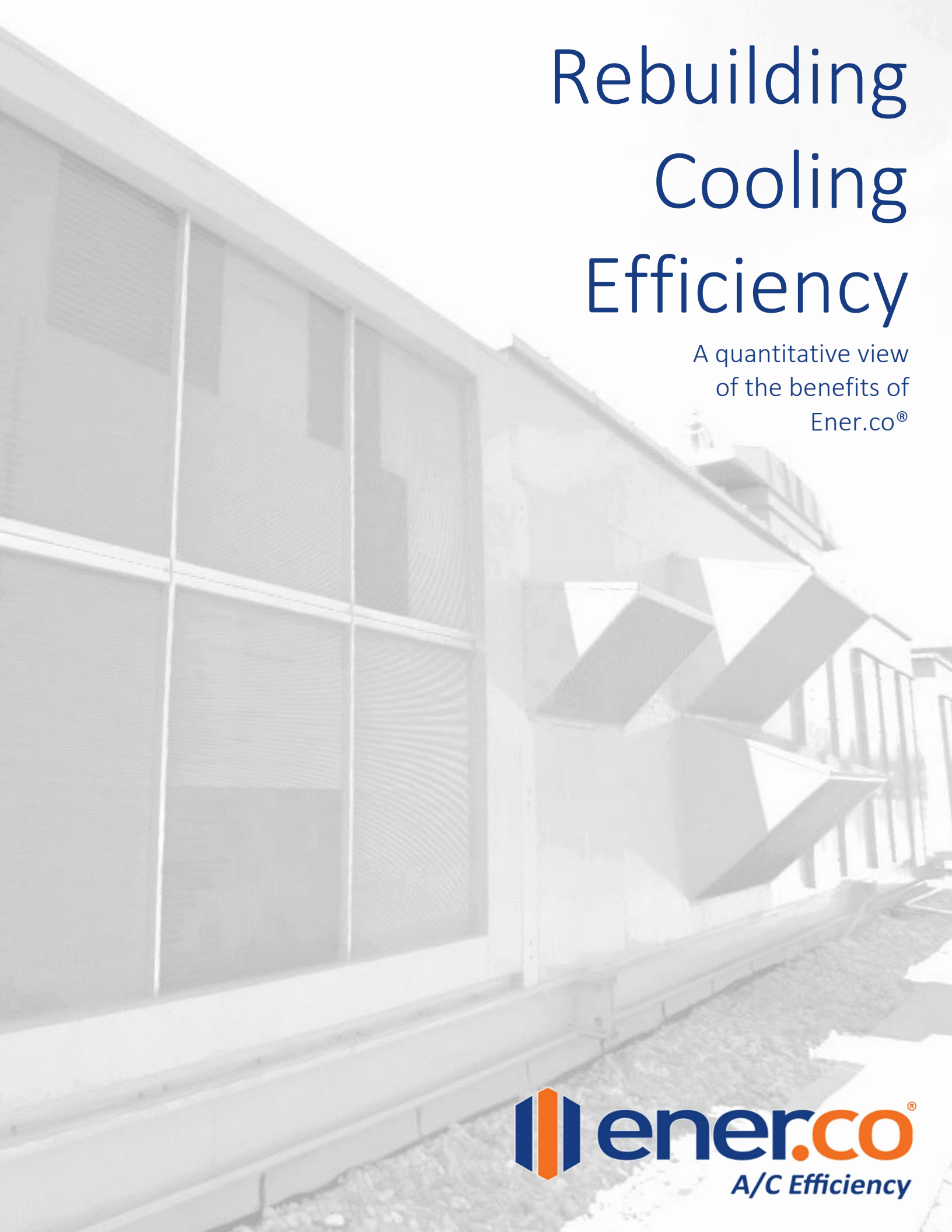
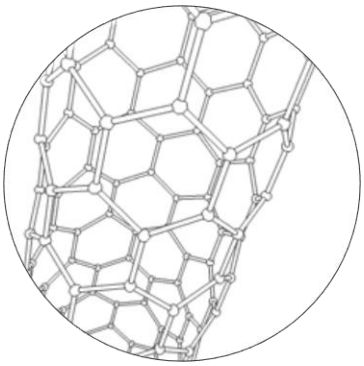


Rebuilding Cooling Efficiency

A quantitative view of the benefits of Ener.co®

ener.co®
A/C Efficiency

Rebuilding Cooling Efficiency



Our mission.

Existing buildings consume more than 60% of the nation's electricity. They deserve to receive as much attention from the clean technology community as new buildings do. Unfortunately, they don't. Our mission is to bring cutting edge clean tech solutions to the existing buildings' marketplace. We reduce energy consumption, curtail capital expenses, trim maintenance costs, and curb environmental impact while improving building comfort and indoor air quality. And by doing all of that, we enhance property values.

Air-cooled heat exchangers lie at the heart of the energy efficiency of the air conditioning system of any building. Ener.co's flagship product is Enercoat™, a graphene nano-polymer coating that provides complete protection from corrosion while simultaneously enhancing the thermal conductivity of any air-cooled heat exchanger.

Volatile weather and environmental conditions as well as airborne dirt and debris threaten outdoor cooling equipment. The exposed surface of an untreated heat exchanger coil begins to corrode from day one. Just 10 years of corrosion can impair thermal performance in a coil by 30% to 50%. The American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) estimates a 3 - 5% loss in efficiency per year. Figures 1 and 2 below illustrate significant improvements in efficiency and cooling capacity– an over 10% reduction of peak demand and electrical consumption and an even greater increase in output and efficiency.

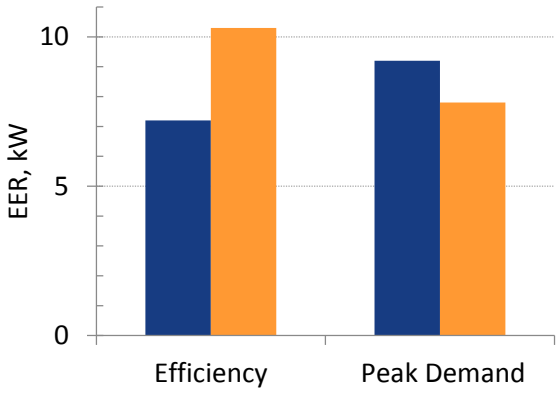


Figure 1: Higher EER and lower peak demand

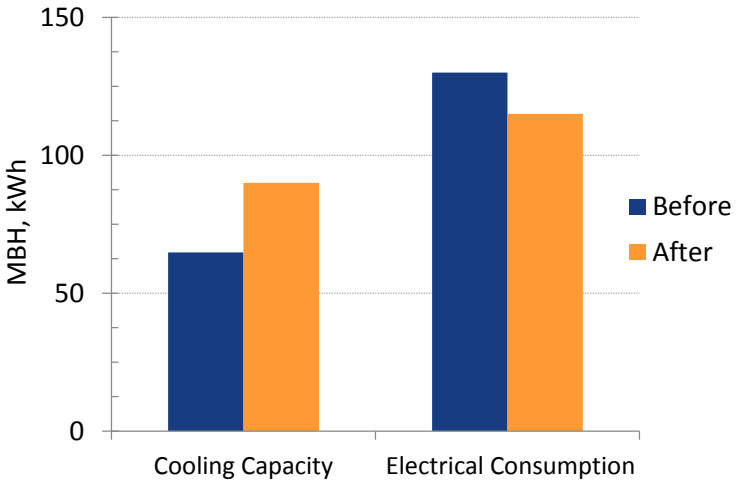


Figure 2: Restored capacity and reduced consumption

Proven results.

When applied as part of our restoration service, our coating treatment is proven to bolster energy efficiency ratios of air-cooled systems from upwards of 20%, yielding a simple payback in one to three years. Performance has been tested globally by third party engineers according to the IPMVP® Option B – ECM isolation protocol. Applying the Ener.co® coating on condenser coils of air-cooled systems can effectively restore a unit's efficiency close to original performance. Further loss in efficiency from heat transfer surface deterioration can be averted, reducing energy bills and the cost of repairing and replacing equipment.

Who can benefit from Ener.co®?

Our coatings are suitable for use on all air-cooled heat exchangers. Original equipment manufacturers (OEMs) can spray-treat or dip before product delivery. End users can have new equipment in-factory treated. Existing HVAC equipment can be treated as part of restoration and maintenance projects.

Independent testing and verification.

Our superior performance is test-verified for thermal conductivity and diffusivity per ASTM 1461 as carried out by Dynalene Labs. Multiple high-level efficiency demonstrations have included data centers, hospitals, factories and pharmaceutical facilities. Our products have delivered on 3,000+ hours of the accelerated corrosion test ASTM B117 conducted by Intertek. Our products have been evaluated by the EPA and state regulatory agencies for component compliance and are low-VOC.

This document serves to reveal the findings gathered from years of field monitoring that establish the effectiveness of Ener.co® on air-cooled heat exchangers. Peak-power demand and electricity consumption reduction along with restored cooling capacity and EER are discussed in detail.

Figure 3: Condenser coil before Ener.co® treatment

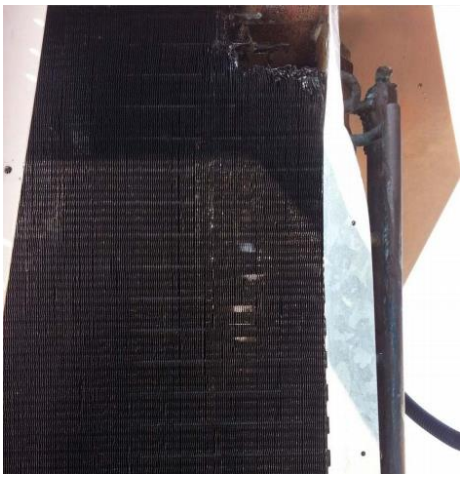


Figure 4: Condenser coil after Ener.co® treatment

Curtail Your Demand

When it counts.

A building's peak electrical demand (kW) occurs during the hot summer months when the outdoor temperature and humidity climb causing air-conditioning to run in high gear. Utilities charge customers a premium for electrical power during these peak periods, and so it is in the best interest of energy managers and facility operators to keep the building's power demand profile to a minimum.

Cooling systems can add up to 40% of a facility's maximum electrical demand. Our treatment process has been proven to reduce the electrical demand of air-cooled AC systems by up to 17% – a large share of a site's load profile. Figure 5 below summarizes the findings for air-cooled AC units that compare peak power draw before and after the treatment process. The coil condition is based on the average of three metrics based on a scale from 1 to 5: the level of corrosion, amount of debris, and fin alignment. Bubble area represents the capacity of the unit ranging from 7.5 to 80 tons. Typically, poorer conditions offer larger opportunities for demand reduction.

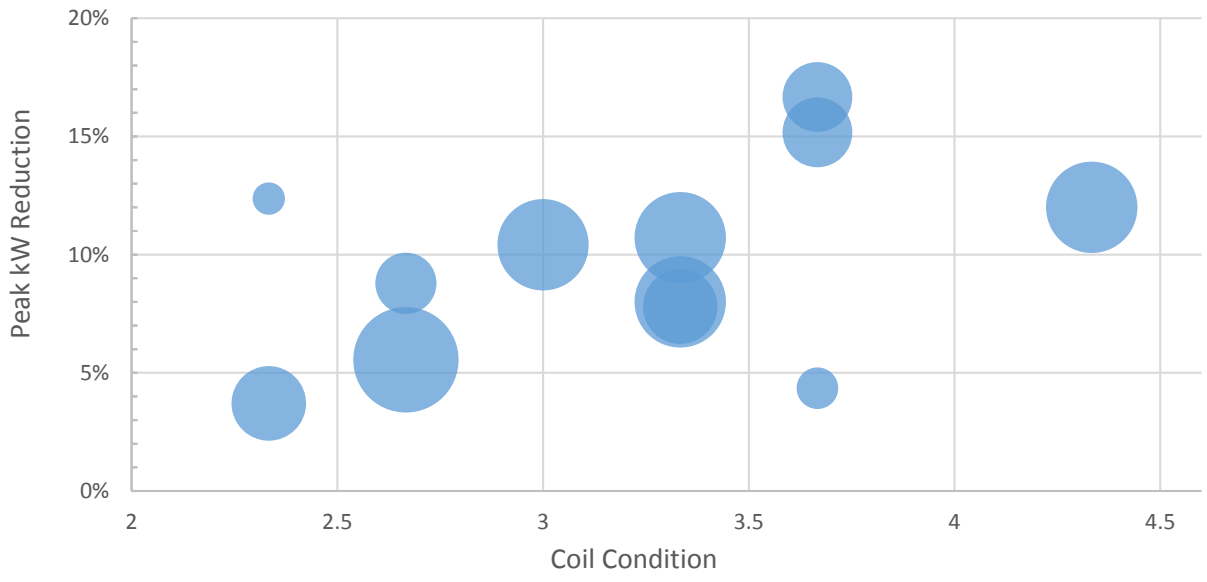
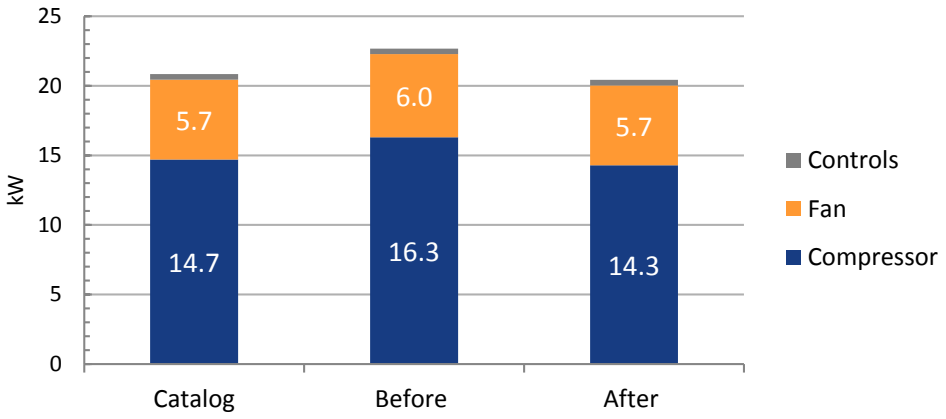


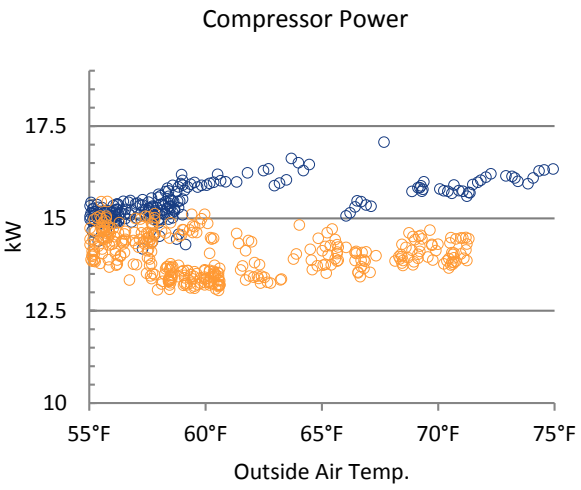
Figure 5: Peak power demand reduction vs. coil condition

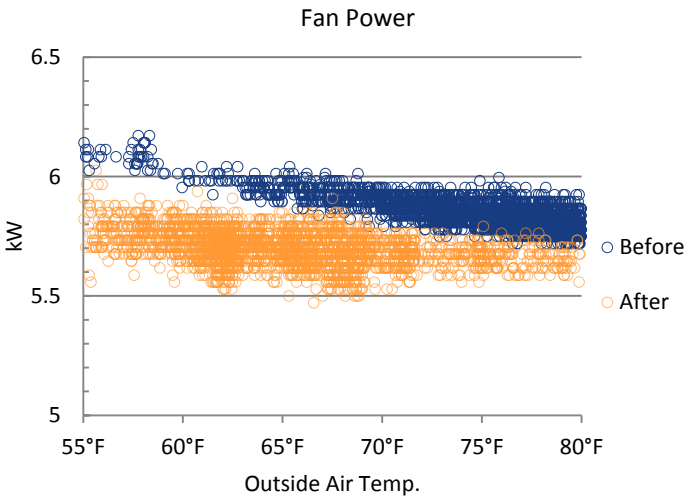
Healthier coils mean healthier compressors and fans.

Component break-down of fan and compressor energy use for an air-cooled chiller is presented in Figure 6 below. Of the total peak kilowatt reduction of 10%, 87% of the drop in power was compressor power, and the other 13% was fan power. Figure 6 below summarizes the findings. Following our treatment, an increase in the heat rejection capacity of the condenser coil results in a lower operating head pressure of the compressors, and therefore a reduction of their power draw. Further, realignment of the aluminum fins increases the aerodynamic efficiency of the coil allowing the condenser fans to pass the same amount of air at a lower power draw.

And lower power draw equates to less compressor and fan use, and therefore less wear and tear on the equipment. Owners could expect savings in life extension of not only the coil itself, but also the compressors and fans.







Figures 6 (top), 7 (left), and 8 (right): Electrical sub-metering summary – reduction by component

Reclaim Your Capacity

A ton today, gone tomorrow.

Our treatment technology offers a proven solution to revive cooling systems and recover lost capacity. Figure 9 below logs the cooling capacity of a five-ton, 20-year-old AC unit during the weeks both preceding and following treatment. Sensible capacity reflects the energy drop in the air temperature. Latent capacity removes moisture from the air.

The unit in Figure 9 was unable to meet the cooling load and left the conditioned space warm and humid. After the treatment, the unit regained its original capacity and maintained a cool and dry building space.

Remove moisture and improve thermal comfort.

Latent cooling capacity has been demonstrated to improve vastly after treatment. A healthier heat exchanger coil results in a cooler, drier, and more comfortable space per the ASHRAE 55 human thermal comfort index. Indoor air quality is vastly improved. An increased heat rejection capacity of the condenser coil promotes a lower evaporator coil temperature due to extra subcooling of refrigerant. The air entering this coil from the conditioned space is more prone to reaching its dew point temperature, and the result is the removal of its moisture (latent heat).

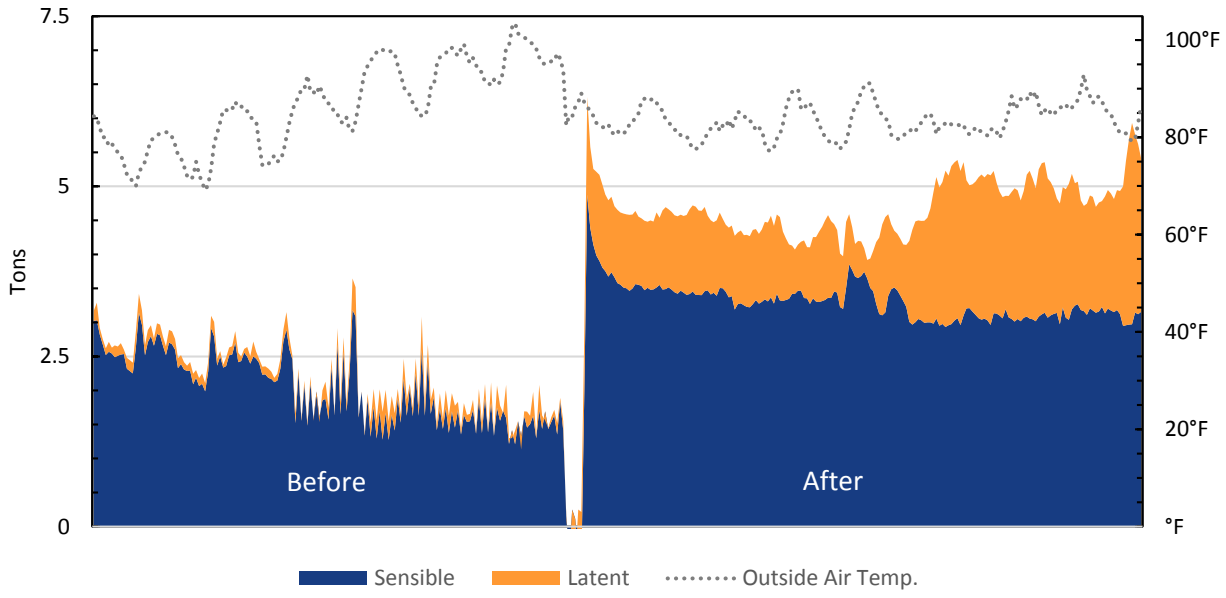
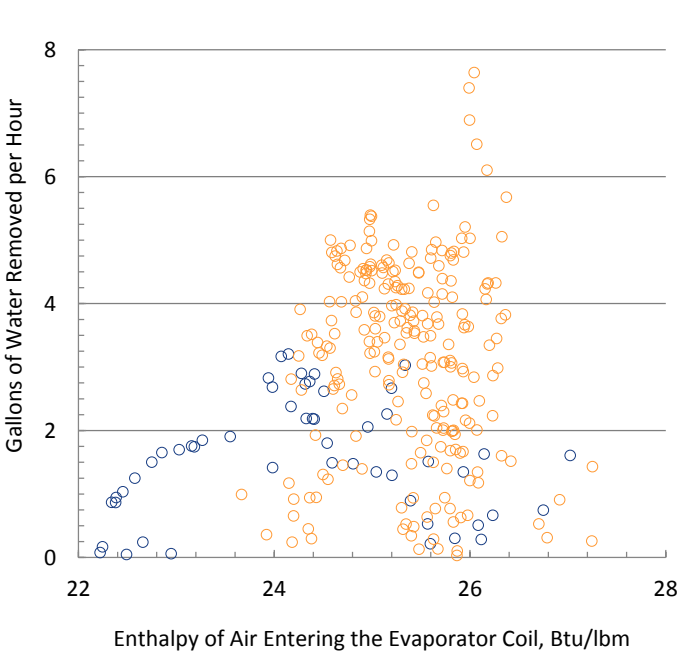


Figure 9: Increased sensible and latent cooling capacity for a 20-year-old five ton unit (two week comparison)

The moisture removal chart shown in Figure 10 below shows a large increase in moisture removal measured in gallons per hour after the treatment based on the enthalpy of the airstream entering the cooling coil. Further evidence can be seen Figure 11 that shows the psychrometric properties of air leaving the evaporator coil before and after the treatment. The ability of the evaporator to remove moisture from the passing airstream can be measured by the tendency of air to approach the 100% relative humidity saturation line.



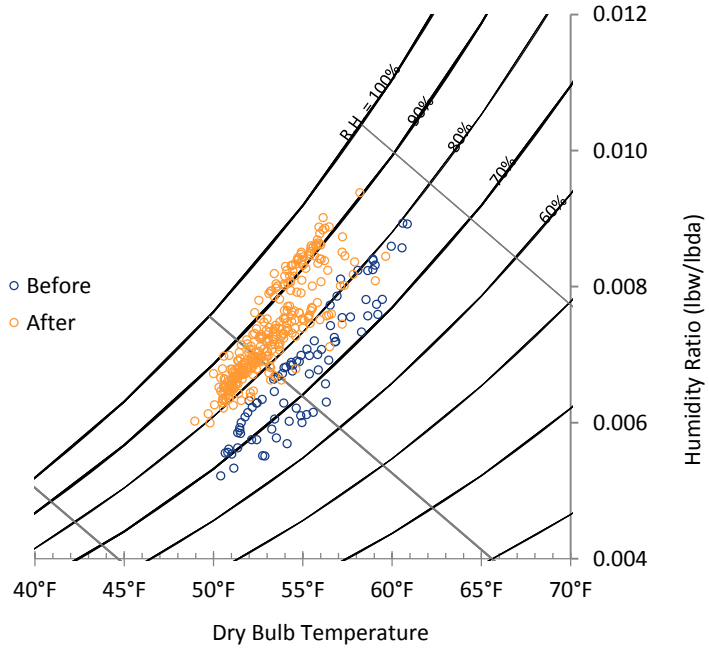
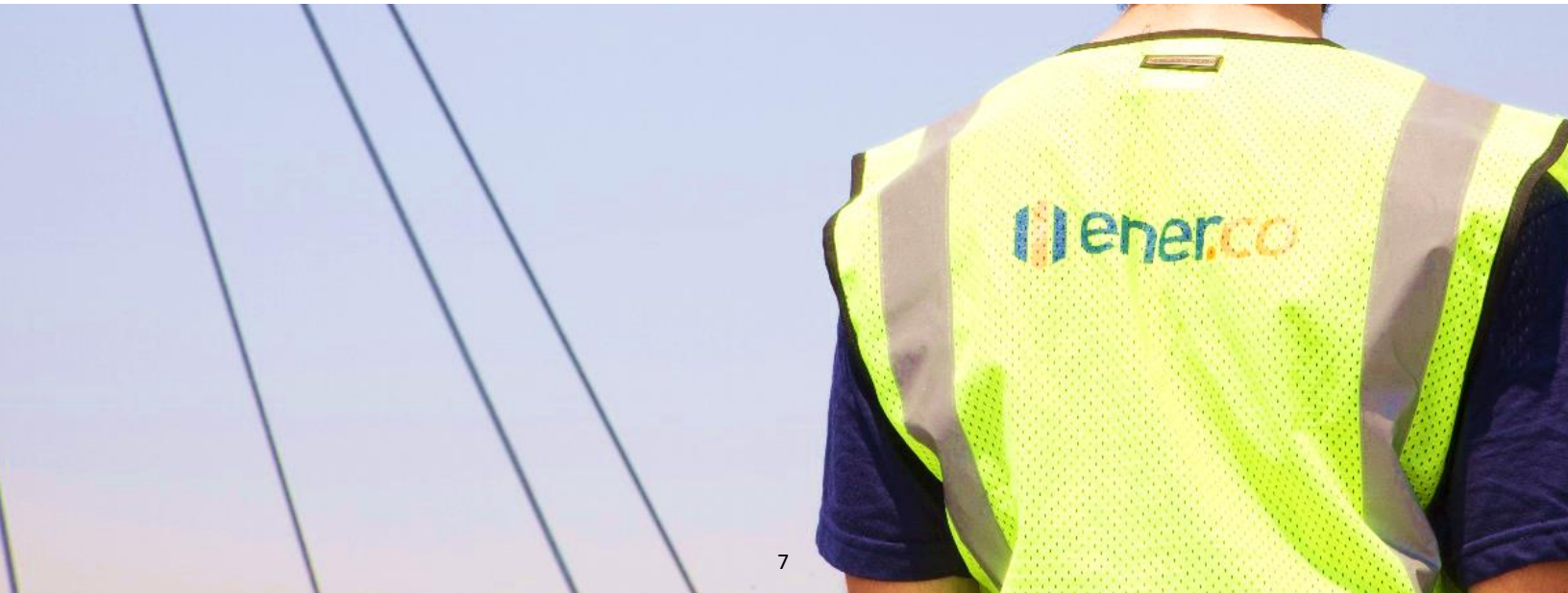
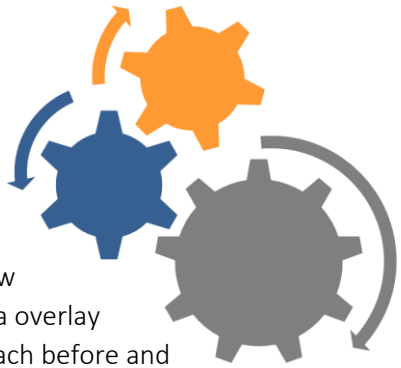


Figure 10 (left) and Figure 11 (right): Improvement of latent heat removal and psychrometric properties of air leaving the evaporator coil



Optimize Your System

Lower kWh and more Btus.



Formulated to cut energy use, slash operating costs, and curtail environmental impact, Ener.co's products offer a premium energy efficiency investment for owners who seek superior performance for their building's cooling systems. Engineered to ensure quality performance, the coating treatment has been proven to nearly double the energy efficiency ratio of air-cooled cooling equipment per AHRI testing protocols.

Our monitoring studies reveal that the enhancement of thermal conductivity of the air-cooled heat exchanger permits AC units to operate at a lower part-load ratio more often than before the treatment. Figure 12 below provides a data overlay of one week each before and after the treatment with comparable weather conditions. Despite warmer outdoor temperatures, the unit was able to ramp-down the required cooling staging. The results are smaller peaks of demand (kW), less total energy consumed (kWh), and a more comfortable building environment.

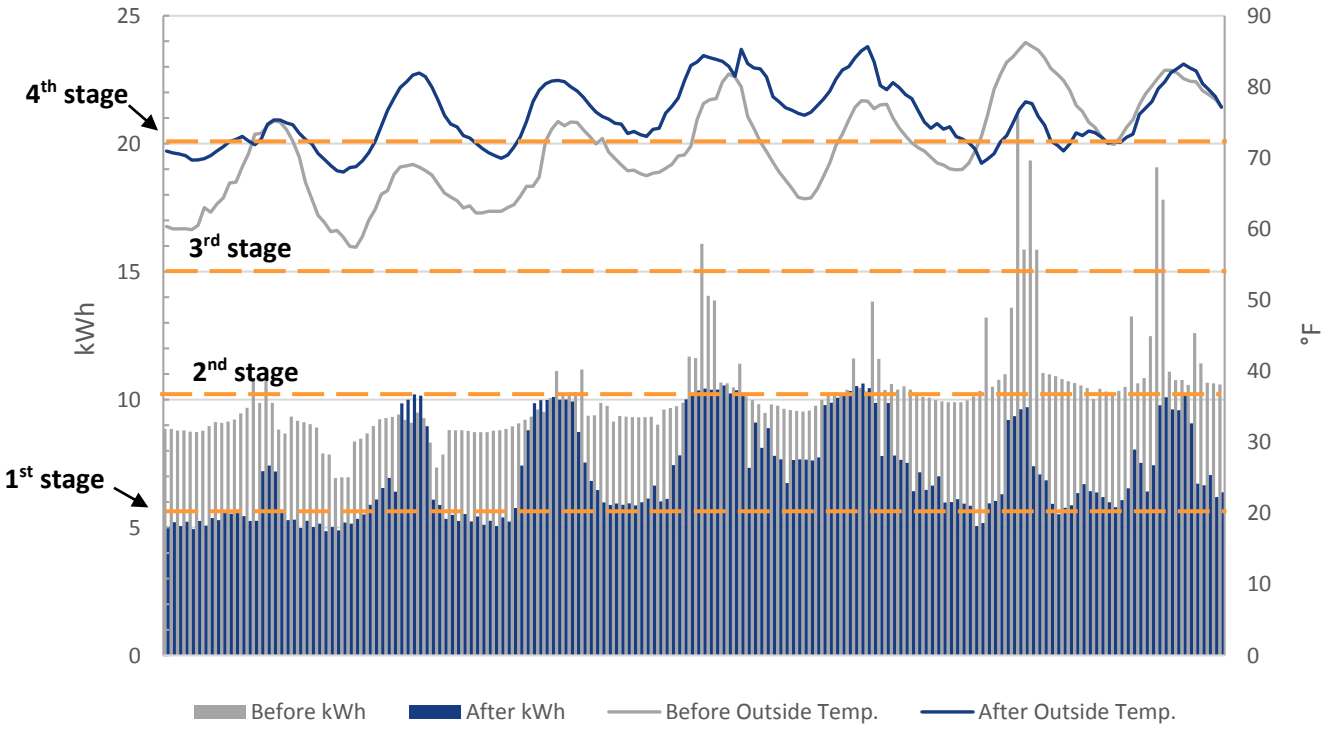
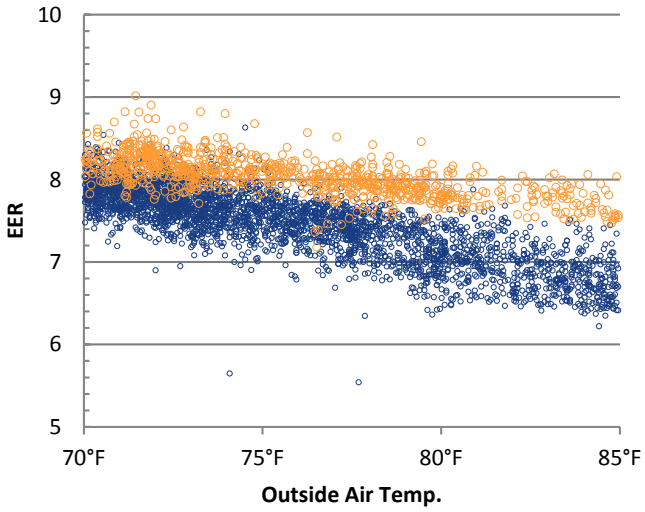


Figure 12: Comparison of energy consumption one week before and after treatment

Advanced technology, uncompromised performance.

Our coatings deliver unrivaled performance under all climate conditions and in all environments. Reduced energy consumption and boosted cooling capacity result in nothing less than a cooling system enhanced to perform at peak levels of energy efficiency. AC unit performance shown in Figure 13 shows the vastly improved cooling performance – EERs rise up to 20% after the treatment. Higher-EER systems require less energy to meet the same cooling load.



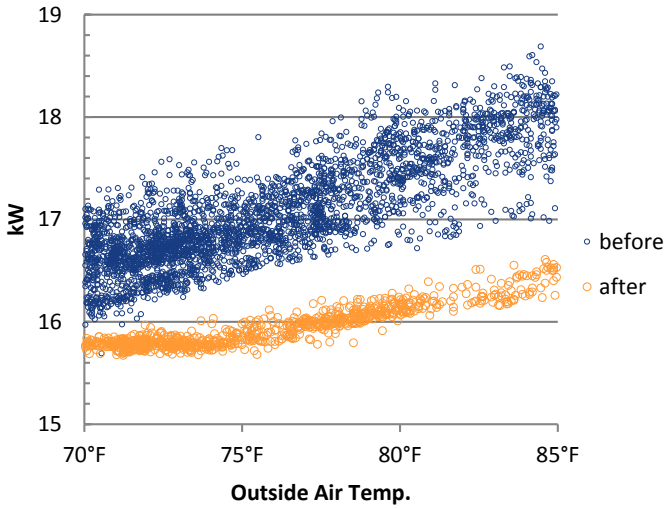


Figure 13 (left) and Figure 14 (right): Improvement of EER and reduction of power draw

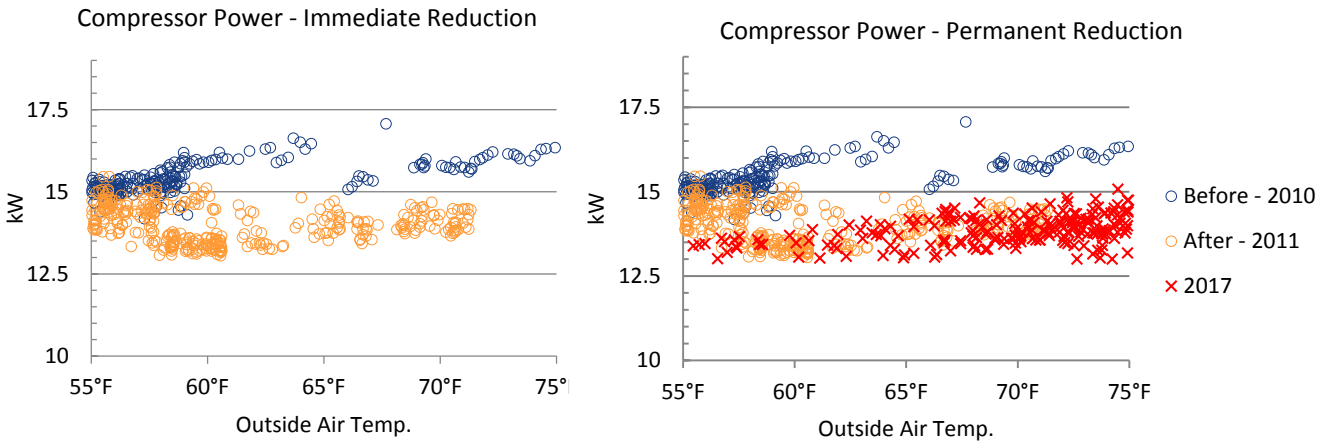
The Ener.co® Advantage.

Traditional intelligence suggests that corrosion prevention coatings come at the cost of decreased thermal conductivity of the heat exchanger surface. This is not the case with our coatings; they all enhance thermal conductivity and halt corrosion for years to come in the harshest of outdoor environments. Our coatings eliminate corrosion at aluminum fins, copper tubes, and the critical fin-to-tube bond, a bond notoriously known for being the weakest link in the heat-flux pathway through the coil assembly. This fin-tube bond is restored to its optimal condition to secure cooling performance and indoor thermal comfort.

In summer 2010, a then four-year-old 60-ton rooftop air-cooled chiller was monitored for energy use to examine the immediate effectiveness of our treatment. Before measurements were taken, the facility performed their own routine cleaning of the coil assembly. The unit was later treated in the fall of 2010. The results after the first year of monitoring evaluation demonstrate that the treatment immediately reduces the kW load of a well-maintained unit. The results are seen in Figures 6, 7, and 8 on page 5. Compressor power reduction, Figure 7, is reshown here as Figure 15. Chiller 1 benefited from a 10% immediate reduction in power draw (2.3 kW), the lion's share of savings, 87%, being compressor power reduction (2.0 kW).

Long-term benefits – 2017 update

Six years later in 2017, continuous monitoring shows that the level of performance reached immediately after the treatment has been maintained, and that the reduction in compressor power endured the five year period. Figure 16 below shows Figure 15 with the addition of 2017 data.



Figures 15 and 16: Permanent reduction in compressor power draw before treatment, after treatment, and 5 years after treatment

Case Study

Iconic Printing Factory – Flushing, NY

In the fall of 2016, Ener.co performed its comprehensive energy saving retrofit measure on the condenser coils part of a mission-critical printing factory equipped with 3,475 tons of air-cooled RTUs in Flushing, NY. The New York State Energy and Research Development Authority (NYSERDA) was responsible for determining the energy savings under M&V IPMVP® Option B Protocol. Treatment resulted in verified energy savings of 18%, improved airflow, enhanced heat transfer, and a permanent reduction power consumption.

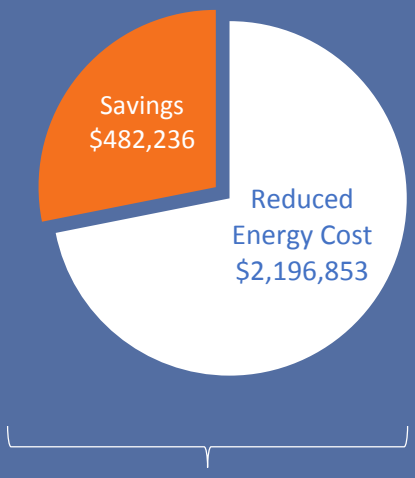
Real-time monitoring shows that the project reached its first-year savings projection and is on track to save the facility an additional $482,236 over the next ten years.

Key metrics include:

* First year energy use reduction: 343,474 kWh (18%)
* Average annual savings: $48,224
* Peak power reduction: 117 kW
* Project incentive awarded through NYSERDA's Industrial and Process Efficiency program

In addition to reducing their energy bills, the customer reduced their maintenance costs while avoiding a $7 million replacement cost for a new set of RTUs.

Projected Cumulative Savings
10 Years



Energy cost without treatment
$2,679,089

Lifetime Energy Cost Comparison