

Buildings Working Group Meeting II



For

Office of Energy Consumption and Efficiency Analysis

September 20, 2018 | Washington, DC

By

Buildings Energy Analysis Team

Overview

- AEO release: this year versus last year
- Policies
- Modeling updates
 - distributed generation
 - commercial computing and office equipment
 - housing starts
 - weather
- Energy efficiency

AEO2018 will include a full suite of side cases

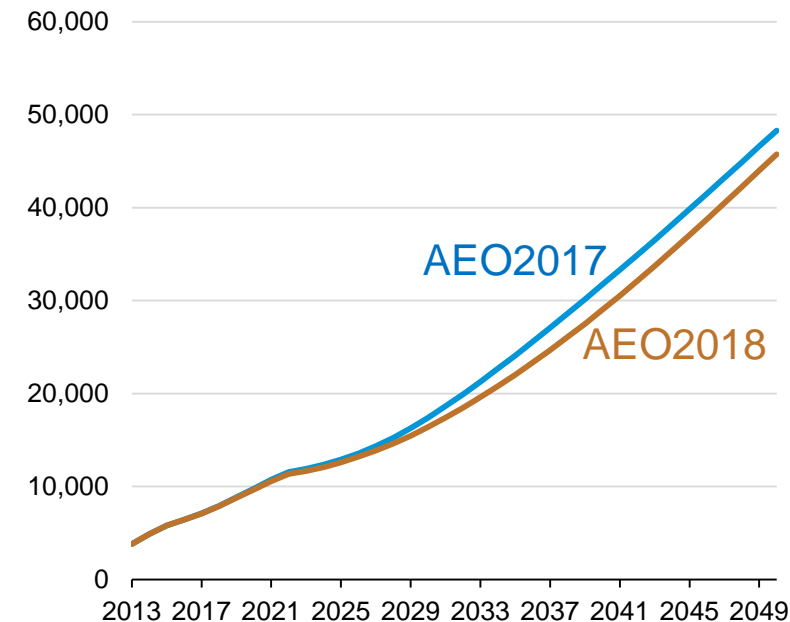
- Unlike AEO2017, which included a limited number of side cases, AEO2018 will include additional side cases beyond the standard set
 - Reference (existing law and policy)
 - High/low oil and gas resource and technology
 - High/low oil price
 - High/low economic growth
 - Other potential side cases:
 - Extended Policies
 - Energy Storage (excluding buildings)
 - with or without Clean Power Plan (opposite of Reference case)
- AEO2018 will highlight results through 2050

Policies

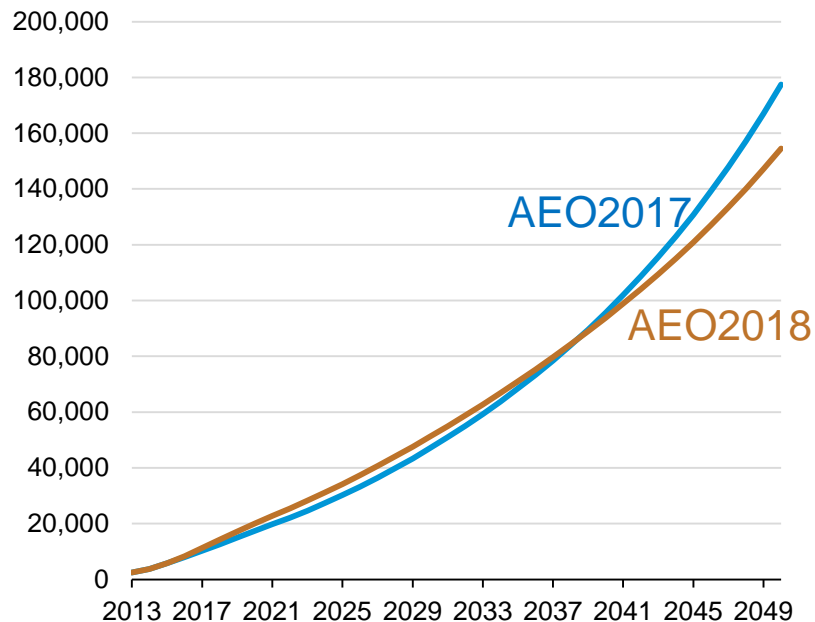
- Federal equipment efficiency standards
 - commercial pre-rinse spray valves (effective 2019)
 - commercial walk-in refrigerator and freezers (effective 2017)
 - residential ceiling fans (effective 2020)
 - residential pool pumps (effective 2021)
- No updates to ENERGY STAR specifications for this AEO

Commercial distributed generation niches updated using 2012 CBECS data, while residential PV penetration model contagion effect and historical data updated

Commercial PV capacity
MW-DC



Residential PV capacity
MW-DC



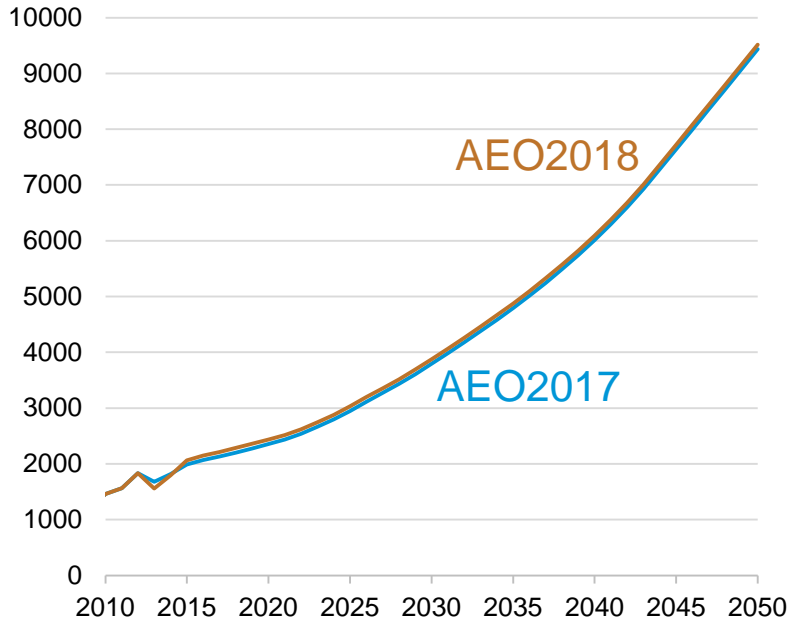
Sources: AEO2018 preliminary, AEO2017

Buildings distributed generation historical updates include capacity and cost information

- Routine update for exogenous solar PV capacity and solar PV system costs **(in progress)**
 - Capacity data from SEIA, cost data from LBNL
 - Testing with newly available EIA-861 data
- Updated exogenous commercial fuel cells capacity **(done)**
- Seeking data for exogenous microturbine capacity
- Routine update for exogenous wind capacity **(done)**
 - Data from *Distributed Wind Market Report*, U.S. DOE, EERE

Commercial CHP capacity data includes updated and additional sources

natural gas DG/CHP capacity
MW-DC



Sources: AEO2018 preliminary, AEO2017

- Some small differences between 2013 and 2015 (down 7% in 2013 and up 4% in 2015), otherwise not much change
- Sources:
 - Fuel Cells 2000 database, online (accessed August 7, 2017)
 - U.S. DOE, Fuel Cell Technologies Office, “Market Analysis Reports” (2007-2015),
 - U.S. DOE, EERE, “Combined Heat and Power Installation Database,” online
 - U.S. EIA, EIA-860 survey data

Commercial 'other' end-use that is not explicitly modeled is now indexed to domestic non-industrial and service gross output

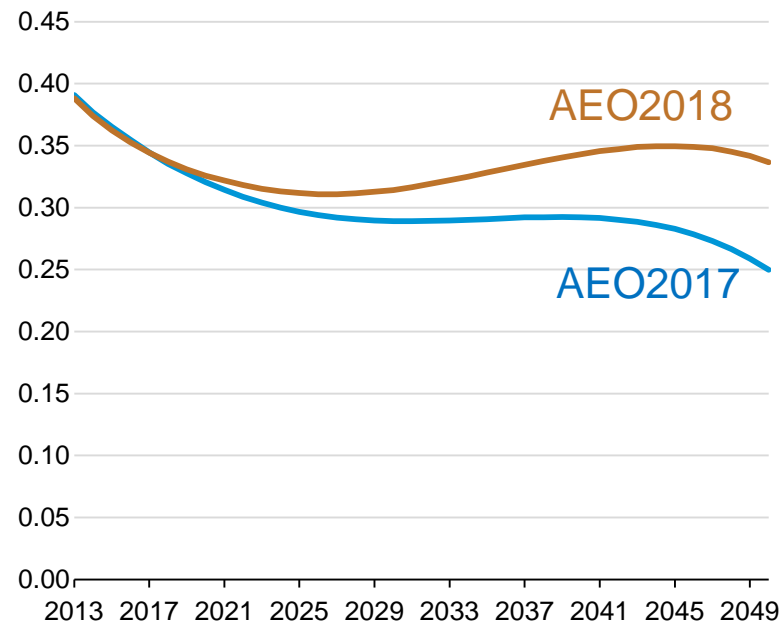
commercial 'other' delivered electricity consumption
quadrillion Btu



Sources: AEO2018 preliminary, AEO2017

Commercial computing and office equipment assumptions updated using revised contractor report

computing consumption
quadrillion Btu



office equipment consumption
quadrillion Btu

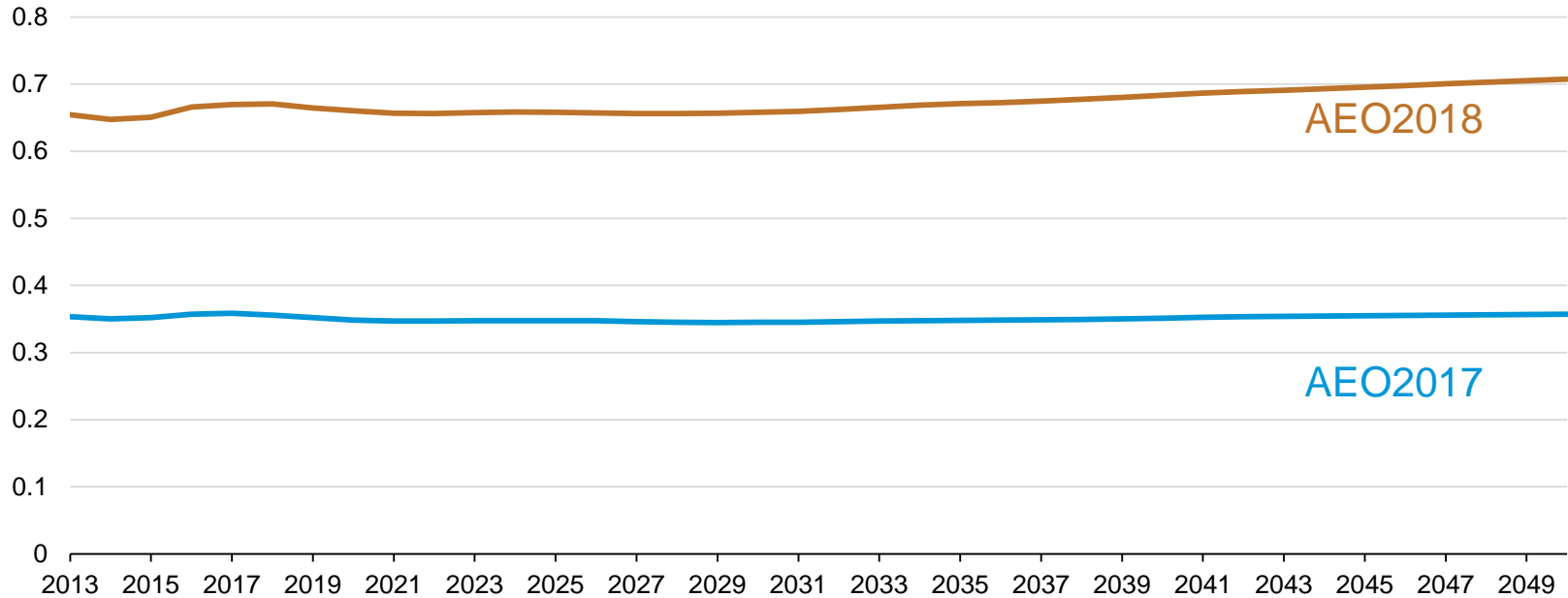


Sources: AEO2018 preliminary; AEO2017; Navigant, Analysis and Representation of Miscellaneous Electric Loads in NEMS

Increased commercial delivered water heating consumption due to revised NEMS code was partially offset by adjustment for pre-rinse spray valve standard

commercial water heating consumption

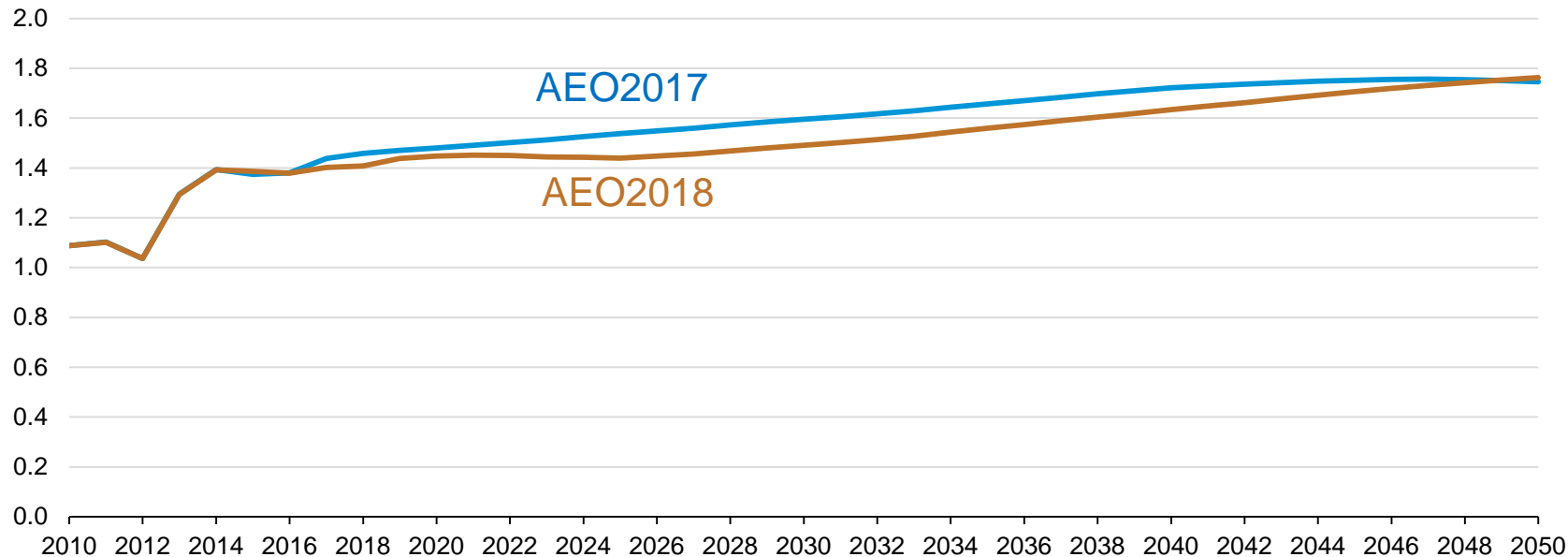
quadrillion Btu



Sources: AEO2018 preliminary, AEO2017

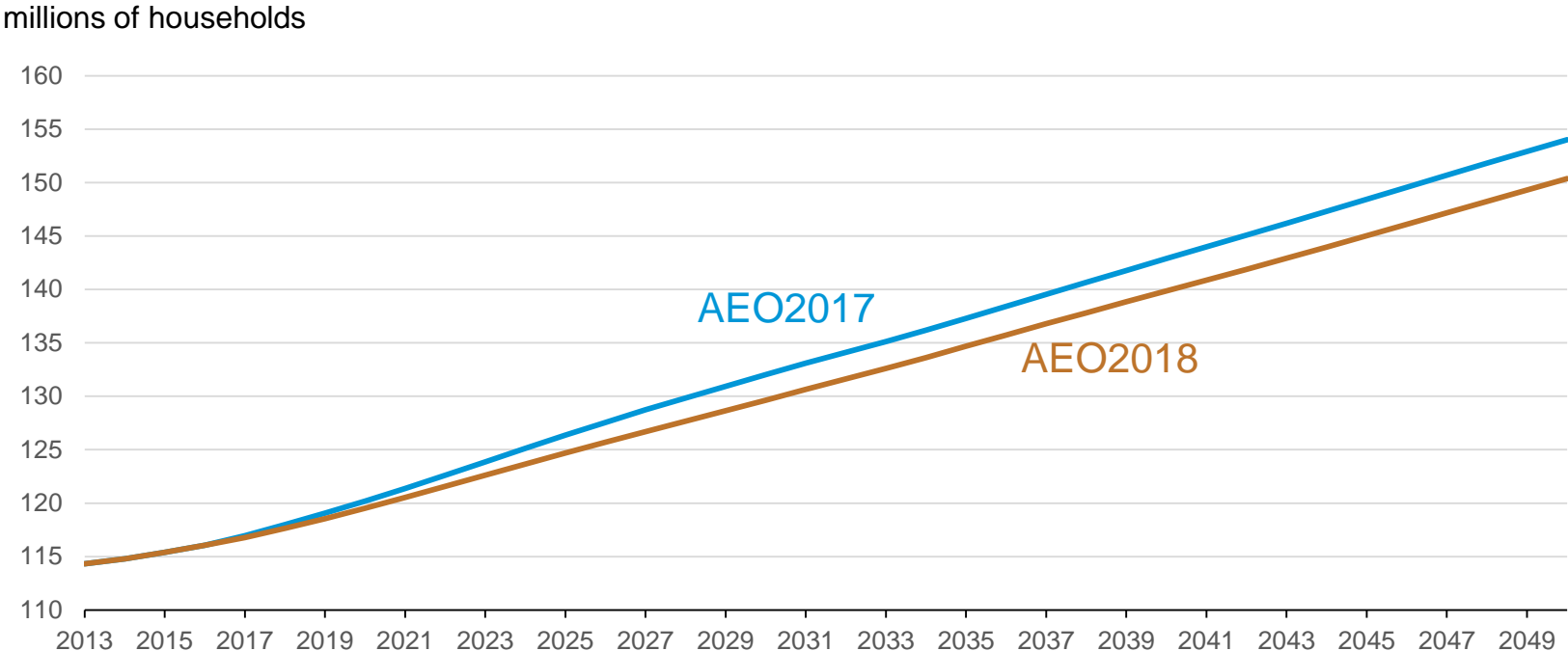
Residential ceiling fan and pool pump standards decrease electricity consumption through projection

residential 'other' delivered electricity consumption
quadrillion Btu



Sources: AEO2018 preliminary, AEO2017

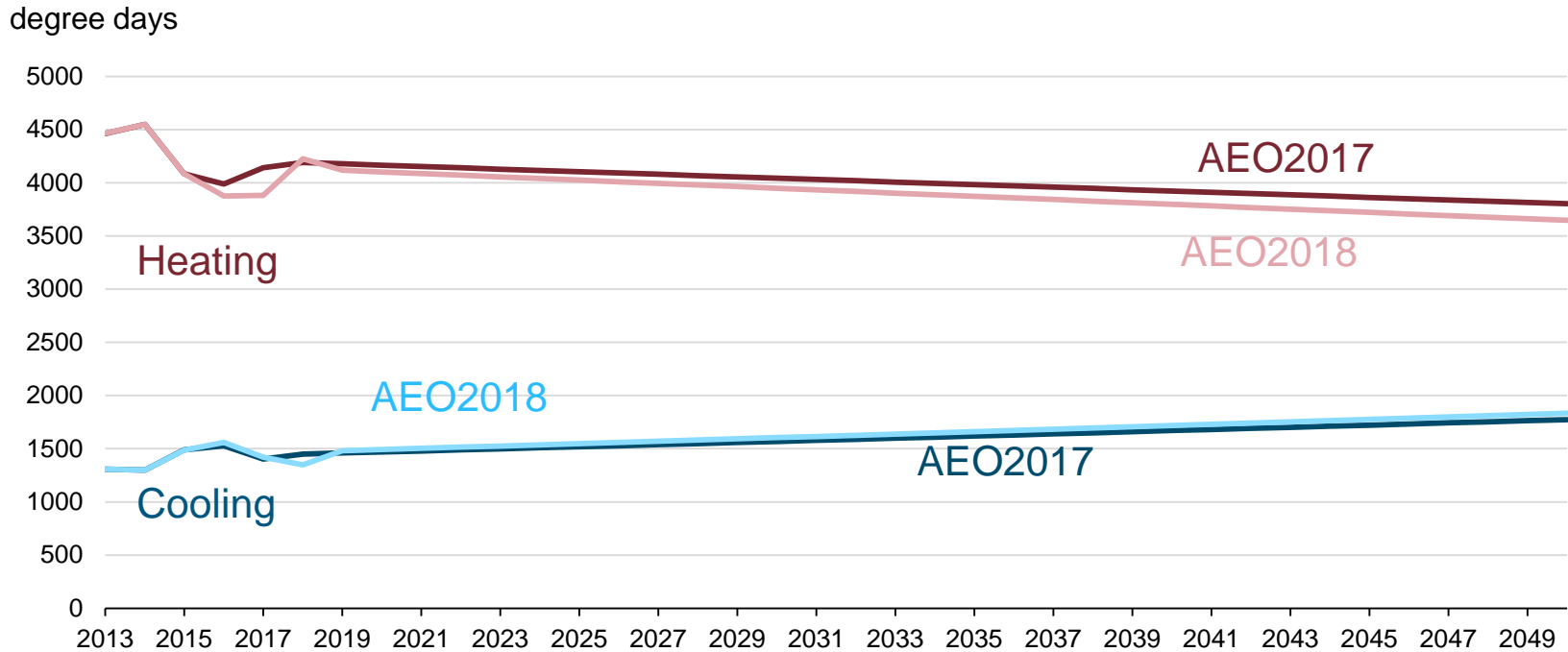
Residential housing starts are lower due to revisions in Macroeconomic Activity Module (MAM) of NEMS



Sources: AEO2018 preliminary, AEO2017



Heating and cooling degree days include NOAA historical data and short-term forecast, along with 30-year trend through projection period



Sources: AEO2018 preliminary, AEO2017

Utility Energy Efficiency Rebates: Preliminary Methodology

- Starting point for rebate levels: contractor report, Consortium for Energy Efficiency (CEE), and Energy Star surveys
- Average rebate levels are adjusted by Census Division based on the percentage of utilities that report offering similar measures according to CEE surveys
- For technologies for which insufficient data was available from the above reports, rebate levels are set equal to 50% of the incremental cost of the technology
- Rebate levels are further adjusted to benchmark total spending to latest available data from the EIA-861 survey
- Rebates for technologies such as LEDs are tapered over time as the technology achieves penetration
- Commercial hurdle rates are refined by end use to match energy consumption to existing levels (not yet completed)

Benchmarking to EIA-861: Preliminary Modeled Spending Levels (Residential)

modeled efficiency incentive spending (electricity only)
millions of 2013 dollars

Census Division	2013		2014		2015	
	AEO2018 (prelim.)	EIA-861	AEO2018 (prelim.)	EIA-861	AEO2018 (prelim.)	EIA-861
1 New England	118	187	94	308	182	309
2 Mid Atlantic	192	185	144	213	185	177
3 East North Central	148	141	108	149	117	131
4 West North Central	97	65	71	77	71	82
5 South Atlantic	201	160	141	179	166	168
6 East South Central	56	19	40	27	41	27
7 West South Central	182	140	125	138	108	114
8 Mountain	92	84	66	98	63	94
9 Pacific	232	270	174	303	430	358
Total	1,317	1,252	962	1,492	1,364	1,459

Selected Preliminary Rebates (Residential)

rebates by Census division
% of installed cost

Technology	CD1	CD2	CD3	CD4	CD5	CD6	CD7	CD8	CD9
Clothes washer	14%	7%	4%	5%	4%	3%	4%	4%	8%
Refrigerator	10%	5%	2%	3%	2%	2%	3%	3%	5%
Air-source heat pump	23%	16%	11%	11%	9%	9%	13%	10%	16%
Central Air Conditioner	32%	15%	8%	11%	9%	7%	17%	11%	18%
Ground-source heat pump	30%	15%	10%	13%	9%	7%	17%	10%	17%
Heat pump water heater	32%	22%	13%	16%	15%	15%	17%	13%	24%
Natural gas furnace	22%	17%	11%	15%	9%	8%	13%	12%	18%
Natural gas boiler	25%	17%	11%	12%	8%	8%	11%	11%	15%
Natural gas water heater	36%	24%	5%	9%	3%	2%	7%	9%	11%
CFLs (2009-2014)	30%	30%	24%	30%	21%	21%	30%	27%	30%
CFLs (2015-2019)	20%	20%	16%	20%	14%	14%	20%	18%	20%
LEDs (2014)	65%	38%	32%	33%	25%	18%	25%	28%	50%
LEDs (2015-2019)	70%	57%	48%	50%	37%	26%	38%	42%	70%
LEDs (2020-2030)	60%	48%	41%	43%	31%	22%	32%	36%	60%

Benchmarking to EIA-861: Preliminary Modeled Spending Levels (Commercial)

modeled efficiency incentive spending (electricity only)
millions of 2013 dollars

Census Division	2013		2014		2015	
	AEO2018 (prelim.)	EIA-861	AEO2018 (prelim.)	EIA-861	AEO2018 (prelim.)	EIA-861
1 New England	181	124	187	248	182	300
2 Mid Atlantic	213	269	234	294	218	314
3 East North Central	141	168	146	175	148	166
4 West North Central	53	66	59	86	60	99
5 South Atlantic	216	144	244	226	241	224
6 East South Central	31	17	38	16	37	18
7 West South Central	68	80	101	80	102	80
8 Mountain	56	91	69	87	69	104
9 Pacific	242	316	285	319	289	280
Total	1,201	1,274	1363	1,530	1,346	1,585

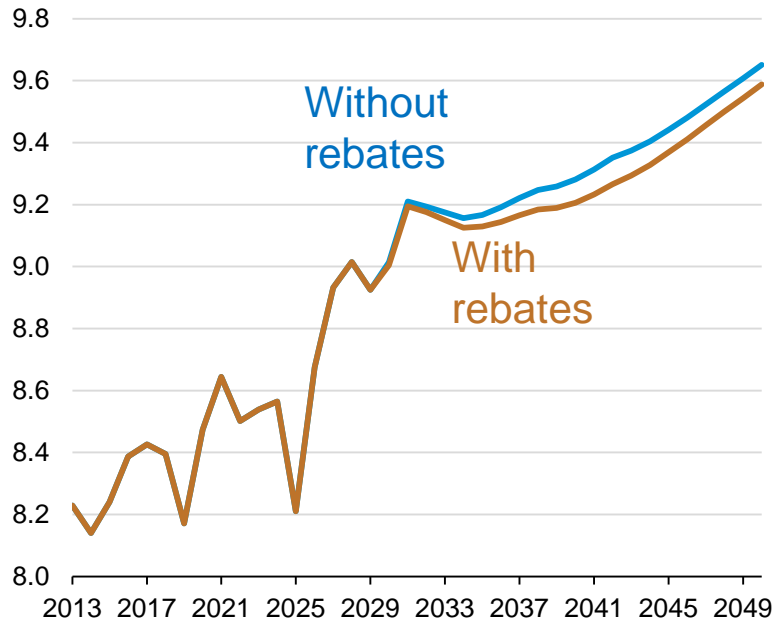
Selected Preliminary Rebates (Commercial)

rebates by Census division
% of installed cost

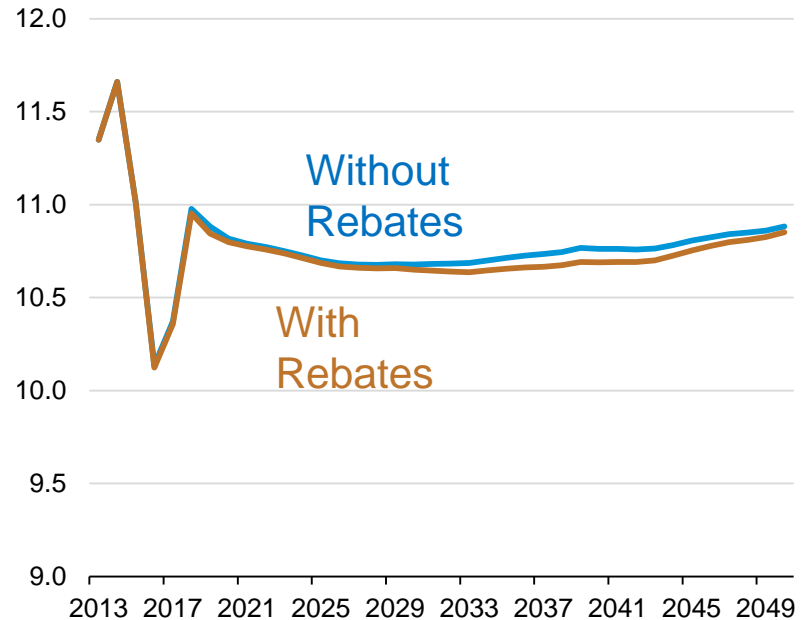
Technology	CD1	CD2	CD3	CD4	CD5	CD6	CD7	CD8	CD9
Rooftop air-source heat pump	18%	14%	11%	10%	12%	7%	10%	13%	13%
Gas furnace	17%	17%	14%	11%	11%	5%	10%	14%	14%
Ground-source heat pump	7%	5%	4%	5%	5%	2%	4%	5%	5%
Rooftop AC	7%	6%	5%	5%	5%	3%	5%	6%	6%
Res-type central AC	16%	9%	6%	6%	8%	4%	7%	9%	9%
Heat pump water heater	20%	13%	12%	11%	8%	5%	10%	12%	12%
Natural gas water heater	14%	14%	11%	11%	11%	6%	11%	13%	13%
CFLs (2009-2014)	13%	13%	13%	13%	13%	13%	13%	13%	13%
LED PAR38, LED A Lamp	67%	67%	67%	67%	67%	67%	67%	67%	67%
LED Integrated Luminaire	52%	52%	52%	52%	52%	52%	52%	52%	52%

Preliminary model results show small impact of utility rebates on residential and commercial electricity consumption

commercial total delivered energy consumption
quadrillion Btu



residential total delivered energy consumption
quadrillion Btu



Source: AEO2018 preliminary

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For more information

U.S. Energy Information Administration home page | www.eia.gov

Today in Energy | www.eia.gov/todayinenergy

Annual Energy Outlook | www.eia.gov/aeo

Short-Term Energy Outlook | www.eia.gov/steo

International Energy Outlook | <https://www.eia.gov/outlooks/ieo/>

State Energy Data System | <http://www.eia.gov/state/seds/>

Monthly Energy Review | www.eia.gov/mer

Residential Energy Consumption Survey | <http://www.eia.gov/consumption/residential/>

Commercial Building Energy Consumption Survey | <http://www.eia.gov/consumption/commercial/>

Bonus slides

How are hurdle rates applied to energy efficiency decisions?

		BEHAVIOR RULES		
		least cost	same fuel	same technology
DECISION TYPES	new	new equipment, least cost rule	new equipment, same fuel rule	new equipment, same technology rule
	replacement	replace equipment, least cost rule	replace equipment, same fuel rule	replace equipment, same technology rule
	retrofit	retrofit equipment, least cost rule	retrofit equipment, same fuel rule	retrofit equipment, same technology rule

- New equipment rule applies when floorspace added (new space is new service demand, which means new equipment)
- Replacement rule applies when an appliance/equipment reaches its lifetime and is taken out of service (when an appliance needs to be replaced this rule applies)
- Retrofit rule applies when a consumer exchanges an appliance before its life cycle is up (retrofit and replacement are similar, retrofit applies before the life cycle of an appliance is up and a replacement is when the change is after)

How are hurdle rates applied to energy efficiency decisions? (continued...)

- First, the model decides if appliances/equipment will be purchased
- Then, the model segments the entire market into behavior rule and decision type combinations
 - This produces a list of options for every appliance/equipment purchase
- Example: Replacing a natural gas main space heater under same fuel rule
 - **Options include natural gas boilers, natural gas furnaces, natural gas heat pumps**
 - **For example: NG boiler 1, NG boiler 2, NG boiler 3, NG furnace 1, NG furnace 2, NG heat pump 1, NG heat pump 2**
 - If this had been replacing a NG space heater under a same technology rule then it would have mattered what the original technology was (i.e., NG boiler has to be replaced with another NG boiler; NG furnace has to be replaced with another NG furnace; etc.); but this is a same fuel rule so we only need detail down to the fuel type

	least cost	same fuel	same technology
new	new equipment, least cost rule	new equipment, same fuel rule	new equipment, same technology rule
replacement	replace equipment, least cost rule	replace equipment, same fuel rule	replace equipment, same technology rule
retrofit	retrofit equipment, least cost rule	retrofit equipment, same fuel rule	retrofit equipment, same technology rule

How are hurdle rates applied to energy efficiency decisions? (continued...)

- Hurdle rates consists of a distribution of 7 segments, each with a premium (rate) and a proportion of customers that use that rate








*10yrT = 10 year Treasury note rate

Segment	Premium (rate)	Market share
1	1000% + 10yrT*	60%
2	100% + 10yrT	10%
3	45% + 10yrT	10%
4	25% + 10yrT	10%
5	15% + 10yrT	8%
6	6.5% + 10yrT	1.8%
7	0% + 10yrT	0.2%

Example: Replacing a natural gas main space heater under same fuel rule
(different end-uses have different market shares)

- The life cycle cost is calculated for each purchase option (from the previous slide: boilers, furnaces, etc.) in each of the hurdle rate segments
 - The segment as a whole then chooses the lowest cost among the options; the corresponding market share is the proportion of customers associated with that rate

How are hurdle rates applied to energy efficiency decisions? (continued...)

segment	premium	NG boiler 1	NG boiler 2	NG boiler 3	NG furnace 1	NG furnace 2	NG heat pump 1	NG heat pump 2	market share
1	1000% + 10yrT		cost 2	cost 3	cost 4	cost 5	cost 6	cost 7	60%
2	100% + 10yrT		cost 2	cost 3	cost 4	cost 5	cost 6	cost 7	10%
3	45% + 10yrT		cost 2	cost 3	cost 4	cost 5	cost 6	cost 7	10%
4	25% + 10yrT		cost 2	cost 3	cost 4	cost 5	cost 6	cost 7	10%
5	15% + 10yrT		cost 2	cost 3	cost 4	cost 5	cost 6	cost 7	8%
6	6.5% + 10yrT		cost 2	cost 3	cost 4	cost 5	cost 6	cost 7	1.8%
7	0% + 10yrT		cost 2	cost 3	cost 4	cost 5	cost 6	cost 7	0.2%

U.S. Census Divisions (CDs) used in Buildings Models



Source: U.S. EIA