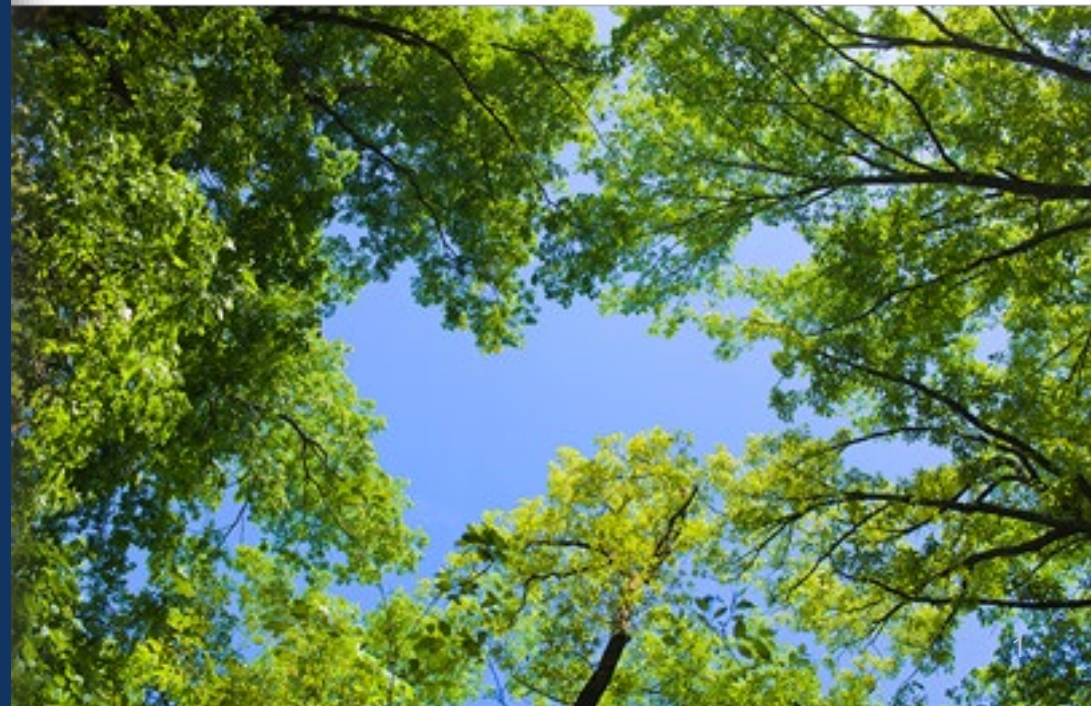
MEASURE, IDENTIFY, VERIFY & IMPROVE

Redefining Measurement and Verification through energy meter data



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QUIZ

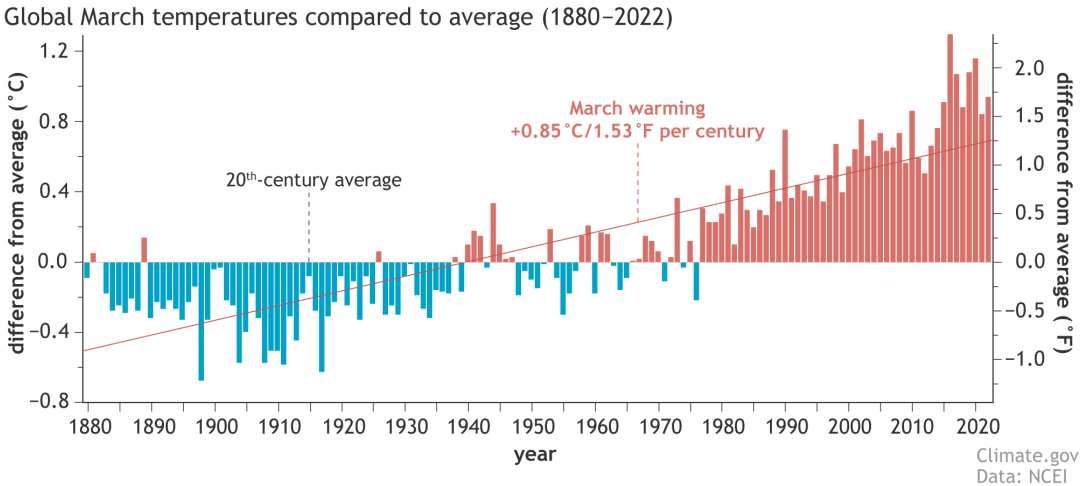
What are the following items related to?

- 50 Billion tons of CO2
- 1.2 in/year of rise in sea level
- Net Zero by 2040

Climate Change

MAKING IT RELEVANT

- 3.5 million : people at risk
- 350% : flood risk increase since 2000
- $50 Billion : damage from Hurricane Irma
- 90% : increased Ocean absorption of atmospheric heat
- 10-17 Inches : Key West predicted sea level rise by 2040



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REDEFINING MEASURE & VERIFICATION

How do we leverage M&V to illicit the same emotional responses?

Source nfl.com

Source https://www.the33rdteam.com/breakdowns/building-the-perfect-nfl-coach/

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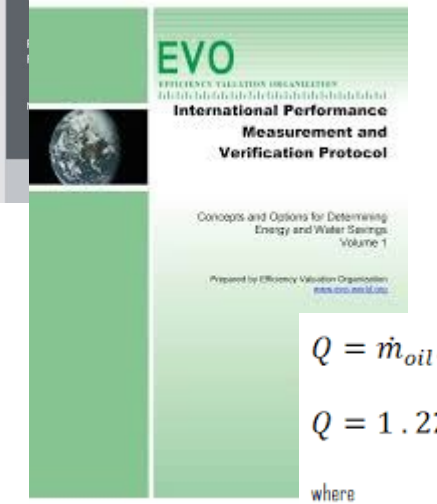
RETHINKING M&V – PATH TO NET ZERO

1	**Measurement & Monitoring**	› Sustainability enablement necessitates baseline of energy consumption to know where and when to implement Energy Conservation Measures. › Utilize IoT metering data to identify project opportunities to enable demand side management.
2	**Demand-side Management (DEM)**	› Utilize consumption data collected through meter data to (a) identify and prioritize savings opportunities through the implementation of Energy Conservation Measures (e.g., HVAC, Lighting, Controls), (b) help create business cases rooted in actual consumption data, and (c) find low-cost/no-cost measures to reduce O&M costs through Distributed Energy Management.
3	**Electrification**	› Reduce carbon footprint of the organization by promoting electrification initiatives including EV Charging › Understand if current infrastructure can support and impact of installed systems
4	**Distributed Generation (DER)**	› Understand consumption to right size solar and storage › Continuously monitor building demands for future needs

M&V – AS WE KNOW IT TODAY



$$Q = \dot{m}_{oil} \cdot c_{oil} \cdot \Delta T$$

$$Q = 1 \cdot 2200 \cdot (70 - 40) = 66\ kW$$

where
Q is the heat flow rate [W]
$\dot{m}_{oil}$ is the mass flow rate of oil
c_{oil} is the specific heat of oil
ΔT is the temperature difference [K]

- Required in most ESPC/UESC contracts
- Based on IPMVP protocols that were initially developed in 1997
  - Many revisions, but the techniques remain largely the same
- Labor intensive & costly
- Major barrier
- Cause of friction between owner & ESCO
- Retrospective
- No significant value

Source https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp

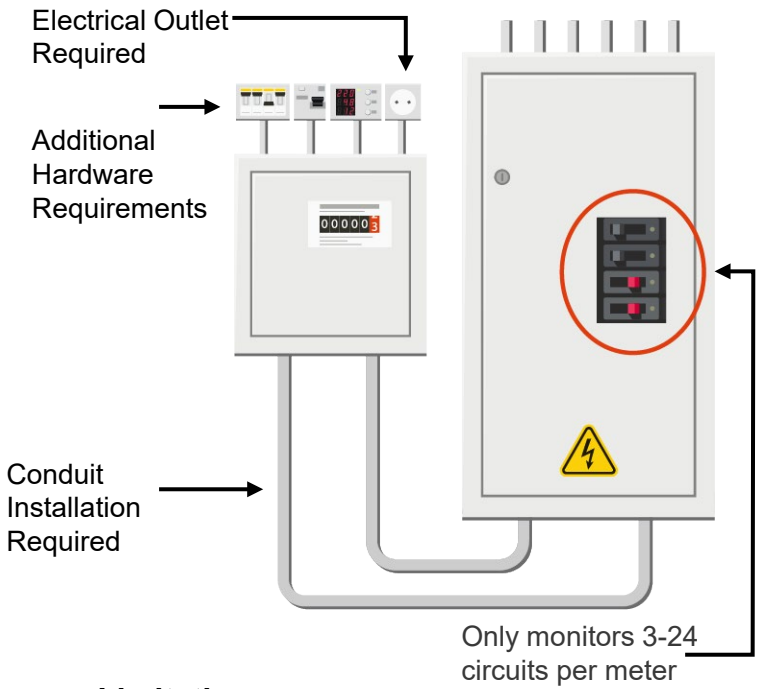
M&V – NEW ERA

- ASHRAE 90.1 requires submetering in commercial buildings (>25,000sq.ft.)
- Energy codes: CA, WA, NY and more to follow
- ESG / SEC reporting requirements

M&V – NEW ERA

Standard Methods

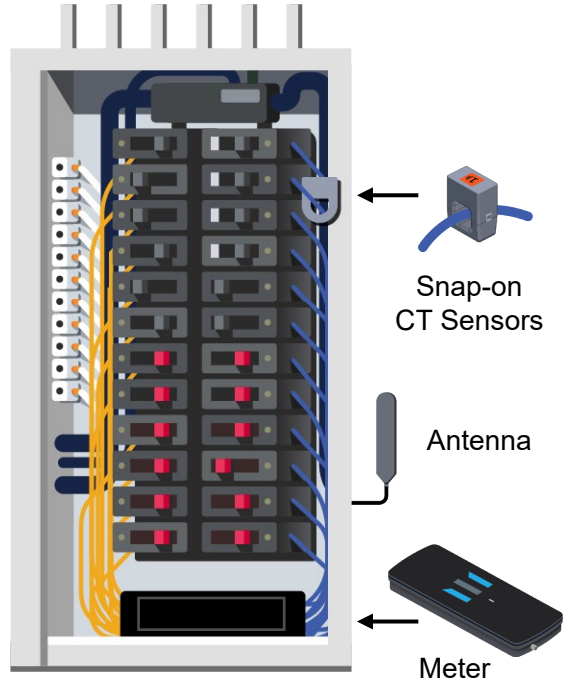
Typical metering system



Limitations

(1) High installation costs and difficult to scale
(2) Requires an electrician and a networking tech
(3) Challenges within building networking
(4) Limitations in number of circuits per meter (3-24)

Modern power meter



ENERGY INSIGHTS AT A FRACTION OF THE COST

Scalable
Quick meter install with easy connectivity enables for a highly scalable platform.

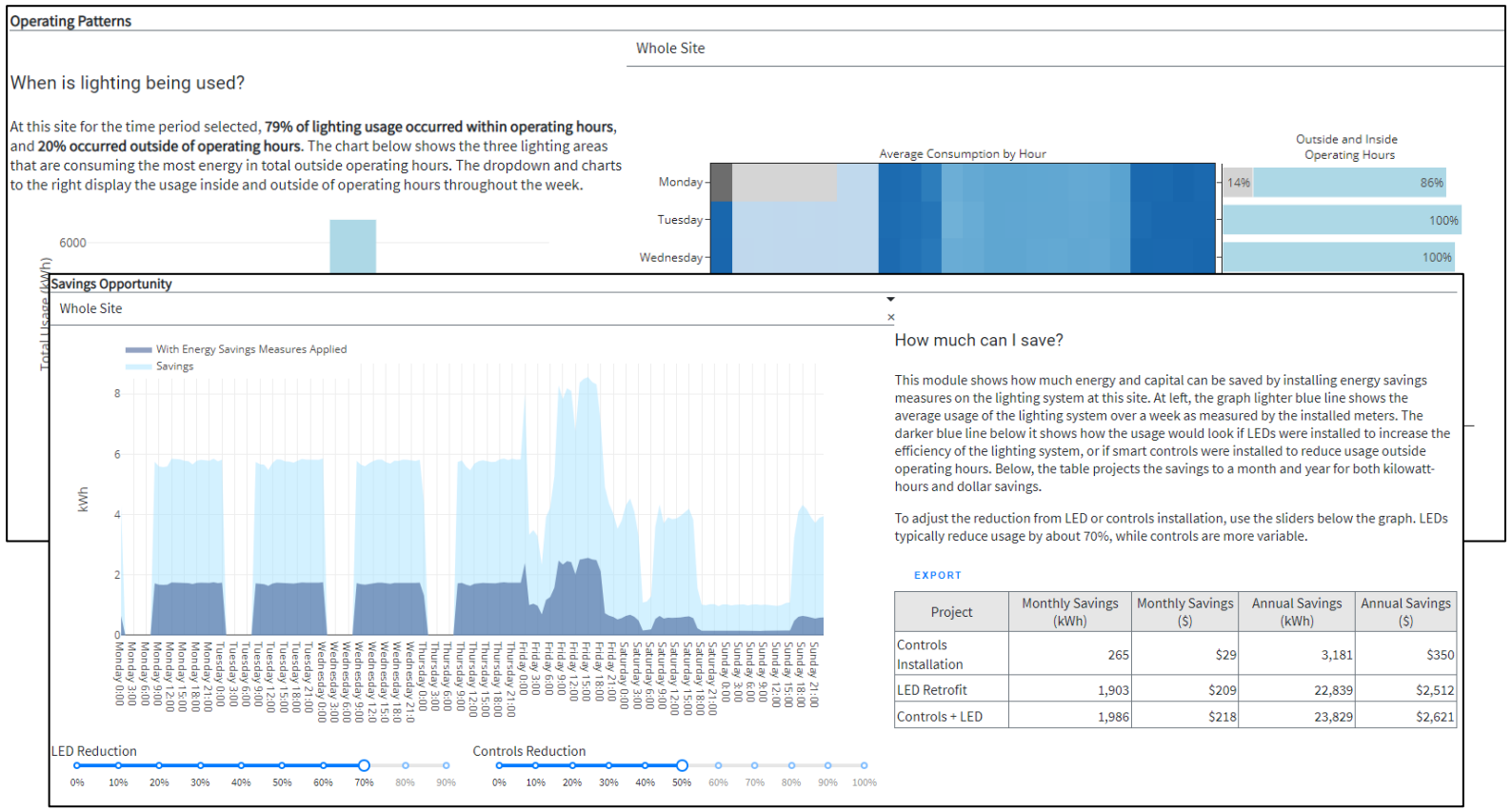
Connected
Efficiently connected building portfolios that are continuously monitored.

Low Cost
Low cost by using embedded networking, in-panel installation.

Insights
Granular energy consumption data captured down to the circuit level and across all buildings.

BEYOND M&V BENEFITS OF SUBMETERING

- Made possible by innovation and advancements of IoT devices
- Real-time and continuous performance measurements
- Granular and Accurate measurements
- Sustain project savings
- Additional reporting
  - ESG (GRESB, CDP, others)
  - SEC requirements
  - Benchmarking
  - LEED and building codes
- Translate data to universal languages
  - $ Saved
  - % reduced
  - CO2 avoided



Project	Monthly Savings (kWh)	Monthly Savings ($)	Annual Savings (kWh)	Annual Savings ($)
Controls Installation	265	$29	3,181	$350
LED Retrofit	1,903	$209	22,839	$2,512
Controls + LED	1,986	$218	23,829	$2,621

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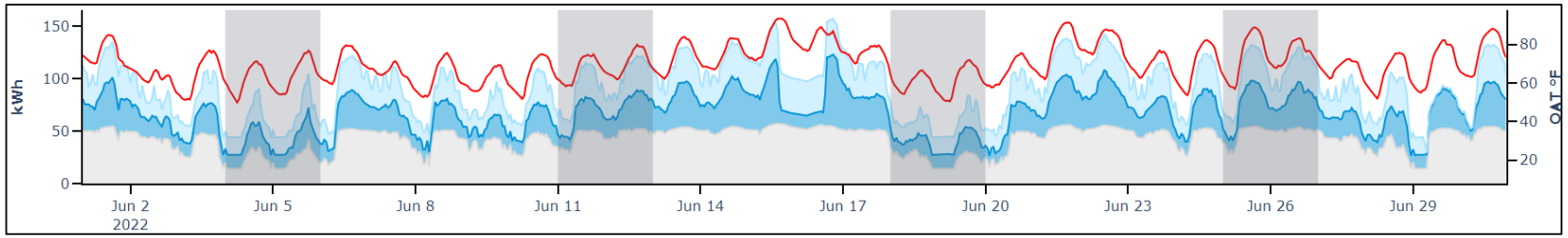
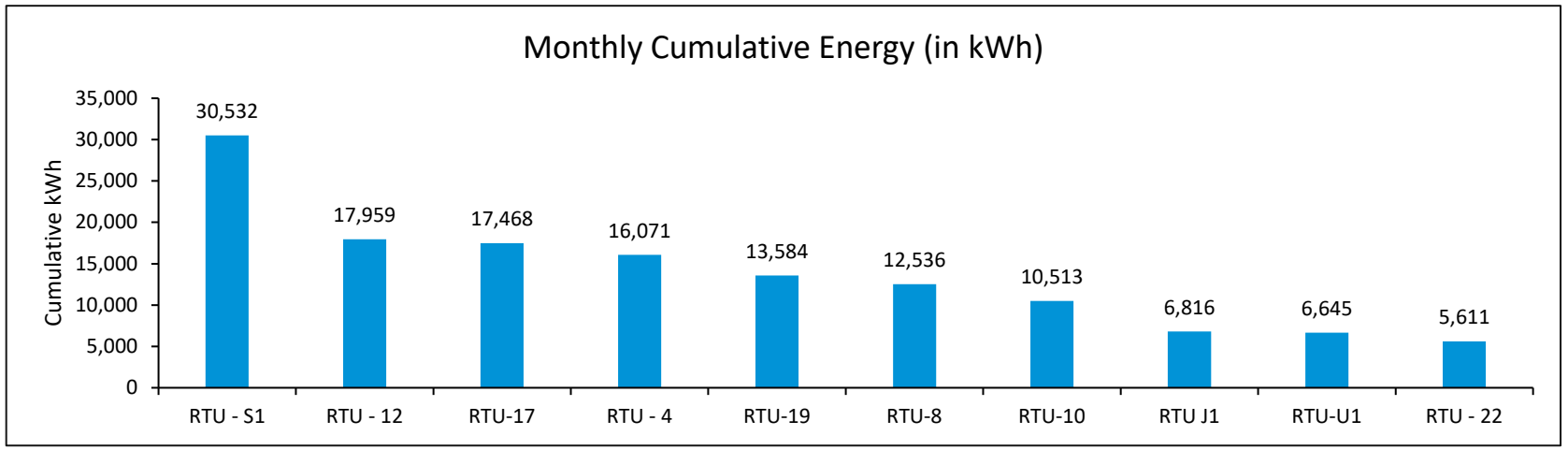
METER / MEASURE





What's possible with a single meter

- 48 circuits per meter
- Accurate and Continuous metering - 4 electrical parameters at sub-second interval
- Secure wireless cellular connection = no connection to customer's IT network

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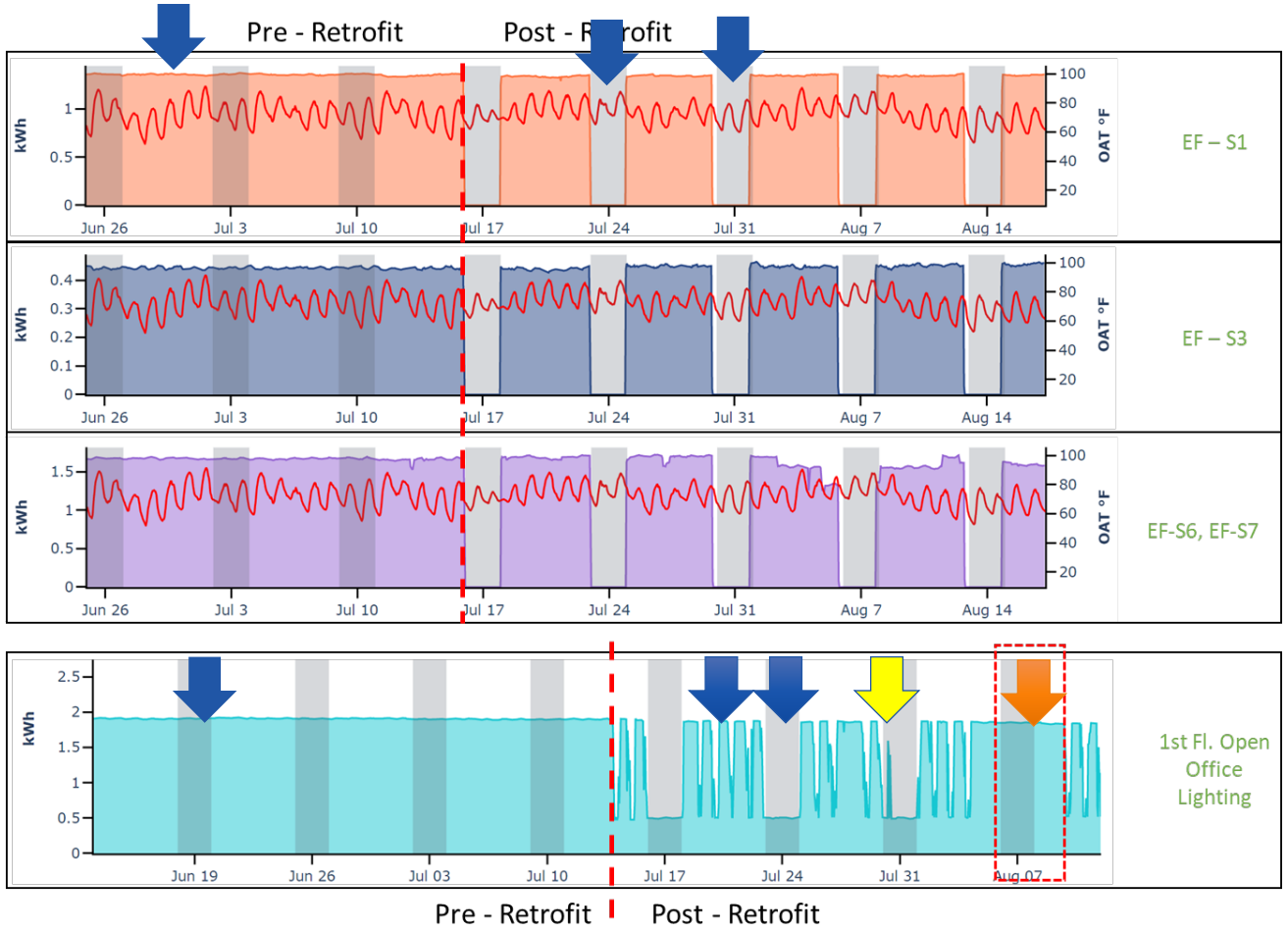
IDENTIFY



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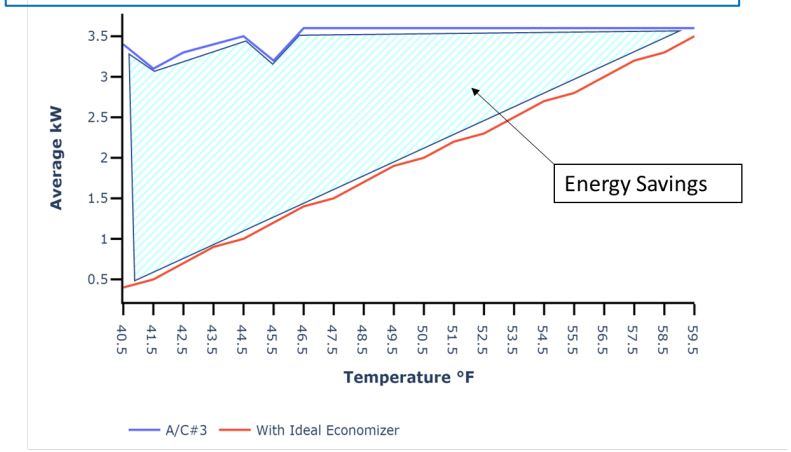
VERIFY

Measured Performance = 20% reduction in energy cost and CO2 emission!

Asset	Building System Type	Panel	Pre - Retrofit Consumption per Month	Post - Retrofit Consumption per Month	Monthly Savings %	Cost Savings ($)
RTU J1	HVAC	JHP1	6615	6299	5%	$ 28.37
RTU J2	HVAC	JHP1	4678	4150	11%	$ 47.46
EF-S6 , EF-S7	HVAC	Spp1	1199	811	32%	$ 34.98
EF-S1	HVAC	Spp1	976	668	32%	$ 27.72
EF-S3	HVAC	Spp1	318	223	30%	$ 8.59
AHU/CU-19	HVAC	SPP1B	372	302	19%	$ 6.27
AHU/CU-17	HVAC	SPP1B	226	160	29%	$ 5.94
RTU - S1	HVAC	HVAC-A	32811	25557	21%	$ 652.88
MEZZ. LIGHTING	Lighting	SDH-A	718	303	58%	$ 37.39
SDC OFFICE LIGHTING	Lighting	SDH-A	34	6	82%	$ 2.49
CAFE LIGHTING	Lighting	XHP1	960	899	6%	$ 5.50
Labeling Lights	Lighting	RHP1	1776	1123	37%	$ 58.76
1st Fl. Open Office Lighting	Lighting	SOH-A	1372	965	30%	$ 36.66
2nd Fl. Open Office	Lighting	SOH-A	748	625	16%	$ 11.07
Total			**52803**	**42091**	**20%**	**$ 964.07**

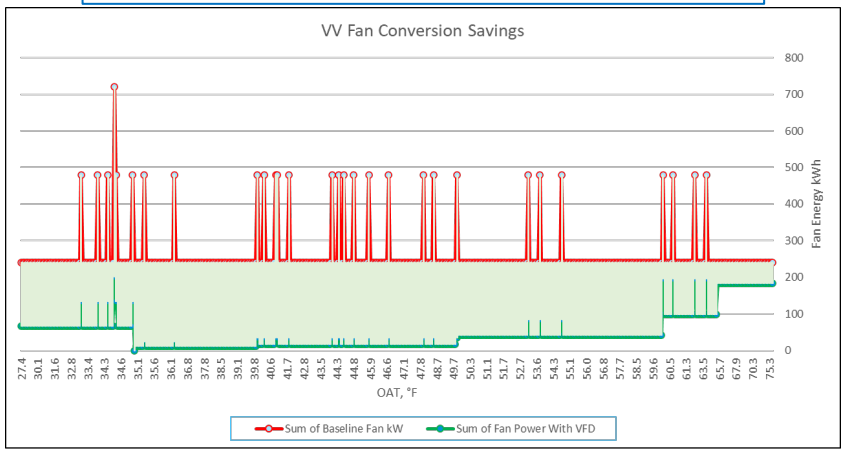
IMPROVE

ECM 1: Integrated Economizer



Messages	
Economizer Status	Unavailable / Needs optimization
Potential Savings (area in blue)	3000 kWh and $300 per month
Indicative ROI	2.5

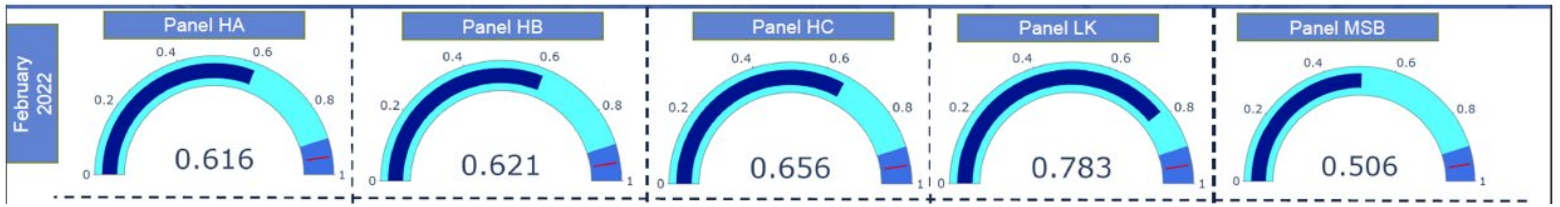
ECM 2: Variable Speed SF



Messages	
Baseline Fan Operation Type	Constant volume on/off
Potential Savings (area in green)	3000 kWh and $300 per month
Indicative ROI	2.5

Opportunities
30% reduction in energy cost and CO2 emission!

ECM 3: Power Factor Correction



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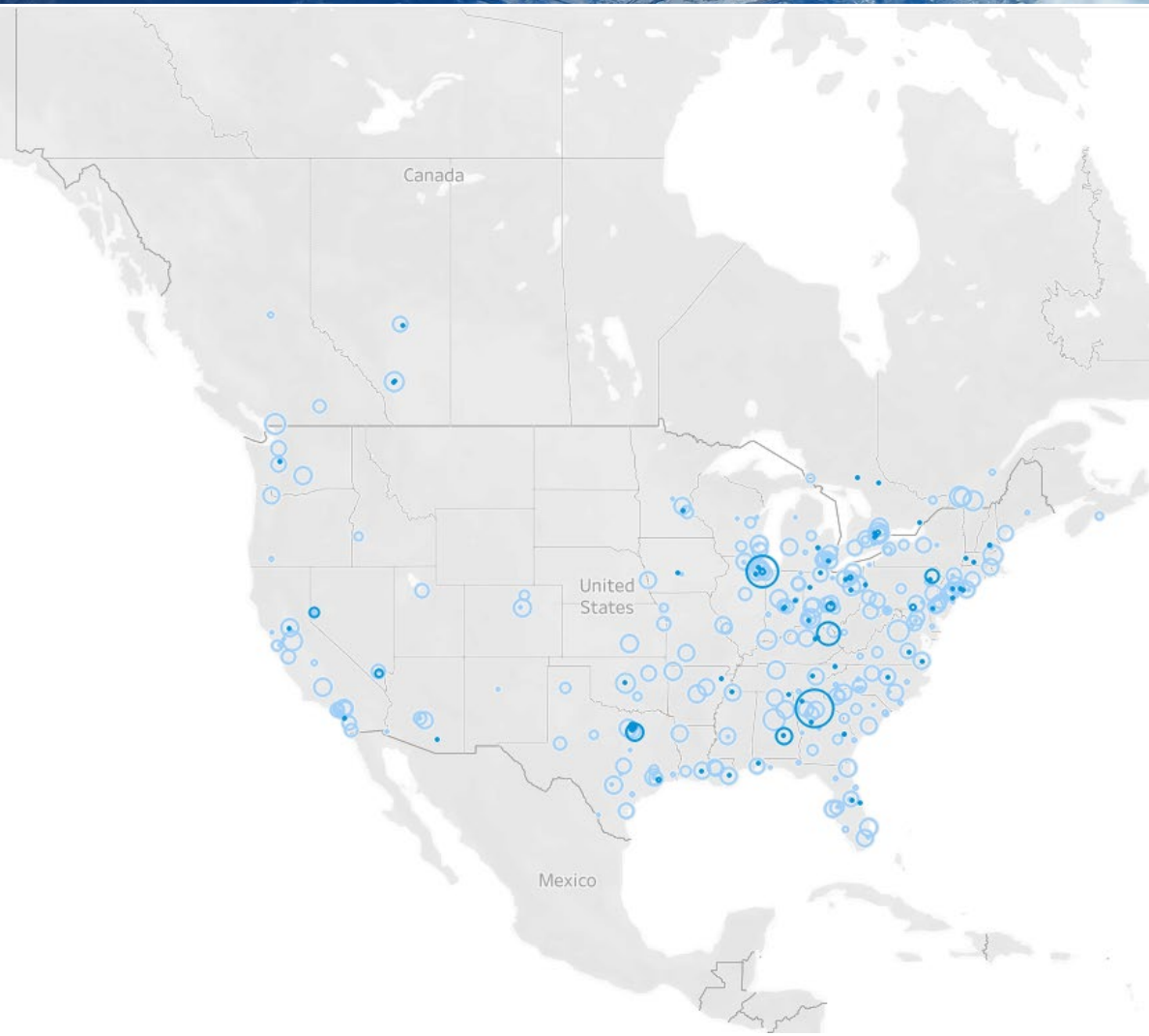
ADDITIONAL BENEFITS

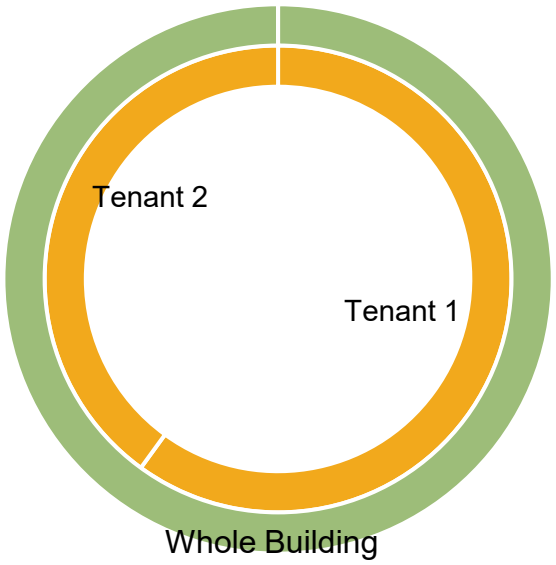
- Measurement and Verification of project performance
- Identification of energy opportunities and projects
- ESG Reporting and financial variance analysis
- Budgeting, back-charges, utility bill discrepancies
- Portfolio wide energy benchmarking across sites
- Trend analysis to determine equipment irregularity
- Disaggregation of Utility Bill
- Participation in demand response and curtailment programs



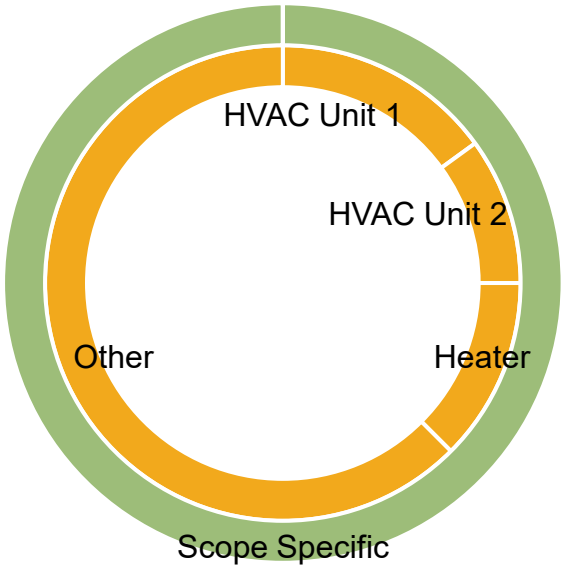
KEY ELEMENTS FOR SUCCESSFUL M&V VIA SUBMETERING

- Submetering is not a silver bullet
- Proper planning: collection of as-builts, equipment information, and other data improves the meter data accuracy and its usefulness.
- Due to lack of documentation in old buildings, the process could be iterative
- Requires a long-term relationship/contract to fully utilize the benefits of metering solutions

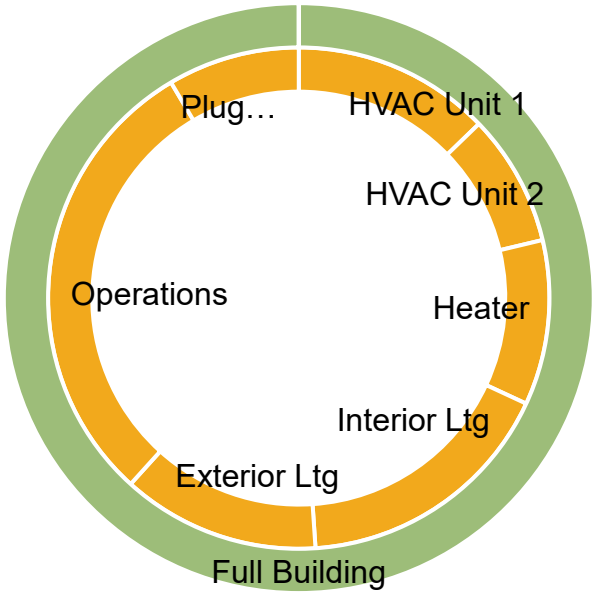
Base Visibility



System Visibility



Complete Visibility



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WHEN DONE CORRECTLY

Energy Insights and Analytics

Visualize consumption baselines, trends, and anomalies within a single building, or across an entire portfolio and dive deep into robust analytics to drive business cases for capital projects and efficiency for MRO.

Project Performance & Transparency

Metering technology that measures actual kWh saved at the circuit level paired with a customer friendly energy consumption dashboard ensures customers only pay for actual savings recognized. Enabling the measurement and verification of each project, every time.

Persistent Asset Monitoring

Monitor potential maintenance issues, power quality, and operational to extend the lifespan of your buildings, equipment, and assets.

WHEN DONE CORRECTLY

Background:

Customer Profile: Office, Warehouse, Service

Location: Mt. Upstate New York

Building Size: 84,393 sq. ft

Property Type: Industrial/Warehouse (mixed)

Summary:

The purpose of this report is to provide a first look at energy consumption data and patterns at the customer's site captured by limited metering Meters were installed on 1 main distribution panel.

Meters Deployed: **1**

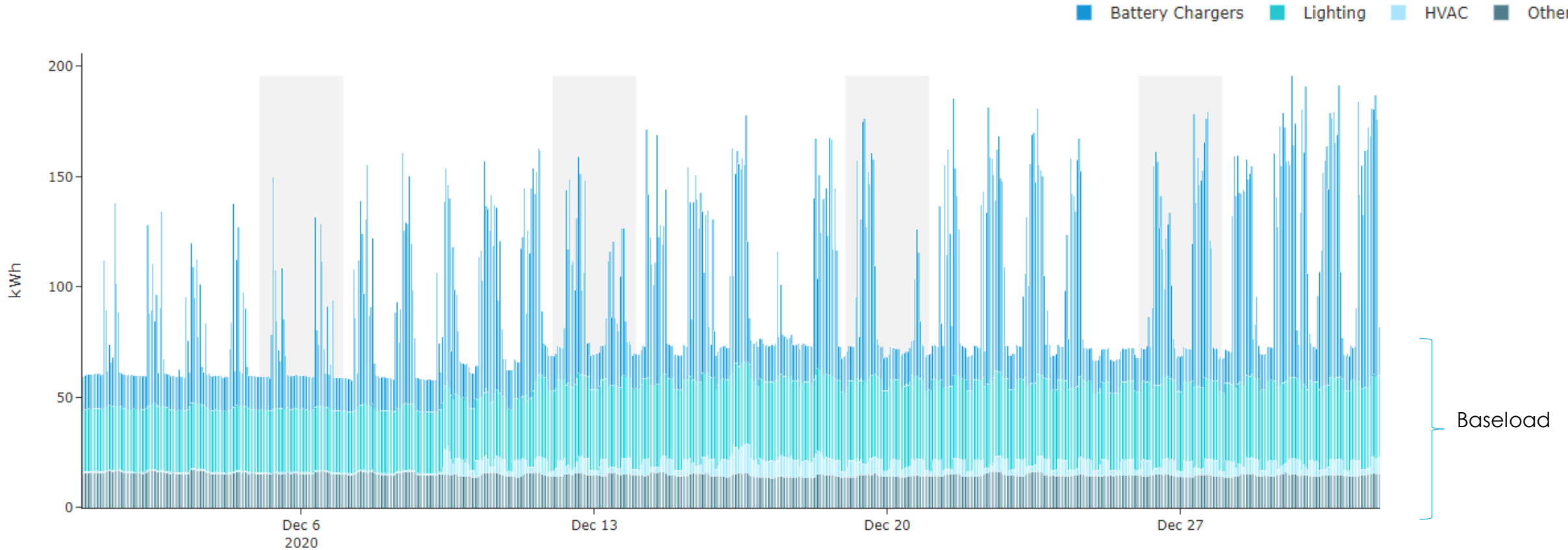
Loads Measured: **36**

Metering Results:

- Primary energy consumption was distributed as follows:
  - Lighting
  - EV Charging
  - HVAC
- Lighting Runtime Analysis suggests total runtime of 8,760 hours annually (i.e. continuously running).
- Measurement Date: Dec 1 – Dec 31, 2020

Main Distribution Panel	
Sub-Panels and Equipment	
1	Offices area panel
2	A/C #4 at the roof
3	A/C #5 at the roof
4	Office area transformer
5	Charger lift panel
6	Warehouse lighting panel
7	Free standing panels

WHEN DONE CORRECTLY



What does this chart represent? Energy consumption within the facility by system type over time (hourly).

What should I be looking for within this chart? Identifying baseload within the chart will provide insight into energy consuming assets that are consistently using electricity. Identifying trends around energy usage inside operating hours vs. outside operating hours will help in identifying baseload as well consumption anomalies.

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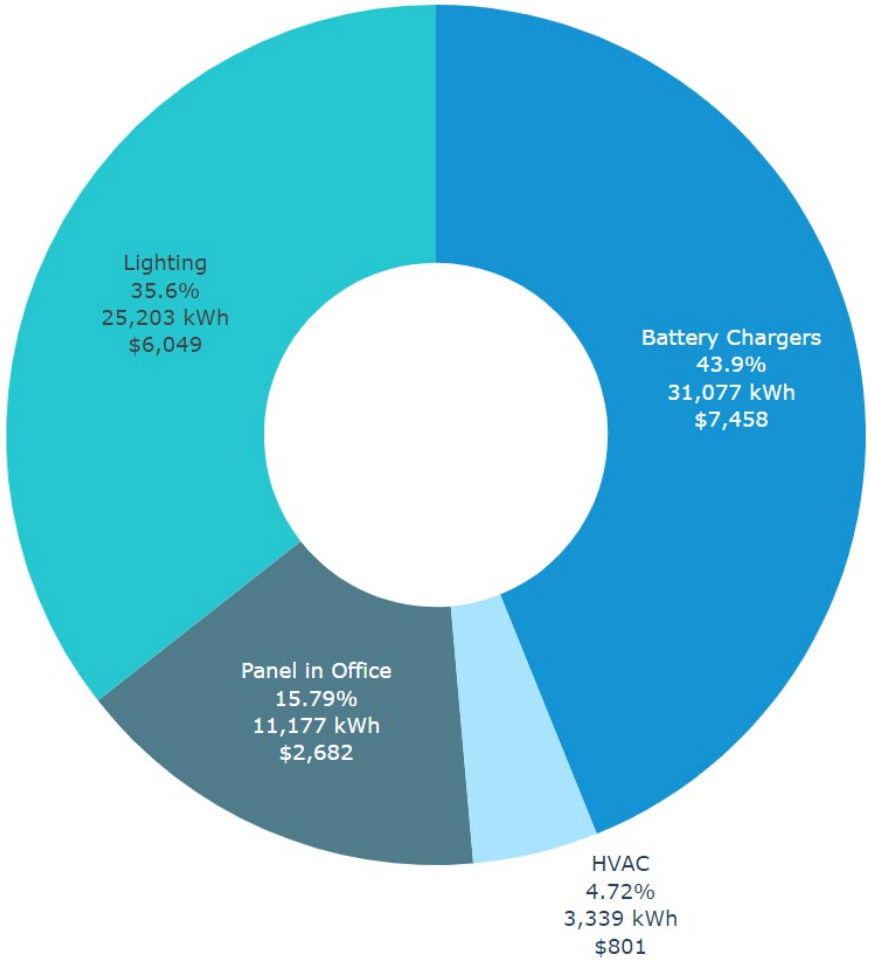
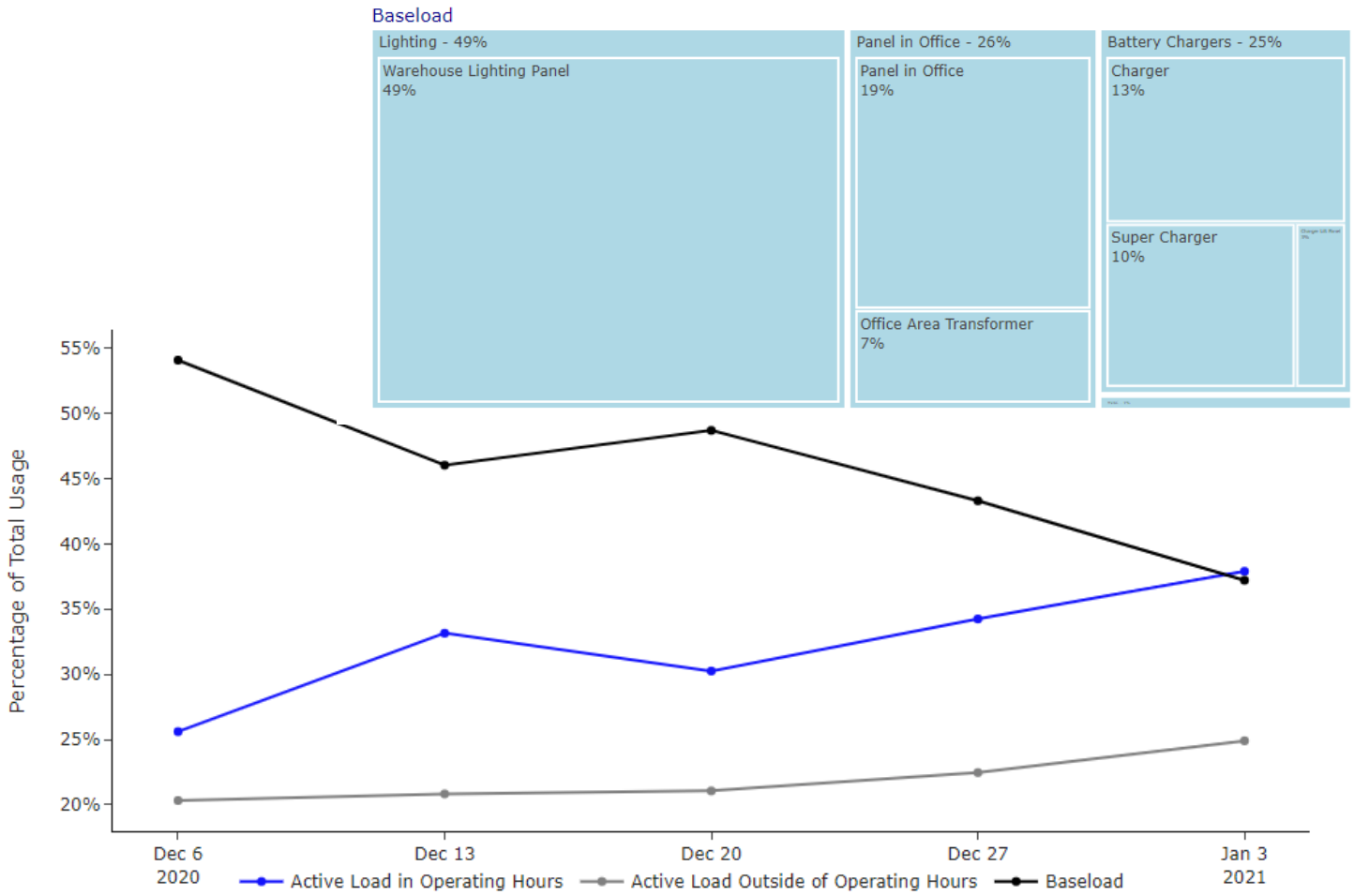
WHEN DONE CORRECTLY





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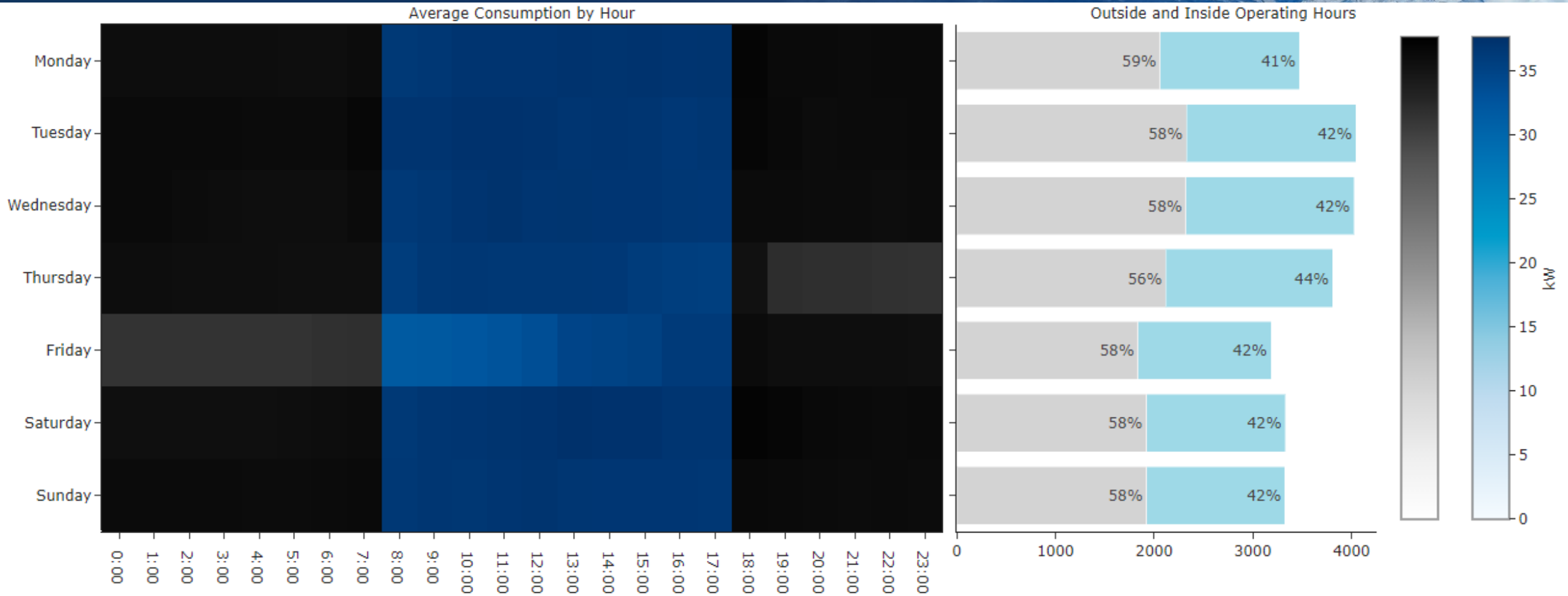
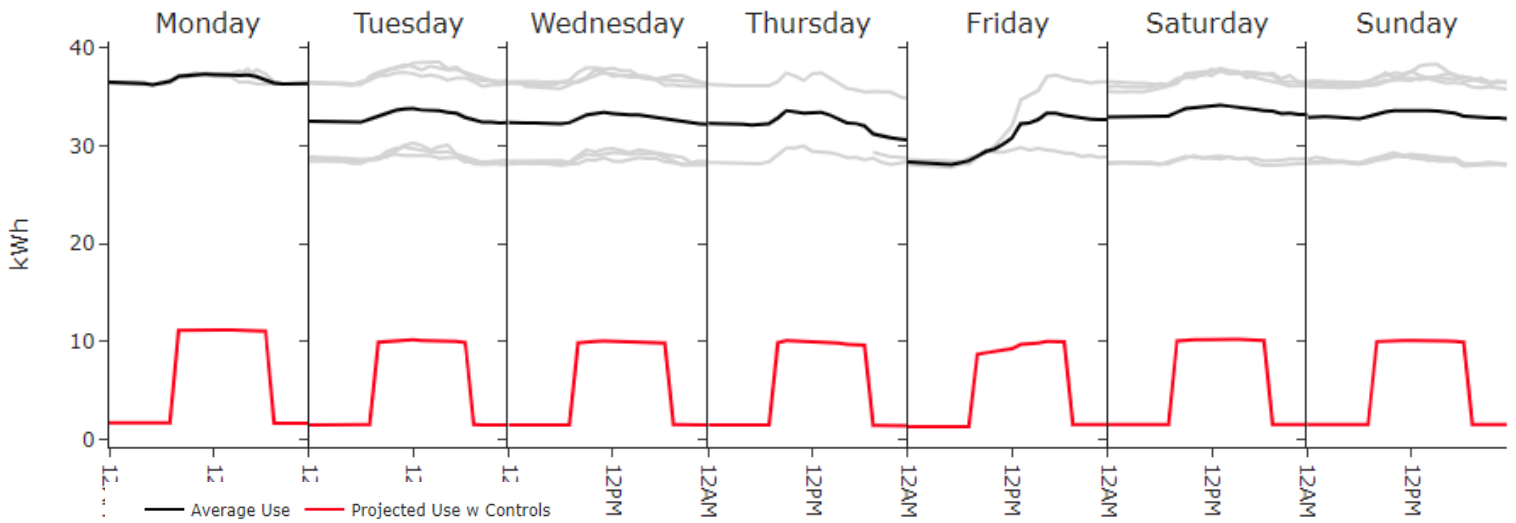
WHEN DONE CORRECTLY



What does this chart represent? This chart represents what percentage of the lighting systems are engaged. Darker shades represent the heaviest amount of consumption by day (y-axis) and time (x-axis). Blue shades represent usage inside operating hours, and grey shades represent usage outside operating hours. The bar char to the right shows total usage on average throughout the week with the same shading scheme.

What should I be looking for within this chart? Dark shades should correspond with the facility's operating hours within the facility and can help to identify consumption that is irregular or outside of operating hours.

WHEN DONE CORRECTLY

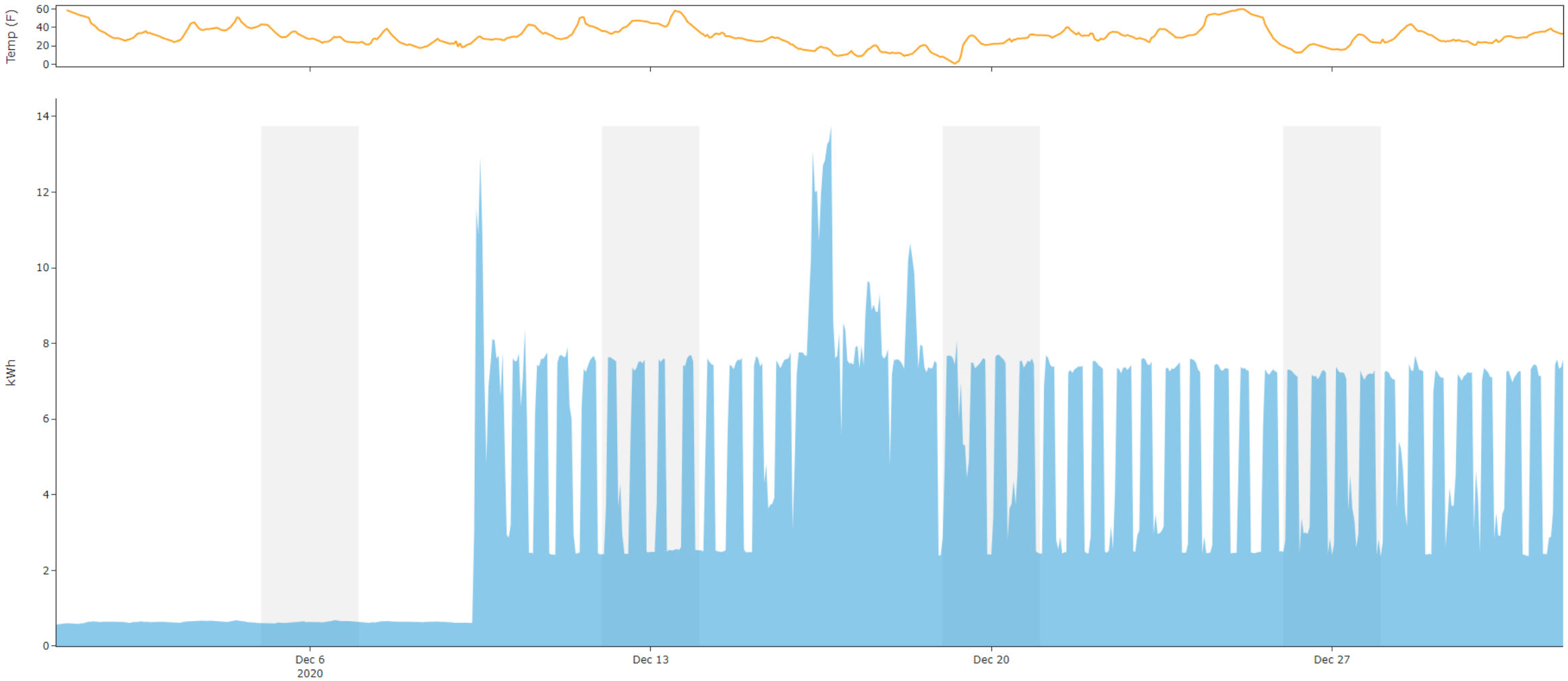


	Weekly (kWh)	Weekly Savings ($)	Monthly (kWh)	Monthly Savings ($)	Annual (kWh)	Annual Savings ($)
LED Retrofit & Controls Installation	4,807	$1,154	19,227	$5,191	249,946	$59,987

What does this chart represent? This chart shows weekly patterns of usage, with the solid black lines representing average usage throughout a day, and the gray lines showing the individual days that make up the average. A small spread of gray lines indicates consistent usage from day to day, while a wider spread represents inconsistent usage. Furthermore, the red lines shown above indicate the projected lighting consumption with a lighting controls system.

What should I be looking for within this chart? If there are a lot of gray traces visible, it is likely that a site would benefit from installation of lighting controls to make lighting usage more consistent. A large delta between the red lines and the black lines shows a large lighting controls savings opportunity.

WHEN DONE CORRECTLY



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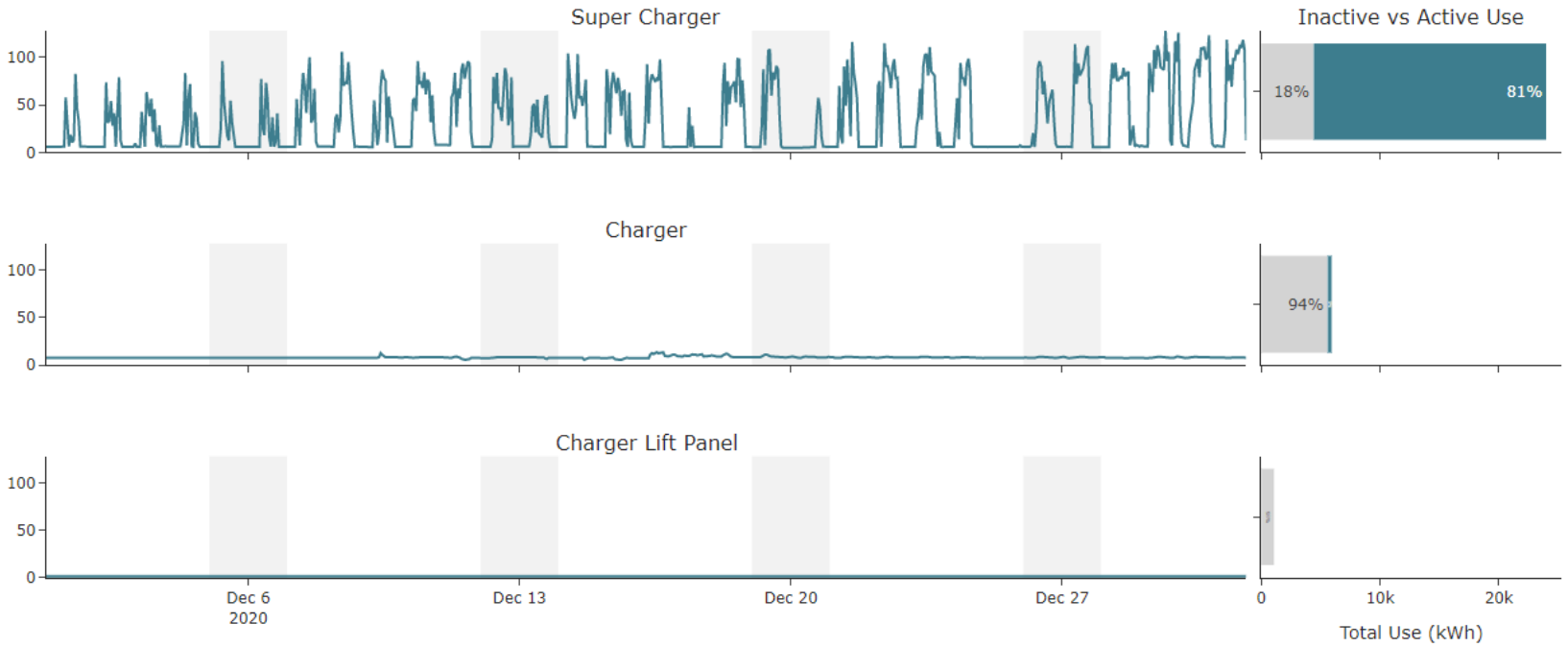
WHEN DONE CORRECTLY



Data in measured period	Baseload kWh	Baseload $	Active kWh	Active $
Super Charger	4,382	$1,051	19,622	$4,709
Charger	5,580	$1,339	341	$81
Charger Lift Panel	1,138	$273	15	$3
Total	**11,100**	**$2,664**	**19,978**	**$4,794**

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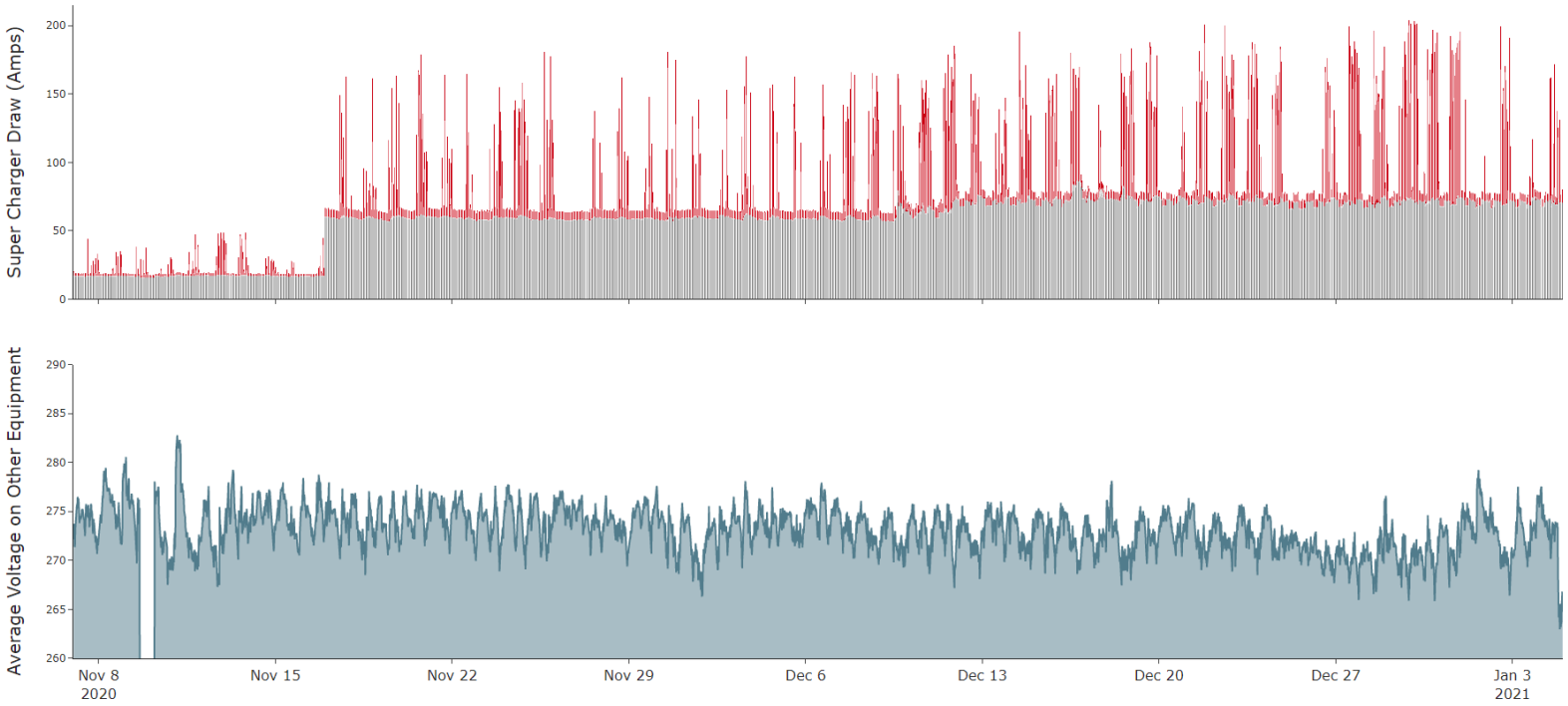
WHEN DONE CORRECTLY



What does this chart represent? These charts show the relationship between the amount of current draw from the Supercharger (in red) and the rest of the facility (in grey) on the top chart. The bottom chart is compares it to voltage draw at the rest of the site.

What should I be looking for within this chart? There are numerous instances where a high draw from the Supercharger will negatively impact the voltage being supplied to the rest of the facility. In the subset of the graph above, the Supercharger being used led to the voltage in the facility falling from 278 Volts to 272 Volts. The effect of the Supercharger is widespread and generally leads to lowered voltage for the period the Supercharger is in use, though the effect is not fully consistent. This indicates a need for voltage regulation within the facility.

Source https://www.the33rdteam.com/breakdowns/building-the-perfect-nfl-coach/

1. **Measure** — **Combine**
2. **Identify** — **Training**
3. **Verify** — **Games**
4. **Improve** — **Superbowl**

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QUESTIONS

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