Flexibility in the Domestic Energy Sector: Insights from Hybrid Working Patterns

Theme 1, sub-topic 1a)
☒ "Academic contribution"

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Extended abstract

1. INTRODUCTION

The transition to net-zero presents both challenges and opportunities for global energy systems. One emerging focus is the impact of increased remote working—especially post-COVID-19—on domestic energy use. With more people working from home, there's potential to shift demand away from peak times, easing pressure on the grid and supporting demand-side management and renewable integration.

However, evidence remains limited on how remote workers use energy at home and their capacity for behavioural flexibility. The role of Working from Home in grid balancing and its difference from office-based energy use is still underexplored.

As part of the Energy Demand Observatory and Laboratory (EDOL) project, this paper shares pilot findings that test methods and offer early insights into home energy behaviours. These will inform the analysis of a larger dataset from 3,806 households.

By identifying flexibility patterns and intervention points, the research supports demand-side strategies that could help decarbonise residential and commercial sectors by lowering peak demand and reliance on fossil fuels.

2. Methodology

This study employed a mixed-methods approach, combining qualitative and quantitative data collection tools to explore energy-related behaviours among WFH and non-WFH households. The methodology included a pilot study followed by a broader household survey considering time-use patterns, appliance usage, occupancy, and behavioural flexibility in the context of remote working.

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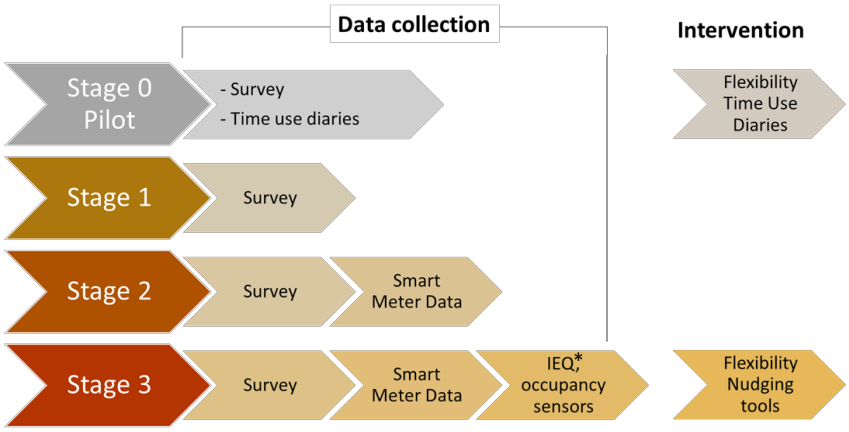

Figure 27: Overview of data collection phases and methods across EDOL study stages. (Note: IEQ = Indoor Environmental Quality).*

Insights from the pilot informed the next project stages. Conducted with 23 households (14 fully completing all phases), the study explored how households adapt and manage energy use beyond price signals. Qualitative methods, such as appliance-use diaries, revealed everyday energy practices and household dynamics. The trial took place over a three-week period in December 2024 and was structured into three main stages:

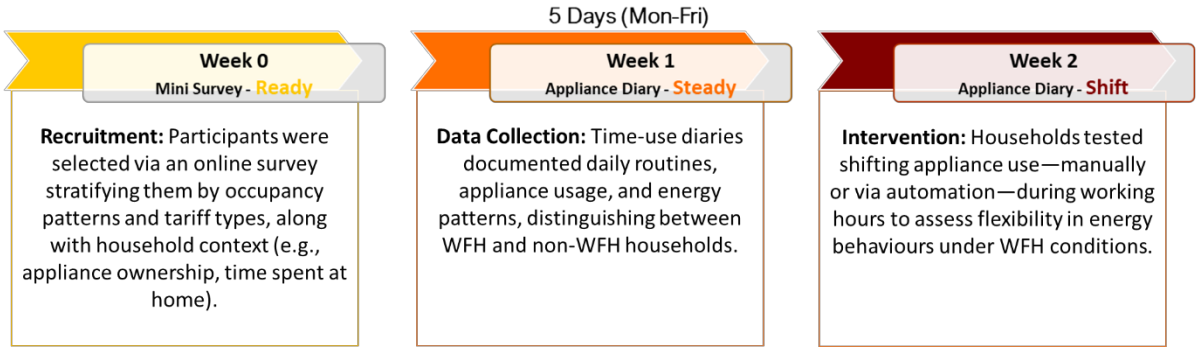

Figure 28: The pilot's different stages of data collection and a flexibility intervention conducted over a three-week period.

3. Findings

Findings from the pilot highlight that household occupancy patterns are likely to support energy flexibility, but that these patterns can include caregiving or retirement, as well as WFH. Energy flexibility is deeply social and contextual, shaped by routines, roles, spatial arrangements, and technologies. Social relations—like family needs, caregiving responsibilities (whether alongside WFH or not), and shared values—play a central role in shaping energy decisions. Daily practices such as cooking, laundry, cleaning, and bathing are often rigidly structured and shaped by gender roles. However, some flexibility in timing and sequencing does emerge, especially when routines are disrupted by competing demands—such as shifting family dynamics captured through a chore-assignment app, changes in electricity tariffs, or supplier-led flexibility opt-in events. A few households used automated functions (e.g. scheduled or programmed appliance operation), actively managing and reconfiguring timers and smart devices to better suit the needs of their everyday lives [1].

3.1.EDOL Survey

Insights from the pilot informed the design of selected questions included in the EDOL 2025 Survey that would help Inform occupancy profiling and that explore appliance and EV ownership: Examine ownership by household size to understand its effect on energy demand.

This analysis examines correlations between occupancy, appliance ownership, and usage practices across a sample of 3,806 households. These findings will inform the next phase, which integrates smart meter data to validate and enrich the survey results.

4. RESULTS

Early EDOL survey findings highlight working-from-home trends at both the individual and household level. The comparison between current working-from-home frequency data and lockdown-era findings offers complementary insights into the evolution of remote work. Figure 3 shows that a significant share of respondents now work from home or engage in caregiving at home three or more times per week. While the graph provides a snapshot of current household-level work-from-home frequencies [2], adds depth by highlighting how these patterns shifted within households during a period of societal disruption. It provides a temporal and household-level perspective, capturing shifts in work-from-home practices before and during the COVID-19 lockdown. The analysis showed 61.4% of households saw no change, 30.9% an increase, and 7.7% a decrease in time spent at home—highlighting both the rise of remote work and its varied, context-dependent evolution.

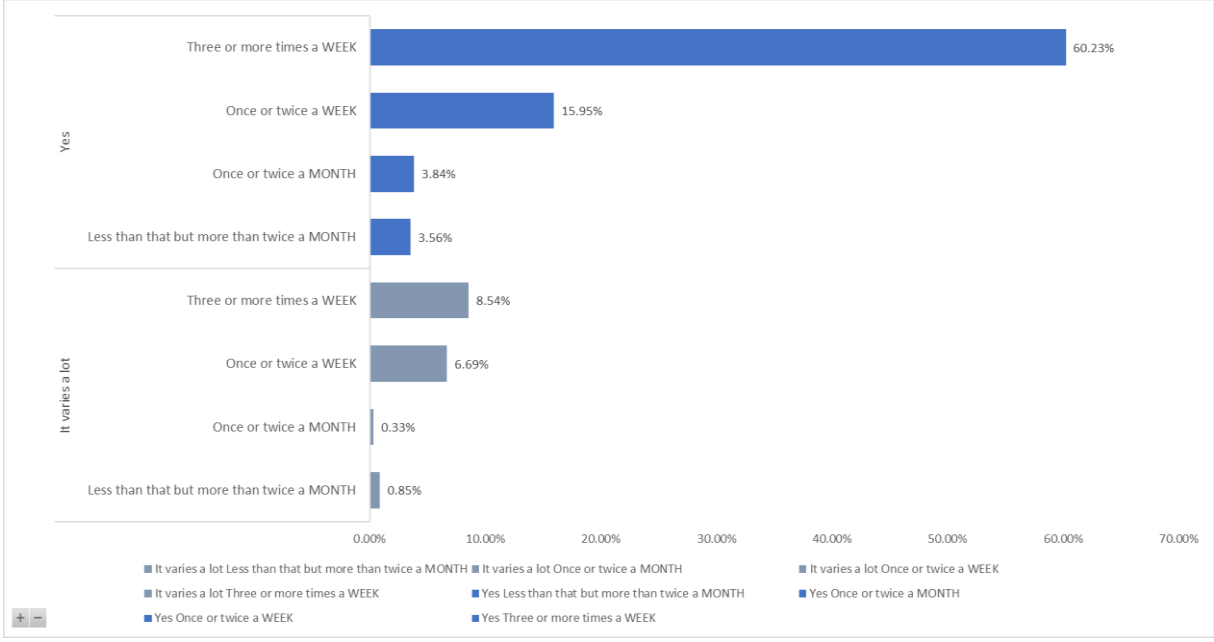

Figure 29: Patterns and frequencies of weekday home occupancy due to remote work, caregiving and other activities.

The EDOL survey (n = 3,806) shows widespread ownership of core appliances: refrigerators (97%), TVs (95%), vacuum cleaners (93%), laptops (89%), washing machines (88%), and irons (87%). Modern kitchen devices are also common, with 73% owning microwaves or air fryers, and 65% owning dishwashers. Cooking appliances are split between gas hobs (49%) and electric alternatives (45%). Smart tech adoption is growing —45% use smart assistants and 20% smart plugs. Mid-level ownership includes electric showers and freezers (40%), heaters (33%), and fans (28%). Less common items include gas ovens (16%), washer-driers (11%), and electric drying racks (9%). These trends reflect a strong reliance on traditional appliances, with gradual uptake of smart and efficient technologies.

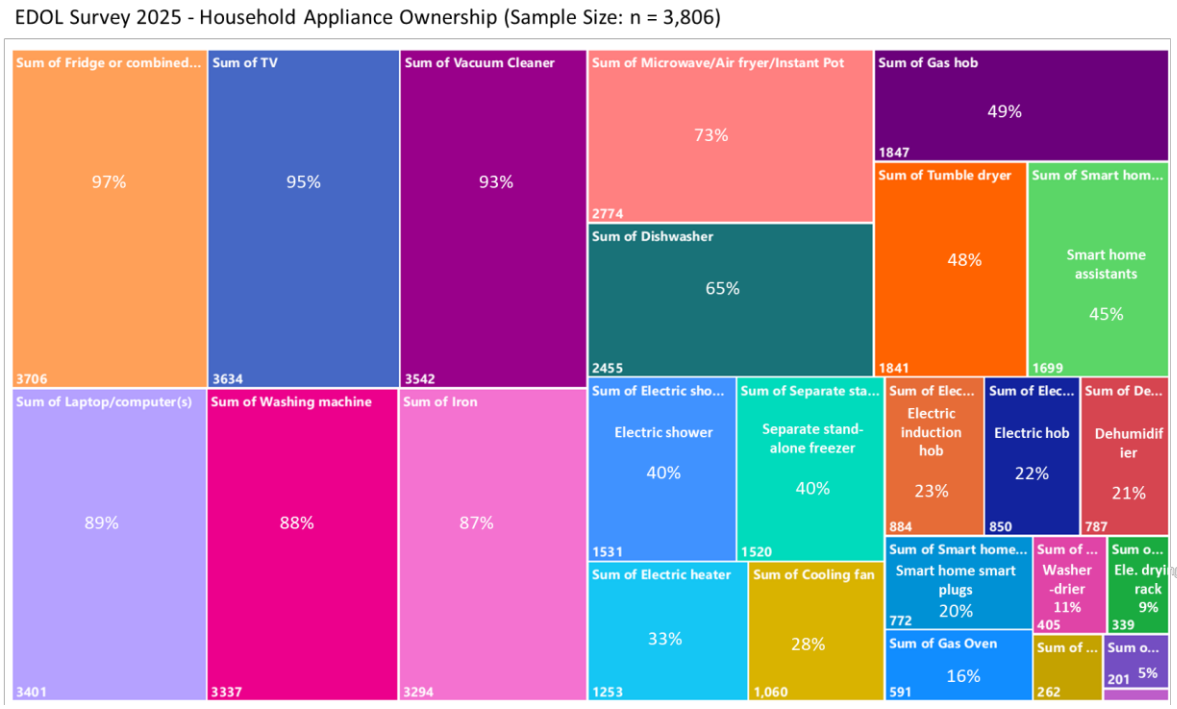

Figure 30: Prevalence of household appliances among UK respondents (EDOL Survey 2025 n = 3,806).

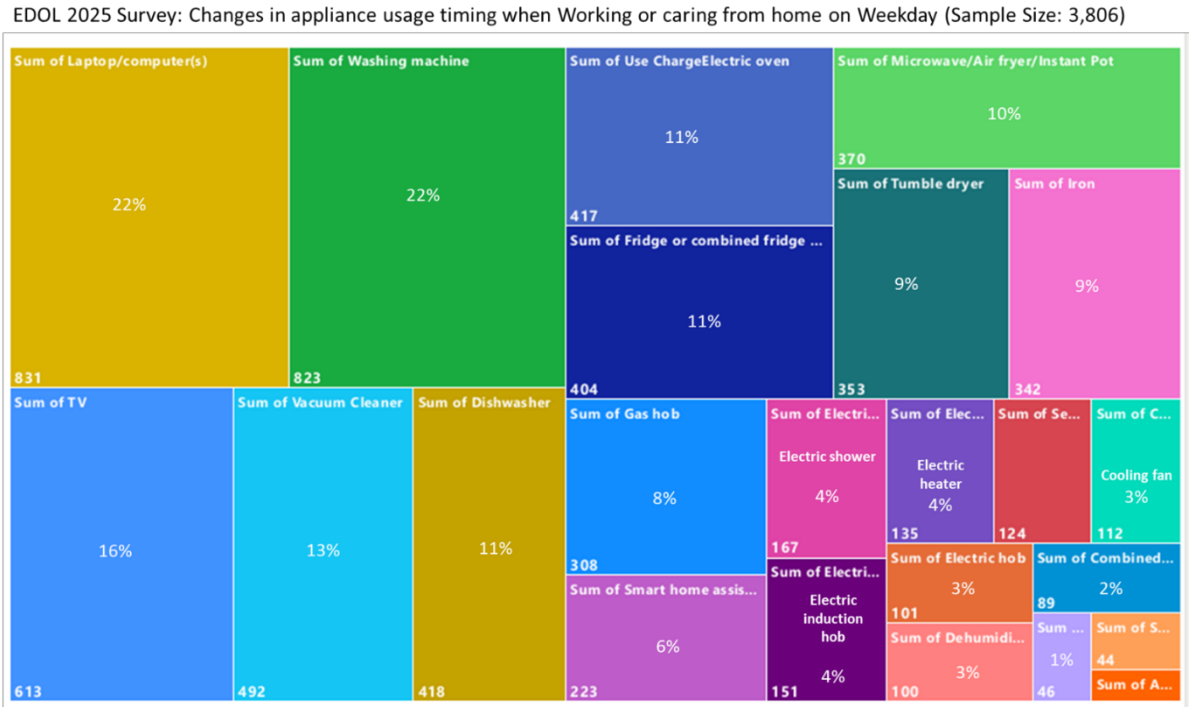

Figure 31: Changes in Weekday appliance usage when working or caring from home (n = 3,806).

A comparison of appliance ownership and weekday use during remote work or caregiving shows clear gaps between possession and flexible use. Despite high ownership—TVs (95%) and vacuum cleaners (93%)—weekday use is low (16% and 13%, respectively). Laptops and washing machines, each owned by over 88%, show the strongest alignment with use (22%), reflecting their role in WFH routines. Common appliances like microwaves, ovens, and dishwashers (48%–73% ownership) are used by only 9%–11% of households. Smart devices also show limited use—6% for assistants and 4% for plugs—despite moderate uptake. These

findings highlight that ownership alone doesn't reflect flexible or frequent use, reinforcing the need to assess actual engagement in energy behaviour.

5. DISCUSSION AND NEXT STEPS

Scaling the pilot methodology to a national level poses technical and logistical challenges. While the pilot offered valuable insights into occupancy, appliance use, and behavioural flexibility, applying these methods at scale requires streamlined tools, harmonised data, and attention to participant diversity. Simplified diaries or passive sensing may be needed to capture time-use patterns without overburdening participants.

Survey data reveal clear trends in ownership, occupancy, and flexibility, but these self-reported behaviours must be validated. Integrating smart meter data will enable real-time analysis to confirm reported flexibility—such as shifting appliance use during WFH—and detect load-shifting potential.

Next steps include building dynamic models using survey data, smart meters, and IEQ sensors to identify segments best suited for demand-side response. In parallel, selected households will test behavioural nudging tools—like feedback, automation, and incentives—to evaluate their impact.

This work ultimately supports equitable, user-centred flexibility strategies, contributing to a more inclusive and resilient path to net-zero.

Acknowledgements
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6. REFERENCES

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