The Importance of Individual Consumption Habits in ICT Emissions

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1 Overview of ICT Emissions and Relevant Challenges

Carbon emissions from the Information and Communication Technology (ICT) sector have steadily increased over the past two decades, with 2020 estimates attributing 800 to 2,300 megatons of CO2 to personal device usage, networks, and data centers, up from an estimated 630 megatons in 2014.[1] A primary focus of our work has been centered around individual activity as a contributor to the rise in ICT emissions through online communications and music and video streaming. Though the per capita effects of each email and hour of streaming continue to be fairly miniscule, the cultural shift towards remote work and a heightened reliance on digital avenues for learning have greatly increased the volume of internet usage, with Telefonia reporting a 45% increase in data traffic in 2020 as a result of the pandemic.[2] With internet connectivity and device usage trends continuing to persist upwards through 2022, there is now a pressing need to address the environmental impact of each individual's digital footprint, and how they may seek to reduce the personal emissions from their daily lives.[3]

The environmental cost of manufacturing new devices has also proven to be staggering, and has historically represented a disproportionately large share of ICT emissions, with the sector responsible for computer and electronic products accounting for 82.83% of the global ICT carbon footprint in 2014.[4] Despite a decline in year over year shipments in smartphones, personal device ownership in OECD countries continues to rise, driving the global production and shipment of an estimated 300.3 million units in the fourth quarter of 2022 alone.[5] Fashion choices and phone replacement contracts have also played a role in the growing appetite for new devices, with the average smartphone lifespan declining from three years in 2014 to two years in 2017.[6] The annual demand and manufacturing trends for new phones have shown few signs of decline, and are expected to continue upwards in the absence of shifts in domestic legislation and cultural habits amongst consumers.[7]

2 Video Streaming Accounted for Over 65% of Global Internet Traffic in 2022[8]

Following the COVID lockdowns and the transition to remote work and learning, upstream internet traffic from virtual conferencing and video streaming rose almost immediately, reaching a monthly growth rate of 123.18% from March to April

[1] Freitag, Charlotte, et al. “The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations” 2021

[2] Stephens, Andie, et al. “Carbon impact of video streaming” 2021; Walkley, Sarah. “The Carbon Cost of an Email: Update!” 2022

[3] International Telecommunication Union. “Digital trends in the Americas region 2021” 2021

[4] Dong, Kangyin, Jianda Wang, Farhad Taghizadeh-Hesary. “Assessing the embodied CO2 emissions of ICT industry and its mitigation pathways under sustainable development: A global case” 2022

[5] Popal, Nabila, Ryan Reith. “Smartphone Market Share” 2022

[6] Suckling, James, Jacquetta Lee. “Redefining scope: the true environmental impact of smartphones?” 2015

[7] Freitag, Charlotte. “The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations” 2021

[8] Sandvine. “The Global Internet Phenomena Report” 2023

2020.[9] Despite the loosening of Covid restrictions and a return to relative normalcy, internet traffic and streaming trends have not returned to pre pandemic levels and have maintained a high annual growth rate through 2022.[10] With each hour-long video estimated to contribute 55 grams of CO2 to total emissions, more than double the carbon output of driving a car 100 meters, the dramatic increase in traffic represents the continuation of a growing concern for ICT emissions and spotlights the importance of monitoring environmental impacts from the technology that has become increasingly ingrained in everyday life.[11]

Digital communications have also played a crucial role in enabling the transition to remote platforms, with emails and lengthy conference calls taking the place of interactions that were largely held in person in the pre-pandemic era. Though seemingly mundane, the carbon cost of an email is very tangible, and has been estimated to reach a high of 26 grams of emissions through electricity and network usage.[12] As the number of emails per year continued to rise over the past decade, global emails were estimated to account for 150 million tons of CO2 in 2019, representing a minor but growing share of the planet's total carbon footprint.[13] Conference calls, which have soared in popularity with the use of Zoom and WebEx, are estimated to emit 157 grams of CO2 in just one hour, nearly triple the carbon cost of an hour of video streaming.[14]

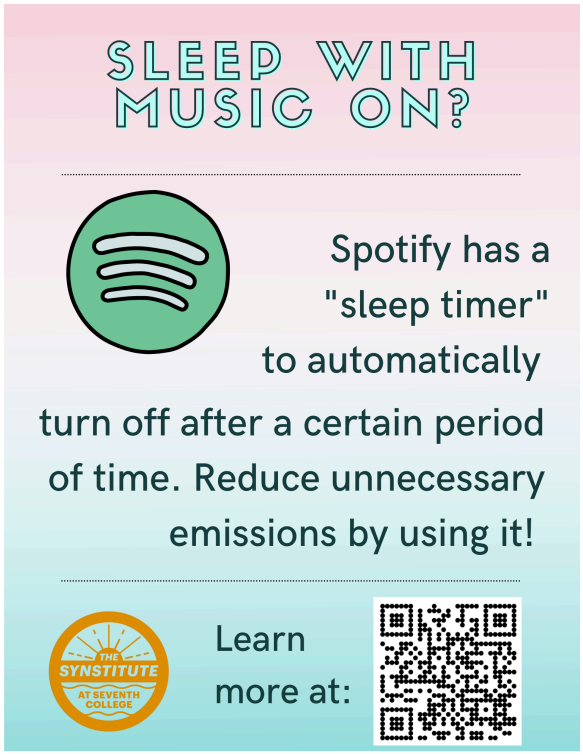
One of the central focuses of our project was to encourage behavioral changes in email usage and the streaming of online content through infographics. In an effort to impact the total volume of emails sent and received each day and the subsequent emissions, many of the flyers recommended the filtering of any spam emails and unwanted newsletter subscriptions.

Changes to video streaming habits and conference call habits can also have significant and tangible effects on global emissions. Youtube and Netflix, which combined to total 26% of global internet traffic during the pandemic lockdowns, are often used as white noise in the background as the user is working or falling asleep.[15] By simply turning off autoplay or limiting consumption when the user is not actively engaged, each individual can choose to avoid the 55 grams of carbon that would have otherwise been emitted with each hour.[16] This same concept can be applied to music streaming services, which are often active throughout the night while the listener is asleep. The Spotify sleep timer, one of the featured subjects of the infographics, can easily prevent unnecessary use and emissions, provided that the user is aware of the feature and its potential relevance to their carbon footprint.

The potential impact of these relatively simple actions speaks to the importance of awareness campaigns that can encourage a broader concern for personal carbon emissions and the actions that each individual can take.

[9] Sandvine. "The Global Internet Phenomena Report COVID-19 Spotlight" 2020
[10] Sandvine. "The Global Internet Phenomena Report" 2023
[11] Stephens, Andie, et al. "Carbon impact of video streaming" 2021
[12] Walkley, Sarah. "The Carbon Cost of an Email: Update!" 2022
[13] Walkley.
[14] Obringer, Renee, et al. "The overlooked environmental footprint of increasing Internet use" 2020
[15] Sandvine. "The Global Internet Phenomena Report COVID-19 Spotlight" 2020
[16] Stephens, Andie, et al. "Carbon impact of video streaming" 2021

Sample infographics developed for campus wide distribution are provided below, and include QR codes that link to an optional feedback form for the public.



3 The Manufacturing Industry is A Key Contributor to ICT Emissions

Though end user emissions play a substantial role in the ICT sector's carbon footprint, the potential impact of individual consumption changes are severely limited by the amount of emissions already generated in the manufacturing process. This especially holds true in the smartphone market, where the flagship Apple and Samsung phones generate over 80% of their total lifecycle emissions during the production stage alone.[17] Even when an individual uses Samsung's S23+ for three years, their activity can only account for 9.9% of the total emissions generated by the device.[18]

In an effort to counteract the consumer trends driving yearly increases in phone demand and manufacturing, our group developed a classroom lesson plan that sought to inform the individual decision making process involved in the purchase of a new phone. Throughout the half hour class, instructor-led discussions and group research sessions encouraged each participant to consider their own ICT emissions, and how their device consumption habits have ultimately contributed to that total. Practical actions were also emphasized, and students were exposed to the environmental benefits of extending device lifespans and referring to repair services as a primary solution to sluggish performance and physical damage.

If similar educational efforts for consumers were brought to scale, even miniscule shifts in purchasing and repair habits could result in a meaningful reduction in ICT emissions,

[17] Apple. "iPhone 14 Pro Product Environmental Report" 2022; Samsung. "Product Environmental Report" 2023
[18] Samsung. "Product Environmental Report, Galaxy S23+" 2023

with the European Environmental Bureau equating a one year increase in the average EU cell phone lifespan with a 2.1 megaton reduction in annual CO2 emissions, “the equivalent of taking over a million cars off the roads.”[19]

4 Semiconductor Fabrication

Manufacturers of semiconductors, which are the backbone of all information technology, have burst onto the scene as some of the most important geopolitical entities in recent years as their products have become more sophisticated and more important for economic and national security. The manufacturers' carbon emissions have kept pace with their importance, with some larger manufacturers like the Taiwan Semiconductor Manufacturing Company (TSMC) edging out legacy car manufacturing giants like General Motors (GM).[20]

Chip production requires energy intensive machinery which constitutes a vast majority of the emissions of the production process. Manufacturers are constantly trying to improve their energy efficiency to lower costs, but the majority of reduction in net emissions these companies achieve currently comes from the purchasing of Renewable Energy Credits (RECs) simply because their plants are not connected to green energy grids.[21]

Countries like the U.S have stricter regulations on emissions, cleaner energy grids, and more open markets for RECs. Most Chinese semiconductor companies don’t even report their emissions publicly.[22] It might not only be in the geopolitical interest of the U.S, but in the interests of fighting climate change to try to establish more of the world's semiconductor manufacturing locally. Offering incentives, like the subsidies the Biden administration is currently pursuing and, in light of the recent construction holdups in building new fabrication plants, cutting red tape in construction would be good moves to further both of these interests.

This industry is only expected to grow as the consumer base for chip utilizing technology expands, and the demand for more sophisticated chips increases with the introduction of new technologies, like AI. Semiconductor production is one of the leading sources of emissions in ICT, with semiconductor production's percentage of global electricity demand expected to grow to 20% over the next decade.[21] Controlling this sector's emissions is going to be an important part of the fight against climate change.

5 Lesson Plan

This research we compiled for this project was scarce and scattered across the internet. With the difficulty it took to find information on this subject, our project focused on compiling the research to educate other people. We created a 30-minute lesson plan with the goal of sharing our findings with students. We also wanted to see if there was public interest in the topic, and get feedback on our project. The lesson plan consisted of 3 main parts: Introduction to the topic of Digital Carbon Footprint, Sharing our research, Group Activity.

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[19] Zuloaga, Francisco, et al. “EEB (2019) Coolproducts don’t cost the earth - full report” 2019

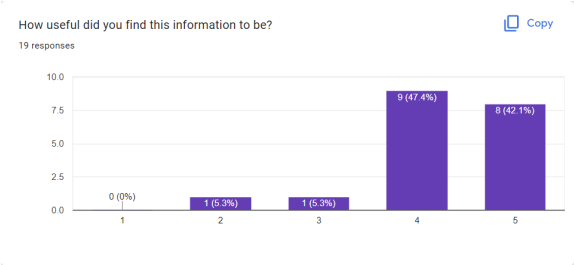
[20] Bloomberg. “The Chip Industry Has a Problem With Its Giant Carbon Footprint” 2021

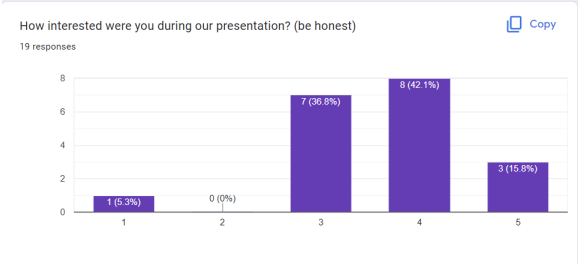
[21] Mckinsey & Company. “Sustainability in semiconductor operations: Toward net-zero production” 2022

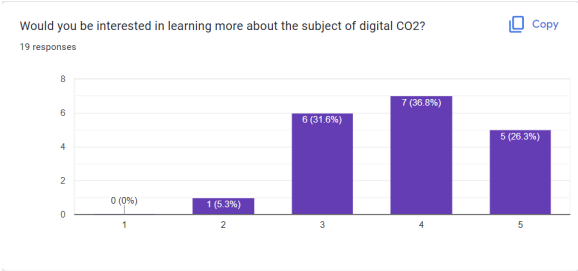
In our introduction to the topic of digital carbon emissions, we explained where digital carbon emissions come from and looked at the biggest emission contributors. After our introduction we shared our group's compiled research and shared useful statistics covering planned obsolescence and mindful internet usage.
After defining important terms and sharing our research, we had the class do their own mini-research activity with their partners. In small groups, the students did research into ways that they can reduce their own digital carbon footprint. We then came together as a class and compiled a list of actions that we can take to start making a change. The goal of this activity is to have students practice doing their own research and get them thinking about what they can do to help.

6 Results

After our presentation, we collected data from the students in the form of a survey. When asked, "How useful did you find this information to be?" on a scale from 1-5, the average was 4.26/5. When asked, "How interested were you during our presentation?" The results averaged 3.63/5. And when asked, "Would you be interested in learning more about the subject of digital CO2?" the results averaged a 3.84/5.







From this data, we can see that participants found our presentation quite useful and showed some interest in learning more. During our presentation, many participants brought up topics that they themselves showed interest in. During the group activity, one group researched the impact of online shopping and asked us if we had more information to share with them.

Unfortunately we weren't able to answer all of their questions, but we recommended that the student pursue the subject further if interested. This shows promise for future students who wish to continue this project. There are a lot of topics yet to be covered and enough public interest to warrant continued research.

7 Future Plans

The subject of digital CO_2 emissions is vast. There is much more research to be done and many sub-topics to dive into. When speaking to the students we lectured, many of them brought up topics that they themselves were interested in that we had not explored. Any future groups that wish to

continue our research have a plethora of interesting topics to pursue, such as online shopping, AI, or continued research into the topics we explored above. Advice that future groups should head is that research into this subject is difficult as many sources lack credibility and not many people have attempted to compile information on the subject of carbon emissions from ICT. That's what the Synstitute is for!

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