

## Calculations for Water Heating Life Cycle Costs

**This document explains the calculations used in the SWH Life Cycle Cost Comparison spreadsheet.**

**The spreadsheet cells with formulae cannot be edited. Most of the inputs can be edited.** Please note that though the “Lookup Tables” inputs can be modified, all modifications to the lookup table data must be stated with the submission of the completed spreadsheet and accompanied by (1) an explanation of the reason for the modification and (2) the source of the new data. All sources must be current at the time of submission and publicly available.

The basic formula for annualized fixed costs is: (equipment cost – rebates)/equipment life.

The basic formula for annual operating costs is: amount of energy needed to heat water\*cost of energy. The amount of water is determined by the number of people in the household. The amount of energy needed to heat water accounts for efficiencies in energy transfer for electricity and gas in the input, as calculated by the Department of Energy (see link in spreadsheet). The operating cost calculation also utilizes solar fraction calculations for solar water heating, and the Heat Pump COP for heat pump calculations when appropriate. The operating cost for solar water heating accounts for maintenance.

<b>Outputs:</b>	<b>Formulae:</b>
Water heater costs (annualized):	
Solar	
Solar Fixed Costs	(Installation Costs, Solar Water Heater – rebate/tax credits, Solar Water Heater) / Estimated Technology Life, Solar
Solar Operating Costs	[Estimated Annual Hot Water Use, Number of People * Energy to heat water, Electric * (1 – Solar Savings Fraction) * Energy Rate/kWh, island-specific] + [(Installation Costs, Solar Water Heater *.10) / Estimated Technology Life, Solar]
Total Solar Costs	Solar Fixed Costs + Solar Operating Costs
Heat Pump	
Heat Pump Fixed Costs	(Installation Costs, Requested Variance technology - rebate/tax credits, Requested Variance technology) / Estimated Technology Life, Heat Pump
Heat Pump Operating Costs	Estimated Annual Hot Water Use, Number of People * Energy to heat water, Electric * (Energy Rate /kWh, island-specific / Heat Pump COP)
Total Heat Pump Costs	Heat Pump Fixed Costs + Heat Pump Operating Costs
Gas	
Gas Fixed Costs	(Installation Costs, Requested Variance technology - rebate/tax credits, Requested Variance technology) / Estimated Technology Life, Gas
Gas Operating Costs	Estimated Annual Hot Water Use, Number of People * Energy to heat water, Gas * Energy Rate /Therm, island-specific
Total Gas Costs	Gas Fixed Costs + Gas Operating Costs
Electric	
Electric Fixed Costs	(Installation Costs, Requested Variance technology - rebate/tax credits, Requested Variance technology) / Estimated Technology Life, Electric
Electric Operating Costs	Estimated Annual Hot Water Use, Number of People * Energy to heat water, Electric * Energy Rate /kWh, island-specific
Total Electric Costs	Electric Fixed Costs + Electric Operating Costs

Formula VariablesWorksheet Tab:Cell Reference

Installation Costs, Solar Water Heater	'SWH LLC Model'!:B17
Rebate/tax credits, Solar Water Heater	'SWH LLC Model'!:B18
Estimated Technology Life, Solar	'Lookup Tables'!:B34
Estimated Annual Hot Water Use, Number of People	'SWH LLC Model'!:B13 <i>input</i> within 'Lookup Tables'!:A3:B18
Energy to heat water, Electric	'Lookup Tables'!:B37
Solar Savings Fraction	'SWH LLC Model'!:B14
Energy Rate /kWh, island-specific	'SWH LLC Model'!:B15 <i>input</i> within 'Lookup Tables'!:A22-27:B22-27
Solar Fixed Costs	'SWH LLC Model'!:B33
Solar Operating Costs	'SWH LLC Model'!:B34
Installation Costs, Requested Variance technology	'SWH LLC Model'!:B20
Rebate/tax credits, Requested Variance technology	'SWH LLC Model'!:B21
Estimated Technology Life, Heat Pump	'Lookup Tables'!:B33
Heat Pump COP	'SWH LLC Model'!:B22
Heat Pump Fixed Costs	'SWH LLC Model'!:B37
Heat Pump Operating Costs	'SWH LLC Model'!:B38
Estimated Technology Life, Gas	'Lookup Tables'!:B32
Energy to heat water, Gas	'Lookup Tables'!:B38
Energy Rate /Therm, island-specific	'SWH LLC Model'!:B15 <i>input</i> within 'Lookup Tables'!:A22-27:C22-27
Gas Fixed Costs	'SWH LLC Model'!:B41
Gas Operating Costs	'SWH LLC Model'!:B42
Estimated Technology Life, Electric	'Lookup Tables'!:B31
Electric Fixed Costs	'SWH LLC Model'!:B45
Electric Operating Costs	'SWH LLC Model'!:B46

## Water Heating Life Cycle Cost Comparison (LCCC), Annualized

**For use if Option #1 is selected on the form for a variance (exemption) from mandated solar water heater installation on a new single-family dwelling.**

Option #1 is selected if the installation of a solar water heater is impracticable due to poor solar resource; and/or installation is cost-prohibitive based upon a life cycle cost-benefit analysis that incorporates the average residential utility bill and the cost of the new solar water heater system with a life cycle that does not exceed 15 years (Hawaii Revised Statutes, §196-6.5).

For a solar water heater variance request to be approved, this LCCC must be completed by a licensed engineer or architect and show that the total annualized water heater costs of a solar water heater is more than the device (listed below) that you want to install.

### Instructions:

Step 1: Fill out the bold red box below with (1) household information, (2) Solar Savings Fraction of dwelling location, (3) Island, (4) costs of solar and applicable tax credits or rebates, and (5) technology type and costs of the water heater system other than solar that you want to install. If you are comparing heat pump to solar water heaters, please also enter the Heat Pump Coefficient of Performance from the heat pump model (in cell B22). The State Energy Office may ask for verification of price quotes for installation and rebate costs.

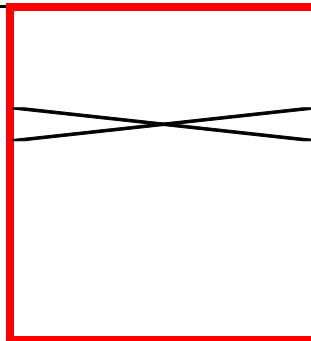
Optional: Confirm assumptions by reviewing relevant variables on "Lookup Tables" tab. Any modifications to the lookup tables must be stated with the submission and accompanied by an explanation of the reason for the modification and the source of the new data. All sources must be current and publicly available.

Step 2: Complete the identifying information on page 2.

Step 3: Submit PDF or printed copy of the signed analysis (and additional Lookup Table tab if edits are made to the assumptions) with the variance application.

### Inputs:

Number of people in household  
Solar Savings Fraction (percent)  
Island  
Solar Water Heater:  
Installation Costs  
    rebate/tax credits  
Requested Variance technology  
Installation costs  
    rebates/tax credits  
-



(Usually 90% for Hawaii. Ask a solar water heater installer for the Solar Savings Fraction)

Outputs:

Water heater costs (annualized):

Solar			
Solar Fixed Costs	\$	-	
Solar Operating Costs		#N/A	(includes a proxy for maintenance costs)
Total Solar Costs		#N/A	
Heat Pump			
Heat Pump Fixed Costs	-		
Heat Pump Operating Costs	-		
Total Heat Pump Costs	-		
Gas			
Gas Fixed Costs	-		
Gas Operating Costs	-		
Total Gas Costs	-		
Electric			
Electric Fixed Costs	-		
Electric Operating Costs	-		
Total Electric Costs	-		

**Identifying Information:**

Analysis performed FOR: (Name): \_\_\_\_\_  
Address of Home: \_\_\_\_\_  
Tax Map Key: \_\_\_\_\_  
County Bldg. Permit Appl. No.: \_\_\_\_\_  
Date: \_\_\_\_\_

Analysis performed BY (Name): \_\_\_\_\_ \*Analysis must be performed by a engineer or architect licensed under HRS Chapter 464

Signature: \_\_\_\_\_  
Business Address: \_\_\_\_\_  
Phone: \_\_\_\_\_

Comments or Notes:

Lookup Tables for SWH LCC

Estimated Hot Water Use		Gal/day	Inc Water Use Gal/day
# of people	Gal/year		
1	5475	15	15
2	10950	30	15
3	16425	45	10
4	20075	55	10
5	23725	65	10
6	27375	75	10
7	31025	85	10
8	34675	95	10
9	38325	105	10
10	41975	115	10
11	45625	125	10
12	49275	135	10
13	52925	145	10
14	56575	155	10
15	60225	165	10
16	63875	175	10

Energy Rates		
Island	Rate /kWh	Rate/Therm
Hawaii	0.317	4.73
Kauai	0.350	4.74
Lanai	0.339	5.07
Maui	0.286	3.88
Molokai	0.336	4.38
Oahu	0.268	4.7

Estimated Technology Life (years):	
Electric	12*
Gas	12*
Heat Pump	15*
Solar	15 Required to be 15 years.

Energy to heat water:	
Electric	0.202739726 kWh/gallon **
Gas	0.010958904 therm/gal **

NOTES or COMMENTS:

\* Relative lifespan based on statutory requirements for Solar

\*\* Energy numbers are from DOE at <https://www.energy.gov/eere/femp/energy-cost-calculator-electric-and-gas-water-heaters-0#output> for one gallon of water