DNV·GL

RESIDENTIAL CUSTOMER PROFILE REPORT: 2013 - 2015

Executive summary

SAFER, SMARTER, GREENER

CONTENTS

3 KEY FINDINGS

4 DATA TYPES
PA-provided data
Third-party data

5 ELECTRIC & GAS COMBINED
Customer population summary by building type
2015 gas and electric end uses
Electric and gas contribution ratios over time

9 ELECTRIC SUMMARY
Electric savings and consumption by block group poverty rate
Electric savings and consumption by block group renter rate
Electric population savings achieved
Electric cross-initiative participant movement

13 GAS SUMMARY
Gas savings by block group
Gas population savings achieved
Electric cross-initiative participant movement

Coming soon!
2017 Residential Customer Profile report - anticipated in spring 2019

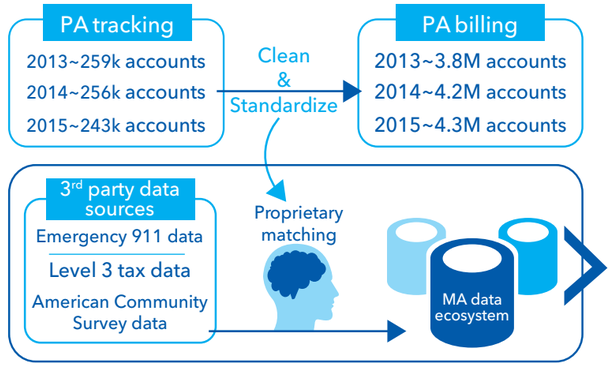
THE PROJECT

The 2013–2015 Residential Customer Profile report offers diverse views of participation, savings, and geographic dynamics within the Massachusetts Program Administrators' (PAs') residential energy efficiency programs.

The overall goals of the Residential Customer Profile project are:

- To integrate the PAs' billing and tracking data into the MA Residential Evaluation Database
- To analyze this data to explore evolving trends and their implications in the residential energy efficiency landscape[1,2]

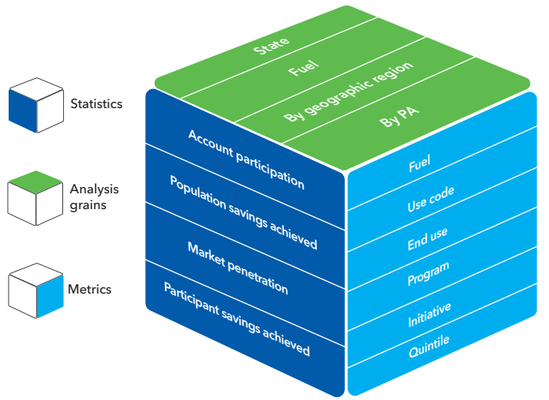
THE DATA



*Tracking does not include behavioral or upstream lighting accounts.

- In its integration of diverse data sources, the Residential Customer Profile has the potential to show the PAs not only **where** they can focus their efforts, but what **building characteristics** and **socioeconomic factors** exist in each area of potential focus.

THE ANALYSIS



The cube to the left shows some possible permutations of the analysis. Based on the data collected and the ways that different datasets can talk to one another, these **statistics** can be calculated for each of these **metrics** at these various **levels of granularity**:

For instance, it's possible to calculate **account participation** by **end use** for **gas**, or to calculate **market penetration** by **program** within a certain **geographic region**.

[1] All data is presented in accordance with the Department of Public Utilities rules to protect individual customer confidentiality. Additional PA data summaries, reports including the Commercial and Industrial Customer Profile reports for 2011 – 2016, and the most recent quarterly filed net and impact adjusted PA data can be found online at www.MassSaveData.com and on the MA EEAC website at www.ma-eeac.org.
[2] For the full 2013-2015 Residential Customer Profile, see http://ma-eeac.org/studies/

KEY FINDINGS

There are geographic differences in program participation and savings, within and across PAs.

Each year, electric customers saved 2% to 4% of their consumption. For gas, customers saved 0.5% to 1.5%.

Electric customers saved the most energy though the Residential Products program, chiefly due to upstream lighting. However, savings per replaced bulb are likely to decrease over time as the lighting market changes, and LEDs become increasingly prevalent in homes.

The Home Energy Services initiative within the Whole House program helped a large number of customers participate and save energy. Customers in the larger cities participated less than in other areas of the state.

From 2013-2015, 14.5% of electric customers and 10.8% of gas customers participated in a PA program. Because upstream lighting data can't be linked to individual customers, it's likely that the actual electric participation rate is higher than 14.5%.

Low- and high-participation areas are not random, but vary according to their geography.

Census block groups with the highest proportion of low-income households saved energy at a rate similar to block groups with the lowest proportion of low-income households. However, there is substantial variation in savings from block group to block group across the population. Notably:

- The data only allows us to look at block groups as a whole, not at individual buildings or customers. We cannot extend block group attributes to individual customers.
- Block group analyses provide quantitative metrics. They do not yield insight into the effectiveness of program design, outreach strategies, PA efforts, or other qualitative factors.

Participation is more challenging to assess. Low-income populations are not demographically or geographically static over time, and data for multifamily buildings served by C&I programs may be captured only at the facility level.

DATA TYPES

PA-provided data

The PAs' customer billing and energy efficiency program tracking data form the foundation of the Customer Profile analysis. In order for the billing data and tracking data to "talk" to one another at the account level used in the Customer Profile, we must merge these two datasets together, matching accounts in the billing data to accounts in the tracking data. The table below shows the success rate of merging the 2013-2015 billing and tracking data.

Tracking to billing data merge success rates, 2013 - 2015*

Fuel	PA	2013		2014		2015	
		Tracking accounts	Merge success rate	Tracking accounts	Merge success rate	Tracking accounts	Merge success rate
Electric	Cape Light Compact	10,165	90%	13,700	97%	13,782	93%
	Eversource	63,580	79%	80,958	91%	78,389	91%
	National Grid	99,023	66%	81,549	99%	70,199	98%
	Unitil	497	94%	741	87%	1,096	90%
	Electric Total	**173,265**	**72%**	**176,948**	**95%**	**163,466**	**94%**
Gas	Columbia	12,655	97%	12,292	62%*	13,473	94%
	Eversource	14,545	96%	12,603	90%	14,263	95%
	National Grid	55,333	77%	50,996	97%	48,330	96%
	Small Gas PAs	3,393	68%	3,155	91%	3,478	91%
	Berkshire Gas Co.	2,073	85%	2,132	89%	1,774	83%
	Liberty Utilities	1,193	38%	741	100%	1,374	100%
	Unitil Gas	127	78%	282	81%	330	96%
	Gas Total	**85,926**	**83%**	**79,046**	**90%**	**79,544**	**95%**
	Grand Total	**259,191**	**76%**	**255,994**	**93%**	**243,010**	**95%**

*When an account number was not available in the tracking data, DNV GL used the physical address in the tracking data to spatially locate the data. This had a particularly important impact for programs, such as multifamily, that are captured by some PAs at the facility level only, and that can cross between residential and commercial/industrial sectors.
*Columbia's 62% merge rate in 2014 resulted from a change in tracking systems midway through the year.
*Upstream and behavioral data are excluded from this table.

Third-party data

To make the analysis more meaningful and useful, we also incorporate data from other sources, called third-party data. The sources we rely on most heavily are the Emergency 911 geographic data, the MA Level 3 tax assessment data, and the American Community Survey data.

The **Emergency 911 geographic data** is a detailed list linking address information (for houses, buildings, apartment blocks, etc.) to corresponding latitudes and longitudes. This source allows us to place nearly every PA customer at a precise geographic location, so we know where, geographically, program activity is occurring. This includes placing facility-level tracking data without account numbers, and C&I data for multifamily locations and housing authorities.

The **MA Level 3 tax assessment data** comes from each town's tax assessor. It contains information about sales, building type, building age, and ownership, and classifies every building into one of several hundred building use codes (like "apartments with 4-8 units" and "residential condominium"). To make this data practical, we simplify these detailed codes into 4 main building types: single family, multifamily, condominium, and other. With these 4 main types, we can show each PA the makeup of its customer and participant building population.

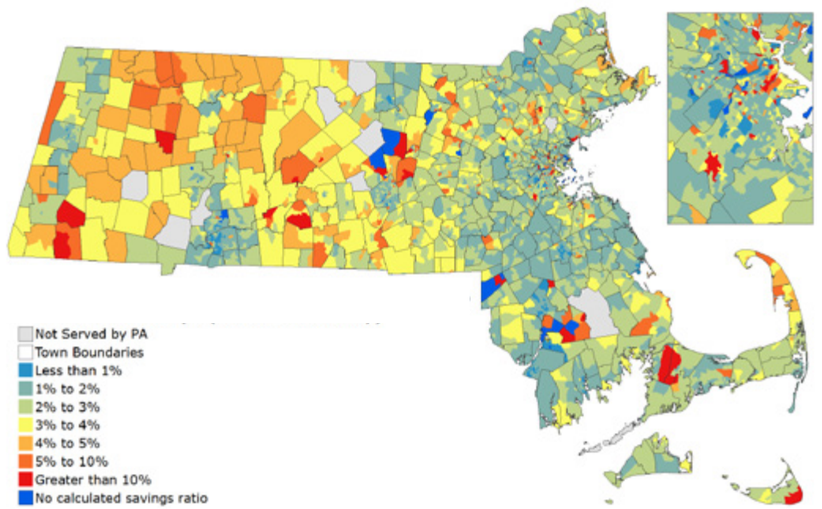
American Community Survey data is collected by the US Census Bureau. It includes numerous details such as languages spoken, income, travel times, building age and building ownership. Notably, these details are not publicly available at the building level, but at the level of the **block group**—a unique group of roughly 600 to 3,000 people covering a contiguous area. We divide block groups into 5 equal sub-groups, called **quintiles,** that help show what proportion of a given block group is below the poverty index, lives in rental properties, etc.

ELECTRIC & GAS COMBINED

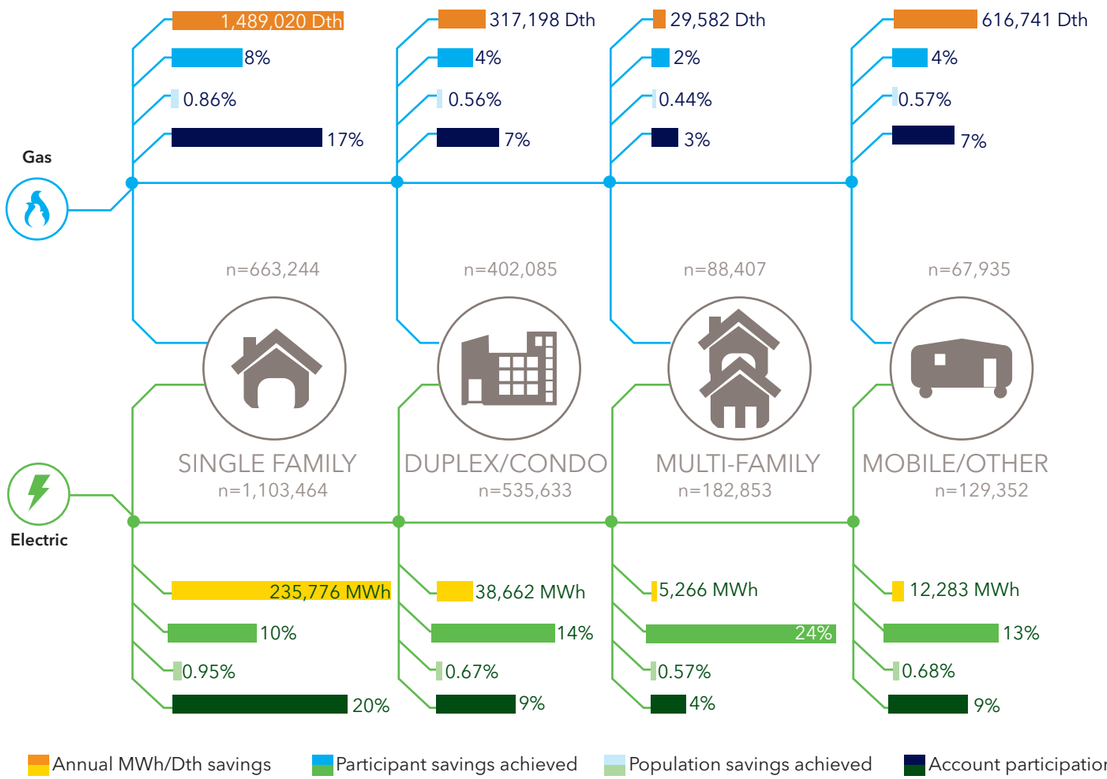
Combined electric and gas participant savings in 2014 and 2015 for all PAs (Boston in inset map)

This map shows PA savings achieved by the population of electric and gas customers across Massachusetts, converted from kWh and therms to common units of MMBTU. Where applicable, it includes behavioral savings and all modeled upstream lighting savings, the latter of which substantially impacts savings in population-dense areas.

The map does not show consumption or savings for delivered fuels or municipal-served fuels, as this data is not available. This means that towns that heavily use delivered or municipal-served fuels, like much of Western Massachusetts, might look like they have higher savings than they actually do. All maps and scatterplots in this summary include C&I multifamily and Housing Authority savings and consumption.

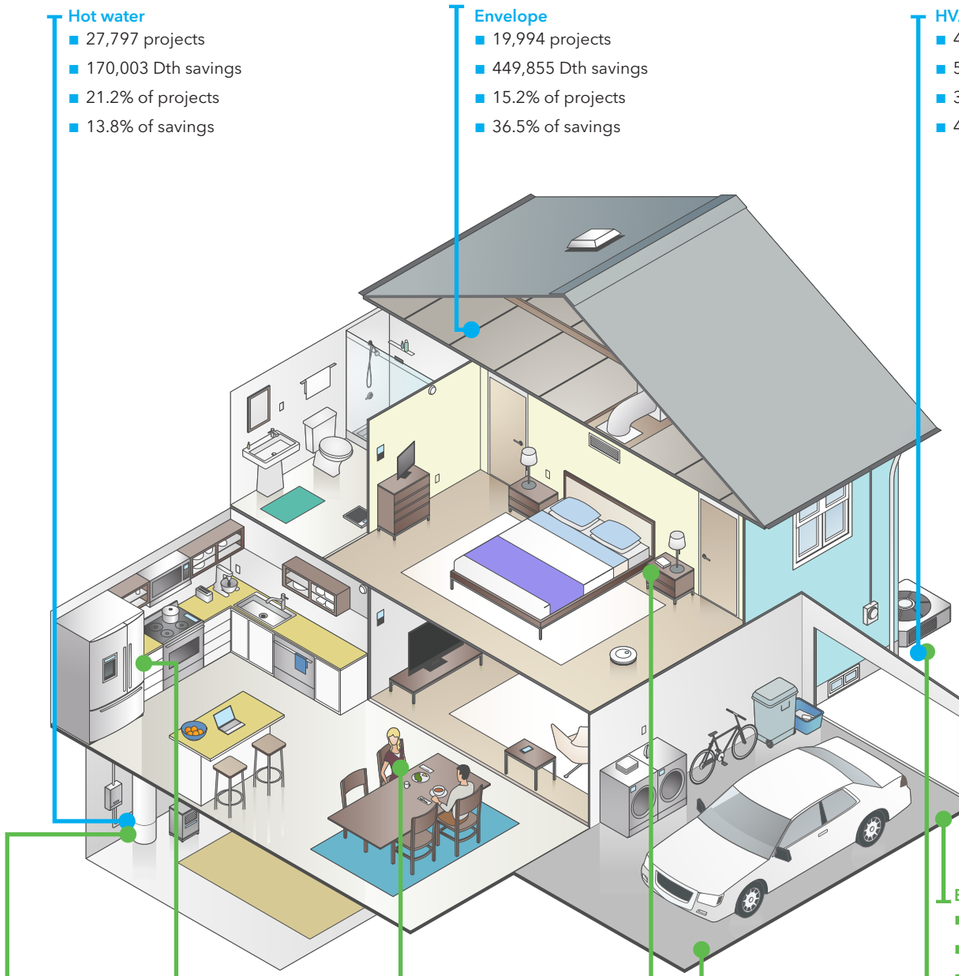


2013-2015 electric and gas customer summary statistics by building type



2015 gas and electric end uses*

Gas end use



Electric end use

*Note that percentages do not add up to 100%, because "uknown/missing" and "other" measures are excluded from this graphic.
** See http://ma-eeac.org/wordpress/wp-content/uploads/TRM_PLAN_2013-15.pdf

The table below shows the number of all unique accounts for each PA in each year. This includes accounts that closed during the year, and is the most conservative capture of the PA population.

Number of billing records per year, 2013-2015

Fuel	PA	Unique accounts			Total unique accounts 2013-2015
		2013	2014	2015	
Electric	Cape Light Compact	180,206	188,763	189,085	222,061
	Eversource	1,003,553	1,000,134	1,034,366	1,329,330
	National Grid	1,088,372	1,350,992	1,357,853	1,577,323
	Unitil	30,392	30,147	30,574	41,627
	Electric total	**2,302,523**	**2,570,036**	**2,611,878**	**3,170,341**
Gas	Columbia	310,950	322,231	325,615	443,182
	Eversource	303,948	251,024	287,088	393,854
	National Grid	761,384	931,260	938,407	1,076,364
	Small Gas PAs	*95,791*	*97,156*	*99,000*	*131,747*
	Berkshire Gas Co.	33,660	34,307	31,057	45,009
	Liberty Utilities	46,420	49,635	50,150	63,943
	Unitil Gas	15,711	13,214	17,793	22,795
	Gas total	**1,472,073**	**1,601,671**	**1,650,110**	**2,045,147**

The next table shows the number of unique participants and the gross savings for each PA each year (these tables present PAs' gross savings, which differ from the net savings that PAs report elsewhere). While some programs, such as multifamily, do not capture individual account numbers, we include the savings from those programs here. Thus, the participant number is likely understated.

Number of program participants per year, and savings per year, 2013-2015*

Fuel	PA	2013		2014		2015		Total unique 2013-2015	
		Participants	Savings	Participants	Savings	Participants	Savings	Participants	Savings
Electric (kWh)	Cape Light Compact	10,166	19,752,399	13,700	23,538,306	13,782	22,307,932	31,915	65,598,637
	Eversource	63,581	225,147,423	80,960	281,877,280	78,390	241,491,862	199,164	748,516,565
	National Grid	99,024	262,863,937	81,550	319,718,064	70,200	261,872,940	226,607	844,454,941
	Unitil	498	3,085,875	742	3,416,622	1,097	4,035,786	2,190	10,538,283
	Electric total	**173,269**	**510,849,634**	**176,952**	**628,550,272**	**163,469**	**529,708,521**	**459,876**	**1,669,108,427**
Gas (therms)	Columbia	12,655	1,918,418	12,292	2,056,692	13,473	2,522,227	36,141	6,497,337
	Eversource	14,545	2,245,010	12,603	2,380,788	14,263	2,391,415	37,414	7,017,212
	National Grid	55,333	6,308,242	50,996	7,478,607	48,330	6,880,526	137,607	20,667,374
	Small Gas PAs	*3,393*	*511,196*	*3,155*	*547,550*	*3,478*	*524,529*	*9,179*	*1,599,004*
	Berkshire Gas Co.	2,073	291,776	2,132	267,599	1,774	240,551	5,460	799,927
	Liberty Utilities	1,193	148,360	741	185,882	1,374	190,428	3,014	540,400
	Unitil Gas	127	71,060	282	94,068	330	93,550	705	258,677
	Gas total	**85,926**	**10,982,865**	**79,046**	**12,463,636**	**79,544**	**12,318,696**	**220,341**	**35,780,928**

* If an account participated in multiple programs in a year, it is only counted once in this table.
* Participant numbers exclude behavioral data. Savings numbers include behavioral data.
*Some PAs' multifamily data is only captured at the account level. This means that while savings are accurate in this table, for those PAs, the participant count is likely understated.

It's important to recognize the role of upstream lighting data in these tables. Upstream programs provide incentives higher up on the distribution chain, such that stores sell customers efficient bulbs, fixtures, etc. at a discount. While these upstream lighting sales result in sizeable savings for the PAs, these sales are only captured at the store level, and the data is not available to tell us which individual customer participated by purchasing the discounted equipment. As a result:

- Participation rates are likely to be conservative, since households that participated in an efficiency program only through an in-store purchase don't get counted as participants.
- While upstream lighting participation doesn't get counted, upstream lighting savings do. This means that dividing savings by participants is unlikely to result in an accurate average savings level. (This is not the case for graphics that don't include any upstream data.)

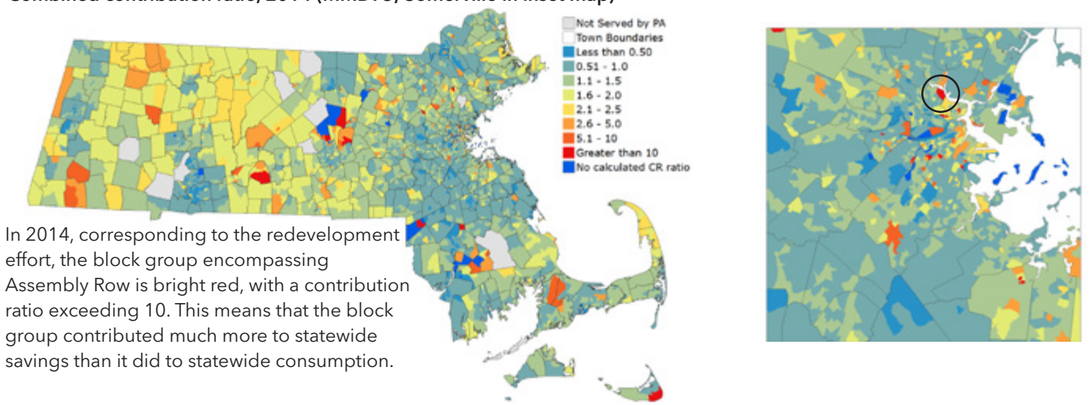
Additionally, customers who participate through multifamily programs often get counted at a master meter level rather than individually. This is another way that participation numbers can look lower than they actually are.

Electric and gas contribution ratios over time

Contribution ratios show how much a block group contributed to the state's total savings relative to how much the same block group contributed to the state's total consumption (e.g., 1 means that the savings share is exactly proportional to the consumption share).

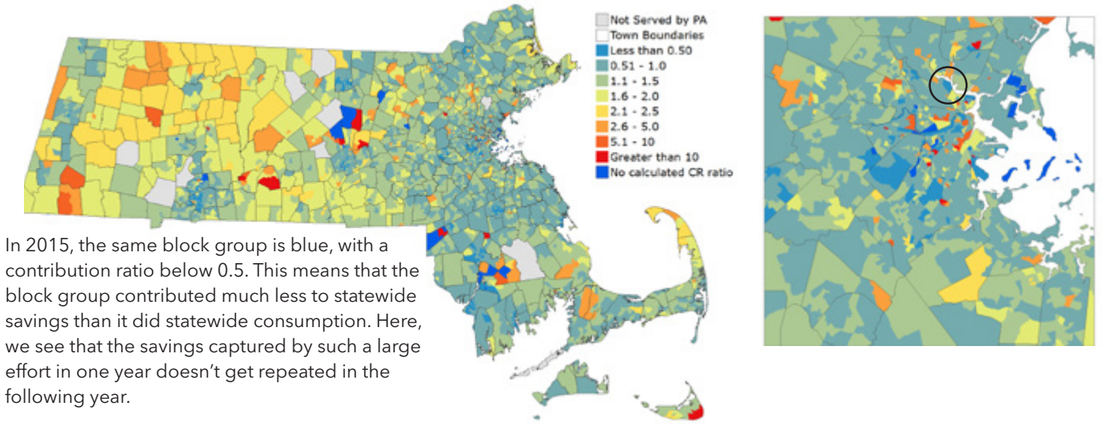
Contribution ratios vary from year to year. Within individual towns, a single project--particularly multifamily or new construction--can substantially affect the yearly contribution ratio. For example, the Assembly Row apartment complex in Somerville underwent a major redevelopment effort in 2014. (This block group is circled on the maps below.)

Combined contribution ratio, 2014 (MMBTU; Somerville in inset map)



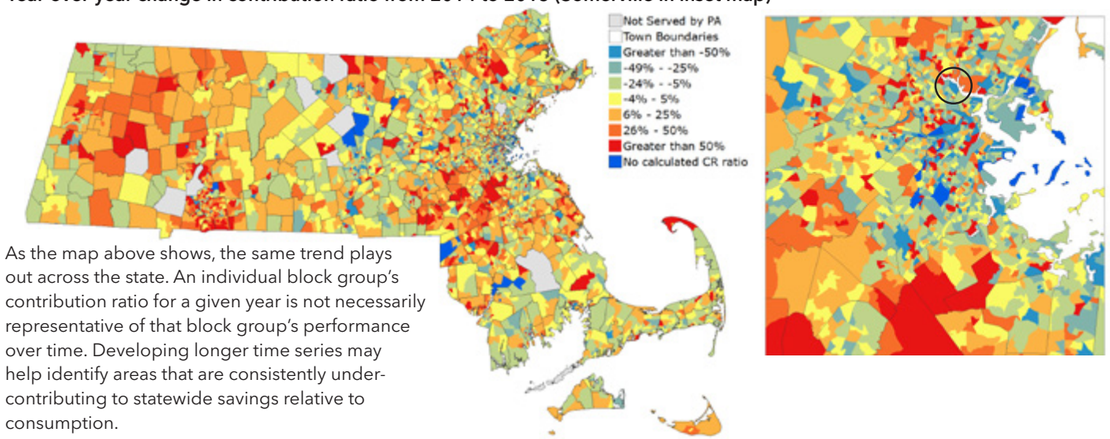
In 2014, corresponding to the redevelopment effort, the block group encompassing Assembly Row is bright red, with a contribution ratio exceeding 10. This means that the block group contributed much more to statewide savings than it did to statewide consumption.

Combined contribution ratio, 2015 (MMBTU; Somerville in inset map)



In 2015, the same block group is blue, with a contribution ratio below 0.5. This means that the block group contributed much less to statewide savings than it did statewide consumption. Here, we see that the savings captured by such a large effort in one year doesn't get repeated in the following year.

Year-over-year change in contribution ratio from 2014 to 2015 (Somerville in inset map)



As the map above shows, the same trend plays out across the state. An individual block group's contribution ratio for a given year is not necessarily representative of that block group's performance over time. Developing longer time series may help identify areas that are consistently under-contributing to statewide savings relative to consumption.

ELECTRIC SUMMARY

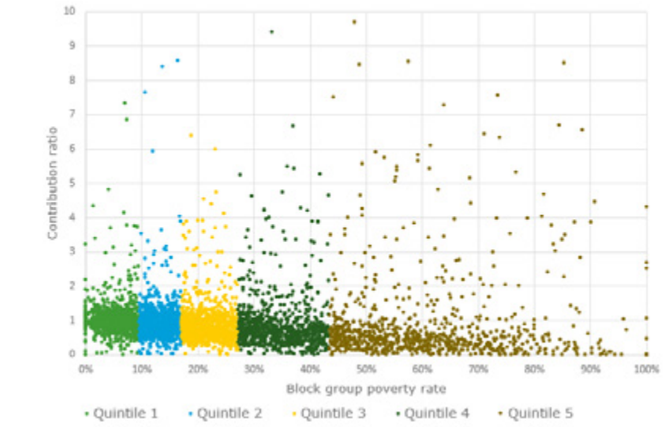
Savings and consumption by block group poverty rate

Combined 2014 & 2015 electric savings by poverty range

	2014 and 2015 electric MMBTU consumption	2014 and 2015 electric MMBTU savings	Quintile population average savings ratio	Quintile poverty range
1 - Low poverty ratio	27,334,002	392,292	1.44%	Zero to 9.5
2	25,593,094	348,991	1.36%	9.5 to 17.0
3	22,953,947	296,784	1.29%	17.0 to 27.2
4	19,230,317	236,847	1.23%	27.2 to 43.4
5 - High poverty ratio	14,230,743	206,944	1.45%	43.4 to 100
Grand Total	**109,342,103**	**1,481,859**	**1.36%**	

The above table summarizes population savings within each quintile. The highest two savings ratios are found in the quintiles with the highest poverty ratio and the lowest poverty ratio, respectively. This could be related to a possible correlation between low-income and multifamily buildings, and further, to the PAs' low-income and multifamily programs. Graphics on this page do not include upstream lighting or behavioral savings.

Scatterplot of combined 2014 & 2015 block group contribution ratio by poverty rate

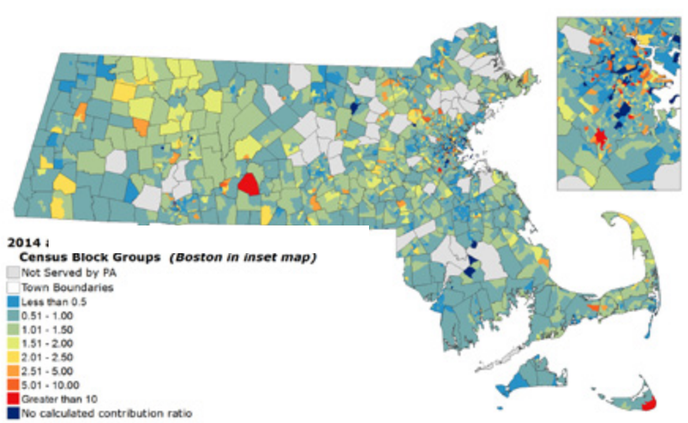


This scatterplot illustrates electric contribution ratio in 2014 and 2015 relative to poverty ratio for block groups across Massachusetts. It shows:

- The 4,364 electric PA-served block groups in Massachusetts, divided equally into 5 quintiles, and ranked by lowest to highest proportion of households in poverty
- Which quintile each block group falls into
- Each block group's contribution ratio for 2014-2015.

The scatterplot illustrates the variability within quintiles, the existence of outlier points, and the similarities between block groups across adjacent quintiles, particularly when the block groups fall near the quintile breakpoints.

Combined 2014 & 2015 electric contribution ratio by census block group (Boston in inset map)



This contribution ratio map shows that individual block group contribution ratios vary greatly within PA service territories, and even within towns. Boston includes areas with no contribution ratio (like the Fenway, Boston Commons, and the industrial part of Chinatown) as well as block groups with contribution ratios exceeding 1, like the Mission Hill area.

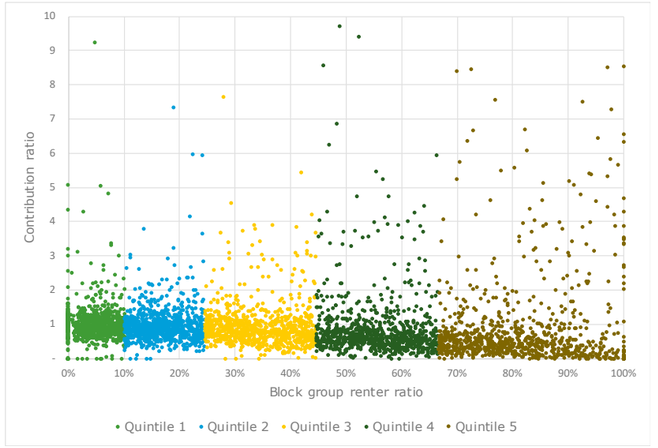
Savings and consumption by block group renter rate

Combined 2014 & 2015 electric savings by poverty range

	2014 and 2015 electric MMBTU consumption	2014 and 2015 electric MMBTU savings	Quintile population average savings ratio	Quintile renter range
1 - Low renter ratio	27,578,491	390,433	1.42%	Zero to 10.2
2	27,253,216	362,412	1.33%	10.2 to 24.7
3	21,932,356	291,582	1.33%	24.7 to 44.7
4	18,247,570	228,168	1.25%	44.7 to 66.6
5 - High renter ratio	14,344,213	209,465	1.46%	66.6 to 100
Grand Total	**109,355,846**	**1,482,061**	**1.36%**	

The above table summarizes population savings within each quintile, as defined by the proportion of renter-occupied households. Even when accounting for common areas that might be under C&I rate codes, block groups with the highest proportion of renter-occupied households used less than half the energy used by block groups with the lowest proportion of renter-occupied households. This could partially be due to many rental spaces, like apartments, being smaller than many single-family homes. Graphics on this page do not include upstream lighting or behavioral savings.

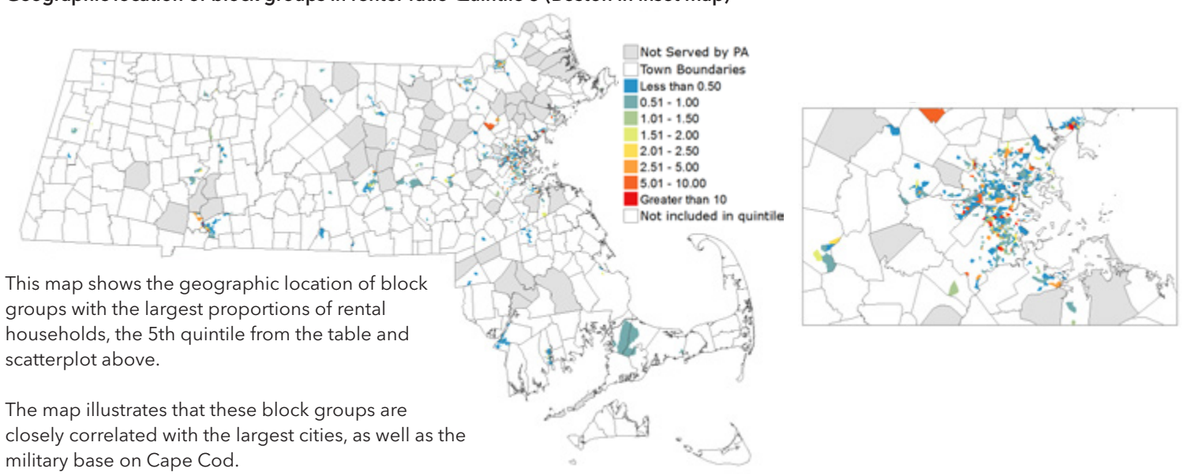
Scatterplot of combined 2014 & 2015 block group contribution ratio by renter rate



This scatterplot illustrates electric contribution ratio in 2014 and 2015 relative to renter ratio for block groups across Massachusetts. Higher block group renter ratios indicate more renter-occupied households.

The scatterplot shows variability within quintiles. It also shows that as the proportion of renters increases, so does the prevalence of outlier contribution ratios. As the bottom map shows, block groups with the highest renter ratios tend to exist in large cities, where rental homes are more likely to be in multi-unit buildings. Many of these building owners participate in energy efficiency by treating multiple units at one time. This approach can cause spikes in contribution ratio and outlier points for individual block groups over the short term.

Geographic location of block groups in renter ratio Quintile 5 (Boston in inset map)

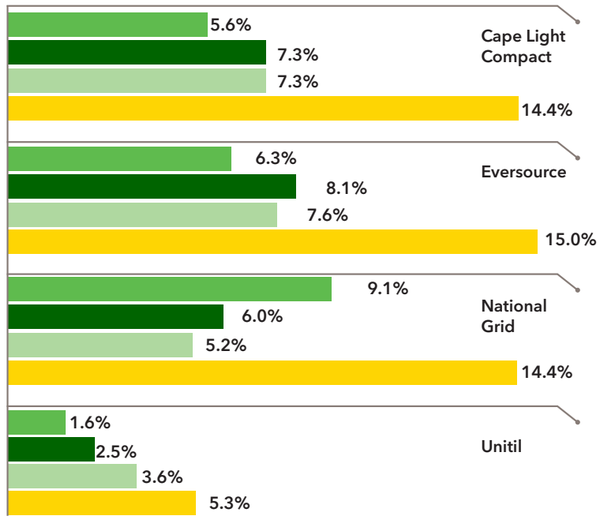


This map shows the geographic location of block groups with the largest proportions of rental households, the 5th quintile from the table and scatterplot above.

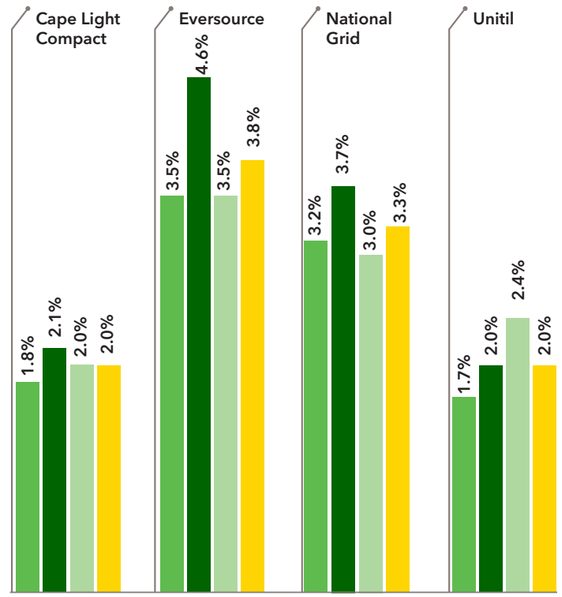
The map illustrates that these block groups are closely correlated with the largest cities, as well as the military base on Cape Cod.

These two charts show time series of electric participation rates, including upstream data, and electric savings rates.

Electric account participation

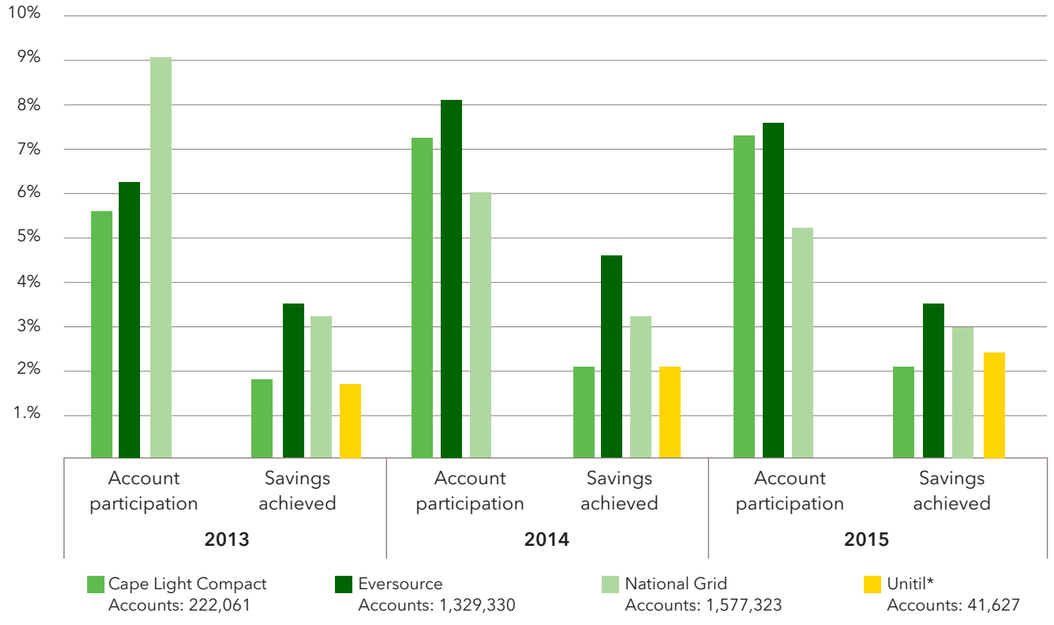


Electric savings



The chart below shows the number of accounts, the participation rate, and the savings achieved statewide from 2013-2015. While this includes upstream savings, which contribute greatly to portfolio savings, the data is not available to show upstream participants in the participant count. Savings from behavior/feedback programs are not included here.

Number of unique accounts, participation rate, and savings achieved 2013-2015

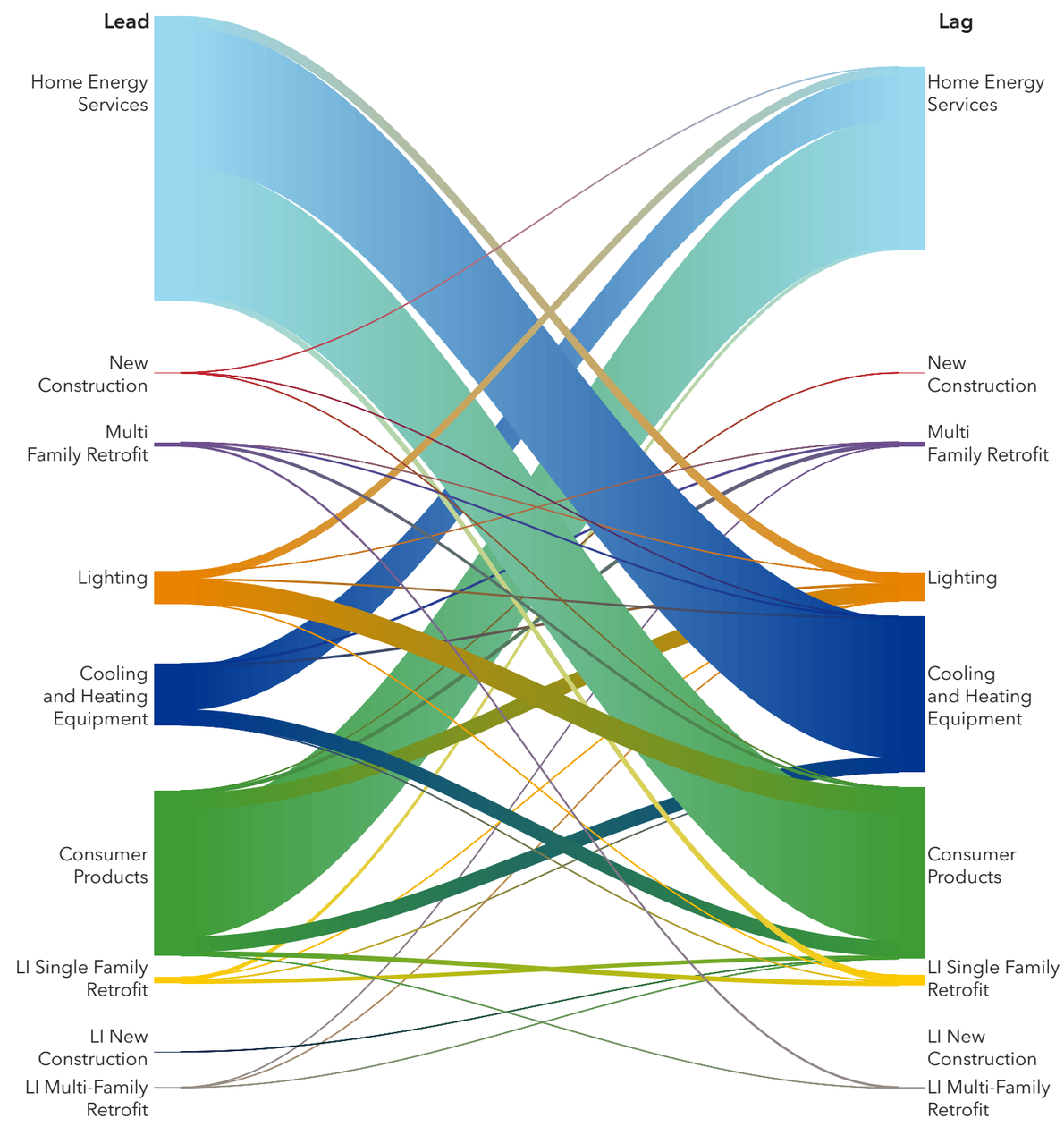


*Unitil's account participation appears lower than other PAs. This is due to missing account data in the tracking system. Notably, Unitil's savings are consistent with the other PAs, suggesting no substantial differences in actual participation.

Cross-initiative movement

This figure shows how customers moved from one initiative to another in 2014 and 2015. The left column shows the first initiative customers participated in (lead), and the right column shows what initiative they participated in afterward (lag). Thicker lines between initiatives indicate more customers participating.

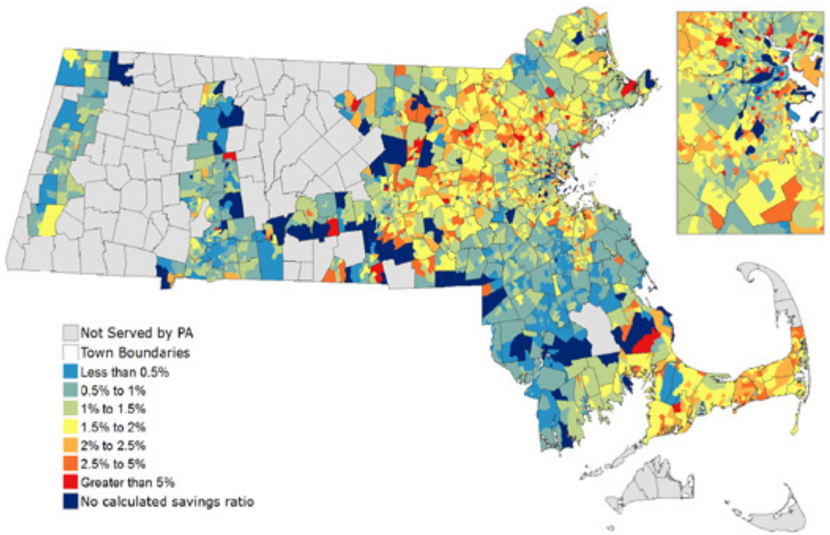
Electric cross-initiative participant movement, 2014-2015



GAS SUMMARY

Savings by block group

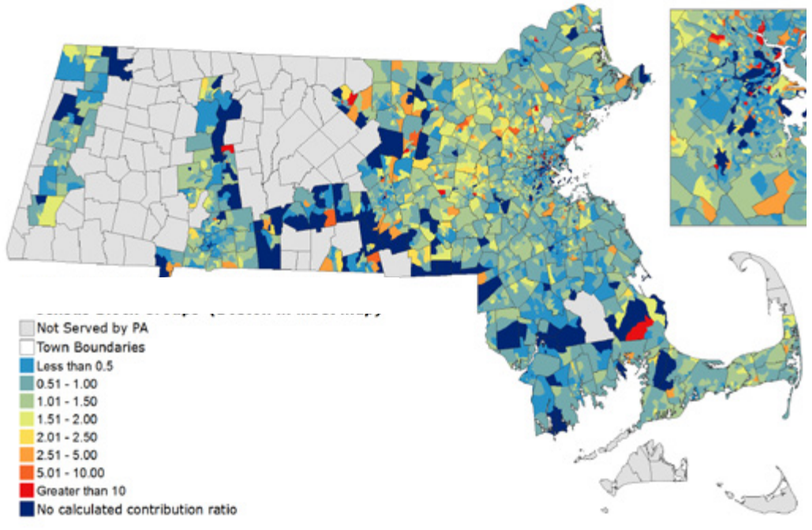
Combined 2014 & 2015 gas savings by census block group (Boston in inset map)



This map shows gas savings across Massachusetts for 2014-2015, by census block group. The map includes savings from behavior/feedback programs. It illustrates higher savings in Boston's commuter towns and the northern portion of the 495 loop.

Areas in dark blue with no calculated savings ratio are likely to be areas with no customers (e.g., cemeteries, lakes) or block groups within PA-served towns that are not actually part of the gas distribution network.

Combined 2014 & 2015 gas contribution ratio by census block group (Boston in inset map)

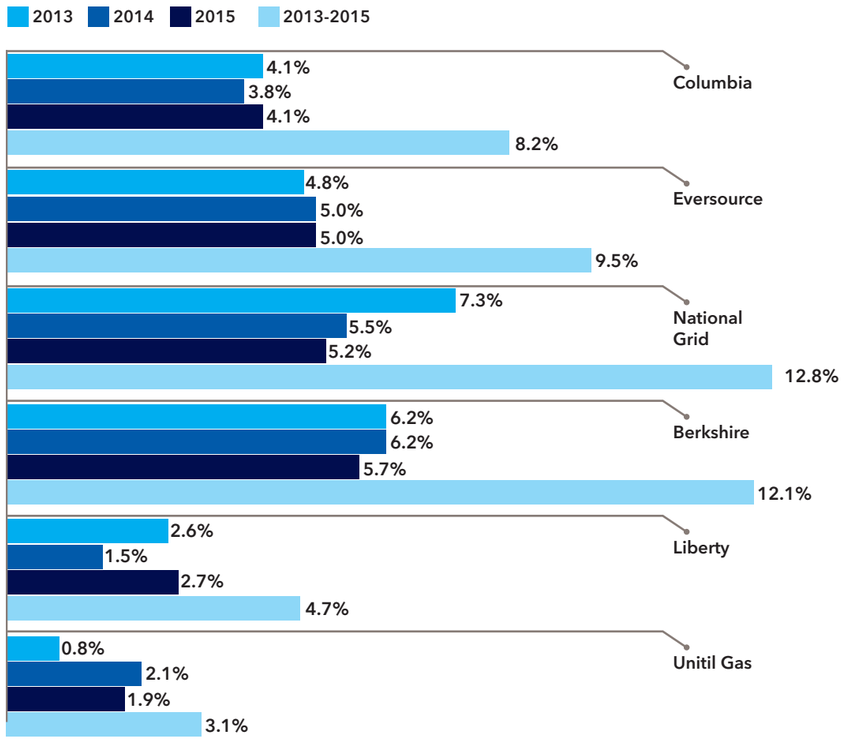


As with the electric contribution ratios, the combined 2014 and 2015 gas contribution ratios vary greatly within PA service territories, and even within towns. The contribution ratios do not include behavioral data for gas PAs with behavioral programs.

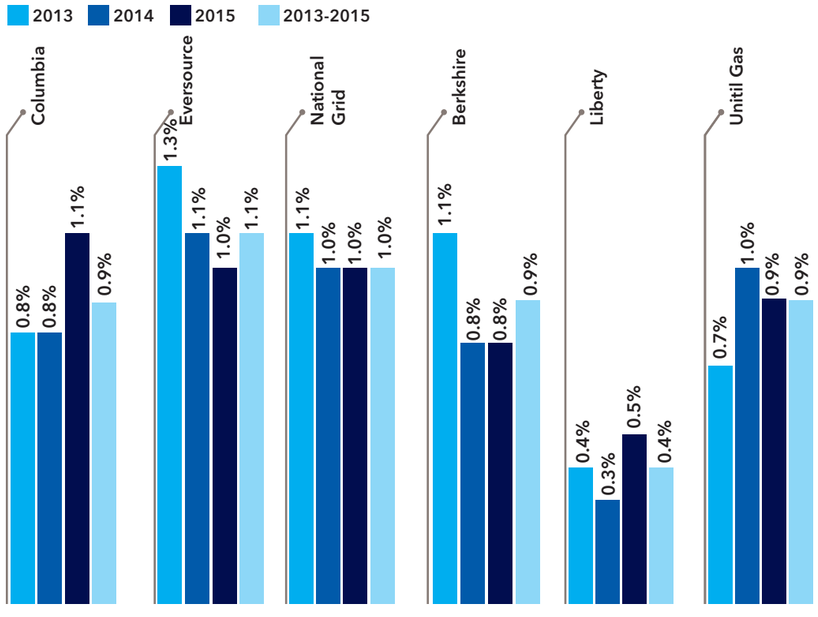
Several of the areas in Boston with no calculated contribution ratio, shown in dark blue, correlate to the downtown steam loop and academic campuses. Areas north-west of Boston have slightly higher contribution ratios than areas in the southern portion of the state.

The following two charts show time series of gas participation rates and savings rates.

Gas account participation



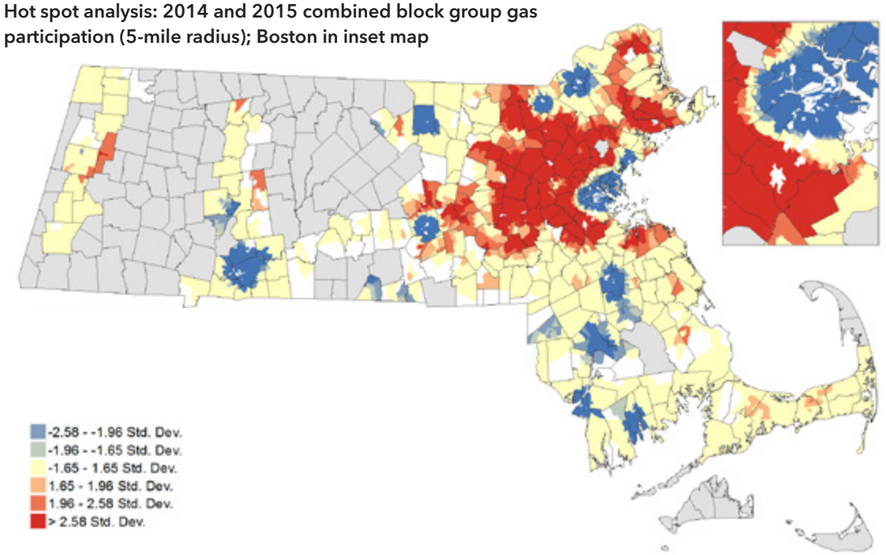
Gas savings achieved



The next map shows the results of the hot spot analysis we conducted on gas participation by census block group, using a five-mile search radius. The hot spot analysis compares each block group to its neighbors, and identifies block groups with comparatively higher or lower participation than we would see with a random spatial distribution (hot spots and cold spots).

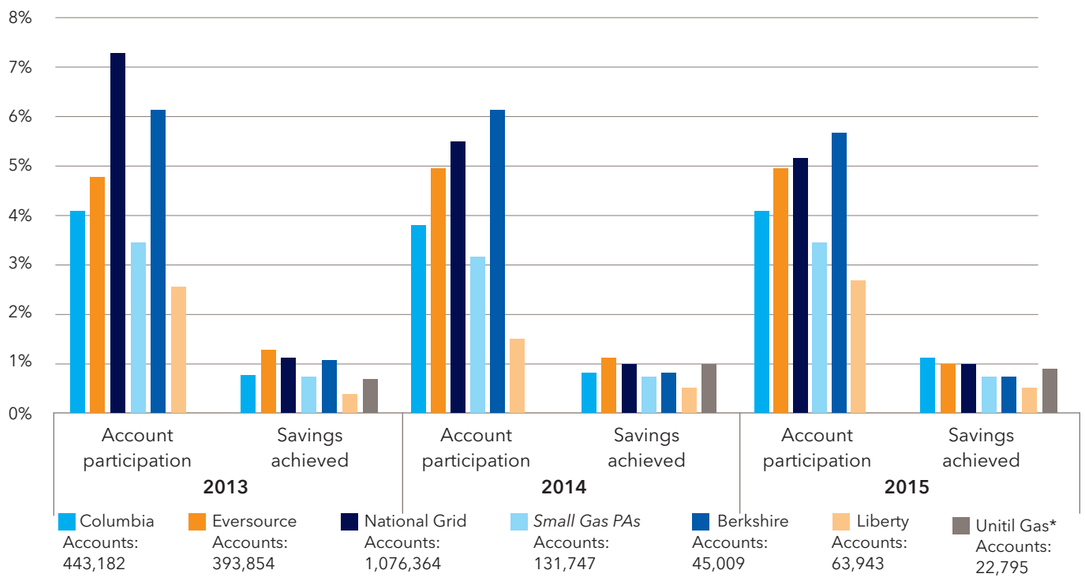
The analysis identified gas participation hot spots north and west of Boston, and a smaller hot spot southeast of Boston. It identified gas participation cold spots in Boston and several of the other large population centers. The electric hot spot analysis found similar trends, suggesting that the relative high and low participation rates in certain areas cannot be linked to a particular fuel or PA, but are likely influenced by these areas' block group characteristics.

Hot spot analysis: 2014 and 2015 combined block group gas participation (5-mile radius); Boston in inset map



While viewing this map, it is important to keep in mind that in and of themselves, higher or lower participation rates in a particular area are not necessarily indicators of program performance. It is entirely possible, for instance, for a block group with a low participation rate to be substantially outperforming expectations for its demographic.

Number of unique gas accounts, participation rate, and savings achieved 2013-2015

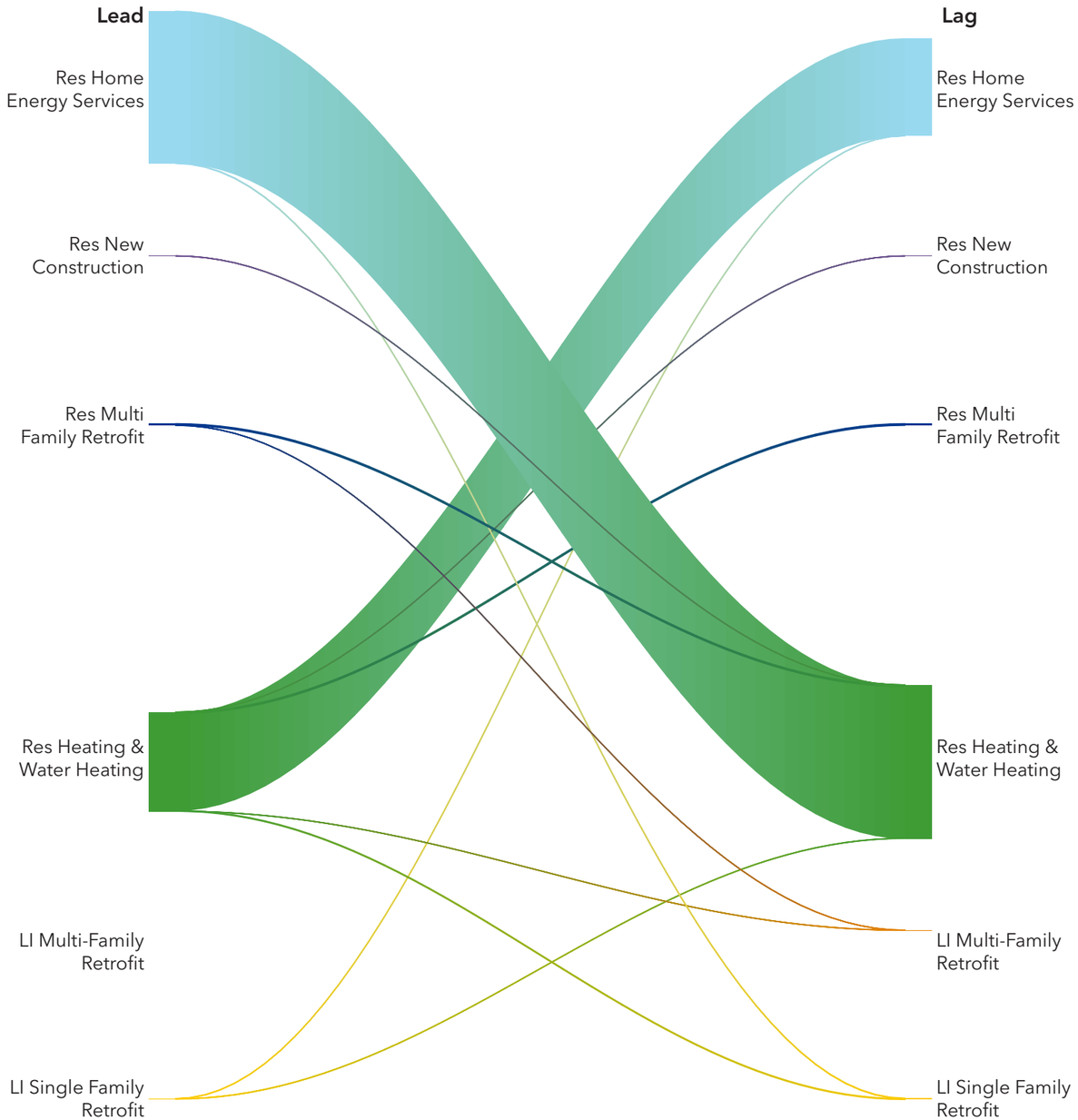


*Unitil's account participation appears lower than other PAs. This is due to missing account data in the tracking system. Notably, Unitil's savings are consistent with the other PAs, suggesting no substantial differences in actual participation.

Cross-initiative movement

This figure shows how customers moved from one initiative to another in 2014 and 2015. The left column shows the first initiative customers participated in (lead), and the right column shows what initiative they participated in afterward (lag). Thicker lines between initiatives indicate more customers participating.

Gas cross-initiative participant movement, 2014-2015



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