Sustainability

The Ecometrica Homeworker Model

Estimating the additional energy consumption and associated greenhouse gas emissions from home working.

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1. Introduction

Ecometrica has been assisting clients to calculate the emissions associated with home working employees for over a decade. Until 2020 home working was undertaken by a minority of employees for most companies, or as an occasional occurrence for the wider workforce, however the restrictions implemented toward the end of Q1 2020 changed this significantly. As the pandemic took hold significant portions of the global workforce were told to work from home and the demand for location specific homeworker emission factors increased. Ecometrica already had developed a base model for calculating the additional energy demand associated with home working and used this in conjunction with country specific residential space conditioning data and emission factors on a country-by-country basis. Prior to 2020 Ecometrica had created home working emission factors for 16 countries (as well as the 26 US e-GRID regions) upon request. By the summer of 2020 it became apparent that we needed to scale up our model to create a global dataset that allows clients to estimate the impact of homeworking in all countries.

2. Methodology

Our existing home worker model includes three distinct energy demands – home office equipment, space heating, and space cooling. The assumed energy use of home office equipment remained constant across all countries whereas the energy required for heating and cooling the home varied significantly and was based on country specific data.

Home office equipment
After additional research into updated statistics on the energy used by typical home office equipment it was decided that the information used in our existing model is still valid. This information is taken from the Chartered Institute of Building Engineers (CIBSE) 2012 document "Energy efficiency in buildings – CIBSE Guide F", specifically Table 12.1 – Examples of levels of energy used by office equipment. Using the ranges provided in the table Ecometrica determined an average 'working day' energy consumption of a typical home office set-up – a laptop, a flat screen monitor and a laser printer. It is recognised that not all home workers have access to a printer, however the model assumes only minimal printer use with sleep mode employed for most of the working day. Our home working model also includes lighting for the room and assumes that a typical working day lasts 8.5 hours (7.5 hours spent 'at work' and 1 hour 'non-working' time during which home office equipment is left running).
The resulting output of this home working equipment element is estimated to be just over 1.2 kWh of energy use per home office per working day.

Space conditioning requirement (heating and cooling)
The typical energy used by a residential dwelling to maintain a comfortable living temperature is climate dependant with some regions requiring heating alone,

others solely cooling and the remainder utilising both across the year. As no global dataset could be found that provides this information for all countries it was necessary to source this data for each country individually. Due to time constraints priority was given to OECD countries, as well as those specifically requested by clients. The preferred source for country (or region) specific heating and cooling data is national statistical databases and these have been used for most European countries (EUROSTAT 2020), Iceland (Orkustofnun 2019), Canada (OEE-EUDH 2020), the United States (EIA 2018), Australia (Commonwealth of Australia 2008), Israel (Government of Israel 2011) and Switzerland (Swiss Federal Office of Energy 2018). Where national datasets were unavailable academic papers were instead referred to. Using these two source types (national databases and academic papers) the typical annual heating/cooling requirement of a residential dwelling was gathered for all 37 OECD countries[1] and an additional 20 non-OECD countries (Bulgaria, Croatia, Cyprus, Malta, Romania, Macedonia, Serbia, Vietnam, Cambodia, Thailand, Indonesia, Malaysia, China, Hong Kong, Azerbaijan, Bahrain, Qatar, United Arab Emirates, South Africa, and Mauritius). All sources are fully listed in the reference section.

To allocate this annual heating/cooling demand to a single working day the value was divided by the assumed number of hours of heating/cooling used during a year (365.25 * 12) to give the average hourly consumption across this year. This method evens out seasonal heating/cooling demand across the year, allowing an average country specific home worker emission factor to be applied regardless of the month. It is believed that this average method is most useful for standard home working model applications where annual data is likely to be collected, however there is scope for a seasonal variant model to be created for those countries where heating (and/or cooling) demand varies significantly across the year if more granular home worker data is available. The calculation assumes that heating/cooling is not active for the whole day, but rather for 12 hours only, as it is not typical to heat or cool a home during the night-time hours.

The hourly heating/cooling value is multiplied by the 8.5 working hours per day. A 58% multiplier is then applied as not all the heating/cooling used during the working day should be assigned to the home worker. This is because some homes would usually be occupied during the day anyway, and for those homes normally unoccupied it is likely that the heating would be on for some of the working day even when the home was empty (for example pre-set heating controls that turn on central heating systems ahead of occupants arriving home). The 58% value has been calculated using an algorithm based on the typical weekly spend on heating in the UK (pre-Covid) and the home working tax relief amount provided by the UK HMRC during the pandemic. This method is designed to account for the extra heating burden placed on homes due to the presence of a home worker. These figures are UK specific but have been applied across the global model for both heating and cooling. It is recognised that in some situations centralised building heating controls mean that there would be little increase in heating activity due to additional home occupancy (in Swedish cities for example). However, in the interests of creating a global methodology that accounts for the likely increased heating/cooling demand that arises from home working in many situations this conservative methodology is applied across all countries. There is scope to increase the accuracy of the model by adjusting this apportioning of space conditioning to the home worker day on a country and even dwelling type (e.g. apartment versus house) basis.

Heating and cooling fuel type

In order to apply the appropriate emission factor to heating energy consumption the most widely used space heating fuel in each country was ascertained. Typically, this information was sourced from the same database or academic paper that provided the consumption value. A full list of sources used to determine heating fuel type for each country can be found in the reference section. It is assumed that all space cooling is provided by an electrical appliance such as a fan or air conditioning unit.

Emission factors

Electricity emission factors used are grid average factors suitable for location-based Scope 2 reporting. These emission factors are taken from national guidance documents

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[1] The OECD countries at the time of writing are Australia, Austria, Belgium, Canada, Chile, Colombia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, South Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and the United States.

where available (for example BEIS for the United Kingdom, EPA e-GRID for the United States), and from Ecometrica's electricity model where nationally provided factors are not available. Ecometrica's electricity model uses national electricity generation data sets in conjunction with fossil fuel emission factors from the IPCC (2006) to create a global set of country specific grid electricity factors. Heating emission factors are fuel specific and come from a range of sources, with national guidance documents the preferred source for location specificity. Where country specific fuel factors are not available the default factor set provided by the IPCC (2006) is used. In some countries heating is typically provided by electricity in which case the grid average electricity factors are applied. Emission factors for all three relevant greenhouse gases (CO2, CH4 and N2O) were sourced and applied where available. In a small number of cases emission factors were available for CO2 only, or were already combined into a single CO2e figure. All sources of emission factors used are listed in the reference section.

Other countries
For the remaining 79 countries included in the Ecometrica home working model the typical heating/cooling demand of a residential dwelling was estimated using an average of the values sourced for the aforementioned countries. These averages were calculated and applied using the Köppen climate region classification system. This climate classification system assigns regions into five main climate groups which are further subdivided based on precipitation and temperature variables. For each country where 'actual' heating/cooling data was sourced its Köppen classification was recorded. In many cases a country spanned several zones in which case the dominant zone was selected, and if no one zone was clearly dominant then the zone in which the capital city abides was chosen. This then allowed the creation of an average heating value and average cooling value for each climate zone, which could then be applied to all countries in the climate zone for which primary data had not been gathered. This estimation approach was taken in the interest of time and resource efficiency, however Ecometrica intends to replace estimates with primary data for any country specifically requested by a client (or any area where significant home working emissions arise), if such data can be found.

Results
As described the model applies country specific grid electricity factors to the assumed energy consumption of home office equipment in order to calculate resultant greenhouse gas emissions. Additionally country specific (or climatic average) residential heating and cooling data is deduced which in turn is subject to location and fuel specific emission factors in order to calculate the emissions from additional heating and cooling due to increased occupancy of homes during home working. Added together these calculation outputs provide the emissions of CO2, CH4 and N2O 'per working day' in order to allow application against a known number of days worked from home for employees in each country.

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