Meta

Electricity consumption of videos viewed on Meta's platforms

This study was conducted in 2024-2025 by ENGIE Impact

Executive Summary

This memo characterizes the electricity consumption of user videos viewed on Meta's platforms in Europe, across the digital (or network) value chain including the edge network, telecommunication networks and end user property. Due to the extraordinary complexity of the digital value chain, doing this analysis requires three assessments, with each assessment providing an element to the overall equation.

The first assessment is a conventional "top-down" accounting of electricity consumption requiring 100% of network electricity use to be allocated to the value chain usages. Using this methodology for reference results, user videos viewed on Meta's platforms in 2022 consumed approximately 2.2 terawatt-hours of electricity across the digital value chain in Europe, of which 0.1% of the electricity consumption is attributed to Meta's edge network, followed by 58% to mobile networks, 35% to fixed networks including in-home equipment (e.g., WiFi routers), and 7% to end user devices. Comprehensive data for the entire digital ecosystem in Europe is unavailable, but we estimate that user videos viewed on Meta's platforms account for only 1% to 2% of the total energy consumption of Europe's entire digital ecosystem using this methodology. While this method provides straightforward environmental accounting of one data service, it does not accurately reflect real-world responses to data traffic from user videos viewed on Meta's platforms.

The second assessment examines mobile network electricity use in response to short-term[1] changes. ENGIE Impact finds that an average user consuming about a hundred videos per day on 4G networks is estimated to cause only a 2.9% electricity use increase per day relative to a baseline scenario of no data traffic. Mobile networks must be powered 24 hours a day, 7 days a week to meet customer demands and this continual power can be a significant portion of total network electricity use.

Assessment 3 broadens the scope to consider the long-term[2] macro impact on networks. Forecasting network energy use is highly complex, with numerous large studies commissioned by EU authorities highlighting inherent limitations due to the multitude of influencing factors and lack of comprehensive data. A quarter of user videos viewed on Meta's platforms are transmitted through mobile networks, which are less mature than fixed networks and have been increasing in energy use. However, this energy use is expected to stabilize with market penetration and efficiency improvements. Fixed networks, which are more mature in terms of connected population and technologies, handle three-quarters of user videos viewed on Meta's platforms. Given the stable or decreasing energy use trend in this segment, the overall energy consumption impact of user videos viewed on Meta's platforms is expected to be relatively minimal.

Together, these assessments demonstrate that while conventional environmental accounting methods of electricity consumption of videos viewed on Meta's platforms indicate a large impact from networks, and particularly, mobile networks. In reality, streaming a video requires a very limited increase in overall network electricity use due to the predominant share of traffic-insensitive energy demands in network infrastructure.

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[1] We define "short-term" as any period of time for which the local network's infrastructure hardware is not upgraded. For this second assessment, we set this period to 24 hours.

[2] We define "long-term" as any period of time that is multiyear.

Introduction

In this memo, ENGIE Impact seeks to quantify and characterize the electricity consumption of user videos viewed on Meta's platforms in Europe across the digital value chain using the latest public research and public data available. All data throughout this study is from 2022 unless indicated otherwise. Due to the use of public information, this study does not take into account efficiency savings in Meta's most recent partnerships with telecommunication operators on video optimization.

For the purposes of this memo, the digital (or network) value chain is defined as the:

- **Edge network:**
  - Content delivery networks (CDNs) serve a particular geographical area by caching copies of the original video data, avoiding network congestion and improving user experience
  - PoPs (Points of Presence) and MNAs (Meta network appliances) cache the most popular content even closer to users than CDNs would be on average
  - The edge network is the only part of the value chain in the boundary of this study that is owned and operated by Meta; the rest is owned/operated by other providers
- **Telecommunication networks include the transmission of data (e.g., videos) from the edge network to the end user. This takes place over internet protocol telecommunication infrastructure, categorized into:**
  - Backbone networks (also known as core, built for long distance and large-scale traffic);
  - Fixed access networks (e.g., copper or fiber optic lines to residences); and
  - Mobile access networks (e.g., base stations or radio access networks)
- **End user property:**
  - Networking equipment: residential terminals and routers connecting home devices to the ISP's fixed access network, including WiFi routers
  - Media devices including smartphones, laptops, desktop computers

This analysis is not a full lifecycle assessment and is not in accordance with ISO 14040 or ISO 14044 standards. The boundary of this study is the gate of Meta's data centers to the end consumer, with key exclusions to allow focus on network, telecommunication and end user property use. In particular, this assessment does not include:

1. Video value chain segments upstream of core data centers (e.g., the producing and uploading of videos)
2. Meta data centers due to the sensitivity of video specific electricity consumption data. Meta however publishes total electricity consumption by data center in its sustainability report and Meta`s data center electricity use is matched with 100% clean and renewable energy[3]
3. Backbone networks connecting Meta data centers to edge servers as their contribution is negligibly small[4]
4. Segments downstream of direct user devices (e.g., TVs used to cast the video using a smartphone as Meta's platforms do not have TV applications)
5. Fixed Wireless Access routers connecting devices to mobile networks over WiFi as their use rate is negligibly small[4]
6. Upstream data traffic from user devices to data centers
7. Devices other than smartphones, laptops, desktop computers
8. Electricity consumption increases in the media device to play the video, nor an allocation of device electricity use to software processes that are not Meta's platforms
9. Non-operational use phase (i.e., embodied use phase)
10. Embodied carbon of devices streaming videos, the network fiber, data center hardware, etc.

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3 Meta, 2024 Sustainability Report, https://sustainability.atmeta.com/wp-content/uploads/2024/08/Meta-2024-Sustainability-Report.pdf

4 "Carbon impact of video streaming", Carbon Trust (2021), https://www.carbontrust.com/our-work-and-impact/guides-reports-and-tools/carbon-impact-of-video-streaming

ENGIE Impact conducted three assessments to complete this analysis:

1. **Assessment 1** calculates the reference impact of user videos viewed on Meta's platforms in 2022 in Europe using a conventional "top-down" accounting method
2. **Assessment 2** assesses the short-term[1] marginal impact of user videos viewed on Meta's platforms on mobile networks, simulating the behavior of a 4G mobile network in response to video traffic
3. **Assessment 3** assesses the long-term[2] impact of data traffic on telecommunication networks, across all data traffic beyond Meta's platforms, to assess the impact of overall data traffic increases that are intertwined with technological improvements

Assessment 1: Reference impact of videos using the conventional impact accounting method

Attributing electricity consumption of the digital value chain to individual online services has historically been extraordinarily challenging, due to the constantly evolving, highly complex, and intrinsically shared aspect of the infrastructure. This challenge has been exacerbated by limited disclosures of network operators on their electricity use and data traffic.

As a result of these challenges, a simple "top-down" extrapolation has become the conventional method for assessing the impact of one single service, recommended in particular by the *ICT Sector Guidance built on the GHG Protocol Product Life Cycle Accounting and Reporting Standard*[5]. ENGIE Impact followed this protocol in assessment 1 which consists of simply dividing the total historical electricity use of networks over a given period of time by the total data traffic volume in gigabytes over that same period of time, which is typically a year. This protocol and intensity metric has been used by telecommunication operators as well as regulators (e.g., the Autorité de Régulation des Communications Électroniques and des Postes et de la Distribution de la Presse (ARCEP) in France). It has also been (mis)used by some studies and press articles to forecast electricity consumption, as further described below.

This method is applied to user videos viewed on Meta's platforms in Europe as a reference assessment. In addition to allocating electricity consumption across the digital value chain, this assessment also calculates the associated greenhouse gas (GHG) emissions across the value chain[6]. ENGIE Impact first calculates the overall impact of all videos transmitted throughout Europe, and specifically for France and Germany as well[7] using 2022 data, with the following key assumptions made:

- 11.5 trillion video views on Instagram and Facebook per year in Europe, derived from 200 billion reels viewed per day globally[8] and the share of Average Facebook Daily Active Users in Europe vs. the world
- A maximum encoded bitrate for 1080p AV1 video of 700 kilobits per seconds[9]
- 1 hour and 5 minutes of average time spent on Facebook and Instagram[10], of which 60% is spent watching videos[11]. This results in an average time spent per video per user of 23 seconds
- An edge network electricity intensity of 0.000108 kWh/GB[12]

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[5] Carbon Trust, Global e-Sustainability Initiative (GeSI), "ICT Sector Guidance," GHG Protocol (2017), Section 4.7.4 ("Calculating network emissions"), https://ghgprotocol.org/sites/default/files/2023-03/GHGP-ICTSG%20-%20ALL%20Chapters.pdf

[6] The identified value chain boundary for this study is broader than Meta's current corporate greenhouse gas inventory, as optional "indirect use-phase emissions" on transmission infrastructure and user devices allowed under the GHG Protocol, ICT guidance.

[7] France and Germany were selected for dedicated assessments due to their large population size, contrasting grid electricity emission factors, and the availability of public information on network energy use.

[8] "Reels ads updates: new performance features, automated creative and suitability solutions", Meta (2023), https://www.facebook.com/business/news/reels-ads-updates-performance-features-automated-creative-suitability-solutions

[9] "How Meta brought AV1 to Reels", Meta (2023), https://engineering.fb.com/2023/02/21/video-engineering/av1-codec-facebook-instagram-reels/

[10] "Average Time Spent on Social Media: The Latest Numbers", Businessdit.com (2023), https://www.businessdasher.com/average-time-spent-on-social-media/

[11] "First Quarter 2024 Results Conference Call", Meta (2024), https://s21.q4cdn.com/399680738/files/doc_financials/2024/q1/META-Q1-2024-Earnings-Call-Transcript.pdf

[12] Priest et al., "Evaluating Sustainable Interaction Design of Digital Services: The Case of YouTube", In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19). Association for Computing Machinery, New York, NY, USA, Paper 397, 1–12. https://doi.org/10.1145/3290605.3300627

- 98.5% of video views are on smartphones and 1.5% on computers[13]
  - 25% of video views on smartphones are on mobile networks and 75% on fixed networks[14]
  - 50% of video views on computers are on desktop computers and 50% on laptop computers
- Mobile network infrastructure electricity consumption in 2022 is allocated using 0.183 kilowatt-hours per gigabyte of data for Europe[15], 0.24 kilowatt-hours per gigabyte of data for France[16], and 0.252 kilowatt-hours per gigabyte of data for Germany[17]. These figures represent the technology mix at the time of measurement including 5G, 4G, 3G, etc.
- Fixed network infrastructure electricity consumption in 2022 is allocated using 0.0139 kilowatt-hours per gigabyte of data for Europe and Germany[18], and 0.0062 kilowatt-hours per gigabyte of data in France[19]. These figures represent the technology mix at the time of measurement including fiber- and copper-based technologies
- Home networking equipment electricity consumption is assumed to be 9W shared by an average of 2.3 of residents per household in Europe, 2.2 in France, and 2.0 in Germany in 2022[20]

The main benefit of the conventional method is that it allows 100% of the electricity and GHG emissions of the digital value chain to be allocated to the individual segments (within the identified boundary of the assessment). Importantly, this includes allocating the networks' electricity use in idle state based on data volume in gigabytes. For example, the share of total electricity consumption of mobile networks is calculated using the proportion of Meta's video data relative to the volume of all other data traffic. This results in 100% of the mobile network's electricity use allocated to the total data traffic, as required by GHG accounting requirements laid out by the GHG Protocol[5].

In terms of limitations, this method may be too simple to be utilized for comparative analysis for decision-making as it was really designed to satisfy attributional GHG impact assessment rules. This method is better suited for straightforward attributional assessments versus comparative or consequential studies (e.g., policy impact assessments). In particular, this simplistic method creates artifacts when studying marginal changes (e.g., from different video compressions). It assumes that network electricity use scales directly with data traffic, from zero to the total watt-hours based on the total gigabytes used in a year. However, electricity use depends on other factors, like idle electricity and system upgrades, which means it doesn't increase linearly with data traffic. This is best illustrated with the home router, which displays a flat power consumption virtually independent of data traffic. Under the present conventional allocation methodology, a linear relationship with data traffic is however created by dividing the home router's yearly electricity consumption by the yearly data traffic.

In applying this conventional method, ENGIE Impact derived that user videos viewed on Meta's platforms in 2022 in Europe consumed approximately 2.2 terawatt-hours of electricity across the digital value chain (as the value chain is defined in this assessment), with 58% attributed to mobile network infrastructure, 35% attributed to fixed networks including 22% from in-home networking equipment and 13% from fixed network infrastructure, 7% attributed to end user media devices, and 0.1% attributed to the edge network. No holistic data for the digital ecosystem in Europe was readily found to provide a definitive total energy use. However, for reference, telecommunication networks in Europe alone used an estimated 25–30 terawatt-hours of electricity in 2022[21], estimated to represent 14-17% of the digital ecosystem's total energy use[22,23]. Based on this estimate, we extrapolate that the energy associated with user videos viewed on Meta's platforms would only represent about 1% to 2% of the total energy consumed by the entire digital ecosystem in Europe. Results are summarized in Table 1 on the following page.

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[13] "Device usage of Facebook users worldwide as of January 2022", Statista (2022), https://www.statista.com/statistics/377808/distribution-of-facebook-users-by-device/

[14] "Network Fee Proposals Are Based on a False Premise", Meta (2023), https://about.fb.com/news/2023/03/network-fee-proposals-are-based-on-a-false-premise/

[15] Calculated by linearly extrapolating electricity use per subscription to 2022 based on 2015-18 trend reported by Lunden, 2022, and dividing by the mobile-broadband Internet traffic per subscription in Europe in 2022 reported by the ITU

[16] "Enquête annuelle "Pour un numérique soutenable" - édition 2024," ARCEP (2024), https://www.arcep.fr/cartes-et-donnees/nos-publications-chiffrees/impact-environnemental/derniers-chiffres.html

[17] "2022 Corporate Responsibility Report", T-Mobile (2022), https://www.t-mobile.com/content/dam/digx/tmobile/us/en/non-dynamic-media/pdf/T-Mobile-2022-Corporate-Responsibility-Report.pdf?icid=MGPO_TMO_U_TMOCPSOCRS_7UL48HP17ITX58D5Q34559

[18] Calculated by linearly extrapolating electricity use per subscription to 2022 based on 2015-18 trend reported by Lunden, 2022, and dividing by fixed-broadband Internet traffic per subscription in Europe in 2022 reported by the ITU. European average is assumed for Germany due to lack of country-specific data.

[19] Calculated by dividing the 2022 electricity use per subscription in France reported by ARCEP with the fixed-broadband Internet traffic per subscription in France in 2022 reported by the ITU

[20] "Housing in Europe – 2023 edition", Eurostat (2023), https://ec.europa.eu/eurostat/web/interactive-publications/housing-2023

[21] European Commission, Joint Research Centre, "Energy Consumption in Data Centres and Broadband Communication Networks in the EU", JRC Publications Repository (2024), https://publications.jrc.ec.europa.eu/repository/handle/JRC135926

[22] Malmodin et al., "The Energy and Carbon Footprint of the Global ICT and E&M Sectors 2010–2015," Sustainability (2018), https://www.mdpi.com/2071-1050/10/9/3027

[23] ADEME and ARCEP, "Le 2ème volet de l'étude (évaluation de l'impact environnemental)," https://www.arcep.fr/uploads/tx_gspublication/etude-numerique-environnement-ademe-arcep-volet02_janv2022.pdf

Table 1: Electricity consumption and GHG emissions by region and value chain segment for user videos viewed on Meta's platforms in 2022

Region	Segment	Energy impact (thousand MWh)	Emissions (thousand tCO_2e)
Europe	Edge network	3.1	0.8
	Mobile networks	1,279.2	321.1
	Fixed networks	297.4	74.6
	User premises networking	476.9	119.7
	User devices	145.5	36.5
	Total	**2,202.1**	**552.7**
France	Edge network	0.5	0.03
	Mobile networks	248.8	16.9
	Fixed networks	19.7	1.3
	User premises networking	70.5	4.8
	User devices	21.5	1.5
	Total	**360.9**	**24.5**
Germany	Edge network	0.6	0.2
	Mobile networks	342.6	125.4
	Fixed networks	57.7	21.1
	User premises networking	101.7	37.2
	User devices	21.5	7.9
	Total	**524.1**	**191.8**

Of the 2.2 terawatt-hours across the value chain in 2022, France and Germany are respectively attributed ~360 and 524 gigawatt-hours. Mobile networks are the top contributor at 69% for France and 65% for Germany, followed by in-home networking equipment at 19% for France and Germany, 5% and 11% for fixed network infrastructure in France and Germany respectively, and the remainder for user devices. Differences between countries are primarily driven by country-specific energy intensities per gigabyte of data transmitted.

The GHG emission total within the digital value chain (and the boundary as defined by this study) is about 553,000 metric tons of carbon dioxide equivalent (tCO_2e) in 2022 using the GHG Protocol's location-based methodology for Europe[24]. Due to the low emission rate of the French electric grid and the relatively high one of the German electric grid, location-based emissions are about 25,000 tCO_2e in France vs. 192,000 tCO_2e in Germany. In all cases, end user media devices account for ~5% of the electricity total, creating negligible emissions, as the study assumed 98.5% of video views are on smartphones and 1.5% are on computers.

Considering the value chain of a single 23 second, 700 kilobits-per-second video watched on a smartphone on an average mobile network in Europe using the same intensity of 0.183 kilowatt-hours per gigabyte of data, an even greater share (98.6%) of the value chain's electricity impact is attributed to mobile networks, relative to 1.4% for the smartphone.

Under this reference assessment and within the identified boundary of the assessment, mobile networks are the top electricity contributor. This is for two main reasons: (1) mobile networks in Europe use more than twice the absolute electricity (TWh) of fixed broadband networks over a year[25] and (2) mobile networks are ~10x more energy-intensive per gigabyte of data relative to fixed networks using the present "top-down" allocation method. Therefore, while three quarters of Meta's video traffic data in Europe occurred on fixed networks[14], a disproportionate ~13% of the value chain electricity is attributed to the fixed network infrastructure and ~22% to in-home networking equipment, relative to mobile networks being attributed 58% of the value chain electricity.

In the next sections, ENGIE Impact contrasts this reference set of results with a second assessment using a

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[24] Emission factors were obtained from the European Environment Agency's dataset "Greenhouse gas emission intensity of electricity generation in Europe" for 2022 and are 251, 68, and 366 g CO_2e/kWh for Europe, France, and Germany, respectively.

[25] Lundén et al., "Electricity Consumption and Operational Carbon Emissions of European Telecom Network Operators", Sustainability (2022), https://doi.org/10.3390/su14052637

short-term marginal impact method for mobile networks at the level of an individual user and a third assessment discussing the long-term, macro impact of data traffic. These complementary assessments will show that increased data traffic (such as videos viewed on Meta's platforms) do not cause the large increases in mobile network electricity consumption that the first assessment implies.

Assessment 2: Short-term marginal impact of videos on mobile networks for individual users

As described in assessment 1, the simplified allocation of the digital value chain electricity use to individual services is not fit for the purpose of assessing the impact of a change in use (i.e., marginal impacts). To assess these short-term[1] or marginal impacts on mobile networks, ENGIE Impact simulated a mobile network's behavior in response to changing data flows on a single smartphone. For this assessment, the network infrastructure hardware is assumed not to change due to upgrades, and we assess the short-term impact over one video transmission and a 24-hour period. This method is based on modeling by Ericsson[26], a major mobile network equipment manufacturer, and it has been notably applied in a Carbon Trust white paper[4].

The main benefit to utilizing this method is that it is well-suited to study the consequence of a change, because it more accurately simulates real-world responses from the digital value chain to changes in data flows on mobile networks. Instead of the reference method's simple ratio of total electricity use by total data traffic, this method separates the base load from the variable load of 4G radio stations and their core network, then allocates each based on a realistic representation of their energy drivers including subscriptions, time and bitrates. Limitations to this method include the assumption of steady-state infrastructure (i.e., no network capacity per subscription is added due to bandwidth constraints) and that it is not fully aligned with the GHG Protocol ICT Sector Guidance[5] as idle time is not allocated, resulting in a possible gap in the allocated value chain emissions.

To perform the assessment, ENGIE Impact first simulated the mobile network's response to one video watched on a smartphone for the duration of the transmission. ENGIE Impact then studied the consequence of a lower-compression version of the video with transmission time held constant. Finally, ENGIE Impact contextualized this over a 24-hour period to capture the relative contribution over time of idle energy. Results are summarized in Table 2.

Table 2: Average data traffic per user for videos encoded at 700 kilobits per seconds and 50% lower compression scenario (1,400 kilobits per second) over 24-hour period and its impact on network electricity consumption relative to base load.

Average number of videos consumed by user per day	103.1
Average data consumed by user per day	256 MB
Base power of 4G network per user per 24 hours	28.8 Wh
Increase in electricity consumption of 4G network from videos	2.9%
Increase in electricity consumption of 4G network from videos with 50% lower compression	5.7%

Assuming a 23 second video with a 6 second data buffer, an encoding resulting in 700 kilobits per second, and real-time data download, the transmitted data volume is 2.5 megabytes, and the transmission duration would be 29 seconds, resulting in a marginal electricity consumption increase of 8.6 milliwatt-hours, equivalent to a 10W LED light bulb switched on for 3 seconds. Should the video compression be 50% less efficient at 1,400 kilobits per second, the file size would double to 5 megabytes. In this scenario, the marginal electricity consumption increase of the mobile network would double to 17.2 milliwatt-hours as it is linearly dependent on both bitrate and transmission time.

Zooming out from a single video, mobile networks must be powered 24 hours a day and 7 days a week to meet customer demands; therefore, they maintain a significant electricity base load use: "*4G radio units need a certain level of power, about 50% of its max power, to establish and maintain area coverage, keep track of and constantly broadcast reference/system/sync data to possibly thousands of mobile devices and be ready to instantly respond*

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[26] Malmodin, "The power consumption of mobile and fixed network data services - The case of streaming video and downloading large files", Electricity Goes Green (2020), https://online.electronicsgoesgreen.org/wp-content/uploads/2020/10/Proceedings_EGG2020_v2.pdf

to any input from users and the network"[26] in addition to the energy used for cooling and power conversion. An average set of five 4G stations serving about 1,000 subscriptions needs about 1,000W of base power (i.e., 1W per subscription). The core network behind mobile networks adds another 0.2W of base power per subscription. As a result, 1.2W of total base power per mobile subscription is consumed around the clock, resulting in 29 watt-hours per day (Table 2).

The average user will consume about 100 videos over that same 24-hour period. Transmitted at 700 kilobits per second, this is equivalent to using <1% of the 100 megabits per second bandwidth of the 4G network for ~3% of the 24-hour period, resulting in a variable electricity consumption of 28.8 watt-hours. This shows that the variable load is relatively small, equivalent to 2.9% of the base load over 24 hours.

Assuming videos with 50% less efficient compression,[27] electricity consumption from the variable power would amount to 5.7% of the base load and cause an increase of 2.8% relative to the base and variable loads of a video at the current compression rate. This illustrative example shows the importance of maximizing video compression.

Assessment 3: Long-term macro impact of video on networks

This third assessment shifts the focus from historical attributional methods and short-term, user-level impact assessments to the challenging domain of forecasting system-wide energy trends in telecommunication networks and acknowledging the inherent limitations in such projections. Predicting the future energy consumption of these networks is remarkably complex, particularly for the mobile segment. This complexity stems from a dynamic interplay of numerous factors, where data traffic volume, while increasing, is far from the sole determinant of energy use. As highlighted by numerous large-scale studies[28], even before delving into subsystem specifics like video traffic, a lack of sufficient granular data and robust forecasting models has historically hampered accurate predictions.

Attempts to forecast network energy use based on attributing energy consumption proportionally to data traffic growth, as seen in some studies leveraging methodologies similar to assessment 1, have proven to be highly inaccurate when compared to subsequent real-world data. First, such approaches fail to account for the continuous and substantial improvements in energy efficiency per unit of data transmitted that occur as networks evolve. Energy consumption per unit of data volume has, in fact, consistently decreased over time[29, 16]. Second, the reality is that networks develop and are upgraded due to a complex mix of drivers aimed at meeting diverse user needs and technological advancements, as further described below.

A quarter of user videos viewed on Meta's platforms transmit on mobile networks[14]. Historically, mobile networks' total energy use has been increasing at rates on the order of 2-15% per year[25,16]. This growth cannot be only attributed to data traffic growth – assessment 2 demonstrated that the traffic-insensitive components of the networks cause the vast majority of energy use. This is corroborated by similar conclusions on system-wide network costs over the years[30]. The overall energy trajectory of mobile networks is the multi-factorial product of growth in their user base, improvements of their performance (coverage, latency, bandwidth, etc.), and the need to power layered generations of infrastructure (3G, 4G, etc.) for continuity of service. This complex interplay of growth drivers and technological transitions, often dictated by the strategic decisions of telecommunications operators and broader systemic trends, renders precise long-term forecasting exceptionally challenging. Ericsson illustrates this uncertainty and the energy saving potential by contrasting forecasts for traditional roll-out of 5G (increasing total energy use) and proposed "breaking the energy curve" approach (leveling off and potentially reducing total energy use)[31]. Understanding the long-term energy trajectory of digital networks requires an analysis that incorporates these fundamental drivers of infrastructure evolution and growth, positioning data traffic volume from any specific application as one variable within a complex, multi-dimensional system. The potential for further energy efficiency gains within mobile networks is a subject of ongoing research and development, often explored through collaborations between content providers and telecommunications operators focused on optimizing traffic management and network resource utilization. Meta is collaborating with

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[27] The assumption of a 50% lower compression video was selected to study the worst case scenario of value chain impacts when data traffic is doubled relative to today's video data volumes

[28] European Commission, 2020, ICT Impact study – Final report (link) European Commission, 2020, Energy efficient Cloud Computing Technologies and Policies for an Eco-friendly Cloud Market (link), ADEME-Arcep study: assessment of the digital environmental footprint in France in 2020, 2030 and 2050 (link)

[29] Aslan, J. et al., "Electricity intensity of Internet data transmission: Untangling the estimates", Journal of Industrial Ecology, https://onlinelibrary.wiley.com/doi/full/10.1111/jiec.12630

[30] Analysys Mason, "The impact of tech companies' network investment on the economics of broadband ISPs, "October 2022, https://www.analysysmason.com/contentassets/b891ca583e084468baa0b829ced38799/main-report---infra-investment-2022.pdf

[31] "On the road to breaking the energy curve", Ericsson, 2022, https://www.ericsson.com/en/news/2022/10/ericsson-publishes-breaking-the-energy-curve-report-2022

European telecommunications operators like Vodafone and Telefónica to optimize network traffic, particularly video, aiming to improve user experience and network efficiency.[32]

In contrast, fixed networks, particularly those where fiber optics have largely replaced older copper technologies, present a clearer energy consumption picture. With an even smaller traffic-sensitive energy component, a more mature infrastructure, and high penetration rates across much of Europe, fixed network energy consumption has shown tendencies towards stabilization or even decrease[33, 16] despite significant increases in data traffic. This is largely attributable to the superior energy efficiency of fiber optic cable compared to copper[34]. The majority of user videos viewed on Meta's platforms (over three quarters[14]) traverses these fixed networks. Given this network segment's stable or decreasing trend in energy use, Meta's video consequential impact on the overall energy consumption can be expected to be relatively minimal, especially when viewed against the backdrop of the established nature of the infrastructure.

Conclusion

This memo walked through three assessments to understand and quantify the electricity consumption, across the digital value chain, of user videos viewed on Meta's platforms in Europe.

Assessment 1 indicates that mobile networks are the top electricity contributor, likely for two main reasons: (1) mobile networks in Europe use more than twice the electricity (TWh) of fixed broadband networks (excluding home routers) over a year[16, 25] and (2) mobile networks are ~10x more energy-intensive per gigabyte of data relative to fixed networks using the present "top-down" allocation method[35]. The attributional methodology used is however not suited for forecasting and decision-making.

Assessment 2 is consequential and focused on the short-term marginal impact of videos on mobile networks for individual users, utilizing recently published data and models for mobile networks' energy use. The results indicated that the variable energy load for the average Meta video user is relatively small, accounting for only 2.9% of the traffic-insensitive base load over a 24-hour period.

Assessment 3 expanded the scope of assessment 2 to examine the long-term macro impact on networks. Forecasting the energy use of networks is highly complex, with numerous large studies commissioned by EU authorities highlighting inherent limitations due to the multitude of influencing factors and lack of comprehensive data. A quarter of Meta's videos flow through mobile networks and represent one variable within this intricate, multi-dimensional system. Mobile networks are less mature than fixed networks and their energy use has been increasing. Energy use is however expected to stabilize with market penetration and efficiency improvements. Fixed networks, more mature in the share of connected population and technologies, transfer three quarters of user videos viewed on Meta's platforms. Given the very low sensitivity to data traffic for this network segment's energy use, the overall energy consumption impact of Meta's videos is anticipated to be and remain relatively minimal.

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[32] https://www.vodafone.com/news/technology/vodafone-and-meta-optimise-short-form-videos-to-improve-network-efficiency; and https://www.telefonica.com/en/communication-room/press-room/telefonica-meta-boost-short-video-experience-network-efficiency/

[33] Lundén et al., "Electricity Consumption and Operational Carbon Emissions of European Telecom Network Operators", Sustainability (2022), https://doi.org/10.3390/su14052637

[34] Copper-based networks consumed 34 kWh per subscription in France in 2022 relative to 10 kWh per subscription for fiber-based networks, according to ARCEP's study

[35] ENGIE Impact calculation using kWh/subscription inputs sourced from Malmodin et al. and GB/subscription inputs sourced from ITU