Estimating Flexibility Activity in SSEN's Licence Areas: An initial Data-Led Assessment

Date/version: March 2025 / Version 1

A Report by ElectraLink in Collaboration with Scottish & Southern Electricity Networks

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Executive summary

Understanding the flexibility potential of domestic and small non-domestic consumers remains one of the more complex and underexplored challenges in energy system transition — particularly at the distribution level. This research was initiated in response to a request from Scottish and Southern Electricity Networks (SSEN) seeking to explore whether available data could be used to estimate or proxy flexibility activity within its licence areas, recognising that such an exercise would necessarily involve a number of assumptions and analytical constraints.

We approached this task by leveraging elective half-hourly settled (EHHS) smart meter data — the only readily available dataset with the temporal granularity required to observe short-term changes in consumption behaviour at scale, which ElectraLink has access to through the Data Transfer Service (DTS). While EHHS MPANs currently represent only a small subset of domestic customers nationally, the dataset provides a unique opportunity to identify behavioural patterns with high resolution and test scalable methodologies for flex detection.

From this, we aimed to produce an initial indication of potential flexibility activity — not to derive exact figures, but to identify the shape, scale, and variability of responses, and in doing so, uncover the areas where further research and industry coordination will be most impactful.

The analysis identified consistent signals of reduced consumption during known flexibility events among a subset of consumers, suggesting visible patterns of response even without direct participation data. A refined baseline methodology applied to selected events enabled estimation of proxy metrics for flexibility delivered per MPAN, highlighting measurable shifts in behaviour.

While limitations in data consistency and granularity remain, this work can demonstrate that meaningful insights can be drawn from existing datasets. The work for this analysis has already laid much of the analytical groundwork, from identifying and processing relevant data sources, refining filtering approaches to navigating known challenges in data behaviour. Furthermore, by incorporating real-world context that supports the interpretation of observed behaviours within the flexibility landscape, we now have a solid and tested methodology that can be enhanced, replicated and scaled.

Key findings: Indicative Flexibility Estimates and Scaling Potential in SSEN areas

Across the four national flexibility events and one locally SSEN instructed event analysed, the results consistently showed observable reduction in consumption during instructed periods, indicating discernible patterns of response and flex activity. Building on these findings and applying industry-aligned baseline methodology, we estimated average responses ranging from **0.068 kWh to 0.254 kWh per MPAN** among participating consumers in the 3 national and 1 local event further analysed. In parallel, the addressable market was estimated using available smart meter data and connectivity status classifications by ElectraLink, identifying approximately 363,697 eligible meters in North Scotland and 1,805,503 in Southern England. Based on a **weighted average per-MPAN reduction of 0.170 kWh,** and applying this to the estimated addressable market, the total **indicative flexibility volume is estimated at approximately 61.828 MWh in North Scotland and 306.935 MWh in Southern England.** Considering that the analysis focused on 1-hour event windows, this corresponds to **a potential 0.368 GW of demand reduction capacity across all SSEN areas.** This estimate is based on currently installed meters; thus, the potential could be significantly higher as the smart meter rollout progresses or is completed. While indicative and subject to key caveats described in detail in the report, such as participation assumptions, limited visibility of multi-hour response behaviour and FSPs dispatch instructions, event specific-dynamics, and representativeness of EHHS data, these figures and analysis provide not only a first indication of measurable consumer-led flexibility, but also a practical foundation for future modelling, profiling, targeted scenario testing and greater industry collaboration.

Introduction

With the uptake of consumer-led flexibility increasing and network constraints becoming more pressing, understanding how domestic consumers and micro-businesses engage with and contribute to flexibility has become an area of growing strategic importance for Distribution Network Operators (DNOs) and Distribution System Operators (DSOs) specifically. Despite this, it remains a developing area of analysis, particularly at the distribution level.

In this context, SSEN and ElectraLink explored whether it would be possible to estimate or assess the magnitude of current and near-term flexibility uptake within SSEN's licence areas.

This report investigates how existing data sources can be used to begin quantifying flexibility activity and provide initial proxy metrics and insight into the magnitude, behaviour and impact of consumer-led flexibility with SSEN's area. The main aim was to establish a strong foundation for profiling and modelling the demand-shifting capabilities of domestic consumers and micro-businesses. Understanding how their aggregated flexibility could influence grid stability – whether as an opportunity to optimise network performance or a challenge requiring careful management – is crucial.

Background

This work began by identifying which data sources could be used to assess flexibility activity, with the EHHS smart meter consumption data emerging as the most viable option. It was understood from the outset that such an approach would require a degree of assumptions and inference. A preliminary exploration of the data was carried out to test whether meaningful response patterns could be observed, and when early signs became visible, the case for a more structured and detailed analysis was established.

Objectives

This research aimed to explore whether existing smart meter data could be used to estimate or proxy the flexibility activity. Whilst the original aim was to explore domestic and small non-domestic consumers, this initial assessment focused on domestic profiles. Recognising the inherent complexity and data limitations in this space, the goal was not to produce definitive metrics, but to assess whether short-term consumption shifts — potentially linked to flexibility events — could be observed and interpreted using EHHS data.

Specifically, the analysis sought to:

1. Identify if signals of flexibility response could be detected in EHHS smart meter data during selected national and local events.
2. Gauge the scale and consistency of consumption reductions among subsets of consumers.
3. Develop a proxy metric of response and volume at area level, providing an initial indication of potential demand-side flexibility while acknowledging the indicative nature of the results.
4. Understand the assumptions and analytical approaches required to interpret such signals.
5. Highlight limitations, data challenges, and behavioural ambiguities — including the role of different types of flexibility, such as embedded.
6. Establish a foundation for future analysis and industry collaboration, with the aim of improving visibility of domestic-scale flexibility and informing next steps in research and policy.

Analytical framework

Initial framing and early design choices

The analysis approach began setting out the overarching structure and design logic that guided the research, presented below:

1. Assess data availability using ElectraLink's EHHS dataset to understand granularity, coverage and consistency
2. Align with available flexibility signals to scope relevant analysis windows
3. Explore the data through initial interrogation to identify patterns, noise and early indicators of response.
4. Set key assumptions and capture limitations
5. Conduct high-level analysis using the assumptions
6. Develop a proxy metric to estimate flexibility response based on observed responses
7. Reflect on confidence and validation needs.

While work began with a planned sequence of analyses, the iterative nature of the data exploration led to refinement and the emergence of additional strands of analysis. As a result, each core analysis – overall consumption and high-level response identification, national event-level comparisons, behavioural checks, and local DNO event analysis – is described in its own section, with the specific methodology, assumptions and filtering steps applied to that strand. This modular approach allowed for targeted interrogation, while supporting comparison and synthesis across findings.

Introduction to EHHS dataset use

A key starting point for this work was determining which data could meaningfully support the investigation. Whilst ElectraLink holds complete consumption records at monthly level via mandatory DTS flows, this does not have the necessary resolution to observe changes in electricity consumption at a granular level. Instead, we drew on EHHS data, of which there are around 1 million meters in the UK. Although suppliers are not obligated to submit this data, a subset do and the data we receive primarily now represents what we believe to be the largest EHHS dataset available outside individual suppliers' systems. While not comprehensive, this dataset provides a substantial and scalable sample for system-level research, one that to our knowledge is not accessible elsewhere outside of suppliers' environments. It forms the best available foundation for assessing flexibility at this scale and resolution.

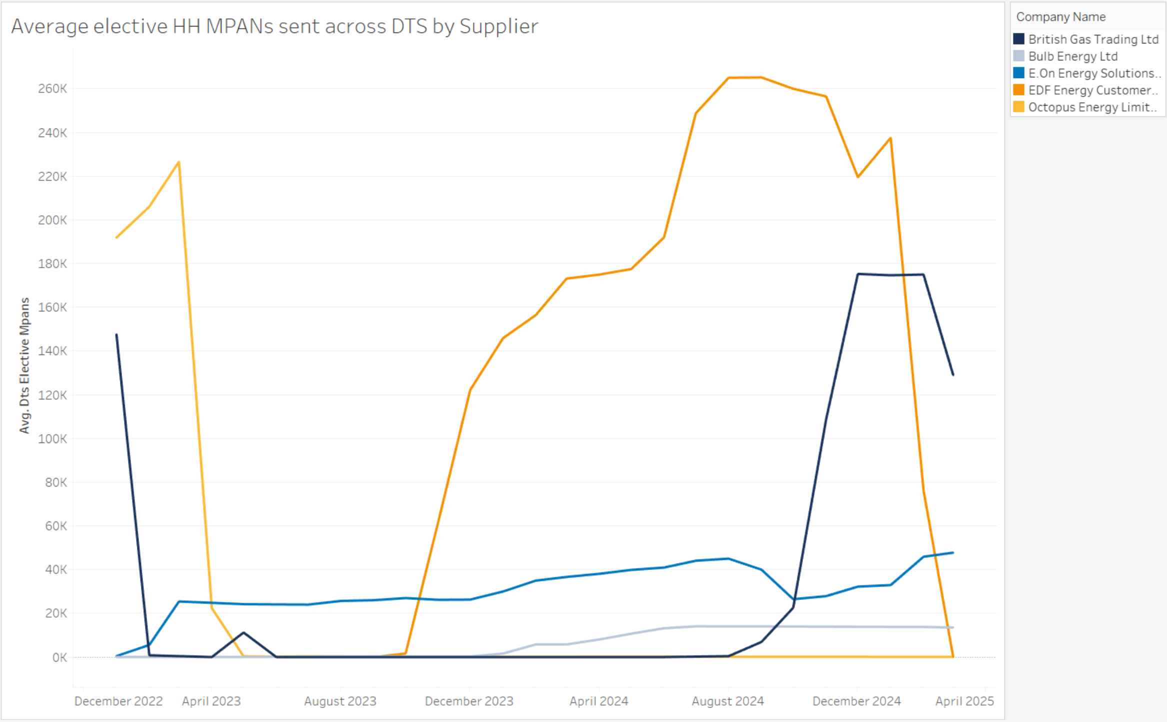


Figure 1: Suppliers sending EHHS data in different time periods

The table below provides a breakdown of the data available within SSEN areas as a foundation of the data available. This is not intended as a direct funnel or filter into the analysis, it offers a useful view of the data landscape across the SSEN area.

Licence Area	Domestic MPANs	Smart MPANs (SMETS 1 and 2)	Elective HH MPANs	Elective HH MAPNs with consumption data
Total SSEN	3,691,902	2,312,745	195,531	42,053
Southern England (H)	2,904,156	1,918,707	166,506	37,034
Northern Scotland (P)	787,746	394,038	29,025	5,019

Table 1: Breakdown of MPANs within SSEN licence area.

Separately, the dataset used for the event analysis was based on **59,177 MPANs** of domestic profile for which we had EHHS consumption data on at least one of the selected event days.

Event selection

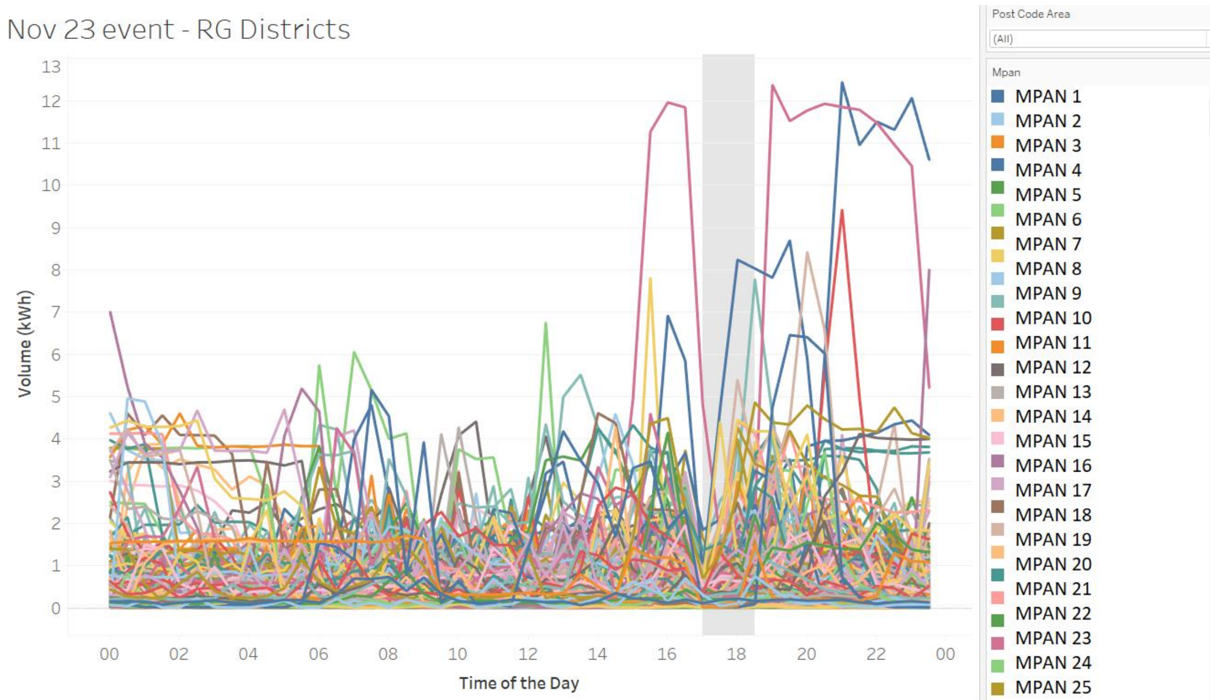
To support this investigation, we selected a set of four national flexibility events as the focal points of analysis. These events were chosen based on their wide-scale participation, clear system-level signals and prominence within the industry, particularly as part of the early roll-out of the Demand Flexibility Service (DFS) during Winter 2022–2023. These events were not only publicly reported and discussed across the energy sector but also demonstrated measurable demand response at the national level, making them a suitable starting point for assessing flexibility activity.

The table below summarises the dates and durations of the four national DFS events analysed in this study. At the time of initial data extraction, a one-hour window was selected for each event to enable consistency across comparisons and reflect the common format of early DFS events, also noting that most of the new, year-round DFS events are all between 2 and 3 hrs of duration. All selected events took place during the winter season, to control for the significant differences in energy consumption and flexibility behaviour between winter and summer months.

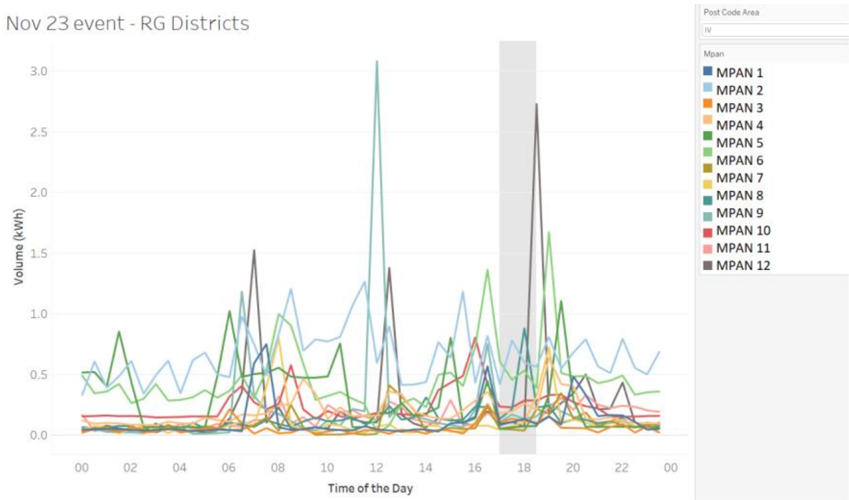
DFS Event	Date	Selected Analysis window	Instructed Duration (by NESO)	Notes	Predominant Supplier Data in EHHS Sample
Event 1	29th November 2023	17:00 to 18:30	17:00 to 18:30	Full event aligned with selected window	EDF, EON
Event 2	8th February 2024	18:00 to 19:00	18:00 to 19:00	Full event aligned with selected window	EDF, EON, Bulb (Octopus)
Event 3	11th December 2024	18:00 -19:00	16:00 to 19:00	Initial 1-hr analysis window; full event spanned 3 hrs	EDF, EON, Bulb (Octopus), British Gas
Event 4	8th January 2025	17:00 -18:00	16:00 to 19:00	Initial 1-hr analysis window; full event spanned 3 hrs	EDF, EON, Bulb (Octopus), British Gas

Table 2: Summary of analysed flexibility events and supplier data coverage.[1]

The analysis began with an initial review of EHHS consumption data around the selected national flexibility events. This high-level exploration aimed to detect any immediate or obvious changes in aggregate consumption patterns that might suggest a response to the events. However, it quickly became clear that the dataset was highly variable and noisy, making it difficult to identify clear signals without further refinement.



[1] NESO Demand Flexibility Service DFS Utilisation Report



Figures 2 and 3: examples of noisy consumption data in a postcode district.

Data coverage and continuity challenges

As also noted in the introduction to the EHHS dataset, the challenges of data consistency and completeness in supplier reporting became evident when analysing the events. The availability of data varied across different time periods and events, often due to changes in supplier participation, temporary gaps in data flows, etc. In some cases, MPANs appeared present in a dataset overall, but lacked valid data consumption for a specific event dates or settlement periods. As a result, data completeness was not uniform across all periods, requiring a structured approach to refine the dataset for meaningful analysis.

This posed a methodological challenge: not all events could be directly compared because the datasets were not consistent in their scope and coverage. Instead, the analysis had to adapt, applying event-specific filtering criteria to ensure that only MPANs with complete data coverage for each individual event were included. While this approach enabled meaningful analysis within each event, the findings are not directly comparable across events due to underlying differences in data coverage.

To account for these challenges, we applied data filtering criteria to ensure that only MPANs with valid, continuous half-hourly records were included in our analysis. This was particularly important when assessing short-term consumption variations, as inconsistencies in data transmission could otherwise distort observed trends. This refinement process enabled us to establish a more reliable dataset, although it also highlighted the inherent limitations of supplier-led EHHS data availability.

Refining the Analysis: Filtering for Meaningful Trends

To enhance the robustness of the analysis, a sequence of data filtering and segmentation steps were applied:

1. Ensuring Data Completeness: MPANs were filtered to include only those with full consumption records for the settlement periods corresponding to each selected event. This ensured that gaps in reporting did not distort the findings.

2. Identifying Potential Demand Reduction: MPANs were further filtered based on whether their consumption dropped by at least 35% compared to the immediate settlement periods preceding the event. This was chosen as a pragmatic balance, it represents a meaningful reduction likely to prompt household and small businesses engagement, while avoiding a level so high that it would exclude a significant portion of users.

Data analysis and results

Comparative Four Events analysis

This part of the analysis explores whether a visible signal of flexibility participation can be identified across selected DFS events, using the above-described dataset and filters. For each event, we visualised average consumption across groups of MPANs, focusing on those that appear to show a meaningful reduction in usage during the event window.

To show the exploration and comparison of potential flexibility response across events, we included the following figures:

1. The first graph (figure 4) shows the total daily consumption across all elective MPANs in SSEN's areas without any filters.
2. Subsequent graphs (figures 5-8) are for each event. In these graphs, two filters were applied:
    a. Data availability: MPANs must have valid consumption data for the full duration of the selected event window. This ensured that only reliable data was used for comparison.
    b. Response indicator: A flag was applied for MPANs that showed a ≥35% drop in consumption during analysed event window, compared to the immediate previous settlement period – aiming to identify a real-time drop indicator.

These figures are intended to illustrate the progressive filtering and interpretation of MPAN-level consumption data, rather than to provide definitive participation metrics. Together, they support a comparative view of how response patterns evolve under different filtering conditions.

To support interpretation of the event-day consumption graphs, the table below summarises the number of MPANs that passed each stage of the filtering logic. It first shows how many had valid consumption data during the relevant settlement periods for each event, and then how many of those exhibited a ≥35% drop in usage. These groupings correspond to the "Yes" and "No" categories visualised in the subsequent graphs.

Event	Data available on event Settlement Periods	Dropped consumption by 35%	
	Yes	No	Yes
Event 1	13,018	11,211	1,807
Event 2	19,054	15,891	3,163
Event 3	49,033	42,471	6,562
Event 4	45,258	38,383	6,875

Table 3: Summary of MPAN counts by event and filter criteria.

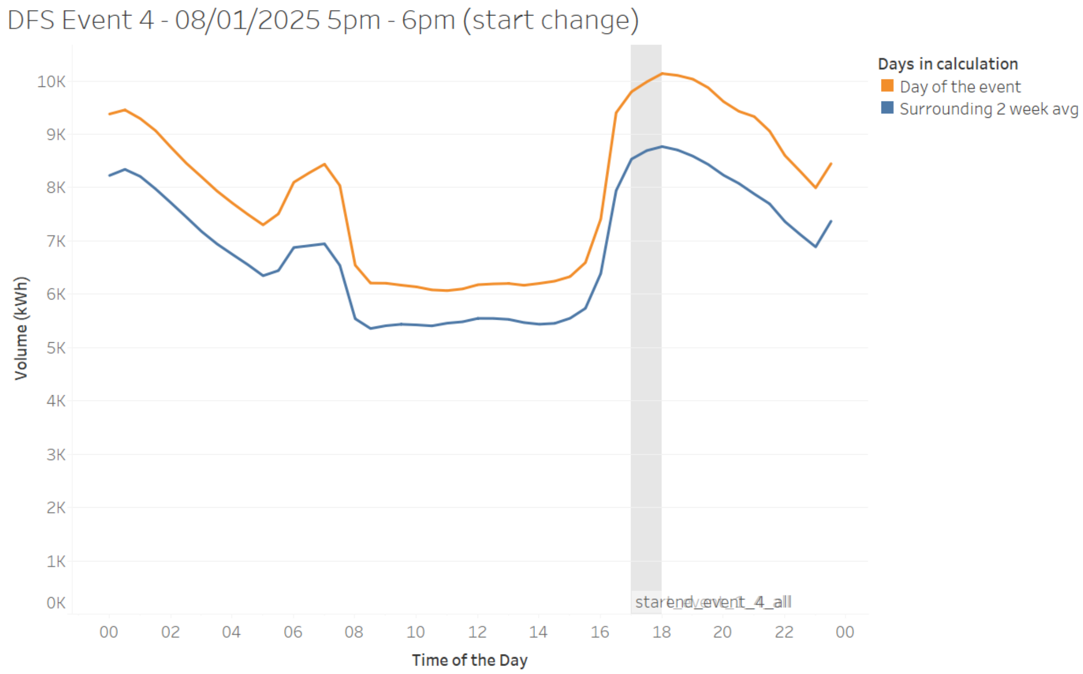


Figure 4: Total daily consumption across all elective MPANs in SSEN's areas without any filters.

As mentioned in the data sources section, the number of available EHHS MPANs varies between events — in some cases more significantly such as from event 1 and 2 compared to 3 and 4 — due to supplier data availability at the time. As a result, comparisons of total consumption volumes across events are not meaningful and unfiltered daily consumption graphs have not been included. Instead, we focus on filtered views that apply consistent criteria to ensure interpretability of potential response patterns.

Each chart below displays the total consumption (in kWh) per settlement period for MPANs that both had valid data during the event and showed a ≥35% drop in consumption at the start of the event window.

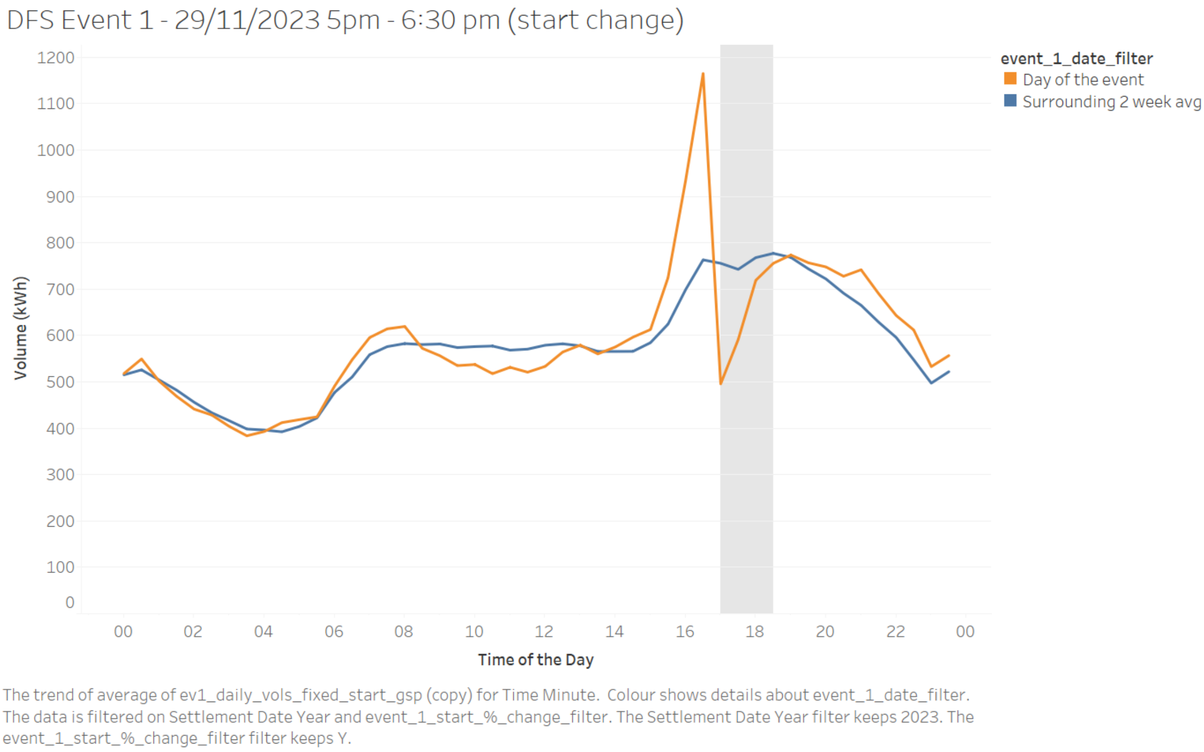


Figure 5: Average consumption of MPANs with ≥35% drop (event day vs baseline)

The orange line represents the total event-day consumption across this filtered group of MPANs (the YES cohort).

The blue line represents the average consumption across the same settlement periods during the week before and after the event (excluding the event day) for the same MPANs. This included both weekdays and weekends at this stage.

This like-for-like comparison illustrated the extent to which consumption on the day of the event differed from typical usage patterns for the same group of MPANs.

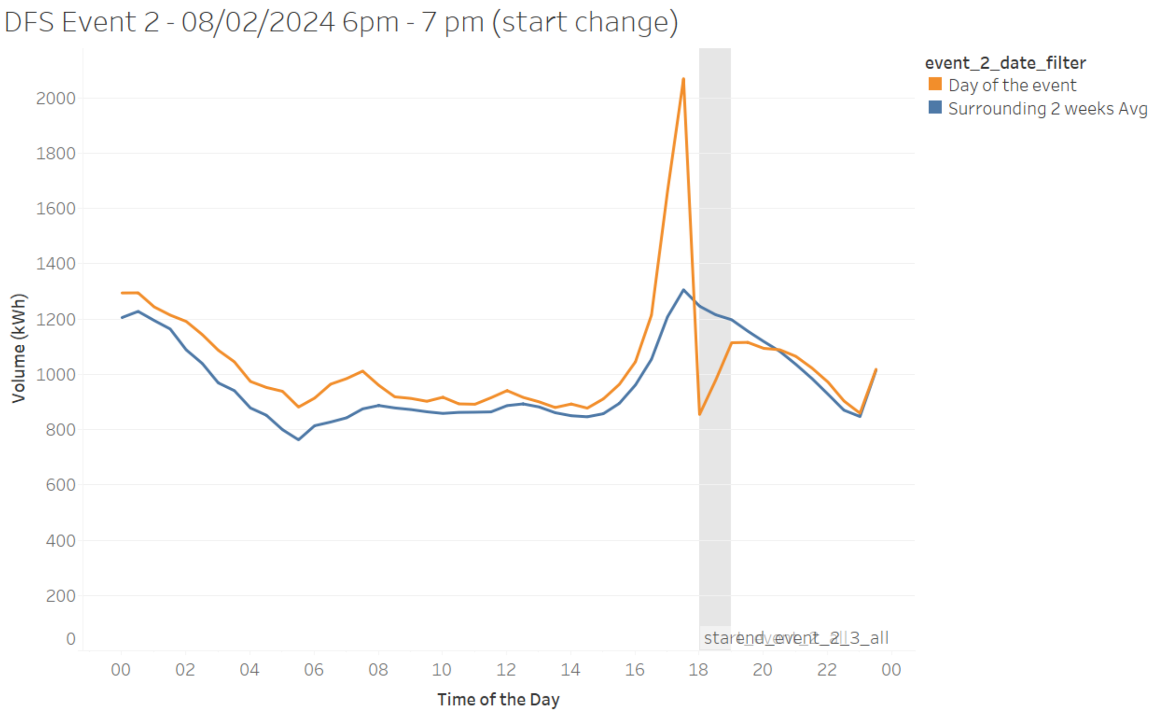
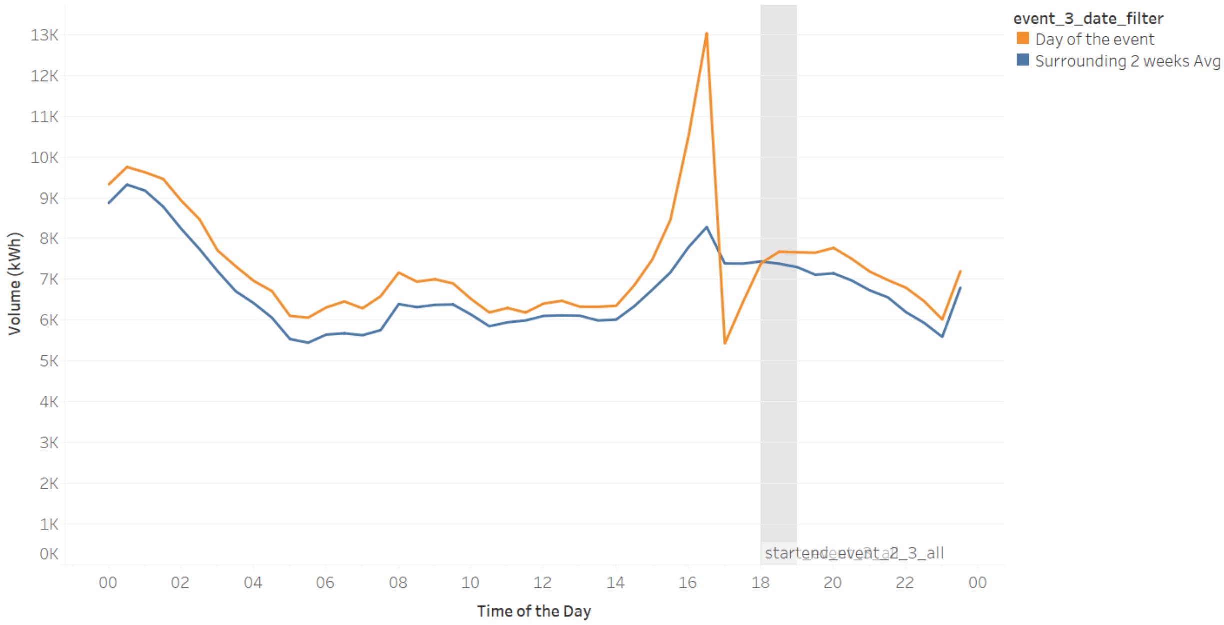


Figure 6: Average consumption of MPANs with ≥35% drop (event day vs baseline)

DFS Event 3 - 11/12/2024 6pm - 7 pm (start change)



The trend of average of ev3_daily_vols_fixed_start_gsp (copy) for Time Minute. Colour shows details about event_3_date_filter. The data is filtered on Settlement Date (MY) and event_3_start_%_change_filter. The Settlement Date (MY) filter keeps December 2024. The event_3_start_%_change_filter filter keeps Y.

Figure 7: Average consumption of MPANs with ≥35% drop (event day vs baseline)

DFS Event 4 - 08/01/2025 5pm - 6pm (start change)

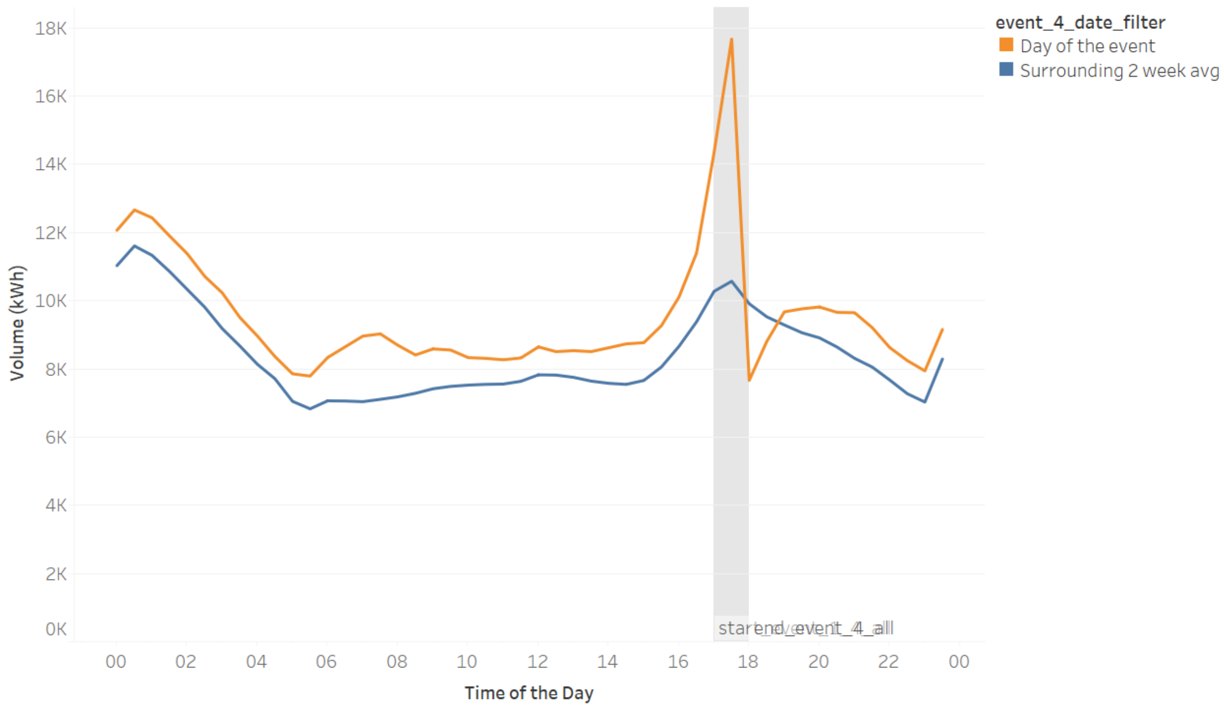


Figure 8: Average consumption of MPANs with ≥35% drop (event day vs baseline)

Findings

While the underlying time window for each event was initially limited to one hour for consistency, it is recognised that some events had instructed durations of up to three hours. In the graphs, the shaded area corresponds to the one-hour window originally used for analysis, but in some cases, a reduction in consumption can also be observed outside this period, aligning with the broader instructed window. See the ***Note on Event Duration and Interpretation** below that led to the incorporation of further analysis.

Across all selected events, a consistent pattern was observed in aggregate consumption behaviour. **One of the main observations is that in each case, a visible drop in electricity usage was evident and broadly aligned with the event windows, suggesting a potential response to the flexibility signal.**

At first glance, they are all remarkably similar. Whilst the magnitude of the response varied by event, the shape of the consumption curves followed a broadly similar trajectory. The repeated pattern across multiple events provided early evidence of systematic behavioural shifts among segment of consumers, reinforcing the rationale for developing a more refined, metric-based analysis.

On the other hand, it also evidenced that the number of MPANs meeting the ≥35% reduction threshold was relatively low, suggesting that participation in flexibility events remains limited among domestic consumers. However, a broader trend of gradual consumption reductions was observed even among MPANs that did not meet the ≥35% threshold, indicating that lower-level responses may still be occurring.

In some cases, a recovery or rebound in consumption is visible following the event window, raising questions about potential overcompensation behaviour — although this requires further investigation.

Another observation is that in each of the charts, a spike in consumption is visible just before or at the start of the flexibility window. This may indicate several things, including pre-event load shifting, or could reflect other routine patterns not directly related to flexibility signals. While this behaviour is not conclusive on its own, its recurrence across multiple events suggests it may warrant further investigation, particularly in relation to automated or pre-programmed responses.

It is worth stressing that these filtered charts only reflect the consumption and behaviour of MPANs that passed the ≥35% drop threshold. As such, they do not show whether other MPANs – those who did not meet the threshold – may still have reduced their consumption to a lesser extent but still responding to an event in a lesser extent. While the filtering logic could be adjusted to explore different levels of response, doing so opens up a wide range of combinations and would require a more extensive and targeted analysis. Given limited time and scope, this report focused on a single comparison across events. Further research could explore the impact of alternative thresholds and investigate whether different levels of response correlate with distinct consumer behaviour or archetypes.

Testing the Nature of Observed Drops: Rebound Filtering and Timing Considerations

In addition to the 35% drop filter, we explored whether a subsequent increase in consumption after the event window could further indicate active participation. The rationale was that a post-event rebound may signal temporary suppression of demand, typical of instructed flexibility. This was tested on **event 3**.

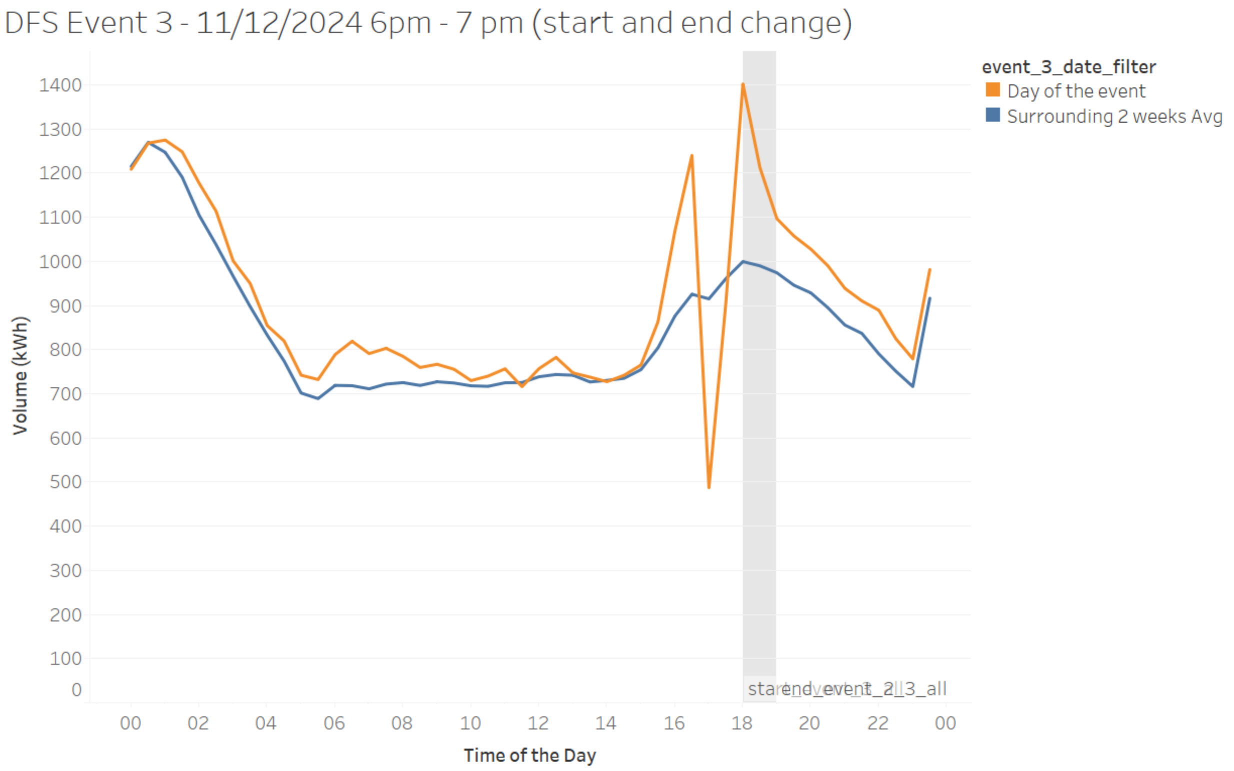


Figure 9: Exploratory test: event 3 MPANs showing consumption drop at start and increase at end of selected event window

The results showed that the number of presumed responders, or flex participants, reduced from 6,562 to 2,532 with the application of this added filter.

One of the most notable effects was the post-event ramp-up in consumption, which in some cases exceeded pre-event levels. This raises a hypothesis around possible over-compensation behaviour following flexibility delivery — whether intentional or coincidental — and invites further investigation. Multiple factors may be at play here, including deferred usage, behavioural rebound or automation schedules. However, the interpretation of this ramp-up is subject to several assumptions which will need to be tested with richer contextual data in future work.

While the concept is analytically valuable, the findings were inconclusive, partly because event durations were often two to three hours, and as mentioned earlier, the likely supplier strategy of staggered customer participation. Further exploration of this approach — especially in collaboration with suppliers who can confirm their dispatch strategies — is recommended for future analysis.

*** Note on Event Duration and Interpretation**

While this initial high-level analysis showed clear and repeatable drops in consumption across all four selected DFS events — closely aligning with the timing of dispatch instructions from National Grid ESO — those findings were based on a simplified framing of each event. At the time of data extraction and analysis, we focused on a one-hour event window for each case, largely informed by the format of early winter events and the need to act quickly to establish a comparable time window across events. In some instances, the actual instructed flexibility window spanned closer to three hours (as most new year-round DFS events from November 2024).

This simplified framing was a practical and necessary starting point, but as the analysis progressed, it became clear that narrowing the event window may have excluded part of the actual response — particularly in cases where suppliers likely delivered flexibility in staggered blocks or where consumer behaviour extended beyond the originally selected hour.[2] **This reflection highlighted the need for more structured and quantifiable assessment**.

In response, a more refined analysis was incorporated and carried out for Event 3 and subsequently for events 1 and 2. This allowed for a clearer view of concentrated response behaviour and provided an opportunity to apply a more structured baseline and filtered cohort. In the "Refined event-level flexibility estimation using baseline comparison" analysis section, we present this and include commentary on the treatment and challenges of analysing multi-hour events.

Before introducing the refined baseline-based approach, the following section presents a behavioural comparison using non-event periods, to further test the uniqueness and reliability of the observed event day patterns.

Behavioural Check Using a Non-Event Control Week

To support interpretation of the event-day results, we conducted an additional comparison using a non-event control week. This analysis used the same cohort of MPANs identified as having responded during event 3 (i.e., those with a ≥35% reduction), and examined their behaviour across the weekdays of 18–22 November 2024 — a period with no known flexibility events.

The aim was not to build a baseline, but to test whether similar reductions occurred independently of any event signal. This helped assess whether the observed drops on event days were unique, or part of a broader behavioural trend. While some minor reductions were observed during the control week, the scale and shape of the response on the event day remained distinct, supporting the interpretation that the event itself likely triggered participation among a subset of MPANs.

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[2] Suppliers participating in DFS may allocate flexibility delivery across their portfolio, meaning different customers may be instructed to reduce consumption during different intervals within the broader event window. For example, one group of customers may be asked to reduce demand between 16:00–17:00, while others may respond between 18:00–19:00, all contributing to the same event delivery.)

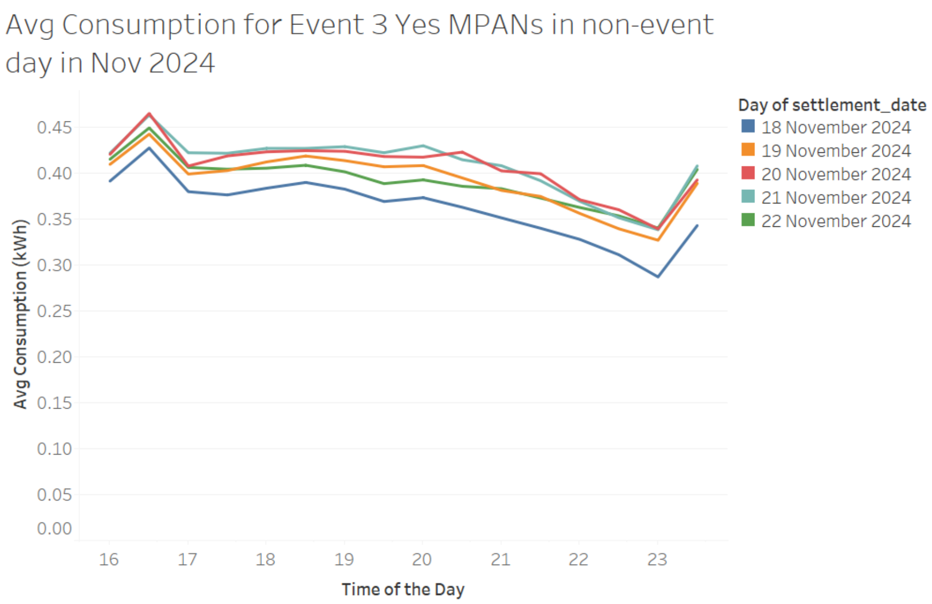

Figure 10: Average consumption of presumed respondents in Event 3 during a week with no known events.

While there may be some level of consistent behavioural reduction among certain users, the distinct shape and timing of the response during Event 3 is unlikely to be coincidental. That said, it's also worth noting that a large proportion of the EHHS MPANs available in our dataset — particularly for event 3 — are EDF consumers and they could be responding to their Sunday Saver challenge, where consumers are encouraged to shift some of their electricity use away from weekday peak hours (16:00-19:00) to earn free hours of electricity the following Sunday[3]. Further investigation, particularly in collaboration with suppliers, would be needed to isolate these effects more conclusively.

Analysis – comparison across licence areas

Given the distinct characteristics of the two licence areas included in this analysis—one in the north of Scotland and the other in southern England—some variation in flexibility response was anticipated from the outset. These areas differ in terms of climate, population density, infrastructure, smart meter rollout and customer composition, all of which can influence both electricity consumption behaviours and the visibility of those behaviours in the data.

Using the filtered subset of MPANs that met the ≥35% reduction threshold, we compared the proportion and distribution of apparent responders across the two areas. While overall levels of detected response remained low in both, some variation in the share and shape of reductions was observed.

[3] EDF Sunday Saver challenge

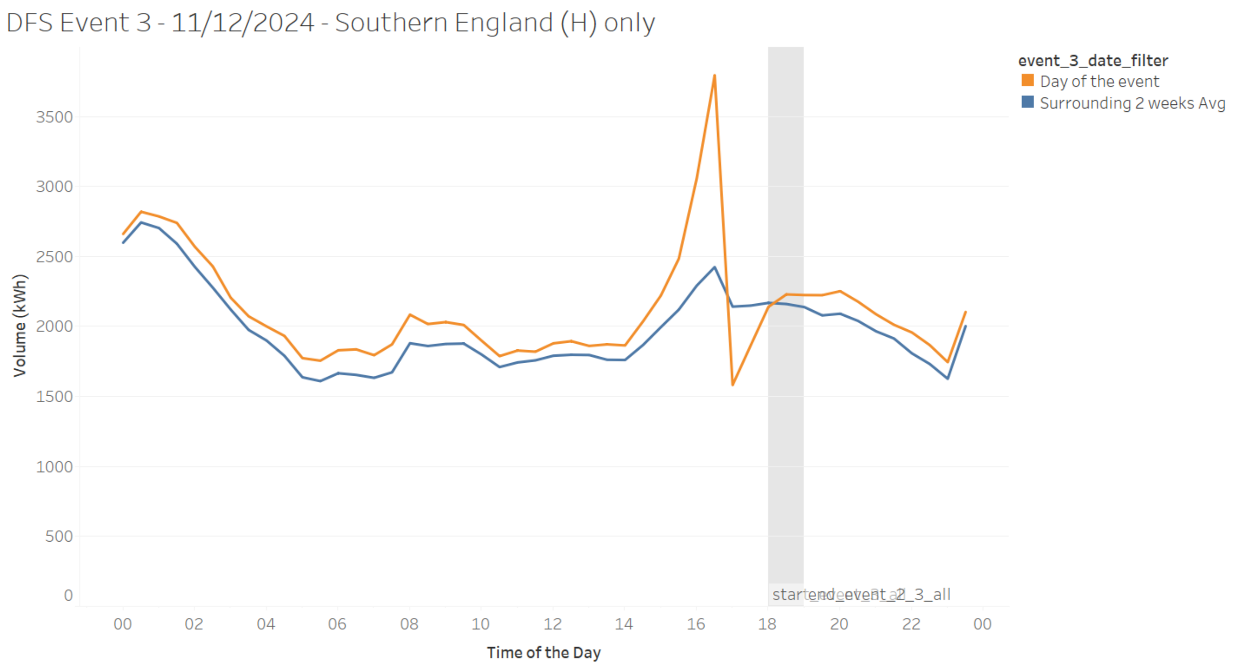

Figure 11: Baseline and event day consumption of MPANs with ≥35% drop only Southern England MPANs

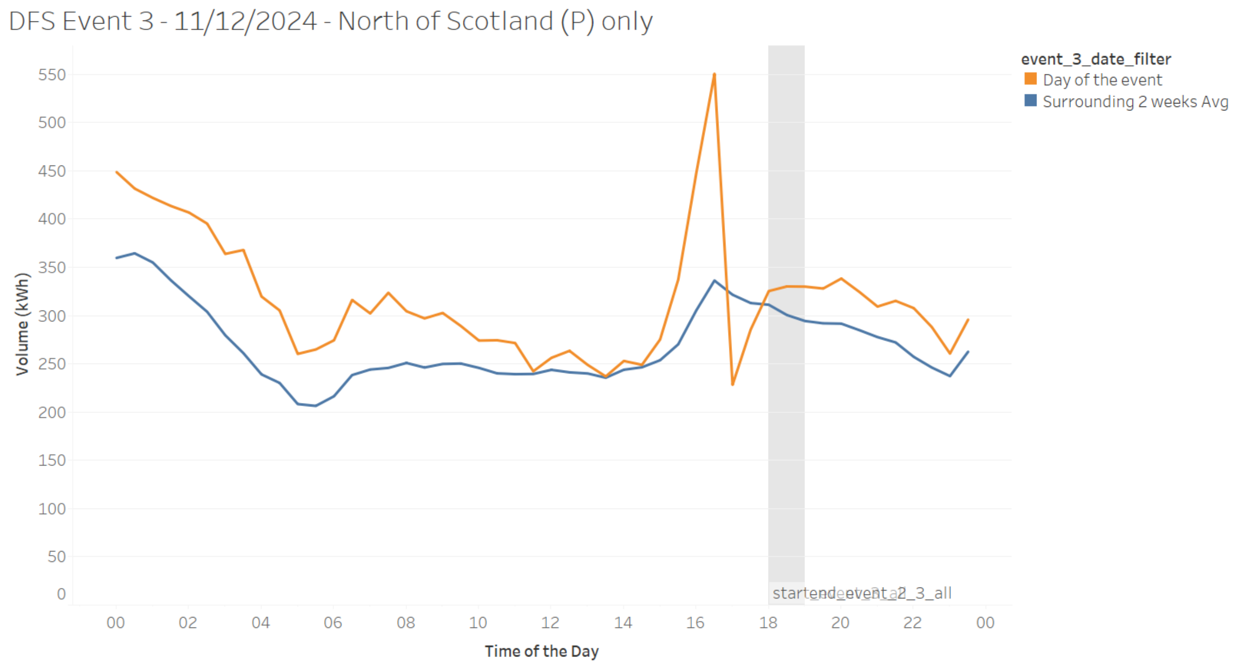

Figure 12: Baseline and event day consumption of MPANs with ≥35% drop only North Scotland MPANs

Findings

The table below shows the findings of the comparison in numbers:

Event	Data available on event Settlement Periods	Dropped consumption by 35%		Percentage of presumed respondent's vs total dataset
	Yes	No	Yes	
North Scotland (P)	5,942	5,161	781	13.14%
Southern England (H)	43,091	37,310	5,781	13.42%

Table 4: Comparative overview of response indicators across the two SSEN areas.

When comparing the two SSEN zones, the first observation is the significant difference in data volume — with Southern England having, unsurprisingly, over six times more MPANs available than North Scotland. This naturally limits the granularity and confidence in analysis for North Scotland. However, when applying the ≥35% drop threshold to identify potential flexibility responders, 13.42% of MPANs in Southern England met the criteria, compared to 13.14% in North Scotland.

While the absolute sample sizes differ, the relative share of presumed responders is strikingly similar. This suggests that flexibility potential may not be solely driven by data coverage or regional scale. That said, when assessing the addressable market, including factors such as smart meter rollout, connectivity, and the types of meters typically recorded as participating in flexibility services, these figures may paint a different picture of relative opportunity and readiness across zones. These explanatory factors could be further tested when combining other data sets and with cross-validation.

Analysis of local, DNO-instructed flexibility event

In addition to national flexibility events, the analysis included a DNO-instructed flexibility dispatch to explore how localised signals manifest in consumption data at a more granular level. The DNO was asked to identify a recent local event in which flexibility had been actively instructed. An event on 30 September 2024 from 07:00 to 09:30 was selected, corresponding to an event with a dispatched duration of approximately 2.5 hours at a specific Bulk Supply Point (BSP) in Alderton.

This event was chosen in part due to its relatively short duration, in contrast to longer events observed (some of which spanned up to 18 hours). A narrower dispatch window increases the likelihood of detecting a defined behavioural response in the data. Shorter events are also more likely to involve direct, time-specific actions from consumers or automated systems, making them more analytically tractable for identifying flex signals.

Using postcode information provided by the DNO for the affected area, we identified which MPANs from our EHHS dataset fell within the specified geography and had valid data for the event date. After applying these filters, only 16 MPANs in that BSP area had available EHHS data for the relevant event window.

Despite the small sample size, we conducted a high-level review of consumption behaviour for these MPANs to assess whether any discernible reduction aligned with the instructed flexibility period. It provided a useful test case to apply a similar approach in a localised setting, and a base to apply this to multiple areas, whether at the same scale, or more targeted levels in secondary substations or specific nodes.

The method followed a simplified version of the approach used in the national event analysis. For each MPAN, electricity consumption during the event window was compared to their average consumption across the same settlement periods in the week prior. Given the smaller sample size, we were able to apply additional filters — excluding weekend days from the baseline — to improve comparability. Furthermore, we limited the baseline to only the week before the event, as the SSEN's own dispatch information indicated that additional flexibility events were called on subsequent days. Including those days in the post-event baseline could have introduced response-related distortions and reduced the reliability of the comparison.

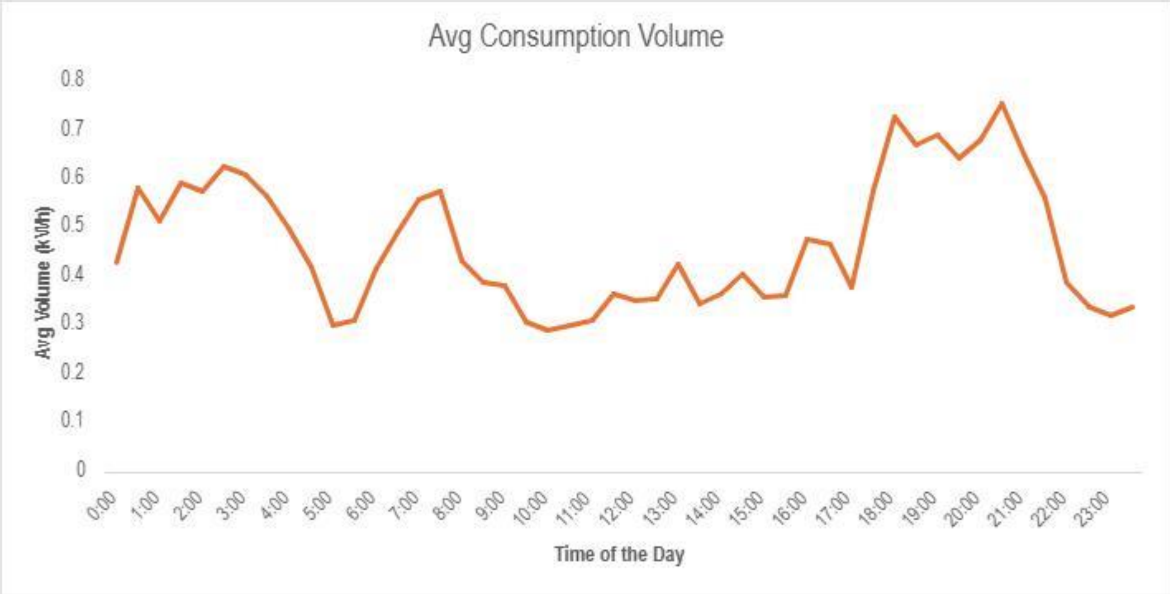

Figure 13: Consumption (in kWh) of individual MPANs during the day of the event

Findings

Of the 16 MPANs assessed, 10 showed a lower level of consumption during the flexibility event window compared to their individual baseline, with an average of electricity reduction or flex delivered of **0.254 kWh.** While this is not in itself conclusive evidence of flexibility participation — especially given the absence of direct opt-in data — it may suggest a response effect, particularly given the alignment with SSEN's instructed event period. In small samples like this, variation may also result from routine behavioural or operational factors, so caution is needed in interpreting individual outcomes. However, the result does demonstrate that even with a limited data footprint, it is possible to explore localised signals of demand-side response using EHHS consumption data.

The table below shows the results of the analysis for each MPAN, specifically whether a reduction in consumption occurred during the event compared to their consumption on previous days during the same hours of the day.

	07:00-07:30	07:30-08:00	08:00 - 08:30	08:30 - 09:00	09:00 - 09:30	Baseline consumption (kWh)	07:00-07:30	07:30-08:00	08:00 - 08:30	08:30 - 09:00	09:00 - 09:30	Event day concumption	Net Change in Consumption (kWh)
MPAN 1	0.597	0.395	0.459	0.477	0.2684	2.196	0.617	0.359	0.319	0.274	0.891	2.46	-0.264
MPAN 2	0.328	0.345	0.161	0.258	0.229	1.3206	0.05	0.017	0.016	0.328	0.032	0.443	0.8776
MPAN 3	0.179	0.276	1.031	1.833	2.0462	5.365	0.603	1.572	0.638	0.845	1.474	5.132	0.233
MPAN 4	0.452	0.315	0.326	0.443	0.2858	1.8218	0.723	0.499	0.572	0.639	0.602	3.035	-1.2132
MPAN 5	0.117	0.126	0.121	0.116	0.12	0.6002	0.143	0.107	0.092	0.144	0.087	0.573	0.0272
MPAN 6	0.168	0.194	0.179	0.101	0.0226	0.6644	0.085	0.212	0.111	0.056	0.023	0.487	0.1774
MPAN 7	0.341	0.241	0.425	0.12	0.1342	1.2608	0.731	0.977	0.202	0.103	0.054	2.067	-0.8062
MPAN 8	0.225	0.186	0.242	0.208	0.1922	1.053	0.187	0.079	0.096	0.251	0.211	0.824	0.229
MPAN 9	0.22	0.267	0.172	0.162	0.4122	1.2338	0.21	0.179	0.208	0.203	0.199	0.999	0.2348
MPAN 10	0.004	0.004	0.004	0.01	0.004	0.0258	0.003	0.004	0.003	0.004	0.003	0.017	0.0088
MPAN 11	0.338	0.361	0.366	0.357	0.4028	1.8252	0.539	0.408	0.46	0.34	0.239	1.986	-0.1608
MPAN 12	1.497	1.867	2.555	1.911	1.3846	9.2138	3.356	3.534	2.31	1.385	0.723	11.308	-2.0942
MPAN 13	0.337	0.421	0.495	0.372	0.2614	1.886	0.296	0.332	0.551	0.749	0.495	2.423	-0.537
MPAN 14	0.479	0.607	0.513	0.394	0.4236	2.4164	0.433	0.445	0.488	0.302	0.371	2.039	0.3774
MPAN 15	0.146	0.105	0.065	0.117	0.0824	0.515	0.038	0.041	0.029	0.013	0.053	0.174	0.341
MPAN 16	1.068	0.824	0.533	0.505	0.6302	3.561	0.969	0.452	0.838	0.602	0.666	3.527	0.034

Table 5: Observed consumption patterns for the 16 MPANs during SSEN instructed flexibility event. Note the fields marked in green represent the potential flexibility delivered per MPAN.

This analysis can be enhanced by incorporating additional datasets such as smart meter to feeder mappings, which enable the aggregation of consumption data at the low voltage feeder level and provide a clearer view of localised demand patterns. While ElectraLink only has individual half-hourly data of smart meters from the EHHS subset, feeder-level data offer a valuable layer of granularity.

Refined event-level flexibility estimation using baseline comparison

As the analysis progressed, it became clear that the simplified framing used in the initial event-level comparison — while practical and necessary as a starting point — would need to be complemented by a more targeted and interpretable approach to produce robust and quantifiable metrics of flexibility activity.

Initially, the refined analysis focused only on Event 3, which had the largest sample of EHHS MPANs with available data. The aim of this approach was to move from indicative response patterns to producing a tangible metric of flexibility activity — calculated in MWh — for a defined subset of MPANs most likely to have responded during the event window.

We focused the analysis on the first hour of the instructed event period — the point at which a concentrated response was most likely to occur. To estimate how much flexibility was delivered by individual consumers during Event 3, the following structured approach was applied:

1. Define analytical cohorts

We then identified the MPANs that showed a ≥35% drop in consumption during that first hour from 16:00 to 17:00 – as opposed to the initial analysis window of 18:00- 19:00 – relative to their immediately preceding settlement period. These MPANs were flagged as potential responders and grouped into Cohort 1. MPANs that did not meet the ≥35% drop were grouped into Cohort 2 as a reference group for behavioural comparison.

2. Build a Baseline and Compare to Event Day Usage [4]

For each MPAN, the average electricity consumption was calculated for the same settlement periods – covering the selected hour of the flexibility event – across the 10 previous working days. This served as an estimate of typical consumption in the absence of a flexibility signal.

Each MPAN's actual consumption during the selected 1-hour window was then compared to its baseline. If the usage was lower than usual, that reduction was considered a potential flexibility response.

This comparison was conducted for both cohorts, allowing us to contract behaviour between presumed responders and non-responders.

3. Calculate Flexibility per MPAN

For MPANs with a positive reduction, the estimated flexibility delivered was calculated as:

Estimated Flexibility (kWh) = Baseline Consumption − Event Day Consumption

Only MPANs with a positive value — indicating lower consumption on the event day than usual — were considered to have delivered flexibility.

[4] Note: this analysis adopts a methodology consistent with established industry practice—such as that used in the Demand Flexibility Service (DFS)—in which a consumption baseline is constructed from recent working days and compared against actual usage during the event window to estimate delivered flexibility. While this is a widely used approach, it is not unique to this study, and the accuracy and standardisation of baseline methodologies remain an active area of development within industry forums, including the ENA's Open Networks project).

Whilst only the drops observed in Cohort 1 were considered as potential delivered flexibility, the analysis of Cohort 2 helped assess whether similar reductions occurred among those not initially flagged, supporting or challenging the strength of the ≥35%.

4. Aggregate the Results

The individual reductions were then summed for each cohort. For Cohort 1, to produce a total estimated volume of flexibility delivered in MWh for the event. For cohort 2, the aggregate reduction was reported only for comparison purposes.

Cohort	Number of MPANs	Baseline consumption (16:00-17:00)	Event Consumption (16:00-17:00)	Change	% change	Flex Delivery in kWh of cohort
1 (≥35%)	5,578	0.616	0.448	-0.167	-27.2%	931.52

Table 6: Cohort 1 – potential responders' consumption and estimated flexibility

Cohort	Number of MPANs	Baseline consumption (16:00-17:00)	Event Consumption (16:00-17:00)	Change	% change	Flex Delivery in kWh of cohort
2 (<35%)	42,948	1.169	1.293	0.124	10.6%	n/a

Table 7: Non-responder comparison

Event 3 presented additional complexity due to its longer, multi-hour duration. While the analysis concentrated on the first hour of that event to improve interpretability and isolate likely response behaviour, we recognised that doing so would only capture a partial view of the overall event impact.

A broader analysis of multi-hour event response is considered important but remains out of scope for this initial phase and is addressed later in the report as a recommendation for further study.

To support and strengthen the validity of this refined approach, the same baseline comparison methodology was applied to Event 1 and Event 2, both of which were single-hour events and therefore less affected by the timing-related ambiguities introduced by longer windows. This allowed us to test the proxy metric across multiple events with different characteristics, improving confidence in the method and offering a more rounded view of potential demand-side response.

The tables below show the results of the baseline comparison for events 1 and 2 applying the same methodology to each.

Event 1:

Cohort	Number of MPANs	Baseline consumption (16:00-17:00)	Event Consumption (16:00-17:00)	Change	% change
1 (≥35%)	1,802	0.651	0.583	-0.068	-11%

Table 8: Cohort 1 – potential responders' consumption and estimated flexibility

Cohort	Number of MPANs	Baseline consumption (16:00-17:00)	Event Consumption (16:00-17:00)	Change	% change
2 (<35%)	11,166	2.5	2.721	0.219	9%

Table 9: Non-responder comparison

Event 2:

Cohort	Number of MPANs	Baseline consumption (16:00-17:00)	Event Consumption (16:00-17:00)	Change	% change
1 (≥35%)	3,299	0.733	0.5	-0.233	-32%

Table 10: Cohort 1 – potential responders' consumption and estimated flexibility

Cohort	Number of MPANs	Baseline consumption (16:00-17:00)	Event Consumption (16:00-17:00)	Change	% change
2 (<35%)	15,689	2.25	2.308	0.058	3%

Table 11: Non-responder comparison

The tables above show how across all three events the refined baseline comparison showed a consistent directional difference between the two cohorts. Cohort 1 demonstrated lower aggregate consumption on the day of the event relative to their baseline. Cohort 2 showed a higher consumption compared to their baseline in all three events. While these are aggregate values and may be influenced by variation within each group, the consistency of this contrast across events strengthens the case for the threshold as a meaningful segmentation for proxy flexibility estimation.

Estimating demand reduction among presumed participating MPANs

Using the figures presented above, we derived proxy metrics to estimate the flexibility delivered, in this case the observed reduction in electricity consumption during the events 1, 2 and 3.

Event	Number of MPANs	Average kWh reduction (flex per MPAN)	Flex Delivery in kWh of per cohort
1	1,802	0.068	122.5
2	3,299	0.233	768.66
3*	5,578	0.167	931.52

Table 12: Estimated flexibility delivered by potential respondents across events

* In Event 3 case, it is based only on the first hour of the duration of the NESO three-hour signal.

This can be read as, e.g. for Event 2:

- ✓ This group of **3,299** MPANs delivered an estimated **768.66 kWh** of demand reduction over 1 hour event, based on the difference between typical baseline consumption and actual usage during the event.

It is Important to note that this are numbers based on an aggregated proxy and assumed all MPANs in the cohort contributed similarly to the observed average reduction. In addition, it is important to flag other assumptions, which may need validation in further research, such as:

1. **The drop threshold (35%) is a valid and reasonable cut-off**
   Chosen as a pragmatic threshold to isolate substantial changes, but inherently arbitrary — it excludes potentially smaller, valid responses and includes some that may not be true flex.
2. **MPANs with a ≥35% drop from the immediate previous settlement period are likely responders**
   Assumes that a sudden and significant drop in consumption is indicative of intentional participation in a flexibility event, without a formal confirmation of instruction or enrolment.
3. **MPANs not meeting the 35% drop are excluded from the metric**
   Assumes that those who didn't meet the threshold likely didn't participate — though in reality, some may have responded with smaller reductions or behaved differently (e.g., load shifting).
4. **The baseline (10 previous weekdays, same SPs) reflects normal consumption**
   Assumes that average consumption across 10 non-event weekdays is an appropriate proxy for "business as usual" consumption for each MPAN.
5. **The net reduction (baseline minus event-day usage) can be interpreted as flex delivered**
   Assumes this difference reasonably approximates the volume of flexibility delivered by each MPAN, in the absence of a more sophisticated counterfactual model.
6. **Event signals were delivered and received in the relevant area**
   Assumes that a meaningful portion of MPANs in the cohort were aware of, or instructed for, the event.

Other considerations are also important to be acknowledged and followed up, such as:

- Whether EHHS users as a meaningful proxy for the wider /mainstream domestic population, acknowledging that EHHS users may not be representative of typical consumers (e.g., may include early adopters, EV or battery owners).
- If pre-event consumption patterns reflect "normal" behaviour.
- How to treat MPANs with missing or irregular data

In the interpretation and discussion section, these points are discussed with wider industry, real-life context and we present an **estimation of all potential flexibility activity across SSEN areas** based on the measurable market.

Validation and Confidence Note

As part of this work, we carried out several complementary strands of analysis — some planned from the outset and others developed iteratively as the research evolved and limitations or new opportunities became apparent. The first line of investigation focused on overall consumption behaviour and high-level response identification, starting with a funnelled comparison across all four selected events, then narrowing to a more detailed and structured examination of **Events 1, 2 and 3.** This refined event-level analysis enabled the production of quantified flexibility estimates at the MPAN level. To support interpretation, a behavioural check was carried out using a non-event control week to assess whether similar patterns of reduction occurred in the absence of any flexibility signal.

In parallel, we explored variation in response across the two licence areas, providing insight into how geography and regional characteristics may influence participation. Finally, a separate analysis was conducted on a DNO-instructed local flexibility event, using postcode-specific data to assess potential responsiveness in a more targeted area.

Together, these strands of analysis serve to both validate to a degree, but mainly to contextualise each other — linking top-down aggregate insights with bottom-up MPAN-level behaviour, testing observed reductions against non-event behaviour and considering variation across time and geography. The project timeframes and the exploratory nature of this phase meant that more rigorous or formal validation was not possible. However, we outline in the future research section how such validation could be developed and where it would add the most value.

Interpretation and reflections

This initial analysis has demonstrated that, despite challenges related to data completeness and granularity, it is possible to detect and estimate flexibility activity from domestic and small non-domestic consumers using elective half-hourly (EHHS) data.

The Comparative Four Event Analysis showed a clear dip, and through subsequent analysis including event-level baselining and cross-checks, we were able to produce indicative metrics of flexibility delivered, expressed in both MWh and MW.

As part of this analysis, we also conducted desktop research alongside this data analysis to improve our understanding and enhance interpretation. While EHHS data provides a highly valuable resource for this analysis, it is important to note that a recent report by NESO on the DFS noted that only around 10% of domestic participants in DFS events are EHHS-settled. As such, the findings here are based on a subset of the total flexibility population.

Another aspect that is important to consider is that EHHS meters may not be a typical sample of average domestic consumers and poses the question of how likely is it that EHHS MPANs have batteries, electric vehicles (EVs) and other high-consuming low carbon technologies (LCTs) – which is likely, given the voluntary nature of the scheme, coinciding with energy-aware consumers that may have opted in via time-of use tariffs, because of a battery of PV system were moved to EHHS to optimise it, etc. This introduces an important variable: these MPANs might already have embedded flexibility behaviour.

EHHS MPANs are not necessarily representative of the general domestic population. During this transition phase, most households on EHHS MPANs are likely to have opted in due to specific tariff arrangements or the presence of high-consumption or flexible technologies — such as EVs, batteries or heat pumps. As a result, observed consumption reductions during event windows may not be solely attributable to event-driven participation. Some behaviours — such as routine battery discharge during peak times or EV charging outside peak windows — could occur regardless of a flexibility instruction.

Nonetheless, this dataset enables a more granular view of consumption behaviours and offers valuable insights into response patterns that are otherwise difficult to detect with lower-frequency data. Furthermore, they can be extended to a broader population as EHHS coverage expand and (enabled to evidence) how to further the analysis and highlight the importance of refining cohort definitions and exploring behavioural baselines in future work

It's worth noting that we also considered exploring embedded flexibility patterns beyond the event window — such as overnight EV charging or battery cycling — but due to the project's delivery timeline, we prioritised a scoped approach focused on event-time response.

Applicability to wider addressable measurable market

As a complementary input to the analysis, we also drew on an existing classification of domestic meters within the DNO area based on their connectivity status. Used in combination with the data available of the number of smart meters (SMETS1/2) in the SSEN licence areas, we obtained the number of meters that are technically capable of supporting flexibility monitoring or participation. While this doesn't reflect participation or readiness per se, it offers a useful reference point for estimating the measurable market — i.e., the population of domestic consumers for whom consumption-based response could, in principle, be observed or measured.

Area	Smart Meters (SMETS 1/2)	% of estimated Communicating SMs	No. of Communicating SMs	Avg. kWh drop per MPAN	Estimated Flexibility (MWh)
North Scotland (P)	394,038	92.3%	363,697	0.170	61.828
Southern England (H)	1,918,707	94.1%	1,805,503	0.170	306.935

Table 13: Estimated addressable market for domestic flexibility in SSEN licence areas. Note that the avg. kWh drop per-MPAN is the same for both areas at this stage.

Taking the estimated kWh drop per MPAN in national events 1, 2, 3 and the local SSEN one, we produced a weighted average as a proxy of reduction, or flexibility delivered per MPAN. When used alongside this proxy metric developed through this analysis, this connectivity view can provide a first approximation of the potential scale of flexibility response across the area — both in terms of absolute volumes and the proportion of the technically measurable base that may be engaging.

This means that based on the analysis, domestic consumers alone could deliver approximately 306,935 kWh of flexible demand during a single 1 hr event in Southern England, and 61,828 kWh in North Scotland.

However, several caveats must be kept in mind: this metric does not confirm intent or actual participation, and connectivity alone does not imply responsiveness or eligibility for flexibility programmes.

Conclusions and strategic takeaways

This analysis demonstrates that it is possible to draw meaningful insight into flexibility behaviours from domestic smart meter data and that the same approach could be extended to micro-businesses, even if not explicitly segmented in this phase.

Through structured filtering, event alignment and baseline comparison, we identified clear observable response patterns – visible reductions in electricity consumption during known flexibility windows – across both national and regional levels. Proxy metrics of demand shift were developed, providing an initial indication of the volume and scale of response, and laying the groundwork for practical use by DNOs and system planners. The work also helps establish a repeatable analytical framework that can be scaled or adapted in future phases.

This initial research was made possible through close collaboration with SSEN, whose request to explore whether flexibility activity could be estimated using existing datasets helped frame the scope and focus of the analysis. While the results are encouraging, key challenges remain — particularly around data consistency, variability in behaviour and attribution of response. Further work is needed to improve the confidence of results at the individual MPAN level, using more advanced statistical modelling to assess participation likelihood and filter out natural variation. As such, the analysis offers a strong first step — not a definitive measurement — in quantifying the contribution of smaller consumers to local and system-wide flexibility.

Having undertaken the bulk of the work required to identify, prepare and structure these relevant datasets, as well as navigating the key analytical challenges and uncertainties, this analysis now provides a solid foundation for continued research. With tested methodologies, clarified data pathways and a deeper understanding of the complexities involved, future phases of work can focus more directly on refining metrics, scaling and enhancing modelling precision.

The following sections outlines recommended next steps for building on this work across research, regulation and operational planning.

Future research opportunities

The analysis surfaced several areas that merit further investigation. For example, the use of a ≥35% drop threshold was a pragmatic starting point, but further exploration is needed to understand the behavioural distribution around that point and to validate its relevance across consumer types.

It is also important to examine the behaviour of MPANs that did not meet the threshold. While excluded from the filtered charts, this broader group may still show partial or systematic reductions, offering insight into varying levels of engagement. Similarly, a recurring observation was the spike in consumption immediately before the event window. Whether this reflects anticipatory load-shifting (e.g. battery charging, pre-heating) or natural peaks is not yet clear, but it affects how demand reductions are interpreted.

While several avenues could be explored, the following are proposed as top five priority areas for further research:

1. Refining Individual MPAN Response Models

Develop statistical methods to assess and increase confidence in identifying genuine flexibility responses at the individual MPAN level.

2. Exploring Partial Responses Below the 35% Threshold

Investigate whether MPANs with consumption reductions below the 35% threshold exhibit consistent, smaller-scale flexibility behaviours.

3. Analysing Pre-Event Consumption Spikes

Examine the causes and implications of observed consumption increases immediately preceding event windows to understand potential pre-event load shifting or automation.

4. Assessing Engagement in Multi-Hour Events

Extend analysis to longer-duration flexibility events to capture and model variations in consumer engagement over extended periods.

5. Integrating Supplementary Data Sources

Combine consumption data with external factors such as pricing signals, weather conditions or technology adoption to enhance the understanding and attribution of observed flexibility behaviours.

Policy and industry considerations

In addition, it should be noted how the wider regulatory framework and policy environment can support the effective access and use of consumer flexibility data and help scale the impact.

a) Improve the visibility of flex event participation

Suppliers, aggregators and third-party providers play a critical role in delivering domestic flexibility, yet current data sharing arrangements mean that DNOs/DSOs often lack visibility of which customers are participating in which events. While some suppliers already provide aggregated outcomes (e.g. increase/decrease per substation), wider and more consistent sharing of anonymised participation data would significantly improve attribution and allow for better alignment between observed behaviours and real flex events.

b) Encourage structured data exchange between suppliers and networks

DESNZ and Ofgem have already take positive steps to encourage suppliers and aggregators to share flex participation data where it materially affects the network. This includes participation in DFS, Supplier Core Flex or local schemes, particularly where response volumes are likely to influence operational decisions. However, further thought on whether it should be required and more clarity on datasets, definitions and deadlines would be beneficial.

c) Support continued progress on data access and standardisation

Ofgem has already taken positive steps to improve data access and sharing across the sector and continues to encourage collaborative approaches to data transparency and interoperability. This direction should be maintained and extended to ensure location-tagged, event-relevant data becomes a routine input to local network planning. Differentiating between types of flexibility (e.g. embedded vs. instructed; long- vs. short-notice) and making those signals visible at a system level will be essential for scaling domestic flexibility with confidence.

These efforts would, in turn, support the continuation of integrating reliable consumer-led flexibility into network planning and operations, with stakeholder collaboration essential to strengthen the ability to confidently assess, forecast and enable low-voltage flexibility, ultimately contributing to a more flexible and responsive energy system.