Umwelt Bundesamt

Für Mensch und Umwelt

Last updated: 7 September 2020

Background information

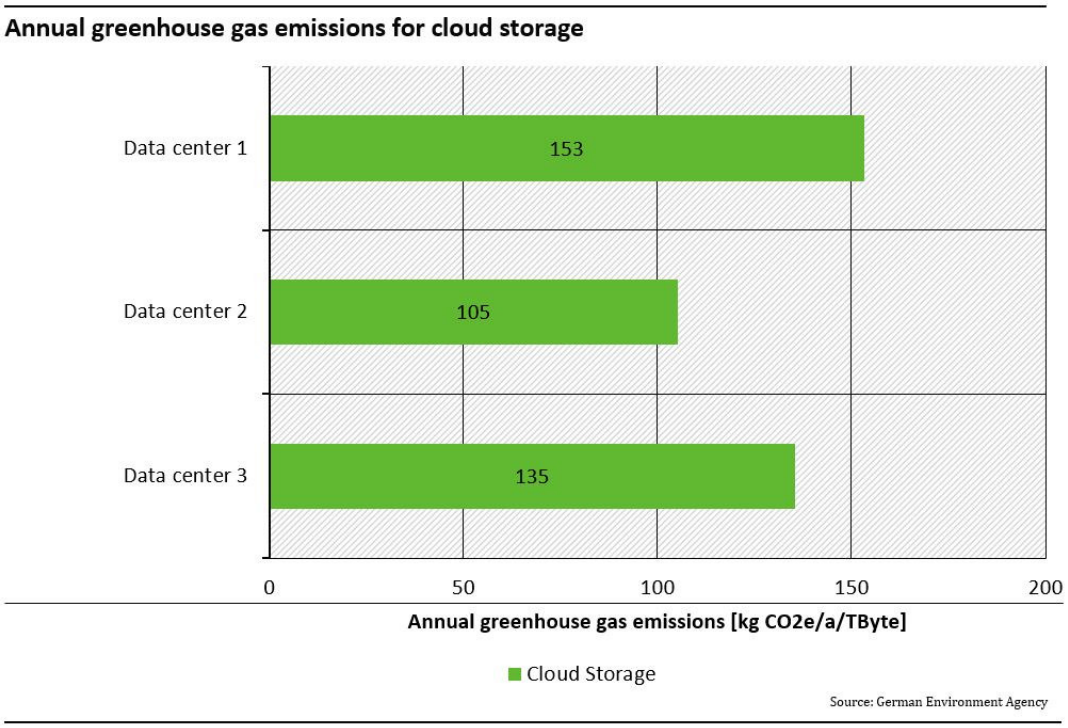
Climate impact of video streaming & co.

1 Calculating carbon emissions of data centres and data transmission

The Green Cloud Computing research project has developed a method for calculating the environmental impacts of individual cloud services. By way of example, the environmental impacts of online storage and video streaming services were calculated. In each case, only the power required for storage and data transmission is calculated; the energy used by end-user devices such as routers, mobile devices or televisions is not included.

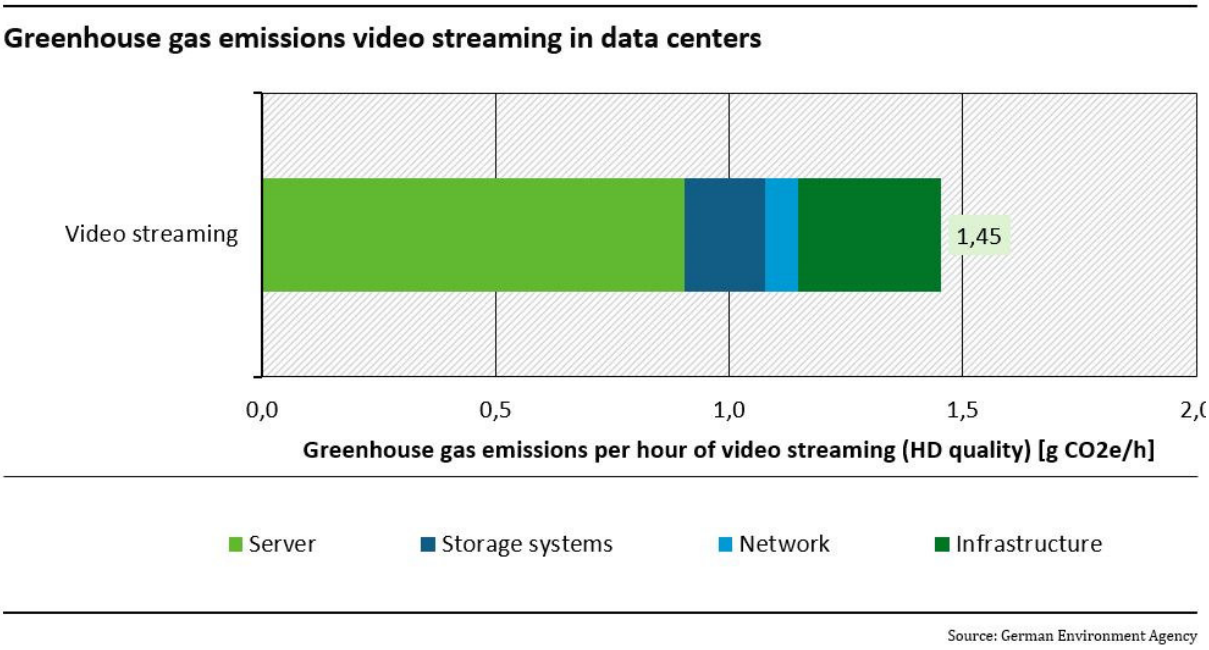
1.1 Carbon footprint of cloud services

Data centres differ greatly in terms of efficiency. Emissions can vary from data centre to data centre depending on whether images, documents or presentation slides are stored in the cloud. During the course of the research project, different data centres were compared. The comparison showed that the range of emissions lies between 105 kilograms and 153 kilograms of CO_2 equivalents per terabyte of storage capacity and per year.



1.2 Carbon footprint of video streaming services

As part of the research project, an account was made of video streaming providers' data centre resources and the energy they consume. This was then used to calculate the greenhouse gas emissions per hour of video streaming. Figure 2 depicts the greenhouse gas emissions of the various components of a data centre (server, storage systems, network and infrastructure). The individual contributions add up to a total of 1.45 grams of CO_2 equivalents per hour of video streaming in the data centre. The data rate of the video stream at 2 gigabytes per hour corresponds to HD quality (High Definition, 1280x720).

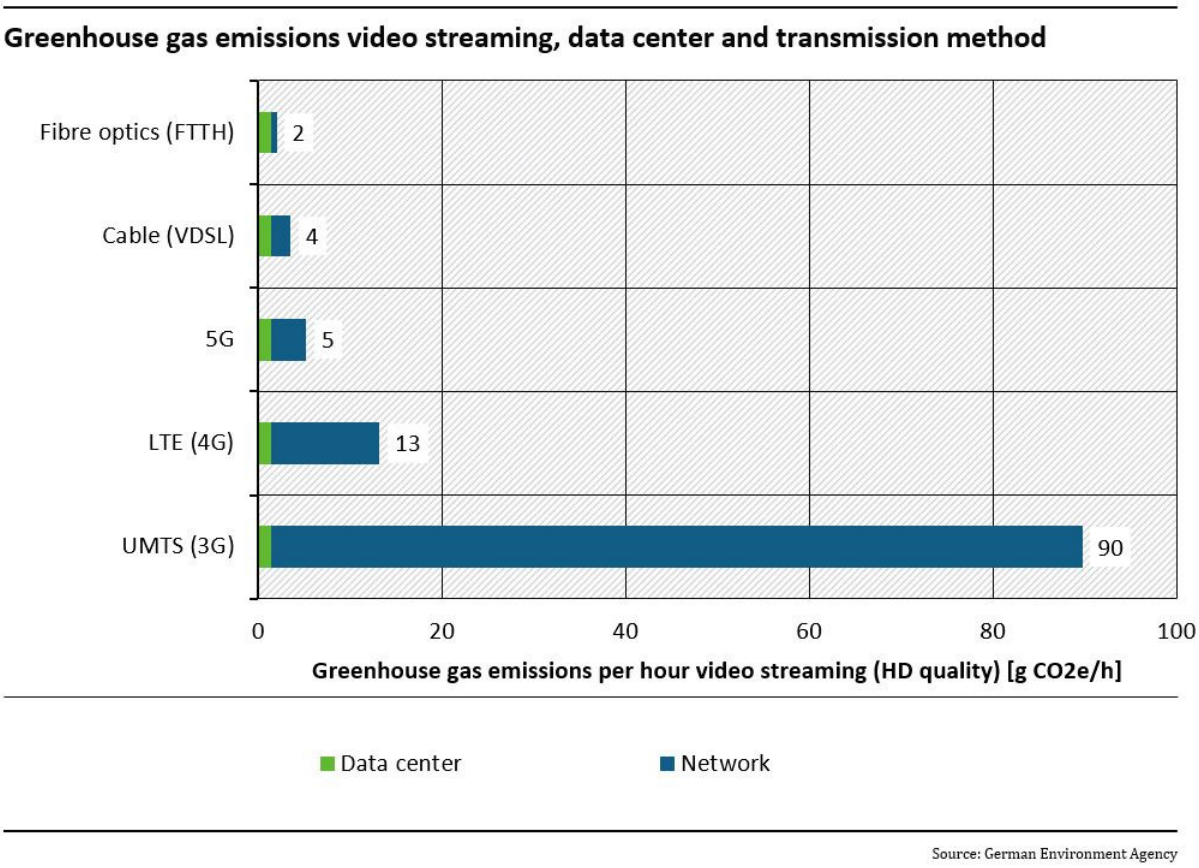


Source: German Environment Agency

1.3 Data networks

In order for data to reach your screen at home or your mobile phone while on the train, the data produced in the data centre still has to be transferred through telecommunications networks. This also consumes energy and leaves a carbon footprint. The calculation model developed can take account of different network architectures and technologies, power supply efficiency levels and utilisation rates.

The following graphic illustrates the transmission of one hour of video in HD quality.



Source: German Environment Agency

While the data centre greenhouse gas emissions remain constant at 1.45 grams of CO_2 equivalents per hour of video streaming, the network greenhouse gas emissions vary widely. The fibre optic network (FTTH - fibre to the home) is the most efficient.

If the stream is run through the fibre optic network, it produces greenhouse gas emissions of 2 grams per hour. If run through a wired broadband connection (VDSL - very high speed digital subscriber line) the stream produces around double this amount - 4 grams of CO_2 equivalents per hour. Transmission via mobile networks produces an even larger carbon footprint. The modern 5G network produces around 5 grams, the more frequently used 4G mobile network (LTE - long term evolution) around 13 grams and the old 3G network (UMTS - universal mobile telecommunications system) generates around 90 grams per hour of video streaming.

In summary:

- Fibre optic is the most climate friendly transmission technology.
- Network access via wired broadband is better than mobile network access.
- Modern mobile networks (5G) are more than 20 times more efficient and climate friendly than old mobile networks (3G).

2 Einsparmöglichkeiten für Verbraucher*innen

2.1 Übertragungsraten bei Videoinhalten

Rund 80 Prozent des Datenverkehrs in Telekommunikationsnetzen sind Videoinhalte. Ihre Datenmenge zu reduzieren, ist deshalb eine besonders effektive Möglichkeit, die Netze zu entlasten und deren Energieverbrauch zu senken. Oft ist dies sogar ohne Qualitätseinbußen möglich, wenn Anzeigegeräte wie Smartphones oder Tablets ohnehin nur über kleine Displaygrößen verfügen. Solche Geräte sind zwar technisch oft dazu in der Lage, eine hohe Pixelzahl darzustellen (z. B. UHD-Auflösung), das menschliche Auge kann die hohe Auflösung, insbesondere bei Bewegtbildern, jedoch nicht von einer geringeren Auflösung unterscheiden. Nutzer*innen können daher weniger Datenverkehr verursachen, wenn sie die Auflösung des Streams auf ihren Handys und Tablets auf das notwendige Maß reduzieren.

In Tabelle 1 sind unterschiedliche Datenmengen pro Stunde für unterschiedliche Bildschirmauflösungen und Videoqualitäten dargestellt. Die Datenmengen reichen von 30 Megabyte pro Stunde für sehr kleine Bildschirmauflösungen bis zu 7 Gigabyte für Ultra-HD-Auflösungen.

Tabelle 1: Datenmengen bei unterschiedlichen Bildschirmauflösungen und Videoqualitäten

YouTube nach Videoqualität	**Bildschirmauflösung (Pixel)**	**Datenmenge pro Stunde**
144p	192 x 144	30 MB/h
240p	320 x 240	150 MB/h
360p	480 x 360	300 MB/h
480p	640 × 480	450 MB/h
HD / 720p	1280 × 720	1,2 GB/h
Full HD / 1080p	1920 x 1080	1,7 GB/h
Netflix nach Videoqualität		**Datenmenge pro Stunde**
Niedrige Qualität		300 MB/h
Mittlere Qualität	1280 × 720	700 MB/h
Hohe Qualität	1920 × 1080	3 GB/h
Ultra-HD	3840 × 2160	7 GB/h

Quelle: eigene Darstellung nach www.tarife.at (2020)

2.2 Unerwünschter Datenverkehr

Videos sind beliebt für die Gestaltung von Webseiten. Um die Aufmerksamkeit von Besucher*innen auf Werbebotschaften zu lenken, starten Werbevideos oft automatisch, sobald sich die Videofenster im sichtbaren Bildschirmbereich befinden.

Dies verursacht erheblichen Datenverkehr. Im Sinne des Klimaschutzes sollten Website-Betreiber darauf möglichst verzichten. Zudem sollte die Autoplay-Funktion standardmäßig abgestellt werden und die Nutzer*innen so mehr Autonomie darüber erhalten, welche Videoinhalte sie tatsächlich abspielen möchten.

3 Ways consumers can save energy

3.1 Transmission rates of video content

Around 80% of data traffic in telecommunications networks is video content. Lowering data volumes produced by video content is therefore the most effective way to free up networks and reduce energy consumption. In the case of small-screened devices like smartphones or tablets, this can often be done without compromising on quality. Although such devices are often technically capable of displaying a high number of pixels (e.g. UHD resolution), the human eye cannot distinguish between higher and lower resolutions, particularly with moving images. Consumers can reduce their data traffic by reducing the stream resolution on their phones and tablets to what is necessary.

Table 1 shows different data volumes per hour for different resolutions and video qualities. The data volumes range from 30 megabytes per hour for very low resolutions to 7 gigabytes for Ultra HD resolutions.

Table 1: Data volumes consumed at different resolutions and video qualities:

YouTube video quality	**Resolution (pixels)**	**Data volume per hour**
144p	192 x 144	30 MB/hr
240p	320 x 240	150 MB/hr
360p	480 x 360	300 MB/hr
480p	640 x 480	450 MB/hr
HD / 720p	1280 x 720	1.2 GB/hr
Full HD / 1080	1920 x 1080	1.7 GB/hr
Netflix video quality		**Data volume per hour**
Low quality		300 MB/hr
Medium quality	1280 x 720	700 MB/hr
High quality:	1920 x 1080	3 GB/hr
Ultra HD	3840 x 2160	7 GB/hr

Source: table based on www.tarife.at (2020)

3.2 Unwanted traffic

Videos are a popular tool in website design. Promotional videos often start automatically as soon as the video windows are in the visible screen area to draw the user's attention to the advertisement.

This causes considerable traffic. In the interest of climate change mitigation, website operators should refrain from using such promotional videos. In addition, the autoplay function should be switched off by default, thus giving users more autonomy over which videos they would actually like to watch.

3.3 Incentives for data reduction and resource conservation

As data transmission in mobile networks has a significantly larger ecological footprint than that of wired broadband networks, mobile network tariffs that incentivise greater data consumption are bad for the climate.

Examples include flat rates and generous data packages for streaming music and videos. These tariffs can lead to users making video calls on messaging services instead of regular voice calls. The difference between video calls and voice calls is 300 megabytes an hour instead of 60 megabytes meaning that video calls consume 5 times more mobile data. This kind of data transfer over UMTS networks results in a significant carbon footprint.

Using WiFi networks is more environmentally friendly than using mobile networks. Environmentally conscious tariffs could, for example, offer free telephone calls on WiFi networks instead of flat rates for mobile telecommunications.

Related research projects of the Federal Environment Agency

KPI4DCE (2018): Schödwell, Björn; Zarnekow, Rüdiger; Liu, Ran; Gröger, Jens; Wilkens, Marc. Indicators for evaluating the resource efficiency of data centres and assessing practical applicability. Published by the Federal Environment Agency. Available online at https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2018-02-23_texte_19-2018_ressourceneffizienz-rechenzentren.pdf.

Green Cloud Computing (2020): Gröger, Jens; Liu, Ran; Stobbe, Lutz; Richter, Nikolai. Life cycle-based data collection on the environmental impacts of cloud computing. Study commissioned by the Federal Environment Agency. In progress.

UTAMO (2020): Stobbe, Lutz et al. Environmental impact assessment of mobile network and end-user device technology. Study commissioned by the Federal Environment Agency. In progress.

Publication data

Published by

Federal Environment Agency (UBA)
Wörlitzer Platz 1
06844 Dessau-Roßlau
Germany
Tel: +49 340-2103-0
Fax: +49 340-2103-2285
www.umweltbundesamt.de
/umweltbundesamt.de
/umweltbundesamt

Press division

Press Officer:
Martin Ittershagen, Felix Poetschke
Deputy press officer:
Laura Schoen
+49 340 2103 2245
presse@uba.de

Last updated: September 2020