

# - Case Study - How much energy do data centers use?



Sustainable development goals (SDGs)

Goal 9: Industry, innovation and infrastructure

Goal 11: Sustainable cities and communities

Goal 7: Affordable and clean energy



Relevant concept/ issues

Green technology



Relevant sector

Renewable energy

A data center consumes a lot of energy to enable web users to stream videos, download books and perform other online activities. The energy consumed for this around the globe is about the same as it takes to power 30 nuclear power plants.

According to Green House Data, data centers around the world use about 30 gigawatts, or 30 billion watts of electricity. U.S. data centers account for nearly one-third of that amount, according to estimates compiled by the *New York Times*. Powering data centers with renewable energy sources, like wind or solar, is an obvious solution to energy problems globally.

Source: Microsoft, Apple, Google Power Data Centers with Renewable Energy (2013).

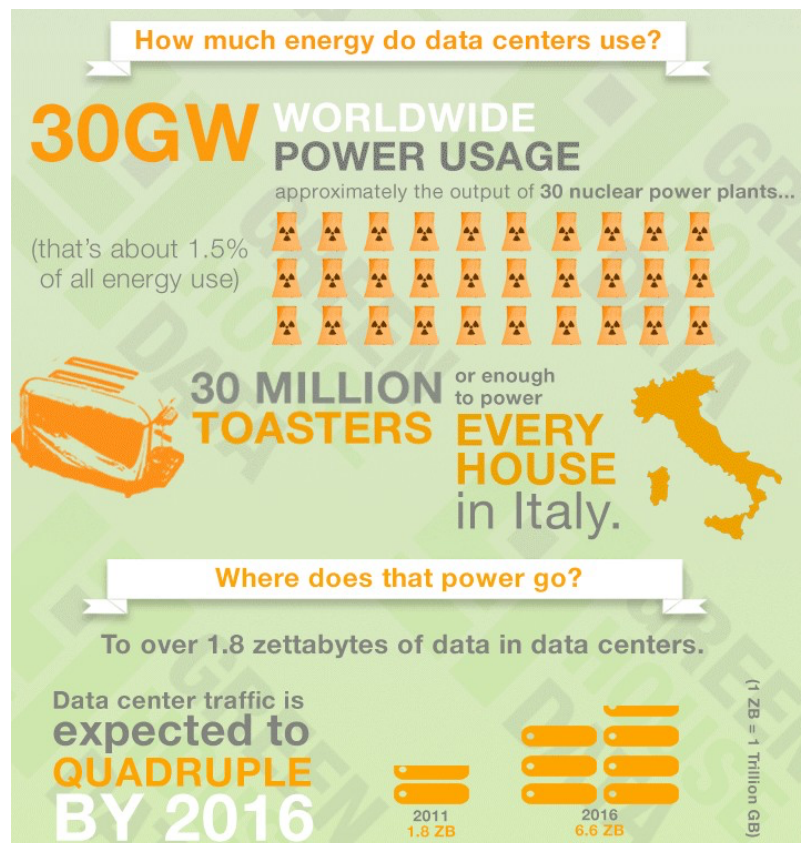


Fig. 1. How much energy do data centers use?

## — THE CASES —

### Case 1: Microsoft

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Microsoft's Azure Cloud has been carbon-neutral since 2012. Half of the energy it uses already derives from 1.2 gigawatts of wind, solar, and hydro-electric sources, which the company expects to increase to 60 percent by 2020 and 100 percent at some point in the future.

According to Microsoft, renewable energy is only part of what makes Azure a more sustainable way of running workloads like SharePoint, Exchange, and even virtual machines and storage than running them in traditional on-premises data centers. The other aspect is energy efficiency, as some is saved due to the efficiency of its custom Azure hardware, but the bulk is saved due to operational efficiency and the efficiency of its data center infrastructure.

Microsoft's report, The Carbon Benefits of Cloud Computing, compares energy consumption and environmental impact of running applications in Azure versus running them in enterprise data centers. Azure, it turns out, isn't just more carbon efficient (up to 98 percent better than on-premises), it also uses 22 percent to 93 percent less energy to run the common enterprise workloads, which consume the most energy in Azure. The study looks at small and large deployments, using both physical and virtual servers. A 10,000-user on-prem Exchange 2016 system spread across two European data centers, for example, used 81 percent more energy than the same deployment in the Microsoft Cloud. Deployment size makes an even bigger difference for SharePoint; large and medium deployments are only 22 percent and 40 percent less efficient than Azure, but small, localized SharePoint systems use 93 percent more energy on premises.

Azure compute is 52 percent more energy efficient than a high-end deployment of virtualized servers in an enterprise data center and 79 percent better than physical servers. Azure storage is 71 percent more efficient than dedicated storage and 79 percent more efficient than direct-attached disks. The figures are similar for reductions in carbon emissions.

Source: How Microsoft is Keeping Its Cloud More Efficient Than Your Data Center (Branscombe, 2018).

### Case 2: Apple

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Apple and its partners are building new renewable energy projects around the world, improving the energy options for local communities, states and even entire countries. Apple creates or develops, with utility companies new regional renewable energy projects that would otherwise not exist. These projects represent a diverse range of energy sources, including solar arrays and wind farms, as well as emerging technologies like biogas fuel cells, micro-hydro generation systems and energy storage technologies.

Apple currently has 25 operational renewable energy projects around the world, totaling 626 megawatts of generation capacity, with 286 megawatts of solar PV generation coming online in 2017, its most ever in one year. It also has 15 more projects in construction. Once built, over 1.4 gigawatts of clean renewable energy generation will be spread across 11 countries.

Since 2014, all of Apple's data centers have been powered by 100 percent renewable energy. And since 2011, all of Apple's renewable energy projects have reduced greenhouse gas emissions (CO<sub>2</sub>s) by 54 percent from its facilities worldwide and prevented nearly 2.1 million metric tons of CO<sub>2</sub> from entering the atmosphere.(Newsroom, 2018)

How Apple keeps its data centers clean? Here are some examples provided by the [Environmental Responsibility Report](#), which covered the fiscal year 2016 and explained what it has done for each of its data centers:

Maiden, North Carolina —

*Between 60 and 100 percent of the Maiden data center's energy use is generated by two 20MW solar arrays, an 18MW solar array, and 10MW of biogas fuel cells.*

*Apple partnered with local utility company, Duke Energy, to build five solar projects, with a combined peak capacity of 20MW.*

*The data center uses outside air cooling, with a waterside economizer that switches on at night and during the colder months of the year. This, combined with water storage, means chillers can be turned off most of the time.*

Newark, California —

*Energy is sourced primarily from wind farms in California, and acquired directly from the wholesale market through the state's Direct Access program. Wide availability of wind power has meant the facility has been powered by 100 percent renewable energy since 2013.*

*Once the 130MW California Flats solar project in Monterey County comes online later 2018, Apple will supply power from the solar field directly to the Newark data center, as well as other Apple facilities in the state.*

Prineville, Oregon —

*The data center's energy needs are partially met by two 'micro-hydro projects', powered by local irrigation canals. The projects generate 12 million kilowatt-hours of renewable energy per year.*

*Apple has signed a 'long-term purchase agreement' with Cypress Creek Renewables to buy energy from a 50MW portfolio of six solar arrays in Oregon.*

*The company signed a 200MW power purchase agreement with a new Oregon wind farm, the Montague Wind Power Project. The first wind project established by Apple itself produces more than 560 million kWh of renewable energy per year.*

*Finally, Apple has signed a power purchase agreement with the 56MW Solar Star Oregon II PV array, which is located 'just a few miles' from the data center. When it came online at the end of 2016, the site produces 140 million kWh of renewable energy a year.*

Source: Sun, wind and sea: Apple details data center renewable energy initiatives (Moss, 2017).

## Case 3: Google

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Apple The use of artificial intelligence (AI) to manage energy efficiency at Google data centers recently entered a new phase. Machine-learning algorithms are now adjusting cooling-plant settings automatically, in real time, on a continuous basis. The system builds on work Google revealed previously – an AI-based recommendation engine. The new system fine-tunes cooling autonomously.

Google's machine-learning algorithms for data center management can save more energy than human operators. The overall benefit is the sum of marginal savings from minor tweaks done continuously. It's making more fine-tuned adjustments than humans would normally make (Sverdlik, 2018).

The new cooling system is now in place at a number of Google's data centers. Every five minutes the system polls thousands of sensors inside the data center and chooses the optimal actions based on this information. There are all kinds of checks and balances here, of course, so the chances of one of Google's data centers going up in flames because of this is low.

Like most machine learning models, this one also became better as it gathered more data. It's now delivering energy savings of 30 percent on average, compared to the data centers' historical energy usage (Lardinois, 2018).

## Case 4: Hong Kong Case

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### Hong Kong Broadband Network (HKBN) Energy Initiatives – 'Something for Nothing'

- **Background**

The Hong Kong Broadband Network (HKBN) aims to minimize the environmental footprint of its network and operations as part of its commitment to responsible business. The company recognized that reducing energy and carbon emissions could also help reduce costs.

- **Quick Wins**

An energy audit was commissioned to identify specific opportunities. HKBN's data centers were identified as a major source of energy consumption; consequently a pilot scheme was launched in one of the larger data centers, progressively raising the room temperature to reduce energy for air-conditioning. The performance of server equipment was closely monitored throughout to ensure service quality remained consistent.

Additional measures included replacing fluorescent lighting with LEDs, removing excess tubes, and zoning air-conditioning and lighting so areas not in use could be shut down more easily.

Together, these initiatives reduced HKBN's overall energy consumption by nearly a quarter (23%) in the first year – creating internal support and momentum for further initiatives across the business.

- **Long-term Investment**

Preparations for phase 2 began in August 2015 with a detailed energy audit across all HKBN operations. The audit identified opportunities to save a further HK\$3.5 million over five years through benchmarking and setting new temperature standards in other data centers, replacing belt-driven air-conditioning fans with high-efficiency chillers and continuing to update lighting and install infrared motion sensors.

The program required an upfront capital investment totaling some HK\$1.74 million – a significant cost for a medium-sized company. Yet through an innovative financing partnership with independent energy consultant, Blue Sky Energy, HKBN will pay nothing upfront.

Instead, the capital expenditure (CAPEX) is funded exclusively by the consultant, who will receive a share of the resultant operational expenditure (OPEX) savings over a contract period of five years. This presents a true win-win, providing HKBN with 'something for nothing' – a zero-risk opportunity – while securing a long-term income stream for Blue Sky Energy.

- **Dialogue for Success**

Preceding the initial phase of the program, HKBN defined four clear sustainability priorities with senior management support – talent, environment, community and social enterprise. In working to become a green office, colleagues or 'talents' were guided by the '4 Cs': 'commit', 'calculate', 'cut' and 'communicate'.

Internal collaboration was critical to making the initiative a success. A cross-departmental committee was established to educate and engage staff on environmental sustainability.

When piloting the new data center temperate standard, close communication between HKBN's sustainability and technical teams helped to build trust and ensure potential issues were identified and addressed early on.

Source: HKBN Energy Initiatives – 'Something for Nothing' – Sustainable Business HK.

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