Better Plants®
U.S. DEPARTMENT OF ENERGY

September 10th, 2025
Oak Ridge, TN

Week 6: Utility Billing Review

Utility Bill Analysis

Virtual InPLT

Christopher Price, ORNL

U.S. DEPARTMENT OF ENERGY

Week 5 Homework:

Common questions, water bills, initial findings

Week 5 Homework Questions – Water

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) Try to use MEASUR to identify your water flows

Utility Bill Analysis V-InPLT Agenda

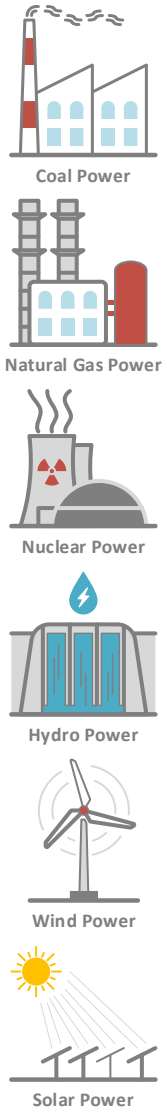
- Week 1 – Markets, Tariffs, and Consumption
- Week 2 – Demand, Power Factor, and Load Factors
- Week 3 – Interval Data, Demand Management, and Costs
- Week 4 – Natural Gas Bills Analysis
- Week 5 – Water Bills Analysis
- **Week 6 – Review and Partner Cast Studies**

Weeks 1-5 Review:

All about utility bills!

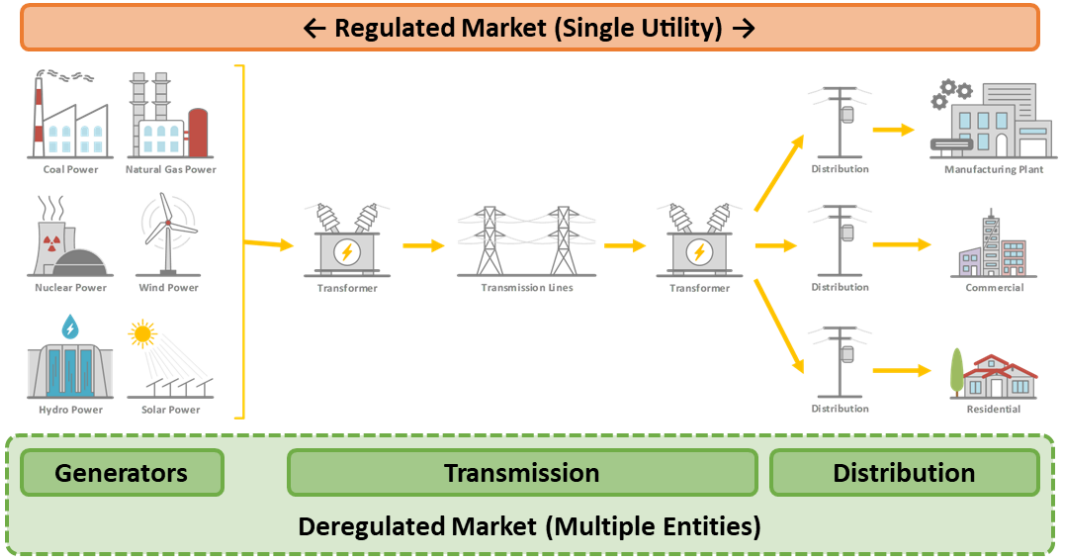
What is electrical energy?

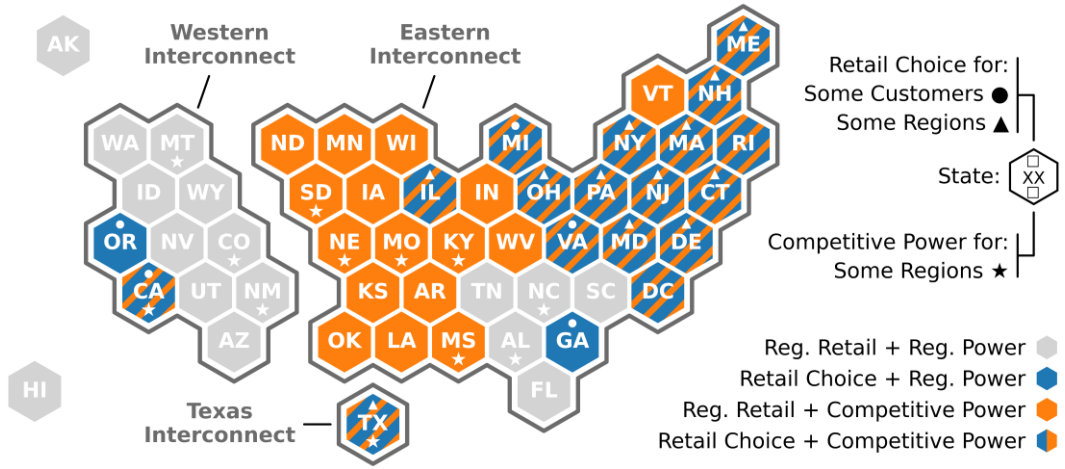
- Electricity is a form of energy from the flow of electric charge through a conductor
- Most electricity is made by converting a primary fuel (e.g., coal, natural gas) to steam that spins a generator
- Approximately 60% of all electricity comes from fossil fuels
- Generation and distribution loses mean saving 1 kWh at saves approximately 2.5 kWh in primary generation
- Electricity is distributed from generators to end customers through the grid



How does deregulation affect me?

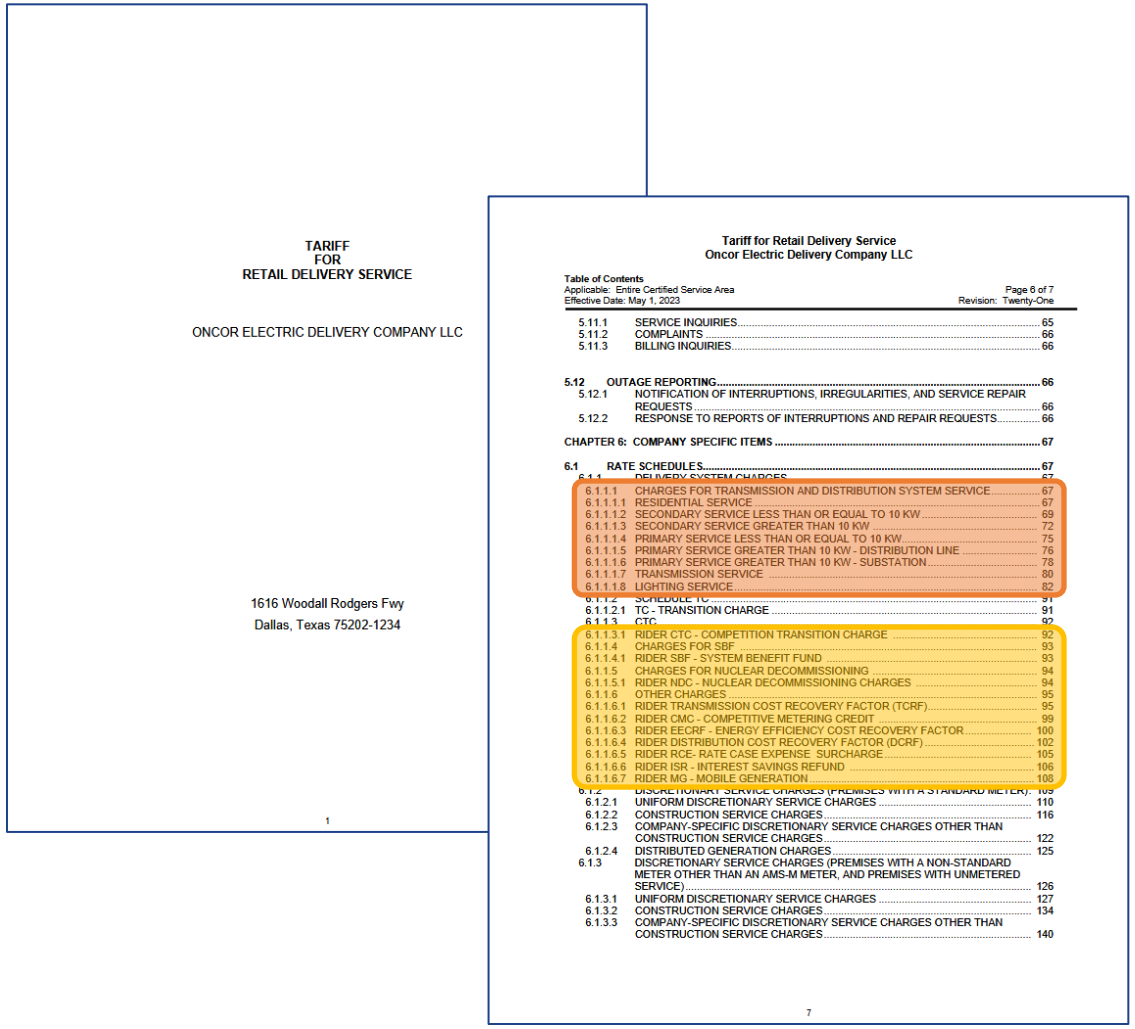
- Deregulation of electricity has happened in 15 states + DC
- Provides more choices for who provides your power
- Competition is designed to drive down prices but does come with some additional risk
- Can have separate bills for transmission, delivery, and generation of your power





What is a rate tariff?

- A rate tariff is your specific pricing structure that sets the terms of your utility contract
- You can usually find your rate tariff with an internet search or by asking your utility to provide it
- Rate tariffs are complicated legal documents, but you can work through them!
- Being on the right rate tariff is extremely important to avoid unnecessary energy charges



TARIFF
FOR
RETAIL DELIVERY SERVICE

ONCOR ELECTRIC DELIVERY COMPANY LLC

1616 Woodall Rodgers Fwy
Dallas, Texas 75202-1234

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Tariff for Retail Delivery Service
Oncor Electric Delivery Company LLC

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Effective Date: May 1, 2023 — Revision: Twenty-One

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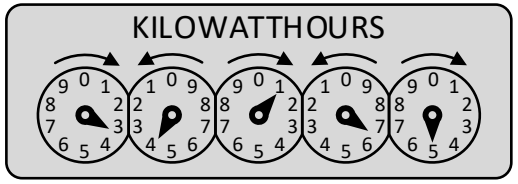
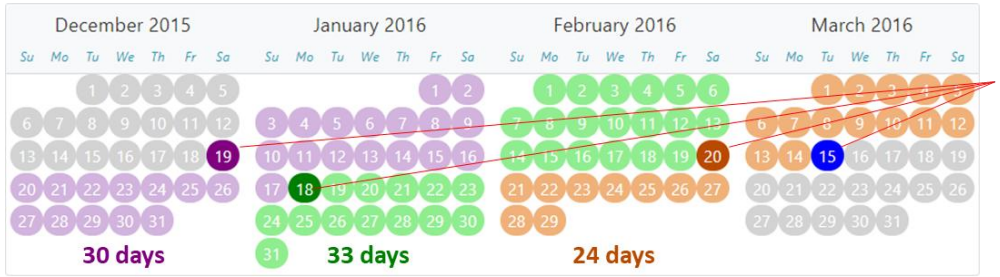
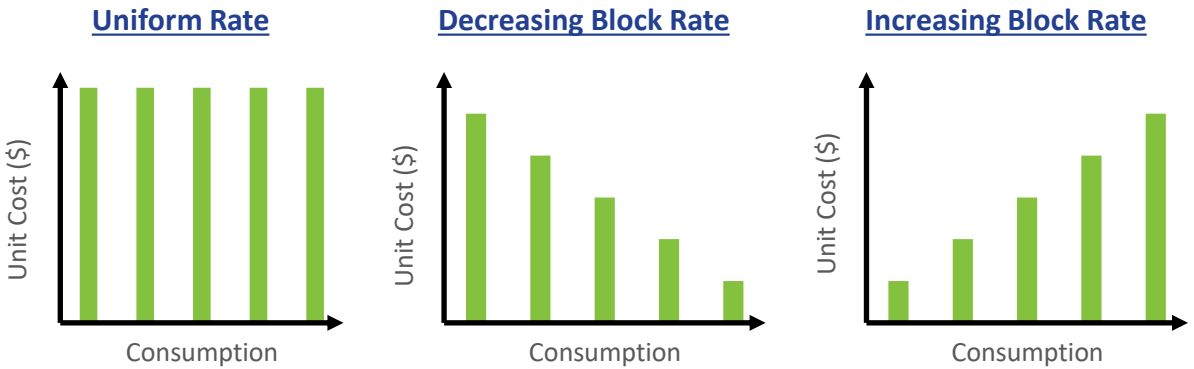
Electricity Consumption (kWh) Charges

- Consumption (usage) is the total amount of electricity you use during a billing period
- Consumption is measured in kWh which is 1 kW of power sustained for 1 hour
- Consumption demands on your usage *and* your billing period
- Calendarization normalizes for inconsistent billing periods
- Your rate tariff sets the structure for your consumption charges



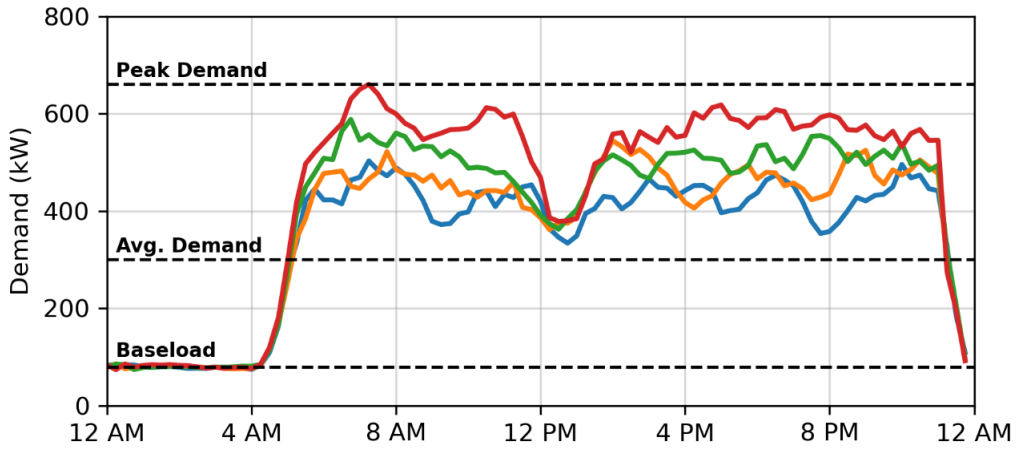
= 34,165 kWh





What is Electrical Demand?

- Electrical demand is the average electricity used over a specified time window
- Measured in kW or kVA depending on your rate tariff
- Demand can be measured using block, lagged, or rolling intervals
- There are many kinds of demand including average, baseload, peak, and coincident peak
- Your utility bills based on your peak demand!
- Billed demand is an adjustment to your peak demand



Difference Between Billed and Real Demand?

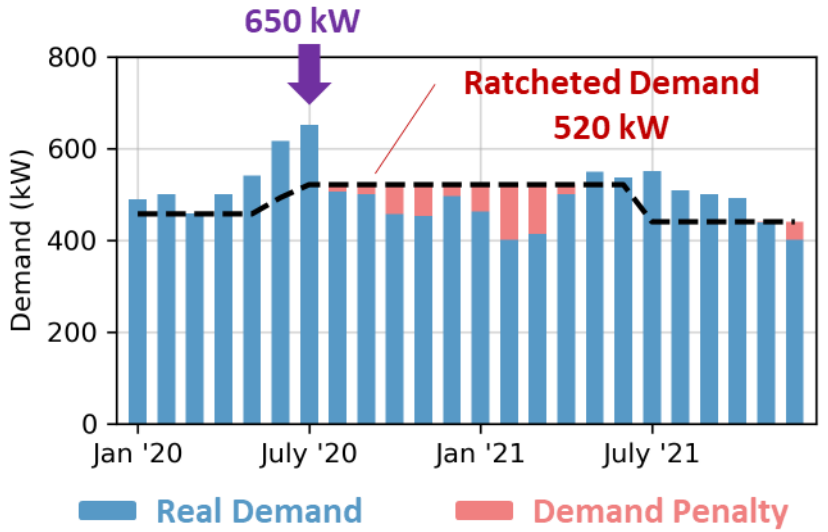
- **Real Demand** is from the meter during from the billing period
- **Billed Demand** is an adjustment to your real demand based on different clauses in your rate structure

  Billed Demand ≥ Real Demand

- A **Ratchet Clause** sets a minimum billed demand based on past usage

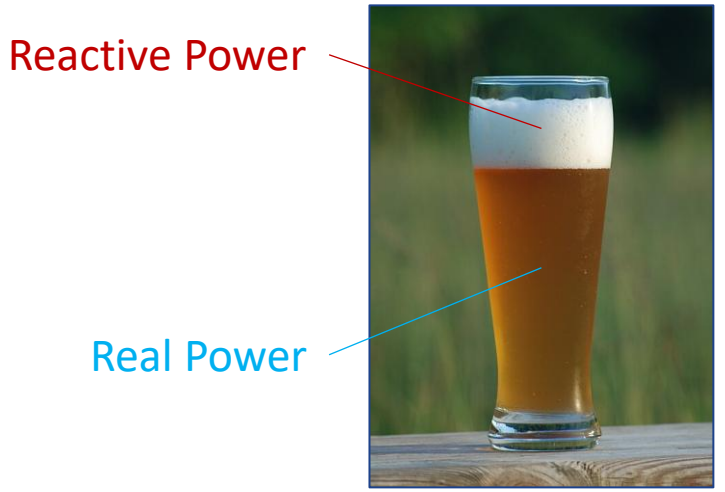
  "at least 80% of maximum real demand from the past year"

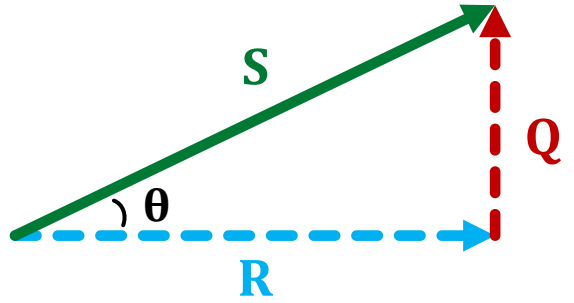
- Avoiding ratchet penalties means preventing large spikes in demand



What is Power Factor?

- PF is a number between 0.0 and 1.0
- Utilities penalize consumers for having low PF
- There are two types of power:
  1) Real Power (R) – Does actual work!
  2) Reactive Power (Q) – Does no work!
- Real and reactive power are related through the PF triangle
- Low PF means your utility must deliver extra Apparent Power (S)



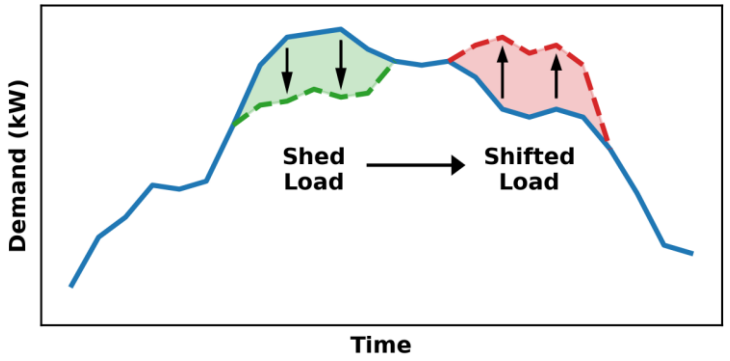


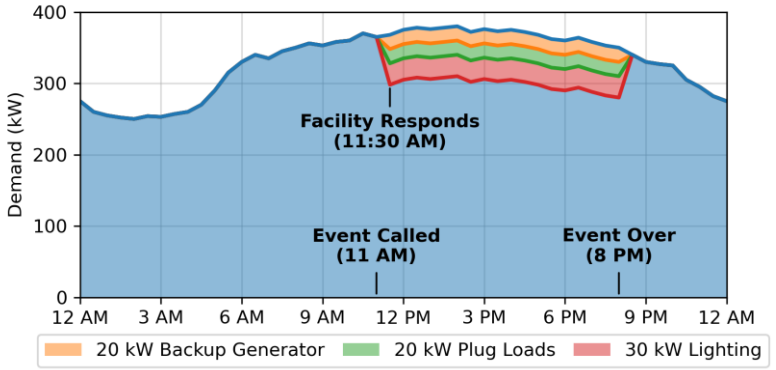
How Do You Correct Bad Power Factor?

- Nearly all facilities have low PF due to large, partially loaded motors in their production process
- Motors are just big coils of wire and act like large inductors
- Can install capacitors outside your facility or at the equipment to counteract too much inductance
- Fix baseload phase difference with static ($) capacitors
- Fix remaining difference with dynamic ($$) capacitors

Basics of demand management

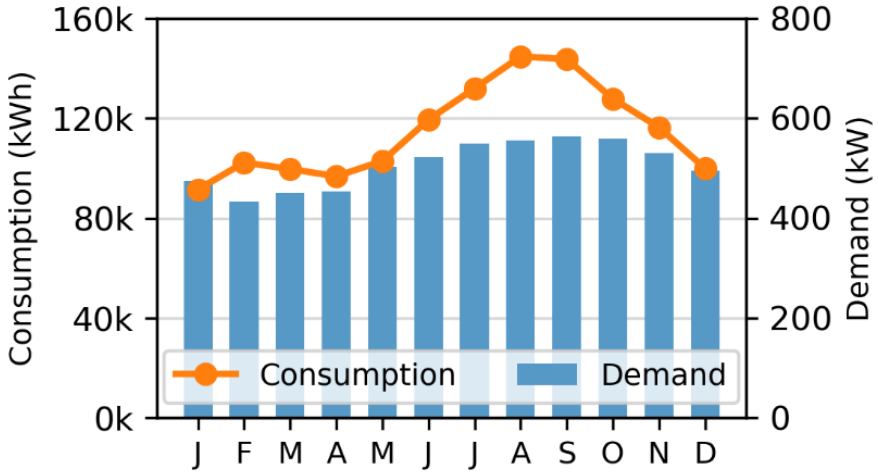
- There are two main demand management strategies
  1) Load Shedding
  2) Load Shifting
- Many utilities offer demand response programs to incentivize load shedding during high grid stress
- Often you can get paid for participating in a demand response program, even if you are not actually called on to shed load!

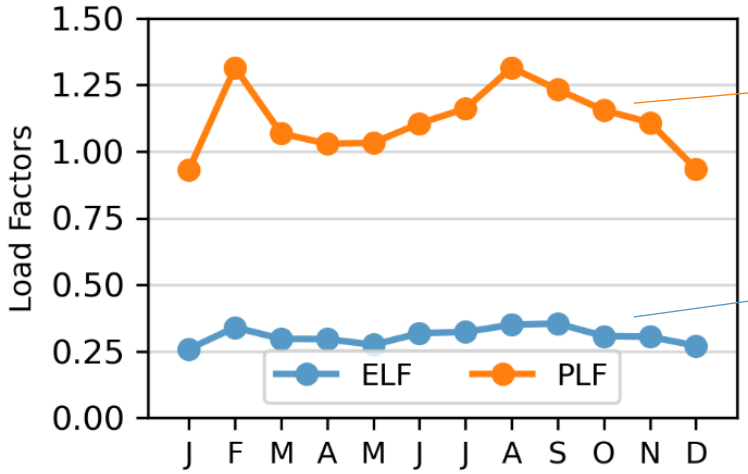




Load Factors are a Simple Way to Track Demand

- Electrical Load Factor is the ratio of monthly kWh consumption to the maximum possible consumption
- Production Load Factor is the ratio of monthly kWh consumption to the maximum operating consumption
- ELF and PLF can help identify spikes in demand and equipment being left on outside of operating hours



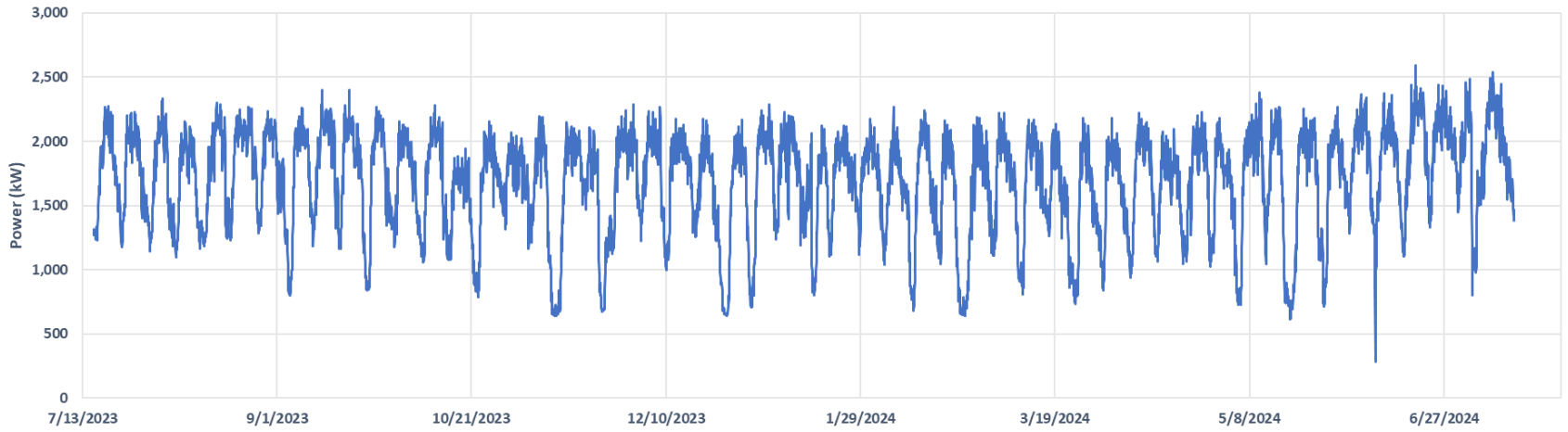


$PLF \gg 1$
Equipment is being left on

$ELF \approx 0.2$
One-Shift

What is demand interval data?

- Digitally captured electrical load measurements
- Time increments more granular than bills (e.g., 15-minutes)
- Question to ask before analyzing interval data...
  - Do you need to aggregate meters?
  - How does your rate tariff set your demand interval?
  - Are the units the same as your bills?

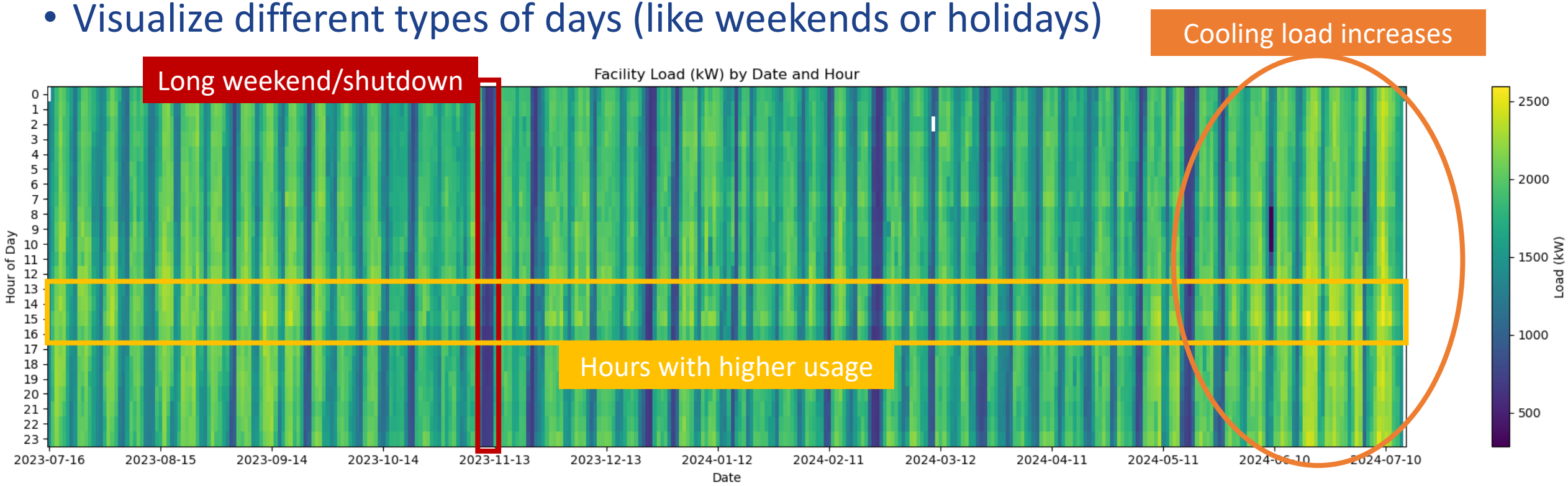


Analyzing demand data is all about visuals

Analysis: Display the whole year by color

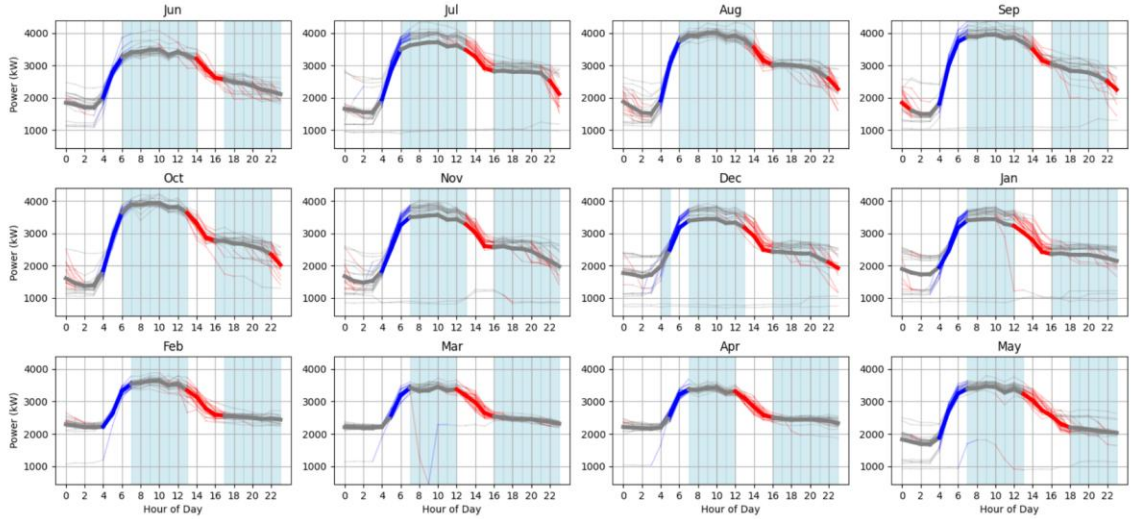
Actions to take:

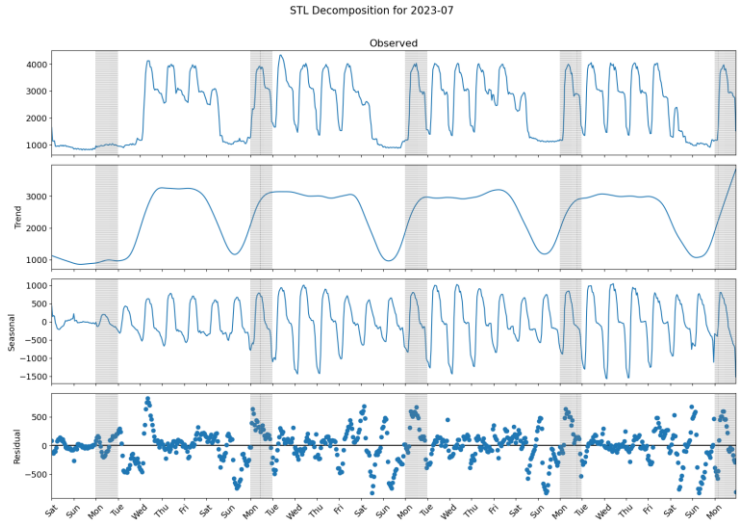
- Identify certain hours that have patterns
- Visualize different types of days (like weekends or holidays)



Key Takeaways from Interval Data Visualization

- Interval data cannot be properly used without informative visualizations
- Integrating interval data with production data can be useful when determining large energy consumers at a facility
- Successful data analysis will lead to informed observations and conversation on the production floor
- Large seasonal trends indicate needs to analyze cooling systems
- Verify the numbers on your bills. Utilities make mistakes





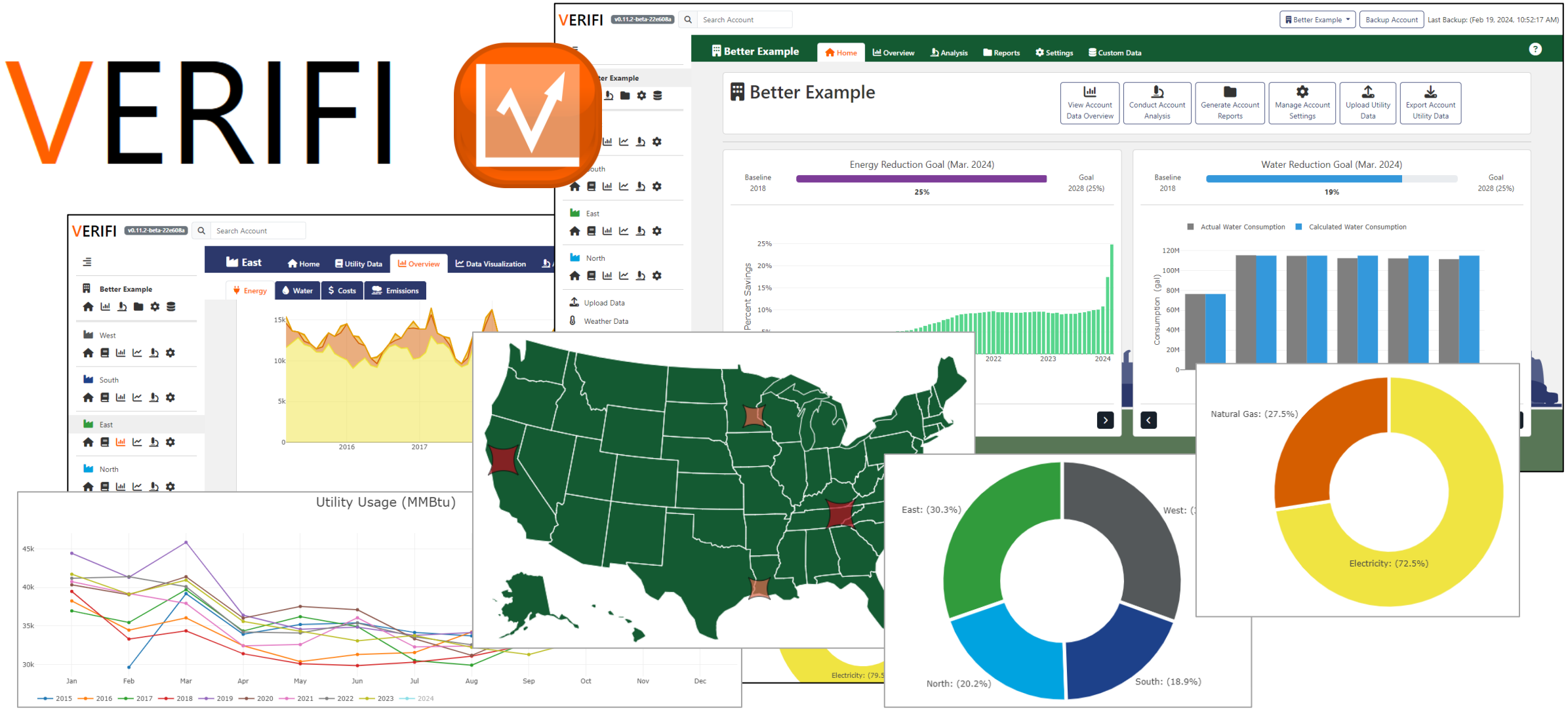
Cost of Electricity

- **Blended Cost** lumps consumption, demand, fixed, and other charges into a single $/kWh rate
  - Simple but cannot be used to estimate demand reduction opportunities

- **Marginal Cost** is the cost of purchasing or saving the next/last unit of electricity on your bills
  - Separate costs for consumption and demand
  - Requires a deeper knowledge of your rate structure
  - Need to be careful with block rates!

- Which cost to use will depends on the type of analysis or project!

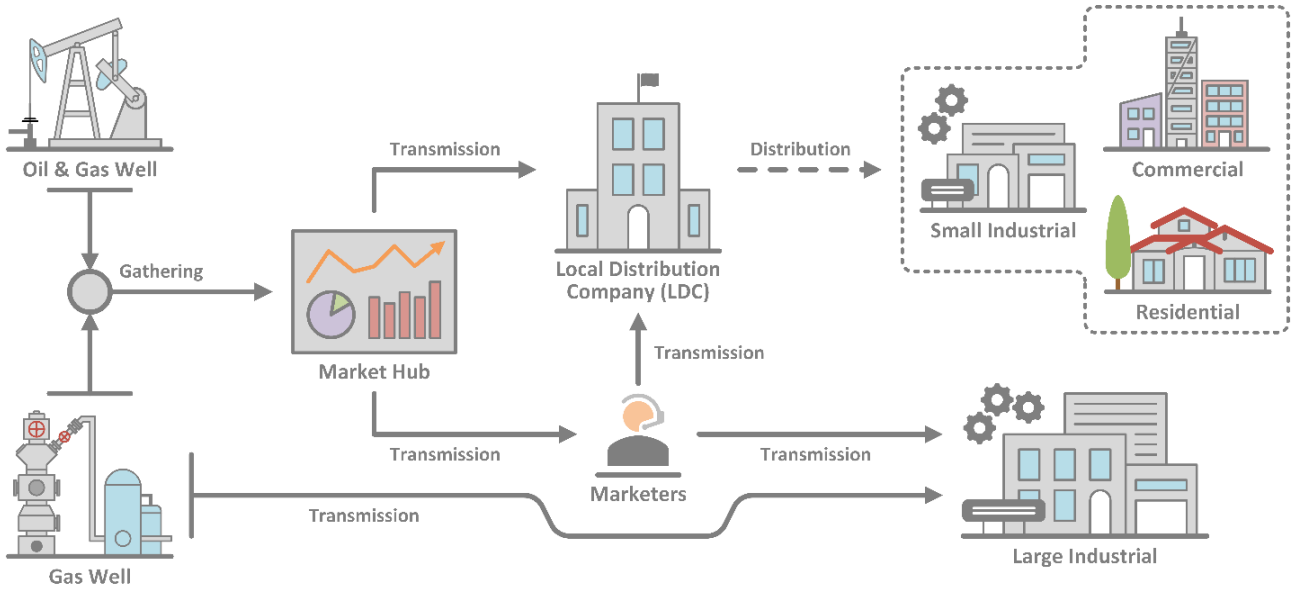
VERIFI for Utility Bill Analysis



Who Can I Buy Gas From?

Deregulation is complex but offers lots flexibility for buyers:

- Large gas customer can purchase gas directly from gas producers
- **Marketers** are third-parties who purchase gas and sell to consumers
- **Market Hubs** are central pricing points where NG is traded daily
- Consumers may receive multiple bills

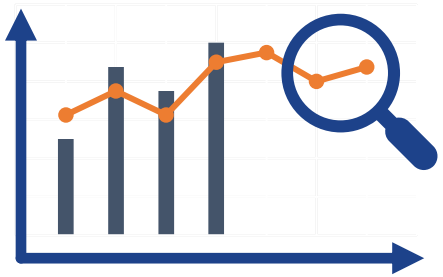


Natural Gas Pricing and Contracts

- Pricing for physical natural gas has two primary components:
  - **Commodity Price:** The price of gas at a specific trading point
  - **Basis Cost:** Price differential between the point of sale and delivery
- The benchmark price of natural gas in the US is the Henry Hub in Erath, Louisiana
- Basis cost can be positive or negative depending on the relative cost of natural gas between hub and delivery
- Both the commodity price and basis cost can be fixed by your contract to hedge against price volatility

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



Natural Gas Consumption Charges

- Natural gas consumption or usage is the total amount of gas your facility uses in its operations
- Can be billed by volume or energy content of the gas
- Common units: CCF, MCF, M^3, therms, MMBtu, etc.
- Billed on a $/unit rate set by your tariff
- Can appear on multiple bills as gas cost, purchase cost, usage cost, commodity cost, etc.

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

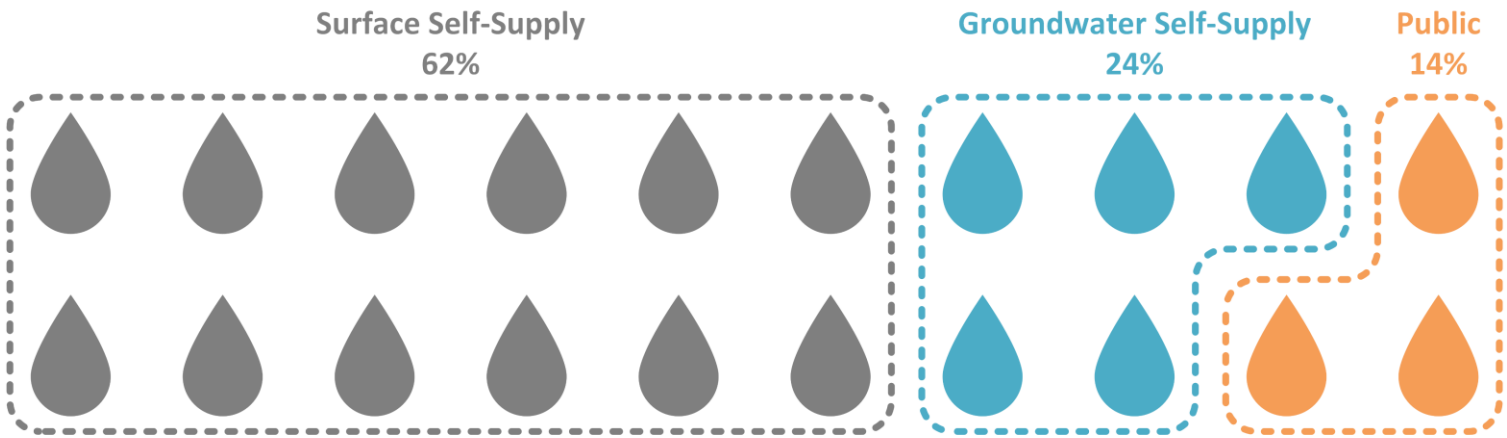
Optimum Rate Selection

- Energy usage characteristics shift over time
  - Operations change
  - Product mix change
  - Operating hour change
- It is a best practice to check if your operation qualifies for a better rate
- Understanding your usage, available rate structures, and billing is critical to evaluate your options

Rate Schedule	Requirements	Rates
Small General Service	< 2,000 therms	Service Charge: $145/month Fixed distribution charge: $0.091202/therm Gas cost: $0.54936/therm
Medium General Service	≥ 2,000 therms < 50,000 therms	Service Charge: $300/month Fixed distribution charge: $0.044966/therm Gas cost: $0.54706/therm
Large General Service	≥ 50,000 therms	Service Charge: $450/month Fixed distribution charge: $0.041131/therm Gas cost: $0.55016/therm

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



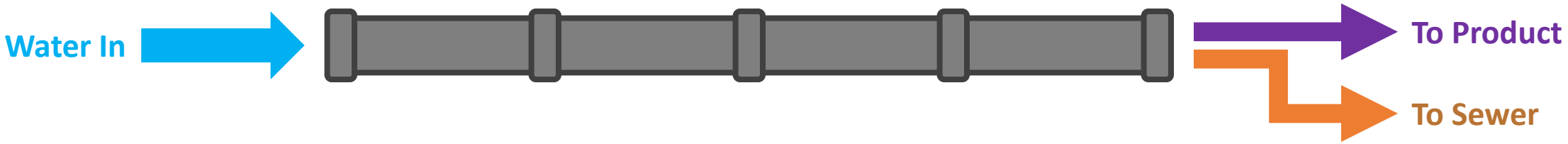
Water Consumption Charges

- 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, cubit 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.

Sewer Charges

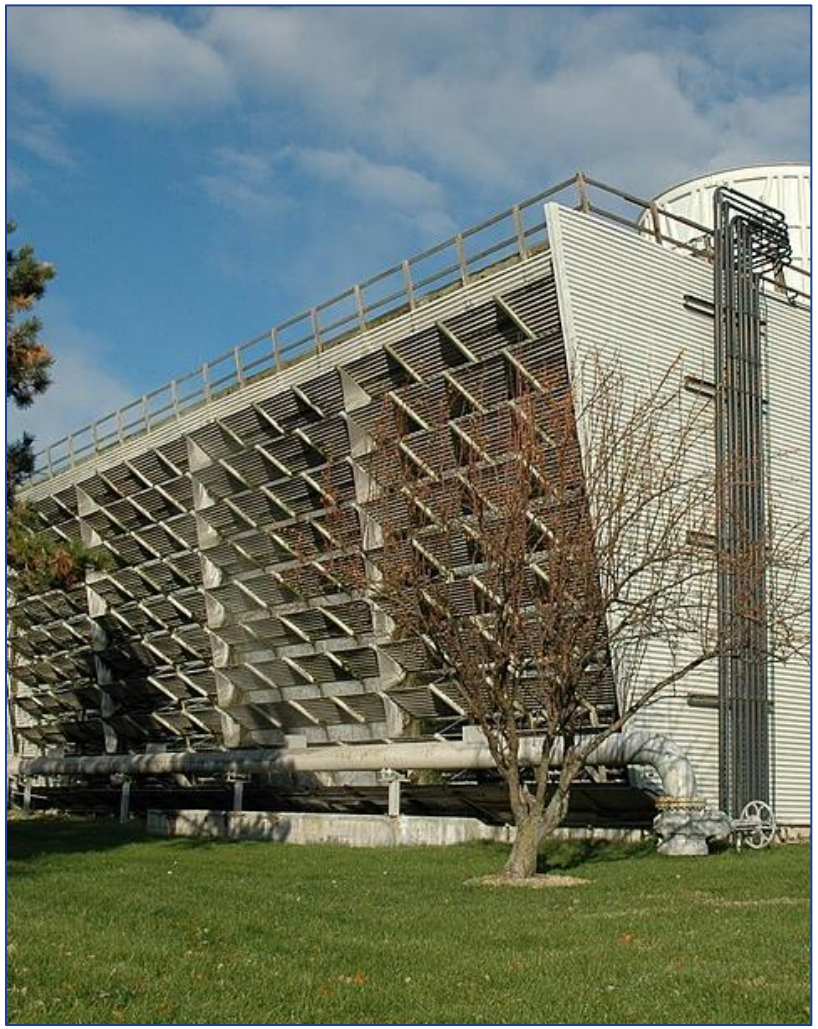
- Facilities are not just billed for their incoming water
- Utilities also charge for water disposal with ***Sewer Fees***
- Sewer fees can be >50% of total water utility cost
- Every facility has an incoming consumption meter, not all facilities have an outgoing ***Sewer Meter***
- Without a sewer meter, 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



Types of sewer lines

- Pay attention to your water sources!
- Use your least expensive 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

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

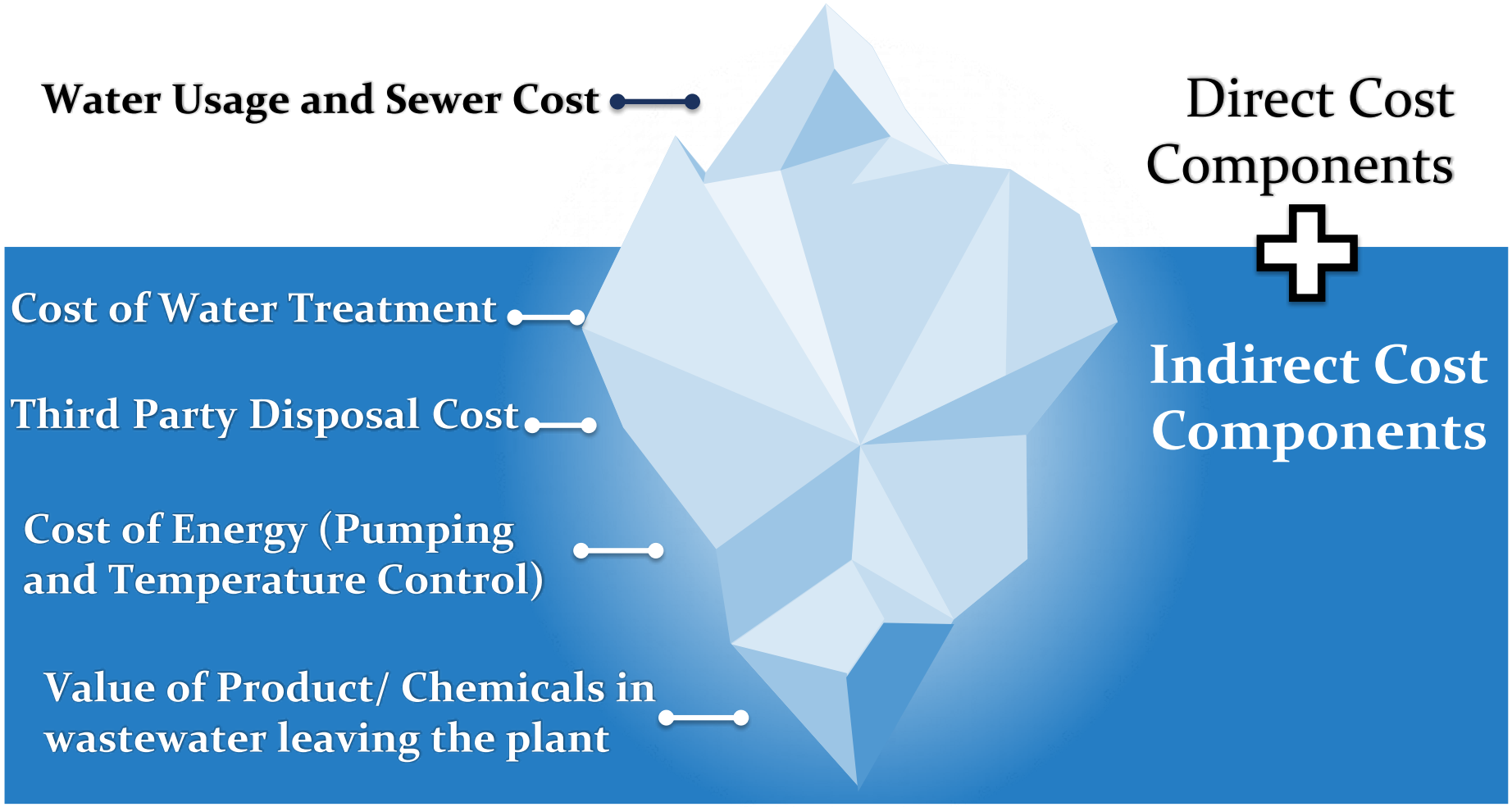
TSS: $0.17/lb × (250 – 175 mg/L) × 8.34 × 0.6 MMgal = $63.80

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

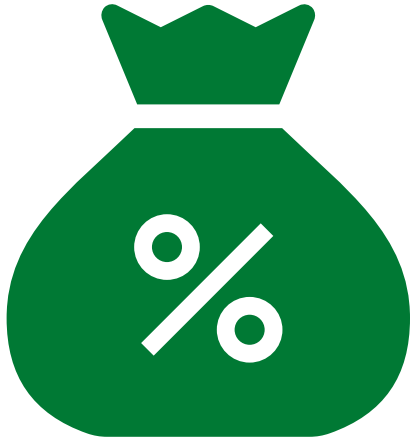
Total Surcharge = BOD + TSS + TN + TP = $278.47/month

Step 2. True Cost of Water

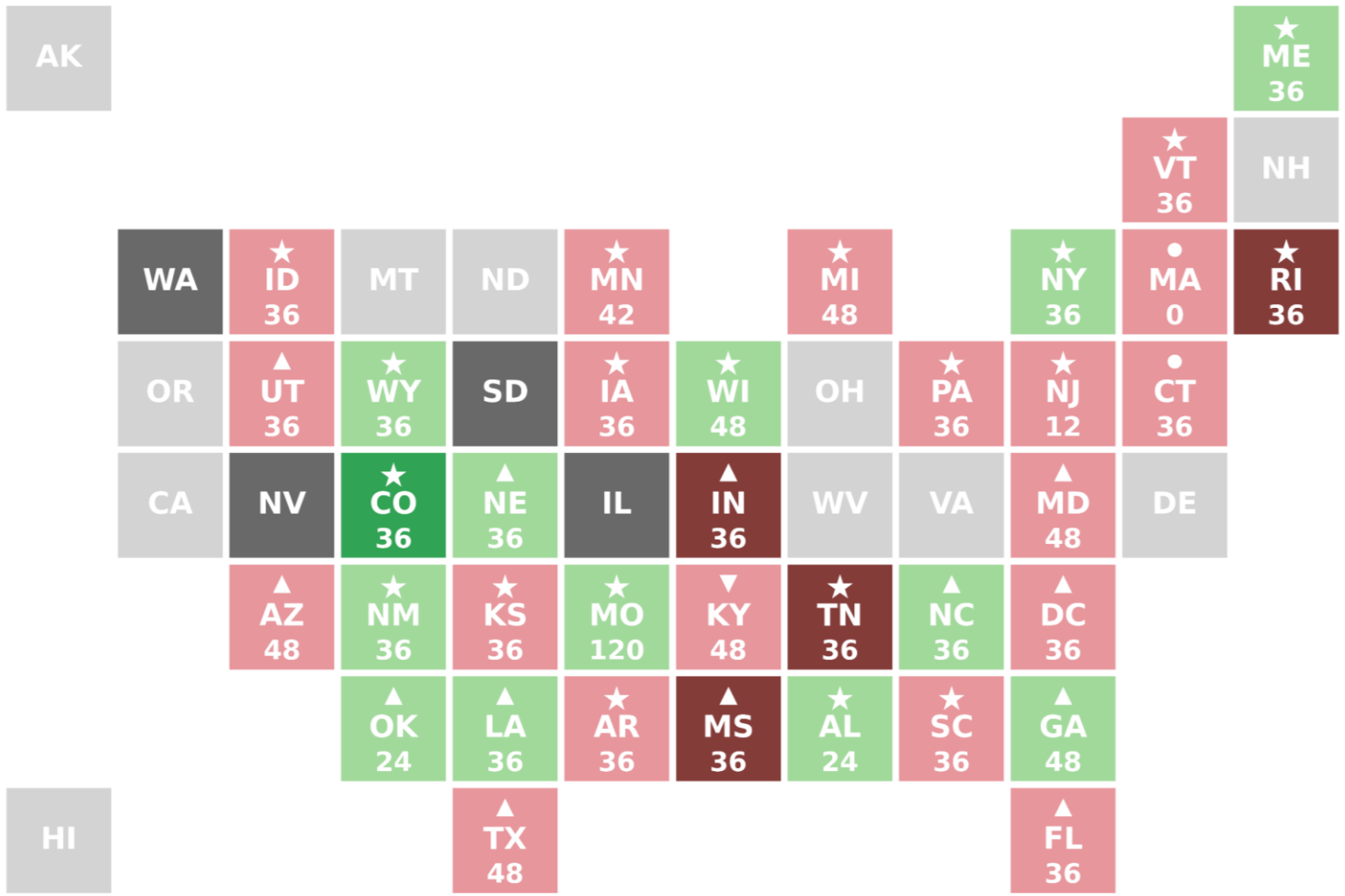


State Sales Tax Exemptions

- 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 energy is used towards manufacturing



Sales Tax Exemption



Rebate Scope

▲ 100% if >50% Manufacturing
● 100% if >75% Manufacturing
▼ 100% if >3% Production Cost
★ Only Manufacturing Usage

XX

Rebate Window (Months)

State Sales Tax

- No Utility Sales Tax
- No Exemption
- Sales Tax < 4.0%
- 4.0% ≤ Sales Tax < 5.5%
- 5.5% ≤ Sales Tax < 7.0%
- Sales Tax ≥ 7.0%

Examples from the Course

Beware of being on the wrong rate structure!

- ITAC visit to a manufacturer around 2010
- Multiple existing buildings were converted to office space
- Production moved to newly constructed buildings
- Did anyone check the rate structure for the old buildings?

New Average Demand:
1,200 kW
New Average Consumption:
480,000 kWh

Monthly Charges	Large General (LGS)	General (GS)
Customer	$125.73	$39.20
Demand (per kW)	$14.18	$7.40
Energy (per kWh)	$0.0052	$0.02210
Minimum Demand	4,000 kW	500 kW
Total	**$59,342**	**$19,527**

~$40,000 per month in extra cost!!!

Block rates can also be tied to your demand!

- Let's look at Indiana Michigan Power's industrial power tariff…

Tariff Code	Service Voltage	Demand Charge ($/kW)	First 410 kWh per kW (¢/kWh)	Over 410 kWh per kW (¢/kWh)	Monthly Service Charge ($)
327	Secondary	16.474	5.703	1.359	180.00
322	Primary	14.089	5.413	1.313	275.00
323	Subtransmission	10.825	5.333	1.296	275.00
324	Transmission	10.194	5.058	1.286	275.00

- Demand Charge = $16.474/kW
- Service Charge = $180.00
- But wait, what's going on with the consumption charge?

There are 2 blocks:

- Block 1 = $0.05703/kWh
- Block 2 = $0.01359/kWh

- Block 2 is **>75% Cheaper**
- For this tariff, the goal is to get into Block 2 as fast as possible!
- The cap for Block 1 is set by the monthly demand!
- Every 1 kW demand reduction is:
  - $16.474 saved in direct demand cost
  - 410 kWh x $0.04344/kWh = $17.81 in indirect energy savings
  - Combined $34.28/kW in savings!

How Much Does Low PF Cost?

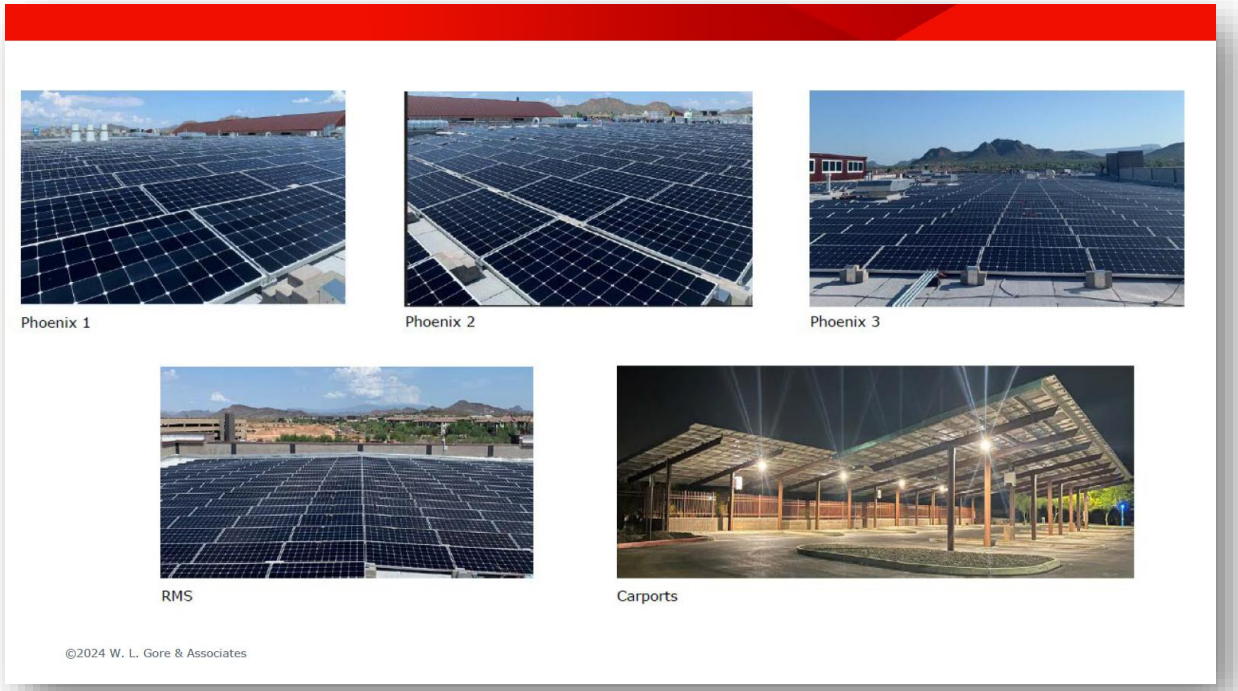
- Facility with average PF of 0.85 $(PF_{avg} = 0.85)$
- Utility requires a minimum PF of 0.95 $(PF_{req} = 0.95)$
- Demand cost is $8/kW with no ratchet clause $(C_d = \$8/kW)$
- Average adjusted demand is 2,000 kW $(A_{avg} = 2{,}000\ kW)$

$$\text{Average Real Demand } (\mathrm{R_{avg}}) = \mathrm{A_{avg}} \times \frac{\mathrm{PF_{avg}}}{\mathrm{PF_{req}}} = 1{,}790\ \mathrm{kW}$$

$$\text{PF Penalty} = \mathrm{C_d} \times \left(\mathrm{A_{avg}} - \mathrm{R_{avg}}\right) \times 12 = \mathbf{\$20{,}160/yr}$$

Utility Bill Verification and Calibration - Example

Taken from 2024 Better Buildings/Better Plants Summit



WL Gore installed 3 MW of solar PV at one of their facilities.

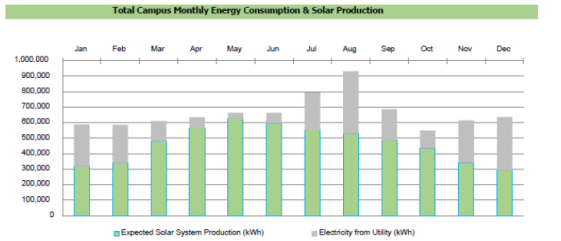
Utility Bill Verification and Calibration - Example

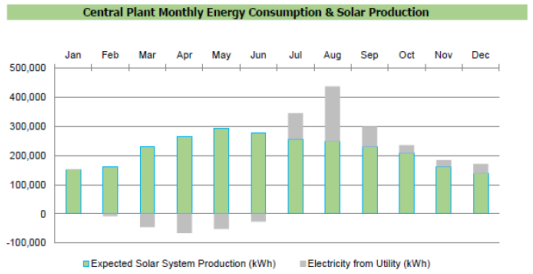
System wasn't generating the savings they expected

Managing Expectations, Phoenix Plant Manager calls in early 2023

The system is generating 70% of our power?

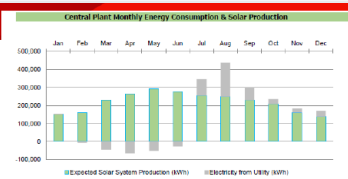
Why has the electric bill only decreased ~20-30%?





Billing Analysis – PHX Central

Demand and fees = 50% of billing



April 2022

Charges for electricity services

Cost of net electricity

Customer account charge	$68.10
Demand charge - delivery	**$9,460.70**
Federal environmental improvement surcharge	$76.41
System benefits charge	$697.24
Power supply adjustment*	$1,430.35
Metering*	$41.94
Meter reading*	$0.27
Billing*	$0.84
Generation of electricity*	$9,371.93
Demand charge - generation*	**$5,163.00**
Federal transmission cost adjustment*	-$434.00
Cost of electricity you used	$29,474.33
Net electricity, in kWh	**189600**
State sales tax	$0.00
County sales tax	$0.00
City sales tax	$813.37
Franchise fee	$590.68
Cost of electricity with taxes and fees	$30,838.27
Total charges for electricity services	**$30,938.27**

Amount of electricity from APS

Meter reading on May 4	191400
Meter reading on Apr 4	184800
Your billed Demand in kW	1000.0

Amount of electricity credited

Meter reading on May 4	1800
Meter reading on Apr 4	2400
Total electricity credited, in kWh	1800
Last month's kWh credit	0
Electricity you used, in kWh	191400
Minus electricity credited in kWh	1800

Comparing your monthly use

	This month	Last month	This month last year
Billing days	30	33	31
Average outdoor temperature	74°	64°	77°

April 2023

Charges for electricity services

Cost of net electricity

Customer account charge	$68.10
Demand charge - delivery	**$7,732.75**
System benefits charge	$0.00
Power supply adjustment*	$0.00
Metering*	$41.94
Meter reading*	$0.27
Billing*	$0.84
Generation of electricity*	$0.00
Demand charge - generation*	**$4,140.73**
Cost of electricity you used	$14,560.65
Net electricity, in kWh	**-131600**
County sales tax	$0.00
City sales tax	$401.82
Franchise fee	$291.80
Cost of electricity with taxes and fees	$15,283.86
Total charges for electricity services	**$15,283.86**

Taxes and fees

Amount of electricity from APS

Meter reading on May 3	109200
Meter reading on Apr 3	117600
Your billed Demand in kW	802.0

Amount of electricity credited

Meter reading on May 3	212000
Meter reading on Apr 3	146400
Total electricity credited, in kWh	212000
Electricity you used, in kWh	109200
Minus electricity credited in kWh	212000

802 is 80% of the highest kW from the last 6 summer months

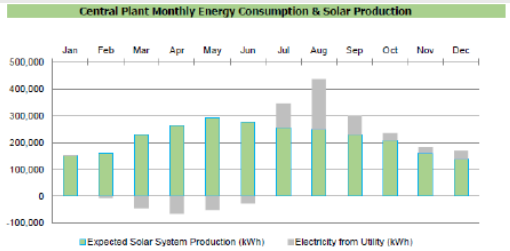
Comparing your monthly use

			This month
Average outdoor temperature	74°	64°	77°
Your total use in kWh	109200	117600	191400
Your average daily cost	$509.46	$493.15	$806.87

Performed a utility bill analysis

Utility Bill Verification and Calibration

A closer look – PHX Central



April 2022

Charges for electricity services

Cost of net electricity

Customer account charge	$68.10
Delivery service charge	$0.00

Amount of electricity from APS

Meter reading on May 4	191400
Meter reading on Apr 4	184800
Total electricity from APS, in kWh	191400

Demand meter reading	459.36
Your billed Demand in kW	**1000.0**
Demand meter reading	359.76
Your billed Demand in kW	**1000.0**
Demand meter reading	388.92
Your billed Demand in kW	**1000.0**
Demand meter reading	353.88
Your billed Demand in kW	**1000.0**

City sales tax	$813.37
Franchise fee	$590.68

	This month	Last month	last year
Billing days	30	33	31

Demand charge - delivery	$9,460.70
Demand charge - generation*	$5,163.00

April 2023

Charges for electricity services

Cost of net electricity

Customer account charge	$68.10

Amount of electricity from APS

Meter reading on May 3	109200
Meter reading on Apr 3	117600
Total electricity from APS, in kWh	109200

Demand meter reading	478.44
Your billed Demand in kW	**802.0**

Summary of what you owe

Amount due on your last bill	$35,946.05
Payments made, (see below)	-$57,018.32
Total bill corrections	-$320,052.37
Your balance forward	-$341,124.64
Your new charges (details on following pages)	
Cost of electricity (includes taxes and fees)	$15,816.93
Your credit balance	**-$325,307.71**

- Found an incorrect billed demand
- Received major credits from their utility

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

Summary and Closeout

Thank you for attending!

Thank you!

- Please stay in touch if you have questions
- A course evaluation form will be sent out, please fill this out!
  - Your feedback really helps us to improve our offerings!
- There are more virtual trainings this year
- Energy Bootcamp @ORNL starts September 29
- All sessions have been recorded and can be found at https://bptraining.ornl.gov/

Open Time for Questions