

Common Sense:

Solutions to Make Your Data Center Energy Efficient

Energy efficiency is a life style. It's also common sense. In a data center, the name of the game is efficiency and how many compute operations you can get for a given amount of power.

You can change the numerator: Get more compute for your energy dollars or you can change the denominator (reduce your power usage), but the first step is to assess all the systems in order to improve your utilization and efficiency.

The good news is that there are many best practices when it comes to data center energy efficiency. The Data Center Task Force, the U.S. Department of Energy Save Energy Now Program for Data Centers and the European Union's Code of Conduct have put much effort into developing best practices for energy efficient data centers, as well as harmonizing the way in which efficiency is benchmarked. Data center owners who are looking for the latest trends and best practices for energy efficiencies should look to these organizations first.

Risk vs. Reward

Looking specifically at large technology companies like Google, Microsoft, and Facebook, we've seen adoption of innovative technology when it comes to building efficient data centers, but that takes on some risk. For large scale data centers, it makes sense to deploy custom innovation because you can leverage benefits that will translate into big energy savings and operational expenditure savings. We have seen de-centralized UPSs, renewable energy sources, custom server designs, and alternative methods of power distribution being implemented to improve energy efficiency.

In a typical data center, you have to work with a variety of vendors, and you don't necessarily have the flexibility to design end-to-end data center solutions. However, there is hope even if you only have a few thousand square feet in size.

The 1-2 Punch

There are two main factors that negatively impact energy efficiency in your data center:

- The inefficient design of your data center
- Lack of operational best practices

The more control you have over your data center design, the more flexibility you have with implementing energy efficiency strategies. For instance, in an existing data center, you have more restrictions because you have to work around a set of parameters and limitations already in place. If you are building a new data center, you can take more liberties and implement best practices, efficient designs, and innovative technology with fewer constraints.



Existing Data Centers

If you are a data center operator and your dream of building a new data center is years away, you can still find opportunities for improving energy efficiency in your data center. The top areas you should assess include:

- Operational best practices
- Right-sizing your cooling system
- Managing air flow
- Improving power distribution system
- Measure, measure, measure

Operational Best Practices

Many of us have heard from our parents, “Turn the lights off when you leave a room.” This may seem obvious at home, but similar operational best practices focused on finding and eliminating waste in the data center should be undertaken. This includes wasted cooling, wasted space, wasted power, and even wasted computing resources.

For example:

Do you know what is running on your servers? If you have a server that has only one or two applications running on it, move the applications to another server and turn the server off.

Are your support systems properly designed for the IT loads they are running and not oversized as a buffer against downtime? If so, your uptime will still exist, but at the expense of efficiency and costs.

Have you adopted best practices to lay out your cabinet rows? If there is no hot aisle/cold aisle arrangement in your data center, this will lead to air mixing, poor airflow management, and an overall inefficient deployment of your cooling system.

Right-Size Your Cooling

One of the main sources of energy inefficiency in the data center is the cooling systems. Many data center operators still cool their data centers at a much colder temperature than necessary. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 2011 thermal guidelines provide expanded temperature and humidity windows in which to operate your data center. The new guidelines also stress using outside air to cool your data center. Whether you choose to use manufactured air, outside air or a combination to cool your data center, these guidelines instruct you on how to optimize your cooling without impacting performance, and as a result, decrease the amount of energy that you are using.

Manage Air Flow

Once you've right-sized the cooling system, ensure you are correctly and efficiently using the air you have with airflow management strategies ranging from the tactical use of blanking panels to strategic use of containment and vertical exhaust ducts (VEDs).

You also need to prevent the hot and cold air from mixing within the cabinet, over the tops of the cabinets, and around the end of the row. A cooling simulation tool can identify and visually simulate the movement of air flow in your data center, helping you to develop solutions.

Improve Power Distribution

In addition to managing cooling and airflow, you also can make improvements to your power distribution system. For instance, you can use higher voltage power distribution to the racks and IT equipment or replace old and inefficient UPSs with new ones.

Not much has changed or evolved in AC distribution systems over the years. Alternating Current (AC) power systems dominate power distribution systems in data centers today. However, the area of most change and opportunity for efficiency is the power distribution to the rack or cabinet. If you have an existing data center, you can improve your efficiency by distributing three phase circuits to the rack at a higher voltage. If your data center is still using 120 Volts to the IT equipment, your power distribution is very inefficient as compared to 208 Volts.

Also be cognizant of the power cord management. Few people pay attention to what's going on inside their rack, and how power cords can impede air flow at the rear of the servers. Details like those add up to costly inefficiencies.

Measure, Measure, Measure

Another area of operational best practice is to try and gain visibility into your data centers. Make it a habit of getting good data on your data center, benchmarking and gaining visibility into power consumption. Use industry metrics such as Power Usage Effectiveness (PUE). A tool that can give you visibility into your data center resources is the use of Data Center Infrastructure Management (DCIM) software.

The Green Grid, a non-profit, open industry consortium of end-users, policy-makers, technology providers, facility architects, and utility companies collaborating to improve the resource efficiency of data centers and business computing ecosystems, introduced a free online tool for data center managers to record their Power Usage Effectiveness (PUE) scores that will establish global consistency in reporting the split between energy flowing to IT equipment and facility operations. There are also DCIM tools that monitor data center systems, providing full visibility into system usage.



Making the Case for Energy Efficiency in an Existing Data Center

Obtaining the capital to modify an existing data center is often difficult to justify to management. The first step is to estimate the return-on-investment (ROI). This may seem like a daunting task at first, but the good news is that data center operators are not alone in this process.

A firm that has expertise specifically in data center energy efficiency can help you determine if you will see a pay back within 2 years, 5 years, or 10 years, and will help you get management's approval to fund the project.

Also, your local utility company may have programs that can help fund an energy improvement project targeted specifically for data centers. Consult with either a firm that specializes in data center energy efficiency or a utility company to determine if there are energy efficiency incentive programs available and what a potential ROI of undertaking such an effort would be. Another resource is the Database of State Incentives for Renewable and Efficiency programs, <http://www.dsireusa.org/>.

Energy Efficiency Opportunities for New Data Centers

A new data center is where you can implement from the ground up the best design principles for energy efficiency. The practices mentioned above for existing data centers also apply to a new data center. In addition, there are more opportunities for energy efficiency in a new data center.

For example, one of the largest consumers of electricity in a data center is your cooling system. In a new data center, the design of your cooling system should ensure your cooling equipment is right-sized to leverage the use of outside air.

Energy Efficient Equipment

One of the best practices you can employ is to purchase the most energy efficient power infrastructure, cooling equipment and servers available. Some specific examples are deploying high efficiency UPSs and Energy Star-rated servers. Your data center design must ensure that your equipment will operate within the efficiency "sweet spot". The "sweet spot" is the spot in which performance is the most efficient. Quite the contrary, a lightly loaded UPS can waste a lot of energy, sometimes more than 50%. The power and cooling equipment most likely don't have the same operational sweet spot.

Redundancy

Closely evaluate how much redundancy is needed and for which applications. If you are running less critical applications, consider moving them into a data center area that is not as redundant. You may also want to consider implementing a zone structure.

A power reliability zone is a high power, high density, high reliability zone for your mission-critical applications. All other applications can be classified in a Zone 2 or even Zone 3 depending upon the nature of the application, the uptime required, and the corresponding cooling and power needs. Decreasing infrastructure redundancy can reduce your overall data center power consumption.

You can reduce your infrastructure drastically by not catering to the five "9s" for non-mission critical applications. The five "9s" refers to a service level agreement of 99.999% uptime. According to the Uptime Institute, even a highly redundant Tier IV data center facility can only achieve 99.995% uptime and only 10 percent of Tier IV facilities will be able to achieve this uptime.

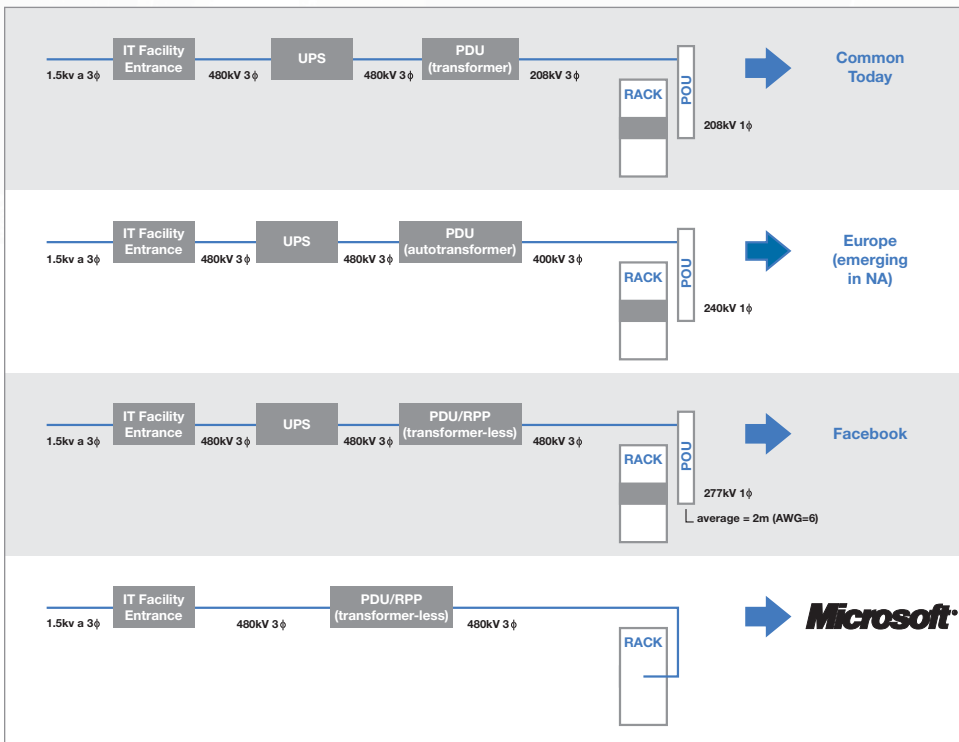
	Tier I Facility	Tier II Facility	Tier III Facility	Tier IV Facility
Availability	99.671%	99.749%	99.982%	99.995%
Downtime	28.8 hours	22.0 hours	1.6 hours	0.8 hours

Keep the End Goal in Mind

When designing a new data center there are many different systems and equipment operating together, not only from a (building) power distribution and cooling stand point, but also from an IT standpoint. Knowing the short- and long-term technical and operating requirements impact the final design and are critical to optimizing the design for energy efficiency.

Power Distribution

In new data centers, the trend in power distribution is to distribute power as a three phase 400V system, and then distributing 230 volts single phase to the IT equipment. Europe has been using 400v/230v distribution for many years, and this is an emerging trend in North America. This is a viable option since most of the power supplies in IT equipment today can readily handle this voltage. The use of three phase power distributed at a high distribution voltage reduces wire size, increases power density, reduces the amount of copper cabling, and reduces copper losses.



The figure above depicts existing power distribution methods used. Companies such as Facebook and Microsoft use higher distribution methods.

Facebook has deployed their design based on the open computing project. Microsoft's (ITPAC) design distributes 480 volts directly to the racks.

Overall Best Practices for Energy Efficiency

If you're an existing data center:

- Adopt operational best practices – properly maintain and control your equipment
- Eliminate waste – in computing, power distribution, and cooling system
- Measure, measure, measure – you can't eliminate waste if you don't identify it first

If you're building a new data center:

- Design your data center with energy efficiency in mind
- Take advantage of free cooling
- Always buy the most energy efficient equipment available

Additional Reading

2012 Best Practices for the EU Code of Conduct on Data Centers by the EU Code of Conduct on Data Centers

Recommendations for Measuring and Reporting Overall Data Center Efficiency (Version 2)
by the Data Center Task Force

Guidelines for Energy-Efficient Data Centers by The Green Grid

Data Center Maturity Model by The Green Grid

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