

# Charting a Course to Energy Independence

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# Cutting Edge Solutions for Data Center Efficiency—What is your Neighbor Doing?

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# Data Center Efficiency

- Data Center Efficiency issues
  - Most Data Centers have not implemented measurements
  - Efficiency calculations are not typically normalized for comparison
  - Efficiency is not enough. Visibility into energy usage is key to improving efficiency
  - Data Centers are typically designed for full usage and not scaled for power and cooling



# Data Center Efficiency

- Data Center Efficiency Calculations

$$\text{PUE} = \text{Total Facility Power} / \text{IT Equipment Power}$$

$$\text{DCiE} = 1/\text{PUE} = \text{IT Equipment Power} / \text{Total Facility Power}$$



# Differences in Calculations

- Efficiency calculations are not typically normalized for comparison
  - Weather
  - Size
  - Occupation, Density
- Comparing Efficiency without taking other factors into account can produce ambiguous results

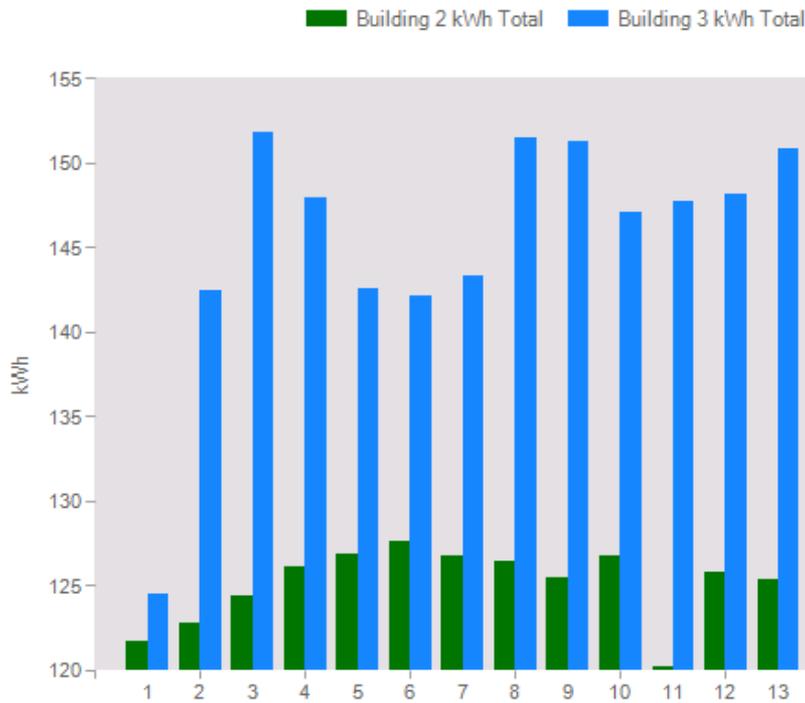


# Normalization

Bldg 2 & Bldg 3 - kWh without Normalization (Read-Only)



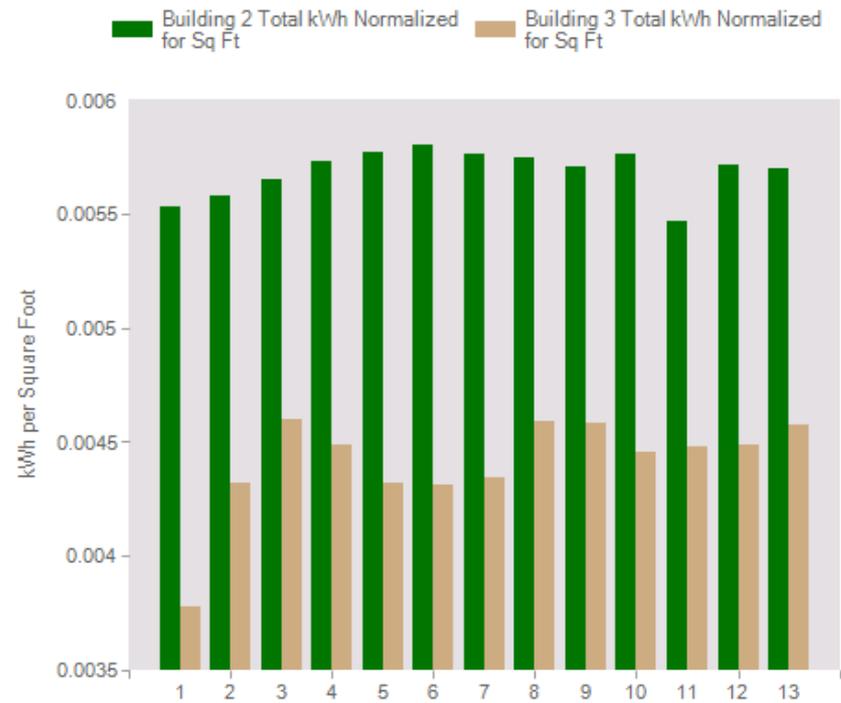
Jan 01 2007 to Mar 31 2007



Bldg 2 & Bldg 3 - kWh Normalized by Square Footage (Read-Only)



Jan 01 2007 to Mar 31 2007



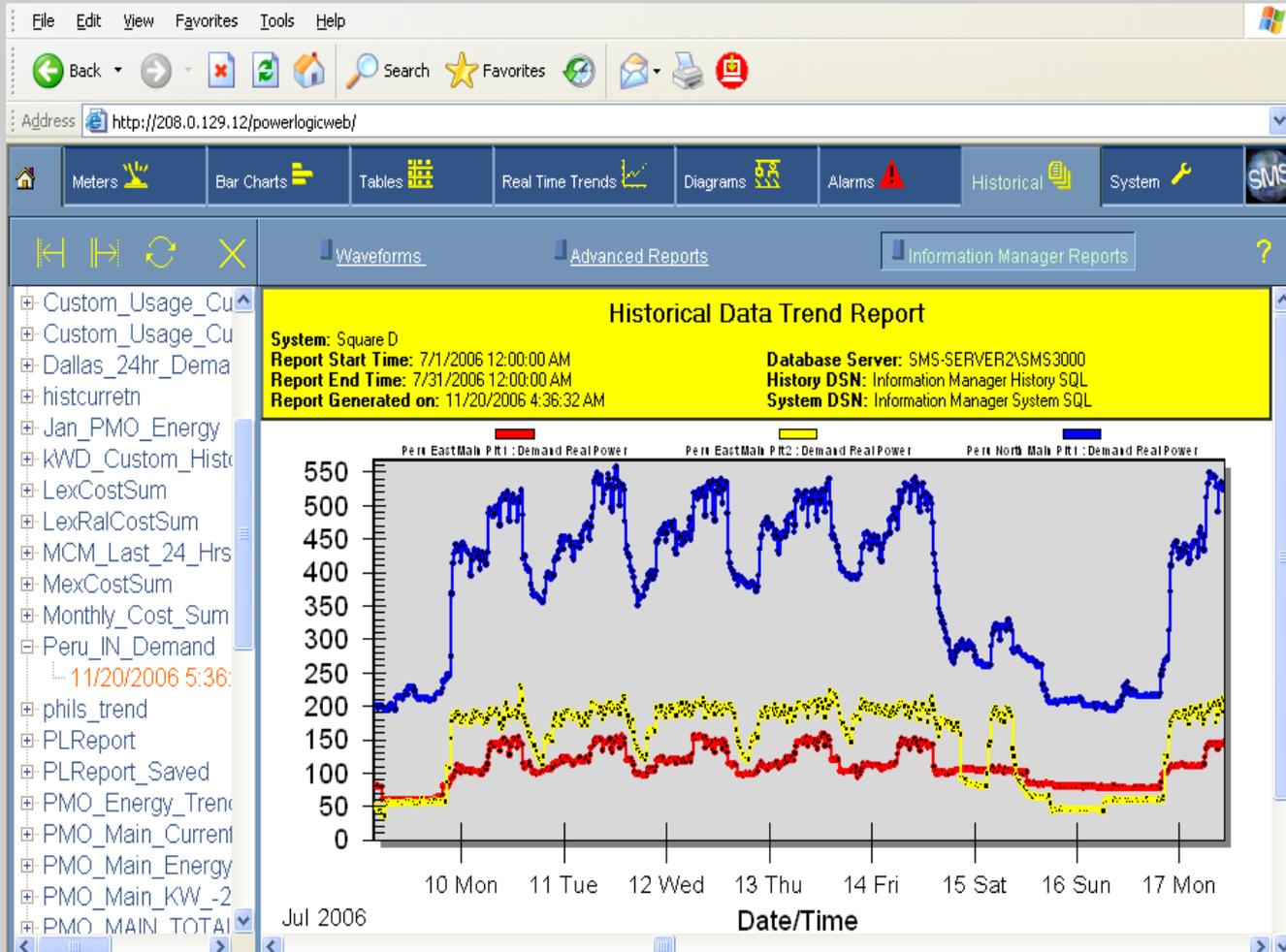


# Making a difference in Efficiency

- Efficiency is not enough
- Visibility into energy usage is key to improving efficiency
  - Data resolution, having enough metering points.
  - Data trends / load profiles
  - Modeling to predict usage

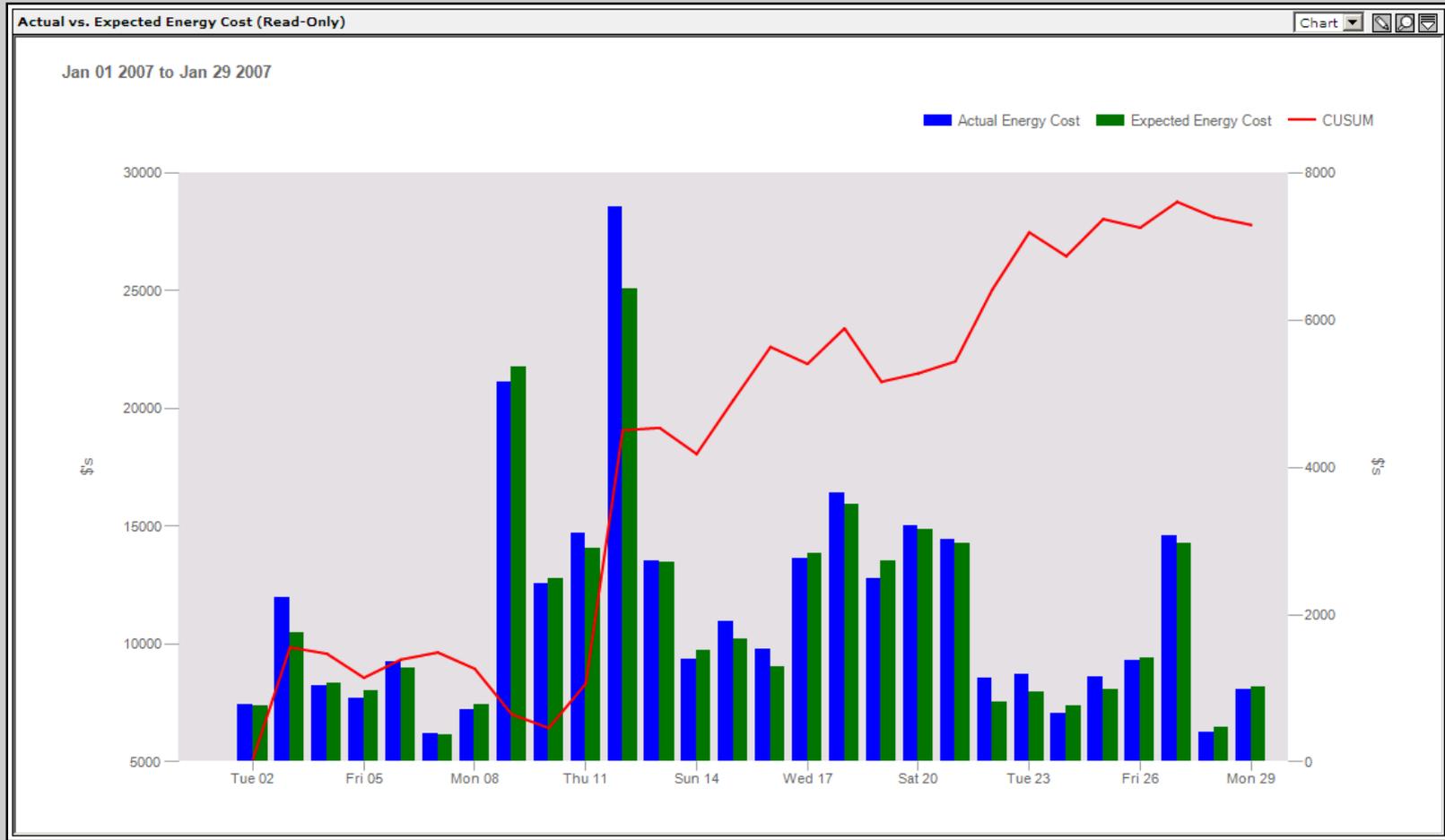


# Load profiling



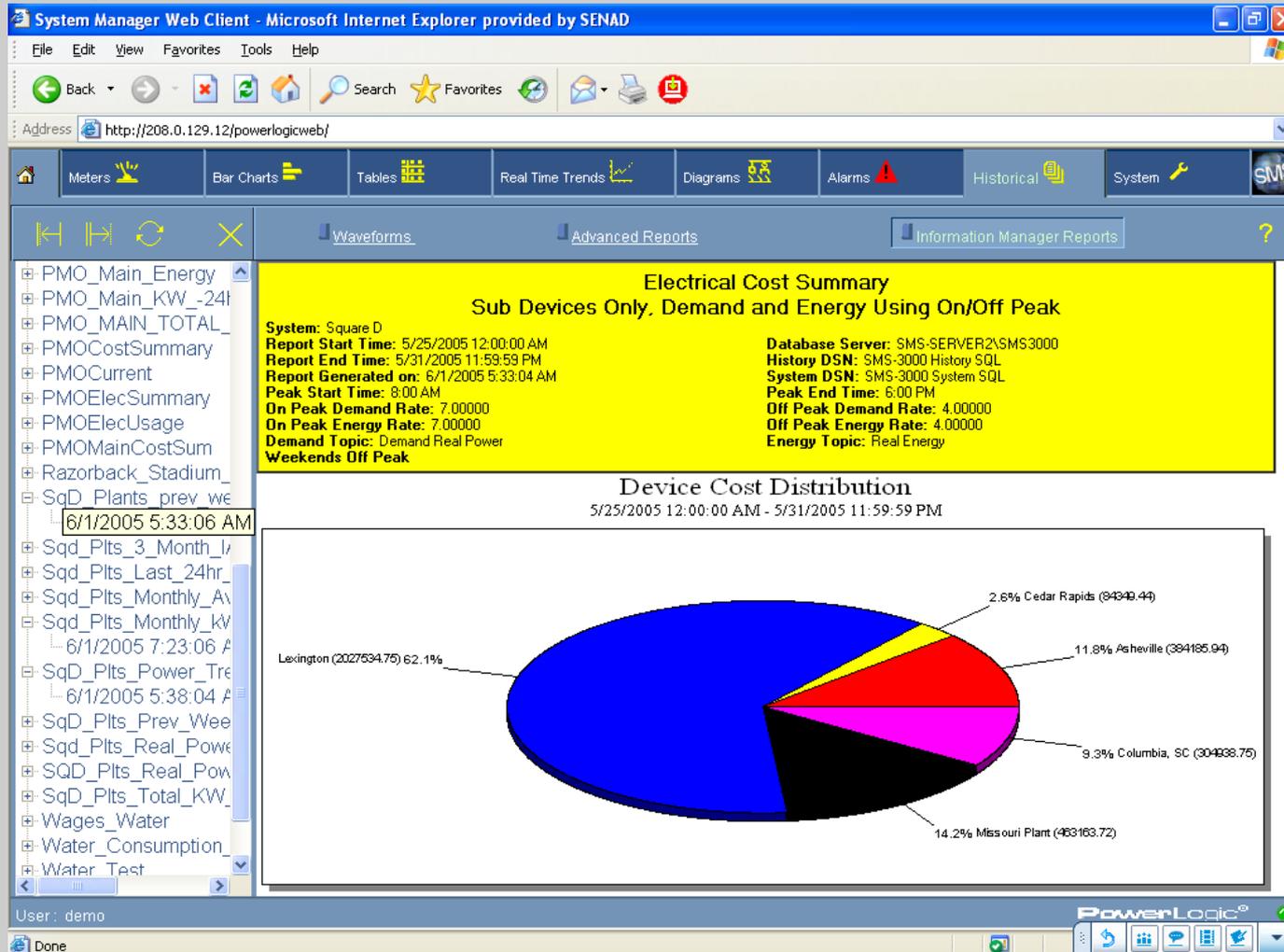


# Energy Modeling





# Energy Distribution





# Customer Example

- Corporate data center
  - Built and Commissioned in 2004
- PowerLogic system implemented
  - about 200 devices
- In 2008, customer began working with the EPA to improve their data center efficiency
- On the following page is an excerpt from an e-mail sent by the EPA July, 2008:



# Letter from EPA to Data Center Customer

- First, to our knowledge no other company has set a separate goal for its data centers. The customer is definitely showing leadership in exploring how this can be done in a meaningful way. This is not to say other companies aren't working towards improving data center efficiency, but to date we have not seen hard goals for data center efficiency.
- Second, regarding PUE vs DCIE vs something else. If it were between PUE and DCIE, PUE is closest to how Climate Leaders is set up- e.g. it's an intensity metric (energy/IT energy, where IT energy is somewhat parallel to a production metric) whereas DCIE is an efficiency metric. Both of these metrics allow comparison across companies.



# Customer Example

- The Customer asked us to:
  - Mine their PowerLogic database to provide a historical value for PUE
  - Provide a tool in their SMS system to measure PUE on an ongoing basis
- We responded to both requests:
  - Engineer on site service to create reports from data and export to excel
  - Monthly average value for PUE was derived from historical data



# Customer Example

- Specified PUE formula was simple
  - Divide the sum of all PDU loads by the Building Main

At right is a one month PUE report summary derived from historical SMS history

Device	Quantity	Min.	Date	Avg.	Max.	Date	Std. Dev.	LoadFactor
PDU A1 480V	Real Power Total	166.2	06/06/2008 10:15	196.7	231	06/23/2008 14:15	12.2	0.8515
PDU A2 480V	Real Power Total	76.44	06/24/2008 13:30	78.59	80.06	06/13/2008 0:00	0.584	0.9817
PDU A3 480V	Real Power Total	41.87	06/06/2008 21:00	46.35	48.23	06/11/2008 0:00	0.7283	0.961
PDU B1 480V	Real Power Total	194.6	06/21/2008 18:45	216.9	229.6	06/15/2008 0:15	6.237	0.9444
PDU B2 480V	Real Power Total	68.33	06/19/2008 2:15	69.02	70.8	06/26/2008 0:00	0.4887	0.9748
PDU B3 480V	Real Power Total	102.4	06/21/2008 18:45	106.4	112.1	06/12/2008 0:00	1.637	0.9493
PDU C1 480V	Real Power Total	199	06/21/2008 18:45	209.6	216.5	06/07/2008 4:02	2.585	0.9683
PDU C2 480V	Real Power Total	62.2	06/27/2008 18:16	64.08	65.91	06/19/2008 0:00	0.6085	0.9722
PDU C3 480V	Real Power Total	71.01	06/06/2008 21:00	75.07	77.65	06/11/2008 4:15	0.6614	0.9667
PDU D1 480V	Real Power Total	195.7	06/21/2008 18:45	209.7	215.6	06/13/2008 18:15	2.87	0.9725
PDU D2 480V	Real Power Total	60.09	06/29/2008 7:30	60.74	61.81	06/01/2008 1:00	0.2168	0.9826
PDU D3 480V	Real Power Total	75.16	06/29/2008 16:30	78.81	81.08	06/20/2008 8:00	1.112	0.972
Average Kw Total				1411.96				
Device	Quantity	Min.	Date	Avg.	Max.	Date	Std. Dev.	LoadFactor
MAIN 2	Real Power Total	2510	06/15/2008 7:15	2706.1	3130	06/20/2008 15:15	104.6	0.8646
PUE AVERAGE				1.916556				



# Customer Example

- The Engineer used the PUE measurement tool on PowerLogic system
  - Similar to an advanced virtual meter
  - PowerLogic Software connects to virtual meter tool via Modbus TCP
  - Basic formula agreed to by customer:

**(12 kV Main 2)**

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**PDU1+PDU2+PDU3+PDU4+PDU5+PDU6+ ... PDU12**



# Customer Example

- Accumulated Energy vs Real Time Power for PUE Meter:
  - Which quantity to use in the formula, accumulated energy or power??
    - EPA recommended that energy be used
  - We explained that a real time measurement cannot be made with an accumulated value, so kW was used for the formula



# Customer Example

- Modification of PUE Formula:
  - Customer stated that the PUE formula was not accurate
    - 12 kV Main 2 meter also fed non data center building loads, such as office space
  - Our Proposal:
    - Add meters to measure non data center building loads and also to measure WQHL lab loads that were not part of data center.
  - Revised formula for PUE looks like this:

**(12 kV Main 2) - (Bldg E Non data center main + WQHL Lab 1 + WQHL Lab 2)**

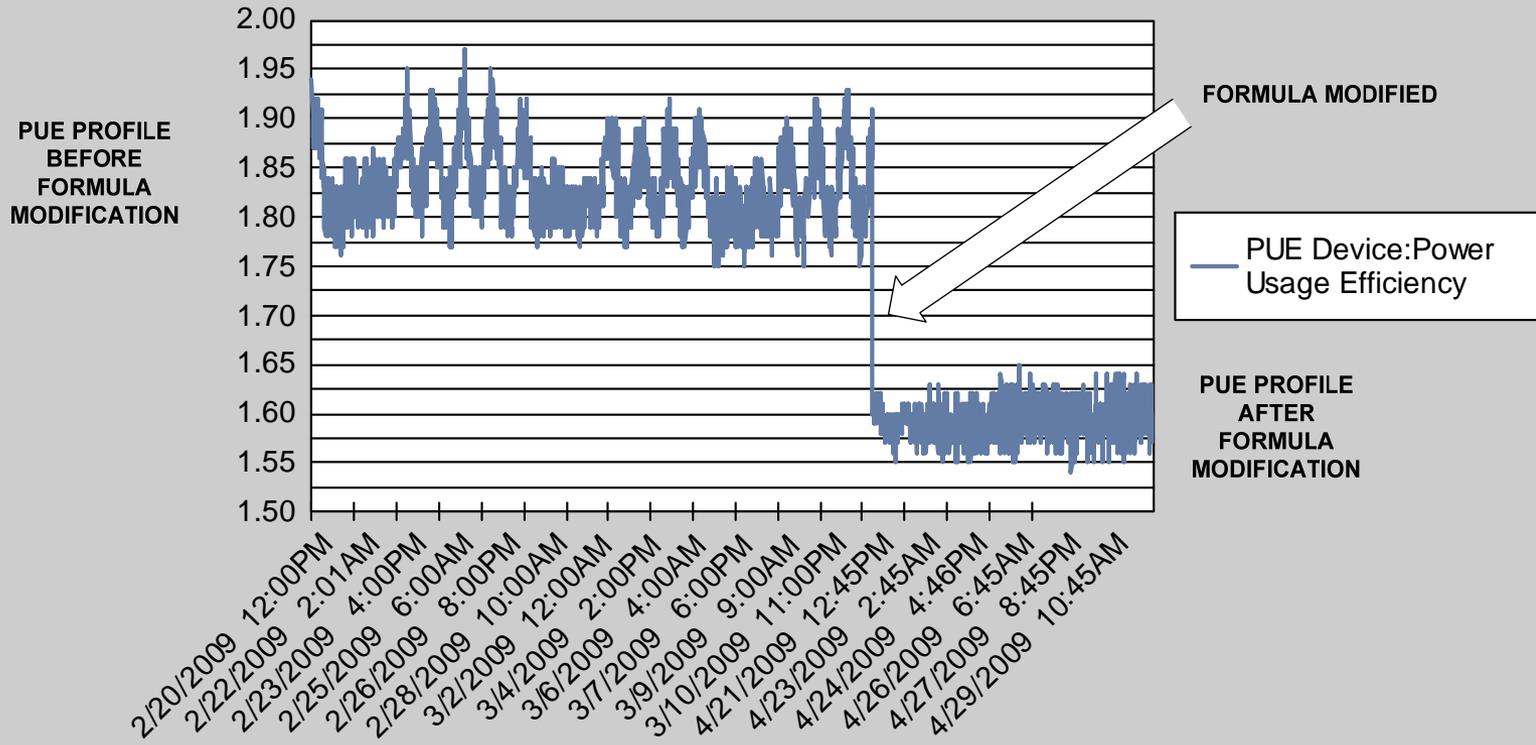
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**PDU1+PDU2+PDU3+PDU4+PDU5+PDU6+PDU7+... PDU12**



# Customer Example

## ADVANCED REPORTS DATA CENTER PUE REPORT





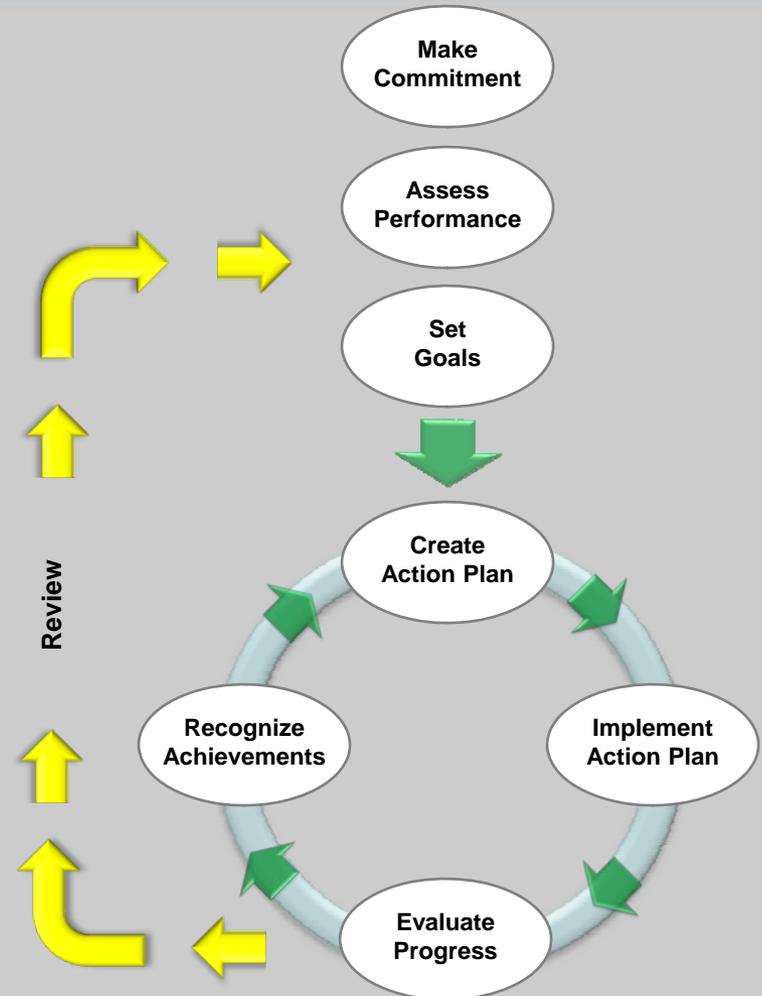
# Lessons Learned

- Understanding and Planning is key
- Metering resolution
- Measuring is only the first step, analyzing usage and putting improvement plans in place are next steps.



# Energy Management Strategy

- Step 1: Make Commitment
- **Step 2: Assess Performance**
- Step 3: Set Goals
- Step 4: Create Action Plan
- Step 5: Implement Action Plan
- **Step 6: Evaluate Progress**
- Step 7: Recognize Achievements





# Contact information

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