

**Residential Water Use Model:
Research Used Part III and
Step-wise Walk-Through of the Calculator
in Spreadsheet Form
(done directly in the Spreadsheet)**

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Energy Ratio - For Site Specific Conditions

The term “Energy Factor” (E_f) is Federally regulated.

In order to avoid confusion and other issues with the use of Energy Factor, the term “Energy Ratio” (E_r) is now proposed when correcting for site-specific water heating energy load conditions.

Both E_f and E_r are used in the same manner for calculating annual hot water energy load.

The Complete “Energy Ratio” Equation:

Based upon an Energy Balance Analysis of the Entire Water Heating System, the following equation has been derived by G.W.E. Van Decker as:

$$E_r = \frac{h_{r_test}}{1 + \frac{h_{r_test}}{E_{f_test}} - \frac{V_{del_site} \cdot (T_{del_site} - T_{a, stby_site})}{V_{site} \cdot (T_{del_site} - T_{in_site})} - \frac{V_{del_test} \cdot (T_{del_test} - T_{a, stby_test})}{V_{test} \cdot (T_{del_test} - T_{in_test})}} - h_{DWHR} \cdot C_{DWHR}$$

Where:

T_{del_site} is the actual water heater set-point temperature, 120 ° F

$T_{a, stby_site}$ is the actual room temperature, assume 67.5 ° F

T_{in_site} is the actual mains water temperature, site specific

V_{site} is the actual hot water draw [gallons per day], which is: $30 \cdot N_{du} + 10 \cdot N_{br}$

T_{del_test} is the test water heater set-point temperature, 135 ° F

$T_{a, stby_test}$ is the test room temperature, 67.5 ° F

T_{in_test} is the test mains water temperature, 58.0 ° F

V_{test} is the test hot water draw, 64.3 gallons per day

η_{r_test} is the primary water heater’s rated recovery efficiency as per test

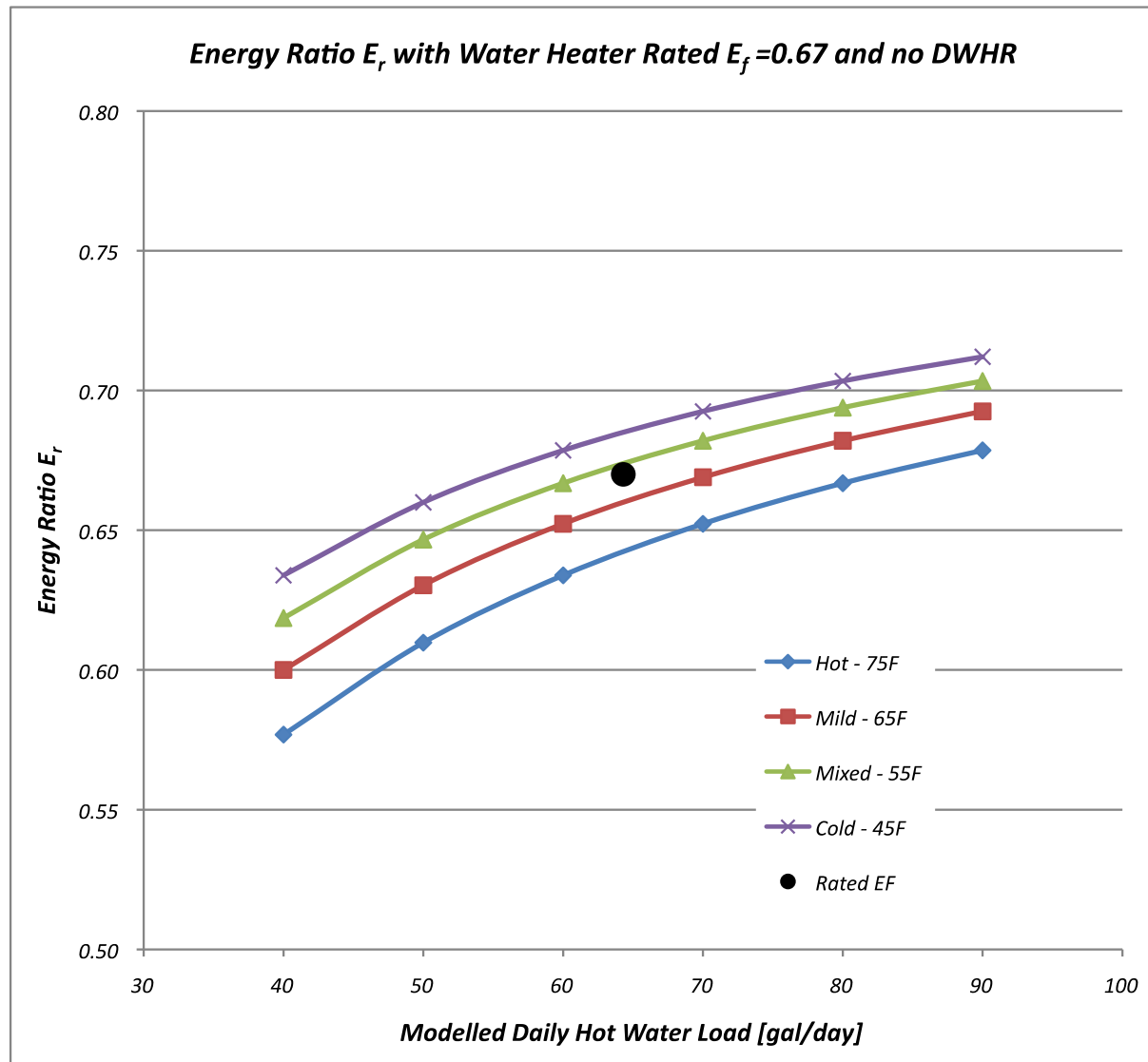
E_{f_test} is the primary water heater’s rated Energy Factor as per test

η_{r_DWHR} is the Drain Water Heat Recovery unit efficiency in accordance to CSA B55.1 and listed by a recognized agency (e.g. UL, ETL).

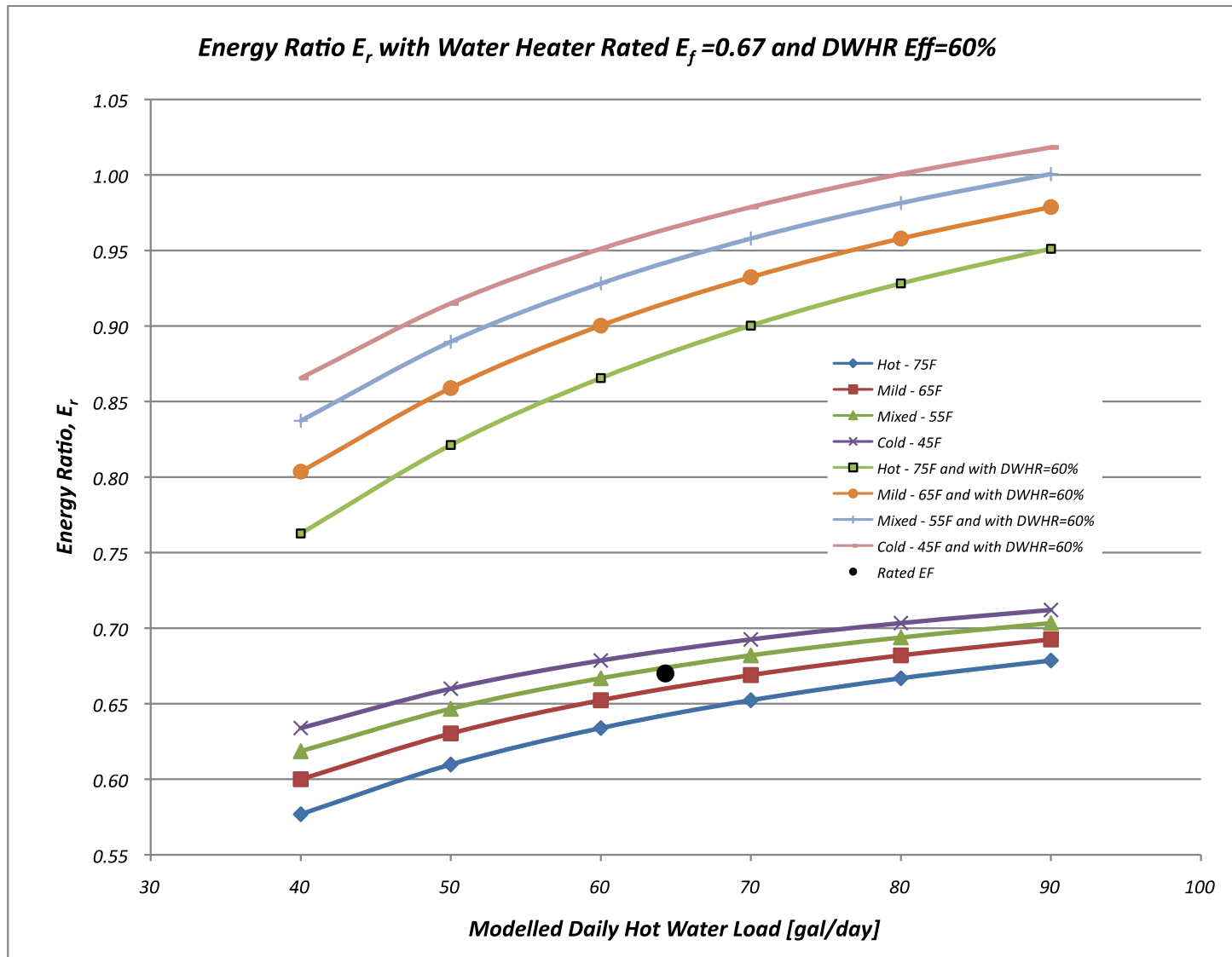
C_{DWHR} is:

- 1) 0.432 if all of the showers in the home are connected to the DWHR unit or units
- 2) 0.216 if there are 2 or more showers in the home and only 1 shower is connected to a DWHR unit or units

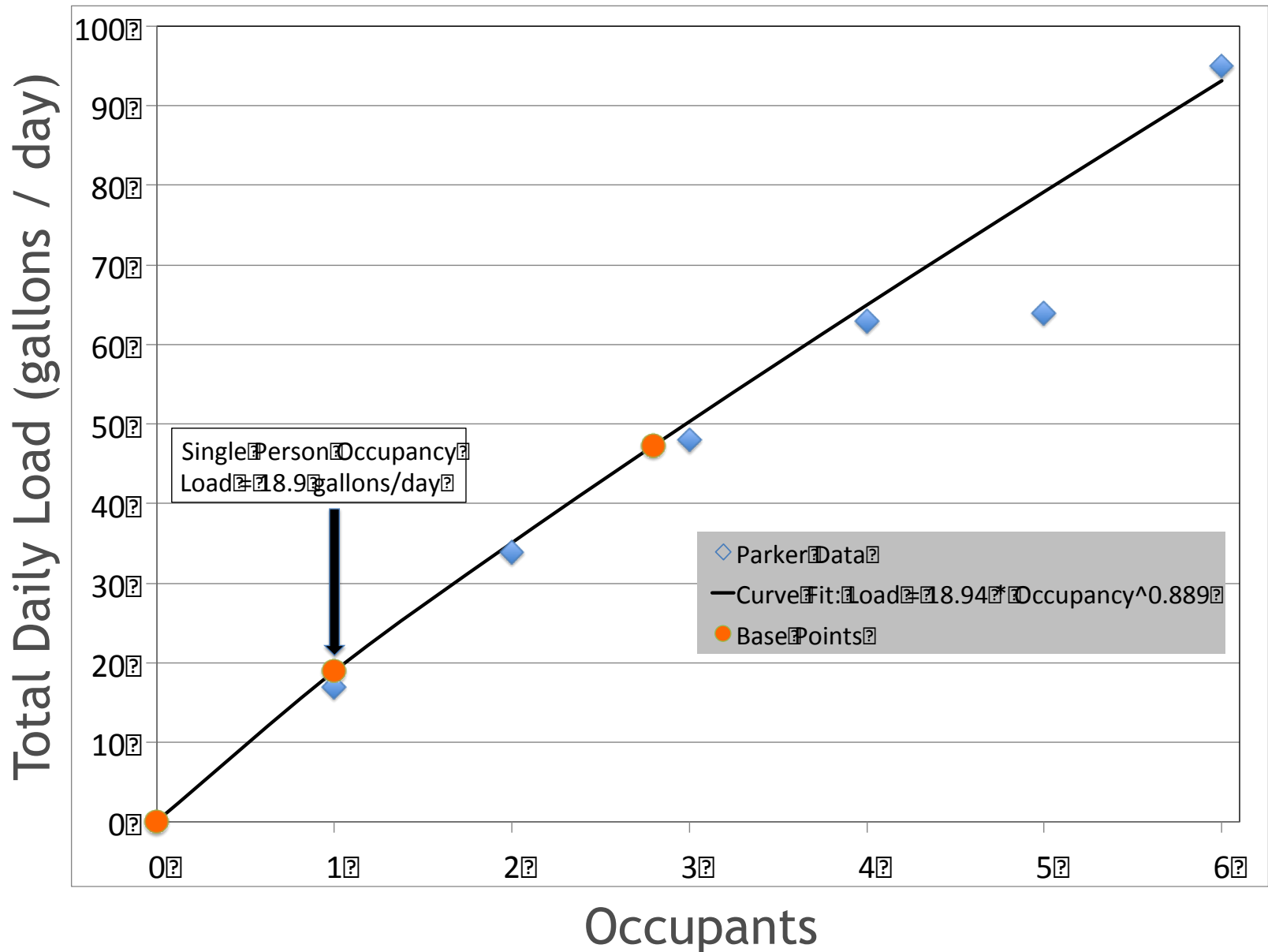
Energy Ratio (E_r) Across a Broad Range of Conditions



Energy Ratio (E_r) Across the same range with DWHR



Hot Water Load Power Fit and Data



Normalized Load Per Person with Power Fit

