

RES 22 - Low Rise Measure Review

The purpose of this workbook is to document the evaluation team's recommendations for gross and net savings assumptions for Low Rise measures. The tables below summarize the team's rationale for gross savings review, and recommendations for future evaluation and analysis topics. The workbook includes the following tabs:

- **Electric Recommendations** - Summarizes recommended savings for electric measures
- **Gas Recommendations** - Summarizes recommended savings for gas measures
- **Participation Analysis** - Includes past participation data used to estimate gross savings in some cases
- **EEYr1_Electric, EEYr1_Gas, Electric Lookups, Gas Lookups** - Includes current savings assumptions data for electric and gas measures
- **MA RES 34 Summary Results** - Includes summary of RES 34 evaluation results, used to estimate gross savings in some cases

Summary of Gross Savings Review Rationale

As documented on the Electric and Gas Recommendations tabs, the team applied the following rationale in recommending gross savings values.

Measure Category	Low Rise saving should be...	Rationale
Hot Water Measures	Similar to Single Family	Water heating for low-rise buildings are typically be the same as single-family systems. 89% of low-rise units have in-unit water heaters (similar to single family).
HVAC	Similar to Single Family	HVAC systems for low-rise buildings are typically be the same as single-family systems. 93% of low-rise units had HVAC systems similar to similar to single family.
Envelope	Similar to High Rise with RBSA weighted Value (1.6)	Envelope measures for low-rise buildings typically have to meet the same building code standards as high-rise buildings and have similar construction components. 2011 RBSA Multifamily Characteristics and Energy Use Study compared actual energy use of low-rise, mid-rise, and high-rise multifamily buildings, and found low-rise unit to use an average of 1.54 times the energy use of a high rise unit for electrically heated units, and 1.65 times the energy use of gas-heated units. With 34.2% of MA multifamily buildings having gas accounts, the average weighting applied to these low-rise measures is 1.6.

Data Source: 2011 RBSA Multifamily Characteristics and Energy Use Study, <https://neea.org/resources/2011-rbsa-multi-family-characteristics-and-energy-use>

Opportunities for Future Evaluation

In addition to recommending values for Low-Rise savings assumptions, the team recommends consideration of the following opportunities for future research.

1 - Gas Measures - Both measures tabs have gas savings measures (EEYr1_Electric, EEYr1_Gas), and in comparing some of the SF/HR measures, the team noted that there are some places where the gas savings disagree with each other. This may be intentional and appropriate since these measures are handled by different PAs, but this might be an opportunity for additional analysis to align gas savings across PAs. (Air sealing, Insulation, etc)
2 - The team recommends reiewing and evaluating measures that don't currently have a low-rise measure, but do have single-family or high-rise measures to compare to. This includes, but isn't limited to, Boiler Reset Control, categories of Insulation for gas, categories of Programmable Thermostats, categories of Wifi Thermostats, categories of Low-Flow Showerheads with TSVs.
3 - Showerhead and Aerator savings - Showerhead savings are higher for single-family than high-rise, but aerator savings lower for single-family than high-rise. This is surprising considering typical hot water systems, distribution systems, and use patterns of single family vs high rise buildings, so this might be worth exploring more. May be an opportunity to compare with other utility programs or other sources of data.
4 - General measure category evaluation - Many measures had different program categories for single family, low rise, and high rise. Often there is a specific reason for this, but other times it may be more accurate to have more consistent categories. Evaluate measures where single-family and high-rise have different categories to identify if new sources of data might justify an adjustment to categories. For example, programmable thermostats is split into electric resistance and AC or no AC, but single family only has "electric." High rise and low rise has a heat pump category, but single family does not.
5 - NTG evaluation - since freeridership and spillover behavior associated with low-rise participation may differ from that associated with single-family and high-rise participation, the team recommends conducting low-rise specific NTG evaluations after the Low Rise program is implemented.

Gas Savings Analysis

Measure	Fuel Category	Gross Savings				Recommended Low Rise Assumption	Low Rise saving should be:	Rationale	Notes	Net Savings				Comparable Measure in Recent NTG Study	Source	Rationale
		Current Low Rise Assumption	SF Savings	High Rise Savings	Low Rise Assumption					Current Low Rise Assumption	Recommended Low Rise Assumption	SF NTG	High Rise NTG			
Air Sealing, Gas	Delivered Fuel	-	31.73	2.50	4.00	Same as High Rise with SF savings of 31.73 and 2.50	Envelope measures for low-rise buildings typically have to meet the	Envelope measures for low-rise buildings typically have to meet the	Updated SF savings value from MA RES 34	#N/A	100%	120%	#N/A	Building Shell Measures	RES 44 Multifamily	Recommended Low Rise assumption is based on the measure-level Freerider Analysis in the 2018 RES 44 MF Evaluation (FR = 0.22 for DHW). The recommended value adds the provisional program-level SO ratio (0.28).
Insulation, Gas	Delivered Fuel	-	102.26	5.50	8.00	Same as High Rise with SF savings of 102.26 and 5.50	Envelope measures for low-rise buildings typically have to meet the	Envelope measures for low-rise buildings typically have to meet the	Updated SF savings value from MA RES 34	#N/A	100%	120%	#N/A	Building Shell Measures	RES 44 Multifamily	
Duct Insulation, Gas	Delivered Fuel	-	73.00	-	73.00	Same as Single Family	Without a high-rise measure to compare to, it is reasonable to	Without a high-rise measure to compare to, it is reasonable to	Updated SF savings value from MA RES 34	81%	100%	100%	100%	Building Shell Measures	RES 44 Multifamily	
Duct Sealing, Gas	Delivered Fuel	-	39.00	-	39.00	Same as Single Family	Without a high-rise measure to compare to, it is reasonable to	Without a high-rise measure to compare to, it is reasonable to	Updated SF savings value from MA RES 34	81%	100%	100%	100%	Building Shell Measures	RES 44 Multifamily	
Pipe Wrap (Water Heating), Gas	Delivered Fuel	-	2.94	1.14	1.82	Same as High Rise with SF savings of 2.94 and 1.14	Envelope measures for low-rise buildings typically have to meet the	Envelope measures for low-rise buildings typically have to meet the	Updated SF savings value from MA RES 34	100%	100%	100%	100%	Building Shell Measures	RES 44 Multifamily	
Pipe Wrap (Heating), Gas	Delivered Fuel	-	14.46	0.16	0.26	Same as High Rise with SF savings of 14.46 and 0.16	Envelope measures for low-rise buildings typically have to meet the	Envelope measures for low-rise buildings typically have to meet the	Updated SF savings value from MA RES 34	100%	100%	100%	100%	Building Shell Measures	RES 44 Multifamily	
Faucet Aerator, Gas	Delivered Fuel	0.86	2.11	0.86	2.11	Same as Single Family	Water heating for low-rise buildings are typically be the same as	Water heating for low-rise buildings are typically be the same as	Updated SF savings value from MA RES 34	85%	100%	100%	100%	DHW Measures	RES 44 Multifamily	
Low-Flow Showerhead, Gas	Delivered Fuel	1.14	9.15	1.14	9.15	Same as Single Family	Water heating for low-rise buildings are typically be the same as	Water heating for low-rise buildings are typically be the same as	Updated SF savings value from MA RES 34	85%	100%	100%	100%	DHW Measures	RES 44 Multifamily	
Low-Flow Showerhead with TSV, Gas	Delivered Fuel	1.66	1.20	1.66	1.20	Same as Single Family	Water heating for low-rise buildings are typically be the same as	Water heating for low-rise buildings are typically be the same as	#N/A	100%	#N/A	#N/A	DHW Measures	RES 44 Multifamily		
Thermostatic Shut-Off Valve, Gas	Delivered Fuel	0.34	1.20	0.34	1.20	Same as Single Family	Water heating for low-rise buildings are typically be the same as	Water heating for low-rise buildings are typically be the same as	#N/A	100%	#N/A	#N/A	DHW Measures	RES 44 Multifamily		
Programmable Thermostat, Gas	Delivered Fuel	3.20	3.20	3.20	3.20	Same as Single Family and	For gas measures, single family and high rise units are deemed the	For gas measures, single family and high rise units are deemed the	#N/A	111%	89%	#N/A	HVAC Measures	RES 44 Multifamily		
Programmable Thermostat, Gas with Central AC	Delivered Fuel	3.20	3.20	3.20	3.20	Same as Single Family and	For gas measures, single family and high rise units are deemed the	For gas measures, single family and high rise units are deemed the	#N/A	111%	#N/A	#N/A	HVAC Measures	RES 44 Multifamily		
Wi-Fi Thermostat, Gas	Delivered Fuel	6.60	6.60	6.60	6.60	Same as Single Family and	For gas measures, single family and high rise units are deemed the	For gas measures, single family and high rise units are deemed the	Updated SF savings value from MA RES 34	#N/A	111%	100%	#N/A	HVAC Measures	RES 44 Multifamily	
Wi-Fi Thermostat, Gas with Central AC	Delivered Fuel	6.60	6.60	6.60	6.60	Same as Single Family and	For gas measures, single family and high rise units are deemed the	For gas measures, single family and high rise units are deemed the	#N/A	111%	#N/A	#N/A	HVAC Measures	RES 44 Multifamily		
Early Retirement Boiler, Forced Hot Water (EE)	Delivered Fuel	9.70	11.40	#N/A	11.40	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	79%	#N/A	#N/A	Boilers	TXC-34 Res HVAC		
Early Retirement Boiler, Forced Hot Water (Retire)	Delivered Fuel	5.90	7.00	#N/A	7.00	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	79%	#N/A	#N/A	Boilers	TXC-34 Res HVAC		
Early Retirement Boiler, Steam (EE)	Delivered Fuel	2.50	2.90	#N/A	2.90	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	79%	#N/A	#N/A	Boilers	TXC-34 Res HVAC		
Early Retirement Boiler, Steam (Retire)	Delivered Fuel	6.80	8.00	#N/A	8.00	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	79%	#N/A	#N/A	Boilers	TXC-34 Res HVAC		
Early Retirement Furnace, (EE)	Delivered Fuel	6.10	7.20	#N/A	7.20	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	76%	#N/A	#N/A	Furnaces	TXC-34 Res HVAC		
Early Retirement Furnace, (Retire)	Delivered Fuel	5.20	6.20	#N/A	6.20	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	76%	#N/A	#N/A	Furnaces	TXC-34 Res HVAC		
Heating System, Furnace, Gas 95%	Delivered Fuel	8.10	8.10	#N/A	8.10	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	76%	#N/A	#N/A	Furnaces	TXC-34 Res HVAC		
Heating System, Furnace, Gas 95% Mini	Delivered Fuel	8.10	8.10	#N/A	8.10	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	76%	#N/A	#N/A	Furnaces	TXC-34 Res HVAC		
Heating System, Furnace, Gas 97%	Delivered Fuel	9.20	9.20	#N/A	9.20	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	76%	#N/A	#N/A	Furnaces	TXC-34 Res HVAC		
Heating System, Furnace, Gas 97% Mini	Delivered Fuel	9.20	9.20	#N/A	9.20	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	76%	#N/A	#N/A	Furnaces	TXC-34 Res HVAC		
Heating System, Forced Hot Water Boiler, Gas 90%	Delivered Fuel	11.40	11.40	#N/A	11.40	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	76%	#N/A	#N/A	Boilers	TXC-34 Res HVAC		
Heating System, Forced Hot Water Boiler, Gas 90%	Delivered Fuel	14.10	14.10	#N/A	14.10	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	79%	#N/A	#N/A	Boilers	TXC-34 Res HVAC		
Heating System, Forced Hot Water Boiler, Gas 95%	Delivered Fuel	10.30	10.30	#N/A	10.30	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	79%	#N/A	#N/A	Boilers	TXC-34 Res HVAC		
Heating System, Combo Condensing Boiler/Water Heater, Gas 95%	Delivered Fuel	12.80	12.80	#N/A	12.80	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	79%	#N/A	#N/A	Boilers	TXC-34 Res HVAC		
Heat Recovery Ventilator, Gas	Delivered Fuel	7.70	7.70	#N/A	7.70	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	111%	#N/A	#N/A	HVAC Measures	RES 44 Multifamily		
Water Heater, Stand Alone Water Heater, Gas 0.87	Delivered Fuel	3.60	3.60	#N/A	3.60	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	100%	#N/A	#N/A	DHW Measures	RES 44 Multifamily		
Water Heater, On Demand Water Heater, Gas 0.82	Delivered Fuel	9.40	9.40	#N/A	9.40	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	100%	#N/A	#N/A	DHW Measures	RES 44 Multifamily		
Water Heater, On Demand, Gas 0.84	Delivered Fuel	9.90	9.90	#N/A	9.90	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	100%	#N/A	#N/A	DHW Measures	RES 44 Multifamily		
Water Heater, Indirect, Gas	Delivered Fuel	8.00	8.00	#N/A	8.00	Same as Single Family	HVAC systems for low-rise buildings are typically be the same as	HVAC systems for low-rise buildings are typically be the same as	#N/A	100%	#N/A	#N/A	DHW Measures	RES 44 Multifamily		

For Reference Only - This was used as a possible analysis approach to weighting the measures, but after researching typical building systems for single family, low rise, and high rise buildings, was not used in the final weighting.

Estimated Annual Low Rise Participation,*

Home Type	Participants	Percent of Low Rise
2-4 Unit Participants (HES)	9,465	73%
3 stories or less (MF)	3,576	27%
Total	13,041	100%

SF	HR
73%	27%

*Assumes "low rise" customers participate in same proportions as previously observed as part of HES and MF

HES Participation (2015/16)

Home Type	Participants	Percent of HES
2-4 Units	18,929	11%
Single Family Detached	155,149	89%
Total	174,078	100%

Source: 2018 HES Process Evaluation, KPI Analysis (RES 34)

MF Participation (2014/15)

Home Type	Participants (Units, not Buildings/Properties)	Percent of MF
Less than 20 units	7,152	28%
More than 20 units	18,693	72%
Total	25,845	100%

Source: Below (note unit information is missing for most participants so these counts/percentages reflect ~15% of total participating MF properties in 2014/15.

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Subject: RE: MF Building Characteristics

Hi Justin -Yes - we've been working on this (credit and thanks to Jason Lai!).

Here you go, with Jason's caveats:

We have a number of buildings that were identified as multifamily that have unreliable unit information. Basically, these are buildings that either participated in a multifamily program, or had a multifamily rate code, but had bad or missing tax information, or only a few accounts account available in the database.

To that end, I included the number of properties columns to provide some context – as you can see, where are quite a few properties for which we have no unit information. This is due to the fact that participation is one of our identifiers for multifamily.

Doug didn't specify whether income status was important - I assumed it is, and it was reasonably straightforward to present the results binned by the low income or market rate status for your consideration

Income	Home Type	# Housing Units	# Participants 2014/2015 (Units)	% of Participants 2014/2015 (Units)	# Properties	# Participants 2014/2015 (Properties)	% of Participants 2014/2015 (Properties)
Low Income	20 or less units	23,693	2,039	25%	3,026	219	11%
Low Income	More than 20 Units	37,133	5,972	75%	540	81	4%
Low Income	No unit information	N/A	N/A	N/A	1,799	1,632	84%
Market Rate	20 or less units	237,103	7,152	28%	29,706	814	16%
Market Rate	More than 20 Units	349,181	18,693	72%	5,418	299	6%
Market Rate	No unit information	N/A	N/A	N/A	5,293	3,992	78%

For buildings with C&I meters only, 64.4% of buildings had electric accounts and 35.6% had gas accounts. For buildings with residential meters only, 91.2% of buildings had electric accounts and 34.2% had gas accounts. The team also looked at buildings with mixed meter types, defined as those with residential gas accounts and C&I electric accounts, and vice versa. Of the buildings that had both C&I and residential meters, 36% had a combination of C&I electric and residential gas meter types and 23.6% had a combination of C&I gas and residential electric meter types. For buildings with both C&I and residential energy meters, 98.7% of average monthly electric energy consumption and 87% of average monthly gas energy consumption was contributed by residential meters. The energy usage values were determined from customer billing data.

Elect	1.54	0.658
Gas	1.65	0.342
	1.57762	

1.595

Table 99. Average Annual Unit Electric Consumption by Building Size

Building Size (Stories)	Electric kWh per Unit		
	Mean	EB	n
Low-Rise (1-3)	6,230	1,356	137
Mid-Rise (4-6)	9,040	691	50
High-Rise (7+)	5,380	1,773	18
All Sizes	7,824	1,137	205

Table 103. Average Annual Total Residential Gas Therms Per Residential Unit by Building Size for Buildings With Gas Service

Building Size (Stories)	Gas Therms per Unit		
	Mean	EB	n
Low-Rise (1-3)	178	45	36
Mid-Rise (4-6)	152	61	18
High-Rise (7+)	108	32	16
All Sizes	163	33	73