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# 2020 EVALUATION REPORT

DELAWARE DEPARTMENT OF NATURAL RESOURCES AND  
ENVIRONMENTAL CONTROL

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## ABBREVIATIONS

AC	Alternating Current
AHRI	Air-Conditioning, Heating, and Refrigeration
ASU	Air Separation Unit
BPI	Building Performance Institute
C&I	Commercial & Industrial
CAA	Community Action Agency
CDD	Cooling Degree Day
CFL	Compact Fluorescent Light
CO <sub>2</sub>	Carbon Dioxide
CY	Calendar Year
DC	Direct Current
DE SEU	Delaware Sustainable Energy Utility
DNREC	Delaware Department of Natural Resources and Environmental Control
DOE	U.S. Department of Energy
DPL	Delmarva Power & Light
DRIFE	Demand-Reduction-Induced Price Effect
DSSC	Division of State Services Center
E2I	Energy Efficiency Industrial
EEAC	Energy Efficiency Advisory Council
EEIF	Energy Efficiency Investment Fund
EER	Energy Efficiency Ratio
EM&V	Evaluation, Measurement, and Verification
EPA	Environmental Protection Agency
EUL	Expected Useful Life
FY	Fiscal Year
GEP	Green Energy Program
GHG	Greenhouse Gas
GWP	Global Warming Potential
HDD	Heating Degree Day
HFCs	Hydrofluorocarbons
HID	High-Intensity Discharge
HOU	Hours of Use
HVAC	Heating, Ventilation, and Air-Conditioning
IDI	In-depth Interview
kWh	Kilo-Watt hours
Lbs.	Pounds
LED	Light Emitting Diode

LIHEAP	Low Income Energy Assistance Program
MMBtu	Million British Thermal Units
MW	Mega-Watts
MWh	Mega-Watt hours
NAC	Normalized Energy Consumption
NEB	Non-energy benefit
NO <sub>x</sub>	Nitrogen Oxides
NPV	Net Present Value
NTG	Net-to-Gross
NWS	National Weather Service
O&M	Operations & Maintenance
PUC	Public Utility Commission
PV	Photovoltaic
RR	Realization Rate
SREC	Solar Renewable Energy Credit
SO <sub>2</sub>	Sulfur Dioxide
TMY	Typical Meteorological Year
TRC	Total Resource Cost
TRACE	Trane Air Conditioning Economics
TRM	Technical Reference Manual
WAP	Weatherization Assistance Program

# EXECUTIVE SUMMARY

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The Delaware Department of Natural Resources and Environmental Control (DNREC) retained EcoMetric Consulting, LLC and NMR Group, Inc. (EcoMetric or EcoMetric team) to evaluate two energy efficiency programs and one renewable program offering for calendar year (CY) 2020. DNREC's programs provide grants for equipment upgrades, engineering studies, and renewable technologies to commercial and industrial customers in Delaware. DNREC also provides weatherization services to income-eligible residential customers through the Weatherization Assistance Program. This report contains gross and net energy savings, peak demand savings, greenhouse gas (GHG) emission impacts, cost-effectiveness results, process evaluation findings, and recommendations for improvement for three DNREC programs.

Energy Efficiency Investment Fund (EEIF) – EEIF provides financial incentives to businesses, state agencies, local governments, and non-profits to make energy efficiency upgrades in existing facilities in Delaware. The incentives are designed to defray some of the cost difference for upgrading existing conventional equipment (i.e., baseline equipment) to high-efficiency solutions. Organizations apply to EEIF for either prescriptive or custom grants. The majority of the projects completed through EEIF were for prescriptive lighting in CY2020.

Green Energy Program (GEP) – GEP provides funding to promote the use of renewable energy to commercial, non-profit, and residential Delmarva Power and Lighting (DPL) customers in Delaware. The program offers incentives for a variety of renewable technologies such as solar photovoltaic, solar hot water, wind, and geothermal systems.

Weatherization Assistance Program (WAP) – WAP is overseen by the U.S. Department of Energy (DOE). WAP provides income-eligible residential customers with free energy efficiency retrofits to reduce their energy costs and improve their health and the safety of their homes. DNREC contracts with local agencies, referred to as “subgrantees,” to administer WAP and deliver weatherization services to Delaware residents with household incomes that fall below 200% of the federal poverty line. Subgrantees are responsible for hiring, managing, and paying home energy auditors and third-party subcontractors who carry out the weatherization work recommended based on the audit results. Upon completion of the work, all homes receive a final inspection conducted by a certified Quality Control Inspector. Also, a sample of all serviced households is inspected by the State Program Monitor, who serves as the state's weatherization technical expert.

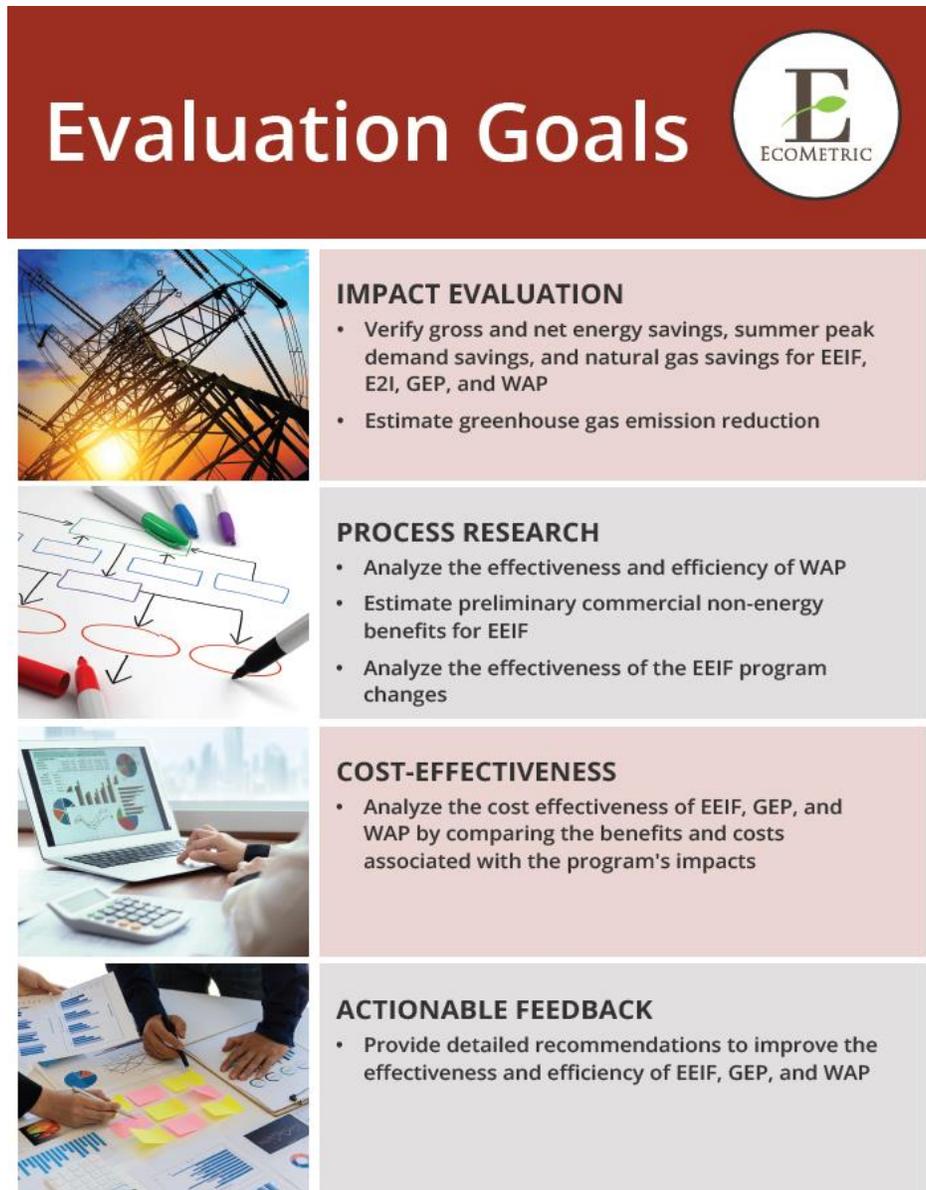
Energy Efficiency Industrial (E2I) – E2I provides financial incentives to large industrial facilities to make energy efficiency upgrades in existing facilities in Delaware. Incentivized projects are meant to be

large and custom in nature. Incentives are paid based on estimated first year electric (kWh) and natural gas (MMBtu) savings.

## E.1 EVALUATION GOALS AND METHODOLOGY

The EcoMetric team set forth clearly defined evaluation goals at the outset of the evaluation to help DNREC improve its energy efficiency programs. The evaluation goals support DNREC’s dedication to providing Delaware’s residents with safe, efficient, and low-cost energy efficiency options, thereby improving the livability and economic well-being of the communities it serves. EcoMetric developed the goals in Figure 1 in collaboration with DNREC.

Figure 1: Evaluation Goals



The impact evaluation provided DNREC with verified savings that reflect the most up-to-date program and market conditions. EcoMetric used the verified savings to evaluate the cost-effectiveness of DNREC’s energy efficiency and renewable energy programs. The approaches that

EcoMetric used to conduct the impact evaluation include engineering analyses, virtual site visits, and billing analyses to calculate the verified energy, peak demand, and fossil fuel savings achieved through energy efficiency or renewable energy projects funded by each of DNREC's programs.

EcoMetric's overall objective for the process evaluation is to provide DNREC program staff with recommendations about improving the effectiveness and efficiency of the programs, including recommendations regarding program design, program administration, cross-program promotion and outreach, implementation, delivery, and customer engagement. The EcoMetric team designed and conducted in-depth telephone interviews with market actors such as program staff, installing contractors, and participants. The goal of the interviews was to understand the market actors' perspectives and satisfaction with the program and assess the program processes.

## E.2 EVALUATION RESULTS SUMMARY

EcoMetric evaluated 296 different projects spread across 2019 (WAP) and 2020 (E2I, EEIF, and GEP) calendar years (CY).

The verified savings and realization rates (RR) for WAP (CY2019), E2I (CY2020), EEIF (CY2020), and GEP (CY2020) are summarized in Table 1 and Table 2.

*Table 1: CY2019 - CY2020 Reported and Gross Verified Electric and Peak Demand Savings*

Program	Reported Energy Savings (MWh)	Reported Peak Demand Savings (MW)	Verified Energy Savings (MWh)	Verified Peak Demand Savings (MW)	Energy Savings RR (%)
EEIF	28,013	NR	28,134	3.89	100%
GEP	NR	NR	3,280	2.11	NA
WAP*	235	0.04	167	0.00	71%
E2I	30,322	3.79	30,322	3.79	100%
<b>Total</b>	<b>58,570</b>	<b>3.83</b>	<b>61,903</b>	<b>9.79</b>	<b>106%</b>

Note: Demand realization rates were calculated but are not shown since the verified demand is much higher than the reported demand.

Not Applicable (NA): the value is not applicable for this line item

Not Reported (NR): the program does not report this value

\* The evaluation period for WAP was the calendar year 2019

Table 2: CY2019 - CY2020 Reported and Gross Verified Fossil Fuel Savings

Program	Reported Fossil Fuel Savings (MMBtu)	Verified Fossil Fuel Savings (MMBtu)	Fossil Fuel Savings RR (%)
EEIF	12,214	-353**	-3%
WAP*	2,444	1,347	55%
E2I	19,047	18,386	97%
<b>Total</b>	<b>33,705</b>	<b>19,380</b>	<b>57%</b>

\* The evaluation period for WAP was the calendar year 2019

\*\* Negative savings are due to an increase (penalty) in natural gas consumption for a fuel-switching project with significant electric savings

EcoMetric used the Delaware Energy Efficiency Advisory Council (EEAC)<sup>1</sup> approved net-to-gross (NTG) ratios to calculate the net verified savings for EEIF, GEP, and WAP. The net verified savings for each program are shown in Table 3. EcoMetric did not calculate net verified for the E2I program.<sup>2</sup>

Table 3: CY2019 - CY2020 Net Verified Savings

Program	Net Verified Energy Savings (MWh)	Net Verified Peak Demand Savings (MW)	Net Verified Fossil Fuel Savings (MMBtu)
EEIF	21,830	3.08	-247
GEP	3,280	2.11	0
WAP*	167	0.00	1,347
<b>Total</b>	<b>25,277</b>	<b>5.20</b>	<b>1,100</b>

\* The evaluation period for WAP was the calendar year 2019

EcoMetric evaluated the cost-effectiveness of DNREC's programs using the Total Resource Cost (TRC) test. The TRC test compares the costs and benefits of energy efficiency programs to determine if the

<sup>1</sup> <http://www.dnrec.delaware.gov/energy/information/otherinfo/Documents/EEAC/Draft%20Proposed%20DE%20EE%20program%20NTG%20values%20with%20assumptions.pdf>

<sup>2</sup> During the CY2020 evaluation, only one of the nine projects were completed through the E2I program. The net verified savings will be calculated when more than 50% of the projects are completed.

benefits a program provides are higher than the program's price. The TRC test considers costs incurred by program participants and Program Administrators in addition to the benefits to the utility and ratepayers. The evaluation team used the cost and benefits defined in the Delaware EM&V regulations in the TRC test.

EcoMetric calculated the cost-effectiveness for GEP using gross verified avoided energy and demand generation values. The EEAC does not oversee GEP, so there is no approved net-to-gross (NTG) value for the program. EcoMetric calculated the cost-effectiveness for EEIF and WAP using net verified savings. The TRC test results for each program are shown in Table 4. EcoMetric did not calculate a cost-effectiveness ratio for E2I.<sup>3</sup>

*Table 4: CY2019 - CY2020 Program Cost-effectiveness Results*

Program	NPV of Program Benefits <sup>4</sup>	NPV of Program Costs <sup>5</sup>	TRC Benefit-Cost Ratio
EEIF	\$34,676,980	\$14,598,050	2.38
GEP	\$10,838,332	\$8,269,519	1.31
WAP*	\$1,301,340	\$3,084,076	0.42
<b>Total</b>	<b>\$46,816,652</b>	<b>\$25,951,644</b>	<b>1.80</b>

\* The evaluation period for WAP was calendar year 2019

### E.3 KEY FINDINGS AND RECOMMENDATIONS

The findings and recommendations below represent the key findings and recommendations from the impact and process evaluations of DNREC’s energy efficiency and renewable energy programs. The key findings and recommendations are not numbered sequentially in this section. The complete and sequentially numbered findings and recommendations are located in the respective program-specific sections in this report.

<sup>3</sup> During the CY2020 evaluation, only one of the nine projects were completed through the E2I program. The cost-effectiveness analysis for the program will be calculated when more than 50% of the projects are completed.

<sup>4</sup> These benefits include avoided cost of energy, avoided cost of capacity, avoided cost of fossil fuel, and NEBs.

<sup>5</sup> These costs include program administration costs and measure costs.

### E.3.1 EEIF KEY FINDINGS AND RECOMMENDATIONS

**Finding 2:** The ex ante electric savings calculations for the EEIF program were generally accurate. More than 81% of the sampled projects have an electric realization rate within  $\pm 10\%$  of 100%.

The percentage of projects in the evaluation sample with electric realization rates  $\pm 10\%$  of 100% increased from 57% in the CY2019 evaluation to over 81% in the CY2020 evaluation. This is a significant improvement and highlights the improved accuracy in calculating the electric energy savings for EEIF projects.

**Finding 3:** The realization rates for the electric projects in the evaluation sample ranged from 74% to 5,547%.

While 43 of the sampled projects had an electric realization rate of  $\pm 10\%$  of 100%, the other 10 electric projects' realization rates varied from 100%. A variation in project realization rates impacts the precision of the verified savings and may result in a larger required sample size to achieve precision estimates.

At the end of 2020, DNREC hired a third-party implementation contractor to help deliver the EEIF program. EcoMetric understands that the third-party implementer is expected to complete a technical review of the savings methodology and algorithm inputs for every project that goes through the program to ensure consistency and alignment with the applicable Mid-Atlantic TRM algorithms.

*Recommendation 2: Ensure there is a technical review completed by the third-party implementer for each energy efficiency project that comes through the EEIF program.*

**Finding 4:** The ex ante savings calculations for CY2020 lighting projects were not fully consistent with the savings methodology outlined in the Mid-Atlantic TRM. The ex ante energy savings did not utilize waste heat factors.

Waste heat factors account for cooling and heating impacts from efficient lighting on energy and demand based on Heating Ventilation and Air Conditioning (HVAC) and building types. The summer peak coincidence factor ensures demand savings calculations reflect the jurisdiction's summer peak period. As was the case with many prescriptive lighting projects in EEIF, not utilizing waste heat factors resulted in an underestimation of energy and demand savings for air-conditioned spaces with non-electric heating—which were common in the EEIF population and throughout Delaware.

Since being hired in late 2020, DNREC's third-party implementer developed a standardized lighting calculator that is fully consistent with the Mid-Atlantic TRM. EcoMetric understands that the standardized lighting calculator was used for projects in 2021.

*Recommendation 3: Ensure the ex ante energy and peak demand savings calculations follow the savings methodology outlined in the Mid-Atlantic TRM. The Mid-Atlantic TRM savings methodology calculates energy (kWh) savings, peak demand (kW) savings, and a heating penalty (MMBtu) when applicable for spaces heated with natural gas.*

**Finding 6:** The project documentation for nearly all prescriptive lighting projects included product specification sheets and invoices that enabled the EcoMetric team to verify the type and quantity of installed light bulbs and fixtures.

**Finding 7:** EcoMetric found discrepancies between the equipment quantities noted in the invoices and the equipment quantities used in the ex ante calculations for only two projects. Program staff clearly remain diligent in verifying the quantity of installed equipment to ensure they award grants correctly.

*Recommendation 5: Continue ensuring reported fixture quantities are in line with quantities shown on project invoices.*

**Finding 11:** One of the custom electric projects involved a major boiler plant replacement, including a fuel switch from electric to natural gas. This means a significant increase in natural gas consumption or penalty was associated with the project. DNREC did not report this penalty with ex ante savings estimates, despite the applicant providing an appropriate estimate. EcoMetric included the penalty in their verified savings analysis. Because the penalty was significant, it more than negated all of the positive natural gas savings for the program. This is not an uncommon finding, and the impact of the negative natural gas savings is offset by the significant electric savings produced by such fuel switching measures.

*Recommendation 8: Natural gas savings or penalties should be considered and quantified for all custom projects. Natural gas penalties are typically associated with fuel switching (e.g., replacing electric boilers with natural gas-fired boilers).*

### E.3.2 GEP KEY FINDINGS AND RECOMMENDATIONS

**Finding 28:** Annual energy generation is tracked for Solar PV projects, but the annual energy savings are not tracked for geothermal projects in the GEP program database.

*Recommendation 28: Add an estimated energy savings (kWh) data field to the Green Grant Delaware online application portal for geothermal projects to allow for program tracking.*

**Finding 30:** EcoMetric found discrepancies between the inverter efficiency listed in the application and the efficiency documented in the technical specifications by the respective Original Equipment Manufacturer for twelve projects.

*Recommendation 29: Ensure the values listed in the application match the values listed in the Original Equipment Manufacturer specification sheets for the installed equipment.*

### E.3.3 WAP KEY FINDINGS AND RECOMMENDATIONS

**Finding 32:** WAP did not claim savings from the previous evaluation report (CY2018). Program staff confirmed that the program used the results from EcoMetric’s CY2016-2017 evaluation as the basis to calculate the reported savings for homes weatherized through the program in CY2019.

**Finding 35:** The CY2019 savings analysis completed for this evaluation included post-weatherization billing data that was impacted by the COVID-19 pandemic. While the verified savings results are valid and accurate for the CY2019 program, we do not recommend using the results to stipulate deemed per-home savings for the program.

Table 5 shows the per-home savings matrix based on the combined analysis of the CY2016-2017 and CY2018 evaluations of WAP completed by EcoMetric in previous evaluation cycles. This table was included in the previous evaluation report, but EcoMetric made one adjustment to weigh the savings by the number of program years corresponding to each billing analysis.

*Recommendation 31: Use the savings matrix in Table 5 to claim savings for each weatherized home according to the home type and primary heating fuel type.*

Table 5: WAP CY2016 – 2018 Weighted Per-Home Savings Matrix

Heating Type	Home Type	Per-Home Energy Savings (kWh)	Per-Home Peak Demand Reduction (kW)	Per-Home Energy Savings (MMBtu)
Electric	Single family	2,044	0.40	NA
	Manufactured home	1,191	0.09	NA
Natural Gas	Single family	825	0.13	9.9
	Manufactured home	672	0.14	14.3
Other fuel	Single family	1,196	0.17	10.6
	Manufactured home	771	0.17	14.6

Not applicable (NA): value is not applicable for this heating/home type

**Finding 36:** WAP currently has just one subgrantee to deliver the program across the entire state.

*Recommendation 32: Contract more than one subgrantee to deliver WAP. DNREC could assign unique geographic territories to each subgrantee or allow them to compete across the state.*

**Finding 37:** The WAP subgrantee contract lacks a performance framework to incentivize the subgrantee to meet program goals.

While it is important for the subgrantee to receive steady funds to support overhead and measure installation costs, the current contract with the subgrantee provides an additional 12% of administrative funds on top of overhead costs each month. These funds are allotted for the executive positions at the subgrantee’s organization that oversee general operations at a high level.

*Recommendation 33: Restructure the WAP subgrantee contract so that monthly administrative fund payments be attached to meeting monthly targets of weatherized homes.*

**Finding 38:** WAP does not have sufficient applicant leads in the program pipeline to reach the goal of weatherizing 400 homes per year.

Considering the volume of income-eligible qualified applications that Delaware's LIHEAP receives each year, this program should be the leading source of WAP applications in Delaware. As LIHEAP is administered by the Division of State Service Centers (DSSC), leveraging LIHEAP applications will require coordination across state organizations and their subgrantees.

EcoMetric recommends that DNREC explore funding opportunities to incentivize the LIHEAP subgrantee to produce WAP applications. Without an incentive to produce WAP applications, it is certain that the LIHEAP subgrantee will continue to focus on their own program and produce the bare minimum amount of WAP applications. LIHEAP's heating season Fuel Assistance effort began October 1st, 2021, which provides a great opportunity to produce quality WAP applications. If a push can be made to incentivize the LIHEAP subgrantee, the number of applications they produce should see an impactful increase.

*Recommendation 34: Explore coordination opportunities with LIHEAP to increase the number of applications in the program pipeline.*

**Finding 40: WAP in Delaware encounters a unique challenge in that 40-60% of the homes that qualify for the program must be deferred for additional services before weatherization measures can be installed.**

While nothing can be done to change the state's housing stock in one broad stroke, DNREC and its WAP subgrantee can work to improve the tracking of deferrals and leverage this data to better target homes ready for weatherization.

EcoMetric recommends that DNREC require the subgrantee to closely track deferral rates and break the data down into subcategories that highlight why particular homes are being deferred. EcoMetric obtained the subgrantee's tracking database, including fields for tracking deferrals, but the data was incomplete and uneven. Understanding where and why homes are being deferred should allow subgrantees to target areas and types of homes that are less likely to be deferred.

*Recommendation 36: Track deferral rates and break the data down into subcategories that highlight why particular homes were deferred. Leverage this data to better target homes ready for weatherization.*

## 1.1 CROSS-CUTTING EVALUATION APPROACH

EcoMetric used a variety of methods to evaluate the verified program impacts of DNREC's energy efficiency and renewable energy programs. The team utilized engineering desk reviews, virtual site inspections, engineering analysis, interval billing analysis, telephone surveys, documentation reviews, interviews with DNREC staff, and program participants to evaluate DNREC's energy efficiency and renewable energy programs. This section explains the evaluation approach in more detail, including the overall sample design and basic descriptions of methods applied.

### 1.1.1 OVERALL SAMPLE DESIGN

The evaluation goals used when developing this sampling plan were:

- ▶ Determine the verified first-year gross energy, demand, and natural gas savings with 90% confidence and 10% precision for the DNREC portfolio.
- ▶ Determine the verified first-year gross energy and peak demand savings for each program.
- ▶ Estimate preliminary non-energy benefits (NEB) for EEIF.
- ▶ Analyze and make recommendations to improve energy efficiency and renewable energy programs.
- ▶ Estimate the avoided greenhouse gas emissions from all fuels.

The Delaware Evaluation, Measurement, and Verification (EM&V) regulations<sup>6</sup> specify that a program year runs from January 1 through December 31. EcoMetric also knows that DNREC tracks program data on a fiscal year basis, which differs from the program year defined in the EM&V regulations. EcoMetric used the EM&V regulation's definition for a program year when developing the sample design. Therefore, the program years all include projects from different fiscal years. For example, the 2020 program year for the EEIF program includes projects completed in the latter half of FY19 and the first half of FY20.

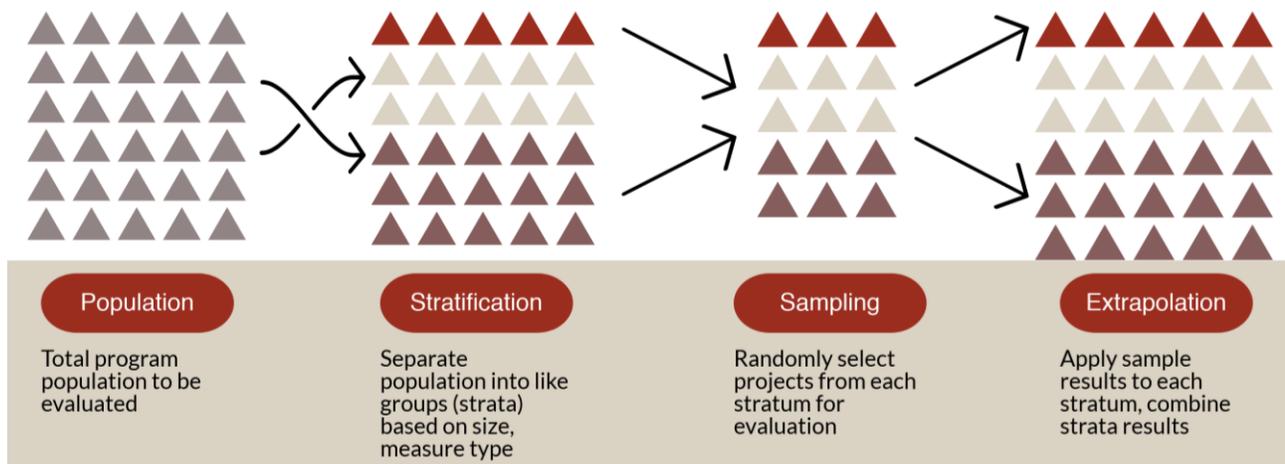
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<sup>6</sup> Regulations Governing Evaluation, Measurement, and Verification Procedures and Standards. Proposed on June 15, 2018. Section 3.0, page 3.

EcoMetric also combined 2020 program year data into one population for the Green Energy Program (GEP) and Energy Efficiency Investment Fund (EEIF) programs. The commercial NEBs quantification work for EEIF consisted of a subset of interviews with CY2020 participants. The Weatherization Assistance Program (WAP) impact evaluation included the CY2019 projects only to ensure sufficient post-weatherization billing data was available from each participant.

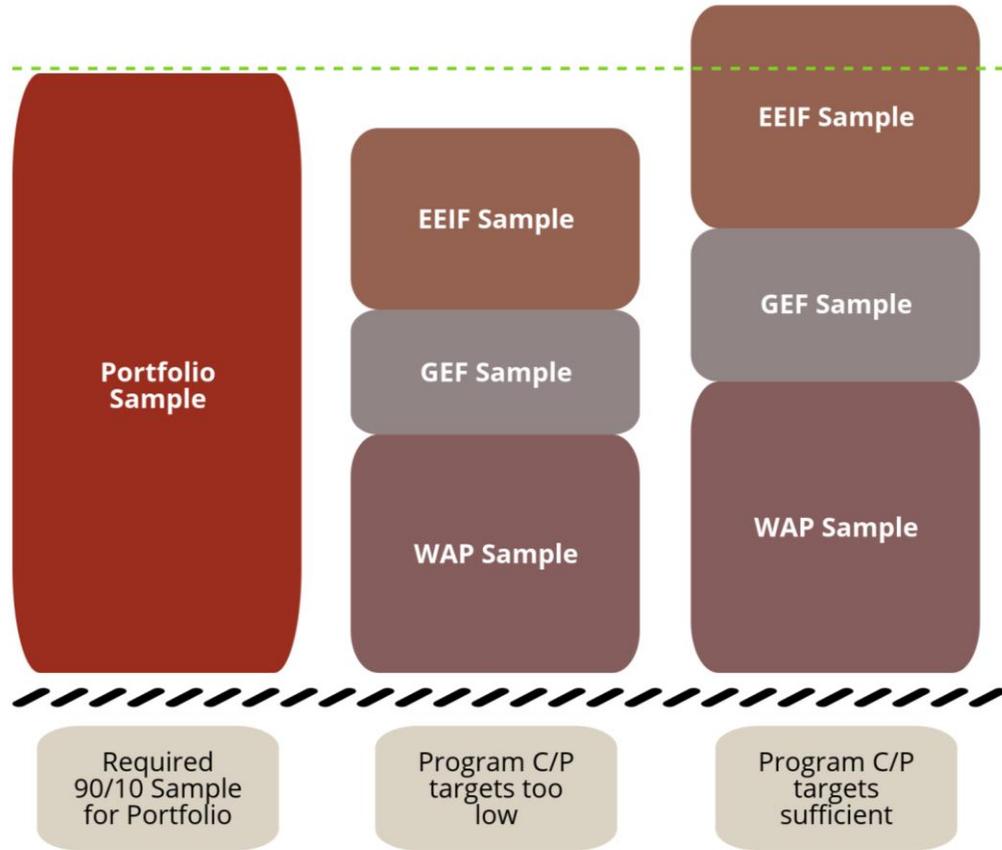
EcoMetric utilized a sampling strategy across different programs. Using a sample allowed EcoMetric to complete a statistically valid review of the program impacts while reducing the number of individual projects or surveys that were required. An example of this sampling process is shown in Figure 2.

Figure 2: Sampling Flow Chart



EcoMetric designed the program samples to achieve at least 90% confidence and 10% precision at the portfolio level, which is the industry standard practice for cost-effective yet rigorous evaluation sampling. This means the actual savings achieved by DNREC are 90% likely to be within plus or minus 10% of the EcoMetric verified savings. EcoMetric set target confidence and precision levels for each program, so the program level samples build to exceed the required number of sample points for the portfolio while maintaining precision below the maximum target (illustrated in Figure 3). Further, EcoMetric conducted a census billing analysis for WAP.

Figure 3: Program Sample Compared to Portfolio Sample



The specific number of sample points for each program was calculated using industry-standard statistical methods.<sup>7,8</sup> EcoMetric determined the required sample sizes for each program based on the desired confidence and precision, using the equation shown below.

$$n_0 = \left( \frac{z * C_v}{P} \right)^2$$

Where:

$n_0$  = required sample size if infinite population

$z$  = z-score of confidence level for normal distribution (i.e., 1.645 for 90%)

$C_v$  = coefficient of variation assumed to be 0.5<sup>9</sup>

$P$  = desired relative precision (i.e., %)

Program populations do not have infinite participants. EcoMetric adjusted the theoretically required sample size to account for finite populations using the following equation.

$$n = \frac{N * n_0}{N + n_0}$$

Where:

$n$  = required sample corrected for finite population size

$N$  = program population

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<sup>7</sup> Khawaja, M.S.; Rushton, J.; and Keeling, J. (2017). Chapter 11: Sample Design Cross-Cutting Protocol, The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures. Golden, CO; National Renewable Energy Laboratory. NREL/ SR-7A4068567. <http://www.nrel.gov/docs/fy17osti/68567.pdf>

<sup>8</sup> Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs. [http://www.puc.pa.gov/Electric/pdf/Act129/SWE\\_PhaseIII-Evaluation\\_Framework082516.pdf](http://www.puc.pa.gov/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework082516.pdf)

<sup>9</sup> Evaluation industry standard is for program sampling, a Cv of 0.5 is a reasonable and conservative assumption to ensure broad sample coverage.

EcoMetric tailored the sample frames, sample design, and stratification utilized to each of the three programs evaluated. Table 6 includes participant sample sizes for impact evaluation activity based on the target confidence levels/precision (margin of error) ranges. EcoMetric describes further details of the program samples within Sections 2, 3, and 4 for the EEIF, GEP, and WAP programs, respectively.

Table 6: Summary of Program Population and Sample Size

Program	Projects Completed	Target Confidence / Precision	Sample Size (# of projects)
EEIF	75	Sample (90%/10%)	53
GEP	255	Sample (85%/15%)	30
WAP	212	Census	212
E2I	1	Census	1
<b>Total</b>	<b>543</b>		<b>296</b>

1.1.2 GROSS SAVINGS VERIFICATION

EcoMetric used various evaluation methods to verify the savings impacts for each of the programs. The evaluation methods include tracking system reviews, engineering desk reviews, in-person and virtual site inspections, and billings analyses. Program-specific methodologies for verifying gross savings, data sources, and data collection methods are described in more detail in Sections 2, 3, 4, and 5.

1.1.3 NET SAVINGS ANALYSIS

EcoMetric calculated the net savings for each program using deemed NTG ratios. The NTG ratios incorporate free-ridership and spillover factors. Free-ridership accounts for any reductions to gross savings due to what the customer would have done absent the program’s influence. The Delaware EEAC completed a literature review and recommended deemed NTG ratios for DNREC.<sup>10</sup> EcoMetric used the approved NTG ratios, shown in Table 7 to calculate the net savings.

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<sup>10</sup><http://www.dnrec.delaware.gov/energy/information/otherinfo/Documents/EEAC/Draft%20Proposed%20DE%20EE%20program%20NTG%20values%20with%20assumptions.pdf>

Table 7: Approved Delaware NTG Values

Sector - Initiative	Program	Approved NTG Ratio
Commercial & Industrial - Prescriptive	EEIF	0.8
Commercial & Industrial - Custom	EEIF	0.7
Residential - Low Income	WAP	1

#### 1.1.4 SUMMER PEAK DEMAND ANALYSIS

EcoMetric verified summer coincident peak demand impacts for each project based on available data. EcoMetric used the following periods to calculate the summer peak demand savings:

- ▶ E2I, EEIF, and GEP: As defined in the Delaware EM&V regulations, the coincident peak is equivalent to PJM's definition of energy efficiency performance hours under the Reliability Pricing Model (RPM), defined as the hours ending 15:00 through 18:00 Eastern Prevailing Time (EPT) during all days from June 1 through August 31, inclusive, that is not a weekend or federal holiday.<sup>11</sup>
- ▶ WAP: WAP peak demand reduction was estimated using hours broader than defined in the Delaware EM&V regulations while still containing PJM's definition of energy efficiency performance hours under the Reliability Pricing Model (RPM). To align with available cooling loads shapes, a peak was defined as the hours ending 13:00 through 19:00 Eastern Prevailing Time (EPT) during all days from June 1 through August 31, inclusive, that is not a weekend or federal holiday between the 1-7 weekday hours over the peak months June to August.

#### 1.1.5 AVOIDED GREENHOUSE GAS EMISSIONS

EcoMetric estimated the economic impact of reductions in greenhouse gas (CO<sub>2</sub>, SO<sub>2</sub>, and NO<sub>x</sub>) emissions achieved by DNREC's programs and included these impacts as benefits in the cost-effectiveness analysis. EcoMetric first determined the estimated pounds of reduced emissions by

<sup>11</sup> <http://regulations.delaware.gov/AdminCode/title7/2000/2105.shtml#TopOfPage>

applying the emissions rates from PJM's 2016-2020 CO<sub>2</sub>, SO<sub>2</sub>, and NO<sub>x</sub> Emission Rates report<sup>12</sup> to the net verified savings values. The 2019-2020 PJM emissions rates are shown in Table 8.

Table 8: 2019-2020 PJM Emissions Rates

GHG	Period	2019	2020
CO <sub>2</sub> lbs./MWh	On-Peak	1,268	1,180
	Off-Peak	1,171	1,046
SO <sub>2</sub> lbs./MWh	On-Peak	0.65	0.54
	Off-Peak	0.57	0.43
NO <sub>x</sub> lbs./MWh	On-Peak	0.72	0.76
	Off-Peak	0.47	0.45

EcoMetric applied monetary values (\$/ton) taken from Delmarva Power and Light's 2016 Integrated Resource Plan<sup>13</sup>, which estimated the cost of externalities caused by greenhouse gas emissions. The resulting monetary value for each greenhouse gas was:

- ▶ CO<sub>2</sub>: \$35.41/ton
- ▶ SO<sub>2</sub>: \$43,000/ton
- ▶ NO<sub>x</sub>: \$9,500/ton

The economic benefit of GHG emissions reductions was calculated as follows:

$$\begin{aligned}
 & \text{Economic Benefit of GHG Emissions Reductions (\$)} \\
 & = \text{Energy Savings (MWh)} \times \text{Emissions Rate} \left( \frac{\text{lbs}}{\text{MWh}} \right) \times \left( \frac{1 \text{ ton}}{2,000 \text{ lbs}} \right) \\
 & \times \text{Externality Cost} \left( \frac{\$}{\text{ton}} \right)
 \end{aligned}$$

<sup>12</sup> <https://www.pjm.com/-/media/library/reports-notice/special-reports/2020/2020-emissions-report.ashx>

<sup>13</sup> The 2016 Integrated Resource Plan remains the most recent at the time of the CY2020 analysis  
<https://dep.sc.delaware.gov/wp-content/uploads/sites/54/2017/03/DPL-Public-IRP-113016.pdf>

These monetary benefits were included in the cost-effectiveness analysis, as described in the following Section.

#### 1.1.6 COST-EFFECTIVENESS ANALYSIS

EcoMetric evaluated the cost-effectiveness of DNREC's programs using the Total Resource Cost (TRC) test. The TRC test computes the ratio of program benefits to program costs, resulting in a number usually between 0.5 and 5. Programs with TRC scores of less than one show that costs exceed total lifetime benefits. A TRC score greater than one indicates the program achieved more lifetime benefits than costs. The TRC test considers costs incurred by program participants and program administrators and benefits to the utility and ratepayers. EcoMetric included the following costs as required in the Delaware EM&V regulations:

- ▶ Equipment and installation costs that are incremental to baseline costs
- ▶ Increases (or decreases) in operation and maintenance costs
- ▶ Cost of removal less salvage value
- ▶ Administrative costs directly attributable to the programs
- ▶ Costs for EM&V activities and utility performance incentives
- ▶ Federal tax credits as a cost reduction

The Delaware EM&V regulations also define the appropriate benefits for inclusion in the TRC test. EcoMetric included the following benefits in the TRC tests:

- ▶ Avoided electric supply costs based on energy costs in the respective zone of the PJM Regional Transmission Organization
- ▶ Avoided electric transmission, distribution, and generation capacity costs valued at marginal cost for the periods when there is a load reduction, based on relevant prices in the respective zone of the PJM Regional Transmission Organization
- ▶ Reduced SREC and RECs requirements
- ▶ Avoided gas supply and delivery costs
- ▶ The effect of lower prices for electric and gas energy and capacity in wholesale markets resulting from reductions in the quantity of energy and capacity sold in those markets, sometimes referred to as Demand-Reduction-Induced Price Effect (DRIPE)

- ▶ Avoided costs of energy savings in fuels other than electricity and natural gas, or from equivalent energy efficiency measures, such as a reduction in delivered heating fuel resulting from improvements in the building envelope or other systems
- ▶ Avoided environmental compliance costs, where such costs can be directly tied to changes in energy use

Additionally, EcoMetric included NEBs in the WAP cost effectiveness analysis, as described in Section 4.1.6 of this report. EcoMetric obtained avoided cost values from the DNREC technical advisor.

EcoMetric determined the monetary value of liquid fuel savings by first converting the MMBtu savings recorded in the tracking data into gallons using typical energy values for each fuel. The team then turned the gallons into dollars using average statewide retail prices derived from the Energy Information Administration (EIA). EcoMetric determined the monetary value of reduced emissions using the approach described in Section 1.1.5.

The TRC test compares the net present values (NPV) of costs and benefits over the lifetime of the measures implemented. The effective useful life (EUL) of each measure is used to determine lifetime savings, and a discount rate is used to discount the value of future costs and benefits to present-day dollars. EcoMetric obtained measure EULs from DNREC staff and secondary sources such as the Mid-Atlantic and Pennsylvania Act 129 Technical Reference Manuals. The Delaware EM&V regulations set forth a discount rate of 4%.

EcoMetric developed a cost-effectiveness model accounting for the appropriate costs and benefits determined through this evaluation. The model calculates a benefit-cost ratio for each program as well as the entire DNREC portfolio.

The equations EcoMetric used to calculate the TRC benefit-cost ratios are as follows:

$$TRC\ BenefitCost\ Ratio = \frac{NPV\ of\ Benefits}{NPV\ of\ Costs}$$

$$NPV\ of\ Benefits = NPV\ of\ Lifetime\ Avoided\ Costs + NPV\ of\ Lifetime\ NonEnergy\ Benefits$$

$$NPV\ of\ Lifetime\ Avoided\ Costs$$

$$= NPV\ of\ Avoided\ Cost\ of\ Energy + NPV\ of\ Avoided\ Cost\ of\ Capacity + NPV\ of\ Avoided\ Cost\ of\ Fossil\ Fuel$$

$$NPV\ of\ Avoided\ Cost\ of\ Energy$$

$$= Net\ Verified\ Annual\ MWh\ Savings \times (NPV\ of\ Avoided\ Cost\ per\ MWh + NPV\ of\ Avoided\ Cost\ of\ GHG\ Emissions\ per\ MWh)$$

EcoMetric derived *NPV of Avoided Cost per MWh* using the avoided costs from the Optimal Energy memo and the discount rate described above. The NPV is taken over the lifetime of each measure.

*NPV of Avoided Cost of GHG Emissions per MWh = NPV(PJM lbs GHG Emissions per MWh × Delmarva Cost per lbs GHG Emissions)* over the lifetime of each measure (see Section 1.1.5).

$$\begin{aligned} & \text{NPV of Avoided Cost of Capacity} \\ & = \text{Net Verified Annual Peak MW Reduction} \times \text{NPV of Avoided Cost per MW} \end{aligned}$$

EcoMetric derived *NPV of Avoided Cost per MW* using the avoided costs from the Optimal Energy memo and the discount rate described above. The NPV is taken over the lifetime of each measure.

$$\begin{aligned} & \text{NPV of Avoided Cost of Fossil Fuel} \\ & = \text{Net Verified Annual MMBtu Savings} \times \text{NPV of Avoided Cost per MMBtu} \end{aligned}$$

EcoMetric derived *NPV of Avoided Cost per MMBtu* using the avoided costs from the Optimal Energy memo and the discount rate described above. The NPV is taken over the lifetime of each measure.

$$\begin{aligned} & \text{NPV of Lifetime NonEnergy Benefits} \\ & = \text{NPV of Avoided Liquid Fuel Costs} + \text{NPV of Other NonEnergy Benefits} \end{aligned}$$

$$\begin{aligned} & \text{NPV of Avoided Liquid Fuel Costs} \\ & = \text{Net Verified Annual Liquid Fuel MMBtu Savings} \\ & \quad \times \text{Gallons of Fuel per MMBtu of Energy} \times \text{NPV of Fuel Price per Gallon} \end{aligned}$$

EcoMetric derived *NPV of Fuel Price per Gallon* using the fuel costs provided derived from EIA data and the discount rate described above. The NPV is taken over the lifetime of each measure.

EcoMetric derived *NPV of Other NonEnergy Benefits* using the non-energy benefits described in Section 4.1.6 and the discount rate described above. The NPV is taken over the lifetime of each measure.

$$\text{NPV of Costs} = \text{Program Administrative Costs} + \text{Incremental Measure Costs}$$

*Program Administrative Costs* were provided by DNREC.

EcoMetric compiled *Incremental Measure Costs* from the tracking and measure data provided by DNREC.

## 1.2 COMMERCIAL NON-ENERGY BENEFITS (NEB)

In an effort to provide DNREC with preliminary values for commercial NEBs from prescriptive lighting measures installed through the Energy Efficiency Investment Fund (EEIF) program, EcoMetric conducted the following tasks:

- ▶ A literature review of prescriptive lighting NEBs measured by other jurisdictions for commercial programs similar to EEIF.
- ▶ In-depth interviews (IDIs) by telephone with nine participant contacts, representing 12 EEIF grantee sites from 2020.

The results presented in this report are preliminary. Due to the small size of the population and sample, it was not possible to deliver statistically valid results at a high degree of confidence. However, these results could potentially provide the foundation for a CY2021 evaluation that DNREC could undertake with a larger survey of 2020 and 2021 participants to bolster these estimates and provide additional support for DNREC adopting statistically valid commercial NEBs values for EEIF.

In this evaluation, “grantee site” refers to the end-use site where the efficient lighting was installed through EEIF. “Participant” refers to the person EcoMetric interviewed, the person most familiar with the outcomes of the site’s participation and experience with the program. Most participants were affiliated with only one grantee site; however, one participant was affiliated with four grantee sites.

## 2 ENERGY EFFICIENCY INVESTMENT FUND RESULTS

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The Energy Efficiency Investment Fund program (EEIF) provides financial incentives to businesses, state agencies, local governments, and non-profits to make energy efficiency upgrades in existing facilities. The incentives are designed to defray some of the cost difference between high-efficiency equipment and equipment that is no more efficient than what is commonly installed in commercial buildings (i.e., “baseline” equipment).

Four types of grants are available through the EEIF program: prescriptive, custom, energy assessment, and combined heat and power. Prescriptive lighting projects comprise the majority of projects supported by EEIF.

**Prescriptive:** The prescriptive path offers incentives for energy-efficient lighting, lighting control improvements, high-efficiency heating, and water heating systems. Organizations that participate apply for a grant for the total of incentives applicable to their project. Grants cannot exceed 30% of the total project cost for eligible prescriptive measures. For each measure implemented through the prescriptive path, the program assigns savings based on TRM-derived savings algorithms or deemed savings values.

**Custom:** The custom path supports cost-effective energy efficiency measures that DNREC does not offer on a prescriptive basis. Custom incentives vary by project and depend on incremental cost, calculated energy and demand savings of a retrofit project, cost-effectiveness, and total project cost. Grants cannot exceed 30% of the total project cost for eligible custom projects. Custom projects are more complex than prescriptive projects and include aggressive measures that permanently raise the efficiency levels over standard equipment.

**Energy Assessment:** Energy assessment grants are available for businesses in need of technical assistance to evaluate their facility for energy-efficient upgrades. This path offers financial assistance to help offset audits, feasibility studies, and project design costs. Grants pay up to 50% of the cost of the audit.

**Combined Heat and Power:** The combined heat and power path provides incentives for five types of combined heat and power systems, including microturbines, reciprocating engines, gas turbines, steam turbines, and fuel cells. Grant amounts are the lesser of \$500 per kW of the installed system or 30% of project costs.

In CY2020, Delaware contractors typically brought customers into the program and helped them through the process of becoming EEIF grantees. DNREC staff were responsible for reviewing and

approving applications, tracking each project's details for the program, and disbursing grant monies upon project completion. DNREC also contracted with a third-party consultant to provide technical review services for some larger and more complex projects prior to pre-approval.

Towards the end of 2020, DNREC hired a third-party implementer to help deliver the EEIF program. It is EcoMetric’s understanding that the third-party implementer will take on most of the duties DNREC was historically responsible for as part of the program delivery.

In this evaluation, “participants” or “grantees” refer to the end-use customers who obtained a grant from EEIF.

## 2.1 IMPACT EVALUATION

### 2.1.1 PROGRAM DATABASE REVIEW AND SAMPLING

For the 2020 calendar year (CY), the EEIF program paid grants for 75 completed energy efficiency projects. EcoMetric defined each line in the tracking data as a unique project. Additionally, EcoMetric only considered projects assigned a “complete” status. A summary of CY2020 reported savings is shown in Table 9.

Table 9: EEIF Program Summary

Calendar Year	Projects Completed	Energy Savings (MWh)	Gas Savings (MMBtu)
2020	75	28,013	12,214
<b>Total</b>	<b>75</b>	<b>28,013</b>	<b>12,214</b>

**Finding 1:** Peak demand (kW) savings were not tracked in the EEIF program database for CY2020 projects, despite most energy efficiency projects completed through the program realizing peak demand savings.

EcoMetric understands that DNREC’s third-party implementer has started tracking and reporting all applicable peak demand savings for energy efficiency projects that were completed through the program. The third-party implementer was hired by DNREC in late 2020. Therefore, it is likely EEIF will report peak demand savings for completed energy efficiency projects in CY2021.

***Recommendation 1:** Track and report peak demand savings for each project in the program tracking database.*

Compared to previous calendar years, the EEIF program experienced steady participation levels. Electric energy savings increased on a per-project basis, while natural gas savings decreased when

compared to CY2019. Table 10 compares per-project savings from the projects completed during CY2016-2018, CY2019, and CY2020.

*Table 10: Comparison of Per-Project Savings*

Calendar Year	2016-2018	2019	2020
Energy (MWh) Savings per-project	75.76	208.43	373.50
Gas (MMBtu) Savings per-project	31.98	305.77	162.85

Prescriptive projects provide the majority of the electrical savings, while custom projects generated all the natural gas savings and contributed to the electric savings. Table 11 summarizes the custom and prescriptive projects completed through the EEIF program during CY2020.

*Table 11: EEIF Program Data Prescriptive versus Custom Projects*

Calendar Year	Project Type	Projects Completed	Energy Savings (MWh)	Gas Savings (MMBtu)
2020	Prescriptive	72	21,201	0
	Custom	3	6,812	12,214
<b>Total</b>		<b>75</b>	<b>28,013</b>	<b>12,214</b>

The sample frame for the EEIF program stratifies the projects into prescriptive and custom strata. EcoMetric pulled projects with natural gas savings into a separate stratum to ensure reliable natural gas savings estimates. The sample design further divided each of the three project types (prescriptive, custom, and gas) into certainty and probability sub-strata. Certainty projects are those that contribute a significant amount of energy savings to the prevailing strata. EcoMetric allocated projects with electricity savings higher than 500 MWh and natural gas projects with more than 1,000 MMBtu to the certainty strata (there was only 1 project for which DNREC reported natural gas savings).

EcoMetric assigned all remaining projects to the probability strata. Due to the large number and significant savings of prescriptive projects, EcoMetric further divided the probability strata into large and small sub-strata. Large prescriptive projects are those with more than 200 MWh but less than 500 MWh. The small prescriptive probability stratum includes all projects with less than 200 MWh of energy savings. The EEIF program sample frame is shown in Table 12.

Table 12: EEIF Program Sample Frame

Project Type	Strata	Description	Project Population	Energy Savings (MWh)	Gas Savings (MMBtu)
Prescriptive	Certainty	Greater than 500 MWh	9	12,934	0
	Large Probability	200 - 500 MWh	15	4,996	0
	Small Probability	Under 200 MWh	48	3,271	0
Custom - Electric	Certainty	Greater than 500 MWh	2	6,280	0
	Probability	Under 500 MWh	0	0	0
Custom - Gas	Certainty	Greater than 1,000 MMBtu	1	532	12,214
	Probability	Under 1,000 MMBtu	0	0	0
<b>Total</b>			<b>75</b>	<b>28,013</b>	<b>12,214</b>

A total of 53 sample points were drawn for the EEIF program to exceed a target of 90% confidence and 10% precision. The sample points were allocated first to the certainty stratum and then to the probability stratum. Utilizing certainty strata ensures that EcoMetric evaluated the most significant projects and ultimately allows EcoMetric to reduce the number of probability projects needed to achieve the confidence and precision targets. The number of sample points allocated to each stratum and the percentage of projects and savings covered by the sampled projects are shown in Table 13.

Table 13: EEIF Sample Coverage

Project Type	Strata	Sample Points	Sampled MWh	Percent MWh	Sampled MMBtu	Percent MMBtu
Prescriptive	Certainty	9	12,934	46%	0	0%
	Large Probability	12	3,943	14%	0	0%
	Small Probability	29	1,937	7%	0	0%
Custom - Electric	Certainty	2	6,280	22%	0	0%
	Probability	0	0	0%	0	0%
Custom - Gas	Certainty	1	532	2%	12,214	100%
	Probability	0	0	0%	0	0%
<b>Total</b>		<b>53</b>	<b>25,626</b>	<b>91%</b>	<b>12,214</b>	<b>100%</b>

## 2.1.2 GROSS SAVINGS VERIFICATION

The primary data sources for the EEIF projects were applications, product specification sheets, scanned calculations, and other data and documentation provided by the program staff in support of the reported savings estimates. EcoMetric carefully reviewed the supplied documentation for each project. The review of project documentation provided an understanding of the efficiency upgrades implemented, and just as importantly, how savings from these upgrades were estimated.

EcoMetric also conducted both in-person and virtual site inspections for a sample of custom and prescriptive projects. The site inspection allows for additional data collection to supplement engineering desk reviews. During the site inspections, the participant was interviewed to confirm any factors that may impact the installed equipment's energy savings. Table 14 summarizes the number of in-depth engineering desk reviews and site inspections that EcoMetric completed for the CY2020 evaluation.

*Table 14: Summary of Desk Reviews and Site Inspections*

Measure Type	Number of Desk Reviews	Number of Site Inspections
Prescriptive	50	8*
Custom - Electric	2	1
Custom - Gas	1	1**
<b>Total</b>	<b>53</b>	<b>10</b>

\*EcoMetric performed site inspections for nine control numbers, accounting for inspections at 13 unique facilities.

\*\*EcoMetric performed a virtual site inspection and pre-review for this project. EcoMetric's pre-review of this project included reviewing the ex ante savings approach and methodology for technical soundness and alignment with evaluation protocols.

### 2.1.2.1 Engineering Desk Reviews

To verify gross savings estimates, EcoMetric completed in-depth engineering desk reviews for all of the projects in the evaluation sample. The evaluation sample included both custom and prescriptive projects. Engineering desk reviews for prescriptive projects ensured the savings followed the

methodology in the Mid-Atlantic TRM.<sup>14</sup> The engineering review for custom projects focused on the specific details unique to the measure type and operating parameters at the installation site.

Each custom and prescriptive project received a document review as part of the engineering desk review. The document review included examining all the project files' information to ensure that projects were consistent with program assumptions. EcoMetric also compared the project documentation to information captured in the tracking system to determine data accuracy. Where a project was inconsistent with the approved assumptions or methods, EcoMetric recalculated the savings based on our experience and engineering judgment, as well as any information available in the project files. EcoMetric also collected additional information during site inspections.

The engineering desk review also included a detailed review of the savings calculations for the custom and prescriptive projects. As noted above, the savings methodologies for custom and prescriptive projects are different. Detailed descriptions of the prescriptive and custom savings reviews are below.

- ▶ For prescriptive projects that were in the EEIF evaluation sample, the engineering desk reviews included the following:
  - Review of invoices and specification sheets to confirm installation date as well as equipment capacities, equipment quantity, and equipment type
  - Review of measures available in the Mid-Atlantic TRM to determine the most appropriate algorithms which apply to the installed measure
  - Recreation of savings calculations using the Mid-Atlantic TRM algorithms and inputs as documented by submitted specification sheets, invoices, and any post-installation documentation
- ▶ For custom projects that were in the EEIF evaluation sample, the engineering desk reviews included the following:
  - Review of engineering analyses for technical soundness, proper baselines, and appropriate approaches for the specific application

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<sup>14</sup> [https://neep.org/sites/default/files/resources/Mid\\_Atlantic\\_TRM\\_V9\\_Final\\_clean\\_wUpdateSummary%20-%20CT%20FORMAT.pdf](https://neep.org/sites/default/files/resources/Mid_Atlantic_TRM_V9_Final_clean_wUpdateSummary%20-%20CT%20FORMAT.pdf)

- Review of methods determining peak demand savings to ensure they are consistent with Delaware EM&V regulations for calculating peak demand savings
- Review of input data for appropriate variables such as equipment capacities, equipment quantities, hours of operation, and weather data to determine if they are consistent with facility operation
- Confirmation of installation using invoices and post-installation reports or documentation
- Review of input data for appropriate baseline specifications to ensure the equipment type, capacities, and efficiencies are consistent with the criteria set forth by the Delaware EM&V regulations
- Review of inputs and outputs from building energy simulation models

### 2.1.2.2 Site Inspections

EcoMetric completed site inspections for custom and prescriptive projects from the evaluation sample. Inspections included a combination of in-person and virtual site visits. Each site inspection took place after the completion of the desk review for the project. The purpose of the site inspections was to visually confirm the installation of the energy-efficient equipment and assess the accuracy with which DNREC documented the project.

The in-person site inspections involved an EcoMetric staff member meeting a facility representative knowledgeable about the energy efficiency project at the location where the project took place. The in-person inspections included the following:

- ▶ Walking through the rooms and spaces affected by the energy efficiency project
- ▶ Visually verifying installed equipment and nameplates and taking photographs
- ▶ Visually verifying installed equipment quantities
- ▶ Interviewing the facility representative about baseline equipment, baseline and post-install operating schedules, and project installation timelines

EcoMetric also completed virtual inspections for certain facilities where in-person site inspections were not possible due to COVID-19 restrictions. To perform the virtual site inspections, EcoMetric utilized various interactive video applications, including FaceTime, Zoom, and Microsoft Teams. Once connected via video call, the facility representative walked through the facility's relevant areas, with the camera on their smartphone or tablet recording live video. EcoMetric staff viewed the video stream remotely via laptop computers or smartphones. The video applications allowed EcoMetric staff to capture screenshots.

Each virtual site inspection included the following:

- ▶ Performing an interactive video call with a representative from the facility where the project took place
- ▶ Capturing photographs (screenshots) of critical equipment and nameplates as the facility representative toured the site
- ▶ Interviewing the facility representative about the project and operation of the affected building equipment or systems
- ▶ Requesting additional documentation or data from the facility representative, if necessary

Following each site inspection, EcoMetric compared the findings from the visit to the information provided in application documentation and updated their independent calculation of projected energy savings achieved by the project.

### 2.1.2.3 Building Simulations

EcoMetric reviewed building simulations and energy models, which customers submitted with two of the custom project applications. The software used to create the models was Trane Air Conditioning Economics (TRACE). For each submission, a contractor – before project installation – developed a baseline model for the building and calibrated the model to its historical energy consumption. Additional models were then created, with the baseline model as the starting point, to reflect the proposed changes to building equipment or operation involved in the energy efficiency project.

As part of each project review, EcoMetric assessed the accuracy of the inputs and feasibility of the outputs from the building simulation or model. The inputs were compared to project and equipment parameters found in other application documentation. EcoMetric also assessed whether the baseline used in the model was appropriate. Where necessary, EcoMetric reviewed the building model and project details with the contractor that developed the model.

### 2.1.3 VERIFIED RESULTS

EEIF projects fall into three categories: prescriptive, custom–electric, and custom–gas projects. As noted in Section 2.1.1, EcoMetric reviewed a sample of the projects completed in CY2020. Table 15 summarizes the electric and natural gas verified savings from the evaluation sample broken out by project type.

*Table 15: EEIF Verified Sample Savings Results*

Project Type	Number of Projects Completed	Electric Realization Rate	Verified Sample Electric Savings (MWh)	Natural Gas Realization Rate	Gross Verified Gas Savings (MMBtu)
Prescriptive	50	99.3%	18,678	NA	0
Custom - Electric	2	99.4%	6,242	NA	-12,567
Custom - Gas	1	100.0%	532	100%	12,214

Not applicable (NA): value is not applicable for this project type

EcoMetric extrapolated the verified savings from the sample of evaluated projects to the population of EEIF projects completed in CY2020 using appropriate statistical methods.

Table 16 shows gross verified energy savings for the population of CY2020 EEIF projects. Overall, the measures achieved an electric realization rate of 100.4%, resulting in 28,134 MWh of first-year electric savings. The evaluation resulted in -353 MMBtu of first-year gas savings. The relative precision<sup>15</sup> of the electric savings realization rate was 9.10% at the 90% confidence level. The relative precision of the gas savings realization did not have any margin of error at the 90% confidence level due to EcoMetric evaluating all of the gas savings projects. Verified gross peak coincident demand savings totaled 3.89 MW<sup>16</sup>.

<sup>15</sup> Relative precision represents the uncertainty of the calculated realization rate for the program’s population relative to the value of the program’s realization rate for the sample at the 90% confidence level.

<sup>16</sup> EcoMetric did not report a realization rate for the peak demand savings because EEIF did not track or report peak demand savings for projects completed in CY2020.

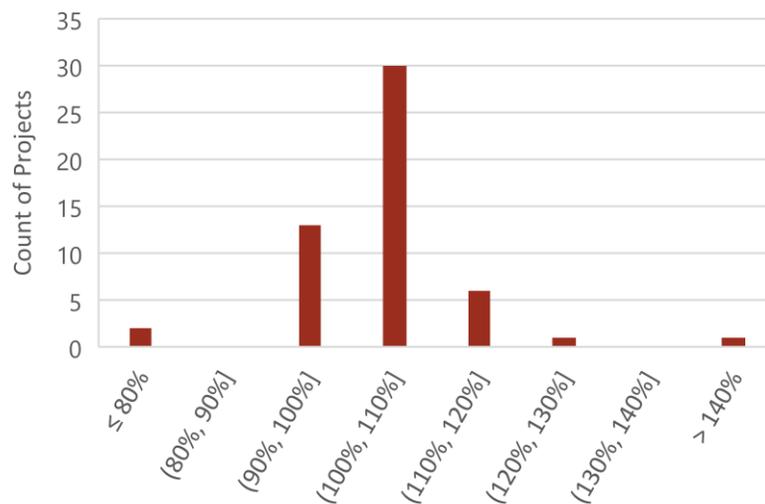
Table 16: EEIF Verified Savings Results

Project Type	Gross Verified Electric Savings (MWh)	Relative Electric Precision at 90% Confidence	Gross Verified Coincident Peak Demand Savings (MW)	Gross Verified Gas Savings (MMBtu)	Relative Precision Gas at 90% Confidence
Prescriptive	21,360	9.10%	3.56	0	NA
Custom - Electric	6,242	NA	0.26	-12,567	0.00%
Custom - Gas	532	NA	0.07	12,214	0.00%
<b>Total</b>	<b>28,134</b>		<b>3.89</b>	<b>-353</b>	

Not Applicable (NA) = value is not applicable for this project type

Figure 4 shows the distribution of electric realization rates for the EEIF sample. Over 81% of the sampled projects have an electric realization rate between 90% and 110%, highlighting the program's overall accuracy of ex ante electric savings calculations.

Figure 4: Distribution of EEIF Electric Realization Rates



**Finding 2:** The ex ante electric savings calculations for the EEIF program were generally accurate. More than 81% of the sampled projects have an electric realization rate within ±10% of 100%.

The percentage of projects in the evaluation sample with electric realization rates  $\pm 10\%$  of 100% increased from 57% in the CY2019 evaluation to over 81% in the CY2020 evaluation. This is a significant improvement and highlights the improved accuracy in calculating the electric energy savings for EEIF projects.

**Finding 3:** The realization rates for the electric projects in the evaluation sample ranged from 74% to 5,547%.

While 43 sample projects have an electric realization rate of  $\pm 10\%$  of 100%, the other 10 electric projects' realization rates varied from 100%. A variation in project realization rates impacts the precision of the verified savings and may result in a larger required sample size to achieve precision estimates.

At the end of 2020, DNREC hired a third-party implementation contractor to help deliver the EEIF program. EcoMetric understands that the third-party implementer is expected to complete a technical review of the savings methodology and algorithm inputs for every project that goes through the program to ensure consistency and alignment with the applicable Mid-Atlantic TRM algorithms.

*Recommendation 2: Ensure there is a technical review completed by the third-party implementer for each of the energy efficiency projects that come through the EEIF program.*

#### 2.1.3.1 Gross Savings Results for Prescriptive Projects

The 72 prescriptive projects completed through the EEIF program achieved 21,360 MWh of gross verified electric savings, accounting for 76% of the program's total electric savings. The prescriptive projects in the sample comprised solely of interior and exterior lighting projects. The evaluation team found that the ex ante electric savings were generally accurate, resulting in an overall electric realization rate of 99.3% for the prescriptive projects. Realization rates for these prescriptive projects varied from 100% for several overarching reasons explained in this section.

As seen in Table 17, while the overall realization rate is close to 100%, EcoMetric made several different types of adjustments to ex ante savings estimates for prescriptive lighting projects. The most impactful types of adjustments included those related to fixture quantities and HVAC waste heat factors. The percentages in Table 17 represent the contribution (positive for increases in savings; negative for decreases in savings) from each adjustment type to the overall energy (kWh) savings adjustment for the prescriptive lighting projects.

Table 17: Occurrence and Impact of Adjustments to Ex Ante kWh Savings

Adjustment Category	Negative Impact		Positive Impact		Overall	
	# Instances	Impact on Savings	Impact on Savings	# Instances	Impact on Savings	# Instances
Reported Savings Discrepancy*	9	-0.42%	0.65%	14	0.23%	23
Fixture Quantity	2	-3.30%	0.01%	3	-3.29%	5
Fixture Input Wattage	7	-0.05%	0.10%	7	0.05%	14
Waste Heat Factor	3	-2.47%	3.89%	39	1.42%	42
Coincident Factor	0	0.00%	0.00%	0	0.00%	0
Hours of Use (HOU)	4	-0.53%	1.39%	2	0.87%	6
Lighting Controls	0	0.00%	0.01%	2	0.01%	2
<b>Total</b>	<b>25</b>	<b>-6.77%</b>	<b>6.05%</b>	<b>67</b>	<b>-0.72%</b>	<b>92</b>

\*This refers to a discrepancy between the savings reported in the program tracking data and those shown in the final calculator spreadsheet provided in project files.

**Finding 4: The ex ante savings calculations for CY2020 lighting projects were not fully consistent with the savings methodology outlined in the Mid-Atlantic TRM. The ex ante energy savings calculations did not utilize waste heat factors.**

Waste heat factors account for cooling and heating impacts from efficient lighting on energy and demand based on Heating Ventilation and Air Conditioning (HVAC) and building type. The summer peak coincidence factor ensures demand savings calculations reflect the jurisdiction’s summer peak period. As was the case with many prescriptive lighting projects in EEIF, not utilizing waste heat factors results in an underestimation of energy and demand savings for air-conditioned spaces with non-electric heating—which are common in the EEIF population and throughout Delaware.

Since being hired in late 2020, DNREC’s third-party implementer developed a standardized lighting calculator that is fully consistent with the Mid-Atlantic TRM. EcoMetric understands that the standardized lighting calculator was used for projects in 2021.

***Recommendation 3:** Ensure the ex ante energy and peak demand savings calculations follow the savings methodology outlined in the Mid-Atlantic TRM. The Mid-Atlantic TRM savings methodology calculates energy (kWh) savings, peak demand (kW) savings, and a heating penalty (MMBtu) when applicable for spaces heated with natural gas.*

**Finding 5:** The CY2020 ex ante savings analyses for projects replacing HID fixtures used the nominal lamp wattage as the baseline fixture power instead of the total fixture input power, which includes both the nominal lamp wattage and the power to operate the ballast. This results in overestimating the energy savings for the project.

Since being hired in late 2020, DNREC's third-party implementer developed a standardized lighting calculator that accounts for the nominal lamp wattage and the power to operate the ballast when determining input fixture power for HID fixtures. EcoMetric understands that the standardized lighting calculator was used for projects in 2021.

*Recommendation 4: Ensure all projects replacing HID fixtures with LED fixtures use the total input fixture power.*

**Finding 6:** The project documentation for all prescriptive lighting projects included product specification sheets and invoices that enabled the EcoMetric team to verify the type and quantity of installed light bulbs and fixtures.

**Finding 7:** EcoMetric found discrepancies between the equipment quantities noted in the invoices and the equipment quantities used in the ex ante calculations for only two projects. Program staff clearly remain diligent in verifying the quantity of installed equipment to ensure they award grants correctly.

*Recommendation 5: Continue ensuring reported fixture quantities are in line with quantities shown on project invoices.*

**Finding 8:** Ex ante savings calculations for two large prescriptive lighting projects incorrectly classified a portion of interior fixtures as being installed outdoors and vice versa. This meant that those line items were assigned inappropriate HOUs. The annual HOUs for light fixtures are one of the primary factors that drive energy savings; therefore, it is essential to quantify HOUs by space type or usage groups when possible.

*Recommendation 6: Continue to ensure participants submit documentation and ex ante calculations that clearly define and support the fixture HOUs for each space type where efficient light fixtures or bulbs are installed.*

**Finding 9:** There was a total of 21 sampled prescriptive lighting projects for which the tracking system savings could not be exactly recreated by EcoMetric based on the supplied project documentation. For many of these projects, a tabular summary of energy

savings was not included with the application documentation. This resulted in a total discrepancy of 42.8 MWh (0.2% of total reported savings for prescriptive projects) between DNREC's tracked ex ante savings and EcoMetric's recreation of ex ante savings. DNREC's new EEIF application portal, which rolled out to participants in 2021, should help resolve these discrepancies.

*Recommendation 7: Ensure the claimed energy savings for each project are consistently documented in the project documentation and program tracking database.*

**Finding 10:** Savings calculations and summaries were not standardized for CY2020 projects. However, since being hired in late 2020, DNREC's third-party implementer has developed standardized calculator tools and documentation templates to ensure consistency for the prescriptive program pathways.

#### 2.1.3.2 Gross Savings Results for Custom Electric Projects

The evaluation team reviewed the only two custom electric projects completed in CY2020. One of the projects included a variety of HVAC improvements in a commercial building; the other project involved upgrades at a wastewater treatment plant. Since custom, non-lighting projects are not bound by the saving algorithms in the Mid-Atlantic TRM, EcoMetric reviewed the savings methodology and technical soundness of assumptions. Project documentation included detailed equipment specifications, operation, and energy modeling reports (for the commercial building project). The verified electric savings for the custom electric projects were 6,242 MWh (accounting for 22% of the program total), resulting in a 100% realization rate.

**Finding 11:** One of the custom electric projects involved a major boiler plant replacement, including a fuel switch from electric to natural gas. This means a significant increase in natural gas consumption or penalty was associated with the project. DNREC did not report this penalty with ex ante savings estimates, despite the applicant providing an appropriate estimate. EcoMetric included the penalty in their verified savings analysis. Because the penalty was significant, it more than negated all of the positive natural gas savings for the program. This is not an uncommon finding, and the impact of the negative natural gas savings is offset by the significant electric savings produced by such fuel switching measures.

*Recommendation 8: Natural gas savings or penalties should be considered and quantified for all custom projects. Natural gas penalties are typically associated with fuel switching (e.g., replacing electric boilers with natural gas-fired boilers).*

### 2.1.3.3 Gross Savings Results for Custom Gas Projects

There was only one custom gas project completed through the EEIF program in CY2020. Similar to the electric custom projects, custom gas projects are not bound by the saving algorithms in the Mid-Atlantic TRM. EcoMetric carefully reviewed the inputs and outputs from the Trane TRACE building energy model developed for the project. The single custom gas project completed in 2020 achieved 12,214 MMBtu of gross verified gas savings, resulting in a 100% realization rate. The gas project also achieved 532 MWh of gross verified electric savings, accounting for 2% of the program's total electric savings.

**Finding 12:** Through our review of the project files and virtual site inspection, EcoMetric believes the baseline used for ex ante savings was appropriate; however, there was no documentation or explicit written explanation included in project files that described the determination of the baseline.

*Recommendation 9: Continue to ensure participants submit documentation and ex ante calculations for custom projects that clearly explain and support the claimed savings, including selection and reasoning behind the baseline used in the savings analysis.*

### 2.1.4 NET SAVINGS VERIFICATION

The Net-to-gross (NTG) ratios for prescriptive and custom commercial & industrial (C&I) projects were deemed through work completed by the Delaware Energy Efficiency Advisory Council (EEAC). The NTG ratios incorporate free-ridership and spillover factors. Free-ridership accounts for any reductions to gross savings due to what the customer would have done absent the program's influence. The EEAC deemed the NTG ratio for prescriptive projects to be 0.8 and 0.7 for custom projects. Table 18 shows the net savings for the EEIF program. EcoMetric calculated the net verified savings using the equation below.

$$\text{Net Verified Savings} = \text{Gross Verified Savings} \times \text{NTG Ratio}$$

Table 18: EEIF Net Verified Savings Results

Measure Type	Approved C&I NTG	Gross Verified Energy Savings (MWh)	Gross Verified Peak Demand Reduction (MW)	Gross Verified Gas Savings (MMBtu)	Net Verified Energy Savings (MWh)	Net Verified Peak Demand Reduction (MW)	Net Verified Gas Savings (MMBtu)
Prescriptive	0.8	21,360	3.56	0	17,088	2.85	0
Custom - Electric	0.7	6,242	0.26	-12,567	4,369	0.18	-8,797
Custom - Gas	0.7	532	0.07	12,214	373	0.05	8,550
<b>Total</b>		<b>28,134</b>	<b>3.89</b>	<b>-353</b>	<b>21,830</b>	<b>3.08</b>	<b>-247</b>

### 2.1.5 GREENHOUSE GAS EMISSION REDCUTIONS

EcoMetric estimates the Net present value (NPV) of the lifetime monetary benefits of greenhouse gas (GHG) emissions reduction achieved by the EEIF program to be \$14,160,647 for projects completed in CY2020. Table 19 shows the lifetime electric savings, lifetime GHG reduction, and lifetime NPV of GHG reduction economic benefits for the program. See Section 1.1.5 for details on how EcoMetric calculated the economic benefits of GHG emissions reductions.

Table 19: EEIF Greenhouse Gas Emissions Reductions

Measure Type	Net Verified Electric Savings (MWh)	Lifetime Electric Savings (MWh)	Net Verified Gas Savings (MMBtu)	Lifetime Gas Savings (MMBtu)	Lifetime GHG Reduction (lbs.)	Lifetime NPV Savings (\$)
Prescriptive	17,088	256,321	0	0	335,278,624	\$10,751,105
Custom - Electric	4,369	65,537	-8,797	-131,957	85,725,239	\$3,141,578
Custom - Gas	373	5,590	8,550	128,247	7,312,012	\$267,964
<b>Total</b>	<b>21,830</b>	<b>327,448</b>	<b>-247</b>	<b>-3,710</b>	<b>428,315,874</b>	<b>\$14,160,647</b>

### 2.1.6 COST-EFFECTIVENESS RESULTS

EcoMetric’s cost-effectiveness analysis shows that the Energy Efficiency Investment Fund program has a benefit-cost ratio of 2.38 using the TRC test. This indicates that the program is highly cost-effective. The program's benefit to cost ratio continues to show strong cost-effectiveness from the TRC perspective due to benefits derived from energy savings and peak demand reduction in CY2020. The TRC ratio declined from CY2019 due to increased fossil fuel consumption attributable to the program in CY2020. Table 20 provides details on the total benefits and costs which EcoMetric included in the TRC test for the EEIF program. Refer to Section 1.1.6 for details on how EcoMetric performed the cost-effectiveness analysis.

Table 20: EEIF Cost-effectiveness Results

Benefit / Cost	NPV of Benefit / Cost
Lifetime Avoided Cost of Energy	\$29,605,447
Lifetime Avoided Cost of Capacity	\$5,071,547
Lifetime Avoided Cost of Fossil Fuel	-\$15
Lifetime Non-Energy Benefits	\$0
<b>Total Benefits</b>	<b>\$34,676,980</b>
Program Administrative Costs	\$469,709
Measure Costs	\$14,128,341
<b>Total Costs</b>	<b>\$14,598,050</b>
<b>TRC Benefit-Cost Ratio</b>	<b>2.38</b>

**2.2 COMMERCIAL NON-ENERGY BENEFITS (NEB)**

Commercial energy efficiency programs may realize non-energy benefits (NEBs) such as improvement in safety and reduction in operation & maintenance, administration, material handling, and waste disposal costs. EcoMetric conducted a literature review and in-depth interviews (IDI) with CY2020 EEIF participants to quantify preliminary values for commercial NEBs from prescriptive lighting measures installed through EEIF. EcoMetric focused on the NEBs resulting from prescriptive lighting projects because the CY2020 program is comprised almost entirely of lighting projects. These NEBs include operations and maintenance, safety, administration, waste disposal, material handling, and sales.

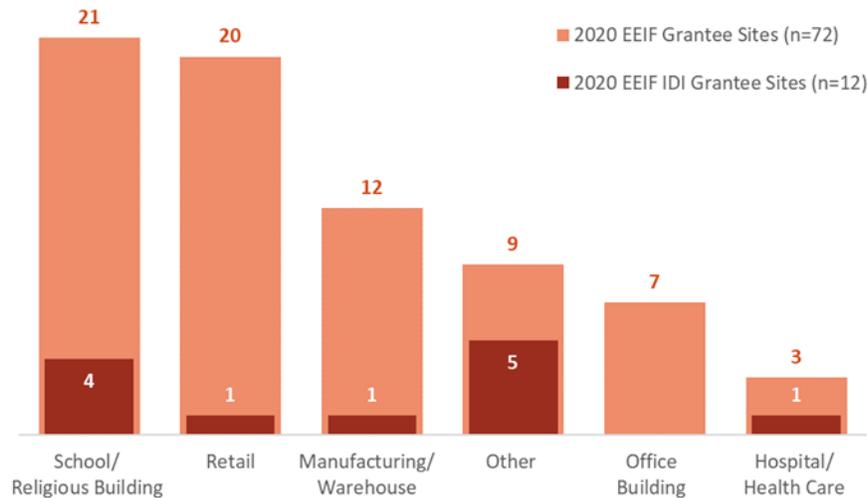
**2.2.1 2020 EEIF GRANTEE SITE CHARACTERISTICS**

EcoMetric categorized 2020 EEIF grantee sites into the following business types: school / religious building (21), retail (20), manufacturing / warehouse (12), office building (7), hospital / health care (3),



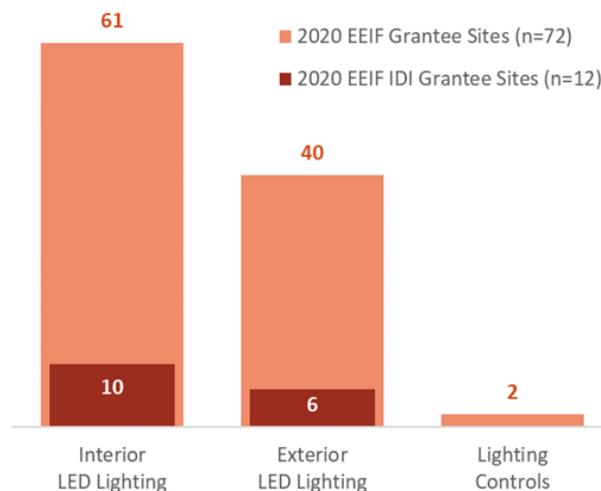
and other building type (9). The 12 grantee sites covered in this study represented all site categories aside from office building, as shown in Figure 5.

Figure 5: 2020 EEIF Grantee Site Types



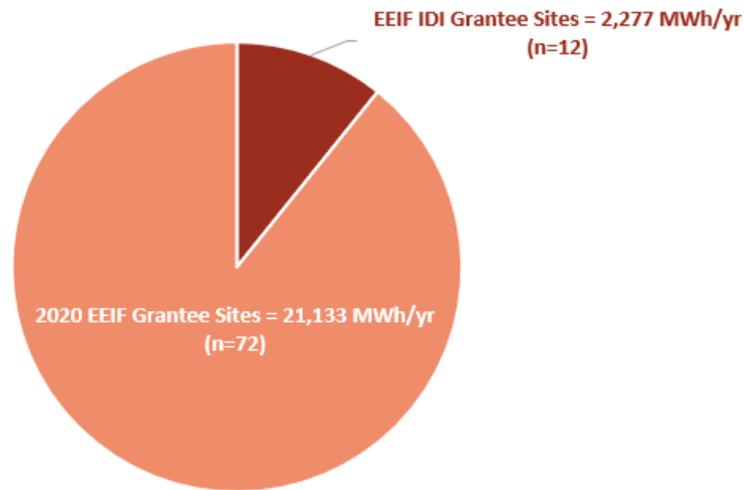
The EEIF prescriptive lighting path offers incentives for exterior and interior energy-efficient lighting and for lighting controls. Ten grantee sites covered in this study had interior lighting installed through EEIF, and six had exterior lighting installed. Four grantee sites had both exterior and interior lighting installed through the program, while no grantee sites had lighting controls installed. (Figure 6)

Figure 6: Measures Installed Through EEIF



As a whole, electric savings achieved through EEIF in 2020 was 21,133 MWh/yr. The 12 grantee sites covered by this study represented 11% of overall electric savings for 2020. (Figure 7)

Figure 7: Electric Savings - 2020 EEIF Grantee Sites versus IDI Grantee Sites



### 2.2.2 LITERATURE REVIEW

EcoMetric conducted a thorough search of other jurisdictions with commercial and industrial (C&I) programs similar to EEIF that had prescriptive lighting NEBs estimated using primary research. Since 2003, four studies have incorporated primary research to monetize commercial NEBs, three of which isolated lighting-specific NEBs estimates.<sup>17</sup> Notably, most of the programs in these studies included CFLs, while EEIF only involves LEDs. The studies calculated and presented average annual NEB values in different ways: three estimated NEBs per participant, one of the three also reported NEBs per kWh, and another one reported NEBs per lifetime kWh.<sup>18</sup> Table 21 presents high level details and recommended NEBs values from the four studies. The EcoMetric team referred to these existing studies when developing the IDI guide (6.2Appendix 4) and NEBs calculations (6.2Appendix 3)

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<sup>17</sup> In 2016, DNV GL followed up on their 2012 NEB study for the Massachusetts PAs, with the goal of quantifying the dollar value of participant NEBs for C&I New Construction projects completed in 2013. The study reported annual NEBs for electric prescriptive lighting as \$757 per measure (\$0.020 NEB/kWh). This study is not included in Table 21 as it focused on new construction and EEIF focuses on retrofits.

<sup>18</sup> Net present value of benefits over measure lifetime divided by lifetime kWh saved, using a 5% discount rate.

Table 21: Literature Review Results – Commercial NEBs

Estimated by	Category	Average Annual NEB	NEB per
WI Focus on Energy, 2003. <sup>19</sup> In 2003, TecMarket Works completed IDIs with participants in Wisconsin's Focus on Energy public benefits energy-efficiency programs. NEBs were not broken out by measure, but lighting was the most common measure installed through the program.			
NEB	Employee morale or satisfaction	\$1,356	Participant
	Waste generation	\$836	
	Productivity	\$3,171	
	Injuries and Illnesses	\$715	
	Defects and Errors	\$1,531	
Massachusetts, 2012. <sup>20</sup> In 2012, DNV KEMA and Tetra Tech used IDIs with 2010 C&I retrofit prescriptive lighting participants to estimate average annual NEB per measure (n=163). NEBs related to lighting included annual operations and maintenance (O&M) costs, administration costs, materials handling, materials movement, waste disposal, sales, other costs, and other revenue.			
Measure Type	Prescriptive Lighting	\$1,636	Participant
		\$0.0274	kWh
EmPOWER Maryland, 2015. <sup>21</sup> In 2014, Itron estimated O&M benefits associated with occupancy sensors and lamp replacements installed through the EmPOWER Maryland's C&I Prescriptive and Small Business Direct Install (SBDI). The study used a bottom-up engineering estimation.			
Measure Type	Linear Fluorescent Fixtures	\$0.004	Lifetime kWh
	Interior LEDs	\$0.030	
	Exterior LED	\$0.015	
	Occupancy Sensor	\$0.081	

<sup>19</sup> TecMarket Works. Non-Energy Benefits From Commercial And Industrial Energy Efficiency Programs: Energy Efficiency May Not Be The Best Story. 2003.

[https://www.aceee.org/files/proceedings/2004/data/papers/SS04\\_Panel4\\_Paper13.pdf](https://www.aceee.org/files/proceedings/2004/data/papers/SS04_Panel4_Paper13.pdf)

<sup>20</sup> DNV KEMA / TetraTech. Commercial and Industrial Non-Energy Impacts Study. June 2012.

[https://library.cee1.org/system/files/library/9929/CEE\\_DNV\\_KEMA\\_FinalMA\\_NEI\\_Rpt\\_29Jun2012.pdf](https://library.cee1.org/system/files/library/9929/CEE_DNV_KEMA_FinalMA_NEI_Rpt_29Jun2012.pdf)

<sup>21</sup> Itron. Development and Application of Select Non-Energy Benefits for the EmPOWER Maryland Energy Efficiency Programs. November 2015. <https://drive.google.com/file/d/11B06DIP3sMKjji6wzCzhCCjBBH4Hkeep/view>

Estimated by	Category	Average Annual NEB	NEB per
AEP Ohio, 2019. <sup>22</sup> In 2019, DNV GL estimated commercial NEBs associated with O&M cost savings, production /revenue changes, and non-O&M or production related NEBs through an engineering lifecycle assessment and a limited set of end-user IDIs with industrial/manufacturing sites that had measures installed through AEP Ohio's C&I programs. NEBs related to lighting included annual O&M costs, comfort, health and safety, sales, and productivity.			
Business Type and Measure	Retail Lighting	\$273	Participant
	Manufacturing Lighting	\$810	
	Hospital Lighting	\$549	

### 2.2.3 PRIMARY RESEARCH

To better understand commercial NEBs in Delaware, the EcoMetric team conducted nine in-depth telephone interviews representing 12 EEIF grantee sites with prescriptive lighting measures installed through the program in 2020. In these interviews, EcoMetric asked participants if their grantee site or sites had experienced an increase, decrease, or no change in possible non-energy costs or revenue from installing prescriptive lighting measures through the EEIF program. EcoMetric used this information to assess attribution to the EEIF prescriptive lighting measures. The following sections detail the results from each NEB category EcoMetric researched.

#### 2.2.3.1 Operations and Maintenance

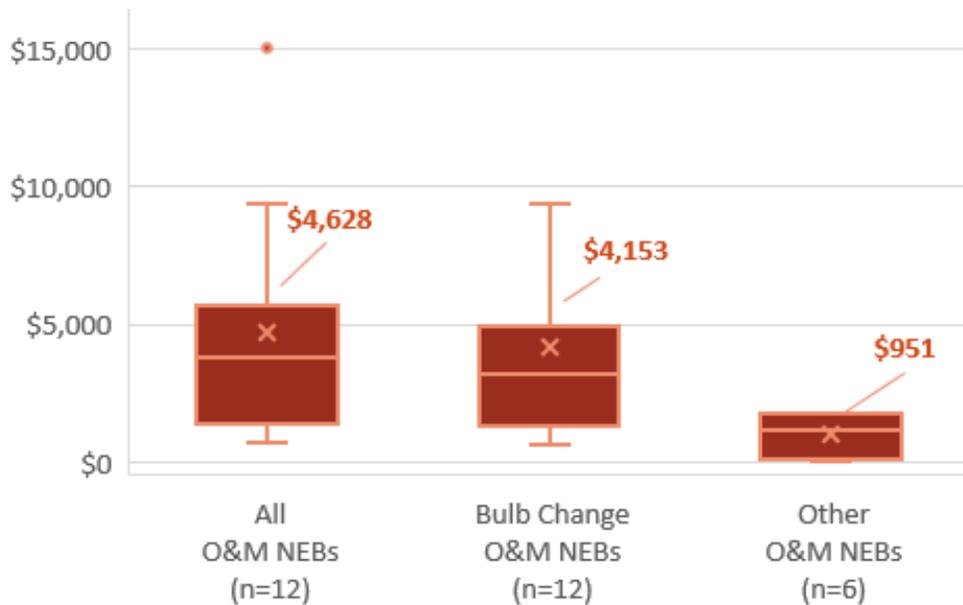
O&M NEBs refer to any change in costs related to maintaining equipment by contractors or in-house staff. All grantee sites experienced a decrease in O&M costs following the installation of efficient lighting through EEIF, and participants were able to quantify the decrease for each site. One participant also noted a one-time increase in O&M costs at their site. Figure 8 compares the range and distribution of values for all O&M, bulb change O&M, and other O&M annual NEBs estimates, including the mean, median, quartiles, maximum, and minimum values. Excluding one outlier, total annual NEBs for O&M alone ranged from \$633 to \$9,360, with an average of \$4,628 per site.

<sup>22</sup> Opinion Dynamics. The bottom line and energy efficiency: how non-energy impacts improve the bottom line and create targeted messages addressing industry specific pain points. August 2019.

[https://www.researchgate.net/publication/339746181\\_The\\_bottom\\_line\\_and\\_energy\\_efficiency\\_how\\_non-energy\\_impacts\\_improve\\_the\\_bottom\\_line\\_and\\_create\\_targeted\\_messages\\_addressing\\_industry\\_specific\\_pain\\_points](https://www.researchgate.net/publication/339746181_The_bottom_line_and_energy_efficiency_how_non-energy_impacts_improve_the_bottom_line_and_create_targeted_messages_addressing_industry_specific_pain_points)

When asked how O&M costs had decreased, participants mentioned fewer bulb and/or ballast replacements for all 12 sites, resulting in labor and equipment savings. Annual O&M NEB estimates related to bulb and/or ballast changes ranged from \$600 to \$9,360, with an average of \$4,153 per site.

Figure 8: O&M NEBs Values for 2020 EEIF IDI Grantee Sites



The wide range of NEBs estimates was due to several factors. The size of the grantee sites covered in the IDIs varied widely; the smallest site was 11,000 ft<sup>2</sup>, while the largest was 196,333 ft<sup>2</sup>. Additionally, what was involved in changing a bulb and/or ballast prior to installing energy-efficient lighting through EEIF varied widely. While some sites needed to use lifts, electricians, or multiple people to change certain bulbs, others had fluorescent tubes replaced by volunteers a few times per year.

When discussing decreases in costs related to changing a bulb or ballast at their grantee sites, participants reported the following:

- ▶ “I haven't had to replace lamps as often, which doesn't seem like much, but ... if the lamps go out, they have to get the lift out. Right? Thirty-foot ceilings. It's probably an hour or two... And you're looking at two guys, because there's one guy down on the ground, and then one [on the lift].”
- ▶ “I feel like every other week we were changing out ballasts with the old, you know, fluorescent things. And certainly, they were in hard-to-reach places, so we didn't take those on ourselves. We had the maintenance crew do that. And so, there's big, big savings there.”

- ▶ “Well, you had traveled time for [the electrician] to get there. I'm going to say three hours because they're going to charge you from the time, they leave their job till they get there and take care of whatever. And in some cases, it would involve multiple trips, because they got there and had to see if it was the bulb or the ballasts, and what they had to order and all that. And it would involve multiple trips.”
- ▶ “We don't have to have maintenance vehicles out here looking at the lights four times a year [anymore]... We had aging fixtures and a lot of times with the traditional fixture, half the time it was the ballasts failing too, and they started leaking, so we were replacing heads and stuff too. I'm going say it was along the lines of \$15,000 a year.”

Six participants noted O&M costs had decreased in other ways, including less time spent checking for burnt-out bulbs and avoided electrician or service costs. One participant reported a one-time non-bulb change-related O&M expense at their site as well. Annual O&M NEB estimates not related to bulb changes ranged from -\$13.33 to \$1,728, with an average of \$951 per site.

### 2.2.3.2 Safety

Safety NEBs refer to any change in costs related to improved safety and avoided injuries, property damage, and insurance costs resulting from the energy-efficient lighting measures installed through EEIF. All participants observed a decrease in safety-related costs at grantee sites, though only three were able to quantify these savings. The three participants who quantified savings represented three different site types and ranged in size from 16,000 ft<sup>2</sup> to 123,000 ft<sup>2</sup> and estimated annual safety-related NEBs at \$390, \$4,500, and \$10,125.

Safety-related NEBs included a reduction in product theft, a reduction in product and property damage, fewer opportunities for accidents or injuries resulting from better lighting, and fewer bulb changes and avoided citations due to exit lights being out.

### 2.2.3.3 Administration

Administrative NEBs refer to any change in costs related to the time employees spend running a business, such as accounting or avoided service or parts/supplies procurement. Four participants noted a reduction in administrative costs at their sites resulting from the energy-efficient lighting measures installed through EEIF, and all four were able to monetize the decrease. One participant noted a one-time increase in administrative costs to reprogram lighting controls for the new lighting installed at their site. Annual administration-related NEB estimates for these four sites ranged from \$72 to \$500, with an average of \$289.25 per site. Administrative-related NEBs mentioned by participants included less time spent ordering bulbs, avoided labor to turning on and off lights, and less time spent issuing and processing work orders.

#### 2.2.3.4 Waste Disposal

Waste disposal NEBs refer to any change in costs associated with avoided waste disposal or waste disposal contracts resulting from the energy-efficient lighting measures installed through EEIF. Three grantee sites had a reduction in waste disposal-related costs as there was no longer a need for the monthly disposal of bulbs. The average annual waste disposal-related NEB estimate from these three sites was \$1,500.

#### 2.2.3.5 Materials Handling

Materials handling NEBs refer to any change in costs associated with the company's time and costs for people in the loading docks and warehouses resulting from the energy-efficient lighting measures installed through EEIF. One participant reported that the better lighting allowed employees to find products quicker at their site and estimated that this increased efficiency reduced payroll by \$1,000 per year.

#### 2.2.3.6 Sales

Sales NEBs refer to any change in revenue resulting from the energy-efficient lighting measures installed through EEIF. Four participants reported an increase in annual sales, though only one was able to estimate an annual increase of \$2,400 due to improved lighting. Increased sales-related NEBs mentioned by participants included an increase in booking events or renting out a space, an increased likelihood of existing clients continuing to rent, more visible inventory, and increased flexibility for outdoor product sales.

#### 2.2.3.7 Other NEBs

In addition to the NEB categories that some participants were able to quantify for their grantee sites, participants provided anecdotal, though unquantified, evidence to support the NEBs values presented above.

### 2.2.4 NEBS RESULTS

Table 22 summarizes the NEBs that EcoMetric asked participants to consider, the number of grantee sites that experienced each NEB, and whether the site had experienced a decrease, increase, or no change for each after installing energy-efficient lighting measures through EEIF. Even if a site had experienced a particular NEB, participants were not always able to quantify the savings, revenue, or costs their organization had experienced for that category. Therefore, the table also includes the number of grantee sites that were able to quantify each NEB.

All 12 grantee sites experienced a decrease in O&M costs following participation, largely due to less time checking and replacing bulbs. All 12 grantee sites also experienced a decrease in costs related to

safety, though only three were able to quantify annual savings. Participants also noted a decrease in costs related to administration (4 of 12 grantee sites), waste disposal (3 of 12), and materials handling (1 of 12) at their grantee sites. One participant observed an increase in O&M costs at their site, and another noted an increase in administration costs. No grantee sites experienced changes in materials movement (time and costs related to deliveries and pickups). They also did not observe any changes in other labor costs, other general costs, or other revenue not included in the existing NEBs categories. Four participants noted an increase or a potential increase in sales revenue due, at least in part, to the installation of efficient lighting through EEIF. Only one participant was able to quantify the increase in sales for their site.

Table 22: EEIF Participant Observations of NEBs

NEB	Decrease		Increase		No Change
	# of Grantee Sites	# w/ NEB Quantified	# of Grantee Sites	# w/ NEB Quantified	# of Grantee Sites
<b>Costs</b>					
O&M	12	12	1	1	0
Safety	12	3	0	-	0
Administration	4	4	1	0	8
Waste Disposal	3	3	0	-	8
Materials Handling	1	1	0	-	11
Materials Movement	0	-	0	-	12
Other Labor	0	-	0	-	12
Other Costs	0	-	0	-	12
<b>Revenue</b>					
Sales	0	-	4	1	8
Other Revenue	0	-	0	-	12

For each NEB category that a grantee site had experienced, EcoMetric asked about the category in more depth in an attempt to estimate monetary costs or benefits when possible. Some participants provided total sum estimates, while others walked through calculations with the EcoMetric. For example, when exploring avoided annual costs resulting from the installation of efficient lighting through EEIF, EcoMetric asked participants to detail avoided labor hours, for how many workers, and at what hourly wage. More details can be found in 6.2Appendix 3.

Figure 9 is a box plot that compares the range and distribution of values for all O&M only and non-O&M annual NEBs estimates, including the mean, median, quartiles, maximum, and minimum values. The figure also shows outliers, defined as any estimate that is 1.5 times larger than the third

quartile or 1.5 times smaller than the first quartile. Excluding the one outlier, total annual NEBs estimates ranged from \$633 to \$9,900, with an average of \$7,126 per site. Similarly, excluding the one outlier, annual estimates for O&M only NEBs ranged from \$633 to \$9,360, with an average of \$4,628 per site. Participants were able to monetize NEBs other than O&M for eight grantee sites. Total annual estimates for all other NEBs combined ranged from \$72 to \$10,125, with an average of \$3,007 per site. Due to the small sample sizes, confidence intervals for the mean estimates are not presented as these intervals would be too wide and not particularly useful.

Figure 9: NEBs Values for 2020 EEIF IDI Grantee Sites

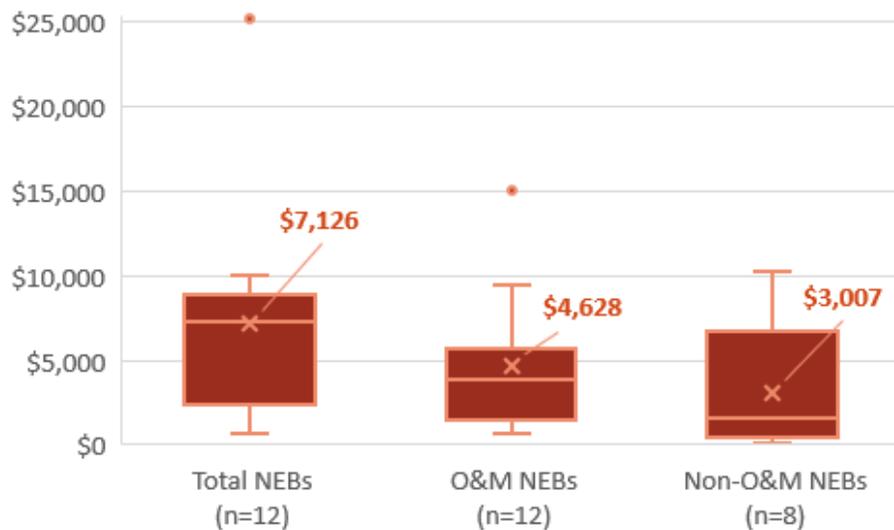


Figure 10 shows NEBs per kWh of electric savings. NEBs by kWh estimates ranged from \$0.006 NEBs/kWh to \$0.557 NEBs/kWh, with an average of \$0.035/kWh. These results are comparable to the 2012 Massachusetts C&I retrofit prescriptive lighting study, which estimated an average of \$0.0274 NEB/kWh for 2010 participants. This value increases to \$0.329 NEBs/kWh when adjusted for inflation.<sup>23</sup>

<sup>23</sup> EcoMetric used the BLS.gov inflation calculator, which is based on the Consumer Price Index (CPI), for inflation adjustment. CPI provides the best indicator for inflation as experienced by private consumers.

Figure 10: NEBs by kWh –MA 2010 C&I Participants vs DNREC EEIF 2020 IDI Grantee Sites

DNREC EEIF 2020 C+I NEBs (n=12)



MA 2010 C+I NEBs – DNV KEMA (n = 163)



**Finding 13:** EcoMetric found the average estimate of total NEBs to be \$7,126 per site per year, or \$0.0350/kWh, for CY2020 EEIF prescriptive lighting participants. These results are comparable to the prescriptive lighting values from the 2012 Massachusetts C&I retrofit study.

**Finding 14:** EcoMetric found that O&M-related decreases in cost were mentioned and quantified by each grantee that was interviewed. The average estimate of total O&M NEBs was \$4,628 per site per year.

*Recommendation 10: Due to the small size of the population and sample, these results should be considered preliminary, and EcoMetric recommends using them only as qualitative indicators of the C&I NEBs. EcoMetric recommends that DNREC consider conducting a follow-up C&I NEBs study with a larger survey of 2020 and 2021 participants to bolster these estimates and provide statistical confidence in adopting commercial NEBs values for EEIF.*

### 2.3 EEIF TARGETED PROCESS STUDY

EcoMetric completed a targeted process study to understand how program processes have changed since adding CLEAResult, a third-party implementer, to the EEIF program delivery team and how these changes have affected program performance towards its goals. EcoMetric completed a

combination of in-depth interviews, Application Portal<sup>24</sup> review, and a review of program processes to develop the findings and recommendations in this section.

### 2.3.1 RESEARCH GOALS

EcoMetric set forth clearly defined goals at the outset of this targeted process study to help DNREC improve the delivery of the EEIF program to meet its participation goals. These goals support DNREC's dedication to providing Delaware's residents and businesses with safe, efficient, and low-cost energy efficiency options, thereby improving the livability and economic well-being of the communities it serves.

The overall objective of this targeted process study was to understand how the EEIF program delivery model changed since adding CLEAResult to the program delivery team and develop recommendations to improve program participation to meet DNREC goals.

Research goals included:

- ▶ Develop an understanding of the roles of DNREC and the program delivery team and how they work together
- ▶ Investigate marketing and outreach efforts to develop recommendations to improve program participation
- ▶ Collect feedback from active participating contractors on their experience and satisfaction with the program
- ▶ Review the Application Portal to measure functionality, ease of use, and depth as an application module

### 2.3.2 PROGRAM DESCRIPTION

EEIF provides financial incentives to businesses, state agencies, local governments, and non-profits to make energy efficiency upgrades in existing facilities. The incentives were designed to defray some of the cost difference between high-efficiency equipment and equipment that was no more efficient than what was commonly installed in commercial buildings (i.e., "baseline" equipment).

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<sup>24</sup> [https://eeif.smartsimple.com/s\\_Login.jsp](https://eeif.smartsimple.com/s_Login.jsp)

Four types of grants were available through the EEIF program: prescriptive, custom, energy assessment, and combined heat and power. Prescriptive lighting projects comprise the majority of projects supported by EEIF.

Historically, Delaware contractors typically brought customers into the program and helped them through the process of becoming EEIF grantees. DNREC staff were responsible for reviewing and approving applications, tracking each project's details for the program, and disbursing grant monies upon project completion. DNREC also contracted with a third-party consultant, Optimal Energy, to provide technical review services for some larger and more complex projects prior to pre-approval.

Towards the end of Calendar Year (CY) 2020, DNREC hired a third-party implementer, CLEAResult, to help deliver the EEIF program. CLEAResult, the third-party implementer, has taken on most of the duties DNREC was historically responsible for as part of the program delivery.

On July 1, 2021, DNREC released the EEIF Application Portal, an online portal used by EEIF participants to submit applications and supporting documentation, calculate savings and incentives, and track their projects through the approval process. The addition of the Application Portal marked a change from the previous application model that was based largely on fillable PDF applications that were emailed to the program delivery team.

In an effort to impact a broader range of Delawareans, DNREC focused on driving participation in the state's small and medium businesses. The grant cap was updated from \$1M per organization to \$100,000 per facility per year to spread out the program's grant money across a wider swath of Delaware's commercial sector. DNREC has also directed the implementation contractors to restructure marketing and outreach to target these small businesses.

### 2.3.3 RESEARCH METHODS

EcoMetric utilized several methods to gain a detailed understanding of the past and current program operation since the transition to include CLEAResult in program delivery. EcoMetric also completed a review of the EEIF Application Portal, which has undergone several updates since its inclusion in the program in CY2020. These methods are described in the subsections below.

#### 2.3.3.1 In-Depth Interviews

EcoMetric completed in-depth interviews with DNREC EEIF Staff (DNREC program manager and supervisor) and staff at CLEAResult responsible for administration, engineering, and marketing for the program. The goal of these interviews was to gain a detailed understating of the program as it relates to program administration and coordination, grantee intake procedures, program marketing, staffing, successes, and challenges.

EcoMetric also completed seven in-depth interviews with contractors who had submitted applications through the EEIF Application Portal. EcoMetric prioritized contractors for interviews based on the number of applications they submitted on behalf of customers, with more active contractors recruited first. This research aimed to assess contractors' experience with the program since the changes to EEIF's delivery model were made.

### 2.3.3.2 Program Marketing Material Review

EcoMetric reviewed program materials used by CLEAResult for program delivery and outreach. These materials included:

- ▶ Tri-fold marketing brochure
- ▶ Frequently Asked Questions (FAQs) document
- ▶ Program checklists
- ▶ Project approval letters

### 2.3.3.3 Portal Review

EcoMetric conducted a review of the EEIF Application Portal in October 2021. EcoMetric assessed the ease of use and navigation, clarity of instructions, and accuracy of technical aspects. The review included all 5 of the main sections that make up an EEIF application:

1. Applicant & Contractor Details
2. Site Information
3. Project Details
4. Calculations
5. Terms & Conditions

As part of the review, EcoMetric created three test applications: Prescriptive Heating, Custom, and Prescriptive Lighting application types. The purpose was to mimic the experience of an actual contractor or facility owner using the site for a real project.

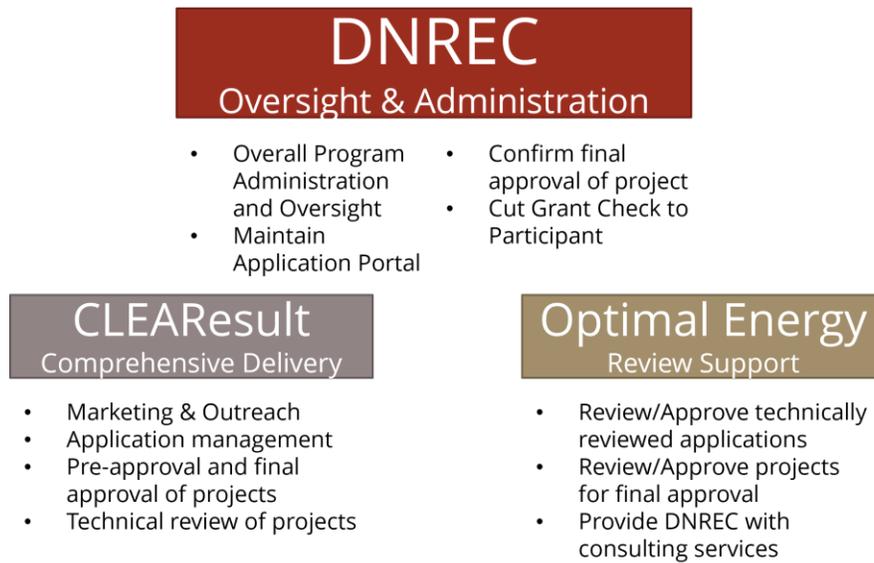
## 2.3.4 RESEARCH FINDINGS AND RECOMMENDATIONS

This section summarizes the key findings and recommendations from the research methods described above.

### 2.3.4.1 Program Administration and Coordination

DNREC, Optimal Energy, and CLEAResult now work together to deliver the EEIF program. Their overall roles and responsibilities are summarized in Figure 11.

Figure 11: EEIF Delivery Organization



DNREC oversees the delivery and administration of EEIF, hiring CLEAResult and Optimal Energy as contractors to implement the program. As the administrator of the program, DNREC signs off on the final approval of EEIF projects and delivers the grant money to participants once all program requirements have been fulfilled. DNREC staff also maintain the Application Portal, ensuring customers and contractors have a smooth experience from application through project approval. The addition of CLEAResult to the program delivery model allowed DNREC to take more of an oversight role, freeing up time to monitor the program at a high level and focus on overall program design and goals.

CLEAResult leads the day-to-day delivery of EEIF, providing comprehensive delivery services throughout the entire program process from marketing and outreach to final approval of projects. EcoMetric’s assessment of the program marketing and outreach is summarized in Section 2.3.4.2. CLEAResult processes applications received through the Application Portal and provides assistance to contractors or customers who have questions or issues as they work through the application and approval process. This includes working with participants to provide missing project documentation, properly completing application and approval steps, and providing communication on project status and next steps. CLEAResult’s engineers conduct engineering reviews of the projects for both pre-approval and final approval.

Optimal Energy supports CLEAResult’s engineering reviews in the pre- and final approval steps, providing CLEAResult with authorization to pass projects on to the next stage if the reviews are deemed adequate and accurate. They also support DNREC with tasks related to Energy Efficiency Advisory Council (EEAC) oversight and strategic planning.

**Finding 15:** DNREC and the EEIF implementation contractors have clear and defined roles that support efficient processes for program delivery.

The key to strong program delivery and performance is clear and consistent communication between teams supported by a defined structure and routine. The implementation contractors, CLEAResult and Optimal Energy, meet weekly to discuss the program and project-specific progress and issues. Leveraging their experience in the program and longer relationship with DNREC, Optimal Energy remains the main point of contact for DNREC program administrators. DNREC also shares an EEIF Inbox with CLEAResult, where each final application review is emailed to DNREC program administrators for final approval, and ad hoc program and project questions are discussed.

**Finding 16:** Overall, the communication structure for the program is strong for the three parties. One DNREC program administrator stated that despite having two groups implementing the program, “it feels like information and data are coming through to us from one team”.

***Recommendation 11:** To further improve communication and build on this, EcoMetric recommends including CLEAResult on Optimal Energy’s direct communications with DNREC.*

As the most “hands-on” implementation contractor, CLEAResult can provide first-hand knowledge and experience of how the program and projects are progressing from the ground level.

To manage application and project documentation, CLEAResult saves all application and project documents to a SharePoint site for all parties to access. This is standard practice to ensure organized and transparent project documentation management. However, the data and information from the Application Portal are not connected to CLEAResult’s program tracking systems, resulting in an additional effort by both DNREC and CLEAResult to track program metrics and create a risk of misalignment.

***Recommendation 12:** EcoMetric recommends that efforts be made to integrate the Application Portal with CLEAResult’s program tracking and delivery systems to improve tracking, invoicing, and reporting processes.*

A possible solution is creating a standardized data export that CLEAResult can download from the Portal and integrate into their systems using automated processes. Automating and standardizing this process greatly reduces the amount of effort and risk of misalignment of important program data. EcoMetric understands that this type of effort is in the planning stages and recommends it be prioritized for the program moving forward.

#### 2.3.4.2 Marketing And Outreach

One of CLEAResult's core responsibilities in EEIF program delivery is conducting marketing and outreach that drives program participation. Once onboard, CLEAResult started a digital marketing campaign to increase program awareness and attract interested customers to the EEIF program landing page hosted on DNREC's website.

**Finding 17:** The digital campaign resulted in a surge in views on the EEIF program page, but the bounce rate remains high—especially for mobile users.

*Recommendation 13: EcoMetric recommends that DNREC work to improve its website's performance for mobile users.*

Today, much of the web traffic is mobile, especially for busy owners and decision-makers of the small and medium businesses the program hopes to attract.

Beyond the digital campaign, CLEAResult also uses classic program marketing media such as brochures, FAQ documents, and print ads to bring awareness to the program. The more detailed documents such as program FAQs and project checklists do a good job of summarizing the steps and supporting documentation required of participants to receive their grant rewards.

**Finding 18:** The brochure outlines the different program paths and measures opportunities well.

Potential participants, both business owners and the contractors they hire are often most concerned with the financial bottom line. Highlighting the amount of funding available and the potential for these projects to result in long-lasting bill savings is a critical message for program outreach.

*Recommendation 14: In the marketing material, consider highlighting the program incentives and bill savings that result from energy efficiency project.*

**Finding 19:** CLEAResult is also implementing a more "on-the-ground" approach to marketing, working directly with contractors and business owners to show them the opportunities and benefits of participating in EEIF.

While the COVID-19 pandemic has undoubtedly put a damper on in-person outreach, webinars remain a valuable resource to speak directly with contractors and business owners about EEIF.

*Recommendation 15: As COVID-19 restrictions are lifted, EcoMetric recommends investing further in this outreach approach through events like contractor lunches and site visits with business owners to provide a personalized approach to marketing EEIF.*

While restrictions and concerns surrounding the pandemic remain, marketers can rely on webinars and video calls to provide a safe, more personal form of marketing and outreach.

While DNREC provides a major public benefit to Delaware, business owners are far more familiar with their local utilities who have their logos on the bills they receive every month. Municipalities also have the ability to reach small and medium businesses to promote the community benefits that participating in EEIF offers.

***Recommendation 16:** EcoMetric recommends partnering with local utilities and municipalities in Delaware to promote EEIF.*

Contractors can be a powerful ally for marketing and outreach of the EEIF program. This is especially true when targeting small to medium business owners who are often too busy to focus on potential energy efficiency investments and program participation requirements. Building relationships with contractors and ensuring they have positive experiences with the program can result in contractors making EEIF funding opportunities part of their “sales pitch” to their customers.

**Finding 20:** EEIF considered implementing a trade ally network in the past but does not currently maintain a trade ally network.

***Recommendation 17:** EcoMetric recommends implementing a trade ally network of contractors experienced in the program. The proposed trade ally network should be marketed on the EEIF program page, with a list of contractors, their specialties, and contact information.*

A trade ally network presents multiple benefits to the EEIF program. First, DNREC and program implementers can invite the most successful and easy to work with contractors to the network to ensure quality applications and projects are coming into the program. Secondly, trade ally networks build trust and deepen relationships between the program and contractors, resulting in contractors who see the marketing value of such a network to their businesses. Engaged contractors are much more likely to market the program to their customers directly.

**Finding 21:** EcoMetric’s primary research revealed that contractors are largely interested in participating in a trade ally network.

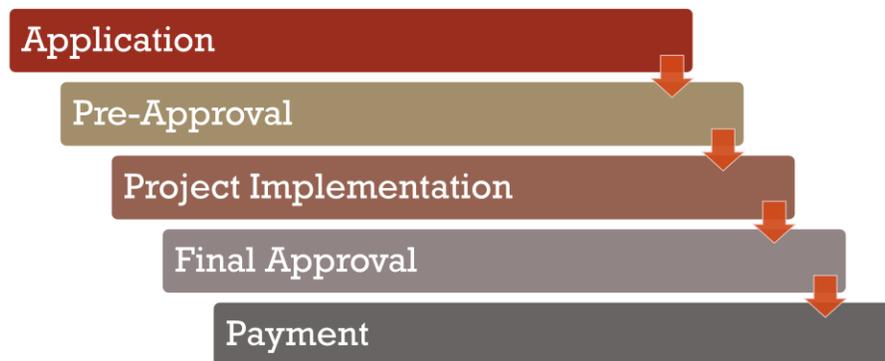
Six out of seven contractors that EcoMetric interviewed said they would be interested in participating in a trade ally network for EEIF. The only non-affirmative response came from a contractor who answered, “I am not the person to ask at my company”.

### 2.3.4.3 Application and Approval Process

Figure 12 summarizes the EEIF program process at a high level. Once an application and supporting documentation is submitted via the Application Portal, all projects must first receive pre-approval from DNREC before purchasing any materials or implementing the proposed project. CLEAResult reviews the application package and conducts a technical review of the proposed project. Optimal Energy reviews this effort and approves CLEAResult to add the project to the list of pre-approved projects for DNREC to review. DNREC reviews this list and authorizes CLEAResult to send applicants a pre-approval letter if they have met program requirements. After the pre-approval is given, applicants must register with the State of Delaware and complete an eSupplier information sheet. Once these steps are completed, the pre-approved project is implemented by the participant and their contractor.

Following the implementation of the project, the applicant must submit additional documentation via the Application Portal for final approval and confirmation the project was implemented as planned. For example, documentation required for final approval of a prescriptive lighting project includes itemized invoices for all equipment in the scope of work, proof of payment of the invoices, eSupplier registration, and completed eSupplier information sheet.

Figure 12: EEIF Process Flow



CLEAResult conducts the final approval to ensure the project was correctly installed according to the scope of work agreed upon in the pre-approval process. Optimal Energy supports engineering reviews, and the final approval goes through the DNREC program staff. Once the final approval is authorized, DNREC processes the grant, and the rebate check is mailed to the participant.

**Finding 22:** Along with the Application Portal, DNREC has also added Excel-based calculators to the application and approval process.

These calculators are designed to gather the correct data and information to accurately estimate savings using TRM-based calculations. Both DNREC and CLEAResult agree that the calculators are

indeed collecting higher quality and more accurate data to achieve this goal of accurate savings estimates. EcoMetric also reviewed the prescriptive calculators to ensure the savings algorithms used in the calculators were in complete alignment with the TRM.

***Recommendation 18:** EcoMetric recommends that these calculators be updated routinely to align with program and TRM changes as they arise.*

EcoMetric asked participating contractors about their experiences with the EEIF application and approval process.

**Finding 23:** Most of the contractors agreed that having the application portal online with status tracking through the Portal was a positive aspect of the program. In terms of room for improvement, several contractors commented that the pre-approval process was lengthy, and approval timing expectations could be clearer.

EcoMetric also asked contractors the open question—what aspects of the EEIF program could be improved? Their responses are summarized in Table 23. Again, most contractors interviewed would like to see the length of the approval process shortened or streamlined.

*Table 23: EEIF Contractor Program Improvements*

Suggested Program Improvement	Count of Responses
Shorten or streamline approval process	4
Increase incentive levels	2

***Recommendation 19:** Considering the focus on attracting more small and medium businesses to the EEIF program, EcoMetric recommends reconsidering the pre-approval step for the prescriptive pathway.*

Smaller prescriptive projects should be subject to less scrutiny in the early stages than custom or CHP projects. The addition of prescriptive calculators that follow TRM algorithms as part of the application process is a great step to provide certainty for these smaller projects. Considering the time and budget constraints of small and medium businesses, coupled with the current market chain issues affecting access to equipment, awaiting pre-approval before ordering equipment can be a major barrier for this target market.

***Recommendation 20:** Taking it a step further, developing a direct install pathway for small and medium businesses would create an attractive option for busy business owners. A direct install path would also provide DNREC with greater assurance that measures are being implemented correctly, eliminating the need for two separate approval steps.*

#### 2.3.4.4 Program Design

**Finding 24:** DNREC has recently shifted its program goals to reach more of Delaware’s small and medium sized businesses through the EEIF program.

As part of this effort, the grant reward cap has been reduced from \$1M per participant to \$100,000 per year per facility so that more funds are spread across more businesses as opposed to being concentrated in larger companies. There will be additional marketing investments and efforts needed to reach decision makers at small and medium businesses compared to large multi-site companies where one relationship can be leveraged to develop several projects throughout the company’s network of facilities. A more on-the-ground, grassroots approach, outlined in Section 2.3.4.2, would be better suited to reach this new target market.

In reducing the grant reward cap from \$1M per participant to \$100,000 per year per facility, DNREC expected the volume of projects from small and medium sized businesses to increase in order to achieve their savings targets for the EEIF program. However, the volume of projects from small and medium sized businesses completed through the program in CY2021 did not increase as expected. It is possible that the COVID-19 pandemic contributed to the participation rate of the small and medium sized business. Reducing the incentive cap also impacts the economic feasibility for larger customers to implement energy efficiency projects through the program.

*Recommendation 21: In order to achieve program savings goals and effectively award grant monies for the completion of energy efficiency projects through EEIF, EcoMetric recommends that DNREC increase the grant reward cap to \$500,000 per participant.*

**Finding 25:** Based on interviews with DNREC and implementation staff, a new construction program pathway is in development for EEIF.

This new pathway is a great fit for the EEIF program and should unlock a healthy market for the program to target.

*Recommendation 22: Marketing and outreach efforts for the new construction pathway should target building developers, engineers, and architects.*

Contractors will continue to be an important ally in marketing of new construction as well, as they can integrate available EEIF funding into their sales pitch for retrofit and new construction jobs, depending on the situation.

*Recommendation 23: In order for the addition of a new construction pathway to be most successful, it will be important to design program documents and processes to closely follow the best current*

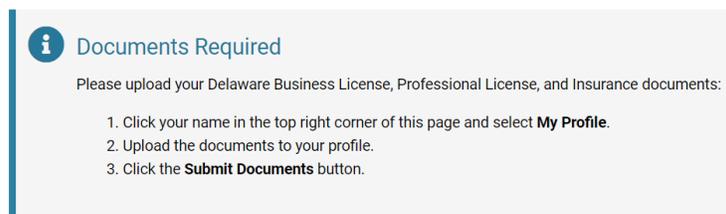
*practices that contractors have grown accustomed to. This includes leveraging the Application Portal to outline program requirements, track project progress, and provide TRM-based calculators for accurate savings and incentive estimates.*

#### 2.3.4.5 Portal Review Results

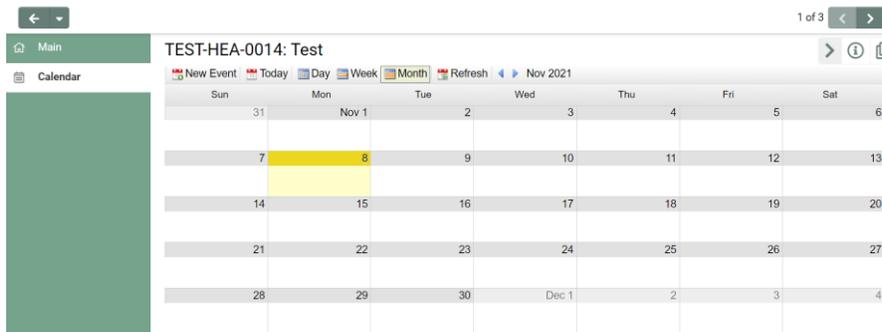
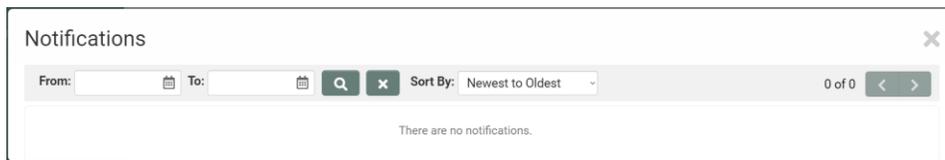
**Finding 26:** Through the review of the Application Portal, it was clear that DNREC had made several important changes and updates to the portal since EcoMetric’s original review in September 2020.

EcoMetric notes the following key findings:

- ▶ The portal displays clear messages to the user regarding required documentation.



- ▶ For the prescriptive heating and prescriptive lighting measures, the portal links directly to a standardized Excel-based energy savings calculator. The user is instructed to fill out the necessary input fields in the calculator tool, then upload it to the portal as part of the application submission.
  - The use of a standardized energy savings calculator is not only helpful to the program administrators, but it should also remove a barrier to participation for some of the sectors that historically have not participated in the EEIF program – namely, small businesses. Small business owners likely have neither the time nor resources to generate their own custom energy savings calculations. The standardized tools only require basic inputs about the facility and equipment involved in the energy efficiency measure(s).
  - It is EcoMetric’s understanding that a similar effort is underway for prescriptive HVAC measures.
- ▶ There are a number of features on the portal site for which no instructions were provided as to their function. EcoMetric did not utilize them as part of their testing with the three test applications. The features include:
  - Notifications
  - Calendar



*Recommendation 24: While the data fields listed above do not seem critical to completing or submitting an application in the Application Portal, EcoMetric recommends including instructions within the portal regarding their usefulness.*

- ▶ In the 'Open - Energy Savings Table' popup on the 'Calculations' tab, the selection of grant tier level is automated based on the user's input for number of end uses, though the explanation of various grant tier levels is confusing.

*Recommendation 25: EcoMetric recommends displaying the grant tier level information in a manner that is easier to digest - perhaps with a decision tree.*

#### Incentive Level Tier

End Uses	Incentive Tier
2	Multi

#### Incentive Level Tiers

<b>Single Tier:</b> Project contains one (1) end use and can be electric and/or gas.									
<b>Multi-Tier:</b> Project must be an Energy Management System (EMS) OR contain two (2) end uses and can be electric and/or gas. If lighting is one end use, 80% of the lighting must be dimmable as defined by the Design Lights Consortium (DLC).									
<b>Comprehensive Tier:</b> Project contains at least three (3+) end uses and can be electric and/or gas. If lighting is one of the end uses, it must include fixture-integrated or networked lighting controls to be considered comprehensive.									
<b>Notes on EMS:</b> A control system that only controls lighting is not an EMS. A control device/system that just establishes the space temperature and a setback temperature is not an EMS.									
<b>End Use examples:</b>									
<table border="0"> <tr> <td>Heating</td> <td>Cooling</td> <td>Ventilation</td> </tr> <tr> <td>Domestic Water Heating</td> <td>Refrigeration</td> <td>Energy Management System (EMS)</td> </tr> <tr> <td>Lighting</td> <td>Industrial Process</td> <td></td> </tr> </table>	Heating	Cooling	Ventilation	Domestic Water Heating	Refrigeration	Energy Management System (EMS)	Lighting	Industrial Process	
Heating	Cooling	Ventilation							
Domestic Water Heating	Refrigeration	Energy Management System (EMS)							
Lighting	Industrial Process								

#### Incentives for Energy Efficiency

Tier	Single Tier	Multi-Tier	Comprehensive Tier
<b>Electric Incentive</b>	\$0.15 / kWh	\$0.20 / kWh	\$0.25 / kWh
<b>Gas Incentive</b>	\$9 / MMBtu	\$18 / MMBtu	\$27 / MMBtu

**Finding 27:** In addition, the terms “energy savings” and “energy consumption” seem to be used interchangeably.

*Recommendation 26: For clarity, EcoMetric recommends ensuring that these terms remain distinct from one another – “energy consumption” should refer to an amount of energy over a period of time, while “energy savings” should refer to the difference in energy consumption between two periods of time due to an energy efficiency measure. Adding ‘tool-tips’ to explain the terms when users hover over the text would be helpful.*

Energy Savings			
Energy Consumption	Units	Incentive Rate (per Unit)	Award
<input type="text"/>	kWh	\$0.20	\$0.00
<input type="text"/>	MMBtu	\$18.00	\$0.00
			\$0.00
<input type="text"/>	tons CO <sub>2</sub>	n/a	<input type="text"/>
<input type="text"/>	tons SO <sub>2</sub>	n/a	<input type="text"/>
<input type="text"/>	tons NO <sub>x</sub>	n/a	<input type="text"/>
			<input type="text"/>
<b>Total Predicted Rebate:</b>			<b>\$0.00</b>

- ▶ The language regarding project and measure description(s) fields could be stronger. EcoMetric has historically seen dozens of applications (including most custom project applications) as part of their annual program evaluation effort where description fields are left blank or simply refer to a separate document.

*Recommendation 27: EcoMetric recommends that DNREC require the applicant to populate fields designated for project, measure, or system descriptions.*

- ▶ Instructions for the fields should explain to the user that the application will not be approved if a detailed written description is not provided.
- ▶ The instructions and formatting on the custom application Excel calculator could be improved:
  - Consider locking all cells with formulas so that the formulas cannot be intentionally or inadvertently overridden with manually-inputted values.
  - The instructions refer to entering energy and emission savings, but the table only shows energy savings (electric kWh and natural gas MMBtu).
- ▶ It may not be necessary to require that the applicant fill out both the Energy Savings Table on the portal and the custom application Excel calculator. All of the energy savings and incentive calculations could take place within the Excel calculator.

The Green Energy Program (GEP) provides funding to promote the use of renewable energy technologies to commercial, non-profit, and residential customers throughout Delmarva Power & Light's service territory in Delaware. The program offers incentives for a variety of renewable technologies such as solar photovoltaic (PV), solar hot water, wind, and geothermal systems.

The customers apply for grant funding on the Green Grant Delaware<sup>25</sup> internet portal for the respective technology type. The grant amount is calculated based on the capacity of the installed equipment.

### 3.1 IMPACT EVALUATION

#### 3.1.1 PROGRAM DATABASE REVIEW AND SAMPLING

GEP had 255 renewable energy projects completed during the 2020 calendar year (CY). EcoMetric defined each project as a unique application and included only projects with the "paid" payment status.

Solar PV projects were the most significant measure for the GEP. On an equivalent energy basis<sup>26</sup>, solar PV accounts for almost 82.6% of the installed capacity through the program. Table 24 shows a summary of CY2020 for GEP.

Table 24: GEP Program Summary

Program Year	Measure	Projects	Capacity (MW)	Capacity (Tons)
2020	PV	227	2.34	NA
	Geothermal	28	NA	139.5
<b>Total</b>		<b>255</b>	<b>2.34</b>	<b>139.5</b>

Not Applicable (NA): value is not applicable for this measure type

<sup>25</sup> <http://greengrantdelaware.com/>

<sup>26</sup> Simply converting tons to watts for geothermal projects by multiplying tons by 12,000 and dividing by 3412.

The GEP evaluation sample frame breaks out each of the measures into separate strata. EcoMetric further segmented each measure type into substrata with the appropriate facility type. A summary of the sample frame is shown in Table 25.

Table 25: GEP Sample Frame

Measure	Facility Type	Stratum	Project Count	Percent (Count)	Capacity (MW)	Capacity (Tons)
PV	Non-Profit	Probability	5	2%	0.16	NA
	Non-Residential	Probability	4	2%	0.23	NA
	Residential	Large Probability	172	67%	1.72	NA
	Residential	Small Probability	46	18%	0.23	NA
Geothermal	Residential	Probability	28	11%	NA	139.5
<b>Total</b>			<b>255</b>	<b>100%</b>	<b>2.34</b>	<b>139.5</b>

Not Applicable (NA): value is not applicable for this measure type

EcoMetric randomly selected projects from the probability strata. The large and small strata for residential solar PV projects separated projects greater than 10 kW (0.01 MW) into the large probability stratum and those less than 10 kW (0.01 MW) into the small probability stratum.

EcoMetric selected a sample of 30 projects, targeting 85% confidence and 15% precision for the program, and allocated the sample points to each of the measure and facility type combinations in proportion to their respective installed capacities. The number of samples given to each stratum and the percentage of projects and capacities covered by the sampled projects are shown in Table 26.

Table 26: GEP Sample Coverage

Measure	Facility Type	Stratum	Sampled Count	Percent Sampled Count	Sampled Capacity (MW)	Sampled Capacity (Tons)	Percent Sampled Capacity
Solar PV	Non-Profit	Probability	2	44%	0.12	NA	30%
	Non-Residential	Probability	2				
	Residential	Small Probability	12	10%	0.16	NA	8%
	Residential	Large Probability	10				
Geothermal	Residential	Probability	4	14%	NA	27	19%
<b>Total</b>			<b>30</b>	<b>12%</b>	<b>0.28</b>	<b>27</b>	<b>13%</b>

Not Applicable (NA): value is not applicable for this measure type

EcoMetric found the GEP database user-friendly and was able to find critical pieces of information for sampled projects easily. The key variables were consistently reported throughout the database and facilitated an efficient review of sampled projects.

**Finding 28:** Annual energy generation is tracked for Solar PV projects, but the annual energy savings are not tracked for geothermal projects in the GEP program database.

*Recommendation 28: Add an estimated energy savings (kWh) data field to the Green Grant Delaware online application portal for geothermal projects to allow for program tracking.*

### 3.1.2 GROSS SAVINGS VERIFICATION

#### 3.1.2.1 Data Collection

EcoMetric referred to the grant applications, interconnection applications, plot diagrams, equipment specification sheets, and invoices for relevant program information and securely accessed the aforementioned program documentation via the Green Grant Delaware portal.

#### 3.1.2.2 Engineering Desk Reviews

EcoMetric completed engineering desk reviews for all projects in the evaluation sample. The reviews used all information included in the project files to verify installed equipment capacity, calculate energy generation, and ensure that projects consistently followed program rules. EcoMetric also

compared the information in the project files to information recorded in the tracking system to verify data accuracy and verify the installed capacity for each sampled project.

**Finding 29: The project documentation provided was easy to locate and was consistent with program requirements.**

### *3.1.2.2.1 Solar PV Analysis*

EcoMetric independently calculated the generation capacity for each sampled project using the PVWatts® calculator<sup>27</sup>. The PVWatts calculator requires user inputs, including PV capacity, module type (standard, premium, and thin film), tilt, azimuth, and estimated system losses. Users add details about the inverter and ground covering ratio (shading factor) in the Advanced Parameters tab. The calculator assumes a typical ground coverage ratio of 0.4 and can calculate inverter efficiency and size ratio with the information provided in the inverter specification sheets included in the GEP program documentation. EcoMetric calculated the PV system size by utilizing plot diagrams to verify the number of panels installed and the PV panel specification sheet to verify rated wattage, both of which were included in the program documentation. The team also verified the tilt and azimuth angles using plot diagrams and interconnection applications.

Figure 13 and Figure 14 show examples of the PVWatts® inputs such as system capacity, type of modules, mounting, system losses, tilt, and azimuth angles of the installed panels. Additionally, details such as DC to AC size ratio and inverter efficiency are captured for the installed system.

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<sup>27</sup> NREL PVWatts Calculator: <https://pwwatts.nrel.gov/pwwatts.php>

Figure 13: PVWatts® Input Window

PVWatts® Calculator



My Location **115 Issacs Shore Drive, Milford, DE, 19963**  
» Change Location

**HELP**   **FEEDBACK**

ALL NREL SOLAR TOOLS

RESOURCE DATA   **SYSTEM INFO**   RESULTS

←

Go to resource data

## SYSTEM INFO

Modify the inputs below to run the simulation.

DC System Size (kW):

11.8

i

Module Type:

Standard ▼

i

Array Type:

Fixed (roof mount) ▼

i

System Losses (%):

14.08

i

Loss Calculator

Tilt (deg):

20

i

Azimuth (deg):

137

i

— Advanced Parameters

---

DC to AC Size Ratio:

1.18

i

Inverter Efficiency (%):

96.5

i

Ground Coverage Ratio:

0.4

i

→

Go to PVWatts® results

RESTORE DEFAULTS

Draw Your System

Click below to customize your system on a map. (optional)

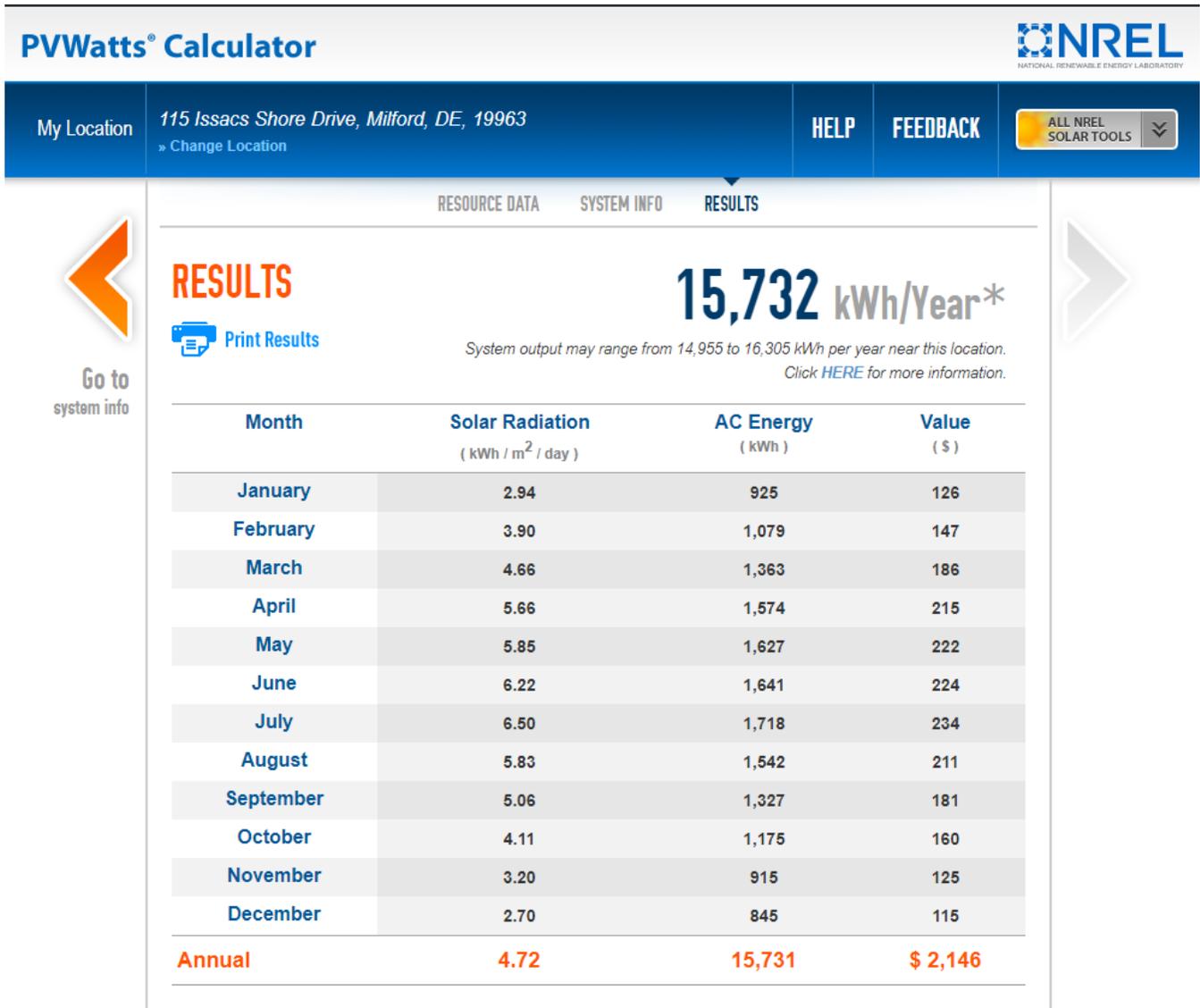




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Figure 14: Example of Results Window from PVWatts®



### 3.1.2.2.2 Geothermal Analysis

For clarity, in this section, “geothermal heat pump” and “ground source heat pumps” refer to the same measure. The program refers to the equipment as geothermal units, while the EcoMetric used the ground source heat pump savings methodology from the Mid-Atlantic Residential TRM Version

10<sup>28</sup> to estimate the energy savings. EcoMetric used Delaware specific full load heating and cooling hours as listed in the Mid-Atlantic TRM to calculate the verified savings. Section 3.1.3.2 provides more detail as it relates to the verified savings approach.

The specifications sheet of a ground source heat pump certified by Air- Conditioning, Heating and Refrigeration Institute (AHRI)<sup>29</sup> include model numbers, cooling and heating capacities, and efficiencies. EcoMetric referenced the AHRI specification sheets when calculating the verified energy-saving section 3.1.3.2.

### 3.1.3 VERIFIED RESULTS

The Delaware EM&V regulations<sup>30</sup> do not govern GEP, so the program does not track peak demand savings. Instead, the GEP focuses on installed capacity as the key performance metric. Therefore, EcoMetric verified the system capacities for a sample of projects in the program. The program achieved a weighted capacity realization rate of 100% for solar PV projects and 100% for geothermal, or ground source heat pump projects completed in CY2020. The solar PV capacity realization rate's relative precision was 1% at the 85% confidence level. The geothermal capacity realization rate did not have any margin of error at the 85% confidence level. The verified capacities, capacity realization rates (RR), and precision values are shown in Table 27.

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<sup>28</sup> Mid-Atlantic Technical Reference Manual Version 10: <https://neep.org/mid-atlantic-technical-reference-manual-trm-v10>

<sup>29</sup> Air-Conditioning, Heating and Refrigeration Institute Product Finder: <https://www.ahridirectory.org/Search/SearchHome>

<sup>30</sup> Delaware Evaluation, Measurement and Verification Regulations statement:

<https://dnrec.alpha.delaware.gov/climate-coastal-energy/efficiency/evaluation-measurement-verification>

Table 27: GEP Verified Capacities

Measure	Facility Type	Stratum	Verified Capacity (MW)	Verified Capacity (Tons)	Capacity (MW) RR	Capacity (Tons) RR	Relative Precision at 85% Confidence
PV	Non-Profit	Probability	0.16	NA	100%	NA	0.05%
	Non-Residential	Probability	0.23	NA	100%	NA	0.33%
	Residential	Large Probability	1.72	NA	100%	NA	0.79%
	Residential	Small Probability	0.23	NA	100%	NA	0.66%
Geothermal	Residential	Probability	NA	139.5	NA	100%	0.00%
<b>Total</b>			<b>2.34</b>	<b>139.5</b>	<b>100%</b>	<b>100%</b>	

Not Applicable (NA): value is not applicable for this line item

In addition to verifying the system capacities, EcoMetric also verified the energy production from solar PV and energy savings from geothermal heat pumps and summer peak demand reduction for all sampled projects. EcoMetric calculated energy generation and peak demand savings for solar PV projects using the PVWatts® calculator, and information provided included GEP project documentation.

EcoMetric also calculated energy and peak demand savings for geothermal projects using the “Ground Source Heat Pumps” methodology in the Ground Source Heat Pump measure from the Mid-Atlantic Residential TRM and information from the installed units’ AHRI certificates, as described in Section 3.1.3.2.

Table 28 summarizes the verified energy (kWh) and verified peak demand (kW) that result from EcoMetric’s evaluation of GEP.

Table 28: GEP Verified Savings (Generation)

Measure	Facility Type	Stratum	Gross Verified Energy Savings (MWh)	Gross Verified Peak Demand Savings (MW)
PV	Non-Profit	Probability	212	0.14
	Non-Residential	Probability	316	0.24
	Residential	Large Probability	2,279	1.49
	Residential	Small Probability	329	0.19
Geothermal	Residential	Probability	144	0.05
<b>Total</b>			<b>3,280</b>	<b>2.11</b>

### 3.1.3.1 Gross Savings Verification for Solar PV Projects

For solar PV projects, EcoMetric used specification sheets for the solar PV panels and inverters included in the GEP project documentation to estimate operating wattages and total wattages for all orientations (azimuth and tilt). Using PVWatts®, EcoMetric estimated annual solar PV generation based on the inverter size, the total wattage of PV panels, orientation, and PV panel type (standard, premium, and thin film). This process was repeated for each of the panel orientations to calculate annual savings for the entire project.

To calculate peak demand reduced by solar PV systems, EcoMetric analyzed hourly performance from all PV panel orientations from 3 PM to 6 PM during June to August. An average of power generated during these hours was estimated to be the demand savings for each project.

**Finding 30:** EcoMetric found discrepancies between the inverter efficiency listed in the application and the efficiency documented in the technical specifications by the respective Original Equipment Manufacturer for twelve projects.

*Recommendation 29: Ensure the values listed in the application match the values listed in the Original Equipment Manufacturer specification sheets for the installed equipment.*

### 3.1.3.2 Gross Savings Verification for Geothermal projects

GEP project documentation included invoices, model numbers, and Air-Conditioning Heating and Research Institute (AHRI) certificates for the installed units. AHRI is an independent third-party testing organization that tests HVAC equipment at standard testing conditions. EcoMetric verified the installed nominal capacity using the AHRI certificates for the geothermal heat pumps. EcoMetric used

the “Ground Source Heat Pumps” methodology outlined in the Ground Source Heat Pump measure from the Mid-Atlantic Residential TRM to determine the gross verified energy savings and peak demand reductions. The verified savings calculations used cooling capacity, cooling efficiency, heating capacity, and heating efficiency for the installed units taken from the AHRI certificates. EcoMetric used the baseline efficiencies and Delaware full-load hours from the Mid-Atlantic TRM.

**Finding 31:** EcoMetric found discrepancies between the nominal capacities of installed systems and the capacities documented in the models’ AHRI certificates.

The GEP program records the total nominal cooling tons and efficiency (EER and COP) for the installed geothermal units. Units tested at AHRI conditions mimic performance as closely as possible to their in-field performance. Therefore, the energy savings and demand reductions calculated using capacities and efficiencies listed in AHRI certificates are more accurate than those computed using nominal manufacturer capacities.

*Recommendation 30: Consider using AHRI testing information available in project documentation rather than nominal values to calculate savings from the installed geothermal heat pump systems.*

#### 3.1.4 NET SAVINGS VERIFICATION

GEP is not governed by the Delaware EM&V regulations and does not have a deemed statewide NTG ratio. Therefore, EcoMetric did calculate net verified energy and peak demand savings (generation) for GEP.

#### 3.1.5 GREENHOUSE GAS EMISSION REDUCTIONS

EcoMetric estimates the net present value (NPV) of the lifetime monetary benefits of greenhouse gas (GHG) emissions reductions achieved by the GEP to be \$2,285,880 for projects completed in CY2020. The sample's verified energy savings were extrapolated to the CY2020 program population following the sampling methodology described in Section 3.1.1. EcoMetric used the total energy savings from the program population and measure effective useful life (EULs) to calculate the lifetime electric savings, lifetime GHG reduction, and lifetime NPV dollar savings.

Table 29 shows the lifetime electric savings, lifetime GHG reduction, and lifetime NPV of GHG reduction economic benefits for the program. See Section 1.1.5 for details on how EcoMetric calculated the economic benefits of GHG emissions reductions.

Table 29: GEP Greenhouse Gas Emissions Reductions

Measure Type	Facility Type	Net Verified Electric Savings (MWh)	Lifetime Electric Savings (MWh)	Lifetime GHG Reduction (lbs)	Lifetime NPV Savings (\$)
Solar PV	Non-Profit	212	5,294	6,674,698	\$148,325
	Non-Residential	316	7,895	9,953,049	\$221,176
	Residential	2,608	65,203	82,202,331	\$1,826,692
Geothermal	Residential	144	2,880	3,777,424	\$89,687
<b>Total</b>		<b>3,280</b>	<b>81,273</b>	<b>102,607,502</b>	<b>\$2,285,880</b>

### 3.1.6 COST-EFFECTIVENESS RESULTS

EcoMetric’s cost-effectiveness analysis shows that the GEP has a benefit-cost ratio of 1.31 using the TRC test. This indicates that the program is cost effective. The program continues to create significant benefits from avoided costs of energy and capacity. The program’s benefit-cost ratio is slightly down from CY2019, due to an increase in total measure costs likely driven by a higher incidence of large residential solar PV projects in CY2020. Table 30 provides details on the total benefits and costs which EcoMetric included in the TRC test for the GEP.

Table 30: GEP Cost-effectiveness Results

Benefit / Cost	NPV of Benefit / Cost
Lifetime Avoided Cost of Energy	\$5,892,828
Lifetime Avoided Cost of Capacity	\$4,945,504
Lifetime Avoided Cost of Fossil Fuel	\$0
Lifetime Non-Energy Benefits	\$0
<b>Total Benefits</b>	<b>\$10,838,332</b>
Program Administrative Costs	\$275,967
Measure Costs	\$7,993,552
<b>Total Costs</b>	<b>\$8,269,519</b>
<b>TRC Benefit-Cost Ratio</b>	<b>1.31</b>

## 4 WEATHERIZATION ASSISTANCE PROGRAM RESULTS

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The U.S. Department of Energy (DOE) oversees the Delaware Department of Natural Resources and Environmental Control's (DNREC) Weatherization Assistance Program (WAP). WAP provides income-eligible residential customers with free energy-efficiency retrofits to reduce their energy costs and improve their health and their homes' safety. DNREC contracts with local non-profit agencies, referred to as "subgrantees," to administer WAP and deliver weatherization services to Delaware residents with household incomes that fall below 200% of the federal poverty line. Subgrantees are responsible for hiring, managing, and paying home energy auditors and third-party subcontractors who carry out the weatherization work recommended based on home audit results. Upon completing the work, all homes receive a final inspection conducted by a Building Performance Institute (BPI)-certified quality control inspector. A sample of all serviced homes is also inspected by the State Program Monitor, who serves as the state's weatherization technical expert.

### 4.1 IMPACT EVALUATION

EcoMetric evaluated 212 homes weatherized during the 2019 calendar year (CY). The CY2019 WAP evaluation timeline differs from other evaluated programs because the billing analysis requires one year of post-weatherization billing data.

#### 4.1.1 PROGRAM DATABASE REVIEW AND SAMPLING APPROACH

EcoMetric reviewed the program tracking database to confirm the amount and type of homes weatherized in CY2019. The program tracking database includes the home type and primary heating fuel and various date fields to record when the audit, installation, and final inspections occurred.

EcoMetric conducted a census review of the projects completed in CY2019 and a prior participant comparison group for the impact evaluation. A census review includes analyzing all 212 homes that were weatherized in CY2019. The evaluation methodology includes reviewing monthly utility data for each of the homes. The program data shows that participants use various fuel types to condition their homes.

## 4.1.2 GROSS ENERGY SAVINGS VERIFICATION

### 4.1.2.1 Data Collection

EcoMetric calculated the gross verified energy savings using data from multiple sources, including program data, historical utility billing data, and local and TMY weather data. The list below provides more detail on the type of data that EcoMetric used to calculate the gross verified energy savings.

- ▶ **Program Tracking Data:** WAP staff provided multiple databases that included participant information, utility information, inspection dates, home characteristics, treatment measures, and installation dates for participant homes.
- ▶ **Historical Utility Billing Data:** EcoMetric received historical, monthly billing data from two electric utilities, one natural gas utility, and one combined gas and electric utility. This historical utility billing data includes pre- and post-weatherization periods for all homes included in the analysis. EcoMetric's CY2019 evaluation also analyzed the energy usage of 353 prior CY2016-2017 program participants as part of the comparison group analysis. EcoMetric used the comparison group to isolate the verified CY2019 program savings from naturally occurring changes in consumption. The comparison group analysis also helped EcoMetric identify externalities affecting energy use changes among CY2019 WAP participants, including COVID-19 energy impacts.
- ▶ **Weather Data:** Based on the location of each weatherized home, EcoMetric retrieved the local and TMY (30-year normalized) weather data for the appropriate periods to correspond with the utility billing data.

### 4.1.2.2 Reported Savings

In CY2019, the program reported 2,444 MMBtu in natural gas and other fossil fuel savings, 167 MWh in electric savings, and 0.04 MW in peak demand savings. Table 31 summarizes the reported electric and non-electric energy savings for homes weatherized through WAP in CY2019.

*Table 31: WAP Reported Savings Summary*

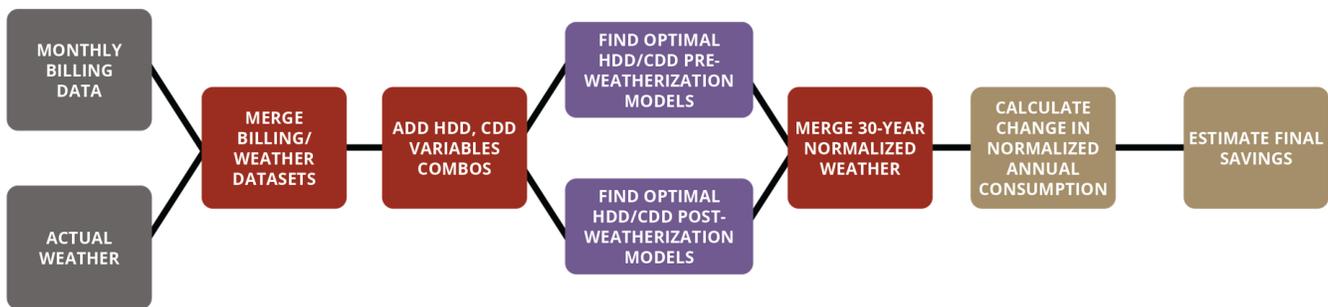
Calendar Year	Weatherized Homes	Fossil Fuel Savings (MMBtu)	Electric Savings (MWh)	Demand Savings (MW)
2019	212	2,444	167	0.04
<b>Total</b>	<b>212</b>	<b>2,444</b>	<b>167</b>	<b>0.04</b>

**Finding 32:** WAP did not claim savings from the previous evaluation report (CY2018). Program staff confirmed that the program used the results from EcoMetric’s CY2016-2017 evaluation as the basis to calculate the reported savings for homes weatherized through the program in CY2019.

#### 4.1.2.3 Data Preparation and Billing Analysis

EcoMetric utilized a two-staged utility billing data analysis (DOE UMP<sup>31</sup>) to calculate verified CY2019 savings. The billing model calculated whole-home energy savings based on primary home heating fuel type (electric, natural gas, or other fossil fuel) and by home type (single family or manufactured home). Figure 15 outlines the WAP billing analysis process.

Figure 15: WAP Billing Analysis Project Flow



EcoMetric applied standard billing data filters to remove abnormal and out of range monthly records. The most common adjustments included the following:

- ▶ Zero or near zero values for one or more months
- ▶ Billing month length less than 19 or greater than 35 days
- ▶ Less than 12 months of available monthly bills, either pre- or post-weatherization

After cleaning the billing data, the final dataset included between 12 and 16 months of pre- and post-weatherization consumption for each home. The final dataset included 187 homes or 88% of the 212

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<sup>31</sup> Li, M.; Haeri, H.; Reynolds, A. (2018). The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures. Golden, CO; National Renewable Energy Laboratory. NREL/SR-7A40-70472. <http://www.nrel.gov/docs/fy18osti/70472.pdf>

CY2019 WAP participants. Similarly, the comparison group's final dataset included 353 homes with similar heating fuel, home type, and energy usage patterns as the CY2019 program participants.

EcoMetric used weather data from one of three National Weather Service stations in the Delaware region listed below. The regression model calculated the distance from each home to each of the weather stations to find the closest weather station from which to reference historical weather data.

- ▶ New Castle County Airport
- ▶ Dover AFB
- ▶ Salisbury-Ocean Regional Airport (northern Maryland)

The first stage of the billing analysis calculated the optimal relationship between home energy consumption (utility bills) and local weather data. To account for extreme weather from year-to-year, EcoMetric normalized each home's annual energy consumption with 30-year weather averages (TMY). EcoMetric completed this calculation separately for both pre- and post-weatherization periods.

The second stage of the billing analysis combines first stage weather normalized consumption results with home characteristics such as size, primary heating fuel, and home type to estimate the final per-home energy savings averages.

A detailed description of EcoMetric's billing analysis is in 6.2Appendix 2 of this report. The detailed description includes the inputs and algorithms EcoMetric used in the two-staged billing analysis.

#### 4.1.2.4 Verified Savings Results

The 212 homes weatherized through WAP in CY2019 achieved a combined 167 MWh of gross verified first-year electric energy savings and 1,347 MMBtu in first-year fossil fuel savings. The verified electric per-home savings for the electrically heated homes increased compared to the savings values from the previous evaluation (CY2018). Conversely, the verified electric and fossil fuel per-home savings for homes heated with natural gas and other fuels decreased compared to the previous evaluation (CY2018). Table 32 compares reported and verified per-home energy (kWh) and fossil fuel (MMBtu) savings.

Table 32: WAP Reported and Verified Per-Home Savings Estimates

Heating Type	Home Type	Reported Per-Home Energy Savings (kWh)	Verified Per-Home Energy Savings (kWh)	Reported Per-Home Energy Savings (MMBtu)	Verified Per-Home Energy Savings (MMBtu)
Electric	Single family	2,073	2,285	NA	NA
	Manufactured home	1,023	1,901	NA	NA
Natural Gas	Single family	1,081	305	9.6	7.7
	Manufactured home	851	305	16.2	7.7
Other fuel	Single family	1,197	130	10.7	7.7
	Manufactured home	968	719	16.7	7.7
<b>Total/Average</b>		<b>1,108</b>	<b>787</b>	<b>13.0</b>	<b>7.7</b>

Not Applicable (NA): value is not applicable for this heating/home type

**Finding 33:** The CY2019 per-home verified savings for the electrically heated homes weatherized through WAP increased from the previous evaluation of CY2018 electrically heated homes.

**Finding 34:** The CY2019 per-home verified savings for the non-electrically heated homes weatherized through WAP decreased from the previous evaluation of CY2018 non-electrically heated homes.

It is not uncommon for the verified savings for weatherization programs to vary from year to year. Each evaluation includes a different set of homes with participants who use energy differently.

To calculate the peak demand savings, EcoMetric isolated the cooling savings in the billing data. EcoMetric’s analysis showed that no peak demand savings were realized for the homes weatherized in CY2019. The cooling usage increased for the CY2019 program participants as well as the comparison group during the spring/summer of 2020, which is the post-weatherization period. The increase in summer energy usage can likely be attributed to the COVID-19 induced shutdowns. During these shutdowns, many participants were at home during times when they would typically be away for work. The COVID-19 induced shutdowns also likely caused the decrease in natural gas and

fossil fuel energy savings due to increased heating energy usage, compared to the CY2018 evaluation.

Table 33 compares total reported and verified electric savings for homes weatherized through WAP in CY2019. Total CY2019 electric (kWh) savings were 167 MWh, resulting in a 71% realization rate. Verified demand reduction realization rates calculations were not applicable due to likely COVID-19 induced zero peak demand reduction.

Table 33: WAP Verified Electric Savings

Heating Type	Home Type	Weatherized Homes	Reported Energy Savings (MWh)	Verified Energy Savings (MWh)	Realization Rate for Energy	Reported Peak Demand Reduction (MW)	Verified Peak Demand Reduction (kW)	Realization Rate for Peak Demand
Electric	Single family	16	33	37	110%	0.007	0	NA
	Manufactured home	22	23	42	186%	0.001	0	NA
Natural Gas	Single family	37	40	11	28%	0.007	0	NA
	Manufactured home	6	5	2	36%	0.001	0	NA
Other fuel	Single family	32	38	4	11%	0.007	0	NA
	Manufactured home	99	96	71	74%	0.022	0	NA
<b>Total/Average</b>		<b>212</b>	<b>235</b>	<b>167</b>	<b>71%</b>	<b>0.04</b>	<b>0.00</b>	<b>NA</b>

Not Applicable (NA) because there was no CY2019 verifiable peak demand reduction.

EcoMetric's billing analysis for homes heated with fossil fuels (natural gas and other fuels) resulted in verified savings of 1,347 MMBtu, or 59% of the reported savings. Table 34 summarizes the CY2019 verified fossil fuel savings for each heating fuel type and home type.

Table 34: WAP Verified Fossil Fuel Savings

Heating Type	Home Type	Weatherized Homes	Reported MMBtu Savings	Verified MMBtu Savings	RR for MMBtu Savings
Electric	Single family	16	NA	NA	NA
	Manufactured home	22	NA	NA	NA
Natural Gas	Single family	37	355	286	81%
	Manufactured home	6	97	46	48%
Other fuel	Single family	32	341	248	73%
	Manufactured home	99	1,651	766	46%
<b>Total/Average</b>		<b>212</b>	<b>2,444</b>	<b>1,347</b>	<b>59%</b>

Not Applicable (NA): value is not applicable for this heating/home type

**Finding 35:** The CY2019 savings analysis completed for this evaluation included post-weatherization billing data that was impacted by the COVID-19 pandemic. While the verified savings results are valid and accurate for the CY2019 program, we do not recommend using the results to stipulate deemed per-home savings for the program.

As described in Finding 35, the post-installation period of EcoMetric’s analysis was impacted by the COVID-19 induced shutdowns that spanned from March 2020 to the end of 2020. During these COVID-19 induced shutdowns, many Delawareans, including WAP participants, were encouraged to stay home, which would increase the energy usage in the home during the post-weatherization period due to more occupied hours. Therefore, the savings EcoMetric calculated in CY2019 may be lowered than expected due to WAP participants being home more often during the COVID-19 induced shutdowns (March 2020 – December 2020) when compared to the pre-weatherization period (2018), which was not impacted by any COVID-19 induced shutdowns.

Table 35 shows the per-home savings matrix based on the combined analysis of the CY2016-2017 and CY2018 evaluations of WAP completed by EcoMetric in previous evaluation cycles. This table was included in the previous evaluation report, but EcoMetric made one adjustment to weigh the savings by the number of program years corresponding to each billing analysis.

**Recommendation 31:** Use the savings matrix in Table 35 to claim savings for each weatherized home according to the home type and primary heating fuel type.

Table 35: WAP CY2016 – 2018 Weighted Per-Home Savings Matrix

Heating Type	Home Type	Per-Home Energy Savings (kWh)	Per-Home Peak Demand Reduction (kW)	Per-Home Energy Savings (MMBtu)
Electric	Single family	2,044	0.40	NA
	Manufactured home	1,191	0.09	NA
Natural Gas	Single family	825	0.13	9.9
	Manufactured home	672	0.14	14.3
Other fuel	Single family	1,196	0.17	10.6
	Manufactured home	771	0.17	14.6

#### 4.1.3 NET SAVINGS VERIFICATION

The Delaware EEAC deemed the Net-to-gross (NTG) ratios for income-qualified programs.<sup>32</sup> The NTG ratio for all income-qualified programs is 1.0. Table 36 shows the gross and net verified electric savings, while Table 37 lists the total gross and net verified gas energy savings (MMBtu). EcoMetric calculated the net verified savings using the equation below:

$$\text{Net Verified Savings} = \text{Gross Verified Savings} \times \text{NTG Ratio}$$

<sup>32</sup><http://www.dnrec.delaware.gov/energy/information/otherinfo/Documents/EEAC/Draft%20Proposed%20DE%20EE%20program%20NTG%20values%20with%20assumptions.pdf>

Table 36: WAP Net Verified Electric Savings Summary

Heating Type	Home Type	Approved Low Income NTG	Gross Verified Energy Savings (MWh)	Gross Verified Peak Demand Reduction (MW)	Net Verified Energy Savings (MWh)	Net Verified Peak Demand Reduction (MW)
Electric	Single family	1.0	37	0	37	0
	Manufactured home	1.0	42	0	42	0
Natural Gas	Single family	1.0	11	0	11	0
	Manufactured home	1.0	2	0	2	0
Other fuel	Single family	1.0	4	0	4	0
	Manufactured home	1.0	71	0	71	0
<b>Total</b>			<b>167</b>	<b>0</b>	<b>167</b>	<b>0</b>

Table 37: WAP Net Verified Fossil Fuel Savings Summary

Heating Type	Home Type	Approved Low Income NTG	Gross Verified MMBtu Savings	Net Verified MMBtu Savings
Electric	Single family	1.0	NA	NA
	Manufactured home	1.0	NA	NA
Natural Gas	Single family	1.0	286	286
	Manufactured home	1.0	46	46
Other fuel	Single family	1.0	248	248
	Manufactured home	1.0	766	766
<b>Total</b>			<b>1,347</b>	<b>1,347</b>

#### 4.1.4 GREENHOUSE GAS EMISSION REDCUTIONS

EcoMetric estimates the net present value (NPV) of the lifetime monetary benefits of greenhouse gas (GHG) emissions reductions achieved by WAP to be \$88,997. Table 38 shows the lifetime electric savings, lifetime GHG reduction, and lifetime NPV of GHG reduction economic benefits for the

program. See Section 1.1.5 for details on how EcoMetric calculated the economic benefits of GHG emissions reductions.

Table 38: WAP Greenhouse Gas Emissions Reductions

Heating Type	Home Type	Net Verified Energy Savings (MWh)	Lifetime Energy Savings (MWh)	Net Verified Gas Savings (MMBtu)	Lifetime Gas Savings (MMBtu)	Lifetime GHG Reduction (lbs)	Lifetime NPV Savings (\$)
Electric	Single family	37	594	NA	NA	768,399	\$19,499
	Manufactured home	42	674	NA	NA	878,848	\$22,302
Natural Gas	Single family	11	177	286	4,592	237,290	\$6,022
	Manufactured home	2	32	46	739	38,480	\$976
Other fuel	Single family	4	64	248	3,982	87,392	\$2,218
	Manufactured home	71	1,140	766	12,299	1,496,645	\$37,980
<b>Total</b>		<b>167</b>	<b>2,681</b>	<b>1,346</b>	<b>21,612</b>	<b>3,507,054</b>	<b>\$88,997</b>

#### 4.1.5 COST-EFFECTIVENESS RESULTS

EcoMetric’s cost-effectiveness analysis shows that the WAP has a benefit-cost ratio of 0.42 using the TRC test. This indicates that the program is not cost-effective. It should be noted that WAP is a public benefit program with considerable societal benefits which cannot be quantified entirely by econometric methods. The TRC ratios for WAP programs across the country are typically less than 1.0. The program generated \$985,785 of lifetime non-energy benefits for Delaware's low income population.

The program’s CY2019 TRC ratio declined from CY2018 due to a reduction in benefits from lifetime avoided costs. The verified savings EcoMetric calculated for CY2019 show that the per-home savings were lower when compared to verified savings from previous evaluation years. The post-weatherization period (January 2020 – December 2020) of EcoMetric’s analysis included COVID-19 induced shutdown. During these shutdowns, participants were in their homes more often when compared to the pre-weatherization period (January 2018 – December 2018). This resulted in more post-weatherization energy usage and lower per-home energy savings when compared to previous evaluations. The lower per-home savings values impact the lifetime benefits the program achieves through weatherizing homes.

The program achieved a large amount of fossil fuel savings in CY2019, mainly natural gas, but the avoided cost of the natural gas and fossil fuels is low and does not generate substantial lifetime benefits compared to total program costs. The program also weatherized fewer homes in CY2019 compared to CY2018. Furthermore, there was an oversight in the accounting of measure costs in the CY2018 WAP cost effectiveness analysis, resulting in an underestimation of total program costs and thus an overestimation of the TRC ratio.

Table 39 provides details on the total benefits and costs which EcoMetric included in the TRC test for WAP. Refer to Section 1.1.6 for details on how EcoMetric performed the cost-effectiveness analysis.

*Table 39: WAP Cost-effectiveness Results*

<b>Benefit / Cost</b>	<b>NPV of Benefit / Cost</b>
Lifetime Avoided Cost of Energy	\$227,282
Lifetime Avoided Cost of Capacity	\$0
Lifetime Avoided Cost of Fossil Fuel	\$88,272
Lifetime Non-Energy Benefits	\$985,785
<b>Total Benefits</b>	<b>\$1,301,340</b>
Program Administrative Costs	\$1,740,464
Measure Costs	\$1,343,612
<b>Total Costs</b>	<b>\$3,084,076</b>
<b>TRC Benefit-Cost Ratio</b>	<b>0.42</b>

#### 4.1.6 NON-ENERGY BENEFITS (NEB)

EcoMetric monetized three participant NEBs using primary data collection and analysis during each of the two previous evaluations (CY2016 - 2017 and CY2018): thermal comfort, noise, and health. EcoMetric found the overall NEBs value to be \$264 per household per year for the CY2016-2018 period (\$154 for thermal comfort, \$54 for noise, and \$56 for health). With two years of primary data collected over the three previous calendar years, EcoMetric did not conduct any additional interviews to further quantify the NEBs. As detailed in Section 4.1.5, WAP generated a total of \$985,785 of lifetime NEBs for Delaware's low-income population in CY2019, representing a substantial portion of the program's total benefits in the TRC analysis.

## 4.2 PROCESS RESEARCH

EcoMetric completed a process research study for WAP to investigate the challenges the program is facing in reaching its participation goals. DNREC has set a goal for the WAP subgrantees to weatherize 400 homes per year. Since 2016, WAP has struggled to meet this goal.

EcoMetric utilized several methods to complete this research study. These methods include:

- ▶ In-depth interviews with WAP Grantee (DNREC program manager and supervisor) and the WAP subgrantee (program manager and program coordinator)
- ▶ A literature review of program documents and resources from WAPs in surrounding Mid-Atlantic and Northeast jurisdictions, including evaluation reports, industry resources, and applicable Codes of Federal Regulations
- ▶ A jurisdictional scan of WAPs in Pennsylvania, Colorado, and New Mexico. EcoMetric interviewed the program managers to learn the successes and challenges their programs face

The goal of these research efforts was to gain a detailed understanding of how DNREC's WAP operates and how programs from other jurisdictions find solutions to the unique challenges WAPs face in meeting program goals.

DNREC's WAP has the potential to greatly impact Delaware's income-eligible community, providing significant energy savings and non-energy benefits to the Delawareans who need them the most. DNREC has access to grant funds to develop and administer this program to meet its lofty goals. While solid progress has been made in delivering this program to the income-eligible community over the past few years, DNREC has the tools at its disposal to improve the performance of the program and ensure more homes than ever are weatherized each year.

The following subsections summarize the key findings and recommendations that resulted from the study.

### 4.2.1 PROGRAM ADMINISTRATION

Currently, WAP is administered by a sole subgrantee that delivers the program across the entire state. Previously, two subgrantees delivered the program, each with their own territories. Having more than one subgrantee spreads out the program delivery workload and allows subgrantees to focus on their unique strategies and strengths to meet program goals.

**Finding 36: WAP currently has just one subgrantee to deliver the program across the entire state.**

*Recommendation 32: Contract more than one subgrantee to deliver WAP. DNREC could assign unique geographic territories to each subgrantee or allow them to compete across the state.*

The current contract with the program's sole subgrantee ensures that the subgrantee receives 100% of the grant money allotted for the program year regardless of their performance in weatherizing homes. This type of contract structure lacks mechanisms to incentivize the subgrantee to meet program goals. To keep the subgrantee motivated to meet goals, the subgrantee contract structure should have some performance-based elements.

**Finding 37: The WAP subgrantee contract lacks a performance framework to incentivize the subgrantee to meet program goals.**

While it is important for the subgrantee to receive steady funds to support overhead and measure installation costs, the current contract with the subgrantee provides an additional 12% of administrative funds on top of overhead costs each month. These funds are allotted for the executive positions at the subgrantee's organization that oversee general operations at a high level.

*Recommendation 33: Restructure the WAP subgrantee contract so that monthly administrative fund payments are attached to meeting monthly targets of weatherized homes.*

The performance of the current and historical non-profit subgrantees implementing Delaware's WAP has been sub-par. While there are non-profits capable of successfully implementing WAPs across the nation, there has not been a proven success in Delaware's market. According to DOE bylaws, WAP grant money from DNREC has to go directly to non-profit organizations. However, subgrantees are free to subcontract for-profit companies to help implement the program.

#### 4.2.2 APPLICATION PIPELINE AND MARKETING

EcoMetric's review of the number of applications coming through the program pipeline found that it was not sufficient for the program to achieve its goal of weatherizing 400 homes per year. The strength of the application pipeline relies on marketing efforts from the subgrantee and their partners. Additionally, the program has also utilized the Low Income Energy Assistance Program (LIHEAP) for participant leads. The LIHEAP program receives up to 10,000 applications per year, and the implementer of LIHEAP is required to also inform applicants of the opportunities for weatherization assistance through WAP. EcoMetric's jurisdictional scan found that approximately 80% of applications for a WAP in Colorado came from their LIHEAP.

**Finding 38: WAP does not have sufficient applicant leads in the program pipeline to reach the goal of weatherizing 400 homes per year.**

Considering the volume of income-eligible qualified applications that Delaware's LIHEAP receives each year, this program should be the leading source of WAP applications in Delaware. As LIHEAP is administered by the Division of State Service Centers (DSSC), leveraging LIHEAP applications will require coordination across state organizations and their subgrantees.

EcoMetric recommends that DNREC explore funding opportunities to incentivize the LIHEAP subgrantee to produce WAP applications. Without an incentive to produce WAP applications, it is certain that the LIHEAP subgrantee will continue to focus on their own program and produce the bare minimum amount of WAP applications. LIHEAP's heating season Fuel Assistance effort began October 1st, 2021, which provides a great opportunity to produce quality WAP applications. If a push can be made to incentivize the LIHEAP subgrantee, the number of applications they produce should see an impactful increase.

***Recommendation 34:** Explore coordination opportunities with LIHEAP to increase the number of applications in the program pipeline.*

EcoMetric found that many WAPs around the United States leverage a network of Community Action Agencies (CAAs) and non-profits to market and deliver the program. CAAs develop deep roots in local income-eligible communities and can provide a powerful conduit to reach those populations. While many states are much larger in population than Delaware, EcoMetric found that Connecticut is the only other state that works with just one CAA or non-profit. Rhode Island, which has a similar population as Delaware, leverages seven CAAs to deliver their WAP.

**Finding 39:** The majority of WAP administrators in other states utilize a network for CAAs, or other non-profit companies, to deliver their WAPs.

Spreading out the load of marketing and delivering WAP services should result in a more efficient process and more weatherized homes. Furthermore, CAAs have deeper ties to income-eligible populations in Delaware, resulting in a higher number of completed applications.

***Recommendation 35:** EcoMetric recommends that DNREC contract several more CAAs and/or non-profits or require the subgrantees to contract such agencies to market and deliver the WAP alongside the implementation contractors.*

#### 4.2.3 HOME DEFERRALS

Through conversations with DNREC and subgrantee staff, EcoMetric learned that 40 to 60% of the homes through the Delaware WAP were unfit for weatherization. In these instances, the homes were deferred to a different program to receive the required services before the home may return to WAP for weatherization. These services can include fixing broken windows, roof repairs, or addressing

moisture and mold issues. EcoMetric interviewed WAP managers in Colorado and New Mexico to learn how their programs manage deferred homes. They said that deferral of homes for unfit conditions was not an issue in their states. Due to the age and condition of the housing stock in Delaware and much of the Mid-Atlantic, WAP deferrals can be seen as a unique problem to the region.

Deferrals directly impact the ability of Delaware's WAP to reach weatherization goals, as unfit conditions of the deferred homes must be remedied before the home can return to WAP. This process extends the installation timeline and requires additional touch points with the participants.

**Finding 40: WAP in Delaware encounters a unique challenge in that 40-60% of the homes that qualify for the program must be deferred for additional services before weatherization measures can be installed.**

While nothing can be done to change the state's housing stock in one broad stroke, DNREC and its WAP subgrantee can work to improve the tracking of deferrals and leverage this data to better target homes ready for weatherization.

EcoMetric recommends that DNREC require the subgrantee to closely track deferral rates and break the data down into subcategories that highlight why particular homes are being deferred. EcoMetric obtained the subgrantee's tracking database, including fields for tracking deferrals, but the data was incomplete and uneven. Understanding where and why homes are being deferred should allow subgrantees to target areas and types of homes that are less likely to be deferred.

***Recommendation 36:** Track deferral rates and break the data down into subcategories that highlight why particular homes were deferred. Leverage this data to better target homes ready for weatherization.*

E2I provides financial incentives to large industrial facilities to make energy efficiency upgrades in existing facilities in Delaware. Incentivized projects are meant to be large and custom in nature. Incentives are paid based on estimated first year electric (kWh) and natural gas (MMBtu) savings.

Only one project was completed in CY2020 – this was the first project to be completed through the E2I program since its inception. As part of that project, Messer North America, Inc. (previously known as Linde) completed an air separation unit (ASU) system upgrade at their Delaware facility which resulted in electric, peak demand, and natural gas savings. The facility uses ambient air to produce gaseous Nitrogen, liquid Nitrogen, liquid Oxygen, and liquid Argon (byproduct) via a series of compression, expansion, and heating and cooling processes.

**Finding 41: The project documentation provided by the program was detailed and complete. The project documentation also included energy calculations with clearly defined algorithms and assumptions that enabled EcoMetric to complete a thorough review of the project and energy calculations.**

Due to the size and complexity of the ASU system upgrade at Messer, EcoMetric drafted a detailed evaluation report specifically for the project. EcoMetric delivered the project-specific evaluation report to the DNREC Energy Programs Section Administrator in advance of this evaluation report. The following subsections summarize the EcoMetric’s evaluation methods and evaluated savings that are explained in more detail in the project-specific evaluation report.

## 5.1 IMPACT EVALUATION

EcoMetric reviewed the project application and all other documentation relevant to the project – historical utility bills, scopes of work, specification sheets, email correspondences, M&V plans, energy savings calculations, operating data, and invoices. EcoMetric also performed a post-installation site inspection as part of the evaluation.

### 5.1.1 REPORTED SAVINGS

Messer calculated the energy (kWh), peak demand (kW), and natural gas savings (MMBtu) by comparing the consumption during a 24-hour baseline performance test to a 24-hour post-installation performance test. The difference in energy consumption between the two-performance tests was then extrapolated to calculate the savings for an entire year.

### 5.1.1.1 Peak Demand (kW)

Messer calculated the peak demand savings primarily using the average site demand during the two performance tests. Small weather corrections were also applied due to the difference between weather conditions for each performance test. The algorithms below illustrate Messer's peak demand savings calculations.

*Peak Demand Savings (kW)*

$$= \text{Avg. Baseline Demand} - \text{Avg. Post\_Install Demand} + \text{Weather Adjustment}$$

### 5.1.1.2 Natural Gas (MMBtu)

Messer calculated annual natural gas savings using historical monthly billing data (baseline) and measured consumption (post-installation) on the performance test day using the following algorithms.

*Annual Natural Gas Savings (ccf)*

$$= \text{Baseline Yearly Consumption} - (\text{Post Install Performance Test Consumption} * 365 \text{ Days})$$

### 5.1.1.3 Energy (kWh)

Since the baseline and post-installation performance tests spanned only 24 hours, an extrapolation method was required to estimate annual energy savings. Messer calculated annual energy (kWh) savings based on the peak demand (kW) savings estimates using the algorithm below.

$$\text{Annual Energy Savings (kWh)} = \text{Peak Demand Savings (kW)} * 8,760 \text{ hrs} * \text{Load Factor}$$

Messer calculated the plant load factor value by analyzing monthly billed energy consumption and peak demand. For each month during the baseline period (January 2015 through January 2018), the load factor was calculated using the algorithm shown below.

$$\text{Load Factor (\%)} = \frac{\text{Actual Energy Consumption (kWh)}}{\text{Theoretical Maximum Consumption (kWh)}}$$

where,

*Theoretical Maximum Consumption (kWh)*

$$= \text{Peak Demand (kW)} * \text{Number of Days in a month} * 24 \frac{\text{hrs}}{\text{day}}$$

## 5.1.2 GROSS VERIFIED SAVINGS

EcoMetric reviewed the data and reports from Messer's performance tests as part of the evaluation of the reported savings estimates. This section summarizes EcoMetric's evaluation methods and the resulting savings.

A licensed professional engineer from EcoMetric visited the site for several hours during the post-installation performance test in April of 2021. Facility representatives toured the EcoMetric representative around the plant and showed the various aspects of the plant controls system. Facility representatives provided a detailed summary of the plant operation and identified the equipment and areas affected by the upgrade project.

### 5.1.2.1 Annual Energy Savings

As part of the review of this project, EcoMetric completed two independent savings analyses. The lack of a full year of post-installation data made it difficult to establish an accurate, verified savings value for this project. EcoMetric's goal was to test the reasonableness of the values reported by Messer and investigate if the reported values fall within the range of possible values calculated by EcoMetric. Both of EcoMetric's methods yielded annual electric energy savings greater than the savings (30,322,390 kWh or 30,322 MWh) reported by Messer. Given that EcoMetric's methods yielded savings higher than the values reported by Messer and considering the lack of available post-installation data for an entire year that introduced some uncertainty in the savings estimates, EcoMetric deemed Messer's estimate of 30,322 MWh as reasonable and likely conservative.

### 5.1.2.2 Peak Demand Savings

EcoMetric also used multiple methods to estimate peak demand savings. For the baseline period, peak demand could arguably be based on average or maximum observed values from either the performance test or historical billing data. The performance test neither took place during the peak coincident months (June through August) as specified in the Delaware EM&V Regulations<sup>33</sup> nor on a particularly hot or humid day. Historical billing records include the peak coincident months, but there is not enough granularity in the data to confirm if the monthly peak demand values provided by Messer came from peak coincident hours (non-holiday weekdays between 3:00-6:00pm) during those months. To calculate the coincident peak demand savings would require Messer providing interval

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<sup>33</sup> <https://regulations.delaware.gov/AdminCode/title7/2000/2105.shtml#TopOfPage>

meter data for the entire coincident peak demand period<sup>34</sup>, which was not possible based on the project timeline.

Considering the limited project timeline, EcoMetric attempted to calculate a coincident factor (CF) to determine the coincident peak demand savings using the monthly baseline billing data. While EcoMetric could have calculated a baseline CF with the provided data, there was no evidence to confirm that the post-installation CF would be the same as the baseline without making a significant assumption.

For the post-installation period, there were also multiple potential sources of peak demand. During the performance test, the highest recorded value was 23,188 kW, occurring outside of the peak coincident period. The highest hourly demand observed during a peak coincidence period was 21,361 kW.

Given the lack of available demand data and resulting uncertainty about the savings estimates, EcoMetric was only able to determine that the customer's reported savings value of 3,786 non summer-peak demand (kW) was reasonable and conservative.

#### 5.1.2.3 Annual Natural Gas Savings

EcoMetric used thirteen months of historical monthly billing data to estimate the baseline annual natural gas consumption. The natural gas consumption in June 2017 of the baseline period was over 50% higher than the average of all other months and reflected a month that included a significant maintenance-related outage. The natural gas consumption in June 2017 does not appear to be representative of normal operation, so EcoMetric estimated that month's consumption to be the average of the two adjacent months' consumption. This adjustment reduced the baseline annual consumption value from 206,110 ccf to 199,716 ccf.

EcoMetric's approach for calculating the annual natural gas savings followed the same approach as Messer (i.e., baseline consumption based on historical monthly billing; post-installation consumption based on the post-installation performance test measured value multiplied by 365 days) but used the reduced annual consumption value resulting from the adjustment of one outlier month.

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34 Defined as the hours ending 15:00 through 18:00 Eastern Prevailing Time (EPT) during all days from June 1 through August 31, inclusive, that is not a weekend or federal holiday.

This method assumed that post-installation consumption was the same every day of the year and was equal to the consumption on the day of the post-installation performance test. Due to the amount and granularity of the available natural gas consumption data, EcoMetric used the same assumption in the evaluated savings analysis.

#### 5.1.2.4 Savings Summary

EcoMetric’s evaluation yielded higher estimates of annual energy (kWh) savings than the value reported by Messer, but there was not sufficient data available to verify savings with a high degree of accuracy beyond the values Messer reported. EcoMetric calculated a range of values based on its independent analysis and determined that Messer’s reported electric savings (kWh) estimates were likely conservative. EcoMetric was also able to ascertain that Messer’s reported demand (kW) savings value of 3,786 kW did not represent the summer coincident peak demand savings but was reasonable and conservative.

EcoMetric recommended adjusting Messer’s estimate of natural gas savings. This is due to the adjustment of an outlier in the historical monthly billing data (June 2017), as described in Section 5.1.2.3. The adjustment lowered the annual natural gas savings for the project from 184,210 ccf (19,047 MMBtu) to 177,817 ccf (18,386 MMBtu), a 4% decrease from the savings reported by Messer. Table 40 presents a summary of EcoMetric’s evaluated electric and natural gas savings for this project.

*Table 40: E2I Reported and Evaluated Savings*

Program	Energy Savings (MWh)	Peak Demand Savings (MW)	Natural Gas Savings (MMBtu)
Reported	30,322	3.79	19,047
Evaluated	30,322	3.79	18,386
Realization Rate	100%	100%	97%

**Finding 42:** EcoMetric found that the detailed energy calculations for the reported savings were technically sound and utilized a combination of historical billing data and pre- and post-installation performance test data.

### 5.1.3 NET SAVINGS

EcoMetric did not calculate net savings for this program as only one of the nine projects in the program were completed in CY2020. Net savings for the program may be calculated when more projects are completed.

DNREC launched the Cool Switch Low Impact Refrigerant program (Cool Switch) in March of 2020, with a goal of reducing the amount of hydrofluorocarbons (HFCs) released into the atmosphere. The program promotes the use of refrigerants with a Global Warming Potential (GWP) lower than 1,500 by Delaware non-residential (commercial and industrial) customers. The program requires the refrigerants to also comply with existing Delaware regulations.

The Delaware Cool Switch Program is available to non-residential customers that use at least 50 pounds of refrigerant in their facilities. There are two pathways available to businesses interested in participating in the Cool Switch Program: existing system retrofits and new systems. Existing system retrofit projects will receive an incentive for switching from a high GWP refrigerant to a refrigerant with a GWP lower than 1,500. New system projects will incentivize installing natural refrigerant systems or using low GWP refrigerants in new conventional systems. New system projects refer to the installation of new low GWP systems either in new construction applications or the replacement of equipment that is past its deemed useful life as determined by DNREC.

EcoMetric completed a review of the calculation methodology, program assumptions, and completed applications to assess the technical accuracy and alignment with similar programs from other jurisdictions. As part of this review, EcoMetric reviewed applications, calculation spreadsheets, and project-specific equipment specification sheets.

### 6.1 PROGRAM DOCUMENTATION REVIEW

EcoMetric reviewed applications and relevant project documentation for three Cool Switch projects completed for a single customer. The application included customer information, contractor information, and project details such as cooling capacity, refrigerant type, leak rate, and system charge. Along with the application, DNREC also provided specification sheets for the installed system and a scope of work completed by the contractor.

**Finding 43:** Although the project information tab of the application provided the relevant information, it did not clearly state whether the projects followed the existing system retrofit path or the new system path. This is an important designation to ensure the correct calculation of CO<sub>2</sub> savings.

*Recommendation 37: Ensure the project application clearly designates which system path – Retrofit/Replacement or New – is being considered for the project.*

The values documented in the “Expected system remaining or useful life” section of the applications EcoMetric reviewed appeared to be inconsistent with the desired applicant responses. For example, the applicant responses documented in the applications EcoMetric reviewed all detailed the age of the existing equipment instead of the expected system remaining or useful life. However, DNREC clarified that the program remedied this discrepancy by capping the measure life based on values in the Mid-Atlantic TRM.

EcoMetric also found that the baseline leakage rates listed in the application appeared high compared to other publicly available industry resources. To help standardize the leakage rates, DNREC capped the baseline leakage rate at 20%, which is in line with EPA's Refrigerant Management Requirements<sup>35</sup>.

**Finding 44: EcoMetric found the assumptions regarding measure life and leakage rates to be reasonable and appropriate when compared to industry standard practice.**

## 6.2 METHODOLOGY REVIEW

EcoMetric reviewed the calculation methodology to ensure the technical accuracy and appropriateness compared to similar programs from other jurisdictions. DNREC provided a detailed description of the calculation methodology and the associated algorithm inputs.

EcoMetric found that the existing system retrofit projects were appropriate for businesses that replaced high GWP refrigerants in existing equipment with low GWP alternatives. High GWP refrigerants are R-22, R-404A, R-407A, and others with GWP values greater than or equal to 1,500. Low GWP refrigerants are those such as R-449A, R-448A, and others with GWPs less than 1,500.

The new system projects were appropriate for businesses that installed a new refrigerant system, either in a newly constructed facility, a facility in which a major renovation occurs, or replacing an existing piece of equipment that has passed its useful lifespan. The new systems pathway encourages participants to install systems that use refrigerants with low GWPs such as R-449A, R-448A, and others, or very low GWP refrigerants such as ammonia and carbon dioxide. New systems must use a refrigerant with a GWP of less than 1,500 to be eligible for grants through the Cool Switch Program.

The program uses the formula listed below to calculate the Avoided Emissions of CO<sub>2</sub>-equivalent GHGs:

$$mtCO_2e =$$

$$\text{Years of Operation} * [(GWP_B * Charge_B * Leakage_B) - (GWP_N * Charge_N * Leakage_N)] / 2,204.6$$

In the equation above, 'GWP' corresponds to refrigerant global warming potential defined as equivalent pounds of carbon dioxide per pound of refrigerant; 'charge' corresponds to pounds of refrigerant; 'leakage' corresponds to annual estimated percent loss of refrigerant to atmospheric emissions; and the subscripts B and N correspond to baseline and new refrigerant systems, respectively. Pounds of carbon dioxide equivalent emissions are converted to metric tons using a standard conversion factor of 2,204.6 pounds per metric ton.

**Finding 45:** The algorithm to calculate the avoided emissions of CO<sub>2</sub>-equivalent GHGs is technically sound from an engineering perspective.

# Appendix 1                      PROGRAM EVALUATION TEARAWAYS

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This section contains Program Evaluation Tearaways that summarize the key findings and recommendations from the impact and process evaluations for each program.

# DNREC PORTFOLIO

## 2020 Evaluation At-A-Glance



**SPANNING**  
2019 - 2020

**4** PROGRAMS EVALUATED

**542** PROJECTS COMPLETED

**295** PROJECTS EVALUATED

### ENERGY EFFICIENCY INVESTMENT FUND (EEIF)

**75** PROJECTS GRANTED

**100%** ELECTRIC REALIZATION RATE

**21,830 MWh** **3.08 MW** FIRST YEAR NET SAVINGS

**53** PROJECTS EVALUATED

**2.38** TOTAL RESOURCE COST RATIO

**214,158 TONS** OF LIFETIME GHG REDUCTION

### GREEN ENERGY PROGRAM (GEP)

**255** PROJECTS GRANTED

**30** PROJECTS EVALUATED

**2.34 MW** **139.5 Tons** VERIFIED CAPACITY  
SOLAR PV GEOTHERMAL

**100%** CAPACITY REALIZATION RATE

**1.31** TOTAL RESOURCE COST RATIO

**51,304 TONS** OF LIFETIME GHG REDUCTION

**3,280 MWh** AVOIDED ELECTRIC GENERATION

### WEATHERIZATION ASSISTANCE PROGRAM (WAP)

**212** PROJECTS COMPLETED & EVALUATED

**167 MWh** **1,347 MMBtu** FIRST YEAR NET SAVINGS

**71%** ENERGY REALIZATION RATE

**\$264** NON-ENERGY BENEFITS PER HOME

**0.42** TOTAL RESOURCE COST RATIO

**1,754 TONS** OF LIFETIME GHG REDUCTION

# ENERGY EFFICIENCY

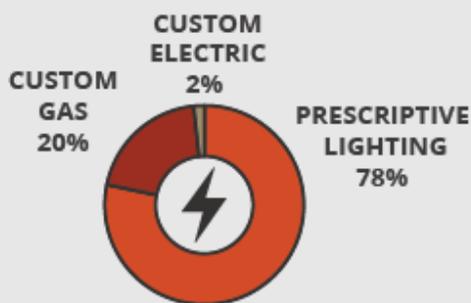
## Investment Fund 2020 Evaluation At-a-Glance



**75** PROJECTS GRANTED

**53** PROJECTS EVALUATED

### NET ELECTRIC SAVINGS



### NET VERIFIED SAVINGS



**ELECTRIC  
REALIZATION RATE**



**TOTAL RESOURCE  
COST RATIO**



**214,158  
TONS  
OF LIFETIME  
GHG REDUCTION**

## KEY IMPACT RECOMMENDATIONS

- Continue to ensure participants submit documentation and ex-ante calculations that clearly explain and support the claimed savings.
- Provide standardized calculator tools for use by applicants and contractors in estimating ex-ante energy savings for each project.
- Ensure there is an adequate number of implementation staff with subject matter expertise to review each of the energy efficiency projects that come through the EEI program.

# GREEN ENERGY PROGRAM

## 2020 Evaluation At-a-Glance



255

PROJECTS  
GRANTED

30

PROJECTS  
EVALUATED

### VERIFIED CAPACITY

2.34

MW



SOLAR  
INSTALLED

139.5

Tons



GEOHERMAL  
INSTALLED

3,280

MWh



AVOIDED  
ELECTRIC  
GENERATION

2.11

MW



AVOIDED PEAK  
DEMAND  
GENERATION

100%



CAPACITY  
REALIZATION RATE



1.31

TOTAL RESOURCE  
COST RATIO



51,304  
TONS  
OF LIFETIME  
GHG REDUCTION

## KEY IMPACT RECOMMENDATIONS

- ⚡ Consider using AHRI certifications available in project documentation rather than nominal values to verify the capacity and calculate savings of installed geothermal heat pump systems.
- ⚡ Customers/Contractors should provide a summary of their energy savings methodology, and software modeling inputs, if any.

# WEATHERIZATION ASSISTANCE PROGRAM

## 2020 Evaluation At-a-Glance

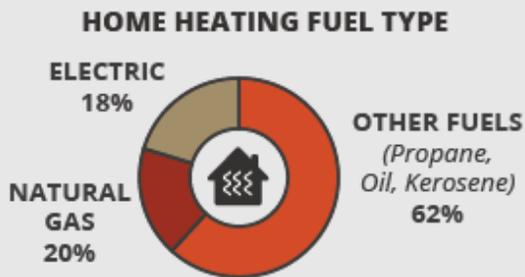


**212** PROJECTS COMPLETED

**212** PROJECTS EVALUATED

**NON-ENERGY BENEFITS**

\$154 THERMAL COMFORT	\$54 NOISE	\$56 HEALTH



**NET VERIFIED SAVINGS**

<b>167</b> MWh ELECTRIC	<b>1,347</b> MMBtu FOSSIL FUEL
-------------------------------	--------------------------------------

**71%**  
ELECTRIC REALIZATION RATE



**0.42**  
TOTAL RESOURCE COST RATIO



**1,754 TONS**  
OF LIFETIME GHG REDUCTION

### KEY PROCESS RECOMMENDATIONS

- Contract more than one subgrantee to deliver WAP. DNREC could assign unique geographic territories to each subgrantee or allow them to compete across the state.
- Restructure the WAP subgrantee contract so that monthly administrative fund payments be attached to meeting monthly targets of weatherized homes.
- Explore coordination opportunities with LIHEAP to increase the number of applications in the program pipeline.

This appendix includes a detailed description of the billing analysis EcoMetric used to calculate the verified savings for WAP. The detailed description below includes the inputs and algorithms EcoMetric used in the two-staged billing analysis. EcoMetric summarizes the results, findings, and recommendations in Section 4 of this report.

EcoMetric converted daily average temperature data into heating degree (HDD) and cooling degree (CDD) day values. Degree day calculations convert average daily temperature into variables that help identify outdoor air temperatures where a home's cooling or heating system mostly likely turns on. Monthly billing HDD variables were calculated for every base temperature between 40 to 70°F and CDD base values between 60 to 80°F. Equations 1 and 2 show the derivations of HDD and CDD values;

$$HDD = \max(\text{Temp}_{Base} - \text{Temp}_{Avg}, 0) \quad (1)$$

where  $\text{Temp}_{Base}$  varies and  $\text{Temp}_{avg}$  = the average of the high and low temperature for the day. For example, when calculating HDD at temperature base = 65 °F, if the average daily temperature is 60 °F, HDD = 5 for the day. The formula for CDD is similar, except the average and base temperature terms are reversed to capture that cooling is needed when the outdoor temperature exceeds the base temperature. For example, when calculating CDD at temperature base = 65 °F, if the average daily temperature is 70 °F, CDD = 5 for the day. The HDD and CDD values were estimated for each day in the associated billing period and then summed to a billing period total.

$$CDD = \max(\text{Temp}_{Avg} - \text{Temp}_{Base}, 0) \quad (2)$$

For example, when calculating CDD at temperature base = 65 °F, if the average daily temperature is 70 °F, CDD = 5 for the day. The HDD and CDD values were estimated for each day in the associated billing period and then summed to a billing period total.

The first stage of modeling required EcoMetric to run participant-specific regression models for each combination of HDD and CDD base temperatures, retaining only the best performing pair. The team repeated the optimal model selection process for each participant and comparison home and independently for both pre and post-weatherization periods. EcoMetric used the model's R-squared value to score, rank, and retain the best model parameter combinations.

Equation (3) shows the electric kWh regression model algorithm used to calculate the best HDD and CDD parameter combination. EcoMetric leveraged the same model form for finding optimal model combinations pre and post weatherization.

$$KWH_i = \beta_0 + \beta_1HDD_i + \beta_2CDD_i + \varepsilon_i \quad (3)$$

where;

$KWH_i$  = Billed kilowatt-hours for month i divided by the number of days in the billing period

$HDD_i$  = Heating degree days base (40 to 70 °F base) for month i

$CDD_i$  = Cooling degree day base (60 to 80 °F base) for month i

$\beta_0, \beta_1, \beta_2, \varepsilon$  = Coefficients determined by the regression model and error term ( $\varepsilon$ )

Equation (4) lists the natural gas (in therms) billing data regression model form used to calculate the best HDD only parameter for each participant. Similar to electric models, EcoMetric used the same process to identify optimal model combinations for both pre and post weatherization.

$$THERM_i = \beta_0 + \beta_1HDD_i + \varepsilon_i \quad (4)$$

where;

$THERM_i$  = Billed therm for month i divided by the number of days in the billing

$HDD_i$  = Heating degree day base (40 to 70 °F base) for month i

$\beta_0, \beta_1, \varepsilon$  = Coefficients determined by the regression model and error term ( $\varepsilon$ )

EcoMetric used the results from Equations (3) and (4) to estimate each home's pre and post normalized energy consumption. Equation (5) for electric analysis and Equation (6) for natural gas analysis show how the coefficients from Equations (1) and (2) are used to calculate normalized energy consumption (NAC) before and after weatherization.

$$NAC_j = \beta_0 365.25 + \beta_{1,j}HDDNorm_j + \beta_{2,j}CDDNorm_j + \varepsilon_j \quad (5)$$

$$NAC_j = \beta_0 365.25 + \beta_{1,j}HDDNorm_j + \varepsilon_j \quad (6)$$

where;

$NAC_j$  = Normalized annual consumption for participant j

$HDDNorm_j$  = 30-year average annual heating degrees for participant j at optimal

$CDDNorm_j$  = 30-year average annual cooling degrees for participant j at optimal

$\beta_0, \beta_1, \beta_2, \varepsilon$  = Coefficients determined by the regression model and error term ( $\varepsilon$ )

Equation (7) calculates the change in NAC between the pre and post periods for each participant:

$$\Delta NAC_j = NAC_{pre} - NAC_{post} \quad (7)$$

Finally, EcoMetric calculated the verified electric energy savings values for each home by including home size, primary fuel type, and housing type in the regression model. Equation (8) displays the final model algorithm.

$$\Delta NAC = \beta_0 + \beta_1 SQFT + \beta_2 Part + \beta_3 ElecSF + \beta_4 ElecMH + \beta_5 OthSF + \beta_6 OthMH + \beta_7 Part * ElecSF + \beta_8 Part * ElecMH + \beta_9 Part * OthSF + \beta_{10} Part * OthMH + \varepsilon_j \quad (8)$$

And the per home natural gas per home savings were estimated using Equation (9)

$$\Delta NAC = \beta_0 + \beta_1 SQFT + \beta_2 Part + \varepsilon_j \quad (9)$$

where;

- $\Delta NAC$  = Change in normalized annual consumption for participant
- $SQFT$  = Home size in square feet
- $Part$  = Indicator for participant status (0 = no, 1 = yes (comparison group))
- $ElecSF$  = Primary heating fuel electric and single family home (1 = yes, 0 = no)
- $ElecMH$  = Primary heating fuel electric and manufactured/mobile home (1 = yes, 0 = no)
- $OthSF$  = Primary heating fuel other fossil and single family home (1 = yes, 0 = no)
- $OthMH$  = Primary heating fuel other fossil and manufactured/mobile home (1 = yes, 0 = no)
- $\beta_0 - \beta_{10}, \varepsilon$  = Coefficients determined by the regression model and error term ( $\varepsilon$ )

EcoMetric calculated verified peak demand savings by combining weather dependent summer cooling savings and additional non-weather dependent savings from water heaters, improved

ventilation, and efficient lighting. Regional space cooling load shapes<sup>36</sup> identified that 23% of total annual WAP project cooling savings occur between the 1-7 pm weekday hours between June and August. The team calculated average demand savings by taking the resulting annual cooling savings and dividing them by the typical number of weekday peak hours in the summer (390).

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36 Ontario Independent Electricity System Operator annual cooling load shapes were used to determine percent of cooling load occurring during Jun-Aug on-peak hours (1-7pm)

This appendix includes a summary table of the algorithms and the number of responses EcoMetric received from grantees when conducting interviews. For each NEB category that a grantee site had experienced, interviewers asked about the category in more depth in an attempt to estimate monetary costs or benefits when possible. Some participants provided total sum estimates, while others walked through calculations with the interviewer. Table 41 shows all the formulas used to calculate NEBs by category. EcoMetric presents the preliminary NEB values in section 2.2 of this report.

Table 41: Formulas Used to Calculate NEBs

NEB	Cost/Revenue Category	Formula	# of NEBs Using Formula
Operations & Maintenance	Labor	Hours per year due to Old Equipment * Cost per hour	6
		Hours per year due to Old Equipment * Wage per hour	7
		No calculation required - Value stated upfront	3
	Labor - One Time Cost	Total cost / Measure life	2
	Parts + Supplies	Cost of parts * Number of parts * Times per year	2
		Cost of parts * Number of parts per year	1
		Cost of parts * Times per year	5
		No calculation required - Value stated upfront	2
		Times per year * Cost of parts	1
Administrative	Labor	Hours per year due to Old Equipment * Wage per hour	3
		No calculation required - Value stated upfront	1
Safety	Labor - One Time Cost	(Hours due to New Equipment * Wage per hour) / Measure life	1
	Employee Injury	Total cost per Incident / # of years Incident likely to occur	1
	Labor	Times per year * Wage per hour	1
	Product/Property Damage	Total cost per Incident / # of years Incident likely to occur	2
Materials Handling	Labor	Labor costs per year	1
Waste Disposal	Labor	Total cost * Times per year	3
Sales	Sales Revenue	Annual Rent * % Attributed to EEIF lighting	1

# Appendix 4 EEIF COMMERCIAL NEBS EVALUATION IDI GUIDE

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## Background

The EcoMetric team will conduct in-depth phone interviews with 2020 EEIF participants to provide DNREC with preliminary ballpark values for non-energy benefits (NEBs) from measures installed through EEIF. Due to the small size of the population and sample, it will not be possible to deliver results at the 90% confidence level. Should the results from this preliminary assessment warrant it, they could potentially provide the foundation for a CY2021 evaluation that DNREC could undertake with a larger survey of 2020 and 2021 participants to bolster these estimates and provide additional support for DNREC adopting commercial NEBs values for EEIF.

[IF LEGITIMACY REQUESTED, REFER CONTACTS TO the Delaware Department of Natural Resources and Environmental Control at (302)-735-3480; ask for Maya Krasker or Keri Knorr].

Sample Variable	Description
CONTACT_NAME	Applicant contact name from 2020 program records
GRANTEE	Grantee name from 2020 program records
ADDRESS	Grantee address from 2020 program records
EXTERIOR LED LIGHTING	1 = Exterior LED lighting installed (exterior mogul lamps, outdoor fixtures, parking garage fixtures)
INTERIOR LED LIGHTING	1 = Interior LED lighting installed (case and track lighting, high-bay and low-bay fixtures, linear lamps, mounted fixtures, screw-in/pin-base lamps, troffer and panel fixtures and retrofit kits)
LIGHTING CONTROLS	1 = Lighting controls installed (wall mount occupancy sensors)

## Introduction

Hello, I'm calling you on behalf of the Delaware Energy Efficiency Investment Fund. May I please speak with [CONTACT\_NAME]?

Last year, [GRANTEE] received grant funding from the Delaware Energy Efficiency Investment Fund to install energy-efficient lighting measures. My firm, NMR Group, is interviewing participants in the program to determine whether the lighting measures installed through the program might have had any positive or negative effects on their businesses or workers beyond energy savings. Are you still the person at [GRANTEE] most familiar with the outcomes of your organization's participation and experience with the program?

0a. [IF NO] Could I please speak to the person who is most familiar with your organization's participation? [IF NO THANK AND TERMINATE]

0b. [IF NOT AVAILABLE] When would be a good time for me to call back and speak to them? [RECORD RESPONSE; IF NEVER, THANK AND TERMINATE]

This interview should take about 20 minutes. In appreciation for your time, we'll send you a \$100 gift card. Is now a good time to talk? [SCHEDULE FOR ANOTHER TIME IF DESIRED; IF NO, THANK AND TERMINATE]

May I record this conversation for quality control? We will not share the recording with anyone. All of your answers are confidential and will only be reported in aggregate. [TALKING POINTS IF NEEDED]

What is the Delaware Energy Efficiency Investment Fund? The Energy Efficiency Investment Fund program (EEIF) provides financial incentives to businesses, state agencies, local governments, and non-profits to make energy-efficiency upgrades in existing facilities in Delaware. The incentives are designed to defray some of the cost difference between high-efficiency equipment and equipment that is no more efficient than what is commonly installed in commercial buildings (i.e., "baseline" equipment).

Who is NMR? NMR is a subcontractor to EcoMetric, an independent evaluation firm hired to do this research.

Timing: This interview should take about 15 to 20 minutes depending on your answers. [IF IT IS NOT A GOOD TIME, SET UP CALL BACK APPOINTMENT OR OFFER TO LET THEM CALL US BACK.]

Sales concern: This is not a sales call; we would simply like to learn about your organization's experiences with the Energy Efficiency Investment Fund. Your responses will be kept confidential. If you would like to talk with someone to verify this interview, please feel free to contact the Delaware

Department of Natural Resources and Environmental Control at (302-735-3360) and ask for Maya Krasker or Keri Knorr.

### Firmographics

For the rest of our conversation, I'm going to refer to the Energy Efficiency Investment Fund by its acronym, EEIF, or just call it "the program" or "the EEIF program."

I'm going to start with a few questions about your company and your role.

Which kind of business does your company operate at [ADDRESS]? [Do not read list]

- |                            |                                  |
|----------------------------|----------------------------------|
| a. Manufacturing           | i. Warehouse/Distribution Center |
| b. Small Retail            | j. Grocery                       |
| c. Multi Story Retail      | k. School/University             |
| d. Big Box Retail          | l. Church/Religious building     |
| e. Small Office            | m. Home Improvement              |
| f. Large Office            | n. Car Dealership                |
| g. Full-Service Restaurant | o. Other [_____]                 |
| h. Fast Food Restaurant    |                                  |

Which statement best describes your company's relationship to the space at [STREET]?

- Your company owns, manages, and occupies it
- Your company occupies it, but does not own or manage it
- Your company owns or manages it, but does not occupy it
- Other [\_\_\_\_\_]
- Don't know

What is your title?

## Equipment Verification

My records show that your organization installed the following measures through EEIF:

[IF EXTERIOR\_LED\_LIGHTING=1] Exterior LED lighting [IF NEEDED READ: For example, exterior mogul lamps, outdoor fixtures, or parking garage fixtures.]

[IF INTERIOR\_LED\_LIGHTING=1] Interior LED lighting [IF NEEDED READ: For example, case and track lighting, high-bay and low-bay fixtures, linear lamps, mounted fixtures, screw-in/pin-base lamps, troffer and panel fixtures, or retrofit kits.]

[IF LIGHTING\_CONTROLS=1] Lighting controls [IF NEEDED READ: Wall mount occupancy sensors]

Is this equipment still installed?

Yes, all if it is still installed

Some equipment is no longer installed

No

Don't know

[IF 0=2 OR 3] Why was it removed?

[IF 0=2 OR 3] What, if anything, did you install in its place?

[IF 0=1] Is this equipment still operational?

Yes

No

Don't know

[IF 0=2] Why not?

## Non-Energy Effects

Now I'd like to ask you some questions about possible non-energy effects associated with the lighting that was installed through the EEIF program. By non-energy effects, I mean costs or benefits other than savings on your energy bills that your organization might have experienced from installing these measures.

First, I'm going to go through a checklist of cost and benefit categories and ask you if your organization realized any costs or benefits in each one. Then we'll go back through and explore each relevant category in more depth. We're trying to estimate monetary costs or benefits, so for some of these categories, we're going to try to convert time into money.

Since the high efficiency lighting was installed through the program, have you noticed an increase, decrease, or no change in [A-H] costs? [READ]

Costs Category	Definition
A. Annual operations and maintenance?	Anything that is spent (both time and parts) on maintaining existing equipment, like avoided bulb changes, avoided electrician/service costs, avoided system monitoring (occupancy sensors), and avoided parts purchases. This could be work done by contractors or in-house staff.
B. Administration?	The company's time costs related to the time employees spend running a business, such as accounting or avoided service or parts/supplies procurement
C. Materials handling?	Time and costs for people in the loading docks and warehouses (avoided parts handling in warehouse)
D. Materials movement?	Time and costs (gas, vehicles, pay) for truck drivers, both deliveries and pickups
E. Other labor?	Any labor not included in O&M, Administration, materials handling, or materials movement
F. Safety?	Any time and costs related to improved safety and avoided injuries, property damage, and insurance costs
G. Waste disposal?	Avoided waste disposal and waste disposal contract
H. Other costs?	Avoided accidents

Since the high efficiency lighting was installed through the program, have you noticed an increase, decrease, or no change in [I-J] revenue? [READ]

	Revenue Category	Definition
I.	Sales?	Sales revenues from improved product lighting
J.	Other revenue?	Includes any revenues from any sources we have not yet discussed (increased productivity)

- Increase
- Decrease
- No change
- Don't know

[ASK O&M FOR ALL (IF CHANGE INDICATED); RANDOMIZE OTHER NEBS. ASK FOR ALL NEBS INDICATED IF TIME ALLOWS].

#### Operations and Maintenance Costs

[IF 0A=1 OR 2]

This Section refers to anything that is spent maintaining an existing equipment, like time and parts to maintain existing equipment, avoided bulb changes, avoided electrician/service costs, avoided monitoring of lights because of occupancy sensors, and avoided parts purchases. This could be work done by contractors or in-house staff.

By how much would you say the installation of high efficiency lighting ...

[IF 0A=1] increased your annual operation and maintenance costs?

\$ \_\_\_\_\_

Don't know

[IF 0A=2] decreased your annual operation and maintenance costs?

\$ \_\_\_\_\_

Don't know

[Record dollars; If respondent cannot answer, GO TO 0.]

How did you estimate this amount? [probe: what parts of the O&M costs were reduced/increased]

[IF 0A=2] In what ways did the installation of high efficiency lighting increase your O&M costs?

[IF 0B=2] In what ways did the installation of high efficiency lighting decrease your O&M costs?

[probes:

Internal/External Labor: Annual hours of increase/decrease and an hourly rate.

Parts: Quantify the number and type of parts that increased or decreased and the unit cost of each.

Other: Any other NEB related costs that increased or decreased not yet covered.]

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	Category	How/why it changed	\$ Value
A.	Internal Labor	Ex. Not as many bulb changes; 15 min/week; \$15/hr.	(15min*52 weeks)/60 = 13 hrs  13 hrs * \$15 = \$195
B.	External Services/Labor		
C.	Parts + Supplies		
D.	Other (Specify)		

---

NEB costs b-h

[IF 0B through 0H=1 OR 2]

This Section refers to DEFINITION.

By how much would you say the installation of high efficiency lighting ...

[IF 0B through 0H=1] increased your annual NEB costs?

\$\_\_\_\_\_

Don't know

[IF 0B through 0H=2] decreased your annual NEB costs?

\$\_\_\_\_\_

Don't know

[Record dollars; If respondent cannot answer, GO TO 0.]

How did you estimate this amount? [probe: what parts of the NEB costs were reduced/increased]

[IF 0A=2] In what ways did the installation of high efficiency lighting increase your NEB costs?

[IF 0B=2] In what ways did the installation of high efficiency lighting decrease your NEB costs?

[probes:

Internal/External Labor: Annual hours of increase/decrease and an hourly rate.

Parts: Quantify the number and type of parts that increased or decreased and the unit cost of each.

Other: Any other NEB related costs that increased or decreased not yet covered.]

---

	Category	How/why it changed	\$ Value
A.	Internal Labor	Ex. Not as many bulb changes; 15 min/week; \$15/hr.	(15min*52 weeks)/60 = 13 hrs  13 hrs * \$15 = \$195
B.	External Services/Labor		
C.	Parts + Supplies		
D.	Other (Specify)		

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NEB Revenue I-J

[IF 0I OR 0J]=1 OR 2]

This Section refers to DEFINITION.

By how much would you say the installation of high efficiency lighting ...

[IF 0I OR 0J]=1] increased your annual NEB revenue?

\$\_\_\_\_\_

Don't know

[IF 0I OR 0J]=2] decreased your annual NEB revenue?

\$\_\_\_\_\_

Don't know

[Record dollars; If respondent cannot answer, GO TO 0.]

How did you estimate this amount? [probe: what parts of the NEB revenue were reduced/increased]

[IF 0A=2] In what ways did the installation of high efficiency lighting increase your NEB revenue?

[IF 0B=2] In what ways did the installation of high efficiency lighting decrease your NEB revenue?

[PROBES: # of units produced/sold, per unit production costs, revenue per unit]

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	Category	How/why it changed	\$ Value
A.	# of units		
B.	Per unit production costs		
C.	Revenue per unit		
D.	Other (Specify)		

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#### Closing

Those are all of the questions that I have for you. Do you have any final comments that you'd like to share? [RECORD]

Thank you for your time.