Chantilly 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.

LBNL 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 Usage 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

Real Time PUE = (p1 + p3 + p4 + p5) ÷ 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) ÷ 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."

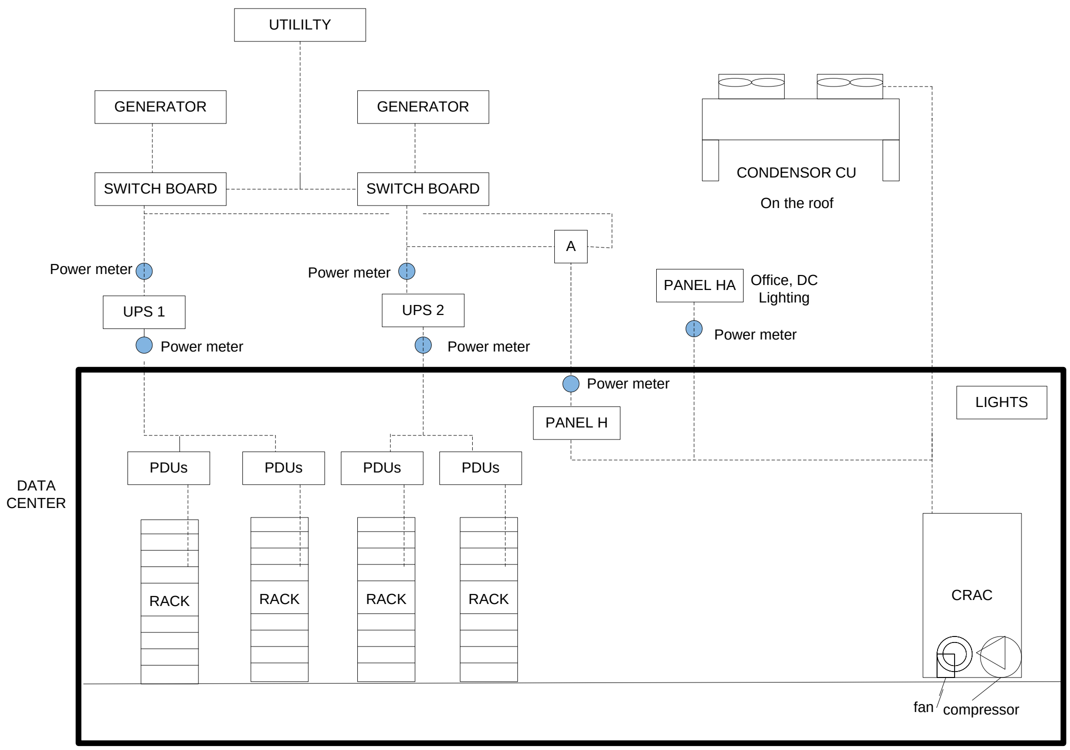
Chantilly Data Center Overview:

The 4,000 square feet data center is located on the first floor of a one story office building.
The center is under major renovation. In an effort to upgrade the data center to a Tier3 level, redundancy is enhanced. The following describes the new configuration of the data center. The installation will be completed by March 2011 and management plan is to have meters installed by that date. Two 275kVA UPS units (one redundant) are supported by two 1,000kW generators (one

redundant). Block heaters are sized at 5kW. Generators are outdoor units. Generators support cooling system as well as lighting and office load.

IT equipment is supported by four PDU units sized at 150kVA each. The current IT load was noted at about 84kW. Existing load based on the IT equipment list in drawing E5 is about 120kW. Cooling is provided by four 20ton CRAC units with their condensers on the roof.

Metering points are identified in the following diagram:



Notes:

Lighting energy use is estimated by totaling the load for 200hours monthly operation. This will be added to total after HA load is deducted

Reading power output from PDU display and comparing with UPS output will identify PDU loss

Generators block heater load can be estimated by multiplying load by hours of operation

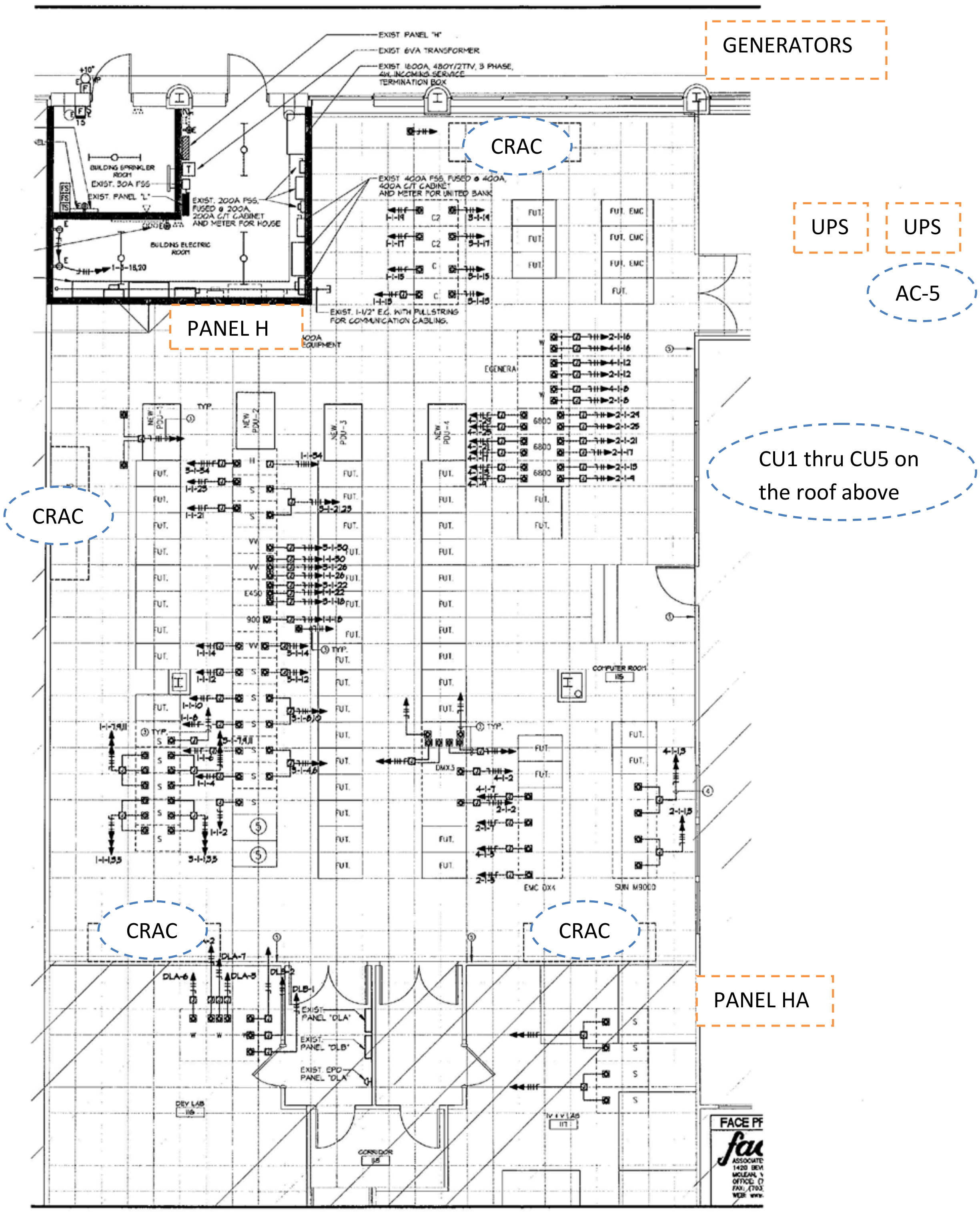
Generators fuel equivalent energy can be estimated by multiplying gallons of fuel by 2.4

UPS1 and UPS2 will be installed in the room/corridor area adjacent to the data center. Cooling of this area is provided by AC5 (7.5ton unit). This load needs to be considered in the calculation of the total cooling load. Also, a more accurate metering can be accomplished by metering the output of power distribution units.

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

Parameter to be measured	Units	Type of Point	Comments	Meters
CRAC fan power	kW	Virtual	For constant flow fans, the option is to spot measure once and multiply by number of the similar CRAC units	Power Meters
CRAC compressor power	kW	Analog	Part of power to cooling system	Power Meters
CRAC condenser power	kW	Analog	Part of power to cooling system	Power Meters
AC5, fan, compressor and condenser	kW	Analog	Cooling unit for UPS room, Part of power to cooling system	Power Meters
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 Input	kW	Analog	Optionally, Switch board might provide this info with no need for meter -2 UPSs	Power Meters
UPS Output	kW	Analog	UPS might provide this info with no need for a new meter- 2 UPSs serving 2 PDUs each	Power Meters
Power to Panel H	kW	Analog		Power Meters
Power to Panel HA	kW	Analog	Non data center load will be deducted from power to power H	
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

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:

Existing Transfer Switch inside data center, it will be replaced.

Panel H (600amp)serving data center cooling system and Panel HA

Future UPS and switch boards room, Generators will be installed behind the wall on the right side

Two Labs on the back side of the main data center are planned to be considered as part of the data center. Although separation of these two rooms from data center power use will provide a better measure of data center energy use efficiency, the complexity of the electrical distribution and the cooling systems that are common between these rooms and the main data center makes this a very difficult effort.