Infinitum

Data Center Case Study

How Right-Sizing Can Reallocate Power for Revenue Growth

Data centers are constrained by power availability, and designing for optimal power allocation is critical to maximizing revenue. This case study explores how building a data center with right-sized motors tailored to the specific cooling load enabled a significant reallocation of power to IT equipment, resulting in a more efficient data center with a lower carbon footprint and opportunities to generate additional revenue.

The Challenge

Standard Motor Design Limits IT Capacity

Data Center A planned to utilize 72 MW of incoming power for its operations. The initial design allocated power as follows:

> **21.6 MW for cooling equipment** using standard 10 HP (7.5 kW) motors operating at 1800 RPM.

> **43.2 MW for IT computing power**, with servers comprising the bulk of the load **(38.4 MW)**.

Using this setup, the facility would require **3000 motors** to handle the cooling load, with half of those allocated to the chillers and fan walls. The remaining power would support approximately 3600 server racks.

The power allocated towards the cooling load is dependent on several factors including the flow and pressure necessary to cool the server rooms and the connected power of the motors and drives. The connected power is defined by the power listed on the nameplate of each fan, pump, and VFD, regardless of if the full amount of power is utilized or not. In this example, the facility is designed to allocate 22 MW to cooling equipment, even though the peak load of the data center requires significantly less. This approach not only ties up power that won't be used, but it also leaves no room for growth in IT capacity without significant infrastructure upgrades.

Solution

Designing with Right-Sized Motors

Instead of relying on standard motors, the data center decided to customize its cooling system with right-sized motors during the design phase. These motors were tailored to the specific load requirements of their application, allowing the facility to avoid over-allocation of power to cooling.

> The custom motor specifications were:
> 6 HP / 4.4 kW / 1,225 RPM / 7 A

By designing the facility with these motors, the facility allocated only the required power for cooling, reducing the cooling system's power allocation from 21.6 MW to 17.7 MW—a **3.9 MW reduction** (inclusive of additional cooling needed for additional servers) compared to the standard motor design. The electrical infrastructure was strategically sized to match the mechanical cooling system, unlocking additional capex savings.

Results

More IT Capacity, Higher Revenue

The reduction of the cooling system's power allocation allowed the facility to increase its IT capacity by 3.9 MW with additional servers.

> **New Power Allocation:**
> Cooling: 17.7 MW (including additional units to cool the additional servers)
> IT Equipment: 51.9 MW (3.9 MW of additional server capacity)

> **Increased IT Capacity:**
> Added 322 server racks, housing 13,506 additional servers.

Cost Analysis

One-Time Investment

Building with right-sized motors required a one-time investment in additional cooling and additional servers. However, this investment is quickly offset by the additional revenue generated from the extra IT capacity, resulting in a payback period of just a few years.

Conclusion

This case study demonstrates that designing a data center with right-sized motors tailored to specific cooling loads can unlock significant revenue potential and reduce power waste. While it requires foresight during the design phase, the payoffs are substantial.

SOURCES:

Breaking Down Data Center Cost: Building vs. Outsourcing
In the United States, construction costs for data centers are estimated to average at approximately $9.5 million per megawatt.

A survey on data center cooling systems:

Technology, power consumption modeling and control strategy optimization
30% of a data center's power consumption is dedicated to cooling.

Data Center Power: A Comprehensive Overview of Energy
In a typical data center, servers alone can account for 50% to 70% of the total power consumption. Cloud Service Providers (CSPs), such as Amazon Web Services (AWS), and large internet companies like Meta Platforms (Facebook), operate at power densification levels ranging from 10 kW to 14 kW per rack.

A Guide to Server Rack Sizes for Data Centers
The most common server rack size you'll encounter in data centers is 42U which accommodates 42 units (U).

CBRE Report: North American Data Center Pricing Nears Record Highs, Driven by Strong Demand and Limited Availability
Average hosting charge between $150-$200 per kw/month.

Energy Consumption of Information Technology Data Centers
About half the cooling energy used is consumed at the refrigeration chiller compressor and about a third is used by the room level air-conditioning units for air movement, making them the two primary contributors to the data center cooling energy use.