



Maximize the Value of Each Existing Utility Meter

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An aerial photograph of the UC Davis Main Campus. The image shows a large, sprawling campus with numerous buildings, green spaces, and a complex network of roads and highways. The campus is situated in a valley, with hills visible in the background. The text is overlaid on the left side of the image.

UC Davis (Main Campus)

- 34k students, 23k Faculty & Staff
- 1,000+ buildings, 180 over 10,000SF
- 11.3M SF total, 5,300 acres land
- Founded 1905, avg building age: 41 years old
- Steam production: 700M lbs/yr (NG boilers)
- Chilled water production: 30M ton-h/yr (elect chillers)
- Purchased utilities cost (elect & gas): \$30M/year

Better utilizing data from a single electricity meter

“Developing a clear data picture from existing meters might be more valuable than installing a thousand new ones. The proliferation of new sensors should not outpace our efforts to take action using existing data streams.”



UC DAVIS

Business Challenges

- A. Inform occupants of building device status in real time
- B. Generate alarms for assets
- C. Assess device utilization to inform building standards development
- D. Optimize runtime of building devices

Solution

- A. Increase frequency of data collection
- B. Develop detailed equipment inventory
- C. Train and build real time analytics using machine learning

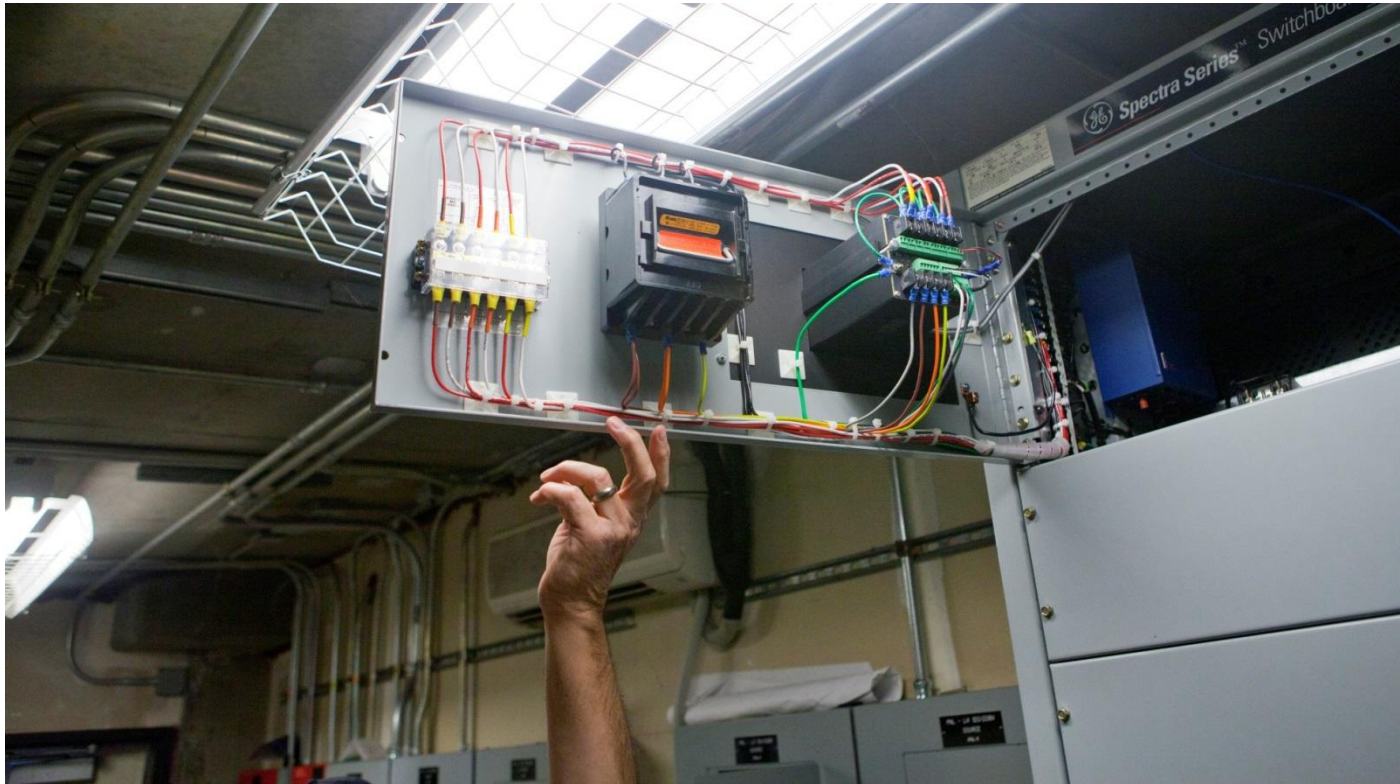
Results and Benefits

- “Easy” fixes by inspection
- Proof of concept app that integrates siloed car charger data

The study area includes a 3-level parking structure and adjacent parking lots



Like many sites, a single electrical meter monitors the whole district



Many electrical loads on the same meter: lights



Many electrical loads on the same meter: pumps & an elevator



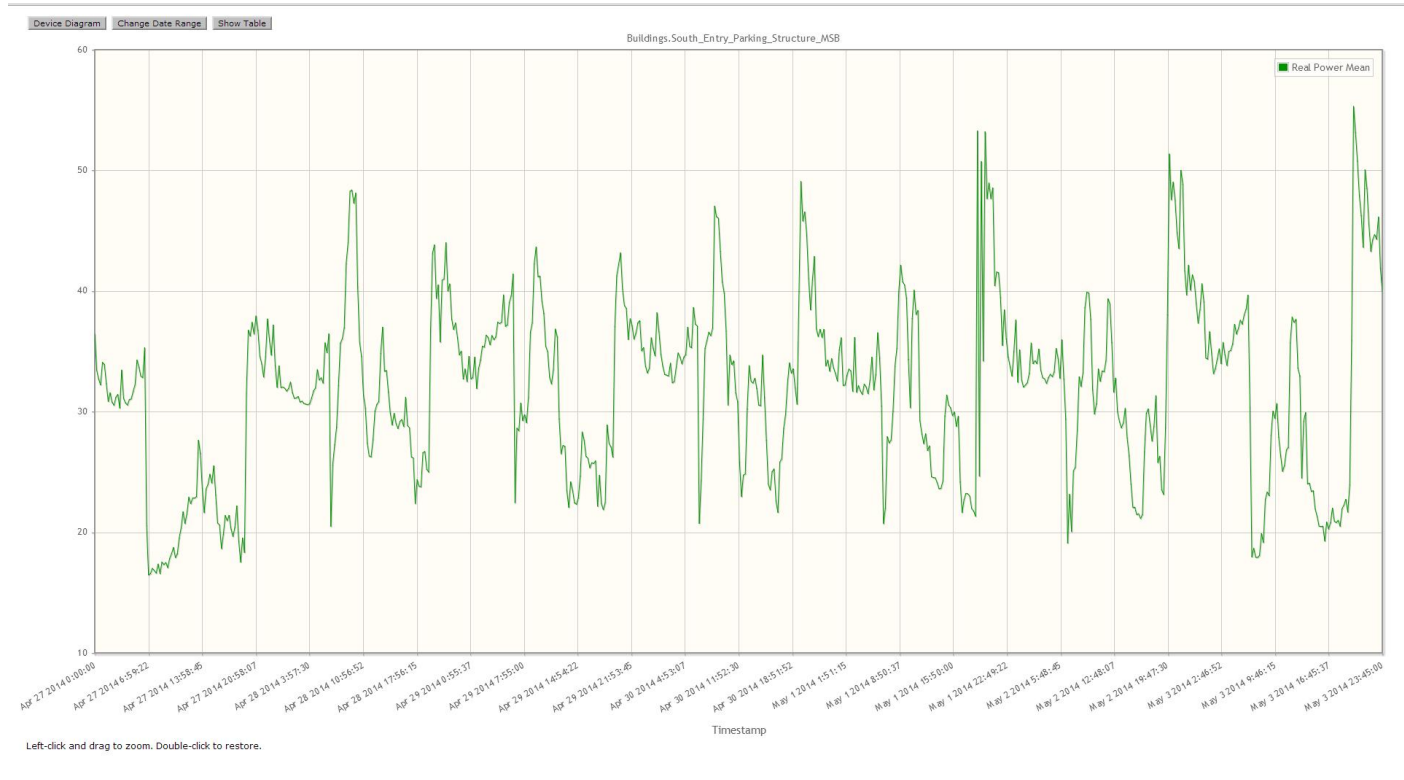
Many electrical loads on the same meter: ticket machines & chargers



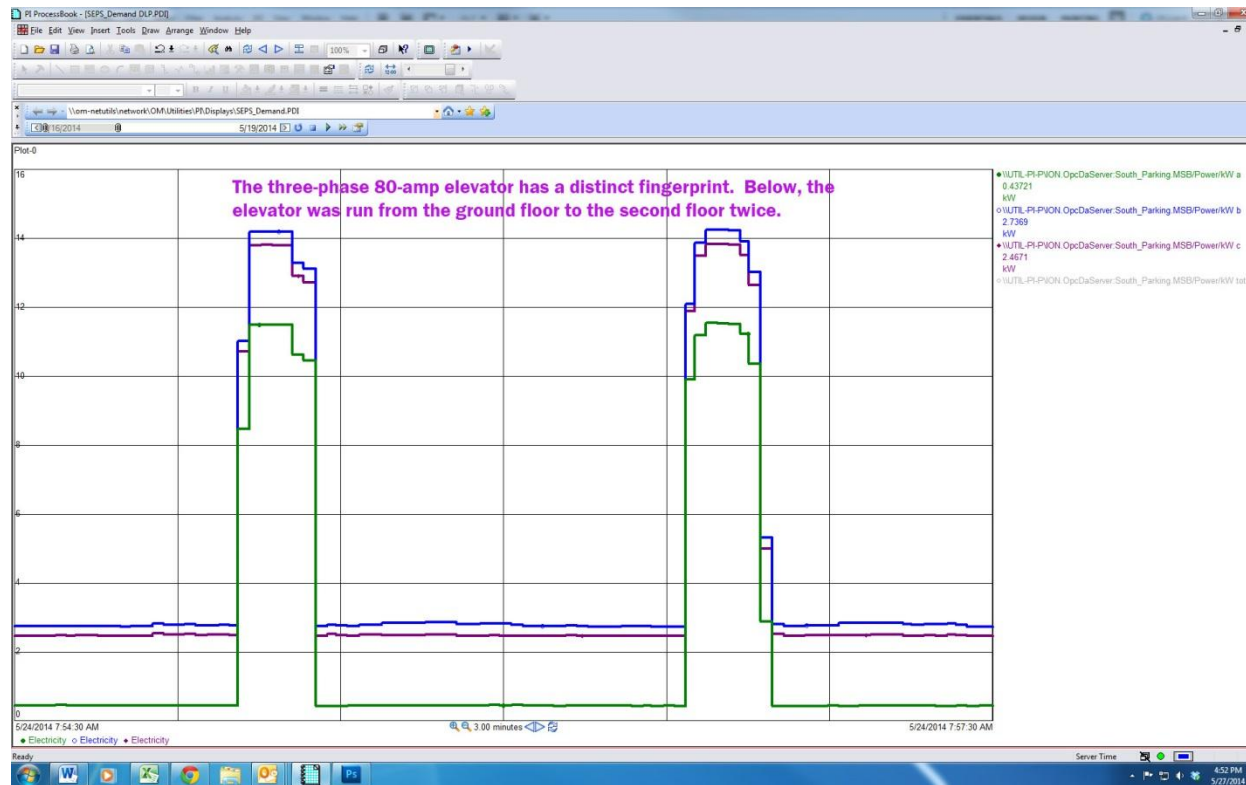
Business Challenges

- Inform occupants of building device status in real time
- Generate alarms for assets
- Assess device utilization to inform building standards development
- Optimize runtime of building devices

Historically, power use has been stored as typical 15-minute interval data



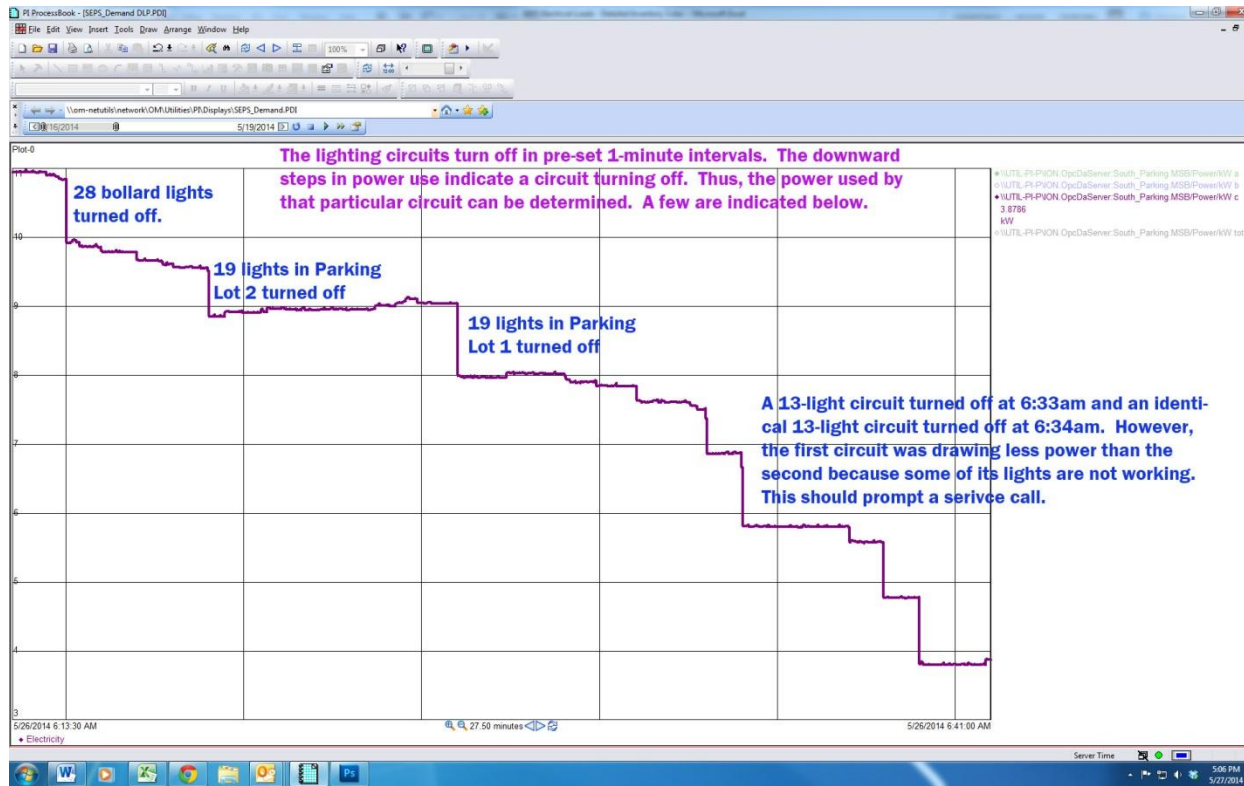
Increased frequency of data collection brings out unique device signatures



Increased frequency of data collection brings out unique device signatures

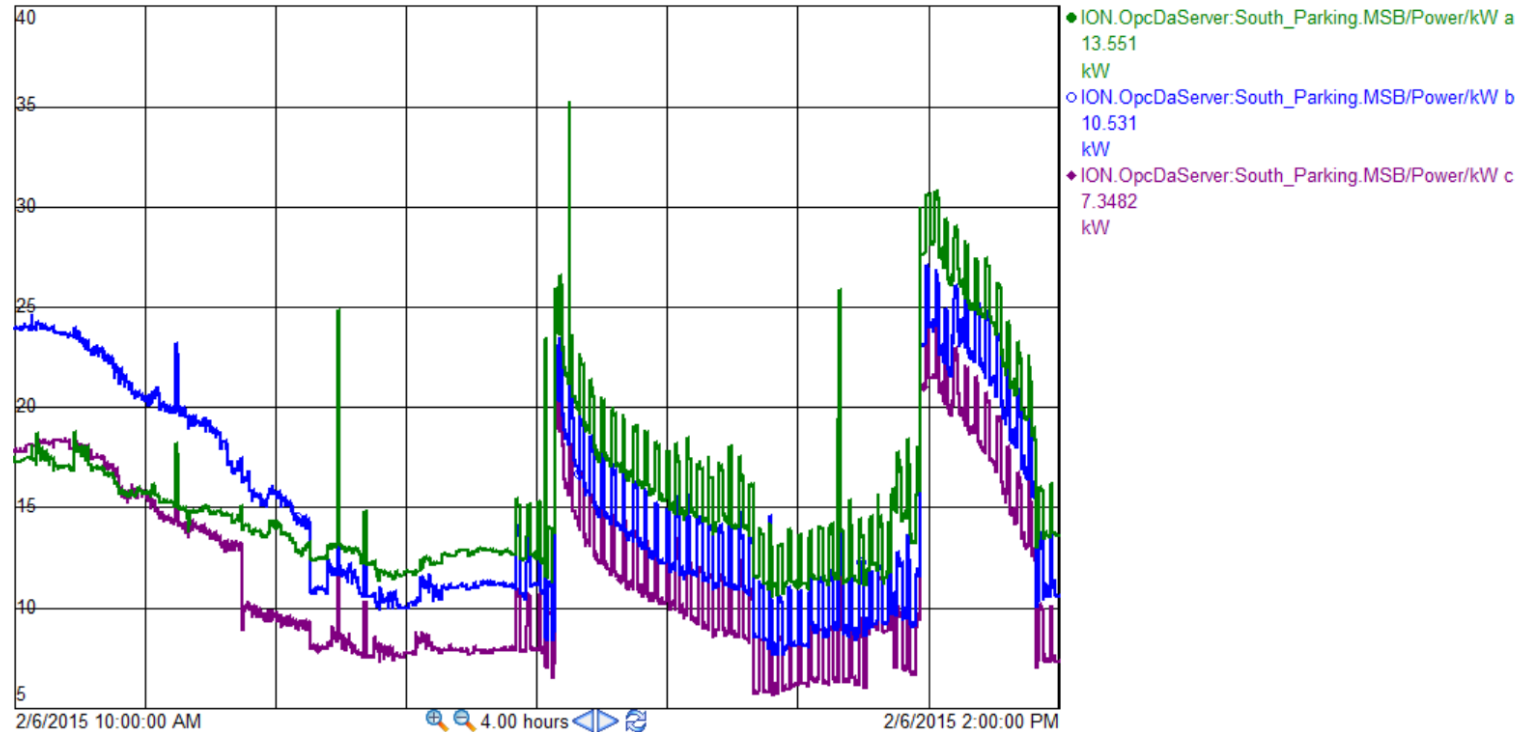


Increased frequency of data collection brings out unique device signatures



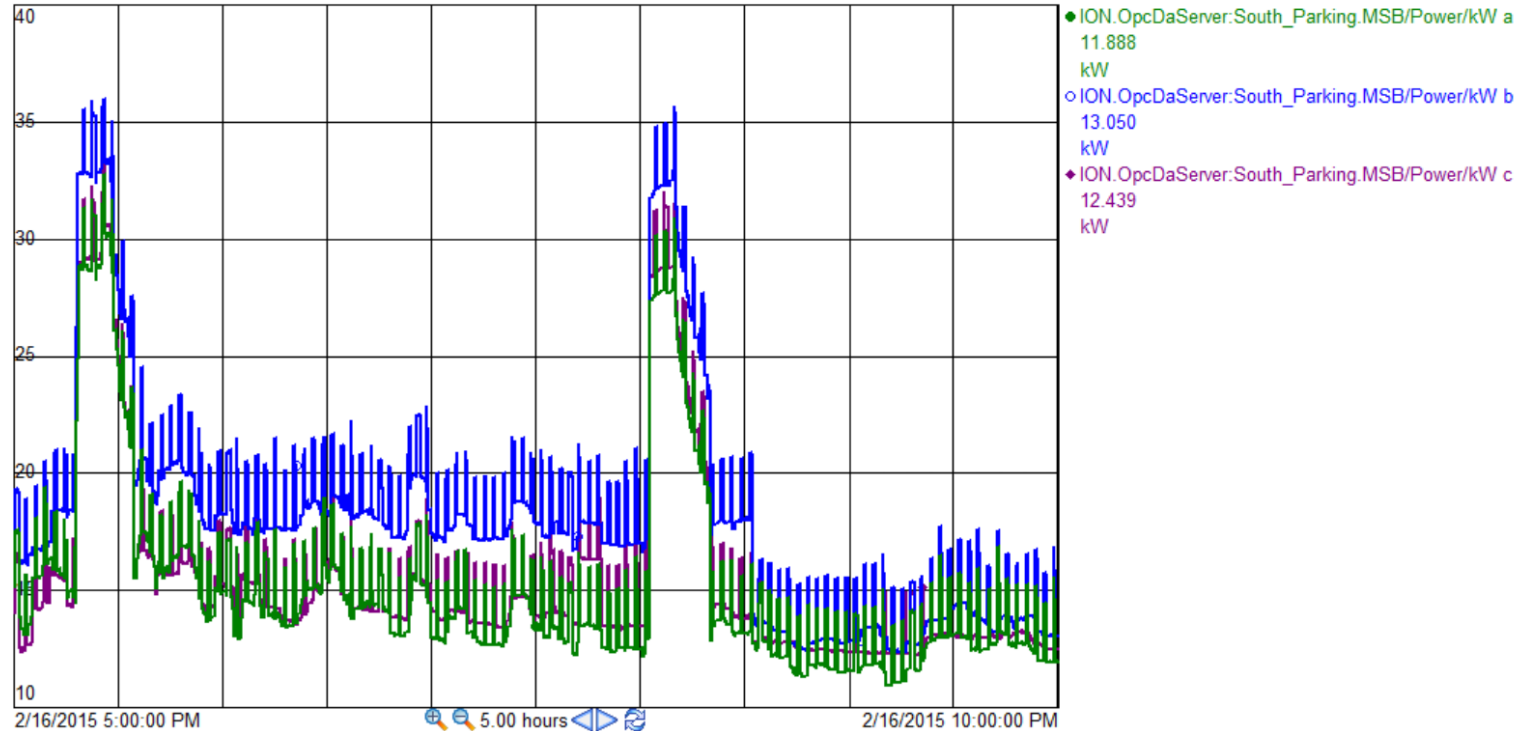
Status obvious at a glance: Storm pumps running when it's raining

Plot-0



Problems also obvious: Pumps still running a week later

Plot-0



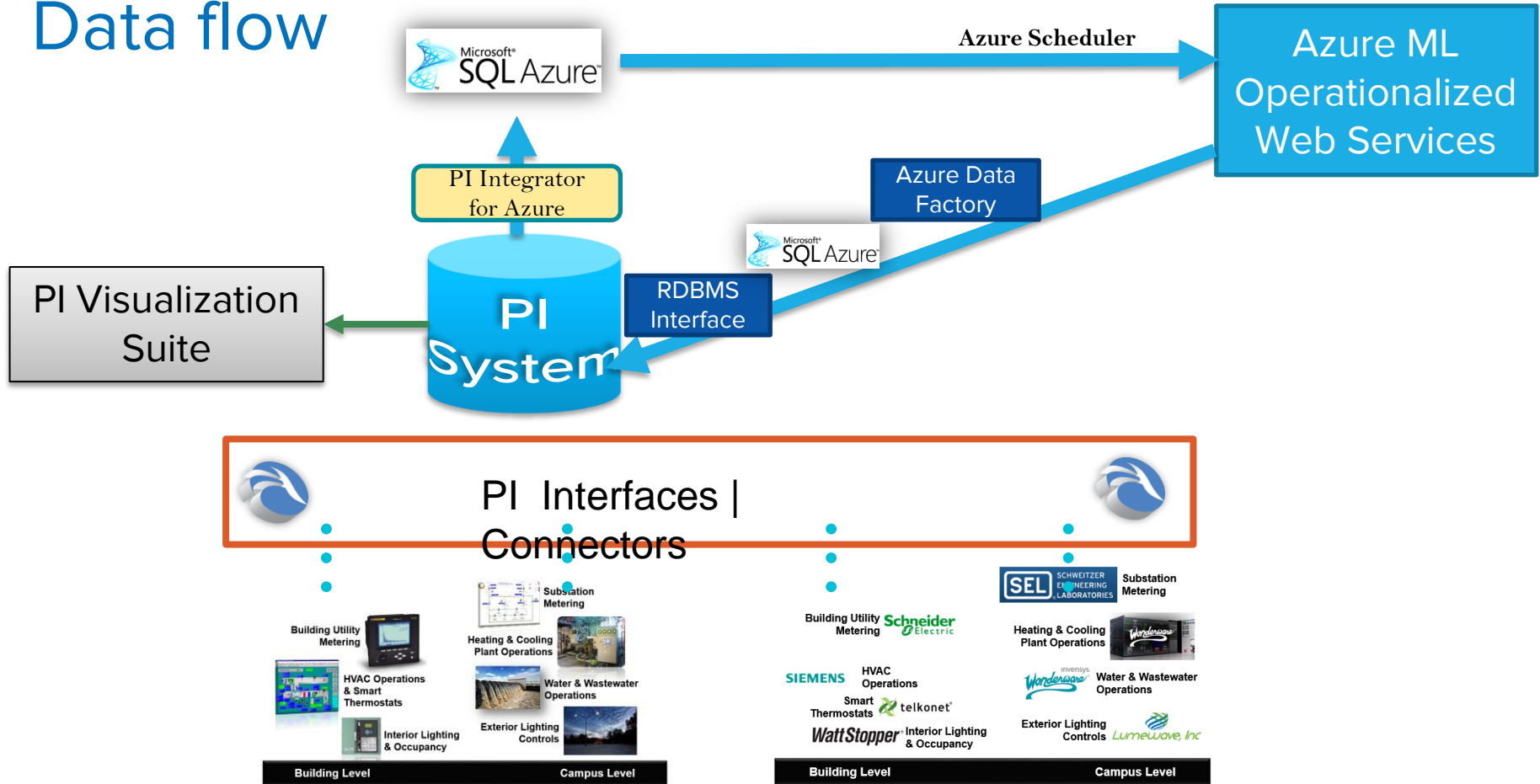
All loads entered into a database to support disaggregation

Load			Fed from		Breaker		Leg		Load Pattern
Load Number	Load Type	Description	High W	Low W	Panel	No.			
1	Elevator	3-Phase Elevator	11 kVa		EH	32, 34, 36	ABC		Periodic based on occupancy
2	Pumps	3-Phase Storm Drainage Pump 2x10HP	7.7 kVa		EH	26, 28, 30	ABC		Periodic based on rainfall
3	Pumps	3-Phase Sewage Ejector 2x1.5HP	1.4 kVa		EH	25, 27, 29	ABC		Periodic based on water use
4	Charger	3-Phase Quick Charger Under Solar Canopy			EH	20, 22, 24	ABC		Periodic based on demand
5	Cooling	2-Pole Cooling Unit, CU-1 in Elev. Rm.			L2	14,16	ABC		Periodic based on temperature
6	Heating	2-Pole Water Heater 4,500W			L2	18,20	CA		Periodic based on water use
7	Heating/Cooling	2-Pole Heat Pump (Ext)			L2	22, 24	BC		Periodic based on temperature
8	Heating/Cooling	2-Pole Heat Pump (Int) in Office			L2	13, 15	ABC		Periodic based on temperature
15	Electronics	Irrigation Controller			L2	26	A		Always on
16	Fans	Fans in Bathroom, Jan., & Office, EF-1, EF-5, SF-1			L2	27	B		Periodic based on occupancy
17	Heating	Generator Heater			L2	28	B		Periodic based on temperature
18	Pumps	MH ABCD Sump Pump			L2	30	C		Periodic based on rainfall
23	Refrigerator	Refridgerator			L1	18	C		Periodic based on temperature
24	Lighting	Traffic Lights	0.2 Kva		L1	1	A		Always on
28	Lighting	South Entry Parking Structure Ground-level	115	55	EH	1	A		Always on - Hi/Lo
31	Lighting	South Entry Parking Structure 2nd-level	115	55	EH	17	C		Always on - Hi/Lo
35	Lighting	South Entry Parking Structure Stairs	70	70	EH	10	B		Dusk-30m to Dawn+30m - Constant
62	Lighting	Parking Lot 1	75	38	H2	1	A		Dusk-30m to Dawn+30m - Hi/Lo
63	Lighting	Parking Lot 1 Under PV Canopy	75	38	H2	1	A		Dusk-30m to Dawn+30m - Hi/Lo

Machine learning: model training



Data flow



EV charger status in Asset Framework (AF)

The screenshot displays the UTIL-AF AzureML - PI System Explorer application. The interface is divided into several sections:

- Left Panel (Elements):** A tree view showing the hierarchy of elements. Under 'Gateway', 'EL1' is expanded, showing a list of 'EV Chargers' including Device100, Device101 (selected), Device104, Device106, Device108, Device17, Device96, Device97, and Device98. Below this is 'Element Searches'.
- Top Bar:** Contains a menu (File, Edit, View, Go, Tools, Help) and a toolbar with icons for Database, Query Date, Back, Check In, Refresh, New Element, and New Attribute. A search bar 'Search Eleme...' is on the right.
- Center Panel (Device101):** Displays the configuration for 'Device101'. It has tabs for General, Child Elements, Attributes, Ports, Analyses, and Version. The 'General' tab is active, showing a table with columns 'Name' and 'Value'.

Name	Value
phase_a	0.472196937
phase_b	2.330983
phase_c	0.648049057
state	On
state_numerical	1
- Right Panel (Properties):** Shows configuration details for the selected element. It includes fields for Name (phase_a), Description, Configuration Item, Categories, Default UOM (<None>), Value Type (Single), Value (0.472196937), and Data Reference (PI Point). A 'Settings...' button is at the bottom, with a path below it: \\UTIL-PI-PI\\Gateway-EL1-Device101-phase_a.

Asset Analytics on EV charger status

\\UTIL-AF\AzureML - PI System Explorer

File Edit View Go Tools Help

Database Query Date Back Check In Refresh New Element

Elements

- Elements
 - Gateway
 - EL1
 - EV Chargers
 - Device100
 - Device101
 - Device104
 - Device106
 - Device108
 - Device17
 - Device96
 - Device97
 - Device98

Element Searches

EV Chargers

General Child Elements Attributes Ports Analyses Version

Name Backfilling

- Chargers_available_count
- Chargers_on_count
- Chargers_on_fraction

Name: Chargers_on_count

Description:

Categories:

Analysis Type: ☐ Expression ☒ Rollup ☐ Event Frame Generation

Rollup attributes from

☒ Child elements of EV Chargers

☐ This element - EV Chargers

To select attributes set criteria below

Attribute Name: state_numerical

Attribute Category:

Element Category:

Element Template:

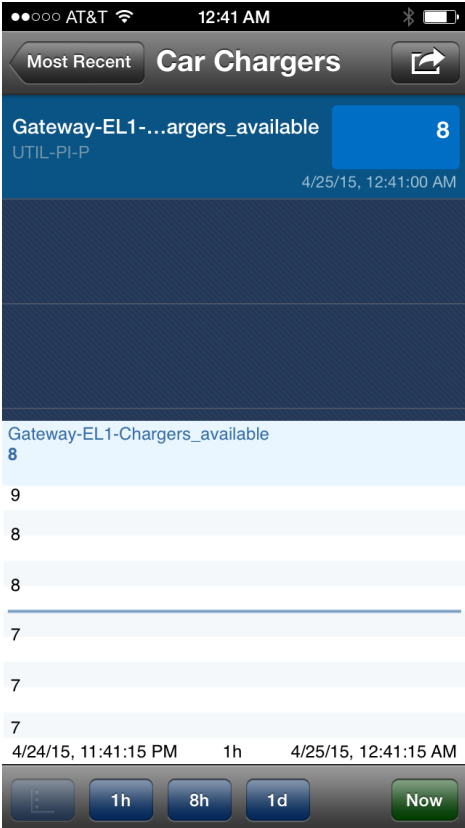
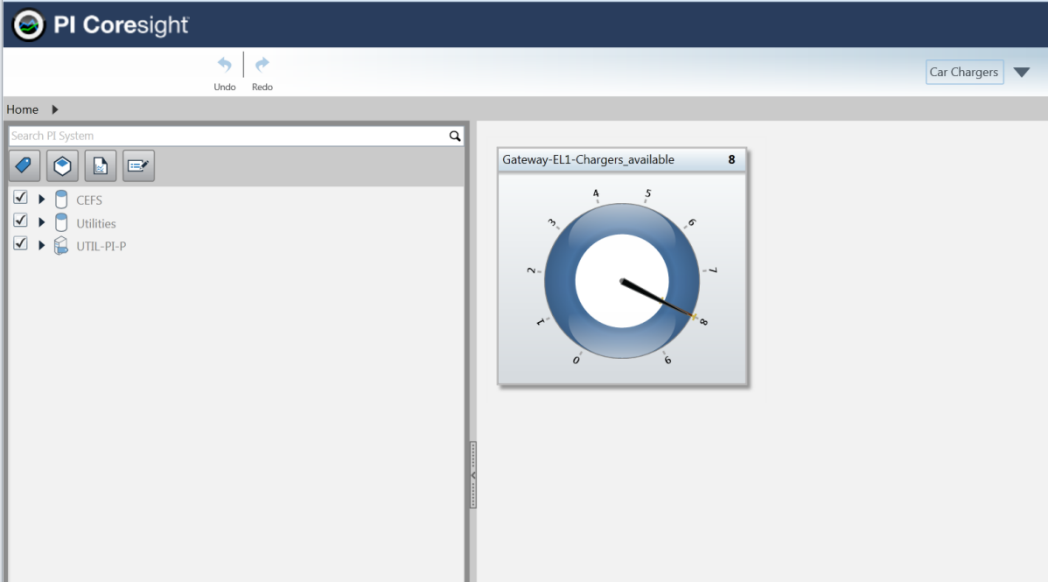
Select the function(s) to write to an attribute Evaluate

Function	Output(s)	Value
<input checked="" type="checkbox"/> Sum	Chargers_on	
<input type="checkbox"/> Average		
<input type="checkbox"/> Minimum		
<input type="checkbox"/> Maximum		
<input type="checkbox"/> Count		
<input type="checkbox"/> Median		
<input type="checkbox"/> Population standard deviation		
<input type="checkbox"/> Sample standard deviation		

Attributes

Name	Parent Element	Category
state_numerical	Device101	
state_numerical	Device97	
state_numerical	Device96	
state_numerical	Device17	
state_numerical	Device100	
state_numerical	Device98	
state_numerical	Device108	
state_numerical	Device106	
state_numerical	Device104	
phase_a	Device101	
phase_a	Device104	
phase_a	Device98	
phase_a	Device97	
phase_a	Device96	
phase_a	Device17	
phase_a	Device100	
phase_a	Device108	
phase_a	Device106	
phase_b	Device96	
phase_b	Device104	
phase_b	Device98	
phase_h	Device97	





Coresight app: number of chargers available



Extensions

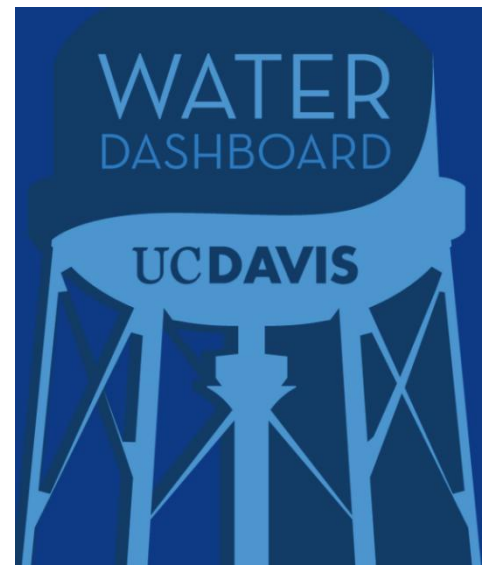
- Deploy car charger app across campus and publicize
- Automate alarms for lights, pumps, elevators
- Use light utilization data to turn the lights down
- Use historical data to inform campus planning

Gateway District

SYSTEMS AND STATUS								
CURRENT USE	43% Max	1/8 Spots						
USE OVER LAST DAY	66% Max	22 Cars	16 Rides	2 Cycles	0 Cycles			
COST OVER LAST WEEK	\$251	\$143	\$18	\$3	\$0	\$8	\$28	\$75

Better utilizing data from a group of water meters

“Developing a clear data picture from existing meters might be more valuable than installing a thousand new ones. The proliferation of new sensors should not outpace our efforts to take action using existing data streams.”



Business Challenges

- A. Meet campus 20% water reduction goal

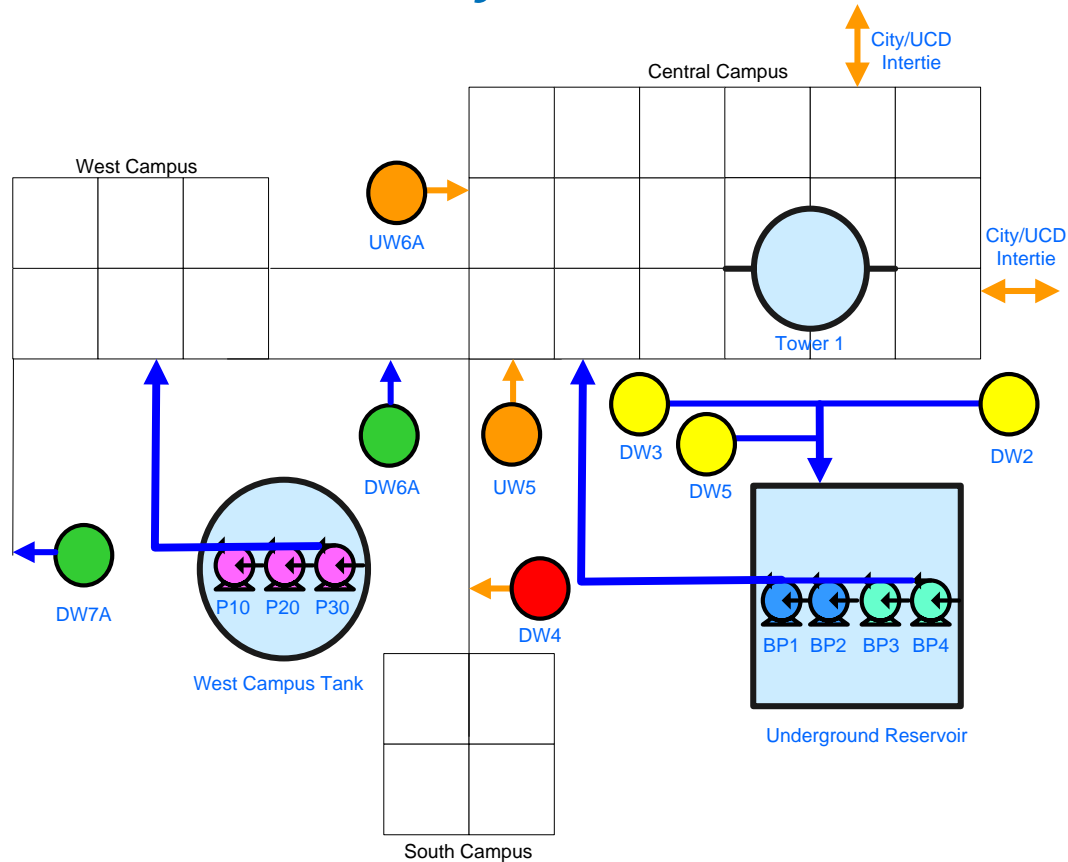
Solution

- A. Publicly display usage data
- B. Integrate data systems with the PI Server (in progress)
- C. Work with stakeholders to identify ways to save

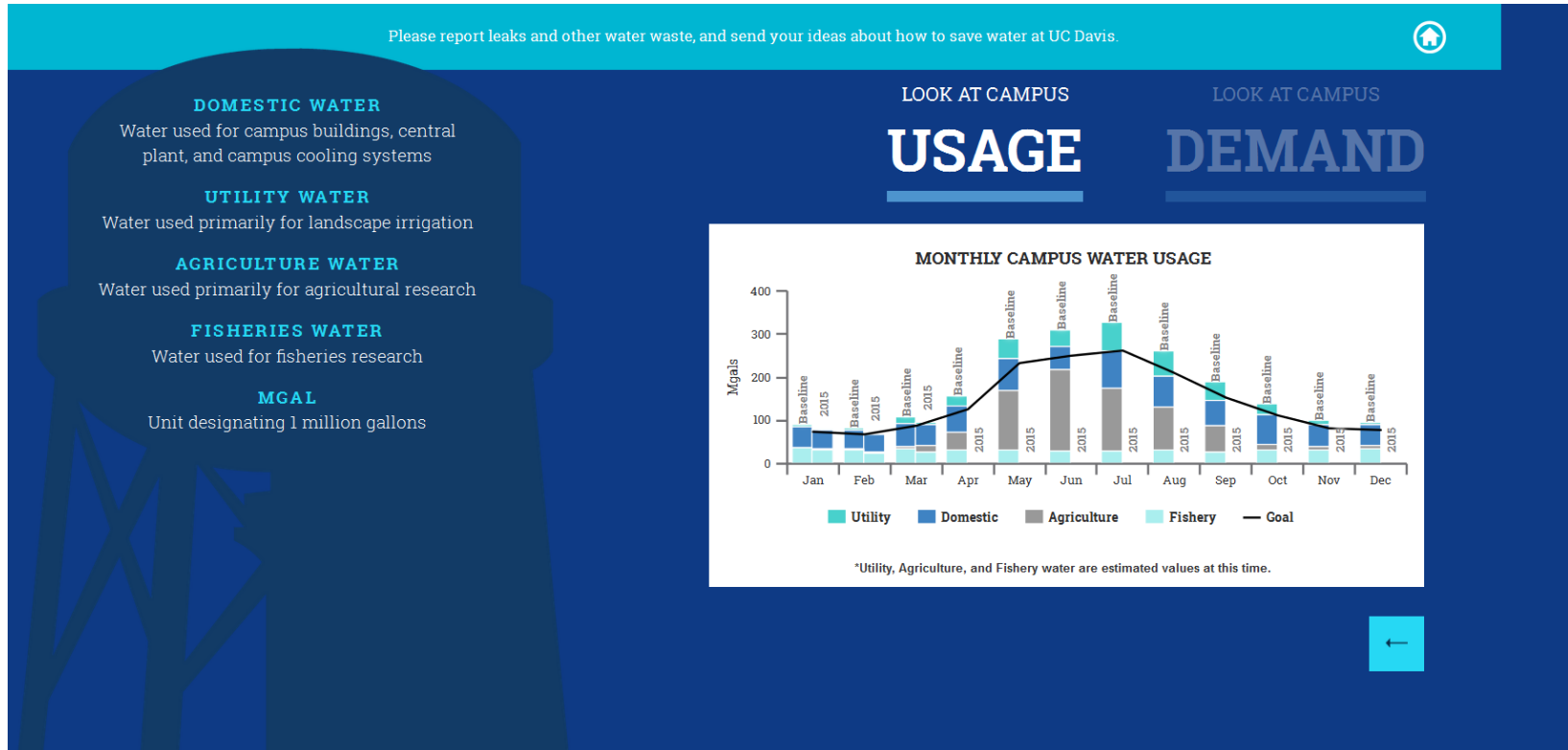
Results and Benefits

- We know where we stand
- Better defined ownership
- Healthy peer pressure

Campus domestic water system



Publicly display usage: water.ucdavis.edu



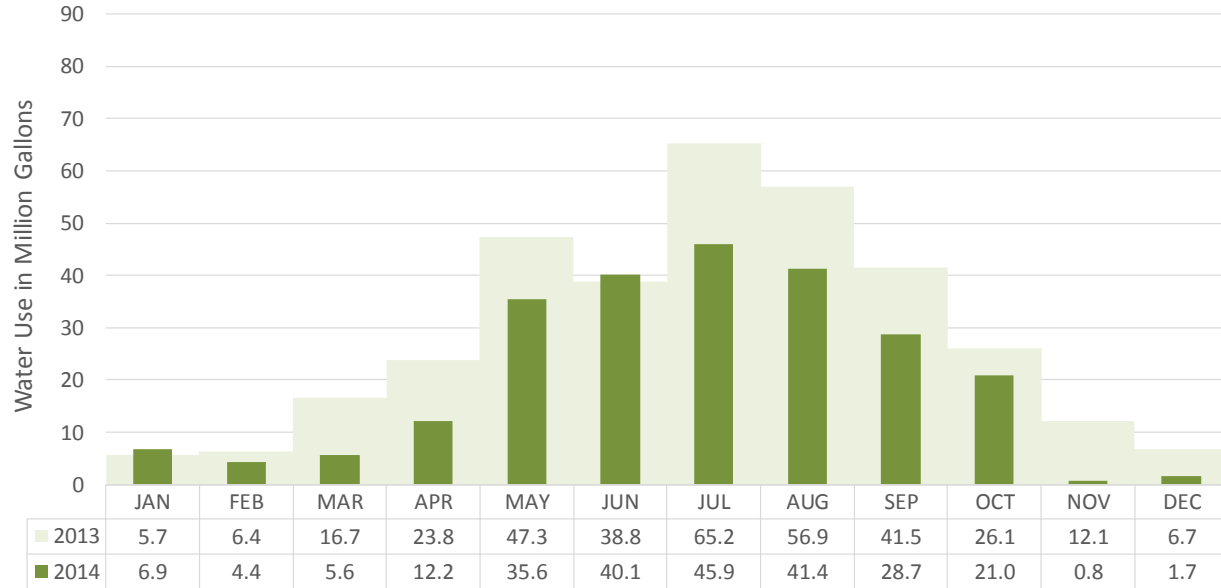
Integration with the PI System

- Real-time demand for domestic and landscape irrigation water: in the PI System from Wonderware, displayed through PI Web API/PI Web Services
- Monthly totals: currently through manually read meters; to be integrated with the PI System in real-time or through PI Manual Logger

Results

Utility Water Use for 2014 and 2013

Total Use in 2014 was 70% of 2013 Baseline



Results

- We know where we stand
- Better defined ownership
- Healthy peer pressure

Questions

Please wait for the **microphone**
before asking your questions

State your
name & company





THANK YOU

Especially to our project team at Microsoft and OSIsoft

