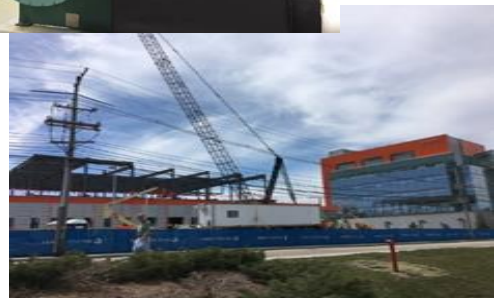
# Electrocell Savings Validation and Case Study for Massachusetts Pharmaceutical Company

# Energy Efficiency & Sustainability
## Ways of Working SpC Engineering – Key Initiatives for 2022

### Key attributes of energy improvements at sites

- Maintain constant communication with site EMs tracking progress
- Implement Energy Management System (EnMS) and ISO 50k
- Virtually attend ISO 50k audits, communicate findings with other sites
- Continue to promote L3 digital fault diagnostics where applicable
- Continue to promote new technology pilots at sites for scale-up 2022-2024 sustainability projects (ex: Electrocells, UVC, solar heating, solar voltaic, heat recovery chillers, heat pumps, carbon capture)



### Energy efficiency on new investment projects at sites

- Complete sustainability energy assessments for new projects >1M€
- Consider new technologies for implementation (deviate from norm)
- Ensure adequate building controls are in place for L3 digital fault diagnostics (Cimetrics Analytika)
- Complete energy models where applicable on larger projects to understand consumption and cost requirements
- Leverage Framingham Energy Pilot (B2022) over the SpC network

# Energy Efficiency & Sustainability

## What is an Electrocell?

An Electrocell system is an electrostatic precipitator which removes particles from open condenser cooling tower water streams down to 1 micron. This low maintenance piece of equipment cleans the water through electrolysis versus using sand filtration which uses significant pumping energy. The unit cleans the water so clean there is no longer build up of debris on the inside of the chiller tubes. Introducing an electromagnetic field to water changes the surface tension of the water resulting in better heat transfer.

## Energy Savings

Because the condenser water is so clean from this process, cleaning chiller tubes is no longer necessary. When chiller tubes are clean, heat transfer is increased resulting in a higher coefficient of performance, the result is energy savings.

## Water & Chemical Savings

There are chemical and water savings as well. Large amounts of chemicals used to suspend solids in the condenser water and flush them out with city water is no longer needed. Chemicals are still required for conductivity and biocidal control. The result is a significant reduction in water and chemical consumption.

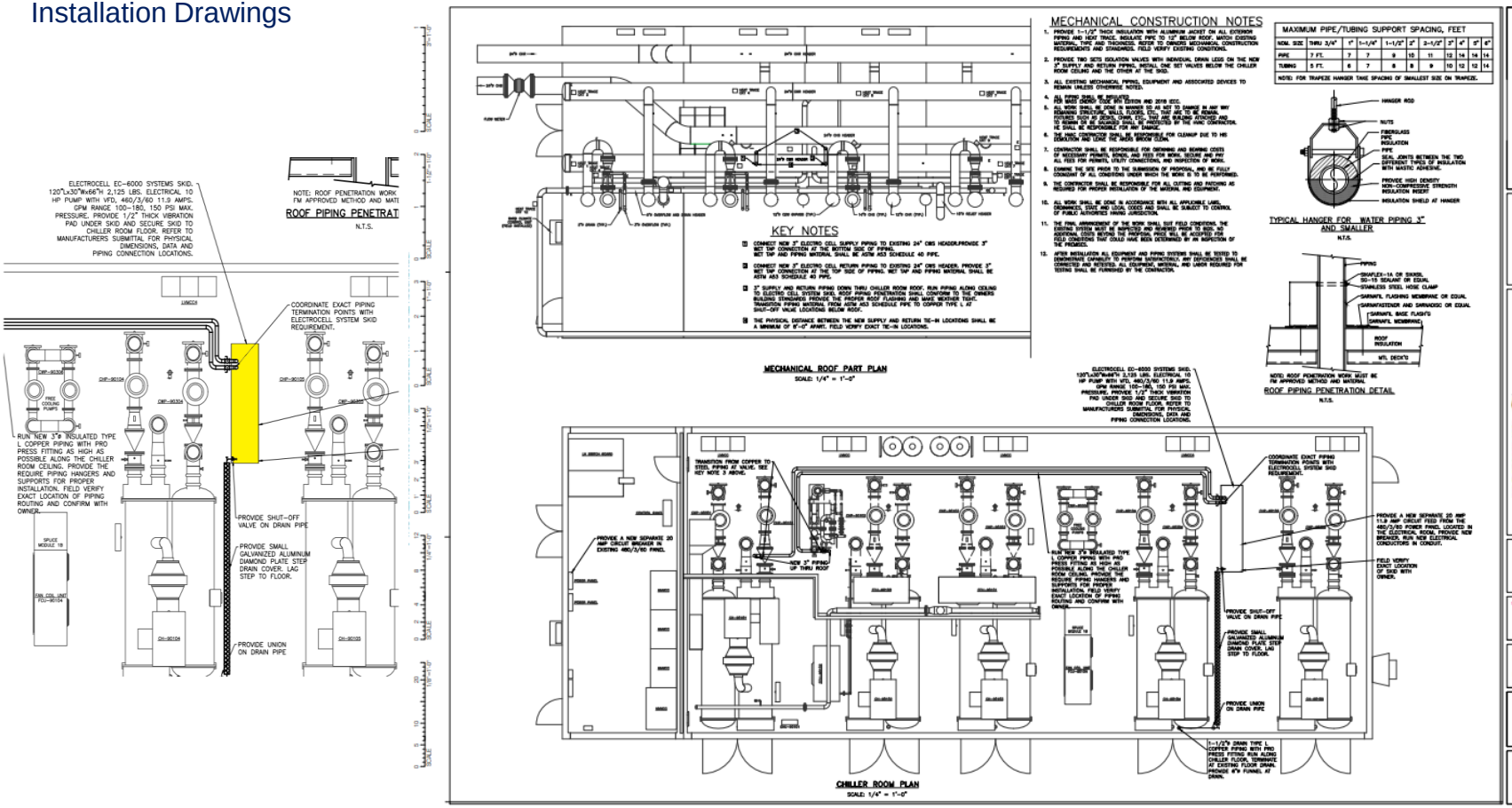
## Carbon Emissions Savings

Higher chiller efficiency (coefficient of performance) and reduced pumping power results in less kilowatts consumed. Less kilowatts = **Less carbon emissions!**

# Energy Efficiency & Sustainability

*Overview of Technology*

## Installation Drawings



# Pilot of Electrocell Units

## Electrocell Installation

EC-6000 as installed

Electrostatic rod removed for cleaning

Visually "clear" condenser water

Particulate removed from Condenser water after 24-hours with ElectroCell

# Energy Efficiency & Sustainability

## Validated Energy and Water Savings Results of Installed Electrocell Units

### Summary of Savings

| Chiller Plant | Compressor Demand Reduction (kW/ton) | Compressor Demand Reduction (percent) | Avg Monthly Reduction (kW) | Annual Electric Savings (MWh) | Annual Energy Savings (USD) | Water savings (kGal) | Annual Water Savings (USD) | Total Savings |
|---|---|---|---|---|---|---|---|---|
| **55 NYA** | 0.08[a] | **13.9%** | 65 | 569 | $76k | 1275 | $21k | $97k |
| **70 NYA** | 0.12[b] | **14.6%** | 126 | 1100 | $148k | 2061 | $34k | $181k |
| | | **Total** | **191** | **1673** | **$224k** | **3336** | **$55k** | **$279k** |

Not included are chemical water treatment and reduced maintenance savings.

### Utility Rates

| | Water | Energy | Demand |
|---|---|---|---|
| **Oct -May** | $16.38/kGal | $0.086/kWh | $29/kW |
| **June-Sept** | $16.38/kGal | $0.086/kWh | $39/kW |

a – compressor demand reduction analysis completed by Cimetrics, kWh and water savings by EMA.
b – compressor demand reduction, kWh, and water savings completed by EMA.

Local utility incentive up to 50% of the Project Cost

Annual savings = $279k (Rebate $489k project cost/2=$244k) $489k-$244k = $245k cost

**10.5 Months Payback and 375 MTCO2 Annual Carbon Reduction !**

# Energy Efficiency & Sustainability
## Investment Performance Summary

| Project Totals for 55 + 70 Electrocell Installation | |
|---|---|
| Total Project Kwh Savings | 1,161,487 |
| Total NPV (at 4.5%) | $2,083,410 |
| Total Investment | -$489,110 |
| Average IRR *(two installations)* | 51.6% |

Importantly Noted: These numbers do not include the escalation of energy and water costs over the 15 year life cycle so actual savings realized will be significantly higher over time.

The same would apply to chemical treatment savings.

ELECTROCELL SYSTEMS

**PARTICLE ANALYSIS REPORT**

# Massachusetts Pharmaceutical Company

**Sampling Source: Cooling Tower Basin Water (55NYA)**


**95.8%**
**particle reduction after 7.8 weeks**

***Electro Cell System:*** ***XCell-4000 Particle Precipitator***

**TEST METHOD:** All tests completed by independent third-party laboratory. Samples analyzed by electro-optical particle analyzer employing the light scattering principle of operation with filtered water and particle data corrected Stirring was continuous.

| BASELINE SAMPLE - Prior to ElectroCell Start-up - 22-OCT-2020 | | | AFTER 7.8 WEEKS with ElectroCell System - 16-DEC-2020 | | |
|---|---|---|---|---|---|
| **PARTICLE COUNTS PER 100mL TEST PORTION** | | | **PARTICLE COUNTS PER 100mL TEST PORTION** | | |
| 1 - 3 micron: | 425,460 | | 1 - 3 micron: | 396,835 | |
| 3 - 5 micron: | 86,160 | | 3 - 5 micron: | 79,229 | |
| 5 - 10 micron: | 104,600 | | 5 - 10 micron: | 46,577 | |
| 10 - 15 micron: | 40,680 | | 10 - 15 micron: | 7,926 | |
| 15 - 25 micron: | 43,500 | | 15 - 25 micron: | 4,693 | |
| Over 25 micron: | 31,600 | | Over 25 micron: | 1,267 | |
| **TOTAL / 100mL:** | **732,000** | | **TOTAL / 100mL:** | **536,527** | |
| **SOLIDS PER 100 LITERS OF SYSTEM VOLUME ( $mm^3$ )** | | | **SOLIDS PER 100 LITERS OF SYSTEM VOLUME ( $mm^3$ )** | | |
| 1 - 5 micron: | 8.92 | | 1 - 5 micron: | 8.25 | |
| 5 - 10 micron: | 44.14 | | 5 - 10 micron: | 19.66 | |
| Over 10 micron: | 21,525.48 | | Over 10 micron: | 887.88 | |
| **TOTAL / 100 Liters:** | **21,578.54** | **216 ppm** | **TOTAL / 100 Liters:** | **915.79** | **9 ppm** |

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ELECTROCELL SYSTEMS

**PARTICLE ANALYSIS REPORT**

# Massachusetts Pharmaceutical Company

**Sampling Source: Cooling Tower Basin Water (70NYA)**

**99.84%**
**particle reduction after 4 weeks**

***Electro Cell System:*** ***XCell-6000 Particle Precipitator***

**TEST METHOD:** All tests completed by independent third-party laboratory. Samples analyzed by electro-optical particle analyzer employing the light scattering principle of operation with filtered water and particle data corrected Stirring was continuous.

| **BASELINE SAMPLE - Prior to ElectroCell Start-up - 16-DEC-2020** | | | **AFTER 4 WEEKS with ElectroCell System - 13-JAN-2021** | | |
|---|---|---|---|---|---|
| **PARTICLE COUNTS PER 100mL TEST PORTION** | | | **PARTICLE COUNTS PER 100mL TEST PORTION** | | |
| 1 - 3 micron: | 14,273,000 | | 1 - 3 micron: | 58,381 | |
| 3 - 5 micron: | 2,807,400 | | 3 - 5 micron: | 15,738 | |
| 5 - 10 micron: | 3,861,200 | | 5 - 10 micron: | 12,842 | |
| 10 - 15 micron: | 2,579,000 | | 10 - 15 micron: | 4,219 | |
| 15 - 25 micron: | 2,707,800 | | 15 - 25 micron: | 4,972 | |
| Over 25 micron: | 3,403,400 | | Over 25 micron: | 5,359 | |
| **TOTAL / 100mL:** | **29,631,800** | | **TOTAL / 100mL:** | **101,511** | |
| **SOLIDS PER 100 LITERS OF SYSTEM VOLUME ( $mm^3$ )** | | | **SOLIDS PER 100 LITERS OF SYSTEM VOLUME ( $mm^3$ )** | | |
| 1 - 5 micron: | 293.86 | | 1 - 5 micron: | 1.47 | |
| 5 - 10 micron: | 1,629.43 | | 5 - 10 micron: | 5.42 | |
| Over 10 micron: | 2,302,178.61 | | Over 10 micron: | 3,630.71 | |
| **TOTAL / 100 Liters:** | **2,304,101.90** | **23041 ppm** | **TOTAL / 100 Liters:** | **3,637.60** | **36 ppm** |


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# Energy Efficiency & Sustainability
## Third Party Energy Savings Validation for Utility

**Measurement & Verification of Energy & Water Savings; Achieved through the application of an ElectroCell System**

February 21, 2020

### Introduction

This document describes the methods for defining and verifying annual electrical and water savings resulting from the application of an ElectroCell System. The system is applied to the open-loop condenser water system and savings are realized in reductions in cooling plant energy and tower makeup water.

The savings definition and verification methods are consistent with guidelines and methods established by the International Performance Measurement and Verification Protocol (IPMVP) committee. The consolidation of energy use data is consistent with Air Conditioning Heating and Refrigeration Institute (AHRI) Integrated Part Load (IPLV) methods for categorizing chiller kW/ton data.

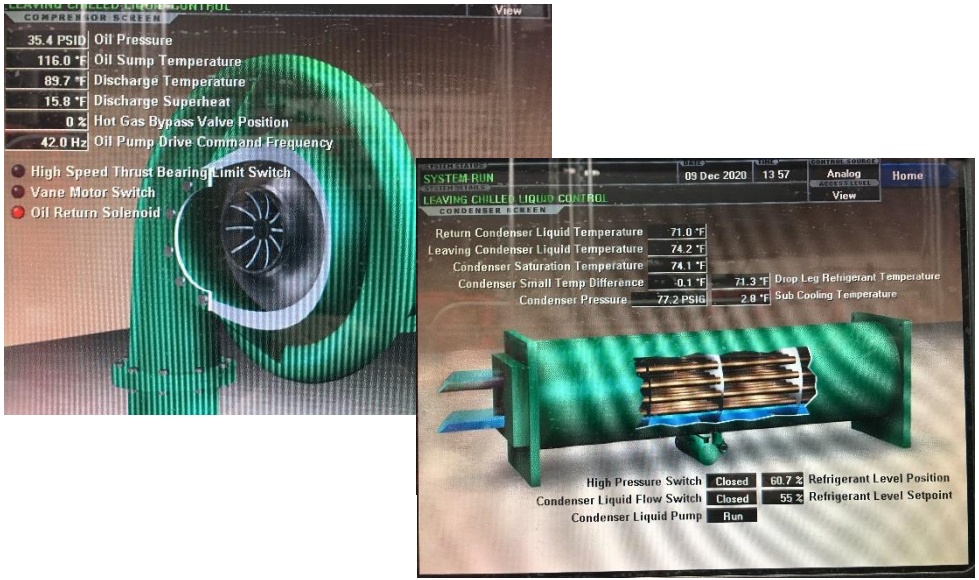
# Energy Efficiency & Sustainability

## Third Party Energy Savings Measurement & Validation for Utility

**General M&V Methodology**

Tonnage across chiller evaporator, concurrent kW of compressor, and concurrent condenser water temperature entering condenser bundle was evaluated before and after installation of Electrocell. Before and after kW/ton values for similar tons and condenser water temperatures were used to determined overall kW/ton reduction for each plant. kW/ton reduction was applied to chilled water load profiles (average ton versus month) to determine monthly kW reduction and kWh savings (see below for details). Final electric demand reductions and energy savings includes turning off sand pumps and netted against Electrocell electric load. Water savings was calculated based on a 3 gpm/ton, 1% evaporation rate, applying kW/ton demand reduction percentage that was determined for each plant.

Note: Weekly readings were taken of chiller performance and condenser water pumps through all seasons to confirm actual KwH reduction to baseline.




**M&V Details - 70 NYA**

This variable primary chilled water plant is not connected to Cimetrics, pre and post retrofit data was collected manually. Compressor kW was calculated from recorded amps, recorded voltage, and an assumed (constant) PF. *Pre-retrofit* tonnage was determined by measuring delta T across the evaporator and apply it to an assumed pump-speed of 48 Hz (based on observations and discussions with plant supervisor) using the chiller-specific table (below) to determine flow (gpm). *Post-retrofit* tonnage was determined by dT and measured and recorded Pump Hz using the below table. 70 NYA Chiller compressor monthly kW reductions and kWh savings were determined using a 70 NYA chilled water Tonnage versus real-time load profile curve developed by Kevin Gregory PE in 2012.

**Cox TAB Report**

| 70 NYA Chiller | 40 Hz (TAB) | GPM/Hz |
|---|---|---|
| **90101** | 1864 | 46.60 |
| **90102** | 1820 | 45.50 |
| **90103** | 1840 | 46.00 |
| **90104** | 1619 | 40.48 |
| **90105** | 1849 | 46.23 |

**M&V Details - 55 NYA**

This chilled water plant had data pulled from Cimetrics which provided significant amounts of pre and post retrofit data. Compressor kW was calculated from recorded amps, assumed 460 volts, and an assumed PF vs. load curve used to convert calculated KVA to kW at all loads. Tonnage was determined by measuring delta T across the evaporator at an assumed flow of 1900 gpm. 55 NYA kW reductions and kWh savings were determined using the same load profile curve, applying a 65% multiplier to account for reduced plant size.