



LibertyTM

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May 3, 2021

Arkansas Public Service Commission
1000 Center Street
PO Box 400
Little Rock, AR 72203-0400

Re: Docket No. 07-076-TF
Annual SARP Filing

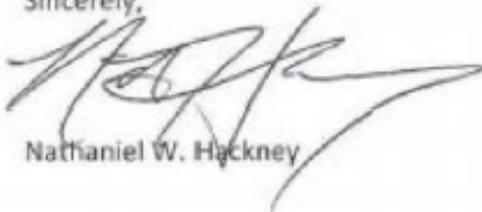
Dear Ms. Loos:

The Empire District Electric Company hereby submits its Standardized Annual Report Packet for 2020 for filing in the above-referenced docket.

If you have any questions about the filing, please do not hesitate to contact the undersigned.

Thank you for your assistance with this matter.

Sincerely,



Nathaniel W. Hackney

THE EMPIRE DISTRICT ELECTRIC COMPANY ENERGY EFFICIENCY ANNUAL REPORT Filed May 3, 2021

1.0 EXECUTIVE SUMMARY

1.1 Brief historical background of the EE portfolio

The Empire District Electric Company (“Empire” or “Company”) began its Quick Start Energy Efficiency (“EE”) portfolio in 2007 as directed by the Arkansas Public Service Commission’s (“Commission” or “APSC”) Rules for Conservation and Energy Efficiency Programs approved in Order No. 18 of Docket No. 06-004-R. This initial portfolio consisted of participation in the two state-wide programs, Energy Efficiency Arkansas (“EEA”) and the Arkansas Weatherization Program (“AWP”). Empire also implemented a Central Air Conditioner (“CAC”) Tune-up rebate program and Commercial & Industrial (“C&I”) Prescriptive rebate program.

In 2010, the Commission approved the addition of a high efficiency central air conditioner replacement component to the existing CAC tune-up rebate program, along with a rebate for a programmable thermostat. The Commission also approved the Interruptible program, a voluntary curtailment program for large commercial and industrial customers.

In the spring of 2011, Empire filed for approval of a High-efficiency Residential Lighting program and a Home Energy Comparison Program to supplement its portfolio. However, in July 2011 the Commission requested Empire re-file its portfolio to incorporate data for the 2012 and 2013 program years. During this time Empire, with the help of its demand-side consultant Applied Energy Group (AEG), decided to completely overhaul the existing portfolio in an attempt to increase customer participation and overall savings levels. As a result of the Commission’s order and Empire’s new portfolio expansion, primary focus was dedicated to the new portfolio and the September 2011 filing deadline. The new portfolio was filed in September 2011. The new portfolio became active January 1, 2012. It excluded the AC tune-up program, and added a Residential Lighting Program, C&I Custom program, Energy Star® Appliance program, and Small Business Lighting program.

On December 28, 2012, Empire made a filing with the APSC that would add two new programs: Residential AC Tune-up and Duct Repair and an independent, contractor-driven Residential Weatherization. These programs leverage the design and contractors of a similar program designed and successfully implemented by Oklahoma Gas & Electric (“OG&E”). These programs were funded using re-appropriated budgets from underperforming programs in Empire’s Arkansas EE portfolio.

In 2016, Empire filed a new energy efficiency portfolio for 2017-2019. This new portfolio sought to streamline the inefficiencies and alleviate the shortcomings of the program. The new portfolio focused on getting rid of underperforming programs and focusing on programs with a proven track record of success. In doing so, it also set budgets at a more reasonably achievable level, which helped abate Empire’s potential for over-recovering the costs associated with these programs.

In 2019, Empire filed a new energy efficiency portfolio for 2020-2022. The new portfolio initially featured the reluctant discontinuation of the Weatherization Program, which was not found to be cost-effective in the initial analysis. The portfolio, as proposed without the Weatherization program, was approved for 2020, alongside a request that Liberty worked with the Independent Evaluation Monitor

("IEM") and Parties Working Collaboratively ("PWC") to integrate new variables to cost-effectiveness into its analysis of the Weatherization program. This modification pushed the Weatherization program into cost-effectiveness, and the addition of this program was approved to be re-introduced for 2021 and 2022.

This annual report provides the results of the portfolio for the 2020 program year.

Table 1.1

2020 Portfolio Summary							
Net Energy Savings		Costs			Cost-Effectiveness		
Demand MW	Energy MWh	Actual Expenditures	LCFC	Performance Incentives	TRC Net Benefits (NPV)	TRC Ratio	PAC Ratio
0	134	\$ 58,965	\$ 97,964	N/A	\$ 81	1.67	0.00

1.2 Major Accomplishments and Milestones Reached

Empire's portfolio achieved an evaluated annual energy savings of 134,484 kWh in 2020. Empire's evaluated annual demand savings for 2020 was 20 kW.

Empire continues to utilize informal partnerships reported in previous program years with agencies like the Arkansas Energy Office. Empire's 2020 energy efficiency portfolio participation was highlighted by vastly increased participation in the Commercial and Industrial – Custom program.

Table 1.2

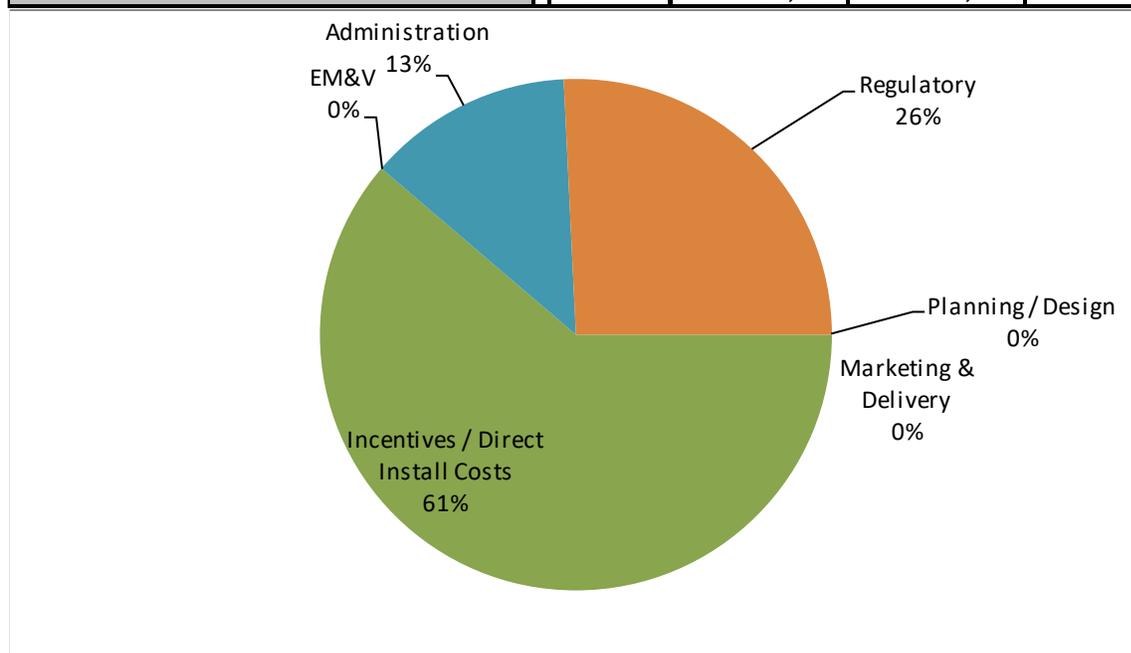
EE Portfolio Expenditures by Program					
Program Name	Target Sector	Program Type	2020		% of Budget
			Budget (\$)	Actual (\$)	
Residential Products	Residential	Consumer Product Rebate	20,417	19,118	94%
School-Based Energy Education	Residential	Consumer Product Rebate	14,842	14,658	99%
Commercial and Industrial (Custom)	Commercial & Industrial	Custom	9,415	1,150	12%
Commercial and Industrial (Prescriptive)	Commercial & Industrial	Prescriptive/Standard Offer	21,410	3,354	16%
Online Energy Calculator	All Classes	Behavior/Education	2,000	3,995	200%
Energy Efficiency Arkansas Regulatory	All Classes	Behavior/Education	1,499	1,499	100%
	-	-	5,401	15,191	281%
		Total	74,983	58,965	79%

1.3 Goals and Objectives for EE portfolio

For its 2020 energy efficiency portfolio, Empire planned for annual estimated energy savings of 304,587 kWh and for annual estimated demand savings of 158 kW.

Table 1.3

EE Portfolio Expenditure Summary by Cost Type				
Cost Type	2020 Total Expenditures			
	% of Total	Budget (\$)	Actual (\$)	% of Total
Planning / Design	0%	-	-	0%
Marketing & Delivery	75%	55,906	-	0%
Incentives / Direct Install Costs	18%	13,676	36,124	61%
EM&V	5%	3,900	-	0%
Administration	0%	-	7,650	13%
Regulatory	2%	1,501	15,191	26%
	100%	74,983	58,965	100%

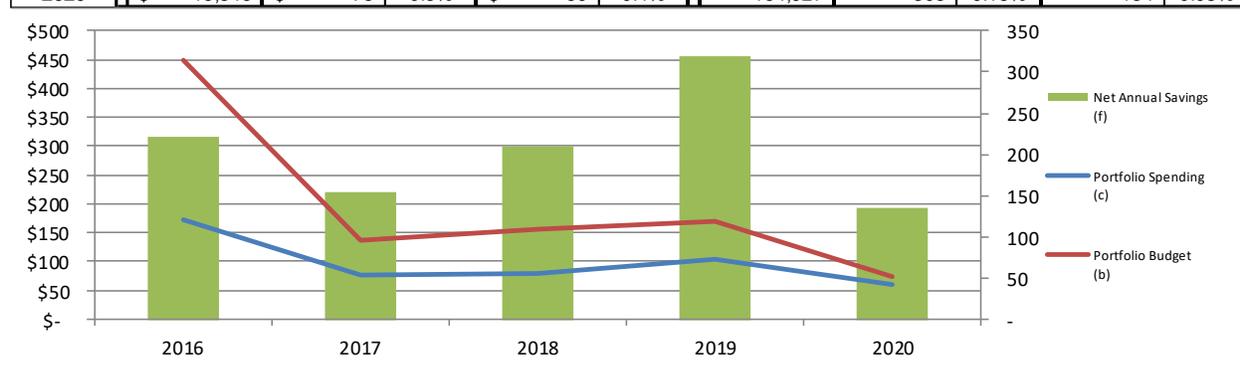


1.4 Progress achieved versus goals and objectives

Since 2012, Empire has experienced fairly consistent participation in its energy efficiency programs in Arkansas, in spite of well-documented difficulties it faces in its service territory (See Section 1.7 – *What’s Working and What’s Not*). Empire attempted to set more reasonable savings goals and budgets, allowed by the exemptions to the savings targets, as allowed by Order No. 62 in Docket No. 07-076-TF (“Order No. 62”). 2020 was the first year of Empire’s current energy efficiency portfolio . Empire achieved 20 kW, 13 percent of its demand savings goal. Empire achieved 134,484 kWh, 44 percent of its savings goal.

Table 1.4

Company Statistics										
Program Year	Revenue and Expenditures					Energy				
	Total Revenue (a) (\$000's)	Budget		Actual		Total Annual Energy Sales (d) (MWh)	Plan		Evaluated	
		Portfolio Budget (b) (\$000's)	% of Revenue (% = b/a)	Portfolio Spending (c) (\$000's)	% of Revenue (% = c/a)		Net Annual Savings (e) (MWh)	% of Energy Sales (% = e/d)	Net Annual Savings (f) (MWh)	% of Energy Sales (% = f/d)
2016	\$ 14,884	\$ 449	3.0%	\$ 173	1.2%	170,937	1,170	0.68%	220	0.13%
2017	\$ 15,213	\$ 136	0.9%	\$ 78	0.5%	170,908	227	0.13%	155	0.09%
2018	\$ 16,599	\$ 157	0.9%	\$ 79	0.5%	175,630	228	0.13%	210	0.12%
2019	\$ 15,625	\$ 171	1.1%	\$ 104	0.7%	175,461	229	0.13%	320	0.18%
2020	\$ 15,846	\$ 75	0.5%	\$ 59	0.4%	164,927	305	0.18%	134	0.08%



1.5 High-level recap of portfolio savings, participation levels, prior year comparisons, trends, etc.

Empire’s portfolio-level achievements are summarized below.

- Empire achieved verified net energy savings of 134 MWh, as compared to 320 MWh in 2019 210 MWh in 2018 and 155 MWh in 2017.
- Empire achieved verified net demand savings of 20 kW in 2020, as compared to 90 kW in 2019, 39 kW in 2018 and 35 kW in 2017.
- Empire’s portfolio expenditures (\$58,965) were 44% lower than 2019 (\$104,005), were 25% lower than 2018 (\$78,639) and 24% lower than 2017 (\$77,854). This reduction was due largely to the one-year suspension of the Weatherization program¹, to the planned expenses associated with conducting EM&V for 2016, 2017, and 2018, and designing the 2020-2022 portfolio.

¹ Empire’s Weatherization program was not included in its 2020 program year, as approved by Order No. 84 in APSC Docket No. 07-076-TF, because it was not cost-effective. Modifications to the TRM, as well as a modified filing, allowed the program to be re-integrated into Empire’s 2021-22 program portfolios, as approved by Order No 86 in Docket No. 07-076-TF.

1.6 Highlights of well-performing programs

This year, in spite of the challenges of COVID-19, Liberty achieved participation in 3 out of 4 programs with measurable participation goals. 2 of these 3 (School-based Energy Education and Residential Products) exceeded their participation targets.

Through its Residential Products program, Empire distributed 549 3-packs of LED bulbs, as well as 150 Direct Install kits to Empire's residential customers in 2020 resulting in evaluated savings of 90,140 kWh. This program replaced the Residential Lighting Program, offered in the 2017-2019 portfolio.

Perhaps the most challenged of all programs were the Commercial and Industrial programs. Because of COVID-19, many businesses were forced to temporarily close or enter into austerity measures. This caused many utility programs across the country which are centered on partnerships with commercial businesses to fall short of goals for the 2020 program year. Empire was no different in this respect. Empire received 1 participant in its Prescriptive Commercial and Industrial program, which completed a relatively small project, totaling savings of 18,130 kWh.

1.7 What's Working and What's Not

Citing the comments of the IEM, "it is unlikely that Empire's program portfolio will ever reach its participation goals due to the challenges it faces in its service territory²." Empire has expanded on these challenges in various filings over the last three years, beginning with its response to Order No. 40 in APSC Docket 07-076-TF³. A summary of these was filed in support of Empire's 2013 Energy Efficiency Cost Recovery rider re-determination filing.

Empire serves a very small number of customers in Arkansas (about 4,300) in a predominately rural and relatively remote area with a few small towns ranging in size of roughly 100 to 3,158 residents. The Commission has recognized that due to the size and other demographics that Empire faces a challenge unique among the public utilities subject to the required EE achievement targets. As outlined in Empire's other energy efficiency filings, some of these hurdles include:

- *Energy efficiency overhead costs - administrative/regulatory costs must be recovered over a small customer base*
- *Size of operations - by customer count Empire is less than one-tenth the size of the next smallest IOU in Arkansas*
- *Rural service territory - Empire's service territory includes no urban population centers that can offer economic activity and diversity*
- *Scope of operations - by population, Empire serves only about 3.7% of the only Arkansas County that it provides service*
- *Composition of customer base - Empire's Arkansas service territory is comprised of about 82% residential customers*

² APSC Docket 07-076-TF, Doc. 192. Filed June 3, 2013

³ APSC Docket No. 07-076-TF, Doc. 169. Filed September 14, 2012

- *Service territory demographics - based on 2010 U.S. Census Data about 42% of the citizens in Empire's Arkansas service territory live in renter-occupied housing*
- *Industrial/Commercial customer base - nearly half of Empire's electric sales in Arkansas come from two large commercial/industrial customers⁴*
- *Service territory economy - nationwide franchises and big box stores that may fill the landscape of high commerce areas are virtually nonexistent in Empire's Arkansas service territory*
- *Service territory media - limited cost-effective media outlets for this specific rural area are available to promote Empire's energy efficiency programs⁵*

Empire's 2017-2019 and 2020-2022 energy efficiency portfolios were configured to remedy this issue. The 2020-2022 and features six programs. This effort is supported by the variances granted to Empire by Order No. 62⁶. Order No. 62 granted Empire the following variances.

- Empire shall set realistically-achievable program plans and budget levels;
- Current mechanisms for collecting LCFC and any utility performance incentive shall remain in place, as described in Section 7 of the C&EE Rules;
- Empire is granted the flexibility listed above from specific items in the Comprehensiveness Checklist described in Order No. 17 in Docket No. 08-144-U in order to streamline program offerings and best serve its customers with programs primarily aimed at cost-effectiveness;
- Pursuant to Section 4.B of the C&EE Rules and Rule 2.05 of the Commission's Rules of Practice and Procedure, the Commission finds that it is in the public interest and good cause has been shown to grant Empire an exemption from Section 9 of the C&EE rules concerning annual reporting and it is instead required to file this information during each program design cycle, which is anticipated to be a three-year cycle;
- Empire is required to continue market its EE programs to the best of its ability and resources.

1.7.1 Comprehensiveness Checklist Factors

Per Order No. 62, Empire is exempt from strict compliance with the Comprehensiveness checklist, established by Order No. 17 in APSC Docket No. 08-144-U. In its report on 2018 EM&V, the IEM recommends, "Empire should start tracking its progress in meeting the Commission Comprehensiveness Checklist Factors to the extent possible⁷." Empire agrees that these recommendations are appropriate as a best practice and a benchmark, and in the following section, in compliance with the IEM's recommendation, details each item in the checklist, followed by a description of Empire's progress toward it.

⁴ Empire's two-largest Industrial customers—which comprise nearly half of its Arkansas sales—are cited above as hard-to-reach customers upon whom the portfolio's success will inevitably depend. Both of these customers are now exempt as Self-Direct Opt Out customers, which is still a large barrier to Empire's energy efficiency success, but in a different way.

⁵ APSC Docket No. 13-002-U, Doc. 40. Filed May 15, 2013

⁶ APSC Docket No. 07-076-TF, Doc. 267, filed May 3, 2016.

⁷ APSC Docket No. 07-076-TF, Doc. 368, filed July 5, 2019.

Whether the programs and/or portfolio provide, either directly or through identification and coordination, the education, training, marketing, or outreach needed to address market barriers to the adoption of cost-effective energy efficiency measures;

The School-based Energy Education program features an education curriculum designed to increase the energy awareness of middle schoolers. It is the intention of this program for these students to take home the awareness and enthusiasm for energy efficiency gained through their participation and share it with their families. To further encourage this, the students are equipped with direct install measures and educational materials to bring home to share what they have learned.

The Residential Products program, which primarily offers lighting measures to Empire customers, promotes future penetration of high-efficiency lighting by offering what will amount to a “sample” of LED Lighting. This, theoretically, will lead to further adoption of this technology by dispensing of misinformation regarding this technology and other high-efficiency products.

Whether the programs and/or portfolio, have adequate budgetary, management, and program delivery resources to plan, design, implement, oversee and evaluate energy efficiency programs;

Due to the economies gained by leveraging implementation contractors of other Investor-Owned Utilities (“IOUs”) in Arkansas, and from using the same EM&V Consultant, Empire is able to continually offer energy efficiency programs that test as cost-effective. The cost-effectiveness of the portfolio overall, should improve with reintegration of the Weatherization program in 2021, as approved by Order No. 86 in APSC Docket No. 07-076-TF.

Whether the programs and/or portfolio, reasonably address all major end-uses of electricity or natural gas, or electricity and natural gas, as appropriate;

Empire reluctantly had to discontinue the Weatherization program temporarily for 2020. Unfortunately, this program offers the most diverse array of end-use measures of any of Empire’s programs, past or present. The reintroduction of this program in 2021 will increase the diversity of end-uses of Empire’s residential portfolio. The Residential Products program replaced the Residential Lighting program in 2020, by adding LivingWise Energy Savings kits to customers. These include water saving measures, which increase the diversity of end-uses available through this program. The commercial program features a wide array of prescriptive measures for its customers, as well as custom rebates in order to address any conceivable end-use for which cost-effective energy savings can be demonstrated. For these reasons, Empire believes it is delivering as wide an array of end-uses as is reasonably achievable in the interest of its customers.

Whether the programs and/or portfolio, to the maximum extent reasonable, comprehensively address the needs of customers at one time, in order to avoid cream-skimming and lost opportunities;

Empire’s energy efficiency programs are focused on giveaways, and kits, in order to minimize the cash investment requirements for its economically-depressed service territory. Residential Products program and the School-based Energy Education are offered completely free to

participants, and feature as diverse and as many direct install energy efficiency measures as can be cost-effectively delivered. They are designed to be as comprehensive as they can cost-effectively be, offering the customers the greatest value possible.

Whether such programs take advantage of opportunities to address the comprehensive needs of targeted customer sectors (for example, schools, large retail stores, agricultural users, or restaurants) or to leverage non-utility program resources (for example, state or federal tax incentive, rebate, or lending programs);

Due to the well-established challenges of its service territory, it would not be cost-effective for Empire to offer a wide variety of programs targeted at specific economic sectors. Particularly, the size of its customer base would make segmented programs inefficient. Its service territory has fewer than 700 commercial customers across all customer sectors. For example, Empire has 3 school districts in its entire service territory. Offering a commercial program specifically designed for schools is not justified. Instead, Empire offers one commercial rebate program designed to be as inclusive as possible, both in terms of the types of customers and the types of end uses that can be eligible.

Whether the programs and/or portfolio enables the delivery of all achievable, cost-effective energy efficiency within a reasonable period of time and maximizes net benefits to customers and to the utility system; and

Empire believes it has complied with this item with the following actions:

- Placing emphasis on direct install measures, meaning savings begin happening immediately,
- Incentivizing customers to perform as many energy efficiency measures as can cost-effectively be done through its Weatherization program and School-based Energy Education programs,
- Incentivizing customers to change energy usage habits through its School-based Energy Education program, meaning savings are instantaneous and long-term.
- Offering many residential programs at no cost to the customer.

Whether the programs and/or portfolio, have evaluation, measurement, and verification ("EM&V") procedures adequate to support program management and improvement, calculation of energy, demand and revenue impacts, and resource planning decisions.

By committing to return to annual EM&V, and by leveraging ADM Associates, which provides services to other IOUs in Arkansas, Empire has utilized available resources to optimize the levels of costs and precision in its evaluations, and annually ensure cost-effectiveness of its programs.

1.8 Planned changes to programs or budgets

Empire made no modifications to the budgets in 2020.

1.9 Estimation of EE Resource Potential

Empire has not conducted a Potential Study solely for its Arkansas service territory, as less than three percent of Empire's customers reside in Arkansas. Empire did participate in Arkansas's most recent Statewide Potential Study, and was included in its findings.

1.10 Training Achievements

Empire did not offer any trade ally training sessions in 2020.

2.0 Portfolio Programs

2.1 Residential Products Program

2.1.1 Program Description

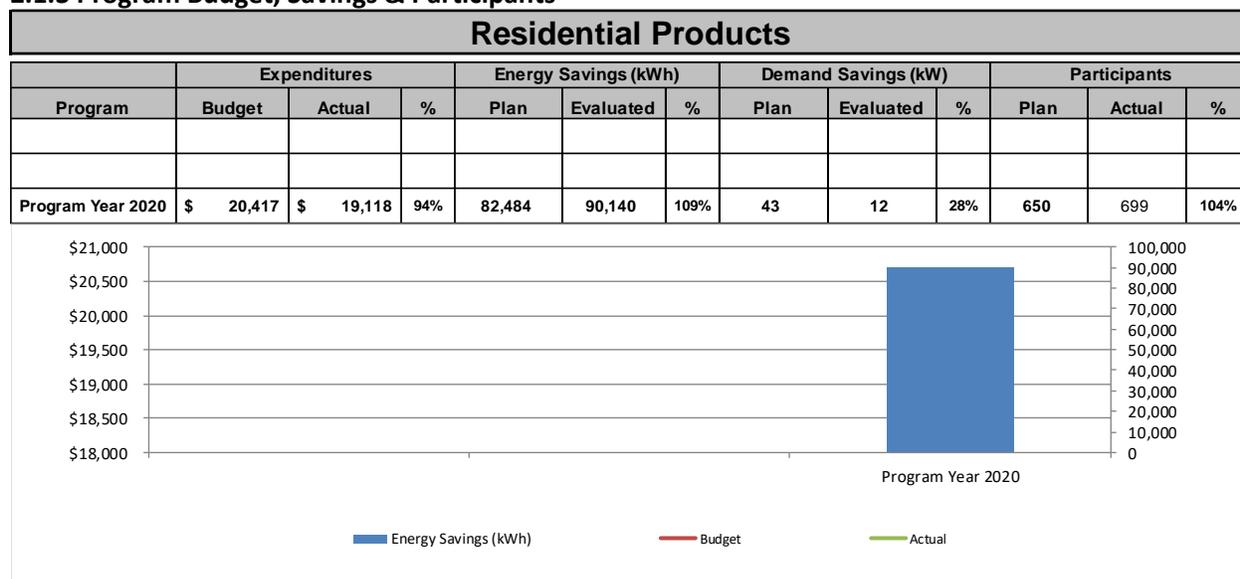
Customers who respond to a pre-paid postcard inserted into their bills receive a 3-pack of LED Light bulbs. A random sampling of these customers will also receive a direct-install kit featuring:

- (2) - LED 9 Watt Simply Conserve Bulb
- (1) - Digital Thermometer
- (1) - Flow Rate Test Bag
- (1) - Filtertone Alarm
- (1) - Installation Instruction Book
- (1) - Kitchen Aerator 1.5 gpm
- (1) - Low-flow showerhead
- (1) - Mini Tape Measure
- (1) - Nightlight - LED Photocell
- (1) - Teflon Tape Card
- (1) - Toilet Leak Detector Tablets

2.1.2 Program Highlights

- This program performed above its targets in its first year.
- 549 customers received a 3-pack of LED's
- 150 customers received direct install kits

2.1.3 Program Budget, Savings & Participants



2.1.4 Description of Participants

Empire defines a participant for this program as a distributed lighting or direct-install kit.

2.1.5 Challenges & Opportunities

The delivery of this program is rare, as the standard choice tends to be a point-of-purchase program. However, Empire’s lack of a big-box retail store makes such a delivery impossible. Empire has successfully delivered a lighting-by-mail for 9 years. Empire is proud of its ability to keep this program viable and cost-effective in spite of its challenges.

2.1.6 Planned or Proposed Changes to Program & Budget

Empire made no modifications to this program’s budget in 2020.

2.2 School-Based Energy Education

2.2.1 Program Description

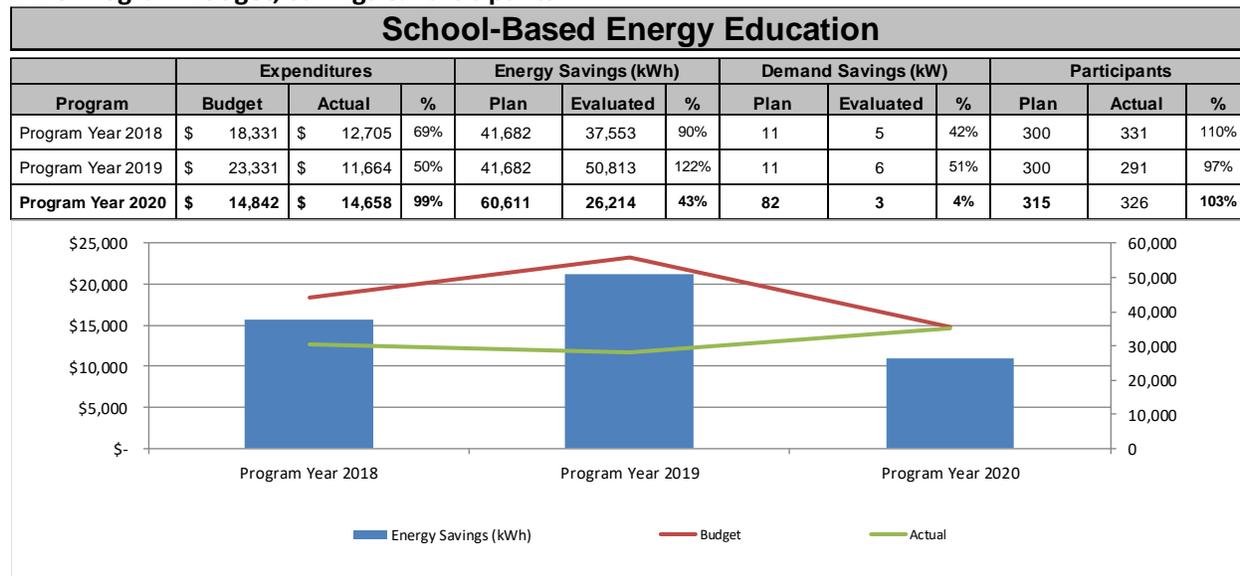
Empire provides educational kits with low-cost energy saving items and information to middle school children⁸.

2.2.2 Program Highlights

- Distributed 326 kits to middle schoolers.
- This program continues to receive positive feedback from participants.

⁸ APSC Docket 07-076-TF, Doc. 121. Filed September 30, 2011.

2.2.3 Program Budget, Savings & Participants



2.2.4 Description of Participants

A participant in this program is defined as a sixth grade student receiving an EnergyWise® kit.

2.2.5 Challenges & Opportunities

The number of customers that can be reached by this program is limited by the number of school districts in Empire’s service territory. Empire seeks to continue to educate its future and young customers in better and new ways.

2.2.6 Planned or Proposed Changes to Program & Budget

Empire made no modifications to this program’s budget in 2020. It did, however, modify the kit slightly on an experimental basis for the year. In accordance with recommendations of the AG’s office⁹, which called into question Empire’s reliance on Non-Energy Benefits (“NEBs”) provided by water-saving measures, Empire tested providing the kit this year without the low-flow showerhead. This decreased the *quantity* of kWh savings, but aimed to increase the *quality* of savings by lessening the number of kWh derived from NEBs. As a result, only 50.5% of the Total Resource Cost (“TRC”) benefits came from NEBs in 2020. This change was intended to be a trial for the 2020 program year, and Empire will assess the inclusion of the low-flow showerhead for the 2021 program year based upon the recommendations of its EM&V consultant and the IEM.

2.3 Commercial and Industrial (Custom)

2.3.1 Program Description

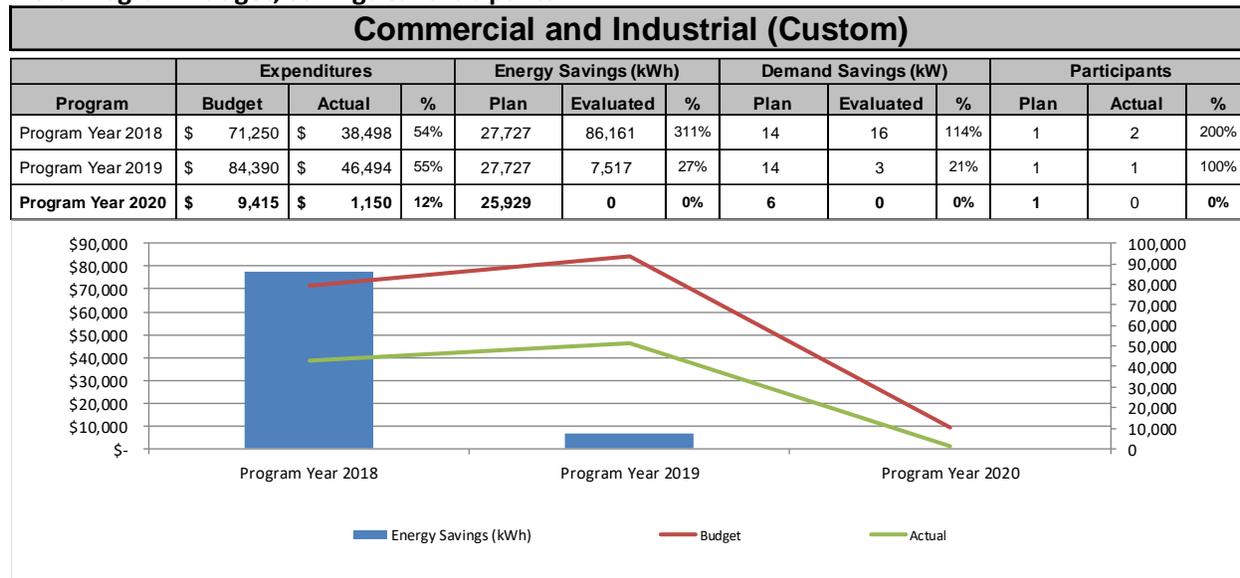
⁹ Direct Testimony of Christina L. Baker, APSC Docket 07-076-TF, Doc. 396. Filed July 17, 2020.

C&I customers receive rebates for the installation or replacement of cost-effective, efficient measures not included in the C&I prescriptive program.

2.3.2 Program Highlights

- This program had no participation in 2020.
- There was one applicant, but the project did not come to fruition.

2.3.3 Program Budget, Savings & Participants



2.3.4 Description of Participants

A participant for this program is defined as a single business receiving an incentive for installation of an energy efficiency measure(s).

2.3.5 Challenges & Opportunities

As Empire described at length in its response to Commission Order No. 40 in APSC Docket No. 07-076-TF¹⁰, and briefly above in Section 1.7 - *What's Working and What's Not*, there are various challenges to successful implementation of energy efficiency programs in its Arkansas service territory. This concern was echoed by the IEM in her 2013 EM&V Report¹¹.

Because Empire contracts Applied Energy Group to process applications for this program, and not all applications result in evaluated energy savings, the cost-effectiveness of this program is a consistent challenge.

2.3.6 Planned or Proposed Changes to Program & Budget

Empire did not make any changes to the approved budget for the 2020.

¹⁰ APSC Docket No. 07-076-TF, Doc. 169. Filed September 14, 2012.

¹¹APSC Docket 07-076-TF, Doc. 192. Filed June 3, 2013

2.4 Commercial and Industrial (Prescriptive)

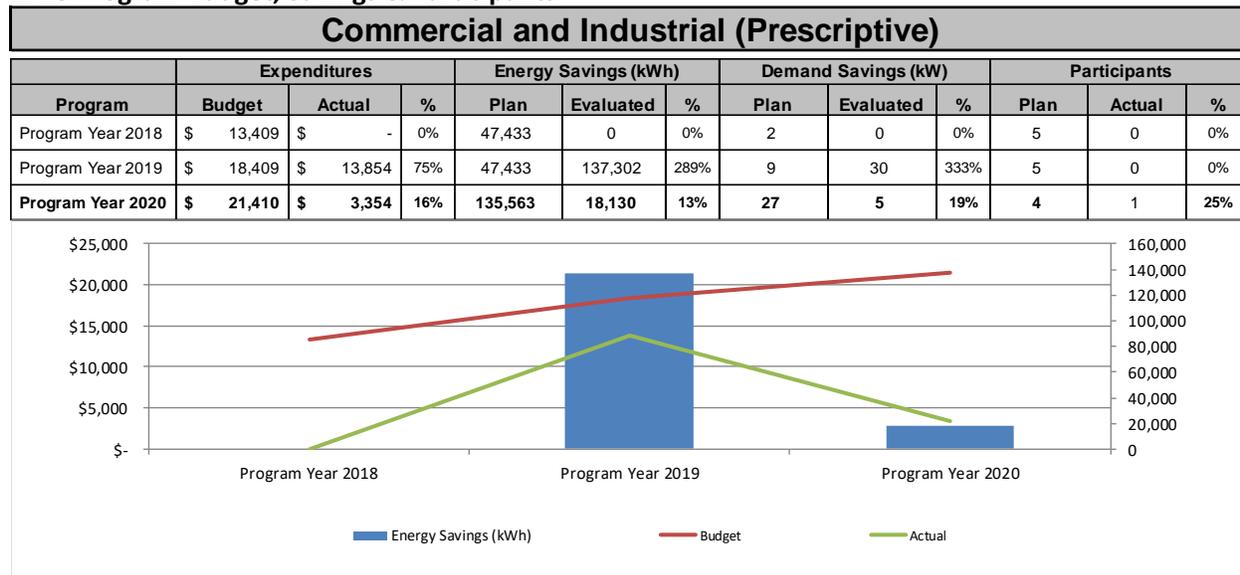
2.4.1 Program Description

C&I customers receive rebates for the installation, replacement or retrofit of qualifying electric savings measures.

2.4.2 Program Highlights

This program had one participant, in 2020: a lighting project which produced 18,130 kWh in energy and 5 kW of peak demand savings. The expansion of the number of measures that qualify under the Prescriptive C&I program for 2020-2022 has increased the customer participation in this program.

2.4.3 Program Budget, Savings & Participants



2.4.4 Description of Participants

Empire defines a “participant” for this program as a qualifying customer receiving a rebate. A single customer can receive a rebate for more than one measure.

2.4.5 Challenges & Opportunities

Because there are few or no commercial energy efficiency vendors with offices in Empire’s service territory, the program counts on contractors from nearby metropolitan areas. It is a consistent struggle to find vendors with an interest in the small number of commercial customers in this area.

2.4.6 Planned or Proposed Changes to Program & Budget

Empire did not make any changes to this program’s approved budget for the 2020 program year.

2.5 Online Energy Calculator

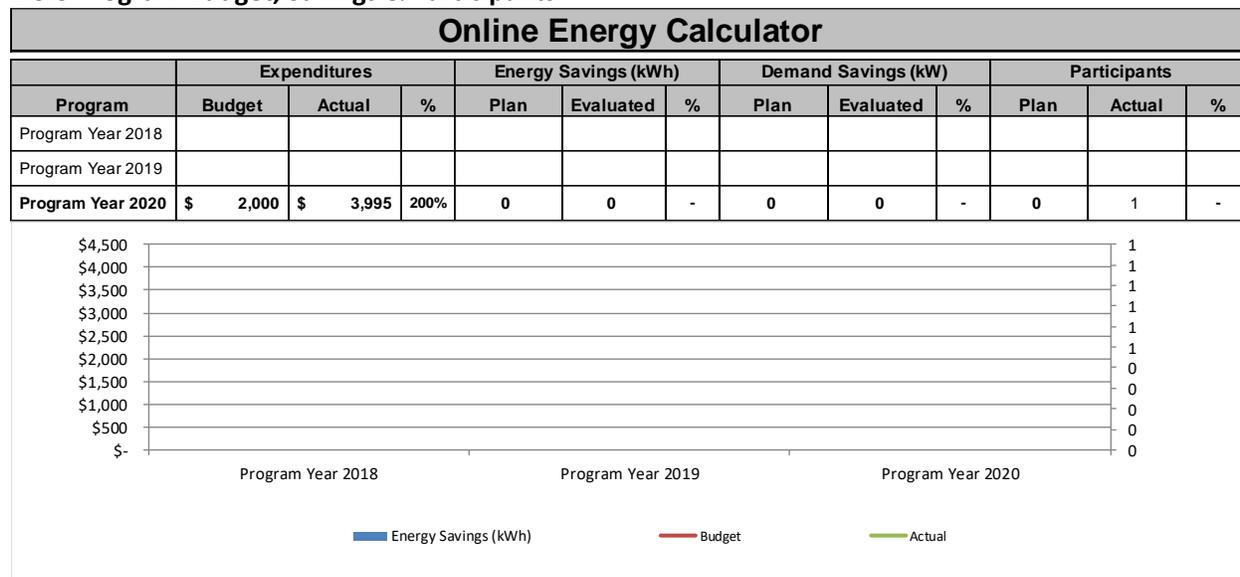
2.5.1 Program Description

Empire customers are eligible to conduct an online energy assessment and use the online energy calculator, and sign up for regular energy efficiency tips and information about how to reduce their bills, through Empire’s partnership with Apogee.

2.5.2 Program Highlights

This program is well-used, but does not directly provide measurable energy savings itself.

2.5.3 Program Budget, Savings & Participants



2.5.4 Description of Participants

Empire does not measure specific participants at a level attributable to its Arkansas jurisdiction.

2.5.5 Challenges & Opportunities

While Empire is confident in the spillover effects of this program, which would lead participants to other programs and energy efficiency upgrades, there is no way to calculate this.

2.5.6 Planned or Proposed Changes to Program & Budget

Empire did not make any changes to this program’s approved budget for the 2020 program year.

2.6 Energy Efficiency Arkansas

2.6.1 Program Description

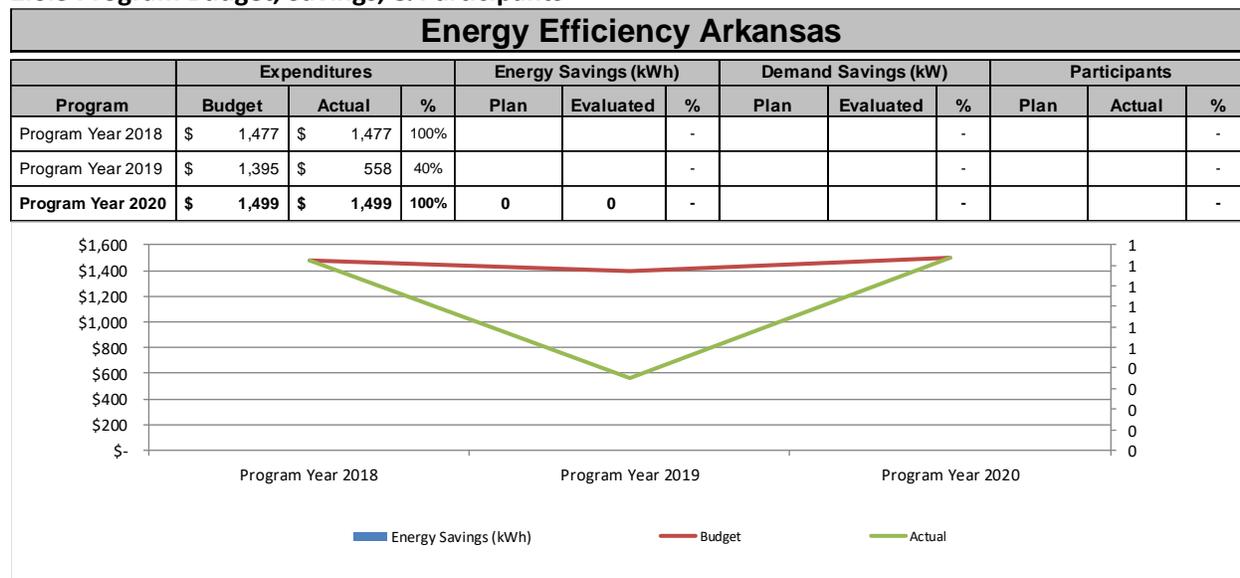
This program provides education to residential customers and technical training to contractors and business customers¹².

2.6.2 Program Highlights

- Empire is pleased to cooperate with the Arkansas Energy Office on this program.
- This program is a statewide education and awareness campaign and does not produce a measureable demand or energy savings.

¹² APSC Docket 07-076-TF, Doc. 121. Filed September 30, 2011.

2.6.3 Program Budget, Savings, & Participants



2.6.4 Description of Participants

This program is a statewide education and awareness program and does not measure participation.

2.6.5 Challenges & Opportunities

Empire does not implement any of these programs, and thus, does not face any challenges.

2.6.6 Planned or Proposed Changes to Program & Budget

There were no changes to this budget in 2020.

3.0 Supplemental Requirements

3.1 Staffing

Empire currently employs one full-time employee devoted to energy efficiency with the job title of “Senior Reporting and Systems Analyst”.

Empire also has additional staff that supports energy efficiency. This includes management, marketing, customer service and analysts.

In 2020, a Senior Manager of Energy Efficiency was hired, to oversee energy efficiency employees in Liberty Utilities’ East, West, and Central Region, which includes Empire.

3.2 Stakeholder Activities

Empire participates in frequent meetings of the Parties Working Collaboratively (“PWC”). This includes discussions of the TRM, discussions of AWP and the statewide C&I and Weatherization Collaboratives. Empire generally participates via phone and/or Webinar, as a means to minimize administrative and travel costs.

3.3 Information Provided to Consumers to Promote EE

Because Empire operates with a dramatically smaller and more rural customer base than any of its peers—described at length in its response to Commission Order No. 40 in APSC Docket No. 07-076-TF¹³ and other subsequent filings—customer surveys and experience have shown that direct mail is the preferred method of communication with Empire’s Arkansas customers. Alongside these communications, the proliferation of social media has allowed Empire new opportunities to reach its customers. Empire continues to learn how to fully utilize social media to raise awareness of its energy efficiency programs. Empire occasionally makes presentations on the programs available to community organizations in its service territory. It also appears at some community events to meet with customers and answer questions. As a means to better inform its customers, Empire coordinates with the Arkansas Energy Office for as many of these appearances as possible. Lastly, as a part of a larger corporation in the Liberty Utilities family, Empire has unprecedented access to knowledge, resources, and practices of its peers in other regions of Liberty Utilities.

4.0 Appendix A: EM&V Contractor Report

Attached as Appendix A to this report is Empire’s 2020 EM&V Report and cost-benefit analysis, prepared by ADM Associates.

¹³ APSC Docket No. 07-076-TF, Doc. 169. Filed September 14, 2012.



ENERGY RESEARCH
AND EVALUATION

Empire District Electric Company Arkansas Energy Efficiency (EE) Portfolio Evaluation Report for Program Year (PY) 2020

Pursuant to Section 9 the Rules for Conservation and Energy Efficiency Programs:
Annual Reporting Requirements, Order No. 29, Docket No. 06-004-R, May 20,
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Acronyms and Abbreviations

Acronym	Term
AC	Air conditioner
AOH	Annual operating hours
APS	Advanced power strip
APSC	Arkansas Public Service Commission
CWA	Consistent Weatherization Program
C&EE	Conservation and energy efficiency
C&I	Commercial and industrial
C&I Rebate	Commercial and industrial Rebate Program
CEE	Consortium for Energy Efficiency
CEI	Continuous Efficiency Improvement
CF	Coincidence factor
CFL	Compact fluorescent lamp (bulb)
CFM	Cubic feet per minute
DI	Direct install
EECR	Energy Efficiency Cost Recovery
EER	Energy efficiency ratio
EFLH	Equivalent full-load hours
EISA	Energy Independence and Security Act
EL	Efficiency loss
EM&V	Evaluation, measurement, and verification
EUL	Estimated Useful Lives
FR	Free ridership
GPM	Gallons per minute
HDD	Heating degree days
HID	High intensity discharge
HOU	Hours of use
HP	Heat pump
HSPF	Heating seasonal performance factor
HVAC	Heating, ventilation, and air conditioning
IEF	Interactive effects factor
IEM	Independent Evaluation Monitor
IEER	Integrated Energy Efficiency Ratio
IPLV	Integrated part load value
ISR	In-service rate
kW	Kilowatt
kWh	Kilowatt-hour
LED	Light emitting diode

Acronym	Term
LPG	Liquefied petroleum gas
M&V	Measurement and verification
MW	Megawatt
MWh	Megawatt-hour
NC	New construction
NEB	Non-energy benefit
NGS	Natural gas savings
NPV	Net present value
NTGR	Net-to-gross ratio
PCT	Participant cost test
PY	Program year
QA	Quality assurance
QC	Quality control
RCA	Refrigerant charge adjustment
RIM	Ratepayer impact measure
ROB	Replace on burnout
SEER	Seasonal energy efficiency ratio
SO	Spillover
TRM	Technical reference manual
UCT	Utility cost test
VFD	Variable frequency drive
Wx	Weatherization

1 Executive Summary

1.1 Introduction

In March of 2019, Empire District Electric Company (Empire) filed its three-year EE Portfolio Plan for PY 2020-2022.¹ The plan was found to be in compliance with Order No. 25, Docket No. 13-002-UF,² which set the time for the next three-year Portfolio to be filed and with Order No. 43³ of Docket No. 13-002-U, which set the targets requiring electric investor-owned utilities to capture energy savings in the amount of 1.20% of their 2018 sales. However, Order No. 62⁴ states that Empire is exempt from these Commission set targets.

Empire's budgets and energy savings and demand reduction goals, included within their energy efficiency plans, serve as the basis against which its portfolio of programs were evaluated. Empire's Plan includes a portfolio of energy efficiency programs designed to facilitate reductions in electricity and peak demand in every customer class. Empire is an operating company of Liberty Utilities. Empire offers retail electric service in Missouri, Kansas, Oklahoma and Arkansas, servicing approximately 4,300 customers in Arkansas. Empire's Arkansas service territory encompasses the City of Gentry and several nearby municipalities.

In accordance with APSC Rules for Conservation and Energy Efficiency Programs (CE&E Rules), Empire engaged ADM Associates, Inc., (ADM) to conduct an evaluation, measurement, and verification (EM&V) of its portfolio. The ADM staff, collectively referred to as the Evaluators, evaluated the Empire portfolio.

1.2 Summary of Empire's Energy Efficiency Portfolio

Empire offered a portfolio of energy efficiency programs, which provided a comprehensive range of customer options focused on energy efficiency and educational options. Empire designed its programs to achieve the following objectives:

- Achieve the 2020 net energy savings goal of 304,586 kWh and demand reduction goal of 157.6 kW;
- Significant energy-savings opportunities for all customers and market segments;
- Broad ratepayer benefits; and

¹ The PY2020-PY2022 Plan can be found in Docket 07-076-TF, here: http://www.apscservices.info/pdf/07/07-076-TF_348_1.pdf

² http://www.apscservices.info/pdf/13/13-002-U_198_1.pdf

³ http://www.apscservices.info/pdf/13/13-002-U_293_1.pdf

⁴ http://www.apscservices.info/pdf/07/07-076-TF_267_1.pdf

- Comprehensiveness in designing its portfolio to have programs that are cost-effective and to market its energy efficiency programs.⁵

For PY2020, the Evaluators evaluated the results for two residential programs and one commercial and industrial (C&I) program.

A brief summary of the programs can be found in the table below.

Table 1-1 PY2020 Empire Energy Efficiency Program Summary

Program	Description
Residential Products Program	LEDs or LEDs and aerators delivered by mail to participating customers who respond to a prepaid billing insert postcard.
School-Based Energy Education Program	Educational materials and energy efficiency kits distributed to students within the service territory.
C&I Rebate Program	C&I customers may receive incentives for prescriptive or custom measures.

Through its energy efficiency portfolio, Empire also seeks to provide customers with easy program entry points, flexible options for saving energy, and ongoing support for those who want to pursue deeper energy savings or demand reduction. Refer to Table 1-2 for a list of the Empire programs and targeted customer segments.

Table 1-2 Empire PY2020 Energy Efficiency Portfolio of Programs

Program	Residential	Multi-family ⁶	Small Business	C&I	Institutional & Municipal
Residential Products	X	X			
School Based Energy Education	X	X			
Commercial and Industrial Rebate			X	X	X

This report presents the results of the evaluation of these programs.

⁵ “The PWC also recommend that Empire not be required to meet certain aspects of the Commission's energy efficiency program comprehensiveness checklist, including offering programs that meet all major end-uses for each customer sector; taking advantage of opportunities to address the comprehensive needs of targeted customer sectors; and enabling the delivery of all achievable cost-effective EE within a reasonable period of time, maximizing net benefits to customers and to the utility system. The PWC note that relaxing the reporting and comprehensiveness requirements will allow Empire to include only cost-effective programs and reduce administrative expense. The PWC recommend that Empire be required to file annual Energy Efficiency Cost Recovery Rider (Rider EECR) rate adjustments on the same schedule as other IOUs; design its portfolio and programs to be cost-effective; and market its EE programs.” Order #62:
http://www.apscservices.info/pdf/07/07-076-TF_267_1.pdf

⁶ All multifamily are duplexes that are single-metered.

1.3 Evaluation Objectives

The goals of the EM&V effort are as follows:

- **Verify savings for prescriptive measures.** This is to verify that savings are being calculated according to appropriate TRM guidelines. For most measures, this constitutes applying the Arkansas Technical Reference Manual methodologies. For this evaluation that would include version 8.1⁷ (AR TRM v8.1) for PY2020.
- **Verify savings for custom measures.** This effort comprises the calculation of savings according to accepted protocols (such as IPMVP). This is to ensure that custom measures are cost-effective and providing reliable savings.
- **Conduct process evaluations.** This is to provide a comprehensive review of program operations, marketing and outreach, quality control procedures, and program successes relative to goals. From this, the Evaluators are to provide program-level recommendations for Empire. Process evaluation activities include interviews of key program actors, surveys of participants, literature reviews, best-practices assessments, and documentation of program activities, successes, and shortcomings. The scale of these evaluation is driven by Protocol C in the AR TRM v8.1.⁸
- **Conduct net-to-gross assessments.** The Evaluators developed net-to-gross ratios specific to each program and measures utilizing literature reviews due to time constraints.

1.4 Evaluation Findings

The evaluation of Empire's PY2020 portfolio is included in this evaluation report. In addition to verifying the savings reported by Empire, the Evaluators calculated lifetime impacts for the programs and measures. As part of this process, in the body of the report the Evaluators refer to the impacts (energy savings or peak demand reduction) accrued during the program year being evaluated as "first year" impacts.

Table 1-3 shows the Empire PY2020 goals, reported gross impacts, the Evaluators evaluated first year ex post gross energy savings (97,799 kWh) and demand reductions (18.17 kW), gross realization rates (90% for kWh, 100% for kW), net impacts (84,471 kWh and 16.11 kW), net-to-

⁷ <http://www.apscservices.info/EEInfo/TRM6.pdf>

⁸ The Evaluators performed a process evaluation based on PY2018 program activity and did not perform process evaluation activities based on PY2016 or PY2017 program activity. Therefore, the AR TRM v8.1 Protocols were utilized for the process evaluation.

gross (NTG) ratios, and net lifetime impacts (1,299,026 kWh).⁹ The levelized cost of energy savings (kWh) for the PY2020 portfolio is \$0.0544 (\$/kWh).

Table 1-3 PY2020 Empire Portfolio Evaluation Impacts

Impact	Metric	Res. Products	School Kits	C&I Rebate	Total
Energy Savings (kWh)	Goals (Net)	82,484	60,611	161,491	304,586
	Ex Ante (Gross)	108,603	28,611	9,107	146,321
	Ex Post (Gross)	108,603	28,611	18,314	155,528
	Realization Rate	100%	100%	201%	106%
	Ex Post (Net)	90,140	26,214	18,131	134,485
	NTG Ratio	83%	92%	99%	86%
	% of Goal (Net)	109%	43%	11%	44%
	Lifetime (Net)	1,340,264	392,035	276,842	2,009,141
Annual Demand Reduction (kW)	Goals (Net)	43.2	82.3	32.1	157.6
	Ex Ante (Gross)	14.7	3.32	4.2	22.22
	Ex Post (Gross)	14.7	3.32	4.75	22.77
	Realization Rate	100%	100%	113%	102%
	Ex Post (Net)	12.2	3.03	4.7	19.93
	NTG Ratio	83%	91%	99%	88%
	% of Goal (Net)	28%	4%	15%	13%

The contribution to portfolio energy (kWh) savings by program, by program year, is summarized in the figures below.

⁹ Lifetime impacts are the sum of energy savings over the course of the measure’s estimated useful life (EUL) and the weighted average demand reduction across the lifetime of the measure divided by the EUL (in years).

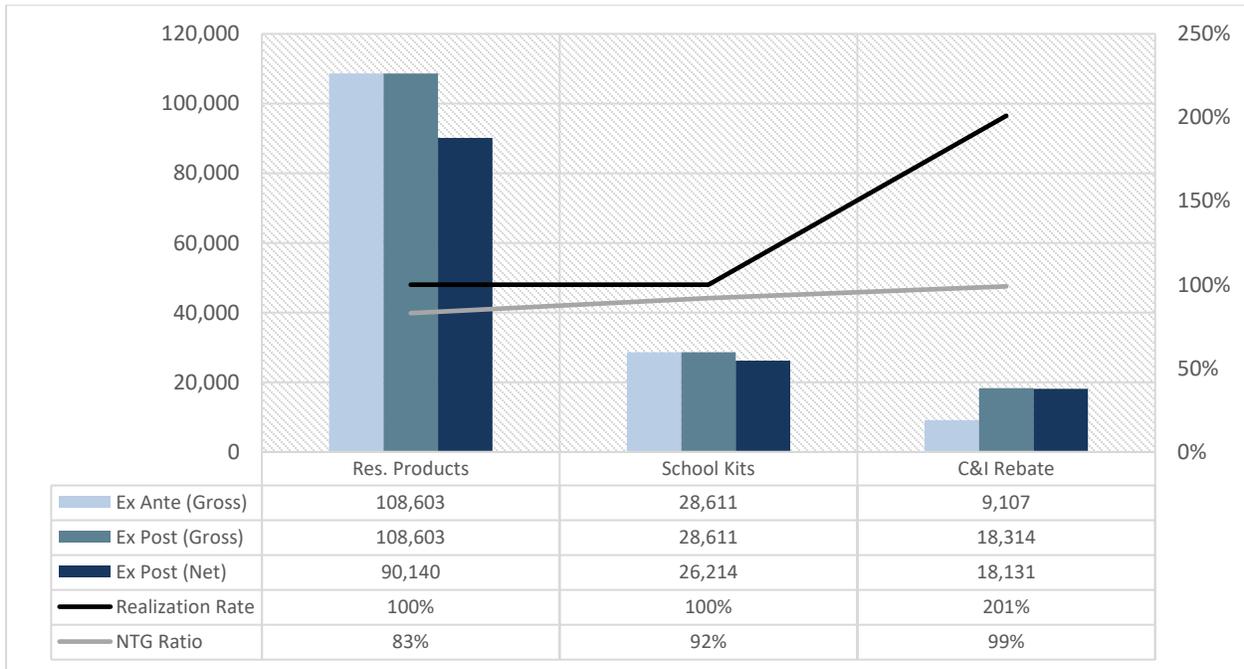


Figure 1-1 PY2020 Contribution by Program, based on Energy Savings (kWh)

Each bar in the figures below shows the ex ante gross energy savings (kWh) and the line represents the percentage of savings for each measure in the residential sector by program for PY2020.

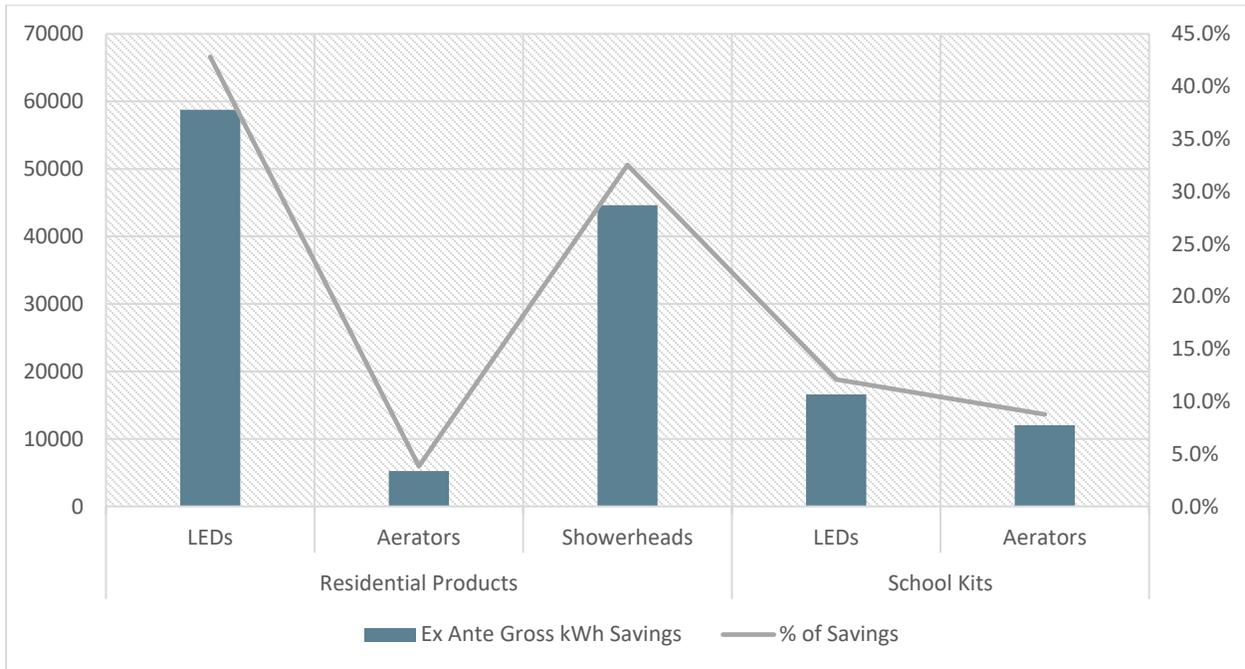


Figure 1-2 PY2020 Percentage of Energy Savings by Measure for the Residential Sector

In the C&I Rebate program, 100% of savings were from prescriptive lighting. Savings were calculated using AR TRM v8.1 algorithms.

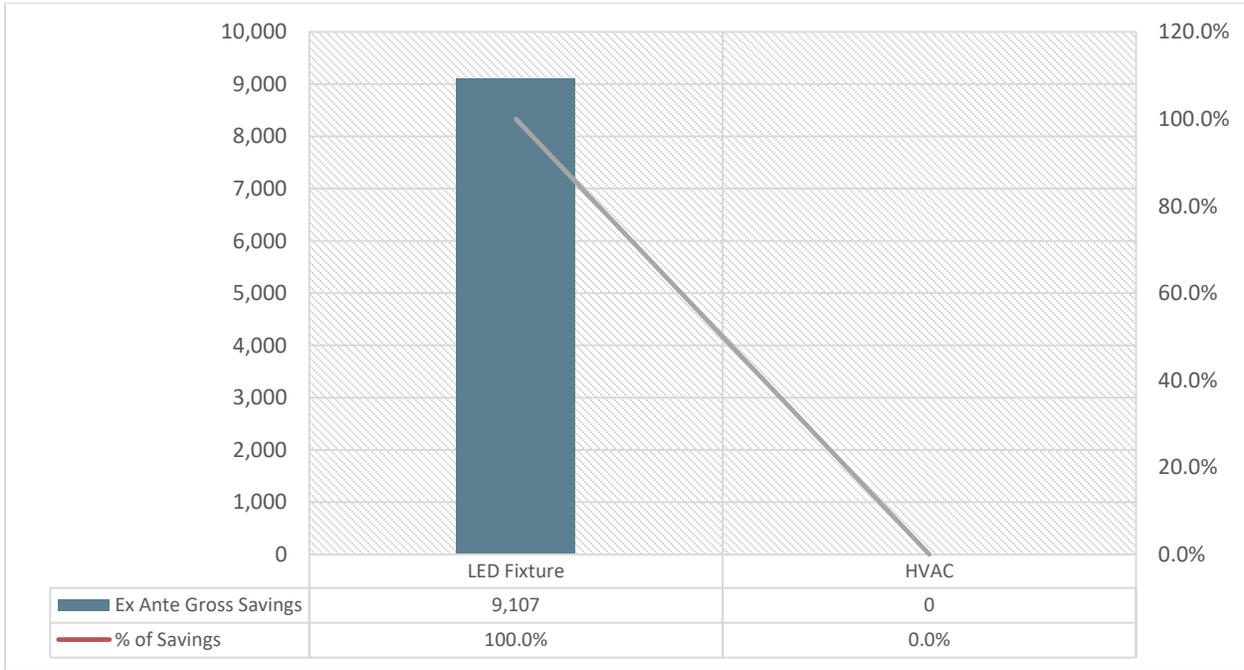


Figure 1-3 PY2020 C&I Savings by Measure based on Ex Ante Savings (kWh)

Further, the Evaluators put the net savings into the context of Empire’s PY2020 goals. Table 1-4 below summarizes the performance against goals of programs evaluated in this report.

Table 1-4 Empire's PY2020 Performance against Energy Savings (kWh) Goals

Program	2020 Verified Net Energy (kWh) Target	2020 Net Energy (kWh) Saving Achieved	% of Goal Attained
Residential Products	82,484	90,140	109%
School Based Energy Education	60,611	26,214	43%
C&I Rebate	161,491	18,131	11%
Total	304,586	134,485	44%

The PY2020 budgets and actual spend are summarized in Table 1-5 below.

Table 1-5 Summary of Budgets and Actual Spend in PY2020

Program	Budgeted Spend ¹⁰	Actual Spend
Residential Products	\$19,750	\$19,118
School Based Energy Education	\$13,860	\$14,658
C&I Rebate	\$30,158	\$4,504
Energy Efficiency Arkansas	\$3,499	\$5,494
EM&V	\$3,500	\$0
Regulatory	\$3,501	\$15,191
Total	\$74,268	\$56,380

1.5 Summary of Evaluation Findings

Following a review of present program offerings and interviews with utility and third-party implementation (TPI) staff, the Evaluators found the following.

1.5.1 Overview of Barriers

Citing the comments of the IEM, “it is unlikely that Empire’s program portfolio will ever reach its participation goals due to the challenges it faces in its service territory.¹¹” Empire has expanded on these challenges in various filings over the last three years, beginning with its response to Order No. 40 in APSC Docket 07-076-TF¹². The Commission has recognized that due to the size and other demographics that Empire faces a challenge unique among the public utilities subject to the required EE achievement targets. As outlined in Empire’s other energy efficiency filings, some of these hurdles include:

- Energy efficiency overhead costs - administrative/regulatory costs must be recovered over a small customer base.
- Size of operations - by customer count Empire is less than one tenth the size of the next smallest IOU in Arkansas.
- Rural service territory - Empire’s service territory includes no urban population centers that can offer economic activity and diversity.
- Composition of customer base - Empire’s Arkansas service territory is comprised of about 82% residential customers.
- Industrial/Commercial customer base - nearly half of Empire’s electric sales in Arkansas come from two large commercial/ industrial customers.

¹⁰ Budgeted Spend was adjusted after the 2017-2019 Plan was filed.

¹¹ APSC Docket 07-076-TF, Doc. 192. Filed June 3, 2013

¹² APSC Docket No. 07-076-TF, Doc. 169. Filed September 14, 2012

- Service territory economy - nationwide franchises and big box stores that may fill the landscape of high commerce areas are limited in Empire's Arkansas service territory.
- Service territory media – as a small rural area, there are limited cost-effective media outlets available to promote Empire's energy efficiency programs.

1.5.2 PY2020 Portfolio Conclusions

1.5.2.1 Residential Products

- The Residential Products Program met participation goals for PY2020 (500).
- Empire did not meet savings goals for PY2020 (82,484 kWh).
- Non-energy benefits (NEBs) accounting for 5.1% of program TRC benefits.

1.5.2.2 School Based Energy Education

- Non-energy benefits (NEBs) accounting for 50.5% of program TRC benefits.
- The School Based Energy Education Program met participation goals for PY2020 (150).
- Empire did not meet savings goals for PY2020 (60,611 kWh).
- The faucet aerators in the program had poor realization rates (65%). The Evaluators were not provided calculation workbooks to demonstrate how the expected savings were calculated; documentation was limited to a summary of inputs in PDF reports provided by the program implementer to Empire.

1.5.2.3 Commercial and Industrial Rebate Program

- The C&I program runs in a small and rural area of Arkansas, and as a result, program participation is fairly low. The Evaluators conclude that a program-level tracking file may not be necessary as the C&I Program typically sees only a few projects each year.

1.5.3 Progress on Previous Recommendations

In PY2020 six program or portfolio level recommendations were provided to Empire as part of the EM&V of their portfolio. The Evaluators reviewed Empire's response to recommendations from the PY2020 EM&V report¹³ and categorized them as follows:

- 1) **Adopted.** This applied to recommendations that pertained to the correction of an issue (such as using an incorrect baseline methodology) or modifications in program outreach that do not require a filing. Three of the six recommendations were adopted.

¹³ Empire's PY2015 Evaluation Report, developed by Cadmus, can be found here:
<http://www.apscservices.info/EEInfo/EEReports/Empire%202015.pdf>

- 2) **In progress.** This applies to recommendations that have been accepted but have not yet completed implementation. No recommendations are in progress.
- 3) **Under consideration.** This applies most typically to larger recommendations that would require APSC approval. One of six recommendations are in under consideration
 - a. One of the recommendations are under consideration.
 - b. The recommendation was to expand the tracking data to include full customer information.
- 4) **Rejected.** This applies to recommendations which are reviewed by Empire and rejected. Two recommendations were rejected.
- 5) **Not applicable.** This would apply to recommendations which are no longer applicable to the Empire’s portfolio. No recommendations are not applicable.

Figure 1-4 below outlines the status of the recommendations.

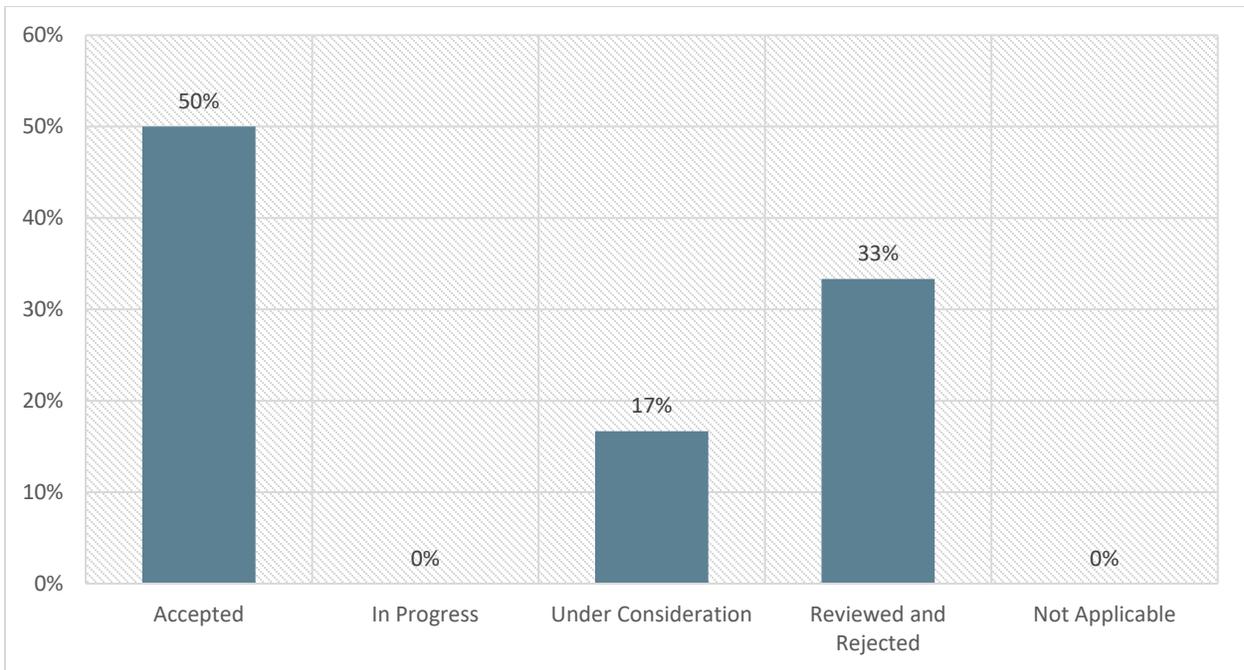


Figure 1-4 Summary of Status of PY2020 Recommendations

1.6 Structure of the Report

This report is structured as shown below:

- Section 1 Executive Summary;

- Section 2 General Methodology;
- Section 3 Portfolio-level Findings;
- Section 4 Residential Products Program Findings;
- Section 5 School Based Energy Education Program Findings;
- Section 6 Commercial and Industrial Rebate Program findings;
- Appendix A – Portfolio Cost-Effectiveness;
- Appendix B – Gross Savings Approaches;
- Appendix C – Literature Review Outcomes; and
- Appendix D – Marketing Materials.

2 General Methodology

2.1 Introduction

This section details general impact evaluation methodologies by program-type as well as data collection methods applied. This section will present full descriptions of:

- Gross savings estimation;
- Net-to-Gross estimation;
- Process evaluation methodologies; and
- Data collection procedures.

2.2 Glossary of Terminology

As a first step to detailing the evaluation methodologies, the Evaluators provide a glossary of terms to follow:

- *Deemed Savings* – An estimate of an energy savings or energy demand savings outcome (gross savings) for a single unit of an installed energy efficiency measure. This estimate (a) has been developed from data sources and analytical methods that are widely accepted for the measure and purpose and (b) is applicable to the situation being evaluated.
- *Ex Ante Gross Savings* – Forecasted savings used for program and portfolio planning purposes (from the Latin for “beforehand”).¹⁴ These savings are also referred to as Expected or Claimed savings.
- *Ex Post Gross Savings* – Savings estimates reported by an evaluator after the energy impact evaluation has been completed (from the Latin for “from something done afterward”).¹⁵ These savings are sometimes also referred to as Realized or Evaluated savings.
- *Ex Post Net Savings* – When Ex Post Evaluation Estimated Savings are multiplied by the Net-to-Gross Ratio.
- *Free rider* – A program participant who would have implemented the program measure or practice in the absence of the program. Free riders can be total, partial, or deferred.
- *Gross Realization Rate* – The ratio of Ex Post Gross Savings and Ex Ante Gross Savings.
- *Participant* – A consumer who received a service offered through the subject efficiency program in a given program year.

¹⁴ Definition provided in the Glossary of the AR TRM v8.1 for ‘Ex ante Savings Estimate’, page 100.

¹⁵ Definition provided in the Glossary of the AR TRM v8.1 for ‘Ex post Evaluation Estimated Savings’, page 100.

- *Net-to-Gross Ratio (NTGR)* – A factor representing net program savings divided by Ex Post gross program savings that is applied to Ex Post Evaluated gross program impacts, converting them into net program load impacts after adjustments for free ridership and spillover. $(1 - \text{Free ridership \%} + \text{Spillover \%})$.
- *Spillover* – Reductions in energy consumption and/or demand caused by the presence of the energy efficiency program that exceed the program-related gross savings of the participants. There can be participant and/or non-participant spillover rates depending on the rate at which participants (and non-participants) adopt energy efficiency measures or take other types of efficiency actions on their own (i.e., without an incentive being offered).
- *Estimated Useful Life (EUL)* - An estimate of the median number of years that the efficiency measures installed under a program are still in place and operable.

This glossary is drawn from several evaluation-related reference documents, such as the 2007 IPMVP, 2004 California Evaluation Framework, 2006 DOE EERE Guide for Managing General Program Evaluation Studies and the AR TRM v8.1.¹⁶

2.3 Overview of Methodology

The proposed methodology for the evaluation of the 2020 Empire portfolio is intended to provide:

- Net impact results at the 90% confidence and +/-10% precision at the program level; and
- Program feedback and recommendations via process evaluation.

In doing so, this evaluation will provide the verified net savings results, provide the recommendations for program improvement, and ensure cost-effective use of ratepayer funds. By leveraging experience and lessons learned from prior evaluations, the evaluation is streamlined to focus on areas in need of research and improvement.

2.3.1 Sampling

Due to the limited budget associated with Empire programs, the Evaluators did not develop samples for participant surveying or field inspection. The analysis of savings was based on desk review of a census of program tracking, along with a review of supporting invoices for the work completed.

¹⁶ Full AR TRM v8.1 Glossary is found on page 98.

2.3.2 Net-to-Gross Approach

In determining ex post net savings for the Empire portfolio, the Evaluators performed literature reviews for each measure in each program. More information about the results of those Literature Reviews can be found in Appendix C. Literature Review Outcomes.

Table 2-1 lists the NTGR sources by program for Empire. The rationale for the NTGR sources is as follows:

- **Residential Products:** Empire does not administer a retail markdown lighting program as seen elsewhere in Arkansas. Due to a lack of large retailers in their service area and concerns over program leakage, Empire’s Residential Products Program instead provides free-of-charge mailer kits with three LEDs or mailer kits with two LEDs and one aerator. There is no analogous program administered by other Arkansas IOUs. The NTGR for this program is based on a literature review of similar programs administered in other states. The details of this literature review can be found in Appendix C: Literature Review Outcomes.
- **School-based Energy Education:** SWEPCO does not administer a similar program. The Evaluators cited OG&E’s PY2020 Schools program channel within their Home Energy Efficiency Program (HEEP) and applied the resulting NTGR to Empire.
- **Commercial & Industrial Rebate:** The most proximal investor-owned utility (IOU) is Southwestern Electric Power Company (SWEPCO), and they administer a similar program (Commercial & Industrial Energy Efficiency Program). The Evaluators applied the PY2020 NTGR findings from this program to Empire’s program.

Table 2-1 NTGR Sources by Program

Program	NTGR Source
Residential Products	2018 Literature Review
School Based Energy Education	OG&E PY2020
Commercial and Industrial Rebate	SWEPCO PY2020

2.3.3 Impact Evaluation Activities by Program

The Evaluators used established, industry-standard approaches to estimate energy savings and demand reductions at the measure, program, and portfolio levels. The Evaluators followed all applicable measure- and program-level guidelines and protocols from the AR TRM.

To evaluate program impacts, the Evaluators adjusted program-reported ex ante gross savings using the results of our research, relying primarily on engineering desk reviews, and TRM deemed savings calculation for applicable programs. To calculate deemed savings, the

Evaluators verified the appropriateness of savings algorithms and values in program tracking data as compared to guidelines in the AR TRM. There were no site visits or surveys administrated by the Evaluators to support this evaluation. There were survey responses provided by AM Conservation to support the Schools Based Energy Efficiency program.

For each program and measure category, the Evaluators estimated energy savings and demand reduction by applying a ex post gross savings adjustment to ex ante gross savings provided by the implementors.

The types of activities performed to support the evaluation are listed below:

- **Tracking Database Verification:** Verify that program tracking data supported total claimed savings and quantities and are in compliance with the AR TRM v8.1.
- **Tracking Database Review:** Verify that the tracking database captured adequate and complete information.
- **Ex Ante Savings Review:** Verify that AR TRM v8.1 values were used correctly and evaluated per-unit savings for program measures. See Appendix B – Gross Savings Approaches for more information.
- **Net Savings Review:** Apply net-to-gross (NTG) values to program savings. Due to its geographical proximity and similar market conditions, the Evaluators largely derived NTG values from its evaluation work conducted in the neighboring territories and literature reviews. See Appendix C – Literature Review Outcomes for more information.
- **Site Visits:** Due to time constraints there were no site visits performed to support this evaluation.

2.4 Overview of Process Evaluation

The Evaluators took the following steps to determine the scope of the process evaluation for the PY2020 programs in Empire’s portfolio.

2.4.1 General Approach

The Evaluators’ general approach to process evaluation begins with a review of the tests for timing and appropriateness of process evaluation as defined in Protocol C of the TRM v8.1. In this review, the Evaluators determine what aspects of the program warrant a process evaluation.

In general, process evaluations assess organizational and procedural aspects of programs to provide feedback on features of programs that are functioning well and contribute recommendations when areas of improvement are identified. Specifically, Protocol C defines

the criteria that require a process evaluation be undertaken as well as the criteria that justify conducting a process evaluation.

Table 2-2 provides details on specific criteria that must be met prior to proceeding with a process evaluation.

Table 2-2 TRM 8.1 Volume 1 Protocol C: Process Evaluation Guidance

AR TRM v8.1 Process Evaluation Criteria
Process evaluation required if: <ul style="list-style-type: none">■ Program is new/modified■ No process evaluation has been undertaken during current funding cycle■ A change in program implementation occurred
Process evaluation potentially needed if: <ul style="list-style-type: none">■ Program impacts are lower than expected■ Goals (both informational and educational) are not being achieved■ Rates of participation are lower/slower than expected■ Program’s operational system is slow to get up and running■ Cost effectiveness of the program is less than expected■ Participants (both customers and market actors) report problems/low rates of satisfaction with program.

Based on Protocol C guidance, the Empire portfolio in its entirety required process evaluation. The Evaluators performed the extent of process evaluation activities supportable with the available program budget: review of participant survey responses provided by AM Conservation, program staff interviews, and a program documentation review.

3 Portfolio-Level Findings

This chapter provides a summary of the portfolio-level findings and any cross-cutting evaluation activities that occurred over the course of the PY2020 EM&V efforts. Specifically, this chapter includes:

- A summary of program and portfolio performance;
- A summary of EM&V activities and expenditures; and
- High-level findings that cut across programs.

3.1 Summary of Evaluation Effort

Specific PY2020 primary data collection activities are included in Table 3-1.

Table 3-1 Summary of PY2020 Data Collection Efforts

Program	# Site Visits	# Staff Interviews	# Participant Surveys	# of Measure-level Lit. Reviews
Residential Products	0	1	0	1
School Based Energy Education	0	1	291 ¹⁷	1
C&I Rebate	0	1	0	1
Total	0	3	291	3

3.2 High Impact Measures (HIMs)

Lighting measures produced most savings in the residential sector. Custom measures produced most savings in the commercial sector. This section outlines the High Impact Measures (HIMs) for each program and sector in the PY2020 Empire portfolios of programs.

3.2.1 Residential Programs

Each bar in the figures below shows the ex ante gross energy savings (kWh) and the line represents the percentage of savings for each measure in the residential sector for PY2020.

In PY2020, LEDs accounted for 76% of savings.

¹⁷ Surveys completed by implementation contractor as part of implementation process.

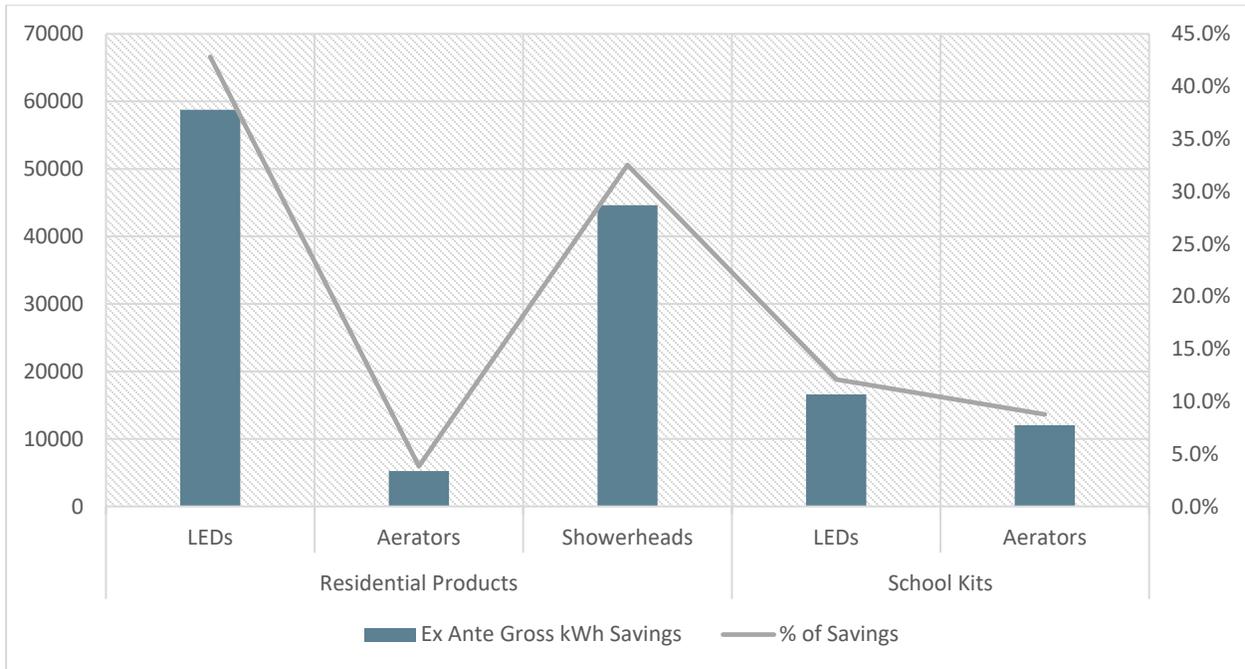


Figure 3-1 PY2020 Percentage of Energy Savings by Measure for the Residential Sector

Additionally,

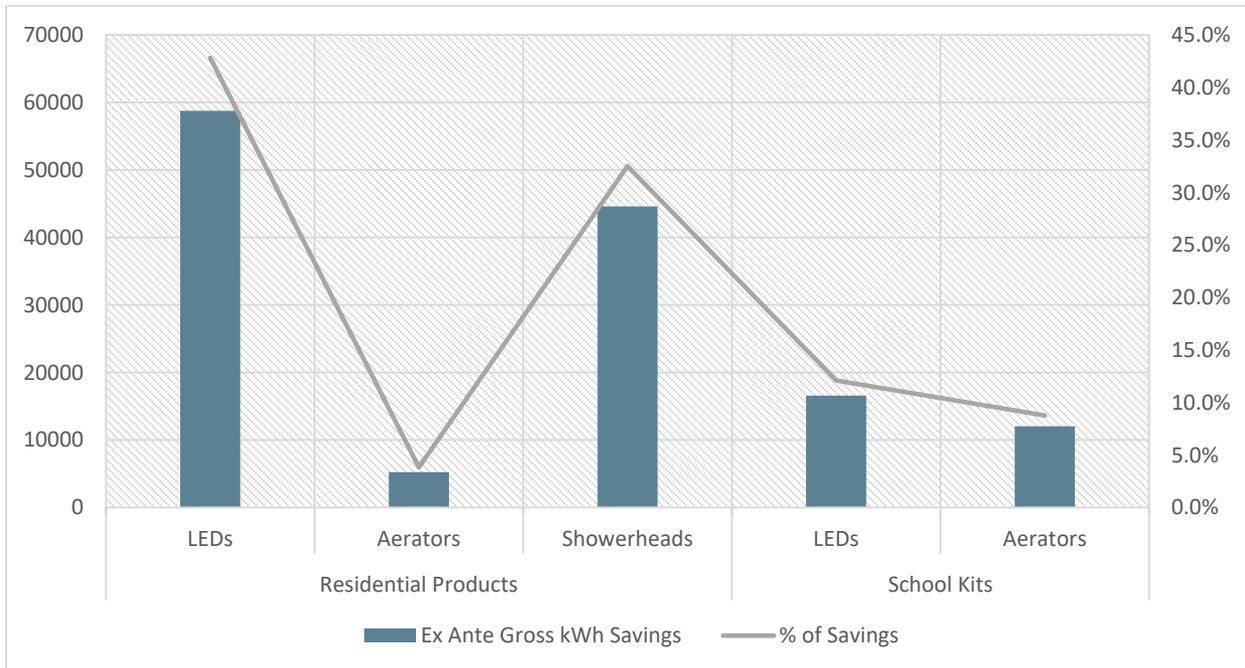


Figure 3-1 outlines the ex-ante energy (kWh) savings by end-use across all residential programs in the PY2020 portfolio.

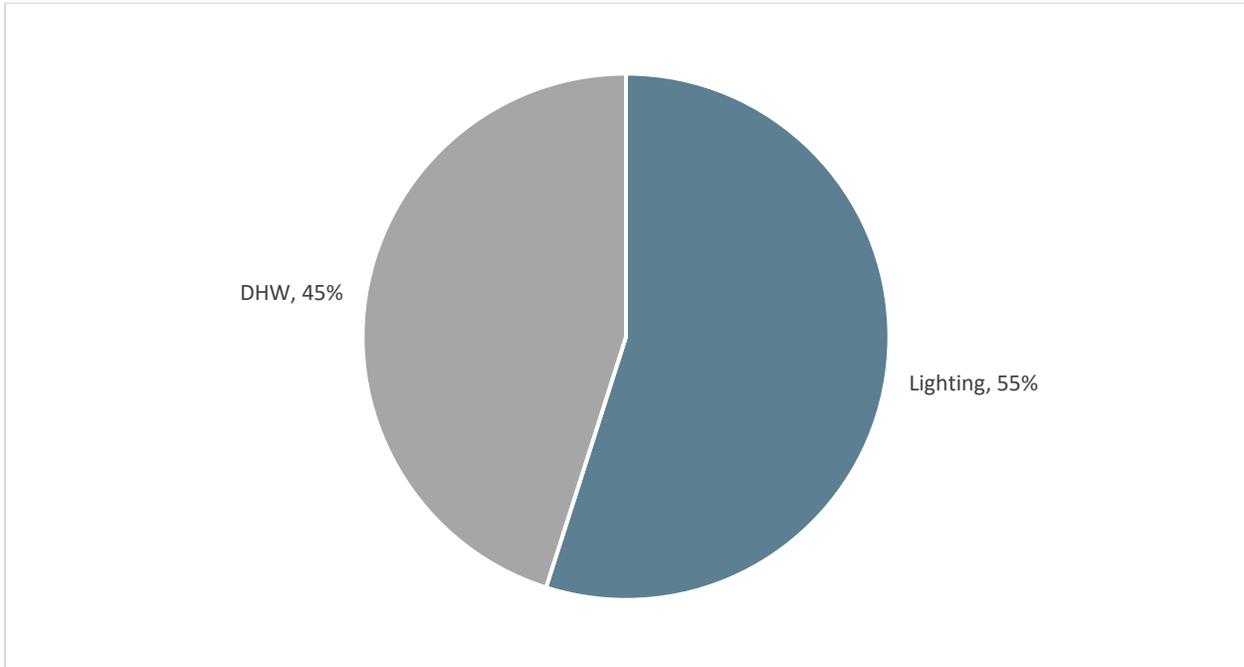


Figure 3-2 PY2020 Residential Ex Ante Energy Savings (kWh) by End-Use

3.2.2 Commercial and Industrial Programs

Lighting accounted for 100% of gross energy savings (kWh) for PY2020.

3.3 Tests of Portfolio Comprehensiveness

The Tests of Portfolio Comprehensiveness is characterized by seven factors. These factors become a guide for all parties invested in energy efficiency programs to analyze proposals. These factors cover a broad range of topics involved in running an energy efficiency programs, including targeted customer sectors, budgets and management, and addresses different types of heating and cooling types. Most utilities in Arkansas service a large geographical footprint, thus those utilities are required to meet all seven factors in their program.

Since Empire is servicing a smaller geographical location than most other utilities located in Arkansas, the PWC decided that Empire did not have to meet all seven criteria. The PWC recommended that Empire, “design its portfolio and programs to be cost-effective; and market its EE programs”. The PWC decided this for Empire so they would only need to include cost effective programs and be able to reduce costs all around their portfolio.

3.3.1 Summary of Marketing Efforts

The Evaluators received summaries of marketing spend for PY2020 as well as a copy of the bill insert used by Empire. From PY2016 to PY2018, Empire moved away from using print media advertisement. They have since focused on direct mail bill inserts.

As part of the C&I program’s marketing efforts, marketing is mainly conducted by direct mail to customers and distributing brochures.

The Marketing & Development (M&D) expenditures percent for the Empire portfolio by program year is as follows:

- PY2020: 3.1%
- PY2020: 5.7%

3.4 Summary of Cost Effectiveness Results

3.4.1 Cost Effectiveness Findings

Table 3-2 below outlines the results from the cost-effectiveness analysis performed on the PY2020 portfolios, by program.

Table 3-2 PY2020 Cost Effectiveness Test Results

Program	TRC	UCT	RIM	PCT	TRC Net Benefits
Residential Products	2.30	1.34	0.33	10.01	\$44,473
School Based Energy Education	1.82	0.43	0.22	6.50	\$23,048
C&I Rebate	2.77	0.51	0.25	14.48	\$13,841
EEA	0.00	0.00	0.00	0.00	-\$5,494
Regulatory	0.00	0.00	0.00	0.00	-\$15,191
Total	1.67	0.51	0.24	10.15	\$60,676

3.4.2 Cost Effectiveness Methodology

See Appendix A of this report for additional details on the Evaluators approach.

3.5 Non-Energy Benefits (NEBs)

Below is a summary of the Non-Energy Benefits (NEBs) that were calculated in each program in PY2020.

- **Residential Products:** this program captured avoided replacement costs and natural gas;
- **School Based Energy Education:** this program captured avoided replacement costs, propane, natural gas, and water; and
- **C&I Rebate:** this program captured avoided replacement costs, and natural gas.

The tables below outline all potential NEBs for the Empire energy efficiency portfolios.

Table 3-3 Residential NEBs by Measure¹⁸

Measure	Water	Other Fuel	ARCs/ DRCs	AR TRM v8.1 Section
ENERGY STAR LEDs		X	X	2.5.1.4
Faucet aerators	X	X		2.3.4
Low-flow showerheads	X	X		2.3.5

Table 3-4 C&I NEBs by Measure

Measure	Water	Other Fuel	ARCs/ DRCs	AR TRM v8.1 Section
High intensity discharge (HID) lamps		X	X	3.6.3
Integrated-ballast LED lamps		X	X	3.6.3
LEDs		X	X	3.6.3
Lighting controls		X		3.6.2
Modular CFLs and CCFLs		X	X	3.6.3
Other linear fluorescents		X	X	3.6.3

The table below summarize of the net present value (NPV) of all NEBs in the Empire portfolio.

Table 3-5 PY2020 Empire NEB Findings Summary

Program	NPV NGS (\$)	NPV LPGS (\$)	NPV of Water/ WW	ARC (\$)	Total NPV of NEBs
Residential Products	(\$3,340)	\$0	\$24,340	\$6,892	\$27,892
School Based Energy Education	\$4,131	\$2,820	\$27,872	\$2,789	\$37,612
C&I Rebate	\$0	\$0	\$0	\$10,071	\$10,071
Total	\$791	\$2,820	\$52,212	\$19,752	\$75,575

¹⁸ Table 3-4 and Table 3-5 represent potential NEBs for each measure. In some cases, there is either not enough data available to calculate those NEBs, or that NEB was not applicable in that application.

4 Residential Products Program

The Residential Products Program provides a free lighting kit which includes a 3-pack of light emitting diodes (LEDs) when customers respond to a billing insert offering a pre-paid coupon. Additionally, in PY2020, Empire offered a free-of-charge self-install mailer kits which included (3) LEDs, and (1) kitchen aerator.

The program has received an impact and process evaluation. The evaluations included desk reviews to estimate ex post gross savings estimates, the estimation of NTG through a literature review, incentive level benchmarks against other similar programs, and strategic recommendations for program improvement.

4.1 Impact Evaluation Approach and Findings

4.1.1 Gross Impact Approach and Findings

Empire provided the Evaluators a description of the LED kits issued in the program. Add very brief paragraph explaining desk review and reference Appendix B – Gross Savings Approaches.

All measures installed in this program have deemed savings provided in the AR TRM. Specific inputs came from the following sections:

- PY2020: AR TRM v8.1: 2.5.1.4 ENERGY STAR® Omni-Directional LEDs
- PY2020: AR TRM v8.1: 2.3.4 Faucet Aerators
- PY2020: AR TRM v8.1: 2.3.5 Low-Flow Showerheads

In PY2020, a total of 549 lighting kits (1,647 lamps) were delivered through the program. Additionally, 150 direct install kits (300 lamps, 150 kitchen aerators, 150 showerheads) were delivered. Ex ante gross and ex post gross annual savings are presented in the table below.

Table 4-1 PY2020 Residential Lighting Gross Savings Summary

Measure	Ex Ante kWh Savings	Ex Post kWh Savings	kWh Realization Rate	Ex Ante kW Savings	Ex Post kW Savings	Peak kW Realization Rate
Lighting Kits	51,143	51,143	100%	8.32	8.32	100%
Direct Install Kits	57,459	57,459	100%	6.42	6.42	100%
Total	108,603	108,603	100%	14.74	14.74	100%

4.1.2 Net Impact Approach and Findings

The Evaluators established the NTG ratio (82.9%) based on secondary research in PY2018 through the use of a literature review. More information on this literature review can be found in Appendix C – Literature Review Outcomes.

Ex post gross and ex post net annual savings for the Residential Products program are presented in Table 4-2.

Table 4-2 PY2020 Residential Products Net Savings Summary

Measure	Ex Post Gross kWh Savings	Ex Post Net kWh Savings	NTG	Ex Post Gross kW Savings	Ex Post Net kW Savings
Lighting Kits	51,143	42,449	83%	6.90	6.90
Direct Install Kits	57,459	47,691	83%	5.33	5.33
Total	108,603	90,140	83%	12.23	12.23

Ex post gross and ex post net lifetime savings for the Residential Products program are presented in Table 4-3.

Table 4-3 PY2020 Residential Products Lifetime Savings Summary

Measure	EUL	Ex Post Gross Lifetime Energy Savings (kWh)	Ex Post Net Lifetime Energy Savings (kWh)
LED Lamp	19	1,116,250	926,488
Aerators	10	52,453	43,536
Showerheads	10	446,072	370,240
Total	-	1,614,775	1,340,264

4.2 Non-Energy Benefits (NEBs)

Protocol L of the AR TRM v8.1 (PY2020) states that EM&V of demand-side management (DSM) programs in Arkansas must account for non-energy benefits (NEBs) resulting from each program. Specifically, the categories of NEBs that are to be calculated for each DSM program are as follows:

- Benefits of electricity, natural gas, and liquid propane energy savings (i.e. other fuels);
- Benefits of public water and wastewater savings; and
- Benefits of avoided and deferred equipment replacement costs.

As discussed below, the NEBs applicable to the Program in PY2020 are avoided replacement costs (ARCs).

4.2.1 Natural Gas Energy Savings

The Evaluators calculated the negative therm interaction for PY2020.

Table 4-4 Therm Savings by Measure in PY2020

Measure	Ex Ante Therms	Ex Post Therms	Ex Post Net Therms
LED Lamp	-382	-382	-317
Total	-382	-382	-317

4.2.2 Propane Savings

There were no propane savings identified in the PY2020 Residential Products program.

4.2.3 Water Savings

In PY2020, the water saving measures implemented through the Program included faucet aerators, and toilet leak repair. The water savings for faucet aerators were determined using the AR TRM v8.1 (PY2020).

Below are the water savings identified in the PY2020 Residential Products program.

Measure	Water Savings (Gallons)
Aerators	53,850
Showerheads	457,950
Total	511,800

4.2.4 Avoided and Deferred Replacement Costs

To calculate avoided replacement costs (ARC) and incremental costs for LEDs in the Residential Products Program the AR TRM v8.1 Protocol L calculator was used with the following assumptions: 1) replacement-on-burnout for all bulbs and 2) EUL for LEDs is 19 years [1]. For direct install LEDs, the Evaluators assumed that the incentive was equal to the total cost of equipment and labor.

In cases where project cost was not available and the project was not direct install, the Evaluators cited costs from IL TRM V6.0 Volume 3¹⁹.

There were no deferred replacement costs (DRC) estimated in the PY2020 program. The tables below show the ARC benefits for the program in PY2020.

¹⁹ http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_6/Final/IL-TRM_Effective_010118_v6.0_Vol_3_Res_020817_Final.pdf

Table 4-5 Avoided Replacement Costs (ARCs) by Measure in PY2020

Measure	Ex Post Gross ARCs (\$)	Ex Post Net ARC (\$)
LED Lamps	\$8,303	\$6,892
Total	\$8,303	\$6,892

4.2.5 NEBs Summary

The table below summarizes the net present value (NPV) of NEBs attributable to the program, including only avoided replacement cost.

Table 4-6 PY2020 Non-Energy Benefits (NEBs) Summary

Measure	NPV NGS (\$)	NPV LPGS (\$)	NPV Water/WW (\$)	NPV ARC (\$)	Total NEB NPV (\$)
LED Lamps	(\$3,340)	\$0	\$0	\$6,692	\$6,113
Aerators	\$0	\$0	\$2,561	\$0	\$21,779
Showerheads	\$0	\$0	\$21,779	\$0	\$21,779
Total	(\$3,340)	\$0	\$24,340	\$6,692	\$27,892

4.3 Process Evaluation Approach and Findings

4.3.1 Protocol C: Determining Need for Process Evaluation

The Evaluators performed a process evaluation on the PY2020 Residential Products Program. The AR TRM v8.1 Protocol C addresses the criteria used to determine the timing and conditions needed for a process evaluation, and the following tables summarize the program in the context of these requirements.

Table 4-7 Determining Process Evaluation Timing

Variable Name	Variable Type
New and Innovative Components	Partially. The program added direct install kits to their offering.
No Previous Process Evaluation	The Program received a process evaluation in this planning period.
Less than Expected Energy Savings or Accomplishments	No. Empire’s offerings have shown consistently low energy savings expectations in prior years.
Participant Reported Problems or Low Participant Satisfaction	Unsure. There were no Participant Satisfaction surveys measured.
New Vendor or Contractor	No. The program continues to be distributed by AM Conservation Group.
Energy Savings are being Achieved Slower than Expected	Yes. Energy savings are not being achieved at a rate that is consistent with program expectations.

Table 4-8 Determining Process Evaluation Conditions

Component	Status
Impact problems	No. Savings are not substantially lower than expected for most measures although M&V activities will verify the accuracy of savings estimates and TRM guidelines.
Informational/educational objectives	None identified thus far.
Participation problems	None identified thus far.
Operational challenges	None identified thus far.
Cost-effectiveness issues	No. The program is designed to implement the most cost-effective measures for each participating customer, and historical cost-effectiveness for the offering has been adequate.
Negative feedback	None identified thus far.
Market effects	None identified thus far.

4.3.2 Process Evaluation Findings

This section outlines the findings of the PY2020 Program process evaluation.

4.3.3 Data Collection Activities

The Residential Products Program does not maintain a tracking system. At the request of the Evaluators, Empire compiled a summary of kit distribution.

4.3.4 Program Marketing

The marketing approach in 2020 mainly consisted of bill inserts inside of a pre-paid postcard delivered to all customers. Empire does not have many ways to publicly market their program due to being in a small and rural territory. If they were to market via television ads or radio, the ads would reach other utility territories and potentially result in market confusion.

4.3.5 Process Results and Findings

This section presents the results and key findings from the process evaluation activities. These findings are based upon interviews with utility staff, implementation staff, and a program documentation review. The findings presented pertain to program communications and marketing, program delivery, participant energy efficiency awareness and behaviors, and customer characteristics.

4.3.5.1 Empire Staff Interview Findings

Empire does the marketing for the Residential Products program. Empire uses a subcontractor, AM Conservation Group, to distribute the mailer kits to participants. The residential program

uses mailer kits because the service territory is small to use a retailer to sell and track the bulbs. Using mailer kits helps reduce the administration costs of using contractors.

4.3.5.2 Implementation Staff Interview Findings

Empire has a supporting firm that sends the mailer kits to residential homes.

4.3.5.3 Adherence to Protocol A

The Evaluators also previously reviewed program tracking data in PY2020 to assess its compliance with Protocol A of the AR TRM v8.1 which specifies that tracking data should be checked for:

- Participating Customer Information;
- Measure Specific Information;
- Vendor Specific Information;
- Program Tracking Information;
- Program Costs; and
- Marketing & Outreach Activities.

Due to the small size of Empire's portfolio, tracking systems are often limited, and it is not economically feasible to maintain tracking to the same level of detail observed in the programs administered by other utilities in Arkansas. In the program-level Protocol A Assessments, the Evaluators have endeavored to constrain comments to areas that would be financially feasible and cost-effective to execute.

The Residential Products Program maintained a tracking system of applicants and whether they were approved to participate in the program. The Evaluators determined quantities shipped in the program based on a review of program tracking data. It is recommended that Empire develop a tracking system that shows full customer account number, unit cost, and energy impacts.

4.3.6 Response to 2019 Recommendations

Table 4-9 PY2020 Recommendations and Status in PY2020

PY2020 Recommendation	Response	Status in PY2020
Expand program tracking. Program tracking did not contain full customer information; future iterations of the tracking data should be expanded to include this information if feasible.	Under Consideration	Currently considering expansion of entire tracking.

4.3.7 Planned Program Changes

There are no planned program changes for PY2021.

4.4 Conclusions & Program Recommendations

4.4.1 Conclusions

The key conclusions from the PY2020 evaluation of the Program are as follows:

- The Residential Products Program met participation goals for PY2020 (500).
- Empire did not meet savings goals for PY2020 (82,484 kWh).
- NEBs accounted for 5.1% of TRC benefits.
- The program successfully leveraged existing infrastructure from the School Based Efficiency Program to cost-effectively provide kits to customers throughout Empire’s service territory.

4.4.2 Recommendations

The key recommendations from the PY2020 evaluation of the Program are as follows:

- **Consider expanding kit contents with other cost-effective measures.** Possibilities include and advanced power strips.

5 School Based Energy Education Program

Through the School Based Energy Education Program, Empire conducts energy efficiency education and provides direct-install measures to sixth grade middle school students within its service territory. Empire provides energy efficiency kits, containing low-cost measures for students to install in their homes, including the following:

- Kitchen faucet aerator;
- Toilet leak repair;
- LED lamps;
- Night light; and a
- FilterTone® alarm.

In addition to the kit, students receive unlimited access to an interactive program website and a toll-free help line, where they can ask questions. Empire also provides teachers with teaching aids and supplemental materials, such as a teacher book, a step-by-step program checklist, lesson plans, program videos, program evaluation forms, an Arkansas State Education Standards Correlation Chart, a pre-test and post-test answer key, and electricity, water, and natural gas posters that can be used to increase student awareness of and appreciation for energy efficiency.

The Program has received an impact and process evaluation. The evaluations included desk reviews to estimate ex post gross savings estimates, the estimation of NTG through a literature review, incentive level benchmarks against other similar programs, and strategic recommendations for program improvement.

5.1 Impact Evaluation Approach and Findings

5.1.1 Gross Impact Approach and Findings

All measures installed in this program have deemed savings provided in the AR TRM. Specific inputs came from the following sections:

- PY2020: AR TRM v8.1:
 - Kitchen faucet aerator: 2.3.4 Faucet Aerators
 - LED lamps: 2.5.1.4 Omni-Directional LEDs

For detailed engineering equations used for the desk review approaches, see Appendix B – Gross Savings Approaches.

In PY2020, a total of 326 school kits were delivered through the program. Ex ante gross and ex post gross annual savings are presented in the table below.

Table 5-1 PY2020 School Based Energy Education Gross Savings Summary

Measure	Ex Ante kWh Savings	Ex Post kWh Savings	kWh Realization Rate	Ex Ante kW Savings	Ex Post kW Savings	Peak kW Realization Rate
LED Lamps	16,589	16,589	100.0%	2.07	2.07	100.0%
Aerator	12,022	12,022	100.0%	1.25	1.25	100.0%
Total	28,611	28,611	100.0%	3.32	3.32	100.0%

5.1.2 Net Impact Approach and Findings

The Evaluators established the NTG ratio (92.5%) based on secondary research in PY2020 through the use of a literature review. More information on this literature review can be found in Appendix C – Literature Review Outcomes.

Ex post gross and ex post net annual savings for the School Based Energy Education Program are presented in Table 5-2 (PY2020).

Table 5-2 PY2020 School Based Energy Education Net Savings Summary

Measure	Ex Post Gross kWh Savings	Ex Post Net kWh Savings	NTG	Ex Post Gross kW Savings	Ex Post Net kW Savings
LED Lamp	16,589	14,433	87%	2.07	1.80
Aerator	12,022	11,781	98%	1.25	1.23
Total	28,611	26,214	92%	3.32	3.03

Ex post gross and ex post net lifetime savings for the School Based Energy Education Program are presented in Table 5-3 (PY2020).

Table 5-3 PY2020 School Based Energy Education Lifetime Savings Summary

Measure	EUL	Ex Post Gross Lifetime Energy Savings (kWh)	Ex Post Net Lifetime Energy Savings (kWh)
LED Lamp	19	315,199	274,223
Aerator	10	120,216	117,811
Total		435,415	392,035

5.2 Non-Energy Benefits (NEBs)

Protocol L of the AR TRM v8.1 states that EM&V of demand-side management (DSM) programs in Arkansas must account for non-energy benefits (NEBs) resulting from each program. Specifically, the categories of NEBs that are to be calculated for each DSM program are as follows:

- Benefits of electricity, natural gas, and liquid propane energy savings (i.e. other fuels);
- Benefits of public water and wastewater savings; and
- Benefits of avoided and deferred equipment replacement costs.

Applicable NEBs for this program in PY2020 are avoided replacement costs (ARCs), propane savings, natural gas savings, and water savings.

Measures with zero entries are included to ensure consistency of table structure and to demonstrate that no measures or potential energy and non-energy impacts were omitted.

5.2.1 Natural Gas Energy Savings

In the Program, Empire customers can have either electric or natural gas heating. When a customer has natural gas heating, they can claim the natural gas therms savings as NEBs. Participant survey responses provided by the program implementer, AM Conservation, determined the percentage of students who lived in homes with natural gas heating. The table below presents the ex post net natural gas can be claimed as NEBs for cost-effectiveness purposes.

Table 5-4 Therm Savings by Measure in PY2020

Measure	Ex Ante Therms	Ex Post Therms	Ex Post Net Therms
LED Lamp	-73	-73	-63
Aerator	882	882	864
Total	809	809	801

5.2.2 Propane Savings

When a customer has propane, Empire can claim the savings as NEBs. Participant survey responses provided by the program implementer, AM Conservation, determined the percentage of students who lived in homes with propane heating. The table below presents the ex post net propane savings can be claimed as NEBs for cost-effectiveness purposes.

Table 5-5 Propane Savings by Measure in PY2020

Measure	Propane Savings (Gallons)
LED Lamp	-12
Aerator	175
Total	163

5.2.3 Water Savings

In PY2020, the water saving measures implemented through the Program included faucet aerators, and toilet leak repair. The water savings for faucet aerators were determined using the AR TRM v8.1 (PY2020). The water savings estimates for the toilet leak repair is 200 gallons per day.²⁰ Table 5-6 below presents the estimates.

Table 5-6 Water Savings by Measure Type in PY2020

Measure	Water Savings (Gallons)
LED Lamp	-
Aerator	411,389
Toilet Leak Repair	149,423
Total	560,812

5.2.4 Avoided and Deferred Replacement Costs

To calculate avoided replacement costs (ARCs) and incremental costs for LEDs in the School Based Energy Education Program, the AR TRM v8.1 Protocol L calculator was used with the following assumptions: 1) replacement-on-burnout for all bulbs and 2) EUL for LEDs is 19 years [1]. For direct install LEDs, the Evaluators assumed that the incentive was equal to the total cost of equipment and labor. For kit-installed LEDs, the Evaluators assumed that the incentive was equal to the total cost of equipment and administrative costs to assemble the kits.

In cases where project cost was not available and the project was not direct install, the Evaluators cited costs from IL TRM V7.0 Volume 3²¹.

There were no deferred replacement costs (DRCs) estimated in the PY2020 programs.

The tables below show the ARCs and DRCs benefits for the program.

Table 5-7 Avoided Replacement Costs (ARCs) by Measure in PY2020

Measure	Ex Post Gross ARCs (\$)	Ex Post Net ARC (\$)
LED Lamps	\$3,206	\$2,789
Total	\$3,206	\$2,789

²⁰ <https://blog.epa.gov/2013/03/21/around-the-water-cooler-is-your-toilet-leaking/>

²¹ http://s3.amazonaws.com/ilsag/IL-TRM_Effective_010119_v7.0_Vol_3_Res_092818_Final.pdf

5.2.5 NEBs Summary

The table below summarizes the net present value (NPV) of NEBs attributable to the program, including natural gas, propane savings, water savings and avoided replacement cost.

Table 5-8 PY2020 Non-Energy Benefits (NEBs) Summary, Empire

Measure	NPV NGS (\$)	NPV LPGS (\$)	NPV Water/WW (\$)	NPV ARC (\$)	Total NEB NPV (\$)
LED Lamp	(\$666)	(\$369)	\$0	\$2,789	\$1,754
Aerator	\$4,797	\$3,189	\$23,101	\$0	\$31,086
Toilet Leak Repair	\$0	\$0	\$4,771	\$0	\$4,771
Total	\$4,131	\$2,820	\$27,872	\$2,789	\$37,612

5.3 Process Evaluation Approach and Findings

5.3.1 Protocol C: Determining Need for Process Evaluation

The Evaluators performed a process evaluation on the PY2020 School Based Energy Education Program. The AR TRM v8.1 Protocol C addresses the criteria used to determine the timing and conditions needed for a process evaluation, and the following tables summarize the program in the context of these requirements.

Table 5-9 Determining Process Evaluation Timing

Variable Name	Variable Type
New and Innovative Components	No. The program continues to incorporate a set list of measures that is similar to prior years.
No Previous Process Evaluation	The Program has received a process evaluation in this planning period.
Less than Expected Energy Savings or Accomplishments	No. Empire offerings have meet energy savings expectations in prior years.
Participant Reported Problems or Low Participant Satisfaction	No. There have been few reported incidences of customer dissatisfaction for Empire’s offerings.
New Vendor or Contractor	No. The program continues to be implemented by Empire.
Energy Savings are being Achieved Slower than Expected	No. Energy savings are being achieved at a rate that is consistent with program expectations.

Table 5-10 Determining Process Evaluation Conditions

Component	Status
Impact problems	Partial. Savings goals are being met but some measures have low realization rates.
Informational/educational objectives	None identified thus far.
Participation problems	None identified thus far.
Operational challenges	None identified thus far.
Cost-effectiveness issues	No. The program is designed to implement the most cost-effective measures for each participating customer, and historical cost-effectiveness for the offering has been adequate.
Negative feedback	None identified thus far.
Market effects	None identified thus far.

5.3.2 Process Evaluation Findings

This section outlines the findings of the PY2020 Program process evaluation.

5.3.3 Data Collection Activities

The Evaluators reviewed invoices to confirm quantity and type of measures installed in each home that participated in the program.

5.3.4 Program Marketing

The program is marketed by the program implementer, AM Conservation. The implementation team, with the approval of Empire Electric, identifies eligible school and teachers for the

program. During the outreach process, the team introduce the program to teachers and interested teachers are enrolled individually. The implementation team is also the ones responsible for incorporating Empire Electric branding on program materials to increase Empire Electric awareness within the community. Through a Teacher Program Elevation Form, 100% of the participating teachers indicated they would conduct the program again. 100% of the participating teachers also indicated they would recommend the program to their colleagues.

5.3.5 Process Results and Findings

This section presents the results and key findings from the process evaluation activities. These findings are based upon interviews with utility staff and a program documentation review. The findings presented pertain to program communications and marketing, program delivery, participant energy efficiency awareness and behaviors, and customer characteristics.

5.3.5.1 Empire Staff Interview Findings

The Evaluators conducted an interview with Empire Electric staff to gain insights regarding various aspects of the program, reporting, data management, and marketing. One staff member participated in the interview.

Empire staff discussed that marketing for this program is conducted by AM Conservation. The Implementer is responsible for distributing the kits to participating schools and for calculating the energy, gas, and water savings from the kits. They then provide a report to Empire that summarizes these findings, as well as survey findings from program participants. The report is provided on a school-year basis while Empire operates on a calendar year. This is problematic in that it does not align results with Empire reporting requirements, and the Evaluators recommend realigning their reporting schedule to correspond to the program year.

5.3.5.2 Implementation Staff Interview Findings

The Evaluators were not able to reach AM Conservation for an implementation staff interview during the evaluation.

5.3.5.3 Adherence to Protocol A

The Evaluators also previously reviewed program tracking data in PY2020 to assess its compliance with Protocol A of the AR TRM v8.1 which specifies that tracking data should be checked for:

- Participating Customer Information;
- Measure Specific Information;
- Vendor Specific Information;

- Program Tracking Information;
- Program Costs; and
- Marketing & Outreach Activities.

Due to the small size of Empire’s portfolio, tracking systems are often limited, and it is not economically feasible to maintain tracking to the same level of detail observed in the programs administered by other utilities in Arkansas. In the program-level Protocol A Assessments, the Evaluators have endeavored to constrain comments to areas that would be financially feasible and cost-effective to execute. The School-Based Energy Education Program does not maintain a program tracking system. Savings estimates were derived from summary reporting submitted by Empire to the Evaluators.

The reports provided by AM Conservation are not annualized; they are provided to Empire on a school-year basis. This is problematic in that the summary savings values need to be split across program years. The Evaluators cross-referenced the survey results (in-service rates, electric water heating rates, etc.) with participation dates on the supporting invoices to parse out each batch of kits to the appropriate program year.

There are inherent difficulties in maintaining an Excel-based tracking system for this program, due to the low budget for program administration. However, AM Conservation should be required to submit reports to Empire that reflect a calendar year of operation, rather than a school year. The corresponding invoices should then be identified and appended to this report, along with a detailed description of the contents of the kits delivered. This will allow for an easier audit of the program savings in the next three-year evaluation.

5.3.6 Response to 2019 Recommendations

Table 5-11 PY2020 Recommendations and Status in PY2020

PY2015 Recommendation	Response	Status in PY2020
Track school kits delivery by calendar instead of school year. Current reports are proved on a school-year basis, which requires the Evaluators to split savings across program years. This can cause inaccurate savings estimates while cross-referencing survey results.	Accepted	This will be done in 2020.
Provide detailed description of kits contents. Accurate and detailed of description of kit contents can help calculate accurate savings estimates.	Accepted	This was done in PY2020 and will continue to be enhanced in 2020.

5.3.7 Planned Program Changes

There are no planned program changes for the School Based Energy Education Program.

5.4 Conclusions & Program Recommendations

5.4.1 Conclusions

The key conclusions from the PY2020 evaluation of the Program are as follows:

- The program produces significant non-energy benefits (NEBs), accounting 50.5% (PY2020) of program TRC benefits.
- The School Based Energy Education Program met participation goals for PY2020 (150).
- Empire did not meet savings goals for PY2020 (60,611 kWh).
- The faucet aerators in the program had poor realization rates (65%). The Evaluators were not provided calculation workbooks to demonstrate how the expected savings were calculated; documentation was limited to a summary of inputs in PDF reports provided by the program implementer to Empire.

5.4.2 Recommendations

The key recommendations from the PY2020 evaluation of the School Based Efficiency Program are as follows:

- **Incorporate low flow showerheads into the kit.** This measure is proven cost-effective in similar kit programs administered in Arkansas (such as the program administered by OG&E).

6 Commercial and Industrial Rebate Program

The Commercial and Industrial Rebate (C&I) Program is designed to encourage the installation of energy efficient equipment by providing incentives to lower the cost of energy efficient equipment for commercial and industrial facilities. The primary goal of the program is to generate energy and demand savings for large and small commercial and industrial customers through the promotion of high efficiency electric end use products including (but not limited to): lighting, retrofit of existing equipment, and HVAC replacement.

The program provides customers with a free energy audit to identify opportunities for energy efficiency improvements at customer facilities without the obligation to participate in the program. Following the audit, incentives are offered to lower the cost of purchasing energy efficient equipment for commercial and industrial facilities. The program consists of the following:

- **Prescriptive Rebates:** Pre-qualified prescriptive rebates are available for new construction and retrofit projects.
- **Custom Rebates:** Equipment that does not qualify for a prescriptive rebate will be eligible for a custom rebate. Applications must be pre-approved by Empire before equipment is purchased and installed and must produce a Total Resource Cost Test benefit-cost ratio of at least 1.0.

A \$20,000 incentive cap is imposed per facility per program year. However, the cap can be exceeded based upon available funding levels. The program was marketed through partnerships with Empire trade allies as well as newspaper advertisements, email blasts and targeted mailings to customers and contractors, bill inserts, and advertising in HVAC trade publications.

AEG was contracted to implement the C&I Program for the evaluated program years. AEG was responsible for program planning, development of marketing material, quantifying ex ante energy savings estimates and paying appropriate incentives to customers. AEG also identified and approved Trade Allies and distributors for participation in the program.

In PY2020, the C&I Program had a total of one project, as shown in the tables below. Due to the limited number of projects, the Evaluators performed a census review which resulted in a desk review being done for the project.

Table 6-1 PY2020 C&I Program Summary

Measure	Number of Projects	Ex Ante Gross kWh Savings	Ex Ante Gross Peak kW Savings	Percent of kWh Savings
Custom: LED Fixture	0	-	-	0%
Prescriptive: LED Fixture	1	9,107	4.20	100%
Total	1	9,107	4.20	100%

6.1 Gross Impact Evaluation Approach

Energy savings from prescriptive measures are calculated using deemed values and savings algorithms provided in the AR TRM v8.1.

Specific inputs came from the following sections:

- LED Fixtures: 3.6.3 Lighting Efficiency (Appendix B: B.1.6)

6.2 Gross Impact Evaluation Findings

In PY2020, a total of one project was delivered through the program. Ex ante gross and ex post gross annual savings are presented in the tables below.

The program-level kWh realization rate is 201.0% and the program-level kW realization is 113.1%. The higher overall realization rate for lighting projects is due the following:

- Ex ante savings used Religious building type hours and a CF of 0.53. The Evaluators revised AOH and coincidence factors to align with the correct space type (Retail).

Table 6-2 PY2020 C&I Project-Level Gross Savings

Measure	Project Number	Ex Ante kWh Savings	Ex Post kWh Savings	kWh Realization Rate	Ex Ante kW Savings	Ex Post kW Savings	Peak kW Realization Rate
Prescriptive: LED Fixture	1	8,495	17,082	201%	4.00	4.43	111%
Prescriptive: LED Screw-In	1	613	1,232	201%	0.20	0.32	160%
Total		9,108*	18,314	201%	4.20	4.75	113%

6.3 Net Impact Evaluation Approach

The Evaluators established the NTG ratio (99%) based on secondary research in PY2020 through the use of PY2020 SWEPCO AR SBP NTG. More information on this NTG can be found in Appendix C – Literature Review Outcomes.

6.4 Net Impact Evaluation Findings

Net savings for the C&I Program are shown in the table below.

Table 6-3 PY2020 C&I Net Savings Summary

Measure	Ex Post Gross kWh Savings	Ex Post Net kWh Savings	NTG	Ex Post Gross kW Savings	Ex Post Net kW Savings
Prescriptive: LED Fixture	17,082	16,911	99%	4.43	4.39
Prescriptive: LED Screw-In	1,232	1,219	99%	0.32	0.32
Total	18,314	18,131	99%	4.75	4.70

Ex post gross and ex post net lifetime savings for the C&I Program are presented in the tables below.

Table 6-4 PY2020 C&I Lifetime Savings Summary

Measure	EUL	Ex Post Gross Lifetime Energy Savings (kWh)	Ex Post Net Lifetime Energy Savings (kWh)
Prescriptive: LED Fixture	15	256,234	253,672
Prescriptive: LED Screw-In	19	23,404	23,170
Total		279,638	276,842

6.5 Non-Energy Benefits (NEBs)

Protocol L of the AR TRM v8.1 states that EM&V of demand-side management (DSM) programs in Arkansas must account for non-energy benefits (NEBs) resulting from each program. Specifically, the categories of NEBs that are to be calculated for each DSM program are as follows:

- Benefits of electricity, natural gas, and liquid propane energy savings (i.e. other fuels);

- Benefits of public water and wastewater savings; and
- Benefits of avoided and deferred equipment replacement costs.

As discussed below, the NEBs applicable to PY2020 are avoided replacement costs (ARCs), propane, natural gas, and water savings.

Measures with zero entries are included to ensure consistency of table structure and to demonstrate that no measures or potential energy and non-energy impacts were omitted.

6.5.1 Natural Gas Energy Savings

In the C&I Program, Empire customers can have either electric or natural gas heating. When a customer has natural gas heating, they can claim the natural gas therms savings as NEBs. NEBs can be negative for some gas savings measures due to a negative therms penalty for increased natural gas heating (e.g. lighting measures). The tables below present the ex post net natural gas can be claimed as NEBs for cost-effectiveness purposes.

Table 6-5 C&I Natural Gas Savings by Measure in PY2020

Measure	Ex Ante Therms	Ex Post Therms
Prescriptive: LED Fixture	-	-
Total	-	-

6.5.2 Propane Savings

When a customer has propane, Empire can claim the savings as NEBs. However, there were no C&I customers with propane and no propane savings in the program year.

6.5.3 Water Savings

There were no water saving measures implemented in the C&I program during the evaluated program year; therefore, there are no claimed water savings.

6.5.4 Avoided and Deferred Replacement Costs

To calculate avoided replacement costs (ARC) and incremental costs for lighting in the C&I Program, the AR TRM v8.1 Protocol L calculator was used with the following assumptions:

- Assumed all bulbs are replace on burnout (ROB);
- Set costs for halogens, CFLs and LEDs (bulb and installation) based on the IL TRM v8.1; and
- Specified EULs for all bulb types based on AR TRM v8.1. The table below shows the avoided or deferred replacement costs for LEDs.

There were no deferred replacement costs (DRC) estimated in the PY2020 programs.

Table 6-6 tables below show the ARC and DRC benefits for the C&I Program.

Table 6-6 Avoided Replacement Costs (ARCs) by Measure in PY2020

Measure	Ex Post Gross ARCs (\$)	Ex Post Net ARC (\$)
Prescriptive: LED Fixture	\$10,167	\$10,065
Prescriptive: Screw-In	\$6	\$6
Total	\$10,173	\$10,071

6.5.5 NEBs Summary

The table below summarizes the net present value (NPV) of NEBs attributable to the program, including natural gas and avoided replacement cost.

Table 6-7 PY2020 Non-Energy Benefits (NEBs) Summary

Measure	NPV NGS (\$)	NPV LPGS (\$)	NPV Water/W W (\$)	NPV ARC (\$)	Total NEB NPV (\$)
Prescriptive Linear LED Tubes	\$0	\$0	\$0	\$10,065	\$10,065
Prescriptive Screw-In Bulbs	\$0	\$0	\$0	\$6	\$6
Total	\$0	\$0	\$0	\$10,071	\$10,071

6.6 Process Evaluation Approach and Findings

6.6.1 Protocol C: Determining Need for Process Evaluation

The Evaluators performed a limited process evaluation on the C&I Program. The AR TRM v8.1 Protocol C addresses the criteria used to determine the timing and conditions needed for a process evaluation, and the following tables summarize the program in the context of these requirements.

Table 6-8 Determining Process Evaluation Timing

Variable Name	Variable Type
New and Innovative Components	Partially. The program continues to incorporate a set list of measures that is similar to prior years with a few additions.
No Previous Process Evaluation	The Program has not received a prior process evaluation in this planning period.
Less than Expected Energy Savings or Accomplishments	Yes. The program did not meet expected savings.
Participant Reported Problems or Low Participant Satisfaction	No customer surveys were conducted.
New Vendor or Contractor	No. The program continues to be implemented by AEG and uses installation contractors who were previously involved.
Energy Savings are being Achieved Slower than Expected	Yes. Energy savings are lower than expected.

Table 6-9 Determining Process Evaluation Conditions

Component	Status
Impact problems	Yes. Savings are lower than expected for most measures although M&V activities will verify the accuracy of savings estimates and TRM guidelines.
Informational/educational objectives	Empire’s EE plan called for marketing through email blasts, newspaper ads, etc. However, no marketing materials were provided to the Evaluators.
Participation problems	Participation has declined in recent years.
Operational challenges	None identified thus far.
Cost-effectiveness issues	No. The program is cost-effective
Negative feedback	None identified thus far.
Market effects	None identified thus far.

6.6.2 Process Evaluation Findings

This section outlines the findings of the C&I Program process evaluation.

6.6.3 Data Collection Activities

- Utility Staff Interviews
- Implementer Interviews
- Review of Program Tracking Data

6.6.4 Program Marketing

As part of the C&I program's marketing efforts, marketing is mainly conducted by direct mail to customers and sometimes marketed through business journals.

6.7 Process Results and Findings

This section presents the results and key findings from the process evaluation activities. These findings are based upon interviews with utility staff, implementation staff, and a program documentation review. The findings presented pertain to program communications and marketing, program delivery, and adherence to TRM protocols.

6.7.1.1 Empire Staff Interview Findings

On March 19th, 2021, the Evaluators conducted an interview with Empire Electric staff to gain insights regarding various aspects of the programs, reporting, data management, and marketing. One staff member participated in the interview.

The interviewee was asked a series of questions regarding program design and changes in programs. The program staff interviewee did not indicate any changes in program design for the C&I program.

6.7.1.2 Adherence to Protocol A

The Evaluators also previously reviewed program tracking data in PY2020 to assess its compliance with Protocol A of the AR TRM v8.1 which specifies that tracking data should be checked for:

- Participating Customer Information;
- Measure Specific Information;
- Vendor Specific Information;
- Program Tracking Information;
- Program Costs; and
- Marketing & Outreach Activities.

Due to the small size of Empire's portfolio, tracking systems are often limited, and it is not economically feasible to maintain tracking to the same level of detail observed in the programs administered by other utilities in Arkansas. In the program-level Protocol A Assessments, the Evaluators have endeavored to constrain comments to areas that would be financially feasible and cost-effective to execute.

The C&I Program does not maintain a program-level tracking system. The Evaluators conclude that a program-level tracking file may not be necessary as the C&I Program does not typically

see more than three projects per year. Project-level analyses are completed in a spreadsheet tool by AEG. This included a sufficiently detailed inventory of lighting installed by location within the facility (tracking quantities, wattages, fixture codes, and location of installation). The values from these analyses are then compiled by Empire for reporting.

The project-level analysis files should add the following detail:

1. Point of contact name and phone number;
2. Hours of use;
3. Source for hours of use, if deviating from the AR TRM; and
4. HVAC configuration type.

6.7.2 Response to 2019 Recommendations

Table 6-10 PY2020 Recommendations and Status in PY2020

PY2018 Recommendation	Response	Status in PY2020
Provide surveys to C&I customers after retrofits. This will ensure that customers are satisfied with the program and identify any areas for program improvement.	Rejected	
Ask contractors to take photos before (pre) and after (post) a retrofit. This will help document the work that has been done and serve as a reference for EM&V activities.	Rejected	
Document AOH assumptions when they differ from the TRM. AEG used several custom hours inputs without sufficient supporting documentation.	Accepted	Customers report their own AOH as part of the application process. If this is not a standard utility practice, we can begin using base assumptions in 2020 analysis.

6.7.3 Planned Program Changes

According to Empire staff, there were no program changes in 2020. There are no expected changes to the program going forward.

6.8 Conclusions & Program Recommendations

6.8.1 Conclusions

The key conclusions from the evaluation of the Program are as follows:

- The C&I program runs in a small and rural area of Arkansas, and as a result, program participation is fairly low. The Evaluators conclude that a program-level tracking file may not be necessary as the C&I Program typically sees only a few projects each year.
- Additional detail should be added to the project-level analysis files (e.g. point of contact name/phone number, hours of use, HVAC configuration, etc.).

6.8.2 Recommendations

The Evaluators have no recommendations for the C&I Rebate Program at this time.

Appendix A. Portfolio Cost-Effectiveness

Overview

The Evaluators estimated the cost-effectiveness for the overall energy efficiency portfolio and programs, based on 2020 costs and savings estimates provided by Empire and their third-party implementers. This appendix provides the cost-effectiveness results, as well as a brief overview of the approach taken by the Evaluators. The tables below presents the cost effectiveness results for the PY2020 portfolios.

Table A-1 PY2020 Cost Effectiveness Results

Program	TRC	UCT	RIM	PCT	TRC Net Benefits
Residential Products	2.30	1.34	0.33	10.01	\$44,473
School Based Energy Education	1.82	0.43	0.22	6.50	\$23,048
C&I Rebate	2.77	0.51	0.25	14.48	\$13,841
EEA	0.00	0.00	0.00	0.00	-\$5,494
Regulatory	0.00	0.00	0.00	0.00	-\$15,191
Total	1.67	0.51	0.24	10.15	\$60,676

Approach

The California Standard Practice Model was used as a guideline for the calculations, along with guidance from the Arkansas TRM v8.1. The cost effectiveness analysis methods which were used in this analysis are among the set of standard methods used in this industry and include the Utility Cost Test (UCT), Total Resource Cost Test (TRC), Ratepayer Impact Measure Test (RIM), and Participant Cost Test (PCT). All tests weigh monetized benefits against costs. These monetized amounts are presented as Net Present Value (NPV) evaluated over the lifespan of the measure. The benefits and costs differ for each test based on the perspective of the test. The definitions below are taken from the California Standard Practice Manual.

- **The Total Resource Cost Test (TRC)** measures the net costs of a demand-side management program as a resource option based on the total costs of the program, including both the participants' and the utility's costs.

- **The Utility Cost Test (UCT)**²² measures the net costs of a demand-side management program as a resource option based on the costs incurred by the program administrator (including incentive costs) and excluding any net costs incurred by the participant. The benefits are similar to the TRC benefits. Costs are defined more narrowly.
- **The Participants Cost Test (PCT)** is the measure of the quantifiable benefits and costs to the customer due to participation in a program. Since many customers do not base their decision to participate in a program entirely on quantifiable variables, this test cannot be a complete measure of the benefits and costs of a program to a customer.
- **The Ratepayer Impact Measure Test (RIM)** test measures what happens to customer bills or rates due to changes in utility revenues and operating costs caused by the program. Rates will go down if the change in revenues from the program is greater than the change in utility costs. Conversely, rates or bills will go up if revenues collected after program implementation is less than the total costs incurred by the utility in implementing the program. This test indicates the direction and magnitude of the expected change in customer bills or rate levels.

A common misperception is that there is a single best perspective for evaluation of cost-effectiveness. Each test is useful and accurate, but the results of each test are intended to answer a different set of questions. The questions to be addressed by each cost test are shown in the table below.²³

²² The UCT is sometimes referred to as the Program Administrator Cost Test (PACT).

²³ <http://www.epa.gov/cleanenergy/documents/suca/cost-effectiveness.pdf>

Table A-2 Questions Addressed by the Various Cost Tests

Cost Test	Questions Addressed
Participant Cost Test (PCT)	<ul style="list-style-type: none"> ■ Is it worth it to the customer to install energy efficiency? ■ Is it likely that the customer wants to participate in a utility program that promotes energy efficiency?
Ratepayer Impact Measure (RIM)	<ul style="list-style-type: none"> ■ What is the impact of the energy efficiency project on the utility’s operating margin? ■ Would the project require an increase in rates to reach the same operating margin?
Utility Cost Test (UCT)	<ul style="list-style-type: none"> ■ Do total utility costs increase or decrease? ■ What is the change in total customer bills required to keep the utility whole?
Total Resource Cost Test (TRC)	<ul style="list-style-type: none"> ■ What is the regional benefit of the energy efficiency project (including the net costs and benefits to the utility and its customers)? ■ Are all of the benefits greater than all of the costs (regardless of who pays the costs and who receives the benefits)? ■ Is more or less money required by the region to pay for energy needs?

Overall, the results of all five-cost-effectiveness tests provide a more comprehensive picture than the use of any one test alone. The TRC cost test address whether energy efficiency is cost-effective overall. The PCT, UCT, and RIM address whether the selection of measures and design of the program are balanced from the perspective of the participants, utilities, and non-participants. The scope of the benefit and cost components included in each test are summarized in the table below.²⁴

²⁴ Ibid.

Table A-3 Benefits and Costs Included in each Cost-Effectiveness Test

Test	Benefits	Costs
PCT (Benefits and costs from the perspective of the customer installing the measure)	<ul style="list-style-type: none"> ■ Incentive payments ■ Bill Savings ■ Applicable tax credits or incentives 	<ul style="list-style-type: none"> ■ Incremental equipment costs ■ Incremental installation costs
UCT (Perspective of utility, government agency, or third party implementing the program)	<ul style="list-style-type: none"> ■ Energy-related costs avoided by the utility ■ Capacity-related costs avoided by the utility, including generation, transmission, and distribution 	<ul style="list-style-type: none"> ■ Program overhead costs ■ Utility/program administrator incentive costs
TRC (Benefits and costs from the perspective of all utility customers in the utility service territory)	<ul style="list-style-type: none"> ■ Energy-related costs avoided by the utility ■ Capacity-related costs avoided by the utility, including generation, transmission, and distribution ■ Additional resource savings ■ Monetized non-energy benefits as outlined by the TRM version 7.0 	<ul style="list-style-type: none"> ■ Program overhead costs ■ Program installation costs ■ Incremental measure costs
RIM (Impact of efficiency measure on non-participating ratepayers overall)	<ul style="list-style-type: none"> ■ Energy-related costs avoided by the utility ■ Capacity-related costs avoided by the utility, including generation, transmission, and distribution 	<ul style="list-style-type: none"> ■ Program overhead costs ■ Lost revenue due to reduced energy bills ■ Utility/program administrator installation costs

Non-Energy Benefits

In Arkansas, the IEM, in collaboration with Empire and the other investor owned utilities (IOUs) and other stakeholders through the Parties Working Collaboratively (PWC), have developed a uniform set of benefits to be associated with measures implemented in the portfolio. These Non-Energy Benefits (NEBs) are an addition to programs under the authorization of Arkansas TRM 7.0. Volume 1 - Protocol L. After reviewing the guidance from the PWC, the Arkansas Public Service Commission (Commission) issued Order No. 30 in Docket 13-002-U on December 10, 2015, which provided direction and guidance regarding the inclusion of NEBs in the Technical Reference Forum, as follows:²⁵

“The Commission therefore orders and directs that the following three categories of NEBs be consistently and transparently accounted for in all

²⁵ Arkansas TRM version 6.0, Protocol L.

applications of the TRC test, as it is applied to measures, programs, and portfolios:

- a. benefits of electricity, natural gas, and liquid propane energy savings (i.e., other fuels);*
- b. benefits of public water and wastewater savings; and*
- c. benefits of avoided and deferred equipment replacement costs as conditioned herein.”*

In response to the Commission Order for NEBs outlined above, Protocol L was added to the Arkansas TRM version 6.0 and retained in version 7.0, which encompasses NEBs:

- Protocol L1: Non-Energy Benefits for Electricity, Natural gas, and Liquid Propane (“other fuels”)
- Protocol L2: Non-Energy Benefits for Water Savings
- Protocol L3: Non-Energy Benefits of Avoided and Deferred Equipment Replacement Costs.

This recommended approach has been developed jointly by the IEM and the PWC for each category as directed by the Commission. Below is a summary of the NEBs that were calculated in each program in PY2020. The values associated with each NEB in the cost benefit analysis are outlined in each program chapter.

- **Residential Products Program:** this program captured natural gas savings and avoided replacement costs (ARCs).
- **School Based Energy Education Program:** this program captured propane, natural gas, water, and ARCs.
- **Commercial and Industrial Rebate Program:** this program captured natural gas and ARCs.

Economic Inputs for Cost Effectiveness Analysis

The Evaluators used the economic inputs provided by Empire for the cost benefit analysis. The rates utilized for avoided water and avoided propane use were from Protocol L in the AR TRM v8.1. The Evaluators used information provided by Empire to perform the cost benefit analysis, and these values align with the rates used in the previous SARP filing.²⁶ Tables A-4 through A-8 outline the economic inputs used in the cost benefit analysis.

²⁶ PY2016 Energy Efficiency Cost Recovery Tariff, Schedule TWT-1 filing found here: http://www.apscservices.info/pdf/07/07-076-TF_249_1.pdf

Table A-4 PY2020 Economic Inputs for Cost Effectiveness Analysis

Discount Rates	
Utility (TRC)	7.33%
Utility (UCT)	7.33%
Utility (RIM)	7.33%
Societal (SCT)	7.33%
Participant (PCT)	7.33%
Line Losses (demand)	6.88%
Line Losses (energy)	6.88%
Line Losses (therm)	6.88%
Escalation rate	2.50%
Avoided Energy (\$/kWh)	\$0.04
Avoided Demand (\$/kW)	\$36.95
Avoided Natural Gas (\$/therm)	\$0.60
Avoided Water (\$/gallon)	\$0.01
Avoided Propane (\$/gallon)	\$2.00

Results

The tables below outline the results for each test, for both the programs and the portfolio as a whole. Summations may differ by \$1 due to rounding.

Table A-5 PY2020 Cost-Effectiveness Results by Program

Program	TRC	UCT	RIM	PCT
Residential Products	2.30	1.34	0.33	10.01
School Based Energy Education	1.82	0.43	0.22	6.50
C&I Rebate	2.77	0.51	0.25	14.48
EEA	0.00	0.00	0.00	0.00
Regulatory	0.00	0.00	0.00	0.00
Total	1.67	0.51	0.24	10.15

Table A-6 PY2020 Cost-Effectiveness Benefits by Program

Program	TRC Benefits	UCT Benefits	RIM Benefits	PCT Benefits
Residential Products	\$78,625	\$49,839	\$49,839	\$150,546
School Based Energy Education	\$50,995	\$14,234	\$14,234	\$86,351
C&I Rebate	\$21,665	\$11,594	\$11,594	\$48,083
EEA	\$0	\$0	\$0	\$18,113
Regulatory	\$0	\$0	\$0	\$18,113
Total	\$151,285	\$75,667	\$75,667	\$321,206

Table A-7 PY2020 Cost-Effectiveness Costs by Program

Program	TRC Costs	UCT Costs	RIM Costs	PCT Costs
Residential Products	\$34,152	\$37,231	\$150,238	\$15,034
School Based Energy Education	\$27,947	\$32,770	\$65,774	\$13,290
C&I Rebate	\$7,824	\$22,617	\$46,267	\$3,320
EEA	\$5,494	\$23,607	\$23,607	\$0
Regulatory	\$15,191	\$33,304	\$33,304	\$0
Total	\$90,609	\$149,529	\$319,191	\$31,644

Table A-8 PY2020 Cost-Effectiveness Net Benefits by Program

Program	TRC Net Benefits	UCT Net Benefits	RIM Net Benefits	PCT Net Benefits
Residential Products	\$44,473	\$12,608	-\$100,399	\$135,512
School Based Energy Education	\$23,048	-\$18,536	-\$51,539	\$73,062
C&I Rebate	\$13,841	-\$11,023	-\$34,673	\$44,762
EEA	-\$5,494	-\$23,607	-\$23,607	\$18,113
Regulatory	-\$15,191	-\$33,304	-\$33,304	\$18,113
Total	\$60,676	-\$73,862	-\$243,523	\$289,562

Appendix B. Gross Savings Approaches

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B.1 Commercial Measures

B.1.1 Commercial Faucet Aerators

The commercial faucet aerator measure savings are calculated using the values and equations from AR TRM v8.1 Volume II Faucet Aerators, Section 3.3.2., faucet aerators are assigned an EUL of 10 years. The following equations from the AR TRM v8.0 Volume II are used to estimate annual savings.

Calculation of Deemed Savings

$$\Delta kWh = \frac{\rho \times C_p \times U \times (F_B - F_P) \times (T_H - T_{Supply}) \times \left(\frac{1}{E_t}\right) \times Days/Year}{3,412 \text{ Btu/kWh}}$$
$$\Delta kW = \frac{\rho \times C_p \times U \times (F_B - F_P) \times (T_H - T_{Supply}) \times \left(\frac{1}{E_t}\right) \times P}{3,412 \text{ Btu/kWh}}$$

The table below summarizes AR TRM v8.0 Volume II key parameters used to compute savings.

Table B-1 Parameters for Annual Energy and Peak Demand Savings Calculations

Parameter	Description	Value
<i>FB</i>	Average baseline flow rate of aerator (GPM)	2.2
<i>FP</i>	Average post measure flow rate of aerator (GPM)	≤ 1.5
<i>Days/Year</i>	Annual building type operating days for the applications:	
	1. Prison	365
	2. Hospital, nursing home	365
	3. Dormitory	274
	4. Multifamily	365
	5. Lodging	365
	6. Commercial	250
	7. School	200
<i>T_{supply}</i>	Average supply (cold) water temperature (°F)	Zone 9: 65.6 Zone 8: 66.1 Zone 7: 67.8 Zone 6: 70.1
<i>TH</i>	Average mixed water (after aerator) temperature (°F)	105
<i>U</i>	Baseline water usage duration, following applications 488	
	1. Prison	30 min/day/unit
	2. Hospital, nursing home	3.0 min/day/unit
	3. Dormitory	30 min/day/unit
	4. Multifamily	3.0 min/day/unit
	5. Lodging	3.0 min/day/unit
	6. Commercial	30 min/day/unit
	7. School	30 min/day/unit
<i>ρ</i>	Unit conversion: 8.33 pounds/gallon	8.33
<i>C_p</i>	Heat capacity of water – 1 Btu/lb °F	1
<i>Et</i>	Thermal Efficiency of water heater	Default values: 0.98 for electric resistance 2.2 (COP) for heat pump, 0.80 for gas
<i>P</i>	Hourly water consumption during peak period as a fraction of average daily consumption for applications: 490	
	1. Prison	0.04
	2. Hospital, nursing home	0.03
	3. Dormitory	0.04
	4. Multifamily	0.03
	5. Lodging	0.02
	6. Commercial	0.08
	7. School	0.05

B.1.2 Commercial Low-Flow Showerheads

The commercial low-flow showerhead measure savings are calculated using the values and equations from AR TRM v8.0 Volume II Low-Flow Showerheads, Section 3.3.5. Low-flow showerheads are assigned an EUL of 10 years. Table B-2 summarizes AR TRM v8.0 Volume II baseline and efficiency standards for low-flow showerheads.

Table B-2 Low-flow Showerhead – Baseline and Efficiency Standards

Measure	New Showerhead Flow Rate	Existing Showerhead Baseline Flow Rate
2.0 gpm showerhead	2.0 gpm	2.5 gpm
1.75 gpm showerhead	1.75 gpm	2.5 gpm
1.5 gpm showerhead	1.5 gpm	2.5 gpm

Table B-3 and Table B-4 summarizes AR TRM v8.0 Volume II building type and weather zone parameters.

Table B-3 Showers per Day (per Showerhead) and Days of Operation by Building Type

Building Type	N	Days/Year
Hospital/Nursing Home	0.89	365
Hospitality	1.25	365
Commercial	0.97	250
Fitness Center	19.94	365
School	1.32	200

Table B-4 Average Inlet Water Temperature (Tsupply) and Hot Water Fraction (FHW) by Weather Zone

Weather Zone	Tsupply (°F)	FHW (%)
9 Fayetteville	65.6	72%
8 Fort Smith	66.1	72%
7 Little Rock	67.8	71%
6 El Dorado	70.1	70%

Table B-5 summarizes the AR TRM V8.0 Volume II values for reduction in daily hot water usage by weather zone and building type.

Table B-5 Reduction in Daily Hot Water Usage, ΔV (GPD)

Flow Rate of Installed Showerhead	Weather Zone	Building Type				
		Hospital/Nursing Home	Hospitality	Commercial (General) – Employee Shower	Fitness Center	Schools
2.0 GPM	Fayetteville	2.51	3.53	2.74	56.30	3.73
	Fort Smith	2.51	3.52	2.73	56.15	3.72
	Little Rock	2.47	3.48	2.70	55.45	3.67
	El Dorado	2.43	3.41	2.64	54.36	3.60
1.75 GPM	Fayetteville	3.77	5.29	4.11	84.45	5.59
	Fort Smith	3.76	5.28	4.10	84.22	5.58
	Little Rock	3.71	5.21	4.05	83.17	5.51
	El Dorado	3.64	5.11	3.97	84.54	5.40
1.5 GPM	Fayetteville	5.03	7.06	5.48	112.61	7.45
	Fort Smith	5.01	7.04	5.46	112.29	7.43
	Little Rock	4.95	6.95	5.39	110.89	7.34
	El Dorado	4.85	6.81	5.29	108.72	7.20

The following AR TRM v8.0 Volume II equation is used to calculate deemed energy:

$$Energy\ Savings = \frac{\rho \times C_p \times \Delta V \times (T_H - T_{Supply}) \times \left(\frac{1}{E_t}\right)}{Conversion\ Factor} \times \frac{days}{year}$$

Where,

ρ = Water density = 8.33 lb/gallon

C_p = Specific heat of water = 1 Btu/lb·°F

ΔV = gallons saved per day (GPD)

T_H = Temperature to which water is heated in the water heater, 120°

T_{Supply} = Average inlet water temperature (water mains temperature)

E_t = Thermal efficiency of water heater (or in the case of heat pump water heaters, COP); if unknown, use 0.98 as a default for electric resistance water heaters, 2.2 for heat pump water heaters, or 0.80 for natural gas water heaters

Conversion Factor = 3,412 Btu/kWh for electric water heating or 100,000 Btu/therm for gas water heating

$\frac{days}{year}$ = annual operating days for the building type in which the retrofit is being implemented

The following equation will be used to calculate deemed demand savings and is from AR TRM v8.0 Volume II Equation 287:

$$Energy\ Savings = \frac{\rho \times C_p \times \Delta V \times (T_H - T_{Supply}) \times \left(\frac{1}{E_t}\right)}{Conversion\ Factor} \times P$$

Where,

P = gas and electric peak coincidence factors, as provided for each building type

Table B-6 summarizes AR TRM v8.0 Volume II key parameters used to compute savings.

Table B-6 Parameters for Annual Energy and Peak Demand Savings Calculations

Parameter	Description	Value	
U	Baseline shower duration (min/shower)	7.8	
N	Number of showers per day per showerhead		
	1. Hospital, Nursing Home	0.89	
	2. Lodging	1.25	
	3. Commercial	0.97	
	4. Fitness Center	19.94	
	5. Schools	1.32	
QB	Average baseline flow rate of showerhead (GPM)	2.5	
QP	Flow rate of installed showerhead (GPM)	≤ 2.0	
FHW	Share of water flowing through showerhead coming from the water heater (%)		
	Zone 9: Fayetteville	72.4	
	Zone 8: Fort Smith	72.2	
	Zone 7: Little Rock	71.3	
	Zone 6: El Dorado	69.9	
ρ	Density of water (lb/gal)	8.33	
Cp	Heat capacity of water (Btu/lb-°F)	1	
THW	Temperature to which water is heated by the water heater (°F)	120	
$Tsupply$	Average supply (cold) water temperature (°F)		
	Zone 9: Fayetteville	65.6	
	Zone 8: Fort Smith	66.1	
	Zone 7: Little Rock	67.8	
	Zone 6: El Dorado	70.1	
Et	Thermal Efficiency of hot water heater:		
	1. Conventional Electric Storage Water Heater	0.98	
	2. Heat Pump Water Heater (COP)	2.2	
	3. Gas Storage Water Heater	0.80	
$Days/year$	Annual building type operating days for the applications:		
	1. Hospital, Nursing Home	365	
	2. Lodging	365	
	3. Commercial	250	
	4. Fitness Center	365	
	5. School	200	
P	Peak Factor:	Gas	Electric
	1. Hospital, Nursing Home	8.2 e-6	0.03
	2. Lodging	8.2 e-6	0.02
	3. Commercial	1.2 e-5	0.08
	4. Fitness Center	8.2 e-6	0.08
	5. School	1.5 e-5	0.05

B.1.3 Commercial Low-Flow Pre-Rinse Spray Valves

The commercial low-flow pre-rinse spray valve measure savings are calculated using the values and equations from AR TRM v8.0 Volume II Low-Flow Pre-Rinse Spray Valves, Section 3.8.11. The EUL for this measure is 5 years. The following equations from the AR TRM v8.0 Volume II are used to calculate annual kWh and peak kW savings.

Calculation of Deemed Savings

$$\Delta kWh = \frac{\rho \times C_p \times U \times (F_B - F_P) \times (T_H - T_{Supply}) \times \left(\frac{1}{E_t}\right) \times \frac{days}{year}}{3,412 \text{ Btu/kWh}}$$
$$\Delta kW = \frac{\rho \times C_p \times U \times (F_B - F_P) \times (T_H - T_{Supply}) \times \left(\frac{1}{E_t}\right) \times P}{3,412 \text{ Btu/kWh}}$$

Table B-7 summarizes AR TRM v8.0 Volume II key parameters used to compute savings. Table B-8 summarizes AR TRM v8.0 Volume II building type definitions. Table B-9 summarizes AR TRM v8.0 Volume II daily operating hours values.

Table B-7 Variables for the Deemed Savings Algorithm

Parameter	Description	Value
F_B	Average baseline flow rate of sprayer (GPM)	2.25
F_P	Average post measure flow rate of sprayer (GPM)	1.28
$Days/Year$	Annual operating days for the applications: 1. Fast food restaurant 2. Casual dining restaurant 3. Institutional 4. Dormitory 5. K-12 school	365 365 365 274 200
T_{Supply}	Average supply (cold) water temperature (°F)	Zone 9: 65.6 Zone 8: 66.1 Zone 7: 67.8 Zone 6: 70.1
T_H	Average mixed hot water (after spray valve) temperature (°F)	120
U_B	Baseline water usage duration for the following applications: 1. Fast food restaurant 2. Casual dining restaurant 3. Institutional 4. Dormitory 5. K-12 school	45 min/day/unit 105 min/day/unit 210 min/day/unit 210 min/day/unit 105 min/day/unit
ρ	Density of water 8.33 BTU/Gallon	8.33
C_p	Heat capacity of water, 1 BTU/l°F	1
E_t	Thermal efficiency of water heater	Default value 0.98 for electric and 0.80 for gas
P	Hourly peak demand as a fraction of daily water consumption for the following applications: 1. Fast food restaurant (Fast Food) 2. Casual dining restaurant (Sit down rest.) 3. Institutional (Nursing Home) 4. Dormitory (Sit down rest.) 5. K-12 School (High school)	0.05 0.04 0.03 0.04 0.05

Table B-8 Building Type Definitions

Building Type	Operating Days	Representative PRSV Usage Examples
1. Fast food restaurant	365	Establishments engaged in providing food services where patrons order and pay before eating. These facilities typically use disposable serving ware. PRSV are used for rinsing cooking ware, utensils, trays, etc. Examples: Fast food restaurant, supermarket food preparation and food service area, drive-ins, grills, luncheonettes, sandwich, and snack shops.
2. Casual dining restaurant	365	Establishments primarily engaged in providing food services to customers who order and are served while seated (i.e. waiter/waitress service). These facilities typically use chinaware and use the PRSV to rinse dishes, cooking ware, utensils, trays, etc. Example: Full meal restaurant.
3. Institutional	365	Establishments located in institutional facilities (e.g. nursing homes, hospitals, prisons, military) where food is prepared in large volumes and patrons order food before eating, such as in dining halls and cafeterias. These facilities typically use disposable serving ware and serving trays. PRSVs are used for rinsing cooking ware, utensils, tray, etc. Examples: Nursing home, hospital, prison cafeteria, and military barrack mess hall.
4. Dormitory	274	Establishments located in higher education facilities where food is prepared in large volumes and patrons order food before eating, such as in dining halls and cafeterias. These facilities typically use disposable serving ware and serving trays. PRSVs are used for rinsing cooking ware, utensils, trays, etc. Example: University dining halls.
5. K-12 School	200	Establishments located in K-12 schools where food is prepared in large volumes and patrons order food before eating, such as in dining halls and cafeterias. These facilities typically use disposable serving ware and serving trays. PRSVs are used for rinsing cooking ware, utensils, trays, etc. Example: K-12 school cafeterias

Table B-9 Daily Operating Hours

Food Service Operation	Min (Min/Day)	Max (Min/Day)	Average (Min/Day)
Small Service (e.g., quick-service restaurants)	30	60	45
Medium Service (e.g., casual dining restaurants)	90	120	105
Large Service (e.g., institutional such as cafeterias in universities, prisons, and nursing homes)	180	240	210

B.1.4 Commercial Door Air Infiltration

The commercial door air infiltration measure savings are calculated using the values and equations from AR TRM v8.0 Volume II, Section 3.2.11. Air infiltration measures are assigned an EUL of 11 years. The following equations from the AR TRM v8.0 Volume II are used to calculate annual electric cooling savings and electric heating savings.

Calculation of Deemed Savings

$$Electric\ Clg\ kWh_{savings,day} = \frac{CFM_{pre,day} \times CFM_{reduction} \times 1.08 \times \Delta T \times \frac{1.0kW}{ton \cdot Hours_{day}}}{12,000 \frac{Btu/h}{ton}}$$

$$Electric\ Clg\ kWh_{savings,night} = \frac{CFM_{pre,night} \times CFM_{reduction} \times 1.08 \times \Delta T \times \frac{1.0kW}{ton \cdot Hours_{night}}}{12,000 \frac{Btu/h}{ton}}$$

$$kWh_{savings,elect\ clg} = Electric\ Clg\ kWh_{savings,day} + Electric\ Clg\ kWh_{savings,night}$$

$$kW_{savings,elect\ clg} = \frac{kWh_{savings,elect\ clg}}{ELFH_C}$$

$$Electric\ Htg\ kWh_{savings,day} = \frac{CFM_{pre,day} \times CFM_{reduction} \times 1.08 \times \Delta T \times \frac{1.0kW}{ton \cdot Hours_{day}}}{COP \times 3,412 \frac{Btu/h}{kW}}$$

$$Electric\ Htg\ kWh_{savings,night} = \frac{CFM_{pre,night} \times CFM_{reduction} \times 1.08 \times \Delta T \times \frac{1.0kW}{ton \cdot Hours_{night}}}{COP \times 3,412 \frac{Btu/h}{kW}}$$

$$kWh_{savings,elect\ htg} = Electric\ Htg\ kWh_{savings,day} + Electric\ Htg\ kWh_{savings,night}$$

Where,

$CFM_{pre} = 79\%$

108 = Sensible heat equation conversion

ΔT = Change in temperature across gap barrier

$Hours_{day} = 12$ -hour cycles per day, per month = 4,380 hours

$Hours_{night} = 12$ -hour cycles per day, per month = 4,380 hours

COP = Heating coefficient of performance; 1.0 for Electric Resistance and 3.3 for Heat Pumps

$EFLH_C$ = Average cooling equivalent full-load hours across all building types

Table B-10 summarizes AR TRM v8.0 Volume II daytime and nighttime design temperatures. Table B-11 summarizes AR TRM v8.0 Volume II average monthly ambient temperatures.

Table B-10 Daytime and Nighttime Design Temperatures

Temperature Description	TDesign (°F)
Daytime Cooling Design Temperature	74
Daytime Heating Design Temperature	72
Nighttime Cooling Design Temperature (assuming 4 degree setback)	78
Nighttime Heating Design Temperature (assuming 4 degree setback)	68

Table B-11 Average Monthly Ambient Temperatures

Month	Zone 9 Rogers		Zone 8 Fort Smith		Zone 7 Little Rock		Zone 6 El Dorado	
	Day	Night	Day	Night	Day	Night	Day	Night
	Tavg (°F)	Tavg (°F)	Tavg (°F)	Tavg (°F)	Tavg (°F)	Tavg (°F)	Tavg (°F)	Tavg (°F)
Jan	35.6	30.6	38.8	32.6	39.4	34.2	45.2	39.7
Feb	45.3	36.7	40.8	33.8	50.0	42.3	49.1	38.6
Mar	45.5	37.5	56.9	46.2	56.3	48.0	65.8	54.7
April	60.0	50.1	64.4	55.1	67.3	57.3	71.2	57.3
May	70.5	59.7	73.9	64.0	74.6	65.3	80.2	69.6
Jun	80.9	70.4	83.6	71.4	84.4	73.1	84.8	72.9
July	82.9	72.3	86.9	76.2	87.1	76.0	85.7	74.2
Aug	88.4	76.1	85.8	73.7	87.0	75.4	95.8	77.7
Sept	79.1	67.9	82.2	69.6	79.9	69.7	85.0	72.3
Oct	61.1	51.5	66.8	54.4	67.6	56.5	67.3	52.4
Nov	50.8	45.2	56.4	48.1	57.4	49.5	59.5	51.7
Dec	45.9	40.1	44.4	35.3	45.4	38.7	47.0	38.5

Table B-12 through Table B-15 summarizes AR TRM v8.0 Volume II deemed door sweeps savings values.

Table B-12 Door Sweeps – Deemed Electric Cooling Energy Savings Values (kWh per linear foot)

Weather Zone	Gap Width (inches)			
	1/8	1/4	1/2	3/4
Zone 9: Rogers	2.73	5.54	10.99	16.49
Zone 8: Fort Smith	3.34	6.78	13.43	20.16
Zone 7: Little Rock	3.30	6.69	13.26	19.91
Zone 6: El Dorado	4.63	9.04	18.63	27.97

Table B-13 Door Sweeps – Deemed Electric Resistance Heating Energy savings Values (kWh per linear foot)

Weather Zone	Gap Width (inches)			
	1/8	1/4	1/2	3/4
Zone 9: Rogers	125.19	253.13	502.35	754.10
Zone 8: Fort Smith	108.83	220.04	436.67	655.51
Zone 7: Little Rock	91.75	185.61	368.27	552.83
Zone 6: El Dorado	67.78	137.41	272.41	408.93

Table B-14 Door Sweeps – Heat Pump Heating Energy Savings Values (kWh per linear foot)

Weather Zone	Gap Width (inches)			
	1/8	1/4	1/2	3/4
Zone 9: Rogers	37.94	76.71	152.23	228.51
Zone 8: Fort Smith	32.98	66.68	132.32	198.64
Zone 7: Little Rock	27.81	56.24	122.76	167.52
Zone 6: El Dorado	20.54	41.64	82.55	123.92

Table B-15 Door Sweeps – Deemed Electric Cooling Demand Savings Values (kW per linear foot)

Weather Zone	Gap Width (inches)			
	1/8	1/4	1/2	3/4
Zone 9: Rogers	0.0022	0.0044	0.0087	0.0132
Zone 8: Fort Smith	0.0024	0.0049	0.0098	0.0147
Zone 7: Little Rock	0.0023	0.0047	0.0093	0.0140
Zone 6: El Dorado	0.0028	0.0055	0.0113	0.0170

B.1.5 Commercial Lighting Controls

The commercial lighting controls measure savings are calculated using the values and equations from AR TRM v8.0 Volume II Section 3.6.2. The kWh savings for each combination of fixture type, fixture location, building type, and refrigeration type are calculated separately.

Calculation of Deemed Savings

$$kW_{savings} = N_{fixt} \times \frac{W_{fixt}}{1000} \times CF \times IEF_D$$

$$kWh_{savings} = N_{fixt} \times \frac{W_{fixt}}{1000} \times (1 - PAF) \times AOH \times IEF_E$$

Where:

N_{fixt} = Number of fixtures

W_{fixt} = Rated wattage of post-retrofit fixtures

Note: If the fixture was retrofitted, use the installed fixture wattage; if fixture was not retrofitted, use the existing fixture wattage

PAF = Deemed power adjustment factor based on control type

CF = Peak demand coincidence factor = 0.26

AOH = Annual operating hours for specified building type

IEFD = Interactive effects factor for demand saving

IEFE = Interactive effects factor for energy savings

Table B-16 shows PAF values for Lighting Controls.

Table B-16 Lighting Controls – Power Adjustment Factors

Control Type	Power Adjustment Factor (PAF)
No controls measures	1.00
Daylighting Control – Continuous Dimming	0.70
Daylighting Control – Multiple Step Dimming	0.80
Daylighting Control – ON/OFF (Indoor)	0.90
Daylighting Control – ON/OFF (Outdoor)	1.00
Occupancy Sensor	0.70
Occupancy Sensor w/ Daylighting Control – Continuous Dimming	0.60
Occupancy Sensor w/ Daylighting Control – Multiple Step Dimming	0.65
Occupancy Sensor w/ Daylighting Control – ON/OFF	0.65

B.1.6 Commercial Lighting

The commercial lighting measure savings are calculated using the values and equations from AR TRM v8.0 Volume II Section 3.6.3. This measure provides energy and demand savings calculations for the replacement of commercial lighting equipment with energy efficient lamps or fixtures. The equations are summarized below.

Calculation of Deemed Savings

New Construction:

$$kW_{savings} = \left(\left(SF \times \frac{LPD}{1000} \right) - \Sigma \left(\left[N_{fixt(i)} \times \frac{W_{fixt(i)}}{1000} \right]_{post} \right) \right) \times CF \times IEF_D$$

$$kWh_{savings} = \left(\left(SF \times \frac{LPD}{1000} \right) - \Sigma \left(\left[N_{fixt(i)} \times \frac{W_{fixt(i)}}{1000} \right]_{post} \right) \right) \times AOH \times IEF_E$$

$$therms_{penalty} = kWh_{savings} \times IEF_G$$

Where:

SF = Total affected square footage of the new construction facility

LPD = Maximum allowable power density by building type (W/ft²)

$N_{fixt(i)_{post}}$ = Post-retrofit # of fixtures of type i
 $W_{fixt(i)_{post}}$ = Rated wattage of post-retrofit fixtures of type i
 AOH = Annual operating hours for specified building type
 IEF_D = Interactive effects factor for demand savings
 IEF_E = Interactive effects factor for energy savings
 IEF_G = Interactive effects factor for gas heating savings

Retrofit with no existing controls:

$$kW_{savings} = \Sigma \left(\left[N_{fixt(i)} \times \frac{W_{fixt(i)}}{1000} \right]_{pre} - \left[N_{fixt(i)} \times \frac{W_{fixt(i)}}{1000} \right]_{post} \right) \times CF \times IEF_D$$

$$kWh_{savings} = \Sigma \left(\left[N_{fixt(i)} \times \frac{W_{fixt(i)}}{1000} \right]_{pre} - \left[N_{fixt(i)} \times \frac{W_{fixt(i)}}{1000} \right]_{post} \right) \times AOH \times IEF_E$$

$$therms_{penalty} = kWh_{savings} \times IEF_G$$

Retrofit with existing controls:

$$kW_{savings} = \Sigma \left(\left[N_{fixt(i)} \times \frac{W_{fixt(i)}}{1000} \right]_{pre} - \left[N_{fixt(i)} \times \frac{W_{fixt(i)}}{1000} \right]_{post} \right) \times IEF_D \times CF_{controls}$$

$$kWh_{savings} = \Sigma \left(\left[N_{fixt(i)} \times \frac{W_{fixt(i)}}{1000} \right]_{pre} - \left[N_{fixt(i)} \times \frac{W_{fixt(i)}}{1000} \right]_{post} \right) \times IEF_E \times AOH \times PAF$$

$$therms_{penalty} = kWh_{savings} \times IEF_G$$

Where:

$N_{fixt(i)_{pre}}$ = Pre-retrofit number of fixtures of type i
 $N_{fixt(i)_{post}}$ = Post-retrofit number of fixtures of type i
 $W_{fixt(i)_{pre}}$ = Rated wattage of pre-retrofit fixtures of type i
 $w_{fixt(i)_{post}}$ = Rated wattage of post-retrofit fixtures of type i
 CF = Peak demand coincidence factor
 $CF_{controls}$ = Controls peak demand coincidence factor = 0.26
 AOH = Annual operating hours for specified building type
 PAF = Power adjustment factor for specified control type
 IEF_D = Interactive effects factor for demand savings
 IEF_E = Interactive effects factor for energy savings
 IEF_G = Interactive effects factor for gas heating savings

Table B-17 to Table B-19 shows AOH, CF, and interactive for various building types.

Table B-17 Annual Operating Hours (AOH) and Coincidence Factors (CF)

Building Type	AOH	CF
All Building Types: Exit Signs	8,760	1.00
Education: k-12, w/o Summer Session	2,777	0.47
Education: College, University, Vocational, Day Care, and K-12 w/ Summer Session	3,577	0.69
Food Sales: Non 24-hour Supermarket/Retail	4,706	0.95
Food Sales: 24-hour Supermarket/Retail	6,900	0.95
Food Service: Fast Food	6,188	0.81
Food Service: Sit-down Restaurant	4,368	0.81
Health Care: Out-patient	3,386	0.77
Health Care: In-patient	5,730	0.78
Lodging (Hotel/Motel/Dorm): Common Areas	6,630	0.82
Lodging (Hotel/Motel/Dorm): Rooms	3,055	0.25
Manufacturing – 1 and 2 Shift	4,547	0.64
Manufacturing – 3 Shift	6,631	0.89
Multi-family Housing: Common Areas	4,772	0.87
Nursing & Resident Care	4,271	0.78
Office	3,227	0.54
Outdoor	3,996	0.00
Outdoor Athletic Fields	503	0.00
Structure	7,884	1.00
Public Assembly	2,638	0.56
Public Order and Safety	3,472	0.75
Religious	1,824	0.53
Retail: Excluding Malls & Strip Centers	3,668	0.69573
Retail: Enclosed Mall	4,813	0.93
Retail: Strip Shopping & Non-enclosed Mall	3,965	0.90
Service (Excluding Food)	3,406	0.90
Warehouse: Non-refrigerated	3,501	0.77

Table B-18 Commercial Conditioned and Refrigerated Space Interactive Effects Factors

Building Type	Temperature Description	Heating Type	IEF _D	IEF _E
All building types (Except Outdoor & Parking Structure)	Air-Conditioned Space – Normal Temps. (> 41°F)	Gas	1.20	1.09
		Electric Resistance		0.87
		Heat Pump		1.02
		Heating Unknown		0.98
	Refrigerated Space – Med. Temps. (33-41°F)	All	1.25	1.25
	Refrigerated Space – Low Temps. (-10-10°F)	All	1.30	1.30

Table B-19 Commercial Conditioned Space Gas Heating Penalty

Building Type	Heating Type	IEF _G
All building types (Except Outdoor & Parking Structure)	Gas	-0.008
	Heating Unknown	-0.004

B.1.7 Strip Curtains for Walk-in Coolers and Freezers

The commercial strip curtains for coolers and freezers measure savings are calculated using the values and equations from AR TRM v8.0 Volume II Section 3.7.7. This measure applies to the installation of strip curtains on walk-in coolers and freezers to reduce the refrigeration load associated with the infiltration of non-refrigerated air into the refrigerated space. The EUL assigned to this measure is 4 years. The equations used to calculate savings are summarized below.

Calculation of Deemed Savings

$$\Delta kWh = \frac{\Delta kWh}{sqft} \times A$$

$$\Delta kW_{peak} = \frac{\Delta kW}{sqft} \times A$$

Where,

$\frac{\Delta kWh}{sqft}$ = Average annual kWh savings per square foot of infiltration barrier

$\frac{\Delta kW}{sqft}$ = Average kW savings per square foot of infiltration barrier

A = Total gasket length

The deemed savings values provided by the AR TRM v8.1 Volume II were calculated using the equation below.

$$\frac{\Delta kWh}{sqft} = \frac{365 \times t_{open} \times (\eta_{new} - \eta_{old}) \times 20 \times CD \times A \times \left\{ \left[\frac{T_i - T_r}{T_i} \right] \times g \times H \right\}^{0.5} \times [\rho_i - h_i - \rho_r \times h_r]}{3,412 \frac{Btu}{kWh} \times COP_{adj} \times A}$$

The deemed savings values are summarized in the table below.

Table B-20 Strip Curtains – Deemed Savings Values

Type	Pre-existing Curtains	Energy Savings	Demand Savings
Supermarket – Cooler	Yes	37	0.0042
Supermarket – Cooler	No	108	0.0123
Supermarket – Cooler	Unknown	108	0.0123
Supermarket – Freezer	Yes	119	0.0136
Supermarket – Freezer	No	349	0.0398
Supermarket – Freezer	Unknown	349	0.0398
Convenience Store - Cooler	Yes	5	0.0006
Convenience Store - Cooler	No	20	0.0023
Convenience Store - Cooler	Unknown	11	0.0013
Convenience Store - Freezer	Yes	8	0.0009
Convenience Store - Freezer	No	27	0.0031
Convenience Store - Freezer	Unknown	17	0.0020
Restaurant – Cooler	Yes	8	0.0009
Restaurant – Cooler	No	30	0.0034
Restaurant – Cooler	Unknown	18	0.0020
Restaurant – Freezer	Yes	34	0.0039
Restaurant – Freezer	No	119	0.0136
Restaurant – Freezer	Unknown	81	0.0092
Refrigerated Warehouse	Yes	254	0.0290
Refrigerated Warehouse	No	729	0.0832
Refrigerated Warehouse	Unknown	287	0.0327

B.1.8 Door Gaskets for Coolers and Freezers

The commercial door gaskets for coolers and freezers measure savings are calculated using the values and equations from AR TRM v8.0 Volume II Section 3.7.8. This measure applies to the installation of door gaskets on walk-in coolers and freezers to reduce the refrigeration load associated with the infiltration of non-refrigerated air into the refrigerated space. The equations used to calculate savings are summarized below.

Calculation of Deemed Savings

$$\Delta kWh = \frac{\Delta kWh}{ft} \times L$$

$$\Delta kW_{peak} = \frac{\frac{\Delta kWh}{ft}}{8760} \times L$$

Where,

$\frac{\Delta kWh}{ft}$ = Annual energy savings per linear foot of gasket

$\frac{\Delta kW}{ft}$ = Demand savings per linear foot of gasket

L = Total gasket length

Table B-21 shows the deemed savings values for gaskets.

Table B-21 Door Gaskets Deemed Savings Values (per Linear Foot of Gasket)

Refrigerator Type	Walk-In or Reach In	Refrigerator Type
	$\frac{\Delta kWh}{ft}$	$\frac{\Delta kWh}{ft}$
Cooler	0.0017	15
Freezer	0.0131	115

B.1.9 Unitary and Split System AC/HP Equipment

The unitary and split system AC/HP equipment savings are calculated using the values and equations from AR TRM v8.0 Volume II Section 3.1.18. This measure applies to the installation of packaged or split system air conditioners (AC) or heat pumps (HP), excluding PTACs/PTHPs. Unitary or split system ACs/HPs consist of one or more factory-made assemblies that normally include an evaporator or cooling coil(s), compressor(s), and condenser(s). They provide the function of air cooling, and may include the functions of air heating, air circulation, air cleaning, dehumidifying, or humidifying.

Calculation of Deemed Savings

Deemed peak demand and annual energy savings for unitary AC and HP equipment should be calculated as shown below. Note that these savings calculations are different depending on whether the measure is replace-on-burnout or early retirement.

New Construction or Replace-on-Burnout

$$kW_{Savings} = CAP_C \times \frac{1 kW}{1,000 W} \times \left(\frac{1}{\eta_{base,C}} - \frac{1}{\eta_{post,C}} \right) \times CF$$

$$kWh_{Savings, AC} = CAP_C \times \frac{1 kW}{1,000 W} \times EFLH_C \times \left(\frac{1}{\eta_{base,C}} - \frac{1}{\eta_{post,C}} \right)$$

$$kWh_{Savings, HP, C} = CAP_C \times \frac{1 kW}{1,000 W} \times EFLH_C \times \left(\frac{1}{\eta_{base,C}} - \frac{1}{\eta_{post,C}} \right)$$

$$kWh_{Savings, HP, H} = CAP_H \times \frac{1 kW}{1,000 W} \times EFLH_H \times \left(\frac{1}{\eta_{base,H}} - \frac{1}{\eta_{post,H}} \right)$$

Where:

- CAP_C = Rated equipment cooling capacity of the new unit (BTU/hr)
- CAP_H = Rated equipment heating capacity of the new unit (BTU/hr)
- $\eta_{base,C/H}$ = Baseline energy efficiency rating of the cooling/heating equipment
- $\eta_{post,C/H}$ = Nameplate energy efficiency rating of the installed cooling/heating equipment
- CF = Coincidence factor (Table B-22)
- $EFLH_C$ = Equivalent full-load hours for cooling
- $EFLH_H$ = Equivalent full-load hours for heating

Table B-22 Commercial Coincidence Factors by Building Type

Building Type	Coincidence Factor
Assembly	0.82
College	0.84
Fast Food	0.78
Full Menu	0.85
Grocery	0.90
Health Clinic	0.85
Large Office	0.84
Lodging	0.77
Religious Worship	0.82
Retail	0.88
School	0.71
Small Office	0.84

Early Retirement

Annual kWh and kW savings must be calculated separately for two time periods:

1. The estimated remaining life of the equipment that is being removed, designated the remaining useful life (RUL), and
2. The remaining time in the EUL period (15 – RUL).

For the RUL:

$$kW_{Savings} = CAP_C \times \frac{1 kW}{1,000 W} \times \left(\frac{1}{\eta_{base,C}} - \frac{1}{\eta_{post,C}} \right) \times CF$$

$$kWh_{Savings, AC} = CAP_C \times \frac{1 kW}{1,000 W} \times EFLH_C \times \left(\frac{1}{\eta_{base,C}} - \frac{1}{\eta_{post,C}} \right)$$

$$kWh_{Savings, HP, C} = CAP_C \times \frac{1 kW}{1,000 W} \times EFLH_C \times \left(\frac{1}{\eta_{base,C}} - \frac{1}{\eta_{post,C}} \right)$$

$$kWh_{Savings, HP, H} = CAP_H \times \frac{1 kW}{1,000 W} \times EFLH_H \times \left(\frac{1}{\eta_{base,H}} - \frac{1}{\eta_{post,H}} \right)$$

$$kWh_{Savings, HP} = kWh_{Savings, HP, C} + kWh_{Savings, HP, H}$$

For the remaining time in the EUL period (15 – RUL), lifetime kWh savings for early retirement projects is calculated as follows:

$$Lifetime kWh_{savings} = (kwh_{savings, ER} \times RUL) + [kWh_{savings, ROB} \times (EUL - RUL)]$$

Where:

ROB = Replace-on-Burnout

ER = Early Retirement

CAP_C = Rated equipment cooling capacity of the new unit (BTU/hr)

CAP_H = Rated equipment heating capacity of the new unit (BTU/hr)

η_{base,C/H} = Nameplate energy efficiency rating of the existing cooling/heating equipment

η_{post,C/H} = Nameplate energy efficiency rating of the installed cooling/heating equipment

HSPF = *COP* × 3.412

CF = Coincidence factor

EFLH_C = Equivalent full-load hours for cooling

EUL = Estimated Useful Life

RUL = Remaining Useful Life (Table B-23)

Table B-23 Remaining Useful Life (RUL) of Replaced Systems

Age of Replaced System (Years)	RUL (Years)	Age of Replaced System (Years)	RUL (Years)
5	10.0	13	3.8
6	9.1	14	3.3
7	8.2	15	2.8
8	7.3	16	2.5
9	6.5	17	2.2
10	5.7	18	1.9
11	5.0	19 +	0.0

B.1.10 Central Air Conditioner and Heat Pump Tune-Up

The central air conditioner and heat pump tune-up measure savings are calculated using the values and equations from AR TRM v8.0 Volume II Section 3.1.7. This measure applies to central air conditioners and heat pumps. An AC tune-up, in general terms involves checking, adjusting and resetting the equipment to factory conditions, such that it operates closer to the performance level of a new unit. The EUL assigned to this measure is 10 years.

Calculation of Deemed Savings

The deemed peak demand and annual energy savings for unitary AC/HP tune-ups are calculated using the following equations from the AR TRM v8.1 Volume II.

$$kW_{savings,C} = CAP_C \times \frac{1 \text{ kW}}{1,000 \text{ W}} \times \left(\frac{1}{EER_{pre}} - \frac{1}{EER_{post}} \right) \times CF$$

$$kW_{savings,C} = CAP_C \times \frac{1 \text{ kW}}{1,000 \text{ W}} \times EFLH_C \times \left(\frac{1}{EER_{pre}} - \frac{1}{EER_{post}} \right)$$

$$kW_{savings,H} = CAP_H \times \frac{1 \text{ kW}}{1,000 \text{ W}} \times EFLH_H \times \left(\frac{1}{HSPF_{pre}} - \frac{1}{HSPF_{post}} \right)$$

$$kWh_{savings,AC} = kWh_{savings,C}$$

$$kWh_{savings,HP} = kWh_{savings,C} + kWh_{savings,H}$$

Where,

CAP_C = Rated or calculated equipment cooling capacity (BTU/hr)

CAP_H = Rated or calculated equipment cooling capacity (BTU/hr)

EER_{pre} = Calculated or measured efficiency of the equipment for cooling before tune-up

EER_{post} = Nameplate efficiency of the existing equipment for cooling; if unknown, use default EER value from

Table B-24 and Table B-27

$HSPF_{pre}$ = Calculated or measured efficiency of the equipment for heating before tune-up

$HSPF_{post}$ = Nameplate measured or calculated efficiency of the existing equipment for heating; if unknown, use default HSPF value from Table B-26

CF = Coincidence Factor

$EFLH_c$ = Equivalent full-load cooling hours

$EFLH_H$ = Equivalent full-load heating hours

The following tables summarize default values from the AR TRM V.7.0 Volume II.

Table B-24 Default Air Conditioner EER per Size Category

Size Category (BTU/hr)	Default EER
< 65,000	11.8
≥ 65,000 and < 135,000	11.0
≥ 135,000 and < 240,000	10.8
≥ 240,000 and < 760,000	9.8
≥ 760,000	9.5

Table B-25 Default Heat Pump EER per Size Category

Size Category (BTU/hr)	Default EER
< 65,000	11.8
≥ 65,000 and < 135,000	1.8
≥ 135,000 and < 240,000	10.4
≥ 240,000	9.83

Table B-26 Default Heat Pump HSPF per Size Category

Size Category (BTU/hr)	Subcategory or Rating Condition	Default HSPF
< 65,000	Split System	8.2
	Single Package	8.0
≥ 65,000 and < 135,000	47°F db/43°F wb Outdoor Air	11.3
≥ 135,000	47°F db/43°F wb Outdoor Air	10.9

For heat pump systems, an additional savings credit may be taken as follows:

$$HSPF_{pre} = (HSPF_{post}) \times (1 - M)^{age}$$

Where,

M = Maintenance factor, use 0.01 if annual maintenance conducted or 0.03 if maintenance is seldom; use default value of 0.03 if maintenance history is unknown

age = age of equipment in years, up to a maximum of 20 years, use a default of 10 years if unknown.

B.1.11 Chillers

The commercial chillers measure savings are calculated using the values and equations from AR TRM v8.0 Volume II Section 3.1.19. This measure requires the installation of any air cooled or water-cooled chilling package, referred to as a chiller. A chiller is commonly used to provide cooling for a variety of building types and process loads.

Calculation of Deemed Savings

Deemed peak demand and annual energy savings for chillers should be calculated using the following formulas:

New Construction or Replace-on-Burnout

$$kW_{Savings} = CAP \times (\eta_{base} - \eta_{post}) \times CF$$
$$kWh_{savings} = CAP \times EFLH_c \times (\eta_{base} - \eta_{post})$$

Where:

CAP = Rated equipment cooling capacity of the new unit (Tons)

η_{base} = Baseline energy efficiency rating of the baseline cooling equipment (kW/ton or EER converted to kW/ton)

η_{post} = Nameplate energy efficiency rating of the installed cooling equipment (kW/ton)

CF = Coincidence factor

$EFLH_c$ = Equivalent full-load hours for cooling

$EFLH_H$ = Equivalent full-load hours for heating

Early Retirement

Annual kWh and kW savings must be calculated separately for two time periods:

1. The estimated remaining life of the equipment that is being removed, designated the remaining useful life (RUL), and
2. The remaining time in the EUL period (EUL – RUL), where the EUL is either 20 or 25, depending on the chiller type.

For the RUL:

$$kW_{Savings} = CAP \times (\eta_{pre} - \eta_{post}) \times CF$$
$$kWh_{savings} = CAP \times EFLH_c \times (\eta_{pre} - \eta_{post})$$

For the remaining time in the EUL period (EUL – RUL):

$$Lifetime kWh_{savings} = (kwh_{savings,ER} \times RUL) + [kWh_{savings,ROB} \times (EUL - RUL)]$$

Where:

CAP = Rated equipment cooling capacity of the new unit (Tons)

η_{pre} = Nameplate energy efficiency rating of the existing cooling equipment

η_{post} = Nameplate energy efficiency rating of the installed cooling equipment
 CF = Coincidence factor
 $EFLH_c$ = Equivalent full-load hours for cooling
 EUL = Estimated Useful Life = 25 years (centrifugal chillers); 20 years (all other chillers)
 RUL = Remaining Useful Life (Table B-27)

Table B-27 Remaining Useful Life (RUL) of Replaced Systems

Non-Centrifugal Chilled Water Systems		Centrifugal Chilled Water Systems	
Age of Replaced System (Years)	RUL (Years)	Age of Replaced System (Years)	RUL (Years)
5	14.7	5	19.9
6	13.7	6	18.9
7	12.7	7	17.9
8	11.8	8	16.9
9	10.9	9	15.9
10	10.0	10	14.9
11	9.1	11	13.9
12	8.3	12	12.9
13	7.5	13	11.9
14	6.8	14	10.9
15	6.2	15	10.1
16	5.5	16	9.3
17	5.0	17	8.7
18	4.5	18	8.1
19	4.0	19	7.5
20	3.6	20	7.1
21	3.2	21	6.6
22	2.9	22	6.3
23	2.6	23	5.9
24 +	0.0	24	5.9
		25	5.4
		26	5.1
		27	4.9
		28	4.7
		29	4.5
		30	4.3
		31+	0.0

B.1.12 Premium Efficiency Motors

The premium efficiency motors measure savings are calculated using the values and equations from AR TRM v8.0 Volume II Section 3.4.2. Currently a wide variety of NEMA premium efficiency motors from 1 to 500 hp are available. Deemed saving values for demand and energy savings associated with this measure must be for motors with an equivalent operating period (hours x Load Factor) over 1,000 hours.

Calculation of Deemed Savings

Replace on Burnout (ROB)

$$kWh_{Savings} = Rated\ HorsePower \times Conversion\ Factor \times LF \times \left(\frac{1}{\eta_{baseline}} - \frac{1}{\eta_{post}} \right) \times Hrs$$

$$kW_{Savings} = Rated\ HorsePower \times Conversion\ Factor \times LF \times \left(\frac{1}{\eta_{baseline}} - \frac{1}{\eta_{post}} \right) \times CF$$

Where:

Rated HorsePower = Nameplate horsepower data of the motor

Conversion Factor = 0.746 kW/hp

LF = Estimated load factor for the motor

$\eta_{baseline}$ = Baseline Efficiencies (in the case of rewind motors, in situ efficiency may be reduced)

η_{post} = Efficiency of the newly installed motor

Hrs = Estimated annual operating hours for the motor

CF = Coincidence Factor = 0.74

Early Retirement (ER)

Annual kWh and kW savings must be calculated separately for two time periods:

1. The estimated remaining life (RUL, see
2. Table B-30) of the equipment that is being removed, designated the first N years, and
3. Years EUL - N through EUL, where EUL is 15 years.

For the first N years:

$$kWh_{Savings} = Rated\ HorsePower \times Conversion\ Factor \times LF \times \left(\frac{1}{\eta_{baseline}} - \frac{1}{\eta_{post}} \right) \times Hrs$$

$$kW_{Savings} = Rated\ HorsePower \times Conversion\ Factor \times LF \times \left(\frac{1}{\eta_{baseline}} - \frac{1}{\eta_{post}} \right) \times CF$$

For Years EUL - N through EUL: Savings should be calculated exactly as they are for replace on burnout projects, referred to as $kWh_{SavingsROB}$.

Total lifetime savings for early retirement projects are then determined by adding the savings calculated under the two preceding equations as follows:

$$\begin{aligned} & \text{Lifetime } kWh \text{ savings for Early Retirement Projects} \\ & = (kWh_{SavingsRUL} \times RUL) + [kWh_{SavingsROB} \times (EUL - RUL)] \end{aligned}$$

Where:

RUL = The Remaining Useful Life of the equipment, in years, see Table 365

EUL = The Estimated Useful Life of the equipment, deemed at 15 years

Table B-28 and Table B-29 show baseline efficiencies. Table B-30 summarizes the remaining useful life of the replaced motors.

Table B-28 Replace on Burnout Baseline Efficiencies by Motor Size

hp	$\eta_{\text{baseline, Open Motors}}$			$\eta_{\text{baseline, Closed Motors}}$		
	6-Pole	4-Pole	2-Pole	6-Pole	4-Pole	2-Pole
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	91.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93.0	94.1	94.5	93.0
60	94.5	95.0	93.6	94.5	95.0	93.6
75	94.5	95.0	93.6	94.5	95.4	93.6
100	95.0	95.4	93.6	95.0	95.4	94.1
125	95.0	95.4	94.1	95.0	95.4	95.0
150	95.4	95.8	94.1	95.8	95.8	95.0
200	95.4	95.8	95.0	95.8	96.2	95.4
250	94.5	95.4	94.5	95.0	95.0	95.4
300	94.5	95.4	95.0	95.0	95.4	95.4
350	94.5	95.4	95.0	95.0	95.4	95.4
400	n/a	95.4	95.4	n/a	95.4	95.4
450	n/a	95.8	95.8	n/a	95.4	95.4
500	n/a	95.8	95.8	n/a	95.8	95.4

Table B-29 Early Retirement Baseline Efficiencies by Motor Size

hp	$\eta_{\text{baseline, Open Motors}}$			$\eta_{\text{baseline, Closed Motors}}$		
	6-Pole	4-Pole	2-Pole	6-Pole	4-Pole	2-Pole
1	80.0	82.5	75.5	80.0	82.5	75.5
1.5	84.0	84.0	82.5	85.5	84.0	82.5
2	85.5	84.0	84.0	86.5	84.0	84.0
3	86.5	86.5	84.0	87.5	87.5	85.5
5	87.5	87.5	85.5	87.5	87.5	87.5
7.5	88.5	88.5	87.5	89.5	89.5	88.5
10	90.2	89.5	88.5	89.5	89.5	89.5
15	90.2	91.0	89.5	90.2	91.0	90.2
20	91.0	91.0	90.2	90.2	91.0	90.2
25	91.7	91.7	91.0	91.7	92.4	91.0
30	92.4	92.4	91.0	91.7	92.4	91.0
40	93.0	93.0	91.7	93.0	93.0	91.7
50	93.0	93.0	92.4	93.0	93.0	92.4
60	93.6	93.6	93.0	93.6	93.6	93.0
75	93.6	94.1	93.0	93.6	94.1	93.0
100	94.1	94.1	93.0	94.1	94.5	93.6
125	94.1	94.5	93.6	94.1	94.5	94.5
150	94.5	95.0	93.6	95.0	95.0	94.5
200	94.5	95.0	94.5	95.0	95.0	95.0
250	94.5	95.4	94.5	95.0	95.0	95.4
300	94.5	95.4	95.0	95.0	95.4	95.4
350	94.5	95.4	95.0	95.0	95.4	95.4
400	n/a	95.4	95.4	n/a	95.4	95.4
450	n/a	95.8	95.8	n/a	95.4	95.4
500	n/a	95.8	95.8	n/a	95.8	95.4

Table B-30 Premium Efficiency Motors - RUL of Replaced Systems

Age of Replaced System (Years)	RUL (Years)	Age of Replaced System (Years)	RUL (Years)
5	10.0	14	3.3
6	9.1	15	2.8
7	8.2	16	2.5
8	7.3	17	2.2
9	6.5	18	1.9
10	5.7	19	0.0
11	5.0		
12	4.4		
13	3.8		

B.2 Residential Measures

B.2.1 Residential Faucet Aerators

The residential faucet aerator savings are calculated using the values and equations from AR TRM v8.0 Volume II Faucet Aerators, Section 2.3.4. The EUL assigned to residential faucet aerators is 10 years. Table B-31 summarizes AR TRM v8.0 Volume II faucet aerator baseline and efficiency standards.

Table B-32 summarizes AR TRM v8.0 Volume II average water main temperature by weather zone.

Table B-31 Faucet Aerator – Baseline and Efficiency Standards

Baseline	Efficiency Standard
2.2 gpm	1.5 gpm maximum

Table B-31 Faucet Aerator – Baseline and Efficiency Standards

Baseline	Efficiency Standard
2.2 gpm	1.5 gpm maximum

Table B-32 Average Water Main Temperature by Weather Zone

Weather Zone	Average Ambient Temperature (°F)
9 Fayetteville	65.6
8 Forth Smith	66.1
7 Little Rock	67.8
6 El Dorado	70.1

The following equation is used to calculate values for baseline and post water consumption is from AR TRM v8.0 Volume II Equation 104:

$$Water\ Consumption = \frac{\frac{Faucet\ Use\ per\ Person}{Day} \times Occupants\ per\ Home \times \frac{365\ Days}{Year}}{Faucets\ per\ Home}$$

Applying this formula to the values from Table B-33 returns the following values for baseline and post water consumption:

Baseline (2.2 gpm) = 2,467

Post (1.5 gpm) = 2,086

Post (1.0 gpm) = 1,831

Table B-33 summarizes AR TRM v8.0 Volume II estimated aerator hot water usage reduction. Table B-34 summarizes AR TRM v8.0 Volume II mixed water temperature calculation.

Table B-33 Estimated Aerator Hot Water Usage Reduction

Assumption Type	Seattle Study	Tampa Study	East Bay Study	Average	Value used for Arkansas
Faucet use gallons/person/day (baseline)	9.2	9.4	10.5	9.7	9.7
Faucet use gallons/person/day (1.5 gpm)	8.0	6.2	10.5	8.2	8.2
Faucet use gallons/person/day (1.0 gpm)	--	--	--	--	7.2
Occupants per home	2.54	2.92	2.56	2.67	2.69
Faucets per home	--	--	--	--	3.86
Gal./yr./faucet (baseline)	--	--	--	--	2,467
Gal./yr./faucet (1.5 gpm)	--	--	--	--	2,086
Gal./yr./faucet (1.0 gpm)	--	--	--	--	1,831
Percent hot water	76%	Not listed	58%	69%	67%
Water gallons saved/yr./faucet (1.5 gpm)	--	--	--	--	381
Water gallons saved/yr./faucet (1.0 gpm)	--	--	--	--	636

Table B-34 Mixed Water Temperature Calculation

Weather Zone	Average Water Main Temperature (°F)	Percent Hot Water	Mixed Water Temperature (°F)
9 Fayetteville	65.6	66.9%	102.0
8 Fort Smith	66.1	66.9%	102.2
7 Little Rock	67.8	66.9%	102.7
6 El Dorado	70.1	66.9%	103.5
Average for Arkansas (T_{mixed})			102.6

Calculation of Deemed Savings

The following equations are referenced from the AR TRM v8.0 Volume II and are used to calculate deemed kWh and kW savings for faucet aerators:

$$Annual\ Energy\ Savings = \frac{\rho \times C_p \times V \times (T_{Mixed} - T_{Supply}) \times \left(\frac{1}{RE}\right)}{Conversion\ Factor}$$

Where,

ρ = Water density = 8.33 lb/gal

C_p = Specific heat of water = 1 BTU/lb·°F

V = gallons of water saved per year per faucet

T_{Mixed} = Mixed water temperature, 102.6°F

T_{Supply} = Average supply water temperature

RE = Recovery Efficiency; if unknown, use 0.98 as a default for electric resistance water heaters, 2.2 for heat pump water heaters, or 0.79 for natural gas water heaters

$Conversion\ Factor$ = 3,412 Btu/kWh for electric water heating or 100,000 Btu/Therm for gas water heating

For homes with electric water heating, demand savings is calculated using the following formula:

$$kW_{savings} = kWh_{savings} \times \frac{Ratio\ Peak\ kW}{Annual\ kWh}$$

Where,

$$\frac{Ratio\ Peak\ kW}{Annual\ kWh} = 0.000104$$

B.2.2 Residential Low-Flow Showerheads

The residential low-flow showerhead savings are calculated using the values and equations from AR TRM v8.0 Volume II low-flow showerheads, Section 2.3.5. The EUL assigned to residential low-flow showerheads is 10 years.

Table B-35 summarizes AR TRM v8.0 Volume II low-flow showerhead baseline and efficiency standards. Table B-36 summarizes AR TRM v8.0 Volume II average water main temperature by weather zone.

Table B-37 summarizes AR TRM v8.0 Volume II estimated showerhead hot water usage reduction. Table B-38 summarizes AR TRM v8.0 Volume II mixed water temperature calculation.

Table B-35 Low-Flow Showerhead – Baseline and Efficiency Standards

Measure	New Showerhead Flow Rate (gpm)	Existing Showerhead Baseline Flow Rate (gpm)
2.0 gpm showerhead	2.0	2.5
1.75 gpm showerhead	1.75	2.5
1.5 gpm showerhead	1.5	2.5

Table B-36 Average Water Main Temperature by Weather Zone

Weather Zone	Average Water Main Temperature (°F)
9 Fayetteville	65.6
8 Fort Smith	66.1
7 Little Rock	67.8
6 El Dorado	70.1

Table B-37 Estimated Showerhead Hot Water Usage Reduction

Assumption Type	Seattle Study	Tampa Study	East Bay Study	Average	Value used for Arkansas
Gallons/shower @ 2.5 gpm (baseline)	19.8	20.0	22.3	20.7	20.7
Gallons/shower @ 2.0 gpm	15.8	16.0	17.8	16.5	16.5
Gallons/shower @ 1.5 gpm	11.9	12.0	13.4	12.4	12.4
Showers/person/day (baseline)	0.51	0.92	0.65	0.69	0.69
Showers/person/day (post)	0.59	0.82	0.74	0.72	0.72
Occupants per home ¹⁸¹	2.54	2.92	2.56	2.67	2.69
Showers per home ¹⁸²	not listed	not listed	not listed	not listed	1.62
Water gal./yr./showerhead @ 2.0 gpm saved	not listed	not listed	not listed	not listed	1,457
Water gal./yr./showerhead @ 1.75 gpm saved	not listed	not listed	not listed	not listed	2,351
Water gal./yr./showerhead @ 1.5 gpm saved	not listed	not listed	not listed	not listed	3,246
Percent hot water	74%	not listed	66%	70%	70%

Table B-38 Mixed Water Temperature Calculation

Weather Zone	Average Water Main Temperature (°F)	Percent Hot Water	Mixed Water Temperature (°F)
9 Fayetteville	65.6	70%	103.7
8 Fort Smith	66.1	70%	103.9
7 Little Rock	67.8	70%	104.4
6 El Dorado	70.1	70%	105.1
Average for Arkansas (TMixed)			104.3

Calculation of Deemed Savings

Low-flow showerhead deemed savings are calculated using the following formula from the AR TRM v8.0 Volume II:

$$\text{Annual Energy Savings} = \frac{\rho \times C_p \times V \times (T_{Mixed} - T_{Supply}) \times \left(\frac{1}{RE}\right)}{\text{Conversion Factor}}$$

Where:

ρ = Water density = 8.33 lb./gallon

C_p = Specific heat of water = 1 BTU/lb. °F

V = Showerhead gallons saved per year

T_{Mixed} = Mixed water temperature

T_{Supply} = Average supply water temperature (Water main temperature)

RE = Recovery Efficiency

$\text{Conversion Factor } r$ = 3,412 Btu/kWh for electric water heating or 100,000 Btu/Therm for gas water heating.

B.2.3 Residential Duct Sealing

The residential duct sealing savings are calculated using the values and equations from AR TRM v8.0 Volume II Duct Sealing, Section 2.1.11. The EUL assigned to duct sealing is 18 years. Table B-39 and Table B-40 summarizes AR TRM v8.0 Volume II values for calculating energy savings for duct sealing.

Table B-39 Enthalpy at Design Conditions

Weather Zone	Location	h_{out}	h_{in}
9	Rogers	39	30
8	Fort Smith	39	29
7	Little Rock	40	30
6	El Dorado	40	30

Table B-40 Equivalent Full Load Hours for Heating and Cooling

Weather Zone	$EFLH_C$	$EFLH_H$
9 Rogers	1,305	1,868
8 Fort Smith	1,432	1,738
7 Little Rock	1,583	1,681
6 El Dorado	1,738	1,521

Calculation of Deemed Savings

Gross annual energy savings for incentivized duct sealing with electric cooling are calculated using the equation from the AR TRM v8.0 Volume II.

$$kWh_{savings,C} = \frac{(DL_{pre} - DL_{post}) \times EFLH_C \times (h_{out}\rho_{out} - h_{in}\rho_{in}) \times 60}{1,000 \times SEER}$$

Where:

DL_{pre} = Pre-improvement duct leakage at 25 Pa (ft³/min)

DL_{post} = Post-improvement duct leakage at 25 Pa (ft³/min)

$EFLH_C$ = Equivalent full load cooling hours

HDD = Heating degree days

h_{out} = Outdoor design enthalpy (Btu/lb)

h_{in} = Indoor design enthalpy (Btu/lb)

ρ_{in} = Density of outdoor air at 95°F = 0.0740 (lb/ft³)

ρ_{out} = Density of conditioned air at 75°F = 0.0756 (lb/ft³)

1,000 = Constant to convert from W to kW

$SEER$ = Seasonal Energy Efficiency Ratio of existing system (Btu/W·hr) = 11.5 (default)

Gross annual energy savings for incentivized duct sealing with heat pump are calculated using the equation from the AR TRM v8.0 Volume II.

$$kWh_{savings,H} = \frac{(DL_{pre} - DL_{post}) \times 60 \times HDD \times 24 \times 0.018}{1,000 \times HSPF}$$

Where:

DL_{pre} = Pre-improvement duct leakage at 25 pa (ft³/min)

DL_{post} = Post-improvement duct leakage at 25 Pa (ft³/min)

$EFLH_H$ = Equivalent full load heating hours

60 = Constant to convert from minutes to hours

HDD = Heating Degree Days

24 = Constant to convert from days to hours

0.018 = Volumetric heat capacity of air (Btu/ft³°F)

CAP = Heating capacity (Btu/hr)

1,000 = Constant to convert from W to kW

$HSPF$ = Heating Seasonal Performance Factor of existing system (Btu/W·hr) = 7.30 (default)

Gross annual energy savings for incentivized duct sealing with electric resistance are calculated using the equation from the AR TRM v8.0 Volume II.

$$kWh_{savings,H} = \frac{(DL_{pre} - DL_{post}) \times 60 \times HDD \times 24 \times 0.018}{3,412}$$

Where:

3,412 = Constant to convert from Btu to kWh

Gross annual cooling demand savings for incentivized duct sealing are calculated using the equation from the AR TRM v8.0 Volume II.

$$kW_{savings,C} = \frac{kWh_{savings,C}}{EFLH_C} \times CF$$

Where:

- $kWh_{savings,C}$ = Calculated kWh savings for cooling
- $EFLH_C$ = Equivalent full load cooling hours
- CF = Coincidence factor = 0.87

B.2.4 Residential Ceiling Insulation

The residential ceiling insulation savings are calculated using the values and equations from AR TRM v8.0 Volume II Ceiling Insulation, Section 2.2.2. The EUL assigned to ceiling insulation is 20 years.

The values in the following tables (Table B-41 through Table B-48, summarized from the AR TRM v8.0 Volume II) are used to calculate ceiling insulation deemed savings values for each weather zone by multiplying the value by the square footage of the ceiling area over a conditioned space that is being insulated.

Table B-41 Ceiling Insulation (R-38) – Deemed Savings Values – Zone 9 Northwest Region

Ceiling Insulation Base R-value	AC/Gas Heat kWh (/ sq. ft.)	Gas Heat (no AC) kWh (/ sq. ft.)	Gas Heat Therms (/ sq. ft.)	AC/Electric Resistance kWh (/ sq. ft.)	Heat Pump kWh (/ sq. ft.)	AC Peak Savings (kW) (/ sq. ft.)	Peak Gas Savings (therms) (/ sq. ft.)
≤ 1	1.716	0.254	0.342	9.366	5.071	0.00140	0.00541
> 1 and ≤ 5	0.969	0.141	0.189	5.212	2.764	0.00080	0.00283
> 5 and ≤ 8	0.586	0.084	0.114	3.136	1.653	0.00050	0.00164
> 8 and ≤ 15	0.364	0.052	0.070	1.926	1.013	0.00032	0.00100
> 15 and ≤ 22	0.172	0.025	0.034	0.931	0.486	0.00014	0.00047

Table B-42 Ceiling Insulation (R-38) – Deemed Savings Values – Zone 8 Northeast/North Central Region

Ceiling Insulation Base R-value	AC/Gas Heat kWh	Gas Heat (no AC) kWh	Gas Heat Therms	AC/Electric Resistance kWh	Heat Pump kWh	AC Peak Savings (kW)	Peak Gas Savings (therms)
	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)
≤ 1	1.8642	0.2203	0.3060	8.734	4.572	0.00107	0.00539
> 1 and ≤ 5	1.0497	0.1215	0.1687	4.846	2.495	0.00061	0.00284
> 5 and ≤ 8	0.6330	0.0728	0.1011	2.909	1.495	0.00038	0.00165
> 8 and ≤ 15	0.3909	0.0446	0.0618	1.784	0.917	0.00025	0.00099
> 15 and ≤ 22	0.1847	0.0216	0.0299	0.858	0.439	0.00011	0.00048

Table B-43 Ceiling Insulation (R-38) – Deemed Savings Values – Zone 7 Central Region

Ceiling Insulation Base R-value	AC/Gas Heat kWh	Gas Heat (no AC) kWh	Gas Heat Therms	AC/Electric Resistance kWh	Heat Pump kWh	AC Peak Savings (kW)	Peak Gas Savings (therms)
	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)
≤ 1	1.8820	0.1933	0.2700	7.936	4.067	0.00201	0.00482
> 1 and ≤ 5	1.0505	0.1070	0.1495	4.401	2.252	0.00118	0.00254
> 5 and ≤ 8	0.6315	0.0643	0.0898	2.643	1.355	0.00073	0.00149
> 8 and ≤ 15	0.3901	0.0394	0.0551	1.624	0.834	0.00047	0.00090
> 15 and ≤ 22	0.1854	0.0190	0.0266	0.781	0.400	0.00022	0.00043

Table B-44 Ceiling Insulation (R-38) – Deemed Savings Values – Zone 6 South Region

Ceiling Insulation Base R-value	AC/Gas Heat kWh	Gas Heat (no AC) kWh	Gas Heat Therms	AC/Electric Resistance kWh	Heat Pump kWh	AC Peak Savings (kW)	Peak Gas Savings (therms)
	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)
≤ 1	2.1230	0.1703	0.2378	7.482	3.873	0.00203	0.00440
> 1 and ≤ 5	1.1967	0.0954	0.1331	4.200	2.180	0.00118	0.00235
> 5 and ≤ 8	0.7242	0.0578	0.0806	2.545	1.324	0.00073	0.00137
> 8 and ≤ 15	0.4497	0.0356	0.0497	1.574	0.820	0.00047	0.00082
> 15 and ≤ 22	0.2116	0.0172	0.0240	0.753	0.391	0.00021	0.00040

Table B-45 Ceiling Insulation (R-49) – Deemed Savings Values – Zone 9 Northwest Region

Ceiling Insulation Base R-value	AC/Gas Heat kWh	Gas Heat (no AC) kWh	Gas Heat Therms	AC/Electric Resistance kWh	Heat Pump kWh	AC Peak Savings (kW)	Peak Gas Savings (therms)
	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)
≤ 1	1.756	0.260	0.350	9.578	5.182	0.00143	0.00581
> 1 and ≤ 5	1.009	0.146	0.197	5.424	2.876	0.00084	0.00310
> 5 and ≤ 8	0.626	0.090	0.121	3.348	1.764	0.00053	0.00185
> 8 and ≤ 15	0.404	0.057	0.077	2.139	1.124	0.00036	0.00116
> 15 and ≤ 22	0.212	0.031	0.041	1.143	0.597	0.00018	0.00061

Table B-46 Ceiling Insulation (R-49) – Deemed Savings Values – Zone 8 Northeast/North Central Region

Ceiling Insulation Base R-value	AC/Gas Heat kWh	Gas Heat (no AC) kWh	Gas Heat Therms	AC/Electric Resistance kWh	Heat Pump kWh	AC Peak Savings (kW)	Peak Gas Savings (therms)
	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)
≤ 1	1.907	0.225	0.313	8.931	4.673	0.00109	0.00550
> 1 and ≤ 5	1.093	0.126	0.176	5.043	2.596	0.00064	0.00295
> 5 and ≤ 8	0.676	0.077	0.108	3.105	1.596	0.00040	0.00176
> 9 and ≤ 14	0.434	0.049	0.069	1.981	1.018	0.00027	0.00110
> 15 and ≤ 22	0.228	0.026	0.037	1.055	0.539	0.00013	0.00058

Table B-47 Ceiling Insulation (R-39) – Deemed Savings Values – Zone 7 Central Region

Ceiling Insulation Base R-value	AC/Gas Heat kWh	Gas Heat (no AC) kWh	Gas Heat Therms	AC/Electric Resistance kWh	Heat Pump kWh	AC Peak Savings (kW)	Peak Gas Savings (therms)
	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)
≤ 1	1.925	0.198	0.276	8.115	4.159	0.00207	0.00492
> 1 and ≤ 5	1.093	0.111	0.156	4.581	2.344	0.00124	0.00264
> 5 and ≤ 8	0.674	0.069	0.096	2.822	1.447	0.00079	0.00159
> 9 and ≤ 14	0.433	0.044	0.061	1.803	0.926	0.00053	0.00100
> 15 and ≤ 22	0.228	0.023	0.033	0.960	0.492	0.00027	0.00053

Table B-48 Ceiling Insulation (R-49) – Deemed Savings Values – Zone 6 South Region

Ceiling Insulation Base R-value	AC/Gas Heat kWh	Gas Heat (no AC) kWh	Gas Heat Therms	AC/Electric Resistance kWh	Heat Pump kWh	AC Peak Savings (kW)	Peak Gas Savings (therms)
	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)	(/ sq. ft.)
≤ 1	2.173	0.174	0.243	7.657	3.964	0.00208	0.00449
> 1 and ≤ 5	1.247	0.099	0.139	4.375	2.271	0.00123	0.00244
> 5 and ≤ 8	0.774	0.061	0.086	2.719	1.415	0.00078	0.00146
> 9 and ≤ 14	0.500	0.039	0.055	1.748	0.911	0.00053	0.00090
> 15 and ≤ 22	0.262	0.021	0.030	0.928	0.482	0.00027	0.00048

B.2.5 Residential Air Infiltration

The residential air infiltration savings are calculated using the values and equations from AR TRM v8.0 Volume II Air Infiltration, Section 2.2.9. The EUL assigned to air infiltration measure is 11 years.

Calculation of Deemed Savings

Gross annual energy savings for discounted air infiltration are calculated using the deemed savings equations from the AR TRM v8.0 Volume II:

$$kWh_{savings} = CFM_{50} \times ESF$$

$$kW_{savings} = CFM_{50} \times DSF$$

Where,

*CFM*₅₀ = Air infiltration reduction in Cubic Feet per Minute at 50 pascals, as measured by the difference between pre- and post-installation blower door air leakage tests

ESF = corresponding energy savings factor

DSF = corresponding demand savings factor

The equations above are calculated using deemed savings values from Table B-49 and Table B-52, summarized from the AR TRM v8.0 Volume II.

Table B-49 Air Infiltration Reduction – Deemed Savings Values – Zone 9 Northwest Region

Equipment Type	kWh Savings / CFM (ESF)	kW Savings / CFM (DSF)
Electric AC with Gas Heat	0.166	0.000098
Gas Heat Only (no AC)	0.073	n/a
Elec. AC with Resistance Heat	2.344	0.000098
Heat Pump	1.099	0.000098

Table B-50 Air Infiltration Reduction – Deemed Savings Values – Zone 8 Northeast/North Central Region

Equipment Type	kWh Savings / CFM (ESF)	kW Savings / CFM (DSF)
Electric AC with Gas Heat	0.188	0.00014
Gas Heat Only (no AC)	0.062	n/a
Elec. AC with Resistance Heat	2.079	0.00014
Heat Pump	0.942	0.00014

Table B-51 Air Infiltration Reduction – Deemed Savings Values – Zone 7 Central Region

Equipment Type	kWh Savings / CFM (ESF)	kW Savings / CFM (DSF)
Electric AC with Gas Heat	0.190	0.00016
Gas Heat Only (no AC)	0.053	n/a
Elec. AC with Resistance Heat	1.812	0.00016
Heat Pump	0.818	0.00016

Table B-52 Air Infiltration Reduction – Deemed Savings Values – Zone 7 South Region

Equipment Type	kWh Savings / CFM (ESF)	kW Savings / CFM (DSF)
Electric AC with Gas Heat	0.255	0.00017
Gas Heat Only (no AC)	0.046	n/a
Elec. AC with Resistance Heat	1.641	0.00017
Heat Pump	0.756	0.00017

B.2.6 Residential Wall Insulation

The residential wall insulation savings are calculated using the values and equations from AR TRM v8.0 Volume II wall insulation, Section 2.2.3. The EUL assigned to wall insulation measures is 20 years. The AR TRM v8.0 Volume II contains a deemed savings value for calculating the average kWh savings from wall insulation using a factor based on HVAC type and insulation R-value (R-13 to R-23). The savings per square foot is a factor to be multiplied by the square footage of the net wall area insulated. The deemed savings values from AR TRM v8.0 Volume II are in Table B-53 to Table B-56 below for each weather zone.

Table B-53 Wall Insulation – Deemed Savings Values – Zone 9 Northwest Region

Equipment Type	kWh Savings / sq. ft.		kW Peak Savings / sq. ft.	
	R-13	R-23	R-13	R-23
Electric Cooling with Gas Heat	0.527	0.563	0.00041	0.00048
Gas Heat (No AC)	0.206	0.226	n/a	
Electric Cooling with Electric Resistance Heat	6.644	7.324	0.00041	0.00048
Electric Cooling with Electric Heat Pump	3.424	3.447	0.00041	0.00048

Table B-54 Wall Insulation – Deemed Savings Values – Zone 8 Northeast/North Central Region

Equipment Type	kWh Savings / sq. ft.		kW Peak Savings / sq. ft.	
	R-13	R-23	R-13	R-23
Electric Cooling with Gas Heat	0.586	0.625	0.00027	0.00029
Gas Heat (No AC)	0.179	0.197	n/a	
Electric Cooling with Electric Resistance Heat	6.059	6.689	0.00027	0.00029
Electric Cooling with Electric Heat Pump	2.946	2.980	0.00023	0.00025

Table B-55 Wall Insulation – Deemed Savings Values – Zone 7 Central Region

Equipment Type	kWh Savings / sq. ft.		kW Peak Savings / sq. ft.	
	R-13	R-23	R-13	R-23
Electric Cooling with Gas Heat	0.570	0.607	0.00047	0.00071
Gas Heat (No AC)	0.156	0.173	n/a	
Electric Cooling with Electric Resistance Heat	5.315	5.900	0.00047	0.00072
Electric Cooling with Electric Heat Pump	2.479	2.592	0.00047	0.00061

Table B-56 Wall Insulation – Deemed Savings Values – Zone 6 South Region

Equipment Type	kWh Savings / sq. ft.		kW Peak Savings / sq. ft.	
	R-13	R-23	R-13	R-23
Electric Cooling with Gas Heat	0.712	0.751	0.00046	0.00084
Gas Heat (No AC)	0.134	0.151	n/a	
Electric Cooling with Electric Resistance Heat	4.798	5.389	0.00046	0.00084
Electric Cooling with Electric Heat Pump	2.223	2.388	0.00046	0.00071

B.2.7 Floor Insulation

The residential floor insulation measure savings are calculated using the values and equations from AR TRM v8.0 Volume II Section 2.2.4. This measure applies to the retrofitting of a crawl space underneath an uninsulated floor. The baseline is considered to be a house with pier and beam construction, no insulation under the floor of the conditioned space, and a vented crawl space. In order to qualify for deemed savings, either the floor can be insulated to a minimum of R-19 or the crawl space can be encapsulated. The EUL assigned to this measure is 20 years.

Calculation of Deemed Savings

The deemed savings values summarized below from the AR TRM v8.0 Volume II are per square foot of first level floor area above the crawl space. The savings for this measure is calculated by multiplying the area of the first level floor above the crawl space with the values in the tables below.

Table B-57 R-19 Floor Insulation – Deemed Savings Values – Zone 9 Northwest Region

Equipment Type	kWh Savings/sqft	kW Savings/sqft
Electric AC with Gas Heat	-0.139	-0.000031
Gas Heat Only (no AC)	0.044	n/a
Electric AC with Electric Resistance Heat	1.192	-0.000031
Electric AC with Heat Pump	0.442	-0.000031

Table B-58 R-19 Floor Insulation – Deemed Savings Values – Zone 8 Northeast/North Central Region

Equipment Type	kWh Savings/sqft	kW Savings/sqft
Electric AC with Gas Heat	-0.165	-0.00003
Gas Heat Only (no AC)	0.036	n/a
Electric AC with Electric Resistance Heat	0.985	-0.00003
Electric AC with Heat Pump	0.294	-0.00003

Table B-59 R-19 Floor Insulation – Deemed Savings Values – Zone 7 Central Region

Equipment Type	kWh Savings/sqft	kW Savings/sqft
Electric AC with Gas Heat	-0.159	-0.00002
Gas Heat Only (no AC)	0.031	n/a
Electric AC with Electric Resistance Heat	0.849	-0.00002
Electric AC with Heat Pump	0.237	-0.00002

Table B-60 R-19 Floor Insulation – Deemed Savings Values – Zone 6 South Region

Equipment Type	kWh Savings/sqft	kW Savings/sqft
Electric AC with Gas Heat	-0.101	0.00003
Gas Heat Only (no AC)	0.026	n/a
Electric AC with Electric Resistance Heat	0.706	0.00003
Electric AC with Heat Pump	0.181	0.00003

Table B-61 Crawlspace Encapsulation – Deemed Savings Values – Zone 9 Northwest Region

Equipment Type	kWh Savings/sqft	kW Savings/sqft
Electric AC with Gas Heat	0.031	-0.00003
Gas Heat Only (no AC)	0.062	n/a
Electric AC with Electric Resistance Heat	1.922	-0.00003
Electric AC with Heat Pump	0.625	-0.00003

Table B-62 Crawlspace Encapsulation – Deemed Savings Values – Zone 8
 Northeast/North Central Region

Equipment Type	kWh Savings/sqft	kW Savings/sqft
Electric AC with Gas Heat	0.017	-0.00002
Gas Heat Only (no AC)	0.054	n/a
Electric AC with Electric Resistance Heat	1.647	-0.00002
Electric AC with Heat Pump	0.448	-0.00002

Table B-63 Crawlspace Encapsulation – Deemed Savings Values – Zone 7 Central Region

Equipment Type	kWh Savings/sqft	kW Savings/sqft
Electric AC with Gas Heat	0.011	-0.00005
Gas Heat Only (no AC)	0.048	n/a
Electric AC with Electric Resistance Heat	1.432	-0.00005
Electric AC with Heat Pump	0.397	-0.00005

Table B-64 Crawlspace Encapsulation – Deemed Savings Values – Zone 6 South Region

Equipment Type	kWh Savings/sqft	kW Savings/sqft
Electric AC with Gas Heat	0.122	-0.00003
Gas Heat Only (no AC)	0.045	n/a
Electric AC with Electric Resistance Heat	1.353	-0.00003
Electric AC with Heat Pump	0.401	-0.00003

B.2.8 Central Air Conditioner and Heat Pump Tune-Up

The residential central air conditioner and heat pump tune-up savings are calculated using the values and equations from AR TRM v8.0 Volume II Section 2.1.5. This measure applies to central air conditioners and heat pumps. An AC tune-up, in general terms, involves checking, adjusting and resetting the equipment to factory conditions, such that it operates closer to the performance level of a new unit. This measure applies to all residential applications. The EUL assigned to this measure is 10 years.

Calculation of Deemed Savings

Deemed peak demand and annual energy savings for unitary AC/HP tune-up is calculated using the following formulas from AR TRM v8.0 Volume II.

$$kW_{savings} = CAP_c \times \frac{1 \text{ kW}}{1,000 \text{ W}} \times \left(\frac{1}{EER_{pre}} - \frac{1}{EER_{post}} \right) \times CF$$

$$kW_{savings,C} = CAP_C \times \frac{1 \text{ kW}}{1,000 \text{ W}} \times EFLH_C \times \left(\frac{1}{EER_{pre}} - \frac{1}{EER_{post}} \right)$$

$$kW_{savings,H} = CAP_H \times \frac{1 \text{ kW}}{1,000 \text{ W}} \times EFLH_H \times \left(\frac{1}{HSPF_{pre}} - \frac{1}{HSPF_{post}} \right)$$

$$kW_{savings,AC} = kW_{savings,C}$$

$$kW_{savings,HP} = kW_{savings,C} + kW_{savings,H}$$

Where,

CAP_C = Rated or calculated equipment cooling capacity (BTU/hr)

CAP_H = Rated or calculated equipment heating capacity (BTU/hr)

EER_{pre} = Calculated or measured efficiency of the equipment for cooling before tune-

up

EER_{post} = Nameplate, Measured or calculated efficiency of the existing equipment for cooling; if unknown, use 11.2 EER

$HSPF_{pre}$ = Calculated or measured efficiency of the equipment for heating before tune-up

$HSPF_{post}$ = Nameplate, measured or calculated efficiency of the existing equipment for heating; if unknown, use 7.7 HSPF

CF = Coincidence Factor = 0.87

$EFLH_C$ = Equivalent full-load cooling hours (Table B-65)

$EFLH_H$ = Equivalent full-load heating hours (Table B-65)

The following table summarizes the EFLH values used in the equations above.

Table B-65 Equivalent Full-Load Cooling/Heating Hours

Weather Zone		EFLHc	EFLHh
9	Fayetteville	1,305	1,868
8	Fort Smith	1,432	1,738
7	Little Rock	1,583	1,681
6	El Dorado	1,738	1,521

B.2.9 Central Air Conditioner Replacement

The residential central air conditioner replacement savings are calculated using the values and equations from AR TRM v8.0 Volume II Section 2.1.6. This measure involves a residential retrofit with a new central air conditioning system for the installation of a new central air conditioning system in a residential new construction (packaged unit, or split system consisting of an indoor unit with a matching remote condensing unit). The EUL assigned to this measure is 19 years.

The following table summarizes the AR TRM v8.0 Volume II baseline and efficiency standards for this measure.

Table B-66 Central Air Conditioner Replacement – Baseline and Efficiency Standards

Project Type	Baseline Before 1/23/2006	Baseline After 1/23/2006	Baseline As of 1/1/2015
New Construction	13 SEER		14 SEER
Replace-on-Burnout	11.2 EER		11.8 EER
Early Retirement	10 SEER (Split) 9.7 SEER (Packaged) 9.2 EER		13 SEER 11.2 EER

Calculation of Deemed Savings

Deemed peak demand and annual energy savings for AC replacement is calculated using the following formulas from AR TRM v8.0 Volume II.

Replace-on-Burnout

$$kW_{savings} = CAP_C \times \frac{1 \text{ kW}}{1,000 \text{ W}} \times \left(\frac{1}{EER_{base}} - \frac{1}{EER_{post}} \right) \times CF$$

$$kW_{savings,C} = CAP_C \times \frac{1 \text{ kW}}{1,000 \text{ W}} \times EFLH_C \times \left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{post}} \right)$$

Where,

CAP_C = Rated or calculated equipment cooling capacity (BTU/hr)

EER_{base} = Calculated or measured efficiency of the equipment for cooling before tune-up

EER_{post} = Nameplate, Measured or calculated efficiency of the existing equipment for cooling; if unknown, use 11.2 EER

$SEER_{base}$ = Seasonal energy efficiency rating of the baseline equipment for cooling (Table B-66)

$SEER_{post}$ = Nameplate seasonal energy efficiency rating of the existing equipment for cooling (at least equal to the value from

Table B-66)

CF = Coincidence Factor = 0.87 (default)

$EFLH_C$ = Equivalent full-load cooling hours (Table B-65)

$EFLH_H$ = Equivalent full-load heating hours (Table B-65)

Early Retirement

Annual kWh and kW savings must be calculated separately for two time periods

1. The estimated remaining life of the equipment that is being removed, designated the remaining useful life (RUL), and
2. The remaining time in the EUL period (19 – RUL)

For the RUL (Table B-67):

$$kW_{savings} = CAP_C \times \frac{1 \text{ kW}}{1,000 \text{ W}} \times \left(\frac{1}{EER_{base}} - \frac{1}{EER_{post}} \right) \times CF$$

$$kW_{savings,C} = CAP_C \times \frac{1 \text{ kW}}{1,000 \text{ W}} \times EFLH_C \times \left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{post}} \right)$$

Lifetime kWh savings for Early Retirement Projects is calculated as follows:

$$Lifetime \text{ kWh}_{savings} = (kWh_{savings,ER} \times RUL) + [kWh_{savings,ROB} \times (EUL - RUL)]$$

Where,

ROB = Replace-on-Burnout

ER = Early Retirement

CAP_C = Rated or calculated equipment cooling capacity (BTU/hr)

EER_{base} = Calculated or measured efficiency of the equipment for cooling before tune-up

EER_{post} = Nameplate measured or calculated efficiency of the existing equipment for cooling; if unknown, use 11.2 EER

SEER_{base} = Seasonal energy efficiency rating of the baseline equipment for cooling (Table B-66)

SEER_{post} = Nameplate seasonal energy efficiency rating of the existing equipment for cooling (at least equal to the value from

Table B-66)

EFLH_C = Equivalent full-load cooling hours (

Table B-65)

RUL = Remaining Useful Life (Table B-67)

EUL = Estimated Useful Life = 19 years

Table B-67 Remaining Useful Life (RUL) of Replaced Systems

Age of Replaced System (Years)	RUL (Years)
2	15.8
3	14.9
4	14.1
5	13.3
6	12.6
7	11.9
8	11.3
9	10.8
10	10.3
11	9.8
12	9.4
13	9.0
14	8.6
15	8.2
16	7.9
17	7.6
18	7.3
19	7.1
20	6.8
21	6.8
22	6.4
23	6.2
24	6.0
25	5.8
26+	0

B.2.10 Residential Lighting

The residential efficient lighting savings are calculated using the values and equations from AR TRM v8.0 Volume II residential lighting, Section 2.5.1. Baseline wattages for LEDs are affected by the Energy Independence and Security Act (EISA) requirements that took effect in 2012, 2013 and 2014 shown in Table B-68.

Calculation of Deemed Savings

The kWh savings for LEDs will be calculated via the following formula:

$$LED \text{ kWh savings} = \left(\frac{W_{base} - W_{post}}{1000} \right) * ISR * Hours * IEF_E$$

Where:

W_{base} = Baseline lamp wattage of equivalent lumens; for directional (reflector) lamps, use the default baseline wattages (Column C) in Table 208 of the AR TRM v8.0 Volume II (exempt reflector lamps should use the manufacturer rated equivalent wattage as the

baseline)

W_{post} = Actual wattage of LED purchased/installed

$Hours = 792.6$ = Average hours of use per year

$ISR = 0.97$ = In Service Rate, or percentage of rebate units that get installed, to account for units purchased but not immediately installed

IEF_E = Interactive Effects Factor to account for cooling energy savings and heating energy penalties; this factor also applies to outdoor and unconditioned spaces

Table B-68 EISA Standards

Baselines Minimum Lumens	Baseline Maximum Lumens	Incandescent Equivalent 1st Tier EISA 2007 (Wbase)	Incandescent Equivalent 2nd Tier EISA 2007 (Wbase)	Effective dates for 2nd Tier EISA 2007 Baselines
310	749	29	12	1/1/2020
750	1,049	43	20	1/1/2020
1,050	1,489	53	28	1/1/2020
1,490	2,600	72	45	1/1/2020

Table B-69 Interactive Effects Factor for Cooling Energy Savings and Heating Energy Penalties

Heating Type	Interactive Effects Factor (IEFE)
Gas Heat with AC	1.10
Gas Heat with no AC	1.00
Electric Resistance Heat with AC	0.83
Electric Resistance Heat with no AC	0.73
Heat Pump	0.96
Heating/Cooling Unknown	0.97

Summer Peak Demand Savings

$$kW_{savings} = \left(\frac{(W_{base} - W_{post})}{1000} \right) \times CF \times ISR \times IEF_D$$

Where,

CF = Summer Peak Coincidence Factor for measure

IEF_D = Interactive Effects Factor to account for cooling demand savings and heating demand penalties; this factor also applies to outdoor and unconditioned spaces

Table B-70 Summer Peak Coincidence Factor

Lamp Location	CF
Indoor	10%
Outdoor	0%

Table B-71 Interactive Effects for Cooling Demand Savings and Heating Demand Penalties

Heating Type	Interactive Effects Factor (IEF _D)
Gas Heat with AC	1.29
Gas Heat with no AC	1.00
Electric Resistance Heat with AC	1.29
Electric Resistance Heat with no AC	1.00
Heat Pump	1.29
Heating/Cooling Unknown	1.25

Heating Penalty for Natural Gas Heated Homes

$$\text{Therms Penalty} = ((W_{base} - W_{post})/1000) \times \text{Hours} \times \text{ISR} \times \text{IEF}_G$$

Where:

IEF_G = Interactive Effects Factor to account for gas heating penalties (Δ therm/kWh); this factor also applies to outdoor and unconditioned spaces (Table B-72)

Table B-72 Interactive Effects Factor to account for Gas Heating Penalties

Heating Type	Interactive Effects Factor (IEF _G)
Gas Heat with AC	-0.011
Gas Heat with no AC	-0.011
Electric Resistance Heat with AC	0.00
Electric Resistance Heat with no AC	0.00
Heat Pump	0.00
Heating/Cooling Unknown	-0.0063

B.2.11 Advanced Power Strips

The residential advanced power strips measure savings are calculated using the values and equations from AR TRM v8.0 Volume II Section 2.4.4. Energy savings for smart strips are determined based on the end-use of the strip – either in a home office setting, a home entertainment setting, or some other use.

The determining factor of the end-use in a residence is what kind of an appliance is plugged into the ‘master’ outlet of the smart strip; the AR TRM v8.0 Volume II provides deemed savings values for televisions, personal computers or ‘other’ appliances plugged into the ‘master’ outlet. Deemed savings is shown in Table B-73.

Table B-73 Deemed Savings for Residential APS

Tier	System Type	kW Savings	kWh Savings
1	Home Entertainment	0.030	252.2
	Home Office	0.008	82.5
	Average APS	0.019	167.4
2	Entertainment Center	0.056	307.4
	Computer System	0.018	100.9
	Unspecified Usage	0.037	204.2

B.2.12 ENERGY STAR Smart Thermostat

The residential smart thermostat measure savings are calculated using the values and equations from AR TRM v8.0 Volume II Section 2.1.12. The Smart Thermostats measure involves the replacement of a manually operated or programmable thermostat with an ENERGY STAR certified smart programmable thermostat.

To qualify as a smart thermostat, the units installed, at a minimum, should have the following capabilities and installation parameters:

1. Successful connection to existing WIFI
2. Remote adjustment via smart phone or online
3. Automatic scheduling
4. Energy history
5. Occupancy sensing (set “on” as a default)

Other optional features include:

1. Early on function to allow desired set points to be met at onset of occupancy
2. Filter reminders
3. On screen indication when temperature is set to an energy saving value
4. For heat pumps, smart thermostat must be able to control heat pump to optimize energy use and minimize the use of backup electric resistance heat

Table B-74 provides the deemed savings for smart thermostats.

Table B-74 Deemed Savings Values per Square Foot of Conditioned Space

Baseline	% of pop.	Electric Cooling Energy Savings (kWh/SF)	Electric Resistance Heating Energy Savings (kWh/SF)	Electric HP Heating Energy Savings (kWh/SF)	Gas Heating Energy Savings (therm/SF)
Manual or manually operated T'stat	85%	0.450	0.845	0.395	0.037
Properly programmed Programmable T'stat	15%	0.113	0.212	0.099	0.009
Default		0.399	0.750	0.351	0.033

B.2.13 ENERGY STAR Windows

The residential ENERGY STAR windows measure savings are calculated using the values and equations from AR TRM v8.0 Volume II Section 2.2.7. This measure involves the replacement of windows with ENERGY STAR window(s) in an existing home. This measure applies to all residential applications. The EUL assigned to this measure is 20 years.

The installed windows must meet the minimum efficiency levels, provided in the table below.

Table B-75 ENERGY STAR Windows – Weather Zones

Baseline	Efficiency Levels			
All Zones	Weather Zone	ENERGY STAR Assigned Climate Zone	U-factor	SHGC
Single-pane clear glass aluminum frame no thermal break U-factor of 1.12 SHGC of 0.79 air infiltration rate of 0.7 cfm/sqft	Zone 9	North-Central	0.32	0.40
	Zone 8	South-Central	0.35	0.30
Double-glazed (i.e. double-pane) clear window aluminum frame U-factor of 0.81 SHGC of 0.64 air infiltration rate of 0.7 cfm/sqft	Zone 7	South-Central	0.35	0.30
	Zone 6	South-Central	0.35	0.30

The AR TRM v8.0 Volume II provides deemed savings values based on window type and weather zone, summarized below. Savings are calculated by multiplying the home’s conditioned space with the deemed savings value of kWh or kW savings per square foot.

Table B-76 ENERGY STAR Replacement for Single-Pane Window – Deemed Savings Values – Zone 9 Northwest Region

Equipment Type	kWh Savings/s qft	kW Savings/sqft
Electric AC with Gas Heat	4.884	0.0031
Gas Heat Only (no AC)	0.275	n/a
Elec AC with Resistance Heat	13.050	0.0031
Heat Pump	8.509	0.0031

Table B-77 ENERGY STAR Replacement for Single-Pane Window – Deemed Savings Values – Zone 8 Northeast/North Central Region

Equipment Type	kWh Savings/s qft	kW Savings/sqft
Electric AC with Gas Heat	5.800	0.0036
Gas Heat Only (no AC)	0.187	n/a
Elec AC with Resistance Heat	11.485	0.0036
Heat Pump	7.768	0.0036

Table B-78 ENERGY STAR Replacement for Single-Pane Window – Deemed Savings Values – Zone 7 Central Region

Equipment Type	kWh Savings/s qft	kW Savings/sqft
Electric AC with Gas Heat	5.889	0.0035
Gas Heat Only (no AC)	0.160	n/a
Elec AC with Resistance Heat	10.719	0.0035
Heat Pump	7.278	0.0035

Table B-79 ENERGY STAR Replacement for Single-Pane Window – Deemed Savings Values – Zone 6 South Region

Equipment Type	kWh Savings/s qft	kW Savings/sqft
Electric AC with Gas Heat	6.864	0.0037
Gas Heat Only (no AC)	0.127	n/a
Elec AC with Resistance Heat	10.771	0.0037
Heat Pump	7.526	0.0037

Table B-80 ENERGY STAR Replacement for Double-Pane Window – Deemed Savings Values – Zone 9 Northwest Region

Equipment Type	kWh Savings/s qft	kW Savings/sqft
Electric AC with Gas Heat	3.028	0.0019
Gas Heat Only (no AC)	0.243	n/a
Elec AC with Resistance Heat	10.241	0.0019
Heat Pump	6.303	0.0019

Table B-81 ENERGY STAR Replacement for Double-Pane Window – Deemed Savings Values – Zone 8 Northeast/North Central Region

Equipment Type	kWh Savings/sqft	kW Savings/sqft
Electric AC with Gas Heat	3.730	0.0037
Gas Heat Only (no AC)	0.156	n/a
Elec AC with Resistance Heat	8.476	0.0037
Heat Pump	5.484	0.0031

Table B-82 ENERGY STAR Replacement for Double-Pane Window – Deemed Savings Values – Zone 7 Central Region

Equipment Type	kWh Savings/sqft	kW Savings/sqft
Electric AC with Gas Heat	3.785	0.0036
Gas Heat Only (no AC)	0.134	n/a
Elec AC with Resistance Heat	7.820	0.0035
Heat Pump	5.072	0.0031

Table B-83 ENERGY STAR Replacement for Double-Pane Window – Deemed Savings Values – Zone 6 South Region

Equipment Type	kWh Savings/sqft	kW Savings/sqft
Electric AC with Gas Heat	4.449	0.0042
Gas Heat Only (no AC)	0.109	n/a
Elec AC with Resistance Heat	7.787	0.0042
Heat Pump	5.198	0.0035

B.2.14 ENERGY STAR Pool Pumps

The ENERGY STAR pool pumps measure savings are calculated using the values and equations from the AT TRM v8.0 Volume II Section 2.4.5. The section below describes the methodology for computing savings for this measure.

The baseline condition is a 0.5-3 horsepower (HP) standard efficiency single-speed pool pump. The high efficiency condition is a 0.5-3 HP ENERGY STAR certified variable speed or multispeed pool pump. The AR TRM v8.0 Volume II provides deemed savings values for this measure,

summarized below. The deemed savings for this measure were derived using the ENERGY STAR Pool Pump Savings Calculator.²⁷

Table B-84 ENERGY STAR Variable Speed Pool Pumps – Deemed Savings Values

Pump HP	kW Savings	kWh Savings
0.5	0.24	1,713
0.75	0.28	1,860
1	0.36	2,063
1.5	0.47	2,465
2	0.52	2,718
2.5	0.57	2,838
3	0.72	3,364

Table B-85 ENERGY STAR Multi-Speed Pool Pumps – Deemed Savings Values

Pump HP	kW Savings	kWh Savings
1	0.30	1,629
1.5	0.40	1,945
2	0.41	1,994
2.5	0.46	2,086
3	0.54	2,292

B.2.15 Residential Water Heater Jackets

The residential water heater jacket savings are calculated using the values and equations from AR TRM v8.0 Volume II Section 2.3.2. The EUL assigned to water heater jacket measures is 13 years. Gross annual energy savings for discounted water heater wraps/jackets are calculated using the deemed savings from TRM v8.0. The water heater jacket must be installed on storage water heaters having a capacity of 30 gallons or greater. Deemed savings are per installed jacket based on the jacket thickness, the type of water heating, and the tank size as shown the tables below.

Table B-86 Water Heater Jackets – Electric Heating Deemed Savings Values

Approximate Tank Size (gal)	Electric Water Heating					
	kWh Savings			kW Savings		
	40	52	80	40	52	80
2" WHJ savings kWh	68	76	101	0.005	0.006	0.008
3" WHJ savings kWh	94	104	139	0.007	0.008	0.011

²⁷ The ENERGY STAR Pool Pump Savings Calculator, updated February 2013, can be found on the ENERGY STAR website at: <https://www.energystar.gov/products/certified-products/detail/pool-pumps>.

Table B-87 Water Heater Jackets – Gas Heating Deemed Savings Values

Approximate Tank Size (gal)	Gas Water Heating					
	Therms Savings			Peak Therms		
	30	40	50	30	40	50
2" WHJ savings Therms	3.38	3.96	4.41	0.006	0.007	0.008
3" WHJ savings Therms	4.67	5.46	6.09	0.009	0.010	0.011

B.2.16 Residential Water Heater Pipe Insulation

The residential water heater pipe insulation savings are calculated using the values and equations from TRM v8.0 section 2.3.3. According to AR TRM v8.0 Volume II, the average lifetime of this measure is dependent on the type of water heater it is applied to. The following measure lifetimes should be applied:

- 13 years for electric storage water heating
- 11 years for gas storage water heating
- 10 years for heat pump water heaters

Gross annual energy savings for incentivized water heater pipe insulation are calculated using the following equation from AR TRM v8.0:

$$\begin{aligned}
 & \text{Annual Energy Savings} \\
 &= (U_{pre} - U_{post}) \times A \times (T_{Pipe} - T_{ambient}) \times \left(\frac{1}{RE}\right) \\
 &\times \frac{Hours_{Total}}{Conversion\ Factor}
 \end{aligned}$$

Where:

$$U_{pre} = 1/(2.03^{154}) = 0.49 \text{ BTU/h sq. ft. degree F}$$

$$U_{post} = 1/(2.03 + R_{insulation})$$

$R_{insulation}$ = R-value of installed insulation

A = Surface area in square feet (πDL) with L (length) and D pipe diameter in feet

T_{Pipe} (°F) = Average temperature of the pipe. Default value = 90 °F (average temperature of pipe between water heater and the wall)

$T_{ambient}$ (°F) use 78°F if installed in conditioned space

$Hours_{Total}$ = 8,760 hr. per year

RE = Recovery Efficiency (or in the case of HPWH, EF); if unknown, use 0.98 as a default for electric resistance water heaters, 0.79 for natural gas water heaters, or 2.2 for heat pump water heaters

$Conversion\ Factor$ = 3,412 Btu/kWh for electric water heating or 100,000 Btu/Therm for gas water heating.

The following tables summarize AR TRM v8.0 values used to calculate savings.

Table B-88 Average Ambient Temperature by Weather Zone

Weather Zone	Average Ambient Temperature (°F)
9 Fayetteville	59.6
8 Forth Smith	60.1
7 Little Rock	61.8
6 El Dorado	64.1

Table B-89 Maximum and Minimum Temperatures per Weather Zone

Weather Zone	Ambient Temperature (°F)			
	$T_{ambientMAX}(Electric)$		$T_{ambientMIN}(Gas)$	
	Conditioned Space	Unconditioned Basement	Conditioned Space	Unconditioned Space
9 Fayetteville	78	70	70	4.3
8 Fort Smith	78		70	13.5
7 Little Rock	78		70	12.1
6 El Dorado	78		70	27.8

Appendix C. Literature Review Outcomes

This appendix includes summaries of NTG literature reviews, organized by program and measure.

Residential Lighting

This literature review includes regionally-applicable net-to-gross results for residential lighting kit programs. The kits include a three-pack of LEDs.

Table C-1 Literature Review Results Residential Lighting

Reference Number	FR	SP	NTG	PY	State
1	0%	0%	100%	2017	OK
2	23%	0%	77%	2015	IN
3	29%	0%	71%	2013	IL
4	16%	0%	84%	2015 -2016	IL
Average	17%	0%	83%		
1. https://www.occeweb.com/PU/EnergyEfficiency/2017AnnualReportFinal_CenterPoint.pdf 2. https://www.indianamichiganpower.com/global/utilities/lib/docs/info/projects/IMDemandSideManagement/44841%20Jon%20C.%20Walter%20Direct%20Testimony%20&%20Attachments%20Vol%20II.pdf 3. http://ilsagfiles.org/SAG_files/Evaluation_Documents/Ameren/AIU%20Evaluation%20Reports%20EPY6/AIC_PY6_EEKits_Report_FINAL_2015-07-20.pdf 4. http://ilsagfiles.org/SAG_files/Evaluation_Documents/Nicor%20Gas/Nicor_Gas_GPY5_Evaluation_Reports/Nicor_Gas_GPY5_ESK_Evaluation_Report_2017-05-09_Final.pdf ; http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/Nicor_Gas_NTG_Summary_GPY1-5_2015-03-01_Final.pdf					

School Based Energy Education

This literature review includes regionally-applicable net-to-gross results for residential school kits programs. This kit includes 2 LED lamps, one kitchen faucet aerator, one low-flow showerhead, one toilet leak tablet, one nightlight, and one FilterTone® alarm. Although, only the LED, aerator, and showerhead measures claim savings in this program.

Table C-2 Literature Review Results for School Kits

Reference Number	FR	SP	NTG	PY	State
1	0%	0%	100%	2012	CO
2	0%	0%	100%	2013	NY
3	0%	0%	100%	2018	CO
4	0%	0%	100%	2009	OR
Average	0%	0%	100%		
1. https://www.xcelenergy.com/staticfiles/xe/Regulatory/Regulatory%20PDFs/CO-DSM/CO-2012-Energy-Savings-Kits-Final-Evaluation.pdf 2. https://www.coned.com/energyefficiency/PDF/Residential%20Direct%20Install%20Impact%20Evaluation%20Report.pdf 3. https://www.xcelenergy.com/staticfiles/xe-responsive/Company/Rates%20&%20Regulations/Regulatory%20Filings/School-Education-Kits-Evaluation.pdf 4. https://energytrust.org/library/reports/ETO_HES_Process_and_Impact_Report_Volume_1.pdf					

Literature reviews were utilized to determine NTG for school kits, which ideally include LED lamps, aerators and showerheads and are provided to elementary school students.

Table C-3 PY2020 Sources of Literature Review for School Kits

Utility	State	Year
Ameren Missouri	Missouri	2016
Duke Energy	North and South Carolina	2015
ComEd	Illinois	2017
I&M	Indiana	2016
Duke	Kentucky	2015
Energy New Orleans	Louisiana	2015

Table C-4 PY2020 Sources of Literature Review for School Kits

Program Measure	Number of Studies	Average Value
LED light bulbs	2	87%
Kitchen Faucet Aerators	6	98%

Commercial and Industrial

This literature review includes regionally-applicable net-to-gross results for commercial and industrial measures. This program includes custom and prescriptive lighting measures.

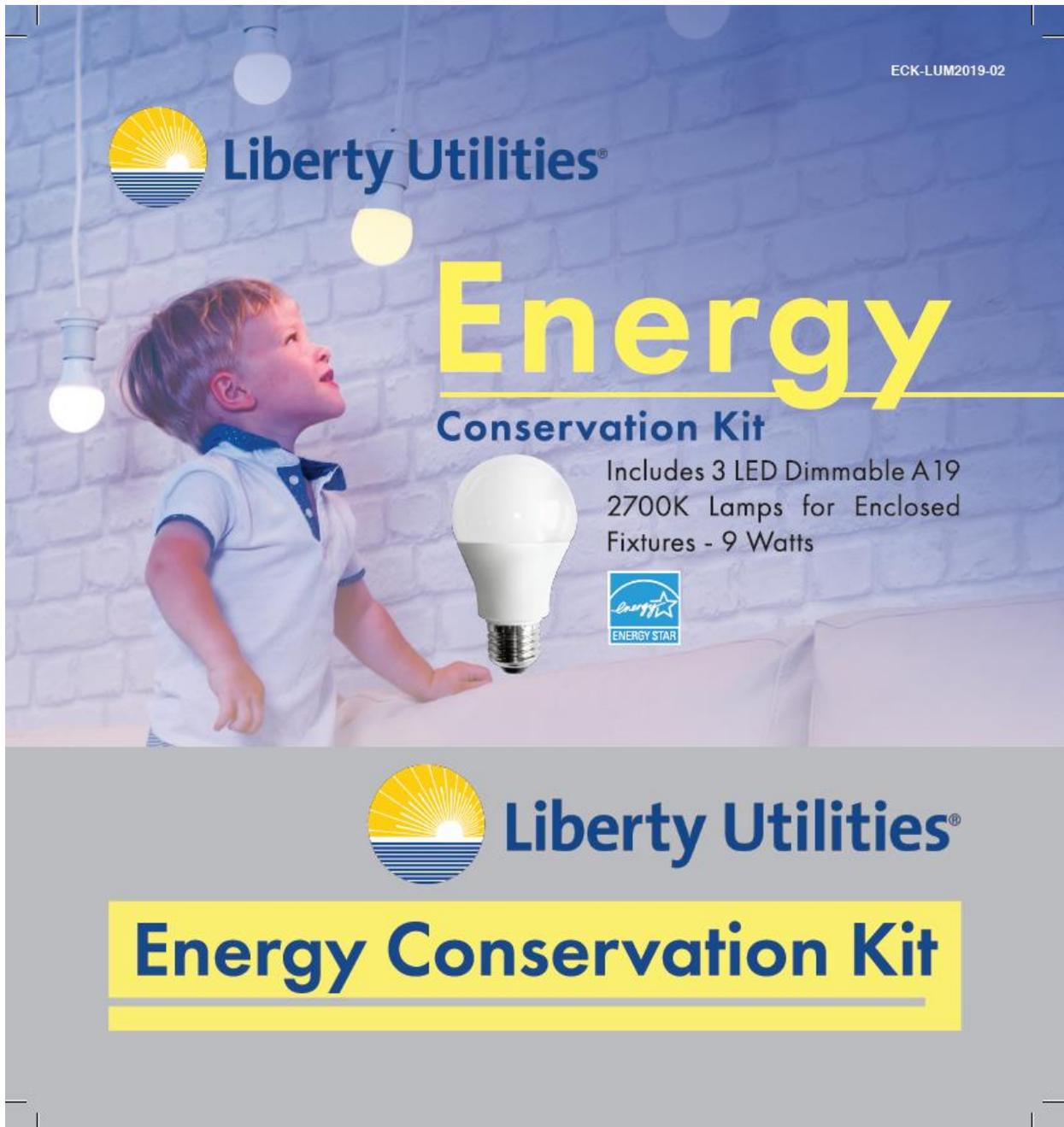
Table C-5 Literature Review Results for Commercial and Industrial rebate Program

Reference Number	FR	SP	NTG	PY	State
1	5%	0%	99%	2019	AR
Average	5%	0%	99%		

1. PY2020 SWEPCO AR Report, Commercial & Industrial Energy Efficiency Program, Net Savings Findings

Appendix D. Marketing Materials

In PY2020, Empire primarily used bill inserts for program marketing, as shown below.



CERTIFICATE OF SERVICE

This is to certify that the undersigned has served a copy of the foregoing instrument via email, to all parties of record on this 3rd day of May, 2021.

/s/ Angela Cloven

Angela Cloven