Better Plants®
U.S. DEPARTMENT OF ENERGY

September 3rd, 2025
Oak Ridge, TN

Week 5: Water Billing

Utility Bill Analysis

Virtual Training

Christopher Price, ORNL

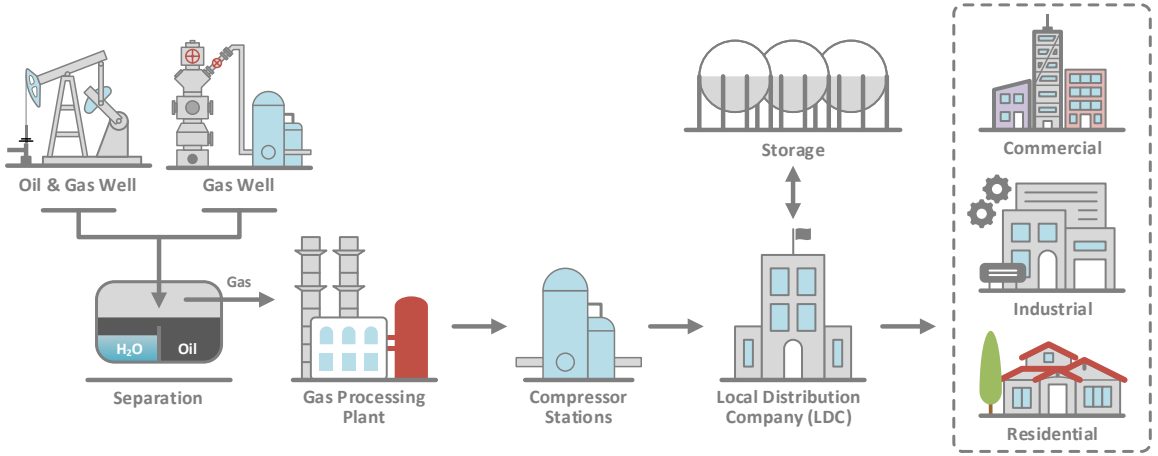
U.S. DEPARTMENT OF ENERGY

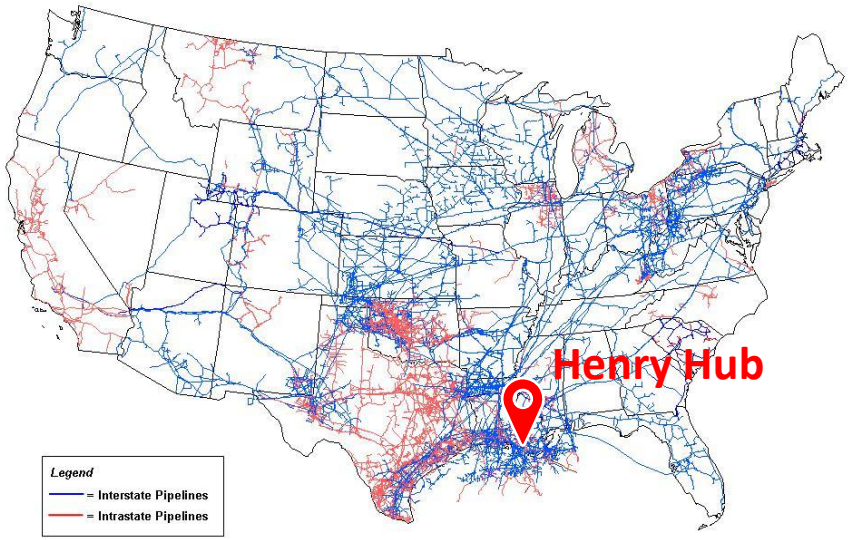
Week 4 Review:

All about natural gas!

Natural Gas Production and Transportation

- Natural gas is formed from the anaerobic decay of dead plants and animals under high heat and pressure
- Raw NG must be processed to remove water vapor and other compounds
- Process NG is compressed and transported to customers through a pipeline network
- The US has more than 3 million miles of pipeline
- **Hubs** and **Citygates** are points where gas is transferred between networks

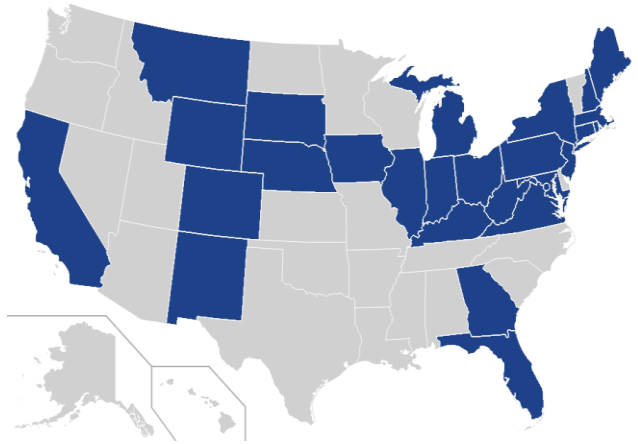


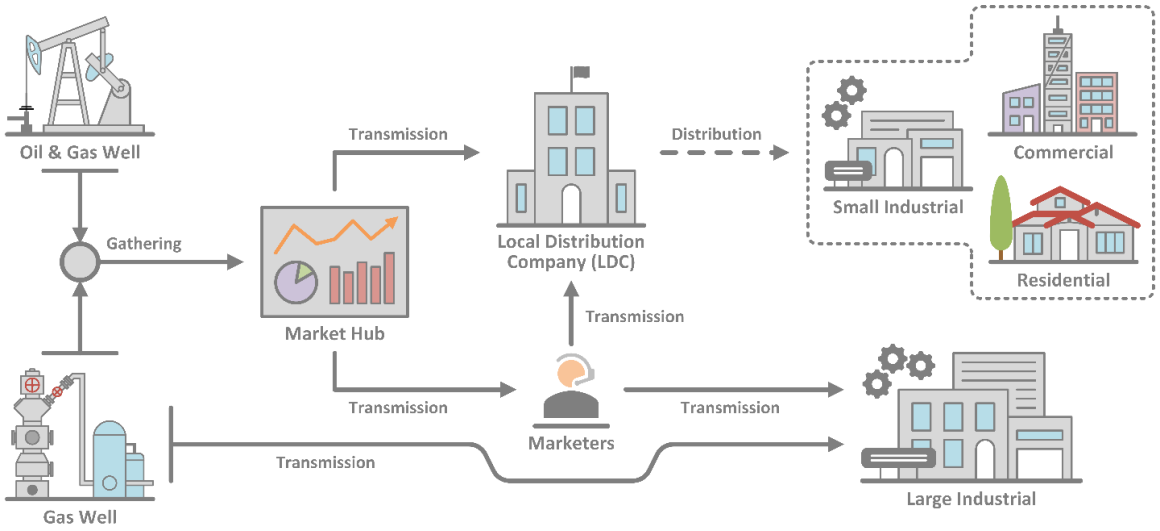


Source: Energy Information Administration, Office of Oil & Gas, Natural Gas Division, Gas Transportation Information System

Natural Gas Deregulation

- In a deregulated gas market, prices are not set by a single utility which separates purchasing gas from transportation and delivery
- At least 28 states have some form of natural gas deregulation
- Deregulation offers flexibility for buyers who can purchase gas:
  - Directly from producers
  - From third-party marketers
  - From market hubs
  - Local Distribution Companies





Natural Gas Billing Units

- Utilities can bill by *volume* of gas **or** by *energy content* of the gas
- Common gas billing units are:
  - 1 CF = 1 Cubic Foot
  - 1 CCF = 100 cubic feet
  - 1 MCF = 1,000 cubic feet
  - 1 M^3 = 35.31 CF
  - 1 MMBtu = 1,000,000 Btu
  - 1 Therm = 0.1 MMBtu
- Convert volume to energy using the BTU factor on your bills
  - 1 MCF ≈ 1.038 MMBtu = 10.38 Therms

https://commons.wikimedia.org/wiki/File:Gas_meter_2.jpg

Types of Natural Gas Service

Size-based Service:

- Larger service typically has higher metering fees, cheaper base rates, and demand-based charges

Firm Service:

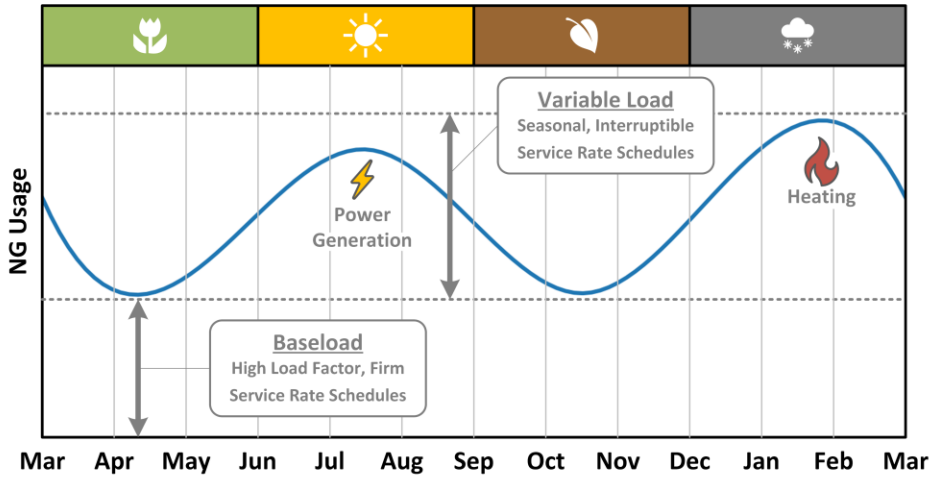
- Guarantees a minimum supply of natural gas is always available
- More expensive but reduces risk

Interruptible Service:

- Supply can be limited based on availability and demand
- Cheaper but increases risk

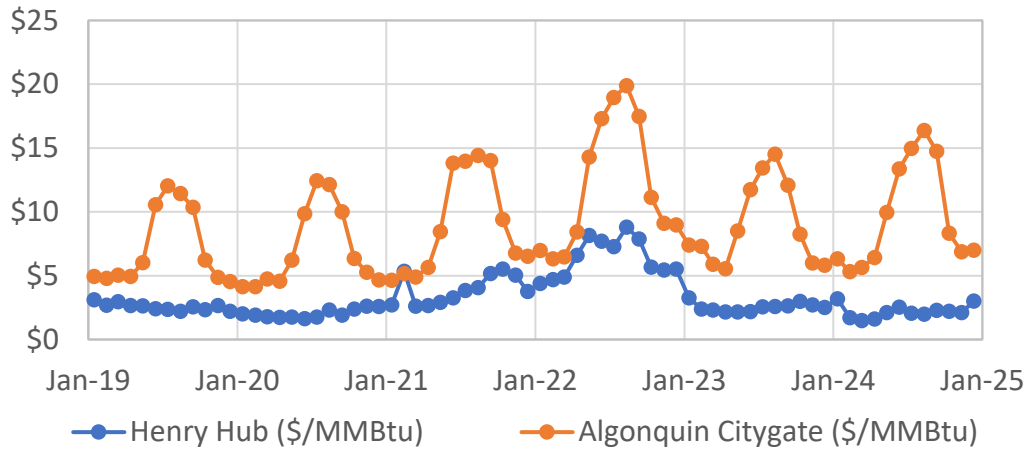
High Load Factor Service:

- Ratio of highest daily gas usage to average usage
- For customers with large baseload gas usage



Natural Gas Pricing

- Gas pricing has two components:
  - **Commodity Price:** Cost of gas at a specific trading point
  - **Basis Cost:** Difference in cost from point of sale and delivery
- Benchmark price of gas in the US is the Henry Hub
- Basis Cost can be positive or negative depending on relative cost between hub and delivery
- Both commodity price and basis cost can be fixed via a contract



NYMEX Price

Spot Henry Hub Price ± Fixed Basis

Index Price

Spot Hub Price ± Floating Basis

Fixed Price

Fixed Commodity Price ± Fixed Basis

Natural Gas Demand Rates

Maximum Daily Firm Quantity (MDFQ)

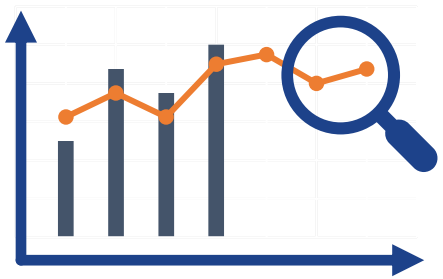
- Quantity of guaranteed daily delivery the utility is obligated to provide
- Delivery of gas is prioritized up to the MDFQ and is not usually subject to weather disruptions or supply constraints
- This quantity is set based on your contract negotiations

Maximum Daily Quantity (MDQ)

- Maximum amount of gas delivered over a 24-hour period during a specific time window
- Analogous to electricity demand charges
- Usually determined over a 36-month window
- Can set your gas charges for a long time!

Forecasting Natural Gas Usage

- De-regulation has opened some gas markets to new suppliers that may offer more competitive pricing
- Using markets to find cheaper gas can generate large cost savings
- May have an option to **Pre-Buy** your natural gas at a cheaper rate
- Requires an accurate estimate your future gas usage:
  - Estimated natural gas is purchased at a base rate ($$)
  - ***Additional gas is more expensive*** ($$$) than the base rate if you underestimate your usage
  - ***Excess gas is sold back at a cheaper rate*** ($) than the base rate if you overestimate your usage

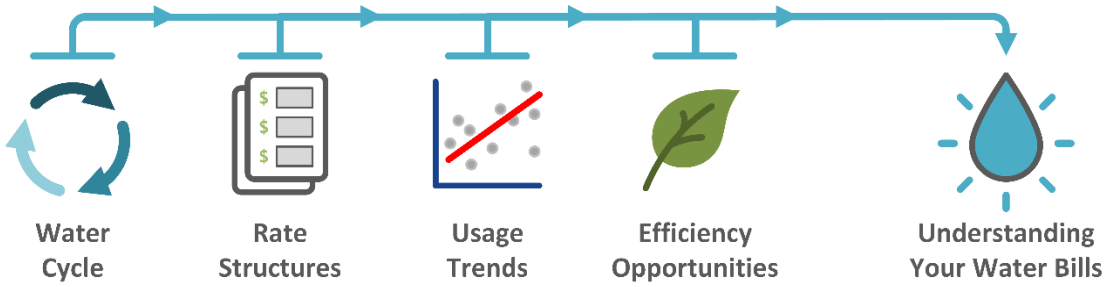


Utility Bill Analysis Virtual Training Agenda

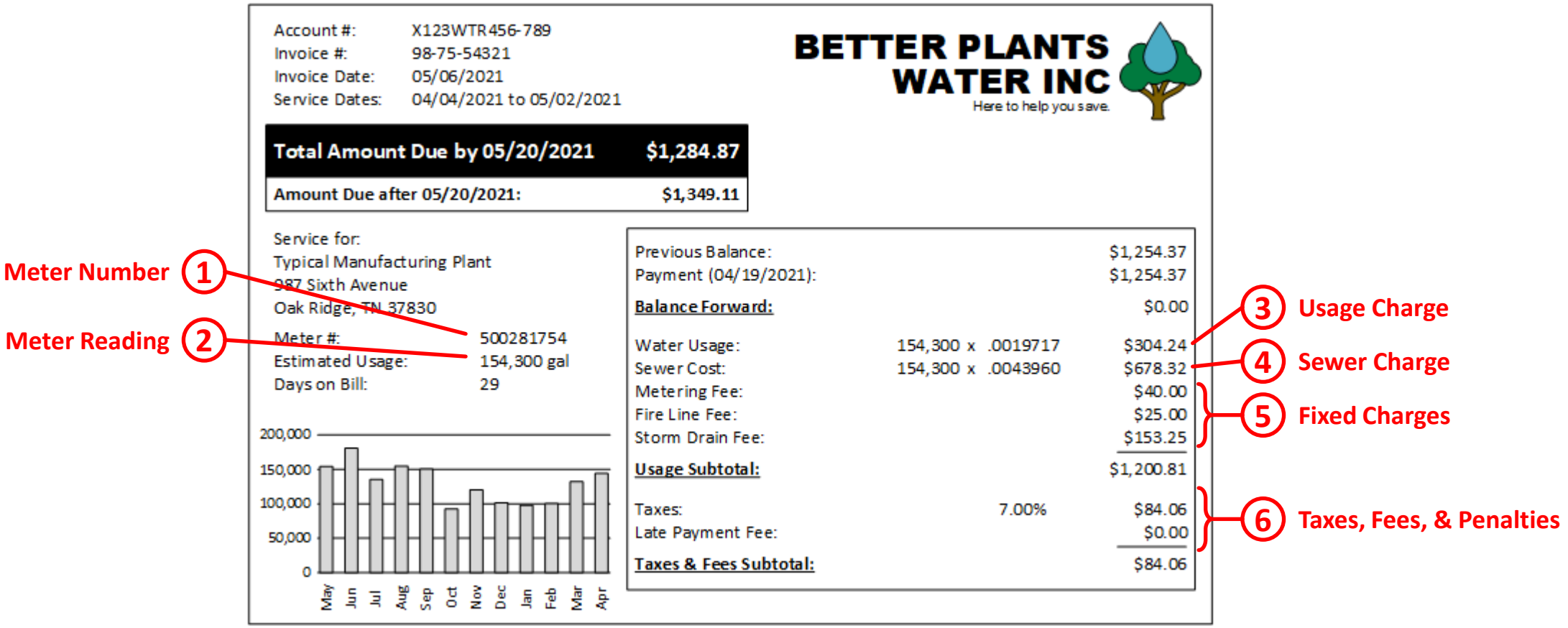
- Week 1 – Markets, Tariffs, and Consumption
- Week 2 – Demand, Power Factor, and Load Factors
- Week 3 – Interval Data, Demand Management, and Costs
- Week 4 – Natural Gas Bills Analysis
- **Week 5 – Water Bills Analysis**
- Week 6 – Review and Partner Cast Studies

Using the Guide

- Some water bills can be hard to decipher
- Some bills can be very detailed, some are very short
- Some charges appear each month, some do not
- Understanding your bills and why your utility charges different fees is important to saving water and cost
- The guide covers the basics of water and sewer bills:



Key Components to Your Water Bills



Week 4 Homework:

Common questions, natural gas bills, initial findings

Week 4 Homework Questions

- Find your natural gas rate tariffs (pipeline and final delivery)
- Add natural gas data to VERIFI and do an analysis
- Determine your blended and marginal costs of natural gas

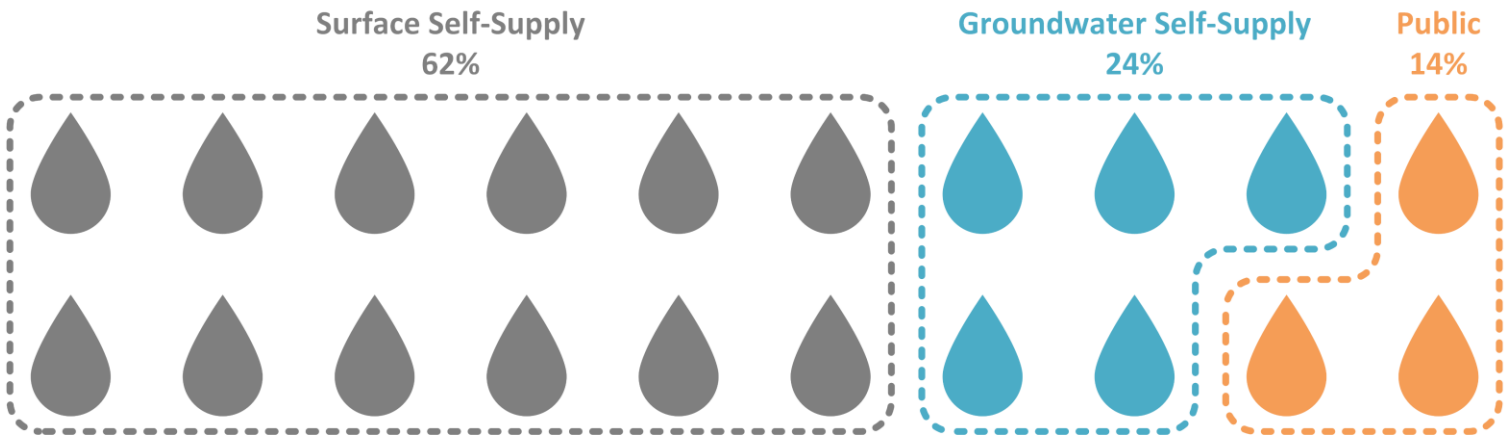
Water Sources and Treatment

What are the basic uses of water?

- **Public Supply** – Water delivered by utilities for domestic, industrial, commercial, or residential use.
- **Domestic** – Water used for household purposes (food, bathing, washing, dishes, etc.).
- **Irrigation** – Water used to support farming activities.
- **Thermoelectric Power** – Water used during electricity generation with steam-driven turbines.
- **Industrial** – Water used in fabrication, processing, washing, cooling, production, etc.
- **Mining** – Water used in the extraction of minerals such as coal, iron, sand, and gravel.
- **Livestock** – water used in watering, feedlots, dairy, and other on-farm needs.
- **Aquaculture** – Water used in raising organisms that live in water.

What do we usually use water for?

- The United States uses ≈400 billion gallons of water per day
- Industrial water usage accounts for 5-6% of total usage
- A large majority of industrial water is from self-supplied sources
- Any water sourced or discharged to a ***Public System*** will have a billing structure associated with that usage

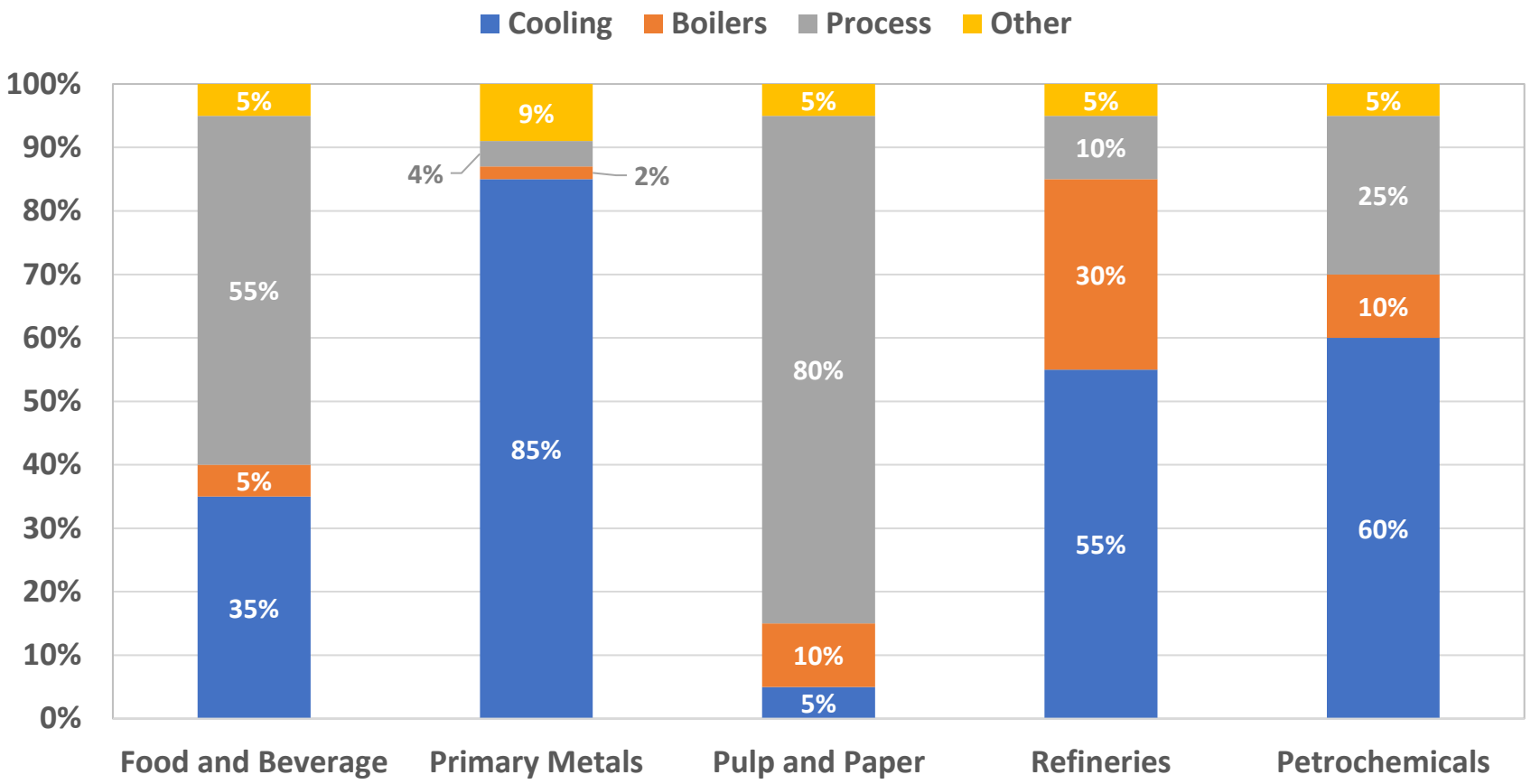


Uses of Water in Industrial Facilities

- **Process Water** – Water use directly related to the production of a product
  - Steam production, cooling, rinsing, quenching, etc.
  - Can be higher or lower quality than municipal supply
- **Comfort Water** – Water not used in production
  - Restrooms, kitchens, HVAC, water fountains, etc.
  - Includes cooling tower water usage and evaporation
- **Irrigation Water** – Water used to maintain landscaping around a facility

Water Use by Different Industrial Sectors

Most water used in industry is for cooling, boilers, or processing



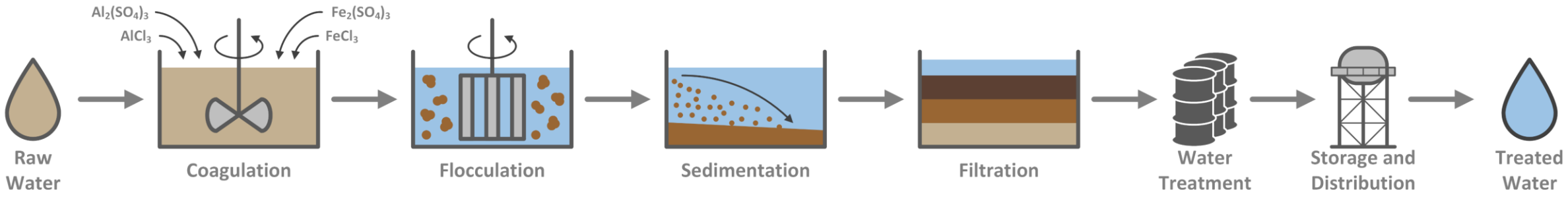
Process Water Use Includes:

- Washing/cleaning
- Diluting (e.g., paint shop)
- Product Transportation
- Fabrication
- Bleaching
- Lubrication
- Sterilization

How is Clean Water Made?

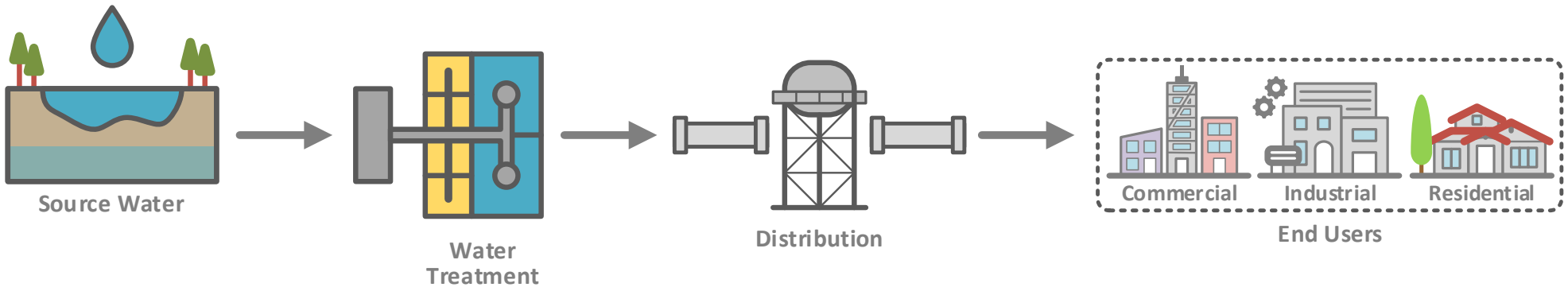
Water Treatment Process:

1) **Coagulation and Flocculation** —Positively charged chemicals are added to the incoming water and debris, causing them to bind with each other forming floc.
2) **Sedimentation** — Floc will settle to the bottom, forming a layer of sediment.
3) **Filtration** — Filtration systems include activated carbon, reverse osmosis membrane, or mixed media (sand, gravel, and charcoal) or a combination
4) **Disinfection** — Chemicals or UV lights can be used to remove any remaining impurities and help protect the treated water during distribution to end users.



How is Water Distributed?

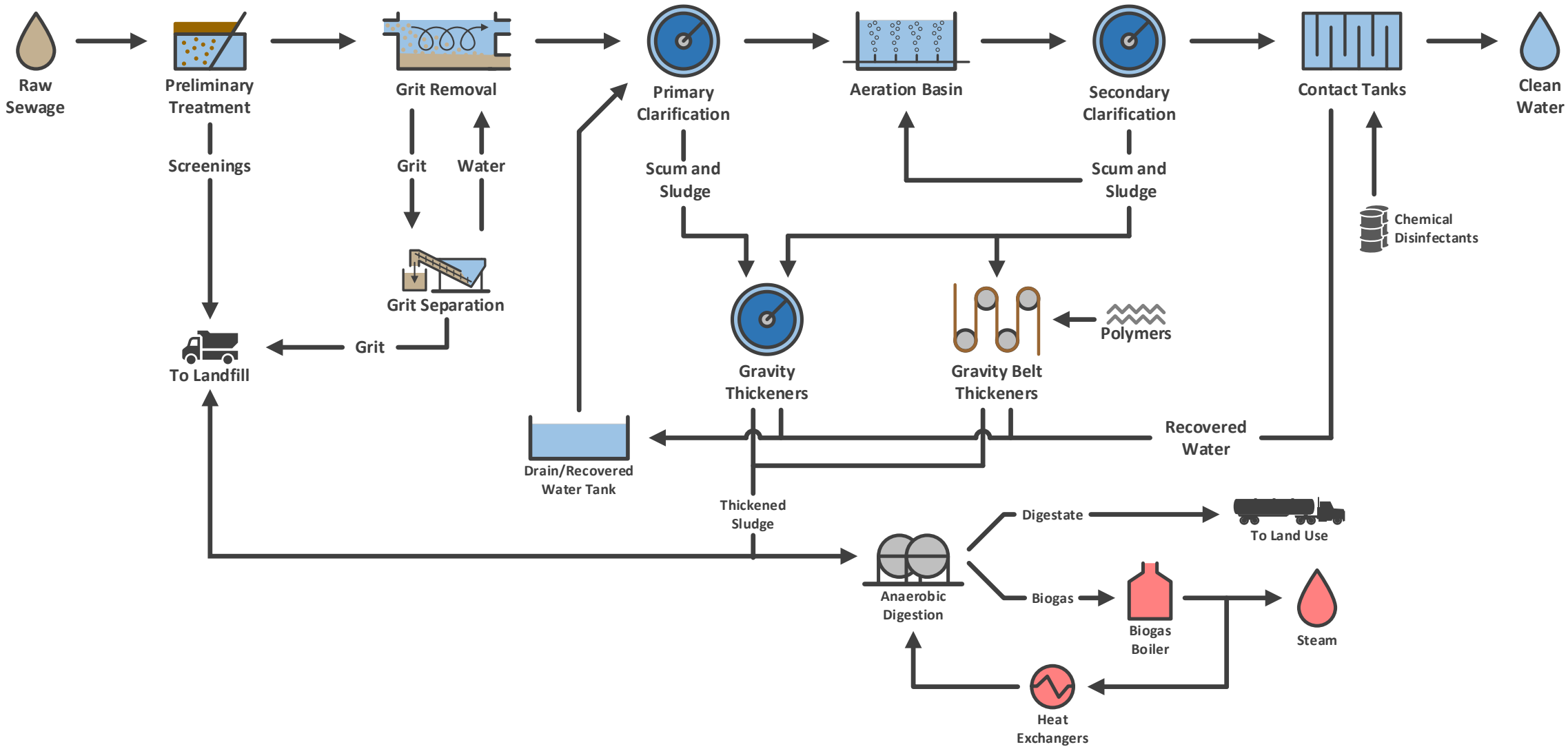
- A distribution network supplies end users with clean water by connecting them to centralized treatment plants and wells
- Network consists of water mains, feeders, reservoirs, pumps, water towers, hydrants, and other components
- Your local utility operates, maintains, and upgrades the system to provide water when you need it



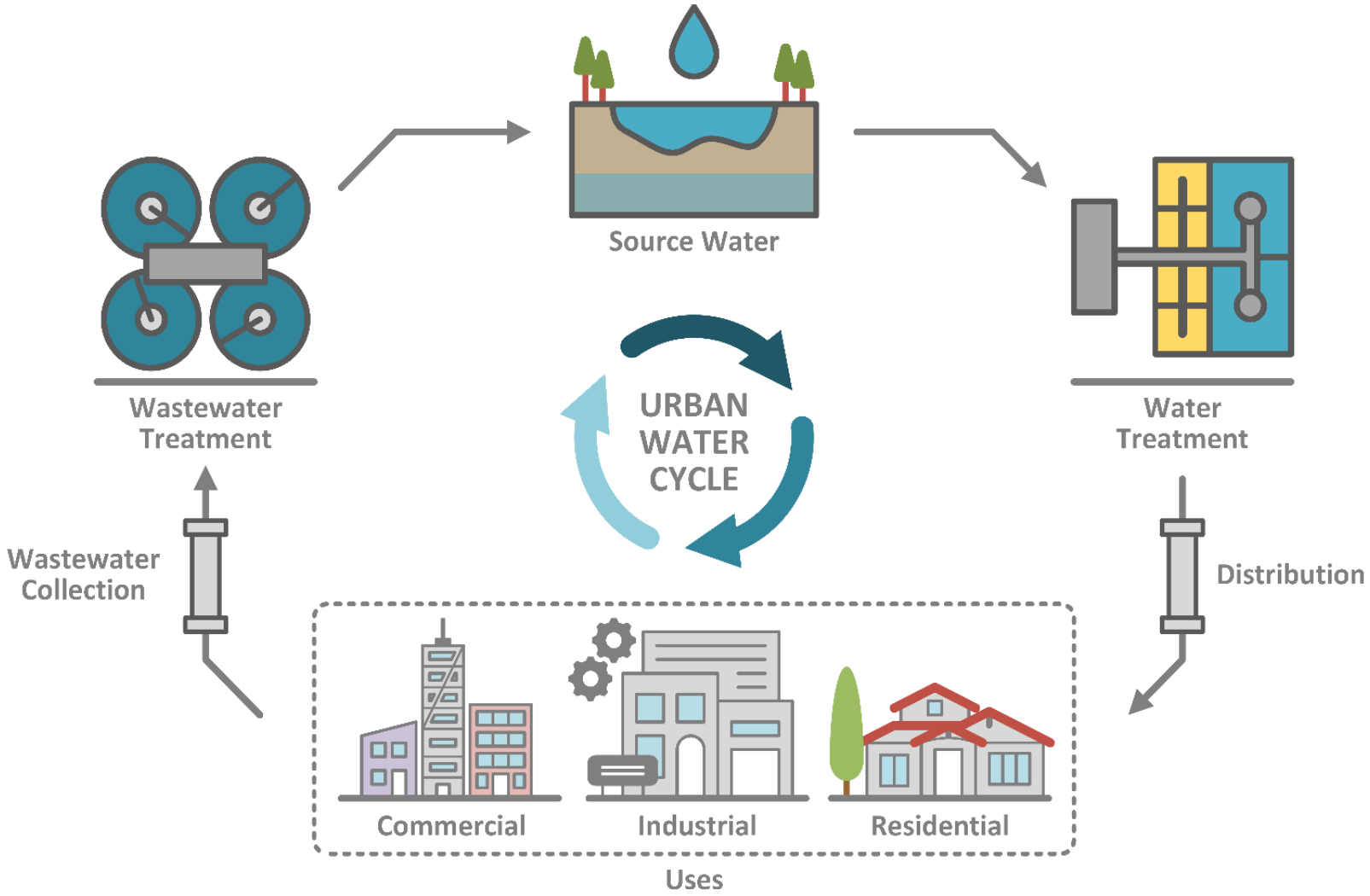
How is Wastewater Collected?

- A network of infrastructure designed to convey sewage from end users to centralized wastewater treatment facilities
- Consists of drains, manholes, pumps, overflow storage, pipes, and other components
- Some municipalities may have combined sewers that also manage stormwater and other surface runoff
  - Can be susceptible to raw sewage discharge during heavy downpours

How is Dirty Water Disposed Of?



The Urban Water Cycle



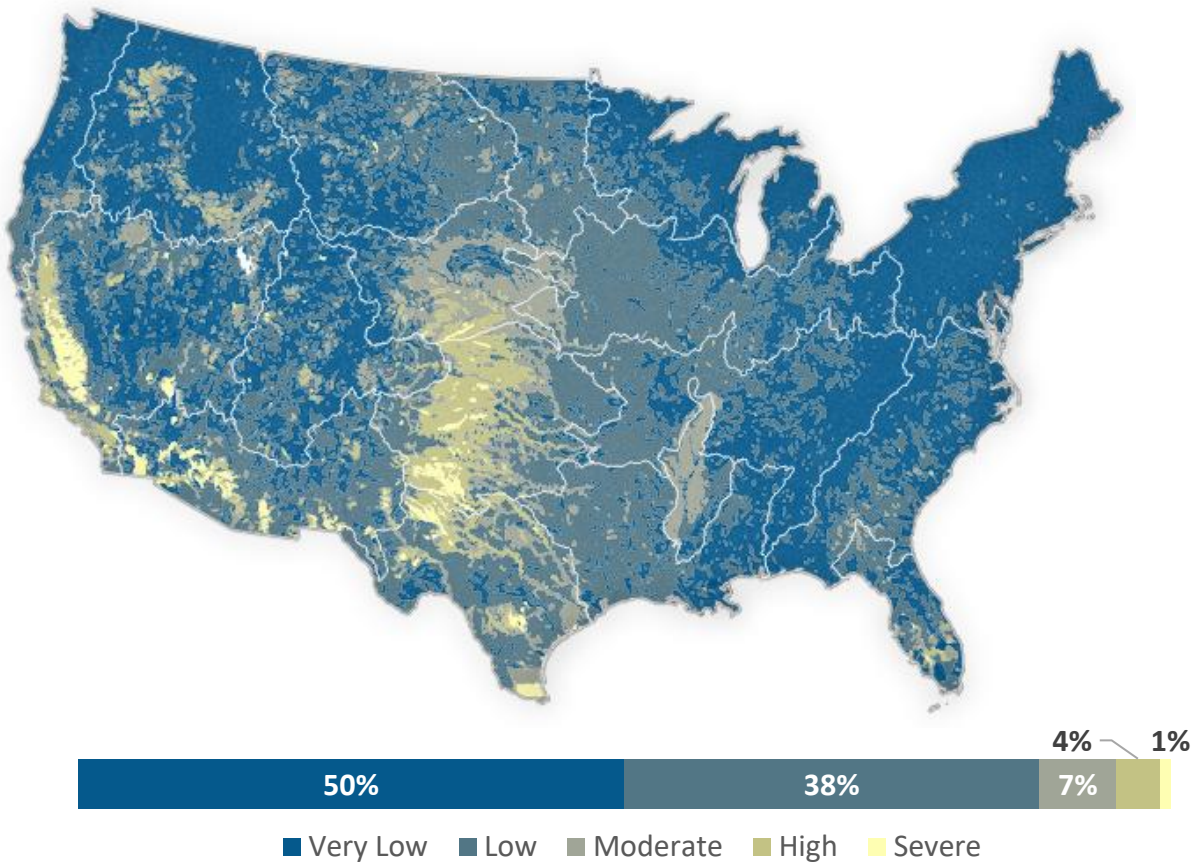
Why Focus on Water Efficiency?

Cost Savings and Operational Improvements	• Cost of **purchasing** water for facility • Cost of **material** for water and wastewater treatment • Cost of discharging **wastewater** • Cost of energy for **heating and cooling** water • Cost of energy for **pumping** water
Business Risk	• Scarcity – Risk of **disruption** of water supply to plant due to drought conditions, regional scarcity etc. • Regulatory – Risk of increased **government regulation** on water use and pollution regulations • Disruption of water supply in supply chain
Reputational Risk	• Sustainability strengthens public trust and helps create better relationship for business

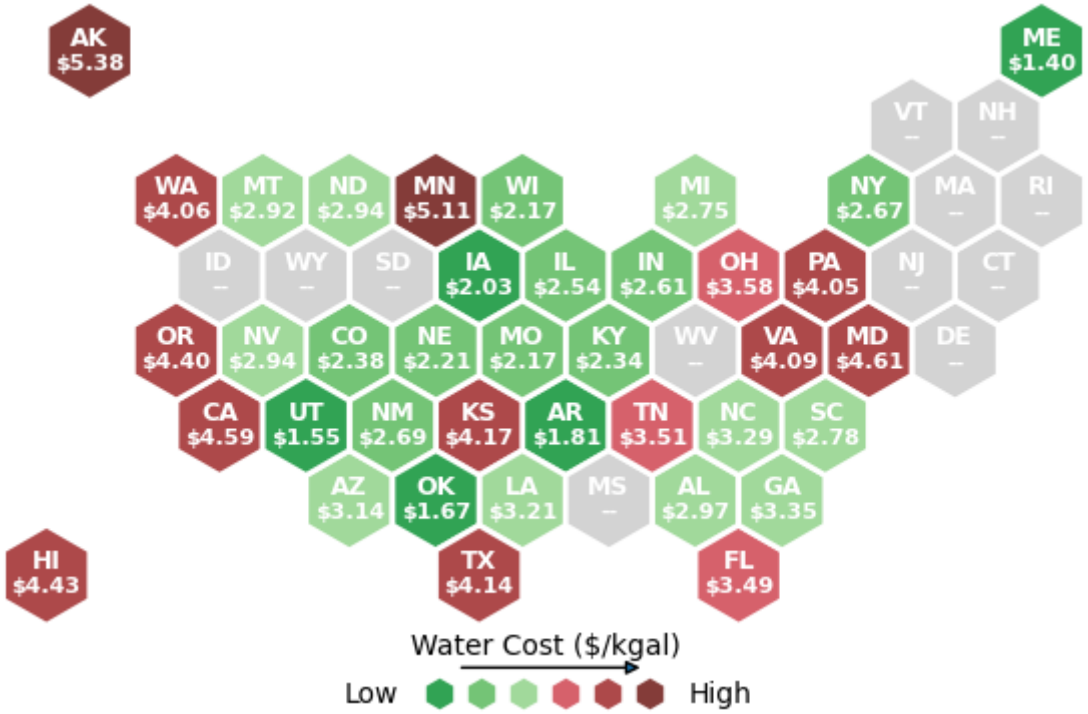
Water Energy Nexus

Why Focus on Water Efficiency?

Water Scarcity in the US



Average Cost of Water in the US



Water Meters

Water Consumption Charges

- Water consumption or Usage is the total amount (volume) of water your facility uses to operate or make product
- Common units: gallons, cubic feet, liters, cubic meters, etc.
- Billed at a $/volume rate that will be set by your rate tariff
- Can appear on your bill as water charge, water cost, usage charge, etc.

Be Careful with Units!

- Units can be tricky, particularly for the imperial system!
- Different facilities may be billed in different units:

1 Cubic Foot = 7.48 US Gallons

100 Cubic Feet = 1 CCF = 748 US Gallons

1 kgal = 1000 US Gallons

1 UK Imperial Gallon = 1.20095 US Gallon

1 US Gallon = 3.785 Liters

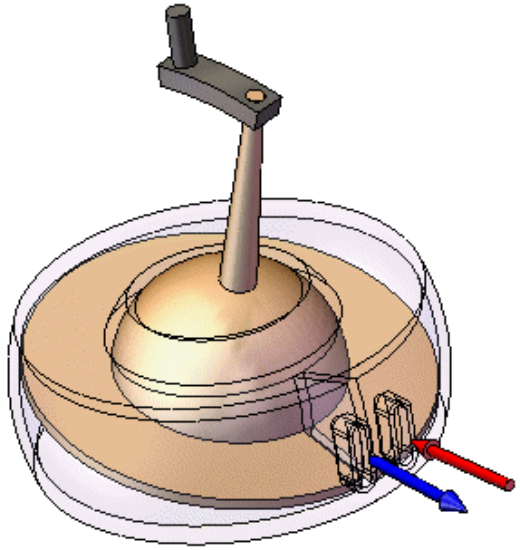
1 Cubic Meter = 1000 Liters

Types of Water Meters

- A water meter measures the total volume of water that a facility uses during a billing cycle
- Water volume does not change much with temperature
  - 1 gallon of water at 40°F has a volume of just 1.01 gallons at 100°F
- Water does not change volume with pressure
  - e.g., water is considered incompressible
- Weather conditions will generally not affect meter readings (unlike natural gas!)
- Usually for cold, potable water but there are many types of water meters

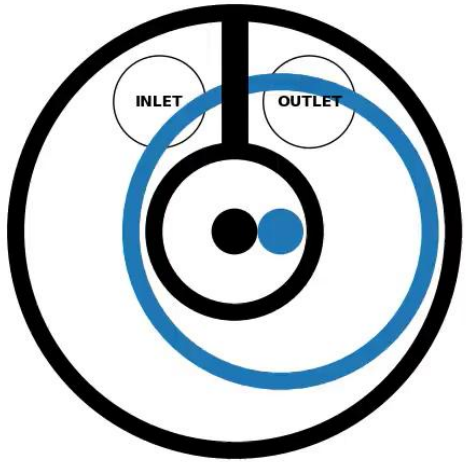
Positive Displacement Meters

- Directly measure the volumetric flow rate of a fluid
- Divide the flow into fixed volumes that can be counted by the meter
- Rely on the fluid to push the measuring element
- Typically used for low-to-moderate flow rates because all flow must go through the meter
- Accuracy of approximately ±0.1%



Nutating Disc Meter

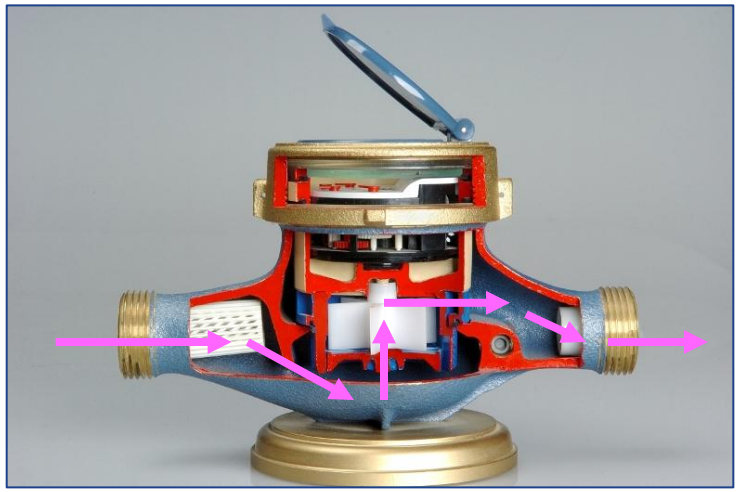
https://commons.wikimedia.org/wiki/File:Dakeyne_disc_engine_animation.gif



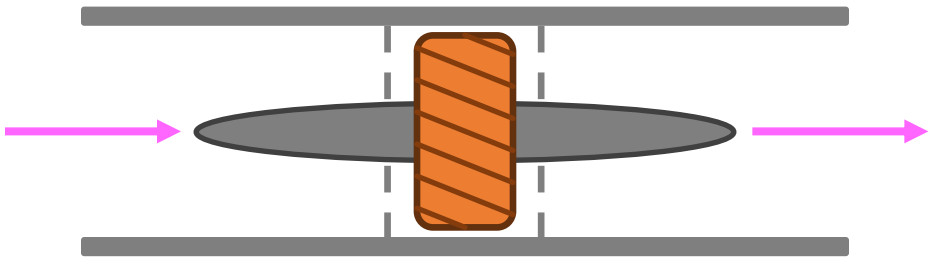
Oscillating Piston Meter

Velocity Meters

- Measure the velocity of fluid through the meter
- Can convert velocity to volume flow rate because the meter has a known volume
- There are several types of velocity meters for different requirements
- Flow path will affect the accuracy and flow rate of the meter
- Can have compound meters for accuracy at high and low flow rates



Single/Multi-jet Flow Meter

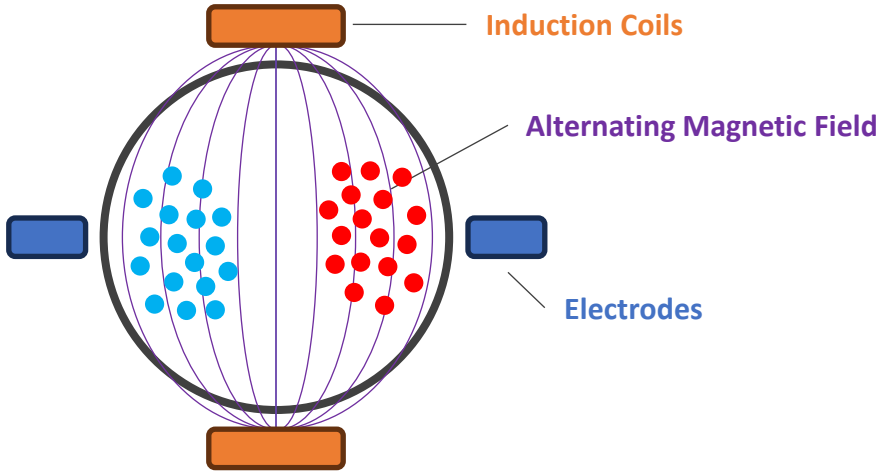


Turbine Flow Meter

Non-contact Water Meters

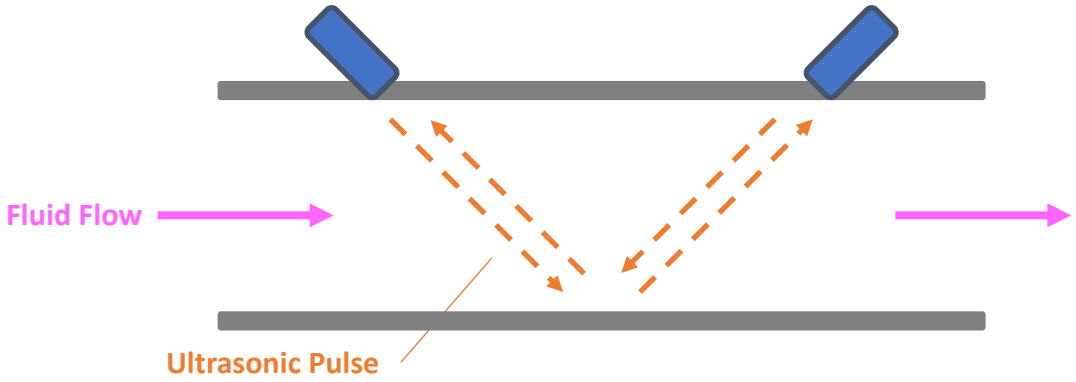
Electromagnetic Meters

- Use electromagnetic induction to measure the flow of water in a pipe
- Require a conductive fluid
- Works with high viscosity fluids and even waste flows like sludge, mud, and manure



Ultrasonic Flow Meters

- Measure the time for ultrasonic pulses to traverse a fluid
- Works with liquids, gases, and hydrocarbons
- Requires clean fluids with no bubbles
- Does not require a conductive fluid
- Can distinguish direction of flow



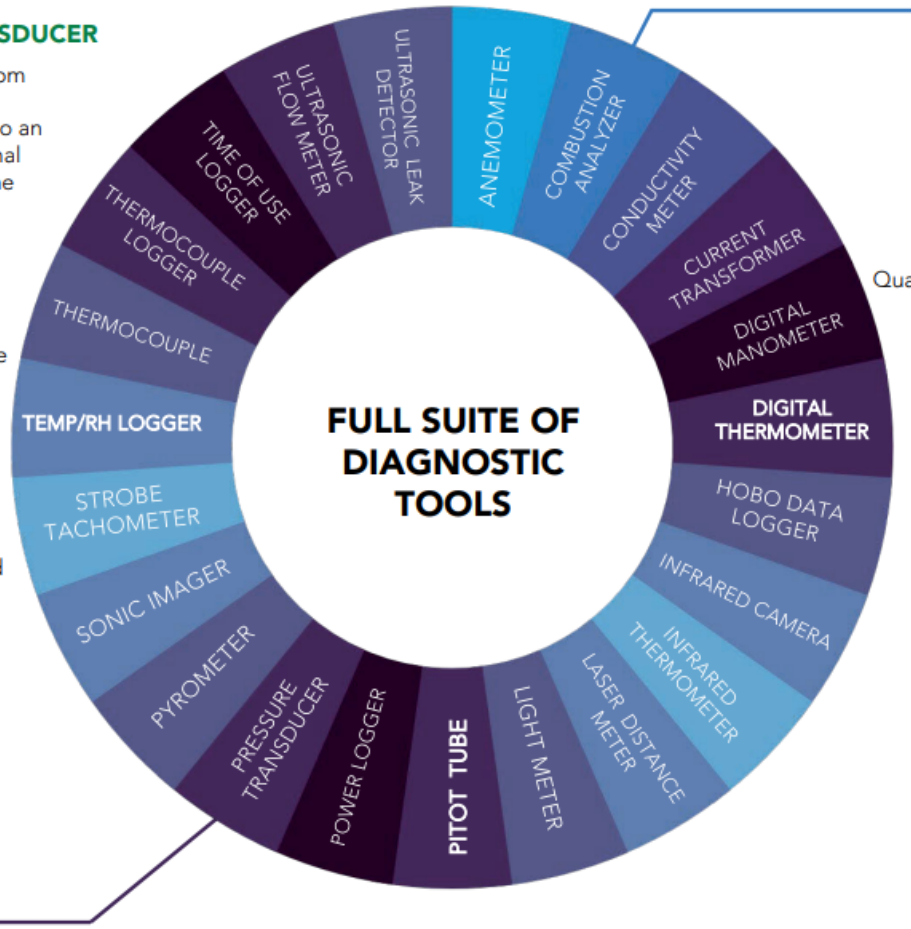
Technical Assistance: Diagnostic Equipment Program

PRESSURE TRANSDUCER

Converts pressure from compressed air and pumping systems into an analog electrical signal for recording, with the use of a data logger.

Why it matters:

Characterizing a compressed air system using pressure transducers and data loggers provides valuable insight into system performance over time. These instruments help identify imbalances between compressed air supply and demand, which enables users to identify and implement energy saving opportunities.



COMBUSTION ANALYZER

Quantifies excess oxygen in boiler/combustion process exhaust.

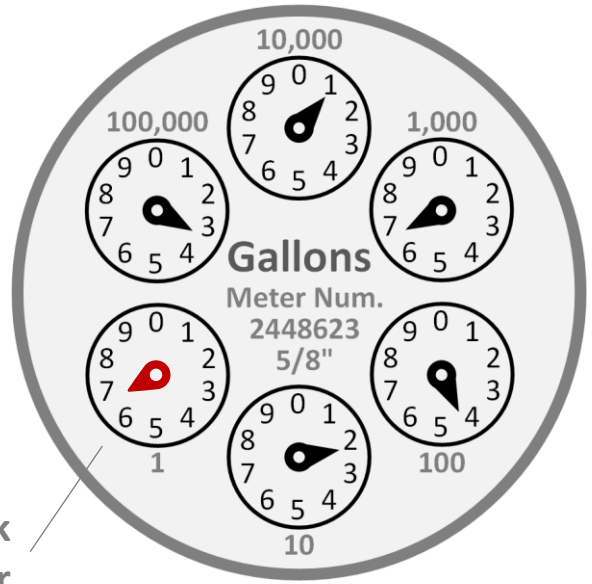
Why it matters:

When more air is present than is needed during boiler and combustion processes, heat is absorbed and exhausted. Quantifying excess oxygen helps reduce payment for heated air that is not being used.

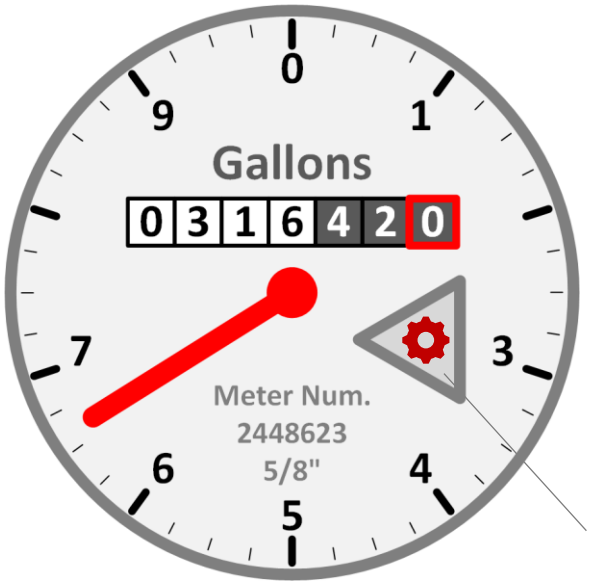
You can borrow power meters and other diagnostic equipment from the Better Plants program!

How to read water meters

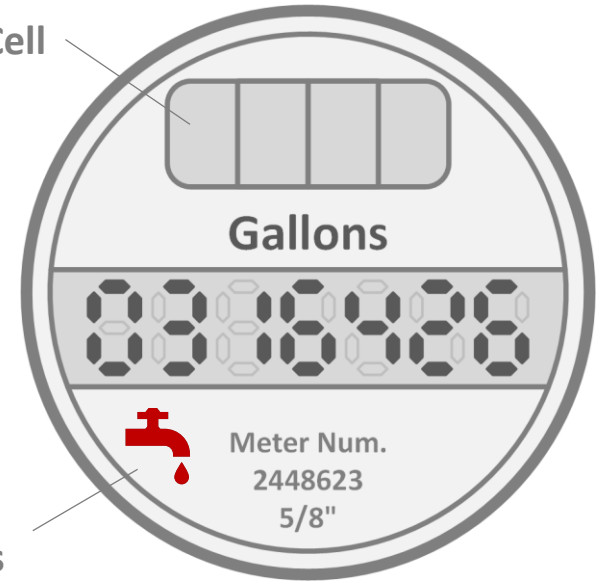
Dial Register



Analog Register



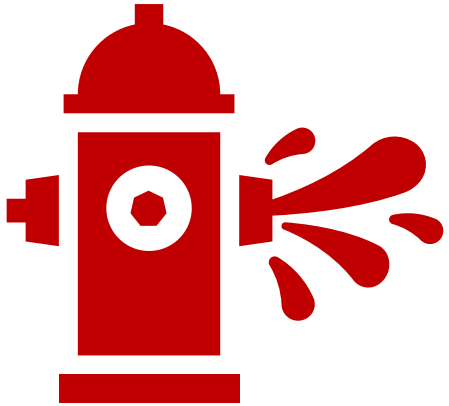
Digital Register



- Each of these meters reads 316,426 gallons
- Subtract previous from current reading to get usage
- Each meter will have a “Low-flow” or “Leak” indicator

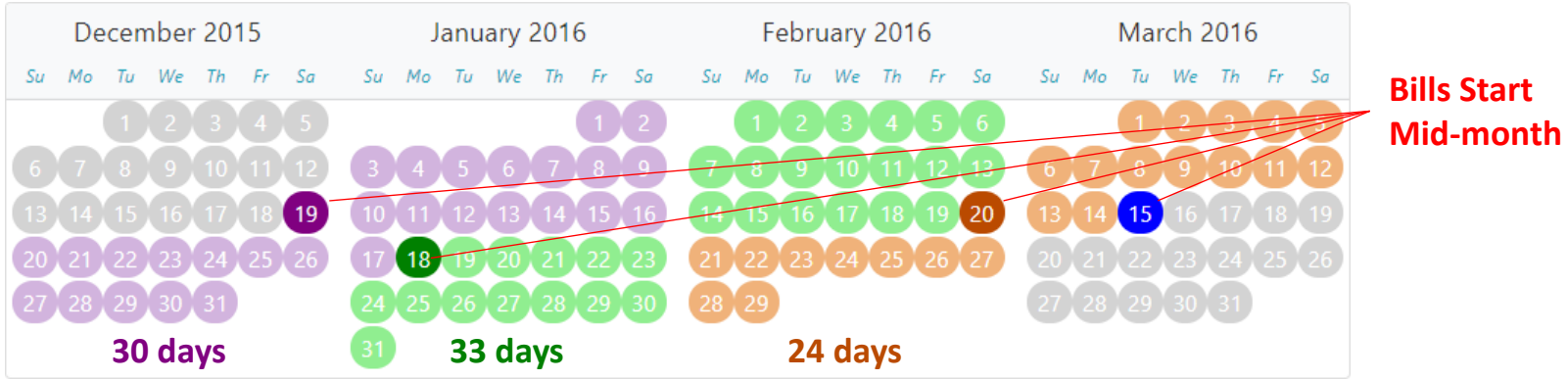
Low-flow Indicators

- To use a low-flow indicator to check for water leaks:
  1) Find your water meter (usually outside near a wall or property line)
  2) Check that the meter number matches the number on your bills
  3) Read the meter and write down the result
  4) Shut off all known water usage in your facility
  5) Observe if the low-flow indicator is moving. If you are not sure if it is moving, take another reading after a few hours.
- If low-flow indicator is active or the reading has changed; you probably have a leak!
- Identifying leaks can save you money on water and repairs!



What is calendarization?

- Billing periods inherently depend on when the utility reads your water meters each month



- Billing periods may be inconsistent and not align with production schedules or weather data
- ***Calendarization*** is the process of normalizing your water and other utility data for varying billing periods

How do you calendarize your data?

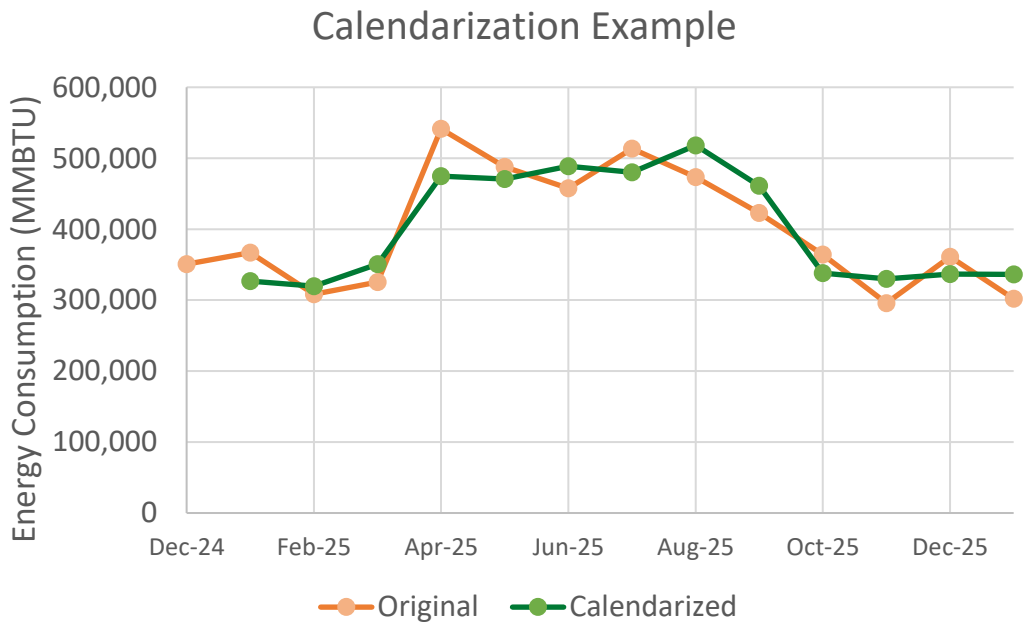
- Divide consumption by the number of days on the bill and allocate energy to the appropriate month.
- EXAMPLE: What is April's usage?

Read Date	Days on Bill	Usage (Gallons)
4/6/2025	35	541,405
5/7/2025	31	487,894

$$6 \times \frac{541{,}405\ gal}{35} = 92{,}812\ gal$$

$$24 \times \frac{487{,}864\ gal}{31} = 377{,}724\ gal$$

April 2025 Usage = 470,536 gal



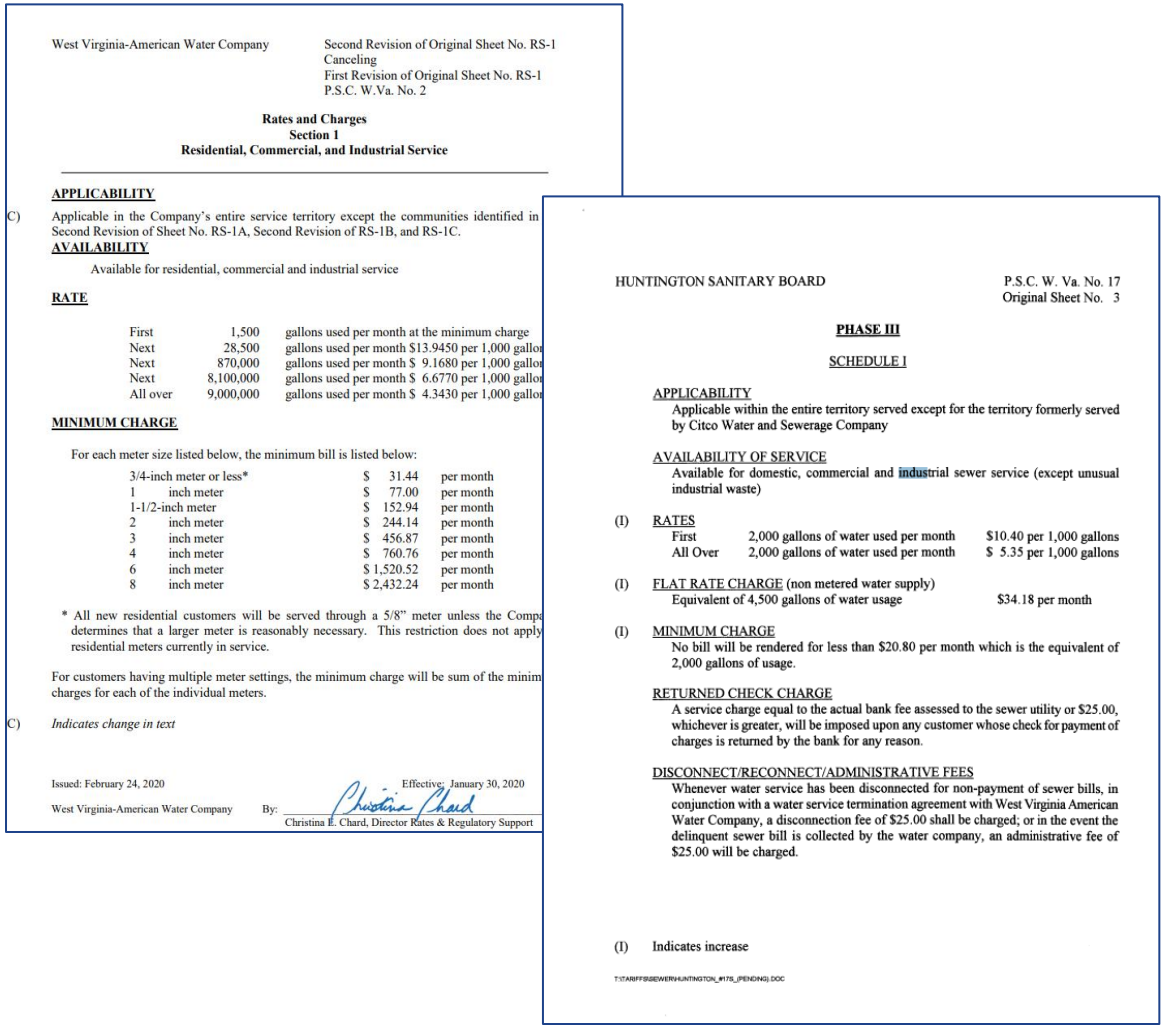
Water Tariffs

What is a Water Tariff?

- A ***Rate Schedule*** is a collection of pricing structures offered by a utility for different kinds of water service
- A ***Rate Tariff*** is a specific pricing structure that sets the terms of your water service
- Schedules and tariffs are generally considered public information
- You can usually find your utility's rate schedule and your specific tariff by…
  - Doing an internet search for "<INSERT UTILITY NAME> rate tariff"
  - Calling your utility

Rate Tariff Documents Can Be Complicated

- Documents can be very long
- Don’t be intimidated! All the information you need to reconstruct your bills is in this document.
- There are some basic tariff types:
  - Residential Service
  - Commercial Service
  - Industrial Service
- May be separate tariffs for supply and for sewer



West Virginia-American Water Company

Second Revision of Original Sheet No. RS-1
Canceling
First Revision of Original Sheet No. RS-1
P.S.C. W.Va. No. 2

Rates and Charges
Section 1
Residential, Commercial, and Industrial Service

APPLICABILITY

C) Applicable in the Company’s entire service territory except the communities identified in Second Revision of Sheet No. RS-1A, Second Revision of RS-1B, and RS-1C.

AVAILABILITY

Available for residential, commercial and industrial service

RATE

First	1,500	gallons used per month at the minimum charge
Next	28,500	gallons used per month $13.9450 per 1,000 gallo
Next	870,000	gallons used per month $ 9.1680 per 1,000 gallo
Next	8,100,000	gallons used per month $ 6.6770 per 1,000 gallo
All over	9,000,000	gallons used per month $ 4.3430 per 1,000 gallo

MINIMUM CHARGE

For each meter size listed below, the minimum bill is listed below:

3/4-inch meter or less*	$ 31.44	per month
1 inch meter	$ 77.00	per month
1-1/2-inch meter	$ 152.94	per month
2 inch meter	$ 244.14	per month
3 inch meter	$ 456.87	per month
4 inch meter	$ 760.76	per month
6 inch meter	$ 1,520.52	per month
8 inch meter	$ 2,432.24	per month

* All new residential customers will be served through a 5/8” meter unless the Compa determines that a larger meter is reasonably necessary. This restriction does not apply residential meters currently in service.

For customers having multiple meter settings, the minimum charge will be sum of the minim charges for each of the individual meters.

C) *Indicates change in text*

Issued: February 24, 2020
Effective: January 30, 2020

West Virginia-American Water Company By: Christina E. Chard, Director Rates & Regulatory Support

HUNTINGTON SANITARY BOARD

P.S.C. W. Va. No. 17
Original Sheet No. 3

PHASE III

SCHEDULE I

APPLICABILITY
Applicable within the entire territory served except for the territory formerly served by Citco Water and Sewerage Company

AVAILABILITY OF SERVICE
Available for domestic, commercial and industrial sewer service (except unusual industrial waste)

(I) RATES

First	2,000 gallons of water used per month	$10.40 per 1,000 gallons
All Over	2,000 gallons of water used per month	$ 5.35 per 1,000 gallons

(I) FLAT RATE CHARGE (non metered water supply)
Equivalent of 4,500 gallons of water usage $34.18 per month

(I) MINIMUM CHARGE
No bill will be rendered for less than $20.80 per month which is the equivalent of 2,000 gallons of usage.

RETURNED CHECK CHARGE
A service charge equal to the actual bank fee assessed to the sewer utility or $25.00, whichever is greater, will be imposed upon any customer whose check for payment of charges is returned by the bank for any reason.

DISCONNECT/RECONNECT/ADMINISTRATIVE FEES
Whenever water service has been disconnected for non-payment of sewer bills, in conjunction with a water service termination agreement with West Virginia American Water Company, a disconnection fee of $25.00 shall be charged; or in the event the delinquent sewer bill is collected by the water company, an administrative fee of $25.00 will be charged.

(I) Indicates increase

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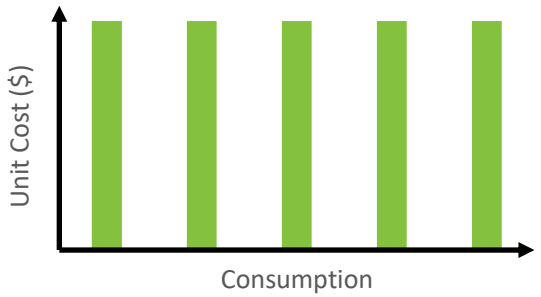
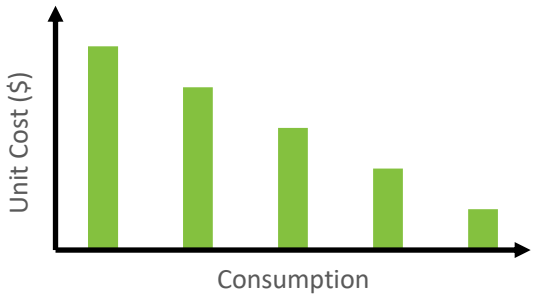
Block Rates

- Cost of water changes based on how much water you use
- Common block structures:

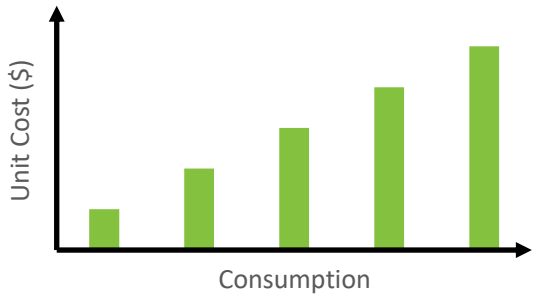
Uniform Rate



Decreasing Block Rate



Increasing Block Rate



Example:

First 1,500 gal	$13.945/kgal
Next 28,500 gal	$9.168/kgal
Next 870,000 gal	$6.677/kgal
All Additional Usage	$4.343/kgal

524,300 gallons of consumption is:

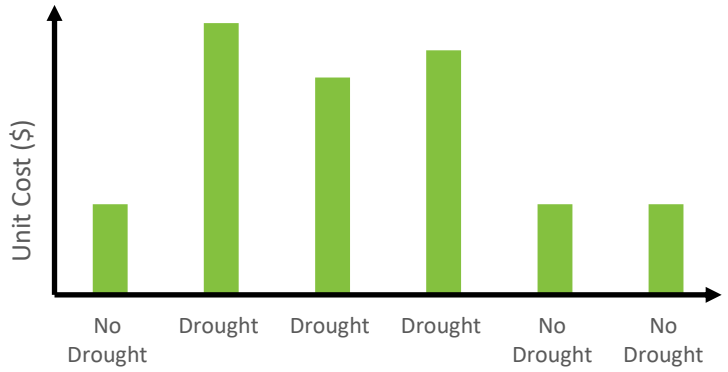
1.5 kgal x $13.945/kgal = $20.92
28.5 kgal x $9.168/kgal = $261.29
494.3 kgal x $6.677/kgal = $3,300.44

$3,582.65

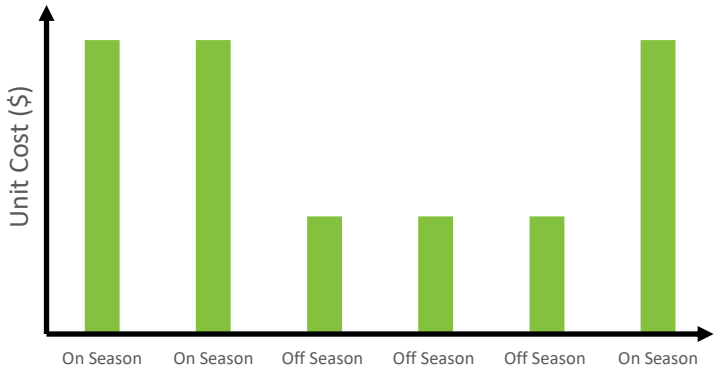
Time-of-Use (TOU) Rates

- Cost of water changes based on when you use water
- Common TOU Rates include:

Drought Rates



Seasonal Rates



Example:

No Drought	$2.667/kgal
Stage 1	$3.333/kgal
Stage 2	$4.000/kgal
Stage 3	$5.667/kgal

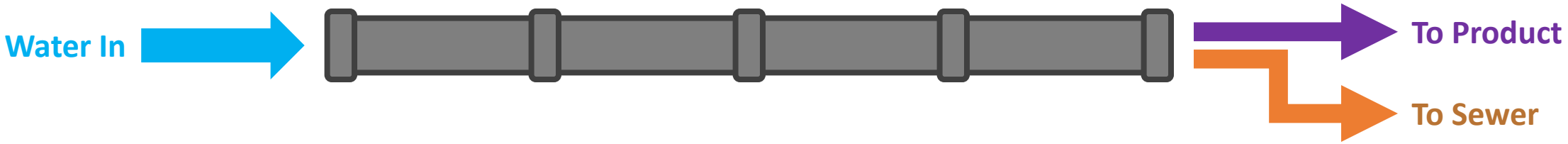
423,220 gallons of water usage is:

No Drought	= $1,128.73
Stage 1 Drought	= $1,410.59
Stage 2 Drought	= $1,692.88
Stage 3 Drought	= $2,398.39

Sewer Charges

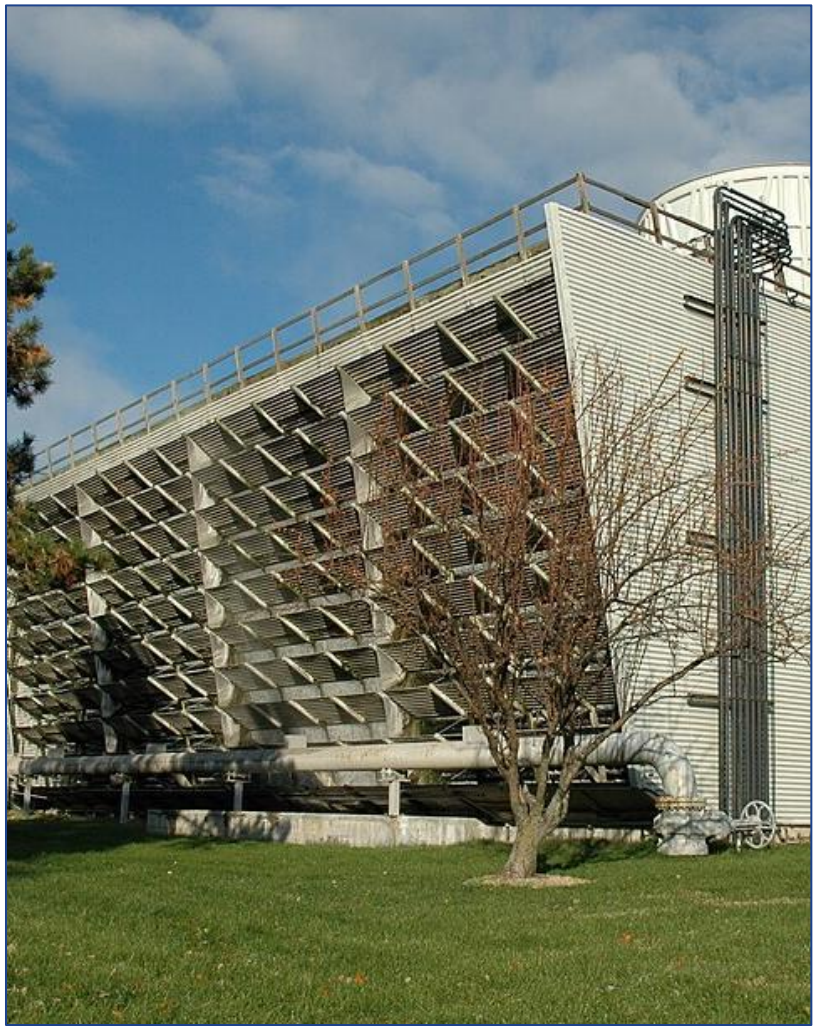
- Facilities are not just billed for their incoming water
- Utilities also charge for water disposal with ***Sewer Fees***
  - Can be *different* utility than the one that delivered the water
- Sewer fees can be >50% of total water utility cost
- Every facility has an incoming consumption meter, not all facilities have an outgoing ***Sewer Meter***
- Without a sewer meter, utilities will assume that…

Incoming Water = Outgoing Water



Avoiding Sewer Treatment Charges

- Sewer meters ensure that you pay water disposal fees only for water that goes down the sewer
  - Good option for industries that consume a lot of water or that make products that contain water
- ***Evaporation Credits*** or ***Sewer Credits*** can also be used if metering is not present or feasible
  - Good options for cooling tower water
  - Requires documentation showing how evaporation rate is calculated or metering make-up water
- Some facilities may be able to treat their own water to avoid high sewer treatment fees



Example: Evaporation Credits for a Cooling Tower

A manufacturing plant monitors the make-up water rate (12,000 gal/day) and bleed-off rate (4,500 gal/day) for their cooling tower. Estimate the potential evaporation credit for this facility assuming a sewer rate of $3.00/kgal and that the drift rate is negligible.

Evaporated Water Volume = Make-up Water Rate – Bleed-off Water Rate
= 12,000 gal/day – 4,500 gal/day
= 7,500 gal/day

Evaporation Credit Savings = Evaporation Rate × Sewer Rate
= 7,500 gal/day × 30 days/month × $0.003/gal
= $675/month or $8,100/year

Types of sewer lines

- Pay attention to your water sources and discharges!
- Use your cheapest source or sewer as much as possible

Industrial Water

- Not as rigorously treated as regular municipal water
- Can be used as process water for non-sensitive products
- Costs **less** than municipal water

Industrial Sewer

- Longer and more involved treatment process needed
- Used when water is too contaminated for regular municipal treatment
- Costs **more** than municipal sewer

Opportunity for Cheaper Water Source

- Manufacturing facility must cool boiler blowdown water before it can be sent down the sewer
- Currently using clean city water directly from domestic water line
- Opportunity to offset city water usage with blowdown water from cooling towers also sent to sewer
- Could save 125,000 gal of city water and $1,625 in utility cost per year

Other Utility Charges

Riders, fees, and taxes

What Are All of These Additional Line Items?

- Several additional charges can appear on your bills
- **Riders** are additional charges that are not part of the base tariff
- Regulated by Public Utility (PUC) or Public Service (PSC) commissions
- Typically have very descriptive names because they are earmarked for specific programs, projects, etc.
- Can be calculated based on consumption OR fixed
- Can be credits or charges
- Your rate tariffs will list all riders with terms and conditions

Example Riders

- Fire-line Fee
- Storm Drain Fee
- Sewer Treatment Surcharge
- Standby Fee
- Inspection Fee

Wastewater Surcharges

- The Federal Clean Water Act regulates discharge of pollutants into all US waters
- Industrial facilities can either:
  - Pretreat wastewater to meet required limits before sending water through the municipal sewer system

    -- OR --
  - Pay a surcharge for excessive waste in the discharge water sent to sewer system
- Regulated properties include:
  - Biochemical Oxygen Demand
  - Total Suspended Solids
  - Oil and Grease
  - Ammonia

Example Surcharge Calculation:

Pollutant	Tested (mg/L)	Limit (mg/L)	Cost ($/lb)
Biochemical Oxygen Demand	300	200	$0.35
Total Suspended Solids	250	175	$0.17
Total Nitrogen	40	20	$0.17
Total Phosphorus	20	10	$0.45

Average Sewer Usage: 600,000 gal/month

BOD: $0.35/lb × (300 – 200 mg/L) × 8.34 × 0.6 MMgal = $175.14

TSS: $0.17/lb × (250 – 175 mg/L) × 8.34 × 0.6 MMgal = $63.80

TN: $0.17/lb × (40 – 20 mg/L) × 8.34 × 0.6 MMgal = $17.01

TP: $0.45/lb × (20 – 10 mg/L) × 8.34 × 0.6 MMgal = $22.52

Total Surcharge = BOD + TSS + TN + TP = $278.47/month

Late Fees Are Just High Interest Loans!

- Every company (including your utility) charges late fees
- Late payment fees can be > 10% of the balance
- Late bills are the same as borrowing money from your utility… at an EXTREMELY HIGH interest rate
- Check if due date is “Mailed By” or “Received By”
- Consider a 5% Late Fee…

Nominal Annual Interest rate $(r) = \frac{5\%}{\text{month}} = \frac{60\%}{\text{year}}$

Compounding Frequency $(n) = 12$

→ Compound Interest $= \left(1 + \frac{r}{n}\right)^n - 1 =$ **80%!**

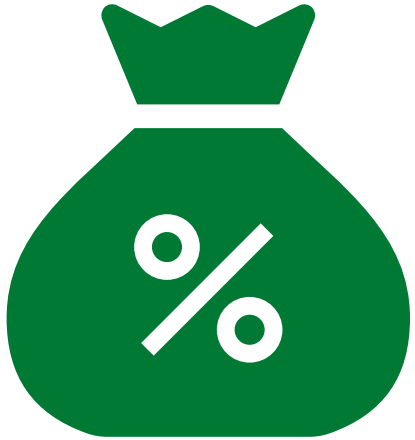
Meter Fees Can Add Up!

- **Fixed Charges** are built into the rate structure
- Amount stays the same each month
- Not related to your water usage but to the water service itself
- Common fixed fees include customer and metering fees
- Larger service typically has higher fixed fees
- *Sometimes* there are opportunities to consolidate meters and avoid duplicate fees
  - Good opportunity with gas and water meters!

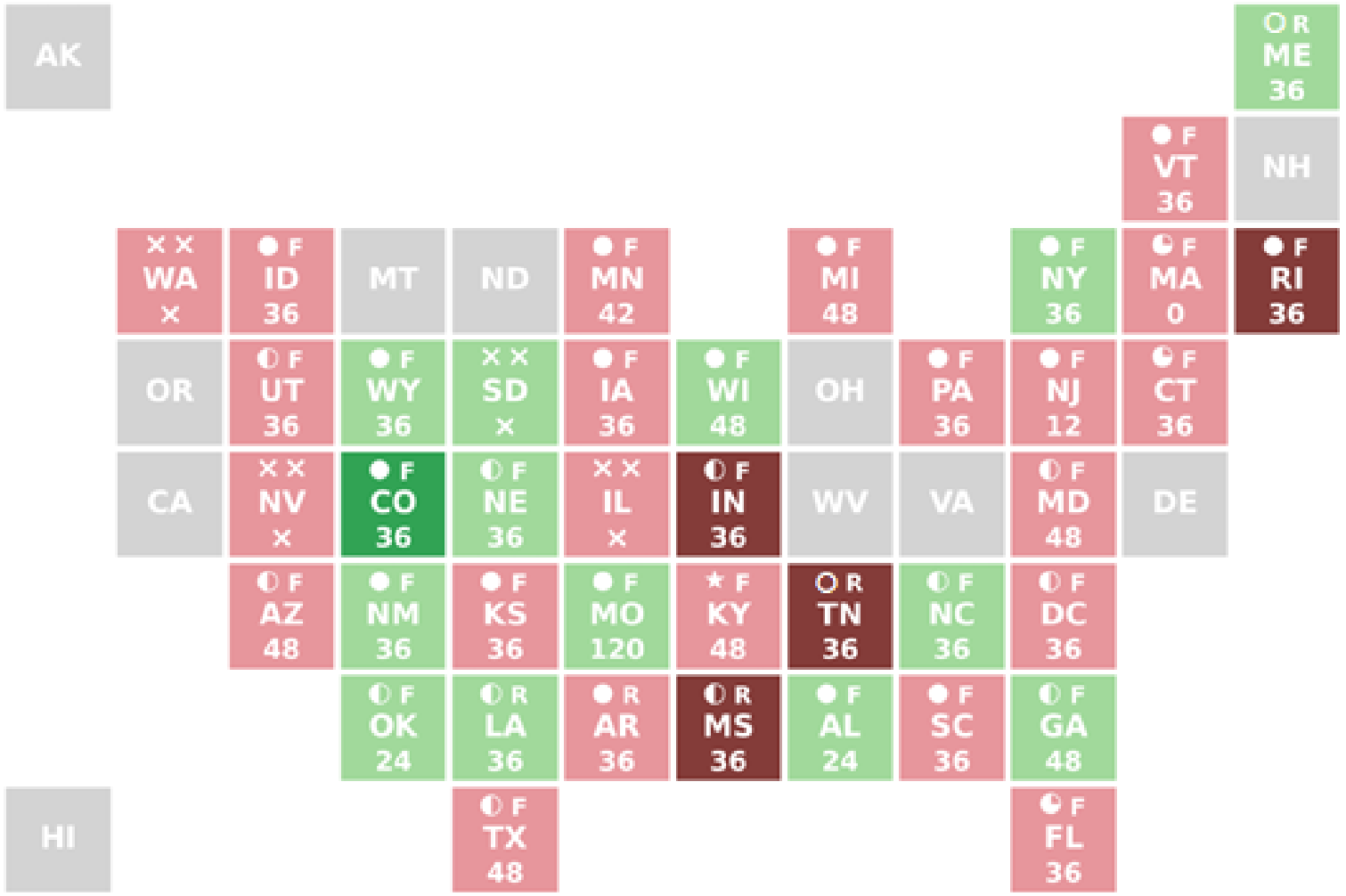
https://upload.wikimedia.org/wikipedia/commons/b/b9/Hydro_quebec_meter.JPG

State Sales Tax Exemptions

- Nearly every state offers some kind of exemption for sales tax on utilities used for manufacturing
- This can be significant depending on your state and utility costs
- States will even let you reclaim previously paid sales tax!
  - Up to 48 months depending on statute of limitations
- Most states require a **Predominate Use Study**
  - Third party assessment to determine manufacturing energy usage
- Depending on the state, can receive up to 100% exemption for meters where >X% of usage is used towards manufacturing



Sales Tax Exemption



Exemption Threshold
- × No Exemption
- ○ Any Manufacturing
- ◐ 50% Manufacturing
- ◔ 75% Manufacturing
- ● Only Manufacturing
- ★ 3% Production Cost

XX
Rebate Window (months)

Exemption Type
- × No Exemption
- F Full Exemption
- R Reduced Rate

State Sales Tax
- No Utility Sales Tax
- Tax < 4.0%
- 4.0% ≤ Tax < 5.5%
- 5.5% ≤ Tax < 7.0%
- 7.0% ≤ Tax

Auditing a Water Bill

Recreating Your Water Bill (Example)

- Fine Factories Incorporated (FFI) has a facility located outside of Huntington, WV
- FFI has a 4-inch service pipe and average monthly water usage of 408,725 gallons
- Consumption is on West Virginia-American Water Company's industrial block tariff
- Sewer provided by the Huntington Sanitary Board

Water Usage Block Tariff

First 1,500 gallons:	$13.945/kgal
Next 28,500 gallons:	$9.168/kgal
Next 870,000 gallons:	$6.677/kgal
All Remaining:	$4.343/kgal

Sewer Block Tariff

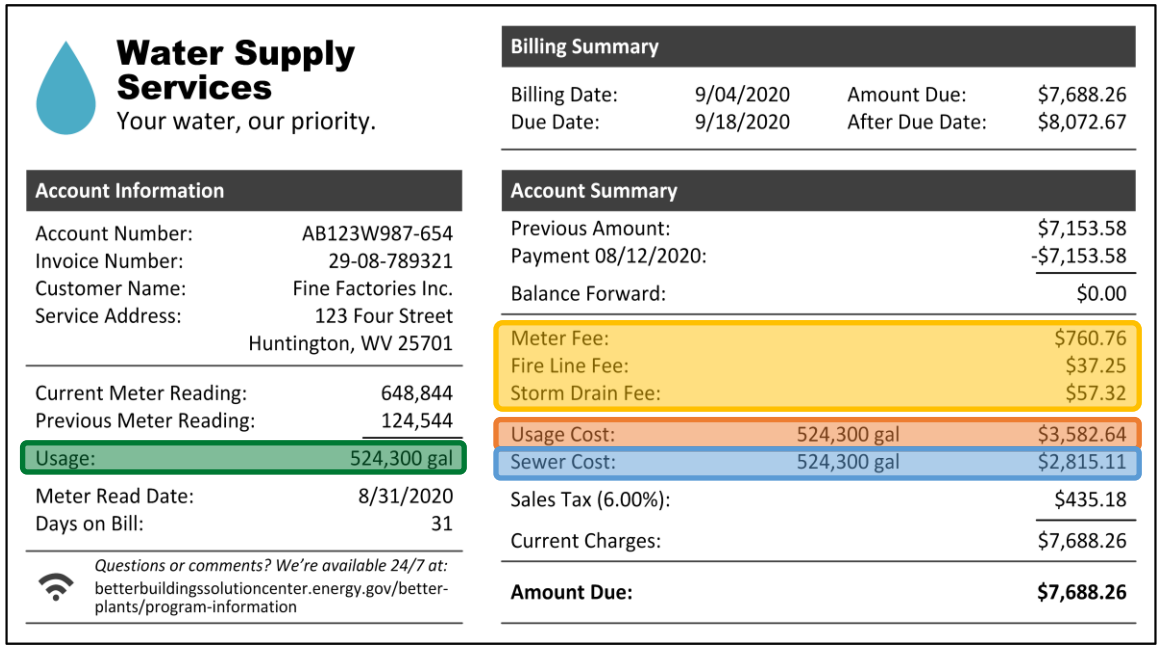
First 2,000 gallons:	$10.40/kgal
All Remaining:	$5.35/kgal

Fixed Fees

Meter Fee (4-inch):	$760.76/month
Fire Line Fee:	$37.25/month
Storm Drain Fee:	$57.32/month

→ MARGINAL WATER COST = $6.667/kgal + $5.35/kgal
= $12.027/kgal

Now let's look at a bill…



Water Supply Services
Your water, our priority.

Account Information

Account Number:	AB123W987-654
Invoice Number:	29-08-789321
Customer Name:	Fine Factories Inc.
Service Address:	123 Four Street Huntington, WV 25701
Current Meter Reading:	648,844
Previous Meter Reading:	124,544
Usage:	524,300 gal
Meter Read Date:	8/31/2020
Days on Bill:	31

Questions or comments? We're available 24/7 at:
betterbuildingssolutioncenter.energy.gov/better-plants/program-information

Billing Summary

Billing Date:	9/04/2020	Amount Due:	$7,688.26
Due Date:	9/18/2020	After Due Date:	$8,072.67

Account Summary

Previous Amount:		$7,153.58
Payment 08/12/2020:		-$7,153.58
Balance Forward:		$0.00
Meter Fee:		$760.76
Fire Line Fee:		$37.25
Storm Drain Fee:		$57.32
Usage Cost:	524,300 gal	$3,582.64
Sewer Cost:	524,300 gal	$2,815.11
Sales Tax (6.00%):		$435.18
Current Charges:		$7,688.26
Amount Due:		**$7,688.26**

→ BLENDED WATER COST = $7,688.56/524.3kgal
= $14.66/kgal

Success!

(But can you spot what they could be doing better?)

Let's step through this bill:

Consumption

(Current Reading – Previous Reading) × Meter Multiplier

(648,844 – 124,544) × 1

524,300 gallons ☑

Consumption Charge

1,500 gallons × $0.013945/gal = $20.92

28,500 gallons × $0.009168/gal = $261.29

494,300 gallons × $0.006677/gal = $3,300.44

$20.92 + $261.29 + $3,300.44 = $3,582.65 ☑

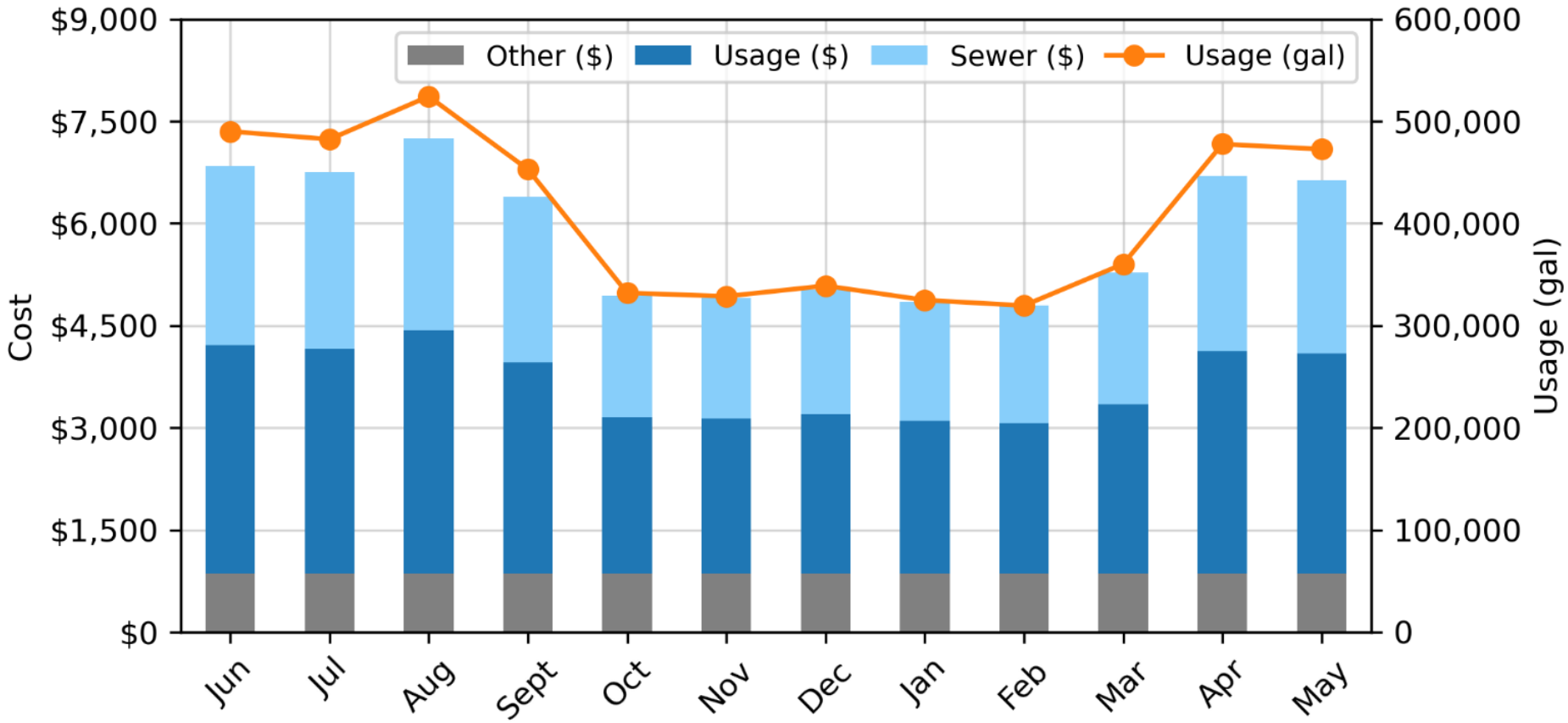
Sewer Charge

2,000 gallons × $0.01040/gal = $20.80

522,300 gallons × $0.00535/gal = $2,794.30

$20.80 + $2,794.30 = $2,815.11 ☑

Tracking Data Allows FFI to Understand Water Costs



True Cost of Water

How to use MEASUR to analyze your water usage

Your Guest Presenter!

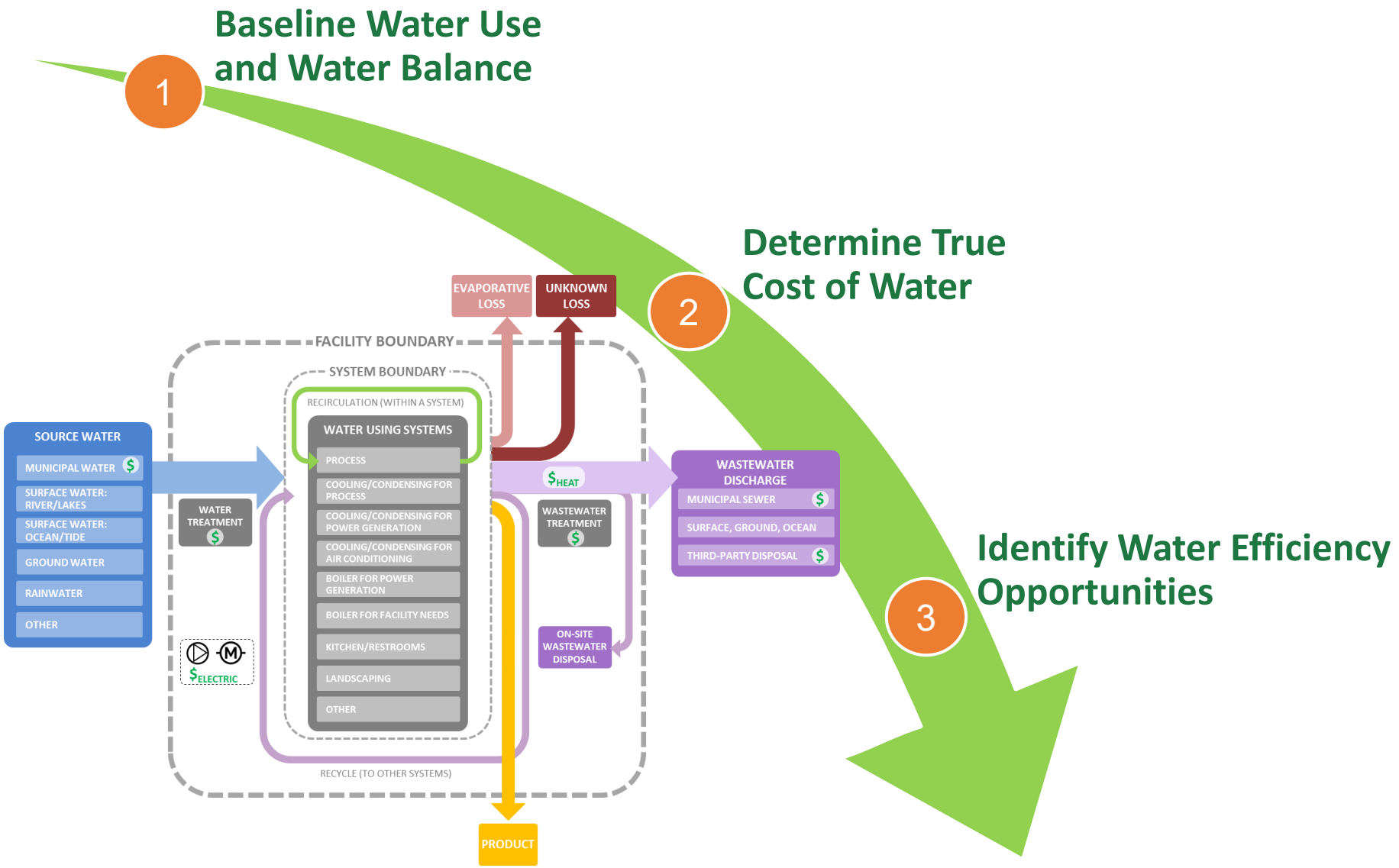
Kiran Thirumaran
R&D Associate
Oak Ridge National Laboratory

MS from North Carolina State University
BS from Anna University, Chennai, India

OAK RIDGE National Laboratory

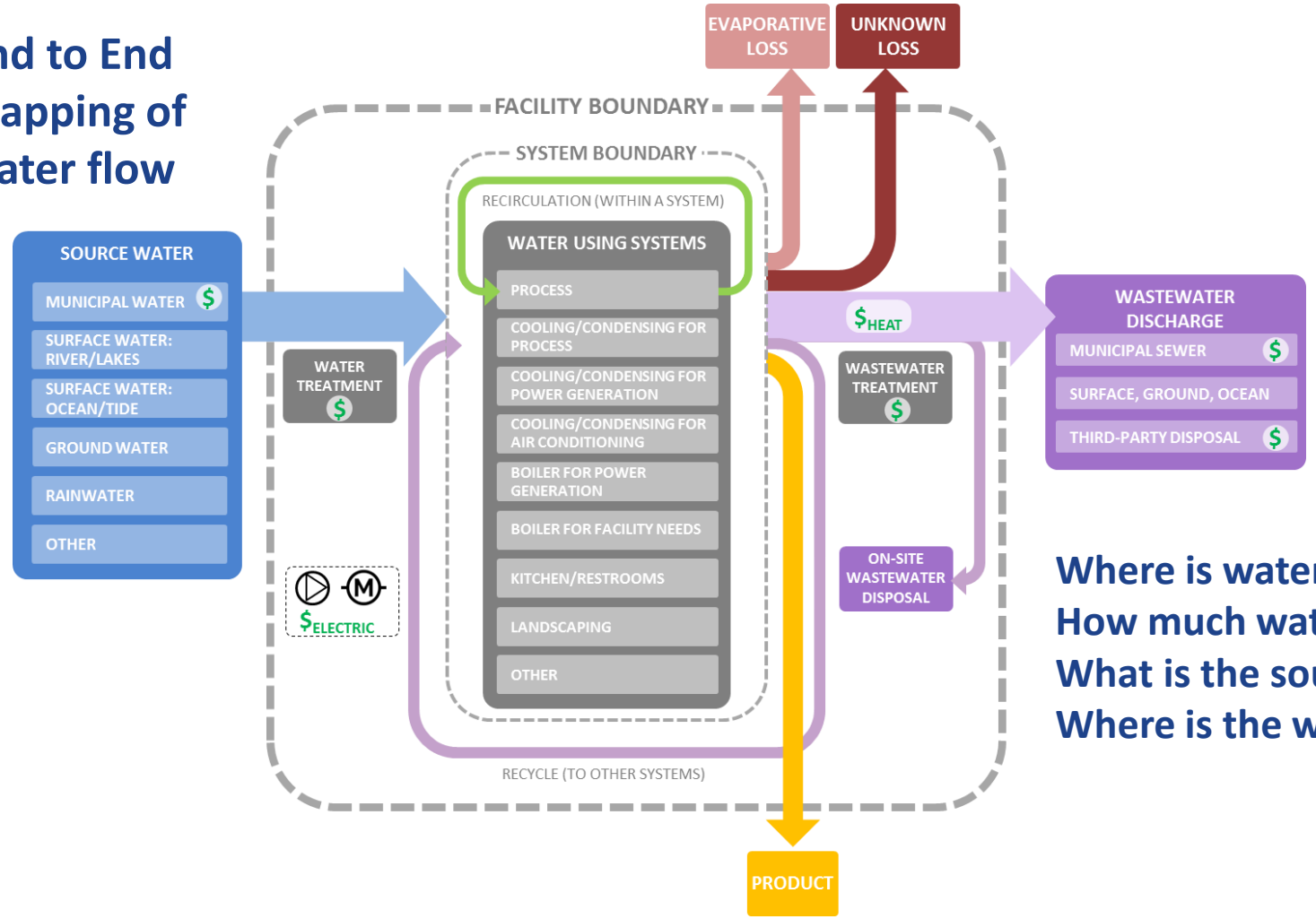
Mr. Thirumaran is a research staff at Oak Ridge National Laboratory (ORNL) with a focus on industrial energy and water efficiency, thermal process intensification, industrial decarbonization, and statistical analysis. Mr. Thirumaran has more than 8 years of professional experience which includes working as a research staff at Oak Ridge National Laboratory, implementing utility rebate programs as an energy engineer for CLEAResult, and as an engineering lead for DOE's Industrial Assessment Center at North Carolina State University. As part of the Manufacturing Energy Efficiency Research and Analysis (MEERA) group, he provides technical support to Better Plants Program and assists manufacturing companies achieve their energy, water, and carbon reduction targets. As the engineering lead for the program's water efficiency efforts, he conducts water efficiency workshops at industrial facilities. Mr. Thirumaran also supports the Department of Energy's (DOE) effort to transition several legacy software tools to a modern, open-source format (MEASUR) and conducts life-cycle assessment and techno-economic analysis in sustainable manufacturing, circular economy, decarbonization, and water-energy nexus.

Steps to performing a Water Assessment



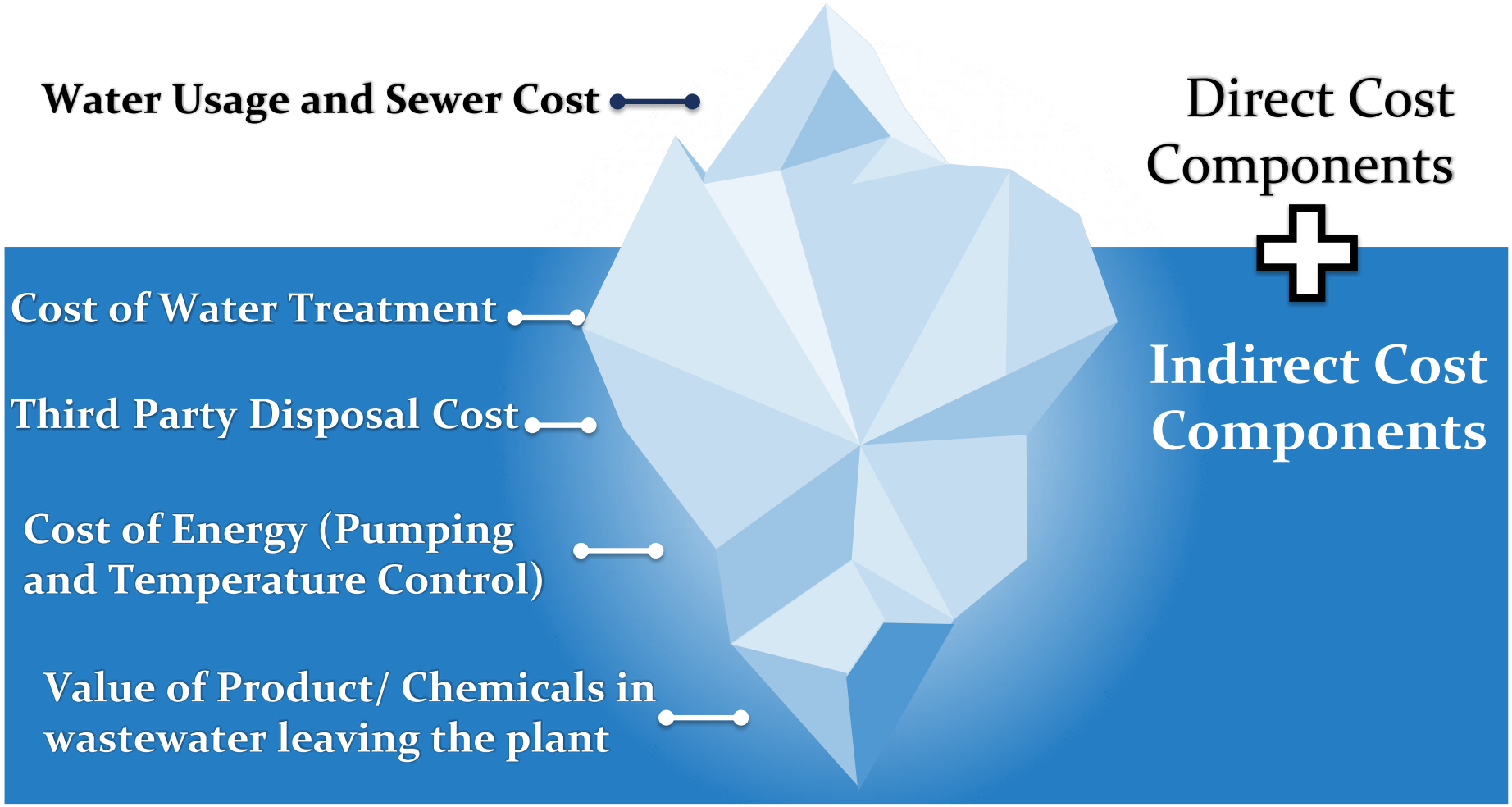
Step 1. Baselining water use

End to End mapping of water flow



Where is water used ?
How much water is used?
What is the source of the water?
Where is the water discharged?

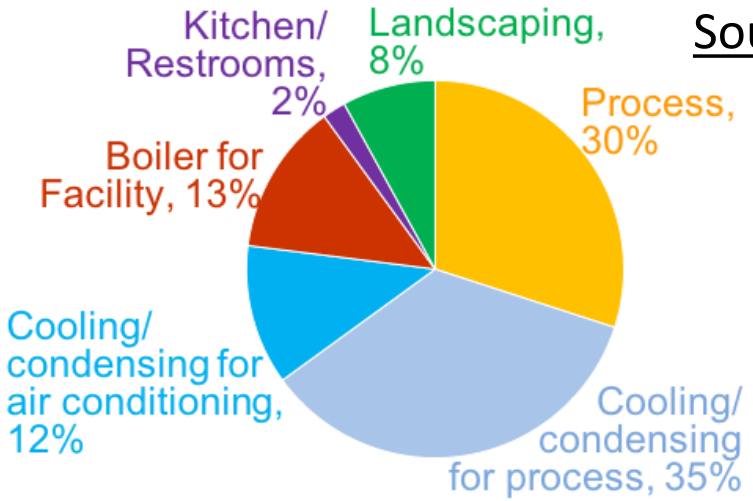
Step 2. True Cost of Water



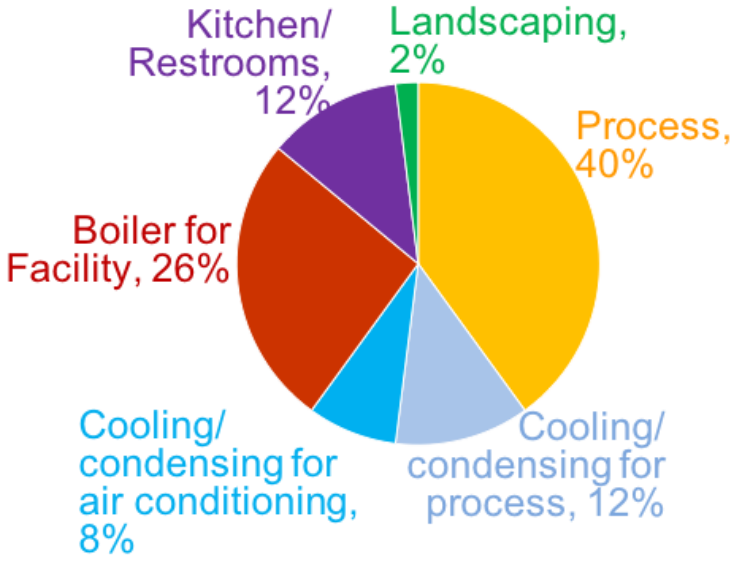
Why true cost of water?

Significance to the facility

- Reveals hidden costs of using water
- Identifies water use-intensive versus cost-intensive systems to help prioritize measures
- Helps estimate the actual cost savings from water efficiency projects, thereby prioritize and justify them



Source water intake



True cost of water

Typical True Cost Components

1. Direct costs
   - Municipal water intake
   - Wastewater discharge

2. Indirect Cost
   1. Cost of pumping (and other motor energy)
   2. Cost of water and wastewater treatment
   3. Cost of heat energy in wastewater
   4. Third Party disposal
   5. Value of product in wastewater stream

Pumps – Motor driven Systems

- Source water intake:
  - Pumping Groundwater
  - Pumping Surface water
- Process
  - Booster Pressure pump
  - Recirculation pumps
- Cooling and condensing system
  - Make-up water pumps
  - Water recirculation pumps
  - Cooling Tower Fans
- Boiler/Steam system
  - Make-up water pumps
  - Boiler Feedwater pumps
  - Condensate Return pumps

Pumps – Motor driven Systems

Outside of these stand-alone motors, there is energy considered as part of water treatment as well

A small fraction of the motor population is responsible for most of the energy consumption

Focus on the relatively big stuff that runs a lot.

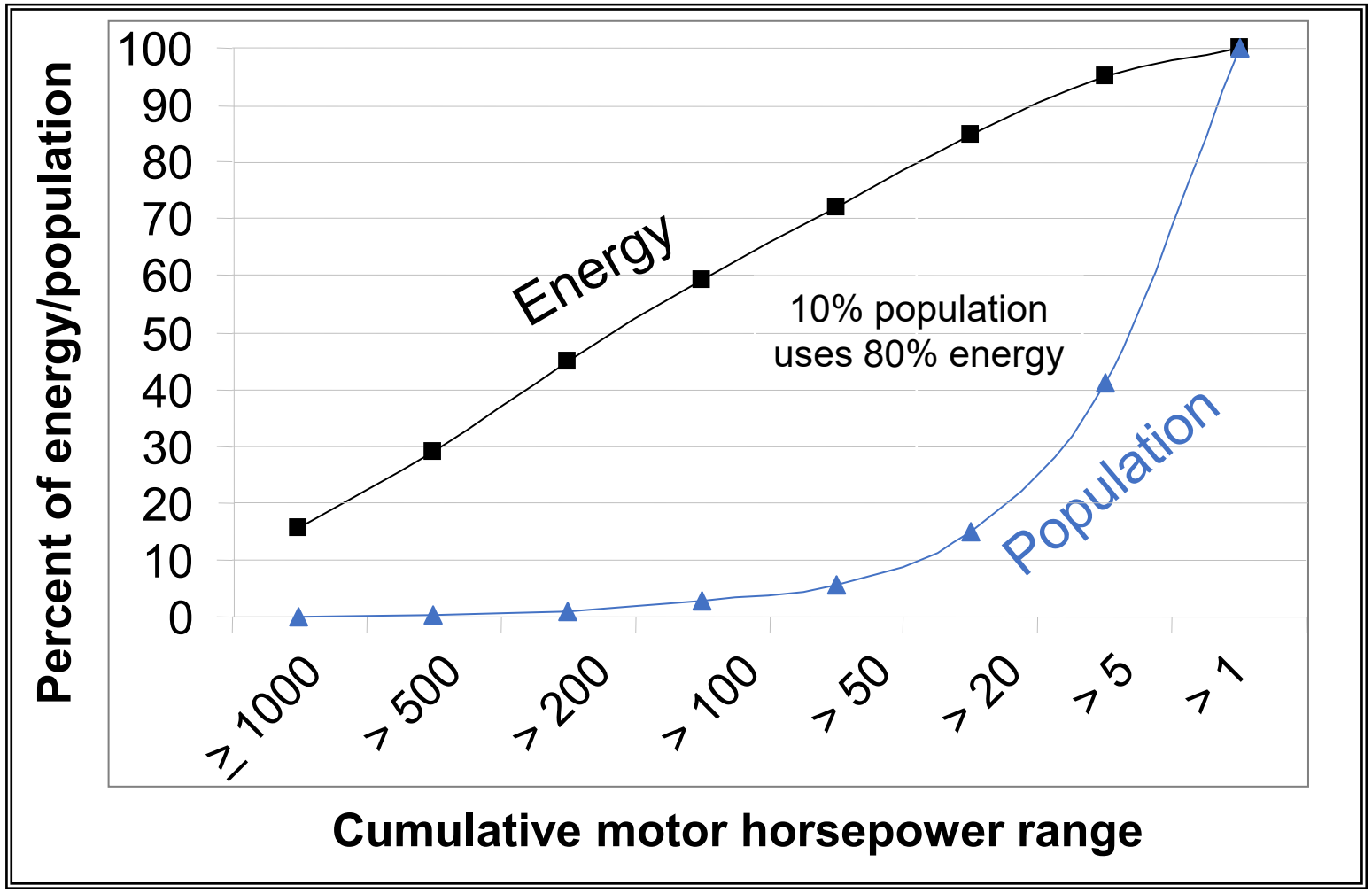
These are typically

- Intake pump station
- Cooling tower recirculation systems
- Plant wide circulation pumps

Facilities inventory can be used if kept updated

System drawing might not have the most updated and accurate information

Secondary pumps can be ignored



Note the descending order (left to right)

Water and Wastewater Systems – Examples

RO System

Aeration System

Settling/Separation tanks (chemical treatment)

Water Softeners

Clarifiers

PH Neutralization Systems

Electrolysis based treatment

Source: BP Summit 2021 , Suncombe

Estimating Cost of Water and Wastewater treatment

For each water and wastewater treatment process:

If maintained by the facility

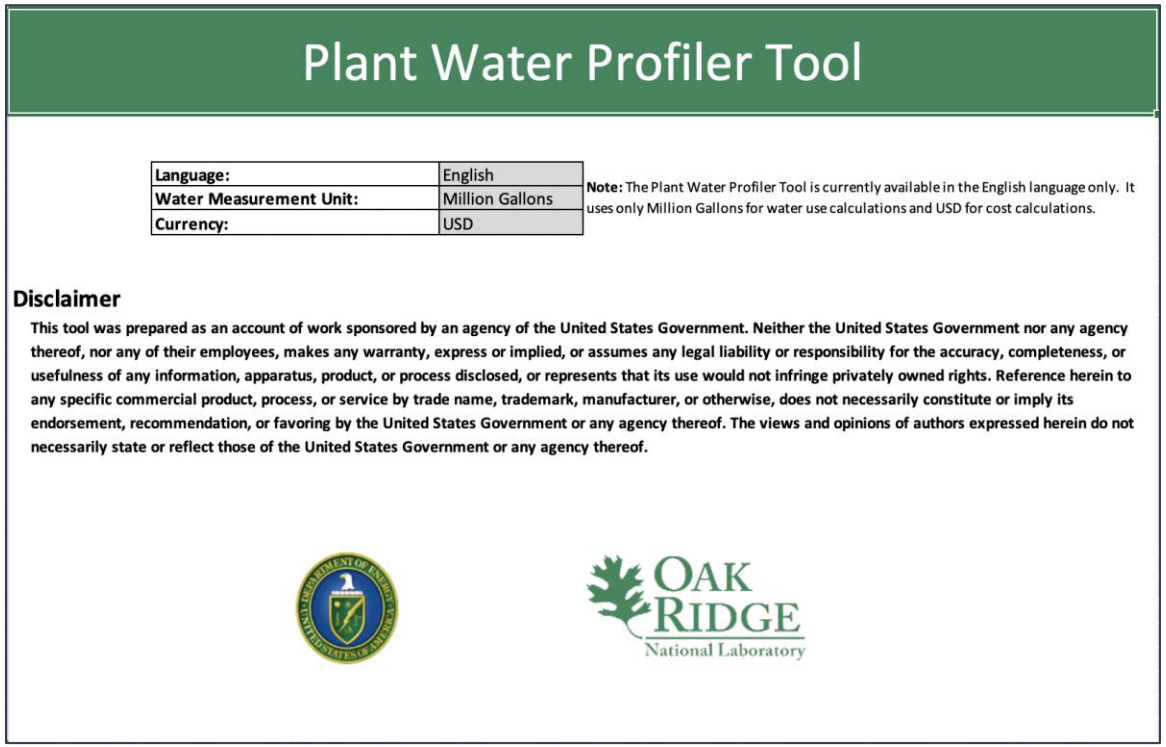
- Cost of water (or wastewater) treatment ($/year) = Sum of unit cost of treatment process ($/kGal)
  - Cost of chemicals
  - Cost of energy
  - Cost of operation (replacements, maintenance)
  - Annualized cost of equipment installation (if appropriate)

If maintained through a third-party service

- Cost of water (or wastewater) treatment ($/year) = Annual total amount paid to the third-party

Plant Water Profiler (PWP) Tool (Legacy)

The Plant Water Profiler (PWP) tool is a comprehensive excel-based tool designed for use by manufacturing plants to help perform a facility level water assessment.



Plant Water Profiler Tool

Language:	English
Water Measurement Unit:	Million Gallons
Currency:	USD

Note: The Plant Water Profiler Tool is currently available in the English language only. It uses only Million Gallons for water use calculations and USD for cost calculations.

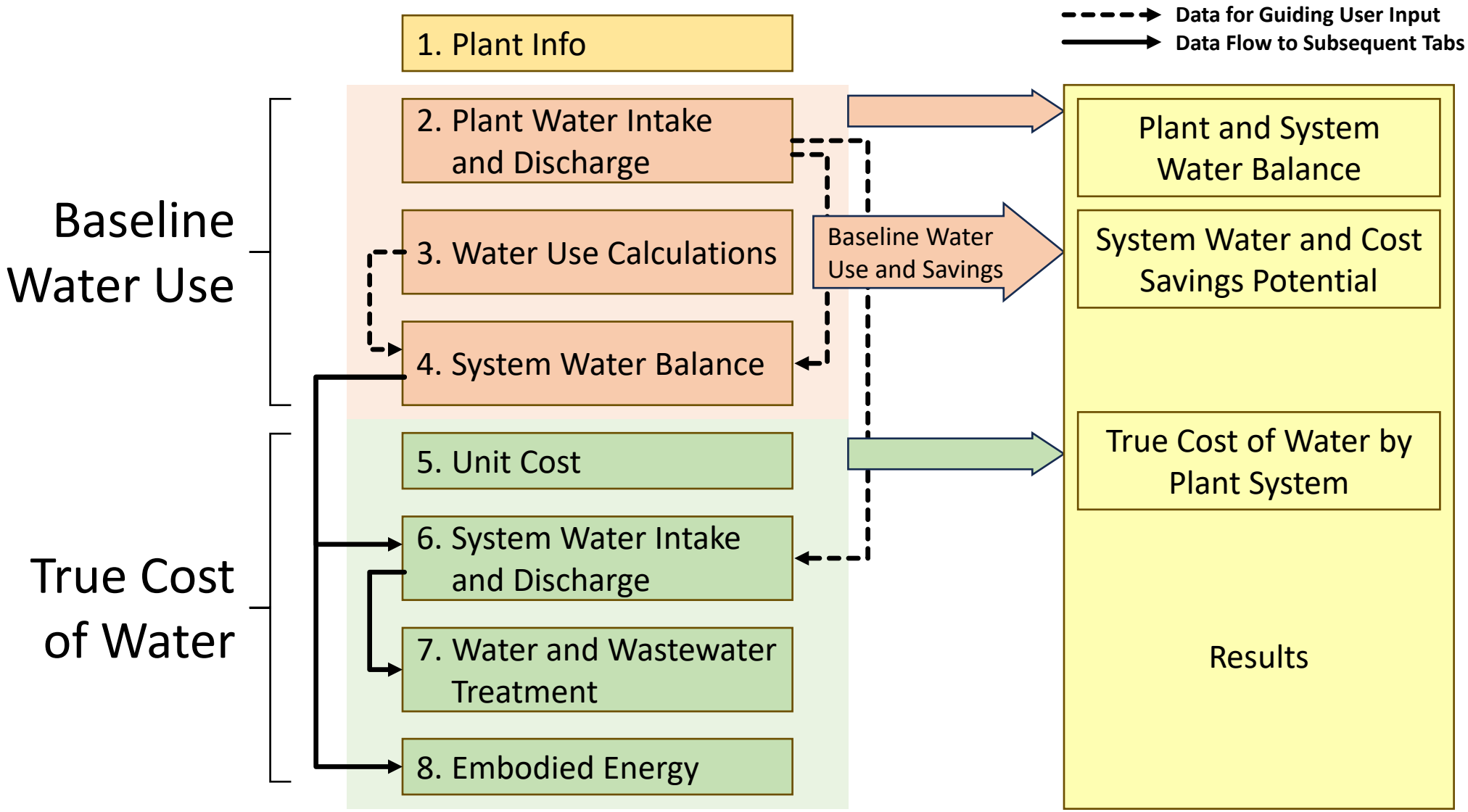
Disclaimer

This tool was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

OAK RIDGE National Laboratory

https://www.energy.gov/eere/amo/plant-water-profiler-tool-excel-beta-version-pwpex-v01

Legacy PWP Tool – Map



*Tab 9 and 10 associated with finding water savings opportunities

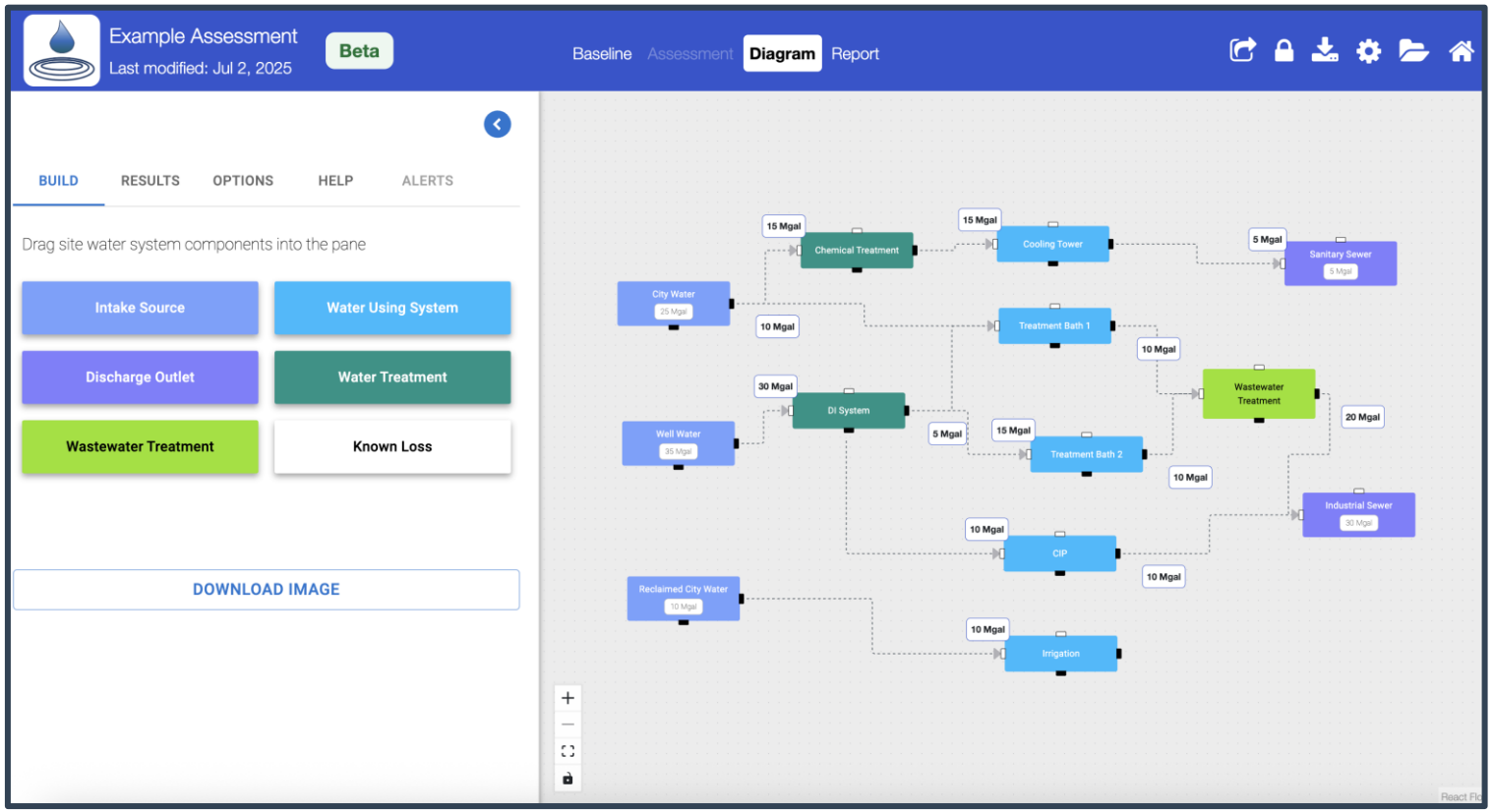
Integrated Energy Software - MEASUR

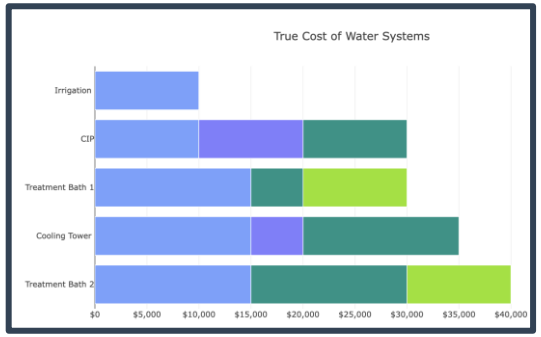
- Includes 8 assessment modules and 75+ individual calculators
- Available for download and online
- Includes built-in guides and tutorials
- A streamlined and consistent interface for easier use and faster learning
- Results and reporting generation features

https://www.energy.gov/eere/amo/measur

Water Assessment Module

Create a dynamic flow diagram and perform the assessment steps using an intuitive interface



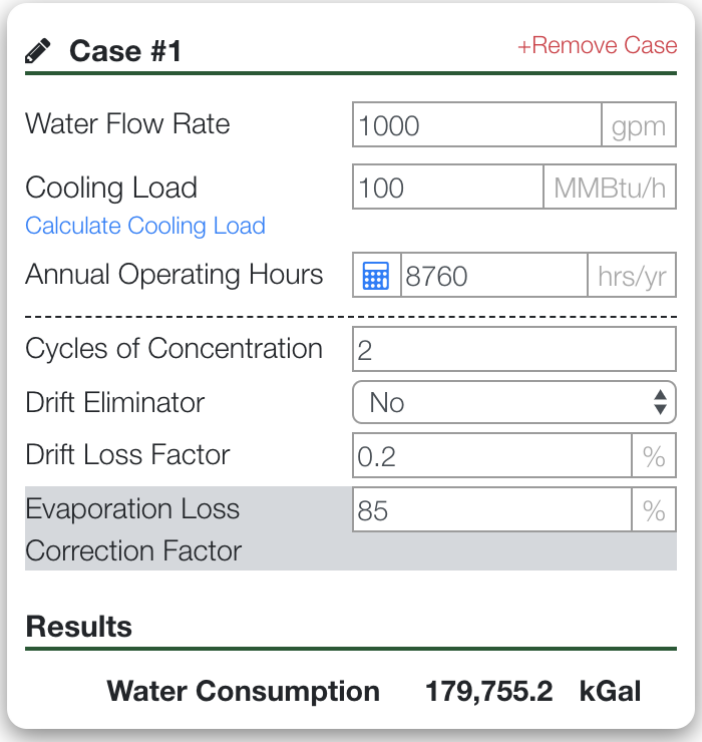


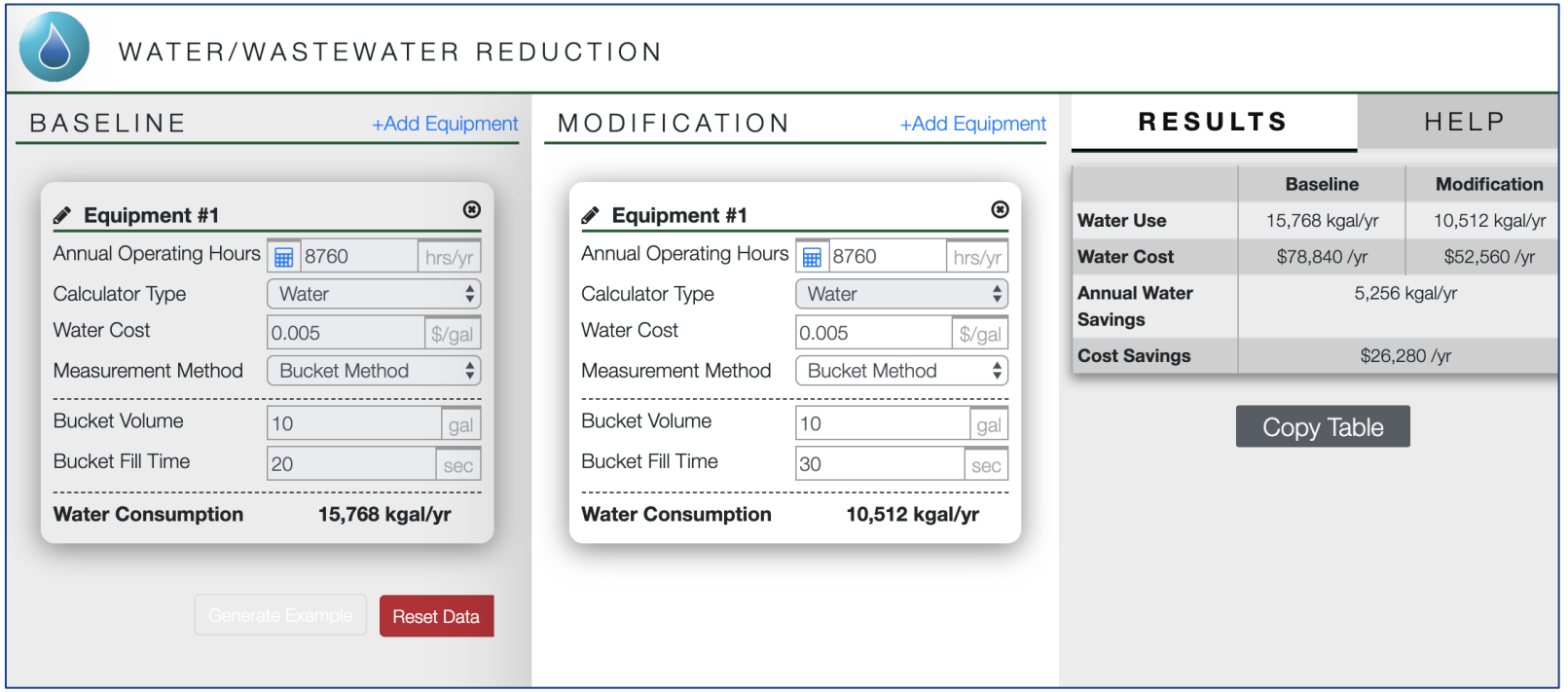
BUILD | RESULTS | OPTIONS | HELP | ALERTS

Annual Intake	
City Water	25 Mgal
Well Water	35 Mgal
Reclaimed City Water	10 Mgal
Total Intake	70 Mgal

Annual Discharge	
Sanitary Sewer	5 Mgal
Industrial Sewer	30 Mgal
Total Known Loss	0 Mgal
Estimated Unknown Loss	0 Mgal
Total Discharge	35 Mgal

Example Calculators Relevant to Water





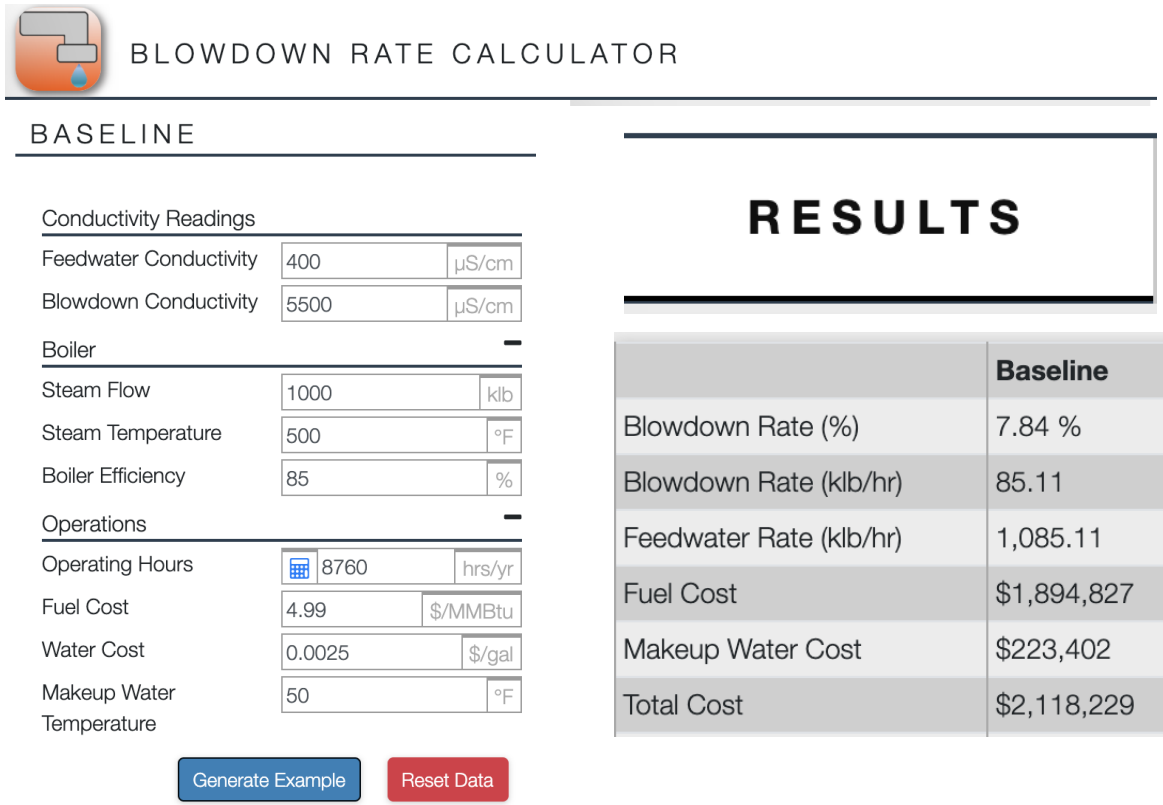
Cooling Tower Water Use Calculator: Analyze the effect of drift eliminators/cycles of concentration on cooling tower water consumption and estimate the resulting water savings.

General Treasure Hunt Calculator for Water: To estimate the savings associated with typical operational opportunities, e.g. Scheduling the equipment, reducing the load on the equipment etc.

Example Calculators Relevant to Water

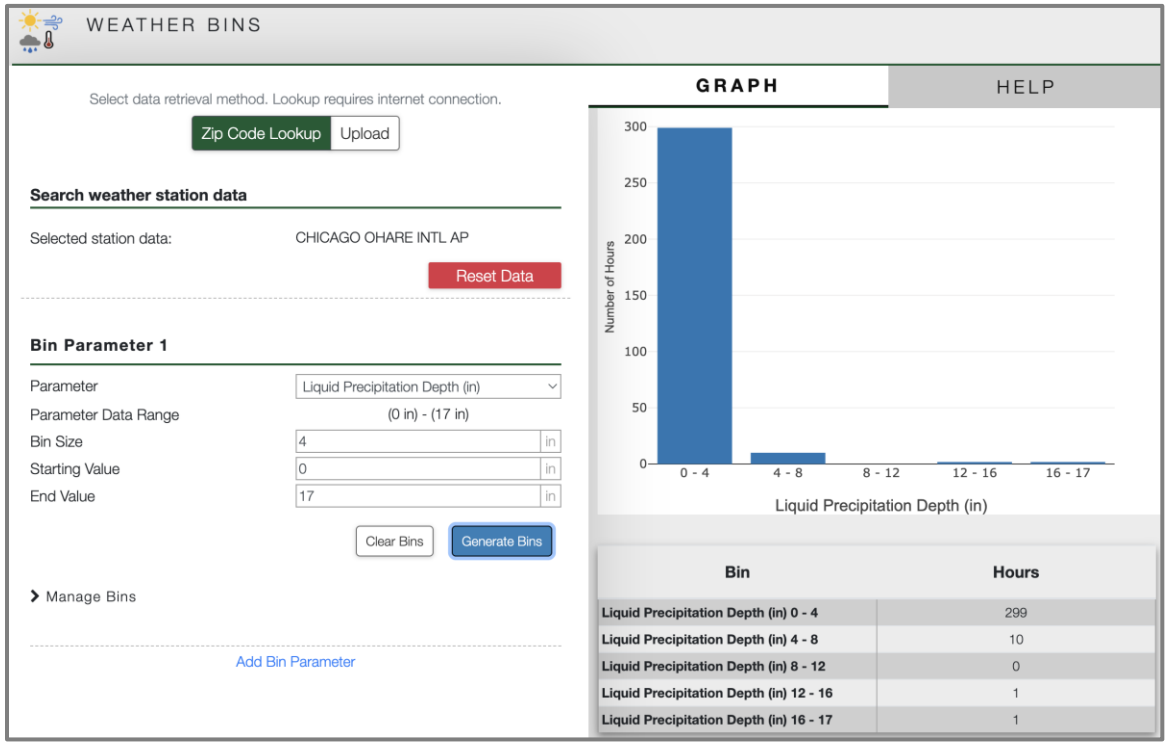
Blowdown Rate Calculator:

Calculate boiler blowdown costs



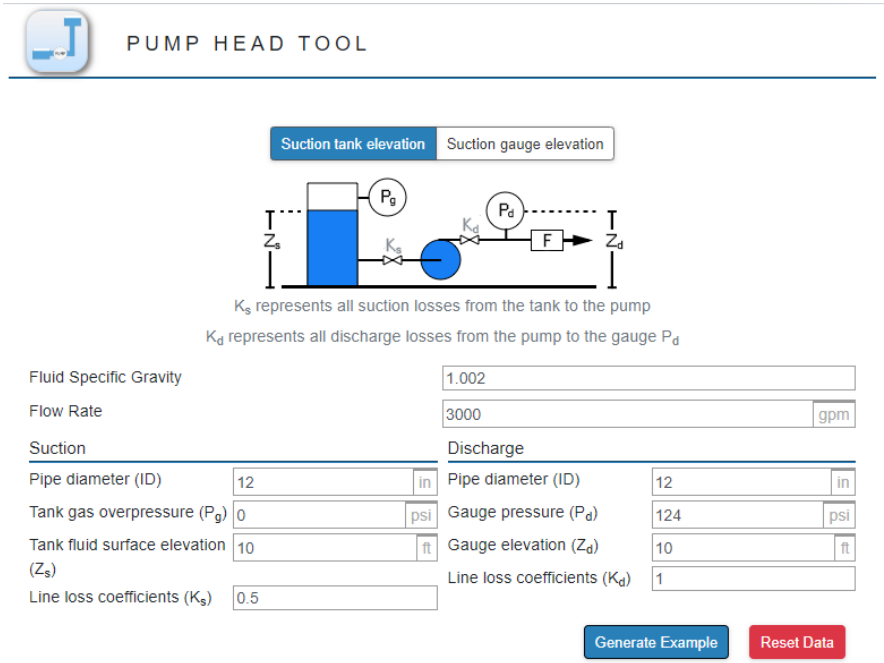
Weather Bin Calculator:

Determine the precipitation in the area

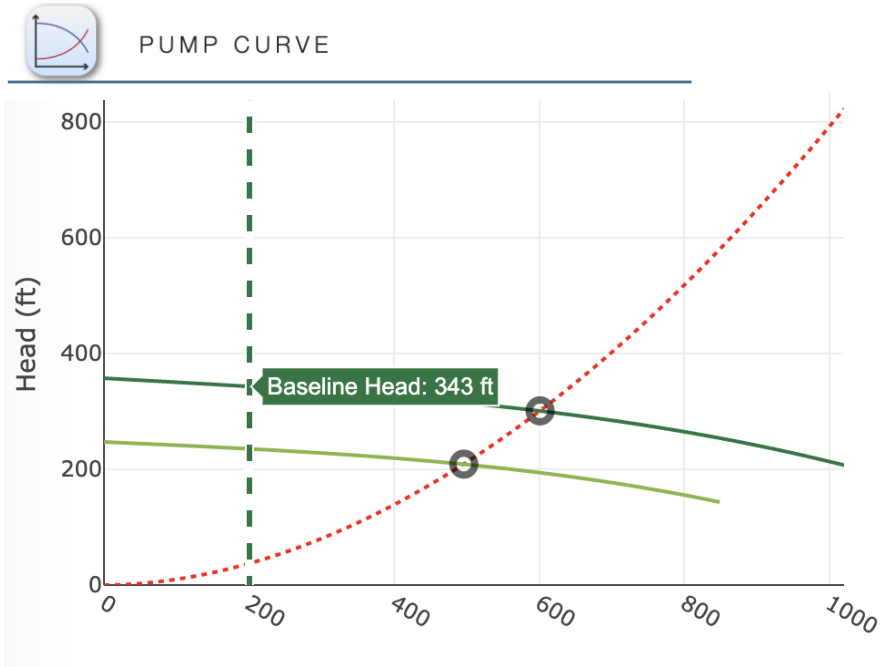


Example Calculators Relevant to Water – Pump Systems

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



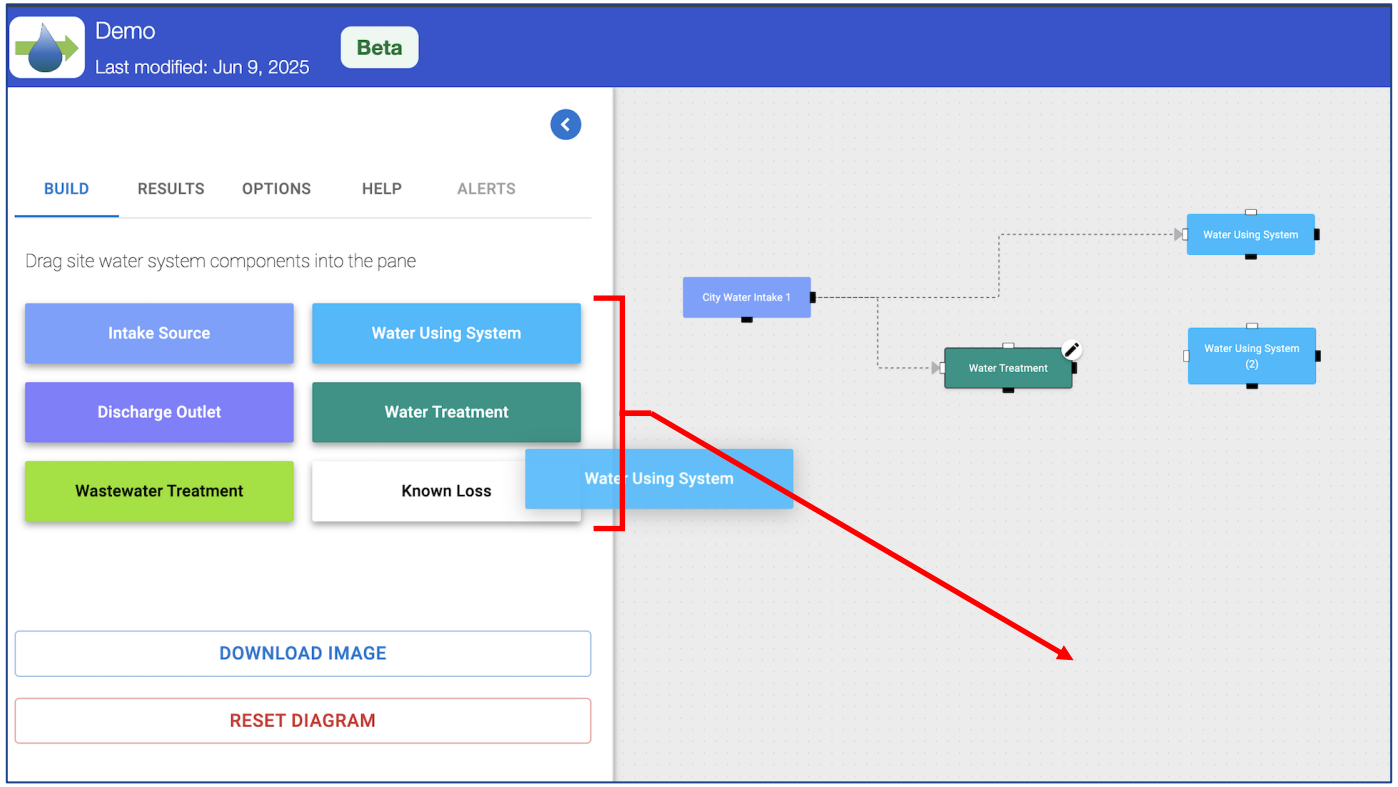
Given a measured pressure, elevation, flow rate, and line size data calculate the head for a pump



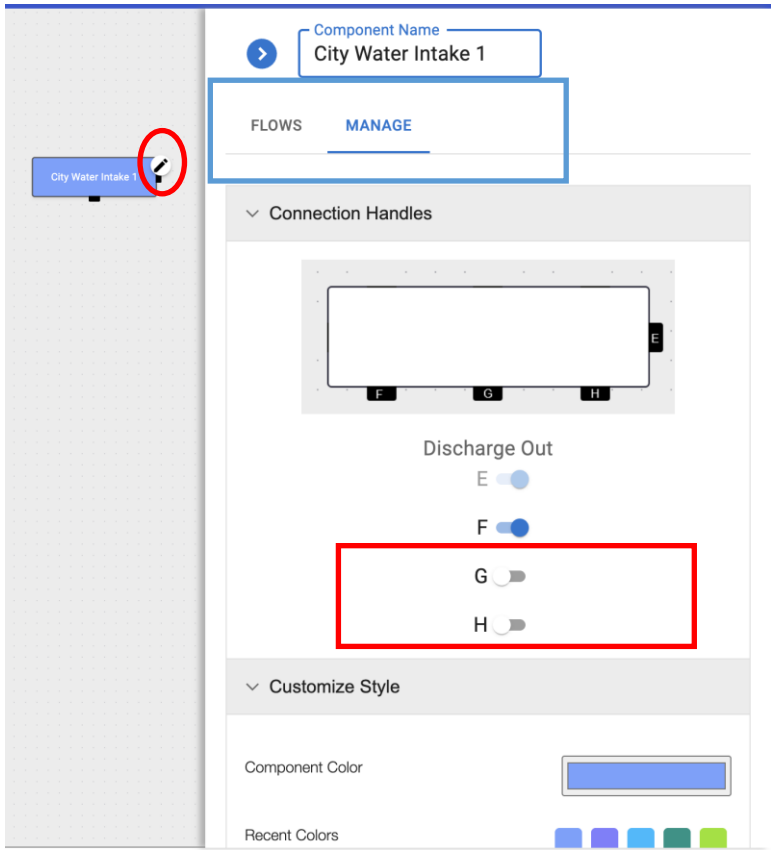
Use pump curve calculator to develop a pump curve and explore the effects of changes in head, flow, pump speed and impeller diameter.

Water Baseline Module – Flow Diagram

Drag, Drop and Connect Components as per water flows

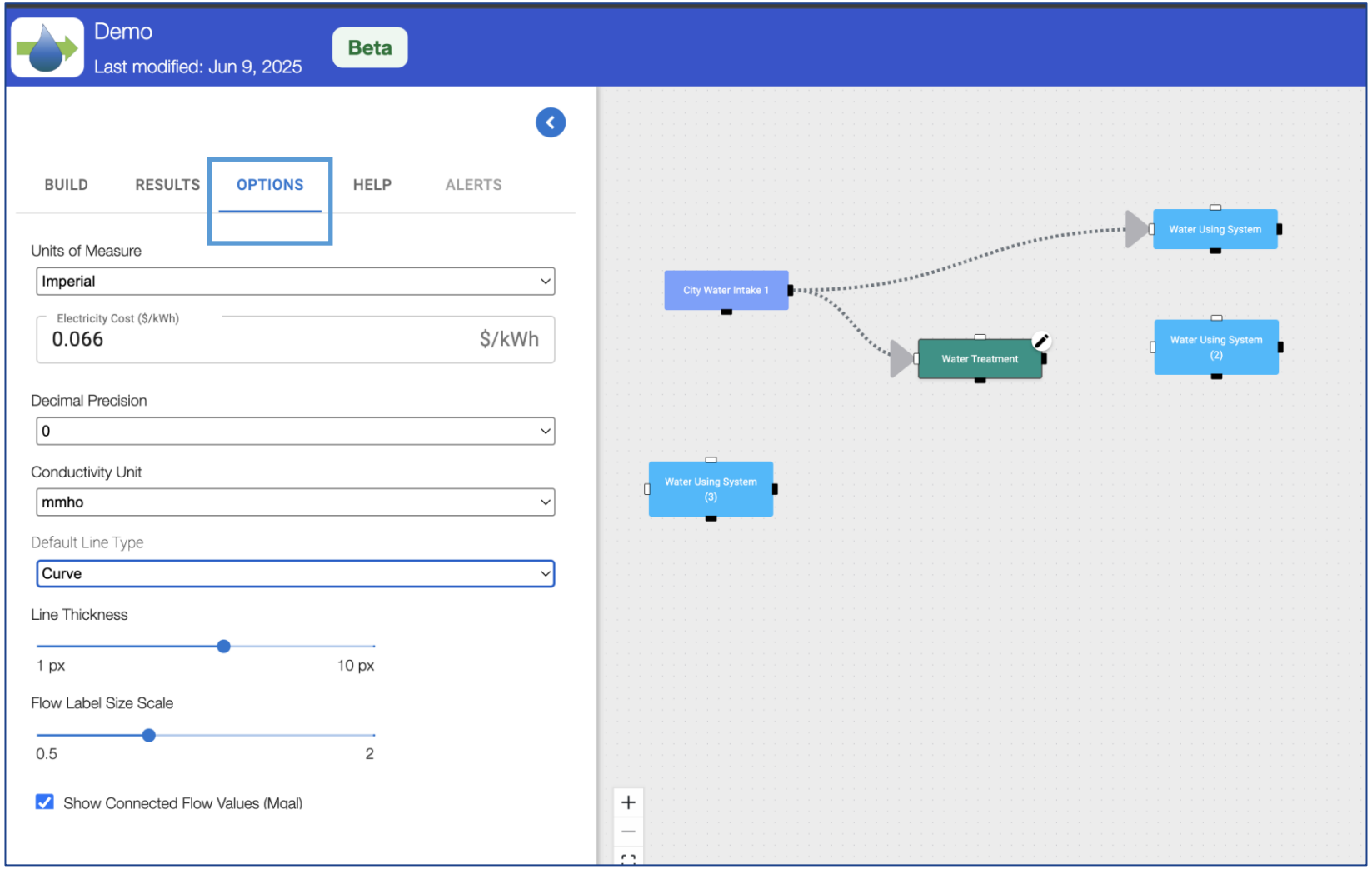


Use pencil icons to edit components



Water Baseline Module – Flow Diagram

Use “Options” tab to customize flow diagram



Water Assessment Module

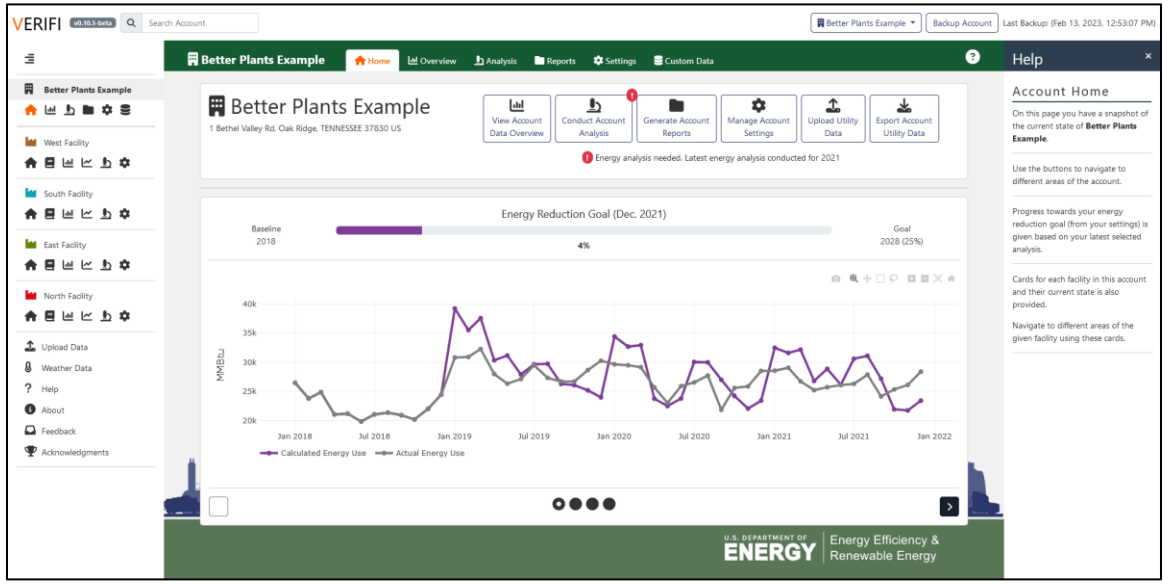
DEMO!

Summary and Closeout

What have we talked about today? Next time!

Opportunities for Cost and Water Savings

- Sewer Water Metering
- Evaporation Credits
- Use Suitable Discharge Options
- Use Suitable Sources of Water
- Avoiding Late Fees
- Analyze your Water Usage
- Tax Exemptions
- Recreate your Bills



New VERIFI Tool can help track your utility usage!
Beta Testing Version now available to try!
https://verifi.ornl.gov

Homework for Next Week

1) Find your water and sewer rate tariffs
2) Add water data to VERIFI
3) Do an analysis on your water usage in VERIFI
4) Use MEASUR to identify your water flows

- If you have any questions, just email me! pricecr@ornl.gov
- Common questions and answers will be discussed at the beginning of next week's training

Next week!

- Review of electricity, natural gas, and water bills
- Case studies from previous utility bill analysis
- **Participant Presentations and Findings**
- Final Q&A
- Participant Course Evaluations

Open Time for Questions