



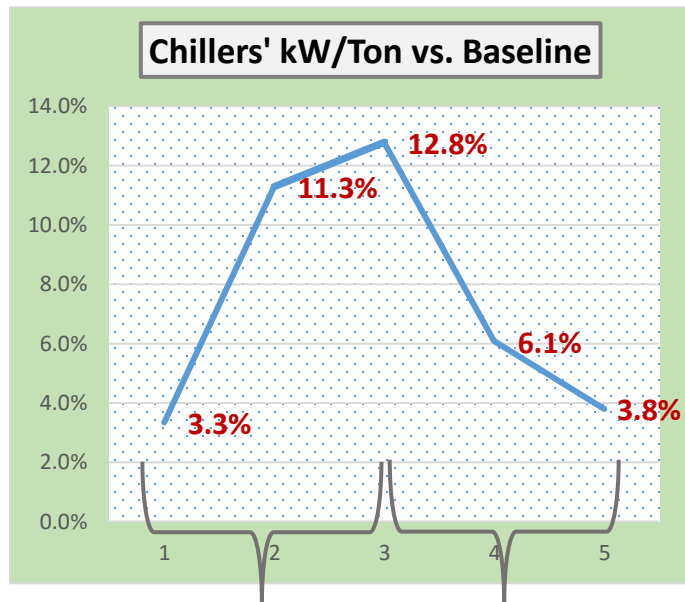
## Advanced Cooling Plant Efficiency System Excels in Customer's Performance Test

ElectroCell Systems, Inc. of Nazareth, PA, manufactures an advanced system of solids control and heat transfer enhancement that is applied to chilled water plants with open-cell cooling towers and claims consistent results in reducing chiller energy use by 10%-15%. An ElectroCell customer whose system was installed in 2016 elected to independently quantify the system's performance after a year of operation by taking the ElectroCell system offline for a month and closely measuring the effects on chillers' energy and efficiency.

Required data points were defined, and hourly data logging on the facility's automation system was performed prior to the test to establish the baseline with the ElectroCell running. It was also established that data analysis would be provided professionally to insure accuracy and the application of relevant variables such as cooling load levels, and condenser water temperatures.

The ElectroCell System was turned off, and data was collected and analyzed in several batches as shown at right. Percentages refer to the increase in kW/Ton over the baseline, which climbed to 12.8% after just twenty-seven days.

At this time the ElectroCell system was turned back on, it having been determined that the 'off condition' effect had been duly demonstrated, along with the customer's desire to "stop losing \$300 a day".



**ElectroCell Off  
(27 Days)**

**ElectroCell On  
(27 Days)**

With the ElectroCell system back on, data was collected for an identical 27-day period. Inefficiency percentages decreased as shown, indicating the restored effectiveness of the ElectroCell System.

# ElectroCell System Performance Test and Evaluation

The ElectroCell System was recently tested at a client site in order to show its capability to keep chillers operating efficiently and sustain substantial electrical energy savings. The ElectroCell System was installed in 2016 in the Wind Creek Casino in Atmore, Alabama, and was being considered for other casino sites. In the Wind Creek chain, however, prior to the ElectroCell installation there had been no baseline information collected that could be used to compare chillers' efficiency before and after installation. It was decided that a test should be run on the system at Atmore in order to show other sites the system's energy saving performance and potential.

## Test Method

In May 2017 the Cooling Plant and the ElectroCell system were in continuous operation. The efficiency test method was to reverse the conventional pre- and post-installation evaluation practice by:

- (1) Measuring the chillers' efficiency with the ElectroCell System running,
- (2) Shutting off the ElectroCell system for three to four weeks and measuring efficiency with the unit offline, and
- (3) Turning the unit back on and measuring performance. The expectation, obviously, was that the efficiency would decline with the System off, and then improve with the System back online. The baseline for the test, therefore, was the measured efficiency with the ElectroCell in operation (prior to the test).



## Data Points

The following data points were logged once per hour for each chiller:

- Entering Chilled Water Temperature
- Leaving Chilled Water Temperature
- Chilled Water Flow
- Entering Condenser Water Temperature
- Leaving Condenser Water Temperature
- Condenser Water Flow
- Evaporator Saturation Temperature
- Condenser Saturation Temperature
- Chiller VSD power input (kW)

## Data Collection and Defining the Baseline and Categorizing Data According to Chiller Loads

Chillers CH-1 and CH-4 were used for the test. Data was collected from May 23, 2016 to May 30, 2016 and put into a spreadsheet for the kW/Ton baseline. The chillers' cooling load (in tons) was calculated for each data point and categorized according to load size for each chiller of 0-25%, 25% to 50%, 50% to 75%, and 75% to 100%. Tracking and categorizing performance with kW/Ton data in 25% increments is consistent with the ASHRAE IPLV/NPLV method for chiller performance and efficiency.

Data Periods	ElectroCell Status	CH-1 kW/Ton by Chiller Load %			
		0%-25%	25%-50%	50%-75%	75%-100%
5/232017 - 5/30/2017	On		0.592	0.580	0.512

Data Periods	ElectroCell System	CH-4 kW/Ton by Chiller Load %			
		0%-25%	25%-50%	50%-75%	75%-100%
5/23/2017 - 6/01/2017	On		0.686	0.629	

Following the baseline, the ElectroCell System was shut off and operating data was collected from CH-1 and CH-4 for twenty-six days as shown below. Data collection with the system off began with a two-day data series, followed by two longer collection periods. Following this period, the ElectroCell system was turned on and data was collected for another twenty-seven days in two datasets. The tables below show kW/Ton according to load % categories and also show the gross increases in kW/Ton.

Data Periods	Chiller CH-1 Cooling Conditions			Chiller CH-1 Load and Efficiency Relative to Baseline							
	ElectroCell Status	Cooling Tons Produced	Condenser Water Entering Temp	CH-1 kW/Ton by Load				CH-1 kW/Ton Increase Over Baseline			
				0%-25%	25%-50%	50%-75%	75%-100%	0%-25%	25%-50%	50%-75%	75%-100%
5/232017 - 5/30/2017	On (Baseline)	64,442	74.1		0.592	0.580	0.512		0%	0%	
5/30/2017 - 6/1/2017	Off	24,882	75.6			0.617	0.573			6.4%	11.8%
6/1/2017 - 6/9/2017	Off	87,571	77.1		0.489	0.620	0.567		-17.3%	6.8%	10.7%
6/10/2017 - 6/25/2017	Off	94,293	82.2			0.712	0.607			22.7%	18.5%
6/28/2017 - 7/14/2017	On	188,269	82.9			0.647	0.666			11.5%	29.9%
7/14/2017 - 7/24/2017	On	121,868	80.3			0.632	0.630			9.0%	22.9%

Data Periods	Chiller CH-4 Cooling Conditions			Chiller CH-4 Load and Efficiency Relative to Baseline							
	ElectroCell Status	Cooling Tons Produced	Condenser Water Entering Temp	CH-4 kW/Ton by Chiller Load %				CH-4 kW/Ton increase over baseline			
				0%-25%	25%-50%	50%-75%	75%-100%	0%-25%	25%-50%	50%-75%	75%-100%
5/23/2017 - 6/01/2017	On (Baseline)	51,269	72.7		0.686	0.629			0%	0%	
6/01/2017 - 6/09/2017	Off	17,352	75.6		0.862	0.669			25.6%	6.4%	
6/10/2017 - 6/26/2017	Off	155,270	77.2		0.881	0.716			28.3%	13.9%	
6/10/2017 - 6/25/2017	Off	90,351	81.4		0.986	0.724			43.7%	15.2%	
6/26/2017 - 7/14/2017	On	155,655	80.5		0.759	0.783			10.6%	24.6%	
7/14/2017 - 7/24/2017	On	87,643	80.4		0.751	0.744			9.4%	18.4%	

## Summarizing the Data: Generating Weighted Averages and Compensating for Weather Conditions

Two additional steps are applied to the data on the previous page in order to show accurate kW/Ton values and efficiency for each chiller. First, the kW/Ton in each cell is weighted according to how many tons were produced at each kW. The weighting will show the actual overall kW/Ton in each data set.

Second, the kW/Ton percentages of increase (or decrease) must be compensated according to weather conditions. Specifically, this means changes in outdoor dry bulb and wetbulb temperatures will affect the condenser water supply temperature, which is directly related to the chillers' power required to reject the heat in the condenser. It is recognized in the industry that for every one degree increase in condenser water temperature, the chiller will experience a 1.0% to 1.5% decrease in efficiency. Data shown below uses 1.25% decrease in efficiency for each condenser water degree increase.

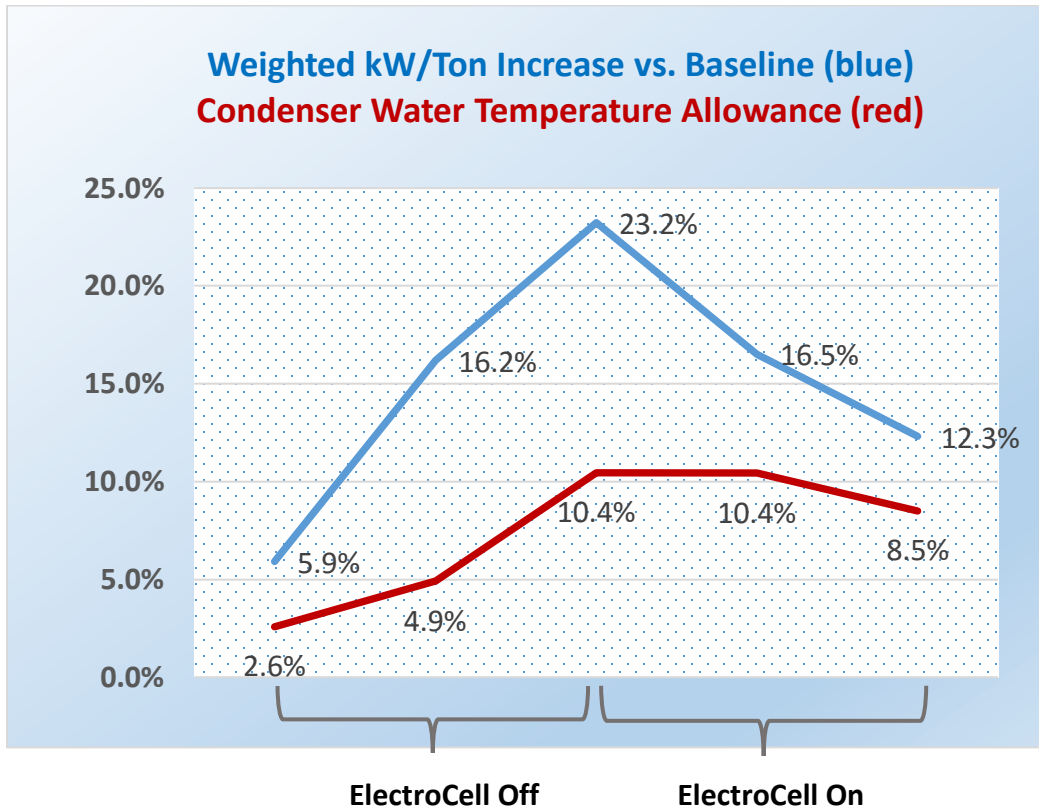
Chiller CH-1 Summary; Weighted kW/Ton Average and Adjusted for Condenser Water Temp						
ElectroCell (EC) Running Condition	Cooling Tons Produced	Condenser Water Supply Temperature	kW/Ton Weighted Average	kW/Ton Increase over Baseline	kW/Ton Increase due to Higher Condenser Water Entering Temp	kW/Ton Increase From Efficiency Loss
ElectroCell On; (Baseline)	64,442	74.1	0.566			
ElectroCell Off	24,882	75.6	0.589	4.1%	1.8%	2.3%
	87,571	77.1	0.605	6.9%	3.7%	3.2%
	94,293	82.2	0.679	20.0%	10.1%	9.9%
ElectroCell On	188,269	82.9	0.655	15.8%	11.0%	4.8%
	121,868	80.3	0.631	11.6%	7.7%	3.9%

Chiller CH-4 Summary; Weighted kW/Ton Average and Adjusted for Condenser Water Temp						
ElectroCell (EC) Running Status	Cooling Tons Produced	Condenser Water Supply Temperature	kW/Ton Weighted Average	kW/Ton Increase over Baseline	kW/Ton Increase due to Higher Condenser Water Entering Temp	kW/Ton Increase From Efficiency Loss
ElectroCell On; (Baseline)	51,269	72.7	0.659			
ElectroCell Off	17,352	75.6	0.715	8.5%	3.7%	4.8%
	155,270	77.2	0.800	21.4%	5.6%	15.9%
	90,351	81.4	0.834	26.6%	10.8%	15.7%
ElectroCell On	155,655	80.5	0.774	17.4%	9.8%	7.6%
	87,643	80.4	0.747	13.3%	9.6%	3.7%

Combined Chillers Summary; Weighted kW/Ton Average and Adjusted for Condenser Water Temp						
ElectroCell (EC) Running Status	Chillers CH-1,4 Run Conditions			kW/Ton Increase over Baseline		
	Cooling Tons Produced	Condenser Water Supply (CDWS) Temp	kW/Ton Weighted Average	kW/Ton Increase over Baseline	kW/Ton Increase due to Higher Condenser Water Entering Temp	kW/Ton Increase From Efficiency Loss
ElectroCell On; (Baseline)	115,711	73.5	0.607			
ElectroCell Off	42,234	75.6	0.641	5.9%	2.6%	3.3%
	242,841	77.2	0.730	16.2%	4.9%	11.3%
	184,644	81.8	0.755	23.2%	10.4%	12.8%
ElectroCell On	343,924	81.8	0.709	16.5%	10.4%	6.1%
	209,512	80.4	0.679	12.3%	8.5%	3.8%

## Data Summary Comparative Graph



The Blue Line tracks the per cent of gross increase (and decrease) in kW/Ton during the data collection period. The Red Line tracks the per cent increase and decrease in kW/Ton that is caused by increases (and decreases) in condenser water entering temperature, which reduces chiller efficiency 1.25% for each one degree farenheit increase. The difference between the blue and red lines is the net effectiveness of the ElectroCell System in chiller efficiency.

All data provided by the client. Approximately 2,400 lines of data samples were collected and used in this report. All calculations performed in accordance with standards and procedures as established by the Association of Energy Engineers (AEE).

**-End of Document-**

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