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# RENEWABLE WATER HEATING MODEL LOCAL ORDINANCE



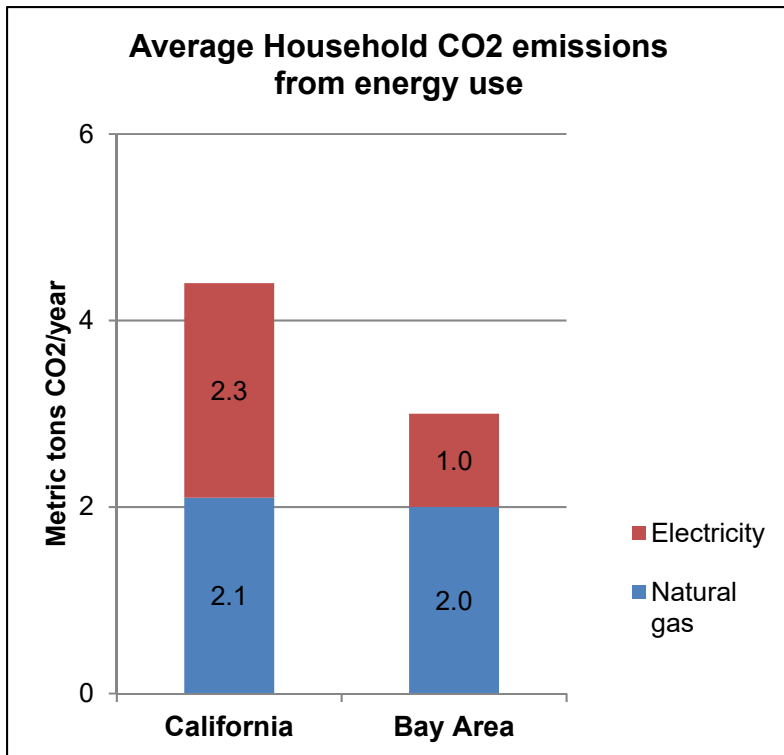
***BayREN Forum***

**June 27, 2017**

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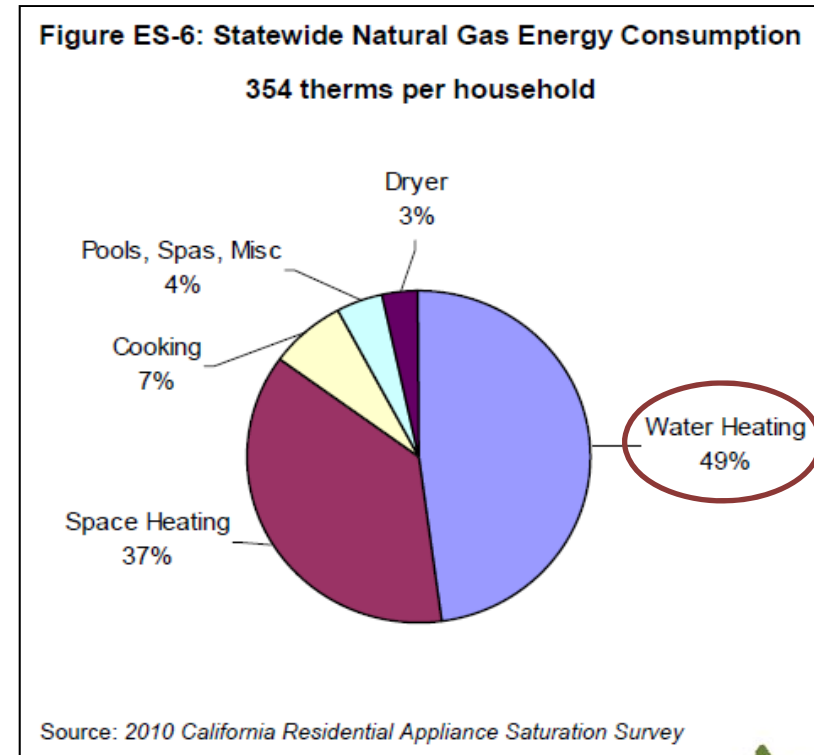
# Why Renewable Water Heating?

- ❑ Natural gas responsible for roughly half of CA residential + commercial GHGs



Source: Jones C., Kammen D., "Bay Area Consumption-Based Greenhouse Gas Emissions Inventory", Jan. 2016

- ❑ And water heating for half of residential gas use



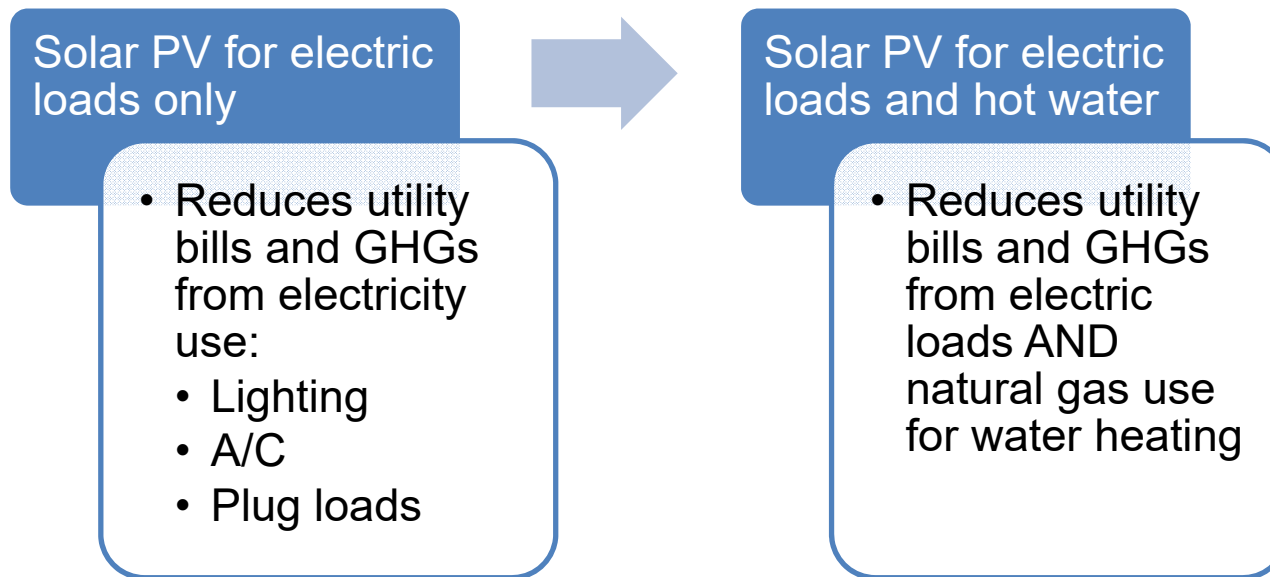
Source: 2010 California Residential Appliance Saturation Survey



# “Renewable Hot Water” Model Ordinance Concept

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Combine heat pump water heater with solar PV, or use solar thermal, to heat water with renewable energy:



Apply to new homes and major retrofits, not water heater replacements in existing homes

# How Does the Ordinance Work?

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## Menu of 3 options:

### Option 1 - **Heat pump water heater + solar PV**

- High-efficiency heat pump water heater (HPWH): NEEA Tier 3-certified
- Enough PV to offset at least 80% of HPWH annual electricity use, in addition to any other solar PV requirements

### Option 2 - **Solar thermal with 60% solar fraction**

- Solar thermal covering at least 60% of annual hot water needs + gas or electric backup water heater for winter season

### Option 3 - **CALGreen “PV-Plus” package**

- No specific renewable water heating requirement, but higher building efficiency requirements (close to CALGreen Tier 2)
- Provides flexibility option for builders and home buyers who do not want to use either options 1 or 2

## This proposal meets the local reach code requirements

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### Must comply with 2016 building code

- ✓ Solar PV credit helps overcome HPWH penalty in code

### Must be cost-effective

- ✓ Powering HPWH with low-cost PV electricity is very cost-effective

### Must not violate federal preemption for appliance efficiency standards

- ✓ Solar thermal and CALGreen “PV-Plus” offer non-preempted options. HPWH is an option, not mandatory.

# Benefits of HPWH+PV vs. gas tankless

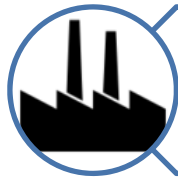
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50% lower fuel costs / utility bills



13% lower life cycle costs



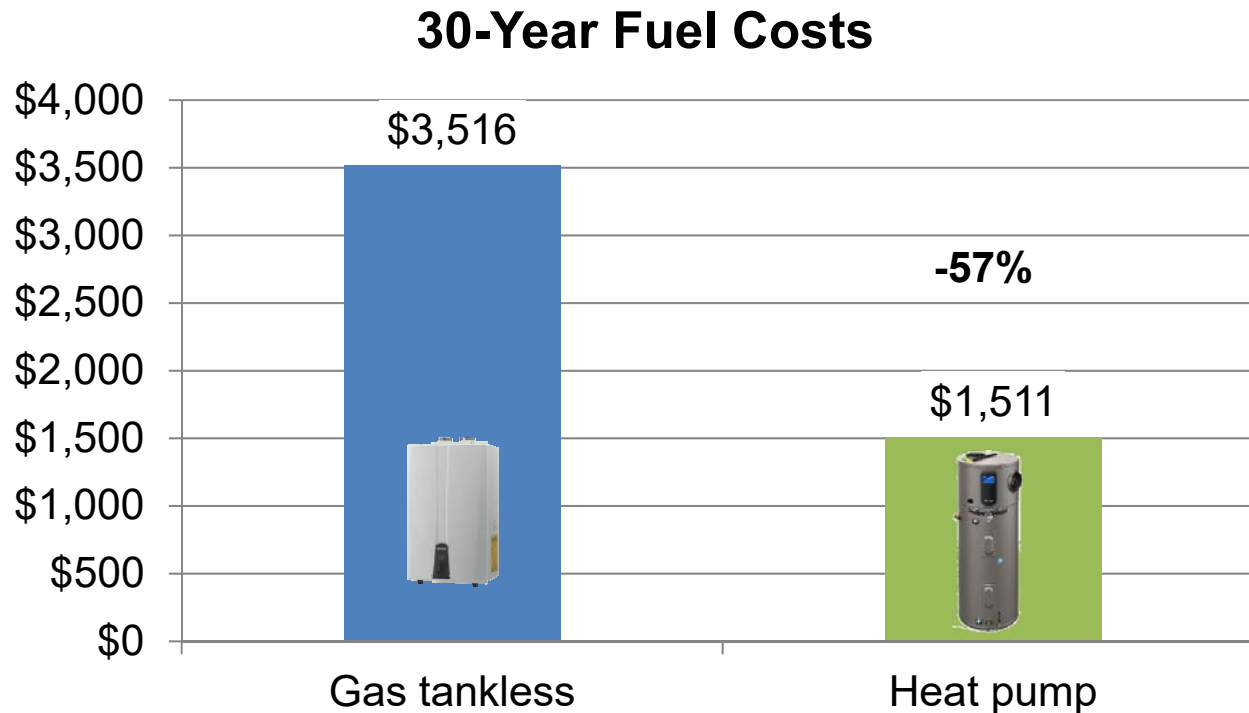
30% lower source energy



50% lower CO<sub>2</sub>

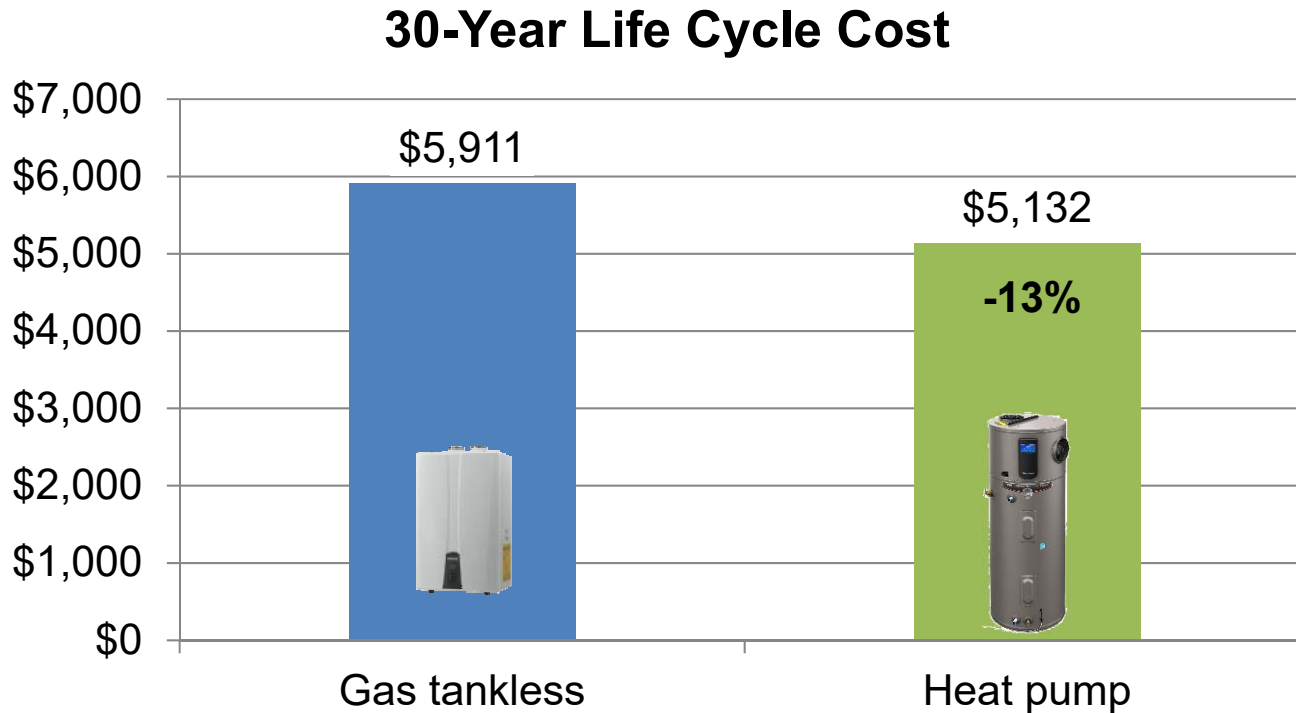
\*California average, climate zone-specific analysis available upon request

# HPWH+PV reduces utility bills/fuel costs by 57%



- Based on average California costs. A climate zone-specific analysis can be provided for interested cities
- 3% discount rate
- Other data sources and assumptions in appendix slides

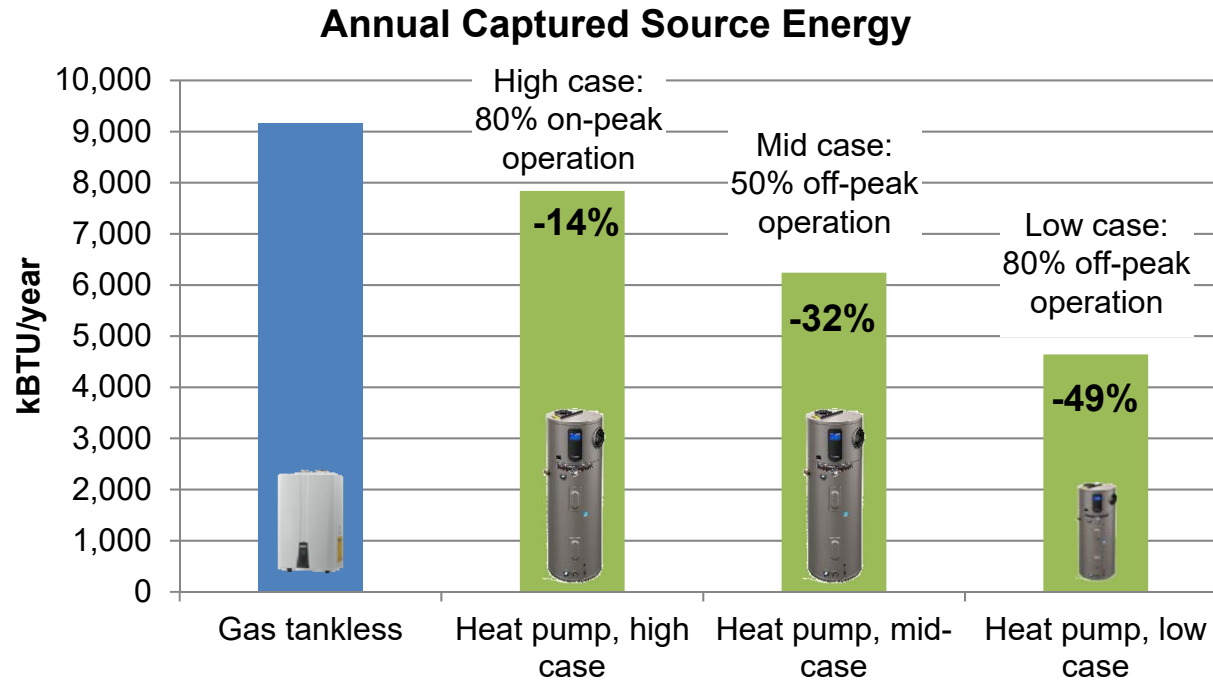
# HPWH+PV reduces life cycle costs by 13% over 30-years



- Life Cycle costs include equipment, installation and operational costs.

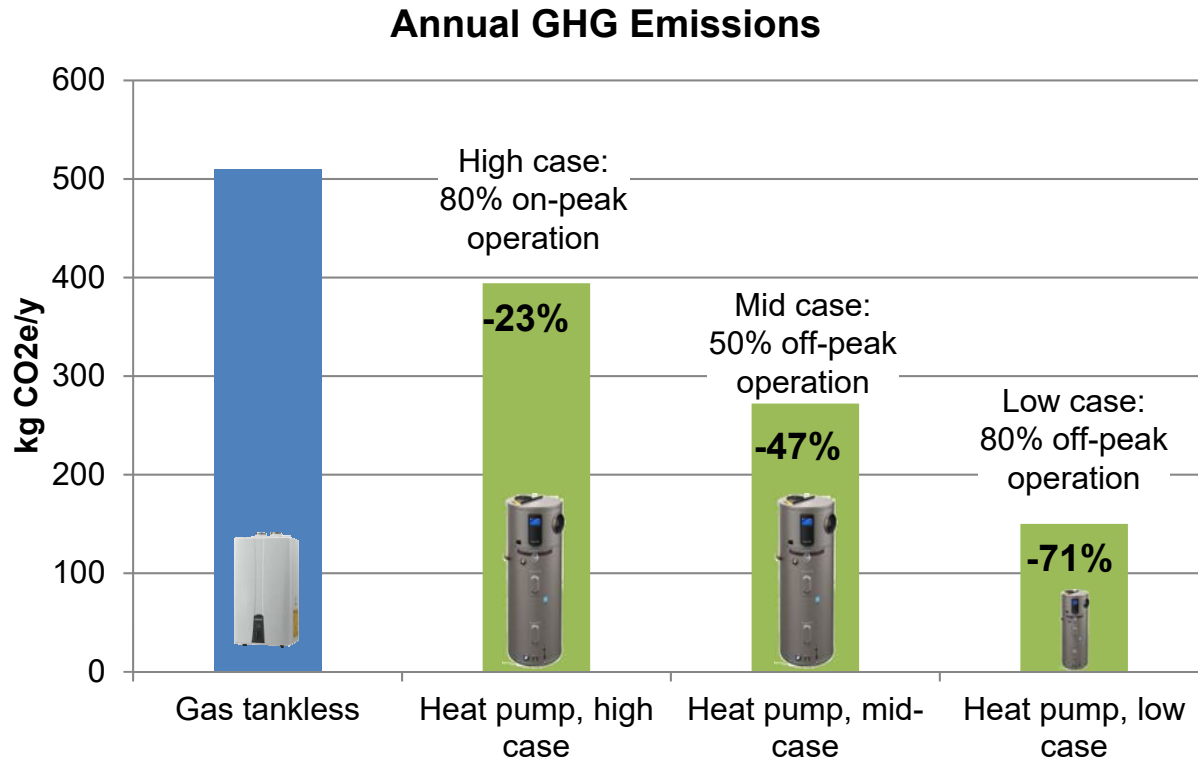


# HPWH+PV reduces source energy use by 14% to 49% (32% median) over 30 years



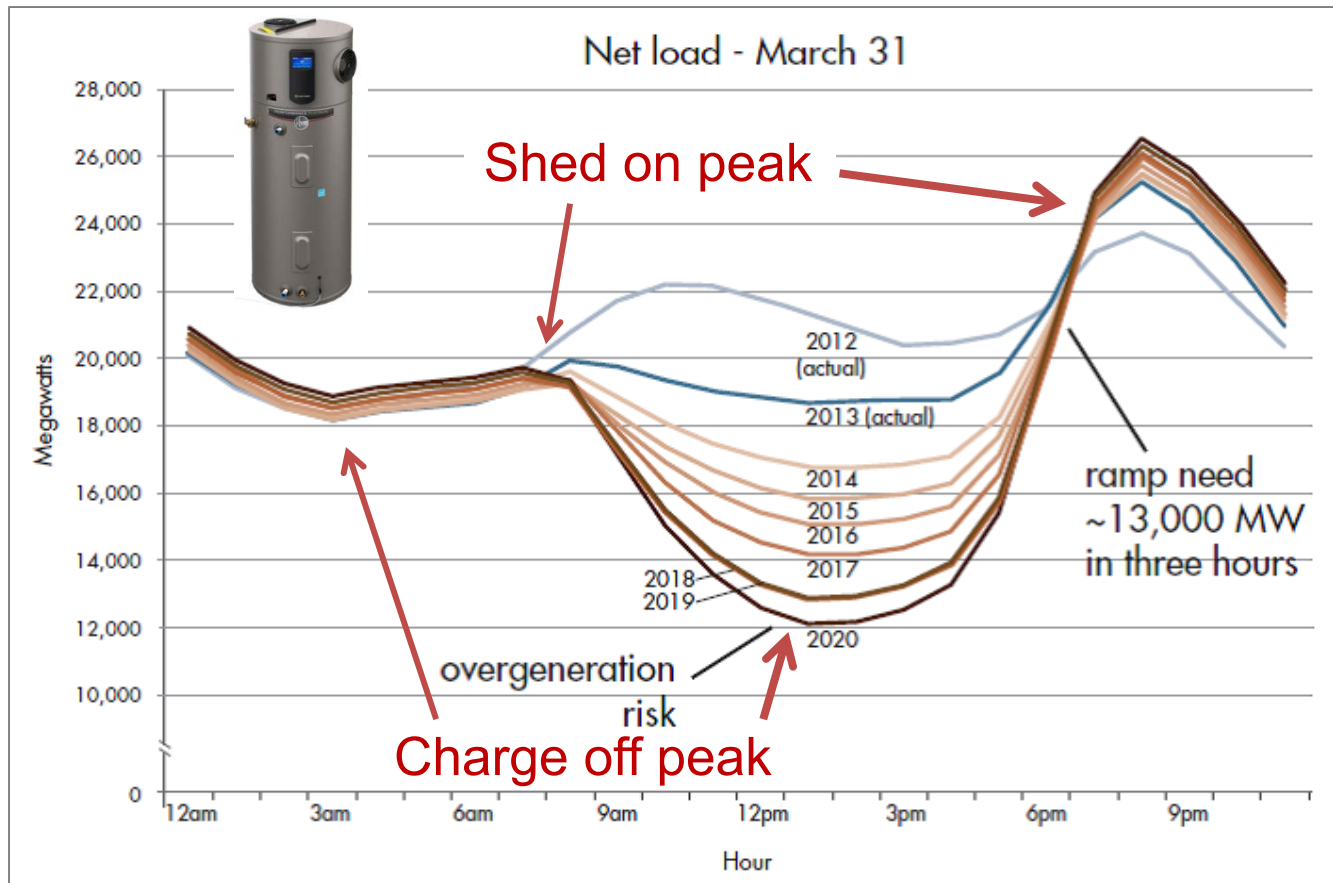
- Using DOE's source energy methodology for renewable energy
- The 3 scenarios correspond to different operating profiles: 80% on-peak, 50% on-peak, 20% on-peak (controlled)

# HPWH+PV reduces GHG Emissions by 23% to 71% (47% median) over 30 years



- Using same scenarios as with source energy

# Grid-connected HPWH can absorb abundant solar generation, helping deep renewables integration



- NRDC et. al. study in-progress to quantify the load shifting capacity and value of HPWH, results planned for Sep. 2017

# How about electric heat pump space heating?

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- Heat pumps can also be used for space heating and cooling
- Even more cost-effective because one heat pump replaces two appliances (furnace and A/C)
- All-electric buildings also avoid gas connection costs (\$5,000+ per unit)
- But all-electric buildings currently have lower customer acceptance, because of preference for gas cooking and fireplaces
- Water heating is an easier first step. Building all-electric is one of the most cost-effective pathways to achieve the water heating requirement, but it does not necessarily need to be part of this ordinance

# Summary

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- ✓ Large reduction in utility bills, cost-effective over life time
- ✓ Large GHG reduction opportunity
- ✓ Thermal storage can help mitigate duck curve, move beyond 50% renewable electricity
- ✓ Opportunity for city leadership -- cities to pave the way for statewide building code

# Thank you!

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# Data Sources and Assumptions - Costs

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- **Discount rate:** 3%
- **Average CA residential gas rate:** \$1.28/therm (EIA, Jan. 2017, <https://www.eia.gov/dnav/ng/hist/n3010ca3m.htm>)
- **30-year discounted cost of photovoltaic in single family:** \$0.114/kWh (\$3.02/watt installed), Davis Energy Group, Enercomp, Misti Bruceri and Ass., “Local PV Ordinance Cost Effectiveness Study”, <https://fremont.gov/DocumentCenter/View/33146>, updated to focus on new construction costs, and to correct overhead and profit costs.
- **Hot water usage:** NRDC calculation based on Kruis et al., California Residential Domestic Hot Water Draw Profiles, May 2016 (Draft), <http://www.bwilcox.com/BEES/docs/Kruis%20-%20Dhw%20Analysis%205.docx>
- **Gas tankless equipment list price:** \$1,042 for 8 GPM, \$1,221 for 10 GPM, per [www.homedepot.com](http://www.homedepot.com) on 4/14/2014. Energy factor: 0.82 EF
- **Gas tankless installation cost:** Gas supply line: \$584, water heater installation: \$581 ([https://www.homewyse.com/services/cost\\_to\\_install\\_gas\\_line.html](https://www.homewyse.com/services/cost_to_install_gas_line.html), reduced by 30% to account for new construction because the plumber already in building). Combustion venting: \$50 equipment and \$178 equipment cost per 2011 DWH CASE report. Combustion testing costs not included.
- **Gas tankless lifetime and replacements:** 20 years (per DOE and 2016 DWH CASE report). The cost of one replacement is included in the calculation.
- **HPWH equipment list price:** \$1,200 for 50-gal, \$1,400 for 80-gal, per [www.lowes.com](http://www.lowes.com) on 4/14/2017. Energy factor 3.5, COP per NRDC-Ecotope 2016 study, <https://www.nrdc.org/experts/pierre-delforge/very-cool-heat-pump-water-heaters-save-energy-and-money>, scaled by 7% to account for performance improvements since 2014 (ratio of 3.5 EF and 3.25 EF)
- **HPWH installation:** \$497 (2014 Itron Measure Cost study adjusted for inflation) + \$200 for 240V conduit cost per online search.
- **HPWH lifetime and replacements:** 13 years (per DOE and 2016 DWH CASE report for storage water heaters). The cost of two replacements is included in the calculation.

# Data Sources and Assumptions – Energy and GHGs

- **Natural gas source to site ratio:** 1.05, Energy Star Portfolio Manager - Technical Reference, <https://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf>
- **Electricity T&D losses:** 1.047, EIA, 2015, , <http://www.eia.gov/tools/faqs/faq.cfm?id=105&t=3>
- **Natural gas emissions factor:** 5.302, kg CO2/th, , <http://www.epa.gov/energy/ghg-equivalencies-calculator-calculations-and-references>
- **Emissions factors:** Table 10, “CEC Draft Staff Report: ESTIMATED COST OF NEW RENEWABLE AND FOSSIL GENERATION IN CALIFORNIA (May 2014)”, <http://www.energy.ca.gov/2014publications/CEC-200-2014-003/CEC-200-2014-003-SD.pdf>

|                       | <u>lbs/MWH</u> | <u>kg CO2/kWh</u> |
|-----------------------|----------------|-------------------|
| <b>Single cycle</b>   | 1,239.3        | 0.5621            |
| <b>Combined cycle</b> | 823.1          | 0.3734            |

- **Source-to-site ratios and heat rates:** Table 39, “CEC Draft Staff Report: ESTIMATED COST OF NEW RENEWABLE AND FOSSIL GENERATION IN CALIFORNIA (May 2014)”, <http://www.energy.ca.gov/2014publications/CEC-200-2014-003/CEC-200-2014-003-SD.pdf>

|                       | <u>Heat rate<br/>Btu/kWh</u> | <u>Thermal<br/>efficiency</u> | <u>Source-<br/>to-site</u> |
|-----------------------|------------------------------|-------------------------------|----------------------------|
| <b>Single cycle</b>   | 10,585                       | 32%                           | 3.10                       |
| <b>Combined cycle</b> | 7,250                        | 47%                           | 2.12                       |