NJ Water Environment Association

NJWEA John J. Lagrosa 102nd Annual Conference & Exposition

Managing Water and Wastewater Utility Data to Reduce Energy Consumption and Cost

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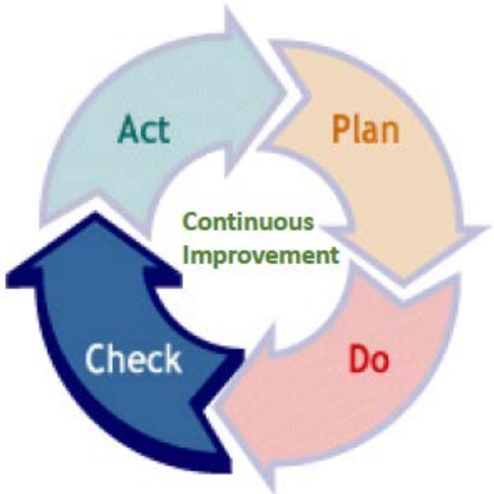
MWH now part of Stantec

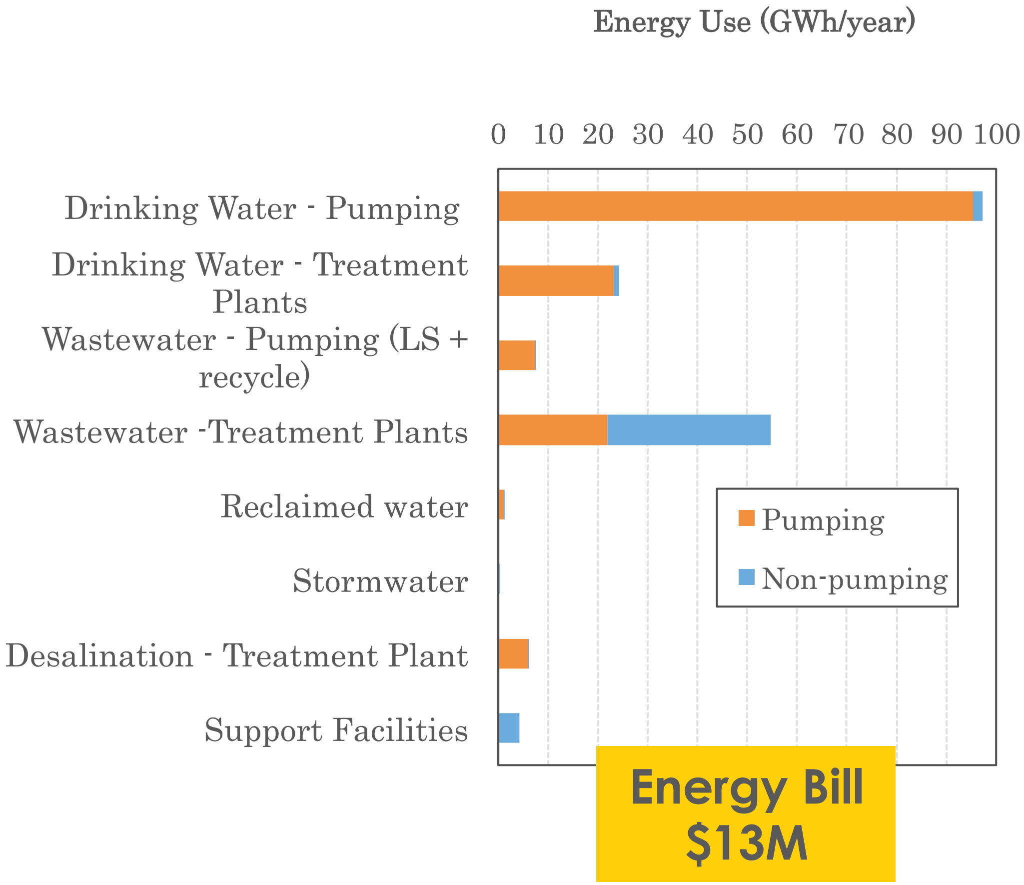
Background

- Energy management is a continuous improvement process
- Information on energy use (where, when, how much, and at what tariff) is extremely important for energy management
- Understanding of the factors impacting the performance of water/wastewater utility assets is critical



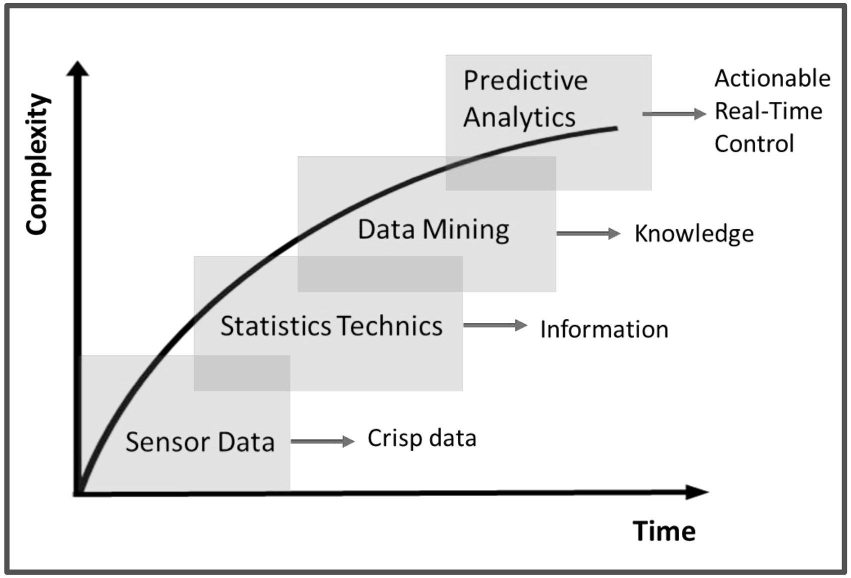
Data Management is Critical for Energy Optimization

- Utilities possess valuable and useful data, but need assistance on identifying the questions to ask
- Data management helps in operational performance benchmarking and improvement
- Long-term energy management depends on more granular level (process specific, equipment level) data management



Holistic and Integrated Approach to Data Management

- Identify data sets of value to reduce energy consumption and cost of pumping operations and treatment processes (i.e., what, when, and where to monitor/ collect/analyze)
- Apply data analytics, platforms, and display methods that will support reduction in energy consumption and cost (i.e., actionable, real-time trends and display)



Presentation Objectives

- How to improve energy efficiency and reduce costs using advanced data management and analytics?
- How to use data for energy efficiency performance benchmarking?
- What are the lessons learned/challenges with data management?

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Case Studies on Pumping Systems Energy Efficiency

Case Study 1

Pilot-Scale Demonstration of the EWQMS Framework for Energy Management

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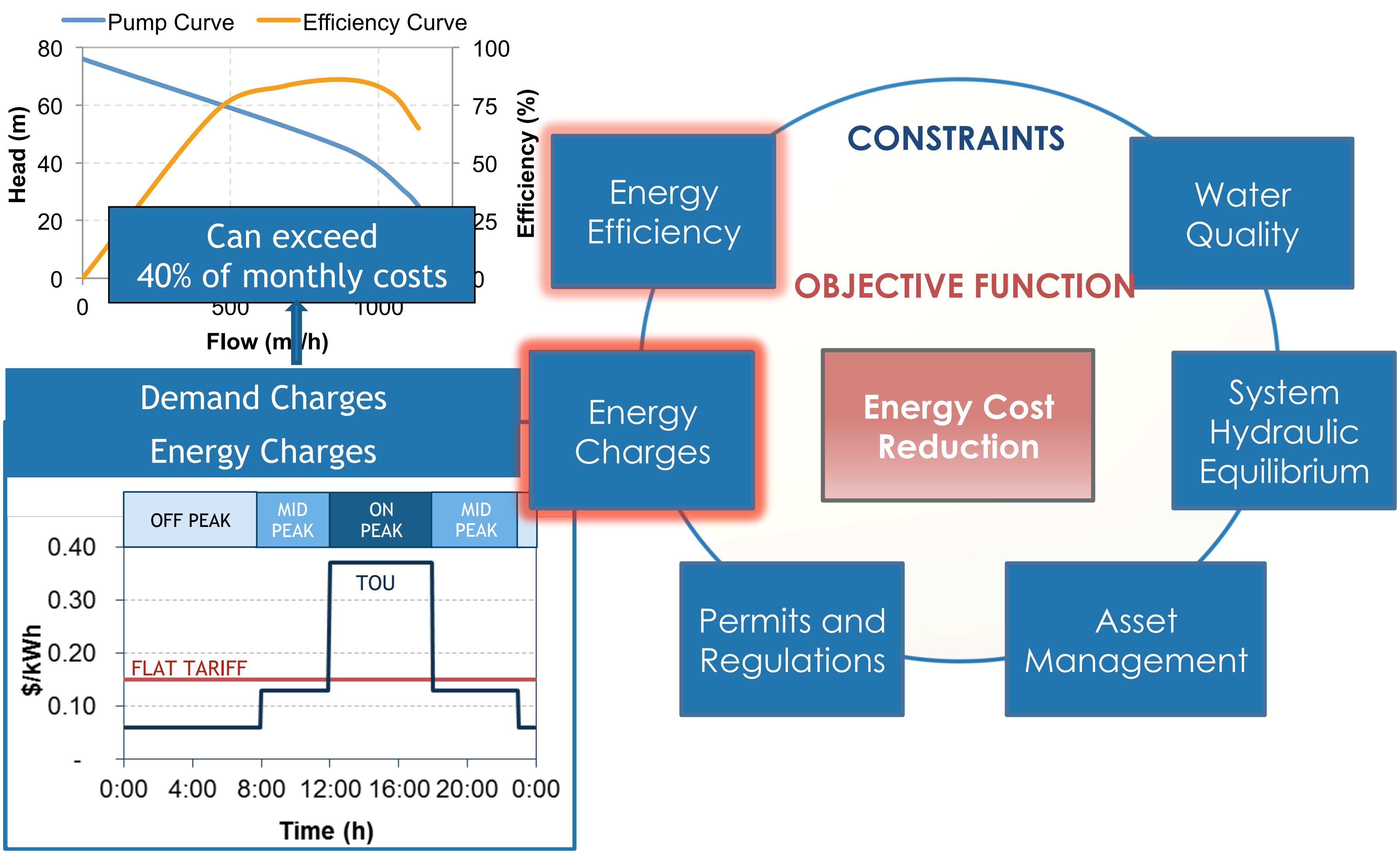
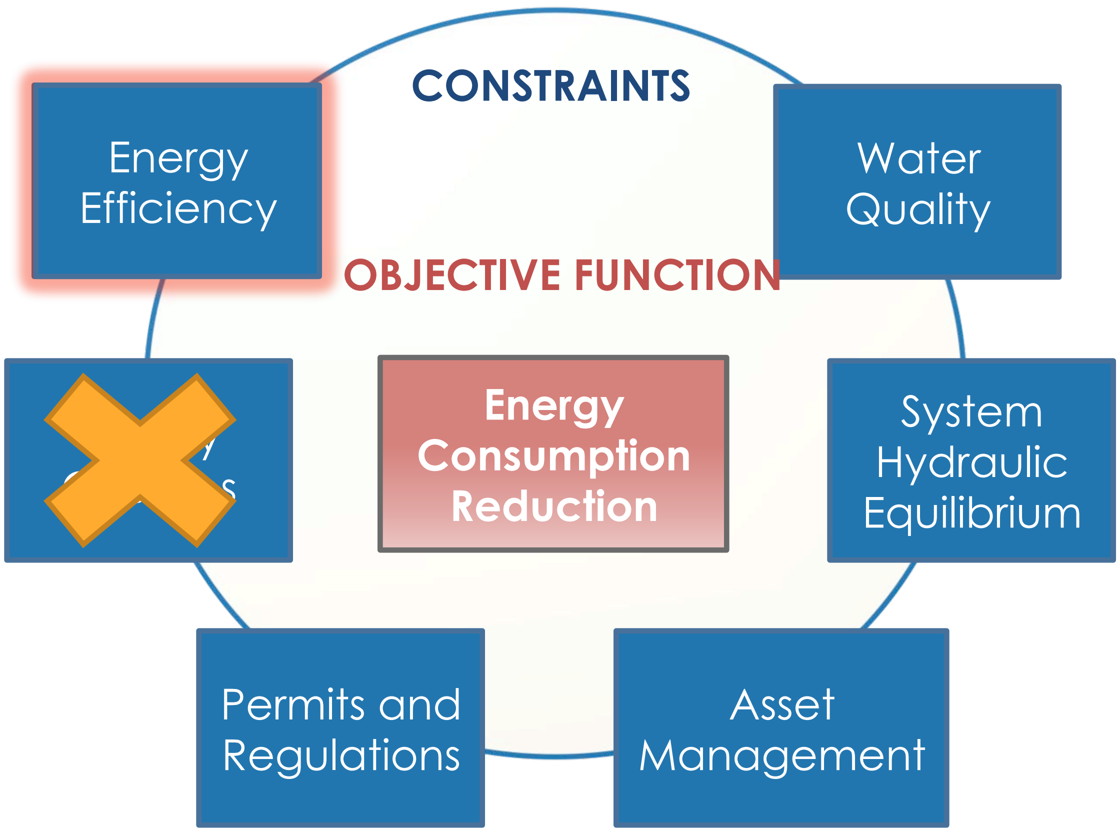
Energy Optimization Principle



Drivers for the Study



- Does lower energy use operation result in increased operating costs for water utilities?

Pilot Site

Cost Optimization

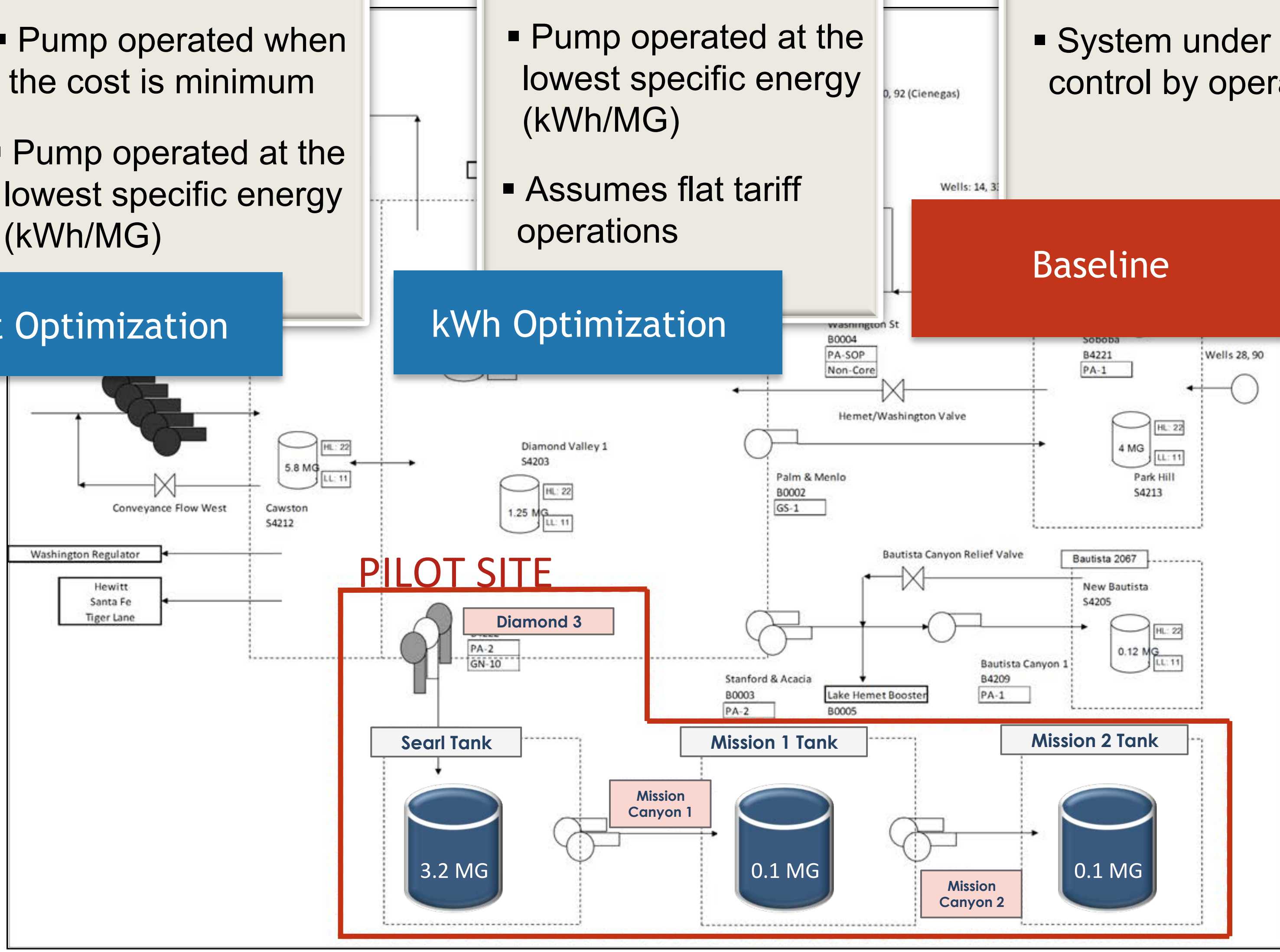
- Pump operated when the cost is minimum
- Pump operated at the lowest specific energy (kWh/MG)

kWh Optimization

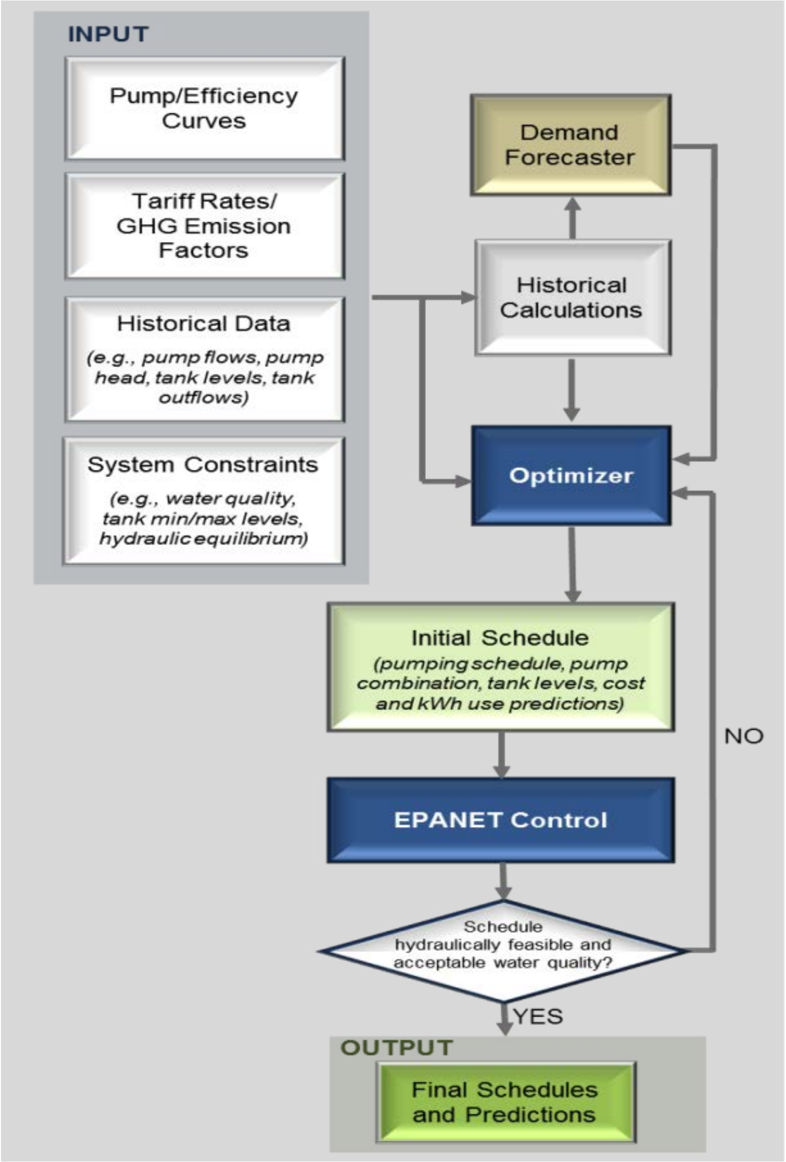
- Pump operated at the lowest specific energy (kWh/MG)
- Assumes flat tariff operations

Baseline

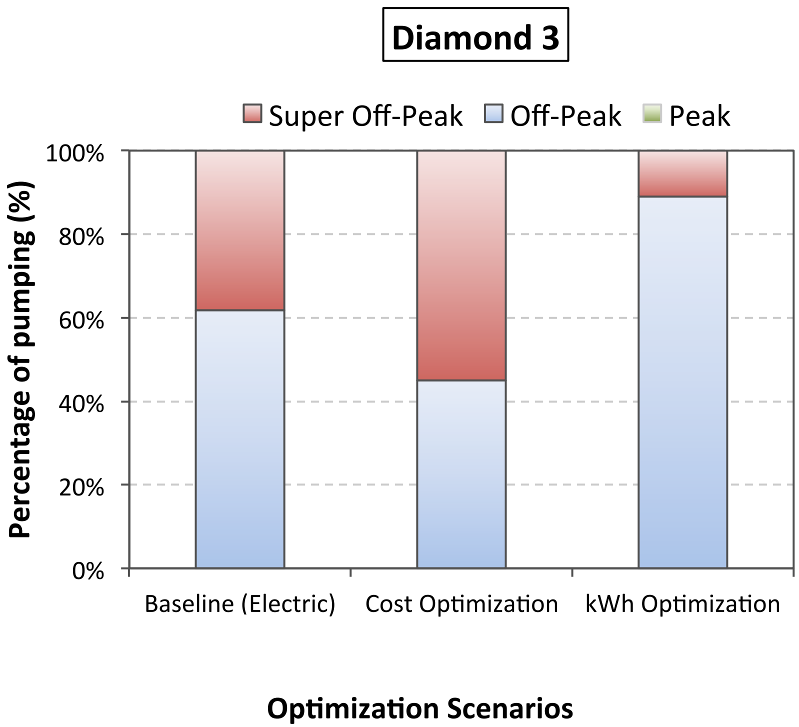
- System under manual control by operators

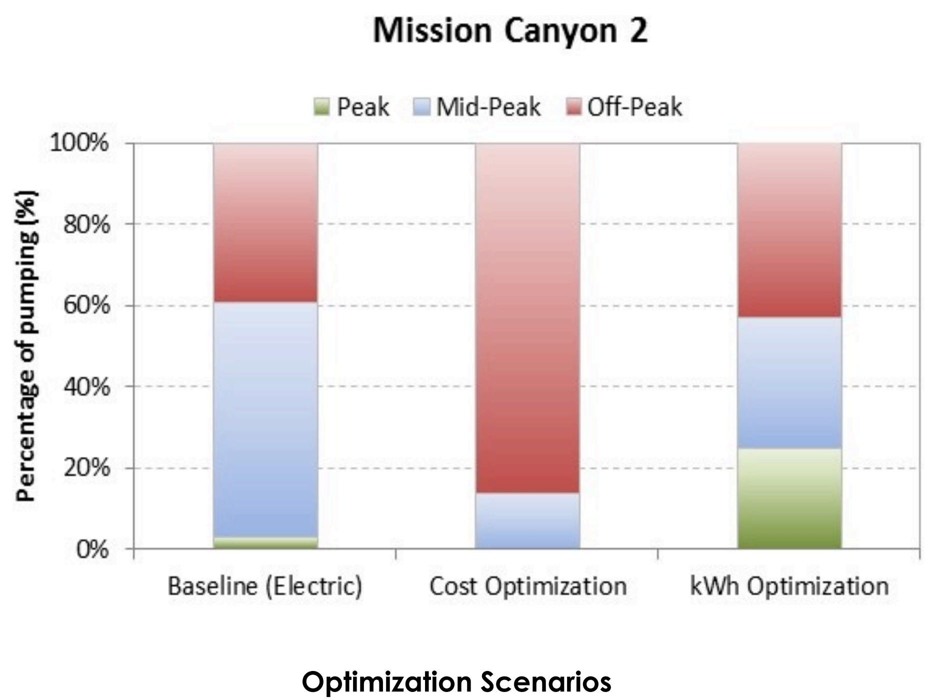


Data Collection Framework

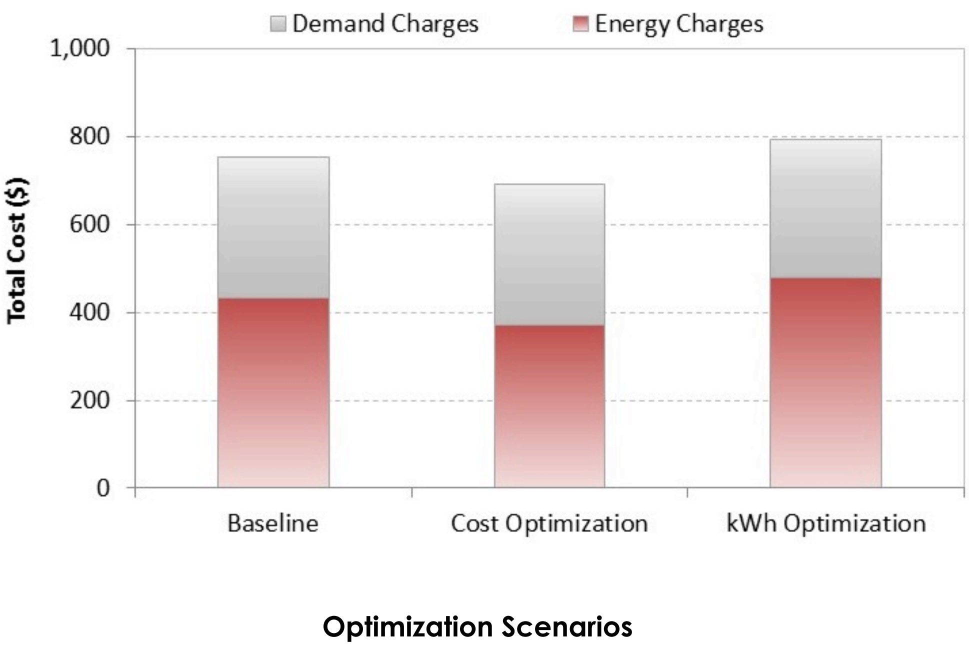


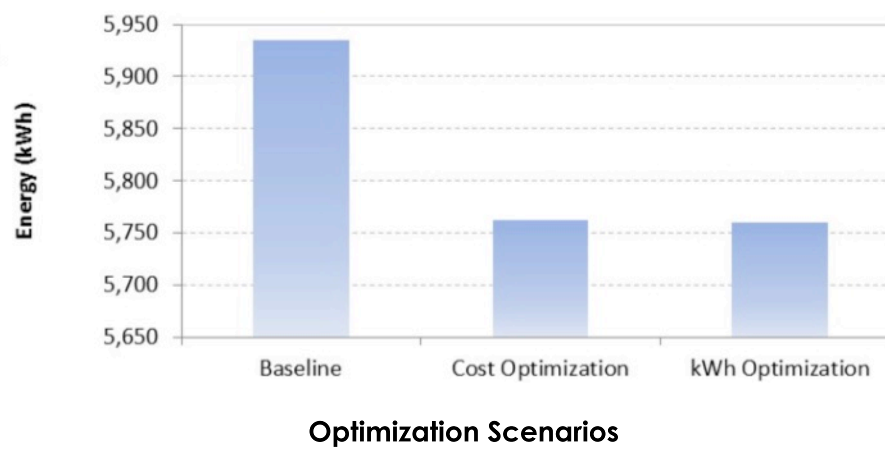
Real-Time Operation Results





Real-Time Operation Results





Badruzzaman et al. (2015) Optimization of energy and water quality management systems for drinking water utilities, A report published by the Water Research Foundation.

Case Study 2

Pilot-scale Demonstration of Lift Station Optimization for Energy Efficiency

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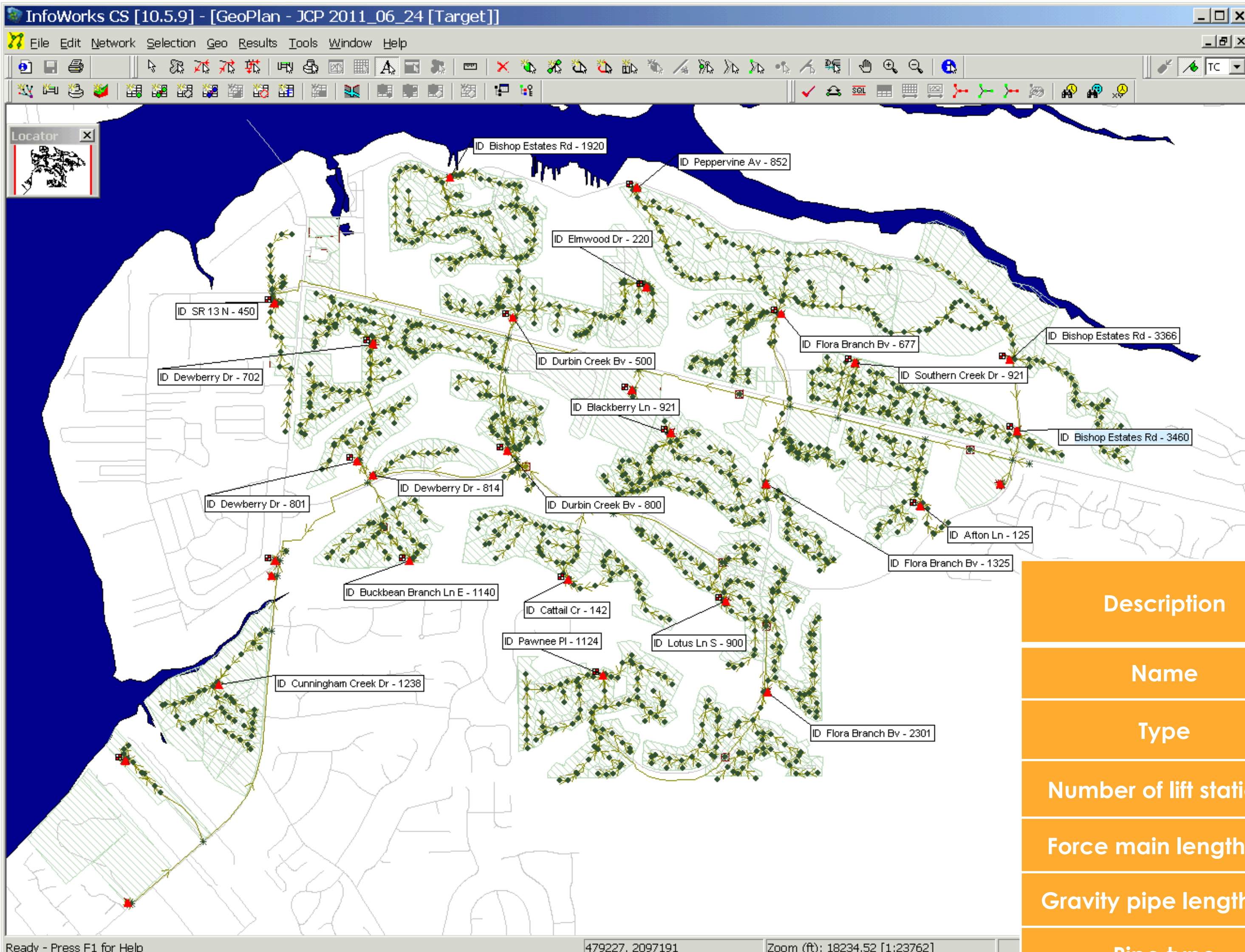
Drivers for Lift Station Optimization

- Operation of Lift Stations with local or basic controls
- Common practice of no hydraulic optimization
- Operation with old instrumentation and SCADA control systems

- Understand how hydraulic model simulation can be integrated with new generation SCADA system

Description of Pilot Site



Description	Value
Name	JCP
Type	New, very tight system
Number of lift stations	21
Force main length (ft)	85,192
Gravity pipe length (ft)	230,867
Pipe type	PVC
I&I Problem	No

Optimization Principles

Model Run	Description	Observation
Scenario #1	Run only one lift station at a time with current on/off levels	Resulted in the highest energy consumption due to pumps running on the right side of their curve
Scenario #2	Run all pumps on VFDs	Resulted in the lowest energy consumption, but was the most costly option due to capital investment in VFDs
Scenario #3	Run all pumps near their BEP	Resulted in inability to maintain the BEP only when additional pumps were called to run
Scenario #4	Level out influent flows to the wastewater plant and store wastewater in the collection system.	Resulted in the lowest energy consumption while still being a cost-effective option

Data Collection Framework

- Level in Wet Wells
- Pump start/stop
- Flow
- Seasonal Variation
- Diurnal Flow
- Pressure in Force main
- Energy Use

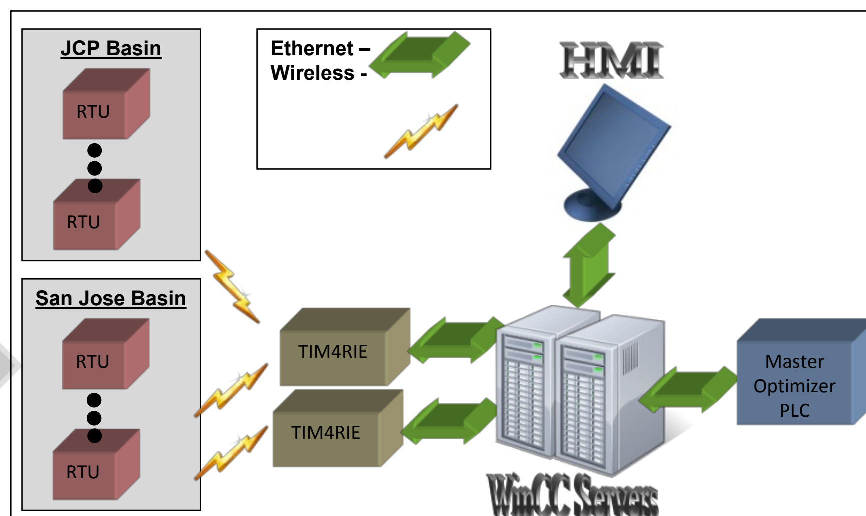
Step 1: Hydraulic modeling to find optimum operating condition

Step 2: Panel procurement

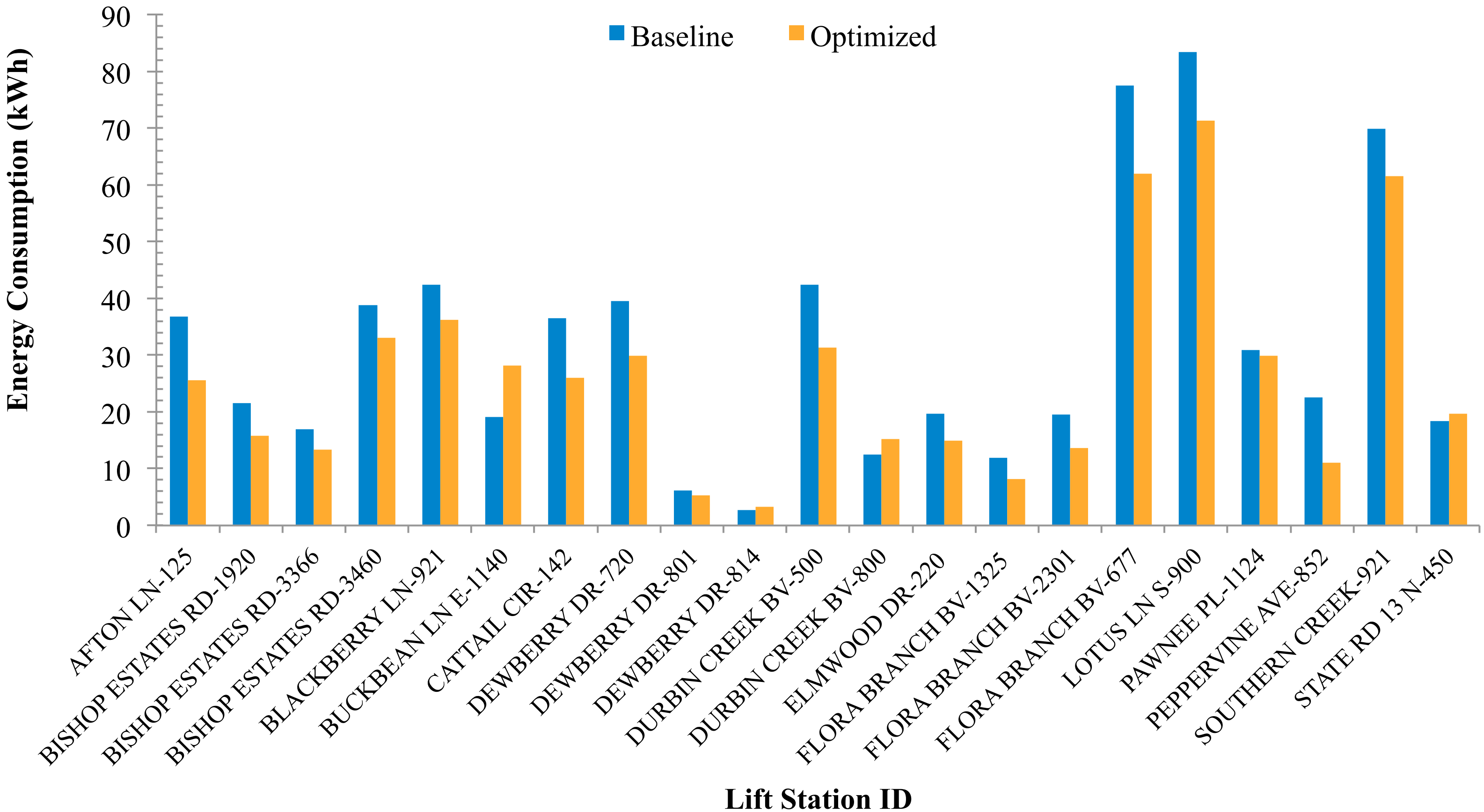
Step 3: Functional algorithms development

Step 4: PLC programming

Step 5: Operation at optimized condition

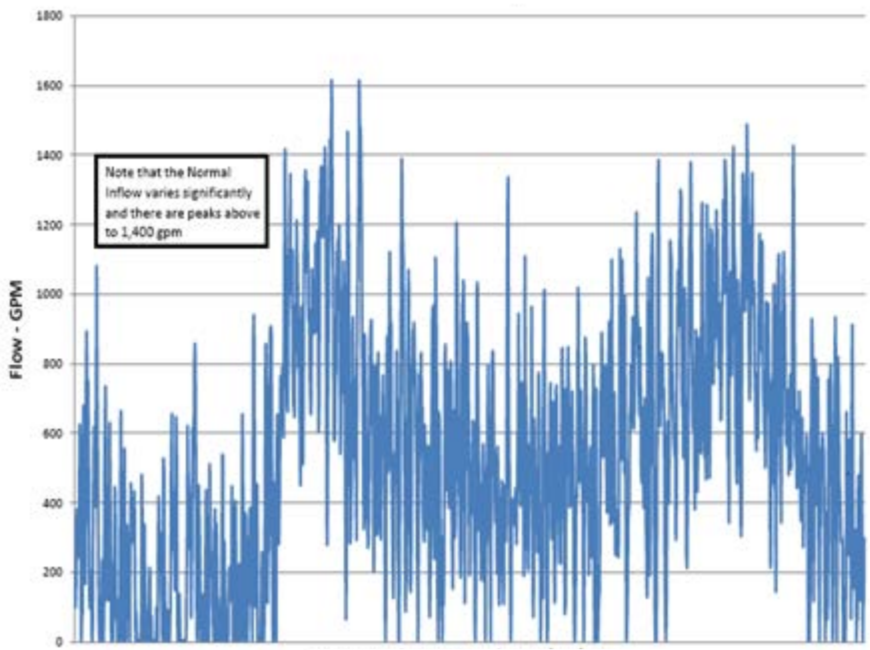


Baseline Vs Optimized Operation



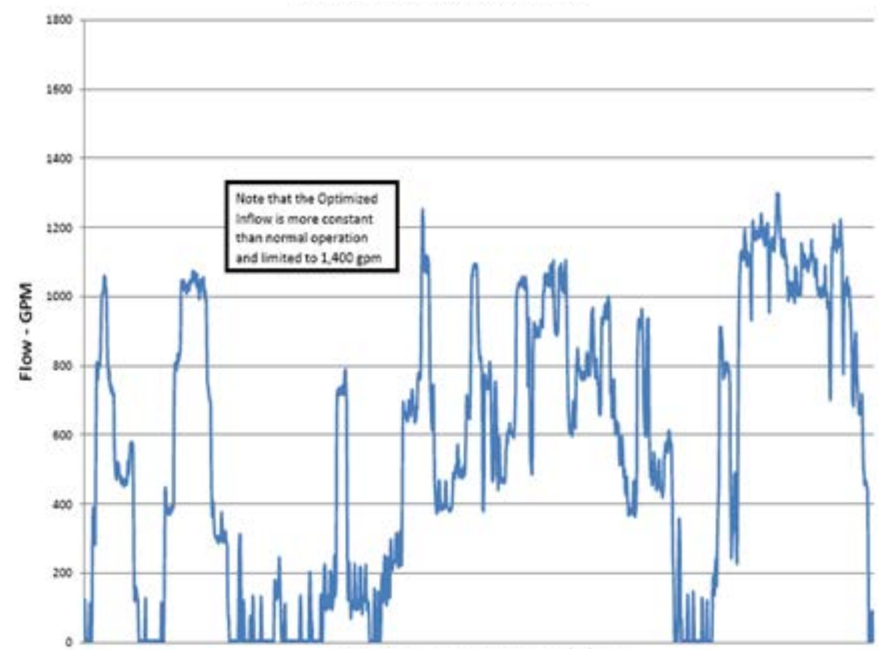
- Average energy reduction observed was about 14-17%

Collection System Flow to Treatment Plant



Before Optimization

After Optimization



Badruzzaman et al. (2016) Minimizing energy use and GHG emissions of lift stations utilizing real-time pump control strategies, Journal of Water Environment Research.

Case Study 3
Benchmarking of Pump Stations for Energy Efficiency

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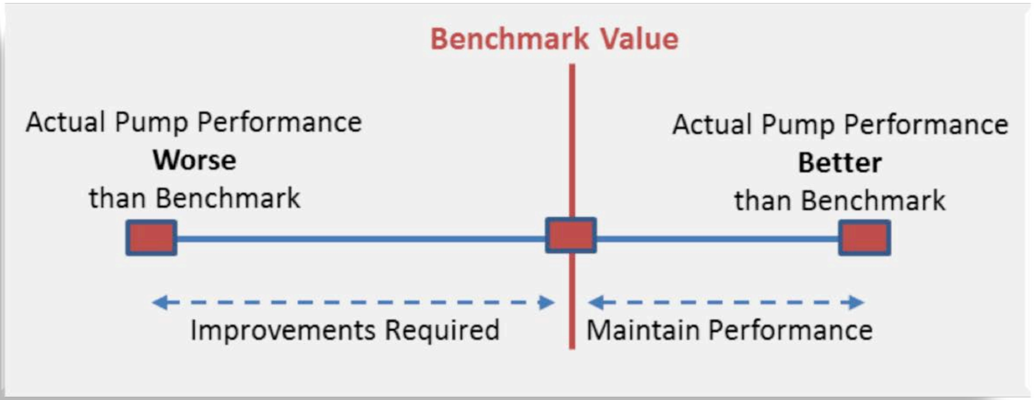
Drivers for Pump Benchmarking

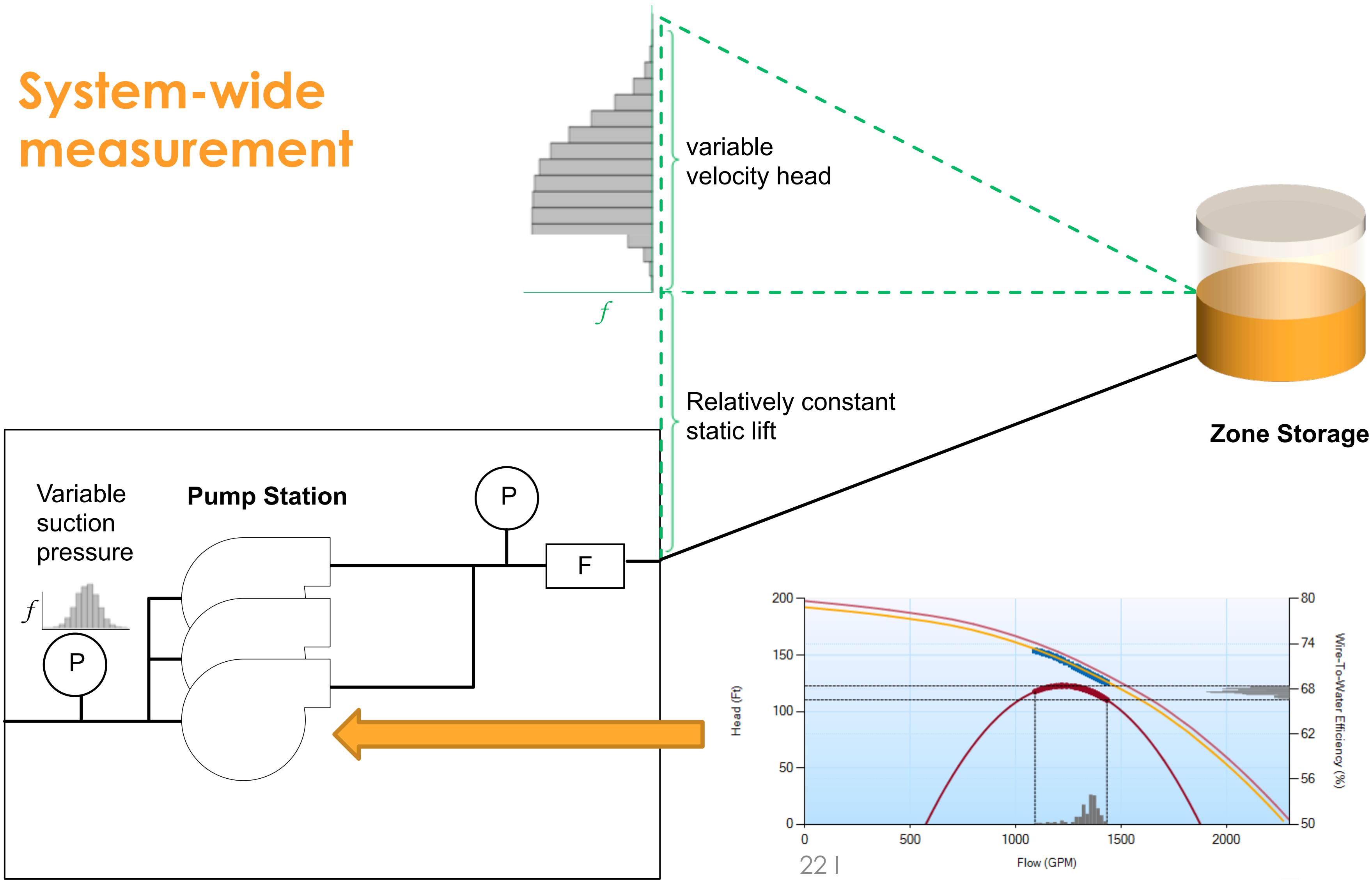
- Benchmarking information is needed on the performance of a pumping system relative to:
  - its baseline performance
  - the performance of a peer-utility pumping system

- Benchmark pump performance for a wide range of categories (type, age, control, etc.)



A New Way to Measure Pump Station Performance

System-wide measurement



Two New Metrics for Pump Performance Assessment

- **Pump Energy Indicator (PEI)** is calculated based on the pressure difference (Total dynamic head, TDH)

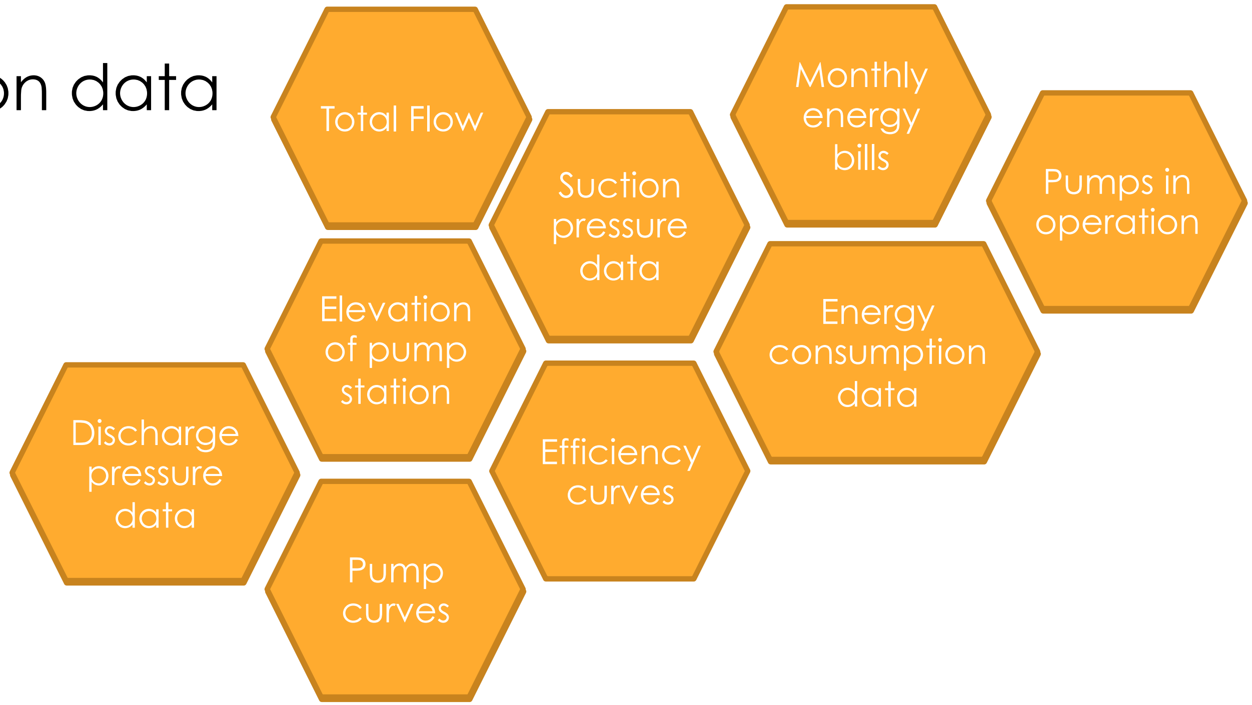
$$PEI = kWh/ML * m(\Delta Pressure)$$

- **Pump Performance Indicator (PPI)** is calculated based on the differences in elevation (i.e., just static head)

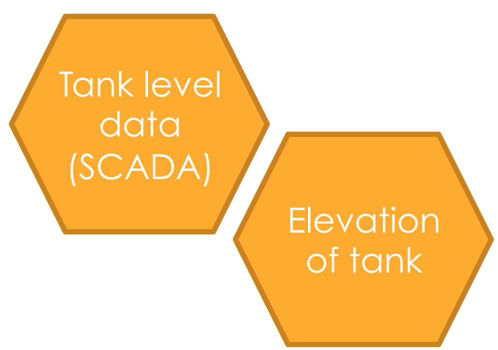
$$PPI = kWh/ML * m(\Delta Elevation)$$

Data Collection Framework

- Pump station data

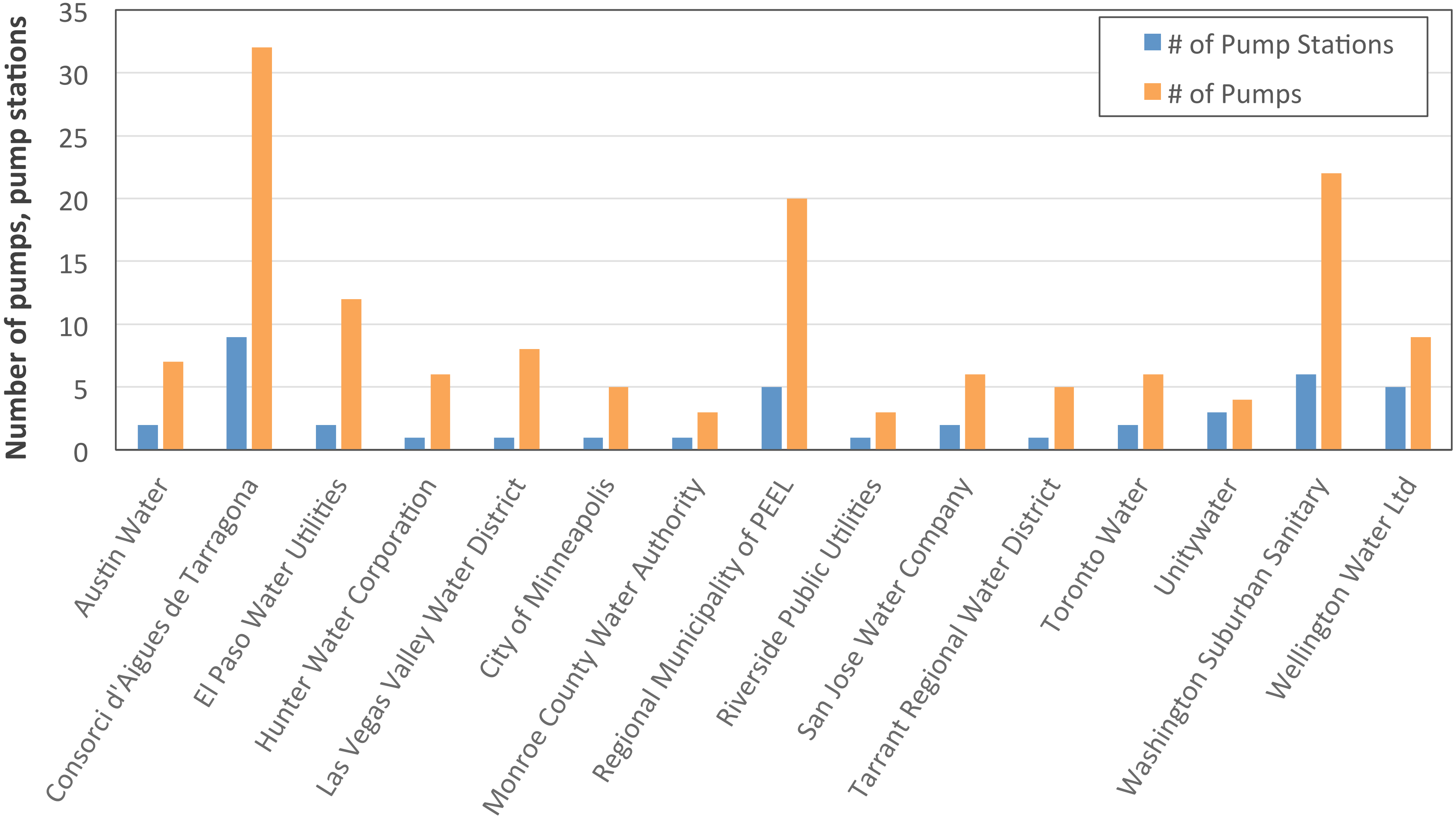


- Hydraulic data for the tank



Data Collection and Validation

Total # of Utilities: 15
Total # of Pump Stations: 42
Total # of Pumps: 148



Database Development/Validation

DATA CLEANING

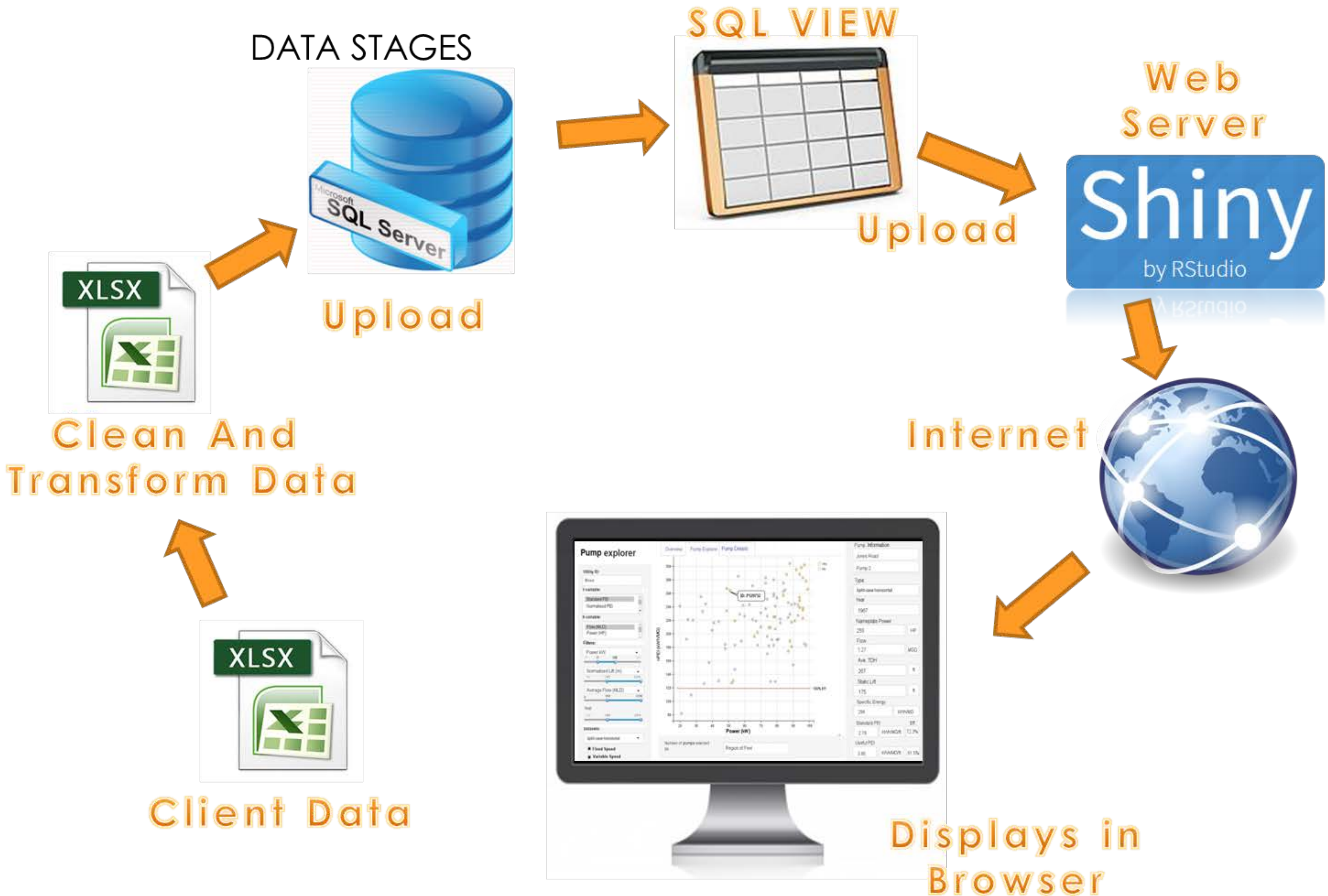
- Data Cleaning
- Conversion to Consistent Units
- Estimate Missing Data
- Matches to Energy Bill
- Remove Outliers

Calculate Performance Metrics

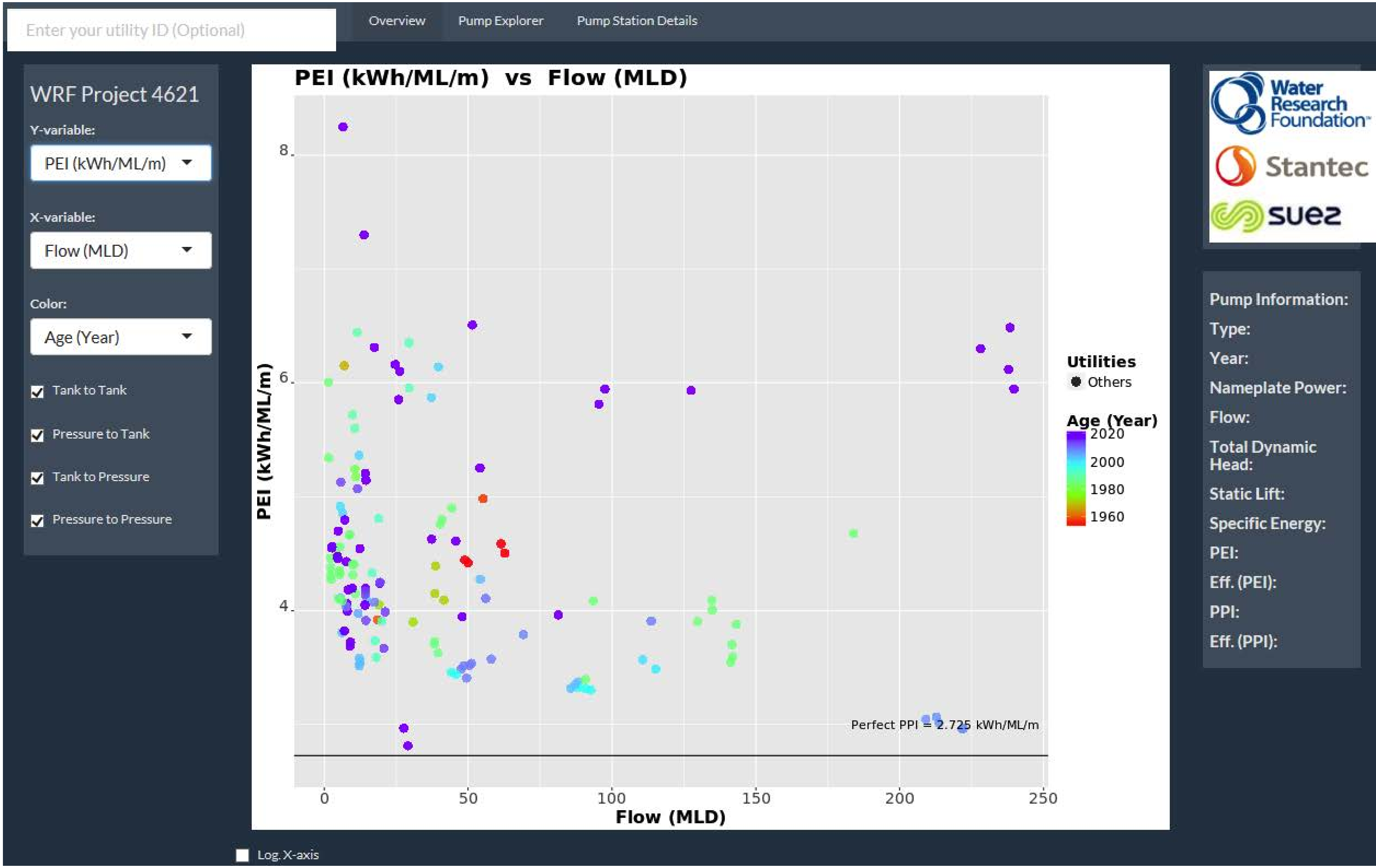
USE OF DATABASE

- Upload to Database
- Visualize Performance
- Publish Results Online
- Compare Your Results with Peers

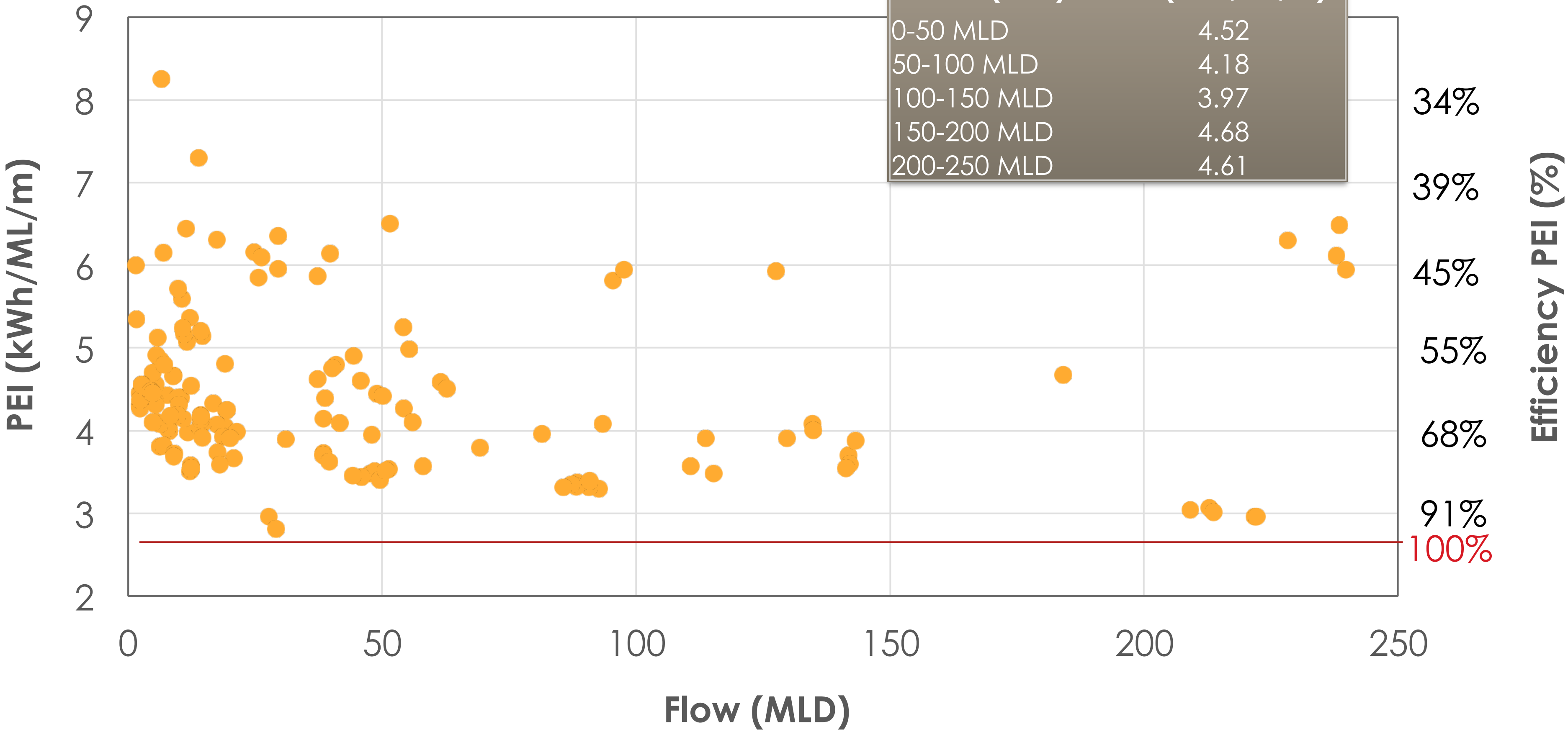
Pump Benchmarking Tool Architecture



Pump Benchmarking Tool



Flow vs PEI



Flow (MLD)	PEI (kWh/ML/m)
0-50 MLD	4.52
50-100 MLD	4.18
100-150 MLD	3.97
150-200 MLD	4.68
200-250 MLD	4.61

Badruzzaman et al. (2017) Performance benchmarking of pumps and pumping systems for drinking water utilities, An ongoing project funded by the Water Research Foundation (WRF 4621).

Energy Data Management is a Complex Process

- Instrumentation quantity
- Instrument accuracy
- Time steps
- Duration
- Data Format
- Different SCADA
- KPIs
- Trade-offs
- Data Scrubbing
- Different EMS
- Data validation
- Staff
- Culture

Badruzzaman et al. (2017), Managing water and wastewater utility data to reduce energy consumption and costs, An ongoing project funded by the Water Research Foundation (WRF 4668)

Acknowledgements

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- Water Research Foundation
- Water Environment & Reuse Foundation
- California Energy Commission

Project Partners

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- David Weightman, CEC

Project Partners

- Derceto/SUEZ
- JEA
- Eastern Municipal Water District
- Other water and wastewater utilities

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Questions

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