DOCKETED

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Miscellaneous Electrical Load Updates

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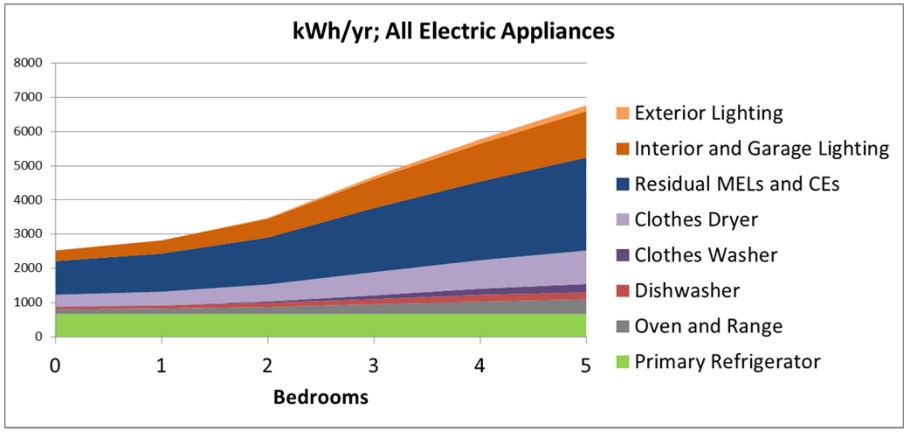
Plug Loads and Lighting

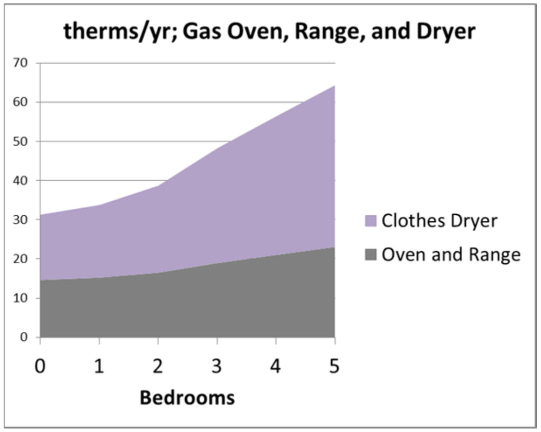
- Background
- Annual Energy Consumption (AEC) Methodology
  - Individually Modeled Plug Loads
  - Lighting
  - Residual MELs (All Remaining Plug Loads)
- AEC Results
- Load Profile Methodology
- Load Profile Results

Background

- CBECC-Res was using the rulesets in the 2008 CA HERS Technical Manual to model annual plug loads and lighting energy use
- These rulesets estimate Annual Energy Consumption (AEC) for various categories of plug loads and lighting based on home size (measured using number of bedrooms or conditioned floor area):

2013 ACM AEC Rulesets:

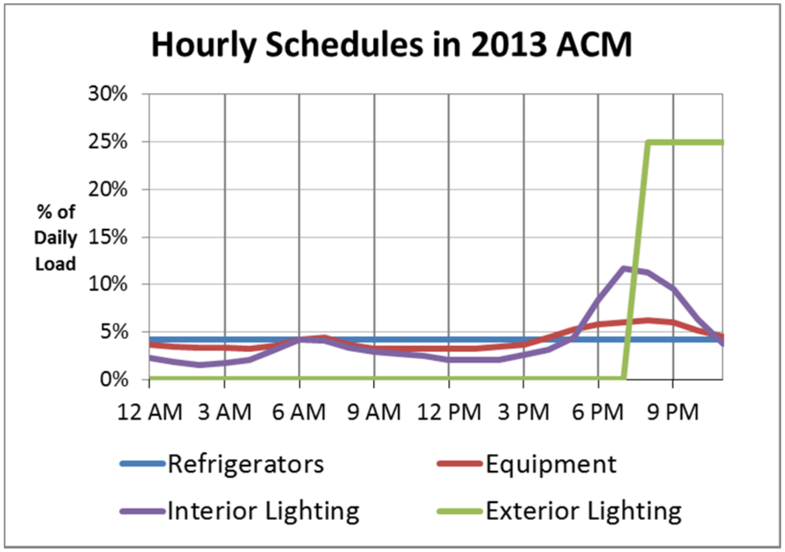


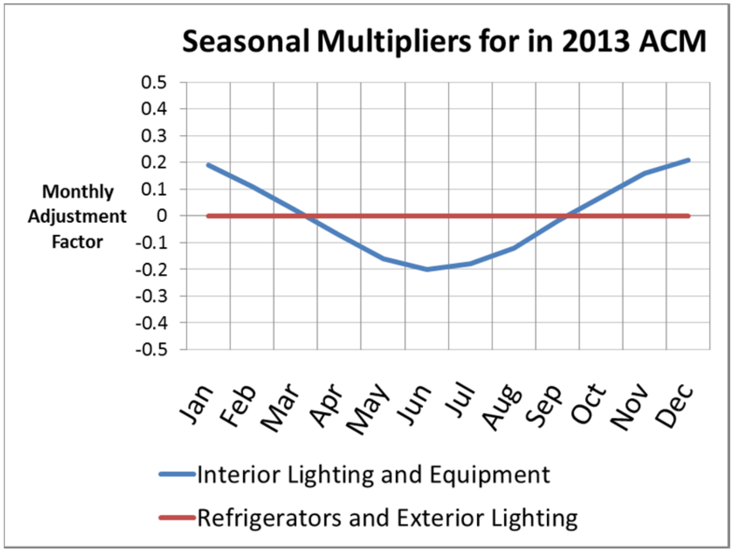


Background

- The rulesets also model daily and seasonal load shapes:

2013 ACM Load Profile Rulesets:

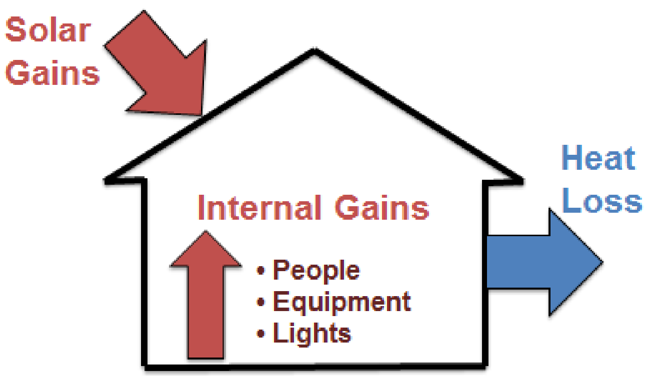




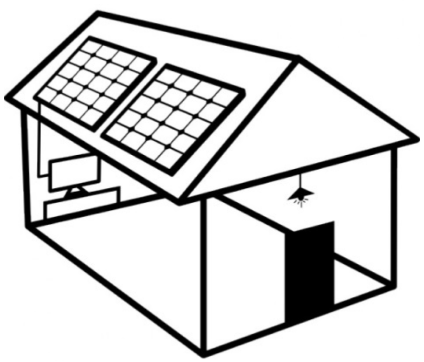
Background

- Together, the AEC and load profile assumptions affect:

  – **Internal gains** estimated from plug loads and lighting
    - Affects **heating/cooling loads** simulated in CBECC-Res



  – **Time Dependent Valuation (TDV)** of plug load and lighting energy use
    - Affects **Energy Design Rating**
    - Along with PV model, determines how **much on-site renewable generation is needed to meet CALGreen voluntary ZNE Tier** (Energy Design Rating = 0)



Observable Predictor Variables Are Limited for Newly Built Homes

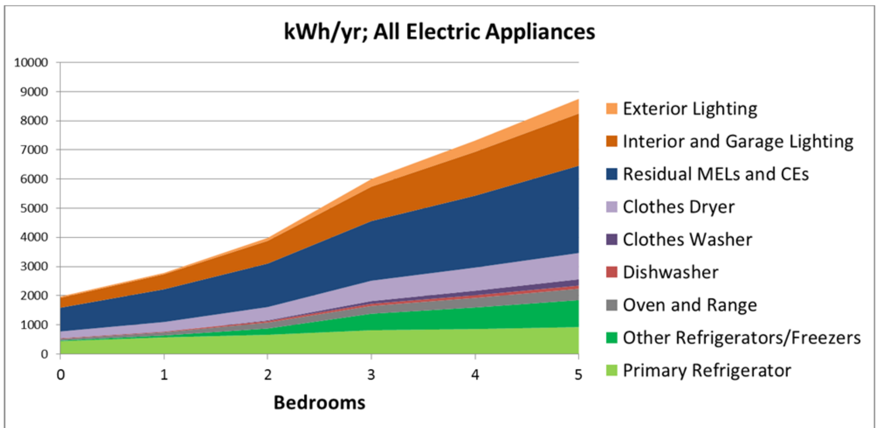
- Rulesets that predict AEC must be based on inputs that are **observable in a newly built home,** such as:
  - Number of bedrooms
  - Conditioned floor area
  - Which white goods will be present (oven, dishwasher, etc.)
  - Energy Guide label on white goods
  - Presence of gas hook-ups (for clothes dryer, oven/range)
  - Etc.

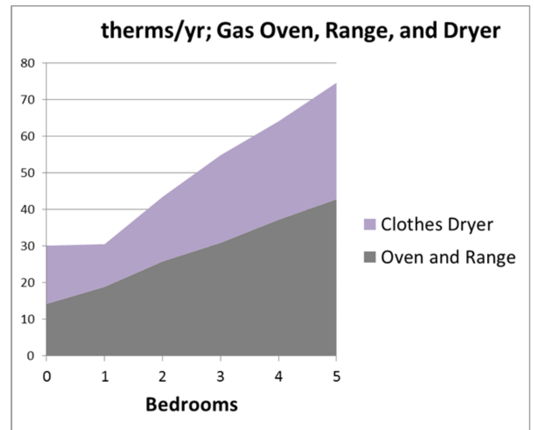
Existing (2013 ACM) AEC Methodology

- Relied heavily on "RASS 2009 CDA"
  - **RASS:** Residential Appliance Saturation Survey
    - **2008 remote survey of 25,000 California households**
    - Asked respondents about:
      - **House** (# bedrooms, floor area, etc.)
      - **Occupants** (# residents, income, demographics)
      - **Devices** (#, type, size, usage of devices)
  - **CDA:** Conditional Demand Analysis
    - Collected the metered, whole-home AEC (therms, kWh) of all of the respondents, not submetering data for each end use
    - Used statistical techniques to **disaggregate respondents' whole-home AEC into <u>AEC for each end use</u>**
      - Relied on engineering equations, survey responses for each home, and statistically-derived adjustment factors

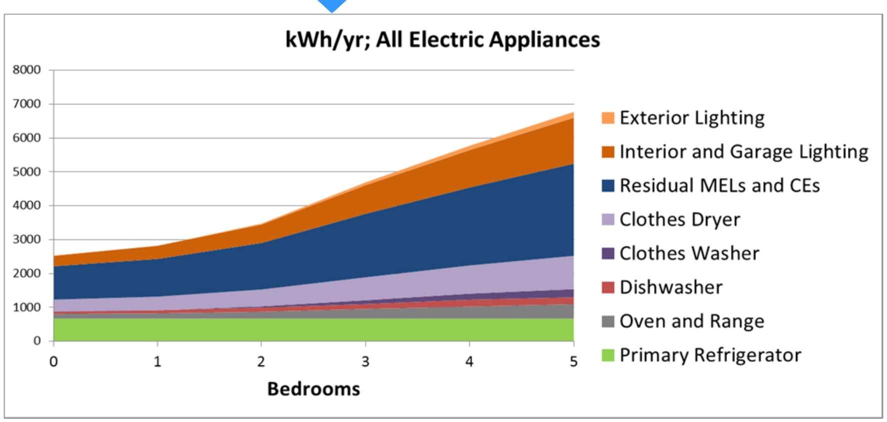
Existing (2013 ACM) Methodology: Relied Heavily on RASS 2009 CDA

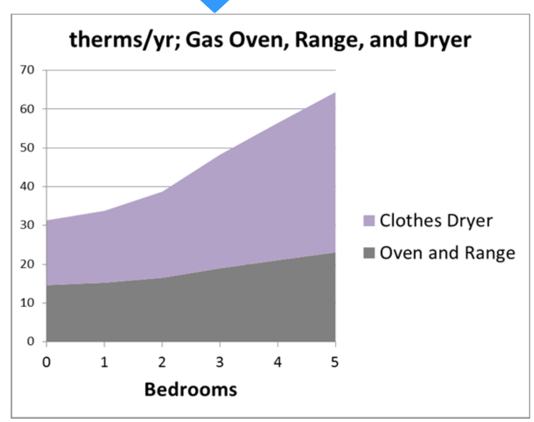
RASS 2009 CDA:





2013 ACM AEC Rulesets:





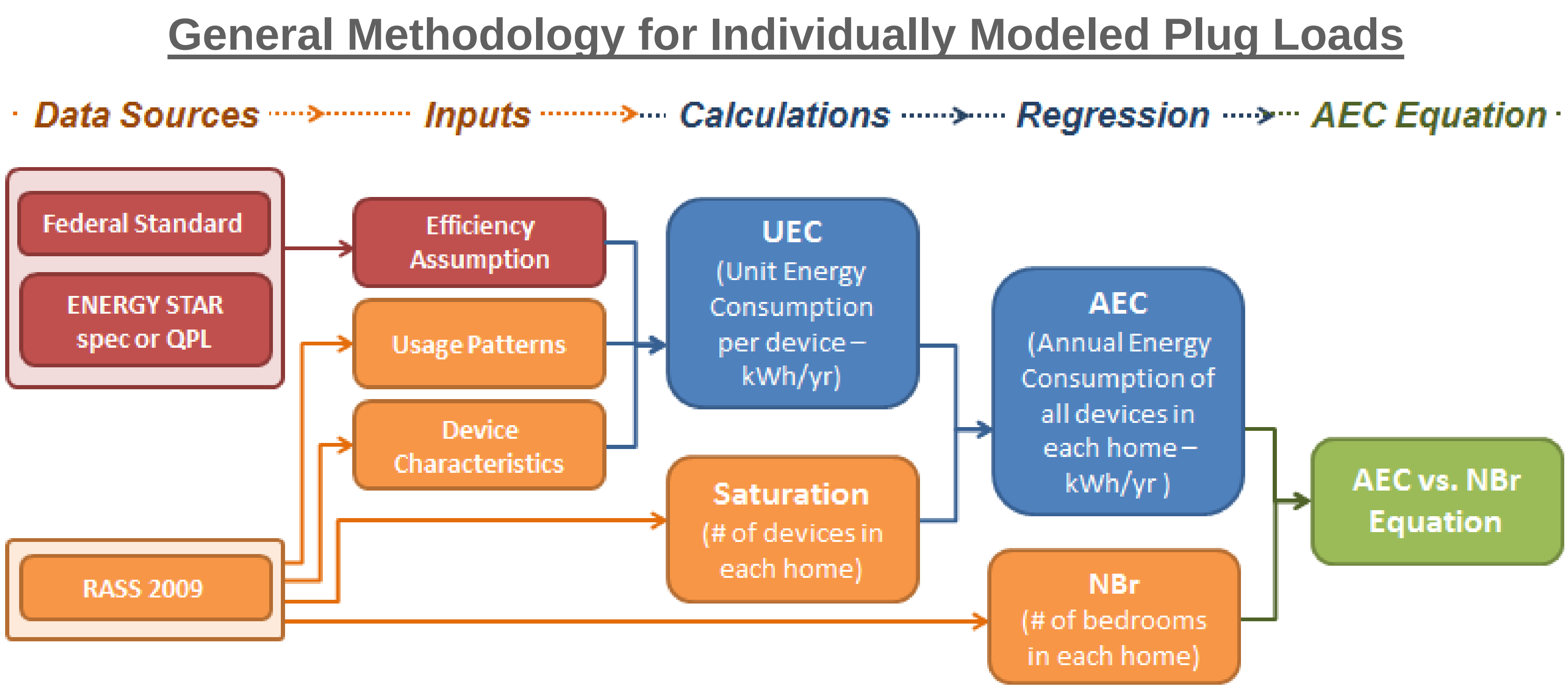
Motivations for Update

- Accurate estimate of plug load and lighting energy use is key to **sizing PV systems correctly** for homes that will meet the CALGreen voluntary **ZNE Tier**, effective January 1, 2017
- The 2013 ACM rulesets were insufficient for this goal:
  - **Overestimated** plug load and lighting energy use for **large buildings**
  - Assumed **simplified load profiles**, which did not reflect the unique timing of different end uses
  - Relied on RASS 2009 CDA, and was thus **out of date** and **could not be easily updated** to reflect new data

Goals for Update

- Update rulesets to more accurately estimate plug load and lighting AEC and load profiles for newly constructed homes built during the 2016 Energy Code cycle
  - Take advantage of **2008-2016 data**
  - Account for updates to energy **efficiency standards**
  - Establish a **modeling framework** that can be **updated on a regular basis** as technologies continue to change and new data becomes available
  - **Correct overestimation** of AEC for **large home sizes**
  - Make the **load profile assumptions more data-driven and granular**

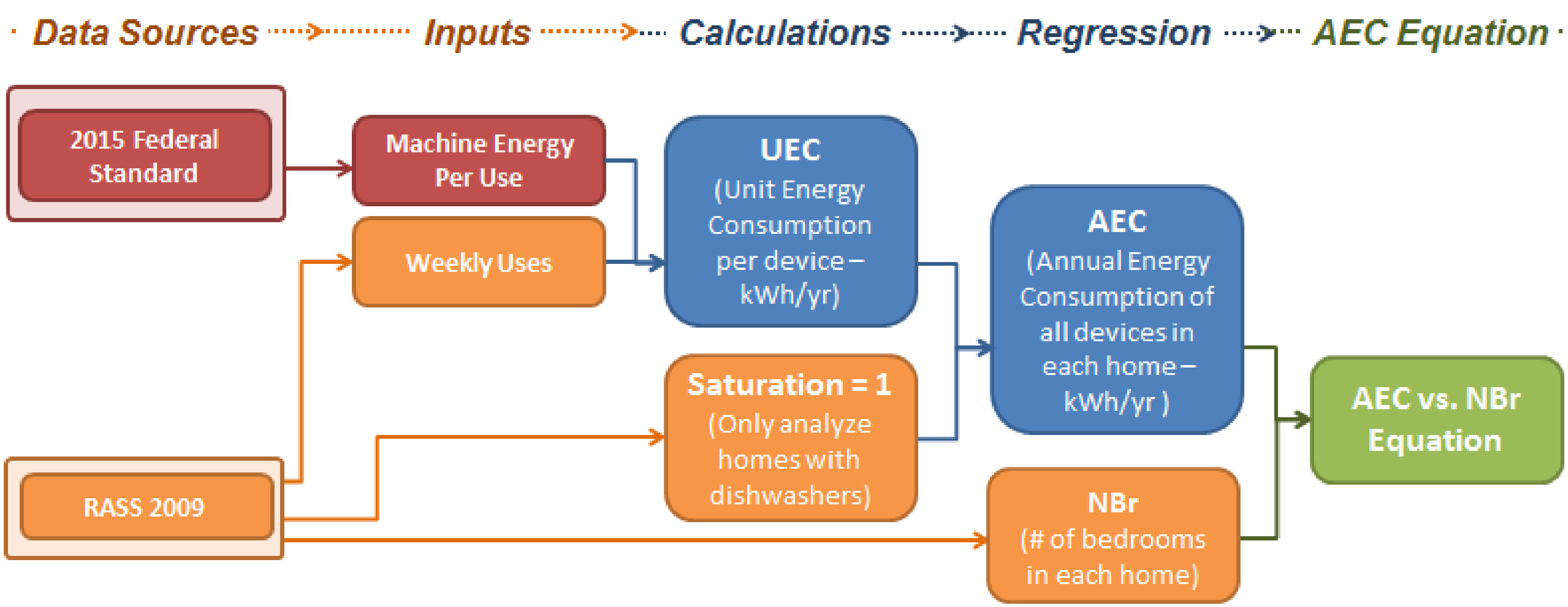
Proposed 2016 ACM Ruleset – AEC Methodology: Apply Modern Efficiency to RASS Survey Data



For primary refrigerator, clothes washer, and dishwasher:

Override equation using data from Energy Guide label, if present

Proposed 2016 ACM Ruleset – AEC Methodology: Example – Dishwasher



- Only assign dishwasher AEC if one is or will be installed
- Override ruleset using data from Energy Guide label, if present

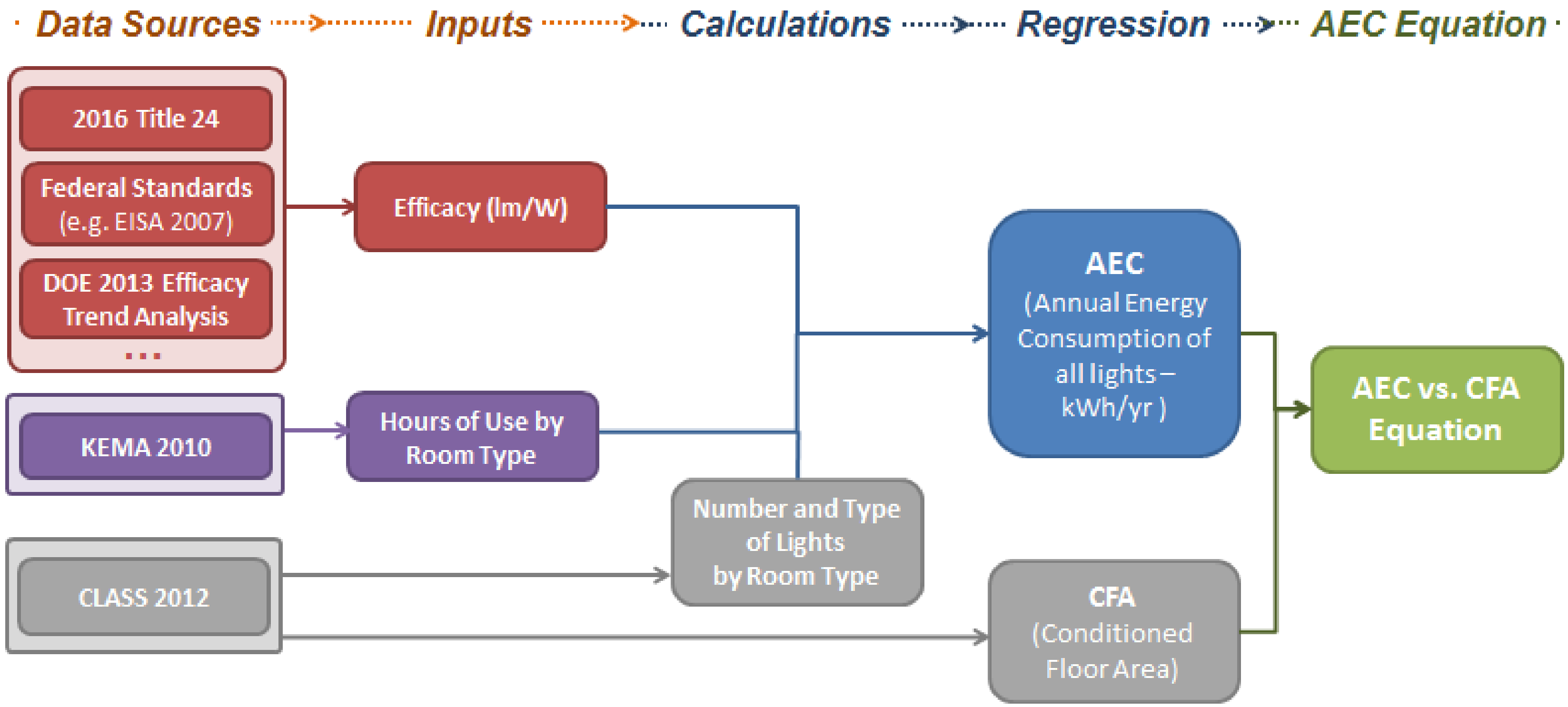
Individually Modeled Plug Loads: Proposed 2016 ACM Efficiency Assumptions

End Use	Age	Efficiency Default	Energy Guide Override?
Oven and Range	New	RASS CDA + DOE Technical Support Doc	No
Dishwasher	New	2015 Federal Standard	Yes
Primary Refrigerator	Mix	2001, 2014 Federal Standards	Yes
Other Refrigerators and Freezers	Mix	2001, 2015 Federal Standards	No
Clothes Washer	Mix	2007, 2015 Federal Standards	Yes
Clothes Dryer	Mix	1994, 2015 Federal Standards	No
Televisions	Existing	ESTAR v6 Spec	No
Computers and Monitors	Existing	ESTAR v6 QPL	No
Set-Top Boxes	Mix	ESTAR v3 QPL	No

Efficiency Default Color Key
[Market Average]
[Federal Minimum Compliance]

Proposed 2016 ACM Lighting AEC Methodology

General Methodology for Interior, Exterior, and Garage Lighting



- CLASS 2012: On-site lighting audits of ~2,000 CA households, administered by CPUC
- KEMA 2010: Hours of use for each room type derived from light logger data; ~8,000 light loggers deployed in 1,200 CA households

Proposed 2016 ACM Lighting Efficiency Assumptions

Luminaire Type	Location	Light Technology	Share	Efficacy (lm/W)	Average Efficacy (lm/W)
Portable	Any	LED	21%	80	43
		CFL	24%	68	
		Halogen	55%	17	
Hard-wired	Interior	LED	85%	80	80
		CFL	8%	68	
		Lin. fluor.	7%	92	
Hard-wired	Garage	LED	43%	80	86
		CFL	8%	68	
		Lin. fluor.	50%	92	
Hard-wired	Exterior	LED	85%	80	76
		CFL	5%	68	
		Metal halide	10%	49	

- All hard-wired luminaires in new homes will be required to be high efficacy in 2017; specifically, Title 24 will require all screw-based sockets to meet the Appendix JA8 requirements
- The most likely compliance pathway for JA8 will be with LED, and most builders have historically favored screw-based sockets over GU24

- Relative share of LED, CFL, and halogen portable lighting based on shipment data
- Share of linear fluorescent lighting based on CLASS 2012 on-site audits

Proposed 2016 ACM Methodology: AEC of Residual Miscellaneous Electric Loads (MELs)

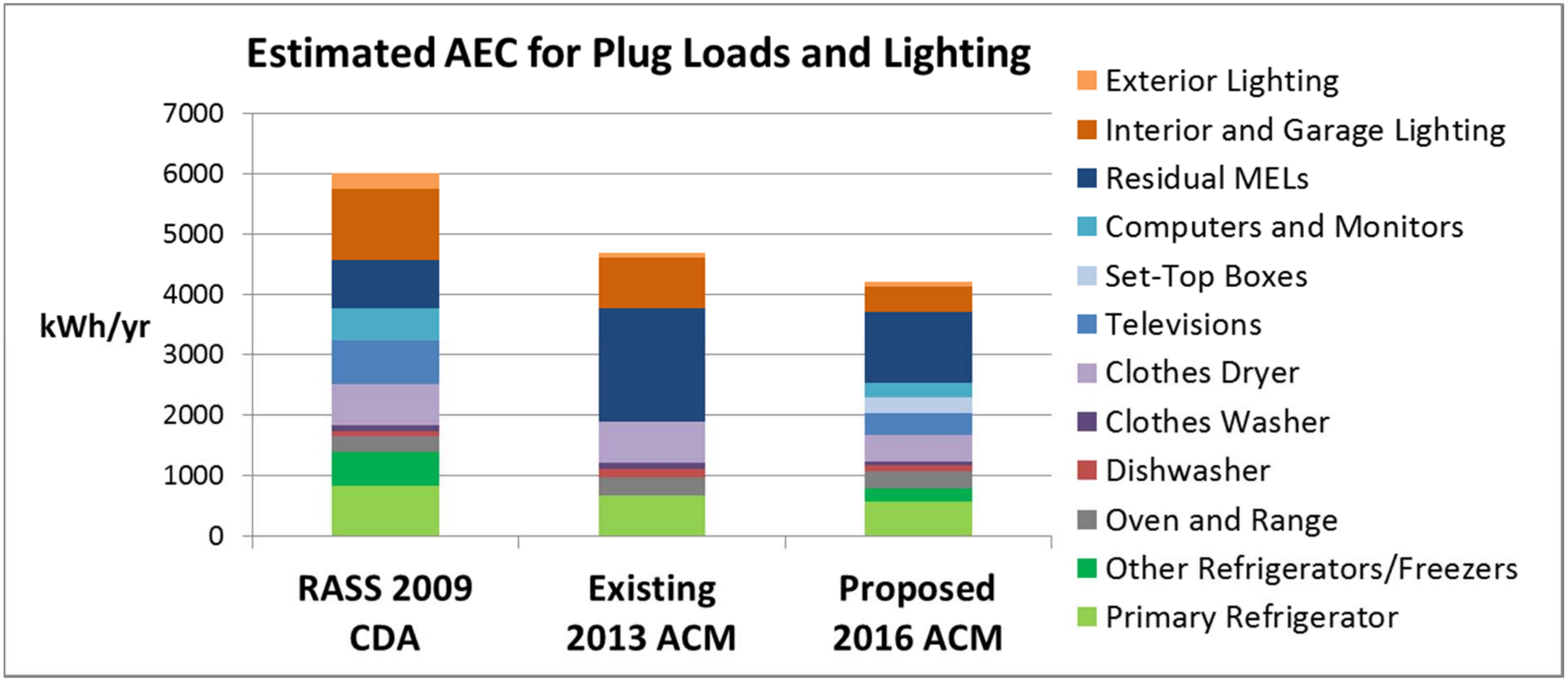
1. **Estimate AEC of residual MELs in 2013:**
   Bottom-up estimate, combining AEC of the 98 most prominent MELs
   Sources: SCE Residential MELs meta-analysis
   DOE TSD on Battery Chargers and External Power Supplies

2. **Account for growth from 2013-2017:**
   4.3 % - 2013 CEC Demand Forecast for Miscellaneous

3. **Determine scaling with Home Size (AEC vs. # bedrooms):**
   Assumed to be similar to scaling of TVs, STBs, Computers and Monitors

Whole-Home Results:

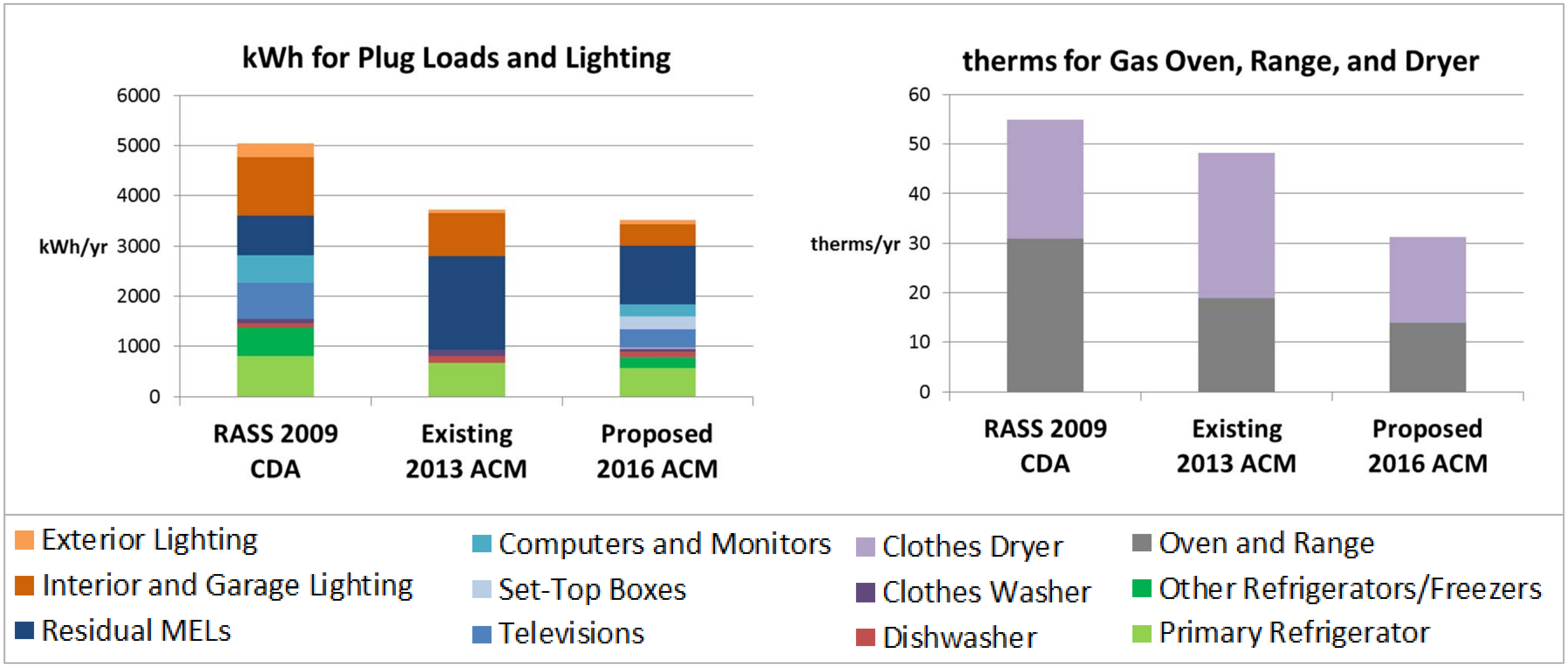
Average 3 Br Home with All Electric Appliances



Energy use from **interior lighting is greatest difference** between rulesets in 2013 ACM and proposed 2016 ACM
(largely due to forthcoming lighting requirements)

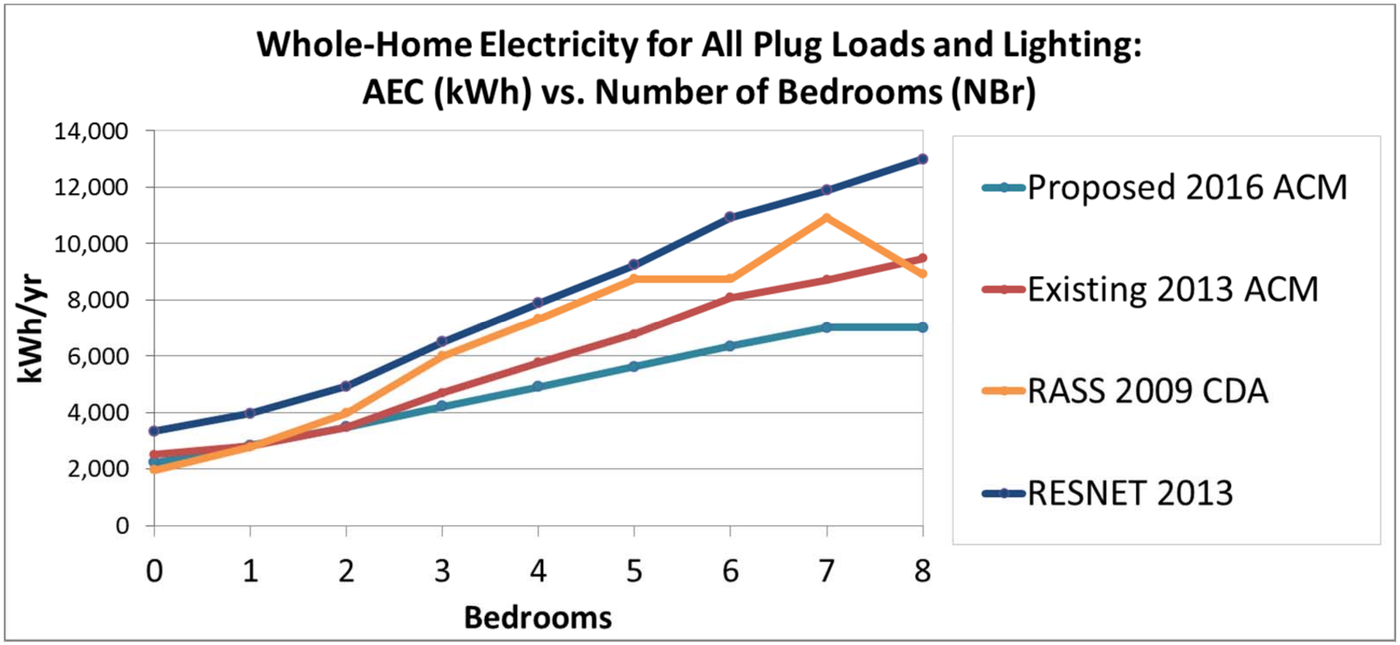
Whole-Home Results:

Average 3 Br Home with Gas Oven, Range & Dryer



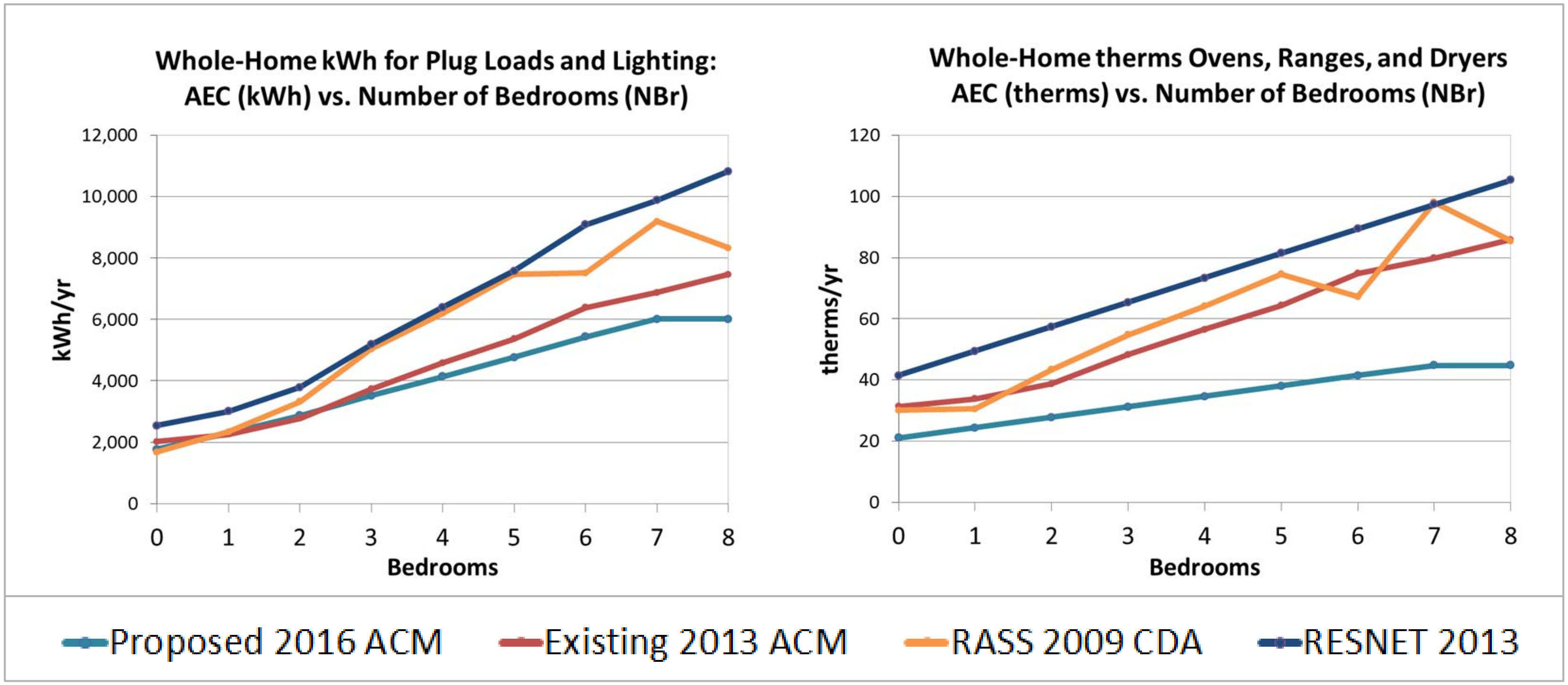
Dryer therms assume minimal compliance with federal standard in effect at the time of manufacture: 28% of 2017 dryers meet 2015 federal standard, 72% meet 1994 standard. (% breakdown based on RASS age data for newly built homes).

Whole-Home Results, Scaling with NBr: Home with All Electric Appliances



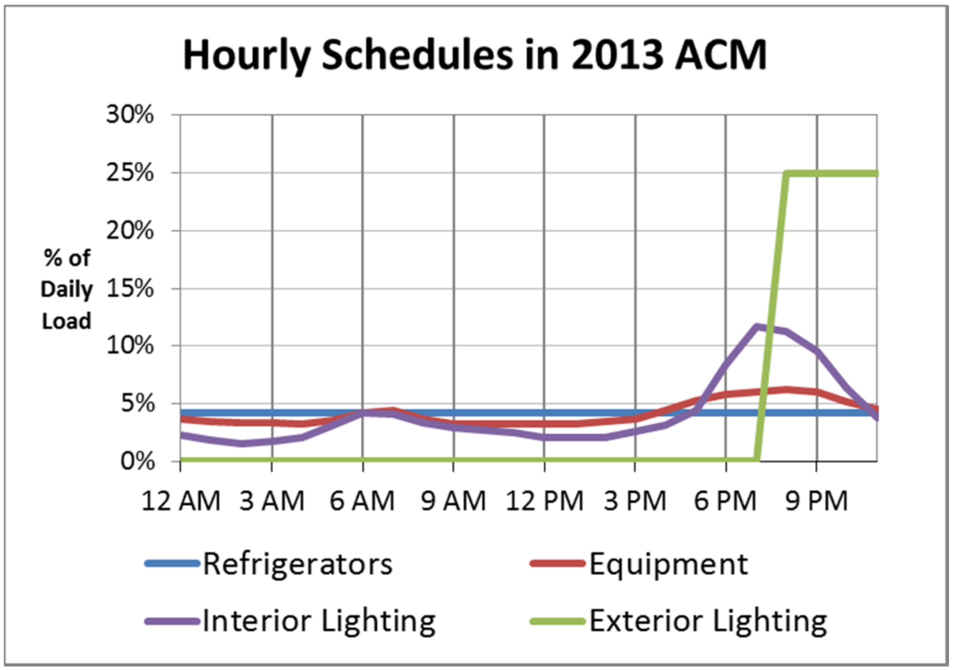
- For **smaller homes**, proposed 2016 ACM and 2013 ACM Rulesets have **similar total kWh**
- AEC from proposed 2016 ACM Rulesets **increases more slowly with NBr** than in 2013 ACM
- Proposed 2016 ACM Rulesets are capped above 7 Br due to poor data availability and because RASS data suggests limits to kWh growth in 8+ Br homes

Whole-Home Results, Scaling with NBr: Home with Gas Oven, Range & Dryer



- Total proposed 2016 ACM kWh is **similar** to 2013 ACM kWh, especially for **small to mid-size homes**
- Total proposed 2016 ACM **therms are lower, particularly for large homes**

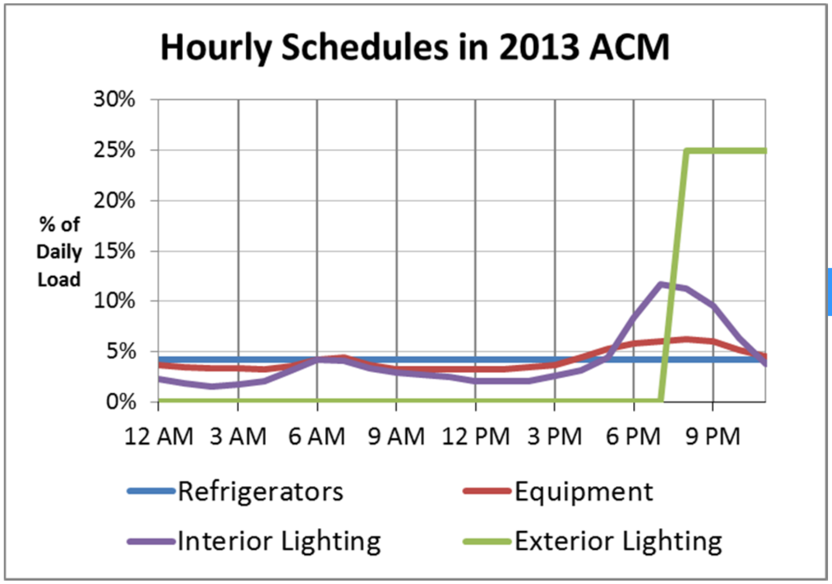
Updated Load Profile Methodology

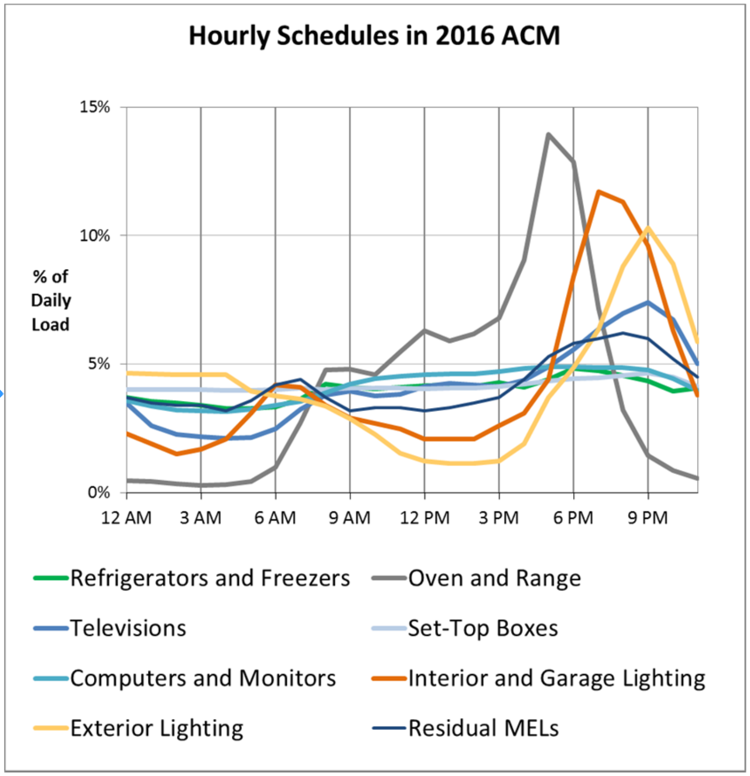


- The 2013 ACM Rulesets has separate hourly schedules for:
  - Interior lighting
  - Exterior lighting
  - Refrigerators
  - All other equipment
- There is one set of seasonal multipliers, applied to most end uses

- The proposed 2016 ACM Rulesets have **separate hourly schedules and seasonal multipliers for each end use**, most of which are derived from more recent submetering studies

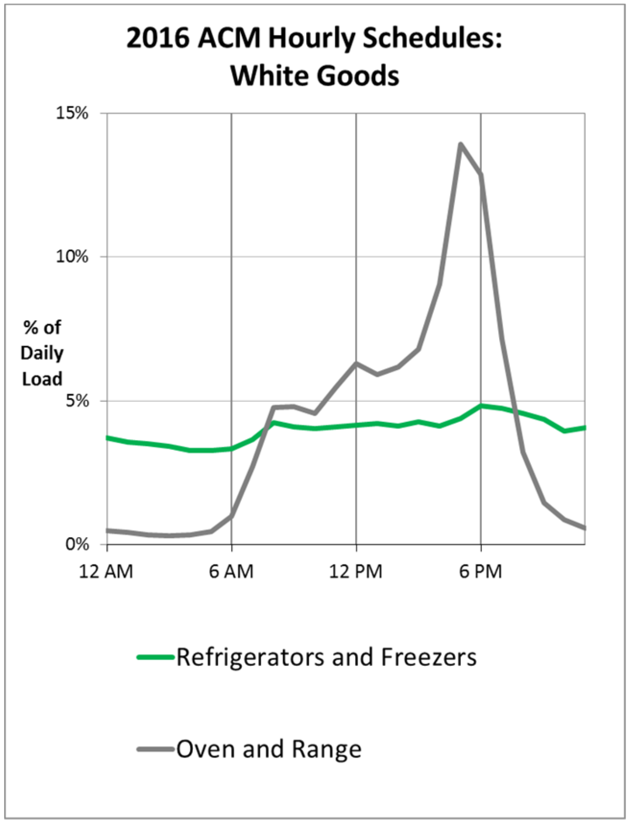
Load Profile Results: Proposed 2016 ACM Hourly Schedules

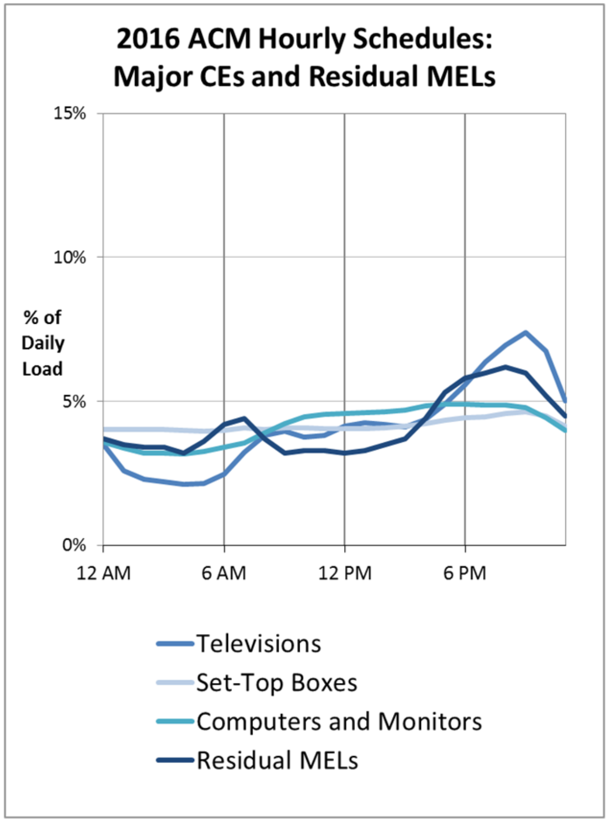


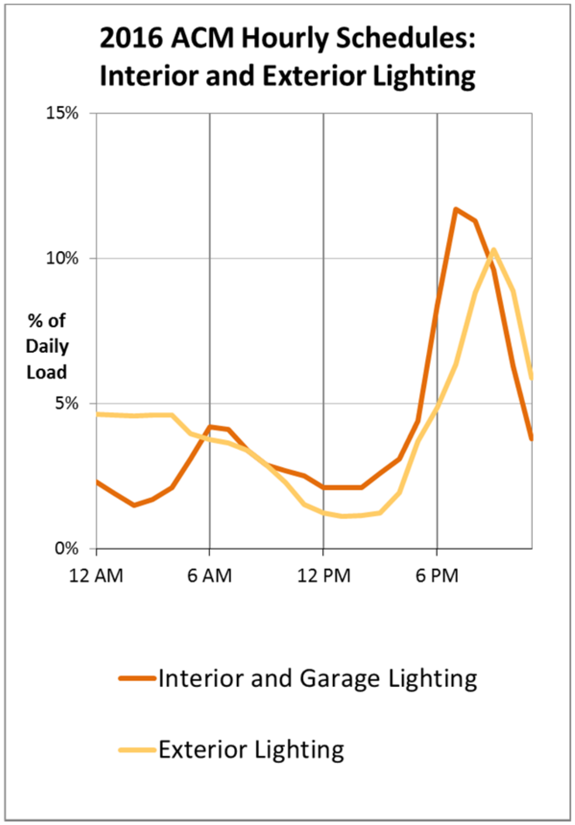


- Dishwasher, clothes washer, clothes dryer will use CBECC hot water heating model
- Other hourly schedules based on submetering or light logging studies from CA, PANW, or FL
- Most end uses have separate weekend/weekday schedules

Load Profile Results: Proposed 2016 ACM Hourly Schedules

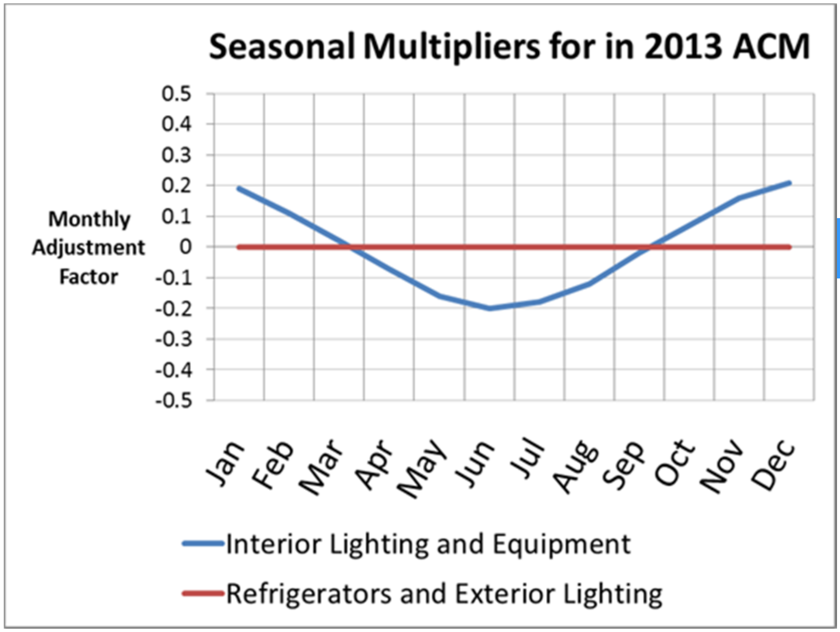


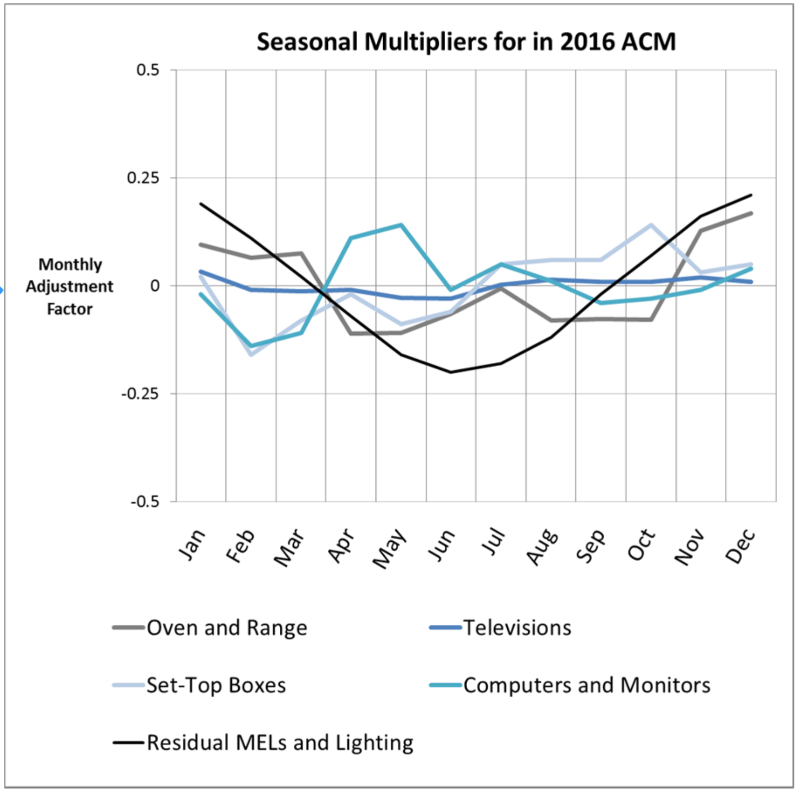




Dishwasher, clothes washer, clothes dryer hourly schedules are not shown above because they will the load profiles in the CBECC-Res hot water heating model

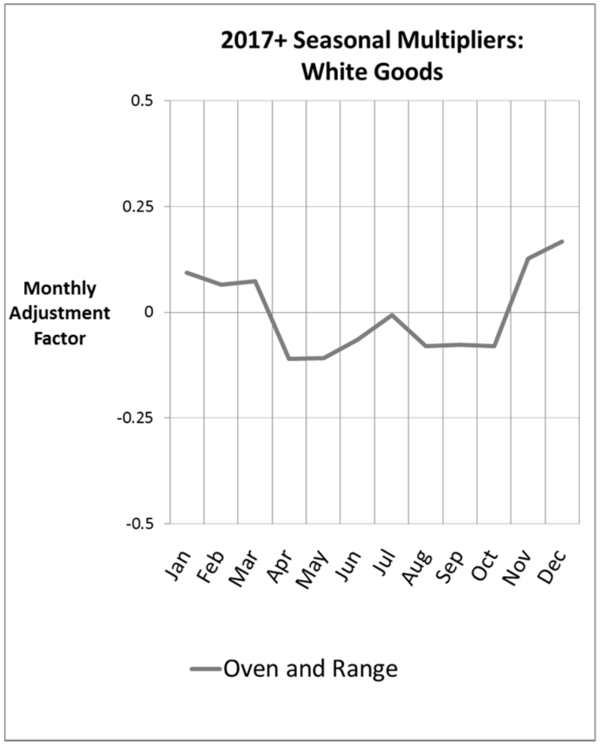
Load Profile Results: Proposed 2016 ACM Seasonal Multipliers

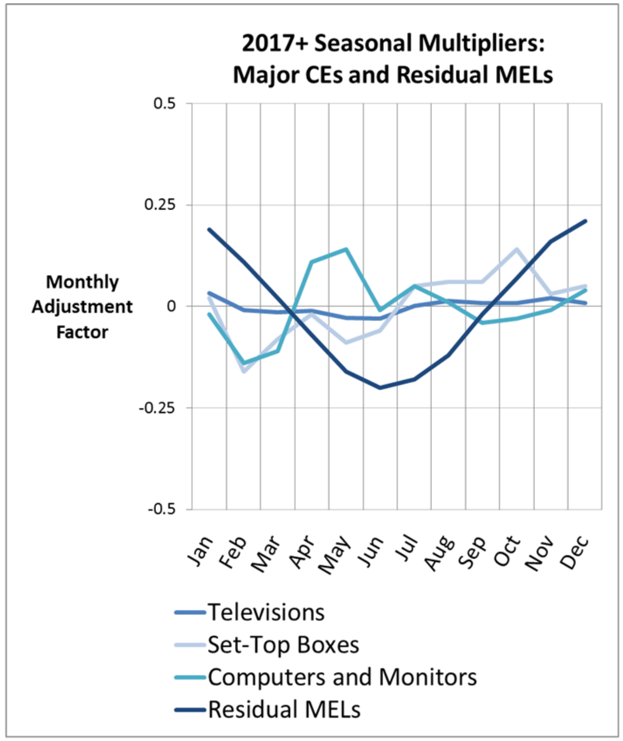


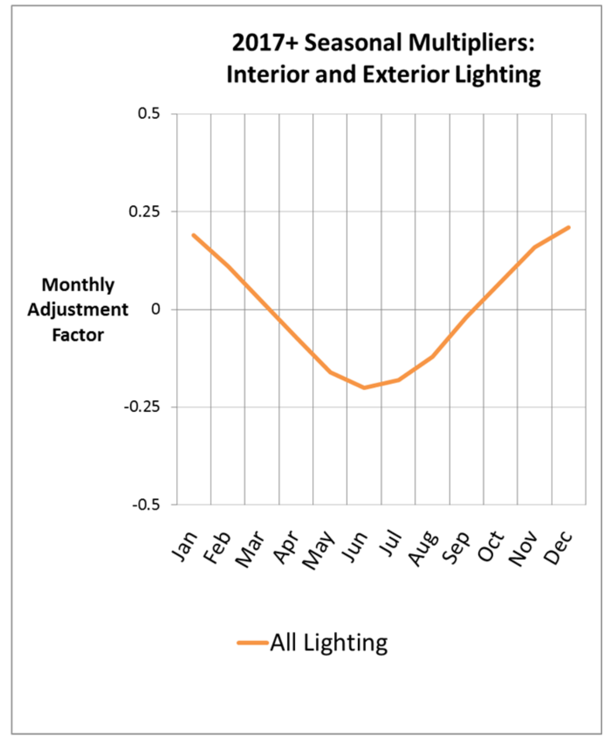


- Most seasonal multipliers use same data source as corresponding hourly schedule
- Dishwasher and clothes washer/dryer based on CBECC hot water heating model
- Refrigerator energy use is adjusted hourly based on simulated interior temperature
- Lighting and residual MELs multipliers are still based on monthly hours of daylight

Load Profile Results: Proposed 2016 ACM Seasonal Multipliers







- Dishwasher and clothes washer/dryer based on CBECC hot water heating model
- Refrigerator energy use is adjusted hourly based on interior temperature simulated by CBECC-Res, using submetering data to relate refrigeration kWh to temperature

Thank You

On behalf of the Statewide Utility Codes and Standards Team