How Clean is Your Cloud?

April 2012

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For more information contact:
enquiries@greenpeace.org

Written by:
Gary Cook, Greenpeace International

Creative Direction & Design by:
Arc Communications

Greenpeace International would like to extend its gratitude to **EvoSwitch Datacenter** in Haarlem, the Netherlands, and to the photographer **Frank van Biemen**, for the use of their photographs in this report. EvoSwitch Datacenter uses green energy to power the system. This energy-efficient datacenter hosts providers, public institutions and private corporations.

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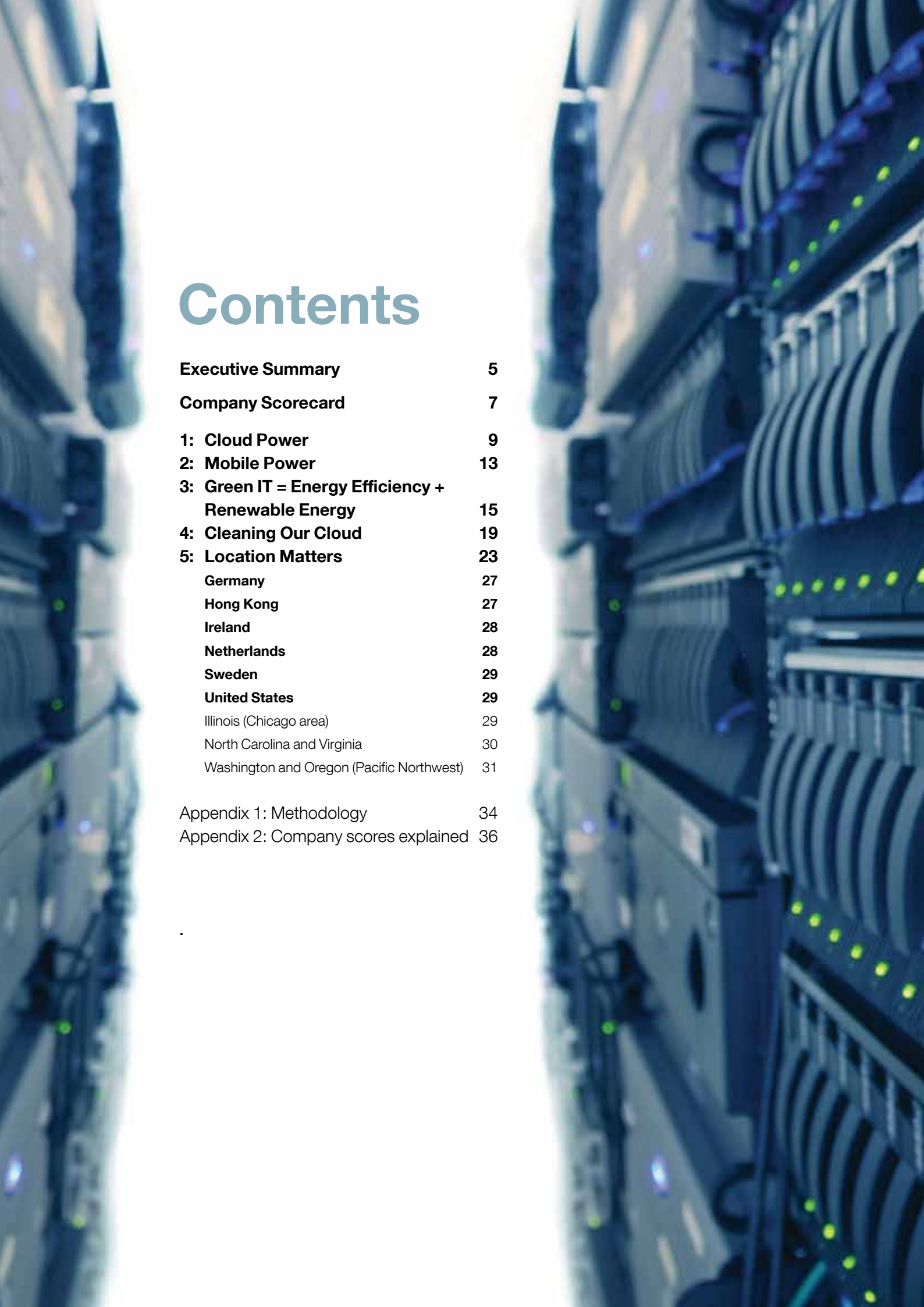
Greenpeace International
Ottho Heldringstraat 5
1066 AZ Amsterdam
The Netherlands
Tel: +31 20 7182000
greenpeace.org



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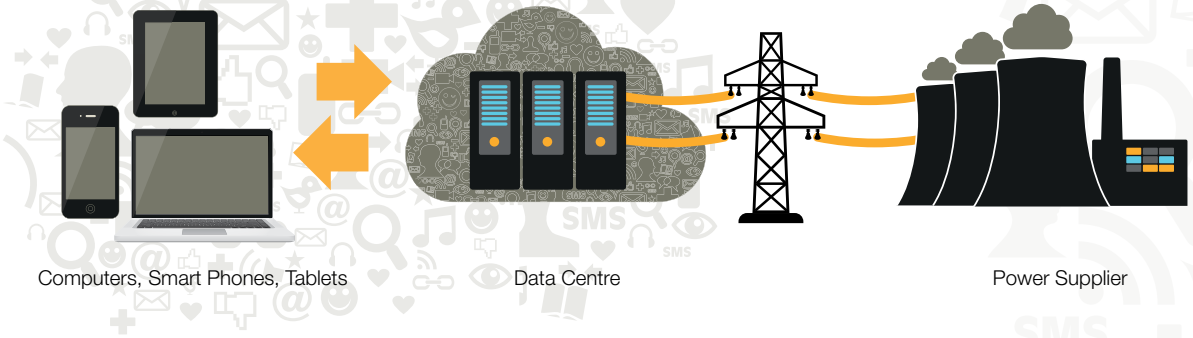


Facebook, Amazon, Apple, Microsoft, Google, and Yahoo – these global brands and a host of other IT companies are rapidly and fundamentally transforming the way in which we work, communicate, watch movies or TV, listen to music, and share pictures through "the cloud." The growth and scale of investment in the cloud is truly mind-blowing, with estimates of a 50-fold increase in the amount of digital information by 2020 and nearly half a trillion in investment in the coming year, all to create and feed our desire for ubiquitous access to infinite information from our computers, phones and other mobile devices, instantly.

The engine that drives the cloud is the data center. Data centers are the factories of the 21st century information age, containing thousands of computers that store and manage our rapidly growing collection of data for consumption at a moment's notice. These cloud data centers, many of which can be seen from space, consume a tremendous amount of electricity; some consume the equivalent of nearly 180,000 homes. Unfortunately, despite the tremendous innovation they contain and the clean-energy potential they possess, most IT companies are rapidly expanding without considering how their choice of energy could impact society.

Given the energy-intensive nature of maintaining the cloud, access to significant amounts of electricity is a key factor in decisions about where to build these data centers. Since electricity plays a critical role in the cost structure of companies that use the cloud, there have been dramatic strides made in improving the energy efficiency design of the facilities and the thousands of computers that go inside. However, despite significant improvements in efficiency, the exponential growth in cloud computing far outstrips these energy savings. Companies must look not only at how efficiently they are consuming electricity, but also the sources of electricity that they are choosing.

This year's report provides an updated and expanded look at the energy choices some of the largest and fastest growing IT companies are making as the race to build the cloud creates a new era of technology. These energy choices are completely invisible to consumers as we continue to rely more and more on our online world, but in places where the cloud touches the ground, these investments are having a very significant and rapidly growing impact in the offline world.

Instead of linking their IT innovation to equally innovative clean sources of electricity, many IT companies are simply choosing to attach their modern information factories to some of the dirtiest sources of electricity, supplied by some of the dirtiest utilities on the planet. These utilities, unlike the IT companies, are not known for their innovation. Because of the tendency within the IT sector to cluster in the same geographic locations, these investments are driving significant new demand for both coal and nuclear power in many regions of the world – and in rapidly growing economies like India, they are driving demand for diesel from large onsite generators. If IT companies continue to rely on dirty sources of energy to power the cloud, the cloud itself will begin to have a measurable negative impact on our environment and communities.

However, we do see a growing realization and commitment from within several leading IT companies to realign their rapid growth with access to renewable sources of electricity at scale to power their online platforms. For these companies, we see these commitments significantly shaping decisions on where they build their data centers. Companies such as Google are also making significant clean energy investments and signing long-term contracts for renewable energy to power their existing facilities. Even more significantly, many IT companies are recognizing that their influence and market power give them the opportunity and responsibility to demand clean energy investments and policy conditions to drive utilities and government officials to make better choices. IT companies can drive the electricity supply on the grid we all use to ever-increasing amounts of renewable energy while phasing out the dirtiest and most dangerous sources.

With this year's update, we have expanded our analysis to examine a total of 14 global IT companies who are leading the sector's move to the cloud, and also taken a closer look at the key places around the globe where significant concentrations of data centers are being built. We explore the challenges and opportunities for IT companies to play a constructive role in driving renewable energy deployment.

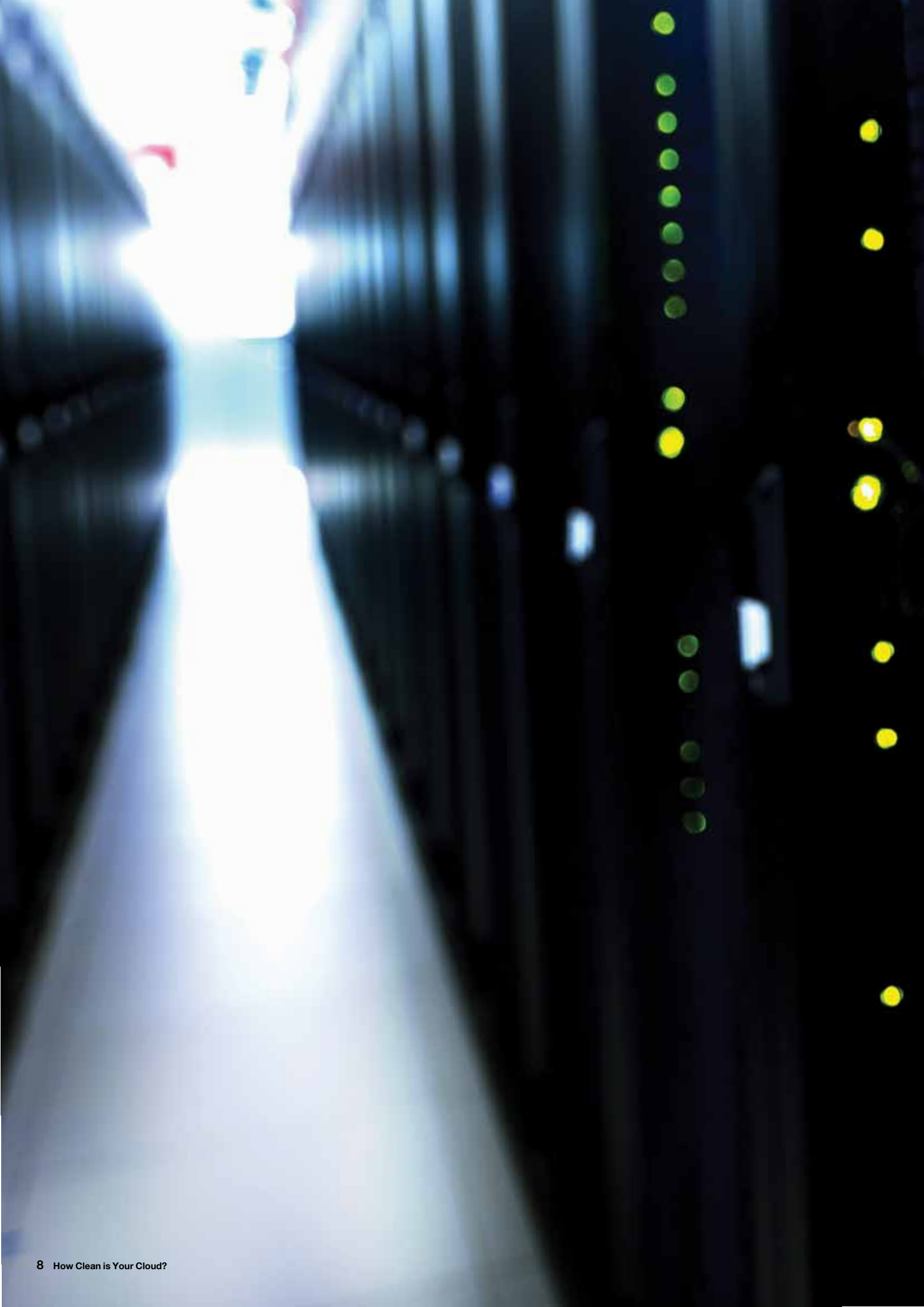
Key findings of this year's report:

1. Three of the largest IT companies building their business around the cloud – Amazon, Apple and Microsoft – are all rapidly expanding without adequate regard to source of electricity, and rely heavily on dirty energy to power their clouds.
2. Yahoo and Google both continue to lead the sector in prioritizing access to renewable energy in their cloud expansion, and both have become more active in supporting policies to drive greater renewable energy investment.
3. Facebook, one of the largest online destinations with over 800 million users around the world, has now committed to power its platform with renewable energy. Facebook took the first major step in that direction with the construction of its latest data center in Sweden, which can be fully powered by renewable energy.
4. A growing concentration of data center investments in key locations is having a significant impact on energy demand and how the electricity grid is managed; if such concentrated expansion is allowed to continue, this will make it increasingly difficult to shift these investments and the surrounding community away from dirty sources of electricity.
5. Akamai, responsible for carrying a tremendous amount of internet traffic, is the first IT company to begin reporting its carbon intensity under the new Carbon Utilization Effectiveness (CUE) standard. There has been a notable absence of reporting under CUE by other companies.
6. There have been increasing attempts by some companies to portray the cloud as inherently "green," despite a continued lack of transparency and very poor metrics for measuring performance or actual environmental impact.
7. There are increasing positive signs of collaboration and open source sharing of best practices in both hardware and software design among IT leaders to help accelerate improvement and deployment of energy efficient IT design
8. There have been increasing signs that more IT companies are beginning to take a proactive approach in ensuring their energy demand can be met with available renewable sources of electricity, and will increasingly play a role in shaping our energy future.

Company Scorecard

Company	Clean Energy Index	Coal	Nuclear	Energy Transparency	Infrastructure Siting	Energy Efficiency & GHG Mitigation	Renewables & Advocacy
Akamai	NA	NA		A	C	B	D
amazon.com web services	13.5%	33.9%	29.9%	F	F	D	F
	15.3%	55.1%	27.8%	D	F	D	D
DELL	56.3%	20.1%	6.4%	C	C	C	D
facebook	36.4%	39.4%	13.2%	D	B	B	C
Google	39.4%	28.7%	15.3%	B	C	B	A
hp	19.4%	49.7%	14.1%	C	D	B	C
IBM	12.1%	49.5%	11.5%	C	D	C	D
Microsoft	13.9%	39.3%	26%	C	D	C	C
ORACLE	7.1%	48.7%	17.2%	D	D	C	D
rackspace HOSTING	23.6%	31.6%	22.3%	C	C	C	C
salesforce	4%	33.9%	31%	B	C	C	C
twitter	21.3%	35.6%	12.8%	F	D	F	D
YAHOO!	56.4%	20.3%	14.6%	C	B	B	B

(a) **Clean Energy Index and Coal Intensity** are calculated based on estimates of power demand for evaluated facilities [http://www.greenpeace.org/cloudcomputingfacilities]
(b) **Akamai**'s global network of server is highly distributed and not possible to individually evaluate as we have done for other brands. However, Akamai is the only company that is reporting a fleet wide and regional Carbon Utilization Effectiveness (CUE), as noted in the data center facility table.
(c) Both **AWS** and **Apple** were provided facility power demand estimates to review, both responded they were not correct, but neither provided alternative estimates. Using conservative calculations, Greenpeace has used best information available to derive power demand, and has decided to publish and invite AWS and Apple to be transparent and provide more accurate data for their facility power demands.



Cloud Power 01
How big is the cloud?

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

However, the lack of transparency from major IT brands remains one of the biggest reasons for this imprecision. This shared secrecy appears to be fed both by concerns about disclosing competitive advantages or disadvantages in operations among major cloud brands, and also a desire to suppress the story of how the IT sector, otherwise perceived as "clean" by the public and its employees, is often heavily reliant upon coal and other dirty sources of energy to fuel its growth.

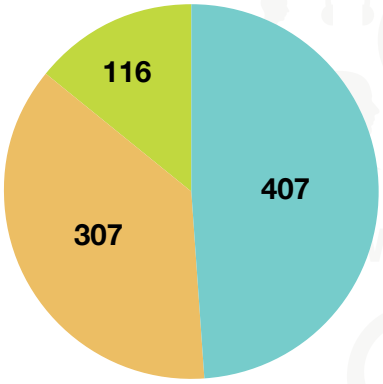
Global IT Estimates of Carbon and Energy

The estimates of the IT sector's carbon footprint performed to date have varied widely in their methodology and scope. One of the most recognized 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 GHG associated with our online and electronic world.

Estimated GHG Emissions of ICT Sector:

$MtCO_2e$ = Million Tonnes Carbon Dioxide Equivalent

Emissions 2007 ($MtCO_2e$)	
Data centres	116
Telecoms and devices	307
Computers and devices	407



iClimate Group and the Global e-Sustainability Initiative (GeSI)(2008). SMART 2020: enabling the low carbon economy in the information age

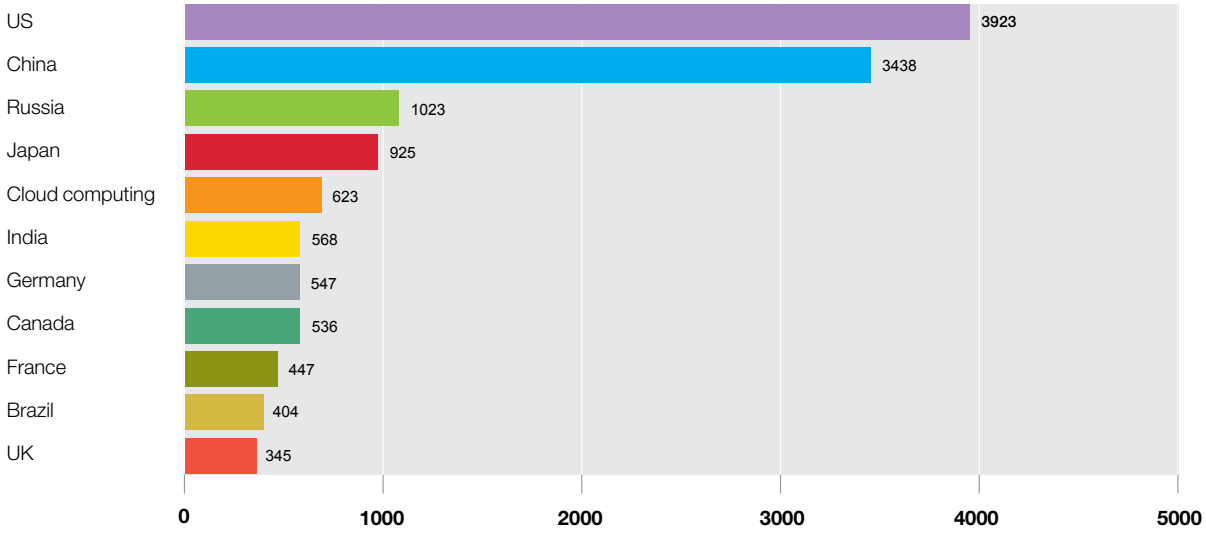
Greenpeace released its own report, *Make IT Green: Cloud Computing and its Contribution to Climate Change* in March 2010, highlighting the scale of the sector's estimated energy consumption, and providing new analysis on the projected growth in energy consumption of the internet and cloud computing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

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

1. The electricity consumption of data centers may be as much as 70% higher than previously predicted.
2. The combined electricity demand of the internet/ cloud (data centers and telecommunications network) globally in 2007 was approximately 623bn kWh. If the cloud were a country, it would have the fifth largest electricity demand in the world.
3. 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.

A recent study[1] on energy demand from data centers released since Greenpeace's *How Dirty is Your Data?* report was published indicated that, due to the economic downturn and continued energy efficiency and performance improvements, global energy demand from data centers from 2005-2010 increased by 56% instead of the 100% worse case scenario that has been estimated previously. This study was quickly seized upon by many in the sector and offered as evidence that the data center energy footprint had "moderated[2]" or "declined," and was generally taken as a sign that the sector's energy footprint was getting under control. While the improvements in energy efficiency are certainly to be recognized, this was the wrong take-home message. The study essentially tracked the middle-of-the-road estimate from the previous study, which had anticipated some important improvements in performance. A 58% increase in energy consumption in a period where global electricity consumption is otherwise essentially flat due to the global recession is still a staggering rate of growth.

2007 electricity consumption. Billion kwH

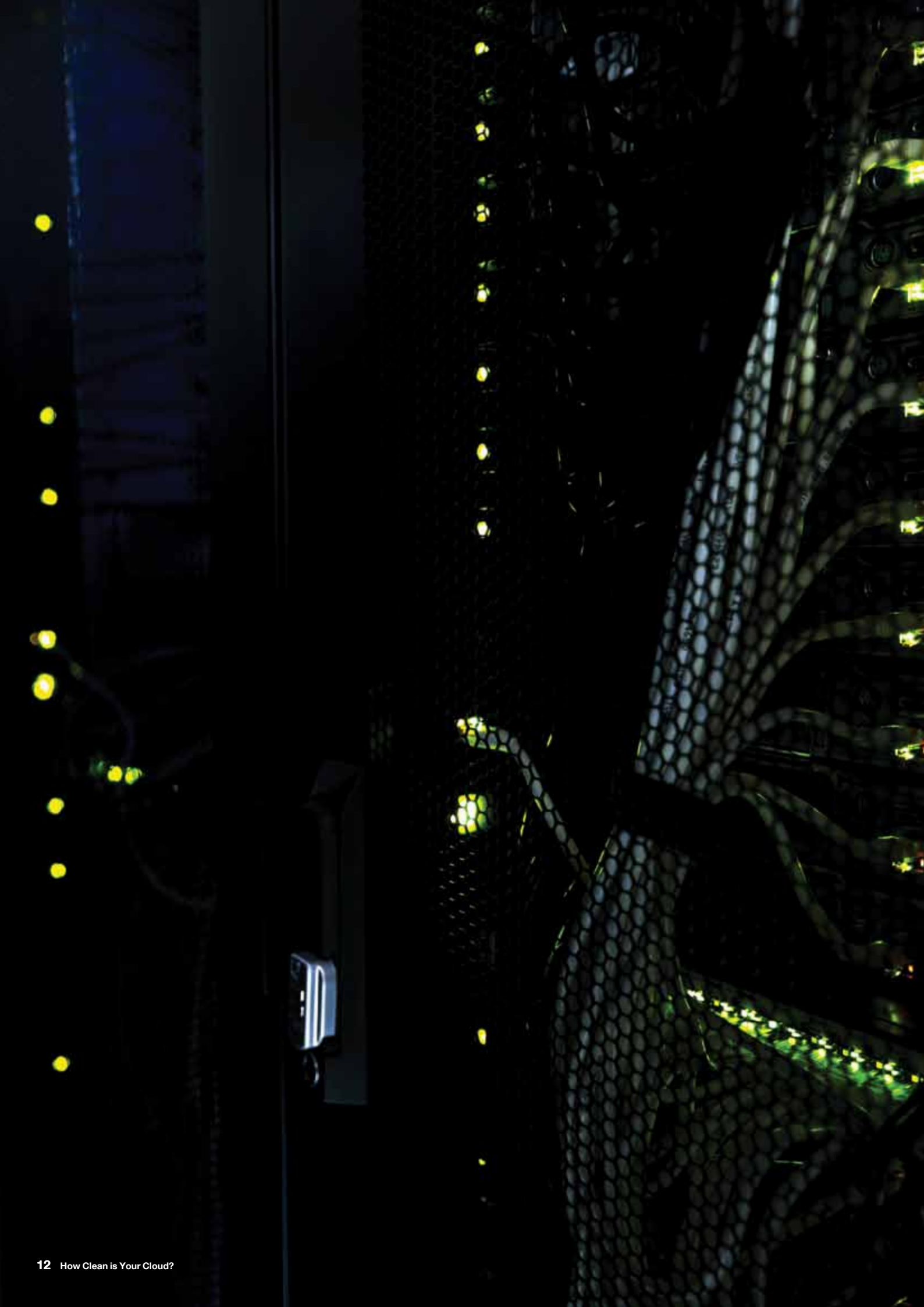


Greenpeace's *Make IT Green Report*, 2010.

Recent key indicators of the scale of investments currently underway and associated growth in energy needed to power the cloud clearly show a sector that is rapidly accelerating even as the global economy is only beginning to recover:

1. Industry leaders estimate nearly $450bn US dollars is being spent annually on new data center space, despite the persistent global economic downturn.[3]
2. Estimates of data center electricity demand come in at 31GW globally, with an increase of 19% in 2012 alone, despite the fact that global electricity demand has remained essentially flat for the past three years.[4]
3. It is estimated that global mobile data traffic grew 133% in 2011, with 597 petabytes of data sent by mobiles every month.[5]

The International Energy Agency (IEA) warned in fall 2011[6] that unless a decisive shift is made to clean energy investment and away from high-carbon sources of energy like coal, in the next five years (by 2017), the Earth will be locked into a disastrous cycle of unavoidable global warming. Electronic devices and the rapidly growing cloud that supports our demand for greater online access are clearly a significant force in driving global energy demand. While many brands are taking steps to manage and reduce pollution by increasing efficiency in their data center operations, only a few companies have demonstrated a significant commitment to meeting their growing electricity needs from renewable sources. This disconnect highlights the tremendous urgency in ensuring that these long-lasting investments in building the infrastructure to deliver the cloud are directed toward renewable sources of energy, and do not lock us in to our addiction to coal and other dirty sources of energy.



Mobile Power

02

The global telecoms sector is growing rapidly. In 2011, it is estimated that 6 billion people or 86.7% of the entire global population have mobile telephone subscriptions.[7] By the end of 2012, the number of mobile connected devices is expected to exceed the global population. Rapid growth in use of smart phones and broadband mobile connections mean mobile data traffic in 2011 was eight times the size of the entire internet in 2000.[8]

In developed markets, the exponential growth of mobile data traffic is driving the need for expanded network capacity and energy hungry data center expansion by telecoms operators and content providers alike.

In developing markets, especially China and India, the two largest mobile markets in the world, growth is driving a rapid expansion of the mobile telecoms network infrastructure.

India provides an example of both the rapid growth of mobile networks and the environmental impacts of powering this growth with dirty energy despite the existence of renewable energy options.

India had 903.73 million mobile connections as of January 2012 and is soon predicted to be the largest mobile market in the world due to rapid growth rates, overtaking China, the world's largest mobile phone market (987.58 million mobile subscribers).[9]

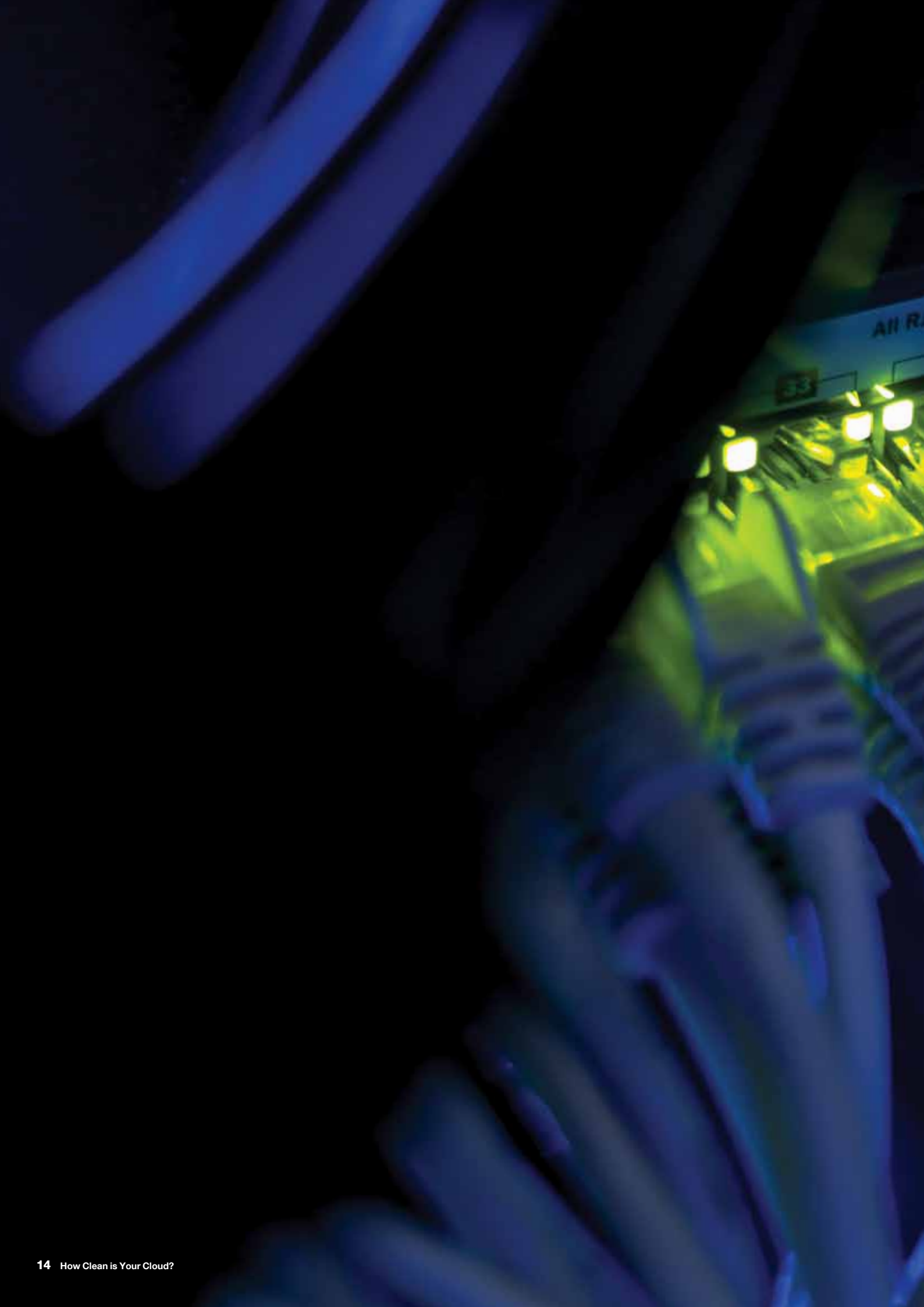
Much of the growth in the Indian telecom sector is from India's rural and semi-urban areas. By 2012, India is likely to have 200 million rural telecom connections at a penetration rate of 25%.[10] The booming domestic telecom market has been attracting huge investments, which are likely to accelerate with the entry of new players and launch of new services. The sector has attracted 8% of the cumulative foreign direct investment (FDI) over the last two years.

Out of the existing 400,000 mobile towers, over 70% exist in rural and semi-urban areas where either grid-connected electricity is not available or the electricity supply is irregular. 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 telecoms sector currently stands at a staggering 3bn liters annually, second only to the railways in India. This consumption is responsible for 10m tons of carbon emissions annually, and is growing.[10A]

Greening the mobile networks

Globally all telecoms operators need to prioritize measures to ensure exponential growth does not result in explosive emission growth, through a combination of implementing transformative energy efficiency measures in networks and sourcing renewable energy to power the networks of the 21st century.

While the mobile network is enabling India and other countries to leapfrog the traditional network, the telecoms sector and leading companies like Bharti Airtel, who are leading mobile network expansion in the developing world, must choose solar power to begin the transition to a clean energy powered network. This would place the mobile network operators in a key role in driving the development of a renewable powered economy based on distributed clean energy generation, instead of repeating the centralized dirty energy production model of the developed world.



Green IT = Energy Efficiency + Renewable Energy

03

What is Green IT?

The rapid growth of cloud computing as a viable business model is made possible in part by significant improvements in how data centers are designed and operated, and IT companies have achieved significant breakthroughs in reducing power consumption. But dramatic improvements to the energy efficiency and cost of delivering cloud-based computing services are actually significantly increasing overall consumption of cloud-based IT products and the environmental impact arising from increased data center power demand[11]. Given the scale of predicted growth, the source of electricity must be factored into a meaningful definition of "green IT". Energy efficiency alone will, at best, slow the growth of the sector's footprint.

Energy efficiency ≠ green

In order to achieve the reductions necessary to keep the sector's emissions in check and maintain safe levels of global greenhouse gases, renewable energy needs to become the priority for IT companies as they rapidly expand their data center infrastructure. A few companies, such as Yahoo and Google, have taken meaningful steps to steer their infrastructure investments toward cleaner energy, but the sector as a whole remains focused on rapid growth, with greater efficiency as a pathway to enable this continued growth. The replacement of dirty sources of electricity with clean renewable sources is still the crucial missing link in the sector's sustainability efforts.

Cloudy green claims

A number of recent studies[12] have sought to portray the cloud as "green" or "lower carbon," particularly in comparison to a non-cloud delivery of IT services. While it is certainly true that engineers have steadily delivered significant improvements to data center design, software coding, and efficiency of the servers; such verdant claims have typically suffered from a combination of three critical shortcomings: a lack of transparency and actual substantiating data; flawed methodology and poor metrics in calculating assumed performance, particularly the consideration of the source of electricity being used; and a misguided understanding that energy efficiency alone is an appropriate measure of environmental impact.

At the core of these current shortcomings is the steadfast desire of most companies to avoid putting any data on the table that would give their competitors any insight into the scale of their infrastructure, their actual performance, or their cost structure. This has often resulted in some companies trying to meet a desire to be more forthcoming by inappropriately using metrics such as Power Usage Effectiveness (PUE) in place of meaningful metrics that would speak to the actual performance of their data center(s) in terms of computing resource or the natural resource being consumed in generating electricity.

There are signs underway of a growing shift towards transparency among several major cloud companies. Google, Akamai, Salesforce, Yahoo and Rackspace are all beginning to reveal more meaningful consumption and carbon performance data associated with their cloud, but these are thus far exceptions. Most cloud companies are interested at best in revealing the PUE associated with their newest data centers, but are not willing to share any data that speaks to the true extent of their total footprint.

PUE: A misused measure

PUE was designed to provide an efficiency benchmark for data center operators to measure the relative consumption of electricity within the data center between the computers' power demand and that of the entire data center, which would include lighting, chillers and other air handling equipment needed to keep the computers performing as designed.

PUE = Total Facility Power/IT Equipment Power.

Until recently, a PUE of 2 or more was average, indicating a data center where nearly 50% of the demand is being directed to equipment other than the computers inside. By comparison, a "perfect" PUE score would be 1, indicating all electricity is being consumed by the computers, and utility-scale cloud companies such as those evaluated in this report are increasingly reporting PUEs between 1.1 and 1.6. PUE has now achieved broad adoption within the sector, and has had value in helping data center operators benchmark the design and performance of their facilities, providing a relatively straightforward metric to measure energy use and broad efficiency of the facility. Companies are also happy to report this figure because it reveals nothing in terms of their actual energy consumption.

Unfortunately, PUE is now increasingly being misused by some companies to assert how "green" a particular data center is. The "expected" PUE is now increasingly included in company announcements of a new data center, offered as the numerical evidence of how green the new facility will be, often in the same way MPG (miles per gallon) is reported for automobiles, and this is increasingly misreported in the media as equivalent to MPG.

However, while PUE can be a useful diagnostic tool for a data center operator, it is a poor metric for determining how green a data center is, as it does not account for how companies are managing computer resources inside the data center, and in some circumstances, it penalizes better performance. For example, if a cloud manager identified servers in their data center that were not being used, and elected to shut them off and create virtual servers, as shown in the table below, this could result in decrease in the power consumption rate (good) but an increase in the facility's PUE (bad).

	IT Power Demand	Total Data Center Power Demand	PUE
Base Case	15MW	20MW	1.33
Idle Servers Down (5 MW)	10MW	15MW	1.5

Another severe limitation of PUE as an indicator of environmental performance is that the figure is totally unrelated to the carbon content of the electricity being consumed. For example, if a data center is largely powered by renewable energy but has a poor PUE, it will still contribute significantly less pollution than a data center largely powered by coal but with a much lower PUE.

Adding carbon to the equation

In response to a growing desire to have a standardized method to report carbon intensity of data center operations, the Green Grid recently adopted CUE (Carbon Usage Effectiveness), which provides a carbon per kilowatt hour intensity measurement. CUE has been a standard for well over a year, and yet only one of the companies evaluated here, Akamai, is publicly reporting its CUE. Others are beginning to track and pledge to report CUE in the coming year. While some companies currently have aggregate data on CO_2/kwh consumed, none were willing to share these figures due to concerns over competitiveness.

Given the significant limitations of PUE, an increasing number of companies are calling for the sector to develop better metrics to drive data center performance across the sector, with the focus on server utilization, or watts per compute function performed. Companies are also calling for an adoption of metrics to measure carbon intensity.

What we need to see in transparency, metrics and energy efficiency

IT companies must show meaningful leadership and advance the debate among peers and government regulators through greater transparency of their energy footprint. Only then will we have meaningful standards for what green IT could mean. Transparency and the adoption of more meaningful metrics will become increasingly important as cloud computing expands, and will allow cloud customers to understand the true environmental performance and carbon footprint of their IT vendors and suppliers.

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Cleaning Our Cloud 04

For all of the tremendous innovation contained in the development of the cloud and the devices that use it, most IT companies are currently choosing to buy their electricity off the rack, at the lowest possible price, with the focus on its quantity, not its quality. This approach can be understood in part by how the industry has largely defined the problem: energy consumption.

The approach to date has been a strictly technical solution at the data center and network level: improve energy efficiency and reduce waste associated with cooling and other non-computing energy demands. What this approach fails to account for, however, is the kind of energy used to feed data centers' explosive energy consumption and the environmental impact of the electricity supply chain.

As one of the fastest growing sectors, both economically and in their energy consumption, global IT and cloud computing companies have a tremendous opportunity and unique responsibility to take greater control of their electricity supply chain, and to manage their energy ecosystem both outside and inside the data center. By making better energy choices and demanding more from utility vendors, cloud companies have the opportunity to be a catalyst in driving utilities and governments toward the development of cleaner electricity generation that will ensure a truly green cloud for their long term sustainability – and a greener grid for us all.

At both a company and a sector level, a meaningful strategy to clean our cloud must include both:

- Direct investing and purchasing of renewable energy
- Demanding from governments and electric utilities to change the policy environment that will enable the acceleration of the investment and deployment of renewable electricity.

We are now seeing several companies, most notably Google, Yahoo and most recently Facebook, that are beginning to take direct responsibility for their electricity supply chain, and are putting in place a strategy that will ensure future growth is based on renewable energy.

Pathway to a Cleaner Cloud

Tapping Renewable Grid Power

Renewable electricity procurement options for a data center operator are hugely dependent upon the location of the data center and its proximity to renewable energy generation capacity. This is justification for a strong infrastructure siting policy. Strategic infrastructure siting allows IT companies to buy clean energy directly from the local grid.

Key examples:

- **Greenqloud/Verne Global, Iceland:** In Iceland, nearly 100% of the electricity is 100% renewable from geothermal and hydropower energy sources. Greenqloud[13], a cloud computing service that markets itself as a green compatible alternative to Amazon Web Services, has established operations in a new data center built by Verne Global on a former NATO Air Force base in Iceland. With fast connection time to both Europe and the U.S. East Coast, Iceland's significant renewable energy resources are attracting interest from many IT brands, with Verne being the first to come online.
- **Yahoo, US:** Yahoo's decision to locate in Lockport, New York, was connected to its ability to secure a substantial (15MW) allotment of hydroelectric power from New York Power Authority.
- **Facebook, Sweden:** Facebook built its third major owned and operated data center in Lulea, Sweden, a location chosen for the large amount of existing hydroelectric capacity at high availability. The data center can be fully powered with renewable energy.

Power purchase agreements for renewable energy

An increasing number of cloud companies have begun to take charge of their electricity supply chain by signing long-term contracts to buy renewable electricity from a specific source through a utility or renewable energy developer via a power purchase agreement (PPA) to help drive renewable electricity onto the grid.

- Google entered into two significant separate 20-year PPAs with a wind energy developer for over 100MW in Iowa and Oklahoma, states where Google has significant data center operations. This is one of the best examples of an IT company directly purchasing renewable energy from a provider that has enough capacity to power its massive data centers. This approach has significant advantage over renewable energy credits (RECs) as a strategy, as it can actually drive deployment of renewable electricity in the same part of the grid where data centers are creating demand. Google has pledged to retire the RECs earned by the agreement.
- Google has also 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.

Onsite renewable energy

A growing number of IT companies have installed renewable energy on site to generate power for their own operations. For many facilities however, it may be difficult technically or economically to power a significant portion of a large data center with on-site renewable energy. This of course depends on the scale of the facility and the available renewable resources. However, companies are increasingly exploring onsite investments that can help provide better protection against electricity price volatility and, with onsite solar, can help shave electricity demand at the most expensive time of the day. Examples of onsite generation:

- i/o Data Centers is installing a large solar array on top of its massive 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 100MW expected 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.
- Apple has announced a 20MW solar array, and has also put a 5MW fuel cell device on site in Maiden, NC. While much has been made of this announcement, it will cover only 10% of their total generation for the data center.
- McGraw-Hill Publishing placed a 14MW solar array on its New Jersey Campus to help reduce the long term electricity costs of its data center, which was the previous largest privately held solar installation in the U.S. However, it appears that McGraw Hill intends to sell the RECs associated with electricity generated by their solar array, effectively negating its environmental benefit (see sidebar).[14]

Investment in renewable energy or offsetting local energy demand

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 have demonstrated significant interest in making direct clean energy investments[15], such as $168m investment in a concentrated solar power facility[16]. This has a much higher impact than RECs; such investment can provide much-needed capital for the development and deployment of renewable energy instead of "renting" the clean attributes of renewable energy generated by others. By putting real money into getting more green energy on the grid, Google's investment could also allow them to consider locating a future data center near this facility or near other clean energy investments it has made.

Funding negawatts: local energy efficiency offsets

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 offset demand of new data centers on the local grid from driving demand for dirty energy. Companies could consider investing in local government or state-sanctioned programs (such as a revolving loan program 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 center or other IT infrastructure.

Clean energy advocacy

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. They can do this by helping to bring more renewable energy online through purchase power, investment and advocacy—yet few companies have demonstrated the bold leadership necessary to ensure that IT's rampant growth will be sustained by clean energy sources.

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, enabling these factories to operate on 100% renewable energy. They can engage in decisions around:

- 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 centers (such as solar, wind, tidal and wave power).
- Additional investments in the development and deployment of grid infrastructure and energy storage technology to enable much higher utilization of variable energy sources, such as wind and solar.

Note: Please see Greenpeace's CoolIT Leaderboard for further evaluation of clean energy policy advocacy leadership by the IT sector.[17]

Limitations of Renewable Energy Credits (RECs):

RECs represent only the property rights to the non-power qualities (environmental) associated with renewable electricity (RE) generation, NOT the electricity itself. RECs can be sold separately from the electricity ("unbundled" or "naked" RECs) or with the RE electricity ("bundled" RECs). RECs allow a consumer who does not have access to RE electricity from its utility or provider the ability to buy the claim to RE electricity from electricity generated elsewhere. RECs also provide the RE developer or utility another product they can sell in addition to the electricity, which can be used to partially offset the higher marginal cost associated with RE, and potentially incentivize additional RE investment.

The indirect approach of RECs raises concerns about whether this premium 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, as most RECs are sold independent of the underlying electricity (e.g. wind-based RECs from Iowa that are used to make "renewable" claims for a facility in Virginia do not supplant the burning of additional coal in Virginia).

Given this disconnect from demand, RECs alone do not suffice as a carbon mitigation strategy. Companies that buy them should only do so when they do not have more meaningful options for securing renewable energy in the locations available to them. They should otherwise look to make more direct investments in renewable energy or push utility and government policy makers to put more renewable energy on the grid allowing customers to have the right to directly contract for it.

"I'm betting that [traditional] energy prices are going to go up. In time…this is going to be a wise business decision as well as a wise environmental decision."

- Joe Kava, Senior Director of Data Centers, Google

Location Matters 05

Many factors go into choosing a location for new cloud computing infrastructure. Data center siting requires the adequate availability of reliable and affordable electricity, as well as telecommunications infrastructure. Tax incentives, climate, and proximity to end-users may entice a company to choose a particular location. Availability of renewable energy to power the data center, while possibly considered, is currently low on most cloud companies' lists. As these data centers continue to multiply and increase their electricity consumption, access to renewable sources of electricity must be prioritized across the sector.

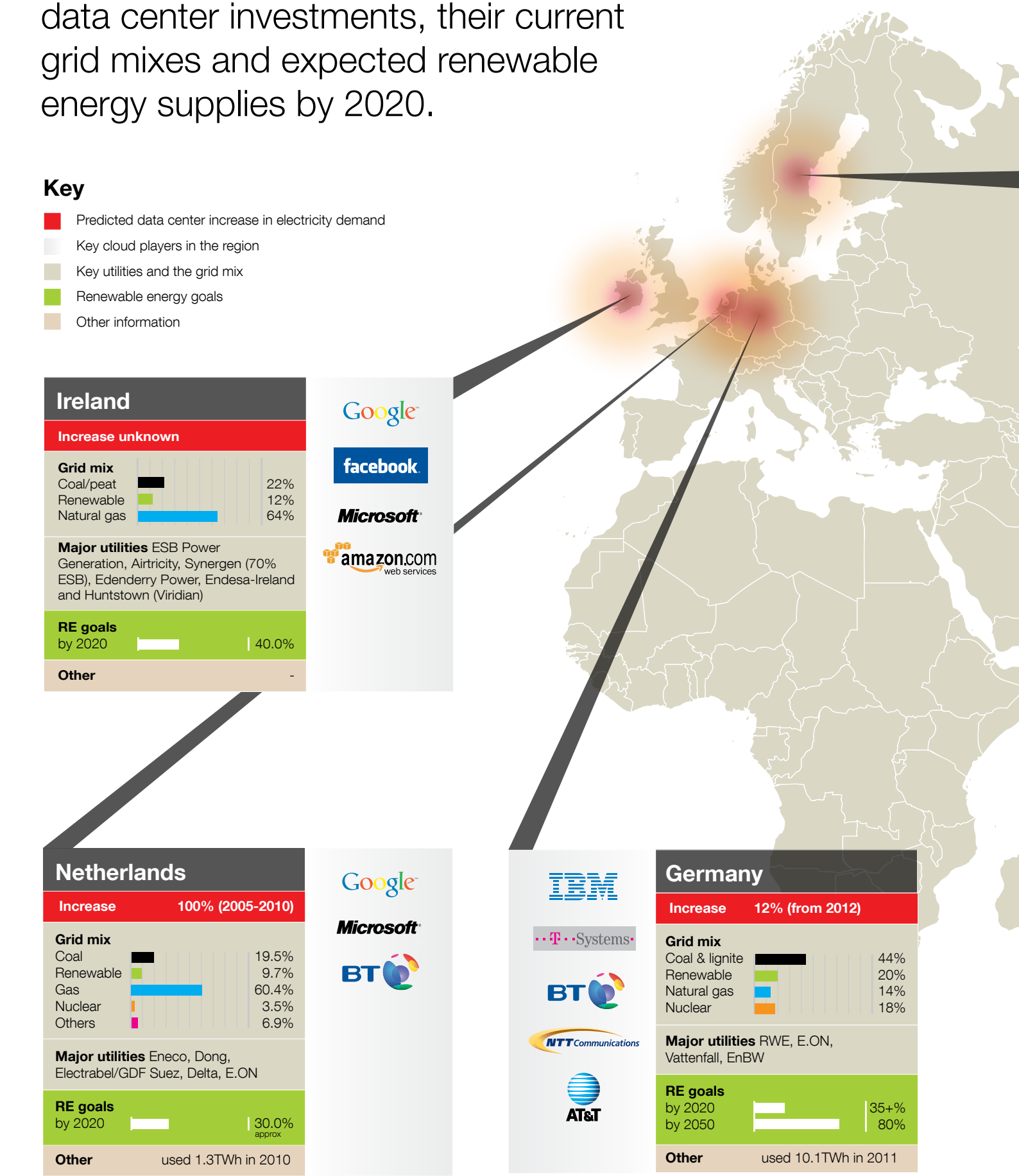
Increasingly, the temperature range of a location is being weighted as a key factor in siting decisions due to the energy implications. A major evolutionary trend in data center design underway is the utilization of "free cooling," or the use of outside air instead of energy-intensive chillers to keep the computers from overheating. This shift is already happening among most major utility-scale operators; as they have identified the major cost savings that can result from efficient building designs and modular containers they rely less on the resource-intensive cooling equipment that has historically composed at least half of a data center's energy footprint.

But for the global data center operator that has a range of options to choose from, location is the single biggest factor in whether clean or dirty energy will be used to power the data center and therefore the location is the greatest factor in the associated environmental impact. Currently, the pursuit of the combination of proximity to major internet interconnections and large amounts of inexpensive electricity has increasingly resulted in rapidly growing regional data center hubs in key markets around the world that are either largely powered by existing hydroelectric capacity, or heavily dependent on coal and nuclear power.

The current and projected supply of clean electricity varies significantly between nations and regions, and renewable energy growth is largely determined by the energy and investment policies in those places and how the utilities and electricity markets are structured. Given the scale and long-lived nature of data centers, in order to ensure that the supply of clean energy can keep pace with IT's rapidly growing demand, companies need to make a corporate commitment to engage in energy policy decisions in regions where they establish operations.

Data centers go global

Here's a look at some key countries' data center investments, their current grid mixes and expected renewable energy supplies by 2020.



Key

- Predicted data center increase in electricity demand
- Key cloud players in the region
- Key utilities and the grid mix
- Renewable energy goals
- Other information

Ireland

Increase unknown

Grid mix

Coal/peat	22%
Renewable	12%
Natural gas	64%

Major utilities ESB Power Generation, Airtricity, Synergen (70% ESB), Edenderry Power, Endesa-Ireland and Huntstown (Viridian)

RE goals
by 2020 | 40.0%

Other -

Google
facebook
Microsoft
amazon.com web services

Netherlands

Increase 100% (2005-2010)

Grid mix

Coal	19.5%
Renewable	9.7%
Gas	60.4%
Nuclear	3.5%
Others	6.9%

Major utilities Eneco, Dong, Electrabel/GDF Suez, Delta, E.ON

RE goals
by 2020 | 30.0% approx

Other used 1.3TWh in 2010

Google
Microsoft
BT

IBM
T-Systems
BT
NTT Communications
AT&T

Germany

Increase 12% (from 2012)

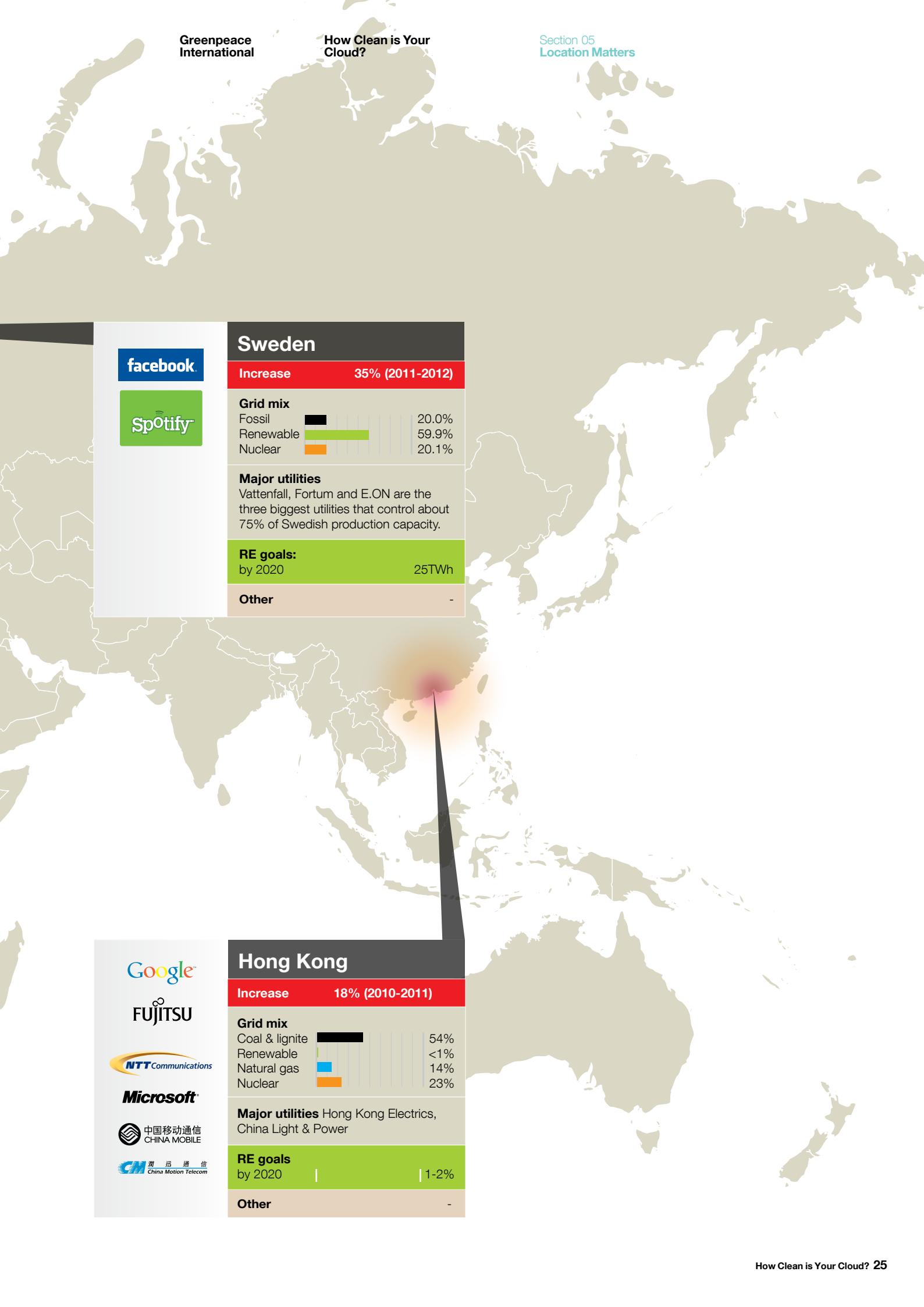
Grid mix

Coal & lignite	44%
Renewable	20%
Natural gas	14%
Nuclear	18%

Major utilities RWE, E.ON, Vattenfall, EnBW

RE goals
by 2020 | 35+%
by 2050 | 80%

Other used 10.1TWh in 2011



facebook

Spotify

Sweden

Increase 35% (2011-2012)

Grid mix

Fossil	20.0%
Renewable	59.9%
Nuclear	20.1%

Major utilities
Vattenfall, Fortum and E.ON are the three biggest utilities that control about 75% of Swedish production capacity.

RE goals:
by 2020 25TWh

Other -

Google

FUJITSU

NTT Communications

Microsoft

中国移动通信 CHINA MOBILE

中国移动通信 China Motion Telecom

Hong Kong

Increase 18% (2010-2011)

Grid mix

Coal & lignite	54%
Renewable	<1%
Natural gas	14%
Nuclear	23%

Major utilities Hong Kong Electrics, China Light & Power

RE goals
by 2020 | 1-2%

Other -

Resisting the lure of King Coal

Though a number of global IT brands claim to include sustainability criteria in their data center site selection process, for most it still appears to be far down the list of factors that lead to the ultimate decision on where to invest. As highlighted in the companies evaluated here, highly profitable companies who have otherwise accepted the science of climate change and associated dangers of coal-fired electricity to the global and local environment are still making huge data center investments based on the short-term lure of low-cost dirty energy, and increasing the demand for coal and the pollution that comes with it.

Growing a cleaner cloud with a renewable energy siting policy

To avoid locking their cloud platform into an environmentally harmful and potentially volatile electricity supply chain, companies need a cloud infrastructure siting policy that institutionalizes a meaningful preference for clean energy. A siting policy 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 unacceptable.

"The absolutely perfect site does not exist but in Nirvana you would have numerous bioenergy and hydroelectric power feeds for example, and you would not destroy 100 acres of forest to put in a solar plant."

- Jack Pouchet, Emerson Network Power

Elements of a strong siting policy for data center operators would include:

1. Preferential treatment for access to renewable energy, and discrimination against coal and other high carbon sources of electricity.
2. Indicative supporting mechanisms, such as a carbon shadow price, electricity performance standard for Power Purchase Agreements (PPAs) or utility grid mix (current and prospective over expected life of facility).
3. Energy procurement standard for co-location (rented facilities).

Facebook: Unfriending coal

Facebook's initial two data center investments in Oregon and North Carolina, while using a highly energy efficient design and technology, were both located in areas where over 60% of the electricity came from coal. These policies generated a significant outcry from its users and criticism from several quarters, including Greenpeace.

Facebook has since put in place a significant commitment to renewable energy and long-term sustainability for its platform; a key component of this new commitment has been the adoption of a data center siting policy that prioritizes the access to renewable energy for its future growth. Facebook's third data center was placed in Lulea, Sweden, where it can be almost entirely powered by renewable electricity year around. This is an important guiding precedent not only for Facebook, but for the future growth of the cloud sector overall.

Other major cloud companies such as Yahoo and Google, while they have not adopted as clear a renewable energy siting policy as Facebook, have made meaningful commitments to power their platforms with renewable energy. They are increasingly making data center investments guided by a goal of achieving access to a cost-effective and reliable clean electricity supply chain for their data centers, with pathways to increase it over time.

Germany

Electricity use of data centers in Germany in 2008 was estimated to be 10.1 terrawatt hour, which is slightly less than 2% of the total electricity demand in Germany.[18] Frankfurt, home to the second largest internet exchange in Europe, has become one of the largest data center hubs, particularly for the colocation market (leasing data centers). IBM has opened a new Cloud Computing Competence Centre in Ehningen (Stuttgart), which is also the location of IBM's largest data center in Europe.[19] Germany is predicted to see at least a 12% increase in electricity demand from data centers in 2012.[20]

IT brands:

AT&T, BT, Dell, IBM, NTT Com, T-Systems (Deutche Telekom)

Grid mix[21]:

44% coal and lignite, 20% renewable energy, 18% nuclear, 14% natural gas, 5% others

Major utilities:

The German energy market is dominated by four large companies (RWE, E.ON, Vattenfall and EnBW), which held 84% of capacities in 2009 and produced about 86% of Germany's electricity. All of them have new investments in coal.[22] RWE and Vattenfall are Europe's largest and second-largest emitters of carbon, mainly due to their German lignite business.

Status:

Germany has a strong renewable energy industry and the government has strong supportive measures for renewable energy development.[23] IT companies should indicate a preference for renewable energy in their siting policy, and look to buy from smaller energy providers that do not invest in coal or nuclear, such as Lichtblick, Greenpeace Energy and Naturstrom.

Hong Kong

Serving as an important foothold into the rest of China, Hong Kong is seeing rapid investment from a wide range of global cloud companies, with an 18% growth rate in data center floor space from 2010-2011.[24] Google has recently announced plans to invest $300m USD in a 300,000 sq ft data center, to be completed in 2013.[25]

IT brands:

China Mobile, China Telecom, Fujitsu, Google, Microsoft, NTT, Rackspace

Grid mix[26]:

54% coal, 23% nuclear, 23% natural gas

Major utilities[27]:

Hong Kong Electrics, China Light & Power

Status:

Hong Kong has an overwhelmingly dirty energy mix, with over half the energy being produced from coal, followed by gas and nuclear energy imported from China. Electricity generation accounts for 67% of local greenhouse gas (GHG) emissions.[28] Currently renewable energy makes up less than 1% of the energy mix. In sharp contrast to the ambitious plans for importing more nuclear power, the Hong Kong government has shown a serious lack of commitment in developing the renewable energy sector. The government currently proposes to expand renewable energy to only 1-2% of the total energy mix by 2020 with 300MW of wind proposed by 2016.[29]

In recent years the peak load of Hong Kong has become static. The expansion of data centers might be the only reason for new capacity. Therefore, the IT sector can have a strong positive influence by setting a renewable energy-friendly siting policy, and the sector can show leadership and responsibility by buying wind power.

Ireland

Ireland, particularly Dublin, has been rapidly emerging as a major cloud computing hub in Europe. Microsoft, Google, and Amazon all have major facilities in Ireland, each of them with expansions planned or underway.

IT brands:

AWS, Facebook, Google, Microsoft

Grid mix[30]:

22% coal/peat, 64% gas, 12% renewable energy

Major utilities:

Ireland is a deregulated market. ESB Power Generation, an arm of Electricity Supply Board of Ireland (ESB), is Ireland's largest power generator. Other utilities include Airtricity, Synergen (70% ESB), Edenderry Power, Endesa-Ireland and Huntstown (Viridian).

Status:

Given the scale of cloud investment Dublin, IT Companies need to become much more active in shaping the electricity supply chain, both by directly investing into renewable energy supply as well as working to advocate for stronger policies to drive more renewable energy onto the grid. Ireland has a strong wind industry[31], and the government has strong tax relief measures

to encourage equity investments in wind, hydro, solar and biomass energy projects approved by the Department of Public Enterprise.

Netherlands

The Netherlands, Amsterdam in particular, has emerged as one of the largest EU internet hubs next to Frankfurt and London. Data centers are estimated to consume 1.3TWh of electricity in 2010, which reflects a doubling of electricity consumption in the past five years. Consumption is expected to triple before 2020. Microsoft has a significant facility operated by GlobalSwitch and Google also has a sizable facility in Eemshaven.

IT brands:

British Telecom, Google, Microsoft

Grid mix[33]:

19.5% coal, 60.4% gas, 9.7% renewable energy, 3.5% nuclear, 6.9% others

Major utilities:

The Netherlands is a liberalized market with eight producing utilities, each with widely differing electricity generation portfolios. The greenest is Eneco with 79% renewable energy (RE), but most others have only a small share of renewable production: Dong 20% RE; Electrabel/GDF Suez 22.3% RE; Delta: 12% RE; E.ON 9% RE.[34]

Status:

Data center companies should switch to utilities that not only offer green electricity products but that also prioritize investments in new renewable production capacity. Nearly all utilities in the Netherlands offer a green electricity product, while most companies (except for Eneco and DONG Energy) mainly invest in new coal or nuclear capacity.

Green electricity production in the Netherlands comprised 9% of total electricity production over the last two years, and is not expected to grow significantly over the next couple of years due to policy obstacles and investments in new coal.

Sweden

Sweden has been active in promoting itself as a destination for international investment in data centers.[35] According to a DatacenterDynamics, in 2010, Sweden had approximately 30,000 server racks covering 100,000 sq m. DatacenterDynamics calculates the investment value of the Swedish data center market to be in the range €250m to €300m per annum.[36] The Nordic region as a whole is projected to see a 35% increase in data center electricity demand in 2012, which is hopefully a reflection of increased awareness and prioritization within the sector to choose sustainable sources of energy.

IT brands:

Facebook, Spotify

Grid mix[37]:

59.9% renewable energy, 20.1% nuclear, 20% fossil fuel (coal, gas, oil)

Major utilities:

Vattenfall, Fortum and E.ON are the three biggest utilities that control about 75% of Swedish production capacity.

Status:

Sweden promotes itself as "a good choice for large-scale, green data center operations." One of the top reasons stated is its green energy mix. The dirty energy concern in the Nordic region is nuclear expansion in Sweden and Finland. All three major utilities in Sweden are heavily invested in nuclear expansion plans. Data center companies should purchase from utilities that prioritize investments in new renewable production capacity. The Swedish government has proposed a vision to be carbon neutral by 2050. Greenpeace believes this must be based on renewable energy supply, not nuclear energy, and has presented a roadmap for this. The IT sector can be a strong positive influence in moving Sweden to accept binding energy efficiency targets and to set clear binding renewable targets for 100% renewable electricity and energy.

United States: Illinois (Chicago area)

Chicago has become one of the hottest data center markets in the U.S. due to its status as a major internet connection hub and low energy prices. Some of the largest data centers in the world are based there, including Microsoft's 700,000 sq ft facility. The Midwestern region of the U.S. is expected to see a 13% increase of data center energy demand in 2012, and Chicago will likely be higher.

IT brands: AT&T, Microsoft, Rackspace, Salesforce,

Major utilities and energy mix:

ComEd, the main utility in the Chicago area, sourced its electricity in 2011 mainly from coal at 44%; and including nuclear at 40%, natural gas at 12%, and renewable energy at 3%.[38]

Illinois does has a renewable energy standard – a state law saying 25% of electricity from utilities has to come from renewable sources by 2025. Illinois was second only to California in new wind power installed last year, and ranks fourth in the country for installed wind capacity.[39] However, the wind industry in Illinois is in trouble, because of the imminent expiration of the wind energy Production Tax Credit, a federal government tax credit that has been a key driver in incentivizing renewable energy investments.

Status:

If IT companies keep building data centers in Chicago in a business-as-usual scenario, the additional electricity they require would come from continued burning of coal, nuclear power plants running at a higher capacity, an increased use of natural gas, and perhaps from some very modest growth in wind power.

But if companies like Microsoft instead demand cleaner electricity to power their Chicago data centers, they could catalyze major growth in the wind market. Instead of a small percentage increase in wind power, IT companies should opt for 100% wind by entering into power purchase agreements (PPAs) with wind energy providers within Illinois or adjoining states.

United States: North Carolina & Virginia

The U.S. East Coast states of North Carolina and Virginia have emerged as two of the fastest growing locations for cloud computing. Unfortunately, both states have some of the dirtiest electrical grids in the United States, relying heavily on nuclear energy and coal from mountain top removal. This concentration of demand that runs around the clock is forcing utilities and grid operators to change the way they are managing the grid, and significantly increasing demand from dirty energy sources. The Eastern U.S. is projected to see a significant increase of 22% in electricity demand from data centers in 2012.[40]

North Carolina

IT brands: Apple, Facebook, Google, IBM, Wipro

Major utilities and energy mix: 61% coal, 31% nuclear, 3.4% natural gas, 2.5% renewable energy[41]

North Carolina is a regulated market, and Duke Energy is the primary utility for the western part of North Carolina where most of the biggest data centers are being built. Duke has put significant effort into recruiting data centers from Google, Apple and Facebook to the region, to utilize excess power demand from their coal and nuclear fleet of power plants. Data center 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 a kilowatt hour, much lower than rates in most parts of the U.S.

Duke Energy is currently seeking to merge with Progress Energy, which services the rest of North Carolina. Duke is one of the only utilities in the U.S. investing in new coal power plants. If Duke merges with Progress, Duke will continue to operate its fleet of dirty coal plants for as long as possible. Duke is also seeking permission from the state to allow for the construction of a new nuclear facility, while it continues to invest very little in renewable energy: less than 5% by 2030, according to current investment plans.

Virginia

The Northern Virginia region near Washington DC has been able to garner a huge slice of the colocation market in the U.S. (rented data center space), along with the location of the U.S. East portion of Amazon Web Services, EC2 Cloud Hosting, which was recently estimated to be where more than 71% of its global EC2 servers are located. Microsoft has also recently announced plans to further expand the $499m facility it has been building in Boydton, Virginia.

Dominion Power is the primary utility for the parts of Virginia where most of the cloud data centers are being built, and has enjoyed explosive growth in electricity demand from data centers in the past three years. In a recent report to investors, Dominion reported that data centers' electricity demand has grown over 250MW in the past two years, and is now projected to increase another 1,200MW over the next five years.[42]

IT brands: Amazon, Facebook, Microsoft, Salesforce

Major utilities and energy mix: : 45% coal, 35% nuclear, 14% natural gas,4% renewable energy (2008)[43]

Status:

Given the importance of the data center market that cloud companies represent to these two utilities, cloud companies have the unique ability and standing to shape how electricity is contracted and ultimately generated in regions where they operate. Howeverm in light of the limited renewable energy choices being offered by both Duke Energy and Dominion, a pathway to a renewable electricity supply for cloud companies operating in these states must include a concerted effort to use their market influence to demand a shift in the investment plans of these utilities away from coal, and invest in putting more renewable energy in the electricity supply chain that is powering their cloud. A critical piece of a long-term solution is for IT companies to generate options for getting their energy, either through direct investment or by advocating for better rules to allow for more competition.

United States: Pacific Northwest Washington & Oregon

Parts of the Pacific Northwest states of Oregon and Washington have earned the nickname of the "Silicon Forest" due to the high concentration of tech companies in the region. The large amount of hydro power in the region has also earned a significant share of data center investments to power the cloud.

By comparison, Pacific Power, the electric utility that operates in the eastern half of Oregon, imports a significant amount of its energy from coal plants outside the state. Approximately 60% of the electricity Pacific Power sold in Oregon in 2010 was from coal. Facebook located its first data center in Prineville, Oregon, which is PacifiCorp territory, and now Apple has apparently decided to invest its second iCloud data center in Prineville as well.

IT brands: Amazon Web Services, Apple, Facebook, Microsoft, Yahoo

Major utilities and energy mix: There are three major utilities selling electricity in areas of major cloud investment in the Pacific Northwest:

Bonneville Power Administration (BPA):[44] 81% renewables and hydro, 9.2% nuclear, 9.9% other

One of the lowest emitting providers of electricity in the U.S., BPA is responsible for managing the hydro power resource in the region and the associated electricity grid, selling at a wholesale level to utilities in the region.

Grant County Public Utility District (Washington):

The local municipal utility for Quincy, Washington, which hosts major data centers from Microsoft, Yahoo, Dell and a number of other major IT brands.

Pacific Power (Oregon): 61% coal, 15% natural gas, 15% renewables and hydro, 8% other[45]

Eastern Oregon, including Prineville where Facebook and Apple data centers are being sited, largely lies in PacifiCorp territory. Pacific Power owns a number of large coal-burning facilities outside of Oregon, but imports this capacity into the state.

What IT companies can do:

The lure of large amounts of inexpensive extra hydro energy capacity in the Pacific Northwest, left behind by the downsizing of the aluminum industry and other heavy industries, has brought many cloud companies to the region. However, this supply of hydro power is not infinite, and as cloud companies look to further expand in this region, much more careful attention must be paid to the overall electricity ecosystem, and where the supply of electricity to meet additional demand will come from.

Without further investment in renewable energy to ensure the demand from cloud infrastructure is being matched with adequate additional renewable energy capacity, cloud companies could outstrip local supply, resulting in the further importing of coal power from PacifiCorp and others outside the region, instead of making the rest of the surrounding grid greener. IT companies in PacifiCorp territory, like IT companies near Duke Energy in North Carolina, are faced with an electricity vendor that remains firmly committed to coal. But, by tapping their market power, financial and brand resources, IT companies in the Pacific Northwest are well positioned to demand better renewable energy options.

Appendix 1
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 footprints of major cloud providers and their respective data centers.

This lack of data is not due to the fact that data does not exist. However, the industry is unwilling 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 (such as PUE) that attempt to measure how green a data center is 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, and focusing on recent investments of select brands and the 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 (by percentage).

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 centers, a company average of clean energy utilized 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.

The above inputs are from the following sources:

- Submissions by companies directly to Greenpeace
- As defined by company when announcing investments
- As reported by the media (in stories on the investments or construction of facilities, 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 USD 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 U.S., the 2007 eGrid State level generation mix as reported by U.S. EPA, or if not applicable, reported subregional egrid generation mix
- Outside the U.S., 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. As companies provide better data, Greenpeace will incorporate this into our evaluation and encourage other companies to follow.

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

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

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 data 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 a 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 maximize the use of clean sources of energy, and avoid an increase in demand for coal or nuclear power to meet the growing demand for electricity from their operations. High scoring companies demonstrate:

- A clean energy siting policy to prioritize 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 patterns 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.

Energy efficiency and GHG 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.
- Companies participate in open source sharing of energy efficient design and equipment specification to enable further learning and improvement within the sector.

Renewable energy investment and political advocacy methodology (Column 7)

Companies are evaluated on the strength of their measurable progress and commitment to renewable energy investments, and actions taken to advocate for ambitious policies at all levels of government that encourage wide-scale renewable energy generation and use. High scoring companies also demonstrate:

- Efforts to meet electricity demand with the direct installation of renewable energy, and to reduce emissions through higher efficiency, will receive the highest marks.
- Investments in clean energy supply and local energy efficiency mechanisms will be rated higher than the purchase of offsets and renewable energy credits to reach established environmental goals.
- Proof of long-term commitment to renewable energy electricity through local renewable energy developers.

Appendix 2
Company scores explained

Akamai launched in 1999 and reported revenues of close to $1.2bn in 2011. Though not exactly a household name, Akamai is one of the major players in online content delivery, and is based in Massachusetts, having been created by academics at MIT. Akamai delivers between 15% and 30% of internet traffic through a distributed network of over 100,000 servers in 75 countries on behalf of many of the bigger brand names in this report.

Transparency: A

The company began disclosing its greenhouse gas (GHG) emissions in 2009, and Akamai continues to receive high points for its level of disclosure of GHG emissions. Akamai is the first company evaluated here and perhaps beyond that is publicly reporting under the new CUE standard, which is a much more useful metric for assessing the environmental performance than PUE. Akamai's reporting of its carbon intensity also 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/Mega bits per second; and (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.

Infrastructure Siting: C

Akamai has one of the larger server fleets powering the cloud, but its business model demands that these servers are distributed across major internet hubs. Though its siting options are different than Apple, Google or Facebook, who have much greater flexibility in site location, Akamai has significant market influence. Akamai has just completed a survey of its large number of global colocation facilities to gather energy and water performance data, which will hopefully inform its contract renegotiation and site selection in the future as it further pursues carbon reduction goals.

Energy Efficiency and GHG Mitigation: B

While Akamai continues to expand rapidly with a nearly 20% increase in the number of servers, Akamai continues to report significant reductions in the energy intensity (67%) of its network operations through use of more energy efficient servers and better software to manage its global network. Akamai collects data from its vendors to measure the Carbon Usage Effectiveness (CUE) for its data centers, and is the first to publicly report on this new metric. Akamai has contacted its colocation providers for better data and metrics on the energy footprint of its operations and, where possible, is converting its contract from a flat-rate power contract to a metered contract, to provide a financial incentive to implement off-peak efficiency measures.

Renewable Energy Investment and Advocacy: D

Akamai has purchased a limited amount of Renewable Energy Credits (RECs), but due to its distributed businesss model has not made significant investments in direct or grid purchases of renewable energy. In addition to becoming more demanding of its colocation providers for more renewable energy options, Akamai should also be more proactive in the political advocacy necessary to shift towards cleaner energy opportunities for the industry.

Amazon.com, the largest online U.S. retailer, launched Amazon Web Services (AWS) in 2006. AWS has made significant investments in data center infrastructure over the past year. Amazon is the structural cornerstone of many well-known online start-ups and major internet brands, including Netflix, Dropbox and Zappos. The company also runs several large online services including the Kindle, Amazon's Appstore for Android, Amazon Instant Video, and Amazon Cloud Player, a personal online MP3 storage space. AWS allows businesses of different sizes to store data in the cloud without having to build data centers and servers individually. AWS again finds itself with poor marks in delivering a renewable energy powered cloud. In a sector that is generally known for its lack of transparency on environmental performance or energy consumption, AWS is among the most opaque in the size or scale of impact from its cloud infrastructure, particularly for a publicly traded company. While Amazon.com does highlight the efforts of its online shopping fulfillment centers to reduce their environmental impact, no information is provided on the impact or performance of AWS infrastructures.[46]

Transparency: F

AWS has seen tremendous growth over the past year, but fails to disclose information on its environmental footprint at either a company-wide or facility level. AWS does not participate in the Carbon Disclosure Project. As more IT companies release the details of their operation's environmental impacts, it is clear AWS is falling behind the industry.

Infrastructure Siting: F

AWS is tight-lipped when it comes to the details of the energy sourcing for its data centers. The company has expanded rapidly over the past year, purchasing existing facilities and land in Sao Paulo, Brazil; Oregon, US; and Dublin, Ireland. From what can be discerned, AWS appears to be heavily reliant on data center operations based in the U.S. A recent analysis indicates that the vast majority – over two thirds – of the servers powering the AWS E2 Elastic Computing cloud computing platform are based in data centers in Northern Virginia, an area where the grid is particularly coal-heavy.

Energy Efficiency and GHG Mitigation: D

AWS has published a limited amount of information on the energy efficiency of its data centers, though far less than Google, Facebook and others in the sector, even though it likely has significant learnings from its ability to effectively scale to meet rapidly increasing demand. However, AWS does not appear to have any environmental goals and it does not publish metrics to evaluate data center performance or impact.

Renewable Energy Investment and Advocacy: F

Despite its significant size and resources, AWS does not appear to have made any purchases or investments in renewable electricity for its facilities. AWS is currently falling out of step with other major cloud companies who are putting in place a long-term business strategy that accounts for impacts the company will face due to climate change.

One of the most world's highest valued companies, with a market cap of over $500bn USD and $100bn in cash reserves at the time of this writing, Apple has proven to be incredibly successful through innovative hardware and software in its smart phones and tablets through its popular iPhone and iPad brands. Building on the recent string of phenomenal "i" product success (iTunes, iPhone and iPad), Apple is now investing heavily in the "iCloud" as a means to tie all of these products together, affording the user seemless sharing of music, movies and other e-content. To deliver iCloud services, Apple has dramatically expanded its data center infrastructure. It has invested at least $1bn in an "iDataCenter" in North Carolina, one of the world's largest data centers, and just announced another facility to be built in Prineville, Oregon. Unfortunately, both of these investments are powered by utilities that rely mostly on coal power. Given the lack of transparency, siting policy or a clear commitment to power the iCloud with renewable energy, Apple is finding itself behind other companies such as Facebook and Google who are angling to control a bigger piece of the cloud. Instead of playing catch up, Apple has the ingenuity, on-hand cash and innovative spirit to Think Different and make substantial improvements in the type of energy that powers its cloud.

Transparency: D

Apple has been incredibly selective about the energy-related details of its iCloud in North Carolina, offering those nuggets of detail and data that it feels are most favorable, such as the size or scale of onsite renewable energy investment, but refusing to disclose the size of the energy demand of the facility itself, or the environmental footprint associated with the iCloud.

Infrastructure Siting: F

Apple's two most recent data center announcements to power the iCloud (Maiden, NC and Prineville, OR) highlight the urgent need for a rapidly expanding cloud company to establish a siting policy with access to renewable energy as a key criteria. The absence of such a policy or strong corporate goal to guide Apple has resulted in iCloud data centers being built in regions served by dirty utilities that are heavily (50-60%) reliant on coal.

Energy Efficiency and GHG Mitigation: D

Apple has provided high-level evidence of a number of innovative energy efficient design features in its Maiden, NC iCloud data center. Apple has also revealed other non-energy related design features that have earned it a LEED Platinum designation. However, Apple's lack of transparency on the performance of the facility and detail of the energy savings design features make it difficult to evaluate its performance. This lack of transparency and detail of data also make it difficult for other IT brands to learn from and improve upon Apple's best efficiency practices.

Renewable Energy Investment and Advocacy: D

Apple's decision to invest in on-site renewable energy generation for its Maiden, NC iCloud data center is a good first step, and should provide as much as 10% of the total energy demand with clean energy. If Apple is really interested in having the "high percentage" of renewable energy it claims to want for the iCloud, it will have to look beyond the initial steps for on-site generation and use its tremendous cash reserves to invest in or purchase renewable energy and also to put pressure on Duke Energy to provide cleaner energy.

Known as a leading computer maker in both the consumer and enterprise markets, Dell has aggressively moved into the data center space in the past few years, through acquisitions such as Perot Systems and capital investments. In a number of areas, Dell is building the foundation to be an environmental leader in the data center arena; it can build upon its thorough company-wide disclosure of greenhouse gas (GHG) emissions by delving into the specific emissions and carbon performance of its growing data center fleet. Similarly, the company can use its ambitious absolute target for GHG reductions (40% of 2007 levels by 2015) as impetus to drive more direct investment in and utility access for renewable energy for its expanding business.

Transparency: C

Dell extensively discloses its overall company carbon footprint, and is one of a handful of companies filing initial declarations on its supply chain (Scope 3) footprint. Given its substantial GHG reduction goals, Dell has showcased a number of ways it is reducing energy consumption and deploying renewable energy solutions within its infrastructure. Given the growth of its data center footprint, Dell should include the emissions factors and renewable energy percentage of its data center fleet, and disclose the carbon intensity of its IT services, using metrics like CUE that its staff have contributed to building through entities like the Green Grid.

Infrastructure Siting: C

Dell's data center business is growing: in the past year, the company announced a billion-dollar spend over two years in 10 countries on data center infrastructure. Just this month, executives were forecasting[47] up to 20 data centers in Asia over the next few years. Having a formalized siting policy that prioritizes access to renewable energy for its infrastructure investment is of paramount importance given these expansion plans. Dell's current absolute GHG emission reduction goals (40% below 2007 levels by 2015) for the company dictate that it can't meet these goals by powering its data center expansion through coal.

Recent investments, such as Quincy, Washington, showcase a preference for renewable energy. Dell's exact plans for siting its growing infrastructure is unclear; it should announce a preference for renewable energy to better clarify its policy to various utilities and countries vying for its business.

Energy Efficiency and GHG Mitigation: C

Given Dell's overall growth plans for its data center footprint, it will have to manage this growth within its ambitious short-term, company-wide GHG reduction goals. Dell has carried its company-wide focus on efficiency into the data center operations space, and has highlighted[48] a number of ways it is investing in best practices for efficient data centers, and also innovating in data center design, such as in its modular[49] systems. The company can take a lead from Facebook and further open source its efficient design specifications. It could also push the boundaries of how it reports its efficiency metrics by publishing computing-based energy performance.

Renewable Energy Investment and Advocacy: D

Dell details[50] that 21% of its electricity (and 17.4% of overall energy use) is purchased using renewable energy, as defined by the U.S. EPA's Green Power Partnership. This appears not to count the grid mix of utility supplied energy, which in certain areas of Dell's infrastructure, such as Austin, Texas and Quincy, includes renewable energy as a portion of the electricity mix. While not valueless, spending money on renewable energy certificates (RECs) should be augmented by additional strategies for increasing renewable energy, such as sizable direct renewable investment, and spending valuable political capital to advocate for renewable supply from utilities and regulators. Dell has been relatively silent on these fronts.

Facebook, the social networking site that now has 845 million users worldwide, has recently taken significant steps in putting itself on a path to being both a leader in energy efficiency, and powering its platform with renewable energy. In the past year, the company announced a new siting policy that prioritizes clean energy for its infrastructure and it has built a new data center in Sweden that will be almost exclusively powered by renewable energy.

Transparency: D

Open Compute Project, launched by Facebook, provides an opportunity to be an open-source model not only in the transparent use of equipment and design of data centers, but also in the disclosure of data centers' emissions and energy sources. Facebook has yet to provide any data on its energy consumption or related GHG emissions at either a corporate or facility level. This is likely to change after the company goes public. The company, through the Open Compute Project, does disclose best practices in energy efficiency measures, which are mainly captured in that separate category.

Infrastructure Siting: B

Facebook was one of the first companies to publicly announce[51] a preference for renewable energy supply when siting its data center infrastructure. The company stated that renewable supply was a key factor in its recent investment in Lulea, Sweden, a data center powered almost exclusively by renewable energy. This is a critical step forward for the environment as the company continues to build out infrastructure. It also signals to power producers vying for its business that they should be investing in renewable energy to enhance the likelihood of procuring Facebook's business.

Energy Efficiency and GHG Mitigation: B

Through Facebook's Open Compute Project, the company published a number of designs and equipment specifications to truly enable learning in areas of data center energy efficiency. The company has showcased how the design of its data centers minimizes energy demand as well as water consumption, which is especially critical for its high desert infrastructure.

Renewable Energy Investment and Advocacy: C

Facebook's announcement[52] that it will increase the amount of renewable energy powering its data centers will likely raise this score as the company continues implementation, which will include lobbying local utility and regulators for additional access to clean energy. At the moment, Facebooks's investment in Lulea, Sweden provides the bulk of the company's overall renewable energy use, and the company has not yet set specific targets for future generation.

Google is a multinational public cloud computing, internet search and advertising corporation; and one of the world's most recognized brands. Google has been the most open in the industry about the importance of increasing not only energy efficiency within the sector, but also the need to move our energy sources to renewable energy. Google has made significant efforts to increase the company's transparency. This is a great step forward that will enable better awareness of energy and carbon management associated with data consumption

Transparency: B

In late 2011, Google increased the transparency of its environmental footprint significantly. The company finally published its energy usage[53] and GHG footprint for the first time. Google has also provided white papers on its energy procurement plans, and basic information to end users on the energy/carbon footprint associated with its various services.[54] Nonetheless, there is room for improvement. Google needs to be transparent with its emissions breakdown and reporting of facility level energy demand mix. The company should set clear goals to reduce absolute carbon emissions.

Infrastructure Siting: C

Google continues to claim to choose renewable energy "where it makes sense" and applies a shadow price for carbon when calculating the power costs of potential data center sites. However, its most recent investments in Asia (Singapore, Taiwan and Hong Kong) put into question the company's prioritization for clean energy sources in the siting of its data centers.

Energy Efficiency and GHG Mitigation: B

Google has a comprehensive energy reduction plan[55] that has resulted in its data centers using half the energy of the industry standard. Google publicizes these best practices[56] on its design choices in order to help improve efficiency within the sector. Nevertheless, there are some concerns over Google's plans to build three data centers in Asia[57] where efficiency can be a challenge due to the climate conditions in the region.

Renewable Energy Investment and Advocacy: A

Google's commitment to using renewable energy[58] *as much as possible* has set the bar for the industry. Google has recently increased its goal of renewable energy purchasing from 25% to 35%[59] of total energy use and added a $94m investment[60] in a portfolio of four solar photovoltaic projects in California. These actions, among a slew of other investments, are playing a useful role in the total expansion of renewable energy. Google has highlighted the benefits of clean energy innovation in a recent study[61] and through its involvement in the lobbying debate[62] to advance clean energy policies in the United States.

Known to many as the world's leading manufacturer of personal computers and printers, Hewlett-Packard (HP) is a diversified IT company that also has significant business in providing cloud services, software and IT solutions among its other hardware product divisions. While HP has consolidated the amount of data centers it owns over the past five years, its data center business has grown due to acquisitions of companies like Electronic Data Systems (EDS) in 2008 and the overall industry growth in cloud services.

Transparency: C

HP discloses its company-wide carbon footprint in a number of forums, and specs[63] out detailed energy, electricity, and emissions data across its business. Over the past few years, HP was able to show significant reductions in data center footprint due to its consolidation efforts. The company participates in the Carbon Disclosure Project voluntary reporting program.

HP does not, unfortunately, report specific energy or emissions data for its data centers, which makes it more difficult to understand the impact that data center investments are having on HP's overall environmental performance metrics and the reduction goals the company has set. Given that HP both owns and manages data center operations for itself and other clients, increasing the level of data center footprint disclosure could provide HP's clients the energy and carbon footprint associated with the use of its services. Considering the number of companies that need to measure and reduce carbon footprints, this makes good business sense for HP in addition to being appropriate environmental leadership.

Infrastructure Siting: D

HP has touted the energy efficiency gains obtained through its server and data center consolidation over the last five plus years. Yet the company selected some of the dirtiest parts of the U.S. electricity grid to site its new, paired data centers (Houston and Atlanta). Think of the further GHG savings that would have occurred if HP had implemented a siting policy that had prioritized investment near sources of renewable energy.

Despite listing "feasibility of renewable energy" as one of many criteria it employs when looking to site a data center, the company states that it is often at the mercy of its clients and its geographic needs for data center locations. There's some truth in this statement, but at the end of the day, there are data centers that are owned and operated by HP for its clients that will be counted on HP's emissions data tally. Given this footprint burden, the company will need to implement stronger preferences for renewable energy in order to achieve its targets for GHG mitigation and renewable energy usage targets.

Energy Efficiency and GHG Mitigation: B

HP has made several industry-wide contributions towards the advancement of energy efficiency and best-practice GHG mitigation strategies for data centers. While the company helped create and drive the adoption of the PUE as an efficiency metric, the company now recognizes the need to go beyond the limits of PUE to better measure computational and energy usage efficiency. HP is actively developing some of the next-generation efficiency metrics.

Through a number of white papers, studies and innovations from its Labs division, HP has showcased best practices for optimizing energy efficiency in data centers, as well as calculating some theoretical full-cost accounting for data center costs, including supply chain emissions for the data center equipment. Finally the company has significant potential efficiency and energy gains if the promise of its Project Moonshot[64] prototype is adopted at scale.

Renewable Energy Investment and Advocacy: C

HP operates a larger, more diversified business than some other entrants assessed in this report. The smaller percentage of renewable energy the company purchases, currently 8%, should be evaluated against the company's significant electricity and energy expenditures. But it is exactly the size of these overall expenditures that makes it paramount that the company grow in a cleaner fashion and not simply buy RECs to mask investments that drive more coal usage. HP has taken some promising first steps, having signed direct power PPAs in San Diego for electricity, and fully powering all of its UK offices and data center with 100% renewable energy. One of a handful of companies willing to get its hands dirty in the policy arena on climate and energy issues, HP should continue to increase its modest advocacy steps and use its large buying power to lobby its utilities and government for more access to renewable energy.

IBM, one of the oldest, largest and most well-known technology companies, was one of the early adopters in shifting investment from the consumer space to provide data center, cloud and consulting services to the world's largest businesses. The company has significantly reduced its own GHG footprint through a variety of innovative and energy efficient means, but can improve specifically in the disclosure of its data centers' carbon footprints and the company's plans to mitigate this GHG growth. IBM should go beyond investing in renewable credits, and increase the clean energy supplying its business through direct investment and through advocating for more supply from utilities and government.

Transparency: C

IBM participates in the Carbon Disclosure Project (CDP) voluntary reporting program and provides significant, detailed information on the total GHG emissions of its business. However, despite claiming to own or operate over 450 data centers 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.

Infrastructure Siting: D

IBM has a stated goal to increase its amount of company-wide GHG reductions via energy efficiency and renewable energy. This should play a significant role in guiding investment for IBM's infrastructure, including its data center expansion. However, given that the company does not report on facility level emissions data, it's unclear how IBM is meeting its increase in data center electricity demand with a growing supply of renewable energy. IBM should state a clear policy preference to site its new infrastructure near renewable sources of energy, like Facebook and Yahoo have done.

Energy Efficiency and GHG Mitigation: C

IBM has engaged in comprehensive emissions reductions and energy efficiency work, with the company achieving significant absolute GHG reductions over the past few decades. This second goal-setting period, aiming to end in 2012 (with the company achieving its goal ahead of schedule) should be renewed. The company should also be applauded for not achieving its GHG gains through the purchasing of carbon offsets.

The company should go beyond PUE and also report other computational metrics that better give a more meaningful picture of data center efficiency and environmental performance, such as CUE.

Renewable Energy Investment and Advocacy: D

IBM reports that 11.2% of its electricity in 2010 was covered through renewable electricity certificates. The company does not disclose what percentage of these RECs was bundled with renewable electricity it purchased, or was retired. Nor does it provide clarity on the role RECs play in the company's overall strategy for increasing renewable energy generation. The company does not report the grid mix of electricity it buys, nor does it report the renewable content of that mix. While demonstrating to governments the feasibility of energy efficiency and GHG reductions, IBM remains largely on the sidelines on policy advocacy, and this extends to issues around increasing renewable energy supply

Microsoft®

Microsoft is experiencing rapid growth in its cloud infrastructure as it seeks to shift to a cloud-based delivery of software, and is making significant investments in both new and existing data center locations to meet expected demand. Microsoft has a strong brand profile in both consumer and business spaces through its cloud offerings. Microsoft has also invested resources in creating more efficient data centers and is beginning to share more design details within the sector. With the company's growing infrastructure and GHG emissions, a more detailed plan must include the prioritization of installed and purchased renewable energy from the grid.

Transparency: C

Microsoft expanded its cloud infrastructure rapidly in 2011 by opening and expanding a number of major data centers in both the U.S. and Ireland. The company has set a relative goal of reducing its carbon emissions by 30% per unit of revenue from 2007 levels by 2012, citing a focus on data centers as one of three necessary components in achieving this goal. The company has also set a goal of reducing its data centers' PUE to 1.125 by 2012[65]. Though its focus on reducing the impacts of its data centers is commendable, more transparency and disclosure is needed to show real leadership in the sector.

Infrastructure Siting: D

Microsoft does not appear to have a stated or consistent data center siting policy that gives preference to renewable energy sources. Though Microsoft shows progress in some areas (such as the expansion of the Quincy, WA and Dublin, Ireland sites) the company is expanding[66] its data center infrastructure in Virginia, which is heavily reliant on coal and nuclear.

Energy Efficiency and GHG Mitigation: C

Microsoft continues to work to identify and address key opportunities for IT energy efficiency gains. The company is also sharing its efficiency designs[67] with others in the sector, specifically the expansion of its Dublin, Ireland site[68]. Microsoft's energy efficiency efforts include attempting to decrease its PUE to 1.125 by 2012.

Renewable Energy Investment & Advocacy: C

The company has set a goal to increase renewable energy (RE) in its overall electricity sourcing. However, Microsoft's 2012 goal is only a 1% increase from its current 24% worldwide RE use to 25% goal, which hardly sets a bar for leadership. Microsoft has contracts for 100% renewable energy for both its UK and Ireland data centers. While the company states that its energy sourcing is a mix of direct installation and RECs, it fails to provide more specific details. Unlike Google, Microsoft is failing to use its buying power and financial resources to secure significant amounts of renewable energy for its growing cloud business. And unlike Google or Yahoo, despite having significant lobbying power, it remains unwilling to push either governments or utilities to include more renewable energy in the grid.

ORACLE®

Oracle is one of the world's largest software companies, providing enterprise-level hardware and software services to the world's largest companies. Oracle currently powers its cloud services and solutions through three main data centers in Texas, Colorado and Utah.

Transparency: D

Oracle reports the company's GHG emissions to the Carbon Disclosure Project at a corporate-wide level, and has established some modest GHG reduction and efficiency goals for portions of its business including U.S. owned and leased buildings and PUE of data centers. Oracle does not disclose its energy mix at a facility level or disclose the amount of renewable energy it uses. It does not provide any carbon intensity metrics and does not share the carbon footprint with consumers who use its products.

Infrastructure Siting: D

Oracle does not state a public preference for renewable energy supply when it sites its data centers, nor does it have a goal for renewable energy percentage of future investments. As the company consolidated its data infrastructure in the past five years, it now has data centers in Texas, Utah, and Colorado, and only the Austin, Texas utility has significant plans to expand its renewable energy offerings and set carbon reduction goals.

Energy Efficiency and GHG Mitigation: C

Oracle has set a modest goal of 10% reduction in energy use for its owned and leased buildings in the United States, by 2016 from a 2010 baseline. This would include its three owned data centers in the United States. The company has also set a goal to increase the PUE of its data centers by 6% within the same time frame. The company has been active in showcasing innovation in its data center operations to drive savings and efficiency across the sector. To score higher, Oracle must disclose its energy performance on a facility level, push for more ambitious goal setting, and report on computing based energy performance metrics in addition to PUE.

Renewable Energy Investment and Advocacy: D

Oracle does not have a stated goal or vision to power its data center infrastructure with increasing amounts of renewable energy. The company did purchase 5% of its power for its data centers using an undefined green power-purchasing program. This goal was met in 2010; no announcement has been made to renew or upgrade this goal. Oracle is not active in advocating for more renewable energy access or renewable energy targets at the utility, regulatory or legislative levels.

Rackspace launched in 1998 as an IT hosting business, including cloud hosting, email and apps, and managed hosting. Rackspace's profits rose roughly 69% in the third quarter of 2011 to reach $20m. Rackspace's core business is IT hosting, unlike many companies who offer cloud services as one service of many. The company sits in the middle of those graded in this report. In order to improve its scoring, Rackspace needs to be more transparent about its environmental impacts and the steps it is taking in mitigating those impacts in regards to its data center and renewable energy investments.

Transparency: C

Rackspace reports basic information on the total power demand of its cloud computing services, and a limited amount of information on its GHG emissions at both corporate and at facility levels. Rackspace does not participate in the Carbon Disclosure Project.

Infrastructure Siting: C

Rackspace has an established Global Energy Policy; the company includes energy mix from a potential facility site in the decision making process. The policy also includes the availability of purchasing or installing renewable energy. However, it doesn't appear that the company prioritizes this information in decision-making, but merely assesses the potential. Rackspace's Slough data center located in the UK is fueled 100% by renewable energy through the purchasing of levy-exempt certificates.

Energy Efficiency and GHG Mitigation: C

Rackspace is a member of the Green Grid and the Open Compute Project. The company also provides some information on its eight data centers, including each facility's power consumption.

Renewable Energy Investment and Advocacy: C

Rackspace has contracted for 100% renewable energy for its UK Slough data center and has purchased a 5% renewable energy contract for one of its Dallas, Texas facilities. The company also evaluates renewable energy opportunities at its data center locations and holds discussions with local utilities on an ongoing basis about its options to expand its facilities renewable energy.

Salesforce needs no circuitous connection to the cloud. With the white fluffy emblem emblazoned on its corporate logo, Salesforce is the world's largest vendor of enterprise cloud computing, under the model of software as a service. Salesforce's data center portfolio is comprised of 100% leased space and because it is dispersed and decentralized, the company has both unique environmental challenges and opportunities. Salesforce prominently promotes the energy savings benefits of its software as compared to hosting a similar capacity on premises or even privately managed cloud deployment. The company should be more forthcoming in disclosing the emissions from its data centers and cite a clear preference to build out its infrastructure with renewable energy wherever possible.

Transparency: B

Salesforce reports its GHG emissions and energy consumption to the Carbon Disclosure Project at the corporate level. Nevertheless, the company is reluctant to set a target to reduce emissions until its data collection infrastructure improves. Salesforce claims to be in the early stages of requiring its rented facilities to provide energy and water performance data, which will hopefully inform its site selection in the future. Salesforce discloses its emissions factors per country as well as its estimated emissions performance per unit (per click).

Infrastructure Siting: C

Salesforce does not build or own its own data centers, but rents space for its servers from colocation providers. Its environmental policy[69] states that the company uses environmental criteria when choosing the location of its leased facilities and is committed to considering the local energy supply. However, its policy doesn't state a clear preference for investments attached to renewable energy, and the latest transactions leases have been in Illinois[70] and Virginia, two U.S. states that heavily depend on coal and nuclear. To score higher, Salesforce needs to be more open with its information per facility and demonstrate that its energy policy is more than a declaration of intentions.

Energy Efficiency and GHG Mitigation: C

Salesforce is committed to considering the energy efficiency of the vendors' data centers. Its new data center in Japan is air-cooled which will significantly reduce the overall power demand for this facility and will have minimal water demand in comparison to a traditionally-cooled data center. Salesforce should set energy efficiency targets as soon as its much needed data collection infrastructure is in place.

Renewable Energy Investment and Advocacy: C

Salesforce reports a certain number of RECs, however this can't be placed into context, as the percentage of electricity demand that comes from renewable energy is not disclosed. Salesforce should use its purchase power and identify opportunities with its vendors to utilize clean energy, and should build upon its advocacy engagement, as demonstrated in supporting the Guadalajara Declaration, to include policy efforts that will directly lead to greater amounts of renewable energy being put on the grid.

Twitter has grown over the past year not only in the number of users and tweets per day but also in its impact on people's ability to communicate through several social justice uprisings across the globe. While assisting in the efforts to challenge the transparency of others, the company remains quiet on its own energy use and associated environmental impacts.

Transparency: F

Twitter stays at the bottom of the industry pack for lacking transparency in disclosing the company's energy footprint. The company has failed to set goals on how to reduce its obviously increasing emissions.

Infrastructure Siting: D

Twitter has begun expanding its cloud infrastructure by leasing an existing site in the Sacramento, CA area after renting servers from NTT America. However, now that the company owns its own servers and is attempting to own its own locations, Twitter still does not have an infrastructure policy that takes either its growing environmental footprint or the need to mitigate climate change-inducing emissions into account.

Energy Efficiency and GHG Mitigation: F

Twitter has provided very little information on its leased Sacramento data center site. The company is not sharing design best practices or speaking on energy efficiency investments.

Renewable Energy Investment and Advocacy: D

Twitter consolidated most of its servers to a location in Sacramento, California in 2011, which has a high percentage of renewable energy. However, Twitter's decision to expand its operations by renting space in Atlanta, which has a high percentage of coal-fired electricity, means that Twitter would need to work harder to mitigate the footprint of its new facility, and will need to work with its colocation provider to demand cleaner energy options .

Yahoo is one of the biggest online destinations, maintaining both owned and rented data center space across the globe to support all its offered services. Because of Yahoo's large brand profile and business portfolio, the company is in a position to help move the industry towards a clean energy future. Yahoo has set new goals to reduce its emissions.

Transparency: C

Yahoo reports limited information to the Carbon Disclosure Project on its corporate environmental footprint. The reported data does not provide a clear picture of operational impacts, and cites 'competitive reasons' for its lack of transparency on its data centers. Yahoo does share best practices[71] on energy efficiency measures. However, the company needs to be more transparent on reporting of facility-level energy demand mix as a way to allow others to better understand its progress towards its 2014 reduction goals for offices and data centers.

Infrastructure Siting: B

Despite Yahoo's commitment to reduce the carbon intensity of their data centers by 40% by 2014, its latest data center siting decisions undermine Yahoo's cleaner energy path. Yahoo currently has several active data center construction projects[72], including expansions at existing data centers in Nebraska and Washington State and new facilities in Singapore and Switzerland with the latest cooling design technologies. However, the company has not made public its renewable energy investment strategy for these new facilities.

Energy Efficiency and GHG Mitigation: B

Yahoo has been recognized for having built some of the world's most efficient facilities using a unique "chicken coop"[73] design that runs almost entirely on free cooling. Yahoo claims to share its innovation successes at data centers to enable improvement within the sector. The company professes that its data centers consume 40% to 50%[74] less energy, eliminate water for cooling and wastewater, and use outside air economizers. The new data center in Switzerland will be the first implementation of a new design in a retrofit of an existing building.

Renewable Energy Investment and Advocacy: B

56% of the company's electricity demand for facilities can be met with renewable energy thanks to data centers in Washington and New York, built in 2007 and 2009 respectively. Yahoo claims that its data center in Washington State[75], powered by clean hydropower, sets the bar for all the facilities to come. Nevertheless, Yahoo's trend with investments in Nebraska[76] and more recently in Asia[77] do not disclose any significant renewable energy investment. Yahoo has been active in the U.S. in supporting continuing tax incentives for renewable energy deployment, and should continue and expand these efforts to increase policy incentives for renewable energy for all of its facilities.

Endnotes

1 Growth in data center electricity use 2005 to 2010, Jonathan Koomey (August 2011)
http://www.analyticspress.com/datacenters.html

2 http://www.datacenterknowledge.com/archives/2011/08/01/report-data-center-energy-use-is-moderating/

3 Intel CEO Paul Ontellini, Speaking at Dell World (October 2011)
http://www.informationweek.com/news/hardware/virtual/231901454

4 http://www.datacenterdynamics.com/research/market-growth-2011-2012

5 http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html

6 http://www.iea.org/press/pressdetail.asp?PRESS_REL_ID=428

7 http://mobithinking.com/mobile-marketing-tools/latest-mobile-stats#subscribers

8 http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html

9 http://www.reuters.com/article/2012/03/07/india-telecoms-subscribers-idUSL4E8E71L320120307

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

10A http://trai.gov.in/WriteReadData/Recommendation/Documents/Green_Telecom-12.04.2011.pdf

11 How Dirty is Your Data? (2011), p.15, Energy efficiency rebound effect - Jevons Paradox

12 Cloud Computing and Sustainability (Microsoft with Accenture and WSP), November 2010; Cloud Computing - The IT Solution for the 21st Century (Carbon Disclosure Project and Verdantix, supported by AT&T), July 2011

13 http://www.greenqloud.com/

14 http://investor.mcgraw-hill.com/phoenix.zhtml?c=96562&p=RssLanding&cat=news&id=1573196

15 Clean energy investments reported as totaling $915 million (USD) http://www.google.com/green/energy/investments/

16 http://googleblog.blogspot.com/2011/04/investing-in-worlds-largest-solar-power.html

17 http://www.greenpeace.org/coolit/

18 http://www.bitkom.org/files/documents/Energieeinsparpotenziale_von_Rechenzentren_in_Deutschland.pdf

19 Broad Group, Oct 2011. German Data Centres: Market Report.

20 http://www.datacenterdynamics.com/research/market-growth-2011-2012

21 Germany gross electricity production mix in 2011.
http://www.bdew.de/internet.nsf/id/DA3DD0BD5352F45BC12579B30034A0C9/$file/120229%20Bruttostromerzeugung%202010%20und%202011%20Vergleich.pdf

22 http://www.wirtschaftsdienst.eu/archiv/jahr/2011/4/2555/?PHPSESSID=7fc7eb7165ea9d306a8e6f84aaa3f5a1

23 http://www.bitkom.org/files/documents/090908_BITKOM-Informationen_zum_UIP_des_BMU%281%29.pdf

24 Ming Pao News, 9 February 2012.

25 http://www.datacenterknowledge.com/archives/2011/12/08/google-to-open-300-million-hong-kong-data-center/

26 http://www.epd.gov.hk/epd/english/climate_change/files/Climate_Change_Booklet_E.pdf

27 http://www.datacentre.gov.hk/en/powersupply.html

28 http://www.info.gov.hk/gia/general/201111/02/P201111020243.htm

29 As of the end of 2011, China's installed capacity of wind was 45.05 GW and solar was 2.14GW.
http://www.chinamining.org/News/2012-03-05/1330925978d54936.html

30 https://www.electricireland.ie/ei/residential/manage-your-account/fuel-mix.jsp

31 http://www.iwea.com/index.cfm/page/windenergyfaqs?#q21

32 A form of tax relief, introduced under Section 62 of 1998 Finance Bill, is available for corporations making equity investments in renewable energy projects. The tax relief scheme applies to wind, hydro, solar and biomass energy projects approved by the Department of Public Enterprise. A company can invest up to €38 million (€12.69 p/a over three years) in a number of renewable energy projects for which it can recoup tax relief at whatever rate the company pays (currently 36% for corporations) from its own profits. http://www.seai.ie/Renewables/Renewable_Energy_in_Business_and_Industry/

33 SOMO (2012). Duurzaamheid in de Nederlandse Elektriciteitssector, available online
http://somo.nl/publications-nl/Publication_3766-nl

34 Greenpeace Netherlands (2012). Duurzaamheid in de Nederlandse Elektriciteitssector (Sustainability in the Dutch Electricity Sector). http://www.greenpeace.nl/graadmeter2012/ (in Dutch)

35 http://www.investsweden.se/world/Industries/ICT/Data-centers/

36 DatacenterDynamics for Enterprise Ireland (2010). Initial Evaluation of Opportunities in European Markets.

37 Nordic total electricity mix (including net import/export)
http://www.svenskenergi.se/upload/Vi%20arbetar%20med/Handel&F%C3%B6rs%C3%A4ljning/Filer/Ursprungsm%C3%A4rkning/V%C3%A4gl%20ursprungsm%C3%A4rkning%20%202011_0829_inkl%20bilagor.pdf

38 http://www.icc.illinois.gov/downloads/public/en/co%20%20med.pdf

39 http://www.awea.org/learnabout/publications/upload/4Q-11-Illinois.pdf

40 http://www.datacenterdynamics.com/research/market-growth-2011-2012

41 US Environmental Protection Agency eGrid 2010 v 1.1 (published May 2011). State Resource Mix.
http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2010V1_1_year07_SummaryTables.pdf

42 Dominion IR Reference Book (September 2011), 58.
http://investors.dom.com/phoenix.zhtml?c=110481&p=irol-irhome

43 Dominion New Directions in Energy
http://www.hrp.org/Site/docs/ResourceLibrary/Dominion%20Power%20Presentation%20to%20VB%20Alt%20Energy%20Task%20Force_6_3_.pdf

44 http://www.bpa.gov/corporate/about_BPA/Facts/FactDocs/BPA_Facts_2010.pdf

45 http://www.pacificpower.net/content/dam/pacific_power/doc/About_Us/Rates_Regulation/Oregon/OR_LabelInsert_LargeBiz.pdf

46 http://huanliu.wordpress.com/2012/03/13/amazon-data-center-size/

47 http://www.computerworld.com/s/article/9225221/Dell_plans_over_20_data_centers_in_Asia_as_customers_look_to_cloud

48 http://content.dell.com/us/en/fedgov/fed-federal-health-solutions-data-center-efficiency

49 http://content.dell.com/us/en/enterprise/by-need-it-productivity-deploy-systems-faster-modular-data-center

50 http://content.dell.com/us/en/corp/d/corp-comm/cr-earth-resource-conservation.aspx

51 http://www.greenpeace.org/international/Global/international/publications/climate/2011/Cool%20IT/Facebook/Facebook_Statement.pdf

52 http://www.greenpeace.org/international/Global/international/publications/climate/2011/Cool%20IT/Facebook/Facebook_Statement.pdf

53 http://www.google.com/green/bigpicture/

54 http://www.google.com/green/bigpicture/#/intro/infographics-1

55 http://www.google.com/about/datacenters/index.html

56 http://www.google.com/about/datacenters/best-practices.html

57 http://www.datacenterknowledge.com/archives/2011/09/28/google-to-build-three-data-centers-in-asia/

58 http://www.google.com/green/energy/use/#purchasing

59 http://www.google.com/green/bigpicture/#beyondzero-grid

60 http://googlegreenblog.blogspot.com.es/2011/12/ending-year-with-another-clean-energy.html

61 http://www.google.org/energyinnovation/enough.html

62 http://www.nytimes.com/gwire/2011/03/09/09greenwire-google-recruits-lobbying-muscle-to-promote-gre-44273.html

63 http://www.hp.com/hpinfo/globalcitizenship/environment/data_and_goals/data_table.html

64 http://h17007.www1.hp.com/us/en/iss/110111.aspx

65 http://www.microsoft.com/about/corporatecitizenship/en-us/reporting/working-responsibly/environmental-sustainability/

66 http://www.datacenterknowledge.com/archives/2011/09/23/microsoft-steps-up-cloud-expansion-plans/

67 http://www.microsoft.com/presspass/features/2011/apr11/04-19GreenDatacenters.mspx

68 http://blogs.technet.com/b/msdatacenters/archive/2012/03/05/microsoft-s-dublin-data-center-grows-with-enhanced-efficiency-and-sustainability.aspx

69 http://www2.sfdcstatic.com/assets/pdf/datasheets/DS_salesforcedotcom_Environmental_Policy_Q2FY11.pdf

70 http://www.illinoisbiz.biz/NR/rdonlyres/EA15E8A9-E0BD-468A-A308-BE58E93D0C03/0/CoalInIllinois2011.pdf

71 http://www.datacenterknowledge.com/archives/2010/04/26/yahoo-computing-coop-the-shape-of-things-to-come/

72 http://www.datacenterknowledge.com/archives/2011/03/11/yahoo-plans-500-million-data-center-expansion/

73 http://www.datacenterknowledge.com/archives/2011/09/07/will-changes-at-yahoo-impact-hosting-operations/

74 http://www.ydatacentersblog.com/blog/new-york/environment/

75 http://www.ydatacentersblog.com/blog/washington/

76 http://www.ydatacentersblog.com/blog/nebraska/

77 http://www.ydatacentersblog.com/blog/singapore/

All URLs reported in these Endnotes were accessed on 5 April 2012.

GREENPEACE

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For more information contact:
enquiries@greenpeace.org

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