: HPNC Net Incremental MW Savings from Engineered Measure Trends (2014 vs 2015)



The most popular measure types among the lighting measures were LED lamps and fixtures. T8 fluorescent fixtures contributed to a lesser degree.

3.1.4.5.3 Custom Track

Table 14 compares the net demand and energy savings for the custom track. Savings decreased from 2014 to 2015 primarily due to a 25% decrease in program participation. However, reasons for changes in savings totals are difficult to identify for the custom track, where savings are based on modelling that is very site- and technology-specific. Sites and measures are not constant from year to year, so savings are similarly not expected to remain constant.

Table 14: HPNC Custom Net Energy and Demand Savings (2014 vs 2015)

Track	Net Demand Savings (kW)	Net Energy Savings (kWh)
2014	5,011.30	14,503,528
2015	3,214.01	13,932,582

3.1.5 Realization Rates

Realization rates were calculated by dividing verified savings by claimed savings. In calculating program average realization rates, individual project realization rates were weighted by contribution to program savings totals.

Realization rates for unidentified projects were estimated by taking a weighted average of the results for projects where the track and/or measure could be identified. Because of the large savings contribution of measures with higher realization rates (e.g. custom, lighting, HVAC controls, and appliances), this value exceeded 100%. However, the final unidentified track realization rates were capped at 100% to avoid incentivizing the submittal of projects with missing or incomplete documentation. For some projects with missing documentation, the track could be identified. Custom projects with missing documentation were also capped at 100% rather than using the program-average realization rate.

Realization rates for the custom track were generally consistent from 2014 to 2015. Savings for the engineered and prescriptive tracks generally increased. This was partially due to the fact that reported savings did not always align with savings calculated using the engineered workbooks or prescriptive savings assumptions. A decrease in the number of participating agribusiness measures was a key contributing factor to the increase in prescriptive track realization rates.

Table 15 provides the realization rates by track from 2014 to 2015. All additional 2014 savings from true-up projects are included in the unidentified track. Savings were awarded using a program-wide weighted average realization rate from the 2014 evaluation.

Table 15: HPNC Realization Rates by Track (2014 vs 2015)

	2014		2015	
Track	**Realization Rate (kWh)**	**Realization Rate (kW)**	**Realization Rate (kWh)**	**Realization Rate (kW)**
Custom[4]	88%	90%	98%	100%
Engineered	84%	80%	111%	89%
Prescriptive	57%	37%	85%	68%
Unidentified[5]	79%	71%	100%	100%
Total	**79%**	**71%**	**100%**	**100%**

[4] 2015 energy and demand realization rates capped at 100%.
[5] 2015 energy and demand realization rates capped at 100%.

3.1.6 Net to Gross Evaluation

For the impact evaluation of the 2015 HPNC program, the evaluation team surveyed participants using the same NTGR self-report survey used in the previous evaluation. The goal of the evaluation was to survey enough 2015 participants to represent the HPNC program at a 90% confidence level with 10 percent precision. In order to meet this confidence level, surveys were completed with 43 participants.

The evaluation team assessed the responses of participants for the following points:

- Whether the participant learned about the program before or after the decision to build,
- Whether the payback period was an important factor in the decision-making process,
- The importance of being "energy efficient" or "green" in the decision-making process,
- The importance of the incentive in the decision to include energy efficiency measures, and
- The extent of the influence of incentives on the building design or the level of energy efficiency.

According to survey results, more than sixty percent of the participants had already decided to build before learning about the program. Sixty-five percent of prescriptive track participants and 73% of custom track participants rated the incentive as fairly important to very important.

The 2015 evaluation found that the free ridership rates increased, as more participants reported that energy efficiency was already a priority for their project prior to seeking out an incentive. For all questions, indications for free ridership increased slightly. The net-to-gross ratios (NTGRs) calculated are available in the table below.

Table 16: HPNC Energy and Demand Net-to-Gross Ratios (2014 vs 2015)

	Track	Free Ridership	Spillover	NTGR
2014	All	46%	0%	54%
2015	All	46%	0%	54%
2015	Prescriptive/Engineered	50%	0%	50%
2015	Custom	44%	0%	56%

3.1.7 Cost Effectiveness

Metrics used for the cost effectiveness analysis for HPNC were the Total Resource Cost (TRC) test, the Program Administrator Cost (PAC) test, and the Levelized Delivery Cost. Results and findings are discussed in the table and section below.

Table 17: HPNC Cost Effectiveness Results

		2014	2015
PAC	Benefit	$26,707,133	$20,909,487
	Cost	$12,742,094	$8,316,839
	Net Benefit	$13,965,039	$12,592,647
	Net Benefit Ratio	2.10	2.51
TRC	Benefit	$26,707,133	$24,045,910
	Cost	$17,049,062	$10,609,747
	Net Benefit	$9,658,071	$13,436,163
	Net Benefit Ratio	1.57	2.27
Levelized Delivery Cost	$/MWh	$61.93	$36.73
	$/MW	$171,694	$154,557

The HPNC program passed both the PAC and TRC tests for 2015, showing improvements over the previous year's performance. Even though 2015 had a decrease in participation, cost effectiveness was not adversely impacted because net program benefits did not decrease significantly and administrative costs were adjusted appropriately for the decrease in projects. Administrative cost increased to 40.7% of total program cost, up from 33.9% for 2014. This had less of a negative effect on the benefit-cost ratio since the benefit per project was higher for 2015.

3.1.8 Key Findings and Recommendations

Below are the key findings and recommendations resulting from the 2015 HPNC impact evaluation:

3.1.8.1 Data Reporting & Tracking Requirements

- **Develop a consistent methodology across the province for capturing key data points for savings calculations. This may be either a centralized database or a list of requirements for each LDC's own database.**

  Data submitted to the program was a bit disorganized and difficult to piece together. Folders of data often did not match the inventory of data needed to verify savings. A consistent methodology for gathering key data points by the LDCs would ensure accurate reporting and verification of savings. It is recommended that a centralized database or a requirements list for each LDC be created. A pre-set folder structure with 'read-me' instructions in each folder can be provided to guide the LDCs in assuring completeness of document uploads.

- **Ensure complete submittal of project documentation to facilitate savings evaluation. Specifically for the custom track, the Simulation Summary Report should be added to the list of mandatory requirements for custom projects. This tabulation of input assumptions for base case and design case is useful to quickly assess the inputs relative to code and energy efficient measures included in the design, as well as assumptions such as operating schedule and temperature settings.**

  Complete documentation submittals are needed for evaluation but often are not available. Many custom projects lacked documentation, which lowered the average realization rate that was applied to all projects. Assuming that these custom projects provided documentation to the LDCs to receive incentives, it is recommended that the LDCs strengthen data retention procedures in order to provide the documentation to evaluators. Assuming the problem originates with the participant not supplying the required documents to the LDC, it is likely that this problem is caused by an incomplete understanding of the requirements by participants and their design teams, consultants, and contractors. It is further recommended that the web page guidance on document requirements be reviewed for completeness and consistency. Providing online walk-throughs explaining document submittal requirements could also be helpful.

- **Assign projects a unique ID to assist with identifying project evaluation status for impact evaluations and true-ups. If unique IDs already exist, include them in project reporting documentation.**

  Projects are sometimes submitted for evaluation after the implementation year in which the project was completed. In some instances, these projects have already been reviewed in a previous evaluation. Additionally, projects are sometimes submitted with an address that

matches another address used in the same or previous implementation year. If unique IDs were provided for all projects, it would be easier to identify which projects should be included in the impact evaluation and true-up.

- **For projects that include multiple measure types, prescriptive and engineered track savings should be reported separately by measure similar to the way they are in the RNC program and in other programs. Currently, savings are only reported to the evaluation team as either custom or prescriptive.**

  Engineered track savings are combined with prescriptive track savings, and none are specified by measure. If no project documents are provided for a project, the evaluation team cannot distinguish between savings that should be awarded to the prescriptive and engineered tracks.

- **Consider adding the Final Commissioning Report to the list of requirements for custom projects. This document would be submitted when the project is complete and would allow reviewers or evaluators to confirm that the facility was operating as designed.**

  The final commissioning report documents that the building controls were completed and set to control mechanical systems, particularly HVAC, in the manner intended and assumed in the energy modelling. The commissioning report will also provide the specific technology that was installed, something frequently left out of the documentation. This requirement will provide an extra level of quality assurance and quality control to the evaluation process.

3.1.8.2 Prescriptive Assumptions

- **The MAL should incorporate base and efficiency case adjustments to all measures as outlined in Appendix B and Appendix C.**

  Incorporating recommended updates to savings calculation methodologies from previous evaluation reports will help to improve realization rates for prescriptive measures.

- **Prescriptive assumptions should be updated to take building type into account. At a minimum, the evaluation team recommends that the existing prescriptive assumptions (using Office as the default building type) be expanded to include the Retail building type.**

  Version 2.0 of the prescriptive savings assumptions uses deemed operating hours for Office buildings to develop savings estimates. While Office is a common building type, the evaluation team would prefer to see savings that are calculated based on assumptions for the building type where the measure is installed. At a minimum, the current MAL should be expanded to include savings calculated using assumptions for Retail buildings. Office and Retail are among the most common building types seen in previous evaluations.

- **No demand savings should be claimed for exterior lighting projects**.

  The HPNC program does not allow for claiming winter demand savings. Therefore, no demand savings should be claimed for exterior lighting projects, as typical operation occurs during off-peak hours.

- **For engineered track workbooks, operating schedules should not exceed 8,760 hours.**

  Engineered track lighting worksheets have a tool to estimate operating schedules based on user inputs. In some older versions of the engineered track workbook, if the user specifies 24 hour per day operation, the resulting annual operating hours are specified as 8,784. This value should be capped at 8,760 hours. This issue appears to be fixed as of version 6.1 (updated May 18, 2016). Therefore, it is important to always use the latest version of engineered track workbooks.

3.1.8.3 Savings Calculation Tools

- **Provide additional functionality for lighting engineered track worksheets to individually report savings for each lamp/fixture type.**

  Currently, for engineered track lighting worksheets, a single savings and incentive value is provided for projects with multiple measures types. This makes it difficult to verify savings for individual lighting measures. It is recommended that a breakdown of savings be specified by measure.

- **Consider adding EnergyPlus (United States Department of Energy-sponsored modelling engine) as an approved modelling software. This is a free software that is continually being improved by the United States Department of Energy.**

  EnergyPlus is a very popular modelling engine commonly used to design commercial buildings. Adding this engine will increase the accessibility of the program to participants.

3.2 Residential New Construction

3.2.1 Methodology

The evaluation team employed the steps below in conducting the impact evaluation for the Residential New Construction (RNC) program. Specific details of the methodologies used for each track (prescriptive, performance, or custom) are given in the succeeding sections.

1. The evaluation team gathered project information from the IESO and conducted a desk review for projects with available project documentation.
2. For prescriptive measures, appropriate baselines and per unit input assumptions were followed according to the Measures and Assumptions List (MAL).
3. For performance measures, energy consumption using the EnerGuide formula and reports was mapped out. The EnerGuide reports provided the new home's energy use. Using the EnerGuide formula,[6] baseline energy use was calculated. Then energy savings was calculated by subtracting the new home's energy use from the baseline energy use.
4. The IESO's definition of peak demand savings[7] and IESO's latest load profiles were used to estimate peak demand savings.
5. The evaluation team summed the savings estimates for individual projects to obtain program-level gross savings.
6. For projects with no or insufficient documentation that could be used to calculate savings, average realization rates were applied. This average percentage is estimated by using the ratio of the gross verified savings and the gross reported savings claimed for projects that provided documentation. To calculate savings for projects with documentation, appropriate realization rates were applied that were specific to the measure type (if the measure was known) or weighted according to frequency of measure types installed in other projects.
7. Net energy and demand savings were calculated using the net-to-gross ratio values calculated for 2015.

[6] EnerGuide Formula: EnerGuide Rating = 100 – 20 * (new house energy usage/base case house energy usage).

[7] The evaluation team followed the IESO's EMV Protocols and Requirements, 2011-2014 definition of peak. This definition of peak is 1pm-7pm, weekdays, June-August.

3.2.2 Review of Inputs Assumptions and Algorithms

This section provides any overview of any major discussion points regarding measures within the prescriptive, performance, or custom track.

3.2.2.1 Prescriptive Track

Available documents for prescriptive measures in the RNC program were reviewed. Most references and assumptions that went behind the savings verification process were the same as used in the previous evaluations. To see these references and assumptions, refer to Appendix B.

3.2.2.2 Performance Track

The limited information available regarding the RNC Performance Track has led to innovative approaches in calculating both Incremental Energy Savings (kWh) and Incremental Summer Peak Demand Savings (kW).

As in past years, the EnerGuide rating sheets provided by the builders to IESO were central to evaluating and determining savings. These sheets list the **Energy Efficiency Ratings** and **Estimated Annual Energy Consumption** in kilowatt-hours for each participating home. Through the published formula[8]:

$$EnergyEfficiencyRating = 100 - \left(\frac{AnnualEstimatedTotalEnergyConsumption}{BenchmarkTotalEnergyConsumption} \right) * 20$$

Incremental Energy Savings are calculated by algebraically determining the Benchmark Total Energy Consumption and subtracting the Estimated Annual Energy Consumption. By analyzing Summer Peak 8760 data, savings are assigned to different uses and demand savings are determined.

At the onset of research for this report, interviews with participating builders and EnerGuide raters indicated that the single most effective way to achieve a high EnerGuide rating was by emphasizing envelope measures such as airtightness and insulation. Past years' savings have been applied to categories such as Lighting and Appliances. Due to the aforementioned emphasis on envelope measures, air-conditioning was considered as a prudent, reasonable, and indeed, necessary source of savings during the Summer Peak. The version of the EnerGuide rating software that was available to the evaluation team (HOT2000) led to this same conclusion, in fact.

However, due to incomplete information provided in Natural Resources Canada's January 2005 *Administrative and Technical Procedures* manual, further inquiry recently revealed that neither Lighting

[8] Source: NRCanada Energy Advisor Procedures Manual March 2010

nor Appliances can be a source of savings as they do not change between benchmark and improved cases. Likewise, further research and interviews indicated that the limited-access raters' version of HOT2000 contradicts the publicly available version; Air-conditioning is not even considered by the HOT2000 software when calculating EnerGuide ratings, as it will be in future versions not yet adopted, according to the Natural Resources staff interviewed.

The average of 2,600 kWh savings, a number derived by the aforementioned method employing the available EnerGuide reports, cannot be reasonably assigned to the only categories available according to Natural Resources Canada, namely:

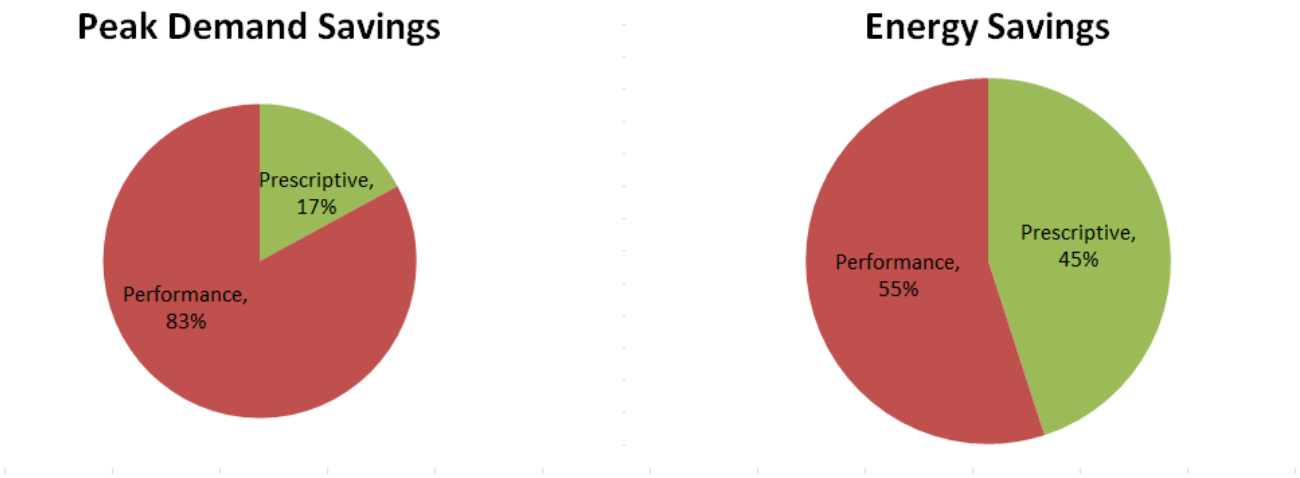
- Space Heating including fans, as less than 20% of homes use electric heat in Ontario. (By way of comparison , the prescriptive track measure for "Electric Furnace with ECM -Continuous Fan Usage- Space Heating & Cooling, New Homes" shows maximum savings of 1218 kWh), and
- Domestic Hot Water, for which electricity accounts for less than 30% in Ontario

The calculated savings, although reasonable, cannot be fully supported as a result of the combined handicap of not having access to the raters' version of the HOT2000 software and the EnerGuide rated homes' HOT2000 files, in conjunction with the majority of builders not providing access to RNC homes.

3.2.3 Impact Evaluation Results

Figure 11 shows the breakdown of demand and energy savings for the RNC program by track in 2015. Performance projects contributed the majority of the savings in the RNC program.

Figure 11: RNC Percentage of Total Savings by Track, 2015



3.2.3.1 Prescriptive Track

Figure 12 shows the contribution to RNC demand savings by measure. ENERGY STAR lighting measures contributed the most energy and demand savings.

Figure 12: RNC Prescriptive Net Demand and Energy Savings by Measure, 2015

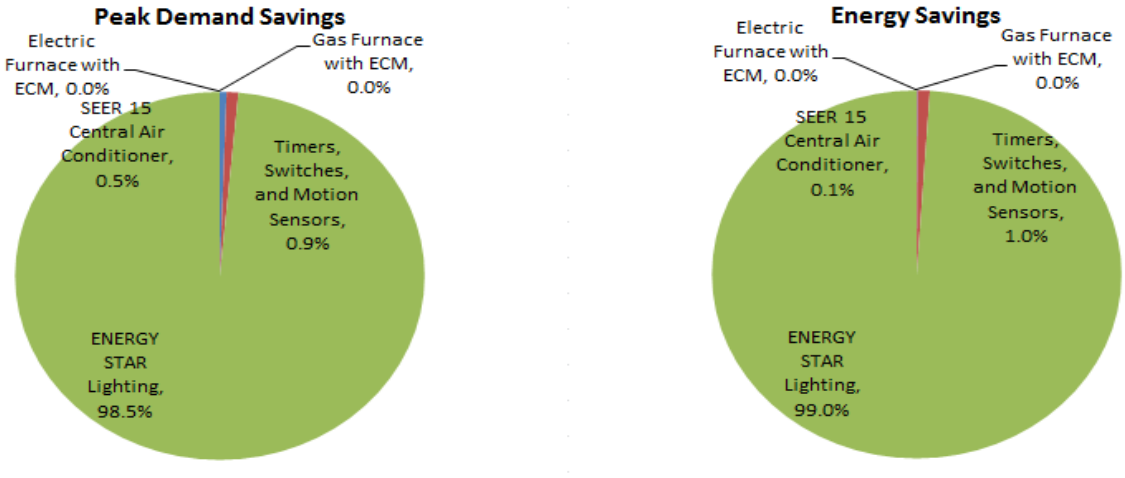


Table 18: RNC Prescriptive Net Energy and Demand Savings by Measure, 2015

Measure	Measure Count	Net Energy Savings (kWh)	% of Total kWh savings	Net Demand Savings (kW)	% of Total kW Savings
All Off Switch	47	5,342	0.2%	0.4	0.2%
ENERGY STAR Qualified Light Fixture 1 or 2 Sockets	36,091	1,351,110	47.6%	90.5	47.6%
ENERGY STAR Qualified Light Fixture 3 or More Sockets	12,587	755,504	26.6%	50.6	26.6%
ENERGY STAR Qualified Recessed Lighting	4,092	89,731	3.2%	6.0	3.2%
ENERGY STAR Qualified Under the Counter Lighting	3,387	57,824	2.0%	3.9	2.0%
ENERGY STAR Qualified LED	33,282	555,040	19.6%	36.4	19.1%
Gas Furnace with ECM	1,148	0	0.0%	0.0	0.0%
Electric Furnace with ECM	71	0	0.0%	0.0	0.0%
SEER 15 Central Air Conditioner	26	1,733	0.1%	1.0	0.5%
Dimmer Switch	396	4,683	0.2%	0.3	0.2%
Indoor Lighting Timer	1	32	0.0%	0.002	0.0%
Indoor Motion Sensor	792	16,690	0.6%	1.1	0.6%
Outdoor Lighting Timer	8	81	0.0%	0.0	0.0%
Outdoor Motion Sensor	6	478	0.0%	0.0	0.0%
TOTAL	**91,934**	**2,838,248**	**100.0%**	**190.2**	**100.0%**

3.2.3.2 Performance Track

Figure 13 shows the contribution of the different Performance track options to RNC demand savings.

Figure 13: RNC Performance Net Demand and Energy Savings by Measure, 2015

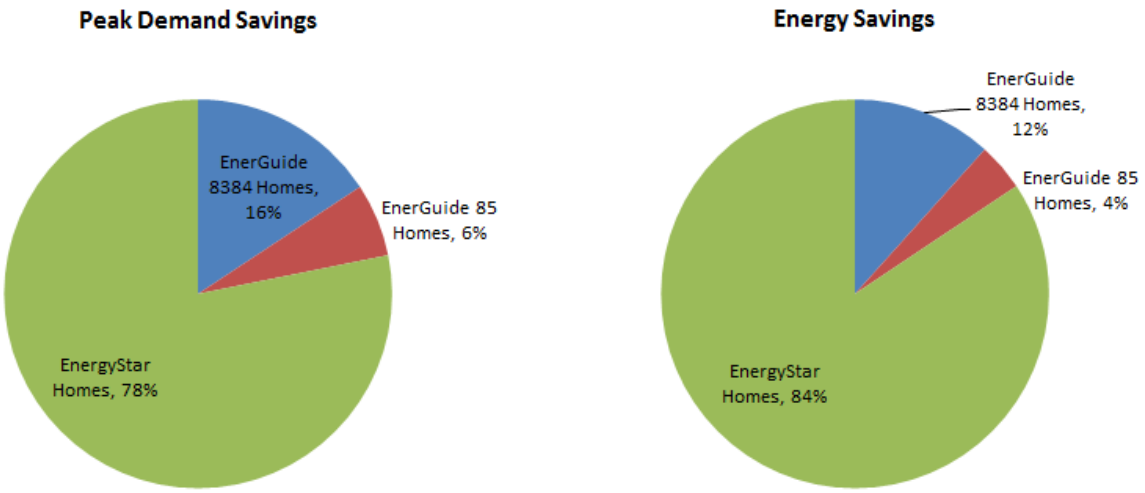


Table 19: RNC Performance Net Energy and Demand Savings, 2015

EnerGuide Score	Net Energy Savings (kWh)	% of Total kWh Savings	Net Demand Savings (kW)	% of Total kW Savings	Number of Homes
EnerGuide 8384 Homes	404,596	12%	145	16%	412
EnerGuide 85 Homes	138,029	4%	56	6%	86
ENERGY STAR Homes	2,924,409	84%	721	78%	1,778
Total	**3,467,033**	**100%**	**923**	**100%**	**2,276**

3.2.3.3 Comparison of 2014 and 2015 Impact Evaluation Results

The following figures provide a comparison of the 2014 and 2015 impact evaluation results of the RNC program. Program year 2015 saw an increase in both energy and peak demand savings largely due to a 30% increase in participation.

Figure 14: RNC Annual Impact Trends, (2014 vs 2015)

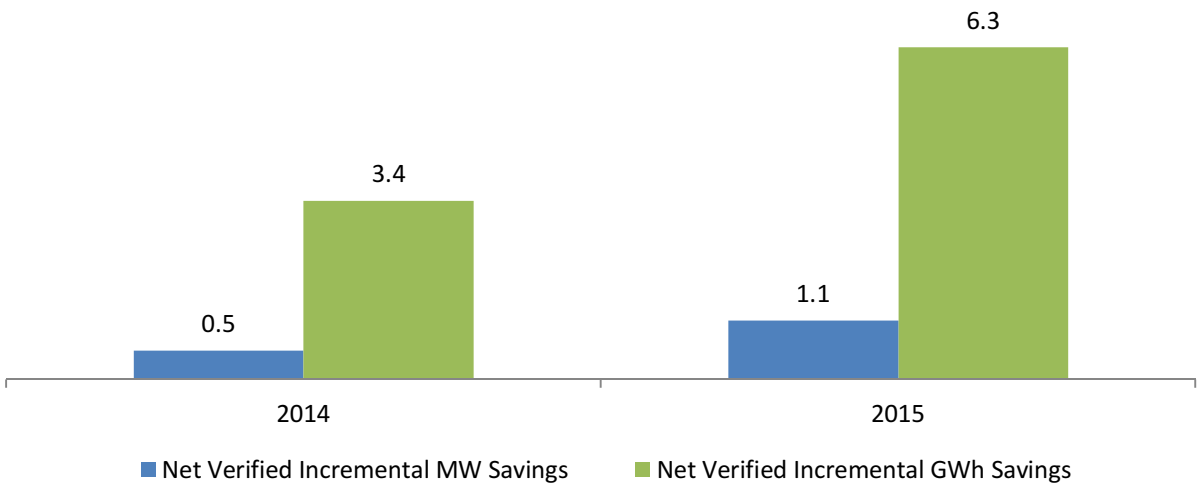


Figure 15: RNC Net Verified Incremental MW Savings by Track, (2014 vs 2015)

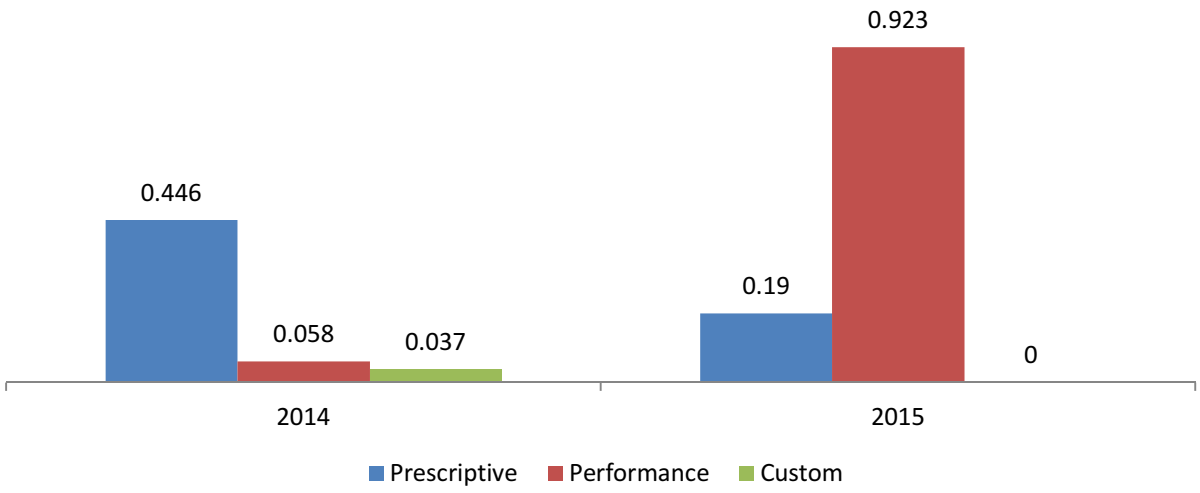
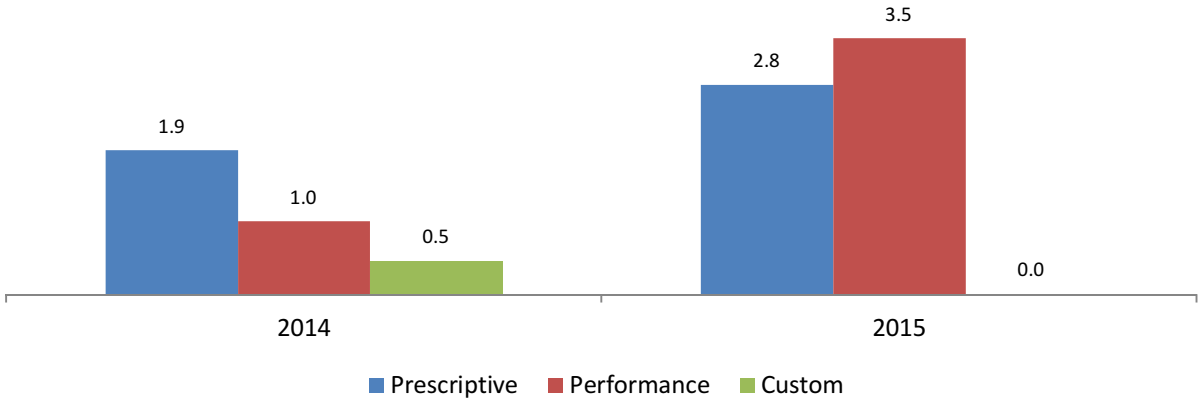


Figure 16: RNC Net Verified Incremental GWh Savings by Track, (2014 vs 2015)



In 2015, most savings came from the performance track, while most savings in 2014 came from the prescriptive track. The custom track saw no participation in 2015.

3.2.3.3.1 Prescriptive Track

Figure 17and Figure 18 show the contribution to RNC energy and demand savings by measure between 2014 and 2015. There was a 91% increase in participation from 2014 to 2015. ENERGY STAR lighting provided the most energy savings in both 2014 and 2015.

Gas Furnace with ECM provided most of the demand savings for prescriptive projects in 2014. However, lighting (ENERGY STAR Qualified LED, ENERGY STAR Qualified Light Fixture 1 or 2 Sockets, and ENERGY STAR Qualified Lighting Fixture 3 Sockets or More) provided most of the demand savings in 2015.

Figure 17: RNC Net Incremental GWh Savings from Prescriptive Measure Trends, (2014 vs 2015)

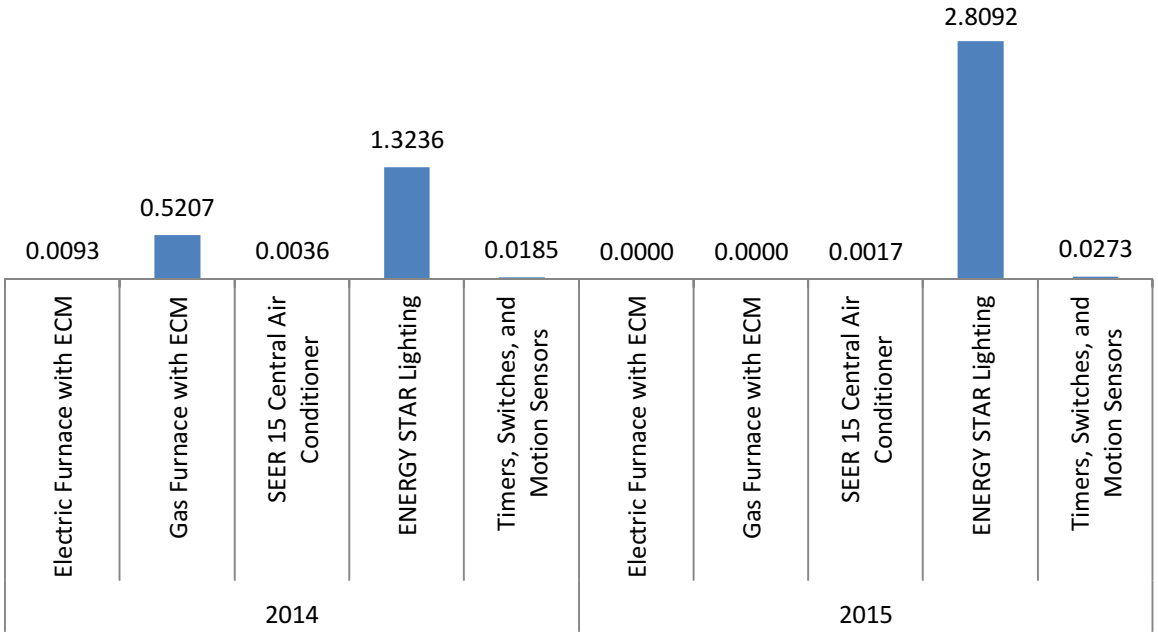
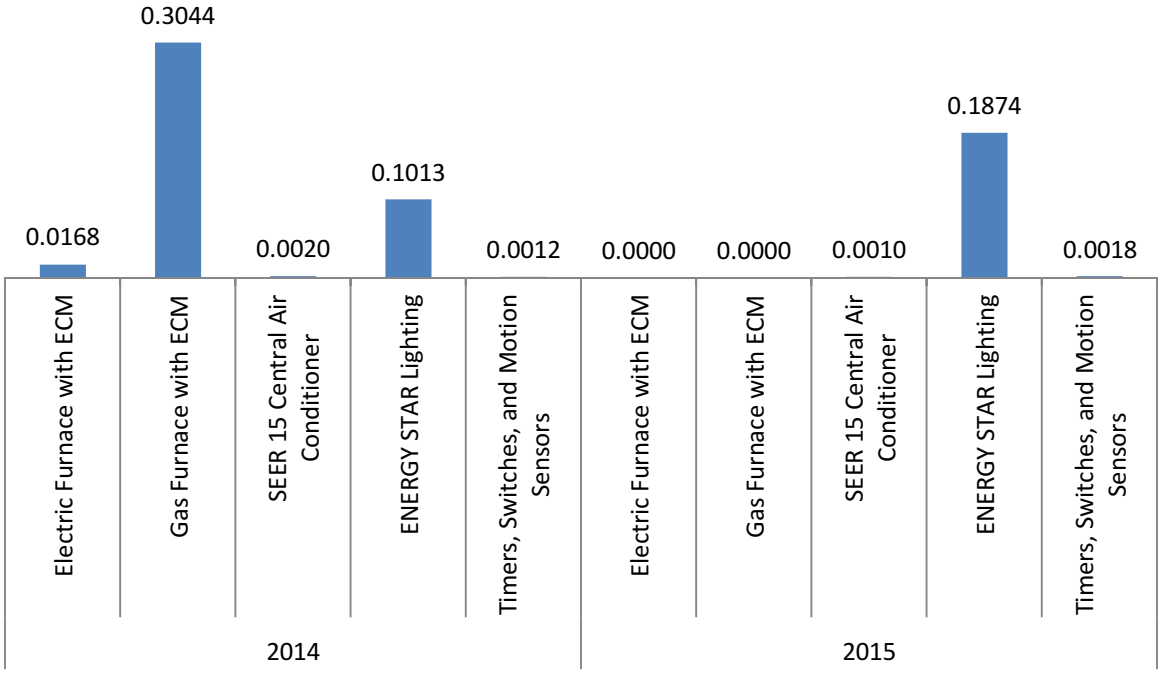


Figure 18: RNC Net Incremental MW Savings from Prescriptive Measure Trends, (2014 vs 2015)



3.2.3.3.2 Performance Track

Performance projects submitted ranged in EnerGuide score from 83 to 87. The majority met the minimum score of 83. ENERGY STAR New Homes were included in the program in 2014, and can be seen providing savings in both 2014 and 2015.

For performance track homes, the participation increase of 56% and increase in demand realization rate are the major drivers behind the energy and demand savings increase.

Figure 19: RNC Net Incremental GWh Savings from Performance Measure Trends, (2014-2015)

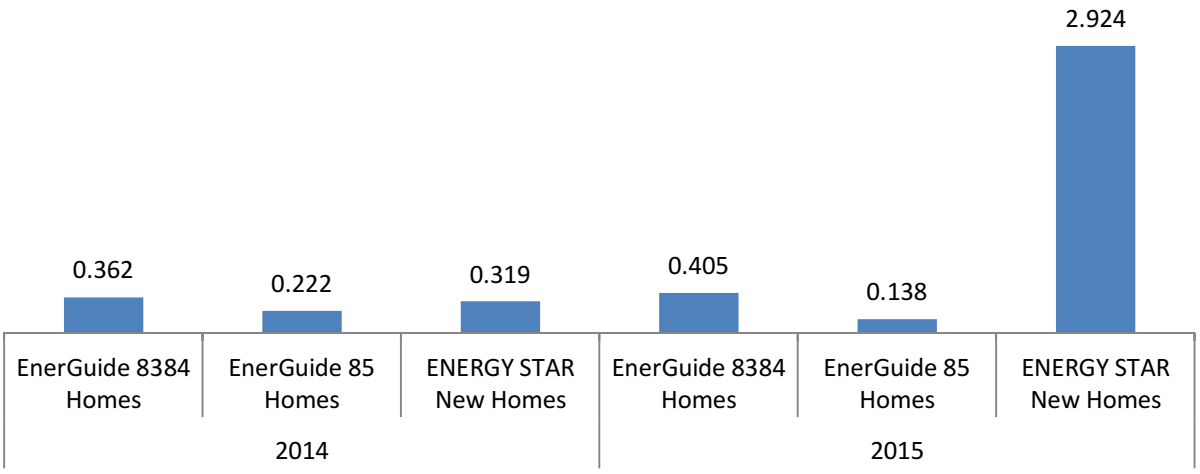
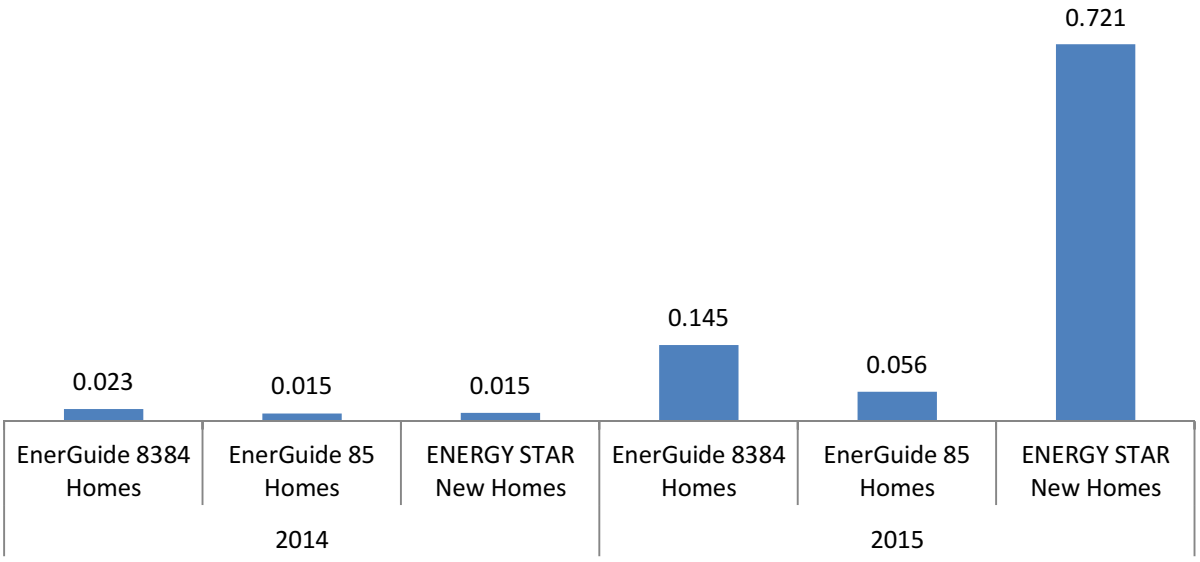


Figure 20: RNC Net Incremental MW Savings from Performance Measure Trends, (2014-2015)



3.2.3.3.3 Custom Track

The savings in the table below come from one project in 2014. There were no projects in 2015 to provide a comparison.

Table 20: RNC Custom Net Energy and Demand Savings, 2014

Number of Homes	Net Energy Savings (kWh)	Net Demand Savings (kW)
55	37.2	451,655

3.2.4 Realization Rates

Realization rates were calculated by dividing verified savings by claimed savings. In calculating program average realization rates, individual project realization rates were weighted by contribution to program savings totals.

In 2014 realization rates were low for ENERGY STAR lighting measures due to lack of information provided about the type of measure installed. ENERGY STAR lighting provided a substantial amount of savings in 2014; the low realization rate for this measure resulted in lower realization rates for the track.

Discontinuation of the Gas Furnace ECM measure in 2015 led to decreased realization rates for this measure as savings were claimed for these projects but disallowed for verified savings results. This is a primary contributor to the overall lower demand realization rates for the prescriptive track in 2015 as compared to 2014.

Realization rates for energy increased slightly from 2014 to 2015. The primary contributor to this increase is the measure mix in 2015 including a high number of projects submitted for the lighting measure. The evaluation team assumed that the average measure installation was a lamp rated between 750-1049 lumens, equivalent to a 60 watt incandescent light bulb which provides slightly more energy savings than the program assumption. See Appendix B for additional details.

The table below shows the realization rates for each track from 2014 to 2015.

Table 21: RNC Realization Rates by Track, (2014 vs 2015)

	2014		2015	
	kWh	kW	kWh	kW
Prescriptive	49%	97%	55%	38%
Performance	147%	178%	109%	921%
Custom	100%	100%	n/a	n/a
Total	**67%**	**100%**	**76%**	**187%**

3.2.5 Net to Gross Evaluation

For the impact evaluation of the 2015 RNC program, the evaluation team surveyed participants (builders) using the same NTGR self-report survey used in the previous evaluation. The goal of the evaluation was to survey enough 2015 participants to represent the RNC program at a 90% confidence level with 10 percent precision. In order to meet this confidence level, surveys were completed with 18 participants.

The evaluation team assessed the responses of participants for the following points:

- Whether the participant learned about the program before or after the decision to build;
- Whether the payback period was an important factor in the decision-making process;
- The importance of being “energy efficient” or “green” in the decision-making process;
- The importance of the incentive in the decision to include energy efficiency measures; and
- The extent of the influence of incentives on the building design or the level of energy efficiency.

All survey respondents claimed that the incentive ranged from important to very important for including energy efficiency measures in the project. All respondents stated that being “green” ranged from fairly to very important during the decision-making process. Also, over 50% of the respondents learned about the program before deciding to build or renovate.

The 2015 evaluation found that the free ridership rates increased, as more participants reported that energy efficiency was already a priority for their project prior to seeking out an incentive. For all questions, indications for free ridership increased slightly. The net-to-gross ratios (NTGRs) calculated are available in the table below.

Table 22: RNC Net-to-Gross Ratios, (2014 vs 2015)

Year	Track	Free Ridership	Spillover	NTGR
2014	All	37%	0%	63%
2015	All	51%	0%	49%
2015	Prescriptive	50%	0%	50%
2015	Performance	51%	0%	49%

3.2.6 Cost Effectiveness

Metrics used for the cost effectiveness analysis for RNC were the Total Resource Cost (TRC) test, the Program Administrator Cost (PAC) test, and the Levelized Delivery Cost. Results and findings are discussed in the table and section below.

Table 23: RNC Cost Effectiveness Results

		2014	2015
PAC	Benefit	$2,321,055	$6,461,767
	Cost	$2,819,540	$3,434,451
	Net Benefit	($498,485)	$3,027,316
	Net Benefit Ratio	0.82	1.88
TRC	Benefit	$2,321,055	$7,431,032
	Cost	$3,402,089	$5,911,717
	Net Benefit	($1,081,034)	$1,519,315
	Net Benefit Ratio	0.68	1.26
Levelized Delivery Cost	$/MWh	$113.46	$42.12
	$/MW	$617,904	$233,897

The RNC program passed both the PAC and TRC cost effectiveness tests. RNC cost effectiveness was able to benefit from a substantial increase in participation for the 2015 program year. With the increase in participation, more money was spent on incentive costs. For 2015, incentive cost was the majority

portion of program cost at 63% of the total. This is a vital characteristic for successful PAC results of a program since more of the cost associated with the program is going directly to potentially beneficial projects.

3.2.7 Key Findings and Recommendations

Below are the key findings and recommendations resulting from the 2015 RNC impact evaluation.

3.2.7.1 Data Reporting & Tracking Requirements:

- **Capture key data points required for savings calculations.**

  Some key data points that are useful for savings calculations are not being captured by the program. Most of these are related to product specifications, while a few others are related to general characteristics of the home such as control setpoint and cooling/heating types of the homes. Specifically, it would be useful to gather the following key data points:

  - Lamp counts tied to indoor lighting timers, outdoor lighting timers, dimmer switches, outdoor motion sensors, and indoor motion sensors;
  - Program settings for lighting controls;
  - Lumens and wattages for all installed lighting;
  - Cooling capacity, Seasonal Energy Efficiency Ratings (SEER), and full-load cooling hours for all HVAC measures; and
  - Cooling and heating-types of the residences.

  In capturing key data points,it is recommended that a consistent methodology across the province be developed. This may be either a centralized database or a list of requirements for each LDC's own database.

- **Assign unique identifiers to each project.**

  For many project sites, subdivision names or street names are given, with no unique identifier provided. Unique project IDs can go a long way in helping the evaluation team track documentation and identify duplicates.

- **Provide detailed modelling inputs and design parameters for performance track projects.**

  Project documents submitted to the program lack details on modelling inputs and design parameters for performance track projects which are useful to fully understand the savings from projects. More specifically, for project sites that participated in both performance and prescriptive tracks, more detailed modelling inputs/design parameters for EnerGuide and ENERGY STAR should be provided to enable the evaluation team to discern between savings attributable to either performance track or prescriptive track.

Appendix A: Glossary

Census Metropolitan Area (CMA): An area of one or more neighbouring municipalities situated around a core. A CMA must have a total population of at least 100,000, of which 50,000 or more live in a core.

Energy Efficiency: The use of less energy to provide the same or an improved level of service to the energy consumer in an economically efficient way. "Energy conservation" is a term that has also been used, but it has the connotation of doing without in order to save energy rather than using less energy to perform the same or better function.

Evaluation, measurement, and verification (EM&V): The process of determining and documenting the results, benefits, and lessons learned from an energy efficiency program. The term "evaluation" refers to any real time and/or retrospective assessment of the performance and implementation of a program. "Measurement and verification" is a subset of evaluation that includes activities undertaken in the calculation of energy and demand savings from individual sites or projects.

Housing starts: An economic indicator that reflects the number of privately owned new houses (technically *housing units*) on which construction has been started in a given period.

Free rider: A program participant who would have implemented the program measure or practice in the absence of the program.

Impact evaluation: Used to determine the actual savings achieved by different programs and specific measures.

Incremental cost: The cost of the energy efficiency device in excess of what the customer would have otherwise chosen and paid in absence of the energy efficiency program.

Measure: Installation of equipment, installation of subsystems or systems, or modification of equipment, subsystems, systems, or operations on the customer side of the meter, in order to improve energy efficiency.

Net-to-gross ratio: A key requirement for program-level evaluation, measurement, and verification. This ratio accounts for only those energy efficiency gains that are attributed to, and the direct result of, the energy efficiency program in question. It gives evaluators an estimate of savings that would have occurred even without program incentives.

Participant: In the HPNC program, a participant is a building or facility owner or manager that receives an incentive for energy efficient measures in a new construction project. In the RNC program, a participant is a home builder that receives an incentive for energy efficient measures in a new construction project.

Portfolio: Either (a) a collection of similar programs addressing the same market, technology, or mechanisms or (b) the set of all programs conducted by one organization.

Process Evaluation: This form of evaluation assesses the extent to which a program is operating as it was intended. It typically assesses program activities' conformance to statutory and regulatory requirements, program design, and professional standards or customer expectations.

Project: A project is any one energy efficiency new construction plan that involves one application to the IESO for an incentive.

Program: Any activity, project, function, or policy that has an identifiable purpose or set of objectives.

Program Administrators: Typically procure various types of energy efficiency services from contractors (e.g., consultants, vendors, engineering firms, architects, academic institutions, community-based organizations), as part of managing, implementing, and evaluation their portfolio of energy efficiency programs. Program administrators in many states are the utilities; in some states they are state energy agencies or third parties.

Spillover: The "spillover" effect is any increase in savings that occurs as an indirect result of the program.

Sources:

"Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers." EPA. November 2008. http://www.epa.gov/cleanenergy/documents/suca/cost-effectiveness.pdf

Glossary at "Impact Evaluations" website for the EPA. http://www.epa.gov/evaluate/impact-eval/index.htm

Appendix B: Updated Prescriptive Assumptions

Track	Measure	Assumption Description	Existing Value	Updated Value	Notes	References
RNC	All Off Switch	kWh savings per switch	53 kWh	227.3 kWh	IESO/LDCs applied deemed savings for power bars to the All Off Switches measures. All Off Switches are different than power bars. All Off Switches are a master control switch that turn off the power to various designated end uses. One switch will turn everything off in the house. Power bars, as defined by the 2008 Measure Substantiation Sheet, are a power strip that has a timer. According to the information provided by Green Switch, All Off Switches provide savings for AC, lighting, electric heating, and home electronics. However, according to plans submitted for the rebate, the All Off Switches are only connected to lighting, electronics, and ventilation fans. Frontier recalculated the savings to not include AC or electric heating savings	
RNC	ENERGY STAR Qualified LED	Daily operating hours	Not specified	3.0 hours		
RNC	ENERGY STAR Qualified LED	kWh savings per lamp	32 kWh	33.9 kWh	It was assumed that the average measure installation was a lamp rated between 750-1049 lumens, equivalent to a 60 watt incandescent light bulb. Please reference comments in the measure substantiation sheet for ENERGY STAR Omni Directional LEDs.	
RNC	ENERGY STAR Qualified Light Fixture 1 or 2 Sockets and 3 or More Sockets	Daily operating hours	Not specified	3.0 hours		

Track	Measure	Assumption Description	Existing Value	Updated Value	Notes	References
RNC	ENERGY STAR Qualified Light Fixture 1 or 2 Sockets and 3 or More Sockets	kWh savings per measure	125 (1-2 sockets) 251 (3 sockets)	1 or 2 Sockets: 50.85 kWh savings 3 or more sockets: 118.65 kWh savings	It was assumed that each socket contained a bulb emitting approximately 750-1049 lumens. If replaced by an LED, that product would save approximately 33.9 kWh per socket. For 1 or 2 socket fixtures, the sockets were assumed to be fitted with 1.5 bulbs, and received 50.85 kWh in savings. For 3 or more sockets, the sockets were assumed to be fitted with 3.5 bulbs, and received 118.65 kWh savings.	
RNC	ENERGY STAR Qualified Recessed Lighting	Daily operating hours	Not specified	3.0 hours		
RNC	ENERGY STAR Qualified Recessed Lighting	kWh savings per measure	32 kWh	41.6 kWh savings	Please reference comments in the measure substantiation sheet for ENERGY STAR Directional LEDs for details.	
RNC	Indoor Lighting Timer	kWh savings	219	64.39 kWh per lamp		Measure Substantiation Sheet - Lighting Timers. Indoor Lighting Timer. October 1, 2010.
RNC	Indoor Motion Sensor	kWh savings per lamp	64 kWh	42.04		Measure Substantiation Sheet - Motion Sensors. Hard Wired Indoor Motion Sensor. October 1, 2010.
RNC	Outdoor Lighting Timer	kWh savings per lamp	68	20.21		Measure Substantiation

Track	Measure	Assumption Description	Existing Value	Updated Value	Notes	References
						Sheet – Lighting Timers. Outdoor Lighting Timer. October 1, 2010.
HPNC	Pin Socket CFLs/GU-24 Lamps	Baselines			Savings specified for this measure in HPNC Prescriptive Input Assumptions Version 1.0 were later removed in Version 2.0 of the prescriptive assumptions because CFLs were determined to be the accepted best practice. The evaluation team agrees that CFLs should be the assumed baseline for this measure, so no savings were claimed for this measure. This is consistent with the evaluation for the PY 2011-2012 programs.	
HPNC	All Off Switch	kWh Savings	All Off Switch deemed savings were based on the Power Bar with Integrated Timer[9] measure	227.3 kWh	The manufacturer's savings estimates proved to be reasonable and these were adjusted to reflect a switch connected only to lighting and home electronics. With this information, it was estimated that it was appropriate for the measure to claim 227.3 kWh savings per All Off Switch.	
HPNC	Agribusiness: Recirculation Ventilation High-Volume Low-Speed (HVLS) Fan	Installed CFM	165 CFM	264 CFM		
HPNC	Agribusiness: Recirculation Ventilation HVLS Fan	Load factor	None	60%		

[9] Revised October 15, 2009. OPA MAL.

Track	Measure	Assumption Description	Existing Value	Updated Value	Notes	References
HPNC	Air Cooled Unitary AC Equipment	Annual operating hours (if Retail)	1,000 hours	800 hours		
HPNC	Air Cooled Unitary AC Equipment	Baseline Efficiencies	Ref. 2011 MAL	Ref. Recommendations		
HPNC	Air Cooled Unitary AC Equipment	CEE Tier 1 and CEE Tier 2 Efficiencies	Ref. 2011 MAL	Ref. Recommendations		
HPNC	ENERGY STAR Clothes Washers	Capacity	45 liters	88 liters	The capacity for clothes washers was updated to 88 litres, up from 45 litres, based on the 2014 ENERGY STAR calculator's default assumption.	ENERGY STAR appliance calculator – updated May 2014
HPNC	ENERGY STAR Clothes Washers	Cycles per year	392 cycles	312 cycles	Additionally, the number of cycles per year was reduced from 392 to 312 based on the same calculator.	
HPNC	ENERGY STAR Clothes Washers	kWh savings per clothes washer	182.68 kWh	284.42 kWh	Demand Savings were calculated by multiplying the energy savings against the total peak load percentage divided by total peak hours as defined in the IESO EM&V Protocols and Requirements. Total peak load percentages were extracted from IESO load profiles for the hours of 2-7 PM, excluding weekends.	
HPNC	ENERGY STAR Dishwashers	EUL	13 years	15 years	The Estimated Useful Life (EUL) was updated from 13 to 15 years based on the DOE 77 Final Rule 31918 Technical Support Document for refrigerators.	ENERGY STAR appliance calculator – updated May 2014

Track	Measure	Assumption Description	Existing Value	Updated Value	Notes	References
HPNC	ENERGY STAR Refrigerators	EUL	18 years	17 years	Demand Savings were calculated by multiplying the energy savings against the total peak load percentage divided by total peak hours as defined in the IESO EM&V Protocols and Requirements. Total peak load percentages were extracted from IESO load profiles for the hours of 2-7 PM, excluding weekends.	ENERGY STAR appliance calculator – updated May 2014
HPNC	ENERGY STAR Refrigerators	kWh savings per refrigerator	112.8 kWh	118.4 kWh	The EUL was updated from 18 to 17 years based on the DOE 76 Final Rule 57516 Technical Support Document for refrigerators.	
HPNC	Lighting (All	Demand Savings			Demand savings calculated using IESO load profiles were deemed too low, resulting in realization rates of less than 30% compared to prescriptive assumptions. Instead, the evaluation team divided energy savings by measure-specific run hours and multiplied against a 0.77 coincidence factor, as specified for a 4 hour summer peak period (1-5 PM) for office buildings in the 2007 coincidence factor study final report prepared for the New England State Program Working Group (SPWG) by RLW Analytics. This is reasonably consistent with IESO's summer peak period of 2-7 PM during the months of June-August and allows for a more reasonable magnitude of lighting demand savings compared to the savings that result from using the lighting load profile provided by IESO.	
HPNC	Lighting (Excluding High Bay Applications)	Annual operating hours	2,594 hours	2,545 hours	The Estimated Useful Life (EUL) for each lighting measure was updated as specified: • Integrated-Ballast LED Lamps (Commercial): 12 year EUL – 30,000 hour rated life ÷ 2,545 hours o Excluding LED lamps for recessed	
HPNC	Lighting: High Performance Medium Bay T8	EUL	5 years	10 years		

Track	Measure	Assumption Description	Existing Value	Updated Value	Notes	References
	Fixtures				lighting • Linear Fluorescent Measures: 15 year EUL – DEER 2014 o o Excluding high bay applications • Linear Fluorescent Measures (High Bay): 10 year EUL – 50,000 hour rated life ÷ 4,792 hours • Non Integrated-Ballast LED Fixture: 20 year EUL – 50,000 hour rated life ÷ 2,545 hours • Recessed LED Lamps: 14 years – 35,000 hour rated life ÷ 2,545 hours • Occupancy Sensors: 8 year EUL – DEER 2014 Note: The 2011 Quasi-Prescriptive MAL assumes 2,594 annual run hours for the office building type, as referenced in DEER 2008. This evaluation uses the updated value of 2,545 annual run hours for the office building type, as referenced in DEER 2011.	
HPNC	Lighting: LED Recessed Downlights	EUL	16 years	14 years		
HPNC	Lighting: Reduced Wattage T8 Fixtures	EUL	9 years	15 years		
HPNC	Lighting: T5 Fixtures	EUL	8 years	15 years		
HPNC	Lighting: T5 Medium and High Bay Fixtures	EUL	4 years	10 years		
HPNC	Lighting Occupancy Sensors	Annual Operating Hours	2,594 hours	2,545 hours		
HPNC	Lighting Occupancy Sensors	EUL	10 years	8 years		

Track	Measure	Assumption Description	Existing Value	Updated Value	Notes	References
HPNC	Recirculation Ventilation HVLS Fans	Savings			Savings were calculated as specified in the 2011 Quasi-Prescriptive Measures and Assumptions List (MAL) Version 1.0 and HPNC Prescriptive Input Assumptions Version 2.0, however the evaluation team accepted adjustments specified in the Nexant evaluation of 2011 business incentive programs from September 2012. Primary adjustments include the reduction of baseline CFM assumption from 500 to 140 CFM and the application of a 60% load factor to the efficiency case. Additionally, installed CFM has been updated from 165 CFM to a weighted average value of 264 CFM based on the evaluation team's review of fan models reported for the 2013 program.	
HPNC	Recirculation Ventilation HVLS Fans	Demand Savings			Demand Savings were calculated by multiplying energy savings by total peak load percentage divided by total peak hours as defined in the IESO EM&V Protocols and Requirements. Total peak load percentages were extracted from IESO load profiles for the hours of 2-7 PM, excluding weekends.	
HPNC	Unitary AC Equipment	Energy and Demand Savings			Savings were calculated as specified in the 2015 Measures and Assumptions List and HPNC Prescriptive Input Assumptions Version 2.0 with a few discrepancies. EFLHs were determined by building type (if specified) rather than using the assumed value of 1,000 EFLH specified for the office building type. Baseline efficiencies were updated to reflect ASHRAE 90.1-2010. Additionally, CEE Tier 1 and Tier 2 efficiency standards were updated to reflect current CEE requirements. Demand Savings were calculated by multiplying the energy savings against the total peak load percentage divided by total	

Track	Measure	Assumption Description	Existing Value	Updated Value	Notes	References
					peak hours as defined in the IESO EM&V Protocols and Requirements. Total peak load percentages were extracted from IESO load profiles for the hours of 2-7 PM, excluding weekends.	
HPNC	Variable Frequency Drives	Energy and Demand Savings			Savings were calculated as specified in the 2015 Measures and Assumptions List and HPNC Prescriptive Input Assumptions Version 2.0. Energy savings were calculated considering the individual annual run hours specified for each measure. In some cases, the hours were not provided. In those cases, the deemed annual run hours assumption from the MAL was used. Based on documentation, the VFDs ran at a 66% load factor. Savings were calculated by multiplying the annual run hours by the difference in wattages between the base measure and the conservation measure, as shown in the following equation. Energy Savings=Annual Run Hours*(75%*Base Measure-66%*Conservation Measure) Demand Savings were calculated by multiplying the energy savings against the total peak load percentage divided by total peak hours as defined in the IESO EM&V Protocols and Requirements. Total peak load percentages were extracted from IESO load profiles for the hours of 2-7 PM, excluding weekends.	

Appendix C: Suggested Adjustments to Measures

A review of the available documents indicated that the most of the calculation methodologies and assumptions listed in the 2011 Quasi-Prescriptive Measures and Assumptions List (MAL) Version 1.0 were reasonable. Where applicable, the evaluation team made adjustments to baselines change cases, and assumptions to improve the accuracy of prescribed savings estimations. This document serves as an overview of all recommended changes. The majority of these changes have also been included in the redlined Measure Substantiation Sheets and Appendix B: Updated Prescriptive Assumptions. However, this section provides a measure-by-measure analysis of suggested changes.

1. HPNC Measures:
    a. Agribusiness Measures – HVLS Fans:
        i. Savings were calculated as specified in the 2011 Quasi-Prescriptive Measures and Assumptions List (MAL) Version 1.0 and HPNC Prescriptive Input Assumptions Version 2.0, however the evaluation team accepted adjustments specified in the Nexant evaluation of 2011 business incentive programs from September 2012. Primary adjustments include the reduction of baseline CFM assumption from 500 to 140 CFM and the application of a 60% load factor to the efficiency case. Additionally, installed CFM has been updated from 165 CFM to a weighted average value of 264 CFM based on the evaluation team's review of fan models reported as part of the 2013 program.
    b. Electric Auxiliary Measures:
        i. Premium Efficiency Motors:
            1. Update efficiency table in measure substantiation sheet to include complete set of horsepower levels (e.g. 4, 5, and 175 hp).
            2. Clarify source of operating hour assumptions. Additionally, specify that heating hours are 2/3 of fan hours and cooling hours are 1/3 of fan hours.
            3. Loading assumption is an oversimplification, but it is reasonable. An example loading distribution from Bonneville Power Administration calculator (available for download on DOE website) creates a deemed low and high loading assumption: Low loading assumption establishes 30% load 15% of the time, 50% load 55% of the time, 70% loading 25% of the time, and 90% loading 5% of the time. High loading assumption establishes 50% loading 20% of the time, 70% loading 60% of the time, and 90% loading 20% of the time. These assumptions result in average loading of 54% for low loading applications and 70% for high loading

applications. IESO may want to consider adding a high and low loading recommendation for this measure.

ii. Synchronous Belts:
    1. Consider including horsepower levels up to 200 hp to align with premium efficiency motors measure.
    2. Consider updating baseline efficiency to 92.5%. A DOE reference sheet claims that V-belt drives operate at a peak efficiency of 95% at the time of installation. Efficiency can deteriorate by as much as 5% over time if slippage occurs because the belt is not periodically re-tensioned. A 92.5% efficiency is derived by averaging these two values.
    3. Consider updating synchronous belt efficiency to 98%. A DOE reference sheet claims that synchronous belts operate with a consistent efficiency of 98% and maintain their efficiency over a wide load range. https://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/replace_vbelts_motor_systemts5.pdf.
    4. Consider using the same 75% load factor for the base and conservation cases and instead calculating the energy savings based solely on the efficiency increase.
    5. Align operating hour assumption with premium efficiency motors measure or specify an applicable reference.

iii. Variable Frequency Drives:
    1. Consider including horsepower levels up to 200 hp to align with premium efficiency motors measure.
    2. The premium efficiency motors measure includes a note that specifies that “motors with variable speed drives operate on average at approximately 50% load,” while the VFD measure substantiation sheet specifies a 66% load factor. Either the measure should be updated to align with the premium efficiency motor measure, or an appropriate source should be listed for this value.
    3. Consider using a more detailed loading distribution. An example loading distribution from the Bonneville Power Administration calculator (available for download on DOE website) creates a deemed low and high loading assumption: Low loading assumption establishes 30% load 15% of the time, 50% load 55% of the time, 70% loading 25% of the time, and 90% loading 5% of the time. High loading assumption establishes 50% loading 20% of the time, 70% loading 60% of the time, and 90% loading 20% of the time. These assumptions result in average loading of 54% for low loading applications and 70% for high loading applications. IESO may want to consider adding a high and low loading recommendation for this measure.

4. Consider updating the EUL from 10 years to 15 years. DEER 2014 specifies a 15 year EUL for VFD applications.

c. ENERGY STAR Appliance Measures:
   i. Utilize updated assumptions and savings for ENERGY STAR Ceiling Fans, Clothes Washers, Dishwashers, and Refrigerators from the latest May 2014 version of the ENERGY STAR appliance calculator. Reference redlined measure substantiation sheets. The U.S. Department of Energy has raised the minimum efficiency for clothes washers, dishwashers, and refrigerators. The existing measure substantiation sheet is based on ENERGY STAR efficiency standards, and ENERGY STAR has updated or will update their standards to align with the DOE update.
   ii. The existing measure substantiation sheet specifies a 14 year EUL for clothes washers. While the evaluation team agrees with the EUL, consider adding the following reference to the measures substantiation sheet: DOE 77 Final Rule 59719 Technical Support Document, April 2012. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/39.
   iii. The existing measure substantiation sheet specifies a 13 year EUL for dishwashers. Consider updating to 15 years based on the DOE 77 Final Rule 31918 Technical Support Document, May 2012. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/67.
   iv. The existing measure substantiation sheet specifies an 18 year EUL for refrigerators. Consider updating to 17 years based on the DOE 76 Final Rule 57516 Technical Support Document, September 2011. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/43.

d. Lighting Measures:
   i. Because this is a prescriptive measure, the 2014 MAL assumes 2,594 run hours (from DEER 2008), corresponding to the Office building type. While it may not be possible to utilize project-specific run hours, IESO should develop a second set of deemed values using run hours specified for the Retail building type. Most lighting projects reviewed as part of this evaluation fell into one of these two building type categories.
   ii. Run hour assumptions for the Office building type from DEER 2008 have been updated to 2,545 in DEER 2011. IESO should adopt the updated value and should reference DEER 2011 if any building types are added to this prescriptive measure.

iii. Do not claim savings for CFL measures in the HPNC program. IESO removed this measure from Version 2 of the prescriptive assumptions, which is used for projects applying for permits on or after January 1, 2012.

iv. The Estimated Useful Life (EUL) values for each lighting measure were updated as specified:

1. Induction Lamps: 20 year EUL – 100,000 hour rated life ÷ 4,792 hours (capped at 20 years)
2. Integrated-Ballast LED Lamps (Commercial): 12 year EUL – 30,000 hour rated life ÷ 2,545 hours (excluding recessed LED lamps)
3. Linear Fluorescent Measures: 15 year EUL, excluding high bay applications (Source: DEER 2014)
4. Linear Fluorescent Measures (High Bay): 10 year EUL – 50,000 hour rated life ÷ 4,792 hours
5. Non Integrated-Ballast LED Fixture: 20 year EUL – 50,000 hour rated life ÷ 2,545 hours
6. Recessed LED Lamps: 14 years – 35,000 hour rated life ÷ 2,545 hours

e. Lighting Controls:

i. Consider updating EUL from 10 years to 8 years. The current measure substantiation sheet references that DEER 2008 (now DEER 2014) specifies an 8 year measure life for lighting controls. This is consistent with what the evaluation team has seen in other jurisdictions.

ii. Run hour assumptions for the Office building type from DEER 2008 have been updated to 2,545 in DEER 2011. IESO should adopt the updated value and should reference DEER 2011 if any building types are added to this prescriptive measure.

f. Unitary AC Measures:

i. Because this is a prescriptive measure, the 2014 MAL assumes 1,000 run hours, corresponding to the Office building type. While it may not be possible to utilize project-specific run hours, IESO should develop a second set of deemed values using 800 run hours, corresponding to the Retail building type. Most unitary AC projects reviewed as part of this evaluation fell into one of these two building type categories.

ii. Update baseline efficiency values to align with ASHRAE 90.1-2010, as required by the Canadian Office of Energy Efficiency (OEE).

iii. The U.S. Department of Energy has raised the minimum efficiency for systems less than 65,000 Btu/hr to 14 SEER, effective January 1, 2015. The existing measure substantiation sheet is based on ENERGY STAR and CEE efficiency standards, which will likely update their standards to align with the DOE update. IESO should consider raising the baseline efficiency for systems less than 65,000 Btu/hr to 14 SEER.

iv. Update CEE Tier 1 and Tier 2 efficiency values to align with updated requirements.
v. Calculate energy savings for systems less than 65,000 Btu/hr (5.4 tons) using SEER rather than EER efficiency values. SEER is more representative of the system efficiency over the entire cooling season. If this recommendation is adopted, EER should continue to be used for demand savings, as EER is more representative of the system efficiency during peak conditions.
vi. Consider incorporating heating energy savings into the measure if Heat Pumps are expected to make up a statistically significant sample of future project submittals.

Table 24: Updated Baseline, CEE Tier 1, and CEE Tier 2 Efficiency Values

Equipment Type	Capacity Category (Tons)	Capacity Category (Btu/hr)	Heat Type	Baseline Eff	CEE Tier 1 Eff	CEE Tier 2 Eff
Air Cooled	< 5.4 split	< 65000 split	ER	13 SEER 11.2 EER	14 SEER 11.8 EER	15 SEER 12.3 EER
	< 5.4 split	< 65000 split	All Other	13 SEER 11.2 EER	14 SEER 11.8 EER	15 SEER 12.3 EER
	< 5.4 packaged	< 65000 packaged	ER	13 SEER 11.2 EER	14 SEER 11.8 EER	15 SEER 12.3 EER
	< 5.4 packaged	< 65000 packaged	All Other	13 SEER 11.2 EER	14 SEER 11.8 EER	15 SEER 12.3 EER
	> 5.4-11.25	> 65000-135000	ER	11.2 EER	11.7 EER	12.2 EER
	> 5.4-11.25	> 65000-135000	All Other	11 EER	11.5 EER	12 EER
	> 11.25-20	> 135000-240000	ER	11 EER	11.7 EER	12.2 EER
	> 11.25-20	> 135000-240000	All Other	10.8 EER	11.5 EER	12 EER
	> 20-63.3	> 240000-760000	ER	10 EER	10.5 EER	10.8 EER
	> 20-63.3	> 240000-760000	All Other	9.8 EER	10.3 EER	10.6 EER
	> 63.3	> 760000	ER	9.7 EER	9.9 EER	10.4 EER
	> 63.3	> 760000	All Other	9.5 EER	9.7 EER	10.2 EER
Water Cooled	< 5.4	< 65000	ER	12.1 EER	14 EER	
	< 5.4	< 65000	All Other	12.1 EER	14 EER	
	> 5.4-11.25	> 65000-135000	ER	11.5 EER	14 EER	
	> 5.4-11.25	> 65000-135000	All Other	11.3 EER	13.8 EER	
	> 11.25-20	> 135000-240000	ER	11 EER	14 EER	
	> 11.25-20	> 135000-240000	All Other	10.8 EER	13.8 EER	
	> 20	> 240000	ER	11.5 EER	14 EER	
	> 20	> 240000	All Other	11.3 EER	13.8 EER	

2. RNC Measures:
    a. Central Air Conditioner – SEER 15:
        i. Develop additional savings tiers for higher efficiencies.
        ii. Heat pumps are currently included in the existing measure substantiation sheet for this measure. However, no heating savings are specified. Consider incorporating heating energy savings into the measure if Heat Pumps are expected to make up a statistically significant sample of future project submittals.
        iii. The U.S. Department of Energy has raised the minimum efficiency for this measure to 14 SEER, effective January 1, 2015. The existing measure substantiation sheet is based on ENERGY STAR efficiency standards, and ENERGY STAR will likely update their standards to align with the DOE update. IESO should consider raising the baseline efficiency to 14 SEER.
        iv. Consider increasing EUL from 18 years to 19 years for air conditioners. If heating savings for heat pumps are incorporated into the measure, EUL should be 16 years for heat pumps. The U.S. Department of Energy Technical Support Document (DOE TSD) for this measure recommends a 19 year measure life for air conditioners and 16 year measure life for heat pumps. The DOE TSD is a more recent and more comprehensive analysis of product measure life, and DOE has not updated their measure life since DEER 2008. IESO may choose to continue to use DEER 2008, but should update source to DEER 2014.
    b. Electric/Gas Furnace with ECM:
        i. In the 2014 Prescriptive Measures and Assumptions List (MAL), deemed Gas Furnace with ECM savings are presented for continuous and non-continuous fan usage. Savings are also specified for space heating only or for space heating and cooling. IESO provided weighted energy and demand savings that were derived using 2011 retrofit participation values. These weighted averages were accepted as part of the current program evaluation. However, due to the small sample size of projects in the Residential New Construction program, these weighted average savings will not be applicable in future evaluations. Instead, LDCs should collect information specifying continuous/non-continuous fan usage and space heating/space heating and cooling for each project.
    c. Lighting:
        i. Consider reorganizing existing measures into the following:
            1. Standard CFLs
            2. Omni-Directional LEDs
            3. Directional LEDs
        ii. Existing incandescent/halogen lamp baseline wattages (40, 60, 75, and 100 W) should be updated to align with current Canadian energy efficiency regulations for general service lamps as specified at

http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869. The 75 and 100 W baseline wattages have already been reduced. 40 and 60 W baseline wattages are scheduled to be reduced in 2015.

iii. Consider allowing integrated-ballast CFLs if installed with a "permanent installation disk" to prevent use of incandescent bulbs.

iv. Consider updating average equivalent CFL and LED lamp wattages and annual run hours to align with those specified in the current ENERGY STAR savings calculator available at http://www.energystar.gov/certified-products/detail/light_bulbs.

v. The 2014 Prescriptive Measures and Assumptions List (MAL) specifies a 16 year EUL for CFL lamps, which matches DEER 2014 for indoor residential CFL fixtures. However, the appropriate EUL for a CFL lamp with an 8,000 hour rated life from DEER 2014 is 7.73 (or 8) years.

vi. The 2014 Prescriptive Measures and Assumptions List (MAL) specifies a 20 year EUL for LED lamps. While the evaluation team agrees with the EUL, consider adding the following reference to the applicable measure substantiation sheets: Emerging Technologies Research Report prepared for the Regional Evaluation, Measurement, and Verification Forum facilitated by the Northeast Energy Efficiency Partnerships, February 13, 2013.

d. Lighting Controls:

i. Consider updating EUL from 10 years to 8 years. The current measure substantiation sheet references that DEER 2008 (now DEER 2014) specifies an 8 year measure life for lighting controls. This is consistent with what the evaluation team has seen in other jurisdictions.

Appendix D: Inspection Checklists

HPNC Prescriptive

The following checklist includes the project data the inspector verified during the site visits.

In-Suite Temperature Controls:

- Thermostat count
- Occupancy sensor count
- Space heating and cooling types

Lighting & Occupancy Sensors:

- Building/space type
- Heating/cooling type
- Posted building hours of operation
- Lamp and/or fixture type
- Lamp and/or fixture count
- Lamp and/or fixture wattage
- Lighting control type
- Lighting control location
- Controlled fixture type/count

Multi-Residential In-Suite Appliances:

- Appliance type
- Appliance count
- Appliance model number
- Water heating fuel type (if applicable)
- Dryer fuel type (if applicable)
- Refrigerator/freezer configuration (if applicable)
- Ceiling fan lamp wattage (if applicable)

Recirculation Ventilation High-Volume Low-Speed (HVLS) Fans:

- Fan location
- Fan count
- Fan cubic feet per minute (CFM)
- Fan model number
- Fan operating schedule (if available) or control

Unitary Air Conditioning (AC) Equipment:

- Building type
- Posted building hours of operation
- Heating type
- Air conditioning equipment type
- Air conditioning equipment count
- Air conditioning equipment model number(s)

Variable Frequency Drives (VFDs):

- Application type (e.g. agriculture, irrigation, HVAC, etc.)
- Building type (if applicable)
- VFD count
- Installed on pump or fan?
- Motor horsepower (HP)
- VFD model number

HPNC Custom

Frontier prepared itemized inspection reports for the custom track projects from data obtained from the HPNC Incremental Cost Estimation and/or the Simulation Summary Report, depending on what was provided by the builders.

The following checklist includes some of the project data that the inspector verified during the site visit:

Lighting & Occupancy Sensors:

- Lighting control type

Multi-Residential In-Suite Appliances:

- Refrigerator/freezer configuration (if applicable)

Envelope Measures:

- Window glazing

HVAC Equipment:

- Posted building hours of operation
- Boilers/Pumps
- Energy Recovery Ventilation
- Heat Recovery Wheel

Variable Frequency/Speed Drives (VFD/VSD):

- Installation on pump, fan or chiller
- Building type (if applicable)
- VFD model number

Energy Recovery Ventilator (ERV):

- Location
- Supply Area

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