Decarbonization of Heating Energy Use in California Buildings

Synapse Third Thursday Webinar

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Asa Hopkins, PhD

Melissa Whited

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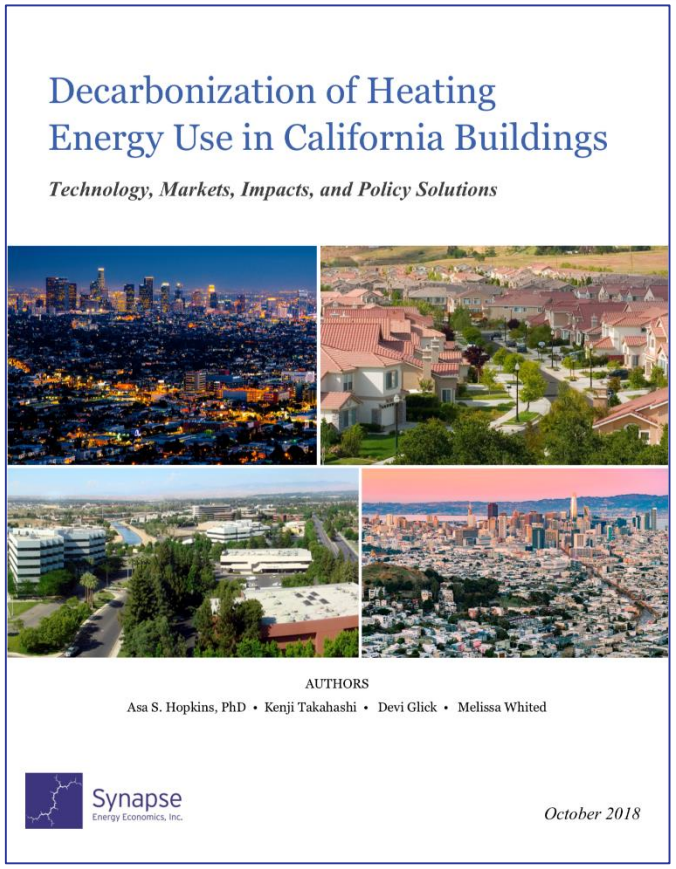

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Webinar logistics

- The webinar is being recorded and will be circulated to all attendees, along with the slides
- All attendees have been muted on entry and will remain muted throughout the webinar
- Please send any questions on the content of the webinar to webinar@synapse-energy.com
- During the Q&A session, the panelists will answer written questions that have been sent to webinar@synapse-energy.com
- Please use the chat feature only to notify the host if you are having a technical issue with the WebEx software or audio

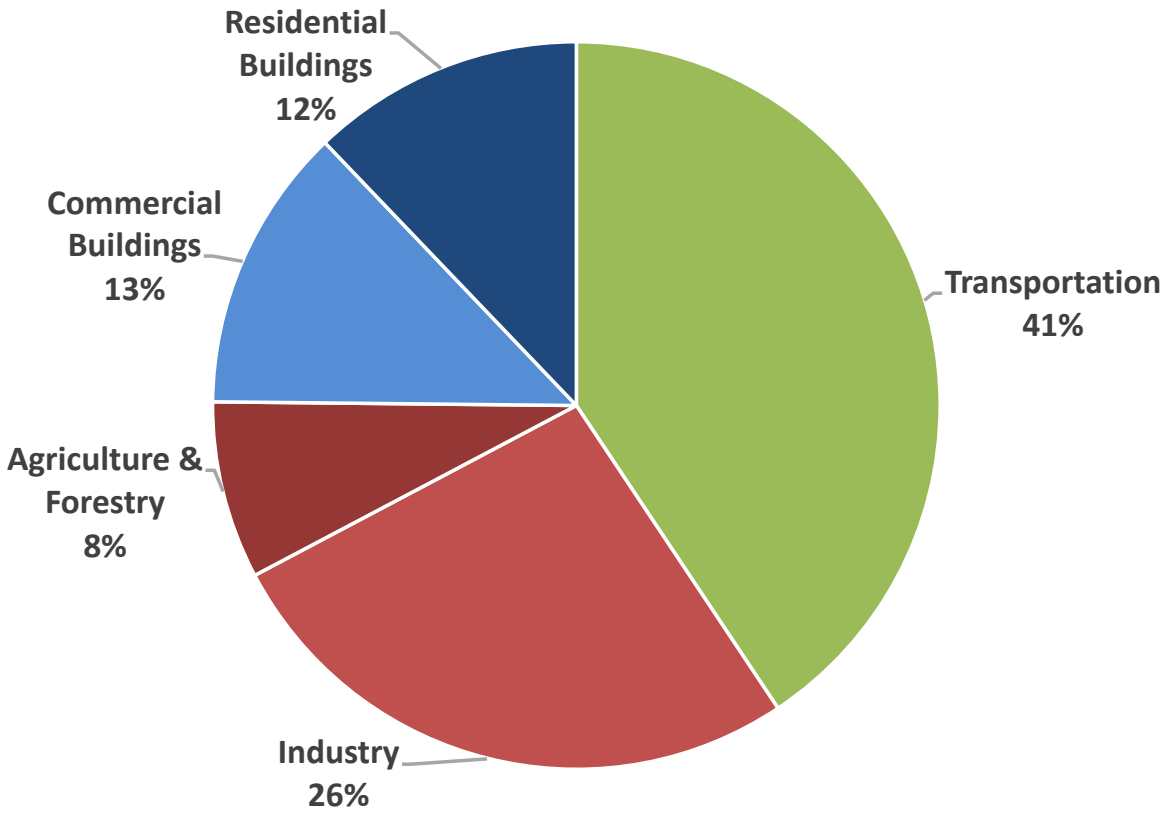
Outline

- California buildings and GHG context
- Technologies and markets for building decarbonization
- Customer economics of decarbonizing buildings
- Grid and utility system impacts
- Policies and programs
- Q&A

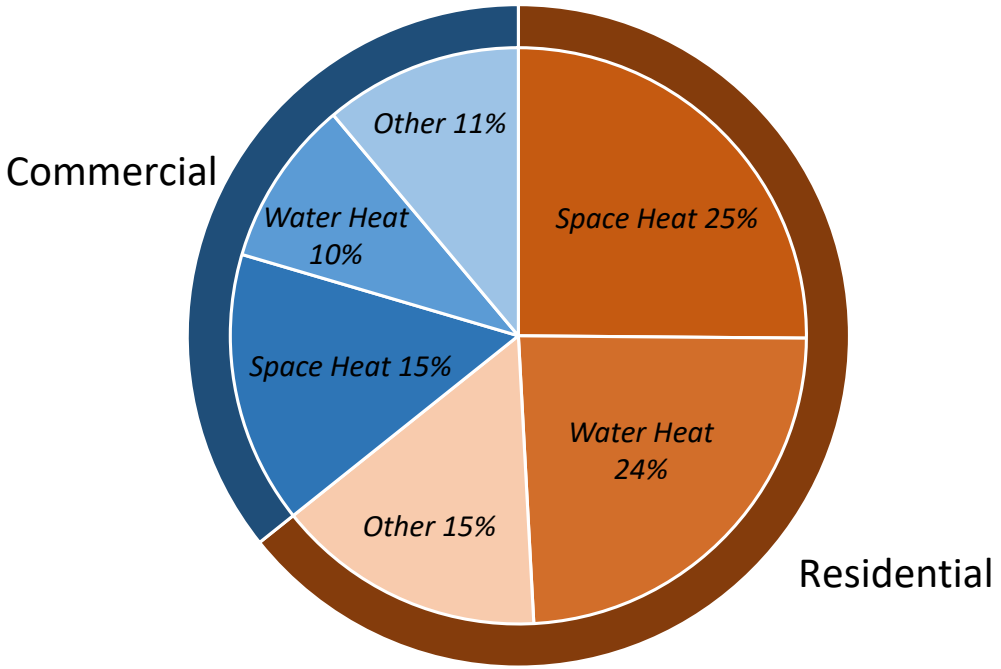
Context

California buildings and GHGs

Buildings are responsible for 25% of California's greenhouse gas (GHG) emissions



Space and water heat dominate direct emissions



- Electrifying space and water heating in 30% of buildings would reduce emissions from these end uses by 18%
- Equivalent to taking 1.5 million cars off the road or shutting off nearly four 500 MW natural gas power plants running 24/7

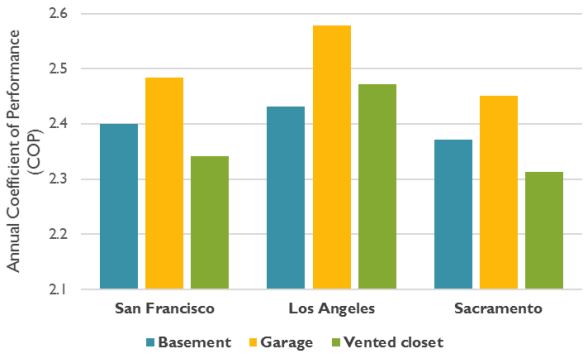
Technologies and Markets

Space heating: Heat pumps

- Focus on ducted heat pumps
  - CA buildings dominated by forced air (ducted) heating systems
- Air source heat pumps are the primary technology
  - Ground- and water-source heat pumps for large buildings, district heating
- Barriers:
  - Unfamiliar technology; inertia to replace in kind
  - Regulatory barriers are just now being reduced
  - Potential electric panel upgrade for homes without AC
- Primary current market opportunities:
  - New construction or major retrofits/shell improvements
  - Where electric rates are favorable or utilities offer incentives
  - Variable refrigerant flow (VRF) and mini-split systems where there aren't ducts or where cooling and heating are needed at the same time

Water heating: Heat pump water heaters (and solar hot water)

- HPWH products available today with “Uniform Energy Factors” of 3.75 or higher
  - Performance varies by climate and install location
- Solar HW can make sense for large, commercial water users but still requires subsidies to make financial sense
- Barriers:
  - Space and air flow requirements
  - Customer inertia to replace water heaters in kind
  - Building energy codes have favored tankless gas water heaters
  - Could require electric panel upgrade
- Primary current market opportunities:
  - New construction
  - Where electric rates are favorable or gas service is not available
  - Multi-family buildings with “ganged” water heaters



Cooking and laundry

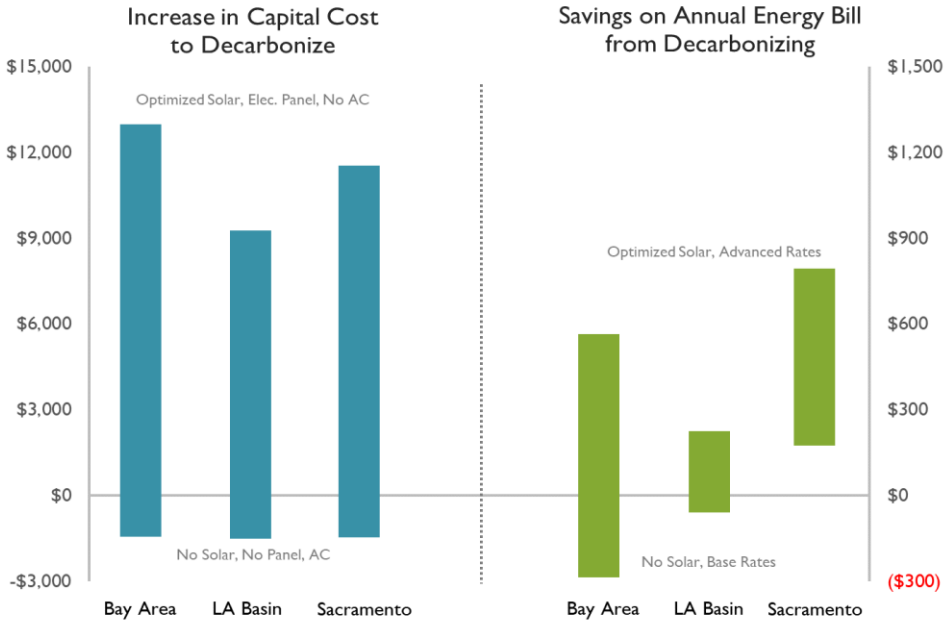
- Cooking: Induction cooktops and ranges
  - Fast, responsive cooking
  - Rated by Consumer Reports among the highest scoring ranges and cooktops
  - Must overcome bias/perception around preference for gas cooking
- Laundry: Heat pump dryers
  - Dehumidify, rather than bake, the clothes
  - Can be ventless
  - >1/3 more efficient than Energy Star-rated electric resistance dryers
  - New to the U.S. market

Customer Economics

Customer economics

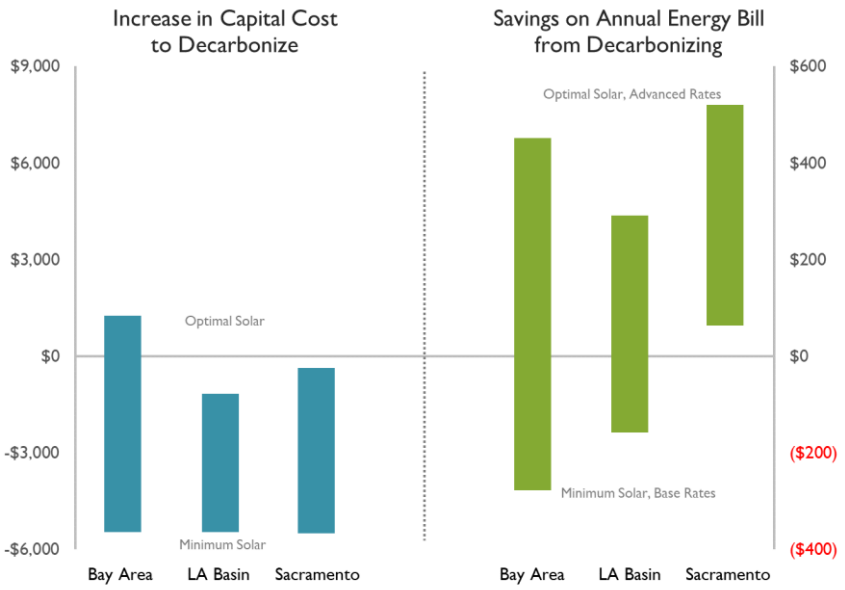
- Calculated capital and operating cost impacts in four cases:
  1. Single-family existing home retrofits with heat pump space and water heating replacing natural gas systems at the end of their useful life;
  2. New construction of an all-electric single-family home;
  3. Multifamily existing home retrofits with heat pump space and water heating replacing natural gas systems at the end of their useful life; and
  4. New construction of an all-electric multifamily home.
- Examined "base" and "advanced" cases to estimate the range of outcomes for each comparison
  - Base: no additional efficiency; default electric rate design
  - Advanced: additional shell and AC efficiency; more advanced rate design
- Range of PV for each home: code minimum up to max reasonable
- Three locations: Bay Area; LA Basin; and Sacramento
- Used hourly load shapes and weather-based HP performance, calibrated to real-world use, to line up TOU rates

Single family retrofit



- Wide range of potential outcomes due to variation between buildings and rate structures:
  - Payback ranges from immediate (both capital and operating savings) to never (upfront capital cost and ongoing operating cost increase)
  - Present value lifecycle savings if home gets full heating and cooling value from HP and doesn't require an electrical panel upgrade
  - Generally better customer economics with PV and with more advanced rate designs
- GHG reductions 34% to 69%, depending on how much PV

New single family



- Again, a wide range of outcomes, but much more positive:
  - Avoided gas infrastructure and no risk of panel upgrades make a big difference
  - Lifecycle savings in all cases
  - Immediate payback in most cases
- GHG reductions of 47% to 76%

Multifamily customer economics

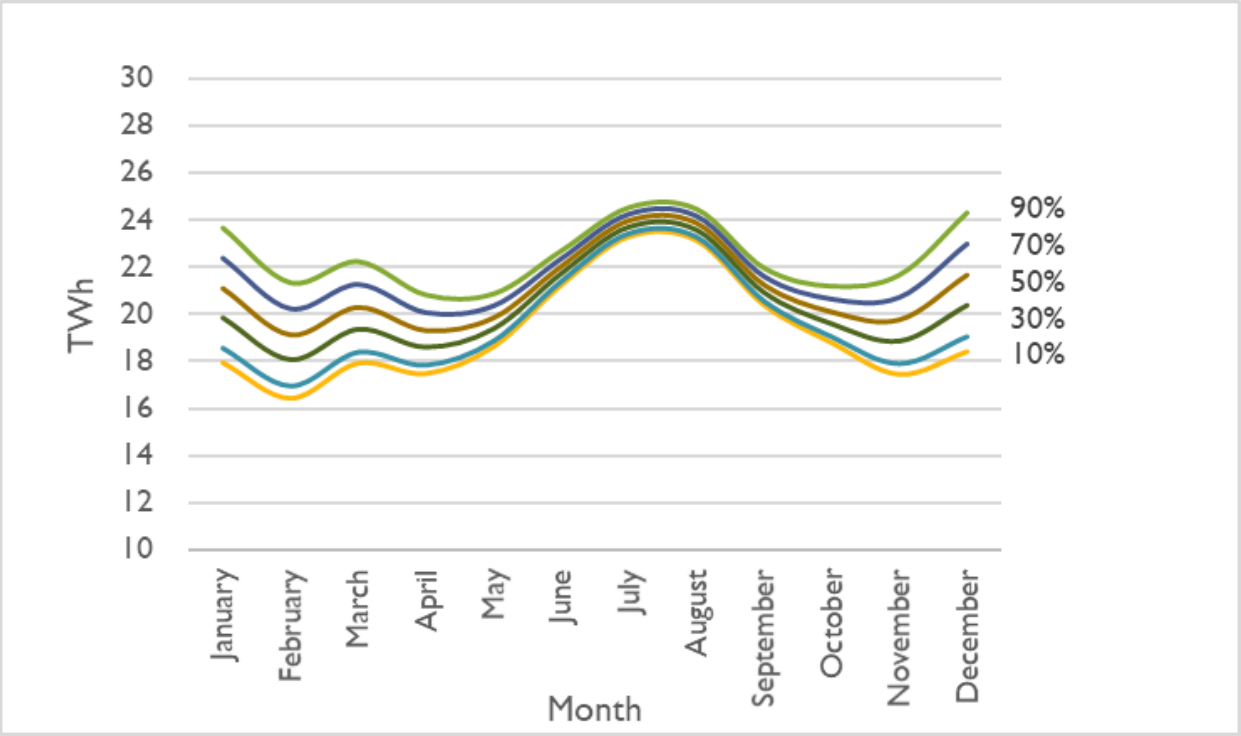
- Coupled multi-family construction, loads, and costs with CARE rates (low-income discount rates) for both electricity and gas
- Smaller operating costs in general also means smaller differences between gas and electric options
- Similar to single-family, the multi-family cases show positive lifecycle savings when there are no additional costs (such as panel upgrades) and better economics in new construction than in retrofits

Grid and Utility Impacts

Butterfly graph

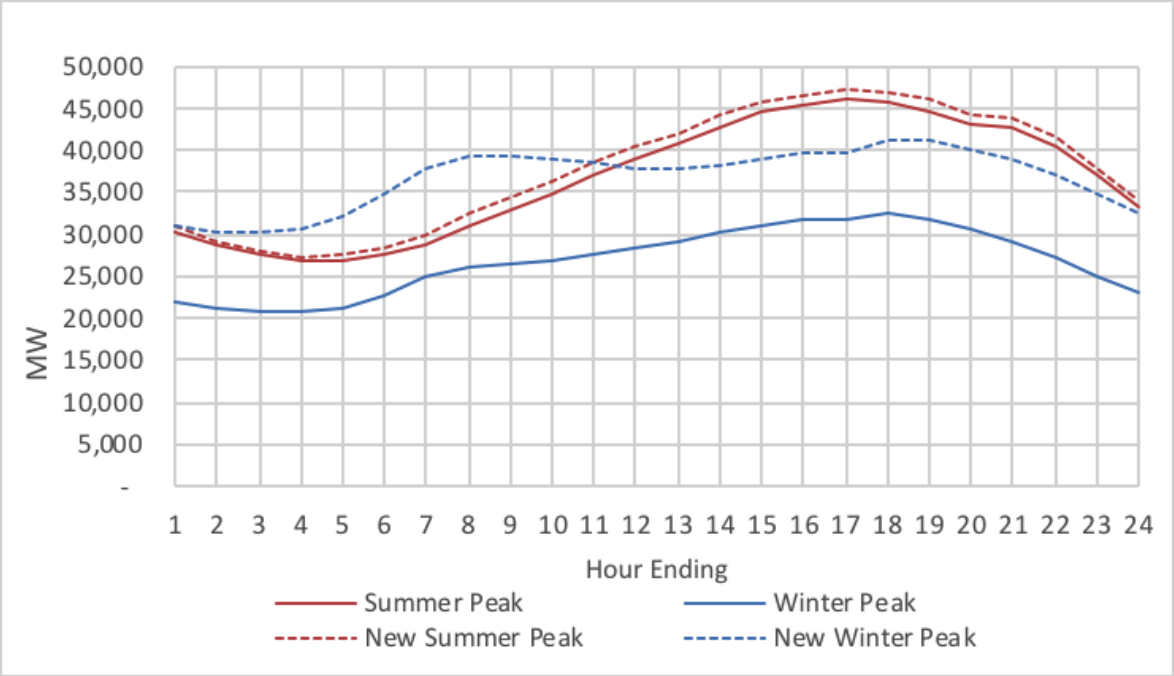
- Examined monthly and peak day impacts of electrification at scale
- Impacts driven by heating loads in winter months

Monthly energy consumption at various heat pump penetration levels



Peak day impacts

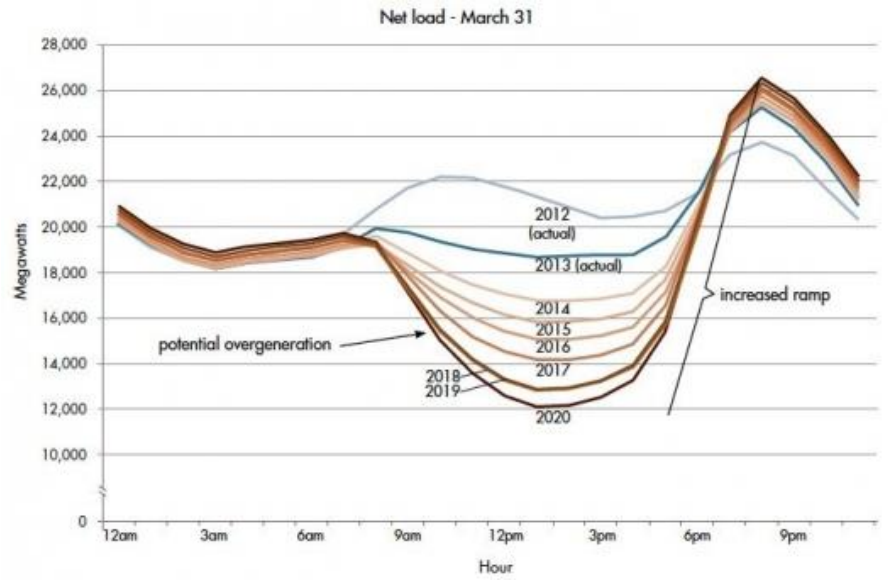
- Small impacts on annual (summer) peaks across CAISO as a whole:



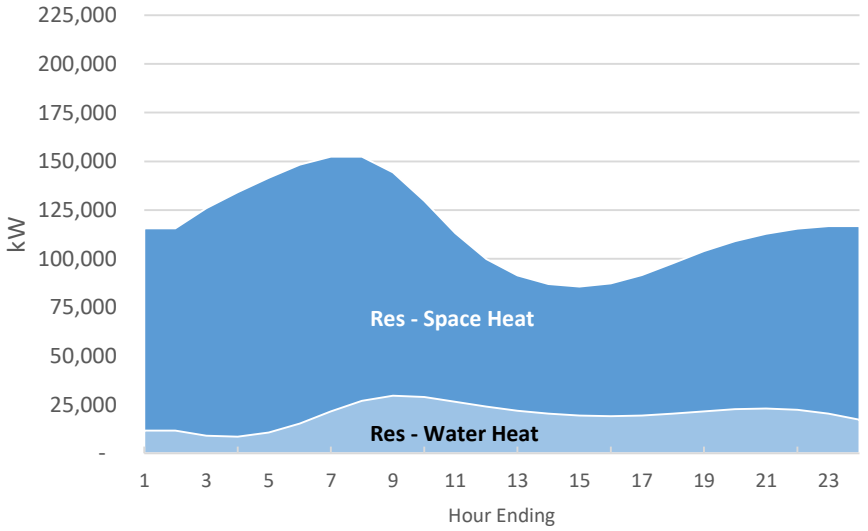
- But PG&E becomes winter peaking when half of buildings are electrified
  - (Absent impacts from other efficiency or transportation electrification)

Hourly grid impacts

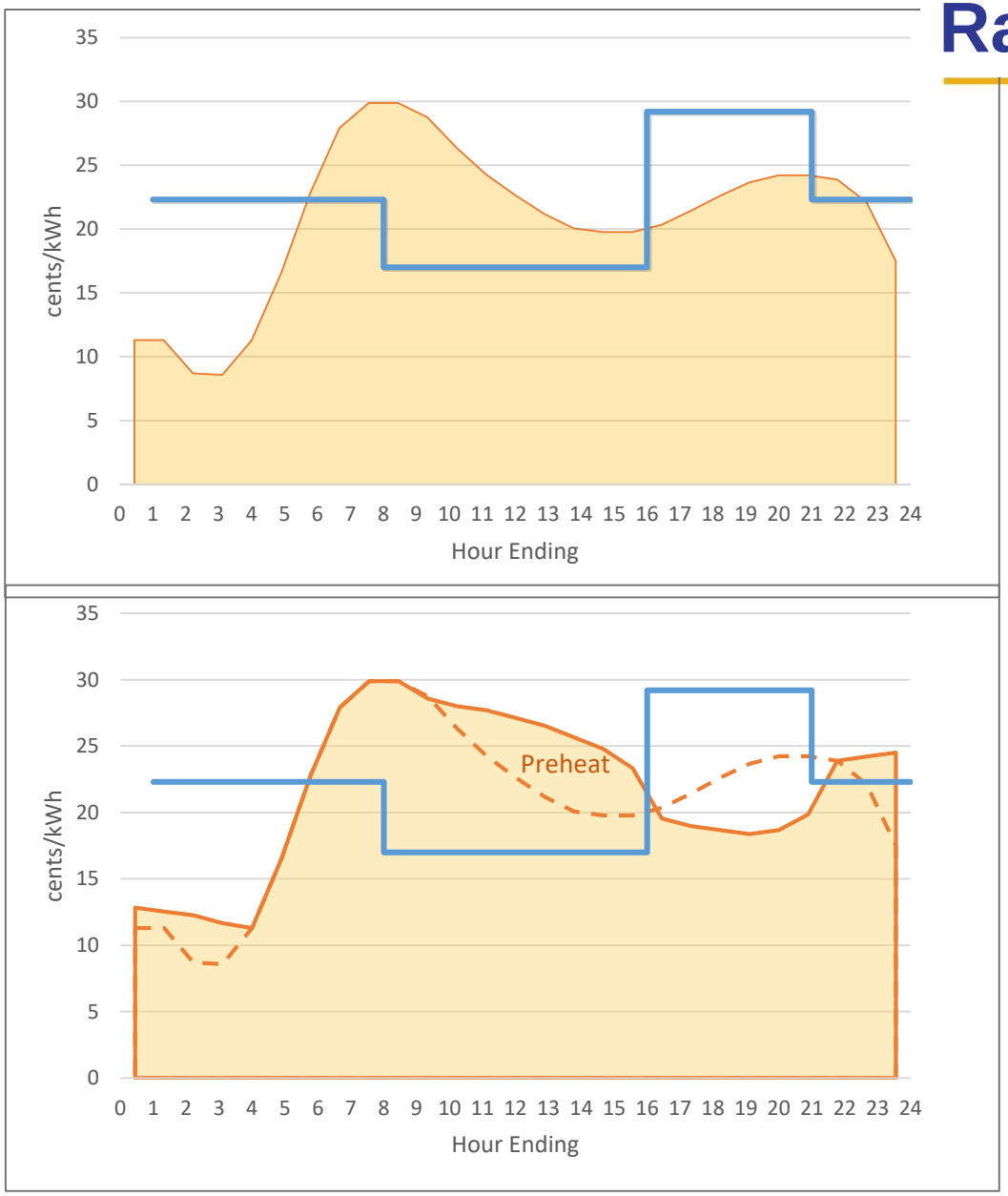
- California's duck curve



- Space and water heating should be managed to benefit the grid



Rate design



- New rate designs can encourage load shifting
- Example: SCE's proposed default TOU rates for residential customers
- Peak to off-peak differential of ~$0.12/kWh (ratio of 1.7:1)
- Need for strong price signals

Policies and Programs

Current California policies

- New law AB 3232 requires CA Energy Commission to assess how to achieve a 40% GHG reduction in the building sector by 2030
- Economy-wide cap and trade program has minimal effects on customer economics at current carbon prices
- SB 1477 (also new) will use GHG revenue to fund incentives for very-low-emissions new buildings and clean heating technologies
- Building energy standards shifting in 2019 to level playing field between electric and gas heating
- “3 prong” test prevents regulated utility EE programs from engaging in fuel switching activities; CPUC is looking at this test this year
- Municipal utilities are running aggressive electrification programs
- Utilities shifting to default TOU rates

Further actions recommended

Four types of actions would help to move markets from nascent to robust:

1. Raise awareness and educate
2. Set targets and develop plans
3. Remove regulatory and market barriers
4. Transform the market

Raise awareness and educate

- Customer and policy maker education on clean heating options
  - Use the applied social sciences—marketing and advertising
  - Educate regarding the pros and cons of various options
  - Identify the selling points for low-carbon options (which may have little or nothing to do with their environmental benefits)
  - Communicate different benefits relevant to different audiences
- Building industry training and education
  - Changes in building industry practices will require an educated and engaged workforce
  - Training is a promising area for public-private partnerships

Set targets and develop plans

- Official governmental targets and plans provide increased certainty for markets
  - Draw investment in market development, human capital
- CA can build from the targets tentatively established by AB 3232
  - Plan with intermediate or sub-targets
  - Coordinate policies and programs across market actors
- Learn from examples in other states (MA, NY, RI, VT)

Remove regulatory and market barriers

- Rate design
  - Rates with high differentials between peak and off-peak can be cost-reflective and improve the customer economics for electric space and water heating
  - Not yet available for all in CA who might like them
  - Compensate for grid services provided by controllable loads, like water heaters
- Financial incentives for heat pumps space and water heating
  - Important signaling value; role for upstream incentives to prep the market to address emergency replacement
  - Funding from GHG cap and trade to start (SB 1477), as has been common in other states
- Eligibility and cost-effectiveness requirements for fuel-switching programs
  - CPUC to examine 3-prong test
  - Recommend approach to cost-effectiveness screening based on the new National Standard Practice Manual

Transform markets

- Update and align building codes
  - Encourage the lowest-emission buildings, in a fuel-neutral, performance-based manner that maintains customer choice
  - Consider a “zero-emission-ready” requirement to avoid future infrastructure costs
- Support research & development
  - Increase efficiency and lower cost
  - Load management
  - Low-GWP refrigerants
  - Products to meet diverse market needs
- Couple electrification with efficiency and demand flexibility
  - Heat pumps work best in well sealed and insulated buildings, with quality ductwork
  - Utility programs could acquire flexibility and summer AC savings, even if they don’t promote electrification *per se*

Questions?

Send them to
webinar@synapse-energy.com

Contact Information

Dr. Asa Hopkins, ahopkins@synapse-energy.com
Melissa Whited, mwhited@synapse-energy.com