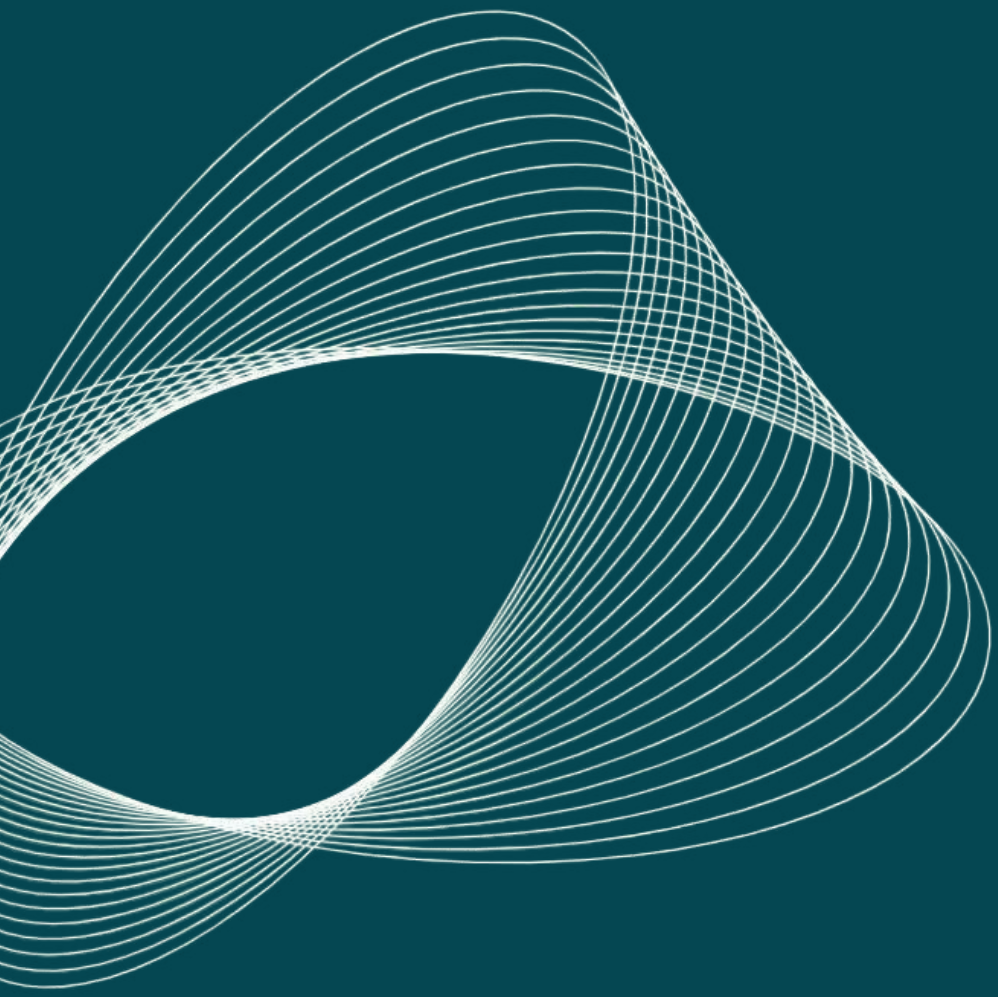
footsprint.

presents

Digital pollution: Ranking the websites of the Top 100 US Advertisers.



2022

with LABELIUM

The Global Digital Performance Agency

Summary

About footsprint.

By empowering companies in transitioning towards more responsible and sustainable digital practices, footsprint aims to accelerate the decarbonization of the digital industry.

Part of the global e-commerce performance group Labelium, footsprint is an end-to-end digital sustainability agency.

By working at the crossroads of sciences with seasoned environmental and digital experts, footsprint reconciles sustainability and digital performance to build the digital ecosystem of the future.

From website foundations to multichannel digital advertising, the agency provides a full stack of sustainable digital solutions, built with a thorough methodology based on the latest industry research.

Find out more: footsprint.co
Contact us: **solutions@footsprint.agency**

Discover **our services.**

sustainable
web design.

responsible
media.

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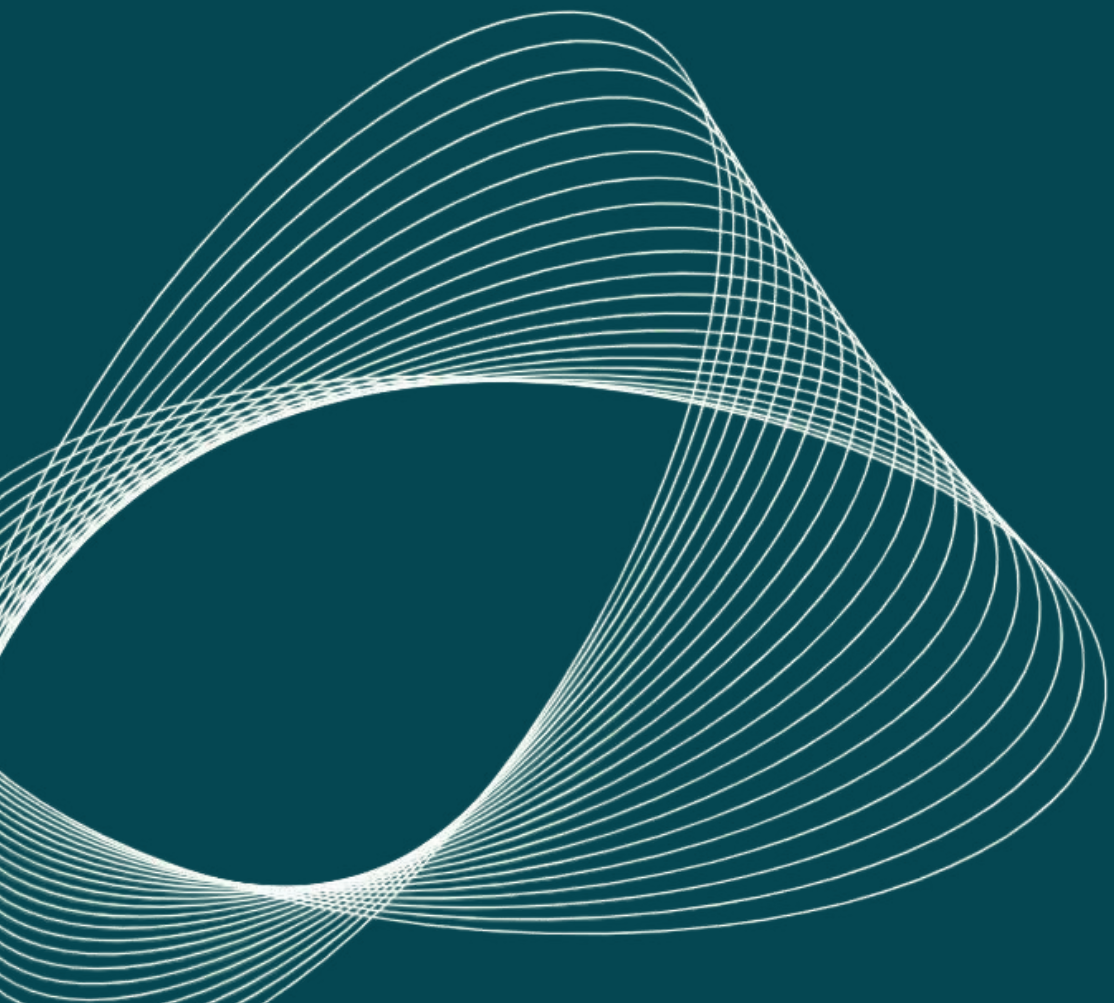
About Juan Sotés, **our environmental expert.**

Throughout his more than 10 years of experience in environmental sciences and global warming, Juan has worked in both private and public sectors, and more specifically for the Toronto Atmospheric Fund as carbon and co-benefits analyst. He joined footsprint in order to help the industry accelerate the transition towards digital sobriety. His expertise in carbon measurement and GHG protocols will contribute to develop and strengthen industry frameworks.

Ranking 2022



A FEW NUMBERS.

10M tons of CO_2e are generated every year in the USA as a result of internet traffic. This is equivalent to:

Los Angeles
Homes' electricity usage for 1 year

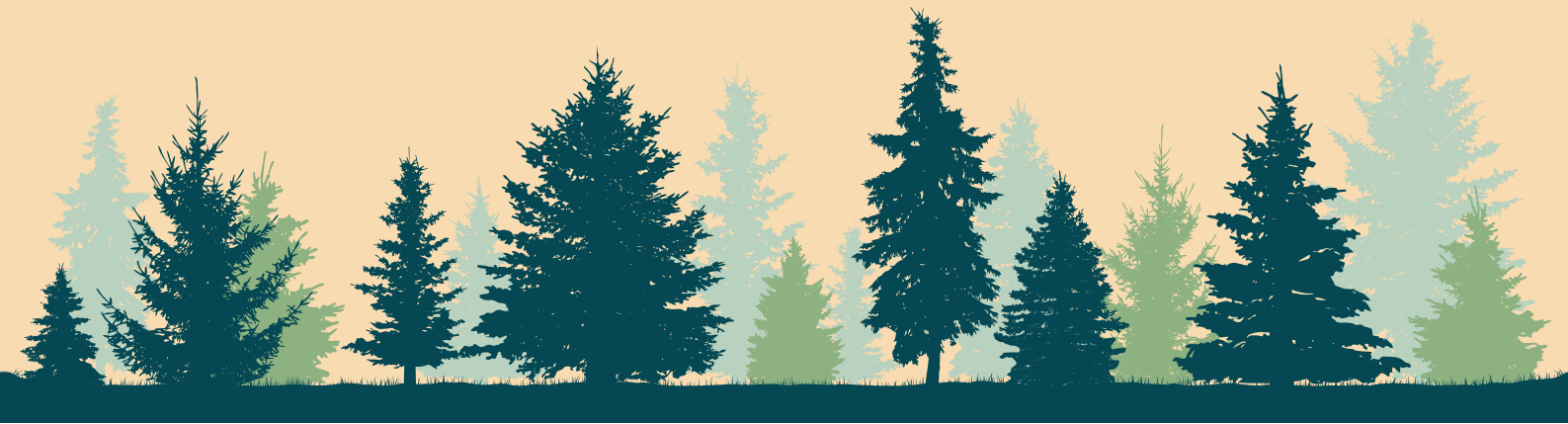
Natural gas-fired power plants in 1 year

2.7
Coal-fired power plants in 1 year

Equivalences data source: United States Environmental Protection Agency [1]

161K with 26 million of website visits per year, the Top 100 US Advertisers alone generate about 161,300 tons of carbon every year

The equivalent of carbon sequestered over a year by **7.3 million trees**



FOOTSPRINT CARBON RANKING:

UNVEILING THE IMPORTANCE OF REDUCING OUR DIGITAL CLIMATE IMPACTS

At the global scale, **worldwide digital activity in 2022 is estimated at 1.2 billion tons of CO_2e per year,** more than any country aside from China, the USA, India and Russia. **Yet digital emissions as of today are not included in companies' carbon footprint measurement**,

nor are they part of the GHG Protocol. In a world where net-zero commitments are becoming mandatory for companies, this means the hidden carbon cost of their digital efforts is severely underestimated, potentially undermining their real net-zero trajectories.

Yet by working at the crossroads of digital and environmental science, methodologies are starting to emerge for measuring the carbon footprint of digital products and services, and regulations will doubtlessly soon follow suit.

In this ranking of the Top 100 US Advertisers, our primary objective is to draw attention to the very tangible impact of website traffic pollution, particularly among high traffic industry leaders. The ranking is based on purely technical criteria, and does not account either for the quality of the Top 100 Advertisers' website content, nor their sustainability initiatives at large. It is also to be noted that the large multi-brand groups featured in this analysis are only analyzed based on the group corporate website. Their total digital traffic emissions are therefore underestimated.

About the ranking

Methodology & sources of emissions

Our methodology is based on **the three core emission sources of digital services:**

- **Server emissions**
- **Network emissions**
- **End user devices emissions**

Those criteria refer to **website energy efficiency and data transfer** (here estimated using page weight), **energy used by segment**, as well as **the grid intensity of web host, transmission network and end user locations** (see methodology section).

For each source, total emissions include manufacturing and use.

Reading the ranking

The objective of this ranking is to reflect a websites' ecological performance based on aforementioned emission factors. So that comparison is fair amongst the different sites, the ranking does not reflect for website traffic, rather we look at average carbon emissions per page view as our key ranking factor.

This does not mean that traffic doesn't matter. To put these figures into perspective, the column "Total emissions per year" enables us to understand the real carbon impact of each website by incorporating yearly traffic volume. The greater the volume, the greater the advertiser's responsibility for improving its ecological performance; 0.1g CO_2e saved per page view can indeed make a big difference when we are talking about hundreds of millions of visits per month.

In case of a tie on emissions per page view, the advertiser generating the lowest yearly emissions is ranked higher.

Find out more: **footsprint.co**
Contact us: **solutions@footsprint.agency**

Executive Summary (1/2)

A single visit on the ‘dirtiest’ website is 115 times more polluting than on the cleanest one.

From the most polluting websites…

Among the Top 100 US Advertisers, the podium for **the top 3 dirtiest websites** belong to **Pepsico, Dish** and **GlaxoSmithKline**. Pepsico stands at the far bottom of the ranking, emitting about 1.2g CO_2e / avg. page view. In comparison, Pepsico’s biggest competitor Coca-Cola obtains the 24th rank, generating 10 times less carbon emissions per page visit than Pepsico.

Ranked second most polluting website (#99 in the ranking) and at the bottom of the Media & Entertainment ranking is Dish, generating 0.75g CO_2e / avg. page view. Among its key competitors, Comcast scores the 16th position, while Disney scores 15th and AT&T 34th.

Finally, GlaxoSmithKline is rated third most polluting website (#98) and at the bottom of the Pharmaceutical ranking when it comes to website emissions. Amongst key competitors and best scorer in the same category, Merck obtains the 8th position and generates 6 times less emissions per page than GSK.

… to the cleanest ones

Much is to be said about the #1 in this ranking when looking at emissions generated per page visit. Out of fairness, we have left Warren Buffett’s Berkshire Hathaway website at the top of the ranking, although we would like to draw attention to a few key points:

- The Berkshire Hathaway website basically hasn’t changed since the 1990s, and is absolutely not a best practice.
- The website works for Berkshire Hathaway because it is built for its shareholders, not to convert customers.

However, due to the **almost complete lack of any kind of feature** on the Berkshire Hathaway website, it is effectively the lightest of the top 100 Advertisers’ list, generating as little as 0.01g CO_2e / page visit.

Executive Summary (2/2)

Much more interesting when looking at successful examples of sustainable web design best practices are our #2, #3 and #4 cleanest websites, Intuit, Facebook and Google, ranking within 0.01g CO_2e / page visit of each other.

With very effective and lean page design minimizing the use of heavy imagery or video, minimized code and effective caching (amongst other criteria, more details in the key learnings below), these three websites stand out as great examples of high impact / low emissions user experiences.

Intuit even achieves the exploit of beating Facebook and Google despite having a heavier homepage through an outstandingly effective use of caching.

Why volume matters

If Google was to reduce its emissions per page on par with Intuit (i.e. a reduction of only 0.03g CO_2e / page view), it would reduce its carbon emissions by 42,969 tons every year in the US alone, the equivalent sequestered in a year by **2 million trees** [1].

If we account for Google's worldwide traffic, then this improvement would enable yearly carbon reduction of 270K tons, the equivalent sequestered in a year by 12 million trees [1].

It's not to say that Google isn't already in a good position in the ranking. But this highlights that **the higher the traffic volume, the larger the carbon impact and the more responsibility companies have to implement sustainability best practices, and to continuously strive to improve.** What can be seen as a negligible improvement on a unitary indicator can enable drastic reductions when multiplied by millions (or even trillions!).

The ranking

Rank	Name	Industry	Total emissions per year (tCO_2e) based on website traffic	Total emissions per page view (gCO_2e/avg page view)
1	Berkshire Hathaway INC	Financial Services	0.02	0.006
2	Intuit	Information & Technology	271.52	0.022
3	Facebook	Information & Technology	9430.11	0.025
4	Google	Information & Technology	74236.46	0.052
5	Netflix	Media & Entertainment	1732.37	0.064
6	Nike	Consumer goods	209.30	0.066
7	Discover	Financial Services	218.65	0.073
8	Yum	Restaurants	2.04	0.078
9	Merck	Pharmaceuticals	3.84	0.079
10	Liberty Mutual Insurance	Financial Services	32.03	0.080
11	Microsoft	Information & Technology	649.84	0.080
12	Adidas	Consumer goods	98.49	0.082
13	Uber	Business service	92.76	0.084
14	Disney	Media & Entertainment	50.84	0.089
15	American Express	Financial Services	404.87	0.089
16	Comcast	Communication services	1185.16	0.096
17	Progressive	Financial Services	115.35	0.099
18	Anthem	Media & Entertainment	50.41	0.101
19	Sanofi	Healthcare	0.23	0.104
20	Amazon	Retail	25516.28	0.111

The ranking

Rank	Name	Industry	Total emissions per year (tCO_2e) based on website traffic	Total emissions per page view (gCO_2e/avg page view)
21	IBM	Electronics	60.76	0.113
22	Capital One	Financial Services	1056.83	0.113
23	Charles Schwab	Financial Services	409.20	0.117
24	Coca Cola	Food & Beverage	12.72	0.119
25	Doordash	Food & Beverage	452.11	0.119
26	Bristol Myers Squibb	Healthcare	5.61	0.123
27	Takeda	Pharmaceuticals	0.44	0.124
28	LVMH	Consumer goods	0.63	0.130
29	Abbvie	Pharmaceuticals	3.32	0.131
30	Wells Fargo	Financial Services	2392.17	0.133
31	Clorox	Consumer goods	2.69	0.136
32	USA gov	Public services	24.30	0.137
33	Walmart	Retail	3686.53	0.137
34	AT&T	Communication services	1150.87	0.140
35	Rocket Companies	Financial Services	0.07	0.141
36	Cox	Communication Services	146.22	0.145
37	InterActive Corp	Media & Entertainment	0.06	0.146
38	Booking	Travel	721.19	0.152
39	Expedia	Travel	875.35	0.152
40	Allstate	Financial Services	114.35	0.155

The ranking

Rank	Name	Industry	Total emissions per year (tCO_2e) based on website traffic	Total emissions per page view (gCO_2e/avg page view)
41	Constellation Brands	Food & Beverage	1.05	0.157
42	Volkswagen	Industrials	20.05	0.158
43	Macys	Retail	1118.18	0.160
44	Wish	Retail	147.59	0.166
45	L'Oréal	Consumer goods	1.21	0.167
46	Kraft Heinz	Food & Beverage	0.20	0.168
47	Nestle	Food & Beverage	0.94	0.170
48	Lilly	Pharmaceuticals	2.64	0.172
49	Ford	Industrials	341.05	0.175
50	General Motors	Industrials	81.07	0.178
51	Dell	Electronics	190.62	0.178
52	Honda	Industrials	122.21	0.180
53	Reckitt	Consumer goods	0.20	0.182
54	United Healthcare	Financial Services	183.65	0.182
55	Nissan	Industrials	55.11	0.188
56	Kroger	Retail	382.72	0.190
57	Johnson & Johnson	Consumer goods	15.78	0.192
58	Statefarm	Financial Services	205.37	0.194
59	Walgreens	Retail	947.73	0.195
60	Gilead	Pharmaceuticals	2.42	0.199

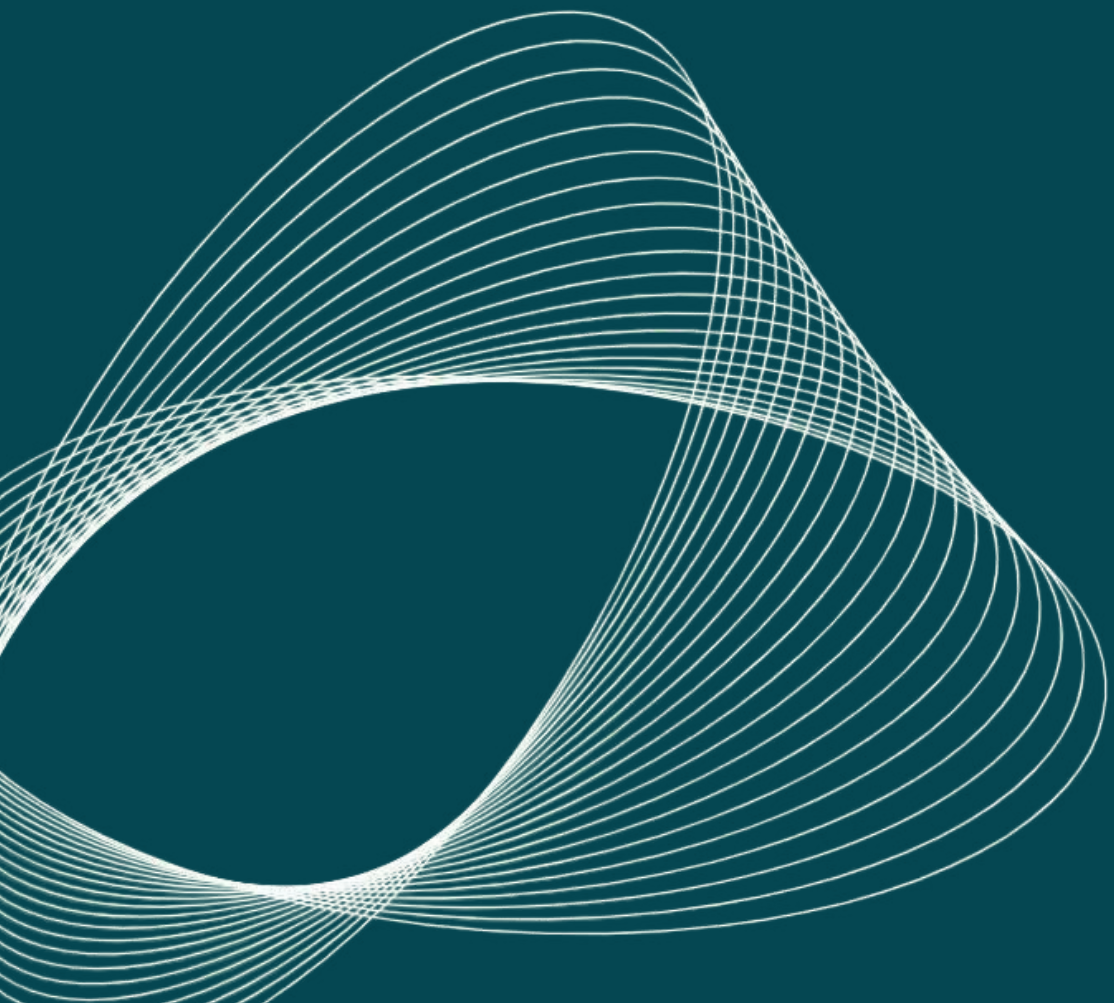
The ranking

Rank	Name	Industry	Total emissions per year (tCO_2e) based on website traffic	Total emissions per page view (gCO_2e/avg page view)
61	Restaurant Brand International	Restaurant	0.49	0.201
62	Unilever	Consumer goods	0.88	0.209
63	Apple	Electronics	1402.01	0.211
64	Paramount	Media & Entertainment	1.41	0.212
65	Inspire	Food & Beverage	2.78	0.213
66	Pfizer	Pharmaceuticals	7.23	0.218
67	Mcdonalds	Restaurants	84.60	0.219
68	Molson Coors	Food & Beverage	0.66	0.228
69	JP Morgan	Financial Services	26.30	0.230
70	Lending Tree	Financial Services	64.37	0.233
71	Sony	Electronics	117.68	0.233
72	P&G	Consumer goods	0.83	0.234
73	Best Buy	Retail	1581.39	0.238
74	Stellantis	Industrials	0.61	0.253
75	AMGEN	Healthcare	1.96	0.259
76	Verizon	Communication services	1081.50	0.268
77	Target	Retail	3524.47	0.269
78	Charter Spectrum	Communication services	135.46	0.280
79	Wayfair	Retail	2267.41	0.283
80	MARS	Food & Beverage	1.80	0.286

The ranking

Rank	Name	Industry	Total emissions per year (tCO_2e) based on website traffic	Total emissions per page view (gCO_2e/avg page view)
81	Bank of America	Financial Services	2947.57	0.288
82	Henkel	Consumer goods	0.47	0.318
83	Citi	Financial Services	1408.80	0.319
84	The Home Depot	Retail	4019.76	0.328
85	Essilor Luxotica	Consumer goods	1.02	0.331
86	Diageo	Food & Beverage	0.47	0.335
87	Toyota	Industrials	380.19	0.336
88	Lowe's	Retail	2436.43	0.343
89	Hyundai	Industrials	133.48	0.365
90	GAP	Consumer goods	2701.72	0.367
91	Colgate Palmolive	Consumer goods	0.43	0.385
92	Kohl's	Retail	2402.47	0.398
93	Novartis	Healthcare	3.10	0.410
94	ABinBev	Food & Beverage	0.54	0.413
95	Estée Lauder	Consumer goods	37.75	0.450
96	T Mobile	Communication services	3050.78	0.460
97	Samsung	Electronics	2041.77	0.473
98	GlaxoSmithKline	Pharmaceuticals	8.33	0.474
99	Dish	Media & Entertainment	154.81	0.753
100	Pepsico	Food & Beverage	30.39	1.155

Key Learnings

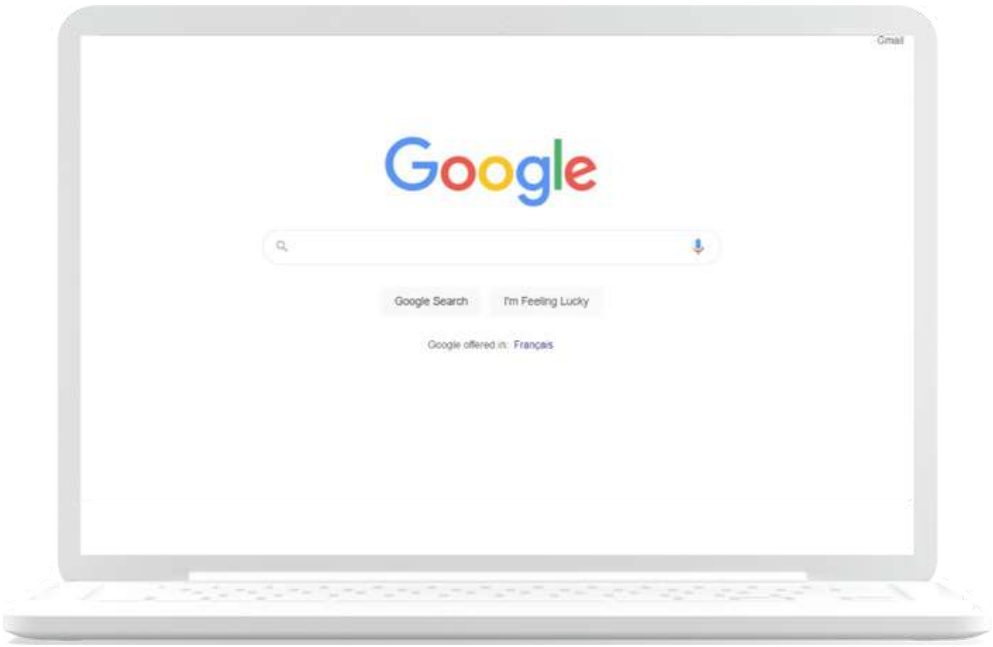


Key Learnings

4 key sustainable web design best practices that can be implemented easily.

ADOPT A LEAN DESIGN

Questioning the use of each feature and piece of content is the key to drastically reduce energy consumption. Does it have an added value or contribute to the brand image?



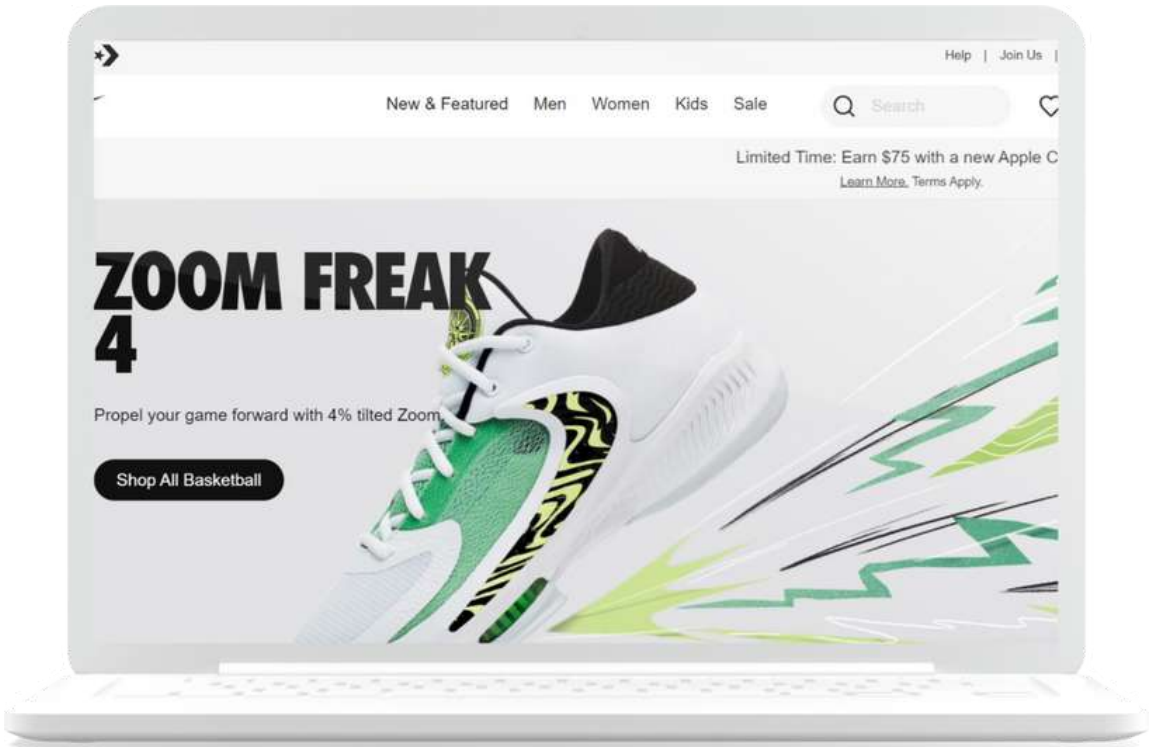
The Google homepage is a good example of lean design, making on on-site experience as simple as possible without adding any unnecessary feature.

Key Learnings

4 key sustainable web design best practices that can be implemented easily.

COMPRESS AND RESIZE CONTENT

When you deem a feature necessary on your web page, it is important to reduce its weight as much as possible by using the most efficient file format and leveraging compression tools.



Nike's images in JPEG and PNG are compressed into WEBP format, with its heaviest image only weighing 25KB. WEBP is a very efficient format for images, enabling on average about a 30% weight reduction compared to JPEG (*Google, WebP Compression Study*)

Key Learnings

4 key sustainable web design best practices that can be implemented easily.

INTEGRATE LAZY LOADING

As only 50% of users go further than the fold line of a web page, make sure the assets below are not loaded 100% of the time.

THEY ARE DOING IT WELL

Despite only being ranked 80th, Mars is actually doing a good job in terms of lazy loading implementation, with a 320% difference in terms of page weight between scroll and no scroll, as images & videos are only loaded as the user scrolls down. However the initial page weight is still much heavier than it could be with more lean design implementation.

LEVERAGE CACHING

Make sure returning visitors don't have to download (again) all the assets when they visit your website for the 2nd time!

The **use of caching** has helped Constellation Brands to reduce the amount of data transferred from 14,642 KB to 1.7 KB! However, as returning visitors account for **30% of traffic**, it is crucial to optimize the initial page weight to reduce the total carbon footprint generated -and limit the amount of data needed to be stored.

Conclusion

Fixing websites for sustainability is also good for business. Here's why.

Faster load speed

If we compare the top and bottom of the ranking in terms of site speed, here's the insight: the Intuit website is **4 times faster** than the Pepsico one (1.4s vs 5.6s). In a world where every second means increased consumer dropout rates, this can significantly affect business performances. Even when comparing within the same industry, the Coca-Cola website (ranked #24) is 2.5 times faster than Pepsico (#100).

The lighter and more efficient the website, the faster it loads. This can translate into very meaningful performance gaps: less friction, more qualified sessions, and higher conversion rates.

Wider reach

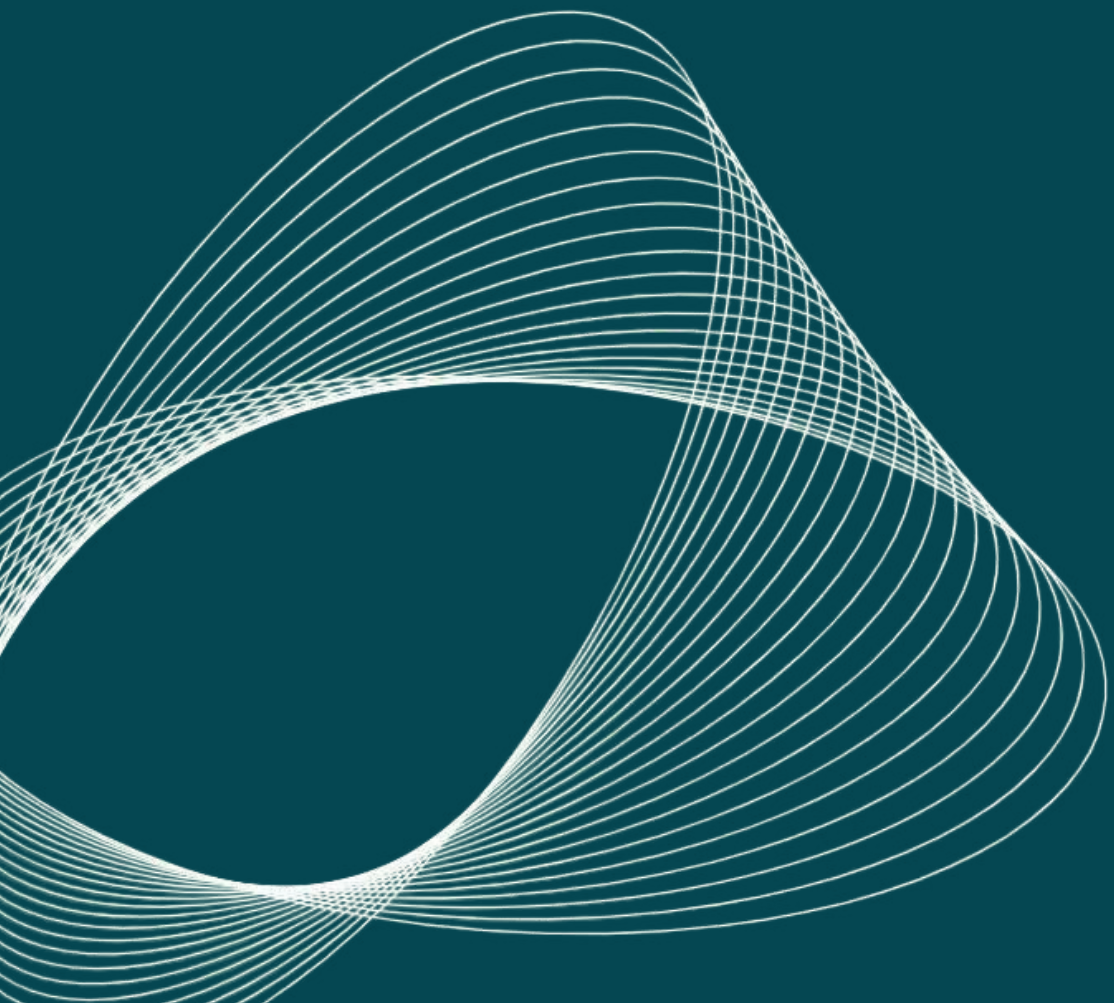
From an accessibility standpoint, lighter websites will also mean increased reach for audiences in less well served areas (poor connectivity, slow devices etc.).

Reduced web hosting costs

Simply put, the more energy efficient the website, the less electricity consumption required. When dealing with the yearly volumes of the top 100 Advertisers, increased page efficiency can translate into meaningful yearly cost savings. **This is particularly true in an inflation context like the one we are in, where the cost of electricity is rising.**

Earlier this year, French company Greenly asked several companies if running a carbon footprint assessment resulted in savings. The answer was yes by 78% of respondents and digital was the fourth pillar to see its spending being reduced. Indeed, reducing website carbon emissions results in the need of less functionalities, less requests, less physical infrastructures, and more bandwidth. **Concretely, it can mean saving money in data transmission and storage.**

Methodology & sources



Methodology

1. Sources of emissions

This study aims to calculate not only the yearly emissions of a website, but its carbon emissions throughout its lifecycle. To do this, we must take into account the **three core emissions sources** of digital services:

- **Server emissions:** during their use and manufacturing
- **Network emissions:** during their use and manufacturing
- **End user devices emissions:** during their use and manufacturing

Incorporating the manufacturing of each of these emissions sources adds a layer of complexity to an already complex methodology, yet it is essential as **user devices such as smartphones and laptops consume eighty percent of their lifetime energy before being turned on for the first time [2]**.

Methodology

2. System segments

Recent research from the IEA **[3]** shows that **the energy efficiency of data centers and telecommunication networks is improving over time,** so that the majority of emissions today are generated by networks and end user devices. Accounting for the manufacturing of each segment, the numbers and percentages we use in our study (outlined below) rely on 2020/21 studies **[4]** from the IEA and other credible sources listed below:

- **Data center emissions:** global energy consumption of 250 TWh, which accounts for about 13% of the system
- **Networks emissions:** global energy consumption (including 4G and emerging 5G networks) of 450 TWh, which accounts for about 24% of the system
- **End user devices emission**s: global energy consumption of 1,200 TWh, which accounts for about 63% of the system

These numbers need to be often revisited due to:

- **Efficiency improvements:** We expect continuous improvement of data center and network efficiency, as well as devices' energy consumption. These different components will achieve different efficiency gains, changing also the proportion in which each of them contribute to total energy consumption.
- **Internet growth:** While the previous factor will increase energy efficiency, this is expected to be offset by internet's growth and total energy consumption will increase in the near future **[4].**

For the purposes of this study, and in an effort to take a conservative approach that captures the full lifecycle impact of the systems in place, we have worked with an average energy intensity of 0.38 kWh/GB, including data storage, transfer and end device [5]. This intensity varies among the analyzed websites depending on the proportion of visits realized via mobile or computer:

Methodology

- **Mobile impact:** Mobile users have variable impacts on the network, because accessing a website using data (being it 4G, 5G, etc.) consumes 4 times more energy than doing it via WiFi. For the purpose of this study, we assume that 70% of mobile users will access the websites using WiFi based on international averages. In terms of device's Life Cycle Assessment (LCA), despite having lower operations emissions, mobiles have higher impact than computers due their short lifespan. It is assumed that all end users are in the US.

- **Computer impact:** We assume that access to the website is done 100% via WiFi and assume a full LCA impact from computers. With our current assumptions, the resulting impact is lower than accessing the Website via mobile.

Note: While mobile access has higher energy consumption intensity for networks and devices, we assume that there is an 11% page weight reduction vs computers, impacting the amount of data transferred and displayed.

Methodology

3. Calculating carbon emissions per page view

Using the above data, the total carbon intensity per page view, expressed in gCO_2e/view, was calculated using the below formula:

$$HP_{ci} = HP_w \times DT_{ei} \times [(E_s \times GIs) \times (1 - GH) + (E_t \times GI_t) + (E_d \times GI_d)]$$
$$HP_{ci} = HP_w \times 0.38 \times [(13\% \times GIs) \times (1 - GH) + (24\% \times GI_t) + (63\% \times GI_d)]$$

HP_{ci} = Total Homepage carbon intensity ($grCO_2$ per visit)

Homepage energy consumption:
HP_w = Homepage weight (KB)
DT_{ei} = Data transfer and storage energy intensity (kWh/KB)

Server Impact:
E_s = % of energy dedicated to server
GI_s = Grid intensity where the server is hosted ($grCO_2$/kWh)
GH = % of additional server green energy proven by green hosting

Transmission network impact:
E_t = % of energy dedicated to transmission network
GI_t = Grid intensity in transmission networks ($grCO_2$/kWh)

End device impact:
E_d = % of energy dedicated to end user devices
GI_d = Grid intensity in end device location ($grCO_2$/kWh)

Note: The weights for average home page and alternative page (another page within the website, we use the “terms and conditions” one to allow comparisons since most websites have it) are obtained averaging different views considering lazy loading and caching (more detailed explanation later).

Methodology

Electricity carbon intensity
While there is high disparity between the grid carbon intensity in different States (for example consuming 1 kWh is 200 times more polluting in Wyoming than in Vermont), in this study we only apply an average grid intensity for the US of 388 grams of CO_2 per kWh [6] for transmission and end devices, since we don't have granular data about end user's location.

For servers, the reason to apply an average value is that most sites use CDNs with multiple servers across the country. For those companies that don't use a CDN, we applied specific grid intensities for the state where the servers are located.

4. Accounting for returning visitors and caching

Caching data is a process that stores multiple copies of data or files in a temporary storage location - or cache - so that they can be accessed faster. This means users do not need to download information every time they access a website. To account for this, we have:

- Calculated the page weight for a returning site visitor enabling caching (usually around 5% of full page weight).

- Estimated that returning visitors account for about 30% of site traffic.

5. Accounting for lazy loading

Lazy loading refers to the design practice where certain elements of the site are only loaded once they become visible for the user. To account for this, we have estimated page weights with and without scrolling to the bottom, assuming for the calculation that 50% of users will scroll down.

Methodology

6. Methodology uncertainty & limitations.

- Uncertainty associated with certain variables in our methodology is very high (we have found values for the data transfer and storage energy intensity factor that range across several orders of magnitude). We will continue our research with the purpose of refining and consolidating those values, which will impact the final numbers, but not the position of organizations across the ranking.

- We use an average grid carbon intensity, this could be fine-tuned with more granular information about users and CDN servers' location.

- We use average electricity emissions factors. Marginal Emissions Factors, which better capture the impact of additional loads on the grid, are expected to increase the total emissions. Estimating the full LCA impact of electricity generation will as well give us a better overview of the real impact of its consumption, increasing emissions in our results.

- While some of the websites are using data centers that claim green energy use, it is unclear at the moment which ones are using real green energy and which ones have Power Purchase Agreement (PPAs) or are buying Renewable Energy Certificates (RECs). Some even mention combinations of those mechanisms without detailing in which proportion each of them contribute to decarbonize their activities. We will continue our research to refine this variable.

- Using one single electricity grid EF won't reflect the differences between sites with more visitors in jurisdictions with particularly high/low grid carbon intensities.

Sources

7. Sources

[1] US EPA Carbon Calculator. (2022). Retrieved 13 April 2022, from: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

[2] Numérique : le grand gâchis énergétique. (2022). Retrieved 13 April 2022, from https://lejournal.cnrs.fr/articles/numerique-le-grand-gachis-energetique

[3] Data Centres and Data Transmission Networks – Analysis - IEA. (2022). Retrieved 13 April 2022, from https://www.iea.org/reports/data-centres-and-data-transmission-networks

[4] Projecting the chiaroscuro of the electricity use of communication and computing from 2018 to 2030. (2019). Retrieved 13 April 2022, from https://www.researchgate.net/publication/331047520_Projecting_the_chiaroscuro_of_the_electricity_use_of_communication_and_computing_from_2018_to_2030/link/5c630968299bf1d14cc1e9ad/download

[5] Coma, M. (2022). Energy policies in the hyperconnected era. Retrieved 13 April 2022, from https://wsimag.com/science-and-technology/67085-energy-policies-in-the-hyperconnected-era

[6] IEA (2022). Emissions by plant and by region. Retrieved 17 September 2022, from https://www.eia.gov/electricity/data/emissions/