



Kansas City Data Center Power Metering for Real Time PUE Calculation

Scope of Work

Prepared for the General Services Administration



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Executive Summary

As the nation's single largest energy user and a significant consumer in many areas of the country, the federal and local government is keenly aware of the need to not only conserve energy, but to invest in the reduction measures that make good business sense while, at the same time, contributing to operational efficiency and modernization. To achieve this goal, the Government established the "Energy Policy Act of 2005 (EPACT) to give guidance in achieving fully managed electrical systems by 2012.

In section 2.2.9.2 Data Centers of GSA plan titled: "FY 2010-2015 Strategic Sustainability Performance Plan", it is noted that GSA will install advanced energy meters in all of the agency-operated data centers by December 31, 2010. Although installation will face some delays GSA is determined to achieve this goal as soon as possible.

LBL was tasked to visit three of GSA's data centers in Ft Worth, TX, Kansas City, MO, and Chantilly, OH and provide a conceptual measurement plan to facilitate real time calculation of Power Utilization Effectiveness (PUE) of each data center. This document identifies the general specification, location, type, and number of meters.

It is expected that each GSA site will use this information to arrange for specifying, bidding and installing the meters.

Introduction:

Power Utilization Effectiveness (PUE)

The purpose of the metering is to identify the real time PUE and annual PUE for each data center.

Power Usage Effectiveness (PUE) is a standard developed by The Green Grid™ consortium to provide a clear answer to the primary issue surrounding energy efficiency within the data center which is how much power is devoted to driving the actual computing/IT components (servers, for example) versus the ancillary support elements such as cooling and lighting. With the rise of computing demands and high density computational environments, the power distribution expressed by either metric is extremely important. The components of the PUE calculation look at the relationship between "Total Facility Power" (TFP) and "IT Equipment Power" (IEP). IEP, or more simply, IT Load, is the sum total of the power used by the facility's computing components including servers, storage devices and networking equipment. TFP includes all the energy used to support data center and should exclude energy used by infrastructure (HVAC, Gas, Fuel, and electrical power) that serve offices and/or other non data center areas or equipment. TFP includes all energy types supplied to the datacenter (electricity, fuel, district chilled water, etc.). All the energy data values in the ratio are converted to common units.

Units: Dimensionless

$$\text{Real Time PUE} = (p1 + p3 + p4 + p5) \div p2$$

where:

p1: Electrical Energy Use (kWh) serving IT equipment, UPS and PDUs, data center and support areas infrastructure such as HVAC and Lighting

p2: IT Electrical Energy Use (kWh)

p3: Normalized Fuel Energy Use (KWh), includes emergency generator
p4: Normalized District Steam Energy Use (kWh)
p5: Normalized District Chilled Water Energy Use (kWh) used in data center cooling

Annual PUE = $(e1 + e3 + e4 + e5) \div e2$

where:

e1: Annual Electrical Energy Use (MMBTU)
e2: Annual IT Electrical Energy Use (MMBTU)
e3: Annual Fuel Energy Use (MMBTU), includes emergency generator
e4: Annual District Steam Energy Use (MMBTU)
e5: Annual District Chilled Water Energy Use (MMBTU)

EPACT & EISA

Following few references to EPACT and EISA recommendations for power metering in the buildings provide a background for next steps taken by GSA to address these recommendations along with those of OMB. Please refer to the published documents in DOE website for more details.

Designed to solve growing energy problems, the Energy Policy Act of 2005 (EPACT) was passed by Congress in July 2005 and signed into law by President Bush a month later. Section 103(e) "Energy Use Measurement and Accountability" amended Section 543 of the National Energy Conservation Policy Act (42 U.S.C. 8253) to read, as regards "Metering of Energy Use":

"By October 1, 2012, in accordance with guidelines established by the Secretary under paragraph (2), all Federal buildings shall, for the purposes of efficient use of energy and reduction in the cost of electricity used in such buildings, be metered. Each agency shall use, to the maximum extent practicable, advanced meters or advanced metering devices that provide data at least daily and that measure at least hourly consumption of electricity in the Federal buildings of the agency. Such data shall be incorporated into existing federal energy tracking systems and made available to Federal facility managers."

FEMP's advocacy role

Because most federal energy management programs are highly decentralized in execution, the responsibility falls to local facility managers to maintain awareness, develop and implement energy projects and ensure that new construction follows sustainable design principles to meet energy goals. Those tasked with implementing these policies locally, however, were not left to meet the challenge alone, thanks to advocacy groups like the Federal Energy Management Program (FEMP).

FEMP was created to help promote cost reduction measures that would lessen the environmental impact of the federal government by advancing energy efficiency and water conservation, promote the use of distributed and renewable energy and improve utility management decisions at federal sites.

EPACT 2005 recommendations on Electric Metering

DOE/EE-0312 was intended to provide federal facility managers with a useful set of "serving suggestions" to help them design their own procedures and programs for complying with EPACT 2005, through consideration of:

- Defining "advanced metering"
- Uses of metered data
- Metering approaches and technologies
- Methods of financing
- Special considerations

Defining "advanced Metering": Advanced meters provide interval data recording, or the ability to measure electrical loads at specific time intervals, and communications to remote locations in formats compatible with automatic meter reading (AMR) systems, also defined in this section. Advanced meters provide 15- or 30-minute interval data recording used in many applications, however, the language in EPACT Section 103 only requires collecting hourly interval data and reporting it every 24 hours.

Uses of metered data: When converted to useful information through energy analysis software, meter data benefits users by allowing them to reduce operating costs through optimized building and equipment performance. This section briefly touches on applications, including revenue billing, time-of-use (TOU) metering, real-time pricing, load aggregation, submetering, energy-sue diagnostics, power quality, measurement and verification (M&V) of energy savings performance contracts (ESPC), emergency (demand) response, and planning and reporting.

Metering approaches and technologies: The point is made that metering per se does not save cost; the savings come when the meter data is converted to information that can be used to develop energy management projects and programs. Levels of resource metering include one-time spot measurements, run-time measurements and short- and long-term monitoring. Also briefly overviewed are metering system components, data storage, and the ways in which metered data can be collected and communicated-from manual "sneaker reads" to wireless and other commonly used methods.

Methods of financing: This section provides a tabular listing and summary of potential funding mechanisms available to federal sites desiring to buy and install metering equipment and systems. Some examples include appropriations, retained energy savings, energy service performance contracts (ESPC), utility energy service contracts (UESC), utility company financing, O&M performance incentives, metering equipment leasing and other options.

Special considerations: This section lists many site-specific factors impacting the development and implementation of metering systems, including leased vs. owned or delegated properties, Operations & Maintenance (O&M) contractors, new vs. existing construction and other considerations. More frequent interval data than the 60-minute EPACT requirement provides a greater degree of data analysis capability and is therefore recommended. Analysis is also recommended to determine when existing standard meters should be retrofitted with advanced metering systems. The point is also made that advance metering should be considered "as far down into the subsystem level as practicable."

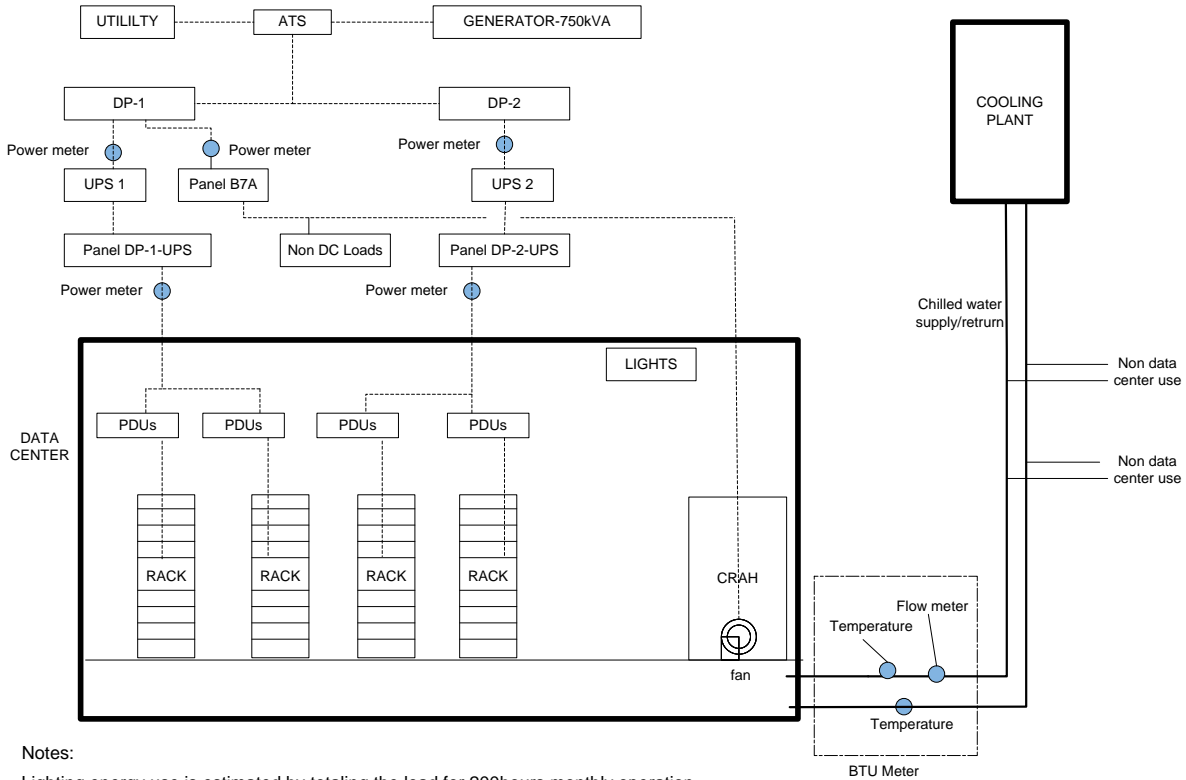
Kansas City (Bannister) Data Center Overview

The 5,600 square foot data center is located on the first floor of a large concrete building. Two UPS units (one rated at 160kVA and the other rated at 300kVA) are supported by a 750kW generator. Block heater was sized at 5kW.

IT equipment is supported by these two UPS units. The current IT load supported by UPS1 was noted at about 90kW. The current IT load supported by UPS2 was noted at about 130kW.

Cooling is provided by six CRAH units and one Fan Coil unit. There are opportunities in the data center for improving of air management, cold or hot aisle containment, raising data center temperature thus saving energy.

Metering points are identified in the following diagram:



Notes:

- Lighting energy use is estimated by totaling the load for 200hours monthly operation
- Reading power output from PDU display and comparing with UPS output will identify PDU loss
- Generator block heater load can be estimated by multiplying load by hours of operation
- Generator fuel equivalent energy can be estimated by multiplying gallons of fuel by 2.4
- HVAC and lighting for generator room, UPS room, and battery room should be considered as a virtual point
- Power to AH-9 serving data center coming from BC5 should be added as a virtual point

A more accurate metering can be accomplished by metering the output of power distribution units. Yet even more accurate metering can be accomplished by metering the power to the building cooling plant such that the chilled water production efficiency (kW/Ton) can be established.

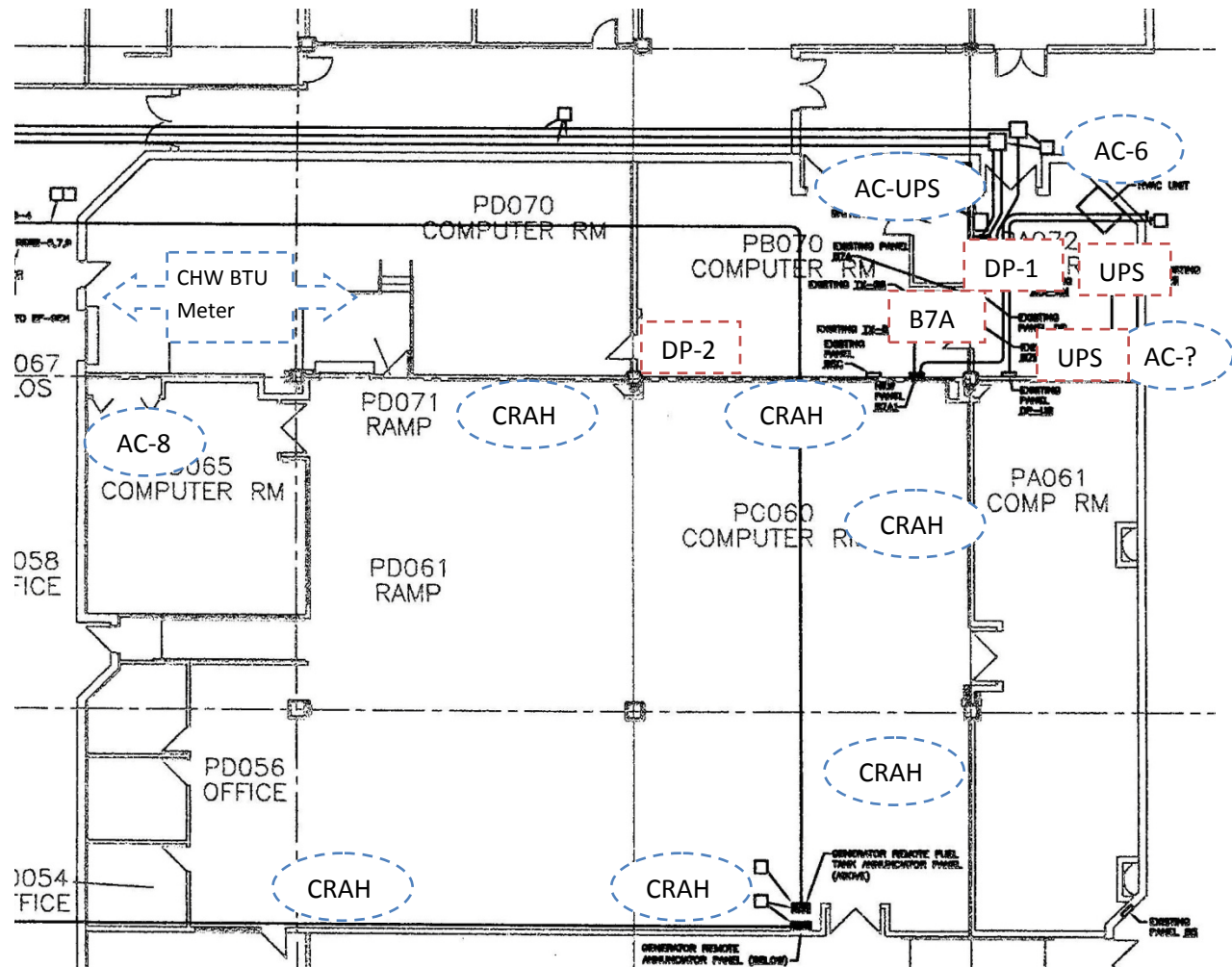
Points, units, and types of metering are described in the following table:

Parameter to be measured	Units	Type of Point	Comments	Meters
CRAH fan power	kW	Analog or Virtual	For constant flow fans, the option is to spot measure once and multiply by number of the similar CRAH units	Power Meters
CHW Supply Temperature	degF	Analog	Part of BTU meter	Temperature Prob

CHW Return Temperature	degF	Analog	Part of BTU meter	Temperature Prob
Chilled water flow	GPM	Analog	Part of BTU meter	Flow/BTU Meter
Lighting Power	kWh	Virtual	If lighting electrical panel is isolated from other loads, a reading at the panel is sufficient. If circuits are shared, spot measure one of each unique fixture and multiply by number of fixtures	NA
UPS-1 Input	kWh	Analog	Optionally, Switch board might provide this info with no need for meter	Power Meters
UPS-2 Input	kW	Analog	Optionally, Switch board might provide this info with no need for meter	Power Meters
DP-1-UPS	kW	Analog	UPS might provide this info with no need for a new meter	Power Meters
AHU 4 power	kWh	Virtual	deduct from DP-1-UPS	NA
DP-2-UPS	kW	Analog	UPS might provide this info with no need for a new meter	Power Meters
B7A	kW	Analog	Located in UPS room	Power Meters
B7B	kW	Analog	Located in AHU room	Power Meters
Non Data center Loads	kWh	Virtual	deduct from B7A power	NA
AHU NW corner power	kWh	Virtual	deduct from D-P2-UPS power	NA
Generator Block Heater	kWh	Analog or virtual	A virtual point can be generated by multiplying power rating by estimated hours of operation	Power Meters
Generator Fuel equivalent power	kWh	virtual	A virtual point can be generated by multiplying fuel used (gallons) by estimated 2.5	NA

Table Notes: Only typical points for measurement are shown in the table. Quantities of each type of the equipment should be considered for calculating the total number of points
Some of the equipment has integrated power meters. There might be an opportunity to use those in lieu of new meters.

Following plan shows the location of the most of the meters in the building:



General Specification for the metering:

Meters and sensors shall be able to communicate with a central location. This front/end system on most of the sites is Schneider's ION-EEM system.

Meters and sensors shall be compatible with Modbus, Bacnet, and Lon.

Meters and sensors shall have expandable capacity

Meters and sensors shall be real time, and remotely monitored.

Site Pictures of those components that are suggested for installing meters on:



Chilled water pipes metering suggested location in AHU room adjacent to data center



Panel DP-1-UPS in UPS room



UPS room, two UPS and one CRAH units serving UPS room are shown



Battery room and its AC unit



Panel DP-2-UPS in Air Handler room



Generator Block heater pump and heater



Panel B7A and related transformers in Air Handler room