



Department for
Energy Security
& Net Zero

Review of Air Source Heat Pump Noise Emissions, Permitted Development Guidance and Regulations

Technical Annex

DESNZ Research Paper Number 2023/046

November 2023



© Crown copyright 2023

This publication is licensed under the terms of the Open Government Licence v3.0 except where otherwise stated. To view this licence, visit nationalarchives.gov.uk/doc/open-government-licence/version/3 or write to the Information Policy Team, The National Archives, Kew, London TW9 4DU, or email: psi@nationalarchives.gsi.gov.uk.

Where we have identified any third-party copyright information you will need to obtain permission from the copyright holders concerned.

Contents

Strand 1 Literature review methodology	7
Key word search	7
Methodology	7
Sound emissions guidance: Prisma diagrams	10
Critical appraisal process	13
Full bibliography	15
Strand 2 Household Research Methodology	19
Objective 1: To understand the factors that contribute to ASHP noise complaints	19
Objective 2: To understand the perceptions of households towards local environmental issues and low carbon heating technologies	22
Strand 2 Invitation letter	26
Strand 2 online survey questions	29
Low carbon heating and your neighbourhood	29
Section 2: Low carbon heating systems	32
Section 3 – About you	33
Strand 2 Interview script (topic guide)	35
Section 1: Introduction (5 mins)	35
Section 2: Socio-demographic questions – 5 minutes	36
Section 3: Views of the neighbourhood – 10 minutes	36
Section 4: Low Carbon Heating Systems – 20 minutes	36
Section 5: Conclusion (5 mins)	37
Strand 2 online survey responses	38
Socio-demographic responses	38
Low carbon heating system responses	39
Local neighbourhood responses	40
Strand 3 Multi-stakeholder research methodology	44
General	44
Local planning authorities	44
Manufacturers	46
Industry bodies	47
Installers	47
MCS installer certification bodies	50

Review of ASHP Noise Emissions, Permitted Development Guidance and Regulations

Opportunities for further research	51
Sound power level	51
Permitted noise level	51
Cumulative effects	51
Perceptions of ASHP noise	51
Proximal neighbours research	51

Figures

Figure 1 - Prisma diagram for sound emissions guidance	10
Figure 2 - Prisma diagram for national and international standards	11
Figure 3 - Prisma diagram for ASHP noise perceptions	12
Figure 4 - Prisma diagrams for all sections	13
Figure 5 - Visualisation of the survey sampling method	24
Figure 6 - Respondents' property type	38
Figure 7 - Respondents' awareness of low carbon heating systems.....	39
Figure 8 - How much respondents liked living in their neighbourhood	40
Figure 9 - What respondents particularly liked about their neighbourhood	41
Figure 10 - What respondents particularly disliked about their neighbourhood.....	41
Figure 11 - Noise noticed by respondents from inside their property during the daytime	42
Figure 12 - Noise noticed by respondents from inside their property during the night-time.....	43
Figure 13 - Prompt shown to interviewees when asked about changes to PDRs	44
Figure 14 - Prompt slide shown to interviewees when asked about ASHP design factors	46
Figure 15 - Prompt slide shown to interviewees when asked about designing quieter ASHPs	47
Figure 16 - Prompt slide shown to interviewees when asked what installation factors are important to them	50

Tables

Table 1 - Keyword search terms used throughout the database search.....	8
Table 2 - Local planning authorities used for the planning application searches with their rural/urban classifications.....	20
Table 3 - Local authority sampling quota.....	45
Table 4 - Manufacturer sampling quota.....	46
Table 5 - Number of installations.....	48
Table 6 - Installer sampling quota.....	49

Strand 1 literature review methodology

Key word search

Methodology

To undertake this review, multiple scientific databases were searched for literature including Web of Science (title/abstract/keywords), SCOPUS (title/abstract/keywords), ScienceDirect (title/abstract/keywords), IngentaConnect (title/abstract/keywords) and Google Scholar (title).

The database search utilised Boolean operators, providing a comprehensive search approach, and minimising the risk of overlooking relevant literature. Search strings consisted of three components: the first identifying the source (ASHP), the second specifying the desired type of literature (papers discussing and mentioning the acoustic characteristics of ASHPs) and the third removing literature unrelated to this review. The search string for Web of Science is presented below, for information. It was adapted to accommodate other search engine protocols:

["heat pump*" OR "air source heat pump*" OR "ASHP*"] AND ["noise*" OR "sound*" OR "acoustic*" OR "loud*" OR "quiet*" OR "auralization*"] NOT ["ground source heat pump*" OR "thermoacoustic*"].

Only publications from the past five years were included so that the knowledge obtained reflects recent industry developments. The search was conducted on 24th June 2023, and yielded the following number of database hits (including duplicates):

- Web of Science: 75
- SCOPUS: 142
- ScienceDirect: 56
- IngentaConnect: 8
- Google Scholar: 13

All 294 citations were imported into Endnote for sorting alongside citations from additional sources. Additional sources included UK Government documents and standards, European Union (EU) regulations, Annex 51 documents, Welsh Government documents, papers identified throughout relevant bibliographies, and papers from the 14th International Energy Agency (IEA) Heat Pump Conference.

The screening process followed the PRISMA approach. Articles were first assessed for relevance following title and abstract screening. Articles not relevant to this review were removed, and all remaining articles were then subject to full-text screening. To identify papers related to the individual research questions, the following methods were used:

- For ASHP sound emission guidance, full-text screening removed papers which were unrelated to ASHP acoustic measurements. This process reduced the number of

relevant papers, with only 25 being relevant. Of those, only five presented case studies of in-situ measurements.

- In relation to the acoustic regulations and standards, full-text screening removed papers deemed unrelated to ASHP acoustic regulations and standards due to their focus on in-situ measurement, perception among various groups, ASHP design optimisation and ASHP noise control. This process reduced the number of relevant papers, with only 30 being relevant to ASHP noise regulation. Of those, 21 were standards, regulations, or policy documents.
- To identify papers related to the perception of ASHPs among consumers, papers primarily discussing technical information relating to ASHP design and noise emission alongside documents focusing on ASHP regulations were removed during full-text screening. This process reduced the number of relevant publications down to 23 of these five were surveys exploring ASHP user perception.

The total number of resources identified throughout this process was 63, instead of 72 as expected. This is due to overlap in the literature.

Due to the variety of content identified throughout these searches, it was decided to synthesize the literature using thematic analysis. The remaining articles for each research question were grouped into smaller subcategories depending on their content and publication style, these groups are presented in Figure 1 to Figure 3. Within these subcategories, articles were critically appraised to identify the extent to which the literature answered the research questions with advice from the technical advisors on the project. Recurring trends and information were extracted. These have been used to inform the findings presented in this report.

During the editorial phase of writing this report, many of the 63 originally identified articles were deemed irrelevant within the context of UK permitted development rights. Only 16 had relevant evidence to support answering the research questions. However, all 63 are included in the final bibliography.

Table 1 - Keyword search terms used throughout the database search

Noise source terms	Acoustic identification terms	Exclusion terms
Heat pump OR Heat Pumps	Noise OR Noisy OR Noises	Ground source heat pump OR Ground Source Heat Pumps
OR	OR	OR
Air Source Heat Pump OR Air Source Heat Pumps	Sound OR Sounding OR Sounds	Thermoacoustic OR Thermoacoustics
OR	OR	[No data]
ASHP OR ASHPs	Acoustic OR Acoustics OR Acoustical	[No data]

Noise source terms	Acoustic identification terms	Exclusion terms
[No data]	OR	[No data]
[No data]	Loud OR Loudly OR Loudest	[No data]
[No data]	OR	[No data]
[No data]	Quiet OR Quietly OR Quietest	[No data]
[No data]	OR	[No data]
[No data]	Auralization	[No data]

Sound emissions guidance: Prisma diagrams

Figure 1 - Prisma diagram for sound emissions guidance

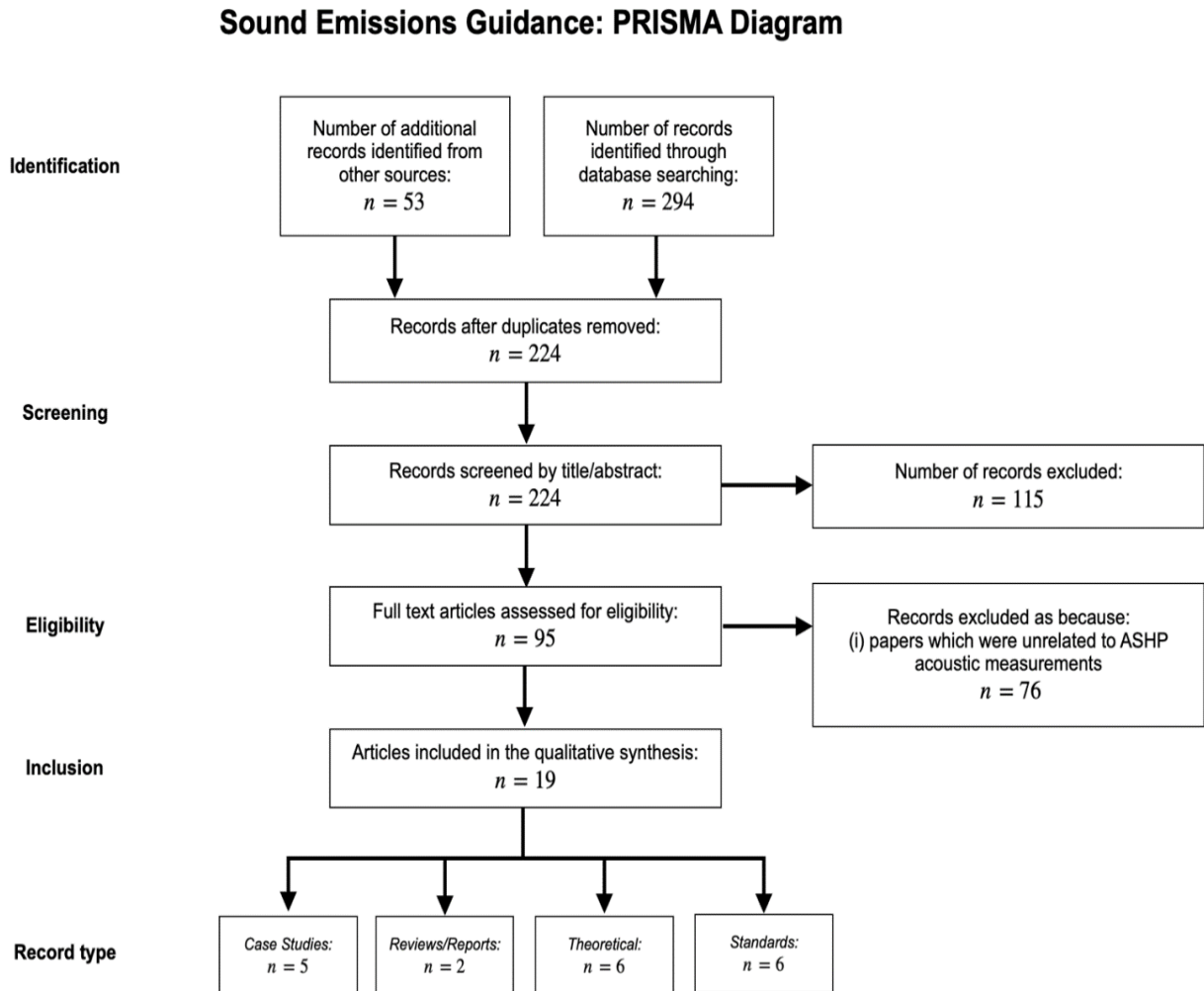


Figure 2 - Prisma diagram for national and international standards

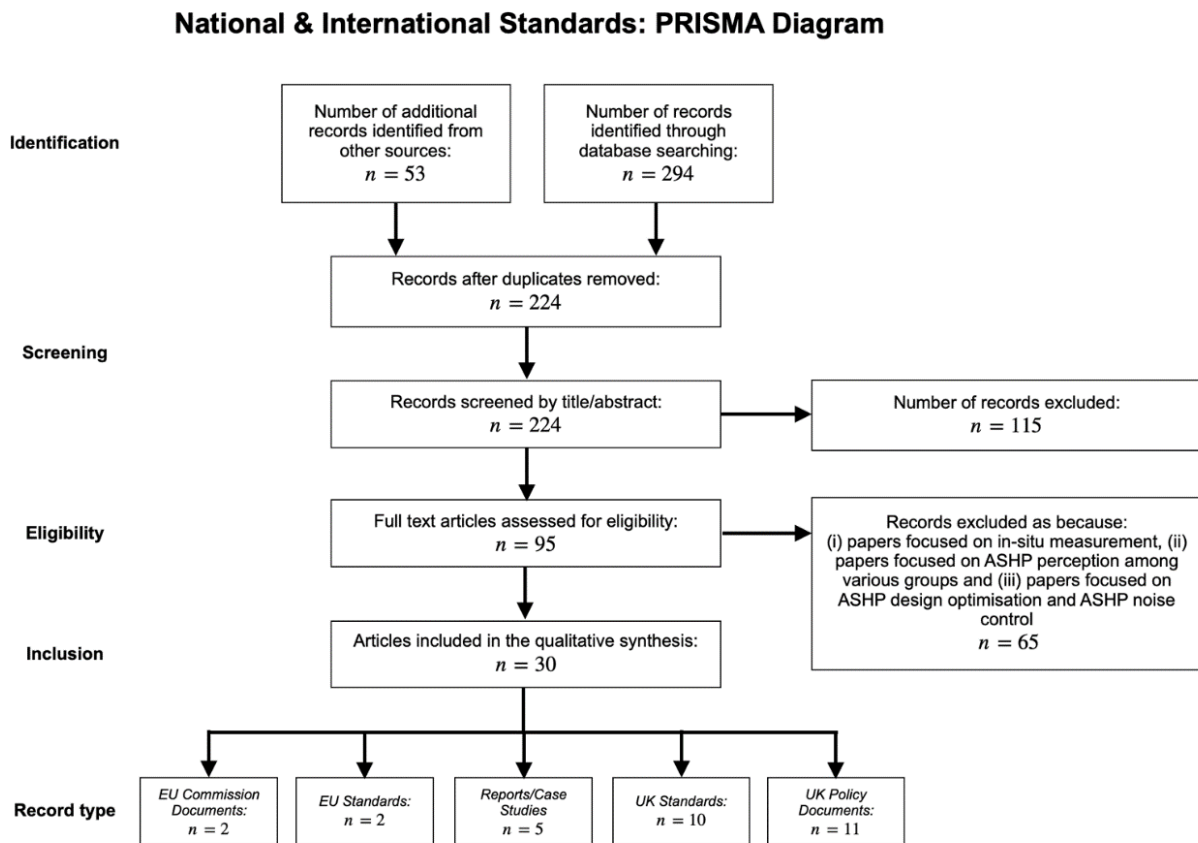


Figure 3 - Prisma diagram for ASHP noise perceptions

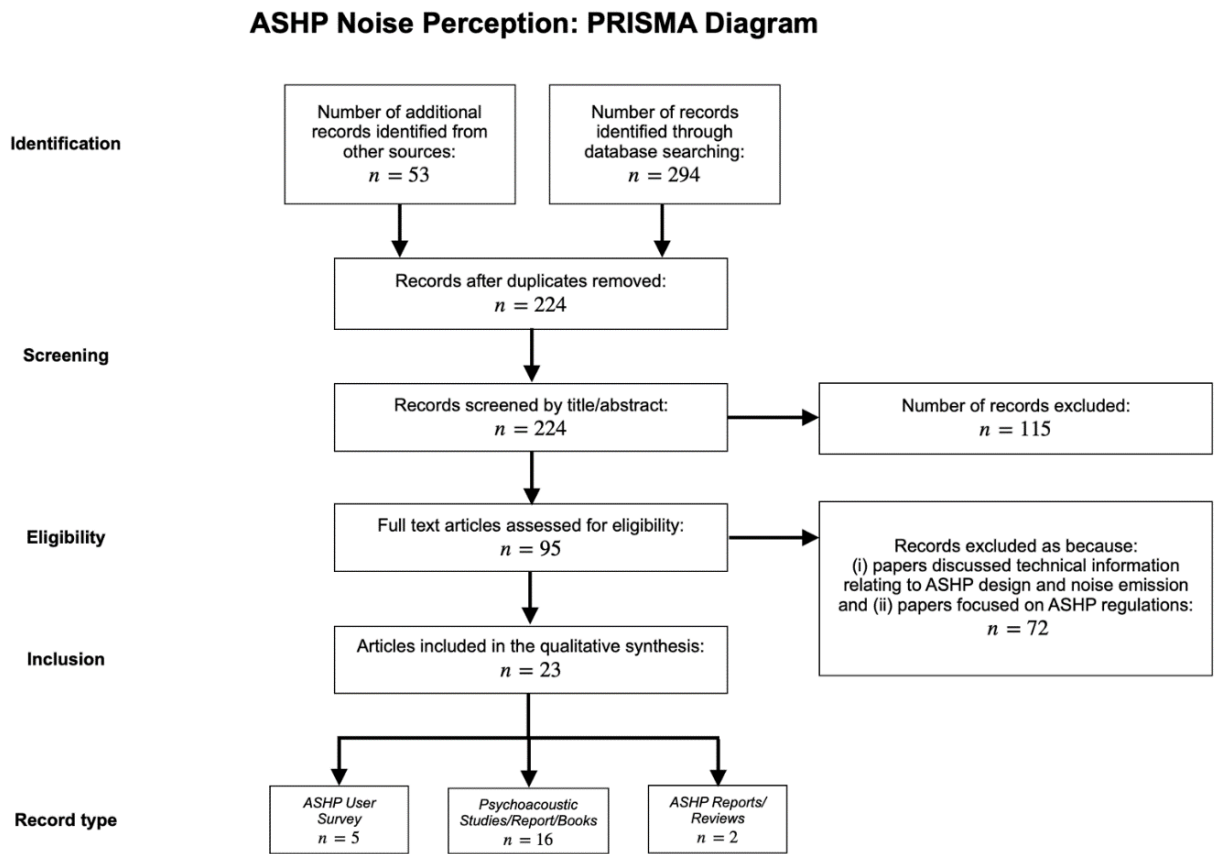
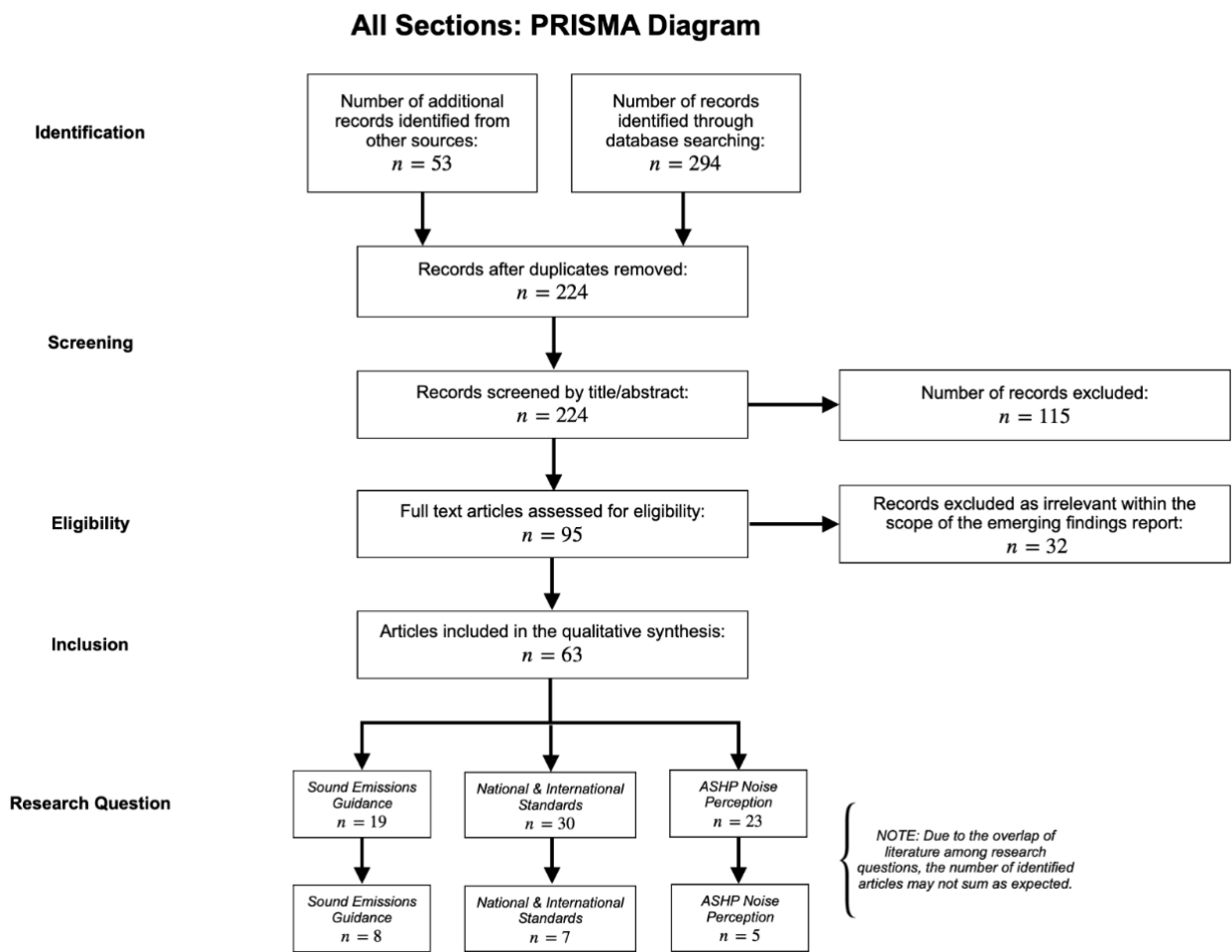


Figure 4 - Prisma diagrams for all Sections



Critical appraisal process

Resources identified throughout respective PRISMA screening processes were grouped according to record type as shown in PRISMA diagrams.

Within these groups, authors generated tables presenting bullet point summaries of all papers associated with individual research questions. Tables included a “general summary” column, whereby the overall scope of the resource was summarised. This column enabled overlapping themes and ideas to be identified independently from specific research questions, minimising the risk of overlooking content significant to the overarching project objectives. A column presenting “key findings” was also generated. This column identified trends and themes relevant to individual research questions.

From the “key findings” column, common trends/themes associated with each research question were used to form the foundations of respective reviews. Related or useful themes identified from the “general summary” columns were then incorporated to add additional context and ensure consistency among individual research inquiries.

The quality of resources used throughout the review was upheld by only utilising resources obtained from respected acoustic journals or conferences, the British Standards Institution, the

Microgeneration Certification Scheme (MCS), the UK Government website, the Institute of Acoustics (IOA), The James Hutton Institute (research institution funded by the Scottish Government) or through channels associated with the ASHP research project commissioned by the Welsh Government. The only exception to this is the following resource:

- Sam Taylor, J.H., Laura Williams, Rhiannon Lee, Charlotte Taylor, and A.N. Peter McCann, Heat Pumps: A User Survey. 2023, NESTA.

Of the 63 documents initially identified as relevant, shown in Figure 4, only 16 documents were included in the report. During the review, it became evident that many of the identified documents did not include information essential to the discussion of ASHP noise emission within the context of evaluating UK permitted development rights. Nonetheless, these documents provided important information which was used to evaluate the methods and outcomes of the included documents. The full list of these documents can be consulted below.

Full bibliography

1. Sustainable Acoustics, Air Source Heat Pump Noise & Permitted Development Rights in Wales, Welsh Government, 2023.
2. Bessac, F. (2020). 2.2 Round Robin Tests Air-to-Water Heat Pump Heat Pump Water Heater.
3. Blank-Landeshammer, B., Sporr, A., Drexler-Schmid, G., Köfinger, C., Emhofer, J., Reichl, C., Kaseß, C., & Waubke, H. (2021). Noise propagation modelling and mapping using augmented reality for HVAC sound sources.
4. British Standard, BS 8233:2014. Guidance on sound insulation and noise reduction for buildings.
5. Broner, N., & Leventhall, H. (1983). Low frequency noise annoyance assessment by low frequency noise rating (LFNR) curves. *Journal of Low Frequency Noise, Vibration and Active Control*, 2(1), 20-28.
6. Bryan, M. (1971). Annoyance effects due to low frequency sound. In *Proceedings, Autumn Meeting of the British Acoustical Society* (pp. 71-109).
7. Caird, S., Roy, R., & Potter, S. (2012). Domestic heat pumps in the UK: user behaviour, satisfaction and performance. *Energy Efficiency*, 5, 283-301.
8. Cohen, S., Evans, G., Stokols, D., & Krantz, D. (2013). *Behavior, health, and environmental stress*. Springer Science & Business Media.
9. Dimplex (2018). *Sound Guide [White paper]*. Bundesverband Wärmepumpe e.V.
10. Drexler-Schmid, G., Kasess, C., Blank-Landeshammer, B., Köfinger, C., Emhofer, J., Waubke, H., & Reichl, C. (2021). Augmented reality acoustics of air heat pumps-App development and methods. In *13th IEA Heat Pump Conference*.
11. Durlach, N., Colburn, H., Carterette, E., & Friedman, M. (1978). *Handbook of perception*. Carterette EC Friedman MP, ed, 360-466.
12. Ed Clarke. (2009). *Permitted Development Rights for Small Scale Renewable and Low Carbon Energy Technologies, and Electric Vehicle Charging Infrastructure*.
13. MCS Foundation, (2019). *Microgeneration Installation Standard: MCS 020*.
14. François BESSAC. (2020). 2.3: Seasonal Sound Power Level.
15. Freya Burns, S. (2021). *Heat pump use in Scotland: an evidence reviews [White paper]*. ClimateXChange.
16. Austrian Government. (2008). *ÖAL-Richtlinie Nr. 3 Blatt 1*.
17. UK Government. (2010). *Noise Policy Statement for England (NPSE)*.
18. UK Government. (2015). *Resistance to The Passage of Sound: Approved Document E*.
19. UK Government. (2017). *Microgeneration Installation Standard: MIS 3005*.

20. UK Government. (2021). Conservation of fuel and power: Approved Document L.
21. UK Government. (2021). Overheating: Approved Document O.
22. UK Government. (2021). National Planning Policy Framework.
23. British Standard, BS EN ISO 3746: 2010 Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane.
24. British Standard, BS 4142: 2014+A 1: 2019 Methods for rating and assessing industrial and commercial sound.
25. British Standard, BS EN 12102-1:2022 Air conditioners, liquid chilling packages, heat pumps, process chillers and dehumidifiers with electrically driven compressors. Determination of the sound power level. Air conditioners, liquid chilling packages, heat pumps for space heating and cooling, dehumidifiers and process chillers.
26. British Standard BS EN 14825:2019 Air conditioners, liquid chilling packages, heat pumps, process chillers and dehumidifiers with electrically driven compressors. Determination of the sound power level. Heat pump water heaters.
27. British Standard BS EN 14825:2022 Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling, commercial and process cooling — Testing and rating at part load conditions and calculation of seasonal performance.
28. Kralicek, J., & Kucera, M. (2018). Acoustic design of noise protection and noise mapping for heat pumps in the courtyard of a residential building. In International Congress on Sound and Vibration 2018 (pp. 1531-1538).
29. Kučera, M., Králíček, J., & Nosek, K. (2020). Heat pump operation in a family house from the perspective of a potential source of noise outdoors. *Vytapeni, Vetraní, Instalace*, 29(4), 226-233.
30. Landström, U., Åkerlund, E., Kjellberg, A., & Tesarz, M. (1995). Exposure levels, tonal components, and noise annoyance in working environments. *Environment International*, 21(3), 265-275.
31. Linhardt, F. (2018). Simultaneous measurements of sound, vibration, and flow, as well as determination of acoustic transfer functions in the context of air water heat pumps.
32. Matt Torjussen (2022). Survey: Noise from Domestic ASHPs [White paper]. Institute of Acoustics.
33. Møller, H., & Rubak, P. (1980). Proceedings of Conference on Low Frequency Noise and Hearing, Aalborg, Denmark, May 7-9, 1980. In Conference on Low Frequency Noise and Hearing. Aalborg Universitetsforlag.
34. Nagai, N., Matsumoto, M., Yamasumi, Y., Shiraishi, T., Nishimura, K., Matsumoto, K., Miyashita, K., & Takeda, S. (1989). Process and emergence on the effects of infrasonic and low frequency noise on inhabitants. *Journal of Low Frequency Noise, Vibration and Active Control*, 8(3), 87-99.

35. Persson, K., & Björkman, M. (1988). Annoyance due to low frequency noise and the use of the dB (A) scale. *Journal of Sound and Vibration*, 127(3), 491-497.
36. Persson, K., & Rylander, R. (1988). Disturbance from low-frequency noise in the environment: A survey among the local environmental health authorities in Sweden. *Journal of sound and vibration*, 121(2), 339-345.
37. Petra Lackova, L. (2016). Heat Pump Survey Final Report [White paper]. The James Hutton Institute, Aberdeen.
38. Roberto Fumagalli. (2019). 1.1 Measurement techniques.
39. Roberto Fumagalli, P. (2020). 1.2 Regulations - Countries overview.
40. Roberto Fumagalli, P. (2020). 1.3 Regulations - Synthesis.
41. Sam Taylor, & Peter McCann, A. (2023). Heat Pumps: A User Survey [White paper]. NESTA.
42. Schneider, M., & Feldmann, C. (2019). "Humming" or "Hissing"? - Psychoacoustical investigation of sounds from heat pumps. In *Proceedings of the International Congress on Acoustics* (pp. 8036-8041).
43. Somayya Yaqub, T. (2022). Heat Pumps Professional Advice Note.
44. Sporr, A., Blank-Landeshammer, B., Kasess, C., Drexler-Schmid, G., Kling, S., Köfinger, C., Waubke, H., & Reichl, C. (2021). Extracting boundary conditions for sound propagation calculations using augmented reality. *Elektrotechnik und Informationstechnik*, 138(3), 197-205.
45. Tempest, W. (1973). Loudness and annoyance due to low frequency sound. *Acta Acustica united with Acustica*, 29(4), 205-209.
46. Torjussen, M. (2020). Sound from domestic air source heat pumps: A case study.
47. UK Government. (1995). The Town and Country Planning (General Permitted Development) Order 1995.
48. UK Government. (2011). Acoustic Noise Measurements of Air Source Heat Pumps (EE0214).
49. UK Government. (2012). Permitted development rights for small scale renewable and low carbon energy technologies, and electric vehicle charging infrastructure consultation: Government response.
50. UK Government. (2014). Planning Practice Guidance: Noise.
51. UK Government. (2017). Census of Owner-Occupier applicants to the Domestic RHI: Waves 1 to 12.
52. UK Government. (2018). Microgeneration Certification Scheme: MCS 007.
53. UK Government. (2019). Planning Practice Guidance: Noise.
54. European Union. (2013). Commission Delegated Regulation (EU) No 811/2013.

55. European Union. (2013). Commission Regulation (EU) No 813/2013.
56. Kamp, I. (2022). Energy transition related noise and vibration issues and their health consequences. In *Internoise 2022*.
57. Vasudevan, R., & Gordon, C. (1977). Experimental study of annoyance due to low frequency environmental noise. *Applied Acoustics*, 10(1), 57-69.
58. Wang, J., & Norbäck, D. (2021). Home environment and noise disturbance in a national sample of multi-family buildings in Sweden-associations with medical symptoms. *BMC Public Health*, 21(1).
59. Waye, K., & Rylander, R. (2001). The prevalence of annoyance and effects after long-term exposure to low-frequency noise. *Journal of sound and vibration*, 240(3), 483-497.
60. Yamada, S., Sueki, M., Hagiwara, S., Watanabe, T., & Kosaka, T. (1991). Psychological combined effects of low frequency noise and vibration. *Journal of Low Frequency Noise, Vibration and Active Control*, 10(4), 130-136.
61. Beentjes, W., & Campmans, T. (2021). Dutch building code regulates noise for outdoor heat pumps. In *INTER-NOISE 2021*.
62. Archive: housing statistics (2020) Archive: Housing statistics - Statistics Explained. Available at: [House statistics](#) (Accessed: August 2023).
63. Philipp Wagner, Brigitte Blank-Landeshammer, Andreas Sporr. (2021). 5.0: Report on heat pump installation with special focus on acoustic impact. In, Annex 51.

Strand 2 Household Research Methodology

This section sets out the detailed methodology used in the data collection and analysis for Strand 2 – Household Research.

Objective 1: To understand the factors that contribute to ASHP noise complaints.

A number of different publicly available and industry specific sources were reviewed in order to create a database which identified factors underlying ASHP noise complaints.

The following data sources were considered for inclusion in the final database:

- MCS ASHP Complaints Database.
- Chartered Institute of Environmental Health (CIEH) local authority noise survey (2020/21), referred to as the CIEH Survey.
- IOA Survey - Noise from Domestic Air Source Heat Pumps (2022-2023), referred to as the IOA Survey.
- Planning applications involving ASHPs from LPA websites.
- Emerging findings from the Air Source Heat Pump Noise and Permitted Development Rights in Wales Phase 1 Report (2023), referred to as the Welsh Government Report.

Of the above sources, all were used apart from the CIEH Survey and the Welsh Government Report, however they were used to supplement the discussion of the findings. In the case of the CIEH Survey, the report did not distinguish between noise from different sources and the Welsh Government Report summarises the emerging findings and therefore there was little data that could be included into the database.

MCS is an organisation which creates and maintains the standards that allows for the certification of products, installers and their installations. They certify low-carbon electricity and heat generators. Installers of ASHPs may be members of MCS, and MCS also provides standards which may be referred to in planning applications. The MCS Complaints Database collates complaints regarding ASHPs and includes details such as the date the ASHP was installed, the date the complaint was received and when the complaint was resolved. In order to incorporate this information into the Objective 1 database, complaints made within the last three years were collated and then the description of the reason for the complaint was entered into the database.

For the IOA Survey, a variety of stakeholders, including the general public and environmental health professions, were surveyed on their experiences with ASHPs. The 121 responses from the survey went through a sift exercise, and any mention of causes of noise complaints from each respondent was added to the Objective 1 database. This meant that 69 respondent's answers were included in the Objective 1 database.

The findings from the Strand 3 - Multi-Stakeholder Research interviews were used to supplement the analysis and determine factors which lead to noise complaints. The raw data was also obtained in order to provide additional context where necessary, however, this data has not been included as part of the coding analysis as it has already been interpreted as part of Strand 3 - Multi-Stakeholder Research. The Strand 3 - Multi-Stakeholder Research researchers interviewed manufacturers, installers, certification bodies and LPAs. For more information on the Strand 3 - Multi-Stakeholder Research methodology, analysis and results please refer to the main report of this research.

Sampling Methodology

A quota sampling methodology was used to identify LPAs for the planning application search. Firstly, the MCS Installations Database¹ was used to determine the number of ASHP installations per LPA in England since 2021. For each LPA, the 2011 Rural Urban Classification Lookup tool² (published in 2021) was used to determine whether each LPA was rural or urban. If an area was classified as 'Mainly Rural', 'Largely Rural' or 'Urban with Significant Rural' it was assigned as a rural LPA for the purposes of the planning application search. The urban LPAs were those where >74% of the resident population lived in an urban area according to the classification tool. Once each LPA had been assigned as either urban or rural, the ten rural LPAs with the most ASHP installations (by number of installations) and the ten urban LPAs with the most ASHP installations were identified. These 20 LPAs are shown in Table 2 below. The same approach was also used for identifying LPAs for the Objective 2 research and, therefore, Table 2 details which LPA was considered for each research objective.

Table 2 - Local planning authorities used for the planning application searches with their rural/urban classifications

Rural urban classification 2011	Local authority	MCS certified installations	LA included in objective 1 and/or 2 research
Urban with Major Conurbation	Leeds	473	Objective 1 and 2
Urban with Major Conurbation	Calderdale	415	Objective 1 and 2
Urban with Major Conurbation	Manchester	369	Objective 1 and 2
Urban with Minor Conurbation	Sheffield	362	Objective 1 and 2
Urban with City and Town	South Gloucestershire	347	Objective 1 and 2
Urban with Major Conurbation	Kirklees	286	Objective 1 and 2

¹ MCS (2023) [MCS Installations Database \[online\]](#). (Accessed 7th September 2023)

² Department for Environment, Food & Rural Affairs (2021) [2011 Rural Urban Classification lookup tables for all geographies \[online\]](#). (Accessed 7th September 2023)

Rural urban classification 2011	Local authority	MCS certified installations	LA included in objective 1 and/or 2 research
Urban with Major Conurbation	Newcastle upon Tyne	285	Objective 1
Urban with Major Conurbation	Bradford	276	Objective 1
Urban with City and Town	Bristol, City of	262	Objective 1
Urban with City and Town	Guildford	231	Objective 1
Mainly Rural	Cornwall	2,510	Objective 1 and 2
Largely Rural	Wiltshire	1,140	Objective 1 and 2
Largely Rural	County Durham	1,127	Objective 1 and 2
Largely Rural	Shropshire	911	Objective 1 and 2
Largely Rural	Dorset	839	Objective 1 and 2
Largely Rural	East Riding of Yorkshire	799	Objective 1 and 2
Largely Rural	East Suffolk	719	Objective 1
Mainly Rural	South Norfolk	719	Objective 1
Largely Rural	Northumberland	650	Objective 1
Largely Rural	South Cambridgeshire	646	Objective 1

The planning portals of each of the 20 LPAs identified for Objective 1 were then searched for planning applications including the search term 'heat pump'. For each LPA, the 15 most recent planning applications that referenced ASHPs were included in the Objective 1 database, with information on objections from the public and comments from the EHO recorded.

Of the 150 rural LPA planning applications for ASHPs, 13 had at least one objection from the public and/or comments of concern in relation to noise pollution from ASHP from the EHO. Out of the 150 urban LPA planning applications, six had at least one objection from the public and/or comments of concern from the EHO in relation to noise. These 19 planning applications were taken forward for inclusion in the detailed analysis of the research.

The Objective 1 database contained 105 relevant entries for noise. This consisted of textual data; therefore, open coding was used to describe and classify the data collected. The data were then analysed by considering links between the codes and identifying common themes.

The process was iterative, with additional codes being added as further analysis was completed. The final common themes and subsequent detailed codes used are listed below:

- Nature of ASHP Noise Heard:
 - Tonal noise from ASHPs
 - Vibration from ASHPs
 - Unspecified noise concern
 - Disturbance during the day
 - Disturbance at night
- Cause of the ASHP Noise:
 - Technical fault
 - Age of unit
 - Incorrect installation/need for enclosures
 - Proximity to neighbours or location of ASHP
 - Cycle of the ASHP
 - Weather conditions
 - Existing low background noise
 - Cumulative noise impacts
- Procedural influences:
 - No EHO involvement
 - Insufficient information provided in the planning application
 - Permission not granted or no permission applied for
 - Concerns with MCS Standards (including how these are interpreted)
 - Concerns with manufacturer specifications
 - Lack of planning guidance

Objective 2: To understand the perceptions of households towards local environmental issues and low carbon heating technologies

In order to investigate Objective 2, a two-fold approach was used: an online survey and follow-up telephone interviews with respondents that could hear noise generated from ASHPs from within their property.

Firstly, the online survey was developed. The survey included 17 questions in total, with 12 main questions and five follow up questions, that aimed to collect data on:

- Awareness of proximal neighbours towards low carbon heating technologies generally.
- Awareness and knowledge of ASHPs.
- The role of word-of-mouth messaging on heat pump deployment.
- Perceptions of ASHP noise.

This Technical Annex includes a copy of the questions included in the online survey.

A letter was sent to proximal neighbours of households that owned an ASHP. The letter included a link to the online survey and instructions on how to complete the survey. In total, the letter was sent to 3,050 households in 60 High Intensity Areas (HIAs). The online survey was available between the 9th and 25th August 2023. This Technical Annex includes a copy of the invitation letter sent to proximal neighbours.

In order to identify the HIAs, data from the MCS Installations Database (from between 2021 – 2023)³ and the UK Government Rural Urban Classification System⁴ were used to determine six Urban and six Rural LPAs with the greatest number of ASHP installations, as per the steps above for Objective 1. Table 2 sets out the LPAs that were considered for Objective 2. Data for property tenure and property type was not available at a postcode level from the MCS Installations Database and, therefore, was not used in the identification process. Instead, this has been recorded at LPA level using Nomis data⁵ in order to understand the mix of property and tenure type in each LPA. It should be noted that questions around property and tenure type were included as part of the questionnaire and are, therefore, known for each respondent.

Postcode data for properties where ASHPs had been installed between 2021 and 2023 (available from the MCS Installations Database) were filtered by these 12 LPAs. Then, for each LPA, the data was filtered to determine multiple postcode entries (areas where multiple ASHPs had been installed). For each of the 12 LPAs, the five most common postcodes were identified and taken forward as the HIAs. Then, publicly available mapping sources were used to determine the locations of approximately 50 proximal neighbours within 50m of the source addresses. This meant that for each LPA, approximately 250 addresses were identified. Letters were sent out to these addresses, not including the source address (owner of the ASHP), to invite them to complete the online survey. If the respondent agreed they were entered into a prize draw to win one of five vouchers worth £20. The prize draw was undertaken in accordance with the Gambling Act 2005⁶.

This process is depicted in Figure 5. Some urban LPAs had shortfalls in the 250 properties, as there were not enough proximal households in Kirklees, Sheffield and Gloucester. The shortfall in addresses was made up with additional address data from Leeds and Manchester LPAs. A limitation of this approach was that some new housing estates were not visible on online mapping sources as the street data had not been updated. This made it hard to search for proximal neighbours in these areas so the newest housing estates with ASHP installations are not included in the survey.

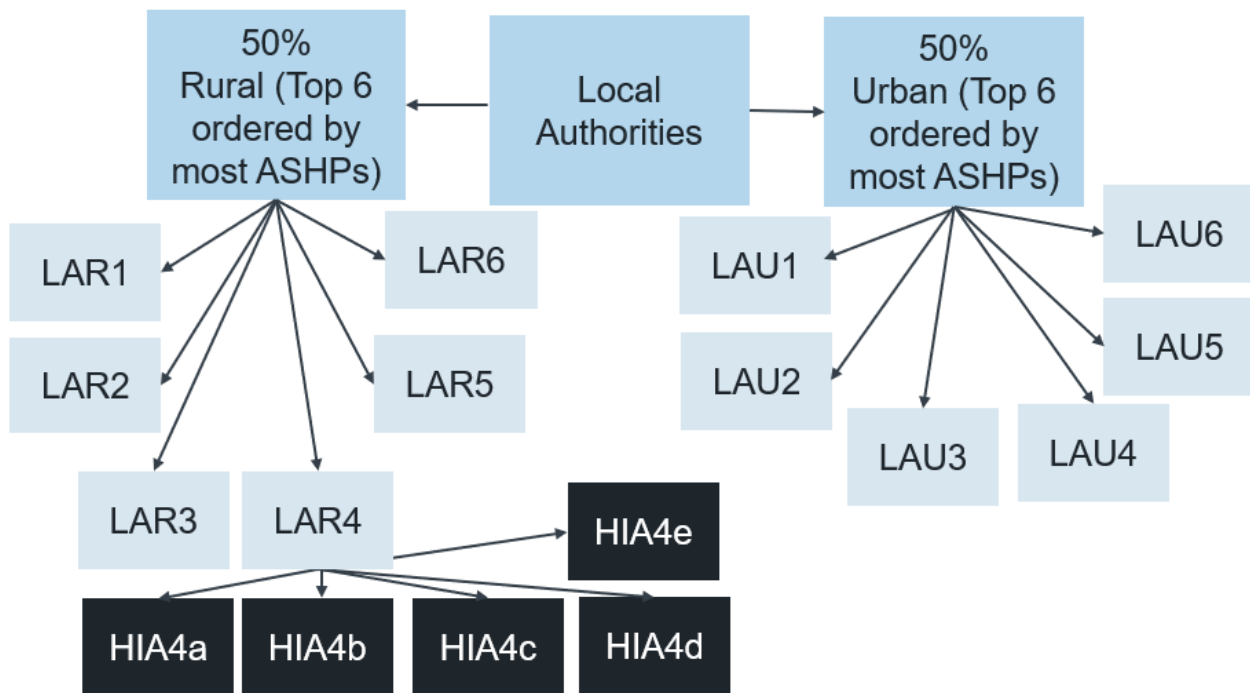
³ MCS (2023) [MCS Installations Database \[online\]](#). (Accessed 7th September 2023)

⁴ Department for Environment, Food & Rural Affairs (2021) [2011 Rural Urban Classification lookup tables for all geographies \[online\]](#). (Accessed 7th September 2023)

⁵ Office for National Statistics (2023) [Nomis \[online\]](#). (Accessed 7th September 2023)

⁶ UK Government (2005) [Gambling Act 2005 \[online\]](#). (Accessed 7th September 2023)

Figure 5 - Visualisation of the survey sampling method



Key: LR – Local Authority Rural, LU – Local Authority Urban, HIA - High Intensity Area

After the HIAs were determined and proximal neighbours' addresses obtained, a randomised spot check was used to understand the property type and the nature of the development (e.g. flats, estates, isolated properties) to ensure a spread of survey respondents. To do this, each address was given an ID number and then a random number generator used to select an address. Thirty-one (1%) of the total of 3,050 addresses were identified. These properties were then checked on a publicly available online mapping service to verify the type of property and to determine if there was a good spread of different property types.

The second component of the Objective 2 research was to undertake up to ten follow-up in-depth telephone interviews with survey respondents. The purpose of the interviews was to gain a more in-depth understanding of neighbours' views of ASHPs and the factors leading to noise concerns or complaints with proximal ASHPs. The planned methodology was based on a quota sampling method, with those who stated they had heard a nearby ASHP within or outside their property in the survey being selected for an interview, however the number of eligible respondents who agreed to an interview did not meet the pre-assigned quota (ten interviews). The sampling was done in this way to specifically find out how noise from ASHP affects proximal neighbours. A financial incentive of £30 was offered to each participant of the telephone interviews. This Technical Annex provides a copy of the topic guide (i.e. interview script) used during the telephone interviews.

The online survey responses were analysed using descriptive statistics. In order to analyse the interviews, the textual nature of the data meant that open coding was used. The same codes that were developed for Objective 1 were used as a starting point in order to provide a consistent approach to themes. The iterative nature of the process also meant that where necessary, additional codes were added and codes that were not relevant were removed. For the interviews, the final codes and their themes are as follows:

- Nature of ASHP Noise Heard:
 - Tonal Noise from ASHPs
 - Vibration from ASHPs
 - Unspecified noise concern
 - Disturbance during the day
 - Disturbance at night
 - Additional changes in soundscape
- How Does the ASHP Noise Impact People:
 - Cost of unit
 - Incorrect installation/need for mitigation
 - Proximity to neighbours or location of ASHP
 - Cycle of the ASHP
 - Weather conditions
 - Cumulative noise impacts
- Procedural influences:
 - Permission not granted or no permission applied for
 - Funding schemes
 - Type of property where the ASHP is installed
 - Use of other heating systems

Strand 2 Invitation letter



09 August 2023

Low Carbon Heating and your neighbourhood

Dear Householder,

We are writing to ask for your help with an important national survey about local neighbourhood issues. The Department for Energy Security and Net Zero (DESNZ) has commissioned WSP to carry out research on low carbon heating and your neighbourhood, with the aim of informing future government policies on these matters. We would like to hear your views and therefore **invite you to take part in a 10 minute online survey**. Everyone who completes the survey will be **entered into a prize draw to win one of five £20 Love2Shop vouchers**. The survey will close at midnight on Friday 25 August 2023.

<https://www.surveymonkey.co.uk/r/Y2SHFQH>



Why did we choose you? Your home is one of those selected at random for inclusion in the survey. To ensure the survey is robust we rely on the voluntary co-operation of people in selected homes – no other addresses can take the place of yours.

What happens next? After the initial survey, you will be asked if you're willing to take part in a follow-up interview to explore your survey responses further. Our research team will select a small number of respondents who have agreed to be followed up and invite them to participate in a 45 minute telephone interview. The interview will be arranged for a time that is convenient for you and you will receive a **£30 Love2Shop voucher** to thank you for your time. If selected to take part in this stage, you must be 18 years of age or older.

Will my response be kept confidential? Your answers will be treated in the strictest confidence. It will not be possible for any individual to be identified from the survey findings and the information will be used by the research team for statistical purposes only. As part of this research, WSP will temporarily store, and process data provided by respondents and will do so in line with the WSP privacy policy, details of which can be found here:

<https://www.wsp.com/en-gl/legal/privacy-policy>. Upon conclusion of the research, all data will be deleted.

We sincerely hope that you will consider participating in this survey. Your contribution is instrumental in shaping national policies that can create a positive impact on our local communities. Should you wish to discuss this matter further with a Government official, please get in contact with us via our mailbox: joseph.rogers@energysecurity.gov.uk.

Thank you very much for your kind assistance.

Yours faithfully,

Dr Matthew Aylott,

Electrification of Heat Policy Lead,

Department for Energy Security and Net
Zero, UK Government

John Rampley-Clarke

Service Line Director – Environmental
Services,

WSP

FAQs

Is the survey compulsory? Participation in the study is entirely voluntary, but your views are vital to help shape future policies on low carbon heating as the government seeks to transition the heating and cooling industry to net zero.

How do I complete the survey? Type the link provided overleaf into your internet browser. Alternatively, use the camera app on your smartphone to scan the QR code on the previous page. You will then be directed to the start of the survey.

Who are WSP? The Department for Energy Security and Net Zero (DESNZ) has commissioned WSP, an independent research agency, to carry out this research on our behalf. WSP's wide range of experts provide strategic advisory, engineering and design services to clients across various sectors. Visit our website for further information:

<https://www.wsp.com/en-gb/who-we-are>

Will my data be kept confidential? Yes, the findings are strictly confidential and will be used for research purposes only. Your name, and contact details will not be shared beyond the research team at WSP. It will not be possible to identify any individuals in the published findings. The research is being conducted in accordance with the Market Research Society Code of Conduct, and any information you provide will be handled securely in line with the UK Data Protection Act and the EU General Data Protection Regulation (GDPR). Your name and contact details will be deleted 12 months after completion of this project. You have a right to have a copy of your data, change your data, or withdraw from the research at any point. If you'd like to do this, please contact the team at: DESNZResearch@wsp.com

Strand 2 online survey questions

Low carbon heating and your neighbourhood

Thank you for taking part in our survey, your participation and contribution will help us to shape national policies that can create a positive impact on our local communities. This survey is voluntary, and all responses will remain confidential.

The survey should take no more than 10 minutes to complete.

We believe in acknowledging your time and effort in completing the survey. Therefore, everyone who completes the survey will be entered into a price draw to win one of five Love2Shop vouchers worth £20. Five winners will be randomly selected after the survey closes on Friday 25 August 2023. The winners will be notified by email no later than Friday 1 September 2023.

Section 1 : Your neighbourhood

With the following questions we are hoping to gain an understanding of your views of your neighbourhood.

1. On the whole, how much do you like living in your neighbourhood?

- Strongly dislike
- Dislike
- Neither like nor dislike
- Like
- Strongly like
- Don't know
- Prefer not to say

2. Is there anything you particularly **like** about your neighbourhood? [150 character limit]

.....
.....

3. Is there anything you particularly **dislike** about your neighbourhood? [150 character limit]

.....
.....

4. Do you believe that any of these environmental factors in your neighbourhood have adversely affected your health and wellbeing? Please tick all boxes that apply.

- Air quality
- Lighting
- Noise
- Odour

4a. Please can you tell us more about why your health and wellbeing has been affected by noise in your neighbourhood?

.....
.....

4b. Have you ever made the local council aware of issues with noise in your neighbourhood in the last three years?

.....
.....

5. When inside your home during the daytime, which sounds do you notice from outside your home? (Tick all that apply)

- Alarms (e.g. burglar, fire or smoke)
- Dogs
- Domestic appliances
- Nearby traffic
- Neighbours doing DIY inside (hammering, drilling etc)
- Neighbours' air conditioning unit
- Neighbours' heat pump unit
- Radio, TV and music (from inside neighbouring homes or outside)
- Voices / shouting / arguments (from inside other homes or from outside)
- I don't notice any noises outside my home
- Any other noise (Please specify)

.....
.....

5a. When inside your home during the daytime, how much does sound from nearby heat pump units disturb you?

- Not at all
- Rarely

- Sometimes
- Often
- Very Often
- Don't know

6. When inside your home during the night-time, which sounds do you notice from outside your home? (Tick all that apply)

- Alarms (e.g. burglar, fire or smoke)
- Dogs
- Domestic appliances
- Nearby traffic
- Neighbours doing DIY inside (hammering, drilling etc)
- Neighbours' air conditioning unit
- Neighbours' heat pump unit
- Radio, TV and music (from inside neighbouring homes or outside)
- Voices / shouting / arguments (from inside other homes or from outside)
- I don't notice any noises outside my home
- Any other noise from neighbours inside their homes (Please specify)

.....
.....

6a When inside your home during the night-time, how much does sound from nearby heat pump units disturb you?

- Not at all
- Rarely
- Sometimes
- Often
- Very Often
- Don't know

Section 2 : Low carbon heating systems

The next section of the survey will allow us to understand your views on low carbon heating systems.

7. Have you heard about any of the low carbon heating systems listed below that heat homes? Please tick all that apply.

- Air source heat pumps
- Biomass boiler
- Electric combi-boiler
- Ground source heat pumps
- Heat networks (also known as communal or district heating)
- Hybrid heat pumps
- Hydrogen boilers
- Hydrogen-ready boilers
- Solar thermal panels

8. Do you know anyone in your neighbourhood who has a low carbon heating system installed in their home?

Yes No

8a. If yes, please can you specify which low carbon heating system is installed from the list below.

- Air source heat pumps
- Biomass boiler
- Electric combi-boiler
- Ground source heat pumps
- Heat networks (also known as communal or district heating)
- Hybrid heat pumps
- Hydrogen boilers
- Hydrogen-ready boilers
- Solar thermal panels
- Don't know

Section 3 – About you

The following questions will help us understand more about you and your home.

9. Do you own or rent the property you live in?

- Own
- Private rent
- Social rent
- Living rent free

10. How long have you lived at the property?

- Under 1 year
- Between 1 year and 3 years
- Between 3 years and 5 years
- Between 5 and 10 years
- More than 10 years

11. What type of property do you live in?

- Flat / apartment
- Terrace
- Semi-detached house
- Detached house
- Bungalow
- Other

12. If other, please provide details.

.....
.....

13. What is the postcode of your main place of residence?

.....
.....

If you'd like a chance to win a free £20 voucher, please provide your full name, email address and telephone number below. Five winners will be randomly selected after the survey closes

on Friday 25 August 2023. The winners will be notified by email no later than Friday 1 September 2023.

Full Name:

Email Address:

Confirm Email Address:

Telephone interviews will be held with a small number of households to explore the issues raised further. The interviews would last no longer than 45 minutes and be arranged for a time that is convenient for you between Wednesday 16 and Wednesday 30 August 2023. Each person that participates in a telephone interview will receive a £30 voucher. To take part in a telephone interview, if selected, you must be 18 years of age or older. If you would be happy to be contacted regarding a telephone interview, please tick this box:

Please provide a telephone number we can contact you on :.....

WSP will temporarily store, and process data provided as part of this online survey and will do so in line with the WSP privacy policy, details of which can be found here: <https://www.wsp.com/en-gl/legal/privacy-policy>. Upon conclusion of the research, all data will be deleted.

By clicking the 'Submit' button below, you are consenting to participate in this study.

End of Survey

Strand 2 Interview script (topic guide)

Section 1: Introduction (5 mins)

Hello. My name is _____. I am an employee of WSP. WSP have been commissioned by the Department for Energy Security and Net Zero to undertake a research project to better understand people's views of their local neighbourhood and low carbon heating.

You have been selected for a telephone interview from those that responded to a recent online survey and indicated that they would be happy to be contacted to provide further information. We believe in acknowledging your time and effort in participating in the telephone interview, and therefore you will receive a £30 Love2Shop voucher for taking part.

I would like to ask you some questions about your experiences of your local neighbourhood and your views of low carbon heating – in particular, air source heat pumps. The responses you provide will help us to shape national policies that can create a positive impact on our local communities.

The outcomes of the research project will be made publicly available, but your responses will be fully anonymised. Please be assured that your personal data and information is protected in line with the WSP privacy policy, which we can email you a copy of. Upon conclusion of the research, all personal data will be deleted.

We would like you to answer as fully as possible and please note there are no right or wrong answers. If there are any questions you prefer not to answer, we fully respect your right to do so. You have the right to withdraw from the interview at any point.

The survey should take approximately 45 minutes to complete. Please can I just find out if you have another commitment directly after this interview, or if you would be able to continue the interview for another 5-10 minutes if required?

Yes No

Do you have any questions regarding the interview?

Do you give consent for me to carry out the telephone interview?

Yes No

[If NO, terminate the telephone interview and provide reason interviewee did not want to proceed. If YES, proceed with the following questions]

Do you consent to the use of anonymised quotations for use in the published report?

Yes No

In order to assist with the analysis of the research, we would like to record the interview. Do you consent to the interview being recorded?

Yes No

Thank you. We will now start with the interview questions. This first section aims to find out a bit more about you.

Section 2 : Socio-demographic questions – 5 minutes

1. Could you tell me about where you live?
2. How long have you lived in your current home?
3. Who do you live with?
4. What do you typically do on a day-to-day basis?
5. How would you describe the area that you live?
 - a) Urban
 - b) Suburban
 - c) Rural
 - d) Not sure

Section 3 : Views of the neighbourhood – 10 minutes

The next set of questions will ask about your views of your local neighbourhood.

6. What are some of the things you like the most about living in your neighbourhood?
7. What are some of the things you dislike about living in your neighbourhood, if any?
8. Have you noticed any changes to the environment in your neighbourhood?
 1. Have these changes affected you or anyone in your household? If so: In what way?

Section 4 : Low Carbon Heating Systems – 20 minutes

The next set of questions relate to low carbon heating systems, specifically air source heat pumps, that are used to heat homes.

9. In the survey that you completed, you indicated that you had heard of [low carbon heating system(s)]. How willing would you be to replace the existing heating system in your home with an air source heat pump?
10. In the survey, you indicated that when inside your home during the daytime, the sound from a nearby heat pump unit(s) disturbs you (Often; Very much). Can you tell me more about this?
11. In the survey, you indicated that when inside your home at night-time, the sound from a nearby heat pump unit(s) disturbs you (Often; Very Much). Can you tell me more about this?
12. When thinking about sounds in your neighbourhood, how does the sound from air source heat pumps compare to other common sources like traffic, air conditioners, or gas boilers? Which of these noise sources would you say impacts you the most?
13. Has the sound from a nearby air source heat pump unit(s) affected you or anyone in your household? If so: In what way(s)?
14. What do you think could be done to improve the situation?
15. Have you ever made your local council aware of noise issues related to air source heat pumps in your neighbourhood?

Section 5: Conclusion (5 mins)

We have now reached the end of the interview. Thank you for taking the time to participate in this research. Is there anything else you would like to share with us today?

Would you be happy for us to contact you if we have any follow up questions?

Your time is really valuable and the answers you've provided will help to shape the outcomes of this research. We will send a £30 Love2Shop voucher to the email address you gave in the survey, please could I just confirm it with you?

As mentioned at the beginning of the interview, we will treat all your responses as confidential, and we will retain your anonymised responses for analysis purposes only. If you would like a copy of what we have discussed here today, need to change any of your answers, or would like to withdraw from the research at any time then please contact me on this number _____.

Thank you once again and I hope you have a good rest of day. Goodbye.

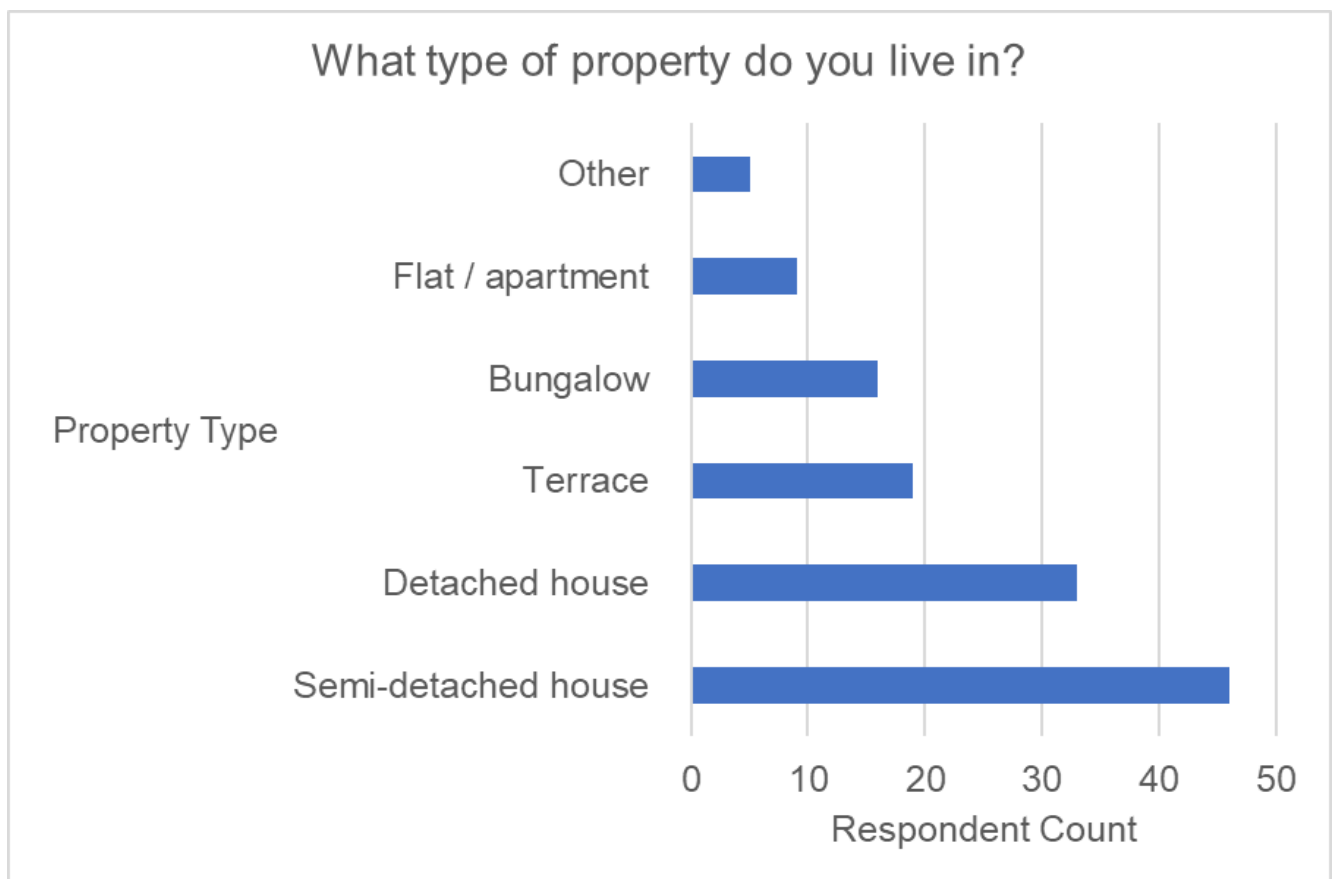
Strand 2 online survey responses

A total of 139 respondents completed the online survey. Respondents residing in all 12 LPAs, where HIAs were identified, completed the online survey, which shows a good geographical spread of responses. Respondents were able to skip questions in the online survey and, therefore, the number of responses differs per question.

Socio-demographic Responses

A total of 128 respondents answered Question 11 ‘What type of property do you live in?’. As shown in Figure 6, the respondents lived in a mixture of semi-detached houses (36%), detached houses (26%), terraced houses (15%), bungalows (13%) and flats / apartments (7%). Of the five respondents (4%) that responded ‘other’, three lived in an end terrace house, one lived in a Grade 2 listed terrace house, and one lived in a detached bungalow.

Figure 6 - Respondents’ property type



Question: What type of property do you live in? Base: 128. Number of respondents per option: Other – 5 (4%), Flat/apartment – 9 (7%), Bungalow – 16 (13%), Terrace – 19 (15%), Detached – 33 (26%), Semi-detached – 46 (36%).

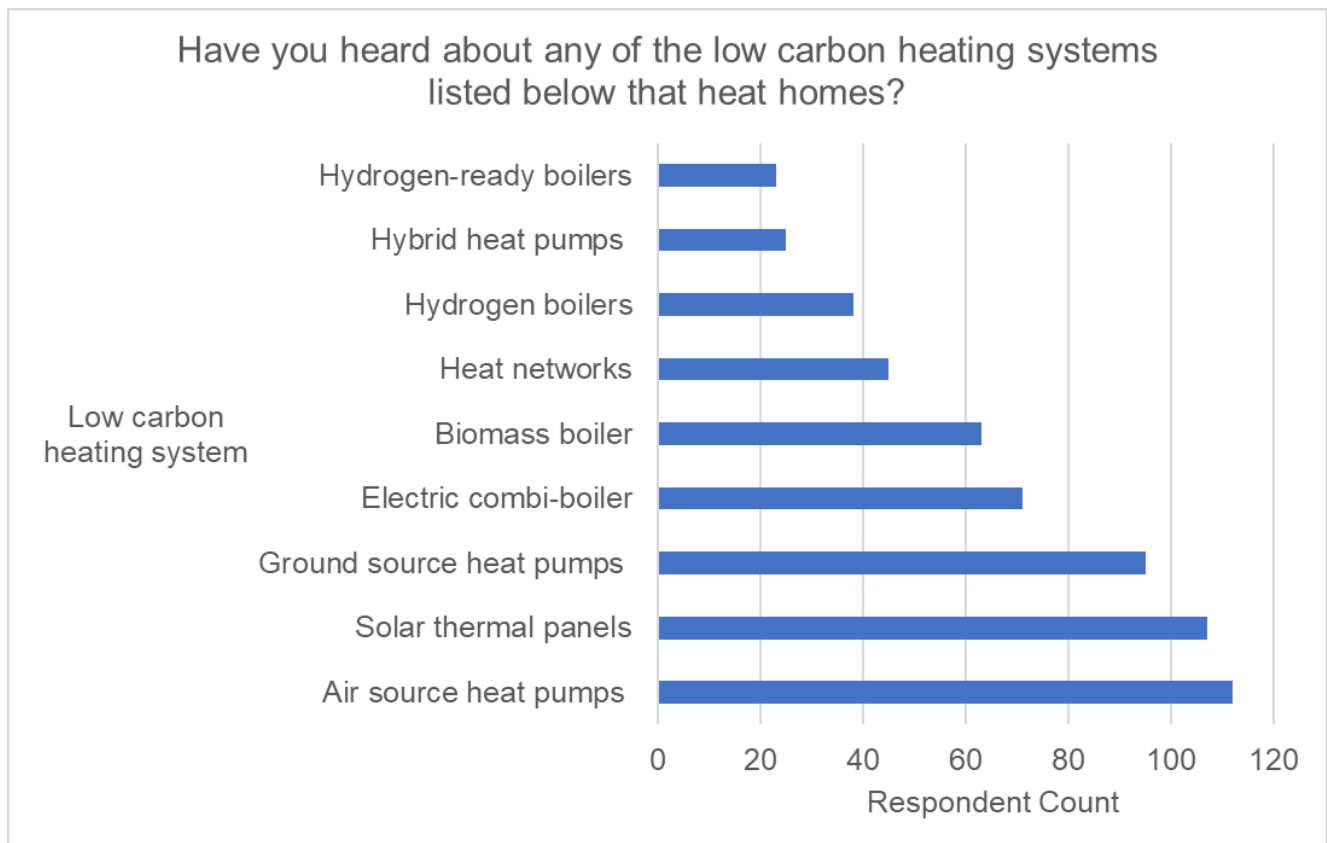
Of the 127 respondents that answered Question 9 ‘Do you own or rent the property you live in?’, 80% owned their own property, 17% lived in a social rented property and 2% lived in a private rented property.

A total of 127 respondents answered Question 10 ‘how long have you lived at the property?’. Most of the respondents (47%) had lived in their property for over 10 years. The remaining respondents had lived in their property between 1 and 3 years (19%), between 5 and 10 years (17%), between 3 and 5 years (10%) and under 1 year (6%).

Low carbon heating system response

Figure 7 presents the 125 responses to Question 7 ‘Have you heard about any of the low carbon heating systems listed below that heat homes?’. Nearly all respondents (90%) had heard of ASHPs. ASHP were the most well-known low carbon heating system in the survey, followed by solar thermal panels (86%) and ground source heat pumps (76%). It should be noted that respondents could provide more than one answer to Question 7. It is important to note that the survey did not ask about level of knowledge, so this may vary across respondents.

Figure 7 - Respondents’ awareness of low carbon heating systems



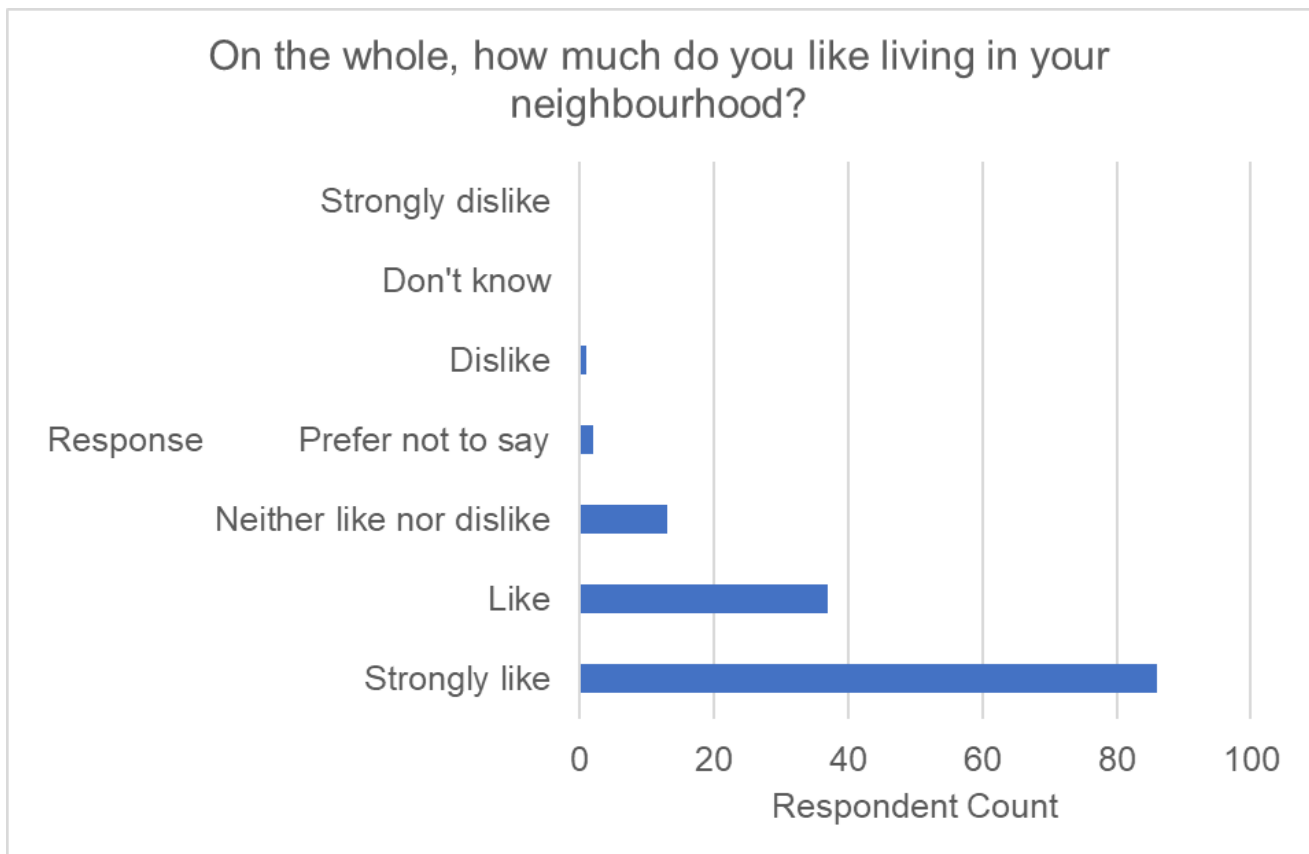
Question: Have you heard about any of the low carbon heating systems listed below that heat homes? Base: 125. Number of respondents per option: Hydrogen-ready boilers – 23 (18%), Hybrid heat pumps – 25 (20%), Hydrogen boilers – 38 (30%), Heat networks – 45 (36%), Biomass boiler – 63 (50%), Electric combi-boiler – 71 (57%), Ground source heat pumps – 95 (76%), Solar thermal panels – 107 (86%), Air source heat pump – 112 (90%).

Of the 128 respondents that answered Question 8 ‘Do you know anyone in your neighbourhood who has a low carbon heating system installed in their home?’, 64% of the respondents answered yes and 36% of the respondents answered no. A total of 81 respondents specified the type of low carbon heating system installed (Question 8a). Just less than three quarters of low carbon heating systems were ASHP (70%) followed by solar thermal panels (21%), ground source heat pumps (4%) and hybrid heat pumps (1%). Three respondents (4%) did not know the type of low carbon heating system.

Local neighbourhood responses

Figure 8 shows the 139 responses to Question 1 ‘On the whole, how much do you like living in your neighbourhood?’. Over half of the respondents (62%) strongly liked living in their neighbourhood. Just over a quarter of the respondents (27%) liked living in their neighbourhood. Thirteen respondents (9%) neither liked nor disliked living in their neighbourhood. A small percentage of respondents (1%) disliked living in their neighbourhood and 1% of respondents preferred not to say.

Figure 8 - How much respondents liked living in their neighbourhood



Question: On the whole, how much do you like living in your neighbourhood? Base: 139. Respondents per option: Don't know – 0 (0%), Strongly dislike – 0 (0%), Dislike – 1 (1%), Prefer not to say – 2 (1%), Neither like nor dislike – 13 (9%), Like – 37 (27%), Strongly like – 86 (62%).

Figure 9 shows a word cloud for the responses to Question 2 ‘Is there anything you particularly like about your neighbourhood?’. The larger and bolder the word is in Figure 9 the more

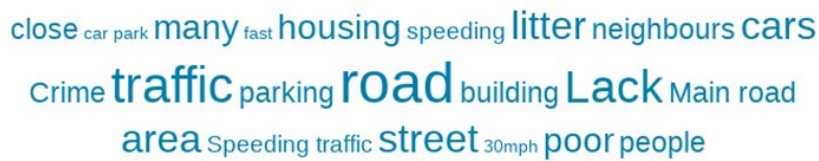
frequently it has been mentioned in response to Question 2. Of the 123 responses, 25 respondents mentioned quietness as one of the reasons they liked their neighbourhood. The key other reasons given included terms, such as ‘community’, ‘neighbours’ and ‘friendly’.

Figure 9 - What respondents particularly liked about their neighbourhood



Figure 10 provides a word cloud for Question 3 ‘Is there anything you particularly dislike about your neighbourhood?’. As shown in Figure 10 ‘traffic’ and ‘road’ featured heavily in the respondents’ answers to Question 3. Of the 122 respondents that answered Question 3, only two mentioned ‘noise’ as a reason why they disliked their neighbourhood.

Figure 10 - What respondents particularly disliked about their neighbourhood



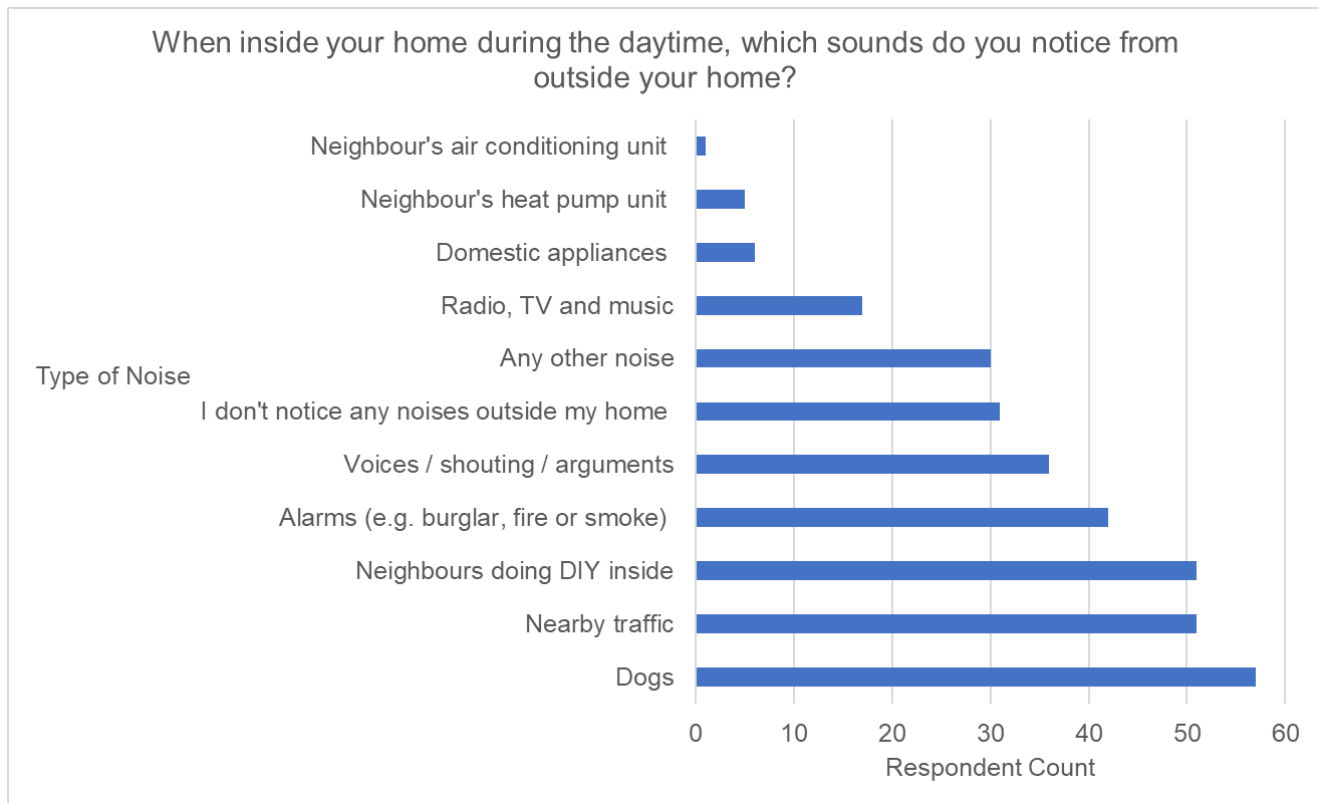
However, of the 57 respondents that answered Question 4 ‘Do you believe that any of these environmental factors in your neighbourhood have adversely affected your health and wellbeing?’, over half indicated that noise (60%) was a contributing factor, followed by air quality (37%), odour (16%) and lighting (14%). It should be noted that respondents could choose more than one answer to this question.

A total of 31 respondents answered Question 4a ‘Please can you tell us more about why your health and wellbeing has been affected by noise in your neighbourhood?’. Of the respondents that answered, 39% indicated that noise affects their sleep and 19% mentioned traffic as a concern. None of the respondents mentioned ASHPs.

Of the 32 respondents that answered Question 4b ‘Have you ever made the local council aware of issues with noise in your neighbourhood in the last three years’, most of the respondent (69%) had not made the council aware and 31% had.

Figure 11 shows the responses to Question 5 ‘When inside your home during the daytime, which sounds do you notice from outside your home?’. Of the 130 responses, most responses related to noise from dogs (44%) followed by nearby traffic (39%) and neighbours doing Do-It-Yourself (DIY) inside their property (39%). In total five respondents (4%) said they could hear their neighbour’s ASHP in their property during the daytime.

Figure 11 - Noise noticed by respondents from inside their property during the daytime

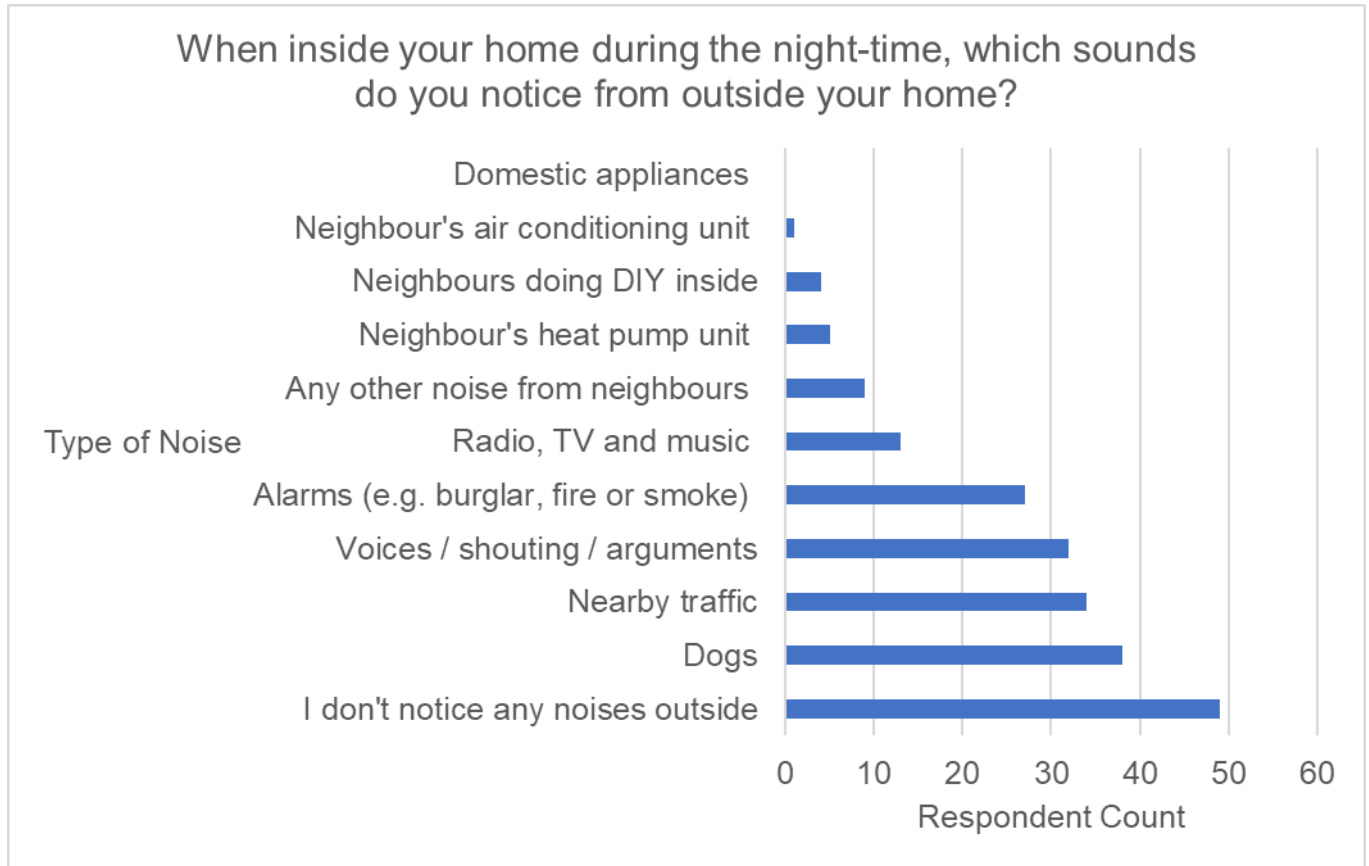


Question: When inside your home during the daytime, which sounds do you notice from outside your home? Base: 130. Number of respondents per option: Neighbour's air conditioning unit – 1 (1%), Neighbour's air source heat pump – 5 (4%), Domestic appliances – 6 (5%), Radio, TV and music – 17 (13%), Any other noise – 30 (23%), I don't notice any noises outside my home – 31 (24%), Voices / shouting / arguments – 36 (28%), Alarms – 42 (32%), Nearby traffic – 51 (39%), Neighbours doing DIY – 51 (39%), Dogs – 57 (44%).

Of the five respondents that answered Question 5a 'When inside your home during the daytime, how much does sound from nearby heat pump units disturb you?', one respondent answered very often, two respondents answered sometimes, and two respondents answered rarely.

Figure 12 presents the 129 responses to Question 6 'When inside your home during the night-time, which sounds do you hear from outside your home?'. Most of the respondents (38%) answered that they did not notice any noise from outside their home. A high number of respondents heard noise from dogs at night-time (29%), followed by nearby traffic (26%) and voices from outside their home (25%). Five respondents (4%) answered that they could heard noise from a neighbours' ASHP from inside their property at night-time.

Figure 12 - Noise noticed by respondents from inside their property during the night-time



Question: When inside your home during the night-time, which sounds do you notice from outside your home? Base: 129. Number of respondents per option: Domestic appliances – 0 (0%), Neighbour’s air conditioning unit – 1 (1%), Neighbours doing DIY – 4 (3%), Neighbour’s air source heat pump – 5 (4%), Any other noise – 9 (7%), Radio, TV and music – 13 (10%), Alarms – 27 (21%), Voices / shouting / arguments – 32 (25%), Nearby traffic – 34 (26%), Dogs – 38 (29%), I don’t notice any noises outside my home – 49 (38%).

Of the five respondents that answered Question 6a ‘When inside you home during the night-time, how much does sound from nearby heat pump units disturb you?’, one respondent answered very often, three answered sometimes and one answered rarely.

Strand 3 Multi-stakeholder research methodology

General

Where possible, interviewees were recruited through direct contacts and both emails and telephone calls were used to recruit. Introductory emails were sent to potential interviewees explaining the research and outlining the privacy policy and data protection protocols that would be followed throughout the research.

Interviews were carried out online with pre-defined questions. During the interview all interviewees were asked for their opinion on the impact of making PDRs stricter or less strict and shown in Figure 13.

Figure 13 – Prompt shown to interviewees when asked about changes to PDRs

Changes to planning regulations		
Factor	Impact to you if stricter	Impact to you if less strict
Size of ASHP		
Location of ASHP		
Noise level limit of ASHP		
Other		

Local planning authorities

The sample design, including primary selection criteria and characteristics and the target quotas for each is given in Table 3 with the aim of carrying out interviews with a total of 20 LPAs. The sampling was selected to provide an even spread across geographical areas, rural/urban areas, LPA type and number of installations. Those with the job role of Environmental Health Officer (EHO) or Planner were targeted to take part in the research. The quota achieved is also given in Table 3.

The interviews included pre-defined questions on the topics of noise regulations and planning rules, noise complaints, employee training and information to members of the public. A pre-interview questionnaire was also used to gather demographic data such as LPA type, number of EHOs and Planners, number of planning applications and number of complaints about ASHP noise.

Table 3 - Local authority sampling quota

LPA type (no. In England)	Geographical area and type	Quota target	Quota achieved
District Council (164)	North of England (U & R) Midlands (U & R) South of England (U & R)	1 LPA for each geographical area and type with 2-2-2 split of low, medium and high number of installations. Total 6	Urban and rural in midlands and south of England. Mixture of low, medium and high number of installations. Total 8
County Council (21)	North of England (U & R) Midlands (U & R) South of England (U & R)	1 LPA for each geographical area with 1-1-1 split of low, medium and high number of installations. Total 3	None (it became apparent ASHPs were dealt with by district councils or unitary authorities, and not county councils)
Unitary Authority (62 plus Isles of Scilly)	North of England (U & R) Midlands (U & R) South of England (U & R)	1 LPA for each geographical area and type with 2-2-2 split of low, medium and high number of installations. Total 6	Urban and rural in north, midlands and south of England. Mixture of low, medium and high number of installations. Total 6
London Borough (32 plus City of London)	London (U)	All urban and low number of installations. Total 2	Urban with low number of installation Total 3
Metropolitan Districts (36)	Nationwide (U)	All urban with 1-1-1 split for low and high number of installations Total 3	North of England with high or medium number of installations Total 2

Manufacturers

The sampling quota target is given in Table 4, with the aim of carrying out interviews with a total of ten manufacturers. The sampling has been selected to provide an even spread across manufacturers with high, mid, and low market share as well as new manufacturers to the UK market. Those with job roles such as technical manager/design manager/product development manager were targeted to participate in the research. The UK market share is based on the BSRIA Heat Pump Market Analysis 2022.

Table 4 - Manufacturer sampling quota

UK market share	Quota target	Quota achieved
> 15%	2	2
5-15%	3	3
1-5%	3	3
<1% or new to market	2	2

The interviews were carried out online and included set questions on the topics of testing ASHPs, design of ASHPs, noise regulations and planning rules, noise complaints, employee training, and information to consumers. Two questions were asked with the aid of a slide, as shown in Figure 14 and Figure 15.

Figure 14 – Prompt slide shown to interviewees when asked about ASHP design factors

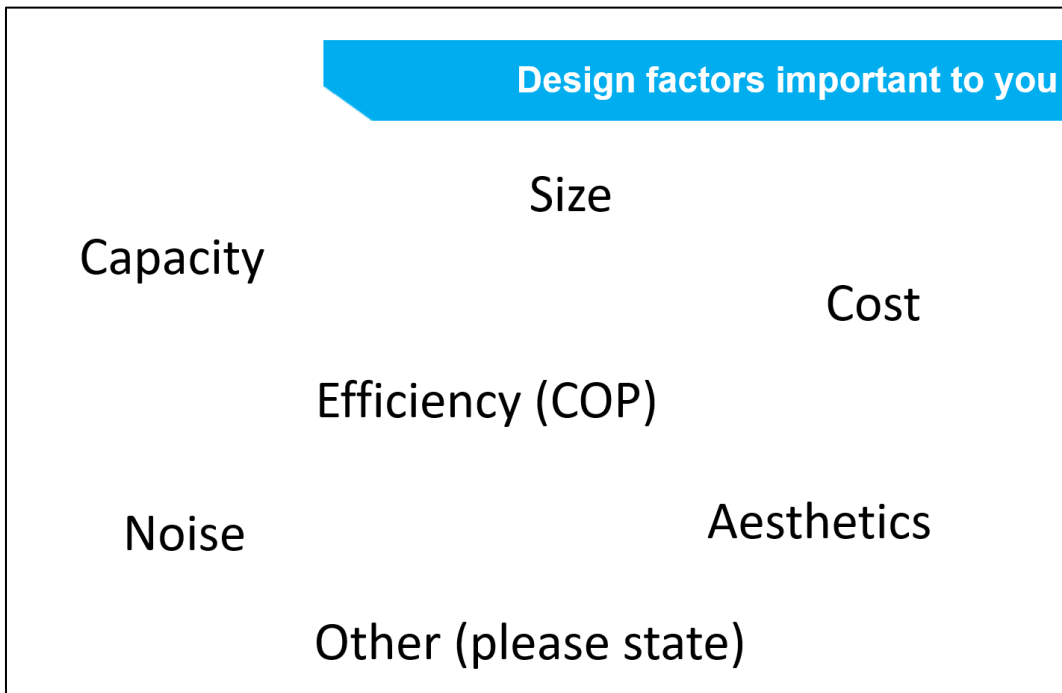
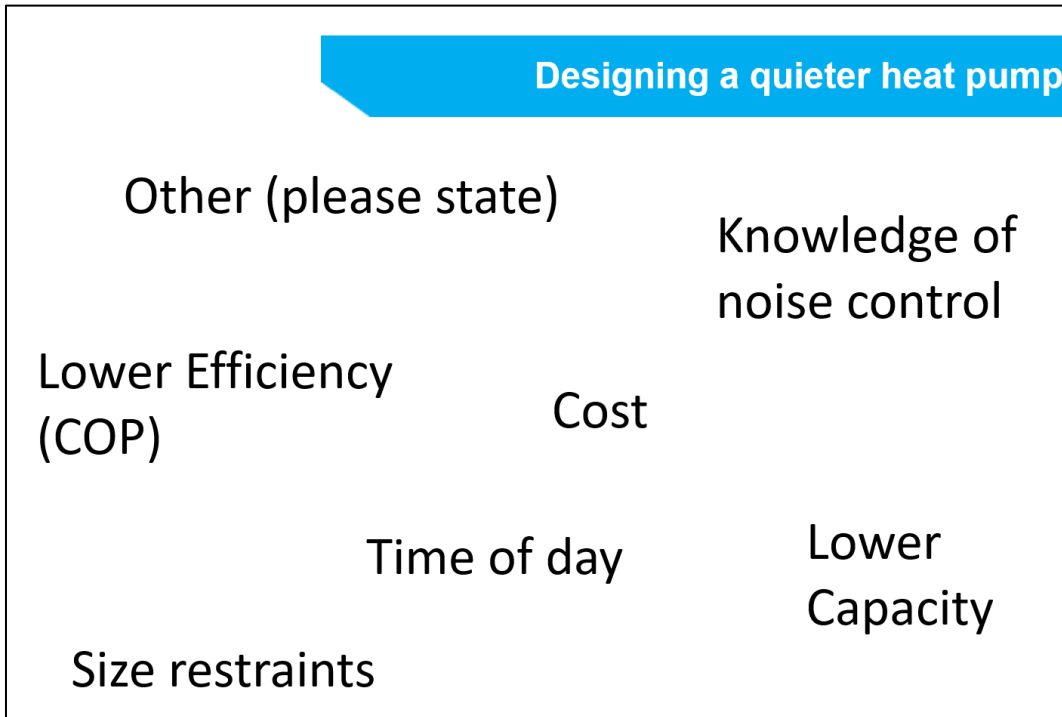


Figure 15 – Prompt slide shown to interviewees when asked about designing quieter ASHPs



A pre-interview questionnaire was also used to gather demographic data such as size of company, number of ASHPs sold, who purchases the ASHPs and noise complaints.

Industry bodies

Seven major industry bodies representing ASHPs and/or the acoustics profession were contacted to participate in the research. Each of the industry bodies chose the individual who participated in the research, and for some industry bodies the opinions were based on a collection of membership views.

The interviews were carried out online and included set questions on the topics of noise regulations and planning rules, noise complaints, employee training, and information to consumers. A pre-interview questionnaire was also used to gather demographic data, with some questions tailored to individual industry bodies.

Installers

MCS provided a database of installers with installation numbers by postcode area. An approximate breakdown of the number of installers and their respective numbers of installation is given in Table 5.

Table 5 - Number of installations⁷

Number of installers	Number of installations between March 2021- March 2023
600	1-10
400	11-50
130	50-100
70	100-200
40	200-500
4	500-800
8	800-1000
3	1000+

As shown in the table above about half of the MCS registered installers have installed fewer than ten heat pumps in the last two years. When the geographical data are analysed installers with up to 50 installations typically operate in a small geographical area. Those installers with 500 or more installations are nationwide. There is a mixture for those installing 50-500 ASHPs, with some spread across the country and some installing a lot of ASHPs in one area.

The sample quota target is given Table 6, with the aim of carrying out interviews with a total of 10-15 installers. Installers that are on site personally carrying out the work, as well as technical managers (or similar) for the largest installers, were targeted to participate in the research.

⁷ The numbers are subject to minor change due to installers raising certificates after the granted 14-day window.

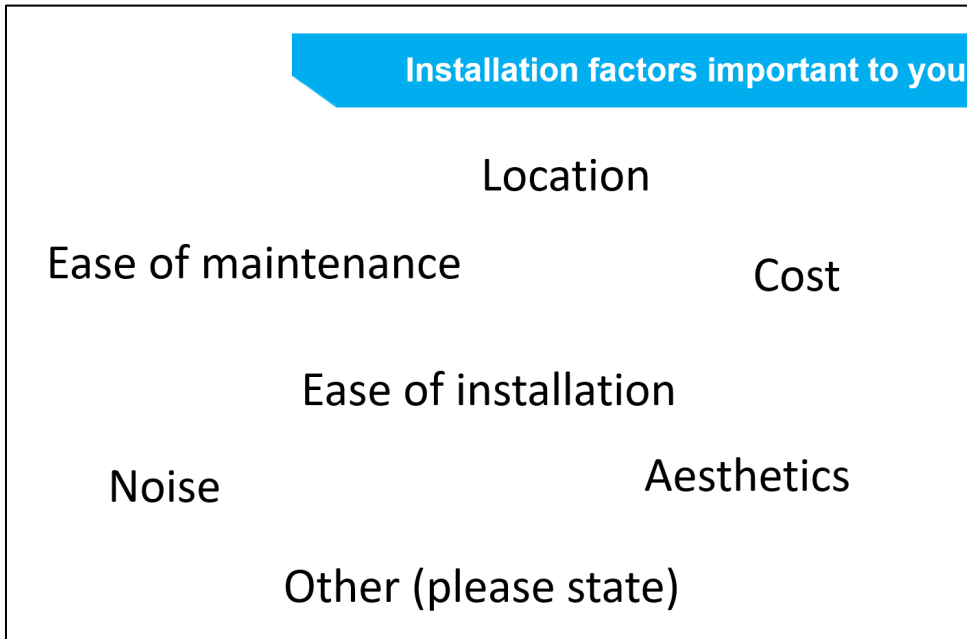
Table 6 - Installer sampling quota

Number of installations	Geographical area	Quota target	Quota achieved
1-10	North of England Midlands South of England	1 installer for each geographical area – total 3	1 installer in south of England Total 1
10-50	North of England Midlands South of England	1 installer for each geographical area – total 3	1 installer in south of England and 1 installer nationwide Total 2
50 - 500	Nationwide Large cluster in one area (urban) Large cluster in one area (rural)	1 installer for each geographical area – total 3	1 installer in north and midlands, 1 installer in south, and one installer nationwide – all working in mixture of urban and rural areas. Total 3
500-1000	Nationwide	3	2 installers nationwide Total 2
1000+	Nationwide	3	1 installer nationwide Total 1

The interviews were carried out online and included set questions on the topics of selecting ASHPs, installing ASHPs, noise regulations and planning rules, noise complaints, employee training, and information to consumers. A pre-interview questionnaire was also used to gather demographic data, such as number of installations, location of installations, and number of noise complaints.

One question was asked with the aid of a slide, as presented in Figure 16.

Figure 16 – Prompt Slide shown to interviewees when asked installation factors that are important to them



MCS installer certification bodies

Six MCS installer certification bodies were contacted to participate in the research, with the aim of carrying out four interviews with CBs. Each of the CBs chose the individual who participated in the research.

The interviews were carried out online and included set questions on the topics of noise regulations and planning rules, noise complaints, employee training, and information to consumers. A pre-interview questionnaire was also used to gather demographic data.

Opportunities for further research

Opportunities for further research have been identified. Future research could be considered in the following areas:

Sound power level

- Prepare consistent guidance for manufacturers to report data.
- Establish a definition of operating conditions for testing.
- Understand noise emission as a function of operating conditions.
- Understand acoustic character, diurnal and seasonal temporal characteristics, and directionality. Describe these factors to inform design, installation, and assessment.

Permitted noise level

- Understand tonality and background noise level in setting permitted noise levels.

Cumulative effects

- Investigate cumulative sound impact due to ASHP exposure.
- Consider cumulative effects according to their land use.

Perception of ASHP noise

- Promote a perception-driven engineering approach and Sound Quality in the design and manufacture of ASHPs.
- Conduct a comprehensive study investigating the perception of sound from ASHPs.
- Identify acoustic and non-acoustic factors influencing ASHP noise perception.

Proximal neighbours research

- Undertake more research in areas of higher density housing (including flats and terraced housing) as they may be more likely to be affected by ASHP noise (particularly from a cumulative noise perspective) due to the smaller distances between properties.
- Undertake face-to-face interviews with a large sample size (for example 2,000 interviewees) of residents in England that are within 50m of an ASHP installation. This is the approach adopted by Government in previous noise attitude studies.
- Undertake, if possible, the online survey and telephone interviews outside of an energy crisis when heating systems may be more freely used.
- Ask questions to understand how the operating mode of ASHPs affect proximal neighbours. This has been suggested because evidence from the database and the interviews suggests that certain ASHP cycles generate greater noise annoyance. Further research is needed to determine the difference in noise levels generated by different operating modes and whether these have greater impacts on residents.

This publication is available from: www.gov.uk/government/publications/air-source-heat-pump-noise-emissions-planning-guidance-and-regulations

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.