

Using the PI System For Real-Time Energy Management at NASA Langley Research Center

Presented by **Todd Herbert**
Energy Analyst, Straughan Environmental Inc.
NASA Langley Research Center



**STRAUGHAN
ENVIRONMENTAL**



Presentation Agenda

- NASA Langley Background
- Our Mission: Energy Intensity Reduction
- Mission Challenges
- How we got started with the PI System
- Applications and Use Cases / How the PI System was Applied
 - Using the PI System to Monitor Meter Data Quality and Communication
 - Using the PI System to Monitor Real-Time Energy Data at the Building Level
 - The PI System allows facility operators to monitor energy consumption
- Next Steps

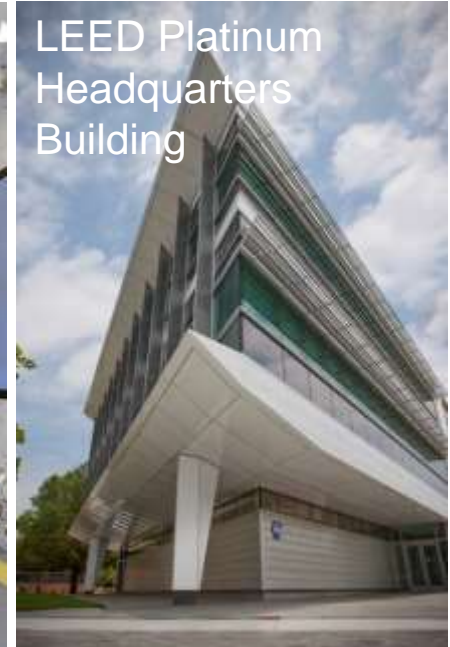
NASA Langley Research Center



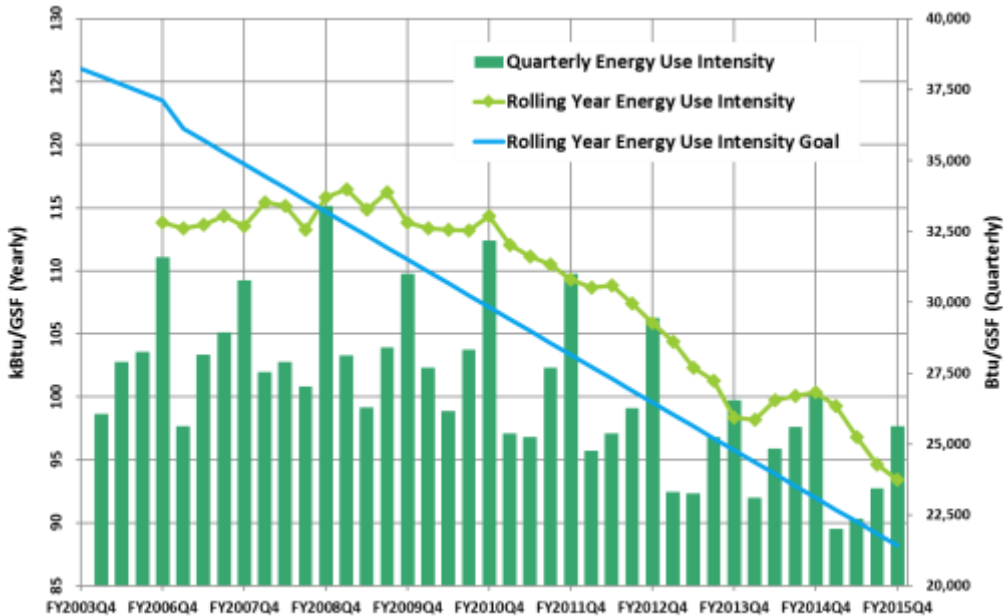
- Established in 1917
- 764 acre research campus
- Over 30 major research facilities and 150 support facilities
- LaRC supports research in the fields of aerodynamics, loads/ structures, thermodynamics, electronics, space technology, systems analysis

NASA Langley Research Center

- Over 130 Buildings represented by over 400 electrical meters
- Old system focused on summary reporting for agency data calls
- Building-level virtual meters had to be created to look at interval data
- Goal Subject Buildings are tracked for energy intensity goals



Our Mission: Energy Intensity Reduction



- Previous energy reduction goals were reset with Executive Order 13693 (Planning for Federal Sustainability in the Next Decade)
- New FY15 baseline year and new reductions required
- Federal Requirements for Energy Intensity Reduction (BTU/GSF)
- 2.5% annual reduction in Energy Intensity from a FY 2015 baseline, 25% reduction by FY 2025

Cumulative Reduction Goal from 2003 Baseline = 30%

Actual Reduction through Q4 2015 = 25.6%

Our Mission: Energy Intensity Reduction

In FY16 alone, LaRC avoided \$1.84M in utility costs for Goal Subject (GS) buildings.

FY07-FY16, HQ/LaRC invested \$3.8M/\$14.6M in GS ECMs and avoided \$10.3M in utility costs (2015 \$).

Projects were primarily HVAC, lighting and building envelope projects (e.g. infrastructure).

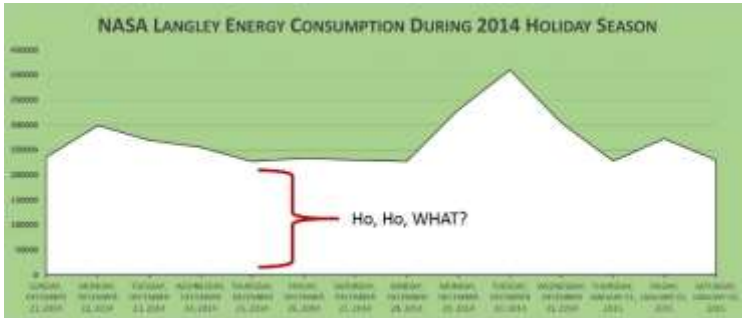
- “Low-hanging fruit” had been picked to meet previous reduction goals
- Limited facilities budget for Energy Conservation Measures
- Can’t compete with other NASA Centers for Agency-level funding because of low utility rates
- High base demand and need for operational changes

Our Mission: Energy Intensity Reduction

- Campus is undergoing a revitalization including demo of older inefficient facilities and construction of energy efficient buildings
- Can't install high capital cost ECMs for many demo-list buildings, but still need to operate for several years while on demo list

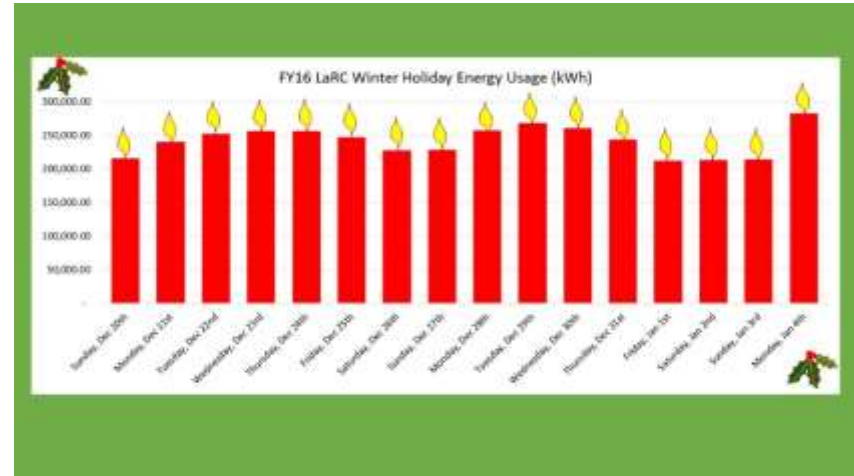


Our Mission: Energy Intensity Reduction



Example: Building 1195 FY15 Total kWh

Day kWh	Night kWh
441,448	462,810



- Problem with night, weekend, holiday energy consumption
- Need to operate buildings for optimal energy efficiency (maintenance items, HVAC setbacks, schedules; lighting controls)
- Needed better tools for examining interval demand and study of individual buildings

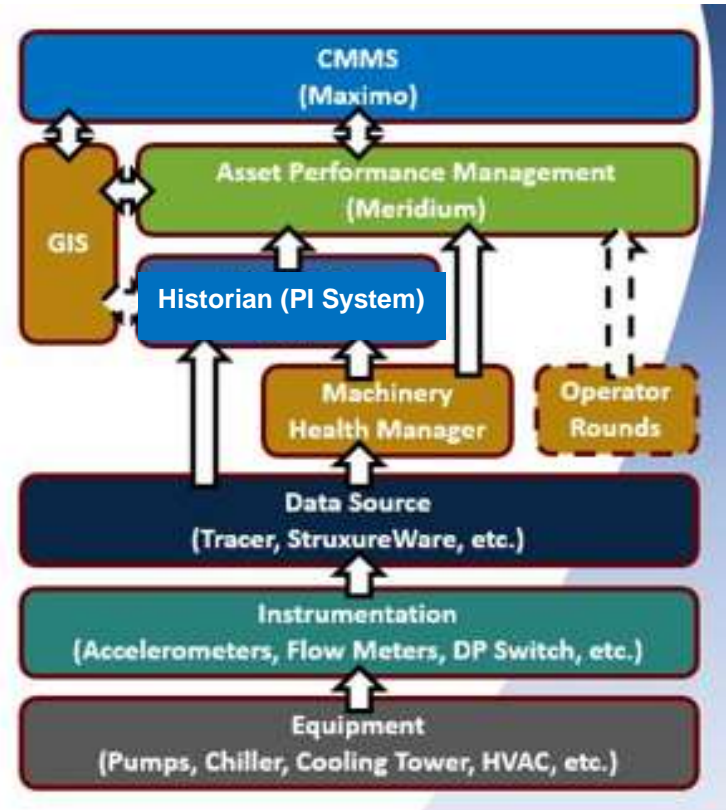
Mission Challenges



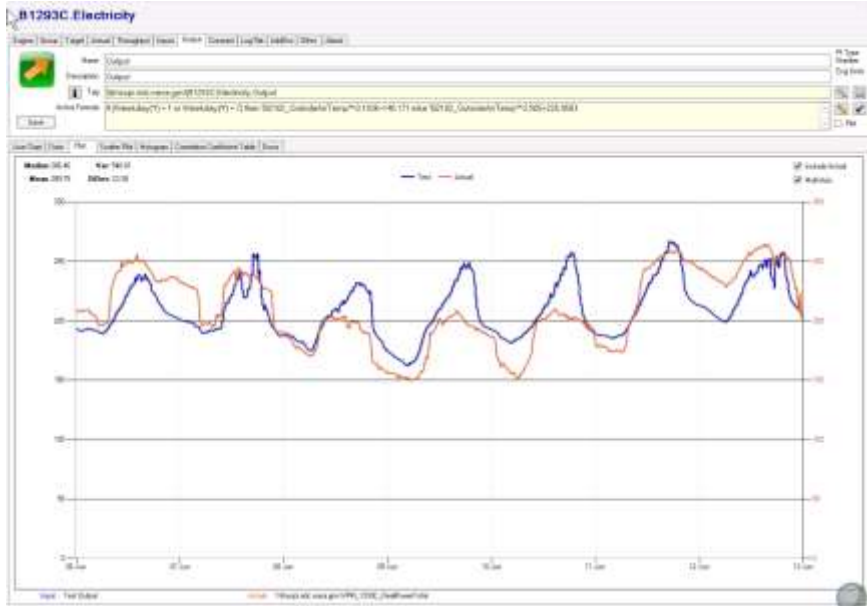
- Problems with meter data quality, gaps being detected after-the-fact
- Powerful metering tools in place but required running individual reports/data analysis at the building level, time consuming
- Existing tools (Reporting and Dashboards) required levels of permission/training not possible for all building level staff

Getting started with the PI System

- The PI System at LaRC for installed for Condition-Based Maintenance program
- Opportunity to create tags from our building-level virtual meters
- Energy Advisor Software Pilot



Emerson Energy Advisor



- Pilot project in 2015 to use Energy Advisor for building-level energy monitoring
- Required real power total (kW) and outside air temp PI tags to set targets for expected energy consumption
- Presented at Emerson Exchange in Austin TX, Oct 2016; Pilot ongoing

Mission Challenges

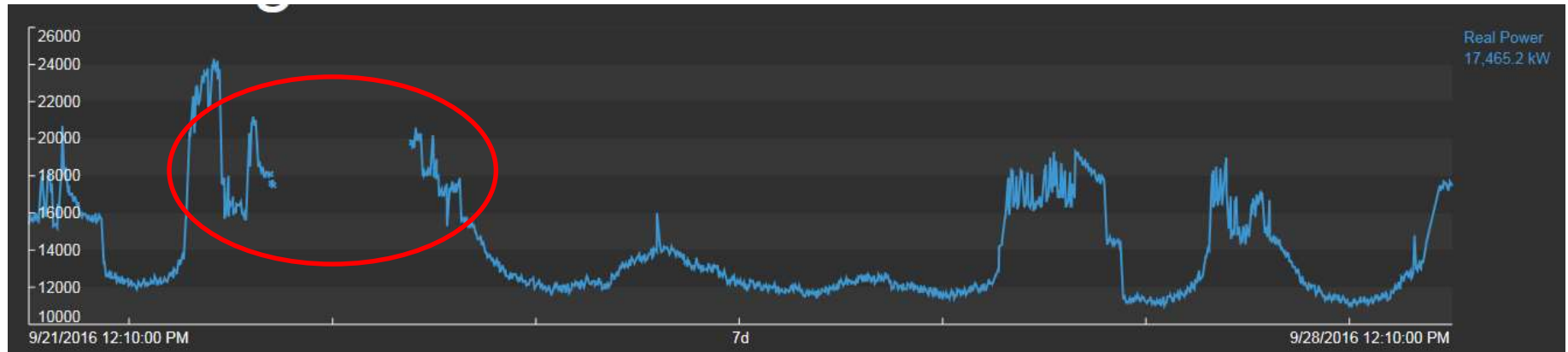


- **Problems with meter data quality, gaps being detected after-the-fact**
- Powerful metering tools in place but required running individual reports/data analysis at the building level, time consuming
- Existing tools (Reporting and Dashboards) required levels of permission/training not possible for all building level staff

Using the PI System to Monitor Meter Data Quality

Message	Date Added
One or more gaps were detected in data used for this report.	10/9/2015 10:58:24 AM

- Problems with meter data quality, gaps not being detected until summary data



Using the PI System to Monitor Meter Data Quality

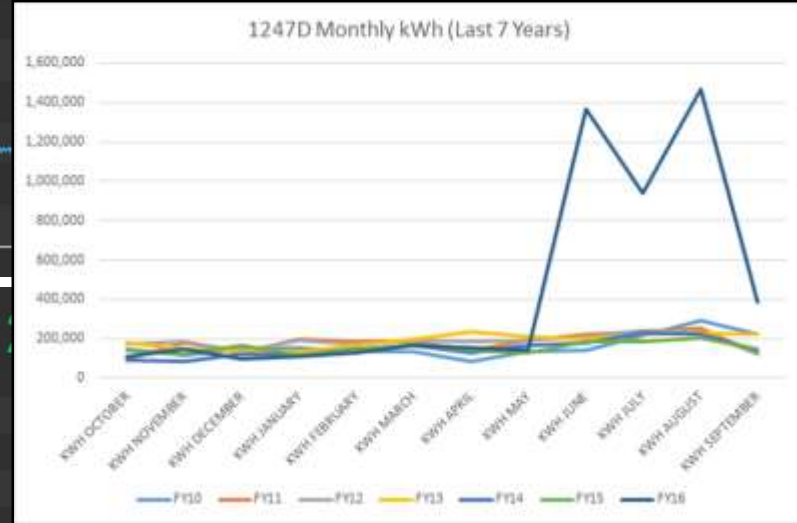
- Real-time PI tag viewing capabilities in PI System tools
- Higher visibility of meter data and communications

	A	C	E	F	G	H	I
1	BLDG	Goal Category	Timestamp	Real Power	kW Demand	% of LaRC Total	
5	1296	Goal Subject	24-Feb-17 09:08:04	Bad	Bad	Data was not available for attribute 'kW Demand'.	
6	1202A	Goal Subject	24-Feb-17 09:14:19	18	Bad	Data was not available for attribute 'kW Demand'.	
7	1206	Goal Subject	24-Feb-17 09:14:34	Bad	Bad		
8	1246	Goal Subject	24-Feb-17 09:13:49	32	34	0.22	
9	1240	Goal Subject	24-Feb-17 09:11:19	6	7	0.04	
10	1267A	Goal Subject	24-Feb-17 09:08:04	Bad	Bad	Data was not available for attribute 'kW Demand'.	
11	LaRC Main Feeder		24-Feb-17 09:14:04	15900	15900		
12	1212C	Goal Excluded	24-Feb-17 09:14:04	192	240	1.51	
13	14 x 22 Tunnel	Goal Excluded	24-Feb-17 09:04:04	0	50	0.31	
14	1247E	Goal Excluded	24-Feb-17 09:14:04	2976	2893	18.19	
15	Compressor Station	Goal Excluded	24-Feb-17 09:14:04	2725	1638	10.30	
16	Compressor #4	Goal Excluded	24-Feb-17 09:06:19	0	0	0.00	
17	1247D	Goal Excluded	24-Feb-17 09:14:19	513	481	3.03	
18	Mach 6, Mach 8 Heaters	Goal Excluded	24-Feb-17 09:13:49	20	20	0.13	
19	1268A	Goal Subject	24-Feb-17 09:14:04	937	911	5.73	
20	1268C	Goal Excluded	24-Feb-17 09:14:19	830	824	5.18	
21	1215	Goal Excluded	24-Feb-17 09:14:04	652	649	4.08	
22	1236	Goal Excluded	24-Feb-17 09:08:04	0	281	1.77	
23	1251	Goal Excluded	24-Feb-17 09:14:04	448	442	2.78	
24	2102	Goal Subject	24-Feb-17 09:14:34	396	383	2.41	
25	648	Goal Excluded	24-Feb-17 09:14:04	287	296	1.86	
26	1250	Goal Subject	24-Feb-17 09:14:19	380	368	2.31	
27	1247I	Goal Excluded	24-Feb-17 09:14:34	318	288	1.81	

Live view of meter data with PI DataLink®

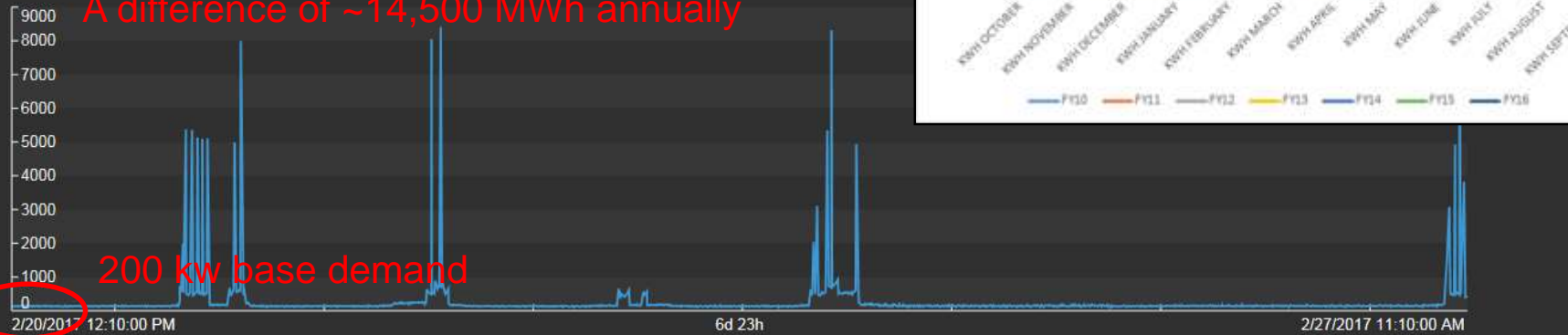
Building: 1247D

12/26/2016 8:10:00 PM



Building: 1247D

A difference of ~14,500 MWh annually



Using the PI System to Monitor Meter Data Quality

COMPANY and GOAL

NASA Langley needed to improve meter data quality for more accurate summary reporting for agency goal tracking

A screenshot of a data table from the PI System. The table has columns for 'Work Category', 'Threshold', 'Last Meter', 'Min Allowed', and 'Max Allowed'. It lists various work categories like 'Work Category 1' through 'Work Category 10' and their corresponding thresholds and allowed ranges. Some cells are highlighted in red, indicating data quality issues or gaps.

CHALLENGE

Problems with meter data quality, gaps

- Over 400 devices monitor over 130 buildings with periodic data gaps
- Gaps were being discovered at the end of a month, quarter, year
- Summary data was being reported that included these gaps, providing inaccurate results

SOLUTION

PI tags created from OPC interface with meter module outputs, allow staff to more closely monitor status and find problems

RESULTS

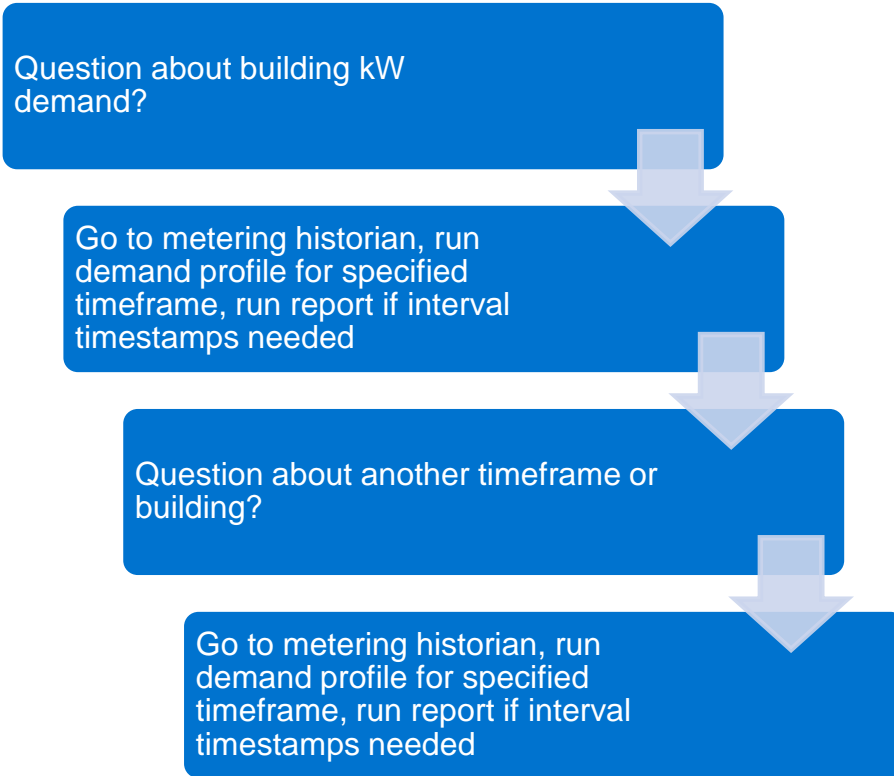
More accurate summary data, higher confidence in reporting with higher visibility for data gaps as they occur

Mission Challenges



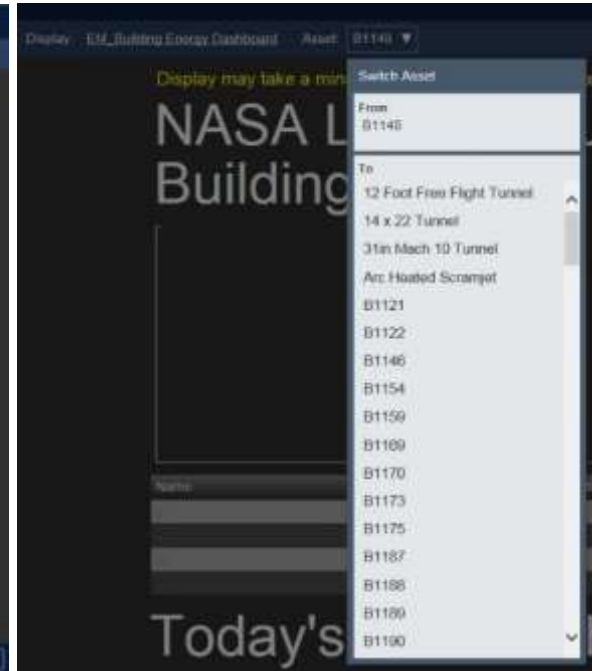
- Problems with meter data quality, gaps not being detected until summary data
- **Powerful metering tools in place but required running individual reports/data analysis at the building level, time consuming**
- Existing tools (Reporting and Dashboards) required levels of permission/training not possible for all building level staff

Using the PI System to Monitor Real-Time Demand at the Building Level



- Powerful metering software tools in place but required running individual reports/data analysis at the building level, time consuming

Using the PI System to Monitor Real-Time Energy Data at the Building Level



- PI System and Element Relative Displays allow for immediate demand profiles for multiple buildings and timeframes

Using the PI System to Monitor Real-Time Energy Data at the Building Level

- Campus map created with PI ProcessBook® allows a center-wide view of current kW demand
- Planning to move to PI Integrator for Esri® ArcGIS®



NASA Langley Campus Energy Map

Real-Time Power Usage for LaRC Facilities

CurrentTime 2/21/2017 2:52:00 PM



Using the PI System to Monitor Real-Time Energy Data at the Building Level

- Asset Framework allows real-time calculated attributes for live dashboard displays

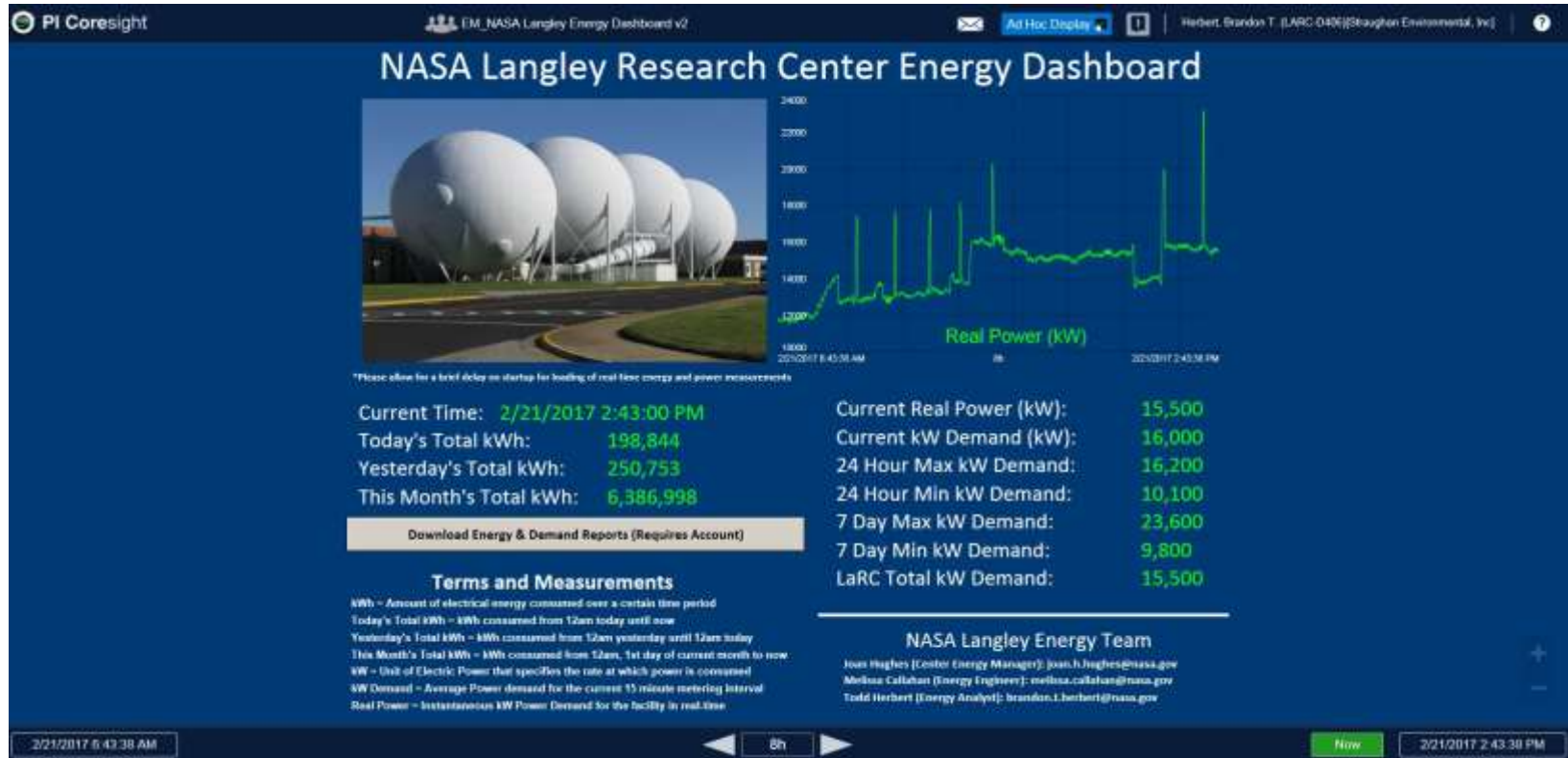
The screenshot shows the 'Building Dashboard Template' configuration window. It includes tabs for 'General', 'Attribute Templates', 'Ports', and 'Analysis Templates'. The 'Name' field is set to '7 Day Max Demand'. The 'Description' is 'Max Demand from Now-7d'. The 'Analysis Type' is set to 'Expression'. The 'Start analysis when created from template' checkbox is checked. Below the configuration fields is a table with columns for 'Name', 'Expression', 'Value at Evaluation', 'Value at Last Trig', and 'Output Attribute'. The table contains one row: 'Variable1' with the expression 'Int(TagMax('kW Demand', '*', '*-7d*))' and the output attribute '7 day Max Demand'.

Name	Expression	Value at Evaluation	Value at Last Trig	Output Attribute
Variable1	Int(TagMax('kW Demand', '*', '*-7d*))			7 day Max Demand

The screenshot shows a data table for 'B1195 Complex'. The table has columns for 'Name' and 'Value'. The data is as follows:

Name	Value
7 day Max Demand	147 kW
7 day Min Demand	66 kW
24 hour Max Demand	147 kW
24 hour Min Demand	71 kW
Air Temp (F)	54.6520004272461 °F
Building Category	Goal Subject
Building Gross Square Footage	60962 ft2
Building number	1195
Current Month Cumulative kWh	45399.6841825787 kWh
Current Time	2/21/2017 2:15:00 PM
Daily Total kWh	1487.76811833773 kWh
FY15 Baseline kWh/GSF	15
FY17 Goal kWh/GSF	14.25
kW Demand	147 kW
LaRC Main Feeder kW Demand	16200 kW
LaRC Total kW	15700 kW
Monthly Total Steam BTU_Output	20188358.5638133 Btu
Percent of LaRC Total Demand	0.9074074 %
Projected EUI for Previous Day_Outp...	12
Real Energy	6100464.392 kWh
Real Power	136 kW
Steam BTU Hourly_Output	11509.9449727277 Btu
Steam lbs	178076.515625 lb
Today Total Steam BTU_Output	113911.738177791 Btu
Today Total Steam lbs_Output	113.911738177791 lb
Total kWh for Yesterday	1974.62759693246 kWh

Using the PI System to Monitor Real-Time Energy Data at the Building Level



Using the PI System to Monitor Real-Time Energy Data at the Building Level

NASA Langley Goal Subject Facility Electrical Use Intensity

Building #	FY17 Goal EUI	Yesterday's EUI	Building #	FY17 Goal EUI	Yesterday's EUI
645	0.95	0	1212	4.75	4
646	17.1	28	1214	45.6	12
645A	14.25	12	1216	19	18
1121	0.95	0	1219	22.8	18
1122	0.95	1	1220	19	18
1146	18.05	13	1221	15.2	12
1148	45.6	30	1222	12.35	10
1159	29.45	26	1222B	17.1	12

- Asset Framework allows for KPI monitoring through calculated attributes (Analyses)



Using the PI System to Monitor Real-Time Energy Data at the Building Level

COMPANY and GOAL

Needed to look at kW demand and energy consumption on an interval basis so that adjustments could be made before the end of the quarter, or end of the year



24 hour Min Demand	71 kW
Air Temp (F)	54.6520094272461 °F
Building Category	Gen Subject
Building Gross Square Footage	60962 sq
Building number	1195
Current Month Cumulative kWh	45399.8041825787 kWh
Current Time	2/21/2017 2:15:00 PM
Daily Total kWh	1487.76811833773 kWh
PY15 Baseline kWh/GSF	15
PY17 Goal kWh/GSF	14.25
kW Demand	147 kW
LaRC Main Feeder kW Demand	16200 kW
LaRC Total kW	15700 kW
Monthly Total Steam BTUx_Output	20188356.5638133 Btu
Percent of LaRC Total Demand	0.9074074 %
Projected EUI for Previous Day_Outp...	13

CHALLENGE

Powerful metering tools in place but required running individual reports/data analysis at the building level, time consuming

- Previous energy reporting focused on kwh totalization over a quarter or year

SOLUTION

PI tags created from OPC interface with virtual meters, allowing for building level monitoring in real-time

- Real Power Total (kW) was available from meters for real-time demand monitoring. Data for real energy (kWh) and kW block demand could also be monitored on an interval basis

RESULTS

Building-level monitoring can occur through dashboard displays, and trends can be used to quickly summarize demand

- Quick and easy to look at building level demand at different time scales and time periods to find operational efficiencies and over-consumption

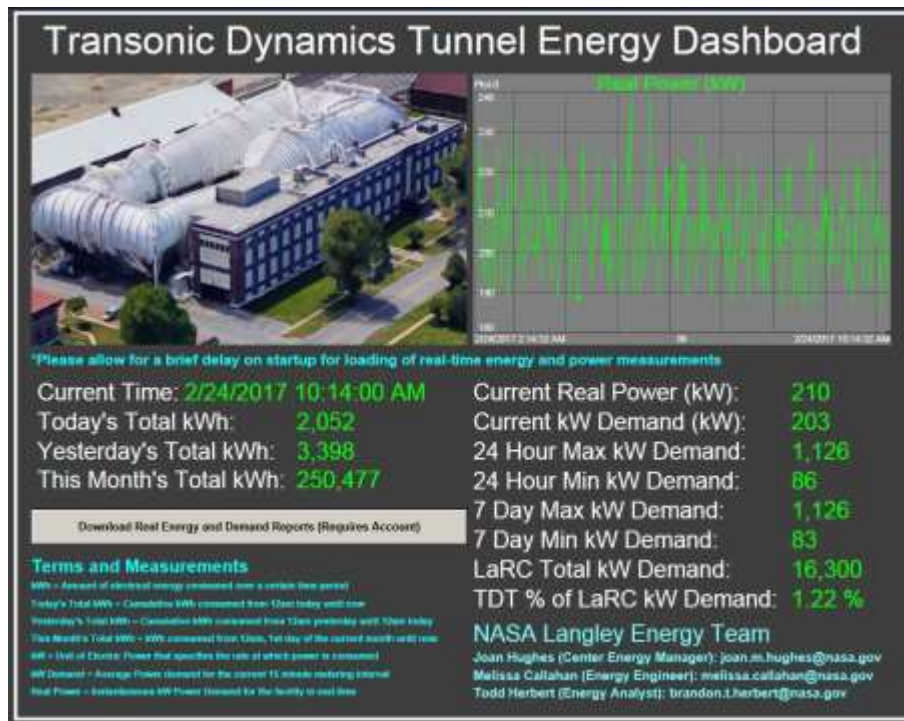
Mission Challenges



- Problems with meter data quality, gaps not being detected until summary data
- Powerful metering tools in place but required running individual reports/data analysis at the building level, time consuming
- **Existing tools (Reporting and Dashboards) required levels of permission/training not possible for all building level staff**

The PI System allows facility operators to monitor energy consumption

- Staff of 3 in the Energy Management Program
- Need to rely on the help of facility staff to monitor consumption
- Previous tools required additional training and levels of permission not possible for all staff



The PI System allows facility operators to monitor energy consumption

LaRC Energy Management Control System Display

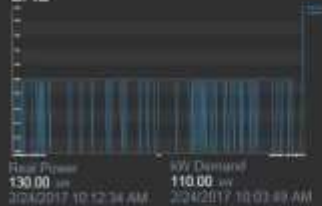
Display may take a minute to load real time data. Please be patient.

LaRC Stratton Main Feeder



Real Power (kW) Trend

LN2



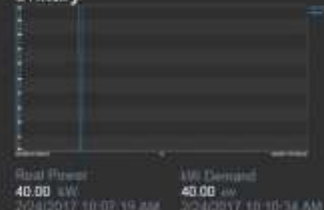
SCR Heaters



TDT



Unitary



14 x 22



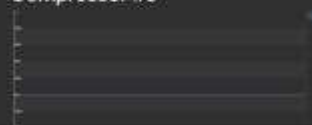
31 in Mach 10



Compressor #4



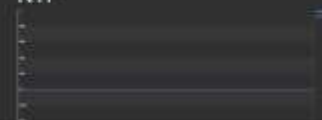
Compressor #5



Compressor #6



NTF



The PI System allows facility operators to monitor energy consumption

Power Dispatcher Tables

LaRC Total (Stratton Main Feeder)

43,551.37 kW

Name	Value	Units	Time	Trend	Minimum	Maximum
LaRC TotalkW Demand	41,300	kW	3/3/2017 10:12:12 AM		10,400	42,000
LaRC TotalReal Power	43,551.37	kW	3/3/2017 10:12:12 AM		13,300	47,000

B1212c - 14 x 22 Tunnel

2,165.5 kW

Name	Value	Units	Time	Trend	Minimum	Maximum
14 x 22 TunnelkW Demand	1,712	kW	3/3/2017 10:12:12 AM		30.00	2,950
14 x 22 TunnelReal Power	2,165.5	kW	3/3/2017 10:12:12 AM		30.00	6,140

B1236 - NTF (National Transonic Facility)

0 kW

Name	Value	Units	Time	Trend	Minimum	Maximum
National Transonic Facility NTFkW Demand	0	kW	3/3/2017 10:12:12 AM		0	0
National Transonic Facility NTFReal Power	0	kW	3/3/2017 10:12:12 AM		0	0

B1241 - LN2 Plant

110.00 kW

Name	Value	Units	Time	Trend	Minimum	Maximum
LN2 PlantReal Power	110.00	kW	3/3/2017 10:12:12 AM		110.00	130.00
LN2 PlantkW Demand	110.00	kW	3/3/2017 10:12:12 AM		110.00	130.00

B1251A - 31 in Mach 10 Tunnel

0 kW

Name	Value	Units	Time	Trend	Minimum	Maximum
31 in Mach 10 TunnelReal Power	0	kW	3/3/2017 10:12:12 AM		0	0
31 in Mach 10 TunnelkW Demand	0	kW	3/3/2017 10:12:12 AM		0	0

B648 - TDT (Transonic Dynamics Tunnel)

112.16 kW

Name	Value	Units	Time	Trend	Minimum	Maximum
TDT - Transonic Dynamics TunnelReal Power	112.16	kW	3/3/2017 10:12:12 AM		70.10	140.10
TDT - Transonic Dynamics TunnelkW Demand	98.18	kW	3/3/2017 10:12:12 AM		81.26	98.18

B1247D - SCR Heaters

30.00 kW

Name	Value	Units	Time	Trend	Minimum	Maximum
Mach 0, Mach 5 HeaterskW Demand	30.00	kW	3/3/2017 10:12:12 AM		23.80	30.00
Mach 0, Mach 5 HeatersReal Power	30.00	kW	3/3/2017 10:12:12 AM		24.80	30.00

B1251 - Unitary Plan Wind Tunnel (UPWT)

21,310 kW

Name	Value	Units	Time	Trend	Minimum	Maximum
Unitary Plan Wind TunnelkW Demand	17,780	kW	3/3/2017 10:12:12 AM		40.00	18,320
Unitary Plan Wind TunnelReal Power	21,310	kW	3/3/2017 10:12:12 AM		30.00	21,310

B1247E - Compressor #4

0 kW

Name	Value	Units	Time	Trend	Minimum	Maximum
Compressor #4 Real Power	0	kW	3/3/2017 10:12:12 AM		0	0
Compressor #4 kW Demand	0	kW	3/3/2017 10:12:12 AM		0	0

B1247E - Compressor #5

0 kW

Name	Value	Units	Time	Trend	Minimum	Maximum
Compressor #5 Real Power	0	kW	3/3/2017 10:12:12 AM		0	0
Compressor #5 kW Demand	0	kW	3/3/2017 10:12:12 AM		0	0

B1247E - Compressor #6

2,681.43 kW

Name	Value	Units	Time	Trend	Minimum	Maximum
Compressor #6 Real Power	2,681.43	kW	3/3/2017 10:12:12 AM		0	2,700
Compressor #6 kW Demand	2,667.50	kW	3/3/2017 10:12:12 AM		0	2,700

Display may take a minute to load real-time data. Please be patient.

The PI System allows facility operators to monitor energy consumption

COMPANY and GOAL

NASA Langley energy staffing challenges require the involvement of facility staff to help monitor energy consumption.



CHALLENGE

Existing tools required levels of permission/training not possible for all building level staff

- Operators were not able to track energy consumption until the end of a month

SOLUTION

PI tags created from OPC export from Struxureware, allowed for facility level monitoring in real-time

RESULTS

Facility-level monitoring can occur through web-based dashboard displays, providing capability for facility staff to monitor energy consumption

- Custom facility displays can be built and Asset Framework calculated attributes can provide live summaries

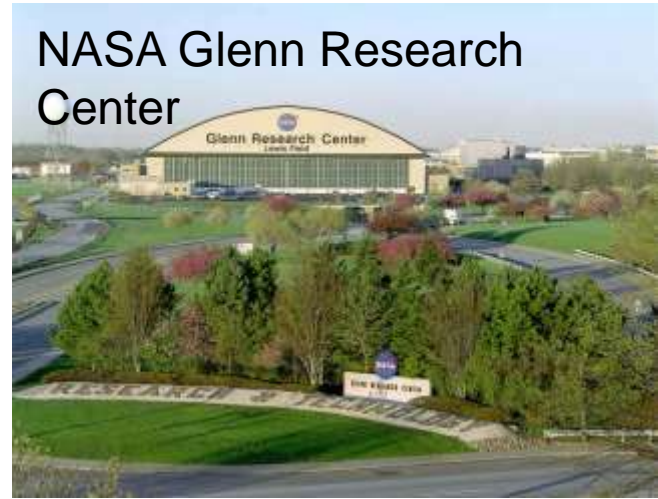
Next Steps

- PI Integrator for Esri ArcGIS
- Use of Event Frames to track over-consumption, meter communication gaps
- Changes to Asset Framework database structure to allow for hosting data from other NASA Centers for both CBM and Energy

NASA Wallops Flight Facility



NASA Glenn Research Center



Contact Information

Todd Herbert

brandon.t.herbert@nasa.gov

Energy Analyst

Straughan Environmental Inc.

NASA Langley Research Center



감사합니다

谢谢

Danke

Merci

Gracias

Thank You

ありがとう

Спасибо

Obrigado

Questions

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



State your **name & company**

Please remember to...

Complete the Online Survey for this session

Download the Conference App for OSISOFT Users Conference 2017



- View the latest agenda and create your own
- Meet and connect with other attendees



HTML

search OSISOFT in the app store

<http://bit.ly/uc2017-app>