



Industrial Water Systems **Virtual INPLT Training & Assessment**

Session 7

Tuesday – July 2nd, 2024

10 am – 12:30 pm

Water Virtual INPLT Agenda

- **Week 1 (May 21st) – Introduction to Industrial Water Assessment and Plant Water Profiler**
- **Week 2 (May 28th) – Understanding System Level Water use**
- **Week 3 (June 4th) – True Cost of Water**
- **Week 4 (June 11th) – Plant Water Profiler Working Session**
- **Week 5 (June 13th) – Identifying Water Savings Opportunity**
- **Week 6 (June 25th) – Virtual Treasure Hunt**
- **Week 7 (July 2nd) – Estimating Water Savings Opportunities**
- **Week 8 (July 9th) – Industrial Water System VINPLT Wrap-up Presentations**

Agenda – Session Seven

Today's Content:

- Resources for Treasure Hunt
- Resources to Estimate Savings
- National Alliance for Water Innovation (NAWI)



Treasure Hunt Event



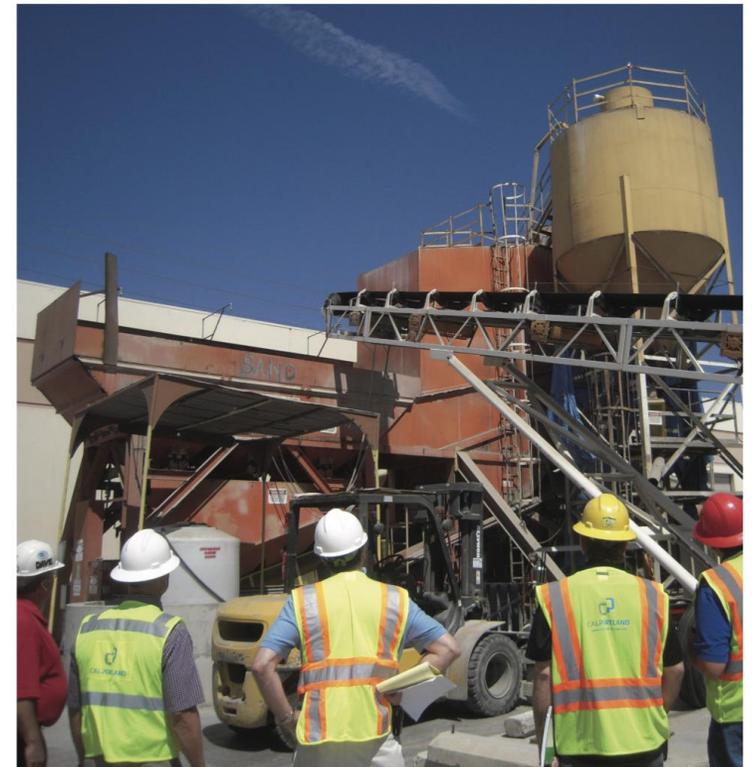
Energy Star – Treasure Hunt Guidance Document

FOUR PHASES FOCUSED ON RESULTS: A comprehensive Energy Treasure Hunt has four distinct phases:

- **Preparation:** Schedule discussions with your organization or facility's leadership to obtain their support. Gather data on current energy usage and costs, equipment specifications, and operating parameters.
- **Pre-Training:** Meet with facility team leaders to confirm roles and responsibilities and Energy Treasure Hunt agenda. Pre-training should begin at least one week before the onsite event.
- **Three-day Onsite Event:** Teams identify and quantify energy-saving opportunities at an onsite three-day event. Summarize and present the results for management review.
- **Follow-up:** Develop a schedule for pursuing the energy reduction opportunities identified during the Energy Treasure Hunt.



U.S. Environmental Protection Agency
**Energy Treasure Hunt Guide:
Simple Steps to Finding Energy Savings**
JANUARY 2014



Document Number 430-R-14-001

DOE Treasure Hunt Toolkit

READY TO START YOUR OWN TREASURE HUNT?

The Department of Energy has developed the necessary tools and materials, collectively known as the Energy Treasure Hunt Toolkit, to help with each individual phase of the treasure hunt process. This toolkit provides the treasure hunt facilitator with the tools needed to effectively plan and prepare for the event, successfully run it, and track the results. Explore the resources listed below to prepare for your Treasure Hunt and execute the three phases.



Start by reading the Treasure Hunt Overview and watching the webinar to the right.

This overview of the Energy Treasure Hunt Toolkit provides information on the different stages of the treasure hunt, as well as the materials in the toolkit.

[READ OVERVIEW](#)



Download the Treasure Hunt Toolkit and begin your search

Explore the Treasure Hunt module in MEASUR

<https://betterbuildingsolutioncenter.energy.gov/better-plants/energy-treasure-hunts>

DOE Tools for Treasure Hunt

WHAT DOES AN ENERGY TREASURE HUNT LOOK LIKE?

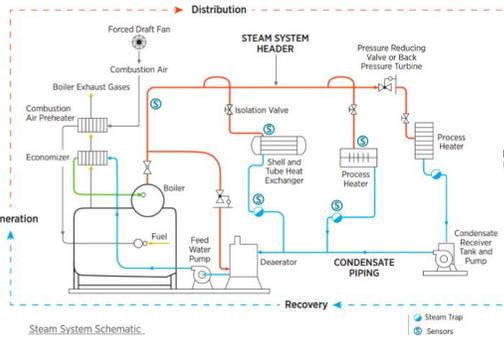


Phase 1 and 2	Phase 3	Phase 4
<p>Event Logistics</p> <ul style="list-style-type: none">• Save the Date (template)• Event Agenda (template) <p>Facility Information</p> <ul style="list-style-type: none">• Data collection sheet• Plant Water Profiler• Plant Energy Profiler <p>Diagnostic Equipment</p>	<p>Treasure Hunt Opening Presentation</p> <p>System Specific Handouts</p> <p>Documenting Opportunity</p> <ul style="list-style-type: none">• MEASUR Treasure Hunt Module• Excel Based tools <p>Water Savings Calculators</p>	<p>Close out presentation (template)</p> <p>Project Implementation Tracker</p>

Handouts

- System specific handout sheets are provided by DOE to help participants identify and quantify energy savings opportunities.
- Three sets of handouts for each system type is available;
 - System Checklist
 - Data Collection Sheet
 - System Cheat Sheet
- **The handouts are not meant to be all encompassing**
- Participants should only use the handouts as a tool to get started and not solely rely on it

Handouts



Best Practices

- 1.) Reduce Steam demand and pressure
- 2.) Optimize Fuel/Air Ratio
- 3.) Fix Steam Traps
- 4.) Insulate Pipes and Tanks
- 5.) Recover condensate/ flash steam and capture water & heat
- 6.) Preheat boiler feed water
- 7.) Install automated blowdown controls
- 8.) Optimize deaerator vent rate
- 9.) Adjust steam system based on production
- 10.) Identify and close off dead legs (unused to sections of steam header)



Steam System - Data Collection Sheet

Energy Treasure Hunt

Measure	Data to Collect	Data	How to Collect
Common System Data	How many boilers?		
	How many boilers are running?		Interview the operators
	Boiler capacity(s) (BTU or lbs./hour)		From panel
	Total generation capacity (lbs./hour)		From panel
	Average steam generation rate (lbs./hour)		From panel
	Average boiler blowdown rate		Interview the operators
	Current System Pressure		From pressure gauge in header line
	Highest Pressure on header		Interview the operators
	Highest Pressure Required at floor		Interview manager/ personnel on the floor
	Stack Temperature		
Steam Leaks	How many leaks/ defective traps		Approximation based on the ones found
	Diameter of the leak		Ultrasonic Leak Detector / visual determination
	Pressure on line		From nearby pressure gauge
	Hours of operation of the leak(or boiler)		



Steam System – Cheat Sheet

Energy Treasure Hunt

Rule of Thumb

- Average efficiency of a steam boiler is 80%.
- 10PSI drop in header pressure is 1% energy reduction
- Every 10.7 F rise in boiler feedwater temperature yields ~1% steam energy savings
- Unmaintained steam system - 15% to 30% of traps failed.
- Ideal, maintained steam system - 5% of traps failed.

Improve Boiler Combustion Efficiency

Excess, %	Combustion Efficiency					
	Flue gas Temperature minus combustion air Temperature, F					
Air	Oxygen	200	300	400	500	600
9.5	2.0	85.4	83.1	80.8	78.4	76.0
15.0	3.0	85.2	82.8	80.4	77.9	75.4
28.1	5.0	84.7	82.1	79.5	76.7	74.0
44.9	7.0	84.1	81.2	782.2	75.2	72.1
81.6	10.0	82.8	79.3	75.6	71.9	68.2

Calculating Steam Cost

Energy required to produce one pound of saturated steam, BTU					
Operating Pressure, psig	Feed water Temperature, F				
	50	100	150	200	250
150	1178	1128	1078	1028	977
450	1187	1137	1087	1037	986
600	1184	1134	1084	1034	984

\$/1000 lbs of steam = $\frac{\$/MMBTU \times 1000 \text{ lbs} \times \text{Btu/lb}}{\text{Combustion Efficiency} \times 10^6}$

Insulate Steam and Condensate Lines

Heat Loss per 100 feet of Uninsulated steam, line, MMBTU/yr				
Line Diameter, Inches	Steam Pressure, psig			
	15	150	300	600
1	140	285	375	495
2	235	480	630	840
4	415	850	1120	1500
8	740	1540	2030	2725
12	1055	2200	2910	3920

Heating Value of Fuels

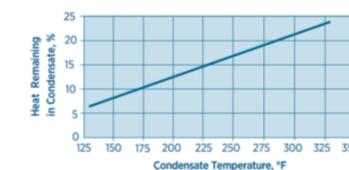
	Units	LHV	HHV
Natural Gas	Btu/CF	1,050	1,050
#2 Fuel Oil	BTU/Gal	138,300	138,300
#6 Fuel Oil	BTU/Gal	150,500	150,500
Propane	BTU/CF	92,000	92,000
Coal - Bituminous	BTU/lbs	14,100	14,100

* Higher Heating Value (HHV): Total energy from combustion process
 * Lower Heating Value (LHV): Assumes heat of condensation cannot be recovered

Steam Trap Failure

- | | |
|----------------------|--|
| Obvious Signs | Less Obvious signs |
| • Steam flashing | • Higher than necessary pressure |
| • Water Hammer | • Excessive condensate & Chemical losses |
| • Pump cavitation | • Condensate water too hot |
| | • Boilers running continuously |

Return Condensate to Boiler



*A steam system operating at 100 pounds per-square-inch-gauge (psig), with makeup water at 55°F. For other conditions use formula to the right.

Losses with steam Trap Failure

Trap Orifice Diameter (inches)	Steam Loss, lb/hr		
	15 psig	100 psig	300 psig
1/32	0.85	3.3	4.8
1/16	3.4	13.2	18.9
1/8	13.7	52.8	75.8
3/16	30.7	119	170
1/4	54.7	211	303
3/8	123	475	682

Calculating %Heat Remaining in condensate using formula

$$\text{Heat remaining in condensate (\%)} = \frac{h_{\text{condensate}} - h_{\text{makeup water}}}{h_{\text{steam}} - h_{\text{makeup water}}} \times 100$$

Example
 $h_{\text{condensate at 180 F}} = 148 \text{ Btu/lb}$; $h_{\text{makeup water}} = 23 \text{ Btu/lb}$
 $h_{\text{steam at 100 psig}} = 1,189 \text{ Btu/lb}$

$$\text{Heat remaining in condensate (\%)} = \frac{148 - 23}{1189 - 23} = 11\% \text{ (as in graph)}$$

Documenting TH Opportunities

- An opportunity detail sheet is a tool that helps organize and document information about identified opportunities
- Each opportunity should have an individual “opportunity sheet”

Information captured

- Description
- Implementation costs
- Water/Energy Saved
- Cost Savings
- Payback Metrics

Info	Title:			Plant:	0	
	Process / Equipment:			Business Unit:		
				Originator:		
				Date:	Set to Today	
Description	Current Situation (Before Energy Treasure Hunt)		Projected Situation (After Energy Treasure Hunt)			
	Annual Operating Hours	Number of Units	Annual Operating Hours	Number of Units		
	Hours /Day Days/Month Months	Eg. Number of leaks, Number of equipment to be turned off etc.	Hours /Day Days/Month Months	Eg. Number of leaks, Number of equipment to be turned off etc.		
* This section is part of the description and the values are not used in calculations.						
Energy	Energy units	Energy Use Before TH (Energy units/yr)	Energy Use After TH (Energy Units/yr)	Energy Savings (Energy Units/yr)		
	Electricity - kWh				0.0	
	Gas - MMBTU				0.0	
Cost / Savings	Implementation Cost		\$/unit	Projected Annual Savings		
	Engineering Services:		\$ 0.10	Electricity	\$ -	
	Material:	\$ -	\$ 6.50	Gas	\$ -	
	Labor: Contract		\$ -	Compressed Air	\$ -	
	Labor: In House		\$ -	Other Fuel	\$ -	
	Other:	\$ -	\$ -	Steam	\$ -	
	Other:	\$ -				
	Other:	\$ -				
	Other:	\$ -		\$ 20.00	Water	\$ -
	Other:	\$ -		\$ -	WWT	\$ -
Total:	\$ -			Other Savings		
				Total:	\$ -	
				Simple Payback Period (yrs):		

Integrated Energy Software - MEASUR



- All system level software tools will be available to through **one platform**
- Includes system modelers and individual calculators for **field validation**
- Includes **built-in guides** and **tutorials**

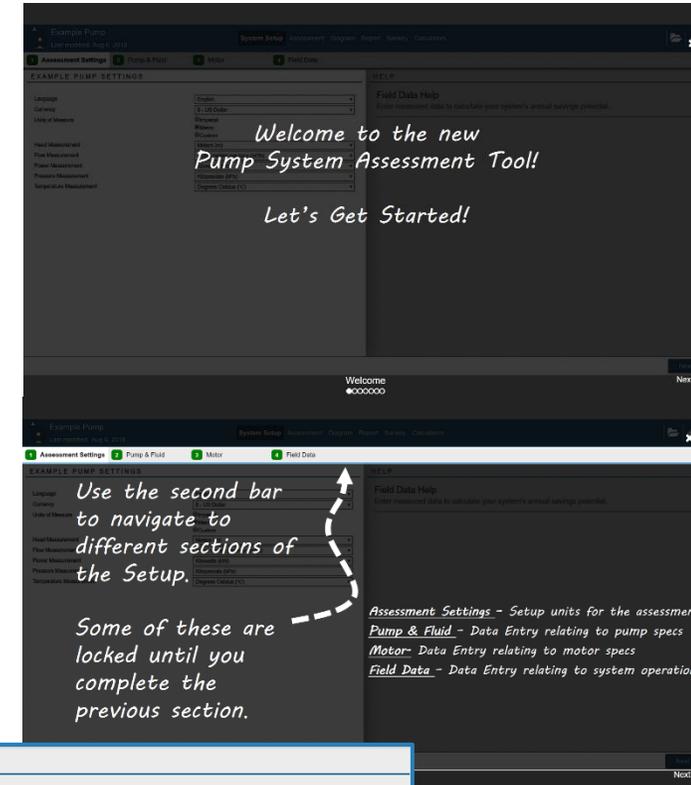
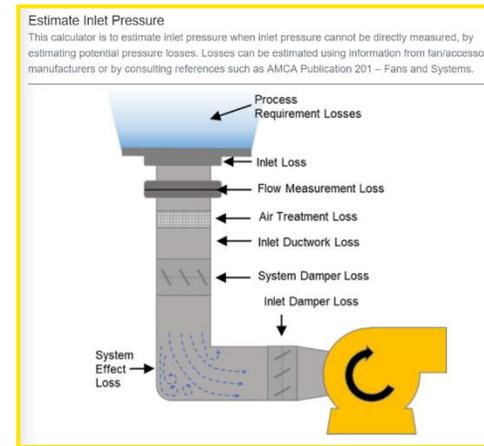
Getting Started

- ➔ Start an assessment
- ➔ View Assessment Dashboard
- ➔ Use Properties & Equipment Calculators
- ➔ Help and User Experience
 - Change Settings
 - View Tutorials
 - Manage Custom Materials
 - Provide Feedback
 - Translate

The screenshot displays the MEASUR web application interface. At the top left is the U.S. Department of Energy logo and the text "Energy Efficiency & Renewable Energy". Below this is a blue "Add Assessment" button. A sidebar on the left contains a "Home" section with "All Assessments" and "Examples" (including Treasure Hunt, Basic Pump, Fan, Reheat Furnace, and 3 Header). Below the sidebar is an "All Calculators" section with a list of categories: Motors, Pumps, Fans, Process Heating, Steam, Compressed Air, Lighting, and General. A yellow box highlights this list, with a yellow arrow pointing to it from the text "Use Properties & Equipment Calculators". Below the sidebar is a "Settings" section with links for Custom Materials, Tutorials, About, Feedback, Acknowledgments, Translate, and version information (v0.6.3-beta). A yellow box highlights this section, with a yellow arrow pointing to it from the text "Help and User Experience". The main content area features the MEASUR logo and a welcome message: "Welcome to the most efficient way to manage and optimize your facilities' systems and equipment." Below this is a "Create Assessment" section with a list of options: Create Pump Assessment (formerly PSAT), Create Process Heating Assessment (formerly PHAST), Create Fan Assessment (formerly FSAT), Create Steam Assessment (formerly SSMT), and Create Treasure Hunt. A blue box highlights this section, with a blue arrow pointing to it from the text "Start an assessment". To the right of the "Create Assessment" section is a "Properties & Equipment Calculators" section with a list of categories: Motors, Pumps, Fans, Process Heating, Steam, Compressed Air, Lighting, and General. A yellow box highlights this section, with a yellow arrow pointing to it from the text "Use Properties & Equipment Calculators". At the bottom of the main content area is a "View All Your Assessments" link. The footer contains the U.S. Department of Energy logo and the text "Energy Efficiency & Renewable Energy".

Key Features - Help Text & Tutorials

- Tutorials
 - Help to get started using tool
- Help text for each data entry field
 - Diagrams to help understand where to obtain data
 - Can switch between help or results being shown by default



RESULTS
HELP

Charge Material Help

Enter measured data to calculate your system's annual savings potential.

Savings Suggestions

Explore possibilities of lowering the final product temperature
Preheating the charge or load material entering the furnace
Pre-drying to reduce moisture content of the load entering the furnace
Maintain charge feed rate as close to the rated capacity as possible
Consider possibility of reducing endothermic reactions by controlling process conditions

Note: These energy saving measures are for guidance only. Not all measures are applicable under all operating conditions. There may be additional measures when considering specific situations and the user is encouraged to review and apply the appropriate measures

HELP

Motor Help

Enter measured data to calculate your system's annual savings potential.

Motor RPM

Motor RPM is the nameplate speed of the motor.
This value is used with the line frequency to determine the number of motor poles. This, in turn, is used (along with motor class and size) to estimate motor efficiency and output shaft power for the measured electrical power or current conditions.

Efficiency Class	Line Frequency	Minimum	Maximum
Standard Efficient	60 Hz	540 rpm	3600 rpm
Standard Efficient	50 Hz	450 rpm	3000 rpm
Energy Efficient	60 Hz	540 rpm	3600 rpm
Energy Efficient	50 Hz	450 rpm	3000 rpm
Premium Efficient	60 Hz	1080 rpm	3600 rpm
Premium Efficient	50 Hz	900 rpm	3000 rpm

Treasure Hunt Module

Treasure Hunt Example
Last modified:

Facility Basics **Find Treasure** Treasure Chest Report

Find ways to save your hard earned treasure!
Use one of the following calculators to determine savings opportunities within your manufacturing facility.
Once an opportunity has been found, save the opportunity to your "Treasure Chest".
Add more details to each opportunity by clicking the  icon and filling out an opportunity sheet.
Click the "Treasure Chest" tab to view a summary of your found treasure.

Filter Calculators by Utility Type:

Lighting Replacement
The calculator is designed to quantify the energy savings associated with lighting opportunities.

Replace Existing Motor
This calculator calculates the energy savings, cost savings, and payback period for replacing an existing motor with a higher efficiency motor.

Upgrade Motor Drive
The Motor Drive Calculator compares the annual energy cost of three motor drives: V-belt drive, Notched V-Belt drive, and Synchronous Belt Drive.

Natural Gas Reduction
This calculator is used to quantify the energy savings associated with reducing natural gas usage.

Electricity Reduction
This calculator is used to quantify the energy savings associated with reducing electricity usage.

Compressed Air Reduction
This calculator reduces the compressed air use. Real description needed.

Custom Savings Opportunity
This calculator provides a space to add a Treasure Hunt Opportunity without using a calculator (such as after having done off-sheet calculations). Enter Baseline and Modification Utility use to calculate savings.

U.S. DEPARTMENT OF **ENERGY** | Energy Efficiency & Renewable Energy

Treasure Hunt Example
Last Modified

Print Export to CSV

Executive Summary Opportunity Summary Opportunity Payback Details Report Graphs Facility Info

Cost Summary

Utility	Cost Savings	Implementation Cost	Payback
Electricity	\$142,987.04	\$122,400.00	0.86
Natural Gas	\$25,855.20	\$10,200.00	0.39
Water	\$4,000.00	\$0.00	0
Mixed	\$100.00	\$100.00	0.92
Total	\$172,842.24	\$132,700.00	0.77

Detailed Summary

Utility	Current Use	Projected Use	Utility Savings	Current Cost	Projected Cost	Cost Savings	Implementation Cost	Payback	
Electricity	kWh	32,000.00	29,184.036.3	2,815,963.7	\$1,600,000.00	\$1,457,012.96	\$142,987.04	\$122,400.00	0.86
Natural Gas	MMBtu	125.000	118.536.2	6,463.8	\$500,000.00	\$474,144.80	\$25,855.20	\$10,200.00	0.39
Water	kgal								
Mixed									
Total									

Treasure Hunt Example
Last Modified

Print Export to CSV

Executive Summary Opportunity Summary **Opportunity Payback Details** Report Graphs Facility Info

Payback Length	Number of Opportunities	Total Savings
Less than 1 year	8	\$115,921.32
1 to 2 years	3	\$45,022.70
2 to 3 years	1	\$6,961.96
More than 3 years	2	\$4,936.26
Total	14	\$172,842.24

- Find low/no cost energy savings opportunities in motor systems, process heating, compressed air, lighting, etc.

Calculators

- 50+ Stand alone Calculators
 - Motors
 - Pumps
 - Fans
 - Process Heating
 - Steam
 - Compressed Air
 - Lighting
 - General
- Most have graphical results

The screenshot shows the website interface for the U.S. Department of Energy's Energy Efficiency & Renewable Energy calculators. The page is titled "Calculators" and is divided into two main sections: "Motors Calculators" and "Pump Calculators".

Motors Calculators:

- NEMA Energy Efficiency:** The predicted efficiency of an induction motor from NEMA MG1, based on size, rotating speed and efficiency class.
- Motor Performance:** Plots current, efficiency, power factor vs motor shaft load for a given motor description.
- Percent Load Estimation:** Calculates Percent Load Estimation.
- Motor Drive:** The Motor Drive Calculator compares the annual energy cost of three motor drives: V-belt drive, Notched V-Belt drive, and Synchronous Belt Drive. Synchronous belts are the most efficient, however cost analysis and application should be considered.
- Replace Existing Motor:** Calculate the energy savings, cost savings, and payback period for replacing an existing motor with a higher efficiency motor.
- Replace vs Rewind:** Compare the cost and energy expenditure of rewinding a failed motor versus replacing it with a new energy-efficient model.

Pump Calculators:

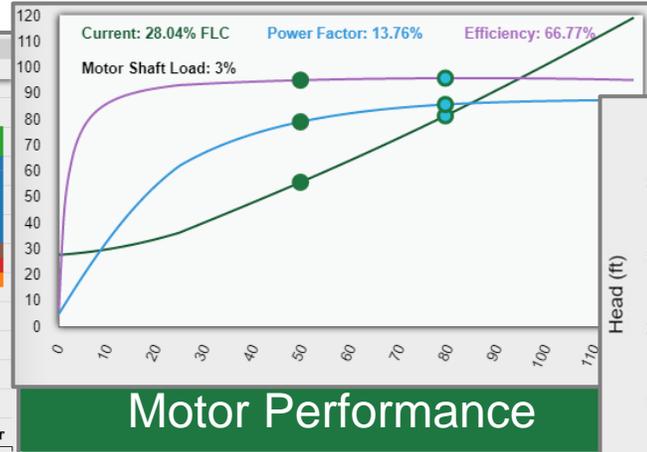
- Head Tool:** Use head tool calculator to calculate pump head.
- System Curve:** Use system curve to graph your pumps flow.
- Specific Speed:** This calculator determines the optimal specific speed for a pump at the given conditions and calculates the amount of efficiency penalty to be deducted from the maximum value due to operation away from the optimal specific speed.
- Pump Efficiency Curves:** Determine the achievable pump efficiency for various pump styles which are based on the Hydraulic Institute (HI) standard ANSI/HI 1.3-2000.
- Pump Curve:** Use pump curve calculator to develop a pump curve and explore the effects of changes in head, flow, pump speed and impeller diameter.

The website also features a navigation menu on the left with options like "Home", "All Assessments", "Examples", "Case Studies", "All Calculators", "Settings", "Custom Materials", "Tutorials", "About", "Contact", and "Acknowledgments". The version number "v0.3.0-beta" is displayed at the bottom of the menu.

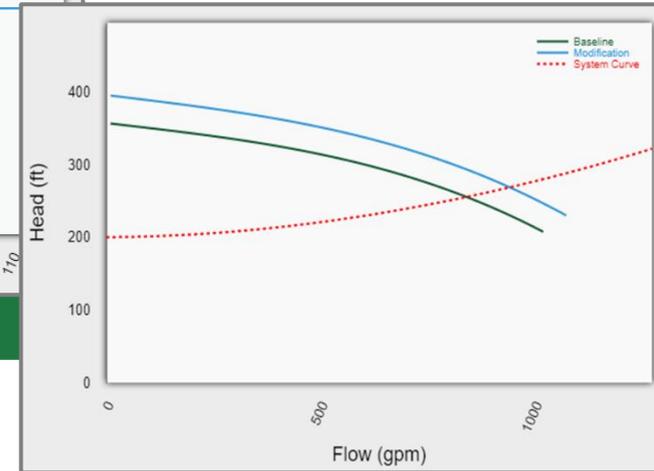
Example Calculators



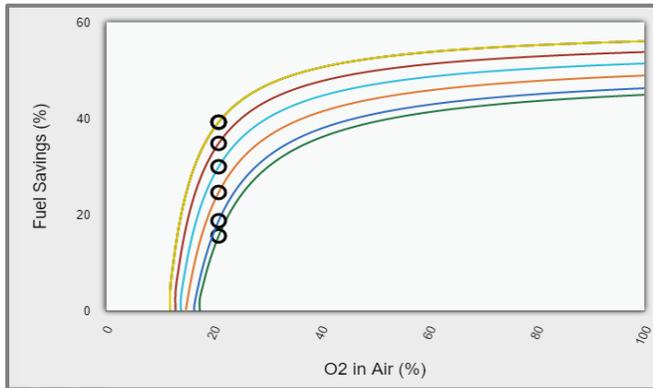
Cash Flow Diagram



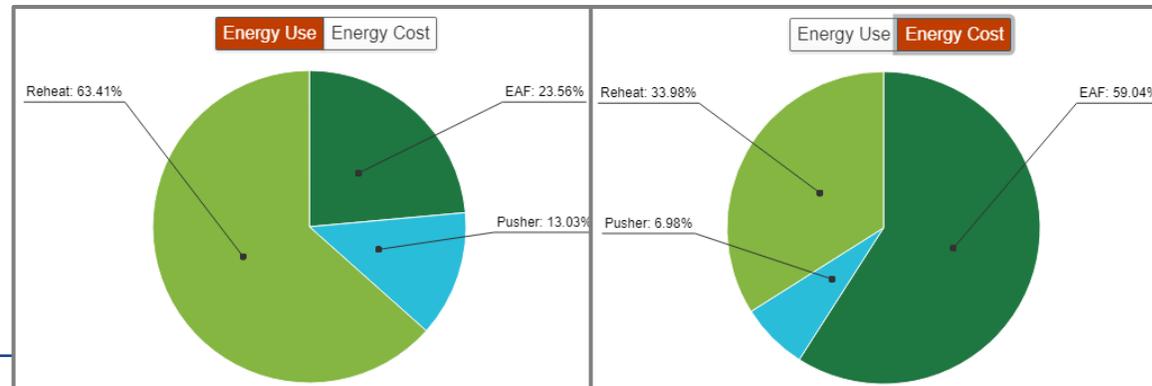
Motor Performance



Pump Curve



O₂ Enrichment



Pre-assessment

Treasure Hunt Calculator for Water


WATER/WASTEWATER REDUCTION

BASELINE +Add Equipment

Equipment #1

Annual Operating Hours hrs/yr

Calculator Type

Water Cost \$/gal

Measurement Method

Bucket Volume gal

Bucket Fill Time sec

Water Consumption **15,768 kgal/yr**

MODIFICATION +Add Equipment

Equipment #1

Annual Operating Hours hrs/yr

Calculator Type

Water Cost \$/gal

Measurement Method

Bucket Volume gal

Bucket Fill Time sec

Water Consumption **10,512 kgal/yr**

RESULTS HELP

	Baseline	Modification
Water Use	15,768 kgal/yr	10,512 kgal/yr
Water Cost	\$78,840 /yr	\$52,560 /yr
Annual Water Savings	5,256 kgal/yr	
Cost Savings	\$26,280 /yr	

To estimate the savings associated with typical operational opportunities, e.g. Scheduling the equipment, reducing the load on the equipment etc.

Excel Version of Treasure Hunt Tools

Opportunity detail sheet helps document the projects and the calculators helps quantify the savings

Step 2: Determine Electricity Consumption

Identify the method to be used:
Electricity consumption can be determined by several different methods. The calculator sheets provide three options to determine consumption. The methods are listed starting with the most accurate and end with the least accurate.

a. Power Meter Method The best way to measure electrical consumption is with a power meter. Manufacturer's data on lights can be entered as if the measurements were done with a power meter.

b. Multimeter Reading Multimeter measurements are the second most accurate means of measuring electrical consumption and are accurate for DC and for AC (When combined with the plant's uncorrected power factor).

c. Name Plate Data Motor nameplate data can provide a reasonable estimation of the energy that motors are consuming but are not as accurate as a power meter. Nameplate data does not tell the user how heavily loaded the motor is.

d. Offsheet/Other Method Choose this option if you are using a different method to find the electricity use

Choose Method of Measurement **b. Multimeter Reading**

Option 2: Multimeter Readings

Current Situation			Projected Situation		
Determine the voltage, current, and power factor of the equipment.			Determine the voltage, current, and power factor of the equipment.		
<i>Data Item</i>	<i>Value</i>	<i>Unit</i>	<i>Data Item</i>	<i>Value</i>	<i>Unit</i>
Voltage	<input type="text"/>	volts	Voltage	<input type="text"/>	volts
Current	<input type="text"/>	amps	Current	<input type="text"/>	amps
Power Factor	<input type="text"/>	-	Power Factor	<input type="text"/>	-
Determine the power consumption.			Determine the power consumption.		
Three Phase?	<input type="text" value="Yes"/>		Three Phase?	<input type="text" value="Yes"/>	
Power	<input type="text" value="0.00"/>	kW	Power	<input type="text" value="0.00"/>	kW
Units	<input type="text"/>	Each	Units	<input type="text"/>	Each
Determine the energy usage.			Determine the energy usage.		
Energy	<input type="text" value="0"/>	kWh	Energy	<input type="text" value="0"/>	kWh

Treasure Hunt Calculators

Info	Title:	Plant:	0	
	Process / Equipment:	Business Unit:		
		Originator:		
		Date:	Set to Today	
Description	Current Situation (Before Energy Treasure Hunt)		Projected Situation (After Energy Treasure Hunt)	
	Annual Operating Hours Hours /Day Days/Month Months	Number of Units Eg. Number of leaks, Number of equipment to be turned off etc.	Annual Operating Hours Hours /Day Days/Month Months	Number of Units Eg. Number of leaks, Number of equipment to be turned off etc.
Energy	Energy units	Energy Use Before TH (Energy units/yr)	Energy Use After TH (Energy Units/yr)	Energy Savings (Energy Units/yr)
	Electricity - kWh Gas - MMBTU			0.0 0.0
Cost / Savings	Implementation Cost		\$/unit	Projected Annual Savings
	Engineering Services: Material: Labor: Contract Labor: In House Other: Other: Other: Other:	<input type="text" value="\$ -"/> <input type="text" value="\$ -"/>	<input type="text" value="\$ 0.10"/> <input type="text" value="\$ 6.50"/> <input type="text" value="\$ -"/> <input type="text" value="\$ -"/> <input type="text" value="\$ -"/> <input type="text" value="\$ 20.00"/> <input type="text" value="\$ -"/>	Electricity Gas Compressed Air Other Fuel Steam Water WWT
Total:		<input type="text" value="\$ -"/>	Other Savings Total:	<input type="text" value="\$ -"/> <input type="text" value="\$ -"/>
Simple Payback Period (yrs):				

Opportunity Sheets

Resources in MEASUR applicable to Treasure Hunts

Treasure hunt module helps create and track opportunity sheets for documenting TH activities

Calculators help quantify the savings associated with an identified opportunity

The results from the calculator are used to populate the opportunity sheets.

Two types of Utility Efficiency Calculators are available

I. Treasure Hunt General Calculators

- To estimate the savings associated with typical operational opportunities, e.g. Scheduling the equipment, reducing the load on the equipment etc.

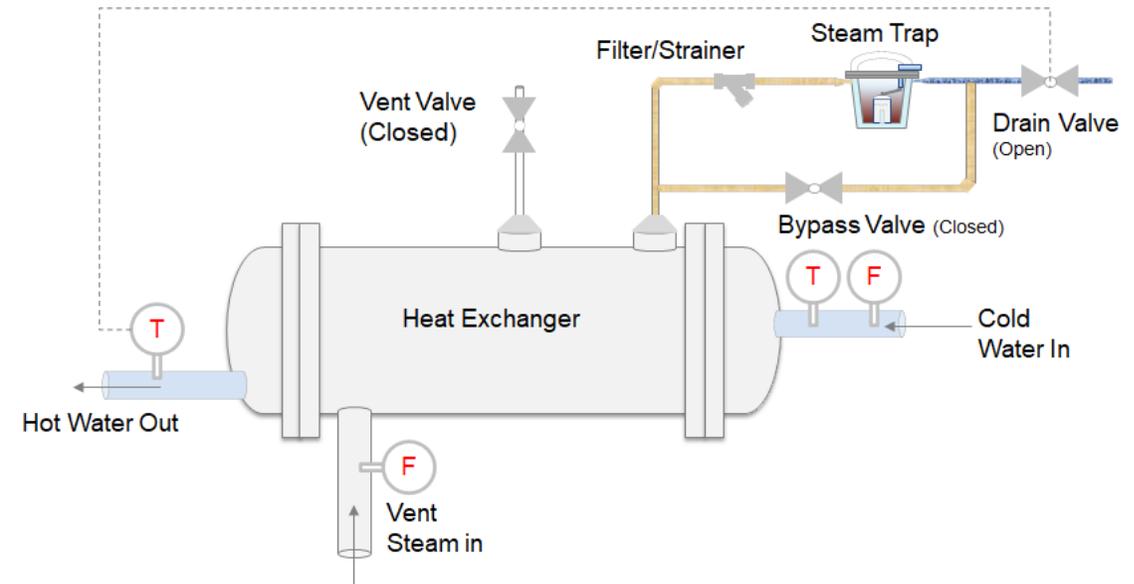
II. Opportunity Specific Calculators

- Available for some common opportunities that cant be easily quantified using the treasure hunt calculator e.g. cooling tower, boiler etc.

Participants can use their own method or tool to quantify savings, however, the result of the calculation and description still needs to be captured in a standard opportunity sheet.

Vent Steam to Heat Exchanger

- Calculates energy and water cost saving when vent steam is used to heat hot water.
- The steam source can be deaerator water tanks, flash steam from condensate return tank or any other equipment / process that vents steam into the atmosphere.



Savings from

- Elimination of energy used to heat water that will be heated by using vent steam.
- Returning condensate back to boiler reducing makeup water and treatment costs

Blowdown Rate Calculator


BLOWDOWN RATE CALCULATOR

BASELINE

Conductivity Readings

Feedwater Conductivity μS/cm

Blowdown Conductivity μS/cm

Boiler

Steam Flow klb

Steam Temperature °F

Boiler Efficiency %

Operations

Operating Hours hrs/yr

Fuel Cost \$/MMBtu

Water Cost \$/gal

Makeup Water Temperature °F

MODIFICATION

Conductivity Readings

Feedwater Conductivity μS/cm

Blowdown Conductivity μS/cm

Boiler

Steam Flow klb

Steam Temperature °F

Boiler Efficiency %

Operations

Operating Hours hrs/yr

Fuel Cost \$/MMBtu

Water Cost \$/gal

Makeup Water Temperature °F

RESULTS

	Baseline	Modification
Blowdown Rate (%)	7.84 %	3.45 %
Blowdown Rate (klb/hr)	85.11	35.71
Feedwater Rate (klb/hr)	1,085.11	1,035.71
Fuel Cost	\$1,894,827	\$833,071
Makeup Water Cost	\$223,402	\$93,749
Total Cost	\$2,118,229	\$926,820
Fuel Savings	\$1,061,757	
Makeup Water Savings	\$129,653	
Total Savings	\$1,191,410	

Calculate Costs associated with boiler blowdown

Cooling Tower Water Use Calculator

Analyze the effect of drift eliminators/cycles of concentration on cooling tower water consumption and estimate the resulting water savings.

 **Case #1** +Remove Case

Water Flow Rate	<input type="text" value="1000"/>	gpm
Cooling Load	<input type="text" value="100"/>	MMBtu/h
Calculate Cooling Load		
Annual Operating Hours	 <input type="text" value="8760"/>	hrs/yr

Cycles of Concentration	<input type="text" value="2"/>	
Drift Eliminator	<input type="text" value="No"/>	
Drift Loss Factor	<input type="text" value="0.2"/>	%
Evaporation Loss Correction Factor	<input type="text" value="85"/>	%

Results

Water Consumption	179,755.2	kGal
--------------------------	------------------	-------------

Boiler and Cooling Tower Calculator from PWP

Boiler	Hours of Operation per Year	Boiler Horsepower (BHP)	Load Factor (Fraction of BHP)	Steam Generation Rate (lb/h) per BHP	Feedwater Conductivity	Makeup Water Conductivity	Blowdown Conductivity	Million Gallon per Year (% of Gross Water Use)				
					TDS ppm	TDS ppm	TDS ppm	Feedwater	Makeup Water	Blowdown	Steam Lost	Condensate Return
									Incoming	Outgoing		
Boiler for:	8,000	100.0	0.8	34.5				-	-	-	-	-
								-	-	-	-	-
								-	-	-	-	-
								-	-	-	-	-
								-	-	-	-	-

Cooling Tower	Hours of Operation per Year	Cooling Tower Tonnage	Load Factor (Fraction of Tonnage)	Evaporation Rate per 10°F Temp. Drop (%)	Temp. Drop Across Cooling Tower (°F)	Makeup Water Conductivity	Blowdown Conductivity	Million Gallon per Year (% of Gross Water Use)				
								Gross Water Use	Incoming	Outgoing		Recirculated Water
									Makeup Water	Blowdown	Evaporation	
								-	-	-	-	-
								-	-	-	-	-
								-	-	-	-	-
								-	-	-	-	-

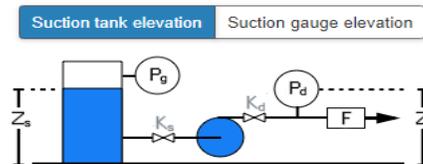
Calculators in MEASUR are similar and follow the same principals

Pumping System

Pumping system characteristics can be estimated by using the Pump Head Calculator and Pump Curves



PUMP HEAD TOOL



K_s represents all suction losses from the tank to the pump
 K_d represents all discharge losses from the pump to the gauge P_d

Fluid Specific Gravity	<input type="text" value="1.002"/>
Flow Rate	<input type="text" value="3000"/> gpm
Suction	
Pipe diameter (ID)	<input type="text" value="12"/> in
Tank gas overpressure (P_g)	<input type="text" value="0"/> psi
Tank fluid surface elevation (Z_s)	<input type="text" value="10"/> ft
Line loss coefficients (K_s)	<input type="text" value="0.5"/>
Discharge	
Pipe diameter (ID)	<input type="text" value="12"/> in
Gauge pressure (P_d)	<input type="text" value="124"/> psi
Gauge elevation (Z_d)	<input type="text" value="10"/> ft
Line loss coefficients (K_d)	<input type="text" value="1"/>

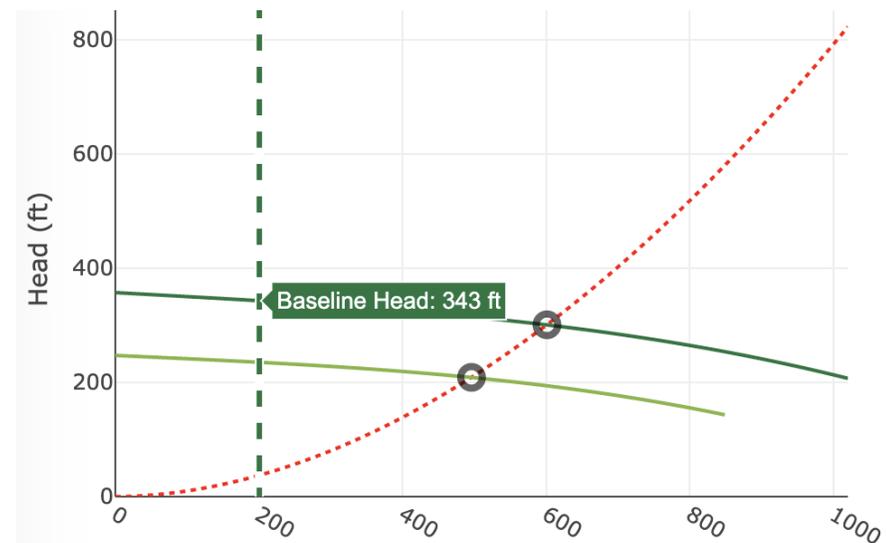
Generate Example

Reset Data

Given a measured pressure, elevation, flow rate, and line size data calculate the head for a pump



PUMP CURVE



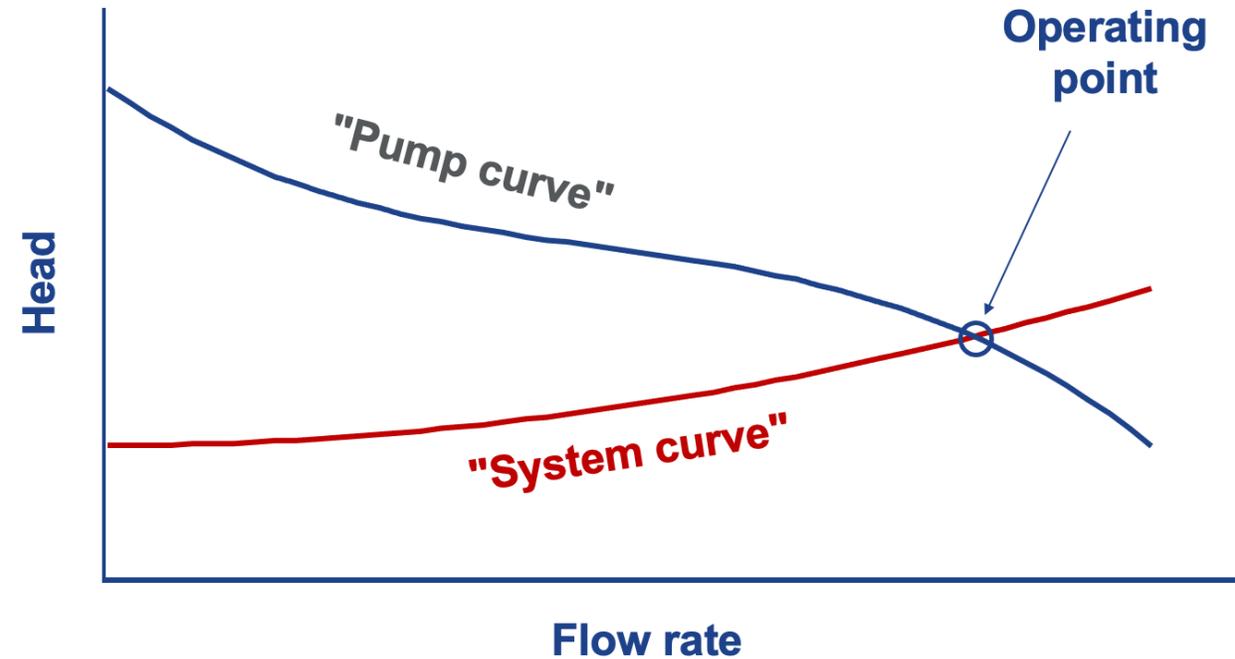
Use pump curve calculator to develop a pump curve and explore the effects of changes in head, flow, pump speed and impeller diameter.

Pump Curves & System Curves

The system curve represents the energy required to move fluid through the system.

If anything in the system changes – including valve positions, flow paths, tank levels, etc., the system curve will change.

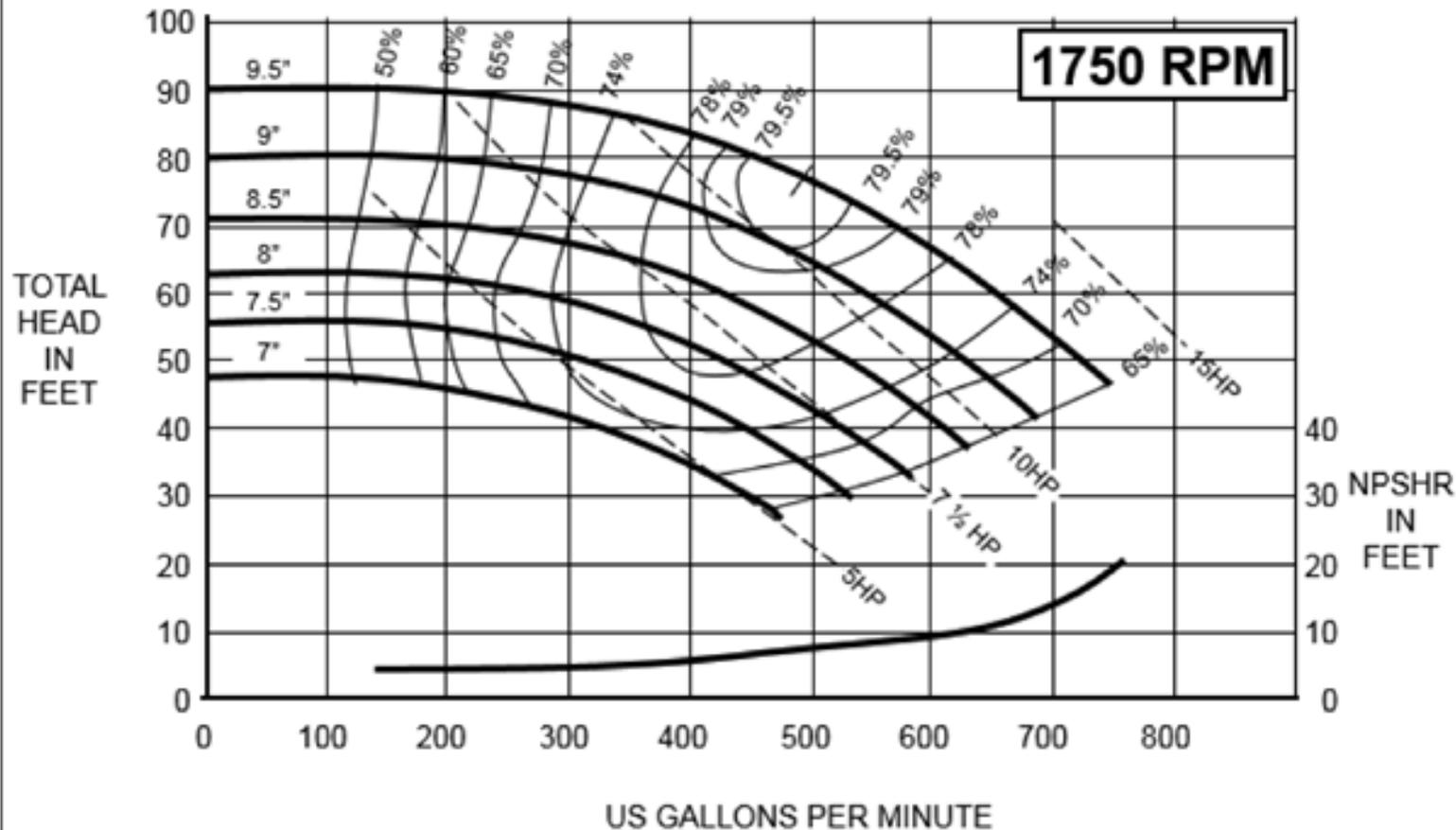
A pump curve gives the performance of a pump when working against a given system pressure to produce a flow



Knowing the system and pump curves can help optimize the flow through a pumping system

Pump performance characteristics

Typical Single Stage Pump Curve



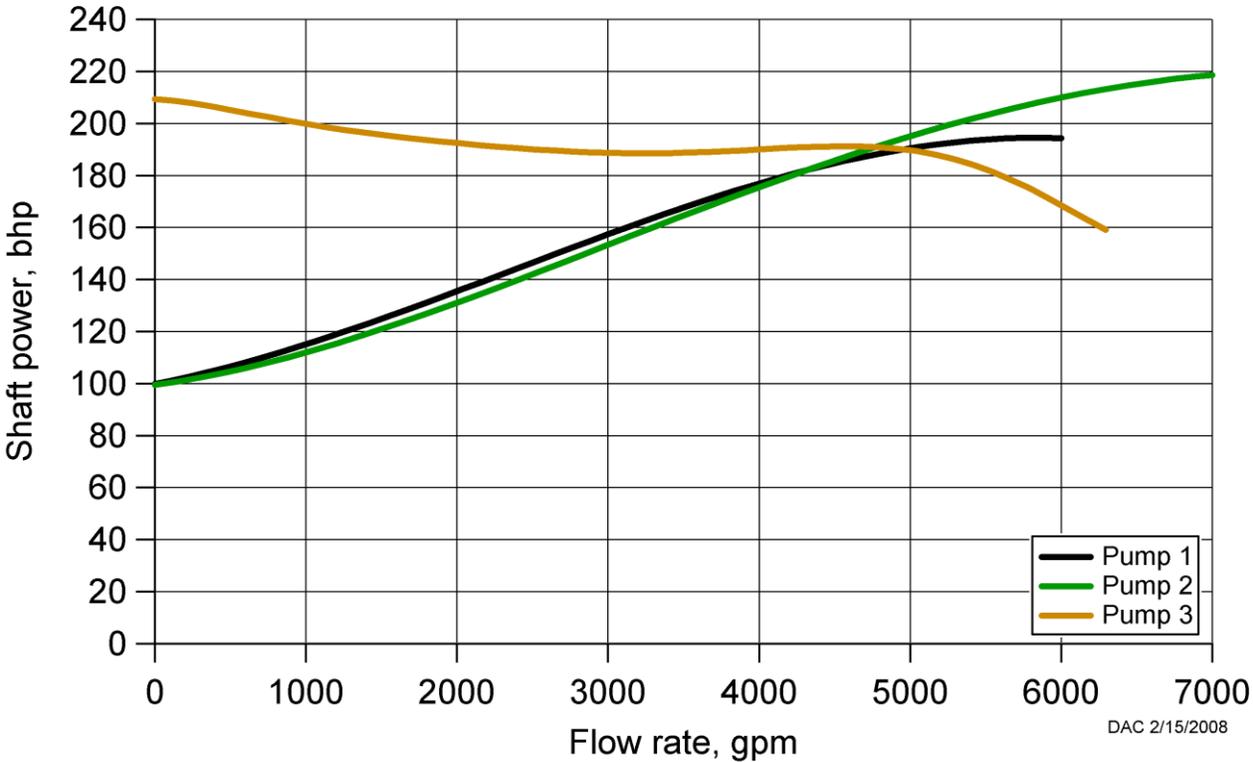
Identifying the right pump curve requires knowing the following

- Manufacturer
- Model Number
- Diameter of impeller
- Associated motor system

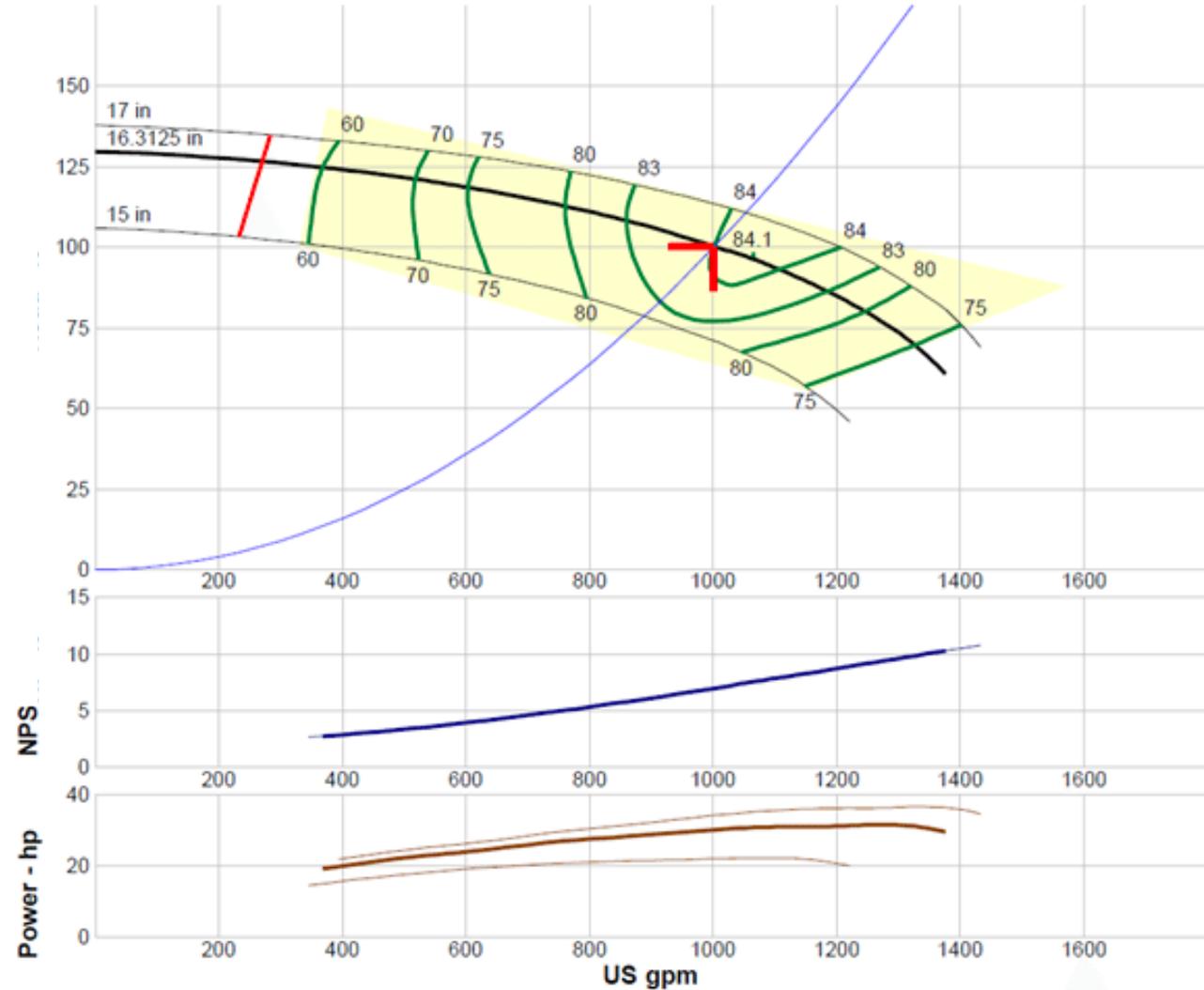
In addition to head, pump curves are also drawn against

- Shaft power
- Efficiency
- Net positive suction head required (NPSHR)

Reading Flow from power curves

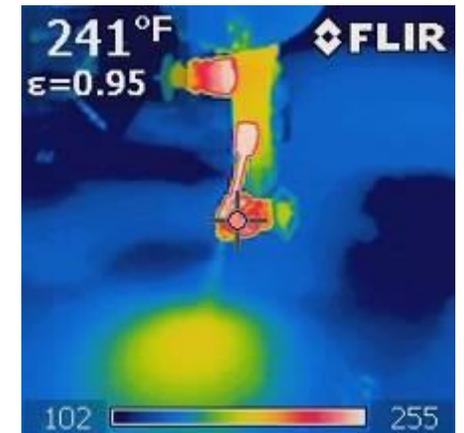


When reading flow rate from graph, double check flow rate using power and head



Steam Leaks

- Steam leaks occur everywhere but most common places are:
 - Flanges and gasketed joints
 - Pipe fittings
 - Valves, Stems and packings
 - Steam traps
 - Relief valves
 - Pipe failures, etc.
- An “order of magnitude” steam loss estimate can provide enough information to determine if the repair must be made immediately, during a future shutdown, or online
- Pipe failures (steam leaks) often present a “safety issue” that demands immediate attention



Steam Leaks

Orifice Diameter [inch]	Leak Rate [lb/hr]						
	Steam Supply Pressure [psig]						
	20	50	100	150	300	400	500
1/16	3	6	11	16	30	39	49
1/8	13	25	43	62	119	157	195
3/16	30	55	98	140	268	353	439
1/4	53	98	174	249	477	628	780
5/16	82	153	271	390	745	981	1,218
3/8	118	221	391	561	1,073	1,413	1,754
7/16	161	300	532	764	1,460	1,924	2,388
1/2	210	392	695	998	1,907	2,513	3,118
	3	18	43	68	143	193	243
	Discharge Pressure [psig]						
Discharge coefficient	0.6 dimensionless						

Third party Tools - Steam Trap Loss Calculator

- The calculator will give you the cost of steam losses associated with a failed trap.
- Leak rate calculated from size of orifice and pressure



STEAM LOSS THROUGH A FAILED TRAP

All too often, steam traps are selected and installed, only to be forgotten. All steam traps fail with time. On average, plants without a regularly scheduled maintenance program experience failure in about 15-25 percent of their traps at any given time.

When failed traps are ignored, hundreds to thousands of dollars worth of steam can be wasted. The following calculator will give you the cost of steam losses associated with a failed trap.

Inlet Pressure (psig)	<input type="text" value="100"/>
Outlet Pressure (psig)	<input type="text" value="50"/>
Orifice diameter	<input type="text" value="1/16"/>
Application	<input type="text" value="Coil/Process"/>
<input type="button" value="Reset"/>	<input type="button" value="CALCULATE"/>

- 7 pounds/hour
- 61320 pounds/year
- \$307/year

Third party Tools - Water Leak

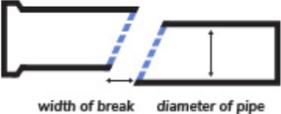
Water cost calculator tool to show how much water and cost associated with a leak

Leak rate calculated from size of leak and pressure

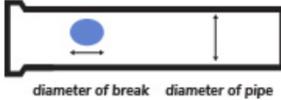
Water Leak Calculator

Leak Information
Select your break type to get started:

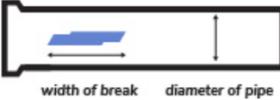
Circular Break



Hole in Pipe

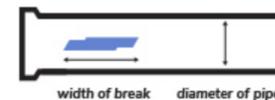


Rectangular Break Along Pipe



Your Water Loss Results

Rectangular Break Along Pipe



Length of Break: .01 feet
Width of Break: .01 inches
Pressure in Pipe: 35 PSI
Cost of Treated Water: \$ per 1,000 gallons

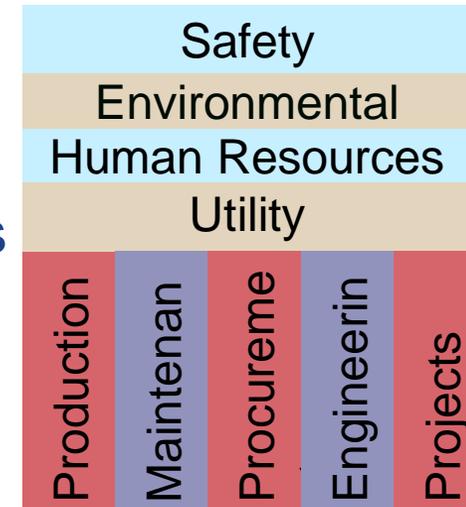
0.19
Gallons Lost Per Minute

274
Gallons Lost Per Day

99,864
Gallons Lost Per Year

Treasure Hunt – Best Practices

- Include participants from across all operations and from outside the host facility
- Operational opportunities can be ideally identified when facility is ideal. Treasure hunts should ideally start on Sundays which typically a non-production day for many facilities
- Target 3 teams of 5 participants, select focus areas based on your facility
- Energy and water treasure hunts can be done together
- Have an effective follow through
 - Have a closing meeting with all stakeholders including management
 - Assign specific tasks to people



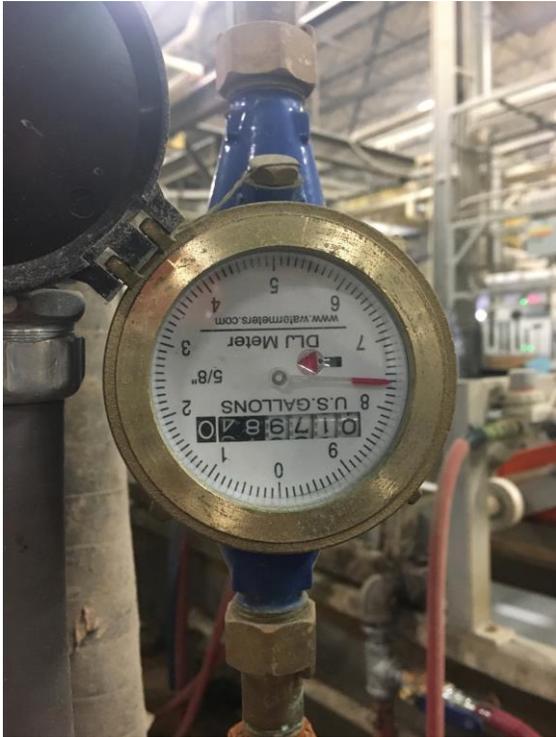
Presenting the Results

- Present results in the language of the management
 - Tie it to facility/ organizational priorities
- Include next steps for each measure
- Include the best practices that you found along with opportunities
- Keep it brief and visual

Closeout presentations helps make immediate discussions and identify steps of actions

Example Presentation

Best Practices



Water flow Metering

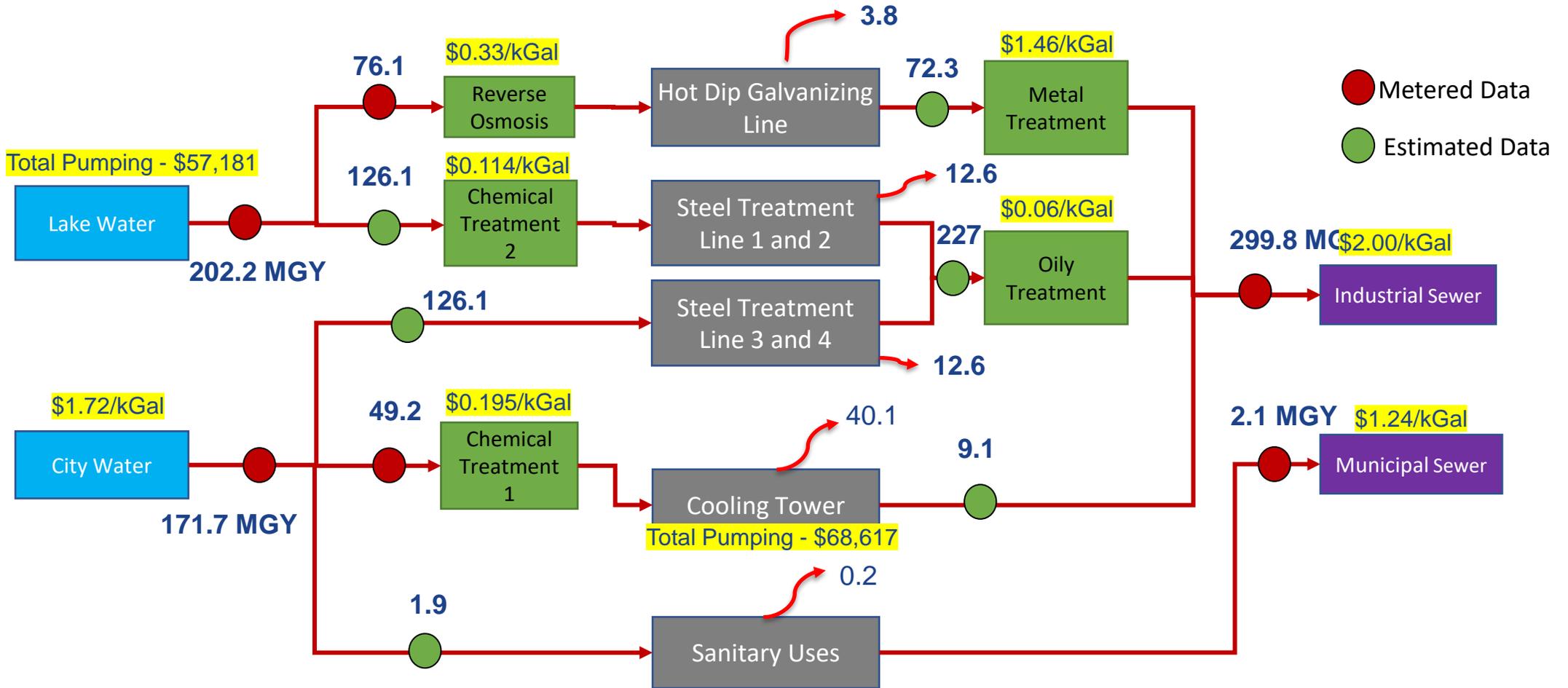


Recirculation System



High Cycles on Tower

Plant Water Flows

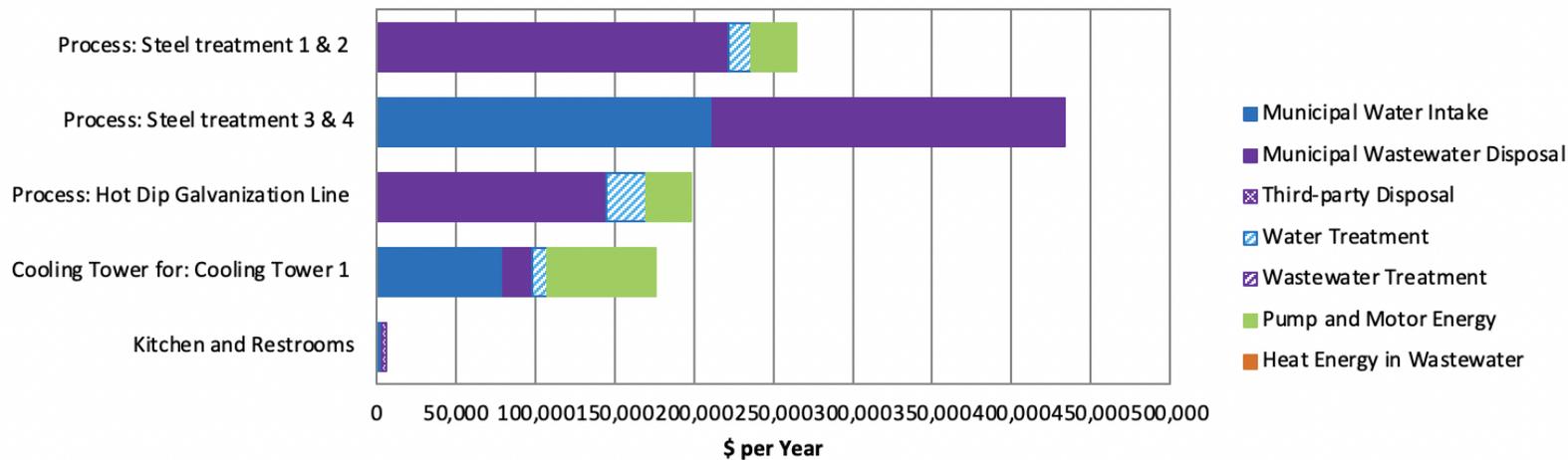


Assessment Results - True Cost of Water

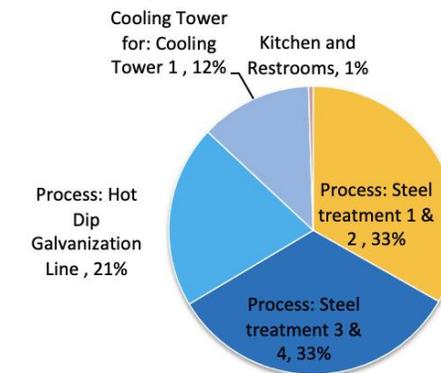
Annual Water Use and Cost Summary by System

Water-Using System	Source Water Intake	Gross Water Use	Direct Costs		True Cost of Water*		True Cost/Direct Cost
	Million Gallon per Year	Million Gallon per Year	\$/Year	\$/kGal	\$/Year	\$/kGal	
Process: Steel treatment 1 & 2	123.19	123.19	\$ 221,742	\$ 1,800	\$ 264,376	\$ 2,146	1.192
Process: Steel treatment 3 & 4	123.19	123.19	\$ 433,629	\$ 3,520	\$ 433,629	\$ 3,520	1.0
Process: Hot Dip Galvanization Line	76.1	76.1	\$ 144,590	\$ 1,900	\$ 198,293	\$ 2,606	1.371
Cooling Tower for: Cooling Tower 1	46.4	4,727.131	\$ 98,008	\$ 2,112	\$ 175,673	\$ 3,786	1.792
Kitchen and Restrooms	1.916	1.916	\$ 5,672	\$ 2,960	\$ 5,672	\$ 2,960	1.0
PLANT TOTAL	370.796	5,051.527	\$ 903,641	\$ 2,437	\$ 1,077,644	\$ 2,906	1.193

True Cost of Water by System



Percent Source Water Intake by System



Water Assessment – Key Conclusions

- Metering production water will help understand water flows better
- Water used in steel treatment is most expensive
- RO brine water needs to be investigated
- Pumping energy and recirculation can be reduced with better controls

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Water Savings Opportunity

- Water Treasure Hunt approach to find savings
- Two teams were formed to identify opportunities
 - Team 1 – Production
 - Team 2 – Facility

Reduce Number of Spray Nozzles per Position

It was observed that majority of nozzles spraying water at the end of positions lack contact with the glass

Opportunity:

40 MGY used in forming tunnels (from sub metering)

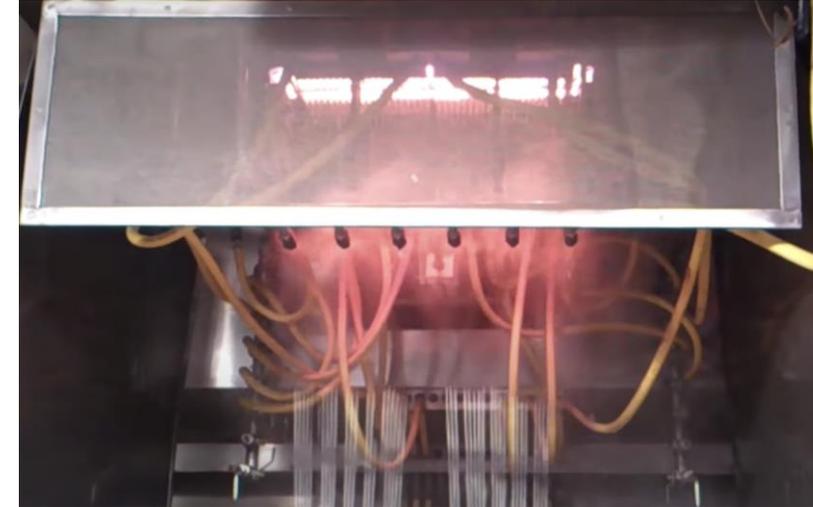
90% of water used in forming is from nozzle spraying (from water balance)

Water used in nozzles = 36 MGY (90% of 40 MGY)

20% reduction of nozzles can be reduced (1 per position) – by comparing it to industry standards

True cost of water = \$3.5 /kgal

Potential Cost Savings = \$27,527



Automated water nozzles



Low Flow Nozzles for Wash Bay

- The wash bay uses warm pressurized water for cleaning
- The flow through the nozzle is determined to be 3GPM
- Using Low flow nozzles this can be cut down by half

Reduction in Water = 1.06 MGY
Estimated Cost savings = \$12,000
Implementation Cost = \$100
Payback = Immediate



Additional Water Savings Opportunity

- Splash out around dip stands
- Cooling Tower replacement
- Use wireless meters to evaluate leaks, drains left open etc.

National Alliance for Water Innovation (NAWI)

Public-private partnership supported by the United States Department of Energy (DOE)



Peter Fiske

Peter S. Fiske is the founder and Executive Director of NAWI and the Director of the Water-Energy Resilience Research Institute (WERRI) at Lawrence Berkeley National Laboratory.

Prior to joining Berkeley Lab, Fiske was the Chief Executive Officer of PAX Water Technologies, Inc. PAX Water pioneered the use of biomimicry to develop innovative and energy-efficient technologies for the water industry.

Fiske has also led research team at Lawrence Livermore National Laboratory and holds Ph.D. from Stanford University and an M.B.A. from the Haas School of Business at the University of California at Berkeley.

Homework #6

- Prepare summary slides for next weeks wrap-up presentation

1 on 1 calls can be setup anytime this week to help with finalizing water baselining, determining true cost ,quantifying savings from projects etc.

Treasure Hunt - Group Meeting

Meeting Goal: Review opportunities from walkthrough and identify projects to pursue further

List of all opportunities identified and separate them in two categories

1. Most promising opportunities identified
 - What additional data is needed to quantify savings
 - Cost and payback of each measure.
 - Make a slide for management presentation
2. Additional opportunities that may require large capital expenditures, or opportunities that require more analysis and should be completed later.

Thank You all for attending today's webinar.

See you all on next Tuesday – July 9th, 2024 – 10 am ET

If you have specific questions, please stay online and we will try and answer them.

Alternately, you can email questions to me at thirumarank@ornl.gov