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Tune Up Your House™

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Portola Valley Home Energy Study Report

During March and April of 2008, energy evaluations were performed on five homes in Portola Valley. The findings are reported collectively below.

Home Profiles

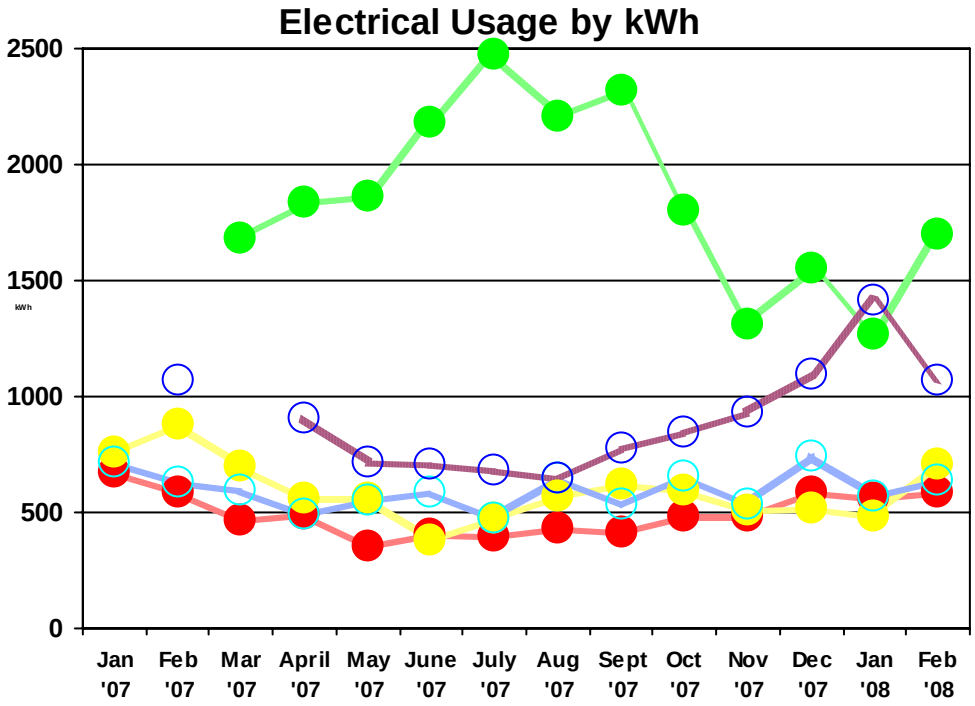
	Square Footage (approx.)	Year Built	Neighborhood	Occupants	Description
Home A	2480	1976/1995	Woodside Highlands	2 adults, 2 children	2-story
Home B	2300	1978	Portola Valley Ranch	2 adults	1-story, flat-roof
Home C	7800	1968	Westridge area	2 adults, 3 children	2 story, cathedral ceilings
Home D	3500	1954 & additions	Alpine Hills	1 adult	1 ½ story, flat-roof
Home E	4200	2001	Alpine Hills	3 adults	2 ½ story, built into hillside

Utility Use:

Analyzing the homes collectively, the mean utility data is provided in the chart below. Home E is not shown in the electricity data below because its photovoltaic array skews its results.

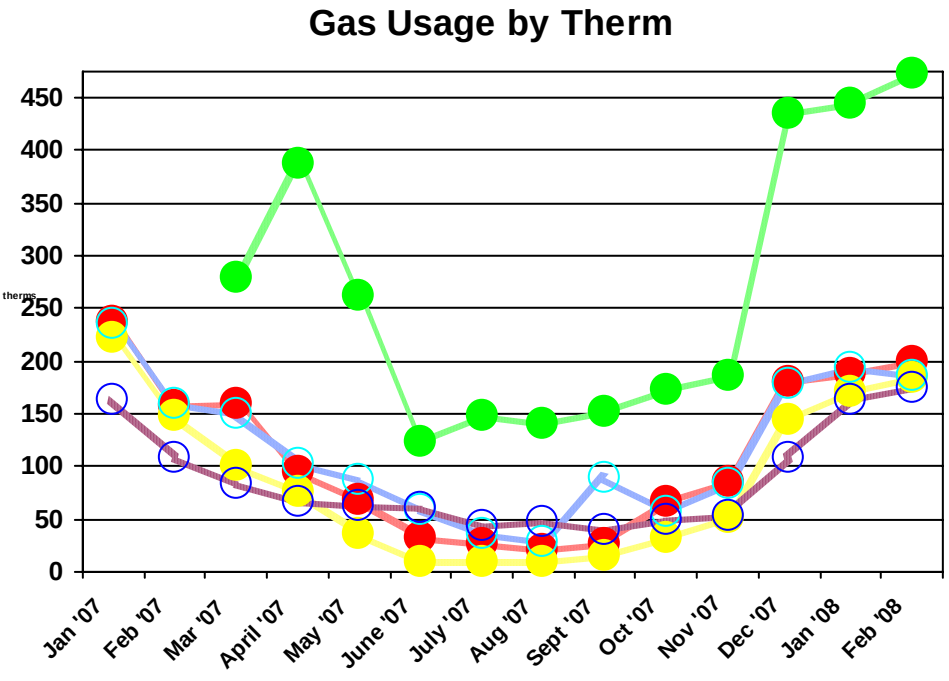
Utility Usage Overview	Electricity - Homes A, B, D		Electricity - Home C		Gas		Water
	$	kWh	$	kWh	$	therms	ccf
Average peak mid-winter monthly utility charge	$140	715	$330	1,314	$360	244	7
Average peak mid-summer monthly utility charge	$55	446	$771	2,471	$73	49	50
Peak seasonal differential (peak season less baseload)	$85	269	$441	1,157	$287	195	43

This chart shows the difference between baseload utility use and peak utility use. The white cells are primarily baseload, yellow cells are peak use, and blue cells are the difference between baseload and peak use. For example, electricity use in homes A, B, and C costs an average of $55 per month mid-summer, when lighting use is at its minimum. In mid-winter, when lighting use is greatest, these homes average $140 per month in electricity charges.

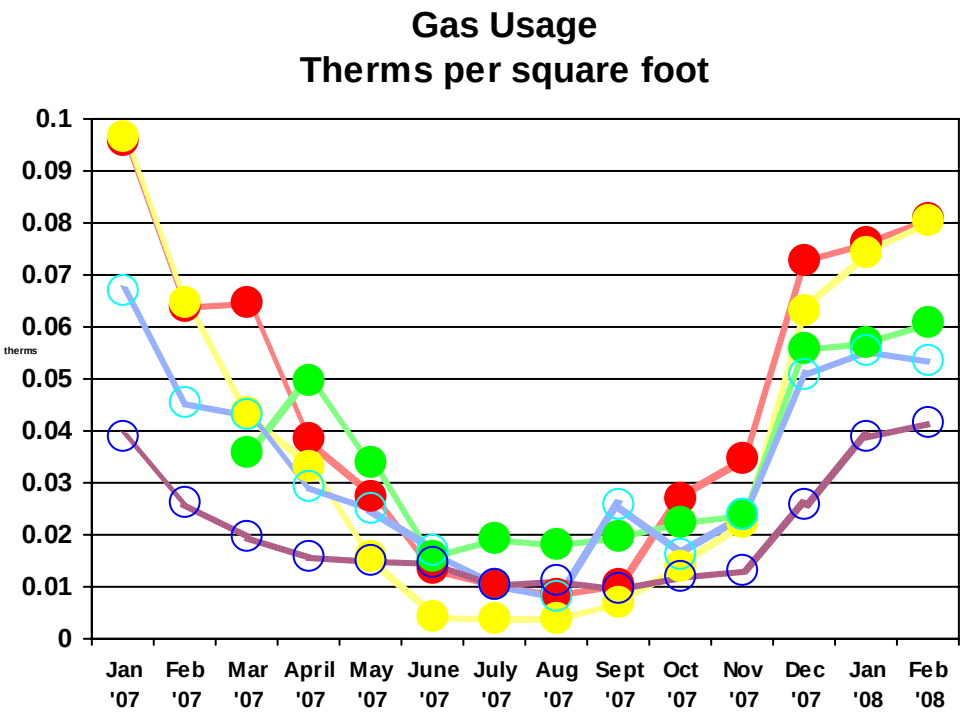


Four of the homes experience a seasonal increase in electricity use in the winter due to more extensive use of lighting. The fifth home (green line) experiences increased electricity use in the summer, possibly due to the increase in pool filtration. Note home E (purple line) installed solar photovoltaic panels in May; the numbers here are electricity purchases from PG&E not including electricity generated from the photovoltaic system.

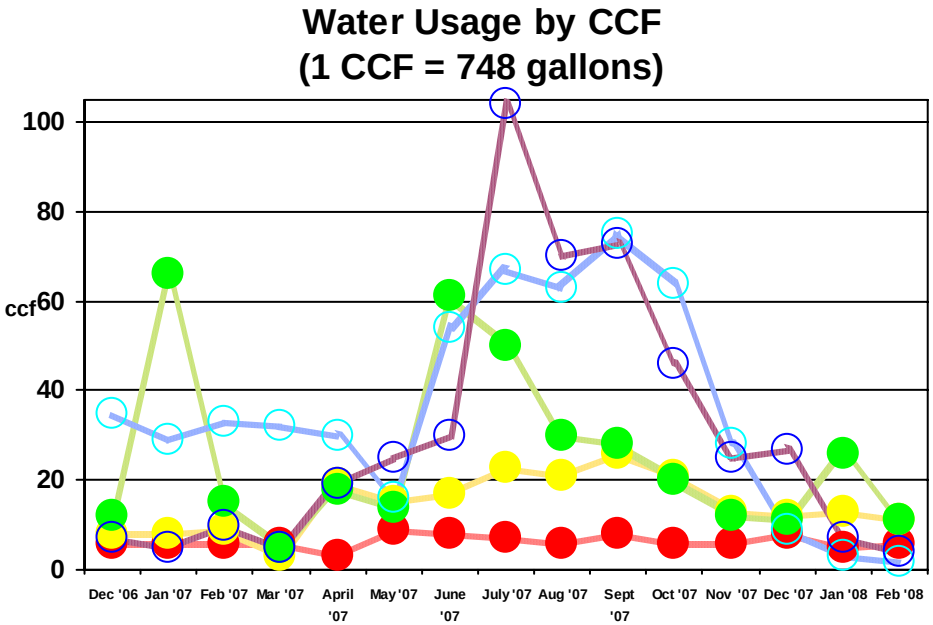
All five homes showed an expected substantial increase in natural gas use during the winter months. During the summer, three homes use only 16-26 therms of natural gas (yellow, red, and blue lines), one home (purple line) uses approximately 45 therms, while the fifth home (green line) uses approximately 152 therms. The home with the notably higher summer gas use (green line) has two hot water heaters and a gas heater for their pool and spa.



The newest of the homes (purple line) has a relatively high baseline gas use of 44 therms during the summer, but uses the least amount of gas during the winter.



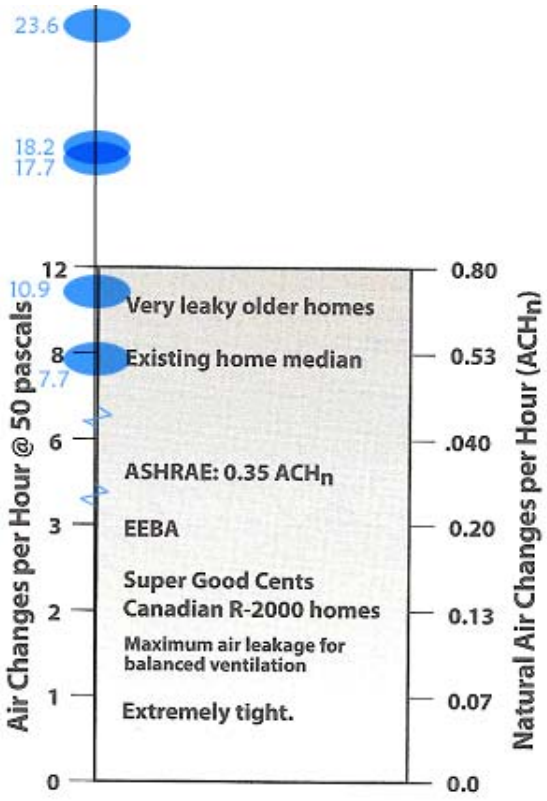
Natural gas usage can also be evaluated on a therms-per-square-foot basis. Looking at the gas use per square footage of home, the notably larger Home C (green line) is using a gas-per-square-foot rate that is comparable to the other homes. This would indicate that Home C is not performing more poorly than the other homes, just that heating a much larger home utilizes much more natural gas.



One family of four (red line) consistently uses approximately 6 ccf of water each month, equivalent to approximately 4,500 gallons; this home increases water use only approximately 2 ccf during the summer gardening season. A second home with two family members (yellow line) uses about 12 ccf of water as their baseline with increases of up to 9-14 ccf during summer months. One family of three (purple line) uses only 5 ccf as their baseline in the winter, but uses up to 104 ccf in the summer. The two homes with swimming pools (blue and green lines), also use about 3 and 12 ccf of water as their baselines, but experience major peaks of water use, using over five times their base water use; it is suspected that these are related to pool maintenance.

Sealing:

- A blower-door test was performed to measure overall air leakage of the homes and identify specific areas of leakage. Four of the five homes can be categorized as "very leaky". However, one home's air leaks are coming predominantly from its unducted air return; installation of a sealed return duct may result in that home performing substantially better on air leakage testing. A second home, if air leakage areas are corrected, could likely achieve "existing median" leakage or better.
- Most of the homes have unsealed recessed lights, plumbing penetrations, and/or electrical penetrations between the conditioned portion of the home and the attic or roofing structure. Recommendation: Replace unsealed recessed lights with recessed lights that are air-tight and rated for contact with insulation ("ICAT"), then caulk at the connection with the ceiling. Alternatively, but less preferably, construct a sealed box of drywall, plywood, or foam board over the top of the recessed lights, providing 6" clearance between the light fixture and the box, then insulate the box. Seal all plumbing and electrical penetrations both from inside the home and from the attic and crawl space.



Portola Valley homes indicated in blue. Underlying graphics © John Krigger & Chris Dorsi, *Residential Energy* (2004).

- Four of the five homes have air leakage through the fireplace. Recommendation: Install a sealed-combustion fireplace insert. Less preferably, utilize a fireplace plug, such as the "Draftstopper" inflatable fireplace plug.
- Several of the fireplace dampers on tested homes were found in the open position. Recommendation: Close the fireplace damper the morning after the fireplace was used. If remembering to re-open the damper is a problem, utilize a "damper closed" damper handle sign.
- All five homes have air leakage around one or more door. Recommendation: Doors to the exterior and to any garage or vented utility closet should be well sealed with weather stripping and/or sealing thresholds.

- One home has a dog door with substantial air leakage around the edges. Recommendation: Replace existing dog door with a model that provides a better closure at the edges. Any pet opening that is no longer being used should be sealed shut.
- Each of the homes has air leakage through electrical outlets and light switches. This is air from the crawl space, attic, or outside the home that enters the wall cavity and then enters the home through

the outlet or switch plate area. Recommendation: Although not a large source of air leakage, these leaks can be remedied easily by adding foam gaskets under the switch plates.

- Two homes have air leakage around the molding surrounding one or more windows. Recommendation: Window frames should be checked for separation and caulked to reduce air infiltration.
- Four homes have air leakage through bathroom fans. Recommendation: The outside end of the fan duct should be checked to confirm that a gravity flapper closes the fan duct when not in use. The recessed portion of the fan should be sealed from the attic side and insulated.

- One home has dryer and bathroom fan exterior vents that appear to be blocked open. Recommendation: Assure fan and exhaust vents have functioning gravity flappers to close the vents when exhaust air is not being released. Dryer vents should be checked for excess lint buildup annually.
- One home has an unsealed, interior-style door between the home and its attached garage. Recommendation: The interior-style door should be replaced with an exterior-style door with a good seal, to reduce air infiltration from the garage and comply with fire safety codes.
- One home has tubes leading out of the ceiling of upstairs bedrooms and through the roof, the purpose of which was not clear.

Insulation:

- Two of the five homes have accessible attic insulation consisting of fiberglass batts. The average insulation level is low, though – approximately R-12 in insulated areas. One home has a substantial number of misplaced or missing insulation batts. One home has a largely-uninsulated skylight shaft. Two homes do not have accessible attics but are believed to have insulation above the home. Recommendation: Insulate accessible attics to at least R-38; if adding additional insulation, the marginal cost of insulating up to R-50 is relatively small, so R-50 is recommended. Existing attic batt insulation can be moved aside to assure all openings are sealed, then the insulation batts replaced, and loose cellulose insulation can

be blown over the top of the older insulation batts. A netting enclosure can be constructed around skylight shafts in order to contain blown-in insulation and fully insulate the shaft. Drywall or plywood dams can be constructed to prevent loose-fill insulation from dropping onto horizontal attic hatches.

- At the two homes with attic hatches, neither hatch is sealed or insulated. Another home has uninsulated crawl space hatches. One home has a vertical hatch without a handle, making access difficult. Recommendation: Seal and insulate attic hatches and crawl space hatches from conditioned portions of the home. Weather-stripping can be utilized around the edges, and layers of insulation board or fiberglass batts can be attached to the back of the door or hatch to insulate it. Handle or loops should be installed on access doors to enable access.
- Four of the homes have known or believed presence of wall insulation. It is not known whether the remaining home has wall insulation. Recommendation: Wall insulation can be checked or confirmed by drilling one or more holes in the wall. Where wall insulation is present but insufficient, depending on the type of insulation, it may be possible to retrofit additional loose-fill insulation into the wall cavity. Insulation can be retrofitted either from the inside or the outside of the home. One or more holes would need to be drilled in each stud bay to insert the insulation tubes, so it should be anticipated that the home will need to be repainted afterwards.

- Four of the homes have fiberglass batt insulation underneath the house. Three of the four homes had insulation batts missing or fallen from their intended locations. Recommendation: Re-attach or replace the missing or fallen insulation batts. Determine whether additional support is needed for other batts. Insulation batts must be in direct contact with the structure to be effective.

Furnace:

- Three of the homeowners reported having cleaned or changed their furnace filters within the last year. It is unclear how long it has been since the filters on the fourth home have been cleaned or replaced. (The fifth home has only radiant heat and a rarely-used air conditioning system.) Recommendation: Furnace filters should be cleaned or replaced every 6 months if there are no pets in the home, and every 3 months if pets live in the home. If replaceable filters are used, they should be pleated filters but not HEPA filters, which add too much static pressure to the furnace system. For example, instead of using the $15 Filtrete Ultra Allergen Reduction Filter in the purple packaging, use the $10 Filtrete Micro Allergen Reduction Filter in the red packaging.

- One of the homeowners reported having had their furnace inspected or serviced within the last year. Recommendation: Have the furnace inspected, cleaned, and "tuned up" annually.
- Four of the five homes have one or more programmable thermostats. One home uses a thermostat program that keeps the main portion of the home at 68° F during times when the family is present and awake, 65° when it is anticipated people will not be home, and 58° during the night; the sleeping area is kept at 63° at night, 65-70° during the morning, and 65° during the day. One homeowner manually sets the thermostat to 68° when awake and present, and turns the furnace off when sleeping or away. A third home has a program only partially entered, and manually sets the thermostat at 67°. Recommendation: If comfortable, try programming the thermostat for 68° when people are present and awake and 55-60° when people are not present or are not awake. The thermostat should be programmed to turn on the furnace at the "awake" setting early enough to warm the home by the time the family gets up in the morning; if the furnace takes a long period of time to re-warm the home, it is more efficient to set the thermostat to turn the furnace on earlier than to install a larger furnace. If the furnace cannot adequately recover from a large temperature set-back, increase the set-back temperature or decrease the time period of the set-back. When optimally sized, a furnace should run almost continuously during the coldest day of the year. Over-sized furnaces perform less efficiently than those that are properly sized.
- Two of the homes have furnaces located in closet space inside the conditioned area of the home and utilizing air vents from the outside to provide combustion air. The ventilation grilles on one home's utility closet are insufficiently sized and clogged with dust. Recommendation: Utility closets containing combustion equipment should be considered "outside space" and should have floor, wall, ceiling, and door sealing and insulation between the closet and the conditioned areas of the home. At the same time, it must be assured that the venting and grilles providing the combustion air are sufficiently sized and kept clear and clean in order to avoid choking the combustion flame, which would decrease combustion equipment efficiency and increase the production of carbon monoxide.

- Two of the three homes have uninsulated air handler plenums. Recommendation: Air handler plenums (the metal boxes just before and after the furnace) should be sealed with mastic, or less preferably with metal tape, and should be insulated with fiberglass batts or fiberglass ductboard.

- Four of the five homes have unsealed plumbing and/or ducting penetrations between the utility area and the conditioned portion of the home. Recommendation: Seal duct, plumbing, and electrical penetrations from both the exterior and interior areas to reduce air leakage.

- One of the three homes has a photovoltaic system producing electricity. Recommendation: If electric bills are over $150 per month, consider installing a photovoltaic system to produce electricity if the home's shading and roof configuration are appropriate. For the home using 1,200-2,500 kWh per month, the pay-back time on a properly-sized system should be appealing.

- Only one home has an air conditioning system, and it is only used for approximately one week each year. This home also has several ceiling fans. Recommendation: Ceiling fans should only be used when people are present in the room, as the use of the fan contributes to the heat load of the room and only adds comfort by blowing air over the skin. Utilize window shades and nighttime cooling to reduce the need for air conditioning. Assure the air conditioning unit is properly charged with coolant and that sufficient space around the condenser is provided for proper air flow.

Heat Ducts

- Analyzed homes with heat ducts have moderately to extremely leaky duct systems. Bands of discoloration on duct insulation at one home show locations of duct leaks. Recommendation: An HVAC contractor should use mastic to seal all seams and connections in the air ducts and plenums. An alternative to using mastic to seal from the outside is the Aeroseal duct sealant system, in which aerosolized adhesive is blown into the duct system to seal leakage from the inside. The HVAC contractor should also seal all duct "boot" connections to the walls and floors where they enter the home.

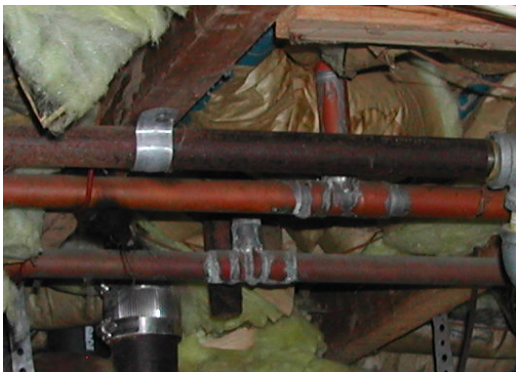
- Two of the homes have fully or partially unducted returns: the return air travels from the interior of the home through a wall cavity back to the furnace instead of traveling through a sealed and insulated

duct. The unducted returns allow substantial air infiltration, provide no insulation to preserve existing air temperature, and may introduce outside air or crawl space air into the return air system. Recommendation: Retrofit unducted returns with sealed and insulated return ducts.

- All four homes with ducted heating have insulation on most of the heat ducts, but all four also have areas where duct insulation is missing or has fallen off. Recommendation: An HVAC contractor, after sealing the ductwork, should install or re-install fiberglass insulation on all ducts and plenums.

Water Heater:

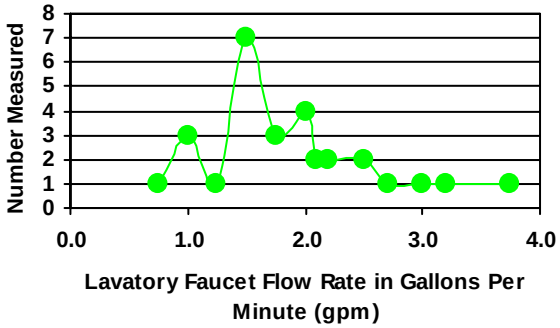
- Four of the five homes have a water temperature at the kitchen tap that slightly exceeds the recommended 120° F. Measured temperatures were 104°, 121°, 124°, 127°, and 136° F. Recommendation: To reduce standby losses from the water heater (and reduce the risk of scalding) keep the water heater set to produce water no hotter than 120° F at the nearest tap.
- With the exception of the home built in 2001 and the radiant heating in another home, almost none of the hot water pipes in the homes are insulated. Recommendation: Insulate hot water pipes wherever they are accessible, including in the attic, crawl space, utility room, and under sinks. Also insulate the three feet of cold water line closest to the water heater.

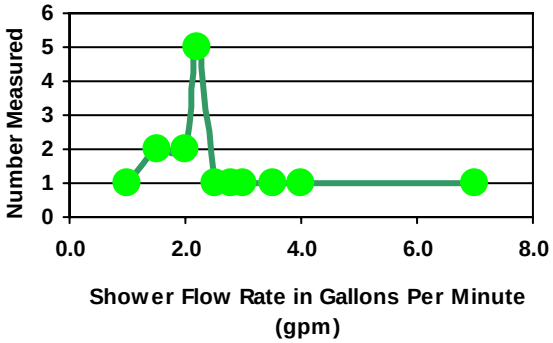


- All of the homes have unsealed openings around plumbing lines, including under the kitchen sink, under bathroom sinks, from the crawl space into the floor structure, and from the water heater area into adjacent walls. Recommendation: Seal plumbing penetrations from outside and inside the conditioned area to reduce air leakage.
- None of the homes has a solar thermal hot water heating system for domestic hot water. One of the homes has a solar thermal system for heating pool water. Recommendation: Consider installing a solar thermal system to heat domestic hot water. If the home has a pool that is heated, it should have a solar water heating system for the pool.

Faucet and Showerhead Flows:

- All of the main kitchen sinks have low-flow kitchen aerators using less than 2.5 gallons per minute. Measured kitchen faucet flow rates are 1.0, 1.2, 1.7, 1.7, 2.0, and 2.2 gallons per minute. One home has a secondary "vegetable sink" faucet without a low-flow aerator; it flows at 4 gallons per minute. Recommendation: Install a low-flow aerator allowing 2.5 gpm or less on any kitchen sink that is not used exclusively for filling pots of water.
- Only 4 of the 29 measured bathroom faucets provide flow greater than 2.5 gpm. Recommendation: Install low-flow aerators on faucets that use more than 2.5 gpm, and consider them for faucets using more than 2.0 gpm. Standard faucet flow at bathroom sinks is 2.2 gallons per minute, and homeowners are usually satisfied with a flow rate of 1.0-1.5 gpm.
- Of the 16 showerheads analyzed, 5 provide flow greater than 2.5 gpm. Recommendation: All showerheads now manufactured in the U.S. must restrict flow to 2.5 gallons per minute (gpm) or less. Replace any using more than 2.5 gpm.





Toilet:

- Of the 22 toilets analyzed, three show indications of leakage, 17 use 1.6 gallon-per-flush (legal maximum for toilets sold now), and 5 are estimated to use greater than 1.6 gallons per flush. Recommendation: Replace older toilets with modern models that use only 1.6 gpf. Better yet, install a dual-flush model using 1.0 gpf for the "fluids flush" and 1.6 gpf for the "solids flush" or an ultra-low flow model using 1.28 gpf. Refer to Maximum Performance ("MaP") testing results, available from the California Urban Conservation Council, to assure you are purchasing a model with a good performance rating.

Refrigerator:

- Three of the homes use one refrigerator/freezer. One home has a second refrigerator, and one home has a secondary refrigerator as well as a wine chiller.
- All but one of the refrigerator temperatures measured were within the recommended range of 38-42° F; one refrigerator was cooled to 35.4° F. Recommendation: Set refrigerator temperature to obtain a temperature of 38-42° F.
- Four of the measured freezer temperatures are within the recommended range of 0-10° F; two freezers were set unnecessarily cold at -10.1° and -1.7 ° F. Recommendation: Set freezer to obtain a temperature of 0-10° F.

- Two of the homes' refrigerator coils have been cleaned within the last year. Recommendation: If refrigerator coils are accessible, brush the dust off of them annually to improve efficiency.
- None of the refrigerators are notably old or in poor condition. One refrigerator is approximately 12 years old and not an Energy Star appliance, though it is marked "energy efficient." Recommendation: Replace and dispose of any refrigerator more than approximately 15 years old. Install an Energy Star refrigerator. Avoid models with water or ice dispensed from the door, as these perform less efficiently. Bear in mind that larger refrigerators use more energy. To evaluate the efficiency of your existing refrigerator, enter your model number into the Refrigerator Retirement Savings Calculator at EnergyStar.gov.

Dishwasher:

- Three homeowners heat-dry dishes all year. Another homeowner sometimes heat-dries and sometimes air-dries. The third uses the "Energy Saver" setting on the dishwasher. Recommendation: Use energy efficiency settings and air dry dishes when feasible. Consider energy efficiency when replacing the dishwasher, as some models use notably less water and electricity than others.

Washing Machine and Dryer:

- One home uses 50% hot/cold laundry loads and 50% cold/cold loads. Two homes uses mostly or completely cool/cool. Recommendation: Use cold water for all washing except white loads; use warm wash and cold rinse for white load if warm water is necessary.
- Three homes use efficient front-loading washing machines and the other two homes use top-loading models. Recommendation: Replace top-loading washers with Energy Star labeled front-loading models, to save on water, energy to heat wash water, and energy to dry the damp clothes.

- One homeowner drip-dries all laundered clothes instead of using a dryer. Recommendation: Drip-drying is a great way to save energy. To avoid adding to the moisture load of the home, try to drip-dry clothes outside or in a garage area.

Lighting:

- One home has already done an impressive job of replacing incandescent bulbs with fluorescent bulbs; another home has begun replacing incandescents. The other homes have many opportunities to replace incandescents with energy-efficient compact fluorescent bulbs, including in traditional shapes, globes, floods, and dimmables. Recommendation: Replace incandescent bulbs with compact fluorescents.

Passive Loads:

- None of the five homes utilize timers or power strips to turn off power to computer peripherals or audio-visual equipment when not in use. However, many of the measured passive loads were not problematically high. Certain measured passive loads – with the equipment turned off but plugged in – are listed below. Recommendation: Turn off computer equipment when not in use; replace older TVs with Energy Star labeled models; consider utilizing an accessible power strip to turn of whole systems of AV equipment or computer peripherals when not in use.

TV and related equipment, collectively	19 watts	Modem	3.5
TV, traditional	12, 8, 2; 3; 0; 0	CD player	1-2
Wide-screen TV	10, 0	Cell phone charger	0
Laptop	7	External hard drive	0
VCR	5, 1		

Pool Equipment:

- Two of the five homes have a functioning pool and spa. At one home, the pool cover and insulated spa cover were in use at the time of the audit, but pool covers were not in use at the other home. One home's pool and spa equipment includes several single-speed pumps; the other home's equipment includes an efficient variable-speed motor. Recommendations:
    - Modify pool filtration timer settings to filter the shortest amount of time that results in a sparkling clean pool. Although filtration times vary based on pool size, use, and debris quantity, the California Swimming Pool Industry Energy Conservation Task Force recommends reducing filter operating times to approximately four hours per day during the summer and two or three hours per day during the winter. Filtration can be set to occur at various times during the day.
    - A pool contractor with training in energy efficient pool equipment should be consulted regarding upgrading existing pumps and motors. New, multi-speed motors may be utilized to perform more efficiently. For example, according to PG&E statistics, a ¾ horsepower, 1.5 SF motor, like the AO Smith pump in one homeowner's current system, if it is operated for 10 hours per day, can be replaced with a multi-speed pump and save approximately $210 per year. PG&E estimates a 30-90% savings can be achieved by replacing older, single-speed pumps, and offers a rebate program for multi-speed pump upgrades.
    - Install a solar thermal system to heat pool water. These systems are relatively simple and the pay-back time is impressive when compared to the cost of heating the pool with natural gas. One of the homes has a solar thermal system, but it was unclear whether the system is functional.

Windows:

- Four of the five homes primarily have single-paned windows. Recommendation: Although replacing existing windows with new windows for energy efficiency purposes is generally not cost effective, if the windows are going to be replaced for purposes of functionality or design, double-paned windows should be utilized, with the correct emissivity coating based upon the window's direction.
- One home has storm shutters on the south side of the home to reduce wind pressure on windows during storms. This has the effect of reducing the air pressure on that side of the home during storms, which helps reduce warm air losses during storms.
- Two of the homes have rolling blinds on either the interior or exterior of some sets of windows. If homeowners utilize them properly, blinds can be utilized to prevent solar heat gain in the summer and heat loss in the winter.
- Two of the homeowners reported uncomfortable temperatures in rooms with skylights. The skylight shaft in one home was found to be uninsulated, exacerbating the problem. Automated horizontal shades, tinted glass skylights, and operable skylights are all options that may improve unwanted heat gain or loss from skylights.

Indoor Air Quality:

- Carbon Monoxide alarms were not observed at four of the five homes. Recommendation: A carbon monoxide alarm should be installed in the sleeping area of any home with combustion equipment, such as a furnace or gas water heater, located within the conditioned portion of the home.
- Three homes have unintentional wildlife access openings to the crawl space, and two of the homes have wildlife droppings visible in the crawl space. Recommendation: Because the air from the crawl space often rises up into the home, preventing that air from becoming contaminated with wildlife droppings is important. Wildlife in the crawl space can also damage insulation, wiring, and other building elements in the crawl space. Assure vents and other openings are sufficiently screened or blocked, set traps to remove intruding wildlife, and remove wildlife droppings from the crawl space at least annually.

- One home has substantial moisture in the crawl space, and a second home had one area of moist soil in the crawl space at the time of the inspection. Recommendation: After removing any wildlife droppings and addressing drainage issues, cover crawl space soil with 6 mil poly sheeting, overlapping several inches at the seams, to reduce water vapor evaporating into air that enters the home.