

Utility Led Acceleration of Residential Efficiency & Electrification Retrofits

A Feasibility Study of Tariffed
On-Bill Financing in Ipswich,
Massachusetts

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The Race to Decarbonize is On

With passage of [An Act Creating A Next-Generation Roadmap for Massachusetts Climate Policy](#) in March 2021, Massachusetts became legally bound to reducing carbon emissions by 50% below 1990 levels by 2030 and to achieving carbon neutrality by 2050. Buildings account for 27% of the state's carbon emissions¹ and are therefore, electrifying buildings along with greening the electric grid, is a key lever for reducing emissions (Fig. 1).

The path to achieving Massachusetts' 2030 decarbonization target is multi-faceted but for the residential building sector alone it means retrofitting over 1 million homes with high-efficiency insulation and clean heating (i.e., heat pumps) over the next eight years.¹ In round numbers, that's over 300 retrofits per day between now and 2030 and mobilization of over \$20 billion in residential investments.

Those are daunting numbers. But the good news—perhaps counterintuitively—is that the single biggest barrier to households making the energy transition is upfront capital cost. Public opinion is aligned with the energy transition: in Massachusetts (and similarly on a national scale), 77% of people believe climate change is real and 71% are worried about it.² We also know that most households will save money on operating costs by switching from fossil fuels to efficient electric equipment. According to Rewiring America, 94% of households in Massachusetts would save a combined \$876 million per year by adopting modern electric space and hot water heating equipment.³

If upfront capital cost is the barrier, tariffed on-bill financing (TOB) may be a pivotal tool for accelerating uptake of energy efficiency and electrification measures across the residential sector.

Imagine your utility told you they wanted to *invest in* state-of-the-art technology for your home. No taking on debt, no credit checks, no matter if you're a renter, and no matter if you plan to move soon. Your obligation? Paying a monthly tariff that sums to no more than the savings in energy costs afforded by the new measures. The tariff, tied to your electric meter, would extend for as long as it takes for the utility to recover its investment, and if you move, would simply transfer to the next occupant.

This is TOB. Unlike traditional on-bill financing, where a utility *makes a loan* to a property owner, thus requiring adequate credit history, willingness to take on debt, etc., TOB decouples capital improvements from the individual resident or business. It is a financing mechanism that enables upgrading properties with measures that reduce operating

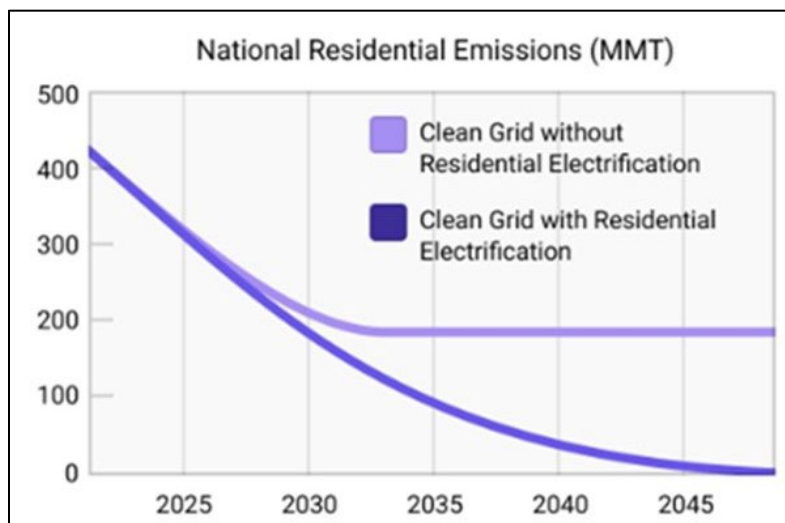


Figure 1. Residential building path to decarbonization.
Source: Rewiring America (2021). Massachusetts: Benefits of Household Electrification.

¹ Massachusetts Executive Office of Energy and Environmental Affairs and the Cadmus Group. (December 2020). [Massachusetts Decarbonization Roadmap](#).

² Yale Program on Climate Change Communication. (2021). [Yale Climate Opinion Maps 2021: Massachusetts Fact Sheet](#).

³ Rewiring America. (2021). [Massachusetts: Benefits of Household Electrification](#).

costs and improve the comfort, health, and environmental footprint of the building, all with little or no upfront capital investment from the ratepayer.

TOB sounds almost too good to be true. Like there's got to be a catch, right?

In fact, since the early 2000s, TOB has been implemented in eight states by 18 utilities. Data culled from existing TOB programs demonstrates the dramatic increases in eligibility, uptake, and scope of energy efficiency improvements compared to traditional on-bill financing (Fig. 2).

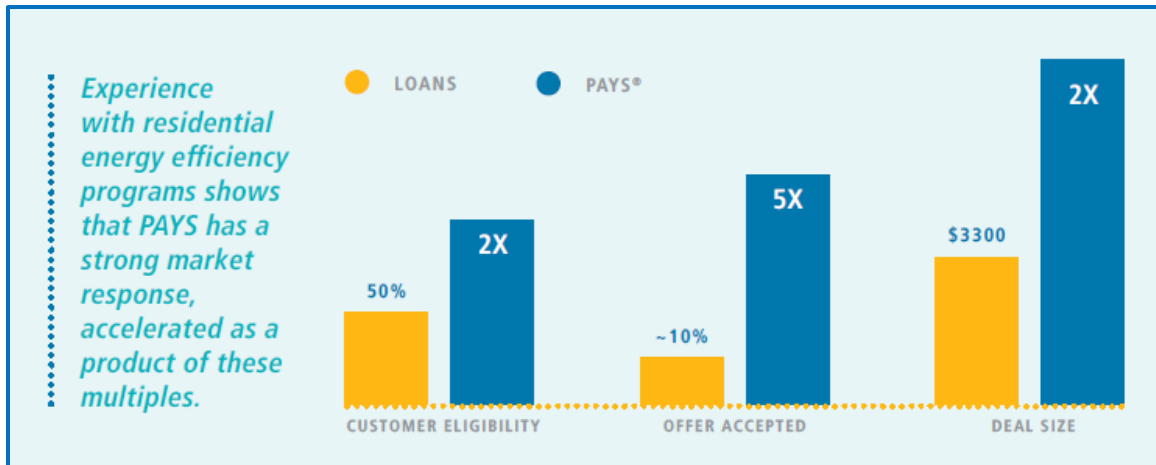


Figure 2. Comparison of eligibility, participation, and project size between traditional loans and Pay As You Save (PAYS) tariffed on-bill financing programs. Source: Mast, B., Hummel, H., Clinton, J. (2020). *Towards an Accessible Financing Solution: A Policy Roadmap with Program Implementation Considerations for Tariffed On-Bill Programs in California*. Building Decarbonization program, p 48 of 72.

The bottom line is that utilities are among the best investors for energy efficiency improvements:

- Utilities can afford long time horizons on investments and have access to low-cost capital pools. Conversely, residents chronically underestimate how long they'll own or occupy a building, which means they forgo investments that would be in their financial interest.
- Utilities have access to usage data that allows for making targeted investments where they'll have the greatest impact and be most cost effective (e.g., locations with weather-driven peak demand).
- A utility's financial, regulatory, and customer service incentives are well aligned; they can make a positive return on investment, comply with state-mandated decarbonization targets, and improve the health and comfort of customers all at once. Participating utilities report cost recovery rates of >99.8%—that's better than the cost recovery on the sale of power!⁴

Prospects for TOB in Massachusetts

Most existing TOB programs are in the Southeast U.S. where the climate is relatively mild, and where the focus of the programs is on reducing electricity consumption by insulating homes and transitioning from electric resistance heating and inefficient air conditioners to electric heat pumps. Here in Massachusetts, the Center for EcoTechnology (CET) and the Ipswich Electric Light Department (ELD) wondered if TOB could be deployed to cost-effectively transition homes

⁴ Mast, B., Hummel, H., Clinton, J. (2020). [Towards an Accessible Financing Solution: A Policy Roadmap with Program Implementation Considerations for Tariffed On-Bill Programs in California](#).

from fossil fuels to heat pumps (i.e., electrify homes), and to undertake deep energy retrofits, including comprehensive weatherization and installation of solar PV and batteries.

The feasibility study was carried out between 2021 and 2022 and comprised three components: 1) An analysis of which measures, on average, would save enough money in operating costs that they could be financed using TOB with little or no upfront cost to the customer; 2) A survey of utility customer interest and likely uptake; and 3) A business case analysis for the Ipswich ELD to study program costs, grid-wide benefits, and the expected return on investment from the program.

Feasibility study methods

Energy Efficiency and Electrification Measure Litmus Test

CET modeled the feasibility of using TOB to finance four distinct measures: weatherization, heat pump hot water heaters, air source heat pumps, and solar PV plus battery storage. The installation and savings costs of each measure were analyzed for three typical residential building types in Ipswich, MA: 11-unit apartment building (each 2-bedroom, 900 sq. ft); small-medium home (1900 sq. ft); large home (3500 sq. ft). Table 1 shows the key assumptions and permutations considered for each of the modelled measures across the three building types.

Table 1. List of measures included in the tariffed-on bill (TOB) measure litmus test, key assumptions, and permutations considered for each measure.

Measure	Key Assumptions	Measure Permutations
Weatherization	Measure results in 10% energy savings across all housing types	Comprehensive air sealing and insulation
Heat pump hot water heaters		Apartment: <ul style="list-style-type: none"> • Whole building • In-unit
Air source heat pumps (ASHP)	ASHP HSPF (heating seasonal performance factor): 10.3	All buildings: <ul style="list-style-type: none"> • ASHP installed with and without weatherization • Oil-to-ASHP conversion (no Mass Save incentives) • Gas-to-ASHP conversion (access to Mass Save incentives) • 1-ton single-zone system • Whole-home multi-zone system (sized according to building sq. footage) with and without electric panel upgrade
Solar PV + battery storage	Apartment: 30 kW system Single-family homes: 9 kW system	All buildings: <ul style="list-style-type: none"> • Solar PV • Solar PV + battery

The objective of the modeling exercise was to determine, on average, which measures could yield enough savings in operating costs to pay for the capital installation over the life of the measure. Model inputs included equipment installation costs based on available market data; incentives available to Ipswich Electric Light Department customers; baseline energy costs derived using building square footage and household heating assumptions from the Massachusetts Department of Energy Resources (DOER); post-installation operating costs using baseline assumptions and new equipment specifications; and measure lifetime.

The feasibility constraints in the model were two-fold: 1) The portion of total estimated savings that can be paid toward capital recovery; and 2) the portion of the measure life over which capital can be repaid. Results reported here assume upper limits of 80% of total estimated savings being paid toward capital recovery with a maximum repayment period

equal to the full measure life. So, if a measure is estimated to save \$1000 over its 10-year lifetime, the maximum cumulative tariff payment would be \$800 over 10 years (equating to a tariff of approximately \$6.70/month).

Customer Uptake

The market research firm, Great Blue Research conducted digital and telephone surveys of Ipswich Utilities customers to capture opinions of overall satisfaction, gauge the importance of several characteristics to customers, and to measure interest in tariffed on-bill financing. Surveys comprised 50 questions and were conducted in January 2022. A total of 325 residential surveys were completed, yielding results with a 5.4% margin of error at the 95% confidence interval. An additional 25 commercial customers responded to the survey, yielding results with a 19.2% margin of error at the 95% confidence interval.

Utility, Participant, & Ratepayer Impacts

The UMass Collins Center for Public Management, in collaboration with Clean Energy Works, utilized a proprietary energy project finance model developed by Cadmus, to project the financial and energy impacts of a proposed TOB program for the Ipswich ELD, program participants, and ratepayers. Results reported in this paper focus on the impact of the program to the utility. The Collins Center also spoke with Massachusetts regulators and implementers elsewhere in the country to identify any potential legal or regulatory obstacles to implementing TOB.

Table 2. Model inputs and associated assumptions and sources used in Clean Energy Works’ energy project finance model.





Model Inputs	Assumptions & Sources
Primary inputs	<ul style="list-style-type: none"> • Proxy wholesale energy cost data • Retail energy rates • Data from existing tariffed on-bill programs to inform upgrade savings and program administrative costs • Data from the U.S. Energy Information Administration regarding utility sales and customers.
Program size	<ul style="list-style-type: none"> • 3,600 participants over 5 years (inferred based on the number of rebates issued in 2021)
Tariff conditions	<ul style="list-style-type: none"> • Cost recovery is capped at 80% of estimated measure savings • Tariff tenure is capped at 80% of the measure life (note this is different from the assumption in the measure feasibility litmus test conducted by CET and described above)
Financial	<ul style="list-style-type: none"> • Interest rate = 2.14% • Discount rate = 5% • Societal benefits and costs discount rate = 3%

Feasibility Study Results

Energy Efficiency and Electrification Measure Litmus Test

As shown in Table 3, most of the measures considered can be financed with TOB with little or no upfront capital costs for the customer. This means that installed measures would generate sufficient operating cost savings that no more than 80% of the savings would be sufficient to fully recover the capital cost over the life of the measure. Weatherization, heat pump hot water heaters, and solar PV plus battery storage are readily financeable with TOB. The feasibility of financing heat pumps is greatly improved when the measure can be bundled with weatherization (Table 3). This increases the differential between historic energy costs and post-installation energy costs, which leaves more savings available for repayment and it has potential to decrease the size and cost of the whole-home heat pump system. Those customers heating with natural gas would be eligible for Mass Save incentives (\$10,000 for the whole home), which are considerably larger than those offered by Ipswich ELD, subsequently making the whole-home gas conversion more economically favorable than oil for large homes in our analysis.

Table 3. Feasibility of financing each energy efficiency and electrification measure using TOB. Assessment is based on the size of the expected upfront cost to the customer. Results account for incentives currently available to customers from the Ipswich Electric Light Department and Mass Save, where applicable.

	Apartment	Small-Medium Home	Large Home
Weatherization	✓+++	✓+++	✓+++
In-unit heat pump hot water heater	⊘	NA	NA
Building heat pump hot water heater	✓+	✓+++	✓+++
Solar PV + battery storage	✓+++	✓+++	✓+++
Air source heat pump – gas conversion			
1-ton heat pump (gas conversion)	✓+	✓+++	✓+
Whole-home heat pump no weatherization (gas conversion)	⊘	✓+++	✓
Whole-home heat pump with weatherization (gas conversion)	✓+++	✓+++	✓+++
Air source heat pump – oil conversion			
1-ton heat pump (oil conversion)	✓+++	✓+++	✓+++
Whole-home heat pump no weatherization (oil conversion)	✓+	✓+	✓
Whole-home heat pump with weatherization (oil conversion)	✓+++	✓+	✓+
 High/prohibitive upfront customer payment required	 Moderate upfront customer payment likely required	 Low upfront customer payment may be required	 No upfront customer payment is likely required

Customer Uptake

Results from the customer survey conducted by Great Blue Research show overwhelming interest in participating in a TOB program. After reading or hearing a description of TOB, 75.1% of respondents indicated that they would be interested in enrolling in the program, another 5.8% were neutral and 7.1% unsure, leaving 12% of the sample stating they were not interested. When asked if TOB would be more attractive than a zero-interest loan, many respondents indicated yes, because “there’s no financial burden”.

The majority of those who were unsure about their preference indicated they needed more information. When asked about the barriers to energy efficiency, “upfront capital cost” was the leading driver for 28% of residential respondents; “knowledge/information/direction” was the second most common barrier at 17.5% of residential respondents.

Utility, Participant, & Ratepayer Impacts

Results of the Clean Energy Works’ analysis indicate a 29% rate of return for the Ipswich ELD and a net present value of over \$32.5 million under the modeled assumptions. The average value generated for the utility by each individual participant is nearly \$10,000, which is a combination of avoided demand costs and increased contribution margin (i.e., revenue less the cost of power). This makes a strong case for not only investing in the program but for considering additional incentive payments to participants facing upfront costs, as there is a significant opportunity cost when a customer declines to participate.

For the first 3,600 program participants, approximately 50% of the utility’s customer base, Ipswich ELD would incur costs of approximately \$59.2 M between retrofit costs, all of which are recovered over time (58% of total costs), program operation costs (3% of total costs), and Ipswich ELD’s existing incentives (39% of total costs) (Table 4). Because existing utility incentives are already being paid, they were not included in the NPV calculation for the tariffed on-bill program.

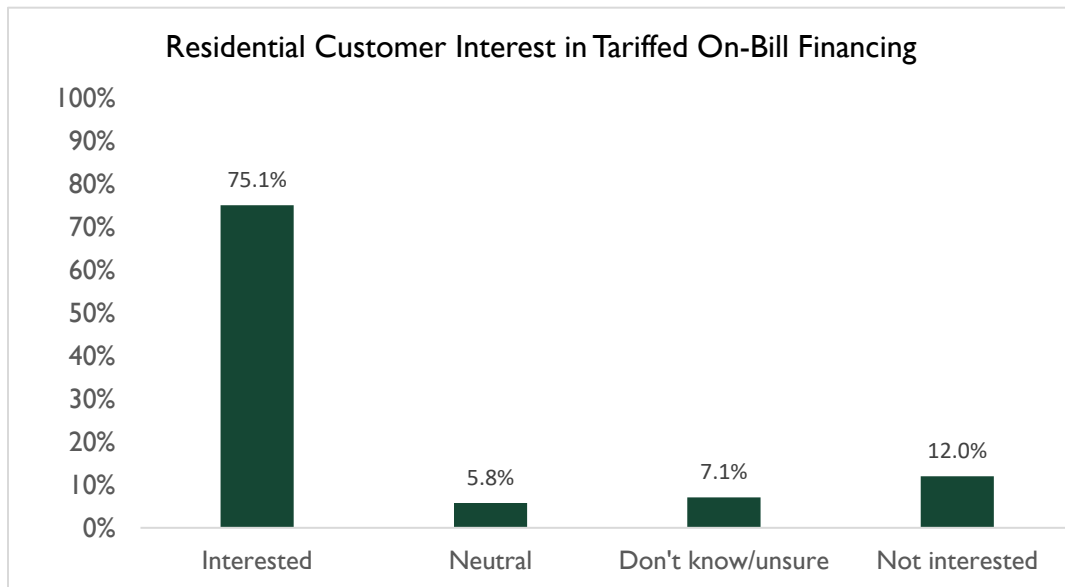


Figure 3. Survey responses (n = 325) from Ipswich Electric Light Department customers asked about their interest in enrolling in a tariffed on-bill financing program to undertake energy efficiency and electrification measures in their home.

Table 4. Estimated net present value of the proposed tariffed on-bill financing program for the Ipswich Electric Light Department.

Cost/Benefit	Value
Avoided Energy Costs	\$9,726,346
Avoided Demand Costs	\$480,999
Utility Retrofit Cost	(\$34,507,181)
PAYS Cost Recovery	\$38,723,781

Utility Electrification Revenue	\$35,868,562
Program Operation Costs	(\$1,806,930)
Utility Incentive	(\$22,911,132)
Total Utility NPV	\$32,518,608
Utility Rate of Return	29%

What's next?

Given the positive results of the feasibility study, Ipswich ELD plans to move ahead with implementing a tariffed on-bill financing program. They are doing so with support from the Massachusetts Municipal Wholesale Electric Company (MMWEC) and several other MLPs that aim to implement the program in the near term. In addition to the favorable analytic outcomes, the feasibility study revealed a smooth legal and regulatory path for a municipal light plant implementing TOB in Massachusetts. The utility is applying for a 0% interest credit line from the U.S. Department of Agriculture's Rural Energy Savings Program to capitalize the program. Together, CET and Ipswich ELD are defining the terms and conditions for the program and developing the necessary tools, processes, and materials for implementation. They hope to launch in early 2023.

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