Quantify Carbon Emission for Employees Working from Home

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DOI: 10.29322/IJSRP.12.10.2022.p13036
http://dx.doi.org/10.29322/IJSRP.12.10.2022.p13036

Paper Received Date: 3rd September 2022
Paper Acceptance Date: 5th October 2022
Paper Publication Date: 13th October 2022

Abstract- This research paper is one of the first type of paper which mention about the methodology of quantifying the GHG emission while working from home. It can be very helpful for several companies who are still trying to figure out that how to quantify the carbon emission of working from home.

Index Terms- Carbon Emissions, Work from Home, COVID Impact, Global Warming, Methodology of Calculating Carbon emissions, Sustainability

I. INTRODUCTION

Coronavirus, which spotted in china and exceed its range to over all the countries around the world. The economic and social disruption caused by the COVID pandemic is devastating: tens of millions of people are at risk of falling into extreme poverty, while the number of undernourished people, currently estimated at nearly 690 million, could increase by up to 132 million by the end of the year.
As the Indian government announced the Lockdown of first phase for 21 days and then phase two till 3rd May to limit and trace the local spread of the novel coronavirus, it is badly impacting on economy.
The working methods of millions of us around the world changed dramatically after pandemic lockdowns went into effect globally in March of 2020. Suddenly, working from home (WFH), which was a relative uncommon practice, become essential to limit the spread of the virus; people who reported doing at least some WFH jumped from 5% to nearly 90% in the India and global offices of major tech companies between typical 2019 practices and April 2020.

Working from home CO2 emissions calculation methodologies are not much available and most of the companies are struggling to calculate their actual Carbon emission for the same. Many tech giant companies claimed that they noticed major reduction in carbon emissions as 95% of their employees working from home (WFH) because of Covid-19.

II. DOES REMOTE-WORKING IS ACTUALLY SAVING CARBON FOOTPRINT?

In order to confirm, it is very necessary to evaluate a firm's carbon footprint reduction due to remote-working arrangements. Some say's that it can be quantified very easily by subtracting a company's carbon footprint based on a hybrid working model, that is, combination of office- and remote-working, from the carbon footprint based on the traditional working model. This hybrid model needs to quantify this carbon footprint may serve as a new methodology tool for evaluation.
This proposed methodology for remote-working carbon emission quantification not only focus on India specific carbon emission but also measure individual carbon emission of the employees who work remotely in other parts of the world for a company.

III. CALCULATION OF CARBON EMISSIONS DUE TO WORK FROM HOME

Major tech companies have done the survey with a mix of work-from-home patterns by the support of survey firms and using extrapolated data and finalised the carbon emission numbers. In USA, a research and development organization focused on residential

energy consumption, to estimate the rebound effects on home electricity and energy use from remote work. For each of the responding participants, they looked at residential energy data over a full year. From this data, they concluded that for an average participant, working from home resulted in an increase in electricity usage of 6.34 kWh per day worked. To calculate a per employee number, they multiplied the average number of work-from-home days per month per employee by the expected uplift in home electricity consumption.
They then converted this to an annual number and multiplied by an EPA emissions conversion factor for electricity use to get to an annual estimate for additional emissions.
While some other companies calculated by using the average U.S. household energy per day times the IEA worldwide electricity conversion factor of 478.7 grams of CO2 per kWh.
While other company installed smart home monitors in the homes of three employee volunteers based in Texas and Florida in the United States. That data was used to construct a remote office baseline.
They estimated 84% reduction in carbon emissions per person compared to the emissions for the same person that would commute and work in an office building.
More or less every methodology works around in of course 4 parameters – Number of employees, Working Hours, Cooling or Heating Load, Machine load etc.
The best method is to conduct work from home survey for all the employees. Based on the results, estimate the number of employees working from home, their electricity consumption to calculate the average work from home emissions for India, and the rest of the world separately.

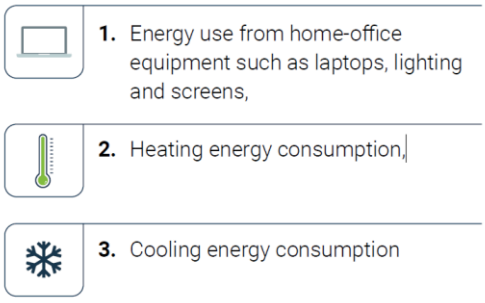
In India, there is not such established methodology available to calculate work from home emissions to date whereas such methodology exists outside India.
Therefore, one can use the Carbon Trust methodology for India and the "Anthesis" methodology for the rest of the world. This two are the best methods to calculate carbon emissions of a company appropriately.

A. India – Calculation of Carbon Emission

Carbon Trust has done the assessment of the impact of working on carbon savings and the longer-term effects on infrastructure services based on an impartial analysis of primary and secondary sources, including expert interviews.

It provides a working methodology to complement the Greenhouse Gas (GHG) Protocol for remote workers.

The carbon trust methodology calculate work from emissions in detail considering additional kWh load of laptop/desktop, monitor screen, light, kettle, printer and cooling load.



Appliance	Power Draw (watt)	Additional Operational Time per day (hours)	Additional energy Use (kWh/day)
Laptop/desktop	38.6	8	0.31
Computer Monitor Screen	30	8	0.24
Printer	0.5	7.9 hrs. Standby & 0.1 hrs. Printing	0.04
Office Light	15	8	0.12
Kettle	0.1kWh per 3min boil	6min	0.20
			0.91

Domestic energy calculation approach:

$$\text{additional kWh/day} \times \text{Electricity grid emission factor kgCO}_2\text{e/kWh}_{\text{by country}} \times \text{Days per year worked from home}_{\text{by scenario, by country}}$$

$$((kWh.home.day_{\text{by emissions source}} \times kgCO_2e.kWh_{\text{by emissions source}}) \times (1\text{-}\%\ \text{households with ability to heat single rooms})) + ((kWh.room.day_{\text{by emissions source}} \times kgCO_2e.kWh_{\text{by emissions source}}) \times (\%\ \text{households with ability to heat single rooms}))$$

$$(\text{Average AC kW/hr} \times 4\ \text{hours per day}) \times (\text{Number of days worked from home}_{\text{by scenario, by country}} \times 50\%\ \text{cooling season days per year})$$

Company has the data of percentage of employees worked from home during pandemic time. Then, calculate using above methodology to calculate actual carbon emissions. Note that you need to consider the rest of employee travelled to office, let's say 10%, this carbon emission due to employee commute will be calculated separately.

B. Global Locations – Calculation of Carbon Emission

Rest of the world, one can use the "Anthesis" methodology to calculate the work from home emission for the rest of the world. They have collected and analyzed actual consumption data for 2019 and 2020 in three regions globally (North America, Europe and Asia Pacific) based on International Energy Agency (IEA) data.

Survey questions included several variables that could influence energy consumption patterns (i.e., hours and days worked, primary energy sources, number of others at home, other high energy-using sources, size of home/ workspace, regional nuances, etc.)

There are three specific methods to calculate the carbon emissions for global countries.

3.2.1. **No Survey Method** – This approach uses the number of remote workers by country or geographic region and recommended regional energy intensities (i.e., energy consumed per person per day) to estimate the amount of electricity and natural gas consumed. The energy consumption is then multiplied by appropriate emission factors to calculate the GHG footprint of remote workers.

This option is the easiest of the three to implement as it requires minimal information from a company (likely obtained from the human resources department) and uses several assumptions for key factors that drive emissions.

The participating company will only need to provide the number of full-time employees (FTEs) working from home by electricity grid region or, at minimum, by region.

3.2.2. **Basic Survey Method** – This approach also uses the number of remote workers by country or geographic region and same recommended regional energy intensities. In addition, minimal data are collected via survey to adjust certain assumptions regarding energy use, such as the specific energy types used. While this approach relies on fewer assumptions and is slightly more accurate than the No Survey approach, it requires more time and resources to implement because of the need to develop, issue and manage the survey and to clean, assimilate and analyze the survey responses.

3.2.3. **Enhanced Survey Method** – This approach also uses a survey but with questions designed to gather actual consumption data by energy type and to provide more in-depth insights into variables that may influence consumption. The energy data gathered can be classified by country, geographic region and energy type, and are then multiplied by appropriate emission factors to calculate the GHG footprint of remote workers. This approach uses the fewest assumptions and is the most accurate. However, it is also the most time- and resource-intensive of the three approaches because it requires significant time to clean, assimilate and analyze more extensive survey responses. As a result, it should be combined with existing commute surveys (or conducted at least every two to three years).

Methodology	Recommended Data Requests	Assumptions
No Survey	• Full Time Employees (FTEs) per region • General business hours (e.g. 5 days/ week and 48 weeks/year)	• Energy types consumed, by region • Percentage split in energy type, by region • No renewable energy used, Renewable Energy Credits (RECs) purchased, nor emissions offset
Basic Survey	• Region / Country of work • Energy types consumed (i.e., electricity, natural gas, other) • Average days/year worked at home • Number of others sharing home during work hours	• 8 hours/day worked from home • No renewable energy used; RECs purchased nor emissions offset
Enhanced Survey	• All similar data requests for Basic Survey • Hours/year worked from home • Total electricity consumed • Total natural gas / other fuel consumed • Control-level for heating/cooling (i.e., centrally or zone-specific) • Other high-energy using devices/ appliances in home • Renewable energy purchases (incl. RECs) and carbon offsets purchases	

Percentage Ratio Explanation

1. The ratios are incremental to baseline energy intensity by region and energy type. The incremental energy intensities are an average of select countries covered by the various studies on remote work.
2. As a result of the shift towards remote work, the ratio of incremental energy to baseline energy is a metric that compares the increase in energy consumption relative to the baseline energy use per person per day in a home.
Or we can say, it's a diversity factor.

	Baseline Energy Intensity (kWh/person/day)		Ratio of Incremental to Baseline	
Region	Electricity	Natural Gas	Electricity	Natural Gas
AMER	12.50	14.05	62.57%	38.39%
APAC	3.62	2.58	26.24%	60.10%
EMEA	4.00	8.02	57.79%	70.68%

Let's understand this with an example of an office in APAC region.

A	B
Remote workers	**Location**
2000	INDIA
C	D
Electricity intensity (kWh/person/day)	**Natural Gas intensity (kWh/person/day)**
3.62	**2.58**
E	F
Electricity Ratio of Incremental to Baseline	**Natural Gas Ratio of Incremental to Baseline**
0.26	0.60
G	H
Working days/week	**Working weeks/year**
5	**48**
I	J
Electricity consumption for the full year	**Natural gas consumption for the full year**
I=A*C*E*G*H	J=A*D*F*G*H
455946	**744278**

IV. CONCLUSION

This research paper is very much valid and helpful in quantification of work from home carbon emission for all the companies. I am a sustainability advocate and understand the vision of several companies to become carbon neutral. This study is really important as it captures both India and Global countries for work from home emission calculations.

V. REFERENCES

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