RESEARCH ARTICLE

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Survey on Carbon Dioxide Emissions Through Email Conversion

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Abstract

In today's scenario emissions of carbon dioxide and methane areca increasing day by day, leading to climate change. The aim of this paper is to explain carbon dioxide emissions through e-mail conversion. As an average spam email, a standard email, and an email with 'long attachments' emits 0.3g CO_2e (carbon dioxide equivalent), 4g CO_2e and 50g CO_2e, respectively. The number of emails received by a common office worker is 121 and half of them are spam. The carbon footprint of emails received in a day is similar to 1,652 g CO_2e. And those one year- received emails emit 0.6 tons of carbon dioxide. The carbon footprint of an Indian's entire year is around 1.5 tons CO_2e. So, three average workplace staff members yearly receive emails to exceed their carbon footprint for all the activities of another human for a year. An email with attachments releases 50g CO_2e, that is an equivalent quantity as if one had used 5 plastic bags. So, overall, this paper shows how much carbon dioxide is emitted by an e-mail and how it works.

Keywords: *Arpanet, Carbon dioxide, Climate change, CO_2, E-mail, Emissions.*

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Introduction

These days India is becoming digital, which has led to an increase in the number of emails. People are becoming more interested in online shopping, reading newspapers, articles, different apps and online games, etc. This leads to an increment in emails which leads to an increase in the amount of carbon dioxide in the atmosphere. An increase in the production of CO2, a greenhouse gas, means an increase in the greenhouse effect and global warming leads to climate change.

This paper is divided into 6 sections: (1) History of carbon dioxide emissions; (2) Global emissions of carbon dioxide in 1850-2019; (3) Asia became highest emitter of CO_2. These three sections give a brief idea about emissions of carbon dioxide by different countries from 1850 to present time. (4) History of email and its pros and cons, explains

popular, and its advantages to present time. (5) Outcome of other survey, explain a survey carried out in the UK and its results. (6) Prediction of carbon dioxide emissions through email conversion in text and number form, explains how much amount of carbon dioxide is emitted through email conversion.

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History of Carbon Dioxide Emissions

Carbon dioxide (CO_2) has existed in the air since our globe was formed from a hot gases ball due to the detonation of a large star about five billion years ago. At that moment, the air was chiefly composed of nitrogen, carbon dioxide and

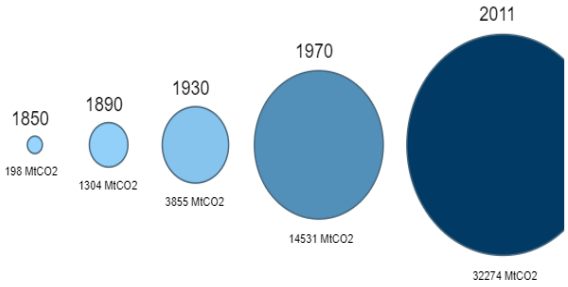

Figure 1: CO_2 global emissions between 1850-2011[2]

vapor, passing between fissures on the earth's surface. A very similar composition emerges from volcanic eruptions nowadays. As the planet cooled more, part of the water vapor converted into oceans through the process of condensation and dissolved much less carbon dioxide. However, it was still present in the atmosphere in massive amounts.[1]

CO_2 plays a vital role in climate as a result of it's one among the atmospheric "greenhouse" gases that keep the earth's surface concerning thirty-three degrees hotter than the -18 C temperature. They do this by allowing rays coming from the sun to reach the earth's surface easily, permitting them to heat the surface, and on the other hand, they absorb the heat that the earth emits. So, by this they house the heat in the air and enhance warming. Within the present climate, the foremost effective greenhouse gases are vapors, which is to blame for 2/3 of the whole warming, and carbon dioxide is around the fourth part.[1]

Currently, carbon dioxide emissions due to human activities are at their highest in our history. In fact, the world's global emissions were one hundred fifty times higher in 2011 than they were in 1850.[2]

Global Emission of Carbon Dioxide Between 1850-2011

Figure 1 explains how global emissions of carbon increased over a period of time. At the beginning of the year 1850, United Kingdom was the highest emitter of CO_2, with six times more emissions than United States, who was second highest emitter followed by France, Germany and European countries. In 2011, China, the United States, India, Russia, and Japan were prime five emitters. Whereas the United States again became the world's second-largest emitter, its emissions in 2011 were 266 times bigger than in 1850.

Between 1850 and 1960, the global has suffered an increase in emissions of carbon dioxide, mostly due to industrial development and increasing population. This development was little interrupted by momentous events, just like the economic crisis within the 1930s and also in 1945, the year when World War II ended. By the Fifties, there was rise in economy of China and Russia. So, both countries have also started seeing a rise in their emissions.

After 1960 some new development started and till 2005 United States remained highest carbon dioxide emitter. Also, Asian countries began to emerge.

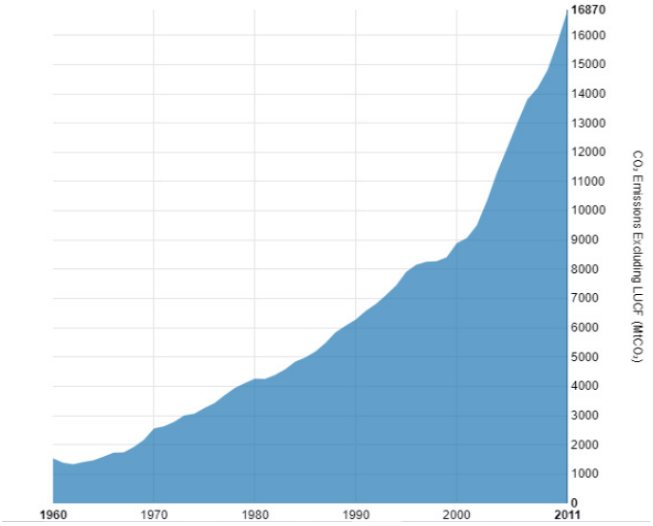

Figure 2: CO_2 emission in Asia between 1850-2011[2]

Asian Become Highest Emiiter of Co_2

In 1994, Asia had the biggest gross domestic product in the world. But already Asia became the biggest emitter of carbon dioxide in 1993 because of a fast economic process in China. In the past, Europe and North America were major emitters of carbon dioxide emissions globally. But by the end of 2011, Asia became top emitter as it emits more than half the ssnumber of global emissions.

Even developing countries' carbon dioxide emissions exceeded developed countries by the year 2007.[2]

Before 80-90 years, major emissions came from a small number of countries. But in 2011, the highest ten emitters (China, United States, European Union, India, Russian Federation, Japan, South Korea, Iran, Canada, Saudi Arabia) contributed 78% of the world's carbon dioxide emissions. Figure 3 shows the highest ten emitters for CO_2 emissions (land use modification and forestry are not included here).[3]

So, whenever there is an increase in economic growth, carbon dioxide is more emitted due to industrial activities which are not environmentally friendly.[2]

After 2011, global emissions of carbon dioxide remained increasing as a result, global carbon dioxide emissions were 36.2 billion tons in 2017.[3]

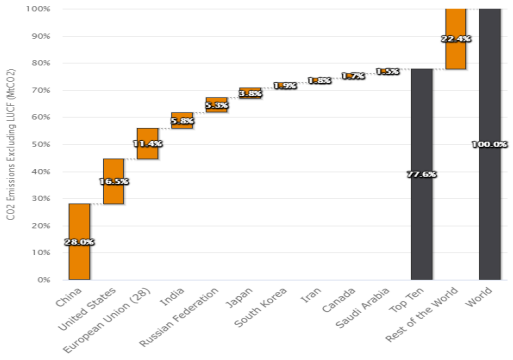

Figure 3: Top then emitters of CO_2,2011[2]

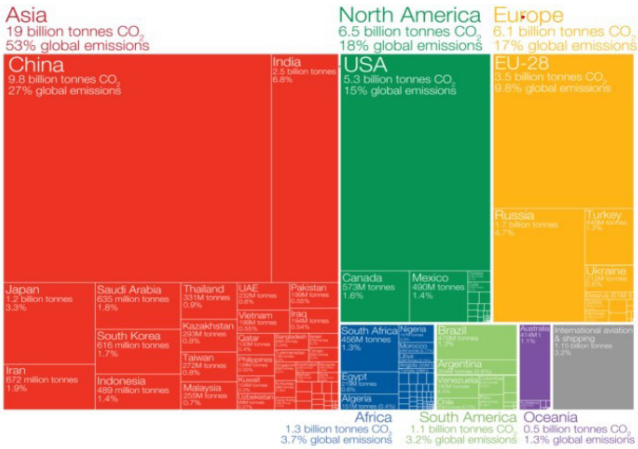

Figure 4: Global CO_2 emissions in 2017[4]

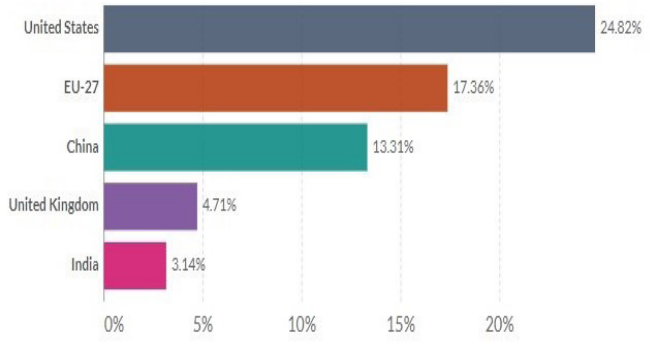

Figure 5: Share of global cumulative CO_2 emissions,2019[5]

Figure 4 shows that Asia emits 19 billion tons of carbon dioxide which is 53% of global emissions, and North America and Europe emit 6.5 billion tons and 6.1 billion tons, respectively; that is, 18% and 17% of global emissions, respectively.[4]

Figure 5 shows different countries share of cumulative global carbon dioxide emissions. Here, cumulative emissions are the sum of annual emissions from 1751 to 2019. When we compare global emissions on the basis of cumulative emissions, the United States, Europe, China, United Kingdom, India are top five countries and United States ranks first.[5]

There was a fall in carbon dioxide global emissions by -17% by early April 2020 compared to 2019 levels because of changes in surface transport due to the COVID-19 pandemic. Even emissions in individual countries fell by -26%.[8] In 2021 it looks like carbon dioxide emissions are again going to rise and could be the second biggest increase till now as carbon dioxide emissions are rising by 1.5 billion tons[6]

Figure 7 explains the amount of CO_2, CO, CH_4,that is 965.9Tg,22.5Tg,16.9Tg are emitted per year.[10] From total carbon dioxide emissions electricity generation contributes 35.5% and transport contributes 25.5%.[7]

Amid 2005 and 2013, greenhouse gas emissions from the manufacturing sector almost doubled. That is, from 315 million tons (MMT) to 623MMT. As per 2013 estimates, nearly 95% of manufacturing emissions in India came from 15

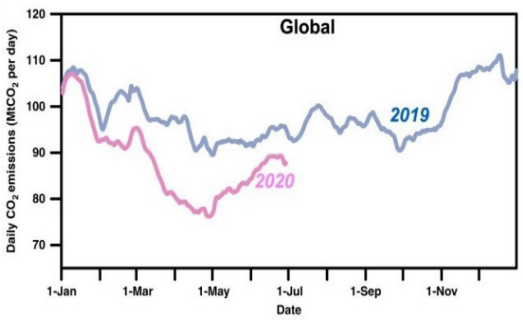

Figure 6: CO_2 emissions in 2019 and 2020[6]

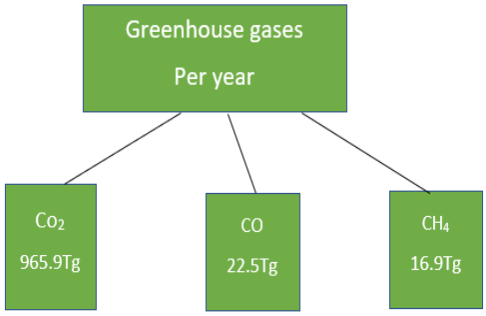

Figure 7: Flow chart of greenhouse gases emissions per year.[7]

states of the country. In which 80% of emissions are from 10 states: Gujarat, Odisha, Chhattisgarh, Jharkhand, Karnataka, Maharashtra, Andhra Pradesh, Rajasthan, West Bengal and Tamil Nadu.[8] Emissions from fuels like coal contribute 70% of total emissions. Emissions from coal have also increased from 171 million tons of carbon dioxide in 2005 to 385 million tons in 2013.[8]

Figure 9 explains emissions of carbon dioxide from different states of India through manufacturing sector and industries in 2013.[9]

Globally, generation of electricity and heat causes 42 % of the total carbon emissions followed by the manufacturing sector and road transportation contributing 19 and 17 %, respectively. The same trends are seen in India, where power and heat generation cause 51% of total emissions, followed by the industrial and transport sectors emitting 26% and 11%, respectively. This is because India is dependent on conventional sources for its energy needs.[7]

In 2020, along with crashing economy of India there was also a fall in carbon dioxide levels of the nation due lockdown. But, by the end 2021 India can face major rise in carbon levels as industries and transportation started again after lockdown.[7]

History of Email, and Its Pros and Cons

Email or electronic mail is used worldwide as a mode of communication. The very first(MIT),which only allowed users to share files and messages on university computers and users could see the message when they again login the

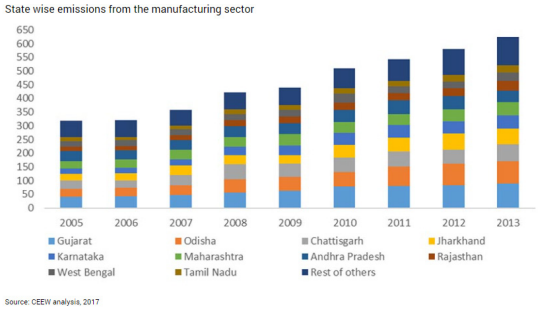

Figure 8: State wise emissions from the manufacturing sector[7]

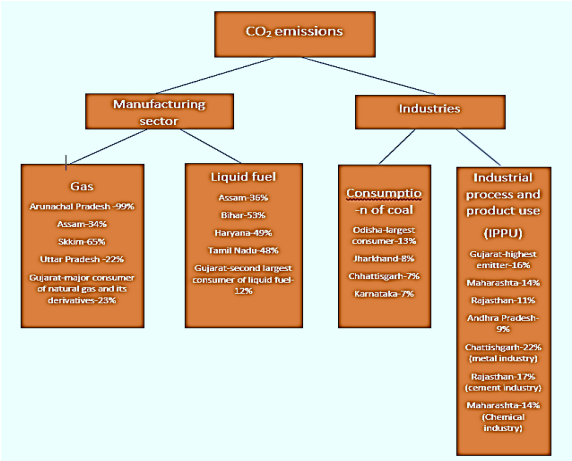

Figure 9: emission of carbon dioxide from states of India in 2013[9]

computer. In 1971, American computer programmer 'Ray Tomlinson' found version of email was invented in 1965 at Massachusetts Institute of Technology the method of sending email from one computer to another across the ARPANET, that is, 'Advanced Research Projects Agency Network' executed by the US defense department by using '@' sign. Which allowed to message certain targeted users on certain machines. Over time, networks started to develop, leading to the launch of webmail services like Microsoft mail, Hotmail, Yahoo, and lastly Gmail in 2004. During this period different types of emails also developed like in 1990 first spam mail was recorded and in 1992 email with attachments was founded after release of multipurpose internet mail extensions (Mime) protocol.[12]

In 2007, Apple's first iPhone was launched with an excess to email on the phone. And now email has become the most common and easy mode of communication for people,specially used by professions. This has led to an increase in the number of emails sent day by day.[12]

COMPARATIVEANALYSIS

Research done in United Kingdom in 2019 by conducting survey in 3,000 adults above 16 years between 14th November 2019 - 17th November 2019, reveals the United Kingdom was able to reduce its carbon emissions up to 16,433 tons.

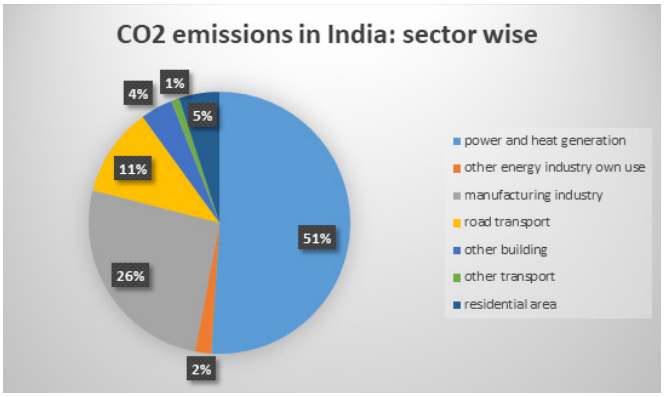

Figure 10: CO_2 emissions in India: sector wise

Table 1: Pros and Cons of email [12]

PROS	*CONS*
Easy to send, once individuals know how to do it.	Both sender and receiver will need an email address and access to a device with internet access in which it can be viewed.
Emails are free to send, as long as individuals have internet access.	If sender doesn't know receiver's email address than sender cannot send them message.
Emails are received quickly once they are sent.	Spam is a big problem.
Extra documents can be attached to email.	Email attachments can contain viruses.
Numerous copies of messages can be sent to other people also.	Sometimes individuals may have to wait for a reply.
You can see receipt or email is being opened. Messages can also be encrypted for confidential information.	There are email scams and it is easy to get fooled by them.

Only by sending one less 'thank you' email per person a day.[18] Here the number of adults is considered to be the whole population of the country. This research shows that almost 72% of the people don't know about the emissions of greenhouse gases due to the emails present in their mailbox. More than 64 million unnecessary emails are sent every day, which results in 23,475 tons of carbon dioxide per year being added to the nation's emissions. While, 49% of people reveal that they are sending unnecessary emails to people they know every single day, even if they are near to each other, contributing to United Kingdom population's carbon footprint.[13]

Table 2: Top 10 most 'unnecessary' emails sent.[13]

Top 10 most 'unnecessary' emails sent	
1. Thank you	6. Appreciated
2. Thanks	7. Have a good evening
3. Received	8. You too
4. Did you get/see this?	9. LOL
5. Have a good weekend	10. Cheers

StepsImplemented

Below are the common carbon footprints of various email[14]

A standard email: 4g CO_2e

An email with 'long attachments':50g CO_2e

CO_2e or carbon dioxide equivalent is standard unit for measuring carbon footprint.

Mike Berners Lee, professor at Lancaster University, England estimated above values 11 years ago by his expertise, in carbon metrics and sustainable food systems. He is also author of book 'There is No Planet B' and 'How Bad are Bananas – The Carbon Footprint of Everything[13] Charlotte Freitag, a carbon footprint expert at Small World Consulting, says 'the figures mention above might have gone up'. She explains that nowadays people are using bigger phones so greenhouse gas emission per message could be higher at present.[15] Value may not appear a lot of high at the start or more. However, after you add up the number of emails sent and received, one will realize what proportion of carbon is released by emails.

It is random calculation that, the common workplace employee receives approximately 121 emails per day, 60 spam emails per day,30 normal emails per day, 30.25 emails with attachments per day.[16]

So,

60 spam emails × 0.3gCO_2e =18 g CO_2e

30 normal emails × 4g CO_2e =120 g CO_2e

30 emails with attachments × 50GCO_2e =1500 g CO_2e

By this information, it takes simply 3 average workplace staff yearly received emails to exceed the carbon footprint for another human's activities for a year. An email with attachments releases 50g CO_2e, that's an equivalent quantity as if one had used 5 plastic carrier luggage.[17]

The process of writing an email needs electricity. It is not only used to run the computer, server, and routers but also used to manufacture the instrumentation. For the production of electricity, fuels like coal, oil, and gases are burned in power plants. This process also emits massive amounts of greenhouse gases, which additionally cause global climate change. Internet used for sending email and receiving also has a carbon footprint.

General Information Protection Regulation (GDPR) has proven reducing emails results in a decrease in carbon footprint. After the GENERAL PROTECTION REGULATION ACT in 2018, businesses are currently enforced to reach their audience and procure content before launching digital advertising. GDPR has decreased carbon dioxide emissions by 360 tons per day, equal to the carbon footprint of saving 260 hectares or 650,000 trees from deforestation. After EU legislation came into action, the amount of marketing emails in people's inboxes has decreased by 1.2 billion per day.

A one-megabyte email (= one MB) throughout its life cycle emits 20 grams of carbon dioxide equivalent to an old 60-watt lamp that lights up for 25 minutes. Twenty emails a day per user per year produce the equivalent CO_2 emissions of an automobile traveling thousands of kilometers.

In 2015 number of emails sent and received per day was more than 205 billion and this figure is expected to increase at an average annual rate of 3% and will become 246 billion by 2019. So around 2.4 million emails are sent every second and around 74 trillion emails are sent per year. Let us assume that all emails emit around 0.3g of carbon dioxide equivalent. The total carbon dioxide generated globally by emails should be 22 million metric tons of CO_2 annually. This is equal to the emissions of greenhouse gases by almost five million cars. If all emails emit 50g of carbon dioxide per email, then around four billion metric tons of carbon dioxide would be generated annually. This amount could be equal to the carbon dioxide emitted by 890 million cars annually.[18]

Conclusion

Everything incorporated with human life emits carbon dioxide; it doesn't matter how small it is. This also includes email. As mentioned before, the carbon footprint of a single email is negligible but when we calculate the amount of carbon dioxide it emits from the total number of emails per person per year, it is massive, and the bad news is it is increasing. This is a digital period and a complete boycott of email can't seem possible. But, on a personal basis we can do some things, like not sending unnecessary emails; unsubscribing to newspapers and magazines, which we don't read now; regularly cleaning and maintaining mailing lists, and, rather than adding attachments, add links to the files or websites. By this there are chances we can see a fall in emissions of carbon dioxide. As we can see 1 less email per person per day has reduced carbon dioxide emissions by many tons of carbon dioxide emissions yearly. By reducing emails, we should also try to decrease carbon emissions by other means. As climate change is becoming a global issue.

Futurework

"The average American has around 500 unread, most likely junk, emails. Assuming that each email contributes 0.3 grams of CO2 based on carbon emissions, we are dealing with 150 grams of extra carbon dioxide per U.S. citizen." as per The Good Planet. Also, the information we got from this paper, so

let's think about INDIA as many people who don't know about this and use bunch of email daily. Like sending "Thank You…" emails, Marketing, Forwarded email or any unnecessary emails. So, our future work is to know how many emails are received and sent daily, then we can know how much pollution we inadvertently spread. As well as we should know how produced CO_2 works in the environment. How email cycles produce email. How many years can it destroy the earth if carbon dioxide emits only from EMAIL! Considering Gujarat region. Using the concept of computer science "Machine Learning Predication Model", we can predict carbon dioxide produced by email conversations in Gujarat region (also of India) and its future losses from this scenario.

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