AABC Commissioning Group

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# Optimizing Chilled Water Systems for Energy Efficiency and Occupant Comfort

Course Number: CXENERGY1709

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

# Copyright Materials

# Water Cooled Chilled Water Plant Optimization

A chilled water (CHW) system is often the most energy-intensive, occupant-satisfaction related component in a facility. This presentation provides information on implementing a holistic approach to CHW system management and the fundamental thermodynamic principles that will lead to reduced energy consumption, improved occupant comfort and extended equipment life.

# Learning Objectives

At the end of the this course, participants will be able to:

1. Learn to qualify a chiller plant for an optimization project.
2. Learn the methodology and sequencing of steps associated with plant optimization.
3. Learning the obstacles to achieving an optimized plant and how they can be remedied.
4. Learning the steps associated with documenting and verifying delivered savings.

CxEnergy 2017 CONFERENCE & EXPO

Orlando, Florida | April 24-27, 2017

# Siemens APOGEE® Demand Flow™

**A unique energy and operational cost savings application for water-cooled, central chilled water plants**

## Chilled Water Plant Characteristics

- Most chilled water plants have some form of constant flow pumping
- Most plants bypass chilled water flow – excessive pumping energy
- Operate best with wide temperature splits across the chiller – at or near original design intent (known as "delta-T")
- Usually operate at design intent conditions only 5% of the time

## Chilled Water Plant Operational Shortcomings

- Most plants today are plagued with "Low Delta-T Syndrome"
- Inefficiently operated 95% of the time due to design
- The Industry has tried to solve these issues with limited success
- Often plant efficiency is sacrificed for comfort
- Nominal plant capacity is usually never realized – causing perceived need for additional chillers

**5 fundamental subsystems of a chilled water system that consumes energy and influences deliverable capacity;**

- Chilled Water Pumping
- Condenser Water Pumping
- Chillers
- Cooling Tower Fans
- Air Side

**These 5 subsystems are interdependent**

- Energy and deliverable capacity are interdependent
- Often "conservation methods" reduce deliverable system capacity
- Often what is done in the name of energy conservation results is a "transfer of energy" among these 5 subsystems with no net savings realized, or increase in energy

**Siemens Demand Flow understands these technical relationships, delivering a "holistic" approach to Chiller System Optimization**

## What's Different?

- Effectively establishes only One Chilled Water Loop, virtually no bypass water
- Water Flow Varies thru Chiller Evaporator and Condenser
- VFDs are installed on all CHW & CW Pumps and on all Cooling Tower Fans
- VFDs are <u>not</u> required on the Chillers
- Optimize Pressure and Temperature set-points on Chilled and Condenser Water systems based on current system dynamics

## Effects

- Increases system deliverable tonnage
- Manages chiller "lift", effectively eliminates refrigerant flow issues at low load conditions
- Stable Chiller Refrigerant loop performance at virtually all tonnage loads

## System Energy Shifts

- CHW Pumping Energy is Reduced
- CW Pumping Energy Reduced
- Chiller KW/Ton Reduced
- Airside Fan savings possible (VAV Systems)
- Net Cooling Tower Fan Energy Optimized
- Net Plant Energy Consumption Reduced
- Dramatic energy savings in most cases

## System Capacity Shifts

- Increased Chiller Plant *Deliverable* Cooling Capacity (not nominal & where low Delta T is present)
- All pumping and tower fan subsystems are submetered through the KW Outputs on the VFDs
- Chillers are submetered by Digital Energy Monitors (DEM) to measure their performance

## What about Warranties?

- No Manufacturer Operating Limits Breached
- Manufacturer Warranties are not Voided
- Existing Siemens Demand Flow$^{TM}$ Projects on Trane, York, McQuay, Carrier, Westinghouse Chillers,

- **What do Chillers Know?**
  - **Temperature**
  - **Pressures**

- **Robina Hospital - Robina, Australia**

**Observed Results**

- 20–50% plant energy savings
- 1-4 year simple paybacks
- Often over 25% IRR

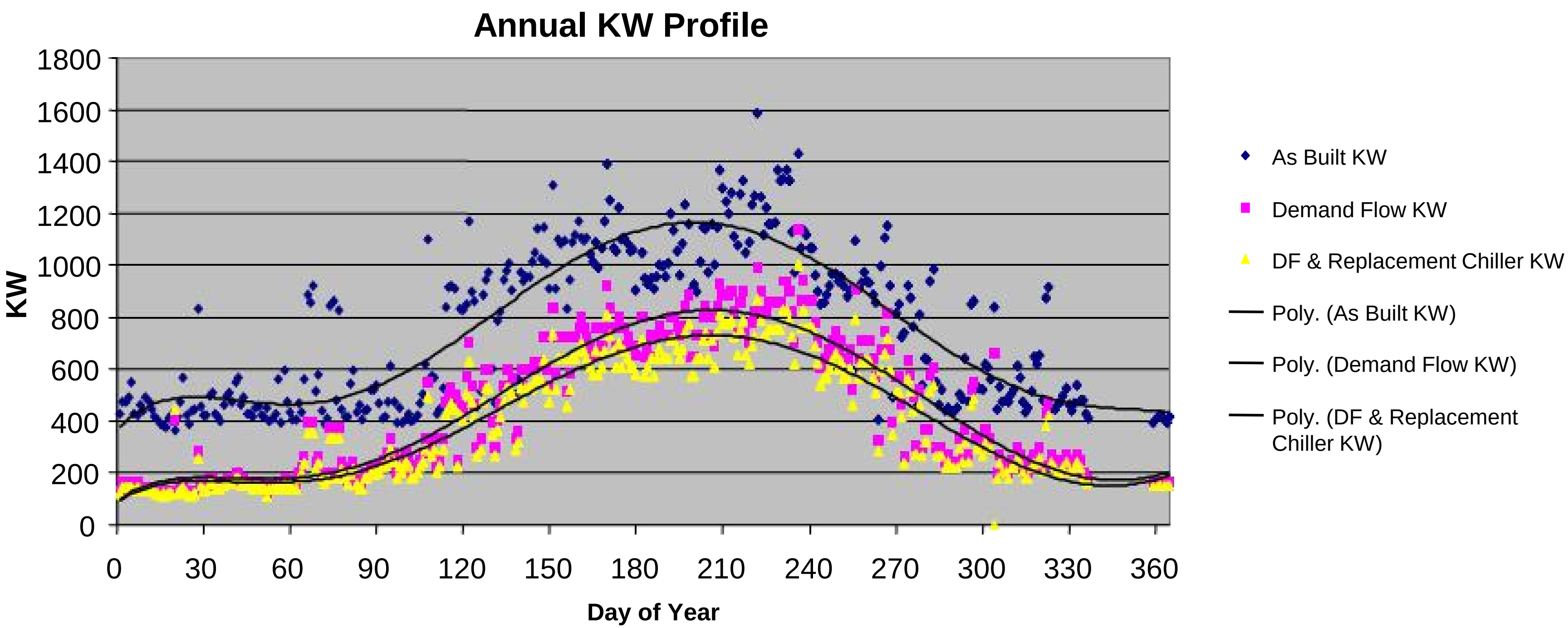
**Project includes;**

- Turn key Installation & commissioning
- Pre and Post Implementation Measurement & Verification for proof of performance via Siemens EMC Web-Based Monitoring System
- Maintenance service coverage for APOGEE controls and plant mechanical equipment (optional)

## Navigator Web-Based Sub-Metering and Reporting

- Navigator is an M&V application for Demand Flow
- Critical DF Points are sub-metered
- Trended data is viewable via the internet on the Navigator web-based tool
- One way transmission of data to Navigator server
- Performance indicators will be measured and reported electronically on a monthly basis
- Basic reporting is average KW/T and KWH on performance
- Advanced reporting and solutions can be customized for more in-depth analysis

We can accurately calculate annual Plant savings after collecting 6-8 weeks of hourly trend data from the plant.

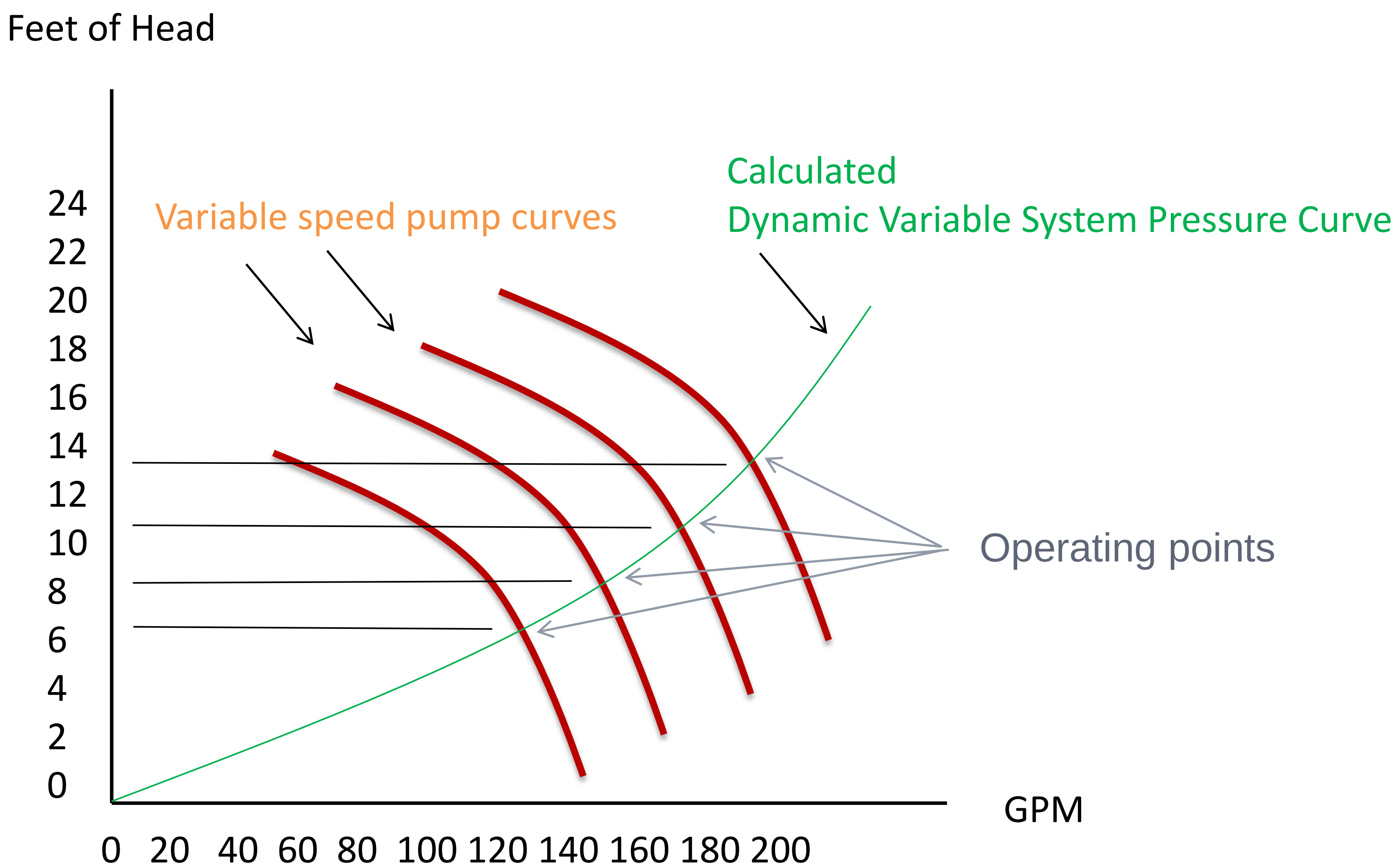


## Demand Flow Variable Pressure Curve Logic (VPCL)

- A majority of the industry controls to a constant pressure
- A majority of systems have some component of constant speed pumping
- Demand Flow uses variable speed pumping on both chilled and condenser water flow
- Demand Flow resets systems pressure based on load

## Calculated “Dynamic” Variable System Pressure Curve

- Siemens Demand Flow APOGEE  Panel calculates the optimal variable system pressure curve
- Demand Flow resets system pressure as pump speed varies along this variable system pressure curve


Feet of Head
Variable speed pump curves
Calculated
Dynamic Variable System Pressure Curve
Operating points
24
22
20
18
16
14
12
10
8
6
4
2
0
0 20 40 60 80 100 120 140 160 180 200
GPM

## Demand Flow™ does not Sacrifice Comfort for Energy Savings

## Simplified System Operation

## Reduce Energy Consumption

- A Demand Flow™ plant delivers chilled water for less money

## Extended Equipment Life

- Demand Flow™ increases chiller plant deliverable tonnage
- A Demand Flow™ plant usually uses less equipment to deliver the same tonnage as the as-built plant

## Less Maintenance

- Reduced load = reduced wear and tear on the chiller plant components

Demand Flow Example: Typical 1,800 Ton Plant

| | |
|---|---|
| **DF savings: 100k/yr** | **Service + M&V: $ 15k/yr** |
| **DF sell price: $ 300k** | **CPI: 2% escalation** |

| Year | Savings ($) | Project Cost ($) | Service & M&V ($) | Annual Cash Flow ($) | Cumulative Cash Flow ($) |
|---|---|---|---|---|---|
| | | | | -300,000 | |
| 1 | 100,000 | 300,000 | 15,000 | +85,000 | -215,000 |
| 2 | 102,000 | - | 15,300 | +86,700 | -128,300 |
| 3 | 104,040 | - | 15,606 | +88,434 | -39,866 |
| 4 | 106,121 | - | 15,918 | +90,203 | 50,337 |
| 5 | 108,243 | - | 16,236 | +92,007 | 142,343 |
| 6 | 110,408 | - | 16,561 | +93,847 | 236,190 |
| 7 | 112,616 | - | 16,892 | +95,638 | 331,914 |
| 8 | 114,869 | - | 17,230 | +97,638 | 429,552 |
| 9 | 117,166 | - | 17,575 | +99,591 | 529,143 |
| 10 | 119,509 | - | 17,926 | +101,583 | 630,726 |

~ 3 years payback

Excess cash flow

| | |
|---|---|
| **Total cost: $ 300,000** | **IRR: 27.2%** |
| **Total benefit: $ 930,726** | **ROI: 210.2%** |

8,900 Ton Plant

Immediate 26% Reduction in Energy Usage

Pre-Demand Flow – 0.89 Average Annual KW/Ton

Post Demand Flow – 0.61 Average Annual KW/Ton

$230,000 Utility Rebate

Improved Thermal Storage System

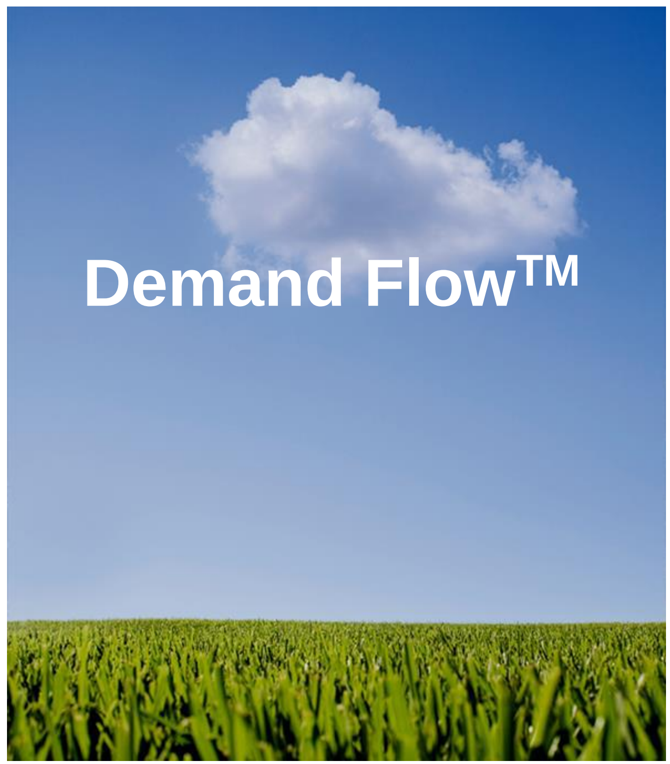
2 Year Simple Payback

*“We track the savings continuously, and Demand Flow lives up to its reputation. In fact, based on our reduced demand, we have earned a $230,000 rebate from our local electrical utility.”*
John Lepper, CEM
RTP Site Energy Coordinator
IBM Corporation

# Typical Questions

- Will DF work with Magnetic Bearing Chillers?
- How does DF prevent surging on machines?
- Will DF work with machines that map surge conditions?
- Will DF work with non Siemens BMS systems?
- Will DF work with PLC’s?
- Will DF improve the efficiency of a Variable Primary plant?
- Can DF be installed on a new construction project?
- Will DF work with absorber machines?
- Can DF work with existing SO’s or do you have to rewrite the SO?
- How many projects has been installed on?
- Demand Flow and Pressure Independent control valves

# Questions?



This concludes The American Institute of Architects Continuing Education Systems Course

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Contact Information

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