

Energy consumption of the Internet

RIPE 86 Student Event: Threats to the Internet as we know it and what the technical community (and you) can do to prevent them

10 mei 2023, Rudolf van der Berg

My career: Internet traffic a major theme

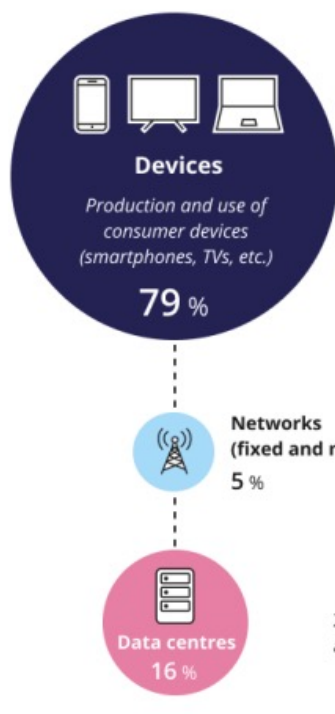
- **Twente Uni – Master of Public Administration:** vice-chair Campusnet. (1994- 10Mbps/room, 1998 100Mbps!)
- **Dutch-German Internet Exchange (NDIX):** internet off-campus was €5K/2Mbps in 2001! (Booking.com left)
- **Ministry Economic Affairs:** First study on net neutrality, transit and peering in 2006. AT&T wanted payment for pipes!
- **LogicaCMG** SIM-cards and high traffic/switching costs for IoT. Promoted SIMs for large scale IoT → pushed GSMA to allow eSIM
- **OECD:** Initiated BEREC-OECD meeting on IP-interconnection (2011-2012). ETNO wanted Sending Party Network Pays. Stats on FTR/MTR
- **Stratix:** Cost elements 5G. Datacenter factcheck (energy, data growth). For municipalities 5G small cell regs and Gigabit Infra Act



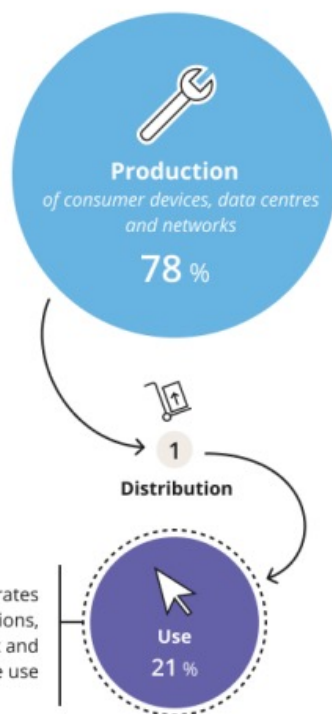
Environmental effects of our digital world are significant

Devices and their production account for the overwhelming majority of the digital carbon footprint

Breakdown of the digital carbon footprint in 2020 by ICT component (%)

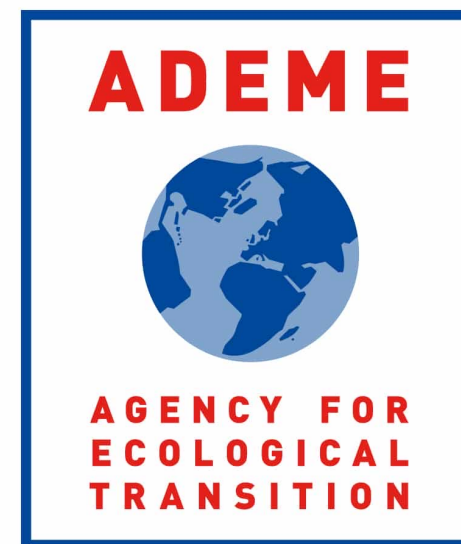
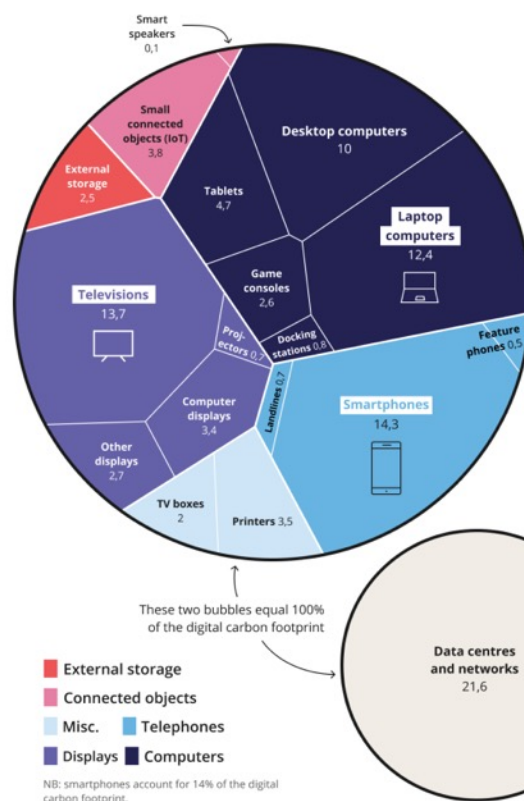


Breakdown of the digital carbon footprint in 2020 by life cycle stage (%)



Smartphones and televisions: the two main sources of the digital carbon footprint

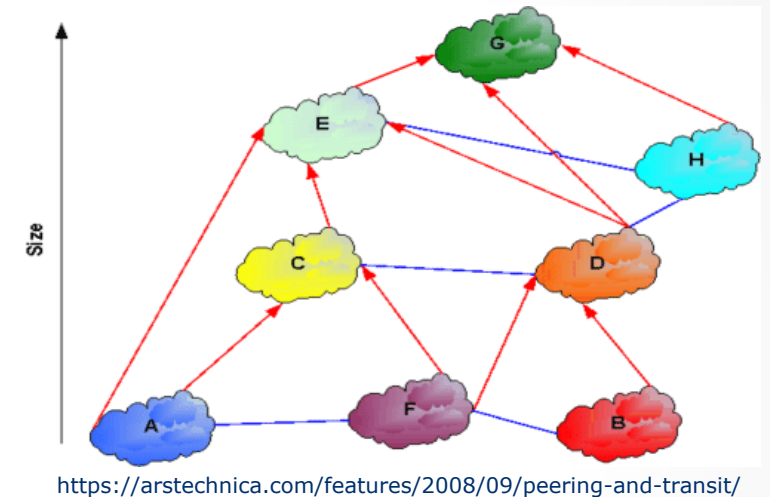
The digital carbon footprint of each type of device (across its life cycle) in 2020 is compared to data centres and networks' footprint (%)



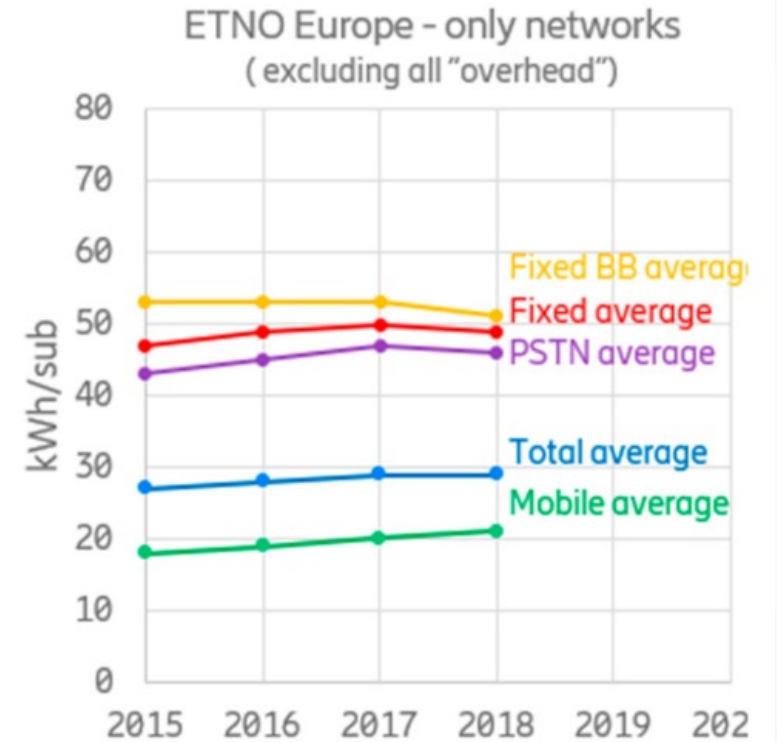
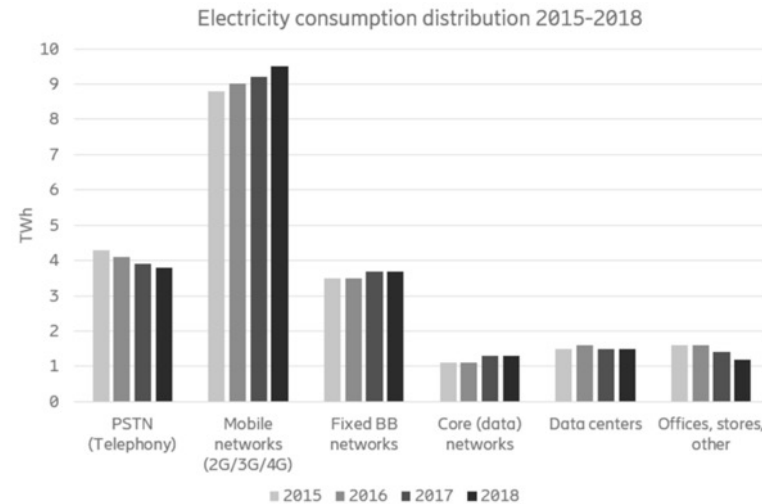
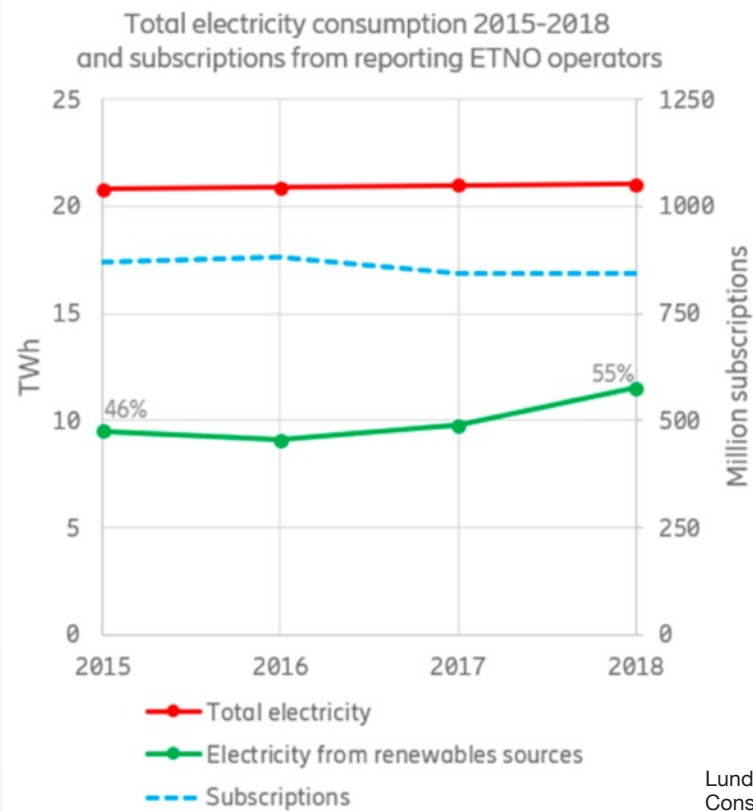
<https://en.arcep.fr/news/press-releases/view/n/environment-060323.html>

Energy use of the Internet? Define “the Internet” Here I look at networks and datacenters

- The Internet is a network of now more than 75 thousand interconnected networks!
- Innovation was that everybody pays for its own network. Royal Dutch Shell, Tax Service, DoD, Deutsche Telekom, Surfnet, KPN, T-Mobile, Netflix, Tinder etc.
 - RIPE NCC issues AS-number
- Networks → fixed, mobile, fiber optic, cable, public, private, submarine
- Datacenters → Where the computers are housed.
- Business and home connections → internal networks, computers, devices etc.



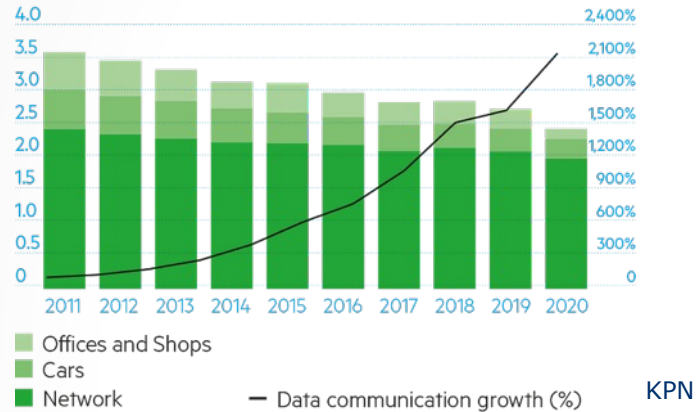
Energy use of networks (ETNO members)



(b)

Lundén, Dag, Jens Malmödin, Pernilla Bergmark, and Nina Lövehagen. 2022. "Electricity Consumption and Operational Carbon Emissions of European Telecom Network Operators" *Sustainability* 14, no. 5: 2637. <https://doi.org/10.3390/su14052637>

There is no correlation between data use on networks and energy use



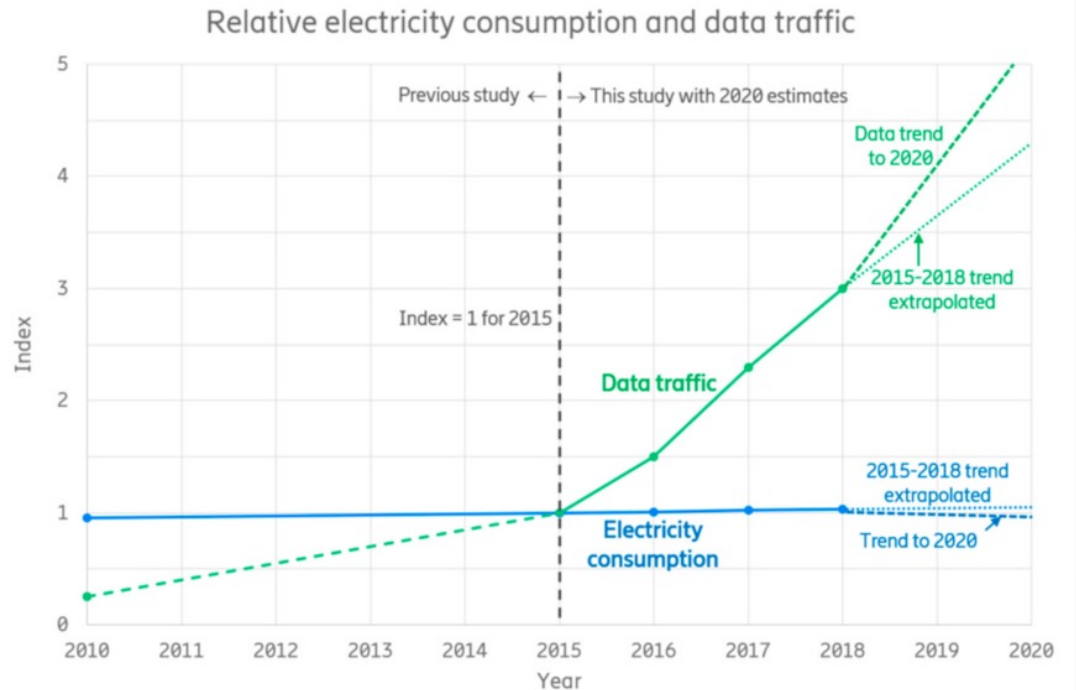
Fixed Network Energy Use (in MWh) year-on-year changes	159,767	183,070 15%	180,373 -1%
Fixed Network Data Traffic (in Exabyte) year-on-year changes	7.5	9.1 21%	12.9 42%
Energy use per Exabyte / annum (in MWh) year-on-year changes	21,302	20,118 -6%	13,982 -30%

Stijging in het Vaste Netwerk (2018, 2019, 2020)

VodafoneZiggo

Mobile Network Energy Use (in MWh) year-on-year changes	123,431	111,977 -9%	111,892 0%
Energy use per Terabyte / annum (in MWh) year-on-year changes	1.07	0.73 -32%	0.50 -32%

Daling in het mobiele netwerk (2018, 2019, 2020)



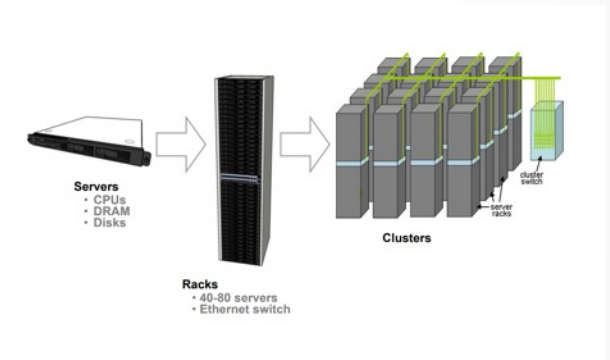
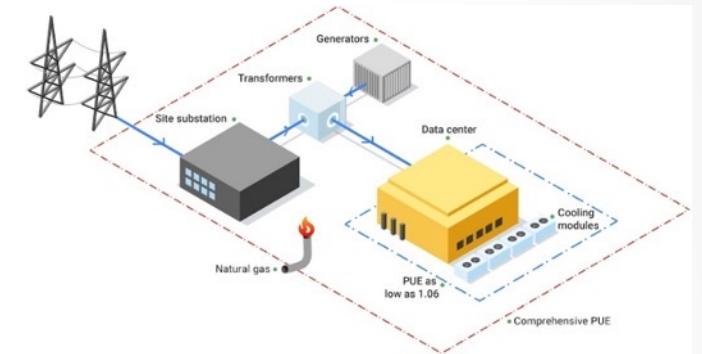
ETNO – Lunden

- Mobiel netwerk = 132.616 mWh
- Vast netwerk = 21.338 mWh
- Datacenters = 13.513 mWh
- Winkels & kantoren = 6.005 mWh

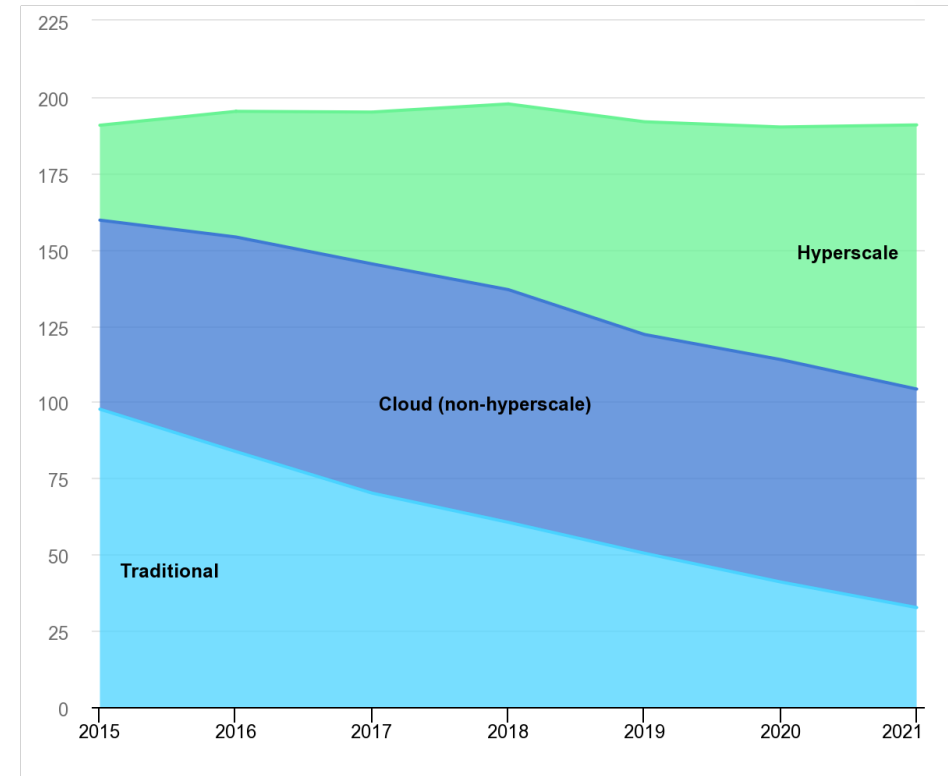
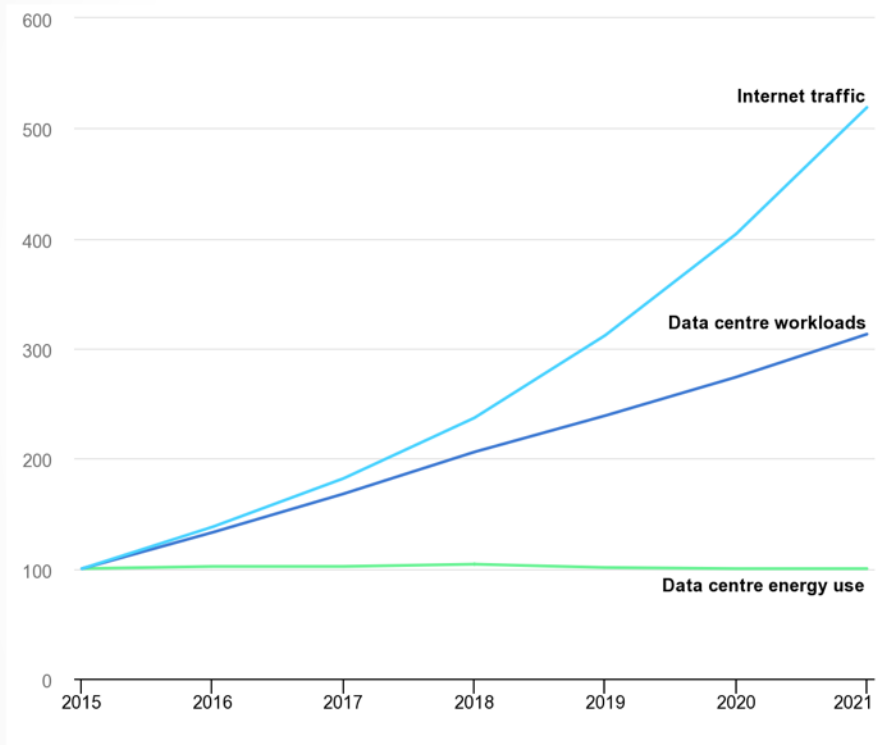
T-Mobile NL

Types of datacenters

- Private inhouse → government, banks, big business. → inefficient
 - Dutch gov moved from 63 private datacenters to 4 colocation it saved over 100MWh (40%)!
 - Power use efficiency from 2.4 to <1.4
- Colocation → Customers rent space, electricity and cooling → many around Amsterdam
- Hyperscale → Dedicated to one firm and types of applications
- Scale helps with energy (and operational efficiency)
 - On inhouse servers a bug that increases peak energy use 1% might go unnoticed
 - On hyperscale with 10K servers for e.g. email a 1% increase is very visible!



Global energy use of datacenters (IEA)



<https://www.iea.org/data-and-statistics/charts/global-trends-in-internet-traffic-data-centre-workloads-and-data-centre-energy-use-2015-2021>

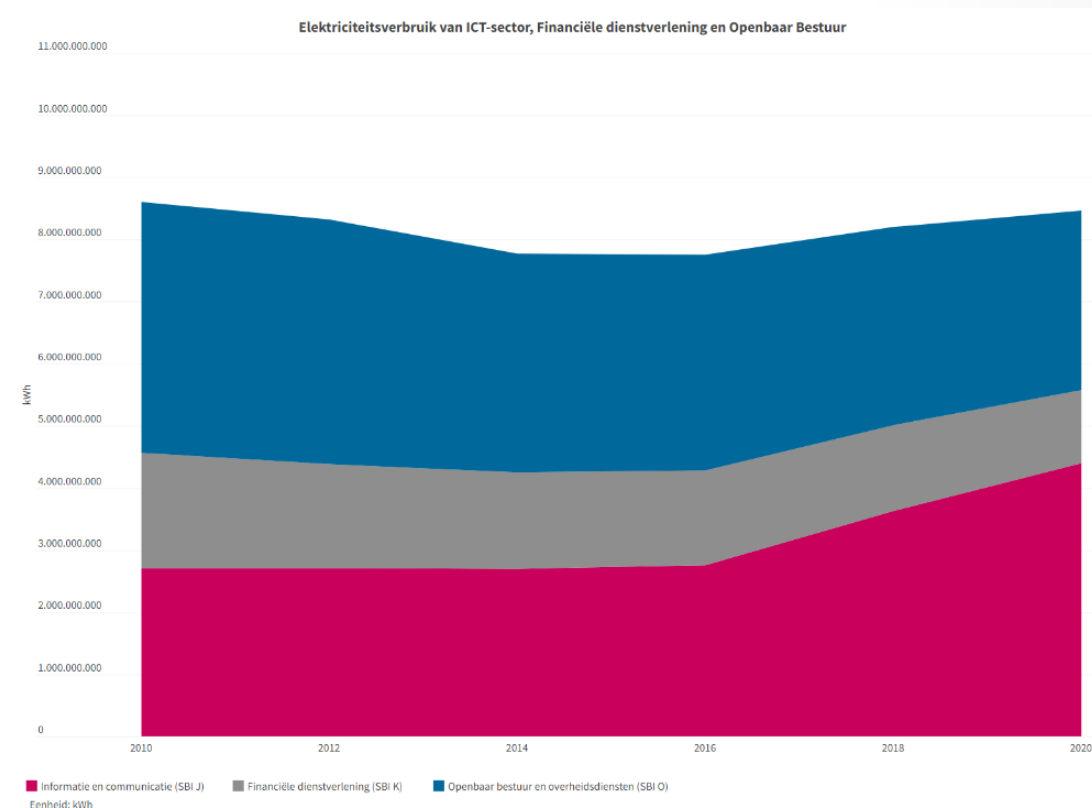
Energy use datacenters → how to interpret official data?

A	B			C			D			E		
	Aantal van EAN			Som van MW - max			Som van gecontracteerd vermogen actueel			Som van technisch vermogen		
	Okt 2020	April 2021	Feb 2022	Okt 2020	April 2021	Feb 2022	Okt 2020	April 2021	Feb 2022	Okt 2020	April 2021	Feb 2022
A'dam	29	29	29	97	99	105	131	130	132	265	265	265
H'meer	15	15	15	92	92	119	250	256	279	291	314	314
Overig	7	7	7	25	22	24	37	54	54	64	81	81
Totaal	51	51	51	214	213	248	418	440	465	620	660	660

Onderwerp	Leveringscategorie	Eenheid	2017	2018	2019
Levering elektriciteit datacenters	Totaal	GWh	1.648	2.362	2.742
	< 10 GWh	GWh	353	382	360
	> 10 GWh	GWh	1.295	1.980	2.382
t.o.v. totaal elektriciteitsverbruik	Totaal	%	1,48	2,08	2,42
	< 10 GWh	%	0,32	0,34	0,32
	> 10 GWh	%	1,16	1,75	2,1
t.o.v. totaal elektriciteitslevering via openbaar net	Totaal	%	1,67	2,34	2,72
	< 10 GWh	%	0,36	0,38	0,36
	> 10 GWh	%	1,31	1,96	2,37
Adressen	Totaal	aantal	200	200	205
	< 10 GWh	aantal	170	170	165
	> 10 GWh	aantal	35	35	40

Bron: CBS

<https://www.stratix.nl/stratix-rapport-met-feiten-en-cijfers-datacenters/>



Figuur 18: elektriciteitsverbruik van ICT, publieke sector en financiële dienstverlening (bron: CBS)

Are your online video habits killing the planet?

Grossly mistaken publications get much attention

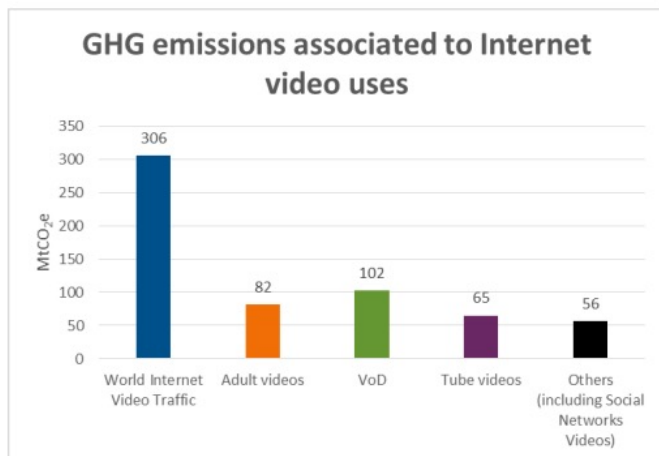


Figure 5: Greenhouse gas emissions generated by the different uses of online video in 2018
[Source : « [Video+ Materials] Internet Video Traffic by use » (The Shift Project Materials, 2019a)]

Company | 01-13-2022 | Wolfgang Kopf | 4 Comments

How sustainable is unlimited data growth on the Internet?

Share Print Read out

An article by Wolfgang Kopf, Senior Vice President for Group Public and Regulatory Affairs at Deutsche Telekom AG.

Streaming

Het stroomverbruik van Squid Game is geen kinderspel

Als antwoord op @PatrickAJansen @WattisDuurzaam en 2 anderen

Als je de hele internetketen meerekent (upload, transport, thuisapparaten), wordt het verbruik op 2.48 of 5.12 kWh (twee studies) per MB geschat. Een minuut videobellen kost je 4 MB per minuut, maar al de andere in de meeting ook!

onlinelibrary.wiley.com/doi/pdf/10.1111...

9:33 a.m. · 27 okt. 2021 · Twitter for Android

1 Vind-ik-leuk

Too much bad (academic) data

- Most studies are based on kWh/GB. That's like dividing energy use of streetlights over number of cars that drive by and then using that for extrapolation.
- Basic physics; energy use is result of distance signal needs to cover, frequency used, spectrum bandwidth use, transmission type and medium
 - Not modulation or number of bits
 - Can't use too much energy, because this will overload the receiver
 - It's like music: The larger the stadium, the more power you need. To hear the nuance it can't be too loud!
- Basis for Dutch electricity grid policy, datacenter policy, climate policy etc.
- Some examples of good studies:
 - Sources of data center energy estimates: A comprehensive review, Mytton D., Ashtine M. (2022) *Joule*, 6 (9) , pp. 2032-2056.
 - Lundén, Dag, Jens Malmödin, Pernilla Bergmark, and Nina Lövehagen. 2022. "Electricity Consumption and Operational Carbon Emissions of European Telecom Network Operators" *Sustainability* 14, no. 5: 2637. <https://doi.org/10.3390/su14052637>
 - The carbon footprint of streaming video: fact-checking the headlines, Kamiya, IEA, 2020 <https://www.iea.org/commentaries/the-carbon-footprint-of-streaming-video-fact-checking-the-headlines>
 - Koot, Martijn & Wijnhoven, Fons, 2021. "Usage impact on data center electricity needs: A system dynamic forecasting model," *Applied Energy*, Elsevier, vol. 291(C).

Questions?

Stratix – independent consulting on network infrastructure and services

- Independent means – not aligned with specific telecom firms or vendors.
- Tactical and strategic advice on regulatory, financial and technical aspects of ICT
- Typical customers: Public sector, telecom firms, private sector and investors
- Solutions that work in long term for our customer and other stakeholders
- Support and promote ideas, for the good of society, even if there's no client (yet)
 - FTTH → business models, promotion of ideas and broadband maps
 - Govroam → Euroam in Dutch government
 - 112 over 4G → policy makers and sector unaware of issues with handsets and roaming
 - Internet interconnection ~ net neutrality ~ internet traffic

Some recent work by Stratix that might interest you

- 5G and FTTH investment and stats – Maps, cost modelling, market analysis etc.
- Datacenters – objective facts and figures (Metropolitan Region Amsterdam), Belgian market (BIPT)
- Submarine cables – “How to lay a cable to the Netherlands” and market research
- State and future of Internet and Telecom Standards
- Connectivity in municipalities and regions; regulations, innovation, cooperation etc.
- Spectrum policy; digital microphones, dynamic spectrum management, private LTE and frequencies on the North Sea



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