

**DATA CENTER ENERGY
CHARACTERIZATION STUDY
SITE REPORT**

DATA CENTER FACILITY 3

FEBRUARY 2001

I. Review of Site Characteristics

Facility

Facility 3 is a two-story 42,000 square foot (sf) data center facility located in Silicon Valley, California. This facility provides co-location service, which is an unmanaged service that provides rack space and network connectivity via a high-capacity backbone. The building houses 25,000 sf of data center space, 4,580 sf of office/support space, and 900 sf of electrical room space. 59 percent of the building is data center space. During the monitoring period, 85 percent of the data center was occupied. Combined office and support space accounts for 11 percent of the building. The data center's environmental system operates 24 hours a day year-round. The users of the co-location space require full access to and control of their caged space 24 hours a day.

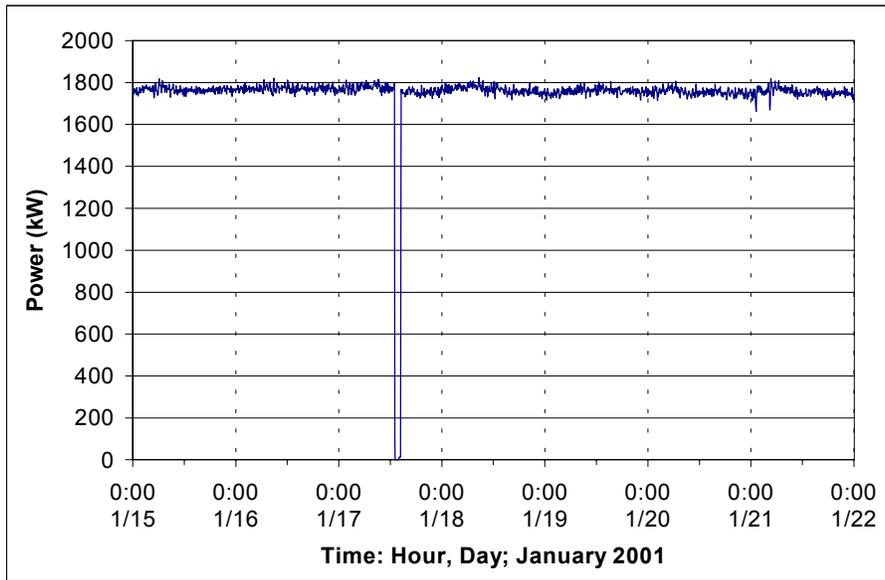


Customer Cage

Electrical Equipment and Backup Power System

The electricity use at Data Center Facility 3 was monitored from January 15, 2001 through January 22, 2001. Facility 3 has a PG&E service feed of 2,000 kVA. Of this, an average of 1,780 kVA is being used. The site drew an average of 1,760 kW over the monitoring period. Note that the power drops to zero on January 17, 2001 at 1:00 p.m. due to a rolling blackout. Data center floor power was not disrupted during the one and a half hours of the blackout. Disregarding the power outage, the load varied $\pm 4.5\%$ from the average, and the load factor was 0.97.

Chart 1. Facility 3 Whole Building Power Consumption



This site utilizes Liebert and PowerWare uninterruptible power supplies (UPS) to condition the utility power in order to shield critical loads on the data center floor from disturbances. In addition, a constant delivery voltage to the data center is maintained. Anytime the voltage drops below 480, the UPS systems' batteries feed in the necessary voltage to maintain 480 volts. The UPS converts AC current and stores it as DC current. When the voltage is needed, it is converted back to AC current. In the event of a power loss, 3 Onan diesel generators each provide 1,500 kW for backup. The generators with a full tank of diesel fuel can provide electricity to the building for approximately 8 hours. The data center is designed for N+1 redundancy on the electricity circuit level.



UPS System

Cooling System

The rooftop mechanical pad includes a farm of air-cooled condensers for the CRAC (computer room air conditioning) units, two package units for office space conditioning, and two exhaust fans.



Condenser Units

The data center is on a raised floor, through which cooling air is circulated via the CRAC units. Twenty-eight CRAC units serve the space: 22 Lieberts rated at 22 tons each and 8 Data Aire units rated at 10 tons each. The room temperature and relative humidity are maintained at an average of 65 °F and 40%, respectively.



Data Center CRAC Unit

Facility 3's electrical rooms are dispersed throughout the building. The DC power and transfer switch electrical rooms produce a high heat load. Thus they are cooled by two Liebert and four Data Aire CRAC units. These two rooms consist exclusively of equipment to power data center floor equipment. A temperature of 66 °F and relative humidity of 45% are maintained in the electrical rooms. The Liebert cooling units have a compressor EER (energy efficiency rating) of 11.7.

II. Electricity Use Characteristics

The facility's end-use of electricity is shown below in Table 1 and Chart 2. "Other" was calculated by subtracting all of the measured data from the "Whole Building" power. Eighty-eight percent of the power goes to energizing the data center: 59 percent for server and related equipment loads, 4 percent to the DC power equipment, and 25 percent to the cooling equipment. The DC power equipment is considered as part of the data center load since it is located on the data center floor. The HVAC electricity use is a significant amount of the whole building power consumption and is where energy efficiency improvements can be made. A 15 to 50 percent reduction in HVAC electricity use can be achieved. This corresponds to 66 to 221 kW of electricity savings. Lighting was calculated based on a design watt per square foot value. "Other" contributes 10 percent of the whole building consumption; it includes items such as losses of power in the electrical equipment, office plug loads, and office space conditioning.

Table 1. End-Use of Electricity

Description	Electricity Consumption (kW)	% of Whole Building	Square Feet (sf)	Watts / sf
Whole Building	1,760	--	42,000	42
Data Center Server Load	1,040	59	25,000	44
DC Power Equipment	68	4		
Data Center and Electrical Room Cooling	442	25	25,900	17
Lighting	42	2	42,000	1.0
Other	172	10	42,000	4.1

Chart 2. Facility 3 Electricity End-Use

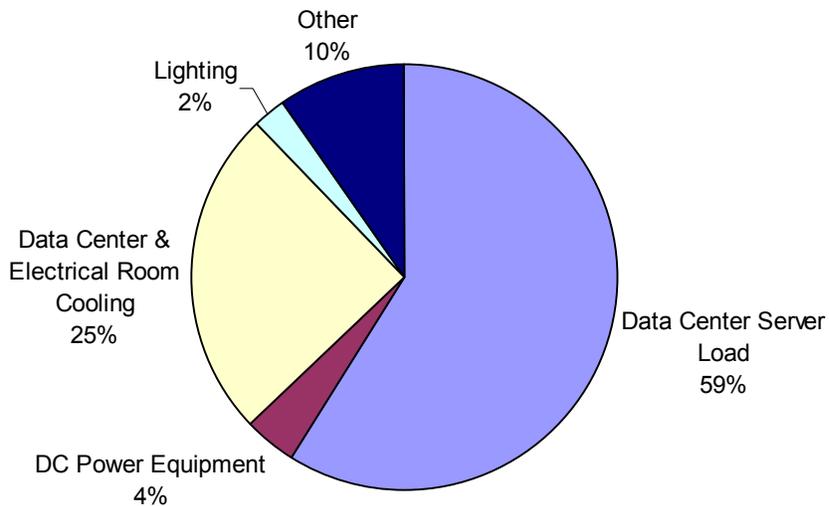
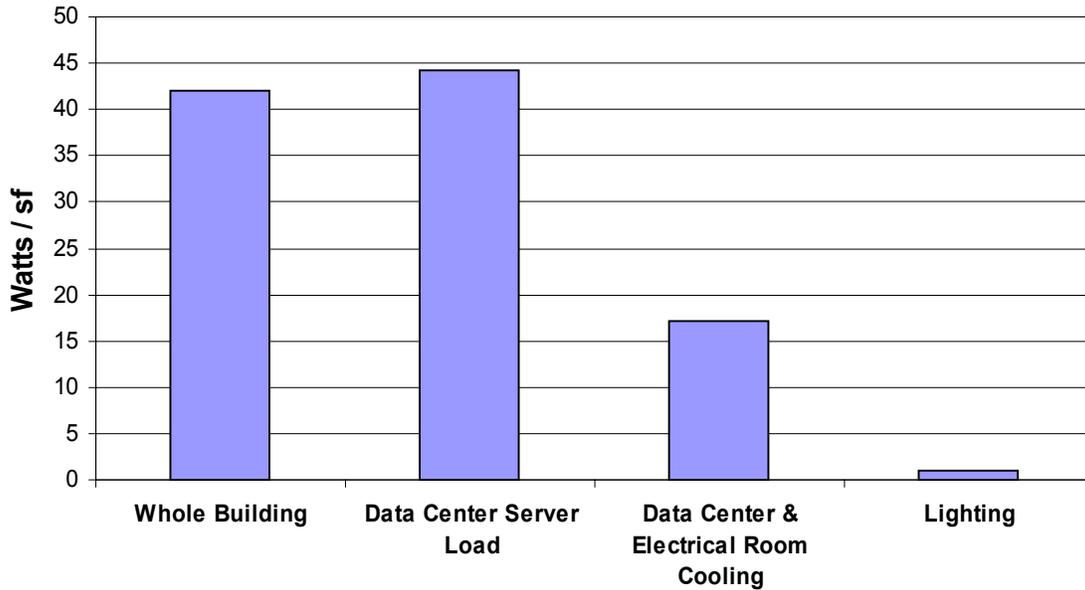


Chart 3. Facility 3 Operating Energy Densities



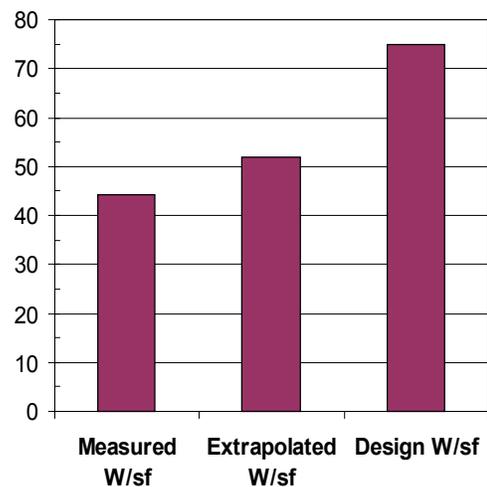
III. Electricity Use Diversity

In determining the size of the equipment needed in a data center facility, designers, in most cases, use an energy density value expressed in watts per square foot (W/sf). The type and number of server equipment in the data center are difficult to estimate; designers therefore oversize electrical equipment, so that a lack of capacity will not be a concern. Table 2 shows the operating conditions of the facility in comparison with the designed conditions. Also, an extrapolated value was calculated to determine what the operating W/sf would be if the data center were fully loaded.

Table 2. Server Load Diversity Factor

Measured W/sf	44
Extrapolated Full Load W/sf	52
Design W/sf	75
Diversity Factor (Measured / Design)	0.59
Diversity Factor (Extrapolated / Design)	0.69

Chart 5. Server Load Density



The data center was 85 percent occupied at the time of monitoring. Thus 85 percent of the 25,000 sf area was used in calculating the extrapolated data center server load. The extrapolated diversity factor demonstrates that the data center is fully loaded, it will operate at 69 percent of the expected or designed load.