

## DEEMED SAVINGS TECHNICAL ASSUMPTIONS

## Product: SD - Water Heating

## Description:

Residential electric customers with standard electric water heaters can receive a rebate for replacing it with a heat pump water heater.

## Equations:

|                              |                                                                                                                      |
|------------------------------|----------------------------------------------------------------------------------------------------------------------|
| Hot_Water_Energy (Tank-type) | = Qty x Hot_Water_Demand x Water_Heater_Delta_T x Days_Per_Year x Water_Density x Proposed_Tank_Size / Std_Tank_Size |
| Hot_Water_Energy (Tankless)  | = Qty x Hot_Water_Demand x Water_Heater_Delta_T x Days_Per_Year x Water_Density                                      |
| Water_Heater_Delta_T         | = Water_Heater_Temperature - City_Mains_Temperature                                                                  |

## Electric Equations:

|                                                    |                                                                   |
|----------------------------------------------------|-------------------------------------------------------------------|
| Customer kWh                                       | = Baseline_kWh - Proposed kWh + Cooling_Benefit - Heating_Penalty |
| Baseline_kWh                                       | = Hot_Water_Energy / Baseline_Eff_Electric / 3,412                |
| Proposed_kWh                                       | = Hot_Water_Energy / Proposed_Eff / 3,412                         |
| Baseline Efficiency Electric-Resistance Storage WH | = coef1 - (coef2 x Proposed_Tank_Size)                            |
| Customer kWh                                       | = Baseline_kW - Proposed_kW                                       |
| Baseline_kW                                        | = Standard_Water_Heater_kW + Cooling_Benefit / Cooling_Hours      |
| Proposed_kW                                        | = Standard_Water_Heater_kW - (Baseline_kWh - Proposed_kWh) / 8760 |
| Customer_PcKW                                      | = Customer_kW x Coincidence_Factor                                |

| Variable ID                                        | Value          | Description                                                                       |
|----------------------------------------------------|----------------|-----------------------------------------------------------------------------------|
| Hot_Water_Demand                                   | 64.3           | Average gallons per day of hot water use. (Reference 1)                           |
| Water_Heater_Temperature                           | 135            | Water heater setpoint temperature °F. (Reference 1)                               |
| City_Mains_Temperature                             | 51.9           | Water temperature of city water entering the water heater °F. (Reference 2)       |
| Conversion from Btu to kWh                         | 3,412          | 1 kWh = 3,412 Btuh                                                                |
| Specific Heat of Water                             | 1              | Btu/lb/°F                                                                         |
| Water_Density                                      | 8.33           | lb/gal H2O                                                                        |
| Days_Per_Year                                      | 365            | Days per Year                                                                     |
| Heating_Penalty                                    | See Table 1    | Heating penalty due to heat pump water heater operating during heating season.    |
| Cooling_Benefit                                    | See Table 1    | Cooling savings due to heat pump water heater operating during cooling season.    |
| Standard_Water_Heater_kW                           | 4.5            | Assumed kW for a typical electric resistance water heater.                        |
| Cooling_Hours                                      | 663            | Number of hours in a TMY3 year above 77°F.                                        |
| Coincidence_Factor                                 | 100%           | We are using the average water heater savings over the summer hours.              |
| Proposed_Tank_Size                                 | Customer Input | Storage capacity for tank type water heaters.                                     |
| Type of Proposed Water Heater                      | Customer Input | Type of proposed water heater. (i.e. Storage, Tankless, Heat Pump)                |
| Home Heating and Cooling Type for HP Water Heaters | Customer Input | Source for the home's heating and cooling. See Table 1.                           |
| Proposed_Eff                                       | Customer Input | Uniform Efficiency Factor for proposed water heater.                              |
| Qty                                                | Customer Input | Equipment Quantity                                                                |
| Measure Life                                       | See Table 2    | Lifetime of water heaters. (Reference 3)                                          |
| Incremental Costs                                  | See Table 2    | Incremental cost of efficient technology over baseline technology.                |
| coef1                                              | See Table 3    | Code-based formula coefficients to determine baseline energy use                  |
| coef2                                              | See Table 3    | Code-based formula coefficients to determine baseline energy use                  |
| Std_Tank_Size                                      | 45.0           | Reference tank volume storage capacity based on historical program participation. |
| Water Heater Self-Installation Rate                | 52%            | Percent of Water Heaters that self-installed after retail purchase (Reference 9)  |

Table 1 - Secondary Cooling and Heating Benefits (References 6, 7)

| Heating Type | Cooling Type      | Cooling_Benefit<br>kWh | Heating_Penalty<br>kWh | O&M<br>\$ |
|--------------|-------------------|------------------------|------------------------|-----------|
| Natural Gas  | Refrigerant Based | 61.5                   | 0                      | \$(65.17) |

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|                     |                       |      |       |            |
|---------------------|-----------------------|------|-------|------------|
| Electric Resistance | Refrigerant Based     | 61.5 | 1,634 | \$ -       |
| Heat Pump           | Refrigerant Based     | 61.5 | 724   | \$ -       |
| Natural Gas         | Non-Refrigerant Based | 0.0  | 0     | \$ (65.17) |
| Electric Resistance | Non-Refrigerant Based | 0.0  | 1,634 | \$ -       |
| Heat Pump           | Non-Refrigerant Based | 0.0  | 724   | \$ -       |

**Table 2 - Incremental Cost, Lifetime, NTG - References 3, 10**

| Water Heater Type                 | Size | Draw Pattern | Baseline Cost | Incremental Cost | Lifetime | NTG  |
|-----------------------------------|------|--------------|---------------|------------------|----------|------|
| Air Source Heat Pump Water Heater | N/A  | NA           | \$ 958.62     | \$ 611.45        | 10       | 100% |

**Table 3 - Baseline Efficiency Coefficients Reference 8 ( >= 20gal & <= 55 gal )**

| Draw Pattern | Elec (Storage) |        |
|--------------|----------------|--------|
|              | coef1          | coef2  |
| Medium       | 0.9307         | 0.0002 |
| High         | 0.9349         | 0.0001 |

**References:**

1. Energy Conservation Program for Consumer Products: Test Procedure for Water Heaters; United States Department of Energy; <http://www.gpo.gov/fdsys/pkg/FR-1998-05-11/pdf/98-12296.pdf>
2. Denver Water's 2006 Treated Water Quality Summary Report;
3. Energy Star Residential Water Heaters -Final Criterial Analysis, April 2008.  
[http://www.energystar.gov/ia/partners/prod\\_development/new\\_specs/downloads/water\\_heaters/WaterHeaterAnalysis\\_Final.pdf](http://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/water_heaters/WaterHeaterAnalysis_Final.pdf)
4. Not Used
5. US Department of Energy; Residential Heat Pump Water Heaters;  
<http://energy.gov/eere/femp/covered-product-category-residential-heat-pump-water-heaters>
6. US Department of Energy; Residential Air Conditioners and Heat Pumps; [http://www1.eere.energy.gov/buildings/appliance\\_standards/product.aspx/productid/75](http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75)
7. US Department of Energy; Residential Furnace Standards. [https://www1.eere.energy.gov/buildings/appliance\\_standards/product.aspx/productid/72#standards](https://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/72#standards)
8. US Department of Energy, Residential Water Heater Standards 10 CFR 430.32(d):
9. EnergyStar - [http://aceee.org/sites/default/files/files/pdf/conferences/hwf/2016/Ryan\\_Session1C\\_HWF16\\_2.22.16\\_0.pdf](http://aceee.org/sites/default/files/files/pdf/conferences/hwf/2016/Ryan_Session1C_HWF16_2.22.16_0.pdf)
10. Equipment Manufacturer Retail Price Information Request ( Q4 - 2017 )
11. NREL - National Residential Efficiency Measure Database, <https://remdb.nrel.gov/measures.php?gld=6&ctld=270>