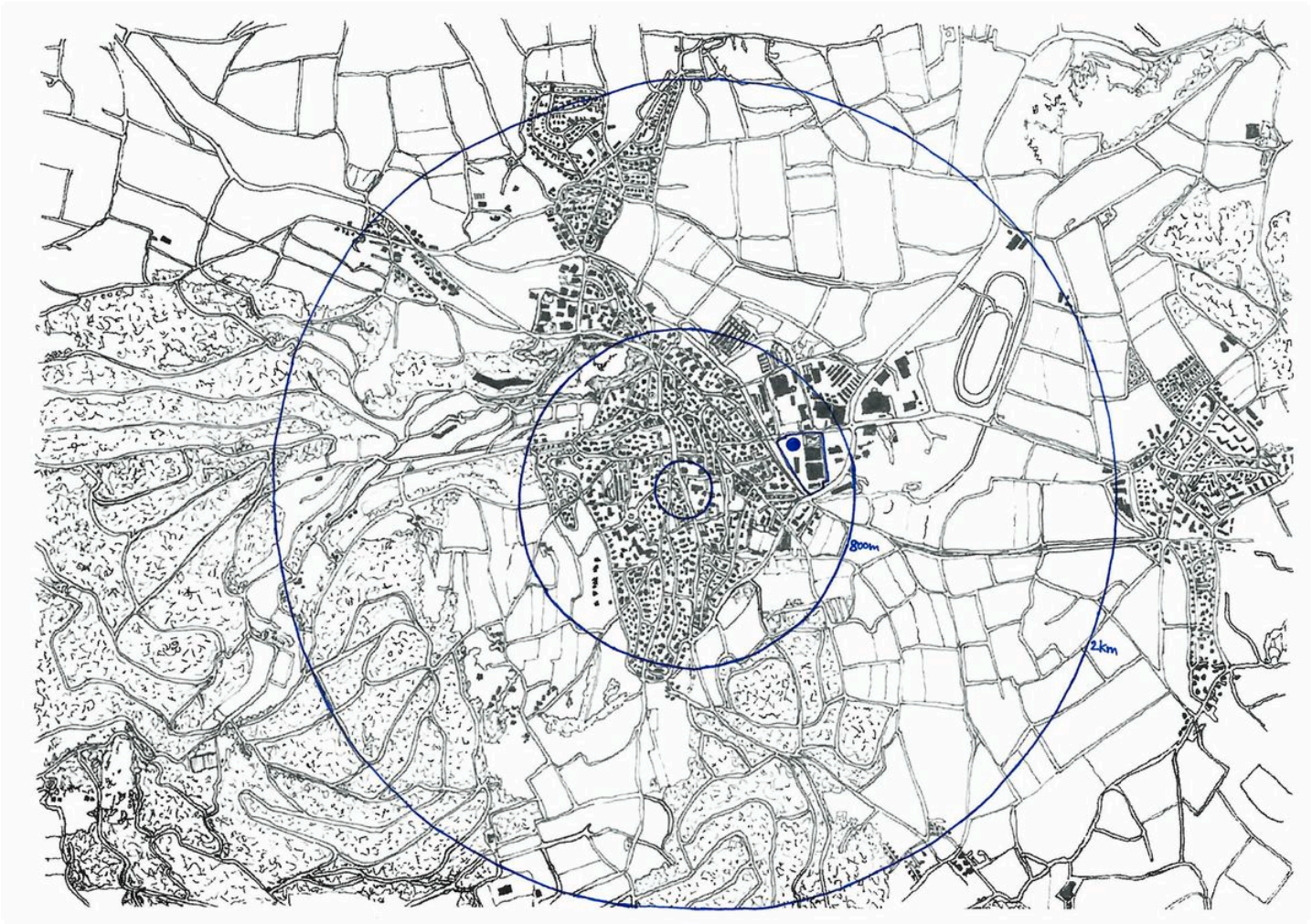
ETH Zurich Department of Architecture
ARCHITECTURE OF TERRITORY
Chair of Architecture
and Territorial Planning
Professor Milica Topalović

The Production of Cloud
Spring 2026

Land Use and Location

Where Data Meets People: Rethinking Data Centre Locations

Emma Kleinbölting, Antonia Johanna Karl, Beda Füssler, and Simone Graf

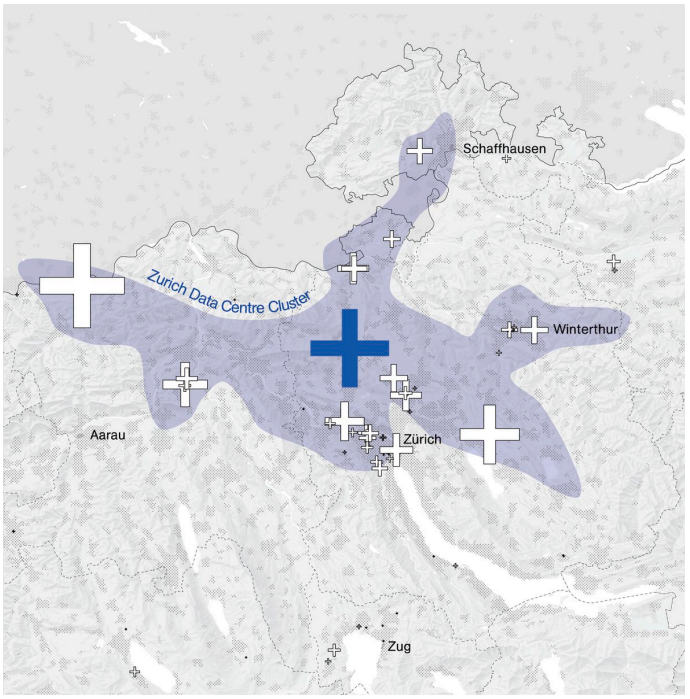


As digital demand continues to grow, private investors and data centre companies are increasingly focused on developing more efficient data centres. With this steadily rising density of data centres, especially in established clusters like Zurich's, the question of location factors has become more significant than ever.

Site selection is largely driven by technical requirements, such as connectivity to the electrical grid (often leading to the construction of new substations), proximity to the fibre-optic systems of multiple carriers, low latency to end users, as well as accessibility via transport systems like airports and trains.

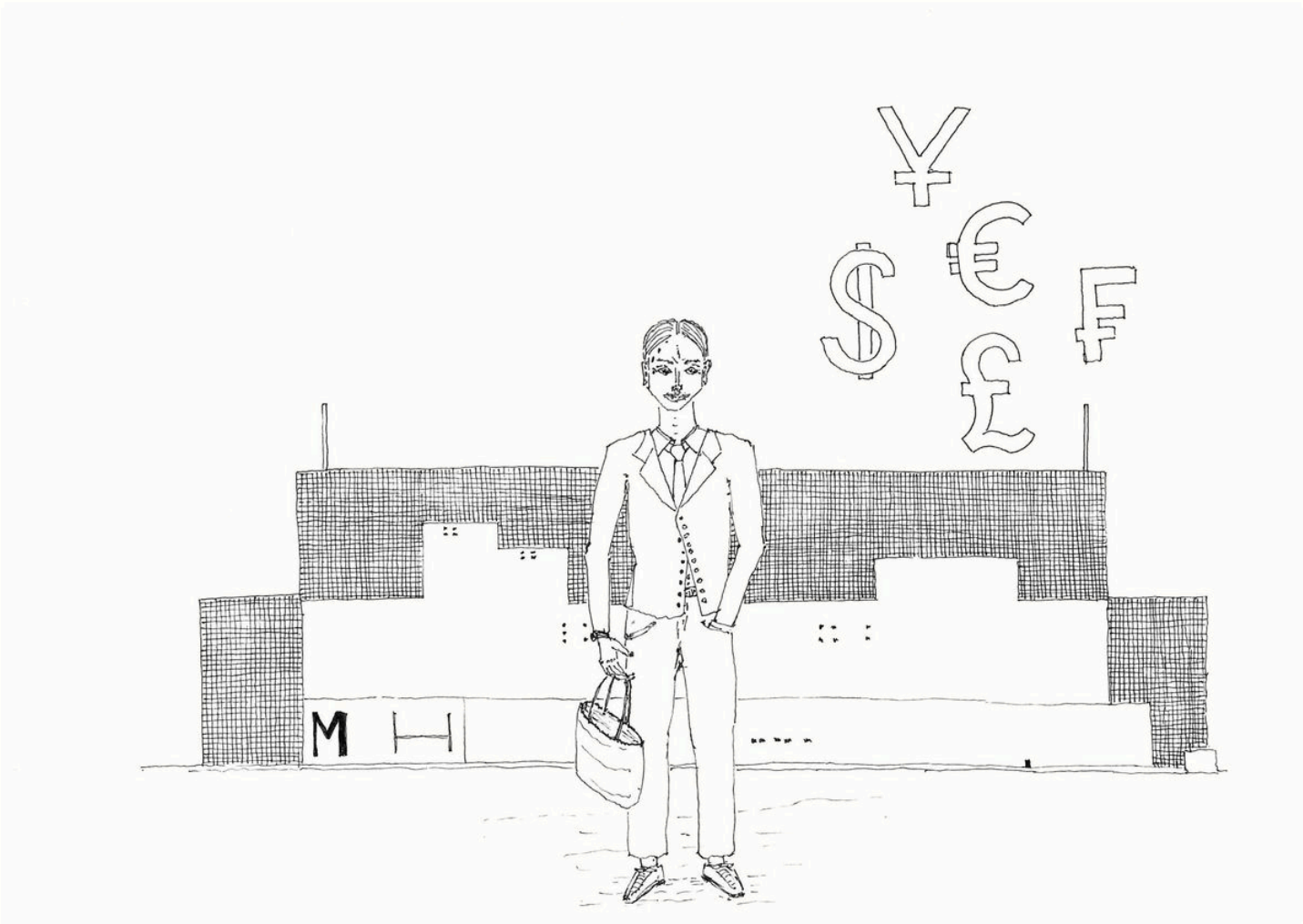
Although this economic and technical approach is today's reality, it neglects an important dimension: The integration into the surrounding environment as well as the local neighbourhood. Data centres are often perceived as grey boxes on the periphery of municipalities. However, they affect nature and the human body in more ways than is commonly understood. Constant operational noise, increased heat emissions, and a windowless buildings towering over a community drastically influence the quality of life.

Through strategic intervention in the legal planning process and the introduction of a design toolbox, this project explores ways in which data centres can respond more cautiously to the surrounding ecologies and communities.



Name Data Centre: Metro Campus Zürich
Commune: Dielsdorf
Type Data Centre: Hyperscaler
Capacity: 90 MW
Operator: Green Datacenter AG
Year: 2023
Status: 2 buildings built, 1 under construction
Waste Heat Use: District heating

The Geography of Today's Data Infrastructure



Private companies and investors, often operating on an international scale, have become the dominant stakeholders in the development of today's data infrastructures. Their decisions are primarily driven by the pursuit of economic efficiency and the reduction of operational costs. As a result, the existing energy grid, the infrastructure system and the fibre-optic network have emerged as the most decisive factors when selecting a site for a data centre.

“Zurich is one of the most important digital hubs in Europe,” someone told us at the beginning of our research. While analysing Zurich’s data centre cluster and our case study project—the Metro Campus in Dielsdorf by Green Datacenter AG—we began investigating the factors that influence how companies such as Green select sites for new data centres.

Some of these considerations initially came across as highly technical or logistical, others seemed to be primarily business-driven. Yet ultimately, they all converge around one central objective: maximising operational reliability, connectivity, and economic efficiency for the data centre operator.

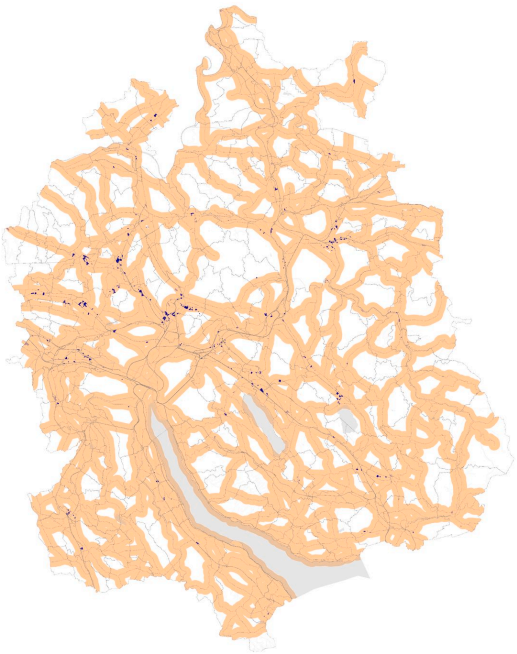


Why Dielsdorf? On Choosing a Site for a Data Centre, video essay, 2026.
https://www.youtube.com/watch?v=n4fYojL6620

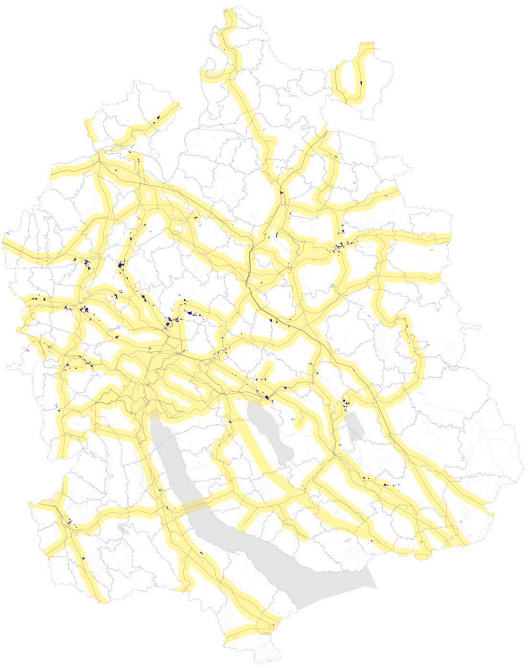
One of the most decisive factors in site selection is proximity to end users. Low latency is essential for digital services, leading to the formation of concentrated digital hubs around major metropolitan regions.

Data centers continuously synchronize data, store backups, and exchange information within interconnected networks. Rather than operating as isolated facilities, they function as part of a larger infrastructural ecosystem. Therefore, the proximity to other data centres is crucial.

Equally important is access to the electrical grid. Due to their enormous energy demand, new data centres frequently require the construction of dedicated substations nearby. Sites where sufficient electrical capacity already exists or where expansion can be realised are advantageous.



Infrastructural lines in the Canton of Zurich.

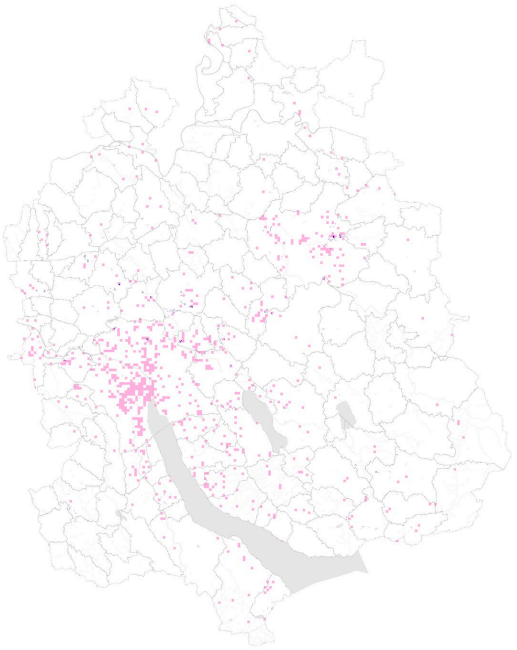


Electrical grid, Canton of Zurich.

Digital connectivity forms another critical layer of infrastructure. Reliable access to multiple fibre-optic carriers is essential, as the planning and construction of new fiber-optic networks is both costly and time-intensive.

Geological and environmental stability also play a major role. Data centers are designed for continuous 24/7 operation, making locations vulnerable to flooding, unstable ground conditions, earthquakes, or high groundwater levels fundamentally unsuitable.

Finally, zoning and permitting strongly shape where data centers can be developed. In Switzerland, they are generally restricted to industrial zones and must undergo the same approval procedures as other large-scale construction projects. Due to the scale and infrastructural complexity of these facilities, close cooperation with municipalities and permitting authorities becomes a central part of the development process.

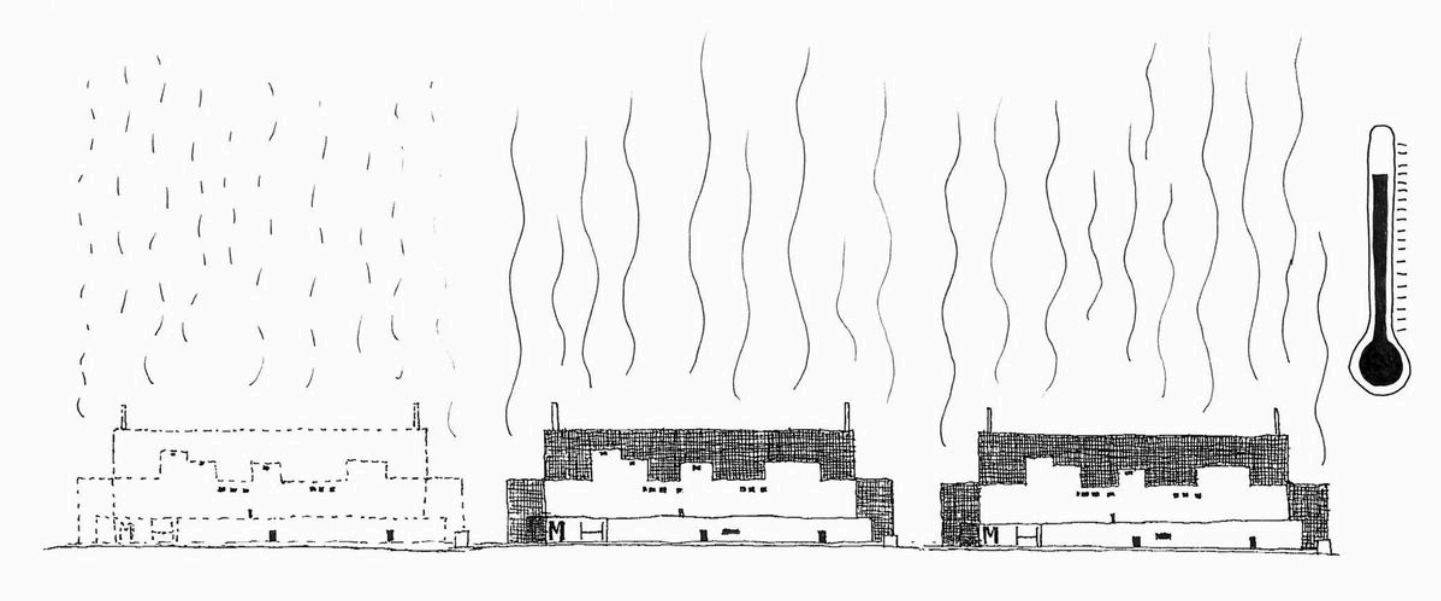


Fibre-optic connectivity, Canton of Zurich.



Geological and environmental risk zones, Canton of Zurich.

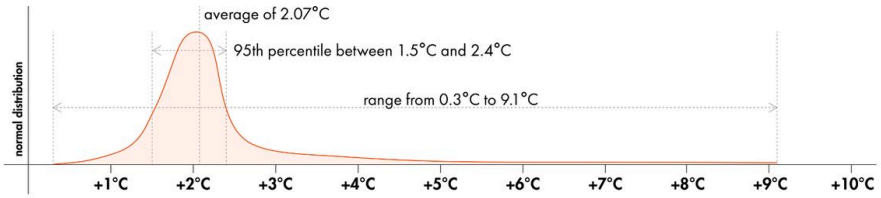
The Thermal Footprint of Data Infrastructures



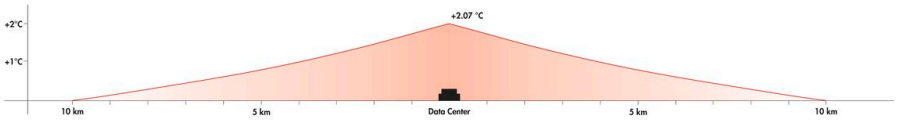
Data centres generate large amounts of heat due to their constant energy use. This heat is not contained, but spreads outward, affecting areas within a radius of roughly 10 km. As a result, data centres can contribute to local warming and impact nearby environments, which can be critical especially in hot climate zones or around existing heat islands.

Data centres run continuously and generate enormous amounts of heat. This heat spreads up to a distance of 10 km from the source, warming up the surrounding environment and contributing to urban heating in ways that are only beginning to be understood.

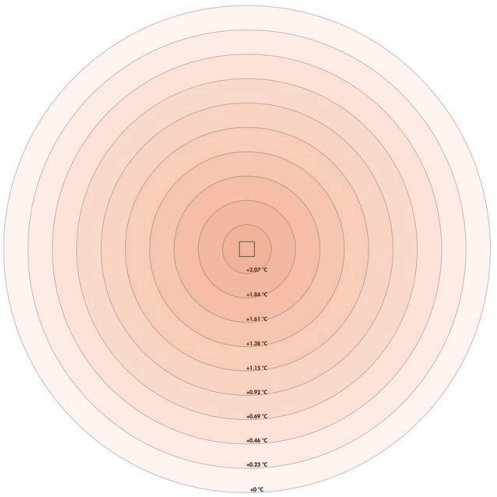
The temperature increase caused by AI data centres follows a clear pattern. The average heating effect on surrounding ground-level areas is 2.07 °C, with 95 % of cases falling between 1.5 and 2.4 °C.



Normal heat emission distribution.



Heat emission in relation to distance from the source, section.



Heat emission in relation to distance from the source, top view.



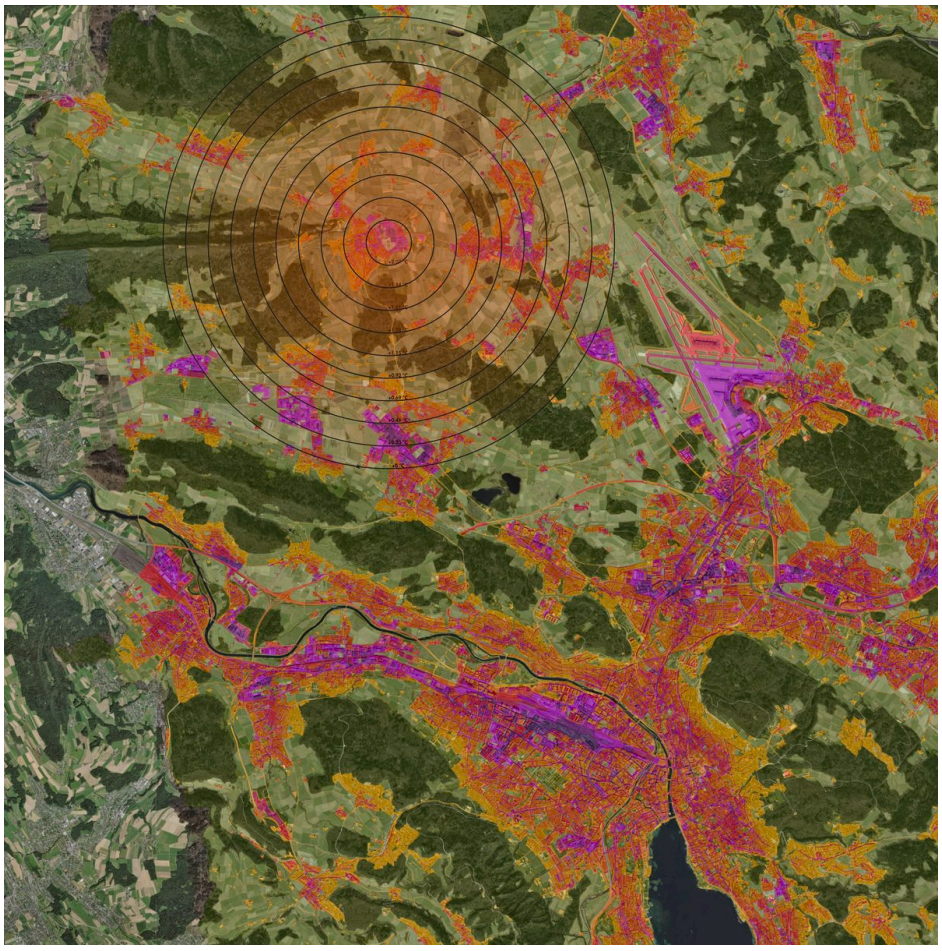
Dielsdorf, urban scale.



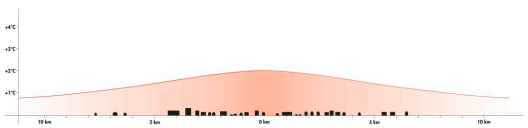
Dielsdorf, heat emission through the Metro Campus on an urban scale.

Looking at our case study, the Metro Campus in Dielsdorf, the 10 km radius reveals an unexpectedly wide radius. At the urban scale, the immediate neighbourhood is clearly affected. At territorial scale, zoomed out to the Canton of Zürich, the full extent becomes striking.

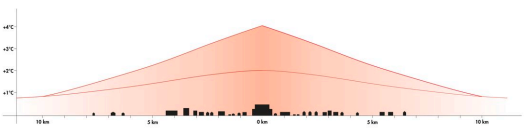
Urban centres already have heat problems. Dense surfaces, asphalt, and buildings trap warmth and create heat clusters, areas that are measurably hotter than their surroundings. Adding a data centre on top of an existing heat cluster compounds the problem. Data centres should not be located where temperatures are already critical.



Heat radiance by the Metro Campus in Dielsdorf,
impacting surrounding villages and existing heat islands.

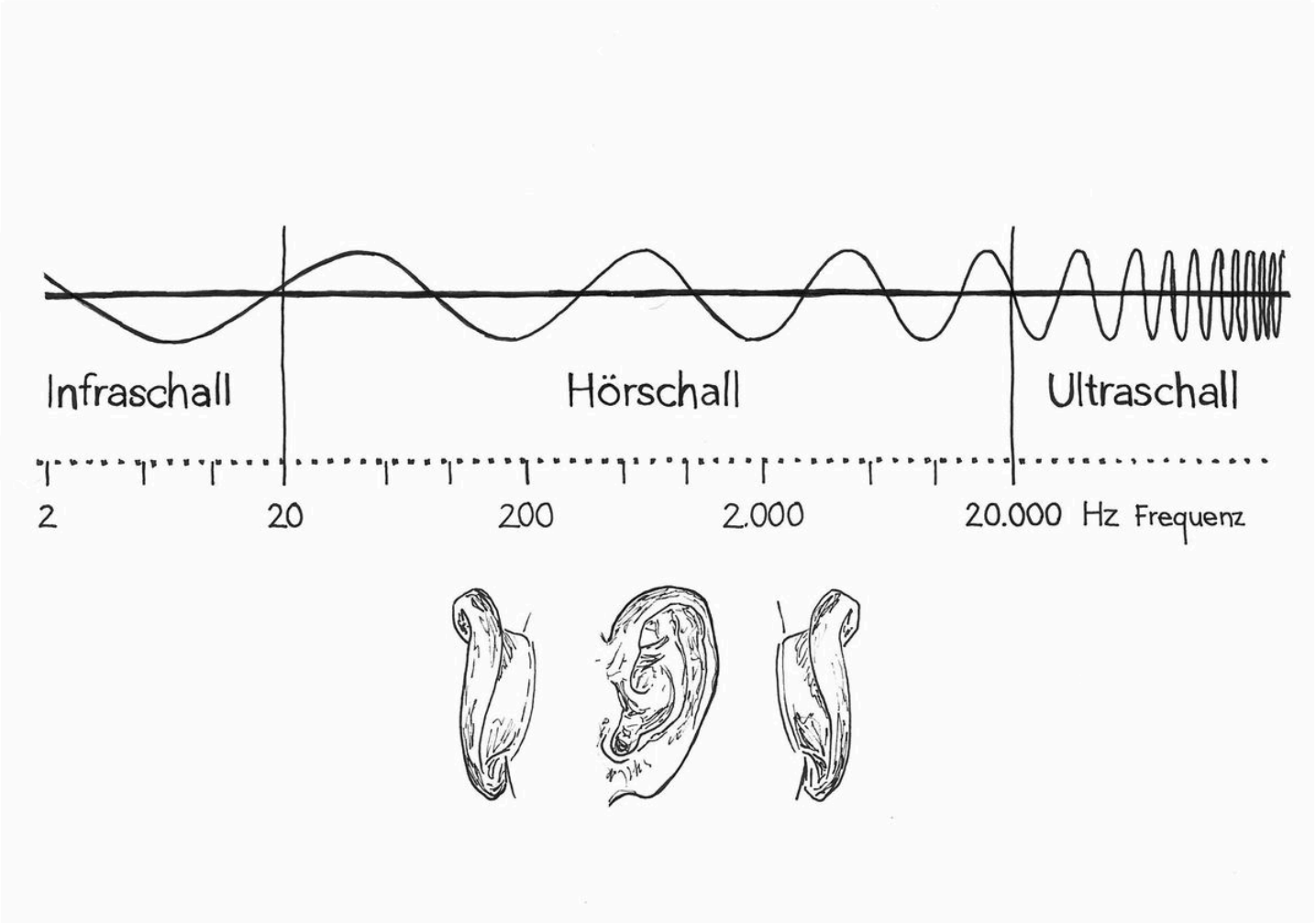


Heat Cluster



Data Center Addition

The Acoustic Footprint of Data Infrastructures

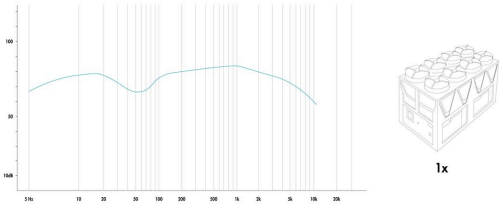


Data centres also pollute through noise, mainly deriving from rooftop cooling systems. In addition to high-frequency noise that is quickly reduced by buildings, air, and vegetation, the coolers generate low-frequency infrasound, which encounters far less resistance and can travel much further. Prolonged exposure to such infrasound may affect human health.

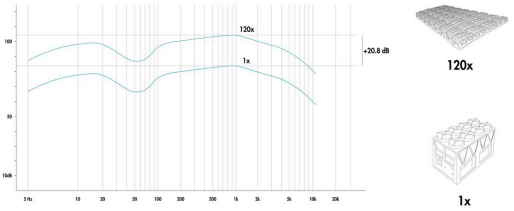
How loud is a data center? Sources vary widely, indicating dB (A) between 55 and 96. The range itself reveals the problem: there is no reliable standard, and measurements differ substantially depending on facility size, equipment, and methodology.

Rooftop coolers are the predominant source of noise. Their frequency spectrum shows a peak in the mid-range, but also a clear presence in the infrasound range. Both matter, but for very different reasons.

The Metro Campus in Dielsdorf has 120 rooftop coolers. In a simplified cumulative calculation, this stacking of identical sources results in a combined level approximately 20.8 dB louder than a single unit.



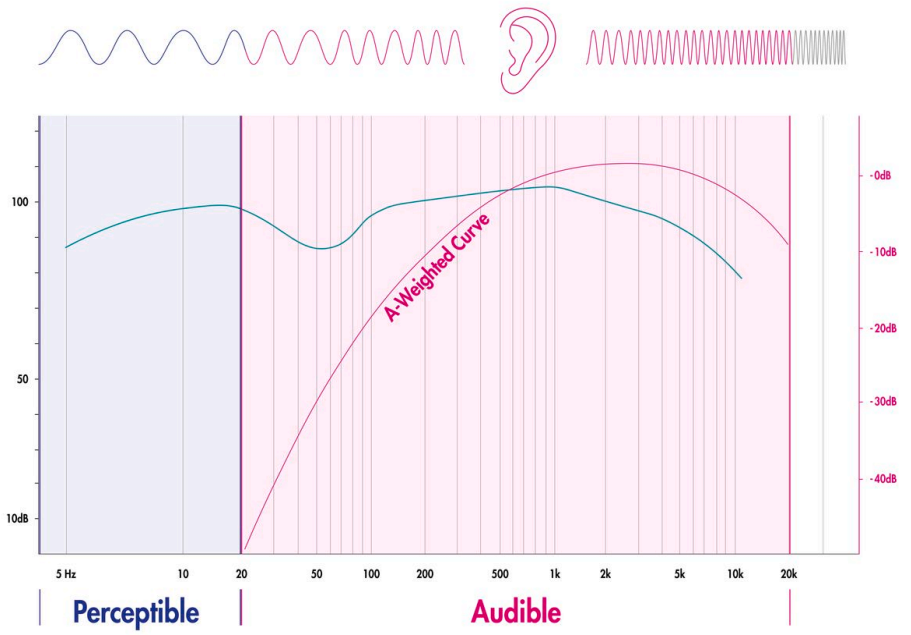
Noise emission of one cooler.



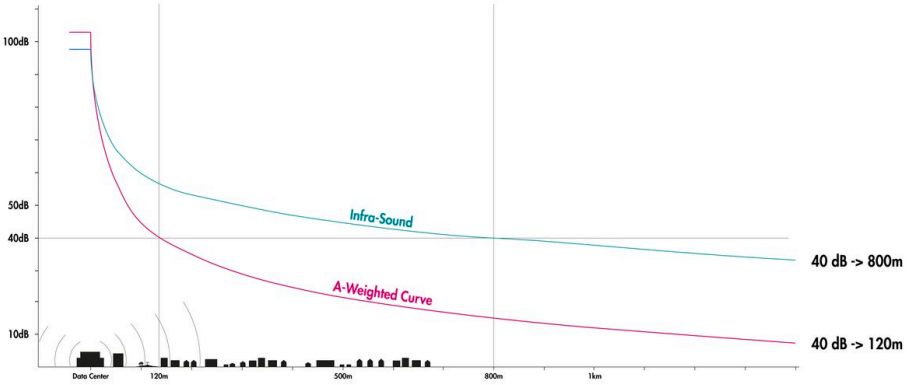
Noise emission of 120 coolers.

Human hearing spans 20 Hz to 20,000 Hz, reflected by the A-weighting curve, which weights frequencies according to how sensitively we perceive them. Below 20 Hz lies infrasound: we can not hear it, but we feel it. In a number of studies, extended exposure was linked to stress, sleep disruption, and other health effects.

A-weighted sound from the data centre in Dielsdorf attenuates to 40 dB, the nighttime limit for residential zones, within a roughly 120 metres radius. Infrasound reaches the same threshold only after 800 m, encountering almost no resistance along the way. Current regulation focuses on A-weighted levels. For data centres, infrasound needs to be part of the picture too.

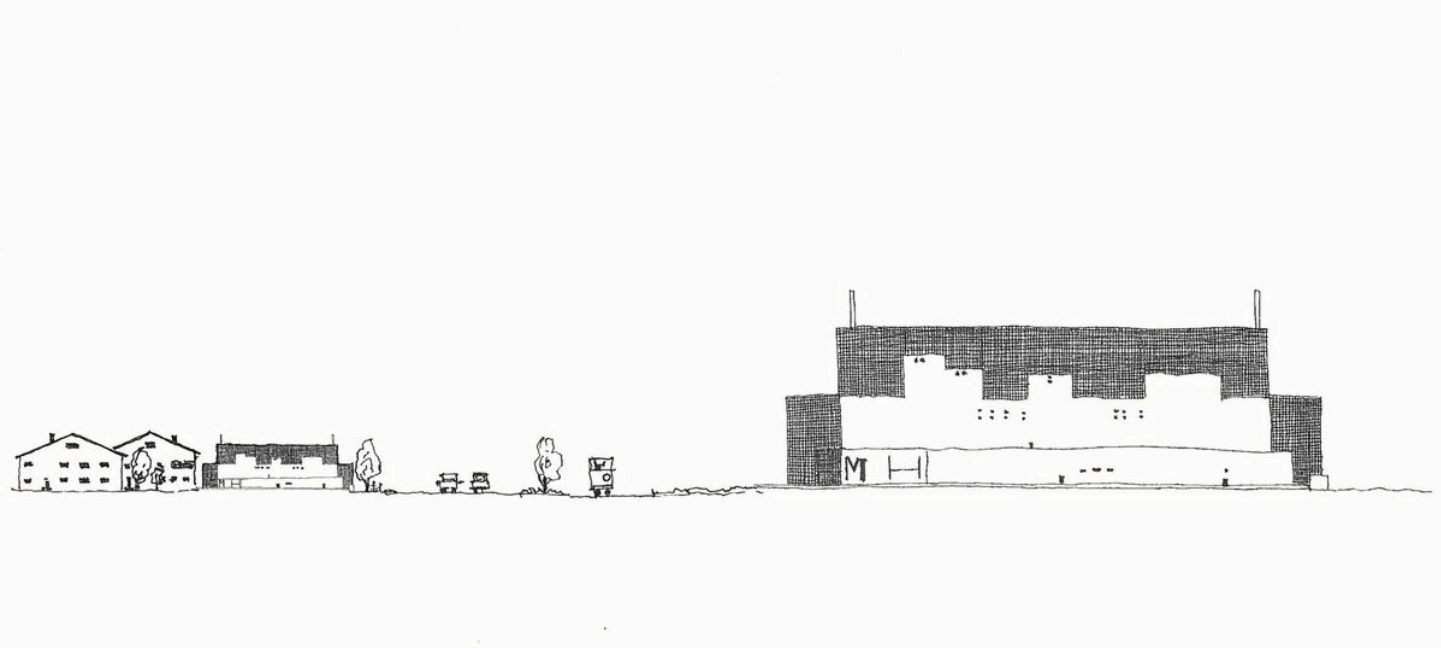


Audibe and perceptible sound.



Travel distance of sound: infra vs. A-weighted.

New Locations for Data Centres

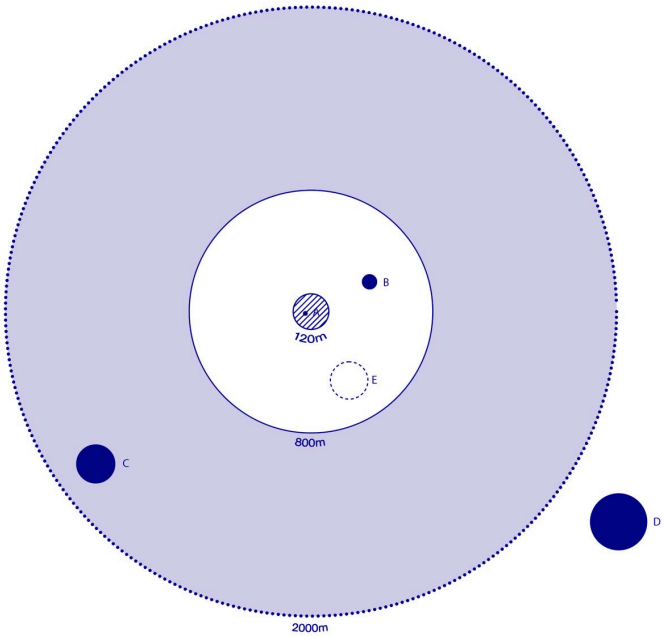


The discrepancy between economic suitability and social and environmental conditions reveal the need for a new evaluation of suitable locations for data centres. We propose adapted location factors for the Zurich data centre cluster in relation to their scale and distance to housing.

As our research expanded to include socio-environmental considerations, a clear discrepancy emerged between the economic criteria and the social and environmental conditions defining the “ideal” site for a new data centre.

The economic logic of data centre development tends to push these facilities closer to urban agglomerations and end users. This is largely driven by existing digital infrastructure, established fibre-optic networks, and the economic advantages of locating within already highly connected territories.

Our socio-environmental analysis, however, suggested the opposite. Factors such as heat emissions, noise pollution, and spatial impact indicate that the most suitable locations for large-scale data centres may instead lie within the peripheral areas surrounding Zurich, further removed from densely populated environments.



Proposed scheme for the location of data centres depending on their size. A: B:C:D

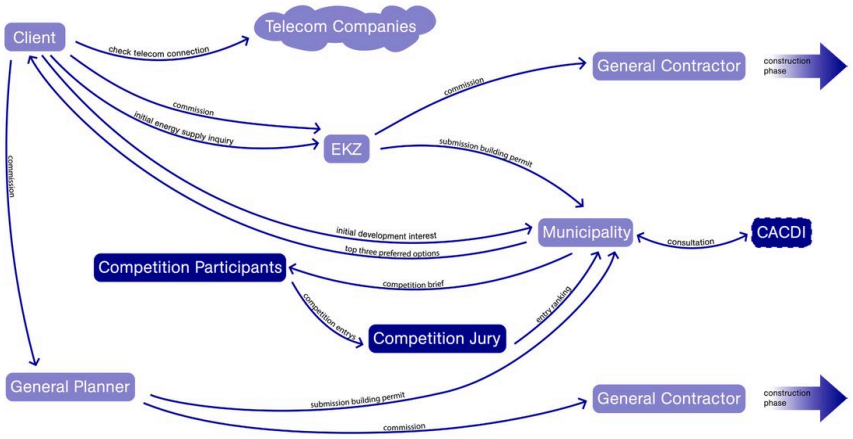
These observations primarily concern large commercial data centres. The relevance and intensity of these impacts are directly linked to scale. For this reason, the projects within our studio were categorized according to five distinct typologies.

SMALL-SCALE DATA CENTRES

Small-scale infrastructures, such as decentralised server systems with limited cooling requirements and lower energy demand, generate significantly fewer socio-environmental conflicts. In these cases, issues such as heat emissions or acoustic disturbance become far less critical.

LARGE-SCALE DATA CENTRES

Based on these findings, we developed a proposal for how Type C—large-scale, privately operated commercial data centres—could be planned and integrated in the future. After identifying suitable sites among the few remaining eligible plots, we proposed a new planning procedure intended to strengthen the role of municipalities within the development process.



Proposed planning procedure for a data centre, strengthening the role of the municipality.

THE INTRODUCTION OF AN URBAN AND ARCHITECTURAL COMPETITION

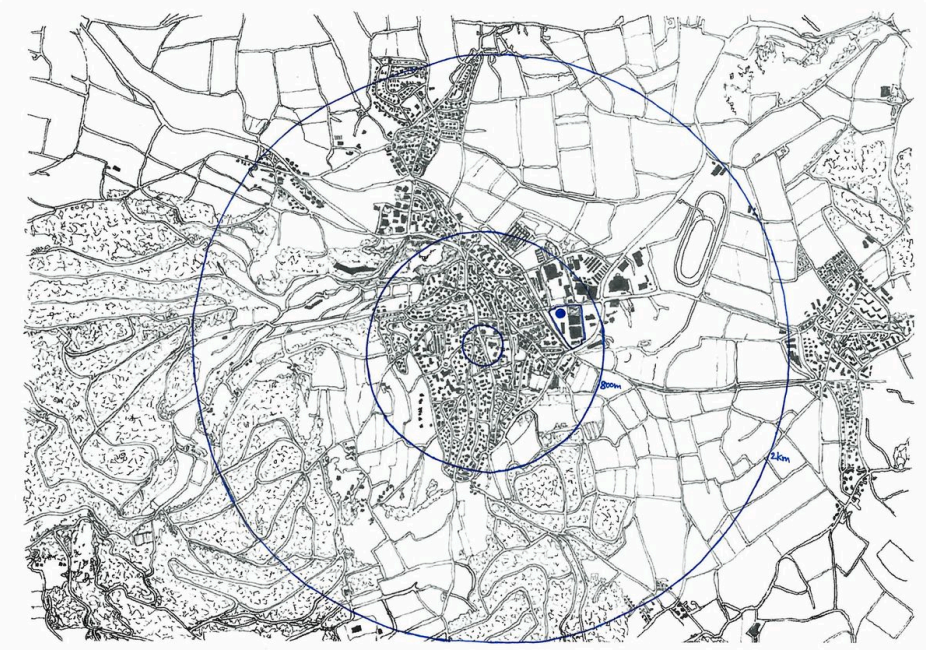
Central to this proposal is the introduction of an urban and architectural competition procedure, in which both the Data Centre Operator and the Municipality actively participate in the final project selection and definition. At present, municipalities often lack the technical expertise required to clearly articulate and defend their territorial interests in relation to digital infrastructure projects.

THE CANTONAL ADVISORY COUNCIL FOR DIGITAL INFRASTRUCTURE

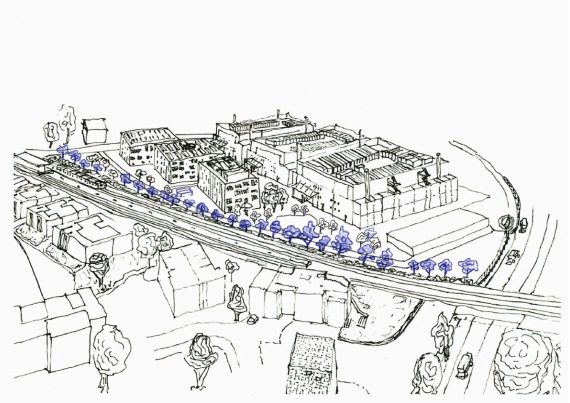
To address this imbalance, we propose the establishment of a Cantonal Advisory Council for Digital Infrastructure — an interdisciplinary institution composed of experts in planning, energy, environment, infrastructure, and urban development. The council would support municipalities throughout the planning process and help translate local concerns into concrete planning requirements.

RETROFITTING

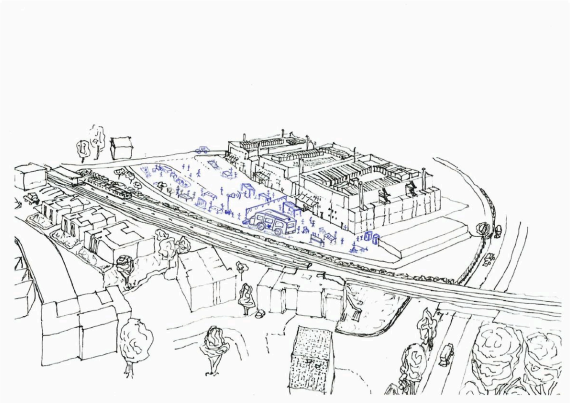
In parallel, we also examined the condition of existing large-scale commercial data centres, many of which, according to our research, are located within unsuitable urban contexts. While the territorial and environmental damage already caused by these developments cannot be reversed entirely, targeted retrofitting strategies can help mitigate their impact on surrounding communities and environments.



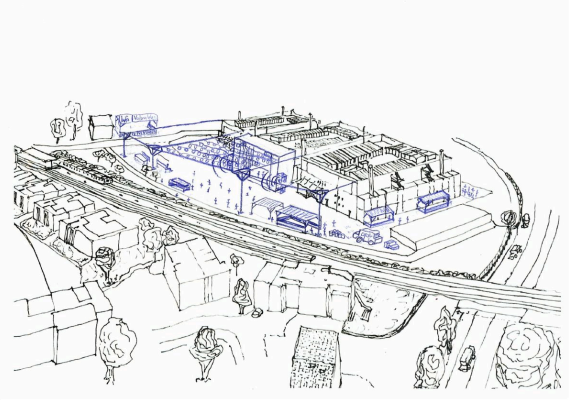
Typologa radius applied to the case study of Dielsdorf.



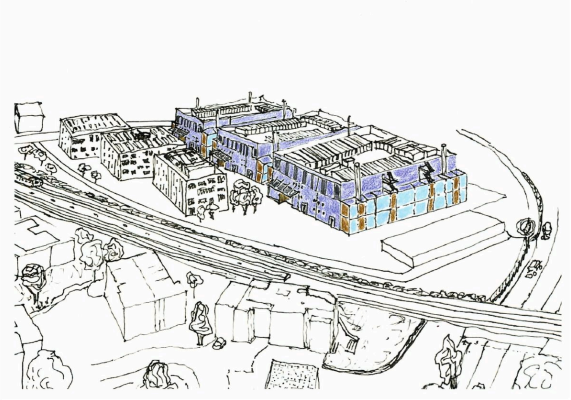
Trees to shield the view and percieved noise.



Flea market as social programme.



Concerts as social programme.



"Just make the facade anything except white, black or gray."

ACKNOWLEDGEMENTS

To all our interview partners: Thomas Rolli, Luc Pestalozzi, Nils Beckhaus, Andrea Campomilla, Astrit Abazi

SOURCES

- Alves, Juliana A.; Silva, Ligia T.; Remoaldo, Paula C. “Impacts of Low-Frequency Noise Exposure on Well-Being: A Case-Study From Portugal.” *NCBI*. July 2018. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6122264/
- Asomar, Catherine; Bangsund, John. “Diesel Generators at Data Centers.” *Better Data Center Project*. March 2026.
- Bayerisches Landesamt für Umwelt. “Die Wirkung von Lärm auf den Menschen.” Bayerisches Landesamt für Umwelt online. 15 May 2026. https://www.lfu.bayern.de/laerm/laerm_allgemein/wirkung_auf_menschen/index.htm
- Connell, Christopher. "Why are data centers so noisy? Loose rules, pricey solutions, critics say." *Piedmont Journalism Foundation*. 17 November 2022. https://www.princewilliamtimes.com/news/why-are-data-centers-so-noisy-loose-rules-pricey-solutions-critics say/article_18113e2e-66b5-11ed-9e82-f3debf6366c2.html
- Crysound. "Data Center Noise Compliance: How 24/7 Monitoring Helps Avoid Fines." *Crysound* online. 12 May 2026. https://www.crysound.com/blog/data-center-noise-compliance-how-24-7-monitoring-helps-avoid-fines/
- “Faktenpapier Infraschall (Kurzfassung).” Bürgerforum Energieland Hessen. Accessed 15 May 2026. https://www.buergerforum-energiewende-hessen.de/mm/KurzfassungFaktenpapierInfraschall.pdf
- Frens. “Comparing the Noise Levels of Air-Cooles Chillers to Water-Cooles Chillers.” *Amcon*. 2 December 2023.
- “Infraschall einfach erklärt.” Umwelt Bundesamt. Accessed 15 May 2026. https://www.umweltbundesamt.de/system/files/medien/479/publikationen/ broschuere_infraschall.pdf
- Javadi, Anis; Pourabdian, Siamak; Forouharmajd, Farhad. “The Effect of Low-Frequency Noises Exposure on the Precision of Human at the Mathematical Tasks.” *NCBI*. 23 February 2022. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8980828/
- Llorico, Abby; Robinson, Bryce. "What’s all the data center noise about?: Neighbors say Northern Virginia data centers emit a noise they just can’t tune out. We took to the streets and dove in to the science to figure out why." *Wusa9*. 7 April 2023. https://www.wusa9\.com/article/news/verify/verify-whats-all-the-data-center-noise-about/65-0a695ecf-9eac-44bc-93f8- 9fd7f4bbfd88
- Lyver, Dr. John. "Scientific Study Says Data Center Noise Would Hinder Operations at Bristow, Gainesville Schools.“ *Bristowbeat.* 1 Febuary 2023. https://bristowbeat.com/stories/scientist-says-data-center-noise-levels-would-affect-bristow-gaineseville-schools,27378
- Marinoni, Andrea, et al. “The Data Heat Island Effect: Quantifying the Impact of AI Data Centers in a Warming World.” Acessed 25 May 2026, https://arxiv.org/pdf/2603\.20897
- Miljković, Dubravko. “Noise within a Data Center.” *Research Gate* Online. May 2016. https://www.researchgate.net/publication/304079164_Noise_within_a_Data_Center
- Peng Liang; Jiangjing Li; Zenglei Li; Jing Wei; Jing Li; Shenghao Zhang; Shenglong Xu; Zhaohui Liu; Jin Wang. “Effect of low-frequency noise exposure on cognitive function: a systematic review and meta-analysis.” *BMC Public Health*. 9 January 2024. https://bmcpublichealth.biomedcentral.com/articles/10\.1186/s12889-023-17593-5
- Professur für Architektur und Bauprozess, Prof. Sacha Menz. “Planungs- und Bauprozess”. *map* online. 25 May 2026. https://map.arch.ethz.ch/artikel/51/planungs-und-bauprozess
- Quilty-Harper, Conrad. "Can Waste Heat From Data Centers be Made Less Wasteful?." *EQT* online. 11 May 2026. https://eqtgroup.com/thinq/infrastructure/can-waste-heat-from-data-centers-be-made-less-wasteful
- Richardson, Kelly. “Technische Aspekte der Lärmreduzierung in Rechenzentren.” *Computer Weekly* online. 15 May 2026. https://www.computerweekly.com/de/tipp/Technische-Aspekte-der-Laermreduzierung-in-Rechenzentren
- Tamura, Haruka; Ohgami, Nobutaka; Yajima,Ichiro; Iida, Machiko; Ohgami, Kyoko; Fujii, Noriko; Itabe, Hiroyuki; Kusudo, Tastuya; Yamashita, Hitoshi; Kato, Masashi. “Chronic Exposure to Low-Frequency Noise at Moderate Levels Causes Impaired Balance in Mice.” *NCBI*. 29 June 2012. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3387207/
- “Vantage Data Centers DUB1: Noise Assessment.” Ramboll. Accessed 25 May 2026. https://epawebapp.epa.ie/licences/lic_eDMS/090151b280927620\.pdf
- “What are the 5 Main Causes of Noise in Data Centers?” *Datacenter Knowledge*. Accessed 20 May 2026. https://www.datacenterknowledge.com/data-storage/what-are-the-5-main-causes-of-noise-in-data-centers-
- “What Are The Noise Levels Of Different HVAC Air Handlers?” Hi-SURP.Hicon. Accessed 19 May 2026. https://www.hisurp.com/blog/what-are-the-noise-levels-of-different-hvac-air-handlers-418623\.html

This work by Emma Kleinbölting, Antonia Johanna Karl, Beda Füssler, and Simone Graf was created as part of the design studio The Production of Cloud at ETH Zurich in Spring 2026. The PDF is intended for educational purposes only. Its commercial distribution is strictly forbidden.

© 2026, Architecture of Territory

Architecture of Territory
Professor Milica Topalović

TEACHING TEAM
Dorothee Hahn
Martin Kohlberger
Yiqiu Liu
Milica Topalović
Jakob Walter
Jan Westerheide

Prof. Milica Topalović
ETH Zurich
ONA G41
Neunbrunnenstrasse 50
8093 Zurich
Switzerland
+41 (0)44 633 86 88
www.topalovic.arch.ethz.ch