Zero-Carbon All-Electric Buildings

How to do it

Nick Young
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We Must Electrify

- Energy efficiency
- Decarbonize the grid
- Electrify vehicles and buildings
- Decarbonize remaining fuels
Electrification is Already Happening

Growing number of developments across CA choosing to pass on gas.
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How to Do It

CA Residential Natural Gas Consumption

- Water Heating: 49%
- Space Heating: 37%
- Cooking: 7%
- Dryer: 3%
- Pool/Spa/Misc: 4%

Source: 2010 California Residential Appliance Saturation Survey
Heat Pump Basics
What is a Heat Pump?
How a Heat Pump Works

It **moves heat** from one place to another using **refrigerant**.

Just like an air conditioner or refrigerator.
What’s so great about heat pumps?

- Hyper-efficient (4-5x equivalent gas products)
- Enable Zero Emissions Buildings via carbon-free renewable energy
- Can utilize on-site solar and act as a thermal battery
- Improve air quality – no local emissions
- Improve safety – no gas lines in building
Refrigerant Cycle
Electric Water Heating
Heat Pump Water Heaters - Individual

Split Heat Pump Water Heater

Combined Heat Pump Water Heater
Heat Pump Water Heaters - Central
Heat Pump Water Heaters

**Key Considerations**

- Optimal sizing will likely have more storage than gas-based system
  - Engineer should NOT use same sizing parameters as gas hot water system
  - Engage with heat pump manufacturer to obtain sizing recommendations
- Individual systems may be locatable inside a unit with no outside air
  - Always confirm with manufacturer
- Larger or central systems will need access to outside/garage air
  - Many can be ducted if space is tight
Point-of-Use Electric Water Heaters
Point-of-Use Electric Water Heaters

Incur significant Energy Code compliance penalty. Should only be used at fixtures used very infrequently and with very low flowrates.

e.g. common area restrooms, but not apartments.
What about Renewables?
Solar Photovoltaic (PV) vs. Solar Thermal

Solar PV

Solar Thermal
# Solar Photovoltaic (PV) vs. Solar Thermal

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**Generally, Solar PV-only is best approach for all-electric buildings.**
Electric Space Heating
Space Heating - Heat Pumps

Ducted Heat Pump

Mini-Split Heat Pump (Ducted or Ductless)

Packaged Terminal Heat Pump (PTHP)
Space Heating - Heat Pumps

Remember:
With heat pumps, you also get **cooling**!
Space Heating - Heat Pumps

Variable Refrigerant Flow

Packaged Rooftop Heat Pump

Heat Recovery Chiller
Space Heating – Electric Resistance

Electric Baseboard

Electric Wall Heater (w/ Fan)
Space Heating – Electric Resistance

Key Considerations:

• Electric resistance heating ~3x less efficient than heat pumps.
• Should have very good envelope and ventilation to reduce loads.
• Will incur considerable Energy Code compliance penalty.
• Would require separate cooling system.
Electric Cooking
Electric Cooking

Induction

Radiant

Resistance
Electric Cooking

Induction

Radiant

Resistance
What’s so great about induction?

- Fastest response time of any heating type (faster than gas!)
- Boils water in ½ the time of any other heating type
- Extremely precise heat control down to very low levels
- Less waste heat = less overheating of kitchen
- No open flames, and only pan gets hot = SAFER
Electric Laundry (Dryers)
Residential Clothes Dryers

- Heat Pump Dryer
- Electric Resistance Dryer
- Combo Washer + Resistance Dryer
Commercial Clothes Dryers

Electric Resistance Dryer

Electric Heat Pump Dryer
(Not yet available in US)
Electric Transportation
Electric Vehicle Charging

• The EV revolution is here, and new buildings need to be ready for it.

• Many state and local requirements for EV charging.

• Consider sizing electrical service and infrastructure for all-EV future to reduce service upgrade costs down the road.
Electric Storage
What About Battery Storage?

• Battery storage systems are available and cost-effective for many building types, particularly when combined with solar PV.

• Batteries can improve resiliency by powering critical systems during a utility outage.

• Storage can also reduce peak electrical charges.

• May not work for all project types, but worth investigating.
Electric Pools & Spas
Heat Pump Pool Heaters
Electric Infrastructure
Just (a Bit More) Electricity

• All-electric buildings eliminate costs of gas: main extensions, meters, interconnection fees, and in-building infrastructure.

• With all systems powered by electricity, projects will need larger electrical service.

• Consult with electrical engineer and ensure they know early-on that project will be all-electric.
The All-Electric Future is NOW

• Many jurisdictions across CA are considering 2020 reach codes that favor all-electric.

• The City of Berkeley already passed an ordinance to completely phase out gas in new construction.

• For California to reach carbon neutrality by 2045, ALL buildings (new AND existing) will need to be all-electric.

• Starting now, any new gas infrastructure in CA will be a stranded asset before it is paid off.

• As more buildings move off of gas, fewer and fewer customers will share burden of fixed system costs, increasing gas rates considerably.