Cloud Computing's Green Potential

Tom Raftery

Digital Trends 2011 - Green ICT & Cloud Computing

December 2011

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CIX, Chip & Zenith – involvement with Cloud, going back to late 90's

Who are you?

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Deployed cloud solutions? Or plan to...
How many think Cloud is Green?

Cloud Computing?

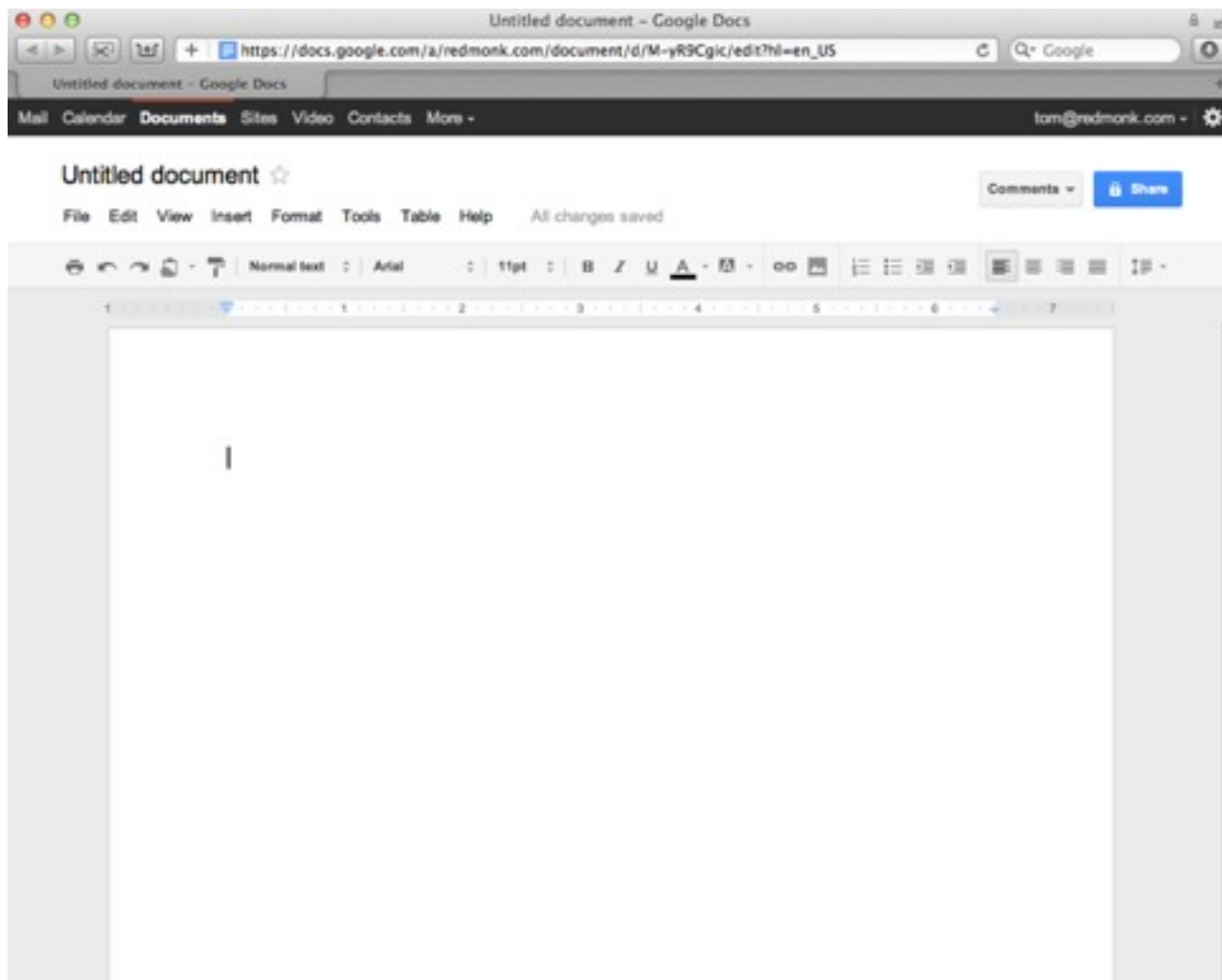Photo http://www.flickr.com/photos/saxoji/3157404267/

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Browser delivered

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First blush — it is simply browser delivered software — but much more now

Nothing New

Launched July 1996 – one of the 1st widely used SaaS applications
Goes back to mainframe computing in the 60's

SaaS

Photo http://www.flickr.com/photos/kiewic/4227455448/

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Social Networks, Zoho, Google Apps, SlideShare, Dropbox, etc.

PaaS

Photo http://www.flickr.com/photos/fhke/383366149/

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PaaS is like abstracting SaaS back one level – deploying, as a service, the platform to dev/rollout SaaS apps
Force.com, Google AppEngine, Microsoft Azure, Cloud Foundry, AppScale, etc

IaaS

Photo http://www.flickr.com/photos/br1dotcom/4297727518/

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IaaS abstracts back another level, making hardware (network, disk, cpu) available as a service
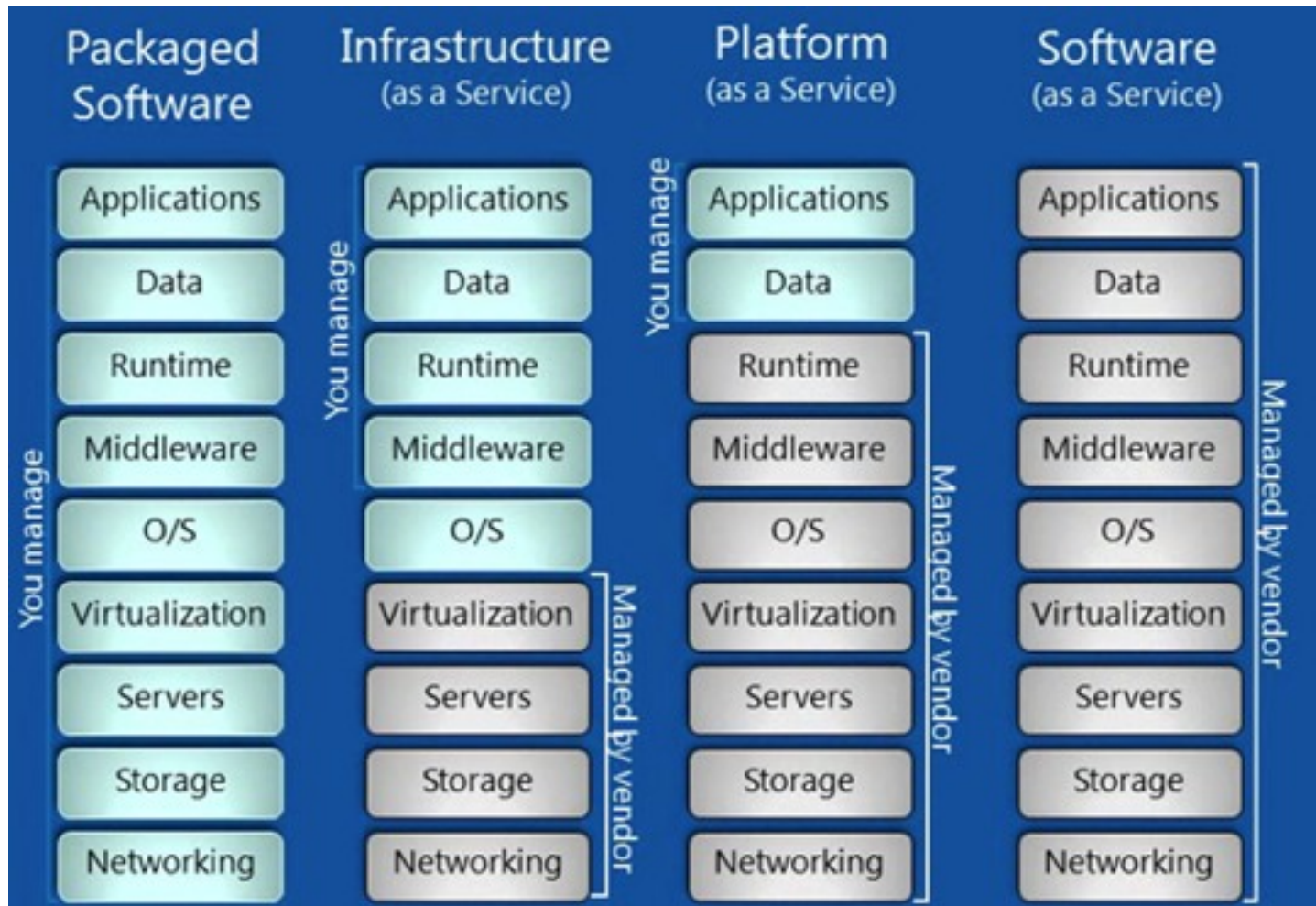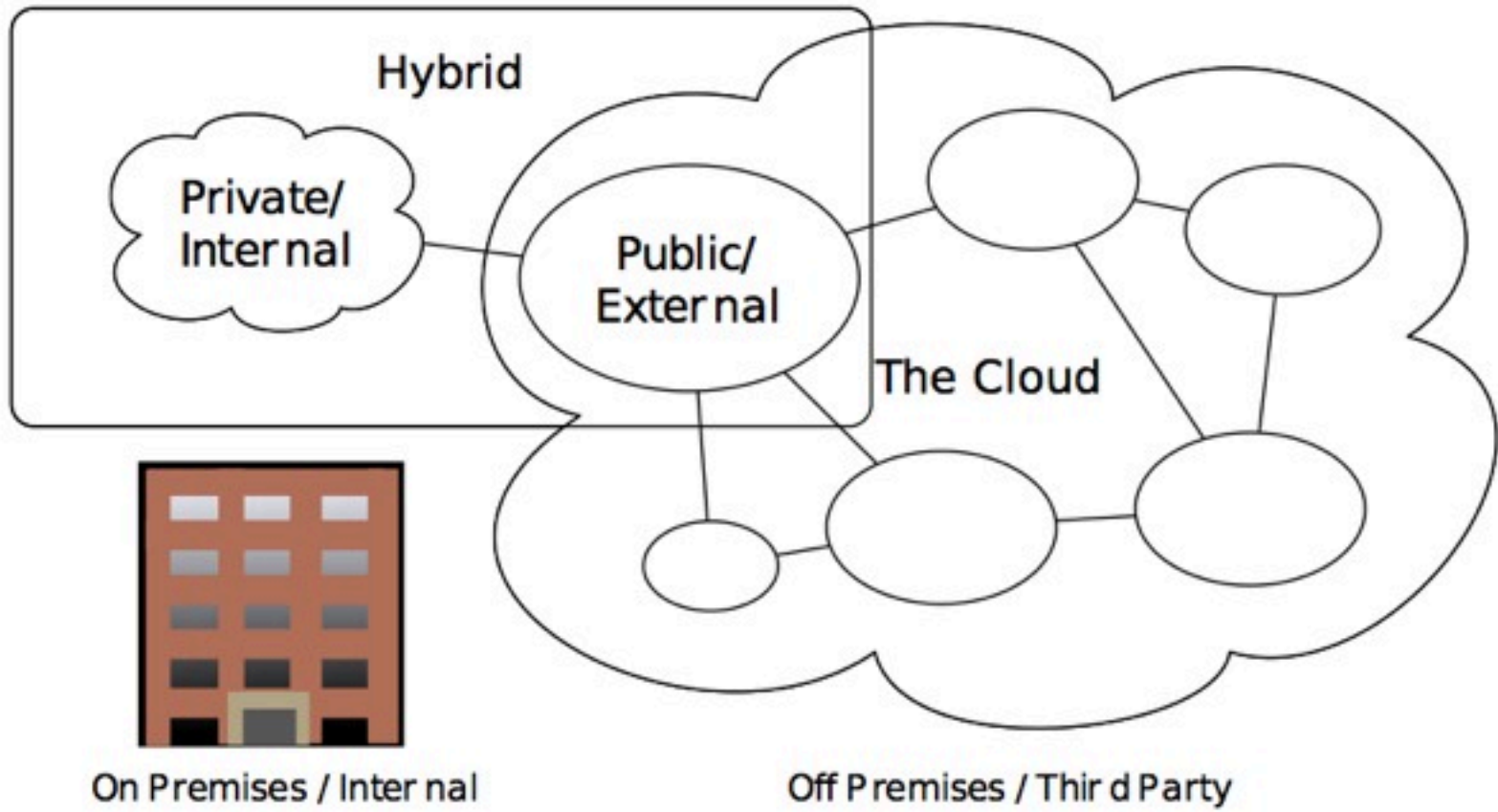Amazon EC2, S3, OpenStack, VMWare, Rackspace CloudForms

Huh?

Types

Cloud Computing Types

CC-BYSA 3.0 by Sam Johnston

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Energy Efficient?

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Energy & Carbon?

Microsoft, Accenture and WSP Environment & Energy Study Shows Significant Energy and Carbon Emissions Reduction Potential From Cloud Computing

November 2010

Link http://www.microsoft.com/Presspass/press/2010/nov10/11-04CloudBenefitsPR.mspx

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Energy & Carbon?

Microsoft, Accenture and WSP Environment & Energy Study Shows Significant Energy and Carbon Emissions Reduction **Potential** *From Cloud Computing*

November 2010

Link http://www.microsoft.com/Presspass/press/2010/nov10/11-04CloudBenefitsPR.mspx

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Streamlining

Photo: http://www.flickr.com/photos/pedrosimoes7/201099447/

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Traditional servers:
RFP -> PO -> Order -> delivery -> Image -> Patch -> Apps ->Test -> deploy - (weeks -> months)

Cloud
PO often not necessary (not large capital expense) - Order & deploy (minutes->hours)
Streamlining - faster to purchase & deploy virtual servers than physical ones
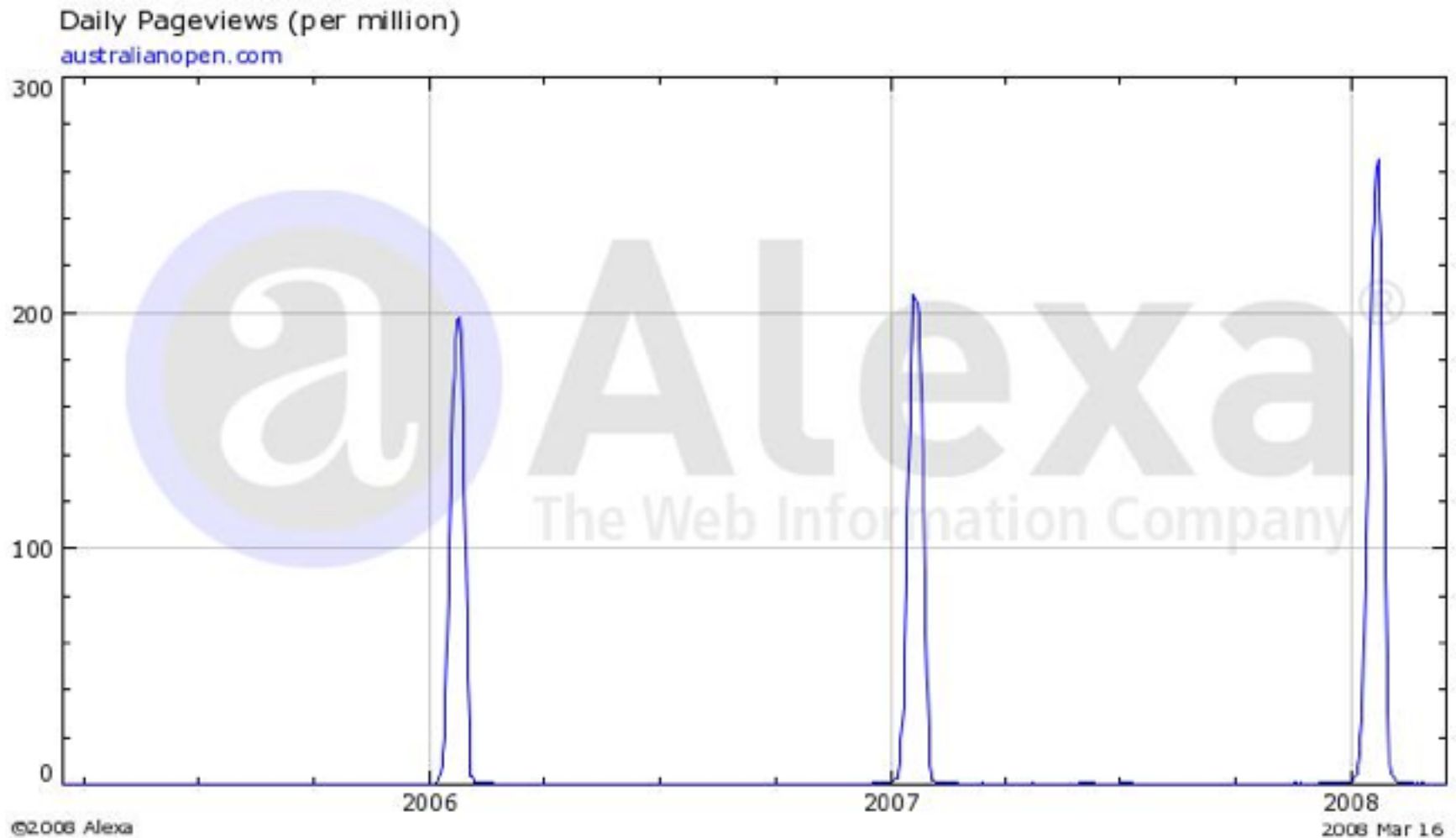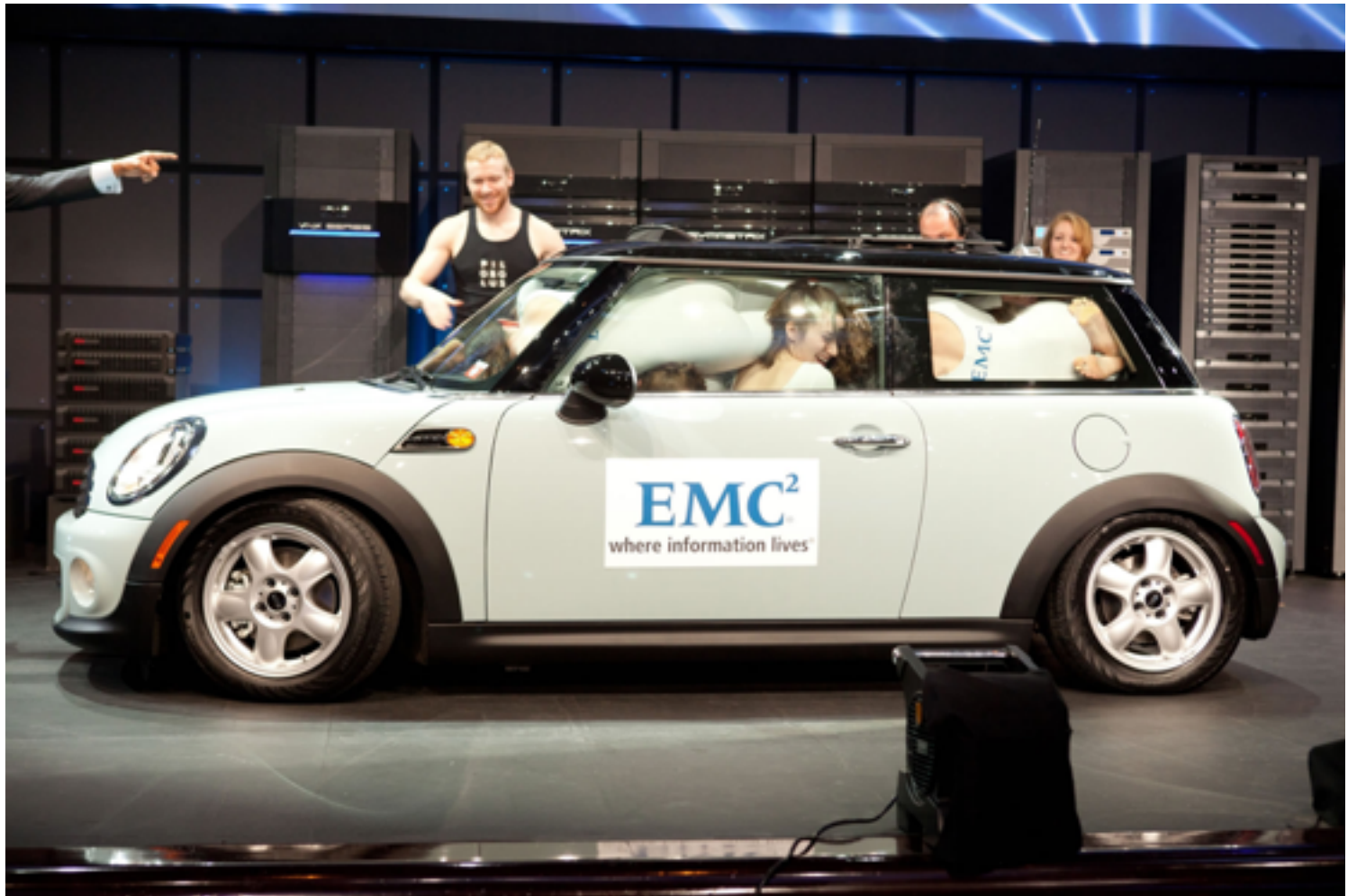
Dynamic Provisioning

Daily Pageviews (per million)
australianopen.com

2008 Mar 16

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Multi-tenancy

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Multi-tenancy
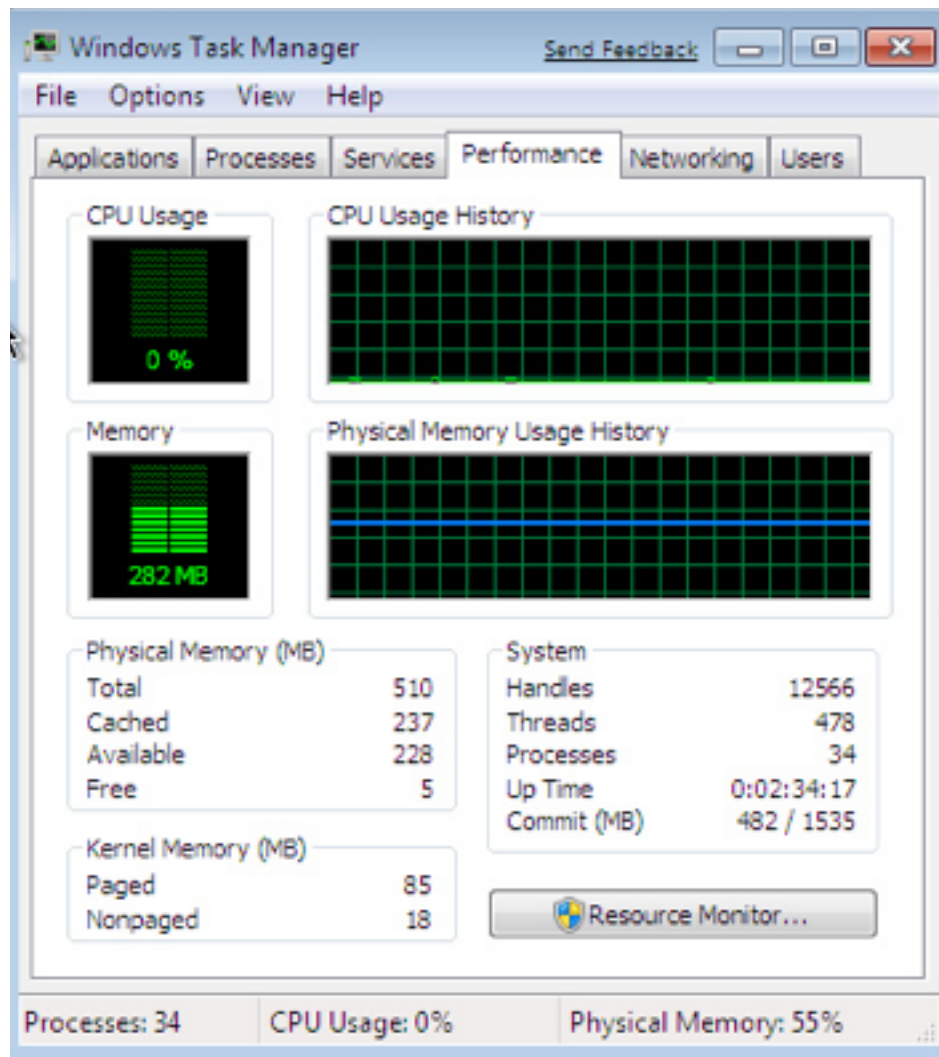
Server Utilisation

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Traditional servers under-utilised
Cloud ones?

Chasing the moon

Photo http://www.flickr.com/photos/traftery/5546154606/

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Chasing the moon

Ubiquitous Information

Photo http://www.flickr.com/photos/citrixonline/5447248934/

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Ubiquitous access to information enables work from anywhere (with a connection!)

Tele-working

Photo http://www.flickr.com/photos/citrixonline/5447248262/

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About 25% of IBM's 320,000 workers worldwide telecommute from home offices, saving $700 million in real estate costs.

Energy Efficient?

Less commuting &
Less building stock - yes

But less energy consumption or offsetting?

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Energy Efficient?

"If you can't measure it, you can't manage it"

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Energy Efficient?

Hands up exercise...

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Hands up if you have you moved some of your applications to a Cloud provider

Keep your hands up if you know what the energy consumption of that application was before moving it to the cloud

Keep your hands up if you know the energy consumption of your application after it has moved to the Cloud

Energy Efficient?

Without data, no way to know, but...

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Given lack of data - impossible to say

Energy Efficient ≠ Green

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Common mistake is to conflate energy efficiency with Green

Green?

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CDC Report

"A typical food & beverage firm transitioning its human resources (HR) application from dedicated IT to a public cloud can reduce CO2 emissions by 30,000 metric tons over five years"

Cloud Computing – The IT Solution for the 21st Century
CDC & Verdantix
July 2011

https://www.cdproject.net/en-US/WhatWeDo/Pages/Cloud-Computing.aspx

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CDC Report

*"allowing companies to maximize performance, drive down costs, reduce inefficiency and minimize energy use – **and therefore carbon emissions**"*

Cloud Computing – The IT Solution for the 21st Century
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https://www.cdproject.net/en-US/WhatWeDo/Pages/Cloud-Computing.aspx

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Association of energy & carbon is a fundamental error – depends on the source of the energy (renewable vs fossil fuel)

Reducing energy use doesn't necessarily reduce CO_2

Takedown

GreenMonk: the blog

Green from the roots up, Sustainable from the top down

ABOUT   BRIEFINGS/SALES   ENERGY & SUSTAINABILITY SHOW   PRIVACY POLICY

Carbon Disclosure Project's emissions reduction claims for cloud computing are flawed

The Carbon Disclosure Project (CDP) is a not-for-profit organisation which takes in greenhouse gas emissions, water use and climate change strategy data from thousands of organisations globally. This data is voluntarily disclosed by these organisations and is CDP's lifeblood.

Yesterday the CDP launched a new study Cloud Computing – The IT Solution for the 21st Century a very interesting report which

> delves into the advantages and potential barriers to cloud computing adoption and gives insights from the multi-national firms that were interviewed

http://greenmonk.net/carbon-disclosure-projects-emissions-reduction-claims-for-cloud-computing-are-flawed/

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Based on assumptions and a PUE–based model – could just as easily increase emissions by 30,000 tons

PUE?

Power usage effectiveness (PUE): ratio of total amount of power used by a data center, to the power delivered to computing equipment.

http://en.wikipedia.org/wiki/Power_usage_effectiveness

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Hands up who has heard of/knows what PUE is...

PUE?

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Traditionally, no standard for where it is metered (some at HV, some at MV, some at LV) – includes all conversions (and losses) or not

PUE?

IT Equipment	Total Power	PUE
1MW	2MW	2.0
0.75MW	1.75MW	2.33

http://datacenterdesign.blogspot.com/2009/07/linkedin-discussion-on-power-usage.html

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No account taken of the efficiency of use of IT equipment
Turning off unused servers reduces your consumption but PUE goes up!

PUE?

Data Centre	Supply Carbon Intensity	PUE	IT Carbon Intensity
Typical	0.5kg CO2/kWh	1.5	0.75kg CO2/kWh
Good PUE mostly coal-fired power	0.8kg CO2/kWh	1.2	0.96kg CO2/kWh
Poor PUE but mostly renewables	0.2kg CO2/kWh	3.0	0.6kg CO2/kWh

http://www.romonet.com/blog/coal-fired-clouds

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In US – most Cloud Dc's are coal powered as it is lowest cost elec
DC with good PUE run on coal–fired power emits 50% more CO2/kWh than DC with poor PUE run on mostly renewables
Elec supply is more impt than PUE is assessing how Green a DC is
There is a CUE metric but is poorly adopted atm

Green?

*"A typical food & beverage firm transitioning its human resources (HR) application from dedicated IT to a public cloud can **increase** CO2 emissions by 30,000 metric tons over five years"*

Carbon Disclosure Project's emissions reduction claims for cloud computing are flawed
GreenMonk
July 2011

http://greenmonk.net/carbon-disclosure-projects-emissions-reduction-claims-for-cloud-computing-are-flawed/

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Facebook

Photo http://www.facebook.com/album.php?id=193287527693&aid=183026

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A practical example of this is...

Green?

"As of the end of Q3 2011, the Prineville data center had a <u>power usage effectiveness</u> (PUE) of 1.08... much lower than the industry standard of 1.5.

Facebook's energy consumption per unit of computing power has declined by 38%"

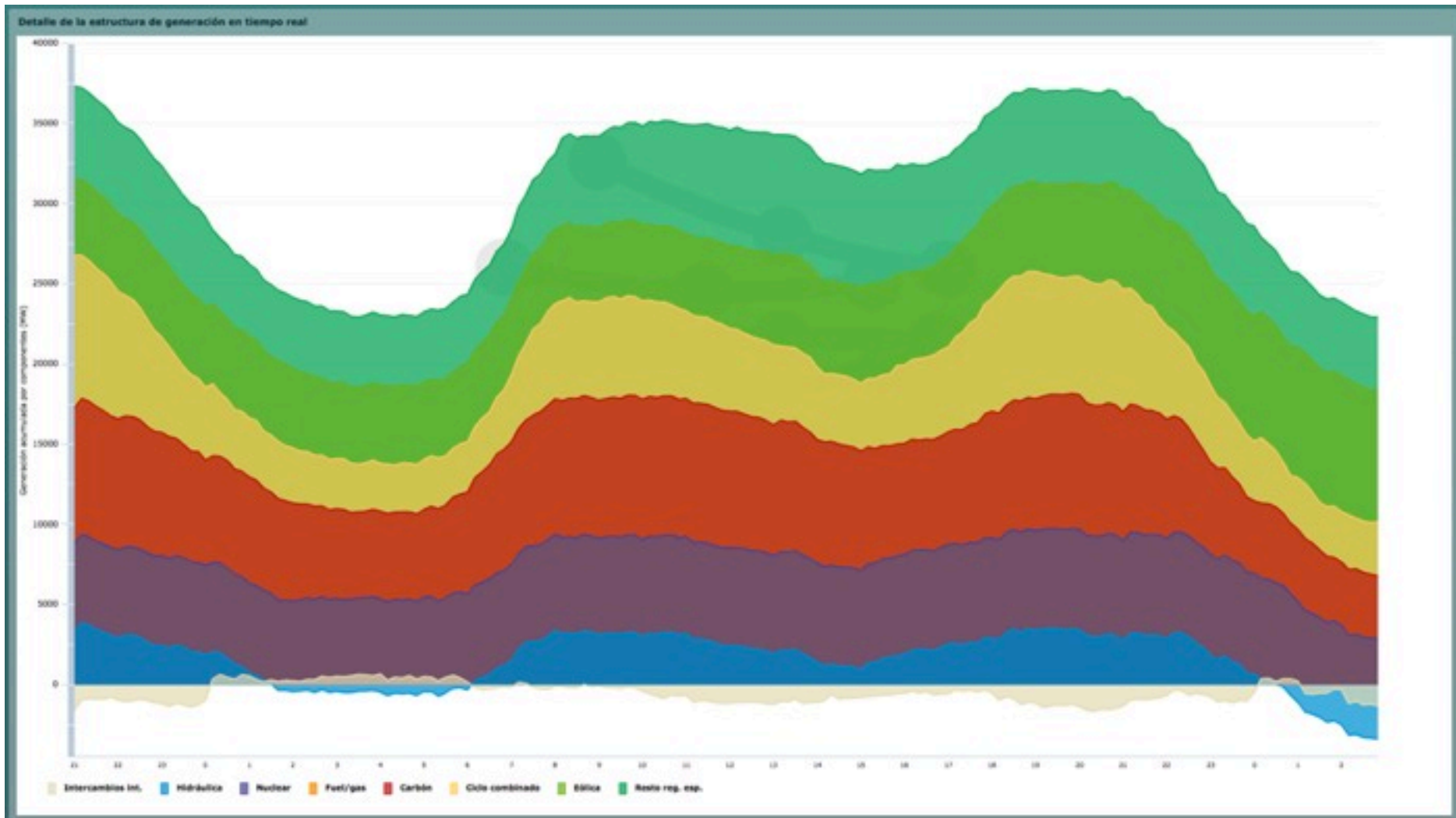http://opencompute.org/about/energy-efficiency/

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PacificCorp

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58% of its energy from coal and another 12% from gas so over 70% from fossil fuel directly.

22.5% is purchased from other suppliers so could also be fossil fuel.
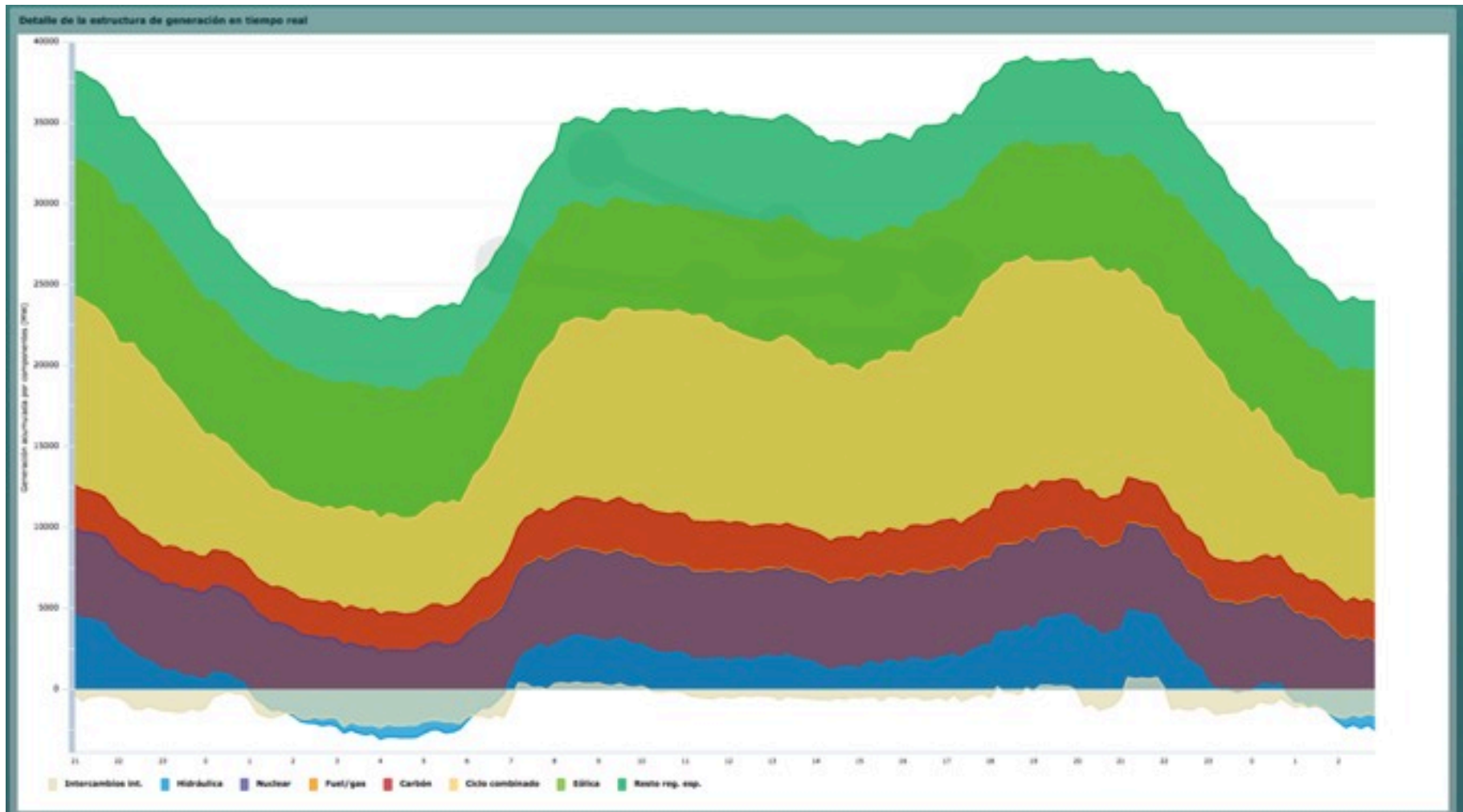
Spain

Detalle de la estructura de generación en tiempo real

Intercambios Int. | Hidráulica | Nuclear | Fuel/gas | Carbón | Ciclo combinado | Eólica | Resto reg. esp.

https://demanda.ree.es/generacion_acumulada.html

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Coal averaging around 20%
Gas around 14%
Wind around 25%

Spain

https://demanda.ree.es/generacion_acumulada.html

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Coal around 9%
Gas around 30%
Wind around 25%

Dublin

Key European Cloud Computing Hub

Dublin has become a key cloud computing gateway to Europe and beyond for U.S. companies due to several factors, including the city's location, connectivity, climate and ready supply of IT workers. Dublin's temperature is ideal for data center cooling, allowing companies to use fresh air to cool servers instead of using huge, power-hungry chillers to refrigerate cooling water.

This allowed Microsoft to design and build one of the world's most efficient data centers, a huge facility that hosts the company's cloud services for Europe and operates entirely without chillers. At 550,000 square feet, it is also one of the world's largest data centers.

Amazon opened a data center in Dublin in December of 2008 to house the European availablity zones for its EC2 cloud computing services. The company recently acquired a 240,000 square foot building in Dublin which will be converted into an expansion data center.

http://www.datacenterknowledge.com/archives/2011/08/07/lightning-in-dublin-knocks-amazon-microsoft-data-centers-offline/

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Microsoft
Amazon
Google
IBM
SunGard
Digital Realty Trust

All have significant DC's in Dublin

Green?

Ireland sources 84% of electricity from fossil fuels

http://www.eirgrid.com/operations/systemperformancedata/electricitystatistics/

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OTOH...

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iCloud

Photo http://www.engadget.com/2011/02/23/apple-tells-shareholders-north-carolina-data-center-is-for-itune/

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Apple's iCloud 500,000 sq ft data center in North Carolina
Duke energy 78% coal & nuclear (nuclear has enormous water footprint)

Apple solar data center? 121-acre site cleared for solar http://www.guardian.co.uk/environment/2011/nov/23/apple-green-solar-data-centre

Greenwash?

Google & PPA's

The Official **Google** Blog — Insights from Googlers into our products, technology, and the Google culture.

Reducing our carbon footprint with the direct purchase of renewable energy

7/20/2010 07:12:00 AM

When we decided in 2007 to voluntarily become carbon neutral, our intent was to take responsibility for our carbon emissions and promote sustainable environmental solutions. We approach this goal in three ways. First, we minimize our energy consumption; in fact, we've built some of the world's most energy efficient data centers. Second, we seek to power our facilities with renewable energy, like we did in Mountain View, CA with one of the largest corporate solar installations. Finally, we purchase carbon offsets for the emissions we cannot directly eliminate.

We just completed a substantial 20-year green Power Purchase Agreement that allows us to take responsibility for our footprint and foster true growth in the renewable energy sector. On July 30 we will begin purchasing the clean energy from 114 megawatts of wind generation at the NextEra Energy Resources Story County II facility in Iowa at a predetermined rate for 20 years. Incorporating such a large amount of wind power into our portfolio is tricky (read more about how the deal is structured), but this power is enough to supply several data centers.

The wind farm, which began operation in December 2009, consists of 100 GE 1.5MW XLE turbines.

http://googleblog.blogspot.com/2010/07/reducing-our-carbon-footprint-with.html

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PPA's mean security of energy pricing for 20 years
REC's for excess

Google & PPA's

The Official **Google** Blog

Insights from Googlers into our products, technology, and the Google culture.

Oklahoma, where the wind comes sweepin' down the plain

4/21/2011 08:20:00 AM

Rodgers and Hammerstein weren't kidding when they wrote what is now Oklahoma's official state song. The gusts on the plains are fierce, which makes the Sooner State a great place to harness clean, renewable wind energy. Our commitment to greening our energy supply is also strong, which is why we've just signed a power purchase agreement (PPA) for wind energy—our second in less than a year—in Oklahoma.

The purchase is similar in size and structure to the agreement we signed last July for wind energy in Iowa, but this time we will be applying the power to our Mayes County, Okla. data center, which will be fully operational later this year. We've agreed to purchase all of the energy from NextEra Energy Resources' Minco II wind facility in Oklahoma for the next 20 years, through Google Energy LLC, an entity that enables us to participate in the wholesale energy market. This 100.8 megawatt facility will be built as a direct result of our financial commitment and should be operational in late 2011.

Google's Oklahoma Power Purchase Agreement
by GoogleVideos

NextEra Energy Resources Minco I facility

Google

▶ ◀)) 0:12 / 0:28   360p + You Tube

http://googleblog.blogspot.com/2011/04/oklahoma-where-wind-comes-sweepin-down.html

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PPA's mean security of energy pricing for 20 years
REC's for excess

Other Google initiatives

- Google invested in early-stage companies such as Makani Power and Potter Drilling

- Invested $75 million to create a fund that will help up to 3,000 homeowners go solar

- Invested $280 million in a SolarCity fund to help provide innovative financing for residential solar projects

- Invested $178 million into utility-scale solar project called Ivanpah, in Mojave Desert

- Invested a 37.5% equity stake in the critical early-stage development of the Atlantic Wind Connection

- Invested a total of $157 million in two projects totaling 270 MW at the Alta Wind Energy Center

- Invested $100 million into 845MW Shepherd's Flat windfarm

- $38.8 million in two wind farms in North Dakota

- First international investment of €3.5 million in a solar facility in Brandenburg, Germany

http://www.google.com/green/collaborations/investments.html

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9 bullet points on a single slide is a record for me
In fact, 9 bullet points in a single presentation is normally way above my average!

Having said that...
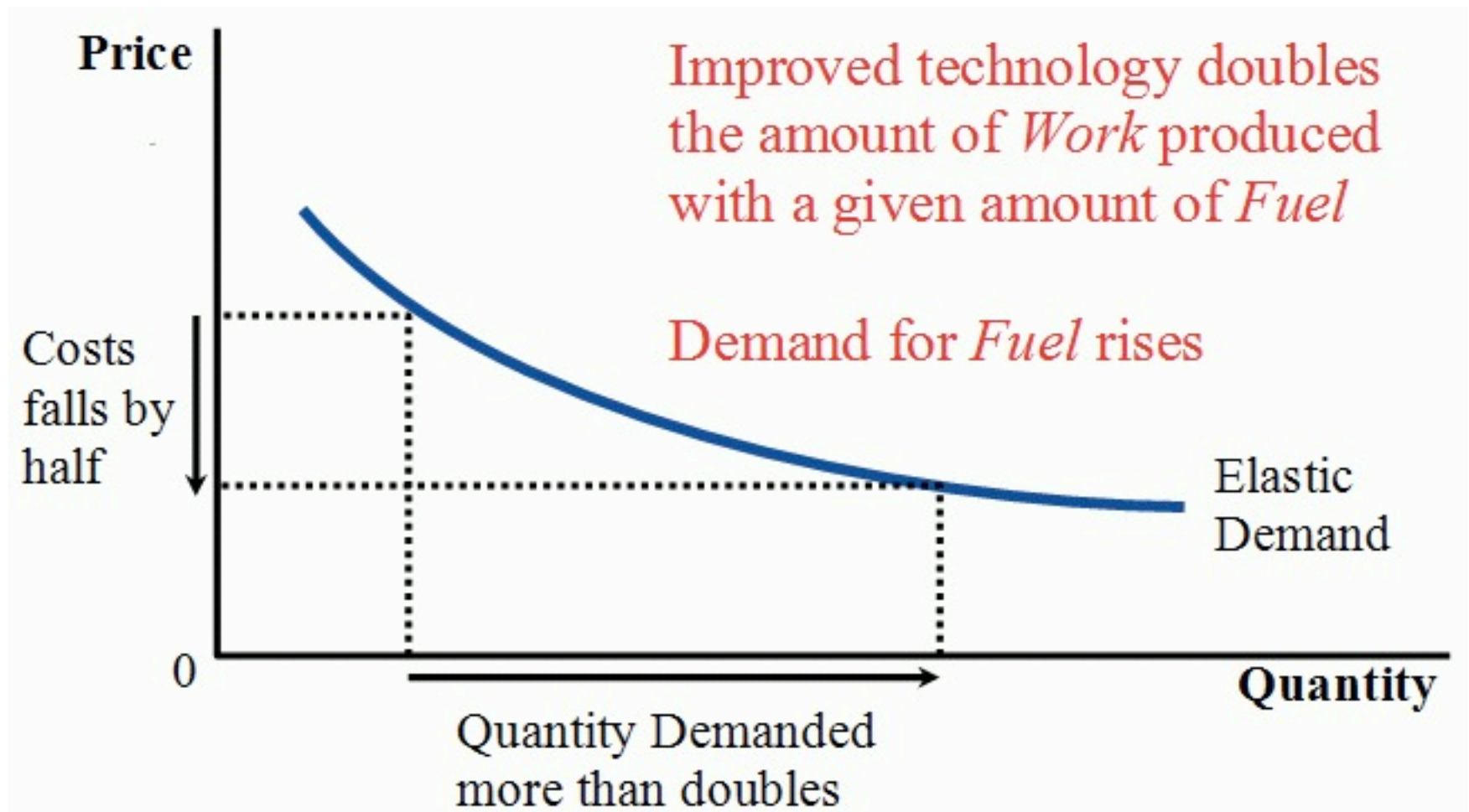
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Jevons Paradox

Having said that...

UK Economist William Stanley Jevons (1835–1882)
As steam engines become more efficient, consumption of coal increases!

Parkinson's Law

*Data expands to fill the
space available for storage*

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Promotes Consumption

GMail 1GB mail limit - now 7.5GB

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Cloud promotes consumption – not Green

Gmail – 1GB mail limit – when HotMail had 2mb & Yahoo! had 4mb

GMail has 25mb. Suddenly people could use the resource, so they did
Unlimited storage

If we had to live in a more constrained world, we could

Promotes Consumption

"EC2 means anyone with a $10 bill can rent a 10-machine cluster, with 1TB of distributed storage, for 8 hours"

Infochimps' CTO Flip Kromer

http://mrflip.github.com/wukong/INSTALL.html

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Green?

Not very Green!

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Green?

Confused yet?

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Irony?

Cloud delivered Green software...

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Irony?

http://www.hara.com

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Irony?

http://www.nootrol.com

RedMonk

Irony?

http://www.sapcarbonimpact.com/

58

Irony?

http://www.eyeonearth.org/

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Boom!

Photo: http://www.flickr.com/photos/tzofia/270800047/

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Conclusion

Cloud Computing has many advantages

Being Green is not one of them.

Given it is delivered using fossil fuels
And it drives further consumption

One last thing...
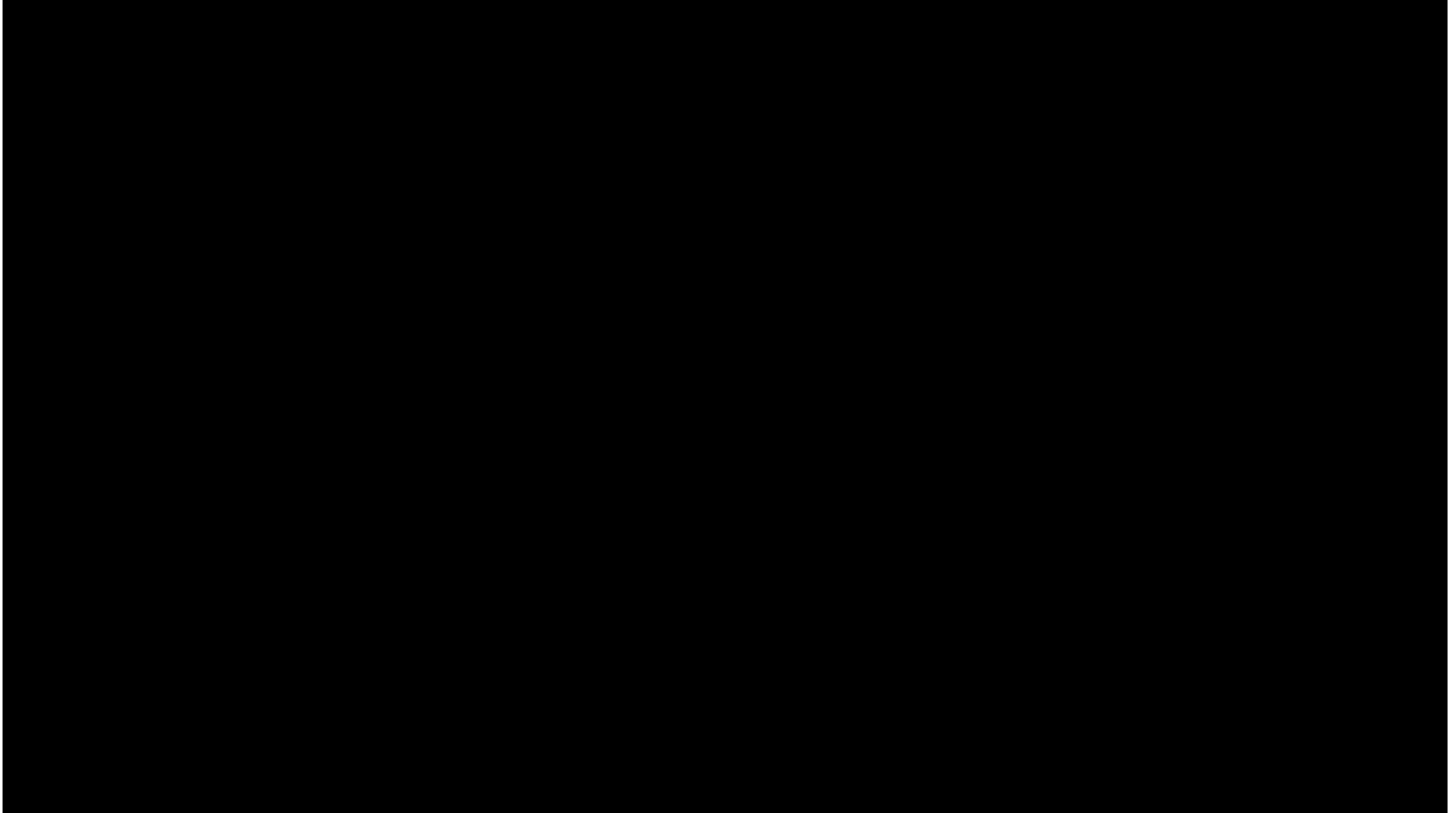
ευχαριστώ!

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