The Time to Act Is Now:

Media Industry's Unique Position On Reducing the Internet's CO_2 Impact

Index

SEENTHIS

A Call to Action

Media industry's unique position on reducing the Internet's CO_2 impact: The time to act is now

We need to work together with ICT[1] & media to land common standards.

We need do what we can right now.

Streaming

Improves performance

Reduces CO_2-Impact

Reduce this by streaming

Start here

Internet is a complex supply chain

- Data Centers
- Core Network
- Content Delivery Networks
- Access Networks
- Devices

When an ad is served it travels across this entire infrastructure

Energy to power the Internet accounts for 2% of global greenhouse gases

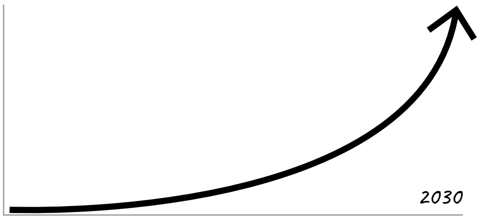
That's on par with aviation

This is SeenThis' number based on certain assumptions and an imperfect approach

1 kg CO_2 per GB data

And data transfer will explode

x40



Main drivers for explosion:

- Video consumption
- Mobile Internet
- Consumer expectations

The problem bingo

Horizontal supply chain	Lifecycle components	Type & amount of data
Type of network	Type of device	Energy mix

There are a number of widespread opinions on the CO_2 impact from data transfer. That's because there are six factors that influence the footprint, and there's no standard for how they should be accounted for

What can be done to face this challenge?

Two levers available to alleviate the effects of the data explosion: make data transfer more energy efficient, and reducing the amount of data (number of GBs) that is pushed through the system.

1. Increase efficiency of data transfer
2. Reduce the amount of data being sent
3. Supply the Internet with green energy only

Not a true solution, since this taps into the very scarce pool of green energy, effectively limiting it for use by other industries

Ok, should we just do static display ads then?

No — it is somewhat naive to assume the media industry will make decisions that's good for the planet but bad for campaign performance

[1]Internet and communications technology

Introduction

The Internet represents at least 2% of global greenhouse gas emissions (on par with the aviation industry) and contributes to the media industry's overall emissions. The media's Internet CO_2 footprint stems from the large amount of data transported through the Internet infrastructure to ensure digital ads are delivered to an end user. Yet, up until now, this source of emissions has been largely overlooked. The following text hopes to change that by shedding light on the topic and by providing concrete suggestions for immediate action.

In this paper, you're invited to a discussion on the Internet's CO_2 footprint, or more specifically, the CO_2 emissions caused by data transfer over the Internet.

You will be guided through why the Internet is causing CO_2 emissions, the infrastructure components that make up the Internet, how data transfer comes into play, and why this matters for the media industry. The trends that drive the expected explosion of data transfer in the upcoming decade will be highlighted, along with the importance of efficiently minimizing data transfer to make Internet usage carbon neutral. Moreover, the text discusses what is known and widely agreed upon in terms of the CO_2 impact from data transfer, while proposing one (imperfect) method for settling on a quantity of 1 kg of CO_2 per GB. Finally, a call to action and concrete next steps are proposed.

You are welcome to comment on any parts of this article and contribute with additional ideas, information, or articles you think we should read. We welcome you to help us sharpen our arguments and explain to us where we might be overlooking critical facts.

The Internet's Impact on Par With the Aviation Industry

As the world transitions further into the 21st century, the urgency of the climate crisis becomes imminent. The United Nations' annual COP26 climate conference is one initiative bringing the world together to tackle the challenges that lie ahead. COP26 aims at securing global net zero emissions by mid-century and keeping a maximum temperature increase of 1.5 degrees within reach.

Naturally, the organizers of such a conference must jump through several hoops in order to align world leaders on actions, targets and next steps. Therefore, all players are needed—public, private and third sector—to solve this extensive global challenge.

In so doing, each industry faces their own set of unique challenges in adapting business models to more climate-friendly alternatives. On this mission, one question is key: Where do emissions actually come from? Then—and only then—can reduction start to happen, and businesses can adapt in ways that actually make an impact.

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Turning specifically to the media and communications industry, one initiative that took place in November 2021 to unite and create impact was the Ad Net Zero Global Summit. Many important topics were raised in the summit, such as the power the media industry holds in shaping consumer behavior and mindset, and how to measure CO_2 emissions from media operations. In summary, it's clear that many marketing and media professionals are eager to make more sustainable choices. However, a comprehensive analysis of the CO_2 impact of advertising is currently missing a key component: the CO_2 impact created from digital advertising.

Given that 2% of the world's greenhouse gas emissions come from the Internet, on par with the entire aviation industry, this is a fact that cannot be overlooked. By serving digital ads, the media industry has a part in causing these emissions and thereby, a responsibility to measure and reduce them.

Some players are already designing and implementing tools to measure their CO_2 footprint, such as with Publicis' A.L.I.C.E tool or IPA's Carbon Calculator. A.L.I.C.E includes data and technology measurements, but further details are yet to be disclosed publicly. Currently, IPA's carbon calculator excludes data centers and servers. All in all, these are great starting points to build on.

Now, as an industry, there's a need to join forces in adding the Internet's CO_2 footprint to a set of standardized measurements.

The Internet represents at least 2% of global greenhouse gas emissions (on par with the aviation industry) and contributes to the media industry's overall emissions.

The Internet: What Is It and Why Is It Part of the Media Industry's Carbon Footprint?

The link between the Internet's carbon footprint and the media industry may not be obvious to some, so it's relevant to break things down. Simplified, the Internet is a supply chain, transporting data (files, images, video, etc.) from point A to point B, involving five steps:

1. **Data centers** are large buildings with servers that store all types of information and consequently, require a lot of electricity and cooling to keep up and running. You may have heard about Google's data centers, or Facebook's, but there are many others that exist as well. Whenever an image is uploaded to the Internet, it lands on one of these servers.

2. **Core network** is comparable to the public infrastructure of the Internet. In essence, it consists of underground or underwater cables enabling an uploaded image to travel to someone on the other side of the globe.

3. **Content Delivery Networks**, or CDNs for short, are intermediary stops for content so it can be stored closer to the end consumer. These exist so data doesn't have to travel across the core network every time a user in Singapore, let's say, wants to see an image originating from a data center in New York.

4. **Access network** connect end-user devices to the Internet using infrastructure components such as masts, fiber, and other types of communication technology. These are more commonly known as fixed and mobile broadband connections.

5. **End-user devices** are how users see and interact with images and videos on the Internet, such as with smartphones, smart TVs, desktops, and laptops.

When digital content is being sent over the Internet, all these aforementioned components require electricity to stay up and running. This need for electricity is the basis for the carbon emissions that the Internet is responsible for.

However, carbon emission calculations based on electricity use are tremendously underestimating the true carbon footprint, since they only consider marginal energy use and not the total lifecycle analysis of the steel and plastic required to actually build the Internet. This will be revisited shortly.

In the meantime, what's key to understand is that one ad served over the Internet must travel across this entire infrastructure before it reaches its intended audience.

Data Transfer, a Major Driver of Internet Carbon Emissions, Will Soon Skyrocket

Data transfer is projected to skyrocket in the coming decade, growing at a rate of 40% per year, resulting in a 40x increase by 2030. There are three primary market trends driving this increase: video consumption, mobile Internet and consumer expectations.

Video Consumption

Video consumption represents 66% of all mobile data traffic today, a share that is forecasted by Ericsson to increase to 77% in five years. More video consumption (with larger files) more often, means more data transfer.

Mobile Internet

The amount of mobile Internet connections is increasing faster than the amount of fixed broadband connections. When building out their ICT infrastructure, some countries skip the fixed broadband route and opt directly for mobile Internet. This means more Internet content can be consumed on the go and therefore, more data can be transferred. What's more, mobile Internet connections consume more energy than do fixed ones.

Consumer Expectations

Consumer expectations are also on the rise and a seamless Internet experience is ubiquitously expected by everyone, everywhere. Forbes mentions that "customers have become accustomed to the highly curated experience provided by rich online shopping experiences." This naturally increases demand for higher quality content and as such, also increases the amount of data transferred.

To meet the needs of the explosion in data transfer, the Internet industry is building out the infrastructure to increase its capacity by adding new data centers (examples can be found here, here, and here) and exchanging old technology for newer, more efficient data centers, processors, etc. The product lifetime of a data server is around four years, meaning that to keep the current systems up and running efficiently, a lot of energy and resources are required.

Therfore, the amount of data pushed through the Internet is correlated with carbon emissions.

One could argue that the sole purpose of the Internet is to store, process and send data,whether it be serving a 200 kB static ad, streaming video in a conference call, downloading a file, or playing online games. Hence, the entire electricity footprint of the Internet can be attributed to data storage, processing, and transfer, posing a troublesome challenge.

What will happen to carbon emissions with the skyrocketing of data transfer? What options exist in tackling this challenge?

Energy Efficiency Gains Are Not Enough

There are two levers available to alleviate the effects of the skyrocketing of data transfer: making data transfer more energy efficient, thereby reducing the energy required to transfer one GB of data and reducing the amount of data (number of GBs) that is pushed through the system.

The Internet industry is focusing largely on the former and is replacing legacy technology with new state of the art efficiency and innovation. In fact, over the last decade, despite a doubling in the operations performed on data centres, energy consumption has remained largely unchanged. Despite this continued innovation, the advancement in energy efficiency is expected to be slower than the growth in data transfer (13% vs. approximately 40% per year). For this reason, it's vital to also pull the second lever to alleviate pressure: reducing the amount of data transferred through the system, without negatively impacting the user experience. Ultimately, it's about being smarter about if and how data should be sent.

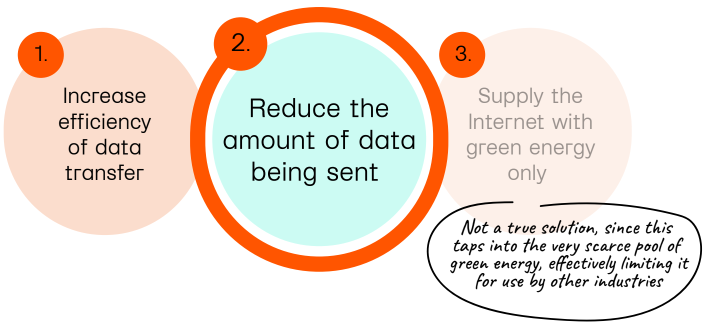
Some even argue that there's a third lever; that the fastest way to make the Internet carbon neutral is to use only clean energy to power the Internet. For example, certain providers build "carbon-free" data centers in regions with access to clean energy. Nevertheless, this approach fails to take the larger picture into account. First, it disregards the full life cycle of the products and the emissions stemming from their production, transportation and end-of-life handling.

Second, there's a limited amount of clean energy in the world. While the total energy need is growing (by 19% between 2009 and 2019), the pace of transition to clean energy isn't rapid enough. In fact, the share of the world's energy that came from fossil fuels in 2000 was 86.1%. In 2019, that number was 84.3%, a marginal decrease. Thus, unless the proposed solutions can reduce the need for power, they are hindering other industries, actors, and regions from accessing clean energy.

Ultimately, it's about being smarter about if and how data should be sent.

Admittedly, the second lever needs to be pulled and data reduction must happen. One theoretical option is to simply use the Internet less: reduce video consumption, reduce time spent playing online games, and reduce the use of data heavy types of advertisements, such as video banners.

Are these actions realistic for companies and individuals? Will the media industry choose only static and rudimentary display advertisement over video in order to keep data usage down, or perhaps stop advertising altogether? Invariably, the answer is no.



Media Decisions That Are Good for the Environment but Bad for Brands Aren't Truly Sustainable

The reason for the above argument is because of how society works and the forces that are at play in the media industry. When discussing sustainability, the "triple bottom line" is often referred to. What this means is that people, profit, and the planet must be simultaneously considered in order for something to be considered truly sustainable.

In practice, it means that business decisions that are good for the environment but bad for profit are not truly sustainable. For the media industry as of now, it's therefore fair to assume that the media mix will be selected primarily with return on marketing investment and individual profit and loss statements in mind. For a particular campaign, this might mean 30% of the budget for TV, 20% for radio, 10% for print, 5% search engine marketing (SEM), 10% social media, 15% online video, and the rest of the budget for display. However, once the media mix decision has been made, it's expected that an effort is expended in reducing the CO_2 impact of each channel. One such method is to use adaptive streaming instead of non-adaptive downloading technologies for display advertising. More on this shortly.

To illustrate this dynamic, imagine a producer of goods who needs to deliver to another city in the same country. In this country, the most sustainable mode of transportation is renewably-sourced electric powered trains. Still, it wouldn't make any sense for the producer to select train cargo as the only freight solution if the end-destination didn't have a railroad connection—the goods simply wouldn't make it there. Hence, this kind of decision is good for the planet, but bad for profit. A wiser decision would be to select road transportation and then ensure that the vehicle runs on the most environmentally friendly fuel possible.

Similarly, if media agencies switched away from video, this would be bad for business, and brand customers would turn elsewhere with their campaigns. Consequently, it's not reasonable to expect commercial marketing activities to cease anytime soon, even though it may be best for the environment. Instead, the triple bottom line must be kept in mind when making sustainable decisions.

Concretely, the media industry should be expected to continue optimizing media campaigns, while ensuring that each campaign is delivered in the most sustainable way. In order to do that, the industry must start measuring the baseline of its CO_2 impact for each ad served through each channel, while also working to reduce that impact.

With this objective in mind, a reliable, standardized and widely agreed-upon methodology for calculating the magnitude of Internet CO_2 emissions per GB file transfer is an absolute necessity.

Non-adaptive Download vs. Adaptive Streaming—What's the Difference?

Remember the good old days when listening to music from the Internet required downloading an mp3 file? Then Spotify came around and revolutionized the experience with their streaming technology, allowing songs to load instantly.

The same technology is now available for images and video in the browser, but the majority of sites still use non-adaptive downloading technologies (i.e. lazy loading and progressive jpegs) that essentially download the entire image whenever a request to the server is triggered.

Adaptive streaming, on the other hand, splits the image or video into smaller segments and streams segments only when the image or video is in view, thus avoiding unnecessary data transfer.

All in all, adaptive streaming of images and video in a browser improves business performance and user experience, as well as benefits the environment due to lower amounts of data transfer.

Major Disagreement on the Magnitude of Carbon Dioxide Emissions

As it turns out, there's not a single number that can easily describe how much carbon dioxide is consumed by one GB of data transferred. On the one hand, there are a plethora of alarmist headlines and statistics stating numbers as high as 3 kg of CO_2/GB data, as seen in the New York Post, CBC, Yahoo, DW, Gizmodo, Phys.org and BigThink. On the other hand, there are many great counter-arguments as to why the actual number is significantly lower, presented by Ericsson's Jens Malmodin and IEA.

This divergence of opinions itself is also called out, such as found in this research and analysis paper by Joshua Aslan, Kieren Mayers, Jonathan G. Koomey, and Chris France.

This points to a significant concert that brings attention to the original question: If the CO_2 impact of data transfer from digital advertising can't be accurately measured, how can anything be done about it?

This is certainly a hot topic, with many pointing out the tendency of companies to both underestimate and inaccurately measure their own emissions. Essentially, four main factors drive these inconsistencies: innovation moving faster than research, innovation moving faster than standards, many influential players, and complex technologies.

Despite all this, there are some irrefutable facts about the Internet's energy consumption, specifically in terms of data transfer and the technologies involved. Agreeing on these points can hopefully take the discussion one step closer towards reducing the CO_2 emissions related to digital advertisement.

Innovation Faster Than Research

Information and communications technology (ICT) innovation happens at an incredible speed. Some technology innovated today may not be around in the next three years. This naturally means that the academic world faces a tough challenge when keeping up with the latest data.

Innovation Faster Than Standards

For similar reasons, government bodies and organizations have trouble keeping up with standards, certifications and recommendations. Consequently, there is no single source of truth or guidance.

Many Influential Players

The information and communications technology space is filled with very large and influential players. These players inevitably act according to their own agendas and deal with problems in their own ways.

Complex Technologies

Information and communications technology also consists of many complex technologies. They are simultaneously the engine that powers the information revolution and a massive, largely unstructured network that expands in all directions. All this makes it challenging to neatly organize the technologies into mutually exclusive buckets.

The Undeniable Truths About the Internet's Carbon Dioxide Emissions

There are, however, six undeniable factors influencing the CO_2 footprint left by data transfer:

Access Networks

The CO_2 footprint of the Internet will depend on what parts of the Internet value chain are included in the calculation, all the way from data centers, to core networks, CDNs, mobile network operators, and end user devices. The more comprehensive the scope, the higher the CO_2 footprint.

Lifecycle Components

Similarly, the CO_2 footprint of transferring data will depend on whether only marginal energy is included, or whether indirect emissions are accounted for as well. This includes CO_2 emissions from building, maintaining, and disposing of the Internet's physical infrastructure. Watershed, a carbon footprint measurement software company, illustrates this point in their blog post here.

Type of Data and Amount of Data Transmitted

Whether a reality show is being streamed, or a heavy file is being downloaded, these actions impact the amount of energy required. In addition, energy use increases if a more complex computation is required to locate the requested file in the data center or CDN, as illustrated here.

Type of Network Connection Used

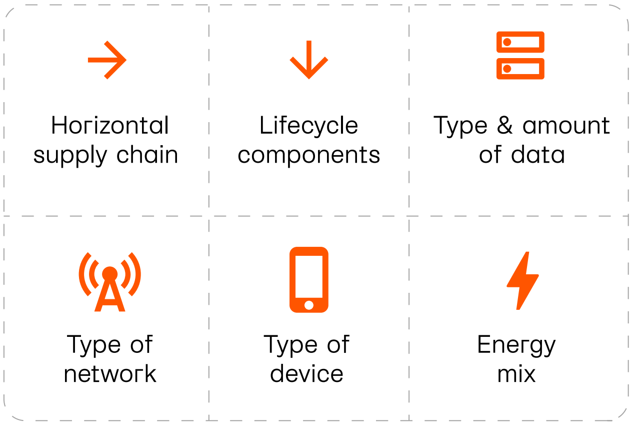
A mobile connection will consume more energy to keep up and running compared to a fixed one. This is explained in more detail here.

Type of Device Used

A larger device such as a smart TV will consume more energy than a smartphone, also pointed out here.

Location in the World And Corresponding Energy mix

Different parts of the world get their energy from different sources that also differ in their carbon footprint. Naturally, a country with energy from more renewable sources will have a lower CO_2 footprint.



What Researchers and Key Players Do Not Agree On

Across all variables that impact Internet energy usage, there seems to be disagreement on their respective magnitude and their interdependencies. There also seems to be major disagreement on how to work with all six factors and what to actually include for an accurate calculation.

When investigating the sustainability arena in more detail, it becomes clear that a common approach for a company is to carefully scope what to include in the calculation. A fitting example is in the auto industry, where CO_2 emissions from cars are measured by looking at the amount of CO_2 emitted per kilometer driven, effectively excluding the CO_2 emissions that stem from production, or from materials (plastic, steel, …) that make up the car.

This type of scoping is the reason why there's so much disagreement on how to run emission calculations most accurately.

Seenthis' Take On Calculating Data Transfer Emissions

Nevertheless, SeenThis has developed one imperfect formula to calculate data transfer emissions: amount of CO_2 emitted from one GB of data transfer. That number is between 200 g–1 kg of CO_2 per GB data transferred, where 1 kg is believed to be the most accurate. It was developed together with a top tier management consultant firm and further validated with independent industry experts. In addition, it falls largely in line with the orders of magnitude presented by other sources mentioned earlier. The assumptions that went into the methodology are as follows:

Horizontal Value Chain

Include electricity usage across the entire horizontal value chain, from data centers (workload, storage, data transfer in/out), to network infrastructure (core network, CDN storage, CDN data transfer in/out, access networks) to end-user device (data transfer/Internet and non-Internet related).

Lifecycle Components

Include three layers of the vertical value chain: first, the marginal energy use from sending a GB of data across the Internet. Second, the energy needed to produce the infrastructure across the full value chain, and third the CO_2 connected to the physical materials required to build Internet infrastructure.

No specific data for the CO_2 connected to the physical materials required to build the Internet infrastructure has been found. Therefore, a conservative assumption has been applied; an additional 50% energy equivalent is necessary to account for the CO_2 emitted by this third layer. Research concludes that the so-called embodied emissions (from materials and production, as opposed to marginal energy use called operational emissions) are responsible for as much as two thirds of the total emissions.

It is worth noting that a lifecycle analysis including the embodied emissions is a standard approach for measuring carbon emissions in any industry, and the same should hold true for the components of the Internet. In the construction industry, for example, the standards laid out by the International Organization for Standardization (ISO) can be found here.

Type of Data and Amount of Data Transmitted

In the calculations, no differentiation has been made between different types of data, but rather a top-down approach has been used based on the total amount of gigabytes transferred over the Internet annually. After, the energy use per step in the horizontal value chain is divided by the total amount of data transferred.

To exemplify, network infrastructure consumes around 279 TWh annually, and 2993 EB (exabytes, 10^{18} bytes) of data is transferred in the world per year. With these numbers, it is possible to obtain the amount of energy consumed by network infrastructure per GB by dividing the amount of electricity consumed by network infrastructure by the total amount of GBs transferred (279 TWh / 2993 EB). In so doing, there is also the implicit assumption that data flows uniformly throughout the Internet. When one GB of data is sent to a smartphone, it travels through all parts of the horizontal value chain.

Here, it is worth noting that this is a simplified approach that does not reflect all details of how the Internet works. However, this approach is believed to be solid enough for use cases within the digital advertising industry.

Type of Network Connection Used

Here, no differentiation has been made, but mobile network operators as a whole and their total energy consumption has been considered.

Type of Device Used

Similarly, no differentiation is made here either, where the total amount of electricity consumed by all end-user devices is considered.

Location in the World and Corresponding Energy Mix

For this post, an assumption has been made that the world has one global energy pool, and that any unnecessary energy use is tapping into the most carbon-heavy source (i.e. energy from burning coal).

This is considered fair, because if this unnecessary energy consumption could be removed, then the corresponding coal energy could be deprecated. It is also a methodology for framing the electricity mix used by other researchers (article in Swedish). Note that many Internet players brand themselves as "Net Zero" by purchasing renewable or "green" energy, effectively reducing the supply of green energy available to other industries (as discussed earlier).

An illustrative example is a limited geographical area like the European Union; the EU has an energy dependency rate of around 60%, meaning that more than half of the energy consumed in this area comes from net imports. Of these net imports, two thirds consist of petroleum products mainly from Russia, Iraq and Nigeria. Every KWh in decreased energy demand could therefore mean one less KWh of crude oil imported.

To put the 1 kg of CO_2/GB data transferred into context, it might be relevant to illustrate with an example from the media industry: With a large global brand that purchases 40 billion impressions of programmatic advertising each year, this emits as much as 8000 tons of CO_2 annually from this campaign alone, with an average ad size of 200 kB. That's equivalent to more than 200 million plastic bags[1].

Let that sink in for a minute.

This is SeenThis' number based on certain assumptions and an imperfect approach

1 kg CO_2 per GB data

The calculations supporting this reasoning can be downloaded here, including the sources and data points used.

[1]There are of course many things in addition to carbon emissions that are problematic with plastic bags, such as debris with a hugely negative effect on ocean wildlife and ecosystems.

A Call to Action

It is clear that action and concrete next steps are needed to make a real positive impact on the world's carbon emissions. In this quest, an invitation is hereby extended to the entire media industry to be part of the journey and the solution.

To lead with an example, SeenThis commits to do the following:

- Continue refining the adaptive streaming technology that reduces data transfer for display advertising, while developing new technologies that help companies improve their business performance and also reduce their footprint. The main goal in this endeavor is to build a future-proof business that provides value to clients for many years to come. Right now, sustainability is a hot topic, but in five years' time, chances are it will be a hygiene factor for any product, physical or digital. SeenThis wants to be part of setting that new standard.
- Work together with the industry, researchers, and other organizations to ensure standards are created for the advertising industry to measure their digital footprint. This can be done in many ways; one example is by providing details on the methodology outlined in this report.
- Work with the carbon footprint of internal company operations, by first landing a way to measure them and then by systematically reducing them.

SeenThis is but one company in a vast and dynamic industry; it's imperative that other actors, both industry bodies and commercial organizations, join forces and commit to taking action.

Commitments can come in a number of shapes and forms. Below are some suggestions:

First, there is a need for a standardized framework that allows the industry to agree on how to scope calculations. This work should ideally be driven by an industry organization, such as IAB.

Second, there's a need to invest in learning about this topic and how day-to-day media decisions impact energy use. What is included in this report is only scratching the surface and surely, parts of the argumentation will need updating in the future.

Nevertheless, the environment cannot wait for the industry to have all the answers before it starts to act. It's clear that digital advertising has an environmental impact, regardless of whether that impact is 200 g or 1 kg of CO_2 per GB. Why wait? With this in mind, commitments can also come in the form of using tools already available to start reducing data with intentional shifts.

This could mean asking questions such as: what are the ways in which a media mix can be executed in the most environmentally friendly way? Streaming of ads (as opposed to non-adaptive download technologies) is one such way. SeenThis' technology not only improves business performance, as it does with CTR for ads or CvR for e-com, but also significantly reduces the amount of data that is sent over the Internet. The technology is plug-and-play with immediate effect, primarily improving ad performance across all metrics and includes sustainability as a too-good-to-pass add-on.

You are hereby invited to join the discussion for a more sustainable Internet. What will be your commitments?

Click here to learn more about SeenThis technologies and how you can get started today.

About SeenThis

Since 2017, Swedish tech company SeenThis has been evolving screen experiences for everyone, everywhere. With its groundbreaking adaptive streaming technology, SeenThis is transforming the distribution and climate impact of digital content. With billions of streams served for more than 1000 brands in over 40 countries, the company is on a journey to reshape the internet — for good. Working across eight offices globally, SeenThis employees are obsessed with creating a truly high-speed and energy efficient Internet.

seenthis.co

SeenThis
contact@seenthis.co
press@seenthis.co

HQ
Hammarby Kaj 10D 120 32
Stockholm, Sweden

Postal
Fredriksdalsgatan 22 120 32
Stockholm, Sweden