Energy Implications of Hybrid Work: Insights from a Large-Scale Employee Survey

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Abstract. Hybrid work encompasses both physical and digital environments, involving tasks performed in offices, homes, and other locations. Despite growing awareness of hybrid work's benefits, its energy implications remain largely unexplored, particularly due to the limited understanding of how employees' work patterns and behaviors affect overall energy demand. Through a large-scale employee survey in Belgium, this study investigates how hybrid work practices influence energy demand, focusing on employees' commuting behaviors, consumption habits, social practices, and organizational factors. Through statistical methods relationships are explored between hybrid work practices, energy considerations, and energy-related behaviors. The results show consistency with assumed relationships, such as a negative correlation between time spent working from home and time spent in the office, or a priority for home-based work when allowed the flexibility. Data revealed that energy awareness did not significantly influence work-related decisions, while hybrid work intensity appeared to impact energy considerations – with lower energy considerations demonstrated by dominant office workers. Additionally, no relevant correlation was found between energy awareness and commuting choices, suggesting that practical factors like comfort and wellbeing may play a more significant role.

1. Introduction

Advancements in communication technology are changing how we define a workplace, with virtual environments increasingly being added to physical work locations (ARUP, 2023). Hybrid work (HW) is transforming the traditional concept of an 'office,' which is evolving from spaces focused on shared facilities, to those centered on collaboration, culture-building, and talent acquisition. The adoption of HW practices has accelerated since the global pandemic, and the potential for productive work beyond traditional office spaces has already been demonstrated (Guerin, 2021). This is significant within the built environment, since HW offers an opportunity to address emerging challenges – such as the need for work flexibility, the health and well-being of employees, and the efficient use of available space (ARUP, 2023). However, despite such advantages, a complete switch to remote working away from physical office spaces is not feasible (Cappelli, 2021) since collaborative activities within physical work environments have been reported to benefit from in-person interactions (Levine & Prietula, 2014; Mantesi, Chmutina, and Goodier, 2022). Effectively, even in the post-pandemic era, a continued demand for office spaces has been emphasized towards fostering collaboration, and for addressing the social needs of employees (Aroles et al., 2021).

The environmental implications of HW, particularly its implications on energy demand, are not well understood. Specifically, there is a lack of clarity on how HW can reduce (or shift) energy consumption across home and office spaces (Belzunegui-Eraso & Erro-Garcés, 2020; Cappelli, 2021). For instance, although some studies suggest that HW reduces commuting energy use, the increased reliance on digital platforms and home-based work raises questions about residential energy consumption and its net impact (ARUP, 2023). Existing studies also tend to overlook the complex interplay between physical office spaces, home offices, and the broader energy and environmental implications of this transition (Tiwari, Pal, and Khandelwal, 2023). Moreover, uncertainties around optimal energy management in hybrid setups tend to hinder the development of sustainable policies (Halford, 2005). This highlights the critical need for studies that investigate the broader environmental implications of HW, focusing on how it shifts energy demand between home and office settings. To address this gap, empirical research is needed to understand the nuanced impacts of HW on energy demand and to provide actionable insights for sustainable decision-making.

This study investigates the influence of HW practices on energy consumption in Belgium's key employment sectors and explores the effect of commuting behaviors, consumption habits, and social practices. The study also examines how organizational characteristics such as company policies shape the energy implications of HW. By focusing on data collected from a large-scale employee survey, the study aims to identify key factors shaping energy consumption and to establish a foundation for understanding the long-term implications of HW through future longitudinal analysis.

The analysis is conducted on a dataset from a large-scale employee survey conducted in Belgium, which gathered responses from 7691 participants across diverse activity sectors. The survey is part of an interdisciplinary project called Sustaining Hybrid Work (SUSHY), funded by The Belgian Science Policy Office (BELSPO). This study focuses on the challenges of HW from the perspective of energy performance. The analyses aimed to quantify the relationships between HW practices and energy considerations, focusing on variables such as organizational policies, commuting behaviors and energy use habits. Statistical methods, such as, Pearson and Spearman correlation analysis, and the Mann-Whitney U test, were used to explore associations, test variability, and identify significant patterns within the data.

2. Methodology

The first wave of data collection was conducted from October to December 2023, using an online survey designed and administered using the Qualtrics platform. The questionnaire covered five main areas: HW practices (such as frequency of remote work, location preferences, and control over work schedules), energy-related behaviors (such as respondents' energy considerations during HW, adjustments to heating and cooling systems, lighting conditions, and spatial arrangements while working from home, the impact of HW on their overall energy consumption, and their commuting habits, including distance, time, and mode of transportation), socio-demographics (such as age, gender, education, and other background variables), job performance and productivity, and well-being. The survey was made available in English, French, and Dutch to accommodate Belgium's multilingual population. For respondents' privacy, the survey was fully anonymous. However, the participants could provide their email addresses if they wished to be contacted for the project's next phase.

Through the two months of data collection, 7691 volunteering participants completed the survey, representing responses from various sectors – with the public sector, banking, insurance, IT, education, and research leading both in survey distribution and response rates. To ensure relevance to the study's objective, participants were required to be employed in Belgium and to be actively engaged in HW practices. For verification, the survey included an item regarding their involvement in HW, and those responding "No" were excluded from further analysis.

For the data analysis, a structured approach driven by four preformulated hypotheses was taken to examine the relationship between HW practices and energy demand. General trends were identified via descriptive statistics that revealed general behaviors and preferences, following which, initial tests were conducted to evaluate the normality of variables and consistency in the dataset. The key hypotheses were then tested to explore relationships between HW practices and energy-related behaviors, and appropriate statistical methods were applied based on the individual data structure. Correlation analyses, such as Pearson and Spearman correlations examined relationships between variables, while comparative tests, including Mann-Whitney U tests and Chi-Square analyses, were performed to compare groups and assess differences based on HW behaviors.

3. Results

3.1. Initial descriptives

The survey respondents were primarily females (70.6%), with 44.7% respondents living as couples with children, and 30.5% working in the Public Administration and Defense sector, and 47% working in large offices that employed over 250 people. Half of respondents have completed at least a Master's degree, and nearly all (98.3%) of them are allowed to work remotely (with 18.4% often required to do HW due to organizational policies). A majority (75.8%) report having medium control over their remote work schedules, averaging 2.6 days per week if allowed to do HW. 74.4% work from their offices several times a week, while 68.2% work from home several times a week. 77% of the sample has been engaged in HW since 2020. 44.9% of the respondents strongly disagree that energy use is the main factor that decides where and when they choose to work, with 58.7% perceiving that their overall energy use has increased due to HW. 57.3% believe that HW reduces their fuel use, while 70% report an increase in their home lighting energy use. 36.8% of respondents rely on public transport, while 35.4% commute by car, averaging 2.8 days of commuting per week.

3.2. Hypotheses results

3.2.1. Hypothesis 1: If employees are allowed to work remotely, they will prioritize working from home.

The relationship between time allocation across different work locations was investigated, and the prioritization of various HW environments was evaluated, such as home-working, on the go, in public spaces, and in co-working spaces. By tabulating frequencies, it was identified that employees who decrease their office working hours tend to increase their hours working from home (Table 1), thereby ensuring the consistency with the expected relationship. A chi-square test to evaluate the association between these variables yielded $p<0.05$, indicating a statistically significant link. Spearman's rank correlation analysis was performed to further examine the nature of this relationship, considering the correlation between home and office work and the relationships between all work locations (Table 2). The analysis revealed a moderate negative correlation between working from home and working from the office, suggesting that employees who spend more time working from home tend to work less from the office, demonstrating an inverse relationship.

Table 1. Crosstabulation of work frequency: Employer premises vs. home.

			Working from home frequency *(coded as HW6_1)*					
			0	1	2	3	4	Total
Working from premises frequency *(coded as HW6_2)*	0	% within HW6_1	6	5.3	5.3	23.8	59.6	100
	1	% within HW6_1	0	2.5	4.1	51	42.3	100
	2	% within HW6_1	0.1	1.2	20.6	69.6	8.5	100
	3	% within HW6_1	0.5	4.5	16.9	77.1	1	100
	4	% within HW6_1	33.6	38	18.5	6.2	3.6	100

0: rarely or never, 1: once or twice a month, 2: several times a month, 3: several times a week, 4: daily

Table 2. Spearman's rho correlation coefficient matrix for different work locations.

	Premises	Home	Public	Client	On the go	Co-working
Premises	1	-.381**	-.041	-.067	-.04	.011
Home	X	1	.058**	.004	.071**	-.006
Public	X	X	1	.184**	.307**	.168**
Client	X	X	X	1	.227**	.090**
On the go	X	X	X	X	1	.116**
Co-working	X	X	X	X	X	1

[r<0.1 (not practically relevant), 0.1<r<0.3 (small effect. Highlighted in light shade grey), 0.3<r<0.5 (moderate effect, highlighted in medium shade grey)]
**. Correlation is significant at the 0.01 level (2-tailed).

3.2.2. Hypothesis 2: A desire to reduce their energy use, leads employees to prefer hybrid work.
Most of the respondents (74%) reported to follow a HW schedule during the week; yet, about half of these (corresponding to 33% of the total sample) reported paying very little attention to energy use in their work-related decisions (Figure 1). Across the various Pearson correlations between employees' responses, no practically relevant associations were detected between energy awareness and HW practices. This result was obtained also when considering only specific sub-samples, such as higher-income employees or those commuting over 100 km to reach their work premises. However, according to Mann-Whitney U tests, differences in energy consideration were observed based on employees' frequency of working from premises (Figure 2). Table 3 presents the effect sizes and indicates a small difference in energy considerations between individuals who go to the premises daily and those from other groups. It also suggests that HW intensity may influence energy-related choices, as employees working more often from their office showed lower energy consideration compared to those with a higher frequency of HW practice.

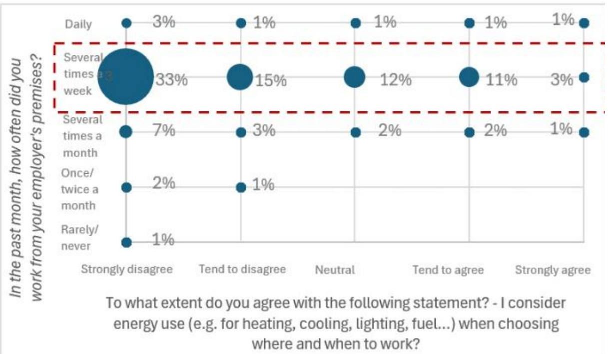

Figure 1. Distribution of HW intensity by levels of energy consideration.

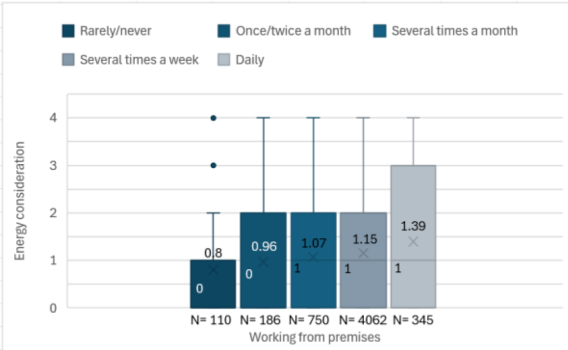

Figure 2. Boxplot of energy consideration by frequency of working from premises.

Table 3. Effect size matrix for energy consideration based on working from premises frequency.

		Working from premises				
		Rarely/never	Once/twice a month	Several times a month	Several times a week	Daily
Working from premises	Rarely/never	X	0.059	0.071*	0.046**	0.181**
	Once/twice a month	X	X	0.036	0.034*	0.144**
	Several times a month	X	X	X	0.027	0.103**
	Several times a week	X	X	X	X	0.042**
	Daily	X	X	X	X	X

Refer to Table 2. For legend.

3.2.3. Hypothesis 3: Employees with high awareness of their energy use, are more likely to use public transportation for commuting.

Although public transport was the dominant mode of transportation (36.8%), half of the respondents (50.6%) commute using either their own or via company car. When examining energy considerations based on transportation choices, individuals who use personal cars show slightly higher energy considerations than others. Alternatively, those using company cars exhibit slightly reduced consideration for energy use – which was again consistent with general expectations (Figure 3). However, no practically relevant associations were detected between energy awareness and modes of transportation, with practically relevant correlations observed only between commuting modes, such as between "company car" and "own car" and between "on foot" and "public transport”. The findings indicate that commuting decisions are mostly influenced by the selected transportation mode, rather than considerations for energy-use.

3.2.4. Hypothesis 4: Employees inclined to reduce their energy footprint, would adjust home heating/cooling/lighting while working from home.

The descriptive analysis demonstrates that individuals with lower energy consideration are likelier to report "never" or "rarely" heating/cooling adjustment. In contrast, those with higher energy consideration are more inclined to report "sometimes," "often," or "always" making such adjustments. However, the relationship between heating/cooling/lighting adjustments at home and energy consideration is less pronounced, suggesting considerable variability in individual behavior (Figure 4). A chi-square test reveals a statistically significant association between energy consideration and heating/cooling/lighting adjustment. Despite this, Spearman's correlations between employees’ responses only identified practically relevant associations between energy consideration and heating/cooling adjustment (Table 4). Furthermore, a moderate positive correlation was found between heating/cooling adjustment and lighting adjustment at home (coefficient = 0.347). This indicates that individuals who adjust one are generally more likely to adjust the other, suggesting a potential link between these two behaviors.

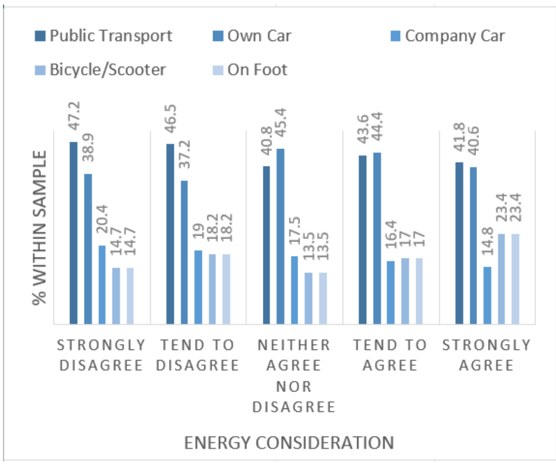

Figure 3. Distribution of transportation mode preferences by levels of energy consideration.

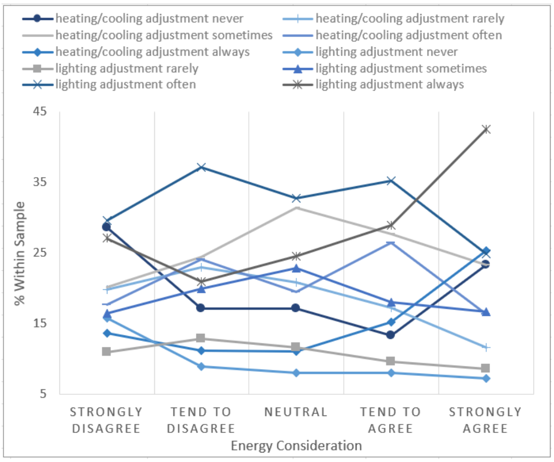

Figure 4. Energy consideration levels by heating and lighting adjustments at home.

Table 4. Correlation coefficients for energy consideration and heating/cooling/lighting adjustments.

	Energy consideration	Heating/cooling adjustment	Lighting adjustment
Energy consideration	1	.120**	.069**
Heating/cooling adjustment	X	1	.347**
Lighting adjustment	X	X	1

Refer Table 2 for legend.

4. Discussion and Conclusion

This research contributes to the growing body of literature on HW by investigating the potential relationships between HW practices and individuals' energy considerations, as well as energy-related behaviors in Belgium, based on a large-scale survey. The discussion and conclusions from this study are as follows:

- As employees allocate more time to working from home, their time spent in the office decreases, and conversely, when their time in the office increases, time spent working from home decreases. This inverse relationship suggests that employees tend to prioritize home-based work when given the flexibility, leading to a more balanced time allocation between office and home.
- Energy awareness did not play a major role in the respondents' work-related decisions. However, there are small differences in employees' energy considerations based on the frequency of their work from the premises. This suggests that HW intensity may influence energy-related behaviors, with employees who spend most of their time working from their premises demonstrating lower energy considerations than other HW profiles.
- No practically relevant correlation was found between energy awareness and transportation modes, suggesting that commuting behaviors may be influenced more by practical factors, such as commuting distance, comfort, and time. It emphasizes the need to consider other variables that may have a more substantial impact on commuting decisions.
- Individuals with high energy considerations tend to adjust their heating and cooling systems while working from home. However, significant variability exists in individual behaviors, suggesting that factors beyond energy awareness may also influence these decisions.

This study is part of a broader longitudinal effort to track changes and trends in HW and energy behaviors over time. Further research is needed to explore these dynamics more comprehensively, considering variables including sociodemographics, well-being, job performance, and productivity.

Acknowledgments

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