Extracting 25% Efficiency From a 16,000T Chiller Plant

IDEA Campus Conference

February 18-21, 2014

Chiller Plant Optimization

Outline

- **Phase 3**
- **Site Overview**
- **Project Drivers & Goals**
- **Project Description**
- **Project Implementation**
- **Dashboard Reporting**
- **Project Challenges**
- **Project Outcome**
- **Take Away Points**

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Phase 3

This is the third presentation at IDEA summarizing the evolution and improvements of the Pepco Energy Atlantic City Midtown Thermal Plant. Significant investment has been made with the goal to continually improve operational efficiency, reduce operating costs and be more environmentally conscience. All have been achieved.

- **Phase 1 – Cogeneration Installation – 2010-2011**
- **Phase 2 – New Plant Control System (PCS) - 2012**
- **Phase 3 - Chiller Plant Optimization - 2013**

Chiller Plant Optimization

Atlantic City Operations

- MTCC Overview
  - Cogen Plant
  - Boiler Plant
  - Chiller Plant
  - District Customers
- Remote Locations Overview
  - Taj Mahal Plant
  - Golden Nugget Plant
  - Convention Center Thermal Plant
  - Convention Center Solar System
  - Wilmington, DE Loop

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MTCC Overview

Energy Distribution System

- 4 miles of steam & chilled water piping
- Fiber optic controls throughout system
- Steam Header leaving the plant – 20”
- Chilled water header leaving the plant – 42”

Energy Transfer Stations – ETS’s

- Chilled water and steam heat exchangers located at various locations within customer sites
- Transfer point of product for billing
- Chilled water delivered at 42F

	Steam	Chilled Water
Caesars:	5 ETS’s	5 ETS’s
Bally’s :	2 ETS’s	2 ETS’s
Claridge:	1 ETS	1 ETS
Trump Plaza:	2 ETS’s	2 ETS’s
Boardwalk Hall:	2 ETS’s	2 ETS’s
Pier Shops:		1 ETS

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Atlantic City District System (MTCC) Overview

Cogeneration Plant

- Solar Taurus 60 – 5.5Mw Turbine 27,000pph steam
- Rentech HRSG – 45,000 pph saturated steam at 175psi
- *72,000 pph total*

Boiler Plant

- 2–73,400pph, 1-73,556pph Zurn two drum bent tube steam boilers
- *220,356 pph total*
- 175psi saturated steam

Chiller Plant

- ***16,200 ton*** **chiller plant**
- **4-York 4160v series counter flow chillers**
- **10–York 480v VSD series counter flow chillers**
- **System pumping capacity – 40,000gpm**
- **Production temperature 42F**

Customers Served

- Bally's, Caesar's, Trump, Pier Shops, Wild West, Claridge, Boardwalk Hall

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Project Drivers and Goals

Project Drivers

- Reduce Cost of Goods Sold (COGS)
- Efficiency in use of energy is at the forefront of our goals
- Consistent operation of chilled water plant
- Reduce carbon footprint – Corporate mandate

Project Goals

- Improve operational efficiency
- Reduce electric consumption by 20% (9,000,000kwh)
- Maximize asset deployment

Chiller Plant Optimization

Project Description

Project Description

- Implementation and operation of a fully automated chiller plant optimization system for a 16,000T district chilled water plant – *Compressor mapping, pump curves and tower profile are key elements to the optimized algorithm*

- The non-proprietary system algorithm utilizes a brute force optimizing modeling approach –*Constant repetitive mathematics are used to determine the most efficient equipment sequence and settings*

- The system fully directs the plant control system and commands the chillers, condenser water pumps, secondary pumps and cooling towers fans to the lowest possible system kw/ton – *Operator "Hands-Off"*

Chiller Plant Optimization

Project Description

Project Description

- Offline equipment is excluded from the calculation and the best operating scenario is determined based on available assets- *Optimizes regardless of available equipment*

- Respects the customer requirements and equipment parameters and limitations- *Customer sacrifices are not made at the expense of forcing efficiency*

- ***Electric savings of over 30% have been realized in first 4 months of operation***

Chiller Plant Optimization

Project Description

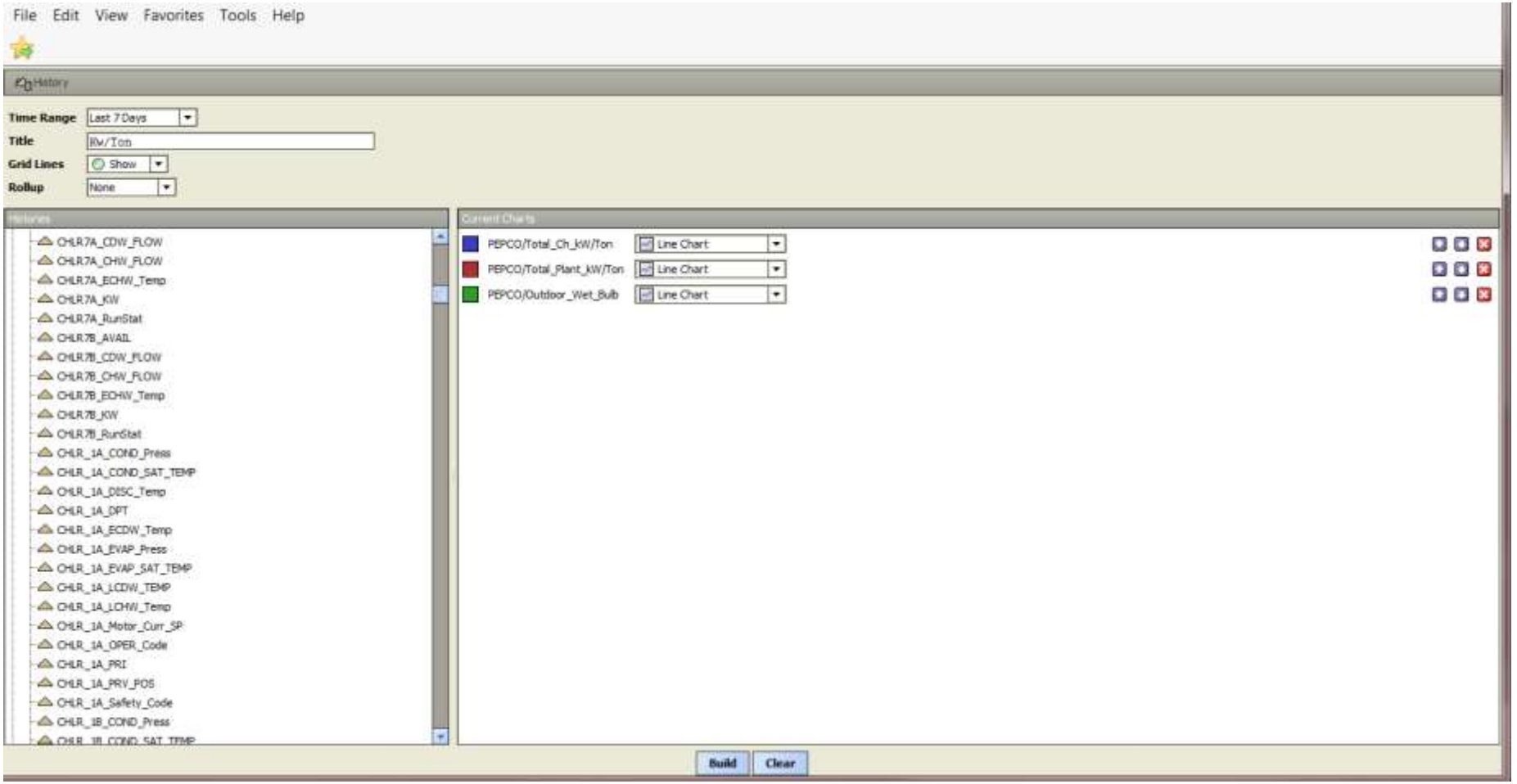
Project Benefits

- The system has the capability of supporting demand response events by limiting plant kW to meet ISO programs
- Allows operator override capability for unique events
- Operator training is minimal – Manual or Automatic control on PCS screen
- Reporting tool and historical data easily retrieved

Chiller Plant Optimization

Project Description

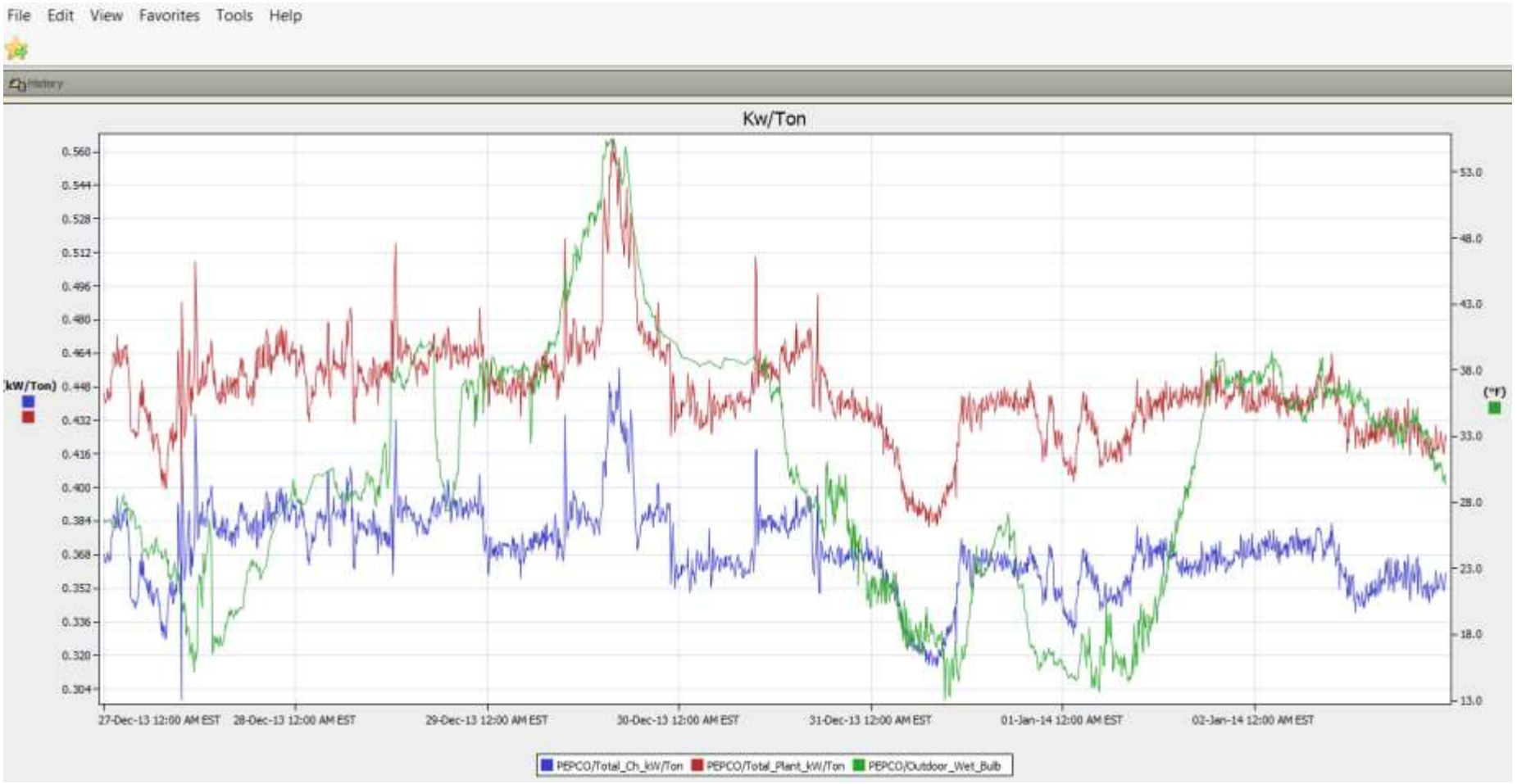
Report Builder



Chiller Plant Optimization

Project Description

Report Builder



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Project Implementation

Step 1 – SCADA Foundation

- Optimization can not be effective without a strong controls foundation
- New Plant Control System (PCS) installed in 2012
- Instrumentation upgrade to ensure valid measurements

Step 2- Historical Data

- Hourly tag data for over 300 chiller plant points captured for 12 month period
- This data is the basis for benchmark comparative
- Equipment data sheets and pump curves – extremely critical
- Measurement and verification of equipment to validate data
- Assessment made of savings opportunities and project worthiness

Step 3 – Equipment Upgrades

- VFD's added to cooling tower fans
- VFD's added to condenser water pumps (480V machines)
- Additional flow meters and temperature transmitters added for accuracy

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Project Implementation

Step 4 – Utility Rebate

- Application submitted for efficiency rebate
- No equipment installed until site review completed

Step 5 – System Integration

- Coordination of platforms between PCS and optimization database
- Sandbox testing of algorithm
- Manual driving of the plant with the algorithm
- Automatic control of the chiller plant – hands off by operators

Step 6 – Dashboard Reporting

- Monitors installed in the plant and executive area
- Real time monitoring of performance
- Actual chiller data performance tags displayed – Approach temps, pressures etc.

Chiller Plant Optimization

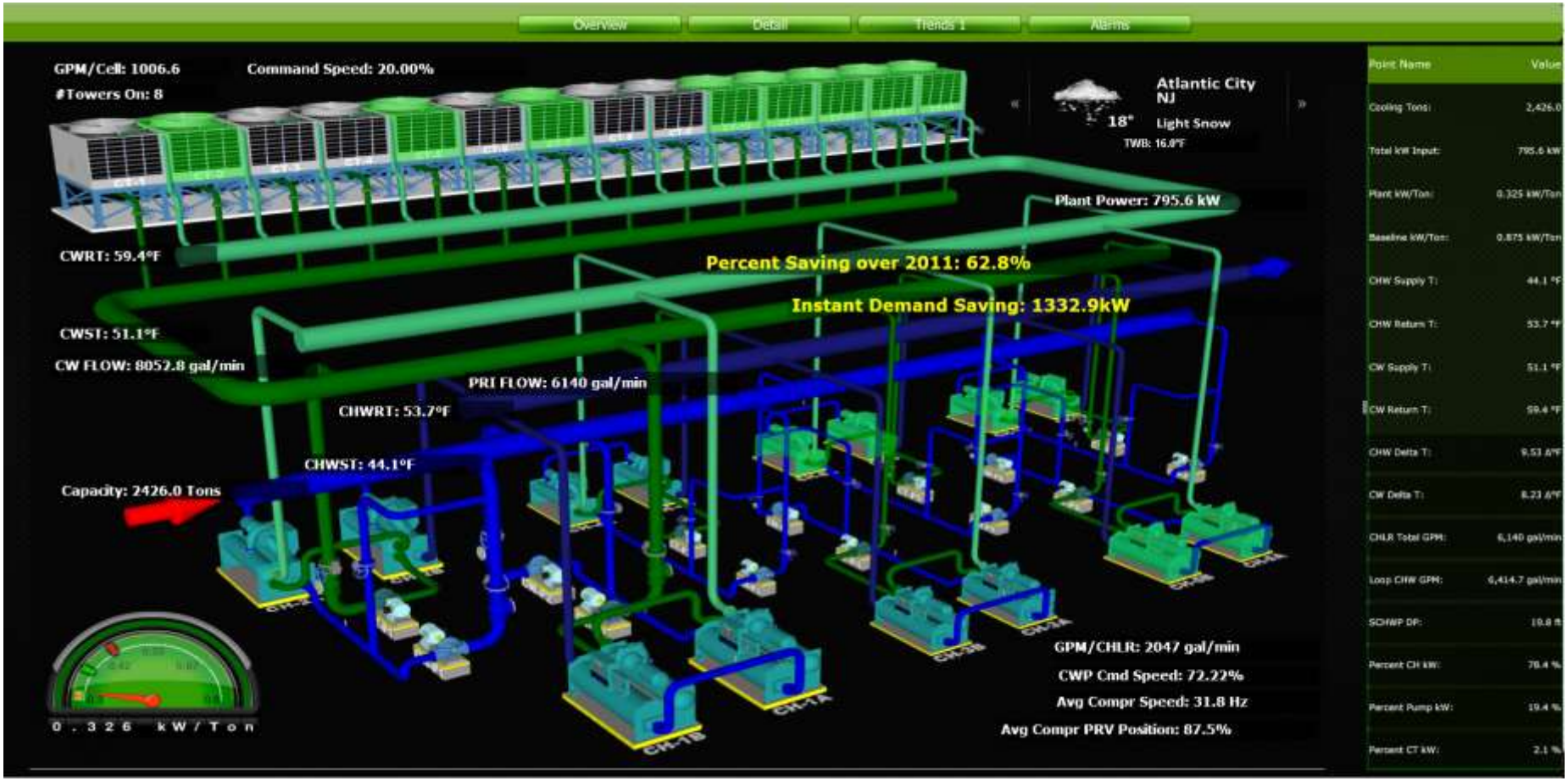
Production Dashboard

January 3, 2014, 9:00am

Chiller Plant Optimization

Production Dashboard

January 3, 2014, 9:00am



Chiller Plant Optimization

Production Dashboard

January 3, 2014, 9:00am

Chiller Plant Optimization

Production Dashboard

January 13, 2014, 4:00pm

WBT: 40.5F, OAT: 52F, Savings 39.3%

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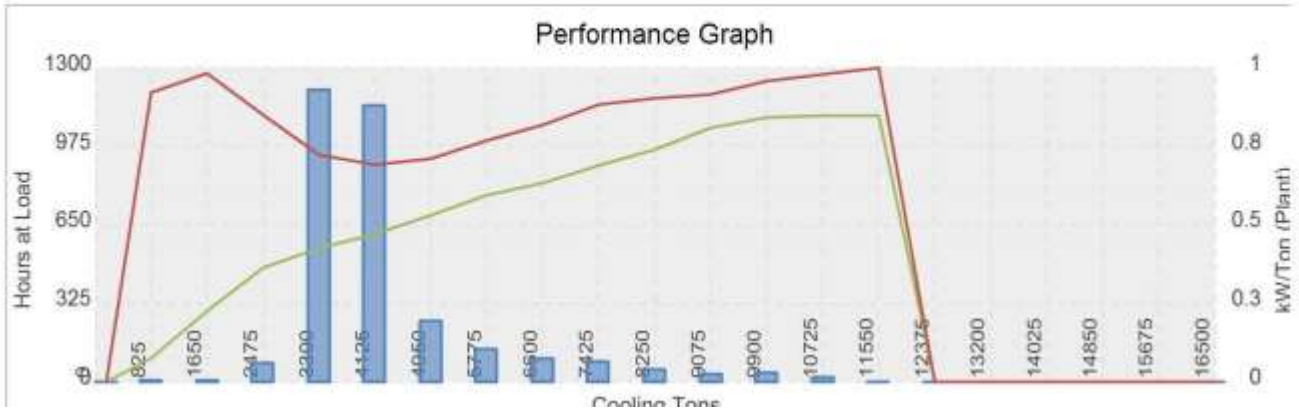
Production Dashboard

Chiller Plant Performance Report

Site Name:	Pepco Energy Services, Atlantic City, New Jersey, Midtown Thermal Control Center (MTCC)
Start Date:	Tuesday, October 1, 2013
End Date:	Monday, February 17, 2014
Accumulated Ton Hours:	13,798,125 Ton-Hours
Accumulated kWh:	7,314,436 kWh
Accumulated Efficiency:	0.530 kW/Ton
Accumulated Baseline Efficiency:	0.763 kW/Ton
Saved kWh:	3,219,932 kWh
Total Runtime Hours:	3,201 Hours

32.6%



Chiller Plant Optimization

Production Dashboard

Tons	Hours	kW/Ton	Baseline kW/	Dry Bulb T	Wet Bulb T	CHWST	Ton-Hrs	kWh	kWh Baseline	Saved kWh
165	0	0.000	0.000	0.0	0.0	0.0	0	0	0	
825	7	0.076	0.938	50.7	38.9	41.1	5,775	441	5,416	4,97
1,650	12	0.229	1.000	46.0	25.2	41.1	19,800	4,535	19,792	15,25
2,475	80	0.369	0.865	25.2	11.5	43.2	198,000	73,103	171,331	98,22
3,300	1,213	0.433	0.736	34.7	23.0	43.0	4,002,900	1,732,787	2,944,688	1,211,90
4,125	1,149	0.479	0.704	43.6	34.9	42.7	4,739,625	2,268,752	3,335,093	1,066,34
4,950	254	0.540	0.723	53.3	44.3	41.7	1,257,300	679,310	909,380	230,07
5,775	140	0.605	0.782	62.4	52.6	41.1	808,500	489,146	632,381	143,23
6,600	103	0.644	0.833	64.4	57.4	41.1	679,800	438,111	566,143	128,03
7,425	88	0.701	0.898	66.2	62.3	41.2	653,400	458,089	586,977	128,88
8,250	57	0.753	0.919	69.7	63.7	41.3	470,250	354,023	432,311	78,28
9,075	33	0.823	0.931	72.7	64.1	41.4	299,475	246,494	278,839	32,34
9,900	43	0.857	0.974	72.2	67.3	41.2	425,700	364,739	414,762	50,02
10,725	20	0.862	0.997	72.8	68.7	41.2	214,500	184,987	213,750	28,76
11,550	2	0.862	1.018	74.5	69.7	41.3	23,100	19,920	23,506	3,58
12,375	0	0.000	0.000	0.0	0.0	0.0	0	0	0	
13,200	0	0.000	0.000	0.0	0.0	0.0	0	0	0	
14,025	0	0.000	0.000	0.0	0.0	0.0	0	0	0	
14,850	0	0.000	0.000	0.0	0.0	0.0	0	0	0	
15,675	0	0.000	0.000	0.0	0.0	0.0	0	0	0	

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Project Challenges

Project Challenges

- Overcoming skepticism by Senior management of actual savings – “Seemed too good to be true”
- Providing **actual** equipment data sheets, not submittal data
- Change Management – proving performance to the operators

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Project Outcome

Project Outcome

- On track to reduce chiller plant kw/ton from 0.83 to 0.64
- Reduce electric consumption by ~10,000,000kwh/yr
- COGS reduction of ~$500,000+ per year
- Earned a $500,000 Utility rebate
- Project went live on time
- Meaningful efficiency gains within one week of live operation

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Take Away Points

- ✓ **Strong Plant Control System (PCS) foundation ensures efficient integration**
- ✓ **Double and triple check actual equipment specifications**
- ✓ **Install or ensure precision meters and transmitters**
- ✓ **The right team makes a difference**
- ✓ **Patience – It is a new system**
- ✓ **Understand the coordination of equipment**

Chiller Plant Optimization

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