Data Center Noise Analysis
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Introduction:

Data Centers and the construction thereof, are causing increased concern on local residences living by or near such facilities. These concerns include, but not limited to, power and water usage, heat produced, air quality and noise levels produced from such facilities. This synthesis paper looks at the effects of noise, specifically low frequency noise, produced by such facilities.

Problem: The problem is people living near or by a data center perceive low frequency, high decibel noise will negatively affect both health and property values.

Argument: The closer residences are to data center noise sources the greater the negative impact on both residency health and property values.

Research Questions:

1. At what distances and rate do low frequency, high decibel sound waves, like those produced by a data center, travel before they become non-impacting to human physiology?
2. At what distances and rate do low frequency, high decibel sound waves, like those produced by a data center, travel before they become non-impacting to property values?

Limitations include the use of secondary data and information from sources that may not be consider as authoritative. In such cases, multiple sources have been noted, whenever possible, in order to make the facts presented both true and strong. This does not replace the need for primary or more formal research to occur.

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Methodology:

The methodology of research includes the use of relevant secondary data and information gathered from both authoritative and non-authoritative sources through the use of the internet and with the assistance of AI for gathering and conformation purposes only and when applicably. The data and information gathered was reviewed, sorted, and analyzed using established and accepted academic research methodologies as best can be applied given the type data and information. Then organized and presented in a manner also consistent with accepted academic research methodologies. AI has not been quoted or cited.

Background:

Sound as a phenomenon is defined as a mechanical disturbance that propagates through a medium. A sound wave is the measurement of that disturbance in terms of frequency, wavelength, and amplitude. [1,2,6] Where frequency is the number of times a sound vibrates per second and wavelength is the distance between each wave height. See Figure 1. As such, there is an inverse relationship between frequency and wavelength. Meaning the higher the frequency the short the wavelength. Therefore, high frequency sounds have shorter wavelengths and low frequency sounds have longer wavelengths. See Figure 2.

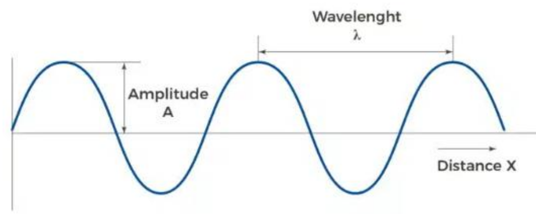


Figure 1: Amplitude, Wavelength. [1]

Frequency, for humans is between 20 and 20,000 Hz [5,7], See Figure 3, and is organized into three basic categories low, medium and high. Where:

- Low Frequency 20 – 500 Hz: Have long, wide wavelengths carrying immense energy. These wavelengths can easily bend around obstacles, pass through walls, and travel vast distances depending on medium. [3,7]
- Medium Frequency 500 – 2,000 Hz: Are at the core of Human/Animal/ Insects detection. Medium frequency sounds can travel up to 2 miles depending on frequency, amplitude, and medium. [3,7]
- High Frequency 2,000 – 20,000 Hz: Have short, closely packed wavelengths that don't bend easily around solid objects, are easily blocked and absorb quickly into the air. High frequency sounds don't travel far less than 1000 feet depending on medium and volume. [3,7]

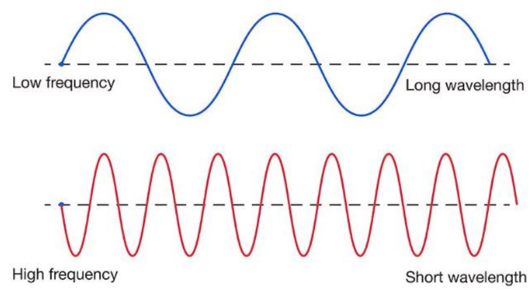


Figure 2: Long and Short Wavelengths. [2]

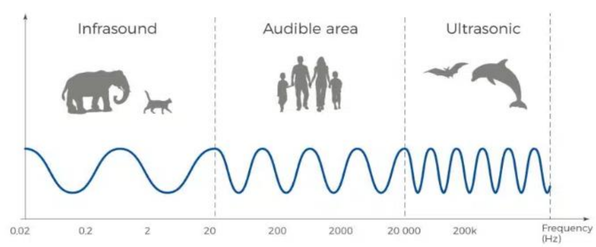


Figure 3: Human Low to High Frequency Range.

Amplitude is the measurement of energy contained within the soundwave, its intensity, i.e. loudness, measured in decibels (dB). [8,9,10] Soundwaves with a higher amplitude carry more energy thus create a louder sound.

- 10 dB: Sound of a pin drop.
- 20 dB: Barely perceptible sound, registering just slightly above the threshold of human hearing
- 30 dB: A quiet library or whispering.
- 60 dB: Normal conversation.
- 85 dB: The threshold for potential hearing damage with prolonged exposure.
- 120 dB: A live rock concert or a siren, which can cause immediate physical discomfort or pain.

Normal back ground noise range between 30 dB in the wilderness to 85 dB in cities and other urban areas. With a normal conversation ranging between 60 – 70 decibels. [10,11] Continued exposure of over 80 dB will cause hearing loss. [11,12] The volume (dB) and the length of exposure gives indication as to how harmful the noise is. "In general, the louder the noise, the less time required before hearing loss will occur." [13] See Table 1. OSHA requires hearing protection for 8-hour exposure above 85 dBA [17]

Noise Level dBA	Maximum Exposure Time	Noise Level dBA	Maximum Exposure Time
85	8 hours	106	3.7 minutes
88	4 hours	109	1.85 minutes
91	2 hours	112-118	Less than 1 minute
94	1 hour	121-124	Less than 10 seconds
97	30 minutes	127	1 second
100	15 minutes	130-140	Less than 1 second
103	7.5 minutes	140+	NO EXPOSURE TIME

Table 1: Noise Exposure [13]

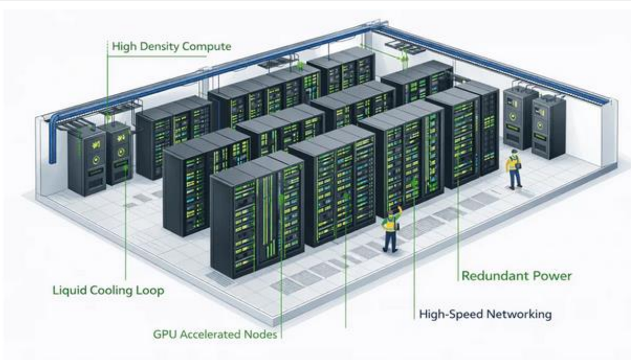


Figure 4: Data Center [15]

Data Center: A data center is a centralized physical facility, generally operating 24/7, that securely houses vast amounts of computing equipment and infrastructure support systems` used to facilitate Cloud Computing, Web Hosting, and Artificial Intelligence. [14, 15] See Figure 4.

There are 4 basic types of data centers: Enterprise Data Centers – owned and operated by a single organization strictly for their own use and generally located in or near a company headquarters [43,44,45]; Colocation (Colo) Data Centers – shared buildings where multiple organizations rent space, power, and cooling systems housing their own servers and networking systems [48,49,50]; Hyperscale Data Centers – large scale facilities typically located in or near a major city occupying thousands of square feet containing thousands of severs and miles of connecting equipment. Some these hyperscale data centers can be as large as 60,000 square feet [41,43,44,45] housing as many as 10,000 server racks with a capacity in excess of 80 megawatts (MW) [51]; and Edge Data Centers – smaller data centers ranging from a single server rack to as many as a 100 generally operating in the 500 kilowatts (kW) to 2 megawatts (MW) range. [51] Within each of these data centers are a large number of servers, storage systems, and networking equipment all configured within server racks. [40,41,42]

There are two basic types of server racks. The standard 42U server rack containing about 35 individual servers and the 48U server rack typically housing about 43 servers. Each individual server within a server rack can produce 1000 to 3,000 BTUs of heat per hour, with an average of 1600 BTUs per hour. Each server rack can produce up to 70,000 BTUs per hour. [47,48]

1600 BTUs per Server per Hour x 43 Servers per Server Rack = 68,800 BTUs/Hour (70,000 rounded)

Each server rack on average occupies a space of approximately 6 sq. ft. on a foot print of 3 by 2ft. Meaning, a 60,000 sq. ft. Hyperscale Data Center may contain as many as 10,000 server racks each producing up to 70,000 BTUs/Hour resulting in temperatures over 200°F without an effective cooling system.

In order to maintain proper cooling temperatures most data centers use backward-curved centrifugal cooling fans. The average output for one of these fans, in terms of airflow, is approximately 3000 CFMs. Using a rule of thumb for data center cooling of 1 to 1.5 CFMs per square foot. This equates to needing one cooling fan for every 2000 sq. ft. of data center space. When in operation each these cooling fans can produce an overall noise level of approximately 85 decibels at an average frequency between 80 and 100 Hz. [18,21,23] Thus, a 60,000 sq. ft. data center will require at least 30 backward-curved centrifugal cooling fans to maintain an ASHRAE-recommended temperature between 64 – 81°F.

A Data Center, when in operation, produces sound frequencies between 20 – 20,000 Hz but generally in the range of 60 to 250 Hz with an approximate average of 80 to 100 Hz. These low frequencies are the “dominant characteristic of data center” [19] putting out significant amounts of low frequency sounds [22] ranging from 60 decibels to as high 100 decibels or more [21,24] depending the number of cooling fans and/or HVAC units. Most of which are located on the data center’s roof, allowing for low-frequency sound waves to travel greater distances unrestricted; impacting nearby communities [20] including those at much as 3 miles away particularly at night when overall ambient noise decreases and cooler temperatures [24] provide a more favorable medium in which to transmit. [32,33,34]

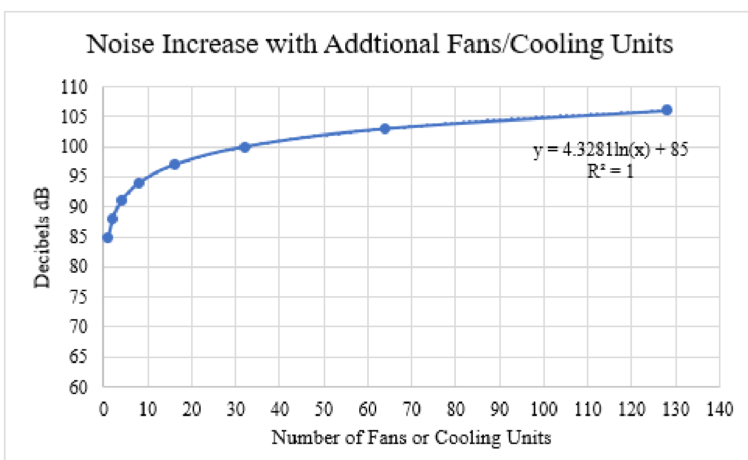
Discussion:
Data Center: As noted above a Data Center’s most dominant characteristic is the generation of low frequency sound waves, 80 to 100 Hz, at high decibel levels; 85 dBs or greater. This frequency places data center noise directly in line within a human beings’ low frequency hear range as shown in table 2.

	Low Frequency						Medium Frequency	
Frequency Hz	0	50	100	150	200	250	300	350
Data Center								
Human								

Table 2: Data Center, Human Low Frequency Range

With additional cooling fans decibel levels can increase to over 100 dBs on a logarithmic scale. Meaning that for each doubling of a data center cooling fan the number of decibels increases by 3. [26,27,28] Therefore, there is little difference between having one fan or 100. See Figure 5.

No. of Fans	Decibels
1	85
2	88
4	91
8	94
16	97
32	100
64	103
128	106



See Figure 5: Additional Cooling Fan Effects

Low frequent sound dissipation, in normal atmospheric conditions, is also logarithmic dropping approximately 6 decibels for each doubling of feet traveled (See Inverse Square Law). [4,29,31]

100 Hz Cooling Units (Fans) in Decibels				
Feet	1 Unit	30 or More	Subjective	Comments
0	85	101	Very Load	Hearing Protection Required
3	79	95		
7	73	89		
13	67	83		
26	61	77	Loud	Disruptive/ Maybe Painful
52	55	71		
105	49	65	Moderate	Normal Conversational Range
210	43	59		
420	37	53		
840	31	47		
1680	25	41	Faint	Quiet/ Whispering
3360	19	35		
6719	13	29	Very Faint	Barely Perceptible
13438	7	23		

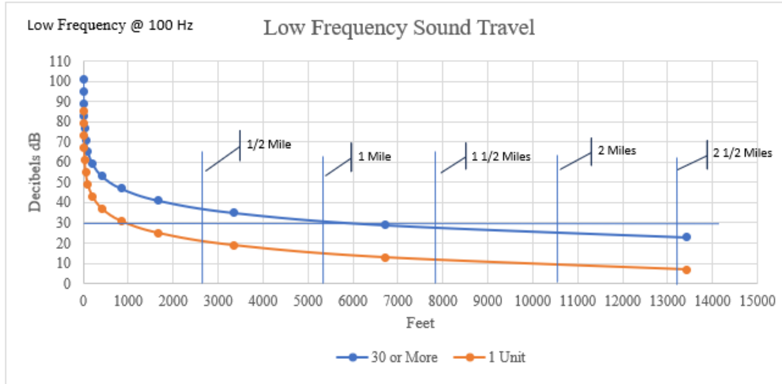


Figure 6: Low Frequency Sound Travel

As shown figure 6, a low frequency 100 Hz sound beginning at 85 decibels, equivalent to a data center with 1 cooling fan, would most likely dissipate to the very faint level (barely perceptible 30 dBs or lower) after traveling approximately 1,680 ft or about ⅓ of a mile. A low frequency 100 Hz sound beginning at 101 decibels, equivalent to a data center with 30 or more cooling fans or units, would most likely dissipate to the very faint level (30 dBs or lower) after traveling approximately 6,719 ft or about 1¼ miles.

Human Effects: Low frequency, high decibel sound waves can cause serious health issues, especially to those closer to the sound source. Health issue reported include, but not limited to: increased level of anxiety and depression, increased stress levels, hypertension, headaches & migraines, reduced memory, concentration, sleep deprivation, and reduced ability to work or exercise. [16,34,35,36,37]

Land Value Effects: Low frequency, high decibel sound waves, like those produced by data centers, may have a negative impact on established neighboring residential land and property values especially those living in close proximity, a mile or less, although there is little published data to support it.

In fact, one such study that actual refutes that proposition conducted by George Mason University's Schar School of Policy and Government found homes, whether single-family residences, townhomes, or condos, closer to a data centers actually sold for more. Reason; data centers are typically built in areas with strong infrastructure, including good roads, reliable utilities, and easy access to jobs and airports, all of which are features that make nearby neighborhoods more desirable. [38]

Although, according to documentation published by Own Luxury Homes ® [39] any resident within a mile of a data center may experience as much as an 18% discount. Those between 1 and 2 miles of a data center may actually see a 1 to 4% increase in property value. Those between 2 and 5 miles may see a 2% increase in value and residencies greater than five miles are unaffected with home values set at current market value. See Table 3.

Distance from Facility	OLH Designation	Noise Level (est.)	Visual Impact	Employment Premium	Value Impact	OLH Guidance
0–500 ft	Immediate Adjacency	55–65 dB continuous	High — direct view	Minimal	Discount 8–18%	Avoid for residential purchase. Industrial neighbor discount is permanent.
500 ft–0.25 mi	Near Adjacency	40–55 dB	Moderate	Low	Discount 3–8%	Due diligence required. Verify cooling system type (air vs water cooled) and noise barrier.
0.25–0.5 mi	Transition Zone	Under 40 dB	Low–None	Low–Moderate	Neutral ±1%	Standard due diligence. Verify no expansion planned within 0.25 mi.
0.5–1 mi	OLH Proximity Sweet Spot	None	None	Moderate	Neutral to +2%	Optimal range. Employment benefit without adjacency discount.
1–2 mi	Employment Catchment	None	None	High	+1–4%	Strong position. Captures DC employer demand; residential character unaffected.
2–5 mi	Corridor Catchment	None	None	Moderate	Neutral to +2%	Broad employment benefit. Useful for investor analysis of employment-driven appreciation.
5+ mi	General Metro	None	None	Low	Market rate	No specific DC proximity effect. Standard market analysis applies.

OLH Data Center Proximity Valuation Framework, May 2026. Distance ranges and discount/premium estimates are approximate and market-specific. Northern Virginia markets have higher discount/premium sensitivity due to density of DC facilities. Noise levels are estimates based on EPA industrial facility guidance and published hyperscale facility specifications. Value impact estimates based on OLH analysis of comparable sales data in Northern Virginia, Phoenix, and Columbus DC corridors.

Table 3: Residential Home Value Impact. [39]

When above information is plotted in relationship to low frequency sound travel it appears that homes that within a mile of the data center may experience negative home values and the closer to the data center the more negative the value becomes. See Figure 7.

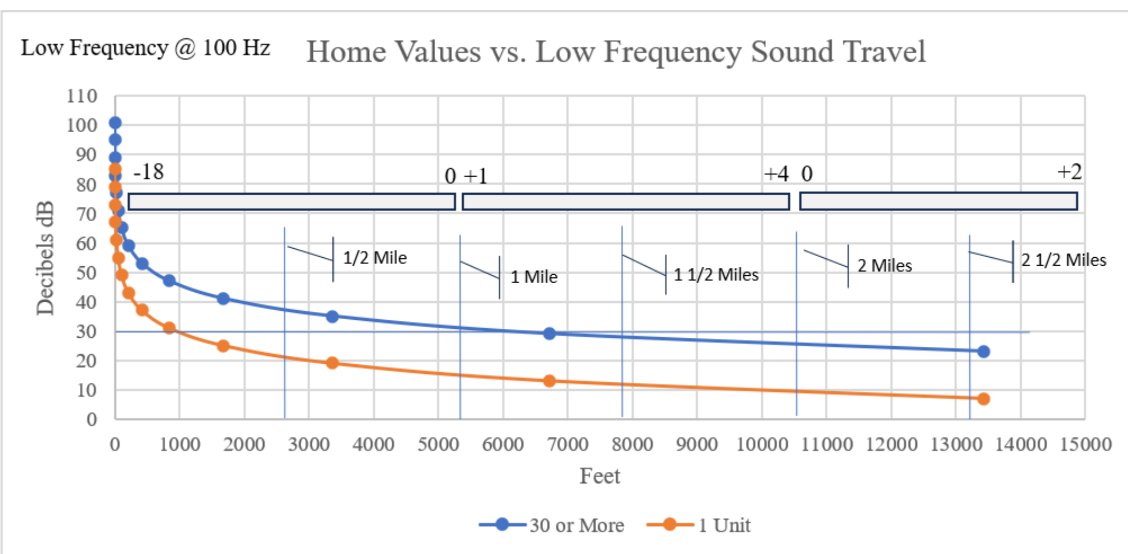


Figure 7: Home Values vs. Low Frequency Sound Travel

Homes between one and two miles away from a data center may see a positive increase in home values, as much a 4% the closer the home is to the two-mile mark benefitting from a what is called the employment catchment area defined as a geographic area from which the data center draws its workforce. After the two-mile mark and before the five-mile mark, home values may increase in value only about 2% due to the home being in what is known as the corridor catchment area. Past the five-mile mark local market rates apply.

Conclusion:
From the data and information provided a data center when in operation can generate a significant amount of low frequency sound waves ranging between 60 and 250 Hz [18,21,23] with an average of approximately 80 – 100 Hz [21,25] at decibel levels of 85 dB or greater depending on number of cooling fans or units applied.

Unlike high frequency sound waves that generally travel short distances and are easily blocked by barriers such as walls or other structures. [3,7] Low frequency sound waves can travel great distances and cannot be easily by the blocked by walls or other structures. [3,7] Low frequency, high decibel sound waves, like those produced by data centers, can travel up to 1½ miles before sound dissipation falls below the 30 dB level depending on the environmental medium.

Those living within 1¼ miles and moving towards a data center, consisting of 30 or more cooling fans producing low-frequency 100 Hz sound waves at 100 dB will most likely experience ever increasing hearing loss, increased health issues, along with decreasing property values as much as an 18% or more.

Those living greater than 1¼ miles and moving outwards from a data center, consisting of 30 or more cooling fans producing low-frequency 100 Hz sound waves at 100 dB will most likely not experience the same health effects as those living within 1¼ miles and may find property values increase.

Therefore, for those residing within 1¼ miles of a data center the argument “the closer residences are to data center noise sources the greater the negative impact on both residency health and property values” is true and the problem statement “people living near or by a data center perceive low frequency, high decibel noise will negatively affect both health and property values” is verified.

References:

[1] https://svantek.com/academy/sound-wave/
[2] https://sciencephotogallery.com/featured/wavelength-and-frequency-science-photo-library.html
[3] https://acousticalsolutions.com/sound-frequency-chart?srsltid=AfmBOorYLMZMtae9QICCQmZLk9SNhFAJXdUfK2H5baVHxRxY6iib6WDQ
[4] https://avcsstechworld.com/the-inverse-square-law/
[5] https://www.hearingyourbest.com/blog/how-human-hearing-stacks-up-in-the-animal-kingdom/
[6] https://mecanum.com/frequency-wave-length/
[7] https://www.soundproofcow.com/difference-high-middle-low-frequency-noise/?srsltid=AfmBOoqoLl3moD5vueQDWZbO9_WblH0GdD_yZEWlGTLNsah4h4iQiZy-
[8] https://int.livhospital.com/what-decibel-level-is-harmful-to-your-hearing/
[9] https://www.johndcook.com/blog/2008/03/11/how-loud-is-the-evidence/
[10] https://ia.cpuc.ca.gov/environment/info/aspen/cresseygallo/fmnd/5-12_noise.pdf
[11] https://ehs.yale.edu/sites/default/files/files/decibel-level-chart.pdf
[12] https://noiseawareness.org/info-center/common-noise-levels/
[13] https://www.mdhearingaid.com/blog/decibel-chart/?srsltid=AfmBOooWSrVC2IoVMchJa2WM9O7dbOnZumFk2EKlPs8PTTfv71BAj5yy
[14] https://aws.amazon.com/what-is/data-center/
[15] https://www.supermicro.com/en/glossary/data-center

[16] https://www.eesi.org/articles/view/communities-are-raising-noise-pollution-concernsabout-data-centers
[17] https://acousticalsolutions.com/data-center-noise-pollution?srsltid=AfmBOoquM3pBoQAtDN3x-6Y0jDAYxCO0QcPkgpqzKsPoiZIti1XU9eAG
[18] https://ketchumandwalton.com/noise-control-in-data-centers-what-it-is-why-it-matters-and-how-to-get-it-right/
[19] https://noisemonitoringservices.com/data-center-noise-control/
[20] https://www.datacenterknowledge.com/data-storage/what-are-the-5-main-causes-of-noise-in-data-centers-
[21] https://www.lsars.com/data-center-noise
[22] https://lab.acentech.com/2025/11/06/good-noise-neighbor/
[23] https://energylinkinternational.com/areas-of-focus/noise-management-solutions/data-centers/
[24] https://pragmaticenvironmentalistofnewyork.blog/wp-content/uploads/2025/10/physical-attributes-of-a-typical-loudoun-county-v.pdf
[25] https://www.environmentalhealthproject.org/post/the-dangers-of-data-centers
[26] https://www.sonitron.be/combined-sound-sources-calculator/
[27] https://www.ussi.com/acoustical-rules-and-demystifying-decibel.php
[28] https://www.firgelliauto.com/blogs/calculators/noise-pollution-db-addition-calculator
[29] https://isostore.com/research/understanding-the-inverse-square-law/?srsltid=AfmBOor1zi3V4Rsat84vJL7jFsqsLOkhM2mxcz9-7QamIvkNEtLnUBcn
[30] https://www.mdpi.com/2076-3417/10/15/5205
[31] https://www.firgelliauto.com/blogs/engineering-calculators/decibel-distance-calculator-sound-level?srsltid=AfmBOoqd5ohpVLXIOvW9fIcGFd1p6EhLjDEsi_N4SYDbqmvKyAsP_RVJ
[32] https://www.peacefulpeculiar.org/uploads/1/5/0/3/150368424/health_issues_461968685l4666.pdf
[33] https://www.sierraclub.org/sites/default/files/2025-07/data-center-factsheet-4.pdf
[34] https://www.pwcva.gov/assets/2024-06/240605%20Presentation%20to%20DCOAG-JMT%20%28Lyver%29.pdf
[35] https://www.epa.gov/archive/epa/aboutepa/epa-identifies-noise-levels-affecting-health-and-welfare.html
[36] https://lailluminator.com/2026/06/09/data-centers-3/
[37] https://gerrymcgovern.com/data-centers-are-noisy-and-smelly/
[38] https://www.housebeautiful.com/design-inspiration/real-estate/a71253889/data-center-property-values/
[39] https://www.ownluxuryhomes.com/markets/ai/guide/data-center-adjacent-residential-values
[40] https://encoradvisors.com/data-center-hardware/
[41] https://www.fortinet.com/resources/cyberglossary/data-center
[42] https://datacenteruniversity.be/whats-inside-a-data-center/
[43] https://www.ibm.com/think/topics/data-centers
[44] https://www.acceldata.io/blog/data-center-types-enterprise-to-edge-explained
[45] https://www.nlyte.com/faqs/what-is-a-data-center/
[46] https://www.jll.com/en-us/insights/why-smaller-data-centers-are-taking-off
[47] https://www.serverroomenvironments.co.uk/blog/how-to-calculate-server-room-air-conditioner-sizes?srsltid=AfmBOoo4mekIlTDw05rgymxlyvbnpG6d14uqQgziUCliQN3NxHApKhwN
[48] https://www.techtarget.com/searchdatacenter/tip/Data-center-cooling-optimization-in-the-virtualized-server-world.
[49] https://scispace.com/pdf/low-frequency-noise-and-its-main-effects-on-human-health-a-1mi8gdwyfc.pdf
[50] https://pmc.ncbi.nlm.nih.gov/articles/PMC9008144/
[51] https://www.tri-cityaudiology.com/hearing-loss-articles/sounds-can-have-a-bigger-impact-on-your-health-than-you-know/
[52] https://pmc.ncbi.nlm.nih.gov/articles/PMC10001830/