Circulating Block Heater

CALIFORNIA
TECHNICAL FORUM

ALFREDO GUTIERREZ

APRIL, 2015

Presentation Overview

Objective: Update the CALTF on Work Paper Analysis

- Measure Description
- Work paper Methodology
- Results
- Issues and Concerns
- Questions or Comments

Measure Description

Base Case

Thermo siphon heater

- Relies on temperature variation to drive circulation which leads to non-uniform temperatures
- Generates waste heat
- Only contains an electric resistance heater

Measure Case

Circulating block heater

- Integrated pump circulates heated coolant through engine block
- Leads to more uniform temperatures
- Requires a smaller heating element due to improved temperature mixing

Measure Description

- **Units:** per unit
- **Measure Application and Delivery Type**
  - Downstream Deemed (ROB and New)
- **Eligibility**
  - Climate Zones: All
  - Building Types: All Non-Residential
- **Target Market**
  - Industrial sector
  - Commercial sector
- **Market Potential**
  - Estimated at 300 installations in 2014 though SCE’s customized program by years end.

Measure Description

- **Measure Costs**
  - Baseline cost (material + labor): $750 – $1,500
  - Measure cost: $1,000 - $1,800
  - Incremental cost: $250 - $600

- **EUL**
  - 15 year (DEER EUL ID: Motors-pump)

- **NTG**
  - 0.85 (DEER EUL ID: ET-Default)

Work paper Methodology: Baseline/Measure

- Baseline data collection
  - Bonneville Power Administration (BPA) Emerging Technology Case Studies
  - 17 Sites
    - Waste Water Plants
    - Data Centers
  - Parameters
    - Daily Average kWh
    - Outside Air (OA) Temperature
    - Duty Cycle

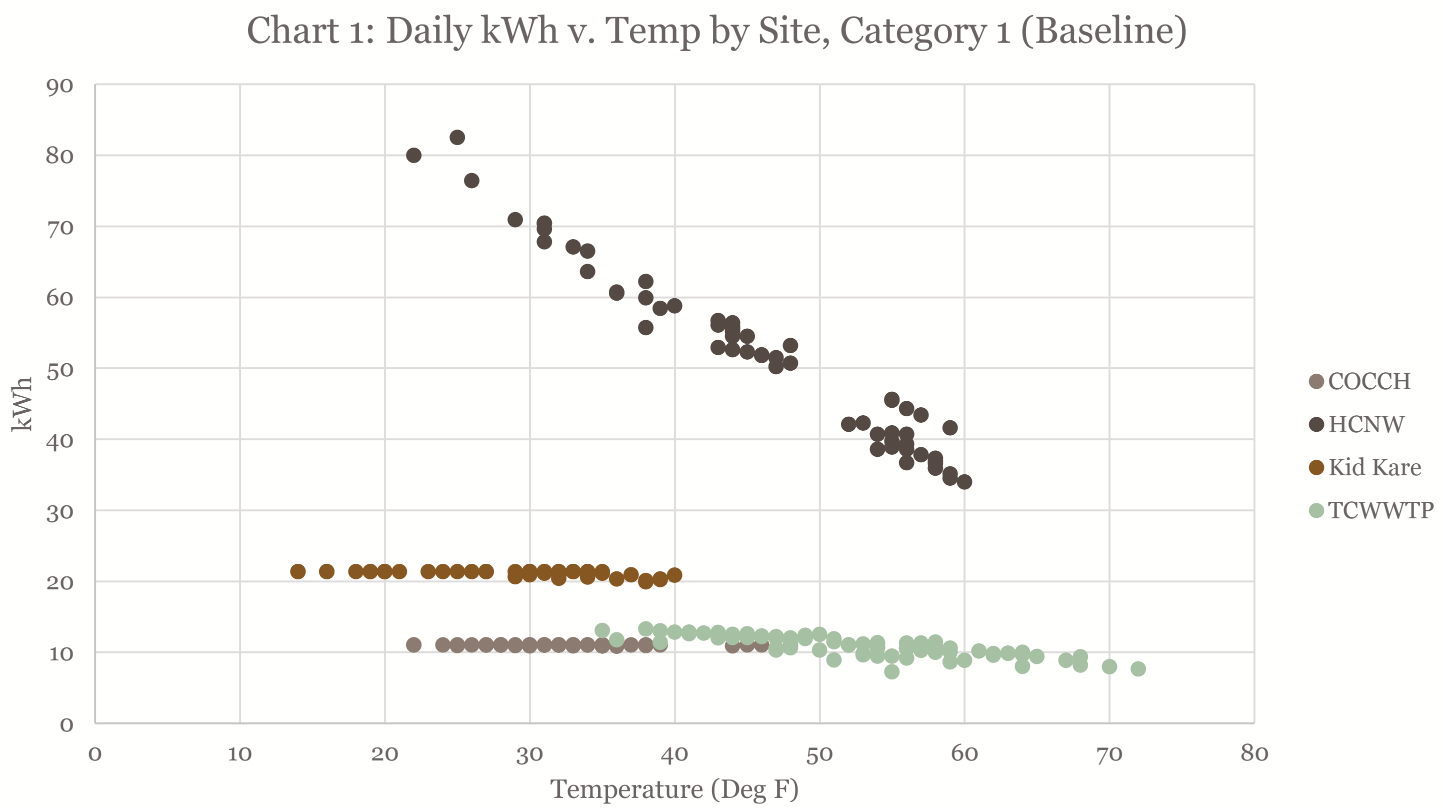
- Baseline methodology
  - kWh vs OA was collected, on average, for 2 months pre and post
  - Multi Variable Regression models were then created from site data
    - This made the savings dependent on the following parameters:
      - Site size category
      - Baseline heater size
      - New heater size
      - Climate zone (to determine average temperature)
  - Average yearly temperature found for each climate zone
  - 2013 CEC TMY3 weather files
  - Assumed 334 days of operation for the generator
  - One month of downtime for maintenance

Work paper Methodology: Regression Models

Site	Site Size Category	Generator Size kW	Baseline Heater Size kW	Existing Measured kW	Avg Baseline kWh	New Rated Heater Size kW	New Measured kW	Avg Treatment kWh
COCCH	1	15	0.5	0.46	11.0	1	0.99	6.8
Kid Kare	1	40	1	0.89	21.1	1	0.99	13.4
TCWWTP	1	15	1	0.93	10.9	1	1.03	8.2
HCNW	1	600	6	4.3	52.0	6	5.4	46.8
COCFD	2	75	1	0.88	20.9	1	0.94	11.6
COCTV	2	100	1	0.88	20.9	1	0.92	7.2
COMKR	2	50	1	0.93	20.7	1	1	11.7
COMW	2	100	1	0.95	22.7	1	0.98	16.1
KE ECAM	2	65	1	0.93	22.3	1	0.99	12.5
TCWP	2	20	1	0.97	22.3	1	1.05	10.5
BLDG210	2	250	2.5	2.22	47.1	3	2.8	24.2
PCDC	2	900	6[1]	4.62	48.4	6	5.5	44.1
BayView	3	150	1.5	1.39	33.3	1.5	1.34	14.9
BNS GEN	3	500	4.95	1.85	44.3	2.5	1.89	26.3
KRMC[2]	3	1000	6	4.5	87.7	6	5.7	21.0
COCWWTP	3	664	6	5.9	112.8	3	2.9	40.8
NQ	4	1000	10	9.54	228.4	10	10.15	110.3

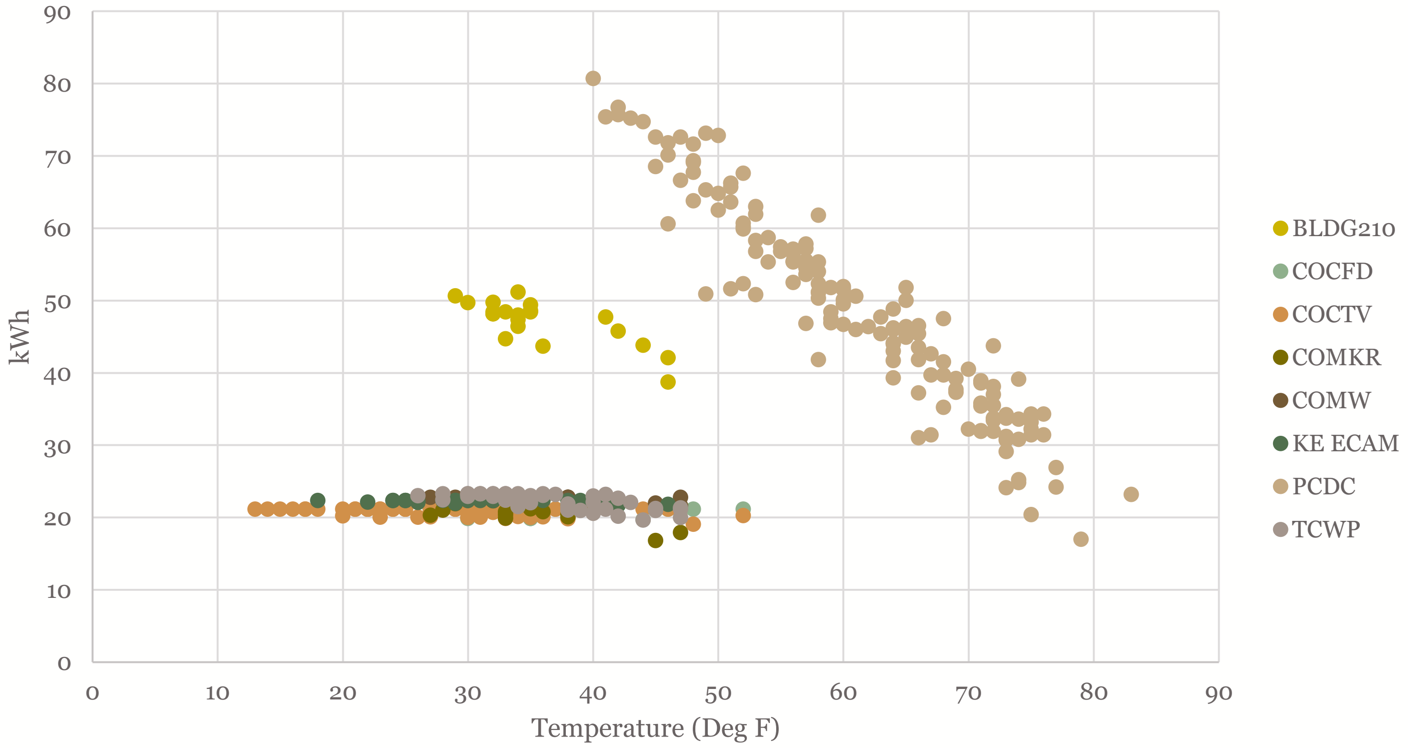
[1] PCDC was reported to have a baseline heater size of 12 kW; this value is anomalously large and not consistent with other observable data. Based on measured kW and usage levels, a heater size of 6 is more plausible and more consistent.
[2] Runtime logging for KRMC strongly suggest that the replacement heaters were significantly oversized for their needs. Therefore, the usage data are not representative of a site with an appropriately-sized heater. As a result, KRMC data are excluded from the analysis.

Work paper Methodology: Regression Models

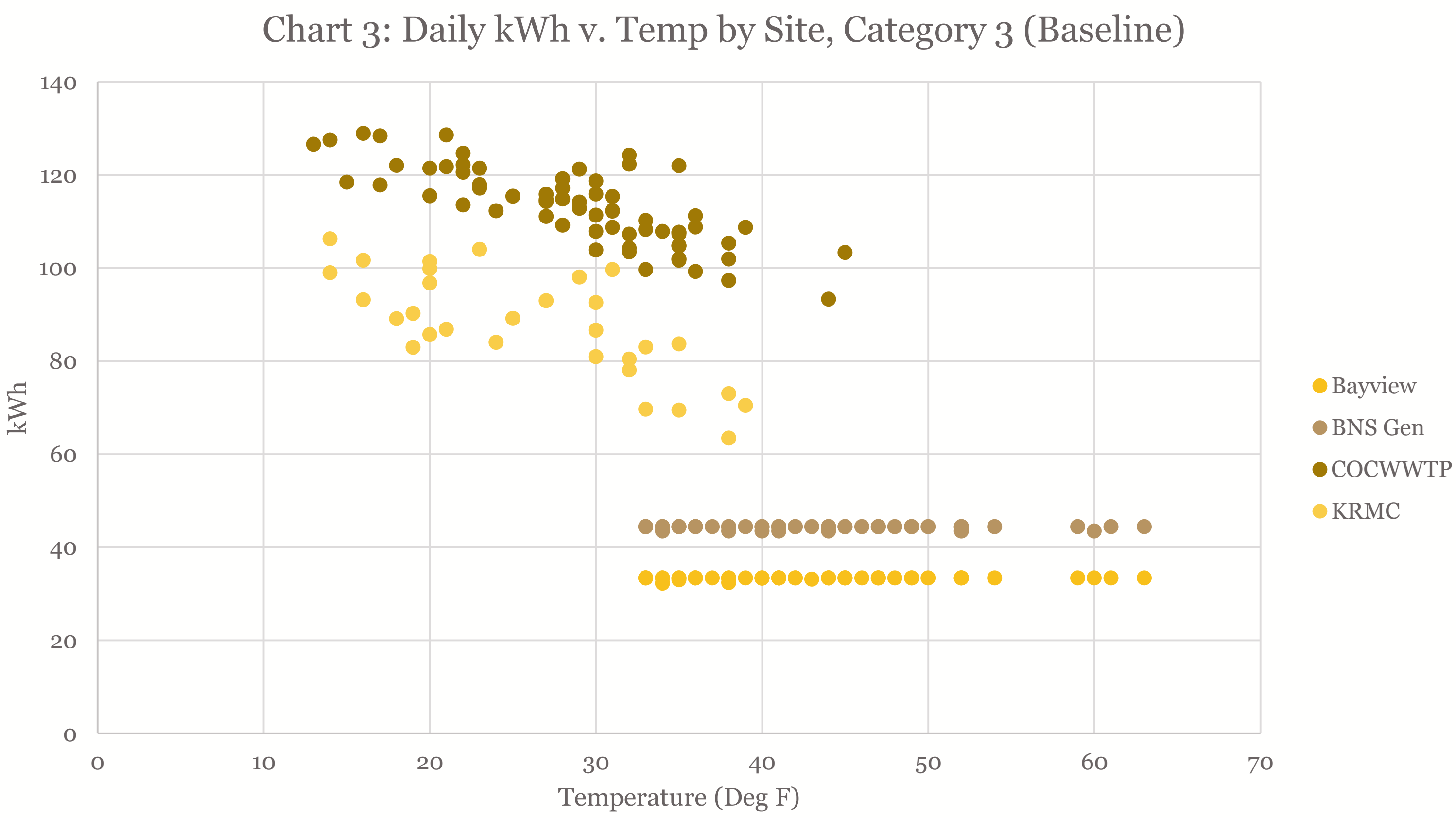


Work paper Methodology: Regression Models

Chart 2: Daily kWh v. Temp by Site, Category 2 (Baseline)



Work paper Methodology: Regression Models



Work paper Methodology: Regression Models

- Baseline for Properly Sized Sites
  - $daily\_kWh = \beta_0 + \beta_1 * Temperature + \varepsilon$

    Where:

    Daily_kWh is the daily usage (kWh) as collected

    Temperature is the observed average outside air temperature (°F)

- Treatment Usage for All Sites
  - $daily\_kWh = \beta_0 + \beta_1 * New\_Heater\_Size + \beta_2 * New\_Heater\_Size * Temperature + \varepsilon$

    Where:

    Daily_kWh is the daily usage (kWh) as collected

    New_Heater_Size is the recorded new heater size (kW)

    Temperature is the observed average outside air temperature (°F)

Work paper Methodology: Regression Models

Table 9: Baseline Heater Size Ranges (as suggested by data)

Site Size Category	Undersized Heater Range	Proper-sized Heater Range
1	1 kW and below	2 kW and above
2	1 kW and below	2 kW and above
3	5 kW and below	6 kW and above

Table 10: Estimated Baseline Usage for Properly-Sized Sites (regression results)

Site Size Category	Regression Coefficients	
	Intercept	Temp.
1	105.91	-1.178
2	88.92	-0.701
3	139.85	-0.932

Table 11: Estimated Treatment Usage (regression results)

Site Size Category	Regression Coefficients		
	Intercept	Heater Size	Heater Size * Temp.
1	3.70	13.135	-0.136
2	5.86	13.195	-0.133
3	10.26	16.688	-0.179
4	229.52	0	-2.577

Results

Sample Calculation

- Sample: Climate Zone 6, site size category 1, baseline heater size 1 kW, new heater size 1 kW, annual operation 334 days / year.
  - Designation: Undersized
  - Annual Average Temperature: 61.5°F
  - Baseline Daily kWh: 20.2 * [Baseline Heater Size] = 20.2 kWh / day.
  - Treatment Daily kWh: 3.70 + 13.135 * [New Heater Size] – 0.136 * [New Heater Size] * [61.5°F] = 8.4 kWh / day
  - Annual Savings: (20.2 kWh/day – 8.4 kWh/day) * 334 days/year = 3,928 kWh/year.

Issues and Concerns

Abstract Review Comments from the Cal TF

- ✓ Perform a sensitivity analysis
  - A bin analysis using daily average temperatures was performed for two climate zones (6 & 15)
  - The savings from the bin analysis and the original methodology are within 0.10% for both climate zones
- ✓ Verify if savings will be impacted by thermostatic controls
  - As SCE is still awaiting monitored data from customized projects, the impact of thermostatic controls is not yet known. They will be verified as soon as data is received from custom projects installed within SCE territory.
- ✓ Perform a multi variable analysis
  - Methodology has been updated to show multiple variables have been taken into account

Issues and Concerns – Future Updates

- Equipment Cost
  - Preliminary costs were taken from one manufacturer
  - In-house labor costs were taken from one customer
  - With more customers, we will have a better set of data to establish equipment/labor costs

- SCE Specific Data
  - Currently, BPA data is used. This data source has been questioned whether it is appropriate for SCE territory.
    - Response – Regression Analysis was performed. Linear models show relationship between OA and kWh so climatic region should not impact energy savings
  - Data for 10 sites is scheduled to be provided by early December. The work paper will then be updated with this new data.
    - Data will inform whether thermostatic controls affect savings/costs
    - Proposal – If new data results in more than 10% change in savings, then we will update the work paper.
  - Not a High Impact Measure and the parameters to be collected are not assumed to have a huge impact on preliminary values.

Questions or Comments?