Department for
Energy Security
& Net Zero

Interim Evaluation of Domestic Energy Affordability Support Schemes in Great Britain

Annex C: Supplementary Research

April 2025

Contents

List of figures

List of tables

Annex C1 Continuous cruisers report

1.1 Introduction to the Energy Bills Support Scheme Alternative Funding for Continuous Cruisers

Between September and December 2023, the Department for Energy Security and Net Zero (DESNZ) ran the Energy Bills Support Scheme Alternative Funding for Continuous Cruisers (EBSS AF CC). People living on boats were eligible for EBSS AF and often Alternative Fuels Programme Alternative Fund (AFP AF) but since continuous cruisers did not have a home mooring, they did not have a permanent address they could use to apply for the scheme/s. This was the reason for the later delivery of the EBSS AF CC.

The scheme was targeted at:

- People who live on a boat, and,
- Held a Canal & River Trust long term leisure without a home mooring (continuous cruiser 6 or 12 month licence) for a minimum of one day between 27 February 2023 and 31 May 2023, and,
- Had not received support from the Energy Bills Support Scheme or the Alternative Fuels Payment support during the winter of 2022/23.
- People were not eligible for support if they had a home mooring or had already received support under another scheme.

Those eligible for support received a £600 ‘PayPoint Open Pay voucher’ via post, SMS, or email. £600 was the combined amount of EBSS AF (£400) and AFP AF (£200), since alternative fuel use was known to be high amongst the continuous cruiser population.

Only the person named on the voucher could redeem the voucher. No application process was required, although ahead of receiving the voucher the CRT emailed those on its licence register and asked them to check their details and ensure they were up to date.

Once the voucher was received, to redeem the voucher recipients could either have the money transferred directly into their bank account, or they could take the voucher to any shop with a PayPoint terminal and request the money in cash from the shop till.

1.2 Evaluation Methodology

DESNZ commissioned Ipsos to carry out an evaluation of the EBSS AF CC following the evaluation framework of the main study.

This report summaries the findings and conclusions of the evaluation. The report is structured according to the relevant questions in the evaluation framework for the larger evaluation, of which this study forms one part of.

Data collection methods consisted of

- Qualitative interviews with 20 recipients of the vouchers via phone or MS Teams
- Qualitative interviews with 5 key stakeholders

  - 2 x DESNZ interviews

  - 1 x Canal & River Trust (CRT) interview (consisting of three people)

  - 1 x PayPoint interview

  - 1 x National Bargee Travellers Association interview

- Quantitative data analysis of CRT data on recipients and voucher redemption
- Review of key literature related to the EBSS AF CC.

Fieldwork was carried out between mid-March 2024 and early May 2024.

1.3 Process Evaluation

1.3.1 PEQ1: What were the levels of awareness of the interventions?

Key findings

- In 2022, when EBSS and EBSS AF were announced, there were no communications from the government on whether support would be made available to boaters. As a result, boaters came to expect that no support would be made available.
- The scheme was announced in summer 2023 at very short notice and came as a surprise to recipients and some stakeholders – although Canal and River Trust had been involved at development stage.
- Those eligible were aware of the scheme once it launched as they first had to confirm their details were correct with the CRT before receiving their vouchers.
- Most government communication about the scheme was disseminated through the Canal and River Trust to ensure it reached the right people. There was a link to the scheme on the GOV.UK website but it was constrained to the broader AF scheme and there was a lack of direct information about support for continuous cruisers. As a result, many people had to search social media and the internet to get information on the scheme.
- Many people turned to Facebook groups, and conversations on the towpath, to make informed judgements about the scheme.
- Communications mainly came from CRT and the National Bargee Travellers Association (NBTA).
- Both CRT and NBTA encountered boaters who were unaware of the scheme and what needed to be done to receive support.

Conclusion

- Boaters found out about the scheme through a CRT email asking them to confirm their details before receiving the voucher. As a result, boaters were aware of the scheme and were expecting to receive a voucher.
- But no direct communications were received from the government. As a result, many boaters turned to neighbours and social media groups to get confirmation on the legitimacy of the communications and emails received.
- News spread fast by word-of-mouth amongst this group. This was helpful for awareness of the scheme but poses a risk for misinformation and misunderstanding about the scheme.
- Stakeholders told us that this group is typically less trusting of government. This may have led to some not taking up the vouchers due to a lack of trust.
- Many people thought the scheme was run by the CRT, as this is where most communications came from. CRT often had to correct people and redirect them to DESNZ when they had queries. This was not helpful for people looking to get help with payments.

1.3.2 PEQ3: What were levels of understanding of the support amongst intended recipients?

Key findings

- Based on interviews with recipients, most were clear on the support they were due to receive and how to access the support.
- The CRT received a high volume of phone calls from boaters. Many phone calls were from people who lived on the water trying to find out if they were eligible for support or not. However, in a high proportion of cases these callers were not eligible for support according to the scope set by DESNZ.
- Many eligible recipients mentioned that those with leisure licences were not getting support, and they felt that they should get support, and were perhaps more in need of support than themselves.
- Many boaters thought the scheme was being run by the CRT. Many did not understand that the scheme was being run by DESNZ. This was largely due to most communications coming from the CRT, and there being limited communications coming directly from DESNZ.

Conclusion

- Understanding of the support was high, as was understanding of how to access the support. However, there was concern for those boaters on leisure licences who were not eligible for support.

1.3.3 PEQ6: What was the scale and nature of enquiries from households?

Key findings

- The CRT ran a helpline which recipients said worked well.
- Recipients also resorted to unofficial Facebook groups to resolve queries.
- The CRT received a high volume of calls (c.7000) and emails (c.6000) during September to December 2023.
- People called up to find out if they would be eligible, or to find out when their money would be received.
- Not all bank transfers were received immediately, and so people called up to find out why not.
- Calls to CRT were reported as often distressing or abusive.
- The CRT had several agents go on sick leave or resign due to the stress caused by the calls.
- CRT reported that the most challenging calls were not the abusive calls, but those calls from people in distress or desperation who the CRT could not help due to the narrow scope of the scheme.

Conclusion

- The scheme created a lot of correspondence for the CRT who were insufficiently resourced and trained to receive the volume and nature of the calls received.
- The CRT were fielding the phone calls but had limited agency in being able to make the kind of interventions required to help those calling.
- Interventions were often required from DESNZ or PayPoint to resolve individual cases. This resulted in a poor customer journey, where people were passed from CRT to DESNZ to PayPoint.
- The level of correspondence generated by the scheme was disproportionate to the size and scope of the scheme.
- Much of the correspondence was from those who were not eligible for support based on the scope of the scheme. This suggests there was a lot of unmet need that was exposed by the announcement of this scheme.

1.3.4 PEQ13: To what extent did all eligible households receive the full support available?

Key findings

- Eligible households were identified using CRT registers only. But CRT covers 80% of the canals and rivers in the UK. There are 12 other waterways in England and Wales, but there is no data on who is living on these waters.

- The CRT estimates there are around 35,000 boats on CRT canals and rivers. Approximately 79% have a mooring, and 21% are continuous cruisers. The Environmental Agency has 26,000 boaters registered on its waters. However, it cannot tell who fits the description of a 'continuous cruiser' and who does not.
- Moorings can be leisure or residential moorings. This is determined by the planning status of the mooring. CRT does not have data on which moorings are leisure and which are residential.
- Those with proof of a residential mooring could access the EBSS AF. Those with a leisure mooring could not access EBSS AF or EBSS AF CC.
- Based on interviews with stakeholders and recipients, there appears to be a high number of people living on boats that have a leisure mooring. Every recipient we spoke to knew people living on boats with a leisure mooring which suggests there are a high number of people who could not get any support.
- Based on CRT census figures, we estimate there are approximately 21,000 boaters with a leisure mooring. With current data, we cannot estimate how many of these have people living on boats with a leisure mooring, and how many are used for leisure purposes only.
- Of the 7601 records on the CRT database of people eligible for support, 6408 (84%) redeemed their voucher, either in cash (11%) or by digital bank transfer (89%).
- Recipients Ipsos spoke to felt that largely those within scope of the scheme received the support. But they also felt the scope of support should have included all boaters. There were many on different licence types or fell just outside the period of having a licence who they felt should have also received payment.
- Due to limited access to good data from other waterway authorities, it is not possible to know the exact size of other potentially eligible populations. The narrow scope of the support reflected this.
- Continuous cruisers are hard to reach, often vulnerable or with complex needs, and can sometimes be less trusting of official bodies.
- As a result, they do not always share their real details with the waterways authorities, and the waterways authorities do not carry out verification checks on the data provided to them prior to the scheme.
- This makes the group hard to identify and hard to verify when processing payments

Conclusion

- 84% of continuous cruisers with an eligible licence received support.
- This group were on the CRT database of continuous cruisers but the criteria for support was narrow and excluded an unknown quantity of people who needed support.
- Due to data and information gaps, there are a potentially high number of people living on non-CRT waterways or living on a CRT waterway with a leisure mooring, who have missed out on support.

- Based on the level of correspondence received (see section 1.3.3), the volume of unmet need could be expected to be large in comparison to those who received support.

1.3.5 PEQ15: How quickly were these payments made?

From Ipsos interviews with stakeholders and recipients:

- Most people who redeemed their voucher by electronic transfer received it immediately.
- Common issues with redeeming the voucher digitally included CRT registration name being different to the individuals bank account name, and the automatic identity checks carried out by national banking infrastructure could not account for names with special characters (such as accents). As a result, digital transactions would fail and required manual intervention by PayPoint.
- Many PayPoint stores did not hold £600 in cash. We heard reports of stores refusing to hand over any cash to voucher holders due to a lack of cash in the till, or due to shop keepers believing the voucher to be a scam.

From Ipsos data analysis:

- Within the first 7 days, 58% of vouchers were redeemed (by volume and value)
- 99% of all voucher redemptions were within 62 days (by value).
- 99% of all online redemptions were within 61 days (by value).
- 99% of all cash redemptions were within 70 days (by value).

Conclusion

- For the majority of people, online digital transfers were quick and easy.
- There were problems with cash transfers that made it difficult, slow, and inconvenient for those who chose this route to redeeming their vouchers. These problems might have been mitigated with better communications and advice to stores regarding the cash redemption of vouchers.

1.3.6 PEQ23: What compliance and enforcement processes were carried out?

Key findings

- The scheme relied on existing infrastructures within PayPoint and the national banking infrastructure to ensure payments were compliant.
- Photo ID was required for cash payments in stores.
- There were limited checks on dual payments across schemes. DESNZ checked data against applications for the EBSS AF to ensure those who had received payment from EBSS AF did not also receive payment from EBSS AF CC. But DESNZ could not check against the main EBSS scheme due to challenges of getting data from energy suppliers.

Therefore, those with a house and a boat may have received payment from both the EBSS and the EBSS AF CC.

- Due to the quality and type of CRT data it is not possible to be sure that payment were issued to one person per boat only. It is also not possible to be sure that people with two boats or more did not receive two payments or more.
- Due to the relative scale of the scheme, DESNZ is not carrying out any follow up checks for fraud and error.
- Cash redemption data shows some anomalies where individual stores processed a particularly high amount of cash.

Conclusion

- The focus of the scheme was on getting payments out to people quickly.
- There has been limited focus on following up on fraud and error.
- The existing infrastructures within PayPoint and national banking offered a sufficient level of security for verifying the digital payments went to the right individuals.
- However, cash payments lacked scrutiny and relies on local shop keepers to verify the identity of individuals.
- The need for a photo ID to redeem cash in store may have been a challenge for some individuals amongst this group.

1.3.7 PEQ35: How did end-beneficiaries find the experience of applying for support?

Key findings

- DESNZ had learnt from other schemes that the burden of an application system for a smaller population was not worth the resource and costs, given the amount of money that would be distributed.
- Therefore, a voucher system based on that used in Northern Ireland was opted for.
- Recipients found the online bank transfer easy. They only had to verify their details with CRT ahead of receiving the voucher.
- Those who chose to redeem voucher in store had more trouble. In a number of cases PayPoint stores refused to hand over cash, often due to having insufficient cash in the till, but also for other reasons, such as believing it to be a scam.
- The initial timescales for redemption were too short and led to further extensions to give everyone sufficient time to redeem.

Conclusion

- With no application system, those who opted to receive their support via electronic bank transfer were happy and found the whole process easy. This was the majority of people on the CRT database.

- However, there were instance of issues such as people whose names had special characters would not pass the bank transfer checks. Others had given one name to the bank and another to the CRT, and therefore these would also not pass the checks.
- Those who had to redeem cash in store also faced challenges in accessing cash.
- The customer journey to receiving assistance was not streamlined. CRT fielded a lot of calls but were not able to solve many issues without passing people on to DESNZ, who would pass people on to PayPoint.
- While challenges were to be expected, the route to resolving them was convoluted and likely caused further stress for both recipients and CRT call centre agents.
- Initial timescales for redemption were too short and rather than granting extensions, it would have been more efficient to set longer timescales from the start.

1.4 Outcome evaluation

1.4.1 OEQ1: What were the perceptions of the interventions?

Key findings

- Participants were grateful for the scheme. They initially felt left out but were glad that they eventually received support despite it being later than the main schemes.
- The value was felt to be sufficient to cover the costs of fuel for one winter.
- Some recipients commented that they were not the most in need of support, and it may have been fairer to means test the support.
- Stakeholders often reported that the scope of the support was too narrow, and too short. There are many people who live on the water, and continuous cruisers only covers a proportion of them.

Conclusion

- Those who received the support were grateful, and the value was a significant contribution towards the fuel's costs for a single winter.
- Stakeholders thought it great that continuous cruisers received support, but noted there are many in need who did not receive support.
- Stakeholders thought the scope of the support was too narrow, and the timescales for voucher redemption too short. They highlighted the diversity of people living on the waters and the large number of different licence types.

1.4.2 OEQ5: How have households adapted their energy consumption and wider spending behaviours because of the rise in energy costs?

Key findings

- During the winter of 2022/23, interviewees reported reducing their energy consumption. They did things such as such as storing food outside when cold and switching off the fridge, letting the fire die out overnight, and rationing their fuel use for heat.
- Other ways to keep warm were found such as using hot water bottles etc.

Conclusion

- The payments were received later than for the main schemes, and therefore over the winter of 22/23 people adjusted their energy consumption. This was a very hard period for many people living on the water.
- There is no price cap on the cost of solid fuels, or gas bottles, or red diesel, and these prices also rocketed during the energy crisis, and did not fall back to where they were before the crisis.
- As a result, people adjusted their use of fuels accordingly and reduced their consumption.

1.4.3 OEQ6 & OEQ7: To what extent did households maintain consumption at a safe and comfortable level?

Key findings

- Boaters reported having to use less energy for heating – some could not afford to turn the heating on even when it was very cold, whilst others turned it on for short periods of time, and resorted to other means of keeping warm such as using hot water bottles and wearing extra layers of clothes. Some turned it on only when the temperature dropped below 10 degrees.
- Most participants did not notice any impact on a health as a result of consuming less energy or living in the cold. However, participants with asthma reported struggling to get through winter because of difficulties breathing in cold air.
- Participants with small children said they did not adjust their heating for their family's comfort, and paid more in energy bills as a result.
- A stakeholder reported hearing of two deaths during the winter of 2022/23 potentially linked to reduced fuel consumption due to energy bill affordability challenges. The stakeholder suggested a possible correlation between these deaths and a delay in receiving EBSS AF CC support. However, this claim is currently unsubstantiated.

Conclusion

- Within this group there are some highly vulnerable people.
- There are some examples from our interviews of people experiencing more challenging conditions given their health status.

- However, most people maintained a safe level of energy consumption, but spending was affected.

1.4.4 OEQ10 & 11: How did the level of concern about energy bills and household finances vary before and during the interventions?

Key findings

- The winter of 2022/23 saw the cost of everything go up. The price for red diesel, wood, coal, and gas bottles all went up and are uncapped.
- There was a lot of anxiety over winter 2022/23. Whilst people living connected to the grid were receiving support, continuous cruisers were not.
- Concern during this period was higher amongst those who were more vulnerable or lived with vulnerable individuals. For example, people with asthma or those with a newborn or small children. This is because reducing the heat was less of an option.
- Participants with less financial resources had to lower consumption and budget accordingly. Those with more financial resources were less concerned and could afford the increase in costs.
- When support was finally received in autumn 2023, this lifted some of the pressure. The amount was sufficient to meet a season's heating costs and stabilised the financial situation of those with less financial resources.
- People had come to expect that support would not be available for iterant travellers. So, when support was received, people were grateful to not have been forgotten.
- However, prices are not back to where they were before 2022, and therefore many are concerned on how to afford fuel in the future.

Conclusion

- There was a high level of concern over winter 2022/23.
- People had come to expect that no support would be forthcoming and were grateful to receive support, even though it came later.
- The support received in autumn 2023 was welcomed and helped ease people's concerns about the upcoming winter 2023/24.
- But concern remains about the future. Prices are still much more expensive than they were before winter 2022/23.

1.4.5 OEQ13: How easy or difficult has it been for households to afford their energy bills in general and compared to a year ago?

Key findings

- Winter 2023/24 was easier as the payment received through the schemes helped participants clear their debts, stabilise their financial situation and offset any borrowing

needed for energy costs during winter 2022/23. There was generally less stress and higher affordability in winter 2023/24 due to the support.

- Changes in personal circumstances in some cases made winter 2023/24 more bearable in some cases – such as moving out of a house and on to a boat.
- In other cases, changes in personal circumstances made things more challenging during winter 2023/24 – such as having a baby.
- It was harder for some participants to afford their bills in winter 2023/24. Some reported maxing out their overdraft and requesting help from friends for fuels.
- However, many recipients found winter 2023/24 to be more manageable.
- Though manageable for many, the energy costs in winter 2023/24 were still higher than in the past, which had an impact on other spending, and budgets had to be rationed more.
- Living on a boat is generally cheaper than running a house– this helped some to afford bills.

Conclusion

- The winter of 2022/23 saw a noticeable increase in costs of fuel, and they are not yet back to where they were beforehand.
- People used overdrafts, borrowed from friends, or used up savings to get through winter 2022/23.
- The support offered has stabilised the financial situation of many and made winter 2023/24 easier.

1.5 Conclusions

The scheme provided vital financial relief to a significant proportion of continuous cruisers, with 84% of those on the CRT database receiving the £600 payment. This financial assistance proved particularly crucial after the winter of 2022/23, a period marked by unprecedented energy price hikes and widespread anxiety. Recipients expressed gratitude for the support, acknowledging its role in alleviating financial strain and enabling them to meet essential heating costs.

Challenges in Implementation and scope

Despite its successes, the evaluation uncovered several critical areas requiring attention:

- Limited reach and data gaps: The scheme's reliance on CRT data excluded an unknown number of potentially eligible individuals living on non-CRT waterways or residing on boats with leisure moorings. This data deficiency highlights the need for a more comprehensive understanding of the continuous cruiser population to ensure equitable support distribution in future initiatives.

- Communication and awareness: The lack of direct communication from the government created some confusion and fostered reliance on informal networks, potentially increasing the risk of misinformation and misunderstanding. A more proactive and direct communication strategy from DESNZ is crucial for future schemes to ensure clarity and build trust.
- Strain on CRT and convoluted customer journey: The CRT, tasked with a significant communication and support role, faced overwhelming call volumes and lacked the agency to address many recipient queries. This resulted in a fragmented customer journey, necessitating referrals to DESNZ and PayPoint, which caused frustration and delays. Future schemes must consider appropriate resource allocation and streamlined processes to handle inquiries effectively
- Cash redemption issues: The cash redemption process encountered obstacles, with some PayPoint locations refusing payments due to insufficient cash or misinterpreting the vouchers as scams. Clearer communication and guidance for participating retailers are essential to ensure smooth and accessible cash redemption options.

Recommendations for future schemes

- Implement a proactive and multi-channel communication strategy led by DESNZ to ensure clear, consistent, and timely information dissemination
- Provide adequate resources and training to frontline support staff at the CRT and establish clear escalation pathways to minimise customer journey friction and ensure timely issue resolution. Involving the Waterway Chaplains directly in scheme design and delivery was recommended by a stakeholder because they thought continuous cruisers trusted them more than other organisations.
- Collaborate closely with PayPoint to address cash handling challenges, provide comprehensive guidance to participating retailers, and explore alternative cash disbursement mechanisms.

Annex C2 Alternative Fund Population Estimation in GB

2.1 Background

The Energy Bill Support Scheme Alternative Fund (EBSS AF) and the Alternative Fuel Payment Alternative Fund (AFP AF) were introduced to ensure that households who were unable to receive the EBSS and AFP support automatically, could access equivalent support via an application to their local authority (for full descriptions of all schemes see the main report). To deliver the schemes, ex ante estimates of how many households were potentially eligible for this support had to be made at pace and with the data available at the time, which was limited for some population groups. London Economics (LE) were commissioned to conduct an additional piece of work to assess methods of estimating the size of the alternative funding (AF) populations in Great Britain (GB) to understand how these estimates could be improved in the future with existing data and data that has since become available, particularly the publication of the 2021 census.

Scope of Report

This report establishes methods of estimating the eligible cohort through the examination of how the ex-ante estimates were established and exploring alternative methods of measurement. The scope of the study involved the following elements:

- Identification of data sources that could be used to estimate the size of the AF populations.
- Benefits and limitations of these datasets, including those used in the original estimates and any new ones.
- Identification of methodologies that could be applied to these to estimate these populations.

2.2 EBSS AF

EBSS AF was intended to support households that either do not have a domestic electricity meter, or do not have a direct relationship to a domestic electricity supplier. The ex-ante estimate for this cohort was based on the estimated size of each eligible population group. These groups were broadly as follows:

- Caravans, houseboats, mobile homes and travellers on authorised sites
- Private and social tenants with a commercial meter
- Heat network consumers with a communal electricity supply
- Off-grid households

- Fully or partly self-funded care home residents
- Farmhouses

Note: these are similar to the groups that were finally eligible for the scheme but there was some further refinement of specific eligibility criteria as the scheme was developed. For a full description of the scheme see the main report.

2.2.1 Caravans, Houseboats, Mobile Homes and Travellers

This grouping included residents of residential park homes, those on boats with permanent residential moorings, and those on permanent gypsy and traveller sites.

Original Estimate Methodology and Sources

- For England and Wales, estimates were based on ONS Council tax data on the stock of properties that are caravans, houseboats or mobile homes
- For Scotland, estimates were based on 2011 census for the number of people in households in caravans or other mobile or temporary structures
- DESNZ separately included a count of traveller caravans based on the 2022 Count of Traveller Caravans in England from the Department for Levelling Up, Housing and Communities.[1] This count is derived from data collected by local authorities, who carry out counts twice a year (January and July), offering a snapshot of the number of caravans on authorised and unauthorised sites on the day of the count. [2]
- For travellers in Scotland, DESNZ used 2009 data on the number of travellers on council/RSL sites, private sites, and unauthorised sites and for Wales, 2020 data on the number of traveller caravans on authorised and unauthorised sites published by the Welsh government. [3]

Alternative Data Sources, Methods and Considerations

The primary alternative data source for this population is the 2021 census which has since been released for England and Wales (at the time of analysis 2021 data for Scotland had not been published).

- In the original estimates, travellers were counted separately from caravans and mobile homes, however, this was unnecessary and may have led to some households being double counted. The council tax data used to estimate caravans and mobile homes includes travellers on authorised sites already as “authorised Gypsy and Traveller sites are charged council tax the same as other residential dwellings”[4].

1 GOV.UK (2022), ‘Count of Traveller Caravans, January 2022’
2 GOV.UK (2022), ‘Count of Traveller Caravans, January 2022: England’
3 StatsWales (2020), ‘Number of caravans by authorisation and local authority’
4 South Cambridgeshire District Council, ‘Gypsy and Traveller DPD frequently asked questions’,

- Additionally, the original estimates for caravans and mobile homes in Scotland were based on number of people rather than number of households, however only one EBSS AF payment would be made per household.
- The census captures households living in caravans or other mobile or temporary structures, including travellers, but does not distinguish between travellers on authorised and unauthorised sites. Since only those on authorised sites were able to apply, this could be adjusted for using the data sources that were originally used to estimate the traveller population, which do distinguish between authorised and un-authorised sites.
- The census is likely to represent primary or main dwellings, which reduces the risk associated with the ONS council tax data which may also include caravans that are second homes, such as holiday homes or vacant properties,[5] which would not have been eligible for the scheme

2.2.2 Private and Social Renters with a commercial meter

Private and social renters were eligible to apply in cases where they had a commercial rather than domestic meter, or paid via a landlord with a commercial contract

Original Estimate Methodology and Sources

The total number of private and social renters were obtained from:

- England: 2020 ONS subnational estimates for dwellings by tenure,[6]
- Scotland: 2019 estimated stock of dwellings by tenure and local authority in Scotland,[7] and
- Wales: 2020 estimated data for dwelling stock by local authority and tenure in Wales.[8]

DESNZ then applied an assumption that 3% of this population group could be eligible for the scheme.

Alternative Data Sources, Methods and Considerations

- The subnational dwelling stock estimates largely match the 2021 census data that is now available (England and Wales)
- Even with the latest census, it is difficult to know what proportion of renters have a commercial contract and how accurate the 3% estimate is. The census allows us to estimate the number of households in situations likely to make them eligible (such as living in converted or commercial buildings), but cannot identify them directly

5 GOV.UK, 'How Council Tax works',
6 ONS (2021), 'Subnational estimates of dwellings by tenure, England',
7 Scottish Government (2022), 'Housing statistics: Stock by tenure',
8 StatsWales (2020), 'Dwelling stock estimates by local authority and tenure'

- The English Housing Survey could also be used to estimate the population of renters, however the advantage of the census is it covers every household so it has more comprehensive coverage, and it is less subject to potential sampling errors
- The surveys undertaken as part of the wider evaluation could provide some insights into the proportion of the population with a non-domestic energy contract, but there are limitations as it was not designed to answer this question. Further primary research into the proportion of private and social renters with commercial contracts would be beneficial to informing future estimates
- A potential limitation of the census is its frequency, given the number of private renters increased significantly between 2011 and 2021. Depending on the timeframe, if the most recent census is too out of date it could still be used to inform the proportion of eligible renters

2.2.3 Heat Networks

Households on a heat network were eligible in cases where they did not have an electricity meter due to having a communal electricity supply.

Original Estimate Methodology and Sources

- DESNZ used internal data based on the same Heat Networks Metering and Billing (HNMBR) data that underpins the 2018 Experimental Statistics on Heat Networks. [9] HNMBR does not contain data on electricity supply so it is not known what proportion of heat network consumers would be eligible for EBSS AF

Alternative Data Sources, Methods and Considerations

- The latest census data can be used to identify households with communal heating as their main source of central heating, but similar to HNMBR cannot identify whether they have an electricity meter or a direct relationship to a supplier
- The Living Costs and Food (LCF) survey was considered, and preliminary analysis was undertaken, but LCF has significant limitations. It includes questions on whether the household has an electricity meter and how their electricity is paid for, but a large proportion of respondents did not report their electricity payment method

9 GOV.UK (2018) 'Energy Trends: March 2018, special feature article – Experimental statistics on heat networks'

2.2.4 Farmhouses

Households living in domestic farmhouses with a non-domestic meter were eligible for EBSS AF.

Original Estimate Methodology and Sources

- The Department for Environment, Food and Rural Affairs (DEFRA) reported to DESNZ the number of farmhouses solely used for domestic purposes in the UK. It is not known what data source underpins this figure

Alternative Data Sources, Methods and Considerations

- A number of alternative sources were reviewed but were not found to provide any insight into the proportion of farmhouses without a domestic electricity supply. The national farmers union conducted a survey which found that nine out of 10 farming families had electricity supplied to the house as part of the farm business, however the sample size was small with only 110 respondents.[10]

2.2.5 Care home residents

Care home residents, or those in an assisted living facility, were eligible where they were either fully or partly self-funded, directly or through loss of pension.

Original Estimate Methodology and Sources

The estimate of the eligible care home population was based on the total care home population in each nation, and the proportion that are likely to be fully or partially self-funded

- England: The Office for National Statistics (ONS) Care Homes and the Self-Funding Population dataset estimates the size of the self-funding resident population in England using Provider Information Returns data collected by the Care Quality Commission for the 2021-2022 period[11]
- Scotland: The Care Home Census for Adults in Scotland[12] contains the number of care home residents in Scotland. The percentage of care home resident that are self-funded in Scotland came from an article by Nuffield Trust[13]
- Wales: The ONS estimated the size of the total care home population in Wales in 2020[14]. DESNZ then applied the estimate that 36% were self-funded residents, a figure which was obtained from the care homes market study.[15] This figure was used in error as it actually refers to self-funded residents paying about 36% more than those whose care is state funded. However, it is unlikely that this made a significant difference to the

10 Farmers Weekly (2022), 'Farmhouses could face soaring bills due to business tariffs'
11 ONS, 'All data related to Care homes and estimating the self-funding population, England: 2021 to 2022'
12 Public Health Scotland (2021), 'Care home Census for adults in Scotland'
13 Nuffieldtrust (2023), 'How much social care does each country fund?'
14 ONS (2020), 'Care home and non-care home populations used in the Deaths involving COVID-19 in the care sector article, England and Wales'
15 Competition and Markets Authority (2017), 'Care homes market study final report',

final estimates for Wales as the Nuffield Trust paper on which the estimates for Scotland were based suggests the proportion of self-funded care home residents in Wales is 32%

- Partly Self-Funded residents: For all GB nations, the number of partly self-funded residents was estimated based on their total care home population and the proportion of respondents to the Personal Social Services Adult Social Care Survey that stated either they or their family pay for additional care[16]

Alternative Data Sources, Methods and Considerations

- The 2021 Census allows for a breakdown of the number of care home residents aged over 65 at the local authority level and overall, at the regional level[17]
- Another data source that could be employed for England is the Adult Social Care in England monthly statistics. This dataset contains information on bed occupancy in care homes and the number of individuals in residential care homes and nursing homes receiving long-term, local authority-commissioned adult social care[18]
- An estimate of the proportion of self-funded residents is also available via the ONS.[19] These figures are based on an experimental model, providing weighted annual estimates of the size of the self-funding and state-funded resident population in care homes in England. This provides the most recent data and is a valuable basis for estimating the size of the self-funding population in care homes in England. In cases where local authority-level data was missing, a weighted average of 35.27% for self-funded residents was applied. While this method is not perfect, it offers a practical approach to filling data gaps. However, caution should be taken when applying this approach to other parts of Great Britain, as care policies differ across the regions

2.3 AFP AF

AFP AF was intended to support households that used alternative fuels, but did not have a direct relationship to a domestic electricity supplier and so could not receive the automatic AFP support. It also covered households who were eligible for AFP but where not identified as such based on their postcode, usually due to living in area where gas or electric heating is common.

- While the census provides reliable data on the total number of households using alternative fuels, the AFP AF population is challenging to estimate due to the range of reasons a household might not have received AFP automatically, and the difficulty of identifying households without a direct relationship to a domestic electricity supplier.
- For population groups likely to be eligible, such as those in caravans or mobile/temporary structures, Census data allows for the identification of the number of these households that might be eligible based on central heating type. This approach can also be applied to other census population cohorts that may qualify.

16 NHS England (2021), 'Personal Social Services Adult Social Care Survey, England – 2020-21'
17 ONS (2023), 'Older people living in care homes in 2021 and changes since 2011'
18 GOV.UK (2024), 'Adult social care in England, monthly statistics: March 2024'
19 ONS (2023), 'Care homes and estimating the self-funding population, England',

- The Living Costs and Food Survey (LCF) could also be utilised for estimating eligible cohorts or cross-referencing estimates. The LCF contains information on how people pay for their electricity, household demographics, and housing unit type. It also includes questions on whether a household has a gas supply to the property or part of the property, if the household has central heating, and what type of fuel they use primarily for central heating. A limitation of this is it would not capture those who have a domestic electricity supplier but did not receive AFP automatically due their postcode, for being in an area where alternative fuels are not commonly used.

2.4 Overarching Considerations

The addition of more recent census data reduces the risk of error associated with ex ante estimates, particularly where there is a greater risk of data being out of date. However, many of the populations eligible for EBSS AF cannot be estimated directly from the census, so future estimates would still need to rely on many of the same assumptions about what proportion of a wider population would be eligible. For example, one significant challenge is the lack of direct data on the number or proportion of households with a non-domestic energy supplier. The Living Costs and Food Survey includes a question on method of payment that could provide valuable insights into whether households have a direct or indirect electricity supply, however, the majority of respondents do not report their electricity payment method, meaning in practice it provides no further insight.

Annex C3 Price and income elasticity modelling

3.1 Introduction

This section presents results of additional modelling undertaken to estimate price elasticities of demand. This supplements the primary fieldwork undertaken, by providing estimates of how energy and other consumption would have changed in the absence of the energy affordability schemes and provides estimates of the schemes' impact on maintaining energy consumption, energy burden and non-energy consumption. This work uses aggregate quarterly data from the ONS Consumer Trends and Family Spending Workbook, and annual aggregate data from the DESNZ National Energy Efficiency Data-framework (NEED).

To provide an estimate of how the energy affordability schemes affected energy and non-energy consumption during the intervention period, Almost Ideal Demand System (AIDS/QUAIDS) models[20] of demand were used to calculate price elasticities of demand (the change of consumer demand for a product or service following a change of its price). Due to the universal nature of the schemes, more standard counterfactual impact estimation techniques were not possible. However, the econometric technique of estimating demand systems and demand elasticities allows us to make a counterfactual prediction from the model. Since the various policies contained a mix of price changes and income changes, and these are the main independent variables in consumer demand modelling, we can make a prediction from AIDS/QUAIDS models to say what would have happened without the interventions, i.e., with higher prices and lower incomes.

To model the preferences of consumers, the analysis used a structural model which estimates a system of consumer demand functions. The functions in these models take prices and income as the inputs, and output price elasticities and expenditure, generally expressed as a budget share. Price elasticities of demand are modelled as the percentage changes in energy consumption relative to the percentage changes in prices, for each household group included in the model. These models enable comparisons of the output function at varying price and income levels, such as with/without the EBSS and EPG schemes

The package of energy affordability interventions comprises the following schemes (see main report for full details):

- Energy Bills Support Scheme (EBSS) GB provided a £400 grant to GB households distributed through their energy supplier through six monthly payments of £66 or £67 from October 2022 to March 2023. It was accessible only to households with a domestic electricity meter point who held a household-specific account with the supplier. Landlords had to ensure that the discount was passed down to tenants, who would have

[20] Deaton & Muellbauer (1980), 'An almost ideal demand system', The American economic review, volume 70(3), pages 312-326

the right to legal redress. For consumers on pre-payment meters, the grant was sent via six vouchers, which then had to be accredited to their account at the post office or PayPoint.

- The Energy Price Guarantee (EPG) established a cap (distinct from the existing Energy Price Cap) on the unit price of electricity and gas for households. By doing so, it resulted in households saving - on average - approximately £900 during the winter season (October 2022 – March 2023) compared to what they would have paid under the existing Energy Price Cap. The government compensated suppliers for the difference between the cap and the EPG.
- EBSS Alternative Fund (AF) was available to approximately 900,000 households who were ineligible for EBSS GB because they lacked a domestic energy contract with a licensed supplier and often paid for their energy through a commercial landlord or intermediary. The support intervention involved a one-time payment of £400 to these households on application from February 27th to May 31st 2023 as a single instalment.
- Alternative Fuel Payment (AFP) helped around 2 million households in GB who are not connected to the mains gas grid and who therefore rely on alternative fuels like heating oil or liquid petroleum gas for their heating needs. Eligible households under the AFP received a one-time payment of £200 during the winter season, to safeguard them against the increasing expenses associated with alternative fuel sources. This was in addition to the £400 EBSS GB grant.
- AFP AF provided the same support as the AFP scheme, but was available for households that do not automatically receive the AFP payment. These households typically included those without their own electricity supply, or those without a direct relationship with the electricity supplier, such as caravans, houseboats, mobile homes, Travellers, etc. This could be applied for in addition to the £400 EBSS AF payment.

The work presented in this paper makes use of quarterly aggregate ONS Consumer Trends and Family Spending Workbooks, as well as cross tabulations (crosstabs) of average gas and electricity usage by EPC rating, floor area and income bracket from the NEED data. This aggregate nature imposes some limitations on the modelling undertaken. Most importantly, there may be nonlinear effects not captured in these aggregate results for certain groups of households once they face very high energy prices. This aggregate nature of the data available also, by definition, means that the modelling captures long-term responses to price variation better than any short-term effects that might otherwise be expected. Finally, the modelling did not attempt to model difference between Alternative Fuels (AF) and other populations.

A separate economic evaluation of the affordability schemes has been commissioned by DESNZ. This work is expected to use household level micro-data and undertake further sensitivity testing of the results presented in this paper.

3.2 Methods

The primary focus of this report is to estimate own and income elasticities and apply them to various groups or estimates of groups for the GB economy. The purpose is to estimate the counterfactual impact of what would have happened to energy consumption, and consumption of other goods in the absence of such payments. Given the estimates of the policy changes as income and price supports, the changes in income and price, all else equal, are then modelled for different income deciles. This allows us to estimate changes in energy usage, and impacts on fuel poverty.

The rationale for such an approach derives from empirical research in consumer economics which shows that various commodities can behave as normal, luxury, or inferior goods, in other words, consumers' consumption may change as their income changes with respect to these goods. Moreover, goods may be luxury goods at lower levels of income while inferior goods at higher levels (e.g., alcohol), which means the share of expenditure on any good may increase or decrease over a range of incomes. The models we employ allow us to test and account for different slopes and shapes of the Engel Curve, which describes the behaviour of expenditure on a good as household income changes.

The modelling is based on the Almost Ideal Demand System (AIDS) model of Deaton and Muellbauer (1980). This framework allows for consistent estimation of own and cross price elasticities for specified commodity types and bundles. This modelling framework is 'state of the art' in terms of applying restrictions that are consistent with consumer demand, but that do not impose unnecessary restrictions such as not allowing some goods to be luxury and some to be normal goods. The AIDS model gives a first order approximation to any demand system, and aggregates perfectly over consumers. This strong theoretical underpinning, combined with its ease of estimation, makes for a good approach to estimate the impacts of certain policy scenarios on commodity usage.

We fit the AIDS model to the available data and can then predict how usage and expenditure shares change based on the different policy scenarios from the energy affordability schemes. Detailed descriptions of the models used are given in sub-annex 1, they are demand system models in the AIDS family. We also calculate the compensating variation (CV) and equivalent variation (EV) of the EPG price change policy, which gives a monetary estimate of the value of the policy to different income groups (deciles). The definition of CV and EV are how much money would the household need to be given to achieve the same utility as a price change. The CV and EV are monetary estimates of the impact of the policy change while allowing quantities and income to vary, including a variable marginal utility of income. An explanation of the process of calculating the compensating and equivalent variations is given in sub-annex 2. In short, they answer the question of how much a consumer could in theory be compensated for the impact of a price change. Estimates of fuel poverty and underheating are also investigated.

3.3 Data

The primary data source for this modelling was the ONS Consumer Trends UK quarterly timeseries (CT). This provided 156 observations from 1985Q1 through 2023Q4. For each commodity type there were data for expenditure (in current price) and a quantity index (chained volume measure). The CT quarterly time series are broken down into constant volume and expenditure measures the corresponding implicit prices. Using these values, two further variables were calculated for each commodity: price per unit quantity; and share of total expenditure. This gave us the necessary data required to fit a demand system model to the data, which will be discussed in the next section.

Data from the ONS Family Spending Workbook were used to allow us to estimate how the expenditure timeseries changes for different income deciles. The data did not need to be modified and were simply used to disaggregate the expenditure timeseries data based on the ratio of each decile's expendable income with the median. This data was also used to cross check the model predictions.

It is important to note that the data contains the actual intervention periods of the energy affordability schemes, so the effect of the actual price rises, caps and interventions is contained in the data.

Additional data on various factors such as EPC rating and household income was also made available from the National Energy Efficiency Data-Framework (NEED). The NEED data were not used in the estimation *per se*, but were subsequently used to see how expenditure shares predicted by income decile group changed by EPC rating, with and without energy affordability interventions. The NEED data were provided in the form of cross tabulations (crosstabs) giving averages of gas and electricity usage for each combination of EPC rating, floor area and income bracket, for each year available. The frequency with which each combination occurred was also provided. Combinations with fewer than 5 occurrences were replaced with NA values to make the data non-disclosive.

3.4 Modelling approach

The model allows to predict counterfactuals of 'no intervention' for any chosen impact scenarios. After discussions with DESNZ, two illustrative scenarios to span the main policies were chosen and were compared to the "no intervention" scenario.

- **Receiving a £400 income support (EBBS) and an EPG price reduction[21].**
- **Receive £600 (EBSS £400 + AFP £200), and no EPG[22],**

[21] The estimated price change of EPG was taken from Ofgem's announcement letter of the price cap, suggesting typical bill for the typical consumer of £2,500 under EPG.
[22] Some of these households may have benefitted from EPG on their electricity bill but that cannot be disaggregated using the data available. EPG would not have impacted their heating costs which is the focus of this analysis

This gives a reasonable comparison also of two illustrative policies, i.e., the income and price support of EBSS + EPG and the single income support (without price support) of £600. The illustrative purpose of choosing these two scenarios is also to compare the combined approach of income and price support with a slightly higher income only support. The second scenario represents households which did not have gas or electric heating and used an alternative heating fuel – these households received £600 in payments and no EPG.

To simplify the model, commodities consumed by households were aggregated into five categories of broadly similar types or degrees of necessity. The aggregated groups (with their associated commodity codes) were:

1 Food, drink, water and health (with the ONS expenditure category numbers [1, 4.4, 6])

2 Alcohol, tobacco, narcotics, restaurants, hotels, recreation, culture and miscellaneous (ONS numbers; 2, 9, 11, 12)

3 Clothing, transport, communication and education (3, 5, 7, 8, 10)

4 Rent, house imputed rent and non-water non-energy utilities (4 excl. 4.4 and 4.5)

5 Electricity, gas and other fuels (4.5)

The next step was to find the best models for the data. To do this several models were fit to the data (e.g., AIDS, QUAIDs, Translog) and then the compensated (Hicksian) and uncompensated (Marshallian) price elasticities given by each model were compared with those of the other models to find which models gave the most reasonable predictions under current economic theory. It was also tested whether differences between model results were statistically significant. The models tested were:

- Almost Ideal Demand System (AIDS)
- Generalised AIDS
- Quadratic AIDS (QUAIDS)
- Generalised QUAIDS

These models can be estimated in STATA and give second-order approximations to any demand system. The QUAIDS model expands on the AIDS model and further allows for non-linear Engel curves (curves of how expenditure varies with income). The generalised version of these models enables committed quantities, or minimum subsistence levels, which is often preferable as this ensures that a constant term is included in each demand equation. A detailed description of these models is given in Sub-annex 1.

While the generalised versions of these models have some good properties, they fit the data worse than simpler ones. Based on the rubric and process outlined earlier it was decided to proceed with the AIDS model and have the QUAIDS model as a sensitivity test (both the ungeneralised versions). In general, the AIDS model fit the data well and there wasn't much sensitivity across models. The QUAIDS models fit the data well but gave some counter intuitive predictions for shares of the higher income brackets.

Below, in table 1, we can see the expenditure elasticities derived from the estimated parameters of the AIDS model. The figures in the table are the expenditure elasticities of the goods with respect to income. Thus a % change in energy predicted by the % change in income. A positive value indicates the good is a normal good and a negative an inferior good. Values positive and greater than one are luxury goods, and values positive and less than one are classified as necessity goods. These values confirmed that the AIDS model was working as intended and giving us values that conform to economic literature—e.g., in particular a negative elasticity for energy, that is to say the share of expenditure on energy should decrease with income[23].

Table 1 Expenditure elasticities (AIDS model)

Expenditure	Food, drink… (1, 4.4, 6)	Alcohol, tobacco… (2, 9, 11, 12)	Clothing, transport… (3, 5, 7, 8, 10)	Rent, house… (4 excl. 4.4 and 4.5)	Electricity, gas… (4.5)
Elasticity	**0.568**	**1.221**	**1.318**	**0.653**	**-0.297**
Type	Normal	Luxury	Luxury	Normal	Inferior

Source: London Economics analysis

Bold: P-value < 0.05

The next table (table 2) shows the uncompensated (Marshallian) price elasticities for each of our bundles of commodities in the AIDS model. Uncompensated elasticities contain both the substitution and income effects of a price change. The table for the compensated[24] (Hicksian[25]) price elasticities is similar and can be found in Sub-annex 3.

The main focus here should be on the own price elasticity of electricity, gas and other fuels, which is negative and between zero and one, indicating inelastic demand. These are generally of the expected sign and size, and significant (except one, category 4, rent and housing, which is not surprising). The uncompensated elasticities include the price and income effects. Again, these values gave us confidence in the AIDS model. In particular, we paid close attention to the main diagonal of own-price elasticities of this table.

[23] The value for clothing is perhaps counterintuitive, but clothing might be of both luxury and normal types. Future analysis outside of this evaluation could further disaggregate these categories and estimates.
[24] Compensated price elasticities are elasticities holding utility constant, and so are as if income is used to compensate for a price change in order to hold utility constant. Utility is the major economics concept of consumer wellbeing used to model consumer demands. The origins of utility trace back to before Marshall, and questions such as the diamonds vs water paradox (why one might be more or less useful or valuable). Utility principally differs from income in that there is diminishing marginal utility of income but also of consumption, etc. Utility is a more flexible and less restrictive concept than income, for example it allows for and can explain risk aversion, etc. When income effects are large the two types will be more different.
[25] Named after Sir John Hicks, British economist and Nobel Laureate.

Table 2 Uncompensated (Marshallian) price elasticities (AIDS model)

	Food, drink… (1, 4.4, 6)	Alcohol, tobacco… (2, 9, 11, 12)	Clothing, transport… (3, 5, 7, 8, 10)	Rent, house… (4 excl. 4.4 and 4.5)	Electricity, gas… (4.5)
Food, drink… (1, 4.4, 6)	**-0.772**	-0.045	**-0.088**	-0.022	**0.701**
Alcohol, tobacco… (2, 9, 11, 12)	0.091	**-0.568**	**-0.254**	**-0.287**	**-1.010**
Clothing, transport… (3, 5, 7, 8, 10)	-0.006	**-0.169**	**-0.322**	**-0.469**	**-0.583**
Rent, house… (4 excl. 4.4 and 4.5)	-0.024	**-0.320**	**-0.553**	-0.017	**1.429**
Electricity, gas… (4.5)	**0.143**	**-0.118**	**-0.102**	**0.141**	**-0.241**

Source: London Economics analysis

Bold: P < 0.05

3.5 Usage under counterfactual scenarios

Once the data was modelled using the AIDS and QUAIDS we could then begin the process of predicting the effects using the econometric model. This has the benefits of taking account of the own-price, cross price and income effect together with a consistent set of parameters, with the restrictions on demand and expenditure functions imposed. First, we estimated the impact on the quantities of each commodity group under two policies: EPG and a £400 lump sum, a £600 lump sum only, and the counterfactual of no policy at all.

The estimates presented are from the AIDS model (QUAIDS results are in sub-annex 4). There were virtually no differences between the AIDS and QUAIDS predictions save for the higher income deciles, which gave counter-intuitive results. AIDS model results were consistent with

the seminal findings of Banks, Blundell and Lewbel (1997)[26], which found negatively sloped but linear Engel Curves for Energy for the UK economy. Therefore, we concluded to use the AIDS model as our base case.

The predictions from the AIDS model indicate that the lowest income decile used 28% more energy with the £400 + EPG scenario than under the counterfactual scenario, which is consistent with the policy objectives of increasing energy consumption. It is notable the predicted percentage-change in energy usage decreases with higher income deciles until the 10th decile where there is very little difference with the counterfactual of having no policy. This is due to the negative income elasticity, but also that the own price elasticity creates income and substitution effects.

Also of particular interest is the difference between the EPG plus £400 scenario vs the £600 scenario. The £600 income support scenario has a much smaller impact on the change in energy expenditure. The AIDS model predictions for the £600 support indicate this policy does not change energy use by more than 5% in any decile. This difference in effects is driven by two factors: First, there are no own and cross price elasticity effects in the £600 policy; Second, the overall total value of EPG is significantly larger than the £200 provided to AFP households.

This model also estimated that the share of expenditure going towards electricity, gas and other fuels decreased under the £400 + EPG policy relative to no policy. While the share of expenditure would also fall for the £600 policy when compared to the counterfactual of no intervention, the size of the effect is much smaller. This indicates that under the £400 + EPG policy households were likely to use more energy while also spending more on other goods and services and that the £600 policy would have mostly gone towards other household expenses.

Predictions for low-income vs high income households also differed. Low income households had a considerably larger impact/increase due to either policy; for the highest income households there was effectively no impact. The EPG + £400 policy had a somewhat larger impact on the lowest income household groups than the highest. Given the expectations of previous research, the models, and the estimated elasticities, this is broadly as we would expect.

The detailed results by income decile are found in table 3, below:

[26] Banks, James, Blundell, Richard and Lewbel, Arthur (1997), 'Quadratic Engel Curves And Consumer Demand', The Review of Economics and Statistics, 79, issue 4, pages 527-539

Table 3 Electricity, gas and other fuel (4.5) usage over 2022Q4 and 2023Q1 [kWh] with counterfactual scenarios (AIDS model)

Income Decile Group[27]	Quantity [kWh]					
	£400 + EPG	No Policy	% diff to no policy	£600 only	% diff to no policy	% diff to £400 + EPG policy
1st	6,827	5,178	28%	5,422	5%	23%
2nd	8,008	6,259	25%	6,473	3%	21%
3rd	8,337	6,586	24%	6,758	3%	21%
4th	8,665	7,011	21%	7,136	2%	19%
5th	8,960	7,329	20%	7,428	1%	19%
6th	9,600	8,140	16%	8,200	1%	16%
7th	9,485	8,114	16%	8,159	1%	15%
8th	9,715	8,543	13%	8,555	0%	13%
9th	9,807	8,949	9%	8,927	0%	9%
10th	11,934	12,090	-1%	11,975	-1%[28]	0%

Source: London Economics analysis of AIDs modelling results using ONS data

The energy figures are converted to kWh and percentage changes. The aggregate CT time series is given with constant volume quantity measures for the aggregate economy for each of the commodity types. These units are not readily interpretable and were therefore converted to kWh. Notably, quantities are generally in arbitrary units with implicit prices and expenditures so we used the NEED data to convert the aggregate quantity indices to kWh.

Estimates are consistent for typical households with incomes in the different deciles of the income distribution, so we utilised the published NEED data tables for 2022 (which are the most recent at time of analysis) to estimate winter kWh usage for typical households by decile.

[27] To note, there are 10 income deciles, which divide the income distribution into 10 equal sized groups. Decile 1 here being the lowest income. The decile groups are estimated from disposable household income from ONS data.

[28] The very small negative impact for the highest income group should probably not be interpreted as significant. Nonetheless, it could be intuitively imagined that for these households, the fact that energy is an inferior good, the income effect starts to dominate the price effect. As income increases the price impacts are of less and less consequence, and the desired level of heating and energy use is achieved. More practically, these households could have invested in energy saving equipment with the money saved, although it should be noted the model 'predicts' this change without actually saying in particular how.

To do this, first the income deciles were interpolated from NEED[29], for each of electricity and gas, as the income categories were not exactly matching deciles. Next the total electricity and gas kWh per households per year was summed for the interpolated deciles. Then, from the seasonal quarterly CT time series, for the 2022-23 winter, the proportion of annual expenditure that was on the winter intervention period was calculated. We then created a proportional factor, for each quarter. These proportional factors were then used to give the baseline kWh for the winter quarters of the intervention period and thus scaled the NEED data (which was annual) to the winter period only. The percentage changes for the quantity are then applied for the policy and no policy scenarios as the changes are all proportional.

Next, we examined how the policy scenarios affected other spending categories. The modelling framework developed enables us to predict the change in expenditure, quantity and share for all commodity bundles specified. We present below food and drink and water and health, as how the policies impacted other 'necessities' is of particular interest. The category of food, (non-alcoholic) drink, water and health (1, 4.4, 6) is of obvious importance, so we discuss it here. The complete set of tables for each aggregated group of commodities is included in Sub-annex 3. Of note is the cross-price elasticity of the food, etc category with energy from the demand elasticities table. This figure was significant, near 1 and positive, indicating a decrease in the price of energy would indicate a decrease in the consumption of food, and other necessities.

Table 4, below, shows that the price change for energy was predicted to have a small impact of decreasing expenditure on food, drink, water and health, under the AIDS model.

Of note is that the data in the table are predicted changes in the quantity index and this is an aggregated commodity bundle. The subsequent table converts these quantities to annualized pound expenditure figures, holding prices constant at 2022 levels.

The key takeaway is that for this commodity bundle, the impact of the EBBS+EPG policy was in essence nil for the price and income change. The policy tended to reduce expenditure on this category, but by a small amount for the highest income households. Conversely, the income only policy (EBSS+AFP) increased expenditure broadly across all income groups, but had a bigger impact on lower income households.

This is consistent with the expectations of the Engel curve for these goods and is consistent with substitution of expenditure towards the lower priced energy product. This effect is more pronounced for higher income deciles. The expenditure shares on this category do not change by a large amount for any decile.

[29] This was done by taking a weighted average of the end points of the class groups. In essence, the NEED data consumption groups are for round numbers of annual £ income, e.g., £20,000 - £29,999, whereas the actual income decile groups are from the income levels that divide the population into 10 equal parts by number of households. We do not think this created any large error. Notably, the potential error is only in terms of the predicted decile group annual kWh usage, not in terms of the % change in energy spend or energy quantity, which are unitless and coming from the elasticities.

Table 4 Food, drink, water and health (1, 4.4, 6) usage over 2022Q4 and 2023Q1 with counterfactual scenarios (AIDS model)

Income Decile	Quantity (Constant Volume measure ONS)					Share		
	£400 + EPG	No Policy	% diff	£600 only	% diff no policy	£400 + EPG	No Policy	£600 only
1st	48,924	48,756	0%	52,002	7%	15.3%	16.2%	15.8%
2nd	59,136	59,565	-1%	62,914	6%	13.9%	14.8%	14.4%
3rd	61,373	62,339	-2%	65,128	4%	13.6%	14.5%	14.1%
4th	68,292	69,952	-2%	72,494	4%	12.8%	13.6%	13.3%
5th	70,941	73,044	-3%	75,249	3%	12.5%	13.2%	13.0%
6th	79,804	82,666	-4%	84,921	3%	11.5%	12.3%	12.0%
7th	81,566	84,738	-4%	86,788	2%	11.3%	12.0%	11.8%
8th	86,633	90,479	-4%	92,304	2%	10.7%	11.5%	11.3%
9th	92,206	96,808	-5%	98,449	2%	10.2%	10.9%	10.7%
10th	102,490	108,732	-6%	109,983	1%	9.1%	9.8%	9.7%

Source: London Economics analysis

Table 5 below, details the predicted total expenditures for the different commodity bundles in 2022 Q4 real values per household per annum. We can see that the £600 scenario increased energy expenditure is in line with the increase in usage seen in the previous table, while the £400 + EPG scenario actually decreased energy expenditure while increasing usage thanks to the price support measure. In general, we expect the £600 policy would have increased expenditure across all commodity bundles, and compared to a no policy scenario, the £400 + EPG gave increased expenditure to certain bundles and decreased to others.

Table 5 Real Household Expenditure [2022 Q4 GBP per household per annum]

		2022 Q4	**2023 Q1**
Food, drink, water and health	£400 + EPG	1,511	1,509
	Counterfact: no policy	1,624	1,652
	£600 only	1,670	1,700
	£400 + EPG	4,882	4,912

Clothing, transport, communication, education	Counterfact: no policy	4,347	4,288
	£600 only	4,603	4,541
Rent, house imputed rent plus non water and non energy utilities	£400 + EPG	3,582	3,659
	Counterfact: no policy	3,359	3,346
	£600 only	3,574	3,562
Alcohol, tobacco, narcotics, restaurants, hotels, recreation, culture, misc.	£400 + EPG	2,972	2,979
	Counterfact: no policy	3,165	3,287
	£600 only	3,264	3,392
Electricity, gas and other fuels	£400 + EPG	526	528
	Counterfact: no policy	565	593
	£600 only	570	599

Source: London Economics analysis

3.5.1 Compensating and Equivalent Variation of the Policy

Equivalent variation (EV) and compensation variation (CV) are two measures based on the indirect utility function approach of the economic 'value' seen by a household under a price change. A comprehensive description of these concepts and how they are calculated is given in Sub-annex 2. In essence, the two measures estimate how much income would have to be given to the household in question to give the same utility as a price change.

These measures allow to compare the 'value' or welfare impact of say the £400 + EPG with the £600 direct income support.

To find the EV and CV seen by each household under the intervention we first use our AIDS model to estimate them on a national level then divide out by the number of households (29 million). Since there are different utility levels for each household given income, we predicted the EV and CV for the typical household of each income decile, using the decile estimates from ONS. In STATA EV and CV calculations only account for price changes so we must also add the £400 lump sum to the result of our calculation/predictions of CV and EV. The £600 only policy does not need to be estimated as it's a simple £600 cash payment.

Table 6 Compensating and Equivalent Variation of £400 + EPG Policy [£ per household] (AIDS model)

Income Decile	CV	EV
1st	714.44	710.86
2nd	753.60	750.90
3rd	760.77	758.28
4th	779.34	777.57
5th	784.91	783.43
6th	796.42	795.95
7th	797.26	796.98
8th	796.57	796.87
9th	789.77	790.68
10th	755.65	757.50

Source: London Economics analysis

The results of the EV and CV are interesting. Middle income deciles saw the largest economic benefit from the policy according to both models. This is likely because the lowest decile households are already spending a small total amount of money on energy, even though a large share of income.

Some intuition for this may be that lower income households benefit less from the price change as they have less to spend to begin with. Higher income households may benefit more from a price drop if they are already consuming more of the good. However, energy is estimated to be an inferior good, so higher income households substitute out of the energy good. On the other hand, the income effect tends to increase expenditure on all goods, broadly in proportion to their expenditure shares. Finally, there is an income boost to the policy of £400. The data and examples above suggest that these two effects may have been cancelling.

The net result is that in money terms, the models predict money-equivalent utility increases that are similar for all income groups. In other words, more well-off households did not get significantly ‘more’ utility than poor households because they had a big house and heated it more. The richest households didn’t change energy use much while the poorer ones did and so the net impact was similar across deciles. However, across the board all deciles saw a greater money-metric-utility-value than a £600 lump sum would have provided.

It should be noted here that these results are driven by the aggregate and quarterly data available to us for this modelling work, meaning they do account mostly for long-run effects.

These results should therefore undergo further sensitivity analysis using more disaggregated data.

3.6 Fuel Poverty[30]

In this subsection, we study the impacts of the schemes on fuel poverty. We followed the ONS's technical definition of fuel poverty which is as follows "after housing costs, the total fuel costs needed to maintain a satisfactory heating regime are more than 10% of the households adjusted net income." We used the ratio of total energy expenditure divided by total non-housing expenditure. Using crosstabs of the NEED dataset by EPC and income bracket and our predictions from the AIDS model we can estimate which categories of household were in fuel poverty on average under the different policy scenarios. The usage data from NEED closely matches similar consumption data from OLS and UCL SERL. To carry out these calculations we had to assume that households heat to a satisfactory level, as actual expenditures are the only figures we have. As such our figures are possibly an underestimation.

To calculate these figures, we divide the expenditure shares we obtained from the AIDS model by the share which corresponds to non-housing expenditure. The non-housing expenditure can be found in the ONS Family Spending Workbook. The ONS workbook has figures in average weekly spend by decile, we convert these to percentages of the total and assume housing costs are constant throughout the year. This gives us the share of non-housing costs going towards fuel. The deciles are disaggregated to include EPC ratings using the fact that their expenditure share is proportional to usage (usage data by EPC and income are included in our NEED crosstabs), and the sum of usage in the disaggregation must be equal to the total we already have. The expenditure shares and total expenditure figures on energy, housing, and total expenditure were matched to the FYE 23 ONS Family Spending Workbook1 data by decile. The quantity change and the corresponding % change in the share due to the policy/counterfactual was used from the AIDS model outputs by decile.

Our predictions of the share of spend on energy by decile matched the actual income shares based on ONS FYE 22 Workbook 1 data and the share of energy in all expenditure. However, the model-predicted data did not predict well the FYE 23 workbook1 data, which reflected the intervention period, where shares of energy (even with the policy), were significantly higher. The table below (table 7) highlights the changes in the shares from the workbook1 data, which annualized figures for all UK typical household within the income group (the income deciles are by disposable household income, Table 3.1 in the workbook).

[30] The definitions and measurement of Fuel Poverty vary across countries, including within the United Kingdom. We have used the term fuel poverty as an indicative term and our results should only be interpreted in the terms of what we have assumed and estimated. There are explicit definitions of fuel poverty used in policies elsewhere that should not be confounded with our approach. For more information on the differences in Fuel Poverty definitions across the UK, refer to the House of Commons Library briefing paper.

Table 7 UK Household Share of Energy Expenditure Analysis, 2021-2023

		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	All
2021	% Energy Expenditure	9.4%	8.7%	7.1%	7.0%	6.4%	5.4%	5.4%	4.8%	4.5%	4.0%	5.6%
	% Energy Expenditure after Housing	11.0%	9.8%	8.1%	8.0%	7.0%	6.1%	5.9%	5.2%	4.8%	4.1%	6.1%
2022	% Energy Expenditure	8.6%	8.3%	7.2%	6.5%	6.3%	5.5%	5.4%	5.0%	4.7%	4.1%	5.6%
	% Energy Expenditure after Housing	9.8%	9.5%	8.2%	7.3%	6.8%	6.0%	5.8%	5.3%	4.7%	4.3%	6.1%
2023	% Energy Expenditure	12.2%	11.0%	8.6%	7.9%	8.3%	7.4%	7.1%	6.9%	6.2%	5.9%	7.5%
	% Energy Expenditure after Housing	14.3%	12.0%	9.6%	8.6%	9.1%	8.0%	7.7%	7.3%	6.6%	6.1%	8.1%

Source: ONS Detailed Household Expenditure, 2021-2023

Table 8 shows the share of income going towards fuel costs after housing for each income decile. Highlighted in red are the categories which were in our working definition of fuel poverty on average (within the category group). We can see that in the £400 + EPG scenario the average household in the 1st and 2nd income decile for all EPC ratings were expected to be in fuel poverty by our measure. Only the most efficient households in the middle deciles would not be in fuel poverty. The impact of EPC is significant in that for the least efficient households, they would be in fuel poverty even at the highest income levels, albeit marginally.

Table 8 Share of FY 2022-23[31] income towards fuel costs after housing costs by income decile - £400 + EPG scenario

EPC	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
A	15.4%	12.3%	9.9%	8.8%	9.4%	8.1%	7.5%	7.1%	6.6%	5.9%
B	14.7%	11.2%	8.7%	7.5%	7.8%	6.7%	6.5%	6.2%	5.8%	5.6%
C	16.2%	13.4%	10.7%	9.3%	9.9%	8.7%	8.6%	8.3%	7.8%	7.4%
D	18.9%	15.4%	12.2%	10.9%	11.7%	10.3%	10.2%	9.7%	9.0%	8.2%
E	20.8%	17.0%	13.5%	12.1%	13.0%	11.5%	11.6%	11.0%	10.2%	9.5%
F	20.4%	16.6%	13.4%	12.3%	13.3%	11.9%	12.1%	12.3%	11.8%	11.1%
G	19.5%	15.4%	12.2%	11.0%	12.0%	10.9%	10.9%	10.9%	10.5%	10.0%

Source: London Economics analysis using ONS family spending, NEED, and LE results from AIDS modelling

Table 9 shows the predicted share of income in the counterfactual scenario of having no policy. The most relevant use of these tables is to compare the impacts of the policies and the no policy scenario. Comparing the £400 + EPG scenario (table 8) with the counterfactual of having no policy (table 9), we can see that the standard policy had quite a significant impact on fuel poverty keeping the 4th to the 10th decile groups out of fuel poverty for C and lower EPC rated households. The slight difference between the A and B rated households in the 4th to 6th decile groups is marginal, but stems from the estimates of actual consumption by decile and controlled to the data from NEED, with the A-rated households having slightly higher consumption – possibly from bigger houses or overheating.

Table 9 Share of income towards fuel costs after housing costs by income decile - Counter factual: no policy

EPC	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
A	17.8%	14.6%	11.7%	10.7%	11.4%	10.3%	9.5%	9.2%	8.8%	8.7%
B	17.1%	13.3%	10.4%	9.0%	9.5%	8.4%	8.2%	8.1%	7.8%	8.3%
C	18.8%	15.9%	12.7%	11.3%	12.0%	10.9%	10.9%	10.8%	10.5%	11.0%

[31] The shares of income were normalise to 2022-23 expenditures from the ONS Family Spending detailed workbook

D	22.0%	18.4%	14.6%	13.2%	14.2%	13.0%	12.9%	12.6%	12.1%	12.2%
E	24.2%	20.2%	16.0%	14.6%	15.8%	14.5%	14.7%	14.3%	13.7%	14.1%
F	23.7%	19.7%	15.9%	14.9%	16.1%	14.9%	15.3%	16.0%	15.8%	16.5%
G	22.6%	18.4%	14.5%	13.3%	14.6%	13.7%	13.8%	14.2%	14.2%	14.8%

Source: London Economics analysis using ONS family spending, NEED, and LE results from AIDS modelling

The next table (table 10) shows the impact of the £600 policy with no EPG (corresponding to the EBSS+AFP interventions). This metric suggests that the £400 + EPG policy was again more effective than the £600 policy would have been, or indeed, implementing no policy, as the impact of this in terms of the fuel poverty measure shows an intermediate case between the EPG + £400 and the no-policy scenario.

Table 10 Share of income towards fuel costs after housing costs by income decile - £600 policy

EPC	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
A	16.2%	13.0%	10.4%	9.2%	9.8%	8.5%	7.8%	7.4%	6.9%	6.1%
B	15.5%	11.8%	9.1%	7.8%	8.1%	7.0%	6.8%	6.5%	6.0%	5.8%
C	17.1%	14.2%	11.2%	9.8%	10.3%	9.1%	9.0%	8.7%	8.1%	7.8%
D	20.0%	16.3%	12.8%	11.5%	12.2%	10.8%	10.7%	10.2%	9.4%	8.6%
E	21.9%	18.0%	14.1%	12.7%	13.5%	12.1%	12.1%	11.5%	10.7%	10.0%
F	21.5%	17.5%	14.0%	12.8%	13.8%	12.4%	12.6%	12.8%	12.3%	11.6%
G	20.5%	16.3%	12.8%	11.5%	12.5%	11.4%	11.4%	11.4%	11.0%	10.5%

Source: London Economics analysis using ONS family spending, NEED, and LE results from AIDS modelling

Limitations

We can multiply the numbers of households in each category of the cross tab EPC x Decile to give an estimate of the numbers moved in and out of FP by the policies. However, a number of limitations of the analysis should be noted. The categories in the tables and analysis should give a good approximation but do not give exact numbers in fuel poverty, because the distribution of energy use within each category of the table is not known. There would be some households with very small floor space, and or, very efficient use, etc, within each cell of the table. Given the exact distributions of energy usage by EPC rating and income decile it would

be possible to estimate how many households were able to avoid falling into fuel poverty, however these distributions were not obtainable for the evaluation and so the analysis was done based on the average household in each category from crosstabs of the NEED dataset. Nonetheless, we would argue that the amount of error in the table is likely to be small, as for example, it is unlikely many households in the first 2-3 decile groups, particularly at the lower EPC ratings, would not have been in fuel poverty, and similarly very few households in the upper decile groups would have been in fuel poverty.

Another limitation of the analysis is that certain households in the poorest income decile groups probably received other income support including fuel support and arguably this could have been excluded from the shares' estimates (the impact to lower the % of the poorest households in fuel poverty).

On the other hand, it is also possible that some of the poorest households did not heat their housing units to an acceptable degree – however we used data on actual expenditures and consumption. This is unlikely to impact the results for the poorest households, as they are already well over the threshold of fuel poverty for all efficiency categories. Similarly, the worst/least efficient households for the least efficient categories are already in fuel poverty by the estimates, and the actual consumption figures and shares should reflect the fact that they likely underheated certain parts of the housing unit. The likelihood of changing this measure would impact on the marginal household unit groups with near fuel poverty level shares of fuel expenditure, such as the C-rated and 5th income decile.

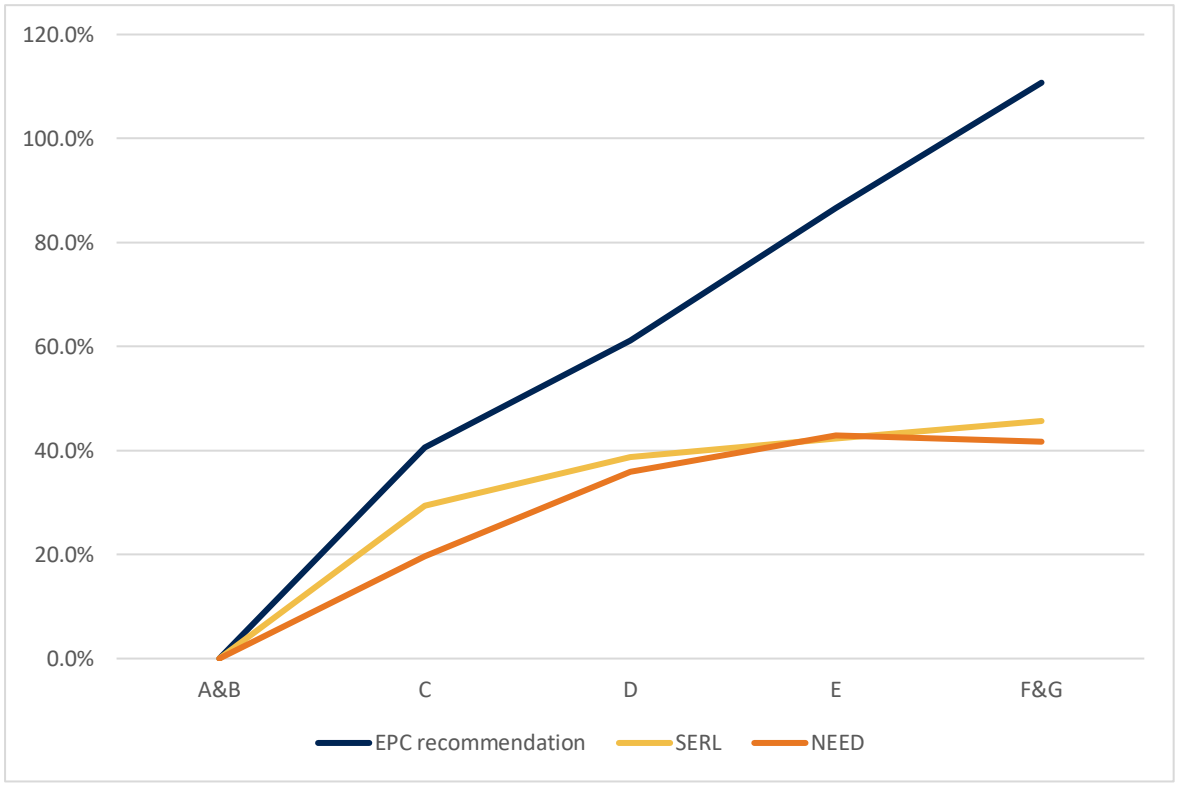
3.7 Underheating

In order to obtain estimates of underheating, we used data from NEED. Estimates of household energy usage per metre squared were estimated by EPC rating and income decile using the NEED data. This was done simply by dividing the average usage by the midpoint of the corresponding area [m2] band.

While we don't have 'true' measures of underheating, the EPC rating gives a standardized predicted usage value per meter squared per annum. This value takes account of a standardized set of weather, all the housing unit characteristics, efficiency, insulation, etc, and behavioural assumptions (such as heating to a certain temperature each room, etc). It is well known that for inefficient housing units, these estimates vastly over-predict the actual consumption. With the NEED data, which includes EPC for each unit, we can compare actual consumption by rating to the predicted consumption. The AIDS model results could then be applied to predict the change in consumption under the different scenarios. These figures were then be compared to the recommended usage by EPC, and UCL SERL data[32] of actual usage, to give an idea of the levels of underheating.

[32] McKenna, Few, Pullinger, Hanmer, Zapata-Webborn, Elam, & Oreszczyn (2023), 'Smart Energy Research Lab: Energy use in GB gas heated domestic buildings during the 2022/2023 heating season'

Figure 1 Extra energy usage per square metre over house with A/B rating[33]



Source: London Economics, SERL

The percentage gap between the lines in figure 1 gives us the underheating estimates below. The percentage can be interpreted as the percent of consumption less than what would have heated the full floor space of the households to the EPC model behavioural assumption.

Note that we cannot assess the manner in which households actually do underheat. For example, do they heat the entire dwelling to 18 degrees C, or do they close off and put no heating into 10% of the floorspace[34].

The NEED data give us a breakdown of income brackets for each EPC rating. The AIDS model is applied to the corresponding income deciles for each EPC rating and then the average is taken to give the estimates in the final two rows below (table 11).

Also note that these percentages should be interpreted as indicative and likely proportional to the true levels of underheating, which depends on the specific definition used.

[33] The figures here are normalised to be the percentage increase in usage over households with an A/B rating.
[34] Note also the EPC model is worked out with thermodynamic models underlying it's predictions, so say, not heating 10% of the floorspace might not save 10% of the energy, as some energy is leaked into the unheated room; similarly, the heating cost to increase temp is probably nonlinear as heat loss increases at an increasing rate given the differential between the indoor and outdoor temps, so a 10% reduction in temp might not give a 10% reduction in fuel use. We just use these figures as a rough approximation for illustrative purposes.

Table 11 Estimates of underheating percentages by EPC classification

	A&B	C	D	E	F&G
EPC recommendation	0.0%	0.0%	0.0%	0.0%	0.0%
SERL estimates	0.0%	7.9%	13.9%	23.8%	30.9%
NEED – £400+ EPG	0.0%	14.9%	15.7%	23.4%	32.8%
NEED – counterfactual no policy	0.0%	15.7%	16.6%	24.1%	33.2%
NEED – counterfactual £600	0.0%	15.1%	15.9%	23.6%	32.9%

Source: London Economics analysis, SERL

There is a small positive impact of both policies evident. We attempted to expand these tables out by income decile as well, however it became apparent there were other factors at play. As can be seen in table 12, higher income households with an A-D rating were using less energy per square metre of their home. This may be reflective of these households having larger homes and there is a per unit 'scale economies' factor in larger units. Alternatively, larger energy efficiency gains could have been more affordable to higher income households. Accounting for these in an expanded analysis would require more data and modelling, and improve the granularity /resolution of our results. However, from the earlier discussed AIDS modelling we can conclude that lower income households likely had a greater benefit to their level of underheating. This is because under the £400 + EPG policy they saw a larger impact in increasing their energy consumption compared to higher income households and the level of underheating is directly proportional to energy consumption.

Table 12 Underheating kWh per m2 estimates from NEED data by EPC rating and income decile (2022/23)

Income Decile	A&B	C	D	E	F&G
1st	191	218	198	189	175
2nd	163	192	180	179	168
3rd	157	184	177	180	171
4th	149	182	179	183	175

5th	145	180	180	185	176
6th	140	179	181	186	178
7th	132	175	181	190	180
8th	123	171	181	187	186
9th	120	168	180	187	193
10th	117	168	181	193	197

Source: London Economics analysis, NEED crosstabs

3.8 Conclusions

The AIDS model results indicated the model was well specified, in that coefficients and elasticities were significant and of expected signs and of magnitudes consistent with decades of econometric research and evidence; elasticities derived from it indicate that it fit in well to the expectation for these values according to economic theory. The QUAIDS model was also estimated on these data as a sensitivity and it gave similar results, this gave further confidence to the AIDS model. We additionally estimated other sensitivities such as generalized AIDS, which allows for minimum or 'subsistence' quantities, and with integer independent variable scaling to account for technology effects. These tests indicated that our results were very insensitive to the overall conclusions of own price elasticities.

The AIDS model suggests that the policy had a substantial effect on allowing/encouraging people to heat their homes better than they would have under no policy over the winter period of 2022/23. Indeed, the price support was well targeted on electricity and gas and didn't cause major changes in spending to other areas. The model predicted that EBSS + EPG induced a 28% increase in energy usage for the lowest decile. This effect decreased for higher deciles until there was practically no effect for the highest income decile. The median household likely saw an uptick in energy usage of 15-20%.

Analysis suggests the impact of the £600 policy support (EBSS + AFP) was less specific to energy and roughly causes a proportional (to current spending shares) increase in spending to all shares. According to the model, for the lowest income decile the £600 policy would have increased energy [kWh] used slightly to a level about 23% lower than the £400 + EPG policy. This difference is presumably down the EPG price change, as it directly targeted the energy prices and could not be 'transferred' to use on other commodities. We also see that expenditure on food, drink, water and health (1, 4.4, 6) was not predicted to have a significant change under the policy or the counterfactual scenarios.

The £400 + EPG policy gave a higher equivalent variation and compensating variation (about £775 on average) compared to the £600 policy, which of course has an EV/CV of £600. So, the £400 + EPG policy had a higher utility to households. Middle incomes saw the highest

benefit under the £400 + EPG measure, with their EV and CV just below £800. The high and low income saw a lesser benefit, in particular, the lowest income decile saw an EV and CV of about £710. The total monetary value of the policy was broadly similar at over £700 for all deciles, which gives a greater proportional impact for lower income deciles.

Our results on fuel poverty indicate that the £400 + EPG policy helped the average household across all deciles and helped the poorest households the most. However, based on the income shares from ONS Family Spending Workbook and our predictions from the AIDS model, the households in the first 1-3 deciles were unlikely to have been moved out of fuel poverty by the measures. The marginal benefits of the policies in keeping households out of fuel poverty focused on households with C-rated units for the middle to high income Decile Groups (4th to 10th for C) and D-F rated Units for 8th to 10th Decile Groups. The main policy £400 + EPG kept these groups below the threshold of 10% after housing expenditure share on fuel and energy.

Finally, we looked at levels of underheating. The effects here follow a similar trend as above with the £400 + EPG having a stronger positive outcome than the £600 policy. The absolute effects here are small, however they indicate the policy performed better on lower income households. This greater impact is due to their smaller energy usage, and the policy being worth a greater proportion of their income.

Overall, the £400 + EPG policy gave a greater benefit compared to the counterfactual £600 scheme or the do-nothing scenario, with the £600 policy coming in second of course. This is true both for the estimated changes in expenditure and expenditure shares where the £400 + EPG had more precision in increasing energy consumption for households that need it most, and for the utility afforded according to the EV and CV calculations. The estimates for fuel poverty and underheating reinforce this result further.

3.9 Sub-annex 1: AIDS and QUAIDS Models

The choice of expressing prices on a logarithmic scale is motivated by the desire to simplify the modelling process. The logarithmic transformation allows for a more intuitive understanding of percentage changes in price and ensures all values are unitless. Assuming a constant elasticity in this framework, to estimate a demand equation can only ever give us a linear approximation.

$$\frac{\partial \ln(q)}{\partial \ln(p)} = \varepsilon \rightarrow \ln(q) = \varepsilon \ln(p) + \beta$$

It is important to note, however, that this constant elasticity approach can yield inaccurate approximations, particularly when dealing with substantial price fluctuations. But this can be avoided by using a more complex model, like the Almost Ideal Demand System (AIDS) model, introduced by Deaton and Muellbauer.[35] This model gives a first order approximation to any

[35] Deaton & Muellbauer (1980), 'An almost ideal demand system', The American economic review, volume 70(3), pages 312-326

demand system, and aggregates perfectly over consumers. The AIDS model is based on the specification of its cost function, $c(u,p)$:

$$\ln\big(c(u,p)\big) = \alpha_0 + \sum_k \alpha_k \ln(p_k) + \frac{1}{2}\sum_k \sum_j \gamma_{ij}^* \ln(p_k)\ln(p_j) + u\beta_0 \prod_k p_k^{\beta_k}$$

Where, u is utility, p a vector of prices, and α_i, β_i and γ_{ij}^* are parameters. From this we can derive the budget shares, w_i:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln(p_j) + \beta_i u \beta_0 \prod_k p_k^{\beta_k}$$

Where $\gamma_{ij} = \frac{1}{2}\left(\gamma_{ij}^* + \gamma_{ji}^*\right)$. For a utility maximising household c(u,p) is equal to the total expenditure, x. We can hence rewrite the budget share equations as:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln(p_j) + \beta_i \ln\left(\frac{x}{P}\right)$$

Where P is a price index.

This model can also easily be extended to the so-called Quadratic AIDS (QUAIDS) model, first specified by Banks, Blundell, and Lewbel.[36] The budget share equations for the QUAIDS model are of the form:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln(p_j) + \beta_i \ln\left(\frac{x}{P}\right) + \frac{\lambda_i}{\prod_i p_i^{\beta_i}} \left(\ln\left(\frac{x}{P}\right)\right)^2$$

This extends the capability of the model by accommodating non-linear Engel curves and gives a second order approximation to any demand system, while preserving the desirable properties of the AIDS model, in particular its perfect aggregation property, and homogeneity in prices. This ensures that the model remains theoretically sound while capturing more intricate aspects of consumer behaviour. Notably, both the AIDS model and the Translog model, of Christensen, Jorgenson, and Lau,[37] are special cases of the QUAIDS model. Each of these models will be more accurate, to varying degrees, under price shocks than the naïve linear approximation with constant elasticity.

[36] Banks, James, Blundell, Richard and Lewbel, Arthur (1997), 'Quadratic Engel Curves And Consumer Demand', The Review of Economics and Statistics, 79, issue 4, pages 527-539

[37] Christensen, Jorgenson, and Lau (1975), 'Transcendental Logarithmic Utility Functions', The American Economic Review, volume 65(3), pages 367–383.

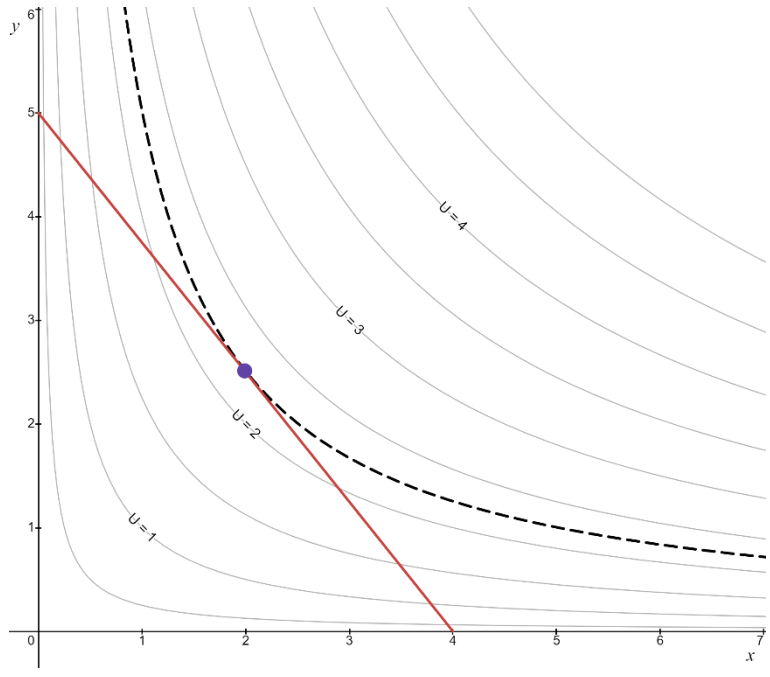
3.10 Sub-annex 2 Equivalent Variation and Compensating Variation

The concepts of equivalent variation (EV) and compensating variation (CV) answer the question of how much the consumer should be compensated for this increase in price, so that their utility remains unchanged overall.

Suppose we have a consumer with a utility function $U(x, y)$, where x and y are the quantities of two goods. The consumer has a budget m and the goods have prices P_x and P_y respectively. The consumer's point of maximal utility lies on their budget line $xP_x + yP_y = m$, and is tangent to the contours of the utility function, $U(x, y)$. The contours of the utility function are known as indifference curves, these are the lines of equal utility.

In the graph below (figure 2), the budget line is the solid red line. The indifference curves are depicted in grey, except the one tangent to the consumers budget line which is in dashed black. The point of tangency is depicted in purple, this is the point of maximal utility for the consumer. We know this point is maximal thanks to the theory of Lagrange multipliers, which tells us that the extrema of utility will be at the point where the line is perpendicular to the gradient of utility (i.e. tangent to the contours).

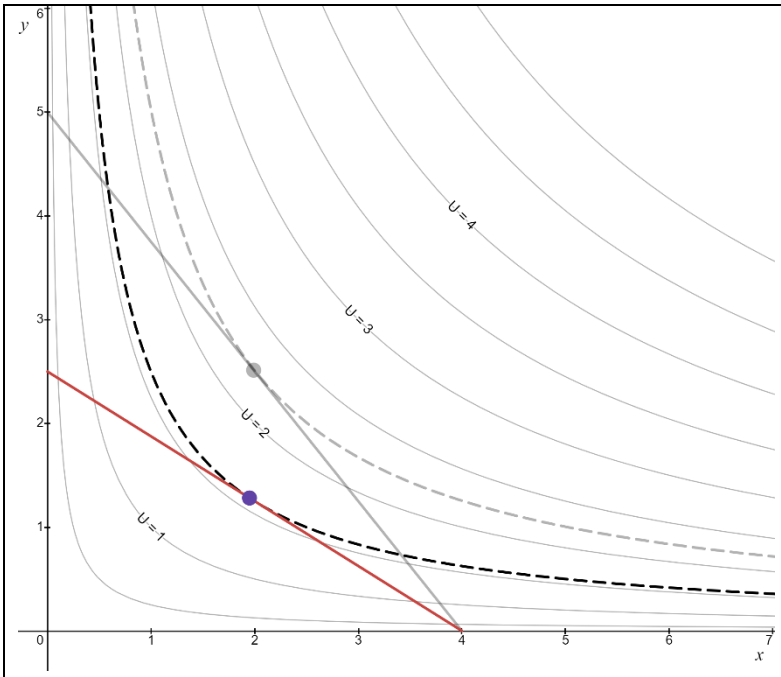
Figure 2 Budget line and indifference curves



Source: London Economics

Now suppose P_y increases to P_y'. In the graph below (figure 3) the new budget line is in red and the old lines have been greyed out. This new budget line is tangent to a lower indifference curve, meaning the consumer's utility has decreased.

Figure 3 Budget line after a price change

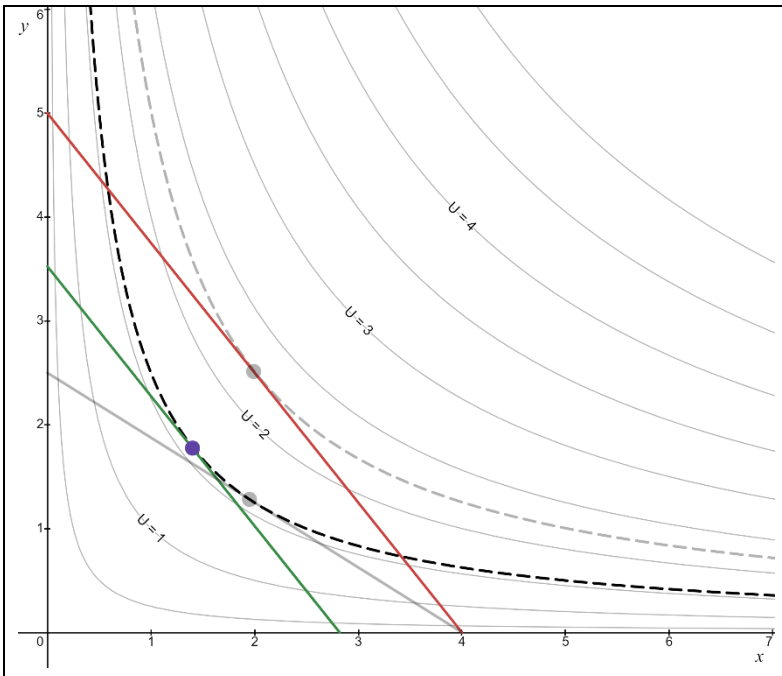


Source: London Economics

Equivalent Variation

The EV is the amount which the consumers budget m must have decreased, given the original prices, for the consumer's budget line to be tangent to the same indifference curve after the price change. To do this we find an m', such that the line $xP_x + yP_y = m'$ is tangent to our new indifference curve, this line is parallel to the original budget line and depicted in green below (figure 4).

Figure 4 Equivalent variation



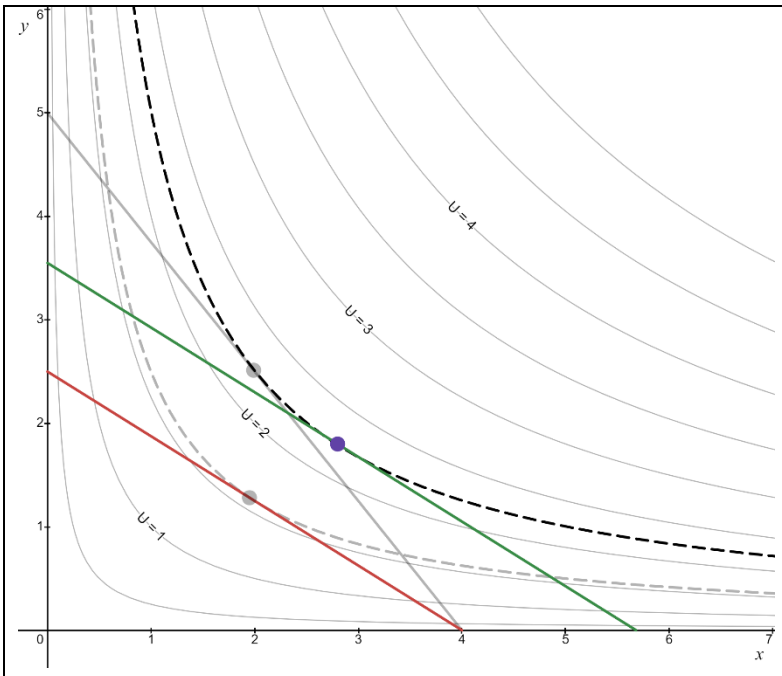
Source: London Economics

Then the EV is given by $EV = m - m'$.

Compensating Variation

The CV is the amount which the consumers budget m must be increase, given the new prices, for the consumer's budget line to be tangent to the original indifference curve. To do this we find an m', such that the line $xP_x + yP'_y = m'$ is tangent to the original indifference curve, this line is parallel to the budget line after the price increase and is depicted in green below (figure 5).

Figure 5 Compensating variation



Source: London Economics

Then the CV is given by $CV = m' - m$.

These methods can be generalised to any number of products, and an arbitrary utility function. Note that the consumer's expenditure is always a linear combination of goods, but this does not mean the EV and CV figures are first-order approximations. Calculating the EV and CV follows directly from inferring the utility function from the model. The degree to which they are accurate is entirely dependent on the accuracy of the demand system model itself.

3.11 Sub-annex 3: AIDS Tables

This annex details the predictions from the AIDS models for all five of the aggregated groups of commodities we considered, as well as a table of the compensated (Hicksian) elasticities.

Table 13 Compensated (Hicksian) piece elasticities (AIDS model)

	Food, drink… (1, 4.4, 6)	Alcohol, tobacco… (2, 9, 11, 12)	Clothing, transport… (3, 5, 7, 8, 10)	Rent, house… (4 excl. 4.4 and 4.5)	Electricity, gas… (4.5)
Food, drink… (1, 4.4, 6)	**-0.706**	**0.095**	0.063	0.053	**0.669**
Food, drink… (1, 4.4, 6)	**0.291**	-0.137	**0.212**	-0.056	**-1.117**
Alcohol, tobacco… (2, 9, 11, 12)	0.148	**0.163**	0.037	**-0.291**	**-0.665**
Rent, house… (4 excl. 4.4 and 4.5)	0.108	-0.037	**-0.247**	0.134	**1.361**
Electricity, gas… (4.5)	**0.159**	**-0.084**	**-0.065**	**0.159**	**-0.247**

Source: London Economics analysis.

Bold: P < 0.05

Table 14 Food, drink, water and health (1, 4.4, 6) usage over 2022Q4 and 2023Q1 with counterfactual scenarios (AIDS model)

Income Decile	Quantity [kWh]					Share		
	£400 + EPG	No Policy	% diff	£600 only	% diff	£400 + EPG	No Policy	£600 only
1st	48,924	48,756	0%	52,002	-6%	15.3%	16.2%	15.8%
2nd	59,136	59,565	-1%	62,914	-6%	13.9%	14.8%	14.4%
3rd	61,373	62,339	-2%	65,128	-6%	13.6%	14.5%	14.1%
4th	68,292	69,952	-2%	72,494	-6%	12.8%	13.6%	13.3%
5th	70,941	73,044	-3%	75,249	-6%	12.5%	13.2%	13.0%
6th	79,804	82,666	-4%	84,921	-6%	11.5%	12.3%	12.0%
7th	81,566	84,738	-4%	86,788	-6%	11.3%	12.0%	11.8%
8th	86,633	90,479	-4%	92,304	-6%	10.7%	11.5%	11.3%
9th	92,206	96,808	-5%	98,449	-7%	10.2%	10.9%	10.7%
10th	102,490	108,732	-6%	109,983	-7%	9.1%	9.8%	9.7%
Source: London Economics analysis								

Table 15 Clothing, transport, communication, education (3, 5, 7, 8, 10) usage over 2022Q4 and 2023Q1 with counterfactual scenarios (AIDS model)

Income Decile	Quantity [kWh]					Share		
	£400 + EPG	No Policy	% diff	£600 only	% diff	£400 + EPG	No Policy	£600 only
1st	94,735	82,707	14%	93,174	2%	29.5%	27.4%	28.1%
2nd	135,655	120,150	12%	133,313	2%	31.7%	29.7%	30.3%
3rd	145,774	130,998	11%	142,452	2%	32.1%	30.2%	30.7%
4th	180,008	163,614	10%	175,495	3%	33.5%	31.6%	32.0%
5th	194,381	178,136	9%	188,969	3%	33.9%	32.1%	32.5%
6th	248,317	228,571	8%	241,657	3%	35.5%	33.7%	34.0%
7th	260,242	240,574	8%	252,890	3%	35.8%	34.0%	34.3%
8th	297,070	276,216	7%	288,328	3%	36.7%	34.9%	35.2%
9th	342,562	320,029	7%	332,260	3%	37.6%	35.8%	36.1%
10th	444,381	418,634	6%	430,470	3%	39.3%	37.6%	37.7%
Source: London Economics analysis								

Table 16 Rent, house imputed rent plus non water and non-energy utilities (4 excl. 4.4 and 4.5) usage over 2022Q4 and 2023Q1 with counterfactual scenarios (AIDS model)

Income Decile	Quantity [kWh]					Share		
	£400 + EPG	No Policy	% diff	£600 only	% diff	£400 + EPG	No Policy	£600 only
1st	68,738	59,422	15%	68,016	1%	20.4%	18.8%	19.6%
2nd	102,632	90,464	13%	101,542	1%	22.9%	21.3%	22.0%
3rd	111,125	99,589	11%	109,275	2%	23.4%	21.9%	22.5%
4th	140,105	127,292	10%	137,468	2%	24.9%	23.5%	23.9%
5th	152,371	139,735	9%	149,055	2%	25.4%	24.1%	24.5%
6th	198,815	183,363	8%	194,771	2%	27.1%	25.8%	26.2%
7th	209,159	193,826	8%	204,590	2%	27.5%	26.2%	26.5%
8th	241,251	225,047	7%	235,703	2%	28.4%	27.1%	27.4%
9th	281,156	263,693	6%	274,527	2%	29.4%	28.2%	28.4%
10th	371,312	351,521	5%	362,130	3%	31.3%	30.1%	30.3%
Source: London Economics analysis								

Table 17 Alcohol, tobacco, narcotics, restaurants, hotels, recreation, culture, and miscellaneous (2, 9, 11, 12) usage over 2022Q4 and 2023Q1 with counterfactual scenarios (AIDS model)

Income Decile	Quantity [kWh]					Share		
	£400 + EPG	No Policy	% diff	£600 only	% diff	£400 + EPG	No Policy	£600 only
1st	101,899	101,515	0%	108,686	-6%	28.7%	30.5%	29.7%
2nd	124,813	125,612	-1%	133,206	-7%	26.4%	28.1%	27.5%
3rd	129,923	131,898	-2%	138,266	-6%	26.0%	27.6%	27.1%
4th	145,954	149,389	-2%	155,312	-6%	24.6%	26.2%	25.7%
5th	152,190	156,600	-3%	161,781	-6%	24.1%	25.6%	25.2%
6th	173,510	179,472	-3%	184,939	-6%	22.5%	24.0%	23.6%
7th	177,843	184,493	-4%	189,499	-6%	22.2%	23.7%	23.3%
8th	190,498	198,605	-4%	203,154	-6%	21.3%	22.8%	22.5%
9th	204,804	214,536	-5%	218,740	-7%	20.4%	21.8%	21.5%
10th	232,595	245,887	-6%	249,301	-7%	18.6%	20.0%	19.8%

Source: London Economics analysis

Table 18 Electricity, gas and other fuel (4.5) usage over 2022Q4 and 2023Q1 [kWh] with counterfactual scenarios (AIDS model)

Income Decile	Quantity [kWh]					Share		
	£400 + EPG	No Policy	% diff	£600 only	% diff	£400 + EPG	No Policy	£600 only
1st	6,827	5,178	28%	5,422	23%	6.1%	7.1%	6.8%
2nd	8,008	6,259	25%	6,473	21%	5.1%	6.1%	5.8%
3rd	8,337	6,586	24%	6,758	21%	4.9%	5.8%	5.6%
4th	8,665	7,011	21%	7,136	19%	4.3%	5.2%	5.0%
5th	8,960	7,329	20%	7,428	19%	4.1%	5.0%	4.8%
6th	9,600	8,140	16%	8,200	16%	3.4%	4.3%	4.1%
7th	9,485	8,114	16%	8,159	15%	3.2%	4.1%	4.0%
8th	9,715	8,543	13%	8,555	13%	2.9%	3.7%	3.6%
9th	9,807	8,949	9%	8,927	9%	2.5%	3.3%	3.2%
10th	11,934	12,090	-1%	11,975	0%	1.7%	2.5%	2.4%
Source: London Economics analysis								

3.12 Sub-annex 4: QUAIDS Tables (Sensitivity)

Table 19 Uncompensated (Marshallian) price elasticities (QUAIDS model)

	Food, drink… (1, 4.4, 6)	Alcohol, tobacco… (2, 9, 11, 12)	Clothing, transport… (3, 5, 7, 8, 10)	Rent, house… (4 excl. 4.4 and 4.5)	Electricity, gas… (4.5)
Food, drink… (1, 4.4, 6)	**-0.628**	**-0.116**	**-0.091**	0.054	**0.406**
Clothing, transport… (3, 5, 7, 8, 10)	**-0.192**	**-0.421**	**-0.169**	**-0.560**	**-0.352**
Alcohol, tobacco… (2, 9, 11, 12)	-0.044	**-0.092**	**-0.524**	**-0.321**	**-0.680**
Rent, house… (4 excl. 4.4 and 4.5)	0.121	**-0.471**	**-0.409**	0.001	**1.174**
Electricity, gas… (4.5)	**0.069**	**-0.070**	**-0.113**	**0.108**	**-0.172**

Source: London Economics analysis.

Bold: P < 0.05

Table 20 Compensated (Hicksian) price elasticities (QUAIDS model)

	Food, drink… (1, 4.4, 6)	Alcohol, tobacco… (2, 9, 11, 12)	Clothing, transport… (3, 5, 7, 8, 10)	Rent, house… (4 excl. 4.4 and 4.5)	Electricity, gas… (4.5)
Food, drink… (1, 4.4, 6)	**-0.553**	0.020	0.058	**0.136**	**0.366**
Clothing, transport… (3, 5, 7, 8, 10)	0.048	-0.009	**0.293**	**-0.306**	**-0.489**
Alcohol, tobacco… (2, 9, 11, 12)	0.140	**0.226**	-0.168	-0.125	**-0.784**
Rent, house… (4 excl. 4.4 and 4.5)	**0.277**	**-0.200**	-0.107	0.167	**1.088**
Electricity, gas… (4.5)	**0.088**	**-0.037**	**-0.076**	**0.128**	**-0.180**

Source: London Economics analysis.

Bold: P < 0.05

Table 21 Compensating and Equivalent Variation of Policy [£ per Household] (AIDS model)

Income Decile	CV	EV
1st	716.86	711.76
2nd	771.64	767.78
3rd	781.22	777.74
4th	804.04	801.93
5th	809.70	808.18
6th	813.54	814.13
7th	811.09	812.11
8th	796.96	799.15
9th	767.18	770.46
10th	659.25	663.33
Source: London Economics analysis		

The QUAIDS model gave broadly similar estimates to the AIDS model. It predicted a 28% increase in energy usage for the lowest income decile under the policy just like the AIDS model. However, there is a general principal to prefer simpler models and as such the analysis using the QUAIDS model was only used as a sensitivity analysis for the AIDS model.

Table 22 Food, drink, water and health (1, 4.4, 6) usage over 2022Q4 and 2023Q1 with counterfactual scenarios (QUAIDS model)

Income Decile	Quantity [kWh]					Share		
	£400 + EPG	No Policy	% diff	£600 only	% diff	£400 + EPG	No Policy	£600 only
1st	50,569	51,691	-2%	52,781	-4%	15.8%	17.2%	16.0%
2nd	55,374	56,027	-1%	57,895	-4%	13.0%	13.9%	13.2%
3rd	56,845	57,552	-1%	59,312	-4%	12.6%	13.3%	12.9%
4th	62,732	62,987	0%	65,293	-4%	11.7%	12.2%	12.0%
5th	65,625	65,829	0%	68,120	-4%	11.5%	11.9%	11.8%
6th	78,651	77,711	1%	81,290	-3%	11.3%	11.5%	11.5%
7th	81,980	80,987	1%	84,521	-3%	11.3%	11.5%	11.5%
8th	93,236	91,685	2%	95,642	-3%	11.6%	11.6%	11.7%
9th	109,082	106,738	2%	111,297	-2%	12.0%	12.0%	12.1%
10th	151,648	147,624	3%	153,136	-1%	13.5%	13.3%	13.5%
Source: London Economics analysis								

Table 23 Clothing, transport, communication, education (3, 5, 7, 8, 10) usage over 2022Q4 and 2023Q1 with counterfactual scenarios (QUAIDS model)

Income Decile	Quantity [kWh]					Share		
	£400 + EPG	No Policy	% diff	£600 only	% diff	£400 + EPG	No Policy	£600 only
1st	88,183	72,281	20%	88,340	0%	27.4%	23.9%	26.7%
2nd	143,352	126,558	12%	143,593	0%	33.5%	31.3%	32.7%
3rd	155,520	140,672	10%	154,826	0%	34.3%	32.4%	33.4%
4th	192,655	179,034	7%	191,567	1%	35.8%	34.6%	35.0%
5th	206,491	194,253	6%	204,901	1%	36.1%	35.0%	35.2%
6th	249,982	239,000	4%	248,696	1%	35.7%	35.2%	35.0%
7th	257,922	247,922	4%	256,431	1%	35.5%	35.1%	34.8%
8th	278,924	270,824	3%	277,443	1%	34.4%	34.2%	33.8%
9th	298,028	292,137	2%	296,830	0%	32.7%	32.7%	32.2%
10th	316,604	315,827	0%	316,630	0%	28.0%	28.3%	27.8%

Source: London Economics analysis

Table 24 Rent, house imputed rent plus non water and non-energy utilities (4 excl. 4.4 and 4.5) usage over 2022Q4 and 2023Q1 with counterfactual scenarios (QUAIDS model)

Income Decile	Quantity [kWh]					Share		
	£400 + EPG	No Policy	% diff	£600 only	% diff	£400 + EPG	No Policy	£600 only
1st	74,907	67,647	10%	73,920	1%	22.2%	21.4%	21.3%
2nd	102,554	91,582	11%	100,945	2%	22.9%	21.6%	21.9%
3rd	110,072	99,265	10%	107,719	2%	23.2%	21.9%	22.2%
4th	137,337	124,218	10%	133,959	2%	24.4%	22.9%	23.3%
5th	149,576	136,169	9%	145,400	3%	24.9%	23.4%	23.9%
6th	199,272	181,298	9%	193,858	3%	27.2%	25.5%	26.1%
7th	211,004	192,806	9%	204,900	3%	27.7%	26.0%	26.6%
8th	248,794	228,566	8%	241,232	3%	29.3%	27.6%	28.1%
9th	298,489	275,537	8%	289,201	3%	31.2%	29.4%	30.0%
10th	420,323	391,886	7%	406,743	3%	35.4%	33.6%	34.0%
Source: London Economics analysis								

Table 25 Alcohol, tobacco, narcotics, restaurants, hotels, recreation, culture, and miscellaneous (2, 9, 11, 12) usage over 2022Q4 and 2023Q1 with counterfactual scenarios (QUAIDS model)

Income Decile	Quantity [kWh]					Share		
	£400 + EPG	No Policy	% diff	£600 only	% diff	£400 + EPG	No Policy	£600 only
1st	100,759	101,232	0%	106,639	-6%	28.4%	30.4%	29.2%
2nd	119,446	120,115	-1%	126,573	-6%	25.3%	26.9%	26.1%
3rd	124,008	125,440	-1%	131,044	-6%	24.8%	26.2%	25.6%
4th	139,525	141,404	-1%	147,250	-5%	23.5%	24.8%	24.4%
5th	146,125	148,554	-2%	153,921	-5%	23.2%	24.3%	24.0%
6th	171,574	173,879	-1%	180,609	-5%	22.3%	23.2%	23.1%
7th	177,367	180,049	-2%	186,445	-5%	22.1%	23.1%	23.0%
8th	195,672	198,744	-2%	205,228	-5%	21.9%	22.8%	22.7%
9th	219,172	222,528	-2%	229,330	-5%	21.8%	22.6%	22.6%
10th	275,340	279,396	-1%	286,530	-4%	22.1%	22.7%	22.8%

Source: London Economics analysis

Table 26 Electricity, gas and other fuel (4.5) usage over 2022Q4 and 2023Q1 [kWh] with counterfactual scenarios (QUAIDS model)

Income Decile	Quantity [kWh]					Share		
	£400 + EPG	No Policy	% diff	£600 only	% diff	£400 + EPG	No Policy	£600 only
1st	6,827	5,138	28%	5,475	22%	6.1%	7.1%	6.8%
2nd	8,008	6,236	25%	6,509	21%	5.3%	6.3%	6.1%
3rd	8,337	6,576	24%	6,790	21%	5.2%	6.1%	5.9%
4th	8,665	7,035	21%	7,170	19%	4.6%	5.5%	5.3%
5th	8,960	7,373	19%	7,470	18%	4.3%	5.3%	5.1%
6th	9,600	8,299	15%	8,305	14%	3.5%	4.5%	4.3%
7th	9,485	8,304	13%	8,287	14%	3.3%	4.3%	4.1%
8th	9,715	8,882	9%	8,798	10%	2.8%	3.8%	3.6%
9th	9,807	9,602	2%	9,425	4%	2.2%	3.2%	3.1%
10th	11,934	15,677	-27%	15,022	-23%	1.1%	2.1%	1.9%
Source: London Economics analysis								

3.13 Sub-annex 5: Sensitivity of including scaling independent variable

Table 27 Expenditure elasticities with scaling independent variable (AIDS model)

Expenditure	Food, drink… (1, 4.4, 6)	Alcohol, tobacco… (2, 9, 11, 12)	Clothing, transport… (3, 5, 7, 8, 10)	Rent, house… (4 excl. 4.4 and 4.5)	Electricity, gas… (4.5)
Elasticity	**0.363**	**1.351**	**1.360**	**0.501**	**-0.271**

Source: London Economics analysis

Bold: P-value < 0.05

Table 28 Uncompensated (Marshallian) price elasticities with scaling independent variable (AIDS model)

	Food, drink… (1, 4.4, 6)	Alcohol, tobacco… (2, 9, 11, 12)	Clothing, transport… (3, 5, 7, 8, 10)	Rent, house… (4 excl. 4.4 and 4.5)	Electricity, gas… (4.5)
Food, drink… (1, 4.4, 6)	**-0.683**	**-0.100**	-0.050	0.000	**0.483**
Food, drink… (1, 4.4, 6)	0.040	**-0.574**	**-0.248**	**-0.288**	**-0.756**
Alcohol, tobacco… (2, 9, 11, 12)	0.152	**-0.189**	**-0.461**	**-0.372**	**-0.411**
Rent, house… (4 excl. 4.4 and 4.5)	**0.031**	**-0.386**	**-0.516**	0.040	**1.206**
Electricity, gas… (4.5)	**0.098**	**-0.102**	**-0.085**	**0.120**	**-0.251**

Source: London Economics analysis

Bold: P < 0.05

Table 29 Expenditure elasticities without scaling independent variable (AIDS model)

Expenditure	Food, drink… (1, 4.4, 6)	Alcohol, tobacco… (2, 9, 11, 12)	Clothing, transport… (3, 5, 7, 8, 10)	Rent, house… (4 excl. 4.4 and 4.5)	Electricity, gas… (4.5)
Elasticity	**0.568**	**1.221**	**1.318**	**0.653**	**-0.297**

Source: London Economics analysis

Bold: P-value < 0.05

Table 30 Uncompensated (Marshallian) price elasticities without scaling independent variable (AIDS model)

	Food, drink… (1, 4.4, 6)	Alcohol, tobacco… (2, 9, 11, 12)	Clothing, transport… (3, 5, 7, 8, 10)	Rent, house… (4 excl. 4.4 and 4.5)	Electricity, gas… (4.5)
Food, drink… (1, 4.4, 6)	**-0.772**	-0.045	**-0.088**	-0.022	**0.701**
Food, drink… (1, 4.4, 6)	0.091	**-0.568**	**-0.254**	**-0.287**	**-1.010**
Alcohol, tobacco… (2, 9, 11, 12)	-0.006	**-0.169**	**-0.322**	**-0.469**	**-0.583**
Rent, house… (4 excl. 4.4 and 4.5)	-0.024	**-0.320**	**-0.553**	-0.017	**1.429**
Electricity, gas… (4.5)	**0.143**	**-0.118**	**-0.102**	**0.141**	**-0.241**

Source: London Economics analysis

Bold: P < 0.05

3.14 Sub-annex 6: Energy consumption by income and EPC rating

Table 31 Typical household energy usage over winter 2022/23 [kWh] - £400 + EPG scenario

	A	B	C	D	E	F	G
1st	5,404	5,169	5,690	6,663	7,318	7,177	6,855
2nd	6,080	5,528	6,609	7,618	8,382	8,180	7,622
3rd	6,451	5,699	6,983	7,996	8,809	8,723	7,982
4th	6,833	5,782	7,247	8,488	9,379	9,517	8,540
5th	7,052	5,837	7,421	8,769	9,723	9,949	8,999
6th	7,187	5,908	7,650	9,097	10,183	10,466	9,588
7th	7,008	6,068	8,065	9,581	10,906	11,327	10,207
8th	7,571	6,640	8,883	10,400	11,734	13,133	11,651
9th	8,046	7,077	9,531	10,979	12,504	14,427	12,891
10th	10,409	9,919	13,190	14,617	16,907	19,688	17,740
Source: London Economics analysis							

Table 32 Typical household energy usage over winter 2022/23 [kWh] – counterfactual no policy scenario

	A	B	C	D	E	F	G
1st	4,099	3,921	4,316	5,054	5,551	5,444	5,200
2nd	4,752	4,320	5,165	5,954	6,550	6,392	5,957
3rd	5,096	4,502	5,516	6,317	6,959	6,891	6,305
4th	5,529	4,678	5,863	6,868	7,589	7,701	6,910
5th	5,769	4,775	6,070	7,173	7,954	8,138	7,361
6th	6,094	5,010	6,486	7,714	8,635	8,874	8,130
7th	5,995	5,191	6,899	8,197	9,330	9,690	8,732
8th	6,657	5,839	7,811	9,145	10,318	11,548	10,244
9th	7,342	6,458	8,698	10,019	11,411	13,165	11,764
10th	10,545	10,049	13,363	14,808	17,128	19,945	17,972

Source: London Economics analysis

Table 33 Typical household energy usage over winter 2022/23 [kWh] – counterfactual no policy scenario

	A	B	C	D	E	F	G
1st	5,180	4,954	5,454	6,386	7,014	6,878	6,570
2nd	5,910	5,374	6,424	7,405	8,147	7,951	7,409
3rd	6,319	5,582	6,840	7,832	8,628	8,544	7,818
4th	6,753	5,714	7,161	8,389	9,269	9,406	8,439
5th	6,998	5,792	7,363	8,701	9,648	9,871	8,929
6th	7,190	5,910	7,653	9,101	10,188	10,470	9,592
7th	7,023	6,081	8,082	9,602	10,930	11,352	10,229
8th	7,623	6,686	8,944	10,471	11,815	13,223	11,731
9th	8,144	7,164	9,648	11,114	12,658	14,604	13,049
10th	10,656	10,155	13,503	14,964	17,308	20,155	18,161

Source: London Economics analysis

Table 34 Distribution of households by income decile and EPC rating (2022/23)

Decile	A	B	C	D	E	F	G
1st	0.02%	0.37%	5.31%	3.58%	0.61%	0.08%	0.02%
2nd	0.02%	0.43%	4.00%	4.33%	1.06%	0.14%	0.03%
3rd	0.02%	0.47%	3.49%	4.60%	1.24%	0.15%	0.04%
4th	0.02%	0.60%	3.17%	4.68%	1.34%	0.16%	0.04%
5th	0.02%	0.72%	3.05%	4.67%	1.35%	0.16%	0.03%
6th	0.02%	0.88%	2.95%	4.61%	1.34%	0.16%	0.03%
7th	0.02%	1.15%	2.87%	4.45%	1.31%	0.16%	0.03%
8th	0.02%	1.50%	2.79%	4.21%	1.28%	0.17%	0.03%
9th	0.03%	1.70%	2.74%	4.07%	1.27%	0.17%	0.03%
10th	0.04%	1.91%	2.40%	3.77%	1.56%	0.29%	0.03%

Source: London Economics analysis, NEED

Annex C4 Case studies

The five case studies presented here were selected to illuminate the most prevalent themes identified during our qualitative research phase. These case studies offer detailed narratives of individuals' lived experiences, reflecting the diverse vulnerabilities and challenges encountered by energy consumers during the winters of 2022/23 and 2023/24. Importantly, the analysis provided considers significant year-on-year developments in individual circumstances or the broader energy landscape.

The names used in each case study have been changed to anonymise. The SEG[38] grouping is a socio-economic classification, mainly based on social and financial circumstances of participants[39].

[38] "The full definitions and numbers for these grades include:
AB: higher and intermediate managerial, administrative and professional occupations (23.3%, 10.9 million people)
C1: supervisory, clerical, and junior managerial, administrative and professional occupations (32.8%, 15.3 million people)
C2: skilled manual occupations (21.3%, 10.0 million people)
DE: semi-skilled and unskilled manual occupations, unemployed and lowest grade occupations (22.6%, 10.6 million people)". See: 'Approximated Social Grade, England and Wales: Census 2021'
[39] ONS, 'Approximated Social Grade, England and Wales: Census 2021'

Case Study 1 – Energy debt/Underconsumption

Key characteristics:

Personal details	Scheme	How they paid	Underconsumption	Employment status
Female, 45-54, SEG E, urban area	EBSS and EPG	Prepayment meter customer (smart)	Yes, experienced underconsumption	Not in paid employment during either wave of interviews

Sandra is a single mother who lives with her two children, aged 20 and 12. She had long-term health issues, had been out of employment for some time and was on Universal Credit of around £400 per month for living costs. She thought her energy usage, both gas and electricity, was quite high due to her children's lifestyles – for example, playing a lot of computer games or taking long, hot showers.

Experience paying energy bills across winter 22/23 and winter 23/24

Sandra struggled to pay her energy bills in winter 2022/23 due to the increased prices. She said she found it difficult to afford anything else after her bills had been paid and the household started to get into debt. Sandra felt this started to affect her mental and physical health:

> *"I'm in debt up to my eyeballs with it. Again, maybe once a month we used to go out for a family meal, to days out. I can't do any of that anymore... It's a struggle. I don't have money left over…We used to do fun, so it's obviously affecting me."*

> *"We just seemed to get more colds and flus. I've got major health problems… And I struggled really to have to live like that. So yes, it had an effect on us. And our mental health, because we're having to watch what we use. In 2022 we're in dressing gowns and have blankets on to keep warm, it's not right. My [children] find it hard."*

> *Participant 143, Wave 1 interview*

Coming into winter 2023/24, Sandra continued to struggle with high energy prices. She noticed not having scheme support because energy felt more expensive and the household went into further, worsening debt. This was despite having access to the Warm Home Discount in 2023/24. Sandra called up her energy company to ask for credit on more than one occasion:

"I've really struggled. I've had no gas and no electricity so I [phoned] the company up and [went] through all my means with them. Where they've had to put credit onto my meter, say, £60. I've got to pay it back but that's how desperate [I am]. Like, I've never done that before… I have had no money left [on] electricity and gas because it just eats it."

Participant 143, Wave 2 interview

Views on the schemes

Sandra thought the amount of support from the 2022/23 schemes did not make up for the total energy price increases. However, she liked the support in monthly instalments because she felt people would be more likely to spend it on energy rather than general costs. Sandra would have appreciated the schemes running again in 2023/24 because even a small amount of support would have reduced stress and made bills more affordable.

"It was sufficient because it helped. But it wasn't a lot really, considering the price they put it up to. So really, we're not benefiting from it because they're just taking it anyway. But something's better than nothing."

Participant 143, Wave 1 interview

"It would help a little bit more. And take the stress of not having to worry as much. Just to know that's coming at the end of the month you just think, 'That's like a week's worth.' Do you know what I mean? So, it takes a bit of the burden off you, that you've only got 3 weeks to pay."

Participant 143, Wave 2 interview

Case Study 2 – Alternative fuels

Key characteristics:

Personal details	Scheme	How they paid	Underconsumption	Employment status
Female, 65 and over, SEG C2, rural area	EBSS AF and AFP AF	Monthly electricity payment to landlord. Also paid directly to supplier for oil twice a year	Has not experienced underconsumption / medium energy usage	Retired

Alice is a pensioner living with her husband in a park home on a residential site. She and her husband both had disabilities and did not receive pension credit. Alice said her household energy usage was average, and they regularly took steps to reduce usage such as pulling plugs out, switching appliances off, and washing clothing at lower temperatures. She paid for oil directly to their supplier twice a year.

Experience paying energy bills across winter 2022/23 and winter 2023/24

Alice was worried about paying for energy during winter 2022/23 because she knew the AFP AF scheme would be coming after the coldest winter months. Because they pay for oil twice a year, Alice budgeted monthly and when she knew the energy prices were going to increase, she re-budgeted and began to see where she could make cuts in household energy usage ahead of receiving scheme support. She also turned her heating down.

> *"I still had to make sure I had the money to pay my bills until that money came in. So, we still had to pay our bills up until the money came. It was early March time before it came in, because once you applied for it you had to wait about 6 weeks…"*
>
> *Participant 153, Wave 1 interview*
>
> *"I had to re-calculate everything… I need to get help because we only get oil twice a year, I need to know I've got the money to pay it. I'll even buy more for the electric, you know, just things like that to try and cover me every month… it was just readjusting everything, cutting back on things that we really didn't need to have and cutting back on shopping."*
>
> *Participant 153, Wave 1 interview*

Alice found paying her energy bills easier in winter 2023/24 because she had aluminium foil installed behind her radiators and said that the price of electricity and oil had reduced slightly

since 2022/23. This meant her house felt warmer even though she kept the heating at the same level as the year before.

> *"But, what I did for this winter, I've now got that aluminium foil behind all my radiators and that's made a huge difference to the heat. And I've got Roman blinds… and that's made it so it's really cosy. My heaters weren't quite so high, so it was slightly less that came in this time and I got longer before I needed to get oil in. So, yes, I was quite happy."*
>
> *Participant 153, Wave 2 interview*

Views on the schemes

Alice was concerned that receiving a lump sum for oil could encourage some people to spend the money on non-essentials. She also noted that people who had to apply for the support schemes received their money later than those who got the discount on their bills automatically. Whilst Alice had saved up enough to afford all her bills over winter 2022/23, she was conscious that not everyone would be able to.

> *"It was later by the time it went through for park homes. But as I say, it just went into the bank and I got my bills paid in April… I just didn't need it because I'd saved up and kept on top of my bills. If it had come earlier, then I would have been able to put it in and then adjust. But it was later in going through."*
>
> *Participant 153, Wave 2 interview*

Case Study 3 – Living in social housing with a disability

Key characteristics:

Personal details	Scheme	How they paid	Underconsumption	Employment status
Male, 45-54, SEG C2	EBSS AF	Monthly payment to housing association for meter shared with other tenants	Has not experienced underconsumption	Self-employed, also on needs-tested benefits

Krish is a single man living alone in a one bedroom flat in a house owned by a housing association. He has limited mobility and other physical disabilities which prevented him obtaining consistent employment. He struggled to leave his flat and was on needs-tested benefits. The energy usage in his household was low and he made monthly payments towards an electricity meter, shared by all tenants of the house.

Experience paying energy bills across winter 2022/23 and winter 2023/24

Krish really struggled to pay for his energy bills in winter 2022/23 as his household income was very low. He had used food banks for over a year in 2022 and 2023. The housing association increased his rent and additional surcharge every year and he was in arrears.

> *"The cost of living is just a burden to most people… I'm using food banks and have been using food banks for about a year and a half. I've only stopped using food banks in the last month."*
>
> *Participant 93, Wave 1 interview*
>
> *"The surcharges go out on standing orders with my bank. It was difficult, you know, basically having an amount which I was used to over the year and then it increasing in April, that was quite difficult. I mean, I was in arrears with my rent over the last autumn…"*
>
> *Participant 93, Wave 1 interview*

He used a buyback service to sell some of his possessions for cash, and then lost the possessions because he could not afford the buyback payment.

> *"It was quite difficult because I was in arrears for the last year and over the winter it didn't seem to change, you know, in terms of the amount going out. So, it was quite a difficult time because… I lost a Breitling watch, it was worth £3000, a year and a half ago… so pawning it and I nearly sold quite an expensive bike at Christmas."*
>
> *Participant 93, Wave 2 interview*

In winter 2023/24, Krish continued to find paying his energy bills challenging and was put on a payment plan by the housing association. He did not report any underconsumption because the housing association did not switch off his energy supply despite his payment difficulties. Krish felt the separate cost of living payments and his additional disability support payments were very helpful over this period, as the energy supports schemes did not run again in 2023/24.

> *"Cost of living, yes. For disability and visibility where I had double vision and severe impairment vision I have received £150 over three months from the government… that again has helped me to provide my life with the things that I needed, food and the bills."*
>
> *Participant 93, Wave 2 interview*

Views on the schemes

Krish received a call from the local authority who helped him fill out the form to receive the £400 EBSS AF payment, for which he was very grateful. He received the payment about three weeks later and said the process was very straightforward and reassuring.

> *"[The phone call] was basically to tell me, you know, that £400 was being provided by the government to people who are renting their accommodation and then he made another appointment… So a week or two later he helped me fill out the form when he phoned again."*
>
> *Participant 93, Wave 2 interview*

Krish was very happy with the government providing support in 2022/23 as it helped reduce his rent arrears. He thought support would have been beneficial in 2023/24 for the housing association to reduce energy costs for tenants and felt that any support at all would have been helpful for him.

> *"I think it would help [the housing association] a lot because they have a lot of properties in [my area] and they… deal directly with the bills and with the authorities and [the water company] and, the electricity companies..."*
>
> *Participant 93, Wave 2 interview*
>
> *"Any help would be beneficial… money, just to survive the winters, and the year."*
>
> *Participant 93, Wave 2 interview*

Case Study 4 – Behavioural changes

Key characteristics:

Personal details	Scheme	How they paid	Underconsumption	Employment status
Male, 65 and over, SEG B, rural area	AFP and EPG	Direct debit	Has not experienced underconsumption	Retired

George is a retiree who lives with his wife in rural Stoke. Their house used oil central heating and wood burning fire, and they primarily relied on electricity, as their house was disconnected from mains gas. George said their energy consumption was higher than average due to their technology usage - George's wife supported local people with their computers, which meant multiple computers were running at once.

Experience paying energy bills across winter 2022/23 and winter 2023/24

To address the increase in energy bills during winter 2022/23, George and his wife made several home improvements. They upgraded the old thermostat on their boiler with a smart meter, and replaced all lighting with LEDs to increase energy efficiency. They monitored their energy consumption patterns - such as looking at peaks and troughs in temperature, turning heating off when out of the house - and cut down on the amount of energy used.

> *"Yes, I think a lot of it was going on to the smart plugs and smart sockets… once we realised we could do that, we could reduce [our energy use], and see the impact, and then use… Alexa to control most of the rooms in the house… [We're] chipping away… doing all the basic stuff, making sure curtains are closed, making sure we minimise drafts, all the kind[s] of normal precautions."*
>
> *Participant 38, Wave 1 interview*

George noted that the Winter Fuel Allowance, Alternative Fuel Payment and pension payments made a significant difference, covering half their energy costs.

> *"Well they were more expensive but with the support grant and the alternative fuel plan plus also the amount that I received as a pensioner that made an enormous difference collectively, so probably accounted for gosh I don't know… half [of their energy costs] during that December, January, February period."*
>
> *Participant 38, Wave 1 interview*

Coming into winter 23/24, George felt comfortable with his energy bills due to the home improvements made, as well as cuts made to energy usage. He observed that his energy bills in 2023/24 were lower than expected, more than half of what it was during Winter 22/23.

Views on the schemes

George thought that the financial support over winter 2023/24 would have been "enormously helpful", as it would support a greater percentage of their total expenditure. He noted that it would have made little difference around household finances, or lifestyle choices, as it was relatively stable. Although he considered using a government grant for heat pumps, the idea was not feasible, as his house did not have a cold water or hot water tank.

> *"Oh, [financial support over winter 2023/24] would have been enormously helpful. Yes, it would have been even more as a percentage of our total expenditure."*
>
> *Participant 38, Wave 2 interview*

Case Study 5 – Scheme experience as a carer

Key characteristics:

Personal details	Scheme	How they paid	Underconsumption	Employment status
Female, 55-64, SEG D, rural area	EBSS, AFP AF and EPG	Direct debit for electricity, direct to supplier for LPG and solid fuel	Has not experienced underconsumption	Carer

Louise lives with her husband in a 4-bedroom house outside of Newmarket in Suffolk. She retired from her job to become a full-time carer for her husband as he was in poor health. Their household primarily used oil, solid fuel or liquid petroleum gas (LPG), because there was no mains gas in their village.

Experience paying energy bills across winter 22/23 and winter 23/24

Her husband's medical condition meant that the couple had the heating on at a high temperature all the time during winter 2022/23. Changing the household's heating usage was not an option for Louise because it would make her husband's condition worse. Louise said they adapted and tried to conserve energy wherever possible. For example, they did not use a tumble dryer or microwave.

> *"No. I don't have any choice. I've got to do what I've got to do. So there isn't any choice, I see it as, 'Oh that's good, that's going to help.' That's my reaction to it. It's just a shame it was a bit difficult to get it."*
>
> *Participant 72, Wave 1 interview*

Reflecting on her household budget during winter 2023/24, Louise noted that energy costs had increased significantly over the past two years.

> *"Food and heating the home are priorities, from that perspective, yes, when you look at the numbers, it's scary. Our energy didn't use to be such a big percentage of household income. And now it's got ridiculously expensive."*
>
> *Participant 72, Wave 2 interview*
>
> *"LPG has increased in price so much, so for us personally, it's double from where we were in May 2023. So, my energy bill has actually now gone up some 50%... it's 50% more for the 2024 year. Because electricity… that's come down a bit. Because the standing charge has gone up so much, it's not a significant reduction that the media would have you believe."*

Participant 72, Wave 2 interview

In their financial circumstances, Louise felt that affording their energy bills across both winters was difficult, yet "doable". She fixed her price with the LPG supplier twelve months in advance and took a practical approach by foregoing perceived luxuries such as holidays abroad or buying cosmetic products.

Views on the schemes

Louise was grateful for scheme support as the amount of £600 reduced her concern about affording the energy her household needed.

> *"So, there was an increased usage and an increased cost. So, with the £600 supplements, that made a big difference. You know, that contribution helped."*
>
> *Participant 72, Wave 2 interview*

However, Louise felt the schemes could have been improved if they were means-tested and if knowledge of LPG-reliant areas had been built into the scheme. She also thought communications about application-based schemes could have been made clearer and more easily accessible.

> *"The LPG, should be a lot more straightforward... [There] should have been some testing because … if an entire village doesn't have access to main-supplied gas. Then it's quite clear that every property in that village is going to qualify... So, I think that's one thing. How else?... In terms of the automatic support, I guess the challenge is about means testing it, because there would have been a lot of people who didn't need it, that received it."*
>
> *Participant 72, Wave 2 interview*

Annex C5 Latent Class Analysis

Using the data from wave 1 of the Ipsos Knowledge Panel survey, the aim of the Latent Class Analysis was to identify distinct and identifiable groups of customers according to their patterns of responses provided across the survey questions related to the mitigation strategies they would have adopted without the governments support.

5.1 Methods

Latent class analysis (LCA) identifies latent groups in the population based on a set of observed variables and is typically conducted in an exploratory manner with no a priori hypotheses regarding the number or nature of the latent classes.

The steps undertaken for this analysis include:

1. Conducting a Latent Class Analysis on statements relating to the impact of the government's support and then selecting the optimal number of segments for the analysis.

LCA uses a mixture regression model that posits that there is an underlying unobserved categorical variable that divides a population into mutually exclusive and exhaustive latent classes. Class membership of individuals is unknown but can be inferred from a set of responses to measures items (i.e. survey questions). Using the SAS command PROC LCA, we used the seven survey questions listed in Table 35 to identify individuals comprising different segments of the population. Selection of the optimal number of segments is somewhat explorative and requires balancing between identifying very small segments and capturing meaningful and distinctive variation between segments. As described below, we eventually identified four segments from the sample of survey responses. Deriving five segments provided very small sample sizes in some segments (making it more difficult to meaningfully distinguish this segment from the others) and three segments resulted in the loss of the distinction between segment 1 and 2 below, which appeared to show distinctive characteristics in terms of response patterns and differences in the demographic characteristics of these groups.

2. Creating a demographic profile for each segment and assessing the relative importance of key demographic variables that discriminate between the different segments.

Since four segments/classes were derived from the Latent Class Analysis, there were six groups that could be compared. We examined the profile of these different groups descriptively (see Table 36) and we also ran a regression analysis. In the regression analysis, each of the segments were coded as binary outcome variables (Class1 vs. Class4, Class2 vs. Class3, etc.). Those binary outcomes were then regressed against the demographic variables using

Shapley Value Regressions, which shows the importance of each demographic variable in distinguishing between the different segments (Figure 6 illustrates the results).

5.2 Summary of findings

Explorative analysis showed that four distinct segments were recognisable in the Ipsos Knowledge Panel survey data based on the Latent Class Analysis. Table 35 provides the patterns of responses in each segment according to each of the statements included in the Latent Class Analysis.

Table 35: Respondents reported impacts if they had not received the governments support

Without government support	Segment 1	Segment 2	Segment 3	Segment 4	Total
Would have stopped putting money into savings/reduced the amount put into savings	81%	16%	68%	21%	48%
Would have had to reduce spending on necessities (e.g. food, clothing, medicines)	98%	87%	35%	6%	37%
Would have had to reduce other spending (e.g. holidays, meals out, days out)	99%	24%	98%	10%	57%
Would have struggled with paying other housing costs or bills	99%	95%	7%	6%	28%
Would have reduced the amount of energy used at home	90%	56%	81%	35%	62%
Would have used alternative heating sources more (e.g. coal/log burner)	26%	5%	20%	13%	18%
Would have taken on household debt/taken on more household debt	42%	43%	2%	4%	12%

Based on the patterns of responses in table 35 and the details of the demographic profiles of each of the different segments in table 36, the profiles of the different segments can be summarised as follows:

Segment 1 (20% of sample) – This segment would have been more likely to resort to reducing their energy use, reduce spending and saving behaviours and more likely to borrow without government support. This segment tends to be younger, more likely to rent, and poorer than the average.

Segment 2 (4% of sample) – This segment would have been more likely to resort to reducing their energy use and cutting back on spending on necessities and more likely to borrow without the government's support. However, they were less likely to have reduced putting money into saving or cut back on other spending (e.g. food, clothing, holidays, etc.), potentially because they were already not saving or spending on non-essentials and so could not reduce this further. This segment tends to be younger, poorer (with a higher proportion earning less than £25,999 relative to segment 1), more likely to have an illness or be disabled, and more likely to rent from a council/housing association than the average.

Segment 3 (33% of sample) – This segment was more likely to report they would have resorted to reducing their energy use, putting less money into savings and reducing spending on other goods (e.g. eating out, clothing, holidays, etc.), as well as less likely to report they would have borrowed more without government's support. The constituents of this segment were more likely to own their own home.

Segment 4 (43% of sample) – This segment would have been less likely to reduce energy use, cut back on spending on necessities and other goods, or borrow more without the government's support. This segment tends to be older (including a relatively large proportion of over 65s compared with other segments) and tend to own their home.

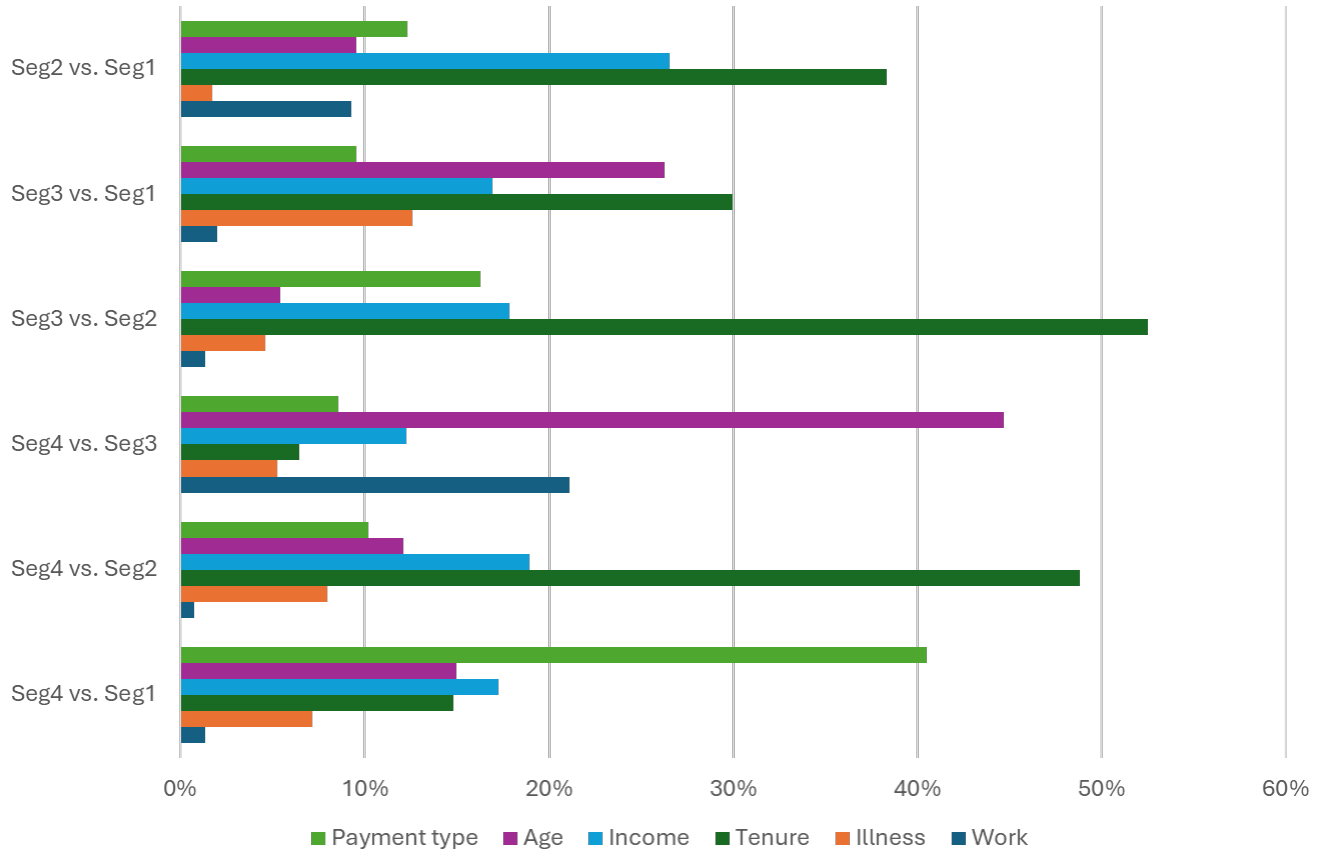
Table 36: Demographic profiles of each of the different segments

		Segment 1	Segment 2	Segment 3	Segment 4	Total
Age	16-34	17%	16%	10%	11%	12%
Age	35-44	20%	14%	12%	9%	12%
Age	45-64	46%	48%	44%	36%	41%
Age	65+	17%	22%	34%	45%	35%
Working status	Full-time	45%	33%	41%	31%	37%
Income	Up to £25,999	37%	51%	23%	24%	27%
Income	£26,000 up to £51,999	31%	19%	32%	30%	30%
Income	£52,000 up to £99,999	13%	8%	19%	17%	17%
Income	£100,000 and above	4%	3%	7%	9%	7%
Tenure	Owned outright/ buying on mortgage	62%	42%	87%	84%	79%
Tenure	Rent from private landlord	18%	24%	8%	8%	11%
Tenure	Rent from council/ housing association	20%	34%	5%	8%	11%
Health	Illness or Disability within the household	40%	42%	24%	22%	27%
Payment Type	Direct Debit	75%	65%	90%	86%	84%

Notes: Only demographics that were found to significantly discriminate between the four segments are presented in this table.

Figure 6 further summarises the results of the analysis discriminating between the different segments. Tenure, age and income were consistently the most important demographic predictors of differences between segments. This was followed by payment type (direct debits vs. non direct debit), which explain more than 40% of the differences between segment 1 and segment 4.

Figure 6: Summary of contributions of demographic predictors to explaining the differences between segments



Notes: For each regression model, the relative contributions of demographic predictors to explaining the differences between segments sum up to 100%. Ethnicity explained less than 1% of the variation between segments, so was omitted from the graph.

Since several demographic predictors were moderately correlated amongst themselves (presence of multi-colinearity), standard logistic regression was deemed unsuitable to determine a predictive contribution of each demographic variable. In presence of multi-collinearity, the importance of some predictors would be under-estimated even if they were strong predictors of the outcome variable. Instead, we derived the importance of the demographics by computing regression models with all the combinations of predictors. This technique is commonly known as Shapley Value Regression. For each of the six scenarios, which evaluated the differences between segments by the demographics:

One regression model had as predictors age and income; another only age; another age, income, tenure; and so on. Then we calculated the importance of each predictor across all the models. The relative importance of each predictor was the average of the contribution of that predictor to all the models. The contribution was measured using the R^2.

This publication is available from: www.gov.uk/government/publications/domestic-energy-affordability-support-schemes-in-great-britain-interim-evaluation

If you need a version of this document in a more accessible format, please email alt.formats@energysecurity.gov.uk. Please tell us what format you need. It will help us if you say what assistive technology you use.