

Monitored Desuperheater Performance in Residential Ground-Source Heat Pumps

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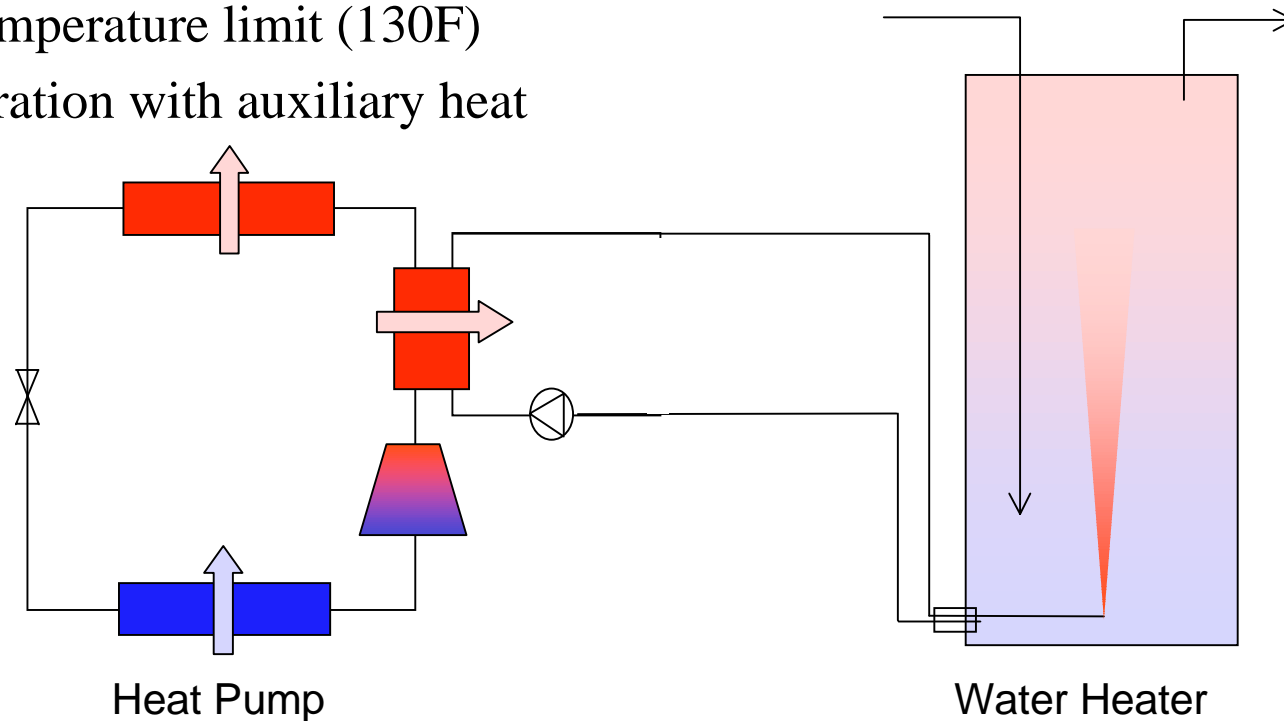


Background

- Experiences based on comprehensive performance field monitoring
- 12 sites in North Carolina
 - Desuperheaters often disabled in winter
- 4 sites in New York
 - 2 DX units & 2 vertical water loops
- 7 sites in Wisconsin
 - Only one site with desuperheater
 - \$700 incremental desuperheater cost
 - Half-priced electricity GSHP promotion
 - Little use of desuperheaters in region
- 14 sites in Georgia
 - Installation issues (control wiring, long pipe runs)
- Highly variable performance overall (water use, temperature, HP use)

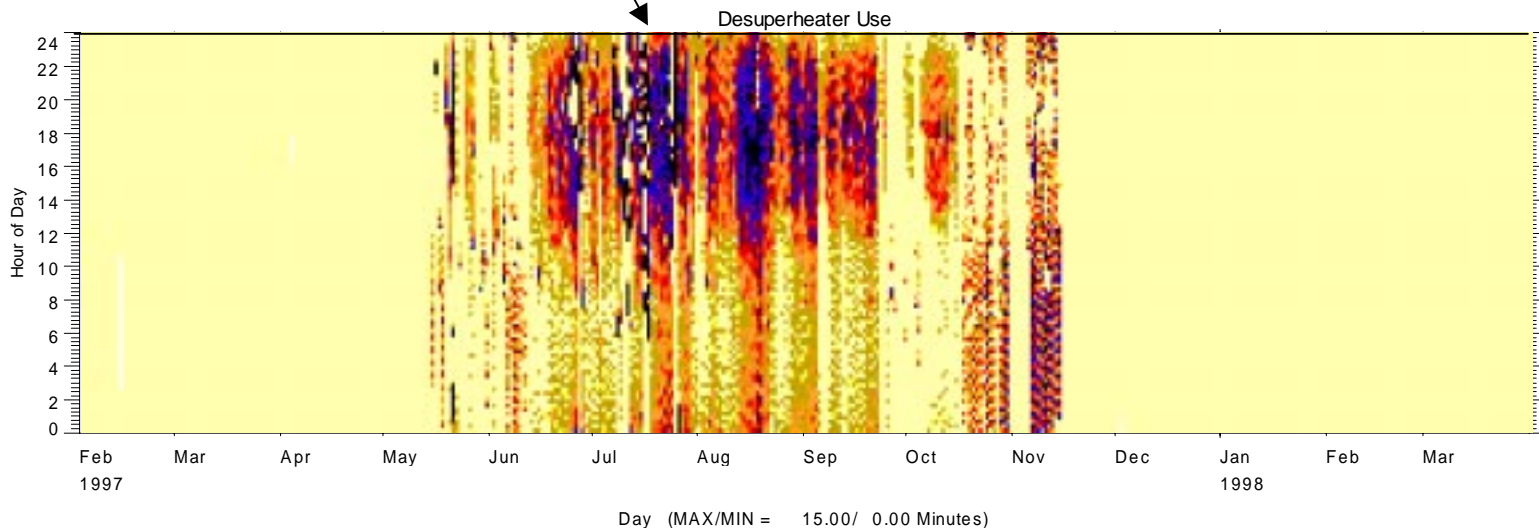
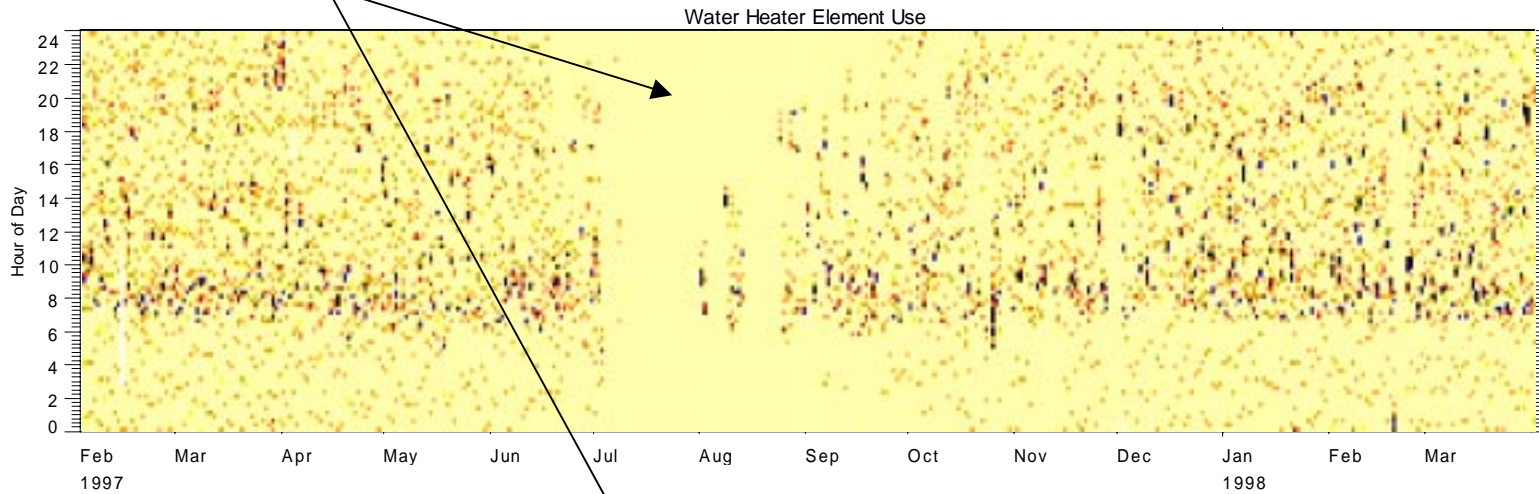
Desuperheater Characteristics

- 10% of heating capacity
- Single tank with concentric coupling in drain port
- Coincident operation with compressor
- High temperature limit (130F)
- No operation with auxiliary heat

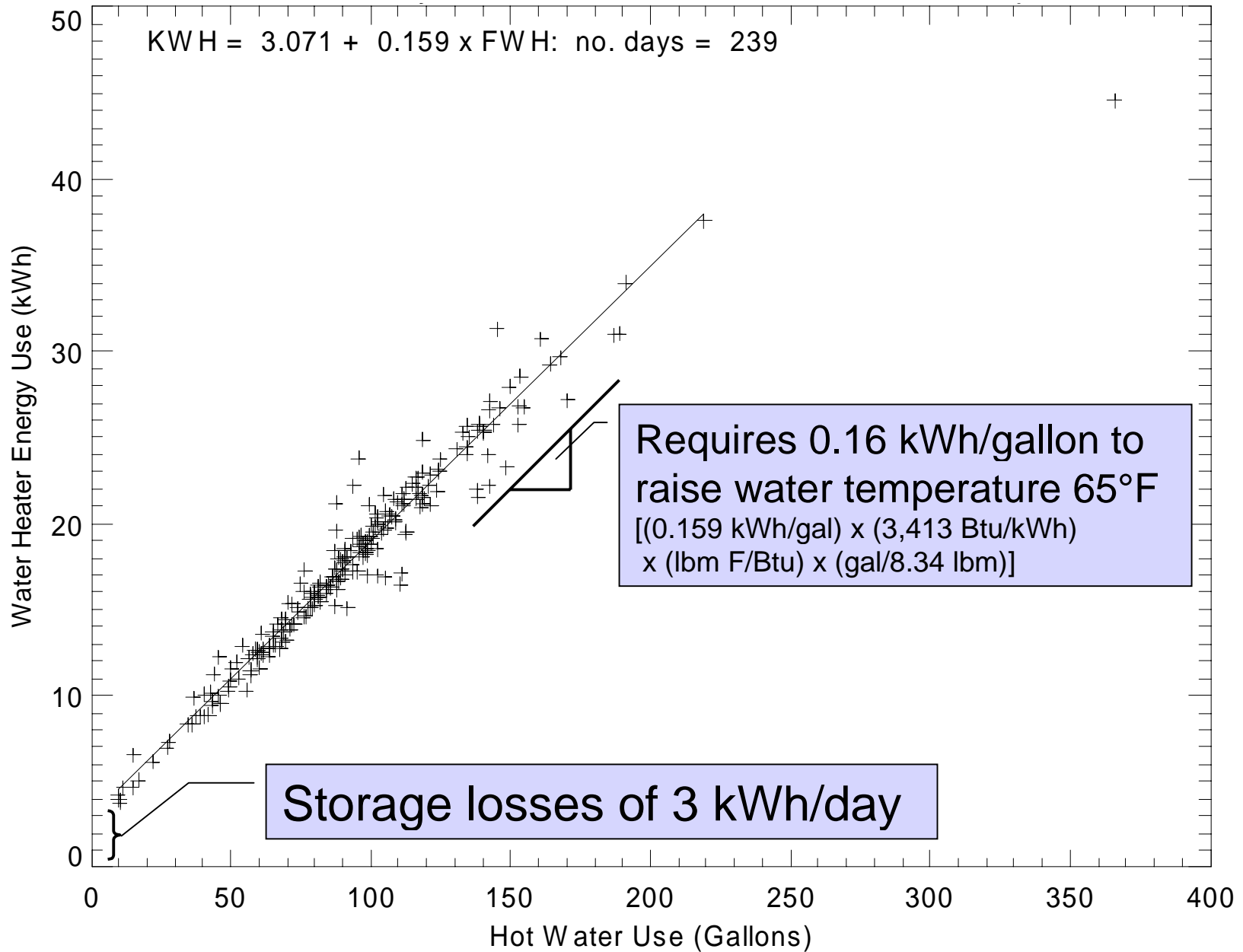


Desuperheater Impact - Qualitative

Reduction in water heater use pattern corresponds to desuperheater use



Water Heating Energy Use



Desuperheater Impact - Model

- Include desuperheater run time in model
- Constraint water heating energy to be positive
- Separate heating and cooling heat pump operation

$$W = [a_0 + a_1 FWH + a_2 SDP_h + a_3 SDP_c]^+ + \varepsilon$$

where,

W = measured water heater electricity use (kWh/day)

FWH = hot water use (gallons/day)

SDP_h = desuperheater run time during heating season (hours/day)

SDP_c = desuperheater run time during cooling season (hours/day)

a₀ = stand-by heat loss (kWh/day)

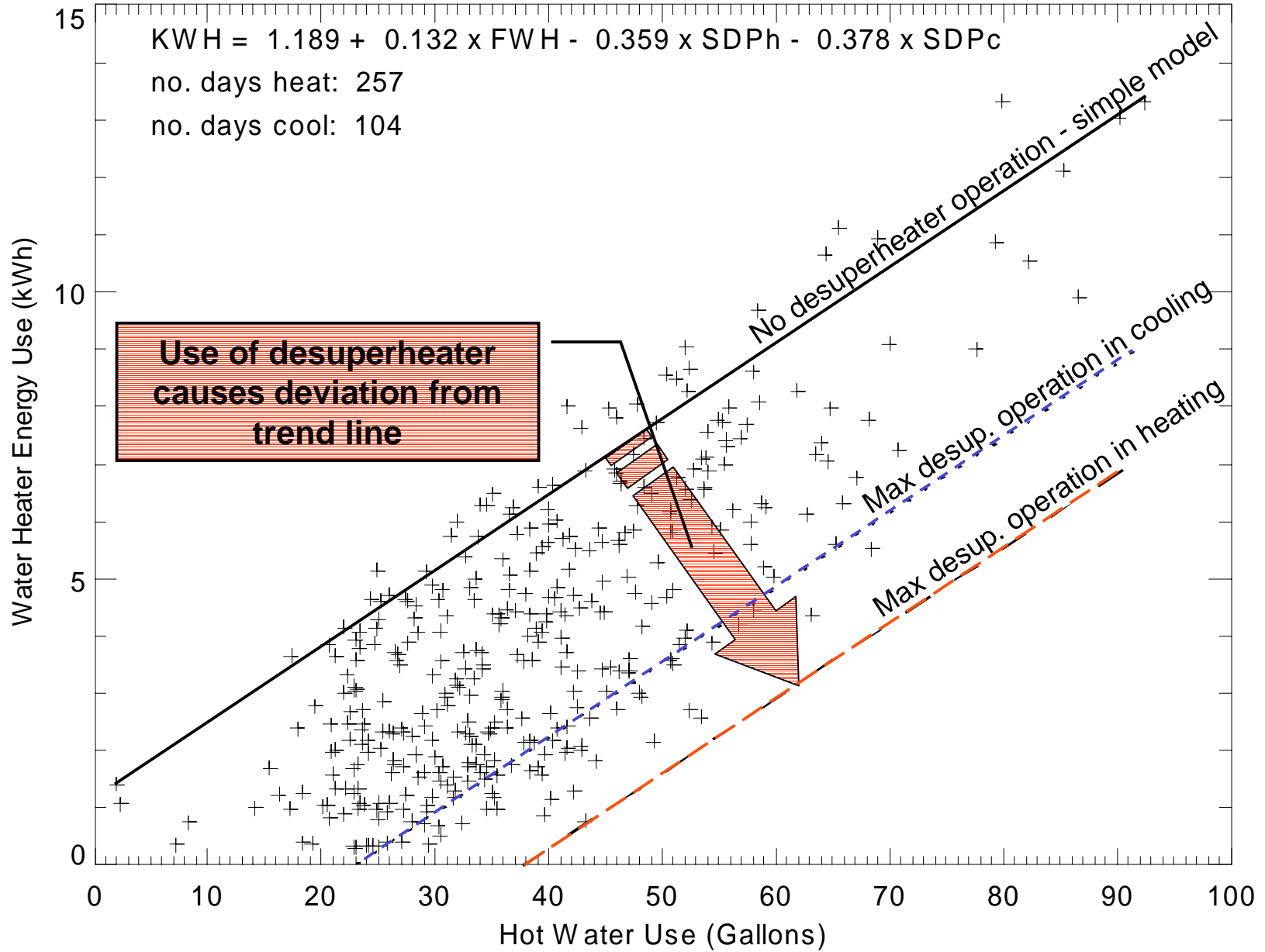
a₁ = water temperature rise factor (kWh/gallon)

a₂, a₃ = desuperheater impact for heating and cooling seasons (kWh/hour of desup. use)

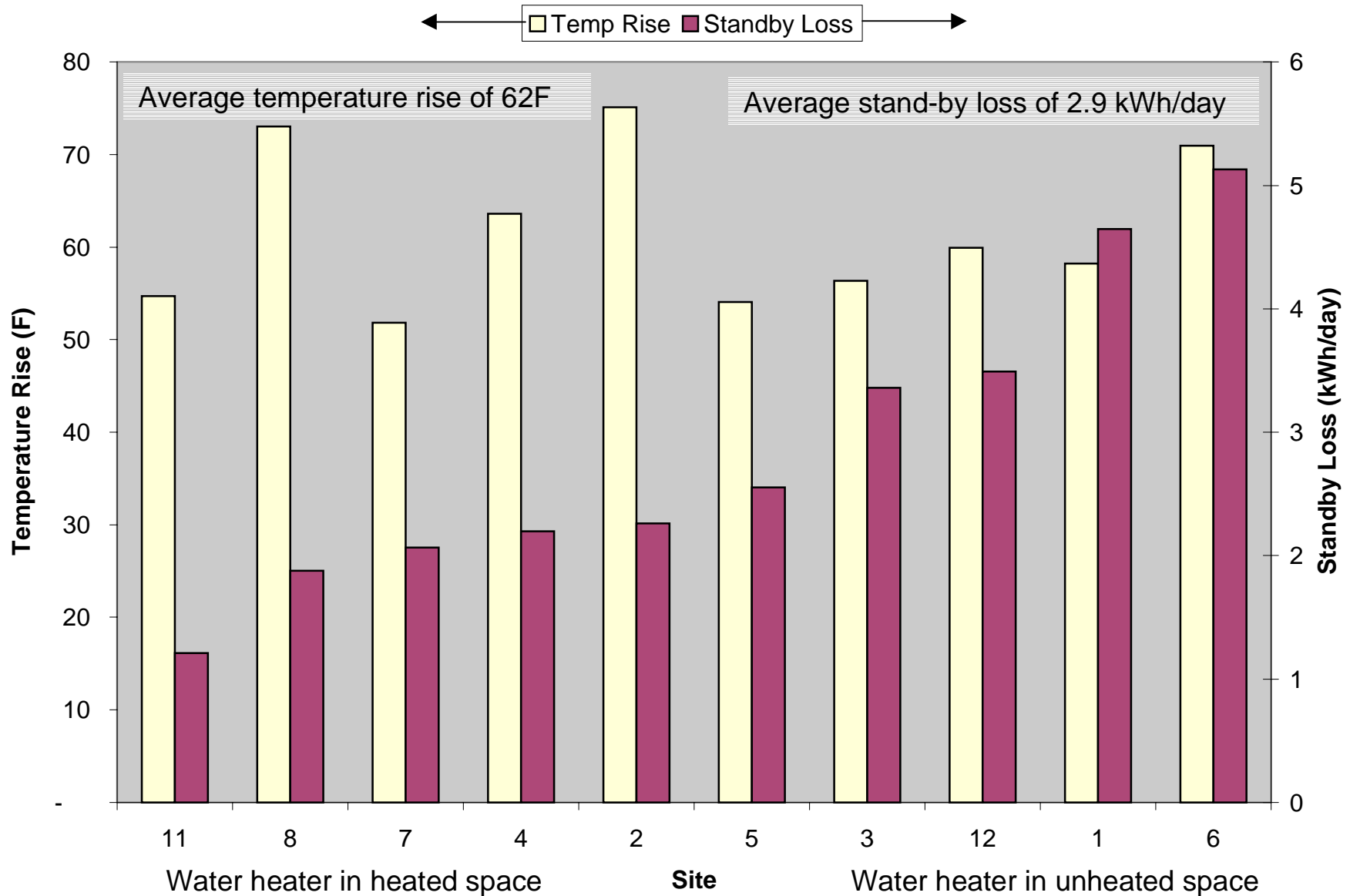
[]⁺ = denotes that the model is constrained to be greater than or equal to zero

ε = model error

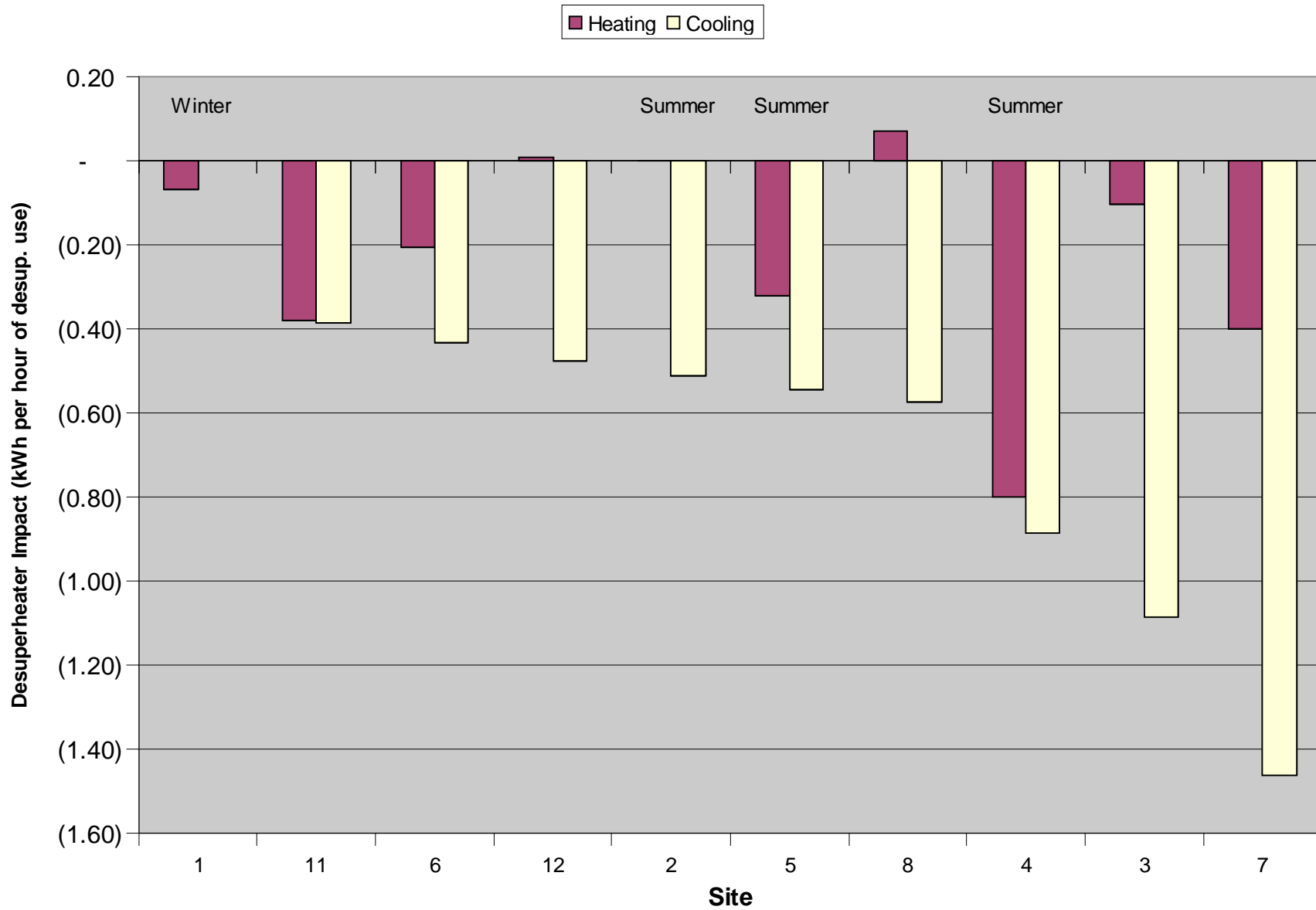
Site 11 Daily Water Heater and Water Use Relationship



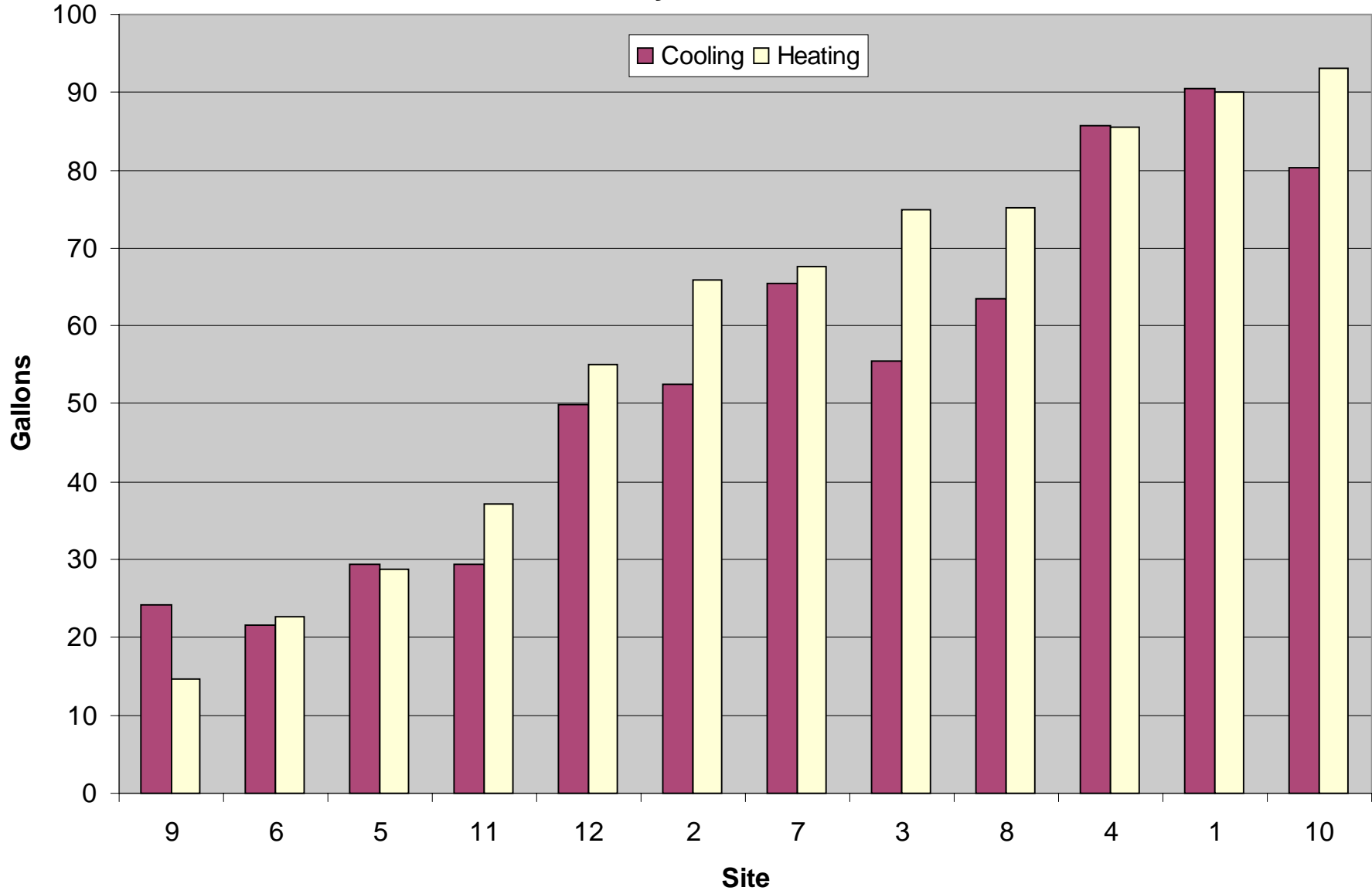
Desuperheater Impact - Model



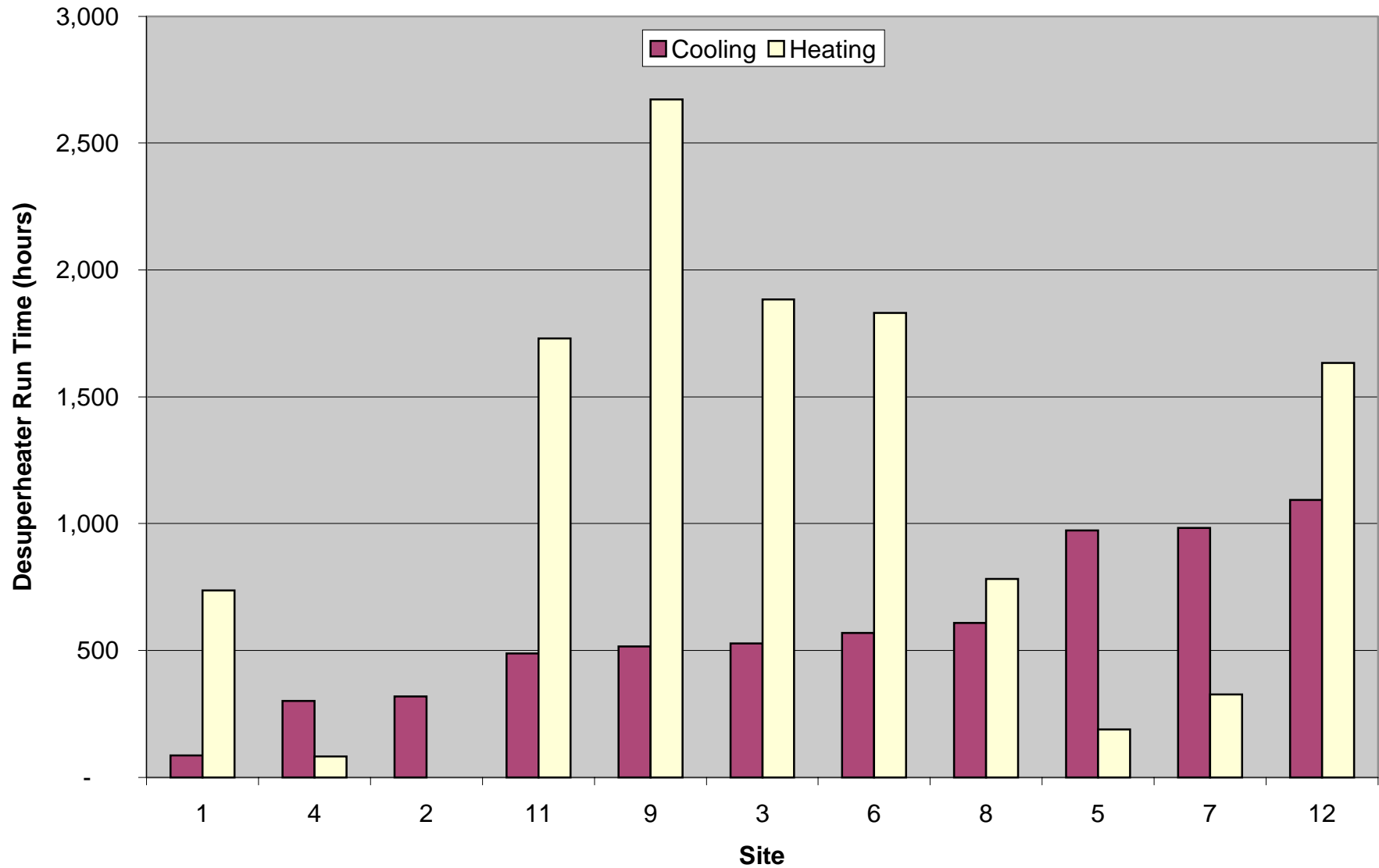
Desuperheater Impact - Model



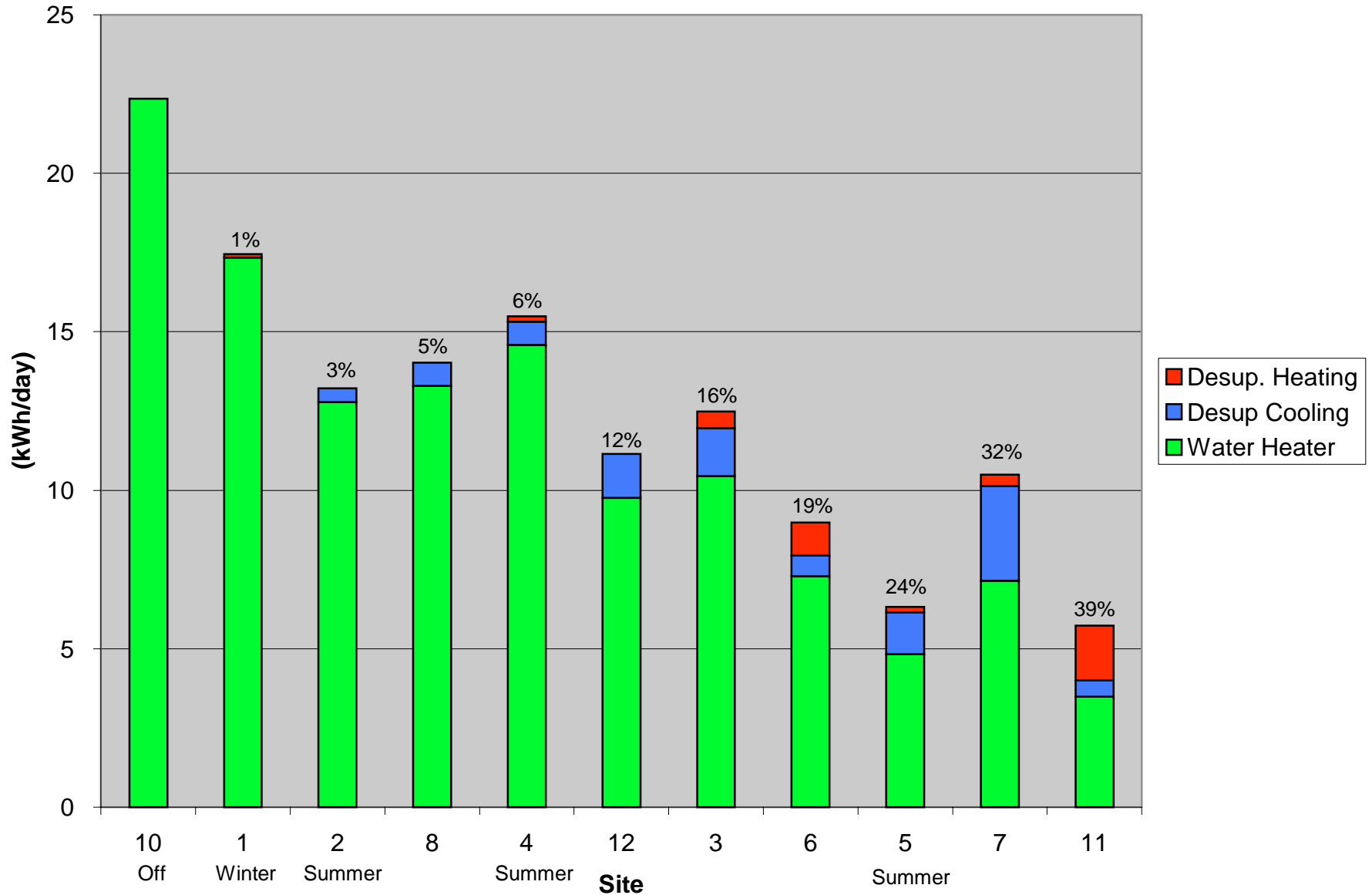
Daily Hot Water Use



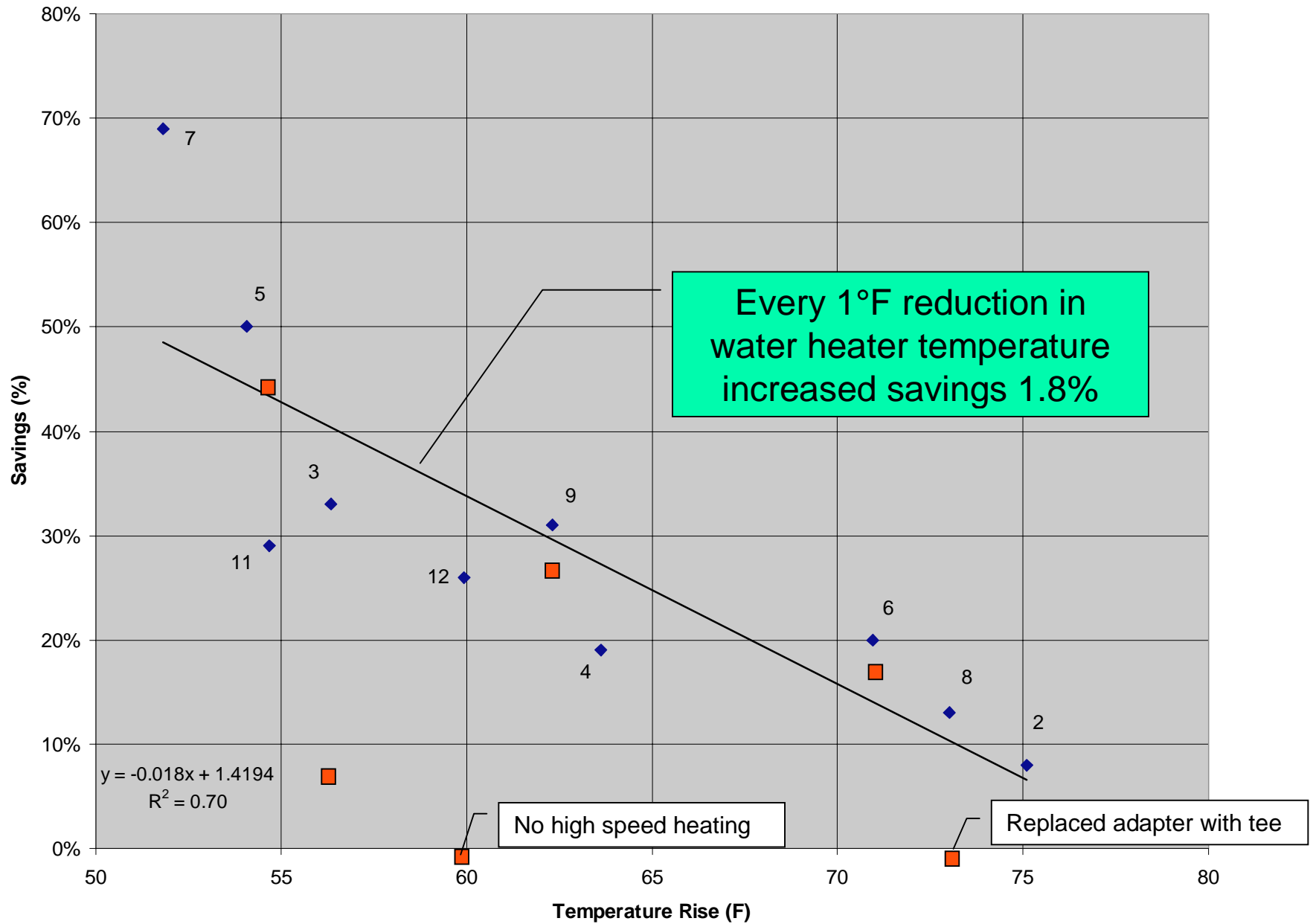
Desuperheater Run Time



Daily Water Heating Energy

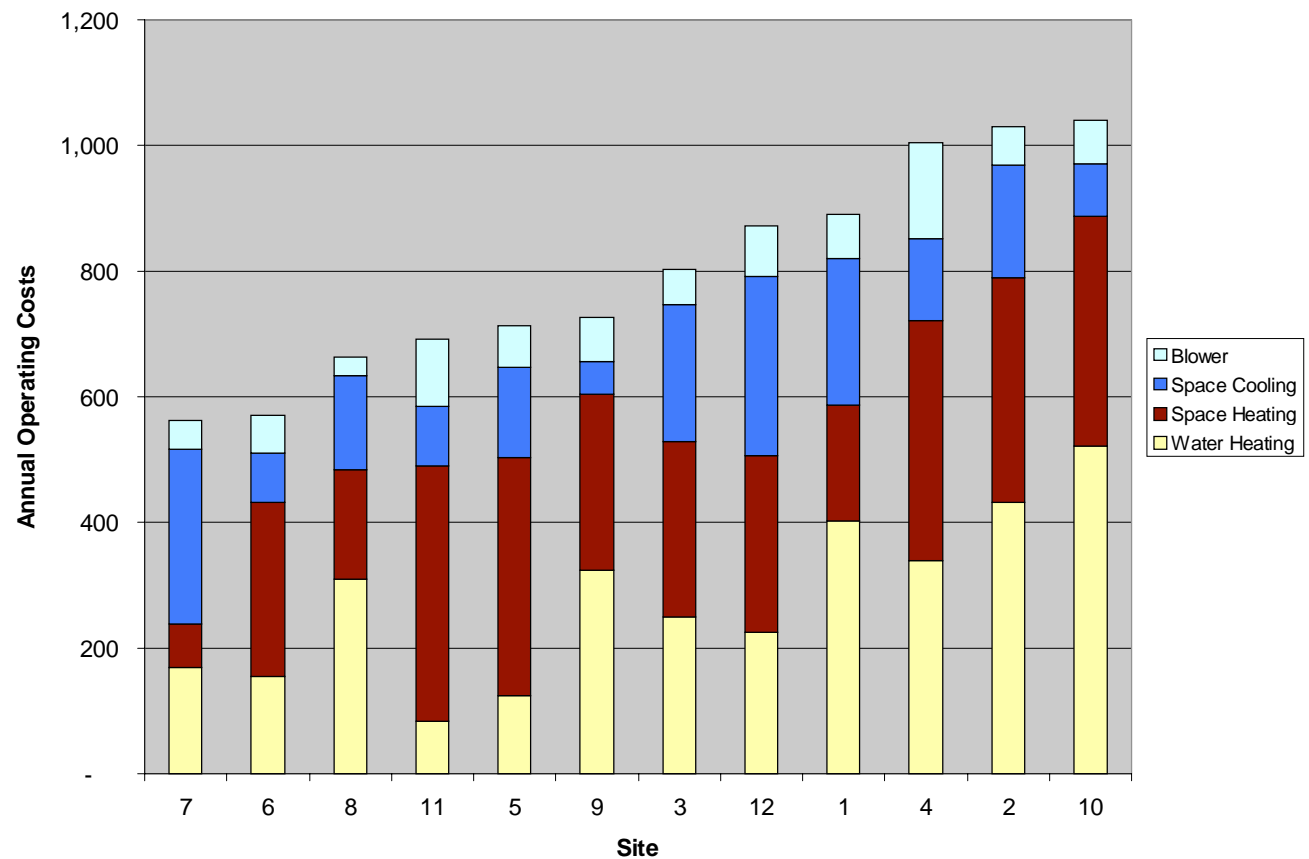


Desuperheater Impact - Site Conditions



Desuperheater Impact - Cost

- Based on electric water heating:
- Up to \$80 of annual savings at 6.5¢/kWh
- Up to \$68 of annual savings at 1\$/gallon
- No savings at \$0.63/therm



Desuperheater Impact

- Capacity reduced at higher water temperature
- Second preheat tank would reduce water temperature and maximize performance
- Desuperheater must run to produce savings
- Impact derived from:
 - water use
 - water heater run time
 - desuperheater run time