Calculating TCO for Energy

Realistically estimate electric use and cost to compare servers

By Scott Barielle

IT organizations and the consultants and salespeople who serve them often generate business cases to project costs of alternatives. Though commonly termed total cost of ownership (TCO), these analyses involve variable costs of IT infrastructure. A trend of the exhaustion of data-center electrical capacity has raised the importance of electrical consumption and costs. In this article, you'll learn how to estimate server electric consumption and calculate the resulting operating expenses for business cases.

Server Electric Values

The first information needed is the amount of electricity each server consumes. This might not seem straightforward. A 70-watt (70 W) light bulb consumes 70 W when on. A 1725 W-rated server doesn't consume 1725 W, though. Even for the same brand and model, different configurations consume different amounts of electricity.

This value is the nameplate rating. The 1725 W example is used by the system central electronic complex

enclosures of many Power Systems* servers. Unlike a light bulb's value, the nameplate rating doesn't state the server's electrical consumption. It states the power supplies' capacity. Calculating electrical use or cost by the nameplate rating results in significant overestimation.

Finding Typical Power Values

What should be used to calculate server electric use and costs? Use typical power, the estimate of a server model/configuration's average electric use. Because modern servers often have large variations in configurations, published typical power values are rare. To get reasonable estimates of typical power for servers built since about 2005, use the vendor's power calculators. Different brands often have separate power estimation (see "Power Sources" on page 40).

For servers built before 2005 (e.g., eServer* pSeries* and RS/6000* platforms), find the site planning documentation. A copy of the Site and Hardware Planning Information, document SA38-0508-12, is available at http://bit.ly/o5h5Hn. Many of the models listed have typical power values.

Site-planning documentation is the authoritative source for electric and space information for all vendors, brands and models. Always use site or installation documents to get values when a calculator isn't available. Many older x86 servers will have electrical information in either an installation guide or user guide. Avoid brochures, datasheets and at-a-glance type marketing materials.

Estimating Typical Power

If the vendor doesn't have a calculator and the site-planning information doesn't list typical power, estimate based on either the category or derivation based on the nameplate rating. Categorically, commodity x86 servers can be estimated reasonably. Average typical power consumption for servers ranges in the following categories:

If the example server is unplugged and its workload deployed elsewhere, $333 per year in electrical expense will be saved.

- 1U rackmount x86: 300 W-350 W
- 2U rackmount, 2 socket x86: 350 W-400 W
- 4U rackmount, 4 socket x86: average 600 W, heavy configurations 1000 W
- Blades: average chassis uses 4500 W; divide by number of blades per chassis (IBM BladeCenter* H is 14 per chassis, so 320 per blade server)

To estimate within these ranges, consider that electrical consumption increases with higher clock-speed CPUs, larger numbers of memory cards such as DIMMs and physical disks, and with greater processor utilization.

Servers that don't fall into one of the listed categories can have typical power estimated by multiplying the nameplate rating by 70 percent. This estimation is reasonable only for a large population of servers, such as a whole data center. It's not accurate with any granularity, and certainly not at the single-server level.

Electrical Units and Price Units

Once typical power is determined or estimated, the expense can be calculated. Electricity is priced per kilowatt-hour (kWh). Watts and kilowatts are steady-state units, so electric bills are based on the use over time. The average price of electricity in the United States for the commercial sector, where most data centers reside, is 10 cents per kWh.

To determine the current average price of electricity in your state, reference the Energy Information Administration of the U.S. Department of Energy (www.eia.gov/electricity/data.cfm#sales), The data is in Table 5.6.B. Typically, you'll use the commercial-sector price.

Cost Calculation

The yearly cost of server electrical (IT load) expense is calculated with the formula:

typical power W ÷ 1,000 x price x hours per year

Divide by 1,000 to convert watts to kilowatts, the unit for pricing. A year has 8,766 hours, assuming the server is always in service. So, if we use an example of a server with typical power of 380 W and price of 10 cents per kWh:

380 ÷ 1,000 x 0.10 x 8,766 = $333 per year

Energy Can't be Created or Destroyed

The server's electrical cost is variable. In an analysis where the example server is unplugged and its workload deployed elsewhere, $333 per year in server electrical expense will be saved. This is a hard dollar savings, whether it's in IT's budget or not. But that's not all.

The server's consumption is known as IT load from a data-center facilities perspective. In fact, data centers have three major electrical cost categories:

1. IT load: The kW used by systems at power supply input
2. Distribution: The kW of losses from conversion of voltage and rectification

3. Mechanical: The kW of thermal dissipation equipment removing the heat generated by IT load and distribution

Every watt a server uses is converted to heat. Every watt lost in conversion of electric distribution converts to heat. At a constant rate, each watt generates 3.4129 BTUs per hour. That heat must be transported outside the data center. The outside transport also consumes watts of electricity, those of the mechanical category.

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Hard vs. Soft Numbers

IT load reduction is a hard number savings. Reductions to distribution losses are also hard dollar savings. When a server is unplugged, the watts it consumed are saved, and because the watts aren't distributed, the losses experienced are saved too.

Normally, only some of mechanical load is variable, meaning that calculating the cooling cost that corresponds with server load is a very soft number. It varies widely by data center, and can be from 0 to 100 percent. If the variable portion of mechanical facility wattage is unknown, estimating it at 25 percent is reasonable.

You can, however, estimate the kW for distribution and mechanical based on the IT load. Typically 15 to 17 percent of IT load is distribution, while 100 percent of IT load is mechanical kW. Bear in mind, these are reasonable averages based on experience. They're representative of medium to large data centers, greater than 20,000 square feet of raised floor.

The power usage effectiveness (PUE) metric may be available for the data center. This is a ratio where 1.0 of the value is the IT load and the remainder is the distribution losses and mechanical load. If we have a data-center PUE, we know the average distribution kW, so the remainder is mechanical kW. For example, if the data center PUE is 2.10, and we assume 16 percent is distribution loss, then: 2.10 – 1.00 – 0.16 = the mechanical load as a percentage of IT load, in this case 94 percent.

Tying it Together

To determine the total yearly electrical operating expense of a server:

IT load cost per year x distribution kW x mechanical kW

To determine the yearly savings if the server were decommissioned: IT load cost per year x distribution kW x (mechanical kW x variable portion).

Using our examples of IT load yearly cost of $333 in a data center with PUE of 2.10, we find:

- Distribution is 16 percent of $333, or $53
- Mechanical is 94 percent of $333, or $313
- Variable mechanical is 25 percent of $313, or $78

Total yearly expense will be $333 plus $53 plus $313, for a total of $699. And the potential savings will be $333 plus $53 plus $78 for a total of $465.

Calculating the cost of server electric requires typical power, electric price and distribution and mechanical percentages for the data center. Calculating the potential savings requires the same, and also requires the percentage of the mechanical load that is variable for the data center.

Power Sources

The IBM power information sources, by brand, are:

IBM BladeCenter and System x Power Configurator
www.ibm.com/systems/bladecenter/resources/powerconfig.html

IBM eServer p5/i5, System p5/i5 Power Load Calculator
http://publib.boulder.ibm.com/infocenter/powersys/v3r1m5/topic/iphdl_p5/powerloadcalc.htm

IBM System p/i, Power servers IBM Systems Energy Estimator
www-912.ibm.com/see/EnergyEstimator

IBM System z 9/10, zEnterprise Resource Link
www.ibm.com/servers/resourcelink/svc03100.nsf?OpenDatabase

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