Impact of heat pump installation on the sound perceived by the owner

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Abstract

Noise emitted by heat pumps will not only affect neighbours but can also impact the owner, compromising living comfort. As outdoor units can be mounted in gardens, on façades, or on roofs, both airborne and structure-borne sounds generated by the heat pump can lead to noise inside the building.

This paper discusses the relevance of both structure-borne and airborne sound transmission based on two distinct field measurements of heat pumps in operation. The first field measurement investigates interaction effects caused by two heat pumps located in the back garden of adjacent semi-detached houses by using a microphone arc measurements and psychoacoustic analysis. The second field measurement focuses on quantifying the structure-borne transmissions originating from a façade-mounted heat pump unit under various mounting scenarios.

Microphone arc measurements showed that while fluctuation strength remained unaffected by combined operation, Roughness consistently peaked at a specific microphone position, possibly due to interaction. Tonal analysis also revealed a directional pattern: low-frequency fan tones were intrusive off-axis, whereas high-frequency tones were concentrated along the fan outlet axis, presenting a significant annoyance risk near building façades. Measurements on the façade-mounted heat pump show that structure-borne noise propagation is relevant to the level and tonality of indoor sound. It also shows that the mounting situation influences the transfer paths and the effectiveness of vibration isolators.

In addition to the analysis presented in this paper, the data used in this study, along with supplementary analyses, will be available on the website of the IEA HPT Annex 63. This allows researchers and professionals to access the collected information and use it for further studies. Ultimately, this paper aims to raise awareness of the acoustic impacts of heat pumps on residents and highlights potential recommendations for future research.

Keywords: heat pump noise; vibrations; psychoacoustic; field measurements; directionality; interaction of heat pump, isolators

1. Introduction

This study evaluates how heat pump installation affects acoustic emissions, with attention to both air-borne and structure-borne sound and their potential to disturb the owner and other residents in the same building. Airborne noise emitted by heat pumps can travel along multiple paths, from exterior sources mainly through openings such as windows, doors, and vents, to interior living spaces via direct air propagation. During operation, heat pumps also cause vibrations that can travel through walls, floors, and ceilings and may radiate as audible noise. The research examines how installation configurations, can alter the perceived noise considering both air-borne and structure-borne sound.

2. Field Assessment of Two Heat Pumps in Adjacent Gardens

2.1. Situation and Measurements

This field measurement investigated the acoustic behaviour of two air source heat pumps (ASHPs) installed in close proximity within a residential setting [1]. The case study site comprised two unoccupied, semi-detached dwellings with adjoining back gardens. Measurements were conducted at the owner's property (P1) and the neighbouring property (P2). Each dwelling was equipped with a Panasonic WH-MDC05J3E5 (5 kW capacity), which features a manufacturer-stated sound power level ($L_{W,A}$) of 59 dB(A) at partial load. The units were installed on opposite sides of the shared wooden fence, running parallel to it and facing perpendicular to the adjacent property. Each ASHP was mounted on a metal bracket, positioned 32 cm from the shared wooden fence and 32cm away from the building façade.

The gardens featured an approximate 40 cm height difference. This resulted in unequal barrier heights at the measurement location: the fence at P1 was 180 cm high, while the total barrier height at P2 (including an additional buttress accommodating the level difference) measured 220 cm. Field measurements were conducted in December at Nottingham, UK. The site was located adjacent to an active construction area and near a motorway. To maintain a sufficiently low background noise floor, all acoustic measurements were performed during the evening hours when construction activity had ceased, and motorway traffic intensity was reduced.

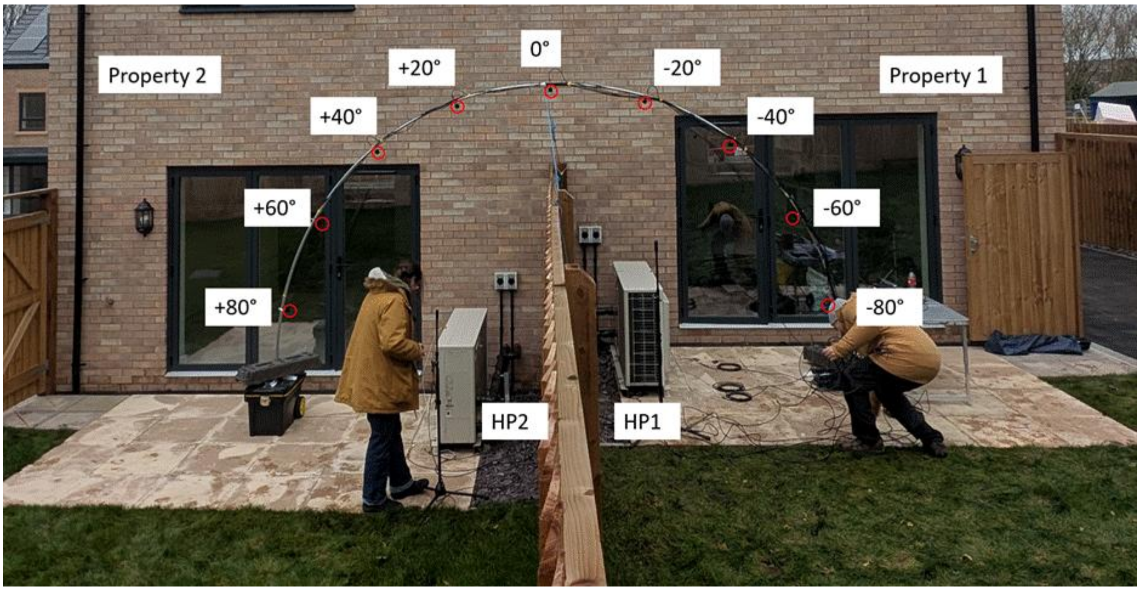


Figure 1: The layout of the microphone arc and the case study site

Acoustic data were acquired using a 2.5 m semi-circular microphone array consisting of nine GRAS 46AO ½" CCP pressure field microphones with windshields (Figure 1). The microphones were positioned at 20° intervals, spanning the range from −80° to +80°. Negative angles corresponded to positions on P1, while positive angles corresponded to P2. The Dewesoft SIRIUSi unit is used for data acquisition. Due to the 40 cm garden height difference, the microphone positions were not vertically aligned relative to the HP units.

The research team maintained full access and direct control over the operation of both HPs. Three specific operating scenarios were examined to compare symmetrical (both units active) and asymmetrical (one unit active) conditions: (1) both units running on normal mode, (2) HP1 on normal while HP2 is inactive, and (3) HP1 inactive while HP2 is on normal.

2.2. Directionality of Acoustic Emissions

The A-weighted sound pressure levels (SPL) across the semi-circular microphone array are shown in Figure 2, illustrating the emission directionality for the four operating conditions relative to the background noise. Measurements of the background noise, taken before ASHP operation, were dominated by motorway traffic and ranged between 35.5 dB(A) and 39.1 dB(A).

In all three operational scenarios, the measured SPL significantly exceeded the maximum background noise floor by a minimum of 6 dB(A), confirming that the acoustic emissions are dominated by the ASHP units. The spatial distribution of the sound field reveals a consistent emission pattern across all operating modes. The maximum SPL consistently occur at the microphone positions that are oriented toward the fan outlet, indicating the main path of sound emission.

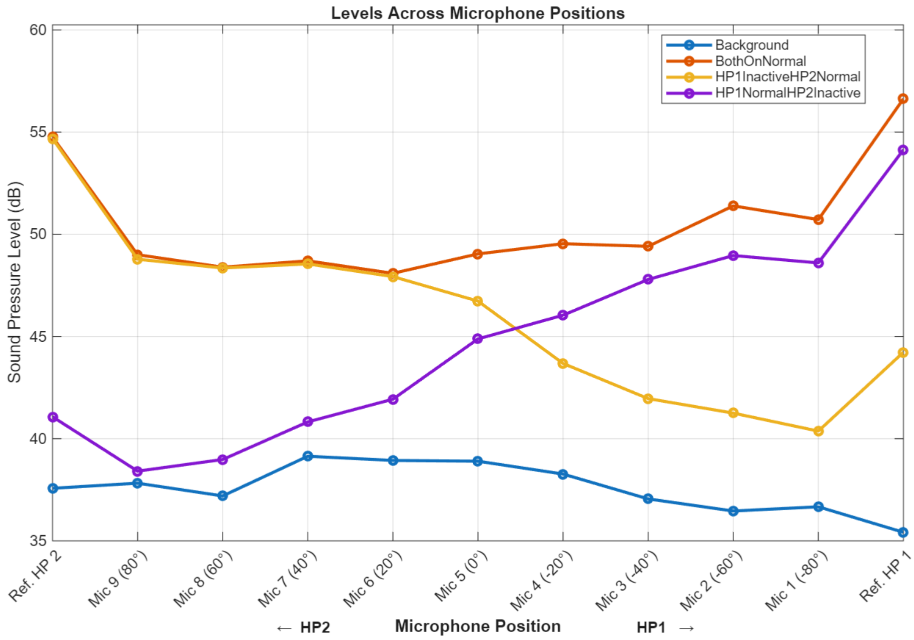


Figure 2: Comparison of sound pressure levels across the microphone positions for different operating scenarios and background noise levels.

Indoor measurements were avoided because the mechanical equipment located within the properties generated significant noise, which would have been the most prominent contributor to the indoor sound levels. To estimate the indoor SPL for a scenario without the mechanical equipment noise, the simplified façade transmission equation based on the façade sound insulation standard [2] was implemented using MATLAB 2025b. The analysis focused on the combined living room/kitchen space of property P1, which opens to the back garden through a bifold glass door. This space had a floor area of approximately 30 m², half of which was carpeted and half covered with floorboards. The outdoor reference sound level was taken from microphone Mic 1, located at −80° directly facing the fan grille of HP1, at a distance of 1.51 m from the unit and 0.9 m from the bifold door. Calculations were limited to the condition where HP1 operated in normal mode, as including emissions from HP2 would require a more complex environmental model. The estimation accounted for the reflections from the hard ground plane and the glass façade. Transmission from outdoor to indoor is estimated using a frequency-dependent filter corresponding to condition C-2 in [3], assuming a partial opening of 0.2 m². The results indicated that the A-weighted sound pressure level decreased from 48.8 dB(A) at the outdoor reference point to 33.7 dB(A) within the adjacent indoor space when HP1 operated under normal conditions. This estimated indoor level is lower than any of the background noise levels measured across the outdoor microphone positions, indicating that noise emissions from the resident's heat pump are highly unlikely to cause noticeable annoyance under normal operating conditions, given the current installation layout and a partially open window scenario.

2.3. 1/3 Spectrum comparison between scenarios

Figure 3 shows a 1/3-octave spectra comparison of the directional characteristics of the two heat pump units under different operating configurations, with a focus on emissions toward property P1's back garden. The scenarios include operation with both units running in normal mode and with only HP1 active. For the microphone Mic 1 positioned at −80° facing HP1, overall levels are consistently highest when both units operate simultaneously (solid red).

Below 500 Hz, the difference between both-on and HP1-only conditions remains small (≈1 dB), suggesting that low-frequency radiation in property P1 is dominated by HP1, and potentially the emissions from HP2 are less pronounced due to destructive interference. Above 500 Hz, however, the difference increases gradually peaking around 3 - 4 kHz, indicating additional high-frequency energy reaching microphone Mic 1 from HP2, likely through diffraction or partial transmission over the boundary fence.

At the opposite side, microphone Mic 9 (+80° facing HP2) exhibits a significantly greater change when HP2 is inactive. When both units operate, levels rise by 8 to 12 dB relative to the HP1-only condition, with the largest separation above 2 kHz. This confirms that HP2 strongly dominates the acoustic field in the garden where it is installed, while radiation toward the opposite garden (from HP1) is comparatively weak. The consistent 2 - 3 dB level advantage of Mic 1 over Mic 9, even under matched conditions, likely reflects geometric asymmetry, namely, the 40 cm elevation difference and non-parallel microphone alignment relative to the fan planes.

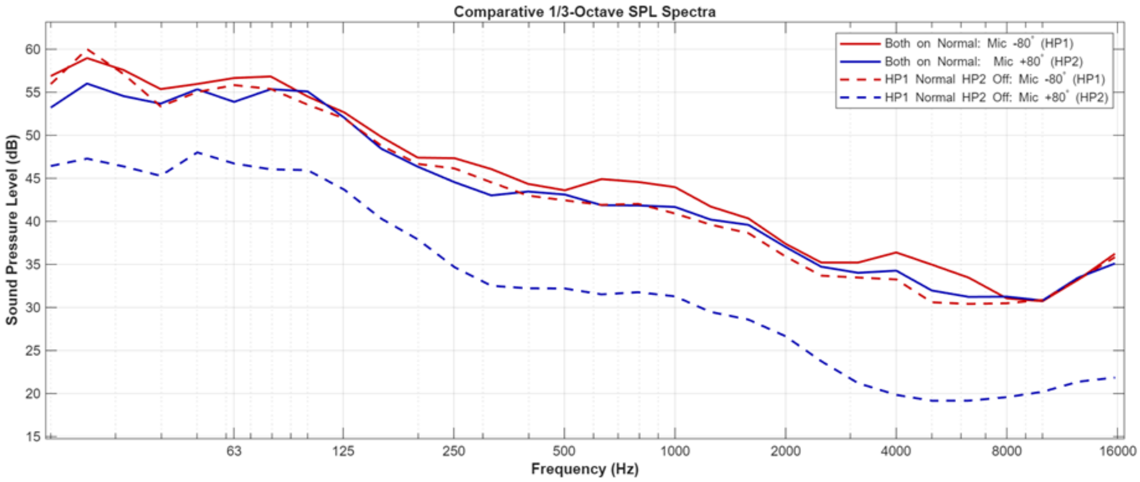


Figure 3: Comparative 1/3-octave SPL spectra at Mic 1 -80° (P1) and Mic 9 +80° (P2), contrasting the symmetric (both on Normal) and asymmetric (HP1 Only) operating scenarios.

These spectral patterns also provide context for the psychoacoustic analysis presented in the following section. The stronger high-frequency radiation in the 2 - 4 kHz range, combined with the inter-unit interaction effects observed when both units operate, is expected to influence perceptual attributes such as tonality, sharpness, and annoyance. The spatial variation in these spectral features suggests that tonal components may be more prominent and perceptually salient in directions aligned with the fan outlet axes, offering a physical basis for the directional differences observed in subjective responses. Additionally, even though the calculated sound transmission values through a partially open window showed that the SPL will be significantly low inside property P1, this can still contribute to annoyance due to the psychoacoustic properties of the emissions.

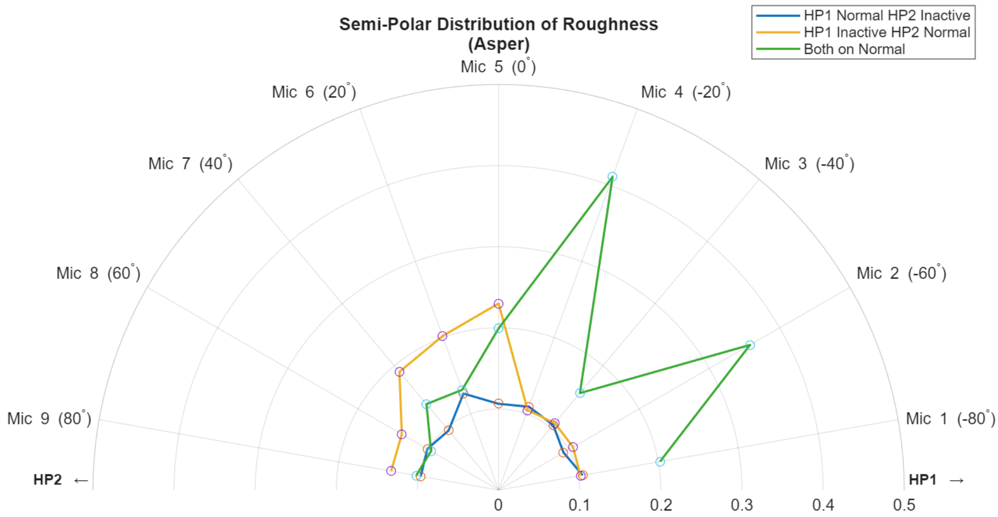


Figure 4: Directivity plot showing the Roughness values across the microphone arc.

2.4. Psychoacoustic Analysis

The focus of the psychoacoustic analysis was to investigate the directionality of the tonality and to understand whether there is any interaction effect when HPs in proximity are operating at the same time. Therefore, the psychoacoustic analysis focused on analysing fluctuation strength, roughness, and tonality metrics.

Fluctuation strength (FS) was conducted following the Osses Vecchi model [4]. The analysis findings were inconclusive in detecting interactions across the four operational scenarios. FS values were consistently low (predominantly <0.1 vacil) and remained below the 10% just noticeable difference threshold. These low values suggest minimal or absent fluctuation. Consequently, further analysis is required to determine the perceptual significance of FS in these operational conditions.

Roughness analysis was conducted using the Sottek Hearing Model, as per ECMA 418-2 (3rd edition) [5]. The findings revealed that individual heat pump operation produced consistently low values across the microphone arc, typically ranging from 0.09 to 0.23 asper (Figure 4). However, when both units operated under identical conditions, a highly localised increase was observed at the −20° position, where roughness nearly quadrupled to 0.41 asper (normal mode) and 0.46 asper (boost mode). This localised elevation suggests a potential beating or interference effect arising from the superposition of similar-frequency components emitted by the two units at this specific geometric location. The observation requires further investigation through replicated field measurements to confirm its origin and assess its perceptual significance.

Additionally, it was observed that the asper values between 0 and +40° rise only when HP2 is operational. While this requires further analysis and confirmation, the possible reason for this is likely the 40 cm elevation difference between the gardens. This difference results in a taller effective barrier height on property P2's side of the garden, resulting in reflections that can amplify the beating patterns that cause roughness. Secondly, the elevation difference means the microphones in Property 2's garden are not facing the fan outlet of HP2 at the same corresponding relative angles as those facing HP1, creating asymmetrical acoustic path length and angle-of-incidence.

Table 1: Calculations of tonal audibility based on BS 4142:2014+A1:2029 Annex D. Mic 1 is located at property P1, facing the fan grill of HP1, while Mic 9 is situated at property P2, facing the fan grill of HP2. (Kt: Tonal Correction, ΔLta: Tonal Audibility, Lpt:

		Ref. 2 (HP2)	**80°**	**60°**	**40°**	**20°**	**0°**	**-20°**	**-40°**	**-60°**	**-80°**	**Ref. 1 (HP1)**
K_T (dB)	Both on Normal	0.00	0.60	0.06	0.34	0.00	1.04	5.42	6.00	6.00	0.26	3.54
	HP1 Normal – HP2 Off	6.00	0.00	3.89	0.00	0.00	0.00	2.39	0.20	1.44	4.69	2.60
	HP1 Off – HP2 Normal	0.00	6.00	3.95	4.64	0.50	0.93	0.00	3.80	2.40	0.00	6.00
ΔL_{ta} (dB)	Both on Normal	1.05	4.60	4.06	4.34	3.36	5.04	9.42	11.96	12.71	4.26	7.54
	HP1 Normal – HP2 Off	11.11	0.00	7.89	0.00	0.00	1.29	6.39	4.20	5.44	8.69	6.60
	HP1 Off – HP2 Normal	3.34	10.06	7.95	8.64	4.50	4.93	0.00	7.80	6.40	0.00	10.37
Tone Freq. (Hz)	Both on Normal	818	14038	110	14038	891	684	4407	13879	13879	684	110
	HP1 Normal – HP2 Off	110	0	110	0	0	818	9033	10608	1575	14160	818
	HP1 Off – HP2 Normal	952	14038	14038	14038	14038	16895	0	110	110	0	110
L_{pt} (dB)	Both on Normal	43.2	20.8	35.0	17.7	39.5	39.2	33.4	23.9	27.3	40.6	46.5
	HP1 Normal – HP2 Off	37.5	0.0	30.2	0.0	0.0	33.8	21.2	18.0	39.2	22.2	46.1
	HP1 Off – HP2 Normal	45.1	21.6	17.9	18.2	13.7	8.8	0.0	31.9	31.2	0.0	40.2

Table 1 shows the Tonal Audibility (ΔL_{ta}) and Tonal Correction factors (K_T) which were calculated using the Joint Nordic Method v2 in accordance with BS 4142:2014+A1:2019 Annex D [6] across all four operating scenarios. The ΔL_{ta} parameter quantifies the audibility of tonal components above the masking threshold, while K_T indicates the adjustment to be applied to the A-weighted equivalent continuous SPL, ranging from 0 to a maximum of 6 dB as tonal prominence increases.

When only one unit operates, low-frequency tonal components near 110 Hz, attributable to the fan's blade passing frequency, are detected predominantly at the neighbouring property and off-axis locations (reference microphones at neighbouring property and around ±60°), with ΔL_{ta} values reaching 11 dB and K_T corrections up to 6 dB. High-frequency tones, concentrated above 14 kHz, are instead detected at microphones positioned directly facing the active fan outlet and along the property boundary, with elevated ΔL_{ta} and K_T values at these locations. Tonal correction factors at several locations exceed the 3 dB threshold, indicating subjectively prominent tones warranting regulatory penalties in environmental noise assessments.

The directional separation between low- and high-frequency tonal components is consistent with the findings on Sharpness. Listeners positioned along the fan outlet axis experience elevated Sharpness and a perceptually hiss-like character due to concentrated high-frequency and tonal content; by contrast, neighbouring property residents are exposed predominantly to low-frequency tonal components and therefore perceive a less sharp but potentially more intrusive low-frequency signature. The elevation difference (40 cm) and geometric asymmetry between the two units potentially further modulate these patterns, creating unequal tonal exposure even under identical nominal operating conditions.

These findings highlight a practical concern: in an installation scenario where the heat pump fan housing faces the garden and therefore the building façade openings, the resident may experience increased annoyance due to tonal emissions even when sound levels transmitting indoors are modest, as with partially open windows or doors. This concern is compounded in warmer regions where heat pumps are used for cooling and residents operate fully open windows and doors, conditions that may apply to both properties. However, these conclusions rest on a single field measurement; further measurements and subjective testing are necessary to substantiate evidence-based recommendations for installation guidance and policy.

3. Measurements on a façade mounted ASHP

3.1. Description of the situation and the measurement setup

This field measurement investigated the acoustic behaviour of one Air Source Heat Pump (ASHP) installed in a typical way on the façade of a residential building in The Netherlands. This setting occurs regularly in circumstances where the positioning of an ASHP separate from the building structure is not desirable or not possible. However, mounting the unit on the façade is known to cause indoor noise issues, which was also observed in the case investigated here.

Figure 5: (Left): View from the ground floor. (Right): View from roof above the kitchen. Installation and measurement setup.

The heat pump is mounted to the side façade of the dwelling, at the first-floor level. The façade consists of a typical cavity wall construction. Measurements were conducted outdoors around the ASHP and indoors in the nearest rooms on the same floor (small office) and on the ground floor (kitchen with open connection to dining and living room). The unit is mounted on L-shaped steel brackets (Figure 5). Due to noise complaints the original mounting of the unit has been changed in the past. The unit is now mounted on soft rubber vibration isolators, specifically designed for light weight installation types like air source heat pump (Figure 5). The measurements were performed using the following instruments:

- Precision Sound Level Meter, Brüel & Kjær, type 2250 with microphone, Brüel & Kjær, type 4189, with windscreen shield.
- Acoustic calibration source, Brüel & Kjær, type 4231.
- Accelerometer, Brüel & Kjær, type 4366.
- Vibration calibrator, Brüel & Kjær, type 4294.
- Noise source (pink noise), Omni LS03.

The measurements were analysed using Spectralyzer analysis software, Peutz, version 3.8.

3.2. Assessment of heat pump mounting

The heat pump is mounted on vibration isolators with a relatively soft type of rubber: hardness of 35°shore. The unloaded height of the vibration isolators is 41±1 mm. The static deflections of the vibration isolators have been measured to determine the theoretical natural frequencies of the mounting situation and to calculate the expected reduction in vibration energy around 100 Hz based on the theory for an ideal spring, see Table 2 below.

Table 2: Static deflections and resulting natural frequency per vibration isolator

position mounting	static deflection [mm]	natural frequency [Hz]	reduction of vibration @ 100 Hz [dB]
front right	8±1	6	50
back right	7±1	6	49
front left	4±1	8	44
back left	1±1	16	32

3.3. Air-borne sound transmission

The reduction of airborne sound from the position of the heat pump to the indoor office behind the wall on the same floor has been measured using a pink noise spectrum from the artificial noise source positioned on the roof of the kitchen. The measured reduction is presented below in Figure 6 (left).

Measurements of the sound pressure level have been performed outside near the heat pump and inside the dwelling, in the office on the first floor. The heat pump was indirectly set to run on maximum heating capacity for the duration of the test by maximizing the demand. The background sound level has also been recorded.

Based on the measured noise levels near the heat pump (1m distance) and the airborne noise reductions measured using the artificial airborne sound source (noise source), the expected airborne noise contribution indoor resulting from the heat pump's operation was calculated. In the right graph of Figure 6 the calculated expected airborne sound spectrum is compared to the measured background noise and the actual measured sound level with the ASHP mounted on rubber vibration isolators.

This figure shows that the calculated expected airborne noise level resulting from the ASHP's operation is approximately 17 dB(A) in the office, with a peak in the 100 Hz 1/3-octaveband of approximately 28 dB. When the heat pump was running, the actually measured sound level in the office was 27 dB(A) with a tonal peak of approximately 43 dB around 100 Hz. This comparison indicates that the indoor sound level is primarily caused by structure-borne sound transmission. Also visible in Figure 6 (right) is that the relevant frequency spectrum for the analysis of the sound levels originating from the ASHP is below 500 Hz.

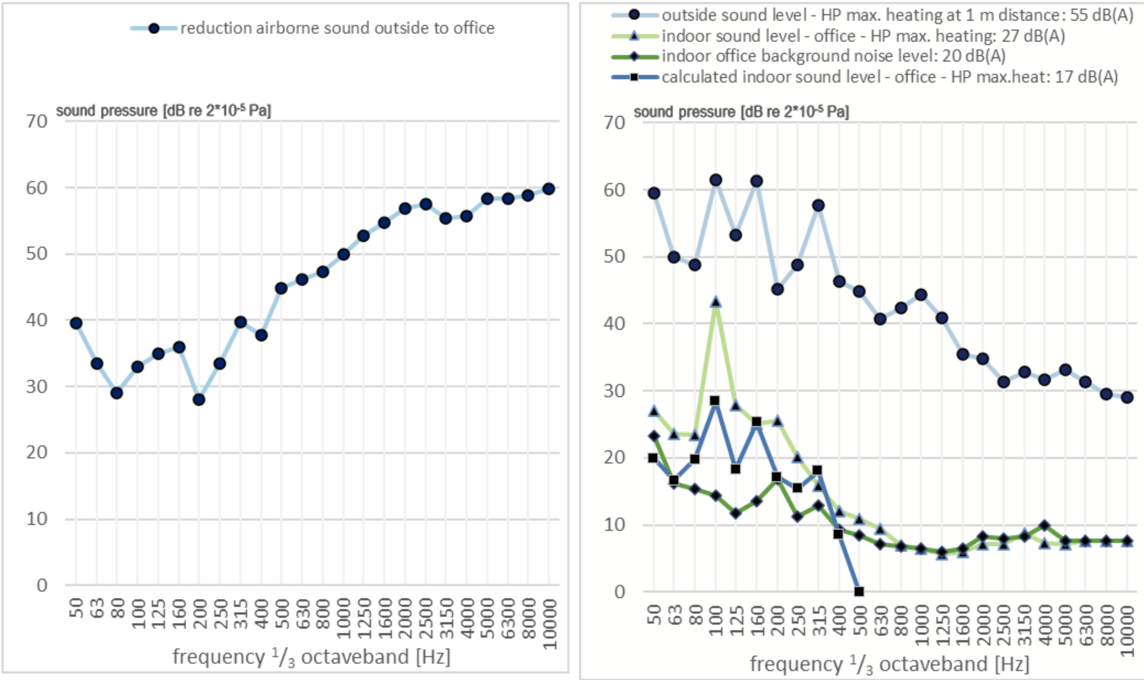


Figure 6: Measured sound reduction (left) and comparison of sound pressure level in the office (right): measured and expected sound pressure level due to air-borne sound transmission.

3.4. Influence of different mounting scenarios

In addition to sound measurements, vibration measurements were also carried out on various components:

- the inside of the façade wall (=indoor), next to top of stairway
- the outside of the façade wall behind the heat pump, different positions
- on the support frame/bracket near the wall mounting - bottom and top bolts
- on the support frame/bracket on the end of the cantilever near the vibration isolators
- above the vibration isolators/the underside of the heat pump frame
- on top of the heat pump housing

In the following section only the data from the most relevant measurement positions for the comparison are presented. The frequency spectrum is restricted to the range of 50 Hz to 500 Hz, as higher frequencies are considered irrelevant for this comparison. Measurement results below 50 Hz are also not included because of the limits to low frequency sound measurements within small spaces. Even the included measurement results in low frequencies should be seen as indicative for the same reason. The sound field is inhomogeneous in the relevant low frequencies. The selected measurement position was a relevant position for the use of the office: in the middle of the room, height of the head/ears.

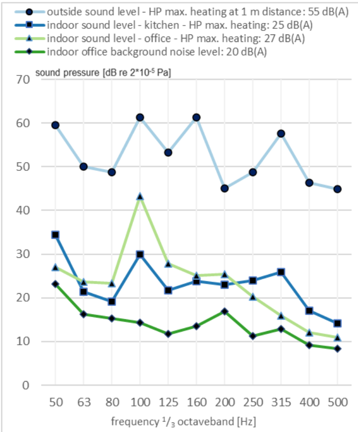
The effect of a situation with the heat pump mounted more rigidly on the frame has been measured. Wooden wedges have been firmly placed in between the underside of the heat pump and the steel frame. Therefore, bypassing the isolators. Another variant has been investigated, where the whole heat pump frame has been rigidly connected to the underlying roof using car jacks on concrete paving slabs which were placed directly on the roof insulation. These variants are shown below in Table 3.

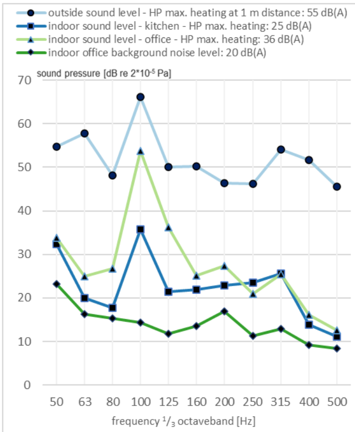
Table 3: Different mounting situations and measurement results of façade mounted ASHP

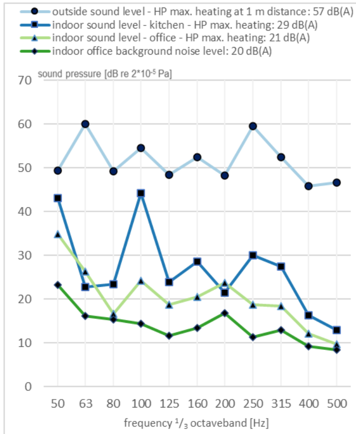
Mounting situation

Rubber vibration isolators	Rigid mounting	Coupled to the kitchen roof
		

Sound pressure measurements



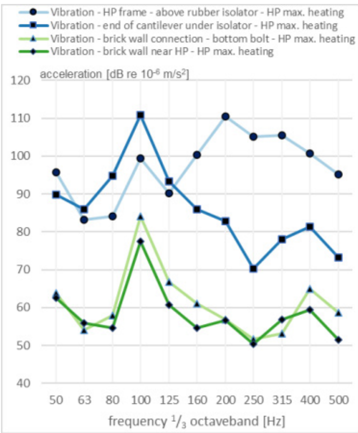


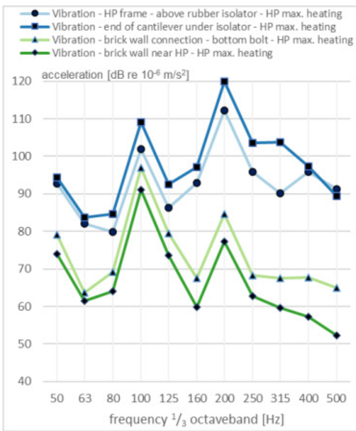


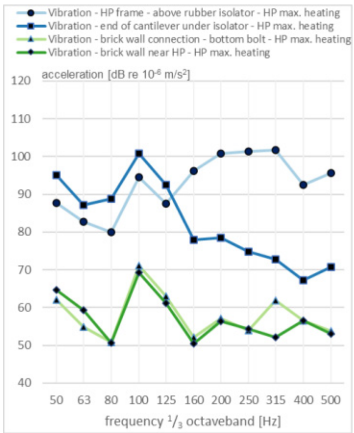
Tonality values

Rubber vibration isolators	Rigid mounting	Coupled to the kitchen roof
Outside: 0.588 tuHMS	Outside: 0.458 tuHMS	Outside: 0.570 tuHMS
Kitchen: 0.050 tuHMS	Kitchen: 0.546 tuHMS	Kitchen: 0.152 tuHMS
Office: 0.203 tuHMS	Office: 0.493 tuHMS	Office: 0.045 tuHMS

Vibrations measurements







Heat pump on rubber mountings

From the static deflection of the rubber vibration isolators the vibration levels at 100 Hz should ideally be reduced by around 50 dB on the right side and around 32 dB on the left side. Contrary to these expectations the vibration measurements with rubber isolators show that, between 63 Hz and 125 Hz, the vibration level in the cantilever exceeds the level above the vibration isolator. This suggests that the support frame/cantilever has a natural frequency in this part of the spectrum which also coincides with the heat pump compressor's harmonic to the rotation frequency of 50 Hz.

Heat pump on wooden blocks

Adding wooden blocks between the ASHP and the cantilever frame results in vibration levels at the cantilever tip that closely follow and in some cases exceed the vibration levels measured on the ASHP frame. The higher vibration level at the frame can be partially attributed to the measurement location being farther from the wall mounting point. This point serves as the rotational axis for cantilever-induced vibrations.

Adding the blocks leads to an increase of acceleration levels of approximately 13 dB around the 100 Hz ⅓ octave band. The outdoor sound level has a notably higher peak around 100 Hz, which does not coincide with the vibration levels shown in the graph but can be related to a higher vibration level in the housing of the heat pump.

The indoor sound pressure levels around 100 Hz increase by 6 dB in the kitchen and 11 dB in the office. According to the owner of the house the indoor sound level was perceived to be even louder in the original situation with the heat pump mounted directly on the support frame (without rubber mountings).

Heat pump support by concrete roof kitchen

The transition of the support to the roof of the kitchen and unloading of the rubber vibration isolators leads to a significant increase of the 100 Hz tonal sound level in the kitchen (by 14 dB at 100 Hz) and a reduction of the tonal sound level in the office (by 19 dB @ 100 Hz). The vibration level in the wall near the mounting point is reduced by approximately 8 dB at around 100 Hz compared to the configuration where the heat pump is supported by rubber isolators on the cantilever frame.

The vibration level in the heat pump frame decreases because the unit's free movement is constrained by its rigid connection to the kitchen roof. The vertical link to the concrete roof provides significantly greater stiffness compared to the cantilever frame mounted on the brick wall, thereby limiting displacement.

Tonality Analysis

The tonality values were calculated using the Sottek Hearing Model (ECMA-418-2 (3rd Ed.)[5] within HEAD Acoustics Artemis Suite 17.1, for various mounting scenarios. Given the nature of this fieldwork, where indoor HP sound levels are low and dominated by low frequencies, the Sottek Hearing Model was selected to better represent human perception, replacing the Joint Nordic Method v2 used in the first part of this paper. The results highlight distinct performance differences between the structural isolation methods.

The outdoor tonality was similar in all three cases when the HP was mounted by the rubber mountings, directly on the kitchen roof, and the wooden blocks. In contrast to the outdoor situation the indoor tonality levels varied significantly. The highest tonality values both in the office and the kitchen were measured with the wooden blocks installed instead of the rubber isolators. In the office, the second highest tonality level was recorded with the HP mounted on the cantilever frame with rubber isolators, with the direct mount to the kitchen roof the lowest. This trend was opposed by the second highest tonality level in the kitchen when the heat pump was directly connected to the roof. Overall, these results are in line with the assessment of the sound- and vibration measurements.

Adding mass to the cantilever frame

To lower the natural frequency of the frame a concrete paving slab has been attached to each cantilever. Each slab has an approximate mass of 10 kg. The graphic below (Figure 7) shows a comparison of the vibration levels in the mounting frame and the wall, with and without extra mass.

The vibration measurements indicate that adding mass to the support frame reduces vibration levels around 100 Hz by approximately 18 dB at the end of the frame and 10 dB at the brick wall. In the mounting frame there is a slight increase of 2 dB around 50 Hz and strong increase of 15 dB around 200 Hz. At the wall, this corresponds to increases of roughly 6 dB at 50 Hz and 3 dB at 200 Hz. The increase near 50 Hz can be attributed to a lowering of the mounting frame's natural frequency due to the added mass. The cause of the increase around 200 Hz remains undetermined.

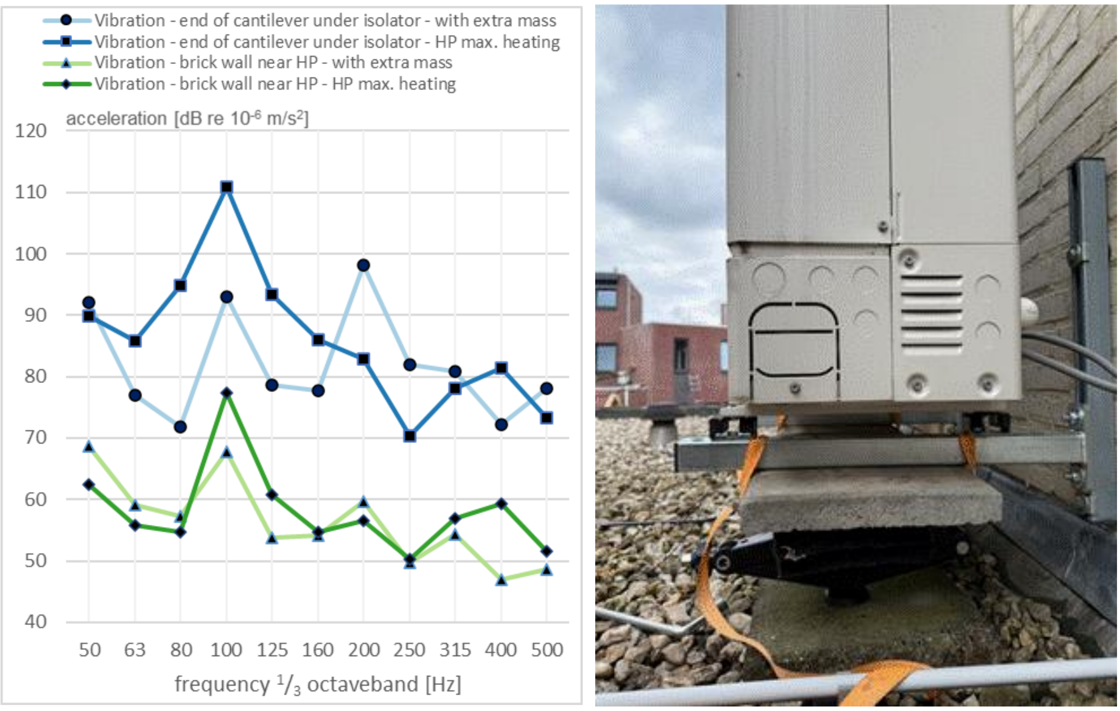


Figure 7: Vibration measurements with mass added to the cantilever frame.

Conclusion

The analysis of two field measurements demonstrates that noise emissions from heat pumps can significantly impact residential comfort. In the cases studied, structure-borne sound was found to be a notable source of indoor airborne noise when it is transmitted through the building structure. The propagation of structure-borne sound varies with the mounting configuration. This creates different acoustic hotspots within the dwelling. Measurements on a façade-mounted heat pump confirm that structure-borne noise influences both the level and tonality of indoor sound. In the two cases studied, the air-borne sound emitted by ASHP appeared less problematic regarding the sound inside of the building. However, psychoacoustic analyses show that the sound character can have a disturbing effect.

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