Department for Energy Security & Net Zero

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

Final Report

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We have republished this report to correct an error in the original version. The final figure in the first paragraph on p.15 covering PDR requirement and sound power levels has been corrected.

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Executive Summary

Project background

WSP was commissioned by the Department for Energy Security and Net Zero (DESNZ), to assess whether, and in what ways, current guidance and planning regulations are fit-for-purpose for the larger-scale deployment of Air Source Heat Pumps (ASHPs) in England. Under permitted development rights (PDR), an ASHP can be installed without the need for planning permission in England, as long as it meets certain criteria related to the sound emissions, size and location of the unit.

Methodology

A mixed methods research design was employed, with the project divided into three strands:

Strand 1 involved a literature review of the current planning standards and guidance, and current evidence base on consumer perceptions of ASHP sound emissions.

Strand 2 involved two components. The first involved a review of planning applications to understand the factors underlying complaints about ASHP noise. The second involved a survey and follow-up interviews with residents living near an ASHP, to understand their views and experiences of local environmental issues (including noise) and low carbon heating technologies. The survey utilised a push to web, self-completion approach and 139 responses were received. Follow-up interviews were conducted over the phone. All fieldwork took place in August 2023.

Strand 3 involved online interviews with Local Planning Authorities (LPAs), manufacturers, installers, and industry bodies to elicit their views on the current application of ASHP planning regulations, and potential changes required to facilitate larger-scale deployment of ASHPs. Interviews were conducted online and were completed between May and August 2023.

Key findings

1. Existing regulatory and design features of ASHPs serve to both enable and constrain the deployment of ASHPs in England.

Enabling factors include:

- Manufacturers have recognised the market value of low noise levels, and some have prioritised them as a selling point.
- Over the past decade, quieter ASHP units have emerged.

Constraining regulatory factors include:

- Currently the sound emission limit (42 dB limit) for neighbouring properties constrains ASHP deployment, particularly where there is a higher density of properties such as blocks of flats and terraced houses. Interviews with stakeholders, including local authorities and industry bodies, expressed reluctance to increase the sound limit given perceived risks of increasing noise complaints.
- Noise assessments may underestimate sound levels from ASHPs owing to a misalignment between sound power levels (SWLs) provided by manufacturers and those measured in-situ. Reasons for these discrepancies were attributed to the ASHP operating condition and the installation location.
- Findings from the literature review and stakeholder interviews suggest that the Microgeneration Certification Scheme (MCS) 020 assessment does not account for ASHPs being situated in places with different background sound levels. This could result in ASHP installations in areas with higher background sound levels being unnecessarily denied, or potentially areas with lower background sound levels experiencing adverse noise impacts, even though the installation complies with MCS 020.
- The MCS 020 assessment does not take account of the acoustic characteristics of an ASHP, particularly tonality, which can increase the adverse effect caused by the noise.
- Larger/ mass market installers said they may not choose to take on a project if they felt it would not meet the PDR requirements, as they did not want to go through lengthy planning applications.
- The literature review and stakeholder interviews highlighted that current PDR operates on a property-by-property basis, lacking mechanisms to address the cumulative impact of multiple ASHP installations within a localised area. This emerged as a concern amongst members of LPAs and industry bodies.
- LPAs expressed concerns that they would not have capacity to cope with the increase in ASHP planning applications and noise complaints that would arise under current PDR requirements, if ASHPs were deployed on a larger scale.

Constraining design-related factors include:

- LPAs, manufacturers and installers acknowledged that larger ASHP units are generally quieter because there is more space for sound insulation measures, and that current constraints on their size (size is currently restricted to 0.6 m^3 under PDR) may limit deployment in locations or property types that are unable to comply with current sound emission regulations. There was concern by LPAs that some may not want larger units because of the loss of their amenity space.
- Manufacturers raised concerns about the increased costs associated with incorporating noise control measures into ASHPs, both for themselves and for consumers.
- ASHPs have a development cycle spanning 3-5 years, making immediate or significant regulatory changes challenging to implement in ASHP design.

2. ASHP noise appears to be a concern for a minority of consumers

- Findings from the strand two survey with proximal neighbours suggest that sound emissions from heat pumps were not reported as noticeable by most participants in the areas of focus for the research.
- A small number of survey respondents said they could hear their neighbour's ASHP from inside their property. Of these, some reported they could hear the ASHP regularly, with others hearing the ASHP either sometimes or rarely. These results apply to both daytime and night-time.
- Interview participants described noise from a neighbour's ASHPs as a low hum and 'rumbling noise'. The two interviewees expressed concern due to the potential for cumulative noise impacts arising from multiple installations, citing noise as one of the considerations for not installing ASHPs in their own property.
- The literature review found that in some surveys a majority of consumers expressed satisfaction with ASHP sound levels.

3. The research found low incidence of ASHP noise complaints. These arose due to poor quality installations, including location and proximity factors

- The available evidence suggests that ASHP noise complaints appear to be relatively infrequent in relation to the total number of ASHP installations in the UK, where industry estimate there were around 71,000 sales in 2022.
- Location and proximity of ASHP units to neighbouring properties emerged as a key cause of noise complaints. According to installers and LPAs, complaints usually centred around disturbed sleep and installers reported they were typically resolved through moving or replacing the ASHP.
- Poor installation quality arose as a factor underlying noise complaints. Simple modifications like rubber matting or acoustic enclosures were found to reduce noise impacts, highlighting the importance of proper installation.

4. Possible revisions to permitted development guidance and regulations

Based on the findings of this research, possible updates to permitted development rights guidance and regulations are provided. Potential revisions include:

- Allow the physical volume of the outdoor compressor unit to increase.
- Provide clear guidance on best practice installation, including orientation, specific location and minimising reflecting surfaces rather than relying on a specific distance from the boundary.
- Consider removing the requirement that all parts of the ASHP must be at least one metre from the property boundary.
- Provide clear guidance on what operating load and environmental test condition(s) of the sound power level should be used in the assessment.
- Clearly define what is meant by a 'solid barrier'.

- Include an assessment methodology that takes account of noise from ASHPs installed at multiple properties in a neighbourhood.
- Include a tonality correction in the noise impact assessment for the acoustic character of the ASHP.

Research limitations

It is important to note several unavoidable limitations relating to the methodologies employed in this study:

- The sample size for the strand 2 online survey was lower than anticipated and is not representative of ASHP owners nor of households in close proximity to an ASHP. The online survey findings are therefore indicative, rather than representative.
- The majority of online survey respondents lived in detached and semi-detached housing. Subsequently, the findings are less indicative of the perceived ASHP sound emissions of higher density property types (i.e. those living in flats and terraced houses).
- Installers interviewed were those willing to participate in the research and therefore less compliant installers (who were mentioned by other stakeholders) may have been less likely to participate. This limited the range of responses across installers.
- Due to lower response rates by installers it was not possible to achieve the quota targets set out during the research design stage and this limited the range of responses across installers.
- Available data does not allow for an accurate determination of the nationwide frequency of ASHP noise complaints.
- Only two people were interviewed for the in-depth telephone interviews for strand 2 (Objective 2). This means that only a small snapshot of opinions of ASHP noise has been analysed and this data is not representative of the population as a whole. The interviews do provide some useful insights although they are limited in range and diversity.

Introduction

WSP was commissioned by the Department for Energy Security and Net Zero (DESNZ) to undertake a mixed method study to provide insight into whether, and in what ways, current guidance and regulations are fit-for-purpose for the larger-scale deployment of Air Source Heat Pumps (ASHPs). The research was conducted by a consortium of technical contributors including BSRIA, University of Salford, WSP and Stephen Turner Acoustics.

The project was designed to support the UK Government's aim of growing the heat pump market to 600,000[1] installations per year by 2028. ASHPs are a key technology for achieving net zero emissions from domestic heating and helping to build the UK's energy resilience and security.

The specific aims of this research project were to:

- Determine whether current ASHP sound emissions guidance and planning standards (the current assessment process required under permitted development rights (PDR)) are working effectively to support the larger-scale deployment of ASHPs across different housing archetypes and in different environments in England.
- Better understand the perceptions, experiences, and impacts of sound emissions and related planning regulations for ASHPs from a multi-stakeholder perspective, including consumers, local planning authorities (LPAs), heat pump manufacturers, industry bodies and installers.

The research was formed of three strands:

- Strand 1 involved a literature review of the current UK and European standards and guidance relating to noise from ASHPs, including consumer perceptions of noise from ASHPs.
- Strand 2 involved i) a review of public documents to understand the factors contributing to noise complaints and ii) an online survey and in-depth telephone interviews to establish the perceptions of households in England to ASHP installations. Letters were sent to 3,050 residents living near an ASHP installation in 12 LPA areas where there is a relatively high proportion of ASHP installations. A total of 139 respondents completed the online survey in all LPAs targeted. Two in-depth follow-up interviews were conducted.
- Strand 3 involved interviews to gather views of multiple stakeholders, including LPAs, manufacturers, installers, industry bodies and certification bodies, towards guidance for ASHPs. Interviews were undertaken with 20 LPAs, ten manufacturers, six industry bodies, nine installers and four Microgeneration Certification Scheme (MCS) installer certification bodies.

[1] energy-security-bill-factsheet-low-carbon-heat-scheme

Further details on the methods described above can be found in the Technical Annex accompanying this report.

The structure of this report includes the aims and findings for each of the strands of this research.

Strand 1 - Literature review

Research aims

The purpose of the literature review was to establish existing evidence on:

- ASHP sound emissions standards and guidance.
- Information and documentation on ASHP sound emissions guidance from industry bodies and ASHP manufacturers.
- Evidence on consumer perceptions of sound emissions from ASHPs and related planning regulations.

Strand 1 findings

Industry standards on measuring ASHP sound emissions

Sound assessment standards

The European Union's (EU) EcoDesign Requirements for Energy-Related Products regulation (which was retained under UK law following the UK's exit from the European Union[2]) requires all ASHP manufacturers to present sound power levels (SWLs)[3] of their products for energy labelling purposes (presented in Section 3 in the IEA Heat Pumping Technologies Annex 51 "Regulations – Countries Overview" [1], where requirements on Energy Labelling are overviewed in the context of European Regulation). Furthermore, within the UK, ASHP sound power levels are required for the noise assessment which is part of the Microgeneration Certification Scheme, Microgeneration Installation Standard (MCS 020) [2]. This must be followed when installing ASHPs under permitted development rights[4]. To obtain these values of SWL, the prescribed test involves operating the ASHP under fixed conditions while acoustic measurements are taken.

The following standards outline the ASHP installation and operating conditions required for UK energy labelling and MCS 020 compliance:

- BS ISO 12102 (Air conditioners, liquid chilling packages, heat pumps, process chillers and dehumidifiers with electrically driven compressors - Determination of the sound power level): This provides installation and test procedure guidance [4].

[2] HMG, The Ecodesign for Energy-Related Products and Energy Information (Amendment) (EU Exit) Regulations 2020

[3] Sound power describes the sound pressure level at the surface of a source and hence is an intrinsic property.

[4] Permitted development rights circumvent the requirement of local planning approval. Homeowners can make limited forms of development in agreement with the national policy outlined in The Town and Country Planning (General Permitted Development) Order 1995

- BS EN 14511: This specifies the standard rating conditions (temperatures, humidity, air/water flow rate, among others) which are designed to provide operating conditions representative of an average climate [5].
- BS EN 14825: Within this document, condition C outlines the heating capacity requirements for the certification of EcoDesign and Energy labelling as stated by the Commission Regulation (EU) No 811/2013 and Commission Regulation (EU) No 813/2013. The required temperature conditions match that of the standard rating condition [6].

For use in MCS 020, SWLs should be measured at 100% load, following the standard rating condition in BS EN14511 [5]. However, interviews with manufacturers undertaken as part of the research project commissioned by the Welsh Government on ASHPs [3] reveal concerns that some manufacturers may wrongly "provide the energy rated product (0, 0, 0) label performance[5], which may be 3 dB or 6 dB lower, for example, because this is the only sound test point that must be published." [3, page 31].

Work as part of the International Energy Agency's (IEA) Heat Pumping Technologies Annex 51 [7] also provides evidence that Energy Related Products (ErP) SWLs are approximately 6 dB lower than average seasonal sound power levels.

In addition, research presented in a paper on Acoustic Noise Measurements of ASHPs [8] provides evidence of a misalignment between SWLs provided by manufacturers and those measured in-situ. The research notes that results from ten, week-long case studies conducted at various ASHP installations throughout the UK revealed that in-situ acoustic emissions were on average 4 dB higher than those presented on manufacturers' datasheets. The greatest difference revealed an 8 dB increase when measured in-situ. Reasons for these discrepancies were attributed to the ASHP operating condition[6] differing from ErP measured conditions and the installation location.

Manufacturers' datasheets

As identified in the Strand 3 findings of this report, noise is a key consideration for manufacturers when considering their research and development budgets. When considering manufacturer's datasheets for units registered with the MCS Product Directory, quieter units have become available in the last decade. As an example of this trend to quieter models, the sound power data presented by Mitsubishi for model PUHZ-W85VAA(-BS) certified in 2018 is 8 dB lower than that of Model PUHZ-W85VHA2(-BS), certified in 2009.

[5] ErP labelling only requires 38% load [3].
[6] The rotation speed of the fan and compressor directly affect the emitted SWL, hence the dependence on operating conditions.

ASHP planning regulations

PDR requirements and cumulative sound levels

To be permissible under PDR, an ASHP must be installed in compliance with MCS 020 which requires SPL to not exceed 37 dB(A) when measured at a point one metre away from the immediately adjacent neighbour's nearest door or window[7]. Under the current system the immediately adjacent neighbour on one side of a property could install an ASHP generating 37 dB(A) one metre away from the immediately adjacent neighbour's nearest door or window, while the immediately adjacent neighbour on the other side could do likewise. The resulting level at the property in the middle would be 40 dB(A), which added to the nominal background sound level of 40 dB(A) will result in 43 dB(A).[8]

Existing PDR operates on a property-by-property basis. Consequently, there is no mechanism to manage the impact from multiple households installing ASHPs within a localised area. The current arrangements, therefore, do not preclude the possibility of ASHPs causing a greater impact than described in MCS 020.

The Institute of Acoustics (IoA) and the Chartered Institute of Environmental Health (CIEH) [10] published in 2022 the Heat Pumps Professional Advice Note. This note pointed out that widespread deployment of noise sources within a localised area, without consideration of the cumulative impact, has the potential to cause an increase in sound levels and cause adverse effects on those living in that area.

Other countries have taken a different approach to the UK with regards the consideration of the cumulative impact of multiple noise sources within a localised area. As an example of regulation in Europe, an Austrian noise regulation (ÖAL Guideline No.3) has a precautionary principle to prevent increasing background sound levels, as presented in Regulations – Countries Overview in the IEA's Heat Pumping Technologies Annex 51 [1]. If there is potential for multiple noise sources to be installed within the local area in the future, sites are subdivided into smaller sections, each with lower permitted levels. This approach allows multiple installations to occur without the overall sound level values exceeding the required levels.

In addition to Austria, the review of evidence suggests that only one other European country is considering such a precautionary principle for multiple noise sources. In Switzerland, the Federal Supreme Court Decision 1C_506_2008 ruled in an objection against the construction permit of a single family building with a heat pump that "the requirement of the compliance of the planned values and the precautionary principle are count cumulative". This implies that the building permit authority must make sure not only that the planned sound levels are not exceeded, but also that the precautionary principle is fulfilled at its best.

Acoustic character

It is recognised in BS 4142:2014+A1:2019 'Methods for rating and assessing industrial and commercial sound' (BS4142) [11] that sounds that exhibit tonal characteristics can be relatively

[7] The permitted development sound limit in MCS 020 is 42 dB(A) and this includes a nominal background sound level of 40 dB(A). Therefore, the effective sound emission limit for ASHP is 37 dB(A).

[8] The addition of two incoherent noise sources (with the same sound level) results in a doubling of sound energy. This equates to a +3dB level increase.

more annoying compared with sounds at the same level without such characteristics. The MCS 020 assessment procedure does not include any method for considering the effect of any such tones.[9] LPAs who took part in the ASHP research project commissioned by the Welsh Government [3] suggested including tonality corrections in any amendments to the MCS 020 calculation procedure.

In the UK, in general, an assessment of industrial sounds requires a consideration of the acoustic character of the sounds as well as the overall level, as stated in BS 4142 [11]. If ASHPs were being installed under the general planning system rather than PDR, the assessment would take account of acoustic character including tonality. The penalty for tonality is 2 dB, 4 dB or 6 dB depending on the prominence of the tone. BS 4142 [11] provides both a subjective and objective method for identifying dominant tones based on one-third octave noise data. This can be laboratory data, as would be produced when ASHPs are tested by manufacturers, or levels measured in-situ.

Most regulations throughout other European countries also include penalties to permitted sound levels following an assessment of tones. Based on Regulations – Countries Overview in the IEA's Heat Pumping Technologies Annex 51 [1], there are tonal penalties in German regulation which are based on the discretion of an expert, with permitted levels reduced by either 0, 3dB or 6 dB depending on the severity of the tones. Permitted levels throughout Sweden and Finland are also reduced by 5 dB following an assessment of tones. Since April 2021, the Dutch Building Code has new requirements for the maximum sound levels at a property boundary, as a result of the operation of installations used for heating and cooling of indoor spaces. These new requirements include a corrective for tonality of +5 dB to be added to the measured sound levels, if there is an audible tone, as presented in Page 108 of the Regulations – Countries Overview in the IEA's Heat Pumping Technologies Annex 51 [1].

Care should be taken in the interpretation of these different regulations across Europe and their comparison with UK regulation. For the specific case of The Netherlands, the Building Code applies to all the heat pumps for dwellings installed after 1st April 2021. The Building Code applies to installations in or around newly built homes as well as for heat pumps installed at existing dwellings. According to the Dutch Building Code, there is no need for permitted development rights (i.e., there is no need to apply for planning permission) to install an ASHP, but the municipality may impose additional requirements, like for instance to demonstrate that the noise requirements are met.

[9] Tones are prominent frequencies that can be heard as distinct 'hums' or 'whistles'.

Background sound levels and permissible sound levels

If ASHPs were being installed under the general planning system rather than PDR, the assessment would also consider the actual existing background sound level of the installation. To account for variations in existing sound level, most European comparators, rather than performing measurements of background sound level on site, have differing permissible sound levels to address anticipated differences in existing sound level throughout various areas of the country[10]. Such considerations facilitate stricter protection of amenity/residential areas than industrial areas.

The strictest permissible sound levels in residential areas throughout Europe are shown in Table 1, sourced from the IEA's Heat Pumping Technologies Annex 51 [1]. Some European comparators have different levels for night and day, hence 'strictest' refers to the lowest permissible sound level, this is typically enforced throughout the night in residential areas. The permissible levels shown in in Table 1, consider overall sound levels and corrections for tonality.

Table 1 Strictest permissible sound levels across Europe (night period)

Country	Permissible Sound Level dB(A)
France	30
United Kingdom	42 (37 dB(A) for ASHP plus a nominal background sound level of 40 dB(A))
Austria	35
Italy	40
Spain	25
Germany	35
Poland	30
Denmark	35
Sweden	30
Finland	30
Norway	28

The impact of noise from the ASHP, when planning consent is needed, is assessed by considering the acoustic character of the sound, as well as the extent to which the background sound level is exceeded, following guidance in BS 4142 [11].

[10] In Italy, these areas can include for example: industrial areas, amenity areas, residential areas (rural or urban), schools, agricultural areas and commercial areas (i.e., shopping centres).

This approach contrasts with the methodology set out in MCS 020 [2] which assumes a fixed value of 40 dB(A) as a measure of the existing sound environment regardless of location. Consequently, an ASHP installed under PDR in areas with higher existing sound noise levels may be unduly denied by the current process. Conversely, those located in areas with low existing sound levels may cause an adverse impact, even though complying with the MCS 020 requirements. This was raised as a concern by LPAs in the Phase 1 Report for the ASHP research commissioned by the Welsh Government [3].

Consumer perceptions of sound emissions from ASHPs

Although the literature review was confined to documents published in the last five years, an exception was made to consumer perception evidence in order to increase the evidence available to review.

One of the main conclusions of this review is that there is a lack of comprehensive studies investigating communities' perceptions of sound emissions from ASHPs. When interpreting the results of the four surveys synthesised throughout this section, it is important to acknowledge that the underlying objectives, survey designs and data analysis methods differed. A nuanced understanding of these differences is essential to contextualise and accurately interpret the observed comparisons.

The sampling methods for each of the studies was usually not described in detail nor properly justified. The results of the studies below should be treated as indicative due to small sample sizes. Formal comparisons between results is also challenging as these studies employed different methodologies, had different aims and were conducted at different timepoints.

Owner perception - Energy Saving Trust survey (2010)

In 2010, the Open University conducted a nationwide survey as part of the large-scale heat pump field trial conducted by the Energy Saving Trust (EST) [13]. The trial aimed to gather user feedback on the experience of using heat pump systems (both ground-source and air-source) for domestic heating and hot water and link this to onsite technical monitoring data acquired by three energy providers. Groups of private and social housing residents participated in the trials. A total of 89 users of heat pump systems took part in a survey.

Out of the 89 users approached, a total of 78 completed the questionnaire (with 6 of these households excluded from the final monitored samples). The questionnaire sought to gather data relating to household demographics, consumer experience and user characteristics that may affect heat pump performance (e.g. understanding the controls).

Regarding ASHP noise, results suggested that most were satisfied with the level of noise from their heat pump with 26% of users reporting intrusive noise to be a problem. Intrusive noise from both ASHPs and GSHPs[11] was more of an issue in social housing (30%) than in private

[11] According to the IEA's Heat Pumping Technologies Annex 51 [1], GSHPs can be source of structure-borne noise transmitted to properties. The magnitude of the structure-borne noise transmitted to properties depends on operating conditions and installation. Annex 51 concludes that there is a need for research into the adverse human impacts of ground source heat pump noise, such as the impact on sleep, mental health, and children's development.

housing (9%). Noise issues among social residents were associated with fans being located near windows, or units located on the walls of bedrooms and/or living rooms.

The 89 heat pump users that took part in the study is not representative of the UK population, in terms of geographical and demographic diversity. Therefore, these findings should not be widely generalised without the appropriate context of the study. It is also important to note that heat pump technology has improved since the original study was conducted over a decade ago, with quieter models emerging on the market.

Owner perception - Orkney Housing Association Limited survey (2016)

Orkney Housing Association Limited (OHAL) conducted a two-phase survey [14] of 282 heat pump owners from 2014 to 2016. Following responses from 2014, a “jargon-free” guide was developed. This was sent to participants in January 2016, prior to the second phase of surveying in February 2016. The primary objective was to understand the reasons behind owners’ dissatisfaction and determine if the guide could effectively address issues concerning views about heat pump performance.

Of those who read the guide, corresponding to 84% of the total sample, 22% indicated it was very helpful and 50% said it was fairly helpful. After receiving the guide, 30% of respondents made changes to their heat pump usage. Noise perception is usually influenced by non-acoustic factors[12], therefore relevant information such as key noise features, quiet modes available, among other factors provided in customers’ guides, has the potential to alleviate complaints due to noise emissions.

The study also found that participants (i.e. heat pump owners interviewed by OHAL) were satisfied with their heat pump installation. Regarding responses on noise gathered in 2016, 43% of respondents felt the heat pumps were too noisy.

The study is a good example of findings in a remote area. On this basis, it should be noted that the sample size is small (n=282) and associated to a remote area of the UK, which is assumed to have relatively low background noise levels compared with the rest of the UK.

[12] According to ISO TC/43/SC1/WG62, non-acoustic factors can be defined as ‘All factors other than the objective, measured or modelled acoustic parameters which influence the process of perceiving, experiencing and/or understanding an acoustic environment in context, without being part of the causal chain of this process’.

Owner perception - Renewable Heat Incentive (RHI) evaluation (2017)

In 2017, the UK Government's Department of Energy & Climate Change (DECC) contacted all successful owner-occupier applicants of the RHI to participate in an evaluation of the programme [15]. Applicants were requested to participate in an online survey, where the aim was to "understand the administration, delivery and performance of the RHI and explore its effects on the renewable heat supply chain" [15].

Participants were asked a variety of questions relating to topics associated with their renewable heating installation. This survey included questions related to the triggers for investing in renewable technologies, approach to installation, experience of installation (including difficulties) and overall satisfaction with the choice of renewable heating.

A total of 1,759 AHSP users took part in the survey. Results revealed that a total of 78% of respondents were either fairly satisfied or very satisfied with the ASHP noise level, with only 8% dissatisfied.

Owner perception - NESTA survey (2023)

A study conducted in 2023 by NESTA [16], with a total of 2,792 responses, revealed 85% of owners were either fairly or very satisfied with ASHP noise levels, approximately 10% were not very satisfied and approximately 4% were not at all satisfied with the noise level. This result suggests similar perceptions of ASHP noise satisfaction compared to results obtained from the Renewable Heat Incentive (RHI) evaluation [15].

Data gathered in this survey from individuals who relocated to homes equipped with heat pumps indicate that *perceived* ASHP noise is a concern. Nearly a quarter (23%) of the respondents expressed apprehension about moving into the property due to potential noise disturbance.

Owner perception - common themes

Though the four studies reviewed are not directly comparable, common themes can be identified:

Most consumers were satisfied with noise levels from ASHPs. Better education for consumers on ASHPs may be beneficial for a better understanding of the key features of ASHPs and to avoid potential complaints due to noise. As noted in the Orkney study consumers found the "jargon-free" guide that was provided to them useful, and some made changes to the operation of their ASHP as a result. The benefit of education was also identified in the Strand 3 findings of this report. Manufacturers identified that some send newsletters to consumers with advice on maintaining the ASHP (e.g. clearing leaves out before winter). These measures were seen by manufacturers to aid the long-term performance of the ASHP and minimise noise issues.

- The NESTA survey identified that there is some apprehension from people about moving to properties that already had an ASHP installed due to potential noise disturbance. This could suggest that better education on ASHP noise and operation would be beneficial to minimise apprehension.

Manufacturer observations – Welsh Government Study (2023)

As part of the study commissioned by the Welsh Government [3], six ASHP manufacturers were contacted and interviewed. The goal of these interviews was to gather views from the top manufacturers (according to the MCS installation database) regarding noise issues associated with ASHPs. Based on responses from the manufacturers interviewed, one of the six participating manufacturers had experienced noise complaints from customers.

Manufacturers said they were actively working to reduce noise emissions; however, they commented that reduced noise often comes at a trade-off with size. Somewhat counter-intuitively, it is easier to reduce the noise from a larger ASHP than a smaller unit. This echoed environmental health officers' sentiment from the same study that increasing the permitted size would help reduce noise emissions.

Manufacturers also commented that changes to the energy labelling requirements from 2019 had enabled sound power levels to be published at partial loads, which produce lower sound power levels, compared with other operational modes. This requirement also makes the comparison between units more challenging. Manufacturers suggested a standardised sound power test condition should be used, removing ambiguity surrounding test requirements.

Manufacturers highlighted the need for a straightforward but robust calculation process in the MCS 020 standard to avoid misunderstandings[13].

Energy supplier observations – Welsh Government Study (2023)

Energy providers interviewed in the study commissioned by the Welsh Government [3] questioned the necessity of a minimum distance requirement if noise impacts on neighbouring residents can be proven acceptable. One provider stated that this constraint often forces units to be in the middle of gardens, making some sites unsuitable. Another commented that “this is currently the major reason for rejecting the installation of an ASHP at a property" [3]. While this constraint is less restrictive under English regulation (only 1 m instead of 3 m required in Wales), it still highlights a barrier to deployment which seems unsupported by energy suppliers and local planning authorities.

Providers also questioned the limitation of ASHP unit size, suggesting that larger units can be quieter, again echoing points raised by manufacturers and environmental health officials.

Of the energy providers interviewed as part of the study, some mentioned that the complete planning application process is too costly and time-consuming for customers, discouraging ASHP installations that require planning permission. As a result, one of these providers only installs ASHPs through PDR, as this provides more certainty of an eventual sale.

[13] Full details about the discussions with manufacturers and key findings can be found in Appendix 3 of the study commissioned by the Welsh Government, Phase 1 [3].

Strand 2 – Household Research

Research aims

The household research had two objectives which are shown in Table 2, along with the research methods used to investigate each. The Technical Annex, accompanying this report, sets out the full research methodology for each objective:

Table 2 Strand 2 Research Objectives and Research Methods

Objective	Research Method(s)
Objective 1: To understand the factors that contribute to ASHP noise complaints	A desk-based review of a number of publicly available and industry-specific sources was used to create a database of factors contributing to noise complaints.
Objective 2: To understand the perceptions of households towards local environmental issues and low carbon heating technologies	Proximal neighbours in areas of high density installations (as defined in the MCS Database[14]) were invited to complete an online survey. Follow-up telephone interviews were held with respondents that could hear noise generated from nearby ASHPs within their property.

Limitations

It should be noted that there are limitations associated with the research methodology employed in this study:

- The response rate for the online survey was lower than anticipated. In addition, the findings cannot be generalised to the English population living in proximity to ASHPs, given that the MCS sampling frame is not representative of ASHP owners nor proximal neighbours. Therefore, the online survey findings are indicative rather than representative.
- It was a challenge to obtain address data for new build properties and, therefore, information from these properties was limited. It would have been useful to have gained an understanding of the perceptions of residents in new build developments, towards ASHP noise levels, and the cumulative noise impacts of multiple ASHPs amongst this

[14] Microgeneration Certification Scheme (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 installations database was accessed 7th September 2023.

property type. A majority of survey respondents lived in detached and semi-detached housing, where ASHP noise may be less noticeable than in higher-density property types. Subsequently, the survey findings are less indicative of perceived noise levels amongst these household types.

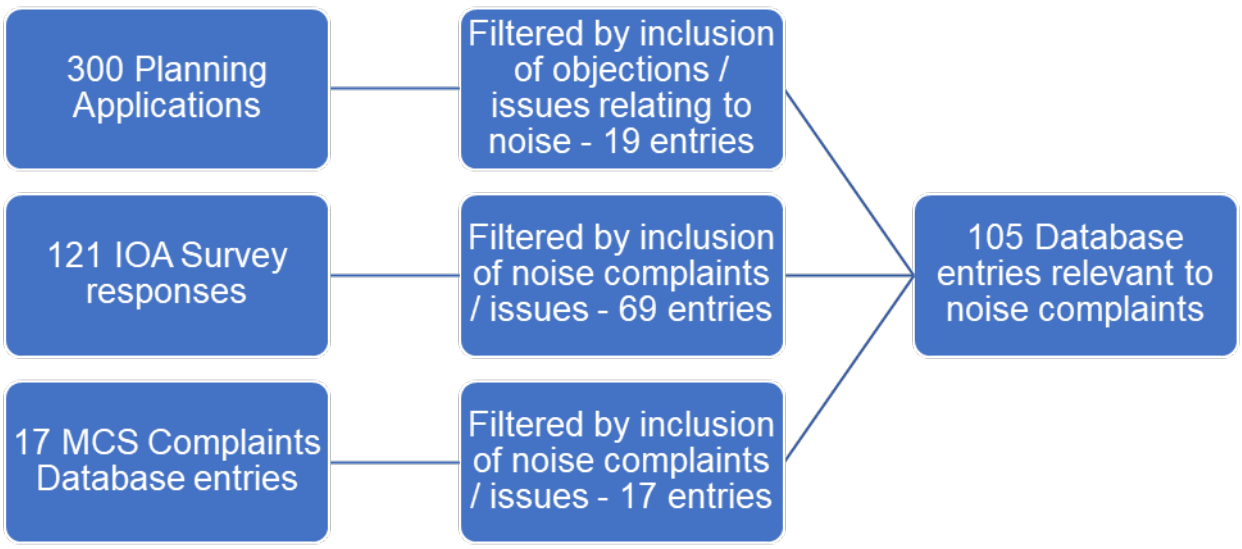
- Only two people were interviewed for the in-depth telephone interviews for Objective 2. This means that only a small snapshot of opinions of ASHP noise has been analysed and it is not representative of the population as a whole. The interviews do provide some useful insights although they are limited in range and diversity.

Strand 2 findings

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

As part of this objective, planning applications in urban and rural areas including ASHPs were reviewed. These were a mixture of single dwellings, where the ASHP installation was proposed as part of an extension or similar works, and larger schemes where ASHPs were proposed on multiple dwellings, as well as commercial developments such as leisure centres and libraries. The filtering of the Objective 1 database showed that of the initial 300 planning applications, 281 ASHP planning applications did not receive any objections in relation to noise and only one was refused because of a lack of information relating to ASHP noise attenuation. The total number of planning applications included in the final database that referred to noise-related objections was 19. Some of these included multiple comments, however each planning application has been treated as one entry. Alongside 69 responses from the IOA Survey (2022-2023) and 17 entries from the MCS Noise Complaints database, there were 105 database entries, as presented in Figure 1. Further detail on the process of creating the research database can be found in the Technical Annex.

Figure 1 Flow diagram of the process of creating the research database



The final 105 database entries that related to noise complaints or objections also showed that, while noise complaints were infrequent, noise generated from ASHPs was sometimes loud enough to impact people in a variety of ways, from being a noticeable noise in the soundscape to affecting sleep patterns.

The review found that there were three main factors which contributed to noise complaints. These were (1) the 'Nature of the ASHP Noise Heard', (2) the 'Cause of the ASHP Noise' and (3) the 'Procedural Influences'. These factors are interlinked and often act in synergistic ways. An overview of the key findings for each of these factors is provided below.

Nature of the ASHP noise heard

Although very few of the database entries referred to the specific nature of the noise from ASHPs, it was mentioned as a contributing factor in some of the responses. In some instances, the tonal nature of the noise was identified (IOA Survey, 2022-2023), or direct comparisons to other well-recognised sources of noise were made, for example referring to the noise as being similar in nature to the sound a fridge makes (IOA Survey, 2022-23).

Many of the concerns, especially those made as objections to planning applications, simply stated that noise was an issue and did not provide any additional information. Within the planning applications many of the comments and objections did not give specific noise concerns, simply stating that ASHPs are 'noisy'. It should be noted that these comments are made at a planning stage before proposed units are installed. Cumulative noise impacts were also raised, particularly in developments where a number of ASHPs were installed at once (IOA Survey 2022-2023). Some of those who responded to the IOA Survey raised concerns that the number of ASHPs installed through PDR could lead to a lack of understanding on noise impacts to neighbouring properties.

Although not mentioned often, some members of the public also described being able to sense the vibrations of nearby ASHPs in rooms in their property (IOA Survey, 2022-2023).

Cause of the ASHP noise

It is clear from the analysis of the Objective 1 database that many of the causes of ASHP noise complaints relate to the location of the ASHP or the proximity of the ASHP to neighbouring properties. In other words, the neighbours are affected by the noise, but attributed the complaint to the location of the ASHP. Where there were objections to planning applications, the location of the ASHP was frequently cited as the main reason for the objection, particularly amongst the public. One professional highlighted how they had noticed that often homeowners installing an ASHP located the outdoor unit away from areas which would inconvenience them, however, this could lead to worse impacts for the neighbour, as it may be closer to their property boundary (IOA Survey, 2022-2023). In addition, some database entries noted that the fan of the ASHP faced the property of the neighbour, rather than the garden of the property with the ASHP, which increased the noise level for the neighbour (IOA Survey, 2022-2023; Rural Planning Application).

Issues in relation to installation were also highlighted, alongside technical faults from the manufacturer. With regard to installation, it was raised by multiple industry professionals in the IOA Survey (2022-2023) that simple amendments, such as rubber matting or installation of an

acoustic enclosure, helped to reduce noise impacts of ASHPs. Additionally, many of the database entries showed that ASHPs produced the most disturbance at night. It was clear from the database entries that this can be exacerbated by the operating mode of the ASHP (e.g. when it is heating water or in lower temperatures, when they work harder to extract heat, or if it is in 'defrost mode') and also when the background noise level is low (e.g. at night or in rural areas).

Sometimes the age of the unit was an issue, with noise disturbances worsening as the equipment ages (MCS ASHP Complaints Database; IOA Survey 2022-2023; Urban Planning Application); with one industry professional suggesting ASHP owners may be more reluctant to fix any issues, as the noise may not affect them as greatly as if it were an internally fitted boiler.

Procedural influences

When looking at the rural and urban planning applications, there were variations across the LPAs in how ASHP impacts were considered. For example, the database showed some ASHP planning applications which included calculations in line with MCS Guidance, whereas Noise Impact Assessments were submitted for other planning applications[15]. In some cases, where no noise impact assessment was submitted with the original planning application, the LPAs required one to be produced as part of the approval process. It should be noted that there are differences between:

1. PDR where the ASHP has to be compliant with an MCS 020 Noise Assessment; and
2. Full planning applications which could include either an MCS 020 Noise Assessment or a more detailed Noise Impact Assessment.

Issues were raised in the IOA Survey around the suitability of the MCS 020 Noise Assessment. The MCS 020 Planning Standard[16] adopts a standard background sound level which is unrepresentative of areas with low background sound levels, and it does not consider noise characteristics such as tonality (IOA Survey, 2022-2023). This, coupled with uncertainties from industry professionals on whether BS 4142:2014 is appropriate (IOA Survey 2022-2023), means that there is very little guidance for planning and environmental health professionals when deciding on a suitable assessment method. Additionally, one professional mentioned an ongoing case where the MCS 020 Planning Standard was alleged to be inaccurate (IOA Survey 2022-2023), while another described a planning application that they reviewed as having a variety of errors in the assumptions made as part of the MCS 020 Planning Standard (IOA Survey 2022-2023).

It was also raised that there is very little guidance in relation to siting and installation of ASHPs. Many respondents to the IOA Survey noted that they had come across ASHPs that were sited where surfaces cause reflection of the noise, or where the positioning is likely to cause noise disturbances to homeowners or neighbours (IOA Survey, 2022-2023). Furthermore, some entries from the MCS Complaints Database also described faulty installations, including one

[15] A noise impact assessment is a quantitative assessment of noise impacts on sensitive receptors that is carried out by a suitably qualified acoustic professional. It often uses modelling to determine what noise levels are at sensitive receptors and may include information on the type of noise (e.g. tonality) that is emitted. If noise impacts are identified, mitigation may be recommended to reduce these impacts.

[16] Microgeneration Installation Standard: MCS 020 (2019). Available at: MCS-020.pdf (mcscertified.com) (Accessed 7th September 2023).

entry which noted that the base for the external unit had not been installed on a level surface, creating excessive noise.

Cumulative noise impacts were also raised as a concern throughout the different sources, including the IOA Survey (2022-2023) and the Planning Applications. In this regard, environmental professionals raised concerns about 'noise creep' as more and more installations are carried out through PDR, particularly on larger new-build estates (IOA Survey, 2022-2023). For one planning application, residents were concerned about a new housing development and, in particular, excessive cumulative noise from the ASHPs, particularly at night-time. The local Environmental Health Officer (EHO) had no concerns following the submission of further detail by the applicant, and the LPA granted permission for the development.

Finally, some database entries also highlighted concerns that the manufacturer noise specifications did not necessarily reflect 'real world' conditions. One industry professional noted that the manufacturer's specifications for one brand of ASHPs carried a degree of uncertainty, as it was not clear whether the test results presented a worst case noise level or not (IOA Survey, 2022-2023) under full or partial load conditions. If this is the case, the MCS 020 assessment which uses manufacturer specifications may be inaccurate at full load conditions.

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

Online survey

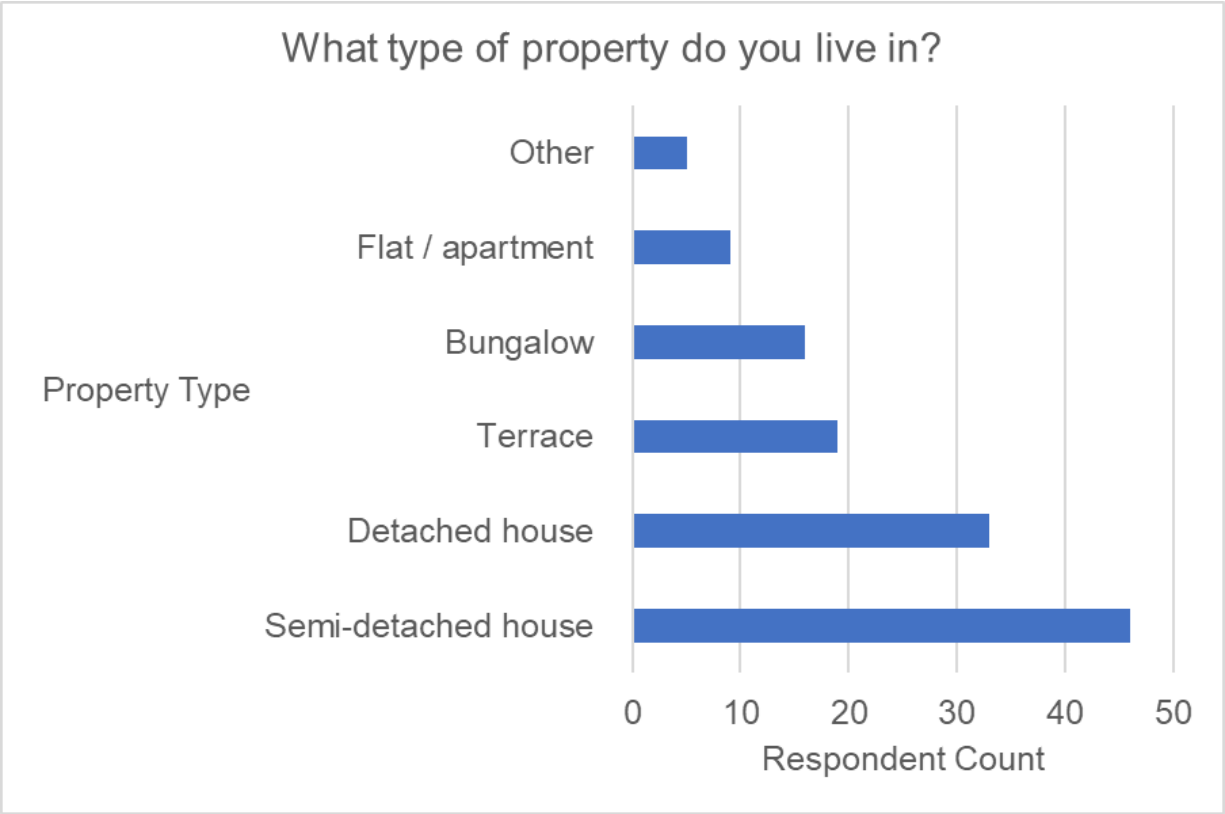
Out of 3,050 letters sent, a total of 139 respondents completed the online survey. Surveys were distributed amongst 60 high intensity ASHP areas (identified using the MCS installation database), to households living within 50m of an ASHP.

The questionnaire was structured in such a way as to avoid bias or leading participants to identify noise from a neighbour's ASHP. Instead, the initial questions were more general in nature, with direct questions about ASHPs asked as follow-on questions, where the respondent had identified that they could hear an ASHP. Responses were received from residents of all the 12 LPA areas with the highest density of ASHP installations, showing a good geographical spread of respondents. This section highlights the key findings from the online survey. The Technical Annex of this report provides a more detailed description of the sampling methodology and survey responses.

Socio-demographic responses

Overall, there was a good spread of respondents living in different property types, as shown in Figure 2. The greatest proportion of respondents lived in a semi-detached property (36% of 128 respondents) and respondents also lived in detached houses, terraced houses, bungalows and flats/apartments. Most respondents owned their own property (80% of 127 respondents), and a small number lived in a social rented property and private rented property. Nearly half of the respondents had lived in their property for over 10 years.

Figure 2 Respondents' property type

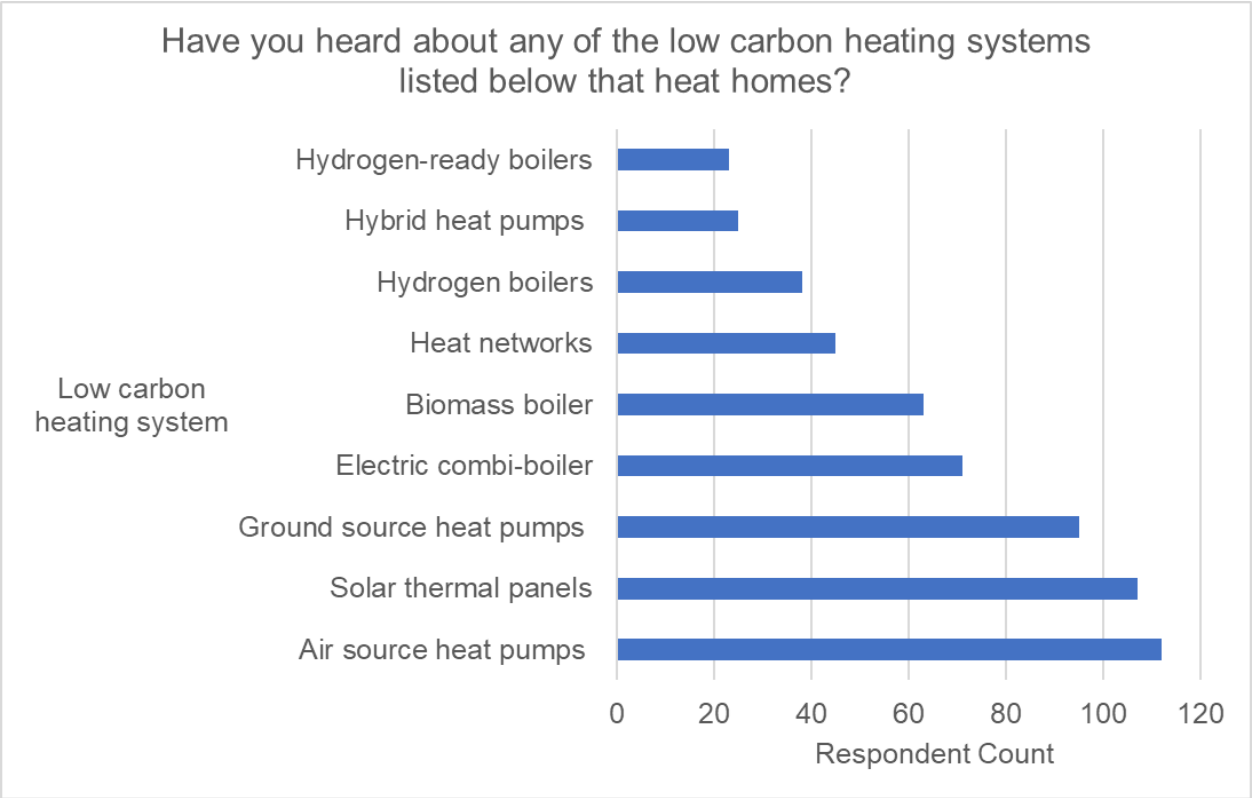


Question: What type of property do you live in? Base: 128. Number of respondents per option: Other – 5 (4%), Flat/apartment – 9 (7%), Bungalow – 16 (13%), Terrace – 19 (15%), Detached house – 33 (26%), Semi-detached house – 46 (36%).

Awareness of low carbon heating

As shown in Figure 3, most respondents were aware of ASHPs. It is important to note that the survey did not ask about level of knowledge, so this may vary across respondents.

Figure 3 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 pumps – 112 (90%).

Nearly two thirds of respondents knew someone in their neighbourhood who had a low carbon heating system installed. Most of these low carbon heating systems were ASHPs (70% of 81 respondents).

Local neighbourhood responses

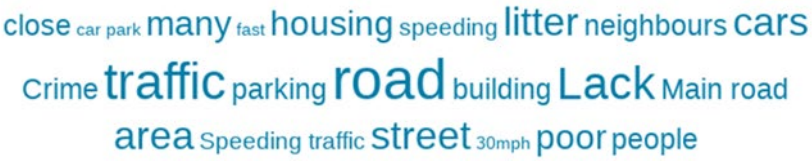
Respondents were asked to what extent they liked or disliked living in their neighbourhood. Out of 139 respondents, 89% said they liked or strongly liked living in their neighbourhood.

Respondents were then asked why they particularly liked living in their neighbourhood. Twenty-five of the 123 respondents mentioned quietness as one of the reasons they liked their neighbourhood. The other reasons given included terms such as 'community', 'neighbours' and 'friendly'. These themes are presented in the 'word cloud' in Figure 4.

Figure 4 Respondents' responses to why they like living in their neighbourhood

In response to the question, what were the reasons for particularly disliking their neighbourhood, 'traffic' and 'roads' featured heavily in the respondents' answers. Of the 122 respondents that answered, only two mentioned 'noise' as a reason. These themes are presented in the word cloud in Figure 5.

Figure 5 Respondents' responses to why they dislike living in their neighbourhood



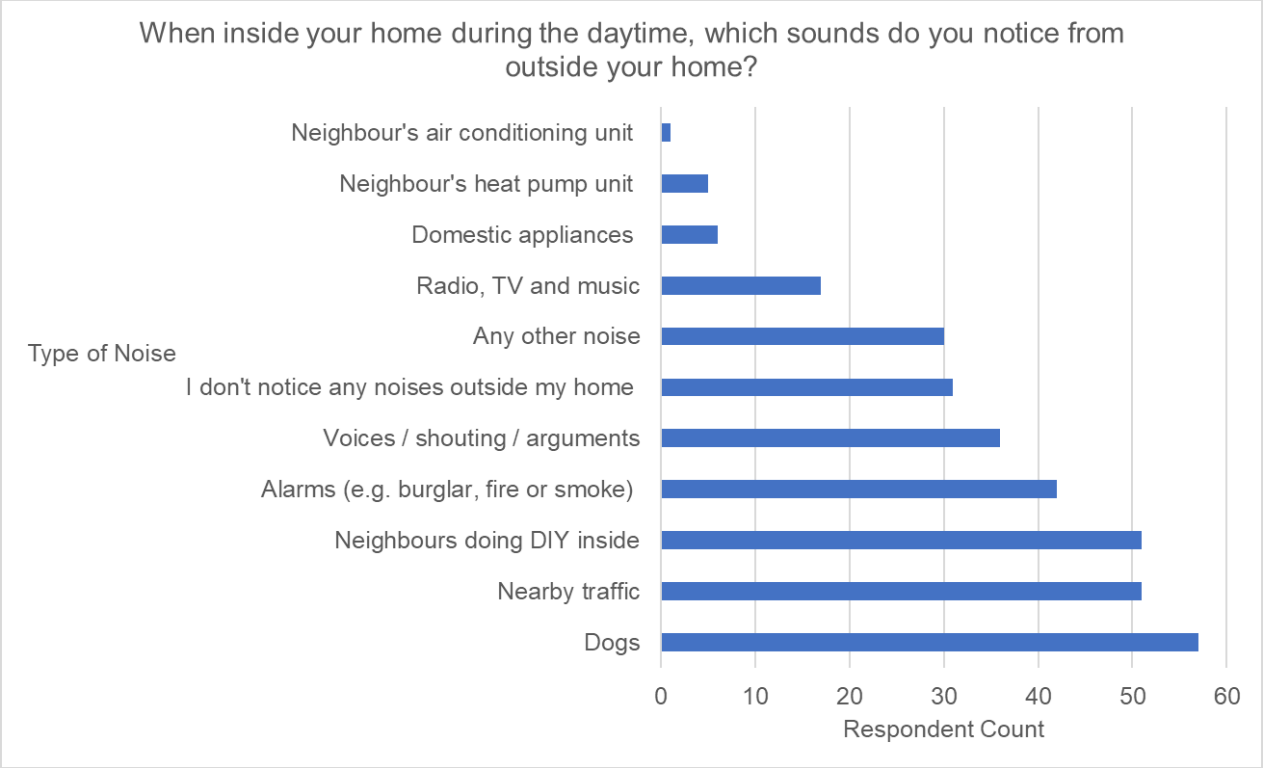
Respondents were asked whether noise in their neighbourhood had adversely affected their health and wellbeing. Approximately two thirds of the respondents who answered this question indicated that it had (60% of 57 respondents[17]). A number of these respondents indicated that noise affected their sleep (39% of 31 respondents), and that traffic was a concern (19% of the 31 respondents). Most of these respondents (69% of 32 respondents) however, had not made their local council aware of issues with noise in their neighbourhood over the last three years.

[17] As noted above, respondents did not have to answer all questions therefore the sample size does vary.

ASHP sound emissions responses

As shown in Figure 6, a low number of respondents (five of 130 respondents) said they could hear a neighbouring ASHP inside their property during the daytime when compared to other noise sources. Of these, one respondent could hear the ASHP very often, two respondents could hear the ASHP sometimes and two respondents could rarely hear the ASHP[18].

Figure 6 Noise noticed by respondents from inside their property during the daytime

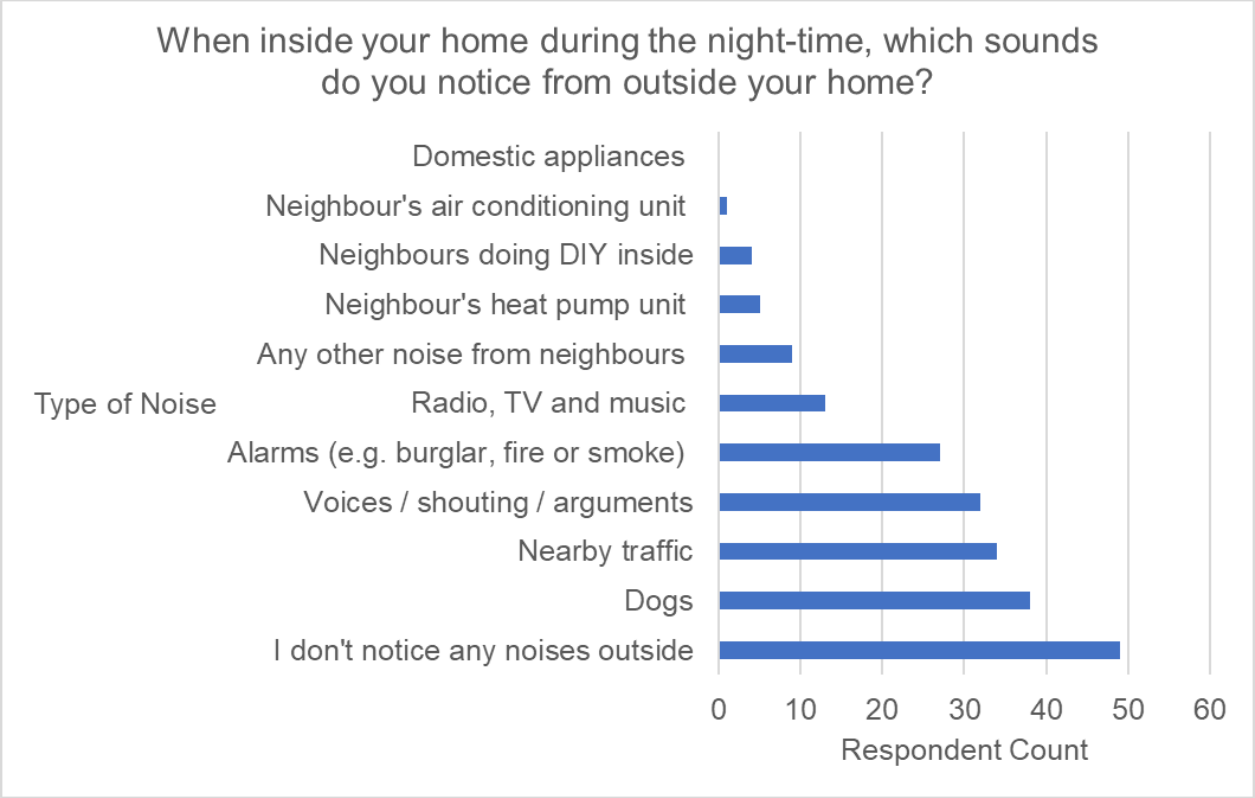


Question: When inside your home during the daytime, which sounds do you notice from outside your home? Base: 130. Number of respondents per option: Neighbour's air conditioning unit – 1 (1%), Neighbour's heat pump unit – 5 (4%), Domestic appliances – 6 (5%), Radio, TV and music – 17 (13%), Any other 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%).

[18] It should be noted that the small sample size (130) means this data should be treated as indicative.

As shown in Figure 7, five of 129 respondents could hear noise from a neighbours' ASHP inside their property at night-time. Of these five respondents that could hear noise generated from ASHPs when inside their property during the night-time, one respondent could hear it very often, three could hear it sometimes and one could hear it rarely.

Figure 7 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 heat pump unit – 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%).

In-depth telephone interviews

Of the five survey respondents that could hear noise generated by ASHPs in their properties during the daytime and night-time, two respondents agreed to participate in an in-depth telephone interview. This selection process means that there is a small sample size in addition to the presence of online bias, which means these findings are indicative. The two interviews are presented below as case studies.

Case Study 1

Interviewee 1 described how they liked living in their local area due to the location of the property and its transport links to the nearby city centre, as well as a number of shops that are located in the vicinity. The interviewee experienced some noise pollution in their neighbourhood, in particular the anti-social behaviour of drivers who “rev” their car engines at night. They explained that a Low Traffic Scheme (LTS) had recently been implemented on a nearby street and this had influenced traffic levels in the area. They described the changes as an improvement in safety, however not all residents have been in favour as some cannot use their cars as easily.

Interviewee 1 lived in a terraced house. The ASHP noise they could hear arose from a neighbouring property which backs onto their garden, with the two gardens adjoining (the ASHP is approximately 10m away from the property). It could be heard by them when outside, on their rear patio, and inside the house when the windows are open. The ASHP can be heard most of the time during the winter months. When asked about the nature of ASHP noise, they described the sound of their neighbours’ ASHP as a low hum, similar to that of an air conditioning unit. The participant described how their household is “learning to live” with the noise, as it is not too disruptive, (for example it is not as loud as traffic noise from fast cars) but is a new addition to the soundscape. They were of the view that the ASHP model installed was a cheaper model and also described it as a “shoddy installation” as there were no obvious signs of noise mitigation, which they believe was exacerbating any noise issues.

Notably, they said that just having one ASHP in the vicinity was not too disruptive. However, they expressed concern that if a number of neighbours were to install ASHPs, the cumulative noise pollution could be an issue due to the enclosed nature of the terraced housing and their adjoining back-to-back yards. They appreciated that ASHPs have a role to play in decarbonisation, however “[they are] not really sure they are the solution in dense, urban environments”. Furthermore, they were of the view the cumulative noise created might have an effect on wellbeing. They were also concerned that LPAs and developers may not be considering cumulative impacts: “I’m worrying a bit that it’s being hidden in any rollout or retrofit rollout that LPAs or developers might consider.”

The participant had considered an ASHP installation for their home as they "wanted to remove fossil fuels from [their] house". However they had decided not to install one due to concerns regarding noise pollution. Additionally, if they had applied for planning permission, they were not sure whether it would have been granted due to proximity to their neighbours' properties and the noise levels may have "bothered [their] neighbour". They stated that they would be more likely to invest in some form of solar energy "because of the [difference in] noise". Currently, they have electric heating, which they would be reluctant to replace with a hydronic heating system[19] as they have just renovated their house. However, if they moved house and there was sufficient space for an ASHP, they would consider installing one.

Case Study 2

Interviewee 2 explained that they enjoyed living in their neighbourhood as it was convenient for seeing family and for spending time at their caravan. Despite there being some heavy traffic at times (due to proximity to a school), they enjoyed living there and had never had any issues with noise or made a noise complaint to the council.

The participant could hear a neighbour's ASHP when inside and outside their home. When outside, they described hearing the fan making a whirring noise. When indoors, they described the ASHP as making a "rumbling noise." The ASHP is located near the participant's backdoor and could be heard throughout the rear of their house and was about as loud as a car driving by. They also noted that there was no insulation or acoustic enclosure on their neighbours' ASHP.

The ASHP that they can hear is loudest in winter, they perceived this to be because it has to "work harder to extract any heat." They also noted that the ASHP appears to be on a timer, so they were becoming accustomed to knowing when the ASHP will turn on. While there has not been a noise impact from their neighbours' ASHP as such, they described it more as "annoyance."

Interviewee 2's property already had solar panels installed when they moved in and gave this as a reason for not installing an ASHP. They also said that the noise from an ASHP would influence their decision to install one on their property. They had done a lot of research into ASHPs and their potential noise impacts, including looking up information on noise impacts and sound levels on websites such as YouTube. They noted their opinions may have been influenced by negative opinions discovered during their research.

[19] A heating system that uses water as the medium to distribute heat.

Summary

Although both interviewees stated they could hear ASHP noise, it was inferred that overall, at current noise levels it was not impacting their health and wellbeing, but it was more of an additional noise in the soundscape.

Both interviewees said they would not consider installing an ASHP due to concerns over noise levels and the effect this might have on surrounding properties. Interestingly, both interviewees raised concerns about the cumulative impacts of ASHPs, particularly when multiple machines are installed in the same area.

Finally, both stated the ASHP they can hear does not have any mitigation installed. This links to the database findings for Objective 1, where some IOA Survey respondents stated that if there were noise issues, often mitigation helped to reduce the noise impacts.

Strand 3 - Multi-stakeholder research

Introduction

This part of the study consists of qualitative research with key stakeholders including Local Planning Authorities (LPAs), manufacturers, installers, MCS installer certification bodies, and industry bodies. The objective of the strand was to obtain a variety of perspectives on current ASHP noise guidance, planning standards and related barriers to large-scale deployment of ASHPs.

The research consisted of in-depth interviews conducted online. The methodology for each stakeholder group is provided in the Technical Annex.

Local planning authorities

Research aims

What evidence exists on ASHP sound emissions and related planning regulations amongst LPAs (e.g. evidence on complaints about noise from ASHPs and how planning regulations for ASHPs are applied across LPAs), and what are the views of LPAs on the role that current ASHP planning guidance plays in limiting their deployment?

In particular,

- What ASHP planning regulations are applied by LPAs (including when assessing cases that require full planning permission), and how consistently are these applied across LPAs?
- What are the views of LPAs as to the adequacy of existing provisions for ASHPs under PDRs?
- What are the characteristics and frequency of noise complaints relating to ASHPs amongst LPAs?
- Are planning regulations for ASHPs (relating to sound emissions and placement) fit-for-purpose for the larger-scale deployment of ASHPs?
- In what ways could existing planning regulations/standards be modified to facilitate the larger-scale deployment of ASHPs?

Findings

The findings are based on interviews with 18 LPAs and email responses from two LPAs. The participating LPAs, shown in Table 3, were from a range of council types across England in both rural and urban areas. A more detailed breakdown of the demographic of the LPAs is provided in the technical annex accompanying the report.

Table 3 Summary of achieved LPA sample

LPA Type	Sample Characteristics	Number of interviews/responses
District Council	Urban and rural in midlands and south of England. Mixture of low, medium and high number of installations	Eight
Unitary Authority	Urban and rural in north, midlands and south of England. Mixture of low, medium and high number of installations	Seven
London Borough	Urban Low number of installations	Three
Metropolitan Districts	Urban High or medium number of installations	Two

There was a varied degree of knowledge about ASHPs and planning regulations amongst LPAs. There were LPA officers interviewed who appeared to have a good level of acoustic knowledge and experience. Other LPAs appeared to have limited or no knowledge about PDR for ASHPs and the MCS 020 Planning Standard.

Overall, there seemed to be good working relationships between Environmental Health Officers (EHOs) and Planners within the LPAs, although Planners greatly relied on EHOs acoustic knowledge to respond to noise aspects of planning applications and often had very little acoustic knowledge themselves.

When LPAs were asked about training, both generally for noise and more specifically about ASHPs, participants noted that while they would be willing to attend training, there was often no financial or time budget available to do so. Furthermore, participants explained that most training for new employees was ad-hoc and on-the-job shadowing of more experienced EHOs and Planners. EHOs also commented that they were often dealing with noise alongside other

environmental health disciplines (e.g., air quality, lighting, odour) and that their time was very stretched.

There was interest from LPAs in producing specific guidance documents for householders about ASHPs, but again time constraints and other priorities meant that this had not happened. Some LPAs were aware of the IOA/CIEH Briefing Note [12] and other LPAs did not mention it at all. Those with awareness often had membership of, and involvement in, the Chartered Institute of Environmental Health (CIEH) and Institute of Acoustics (IOA). Some LPAs have had their IOA, and other relevant memberships removed during budget cuts, which meant information was not as readily available to them as it once was.

None of the LPAs interviewed had a specific noise policy for ASHPs and all followed national policy on noise management[20] or The London Plan[21] within London Borough LPAs. A few LPAs were in the process of reviewing all their noise policies and guidance documents and were likely to consider ASHPs as part of this process. Some LPAs made reference to specific guidance documents produced by other LPAs and would utilise these when considering ASHP planning applications.

On the whole, LPAs treated planning applications for ASHPs as they would for a general industrial noise source and require a noise assessment in accordance with BS 4142 [11] or similar. There was an inconsistency about which threshold (-5dB or -10dB below background) from BS 4142 LPAs required. Some LPAs said for single ASHP applications in areas they considered “low risk of noise complaints”, such as properties with no nearby neighbours, they would just follow an MCS 020 style noise assessment. Planning applications were considered on a case-by-case basis and recommendations for noise mitigation include relocating, for example, moving the ASHP further away from the neighbouring property, especially bedroom windows; barriers, and using quieter units.

LPAs commented that there is inconsistency across authorities in the interpretation of noise policy, either due to misunderstanding of it, or it being not specific enough, because noise policy provides high level objectives on noise control rather than specific numerical objectives, and therefore open to interpretation. The prevailing response was that LPAs looked at planning applications and noise complaints on a case-by-case basis, rather than a broad-brush approach to determining approval or recommending remedial actions. Some LPAs engaged with County-wide in-person or online discussion groups to help determine how they should approach ASHP planning applications.

From those interviewed, it was commonplace for LPAs to have received at least one complaint about noise from ASHPs. However, LPAs highlighted that it is hard to give an exact number, as complaints databases within the LPA are not searchable by the type of noise source originating the complaint, for instance ASHP.

The noise complaints discussed in the interviews were received within the first three months of a new ASHP installation and were about the general “industrial” noise coming from the ASHP and were predominately about disturbed sleep. There had been some more specific complaints about individual installations such as fan noise, low frequency noise and structure-

[20] National policy on noise management
[21] London Plan

borne noise, the latter in the case where ASHPs had been attached to roofs or walls[22]. There were also cases where the ASHPs had been installed on the side of a property and there had been a high level of reflected noise on the adjacent property only 2 or 3m away, which LPAs described as a "canyoning effect".

When noise complaints were investigated, the installations were all carried out through PDRs and had not gone through a full planning application. Initial investigations sometimes found the installations had not complied with PDRs, for example the heat pump was located closer than 1m from the boundary of a property.

In cases where a MCS 020 noise assessment had been carried out, it was often found that the original noise assessment carried out for PDRs had been incorrect, with mistakes at all stages of the noise assessment process. One example was the incorrect interpretation of reflecting surfaces and noise barriers.

LPAs stated they could serve a statutory nuisance[23] as the final way of dealing with a noise complaint, but only a very small number of ASHP noise complaints had gone this far. Although LPAs said they had the ability to go down the route of serving a statutory nuisance, they had all taken a proactive approach and tried to resolve the noise complaint before this stage was reached. For example, an ASHP was repaired, relocated or a noise barrier installed. In general LPAs found homeowners were co-operative in trying to resolve any noise issues but had very little knowledge on how to resolve the issue, and therefore relied on their installer. When there was a fault found with the ASHP, homeowners contacted their installer or ASHP manufacturer to repair or replace the ASHP. LPAs noted in their experience the co-operation and willingness to help, when there was a problem, varied between installers.

LPA stakeholders interviewed did not feel current guidance and regulations, in the form of PDRs, were fit for purpose for the mass deployment of ASHPs. Key concerns were:

- In MCS 020, existing (background) sound levels are not properly taken into consideration for all areas (especially quiet rural areas at night).
- Increasing noise levels and cumulative noise impact of many ASHPs operating in close proximity.
- The guidance is confusing and open to interpretation. The guidance needs to be very simple for non-acousticians to follow to minimise the risk of the practitioner making any (deliberate or accidental) mistakes when carrying out the noise assessment according to MCS 020.

LPAs were particularly concerned about the larger scale roll out of ASHPs, in both urban and rural areas. They saw the environmental benefits of renewable technologies but were concerned about having the resource to deal with the potential increase in both planning

[22] Airborne ASHP noise is radiated through the air. Structure-borne transmission is radiated through structures/surfaces that the ASHP is mounted to, such as walls/roofs. Structure-borne transmission often results in internal airborne transmission.
[23] "For the issue to count as a statutory nuisance it must do one of the following - unreasonably and substantially interfere with the use or enjoyment of a home or other premises; or injure health or be likely to injure health." Guidance on how councils deal with complaints.

applications and complaints about noise from ASHPs installed under PDR. One LPA interviewed stated:

> "Elected Councillors are really keen on anything that's a renewable energy provision. For example, if we took a case to planning committee for a heat pump and there was an issue around noise, but it was a climate positive measure then I think they would go with that. I don't think they would be overly concerned about the noise issue… but we [Environmental Health Officers] are really nervous about it".

One concern raised by LPAs was how best to balance the use of statutory nuisance powers to address noise issues of ASHPs, while also avoiding the loss of amenity to householders' because an ASHP may be their sole source of heating. For example, some remedial actions may result in loss of heating for a period of time; would this be socially acceptable, and therefore how do LPAs make a judgement between the significant adverse health effects caused by the noise impacts and the potential for adverse health effects due to loss of heating? LPAs were keen to have guidance on how to respond to such a situation.

With the large scale roll out of ASHPs there was concern about how soundscapes could change in both rural and urban areas. LPAs were concerned that many rural areas at night are very quiet and with the installation of many ASHPs the overall sound level will increase and with it bring the potential for more complaints about noise. In urban areas there was a concern about the cumulative noise impact of multiple ASHPs being installed on adjacent or nearby properties.

On the whole LPAs felt that while PDRs are a good idea, the robustness of the guidance for ASHPs is inadequate and too generic. They were concerned that many rural areas at night are much quieter than is assumed in the current PDR process. Local existing sound levels and soundscapes are not taken into consideration, with local existing sound levels often being 30 dB(A) in suburban areas and as low as 18-20 dB(A) in very rural areas (compared to the assumed fixed value of 40 dB(A) in MCS 020). However, there were participants who were of the view that all ASHPs should go through a full planning application and remove PDRs. These participants felt the risk of justifiable complaints about noise with the current system was too high. This was due to their LPA areas having very low background noise levels combined with nearby neighbours.

LPAs felt they would be unable to cope with the workload of planning applications from a larger scale roll out of ASHPs requiring planning consent. LPAs stated that the requirements of a full planning application are in many cases robust and fit for purpose, but there would not be enough planning officers and EHOs to cope with this demand.

LPAs would like to see detailed, clear, consistent, and robust planning regulations. They would like training and guidance on how to interpret and implement planning regulations for ASHPs, and also who to contact should they have any questions.

LPAs were asked about the impact on ASHP installations in their area if the three main requirements for PDR were made stricter or less strict, in terms of the physical size of 0.6m^3, 1m from a property boundary, and 42 dB(A) at the nearest sensitive receptor. They responded as follows, and also made reference to changes within the MCS 020 noise assessment:

- None of the LPAs demonstrated a strong objection to allowing physically larger units, although there was concern that residents in smaller properties may not want a larger unit due to loss of their amenity area, and larger units could increase the likelihood of a visual impact.
- Reduction in assumed background noise level and possibly more site-specific background noise levels used.
- Reduction in, or maintaining, the recommended noise level at a neighbour's window, and definitely not an increase in the current 42 dB(A) noise level limit.
- The consideration of other aspects of the noise source and not just the overall broadband noise levels (e.g. frequency band noise levels, tonality, on/off time).
- In favour of maintaining or increasing the distance from the boundary to reduce the likelihood of noise complaints, although many LPAs commented it was more about good placement than simply distance from boundary.
- More detail about appropriate location of an ASHP including orientation, consideration of all reflecting surfaces in the nearby area, and what constitutes a sensitive receptor.
- Explanation of what can be considered an acoustic barrier (i.e. not a hedge or open fence).

ASHP manufacturers

Research aims

- In what ways do ASHP manufacturers respond to sound-related planning guidance (applicable under the Town and Country Planning Act) in the design of their ASHP products?
- Are manufacturers seeking to address sound-related issues with regards to ASHPs, and if so, how? What types of noise abatement measures does this include?
- Would manufacturers foresee making changes to their ASHP products in light of potential changes to planning regulations on ASHP sound emissions and placement, consumer views and competition?
- Are planning regulations for ASHPs (relating to sound emissions and placement) fit-for-purpose for the larger-scale deployment of ASHPs?
- In what ways could existing planning regulations/standards be modified to facilitate the larger-scale deployment of ASHPs?

Findings

These findings are based on interviews with ten ASHP manufacturers with a range of market shares across England. Further details are provided in the technical annex accompanying the report.

The manufacturers were asked which design factors (such as aesthetics, capacity, cost, efficiency, noise, size, and any other design factors) are most important to them when design their ASHPs. All manufacturers stated efficiency was generally the top, or joint top, factor when designing their ASHPs. All manufacturers interviewed considered the sound emissions of their ASHPs at the design stage and noise is a high priority. One manufacturer stated it was their joint top consideration along with efficiency and in the future may become their most important factor when designing new ASHPs as they felt noise levels were a key selling point.

The importance of other design factors varied between manufacturers, although said it was commonplace to state that size was dictated by the requirements of PDRs. Additional design factors mentioned by manufacturers were the importance of adhering to all regulatory requirements, and the importance of using high quality components to ensure long term performance of their ASHP.

The general types of hardware noise control measures described within the boundaries of Intellectual Property were:

- Compressor jackets.
- Compressor anti-vibration mounts, with one manufacturer describing a very complex compressor isolation system.
- Fan design including blade shape, angle, bearings, and motor selection, with one manufacturer describing a fan cover for “psychological sound reduction” – assuming that if the end user cannot see the fan, they do not hear the fan.
- Sound absorption material on the inside of the ASHP chassis.
- Anti-vibration mounts and platforms under the ASHP.
- Specific installation instructions, such as flexible pipework attachments and not attaching the ASHP directly to the wall of a property.

There were also a number of software noise control measures described within the boundaries of Intellectual Property including:

- “Quiet modes” that are programmable by the installer or accessible by the consumer. It was noted by all manufacturers that quiet modes will reduce the capacity of the ASHP by between 10-30% and as such the ASHP may not deliver the required heating demand.
- Scheduling programmes so the heat pump will not operate during certain times.
- More advanced control strategies to allow for smaller incremental changes to fan and compressor speeds to balance capacity and noise level. For example, ten possible fan speeds rather than only three fan speeds.

When asked about if they considered noise over the lifetime of the ASHP, often manufacturers said they gave specific instructions to installers about how to install, service, and maintain products. One manufacturer mentioned that they send out newsletters to customers with specific advice, such as clearing leaves on or around their ASHP before the start of winter. These measures were seen by manufactures to ensure the long-term performance of their ASHPs and minimise noise issues, but they were keen to state any warranties were subject to

consumers/installers following a prescribed servicing and maintenance programme. The length of warranties varied from one to seven years and reflected the level of support offered by manufacturers to deal with any longer term performance or noise issues with their ASHPs. One manufacturer stated they did not consider the noise over the lifetime of their product and were more concerned about designing new ASHPs than the long-term performance of older ASHPs.

The manufacturers were asked which factors (such as cost, knowledge of noise control, lower capacity, lower efficiency, size restraints, time of day, and any other factors) were a barrier to producing quieter ASHPs.

A common response was that they would not want to sacrifice efficiency, in terms of Coefficient of Performance (COP) or Seasonal Coefficient of Performance (SCOP), or capacity to produce a quieter heat pump. One manufacturer stated the majority of their sales were to “fairly leaky uninsulated properties” that have higher heating capacity requirements and therefore they stated:

> “Capacity is the number one thing that stops us making super small units that don’t make any noise, driven by the fact that in the UK the majority of the market is in the retrofit or refurbishment market.”

They then went onto state they installed much smaller capacity and quieter ASHPs in Passivhaus (or highly insulated) developments.

Another concern raised was the added cost to manufacturers to produce ASHPs containing more noise control measures. However, others did not see cost as a barrier as they felt consumers were willing to pay for a more premium product that was quieter.

Manufacturers spoke about trying to reduce the air speed through the ASHP to minimise noise levels without compromising capacity. This is achieved by increasing the size of the evaporator, increasing the size of the fan and lowering the fan speed to enable the same volume of airflow at lower air speeds. Many mentioned if they want to produce ASHPs that comply with the size requirements of PDR, then they are constrained in how much quieter they can make their ASHPs, as they are unable to increase evaporator and fan size or reduce fan running speeds.

None of the manufacturers considered a lack of knowledge of noise control to be prohibiting factor, although one smaller manufacturer stated the time and cost of development was a consideration.

Manufacturers tended to have a member of their research and development team with acoustic expertise, but the level of training for technical and sales staff was very varied. Technical and sales staff are those dealing directly with customers and installers/distributors, so a lack of knowledge of acoustics among this group may result in poor quality, or even incorrect, information being provided.

Manufacturers were asked about any noise complaints they had received about their ASHPs. All stated they had received no or very few noise complaints (generally <1% of sales) and upon investigation, noise complaints were due to faulty parts or units, which were replaced. All manufacturers described a robust procedure for dealing with complaints and feeding back lessons learned to design and sales teams.

Manufacturers currently have to provide an Energy Label[24] for all ASHPs and the sound power level of the ASHP is stated on the Energy Label. Manufacturers tend to provide the minimum required information for Energy Labelling in a very simple format. They feel consumers only want simple information and any further information to consumers about noise is often presented in a marketing rather than technical style in literature, e.g., “silent running” or “whisper quiet”.

Manufacturers saw low noise levels as a key selling point to consumers. In some cases, manufacturers had chosen to seek certification through Quiet Mark[25]. Others had chosen not to use Quiet Mark, as they felt there was a lack of clear guidance on what would be required to obtain certification and the requirements changed regularly. Manufacturers also noted a strong view that a sound power level quoted on an Energy Label is often not understood by a consumer and an alternative, such as a colour coding, would be helpful.

There was a varied level of knowledge of PDRs, Planning and MSC 020 amongst manufacturers. All knew the basics of PDRs, but many noted that because the installations were not completed by them directly, they had limited experience directly dealing with the planning process.

When asked about changes to planning regulations, PDRs and MCS 020, all manufacturers requested information to be presented in a clear and unambiguous format so there was no chance of individual interpretation. For example, it was noted that there is no definition for how the 0.6m^3 limit on the size of the unit should be measured and whether it included the feet of the unit or other attachments.

To enable a larger scale roll out of ASHPs across England, manufacturers feel information needs to be presented in a simpler way to consumers to allow them to make decisions more easily. All manufacturers sell one range of ASHPs across the UK and other European countries. They generally do not design products for only one market and therefore want as much parity in regulations as possible across different countries.

Manufacturers also stated that ASHPs are designed over a 3-5 year period and therefore any immediate or significant changes to regulations would take time to implement. Many also stated that any changes to noise regulations should not conflict with the requirements of other regulations or add additional burden on installers.

Manufacturers were asked about the impact on them if the three main requirements for PDR were made stricter or less strict, in terms of the physical size of 0.6m^3, 1m from a property boundary, and 42 dB(A) at the nearest sensitive receptor. They responded as follows:

- Predominately, manufacturers said requiring physically smaller ASHPs would greatly limit the number of ASHPs they could sell falling under PDR and there are manufacturers who do not sell ASHPs smaller than 0.6m^3.
- There was a general view that the physical size requirement for permitted development rights should be increased, or even removed completely, thus enabling reduction in noise levels for the same capacity units.

[24] Energy Label
[25] Quiet Mark | Quiet Mark | Reducing noise pollution with quieter products

- No strong opinions were noted on the impact of either increasing or decreasing the 1m distance from a boundary requirement, although a few mentioned any relaxation could increase uptake. Some stated minimum clearance distances were required around ASHPs and therefore typically they have to be at least 0.3m away from a wall.
- Potential changes to the 42 dB(A) noise limit had a more divided and stronger response. Responses were received in favour of reducing or keeping it the same to avoid noisy products onto the market which had the potential to impact negatively on the public opinion of ASHPs. Responses were also received stating that if the noise limit increased then this would allow more products onto the market in more locations under PDR without costly mitigation strategies (e.g., acoustic enclosures and barriers), although they did concede this could increase the risk of noise complaints. One manufacturer suggested the removal of a sound pressure level limit at the nearest sensitive receptor, and instead use a limit on the overall sound power level of the ASHP.

Industry bodies

Research aims

- What are the views of industry bodies (IBs) toward current ASHP planning regulations (related to sound emissions and domestic technology placement) in hindering or facilitating their larger-scale rollout?
- According to industry bodies, what changes in current ASHP planning regulations and/or ASHP product design could facilitate the larger-scale rollout of this technology?

Findings

The findings are based on interviews with six IBs and an email response from one IB. The IBs interviewed were from across the industry and included those with both a focus on heat pumps and a focus on acoustics. Further details are provided in the technical annex accompanying the report.

IBs provide guidance to professionals and the general public about noise and/or ASHPs. This information is shared in different ways through websites, call centres, webinars and training events. Some IBs produce their own guidance documentation or training, while others signpost to other sources of information. The focus and content of the guidance depends on the type of IB (e.g. acoustic or ASHP focus).

Historically IBs mainly communicated with professionals, but some do now provide guidance tailored for the general public for specific topics. One IB who has more recently carried out information events for the general public stated, “the appetite [for knowledge] is enormous” and another IB who has produced guidance about ASHPs for homeowners said:

> “It is necessary for homeowners when they are investing and spending a large sum of money that they know what they are getting into…the last thing they want is for their neighbour to be disturbed and EHOs turning up and saying there is a nuisance”.

As would be expected, guidance provided by IBs with a focus on acoustics provides in-depth information on noise from ASHPs, whereas technical guidance documents from IBs with a focus on ASHPs make reference to noise, but no significant details are given. For example, they mention making sure an installation considers potential noise impacts or the importance of carrying out appropriate noise assessments.

All the IBs had a basic understanding of PDRs and planning regulations for noise from ASHPs, and all the IBs were aware anecdotally of noise complaints from ASHPs, but as would be expected, had no first-hand experience dealing with or investigating noise complaints.

IBs agreed there is a desire and need for a larger scale roll out of ASHPs across England to meet net zero targets, but there were concerns about the potential for an increase in noise complaints or other future problems. One IB commented that both sustainability, and health and wellbeing, were important and said:

> "We're looking at the balance of harms and there is the potential, we feel, that ASHPs rolled out in certain situations could have a significant [noise] impact on the public, who are doing their bit for sustainability and that is an unintended consequence, particularly if the roll out is as successful as we would all want it to be".

IBs commented upon the risk of cumulative noise impacts from multiple heat pumps being installed within an area. They also felt that more area specific background noise levels should be used for noise assessments rather than a single value. One IB commented the way to address the potential for long term noise issues was to minimise the requirement for ASHPs and said:

> "I think reducing overall heat demand of the properties and insulation is probably the major thing you can do to at least minimise the size [capacity] of a heat pump that's required".

IBs were keen to ensure potential noise issues are dealt with in a proactive rather than reactive manner, with clear, simple and unambiguous guidance for all, including both professionals and the general public. A number of IBs mentioned a lack of knowledge and understanding about acoustics amongst non-acoustic professionals and the general public with one IB stating:

> "There's a huge knowledge gap just generally in acoustics and sound…we're passionate about empowering the public to make choices themselves".

Participants felt that there should be a consensus on the information given across the industry and from government, with one IB stating:

> "The single biggest point here is that we are not going to get to net zero without collaboration, collaboration and more collaboration, and that includes government being much more open with industry. Once they formulated their new permitted development wording, it needs to be shared with industry before it goes into law."

IBs were asked about their opinion on the three main requirements for PDR and if they were made stricter or less strict, in terms of the physical size of 0.6m^3, 1m from a property boundary, and 42 dB(A) at the nearest sensitive receptor. They responded as follows:

- There was a concern physically smaller ASHPs may have lower capacities and therefore be undersized for the heating demand on the household, or fan speeds would increase and increase noise levels, if installers tried to fit within stricter PDRs.
- Larger ASHPs had the potential to be both quieter or louder, depending on the design, and noise from physically larger ASHPs could be harder to shield with a barrier and have a greater visual impact, but this could be minimised with skins/wraps or sensible positioning.
- Increasing the distance from the boundary would generally decrease noise levels at next door properties, but it was more about specific location and reflecting surfaces rather than purely distance. For example, encouraging best practice on orientation and minimising reflecting surfaces to minimise noise levels, rather than solely distance from a boundary.
- Increasing the distance from the boundary would limit the installation of ASHPs under PDR for properties with smaller gardens or in rows of terraced housing or flats.
- No IBs were in favour of increasing the noise limit due to the increased risk of noise complaints, cumulative noise impact and increasing overall sound levels in an area.
- Decreasing the noise limit was felt to be favourable and achievable by some IBs, with some IB keen for the inclusion of factors such as tonality in the noise assessment.
- IBs stated background noise levels used in the MCS 020 noise assessment should be more site specific to more realistically determine and therefore minimise long-term noise impacts.

ASHP installers

Research aims

- What are the views of ASHP installers certified under the MCS on the suitability of planning regulations and guidance for the installation of ASHPs?
- Is there something installers could do differently, in the installation process, to mitigate or ameliorate sound issues with ASHPs?

Findings

These findings are based on interviews with nine installers. The sample included businesses of varying size, varying number of installations and included businesses that carry out installations across different areas of England. All installers carry out installations in both rural and urban areas. Further details are provided in the technical annex accompanying the report.

The installers mentioned a very wide range of different models of ASHPs that they install, but typically installers chose to install only one or two brands of ASHP. Installers who carry out very bespoke and high-end installations were more likely to choose a whole range of brands of ASHP to match the specific project requirements. Some installers were focused on mass-market cheaper ASHP installations and others focussed on bespoke high-end ASHP installations. Noise was an important factor when selecting which ASHP models to install, and

those installers with more than 5 years of industry experience said noise was now more of a consideration, as consumers were more interested in quieter units and installers were carrying out installations in more built-up areas.

Both small and large installers (in terms of both number of employees and installations) tended to follow a similar process of dealing with customer enquiries, through from initial enquiry, desktop assessments, on site surveys, installation, and finally after care maintenance and servicing. Noise assessments, in accordance with MSC 020, were carried out at the desktop assessment stage of the installation process. All the installers stated they used in-house or third party MCS 020 calculation tools to determine if a particular installation would comply. Larger/mass-market installers stated they may choose not to take on a project if they felt it would not pass the PDR requirements, as they did not want to go through lengthy planning applications. Installers felt assisting customers to obtain full planning permission by engaging with different LPAs, who often had inconsistent planning requirements, was not worth the additional cost and time, and chose to focus their efforts on installations that would comply with PDRs. Smaller installers tended to advise customers about how to carry out a planning application if they did not feel a particular installation would not meet PDRs, but found many customers chose to withdraw from the process if planning permission was required.

Installers were asked which factors (such as aesthetics, cost, ease of installation, ease of maintenance, location, noise, and any other factors) were most important when installing an ASHP. Installers interviewed said location was a very important factor and this was often linked to ease of installation and maintenance. Although noise was an important consideration to installers (especially in built up areas), this was dealt with at the design stage, and selecting possible ASHP locations. Installers said cost and aesthetics were important to customers and a continuous dialogue with customers when choosing where to install the ASHP and implications (e.g. cost, time, disruption) of certain decisions was commonplace.

In general, installers felt consumers had an interest in the noise from heat pumps and this is often a query they receive from potential customers. They did not feel consumers often understood noise nor the datasheets given to them to assist with their decision-making. One installer felt pushing a consumer to a particular product, especially if it is more expensive, would be an unethical sale and therefore they provide as much information so the consumer can make their own choice:

> “We are quite consultative in what we do…we will have discussions [with the customer] around the implications of noisy heat pumps over quieter heat pumps”.

Experience of dealing with noise complaints varied across installers and included dealing with noise complaints from either their own or other companies’ ASHP installations. Others interviewed had not received any noise complaints about their installations. One installer suggested this was because they had a robust design stage and would not install an ASHP if noise complaints were more likely, such as in terraced housing.

Where installers had experienced noise complaints, they reported that these had come from both neighbours (reported via the homeowner or LPA) and homeowners themselves and were general complaints about the noise from the ASHP. Investigations either found an issue with the installation of the ASHP or components within the ASHP. Solutions included replacing or

repairing the ASHP, carrying out maintenance or servicing, or rectifying installation faults. The most common ASHP component to cause a noise issue was the compressor, and this was true for noise complaints on recent (within 6 months) installations and older (+10 years) installations. The noise from compressors was described as a “whine, screech, or hum” and one installer stated upon investigation the noise was particularly bad when the ASHP ramped up or down through particular compressor frequencies. All installers described a robust complaints and feedback procedure, with one installer stating, “every day is a learning day”.

The installers interviewed had a good general knowledge of planning regulations, PDR and MCS 020. Staff training for all employees includes the basics of PDRs and how to carry out an MCS 020 noise assessment for relevant staff. There was a varied level of training on noise, ranging from installers providing none or very little, while others considered noise in training. Staff training in general was again varied between installers, with some providing in-house training while others relied on training provided by manufacturers and a couple attending more detailed ASHP installer training courses.

The installers follow MCS 020 noise assessments, and generally they liked that it is a simple process, although one or two felt it was an unnecessary requirement. It was unclear if they just followed the procedure blindly or had any knowledge of noise, but their responses to questions suggested it was more the former for most installers, although one or two installers demonstrated a slightly more proficient understanding of acoustics. Almost all of the installers incorrectly stated how to identify a barrier, and in some instances installers assumed a hedge or open fence could be classified as a barrier for the purpose of the MCS 020 noise assessment.

To enable a larger scale roll out of ASHPs the installers wanted simple, clear and straight forward documentation to follow and implement. They wanted any required documentation (e.g. for the MCS scheme) to be easy to submit and not become costly or a time-burden. A couple of installers mentioned their MCS 020 assessments were never looked at by anyone – homeowner, MCS, or certification body, during audits.

The installers were asked about their opinion on the three main requirements for PDR and if they were made stricter or less strict, in terms of the physical size of 0.6m^3, 1m from a property boundary, and 42 dB(A) at the nearest sensitive receptor. The installers responded as follows:

- All installers wanted larger ASHPs to be acceptable under PDR, as it would give them more freedom to select the best ASHPs for particular installations and felt this would increase the number of installations.
- A few installers currently install ASHPs smaller than 0.6m^3, but typically for installers restricting the physical size of ASHPs would greatly reduce the number of installations they would carry out.
- Increasing the distance from the boundary would limit the installation of ASHPs under PDR for properties with smaller gardens or in rows of terraced housing and flats. One installer speculated that (outside of London) typically those living in terraced or smaller housing are less affluent than those in larger detached properties, thus potentially creating a rich/poor divide in heat pump uptake under PDR.

- Typically installers were in favour of reducing the distance from the boundary as it would give them more freedom to select the best location at each installation. One installer felt there should be more allowances for individual installations and location specific setups, although they were unclear on how this would be implemented. Another stated orientation and airflow pathways were more important for minimising noise impacts than purely distance from boundary.
- Views were mixed regarding whether decreasing the noise limit would impact installers. One view was that decreasing the noise limit would have a significant impact as it would mean additional costs for mitigation measures (enclosures, longer pipe lengths etc) to ensure noise limits were met under PDR. Whereas other installers felt they would still be able to achieve PDR with the ASHPs they typically installed in noise limits were decreased.
- Finally, one view from installers was that increasing noise limits would be a double-edged sword. It would allow more installations under PDR but risked an increase in noise complaints and therefore add negativity towards ASHP technology and possibly hinder the longer-term larger scale roll out.

ASHP MCS installer certification bodies

Research aims

- What are the views of ASHP MCS installer Certification Bodies (CBs) on the suitability of planning regulations and guidance for the installation of ASHPs?
- According to ASHP MCS installer Certification Bodies (CBs), what changes in current ASHP planning regulations and/or ASHP product design could facilitate the larger-scale rollout of this technology?

Findings

These findings are based on interviews with four CBs. Further details are provided in the technical annex accompanying the report.

The role of the CBs is to initially assess installers for approval onto MCS and then carry out annual audits. The structure of the CBs interviewed were all different, with some using in-house assessors and some using external assessors. Some CBs were new to certifying ASHP installers and had a small member base, while others were well established with a larger member base.

All the CBs interviewed appeared to have a basic knowledge of planning, PDRs and MCS. However, knowledge of acoustics was more varied, with no CBs having any specific training in acoustics, although one interviewee had a basic knowledge of acoustics in their other work outside of their role as a CB assessor.

When explaining the audit process, all the CBs mentioned the requirement for installers carrying out an MCS 020 noise assessment, although a number admitted to not reviewing these during audits. One interviewee had experience of looking through MCS 020 noise

assessments and commented the vast majority were non-compliant with MCS 020 or not carried out correctly.

Apart from the CB who had only recently become an MCS ASHP CB, all the other CBs had dealt with noise complaints from homeowners or neighbours about ASHPs. The noise complaints were often related to sleep disturbance and were generally resolved by relocating or replacing the ASHP.

The CBs were asked about their opinion on the three main requirements for PDR and if they were made stricter or less strict, in terms of the physical size of 0.6m^3, 1m from a property boundary, and 42 dB(A) at the nearest sensitive receptor. The CBs responded as follows:

- Decreasing the physical size of ASHPs would be detrimental to the uptake of ASHP installations and sometimes larger ASHP could be quieter, although one CB stated that larger ASHPs could be less visually appealing.
- Increasing the distance from the property boundary would impact the rollout in more densely populated areas.
- Opinion was split as to whether decreasing the distance from the property boundary would increase the likelihood of noise complaints or not.
- There was no consensus regarding increasing or decreasing the noise limit at the nearest sensitive receptor, with suggestions including considering local background noise levels, limiting the sound power level of an ASHP instead of sound pressure levels at neighbouring properties, keeping the noise limit the same, and decreasing the noise limit.

Limitations

For the stakeholder interviews the limitations of the research were as follows:

- Each stakeholder group have their own bias for and against ASHPs and therefore they may overplay some issues and underplay others. For example, those in favour of ASHPs will underplay noise complaints. Biased results can limit the validity of responses.
- Installers interviewed were those willing to participate in the research and therefore less compliant installers (who were mentioned by other stakeholders) may have been less likely to participate. This limited the range of responses across installers.
- Due to lower response rates by installers it was not possible to achieve the quota targets set out during the research design stage and this limited the range of response across installers.

Conclusions

This section outlines the main concluding points from the research, followed by possible updates to permitted development guidance and regulations that may help address issues relating to noise from ASHPs and aid deployment.

Overall, the main conclusions from this research can be summarised as follows

- There are a range of planning and regulatory related barriers associated with the large-scale deployment of ASHPs.
- There are seemingly a low number of complaints associated with ASHP noise and a low number of rejections to planning applications. Although the evidence used to draw this conclusion is limited in scale.
- The cumulative impact of ASHP noise needs further consideration when reviewing permitted development.

Planning and design related barriers to the deployment of ASHPs

The literature review identified that there were several issues associated with the source sound power level data for ASHPs.

These include:

- Misinterpretation of how to implement the required test conditions in order to generate source noise data for an ASHP.
- Misinterpretation from manufacturers regarding which test conditions are required by MCS.
- The reliability of properly implemented test conditions to accurately represent year-round seasonal in-situ sound power levels.

As a result of these issues, an MCS-certified ASHP may exhibit in-situ acoustic emissions up to 6 dB higher than would have been expected from the assessment carried out using the MCS 020 process. This means that, the level at the assessment receptor may be up to 6 dB higher than that defined in MCS, despite apparently complying with the MCS 020 requirement. Therefore, the process could be improved if this element was more precisely defined.

Similarly, the acoustic features of ASHPs, such as tonality, are not currently included in the MCS 020 assessment methodology. A source exhibiting distinct tonal qualities causes a greater adverse effect than a source at the same noise level but without such a feature. Therefore, considering only a single overall sound level could underestimate the potential adverse effects and hence lead to complaints about ASHP noise, post-installation.

The use of a single value for the existing background sound level in MCS 020 means there is no distinction between areas where the background sound level may be lower, warranting a

more stringent limit to be used, or areas with higher background sound levels, where a relaxation in limit may be appropriate. The extent to which the noise from the ASHP can be heard and cause an adverse impact depends in part on the prevailing sound environment. In both scenarios, this is a potential barrier to the widespread adoption of ASHPs. In quieter areas, noise from ASHPs has the potential to cause relatively more adverse effects. In areas of higher sound levels, installations may be unduly denied despite higher existing sound levels justifying a higher noise level.

For ASHP installations requiring full planning permission (i.e. not using PDR), the standard assessment method requires that account be taken of the actual background sound level and also any acoustic characteristics of the ASHP, including tonality.

Overall, the research has highlighted that current PDR regulations and guidance could be revised to allow greater consistency in the assessment of noise from ASHPs and enable more robust assessments to be carried out. This would help limit the potential adverse impacts relating to noise on the population and aid wider deployment of ASHPs.

Public perceptions of ASHP noise

Although the sample size was small, the limited number of responses to the Strand 2 survey with households known to be in close proximity to an ASHP, found that only a small number of respondents could identify noise from an ASHP.

The review of noise complaints or objections also demonstrated that noise complaints were infrequent. However, where noise complaints were identified, it is apparent that they do impact people to varying degrees. For example, from being described as a noticeable noise in the soundscape, to affecting sleep patterns.

As identified in the literature review and from the interviews conducted with manufacturers, improved education on ASHPs may be advantageous, both in combating any negative attitudes and improving ASHP operation efficiency among owners. As identified in Strand 2, Objective 1, where objections were made to planning applications on the grounds of noise, these were not specific but instead simply expressed a perception that ASHPs are ‘noisy’. Therefore, greater education of the public on the noise produced by ASHPs may help minimise this perception as well as improving the current PDR assessment process.

Cumulative impact of ASHP noise

All three strands of the research identified concerns around noise generated by ASHPs and, in particular, the installation of a number of ASHPs in close proximity to each other (i.e. cumulative impacts).

There is a concern that ASHPs installed via PDR have not been subject to assessments which adequately considered potential noise impacts, in particular cumulative impacts from multiple ASHPs. Where a Noise Impact Assessment has been undertaken as part of the planning process, this may rely on an assessment based on the MCS 020 Planning Standard. However,

the standard does not take into account cumulative impacts and adopts a fixed background sound level to underpin assessments, which means noise impacts from ASHPs may not be adequately considered. Therefore, simply meeting the MCS standard even when associated with a full planning application may not mean significant adverse impacts are avoided and minimised.

The literature review also identified the lack of consideration of the cumulative increase in sound levels as being a potential barrier to achieving successful widespread deployment. If ASHPs are installed in multiple nearby dwellings under PDR, the noise levels experienced at a property could be higher than the permitted level in MCS 020 leading to an increased risk of adverse effects and complaints about noise.

Perceptions from stakeholders on ASHPs

Local Planning Authorities (LPAs) and acoustic-focused Industry Bodies were particularly concerned about the larger scale roll out of ASHPs. They saw the environmental benefits of renewable technologies, but LPAs were concerned about having the resource to deal with the potential increase in both planning applications and complaints about noise from ASHPs installed under PDR.

It was commonplace for the LPAs interviewed to have received at least one complaint about noise from ASHPs and these complaints were predominately about disturbed sleep.

Manufacturers, installers and LPAs were all in favour of allowing physically larger ASHPs within PDRs. LPAs noted that residents in smaller properties may not want a larger unit due to loss of amenity space. Manufacturers noted that it was easier to produce quieter ASHPs if they are larger, as it enables them to accommodate more acoustic insulation and lower speed fans.

Manufacturers have recognised the market value of low noise levels, and some have prioritised them as a selling point. As a result, quieter ASHP units have emerged over the last decade.

Possible updates to permitted development guidance & regulations

Based on the findings set out in this report, Table 4 provides a summary of possible updates to permitted development guidance and regulations that may help address issues relating to noise from ASHPs and aid deployment.

Table 4 - Summary of possible changes to permitted development guidance and regulations in relation to ASHPs

Policy document/ guidance	Relevant section/ clause	Possible change	Evidence from findings
PDR- Permitted Development Rights	The volume of the air source heat pump's outdoor compressor unit (including housing) must not exceed 0.6 cubic metres	Consider having no limit on the size of the unit with regards to the noise impact. As long as there is an upper limit on the noise at the nearby receptor, the size of the unit is not material in itself. There may though be other considerations regarding size. **Reason**: By increasing the size of the evaporator, increasing the size of the fan & lowering the fan speed, the ASHP could run at a lower speed to help minimise noise levels, without compromising capacity.	Local Planning Authorities, Manufacturers
PDR- Permitted Development Rights	All parts of the air source heat pump must be at least one metre from the property boundary.	Consider removing this requirement. From the noise perspective, this requirement is not necessary as long as there is an upper limit on the noise at the nearby receptor. **Reason**: Orientation and acoustic reflections from surrounding surfaces can increase the resulting noise level at a neighbouring property. Taking these into account in the assessment may provide a more accurate assessment of noise impact and minimise the likelihood of complaints.	Industry Bodies
PDR- Permitted Development Rights	More detailed guidance on installation	There should be guidance on best practice installation, including orientation, specific location and minimising reflecting surfaces rather than relying on a specific distance from the boundary. **Reason**: Orientation and acoustic reflections from surrounding surfaces can increase the resulting noise level at a neighbouring property. Taking these into account in the assessment may provide a more accurate assessment of noise impact and minimise the likelihood of complaints.	PDR- Permitted Development Rights

Policy document/ guidance	Relevant section/ clause	Possible change	Evidence from findings
MCS 020	Table 2, Step 1: From manufacturer's data, obtain the A-weighted sound power level of the heat pump. The highest sound power level specified should be used.	Consider providing clear guidance on what operating load and environmental test condition(s) of the sound power level should be used in the assessment. **Reason**: Sound power levels published by manufacturers may be for a lower load than the ASHP will operate at. As such the noise level of the installed unit may be higher than that used in the assessment.	Literature Review
MCS 020	Table 2, Step 5: Establish whether there is a solid barrier between the heat pump and the assessment position using 'Note 5: Barriers between the heat pump and the assessment position' and note any dB reduction. In relation to solid barriers, Note 5 provide the examples of 'a brick wall or a fence'	Consider clearly define what is meant by a 'solid barrier'. **Reason**: Clear guidance is needed so that acoustic screening provided by a barrier is applied correctly. For example, a fence with gaps between panels will not provide any significant attenuation. Similarly hedges and planting should not be considered as 'solid barriers'. Incorrect application of attenuation due to screening may result in an underestimation of the resultant noise level at neighbouring properties. Higher noise levels will increase the adverse effect and may increase the likelihood of complaints.	Local Planning Authorities
MCS 020	Table 2, Step 6: Background noise level. For the purposes of the MCS Planning Standard for air source heat pumps the background noise level is assumed to be 40 dB(A) Lp.	The background level in the current process is simply used add to the level from the ASHP to generate an overall permitted level. This is very simplistic and the cause of much concern. For night-time, the approach could be based on the context principle found in BS 4142. This focuses only on the absolute noise level from the source and would mean identifying a permitted highest level regardless of background. The impact during the daytime is more background dependent and ideally require more site specific background sound levels at the nearest receptor to the installation location to be determined Although modelling could assist, monitoring would be more reliable. If a notional level is used to represent the assumed prevailing sound level, it will inevitably	Literature Review, Local Planning Authorities, Industry Bodies

Policy document/ guidance	Relevant section/ clause	Possible change	Evidence from findings
		be an approximation and will attract criticism depending on the approach adopted. **Reason**: There is a lot of concern about the single value for the background and the issue does need to be addressed.	
PDR / MCS 020	No relevant clause or section in PDR or MCS 020 addressing cumulative effect from multiple households within a neighbourhood installing an ASHP.	Consider taking account of the cumulative impact of ASHPs in a locality. Whilst that is the requirement, it is not straightforward to implement. Assumptions could be made about the number of ASHPs that might exist in a locality (one per household) and the permitted level based on contributions from all of them. The result would be location specific. What would be inequitable would be to penalise subsequent ASHPs in terms of permitted levels simply because a unit had already been installed in the vicinity. This issue exists in locations where there are many air conditioning units. When planning permission is sought, some local authorities seek a permitted level that is very low so as not to affect materially the overall sound level. Mitigation can be used to achieve such a goal. This type of approach, however, would probably not sit well with the required simplicity for PDR. In countries such as Austria and Switzerland areas are sub-divided allowing lower permissible sound levels in each sub-division. Further research is recommended to see which of these potential solutions might work with the terms of PDR. **Reason**: The cumulative noise level from multiple units will be higher than the noise level from a single unit at any given receptor, which will increase the adverse effect and may increase the likelihood of complaints.	Literature Review, Local Planning Authorities, Industry Bodies

Policy document/ guidance	Relevant section/ clause	Possible change	Evidence from findings
MCS 020	No relevant clause or section addressing ‘acoustic character’ (e.g., tones)	Consider including a tonality correction in the noise impact assessment for the acoustic character of the ASHP. Annex C of BS 4142 provides a methodology for assessing tonality where a penalty of up to 6 dB is added if a tone is identified. A similar strategy could be adopted which allows prominent tones to be identified using either laboratory or in-situ sound data. Manufacturers could be asked to supply frequency spectrum data from which it would be possible to determine the extent of any tonality present. **Reason:** ASHP noise, particularly in the lower frequency range (50 Hz-500 Hz), is dominated by discrete tones generated by fan and compressor. The presence of tonal noise can increase the adverse effect compared with a sound with no such character at the same level. Introducing a correction for tonality will provide a more robust assessment methodology and help reduce the likelihood of an adverse effect and complaints.	Literature Review, Industry Bodies

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