Chapter 3
Remote work and the green transition

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1. Introduction

Remote work is not a new phenomenon: it has been going on for decades in various configurations; while recently, facilitated by digital technologies, telework has begun to appear in a range of sectors, affecting a number of occupations, taking a variety of forms including platform work, and taking place in a range of locations (e.g. the home, other working spaces or remote working hubs). Remote work has been increasing over the last decade (Felstead and Henseke 2017), but it was the Covid-19 pandemic that considerably sped up its development, bringing it into a prominent position in discussions on work. Many industries and sectors that had previously not used remote work to a large extent were forced to introduce it due to quarantines and lockdowns. Now, there is a sizeable discourse on the opportunities and challenges of maintaining high levels of remote work even when not forced to do so, given its apparent popularity on the part of both employers and workers (Sisli and Kara 2022).

Among the many discussions emerging on remote work, one that is relatively new and gaining increasing attention is its impact on the environment and climate change, and more broadly concerning the greening of the economy. The relationship between remote work and the green transition would, at first, appear to be glaringly obvious: a positive effect on the environment due to less commuter traffic and thus reductions in carbon emissions. The first studies on the effects of remote work on the environment have focused on trying to measure these effects (Sostero et al. 2020). As it turns out, this focus on telework and home-to-work commutes on non-telework days adopts a very narrow perspective. Researching this relationship is extremely complex, however, and it is mediated by a number of variables and contextual factors. Worker behaviour plays a role, too. For instance, modified work schedules thanks to remote work and diminished work commutes might lead to increased non-work travel, leisure or other recreational activities which leave their own ecological footprint[1] (Cerqueira et al. 2020). Moreover, increases in home energy demand following the increased incidence of working from home also enter into the picture when assessing the overall environmental impacts of remote work.

1. The ecological footprint measures how much nature we use compared to how much we have. This accounting approach tracks how much biologically productive land and water area an individual, population or activity uses to produce all the resources it consumes, to house all its infrastructure and to absorb its waste given prevailing technology and resource management practices (European Commission 2018).

The extent of environmental metrics to measure the effects of remote work on the environment is also expanding with an emerging literature. These go well beyond CO_2 emissions to encompass elements including the following:

— the amount of traffic congestion (e.g. measured in travel time)
— the carbon or ecological footprint (with the latter being broader than the former that looks only at the dimension of CO_2 effects)
— energy demand, for example as measured in kilowatts per hour or otherwise, of office spaces, both at employer premises or home-based and at other remote working hubs
— the purity of air, looking at the quantity of particle matter or average nitrogen dioxide (NO2) in the atmosphere with implications for the incidence of acid rain as well as ozone depletion
— general visible air pollution, as in fog
— noise pollution (measured in decibels) due to the number of vehicles on the roads
— the volume of landfill as a result of wasted ICT equipment that is indispensable for remote work.

Furthermore, studies tend to concentrate on western industrial countries (Europe and the US), so it is unclear what the effects in other parts of the world might be. Thus, there remain many open questions on the actual net effects of remote work on the green transition. Given the limited research, the complex interrelationships, the diversity of the environmental effects and the potential for remote work to have unintended consequences for the environment, an important next step is to take stock of what we know and to point out potentially fruitful directions for future investigation on the basis of the increasing availability of detailed data.

In this chapter, we begin by examining who exactly is doing remote work, namely which occupations and types of workers are engaged in it. This issue is not strictly related to the green transition. However, worker behaviour in transport use, energy consumption and the use of IT and other work-related appliances, as well as the future prospects for working remotely, are key determinants in the outcomes regarding the green transition. Consequently, Section 3 provides a review of the existing evidence on the emerging trends in remote work and the effects these have on energy consumption and the reduction of CO_2. For instance, we examine questions of how large these effects really are and how they may potentially be offset by other forms of energy usage connected with remote working. Finally, we turn to the issue of remote work and mobility. We examine what is happening to patterns of commuting and travel (work or non-work related) with the increasing trends of remote work in home offices and working hubs.

As we examine the existing evidence on who is working in what types of occupations and what effects home offices and the shifts in home-to-work commutes are having on CO_2 emissions, energy use and how mobility patterns are developing and shifting, we place the discussion in a larger context and ask several questions. What are the actual impacts of remote work on the environment? And which contradictory and unintended consequences are arising which may offset the positive gains and potentially affect work and employment adversely? The goal is to unravel the complex interrelationships of remote work's many facets on the green transition – both empowering as well as potentially adverse. When we look at the issue of how remote working affects occupations

and employment, we also consider its potentially negative impacts on inequality and polarisation between occupations and in workers' conditions of employment. In examining the evidence of remote work on energy consumption and reduction, we also take stock of parallel developments in traditional work settings: is there, for example, any evidence of a coincident reduction in the use of heating and air conditioners or the downsizing of office space in response to increasing trends in remote work? Considering the environmental effects at a more general level, we also briefly review any evidence of the relationship between remote working and other forms of pollution such as air and noise pollution. In exploring developments in remote mobility, we consider its future implications concerning the issue of place at a more general level: what happens to the relationship between rural, urban and suburban areas?

The potentially positive effects of remote work on the environment are often used as arguments for why it should be promoted and expanded. Our position is that, for remote work to have a sustainable and positive effect on the green transition, its actual impacts on the environment have to be clarified and its unintended consequences for work and employment understood, thereby enabling meaningful policy responses.

2. Occupations, remote work and the green transition: opportunities and risks

For the green transition, the trend towards remote work being done from home revolves around its sustainability and its extent. The question is whether a greater variety of work and occupations will continue to be carried out in home offices and, if so, what are they? Will meetings – also at diverse locations – continue to be conducted online, thereby reducing the need for business travel? And, critically, will the extent of the work being carried out in home offices lead to a corresponding reduction in office use and space, thereby leading to decreasing energy use?

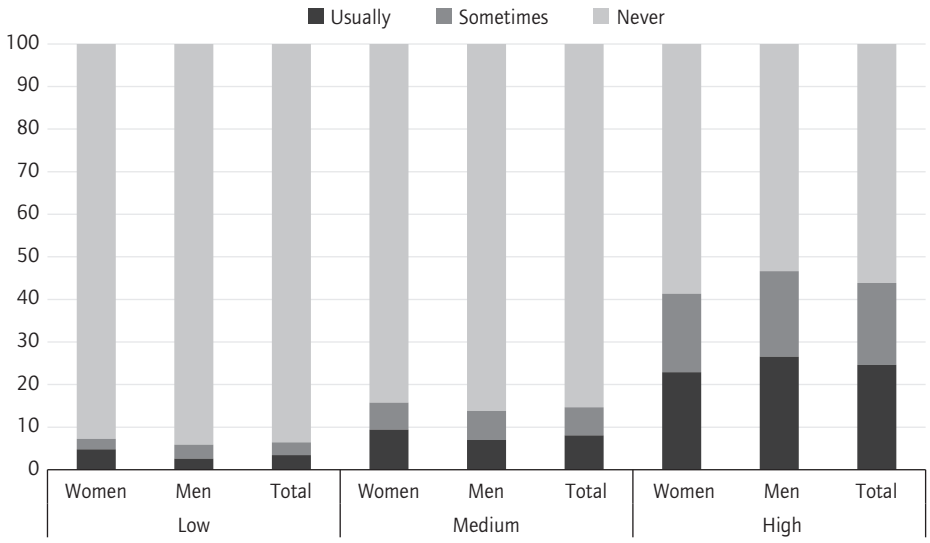
Just as remote work has shifted and diversified over the last two to three decades, so have the occupations being carried out within it. The occupations being exercised remotely, outsourcing across value chains, remote platforms and home offices are quite different but they also share certain characteristics. For one, doing remote work always involves issues of control (or the lack of it) for companies. Solutions can involve quite direct forms of control, as in surveillance and monitoring, or indirect controls involving project goals, targets and schedules, etc. Issues of control are a factor in the extent to which companies are willing to allow work to be carried out off the premises. Another central characteristic of remote work is that it usually entails a new bundling of tasks for some occupations (Felstead and Henseke 2017). This sometimes translates into standardisation and codification to simplify externalisation and enable the work to be carried out online.

The types of occupations most associated with home offices, and therefore most relevant for the green transition, tend to be on the higher range of skill levels, as can be seen in Figure 1 based on Eurostat (2022). This higher level of skill makes the work less susceptible to processes of simplification. Sostero et al. (2020) shows that, despite

the increase in the numbers of home-based remote workers during the pandemic, their socio-spatial characteristics remained largely the same. The social characteristics which strongly correlate with teleworking are education level (74 per cent of such workers have a tertiary qualification); job sector (such as education, financial services and public administration); and gender (with a strong bias towards women) (see Arabadjieva and Franklin, and Zwysen, this volume). As for the gender distribution of remote work, while the presented data do not reveal major differences, it should be noted that the position is delicately nuanced: while women tend to have a larger share of remote work in the lower and medium skills segments, men have a larger share of remote work in high skills categories.

The lockdowns during the pandemic significantly changed the landscape for remote work, including the types of work targeted for it. Many more jobs in traditional industry, government services, commerce and education were by necessity being done remotely, often from home. IT applications and customer service support have been carried out as remote work for some time, although not necessarily in home offices, but rather at 'remote' locations servicing company headquarters or production sites. Occupations that had already been gaining in importance, such as new types of tech workers engaged in IT maintenance and support, software development and coding, and app and algorithmic development, have become even more key.

Figure 1 **Distribution of people working from home by frequency, educational attainment level and by sex, EU, 2021 (in % of total employed people aged 20-64)**



Source: Eurostat (ad-hoc extraction).

Whether the shifts to home offices for the new variety of occupations is a lasting phenomenon, and what effect this has on the green transition, is difficult to answer in any definitive way given the paucity of research. The first indications suggest that, in some sectors (education for example), there is an obvious trend to return to in-

person working. In many other sectors, the move to home offices appears more long-term, although not as 100 per cent of working time. Many occupations including engineering, design, IT, an array of services, finance and human resources are affected by this trend. The extent of the mix between the home and the office is influenced by a number of factors such as companies' reluctance to give up control of working time and performance monitoring, and the benefits of in-person working for aspects of work such as team building, negotiation, conflict resolution, social contact, etc. Given that a mix of remote home offices and office presence appears the most prevalent model for most sectors and occupations, the effects regarding the green transition will, most likely, be limited to reduced commutes and minor reductions in energy and infrastructure emissions with regard to maintaining office buildings.

The trend for selected occupations, particularly those with high skills, to be candidates for carrying out work from home and thus potentially contributing to reduced carbon emissions and energy consumption should not be looked at in isolation, but rather examined in the wider work and employment context.

First, there are a number of occupations in areas such as health and care, a variety of services, public safety, restaurants, repair, maintenance and transport that cannot be done remotely. Here the workforce has to appear in person and has limited autonomy, fixed working times, etc. Their working days are extended by the time needed to commute to and from work. The rift between home office workers in well-paid high skill occupations and those occupations which are carried out necessarily in person could lead to a kind of embedded inequality between occupations and regions. There are already clear differences between regions in the US and Europe regarding the prevalence of working in home offices. In the US, southern, midwestern and more rural areas have lower levels of home offices (Brynjolfsson et al. 2020); in Europe, large well-off urban centres appear to have a higher incidence of home offices. The spatial characteristics of teleworkers have remained the same as in the pre-pandemic period – located primarily in urban areas of a city or a city suburb – although the numbers grew larger during the pandemic (Eurostat 2022).

Second, the privileges associated with being able to conduct work from a home office potentially underscore the existing or emerging inequalities (Sostero et al. 2020). Access to well-appointed computers, monitors, high-speed wi-fi and smartphones are not a given for all workers. The evidence points to a strong association between income levels and the possibility of remote work (Dingel and Neiman 2020). As mentioned previously, individuals who are more likely to be employed in 'teleworkable' jobs are also more likely to be high skilled with better paid jobs. Having higher earnings also allows them to afford to reside in houses or buildings with better energy performance (e.g. better insulated walls and roofs, rooftop solar panels) or to have cars that are using less energy (e.g. electric or hybrid models). It can conceivably work the other way around, however: higher income individuals have a tendency to consume in ways that leave a deeper ecological footprint (e.g. luxury goods, air travel, SUVs). From this perspective, the existing socioeconomic inequalities might lead to further inequalities and make it difficult to assess the overall environmental effects of remote work across income groups.

Third, these differences become even more glaring in international comparison. In developing countries, access to the resources to carry out remote work from homes can be lacking alongside the infrastructures for electricity grids or internet networks being unreliable. While according to Dingel and Neiman (2020) around 20 per cent of jobs globally could potentially be done from home, this share drops to 10 per cent in sub-Saharan Africa, in contrast to more than 45 per cent in the richest countries in Europe. The alternative for workers is often long commutes to central work locations which contributes to already high carbon emissions and air pollution in cities. Reduction of carbon emissions and energy use anywhere is a positive development, but the environmental impact is a global issue. International differences in environmental practices ultimately limit the long-term prospects for the effects to be sustainable. Moreover, remote work and the green transition can affect the development of offshoring and global value chains which can, in turn, influence work content and working conditions.

Therefore, although there are many positive aspects of working in home offices or in decentralised work centres or hubs – both for the environment and the individual's use of time and autonomy – the long-term effects on employment conditions in general are harder to predict. For many jobs and occupations linked to large companies or the public sector which traditionally use permanent employment contracts, a model of mixing home offices with regular in-person workdays appears to be emerging. However, past experience with outsourcing across value chains and the use of platform work suggests that many forms of remote work lead to precarious contracts and the absence of employment and social benefits (Huws 2014; Meil and Akgüç 2021; Meil and Kirov 2017). As remote work spreads to more and more sectors and occupations, the question arises as to whether these jobs are at risk of being permanently outsourced or are susceptible to the introduction of fixed-term contracts. Does a company's incentive to reduce permanent office space, given increases in the use of home offices, correspond with an incentive to reduce regular employment? In a report on remote work in the US during the Covid-19 pandemic, 10.1 per cent reported being laid-off or furloughed since the start of Covid-19 (Brynjolfsson et al. 2020). Given the general increase in more precarious work forms due to outsourcing and platform work that occurred even before the pandemic, it is worth pursuing the ongoing link between remote work and decreases in regular employment contracts in the types of occupations that have been affected in the more recent shifts to home office and decentralised work hubs. This raises the question of whether there has to be an inherent trade-off between good jobs and working conditions in order to achieve reductions in carbon emissions and decreasing energy use.

3. What are the effects of remote work in the context of the green transition and how large are they?

In Section 2, we looked at the share of occupations amenable to remote work and discussed the larger implications surrounding these trends regarding the green transition. The next subsections closely examine the available evidence on the links between remote work and the greening of the economy, focusing mainly on the environmental effects,

energy use and mobility and transport patterns, including the mitigating factors that have an impact on their direction and extent.

One key issue to keep in mind when assessing any of the environmental effects of remote work is that a number of factors play a role, with their effects often being intertwined (see, among others, Eurofound 2022; Giovanis 2018). Table 1 organises these effects into three broad areas which are explored in more detail in the following sections. Inevitably, the share of occupations amenable to remote work and the prevalence of remote workers at firm level would affect the results in how the overall environmental impacts of remote work play out.

Table 1 **Conceptualising the ecological impact of remote work**

Broad area of ecological impact	Example of factors
Environmental effects	– the geography of remote work (rural vs urban development) – noise and air pollution – use of earth minerals and other natural resources
Energy use	– how the office space is managed (e.g. fixed or flexible remote work days, hotdesking and how energy consumption systems are planned during this time) – energy performance of office and residential buildings – size of dwellings and of office spaces – type of heating or cooling systems at the office and residential building – number of people working from home in the household – geographical characteristics of the locations and seasonal dimensions (e.g. length of winter or summer months) with an impact on the use of heating or cooling in buildings – the general carbon intensity of the energy used by (IT) appliances in the office and the home – consumption patterns
Mobility	– distance between workplace and residential location – the availability of (sustainable) public transport – energy performance of the transport mode while working remotely – fuel efficiency of private vehicles – non-work mobility patterns

Source: Authors' own elaboration.

3.1 Remote work and environmental effects

The literature on remote work from the environmental angle is still emerging, but the existing studies tend to focus mainly on CO_2 emissions (Bachelet et al. 2021; Cerqueira et al. 2020; Eurofound 2022; Carbon Trust 2021; Ecoact 2020) related to reduced transport, generally involving commuting with personal cars rather than sustainable public transport. For the case of home-based remote work, however, there are a number of other factors one can consider, such as non-work travel – or even consumption –

patterns, the energy efficiency of dwellings and the carbon footprint of various transport modes.

While detailed data on CO_2 emissions are increasingly available at aggregate level, making it easier to draw up quantitative models to estimate the link with remote work, the same cannot be said for the other environmental metrics mentioned earlier, partly justifying the focus on emissions. Another simplification relates to the concentration on telework, which is a type of remote work but not the only one. Focusing on home-based remote working to understand the environmental effects reduces the number of complex dimensions pertaining to remote work outsourced down global value chains, making environmental traceability complicated.

The comprehensive global analysis conducted by the IEA (2020) suggests that, following the lockdowns during the first phase of Covid-19, gasoline use dropped by more than nine million barrels a day (plus six million barrels of diesel). Moreover, many large cities around the globe consequently witnessed striking drops, such as 65 to 95 per cent, in rush hour congestion. These effects of comprehensive restrictions and lockdowns are indicative of the effects of the reductions in mobility through remote work, but can only be seen as a starting point.

Badia et al. (2021) find that, as a result of lockdowns and homeworking following the Covid-19 pandemic, urban air quality increased significantly in Barcelona as average levels of NO2 – the main pollutant generated by traffic emissions – dropped sharply. Their modelling framework suggests a positive relationship between the number of remote work days per week and NO2: while two such days per week leads to a 4 per cent drop in NO2, four days can lead to a 10 per cent drop. Similar effects are found in a study in India measuring air quality in New Delhi (IEA 2020).

3.2 Remote work and energy use

Comprehensive global analysis during the first phase of lockdowns revealed that one day of working from home has been found to be associated with an increase in household energy consumption in the range of 7 to 23 per cent, depending on a number of factors including the energy efficiency of dwellings to start with but also how many people are remotely working in the same household. It is also shown that the share of energy consumption while teleworking during the working week resembles the average energy demand of Sundays, when most people are off and at home (IEA 2020). Bachelet et al. (2021) use the German Microcensus, together with corresponding energy and carbon prices, to suggest that, while telework increases annual heating energy expenditures by 110 euros per worker, it decreases annual transport expenditure by 840 euros per worker.

From the ecological footprint angle, the overall effect of remote work is not straightforward. According to the findings of Lachapelle et al. (2018), from a study in Canada, if remote working increases productivity, and thereby economic growth, it is also thereby likely to lead to higher production and income, and thus increased

consumption patterns (e.g. more leisure travel, increased consumption of goods beyond essential needs, etc.). This will increase overall energy demand. In this case, while remote work would, in principle, decrease emissions with reduced commuting as a first order effect, it might still lead to a deeper total ecological footprint eventually through increased consumption and greater energy demand.

Moreover, the increased use of telecommunications infrastructure and heating of the home are often identified as having a negative effect on the climate. It also matters whether companies develop strategies to reduce their office space (and therefore energy consumption). What additionally will be the share of duplicated IT equipment? Earlier research has already shown the very dynamic energy use of IT equipment in the last couple of years. The literature on this topic is still emerging, but Efoui-Hess (2019) shows that digital technologies represented nearly 4 per cent of worldwide carbon emissions even before the pandemic – more than civil air transport – and their impact was increasing each year by 8 per cent. In other words, the ICT tools indispensable for remote working are significant sources of emissions. Relatedly, Obringer et al. (2021) point to the carbon footprint of internet use – related to the energy consumption of data and cloud centres – which ranges from 28 to 63 grams of CO_2 equivalent per gigabyte. Among the various internet services, commonly used tools such as videoconferencing are identified as the most energy-heavy option. However, technological advances in this domain are seeing continuous improvements and more energy-efficient solutions are being offered along the way (Obringer et al. 2021).

Last but not least, Sovacool et al. (2019) demonstrate that digital technologies are increasingly relying on rare earth materials and minerals, which are concentrated mostly in a few resource-rich countries. This, in turn, also raises environmental and socioeconomic questions about the excessive extraction of natural resources – and how the latter are shared or rather traded – to keep up with the production of ICT equipment.

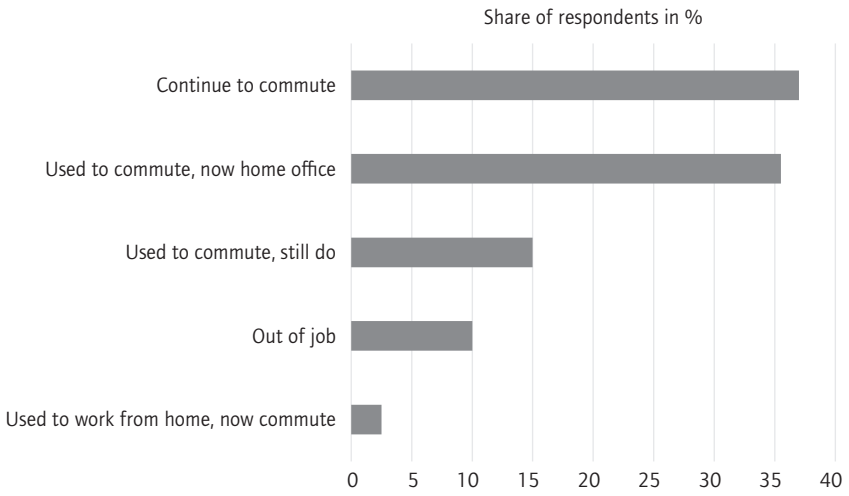
3.3 Remote work and mobility

The main potential benefit of remote work is mostly linked to its role in reducing mobility. Indeed, it is well established (EEA 2022) that transportation is a big contributor to greenhouse gas emissions and that home-to-work commutes take up a high share of it. In the US, the transport sector constitutes the highest share of total emissions and more than half of this is due to personal vehicles (Schupak 2021). With increasing remote work, the discussion about its role in sustainable mobility has gained in importance (Aguiléra and Pigalle 2021) since remote or hybrid work is often referred to as one of the major means of reducing carbon emissions due to the lower levels of home-to-work commutes.

In a report based on a two-wave representative survey in 2020 on working behaviour during the Covid-19 pandemic in the US, Brynjolfsson et al. (2020) find that, of those employed prior to Covid-19, about half are now working from home, including 35.2 per cent who report 'they were commuting and recently switched to working from home'. The share of people switching to remote work tend to be young and in occupations related to

information work 'including management, professional and related occupations'. The most common responses on work behaviour were 'I continue to commute' followed by 'I used to commute and now work from home' (see Figure 2).

Figure 2 **Commuting versus home office behaviour of the employed workforce in the US (2020)**



Source: Adapted from Brynjolfsson et al. 2020 : 5.

Generally, in current publications, the impact of remote work on sustainable mobility is seen in a twofold manner. On the one hand, some studies show it to have a positive effect, with a reduction in car use as the main contribution; in this way, it can reduce commuting and therefore the carbon footprint of mobility (Elldér 2020; Lopez Soler et al. 2021; Yum 2021; Clausen and Schramm 2021). This clearly shows, however, that the only expected impact of remote work in reducing transport related emissions and pollution is reduced mobility (not necessarily more sustainable mobility). On the other hand, other studies question even this contribution and point to remote workers travelling longer distances, thereby offsetting any sustainability effects (Budnitz et al. 2020; Cerqueira et al. 2020).

According to the study of the environmental effects of remote work by Bachelet et al. (2021), the resulting emissions reduction due to decreased commuting by car amounts to 4.5 million tons of CO_2, corresponding to 3 per cent of carbon emissions in the transport sector in Germany. The numbers vary by income groups as well as the residential location of workers. ADEME (2020) estimates that 271 kilograms of CO_2 could be saved annually with one day of remote work per person per week in France, distinguishing the different channels through which the emissions occur (e.g. transport mode, ICT tools, energy demand relocalisation) and then summing these up. According to Beck et al. (2020), remote working plays an important role in reducing commuting by car. They point to the number of days worked from home being crucial, similar to the ADEME report. In a similar vein, Eurofound (2022) also conducted a case study in Ireland – which recorded the third highest share of remote working in the EU following the pandemic – finding that it has a positive climate impact, implying a saving of

164 407 tons of CO_2 emissions per year. Kylili et al. (2020) find that at least 4 litres of transportation fuel and 7.4 kilograms of CO_2 can be saved per hour of remote work per 100 employees in Cyprus.

In contrast to these relatively positive findings, Cerquiera et al. (2020) provide evidence of travel behaviour and remote work in the UK, pointing to the existence of trade-off effects between work and non-work travel. Their overall analysis implies that remote work is related to higher emissions as a result of non-work travel in the absence of work commuting. The study by Elldér (2020) also confirms that part-time remote workers make more journeys than workers who do not work remotely. He concludes, however, that full days of remote working affect mode of transport choice and can indeed cause a reduction in travel demand rather than merely congestion relief which is the main benefit from part-time remote workers. De Abreu e Silva and Melo (2018) state that remote working cannot reduce car travel as it increases the weekly miles of travel given that remote workers make more non-work related journeys by car. Furthermore, increased remote work in home offices might also lead to unexpected consequences regarding negative effects on public transport as well as the sustainability of shops and restaurants in urban centres (Dougherty and Goldberg 2022).

Most research studies tend to focus on the impact of a remote worker's place of residence and the impact on reductions in car use, taking into account where the worker lives, the chosen mode of transport and travel distance but paying less attention to the spatial location of the workplace and its implications for mobility. For example, Budnitz et al. (2020) show that there is also a trend of remote workers living further from their workplace and this increases the tolerance for long-distance commuting.

Especially in suburban and rural areas, the impact of remote work on mobility behaviour is rarely addressed. Due to the suburbanisation and decentralisation that started in Europe many decades ago, many workplaces are situated in suburban and semi-rural areas close to urban centres. These workplaces often have limited access to public transport, leading to the dominance of car use. It is therefore important to look at the potential environmental and climate impact of remote work also from a socio-spatial mobility perspective.

Research by Krasilnikova and Levin-Keitel (2022), carried out in an industrial suburban area of the German city of Hannover, finds that 59 per cent of employees in the area have the potential for a reduction in car traffic through remote work. The area is the headquarters of many leading national and international companies but is also closely connected to housing locations. The study also finds that only 5 per cent of all teleworkers are full-time home-based: the majority work from home 1-3 days per week or less. The authors calculated that two extra days of remote work result in savings of 11 per cent of CO_2 emissions. The authors argue that the role of companies in supporting, enabling and fostering remote work is crucial to its success. An enabling company culture does not only include digital work but a broader shift in business models and human resource policy. Strong cooperation between companies and the city, and on a regional level, could then be helpful as a precondition for the implementation of new local shared workspaces located close to employees' places of residence. Such spaces

have the potential to manage current vulnerabilities on the way to expanding mobile work.

On the other hand, remote work has the potential not only to decrease traffic and travel but, with more time spent in non-urban areas, they can become points of social exchange and social life again – with shopping facilities, cultural offers or simply places to exchange and meet. It has also been shown that remote working might be a game-changer for sustainable mobility, depending on how local companies accept different forms of distance work.

4. Conclusions and looking ahead

In this chapter we show that, when assessing the effects of remote work on the green transition, a number of factors play a role and their effects are often intertwined. One such factor includes the share of occupations and types of work that are amenable to remote work, usually in the form of home offices. The data presented here show that the share of remote work has been increasing. However, the documented rift between home office workers in well-paid high skill occupations and occupations which are necessarily in-person ones does have the potential to increase inequality between occupations and regions and this also might have an effect on the overall ecological balance. Additionally, there are still many open questions regarding the future growth of remote working. Are employers willing to relinquish direct control over large portions of their workforces? Are workers ready to give up the social aspects of work and the benefits of face-to-face interaction? Will the shifts to home offices be limited to certain regions and income groups? The answers to these questions ultimately determine how many fellow employees will be working remotely and how office spaces will be managed.

The studies cited above report that, while remote work indeed has a potential positive effect on the environment, in reality it depends on numerous other factors and the extent to which these can be exploited. Given that a mix of remote home offices and office presence appears the most prevalent model for most sectors and occupations, the effects on the green transition will most likely be limited to reduced commutes and minor reductions in energy and infrastructure emissions in terms of the maintenance of office buildings. Even so, a growing body of literature has shown that reduced home-to-work commuting is the main source of remote working's positive climate and environmental impact as a result of reduced emissions. Some of the studies also show that the actual benefit depends on the modes of transport mix, on working time management (the number of remote working days, full-time or part-time) and on settlement structures. Studies also highlight that, if remote work takes place under the same lifestyle and work organisational framework, using the same settlement structures and transport infrastructure that was designed for full-time office work, it cannot be a game changer in sustainability; the resulting carbon – or more broadly, ecological – footprint may even become worse. The effects of remote work on energy use are even more controversial. While home energy use clearly increases, less energy use in offices does not necessarily follow. Although there are many positive aspects of working in home offices or in decentralised work centres or hubs – both for the environment and the individual's use

of time and autonomy – the long-term effects on employment conditions in general are harder to predict.

We can conclude that, for remote work to have a sustainable and positive effect on the green transition, its actual impacts on the environment have to be clarified and its unintended consequences for work and employment – both empowering as well as potentially adverse – better understood. In order to develop intelligent policy measures to promote the positive aspects of remote work on the green transition, it is necessary to consider the various facets of issues such as home-to-work commutes, mobility, the overall use of energy and occupational profiles, and to understand the potential trade-offs that might hinder or negate the desired effects.

Further research is therefore needed to document the actual environmental impact of different remote working patterns using comprehensive environmental metrics. More studies are necessary to explore the linkages between different types of remote work, settlement structures and modes of transport. Changes in the extent, composition and content of remote work also need to be followed up regularly. Moreover, it is necessary to develop projections of how the environmental effects of remote work might change with the advancing decarbonisation of energy use and transport. Last but not least, systemic changes, such as the pace of technological advance as well as the rate of climate change, will also determine the impacts that remote work will have on the green transition.

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