Accelerated GHG Reduction with Electrification of Domestic Water

Proven technology for the residential market.

Residential water heating is 25-30% of the total amount of energy consumed.

- Gas fired appliances are not going to be considered in this discussion. Natural gas fired storage tanks are currently the cheapest means of water heating.
- The highest performing choices are Heat Pump Water Heaters (HPWH) or Solar Water Heaters.
- Both HPWH and SWH have slow recovery times and see improved performance with larger storage volumes that allow for thermal stratification of the tank.
- HPWH technology was developed in 1935 and has ebbed and flowed based on electricity rates.

Heat Pump Water Heaters

- Most common are the hybrid variety which utilize a heat pump attached directly to the tank with electric resistance elements as backup.
- Electric resistance elements within the tank are utilized during times that the heat pump can not provide enough hot water from a large draw or when the ambient air is below 45°F or over 120°F.
- Energy Star suggest 1000 cubic feet of surrounding air or 12’x12’ for peak performance. NREL found in a 2016 study 10-16% reduced efficiency in confined space.
- According to Flagstaff Research HPWH require an additional 1KW of PV to offset the increased electricity.

Heat Pump Water Heaters

- The Coefficient of Performance (COP) for most units is 2-3 meaning for one unit of energy consumed by the compressor 2-3 units of energy are put into the water. At $0.10/KWH units will cost $33.50 per month to operate.
- The expected life for a HPWH is 15 years and the refrigerants need to be recovered properly. EPA licensing is required to recover refrigerants.
- Flagstaff Research study saw 81% GHG reduction.
- The only EWH’s with Energy Star Ratings are HPWH’s.

Flagstaff Research
Assessment of GHG Reduction Technologies for Water Heating Electrification in California

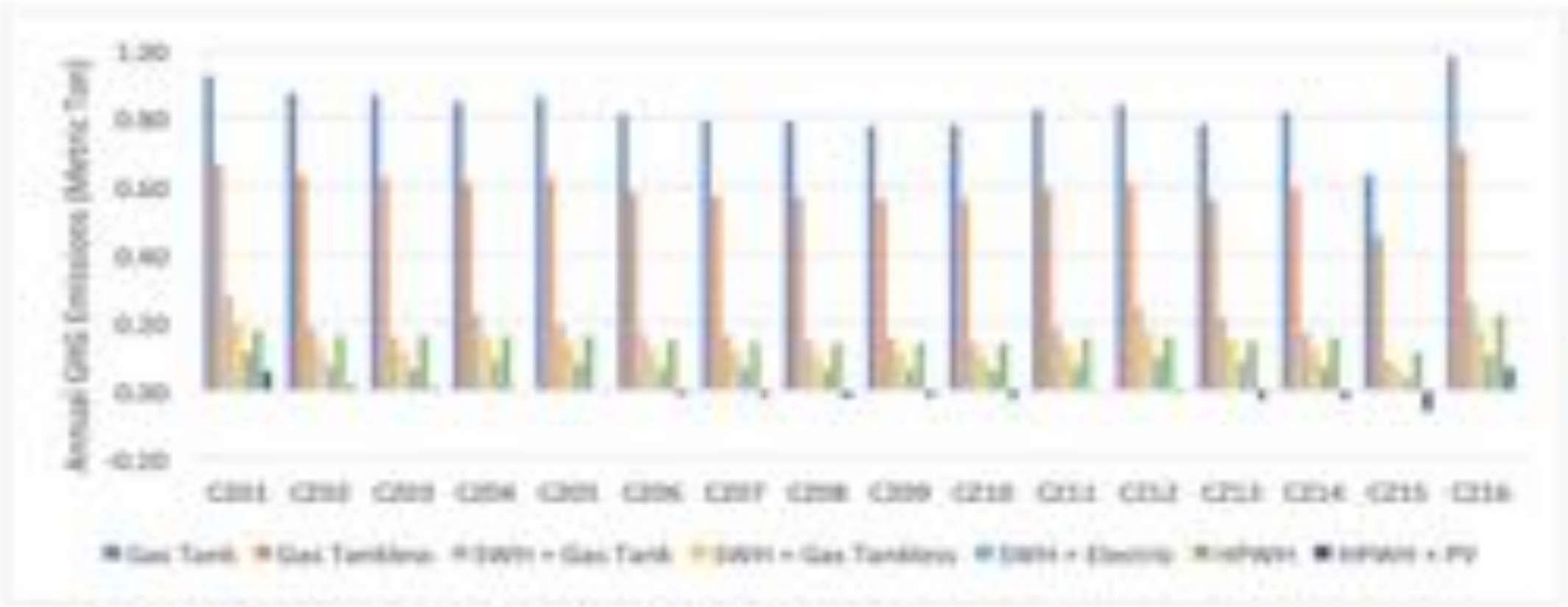

Figure 28. Annual GHG emissions for residential water heating configurations.

Solar Water Heaters

- Solar thermal collectors have been in operation since the late 1800's with many variations to capture the sun's energy. Popularity is closely tied to energy cost and subsidies.
- Modern systems often utilize small circulators that provide for incredible Coefficients of Performance between 20-30 meaning for every unit of energy used by the system 20-30 units of hot water.
- SWH on average will cost $10/month to operate with an electrical rate of $0.10/KWH.
- Cali study saw 90-91% GHG reduction

Solar Water Heaters

- Collectors are often mounted on the roof, piping is routed through the home, controls are rarely plug and play requiring skilled labor.
- Solar storage tanks have an expected life of 15 years and collectors of at least 25 years.
- SWH often achieve temperatures over 140°F killing legionella bacteria.
- Installed cost for SWH ranges from $5,00 -$10,000.

Superior Performance of SWH

Solar Thermal System Configuration:

- 946.6 ft^2 of collector array.
- 800 gallon of solar storage.
- 3 x Grundfos UPS 26-150 Pumps.
- Resol DeltaSol MX Controller.

Monitoring:

- Pump electrical usage: Shark 100 kWh meter.
- Energy calculation: Spire TMAG BTU meter.

System Performance:

- Solar loop run time: 4,180 hours
- Total Pump Energy Consumption: 112 therms
- Total Solar Production: 2,690 therms
- System COP $= \frac{2{,}690}{112} = 24.02$

Operating Cost for Residential DHW in California

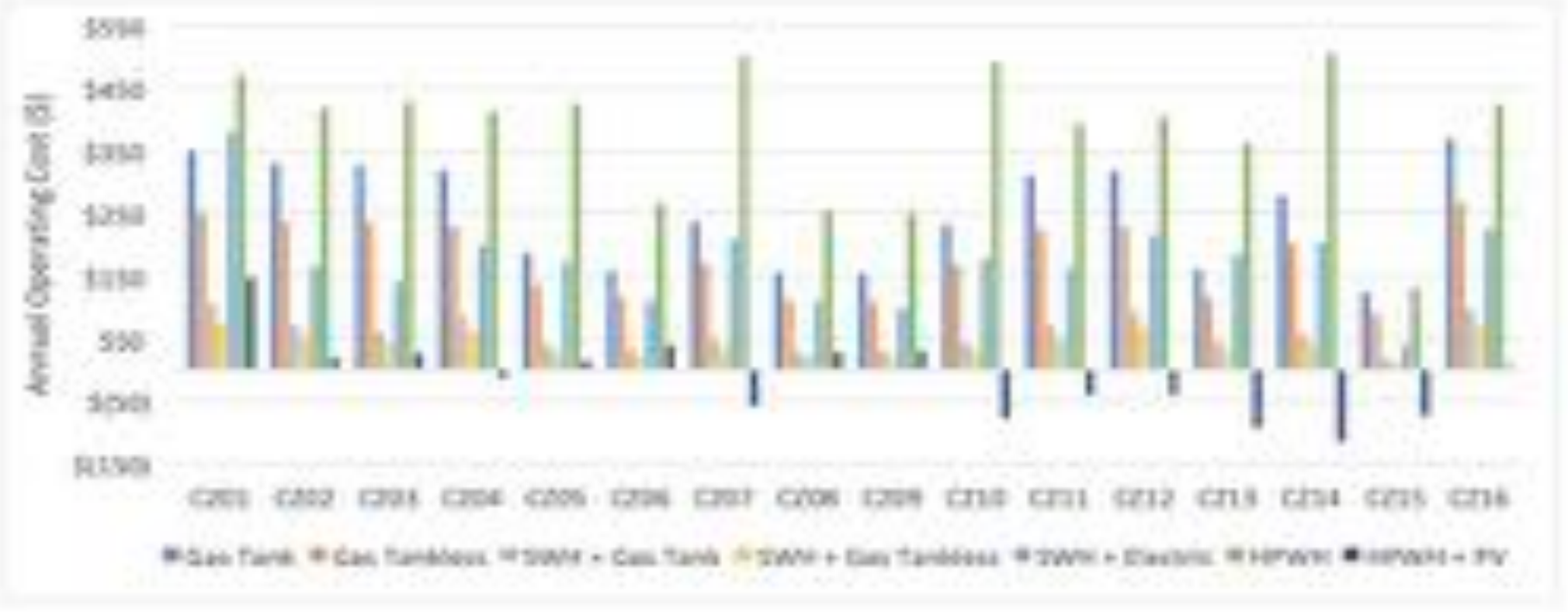

Figure 20. Annual operating costs for residential water heater configurations.

Future Now – Multi Energy Tanks

- Multi Energy Thermal Storage Tanks will allow for Heat Pumps, Solar Thermal, Biomass, PV to integrate with each other.
- Onsite consumption shortens ROI time line for PV

Actions for Impelemantion

- Skilled trades people are needed and programs that provide work/learn pathways with an applied science science approach.
- Partnering with stake holders to strengthen codes through ICC/IAPMO.
- Standardization of ratings for HPWH and SWH to allow for easier consumer decision process.
- Domestic production or easier importation of multi-energy storage devices.
- Consumer education.

Sources:

- **Assessment of GHG Reduction Technologies for Water Heating Electrification in California ,**J.R. Plaisted – Flagstaff Research November 2020
- https://www.energystar.gov/products/high_efficiency_electric_storage_water_heaters/considerations
- **NREL, Field Performance of Heat Pump Water Heaters in the Northeast**

Carl Shapiro and Srikanth Puttagunta,*Consortium for Advanced Residential Buildings,* February 2016

Sunearth presentation on Pressurized or Unpressurized Solar Thermal Systems.