The Hong Kong Polytechnic University
Master of Design | Design Strategies 2023

Reducing pollution in our digital lifestyle

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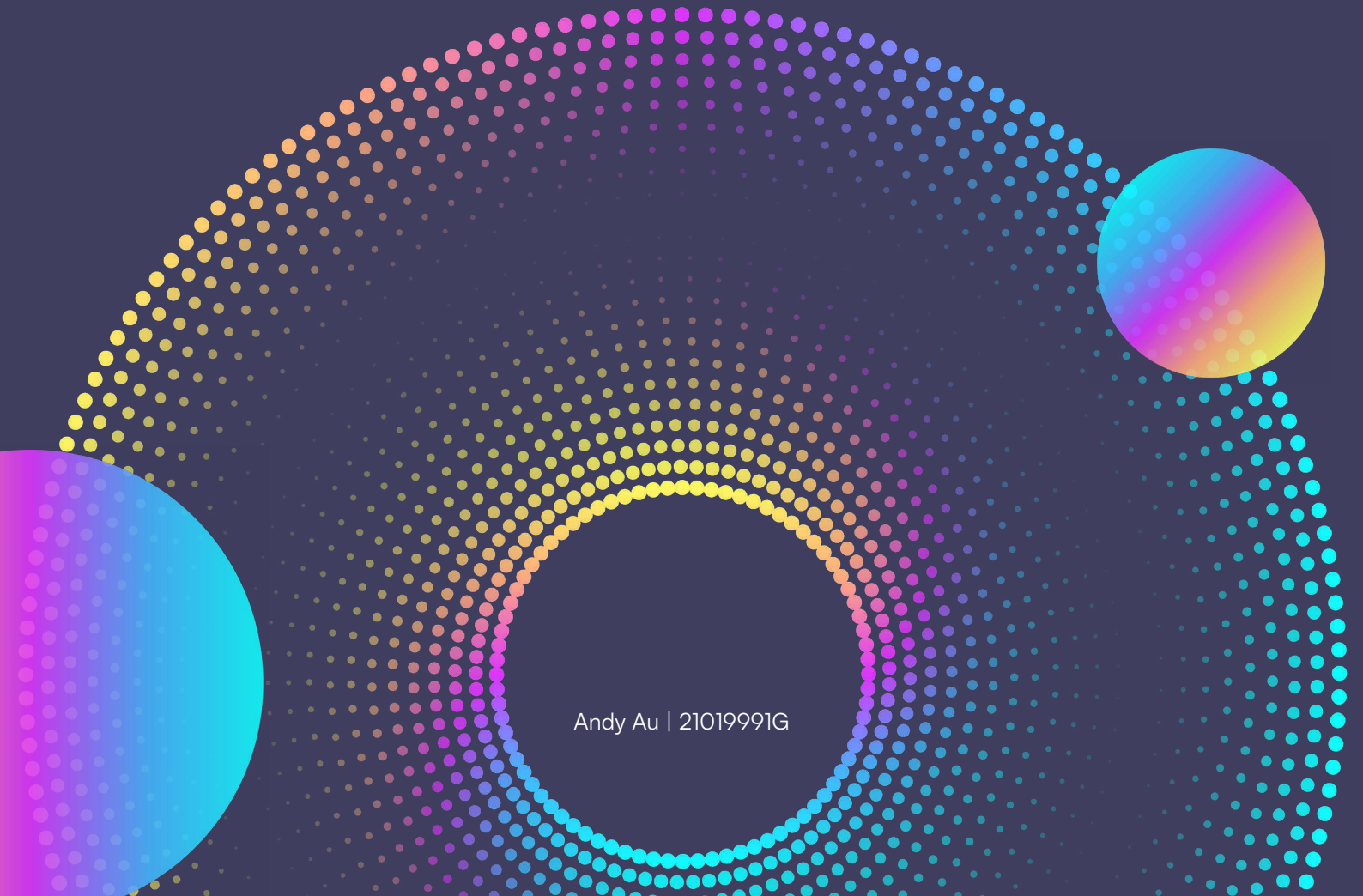
The causes, effects, progress & prospects

SD5303
A Proposition for Design -
Vision and Opportunity



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Abstract

The way people store and access data has undergone countless modifications as a result of the fast-paced development of the digital lifestyle. In the following research, a clear idea on digital pollution has increased as a result of careless storage methods and business strategies designed to keep consumers hooked has been provided.

Digital pollution has increased as a result of careless storage usage, such as amassing excessive photo and video content, habit-forming product development, and persuasion marketing tactics. Users are ensnared in a perpetual state of connectedness due to the addictive nature of the digital environment, which causes anxiety and a fear of missing out. The costs and energy usage of cloud storage and video streaming, as well as the environmental implications of processing power and digital assets like cryptocurrencies and NFTs, are all direct results of digital pollution. In order to avoid these impacts, which include greenhouse gas emissions and climate change, digital pollution must be reduced.

Achieving carbon neutrality and implementing greener alternatives have advanced, but more action is needed from stakeholders including designers, corporations, consumers, marketers, product users, and developers. People living in the contemporary age can conserve the environment and create a sustainable future by embracing eco-friendly purchasing habits, stimulating contemplation through design, encouraging transparency, and encouraging a new digital lifestyle that produces less pollution. Additionally, the research found that consistent efforts to prioritize accountability and openness will pave the road for a greener, more sustainable digital environment and have the potential to reduce digital pollution.

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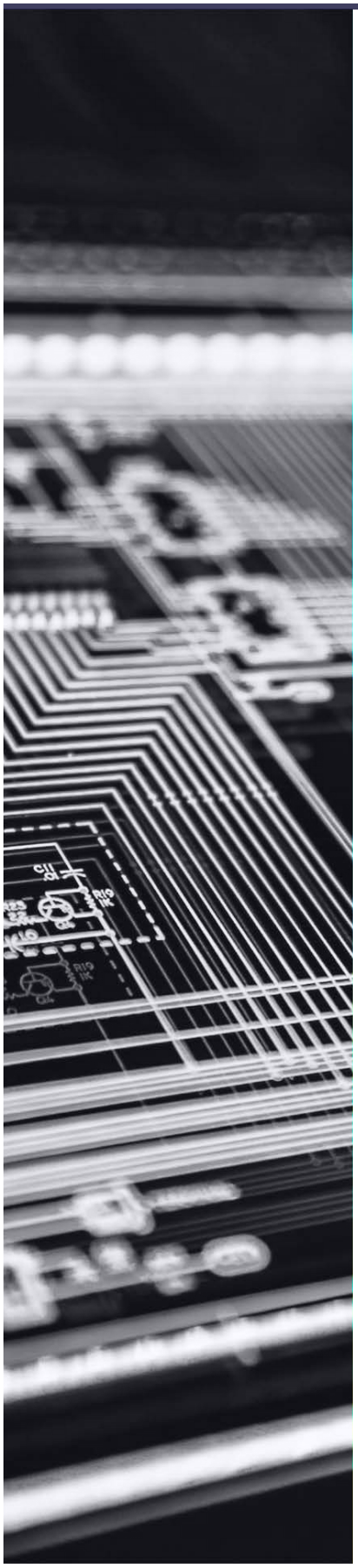


1.1. Evolution of the digital lifestyle

Since the initiation of the contemporary computing age, digital lifestyle has evolved in areas including communication, healthcare, transport and other areas to facilitate further diffusion of technology in an effective manner (Kario, Harada & Okura, 2022). Through this report, a concise idea of the evolution will be provided with a step-wise discussion on the changing market dynamics and technologies in contemporary times.

1.1.1. From SD memory cards to cloud storage

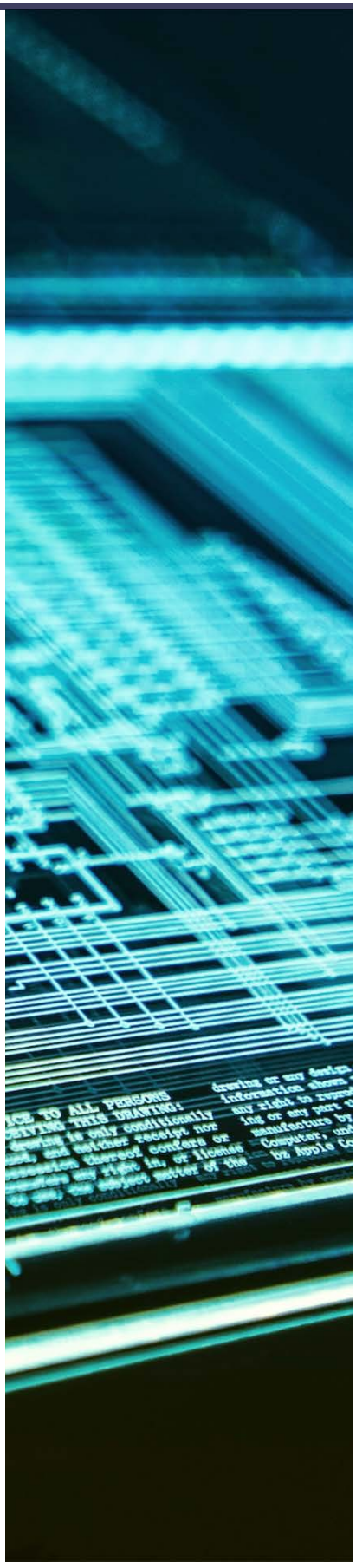
In the previous three decades, especially after digitization started, data storage has evolved significantly (Dey, Yen & Samuel, 2020). During the late 90s and early 2000s, data storage was mostly dependent on hard disk drives or Secure Digital (SD) cards. However, after the fourth industrial revolution, the emergence of cloud computing was seen. During the transition of SD cards and cloud, flash drives enacted as the missing links as they helped store digital data effectively. Even though the basal notion of cloud storage was initiated with the work of ARPANET; yet, the first commercial product came in 2006, namely Amazon Web Services (AWS), which increased the scalability of data and ensured nearly infinite storage capacity that was required as per the changing digital process requirement dynamism.

1.1.2. Digital photo albums

Memorable moments captured with cameras are usually preferred to be stored to ensure individuals can further cherish them. Nevertheless, with the changing lifestyle and emergence of smartphones, printing out photos and storing them in an album became obsolete as other alternatives emerged. As storage-related issues were solved with the cloud and people got the assurance that their photos would be stored effectively with a proper backup system even if their device was lost or crashed, the trends of storing photos in digital albums increased to a greater extent (Guarda et al., 2021). In contemporary times, Android and iOS offer digital albums under their in-built camera and storage application. iPhone's shared album and Google Photos can be considered the two most crucial names in this genre that help to enable access to photos at desirable times. Apart from that, social media sites such as Facebook and Instagram offer options to upload multiple photos under a single album or post, which fulfill the requirements to showcase memories alongside offering options to manage privacy settings as per convenience.

1.1.3. Irresponsible use of storage

Lack of proper digital knowledge, individuals are knowingly or unknowingly taking as well as storing excessive amount of videos and photos without cleaning up the device's storage or the online one (Guarda et al., 2021). Additionally, unnecessarily oversized media such as media with ultra-high resolution, iPhone's Live Photos, 360-degree panoramic and ultra-High-Definition (HD) videos can take up memories in the device and leaves an enormous amount of carbon footprint as those data is being stored at a server that could be freed up generally. Apart from that, irresponsible usage of data can further lead to compromised data in case the phone memory gets full and the user purchases cloud storage from a third-party site instead of an authorized service provider (Zouari & Abdelhedi, 2021). In such instances, misconfiguration and insecure interface-led risks may occur and create challenges in terms of data security and privacy.



1.1.4. Then vs Now user mindset

In times when digital storage capacity was limited, such as during usage of SD cards or flash drives, a maximum of 64 Gigabytes of storage was available and people kept that in mind while taking photos, videos or saving documents or large files. Nevertheless, in contemporary times, purchasing storage on the cloud has become easier as individuals can directly purchase more storage against their existing digital account or open a new account to reap the benefits of the free storage facility provided by almost all cloud service providers to their new users.

Factors	Previous user mindset	New user mindset
Awareness	• Storage constraints • Higher cost of new storage	• Ease of storage availability • Moderate cost of new storage
Consideration	• Total memory • Low to moderate image and video resolution	• Clicking as much as possible pictures and videos • Higher image and video resolution
Focus	• Carefully clicking pictures and saving them • Deleting unnecessary files	• Spontaneously clicking pictures • Storing all files to choose from in future

Table 1.1.4.1: Comparison of user mindset - Then vs Now

The past when people were aware of storage constraints and the high cost of new storage, consideration regarding total memory usage by ensuring saving images as well as video at low to moderate resolution was considered (Rosário & Dias, 2022). Besides that, the underlying focus was to carefully click pictures and save them alongside deleting unnecessary files.

As opposed to the previous era of storage constraints, the new user journey starts with awareness regarding the ease of storage availability. Even if the complimentary version gets full, the moderate cost of new storage makes the new user journey different. Besides, the new user journey generally focuses on storing all files and spontaneously clicking pictures and taking videos as opposed to the previous user journey.

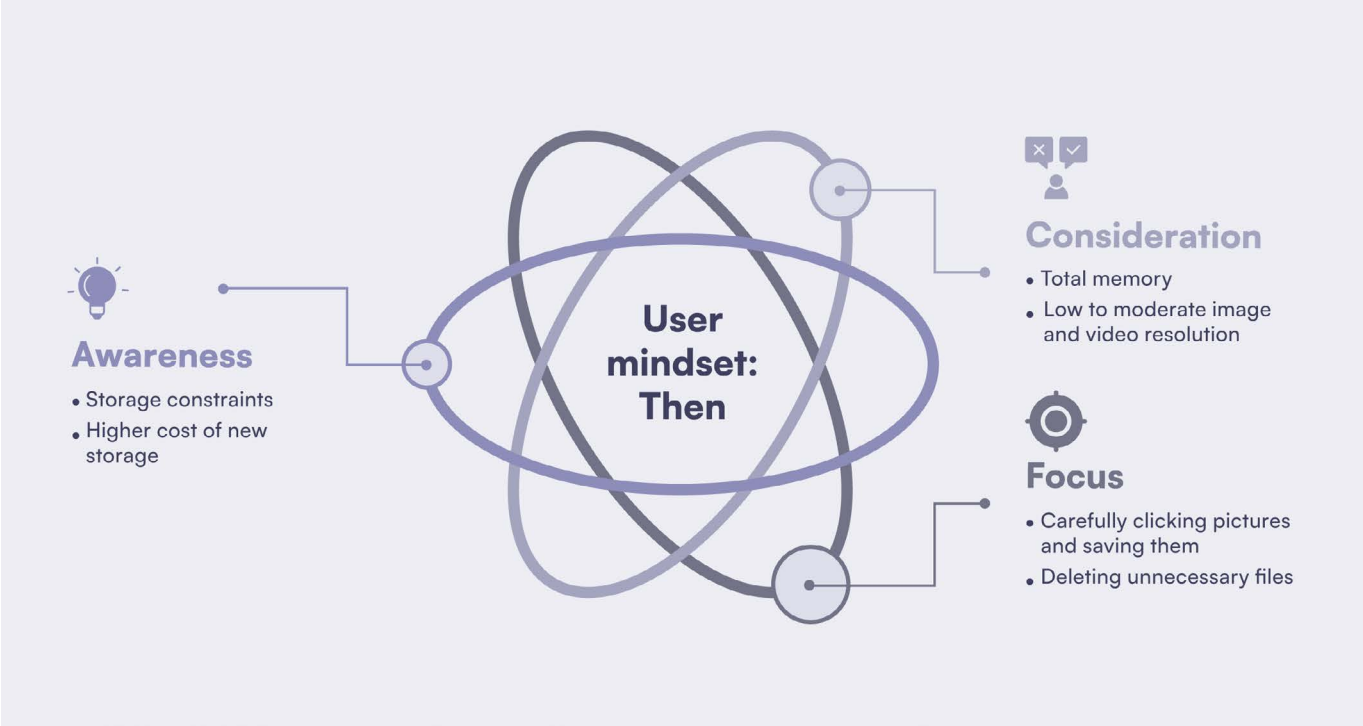


Figure 1.1.4.1: User mindset: Then

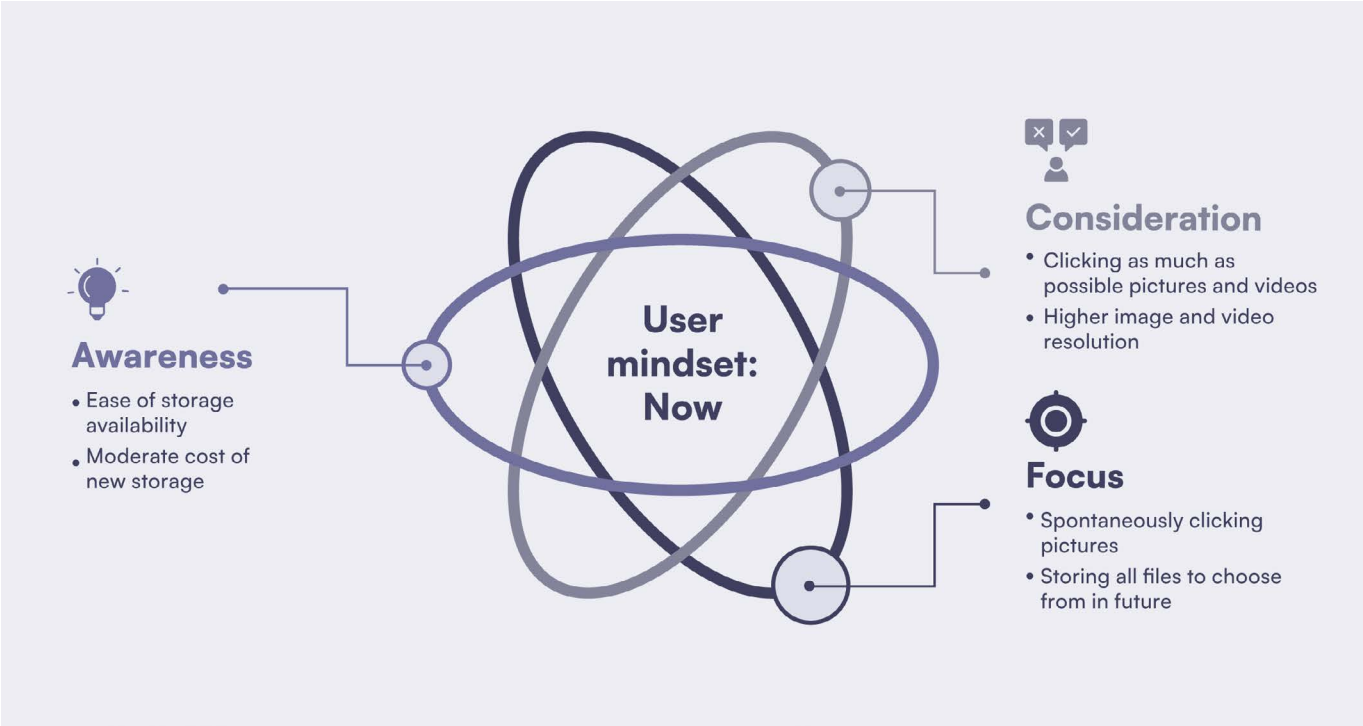


Figure 1.1.4.2: User mindset: Now

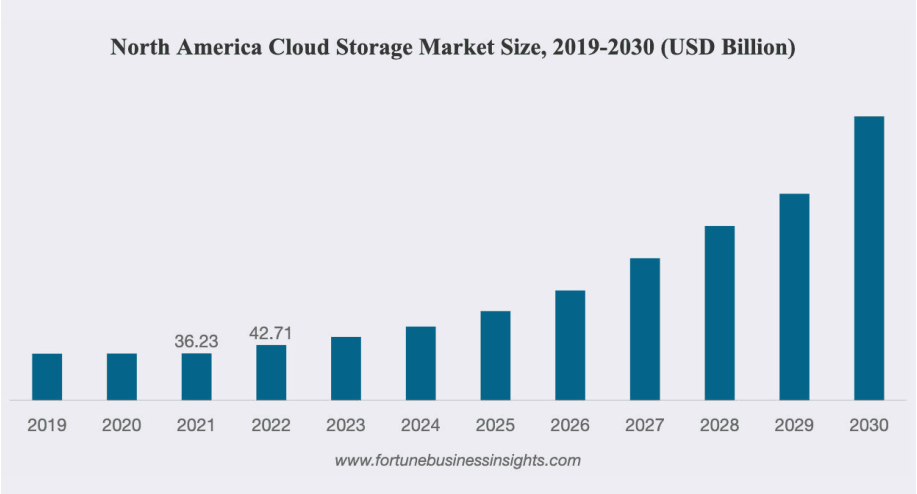
1.2. Corporate tactics to keep consumers hooked

In contemporary times, consumers are hooked by brands to maintain branding pride, for which brands consider strategies that may not be ethical. For example, brands tend to showcase a good image using marketing terms seemingly positive to hear. However, the reality can be completely different as the applied terms and conditions come into play, and the alluring offers or promises get blurred (Sánchez-Vergara, Orel & Capdevila, 2023). Besides, developing a feedback cycle, automating the existing process, and displaying a business' social properties with pride are considered.

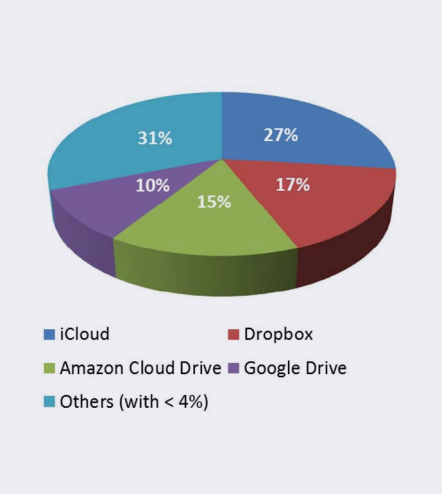
1.2.1. Obtaining market shares and customer acquisition

In order to gain appropriate market share for an organization in the contemporary cutting-edge market, companies mostly focus on acquisitions by binding users to the complimentary storage options (Nash, Jarrahi & Sutherland, 2021). The global market of cloud storage is projected to reach $472.47 billion by 2030, which shows a 23.4% growth rate during the forecast period of seven years. In this specific market segment, applications like Apple iCloud, Dropbox, Google Drive and Amazon Cloud Drive are the most prominent market shareholders having a total market share of 69%. The rest of the market for applications with complimentary storage is divided between smaller third-party organizations.

Mostly, this specific acquisition of applications can help address issues associated with the changing market dynamics that help consumers to get hooked to a specific product. Even though other service providers are offering similar services of cloud computing, yet, Apple, Dropbox, Google and Amazon are the most crucial ones offering diversified storage services that can fulfill individual requirements. Apart from these product designs as well as business tactics to increase market share, the customer acquisition service can be considered as a crucial context leading to a proper success paradigm. Additionally, users falling into the habit of wasting storage led by digital products developed by corporations encouraged higher media resolution and larger file sizes and may lead to more negative tactics.



North America cloud storage market size, 2019-2030



Market shares of cloud storage services

1.2.2. Hooked

According to Eyal & Hoover (2019), ensuring a customer is hooked to a product can be done by fundamentally changing the user's behavioral aspects and creating day-by-day habits based on a call-to-action strategy. Habits can be considered as underlying behavior done with little or no conscious thoughts. Thus, branding of a specific product is suggested to be done in a way following which a brand can establish a clear path for strengthening its presence in the human mind by hooking techniques using a mix of marketing, product quality, and other related aspects to ensure the brand name gets synonymous with a specific product or service. For example, iPhone and Apple's following that binds users to associate high-end phone purchases with the brand even though better quality, prices as well as features are available on Android can be considered here. In essence, the niche of the existing market for high-end phones, the iPhone has made its name synonymous.

1.2.3. The Hook Model - Trigger, Action, Variable Reward, Investment

Nir Eyal created the Hook Model as a framework for developing habit-forming experiences in digital products. Trigger, Action, Variable Reward, and Investment are its four components (Eyal & Hoover, 2019). Product designers can create engaging and addicting user experiences by comprehending and using these phases.

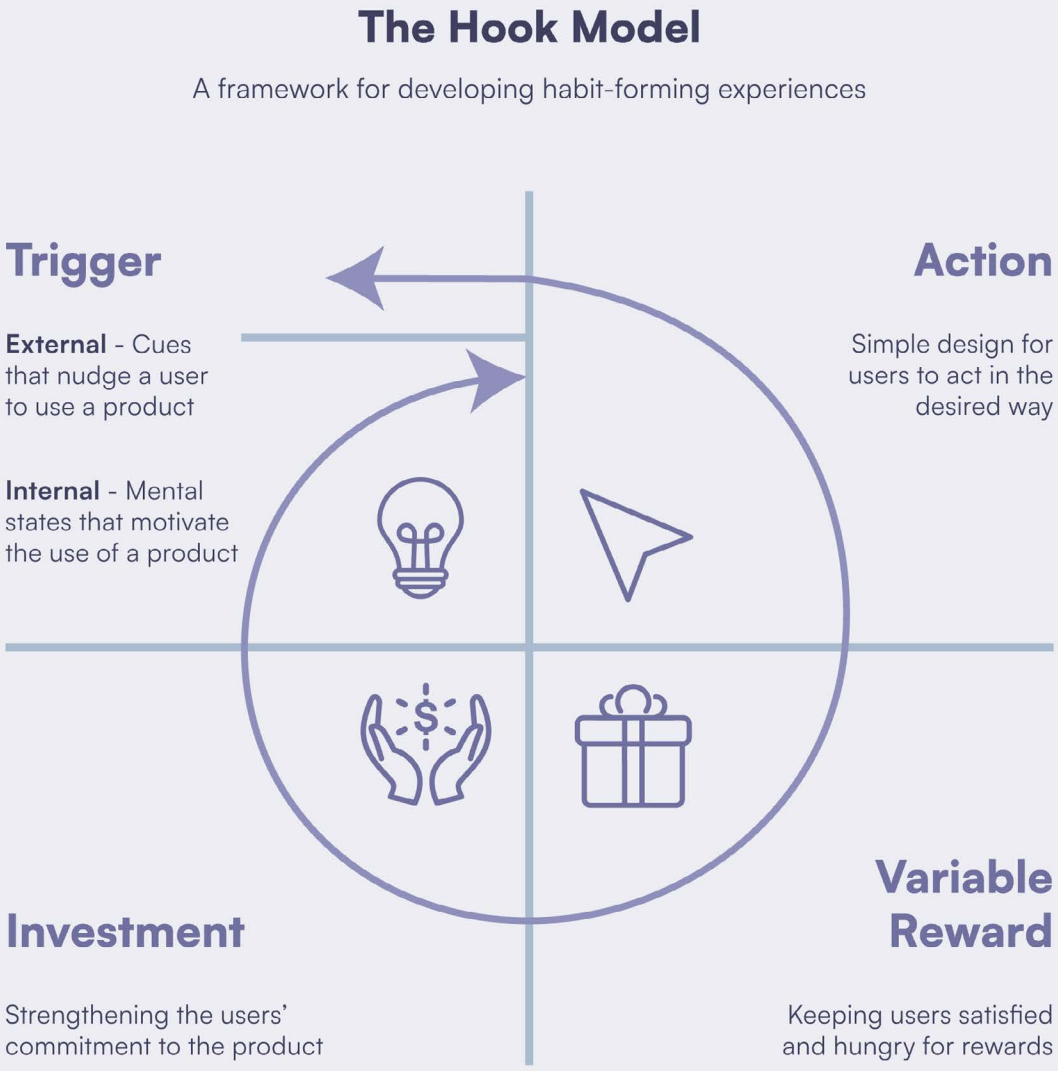


Figure 1.2.3: The Hook Model

Trigger

The Trigger is the initial stage of the Hook Model. Users are prompted to behave and interact with the product using triggers. There are two categories of triggers: external triggers and internal triggers. External triggers, like push notifications or email alerts, are environmental cues that nudge a user to use a product (Productplan.com, 2023). On the other hand, internal triggers are mental or emotional states that motivate the use of a product. For instance, psychological triggers such as boredom or a need for social interaction can cause a person to open a social media app.

Action

The trigger is followed by the action phase. This specific phase tends to make the product's use as simple as possible. Designers must remove any obstacles or friction that can stop users from acting in the desired way. Users are more likely to move on to the next stage if the product is more user-friendly (Kangwa, Mwale & Shaikh, 2020). For instance, actions can be facilitated by a straightforward and intuitive user interface, unambiguous calls-to-action, and expedited onboarding procedures.

Variable reward

The user obtains some sort of incentive or enjoyment for using the product during the variable reward period (Productplan.com, 2023). The development of anticipation and reinforcement of the user's behavior depends greatly on this stage. In order to keep people interested and curious, the reward should be unpredictably distributed and varied. Additionally, the process takes many different forms, including access to privileged content, personal success, or societal validation. The secret is to make people feel satisfied so that they would continue looking for rewards.

Investment

Investment is the Hook Model's last stage. By incentivizing the consumer to expend time, energy, or personal information, this phase seeks to strengthen their commitment to the product (Productplan.com, 2023). Users are more likely to stick with a product they've invested in. Offering features like personalization, customization, or progress tracking can accomplish this. Users grow a sense of ownership and loyalty towards the product by giving them value in exchange for their investment.

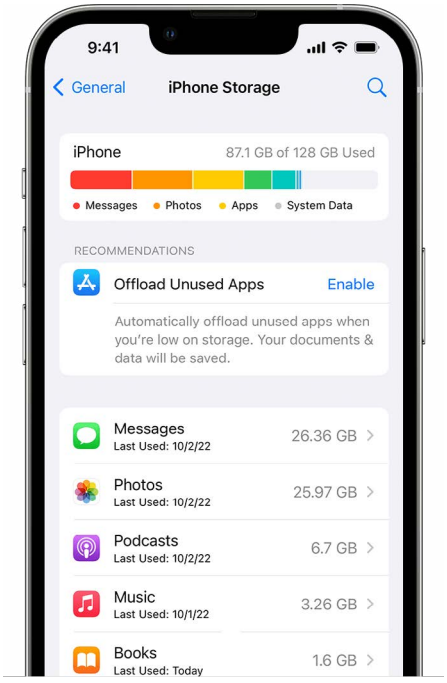
1.3. Consumer behavior manipulated: Nudge marketing

Nudge marketing is a concept that includes subtle changes in consumer behavior and decision-making without limiting their freedom of choice, which is known as psychological economics or choice architecture as well (Effectiviology, 2023). Designing the environment in which decisions are made in a way that encourages people to adopt a certain behavior or decision is at the heart of nudge marketing.

Nudge marketing operates on the libertarian paternalism tenet, in contrast to conventional marketing strategies that frequently rely on persuasion or manipulation. Marketers can use nudges to gradually guide consumers towards desired results, such as making healthier choices, saving money, or adopting sustainable habits, through comprehending human biases, heuristics, and decision-making tendencies. Public policy, financial services, health care, and consumer marketing are just a few of the areas where nudge marketing has seen substantial growth in popularity and use.

1.3.1. Behavioral economics: Loss aversion

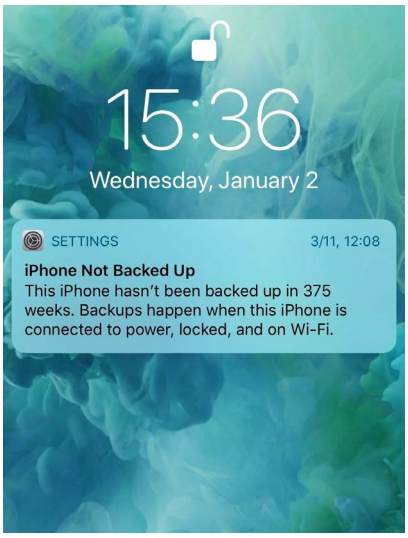
Online storage providers now have a “free-to-use” mentality, promising consumers limitless top-ups and upgrades in addition to the initial free storage space. This strategy deceives consumers into believing they are getting something for nothing while gradually transferring the cost of more storage onto them. These providers foster a feeling of comfort and convenience by giving users a free trial period of storage capacity. Users don’t immediately need to pay to store their data, pictures, and papers. Users soon learn that there is a finite amount of free space and that further storage is expensive as they eventually gather more data. This tactic takes use of loss aversion psychology and the urge to keep from losing important data. In order to avoid the possibility of losing their files, users become more invested in the platform and are more willing to pay for additional storage.

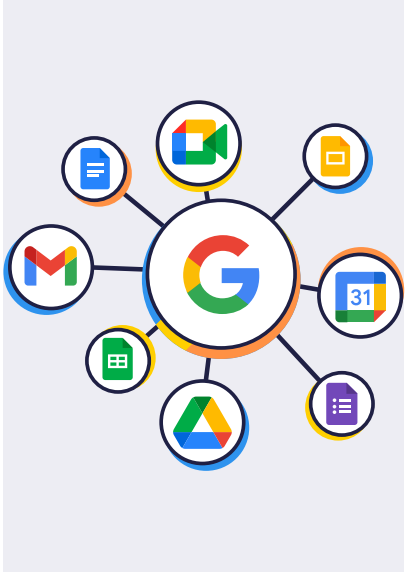


1.3.2. Forging customer retention — Easy to start, difficult to leave

1.3.2.1. Apple products and iCloud storage

Apple products and iCloud storage serve as excellent examples of this technique, which include making it simple to join their ecosystem yet challenging to leave. Users benefit from a fluid and integrated experience because of the integration of Apple's hardware and cloud services (Lewis, 2020). Apple's status as a one-stop shop for users' digital demands is further strengthened by features like iTunes and AirDrop. Furthermore, iCloud subscriptions, along with notifications like "This iPhone hasn't been backed up in XXX weeks," create a sense of urgency and annoyance if consumers were to consider quitting the ecosystem, forging customer loyalty.



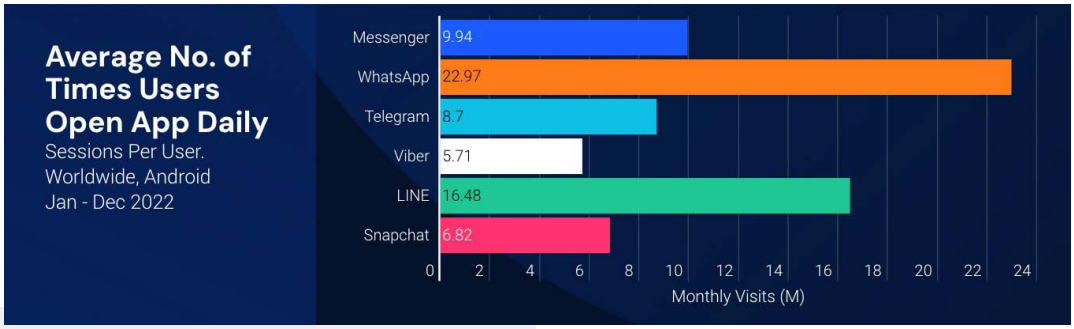


1.3.2.2. Google's ecosystem

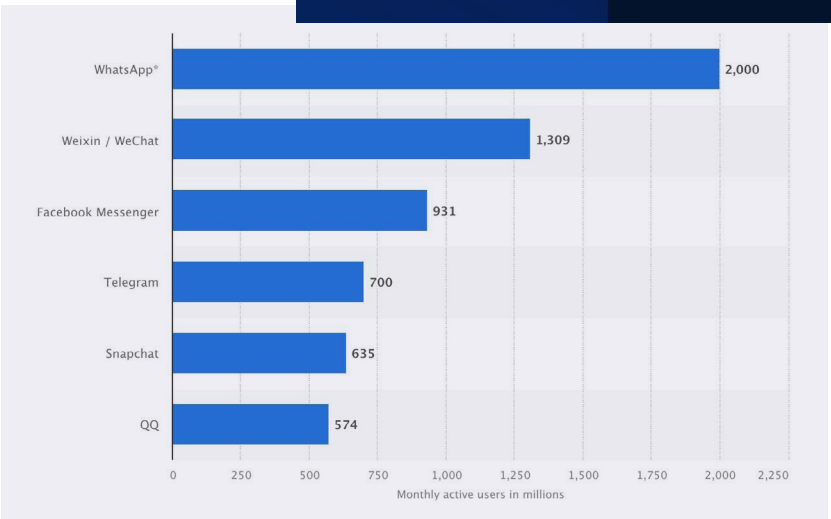
The fact that Google Workspace apps like Gmail, Docs, Forms, Drive, and Calendar are so integrated into users' professional and personal lives helps to raise customer retention. Google provides a full set of tools that are entirely hosted in the cloud, along with a wide range of services. Users will almost certainly rely on Google's ecosystem for their productivity and communication needs with this level of integration. Google apps have a good customer retention strategy since customers find it difficult to migrate to other platforms due to their simplicity, dependability, and familiarity (Hemsley et al., 2020). As a result of their extensive use and omnipresent visibility, Google apps frequently give users the impression that they have no other option.

1.3.2.3. Instant messaging - Communication hubs

Platforms for instant messaging like WhatsApp, WeChat, Telegram, Snapchat, and others grow client retention by making users feel stuck in their online social networks. Both in private and business settings, these platforms are now necessary instruments for communication. Group chats, audio and video conferencing, file sharing, and other capabilities that these messaging apps frequently provide help to further establish them as the primary hubs for communication.



Average No. of Times Users Open App Daily (Similarweb 2023)



Monthly active users on messaging apps (Statista 2023)

Although precise numbers on the amount of online data used by well-known messaging services like WhatsApp, WeChat, Telegram, and Snapchat are not made publicly available, some broad conclusions can be drawn from their market share. WhatsApp had two billion monthly users as of January 2023, and it was widely used and well-known in markets outside the US. One of the most well-liked mobile social apps is widely acknowledged as such (Dixon, 2023). Comparatively, Facebook Messenger had over 930 million users worldwide, while WeChat amassed over 1.3 billion users.

1.3.2.4. Social media - Bottom-up approach

Social media platforms use bottom-up practices to deceive users into investing time and effort into preserving their accounts or channels, making it difficult for them to quit, in addition to encouraging user-generated content to reinforce client retention. Social media content's interconnectedness fosters a sense of dependence on the medium. To stay connected and relevant within their social circles, users feel driven to consistently contribute to and interact with the content. Users' false sense of power is increased by the possibility that their posts and material may reach a large audience, which strengthens their commitment to the site (Attaran, Attaran & Kirkland, 2019).

Average daily time spent on social media (BroadbandSearch 2023)

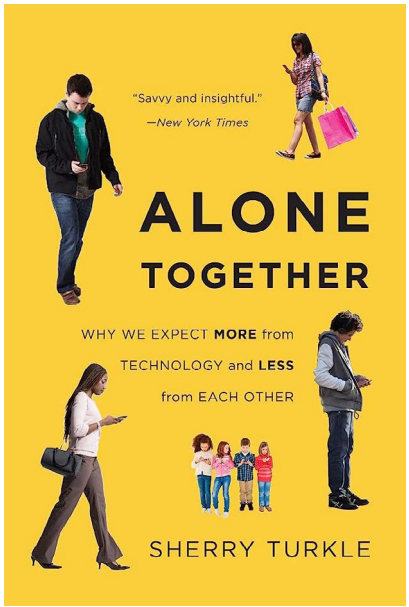
Additionally, by placing a strong emphasis on connections and interactions with friends, followers, and communities, social media platforms can encourage a forced sense of belonging. Users are motivated to be active and constantly engage with the site to preserve their online presence by this psychological desire for social validation and acceptance. Variable reward structures are a major factor in promoting addictive behavior. Likes, comments, and followers offer sporadic and erratic rewards, which cause dopamine reactions in the brain and increase the urge for further connection (Fagherazzi, 2020). This addiction is further fueled by the impact of well-known YouTubers, Key Opinion Leaders (KOLs), and influencers who inspire a sense of aspiration and a drive to achieve success.

1.4. The addicted (us)ers: The descent into dependency

1.4.1. Trapped in the clouds, the always-on connection

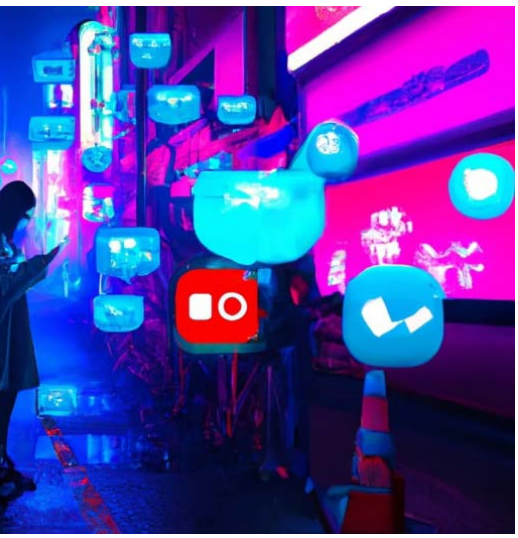
The temptation of ongoing connectedness and the need for affirmation through sharing and staying updated online trap consumers in reliance in the digital era. They remain tethered to the digital world because of their always-on connection and FOMO (Xu et al., 2022). The sense of community fostered by online networks feeds the addiction to continuous pleasure from likes and comments. Users constantly share posts, stories, reels, and live broadcasts as a result of their commitment to keep others informed and stay informed. Apart from that, the urge to document every facet of life and the addicting nature of constant gratification are the causes of a spiral into dependency. Users may get caught in a cycle of seeking and supplying updates, which feeds their addiction to the internet, making it difficult to break away from this hold.

1.4.2. Alone together. The nostalgia of the young.



The impact of constant connectedness and the phenomena of being "alone together" are examined in Sherry Turkle's book "Alone Together." Younger generations may experience anxiety, technophobia, and a sense of nostalgia due to the always-on aspect of technology. The pressure to always be online causes anxiety, the quick development of technology might cause technophobia, and the younger generation could long for a simpler time (Turkle, 2014). The intricate emotional and psychological effects of constant connectedness are highlighted by Turkle's study. Additionally, the importance of striking a balance between technology use and offline activities is emphasized in order to counteract the negative impacts of being "always on." In essence, the process produces the paradoxical impression of feeling connected while alone at the same time. Due to the rapid advancement of technology, people may struggle with both technophobia and anxiety from a fear of missing out.

1.4.3. FOMO — Fear of missing out



The psychological phenomenon known as FOMO, or the Fear of Missing Out, is defined by worry or a fear of being left out of social encounters or activities. The term is frequently linked to ongoing connectedness, exposure to social media, and use of digital platforms. People who worry about missing out on exciting or significant events that are posted online may feel nervous, compelled to check their gadgets frequently and stay active on social media (Gupta & Sharma, 2021). According to research, FOMO is linked to unfavorable psychological effects like higher stress, social anxiety, and decreased life satisfaction. For the purpose of fostering general well-being and preserving a positive connection with technology, it is crucial to comprehend and manage FOMO.

1.4.4. Power to the user vs Power to the algorithms

In the digital sphere, the power struggle between users and algorithms is crucial, especially in regard to the fear of missing out (FOMO) and the penalty of missing out (POMO?). Algorithms are used by platforms like YouTube and social media to decide how visible and ranked material is (Bibri & Krogstie, 2020). As a result, content producers that post less regularly may suffer from algorithmic ranking penalties, which could lead to decreased visibility and engagement. Users may feel FOMO and a want to be connected and informed, while content providers may feel POMO out of concern for their success and visibility if they don't follow the algorithms' preferences. The ability of the algorithms to affect ranks and visibility creates a challenging balance between platform requirements and user demands. The challenge for content producers in this environment is to strike a compromise between upholding their artistic vision and living up to the standards set by the algorithms.

2. The effects of digital pollution

2.1. Cloud storage and hosting power

2.1.1. “Tsunami of data” could consume one-fifth of global electricity by 2025

2.1.2. Global data centers - from global headlines to local headaches

2.2. Energy expenditure and consumption

2.2.1. Digital entertainment

2.2.2. Media streaming

2.2.2.1. The unsustainable use of online video: The practical case for digital sobriety

2.2.2.2. How much electricity does YouTube use?

2.2.2.3. What is the carbon footprint of streaming on Netflix?

2.3. AI Computing power

2.3.1. Machine learning - Chatbots, ChatGPT

2.3.2. Generative AI - DALL-E, Midjourney

2.4. Digital assets

2.4.1. Cryptocurrency and token systems

2.4.1.1. Mining and the proof-of-work mechanism

2.4.1.2. Bitcoin energy consumption

2.4.2. NFTs and the environment

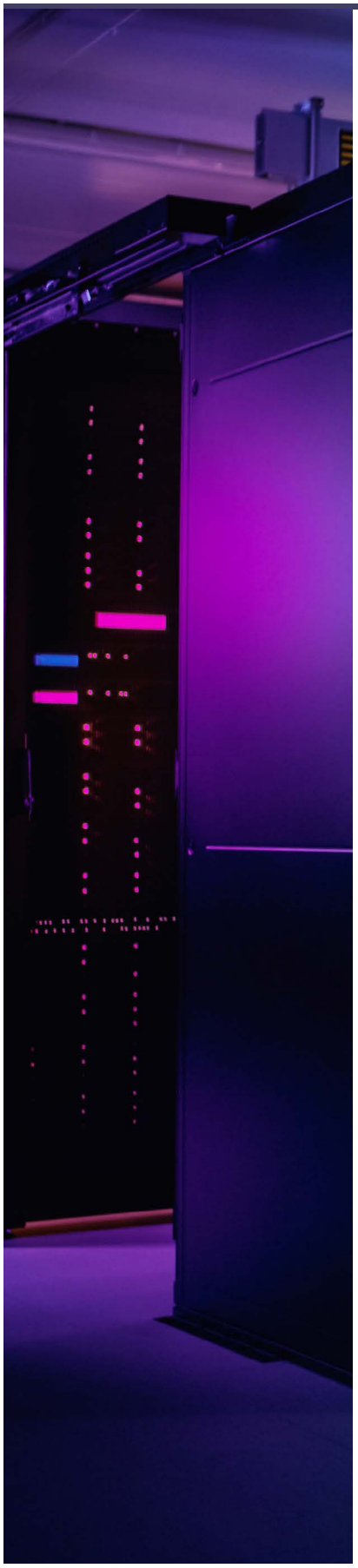
2.4.3. Environmental cost of network security

2.5. Environmental and climate impacts

2.5.1. Greenhouse gases and carbon emissions

2.5.2. Global warming and climate change

2.5.3. Why reduce pollution? Future cone of digital pollution



2.1. Cloud storage and hosting power

Cloud storage is the new normal that is all about off-site storage. It is considered a potential alternative to storing data on-premises. While on the other hand, cloud hosting is all about the ability to make applications as well as websites available on the internet making use of the cloud.

2.1.1. "Tsunami of data" could consume one-fifth of global electricity by 2025

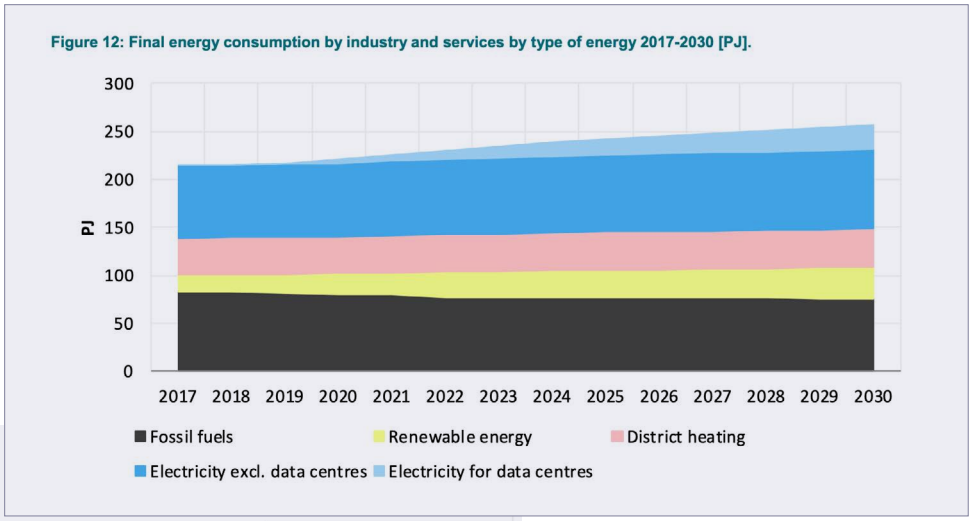
The remarkable development of advanced information in this day and age is presenting huge difficulties, and one of the gravest concerns is its energy utilization. As per estimations, by the year 2025, the sheer volume of information produced and stored could consume one-fifth of the world's power supply, making what a few specialists call a "tsunami of data."

The multiplication of internet-connected gadgets, the ascent of distributed computing, the growing adoption of Artificial Intelligence, and the rising interest in data-intensive applications are adding to this information blast (Fonseca, Kazman & Lago, 2019). The energy necessities of data centers, which house the actual framework supporting the computerized world, significantly contribute to this issue. These data centers being talked about consume significant measures of electricity to power and cool their servers, and as the interest in data storage and handling develops, so does their energy utilization. Resolving this issue requires a diverse methodology. Utilizing more energy-efficient infrastructure and cooling systems, optimizing server utilization, and investigating renewable energy are all options available to data center operators (Bouckaert et al., 2021). Legislatures and administrative bodies can boost energy productivity gauges and advance the improvement of practical server farms.

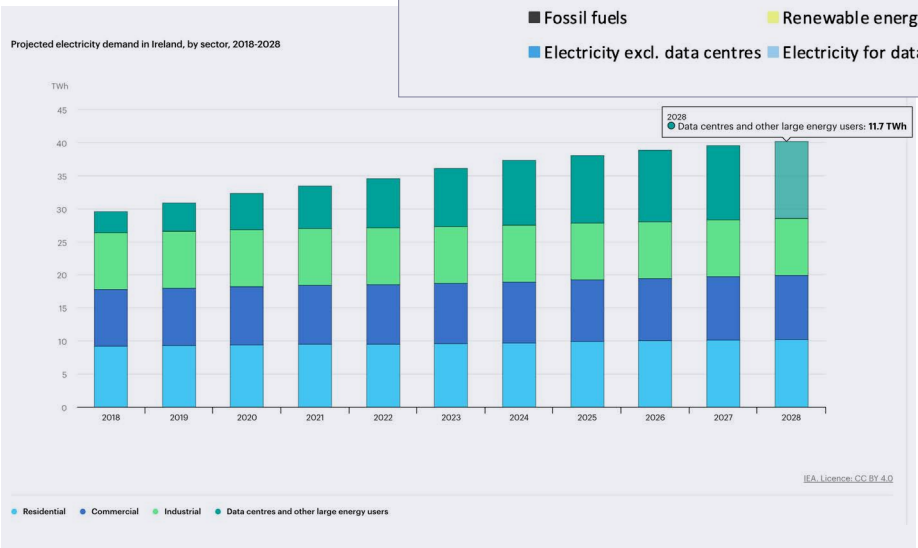
2.1.2. Global data centers — from global headlines to local headaches

With the world gradually shifting to digitalization, data center services are in high demand. Although considerable progress has been made in the area of energy efficiency, including the transition to efficient hyperscale data centers, which has helped limit the growth of data center electricity demand globally. The sudden growth in internet traffic and the impact that data centers have on energy and the environment continue to cause serious concerns.

Data centers are aptly considered the digital backbone of the modern world, and thus their energy demands cannot be compromised. Smaller countries with fast-growing data center markets, such as Denmark and Ireland, are progressively becoming major sources of electricity consumption. There are some alarming headlines. By 2028, data centers could account for almost 30% of Ireland's electricity demand. Data centers will consume 15% of Denmark's electricity by 2030, up from less than 1% today (Kamiya & Kvarnström, 2019).



Denmark's Energy and Climate Outlook
(Danish Energy Agency 2019)



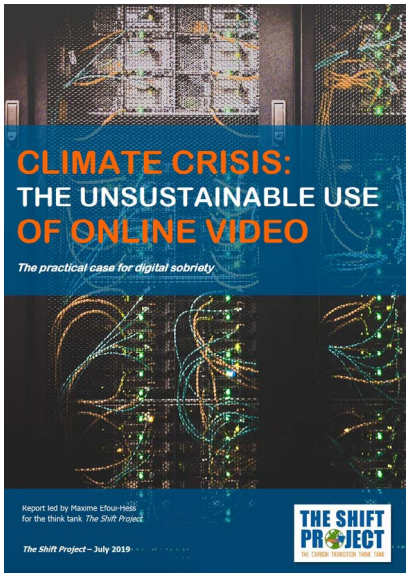
Projected electricity demand in Ireland, by sector, 2018-2028 (IEA 2019)

2.2. Energy expenditure and consumption

2.2.1. Digital entertainment

The modern digital lifestyle includes a significant amount of digital entertainment. Notwithstanding media streaming, there are different ways of behaving that add to this pattern. Web-based gaming, for example, has acquired monstrous ubiquity, with a huge number of individuals participating in multiplayer games across various stages. Besides, computerized content creation, for example, video blogs, web recordings, and music creation, has become open to a more extensive crowd (Masanet et al., 2020). Individuals are currently ready to make, distribute, and consume their own amusement content, obscuring the lines between makers and customers. These ways of behaving mirror the developing idea of amusement in the computerized age, offering different choices for people to draw in with and appreciate.

2.2.2. Media streaming



2.2.2.1. The unsustainable use of online video: The practical case for digital sobriety

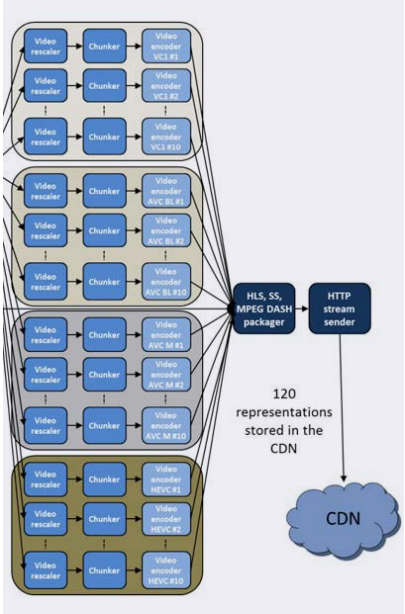
The Shift Project report puts forward the ecological effect of digital activities, explicitly zeroing in on web-based video utilization. The review underscores that the surge in web-based video has prompted a critical expansion in energy utilization and carbon emissions. It requires the need to take on measures for computerized restraint to relieve the environmental emergency (Efoui-Hess, 2019). The report suggests implementing energy-efficient technologies, optimizing video streaming platforms, and encouraging users to adopt conscious consumption practices as strategies. By taking on these practices, people and associations can decrease their carbon impression and add to a more economical computerized biological system.

2.2.2.2. How much electricity does YouTube use?

Due to its large user base and the data-intensive nature of video streaming, YouTube consumes a significant amount of electricity, according to an article on The Fact Source. Gauges propose that YouTube's yearly power utilization is similar to the energy use of a medium-sized country. In order to function and deliver videos to users worldwide, the platform's servers, data centers, and network infrastructure require a significant amount of energy (Preist, Schien & Shabajee, 2019). The platform's energy consumption is likely to rise further as YouTube continues to expand and more content is uploaded and viewed. Currently, YouTube generates an estimated 1.8 trillion video views each year. It consumes about 11.4% of the world's internet traffic, which is equivalent to 243.6 TWh of electricity consumption, exceeding 1% of the world's total.

Youtube channel	Total views in billions (2019)	Electricity consumption (GWh)	How many U.S. homes it could power
T-Series	89	12015	1,112,500
World Wrestling Entertainment	37	4995	462,500
PewDiePie	23	3105	287,500
JustinBieberVEVO	19	2565	237,500
KatyPerryVEVO	17	2295	212,500
Ed Sheeran	16	2160	200,000
TaylorSwiftVEVO	16	2160	200,000
BuzzFeedVideo	15	2025	187,500
5-Minute Crafts	13	1755	162,500

Youtube channel electricity consumption (TheFactSource 2019)



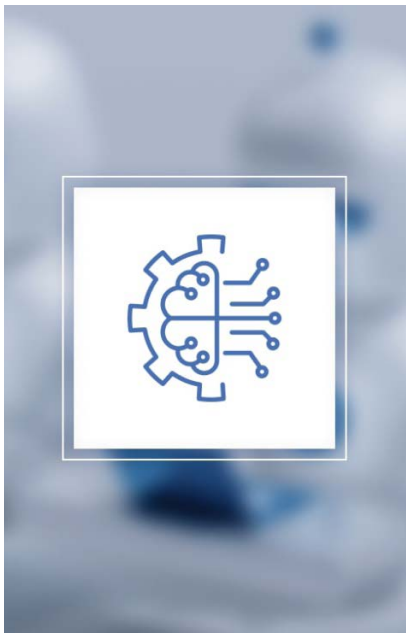
Netflix's OTT delivery (CONVINcE 2017)

2.2.2.3. What is the carbon footprint of streaming on Netflix?

The carbon footprint of web-based video on Netflix has been a subject of conversation as of late. As per Carbon Brief, web-based recordings on Netflix add to ozone-depleting substance emanations, fundamentally because of the energy expected to drive server farms and organization framework. In 2019, Netflix's worldwide streaming produced an expected 451,000 metric lots of carbon dioxide discharges (Kamiya, 2020). In any case, it is vital to take note that the carbon impression each hour of streaming can shift in view of a few variables, including the gadget utilized, video quality settings, and the wellspring of power. Endeavors are being made by Netflix and other streaming stages to further develop energy proficiency and progress to sustainable power sources to diminish their ecological effect.

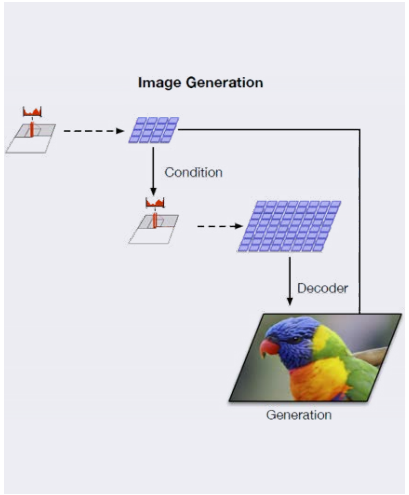
2.3. AI Computing power

AI-based computing can be considered as a math-intensive process that helps to calculate machine learning algorithms with proper software and accelerated systems (Omar et al., 2023). However, the rising reliance on AI computing power will be an upcoming major factor of pollution, which will be adverse in terms of sustainable proceedings. Machine learning processes using chatbots, ChatGPT, as well as generative AI like DALL-E and Midjourney are some of the most used aspects.



2.3.1. Machine learning - Chatbots, ChatGPT

Chatbots are computer programs intended to reproduce human discussion through printed or hearable means. They are handled by Natural Language Processing (NLP) methods and AI calculations. ChatGPT is one such chatbot in light of the GPT-3.5 engineering created by OpenAI (Taecharungroj, 2023). It uses a deep neural network prepared on a huge measure of text information to create human-like reactions. ChatGPT can take part in significant and cognizant discussions, answer questions, give data, and even mimic characters. It can be used for everything from virtual assistants and customer service to language learning and entertainment. In any case, it's essential to note that while (Omar et al., 2023) ChatGPT can create amazing reactions, it might sporadically produce erroneous or absurd responses.



2.3.2. Generative AI - DALL-E, Midjourney

DALL-E is an AI model created by OpenAI that can produce pictures from literary portrayals. It joins thoughts from the GPT-3 design with a modified VQ-VAE-2 image model, permitting it to make interesting and reasonable pictures in light of literary prompts. DALL-E has shown amazing abilities in creating novel and innovative visuals, expanding the potential outcomes of man-made intelligence-produced content (Mann, 2023). A program and service powered by generative AI is also under active development at Midjourney. Users can explore AI artwork generation with Midjourney through the proper utilization of Discord bot commands.

2.4. Digital assets

2.4.1. Cryptocurrency and token systems

2.4.1.1. Mining and the proof-of-work mechanism

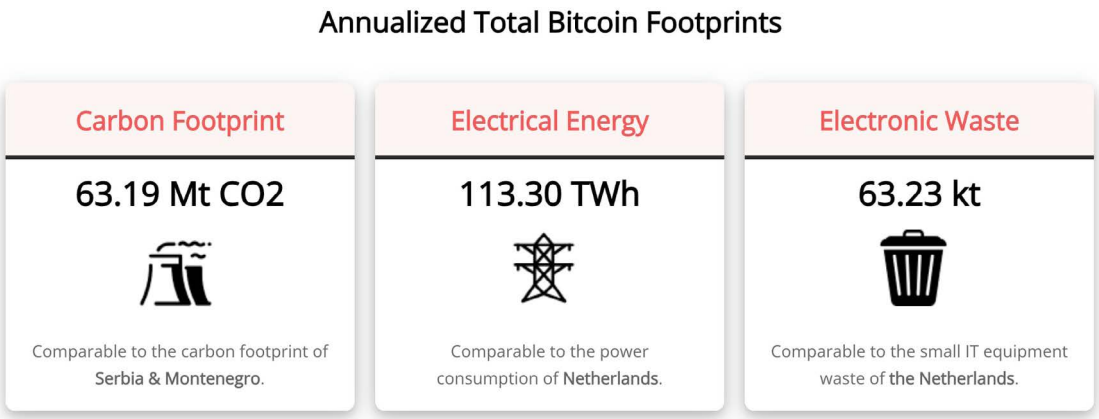
The proof-of-work (PoW) consensus mechanism, which is utilized by digital forms of money, notably Bitcoin, has miners tackling complex numerical riddles to approve exchanges and add them to the blockchain (Fröwis, Fuchs & Böhme, 2019). This cycle requires huge computational power and energy utilization.

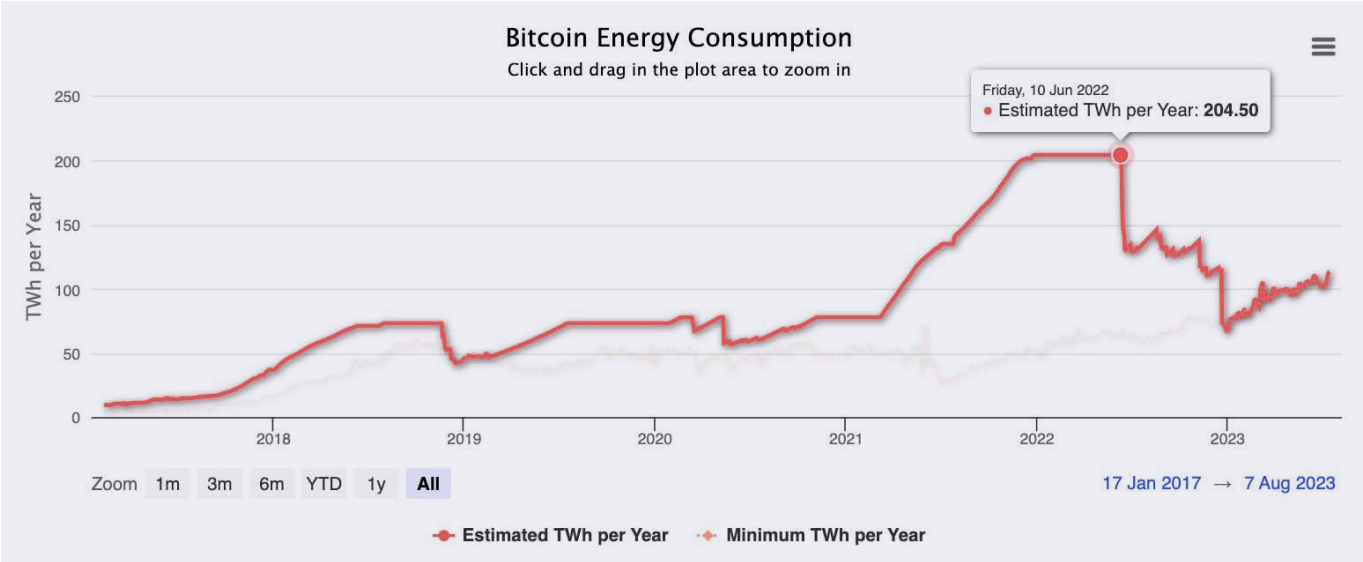
The ecological effect of mining and PoW has raised worries because of its carbon impression and environmental gambles related to high energy utilization. Mining is not straightforwardly environmental risk estimated into crypto-resources. The cost of digital forms of money is not set in stone by market interest and supply elements (Jani, 2017).

Notwithstanding, the ecological effect of mining can, by implication, influence crypto resources in different ways. For instance, expanded investigation and negative impression of digital currencies' carbon impression might prompt administrative activities which can affect their worth (Pernice and Scott, 2021). Moreover, the rising familiarity with climate change and sustainability issues might drive the interest for greener options, possibly impacting market inclinations and venture choices.

2.4.1.2. Bitcoin energy consumption

As indicated by the Digiconomist's Bitcoin Energy Utilization List, Bitcoin's energy utilization is assessed to be very significant. The Digiconomist site reveals that Bitcoin's yearly energy utilization can reach around 200 TWh (terawatt-hours) (Schwiderowski, Pedersen and Beck, 2023). The amount of energy consumed here is comparable to that of some nations.





Bitcoin Energy Consumption (Digiconomist 2023)

The high energy utilization of Bitcoin mining can be ascribed to the computational power expected to take care of the complex numerical issues inborn in the PoW calculation (Pernice & Scott, 2021). Miners compete to solve these puzzles, and the first person to find a solution wins Bitcoins that have just been created.

2.4.2. NFTs and the environment

NFTs (Non-Fungible Tokens) have acquired huge fame lately as exceptional advanced resources. However, environmental concerns have been raised due to the growing prevalence of NFTs. NFTs are mostly created and traded on blockchain platforms. An NFT transaction that takes place on a proof-of-work blockchain, like Bitcoin's, would consume a lot of energy (Schrader-Rank, 2021). This energy utilization adds to fossil fuel byproducts and the overall ecological impression.

Furthermore, the most common way of stamping and moving NFTs includes critical computational power and exchange expenses. One NFT transaction on the Bitcoin network releases approximately 748 kg of CO2, which is comparable to the carbon footprint of 124,714 hours of YouTube viewing or 1.7 million Visa transactions. The participants in these activities must use computing resources that use a lot of energy, which costs the environment even more.

2.4.3. Environmental cost of network security

The organization security of cryptographic forms of money, especially those in light of PoW systems, requires huge computational influence and energy utilization. This energy-serious interaction has an ecological expense.

In PoW-based digital currencies like Bitcoin, excavators contend to tackle complex numerical issues to get the organization and approve exchanges. The computational power expected for this cycle has expanded fundamentally over the long haul, prompting an ascent in energy utilization (Schrader-Rank, 2021). The environmental cost of organization security essentially originates from the energy sources utilized for mining tasks. The use of fossil fuels, for example, as a source of electricity, frequently necessitates the use of non-renewable resources in mining operations.

2.5. Environmental and climate impacts

The environmental and climate impacts of the above-mentioned resources are huge. Be it digital entertainment or digital assets, there have been serious issues regarding energy consumption and sustainability. The increase in carbon footprint and greenhouse gases ultimately impacts global climate change (Schrader-Rank, 2021). In a way, it can be said that the use of technology is bringing about a great deal of transformation; however, it comes at a high cost.

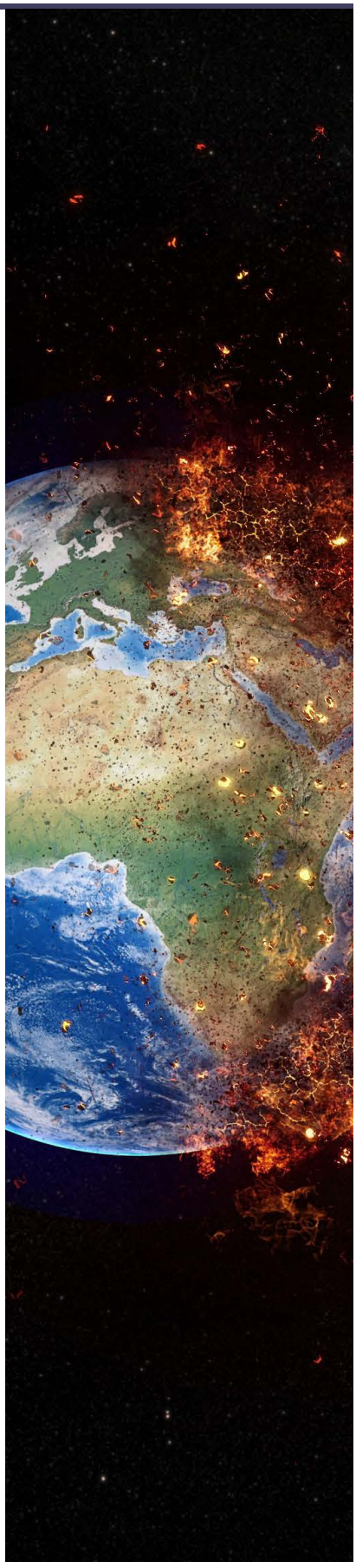
2.5.1. Greenhouse gases and carbon emissions

Greenhouse gases present in the Earth's climate trap heat emanating from the surface. The main ozone-depleting substances incorporate carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and fluorinated gases (Fang et al., 2022). These gases act like a blanket, trapping heat and allowing sunlight to pass through them, causing the Earth's surface to warm.

The byproducts of fossil fuels refer to the release of carbon compounds, mainly carbon dioxide, into the atmosphere due to human activities such as the combustion of fossil fuels, deforestation, and industrial processes. These emissions are the primary drivers of the increasing concentration of greenhouse gases in the atmosphere.

Ozone-depleting substances and fossil fuel byproducts impact our planet sweepingly. The enhanced greenhouse effect brought about by the aggregation of these gases prompts worldwide temperature alteration and environmental change (Fang et al., 2022). The expanded temperature changes atmospheric conditions, causing more frequent extreme heatwaves, tempests, and dry spells. Rising ocean levels result from ice sheets and ice covers dissolving, undermining waterfront regions and low-lying islands.

2.5.2. Global warming and climate change



An Earth-wide temperature increase and environmental change keep presenting serious dangers to our planet, bringing about immense natural harm. These phenomena are characterized by observable impacts such as elevated sea levels, melting ice caps, severe weather patterns, and increasing temperatures. The growing effects of global warming are brought to light in both news reports and scientific studies. As of late, record-breaking heatwaves have cleared across different locales, prompting dry spells and out-of-control fires (Kulakhmetova, 2022). The well-being and prosperity of people are likewise in danger as outrageous climate occasions and changing sickness designs arise.

The frequency and intensity of devastating hurricanes and cyclones have increased, resulting in widespread destruction and death. Communities are being displaced due to rising sea levels, and essential ecosystems are being destroyed. Another alarming sign of climate change is melting ice in the Arctic and Antarctic. The icebergs from around the world are melting, and the standard of living in nearby states is declining at an extraordinary rate, influencing untamed life in natural surroundings and worsening a worldwide temperature alteration by lessening the planet's reflectivity (Fang et al., 2022). Apart from that, the Antarctic ice sheets are losing mass, adding to the ocean level ascent and jeopardizing seaside urban communities and island countries.

Additionally, climate change is a direct cause of biodiversity loss. Increasing temperatures and changing precipitation designs upset biological systems, prompting the elimination of plant and creature species (Kulakhmetova, 2022). Coral reefs, fundamental marine natural surroundings that help a huge swath of marine life, are experiencing fading occasions because of hotter sea temperatures. These environmental damages have far-reaching effects on every facet of human life. Food security is in danger as changing climatic circumstances disturb horticulture and decrease crop yields.

2.5.3. Why reduce pollution? Future cone of digital pollution

We must reduce digital pollution in order to prevent further degradation of the environment and ensure a livable future. Using the future cone framework, a clear illustration of why pollution must be reduced by projecting the future prospects of our environment through the six P's model:

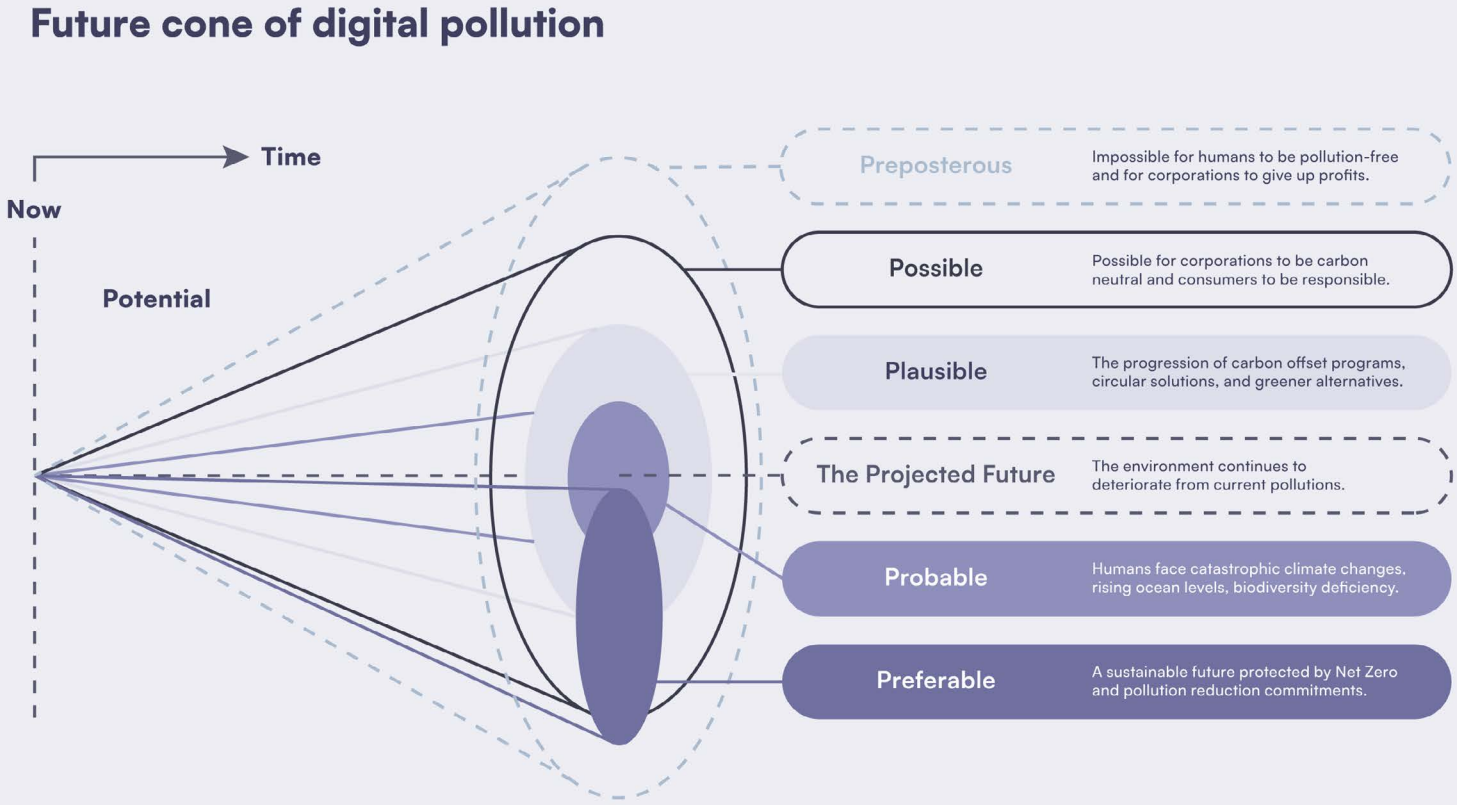


Figure 2.5.3: Future cone of digital pollution

Preposterous

Given that our modern lifestyles rely heavily on energy consumption and industrial procedures, it is absurd to imagine that humans will be completely carbon-neutral or free of greenhouse gas emissions. Global temperatures are expected to reach historic highs, with predicted annual mean global near-surface temperatures between 2023 and 2027 will be 1.1°C to 1.8°C higher on average than during 1850-1900 (World Meteorological Organization, 2023). Thus, it is high time to take one step toward carbon neutrality.

Possible

Notwithstanding, it is possible for additional enterprises to focus on carbon balance endeavors. Users of products can become more responsible by making well-informed decisions, choosing eco-friendly alternatives, and supporting practices that are long-term.

Plausible

The advancement of carbon offset programs, circular arrangements, and greener options is now in progress. Carbon offset drives empower people and organizations to make up for their emanations by putting resources into projects that lessen ozone-depleting substances elsewhere. The reception of circular economy standards advances asset effectiveness and waste decrease. Besides, progressions in innovation and development keep driving the accessibility of greener options in different areas.

The Projected Future

In the event that contamination proceeds unrestrained, what's to come bears a large set of deteriorating results. Due to increased greenhouse gas emissions, global temperature rise is anticipated to intensify. The Intergovernmental Panel on Climate Change (IPCC) cautions that without substantial outflow lowerings, humans might confront horrendous consequences, for instance, outrageous climate events, rising ocean levels, and the depletion of biodiversity.

Probable

Given the ongoing direction, it is probable that a hazardous environmental shift will endure and compound existing ecological ordeals. This will further impact biological systems, human well-being, and economic stability, presenting huge threats to all populations.

Preferable

In order to reach an ideal future, pollution reduction is undeniable. A greener tomorrow involves safeguarding the environment, diminishing fossil fuel by-products, cultivating a supportable turn of events, and focusing on the prosperity of both present and future generations.

3. The progress in reducing digital pollution

3.1. Carbon neutrality and the race to Net Zero

3.1.1. Carbon neutral pledges, Paris Agreement, United Nations Global Compact

3.1.2. The complications of achieving Net Zero

3.1.3. Synchronizing corporate carbon footprints

3.2. Corporate initiatives to reduce pollution

3.2.1. Case Study 1: Microsoft to erase all emissions since 1975 by 2050

3.2.2. Case Study 2: Google commits to worldwide energy transition

3.2.3. Case Study 3: The Merge - from proof-of-work to proof-of-stake

3.3. User-end commitments to reduce pollution

3.3.1. The Solarpunk movement

3.3.2. Individuals' responsibilities

3.1. Carbon neutrality and the race to Net Zero

3.1.1. Carbon neutral pledges, Paris Agreement, United Nations Global Compact

Carbon neutral pledges, the Paris Agreement, and the United Nations Global Compact are undeniably connected with worldwide efforts to address environmental change and advance economic turn of events. Here is an outline of each endeavor:

Carbon neutral pledges: Carbon neutrality refers to achieving a harmony between how much greenhouse gases (GHGs) are discharged into the air and the sum eliminated or offset. Carbon neutral pledges are commitments made by governments, organizations, or individuals to minimize their carbon footprint and reach carbon neutrality by a predetermined date (Hossain et al., 2022). These pledges may include carrying out measures to reduce emissions, embracing sustainable power sources, expanding energy efficiency, and putting resources into carbon offset projects.

Paris Agreement: The Paris Agreement is a global settlement in December 2015 adopted by the parties to the United Nations Framework Convention on Climate Change (UNFCCC). The objective is to curb the escalation of global warming to a level significantly below 2 degrees Celsius above the pre-industrial benchmark while restricting temperature surges to 1.5 degrees Celsius. (Guzović et al., 2022). The understanding sets out a structure for nations to willfully decrease their ozone-harming substance discharges, upgrade versatile limits, and back emerging countries in their environmental change relief and transformation endeavors. It likewise underlines the significance of monetary streams, innovation moves, and limit working to help these objectives.

United Nations Global Compact (UNGC): The UNGC is a deliberate drive sent off by the United Nations in 2000. It is an appeal to businesses and organizations worldwide to align their strategies and operations with the Ten Principles related to the environment, human rights, labor, and anti-corruption. The Compact gives a structure to organizations to add to the economic turn of events and advance mindful practices (Podrecca, Sartor & Nassimbeni, 2022). Through Communication on Progress (CoP) reports, the UNGC encourages businesses to reduce their environmental impact, support clean technologies, and disclose their progress in relation to climate change.

Generally speaking, these ideas address various parts of the worldwide reaction to environmental change and feasible turn of events, with carbon impartial promises exhibiting a pledge to decreasing outflows, the Paris Agreement giving a worldwide system to collaboration, and the United Nations Global Compact directing mindful strategic policies.

3.1.2. The complications of achieving Net Zero

Achieving net zero is an intricate and challenging task that includes tremendous specialized, monetary, and social intricacies. Here are a few key complexities related to achieving net zero (Galvin, 2022):

Technological challenges: The widespread adoption of low-carbon technologies is necessary for the transition to net zero. Large numbers of these advancements are still in the beginning phases or not yet financially suitable at scale. Creating and conveying reasonable and effective eco-friendly power sources, high-level energy stockpiling frameworks, Carbon capture and storage (CCS) advances, and manageable transportation alternatives present critical, innovative difficulties.

Infrastructure transformation: Whether large or small, for tech giants or small firms, achieving net zero requires fundamental changes to existing frameworks. This involves decarbonizing the energy domain, retrofitting structures for energy productivity, and creating brilliant networks. Such changes require significant speculation, broad preparation, and coordination among various partners.

Economic implications: The shift to a net zero economy can have critical monetary ramifications. Ventures heavily dependent on non-renewable energy sources might face disturbances, causing employment misfortunes and monetary imbalances. The call for reducing emissions should be matched with financial development and employment creation. Policymakers and organizations should explore the intricacies of progressing to a feasible economy while limiting unfavorable fiscal effects.

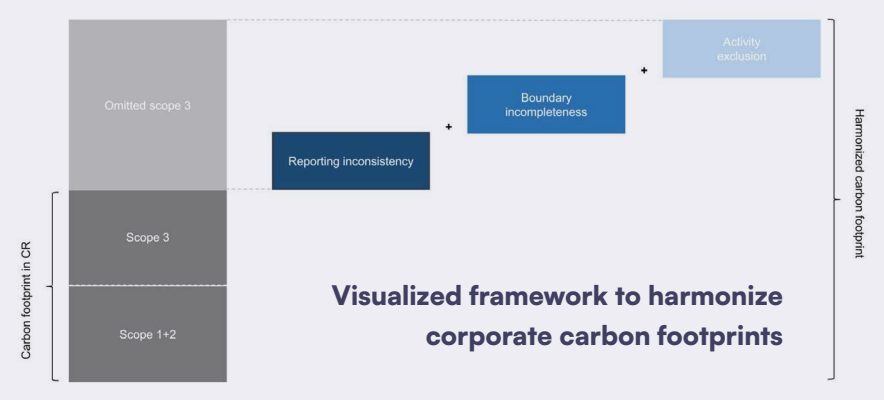
International cooperation: Global cooperation and coordination are required to address the issue of climate change. Achieving net zero requires all nations, especially the powerful players, to make aggressive moves. Global cooperation can be hindered by divergent priorities, political considerations, and economic disparities. Arranging and executing powerful peaceful harmonies, like the Paris Agreement, can be complex and challenging.

Behavioral and social change: Individual and societal behavior must change if net zero is to be achieved. Empowering energy preservation, strengthening economic standards, and moving cultural standards towards low-carbon practices are fundamental but difficult tasks. The main social issues that need to be addressed include overcoming resistance to change, encouraging participation, and guaranteeing equity during the transition.

3.1.3. Synchronizing corporate carbon footprints

As the urgency of addressing environmental change intensifies, reducing GHG emissions has become an increasingly common goal for corporations around the world. Experts have emphasized the importance of synchronizing carbon impressions across associations to maximize correlations (Reichelstein, 2022).

Corporate carbon footprint calculations need to be uniformly calculated in order for them to be accurate and impactful. In light of the fact that organizations utilize numerous estimation methods, it is hard to compare discharge information effectively. The experts propose a comprehensive system based on the GHG Convention that provides rules to calculate emissions from various sources (Liang et al., 2023). Implementing a standard procedure empowers organizations to synchronize their carbon footprint computations, enabling accurate benchmarking and identifying opportunities for outflow reductions.



Synchronizing carbon footprint computations has a variety of beneficial implications. To begin with, it enables straightforward and reliable reporting, thereby increasing stakeholder accountability and trust. Additionally, it enables precise correlation and benchmarking among organizations within a similar industry, promoting healthy competition and fostering the development of low-carbon practices (Jia, Wen & Liu, 2022). Thirdly, synchronization facilitates the acquisition of information at the territorial and international levels, assisting policymakers in developing viable environmental arrangements and guidelines. In the end, a steady strategy ensures the credibility of carbon offset projects and helps to achieve the best strategies for reducing outflows.

In spite of the fact that synchronizing can be beneficial, it can also be challenging. Due to the wide range of business sizes, structures, and operational complexity, implementing a single methodology is a problematic undertaking (Liang et al., 2022). Furthermore, information accessibility and reliability can conflict across associations, obstructing precise estimations. To settle these hindrances, the experts recommend coordinated efforts between organizations, industry affiliations, and policymakers to lay out explicit rules and systems. These rules can be altered to accommodate different authoritative settings.

In order to effectively combat climate change, corporate carbon footprints must be coordinated. By adopting a standard method, organizations can precisely gauge and look at discharges, encouraging transparency and responsibility, ultimately driving progress to a manageable and low-carbon future.

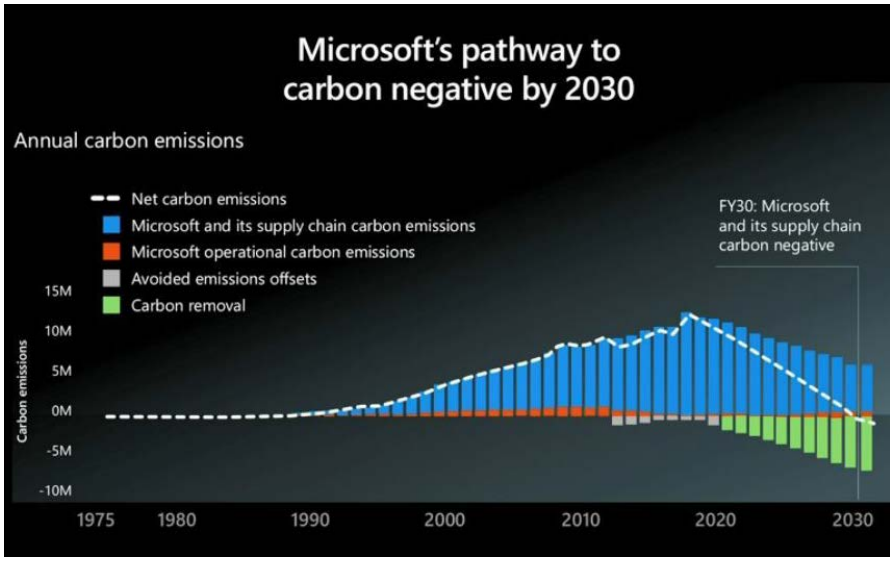
3.2. Corporate initiatives to reduce pollution

3.2.1. Case Study 1: Microsoft to erase all emissions since 1975 by 2050

One illustration of responsibility from a tech organization is Microsoft's obligation to sustainability. In January 2020, Microsoft declared its ambitious objective to become carbon negative by 2030, implying that it plans to eliminate more carbon dioxide from the environment than it produces. In addition, the business pledged to eliminate all carbon emissions it had produced since its inception in 1975 by 2050 (Belousova et al., 2022).

Microsoft provided a comprehensive strategy for achieving these goals. The intention is to allocate $1 billion towards a new Climate Innovation Fund with the aim of accelerating the development of technologies that reduce, capture, and remove carbon emissions. The organization likewise means to move to 100 percent sustainable power for its server farms, structures, and grounds by 2025. Microsoft has established an internal carbon fee to fund sustainability initiatives and hold business divisions accountable for carbon emissions. Furthermore, it expects to utilize its innovation to engage clients and accomplices overall to decrease their carbon impressions.

Beyond carbon neutrality, Microsoft's commitment to sustainability extends (Belousova et al., 2022). The organization has also prioritized monitoring water resources and biodiversity preservation. It has undertaken a number of initiatives to advance circular economy standards, such as reusing and recycling electronic waste.



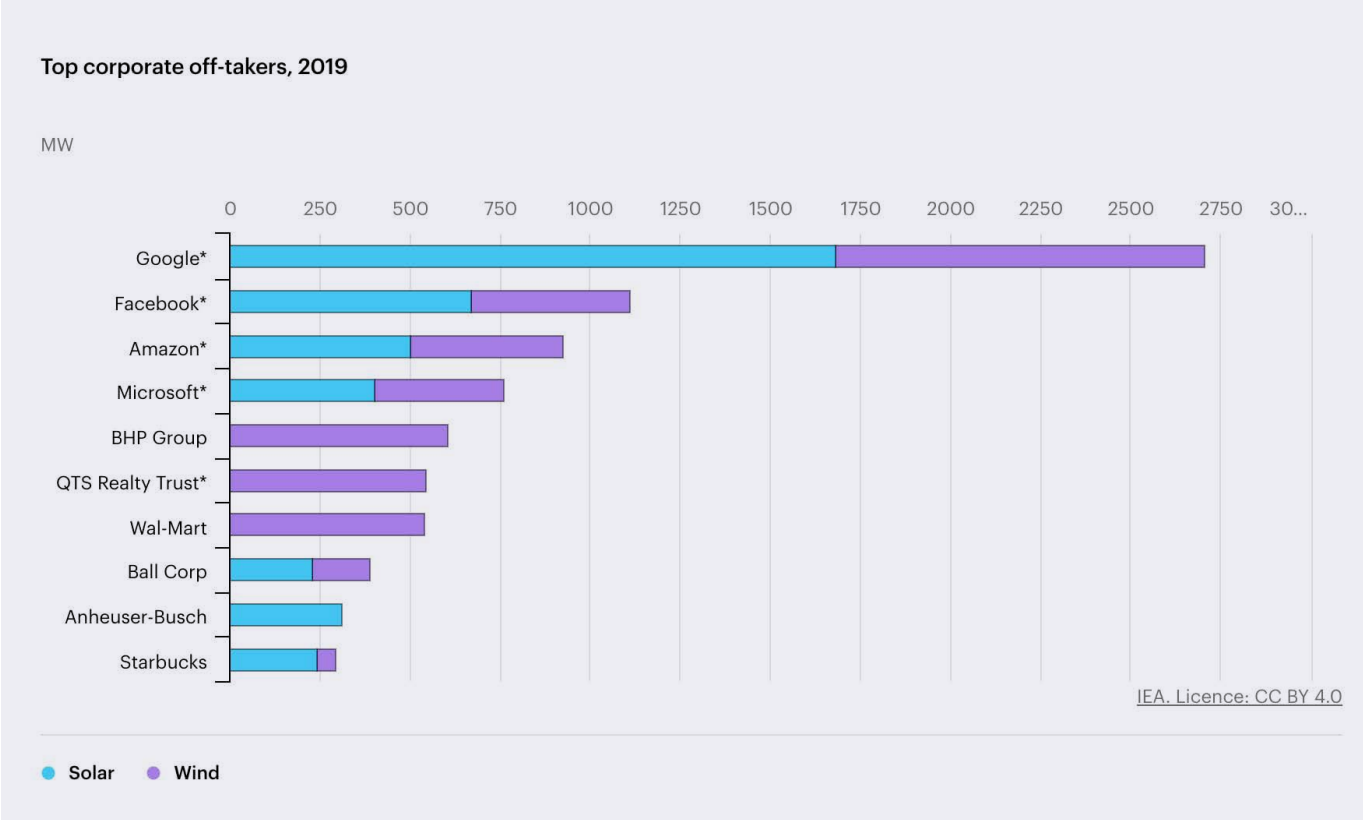
As part of its manageability responsibilities, Microsoft is demonstrating its commitment to addressing the dire difficulties presented by climate change and natural disasters. Microsoft is expected to drive significant improvements across its business and within its tasks by fully utilizing its assets, innovation, and impact.

3.2.2. Case Study 2: Google commits to worldwide energy transition

Google's commitment to renewable energy and sustainability is another example of a tech company. As part of its global efforts, Google has defined an objective to work entirely on sustainable power hotspots. In 2017, Google became the first significant organization of its size to coordinate its whole yearly power usage with eco-friendly power buys.

Google has taken a critical interest in energy conservation projects around the world. The organization has signed long-term PPAs with wind and solar farms to ensure a steady supply of renewable power. To promote sustainability throughout the technology sector as a whole, Google has sent off drives to support using renewable power in server farms and has imparted its prescribed procedures and mastery to different organizations (In, Peterman and Monk, 2022). Google has collaborated with governments and advocated for policies that support the transition to renewable energy.

These arrangements have helped drive the improvement of clean energy projects and have contributed to the development of sustainable energy foundations. By putting resources into reducing its carbon footprint and advancing ecological stability, Google is setting a model for other tech organizations and ventures to follow.



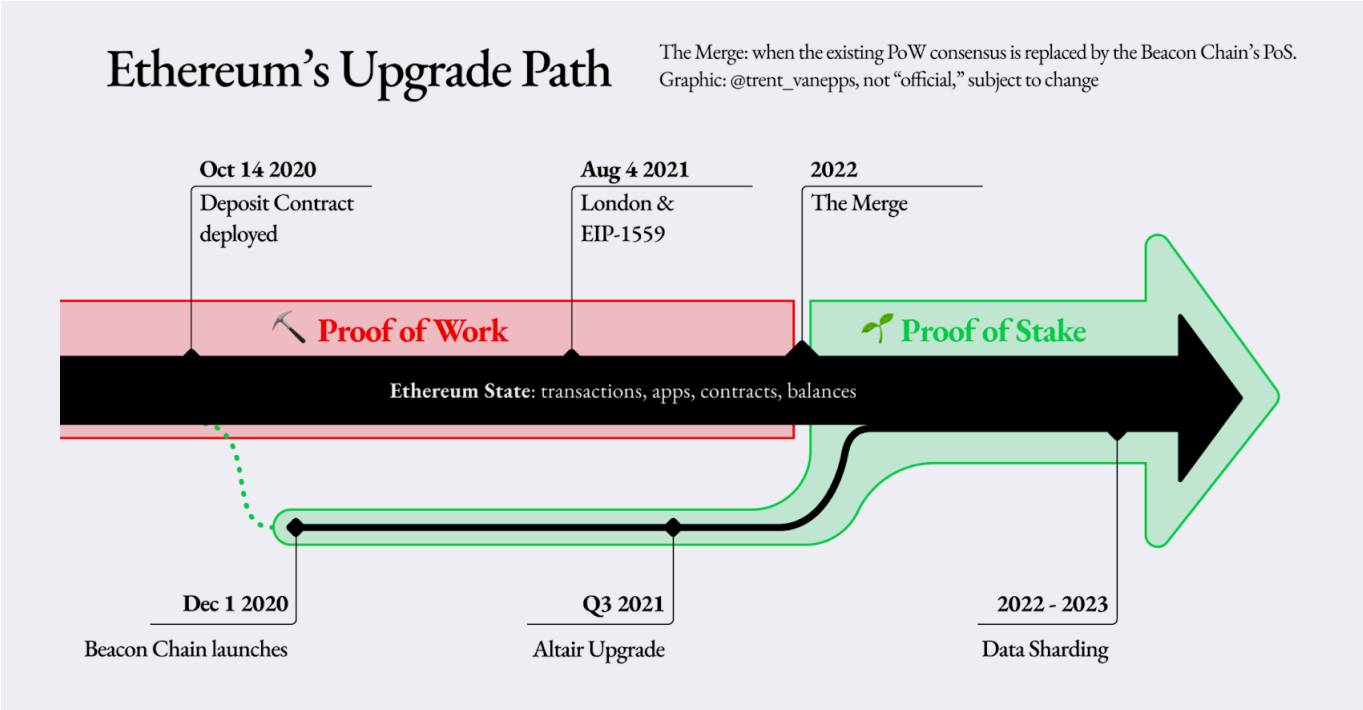
Top corporate off-takers of renewables in 2019 (IEA 2020)

3.2.3. Case Study 3: The Merge - from proof-of-work to proof-of-stake

As of late, regulators have given greater consideration to the energy use and ecological effect of digital forms of money like Bitcoin. The energy utilization and carbon impression related to these cryptographic forms of money have raised worries, with gauges proposing that the Bitcoin network alone could consume north of 13 GW of power every year and create 65 megatons of CO2 discharges (Kapengut & Mizrach, 2023). To address these worries, controllers have made different moves.

Due to environmental concerns, China banned mining in 2021, and the European Parliament considered banning cryptocurrency services; however, it settled for additional environmental disclosure requirements. Regulations have also been implemented by the US government to prevent cryptocurrency miners from relying upon petroleum products for energy.

One method for diminishing digital currencies' ecological effect is changing from energy-escalating mining cycles to other practical options. Ethereum, the second-biggest digital currency, informed the public about a major process known as "The Merge" on September 15, 2022 (Kapengut and Mizrach, 2023). The consolidation supplanted Ethereum's proof-of-work (PoW) mining system with a highly energy-efficient proof-of-stake (PoS) consensus mechanism. The switch to a PoS has significantly reduced energy consumption by 99.98% and carbon emissions by 99.992%. This represents a substantial improvement from previous levels of 11,016,000 to 870 tonnes of CO2e.



Ethereum Merge upgrade path (FXStreet 2022)

3.3. User-end commitments to reduce pollution

3.3.1. The Solarpunk movement

The Solarpunk movement is a dynamic illustration of society's obligation to reduce pollution. It came about as a response to the problems caused by climate change and the desire to create a future that is sustainable and in harmony with the environment. It envisions an existence where environmentally friendly power, green innovations, and nature-driven plans are coordinated into each part of society.

The enthusiasts effectively incorporate manageable practices into their regular routines (Rivero-Vadillo, 2023). They tackle sun-based energy by introducing solar panels, empowering them to produce clean power and decrease dependence on petroleum derivatives. Moreover, they advocate for the utilization of energy-efficient machines and emphasize reusing and upcycling to limit waste. This development further underlines the significance of metropolitan green spaces.

Solarpunk allies participate in local planting drives, roof gardens, and metropolitan cultivation projects. They strive to transform concrete jungles into vibrant, green environments that enhance community well-being, improve air quality, and encourage biodiversity. Solarpunk encourages sustainable transportation options, including cycling, walking, and electric vehicles, as eco-friendly means of commuting. They advocate for the improvement of public transportation frameworks fueled by eco-friendly power sources, such as solar power and wind. The Solarpunk movement exemplifies consumer commitment to reducing pollution and constructing a more sustainable future by actively engaging in sustainable practices and promoting novel solutions.

3.3.2. Individuals' responsibilities

It is imperative to note that individual commitments to reducing digital pollution can take many forms. The following are just a few measures of user-end commitments on a global scale:

Responsible energy consumption: When using digital products in the modern era, responsible consumption entails being cognizant of energy usage and taking measures to minimize it, such as deactivating them when not in use and employing energy-efficient features.

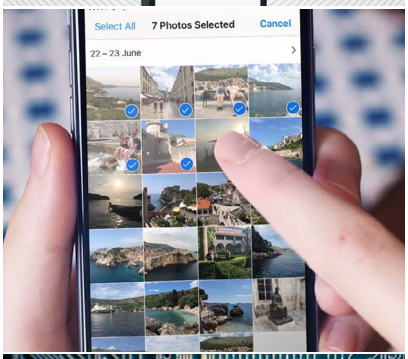
Conscious data consumption: Individuals need to focus on harmless data consumption by adhering to the basic principle of conscious consumerism, whereby data is treated as a product that must be consciously consumed so that digital pollution can be avoided.

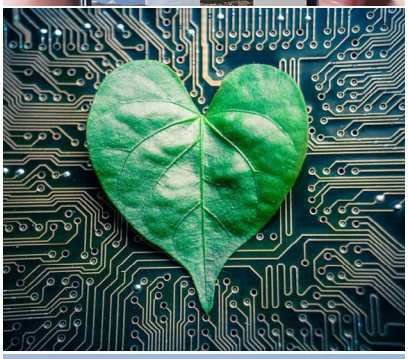
Eliminating digital clutter: As highlighted previously through the contrasting user mindsets, complimentary storage availability and a fast-paced digital lifestyle increase digital clutter. Thus, creating a proper strategy for reducing as well as eliminating digital clutter can be considered an important responsibility.

Selecting ethical digital products: The selection of digital products should be based on ethical standards, which allow users to request deletion and limit server-end storage of their data, as well as consent to access or trade their personal data. A focus on digital ethics and the use of appropriate permissions is considered crucial for better delineation.

Choosing eco-friendly data centers: Choosing eco-friendly data centers with consolidated servers and cloud service providers that use high-efficiency power can be considered a strategic prospect in the future.

Accordingly, these models show how individuals can be effectively committed to diminishing digital pollution by making feasible decisions and advancing eco-accommodating practices in their day-to-day routines.





4. The prospects of reducing digital pollution

4.1. Motivational psychology + Nudge marketing

4.1.1. Influencing users into a new digital lifestyle

4.1.2. Rational or irrational?

4.1.3. User journey towards responsible consumption

4.2. Greener alternatives for corporations

4.2.1. Transforming pollution into energy

4.2.2. Underwater data centers

4.2.3. Carbon offsetting - a model for compensation

4.2.4. Treedefi: Empowering the ESG crypto space

4.3. The role of designers

4.3.1. Navigating conflicts and driving changes

4.3.2. A wake-up call: Design for reflection

4.3.3. The prospects of reducing digital pollution

4.1. Motivational psychology + Nudge marketing

Nudge marketing and motivational psychology both try to affect consumer behavior, however, in different ways. Understanding and addressing individual motivations and motives is a key component of motivational psychology, which aims to promote desired actions (Feroz, Zo & Chiravuri, 2021). Apart from that, the process explores the psychological aspects of decision-making, such as a person's values, beliefs, and objectives. Nudge marketing, on the other hand, uses covert and indirect strategies to affect consumer behavior without overtly limiting options. Utilizing behavioral insights, it modifies the context or presents options in a certain way to encourage customers to make wise decisions. Combining these methods can result in a holistic strategy that encourages and prods consumers to be more environmentally aware.

4.1.1. Influencing users into a new digital lifestyle

Utilizing a variety of tactics to influence consumers' decisions and behaviors is necessary to transition them to a new digital lifestyle that encourages ethical consumer behavior (Marjanovic, Cecez-Kecmanovic & Vidgen, 2021). This can be accomplished by running educational and awareness efforts that draw attention to the negative social and environmental effects of digital use. Additionally, incorporating nudges into digital user interfaces might persuade users to adopt sustainable behaviors, such as energy-saving settings or environmentally beneficial choices. The use of motivational strategies, such as referencing one's own beliefs and goals, tends to encourage consumers to make thoughtful choices regarding their digital consumption. Users can be directed toward a more responsible digital lifestyle that has less harmful effects on the environment and society by combining these strategies.

4.1.2. Rational or irrational?

It might be difficult to determine if giving up convenience or productivity in the context of a responsible consumer mindset is reasonable or irrational (Zhang et al., 2022). Additionally, the process adheres to the values of resource conservation and sustainability. However, as it entails short-term trade-offs, giving up convenience and productivity for environmental friendliness may seem irrational from an irrational point of view. The key to cultivating a responsible consumer mindset that encompasses both rational and irrational parts is to strike a balance between the rational understanding of long-term sustainability and the immediate convenience or productivity needs.

4.1.3. User journey towards responsible consumption

In a responsible consumer attitude, it might be difficult to judge if sacrificing convenience or productivity for environmental friendliness is rational or irrational. Environmental friendliness makes sense from a logical standpoint, especially when you take into account the long-term advantages it offers the world and future generations. Moreover, the process tends to adheres to sustainability ideals. In the near term, it could seem absurd to give up ease or productivity for environmental friendliness. Individual values and priorities will determine this. Besides, it can be considered critical to strike a balance between the rational understanding of long-term viability and present requirements. Recognizing the value of protecting the environment for a sustainable future and making reasonable decisions are crucial components of responsible consumer behavior.

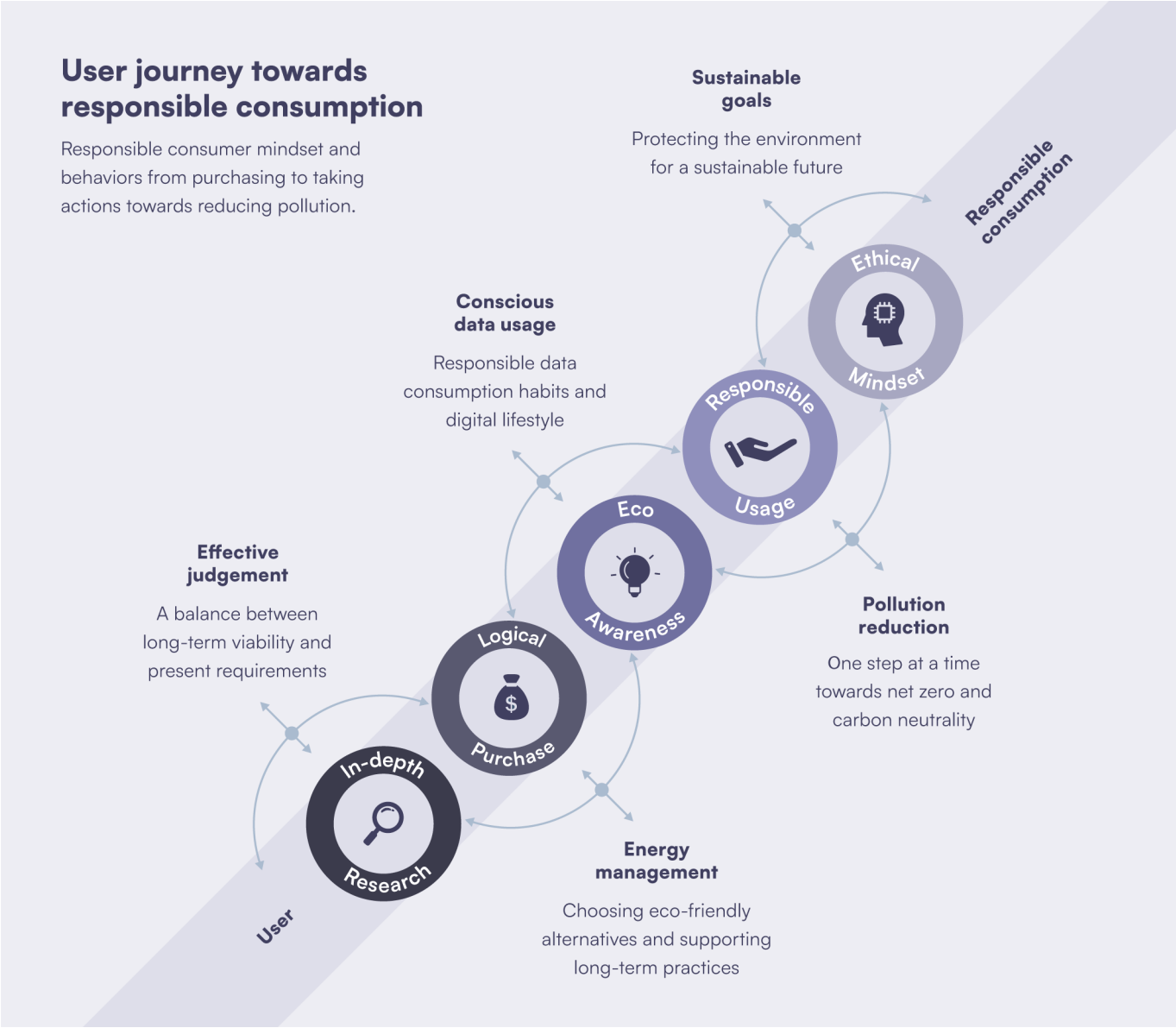


Figure 4.1.3: User journey towards responsible consumption

4.2. Greener alternatives for corporations

4.2.1. Transforming pollution into energy

A promising strategy to lessen the negative environmental impacts of different businesses, including data centers, is the conversion of pollution into energy. Utilizing cutting-edge methods and technologies, pollution can be converted into a clean, renewable energy source (Limb, 2023).

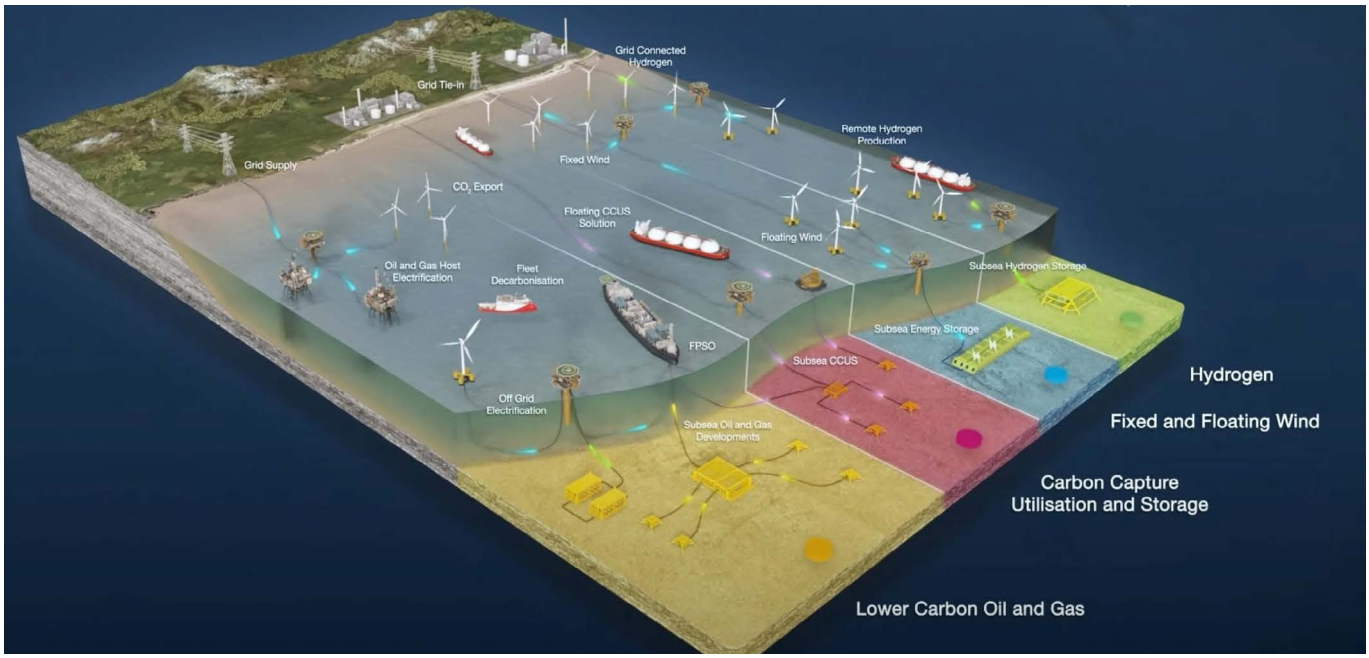
One such business at the fore of this transformative movement is Deep Green. In order to provide sustainable heating solutions for swimming pools, vertical farms, and other applications, they specialize in capturing and utilizing waste heat produced by data centers. This method maximizes the energy potential of data centers' operations alongside lowering their carbon footprint, greatly raising energy efficiency. Usually, waste heat from data centers is vented into the atmosphere, which causes pollution (Masanet et al., 2020). Deep Green's ground-breaking method, though, supports a circular economy and counteracts climate change by recycling the waste heat. Additionally, by rerouting the heat, Deep Green makes it possible for these facilities to run sustainably without having to utilize traditional heating techniques. This novel strategy lessens dependency on fossil fuels alongside lowering energy expenses.

European nations with a history of district heating have taken the lead in reusing waste heat from data centers, including Denmark, Sweden, Latvia, and Lithuania. District heating networks in these countries make it easier to integrate waste heat into their existing systems. The supply of heated water from Amazon's local data center to the town of Tallaght in Ireland is an example of district heating on a smaller scale.

As fossil fuels remain the primary source of energy for networks around the world, there are still many other possibilities besides decarbonizing district heating. In line with sustainability ideals, data centers may help solve environmental problems by converting pollution into energy. The initiative also provides an opportunity for collaboration between many businesses and highlights the importance of pursuing innovative, environmentally friendly solutions for a more sustainable future.

4.2.2. Underwater data centers

As a creative way to lessen the environmental impact of conventional land-based data centers and increase the sustainability of the digital infrastructure, underwater data centers have recently gained popularity. Companies like Subsea are researching innovative ways to reduce CO2 emissions and boost internet efficiency by submerging data centers underwater (Gallagher, 2023). The ocean's chilly temperatures aid in naturally cooling the data center equipment, negating the need for the power-hungry cooling systems found in conventional data centers.



Additionally, to produce electricity, underwater data centers use renewable energy sources like tidal, wave, or wind power. The utilization of these renewable sources aids in reducing dependence on fossil fuels, thereby mitigating the environmental impact (Pernice & Scott, 2021). Underwater data centers have additional benefits in addition to their energy-efficient architecture. Communities near coastal areas may benefit from quicker and more dependable internet connectivity. The total internet speed, as well as responsiveness, are increased due to the lower latency in data delivery. Additionally, the installation of undersea data centers can free up priceless land that would otherwise be occupied by traditional data centers.

Underwater data centers have amazing possibilities; however, have drawbacks. In addition to taking environmental impact and the preservation of the marine ecology into account, maintenance and repairs call for specific methods and tools. In order to be sure, the idea of undersea data centers is a big step in the direction of greener, more sustainable digital infrastructure (Subsea7, 2023). These facilities could reduce CO2 emissions and improve the efficiency and greenness of the internet by utilizing the ocean's inherent cooling capabilities and renewable energy sources.

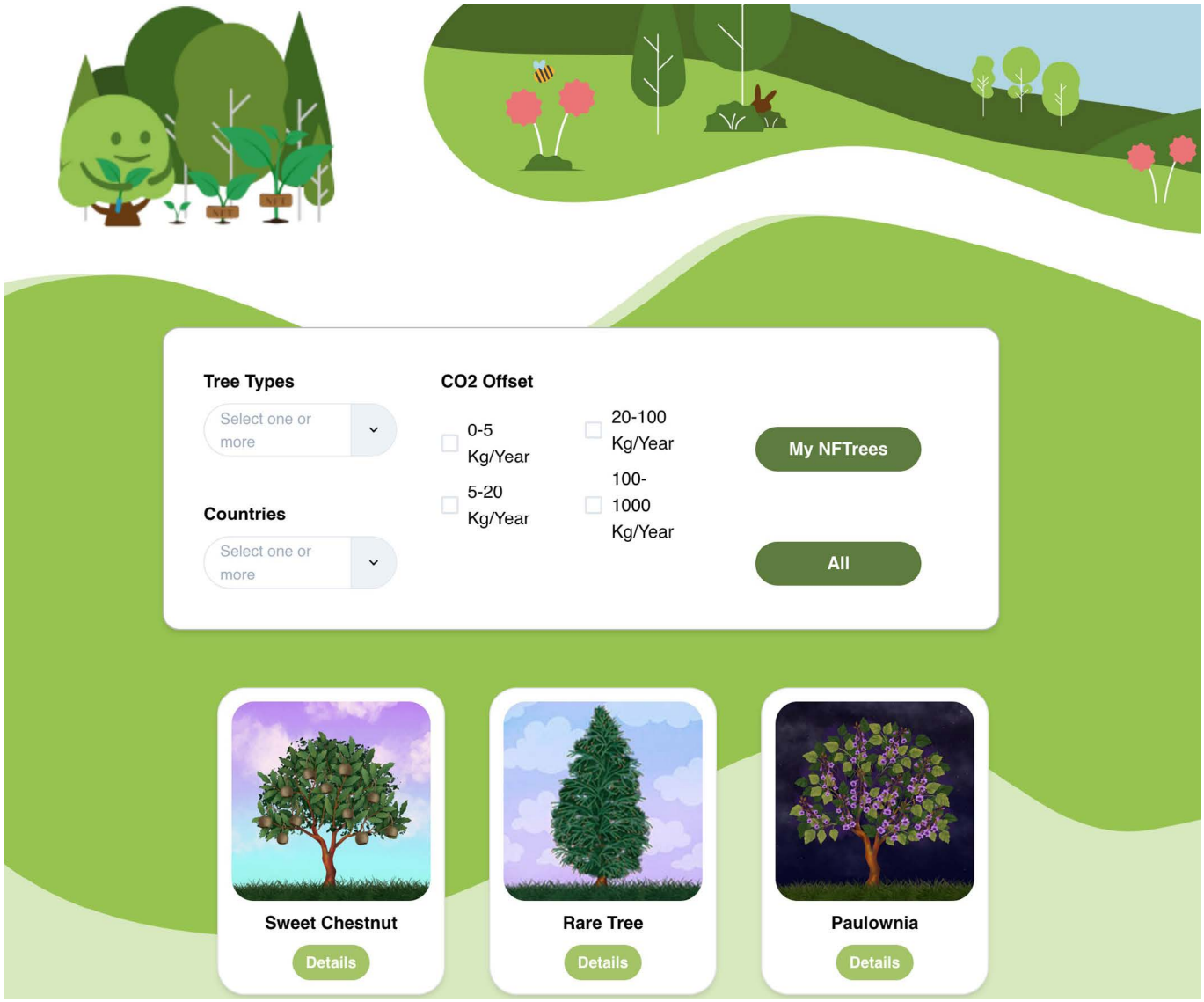
4.2.3. Carbon offsetting - a model for compensation

Primarily, by funding initiatives that lower or eliminate greenhouse gas emissions elsewhere, carbon offsetting is a strategy that enables people and companies to make up for their carbon emissions. Carbon Trade Exchange (CTX) and ClimateTrade are two prominent platforms in the area of carbon offsetting that provide cutting-edge carbon compensation models (Carbon Trade Exchange, 2023). A global marketplace called CTX makes it easier to buy and sell carbon offsets. It links purchasers, such as businesses or people wishing to reduce their carbon footprint, with a variety of global offset projects. The market for carbon offsets is made transparent and standardized by CTX, ensuring the validity and caliber of offsets.

On the other side, ClimateTrade is a platform that uses blockchain technology to build a traceable and transparent market for carbon offsetting. It makes it possible for organizations and people to figure out, monitor, and reduce their carbon footprint. The platform supports numerous programs like reforestation, renewable energy, and energy efficiency that help reduce emissions (ClimateTrade, 2023). Both CTX and ClimateTrade provide easy-to-use systems for carbon offsetting, enabling people and organizations to be accountable for their emissions. They can assist sustainable activities that directly lower global carbon emissions by funding certified offset schemes.

Furthermore, by offering financial support to initiatives that advance renewable energy, conservation, and sustainable behaviors, carbon offsetting plays a critical role in combating climate change (Kulakhmetova, 2022). Apart from that, it supports the shift to a low-carbon economy and enables people and businesses to take direct action toward carbon neutrality. Lowering emissions at the source should always be prioritized over carbon offsetting. Additionally, it should be utilized in conjunction with initiatives to reduce carbon footprints through the adoption of sustainable practices, renewable energy adoption, and energy efficiency measures.

4.2.4. Treedefi: Empowering the ESG crypto space



Through the incorporation of sustainable and environmentally friendly methods into the blockchain sector, Treedefi is a platform that seeks to strengthen the Environmental, Social, and Governance (ESG) crypto space. Treedefi enables users to invest in sustainable projects and receive incentives through decentralized finance (DeFi) systems, with a focus on tree planting and reforestation initiatives (Treedefi, 2023).

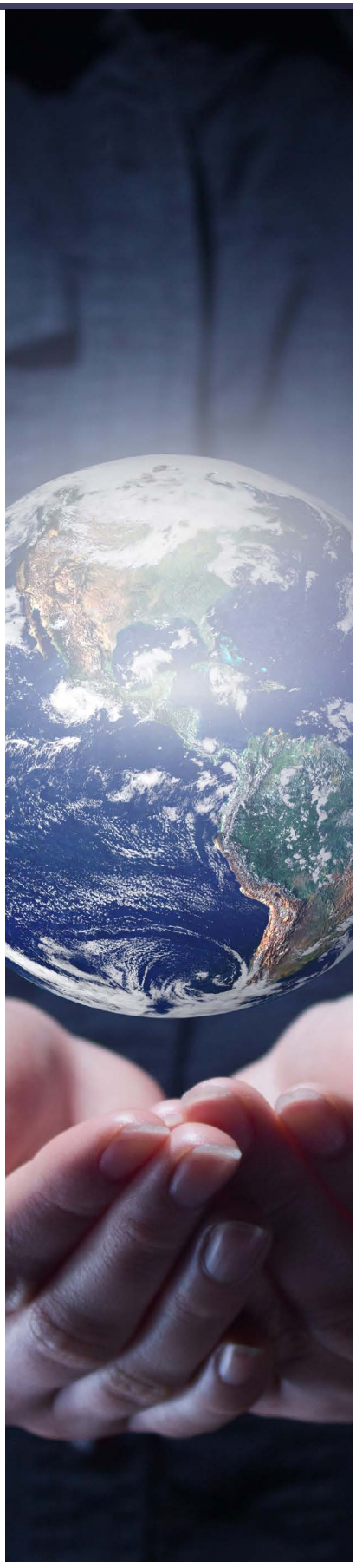
Treedefi encourages ethical and significant investments that help to preserve the environment by bridging the gap between cryptocurrencies and environmental sustainability. Through its platform, Treedefi gives users a special chance to match their cryptocurrency investments with their sustainability beliefs and have a beneficial impact on the environment.

4.3. The role of designers

4.3.1. Navigating conflicts and driving changes

Driving changes that conflict with economic goals, enjoyment, lifestyle, and convenience can be difficult. When it comes to engaging in pollution reduction, there are inherent conflicts between business profitability and user convenience. Up-front costs may impact the immediate profitability of pollution reduction investments (Negrea et al., 2019). Positively, there are opportunities for strategies that support transformations for the future. Adopting sustainable technologies and practices can eventually result in cost savings, enhanced consumer loyalty, and reputational benefits. Companies may stand out from the competition and draw in environmentally mindful customers that value sustainable goods and services by implementing eco-friendly initiatives.

In a similar fashion, it may prove difficult for individuals to give up convenience and lifestyle preferences (Lee & Lee, 2020). Adopting responsible consumer behaviors often requires modifications to routines and habits that may cause disruptions. Despite these shortcomings, the aforementioned global progress has demonstrated that people and businesses are increasingly motivated to find innovative solutions to environmental problems. In order to maintain the momentum of change and foster a culture of responsibility and determination, continuous motivation and design for raising awareness are key components.



4.3.2. A wake-up call: Design for reflection

The awareness of responsible information and energy consumption among users is a major task for designers. The role of designers refers to the entire process of creating a digital product, including product designers, information architects, software engineers, and other stakeholders.

Focusing on “Explain-ability” is one strategy they may employ to help people understand clearly how their actions affect the environment and how much energy it takes to run digital goods and services (Bonneau & Aroles, 2021). Designers might include visual indications in user interfaces, such as data consumption meters or energy usage indicators. Users can grasp the effects of their interactions and make wise decisions with the aid of these visual representations.

Designers may induce thoughtful reflection and motivate people to adopt more sustainable digital habits by bringing awareness in a user-friendly and entertaining way. Strategic designs can trigger users to make eco-friendly decisions by rewarding them for responsible data and energy consumption, for instance, by reaching specific efficiency milestones or lowering their environmental impact. Designers can incorporate engaging training materials or onboarding procedures that inform consumers of the value of responsible consumption. This can entail detailing the negative effects of excessive data usage or emphasizing the advantages of energy-saving measures (Vrana & Singh, 2021).

4.3.3. The prospects of reducing digital pollution

At present, the detrimental effects of digital pollution are being explored and **actions are in progress** by different organizations to address these concerns. Governments and businesses are highlighting the need for digital pollution to be regulated, and are taking initiatives to reduce its impact on the environment and foster responsible consumption and production.

Apart from corporate efforts with **proper transparency**, awareness among individuals will lead to **increased responsibilities** in a clear manner. Individuals can make small changes to their lifestyles and contribute to the cause. This includes reducing the use of digital gadgets, selecting data-efficient services, recycling e-waste, and being mindful of their carbon footprint. **Explainability** of existing progress to unaware individuals, focusing on **continuous development prospects**, and designing a new digital lifestyle that reduces pollution are all important paradigms.

This **new digital lifestyle** should support practices such as sustainable computing, energy conservation, and circular resources. These efforts can help reduce the environmental impact of digital advancements. Finally, more individuals can spread awareness and educate others on sustainability measures that reduce pollution and **protect the future.**

Considering the following roadmap, a clear **prospect for reducing digital pollution** can be achieved:

The prospects of reducing digital pollution: Roadmap

A strategic plan to diminish digital technology's environmental impact

- **Protect the future**
  Sustainability measures to conserve the environment
- **New digital lifestyle**
  Responsible living and consumption habits
- **Continuous prospects**
  Developing strategies to counteract pollution harm
- **Transparency + Responsibilities + Explainability**
- **Actions in progress**
  The effects and progress of digital pollution

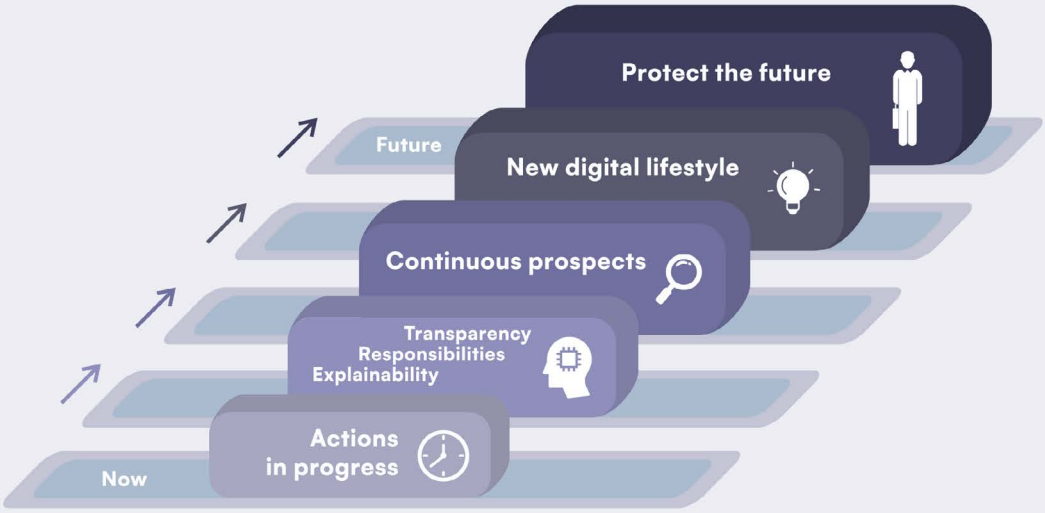


Figure 4.3.3: The prospects of reducing digital pollution: Roadmap

5. Conclusion and future highlights

5.1. Uniting for a greener future

5.2. Revolution of the digital lifestyle

5.1. Uniting for a greener future

On the basis of the overall assessment, it can be concluded that there are considerable opportunities for reducing pollution in our digital lifestyle, providing a road to a greener future. Through the combined efforts of key stakeholders, including **Designers, Corporations, Consumers, Marketers, Product users, and Developers,** the discussed topics can create significant change and have a positive influence. The joint efforts are driven by five end goals: **Net Zero, Carbon neutrality, Responsible consumption, Energy efficiency, and Circular economy.** These objectives represent the achievements that will help create a more responsible and environmentally friendly digital ecosystem.

Each stakeholder must play a crucial part in accomplishing these objectives. Through intuitive interfaces and visual clues, designers may increase awareness and encourage ethical behavior. Apart from that, by implementing sustainable practices across their operations and spearheading industry-wide sustainability efforts, corporations may set the bar high for others to follow. Through their purchasing decisions, support for sustainable products, and responsible data and energy usage, consumers have the ability to create change.

In addition, the research highlighted that designs can inspire and motivate users to make eco-friendly decisions by rewarding them for responsible data and energy consumption, such as reaching specific efficiency milestones or lowering their environmental impact. Furthermore, the research further demonstrated that a new digital lifestyle that cuts pollution and safeguards the future will be made possible by this united effort, ensuring a sustainable and resilient world for future generations.

Five end goals for a greener future:

1. **Net Zero:** Achieving a balance between the amount of GHG released and removed.
2. **Carbon neutrality:** In order to achieve a net-zero carbon footprint, carbon emissions must be offset.
3. **Responsible consumption:** Practice of wise, conscientious, and sustainable consumption.
4. **Energy efficiency:** Increasing the energy efficiency of digital goods and services.
5. **Circular economy:** Reduce, recycle and reuse are keys to a circular economy paradigm.

Key stakeholders and their roles in achieving the end goals through coordinated efforts:

Designers: Designers are essential in creating products that place a high priority on energy conservation and ethical data handling. They should concentrate on creating user-friendly interfaces, adding visual indicators of data and energy use, and encouraging ethical user conduct.
Actions in progress: Adding indicators for energy and data use is currently being done.
Actions to take: Designing user-friendly interfaces that encourage ethical user behavior.

Corporations: Primarily, it is up to corporations to implement sustainable practices across the board. They ought to put an emphasis on building energy-efficient infrastructure, make investments in renewable energy sources, cut down on waste, and implement ethical data management procedures. Corporations can use their power to promote sustainability efforts at the sectoral level.
Actions in progress: Investments in sustainable practices and renewable energy sources are now being made.
Actions to take: Reducing waste, embracing circular economy concepts, and spearheading industry-wide programs.

Consumers: Through their decisions and actions, consumers have the ability to influence change. They should adopt responsible consumption habits, such as reducing data usage, choosing energy-efficient technology, and backing companies that put sustainability first. Additionally, consumers can promote openness and environmental responsibility in goods and services.
Actions in progress: Adopting responsible consumption habits and supporting sustainable brands.
Actions to take: Reduce data usage, choose energy-efficient technology, and support open and eco-friendly products.

Marketers: Marketers are essential in fostering informed decision-making and responsible consumption. They ought to emphasize the advantages that sustainable goods and services provide for the environment, inform customers about available energy-saving choices, and promote responsible usage. In order to empower customers, marketers should steer clear of greenwashing and offer truthful information.
Actions in progress: Highlighting the advantages of sustainable products for the environment.
Actions to take: Consumer education regarding energy-efficient options and avoiding greenwashing.

Product users: Digital product users are duty-bound to utilize technology wisely and effectively. They should be aware of how much power and data they consume, make use of features that save energy, and periodically check and erase superfluous data. Users can offer developers and designers comments to make items more environmentally friendly.
Actions in progress: Utilizing energy-saving features and analyzing unneeded data.
Actions to take: Giving input to help products be more sustainable and encouraging ethical usage.

Developers: In order to create software that is energy-efficient and optimizes digital products, developers are essential. They should build features that support responsible usage, use data compression techniques, and give priority to energy efficiency in coding. Designers and developers can work together to create interfaces that foster sustainability.
Actions in progress: Prioritizing energy efficiency in coding and optimizing digital products.
Actions to take: Using data compression methods and working with designers to develop eco-friendly products.

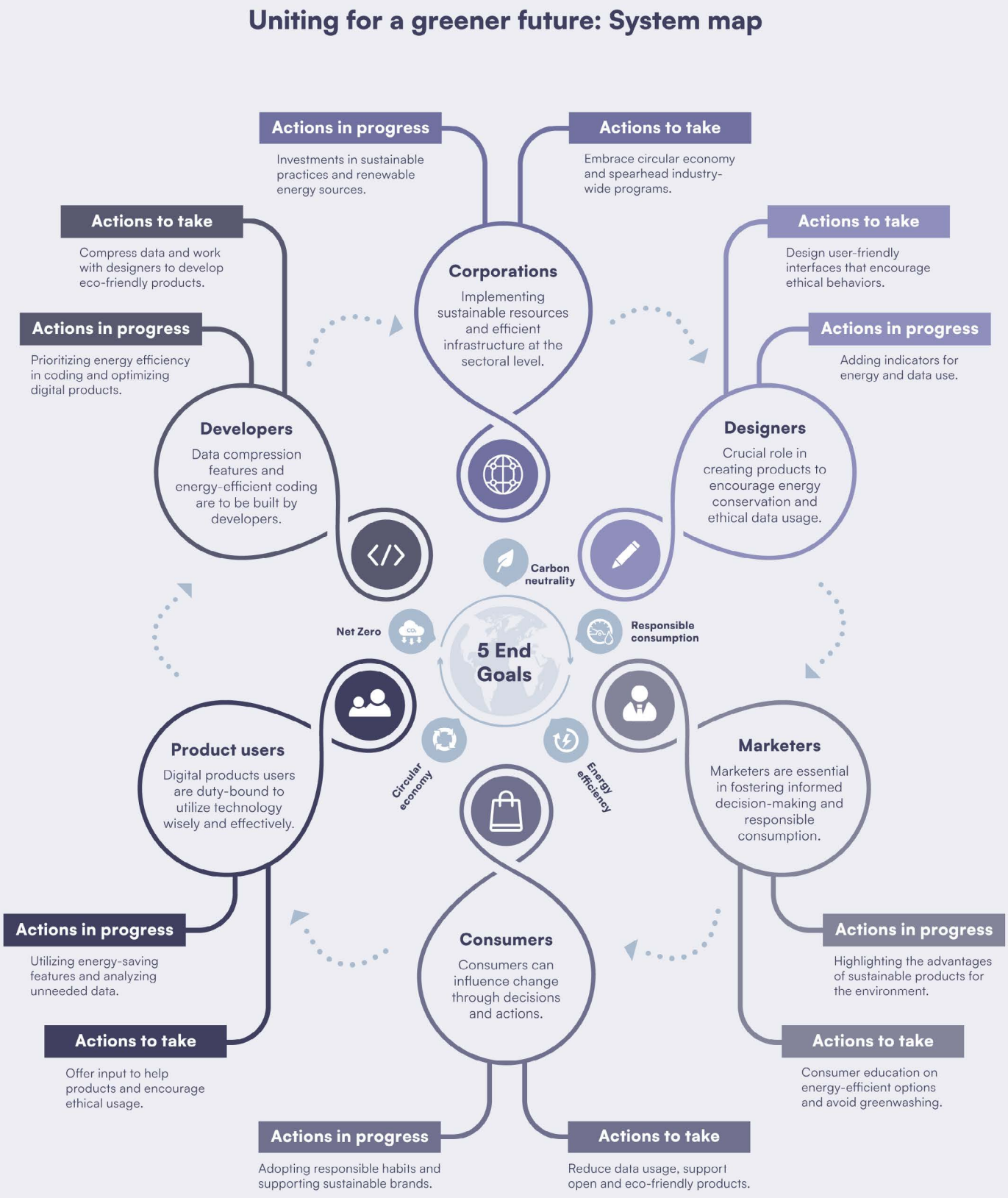


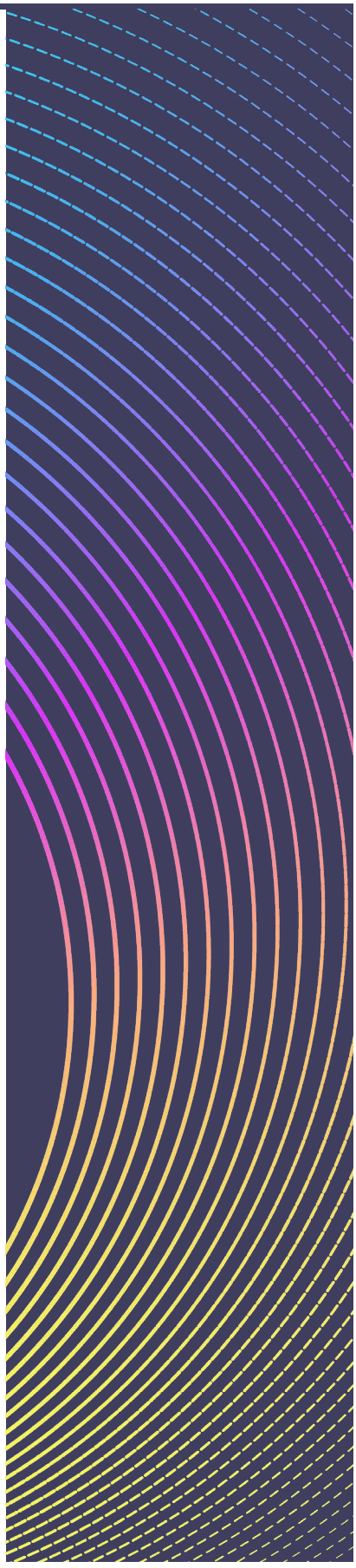
Figure 5.1: Uniting for a greener future: System map

5.2. Revolution of the digital lifestyle

The ideal future will be one when the aforementioned key stakeholders actively take action to reduce digital pollution and always strategize to achieve further progress.

Implementing motivational psychology, increasing investments in renewable energy sources, promoting responsible consumption, highlighting the core advantages for the environment, leveraging energy-saving features, and optimizing code for energy efficiency are a few of these efforts. Transparency, taking responsibility, and explaining actions are key components of accomplishing the end goals. Stakeholders may empower more people in the digital age to make educated decisions and adopt sustainable behaviors. This is done by clearly outlining the environmental impact of digital products and services.

Based on the context discussed, individuals can transition to a revolutionized digital lifestyle that reduces pollution and protects the future. Collaboration, creativity, and a shared commitment to building a greener world are necessary on the path to eliminating digital pollution. In order to seek solutions for these issues, diagnosing data usage, reconsidering the necessity of auto-play enablement on video streaming platforms, compressing mobile web experiences, and emphasizing the drive to reduce excessive data usage must be considered. These measures will enable a thorough knowledge of the nature of responsible consumerism, which is much needed in the contemporary landscape to ensure a better future. Moreover, corporations can apply strategies to enable their employees and users to adhere to sustainable consumption aspects for better outcomes. Overall, a transition towards a sustainable future can be achieved with a determined mindset.



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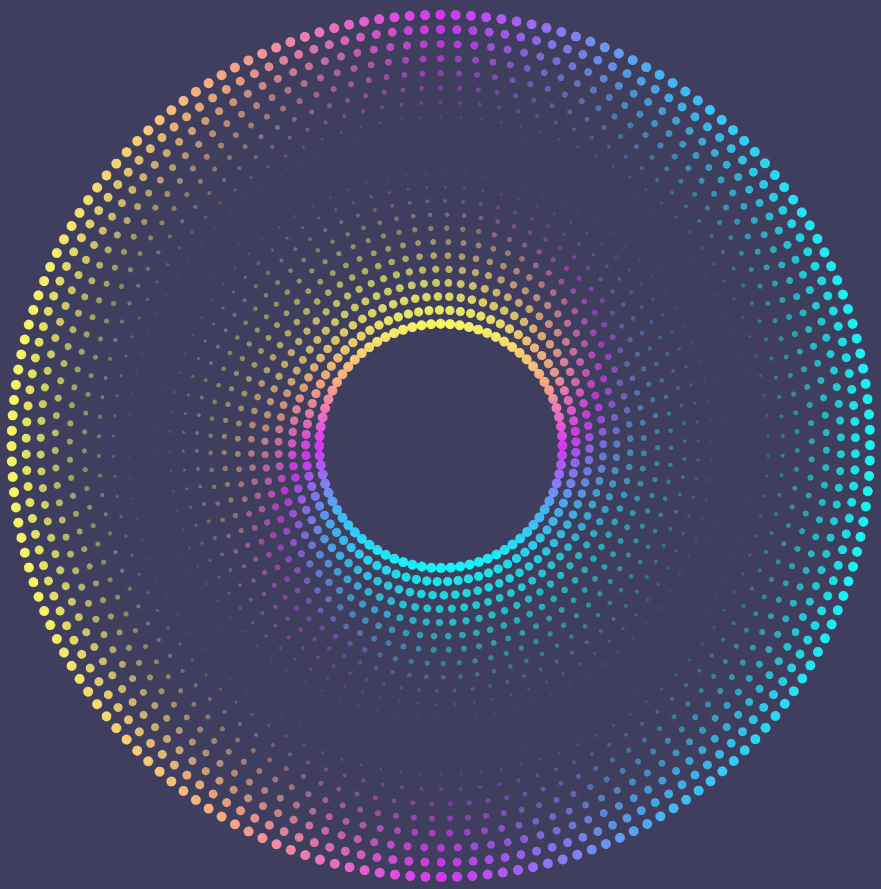

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