

21 March, 2018

# Beneficial Electrification: What's Hot, and What's Not

ACEEE Hot Water Forum Beneficial Electrification Session

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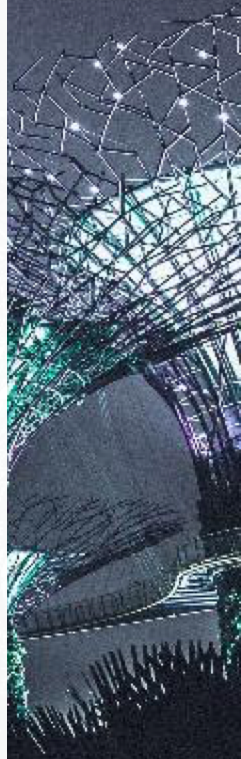
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[raponline.org](http://raponline.org)



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# Things Can Change Quickly

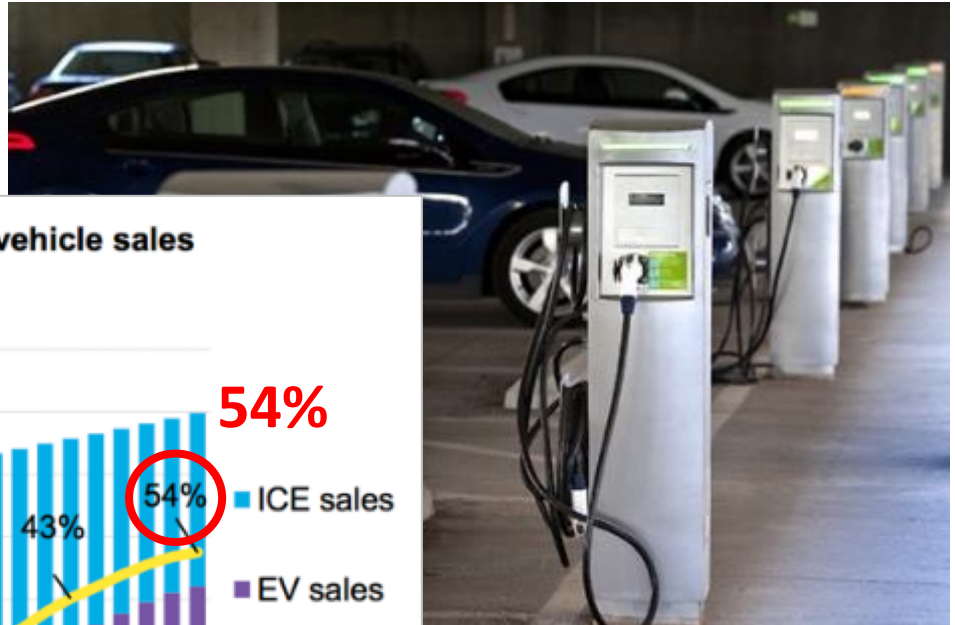
5<sup>th</sup> Avenue, NYC, Easter **1900**  
See any *automobiles*?



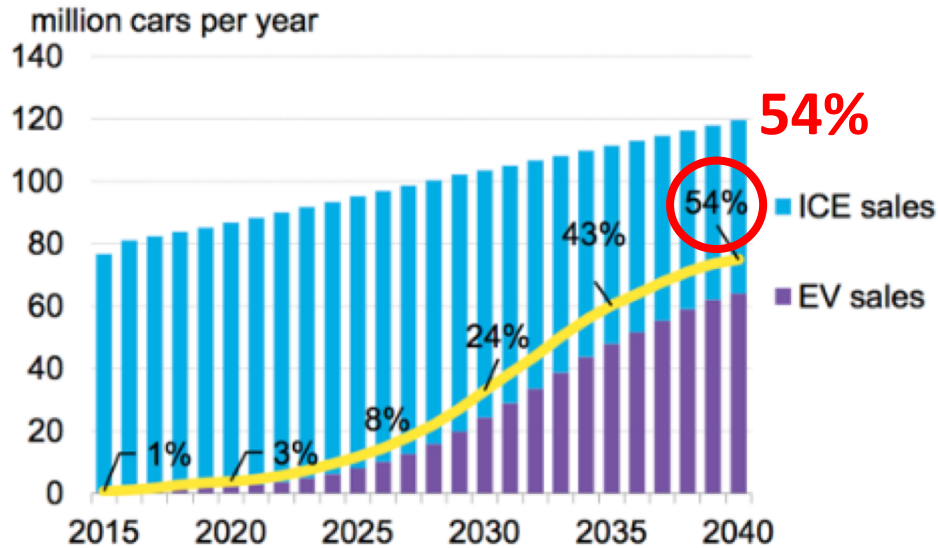
Park Avenue, NYC, Easter **1913**  
See any *horses*?



# Electrification is Well Underway



**Figure 1: Annual global light duty vehicle sales**



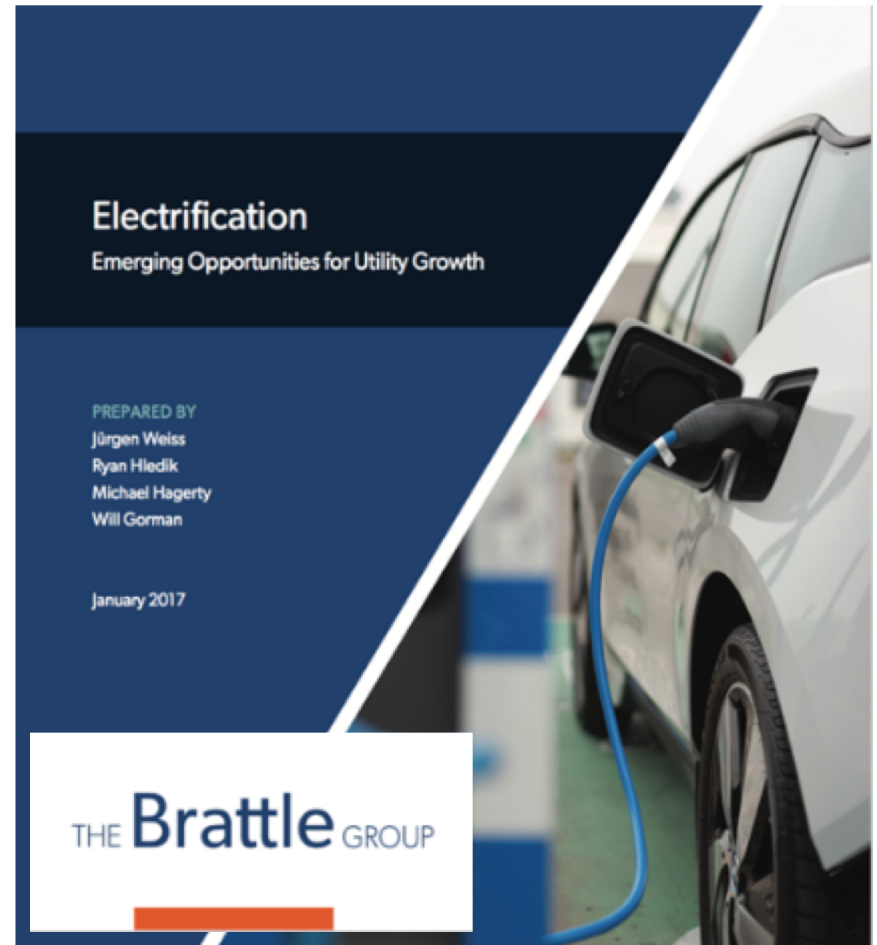
Source: Bloomberg New Energy Finance

Photo credits: Nest and Dennis Schroder, NREL

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# But Not All Electrification Is Created Equal

- *It's all about load growth, right?*
- *Brattle: "Utility sales could nearly double by 2050"!*



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# What Makes for Beneficial Electrification (BE)?

*Three explicit criteria: Achieve At Least One Without Adversely Impacting The Others*



1. Saves Customers Money Long-Term; New Services



2. Reduces Environmental Impacts



3. Enables Better Grid Management

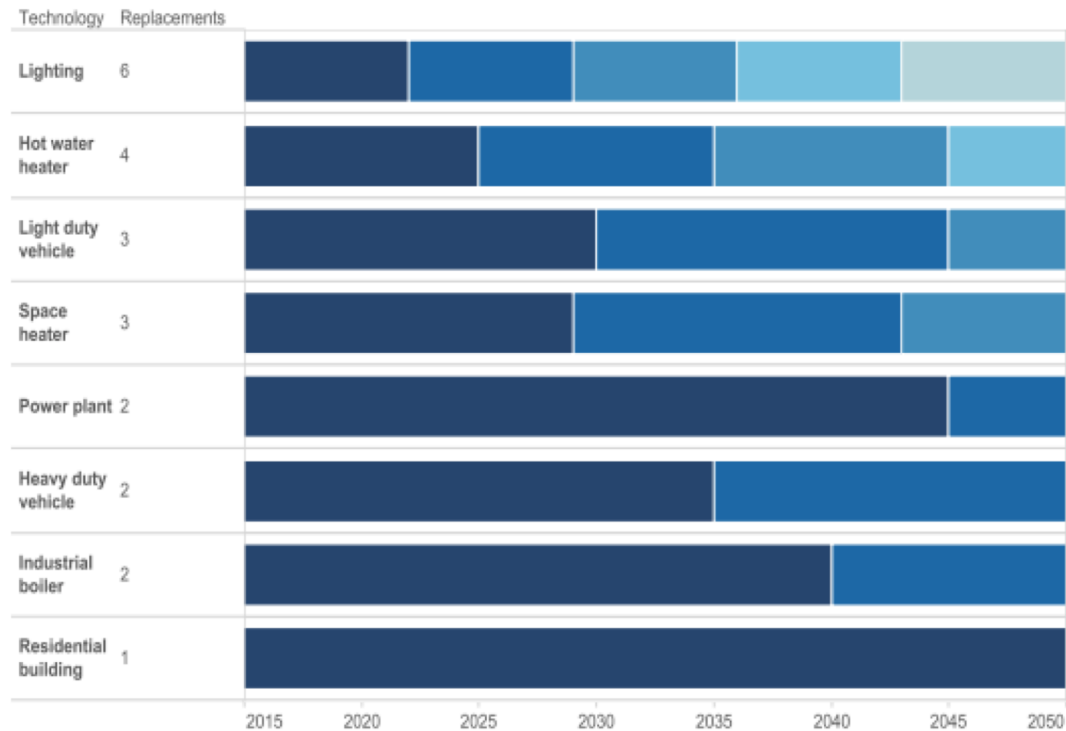
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# Installing a Heat Pump When The Oil Furnace Wears Out Is A Good Idea Now.

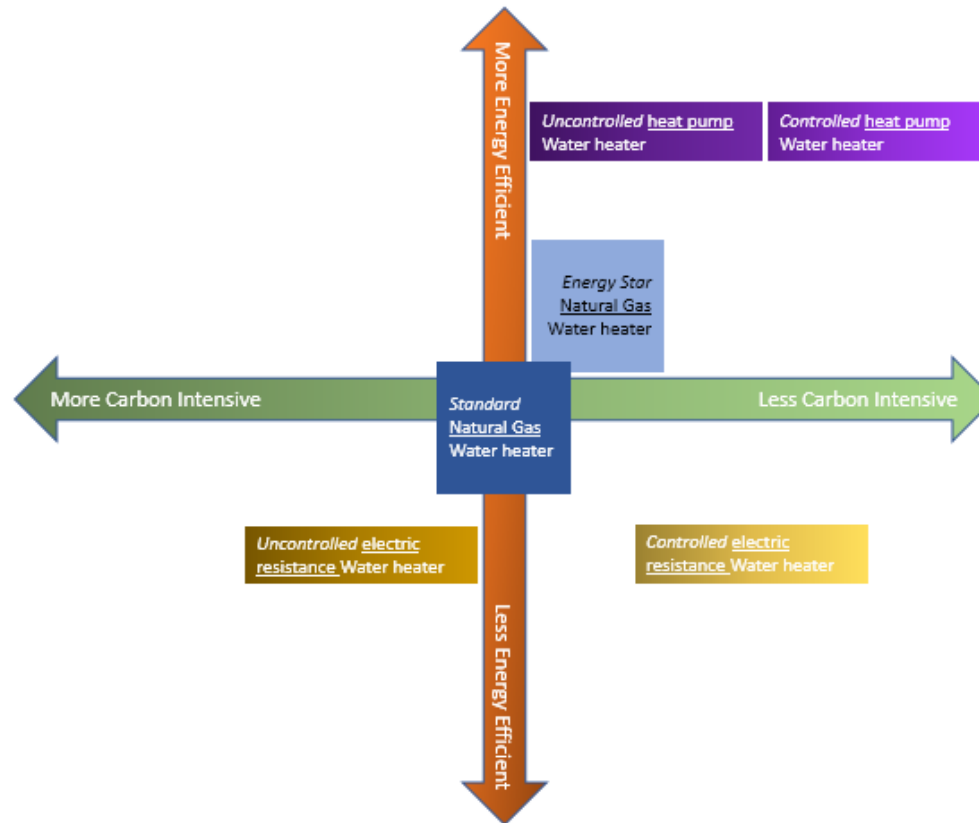


# Appliance Replacement Cycle Matters a Lot

Equipment Infrastructure:  
opportunities between 2015 and 2050



# Efficiency vs. Emissions “Emiciency”





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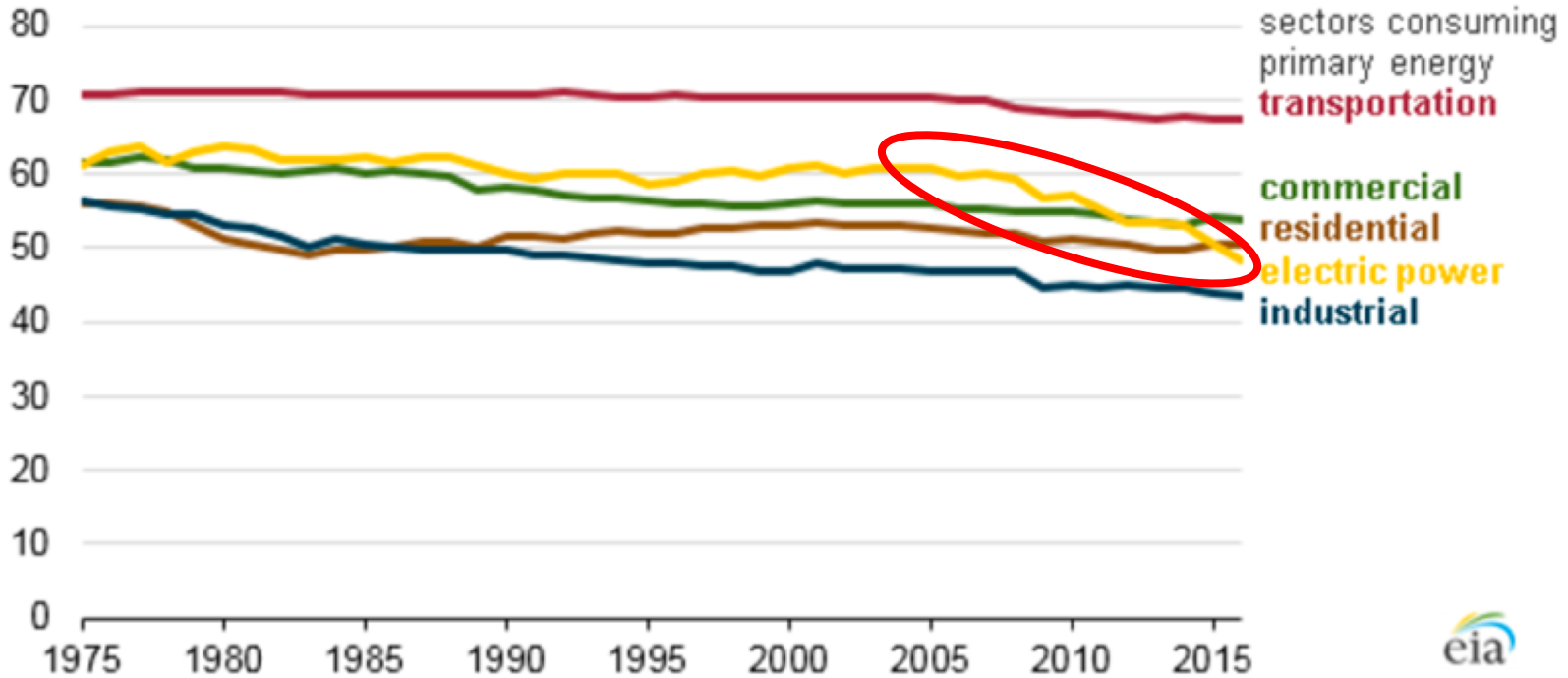
# Swapping Out Water Heaters Is A Bit More Complex Question



# Think Ahead: Electric Power is Getting Much Cleaner...

## U.S. carbon intensity of energy use by sector (1975-2016)

kilograms carbon dioxide per million British thermal units



Source: U.S. Energy Information Administration, [Monthly Energy Review](#)

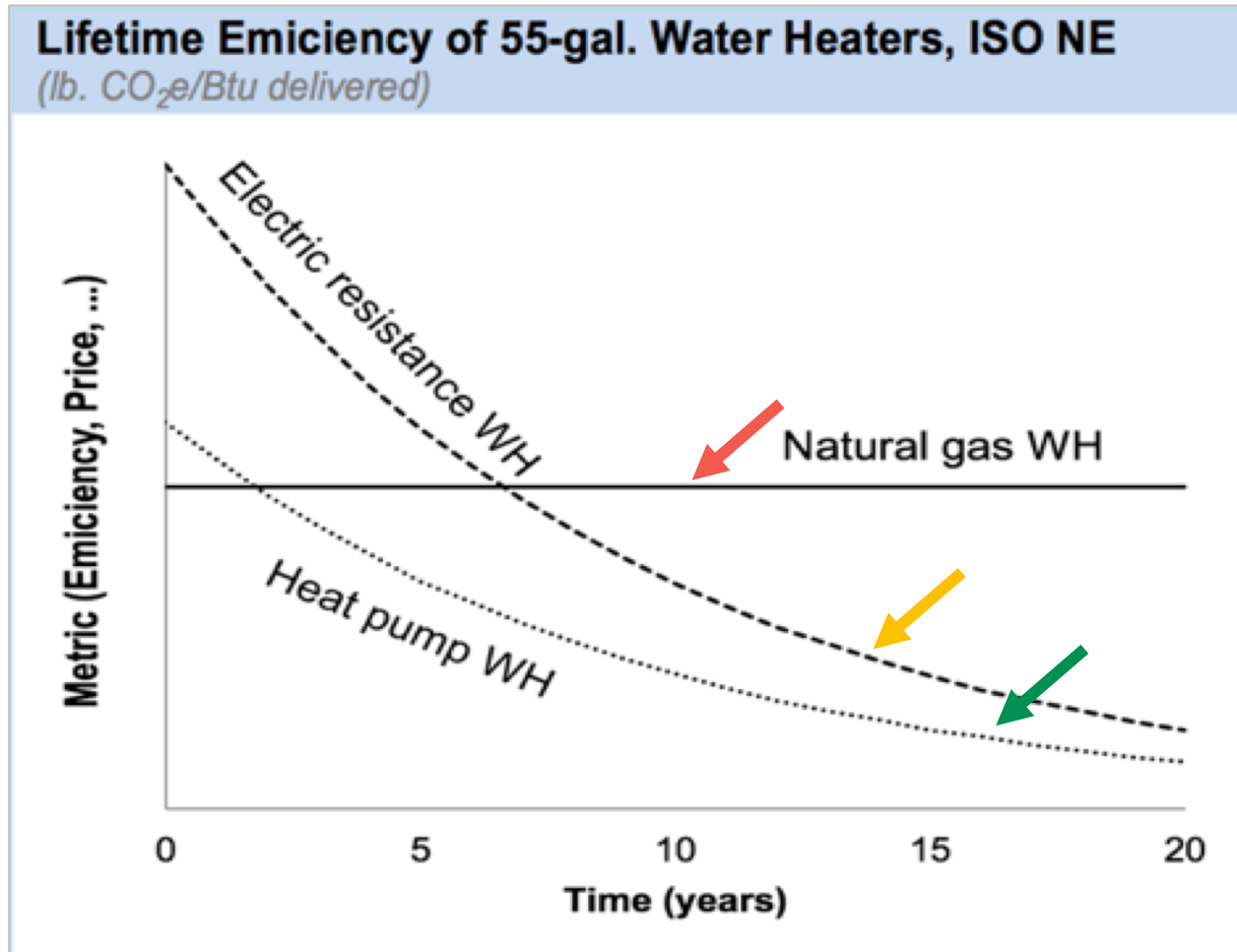


# Efficiency: Metrics Matter...

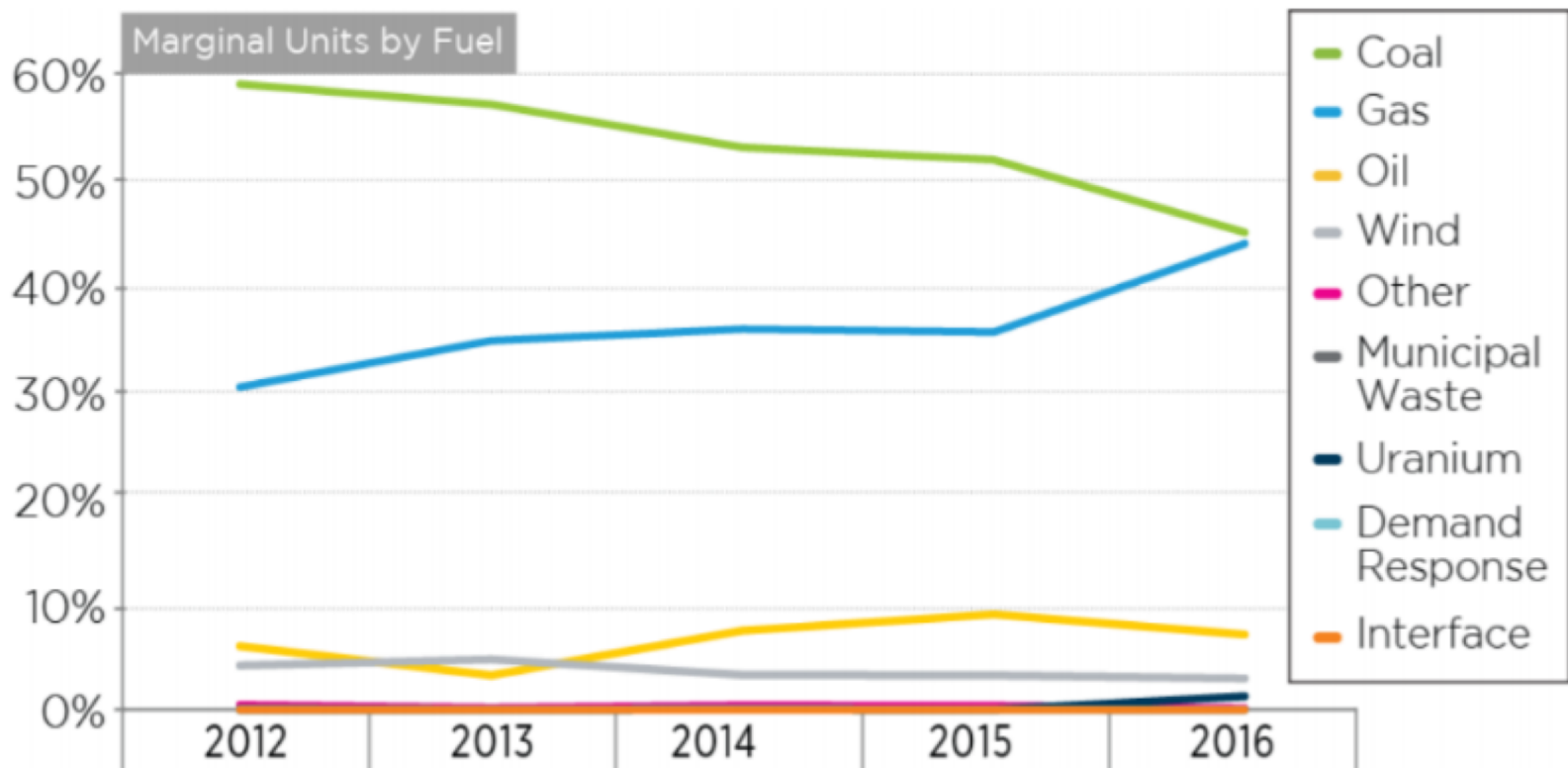
Emissions Efficiency	Existing Fuel #CO <sub>2</sub> /MMBTU	Marginal Resource on System to Serve Load				
		100% Coal	50% Coal / 50% CCCT Gas	100% CCCT Gas	50% CCCT Gas / 50% Non-Carbon	100% Non-Carbon
<b>Utility System #CO<sub>2</sub>/MWh</b>		2,000	1,200	800	400	0
<b>Space Heating - Oil to Heat Pump</b>	202					
Warm Climate 3,000 - 6,000 HDD		209	143	78	39	0
Cold Climate >7,000 HDD		314	215	117	58	0
<b>Space Heating - Natural Gas to Heat Pump</b>	130					
Warm Climate		209	143	78	39	0
Cold Climate		314	215	117	58	0
<b>Water Heating - Gas to Electric Resistance</b>	167	628	430	233	117	0
<b>Water Heating - Gas to Heat Pump</b>	167					
Warm Climate		209	143	78	39	0
Cold Climate		314	215	117	58	0
<b>Clothes Drying - Gas to Ultrasonic</b>	167	157	108	58	29	0
	#CO <sub>2</sub> /Mile					
<b>Automobile - Gasoline to EV</b>	0.65	0.54	0.37	0.20	0.10	0

Green = BE    Yellow ~ OK    Red = Don't electrify, yet

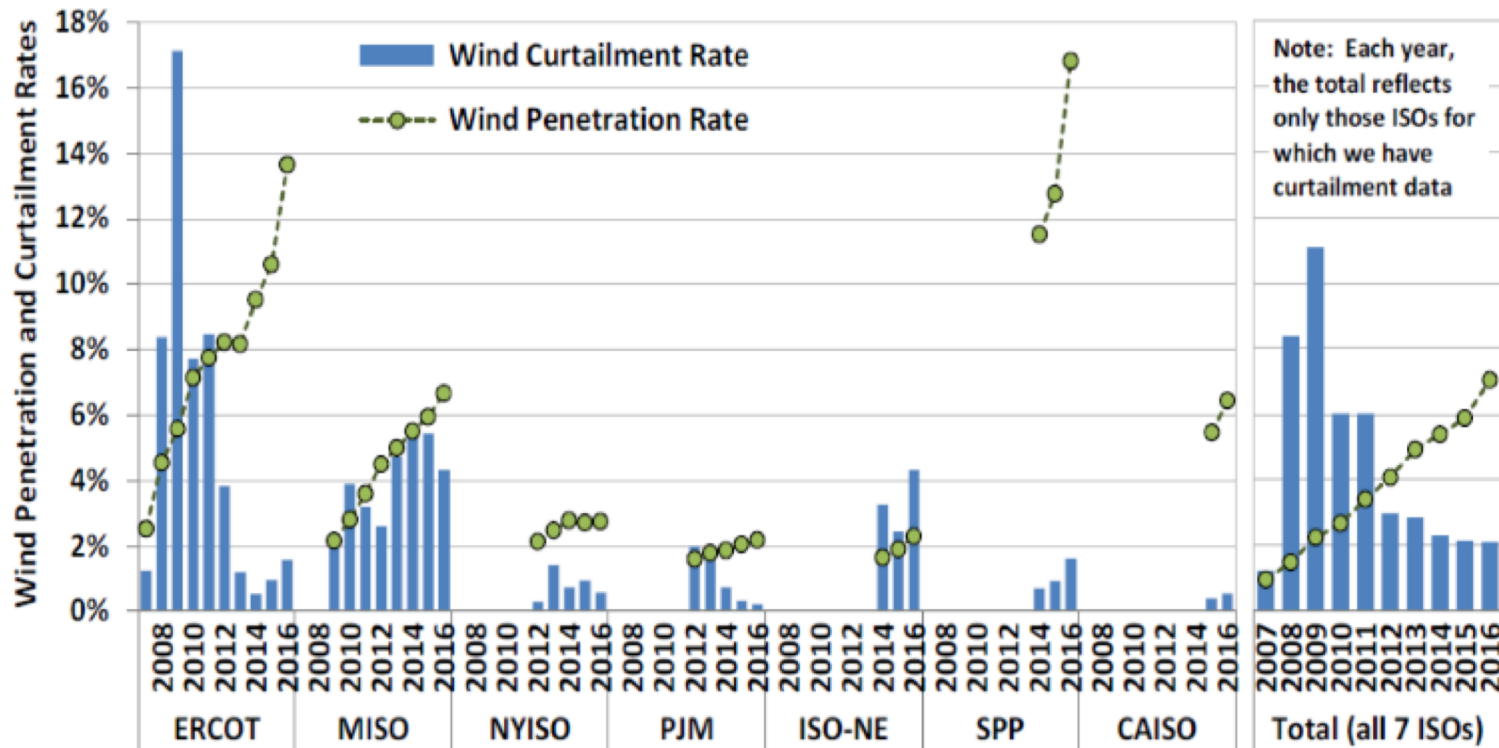
# So Benefits Will Increase Over Time as Devices Improve Along With the Grid



# Marginal, not Average Emissions is What is Relevant



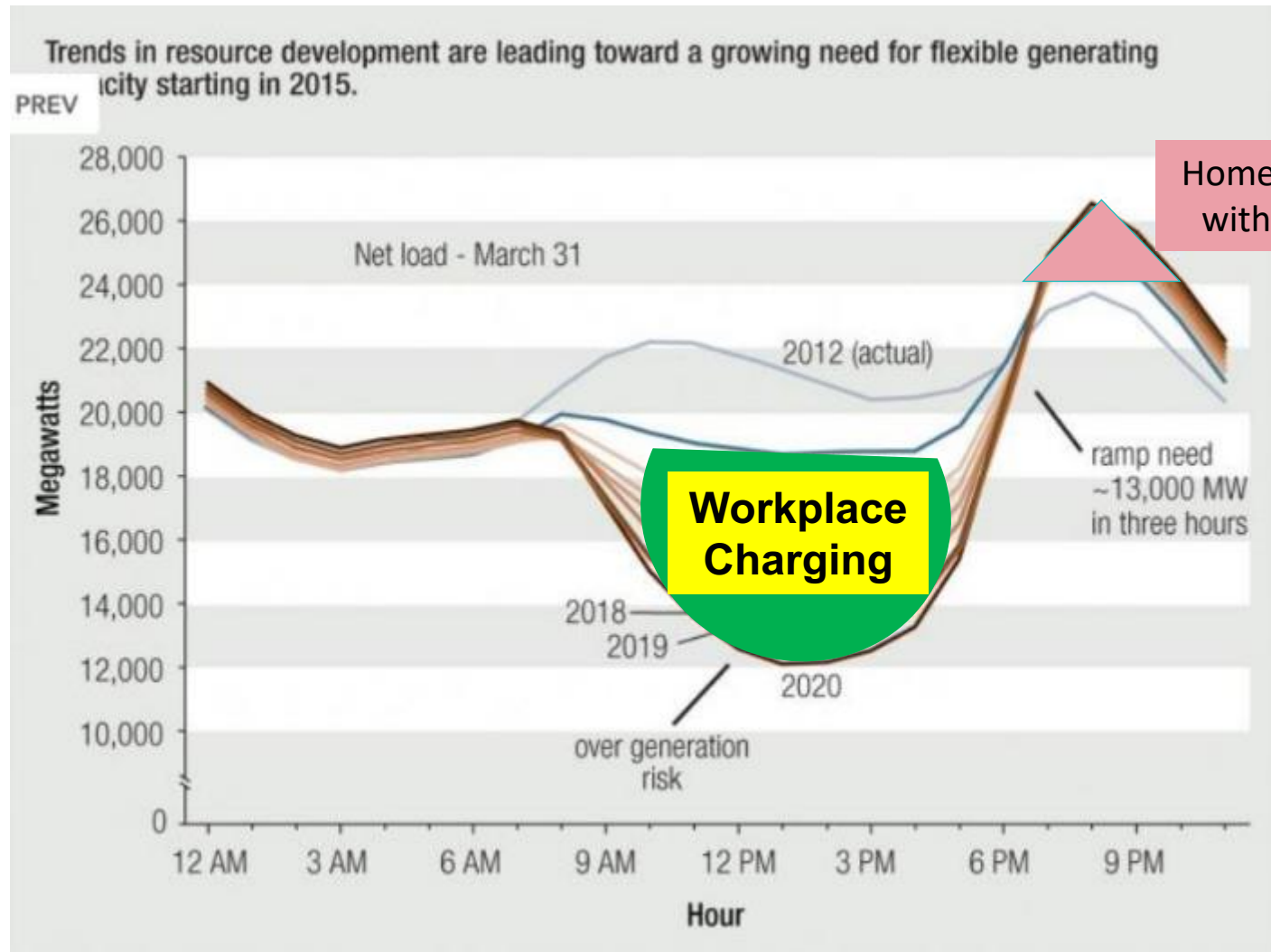
# Electrification of Controlled Loads Can Use Wasted Wind and Solar



Note: All curtailment percentages shown in the figure represent both forced and economic curtailment. PJM's 2012 curtailment estimate is for June through December only.

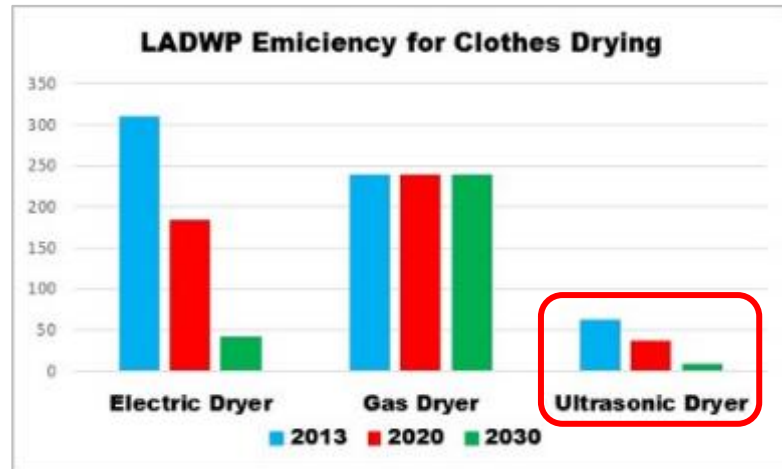
Source: ERCOT, MISO, CAISO, NYISO, PJM, ISO-NE, SPP

# Grid Management: Workplace EV Charging



# Technology Development Continues: Ultrasonic Clothes Dryer

- Uses sound waves to “shake” moisture out
- 80% reduction in electricity consumption compared to electric resistance dryer





# Where Will Electrification Initiatives Originate?

- Consumers
- Policymakers
- Commission Initiatives
- Utility Proposals



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# Next Steps

- RAP Papers published ~ 6/2018
  - Principles
  - Water heat
  - Space Heat
  - Vehicles
- Regulators
  - FERC
  - State
  - Consumer-Owned Utilities
- Appliance Industry
- Housing and Home Maintenance Industry





# Efficient Building Code



# High-efficiency Heat Pump with Air Exchangers



# Ice Storage



# Smart Thermos



# Grid-Integrated Heat-pump Water Heater





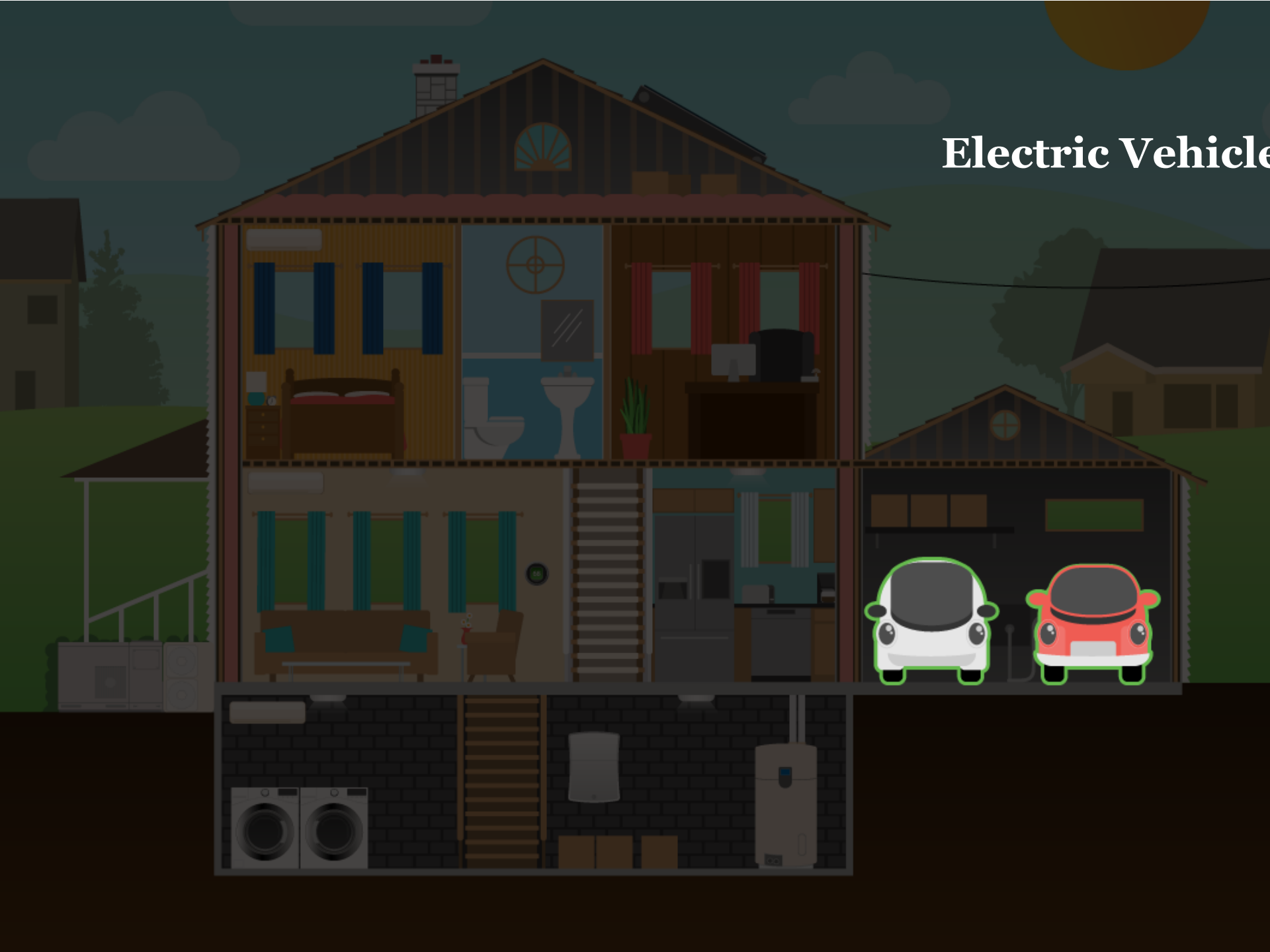
# Solar PV



# Battery Storage



# Electric Vehicle



# Smart Appliances



# Still Connected the Grid





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# ***RAP papers on beneficial electrification coming soon.***

- **Principles**
  - **Space Heat**
  - **Water Heat**
  - **Electric Vehicles**
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- **Publication: June, 2018**

# About RAP

The Regulatory Assistance Project (RAP)® is an independent, non-partisan, non-governmental organization dedicated to accelerating the transition to a clean, reliable, and efficient energy future.

Learn more about our work at [raponline.org](https://raponline.org)



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