



## Heat Pump Furnaces and Water Heaters - A Clean Energy Solution to Decarbonize Bay Area Homes



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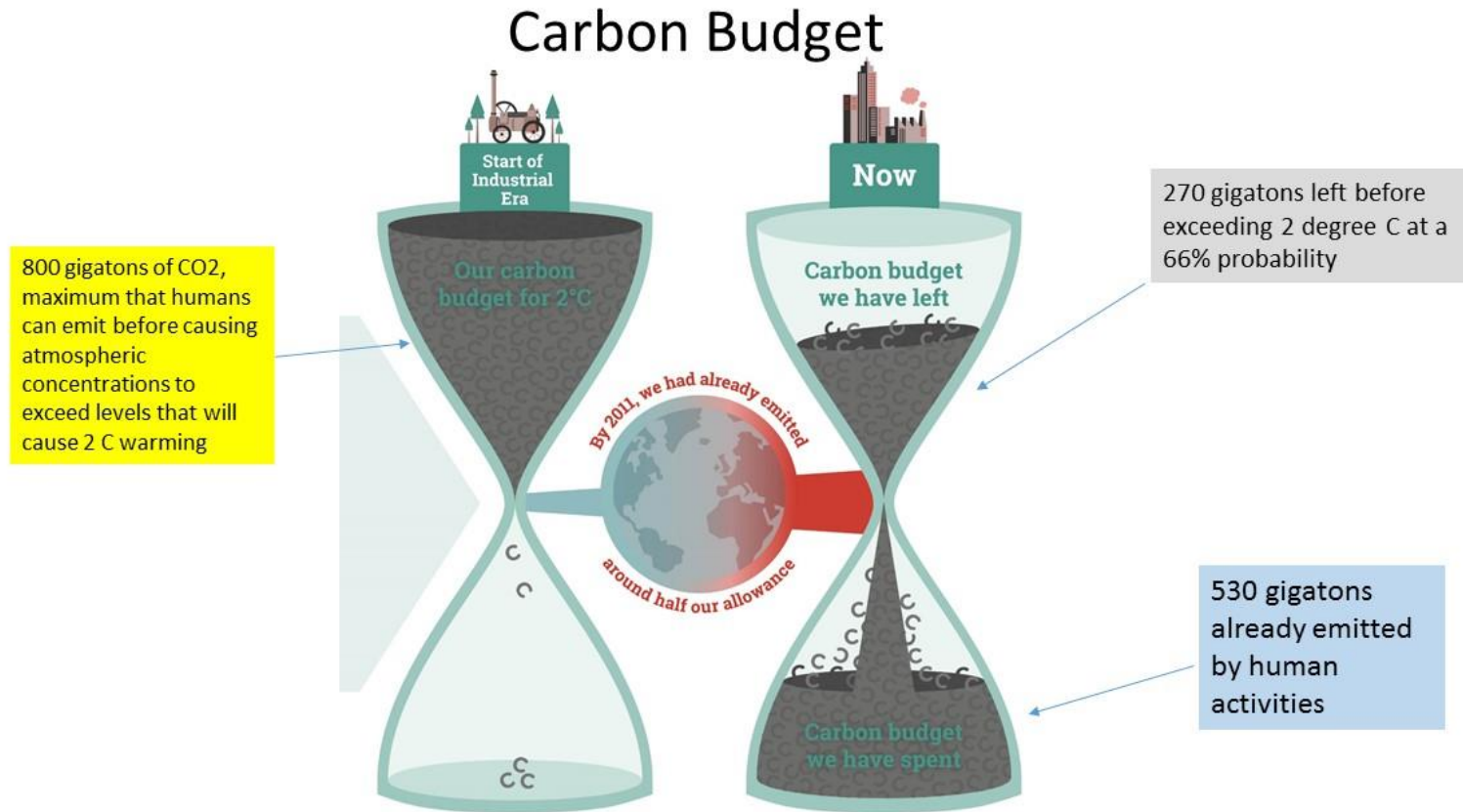


# Tonight's story

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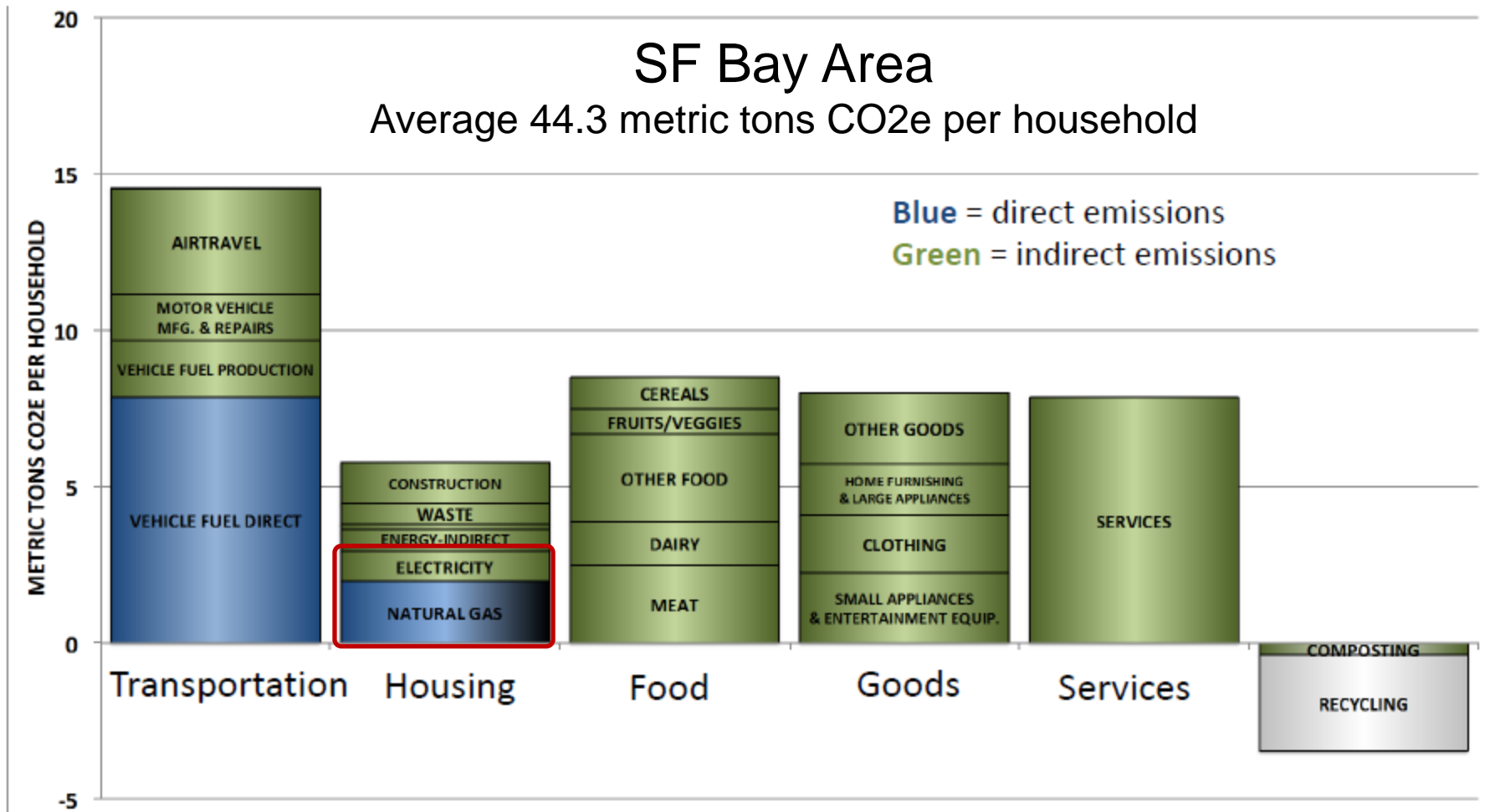
- ❑ The villains: fossil vampires in your closet
- ❑ The hero: here comes the heat pump! (what's that?)
- ❑ The battle: GHGs rule!
- ❑ Now what?
  - How much does it cost?
  - How do I get one?
  - Staying under 1.5°C...

# 2°C carbon budget (Paris agreement: aim for 1.5°C)



<https://ethicsandclimate.org/category/paris/>

# A consumption-based GHG emissions inventory of the SF Bay Area

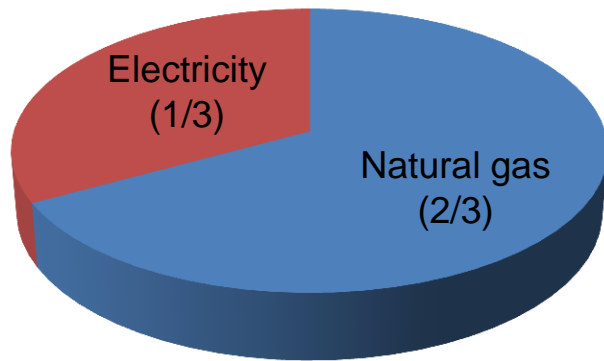


Source: <http://www.baaqmd.gov/research-and-data/emission-inventory/consumption-based-ghg-emissions-inventory>  
 Energy-Indirect represents the construction and maintenance of power plants, power lines, and natural gas production and distribution infrastructure.

# Twice as much CO2 emissions from natural gas as from electricity in average Bay Area home

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CO2 Emissions of Average Bay Area Home<sup>(1)</sup>



As electricity is getting cleaner...

(chart based on PG&E's electricity mix<sup>(2)</sup>, some local utilities even cleaner)

... natural gas is now responsible for two thirds of emissions in the home.

And not even accounting for methane leakage (e.g. Aliso Canyon)

(1) Jones C., Kammen D., "Bay Area Consumption-Based Greenhouse Gas Emissions Inventory", Jan. 2016, <http://www.baaqmd.gov/research-and-data/emission-inventory/consumption-based-ghg-emissions-inventory>

(2) 56% carbon-free in 2014, per <http://www.energy.ca.gov/sb1305/labels/>

# Two pathways to decarbonize buildings + energy efficiency foundation

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- Clean electricity + high-efficiency appliances

Electrification



- Biogas
- Synthetic gas from renewable electricity (power-to-gas)

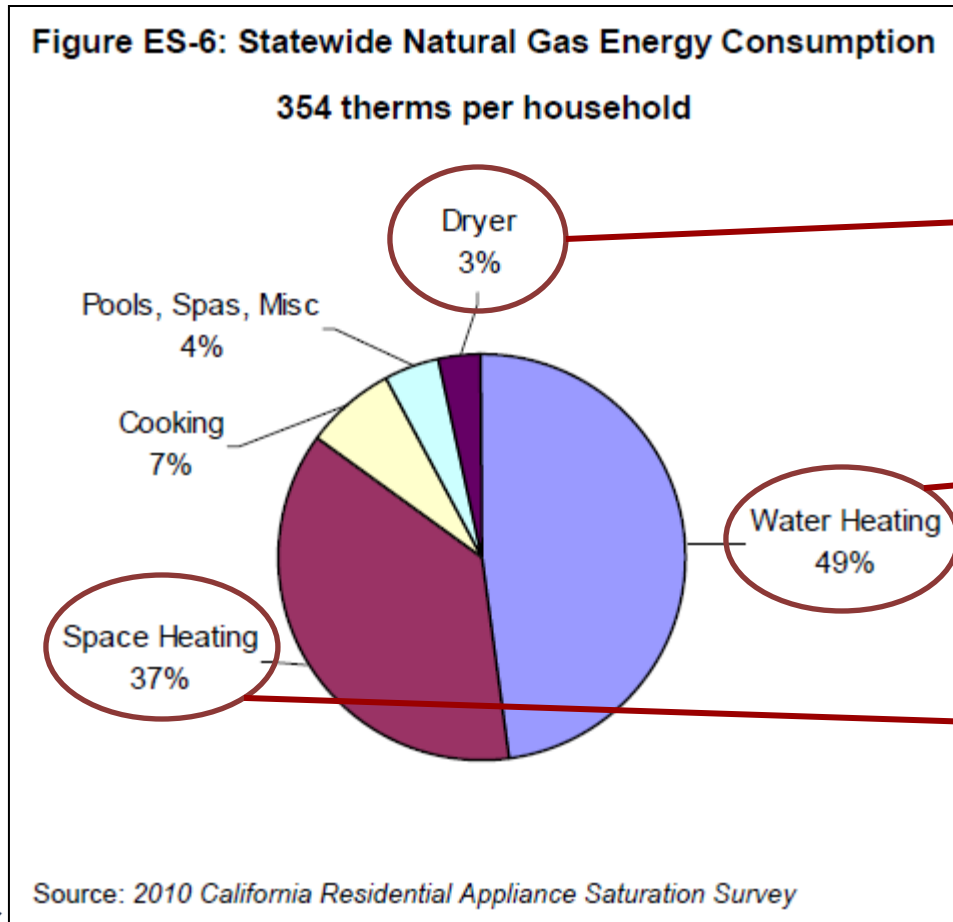
Decarbonized fuels



Energy efficiency



# Heat pump technology is available for three types of home appliances



**Heat-pump clothes dryer**



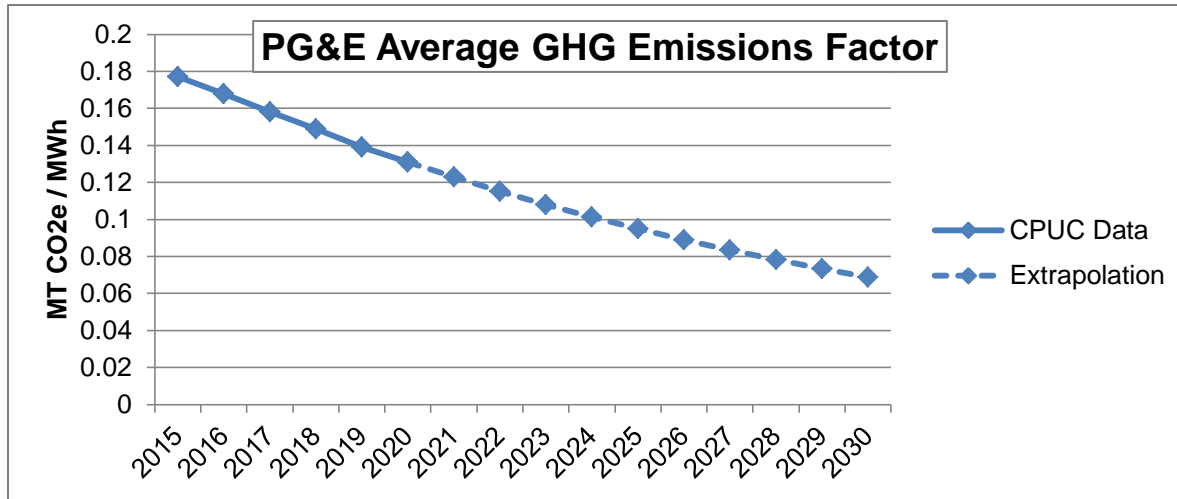
**Heat-pump water heater**



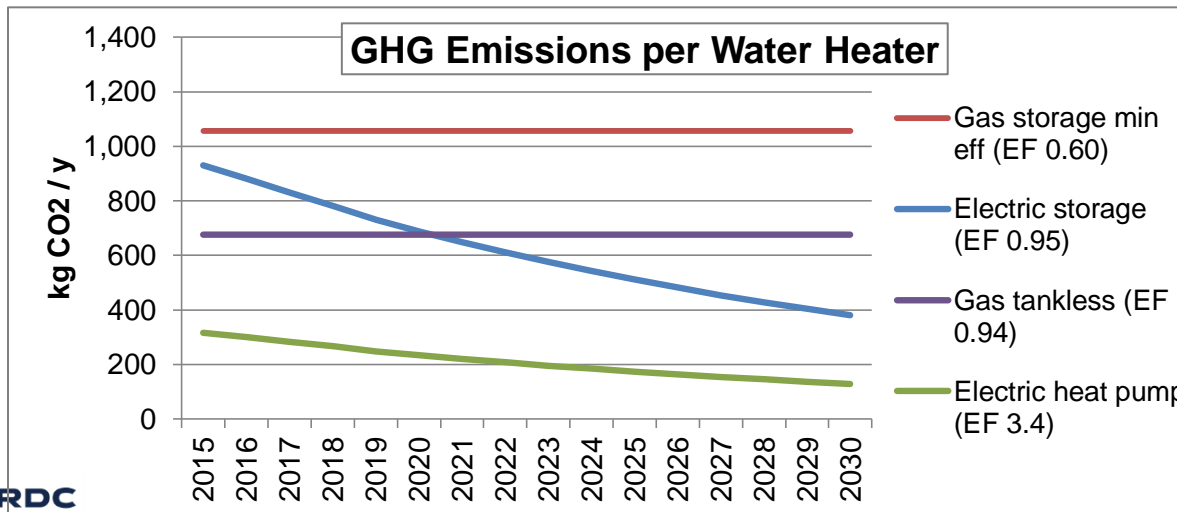
**Air-source and geothermal heat-pumps**



# Water Heater GHG Comparison (PG&E mix\*)



As electricity becomes cleaner over time thanks to CA's clean energy policies...

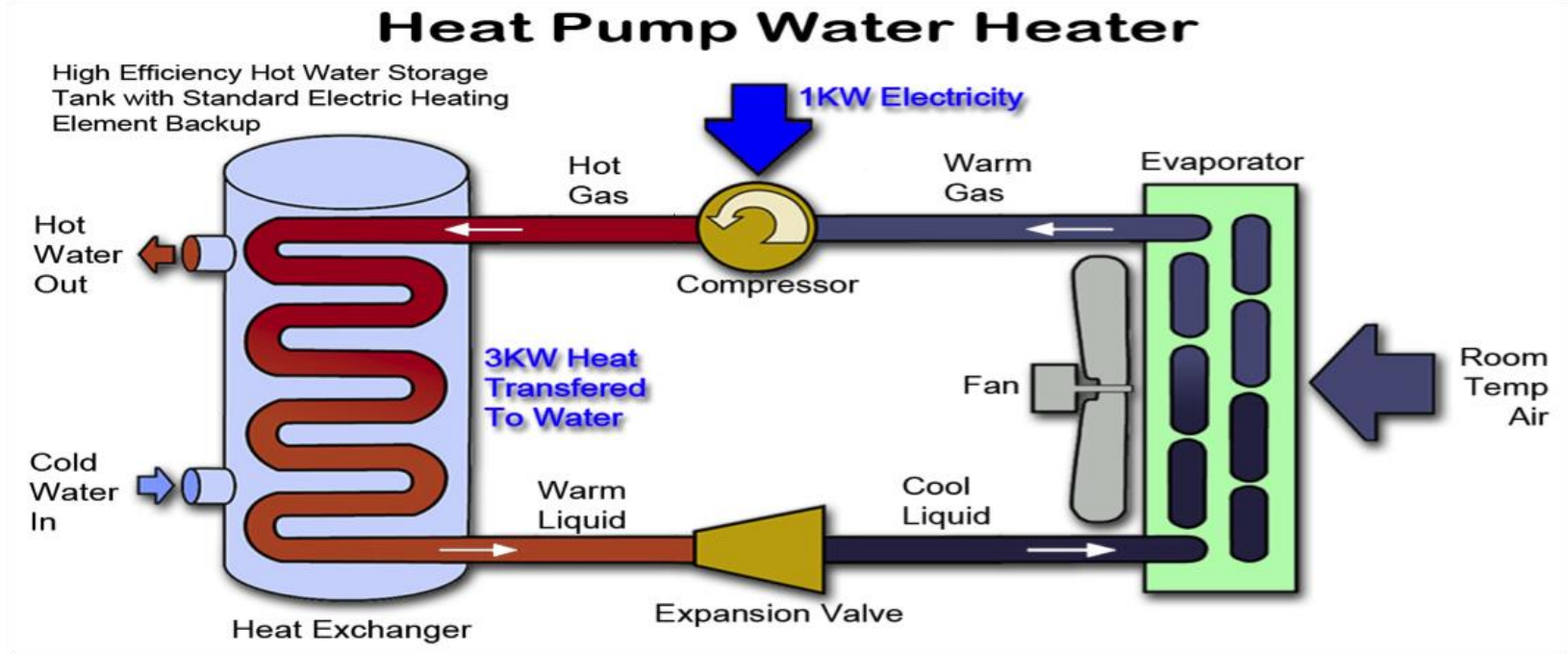


... heat pump water heating will reduce GHG emissions by up to 80% by 2030 vs. natural gas in PG&E territory.

(\*) Comparison varies by utility.



# Heat Pump Technology: 2 to 4 Times More Efficient than Electric Resistance Heating



Moves heat (like a fridge or A/C in reverse) instead of generating it (like electric resistance water heaters).

# Heat Pump Water Heating

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Heat pump water heaters are a mature technology with a wide range of affordable models in the market

Popular models:



GE GeoSpring  
GEH50DEEDSR  
\$1,200-\$1,500



AO Smith  
Voltex  
\$1,200-\$1,500



Kenmore  
Elite Hybrid  
\$1,200-\$1,500



Sanden  
San CO2  
\$2,500-\$3,000



100 ENERGY STAR models (August 2015)

# Heat Pump Space Heating

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Provides both heating and cooling (replaces A/C).

Market is nascent in California, but already well developed in Pacific Northwest and New England.

Two main types of heat pumps for space heating:



Ductless mini-split  
(more efficient)



Ducted heat pumps  
(easier retrofit)

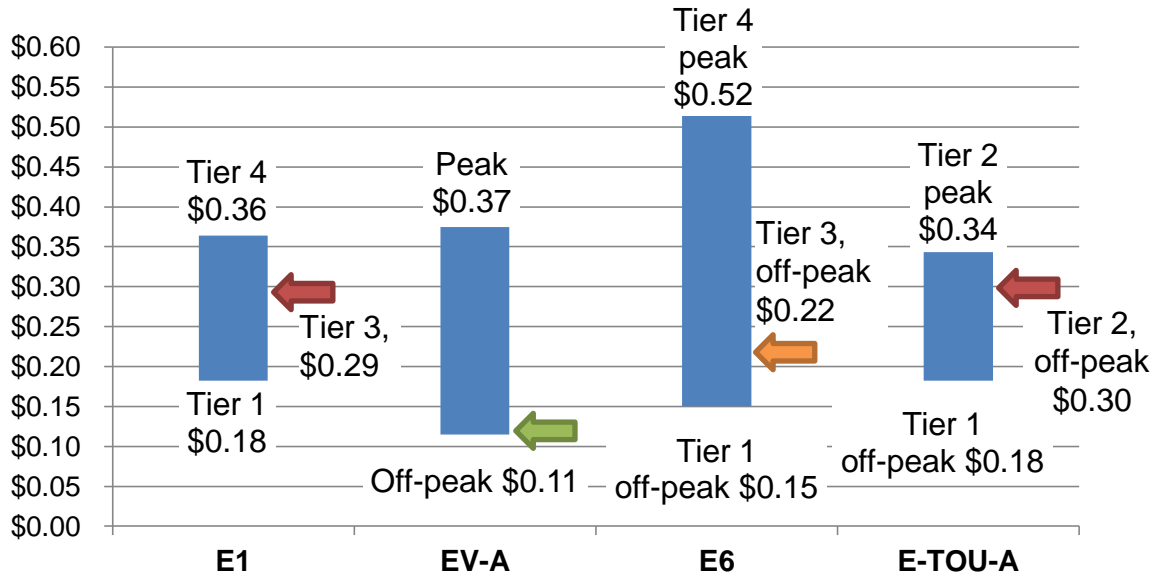
# How much does it cost?

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- Upfront costs (equipment and installation) are currently higher than natural gas appliances
- Operating costs can be lower and offset the higher upfront costs (in the right conditions)
- Situations that help make heat pump cost effective:
  - ✓ Low off-peak time-of-use rates + controls
  - ✓ Rooftop solar
  - ✓ Highest efficiency heat pumps
  - ✓ Installing new central A/C or replacing old one (install a heat pump instead at little extra cost)
  - ✓ New construction or no gas: avoid gas line costs + gas monthly fees
  - ✓ Rebates (\$500 PG&E rebate for heat pump water heater)
  - ✓ Over time: higher natural gas rates...

# Minimizing operational costs

**PG&E rates**  
(March 2016, per kWh, average summer/winter)

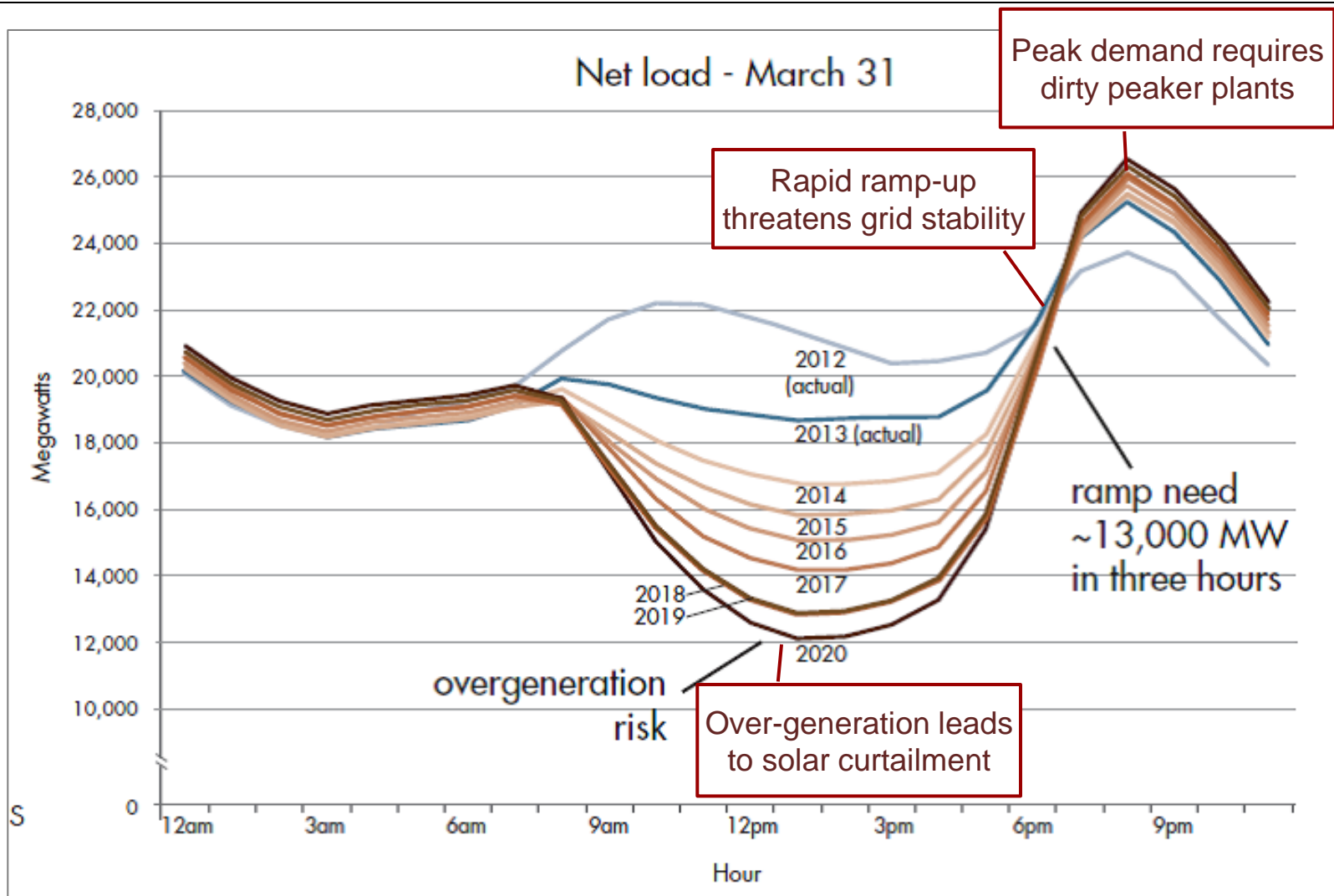


1. Oversize your HPWH to avoid resistive mode
2. Get on a time-of-use rate with lowest possible off-peak rate
3. Schedule your HPWH to run off-peak
4. Go solar

E1 (standard tiered rate)	EV-A (EV rate)	E6 (old TOU and tiered, expiring May 1)	E-TOU-A (new TOU, 2 tiers)
Most HPWH usage likely on tier 3, penalizes electrification	Good if HPWH controlled to run off-peak.	Most HPWH usage likely on tier 3, penalizes electrification	Most HPWH usage likely above baseline, penalizes electrification



# The “duck curve”: avoid using your HPWH at grid peak to minimize emissions from dirty peaker plants



# How do I get one?

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Find a contractor (search for local HVAC contractors advertising heat pump expertise)

## Water heater:

- While no special skills are required to install vs. gas, a contractor with heat pump expertise can advise on model choice and sizing.
- Make sure to get a high efficiency model to minimize operating costs (Energy Factor  $\geq 3.1$ )

## Space heating:

- More complicated and expensive, important to choose a contractor with substantial heat pump expertise and check references.

# How can we scale up the adoption of heat pump technology in the Bay Area?

Barriers	Strategies
Lack of public awareness	Public outreach
Higher equipment and installation costs (including potential electric panel upgrade)	City bulk buy programs, financing, target advantageous situations such as A/C replacement
Rates: standard electric rates penalize heat pump owners	Advocate for utilities and CCEs to set electrification-friendly rates. Target EV / PV owners. Promote highest efficiency models.
Contractors not aware, trained	Contractor outreach and training
Retailers don't stock many models	Retailer partnerships
City building departments not trained	City building departments training
Split financial incentives for renters and landlords	Target home owners first



# Summary

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- ❑ Replacing natural gas appliances (furnace, water heater, clothes dryer) by electric heat-pump appliances is a key opportunity to decarbonize Bay Area residential and commercial buildings
  
- ❑ Promoting electrification-friendly policies in Bay Area cities is an important strategy for local climate advocacy

THANKS!