

IT & Sustainability

Notes on a myth

sebastian büttrich
sebastian@itu.dk

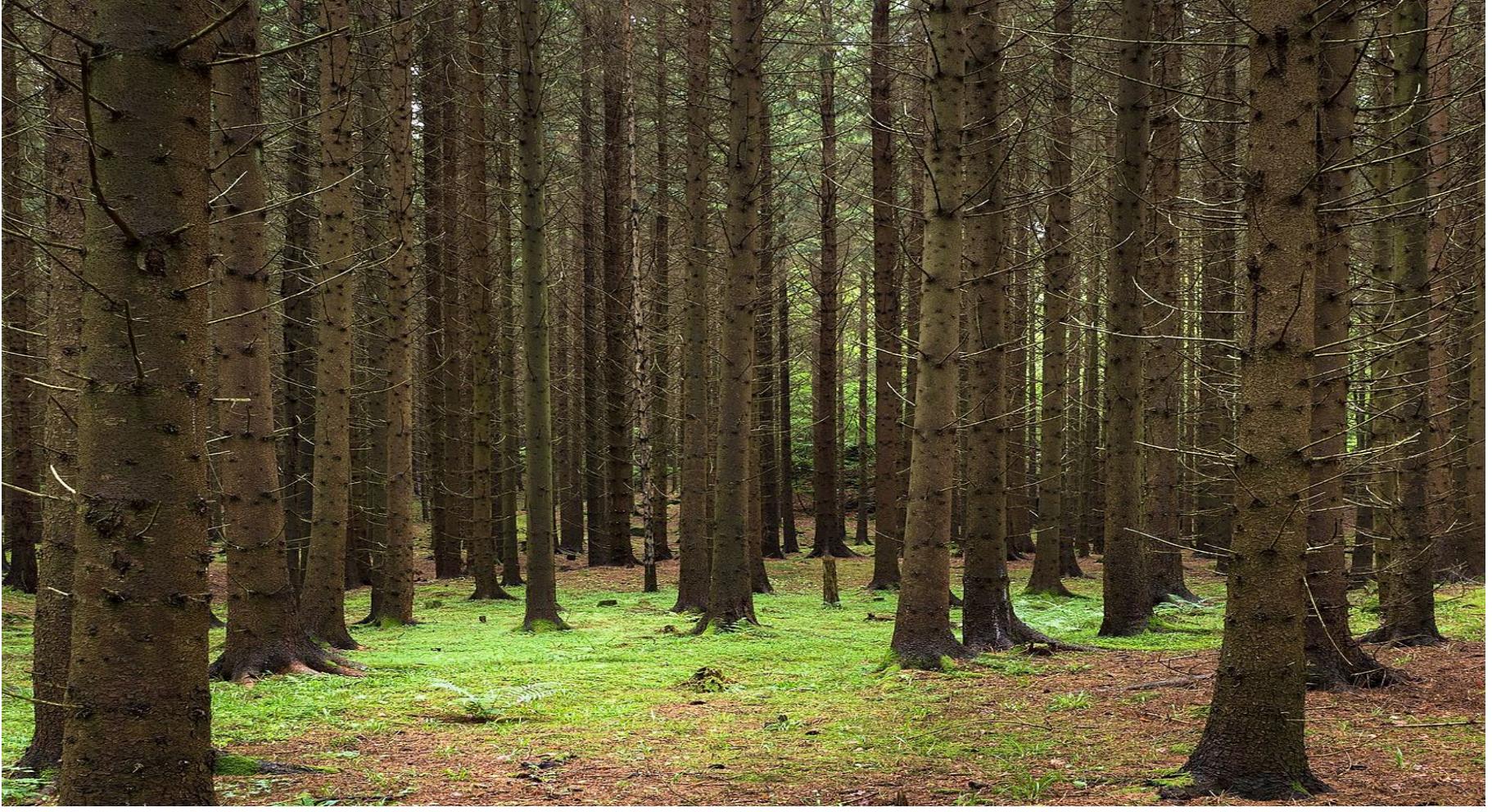


Sustainability – Attempts at a definition

Sustainability is the **ability to exist constantly.**

Development that
meets the needs of the present
without compromising the ability of
future generations to meet their own needs.

["Our Common Future, From One Earth to One World" -
UN - Brundtland Commission Report 1987]



The concept of sustainability, or *Nachhaltigkeit* in German, can be traced back to Hans Carl von Carlowitz (1645-1714), and was applied to **forestry**.

Sustainability – Domains or Pillars

largely agreed on:

environmental, economic and social

with subdomains

cultural, technological and political

This talk focuses on environmental - ecological aspects and to some extent, the economic -

Social - political - cultural

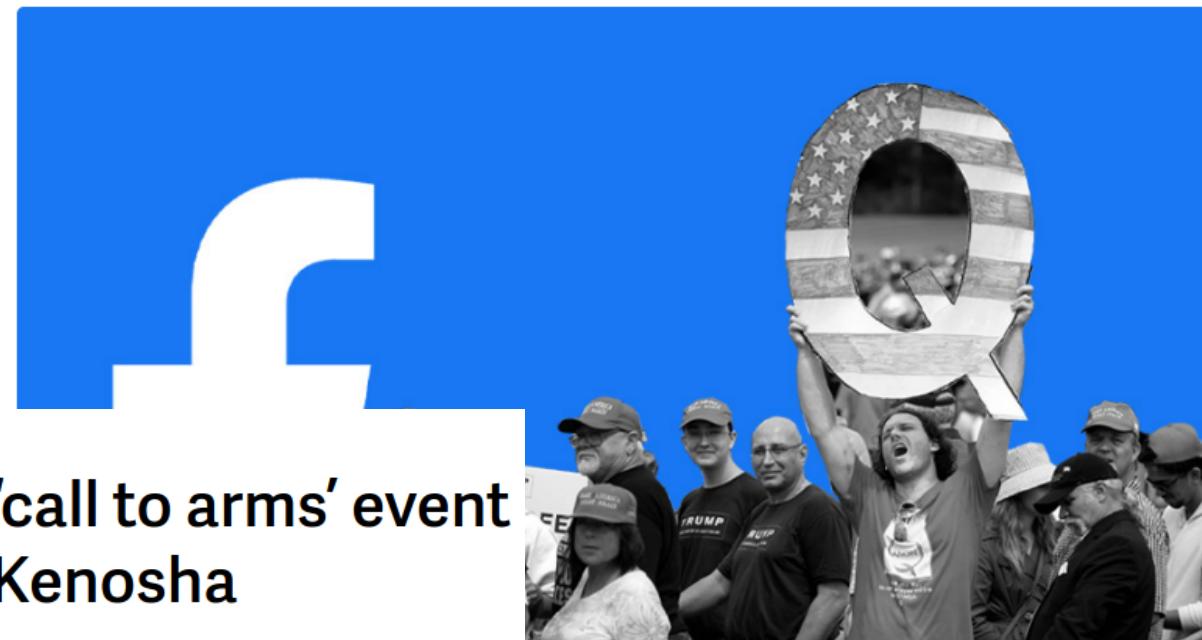
is another (long) talk ...

"Social" media & society

POLICY \ TECH \ FACEBOOK

Facebook takes down 'call to arms' event after two shot dead in Kenosha

'Any patriots willing to take up arms and defend our city tonight from the evil thugs?' asked the Facebook group

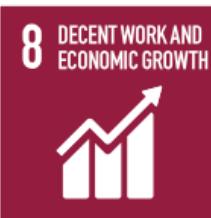


Facebook took decisive action on QAnon Wednesday.

Getty Images, Facebook



SUSTAINABLE DEVELOPMENT GOALS



SUSTAINABLE
DEVELOPMENT
GOALS

The Sustainable Development Goals,
adopted on 25 September 2015 as a part of the UN 2030 Agenda.

Sustainability – Contradictions

Already at this point – there is **contradictions**:

the "**ability to exist constantly**" implies
lack of change, or at least **a circle**.

How does this concept relate to
"development" or **"growth"**?

Constant growth per definition can not be sustainable.

The issue

The IT sector is using energy and natural resources at a fast growing rate

The very tool we claim will help us tackle climate change is responsible for further driving it

Drivers of IT energy hunger

Internet services at large, "Cloud"

>>> data centers!

Video - 75% of all internet traffic

Cisco Annual Internet Report, 2018-2023

"AI", machine learning

Artificial intelligence / Machine learning

Training a single AI model
can emit as much carbon
as five cars in their
lifetimes

Deep learning has a terrible carbon footprint.

by Karen Hao

June 6, 2019



Annualized Total Footprints

Carbon Footprint	Electrical Energy	Electronic Waste
32.04 Mt CO ₂ 	67.46 TWh 	10.55 kt 

Comparable to the carbon footprint of Tunisia.
Comparable to the power consumption of Czech Republic.
Comparable to the e-waste generation of Luxembourg.

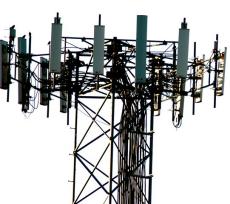
Single Transaction Footprints

Carbon Footprint	Electrical Energy	Electronic Waste
271.32 kgCO ₂ 	571.20 kWh 	89.30 grams 

Equivalent to the carbon footprint of 678,303 VISA transactions or 45,220 hours of watching YouTube.
Equivalent to the power consumption of an average U.S. household over 19.30 days.
Equivalent to the weight of 1.37 C-size batteries or 1.94 golf balls. (Find more info on e-waste [here](#).)

Blockchain & Cryptocurrencies

e.g. bitcoin >>>



Mobile, 5G

Sources: <https://www.cisco.com/c/en/us/solutions/collateral/executive-perspectives/annual-internet-report/white-paper-cl1-741490.html>
<https://digiconomist.net/bitcoin-energy-consumption>
<https://www.technologyreview.com/2019/06/06/239031/training-a-single-ai-model-can-emit-as-much-carbon-as-five-cars-in-their-lifetimes>
<https://doi.org/10.1016/j.jerss.2020.101721>

DASYA

Exact description or estimation of the IT environmental footprint is hard

A personal experience:

someone asked me about **energy footprint of keeping their pictures and videos in the cloud** -
Is it like a light bulb? A fridge? A car?

I couldn't answer initially
and neither could my colleagues.
Can you?

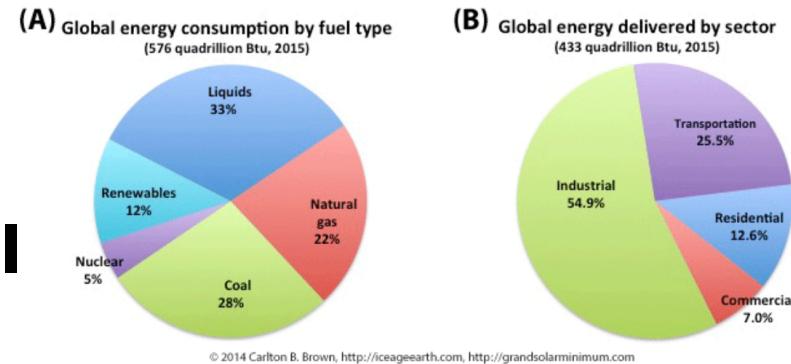
Exact description or estimation of the IT environmental footprint is hard

What to include?

Traditional view of sectors:

Industrial, commercial, residential, transport
==> IT is in all of these

IT Industry is secretive:
Those who know won't tell



Data says what one wants it to say

Sources: <https://www.bp.com/en/global/corporate/energy-economics/energy-outlook/demand-by-sector.html>

ICTs use ~10%* of global electricity

NEWS FEATURE • 12 SEPTEMBER 2018 • CORRECTION 13 SEPTEMBER 2018

How to stop data centres from gobbling up the world's electricity

The energy-efficiency drive at the information factories that serve us Facebook, Google and Bitcoin.

Nicola Jones



A Facebook data centre in Luleå, Sweden. Credit: Jonathan Nackstrand/AFP/Getty

ENERGY SCALE

Global electricity demand

20,000 TWh

Data-centre electricity demand

200 TWh

©nature

Sources: IEA/A. Andrae/Ref. 6

Electricity use by ICT

2,000 TWh

Bitcoin use by mid-2018

20 TWh

Figures are approximate.

Excellent start point for reading: <https://www.nature.com/articles/d41586-018-06610-y>
* with huge uncertainty

Sources: <https://www.iea.org/> <https://eia.gov/>
<https://yearbook.enerdata.net/electricity/electricity-domestic-consumption-data.html>
<https://ember-climate.org/wp-content/uploads/2020/03/Ember-2020GlobalElectricityReview-Web.pdf>
<https://www.nature.com/articles/d41586-018-06610-y>

Some key sources

Andrae et al. (Huawei) have supplied data which is widely used and discussed

Andrae, A.S.G.; Edler, T.

On Global Electricity Usage of Communication Technology Trends to 2030.

Challenges 2015, 6, 117–157.

<https://www.mdpi.com/2078-1547/6/1/117>

Total Consumer Power Consumption Forecast

October 2017

Conference: Nordic Digital Business Summit

Project: Global Forecasting of ICT footprints

Anders S.G. Andrae

https://www.researchgate.net/publication/320225452_Total_Consumer_Power_Consumption_Forecast

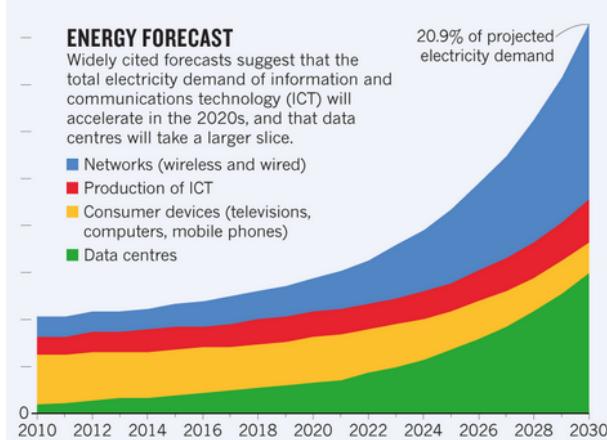
key message:
centralized data & networks are drivers,
not consumer devices and production

9,000 terawatt hours (TWh)

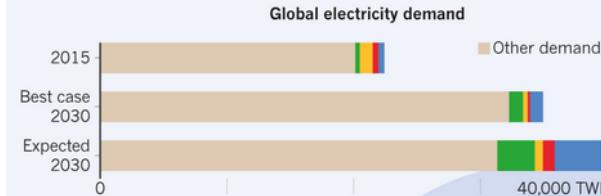
ENERGY FORECAST

Widely cited forecasts suggest that the total electricity demand of information and communications technology (ICT) will accelerate in the 2020s, and that data centres will take a larger slice.

- Networks (wireless and wired)
- Production of ICT
- Consumer devices (televisions, computers, mobile phones)
- Data centres



The chart above is an 'expected case' projection from Anders Andrae, a specialist in sustainable ICT. In his 'best case' scenario, ICT grows to only 8% of total electricity demand by 2030, rather than to 21%.



INTERNET EXPLOSION

Internet traffic* is growing exponentially, and reached more than a zettabyte (ZB, 1×10^{21} bytes) in 2017.

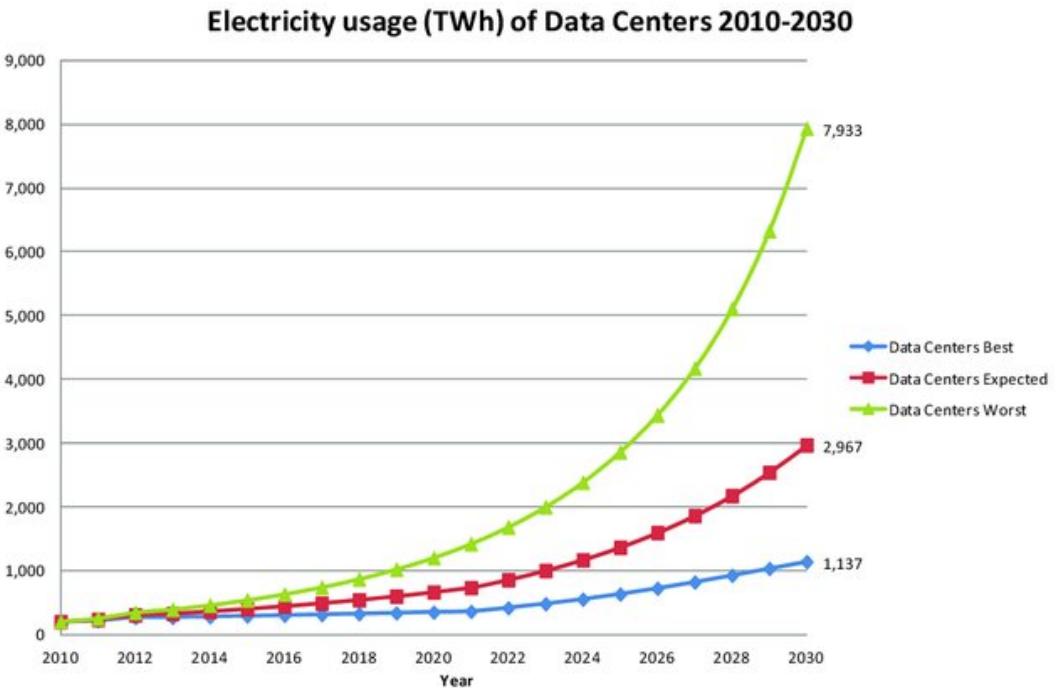


*Traffic to and from data centres.

[†]TB, terabyte (10^{12} bytes); PB, petabyte (10^{15} bytes); EB, exabyte (10^{18} bytes).

©nature

Central role of Data Centers: growing 10% per year



Sources:
<https://www.independent.co.uk/environment/global-warming-data-centres-to-consume-three-times-as-much-energy-in-next-decade-experts-warn-a6830086.html>
<https://www.broad-group.com/data/news/documents/b1m2y6qix5dv5t>
https://www.researchgate.net/publication/320225452_Total_Consumer_Power_Consumption_Forecast

Environment

Global warming: Data centres to consume three times as much energy in next decade, experts warn

416.2 terawatt hours of electricity world's data centres used last year was far higher than UK's total consumption

Tom Bawden Environment Editor | @BawdenTom | Saturday 23 January 2016 22.37 |



Data centres of the world will consume 1/5 of Earth's power by 2025

Joao Lima

12 Dec 2017 (Updated: 25 Jun 2020)
1 minute read

Alarming new research suggests that failure to source renewable energy could make data centres one of the biggest polluters in just seven years.

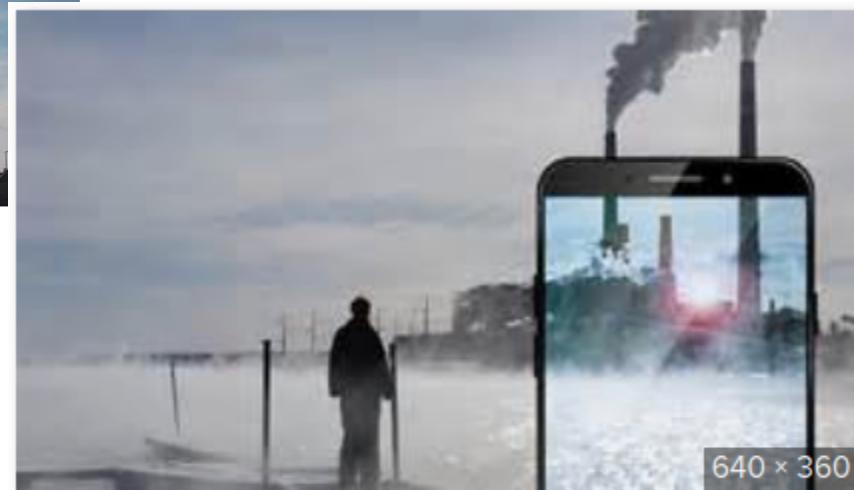
The rapid adoption of data-hungry machines and services is driving the need for more power to keep the lights on in the data centres of the world. As analysts estimate as many as 50 billion devices to be connected by 2020, with some statistics pointing to more than 100 billion a further five years down the line, new alarming research suggests that data centres will be one of the biggest energy consumers on the planet, beating many countries' energy consumption levels. According to a paper to be published by US researchers before the end of the year, the ICT industry is posed to be responsible for up to 3.5% of global emissions by 2020, with this value potentially escalating to 14% by 2040, according to Climate Change News. Researchers say this will be directly related to the fact that the data centre sector could be using 20% of all available electricity in the world by 2025 on the back of the large amounts of data being created at a fastest speed than ever before seen. The figures meet those published by Swedish researcher and Senior Expert Life Cycle Assessment at Huawei, Anders Andrae in 2016 in his "Total Consumer Power Consumption Forecast". Andrae predicts that by 2025, data centres will amount to ICT's largest share of global electricity production at 33%, followed by smartphones (15%) networks (10%) and TV (9%). As for the wider global usage, Andrae also expects data centres to use 20% of the world's energy, however, he places their carbon footprint at 5.5% of the global value, should adoption of more efficient energy sources not evolve at speed. The exponential utilisation of energy by data centres is not new, with the amount of power consumed increasing 9% between 2010 and 2015, according to KPN Integrated. On the global scale, data centres are poised to be the largest global energy users by 2025 at 4.5%, an increase from just 0.9% in 2015, according to Andrae's report. In comparison, consumer devices, fixed access wired services, wireless networks and production are all set to lag behind data centres in terms of energy usage. Globally, data centres were in 2014 responsible for around 1.62% of the world's utilised energy that year, according to Yole Développement. That has increased today to more than 3% of the world's energy (around 420 terawatts) and data centres are also responsible for 2% of total greenhouse gas emissions.

Popular video and rebuttal



Dirty streaming: The internet's big secret

Popular BBC video ..
and the rebuttal



techUK refutes 'Dirty streaming' documentary claims

Arguments against the pessimistic forecast

1. Data Center efficiency (Power usage effectiveness, **PUE**) is improving fast: Google claims 1.1, global average around 1.7

Recalibrating global data center energy-use estimates

E Masanet, A Shehabi, N Lei, S Smith - Science, 2020

Lawrence Berkeley Labs

Science 28 Feb 2020:

Vol. 367, Issue 6481, pp. 984-986

DOI: 10.1126/science.aba3758

2. Data Center Industry moving towards renewables

Microsoft's green plan: Our data centers will run on 60% renewable energy by 2020

Amazon vows to be carbon neutral by 2040, buying 100,000 electric vans

Google, Facebook and Apple lead on green data centers

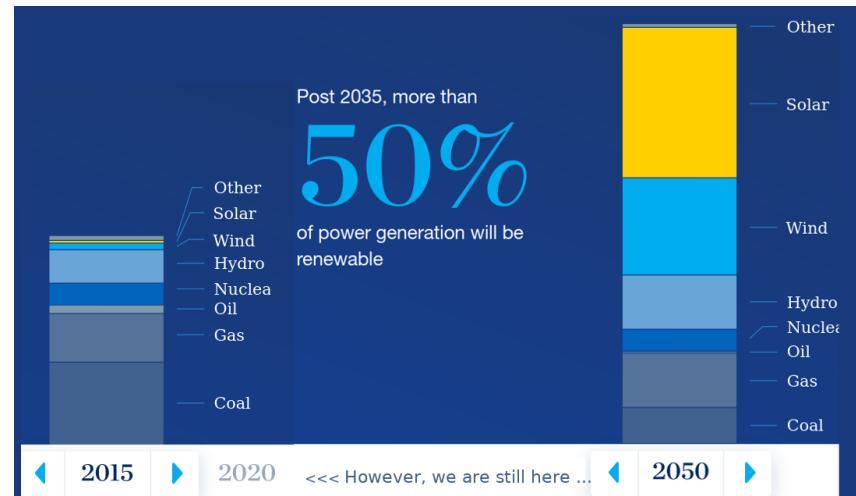
A new report by Greenpeace shows US tech giants are increasingly buying into renewable energy but European companies are still streets ahead



▲ Advania, a data center owner in Iceland and where GreenCloud locates one of its data centers. Photograph: Advania

Some scepticism is due

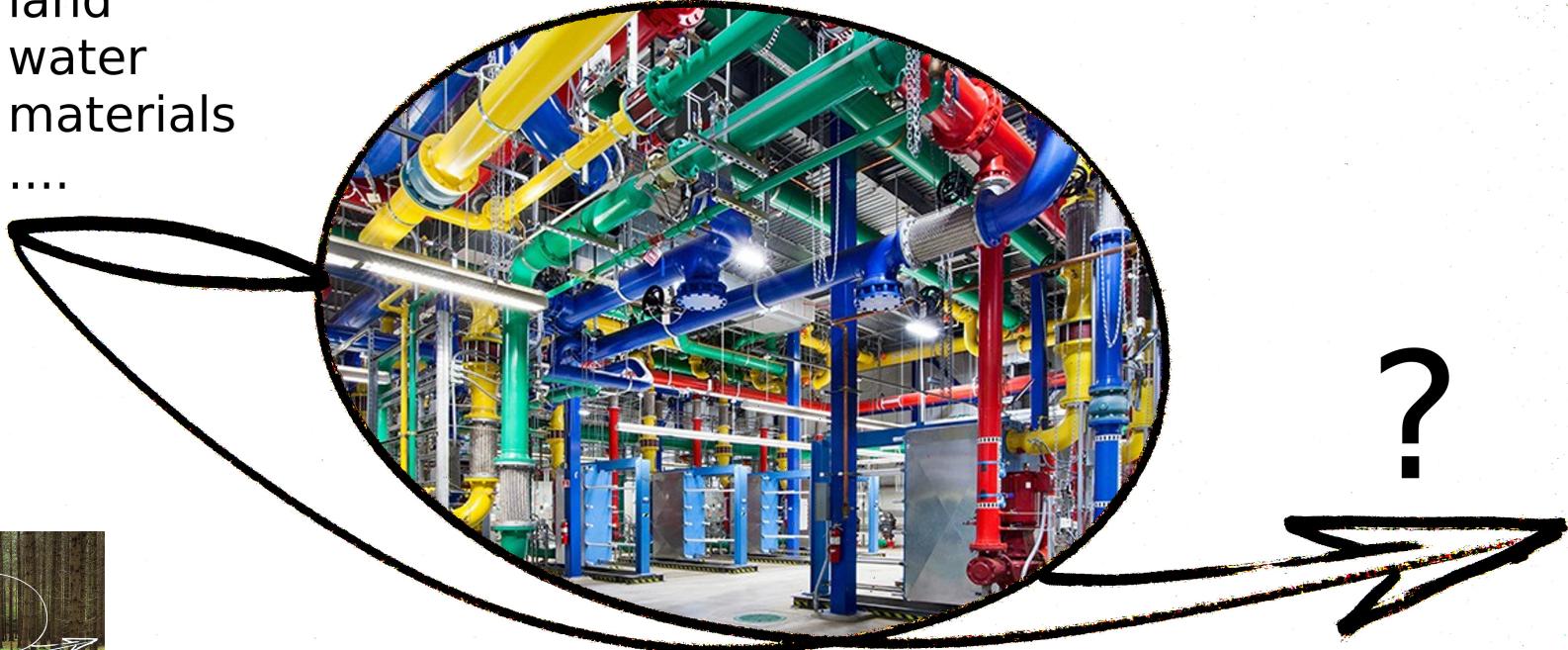
1. If Data Center efficiency (PuE) is already optimized, then there is little room for further improvement
2. Efficiency is highest for Hyperscale Data Centers – arguing for these is in the interest of the industry, but not without implications for sustainability (see: *social - political - cultural*)
3. Vows regarding renewable energy are all very well, but hard to verify, and there is quite some greenwashing about.
4. The reality of renewable energy in 2020 is still: around 10% share in total electricity – and 2030, 2040, 2050 might be too late



Sources: <https://www.mckinsey.com/industries/oil-and-gas/our-insights/global-energy-perspective-2019>

Perhaps the most fundamental problem

energy
land
water
materials
....



Unlike e.g. agriculture, forestry, energy sectors, IT can not produce any of its own input resources

Where to, from here?

- 1. Stop development of ICTs at current level?**
- 2. Impose data taxes?**
- 3. Go back to black and white images and video? ban video?**
- 4. Envision a radically new form of ICTs that is not resource dependent?
(if all of ICTs outputs are virtual, certainly we should be able to run it on virtual inputs?
will quantum computing do that trick?)**
- 5. Can we say goodbye to silicon, run ICTs on organic, renewable systems?**
- 6. or can we _____ ?**

All sources of this talk:

<https://github.com/ITU-DASYALab/IT-sustainability/blob/master/IT-sustainability-sources.md>

grateful for input!

sebastian@itu.dk



DASYA