Home Electrification Study
Preliminary Cost Results from 10 San Mateo County Homes

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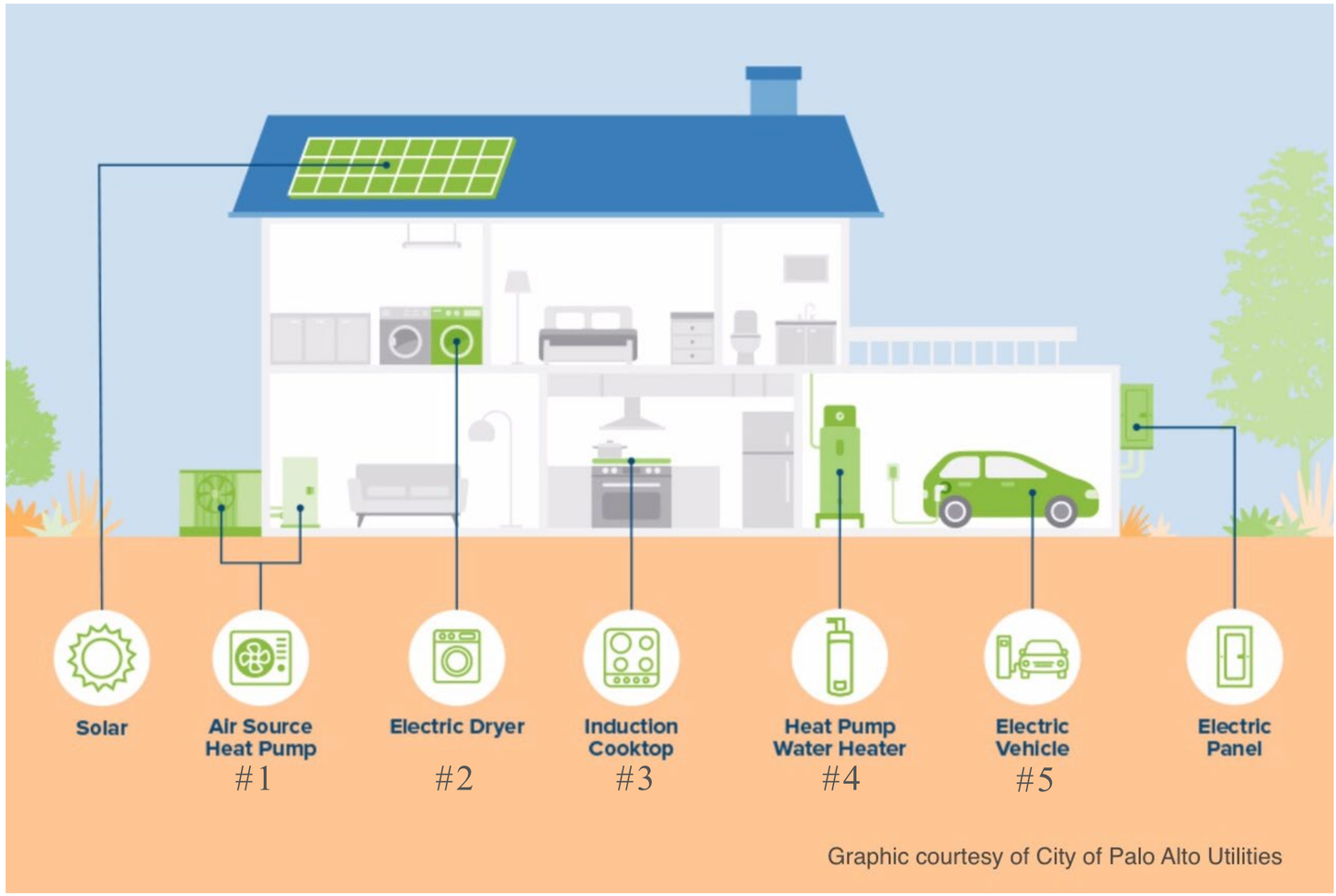
Commissioned by County of San Mateo Office of Sustainability with funding from BayREN

BUILDING ELECTRIFICATION INCLUDES:



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

Electrification Plan Steps

1) Virtual Meeting to learn goals and current house problems (Also get utility data)

1) Site visit to take measurements and pictures
   For heat loss calculations and look at insulation, double panes windows
   For equipment fitting (return air grill size, Furnace box and bonnet dimensions)
   For water heater space and condensate routing
   For compressor placement locations and possible battery locations
   Attic and crawlspace access door dimensions, joist spacing
   EV Charger future location

   Electric service line routing to meter
   Electric panel size(s) and configuration
   Circuit count and pole spaces used and remaining

   Attached Equipment Nameplate pictures
   (Furnace, Water heater, Oven, Cooktop, Others)

1) Office analysis and puzzle solving to find low cost configurations that meet goals

Study Steps

Develop Contractor Quote Packets from plans

Solicit and compile quotes

Make reports to homeowners (7 done, 3 to go)

Share anonymized results with agencies (starting Nov 2022)

Share lessons learned:

- On the process we used and the relative value of components
- On the process of developing electrification plans
- On the value of electrification plans
- On cost effective paths at homes VIPs (very important products)

What we consider to meet client needs and keep costs down

	Technology	Size	Direction	Look at	Amps
Heat and Cooling	Inverter driven	Right sized	Smaller	High Eff	17
Ducts or not	ducts/ductless		Least change		
Insulation	Enough to fit heat pump at 3 tons or under			Attic	
Water heating	Dimensions	Right sized	larger tank	High Eff	13
Cooking	Induction	Right sized	same size		30-48
Drying	HP/Combo	Right sized	same size		0 to 14
EV Charging	Controlled	Right sized	miles/week	remaining Amps	10 to 32
Solar		Panel sized	optional	Sunny?	5.8 kW
Battery		Right sized	optional	V 2 H ?	10 kWh

CONTRACTOR BID PACKET

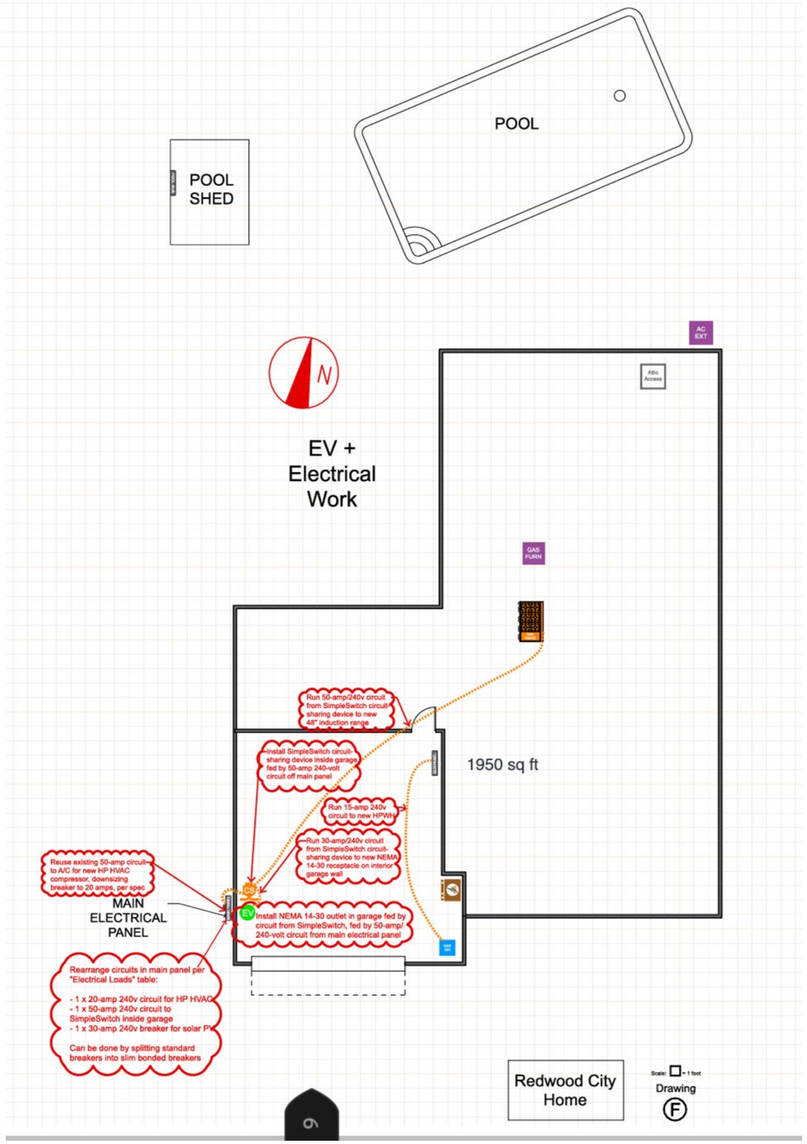
Quote Request

Please provide notional quotes (±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	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.) Code minimum sizing for 4 BR 2 BA home is 62 gallons of first hour rating. 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. 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:	



Wolf Home

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

Electrical Panel Information

Circuits

Main Panel, rated amps: 100

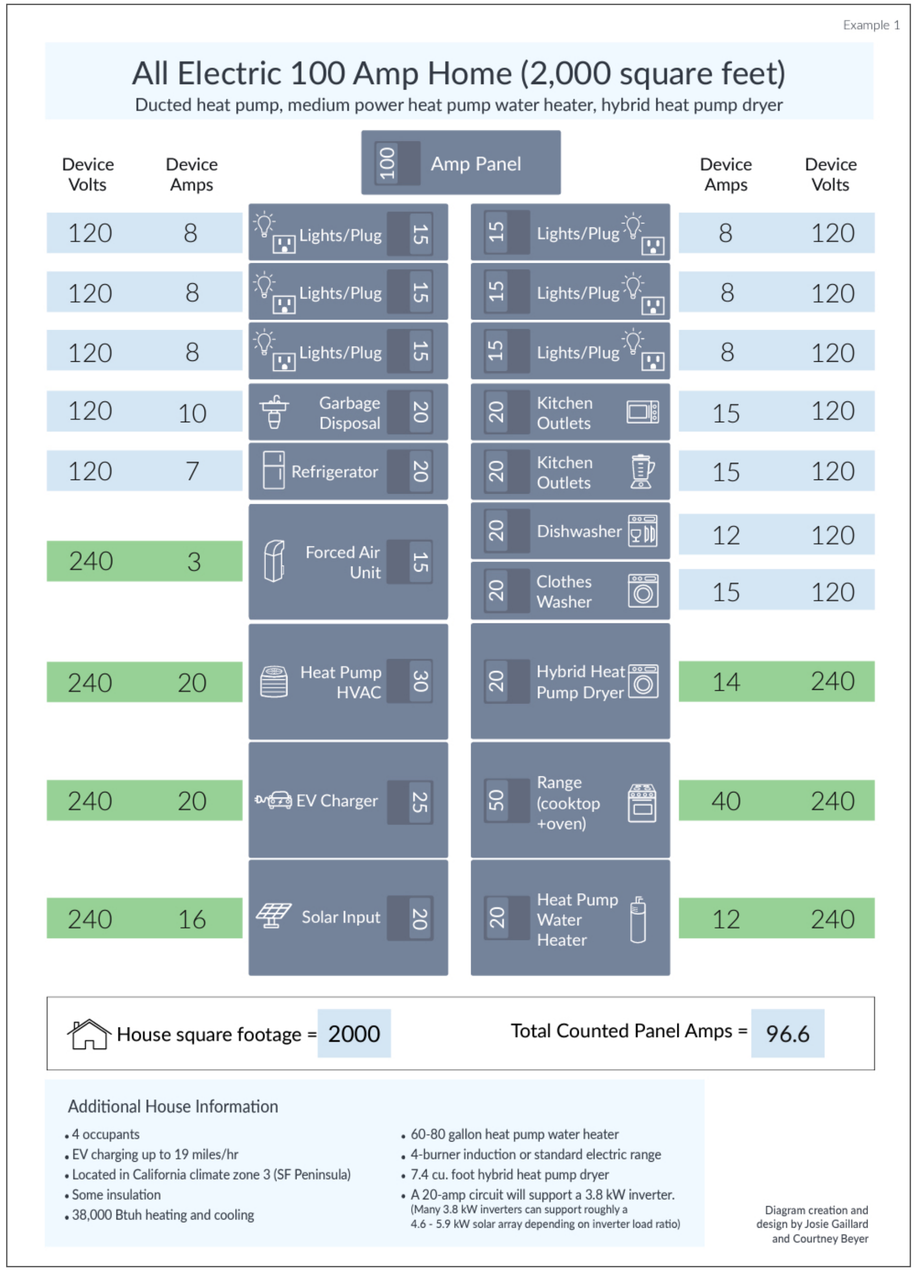
Circuit Number	Voltage	Breaker Amps	Type	Splittable?	Notes
1 + 2	240	100	~~Subpanel~~	yes	~~Subpanel~~ in garage serving most indoor loads
3 + 4	240	50	Air Conditioner	yes	Breaker can be reduced to 20 amps and circuit repurposed for heat pump
5	120	15	Unknown	yes	Assuming no load on this circuit, other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

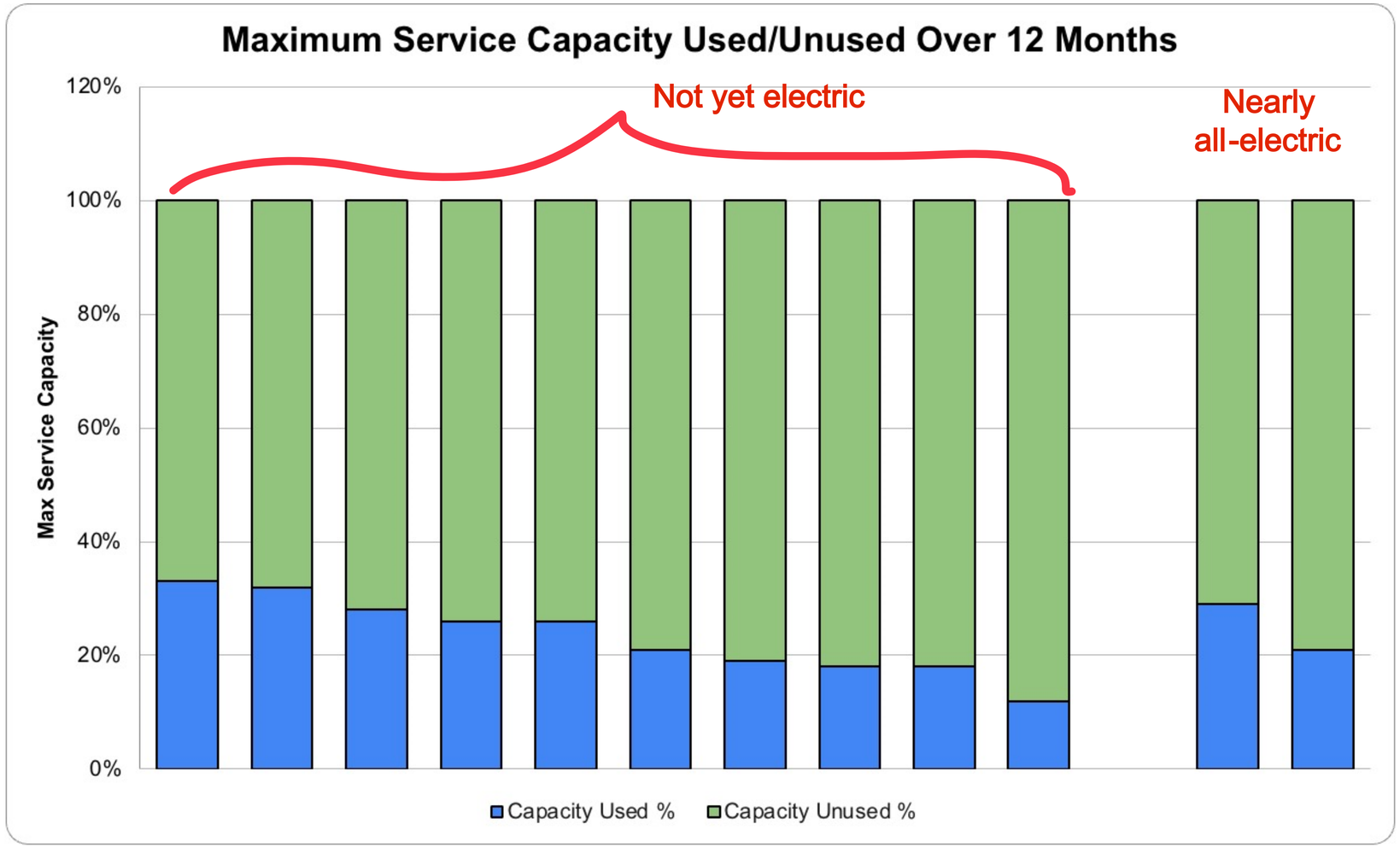
Circuit Number	Voltage	Breaker Amps	Type	Splittable?	Notes
1	120	20	Clothes Washer	no	Washer
3	120	20	Lights and Plugs	no	Lites + Plugs
5	120	20	Lights and Plugs	no	Lites + Plugs
7	120	20	Lights and Plugs	no	Lites + Plugs
9	120	20	Dishwasher	no	Disposal and Dishwasher
11	120	20	Lights and Plugs	no	Lites + 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	Dining 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

“PANEL OPTIMIZATION” for 2,000 sq ft home

- For homes with 100 amp electrical panels
- Helps avoid ~$5,000 electric panel upgrade
- Favors efficient devices w/ low rated amps
- Provides roadmap for building owner
- Helps guide tradespeople



AMPLE SPACE TO ELECTRIFY



WATER HEATER

Uses 1/3 the energy of a gas water heater

Today: 50-gallon gas WH in garage

Recommended: 65-gallon, 15-amp heat pump tank WH in garage

SPACE HEATING/COOLING

Uses 1/3 the energy of a gas furnace

Today: Gas furnace in crawl space under 1st floor

Recommended: Mitsubishi 3-ton inverter-driven heat pump HVAC system w/ 2.5 ton ducted air handler + ½ ton ductless wall unit upstairs

CLOTHES DRYING

Today: Maytag 7.5 cu ft electric resistance dryer 26 amps / 240 volts

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

BUILDING SHELL IMPROVEMENTS

Today:

- Attic, some insulation
- Walls, insulated
- Floors, no insulation

Recommended:

- Attic, increase to R-38
- Walls, no change
- Floors (optional), insulate to R-19

DUCTWORK

Today:

- Ducts appear to be in good condition

Recommended:

- Repair, seal and insulate, as needed

East Palo Alto Home
CONTRACTOR QUOTES

Existing Condition	Proposed Electrification	Trade	Applicable Project	Replace Existing (Gas)	DIY Electric	Low Bid Electric	Mid Bid Electric	High Bid Electric
100-amp main electrical panel + 60-amp garage subpanel	100-amp main electrical panel + 100-amp garage subpanel	Electrician	Panel(s)		$2,100	$2,100	$5,000	$6,460
No dedicated 240-volt circuits to: water heater, HVAC, range, dryer	4 new 240-volt circuits to: water heater, HVAC, cooktop, range	Electrician	Circuits		$0	$3,700	$7,268	$7,800
50-gallon gas water heater	80-gallon heat pump water heater	Plumber	HP Water Heater	$2,754	$0	$5,898	$7,476	$8,265
80% efficient centrally ducted gas furnace	30,000 BTU centrally ducted heat pump HVAC system	HVAC	HVAC	$4,808	$0	$12,586	$15,150	$17,230
4-burner 30" gas range	4-burner 30" induction range	Electrician	Range/Cooktop/Oven	$949	$1,099	$1,099	$1,099	$1,700
7.5 cu ft electric resistance dryer	7.4 cu ft hybrid heat pump dryer	None	Dryer	$0	$0	$0	$0	$0
Insulation: attic - none	Insulation: attic - none	Insulation	Attic		$0	$0	$0	$0
Insulation: walls - none	Insulation: walls - R11	Insulation	Walls		$2,843	$2,843	$3,098	$7,322
Insulation: floor - none	Insulation: floor - none	Insulation	Floor		$0	$0	$0	$0
Ductwork: none	Ductwork: none	HVAC	Ducts	$0	$0	$0	$0	$0
At-home fueling for: 1 EV [12,000 miles/yr]	At-home fueling for: 2 EVs [12,000 miles/yr]	Electrician	EV Charger		$0	$1,565	$2,423	$2,850
REBATES					-$4,625	-$7,875	-$7,875	-$7,875
SUBTOTAL				**$8,511**	**$1,417**	**$21,916**	**$33,638**	**$43,752**
Rooftop solar PV: none	Rooftop solar PV: 5.8 kW	Solar/Battery	Solar		$22,325	$22,325	$22,325	$22,325
Home battery: none	Home battery: 10 kWh	Solar/Battery	Battery		$12,000	$12,000	$12,478	$19,000
REBATES & TAX CREDITS					-$8,925	-$8,925	-$9,049	-$10,745
SUBTOTAL				**$0**	**$25,401**	**$25,401**	**$25,754**	**$30,581**

East Palo Alto Home

Contractor Quotes

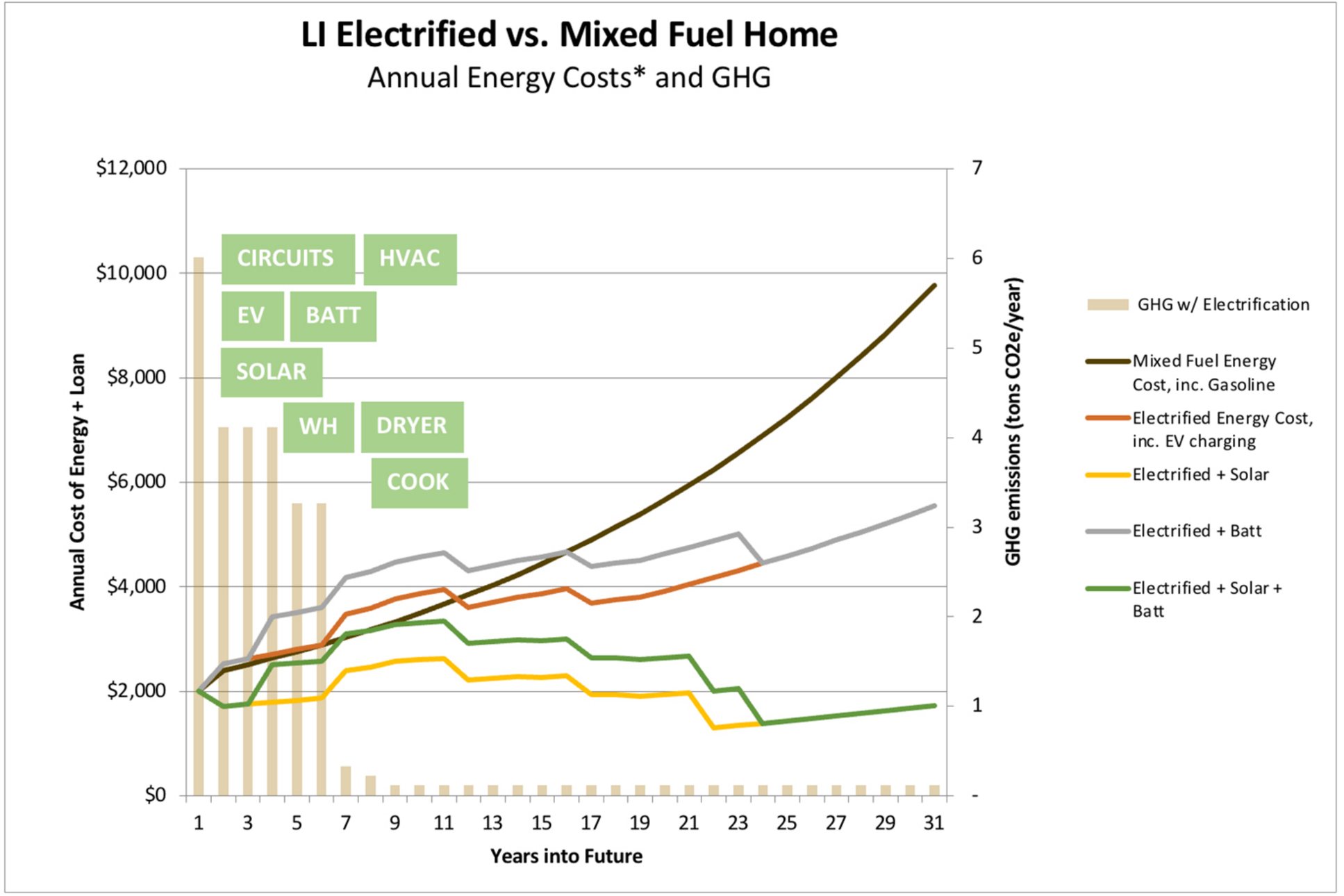
Existing Condition	Proposed Electrification	Trade	Applicable Project	Replace Existing (Gas)	DIY Electric	Low Bid Electric	Mid Bid Electric	High Bid Electric
100-amp main electrical panel + 60-amp garage subpanel	100-amp main electrical panel + 100-amp garage subpanel	Electrician	Panel(s)		$2,815	$2,815	$5,000	$6,460
No dedicated 240-volt circuits to: water heater, HVAC, range, dryer	4 new 240-volt circuits to: water heater, HVAC, range	Electrician	Circuits		$2,550	$2,550	$7,268	$7,800
50-gallon gas water heater	80-gallon heat pump water heater	Plumber	HP Water Heater	$2,754	$4,100	$5,898	$7,476	$8,265
80% efficient centrally ducted gas furnace	30,000 BTU centrally ducted heat pump HVAC system w/ MERV 13 filter	HVAC	HVAC	$4,808	$5,000	$12,586	$15,150	$17,230
4-burner 30” gas range	4-burner 30” induction range	Electrician	Range/Cooktop/Oven	$949	$1,099	$1,099	$1,099	$1,300
7.5 cu ft electric resistance dryer	Optional: 7.4 cu ft hybrid heat pump dryer	None	Dryer	$0	$0	$0	$0	$0
Insulation: attic - none	Insulation: attic - none	Insulation	Attic		$0	$0	$0	$0
Insulation: walls - none	Insulation: walls - R11	Insulation	Walls		$2,843	$2,843	$2,843	$7,322
Insulation: floor - none	Insulation: floor - none	Insulation	Floor		$0	$0	$0	$0
Ductwork: unknown condition	Ductwork: unknown condition	HVAC	Ducts	$0	$0	$0	$0	$0
At-home fueling for: 1 EV [12,000 miles/yr]	At-home fueling for: 2 EVs [12,000 miles/yr]	Electrician	EV Charger		$2,200	$2,200	$2,423	$2,850
REBATES					-$18,061	-$27,342	-$27,342	-$27,342
SUBTOTAL				**$8,511**	**$2,546**	**$2,649**	**$13,916**	**$23,885**
Rooftop solar PV: none	Rooftop solar PV: 5.8 kW	Solar/Battery	Solar		$22,325	$22,325	$22,325	$22,325
Home battery: none	Home battery: 10 kWh	Solar/Battery	Battery		$12,000	$12,000	$12,478	$19,000
REBATES & TAX CREDITS				$0	-$10,298	-$10,298	-$10,441	-$12,398

East Palo Alto Home

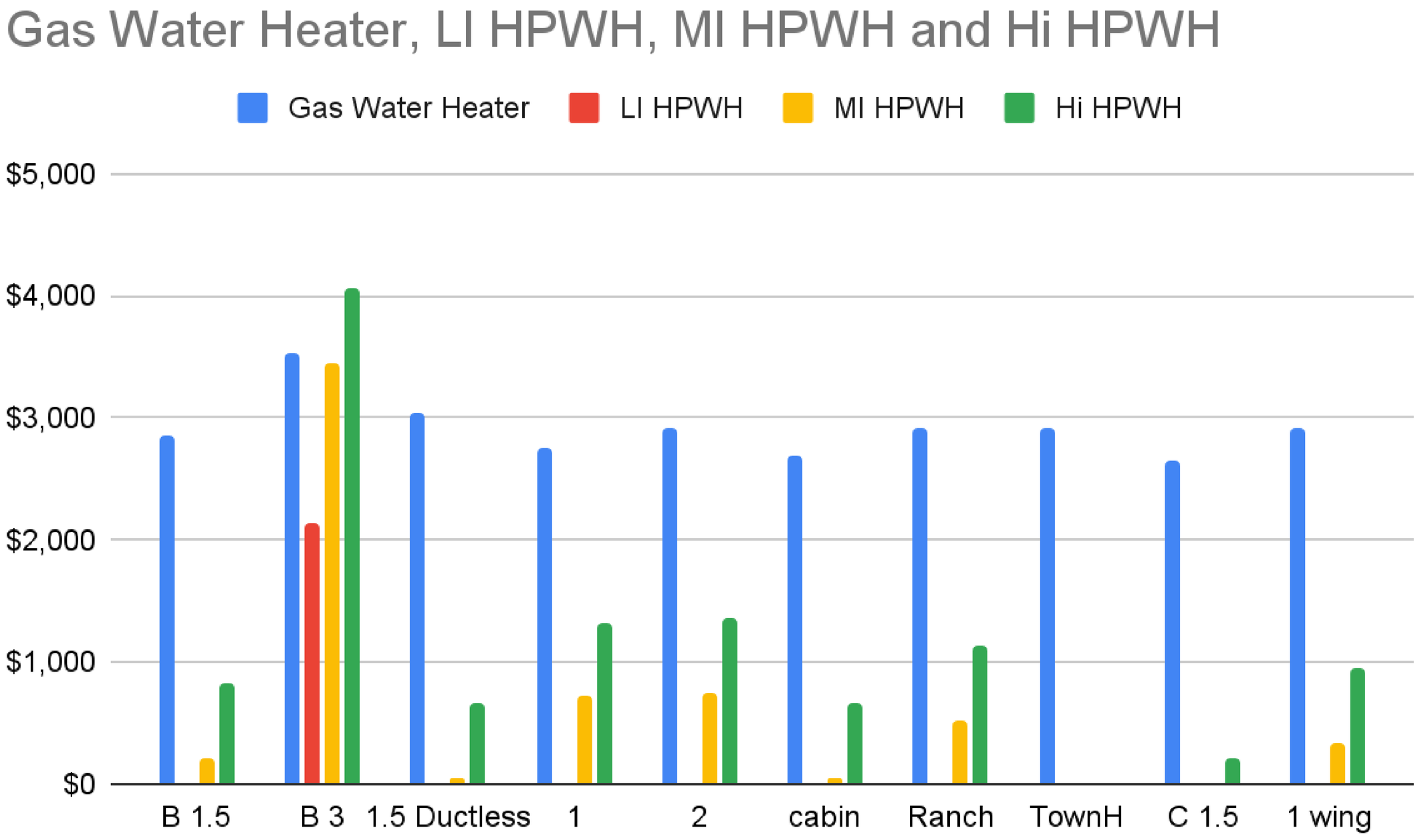
Cost after incentives

Existing Condition	Proposed Electrification	Trade	Applicable Project	Replace Existing (Gas)	DIY Electric	Low Bid Electric	Mid Bid Electric	High Bid Electric
100-amp main electrical panel + 60-amp garage subpanel	100-amp main electrical panel + 100-amp garage subpanel	Electrician	Panel(s)		$921	$921	$3,106	$4,566
No dedicated 240-volt circuits to: water heater, HVAC, range, dryer	4 new 240-volt circuits to: water heater, HVAC, range	Electrician	Circuits		$50	$50	$4,768	$5,300
50-gallon gas water heater	80-gallon heat pump water heater	Plumber	HP Water Heater	$2,754	$0	$104	$1,681	$2,471
80% efficient centrally ducted gas furnace	30,000 BTU centrally ducted heat pump HVAC system w/ MERV 13 filter	HVAC	HVAC	$4,808	$0	$0	$2,564	$4,644
4-burner 30” gas range	4-burner 30” induction range	Electrician	Range/Cooktop/ Oven	$949	$0	$0	$0	$201
7.5 cu ft electric resistance dryer	Optional: 7.4 cu ft hybrid heat pump dryer	None	Dryer	$0	$0	$0	$0	$0
Insulation: attic - none	Insulation: attic - none	Insulation	Attic		$0	$0	$0	$0
Insulation: walls - none	Insulation: walls - R11	Insulation	Walls		$375	$375	$375	$4,854
Insulation: floor - none	Insulation: floor - none	Insulation	Floor		$0	$0	$0	$0
Ductwork: unknown condition	Ductwork: unknown condition	HVAC	Ducts	$0	$0	$0	$0	$0
At-home fueling for: 1 EV [12,000 miles/yr]	At-home fueling for: 2 EVs [12,000 miles/yr]	Electrician	EV Charger		$1,200	$1,200	$1,423	$1,850
SUBTOTAL				**$8,511**	**$2,546**	**$2,649**	**$13,916**	**$23,885**
Rooftop solar PV: none	Rooftop solar PV: 5.8 kW	Solar/Battery	Solar		$15,628	$15,628	$15,628	$15,628
Home battery: none	Home battery: 10 kWh	Solar/Battery	Battery		$8,400	$8,400	$8,735	$13,300
SUBTOTAL					**$24,028**	**$24,028**	**$24,362**	**$28,928**

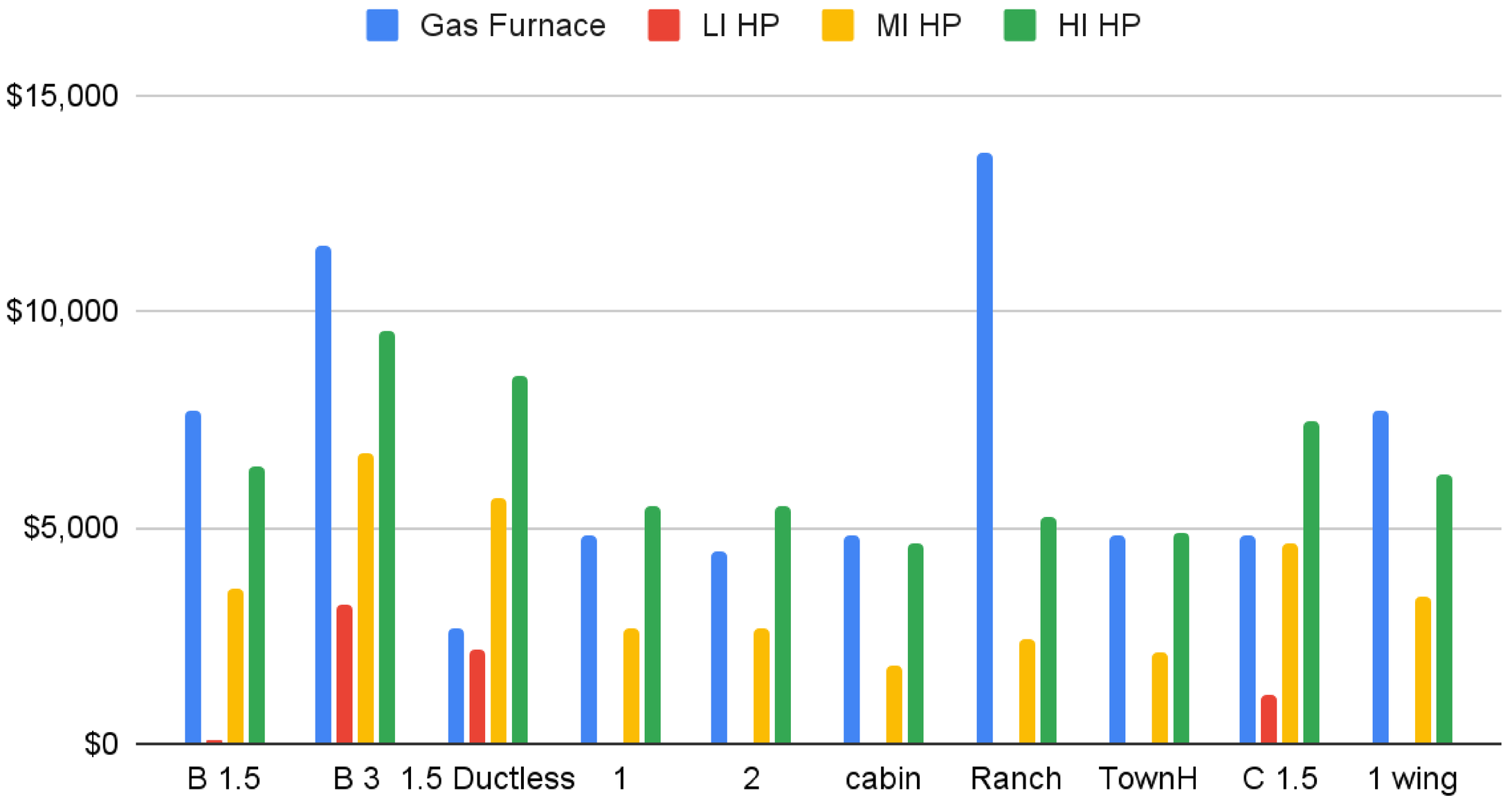
East Palo Alto Home ANNUAL COSTS (w/ LOAN)



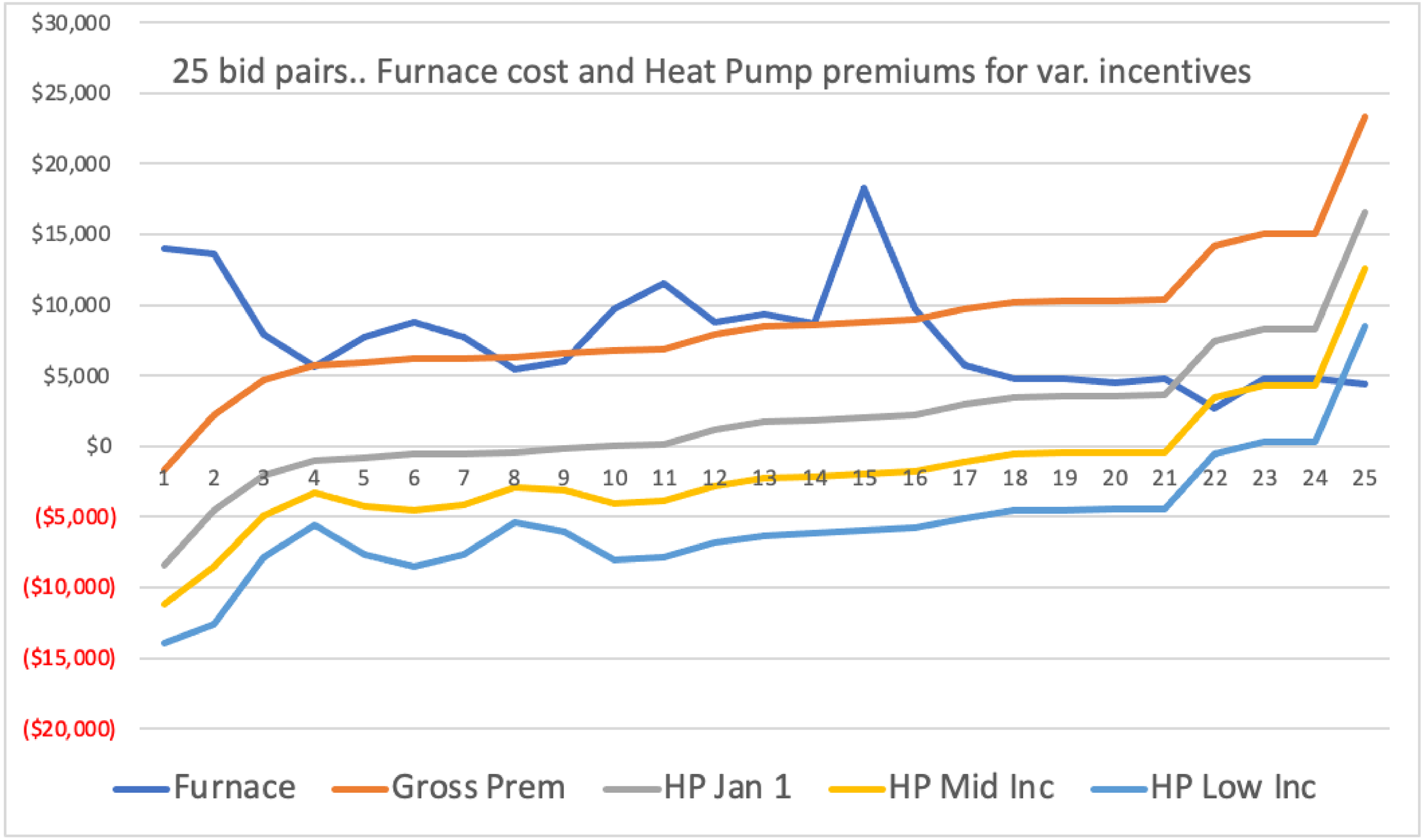
Note: Annual energy costs for Electrified Home include utility electricity payments + loan payment on incremental capital investments for electrification. Escalation rate assumptions for electricty and natural gas rates in PG&E territory and gasoline prices are all taken from the California Public Utilties Commission Report entitled "Utility Costs and Affordability of the Grid of the Future: an Evaluation of Electric Costs, Rates and Equity Issues, Pursuant to P.U. Code Section 913.1", February 2021, p. 73.


Gas Water Heater, LI HPWH, MI HPWH and Hi HPWH
Gas Water Heater
LI HPWH
MI HPWH
Hi HPWH
$5,000
$4,000
$3,000
$2,000
$1,000
$0
B 1.5
B 3
1.5 Ductless
1
2
cabin
Ranch
TownH
C 1.5
1 wing

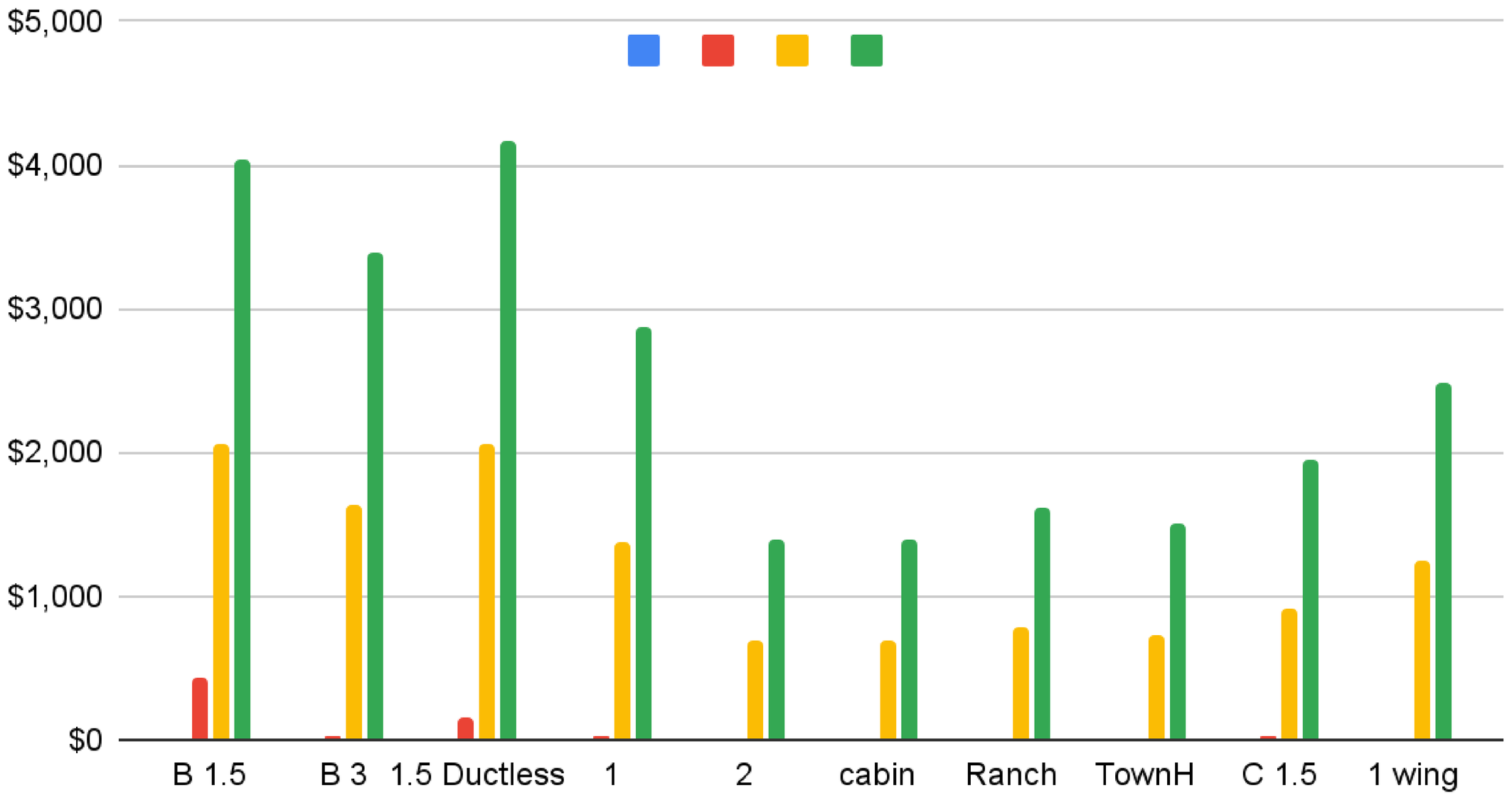
Gas Furnace, LI HP, MI HP and HI HP



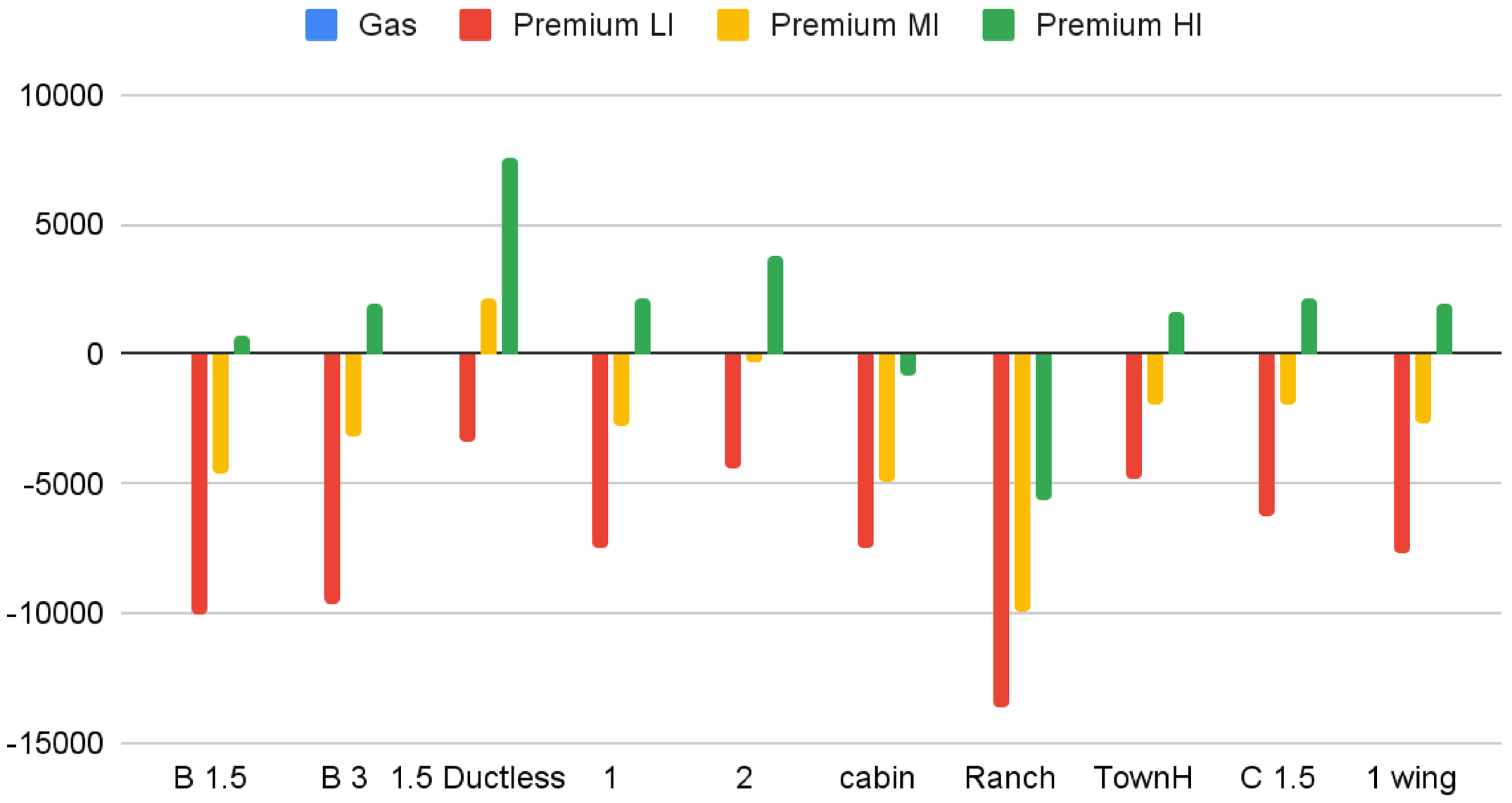
Heat pump costs vs. gas furnaces (same contractor, same home)

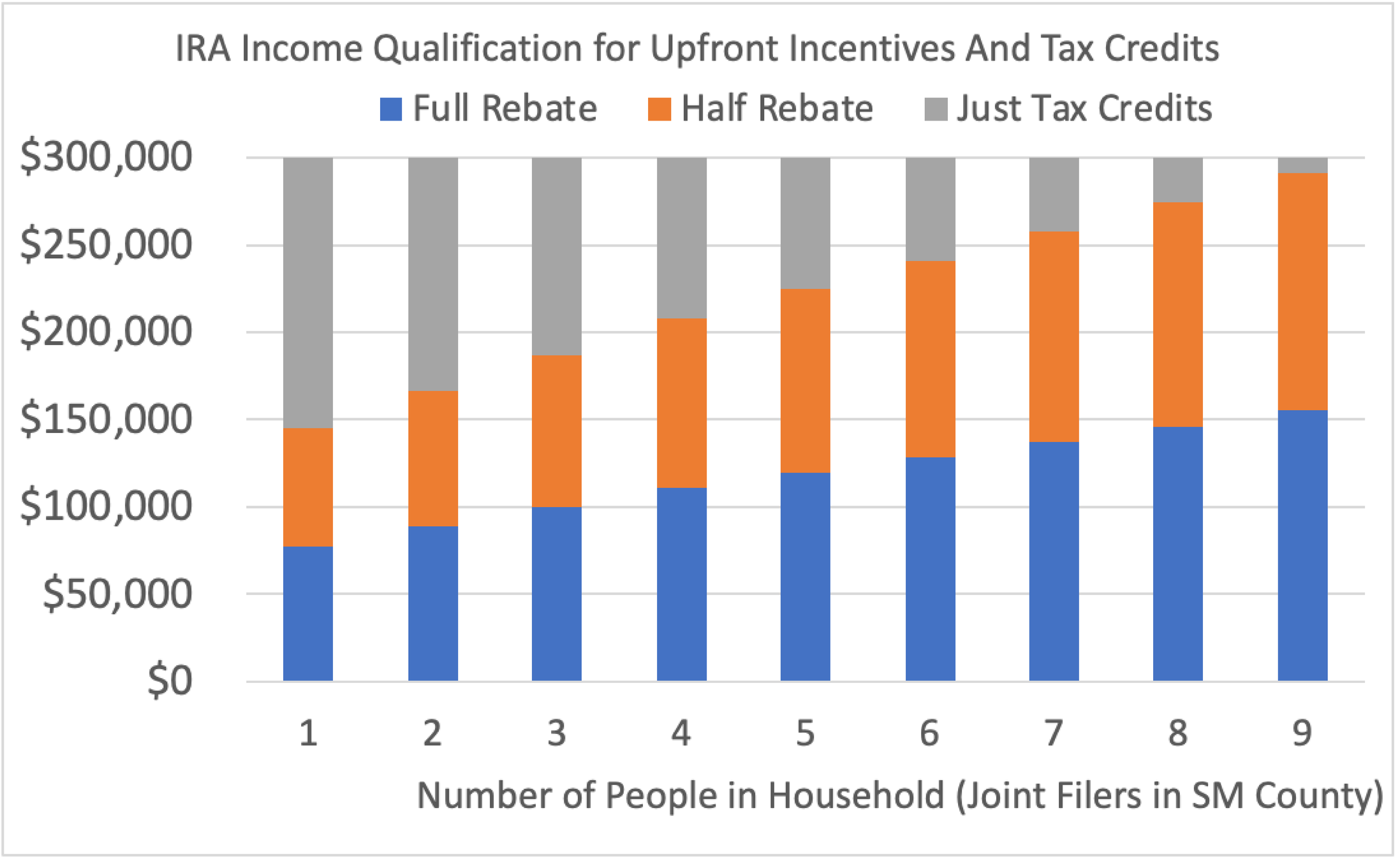


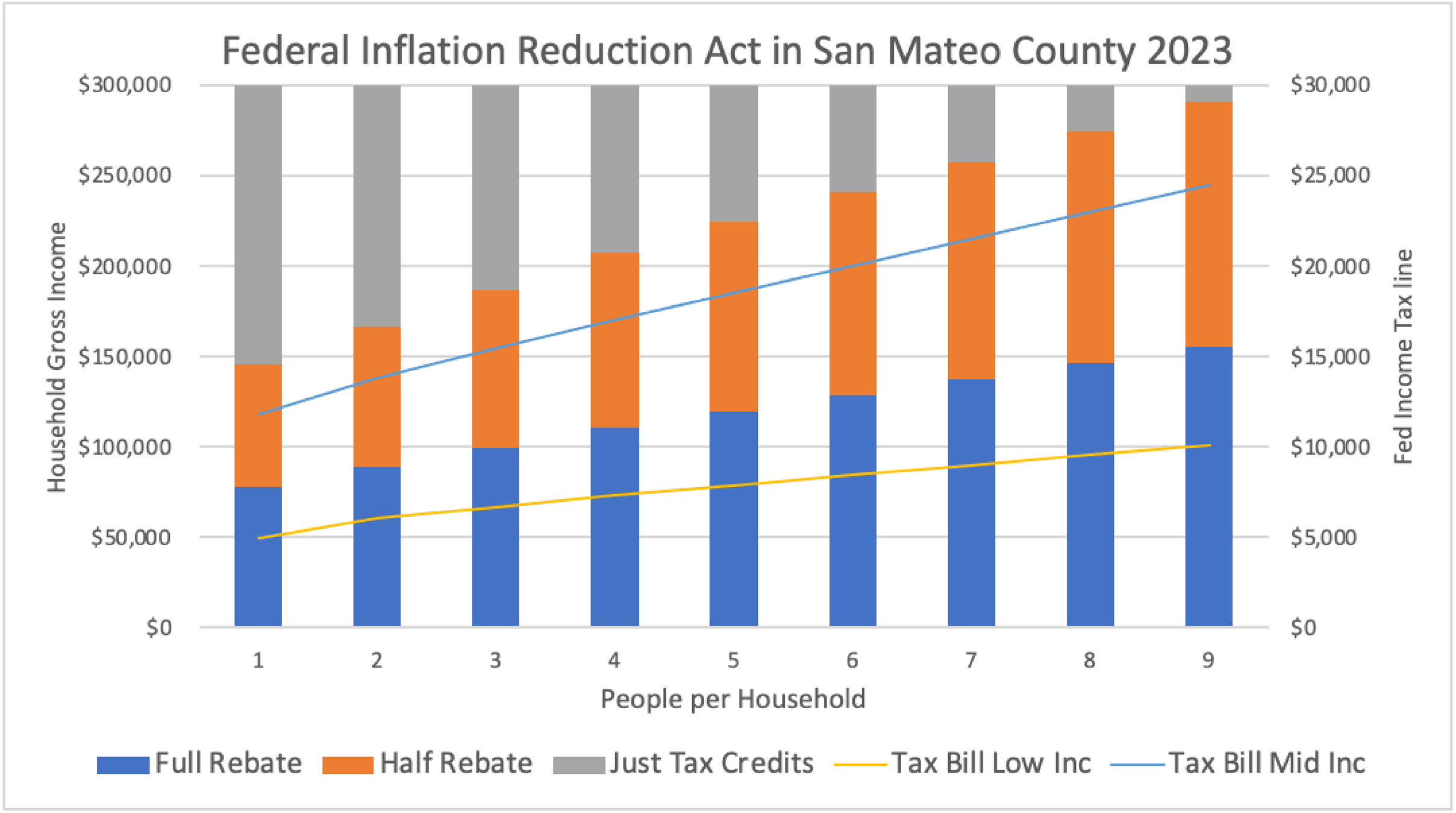
Net Cost of Panels and Circuits for Low, Mid, Hi income homes



Premium to convert circuits, panels, water and space heat




IRA Income Qualification for Upfront Incentives And Tax Credits
Full Rebate
Half Rebate
Just Tax Credits
$300,000
$250,000
$200,000
$150,000
$100,000
$50,000
$0
1
2
3
4
5
6
7
8
9
Number of People in Household (Joint Filers in SM County)


Federal Inflation Reduction Act in San Mateo County 2023
$300,000
$250,000
$200,000
$150,000
$100,000
$50,000
$0
Household Gross Income
$30,000
$25,000
$20,000
$15,000
$10,000
$5,000
$0
Fed Income Tax line
1
2
3
4
5
6
7
8
9
People per Household
Full Rebate
Half Rebate
Just Tax Credits
Tax Bill Low Inc
Tax Bill Mid Inc