Building Electrification Case Studies:
Notes from the Field

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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
STUDY GOALS

- Learn about costs and strategies for decarbonizing existing homes in San Mateo County
  - What does it cost to decarbonize a home?
  - Does a plan help homeowners?
  - What can we learn from assisting homeowners in electrifying?
TEN HOMES SELECTED FOR STUDY

Key selection criteria:

- Location
- Home vintage
- Home size
- Electrical panel size
- Income level

Locations
- Belmont
- Brisbane
- East Palo Alto
- Half Moon Bay
- Pescadero
- Redwood City (2)
- San Bruno
- San Carlos
- San Mateo
STEPS IN COUNTY STUDY

- On-line survey(s) - 78 homeowners applied
- Intro call - 45 mins
- Site visit - 2 hours
- Develop contractor bid packet
- Solicit bids from contractors
- Review bids and run financial projections
- Present plan w/ costs to homeowner
- Write up case study
WOLF HOME

Location: Redwood City, CA
Square footage: 1,900
Occupants: 4
Main panel size: 100 amps
Vintage: 1960's
"AMP 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

### All Electric 100 Amp Home (2,000 square feet)
- Ducted heat pump, medium power heat pump water heater, hybrid heat pump dryer

<table>
<thead>
<tr>
<th>Device</th>
<th>Volts</th>
<th>Amps</th>
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<tbody>
<tr>
<td>Lights/Plug</td>
<td>120</td>
<td>8</td>
</tr>
<tr>
<td>Lights/Plug</td>
<td>120</td>
<td>8</td>
</tr>
<tr>
<td>Lights/Plug</td>
<td>120</td>
<td>8</td>
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<tr>
<td>Garbage Disposal</td>
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<td>10</td>
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<tr>
<td>Refrigerator</td>
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<td>7</td>
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<tr>
<td>Forced Air Unit</td>
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<td>3</td>
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<td>Heat Pump HVAC</td>
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<td>20</td>
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<tr>
<td>Hybrid Heat Pump Dryer</td>
<td>240</td>
<td>14</td>
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<tr>
<td>Range (Gas or Electric)</td>
<td>240</td>
<td>20</td>
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<tr>
<td>Heat Pump Water Heater</td>
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<td>16</td>
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<tr>
<td>Clothes Washer</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Dishwasher</td>
<td>15</td>
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</tbody>
</table>

**House square footage - 2000**

**Total Counted Panel Amps = 96.6**

### Additional House Information
- 4 occupants
- EV charging up to 50 miles/day
- Located in California climate zone 3 (SF Peninsula)
- Some insulation
- 30,000 lbs of heating and cooling

- 60-gallon heat pump water heater
- 4-burner induction or standard electric range
- 7.4 cu. ft. hybrid heat pump dryer
- A 20-amp circuit will support a 3.5 kW inverter.
- Whole 2000 square foothouse can support a 5 kW inverter
- 25-50% solar array depending on available roof space

Diagram created and designed by Studio B Architecture and Courtney Bower
WATER HEATER

Today: 50-gallon gas tank WH in garage

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
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
Recommended: NEMA 14-30 outlet with 30-amp / 240-volt circuit for outside of garage
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
“AMP DIET”

for

3,000 sq ft home

• For homes with 100 amp electrical panels
• Uses “circuit sharing” devices like plug-in smart splitter *Neocharge* or hard-wired version *SimpleSwitch*
• Still easy to avoid ~$3,000 electric panel upgrade
**Quote Request**

Please provide additional quotes (a 10% of expected cost) for the following work.

**Work Description**

<table>
<thead>
<tr>
<th>Work Type</th>
<th>Work Description</th>
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<tr>
<td>HPWH</td>
<td>Replace existing gas-fired 50-gallon tank water heater with new 10-amp electric HPWH in same location about 25 feet from sub panel in unconditioned garage workspace. (WH location is protected from car driving area.) Code minimum sizing for 4 BR 2 BA home is 62 gallons of first hour rating. To preserve Amps for future pool equipment, IT suggest 15-amp water heater similar to Rheem or Ruud 65-gallon or 80-gallon models or State’s Elite tank models. Also please quote an alternative 80-gallon 120-volt retrofit ready HPWH if information can be found for it. 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). Please price labor, permits and materials separately. Also please price a discount if electrification projects are combined. See Drawing B for details. Contractor reply including prices:</td>
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**Electrical Panel Information**

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Description</th>
<th>Voltage</th>
<th>Branches</th>
<th>Type</th>
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<tbody>
<tr>
<td>PV</td>
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<td>Solar Panel</td>
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<td>EV</td>
<td>Electric Vehicle</td>
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<td>EV Charger</td>
<td>EV Charger</td>
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<tr>
<td>Lighting</td>
<td>Indoor Lighting</td>
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<td>5</td>
<td>Fluorescent</td>
<td>Fluorescent</td>
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<tr>
<td>Air Conditioning</td>
<td>Central A/C</td>
<td>240v</td>
<td>2</td>
<td>Heat Pump</td>
<td>Heat Pump</td>
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<tr>
<td>Exhaust</td>
<td>Ventilation</td>
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<td>Fan</td>
<td>Fan</td>
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<td>Security</td>
<td>Alarm System</td>
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<td>Burglar Alarm</td>
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<td>Outlet</td>
<td>Standard Outlet</td>
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<td>GFI</td>
<td>GFI</td>
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<td>GFCI</td>
<td>Ground Fault Circuit Interrupter</td>
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<td>GFCI</td>
<td>GFCI</td>
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<tr>
<td>Generator</td>
<td>Diesel Generator</td>
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<td>Diesel Engine</td>
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<tr>
<td>Solar Inverter</td>
<td>Solar Inverter</td>
<td>120v</td>
<td>1</td>
<td>Solar Inverter</td>
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</tr>
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**Contact Information**

Redwood City, Emerald Hills

519-125-3456

info@contractorbidpacket.com
WHAT WE LEFT OUT...FOR NOW

400,000-BTU gas pool heater

gas fireplace
TYPICAL SITE VISIT

- 2 hours long
- Replaces visits by 6+ different contractors
- 1 hour spent outside:
  - site sketch
  - building and window dimensions
  - electrical panel, potential HVAC sites
  - potential battery sites
  - rooftop solar potential
  - viewing crawlspace for insulation condition, key measurements duct condition and accessibility assessment
- 1 hour spent inside:
  - viewing key appliances to replace
  - recording energy ratings for other major electrical loads
  - viewing attic for insulation condition, key measurements, duct condition and accessibility assessment
KEY LEARNINGS...SO FAR

- Most any home can be fully electrified without upsizing the electrical panel
- A plan helps the homeowner "defend the electrical panel"
- A few key product choices make electrification really easy (and are gentle on the grid):
  - 15-amp heat pump water heaters
  - 17-amp inverter-driven heat pump HVAC systems that are super quiet
  - Centrally ducted heat pump air handlers
  - NEMA 6-15 or 6-20 outlets for EV charging...AVOID 50-amp EV chargers
  - Circuit-sharing devices like Neocharge and SimpleSwitch
  - Split water heaters are great solution for water heaters in tight spaces (e.g. interior closets)
  - Heat pump dryers
KEY LEARNINGS...SO FAR (CONT)

- You can electrify your pool heat or keep your 100-amp panel, but you can't do both
- Heating a pool for a home with a 100-amp panel will likely force a panel upsize...but don't over do it, another 50 amps of panel capacity is plenty
- Upsize the water heater when going from gas to heat pump, for homeowner satisfaction
- Old resistance dryers are energy hogs (e.g. 26 amps), use more power than a 3-ton inverter-drive heat pump HVAC system (17 amps) which can easily heat an entire house
- Insulation is just one tool in the electrification/decarbonization tool kit
- Electrification is not rocket science, but you can be steered down bad paths by contractors
- We need more contractors who understand amp diets and want to sell heat pumps
- There is no shortage of ways to electrify a home on its existing electrical panel
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