M&V Study - HVAC Improvement for a Retail Bank Branch in Tempe, AZ

Updated: January 29th, 2024

The following individuals helped plan, execute, and document the study:

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Contents:

Part 1 - Background:

- **JPMC** – JPMC pursues sustainability and decarbonization strategies at various levels. One of their targets for the real estate footprint is to reduce Scope 1 & 2 emissions in their buildings 40% by 2030, as compared to a 2017 baseline.
- **ECM Technologies** – ECMT's ThermaClear® is a simple and direct solution for A/C oil-fouling. It reduces HVAC energy, GHG emissions, and improves efficiency both in the compressor and at the cooling coils.
- **Context** – After identifying the opportunity and initially vetting ThermaClear®, JPMC requested a pilot installation at a local facility.
- **Kickoff** – JPMC selected a retail branch in Tempe, AZ for a ThermaClear® pilot study to treat all six (6) rooftop units and measure the pre-treatment vs. post-treatment performance. Coordination for the pilot study began in April 2023.

Goal of the study:

To quantify impacts of ThermaClear® HVAC treatment for a retail bank branch, including energy, GHG, and/or operational improvements post-treatment.

Part 1 - Background:

"The window for action to avert the costliest impacts of global climate change is closing… The need to provide energy affordably and reliably for today, as well as make the necessary investments to decarbonize for tomorrow, underscores the inextricable links between economic growth, energy security and climate change."

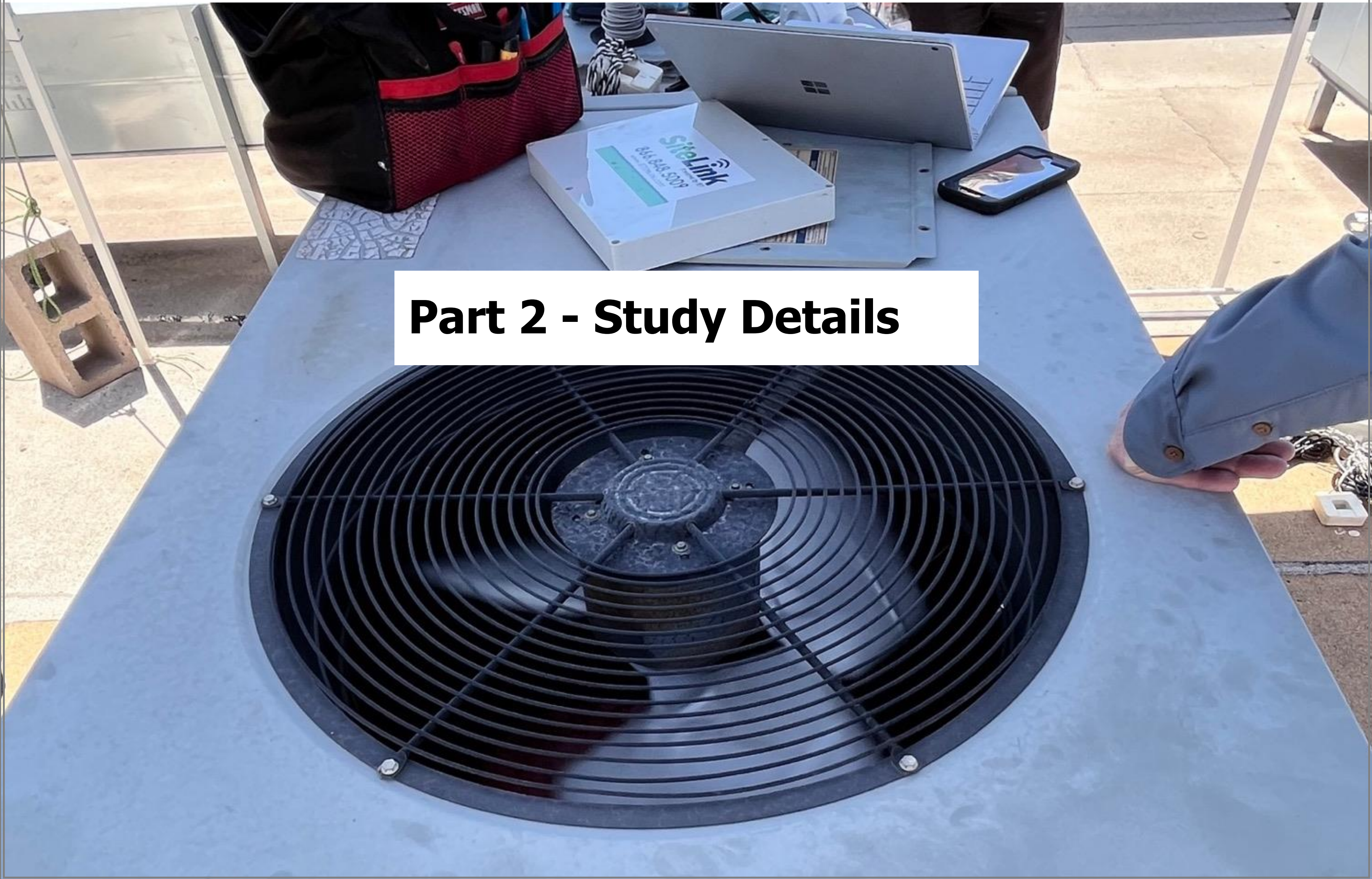
- Jamie Dimon, JPMC Chief Executive Officer

"Retail environments are a great proving ground for HVAC energy improvements because comfort typically reigns supreme, and any energy savings must be achieved while still keeping things nice and cold."

- Michael Daly, P.E. – ECM Chief Engineer

ECM TECHNOLOGIES

Part 2 - Study Details



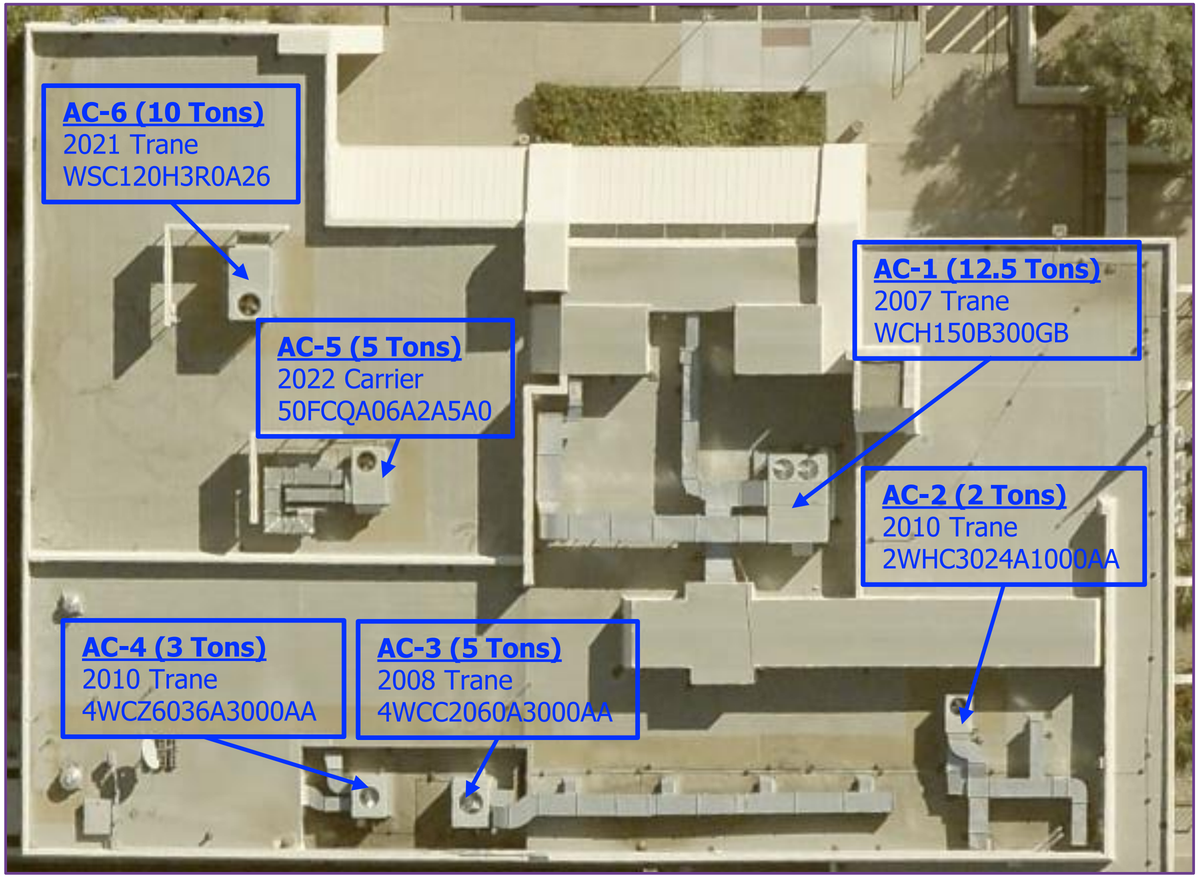
Part 2 - Study Details:

A - Site Overview – 444 W. Broadway Rd., Tempe AZ 85282

- 7,880 GSF, original construction in 1973
- Est. 10-12 Full-time equivalent employees, est. 250 daily customers
- Operates 9a - 5p Mon.-Fri., has back-office staff on weekend days
- Thermostats are (frequently) manipulated by the employees at will

Part 2 - Study Details:

B - HVAC Overview – six (6) packaged heat pump units totaling 37.5 tons

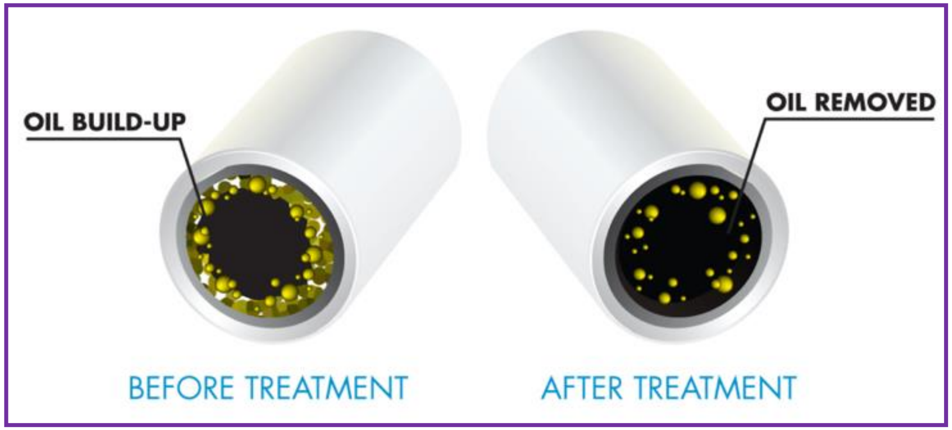


Notes on HVAC:

- Sunbelt climate with 5,000-6,000 Cooling Degree Days / year
- HVAC units between 1 to 16 years old
- 100% of HVAC equipment on roof
- All units treated at the same time
- Noted thermostat issues with AC-1 were resolved prior to data recording

Part 2 - Study Details:

C - Treatment Overview – ThermaClear® reduces oil-fouling

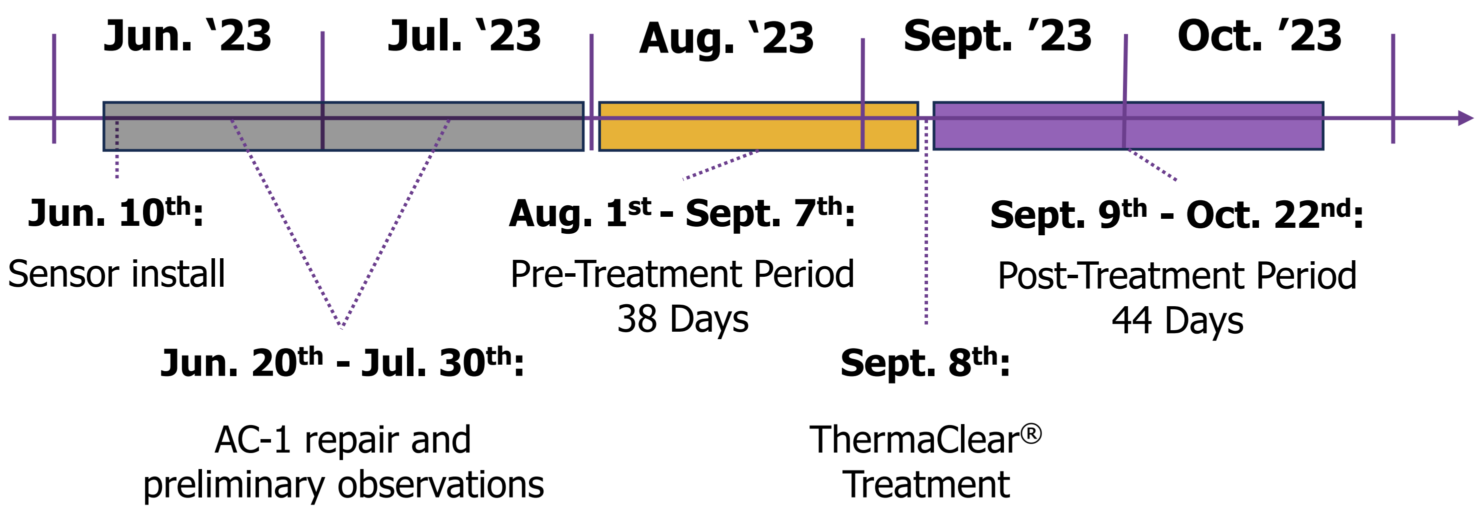


ThermaClear® displaces oil buildup inside of refrigerant coil surfaces

- ✓ Improves heat transfer at the coils, thereby improving supply air temperatures
- ✓ Super-lubricates the compressor
- ✓ Allows HVAC units to reach and hold temperature set-points more effectively
- ✓ Reduces kWh consumption by reducing A/C compressor work and run times
- ✓ Can help extend equipment life and reduce HVAC service calls

Part 2 - Study Details:

D - Implementation Schedule



Pre-Treatment: Average daily temps. from 84 to 105 deg. F.

Post-Treatment: Average daily temps. from 78 to 101 deg. F.

Ambient temps. reasonably matched between pre-and post treatment

Part 2 - Study Details:

E - Measurement & Verification (M&V) Setup

Each A/C unit was fitted with sensors for continuous trending of:

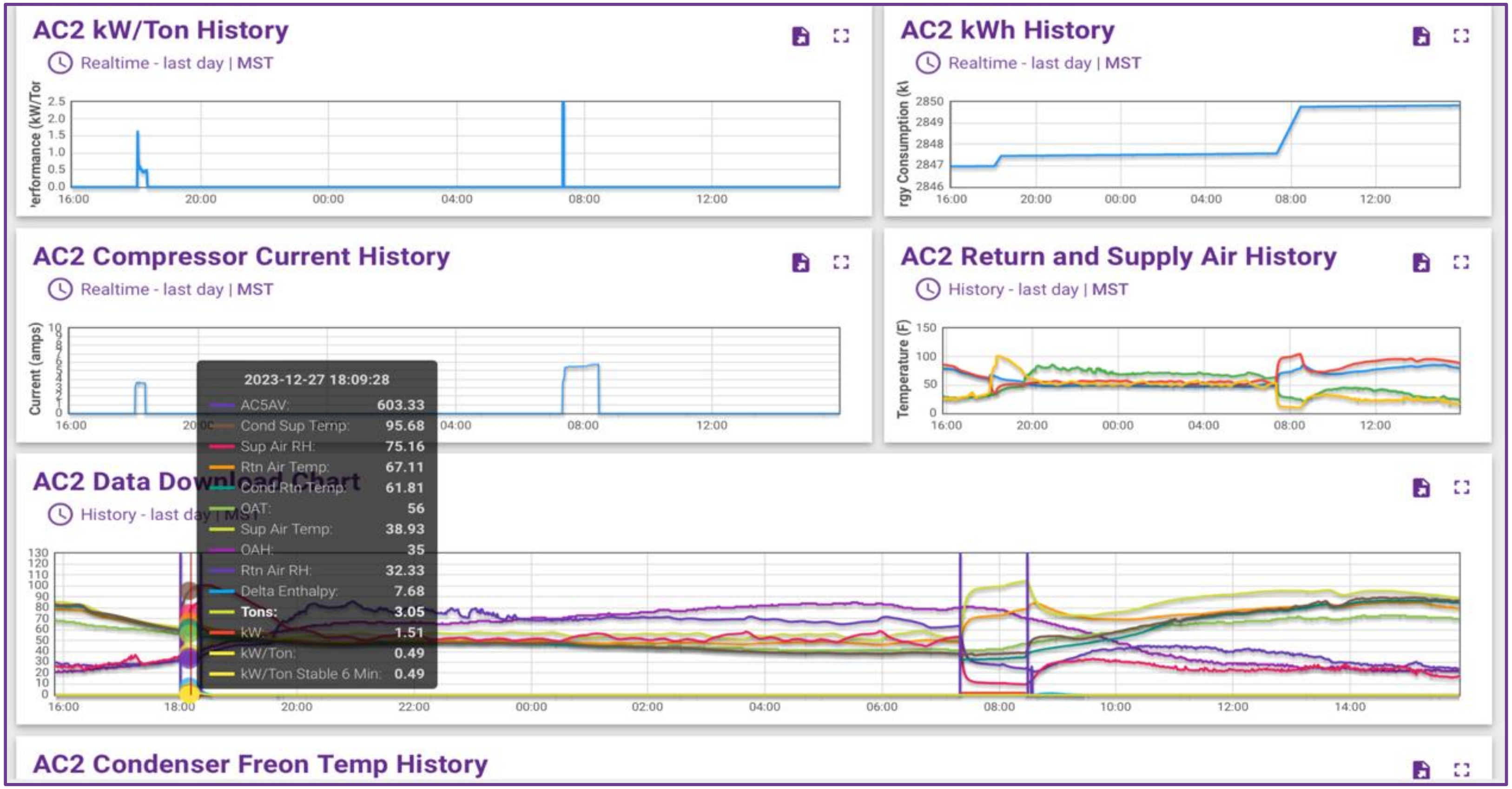
1. Total system power (kW & kWH)
2. Compressor power (kW & kWH)
3. Supply air temp. and humidity
4. Return air temp. and humidity
5. Freon temp. (deg. F.) on the hot side
6. Supply air velocity (fpm)

Sensors for outside air temp. and humidity were also installed on the roof

Part 2 - Study Details:

E - Measurement & Verification (M&V) Setup (Cont'd)

An online dashboard was set up to help monitor data quality/continuity



Part 2 - Study Details:

F - ThermaClear® Treatment Process

Install by Crawford Mechanical:

1. Ensure compressor is running
2. Remove cover and connect pump to low-pressure compressor fitting
3. Pull up handle to draw 1 liquid oz. of ThermaClear® per ton of A/C
4. Push down handle to inject, then disconnect pump and replace cover

No refrigerant loss when installed properly; no need to add or remove any refrigerant to install.

Refrigerant can still be recovered and re-used after treatment.

Part 2 - Study Details:

G - Notes on Data Collection

Seasonal Effects:

- Rooftop temperature data was matched to KPHX weather station data; it differs by a maximum of +/- 5 deg. F, but the average difference is 0.46 deg. F.
- Cooling Degree Day (CDD) analysis used base 65 CDD data. ECM ran various models and estimates the balance point of the building at 65 deg. F.
- All six (6) units are electric heat pumps and will likely also see heating energy savings. Heating energy savings were not considered for this study.

Short Cycling:

- AC-6 short-cycled and had short (~5 min.) run times during both pre- and post-treatment periods. Due to this, the kW/Ton analysis was inconclusive for AC-6.

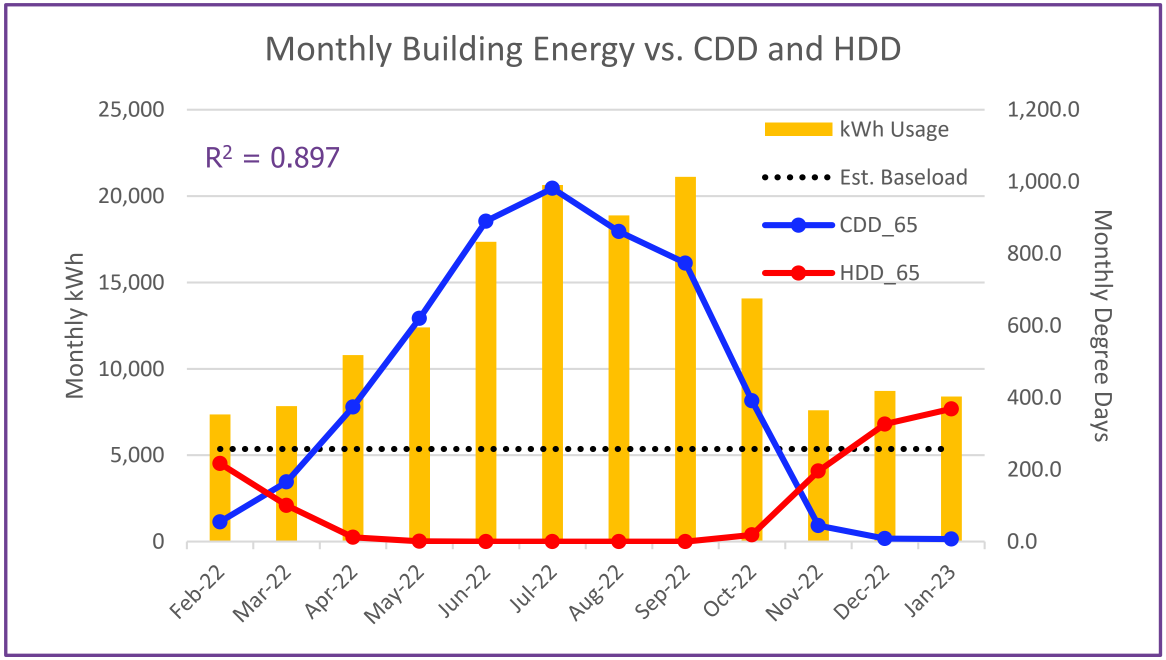
Part 3 - Analysis

Part 3 - Analysis:

A - Weather Sensitivity Analysis (Feb. '22 - Jan. '23)

Total Electric Usage:
155,000 kWh / year
$23,870 / year

Est. HVAC Energy:
90,000 kWh / year
$13,860 / year



58% of all electricity assumed for **HVAC**

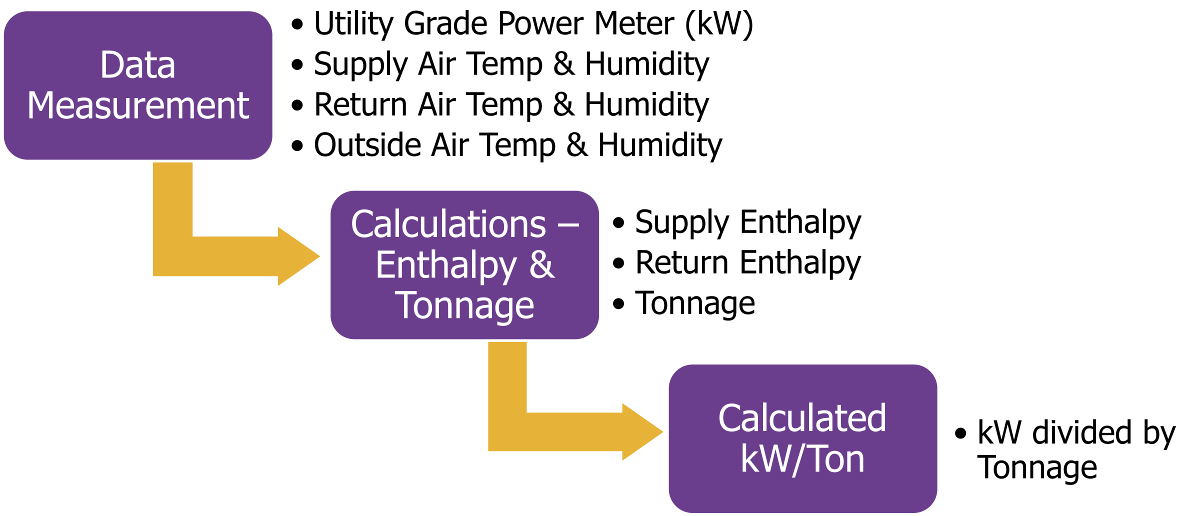
5,357 kWh estimated average monthly baseload (non-HVAC)

See Appendix A for more details on this analysis

Part 3 - Analysis:

B - HVAC Compressor kW/Ton Analysis

Power usage was analyzed against the change in enthalpy for each unit.



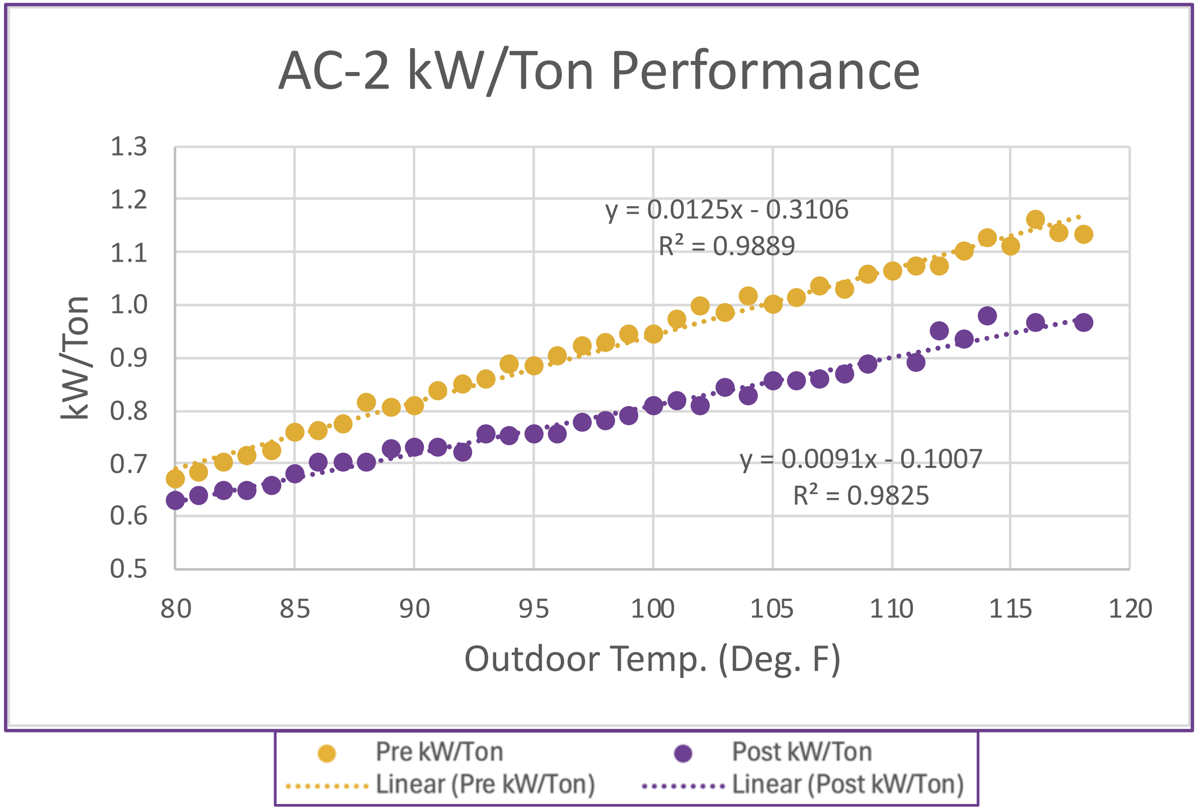
- Only steady state power readings after the first 5-10 min. and before the last 1-2 min. of compressor operation were analyzed (to mitigate outliers).
- AC-6 data was omitted because the compressor never reached steady-state; it short-cycled consistently throughout the pre- and post-treatment periods.

See Appendix B for more details on this analysis

Part 3 - Analysis:

B - HVAC Compressor kW/Ton Analysis (Cont'd)

14.9% average kW/Ton improvement observed across units AC-1 to AC-5.



AC-2 Example:

13.4% avg. improvement for this unit (AC-2) across observed temperatures

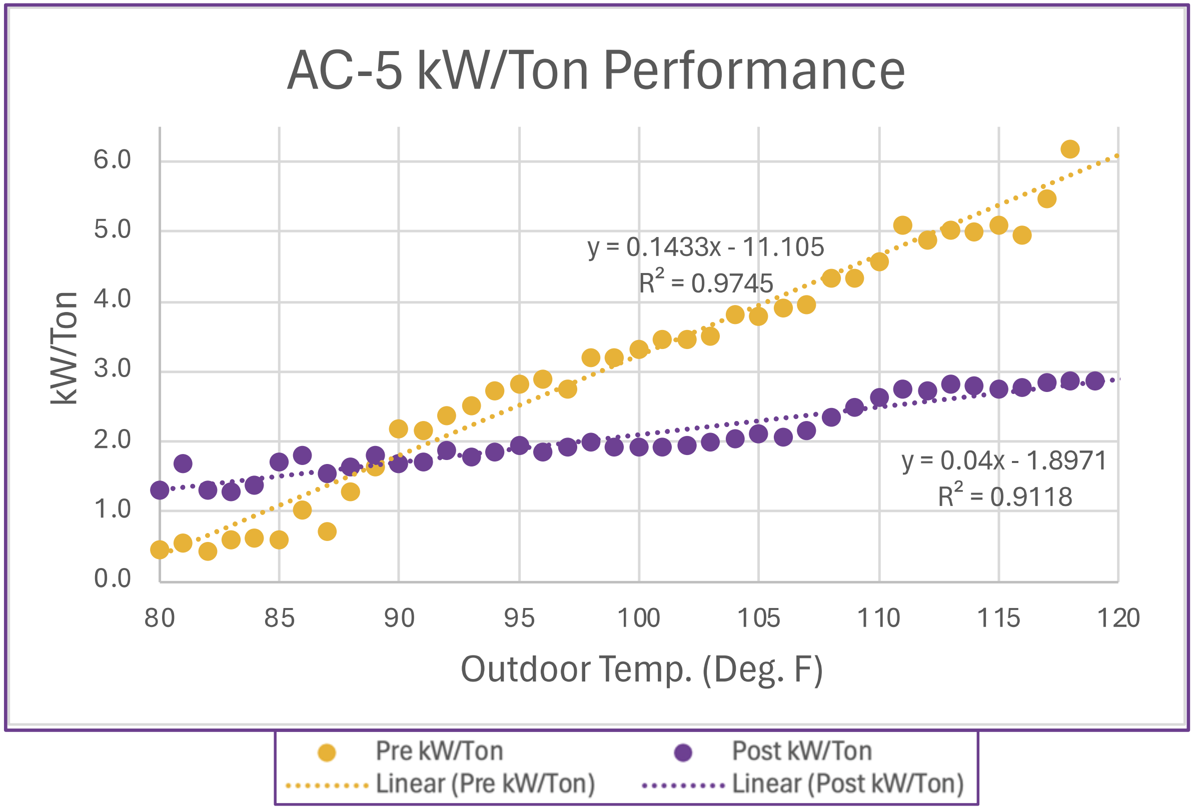
AC-2 is a 2-ton unit and had the most regular run times in the group. The avg. improvement of AC-2 was closest to the avg. improvement of all five units in the kW/Ton analysis.

See Appendix B for more details on this analysis including other units 1, 3, 4, 5 and 6

Part 3 - Analysis:

B - HVAC Compressor kW/Ton Analysis (Cont'd)

AC-5 performance changed significantly (40%). It is the only unit with a fixed orifice valve; it is highly probable that ThermaClear® removed deposits from inside the valve.



Pre-Treatment:
Over 6.5 kW/Ton peak power

Post-Treatment:
Under 3 kW/Ton peak power

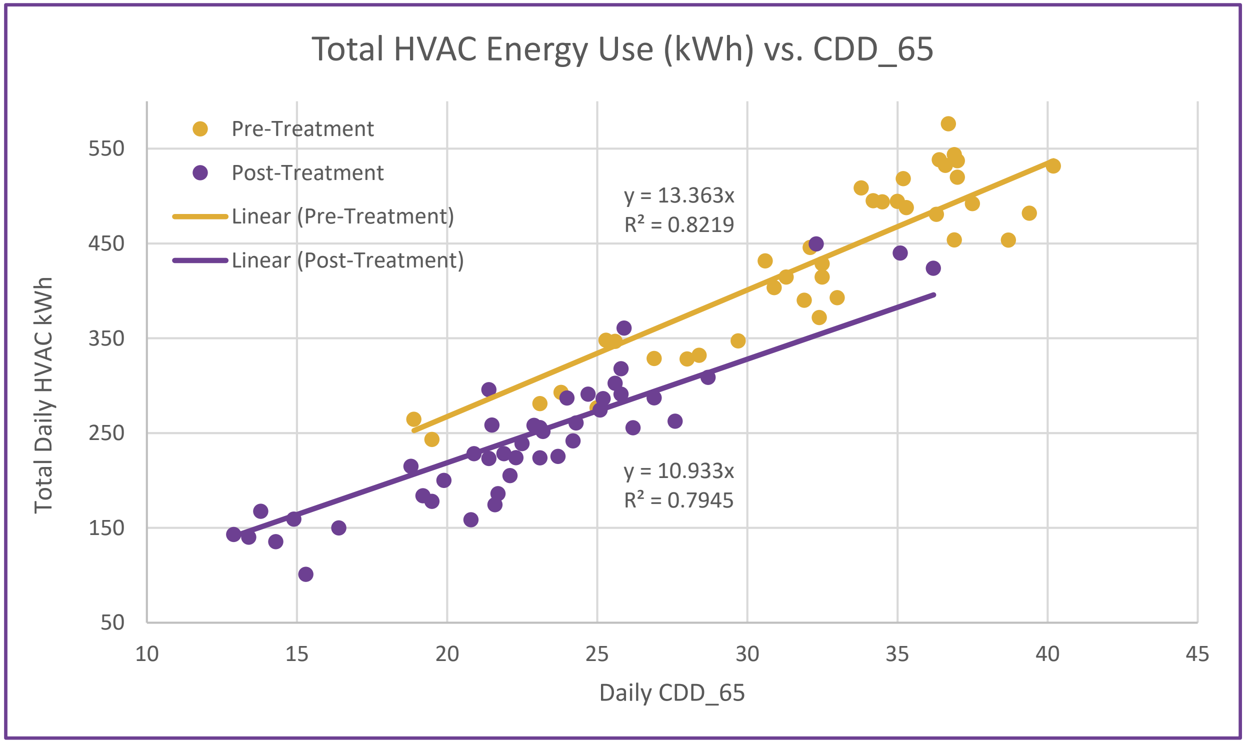
Carrier DX fixed orifice valves are known to be problematic; the valve was not taken apart to confirm this was the issue, however the unit ran considerably better post-treatment despite being <2 years old.

See Appendix B for more details on this analysis

Part 3 - Analysis:

C - Linear Regression of Total HVAC Energy (kWh) vs. CDD_{65}

17.73% Est. total annual HVAC cooling energy savings (kWh) across conditions



Pre-Treatment:
13.36 kWh per CDD

Post-Treatment:
10.93 kWh per CDD

Run-times also decreased beyond kW/ton efficiency, increasing total savings (kWh)

See Appendix C for more details on this analysis

Part 3 - Analysis:

D - Improved (Colder) Supply Air Temperatures

The difference between return and supply air temp. (ΔT) was analyzed for each value of outside air temp. to see if cooling performance improved in the building.

Unit	Tonnage	Improvement	Weighted %
AC-1	12.5	0.33%	4.10%
AC-2	2	7.30%	14.60%
AC-3	5	9.42%	47.08%
AC-4	3	7.39%	22.16%
AC-5	5	7.70%	38.50%
AC-6	10	5.59%	55.86%
Total Tons:	37.5		
Average Improvement Per Ton:			**4.86%**

Unit	Tonnage	Improvement	Weighted %
~~AC-1~~	~~12.5~~	~~0.33%~~	-
AC-2	2	7.30%	14.60%
AC-3	5	9.42%	47.08%
AC-4	3	7.39%	22.16%
AC-5	5	7.70%	38.50%
AC-6	10	5.59%	55.86%
Total Tons:	25		
Average Improvement Per Ton:			**7.13%**

- AC-1 had issues cycling its two compressors and was repaired prior to the pre-treatment period. There may still be other issues present because the ΔT remains well under the conventional target of 20 deg. F. and showed negligible improvement after treatment.

- Like the kW/Ton analysis, only temperature readings at steady state compressor operation were considered when computing the average improvement across the range of data points.

See Appendix D for more details on this analysis

Part 3 - Analysis:

E - Financial Analysis of ThermaClear® Treatment

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals:
kWh	0	0	0	804	1,390	1,819	2,863	2,523	1,886	1,268	423	0	**12,976**
($)	-	-	-	$124	$214	$280	$441	$389	$290	$195	$65	-	**$1,998**

Simple Payback from Energy Savings

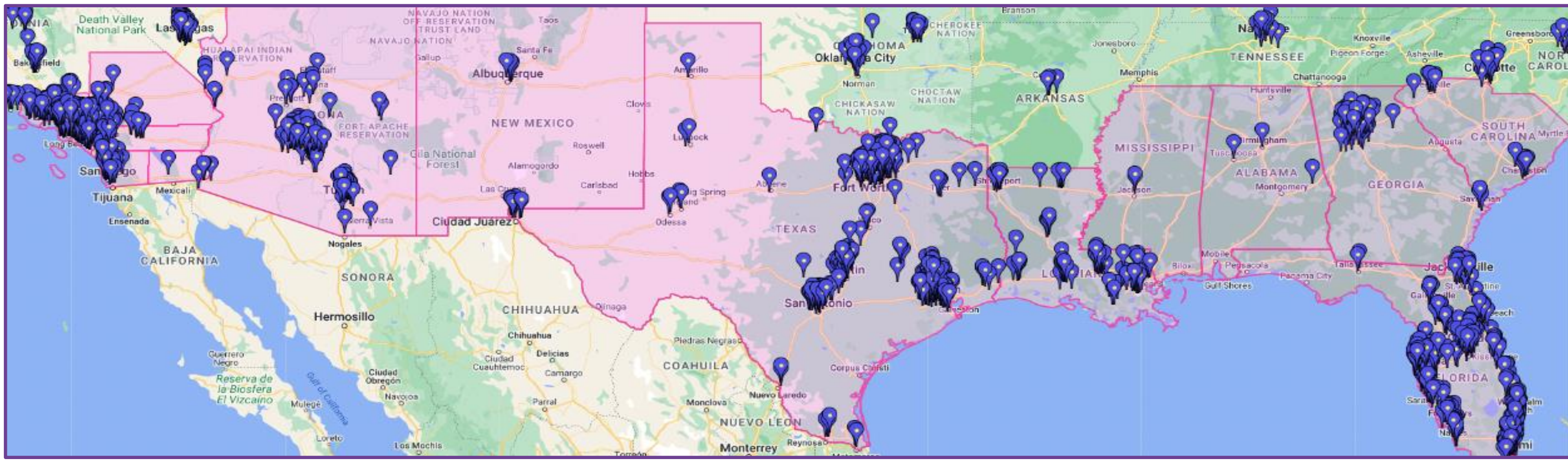
Tonnage	Price/Ton ($)	Total Cost ($)	Price/kWh ($)	Payback (Years)
37.5	$60	$2,250	$0.154	**1.13**

- Monthly kWh savings calculated from the regression models of kWh vs. CDD (Part C). Daily CDD_65 data for calendar year 2023 was used to project full-year (cooling season) results.
- Sites with low-cost electricity have a harder time justifying energy conservation measures. Blended electricity rates at $0.08/kWh can still achieve a simple payback of ~2 years.
- Cost savings related to heating energy and/or unscheduled HVAC repair calls were not analyzed, as no data was available to benchmark these points in the pre-treatment period.
- Additional benefits may accrue by extending the working lives of older HVAC compressors, allowing JPMC to reduce compressor-related repairs or defer larger capital replacements.

See Appendix E for more details on this analysis

Part 3 - Analysis:

F - Repeatability of ThermaClear® Treatment Results



- U.S. sunbelt locations will produce similar results (>4,000 CDD/ year)
  - Blended kWh pricing from $0.11 - $0.19 / kWh ($0.154 / kWh for pilot site)
- HI, CA and the northeast need less cooling but have highest energy cost
  - Blended kWh pricing from $0.20 - $0.40 / kWh (may accelerate paybacks)

Part 4 - Conclusions

Part 4 - Conclusions:

Summary and Takeaways

1. Estimated annual cooling energy (kWh) savings: **18%**
2. Average improved kW/Ton performance: **15%**
3. Increased "delta T" between supply and return air: **5-7%**
4. Estimated simple payback from kWh savings: **<1.2 yrs.**

Ancillary observations

✓ Compressor noise/vibration was noted to be audibly lower by Crawford's technician right after treatment (dB not measured).

ECM TECHNOLOGIES

Part 4 - Conclusions:

Estimated Energy and GHG Impacts

- ✓ Whole-building electricity savings of **8.4%** or **$1,998 per year**
- ✓ Scope 2 GHG savings of **4.83 Metric Tons $CO2_e$ per year**

Potential Operations & Maintenance Impacts

- ✓ Improved supply air temperatures contribute to improved occupant comfort. This can help reduce unscheduled HVAC service calls coming from dissatisfied occupants or employees.
- ✓ During routine maintenance, techs are less likely to add refrigerant if the ΔT between supply and return air is closer to 20 deg. F.
- ✓ Compressor motors may experience longer life expectancy through improved lubrication, reduced run time, and less vibration/noise.

Part 4 - Conclusions:

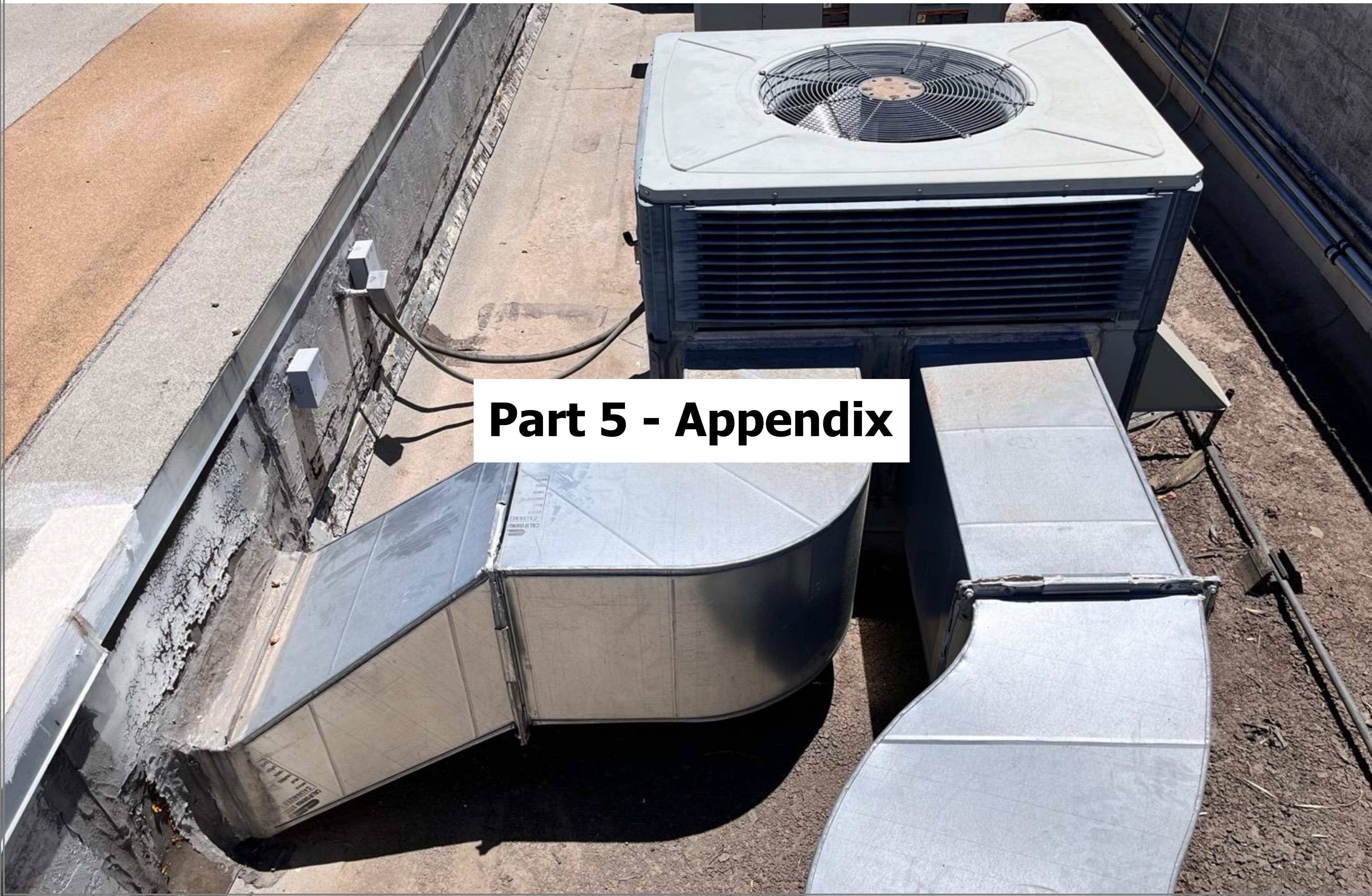
Potential to Scale Impacts

- ✓ No training or coordination required for building occupants
- ✓ A licensed HVAC technician can treat a unit in **10-15 min.**
- ✓ Savings largely a function of tonnage, $/kWh, and operating hours
- ✓ Wide-scale implementation reasonably achieved in 2-4 months
  - ✓ Decarbonization benefits could be validated in <6-12 months

Potential to Validate Longer-Term Benefits

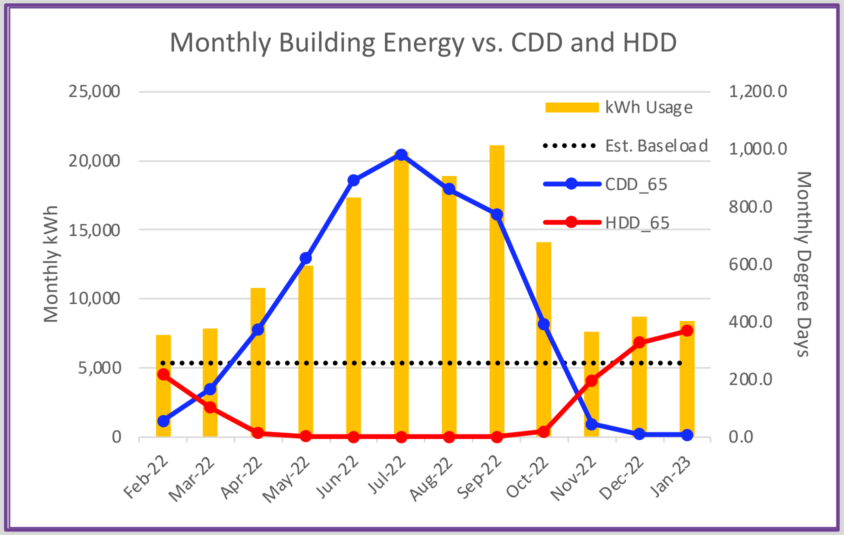
- ✓ JPMC should work with property management (CBRE) to observe and assess long-term performance of the ThermaClear® treatment by collecting occupant feedback, observing maintenance trends, and the comparing the service life of these units to peer sites.

Part 5 - Appendix



APPENDIX:

A - Utility and Weather Sensitivity Analysis



Descriptive Statistics:

	Coefficient	Std. Error	p-value	t-value
Intercept (Const.):	5,357.13	1,936.44	0.022	2.766
CDD_65	15.649	2.713	0.000	5.768
HDD-65	8.022	7.424	0.308	1.080
R^2 Value:	**0.897**	**Adjusted R^2 Value:**		**0.874**

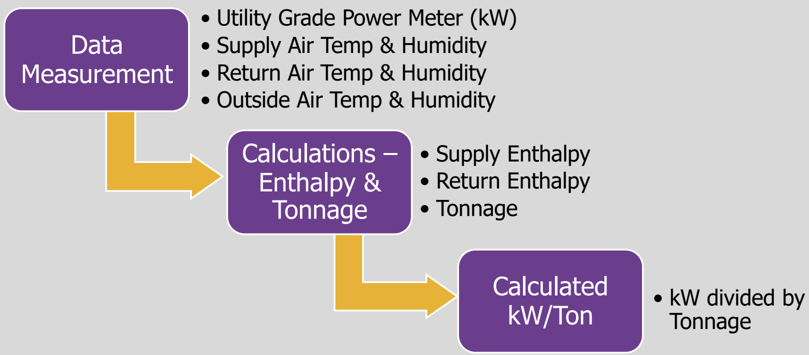
- The chart represents one (1) year of utility and weather data from Jan. '22 to Feb. '23, which was used to estimate the baseload annual energy of the building.

References/Notes:

1. Monthly Heating Degree Days (HDD) and Cooling Degree Days (CDD) were sourced from http://www.degreedays.net/ using a base temperature of 65 degrees and KPHX Sky Harbor Weather Station Data.
2. Multiple base temperatures were tested ranging from base 61 to base 74 degrees F. to fit the balance point of the building. None of the other base temperatures showed a statistical improvement over Base 65 CDD/HDD.
3. Monthly utility data for the site was provided in spreadsheet format by JPMC. Hardcopy utility bills were not analyzed.

APPENDIX:

B - HVAC Compressor kW/Ton Analysis



References/Notes:

1. Only steady state operation was analyzed. The first 5-10 min. and last 1-2 min. of run times were effectively omitted for each compressor cycle.
2. Each unit was instrumented with discrete sensors, so it was possible to filter out the abnormal kW/Ton operating data for AC-1 through AC-5 and capture valid data points going back to 6/10/2023. The statistical confidence of each individual unit analysis was improved by the added data points prior to 8/1/2023. All other analyses start on 8/1.

Enthalpy and Tonnage Calculation:

ENTHALPY (h) – 5^{th} Order Polynomial to Estimate Psychometric Chart Values with 99% Accuracy

$$h = 0.24*TDB+(0.6219)*(0.01*(7.401234E-9*TDB^4 - 4.93526794E-7*TDB^3 + 7.1281097208E-5*TDB^2 - 4.89806163078E-4*TDB + 0.039762055806989)*RH)/(14.7-(0.01*(7.401234E-9*TDB^4 - 4.93526794E-7*TDB^3 + 7.1281097208E-5*TDB^2 - 4.89806163078E-4*TDB + 0.039762055806989)*RH))*(1061.2+0.444*TDB)$$

Where

TDB = Dry-bulb Temperature (°F)
RH = Relative Humidity (%)

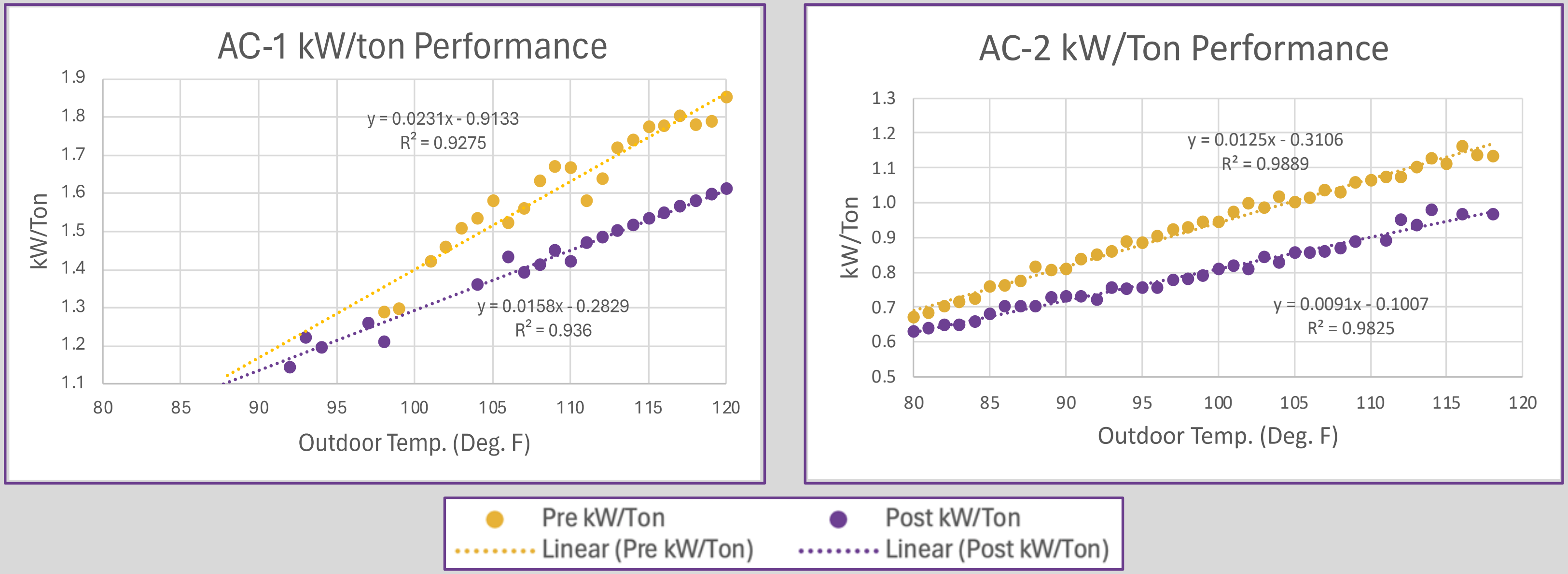
TONNAGE

Tons = h * CFM * 4.5 / 12,000

Where
h = Enthalpy
CFM = Cubic feet per minute of air flow

APPENDIX:

B - HVAC Compressor kW/Ton Analysis (Cont'd)



AC-1 Avg. Improvement: 10.08%

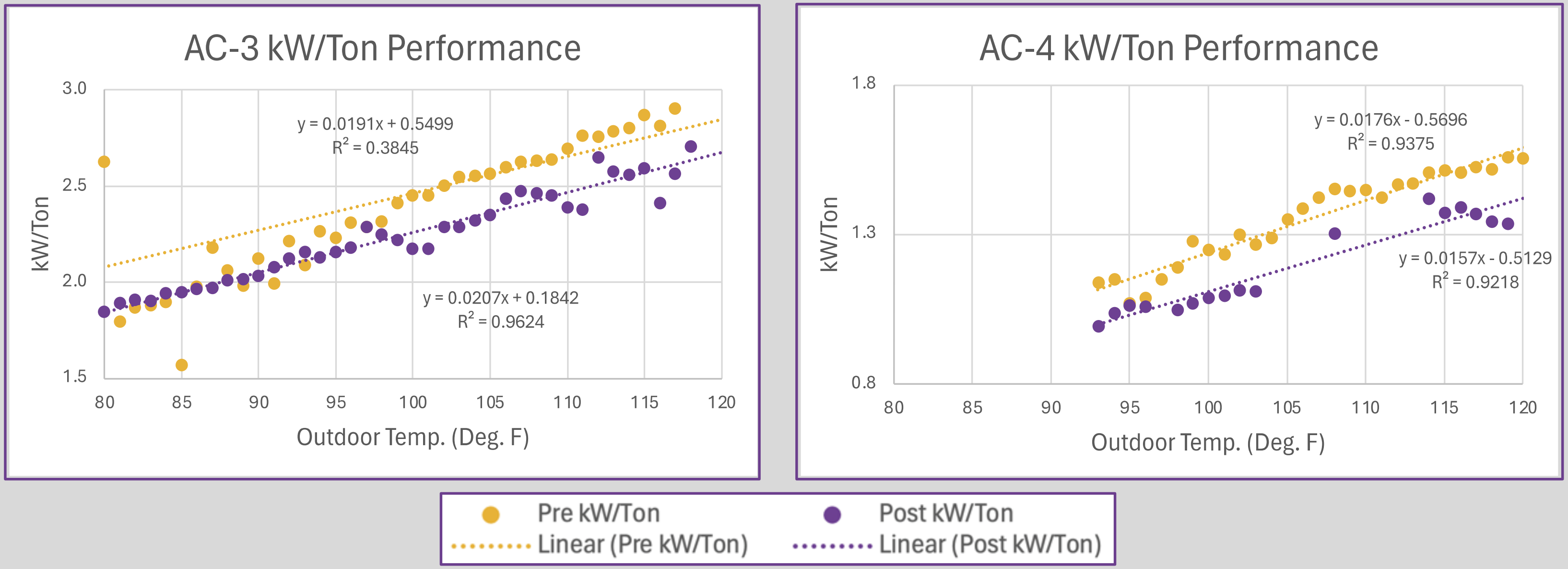
- AC-1 had thermostat issues that were repaired prior to the pre-treatment period, which had caused the compressors to cycle erratically.
- This is the only unit that has two (2) refrigerant compressors, which appeared to cycle abnormally

AC-2 Avg. Improvement: 13.41%

- AC-2 operating data was the most consistent out of the six (6) AC units and appears to be least impacted by neighboring units and/or overall building load.
- AC-2 performance gain is closest to the overall average gain of AC units 1-5 combined (14.9%)

APPENDIX:

B - HVAC Compressor kW/Ton Analysis (Cont'd)



AC-3 Avg. Improvement: 7.38%

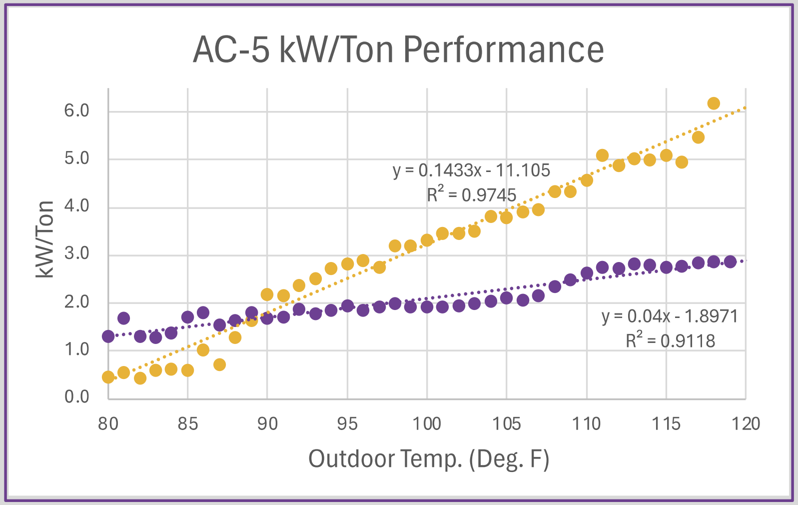
- AC-3 data shows points of high energy consumption at lower outdoor temperatures in the pre-treatment phase. It is likely that the internal loads for this thermal zone shifted after treating neighboring units.
- If other units are now cooling their zones better, this unit may now be less affected by internal loads.

AC-4 Avg. Improvement: 6.12%

- Return air temp. and humidity readings showed that the return air became much cooler (+12%) and more humid (+39%) post-treatment. This causes a unit to work harder, so AC-4 savings may be understated.
- AC-4 still saw a 6.23% increase in average ΔT between supply/return air despite higher humidity

APPENDIX:

B - HVAC Compressor kW/Ton Analysis (Cont'd)



AC-5 Avg. Improvement: 40.36%

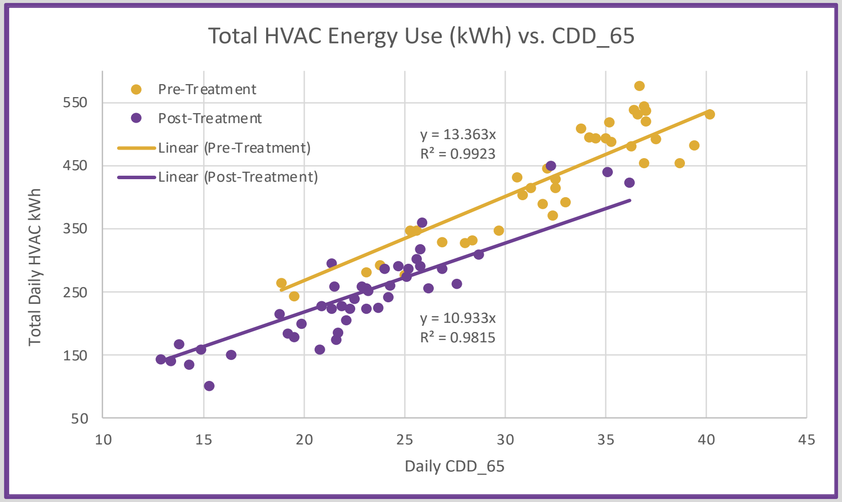
- AC-5 is the only unit with a fixed metering device; the orifice is subject to fouling/clogging which can create significant performance loss. 5-6 kW/Ton for a new 5-Ton DX rooftop unit is sub-par performance.
- The change in kW/Ton indicates a possible clearing of the orifice as a result of ThermaClear® treatment.

AC-6 Avg. Improvement: N/A

- AC-6 ran short cycles during the pre- and post-treatment periods and did not run long enough to stabilize performance data for the kW/Ton analysis.
- kWh usage generally decreased post-treatment, from kW/Ton improvement and/or reduced run-times from neighboring units cooling their adjacent zones better.

APPENDIX:

C - Linear Regression of Total HVAC Energy (kWh) vs. CDD_{65}



Descriptive Statistics:

Pre-Treatment	Coefficients	Std. Error	t Stat	P-value
Intercept	-	-	-	-
CDD_65	13.363	0.193	69.211	9.548E-41
R^2 Value:	0.992	Adjusted R^2 Value:		0.965

Post-Treatment	Coefficients	Std. Error	t Stat	P-value
Intercept	-	-	-	-
CDD_65	10.933	0.229	47.781	6.665E-39
R^2 Value:	0.992	Adjusted R^2 Value:		0.958

References/Notes:

1. Daily Heating Degree Days (HDD) and Cooling Degree Days (CDD) were sourced from http://www.degreedays.net/ using a base temperature of 65 degrees and KPHX Sky Harbor Weather Station Data. This data differed from local OAT sensor data by a maximum of +/- 5 deg. F. and an average of 0.46 deg. F. across the measurement periods.

2. Both models indicate a strong relationship between CDD_65 and kWh Total the two (2) periods examined. The standard errors are relatively low compared to the coefficients, which implies some reliability of the coefficient estimates.

APPENDIX:

D - Improved Supply Air Temperatures

Notes:

1. Supply and return air temperatures were recorded from sensors mounted inside the supply and return air ducts of each unit

2. The temperature difference (ΔT) between these two temperature readings indicates how well the cooling coils were bringing down the supply air temperatures at any given return air temperature.

3. The results were then grouped according to each specific outside air temperature (OAT) ranging from 75 degrees F. to 104 degrees F. and averaged for each discrete OAT, then in total for each unit.

4. Paired t-tests were performed to measure the statistical significance of the difference in ΔT post-treatment versus pre-treatment. The p-value was found at.00000000535, well below the common significance threshold of 0.05. This suggests that there is a statistically significant difference in the ΔT values between the pre-treatment and post-treatment periods for the given range of OAT temperatures.

5. Detailed data tables used for the analysis are on the next slide .

6. AC-1 still operated abnormally during the pre-treatment period, despite the Thermostat repair. It is possibly that there are other issues (ductwork) that inhibited the improvement to ΔT for AC-1.

APPENDIX: D - Improved Supply Air Temperatures (Cont'd)

OA Temp. (Deg. F)	AC-1 Average ΔT		AC-2 Average ΔT		AC-3 Average ΔT		AC-4 Average ΔT		AC-5 Average ΔT		AC-6 Average ΔT	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
75	12.84	11.52	24.15	25.91	17.75	23.01	25.33	28.47	13.14	17.63	16.22	16.28
76	13.90	11.50	23.60	25.12	17.81	22.44	26.47	28.45	15.25	14.92	16.08	17.04
77	11.78	11.47	23.34	26.02	16.06	22.35	27.23	30.17	15.47	15.71	16.09	16.78
78	11.68	11.49	22.61	25.65	16.01	22.27	25.89	29.84	14.35	17.86	15.55	17.71
79	11.08	11.46	22.41	25.38	18.32	21.77	25.17	29.54	14.46	18.29	15.72	17.58
80	10.99	11.64	22.73	24.46	17.01	22.37	25.86	28.74	15.29	16.13	16.71	17.76
81	10.77	11.59	22.56	25.57	19.33	21.39	25.24	28.90	14.53	19.05	15.91	18.47
82	10.70	11.69	22.28	25.39	19.17	21.84	24.90	29.08	14.13	16.13	16.00	17.87
83	10.74	11.76	21.79	25.19	19.65	22.15	24.99	28.76	15.68	17.79	16.02	18.30
84	11.11	11.72	22.59	25.13	19.68	21.28	25.26	28.66	15.24	16.67	16.23	17.52
85	11.22	11.95	22.79	24.57	19.56	21.28	26.02	28.37	15.90	17.31	16.90	18.24
86	11.71	12.19	22.82	24.65	19.68	21.01	25.89	28.46	14.22	17.71	16.64	17.13
87	11.20	11.39	22.44	24.67	18.52	20.82	25.88	28.38	15.06	16.92	16.36	18.05
88	11.42	11.34	22.75	24.47	19.44	21.27	25.80	28.11	15.65	16.46	16.73	17.75
89	11.85	11.34	22.78	23.88	19.06	21.27	26.02	27.67	15.75	16.54	16.82	17.36
90	11.95	11.60	22.77	23.84	19.49	21.09	25.77	27.28	15.16	16.29	16.82	17.68
91	12.00	11.93	22.64	24.77	19.75	20.77	25.73	27.23	15.78	16.27	16.98	17.65
92	12.32	12.29	22.51	24.10	19.35	20.28	25.55	27.30	16.29	16.07	16.79	18.09
93	12.38	12.49	22.48	23.66	18.87	20.51	25.68	27.44	15.99	16.37	17.11	17.63
94	12.22	12.36	22.57	23.91	18.85	20.30	25.82	27.12	15.47	16.20	17.35	18.08
95	12.43	12.95	22.42	24.30	19.51	20.56	25.69	27.04	15.62	16.12	17.00	16.95
96	12.35	12.68	22.52	23.68	19.26	20.54	25.56	26.87	14.90	16.21	17.16	18.14
97	12.94	12.15	22.35	23.52	19.16	19.82	25.52	26.64	15.71	16.02	17.03	17.27
98	-	-	22.43	23.33	19.28	20.06	25.36	26.39	15.72	16.03	17.11	17.68
99	-	-	22.56	23.61	19.59	20.23	25.47	26.25	15.42	16.21	17.24	18.01
100	-	-	22.43	23.71	19.27	20.57	25.18	26.14	15.25	16.19	17.08	17.50
101	-	-	22.40	23.68	19.23	20.66	25.25	25.94	15.63	16.19	17.26	18.00
102	-	-	22.49	23.76	19.55	19.88	25.29	25.85	15.49	15.81	17.22	17.62
103	-	-	22.50	23.43	19.47	20.28	25.08	25.59	15.34	16.05	17.16	17.80
104	-	-	22.36	23.67	19.13	20.06	24.79	25.50	15.18	15.57	17.32	17.84
105	-	-	22.36	23.40	19.35	20.21	24.73	25.49	15.50	15.80	17.26	18.08
106	-	-	22.38	23.30	19.34	19.06	24.51	25.48	15.37	16.12	17.36	17.76
107	-	-	22.37	23.18	19.38	17.75	24.45	25.38	15.26	15.94	17.35	18.10
108	-	-	22.34	23.23	18.81	18.65	24.39	25.23	15.14	15.56	17.48	18.51
109	-	-	22.13	22.98	19.06	18.94	24.29	25.08	14.81	14.95	17.40	18.56
110	-	-	21.88	22.68	19.29	19.52	24.38	25.17	14.80	15.07	17.44	17.90
Avg. ΔT	11.81	11.85	22.57	24.22	18.95	20.73	25.40	27.28	15.22	16.39	16.80	17.74
% Increase ΔT:	0.33%		7.30%		9.42%		7.39%		7.70%		5.59%	

AC-1 ΔT temperature readings were unavailable >97 deg. F due to abnormal operation of the unit/T-stat during hot days

APPENDIX:

Detailed HVAC Unit Information

Label #	Make	Type	Model	Serial Number	Tonnage	Compressors	Manufactured	Age (Years)	Refrigerant	Refrig. Charge (lbs)
AC-1	Trane	DX Heat Pump	WCH150B3006B	707100837D	12.5	2	Feb-2007	16.7	R-22	23.3
AC-2	Trane	DX Heat Pump	4WHC3024A1000	10304MSU3H	2	1	Jul-2010	13.3	R-410A	8.12
AC-3	Trane	DX Heat Pump	4WCC3060A30000AA	85041D89H	5	1	Dec-2008	14.8	R-410A	10.11
AC-4	Trane	DX Heat Pump	4WCZ6036A30000AA	10123HST9H	3	1	Mar-2010	13.6	R-410A	7.13
AC-5	Carrier	DX Heat Pump	50FCQA06A2A5A0A0A0	322206827	5	1	Aug-2022	1.2	R-410A	14.8
AC-6	Trane	DX Heat Pump	WSC120H3ROA26	215110868L	10	1	Dec-2021	1.8	R-410A	16.3

HVAC Unit Information References:

1. HVAC unit data provided by JPMC and verified at each individual unit in the field by ECM and Crawford Mechanical.
2. Refrigerant charges were not measured; reported data is used above.
3. AC-1 issues were reported by Crawford Mechanical June ’23 and addressed by CBRE (property management) in July ‘23

Source of GHG Carbon-Equivalent Conversions:

1. The U.S. EPA’s Emissions & Generation Resource Integrated Database (eGRID) was used to derive GHG emissions content for electricity in the 85282 zip code by using their “Power Profiler” tool, available at https://www.epa.gov/egrid/power-profiler - / . A value of 0.8197 lbs $CO2_e$ per kWh was cited for the 85282 area.

ECM
TECHNOLOGIES