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Title
(re)Awakening to the benefits and climate impacts of telework during COVID-19

Permalink
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Author
Curtis, Matt

Publication Date
2020-06-01

(re)Awakening to the benefits and climate impacts of telework during COVID-19

A CAPSTONE PROJECT

Presented to

The Faculty of the Climate Science and Policy Program

Scripps Institution of Oceanography

UC San Diego

In Partial Fulfillment of the Requirements for the Degree of

Master of Advanced Studies

in Climate Science and Policy

by

Matt Curtis

June 12, 2020

San Diego, California

This capstone project submitted to the faculty of the Climate Science and Policy

Program at UC San Diego, has been read, approved, and accepted by the

candidate's committee in partial fulfillment of the requirement for the degree of

Master in Advanced Studies in Climate Science and Policy.

Dr. Corey Gabriel
Capstone Chair

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Introduction

During the COVID-19 pandemic, millions of employees have shifted to working from home, either full-time or part-time. Prolonged quarantine measures put in place in response to the current global health crisis have forced businesses, both essential and non-essential, to adapt to their workforces stuck at home and no longer able to come into the office. In order to keep their workforce employed, engaged and productive in a prolonged quarantine environment, employers have adapted by enabling large portions of their previous in-office workforce to work remotely from home. The history of working from home, also commonly referred to as telework or telecommuting, is one of mixed success and mixed support; however, when left with few alternatives, businesses are embracing the potentials of a remote workforce. The increase in employees working from home has directly impacted short-term environmental air quality and reduced greenhouse gas (GHG) contributions due to a reduction in employee transportation requirements. In short, people are driving less, and the environment is benefiting. Additional potential benefits from the increase in employees working outside the office include reductions in office electricity consumption, water consumption, and waste generation; as well as cost savings due to potential reductions in total office footprint requirements. This capstone explores the overall environmental impacts, long-term climate implications, return on investment and success strategies for an increasingly remote workforce. Additionally, this capstone offers public and corporate policy suggestions for promoting work from home strategies post-pandemic and briefly explores how the work from home shift is impacting other aspects of daily life.

Background

In this section we briefly examine the background of working from home. In order to fully appreciate the totality of working from home under current circumstances, it's important to look back and ask ourselves how we got here. We answer this question in two ways: first, by tracing the history of, and shifting views on, telework prior to the current health crisis, we obtain basic background knowledge of the state of telework prior to COVID-19; second, we briefly explore the change in corporate work-from-home paradigms during COVID-19, in order to provide awareness of the increase in magnitude and prevailing corporate perspectives on telework once quarantine and social distancing measures became nearly ubiquitous throughout society. Examining the background of working from home provides a framework which enables better understanding of the current situation.

History of Telework

As a concept, the idea of performing work in the home environment is as old as the idea of the home environment itself; indeed, a majority of pre-industrial homestead work took place in and around the home. During the 17th and 18th centuries, large portions of work occurred in places like "top shops" where employees lived and conducted their livelihood in the same building or location. (Dishman 2019) One late 19th century bank president in Boston installed a dedicated telephone line between his bank and home and became the first telecommuter. (The Center for Digital Government 2006) During the early 20th century, famous brands such as Tupperware and Stanley Steamer increased the popularity of in-home sales, which would fall more into the category of remote work rather than strictly work from home. (Dishman 2019) Then, in 1963, a teletype machine was installed in the home of a Defense Advanced Research Projects Agency programmer in order for him to work from home with his pregnant spouse and

the first U.Ss. Government teleworker was made. (The Center for Digital Government 2006) In 1967 a German aerospace manufacturing company was the first company to offer a flexible work schedule option to their employees and shortly thereafter Hewlett-Packard was the first U.S. company to follow suit. (Pasini 2018) Then in 1973, a NASA employee named Jack Nilles, concerned about the environmental impact of excessive automobile commuting, became the father of work from home movement when he wrote his book *The Telecommuting-Transportation Tradeoff* (Pasini 2018) and coining the term "telecommuting." (Allied Telecom 2016)

The next 20 years was marked by limited corporate forays into the world of telecommuting primarily due to limitations in technology. (High Speed Internet 2018) During the 1990s, following advances in technology and passage of the Clean Air Act, telework became more prominent in both the public and private sectors. AT&T promoted a corporate-wide teleworking day in 1994 and IBM began a teleworking program for their employees in 1995. (High Speed Internet 2018) In 1990, passage of the Postal Service and General Government Appropriations Act was the "first time Congress provided funds for [telework] arrangements." (Telework.Gov n.d.) During the first decade of the 2000s, teleworking took off for both public and private sector employees. By the time the Obama administration passed the Telework Enhancement Act in 2010, over 100,000 government employees worked remotely and 40% of IBM's workforce worked without a traditional office space, saving the company an estimated $100M per year. (Allied Telecom 2016) (High Speed Internet 2018).

Since 2010, despite an increase in total work from home employees and an emerging movement towards work from anywhere employment, public and private sector support for telework was marked by dramatic reversals in work from home policies by former leading

advocates and early adopters. In 2011, Sharpe HealthCare in San Diego embraces a work from home policy and transitioned over 1,000 employees to remote work. (Smith 2020) In 2012, Yahoo! led the contraction in corporate telework programs by cancelling telework across the board for their employees, citing the desire to improve employee collaboration and workplace culture. (Graber 2015) By 2015, other prominent brands such as Best Buy, Reddit and Honeywell followed suit in rolling back their telework programs; as did previous forerunners in telework, Hewlett-Packard and IBM. (Schawbel 2018) In 2018, numerous Executive agencies reversed course beginning with the Department of Agriculture's 50% cut the agency's telework program. This reversal by the Executive Branch was sold as move toward increased accountability of the federal workforce, but it was criticized by political opponents as a "Neanderthal move" intended to punish aging members of the federal workforce and weaken the federal employee labor unions. (Rein 2020) In March of 2017, 43% of employees worked remotely in some capacity, with increasing trends in finance, insurance and real estate industries; and decreasing trends in science, engineering, architecture, education, training, community services and social services. (Mann and Adkins 2017) Despite the steady increase in overall work from home employee numbers, one could argue that the popularity of telework programs had stalled or was even on the decline in many corporate and federal spheres leading up to the COVID-19 pandemic.

COVID-19 Paradigm Shift

Since the start of mandatory quarantine measures, there has been a significant rise in both public and private sector WFH participation as well as WFH employee production and working hours. A labor force survey of remote work conducted between April 1-5 by MIT researches revealed that 34% of the workforce switched to remote work during the month of March, with

younger workers more likely to make the switch. (Brynjolfsson, et al. 2020) Another survey carried out by Workplace Evolutionaries between March 30 and April 24 revealed that 88% of respondents were now working from home at least part time, with 77% working from home on a full-time basis; whereas, only 31% of respondents worked remotely at least part time prior to the shutdown, with 60% reporting zero remote work prior to the shutdown. (Lister and North 2020) That same survey reported some interesting productivity results: 77% of respondents reported being fully productive at home; 70% of respondents reported equal or better performance working from home; and the rate of unwanted interruptions and distractions was reduced by half working from home during the shutdown. (Lister and North 2020) Additionally, VPN data between March 15 and March 25 showed that the average length of U.S. workday increased by 3 hours, or nearly 40%, during the period when most of the lockdown measures became fully implemented across the nation. (NordVPN 2020)

Prominent private sector businesses as well as a number of government agencies are touting the success of their recently expanded WFH programs, and many of those businesses and agencies have indicated their intention to maintain expanded WFH programs once quarantine restrictions are lifted. Goldman Sachs recently stated that 98% of their workforce is working remotely during the quarantine. (Hernandez 2020) On March 27, the Department of Defense rolled out a remote work collaboration suite based on Microsoft Teams project sharing software across the Defense workforce. (Williams 2020) Since the beginning of the quarantine the Navy's telework capacity grew by 150% to 250,000 workers and the Navy has plans to increase their work from home capacity by another 250,000 workers. (Williams 2020) Meanwhile, the Indian state governments have set a target of 50% work from home employees. (Parthasarathy 2020) A Gartner survey of HR leaders from 229 companies found that 41% of employees will

likely work from home at least part time when the quarantine measures end, up from 30% prior to the quarantine. (Gartner 2020) The Workplace Evolutionaries survey found that for those engaged in work from home who plan to continue at least part time remote work post shutdown, the preference is to work from home 50% of the time, or 2.5 days per week. As we've seen, there are many factors which have led to increases in remote work up to and during the COVID-19 pandemic, the most important of which is advances in technology. On the other hand, there are many factors which have contributed to the failures of remote work for both employees and their employers.

Success Factors

In this section we examine what makes working from home successful and what makes working from home unsuccessful. As we learned, the policies surrounding working from home by many early adopting employers swung like a pendulum from initially supportive to unsupportive as their remote work programs matured. The history of working from home is a mostly mixed bag, which is primarily attributable to the productivity of remote employees or, more accurately, the *perceived* productivity of remote employees by their employers. Employers, formerly reluctant to think outside the box about what types of work is suitable for remote work employees, how been forced to "find a way" to make remote work successful during the shutdown. In order to fully understand what makes working from home a successful proposition for the stakeholders involved, it's important to understand the obstacles to work from home success and how employers and their employees are overcoming those obstacles. The first two factors in any successful work from home strategy are type of work and employee attributes. After that, organizational support, work from home environment, and organizational processes

make up the other success factors for work from home employees. Understanding successful work from home strategies will promote successful work from home policies moving forward.

Type of Work

The first success factor is work type. Not every job is suited for a work from home employee and there are plenty of industries where it wouldn't make sense for most, if not all, employees to work remotely or from home. Type of work and employee skill level often dictates whether or not a position or employee is eligible for remote work. (Buscaglia 2020) Manufacturing, service, and trade industries are some of the industries where much of the work must be done on site or on location and where hands-on or physical product/customer interaction is necessary. On the other hand, data analysis, finance, legal, accounting, and human resources, to name a few (basically most of the traditional cubicle or desk-based corporate overhead roles), can be performed successfully by remote employees.

Employee Suitability

The second success factor has to do with the suitability of the employee working from home, primarily desire to work remotely rather than in the office and discipline of the employee to keep themselves on a schedule while working from home. Workforce Evolutionaries' survey of remote workers ranked the enablers of success for work from home employees by importance as self-discipline, collaboration, well-being, experience, career opportunities, proper tools, and distraction free environment. (Lister and North 2020) According to remote work, continuous growth, and technology blogger Steph Smith, working from home shouldn't be considered some sort of silver bullet or magic legume for finding personal work-based satisfaction. (S. Smith 2019) In Smith's view, remote work is best described in one word, "autonomy," because remote work offers people the freedom to reshape their work-life relationship in order to pursue other

work-life goals. (S. Smith 2019) Work from home programs should be offered first to employees who express a desire to work from home, and then employers need to evaluate other employee attributes to determine if they are solid work from home candidates.

Employee discipline is the second thing employers should look for in their work from home candidates; however, discipline in a work from home environment cuts both ways. First, employees need to be disciplined enough to establish and maintain a productive at-home work routine. Distractions and competing priorities can often become issues for remote workers and this is where employee discipline comes in to play. Discipline allows the remote employee to block out distractions at home as well maintain good prioritization and time management skills. On the other hand, too much discipline can lead to employee burnout. Overwork leading to burnout is an issue for work from home employees who find themselves working more total hours than they would otherwise work in the office. (Lister and North 2020) In a survey of the biggest obstacles facing remote workers, the top two obstacles were unplugging after work and loneliness. (S. Smith, Best Practices for Managing Remote Teams: A Psychological Perspective 2019) Successful work from home employees must have the discipline to stay focused on their work and stay productive out of the office, as well as the discipline to put their work down and take a break when they need it.

Organizational Support

Regardless of work type or employee suitability, organizational support for any work from home employee program is a critical factor in its success. Most work from home programs will fail in the absence of organizational commitment to the program, and most of the reasons why organizations fail to make a commitment has to do with perception. There is often a perception of little to no value added by work from home employees by their peers, their

supervisors, and upper management. There is also a perception of a lack of appreciation for their work as well as a perception of reduced promotion opportunities by work from home employees themselves. A study conducted by Harvard Business Review of over 1,100 employees, about half of which work at least part time at home, found that perceptions of work from home employees by their colleagues was negative. (Grenny and Maxfield 2017) Moreover, "[r]emote employees are more likely to report feeling that colleagues mistreat them and leave them out […] say bad things behind their backs, make changes to projects without telling them in advance, lobby against them, and don't fight for their priorities." (Grenny and Maxfield 2017) Whether accurate or not, negative perceptions surrounding work from home employees and their efforts exist in the workplace presenting a large obstacle for an organization with remote employees.

"Organization and management cultural changes," rather than technological challenges, are increasingly the biggest barriers to remote work. (Gan and Citylab 2015) An IBM Center for The Business of Government report on lessons learned from implementing telework programs across four federal agencies identified support from top management as the first key to success for any telework program. (Overmyer 2011) In Japanese business culture, a massive barrier to working from home is *hanko*, or the Japanese tradition of placing personal seals on important documents. The Economist reports that, "only 40% of Japanese firms had used digitized contracts at all and just 30% had systems in place to enable remote working," prior to the pandemic shutdown. (The Economist 2020) Japan, recognizing their self-imposed limitations impeding adaptation to business in a quarantine environment, is rapidly adopting to remote business practices and *hanko* culture is undergoing a review by the Japanese government. (The Economist 2020) *Hanko* represents an organizational cultural barrier to change for work from home programs.

Trust that employees will do their jobs is one of the most important factors enabling remote work success. Even the federal government is touting the importance of trust between supervisors and their employees; trust that employees are disciplined, productive, and resourceful enough to remain effective working from home. (U.S. Forest Service 2020) Software companies like InterGuard offer employee monitoring software, also referred to as "tattletale" software that monitors employee keystrokes, takes snapshots of desktop activity, offers video playback of employee activity and productivity reports. All of this intrusive remote employee monitoring sending the message that employers don't trust their work from home employees, adding to remote worker stress levels, damaging morale, and potentially leading to increased employee turnover. (Allyn 2020) If trust and support doesn't come from the top down, then a work from home policy is likely doomed to failure.

Telework Environment

Another success factor for work from home employees is the home environment. A productive work from home environment should allow the employee to work just as effectively from the home as they would in the office by allowing the employee access to similar equipment as they would use in the office and by exceeding the office in terms of minimizing non-productive distractions. Between equipment and distractions, equipment seems to be the smaller issue for work from home employees these days. Reliable Wi-Fi access is now cited by remote employees as the smallest obstacle to remote success. (S. Smith, Best Practices for Managing Remote Teams: A Psychological Perspective 2019) Prior to the quarantine shutdown, many employees were routinely able to take their work computers home with them at the end of the workday and over the weekends. During the shutdown, when faced with the potential for extended telework arrangements, and facing concerns over productivity drop-offs, many

employers allowed their employees to also take their in-office monitors, docking stations, and printers home. Moreover, some employers are purchasing additional resources for their remote workers such as sound-cancelling headphones in order to minimize distractions. A recent survey of remote employees found that 72% of employees report having the what they need, including the equipment they need, to be successful while working from home. Of note, when broken down by generation, Gen Z is least likely to report having what they need to be successful working from home. (Lister and North 2020)

Distractions can be a large problem in work from home environment, but the reality is that distractions can have a serious impact on productivity in the office environment as well. In fact, according to Workplace Evolutionaries recent survey of work from home employees during the COVID-19 quarantine, employees report experiencing twice as many distractions in the workplace as they do in the home environment. (Lister and North 2020) The quarantine work from home environment is filled with distractions for those with families, especially school-age children home with them during traditional working hours; so it's telling that despite the increased distraction potential, work from home employees are still reporting a higher rate of in-office distractions when compared to in-home distractions. On the other hand, the work from home environment in cultures where traditional gender roles are strongest is not as conducive to success, especially for women, because women are mainly responsible for the housework and childcare in the home in those cultures. Lack of hardware and networking, as well as increased in-home distractions make working from home in Indonesia less successful for remote employees. (Mustajab, et al. 2020) In Pakistan, the leading impediment to telecommuting is technology; however, work from home survey respondents in Pakistan in 2017 appreciated the

freedom that remote work policies allow, and reportedly enjoyed greater job satisfaction, better work-life balance, and saved money from commuting. (Zia and Bilal 2017)

Organizational Processes

For the purposes of this discussion, organizational processes refer to the methods an organization uses to increase the effectiveness of their remote employees, including things such as in person training, expectation setting, communication techniques, and collaboration methods. The Center for Digital Government conducted research into teleworking best practices and identified a robust training program as a "foundation for success," and "consistently present in all successful telework implementations." (The Center for Digital Government 2006) Initially, employees should undergo thorough in-person training at the office prior to being allowed to work remotely in order to baseline work from home employees to the expectations and rules of engagement when working from home. The Center for Digital Government's research on teleworking found that for remote work to be successful, "[e]veryone involved must understand what is being done and why, and the role they are expected to play in supporting the whole." (The Center for Digital Government 2006) A Harvard Business Review article suggests establishing "rules of engagement" for remote work employees in order to enable success. (Larson, Vroman and Makarius 2020) Proper expectation setting for all stakeholders is a prerequisite for success in any work from home arrangement.

Once an employee has shifted to remote work, the workplace communication requirements and methods should strike a balance between structured inorganic types of communication and organic, unstructured types of communication. There should be routine, face-to-face or voice-to-voice communication between employee and supervisor during the day/week; and multiple channels of communication should be available between the work from

home employee and their team/supervisor. (Larson, Vroman and Makarius 2020) Successful managers of work from home employees practice intentional, consistent, and frequent communication with their subordinates, according to a 2017 Gallup four-part series on working from home. (Hickman and Sasaki 2017) On the other hand, structure doesn't necessarily promote organic creativity and too much structure can be confining and stifling. As managers have become thrust into the role of remote supervisor, they've often overcorrected in attempting to replicate the in-office experience with their work from home employees. According to a recent Washington Post article, some of the overbearing and micromanaging overcorrections include always-on webcam rules, an increase in meetings, multiple daily mandatory supervisor check-ins, real-time employee activity tracking software, as well as volun-told virtual happy hours, game nights and social lunches. (Harwell 2020) The increased scrutiny and demands on work from home employees can cause additional stress and leave employees feeling overwhelmed and unappreciated.

Employees need organic social interaction with their coworkers and successful employers of work from home employees create a space that facilitates and promotes organic employee interaction. (Larson, Vroman and Makarius 2020) (Hickman and Sasaki 2017) One of the keys to remote work success is creating an online water cooler for remote employees, according to Steph Smith. (S. Smith, The Honest Guide to Remote Work 2019) However, promoting and encouraging team collaboration can be difficult with remote employees. Blogger Steph Smith suggests that employers would do well to design or add key performance indicators to "encourage teamwork or can only be achieved through teamwork." (S. Smith, Best Practices for Managing Remote Teams: A Psychological Perspective 2019) The reason for this is because it becomes difficult to measure collaborative production in team players who add significant value

through collaborative efforts when they are working from home. Employers should design KPIs that encourage work-life balance for their employees, such as a minimum vacation policy. (S. Smith, Best Practices for Managing Remote Teams: A Psychological Perspective 2019)

On the other hand, there is a danger in being too hands-off or in having too little interaction with remote employees. Lack of supervision and lack of access to information are problems for remote employees. (Larson, Vroman and Makarius 2020) In promoting work from home policies, some employers end up almost eliminating in-office interaction altogether. Employees who work from 100% of the time have the lowest levels of self-reported engagement, similar to employees who work in the office full-time. Prominent Stanford telework researcher, Nicholas Bloom, is worried about declines in productivity with during the quarantine and insists that face-to-face meetings are essential for innovation, motivation, and focus. (Gorlick 2020) Daniel Cole, bestselling New York Times author on organization culture, calls face-to-face interaction, "the killer app for creativity." (The Next Big Idea Club 2019) Daniel Cole believes that remote work is best suited for productive work rather than creative work; however, the evidence suggests that while collaborative creativity declines in remote teams, individual creativity increases for remote workers. Popular Wharton Business School professor and expert on organizational culture, Adam Grant, suggests that 2.5 days per week is optimal for maintaining productivity in remote workers. (The Next Big Idea Club 2019)

Environmental and Climate Related Benefits

This section explores the direct and indirect environmental benefits of working from home. The direct, and most significant, environmental benefits attributable to work from home activities are reductions in GHG emissions and air pollution due to reductions in commute related transportation. Indirect benefits are attributable to in-office reductions in energy usage

and waste streams, as well as construction related GHG contributions for smaller office footprint requirements due to increasing proportions of work from home employees. Understanding the direct and indirect environmental benefits of working from home helps to quantify potential long-term impacts of these sustainable work from home employee policies on climate change related emissions reductions targets.

Transportation

GHG contributions

The average CO2 emissions for a passenger vehicle driving one mile is 404 grams, which is approximately .891 pounds. (EPA 2018) The average gasoline vehicle has a fuel economy of approximately 22 miles per gallon. (EPA 2018) In 2010, the transport sector produced 7 GtCO2eq globally. (IPCC AR5 2014) GHG contributions from transportation accounted for approximately 29% of U.S. GHG emissions in 2017. (EPA n.d.) Passenger vehicles alone are the single largest contributor, by category, of GHG emission is California. (California Air Resources Board 2019) According to the 2019 report on California Greenhouse Gas Emission Inventory, the transportation industry accounts for 40.1% of California emissions with passenger vehicles making up 28% of California emissions. (California Air Resources Board 2019) The light-duty vehicle transportation sector is responsible for 28% of GHG emissions in California. (Taylor 2018) In 2017, the transportation sector in California was responsible for emitting approximately 170 million tons of CO2 equivalent while passenger vehicles accounting for 120 million tons. (California Air Resources Board 2019) In San Diego County, on-road transportation makes up 45% of all county GHG emissions. (County of San Diego 2015) On-road transportation made up 55% of all GHG emissions in the City of San Diego Climate Action Plan 2019 Annual Report. (The City of San Diego 2019)

What drives the decision to commute to work as a single rider in a personal vehicle? According to the SANDAG survey, convenience, work schedule, speed and flexibility are the primary reasons for this decision. (True North Research, Inc. 2018) The 2018 Park & Ride survey conducted for SANDAG survey found that 88% of employees work outside their home while 12% work from home; with 84% commuting to work alone in a personal vehicle. (True North Research, Inc. 2018) The same survey found that the average one-way commute duration in San Diego County was 29.08 minutes and the average commute distance was 16.35 miles. (True North Research, Inc. 2018) The City of San Diego 2019 Annual Report on its Climate Action Plan indicated an average daily commute distance of 20 miles. (The City of San Diego 2019) Furthermore, the U.S. Census Bureau claims the mean travel time to work in San Diego in 2018 was 26.6 minutes, 76.5% of workers commuted to work alone, and 6.6% of workers worked from home. (U.S. Census Bureau 2019)

Air Pollution and other Health Considerations

The National Center for Sustainable Transportation claims that on-road transportation contributes to environmental pollution from brake and tire wear and wildlife mortality from all vehicle types, including electric vehicles. (Handy 2020) The California Air Resources Board, in their 2018-2021 Triennial Strategic Research Plan, found that PM2.5 emissions from tires and brakes have been steadily increasing during the past 20 years while PM2.5 emissions from exhaust have decreased dramatically. (California Air Resources Board 2018) The National Center for Sustainable Transportation states that the sedentary activity of driving contributes to obesity and stress. Furthermore, they claim that California highway maintenance costs over $500 million annually. (Handy 2020) In AR5, the IPCC concluded that, [e]xposure to vehicle exhaust emission can cause cardiovascular, pulmonary, and respiratory diseases and several

other negative health impacts." (IPCC AR5 2014) Additionally, inactivity related to commuting, "has been linked to several chronic diseases." (IPCC AR5 2014)   One study from 2005 on the relationship between total vehicle miles travelled and telecommuters found that there is a small reduction in vehicle miles travelled by telecommuters. (Choo, Mokhtarian and Salomon 2005)

Energy Use

In 2006, Sun Microsystems found that in-office energy consumption was 130 watts per hour while at home energy consumption for employees working from home was 64 watts per hour. (Sun Microsystems, Inc. 2008) According to the International Energy Agency, yearly energy demand in 2020 may decline by 6% from 2019 levels. (The Economist 2020) The Economist speculates that we may be, "crossing a psychologically significant boundary" by reducing emissions to 2010 levels because this could mean that we're close to, or maybe even we're already past, peak GHG emissions. However, The Economist warns us not to get too far ahead of ourselves by pointing out other drops in emissions due to previous crisis. (The Economist 2020)

Construction

Building construction emissions accounts for 11% of global emissions while building operations accounts for 28%. (Architecture 2030 2019)

Covid Impacts

During the COVID-19 quarantine, daily CO_2 emissions decreased by 17% in a year-over-year comparison, while reduced surface transportation accounted for 50% of the decline. (Quere, et al. 2020) Ozone pollution has decreased by only 7% on average, which is attributable to only slight reductions in trucking and also to factory and energy production. (Sommer, et al. 2020) According to the International Energy Agency, 2020 will see the largest yearly drop in

GHG emissions since World War 2. (The Economist 2020) One study on electricity use in Manhattan during COVID-19 found that daytime household energy use increased by 25% during the shutdown while overall energy used declined, likely due to a drop in commercial and industrial demand. (Fountain 2020) Another study of satellite emissions data found, "declines in pollution over major metropolitan areas, including Los Angeles, Seattle, New York, Chicago and Atlanta." (Plumer and Popovich 2020) The Road Ecology Center at UC Davis studied the impacts of COVID-19 shutdown on traffic accidents in California and found that total traffic collisions were reduced by 50%, including injury and fatality collisions, resulting in total savings of $40 million per day. (Shilling and Waetjen 2020) Traffic speeds increased during the shutdown, as one would expect with a decrease in overall traffic volume by up to 55%. (Shilling and Waetjen 2020)

Climate Impacts

Global Workplace Analytics, a work from home advocacy thinktank, estimates that about 60 million employees, or 56% of the U.S. workforce, could work from home at least part time and that 25% to 30% of the U.S. workforce will be working from home by the end of 2021. (Global Workplace Analytics n.d.) The IPCC noted that behavioral change is just as important as increasing vehicle efficiencies. (IPCC AR5 2014) Teleworking is not mentioned in the San Diego CAP and is not included as part of the CAP transportation emissions reductions strategy. (The City of San Diego 2015) SANDAG, in their State of the Commute Report from November of 2019 reported rising vehicle miles travelled as well as rising vehicle hours in San Diego due to increasing congestion on San Diego Interstates. (SANDAG 2019) The City of San Diego Climate Action Plan (CAP) uses 2010 CO2e emissions as a baseline for GHG emission reduction

goals. (The City of San Diego 2015) CO2 equivalents: 1 metric ton of CH4 = 25 metric tons of CO2; 1 metric ton of N2O = 298 metric tons of CO2

California goals for GHG emission reductions are to reach 431mmtCO2e by 2020 and 259mmtCO2e by 2030. California has already reached their 2020 goals, but the 2030 goals are much more aggressive. (Taylor 2018) Over the next ten years, Californian's will have to reduce GHG emissions by nearly double the rate they've been reducing during the past 10 years in order to reach 2030 GHG emissions targets. (Busch and Orvis 2020) California is currently estimated to fall short of 2030 GHG emissions targets by 25 mmtCO2e. (Busch and Orvis 2020) Policy analysts suggest that ride sharing and self-driving vehicles actually increase total vehicle miles travelled on the roadways. (Busch and Orvis 2020)

Return on Investment

This section explores the ways in which working from home policies provide return on investment (ROI) for their employers. ROI will be seen in a number of ways, but primarily from the reduction in overall facilities requirements and employee desk spaces. With the right work from home strategy in place, as discussed previously, employers will see comparable or increases in employee productivity, along with ROI in other areas, including increased employee welfare, increased job satisfaction, and reductions in employee turnover. Other considerations such as work from home equipment costs will be briefly considered. Understanding the ROI of successful work from home strategies provides incentive for businesses to promote work from home policies.

Facilities

In 2018, The San Diego Union-Tribune reported that San Diego had, "some of the most expensive office space in the nation, from an average of $275 to $324 per square foot." (Molnar

2018) The average cost to rent an office in San Diego is $2.82 per square foot. (Digsy n.d.) In 2015, the average cost per seat in San Diego, was $23,449 while the average space density per employee was 149 square foot. (CBRE 2016) According to Squarefoot.com the average space density per employee is trending down. In 2019, WGI Parking Solutions reported that the average construction cost of one parking spot in San Diego was $23,386 or $70.41 per square foot. (WGI 2019)

Productivity

The seminal study on telework was conducted by a Stanford researcher in the mid-2010s on employees in a Chinese travel company. The study found that work from home employees were more 13% more productive when compared to their in-office peers, however, after the study was finished, half of the work from home group chose to go back to working in the office primarily due to missing out on daily interaction with other employees. (Mautz 2018) (Bloom, et al. 2015) Gallup found that optimal employee engagement occurs, "when employees spend 60% to 80% of time working off-site." (Hickman and Robison, Gallup 2020) Global Workplace Analytics estimates that if 43% of telework-eligible federal employees worked from home it would translate into $570 million per day in productivity for the federal government. In other words, we the federal taxpayers are potentially losing half a billion dollars a day in federal employee productivity due to a lack of teleworking during the quarantine shutdown. (Lister, Global Workplace Analytics 2020)

An article in the Harvard Business Review from August of 2019 suggests that work from anywhere employees increased productivity by 4% over work from home employees. Individual creativity increases when working from home, while collaboration and management effectiveness increases in the office. (Lister and North 2020) Employees reported overall

satisfaction of non-management activities at similar levels when working from home or in the office. (Lister and North 2020) (Choudhury, Larson and Foroughi 2019) One CEO noted that an unexpected positive result of the increased remote work during the shutdown has been the increased interaction with customers due to the elimination of traditional communication structures like in-person meetings. (MacMillan 2020) However, the same CEO cautioned against getting overly excited about increases in remote work productivity during the shutdown and feels that short-term remote work productivity might be "artificial" and more difficult to realize long-term. (MacMillan 2020) During the quarantine shutdown, 50% of Facebook employees working from home report equal productivity to in-office work. (Rodriguez 2020) When given properly implemented, a successful work from home program makes work from home employees more productive than they were in the office; and there is even some evidence that work from anywhere employees are more productive than those working from home. There are a number of calculators available online that can be used to conduct cost savings estimates based on teleworking employees.

Employee Welfare

A literature review of commuting and wellbeing completed in 2019 found a number of conclusions about the connection between commuting and wellbeing, including overall negative impacts of commuting on subjective wellbeing "both during and after the journey to work," a decrease in commuter satisfaction with increasing commute, "loss of sleep and increased stress." (Chatterjee, et al. 2020) A recent UC Davis White Paper on the benefits of reducing car dependence found that California households spend, on average, approximately $9,000 per year on private vehicle expenses. (Handy 2020) In 2015, federal government telework employees were found to have increased job satisfaction, reduced employee turnover, and reduced

commuting expenses. (Graber 2015) Autommatic, Inc. has a very successful work from home employee program where no employee is forced to work in the office, each employee is provided with the newest technology and $2,000 to spend on a home office, and the company's travel budget provides for each team to meet in person twice per year. (Graber 2015)

Other Considerations

A 2020 study on working from home found that some work from home employees may be willing to accept less pay to work from home. (Baker and Berardino 2020) Mark Zuckerberg claims that 50% of Facebook's employees will be working from home in the next 5 to 10 years; however, Facebook plans to adjust employee salaries of remote workers to better match the cost of living in their geographical home location. (Rodriguez 2020) Square and Twitter plan to allow employees for permanently work from home following the quarantine shutdown. (Abril 2020) In 2008, Sun Microsystems allowed 19,000 employees to work from home and found that the average employee who worked remotely 50% of the time saved $1,700 annually on vehicle expenses. (Sun Microsystems, Inc. 2008) The work from home Stanford study found that attrition decreased by 50% for remote workers during the study and the travel company saved $2,000 in rent per employee on average. (Mautz 2018) Gallup reported that over half of office workers would change jobs for one offering more flexibility. (Hickman and Robison, Gallup 2020)

There are a number of tradeoffs employees are willing to make in order to work from home. Approximately 60% of employees would give up their dedicated high panel stations in common work areas or open office layouts. (Lister and North 2020) On the other hand, only about 50% of employees would not trade a private office at work for a work from home arrangement. (Lister and North 2020) Maybe the surprising takeaway here is that half of

employees would give up their private offices for the freedom and benefits that remote work offers. Nearly 75% of Chief Financial Officers indicate their intention to reduce corporate office space needs in conjunction with future WFH plans. (Lister and North 2020)

Case Study

This section applies the environmental and return on investment benefits to a business in an abbreviated case study format. The case study includes key assumptions about the changes in total numbers of employees working from home during the quarantine transition as well as assumptions about the total sustainable number of telework employees post quarantine. Based on the assumption, the total potential business environmental benefits and ROI will be calculated. The environmental benefits will be discussed in context with local and regional climate action plan goals as well as corporate social responsibility goals. Understanding the relationship between one company's decision to promote work from home policies and larger climate action goals is important for all stakeholders.

Background

Illumina was incorporated in 1998 and is headquartered in San Diego, California. Illumina is a multinational leader in genetic sequencing technology and has heavily contributed to reducing the cost and time of genomic sequencing. Illumina's business model relies heavily on innovation and spends a significant portion of earnings on research and development ($647 million in 2019, ~18% or 2019 earnings). Illumina has approximately 7,800 global employees, with approximately 4,000 employees in San Diego, and leases nearly 1.5 million square feet of office, laboratory, manufacturing, and distribution space in San Diego. One of Illumina's key risk factors to their business is the continued attraction and retainment of top talent, which is relevant to gains seen in employee satisfaction and retention from telework. Illumina released

their first Corporate Social Responsibility report in 2020. (Illumina, Inc. 2020) On January 24, 2020, the New England Journal of Medicine reported that the first complete viral genome of the novel coronavirus was completed, in part, on Illumina genetic sequencing technology (MiniSeq) at the Shanghai Public Health Center. (Zhu, et al. 2020) On March 17, 2020, Illumina announced, "precautionary measures focusing on the health and safety of our employees […] allowing employees to work remotely, where possible." (Illumina, Inc. 2020)

Company operations in the America's regions were impacted by COVID-19 shutdown and social distancing measures, however, despite these setbacks, 2020 Q1 results exceeded expectations. During the COVID-19 shutdown, research volume declined rapidly to 55% and stabilized in early April and clinical run volume declined at a slower rate for 4 weeks until mid-April where it stabilized at 80%. Illumina expects Q2 to be a challenging quarter with revenue declining in each region despite continues global operations, with the biggest risk to the Americas region due to border closures and declines in air freight. Illumina removed all guidance for the rest of 2020. Operating expenses are expected to remain relatively flat throughout 2020; however, operating expenses for the 2nd quarter are expected to decline by $40 million. Illumina has a strong focus on corporate social responsibility (CSR) and released their first CSR report in April of 2020. In their initial CSR report, Illumina reported total scope 1 and scope 2 GHG emissions of 42,054 MTCO2e in 2019, and 19,031 MTCO2e emission from operations in the Americas region. Illumina did not report scope 3 GHG emissions.

The global industry standards used by corporations to report GHG emissions are defined by the Greenhouse Gas Protocol. The GHG Protocol is, "a 20-year partnership between World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), GHG Protocol works with governments, industry associations, NGOs, businesses and

other organizations." (GHG Protocol n.d.) The corporate standards for GHG emissions reporting divides emission into three categories, called scopes. Scope 1 emissions are direct emissions from corporate facilities and vehicles, sources "owned or controlled by the reporting entity." Scope 2 emissions are indirect emissions from purchased energy for heating and cooling of corporate facilities, sources "owned or controlled by another company." Scope 3 emissions are indirect upstream and downstream emission from a number of sources, including purchase goods and services, capital goods, fuel and energy related activities, transportation and distribution of goods and services, waste generated in operations, business travel, employee commuting, leased assets, processing of sold products, franchises and investments; sources, "owned or controlled by other entities in the value chain." The EPA's Greenhouse Gas Reporting Program (GHGRP), "requires reporting of greenhouse gas (GHG) data and other relevant information from large GHG emission sources, fuel and industrial gas suppliers, and CO_2injection sites in the United States." (EPA n.d.) There GHGRP identifies 40+ categories of GHG reporters and establishes general requirements for submission of annual GHG reports when emissions exceed 25,000 MTCO2e under various conditions and categories. (EPA n.d.)

For reporting facilities, both scope 1 and 2 emissions are required reporting, while scope 3 emissions are considered optional. In reporting scope 3 emission, companies have a lot of leeway regarding what and how to report emissions data because of the potential for duplicate reporting. Often corporations choose not to report scope 3 emissions at all. Of the world's largest 200 companies, "78 […] do not report their Scope 3 emissions." (Sustainability Reports 2019) Corporations may have good reasons for not reporting their scope 3 emissions, but one of those reasons might be the sheer magnitude of emissions that fall into scope 3. The emissions data from companies that report scope 3, companies such as BASF, IKEA, PSEG, Ocean Spray,

Apple, and Kraft Foods, show that scope 3 emissions make up the vast majority of overall corporate emissions. In fact, one report found that scope 3 emissions, "are on average 5.5 times the size of a company's combined scope 1 and 2 emissions." (Schmidt 2020) Despite the proportional magnitude of scope 3 emissions, there are some real benefits from tracking and reporting scope 3 emissions data, including efficiency and cost savings, driving innovation, increasing sales and customer loyalty, improving stakeholder relations, and company differentiation. Emissions attributable to employee commuting to and from the office from auto, bus, rail, air, and other modes of travel is an upstream activity under emissions scope 3 (category 7) and can be calculated via one of three methods: fuel-based, distance, or average-data. The GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard also provides for optional accounting of emissions from employee teleworking.

Methods

There were three steps required in order to assess the GHG emissions impact from increased telework at a company like Illumina. The first step is to calculate the annual employee emissions for one employee working at Illumina. This is accomplished by multiplying the average round-trip commute distance for a San Diego resident (32.7 miles) by the amount of CO_2e grams per passenger vehicle mile in San Diego (415) and the number of workdays per year (235). Then, in order to extrapolate this to the entire San Diego workforce for a company the size of Illumina, we have to factor in the average employee EV vehicle, public transportation, walk/bike commute; as well as the number of pre-COVID WFH full-time equivalent employees (FTEE). The second step is to estimate the number of post-COVID WFH FTEE and calculate the CO_2e emission savings. Anecdotal industry information suggests a post-COVID WFH FTEE target of 45%. The final step is to assess the impact of annual telework emission savings

on local and state climate action CO2e emission reduction targets. This is accomplished by applying suggested WFH FTEE factors across San Diego and California industry labor categories and total labor numbers.

There are numerous factors which contribute to a corporate cost savings calculation for WFH telework employees, some of which we have already discussed. The primary factors include employee office space requirements, employee productivity, employee turnover, and employee welfare. Since specific company data was unavailable to use for the return on investment calculations, assumptions were made for each corporate cost savings category. Office space costs are estimated based on available regional data on office leasing costs per square foot. Employee productivity increases and employee turnover reductions are estimated using best available open source information on telework benefits. Overall reductions in emissions, water consumption, and landfill waste were calculated in proportion to suggested post-COVID telework employee office space reductions. Office space reductions are based on per employee average square footage requirements for a cubicle style employee desk arrangement (employee density). Average parking cost per space was estimated based on best available regional data.

Assumptions

Assumptions made for this project.

- Employees working from home:
    1. Pre-COVID – 15%
    2. Post-COVID – 45%
- EV factor – 15%
- Public Transportation factor – 5%

- Annual workdays:

  1. Regular – 235

  2. Vacation days per employee – 20

- Industry WFH factors:

  1. Information – 50%

  2. Financial Activities – 50%

  3. Professional & Business Services – 40%

  4. Education & Health Services – 10%

  5. Leisure & Hospitality – 10%

  6. Other – 10%

  7. Government – 30%

- Productivity increase – 4%

- Turnover reduction – 2%

- Employee density – 149

- Annual lease per square foot – $33.84

Findings

Findings from the calculations on emission reductions, corporate cost savings, and individual employee benefits.

- Annual emissions reduced by 2474 MTCO2e

- Annual corporate cost savings of $12, 981,523 or $7,172.11 per full time teleworker

- Annual individual teleworker benefits:

  o Commute time savings equivalent to 9 days per year

  o Fuel cost savings of $1,039

Other considerations

There are a number of other considerations regarding increased employee telework which weren't considered in this project but are worth briefly mentioning and may provide opportunities for additional research. Traffic monitoring during the quarantine shows that on-road traffic was significantly reduced during the height of the shutdown. Reductions in traffic mean potential reductions in road maintenance, traffic accidents, local air pollution, and wildlife impacts. There is some evidence that telework results in small decreases in overall vehicle miles travelled. Air travel should also be captured for employees who live in different geographic regions than their main office and who occasionally travel back. Differences in electricity use for a telework and an in-office employee should be considered. In home remote workers have different electricity demand profiles which might pair better with home solar systems as distributed energy resources.

Impact on Climate Action Goals

In order to measure the potential impacts of post-COVID19 telework levels on 2030 emissions reduction goals for both San Diego and California, I made optimistic assumptions about industry telework levels post-COVID19. I gathered Bureau of Labor Statistics data for San Diego and California labor levels in the most telework-friendly sectors, including Information, Financial Activities, Professional and Business Services, Education and Health Services, Leisure and Hospitality, Government, and Other; and applied various telework factors to each sector for each geographic region. The total percentage of full-time teleworkers across all identified telework-friendly sectors was estimated to be 28% for both San Diego and California. Applying the case study emissions calculations to San Diego and California telework friendly labor sectors yields some encouraging emissions reductions data. For San Diego, we

would expect an annual CO2e emissions reduction of 761,859 metric tons, which is nearly 10% of all San Diego emissions. For California, we would expect an annual CO2e emissions reduction of 8.2 million metric tons due to telework, amounting to nearly a third of the 25.4 million metric ton gap between 2030 targets and current best projections.

Policy Recommendations

This section makes recommendations promoting work from home policies. The recommendations will be separated into two categories, one for public policy makers and the other for corporate policy makers. Public policy maker recommendations are intended to enable successful work from home strategies with regard to infrastructure requirements and employee welfare needs. Corporate policy maker recommendations are intended to promote work from home policies designed to maximize ROI while minimizing negative environmental impacts. Understanding the positive impacts of the current work from home paradigm shift helps to capitalize on work from home policies moving forward.

Public Policy

1. Promote Community Design

Policy makers should support neighborhood and construction projects designed to support local communities. These projects should include increased residential energy efficiency, distributed energy resources, and broadband internet access. Additional considerations should be given to allocating significant portions of traditional street space to pedestrian travel.

2. Incentivize Corporate Telework

Policy makers should conduct cost-benefit analysis of planned traditional public transportation capital improvement projects vs. innovative telework incentive programs. Some suggestions for corporate telework incentive programs include providing a subsidy or tax break

to companies who meet certain remote employee thresholds, incentivize corporations to report all GHG emissions including scope 3 emissions, and investing public pensions in environmentally friendly businesses and green funds.

3. Incentivize Remote Workers

Policy makers should provide incentives to remote workers who work at companies within the region and for companies in other regions or states. Some of these incentives could include tax breaks for teleworking employees, subsidizing relocation costs for remote workers moving to San Diego, and contributing towards home office expenses for relocating employees.

4. Incentivize Remote Consumption of Services and Products

Policy makers should incentivize remote consumption of goods and services like telemedicine and entertainment. This can occur via promotion of rural broadband access throughout the region as well as strategic deregulation of barriers to remote services such as state medical licensing restrictions.

5. Maximize Public Sector Telework

Policy makers and government officials should encourage public sector employees to telework as much as possible in order to set an example to private industry about the public sector commitment to transportation emissions reductions. Government telework programs will save taxpayer dollars and reduce CO2e emissions.

Ripple Effects

This section examines the ripple effects of a work from home enabled workforce. First, we briefly discuss the permanence of the work from home effect beyond COVID-19 by considering stated intentions of nationally and globally prominent businesses regarding employee work from home policies. Second, we discuss industry and education trends

impacting work from home lifestyles. Finally, we speculate on potential impacts that working from home will have on other areas of society in the future.

Healthcare

The head of Kaiser Health anticipates 30% to 40% of doctor visits post quarantine will occur via telemedicine. During the quarantine 80% of patient visits occurred via telemedicine. There are barriers to acceleration and adoption of telemedicine, including regulatory changes, platform changes, medical licensure changes, and payment policies, but the healthcare industry and the public regulators have shown a willingness to adapt. The pros of telemedicine include things like convenience, safety, increased access to specialists, reduced time to diagnosis, cost, and increased choice. Some of the cons of telemedicine might be familiarity with technology especially for the elderly; continuity of care concerns; lack of personal touch; limitations of exams and missing of non-verbal cues, and patient trust in the care they're receiving. (Whyte 2020)

Education

During the quarantine shutdown, approximately 1.2 billion children have been removed from the classroom, including the single largest movement of students online in Wuhan, China. There are age and socioeconomic concerns with K-12 online education. Poorer students often don't have the technological support for online education in the home and younger students lack the attention capacity to prevent distraction in the home environment. That being said, there is research that remote students retain more information than their in-classroom counterparts and are able to learn the same material at an increased pace. (Li and Lalani 2020) The quarantine resulted in a massive shift of education from in-person to online, spiking demand in online exam monitoring software like ProctoU, Proctorio, HonorLock, and Examity. In San Diego, student in

K-12 schools could attend some form of blended system where they attend both in-person and via remote learning for the next 18 months. (Taketa 2020) Even UC San Diego's own chancellor admits that the shutdown has challenged traditional assumptions about remote learning and suggested that remote learning has the potential to "create opportunities for non-traditional and working students." (KPBS 2020)

Entertainment

There are a number of predictions about how the shutdown will impact the entertainment industry, including the elimination of the exclusive theatrical release window, increased growth in gaming and esports, expanded VR presence, and evolution of the traditional movie theater experience. (Csathy 2020) Apple recently acquired NextVR for an estimated $100 million. (Spangler 2020) The entertainment industry is expected to take a $160 billion hit over the next five years due to the quarantine and its aftermath, including a $24.4 billion setback to the theater industry alone. (D. Bloom 2020) The consensus among analysts and observers is that the long-term trend towards online consumption of entertainment has been rapidly accelerated due to the COVID-19 shutdown. One CBS news poll found that 70% of respondents prefer to consume new releases in the comfort of their own homes. (Mowod 2020) *Trolls World Tour*, sequel to 2016 motion picture release *Trolls*, was released on video-on-demand during the shutdown as a $20 rental. After $100 million in rentals in just three weeks, *World Tour* surpassed its predecessor's 5 month run at the box office in total return to the studio (studios retain 80% of digital release sales compared with 5% of box office sales). In response to the earning of *World Tour*, Universal Studios announced their intention to release future motion pictures on both video-on-demand and in theatre simultaneously. (Schwartzel 2020)

Paradigm shifts in healthcare, education, and entertainment may lead to further transportation sector emission reductions as consumers spend less time and energy travelling back and forth to the service location. We should willingly embrace increasingly remote consumption of these types of services. The argument is not to suggest that people should remain always stuck in their homes, unable to travel or enjoy leisure or other activities outside their primary residence. In fact, my view is just the opposite, by providing more options for in-home healthcare, education, entertainment, work, etc., you free up time and energy folks would otherwise spend travelling back and forth between the various activities of their lives for other pursuits. In effect, by embracing remote connections to our daily activities, we improve the environment and give people back their time and their freedom.

Conclusion

Some say that telework has been a failure of imagination. I don't know that I would agree with that sentiment. Sometimes it's easier to 'see' the future then it is to understand the path on how to get there. From an efficiency standpoint – that is conservation of energy and optimization principles – telework makes sense. Vast amounts of energy, primarily from fossil fuels, are used in transporting commuters, consumers, and other travelers from one location to another in order to expend (transfer) additional amounts of energy at the destination of choice. If the same work can be done (energy expended) at two different locations but the only difference is that one location requires additional energy expenditure just to get there, then it's obviously more efficient not to expend transportation energy for the sole purpose of conducting the same work in a different location. Basically, what happens when we engage in work at a second location requiring a commute, we increase the overall energy expenditure, or energy input, of the final service or product. Since most of the energy used in transportation comes from fossil fuels,

this means that unnecessary transportation in the form of employee commuting increases the

CO2e input of goods and services throughout the operational lifecycle of that product or service.

Of course, the key assumption here is that the work done in either location is equivalent. What

the COVID-19 shutdown has demonstrated is that much of the work in various industry sectors

when done from home is equivalent to, or better than, work done in the office. Telework, when

embraced by the organization, with the right resources, the right positions, the right employees,

and the right processes in place to empower the teleworker, provides benefits to the triple bottom

line of the environment, the company, and the individual, which can't be ignored. Even more

significantly, a paradigm shift in telework will have significant impacts on reducing overall

CO2e emissions from the transportation sector, helping us achieve our climate action goals, not

just in San Diego and California, but globally as well. The climate problem is a global one, but

local action like increasing and maximizing telework will have lasting positive impacts on the

environment and our future. It's time for our imagination to become reality.

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