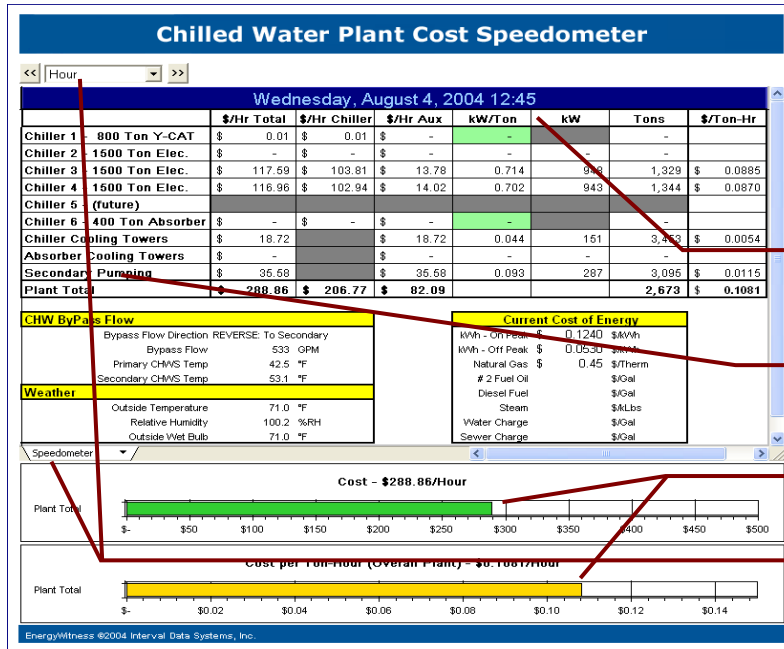


# EnergyWitness™ Chiller Plant Optimization

## Introduction

Chiller plant optimization needs a goal—something measurable and verifiable. Of course, that goal is to operate at the lowest cost and energy consumption, while maintaining space comfort. By modeling your system and applying engineering calculations, EWPowerPlant shows detailed production, efficiency, and cost measurements—updated every 15 minutes—so

you can see exactly how your plant is operating and manage towards the optimal cost for the overall plant.



## Cost Speedometer

EWPowerPlant includes a speedometer to show the hourly operating cost at a glance.

The table shows cost/hour (total, chilled water, & auxiliary), kW, tons, kW/ton, and cost/ton-hour.

Each major system is broken out to easily see the individual chillers, cooling towers, and secondary pumping as well as the plant total.

Easy-to-read gauges show total cost/hour and cost/ton-hour for the overall plant.

Display options allow users to step through time in increments from hours to year, and to select the speedometer view or review the underlying Excel plant configuration models.

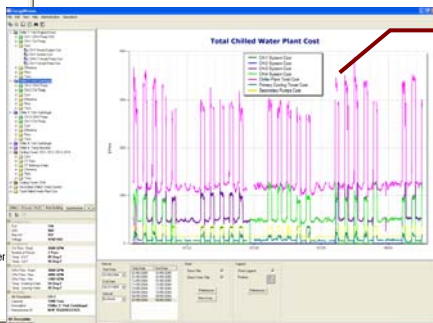
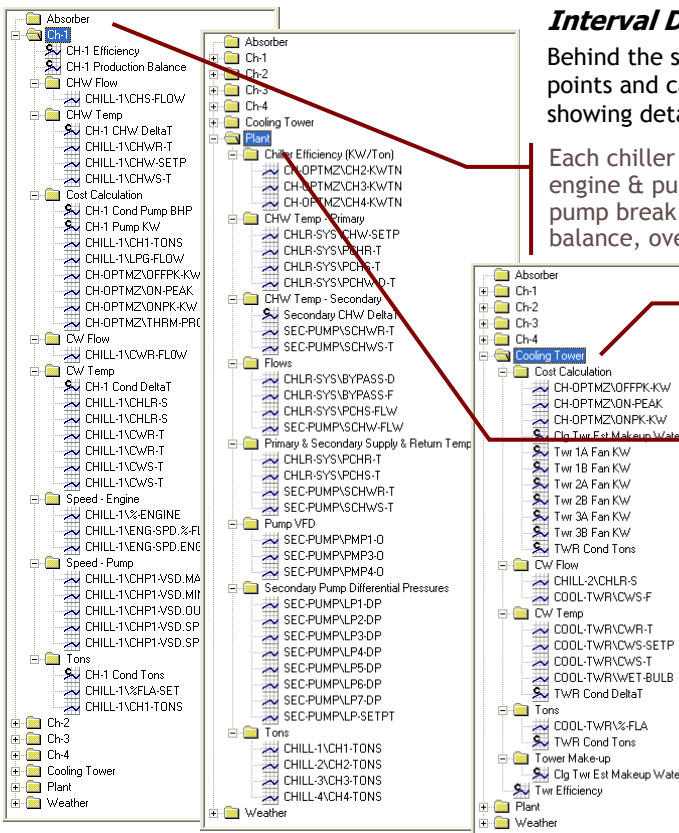
## Interval Data and Calculations

Behind the speedometer is a foundation of data. Here we see the various points and calculations (updated every 15 minutes) for EWPowerPlant, showing detail for the chillers, cooling tower, and overall plant.

Each chiller is configured with interval data for flows, temperatures, engine & pump speeds, and tons output. Calculations include Delta Ts, pump break horsepower, pump kW, condenser tons output, production balance, overall efficiency, and ultimately cost.

Cooling tower data includes flow, temperature and tons interval data, with calculations for Delta T, condenser tons, fan kW, tower makeup water, an overall efficiency calculation, and again, cost.

The plant has the rolled up cost calculations, backed up by chiller tons and efficiency data, primary & secondary loop data, and pump data.



The speedometer can display any cost calculation as a trend, along with any other EnergyWitness data to provide a historical view and assist in diagnosing issues to better manage by plant operating

## Sample Inventory of Chiller Plant System and Optimization Calculations

System	Sub-System	Calculation Name	Calculation Formula
<b>Chiller 1</b> 800 Ton Y-CAT	Chiller	Chiller Efficiency (%)	$\frac{\text{Evaporator BTU output}}{\text{Condenser BTU input} + \text{Drive Motor Energy}}$
	Chiller	Evaporator BTU output (BTU)	$\text{CHW Flow} * \text{CHW } \Delta T * \text{Conversion factor}$
	Chiller	Condenser BTU input (BTU)	$\text{CW Flow} * \text{CW } \Delta T * \text{Conversion factor}$
	Chiller Drive Motor	Drive Motor Energy input	$\text{LPG Flow} * \text{Heat Constant}$
	Chiller	Chiller Efficiency (Scfh/Ton)	$\text{Engine Natural Gas Flow Rate} / \text{Chiller Output}$
	Chilled Water Pump	Motor Brake Horsepower (BHP)	$(\text{CHW Flow} * \text{DPP}) / (\text{Mass Flow} * \text{Mech Eff} / 100)$
	Chilled Water Pump	BHP to kW conversion	$\text{CHW Pump BHP} * \text{Conversion factor}$
	Condenser Water Pump	Motor Brake Horsepower (BHP)	$(\text{CW Flow} * \text{DPP}) / (\text{Mass Flow} * \text{Mech Eff} / 100)$
	Condenser Water Pump	BHP to kW conversion	$\text{CW Pump BHP} * \text{Conversion factor}$
<b>Chiller 2</b> <b>Chiller 3</b> <b>Chiller 4</b> 1500 Ton Electric Chillers	Chiller	Chiller Efficiency (%)	$\frac{\text{Evaporator BTU output}}{\text{Condenser BTU input} + \text{Drive Motor Energy}}$
	Chiller	Evaporator BTU output (BTU)	$\text{CHW Flow} * \text{CHW } \Delta T * \text{Conversion factor}$
	Chiller	Condenser BTU input (BTU)	$\text{CW Flow} * \text{CW } \Delta T * \text{Conversion factor}$
	Chiller Drive Motor	Drive Motor Energy input	$\text{Motor kW} * \text{Conversion factor}$
	Chilled Water Pump	Motor Brake Horsepower (BHP)	$(\text{CHW Flow} * \text{DPP}) / (\text{Mass Flow} * \text{Mech Eff} / 100)$
	Chilled Water Pump	BHP to kW conversion	$\text{CHW Pump BHP} * \text{Conversion factor}$
	Condenser Water Pump	Motor Brake Horsepower (BHP)	$(\text{CW Flow} * \text{DPP}) / (\text{Mass Flow} * \text{Mech Eff} / 100)$
	Condenser Water Pump	BHP to kW conversion	$\text{CW Pump BHP} * \text{Conversion factor}$
	<b>Chiller 5</b> 400 Ton Absorber	Chiller	Chiller Efficiency (%)
Chiller		Evaporator BTU output (BTU)	$\text{CHW Flow} * \text{CHW } \Delta T * \text{Conversion factor}$
Chiller		Condenser BTU input (BTU)	$\text{CW Flow} * \text{CW } \Delta T * \text{Conversion factor}$
Chiller Drive		Steam Energy input	$\text{Absorber LbsSTM} * \text{Conversion factor}$
Purge Motor		Purge Motor Energy input (kW)	$\frac{(\% \text{ Load} / 100) * \text{Purge Motor HP} * \text{Conversion factor}}{\text{Motor Efficiency} / 100}$
Solution Pump		Solution Pump Motor Energy input (kW)	$\frac{(\% \text{ Load} / 100) * \text{Solution Pump HP} * \text{Conversion factor}}{\text{Motor Efficiency} / 100}$
Chilled Water Pump		Motor Brake Horsepower (BHP)	$(\text{CHW Flow} * \text{DPP}) / (\text{Mass Flow} * \text{Mech Eff} / 100)$
Condenser Water Pump		Motor Brake Horsepower (BHP)	$(\text{CHW Flow} * \text{DPP}) / (\text{Mass Flow} * \text{Mech Eff} / 100)$
<b>Primary Cooling Towers</b> 3 Towers 2 Cells Each		Cooling Tower 1, 2, 3 Cells A & B in each tower	Fan Motor Energy (kW) (calculated for each cell)
	Cooling Towers	Cooling Towers Efficiency (%)	$\frac{\text{CW BTU} - (\Sigma \text{ Fan BTU} + \Sigma \text{ Pump BTU} + \text{MUW BTU})}{\text{CW BTU}}$
	Cooling Towers	Condenser BTU output	$\text{CW Flow} * \text{CW } \Delta T * \text{Conversion factor}$
	Cooling Towers	Sum of Tower Fan Energy (BTU)	$(1A + 1B + 2A + 2B + 3A + 3C) * \text{Conversion factor}$
	Cooling Towers	Sum of Pump Energy (BTU)	$(\text{CWP1} + \text{CWP2} + \text{CWP3} + \text{CWP4}) * \text{Conversion factor}$
	Make-up Water	Make-up Water BTU input	$\text{MUW Rate} * (\text{CW Supply Temp} - \text{City Water Temp}) * \text{Conversion}$
<b>Absorber Cooling Towers</b> 2 Towers 1 Cell Each	Cooling Tower 1, 2	Fan Motor Energy (kW) (calculated for each tower)	$\frac{(\% \text{ Load} / 100) * \text{Fan Motor HP} * \text{Conversion factor}}{\text{Motor Efficiency} / 100}$
	Cooling Towers	Cooling Towers Efficiency (%)	$\frac{\text{CW BTU} - (\Sigma \text{ Fan BTU} + \Sigma \text{ Pump BTU} + \text{MUW BTU})}{\text{CW BTU}}$
	Cooling Towers	Condenser BTU output	$\text{CW Flow} * \text{CW } \Delta T * \text{Conversion factor}$
	Cooling Towers	Sum of Tower Fan Energy (BTU)	$(\text{Fan1} + \text{Fan2}) * \text{Conversion factor}$
	Cooling Towers	Sum of Pump Energy (BTU)	$(\text{CWP1} + \text{CWP2}) * \text{Conversion factor}$
	Make-up Water	Make-up Water BTU input	$\text{MUW Rate} * (\text{CW Supply Temp} - \text{City Water Temp}) * \text{Conversion}$
<b>Secondary Chilled Water Pumping</b>	Secondary Pumps 1, 2, 3, 4	Motor Energy (kW) (calculated for each pump)	$\frac{(\% \text{ Load} / 100) * \text{Pump Motor HP} * \text{Conversion factor}}{\text{Motor Efficiency} / 100}$
	Secondary Pumping System	Sum of Secondary Pump Energy (kW)	$\text{Pump1} + \text{Pump2} + \text{Pump3} + \text{Pump4}$

### Constants and Conversions

Heat Constant for Natural Gas = 1015 BTU/cubic foot natural gas  
 Differential Pump Pressure (DPP) = 20 lbs  
 Conversion Mass Flow Units to HP = 1714 lbs gpm/hp  
 Conversion Mass Flow Units to BTU = 501.565  
 Conversion Factor BHP to kW = 0.746 kw/hp  
 Conversion Factor kW to BTU = 3412 BTU/kW  
 Conversion Factor LbsSTM to BTU = 302.96 BTU/lb steam at 70psi

