How dirty is your data?

A Look at the Energy Choices That Power Cloud Computing

Greenpeace International

GREENPEACE

Contents

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Executive Summary

Information Technology (IT) is disruptive. Largely for the better, IT has disrupted the way we travel, communicate, conduct business, produce, socialise and manage our homes and lives. This disruptive ability has the potential to reduce our dependence on dirty energy and make society cleaner, more efficient and powered renewably. But as we applaud the positive, visible impacts and measurable, game-changing potential of IT, we also need to pay attention to what's behind the curtain.

The 'cloud' is IT's biggest innovation and disruption. Cloud computing is converting our work, finances, health and relationships into invisible data, centralised in out-of-the-way storage facilities or data centres. This report seeks to answer an important question about this trend, currently underway across the globe: *As cloud technology disrupts our lives in many positive ways, are the companies that are changing everything failing to address their own growing environmental footprint?*

A quick glance at the letter grades on our Cloud Energy Report Card (found on page 7 of this report) indicates that many IT brands at the vanguard of this 21st century technological shift are perpetuating our addiction to dirty energy technologies of the last two centuries. We analysed the data centre investments of 10 top global cloud companies and our findings show a trend across the industry towards extolling the external effects of IT products and services, while failing to take seriously the need to power this widespread aggregation of the world's information with clean, renewable electricity.

Parts of our individual lives are becoming more efficient even as we consume more. IT can enable us to cut down on energy intensive practices by allowing us to work from home with teleconferencing and telecommuting tools. We can now read our electricity use in real time and manage it better accordingly. We can stream music on the internet instead of taking up space on our hard drives. In each of these examples, there is potential for us to choose to live in less energy-intensive ways, cut our personal greenhouse gas emissions, and shrink our footprint, individually and collectively.

The IT sector has a choice to make as well. As the demand for IT products and services grows exponentially, in the US, Europe and particularly in developing economies such as India and China, so does the amount of data we produce globally. That information requires physical storage and access to reliable electricity. Indeed IT's server farms are expanding and multiplying rapidly. In our technologically interconnected world, data centres are the factories of the 21st Century.

Whereas the factories of the Industrial Revolution got us into a mess by burning coal and releasing carbon pollution into the atmosphere, the factories of the Technology Revolution have the ability to make use of better energy choices. In the following report, we have looked at available information about the choices being made today by major IT brands about where to site and how to power their factories. It is clear that their commitment to transformative change, which includes responsibility for their own growing footprint, is still in question.

Additionally, much of the information that would allow us to assess the net benefits of the cloud by also measuring the true environmental cost of these localised, power-hungry data centres is missing. IT companies, which broadly declare transparency a major tenet of their business model, are highly secretive about their own operations. This veil of secrecy makes it nearly impossible to measure the actual benefits of cloud technologies or understand the extent to which IT's growing need for electricity is increasing the use of dirty energy.

While a few companies have clearly understood that the source of energy is a critical factor in how green or dirty our data is, and have demonstrated a commitment to driving investment attached to clean sources of electricity, the sector as a whole still seeks to define 'green' as being 'more efficient'. This failure to commit to clean energy in the same way energy efficiency is embraced is driving demand for dirty energy, and is holding the sector back from being truly green.

Throughout this report, we attempt to shed light on the state of the cloud's energy footprint by examining available information about IT companies and their data centres. First, we have attempted to explain and summarise the problem through examples of data centre investment and a graded analysis of the infrastructure choices of leading cloud companies. We also assessed best practices and leading footprint mitigation strategies. Finally, we have included some key recommendations for a sector that wishes to be seen as green and transformative, but is coming up short on it's transparency and energy choices.

Will companies such as Facebook, Apple, Twitter, Google and Yahoo! perpetuate the dirty energy issues of older, entrenched industries, or will the innovative IT sector band together to embrace a transformative business model that prioritises a future built on clean, renewable energy?

Key learnings:

- Data centres to house the explosion of virtual information currently consume 1.5-2% of all global electricity; this is growing at a rate of 12% a year.
- The IT industry points to cloud computing as the new, green model for our IT infrastructure needs, but few companies provide data that would allow us to objectively evaluate these claims.
- The technologies of the 21st century are still largely powered by the dirty coal power of the past, with over half of the companies rated herein relying on coal for between 50% and 80% of their energy needs.
- IT innovations have the potential to cut greenhouse gas emissions across all sectors of the economy, but IT's own growing demand for dirty energy remains largely unaddressed by the world's biggest IT brands.
- There is a lack of transparency across the industry about IT's own greenhouse gas footprint and a need to open up the books on its energy footprint.
- In emerging markets, where there is limited reliable grid electricity, there is a tremendous opportunity for telecom operators to show leadership by investing in renewable energy, but many are relying on heavily polluting diesel generators to fuel their growth.
- Data centre clusters (Google, Facebook, Apple) are cropping up in places like North Carolina and the US Midwest, where cheap and dirty coal-powered electricity is abundant.
- IT companies are failing to prioritise access to clean and renewable energy in their infrastructure siting decisions.
- Of the 10 brands graded, Akamai, a global content distribution network, earned top-of-the-class recognition for transparency; Yahoo! had the strongest infrastructure siting policy; Google & IBM demonstrated the most comprehensive overall approach to reduce its carbon footprint to date.
- Across the board, IT companies have thus far failed to commit to clean energy in the same way they are embracing energy efficiency, which is holding the sector back from being truly green.

What do we mean when we talk about the 'cloud'?

The term 'cloud' in the context of the IT sector does not have a clear definition or application. It has been used in disparate ways by the media and others outside the IT sector. The term has been broadly applied to a range of internet-based platforms and services (Gmail, Facebook, YouTube, Flickr, etc) that share a common characteristic of storing or delivering data from an online source to your PC, laptop, iPad and smartphone via a broadband internet connection.

However, many experts in the IT sector would insist that the term 'cloud computing' be distinguished from what is otherwise 'the internet' and applied only to subscription-based or pay-per-use services that, in real time over the internet, extend existing IT capabilities.

To keep pace with the common vernacular and also to avoid unnecessary ambiguity, this report will use the term 'cloud' to describe energy and resources used broadly with online services, and will refer as needed to 'cloud computing' as a type of IT computing services for hire within the online ecosystem.

02

Introduction

"History tells us that systems are most fairly governed when there is an open and transparent dialogue between the people who make decisions and those who are affected by them. We believe history will one day show that this principle holds true for companies as well, and we're looking to moving in this direction with you."

Facebook founder and CEO Mark Zuckerberg

The spread of mobile communication and information technology (IT) is changing how we communicate, relate and manage our daily lives at astounding speeds. Current estimates of our global communications spending for 2011 will reach $4.34 trillion US dollars, and is forecasted to top $5tn in the year 2013[1].

The instant access to information provided by smartphones, the internet and cloud computing is powerful and, in some cases, allows people around the world to 'leapfrog' previous stops on the pathway to development. Accelerated technological iteration brings better means of communication, on a bigger scale, than had previously seemed possible.

But the ongoing, global delivery of entertainment and media via services such as Google, iTunes, Twitter and Facebook is only one small example of a much larger shift to digitisation. Many major sectors of the service economy are rapidly moving from conventional business and delivery models to one that is delivered online.

We have generated 1.2 zettabytes of digital information (zettabyte =1 trillion gigabytes or 250bn DVDs) with our tweets, YouTube videos, Facebook status updates, iTunes downloads, emails and other data transfers. Additionally, there are five billion mobile users worldwide, and over 50bn mobile connections are predicted by 2020[2] as smart meters and other 'smart' devices are added to online networks. The size of the digital world is predicted to continue to increase by a factor of 44 by 2020[3].

This societal shift to moving 1s and 0s instead of atoms and mass has the potential to significantly reduce our footprint on the planet and achieve a more sustainable model for housing the soon-to-be 7 billion neighbours we share it with. However, since the 'cloud' allows our digital consumption to be largely invisible, arriving magically with the tap of the 'refresh' button in our inboxes or onto our smartphones and tablets for immediate access, we may fail to recognise that the information we receive actually devours more and more electricity as our digital lives grow.

The data centres that house this explosion of digital information currently consume more than 3% of US electricity, and approximately 1.5% to 2% of global electricity, growing at a rate of approximately 12% annually.[4] Electronic devices account for 15% of home electricity use, and are predicted to triple by 2030, equivalent to the electricity demand of the US and Japan residential market combined.

And yet, despite the IT sector's stated commitment to transparency and openness, it remains secretive about its energy use and carbon footprint at a time when the world is facing the potential for catastrophic climate change.

Our energy future and our ability to build the clean energy economy are impacted by choices we make, large and small, every day. A choice to prolong our addiction to dirty energy sources instead of choosing clean sources of energy, and the economic and environmental benefits that come with that choice, will have lasting consequences. This report seeks to illuminate the choices of major global IT brands as they compete in a global race to construct a new reality on the cloud.

This report covers:

- Choices that major IT brands are making as they set up cloud infrastructure and the energy consequences attached to those decisions;
- An assessment of green computing leadership, highlighting the good and the bad; and
- Recommendations for the IT sector on how to show bold leadership and green the cloud.

1 TIA's 2011 ICT Market Review and Forecast
2 [http://www.ericsson.com/campaign/opportunitysupportsystems/newsfeed/posts/15/]
3 http://www.emc.com/collateral/demos/microsites/idc-digital-universe/iview.htm
4 Koomey, Worldwide Electricity Used in Data Centers, 2008.

Clean Cloud Power Report Card

Company	Clean Energy Index*	Coal Intensity	Transparency	Infrastructure Siting	Mitigation Strategy
Akamai	N/A	N/A	B	D	C
amazon.com web services**	26.8%	28.5%	F	D	D
Apple	6.7%	54.5%	C	F	C
facebook	13.8%	53.2%	D	F	D
Google***	36.4%	34.7%	F	C	B
hp	9.9%	49.4%	C	D	C
IBM	10.9%	51.6%	C	C	B
Microsoft	25%	34.1%	C	C	C
twitter	21%	42.5%	F	F	F
YAHOO!	55.9%	18.3%	D	B	C

See also Appendix I at the end of this report for the Report Card Methodology

* Clean Energy Index and Coal Intensity are calculated based on estimates of power demand for evaluated facilities [http://www.greenpeace.org/cloudcomputingfacilities]

** AWS was provided facility power demand estimates to review. AWS responded they were not correct, but did not provide alternative estimates. Using conservative calculations, Greenpeace has used the best information available to derive power demand, and have decided to publish and invite AWS to be transparent and provide more accurate data for their facility power demand.

*** Google was provided facility power demand estimates to review, and indicated they substantially exceeded Google's current electricity demand, but did not make additional information available.
Given that these estimates are based on maximum power of each facility, and not estimates of current use, we elected to publish and invite Google to provide current data on energy footprint and carbon consumption.

02

Data is power: clean or dirty?

Our global addiction to dirty energy (fossil fuels and nuclear power) has catastrophic impacts on the health of our societies and the global environment. As our addiction grows larger, so does the size of the problems: oil spills, nuclear accidents and widespread health effects from air pollution. And the biggest crisis of them all is climate change. Scientists have warned us that global CO_2 emissions must peak by 2015, and decline afterwards, if we hope to avoid a permanent and planetary crisis.

Every sector in the economy must take responsibility for reducing the use of dirty energy, particularly the IT sector, which stands to profit from an increase in the use of technological clean energy solutions. Greenpeace sees great potential for the IT sector to transform how we generate and manage our energy needs. In fact, we cannot achieve the level of reduction need to protect the planet without IT energy solutions that will allow us to shift away from dirty energy sources and build our economic and planetary prosperity on clean sources of energy.

But despite the speed and ingenuity of the devices and networks that deliver this information to us, and their potential to make a positive contribution to cutting carbon out of many of our daily activities, the key elements of 21st Century digital infrastructure are still primarily powered by 19th and 20th Century dirty energy - coal and nuclear power - which are largely responsible for our catastrophic levels of global pollution.

The IT industry often points to the cloud or cloud computing as the new, green model for our IT infrastructure needs, but few companies provide data that would allow us to objectively evaluate these claims. In contrast to the functionality of their products, there is a pervasive lack of transparency regarding the environmental impact and energy consumption of IT operations. It is increasingly troubling that IT companies characteristically refuse to disclose the amount of electricity consumed, carbon emitted, or nuclear waste produced as a result of maintaining our digital infrastructure.

Efficiency is not enough

Companies usually seek to shift a discussion of rising IT emissions to the sector's tremendous gains in energy efficiency and examples of how technology is helping to reduce energy consumption elsewhere. It is true that the IT sector has steadily demonstrated improvements in energy efficiency. It has made significant strides toward reducing the energy consumption of its data centres after many years of neglect.

But as the electricity demand of IT remains on the rise, efficiency can only slow emission growth. In order to achieve the reductions necessary to keep the sector's emissions in check and maintain safe levels of global greenhouse gases, clean energy needs to become the primary source of power for IT infrastructure. A few companies have taken steps to steer their infrastructure investments toward cleaner energy, but the sector as a whole remains focused on rapid growth. The replacement of dirty sources of electricity with clean renewable ones is still the crucial missing link in the sector's sustainability efforts.

IT's energy impact is hard to measure

Numerous studies have attempted to quantify the greenhouse gas emissions savings that IT can enable across the global economy. There is strong evidence of IT's potential to create efficiency gains and cut carbon emissions by catalysing dramatic behavioural and energy-use changes. In developing countries, such as India and China, it is now possible to grow the economy with these technologies, 'leapfrogging' the energy-intensive development of industrial economies like the US.

The Climate Group's report, *SMART 2020*: *Enabling the low carbon economy in the Information Age*[5], calculates the potential savings of a shift to IT-enabled solutions, such as dematerialisation, smart grid, telecommuting and others, in the transport, building, power and industrial sectors. IT can transform the economy by applying its technologies to other industries, helping them move away from inefficient or high carbon products and systems.

It is challenging, however, to find data on the actual net impacts of applied IT technologies due to information gaps and a multiplicity of variables, as well as a lack of transparency around the lifecycle impacts of IT's own growing emissions and rising electricity use. Greenpeace evaluates the progress of major IT companies toward the energy and emissions saving potential identified in the SMART 2020 report on our Cool IT Leaderboard[6].

> Consumers and businesses can't manage what they can't measure.
>
> - SMART 2020 Report from the Climate Group

5 http://www.smart2020.org/publications/

6 http://www.greenpeace.org/international/en/campaigns/climate-change/cool-it/leaderboard/

Smart Grid: IT can make the intangibles of our energy use visible through energy tracking and management tools. Behavioural change is one key to unlocking IT's potential, but consumers need access to the right tools. A smart grid allows for real time information to flow between the power generator or utility and the customer. In combination with software like Google's PowerMeter, which translates that data into information that is understandable and educational to the consumer, the smart grid can result in emission savings by helping individuals better manage their energy use.

The power sector was responsible for 26% of global emissions in 2008[7], the largest contributor globally, and could be responsible for 14.26 $GtCO_2e$ in 2020[8], so the potential for IT to reduce power sector emissions through smart grid technology could be substantial – some 2.03 $GtCO_2e$ by 2020. It represents the largest IT opportunity identified in the SMART 2020 study, and cost savings estimates of up to €79bn ($124.6bn).

In addition to helping consumers save energy, the smart grid can support decentralised clean energy production from sources such as solar and wind. As the energy footprint of IT data centres expands, we are urging companies to employ direct on-site renewable energy installation to power more of their operations. The smart system can help companies and individuals that produce their own energy send unused capacity back to the grid, thus helping to power IT operations and offset the burden of its own electricity demand. More cooperation, better data, and greater transparency are needed to fulfill the promised savings of smart grid and metering technologies.

Dematerialisation: Moving bits instead of atoms could reduce emissions significantly, but similar challenges and unknowns exist surrounding technology penetration and development. Telecommuting is, in fact, one of the largest opportunities in this category, but dematerialisation can also be applied to lifestyle activities and help us trade manufactured goods for cloud-based practices.

Digital music: Microsoft and Intel commissioned a report in 2009 to assess the energy and CO_2 performance of downloaded digital music over the electronic purchases of compact discs. While savings are evident, the report underscores the need for a better understanding of more variables and greater consideration of the energy sources behind data storage in each scenario. As society moves to cloud-based information storage, the source of energy matters, and a direct comparison of the options can only be made with more transparency around the carbon footprint of cloud hosting.

Telecommuting: Working remotely could reduce business travel and office building emissions by large percentages, although other emissions will increase as employees come to rely more heavily on their electronics and telecommunication networks to stay in touch. This example stresses the importance of transparency relating to the energy demands associated with telecommuting and a wide array of IT tools, such as teleconferencing. Without that information, which companies are reluctant to share, it is impossible to properly assess the balance sheet.

SMART 2020 identifies how a shift to energy saving IT technologies could produce global reductions of up to 15% by 2020. Realisation of that potential will require better data, greater transparency, bold public policies, incentives and active consumer participation. IT opportunities have great potential, but IT companies must demonstrate that the sources of energy used to power our virtual lives are clean and renewable.

7 http://www.cgdev.org/content/publications/detail/16101/
8 SMART2020

IT's carbon and energy footprint

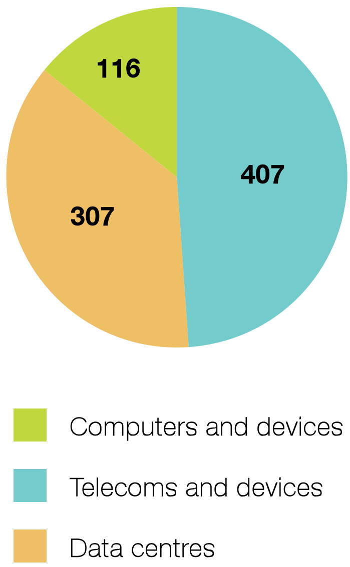
How much energy is required to power the ever-expanding online world? What percentage of global greenhouse gas emissions is attributable to the IT sector? Answers to these questions are very difficult to obtain with any degree of precision, partially due to explosive growth, a wide range of devices and energy sources, and rapidly changing technology and business models.

But a clear lack of transparency from major IT brands is one of the biggest reasons behind this imprecision. Secrecy appears to be fed both by concerns about disclosing competitive (dis)advantage relating to the companies' operations, particularly among data centre operators, and by a desire to muzzle the story of how the IT sector, otherwise perceived as 'clean' by the public and its employees, is reliant upon dirty sources of energy to fuel its growth.

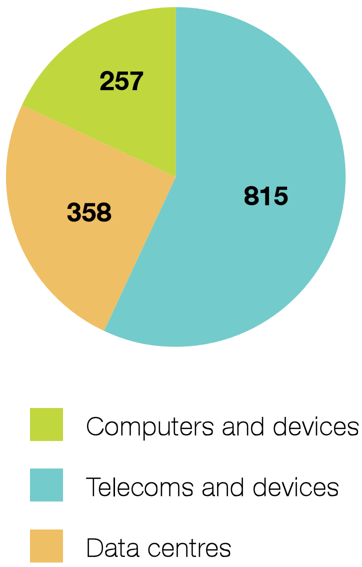
The estimates of the IT sector's carbon footprint performed to date have varied widely in their methodology and scope. One of the most recognised estimates of the IT sector's footprint was conducted as part of the 2008 SMART 2020 study, which established that the sector is responsible for 2% of global GHG emissions. The report outlines three broad areas of greenhouse gas associated with our online and electronic world:

Estimated GHG Emissions of ICT Sector - $MtC0_2e$=Million Tonnes Carbon Dioxide Equivalent

Emissions 2007 ($MtCO_2e$)



Emissions 2020 ($MtCO_2e$)

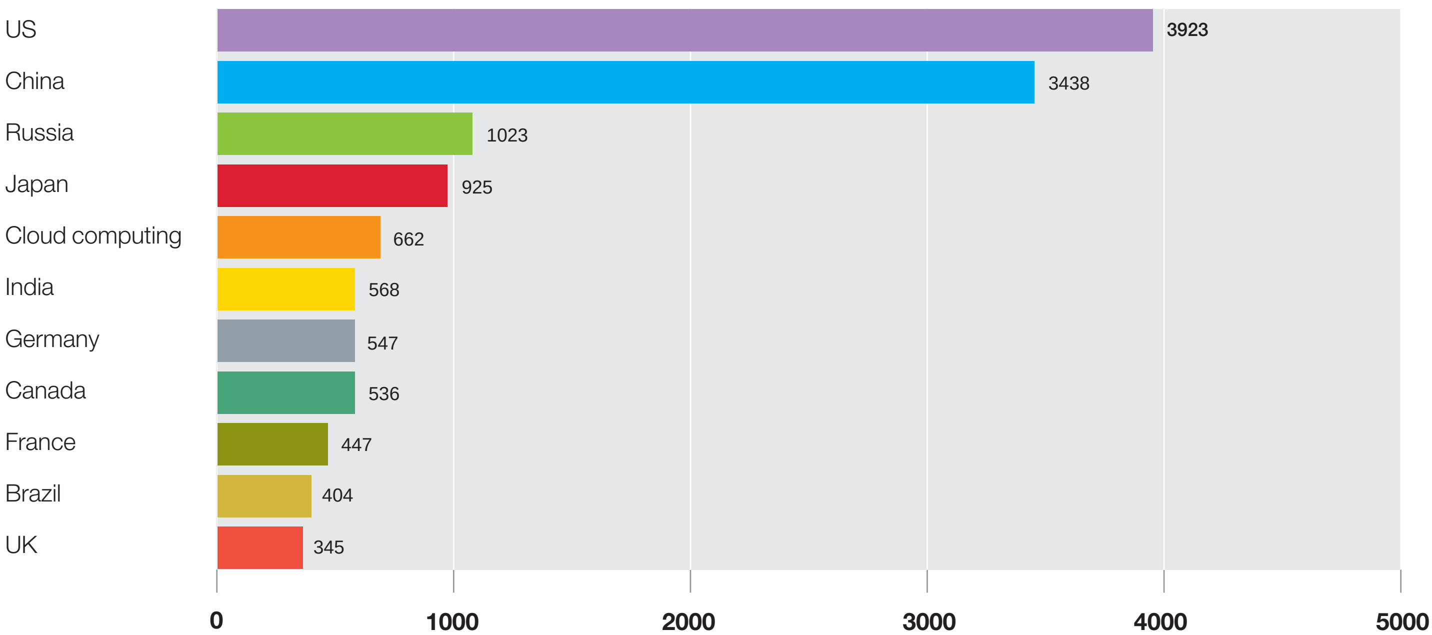


Greenpeace released its own report, *Make IT Green: Cloud Computing and its Contribution to Climate Change*[9] in March of 2010, highlighting the scale of IT's estimated energy consumption, and providing new analysis on the projected growth in energy consumption of the internet and cloud computing for the coming decade, particularly as driven by data centres.

Key findings and outstanding questions from the *Make IT Green* report include:

- The electricity consumption of data centres may be as much as 70% higher than previously predicted.
- The combined electricity demand of the internet/cloud (data centres and telecommunications network) globally is 623bn kWh (and would rank 5th among countries).
- Based on current projections, the demand for electricity will more than triple to 1,973bn kWh, an amount greater than the combined total demands of France, Germany, Canada and Brazil.

2007 electricity consumption. Billion kwH



9 http://www.greenpeace.org/international/en/publications/reports/make-it-green-cloud-computing/

03

IT energy use - growth all around

PC and peripheral electronics devices

The majority of the energy footprint of PCs and equivalent devices is generated by the use phase of the product. Footprint expansion is anticipated as the wealth of developing countries continues to grow, and with it, the use of personal computing devices. Although the iPad has foreshadowed a continued trend toward smaller low-power devices, the relative impact of energy sources in their supply chain footprint will grow significantly.

Some IT manufactures are taking on the challenge of measuring and monitoring the energy and carbon footprint associated with their manufacturing and distribution supply chain, though most are at the very early stages of doing so.

Greenpeace's *Guide to Greener Electronics* has played a catalytic role in evaluating the products and policies of major consumer electronic manufacturers on environmental design and performance. The criteria used in the Guide is being updated to reflect the growing importance of supply chain energy and carbon management, and we will release a new ranking of major consumer electronic manufacturers in late fall 2011.

Telecommunications network and devices

The global telecommunications network has similarly experienced explosive growth, both in terms of number of mobile subscribers and the amount of data that flows through this network to drive the internet. The estimated energy footprint of the network (not including mobile devices) in 2007 was 293bn kWh, larger than the entire electricity demand of Spain (276bn kWh) for the same period.[10]

In the emerging markets of the developing world, mobile telecommunications networks are enabling access to hundreds of millions of new subscribers, leapfrogging the fixed landlines that were unavailable to large segments of the population. However, in countries like India, where the telecom towers extend far beyond the reach of the electric power grid, telecom operators are turning to diesel generators to produce adequate electricity to power the network, which adds a new and heavy source of air and carbon pollution. A 2010 government analysis found that India's greenhouse gas (GHG) emissions rose by 58% between 1994 and 2007, with the energy sector contributing over half of the emissions.[11]

As is most apparent in emerging markets where there is limited reliable grid electricity, there is a tremendous leadership opportunity for the telecom operators to utilise renewable energy sources to power their expansion. But without strong policy intervention and cost incentives for consumers or other types of policy intervention, the opportunity to create a renewably powered telecommunications network may be lost.

Greenpeace will release a special report on leadership and clean energy opportunities for the telecom sector in India and other key emerging markets during 2011.

Data centres

Data centres are nondescript buildings, often out of the public eye, yet increasingly immense in size, and they are the fastest growing source of IT energy use. These buildings house the internet, business and telecommunications systems, and store the bulk of our data. Utility-scale data centres are the size of two to three Walmart stores, and they continue to grow larger in scale and store larger amounts of data, effectively becoming like factories (of information) of the 21st Century, demanding ever-increasing amounts of electricity.

In the US, which hosts approximately 40% of the world's data centre servers, it is estimated that server farms consume close to 3% of the national power supply. Apple's new $1bn US dollar 'iDataCenter' in North Carolina is estimated to require as much 100MW of power, equivalent to about 80,000 US homes or 250,000 EU homes (see box on North Carolina).

Greenpeace's 2010 *Make IT Green* report estimates that the global demand for electricity from data centres was on the order of 330bn kWh in 2007, close to the equivalent of the entire electricity demand of the UK (345bn kWh[12]). This demand is projected to triple or quadruple by 2020.

10 https://www.cia.gov/library/publications/the-world-factbook/rankorder/2042rank.html

11 http://in.ibtimes.com/articles/23248/20100511/industr-transport-drive-leap-in-india-co2-emissions.htm

12 https://www.cia.gov/library/publications/the-world-factbook/rankorder/2042rank.html

India

The Indian telecommunications industry is one of the fastest growing in the world, adding between 8 and 10 million mobile subscribers every month. At current rates of growth, this would translate into 800 million mobile subscribers, the second largest telecom market globally by 2012.

Much of the growth in the Indian telecom sector is from India's rural and semi-urban areas. By 2012, India is likely to have 200 million rural telecom connections at a penetration rate of 25%[13]. Buoyed by the rapid surge in the subscriber base, huge investments are being made into this industry. The booming domestic telecom market has been attracting huge amounts of investment, which is likely to accelerate with the entry of new players and launch of new services, and has attracted 8% of the cumulative foreign direct investment (FDI) over the last two years.

Out of the existing 300,000 mobile towers, over 40% exist in rural and semi-urban areas where either the grid-connected electricity is not available or the electricity supply is irregular[14]. As a result, mobile towers – and, increasingly, grid-connected towers - in these areas rely on diesel generators to power their network operations. The consumption of diesel by the telecom sector currently stands at a staggering 2bn litres annually, second only to the railways in India. This consumption is responsible for 5.2 million tonnes of CO_2 emissions annually and is growing, exceeding 2% of the country's total GHG emissions.

Greening the mobile networks

As much as the mobile telecommunications network is enabling India to leafrog the traditional wired telecommunication network, the Indian telecoms sector must look to solar power to break the telecoms sector's current addiction to diesel, and begin the transition to a clean energy powered telecommunications network.

13 Confederation of Indian Industries and Ernst & Young – "India 2012 : Telecom Growth Continues"

14 http://www.communicationstoday.co.in/oct2007/telecom-towers-a-combination-of-passive-and-active-infrastructure-sharing-seems-to-be-the-way-to-go-2637-41.html

04

Data centres: Information factories of the 21st Century

Data centres, faceless buildings packed with computer servers that dot the modern landscape with ever-increasing enormity, have become the 'information factories' of the digital economy. The investment required to build a modern utility-scale data centre facility is anywhere between $100m and $1bn US dollars, and getting larger all the time. By 2020, it is estimated that the annual investment in data centre construction will soar to over $220bn globally, and $50 billion in the US alone.[15]

Many considerations go into determining where new mega data centres are located, but the primary factors are (1) a reliable and low-cost source of electricity, (2) reliable and adequate capacity in the telecommunications infrastructure to provide a fast connection to customers, and (3) avoiding risk of disruption (earthquakes, floods, tornadoes or civil unrest).

The energy intensity of data centres, which can consume as much power as 40 to 50 thousand average US homes, often dictates that access to a reliable and low-cost supply of electricity is very important, particularly when proximity to users is not a requirement. While IT brands often downplay the significance of energy in their site selection process, evidence of this can certainly be found in Quincy, Washington, which now hosts Yahoo!, Microsoft, Dell and Amazon data facilities. Quincy was not a hub of the IT universe until data centre operators identified and began to tap the low cost hydro-powered electricity supply left behind following the shuttering of the region's aluminum industry.

Similarly, the recent influx of mega utility-scale data centres into western North Carolina (Facebook, Google, Apple) was influenced by the attractive electricity prices offered by local utilities (Duke Energy and Progress Energy), which had extra capacity of dirty coal and nuclear power following the departure of the region's textile and furniture manufacturing. Local tax incentives also attract the attention of IT firms, especially in the US. Hundreds of millions of dollars are dangled by municipalities and states to lure global brands in hopes of (re)building the local economy.

Efficient IT is not necessarily Green IT

The debate over what should be considered 'green' in cloud computing continues to slowly evolve within the IT sector. Until recently, green efforts were almost solely defined by energy efficiency improvements, or decreasing the relative amount of energy consumed for delivery of computing services. Such IT energy efficiency efforts have largely been motivated out of a desire to curb rising energy needs and related costs, and, to some extent, with regard for environmental performance. IT engineers have steadily delivered significant improvements to data centre design, energy efficient software coding, and the energy efficiency of computers, efforts which have produced dramatic improvements in computing power while reducing the amount of equivalent energy use.

A major evolutionary trend in data centre design underway is the utilisation of 'free cooling', or use of outside air instead of energy-intensive chillers to keep the computers from overheating. This shift is already happening amongst most major utility-scale operators, as they have identified the major cost savings that can result from efficient building designs and modular containers. Data centres are increasingly sited in locations where operators can take advantage of cooler climates and rely less on the resource intensive cooling equipment that typically composes at least half of a data centre's energy footprint.

In addition to these operational cost savings, advances in design are helping drive down the construction cost significantly, from an industry average of $15m US dollars per MW of IT energy consumption to $6-8m per MW, with the most recent modular data centre designs by Yahoo! and Microsoft. However, the lowered cost of data centre construction will likely increase the demand for cloud computing services. (See 'Jevons Paradox')

This approach can be understood in part by how the industry has defined the problem: power consumption. Thus the approach has been a strictly technical solution: improve server energy efficiency and reduce waste associated with cooling and other 'non-computing' energy demands. What this approach fails to consider, however, is the kind of energy used to feed consumption.

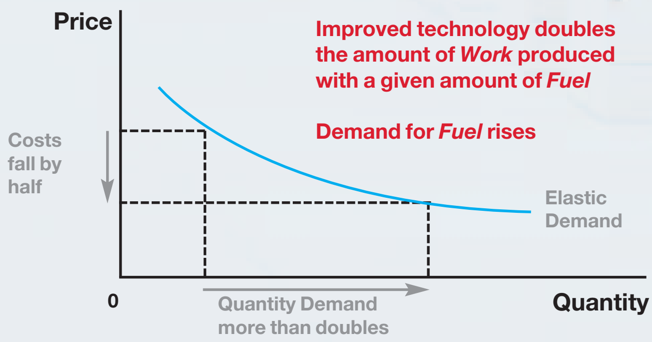
15 Projecting Annual New Data Center Construction Market Size, Christian Belady, Microsoft Global Foundation Services, (March 2011).

Energy efficiency rebound effect – Jevons Paradox[16]

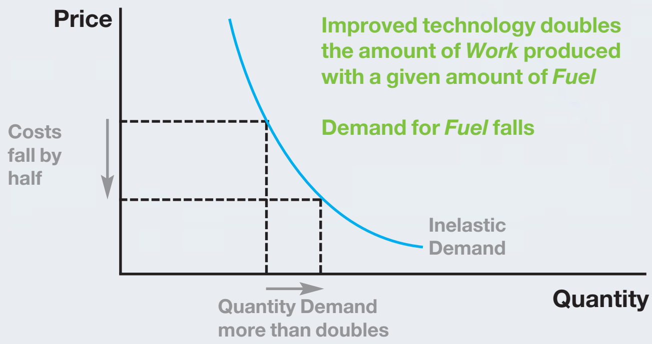
Recently there has been debate over whether improvements in energy efficiency can actually result in greater consumption of resources overall as lower costs enable more demand (more supply at a lower cost). This is known as the Jevons Paradox.

A report by the US EPA in 2007[17] provided some of the most thorough projections of how data centres and computer services will affect US electricity demand. The scenarios assumed that energy efficiency improvements from data centre and server design would be able to flatten, if not bend downward, the electricity demand curve. However, if the tenets of the Jevons Paradox hold true for data centre power consumption, improvements to the energy efficiency and cost of delivering cloud-based computing services could serve to significantly increase data centre power consumption.

Energy innovation continues to occur inside the data centre and computer chassis, but given the scale of predicted growth, the source of electricity must be factored into what is meant by 'green IT'. Energy efficiency alone will, at best, slow the growth of the sector's footprint. Given the potential impacts of the Jevons Paradox, improved IT efficiency will likely increase its environmental footprint even beyond what is currently projected without a shift away from dirty sources of energy.



Elastic Demand for Work: A doubling of fuel efficiency more than doubles work demanded, increasing the amount of fuel used. Jevons Paradox occurs.



Inelastic Demand for Work:A doubling of fuel efficiency does not double work demanded, the amount of fuel used decreases. Jevons Paradox does not occur.

> "We are not going to solve the climate problem via efficiency – we must move to cleaner sources of energy."
>
> Bill Wheil, Google Energy Czar (11 March 2011 - Climate One Forum on Cloud Computing)

16 Belady, C, "Does Efficiency in the Data Center Give Us What We Need?" Mission Critical Magazine (Spring 2008)

17 "Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431", US Environmental Protection Agency (2007)

04

> "Our main goal at Facebook is to help make the world more open and transparent. We believe that if we want to lead the world in this direction, then we must set an example by running our service in this way."
>
> Mark Zuckerberg

Green claims

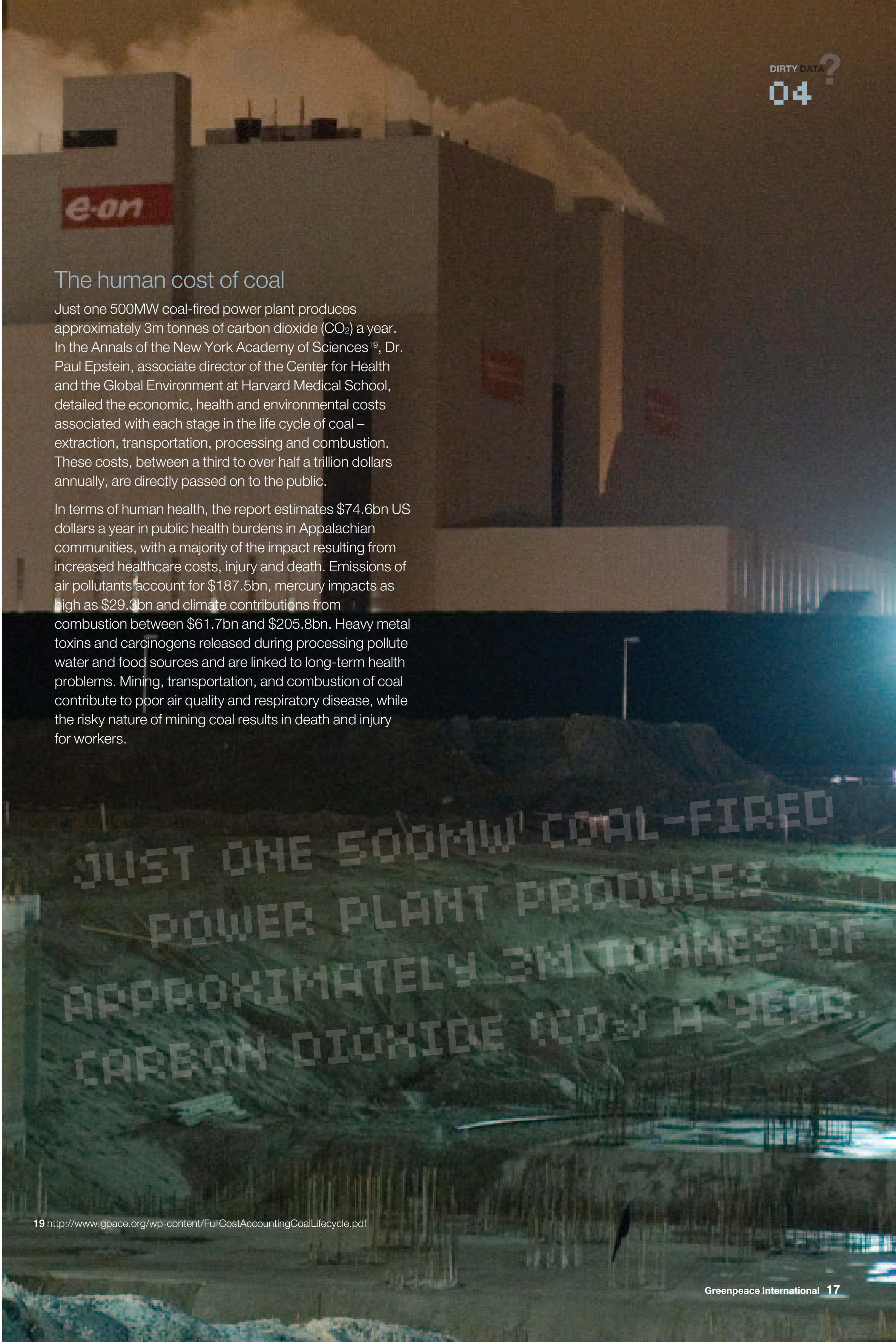
Our ability to measure and compare the environmental performance of data centres has been significantly hindered by the lack of transparency within the sector and the limitations of industry-adopted metrics like PUE & DCiE[18], which speak only to the efficiency of data centre infrastructure relative to energy demand, but not to the overall resource impact or even the amount of energy needed for a particular computing activity.

Metrics like PUE do have value in helping data centre operators benchmark the design and efficiency of their facilities by providing an objective metric that drives efforts to improve facility efficiency. However, many companies are affirmatively using low PUE ratings to communicate externally that their data centres are 'green' and sustainable without accounting for the full environmental picture.

Government institutions like the USEPA and industry associations like the Green Grid (which established PUE) have been largely complicit in this, though recent efforts have been made to develop additional resource-based metrics that speak to the carbon intensity (CUE) and water utilisation (WUE) of a data centre.

Again, much greater transparency is needed from data centre operators on their energy footprint in order to establish meaningful leadership to advance the debate among peers and government regulators and substantiate claims of 'green IT'. That, along with the adoption of clear resource-related metrics that allow customers to identify the environmental performance of their IT vendors and suppliers, will become increasingly important as cloud computing expands.

18 PUE: Power Usage Effectiveness, DCIE: Data Center Infrastructure Efficiency.



The human cost of coal

Just one 500MW coal-fired power plant produces approximately 3m tonnes of carbon dioxide (CO_2) a year. In the Annals of the New York Academy of Sciences[19], Dr. Paul Epstein, associate director of the Center for Health and the Global Environment at Harvard Medical School, detailed the economic, health and environmental costs associated with each stage in the life cycle of coal – extraction, transportation, processing and combustion. These costs, between a third to over half a trillion dollars annually, are directly passed on to the public.

In terms of human health, the report estimates $74.6bn US dollars a year in public health burdens in Appalachian communities, with a majority of the impact resulting from increased healthcare costs, injury and death. Emissions of air pollutants account for $187.5bn, mercury impacts as high as $29.3bn and climate contributions from combustion between $61.7bn and $205.8bn. Heavy metal toxins and carcinogens released during processing pollute water and food sources and are linked to long-term health problems. Mining, transportation, and combustion of coal contribute to poor air quality and respiratory disease, while the risky nature of mining coal results in death and injury for workers.

JUST ONE 500MW COAL-FIRED POWER PLANT PRODUCES APPROXIMATELY 3M TONNES OF CARBON DIOXIDE (CO_2) A YEAR.

19 http://www.gpace.org/wp-content/FullCostAccountingCoalLifecycle.pdf

04

Location Choice = Energy Choice

> "The great thing about a data centre is that they run full-out, 24-7, with no shifts and no seasonality … It's the type of customer where the meter spins and spins at an exponential pace. It may be the most ideal customer we could have."
>
> **- Clark Gillespy, vice president of Economic Development, Business Development and Territorial Strategies for Duke Energy Carolinas.**[27]

The current and projected supply of clean electricity varies significantly between nations and regions, and growth is largely determined by the energy and investment policies in those places.

For the global data centre operator that has a range of options to choose from, location is the single biggest determinant of whether clean or dirty energy will be used to power their data centre. Global brands should use their buying power to drive utilities and governments toward the development of cleaner generation mixes by voting accordingly within their site selection region.

Unfortunately, as we have seen with global IT companies who have located data centres in North Carolina (see 'North Carolina' box), the short-term lure of low-cost dirty energy and tax incentives has often been too much to resist. Though many IT brands claim to include sustainability criteria in their site selection process, for most it appears to be far down the list of factors that lead to the ultimate decision on where to invest.

There are increasingly signs that companies recognise a highly-efficient data centre as only the beginning, and they are paying increasing attention to the goal of access to a cost-effective and reliable clean electricity with pathways to increase it over time. Given the rapid growth of electricity consumption, it is imperative that IT companies use their market power to make clean and reliable supply more available in addition to their advances in computing efficiency. IT can help drive clean energy supply across the regions in which it operates.

In order to ensure that the supply of clean energy can keep pace with IT's demand, companies need to make a corporate commitment to engage in energy policy decisions in regions where they establish operations. As large commercial consumers of electricity, IT companies have standing with utilities and policy-makers to influence an acceleration of the investment and deployment of the clean electricity supplies that will enable these factories to operate on 100% renewable energy. Key opportunities and challenges that IT brands should seek to collaborate with governments and utilities on include:

- Adoption of clean energy investment incentives specific to the IT sector for energy efficiency and renewable energy deployment.
- Development of cost-effective, regionally compatible sources of renewable power generation for data centres (such as solar, wind, tidal and wave power).
- Additional investments toward the development and deployment of grid infrastructure and energy storage technology to enable much higher utilisation of variable energy sources, such as wind and solar.

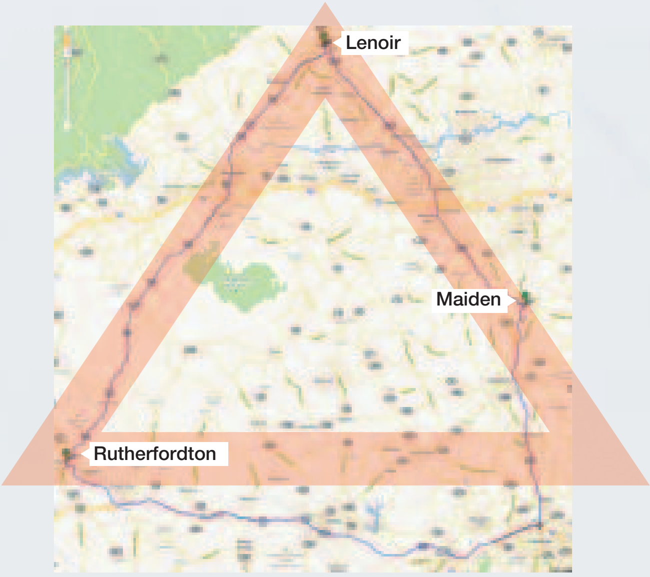
North Carolina's dirty data triangle: Facebook, Google and Apple

While there are a number of emerging data centre hot spots around the world, the mega data centre projects are in rural North Carolina in the US, and they include three of the biggest global brands breaking ground on super-size data centres within an approximate 30 mile (50km) radius. This example is perhaps the most instructive of what needs to change in the race to build the cloud. These mega data centres, which will draw from some of the dirtiest generation mixes in the US, highlights the sway of low-cost energy, misplaced tax incentives, and a corresponding lack of commitment to clean energy.

Google, Lenoir/Caldwell County, North Carolina: Google was one of the first global brands to site in the region, announcing construction of a $600m US dollar data centre in Lenoir in 2007. It is in the process of bringing the second phase of its facility on line to a total of 470,000 sq ft. The power consumption for the Google facility is not public, but is estimated to be between 60 and100MW, based on the size and reported cost of the facility.

Apple, Maiden, North Carolina: Apple is nearing completion of one of the largest data centres in the world, dubbed the 'iDataCentre' by the media. It invested $1bn into the facility, which exceeds 500,000 sq ft and requires an estimated power range of 100MW.

Facebook, Forest City, North Carolina: Facebook recently began construction on its second data centre in North Carolina, a $450m, 300,000 sq ft facility just outside of Forest City, which has an estimated power demand of 40MW.



There are two key attractions that are driving data centres to North Carolina:

1. Low-cost power and utility recruitment

Facing high unemployment (15%) following the decline of the furniture and textile industries, North Carolina's economic development agencies have recruited the IT sector heavily to place data centres there[20], seeking to become the 'next Quincy', with websites dedicated to facilitating site selection in the region.[21]

Duke Energy, the primary utility for this part of North Carolina, also put effort into recruiting Google, Apple and Facebook to the region. Data centre operators are some of the most coveted customers for utilities, and utilities typically play a big role in their recruitment, offering discounted electricity rates for larger customers.

The price of electricity for select industrial customers of Duke Energy has been reported at 4 to 5 cents (.03-.04 euro) a kilowatt-hour[22], much lower than in most parts of the US. Unfortunately, the generation mix in North Carolina is one of the dirtiest in the country, with only 4% of electricity generation from renewable sources and the balance from coal (61%) and nuclear (30.8%).[23]

2. Tax incentives

- **Apple:** North Carolina's legislature approved $46m in tax breaks, and local governments slashed Apple's real estate and personal property taxes by 50% and 85% respectively[24].
- **Google:** North Carolina put together a package of tax breaks, infrastructure upgrades, and other incentives, valued at $212m over 30 years[25].
- **Facebook:** The exact structure of tax incentives has not been disclosed, but the company is reported to have received a package similar to that of Google and Apple, with $17m in local subsidies and tax breaks over 10 years. Facebook will be exempt from paying state taxes on all equipment, electricity and construction materials for the data centres.

20 http://www.siteselection.com/features/2009/sep/North-Carolina/
21 http://www.datacentersites.com/
22 http://datacentersites.com/Data%20Center%20Marketing%202010.pdf
23 Climate Analysis Indicators Tool (CAIT US) Version 4.0. (Washington, DC: World Resources Institute, 2011).
24 http://www.catawbacountync.gov/commish/Minutes/070609spec.pdf
25 http://www.businessweek.com/magazine/content/07_30/b4043066.htm
26 http://www.considerthecarolinas.com/pdfs/ctc-apple-duke.pdf

05

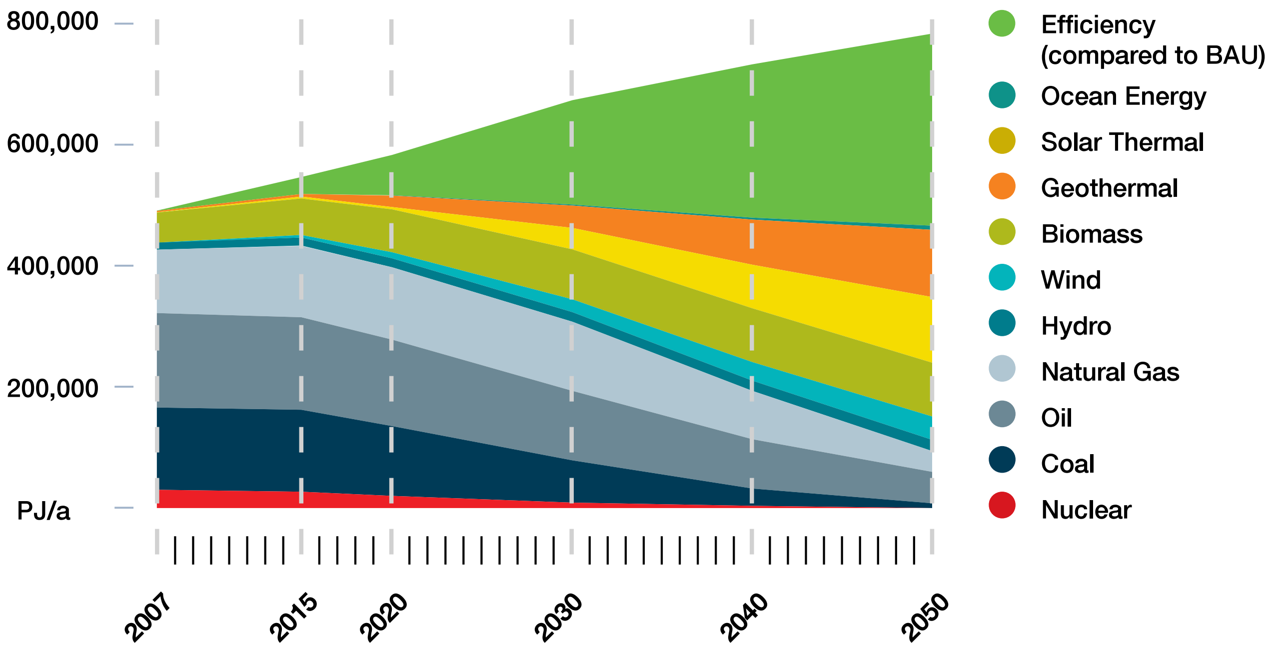
Getting renewable energy right

Greenpeace advocates for the global deployment of clean and sustainable renewable energy to replace existing hazardous and dirty fuels and meet the rapidly growing global demand for energy. In 2010 we published *Energy [R]evolution*[27], a practical blueprint for the world's renewable energy future, which was developed in conjunction with specialists from the European Renewable Energy Council (EREC) and the Institute of Technical Thermodynamics at the German Aerospace Centre (DLR), along with more than 30 scientists and engineers from around the world.

Energy [R]evolution demonstrates a pathway for the world to phase out fossil fuels and reduce CO_2 emissions, while ensuring energy security, but not all replacement power sources are created equal. Below is a list of those sources that can help the IT industry, and the rest of the world, trade in dirty energy for safe, renewable electricity.

Development of primary energy consumption under the three scenarios

('Efficiency' = Reduction compared to the reference scenario)



Source: Energy [R]evolution Fig 6.11, p.72

27 http://www.energyblueprint.info/

Wind power: large-scale development of onshore and offshore wind power, though special attention should be given to minimising the impact on wildlife and biodiversity;

Solar energy: large-scale development of thermal solar energy and solar power for electricity production through photovoltaics and concentrating;

Hydropower: dams built according to the criteria of the World Commission on Dams;

Bioenergy: use of biomass for electricity production and biofuels for transport that meet sustainability criteria (environmentally and socially responsible production, does not cause direct or indirect land-use changes, and does not threaten food security), and result in actual greenhouse gas emissions reductions. Greenpeace does not support the use of non-organic waste or co-firing of biomass in coal-fired power stations;

Geothermal power: Greenpeace supports the development of geothermal power;

Marine/Oceans power: wave, current and tidal power with thorough environmental impact assessment and strict criteria to minimise the environmental impact of tidal power.

There are a number of so-called 'clean' alternatives that fail to safely or reliably reduce carbon emissions. Given the questionable effectiveness of Carbon Capture and Storage (CCS), for example, as well as potential liability and uncertainty surrounding its ability to regulate its safety and environmental impacts, the application of CCS to coal-fired power stations should not be considered as a means of meeting infrastructural electricity demands. A full Greenpeace analysis of CCS can be found in our 2008 report, *False Hope: Why Carbon Capture and Storage Won't Save the Climate*[28].

Nuclear power

Greenpeace has always vigorously opposed investment in nuclear power because of its unacceptable risk to the environment and human health, which we have unfortunately been reminded of by the crisis in Japan. Greenpeace is advocating for a halt to the expansion of all nuclear power, and for the shutdown of existing plants.

Key concerns:

- Nuclear energy is an expensive diversion from the development and deployment of renewable energy, energy efficiency, and decentralised energy systems required for a low carbon future.
- We can reduce carbon emissions much more cheaply and effectively using renewable energy and energy efficiency measures.
- No proven long-term solution exists for dealing with radioactive waste.
- Expanding nuclear power internationally would hugely increase the risk of terrorism and nuclear weapons proliferation.
- Nuclear power plants cannot be built a timeframe necessary to make even the smallest difference in combating climate change.

Data centres powered by nukes:

- Microsoft's Chicago Data Centre

- Facebook Forest City

28 Emily Rochon, Greenpeace International, 5 May 2008. http://www.greenpeace.org/australia/resources/reports/climate-change/false-hope-why-carbon-capture

Where to find renewable cloud power

In Iowa, Google has signed a 20-year power purchasing agreement with a wind energy company, though the clean electricity that will be generated there is not yet linked to a specific facility. Google has pledged to retire the renewable energy credits earned by the agreement. Microsoft also recently announced an agreement to buy wind energy for its Dublin data centre.

i/o Data Centers is installing a massive solar array on top of its new 580,000 sq ft facility in Phoenix, with 5,000 panels that will generate a total 4.5MW at peak capacity. Though just a fraction of the facility's total 80MW capacity, the solar panels will be married with thermal storage technology that will reduce the energy drain of cooling during the heat of the day. The solar had outsized impact on cost, as it provides on-site generation when grid energy is most expensive.[29]

Next Generation Data (NGD) in Newport, Wales, claims to be 100% renewably powered through its purchasing agreement with SmartestEnergy, the UK's largest purchaser of electricity from independent generators of renewable energy. The SmartestEnergy website indicates that customers can choose the proportion and mix of renewables, including wind, hydro and biomass, but NGD does not disclose its specific choices or quantities[30].

In Iceland, GreenQloud is powered 100% by geothermal and hydropower energy, delivering hosting and storage services. The Star Peak Energy Center[31], though still in concept phase, is also pushing a vision of renewably powered data. The company plans to generate geothermal power and attract data centre operators to locate their facilities at its site and purchase Star Peak's renewable energy.

29 http://www.datacenterknowledge.com/archives/2009/06/16/solar-power-at-data-center-scale/

30 http://www.smartestenergy.com/Business-Electricity/Renewable-Energy/Business-Renewable-Energy.aspx

31 http://www.starpeakenergy.com/

Country/Region	Dirty Energy Mix (2007)	2008 Renewable Energy %	2020 Renewable Energy Target (a)
EU			
Denmark	48% Coal	26.1	51.9%
Finland	46.6% Coal/Peat	27.2	33%
France	76.5% Nuclear, 4.7% Coal	14.4	27%
Germany	46.6% Coal, 23.3% Nuclear	14%	38.6%
Ireland	27% Coal	11.2%	42.5%
Italy	15% Coal, 9% Oil	16.6%	26.4%
Netherlands	24.9% Coal, 3.9% Nuclear	7.5%	37%
Poland	91.8% Coal	4.3%	19.4%
Portugal	24.5% Coal, 9% Oil	33.3%	55.3%
Spain	18.8% Nuclear, 15.9% Coal	23.3%	40%
Sweden	42.3% Nuclear, 1.5% Coal	53.6%	62.9%
UK	32.5% Coal, 13.5% Nuclear	5.4%	31%
India	68.6% Coal, 4.1% Oil, 1.8% Nuclear	15.4%	N/A
US			
California (Santa Clara)	25% Coal, 2% Nuclear	43.6%	33% (b)
California (San Jose)	20% Nuclear, 8% Coal	27% (c)	33% (d)
Colorado	66.7% Coal	5%	30%
Georgia	62.3% Coal, 22.4% Nuclear	3.6%	None
Illinois	47.6% Coal, 47.8% Nuclear	1%	17.5%
North Carolina	61.5% Coal, 30.8% Nuclear	3.6%	12.5% (2021)
Oregon	8% Coal	65% (e)	25% (2025) (f)
South Carolina	51.5% Nuclear, 40% Coal	2%	None
Virginia	45% Coal, 34.6% Nuclear	1%	12% (2022)
Washington	8% Coal, 7.6% Nuclear	77% (g)	15% (h)

(a) Taken from National Renewable Energy Action Plan (NREAP)

(b) Target does not include large hydroelectric power, currently 13%

(c) (16% hydroelectric, 14% other renewable energy (see: http://www.pge.com/mybusiness/edusafety/systemworks/electric/energy mix/index.shtml)

(d) Does not include large hydroelectric power, currently 13%

(e) Without large hydroelectric power, renewable electricity is currently approximately 4%

(f) Target does not include large hydroelectric power

(g) Renewable percentage without hydroelectric power is 8.3%

(h) Target does not include large hydroelectric power

Transparency and reporting

There is currently a double standard in the IT sector when it comes to transparency. IT companies want consumers to trust them with greater and greater access to their personal information, but are unwilling to be transparent about their own energy and carbon footprint. As large purchasers of electricity with rapidly increasing energy demands driven by the accelerated growth of the sector, companies must make transparency a tenet of their operations and come clean about their energy use and greenhouse gas emissions.

The IT sector often talks about the economy-wide energy savings that can be unlocked when their technologies are used to provide information to electricity customers. Energy measurement and management is enabled by IT software that relies on the disclosure of consumer data by utility companies. The purpose of these energy management tools is to make that data meaningful to electricity users, and ultimately help them reduce their usage by allowing them to understand and visualise it better.

When companies refuse to disclose their own energy footprint or the sources of energy used to supply their platforms, we are left in the dark with regard to the net impact that cloud computing has on carbon, and thus our own use related emissions. The energy consumption and performance data of IT data centre operations is particularly opaque. Most companies justify their lack of transparency by asserting such information is a trade secret that will be used by competitors.

The sector has preferred to emphasise progress made in energy efficient design and performance, although some companies have adopted overall greenhouse gas reduction targets and report on their progress through frameworks like the Carbon Disclosure Project.

At the facility level, there is a disproportionate focus on energy efficiency metrics over carbon footprint and energy sources. Power Usage Effectiveness (PUE), a broad efficiency metric for comparing total power consumption to computing power consumption, does not provide an indication of the type of energy used, nor does it measure emissions. A newly proposed metric, Carbon Usage Effectiveness (CUE)[32], if broadly adopted, would be a welcomed shift toward greater transparency and provide some basis of comparison of the carbon footprint of existing or planned data centres.

Just as we need to leverage IT energy solutions to help better manage our non-IT energy use, cloud consumers need information from the companies that manage their data in the cloud about the environmental and energy footprint of that data. IT energy transparency and reporting should include:

- Annual reporting of GHG footprint and energy consumption on a corporate level (via CSR report or through the Carbon Disclosure Project);
- Reporting of facility-level energy mix, including emissions factors or renewable energy percentage; and
- Disclosure of performance-based metrics, such as disclosure of the carbon intensity of IT service per unit of data (see Akamai), along with facility level CUE and PUE.

IBM, Cisco and Wipro have demonstrated greater transparency than other companies in the sector with no negative commercial effect. IT companies with growing digital networks should follow the lead of their peers. Broader adoption of standard reporting metrics will increase environmental performance and raise the bar for the sector overall.

32 http://www.thegreengrid.org/en/Global/Content/white-papers/Carbon_Usage_Effectiveness_White_Paper

Infrastructure siting policy

Many factors go into choosing a location for new IT infrastructure. Data centre siting requires the availability of reliable and low-cost electricity, as well as telecommunications infrastructure. Tax incentives, climate, and proximity to end-user may entice a company to choose a particular location. Availability of renewable energy to power the data centre, while possibly considered, is currently low on most cloud companies' lists. As these data centres continue to multiply and increase their electricity consumption, the clean energy source must be prioritised.

A cloud infrastructure siting policy that institutionalises a preference for clean energy will help companies avoid investments that drive demand for dirty energy and increase greenhouse gas emissions. Failure to address the issue of the source of power is a failure of leadership, and may create greater long-term costs for companies as high-carbon energy becomes increasingly expensive or politically penalised.

A strong siting policy for data centre operators would include:

- Preferential treatment for renewable energy, and away from coal and nuclear power.
- Indicative supporting mechanisms, such as a carbon shadow price or electricity performance standard for Power Purchase Agreements (PPAs) or utility grid mix (current and prospective over expected use of facility).
- Energy procurement standard for co-location and rented facilities.

While a number of companies list renewables energy supply as a consideration, there are relatively few companies that clearly make it an investment priority. Yahoo! set a goal to reduce the carbon intensity of its data centres 40% by 2014 through efficient design and by locating new facilities near renewable energy sources.[34] Google employs a carbon shadow price when purchasing electricity to discriminate against coal and incentivise cleaner energy choices. At the same time, Google is utterly non-transparent when it comes to reporting its emissions and total energy use, or even the locations of its data centres, which obfuscates the company's ability to show that it is meeting its commitment and renewable energy preferences are having a positive net impact.

Mitigation

A company that truly takes responsibility for its energy use and associated greenhouse gas emissions will demonstrate a comprehensive mitigation plan, which includes the direct purchase or installation of renewable energy to power its infrastructure in addition to avoided emissions through energy efficiency. This plan should establish an ambitious GHG reduction target or a renewable energy goal with a clear timeline and roadmap of the mitigation strategies that will be used to meet it.

A comprehensive mitigation strategy must address the source of energy as well as energy saved through procurement or direct installation of renewable. Potential elements of mitigation strategy for IT Infrastructure include:

- Improvements in energy efficiency.
- Direct installation of clean energy technologies.
- Investment or power purchase agreement with clean energy developer
- Investment in local energy efficiency offsets to reduce demand on load centre
- Grid mix of renewable energy.
- Utilisation Green-E Tariff offered by utility.
- Limited RECs (limited reliance on RECs if part of early implementation)

IT's growing carbon footprint can be blamed on the lack of a comprehensive plan to end its reliance on electricity from dirty sources of energy. The sector has the ability to change the rules of the game by helping to bring more renewable energy online through purchase power, investment and advocacy, but few companies have demonstrated the bold leadership necessary to ensure that IT's rampant growth will be sustained by clean energy sources.

33 http://forgood.yahoo.com/go_green/doing_our_part/data_center_efficiency.html

05

Mitigation Strategies

Energy Efficiency

The greatest efforts to reduce the footprint of the IT industry have involved energy efficiency measures. Most IT companies now acknowledge the substantial economic benefits of using less energy. Energy efficiency provides a beneficial, near-term return on investment, which is why many IT companies have chosen this path over bolder carbon mitigation strategies.

Companies have approached energy efficiency in a variety of ways, but particularly through data centre design improvements. The Department of Energy awarded $47m US dollars in grants to IT companies in January 2010[34] to fund energy efficiency projects. HP got $7.4m for a data centre design with distributed energy systems, and Yahoo was granted $9.9m to design a chicken-coop-inspired data centre with passive cooling.

While many IT companies are trying to decrease the energy demands of the data centre itself, Google has also focused on building its more energy-efficient web servers. Microsoft has come up with software coding techniques that help the IT sector do what it does best, but more efficiently.

Clean energy direct installation / Self-generation

Some IT companies have installed renewable energy on site to generate power for their own operations, an increasingly positive sign that they are beginning to take direct responsibility for the energy sources used to power their infrastructure. Though it may be difficult technically or economically to power a large data centre completely with on-site renewables, companies that make these investments have better protection against electricity price volatility and are increasing their energy security in addition to doing what is right for the environment.

"Large-scale customers face a critical need to reduce substantially the power costs and carbon footprints of data centres. Verne Global is breaking new ground in using Iceland's natural green resources to mitigate both increasing emissions and rising energy costs."

Dominic Ward from the Wellcome Trust's Investments Division.

In 2006, Google installed what was then the largest solar installation in the country (1.6MW) on its Googleplex headquarters in Mountain View, California. Three years later, an installation by i/o Data Centers in Phoenix topped Google's effort with solar to supplement an immense data centre's energy needs (4.5MW)[35].

Direct purchase of renewable electricity

Clean energy procurement is dependent upon the location of the data centre and its proximity to renewable energy generation capacity, which is further justification for a strong infrastructure siting policy. Strategic infrastructure siting allows IT companies to buy clean energy directly from the utility or other provider through power purchase agreements in which renewable energy is generated and fed to the grid load centre where IT infrastructure is at the point of consumption.

Notable examples include:

- Microsoft, Yahoo! and Google have located data centres in Oregon and Washington to take advantage of the region's hydroelectric capacity, of which there was a surplus left by now-defunct industries, such as aluminium production.
- In Wyoming, Green House Data offers cloud-hosting services in the largest wind-powered data centre in the US, buying electricity from a utility that has partnered with a 30MW wind generation site in Cheyenne.
- Microsoft recently announced a contract to buy wind power for its 22.2MW capacity data centre in Dublin[36].
- Iceland is becoming an increasingly popular place for data centre developers to take advantage of geothermal energy. Verne Holdings built a 44-acre data centre there last year. The company's investors have not underplayed the significance of choosing Iceland's clean energy resources in order to minimise the centre's carbon footprint.

Last year, Google created a subsidiary, Google Energy, which allows it to directly buy and sell federally regulated wholesale electricity. This move offers Google greater flexibility, allowing the company to bypass the local utility and purchase directly from independent power producers for its huge power needs. Then it can sell any excess back to the grid. Google entered into a 20-year contract with a wind company in Iowa, locking in rate for power from NextEra Energy Resources, which is perhaps the best example of an IT company directly purchasing renewable energy from a provider that has enough capacity (114MW) to power its massive data centres.[37]

34 http://www.environmentalleader.com/2010/01/07/hp-ibm-yahoo-share-in-it-energy-efficiency-windfall/

35 http://www.datacenterknowledge.com/archives/2009/06/16/solar-power-at-data-center-scale/

36 http://www.datacenterdynamics.com/focus/archive/2011/02/microsoft-gets-wind-power-for-dublin-data-center

37 http://www.google.com/intl/en/corporate/green/114megawatt.html

IT companies that primarily lease data centre space, and thus are not directly involved in the selection of electricity supply, have different options for pursuing cleaner sources of electricity. Companies could establish a carbon-based procurement standard that sets a minimum carbon performance threshold at a level that would largely eliminate reliance on electricity generated by coal. There is at least one major data centre operator in California, Fortune, which has been granted the ability to give tenants of its new San Jose facility license to choose their energy supply, including sources that are higher in renewable energy content than the surrounding grid[38]. Facebook is reported to be one of two major tenants at this facility.

Direct clean energy investment vs. RECs

While renewable energy and energy efficient technologies continue to develop and grow, there are still significant gaps in the private sector financing needed to deploy them at scale across many markets. IT companies such as Google and Intel have demonstrated increasing interest in making direct clean energy investments, rather than purchase offsets or RECs to manage their emissions footprint. In other words, these companies can invest much-needed capital into the development and deployment of renewable energy instead of 'renting' the clean attributes of renewables generated by others.

Funding negawatts?

As a complimentary strategy to direct installation of renewable energy at new or existing data sites, IT companies could also explore opportunities to provide capital to help reduce electricity demand in the surrounding community. This approach could spur deep cuts in the existing baseload and peak electricity demand to help stop new IT power demand on the grid from driving demand for dirty energy. Companies should consider investing in local government or state-sanctioned programmes (such as a revolving loan programme that drives down the cost and speed of housing and building retrofits). Participation in a clean energy negawatt investment plan has not been demonstrated by any IT company to date, but could prove to be highly transformative to the community that hosts the data centre or other IT infrastructure.

38 http://www.datacenterknowledge.com/archives/2010/10/26/fortune-data-centers-adds-power-choice/

Renewable energy credits

Companies often indirectly purchase renewable energy through the sale of green tags or RECs, which typically means that the customer agrees to pay the local utility or a renewable energy developer a premium for the renewable 'commodity' associated with renewable electricity production, while the actual electricity generated is not in close proximity to the purchaser of the Green Tags or RECs.

The indirect approach to renewable energy procurement raises concerns about whether its premium cost actually leads to investment in additional renewable energy, or simply increases the profit margin for energy traders. It does not guarantee that the increased electricity use for which the REC is purchased cancels out demand for dirty coal-fired electricity locally (e.g. wind tags from Iowa for a facility in North Carolina do not supplant the burning of additional coal in North Carolina). RECs alone do not suffice as a mitigation strategy. Companies that buy them should only do so as a transitional strategy while integrating more meaningful greenhouse gas mitigation measures.

IT advocates needed

The sector can hasten the development and deployment of clean energy, broadening its opportunities for mitigation and ensuring more sustainable cloud growth, by advocating for strong climate and energy policies. Standards, incentives, and financing mechanisms are needed to bring clean energy to a scale that will be necessary to power the cloud cleanly.

Rather than argue that they are helpless to change the grid mix or impact the energy provider's energy choices, IT companies can help bring renewable energy and energy efficiency to scale by throwing their political weight behind:

- Renewable Energy and Energy Efficiency Standards at a national, state or regional level where they have operations or co-location facilities.
- Investment incentives for data centres and internet infrastructure to be powered by renewable energy.
- Regulatory intervention to reduce utilisation of dirty energy in grid mix (e.g.: IRP).
- Mechanisms to drive distributed renewable energy generation (PACE, FIT, etc.) and clean energy storage.
- Increased R&D and deployment funding of clean energy generation and storage technologies.

The IT sector needs to unite behind a policy advocacy platform that pushes the discourse and development of clean energy. While some companies are wading in the policy arena, a clean energy transformation requires much bolder leadership and cooperation.

Appendix I: Cloud energy report card methodology

Clean Energy Index methodology (Column 2)

Greenpeace has established the Clean Energy Index as a response to the lack of useful metrics and publicly available data to evaluate and compare the energy related footprint of major cloud providers and their respective data centres.

This lack of data is not due to the fact that data does not exist, but instead it is related to the industry's unwillingness to provide even the most basic information about both the amount and source of its growing electricity consumption. Despite a proliferation of metrics created by the industry (e.g.: PUE, DCIE, CADE, DH-UE, SI-POM) that attempt to measure how 'green' a data centre as measured by energy efficiency, none of the current metrics shed any light on the basic question: How much dirty energy is being used, and which companies are choosing clean energy to power the cloud?

The Clean Energy Index attempts to provide a basic answer to this question, based on what can be gleaned from the limited information available, focusing on recent investments of select brands and current clean energy supply associated with each investment.

Starting with an initial set of some of the largest cloud providers, Greenpeace has attempted to identify two main inputs from a representative sample of their most recent (five years or less) infrastructure investments. Those inputs are:

(1) Estimated size of electricity demand of each facility (in megawatts);

(2) Amount of renewable electricity being used to power it (in % terms).

This information is then used to approximate, initially on a facility level, the number of megawatts of clean energy being used. Having calculated a facility-level Clean Energy Intensity for a representative sample of data centres, a company average of clean energy utilised is derived.

In compiling the information included in this report, Greenpeace contacted all companies featured here and asked for information regarding their data center facilities, and for information on their Infrastructure Siting and Mitigation Efforts. Estimates of data center power demand were made available to companies for comment in advance of publication, and where issues were raised, those are highlighted in footnotes on the scorecard on page 7.

The above inputs are from the following sources:

- Submissions by companies directly to Greenpeace.
- As defined by company when announcing investment.
- As reported by the media (in stories on the investment or construction of facility, etc).
- For electricity demand, derived by taking the announced size of investment and deriving total number of MW using industry average cost per IT load ($15m US dollars per MW) multiplied by publicly available PUE for facility or, if not available, 1.5 for new facilities.
- If not announced by the company, renewable electricity percentage, is taken from one of the following sources, as available, in declining order of preference:
- The most recent published generation mix of the local utility
- In the US: 2007 eGrid State level generation mix as reported by US EPA, or if not applicable, reported subregional egrid generation mix.
- Outside the US, the European Commission and International Energy Agency 2008/09 Statistics.

Important Note: *This analysis does not attempt to represent itself as a comprehensive snapshot of how much clean energy is being consumed on a company-wide level. Only the companies can properly provide that.*

Greenpeace would welcome the opportunity to incorporate more detailed data to inform our analysis, as that would likely provide a more complete and refined picture of cloud providers and their relevant context regarding their choices of dirty or clean energy. As companies provide better data, Greenpeace will certainly incorporate this into our evaluation and encourage other companies to follow.

Coal Intensity (Column 3)

A company's coal intensity is a simple calculation of the approximate total percentage of coal generated electricity powering the company's data centres. This is calculated initially on a facility level, based on the estimated maximum power demand of the facility and the percentage of coal-generated electricity supplied by the contacting utility or the local grid.

The company-level coal intensity is rendered by adding the total MW of estimated maximum power from coal generation across the sample data centre fleet, divided by the total estimated MW maximum power demand of the same sample data centres.

Energy transparency methodology (Column 4)

Companies are evaluated on the scope and level of detail made publicly available on energy consumption of IT infrastructure that allow stakeholders and customers to evaluate the energy related environmental performance and impact at corporate, product and facility level. Public information includes information from a company's website, annual reports, submissions to regulatory agencies or information clearinghouses such as the Carbon Disclosure Project.

- For corporate and facility-level reporting, key elements of information include: location and size of facilities; size of electricity demand; generation mix and associated carbon content (including and power purchase agreements specific to the facility) and carbon intensity of date delivery and storage. Reporting should include both owned and rented facilities.
- For customer level reporting, companies should provide regular energy and carbon footprint information (pre-offset) associated with the customers' consumption, reported in manner consistent with established reporting protocols.

Infrastructure siting methodology (Column 5)

Companies are assessed on the strength of infrastructure siting criteria and investment decisions that enable the development of the company's IT infrastructure to maximise the use of clean sources of energy, and avoid an increase in demand for coal or nuclear power to meet their growing demand for electricity from their operations. High scoring companies demonstrate:

- A clean energy siting policy to prioritise IT infrastructure investments or procurements that rely primarily upon renewable energy as a source of electricity and discriminate against coal and nuclear power to meet infrastructure electricity demand.
- Consistent pattern of major infrastructure investment decisions that increase or shift electricity demand to renewable sources of electricity.
- Commitment to eliminate coal and nuclear energy from powering company infrastructure.

Mitigation strategy methodology (Column 6)

Companies are evaluated on the strength of their strategies and measurable progress to mitigate the demand for dirty energy generated by their IT infrastructure. The effectiveness and strength of a company's mitigation strategy is measured along the following guidelines:

- Companies with absolute emission reduction goals will be rated higher than those companies who adopt an intensity-based target.
- Efforts to meet electricity demand with the direct installation of renewable energy, and reduce emissions through higher efficiency will receive highest marks.
- Investment in clean energy supply and local energy efficiency mechanisms will be rated higher that the purchase of offsets and renewable energy credits to reach established environmental goals.

A1

Cloud Energy Report Card: letter grades explained

Akamai

Akamai is a global content distribution network (CDN) for the internet. Though not exactly a household name, Akamai is one of the major players in online content delivery. Akamai delivers between 15% and 30% of internet traffic through a distributed network of over 84,000 servers in 72 countries on behalf of the biggest brand names on the planet, including many in this report (Apple, IBM, Yahoo! and Greenpeace)[39].

Energy transparency: B

Akamai's reporting of its carbon intensity merits recognition in two key areas: (1) Akamai reports its cloud related emissions using a metric that allows some comparability with other cloud content providers - CO_2 per megabytes of data delivered.[40] (2) Akamai is in the early stages of making available to its customers a monthly carbon footprint associated with content delivery through the Akamai network servers. By providing customers with this information, Akamai is enabling better awareness of energy and carbon management associated with data consumption, which will hopefully trigger additional reporting and competition for environmental performance. Akamai does participate in the Carbon Disclosure Project[41] voluntary reporting programme.

Infrastructure siting: D

Akamai's business model is based on renting server space on a highly distributed basis, providing different opportunities to influence site location and energy, which is different than other cloud companies focused on designing and building their own data centres. Though Akamai's service model is highly distributed and requires its servers be as close to the end consumer as possible, the increase in the number of data centre operators that offer renewable power (either full or partial) should enable Akamai to use its buying power to include clean energy supply as a key criteria of its future siting and procurement decisions. Akamai is in early stages of requiring its colocation facilities to provide energy and water performance data, which will hopefully inform their site selection in the future.

Mitigation: C

Akamai claims that "it is encouraging adoption of energy efficient IT technologies" and hopes to continue to reduce emissions.[42] However, despite its ability to report a 32% reduction in CO_2 intensity in 2009, Akamai does not have commitment to future reductions. There are likely significant energy efficiency improvements still to be realised, but Akamai should also broaden its discussions with vendors to identify opportunities to utilise more clean energy in powering Akamai's 84,000 servers, which would allow it to reduce its footprint beyond what can be done via efficiency.

amazon.com web services

Amazon.com, the largest online US retailer, launched Amazon Web Services (AWS) in 2006, and has emerged as one of the dominant providers of cloud-based computing and storage capacity. Its straightforward pricing structure and low-cost scalable capacity has won AWS a wide range of customers, from internet start-ups to major online brands, such as Netflix.

Transparency: F

Despite its user friendly retail approach, AWS is secretive about its operations and does not report publicly on the environmental performance or energy demand of any of its data centre operations. AWS does not participate in the Carbon Disclosure Project voluntary reporting programme.

Infrastructure siting: D

AWS does not disclose whether it employs clean energy or other sustainability criteria to identify and prioritise data centre site selection. AWS network hubs in the eastern half of the US are reportedly in Northern Virginia, a region where more than two-thirds of the electrical grid is powered by dirty electricity (46% coal, 41% nuclear[43]). However, AWS's recent decision to invest in Boardman, Oregon, should allow it to power more of its cloud from the region's abundant hydroelectric power, despite it close proximity to the state's only remaining coal plant.

Mitigation: D

While AWS has highlighted some of its energy efficiency efforts to peers within the sector, AWS does not appear to have any environmental goals or published metric(s) to evaluate its data centre performance or impact, nor does it provide evidence of clean energy procurement for its operations beyond the mix that is available on the grid.

39 http://www.akamai.com/html/about/facts_figures.html

40 Akamai Report to Shareholders, 2009, p.15. We note this metric was subsequently changed to "CO2 per unit request," in Akamai's 2010 Carbon Disclosure Report. This would be a significant step back in transparency and efforts to ensure comparability within the sector. We strongly urge the C02Mbps metric be retained in future reporting.

41 http://www.cdproject.net

42 Akamai Sustainability Report, 2009. Available at: http://www.akamai.com/dl/sustainability/Environmental_Sustainability.pdf

43 http://www.dom.com/about/environment/pdf/ghg_report.pdf

Apple has been steadily adding to its online offerings, which can be delivered via the cloud from its iTunes platform. Following the phenomenal success of the iPad, the soon-to-be-completed $1bn US dollar 'iDataCenter' in North Carolina indicates that Apple is moving to significantly increase its cloud-based offerings to iPhone and iPad customers.

Transparency: C

Although Apple has become increasingly transparent about the environmental footprint and operational performance of its products, especially laptops and iPhones, it has not been as forthcoming on the current or expected impacts of its online products. Though many IT companies have pointed to the benefits of downloading entertainment over traditional delivery methods, one of the largest online destinations for such media – iTunes - does not provide any data to evaluate these claims or allow comparison with offerings from other vendors. Apple does participate in the Carbon Disclosure Project voluntary reporting programme.

Infrastructure siting: F

Apple previously touted its operations in California as much cleaner than those that use energy produced on the average grid[44]. Apple's decision to locate its iDataCenter in North Carolina, which has an electrical grid among the dirtiest in the country (61% coal, 31% nuclear[45]), indicates a lack of a corporate commitment to clean energy supply for its cloud operations. The fact that the alternative location for Apple's iDataCenter was Virginia[46], where electricity is also comes from very dirty sources, is an indication that, in addition to tax incentives, access to inexpensive energy, regardless of its source, is a key driver in Apple's site selection.

Mitigation: C

Apple has reported a significant increase in the amount of clean energy it has purchased for its operations in the past two years, and has said that it will continue to look for sources of renewable energy and buy green power wherever it can be found.[47] However, Apple has not declared a renewable energy or greenhouse gas target to shape this commitment. The massive iDataCenter has estimated electricity demand (at full capacity) as high as triple Apple's current total reported electricity use, which will unfortunately have a significant impact on Apple's environmental footprint.

44 Apple 2010 Carbon Disclosure Project Response

45 Climate Analysis Indicators Tool (CAIT US) Version 4.0. (Washington, DC: World Resources Institute, 2011)

46 http://www.charlotteobserver.com/business/story/800764.html
Apple Carbon Disclosure Project Submission, 2010.

47 http://www.pewinternet.org/Reports/2010/Social-Media-and-Young-Adults/Part-3/2-Adults-and-social-networks.aspx

48 http://www.akamai.com/dl/sustainability/Environmental_Sustainability.pdf

49 http://www.oregonlive.com/business/index.ssf/2010/10/facebook_executives_check_in_o.html

Facebook, a transformational young company, which now connects nearly 600 million people worldwide, has thus far failed to recognise the risk and responsibility of how it sources electricity. Facebook, which accounts for 9% of internet traffic in the US and reaches nearly 73% of all internet users[48], appears to lack the vision to become a company powered by clean energy. The company announced two large data centre investments in 2010 to help meet the needs of its users, marking a shift to owning and operating its own data centres instead of renting data centre capacity.

Transparency: D

Facebook's recently announced Open Compute Project provides an opportunity to be an open-source model not only for the transparent use of equipment and design of data centers, but also transparency in the disclosure of data centers' emissions and energy sources. However, Facebook has yet to provide any data on its energy consumption or related GHG emissions at either a corporate or facility level, nor is it transparent about the locations and sizes of its data centres. Facebook is reported to lease nine facilities from large data centre operators in the US: Digital Realty Trust, Coresite Realty, Fortune Data Centres and Dupont Fabros Technology. Facebook does not participate in the Carbon Disclosure Project voluntary reporting programme.

Infrastructure siting: F

Facebook has not released an official siting policy for its infrastructure investments. The company has indicated that it employs a broad number of criteria, including environmental and sustainability criteria, but the most important criteria identified in the selection of the Oregon data centre were: power infrastructure, cost of power, tax environment and availability of land.[49]
Facebook's first two siting decisions have led it to locations and utilities (Oregon and North Carolina) that rely on coal as the primary source of electricity, with nuclear a close second in North Carolina. As these two data centre investments are likely the first in a series of large infrastructure decisions for Facebook, the adoption of an investment and siting policy that prioritises access to renewable energy is critical.

Mitigation: D

Facebook is reported to be designing its Oregon and North Carolina facilities to be as energy efficient as possible, and seeks to leverage outside air cooling to reduce the amount of energy spent on chillers to cool its servers. However, beyond efforts to improve electrical efficiency, Facebook has not provided any additional mitigation strategies or effort to procure and make investment in nearby renewable energy generation.

Google

Google Inc. is a multinational public cloud computing, internet search and advertising corporation. The company's stated mission is "to organise the world's information and make it universally accessible and useful", though apparently this mandate applies to everything except Google's data centre locations and associated energy and environmental footprint. Estimates of the scale and number of Google data centres vary widely, as Google goes to great lengths to keep its operations hidden from scrutiny, citing competitive advantage as its reason to guard the scope of its operations as a trade secret.

Among major cloud brands, Google talks the best and most consistently about the need to not only increase efficiency, but also move to renewable sources of electricity to power the cloud. But if Google is serious about climate leadership, it should open source its emissions footprint, confess to the world that it has a carbon problem, and put its mitigation strategies on the table so others in the sector can learn from and build on them.

Transparency: F

Google only publicly acknowledges the existence of seven data centres globally, though informed estimates place Google's fleet in the range of 20 to 30 data centres[50]. Google fails to disclose information on its energy use or GHG emissions, though it claims to be carbon neutral through the purchasing of carbon offsets and renewable energy[51]. Google needs to be transparent about the size and growth of its carbon problem, and follow in the footsteps of other companies that have set absolute reduction targets. Google does participate in the Carbon Disclosure Project voluntary reporting programme, but provides very little actual data on its operational footprint or energy use.

Infrastructure siting: C

Google claims to choose renewable energy "where it makes sense"[52] and applies a shadow price for carbon when calculating the power costs of potential data centre sites. However, while Google has built sizable data centres attached to clean energy sources in Oregon and Iowa, its recent investments in North Carolina, South Carolina, and Oklahoma indicate that tax incentives and access to inexpensive dirty energy make sense to Google as well. Google reports significant new capital expenditures, with spending rapidly escalating to $757m US dollars in 3Q 2010 and $890m in 1Q 2011[53], and is rumored to be considering significant new investments in Southeast Asia and Europe.

Mitigation: B

Google has played a useful role in advancing discussion within the sector by highlighting the energy efficiency measures of its data centres, and has entered the energy business with the creation of a subsidiary called Google Energy, which can buy "the highest quality, most affordable renewable energy"[54]. However, Google's overall lack of transparency means that neither its claim of being "carbon neutral"[55], nor the collective impact of its mitigation efforts, can be properly assessed. Google's recent commitment to enter into a long term contract to buy 114 megawatts of wind energy in Iowa and retire the associate RECs is at least one unambiguous sign of leadership, and one we hope to see repeated by Google and other IT companies. Google ultimately needs to drop the veneer of being carbon neutral and publicly commit to phasing out dirty fuels on a set time frame in order to remain in line with its 2030 Clean Energy Roadmap.

50 http://www.datacenterknowledge.com/archives/2008/03/27/google-data-center-faq/
51 Official Google Blog: Carbon neutrality by end of 2007 http://googleblog.blogspot.com/2007/06/carbon-neutrality-by-end-of-2007.html
52 https://www.cdproject.net/Sites/2010/16/7616/Investor%20CDP%202010/Pages/DisclosureView.aspx
53 http://www.datacenterknowledge.com/archives/2010/10/15/googles-data-center-spending-soars/
54 http://news.cnet.com/8301-11128_3-10427993-54.html
55 http://www.google.com/intl/en/corporate/green/114megawatt.html

New HP CEO Leo Apotheker recently committed HP to a more cloud-focused delivery of its services[56], which will likely spur further expansion of cloud-focused infrastructure already underway at HP. Since the acquisition of EDS in 2008, HP has managed a significant fleet of data centres in major global markets.

Transparency: C

HP regularly publishes detailed data about its electricity GHG footprint at the organisational level, and notes progress on its RE performance goals.[57] While HP is able to show significant reductions in data centre footprint due to its consolidation efforts, it should break this analysis down to provide more detailed information on the current environmental performance of its cloud services at the facility and product level. HP does participate in the Carbon Disclosure Project voluntary reporting programme.

Infrastructure siting: D

As part of a global data centre consolidation effort in 2006, HP announced plants to build pairs of 200,000 sq feet data centres in Atlanta, Austin and Houston. Despite efficiency gains through its data centre consolidation efforts and organisational goals to increase renewable energy, clean energy sources did not appear to factor highly in its site selection process. The energy mix at the Atlanta and Houston data centres are among the dirtiest in the country. HP's recent opening of an energy efficient data centre in Wynyard, UK, which generates 10% of its electricity from wind power, will hopefully become a new model for HP as it accelerates in its move to the cloud.

Mitigation: C

HP's goal is to reduce GHG emissions from HP-owned and leased facilities to 20% below 2005 levels by 2013 on an absolute basis. This goal is independent of organic business growth and will be accomplished by reducing the worldwide energy footprint of HP facilities and data centres. In addition, HP plans to invest in energy efficiency and renewable energy sources. Having set a goal to increase its purchases of electricity from renewable sources to 8% of total electricity usage by 2012, HP needs to increase its use of renewable energy and showcase more detail on how its efficiency improvements are effectively reducing the energy use and GHG emissions of others on an absolute basis.

One of the world's largest and most well-known IT companies (home of the 'Smarter Planet'), IBM has sought to link its brand to IT-driven environmental solutions and services. In response to many companies outsourcing IT needs to cloud based computing infrastructure, IBM launched 'Project Big Green'[58] in 2007 to deliver 'green' data centre and cloud services to the worlds largest businesses.

Transparency: C

IBM provides detailed annual corporate information on its aggregate emissions and improvements toward environmental goals, which include renewable energy, energy efficiency and total energy consumption. However, despite claiming to own or operate over 450 data centres around the world, IBM does not provide any useful detail to its customers or stakeholders on the energy consumption and impacts associated with the operation of these facilities. IBM does participate in the Carbon Disclosure Project voluntary reporting programme.

Infrastructure siting: C

IBM's goal to increase amounts of renewable electricity should be an important driver of investment as the company seeks to expand its cloud profile. However, little detail on the source of energy is provided, so it is unclear which sources of energy IBM's new infrastructure will draw from. This is particularly true in the case of its new cloud infrastructure in China, the US, Germany and Ireland. IBM must give higher priority to renewable energy access through its siting policy and discriminate against dirty energy sources.

Mitigation: B

IBM should be recognised for its ongoing and comprehensive plan to reduce emissions, in addition to driving significant gains in IT efficiency. A stronger commitment is needed to expand energy efficiency and its use of renewable energy as IBM itself expands, extending the total percentage to well above the current 11%. IBM's mitigation strategy is further strengthened by its refusal to use 'offsets' to achieve environmental goals, choosing to focus on actions that actually reduce emissions or increase energy efficiency, but greater clarity is needed on IBM's policy to purchase and retirement of RECs as part of its renewable power purchase agreements.

56 http://www.hp.com/hpinfo/newsroom/press/2011/110314xa.html?mtxs=rss-corp-news
57 http://www.hp.com/hpinfo/globalcitizenship/datagoals.html
58 http://www-03.ibm.com/press/us/en/pressrelease/21524.wss

Microsoft

Microsoft has rapidly become one of the biggest champions of cloud computing, making significant new investments in its cloud infrastructure. Microsoft has a strong brand profile in both the consumer and business spaces, and is developing a range of cloud offerings to compete in both markets. Microsoft has regularly marketed the environmental benefits of dematerialisation and the energy-saving potential of the cloud, but has offered little data to substantiate the claimed benefits.

Transparency: C

Microsoft's reporting of its corporate environmental footprint does not provide a clear picture of its operational impacts, but has provided basic information on the energy footprint of its major data centres. Also opaque are the metrics used to inform investment decisions and energy choices for its rapidly growing network of data centres.

Infrastructure siting: C

Microsoft has shown its willingness to follow tax incentives and dirty energy supply, as evidenced by Microsoft's recent announcement to construct a new data centre in the coal-heavy state of Virginia in the US.[59] While Microsoft has made some significant data centre investments located near renewable energy sources, there does not appear to be a consistent policy to guide these investments. Microsoft does participate in the Carbon Disclosure Project voluntary reporting programme.

Mitigation: C

Microsoft has worked to identify and address key opportunities for IT energy efficiency gains, including chip design and more energy efficient software coding.[60] Microsoft has begun to point to an increased amount renewable electricity supply in its own operations, including a recent contract to buy wind power for its new energy efficient data centre in Dublin.[61] However, Microsoft does not have an overarching reduction goal to guide its investments, having chosen an energy intensity target instead.

twitter

The world's most famous micro-blogging service has been expanding at breakneck speed, currently adding nearly half a million accounts on average a day[62], and generating over 8 terabytes (TB) of data a day (the NY Stock Exchange generates 1 TB day according to Twitter).[63]

Transparency: F

Twitter has largely maintained an official radio silence on the location and size of its data centres, with the exception of an announcement that it would move its technical operations to Salt Lake City in late 2010[64]. News reports at time of publication reflected considerable confusion and lack of transparency on whether Twitter had migrated fully to Salt Late City Facility, or had remained in California.[65] Twitter has at least put out some basic information on the volume of data it is generating.[66] Twitter does not participate in the Carbon Disclosure Project voluntary reporting programme.

Infrastructure siting: F

Prior to the relocation to Salt Lake City, Utah, in March 2011, the bulk of Twitter's infrastructure was managed under a hosting arrangement with NTT America in a co-located facility in San Jose, California.[67] Although NTT America had touted Twitter's concern over environmental footprint in promotional materials, Twitter's move from San Jose to Utah, which has an electric utility mix that is 97% fossil fuel-based (81% coal) as compared with 27% renewable (w/ <1% Coal and 20% nuclear), is a huge step backwards for Twitter.

Mitigation: F

A move to Utah's coal intensive electricity grid means that Twitter has its work cut out for it to mitigate the footprint of its new facility. Twitter's estimated total electricity load in Utah could easily be met by clean sources of energy, and should be prioritised for discussion with its new facility operator in Utah.

59 http://www.datacenterknowledge.com/archives/2010/08/27/microsoft-picks-virginia-for-major-data-center/
60 http://www.microsoft.com/environment/our_commitment/articles/datacenter_bp.aspx
61 http://blogs.technet.com/b/msdatacenters/archive/2011/02/22/microsoft-s-cloud-gets-even-greener-in-ireland.aspx
62 http://blog.twitter.com/2011/03/numbers.html
63 Presentation by Raffi Krikorian of twitter, http://www.slideshare.net/raffikrikorian/twitter-by-the-numbers-columbia-university
64 http://engineering.twitter.com/2010/07/room-to-grow-twitter-data-center.html
65 http://www.c7dc.com/facilities/bluffdale-utah.htm
66 Presentation by Raffi Krikorian of twitter, http://www.slideshare.net/raffikrikorian/twitter-by-the-numbers-columbia-university
67 http://www.us.ntt.com/fileadmin/NTT-America/media/pdf/about-us/resources/Twitter_Case_Study.pdf

YAHOO!

Yahoo! is one of the biggest online destinations, and it maintains data centres and co-located servers around the world to support its user base. Yahoo!'s most recent data centre investments have reflected a heightened awareness of the importance of siting near clean energy sources and the full economic and environmental benefits that energy efficient design can offer, when combined with clean sources of electricity.

Transparency: D

Yahoo!'s environmental reporting is largely devoid of the data or metrics necessary to evaluate the performance of its data centres. It cites 'competitive reasons' for excluding this data from reporting under the Carbon Disclosure Project.[68] Yahoo! and the sector would be well served by its sharing of the metrics it is using to track its carbon reduction goals.

Infrastructure siting: B

In 2009, tied to the announcement of its new Lockport, New York data centre, Yahoo! moved away from its 'carbon neutral' policy[69], which relied on the purchase of offsets, and committed to reducing its operational footprint directly through energy efficiency improvements and clean energy.[70] With the exception of its Nebraska facility, Yahoo!'s recent data centre siting decisions have put Yahoo! on a cleaner energy path.

Mitigation: C

In place of its prior commitment to 'carbon neutrality', Yahoo! has committed to reduce the carbon intensity of its data centres by at least 40% by 2014.[71] Yahoo! should shift this to an absolute reduction target, and combine it with a clean energy goal to help drive even more investment in clean sources of electricity for its data centres.

68 Yahoo! Carbon Disclosure Project Investor Information Request, question 10.3.
69 http://ycorpblog.com/2007/04/17/dont-even-leave-a-footprint/
70 http://ycorpblog.com/2009/06/30/serving-up-greener-data-centers/
71 http://ycorpblog.com/2009/06/30/serving-up-greener-data-centers/

Greenpeace is an independent global campaigning organisation that acts to change attitudes and behaviour, to protect and conserve the environment and to promote peace.

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