

Future Datacenter Sustainability

EXECUTIVE STRATEGY BRIEF

When managing an infrastructure of hundreds of thousands of servers, it is essential that they be operated efficiently to improve cost and sustainability. As consumers and organizations aggressively adopt cloud-based computing models, the demands on datacenters will grow exponentially, and operators will need to embrace new ways to measure, monitor, and reduce energy use and carbon emissions.

This strategy brief discusses the industry imperative for more sustainable datacenters, presents Microsoft's approach to measuring and reducing carbon emissions, and looks at the implications when data is viewed as the new form of energy.

The Sustainability Imperative

At Microsoft, we are committed to driving software and technology innovations that help people and organizations around the world improve the environment. Our goal is to reduce the impact of our operations and products, and to be a leader in environmental responsibility while providing high quality software and services Microsoft is known for. The environmental sustainability approach for our datacenters is extensive and includes the following:

Build sustainability in from the ground up: This includes favoring locations where renewable resources or alternative energy choices are available, and where the climate allows use of air-side economization rather than chillers. Once we choose a site, we seek to use the most environmentally friendly construction processes and materials available, including reflective and emissive paint, LEED-certified materials, and the use of biodiesel in construction equipment.

Run sustainably every day: Much energy is required to manage heat in datacenter environments, so we standardize on energy-efficient servers and place a great deal of focus on optimizing air flow through a configuration of hot and cold aisles. In fact our newer designs use hot aisle containment. We also deploy sensors throughout our facilities and employ remote management whenever possible to fine tune our operations in response to changes in temperature and humidity. And we're constantly on the lookout for areas where we can reduce waste and improve efficiency in our operations. To instill this emphasis throughout our facilities we incent our datacenter managers based on efficiency improvements as well as uptime.

Measure constantly: We measure and analyze everything we do to make sure we're getting closer to our targets for efficiency. There are several metrics we use to track efficiency, but one of the most well know is Power Usage Effectiveness (PUE), a ratio of the power and cooling overhead required to support our server load. In other words if our PUE is 1.5, for every 1 watt of server power, we use another 0.5 watts in overhead power. The industry PUE average is 2.0 – 2.4. Our average is 1.55 globally. We aim to drive our PUE down to 1.125 by 2012.

Share best practices with the industry: Microsoft believes that the datacenter industry as a whole needs to band together to share best practices around reducing our carbon footprint and making other gains toward environmental sustainability. That's why we helped found and actively participate in The Green Grid and Climate Savers Computing industry consortiums. We also work closely with U.S. Environment Protection Agency, and are a proud participant and endorser of the European Union (EU) Code of Conduct for Datacenters, a voluntary program that encourages organizations responsible for the operations of datacenters to utilize technologies, systems, and processes that maximize the efficient use of electricity.

Looking Forward—New Measures for Sustainability

Power Usage Effectiveness, or PUE, has become a widely used metric to assess the energy efficiency of a datacenter. PUE compares the power consumption for the entire facility with the power consumed by the core IT components—servers, storage and network equipment. This ratio illustrates how effectively the total power being consumed translates into net compute capacity.

Mathematically, the calculation is straightforward:

$$\text{PUE} = \frac{\text{Total Facility Energy}}{\text{IT Equipment Energy}}$$

PUE by inference is a measure of sustainability since reduced power consumption would result in lower carbon emissions. However, PUE does not take into account the sources of the power—whether power is derived from wind, hydro, or coal makes a difference in sustainability.

To account for these differences in power source, Microsoft in concert with the Green Grid is looking at new, more direct measures of carbon emissions from datacenter operations.

“We see sustainability as a much broader issue than power”

CHRISTIAN BELADY
GENERAL MANAGER, DATACENTER ADVANCED
DEVELOPMENT

Carbon Usage Effectiveness

Carbon Usage is an important consideration in the design, location, and operations of datacenter, so a Carbon Usage Effectiveness (CUE) metric is under consideration. Like PUE, CUE uses total IT equipment value as the denominator, and the same value should be used for both metrics.

For datacenters that obtain their entire power source from the energy grid and generate no local CO₂, CUS is defined as follows:

$$\text{CUE} = \frac{\text{Annual CO}_2 \text{ Emissions}}{\text{by Total Datacenter Energy}} \div \text{IT Equipment Energy}$$

The units of the CUE metric are kilograms of carbon dioxide (kgCO₂eq) per kilowatt-hour (kWh).

For datacenters that emit additional CO₂ emissions, such as maintenance operations of diesel generators, the actual local CO₂ emission data is added to the grid-sourced energy.

Using a direct carbon emission metric will help operators identify more sustainable ways to source and deploy energy, compare the true sustainability between datacenters and over time, and highlight the importance of considering renewable sources when selecting datacenter sites.

The Green Grid white paper for CUE can be downloaded at www.thegreengrid.org.

Water Usage Effectiveness

Similarly, as we see temperatures rising around the globe, there is a general drying out across the various continents. This suggests that fresh water will become scarcer, and our proactive view is to use less or even eliminate the use of water in our future designs. We believe that for this reason there needs to be a universal metric for water usage. Again, in collaboration with the Green Grid, we are looking at the development of a Water Usage Effectiveness metric, or WUE which will be published by the Green Grid at the beginning of 2011.

Like PUE and CUE, this metric would compare annual water usage of the facility against IT equipment energy:

WUE=Annual CO₂ Water Consumption of Facility / IT Equipment Energy

We believe these two new measures will be valuable benchmarks in the future as we look to design and operate more sustainable datacenters.

Data as a New Form of Energy

Another area for radically changing the way we design and operate datacenters in the future is to re-think the relationship between data and energy. Christian Belady, Microsoft's Director of Hardware Architecture and one of the thought leaders in the datacenter industry, again challenges those in the industry to rethink new efficiency measures by recognizing that data is the next form of energy.

What happens when we store data instead of electricity? What happens when we distribute data instead of electricity? It is easier and more efficient to store and distribute data over fiber optic cable than electricity over copper wire.

The cost to distribute electricity through a typical power grid is about \$2 million per mile; fiber is much lower cost. Plus, transmission losses in the distribution of electricity to datacenters add to the inefficiencies. As more people embrace and consume cloud computing, it makes sense to combine power generation with datacenter capacity and simply distribute data in fiber rather than electricity in copper. This is a key area focus for our future research and development, and has the potential to fundamentally transform the way we deliver data and services in the coming decades.

Greater Sustainability means Lower Cost

Clearly, the industry is going to face greater challenges in its use of power, carbon, and water as resources. Microsoft is proactively addressing both the measurement and use of these resources, and continues to seek innovative solutions to reduce our environmental impact.

The fortunate truth is that the same efforts to reduce energy consumption and carbon emissions will result in lower cost of operations, helping us bring more value to our customers while leveraging the power of technology to help solve mankind's toughest challenges.

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Microsoft has extensive experience operating cloud services' infrastructures, with a history of innovation, operational excellence and industry leadership. As Microsoft's cloud services portfolio and infrastructure continues to grow with new services and applications launching on a rapid basis, the Global Foundation Services team is making thoughtful investments to answer our customer's needs for greater availability, lower latency, increased security, and lower costs.

Please visit www.globalfoundationservices.com for more information.

A DAY IN THE
MICROSOFT CLOUD 

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