

Reported and Evaluated Field Experience from Pay As You Save® Building Efficiency Upgrades

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ABSTRACT

Between 2002-2021, 23 U.S. utilities in 10 states gained experience offering building efficiency and electrification upgrades through investment programs that are uniquely inclusive, i.e., accessible to occupants no matter their renter status, income, or credit score. All of these utilities have used the Pay As You Save® (PAYS®) system, a set of consumer protections and design parameters that are the basis of the Inclusive Utility Investment approach. With Inclusive Utility Investment, any utility with an approved tariff can pay for site-specific upgrades and recover the full cost at each site over time through a charge on the bill that is less than the estimated savings. Through 2021, U.S. utilities have cumulatively deployed more than \$50 million for building efficiency and electrification upgrades to nearly 6,000 locations through PAYS, and more than \$170 million is committed for deployment over the next three years. This paper summarizes field data on PAYS programs as reported by sponsoring utilities through the year 2021. These utilities have capitalized upgrades to renter and owner-occupied single family and multifamily homes as well as commercial and municipal buildings, with overall participation rates six times greater than those of debt-based programs. The utility's net present value ranges from \$1,000 to \$3,000 per upgraded location and cost recovery averages 99.9%. Altogether, the field data presents a striking picture of a utility investment solution that can reach underserved markets, even in areas of persistent poverty, a requirement for rapid reduction of greenhouse gas emissions from the buildings sector.

Introduction

Direct and indirect emissions from existing building stock contribute 29% of the United States (U.S.) greenhouse gas (GHG) emissions and more than 28% of GHG emissions globally (C2ES 2018; UN 2021). To have even a 50% chance of averting warming above 1.5 degrees Celsius (1.5°C), every home and building — regardless of occupant income, credit score, or renter status — must be fossil free by 2050 or sooner (IPCC 2018). To realize such deep decarbonization of all buildings, each will require some combination of upgrades including: (a) building envelope and heating and cooling system efficiency improvements, (b) conversion of fossil-fuel-powered equipment to electric, (c) demand response devices that provide flexible electric loads and thermal storage, and (d) on-site renewable generation and bi-directional battery storage (Ibid). The price of implementing such a decarbonizing upgrade package is expected to range from \$10,000 to \$40,000 per residential home and even more for commercial buildings (Rewiring America 2020). The current tacit U.S. policy expectation is that the vast majority of the

population will pay for these upgrades themselves with either savings or consumer finance, and that rebates, tax credits, and subsidized interest rates are sufficient to entice them to do so.

This existing financing system for building efficiency upgrades depends on creditworthy counterparties, which categorically disqualifies low and middle-income households, the 36% of U.S. residents who rent, the 51% of U.S. residents with subprime credit scores, anyone unable or unwilling to take on the risk of debt obligation, and one third of adults globally still unbanked (US Census 2017; Brevoort et al. 2016; World Bank 2018). In addition to being inequitable, this exclusive financing approach is also ineffective at achieving the upgrade pace and scale needed to reach all 120 million U.S. homes and all commercial buildings to reduce carbon emissions enough to keep global warming below 1.5°C (IPCC 2018). Even within the U.S. market segment that can access loans, the maximum annual participation rate observed for four of the largest and longest running state-backed energy efficiency loan programs is 0.1% of households in the state (LBNL 2022). Similarly, U.S. government grant programs for building energy upgrades, although crucial for the low-income households who can benefit, have had chronically low funding and, as a result, they have achieved very limited market penetration (Carley 2020). Between 1977 and 2021, U.S. taxpayer and utility ratepayer funds have been used to provide energy efficiency upgrades to approximately 8 million homes, or just 6% of the addressable market, and with only a fraction of the measures required for building decarbonization, as listed above, being installed (NACSP 2018; Hummel et al. 2022 Figure 1). The wide gap between building decarbonization goals and inaccessible, anemic financing and funding programs highlights the need for inclusive investment solutions that can expand participation in building decarbonization to all.

Inclusive Utility Investment

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 (EPA 2021). 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, also, a lower energy bill from day one, assuming the patterns of building operation remain similar. Multiple studies have identified that the building energy upgrades also produce positive cash flow for the utility, and the tariff includes a provision that automatically suspends cost recovery if the upgrades stop working (Bickel et al. 2020, 2022). For that reason, the utility is motivated to work with a program operator that can manage the entire process to ensure the upgrades are installed correctly and perform well. This transforms the building upgrade process from one where customers coordinate contractors and pay for upgrades to one where they simply choose

and receive building efficiency improvements. Historically, utilities and most of their regulators have treated energy efficiency as a cost center with little or no benefit to their core business. Inclusive Utility Investment recognizes that building efficiency and other energy upgrades are essential utility services. In that context, utilities, which already have a commercial relationship with the occupants of virtually every building, can offer to deploy their expansive access to low-cost capital for such investments with terms determined to be just, reasonable, and fair by their regulators or oversight boards. In short, Inclusive Utility Investment makes it financially possible and attractive for utilities to capitalize building efficiency and other energy upgrades that generate savings on the same scale as conventional power plants with similar assurances for cost recovery on a site-specific basis.

The EPA has identified the Pay As You Save[®] (PAYS[®]) system as the original example of Inclusive Utility Investment (EPA 2022). To date, every Inclusive Utility Investment program observed in the field has been based on the PAYS system developed by the Energy Efficiency Institute, Inc. in Vermont and improved with field experience over time (Cillo and Lachman 1999). To be considered a program based on the PAYS system, the program design must meet PAYS Essential Elements and Minimum Program Requirements, a set of consumer protections and design parameters informed by decades of field testing (EEI 2021). From 2002-2021, 23 U.S. utilities in 10 states have used the PAYS system to invest more than \$50 million in over 6,000 customers' homes or businesses, and \$170 million is committed for similar deployment in the next three years. This paper summarizes field data on the performance of Inclusive Utility Investment programs using the PAYS system reported by each of these sponsoring U.S. utilities through the year 2021 (EEI 2022).

How Inclusive Utility Investment Works Under the Pay As You Save[®] System

Once a customer expresses interest in receiving building energy upgrades, the cost-effective upgrade package for each building is determined via an on-site assessment that also takes into account the materials and labor costs as well as current retail energy rates and historical energy usage at that location. A cost-effective upgrade package refers to a set of upgrade measures or equipment that, together, generate enough energy savings to cover the initial cost with cost recovery through a tariffed charge that is capped in both magnitude and duration. The PAYS tariffed charge for cost recovery is capped at 80% of the estimated savings and the duration of the cost recovery is capped at 80% of the useful life of the upgrade, resulting in tariffed charges for cost recovery that are 64% (i.e. 80% X 80%) of the total estimated savings from the upgrade, leaving 100% of the estimated annual savings to the customer during the last 20% of the expected life of the project (EEI 2021). The 80% rule ensures there is sufficient incentive for customers to participate and provides a margin to account for variations in cost estimates. Inclusive Utility Investments are limited to proven technologies with reliable and predictable savings. Figure 1 illustrates the efficiency and electrification measures that have been included to date in Inclusive Utility Investment programs using the PAYS system. They include insulation; air sealing; duct sealing; water heater load control switches; advanced power strips; water heater wraps and pipe insulation; low flow fixtures; air conditioning coil cleaning; solar water heaters; ENERGY STAR certified smart thermostats, LED lighting, air source heat pumps, and heat pump water heaters. Load control devices with customer override have been included in PAYS programs as utility paid, direct install devices.

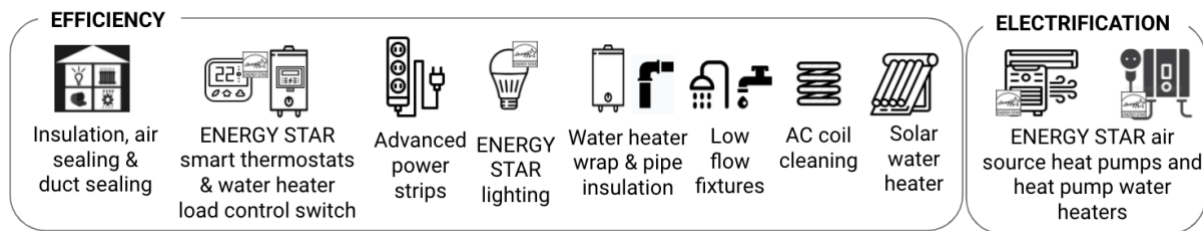


Figure 1. Cost effective upgrade measures deployed in Inclusive Utility Investment programs using the Pay As You Save system as of 2022. Source: LibertyHomes.

As technology cost curves decrease and market conditions change in the future (e.g., carbon pricing, new rate design), additional measures will meet the criteria for cost-effectiveness in a PAYS program, at which point they could be added to the suite of eligible options in Figure 1. Potential measures of interest in the future are summarized in Figure 2 and include: ENERGY STAR certified smart home energy management systems, appliances, and storm windows; community solar when cost recovery is tied to a location; on-site solar with battery storage; bi-directional electric vehicle charging stations; and the on-board batteries of electric vehicle fleets. The U.S. Department of Energy has commissioned research to confirm rooftop solar is compatible with the PAYS system (Cillo and Lachman 2020).

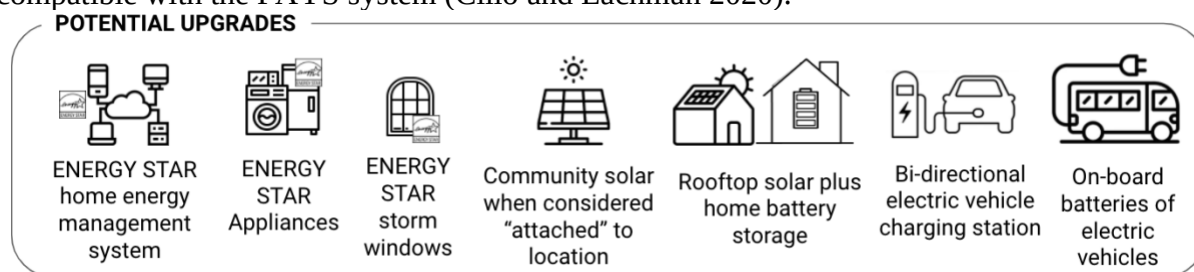


Figure 2. Potentially cost-effective measures for future Inclusive Utility Investment programs. Source: LibertyHomes.

After the scope of cost-effective upgrades for a specific site has been determined, the utility offers to the customer the opportunity to obtain the upgrades with no upfront cost. Once the customer accepts, the utility pays the upfront cost to capitalize this upgrade and it recovers its cost with a portion of the energy savings over time through a fixed monthly tarified charge on the customer's bill as shown in Figure 3. The tarified charge stays on the bill for that location until all costs are recovered, including the utility's cost of capital (EEI 2021). Since the charge is tied to the utility meter at the location and not to the individual, the program participant pays this charge only as long as they occupy the location where the upgrades are installed and working. If the occupant moves, the tarified charge automatically applies to the next occupant in the same way that utility tariffs for other essential services apply automatically to successor customers. In programs to date, the utilities own the upgrades for the duration of cost recovery, after which ownership automatically converts to the building owner; there may be other options. These attributes altogether have produced an expansively inclusive system with a high rate of customer acceptance, resulting in accelerated development of building energy upgrades even in historically underserved market segments (Hummel et al. 2022).

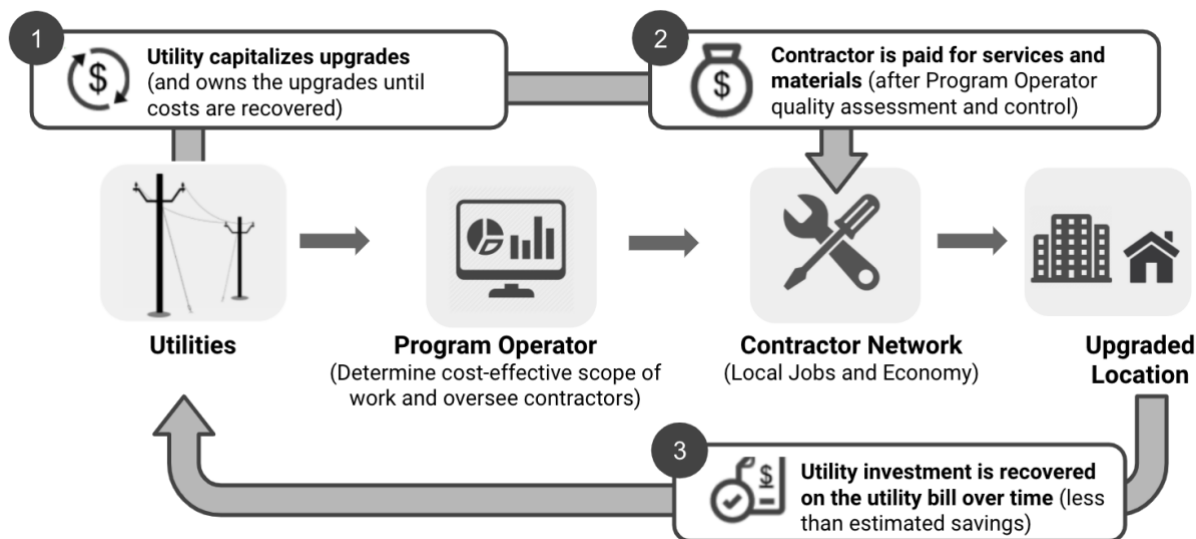


Figure 3. Flow of capital in an Inclusive Utility Investment program. Source: LibertyHomes.

U.S. Federal Government Recognition of the Need for Inclusion and Pay As You Save®

In 2019, the U.S. Department of Energy (DOE) Better Buildings Solutions Center published an Issue Brief on tariffed on-bill investment programs (DOE 2019). This product of the DOE’s Clean Energy for Low-Income Communities Accelerator highlighted case studies of the rural electric cooperative utilities that first pioneered the PAYS system. Their experience has been particularly influential because more than 90% of the persistent poverty counties in the U.S. are served by electric cooperatives, and the results reported by some of these utilities offering Inclusive Utility Investment programs using the PAYS system has underscored the exceptional potential for greater impact with broader adoption (NRECA 2018).

In 2021, the Administrator of the EPA, Michael Reagan, addressed a White House Roundtable on Accelerating Building Decarbonization as part of the federal government’s annual Better Building Summit. Administrator Reagan stated then that the EPA would work to advance emerging models that have “demonstrated success at expanding the scale of efficiency deployment, especially to underserved and overburdened communities, such as...inclusive utility investment with robust consumer protections like the Pay As You Save model [since] everyone deserves to be part of climate solutions: to access the benefits of safe, healthy, efficiency, non-polluting homes, powered by clean energy, with access to clean transportation” (DOE 2021). The EPA followed Reagan’s statements by hosting a webinar series on Inclusive Utility Investments featuring three PAYS program sponsors at its 2021 ENERGY STAR Product Partner Meeting (EPA 2021).

In 2022, the EPA published an online Inclusive Utility Investment resource center that provides a general description, lists of barriers addressed, and key consumer protections that should be included as shown in Table 1 (EPA 2022). By calling for more Inclusive Utility Investments with strong consumer protections, U.S. federal agencies affirmed reasoning by the National Association for the Advancement of Colored People (NAACP) in its landmark report, *Lights Out in the Cold*, which recommended increasing federal funding for weatherization upgrades and also using the Pay As You Save system for energy efficiency upgrades to reduce vulnerability to

high bills (NAACP 2017). If subsequent Inclusive Utility Investment program designs do not incorporate the following consumer assurances based on the PAYS system, they are not likely to produce comparable results. The consumer protections referenced by the EPA are contrasted to those found in prevailing debt-based consumer financing models in Table 2.

Table 1. EPA Inclusive Utility Investment resource center: consumer protections and barriers addressed

Consumer Protections			
Method to accurately estimate savings: Understanding a particular customer's energy usage patterns based on actual billing data as well as the existing equipment and other conditions of the premises are important to ensure modelled energy savings provide an accurate estimate on which to base the cost recovery charge.			
Positive cash flow: Designing the tariff so that the cost recovery charge is lower than the estimated energy bill savings helps ensure a positive cash flow for the customer on an annual basis. Since the cost recovery charge remains with the meter, this also helps protect future residents/tenants.			
Customer choice: Participants are allowed to contribute upfront costs (commonly referred to as a co-payment), if they so desire, so that they have the option of receiving upgrade measures whose cost can only be partially covered by the energy cost savings under the tariff requirements.			
Equipment and labor warranties: Extended equipment and labor warranties are secured to ensure that customers realize benefits from the improvements throughout the cost-recovery period. Require that payments end if an upgrade fails through no fault of the occupants and is not repaired.			
Verification after installation: The utility or program operator inspects measure installation quality and completeness.			
Monitoring of energy savings: Energy usage data are monitored for participating customers to ensure consumption is in line with expectations and to identify anomalies.			
Remove opportunities for conflict of interest: Apply strategies to avoid trade ally, program operator, or Utility conflicts of interest. For example, the trade ally being paid to install the upgrades should not be the same entity that determines the estimated energy savings nor the scope of work at each site.			
Barriers Addressed			
Need for Greater Savings: One major challenge utilities face as they adjust their energy efficiency portfolios to meet savings goals from more comprehensive retrofit measures is achieving the volume, they need to drive savings at scale. Established Inclusive Utility Investment programs have demonstrated that almost all customers are more likely to move forward with offers compared to debt-based offers, therefore increasing uptake of impactful retrofits and utility savings.			
Availability or Access to Capital: More than one third of Americans report being unable to pay for a \$400 emergency with cash savings, and 51% have subprime credit according to the U.S. Federal Reserve. Inclusive Utility Investment programs provide the up-front capital to move forward with retrofits that many Americans cannot afford or either cannot or will not finance through a loan. Credit checks are not necessary under this model. Participants assume no new debt.			
First Cost: Inclusive Utility Investments eliminate financial barriers that prevent customers from investing in energy efficiency upgrades. Programs operating today leverage existing rebates from other programs, if available, to help lower first cost. Homes with high energy intensity (high energy use per square foot) are most cost effective for this model.			
Mistrust and Complexity: Customers often do not trust the energy or monetary savings claims of trade allies who they perceive are motivated to close a sale. Consumers can be overwhelmed by the complexity of contracting. Exposure to high-pressure upselling and poor installation quality are major barriers that deter customer investment. Inclusive Utility Investment programs include consumer protection protocols to prevent upselling and ensure high quality installations.			
Split Incentives and Underserved Sectors: Another challenge facing efficiency and electrification programs is making sure that all customer segments tap into program offerings. This is particularly challenging for low- to moderate-income (LMI) households and renters, which make up about 36% of households. Some Inclusive Utility Investment programs prioritize marketing and outreach to these customers, targeting high energy users. Many utility efficiency programs offer additional incentives and services for LMI households, so it is important that customers are notified they may be eligible to take advantage of no-cost upgrades and services, providing contact information so they may pursue those options first.			

Table 2. Consumer protection attributes: contrast between consumer finance and PAYS®

Consumer Protection Attribute	Consumer Finance On-Bill Loan	Pay As You Save® Tariff	Property Assessed Clean Energy
No Upfront Participant Cost	✓	✓	✓
No Credit or Income Qualification Required		✓	

Renters are Eligible		✓	
Estimated Savings Must Exceed Cost Recovery Charges		✓	
Participant Accepts an Opt-in Utility Tariff Tied to the Location		✓	
Cost Recovery is Through a Fixed Charge on the Utility Bill	✓	✓	
Participant Agrees to Disconnection for Not Paying Utility Bills		✓	
Payments End if Upgrade Fails and is Not Repaired		✓	
Cost Recovery Runs with the Location and Remains in Effect for Subsequent Customers at That Site until Cost Recovery is Complete		✓	

Reported Field Experience from Utilities Across the United States

Over the last 20 years, 23 utilities across 10 states have operated Pay As You Save programs for building efficiency and electrification upgrades as seen in Figure 4. The reasons for program completion have not been reported. These utilities have cumulatively deployed \$50 million to upgrade nearly 6,000 locations consisting of rental and owner-occupied buildings in both single family and multi-family categories as well as commercial and municipal buildings – regardless of the income, credit score, or renter status of the occupant (EEI 2022). Altogether they have committed more than \$170 million for future upgrades using Inclusive Utility Investment with strong consumer protections (LibertyHomes 2022).

In every case, the utilities reported that the combination of expansive eligibility and low barriers to participation produced high uptake rates, with over two thirds of customers accepting their utility’s offer of upgrades at their location with the known terms for cost recovery (EEI 2022). Across these utilities, the average cost recovery rate is 99.9% (Ibid.). In contrast, the loss rate of debt-based loan programs is 30 times that level, on average (Federal Reserve 2020). This paper categorizes the growth and developments of PAYS programs throughout the country through a summary of all utility reported program data organized by utility type (e.g. investor owned utility, electric cooperative, and municipal utility) in the following subsections.

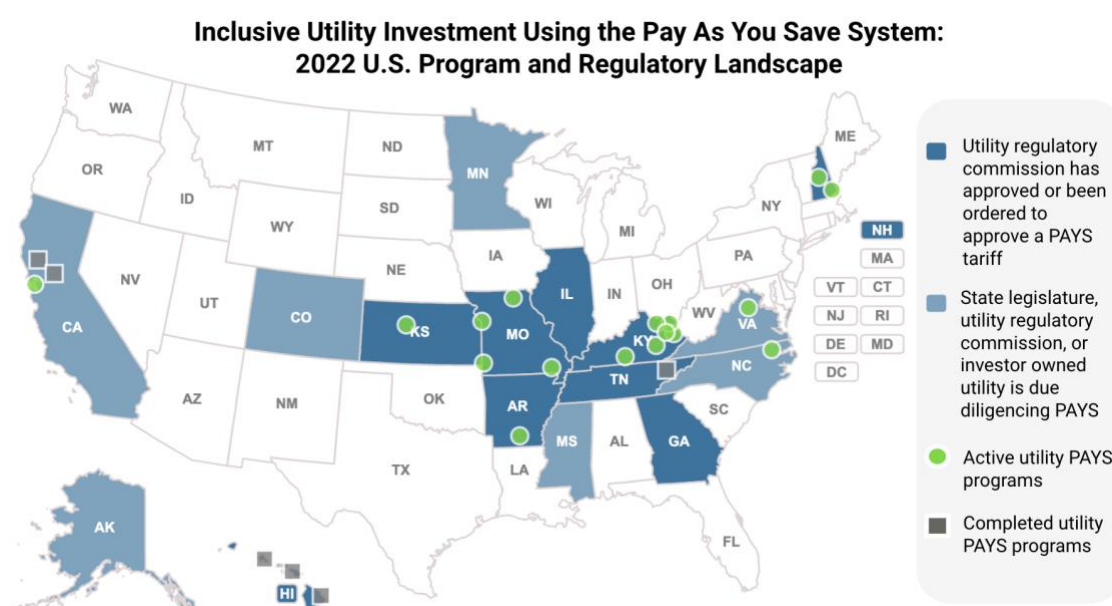


Figure 4. Inclusive Utility Investment programs using the Pay As You Save system across the U.S. as of 2022.
Source: LibertyHomes.

Summary of Investor Owned Utility Field Data

Investor-owned utilities (IOU) in the U.S. are beginning to recognize their unique position to harness their tariff authority to reach underserved market segments that have lucrative upgrade opportunities. IOUs are also facing increasing calls from community advocates and utility regulators for equitable solutions to accelerate building energy upgrades as an essential service, and as a result, more have turned attention to PAYS. Although the first IOU programs used limited ratepayer funded energy efficiency budgets as the source of capital for the upgrades, the latest IOU programs are seeking regulatory permission to use their own balance sheet to capitalize upgrades with a level playing field of opportunity compared to any other type of system upgrade. As seen in Table 3, the most recent IOU programs are in Missouri (MO), which has become the first U.S. state where all IOUs are set to operate a PAYS program. Even though the PAYS programs in Missouri have just launched, their customer sign up rate has outpaced their expectations by more than double and within three months have exceeded their annual enrollment target (Ruder and McNabb 2021). While not all IOUs expecting to offer Inclusive Utility Investments have publicly filed their future investment commitments, the Missouri IOUs have committed \$52.5 million (more than doubling the entire Inclusive Utility Investment field in the U.S. to date) and new IOU programs in the pipeline in the state of Illinois have committed an additional \$120 million, bringing the future commitments to over \$170 million; an investment poised to reach tens of thousands of homes over the next three years (LibertyHomes 2022). See Table 3 for a summary of IOU reported data from their PAYS programs through 2021.

Table 3. Investor Owned Utility reported Pay As You Save® (PAYS®) program data

Program	Smart\$Start	Solar Saver Pilot	Ameren PAYS®	Eversgy PAYS®	Spire PAYS®	Ameren Gas PAYS®
Utility, State	Eversource, NH	Hawaiian Electric, Hawai'i Electric Light, Maui Electric	Ameren Electric, MO	Eversgy, MO	Spire, MO	Ameren Gas, MO
Number of Customers	236 municipals	460,162	1,068,394	546,638	1,101,378	546,638
Inception	2002	2007	2021	2021	2022	2022
Status	Active	Completed	Active	Active	Approved	Approved
Source of Capital	Energy Efficiency Budget	Energy Efficiency Budget	Utility Capital	Utility Capital	Utility Capital	Utility Capital
Program Operator	Utility	Utility	EEtility	EEtility	EEtility	EEtility
Project Type*	M	SF	SF, MF	SF, MF	SF, MF	SF, MF
Upgrade Package	Efficiency	Solar water heaters	Efficiency	Efficiency	Efficiency	Efficiency
Projects Completed	696	484	14	45	NA	NA
Percent of Customers	NR	NR	0.001%	NA	NA	NA
Adoption Rate	NR	NR	NA	NA	NA	NA
Co-payments and Incentives	>\$0	\$484,128	>\$0	NA	NA	NA
Utility Investment	\$14.9M	\$2,900,000	\$54,827	NA	NA	NA

Committed Future Investments	NR	NA	\$15M	NA	NA	NA
Total Job Costs	>\$14.9M	\$3.3M	>\$54,827	NA	NA	NA
Average Repayment Term (years)	8	10	12	NA	NA	NA
Uncollected	<0.0%	<0.1%	NA	NA	NA	NA
Progress Through	6/30/21	12/31/08	8/5/21	8/5/21	8/5/21	8/5/21

Note. *SF=single family; MF=multi-family; M=municipal. NR=not reported; NA=not applicable; not enough data as of 12.31.2021.

Summary of Rural Electric Cooperative Utility Field Data

Several rural electric cooperatives were among the first utilities to implement the PAYS system in the U.S. Being non-for-profit utilities, cooperatives have mostly relied on the U.S. Department of Agriculture (USDA) Rural Electricity Service financing to make building upgrade investments through the PAYS system. The percent of cooperative member-owners that have accepted an offer for an energy upgrade through the PAYS system have been unprecedented in these rural communities, ranging from 70% to 90% (EEI 2022). A fleet of small cooperatives serving rural areas in Kentucky, North Carolina, and Arkansas — regions recognized for persistent poverty and some the highest energy burdens in the country — have all operated PAYS programs that average \$600 in energy cost savings for each participant per year, before applying the cost-recovery fees, demonstrating that the program is well accepted in places considered beyond the reach of traditional approaches (OptiMiser 2018). Midwest Energy in the state of Kansas has been able to scale energy upgrades to 8.3% of its member-owners (0.6% member-owners per year) while Roanoke Electric in North Carolina has reached 5% of member-owners (0.7% member-owners per year), both annual averages representing more than six times the maximum annual market penetration of four of the largest and longest running state-backed loan programs in the U.S. (0.1% customers per year) (LBNL 2022). Additionally, Roanoke Electric has expanded its upgrade package beyond traditional energy efficiency and electrification to include demand response devices such as water heater load control switches and smart thermostats. It is now measuring the value streams of bi-directional electric vehicle charging stations, which could help control wholesale power costs and put downward pressure on rates for all members (Susser and Real 2021). The summary of reported cooperative data from their Inclusive Utility Investment programs using the PAYS system are shown in Table 4.

Table 4. Rural electric cooperative utility reported Pay As You Save® (PAYS®) program data

Program	Smart\$Start	How\$mart®	How\$mart® KY	Upgrade to \$ave	HELP PAYS®	U-Save Advantage	Tariffed Program
Utility, State	New Hampshire Electric Coop, NH	Midwest Energy, KS	Big Sandy RECC, Grayson Electric Coop, Fleming-Mason Energy, Jackson Energy Co-op, Farmers RECC, Licking Valley RECC, KY	Roanoke Electric, NC	Ouachita Electric, AR	Appalachian Electric Coop, TN	Rappahannock Electric

Number of Customers	84,000	29,706	139,230	12,150 2,073	6,916	40,233	157,263
Inception	2002	2008	2011	2015	2016	2019	2022
Status	Active	Active	Active	Active	Active	Completed	Active
Source of Capital	Utility Capital	Various	Various	USDA EECLP	National Rural Utilities Cooperative Finance Corporation, USDA RESP	USDA RESP	USDA RESP
Program Operator	Utility	Utility	Mountain Association	EEtility	EEtility	EEtility	EEtility
Project Type	SF, C	SF, C	SF, C	SF, C	SF, MF, C	SF	SF
Upgrade Package	Energy Efficiency	Energy Efficiency	Energy Efficiency & Electrification	Energy Efficiency & Electrification	Energy Efficiency & Electrification	Energy Efficiency & Electrification	Energy Efficiency & Electrification
Projects Completed	76	2,475	320	654	409	71	NA
Percent of member-owners	NA	8.3%	0.23%	5% 0.05%	6%	0.18%	NA
Adoption Rate	NA	70%	78%	90%	90%	86%	NA
Copayments and Incentives	NA	\$5M	\$826,506	>\$0	NA	>\$0	NA
Utility Investment	\$1.5M	\$14.1M	\$1.6M	\$4.5M \$8,421	\$3.4M	\$425,693	NA
Total Job Costs	≥\$1.5M	\$19.2M	\$2.5M	≥\$4.5M ≥\$8,421	\$3.4M	>\$425,693	NA
Average Repayment Term (yrs)	5-10	10-15	10-15	11 NA	11	12	NA
Uncollected	<0.1%	<0.1%	0.36%	0.2%	0%	NA	NA
Progress Through	7/3/21	7/31/21	6/30/21	8/5/21	6/30/21	8/5/21	12/31/21

Note. *SF=single family; MF=multi-family; C=commercial; NA=not applicable.

Summary of Municipal Utility Field Data

Although municipal utilities have access to low cost capital through the bond market, they face the additional challenges of getting public approval for large bond issuances. Even still, the first municipal utility to implement PAYS was able to reach over 200 single family households and over 200 multi-family units using its own operational budget. Since then, the most recent municipal utility programs have combined various city budgets in order to raise more capital. The summary of reported municipal utility data from their Inclusive Utility Investment programs using the PAYS system are shown in Table 5.

Table 5. Municipal utility reported Pay As You Save[®] (PAYS[®]) P program data

Program	Windsor Efficiency PAYS [®]	Green Hayward PAYS [®]	Water Upgrades Save
Utility, State	Town of Windsor Water Utility, CA	City of Hayward, CA	Regional Program, CA
Number of Customers	7,846	NR	NR
Inception	2012	2015	2021
Status	Completed	Completed	Active
Source of Capital	Utility Operations	Utility Operations	Joint Powers Authority
Program Operator	Sonoma County Energy Independence	Frontier Energy	EEtility
Project Type*	SF, MF	MF	SF, MF
Upgrade Package	Low flow fixtures (indoor and outdoor)	Low flow fixtures (indoor and outdoor)	Low flow fixtures (indoor and outdoor)
Projects Completed	242 SF 233 Units	162 Units	13
Percent of Customers	3%	1.2%	NA
Adoption Rate	NR	23%	NA
Copayments and Incentives	\$354,464	NA	NA
Utility Investment	\$207,240	\$173,115	\$5,501
Total Job Costs	\$561,704	≥\$173,115	≥\$5,501
Average Repayment Term (years)	10-15	3-10	10
Uncollected	<0.1%	NR	NA
Progress Through	6/30/21	6/30/21	6/30/21

Note. *SF=single family; MF=multi-family; NR=not reported; NA=not applicable; not enough data as of 12.31.2021.

Evaluated Energy and Peak Demand Savings

Of the utilities reporting data above, four utilities have shared results from their independent evaluations of actual, post-upgrade performance. The average electricity savings for residential participants in each program has ranged from 2,559 kWh/yr/home to 5,202 kWh/yr/home while the average peak demand savings in each program has ranged from 0.7-1.2 kW/yr/home (Enpira 2021; Midwest Energy 2021). Subsequent analyses will need to conduct an energy bill data analysis to take into account the electricity and energy cost savings after the cost recovery fee has been added in order to report on annual bill reduction for the participant. Most notably, the two utilities that have conducted economic analyses have found that the net present value of each upgrade to the utility is between \$1,300 and \$3,000 (Bickel et al. 2020, 2022). Thus, when applying the Utility Cost Test, which considers the program operation costs, return of capital and cost of capital, and avoided wholesale energy and demand costs, Inclusive Utility Investment programs using the PAYS system are generating economic benefits for the utility. A summary of the data from these utility evaluations are shown below in Table 6. Altogether, the field data presents a striking picture of a utility investment solution that can reach underserved markets even in areas of persistent poverty, making the business case for use of tariffed authority to make inclusive utility investments in the building stock in their service areas, expanding participation in the clean energy economy.

Table 6. Evaluated energy and peak demand savings data from Pay As You Save programs

Program	Midwest Energy (n=2,081 homes)	Roanoke Electric (n=327 homes)	Ouachita Electric (n=394 homes)	Appalachian Electric (n=60 homes)
Average Electricity Savings (kWh/yr/home)	2,559	4,228	3,218	5,202
Average Percent Electricity Savings (%)	NR	18%	17%	22%
Average Fuel Savings (therms/yr/home)	295	NR	NR	NR
Average Peak Demand Savings (kW/yr/home)	NR	1.2	0.7	1.2
Net Present Value to Utility Per Home*	NR	\$3,047	\$1,387	NR
Utility Portfolio Net Present Value of homes to date*	NR	\$996,240	\$546,000	NR

Note. NR=not reported

Applications and Limitations of Inclusive Utility Investment

The most appropriate application of Inclusive Utility Investment in the building sector is for structures that have energy or resource inefficiencies, including the potential for beneficial electrification. Proxies used by utilities to identify homes with the highest potential to be served by Inclusive Utility Investment are: high energy intensity (kWh/square foot or kWh/m²); the ratio of the peak energy consumption in winter and summer months compared to the shoulder months; high energy burden (percentage of annual income spent on energy bills); and high bill complaints (indicating trouble affording bills). Additional analyses of participant cost savings will need to be conducted to determine to what extent Inclusive Utility Investment has been able to reduce energy burdens or energy insecurity. This inclusive investment approach is uniquely useful for buildings whose occupants cannot access traditional funding assistance or consumer finance for building energy upgrades, which represents the majority of the U.S. population. Therefore, Inclusive Utility Investment is an important option that can reach households between the market segment currently eligible to be served by grant assistance programs for low-income households and the market segment eligible to be served by consumer finance products, an underserved market segment which has been deemed to be in the energy efficiency financing coverage gap or “donut hole” (Forrester and Reames 2020).

Inclusive Utility Investment requires that measures generate energy or resource cost savings in order to protect the interests of successor customers at that location to whom the cost recovery charge and the benefit of savings would apply automatically. Therefore, the PAY S system, with its 80% rule discussed above, will not find sufficient net savings from upgrades in buildings where the occupant is curtailing energy use or otherwise has no wasted energy to save. Its application is also limited by the structural integrity of the building. In order for an investment to be prudent and to proceed, a building must be sufficiently sound to continue serving its purpose during the period of cost recovery. In the case of structures where habitability for the duration of cost recovery is questionable (e.g. if a building has health and safety issues such as a leaky roof, cracked foundation, or major water and mold damage), the utility will have to defer that structure from participation in Inclusive Utility Investment until repairs have been made to remediate the building such that the useful life of the building is at least as long as the upgrades. It is estimated that 30 million residential units in the U.S. have major health and safety issues that currently

prevent participation in Inclusive Utility Investment (CAP 2016). Structural repair services, most likely as part of housing preservation and affordability initiatives, will need to be expanded to make this portion of the building stock upgrade ready. For these reasons, Inclusive Utility Investment programs are not a substitute for grant-based, free home weatherization programs. A comparison of general program characteristics between Inclusive Utility Investment programs and traditional consumer finance and U.S. government funding programs is summarized in Table 7.

Table 7. Inclusive Utility Investment compared and contrasted to funding and consumer financing

	U.S. Government Funding or Utility Ratepayer Spending	Inclusive Utility Investment	Consumer Financing
Capital is sourced from:	Ratepayers or Taxpayers	Utility capital markets with (<5% cost of capital recovered from participants)	Capital providers (>5% cost of capital)
Underwriting criteria evaluates:	Low-income qualification (e.g. at or below 200% Federal Poverty Line)	the savings opportunity of the location considering the structure and usage history	the person's credit, homeownership status, income, and assets
Obligation to Pay is Tied to:	NA	Meter	Property owner
Available to:	low-income qualified	all utility customers	only property owners that qualify
If the occupant moves, the payment obligation:	NA	automatically applies to the next occupant; owner is obligated to provide notice	stays with the person or must be bought by another party
When a participant defaults on payments:	NA	Disconnection for non-payment* then successor customer continues payments (0.1% loss rate) *customer have easier time paying a lower bill	a full write-down of all unrecovered funds is triggered (3-5% loss rate)

Note. NA=not applicable

Conclusion

By 2025, the U.S. utilities that will be operating or are committed through legislation or regulatory proceeding to offer Inclusive Utility Investment programs will represent a total addressable market of 27 million households (LibertyHomes 2022). In the future, if programs were offered by all utilities in the U.S., the total addressable market would be approximately 120 million residences (90 million immediately addressable and an additional 30 million once those are repaired to be upgrade ready). At this scale, the maximum technical investment potential of Inclusive Utility Investment at the current average energy efficiency investment per home of \$7,500 is \$630 Billion, which is 20 times that of the technical potential of traditional funding and 15 times that of consumer finance models as seen in Table 8 (Carley 2010; LBNL 2022; EEI 2022). The maximum technical investment potential, which is a function of the eligible target market, the average participation rate, and the average deal size, gives a sense of the relative scale of each type of funding or financing solution in the quest to decarbonize all buildings. If the typical Inclusive Utility Investment upgrade package were expanded from energy efficiency and electrification to include renewable energy and storage for a complete decarbonization upgrade

(~\$30,000/home), the technical investment potential for those cost-effective upgrades would be \$2.8 Trillion, enough to remove all emissions from the homes that participate and keep track with climate targets if invested over the next two decades. Despite its technical potential to channel more capital investments into building decarbonization, Inclusive Utility Investment is not a panacea and can be combined with funding and finance to accelerate the decarbonization of buildings in more countries.

Table 8. Investment potential of Inclusive Utility Investment funding and financing in the U.S.

U.S. Finance Type	Eligible U.S. Homes	Average Participation Rate over Lifetime of Program	Average Deal Size	Maximum Technical Investment Potential*	Average Default Charge-off Rate
Weatherization Assistance e	35,000,000	12%	\$7,500	\$31.5 Billion	NA
Consumer Finance	47,000,000	10%	\$9,000	\$42 Billion	3%
Inclusive Utility Investment at current program performance	120,000,000	80%	\$7,500	\$630 Billion	0.1%
Inclusive Utility Investment if upgrade package were expanded for complete decarbonization	120,000,000	80%	\$30,000	\$2.8 Trillion	0.1%

Sources. Carley 2010, LBNL 2022, EEI 2022

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