

Inclusive Utility Investment in Action: Utility Value of a Pay As You Save® Energy Efficiency Program

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ABSTRACT

Inclusive Utility Investment systems such as Pay As You Save® (PAYS®) make it financially feasible and attractive for utilities to capitalize residential energy upgrades to develop efficiency. PAYS is a tariffed on-bill system that couples site-specific utility investment in energy upgrades on the customer-side of the meter with site-specific cost recovery through a charge on the bill that is less than the estimated savings. This study analyzed weather normalized daily and hourly meter data from Roanoke Electric Cooperative's (REC) Upgrade to \$ave energy efficiency and electrification upgrade PAYS program. Weather normalized evaluation using AMI meter data with extrapolation to homes lacking modeled data revealed that the 655 upgrades are generating 1.8 million kWh/yr. of electricity and 655 kW/yr. of peak demand reduction with a net present value to the utility of \$1.84 million, with an internal rate of return of 6.8%. Program design reforms instituted half-way through the evaluated period increased average energy saving by 46% and average peak demand savings by 71%. In six years of operation the program has invested over \$4.95M and charged-off just \$10,000 (0.22%). Thus, even after considering the cost of capital and program operation costs, REC's Upgrade to \$ave investment portfolio is generating energy savings for its participants as well as economic benefits for the utility and all its non-participants and is expected to provide even greater benefits in the future. The results support the case for expanded use of Inclusive Utility Investment to fund resource efficiency and electrification at scale.

Introduction

This study reviews the full history and performance of REC Upgrade to \$ave Program, an Inclusive Utility Investment program using the Pay As You Save® (PAYS®) system from its inception through December 31, 2021. The analysis evaluates weather-normalized measured electricity reduction (kilowatt-hour, kWh), coincident peak demand reduction (kilowatt, kW) reduction, and extrapolates those savings to a utility net present value (NPV), and internal rate of return (IRR) for the entire portfolio. To date, there have been only two peer reviewed evaluations quantifying the value of a PAYS programs to the sponsoring utility that use meter data to calculate both average electricity and peak load savings from the upgraded locations (Bickel et al. 2020, Bickel et al. 2022). The first section of this paper lays out the history of the Upgrade to \$ave program and its evolution over time. The second section of the paper describes the methods used to analyze the program performance. The results section presents weather-normalized measured electricity reduction (kWh), co-incident peak demand reduction (kW) reduction, utility net present value, and internal rate of return using meter and program data from REC's Upgrade to \$ave energy efficiency and electrification upgrade program operated by EEntility. Energy and

peak demand savings analyses give special attention improvements program performance and value that occurred after the introduction of several new program operation procedures.

Among U.S. households, more than one-third do not own a home and 40% cannot cover a \$400 unexpected expense and so a significant portion of utility customers and member-owners are effectively disqualified from using loans and rebates to access whole home energy upgrades even when they would yield savings (Federal Reserve 2019). Globally, more than one third of adults are still unbanked, further deepening the complete exclusion of an entire segment of the world's population from participating in the clean energy economy (World Bank 2018).

For owner-occupied houses in the United States, there have typically been two paths for delivering whole home energy upgrades: 1) taxpayer or ratepayer funded weatherization programs that deliver at no-cost to low-income households, and 2) market rate programs for customers that bear the full cost of the upgrades after incorporating some form of incentives. The scale of the taxpayer and ratepayer funding for no-cost programs has never met the actual need (Carley and Konisky 2020). In the market rate programs offered with ratepayer funded incentives, most of the clean energy tax credits, rebate, and incentive dollars flow to wealthier customers, sometime for products they were going to purchase anyway, which effectively creates a regressive tax on lower-income tax and rate payers (Borenstein and Davis 2016).

More than half of U.S. households are either renters or not qualified for consumer credit criteria linked to loans, rendering them ineligible for subsidized energy efficiency loan programs. (US Census 2017, World Bank 2018).

Inclusive Utility Investment, as recognized by the U.S. Environmental Protection Agency (EPA), refers to programs structured as utility investments in building efficiency upgrades on the customer's side of the meter with a voluntary tariff that provides utility cost recovery with a site-specific charge assigned to the customer's location rather than to the individual customer (U.S. EPA 2021, Ferguson et al. 2022). These utility investments are governed by tariffs approved as an essential utility service by the utility's oversight body, and they are not consumer loans or leases. The investments are inclusive because the utility is assessing the energy savings potential of the building, rather than the owner's income, liquidity, or creditworthiness, to make investment decisions. As such, traditional financial barriers to participation are avoided, making building efficiency upgrades that produce net savings accessible to all customers without credit checks, upfront cost, or debt obligation. The tariff automatically applies to successor customers with notice, assuring accessibility to renters and owners with short tenancy. The utility recovers its cost through a cost recovery charge that is significantly less than the estimated annual savings from the upgrade. Participating customers enjoy a more comfortable and healthy home or building and, a lower energy bill from day one, assuming the patterns of building operation remain similar.

The original example of Inclusive Utility Investment is the PAYS system developed in 1999 by the Energy Efficiency Institute, Inc. of Vermont, a set of program design rules and strong consumer protections outlined in the PAYS Essential Elements and Minimum Program Requirements and iteratively improved through field experience (Cillo and Lachman 1999; EEI 2021). Upgrade to \$ave is an Inclusive Utility Investment program that adheres to the PAYS system.

The PAYS form of Inclusive Utility Investment has emerged as a scalable and more equitable solution with strong consumer protections that is rapidly gaining traction. PAYS has been implemented by 23 utilities in 10 states, yielding 6,000 projects completed and \$50M (EEI and LibertyHomes 2022) in capital invested at customers' homes or businesses. While the first

ten U.S. utilities across eight states that pioneered PAYS programs grew largely as bottom-up initiatives with individual rural electric cooperative utilities launching programs, the past three years have seen a sudden flurry of top-down state legislative and commission driven action. Between 2019 and 2021, regulators and legislators in Missouri, Georgia, Virginia, and Illinois have either ordered or paved the way for utility PAYS programs, with Missouri becoming the first where every investor-owned utility is making site specific investment and cost recovery a core part of their essential services (EEI and LibertyHomes 2022). Two forthcoming papers document establishment and growth of the system from a utility perspective (Ferguson et al. 2022) and policy perspective (Hummel et al. 2022).

Background on Roanoke Electric Cooperative's Upgrade to \$ave Program

REC is one of the 26 rural electric distribution cooperatives in North Carolina (NC) with 2,210 miles of line across a 1,500 square mile service territory in the northeast corner of the state that includes the counties of Hertford, Bertie, Gates, Northampton, Halifax, Chowan, and Perquimans. REC's 73 employees serve 14,700 electric meters, 95% of which are residential. Housing in the service area is exclusively single family with 50% stick-built; 40% manufactured, mobile, and trailer; and 10% prefabricated modular type homes. REC serves the 4th lowest income Congressional district in all the U.S., and 6 of its 7 counties are recognized by the Department of Agriculture as persistent poverty counties (Hummel and Lachman, 2018). According to the utility, over 50% of REC members have monthly electricity bills of over \$200/month and more than 35% have monthly bills above \$250. The combination of highly energy inefficient, aging, poorly constructed housing, and low average household income results in a high energy burden (i.e. percent of income devoted to utility bills). An annual energy costs of more than \$2400 (more than \$200/mo.) is more than 6% of the average median income in REC counties (Hummel and Lachman, 2018).

In 2014, REC's Board of Directors set a goal of generating economic benefits for member-owners by capitalizing energy upgrades for 1,000 homes (7% of all REC metered locations) within 5 years. Previously, the utility had sought to leverage U.S. Department of Energy's Weatherization Assistance Program grant funds, but found the level of funding provided by the state for the REC the service area was too low to meet the need. Then it had tried introducing an on-bill loan program, but had just a handful of loan offers accepted. The utility management team then identified and selected a tariffed on-bill investment. The Board of Directors unanimously approved use of the PAYS system for the design of its tariff. REC secured \$6 million in Treasury rate financing through the U.S. Department of Agriculture Energy Efficiency & Conservation Loan Program within 90 days of submission (REC 2014). In 2017, REC transferred program management to EEtility, a program operator that was managing a PAYS program Ouachita Electric Cooperative Corporation in Arkansas, that was producing better results than REC's program. REC's program operational practices were different from EEtility's best practices and it approximately 18 months for EEtility to fully transition the program to its best practices.

After EEtility took over program management it progressively introduced a number of reforms and innovations (Table 1) to improve consumer protections and program performance. These included targeted outreach to homes with high energy use per square foot, scoping work to

be PAYS compliant¹ with customized software implemented by an expert Building Performance Institute Certified Auditor volume pricing with contractors, and remote QA/QC of contractor work using time-stamped and geocoded photographs. EEtility also introduced direct installation of low-cost upgrades for homes in need of major repairs due to structural integrity issues that precluded their immediate enrollment in Upgrade to \$ave. At no cost to the residents, these homes received LED lights, smart strips, aerators, water heater blankets, and AC coil cleaning.

Throughout the analysis we will use the terms Legacy period to refer to upgrades conducted under the local non-profit organization that was the original program operator and EEtility period to refer to upgrades overseen by EEtility.

Table 1. Evolution Upgrade to \$ave Program Operation

Legacy Period			EEtility Period		
Program Operator	Date	Onsite data	ENERGY ESTIMATION		QA/QC
		Gathered By	Model Used	Generated By	Method
Original Program Operator	8/15-10/17	PAYS Measure Assessor	OptiMiser	Contractors	Review contractor pricing and approve and perform onsite visual post upgrade inspections
EEtility	8/17-4/19	Contractors	EEtility Customized Version of OptiMiser; deemed savings for select measures	EEtility BPI Certified Auditor and expert user of OptiMiser	Volume pricing, and remote pre- & post-photos (100%) including post-upgrade blower-door and duct blaster air tightness checks
	5/19-12/21	EEtility			

Members that accepted a PAYS upgrade offer usually received weatherization and HVAC improvement and many of those with internet also received demand response devices. The complete list of potential measures is as follows:

- Energy audits: identify cost-effective EE improvements, install LEDs, address health and safety issues including combustion air, venting bath fans, venting dryers, and furnace safety inspection and tune ups as needed
- Furnace replacement with high efficiency heat pumps to switch from propane or oil to electric heating
- Upgrades of existing heat pumps to more efficient models
- Envelope air sealing to reduce infiltration identified through blower door testing
- Duct system sealing where indicated by duct blaster testing
- Insulation of attic and knee walls when poorly insulated
- Demand response via smart thermostat and water heater load control switch

¹ To be PAYS compliant the offer must use 80% or less of the estimated annual savings over 80% of estimated 80% of the weighted average lifetime of the upgrades to pay for the utility's cost recovery.

The REC Board of Directors decision to approve Upgrade to Save's use of the PAYS system was informed by a financial analysis that included the value of avoided wholesale energy purchases, reduced wholesale peak demand charges, and avoided cost of purchasing credits to meet state's Renewable Portfolio Standard. The analysis found the benefits would exceed both program cost as well as foregone revenue on energy that would otherwise be wasted in the homes of member-owners (Wynn 2020). An initial meter data analysis of a subset of upgrades validated that prediction for the evaluated sample by measuring the change in home performance after upgrades were installed (Bickel et al. 2020). The results that follow show the calculated electricity and peak load reduction for the full program period and more recent upgrades.

Methodology

Period of Analysis and Sample Selection

The primary source data for this analysis is 550 homes upgraded between May 2015 and February 2020. Detailed data on upgrades, financing, and home characteristics were assembled from program records and databases and cross checked for accuracy. An additional 105 homes were upgraded between March 2020 and December 31, 2021 and are included in calculations of the total program impact. All 550 homes were modeled as described below and then filtered for model validity and weather correlation. 468 homes had at least 270 days of complete meter data in the 365-days pre-improvement and post-improvement periods. Filtering for degree-day models coefficient of determination (R^2) of 0.3 or greater and a Coefficient of Variation of the Root Mean Square Error (CVRMSE) of 0.4 or less excluded 80 homes, leaving a final total of 388 homes that could be evaluated for electricity savings. Homes that heated with fossil fuel have additional savings that could not be quantified (Table 2).

Table 2. Sample Sizes and Attrition

	Legacy Period	EEtility Period	Total	Description
Total samples	243	412	655	All upgrades as of 12.31.2021
With project data	243	307	550	Detailed project data available at start of analysis; Legacy data from REC provided to Enpira; EEtility data from EEtility Smartsheet database Homes upgraded between 5/15 and 2/20
With sufficient meter data	231	237	468	Homes with 270 days of valid meter data both the pre- and post- improvement periods
Measurable electric savings	186	202	388	Excludes homes with erratic energy usage patterns Weather normalized pre and post upgrade energy use models have acceptable statistical fits ($R^2 \geq 0.3$, $CVRMSE \leq 0.4$)

Measurement & Verification

Hourly advanced metering infrastructure (AMI) data was used in accordance with the Department of Energy's Uniform Method Project Whole-Building Retrofit Protocol, which compares pre- and post-upgrade meter data normalized for weather (UMP 2017). Calculations of weather normalized energy and peak demand reductions were performed using Enpira software.

Calculated Electricity Reduction (kWh)

Electricity reduction for upgraded homes was calculated using Individual Premise Analysis as outlined in the Department of Energy's Uniform Methods Project (UMP 2017). Specifically, hourly usage for each upgraded home was totaled into 24-hour bins, where only complete bins were selected for regression. Average daily temperature from a nearby weather station was computed for each daily total. Optimized variable degree-day base regression models (Figure 1) were computed for the pre-improvement and post-improvement periods for each home with pre-improvement model heating balance point temperature mean 57°F +/- 6°F standard deviation and cooling 68°F +/- 3°F and post model heating 56°F +/- 5°F, cooling 68°F +/- 3°F. Then, weather for a typical meteorological year based on 15 years of historical data (2006-2020) were applied to the pre-improvement and post-improvement models to determine pre-improvement and post-improvement normalized annual consumption.

Coincident Peak Demand Reduction (kW)

REC's wholesale power pricing includes demand charges assessed based on monthly demand at the peak hour in the month. The system winter peaks between 2015 and 2020 all occur between 6-8am and system summer peaks occur between 4-6pm. Analysis of coincident peak demand reduction was based on a comparison of pre-improvement and post-improvement temperature regression models using hourly interval meter data, a method considered appropriate for residential programs with HVAC and shell measures. Separate regression models of usage vs. average temperature are calculated for the morning and the afternoon peak periods for the pre-improvement and post-improvement periods for each home. The difference between the pre-improvement and post-improvement in the morning model with typical monthly winter peak period temperatures applied yields a winter peak demand reduction, and similarly typical monthly summer peak period temperatures applied to the afternoon model yield a summer peak demand reduction. The 2019 monthly peak demand reduction used nearby weather station temperatures during the peak hour on the peak day of each month as the input for the kW/degree regression models.

Results

Upgrade to Save produced substantial electricity savings, peak demand, and net present value to REC. There is

Upgrade to Save Produced Substantial Electricity Reduction

Table 3 summarizes the results of the analysis. Columns labeled "All" present results for all homes with statistically valid weather models. Columns labeled "Legacy" present analyses of

homes upgraded during the Legacy period (April 2015 and October 2017) including those for which the upgrades were scoped and accepted but not yet installed by the first program operator. Columns labeled “EEtility” present results for homes upgraded during the EEtility period (August 2017-February 2020) during which EEtility was transitioning the program to its best practice. There is a slight overlap in the two periods because homes started under the original program operator were completed under EEtility. The left three columns show results for homes with all types of heating (electric, fossil fuel, dual fuel, and beneficially electrified homes). The right three columns show the same analyses excluding homes where propane heating and inefficient air conditioning was replaced with high efficiency electric heat pumps. Since there are only a handful of fuel heated and dual fuel homes, these results largely reflect the performance of electrically heated homes. There are additional energy savings for homes that used fuel for heating but were not beneficially electrified and so continue to use fuel for heat post-upgrade, however, neither the utility nor the evaluators had access to pre and post fuel usage data for these homes.

Table 3. Electricity Savings by Upgrade Period Including and Excluding Beneficially Electrified Homes

	All Fuel Types			Excluding Beneficially Electrified Homes		
	All	EEtility	Legacy	All	EEtility	Legacy
Sample Size	388	202	186	299	162	137
Average Electricity Savings (kWh/yr)	3,587	4,091	2,807	4,571	5,062	3,993
Average Percent Electricity Savings	18%	20%	15%	22%	23%	20%
Percent of Homes Saving Electricity	79%	83%	73%	89%	91%	86%
Pre-Upgrade Electricity Use (kWh/yr)	19,855	20,716	18,921	21,068	21,827	20,172

The sample of 388 Upgrade to \$ave participant homes had a calculated average electricity savings of 3,587 kWh (18%). Savings per home increased by 46% in the EEtility period relative to the Legacy period (4091 kwh/yr. vs. 2807 kWh/yr). Although the average pre-upgrade electricity use was 10% higher during the EEtilty period, average percent savings, even when including beneficially electrified homes, were significantly higher than the Legacy period (20% vs 15%). When beneficially electrified homes are excluded average savings among the remaining 299 homes increase to 4,571 kWh/yr. (22%), EEtility period savings increase to 5,062 kwh/yr. (23%), and Legacy period homes to 3,993 kWh/yr. (20%).

The Vast Majority of Upgraded Homes are Saving Electricity

Figure 3 shows the distribution of electricity savings for all homes in the full measured sample including and excluding the beneficially electrified homes, and for EEtility period and

Legacy period homes excluding beneficially electrified homes.

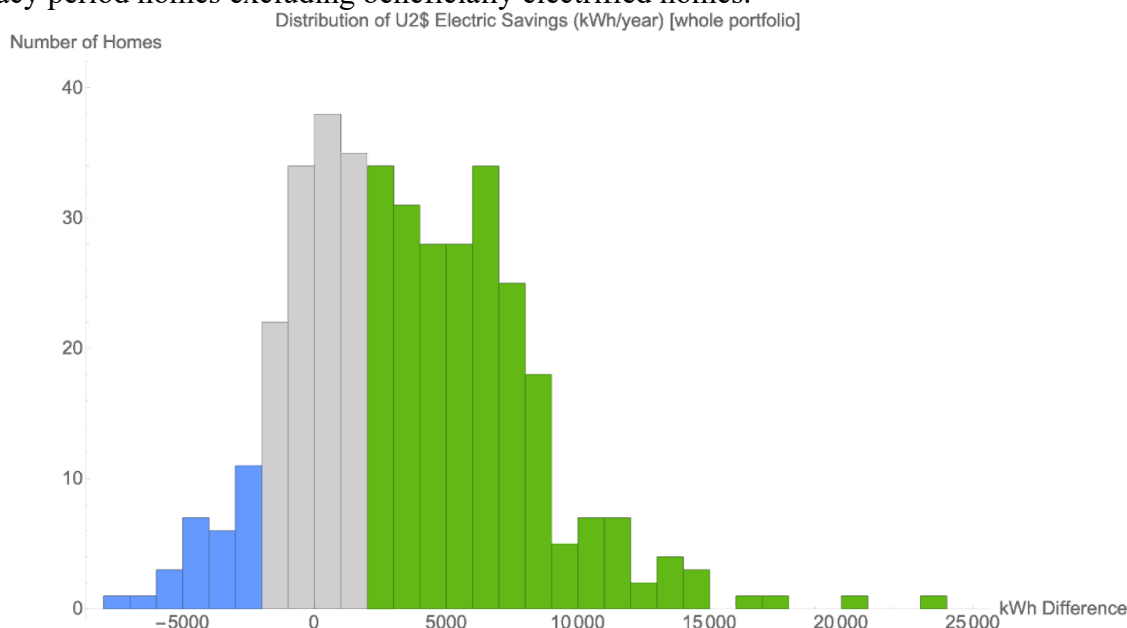


Figure 2. Distribution of electricity savings for Upgrade to \$ave Participants: Full portfolio with all fuel types, and excluding beneficially electrified homes for Portfolio, Legacy period, and EEtility period upgraded homes.

As would be expected, and can be readily observed by comparing the two distributions on the left side of Figure 3, the majority of homes with negative electricity savings are beneficially electrified homes that added electric heating load. Once these homes are excluded, nearly 90% participating households are saving electricity. The increased usage among the remaining 10 percent of households is likely due to occupant choices (i.e. number of occupants, periods of occupancy, comfort preferences, or new high electricity using equipment) or heating and cooling system defects. Appalachian Electric Cooperative, whose U-\$ave Advantage PAYS program is also managed by EEtility, investigated underlying causes for homes using more energy post PAYS upgrade and found occupant choice was the cause in 70% of cases and the remaining cases were correctable equipment issues (Enpira 2020).

In aggregate, in 2022, Upgrade to \$ave is expected to produce 2,349,485 kWh of reduced wholesale electricity for REC and continue to produce savings on the order of 2.3M kWh through 2030 or so with additional savings for the continued lifetime of upgraded measures.

Upgrade to \$ave Generated Substantial Winter and Summer Peak Demand Reduction

Based on a sample of 388 homes, REC's U2\$ program generates approximately 1.2 kW of peak demand reduction per home at the winter mornings with a temperature of 24°F, and 1.0 kW of peak demand reduction per home in summer afternoons with a temperature of 91°F (Table 4). Peak demand reduction for electrically heated and cooled homes was 2.0 kW (24°F) and 1.0 kW (91°F), and for beneficially electrified homes was -1.8kW (24°F) and 1.0 kW (91°F) (Table 4). In aggregate, assuming the measured sample is representative of the entire portfolio, Upgrade to \$ave homes are generated 655 kW of peak load reduction from energy efficiency for REC in 2019 and should continue to provide a similar magnitude of savings through at least through 2030.

Table 4: Peak Demand reduction All Homes

	n	System Peak Hour	Average Temp	Mean (kW)	Percent Reduction
All Homes	388	Winter (7-8am)	24°F	1.2	20%
		Summer (5-6pm)	91°F	1.0	22%
Electric Heat and Cooling	270	Winter (7-8am)	24°F	2.0	32%
		Summer (5-6pm)	91°F	1.0	22%
Beneficial Electrification	89	Winter (7-8am)	24°F	-1.8	-67%
		Summer (5-6pm)	91°F	1.0	20%

U2\$ Delivered Substantial Peak Demand Reduction at All Monthly System Peaks

REC measures peak demand each month, based on its wholesale demand charges. Enpira's regression models (winter mornings, summer afternoons) output peak load reduction per degree.

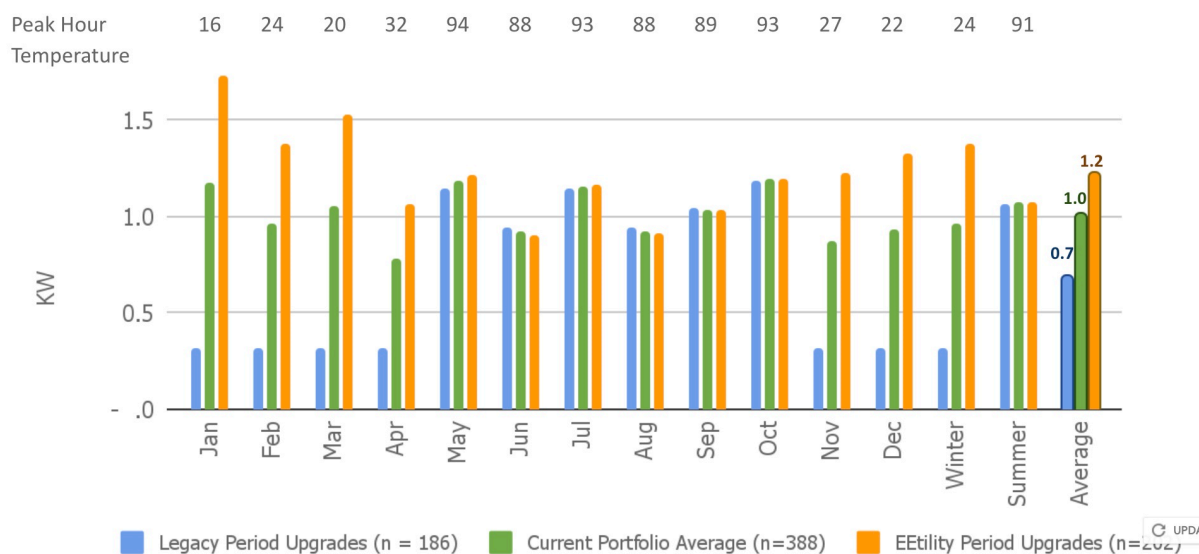


Figure 3. Peak Demand Reduction at 2019 System Peak Temperature by Month for Climate Normal Year (n=388).

Average demand reduction from the energy efficiency improvements at system peak is determined with reference to the average temperature within REC's territory during the 12 peak hours (Figure 3). November-April are winter morning peaks, May to October are summer afternoon peaks. Legacy period upgrades as a population provide little winter peak reduction (0.3 kW/home), which drags down the overall average per home for both Legacy period upgrades (0.7 kW; 0.3 kW winter, 1.0 kW summer) and the full evaluated sample (1.0 kW; 0.9 kW winter, 1.0 kW summer). EEtility period upgrades have similar summer performance (1.0 k) but much better winter performance (1.4 kW) producing average peak load reductions of 1.2 kW, 71% higher than the Legacy period, even though both periods have a similar proportion of beneficially electrified homes.

U2\$ Produced a Positive Return on Investment for REC

Table 5 below summarizes Upgrade to \$ave's utility return on investment over the average expected life of the upgrades (conservatively estimated at 15 years in Roanoke's climate), given all value and cost streams that were identified and quantified. The average upgraded home has a net present value to REC of at least \$2,812 and the 655 homes upgraded by the program as of December 31, 2021 have an aggregate net present value of \$1.84 million with an internal rate of return of 6.8%. The NPV may ultimately be over \$2.04M (\$3,121 per average home, IRR 7.2%) if the avoided cost of purchasing credits to meet the North Carolina's Renewable Energy and Energy Efficiency Portfolio Standard (REEEPS) continues after 2022, at the current value.

Thus, the PAYS investment portfolio is generating economic benefits for the utility with returns that exceed cost of capital, program operation cost, and lost revenue. These calculations do not include the significant additional value of peak load reduction from the 41% of Upgrade to \$ave homes that also enrolled in REC's demand response program and received WiFi thermostats and water heater load control switches at no cost. These results are due to four main factors:

- Two of largest program costs--the utility upgrade investment (average cost of \$7,556) and Program Operation (average cost of \$1,745) are recovered completely over time through the PAYS on-bill tariffed-charge.
- The energy efficiency upgrades generated significant energy and demand savings (\$5,285)
- REC enjoys a modest mark-up on capital of 0.88% (\$432 per upgrade) and six years of avoided cost of purchasing energy efficiency credits to meet the North Carolina's REEEPS (\$443 per upgrade)

Future Program Value is Projected to be Similar or Significantly Higher

The program value per home is projected to be at least equivalent and likely significantly higher for future upgrades, assuming a similar target population, and no changes to the upgrade measure mix and equipment efficiencies. Upgrades in 2022 are projected to generate NPV of \$2,886/home and an IRR of 6.7%, assuming that REC has no future earnings from the REEEPS. In this scenario, value per home remains unchanged because increases in revenue from higher avoided wholesale energy and peak demand costs and reduced program operation costs due to higher offer acceptance rates (80% vs. 63%) are projected to be offset by higher HVAC maintenance costs per home. However, if REEEPS current value is sustained through the average of 11 years of cost-recovery, then the NPV of the upgrades will be \$3,609/home with an IRR of 7.8%, yielding a total value, for the same size portfolio, of \$2.36M.

Charge-offs Remain Low

Since successor customers assume payment of monthly cost-recovery charges for the upgrades that they are benefiting from, REC has had de minimis charge-offs to date. On its \$4.95M of investment REC has had to write-off \$10,000 of unrecovered investment and cost-of-capital for three accounts where the buildings are no longer able to produce revenue for a charge-

off rate of 0.22%. (In the parlance of electric utilities this is referred to as a “charge-off” because the funds are charged off of the balance sheet).

Table 5. Upgrade to \$ave Program Cash Flows, Net Present Value, and Internal Rate of Return

Cost and Revenue Categories	Historical Program (Upgrades through 2021)		Future Program (If All Upgraded in 2021)		Difference in Future Value
	Average per Home	Total Residential Portfolio	Average per Home	Total Residential Portfolio	Assumes: EUtility period energy & peak demand performance
Number of Projects	1	655	1	655	
Avoided Energy Costs	\$2,106	\$1,379,430	\$2,899	\$1,573,310	kWh savings/home (+37%)
Avoided Demand Costs	\$3,179	\$2,082,245	\$3,815	\$2,498,825	kW savings/home (+20%)
Avoided Cost of EE Credits	\$443	\$290,165	\$0	\$0	Uncertain, so excluded
Mark-up on Cost of Capital	\$1,427	\$934,671	\$1,427	\$934,671	
Recovery of Capital Investment	\$7,556	\$4,949,180	\$7,556	\$4,949,180	
Utility Investment In Upgrade	\$(7,556)	\$(4,949,180)	\$(7,556)	\$(4,949,180)	
Utility Cost of Capital	\$(995)	\$(651,725)	\$(955)	\$(651,725)	
Program Operation Cost	\$(780)	\$(510,900)	\$(614)	\$(402,170)	Fewer declined offers (-21%)
Health & Safety Incentives	\$(365)	\$(239,075)	\$(365)	\$(239,075)	
HVAC Maintenance Contracts	\$(600)	\$(393,000)	\$(1,100)	\$(720,500)	11 versus 6 years (+83%)
Total Cash Flow	\$4,415	\$2,891,825	\$4,570	\$2,993,350	
NPV	\$2,812	\$1,841,926	\$2,886	\$1,890,330	
IRR	6.8%		6.7%		
With Full 11 Years of Avoided EE Credit at Current Value (Total undiscounted value \$813)					
NPV	\$3,121	\$2,044,452	\$3,609	\$2,363,895	
IRR	7.2%		7.8%		

Conclusion and Recommendation

This analysis verifies Roanoke Electric Cooperative’s Upgrade to \$ave program, as implemented by EUtility, substantially cuts the electricity use and peak electricity demand of participating households producing a NPV of \$1.8M to \$1.9M to REC. Over 650 cooperative

member-owners who could not have obtained an energy efficiency upgrade because they were not offered in the region—or been able to pay for one—received cost-effective whole home energy upgrades with no upfront cost. As of December 31, 2021 and more than six years of operation, REC has invested \$4.95M and REC has recovered 99.8% of its investments. During the same period, member-owners presented with a PAYS offer have accepted 63% of the time (80% during the latter part of the EEtility period).

REC's investment portfolio is generating substantial economic benefits for the utility. REC will recover its initial investment in the residential upgrades, program operation costs over the lifetime of the measures and generate positive cash flows with a NPV of at least \$M (\$2,812/home, IRR 6.8%) and potentially as high as \$2.04M (\$3,121/home, IRR 7.2%) if the avoided cost of purchasing credits to meet the state REEEPS remain constant and available through the full cost-recovery period. This value represents only a portion of the total program value to the utility because it will receive additional savings from peak load reduction provided by the 41% of Upgrade to Save homes that also participate in REC's demand response program. Future upgrades are projected to have a NPV of \$2,886 or \$3,609 per upgrade depending on the value and persistence of REC's avoided REEEPS purchases.

Program energy savings and peak load reductions increased by 46% and 71% respectively during the second half of the program period (the EEtility period) after introduction of a set of operational reforms that prioritized high savings potential customers, insulated participants from installation contractors, professionalized data gathering and determination of cost-effective measures, and instituted rigorous QA/QC on 100% of upgrades.

Future research will report REC's ongoing evaluation of the participant value including examining net cash flow, comparing estimated to measured savings and assessing the relative contribution of program learning curve, occupant behavior, equipment malfunction to participant value.

These results should be replicable by other distribution utilities with older building stock in similar or more severe climates with similar electric rates and wholesale pricing structures.

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