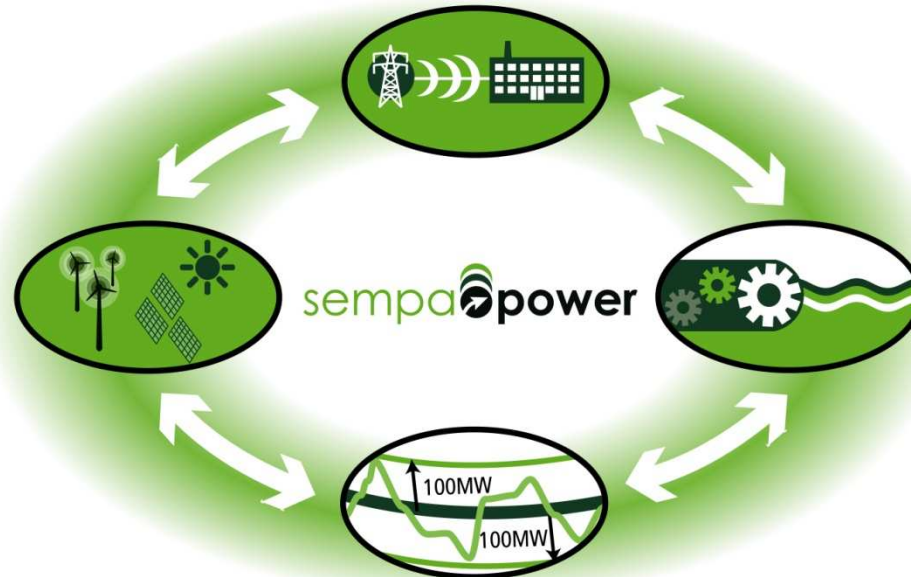


# Regulation Services Network



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# Overview

1. How does the Electricity Market work?
2. What is an ISO/RTO?
3. What is Electricity System Regulation?
4. Sempa's Regulation Services Network (RSN)
5. Examples of Regulating Resources
6. RSN Operations Overview
7. Pilot Opportunity - Next Steps



# Components of the Electricity Market

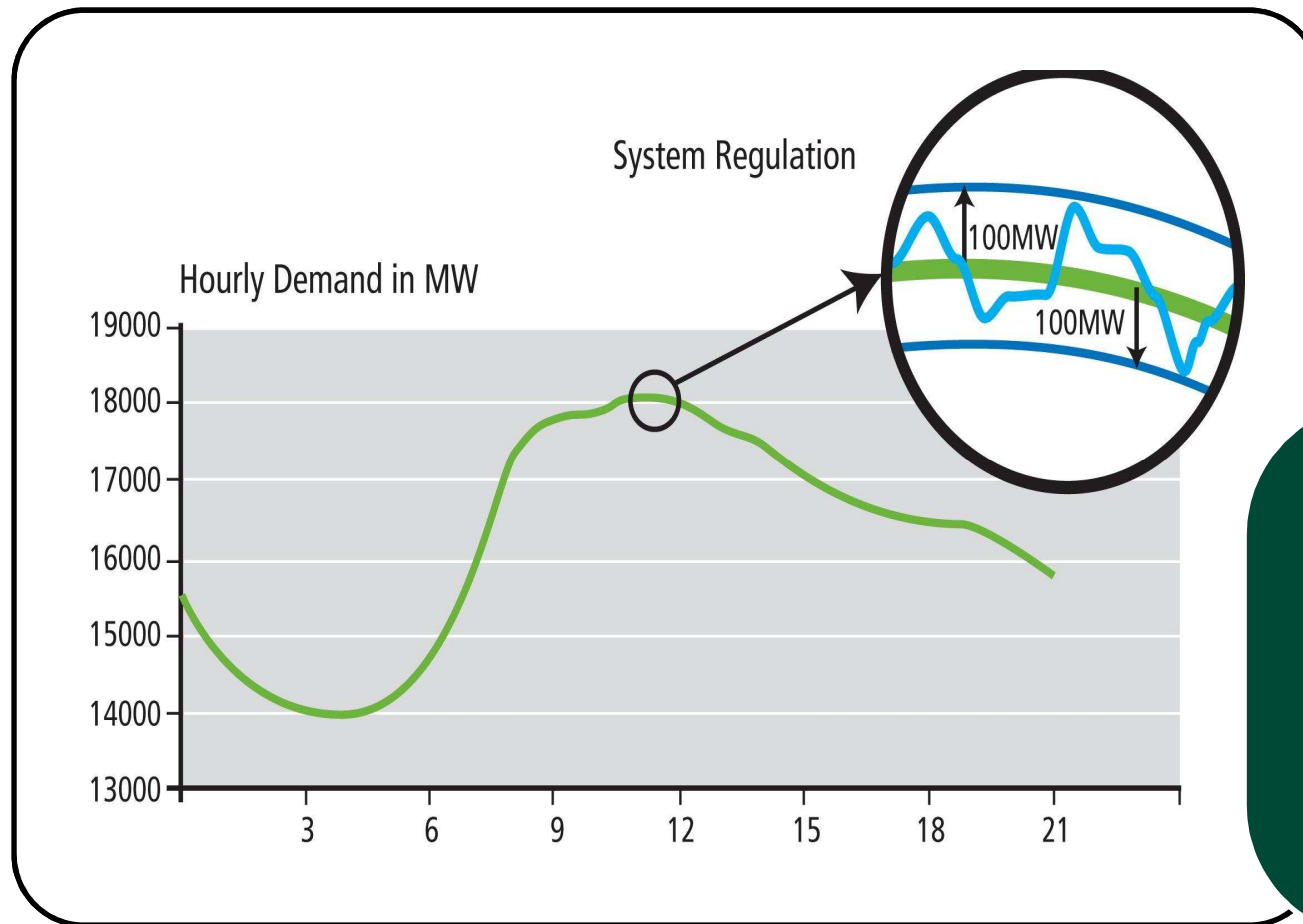


# ISO Procurement of Ancillary Services

## Operation of the grid involves two general areas of activity:

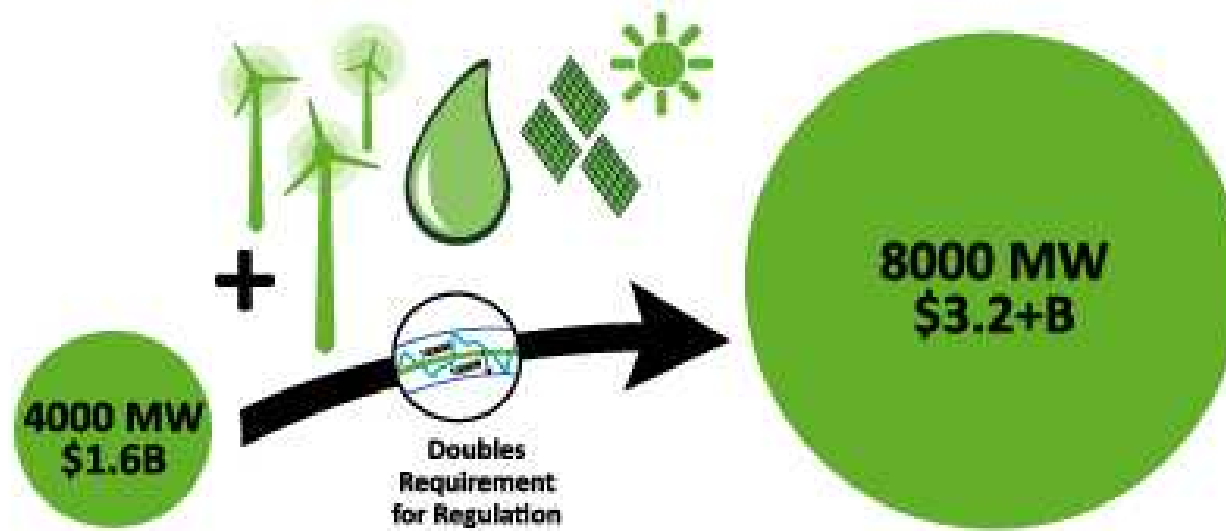
- Transmission system control
- Generation Control
  - Generation Dispatch
  - Automatic Generation Control (AGC)
    - System Regulation is Purchased as a service by the ISO

# System Regulation



Second by second balancing of supply and load (system regulation), is currently accomplished by adjusting generation

# Growing Market Opportunity - Regulation



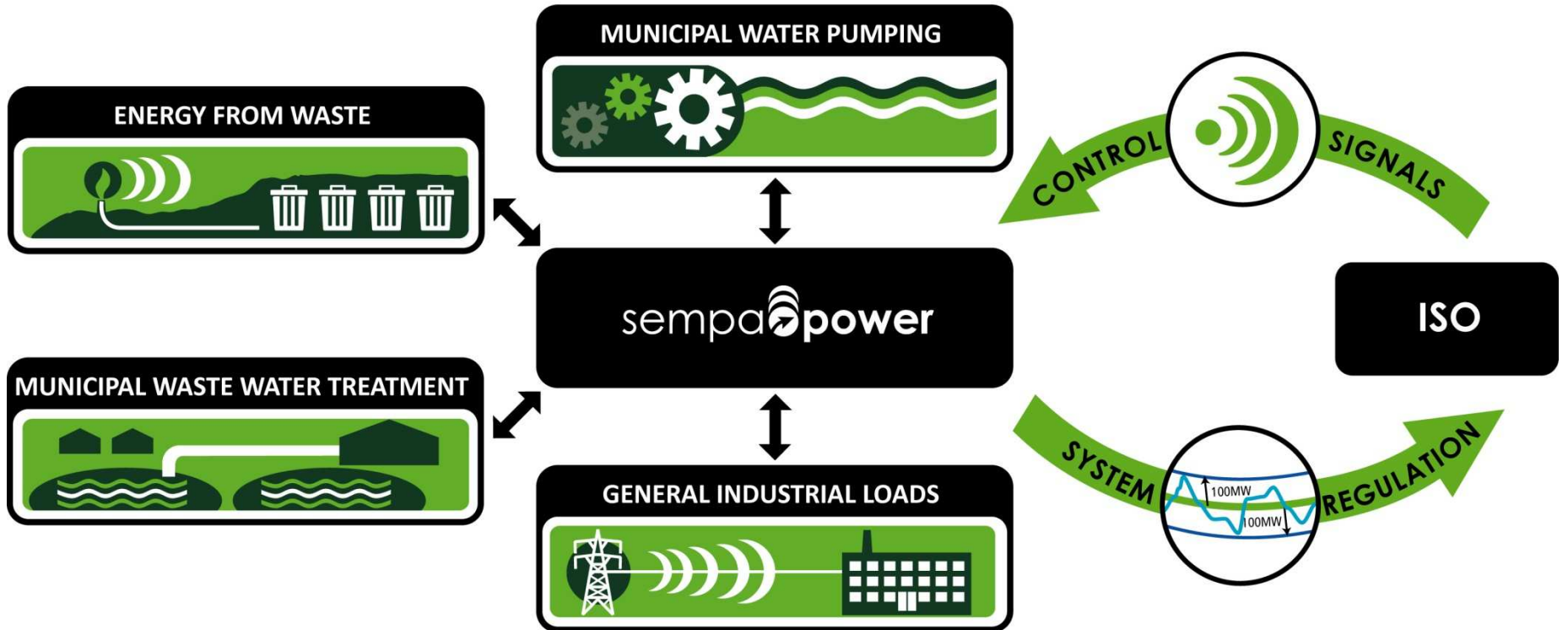
**TODAY**

**Generators**

**TOMORROW - Demand Based Platforms**

**General Industrial Loads**      **Municipal Water**      **Storage**

# Sempa Regulation Services Network



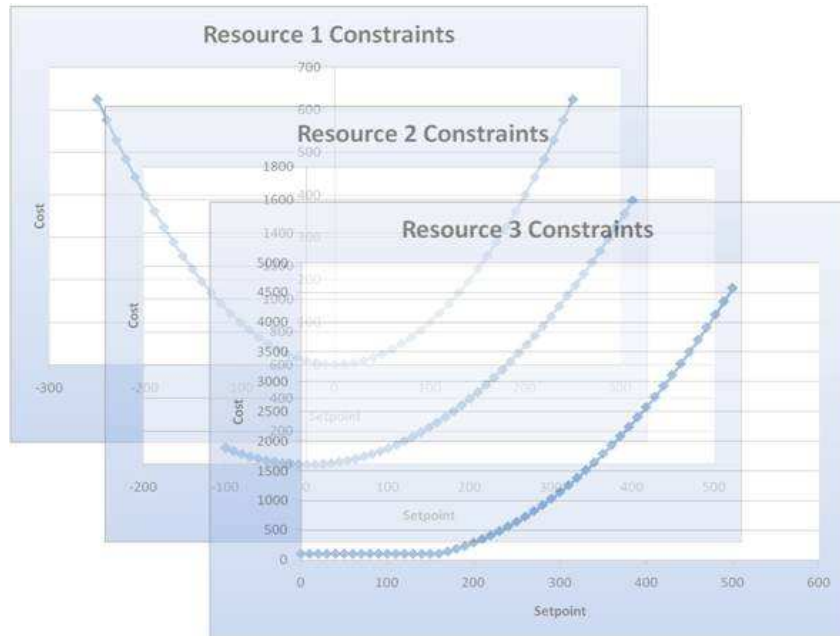
# Opportunities for Water Asset Owners

## Smart Grid to Smart Water – New Revenue for Water and Waste Water Asset Owners



- New revenue stream from existing assets
- Low risk to pilot, rapid success, easy to scale
- Leadership in Smart Grid and Smart Water Technologies

# Resource Control and Optimization



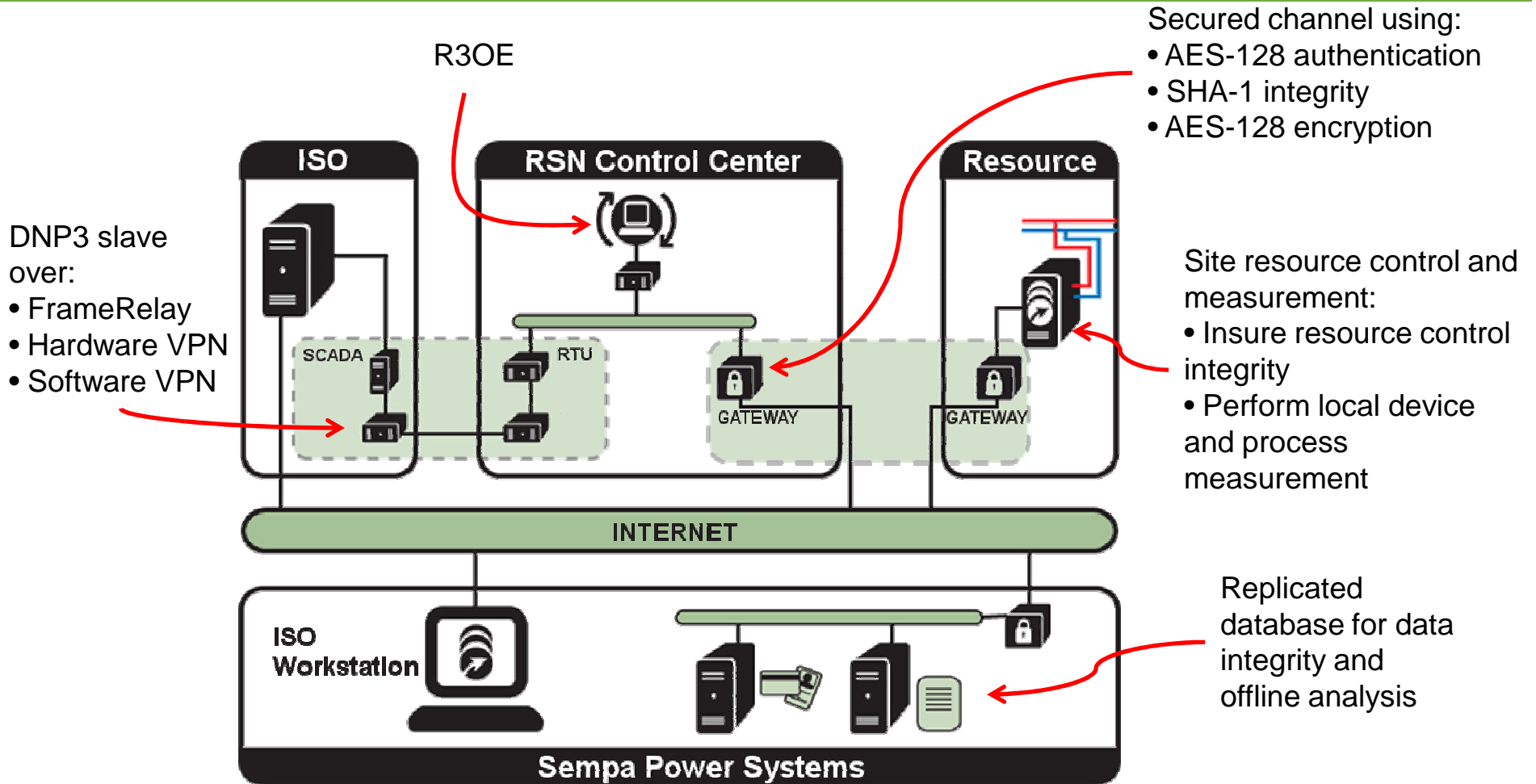
Resource Ontology:  
State-dependent  
operating constraints  
for each resource

Setpoints selected to  
achieve ISO target  
within resource  
constraints

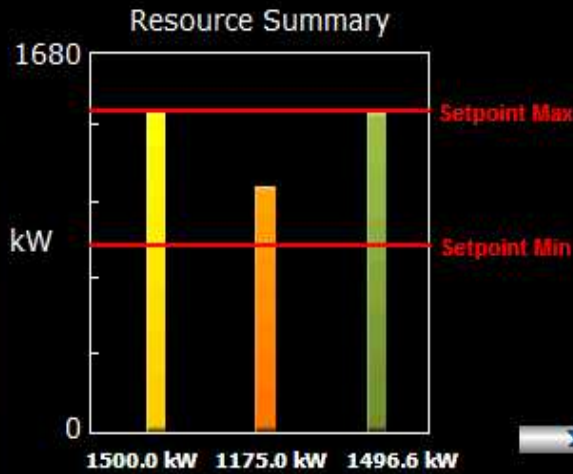


Resource State feedback

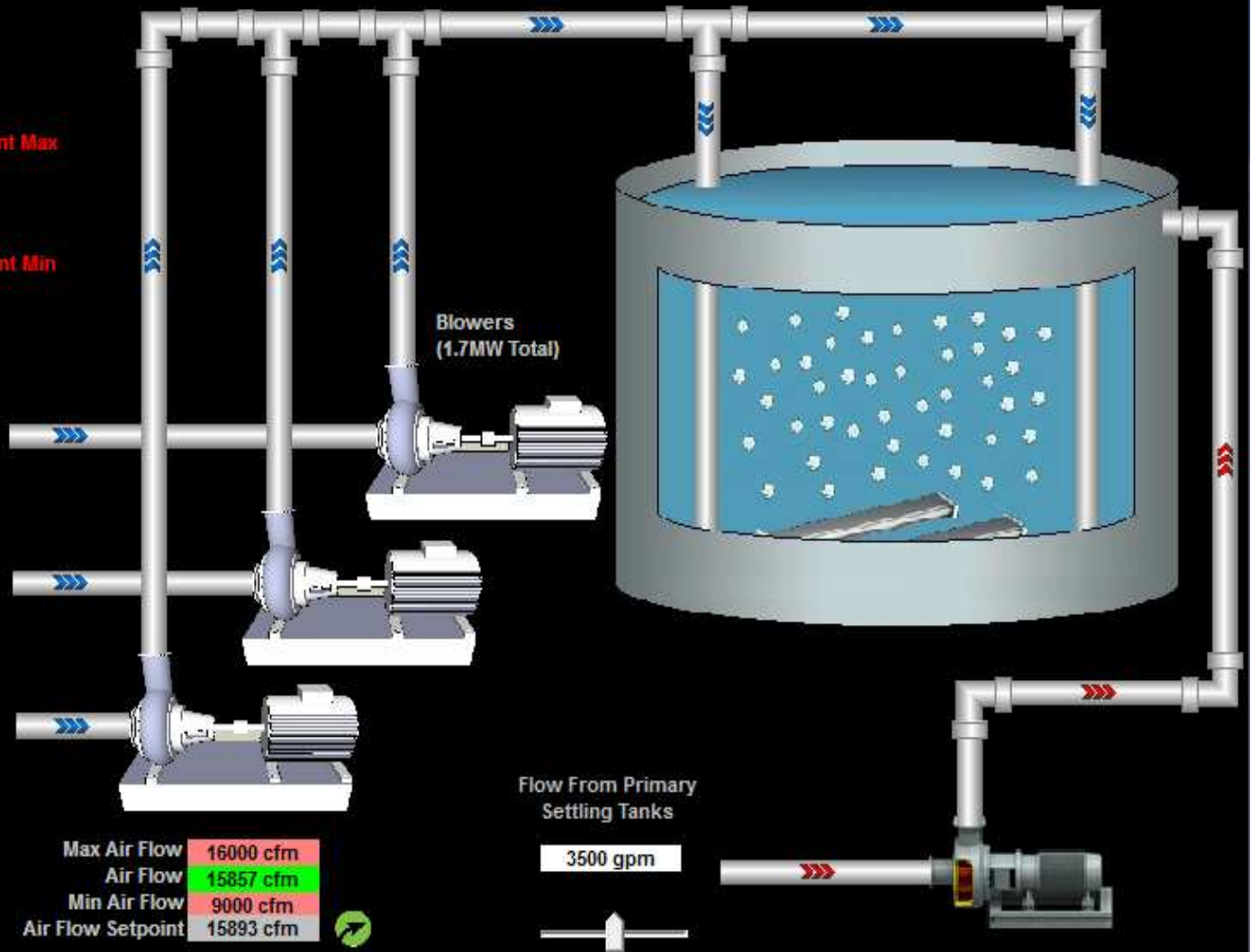
# RSN Technical Architecture



# RSN Aeration Demonstration



- RSN Setpoint (kW)
- Host Setpoint (kW)
- Actual Output (kW)



Legend:

- Point is under RSN control
- Point is under site control

Disable RSN



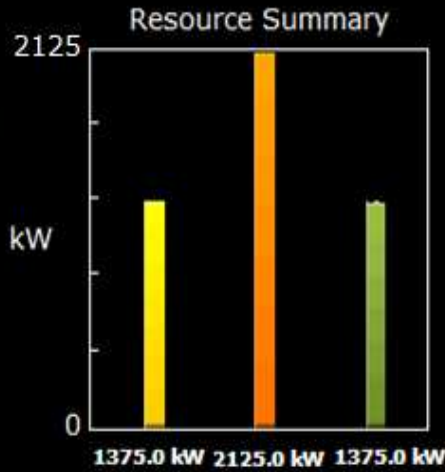
Demonstration Program **Aeration**

Instantaneous Response Graph

Boiler Demo

Pump Demo

# RSN Water Pump Demonstration



- RSN Setpoint (kW)
- Host Setpoint (kW)
- Actual Output (kW)

All Tanks:  
 Top Third for Storage (Setpoint Modulated By RSN)  
 Middle Third for Emergency (Not Affected by RSN)  
 Bottom Third for Fire Fighting (Not Affected by RSN)

### Zone 3 Water Tower

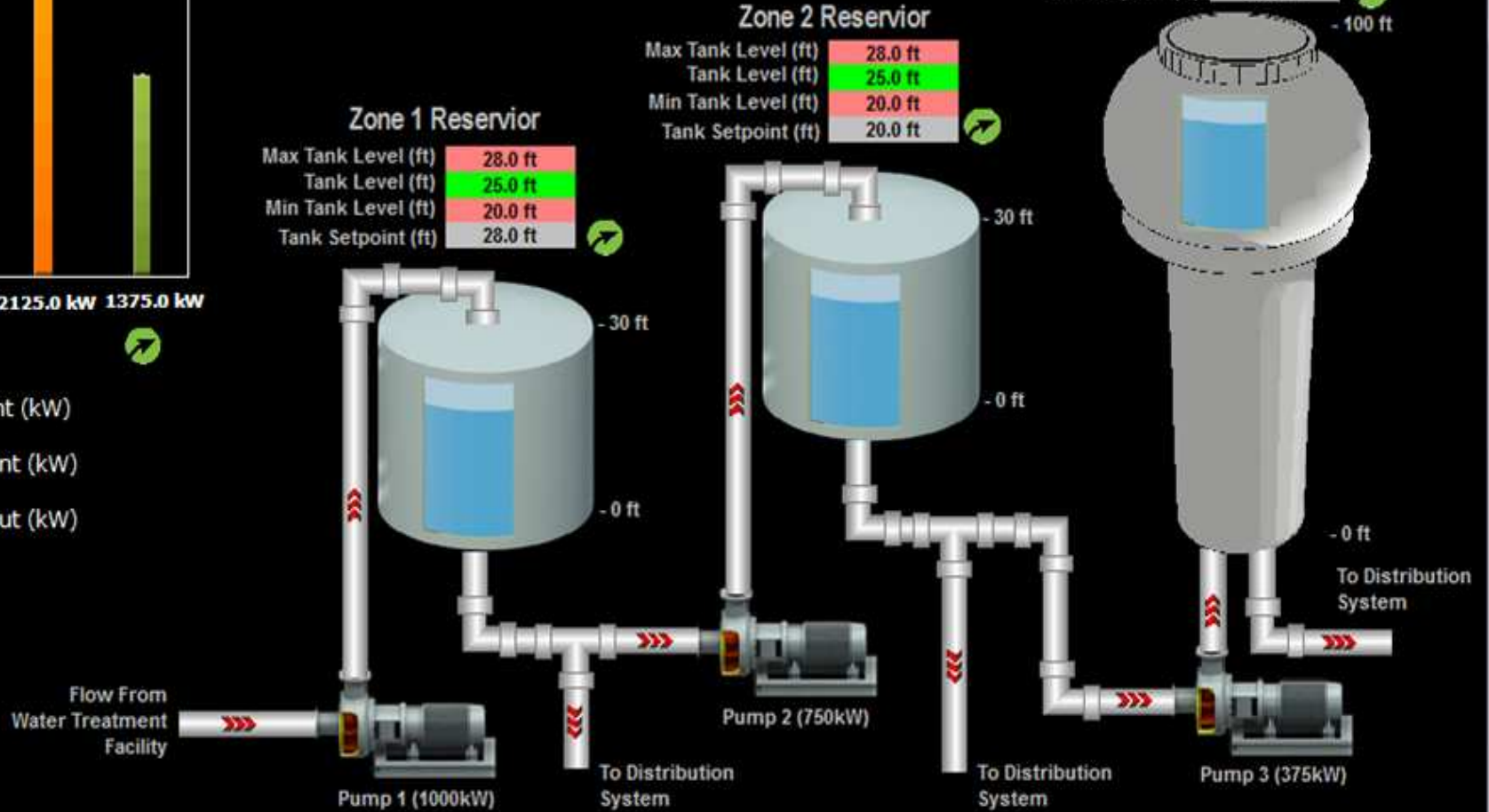
Max Tank Level (ft)	95.0 ft
Tank Level (ft)	83.2 ft
Min Tank Level (ft)	67.0 ft
Tank Setpoint (ft)	95.0 ft

### Zone 2 Reservoir

Max Tank Level (ft)	28.0 ft
Tank Level (ft)	25.0 ft
Min Tank Level (ft)	20.0 ft
Tank Setpoint (ft)	20.0 ft

### Zone 1 Reservoir

Max Tank Level (ft)	28.0 ft
Tank Level (ft)	25.0 ft
Min Tank Level (ft)	20.0 ft
Tank Setpoint (ft)	28.0 ft



### Legend:

- Point is under RSN control
- Point is under site control

Disable RSN



Pump 1 Status: Full Speed  
 Pump 2 Status: Off  
 Pump 3 Status: Full Speed

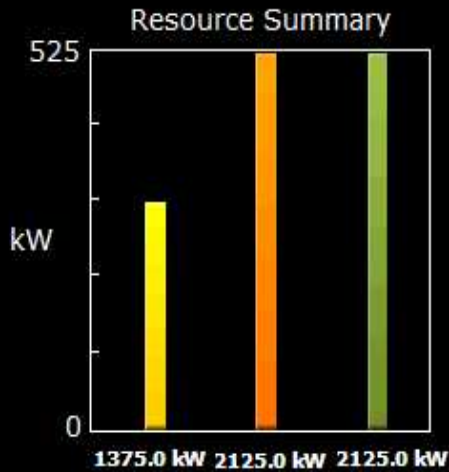


Instantaneous Response Graph

Boiler Demo

Aeration Demo

# RSN Water Pump Demonstration



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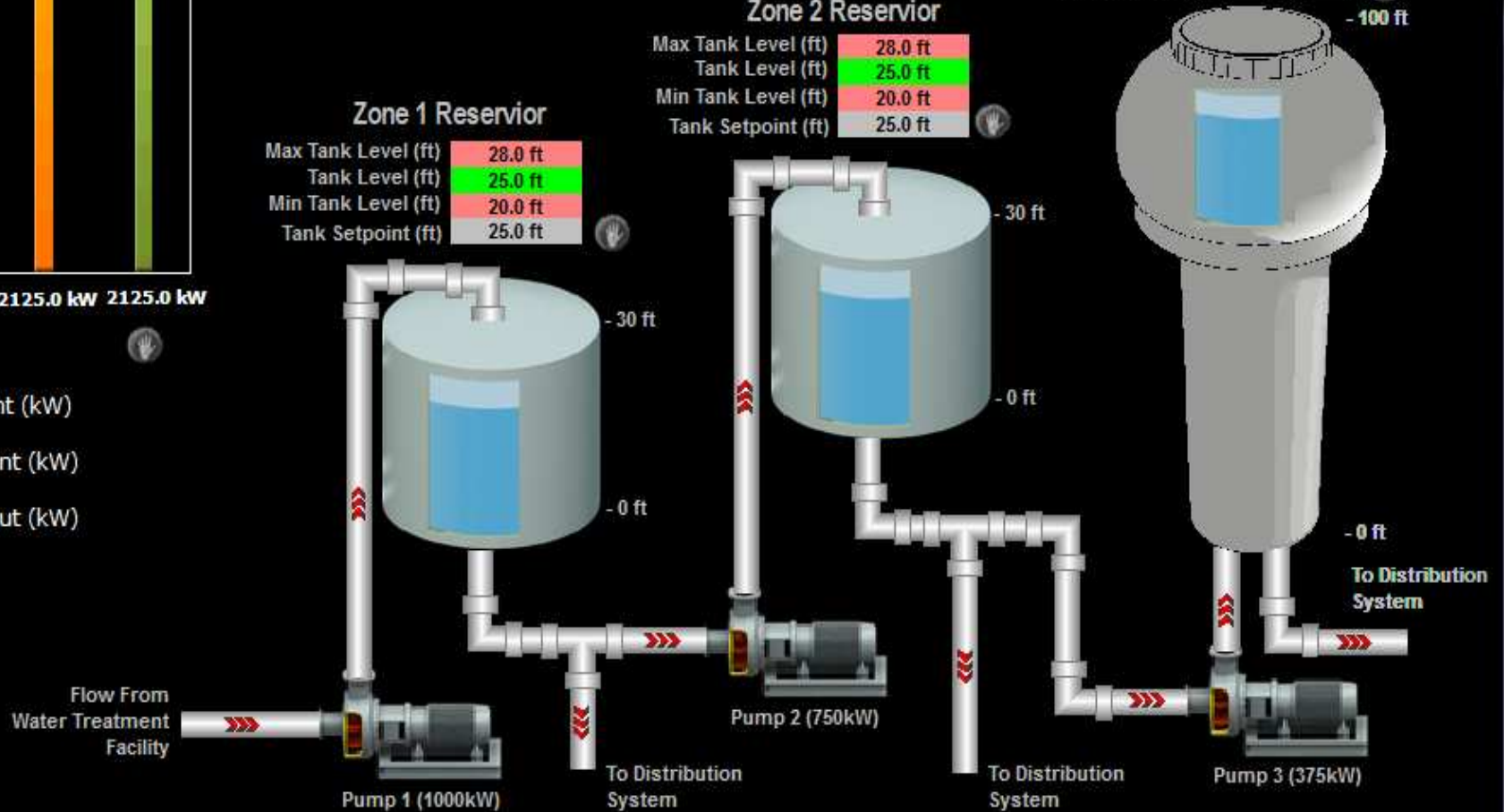
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Tank Setpoint (ft)	25.0 ft

- RSN Setpoint (kW)
- Host Setpoint (kW)
- Actual Output (kW)



#### Legend:

- Point is under RSN control
- Point is under site control

Disable RSN



Pump 1 Status: Full Speed  
 Pump 2 Status: Full Speed  
 Pump 3 Status: Full Speed

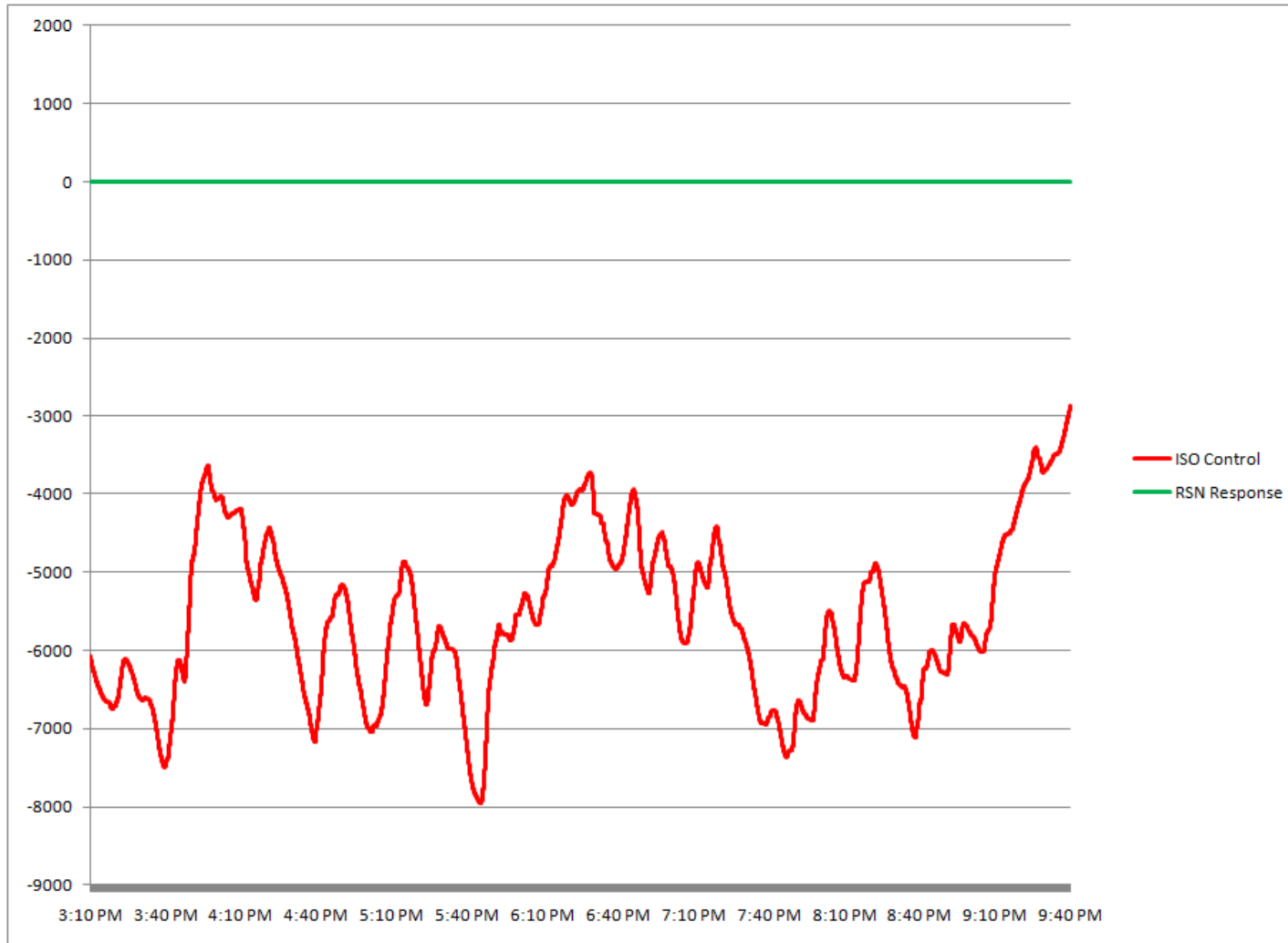


Instantaneous Response Graph

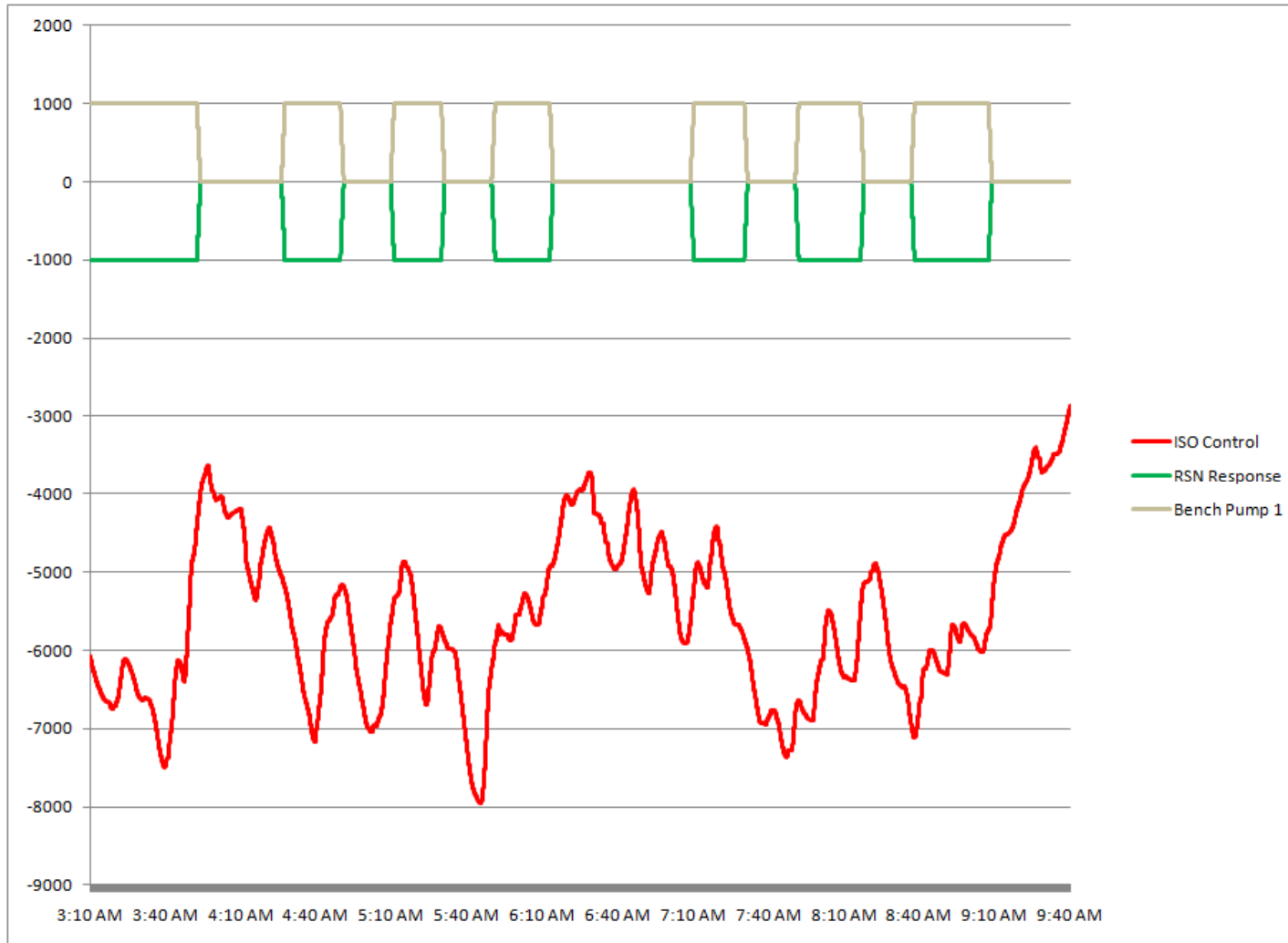
Boiler Demo

Aeration Demo

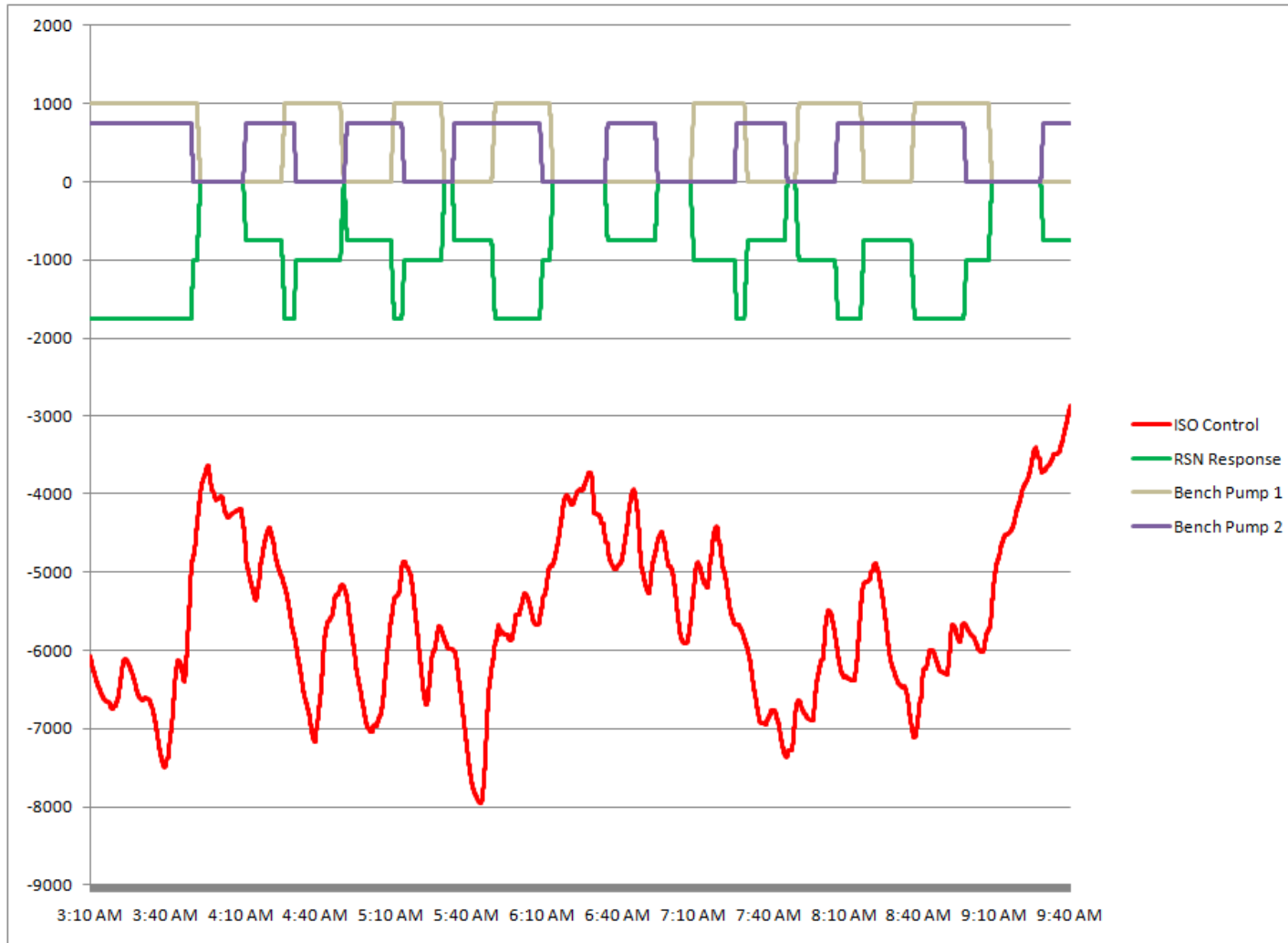
# Regulation – ISO Signal



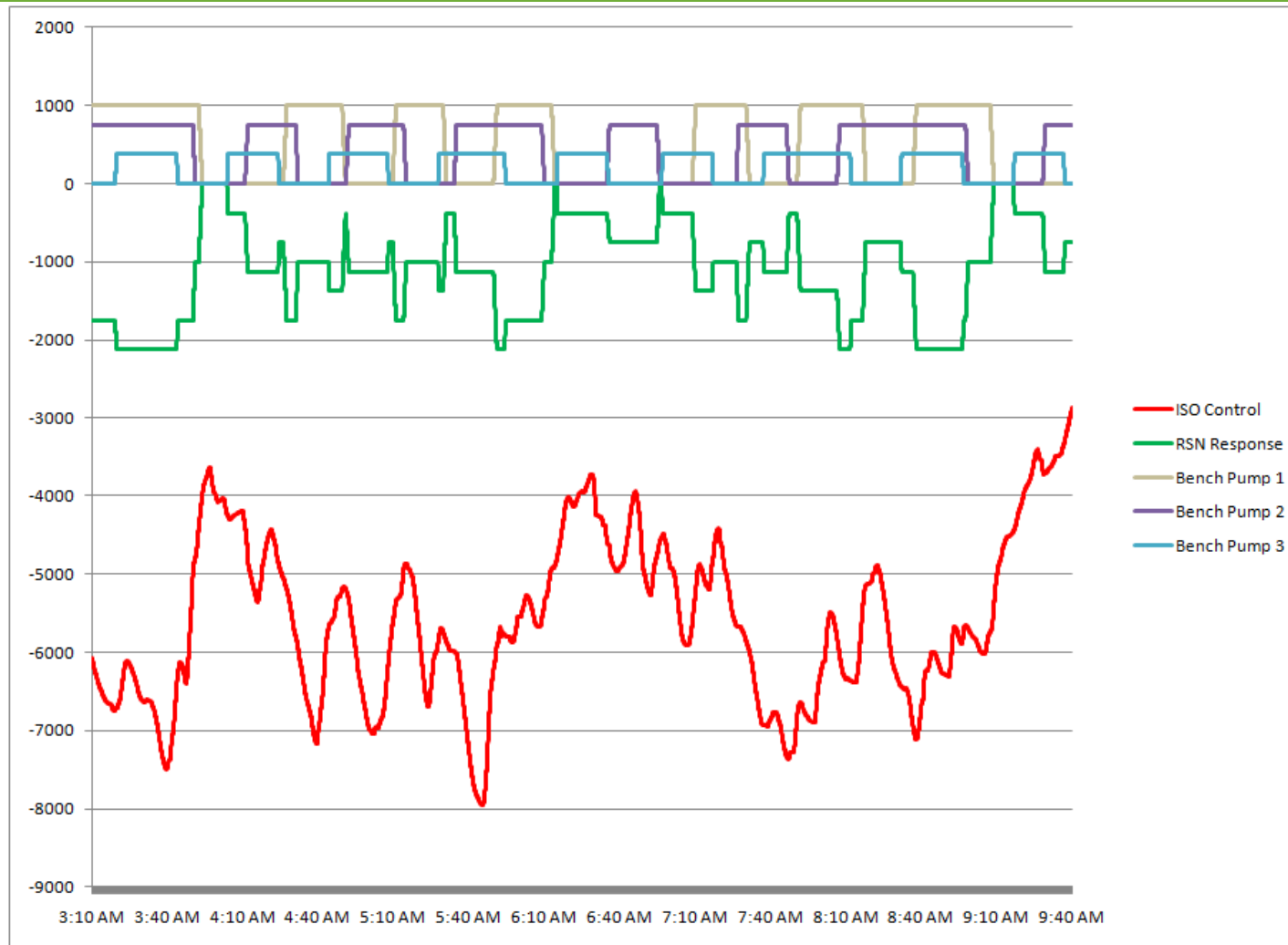
# Regulation – Resource Response



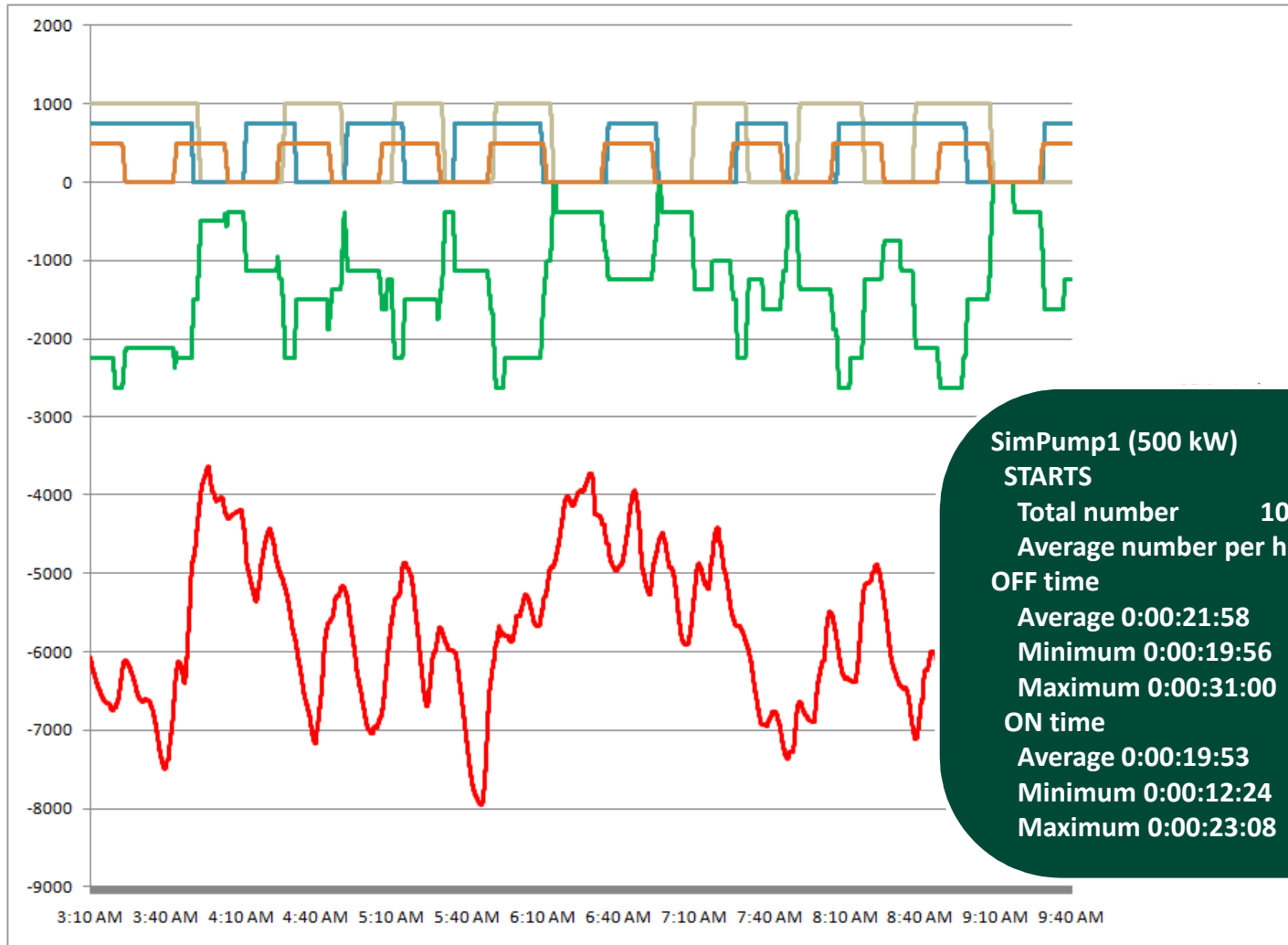
# Regulation – Resource Response



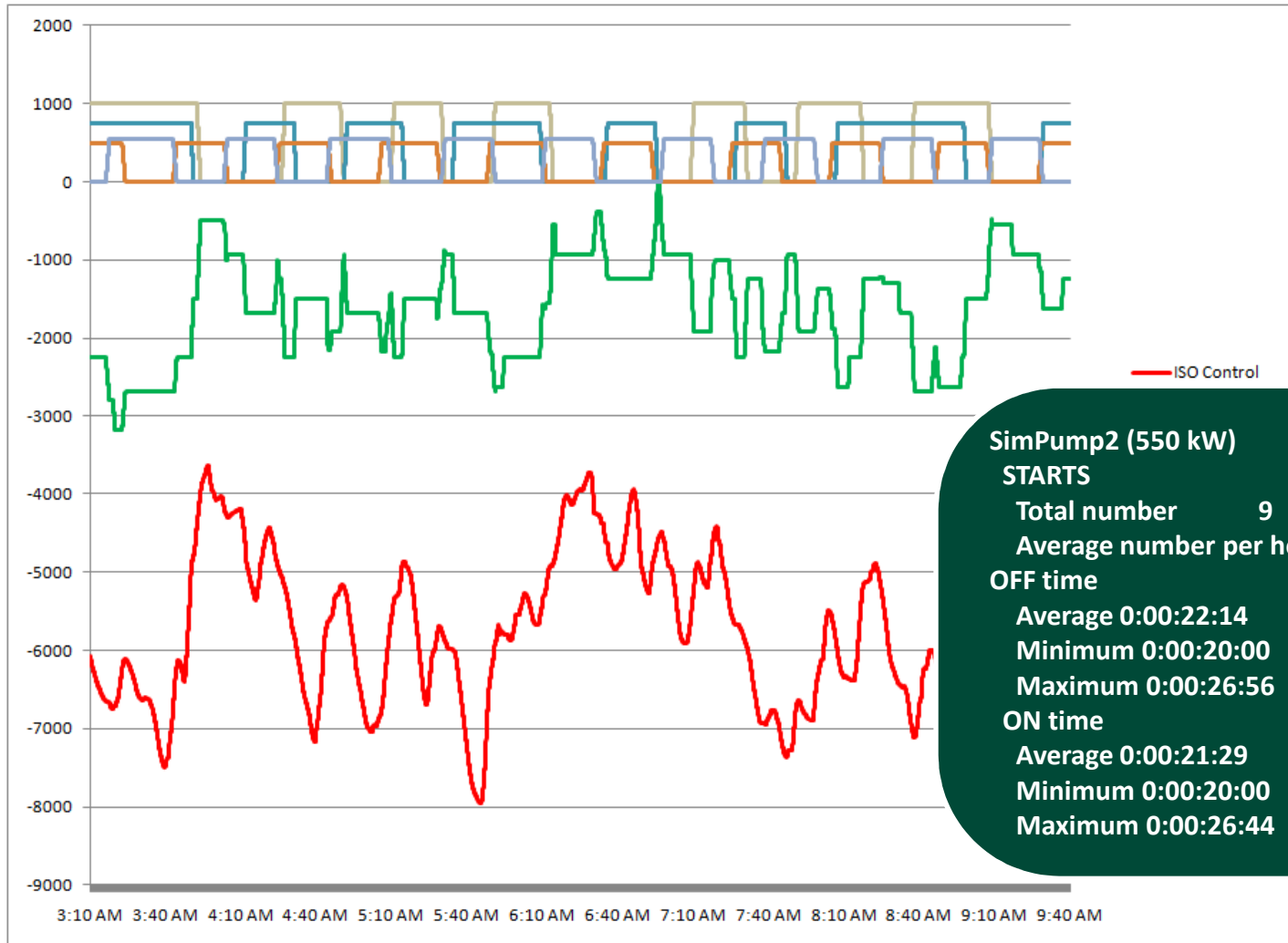
# Regulation – Resource Response



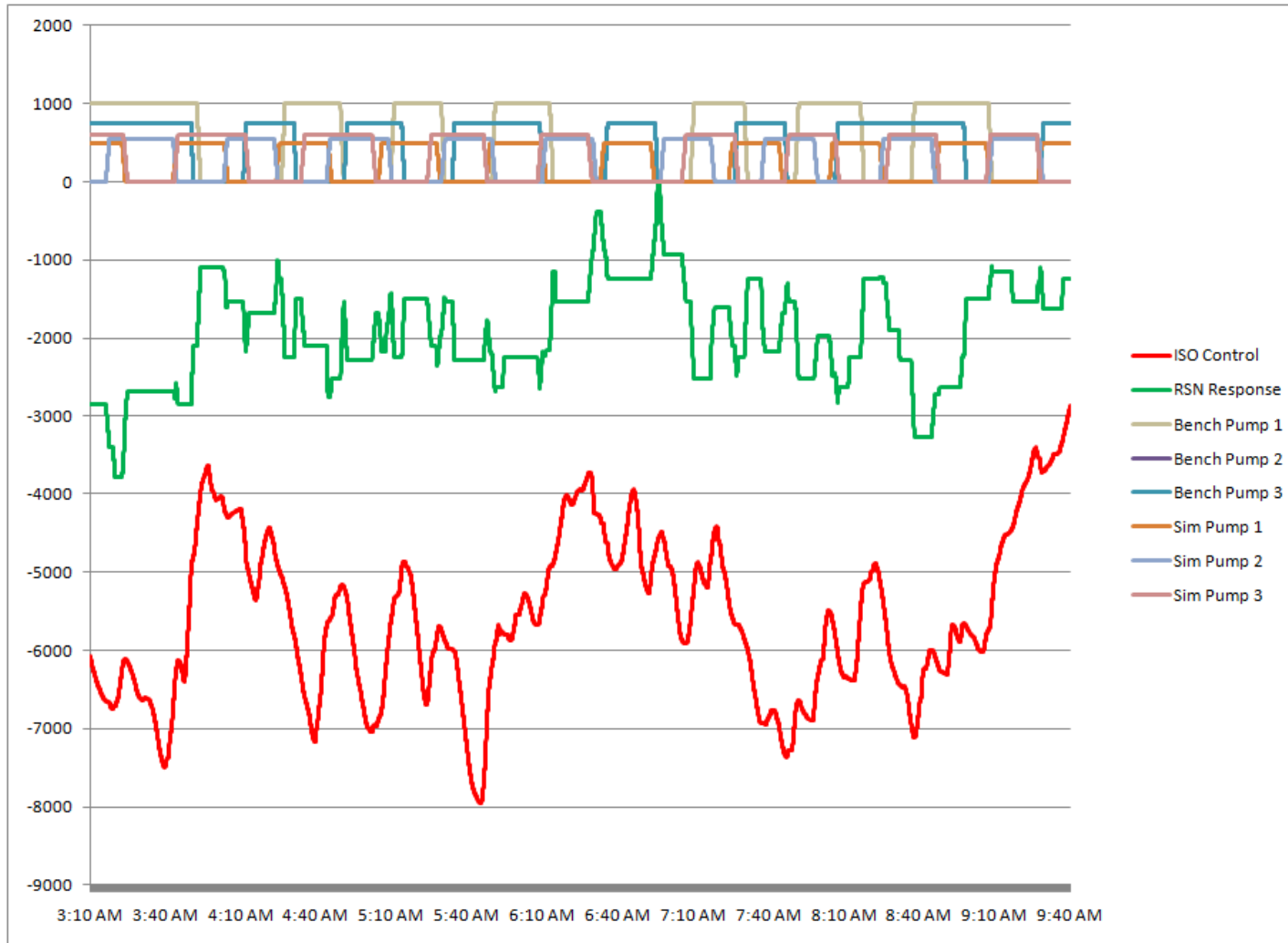
# Regulation – Resource Response



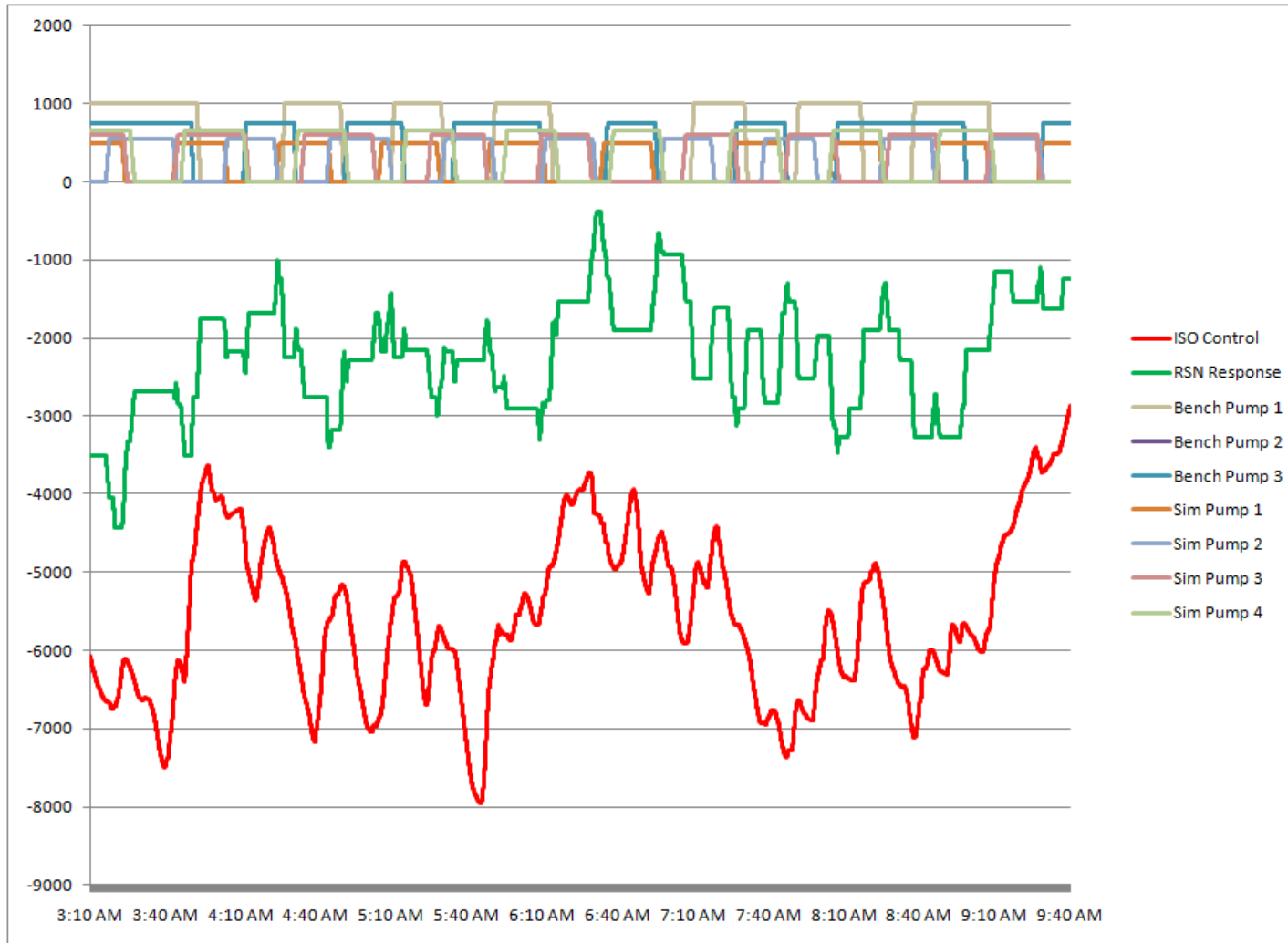
# Regulation – Resource Response



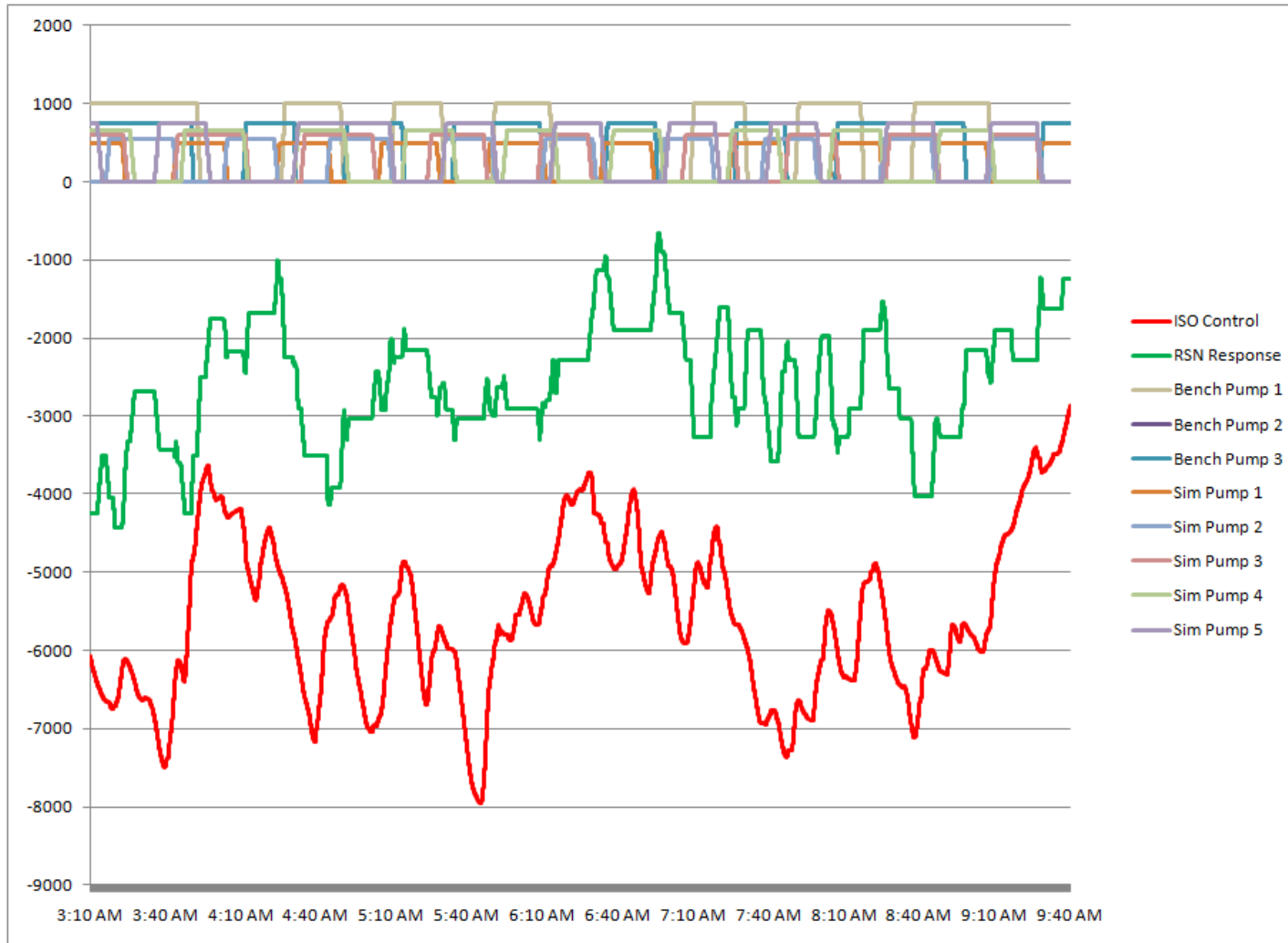
# Regulation – Resource Response



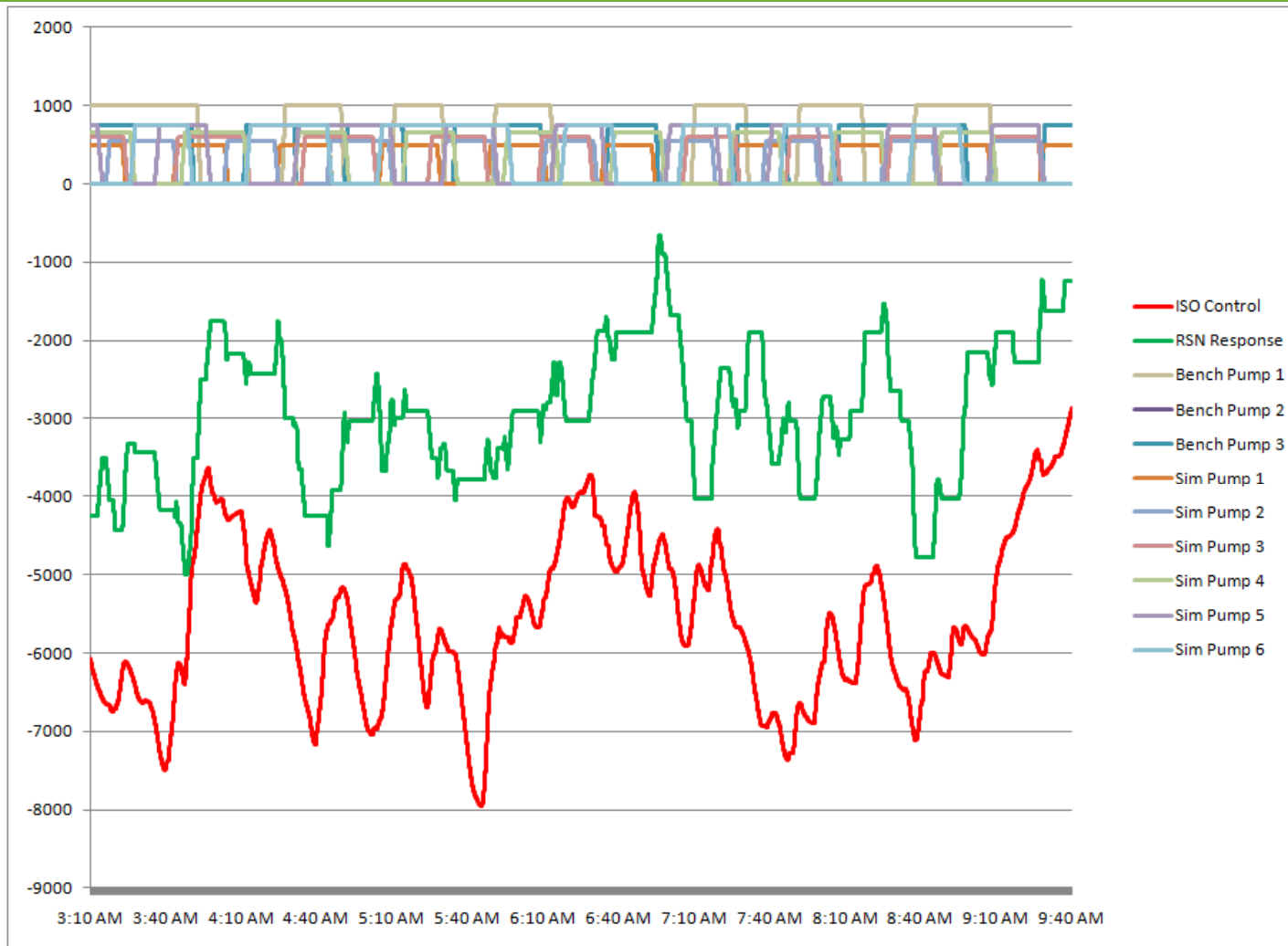
# Regulation – Resource Response



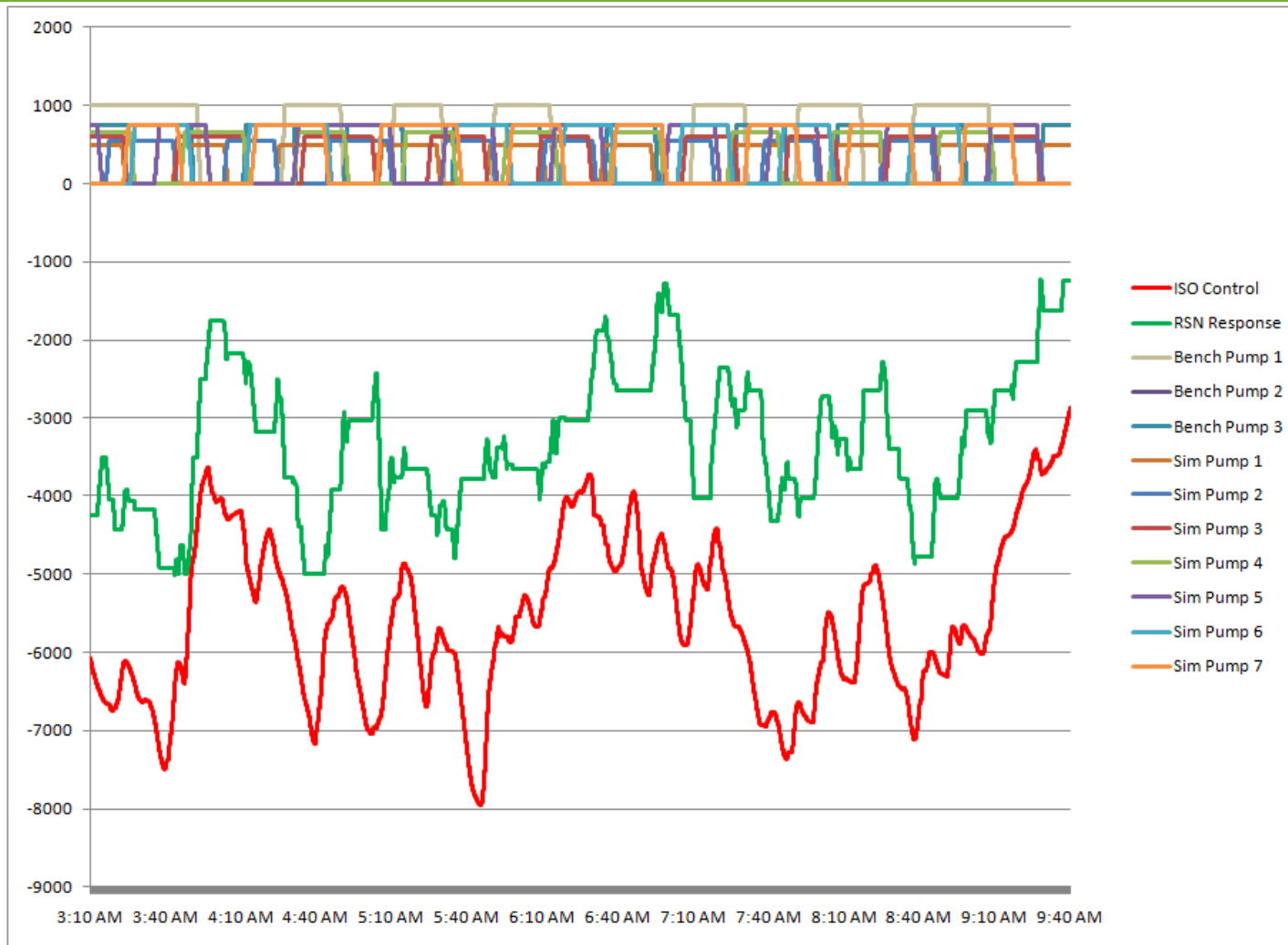
# Regulation – Resource Response



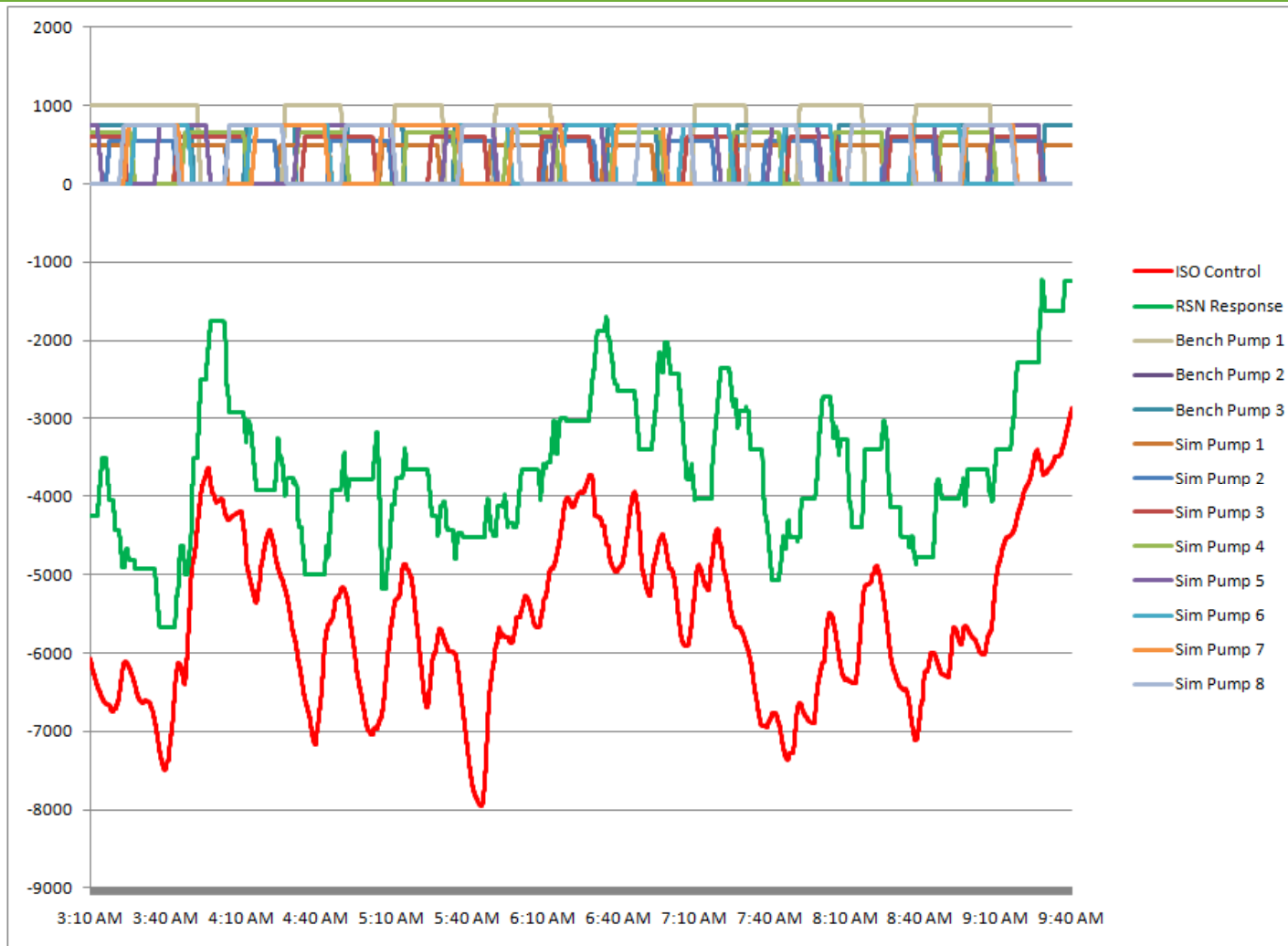
# Regulation – Resource Response



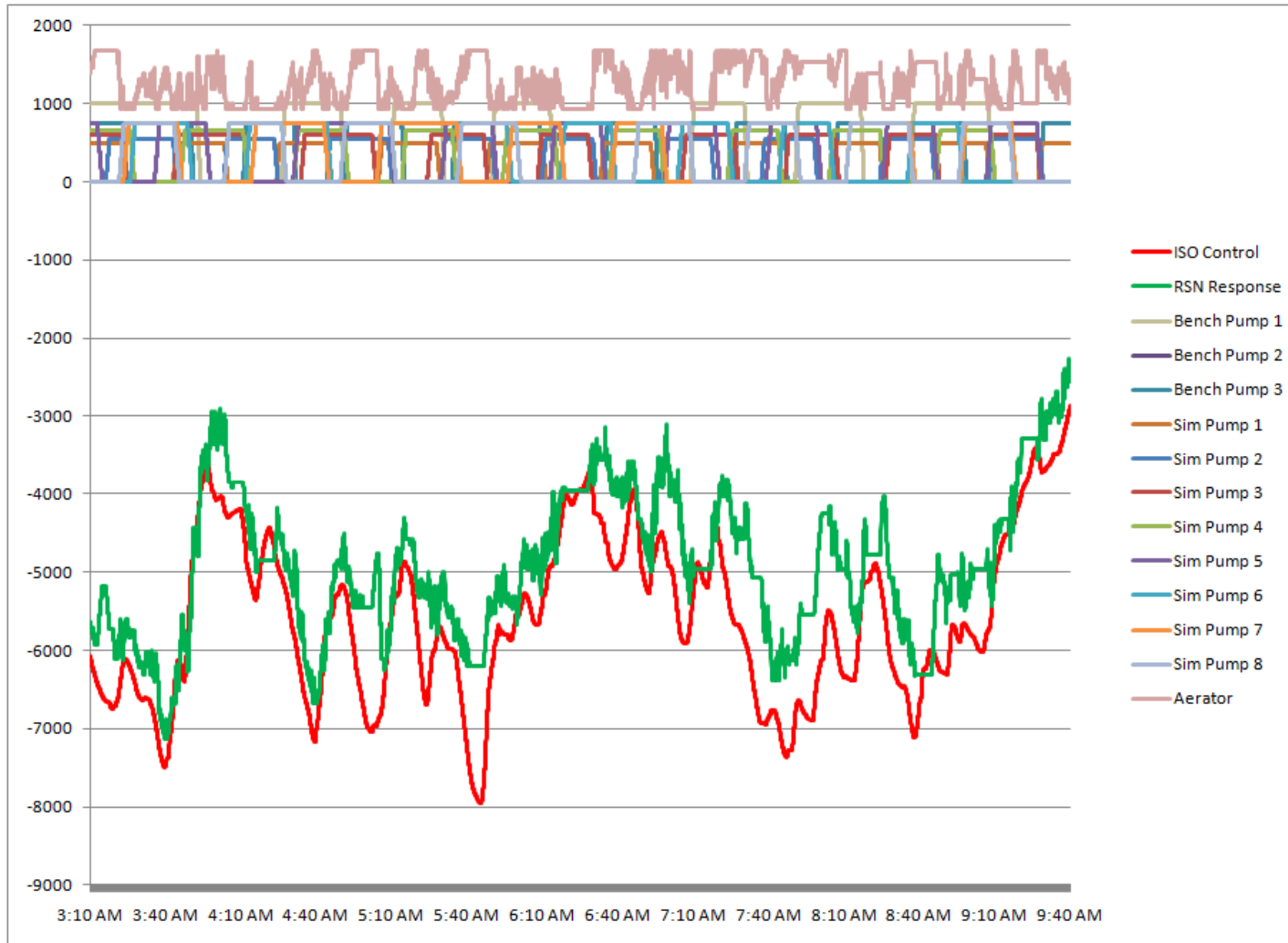
# Regulation – Resource Response



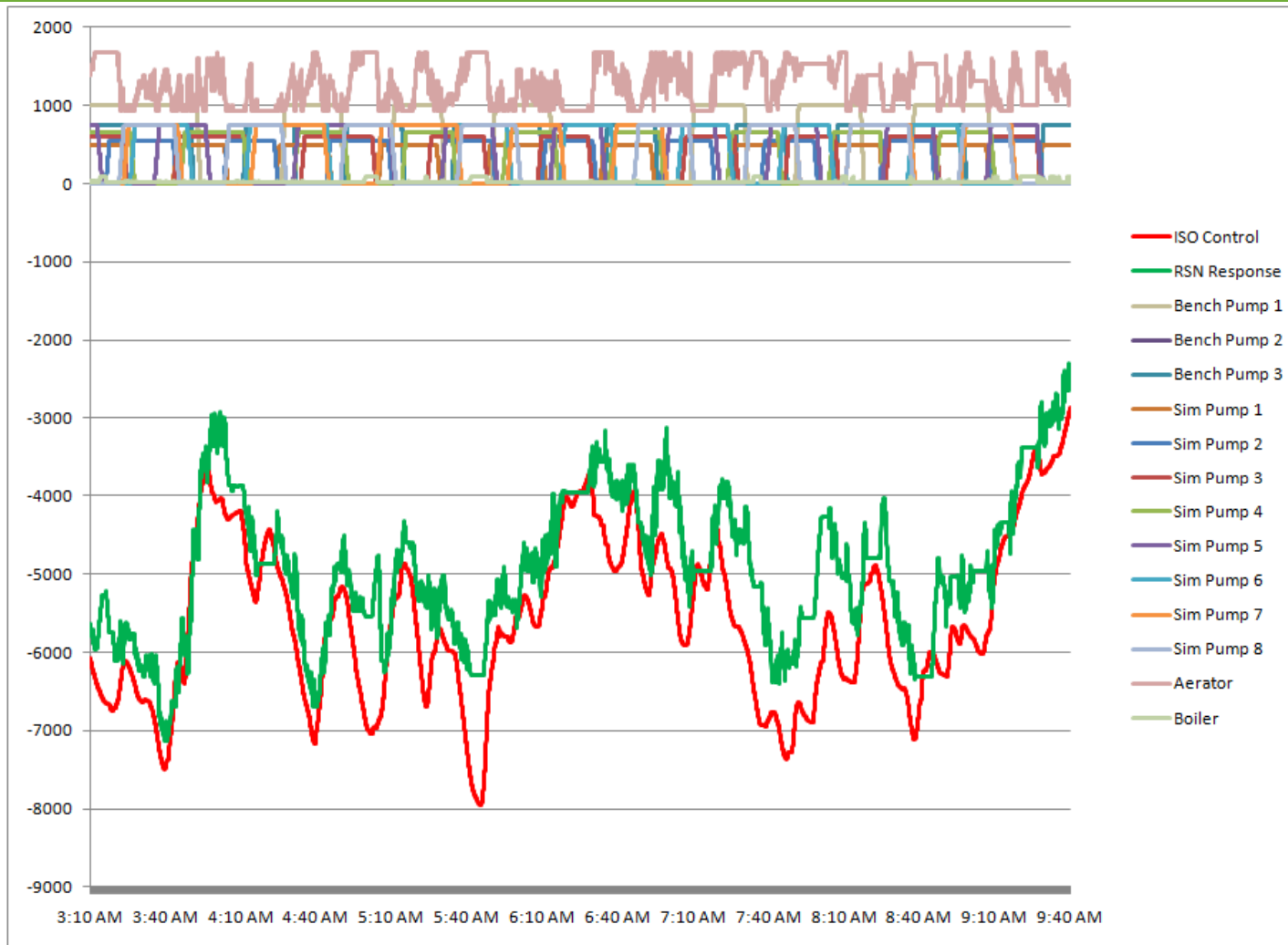
# Regulation – Resource Response



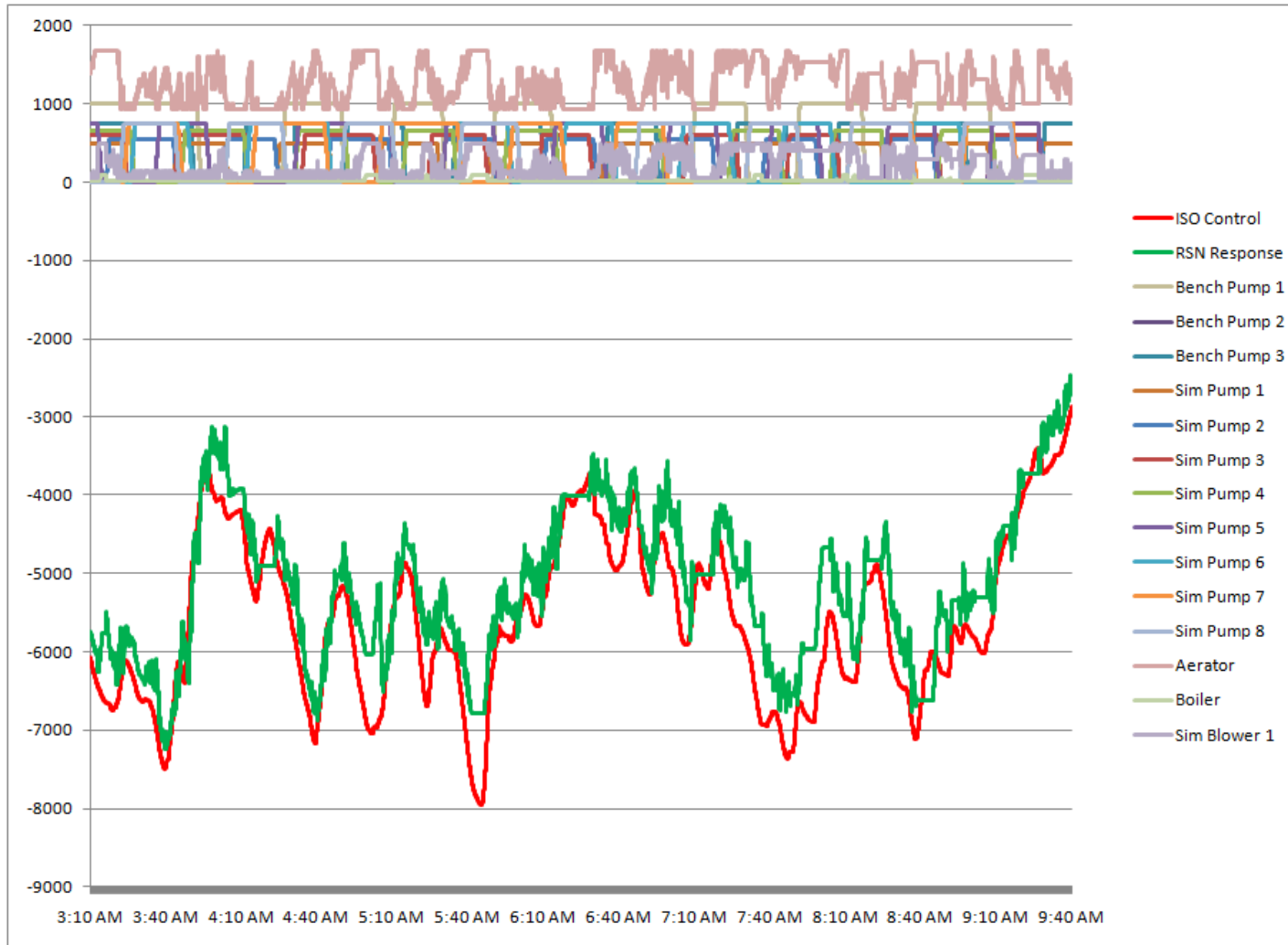
# Regulation – Resource Response



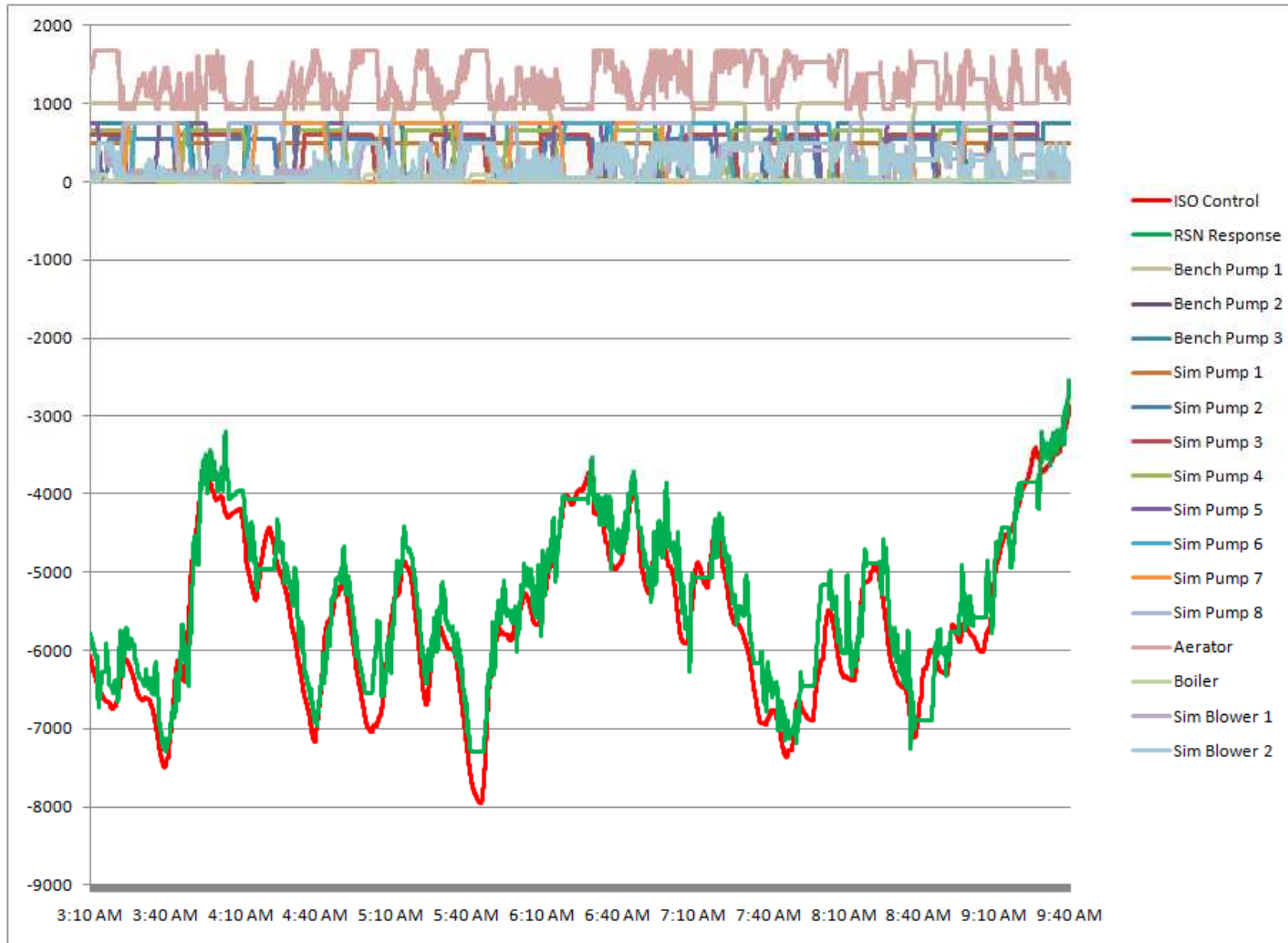
# Regulation – Resource Response



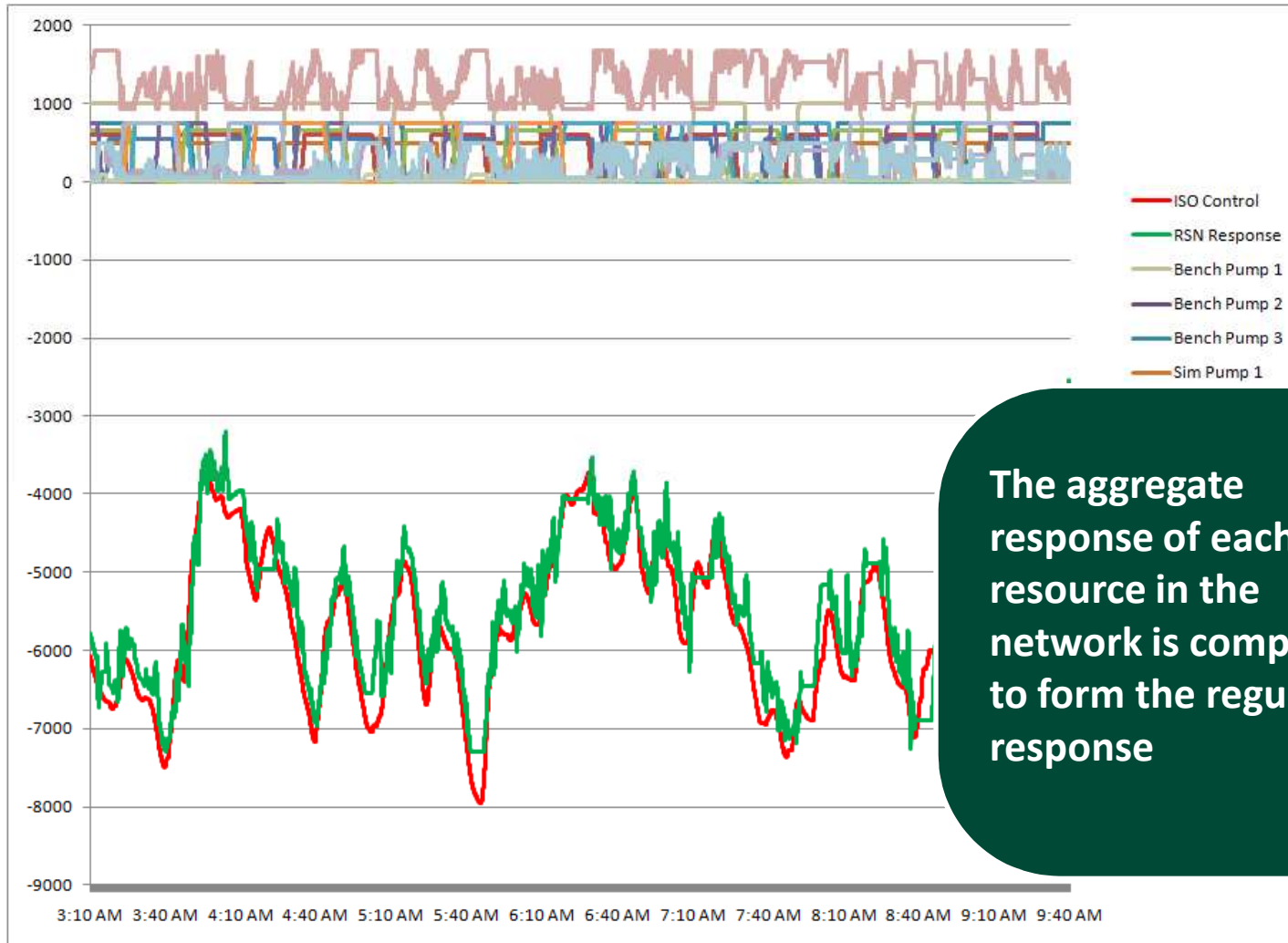
# Regulation – Resource Response



# Regulation – Resource Response



# Regulation – Resource Response

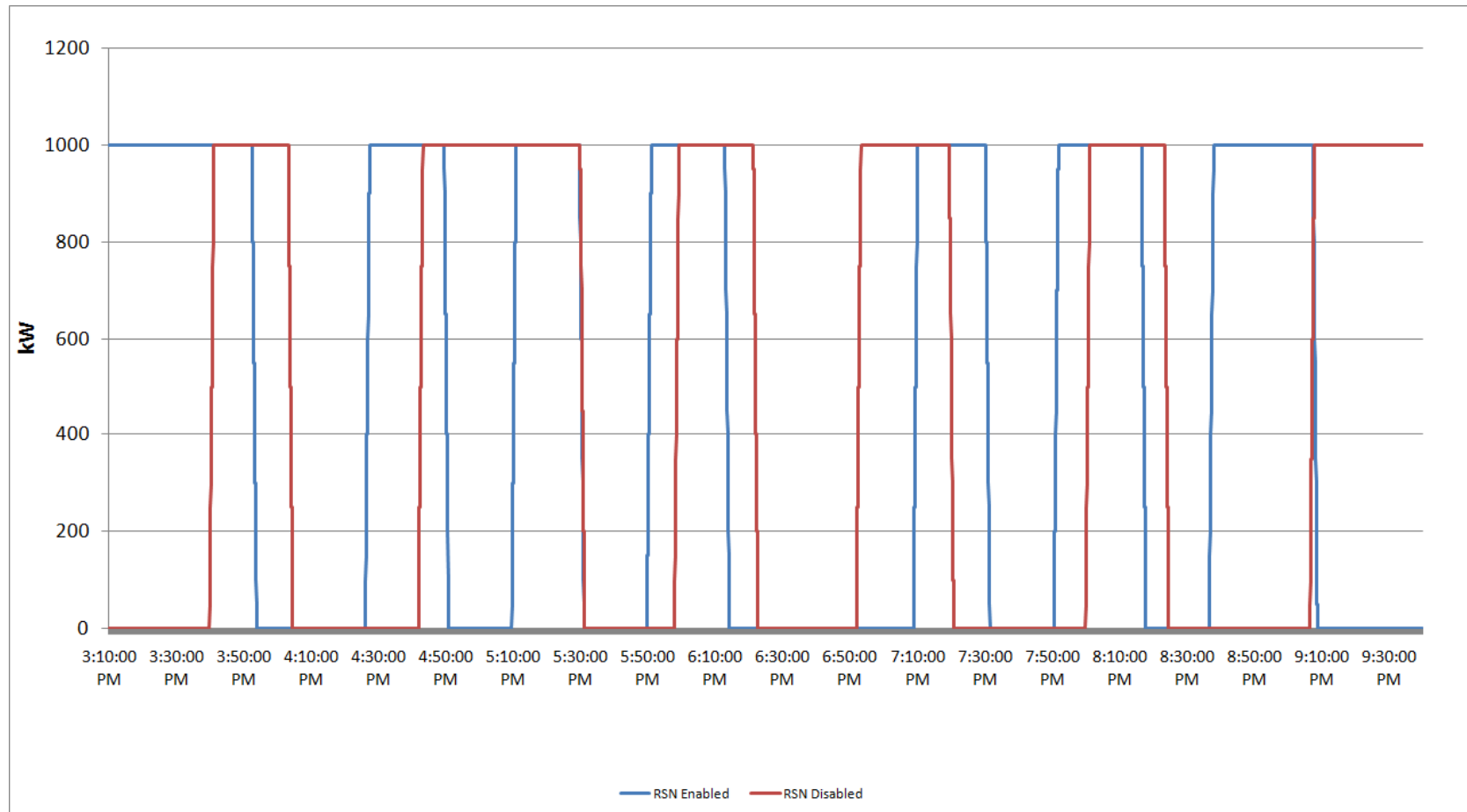


The aggregate response of each resource in the network is compiled to form the regulation response

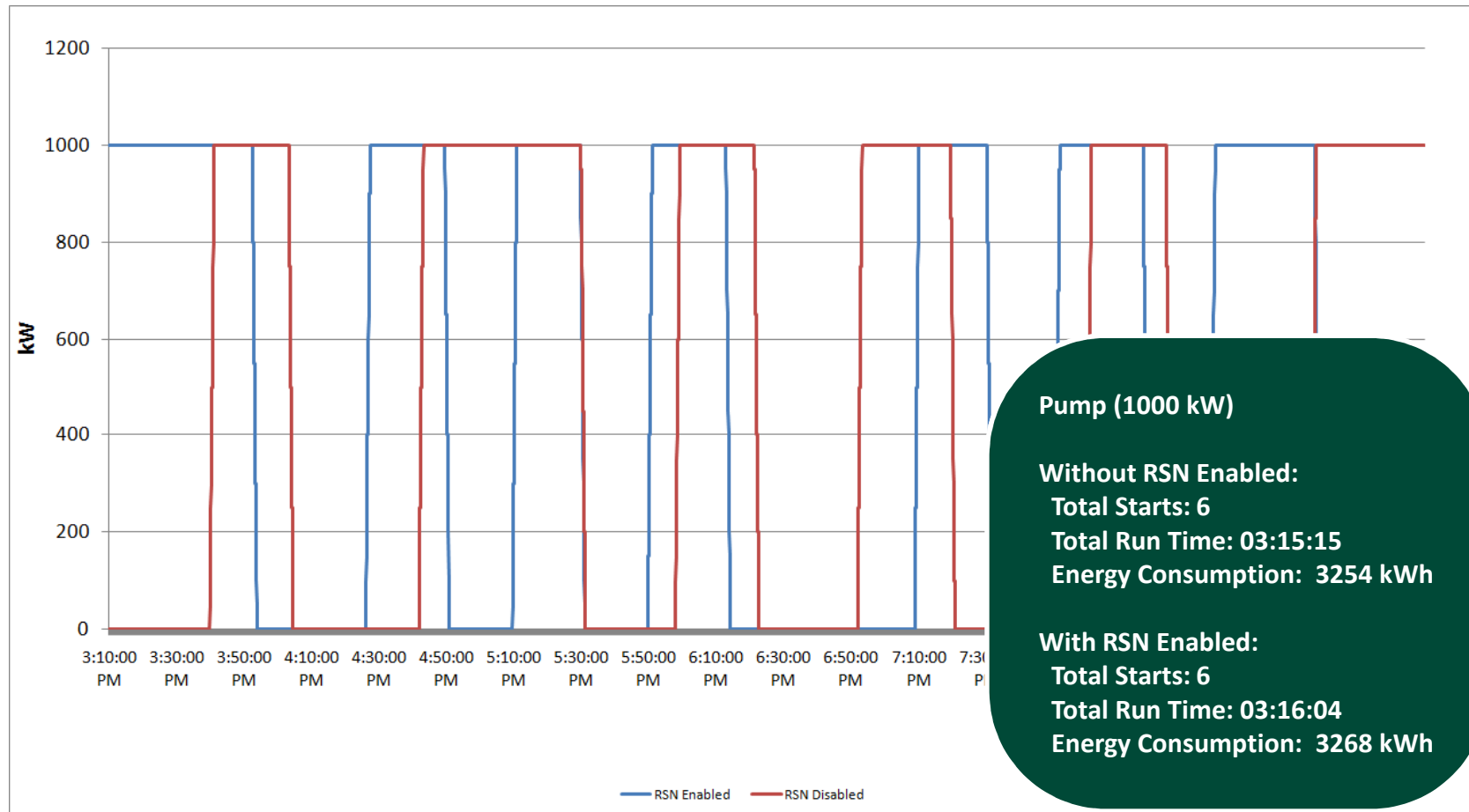
# Resource Operating Neutrality



# Resource Operating Neutrality



# Resource Operating Neutrality

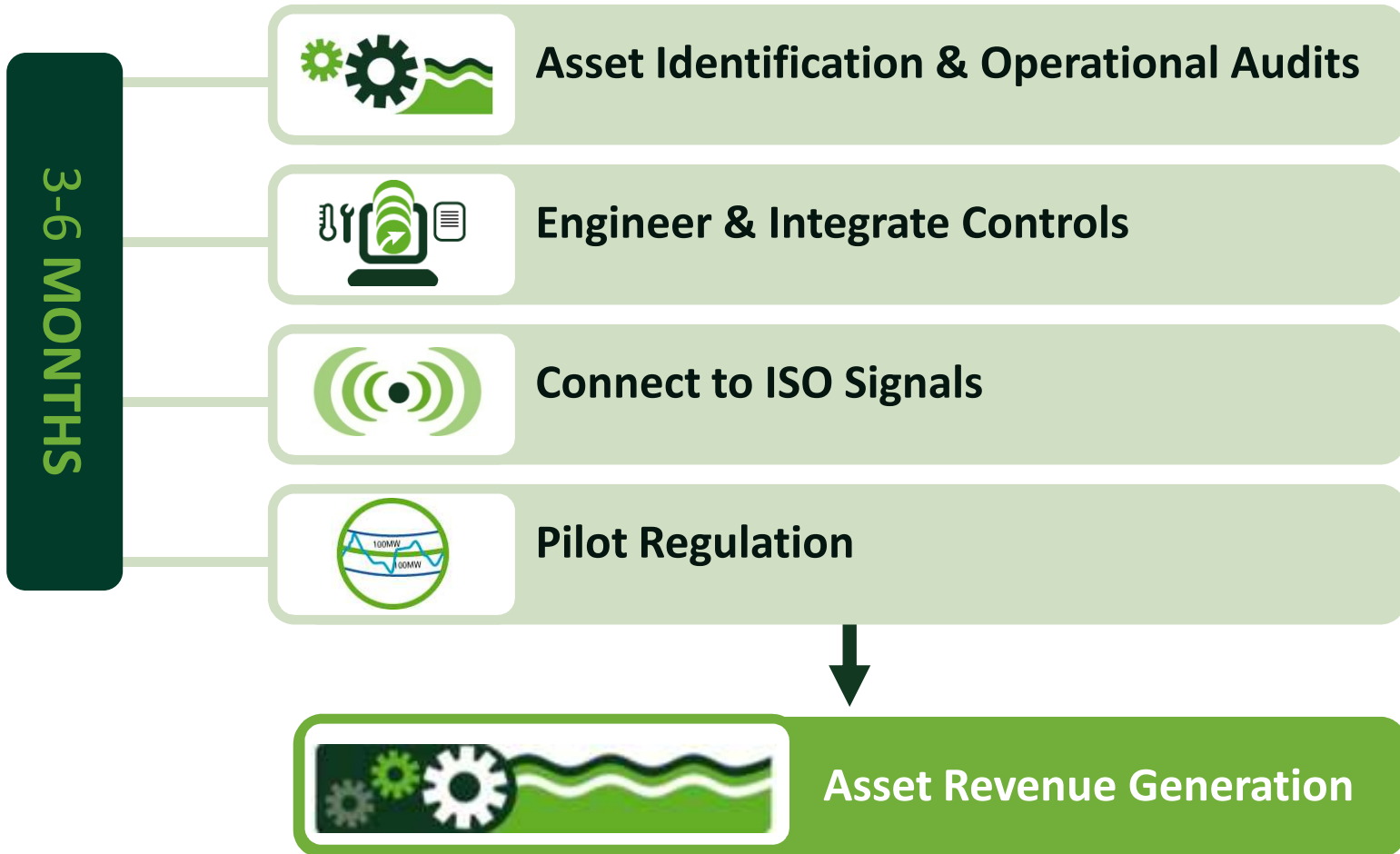


# Revenue Opportunity







Participation in the long term System Regulation market will enable individual resources to generate revenue at an average rate of \$50,000 annually per megawatt of regulation range. The total amount is dependent on the facility's electrical power availability and the resource's operating boundaries.

# Pilot Opportunity - Next Steps



# Ontario Water Energy Nexus Smart Grid Pilot

-  **Ontario Clean Water Agency**  
*Agence Ontarienne Des Eaux*
  - Demonstrated leadership in the water energy nexus
  - Revenue share supports continued innovation
- Municipalities
  - Reduce energy costs associated with water systems (up to \$10M per year)
  - New revenue stream based on monetizing flexibility and storage inherent in existing water assets
-  **ieso**  
*Power to Ontario.  
On Demand.*
  - New, lower cost source of system regulation
  - Free up to 100MW of clean, green power
  - Green, scalable support for integration of intermittent renewables
-  **Ontario**
  - Leading, high value jobs in the green economy
-  **sempa power**  
*A Water Energy Nexus Company*
  - Global leadership in smart grid applications at the water energy nexus

# Thank You

[www.sempapower.com](http://www.sempapower.com)

