AABC Commissioning Group

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TAB Seminar:
Information and Optimization:
A practical approach to getting the most out of existing chilled water systems

Course Number: CxEnergy1904

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Course Description

The US Energy Administration states that over 55% of the Energy Consumption by Year of Construction is before the 1980's. DOE also states that over 60% of office buildings energy consumption is via HVAC, Equipment and Domestic Hot Water.

A significant trend in the marketplace is to gain a better understanding about other opportunities for Chiller plant Optimization and the evolving role of the pumps.

This presentation covers the evolution of the pump and the significant role it plays in the chiller plant.

Learning Objectives

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

1. The key attributes that make central chilled water plants good candidates for optimization

2. To understand the evolving role of pumps within the Chiller Plants.

3. Key steps in the process of optimization

4. Technical pitfalls that can derail projects.

Information and Optimization – A practical approach to getting the most out of existing chilled water systems

Presenter: Mark Gallagher

Director – Business Development
Global Markets

Agenda

Macro Trends and Global Impact of Buildings and HVAC

Identifying Best Candidates

Opportunities for Optimization

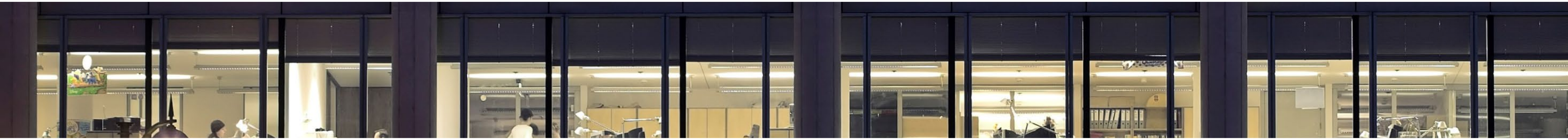
The Evolving Role of Pumps

Pump Savings – Low Hanging Fruit

Establishing a Baseline

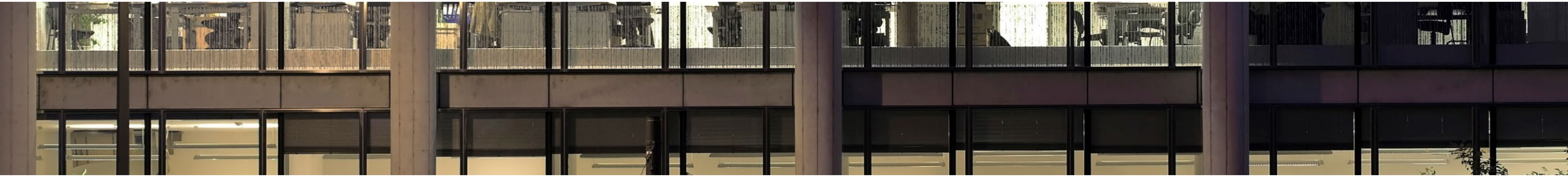
Optimization

Sample Stories

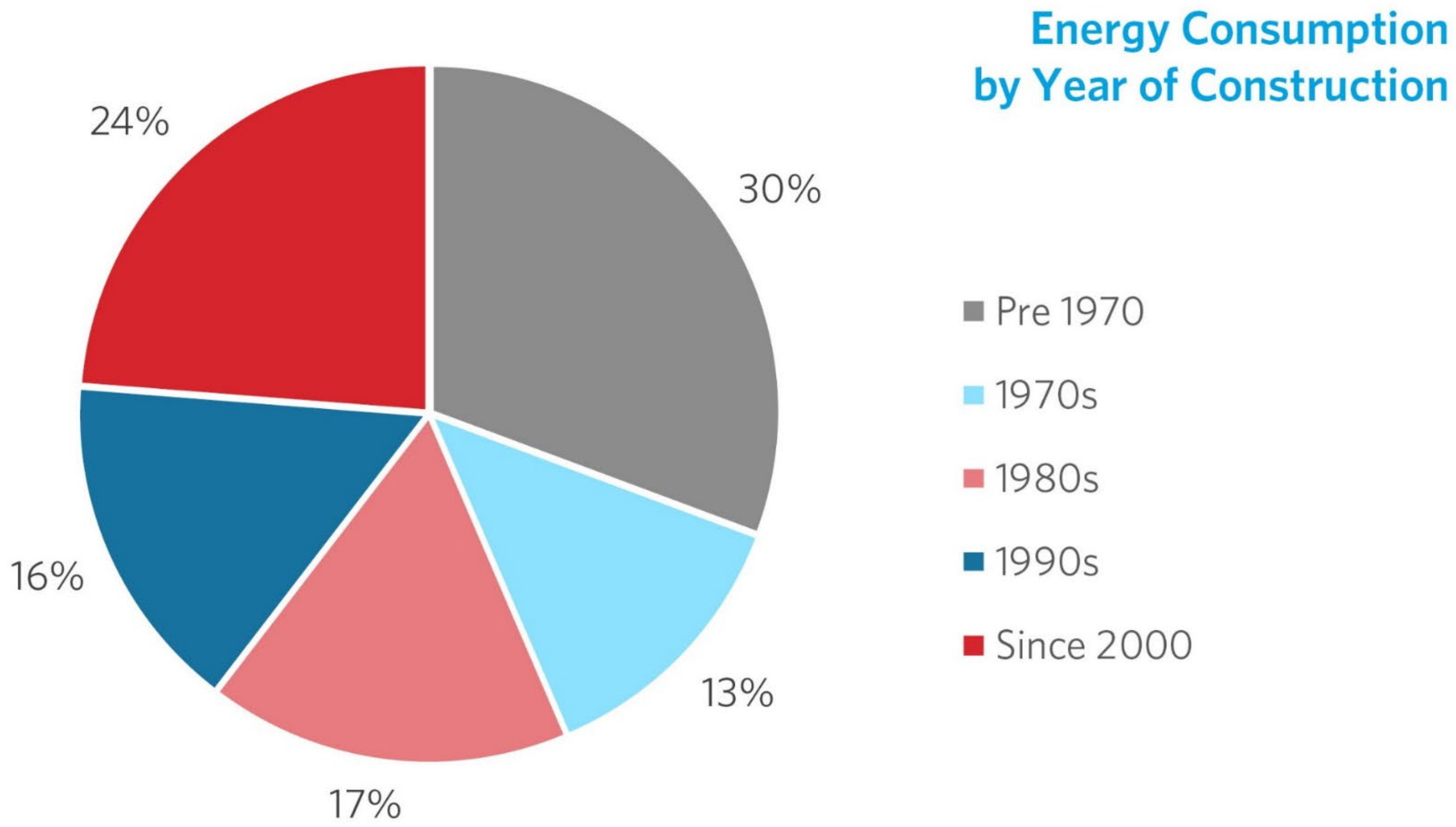


The building sector is responsible for 30% of global energy consumption.

Building retrofits forecasted to grow at 1-2% per year.

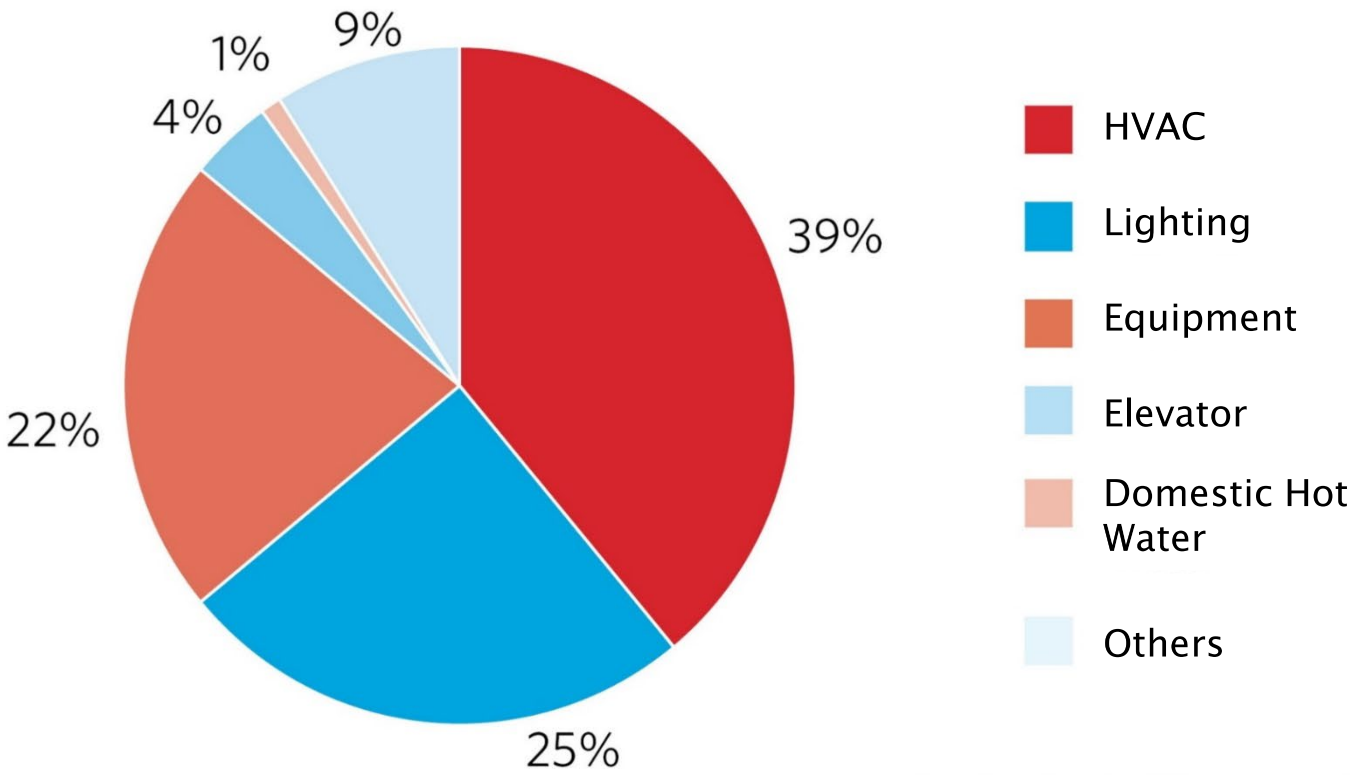


Existing buildings – ripe for upgrade



Source: US Energy Administration (released 2016 from 2012 survey)

Energy consumption – office buildings



Source: Guide to Best Practice Maintenance and Operation of HVAC Systems for Energy Efficiency (January 2012)

Many buildings have already completed a lighting retrofit leaving HVAC as the logical place to pursue energy savings.

Identifying Good Central Plant Optimization Opportunities – Things to Remember

- ✓ All variable plants
  (variable speed and variable flow chillers, VS and VF towers and VS pumps)

- ✓ Headered configuration (pumps and towers)

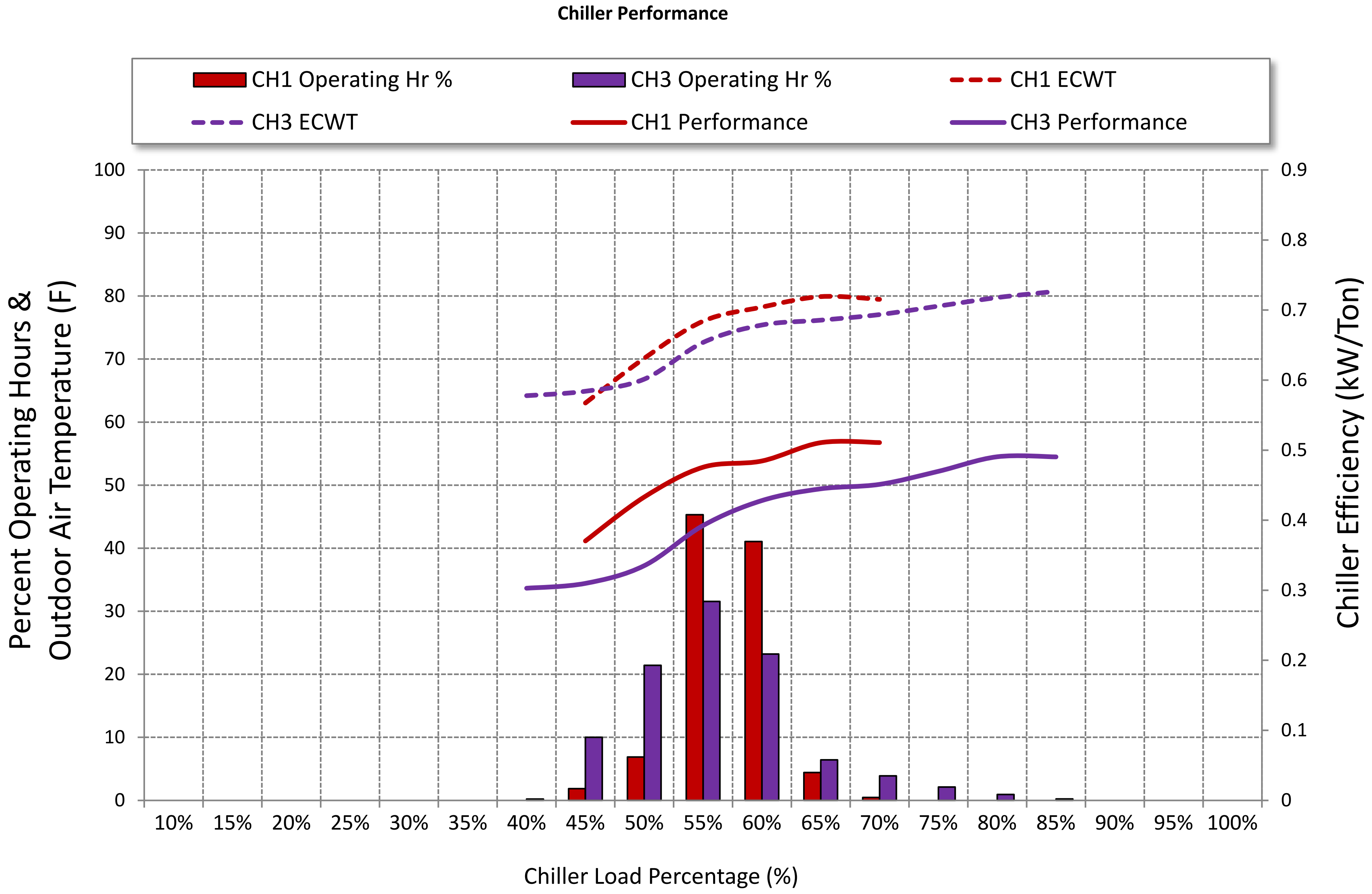
- ✓ High cooling ton hours of production

- ✓ High cost of power

Opportunities available in central plants

New Variable Speed Chiller Plants	Existing practice	Existing best in class	Optimized plant
	Analog era	Analog era	Digital era
	Feedback loop (PID) Silo sub-system control	Feedback loop (PID) Silo sub-system control	Demand based relational Integrated plant solution
	VS chillers, variable secondary CW reset	Variable primary (VPF) with CHW & CW reset	All-variable chiller plant
Plant efficiency – Moderate	0.7[illegible]	0.7[illegible]	0.[illegible]
Plant efficiency – Humid	>.76 kW/ton	>.72 kW/ton	<.50 kW/ton
Plant efficiency – Arid	0.72 kW/ton	0.68 kW/ton	0.48 kW/ton

Optimization is about keeping chillers in their sweet spot



Two identical chillers in the same plant

Audience Participation

Insert Poll Everywhere link for question

While every project is different, if you had to pick a single piece of equipment in a chiller plant to review, which would you typically consider first?

1. Cooling towers
2. Pumps
3. Chillers
4. Unsure/can’t distinguish

Display results

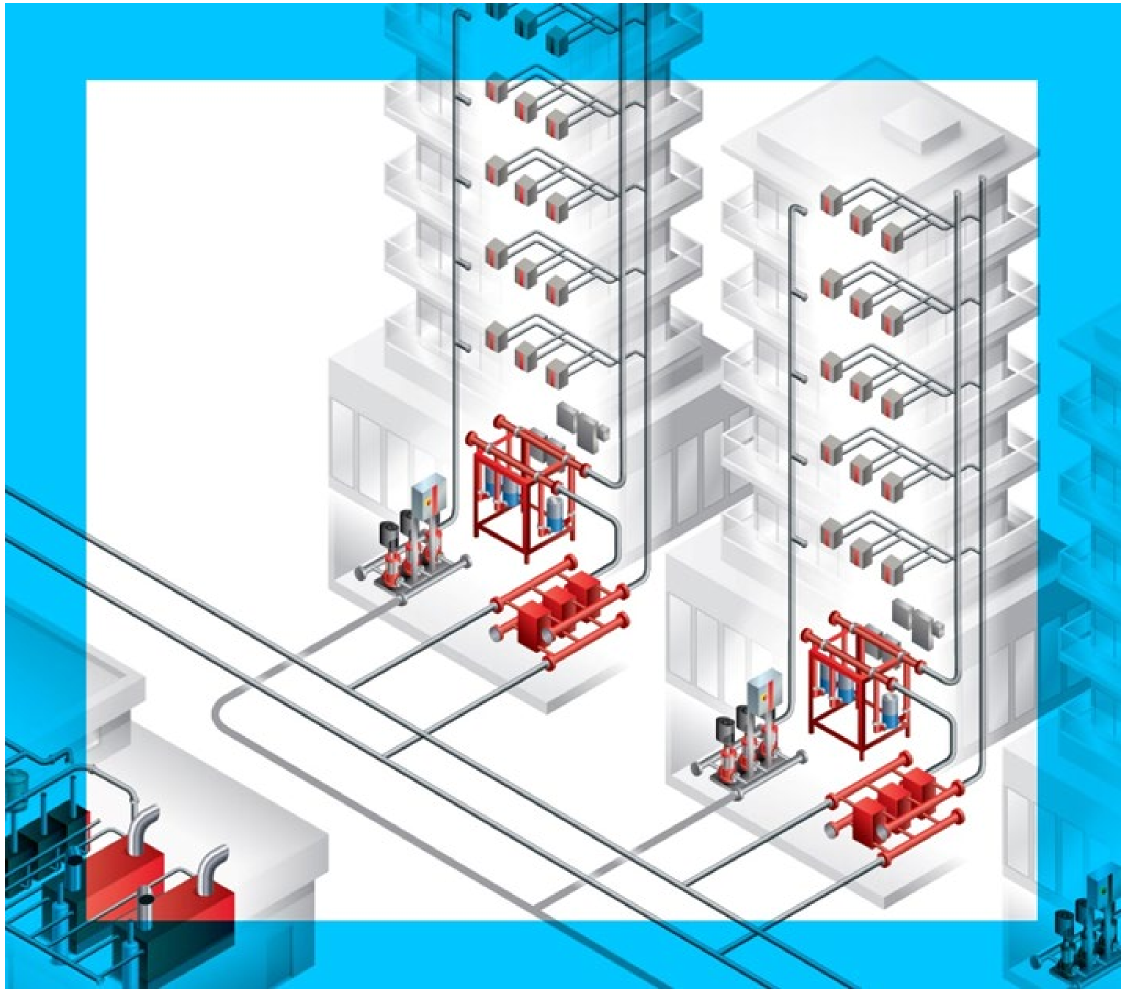
The world is changing – evolution of devices and their underlying function

Pumps … A small upgrade with oversized benefits

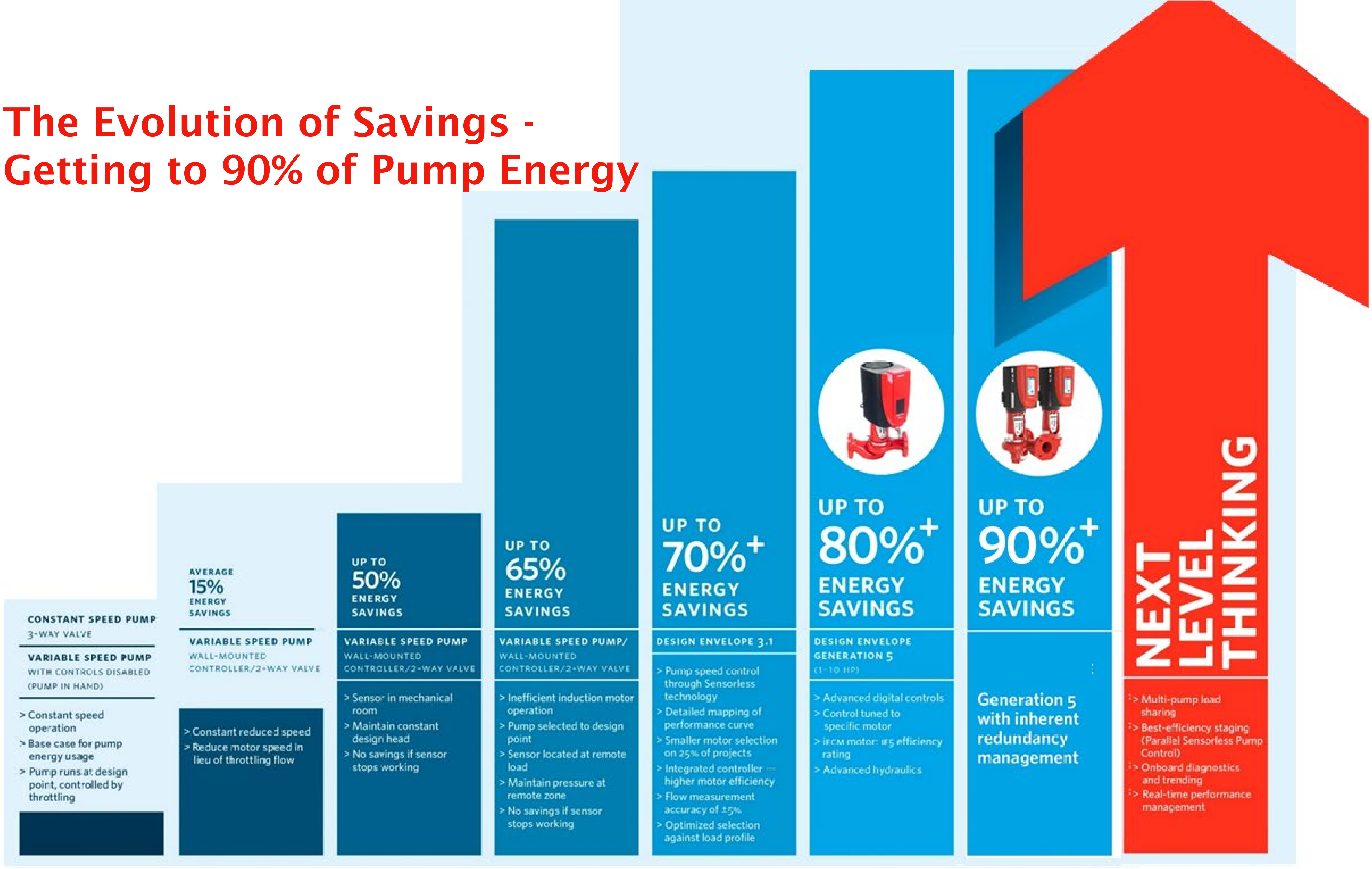
Most financially attractive option in central plant

Improve comfort through optimum flow and consistent temperatures

Intelligent pumps provide insight that pumps did not provide before



The Evolution of Savings - Getting to 90% of Pump Energy

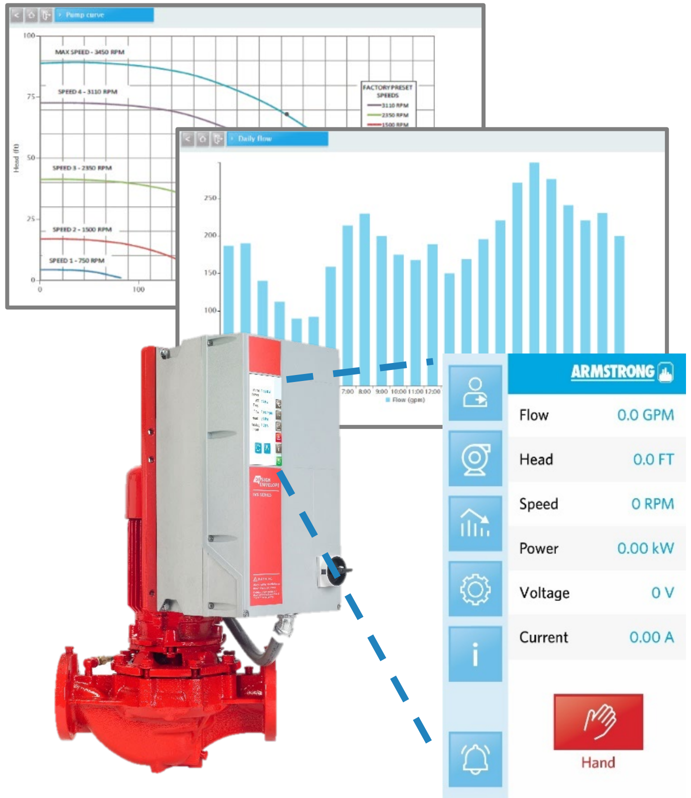


Recent advances in Pumping

1 Improved components and design - New hydraulics with intelligent motors in 1-10hp range

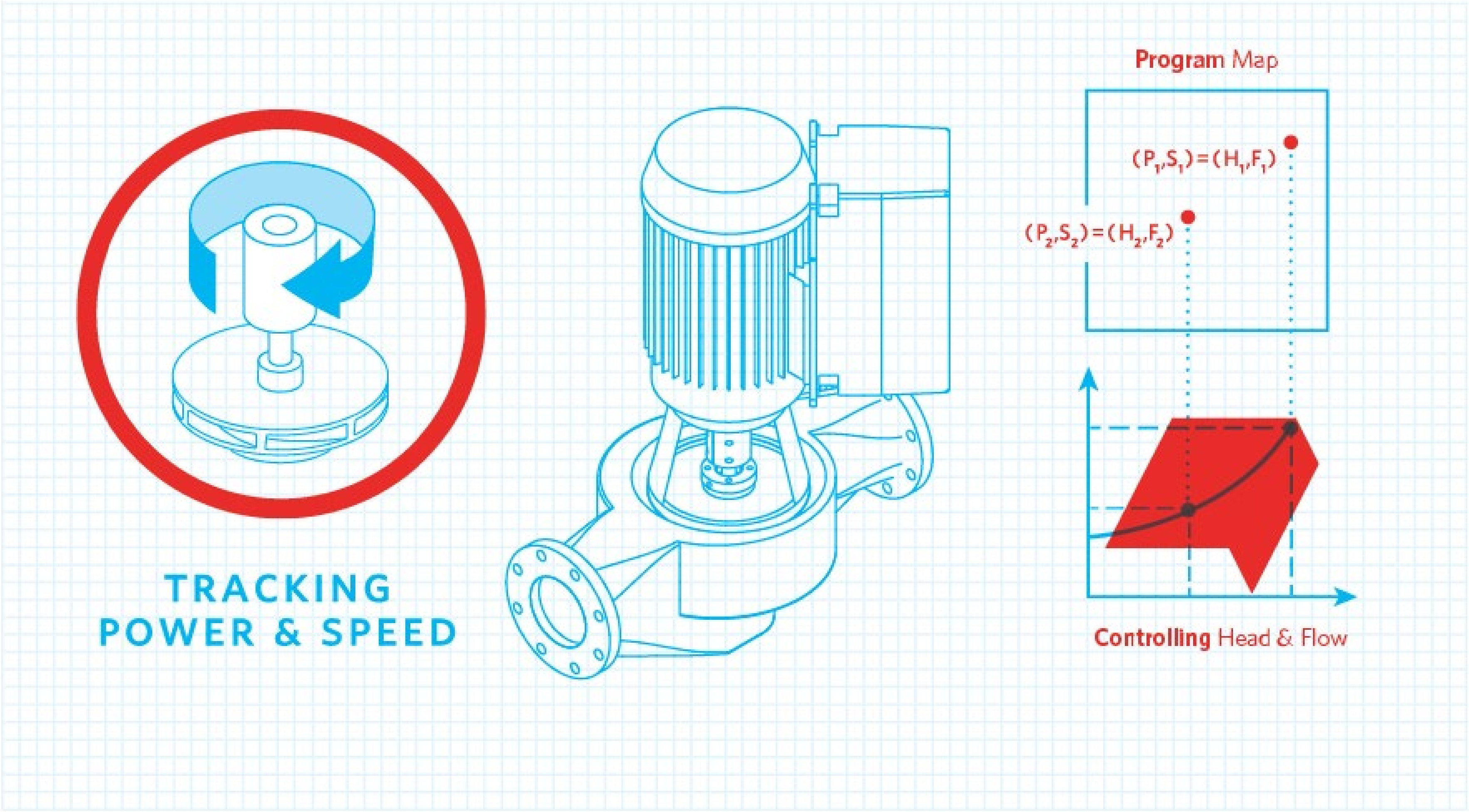
2 Built in Parallel Sensorless pump controls

3 Embedded connectivity with diagnostic insights



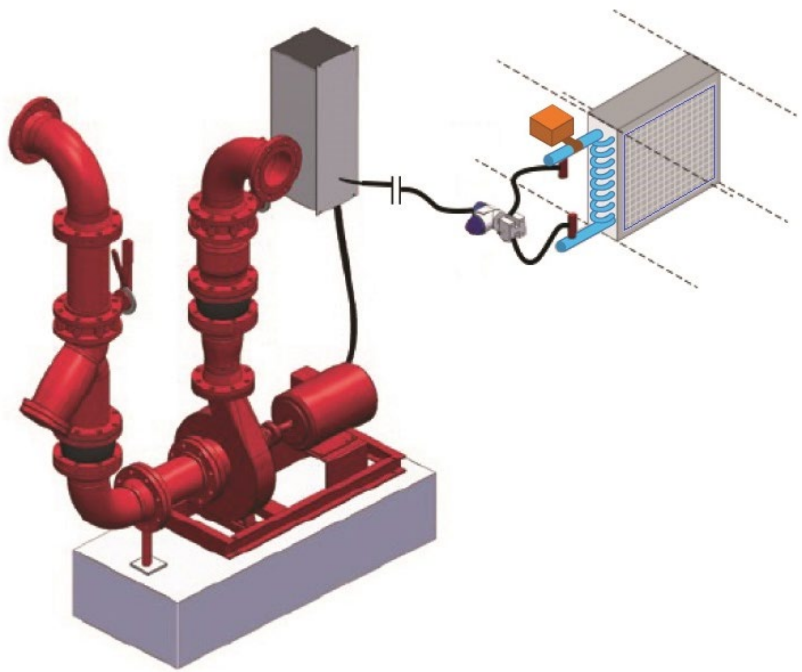
PARALLEL

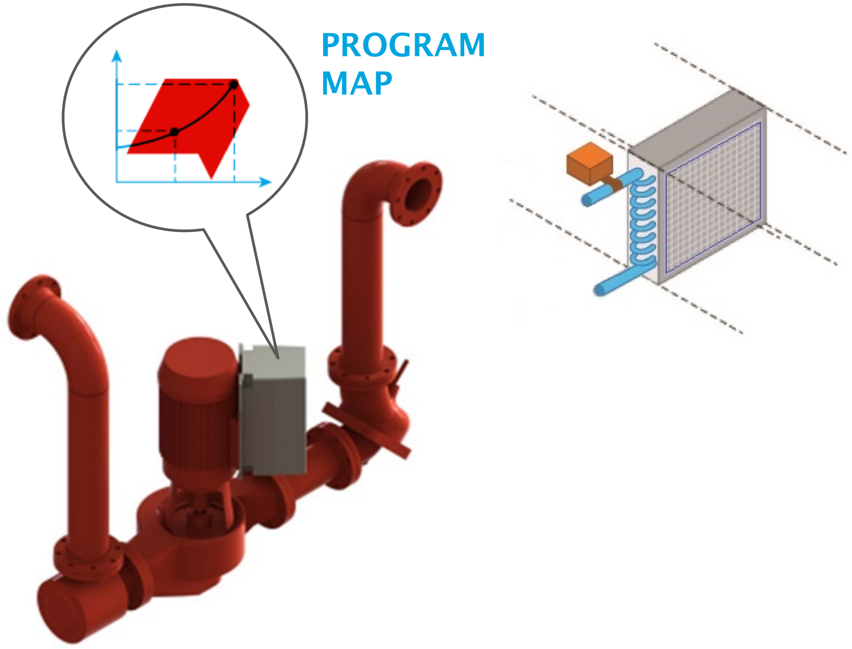
Sensorless Control



Algorithm embedded in controller that mimics performance of sensor

Control with Sensor vs Sensorless control





Control with Sensor

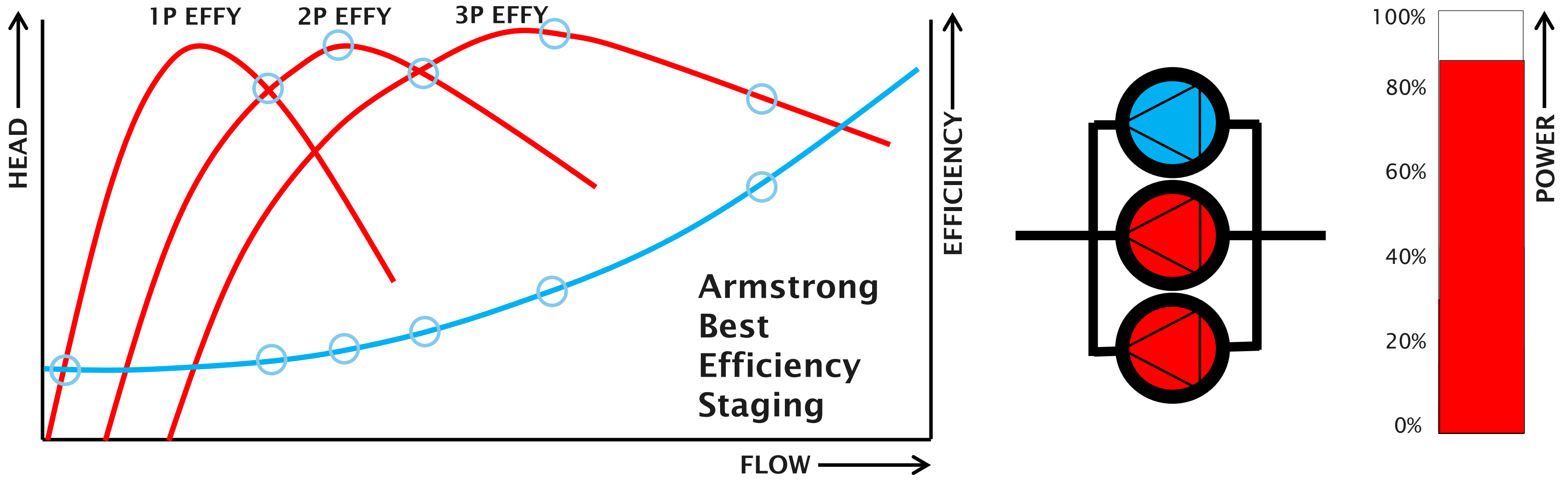
- Changes in system read by DP sensor
- Sensor converts to signal (4-20mA)
- VFD reads signal and modulates speed

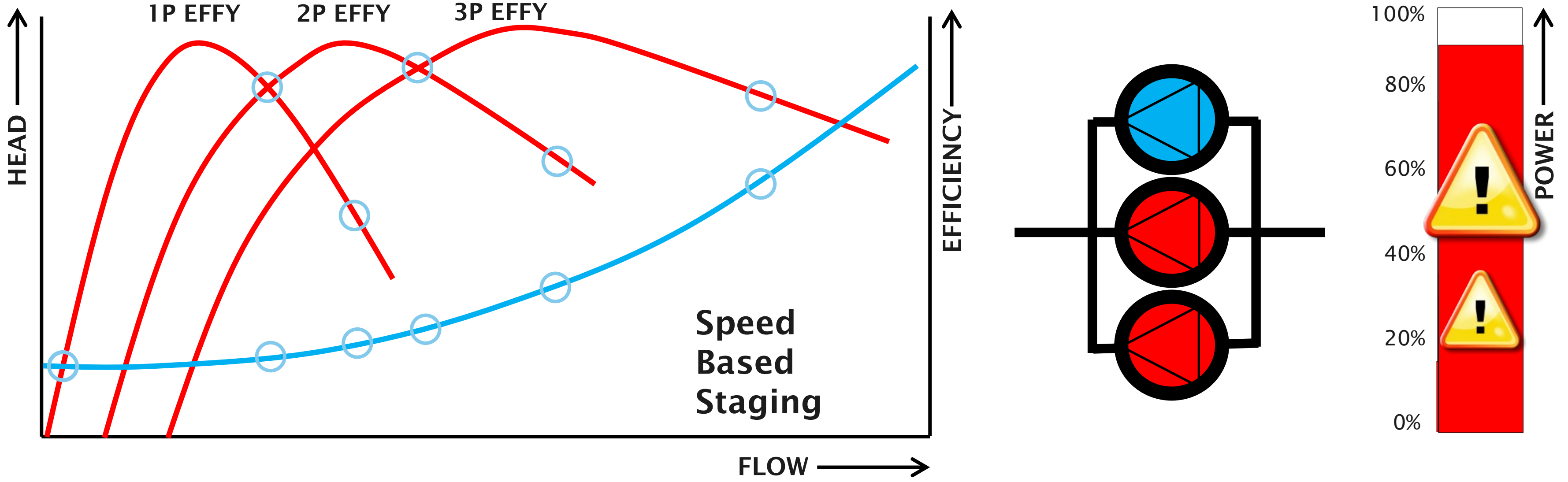
Sensorless control

- Changes in system = motor amp draw change
- DE pump compares amp draw to its Sensorless program map
- DE pump slows down or speeds up based on program map

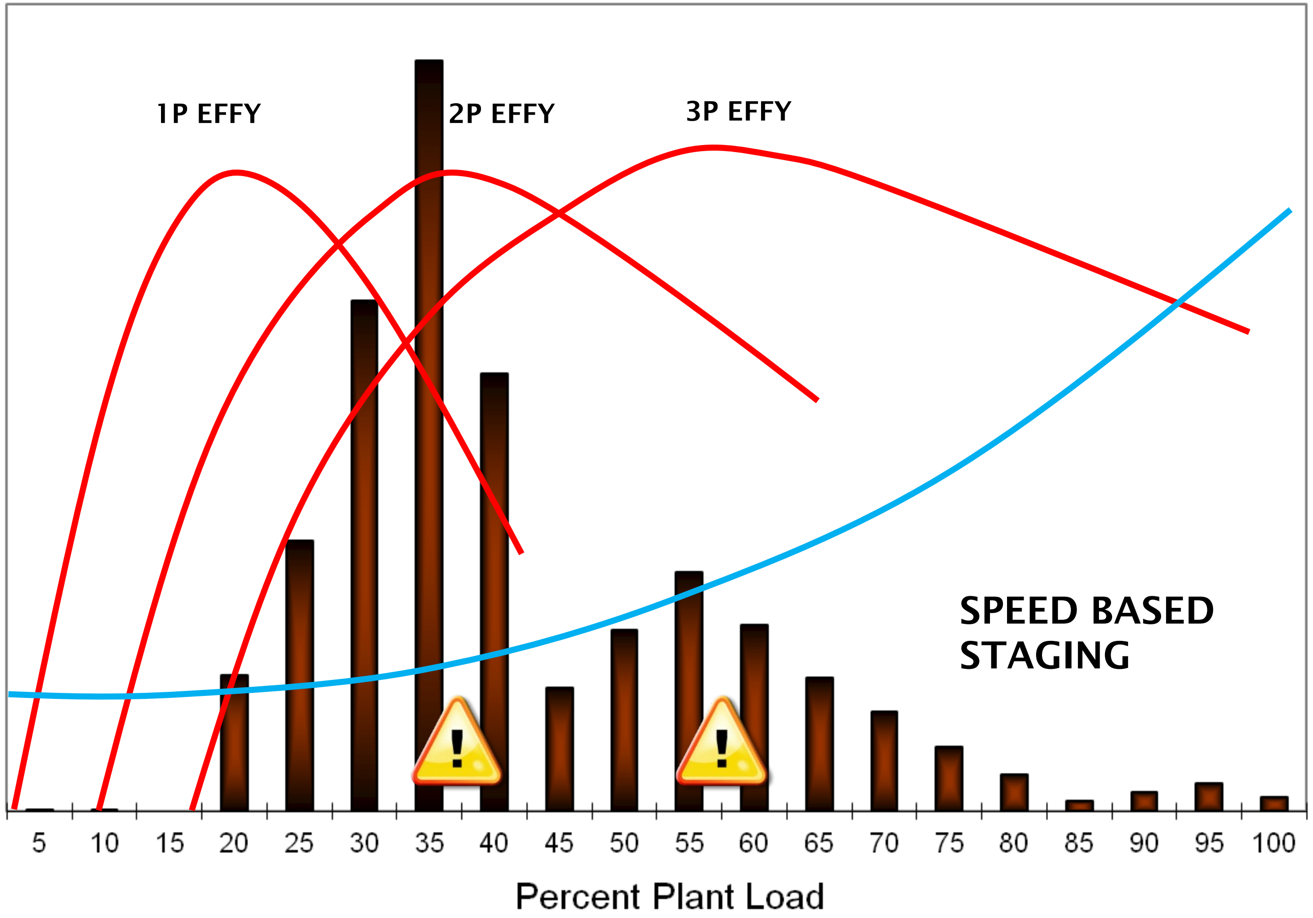
An integrated approach to reducing system cost

Parallel Sensorless Pump Control – staging methodology





Parallel Sensorless pump control – performance benefits



= Areas of highest inefficiency

Energy Savings:
3 x 40HP Pumps

Operating Cost* –
Speed Based Staging
~ $30,371

Best Efficiency Staging
~ $20,092

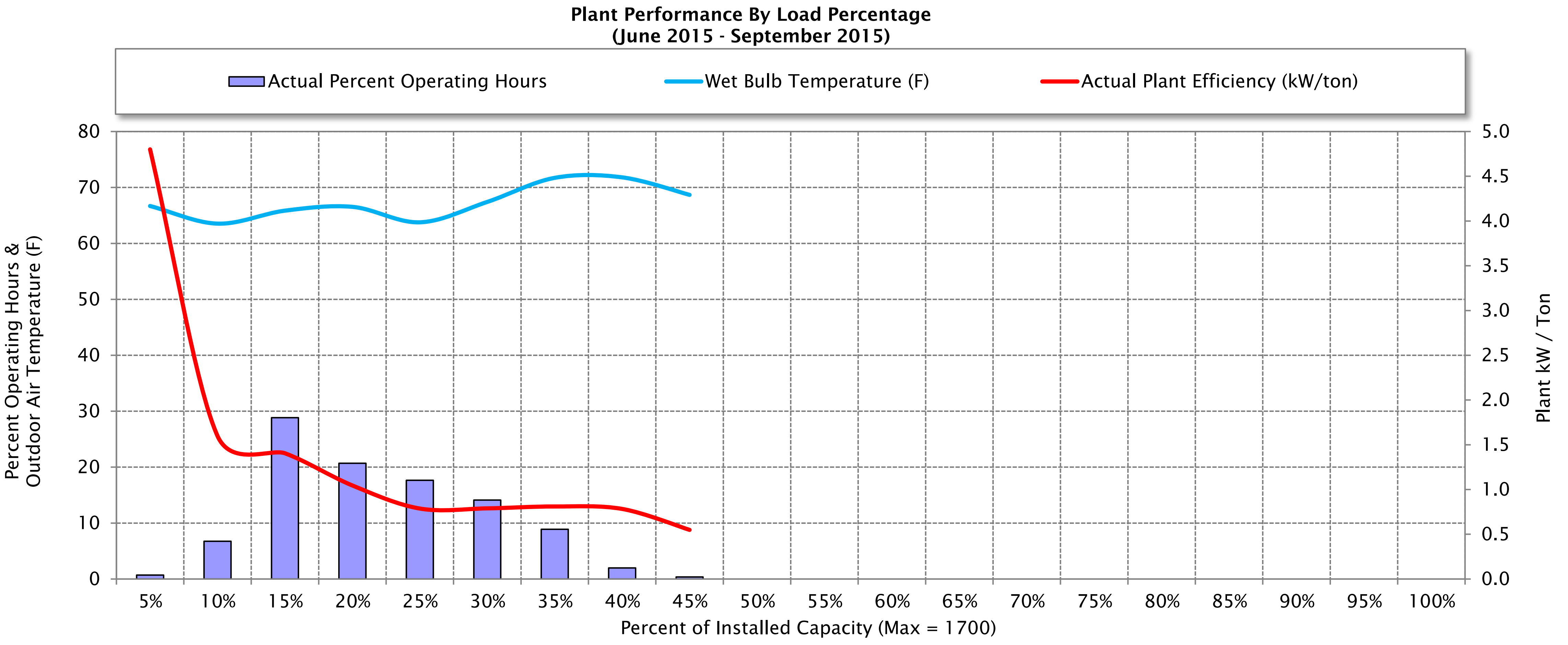
34% Saving

*Based on $0.10/kWh – 12 months operation – 40% design head min pressure

40% SAVINGS ON PUMPS THAT HAVE BEEN INSTALLED ONLY 4 YEARS AGO

Establishing A Baseline

Detailed Baseline – Efficiency by load percentage



Critical Data sets – Question

Critical data sets

- kW draw by equipment
- Equipment speed
- Run hours
- Flow
- Supply water temperature
- Return water temperature
- Entering condenser water temp
- Leaving condenser water temp
- Outdoor air temp
- Outdoor humidity

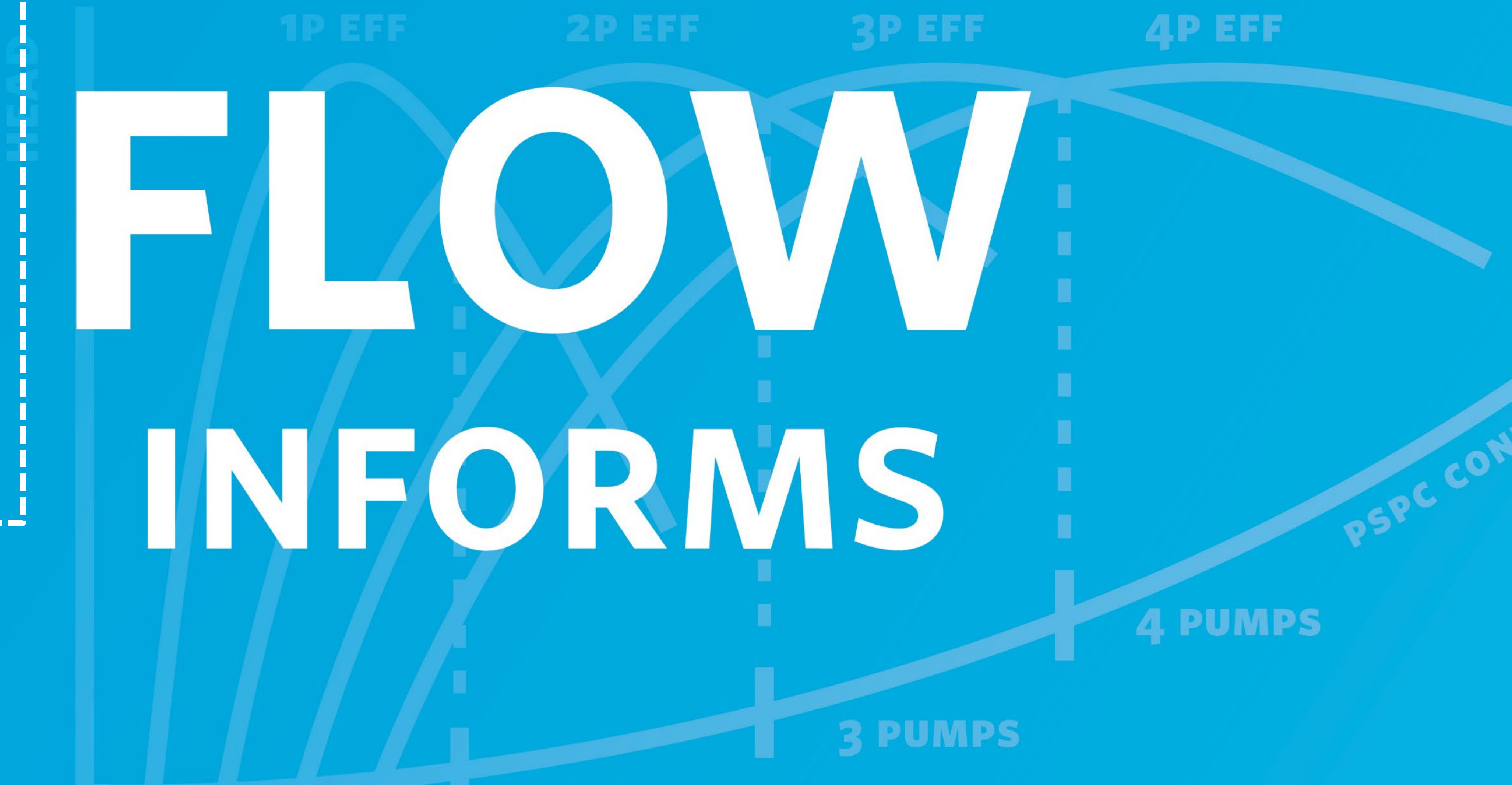
Link to Poll Everywhere survey

If you had to leave one of these pieces of data out of your baseline calculations which would you leave out?

- ❑ Equipment speed
- ❑ Run hours
- ❑ Flow
- ❑ Outdoor air temp
- ❑ Outdoor humidity

Use +/- 5% accuracy for flow measurement as part of the baseline and ongoing operational decisions

FLOW INFORMS



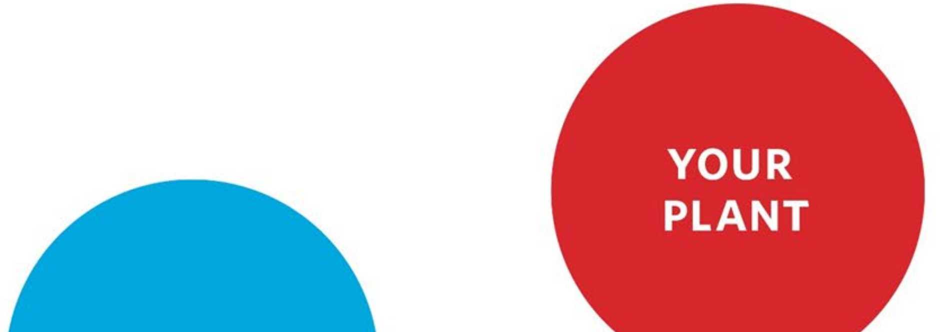
Where to start?

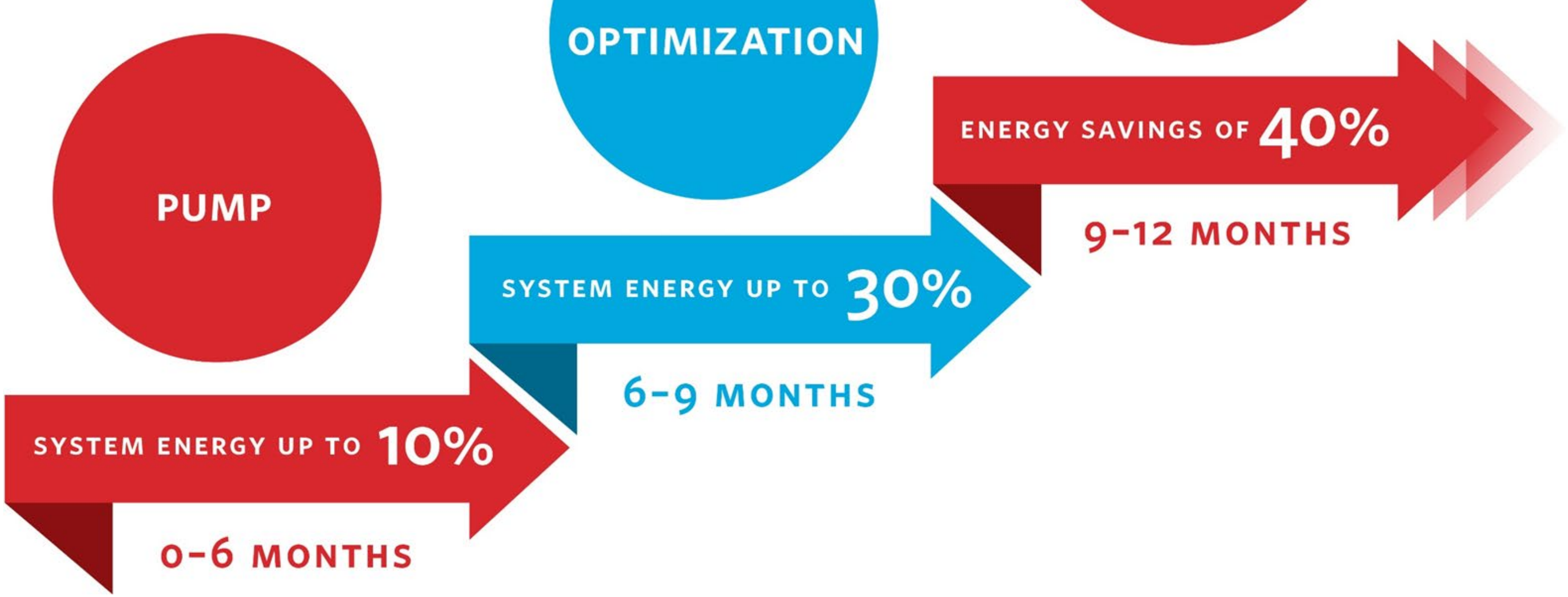
Depends on where you are:

- ❑Your current and future building needs
- ❑Your current equipment configuration
- ❑Your current equipment condition

Potential order – something to think about

Real Time Flow Tracking





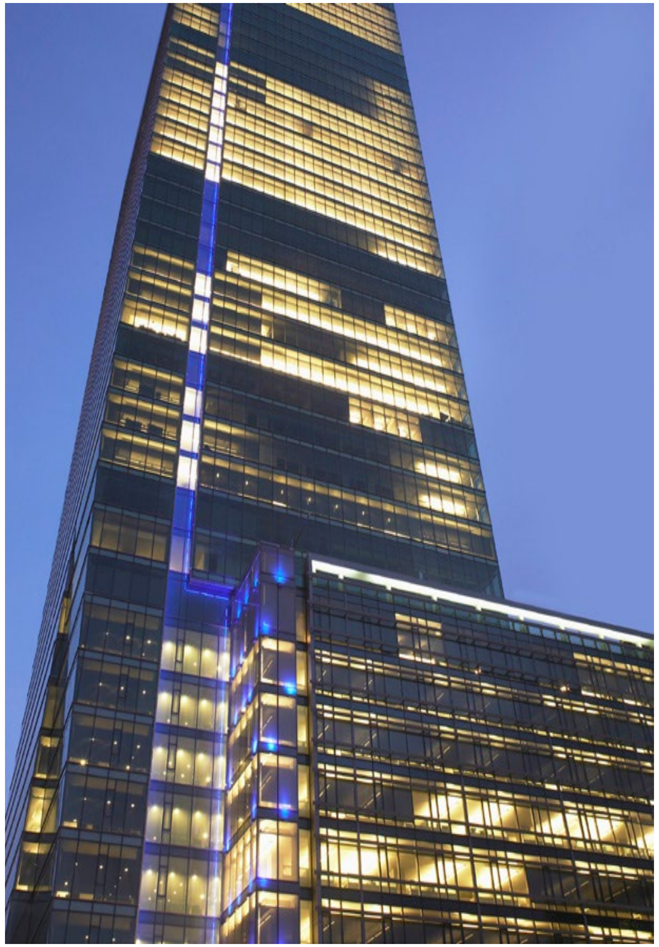
Identifying Best Candidates

- All Variable Plants
- Headered Configuration
- High Cooling Ton Hours
- High Cost of Power

1 Waterfront, HI: 450 Ton Plant, Customer noticed “substantial improvement” in electricity bill

Plant Optimization

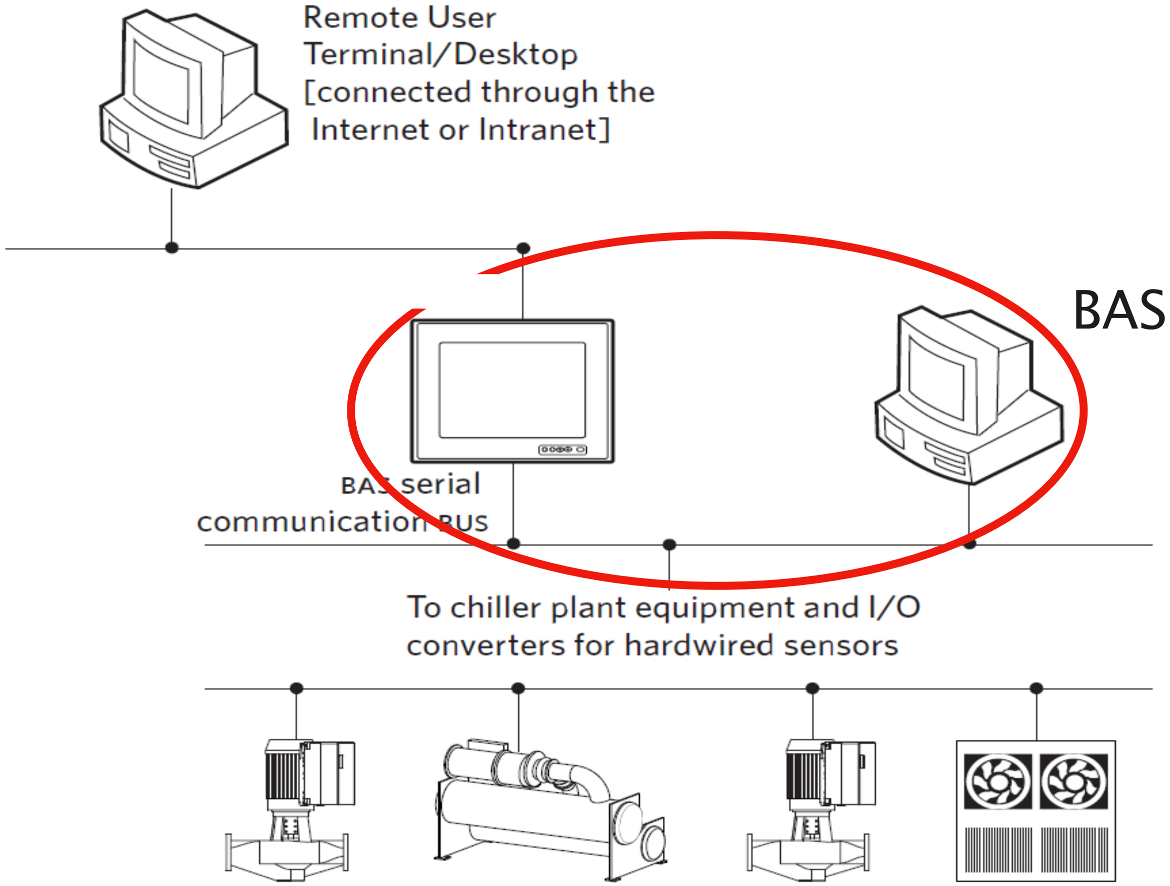
- Ultra-Efficient optimization for all-variable speed and flow chiller plant operation
- Works with existing BAS
- Options to whole plant, condenser side or just parallel pumping
- Immediate Energy Savings of 15-30% over typical Variable Plant Control
- Payback often less than 3 years



Optimize what you already have

Introduce optimization to interfaces with the existing building automation system to provide the optimal operating settings for a chiller plant.

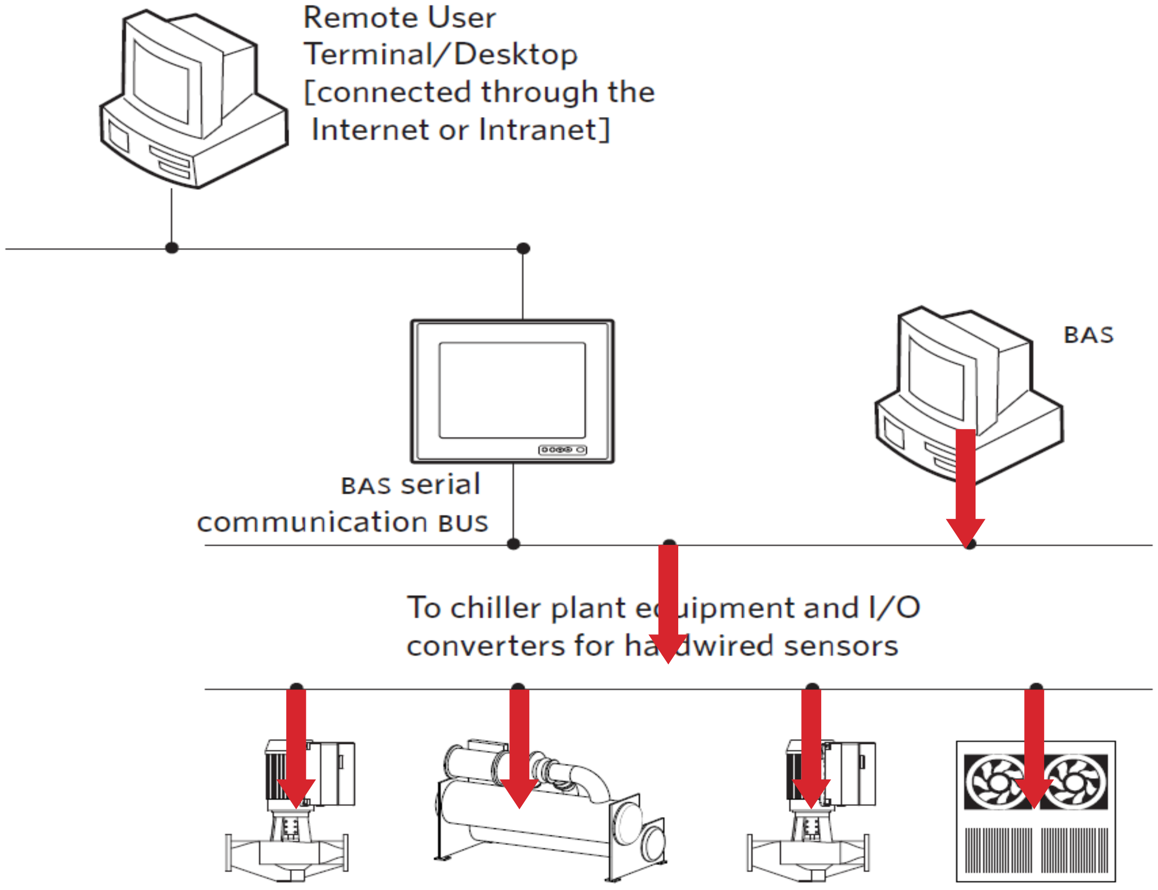
COORDINATED CONTROL FOR PEAK EFFICIENCY



Optimization

What does the Building Automation System continue to do?

- Control the variable primary plant and implement the optimization instructions
- Responsible to safely stage equipment and operate it within its constraints

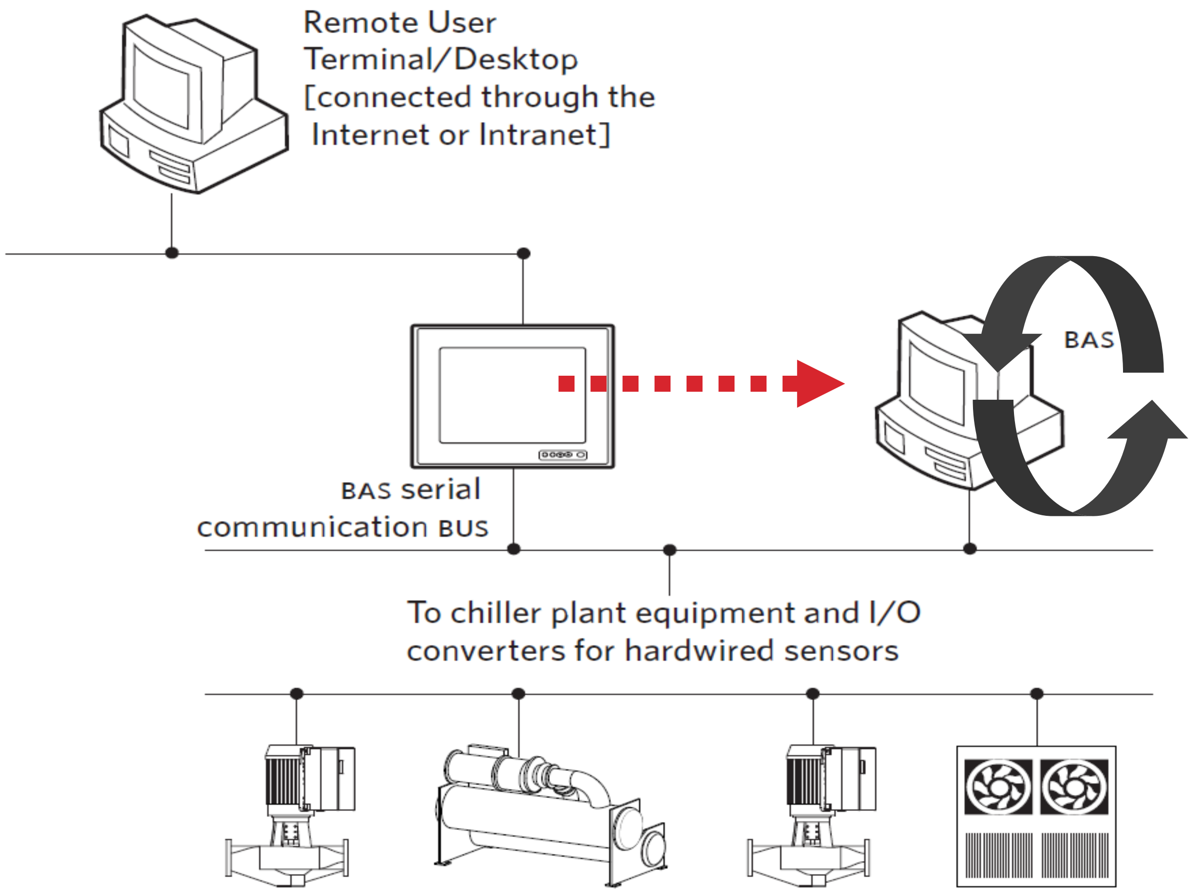


Optimization

What changes are required to the BAS

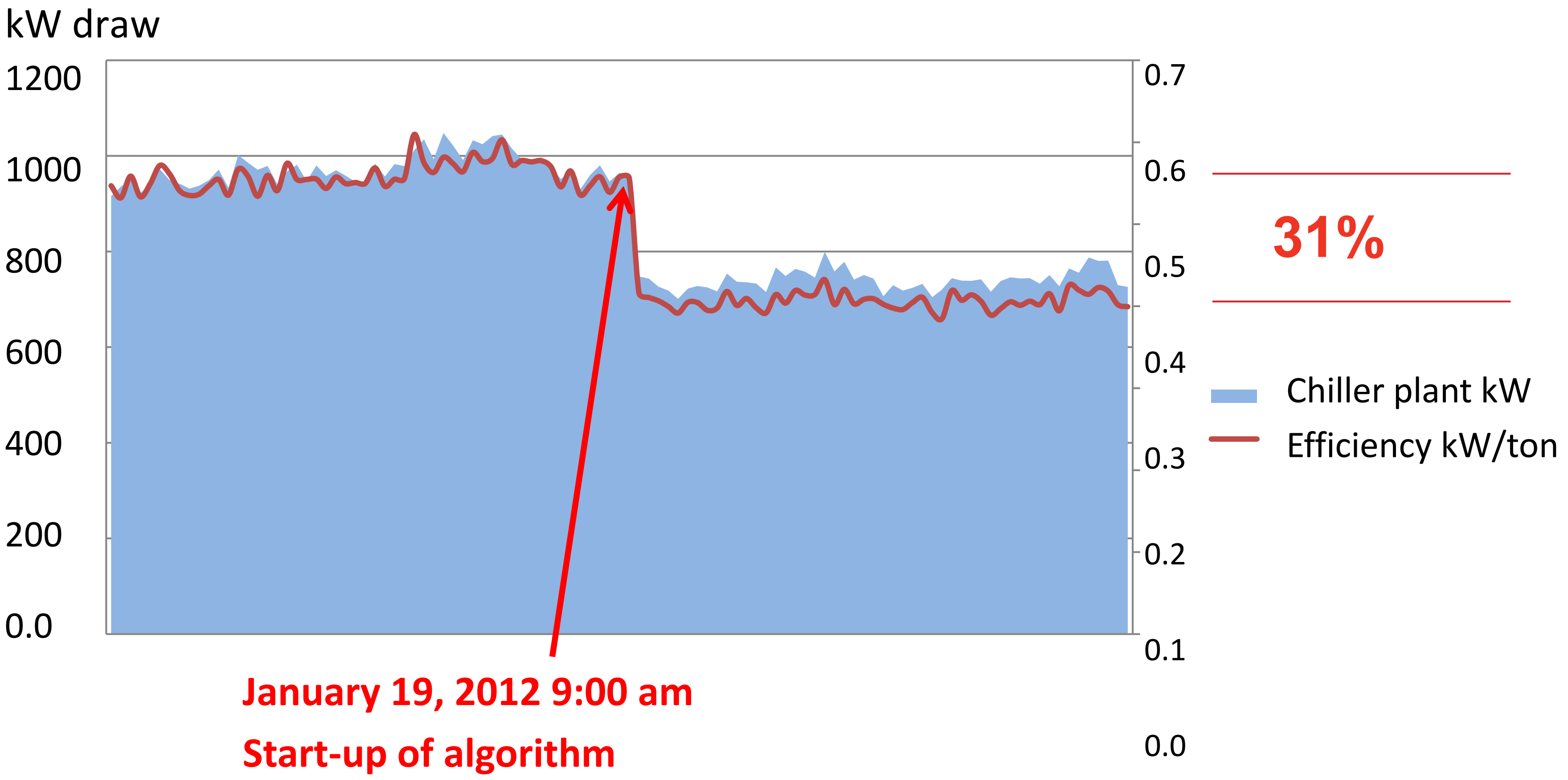
- The BAS must now pickup, process, and implement the recommendations

- New data points and logic are added within the BAS code



Applying dynamic plant optimization – optimization only

Data Center – Southwest U.S.



With optimization only – no equipment changes

Whirlpool HQ – Optimization only

2 x 850 Ton Chiller Plant

- Project Cost: ~$78,000
- Commissioned August 2014
- Baseline data not completed; assumptions inaccurate
- Estimated ending kW/ton performance level not attained but….
- Savings exceeded target:
  - **$60,000 rebate via CLEAResult (through Armstrong M&V)**
  - **$53,000 first year savings in mechanical cooling**
  - **$32,000 first year savings through “all variable” free cooling**

Possible Scenarios – Which of these might work

Let's discuss

	Scenario #1	Scenario #2	Scenario #3
Chillers	2 x 750 ton Variable speed and Variable Flow	2 x 1000 ton VS but constant flow; sized for duty standby	3 x 750 ton Variable speed
Primary pumps	VS and VF, headered	2 VS, constant flow, headered	3 x VS and VF, headered
Secondary pumps	VS and VF, headered	2 VS, VF	3 x VS and VF,
Condenser pumps	2 Constant speed, headered	2 Constant speed, dedicated	3 x Constant Speed, headered
Towers	2 Cells, VS fans with constant flow, dedicated	2 Cells, VS fans with constant flow, dedicated	3 cells, VS fans with constant flow, headered

This concludes The American Institute of Architects Continuing Education Systems Course

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Questions

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