

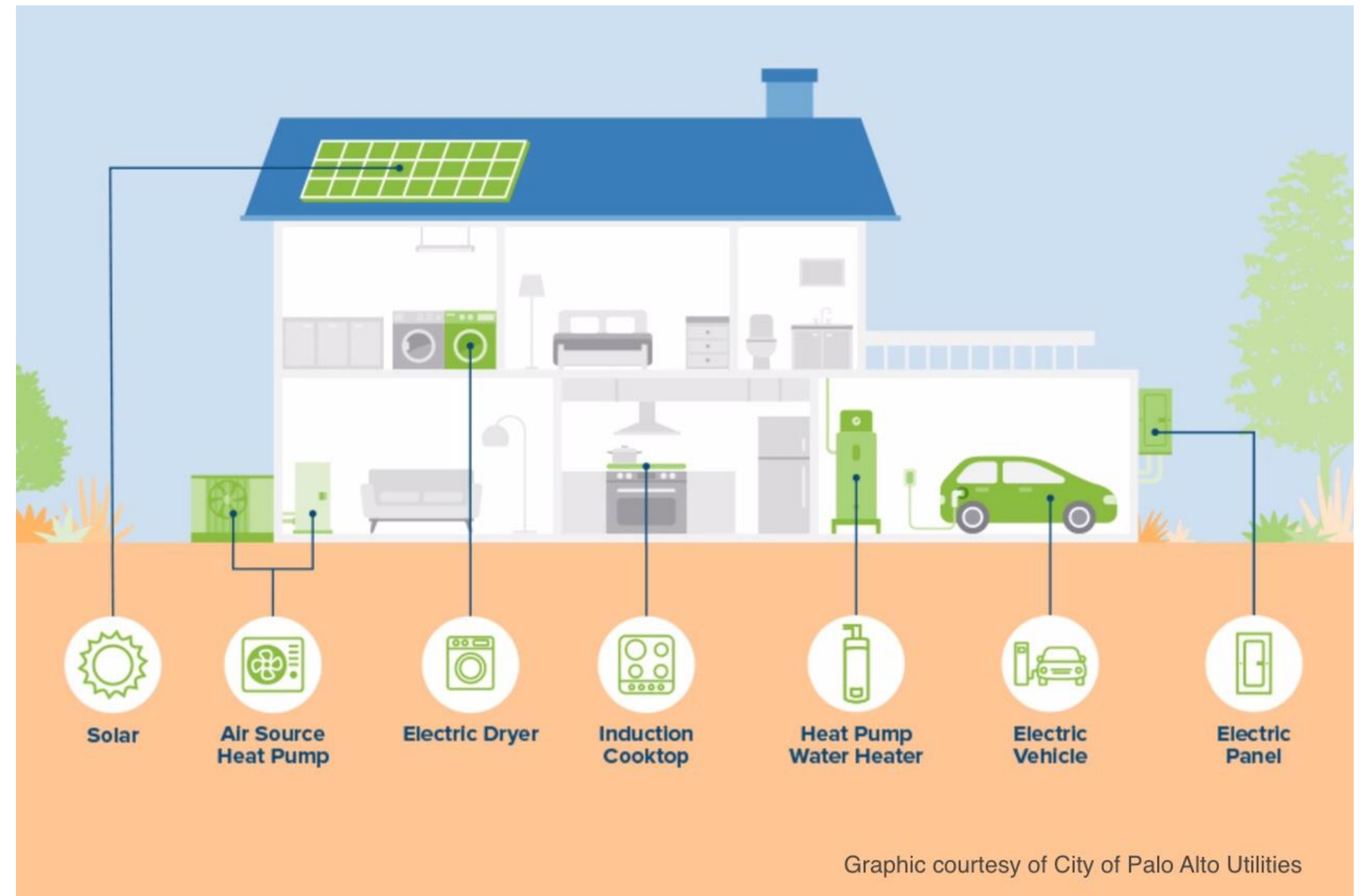
Accelerating the Electrification of Everything

December 22, 2021

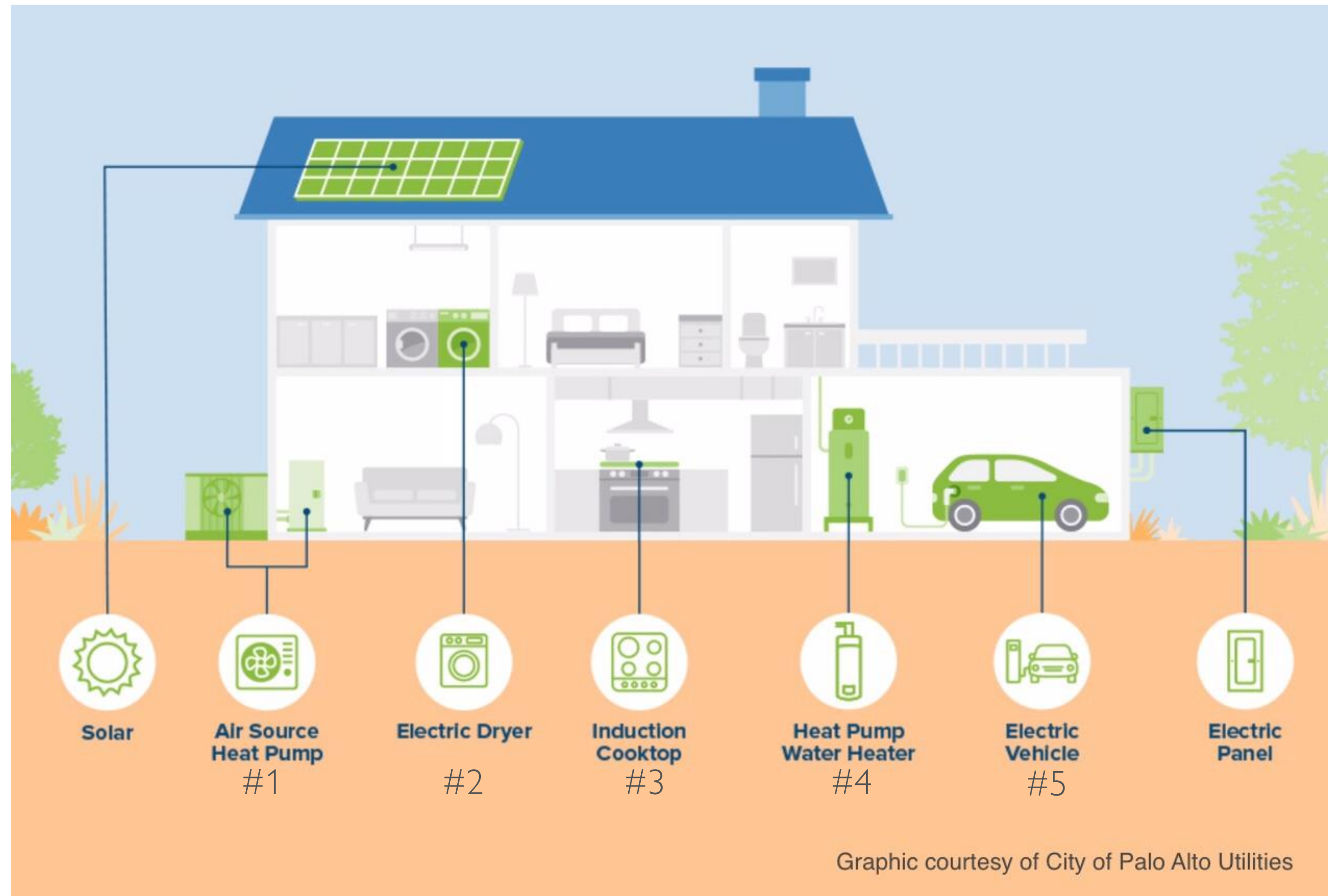
Tom Kabat
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AGENDA

- Defining electrification
- Barriers today
- Home example
- Electrification “silver bullets”
- Solutions needed
- Q&A



WHAT IS BUILDING ELECTRIFICATION?



Replacing all fossil fuel appliances in the building:

- #1 gas furnace
- #2 gas dryer
- #3 gas range
- #4 gas water heater
- #5 gasoline for car

...with high efficiency electric alternatives

- Rooftop solar (at \$0.05–0.10 per kWh) makes all-electric home conversions affordable
- Battery backup systems make all-electric homes reliable during grid outages

BARRIERS TODAY

- Awareness that electrification is a solution to climate change
- Misperception that electrification = utility service (or panel) increase
- Fear, uncertainty, doubt and disinformation spread by fossil fuel industry
- Shortage of knowledgeable contractors
- Slow permitting processes in local jurisdictions
- Misguided first electrification "moves" by building owners
- Poor utilization of existing electric panel/service capacity in buildings
- ▶ Critical gaps in power-efficient equipment offerings

EXAMPLE HOME

Location: Redwood City, CA

Square footage: 1,900

Occupants: 4

Main panel size: 100 amps

Vintage: 1960's



“WATT DIET” for 2,000 sq ft home

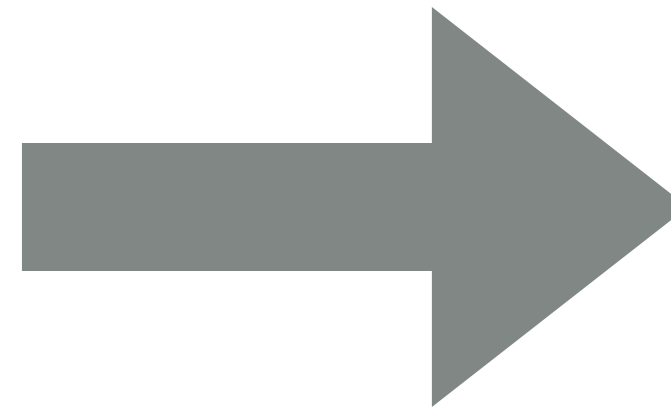
- For homes with 100 amp electrical panels
- Helps avoid ~\$3,000 electric panel upgrade
- Favors efficient devices w/ low rated amps
- Provides roadmap for building owner
- Helps guide tradespeople



WATER HEATER



Today: 50-gallon gas tank WH in garage



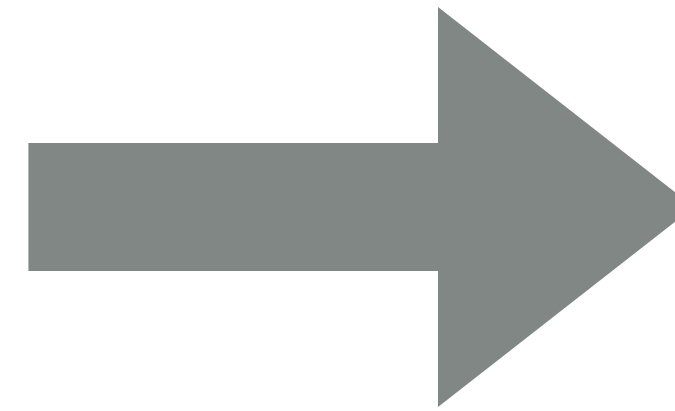
Unmatched Savings & So Much More

Get the Rheem Hybrid Electric Water Heater today and enjoy years of energy-saving and worry-free hot water.

- ✓ **Save Money & Energy**
Save up to \$480 per year in energy costs—that's almost \$5,000 over 10 years!
- ✓ **Energy Saving Scheduling**
- ✓ **Set Vacation or Away Mode**
- ✓ **Demand Response Scheduling**
- ✓ **LeakGuard™ Auto Water Shut-off Valve**
- ✓ **Built-in EcoNet WiFi Technology**
- ✓ **Carbon Footprint Reduction**
- ✓ **Heat Pump Technology**
- ✓ **Energy Use Tracking**
- ✓ **Operation Modes and Scheduling**
- ✓ **Advanced Diagnostics**

Recommended: 80-gallon, 15-amp heat pump tank WH in garage

SPACE HEATING/COOLING



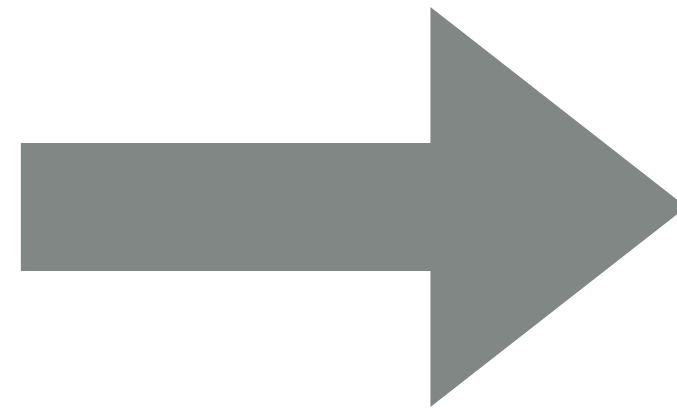
Today: A/C + Bryant gas furnace

Recommended: Mitsubishi 3-ton inverter-driven heat pump HVAC system w/ central air handler

COOKING



Today: 48" gas Jenn-Air range

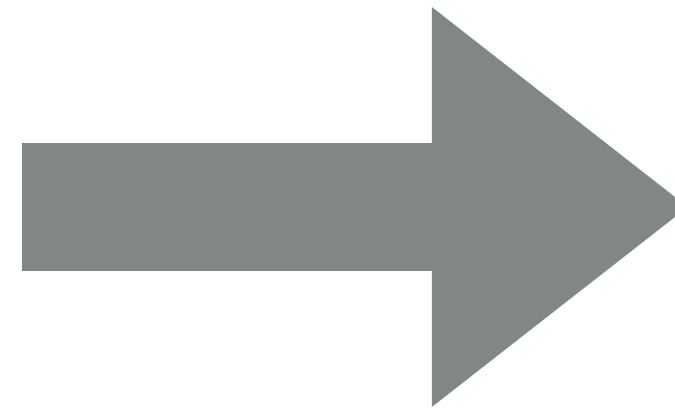


Recommended: 48" AGA induction range

CLOTHES DRYING



Today: Samsung 7.5 cu ft resistance electric dryer 22.5-amps / 240 volts



Recommended: Whirlpool 7.4 cu ft hybrid heat pump dryer 14 amps / 240 volts

EV CHARGING



Recommended: Wallbox Pulsar with adjustable current from 6 to 32 amps (rated 13 amps/240 volts)



Budget Option: NEMA 6-15 outlet with 12-amp/240-volt circuit for outside of garage

CIRCUIT SHARING & AUTOMATIC LOAD SHEDDING



SimpleSwitch Allows
2 appliances to share
one circuit



DCC9
Sheds load for one
circuit



Span.io
Sheds load for 0-32
circuits in the panel

SOLAR + BATTERY



Recommended: 5.8 kW rooftop solar system + 20 kWh battery system

BUILDING SHELL IMPROVEMENTS



Today: Attic, R-19 insulation

Recommend: R-38



Today: Crawlspace, no insulation, poorly insulated ducts

Recommend: R-19 or R-30 for floors, repair ducts

SOLUTIONS
WE ALREADY HAVE

EQUIPMENT GUIDES

✕ Pocket Guide to Home Electrification Retrofits.pdf

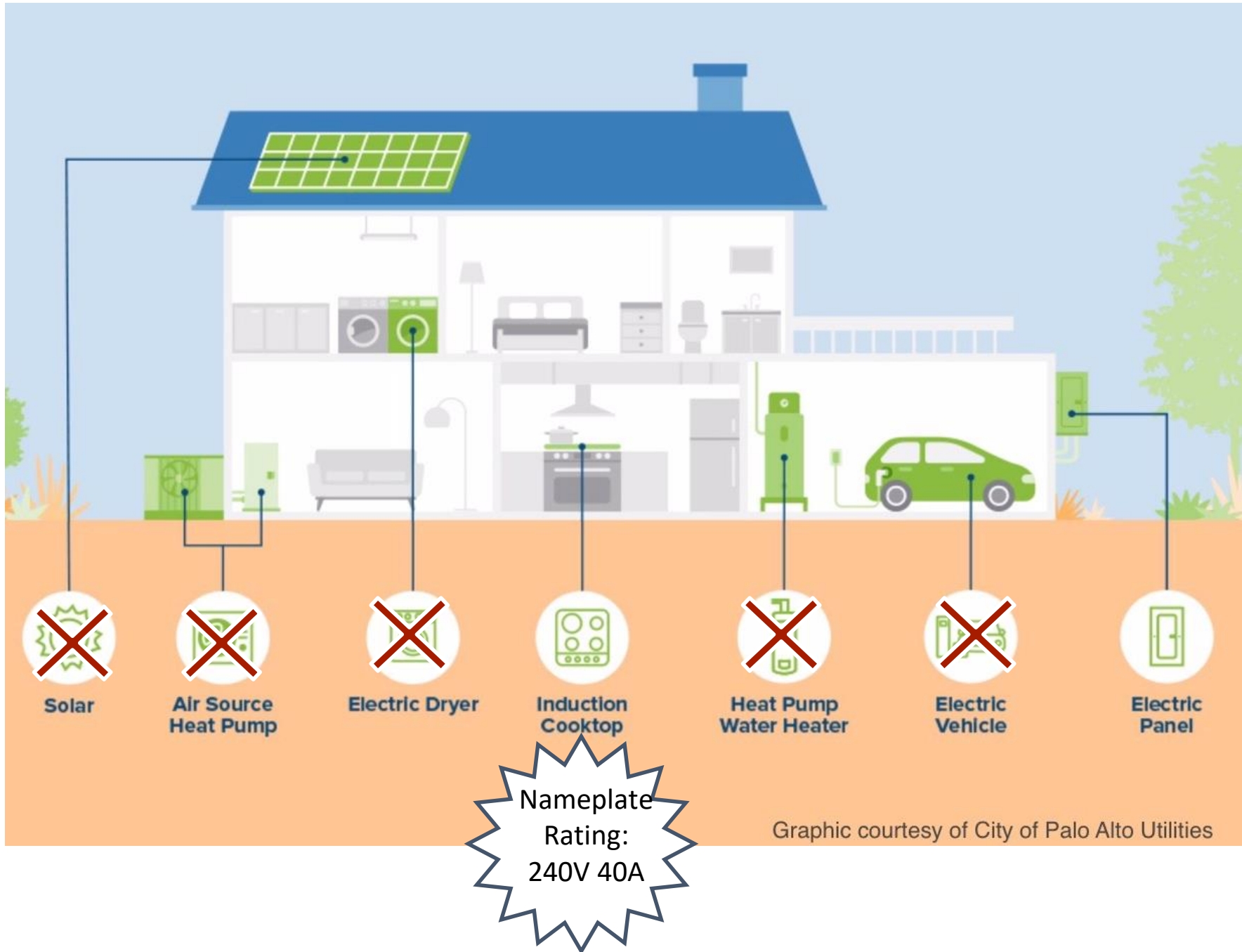


- Released by Redwood Energy and Menlo Spark
- Electrification solutions for existing buildings
- Product lists
- Case studies from across the country
- Watt diet info
- Cost examples
- Download guide here:
<https://redwoodenergy.net/wp-content/uploads/2021/02/Pocket-Guide-to-All-Electric-Retrofits-of-Single-Family-Homes.pdf>
- Great panel calculator tool here:
<https://redwoodenergy.net/watt-diet-calculator/>

EDUCATION ON ELECTRIC LOAD CALCS




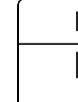




Home A

Total floor area: 1,500 sq ft
Main service capacity: 100 amps
No. of gas appliances: 3



$13,824 \text{ watts} / 240\text{V} = 56 \text{ amps}$



Load Type		Amps	Volts	Watts
	Kitchen Circuit	12.5	x 120	= 1500
	Kitchen Circuit	12.5	x 120	= 1500
	Laundry Circuit	12.5	x 120	= 1500
	Refrigerator	10	x 120	= 1200
	Dishwasher	12	x 120	= 1200
	Garbage Disposal	5	x 120	= 600
	Lights + Plugs	(3 watts / sq foot)		= 4500
	Induct. Range	40	x 240	= 9600
				Subtotal = 21,600
First 8,000 watts @ 1.0 coincidence factor				= 8,000
Remaining watts @ 0.4 coincidence factor				= 5,440

Total = 13,440

ELECTRIFICATION PLANS (PILOT)

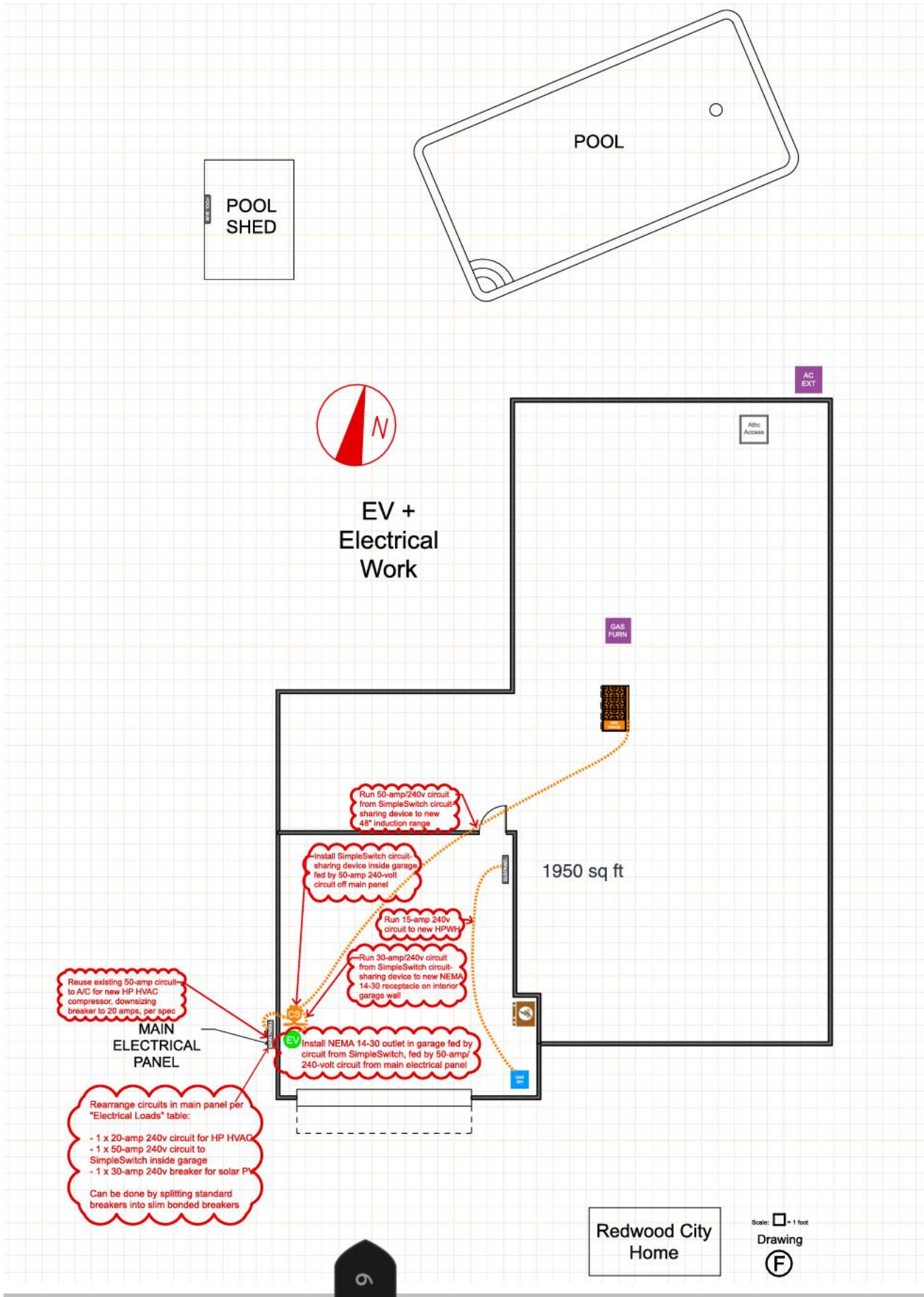
Quote Request

Please provide notional quotes ($\pm 10\%$ of expected cost) for the following work.

Home Background Info
Single-family, detached
1,900 sq ft
1-story
Built 1966
Redwood City Emerald Hills

Please provide separate estimates for each project and a discount estimate if the electrification projects were all combined together. Please separate the \$ quotes into separate cost categories of equipment, labor, permit labor

Work Type	Work Description	Price
1) HPWH	<p>Replace existing gas-fired 50-gallon tank water heater with new 15-amp electric HPWH in same location about 25 feet from sub panel in unconditioned garage workspace. (WH location is protected from car driving area.)</p> <p>Code minimum sizing for 4 BR 2 BA home is 62 gallons of first hour rating.</p> <p>To preserve Amps for future pool equipment, JT suggest 15-amp water heater similar to Rheem or Ruud 65-gallon or 80-gallon models or Stiebel Eltron tank models.</p> <p>Also please quote an alternative 80-gallon 120-volt retrofit ready HPWH if information can be found for it.</p> <p>Price an option for adding a mixing valve (for enhancing the ability to deliver more gallons of 120°F water from any storage tank operated at a higher temperature).</p> <p>Please price labor, permits and materials separately.</p> <p>Also please price a discount if electrification projects are combined.</p> <p>See Drawing B for details</p> <p>Contractor reply including prices:</p>	



Wolf Home

Redwood City Emerald Hills, 94062
Main panel size: 100 amps
Square footage: 1900

Electrical Panel Information

Circuits

Main Panel, rated amps: 100

Circuit Number	Voltage	Breaker Amps	Type	Splittable?	Notes
1 + 2	240	100	Subpanel	yes	Subpanel in garage serving most indoor loads
3 + 4	240	50	Air Conditioner	yes	Breaker can be reduced to 20 amps and circuit repurposed for heat pump
5	120	15	Unknown	yes	Assuming no load on this circuit, other than lights and plugs
6	120	20	Unknown	yes	Assuming no load on this circuit, other than lights and plugs
7 + 8	240	30	Subpanel	yes	Subpanel serving pool equipment

Subpanel 1, rated amps: 100

Circuit Number	Voltage	Breaker Amps	Type	Splittable?	Notes
1	120	20	Clothes Washer	no	Washer
3	120	20	Lights and Plugs	no	Lites + Plugs
5	120	20	Lights and Plugs	no	Lites + Plugs
7	120	20	Lights and Plugs	no	Lites + Plugs
9	120	20	Dish washer	no	Disposal and Dish washer
11	120	20	Lights and Plugs	no	Lites + Plugs
13	120	20	Lights and Plugs	no	Lites + Plugs
15	120	20	Lights and Plugs	no	Whole House Fan
17	120	20	Lights and Plugs	no	Dinng Room Plugs
19	120	20	Kitchen Outlets	no	Kitchen Plugs
21	120	20	Microwave	no	Microwave Oven, microwave is built-in model, 1550 watts/120v
23	120	20	Unknown	no	
2 + 8	240	30	Clothes Dryer	no	Dryer
4 + 6	240	30	Oven	no	Oven 1, part of range
10 + 16	240	20	Oven	no	Oven 2, part of range
12 + 14	240	20	Griddle	no	BBQ but we think it now serves a griddle on the range
18	120	20	Lights and Plugs	no	Plug under pool, side yard light, house fan
20	120	20	Lights and Plugs	no	?
22	120	20	Garage Outlets	no	Garage refrigerator + freezer

EQUIPMENT SILVER BULLETS

1. 15-amp heat pump water heaters
2. 17-amp inverter-driven heat pump HVAC systems that are not just power efficient and energy efficient but also extremely quiet
3. Centrally ducted heat pumps w/ air handlers on same circuit
4. Upsizing the hot heater and adding a mixing valve to compensate for slower recovery time
5. Split heat pump water heaters for tight spaces
6. Heat pump dryers
7. Wallbox Pulsar EV charger with adjustable current (6 to 32 amps)
8. Circuit-sharing devices like Neocharge and SimpleSwitch
9. Circuit-pausers like DCC9 and EV Duty
10. Smart electric panels like Span.io

PITFALLS TO AVOID

- Installing power hogs, like 50-amp EV chargers
- Painting yourself into an expensive corner (requiring a panel upside) by picking sloppy equipment and not planning your electrification
- Waiting until your gas water heater fails to install the necessary circuits for an electric version
- Waiting until your furnace, dryer or cooktop fails to install circuits... be proactive, **pre-wire for electrification!**
- Oversizing your HVAC equipment “just to be safe”
- Undersizing your heat pump water heater

SOLUTIONS

WE NEED

^
desperately

SOLUTIONS WE NEED

desperately

Power Efficient Appliances

- 3400 watt *standard sized (7.4 cu ft)* **heat pump dryer**, bonus: 120 volts
- 7,200 watt 36" **induction cooktop**, bonus: "pacemaker safe"
- 2,500 watt **unitary heat pump water heater**, bonus: Kigali compliant
 - Missing feature today: quiet
- 2,500 watt **split heat pump water heater**, bonus: variety of tank form factors
- Drop in **heat pump HVAC** replacement for old gas wall and floor furnaces
- Low amp EV chargers: 10-amp, 15-amp, 20-amp versions



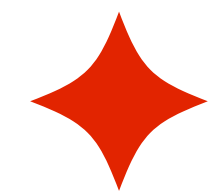
Idea: New DOE "Power Star" rating and label for power efficient appliances

SOLUTIONS WE NEED

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Supply Chain

- American designed and made **heat pumps** for use in appliances
 - Quiet
 - Reliable for 20 years
 - Low cost
 - Kigali compliant
- Shortages could stall electrification transition



Idea: New DOE moonshot program for next gen heat pumps

SOLUTIONS WE NEED

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Software Tools

- Simple on-line electrical load calculator that a homeowner could use to discover how much electrification they can do on their existing panel/service line
- Free, publicly available tool for automating development of building electrification plans
- Software tool like SolarApp to streamline electrification-related permitting



Idea: DOE team focused on public software tools to support electrification

SOLUTIONS WE NEED

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Updates to the National Electrical Code

- Lower assumptions for "light and plug" loads to reflect use of LEDs
- Clearer treatment of load sharing and pausing devices

✦ **Idea:** DOE outreach to relevant NEC advisory bodies and committees

SOLUTIONS WE NEED

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A Home for Rapid Electrification Innovation

- We need an innovation hub for electrification technology solutions
 - Located at LBNL?
 - Team of innovators and problem solvers needed to receive field input on needed innovations
 - Similar to LBNL's LED light bulb development program



Idea: Hub for electrification innovation

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APPENDIX

HOW TO ELECTRIFY QUICKLY

Day 1: Assess your panel, take photos, download your PG&E green button data

Day 2: Determine how much "space" is left on your panel

Day 3: Call contractors and request bids: electricians, plumbers, HVAC

Day 4-8: Receive contractor bids, purchase dryer and induction range

Day 9: Select contractors and start scheduling work

HOW TO ELECTRIFY QUICKLY (CONT.)

Day 15: Have all circuits and EV charger installed

Day 16: First day of HVAC installation

Day 17: Second day of HVAC installation

Day 18: Have heat pump water heater installed

Day 19: Have cooking range and dryer delivered and installed

Day 21: Nice work! You cut your carbon footprint in half very quickly.

TIPS: MAKE A PLAN, DEFEND THE PANEL

- Most single trade contractors will want to get their device in first while you still have panel space
- May be in their interest to sell you a big power using version
- But that paints you into a corner after they are gone.
 - Have your electrification plan so you know how much panel Amperage you are saving for each future need (heating, water heating, 240 V charging, cooking, drying).
 - Install circuits and space for controls if needed
 - Shop for contractors by telling them the maximum nameplate Amps or Watts you are allocating for the device, and that you have the circuit installed
 - Work with them to accept not just selecting overpowered devices
 - Think of the EV as the "shock absorber" in the plan. 120V charging is common.

We can't afford to not fight climate change. But yes, it takes effort.

- Gas has a much bigger carbon footprint than we thought (leakage doubles to quadruples the total emissions). California cannot meet its climate goals without electrifying existing buildings. 'RNG' & 'green H2' cost more than electricity.
- There are manageable capital costs to converting on burnout by planning ahead. E.g. \$4k to \$30k per home or more if you want. You can team up to lower costs.
- The energy use of advanced electric devices is lower, affordable and cleaner.
- Gas prices will rise as emissions get priced, and as flow slows in pipes.
- The existing panel size is usually big enough for good choices e.g. 100A = 24 kW
- You can keep old knob and tube wiring working in place and just add 0-5 new circuits for Heat Pump, Heat Pump Water Heater, Cooking, EV, 220V drying
- Modern Electric Efficiency Advantage: 2 to 4 times better than gas combustion. EVs already cheaper to own for same class and features.
- We have to electrify, even while the grid is improving. Waiting = losing.
- Even gas customers need a \$40 propane camp stove in their quake kit.

BENEFITS OF ELECTRIFYING

For owner/user

- Better controlled advanced modern devices perform more functions
- Cleaner air in home and neighborhood. Reduced asthma risk
- Safer home without gas risks
- Ability to add solar and batteries for long duration resilience.
- Being part of a solution our kids can be proud of.

For Society

- Quicker demonstration of climate progress from a fortunate community
 - Helps show how to speed climate progress elsewhere.
 - (If Menlo Park does not act, why should any community act?)
- Fewer new stranded assets in making gas equipment and pipes that need to be shut down early.
- It's needed to meet climate safety targets, since home and driving are >70%
- Can you imagine solving climate change without electrifying buildings?