On Demand Pump Condition Assessment and Optimization

NEWEA 2015 Annual Conference

Session 15 Instrumentation and Automation

9am Tuesday January 27th, 2015

NEW ENGLAND WATER ENVIRONMENT ASSOCIATION

NEWEA

WORKING FOR WATER QUALITY

Presented by Marc Buchwald

Authored by Jeff M. Miller, PE, ENV SP

and Sam Lauffenburger

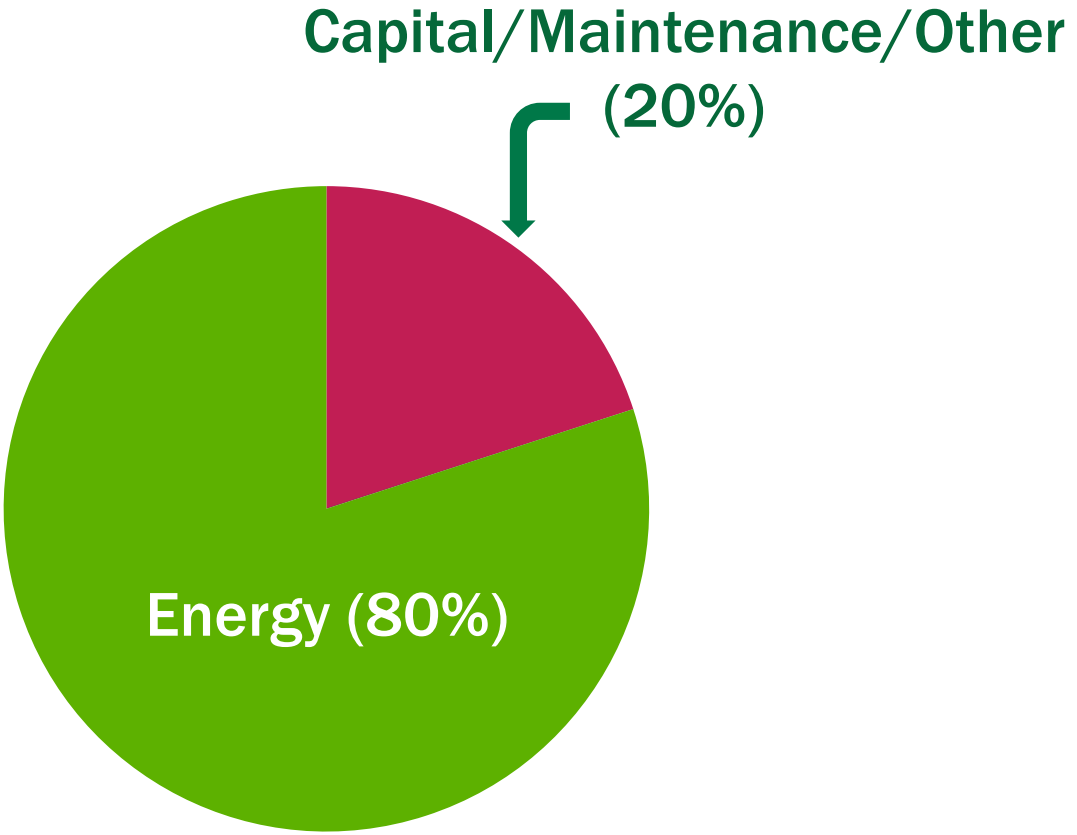
SPECIFIC ENERGY

Schneider Electric

About the Presenter
Marc Buchwald

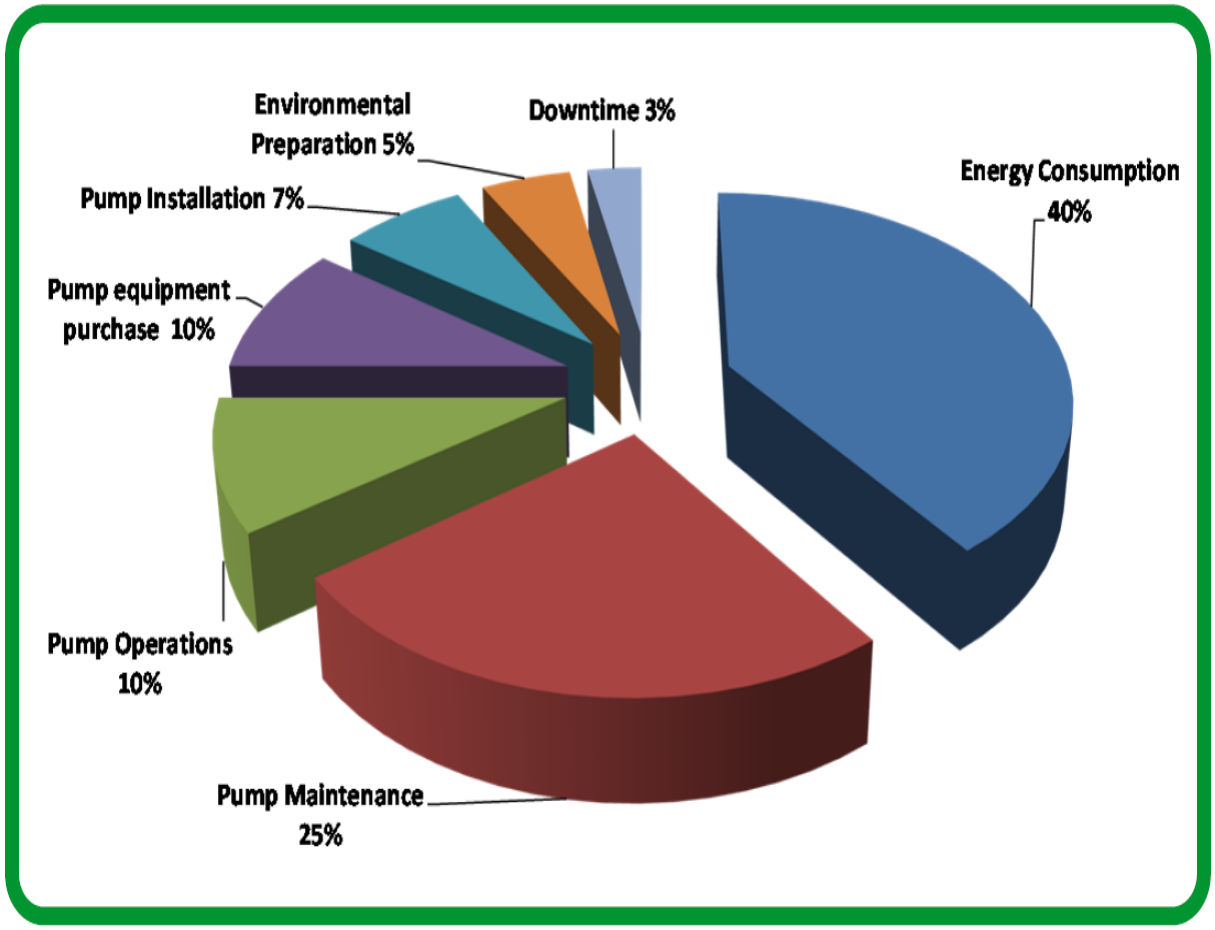
Marc Buchwald is a regional Business Development Manager for Schneider Electric's Water Wastewater Competency Center. Marc graduated from NJIT with a BS in Industrial Engineering and brings 40+ years of experience helping clients with Electrical and Automation solutions. He is an active member in NJAWWA (technical program committee), NYAWWA, NJWEA, NYWEA, LIWC, AEA NJ, NEWEA, and NEAWWA.

Typical Pump Life Cycle Cost



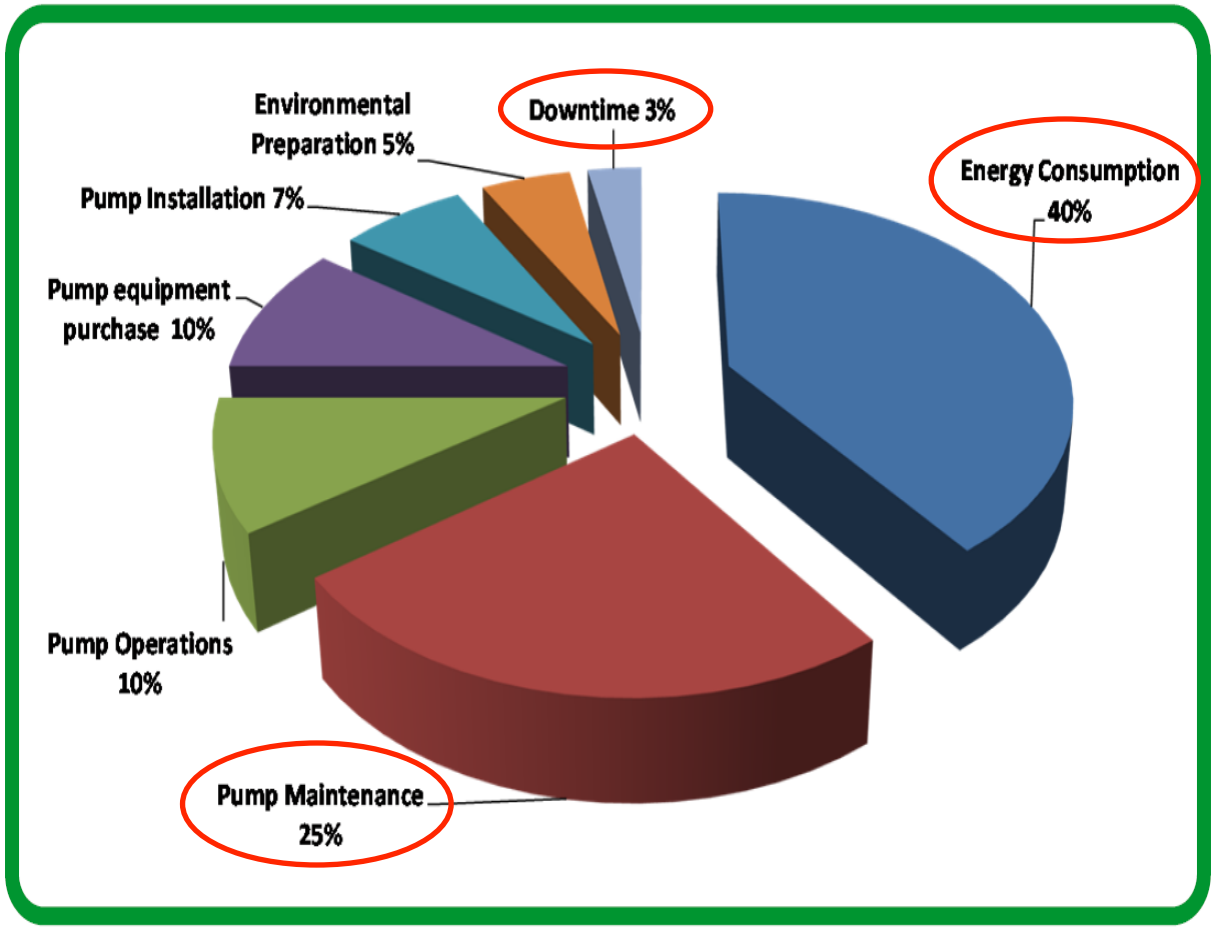
Source: "Reducing Life Cycle Cost By Energy Saving in Pump Systems." Bower, John R., Ingersoll-Dresser Pumps.

Typical Pump Life Cycle Cost



Typical pump life-cycle cost profile (Courtesy of Hydraulic Institute and Pump Systems Matter)

Lowering Pump Life Cycle Costs



Typical pump life-cycle cost profile (Courtesy of Hydraulic Institute and Pump Systems Matter)

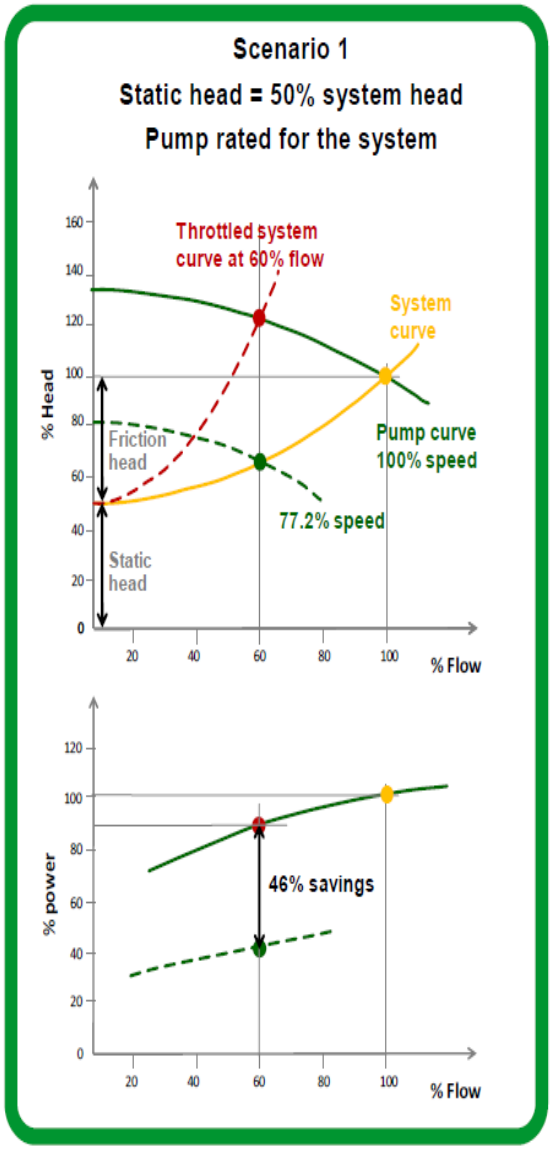
Affinity Laws for Pumps

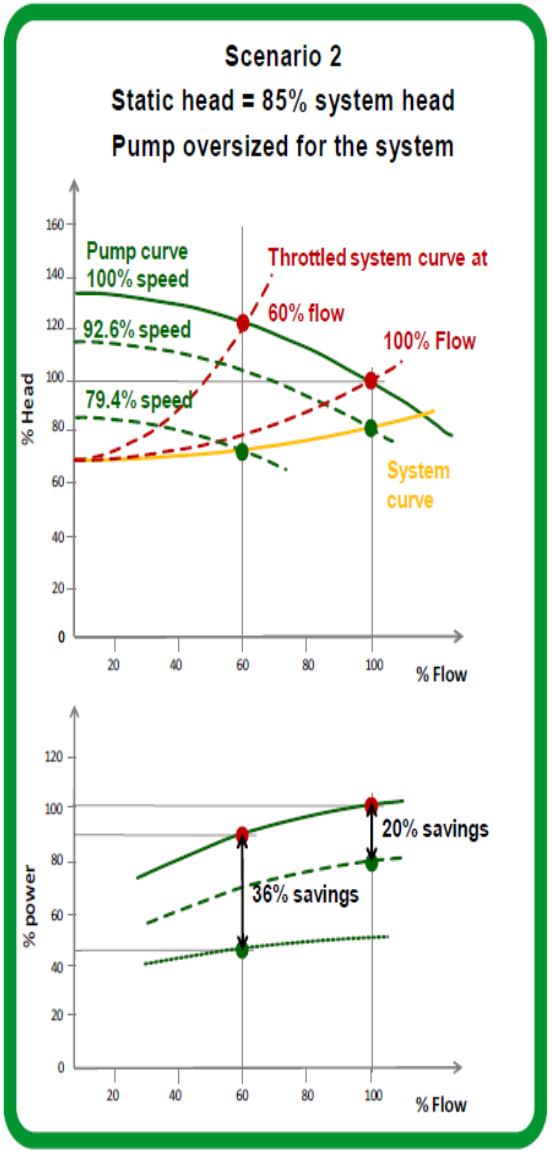
- Simplified Laws
  - Non compressible fluid (water)
  - Centrifugal type pump
  - Flow is proportional to speed of the pump
  - Power is proportional to the $(speed)^3$ of the pump

Affinity Laws for Pumps

Variable Speed vs. Throttled

> *Energy saved with variable vs. fixed speed drives at 100% and 60% flow, according to the static head and pump sizing. The operating point is represented as the intersection of the pump curve with the system curve*

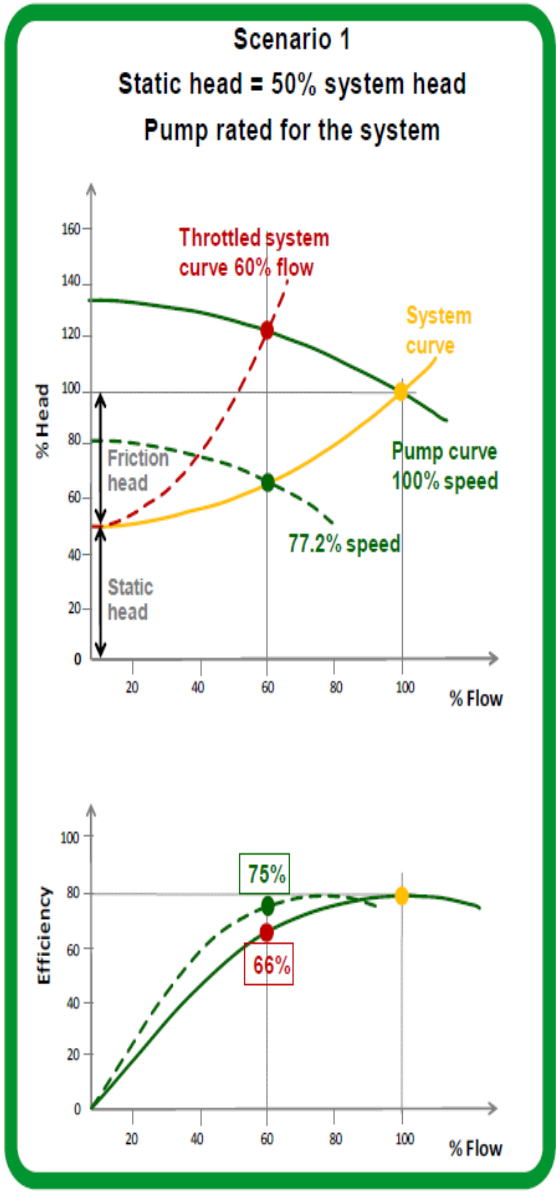


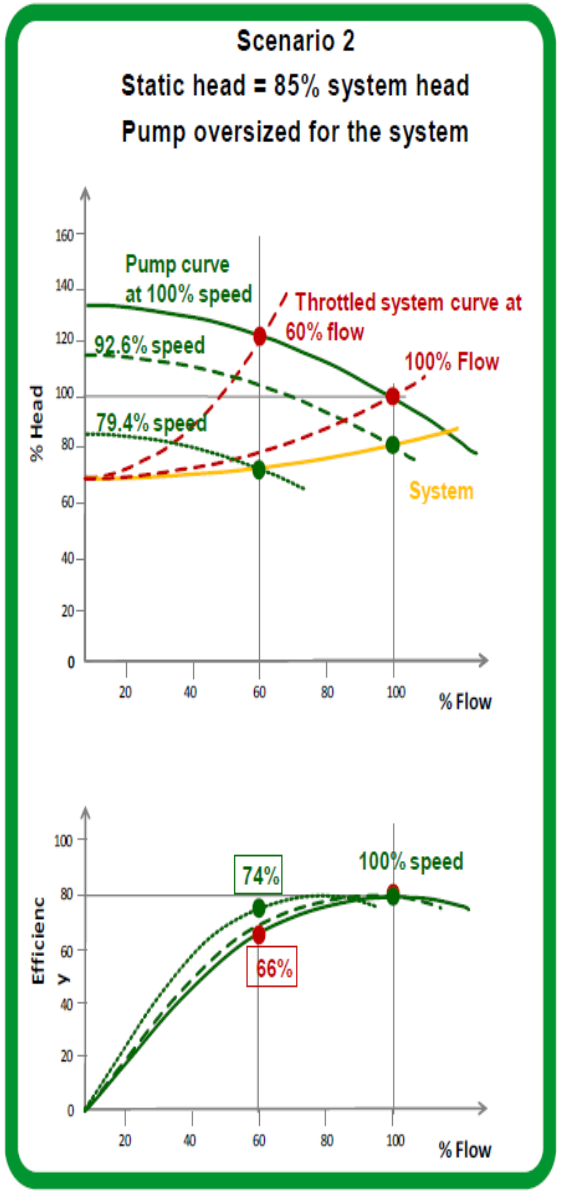


Affinity Laws for Pumps

BEP : Best Efficiency Point

> Comparison of two efficiency scenarios at different flow rates: 8 to 9% more efficient with variable speed drives at 60% flow





Putting Laws into Practice

What Would be the Best Method to Operate and Manage a Pump Station?

Pump Condition Assessment

Measure pumps' capacity and efficiency with automated pump tests

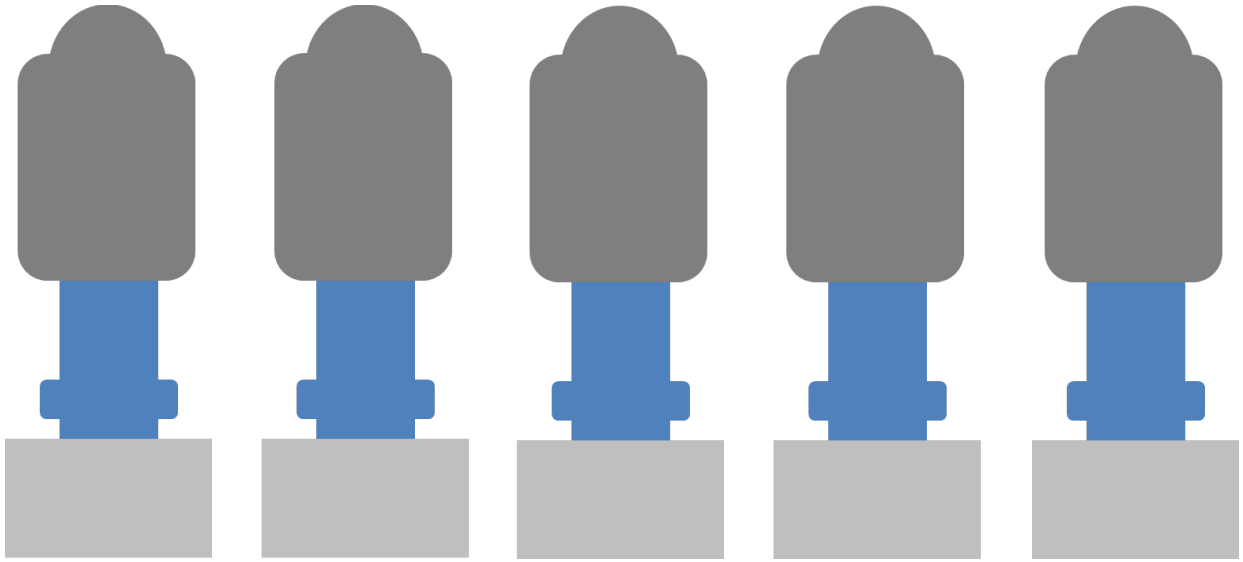
Reduce operating costs
Improve pump reliability

Dynamic Pump Optimization

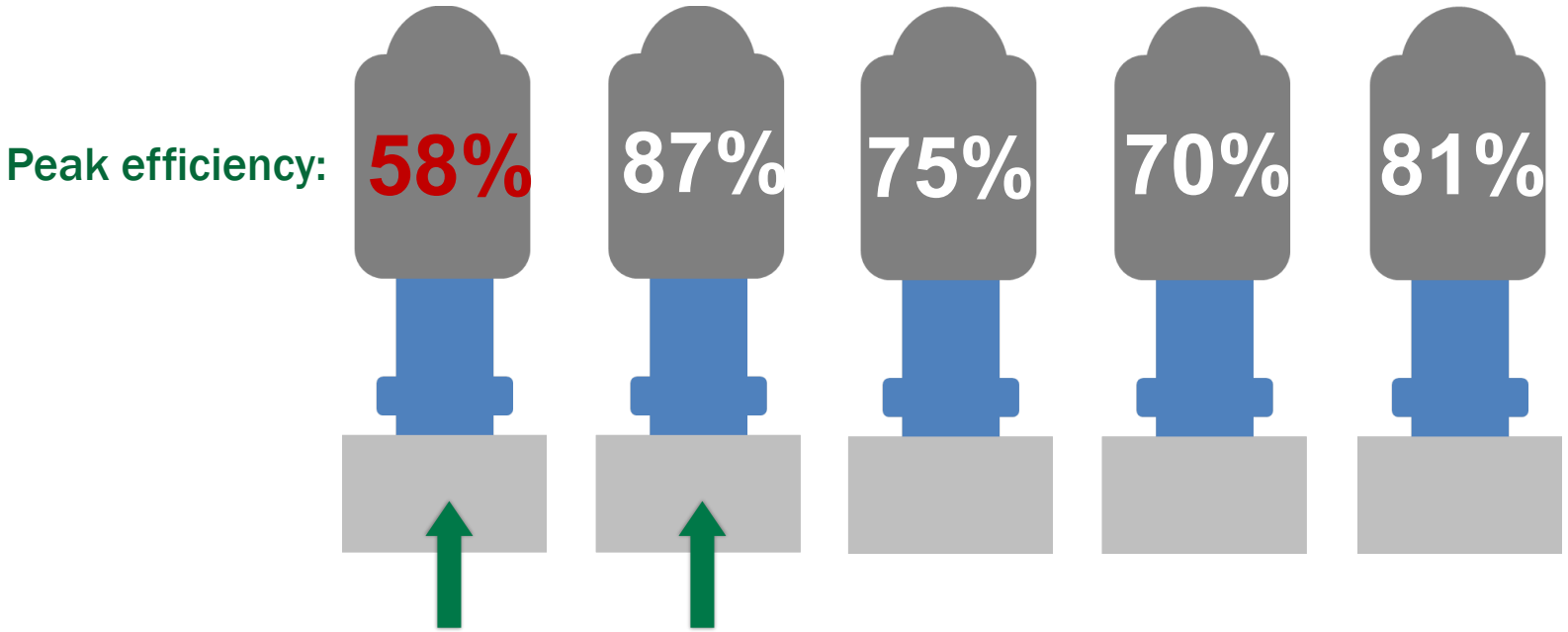
Continually adjust pump station to changing pump and system conditions to operate at peak efficiency

Reduce operating costs
Increase pump life

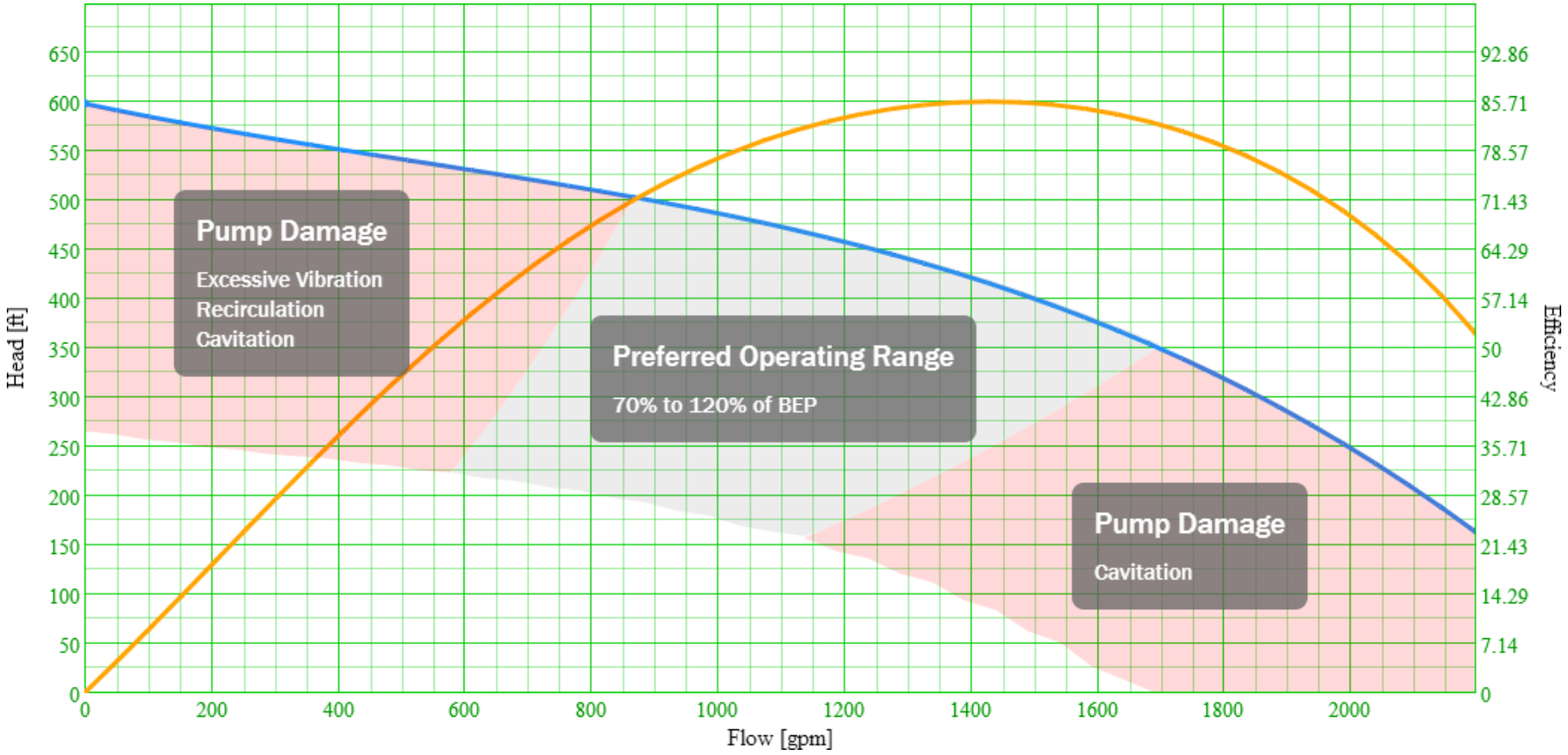
What Operators See – 5 Identical Pumps



The Reality – Pumps are Hardly Identical

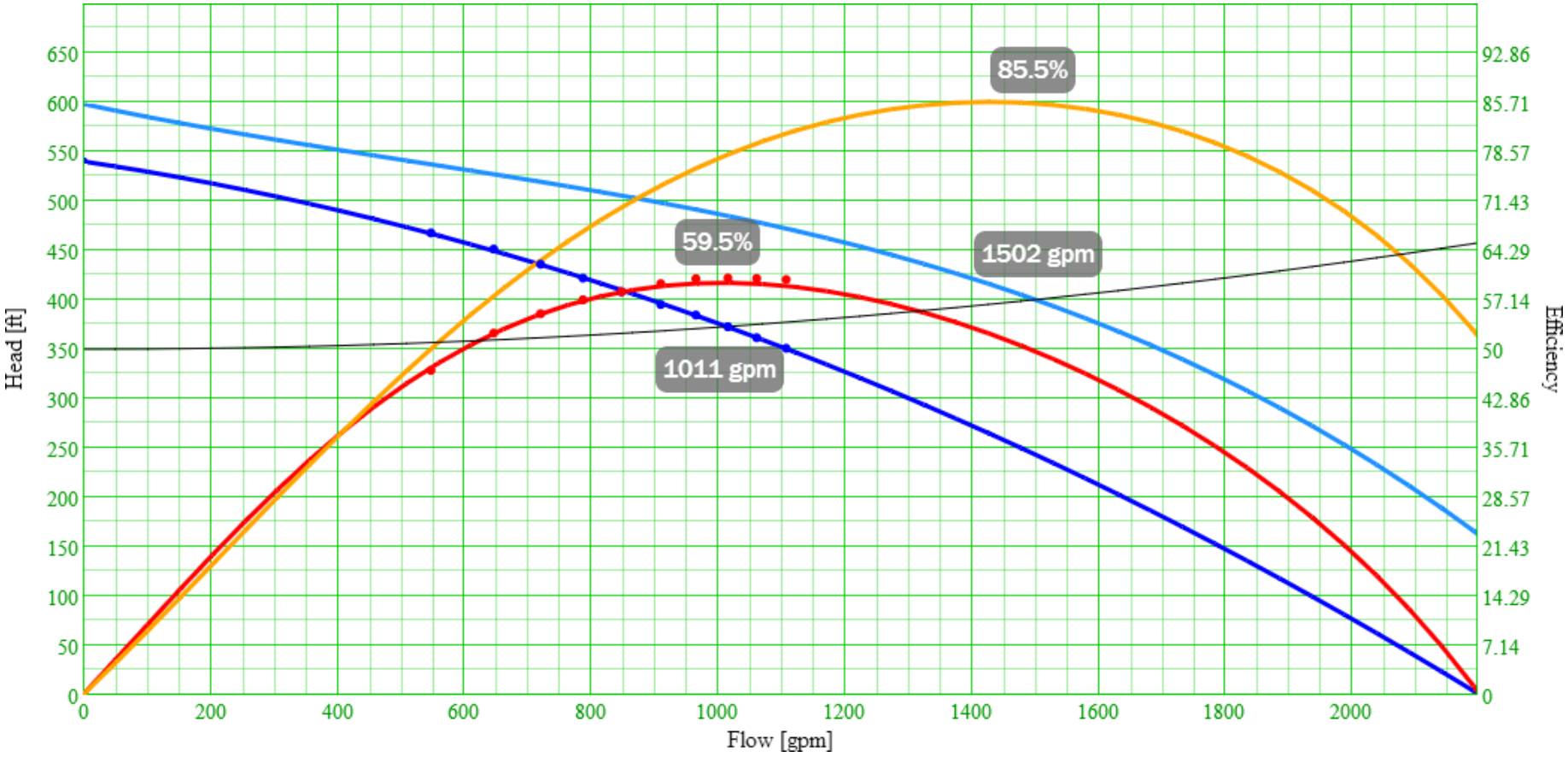


Preferred Operating Range



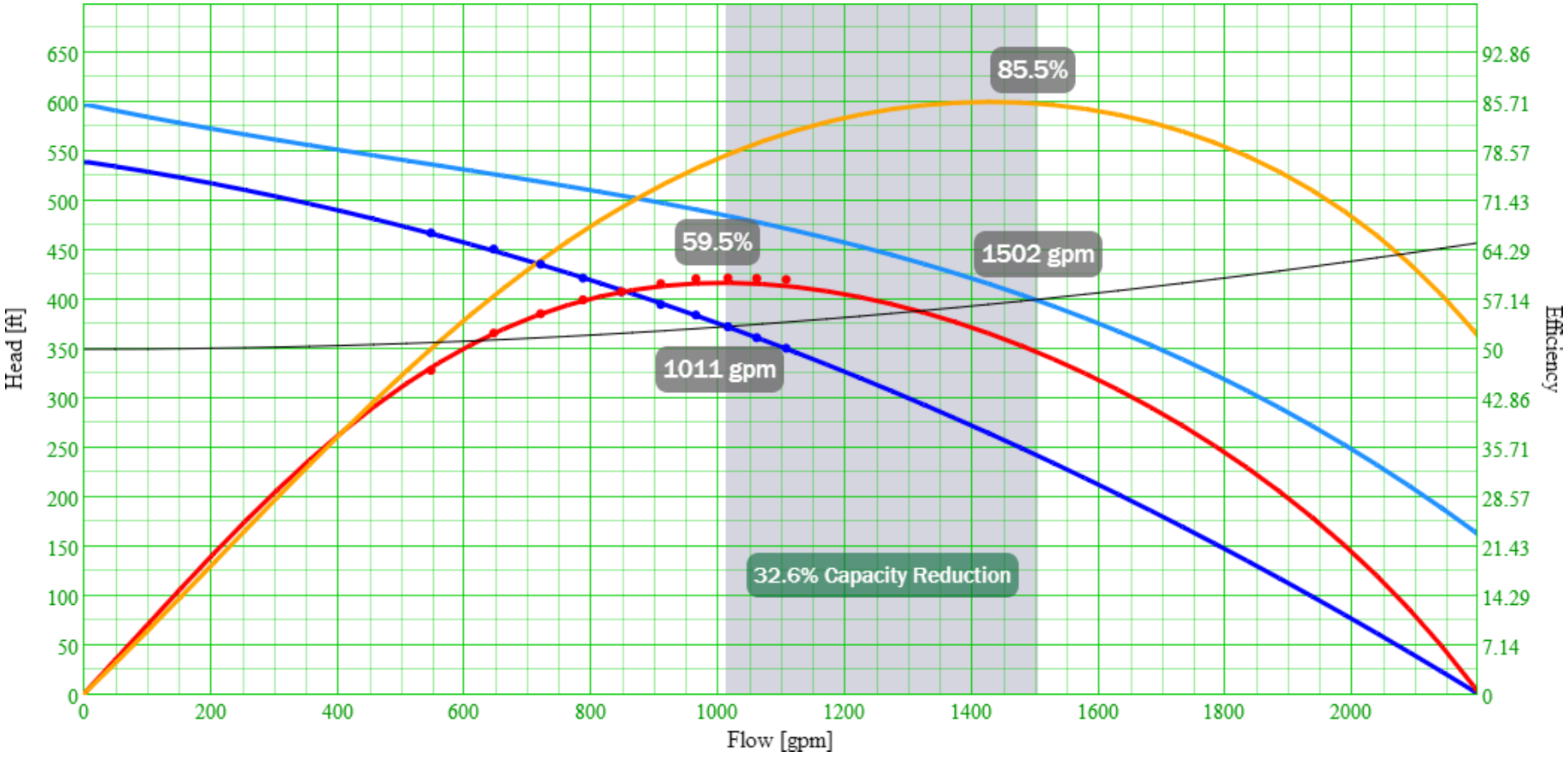
System Curve | Tested Head | Tested Efficiency | Factory Head | Factory Efficiency

Effect of Pump Impeller Wear



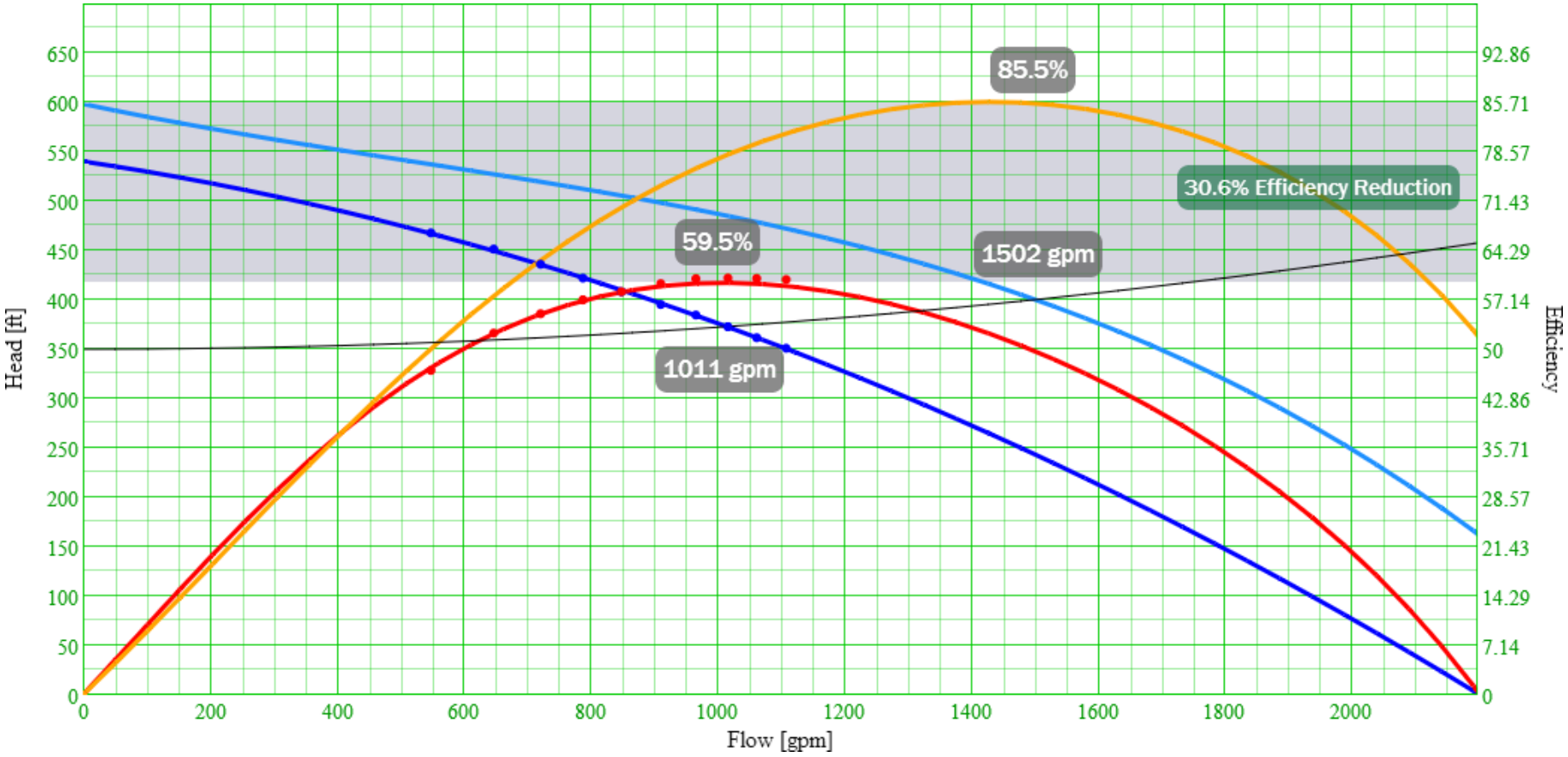
System Curve | Tested Head | Tested Efficiency | Factory Head | Factory Efficiency

Effect of Pump Impeller Wear



System Curve | Tested Head | Tested Efficiency | Factory Head | Factory Efficiency

Effect of Pump Impeller Wear



System Curve | Tested Head | Tested Efficiency | Factory Head | Factory Efficiency

PHI Pump Health Tracking

- Intelligently target pumps for repair
- Opens the door for advanced metrics and advanced optimization
- See pump operating points in real time on up-to-date pump curves

Pump Condition Assessments

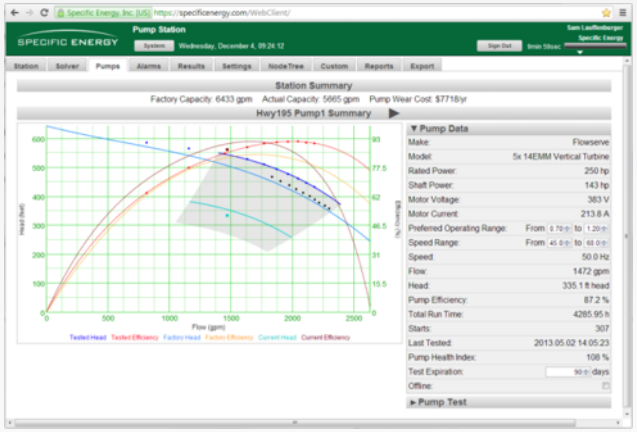
Annual Audits

- Expensive
- Not repeatable
- Often not actionable
- No financial impact analysis
- Not available ad hoc

On Demand Condition Assessment

Asset Management

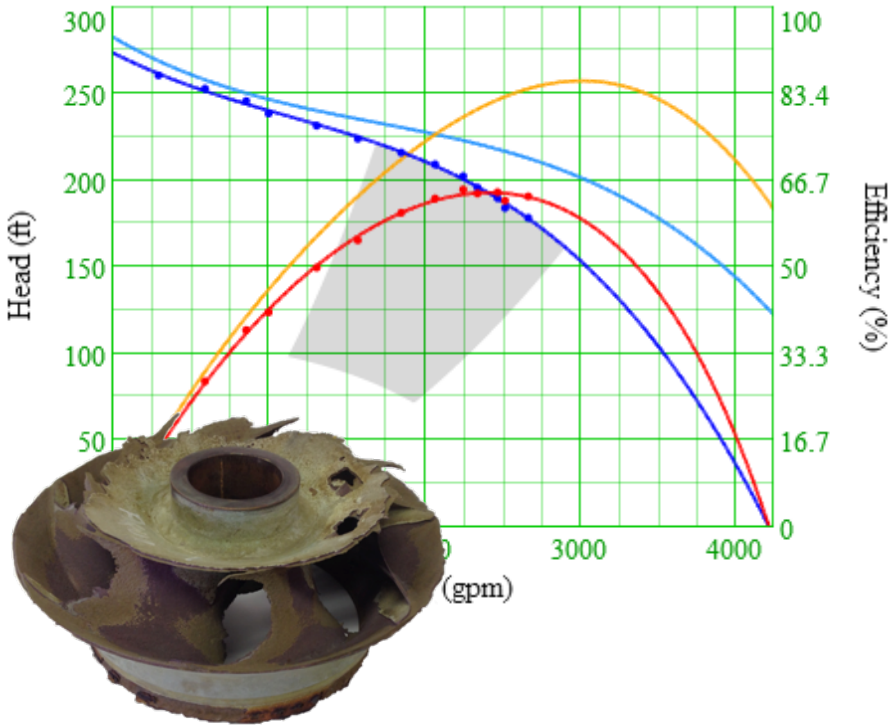
- Perform regular automated pump tests
- Track pump operation in real time on pump curves
- Generate monthly operating reports
- Identify underperforming pumps for repair



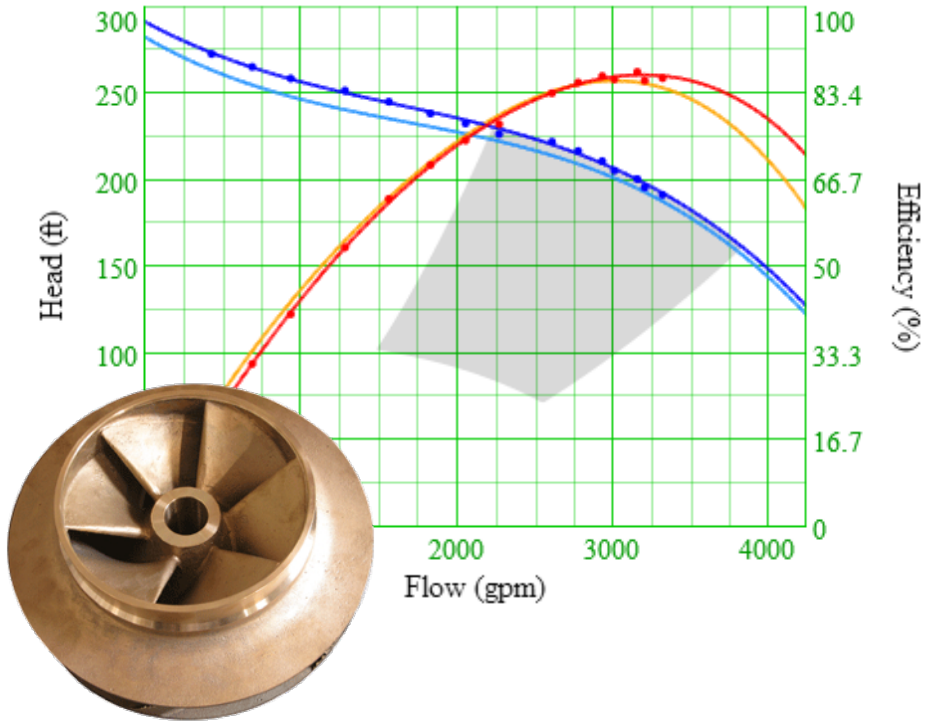
Pump Health Index (PHI)

PHI represents current peak efficiency versus factory peak efficiency.

75 PHI = Severely Worn



101 PHI = Factory Condition

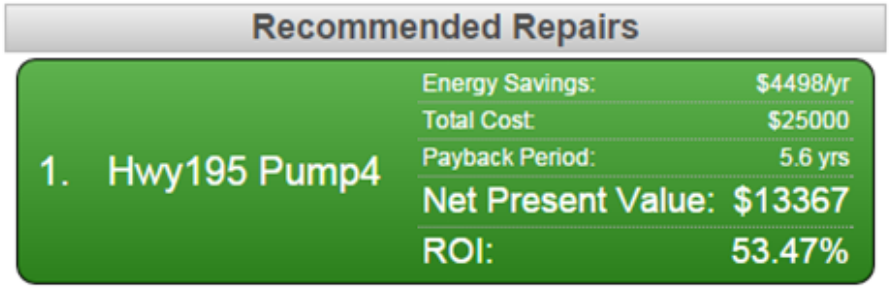


Schedule repairs for pumps with PHI < 85

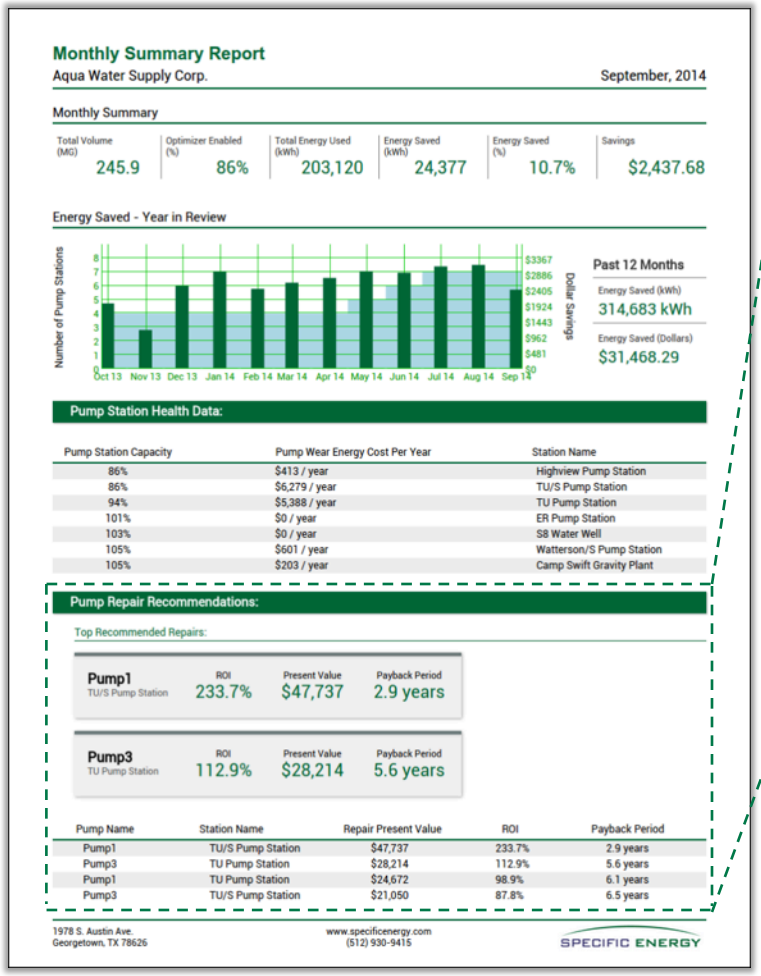
Prioritize Repairs with Financial Metrics

Input:

- Replacement Cost
- Cost of Electricity
- Expected Pump Life
- Interest Rate



Prioritize Repairs with Financial Metrics



Monthly Summary Report

Aqua Water Supply Corp. — September, 2014

Monthly Summary

Total Volume (MG)	Optimizer Enabled (%)	Total Energy Used (kWh)	Energy Saved (kWh)	Energy Saved (%)	Savings
245.9	86%	203,120	24,377	10.7%	$2,437.68

Energy Saved - Year in Review

Number of Pump Stations; Dollar Savings; Oct 13 Nov 13 Dec 13 Jan 14 Feb 14 Mar 14 Apr 14 May 14 Jun 14 Jul 14 Aug 14 Sep 14

Past 12 Months
Energy Saved (kWh) 314,683 kWh
Energy Saved (Dollars) $31,468.29

Pump Station Health Data:

Pump Station Capacity	Pump Wear Energy Cost Per Year	Station Name
86%	$413 / year	Highview Pump Station
86%	$6,279 / year	TU/S Pump Station
94%	$5,388 / year	TU Pump Station
101%	$0 / year	ER Pump Station
103%	$0 / year	S8 Water Well
105%	$601 / year	Watterson/S Pump Station
105%	$203 / year	Camp Swift Gravity Plant

Pump Repair Recommendations:

Top Recommended Repairs:

	ROI	Present Value	Payback Period
Pump1 TU/S Pump Station	233.7%	$47,737	2.9 years
Pump3 TU Pump Station	112.9%	$28,214	5.6 years

Pump Name	Station Name	Repair Present Value	ROI	Payback Period
Pump1	TU/S Pump Station	$47,737	233.7%	2.9 years
Pump3	TU Pump Station	$28,214	112.9%	5.6 years
Pump1	TU Pump Station	$24,672	98.9%	6.1 years
Pump3	TU/S Pump Station	$21,050	87.8%	6.5 years

1978 S. Austin Ave. Georgetown, TX 78626 — www.specificenergy.com (512) 930-9415 — SPECIFIC ENERGY

Pump Repair Recommendations:

Top Recommended Repairs:

	ROI	Present Value	Payback Period
Pump1 TU/S Pump Station	233.7%	$47,737	2.9 years
Pump3 TU Pump Station	112.9%	$28,214	5.6 years

Pump Name	Station Name	Repair Present Value	ROI	Payback Period
Pump1	TU/S Pump Station	$47,737	233.7%	2.9 years
Pump3	TU Pump Station	$28,214	112.9%	5.6 years
Pump1	TU Pump Station	$24,672	98.9%	6.1 years
Pump3	TU/S Pump Station	$21,050	87.8%	6.5 years

What Would be the Best Method to Operate and Manage a Pump Station?

Pump Condition Assessment

Measure pumps' capacity and efficiency with with automated pump tests

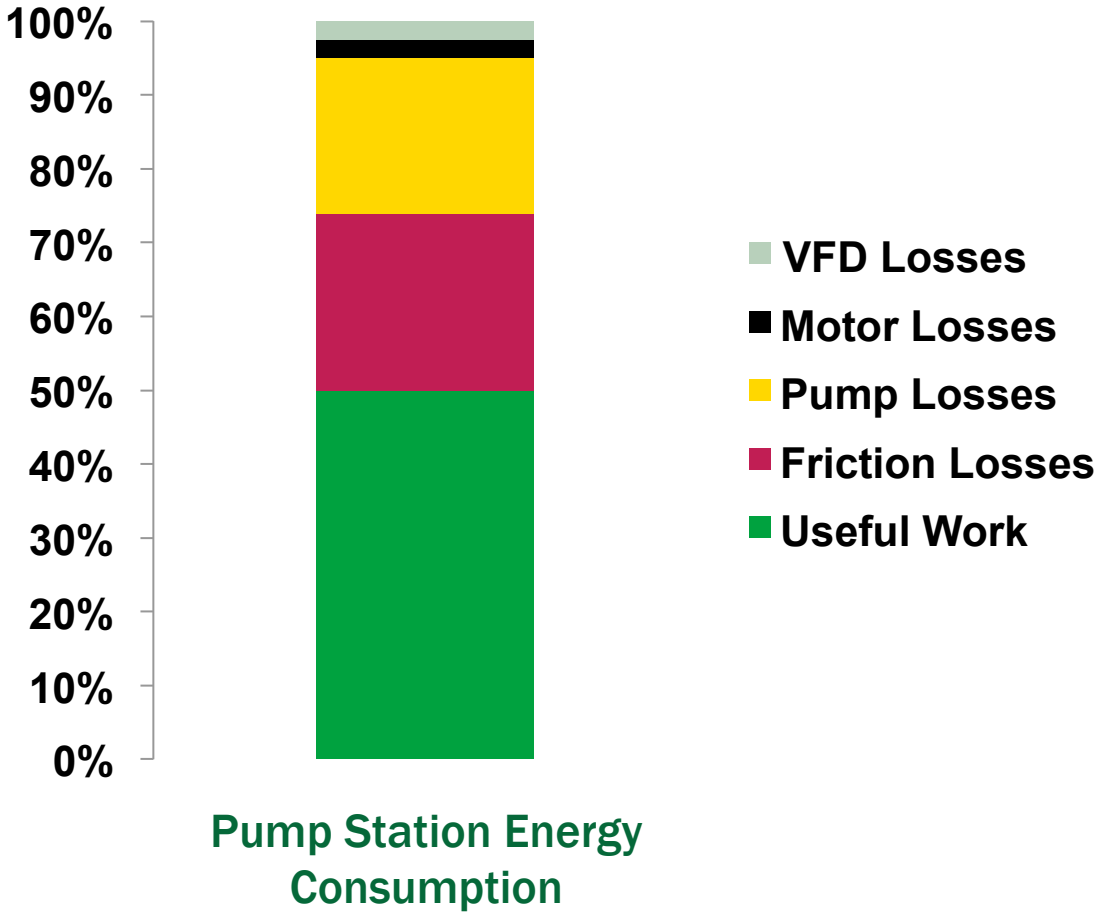
Reduce operating costs
Improve pump reliability

Dynamic Pump Optimization

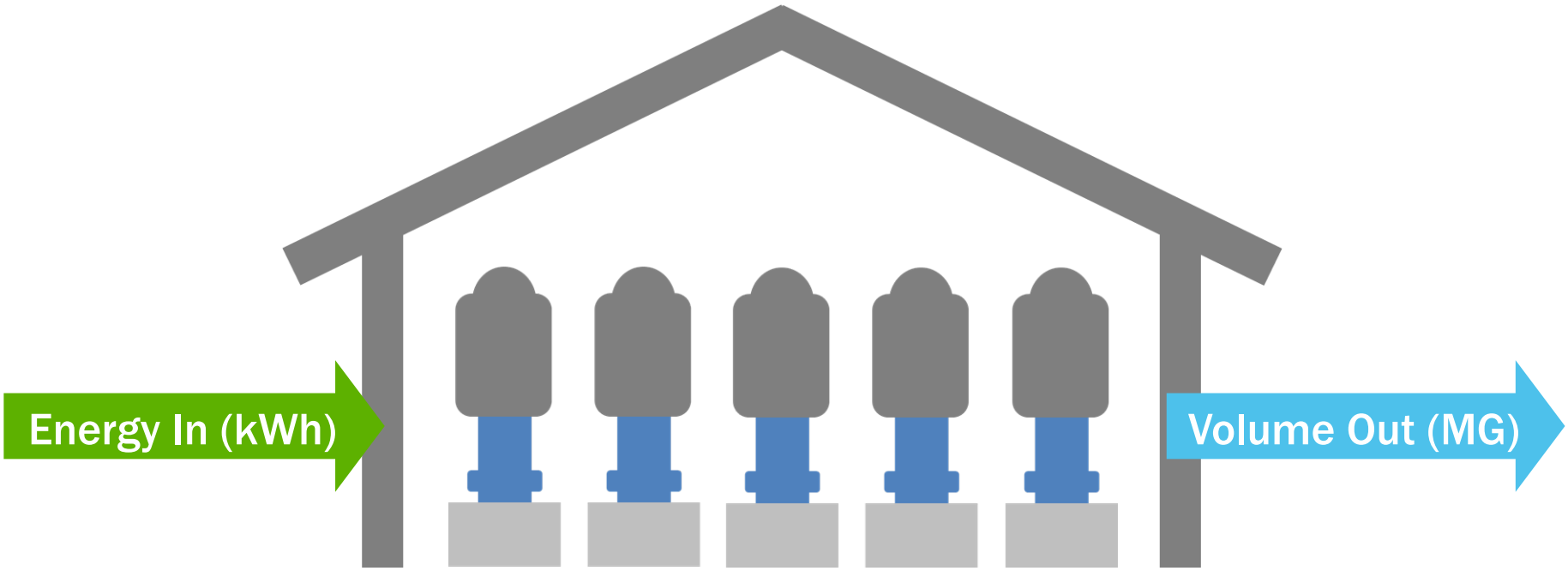
Continually adjust pump station to changing pump and system conditions to operate at peak efficiency

Reduce operating costs
Increase pump life

Pump Station Energy Consumption

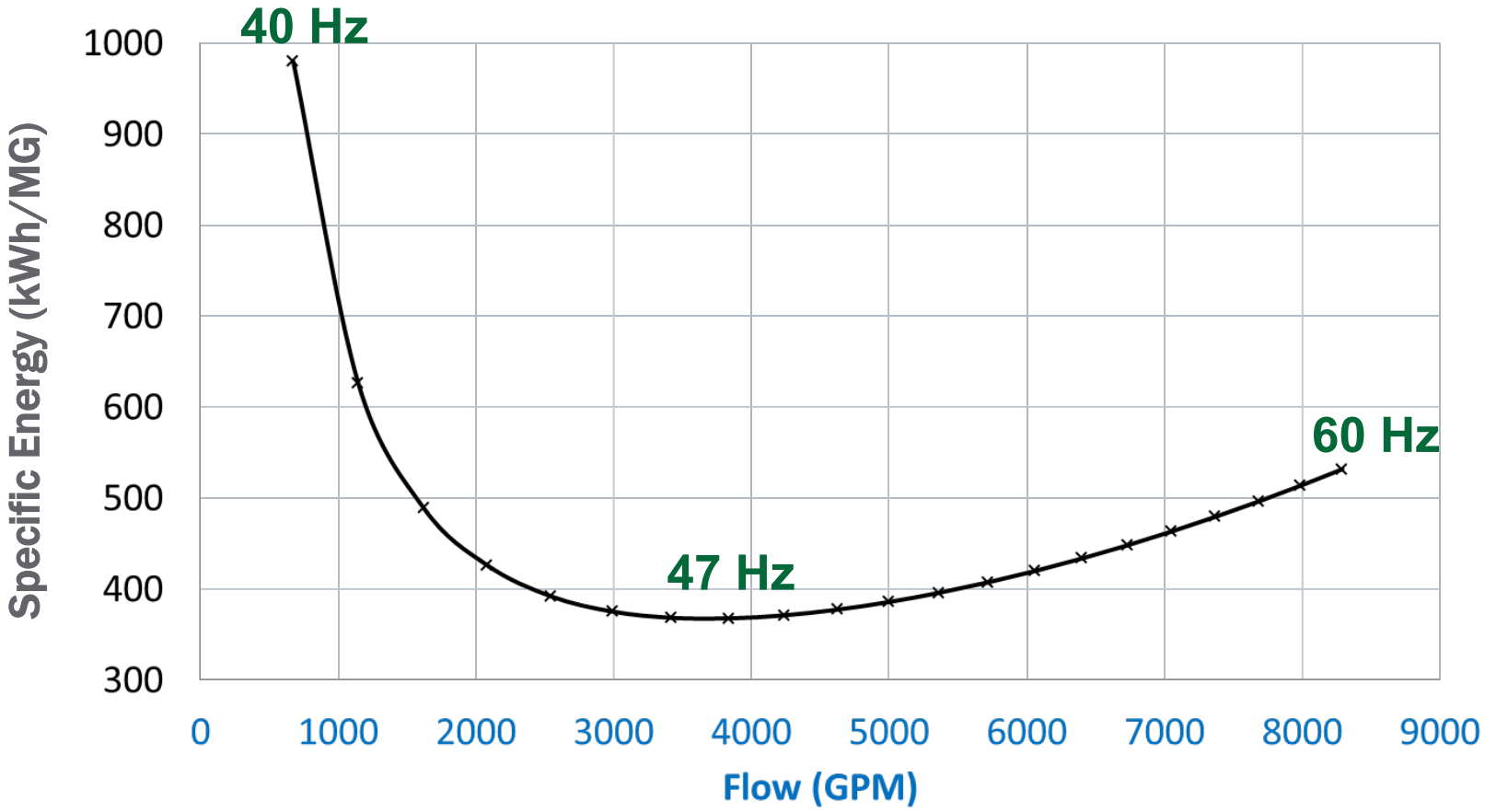


Specific Energy



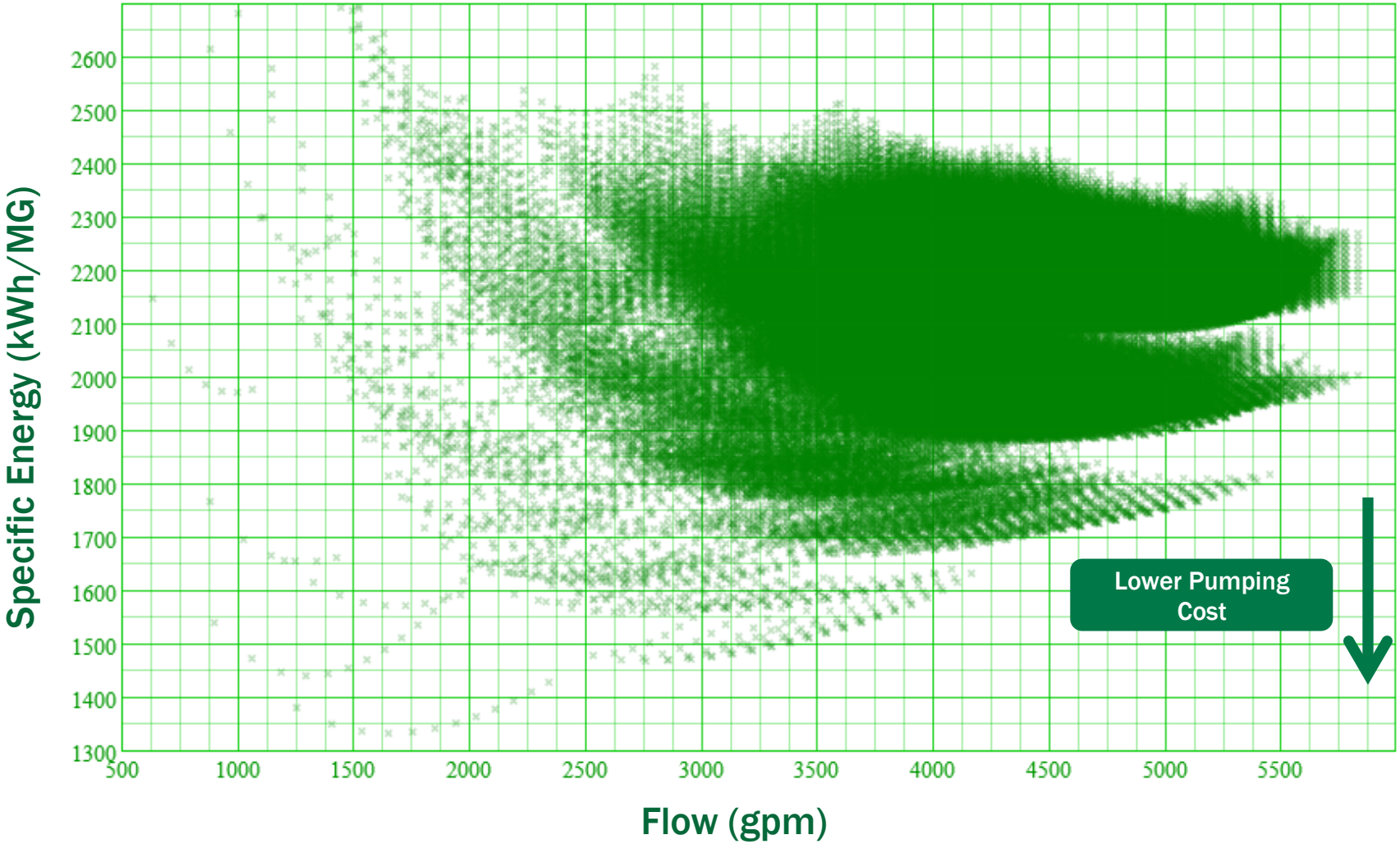
$$\text{Specific Energy} = \frac{\text{Energy In (kWh)}}{\text{Volume Out (MG of water pumped)}}$$

Specific Energy vs. Flow



Dynamic Pump Optimization

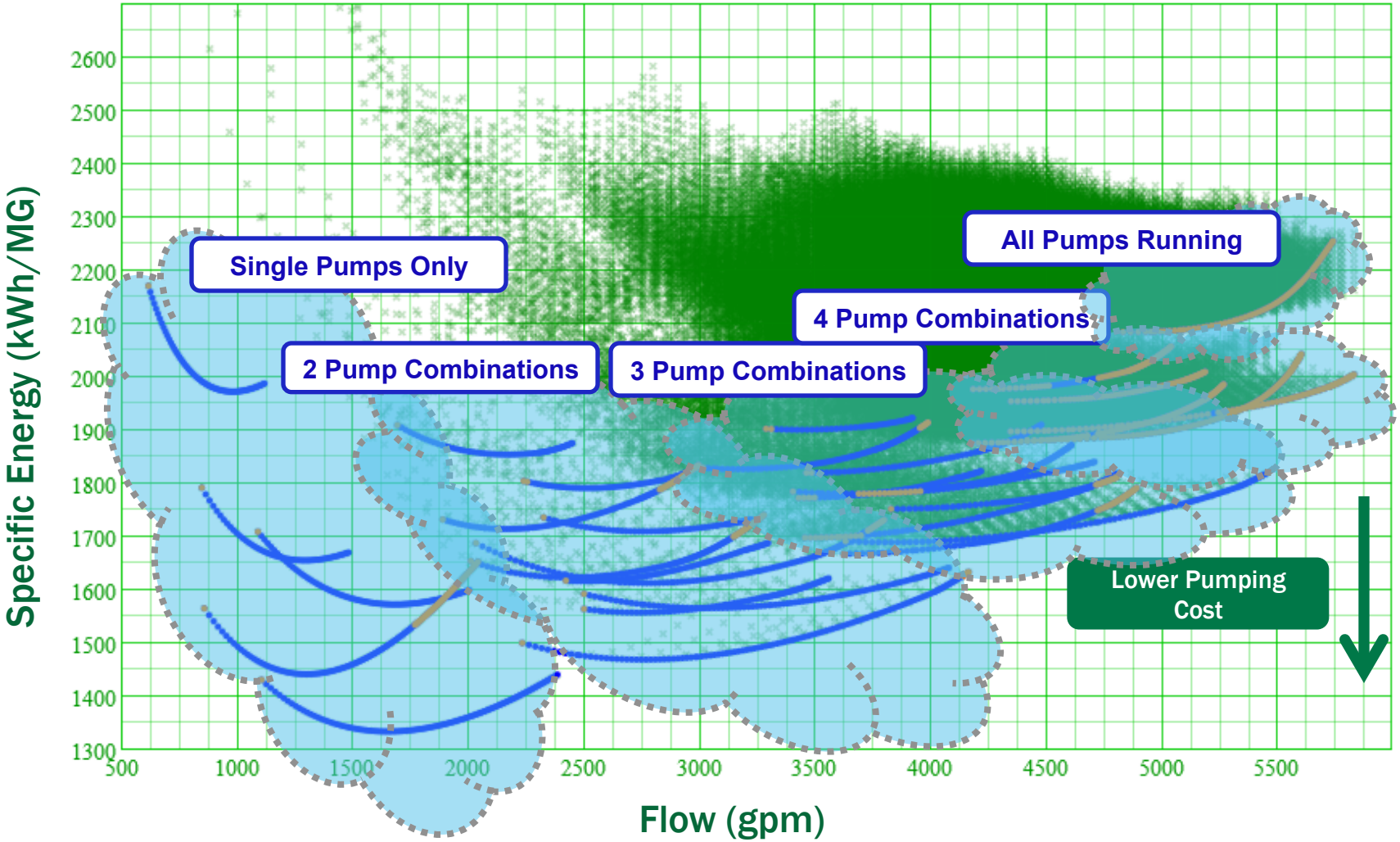
Pump Station with 5 Pumps: Possible Operating Ranges



Best Solution | **Best Pump Ranges** | **Outside Preferred Operating Range** | **Possible Pump Operation**

Dynamic Pump Optimization

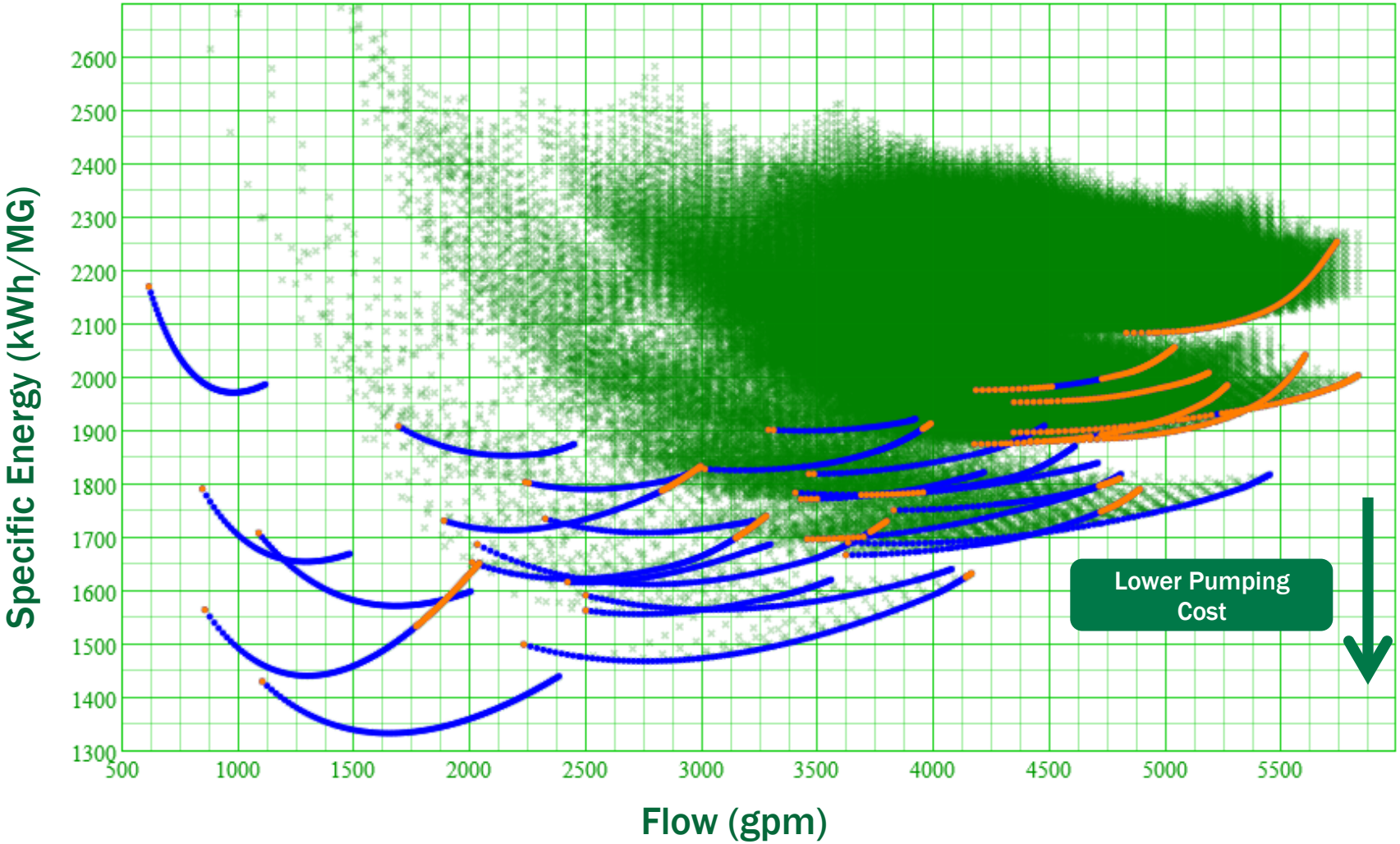
Pump Station with 5 Pumps: Best Pump Ranges



Best Solution | **Best Pump Ranges** | **Outside Preferred Operating Range** | **Possible Pump Operation**

Dynamic Pump Optimization

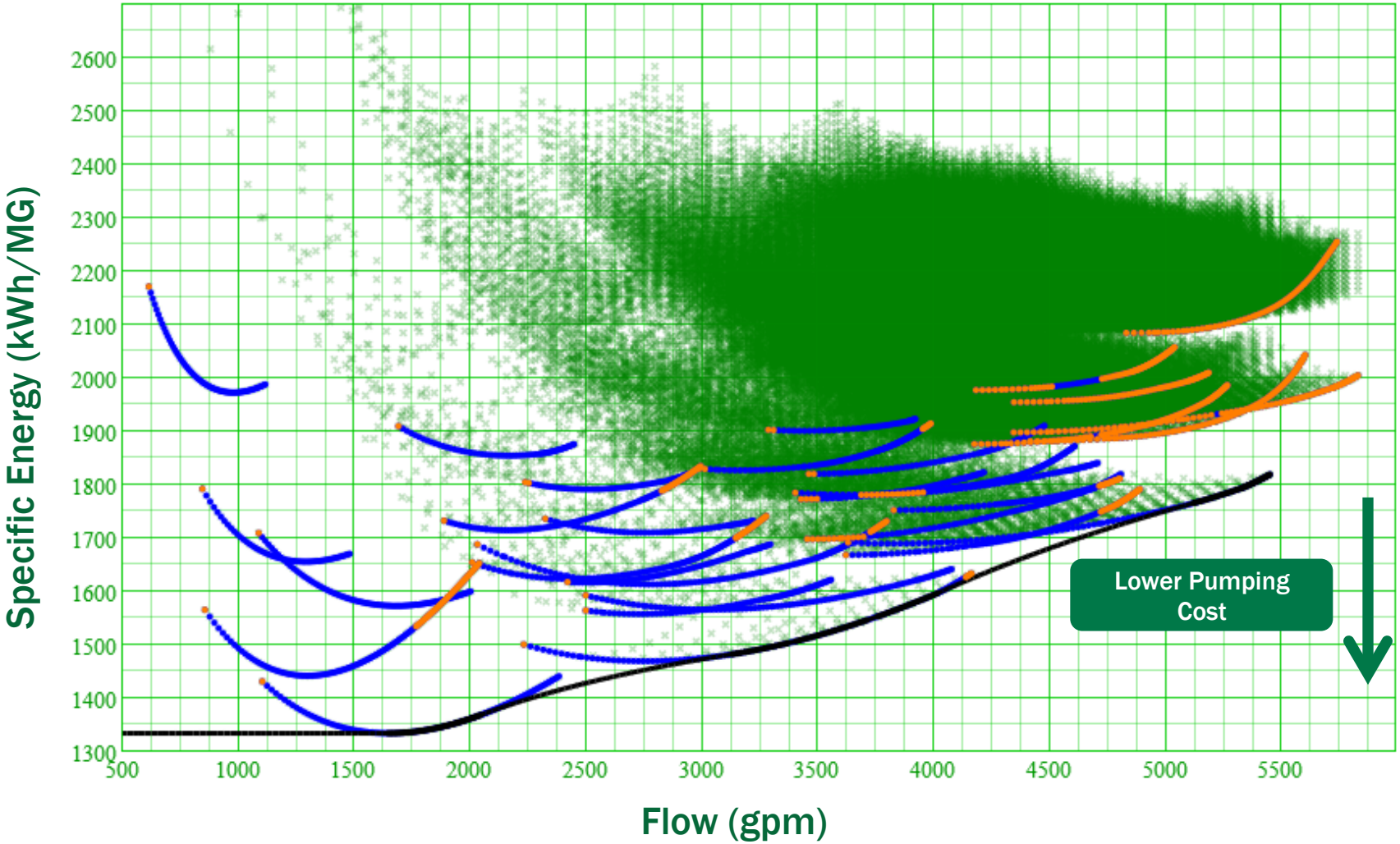
Pump Station with 5 Pumps: Best Pump Ranges



Best Solution | **Best Pump Ranges** | **Outside Preferred Operating Range** | **Possible Pump Operation**

Dynamic Pump Optimization

Pump Station with 5 Pumps: Best Solution

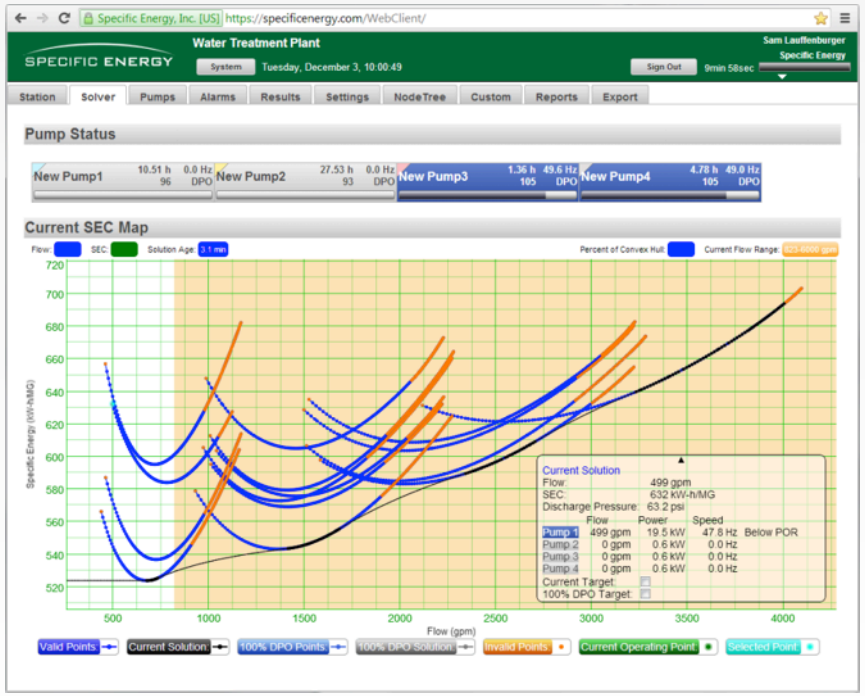


Best Solution | **Best Pump Ranges** | **Outside Preferred Operating Range** | **Possible Pump Operation**

Continuous Optimization

Dynamic Pump Optimization

- Continually operate at peak energy efficiency
- Operate within each pump's Preferred Operating Range
- Reduce leaks with Digital Transient Control
- Peak demand and time-of-day energy management

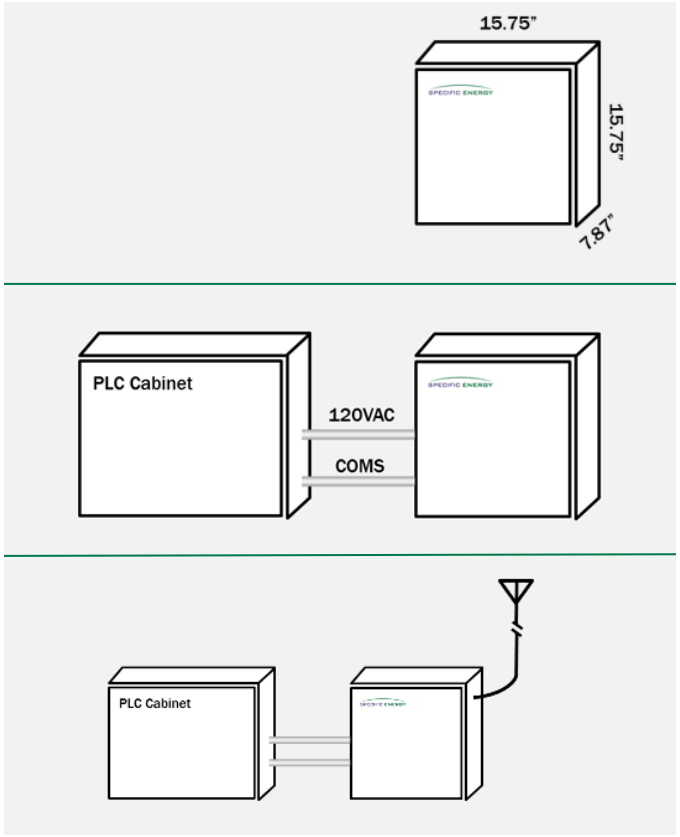


Typical Project Requirements

- System
  - Centrifugal Pumps
- Control Hardware
  - VFD Pump Motor Controllers (optimal)
  - PLC Pump Controller (existing or new)
  - Pump Assessment and Optimizing Panel
- Instrumentation
  - Suction Pressure or Wetwell Level
  - Discharge Pressure
  - Flow
  - Power per Pump

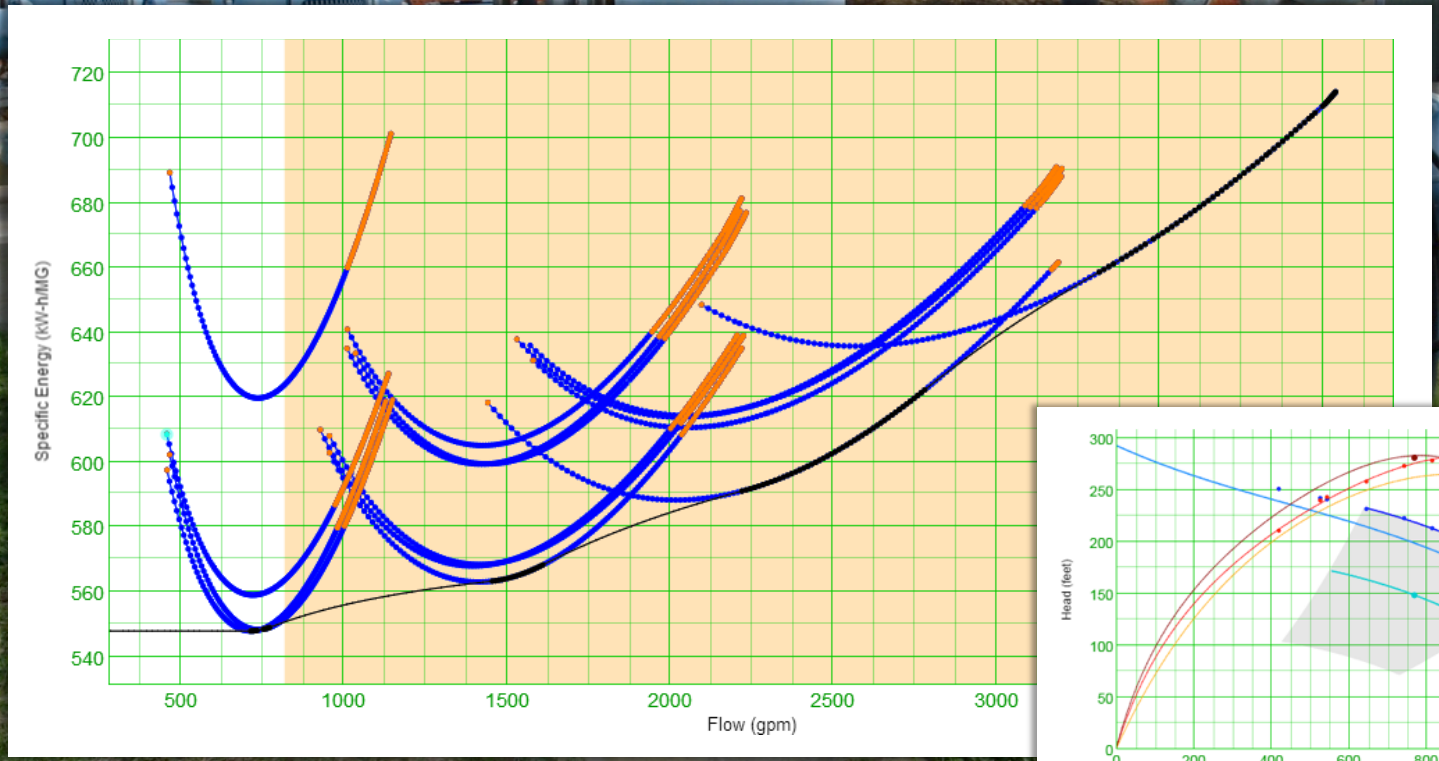
Typical Physical Installation

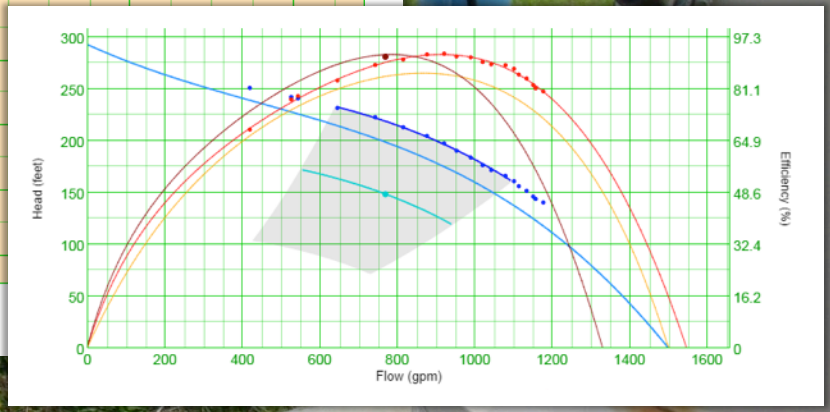
- Install Pump Assessment and Optimization Panel
- Install conduit connections from panel to PLC cabinet (120 VAC power and communications cable)
- Mount external cellular antenna (if necessary)
- Configure PLC to receive panel pump operation and speed recommendations
- Configure PLC to allow panel to read required PLC registers
- Configure HMI to enable operators to toggle optimization mode and display Specific Energy data



Case Study – Camp Swift High Service Pump Station

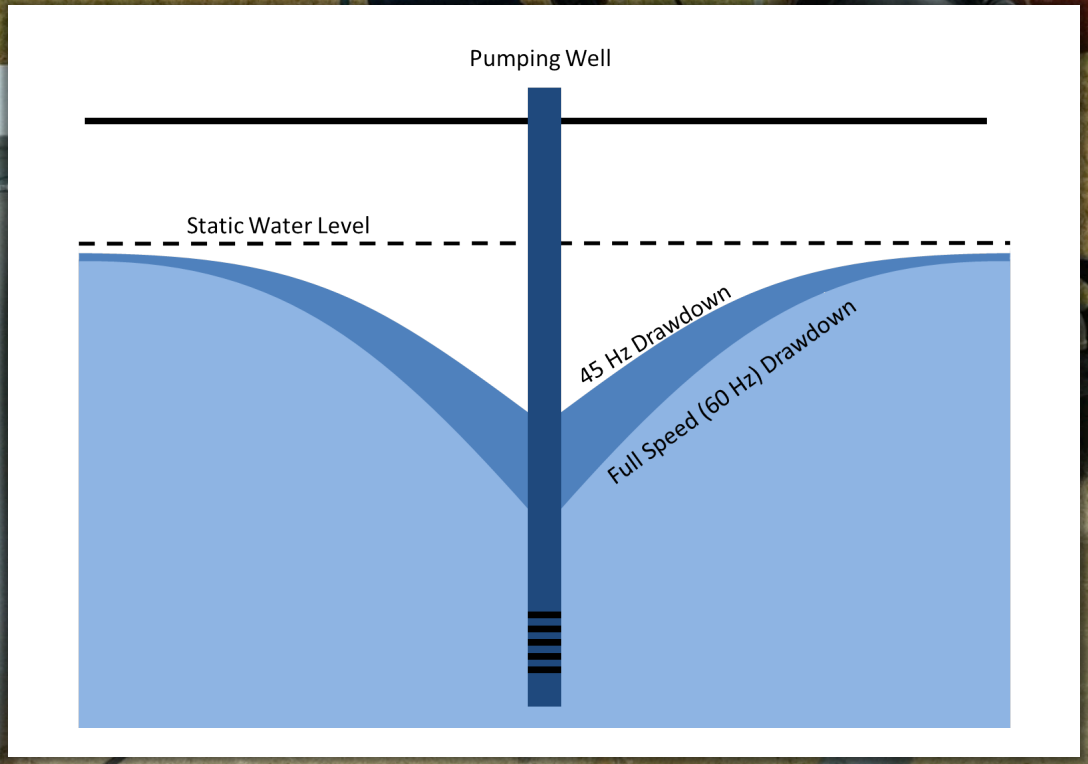
- 4 “Identical” Pumps – 200 HP
- Dramatically improved impeller life
- Energy Savings – 18%

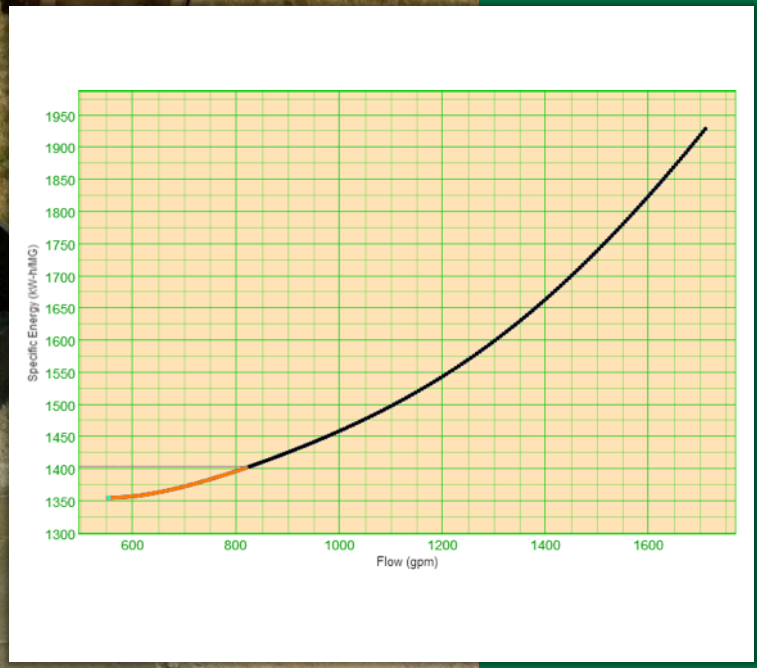


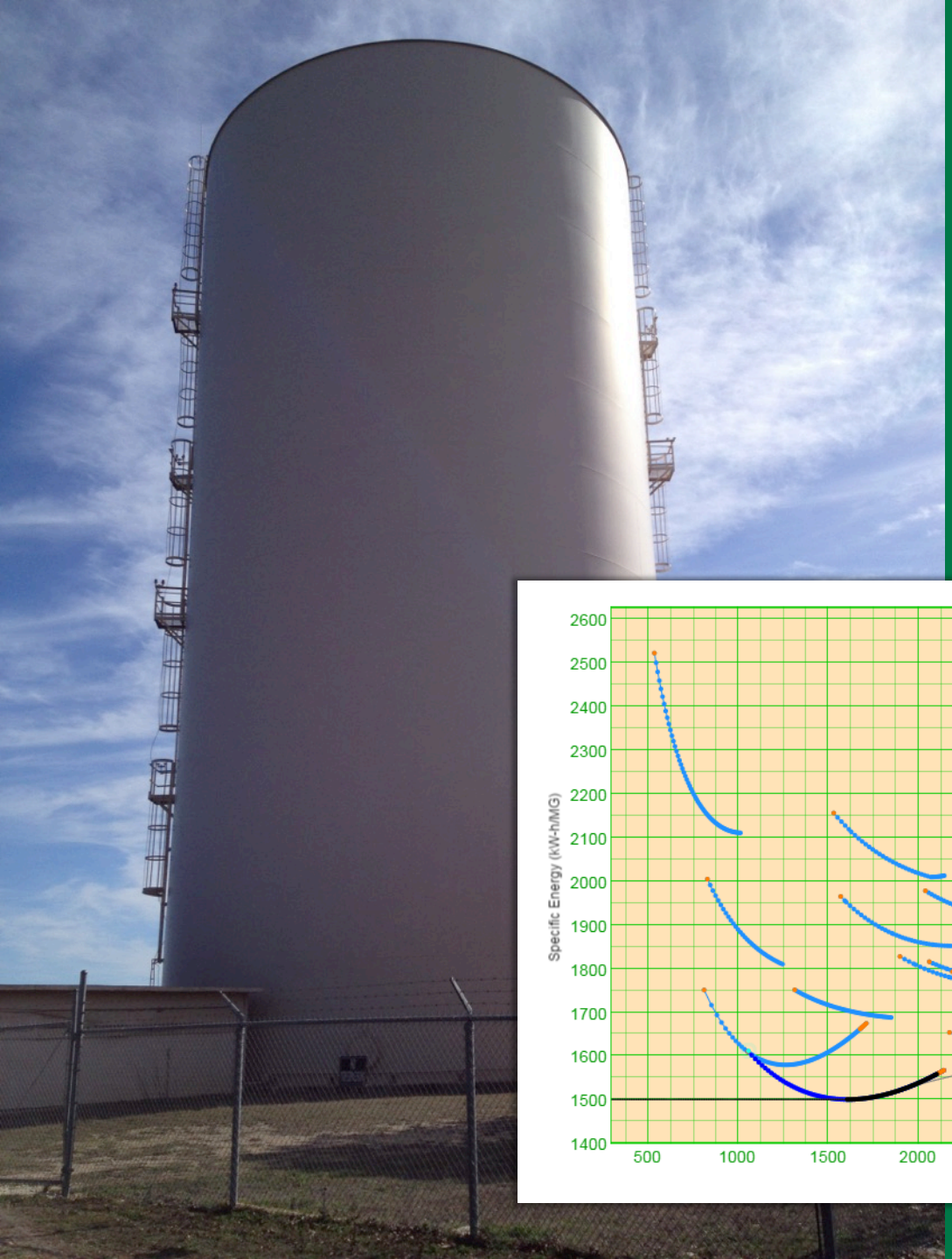


Case Study – S8 Water Well

- 250 HP Well Pump
- Energy Savings – 30%

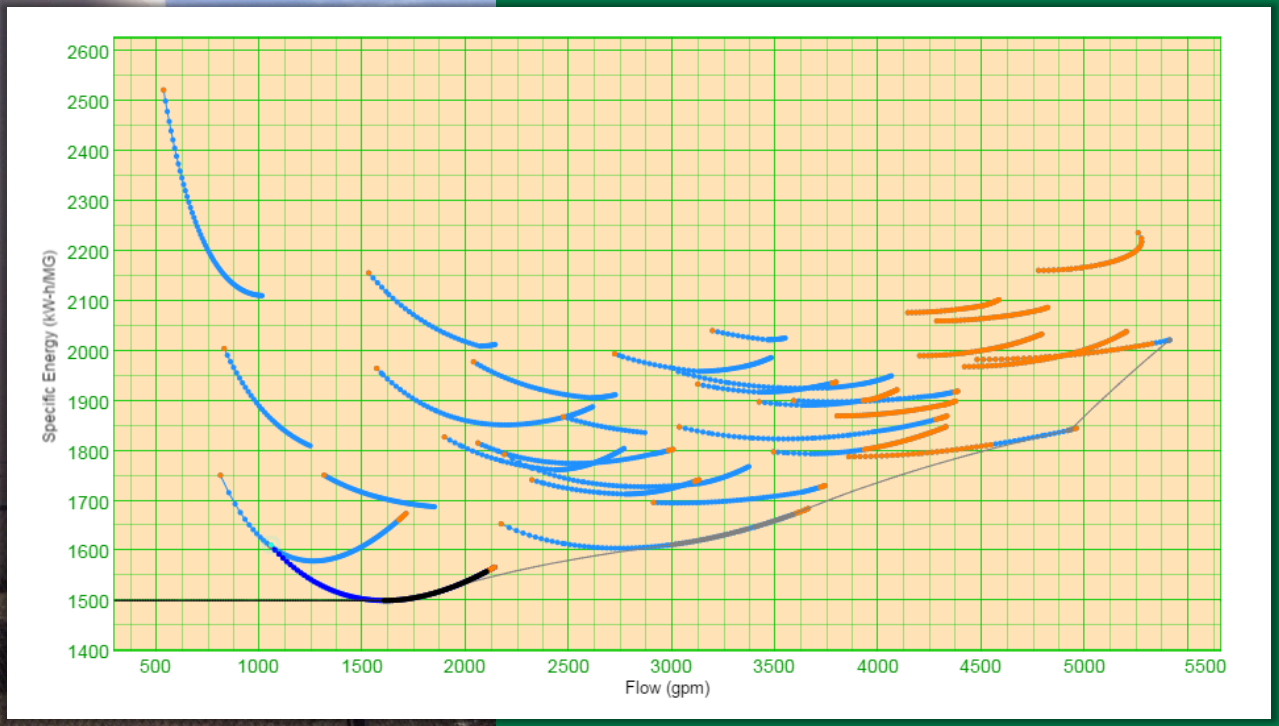






SH195 Pump Station

- 5 “identical” pumps – 1150 HP
- Discovered lead pump was significantly worn
- Energy Savings – 25%



Questions?

Marc Buchwald

Business Development Manager
Water Wastewater Competency Center

2001 Route 46, Suite 402
Parsippany, NJ 07054
Mobile: 201.404.3514
Marc.Buchwald@Schneider-Electric.com
www.schneider-electric.com

Jeff M. Miller, PE, ENV SP

Solutions Architect
Water Wastewater Competency Center

8001 Knightdale Blvd.
Knightdale, NC 27545-9023
Office: 919.266.8360 | Mobile: 919.824.9114
JeffM.Miller@Schneider-Electric.com
www.schneider-electric.com

Questions?

SPECIFIC ENERGY

Sam Lauffenburger
Software Engineer

1978 South Austin Ave.
Georgetown, TX 78626

Sam.Lauffenburger@specificenergy.com
512.930.9415

www.specificenergy.com

Schneider Electric

Jeff M. Miller, PE, ENV SP
Solutions Architect
Water Wastewater Competency Center

8001 Knightdale Blvd.
Knightdale, NC 27545-9023
Office: 919.266.8360 | Mobile: 919.824.9114
JeffM.Miller@Schneider-Electric.com
www.schneider-electric.com