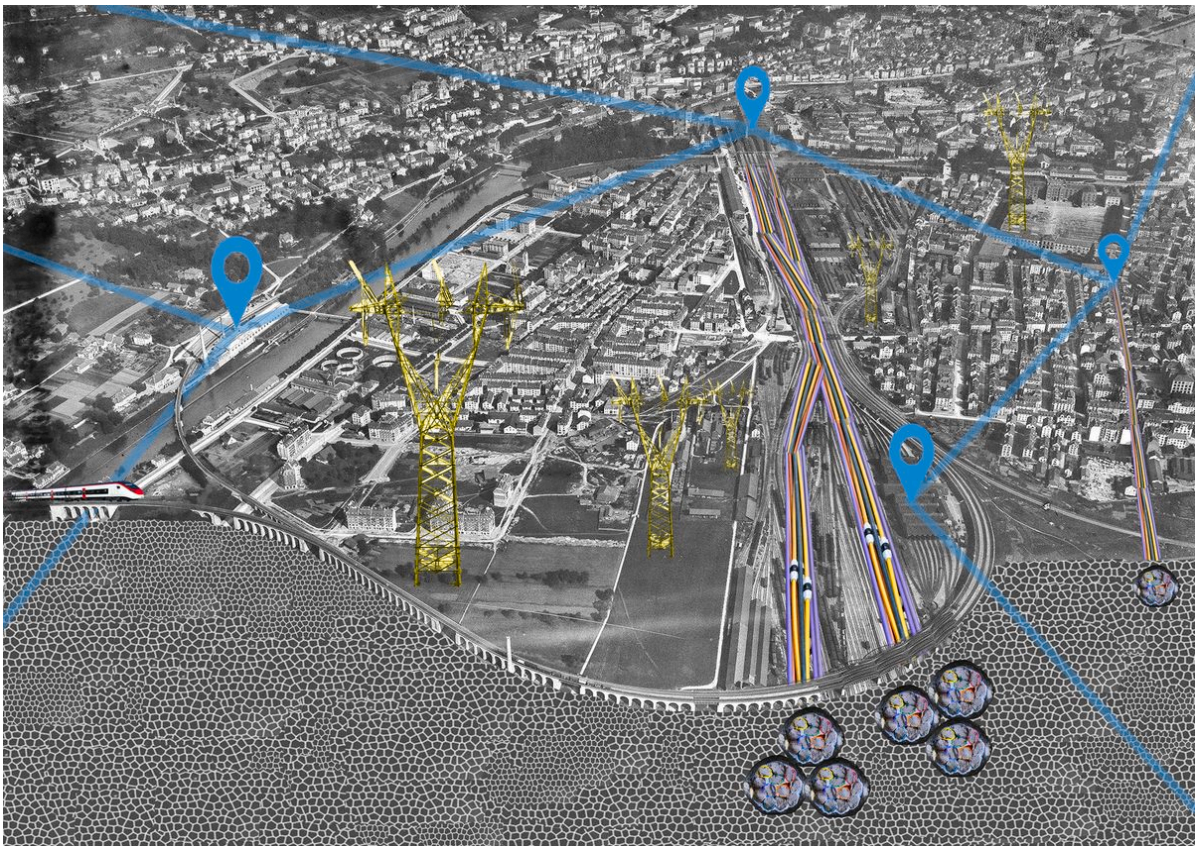
ETH Zurich Department of Architecture
ARCHITECTURE OF TERRITORY
Chair of Architecture
and Territorial Planning
Professor Milica Topalović

The Production of Cloud
Spring 2026

Data Infrastructures

Data Centres as Infrastructure Monsters: Investigating a Small-Scale, Decentralised Approach

Gabriele Zanni, Morris Schüpbach, and Mario Affolter

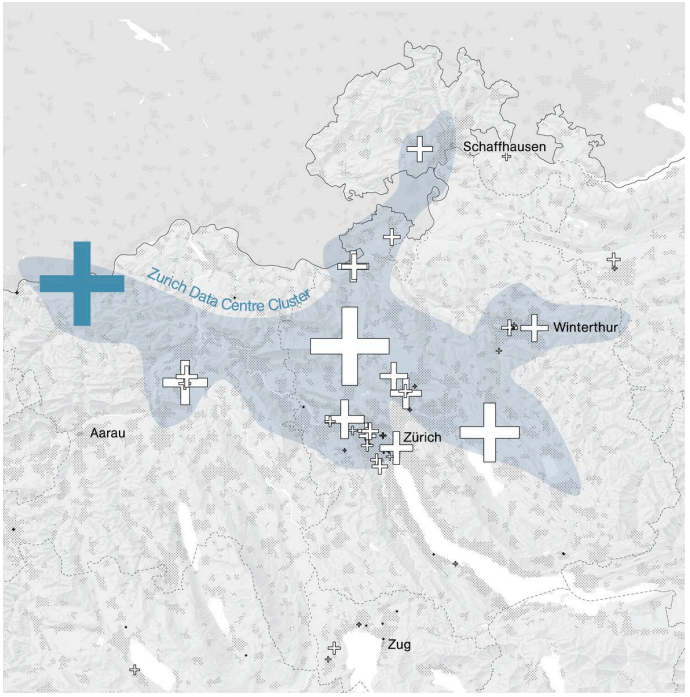


In Laufenburg, the historic heart of the European energy grid, the FlexBase project is transforming the landscape, housing a 1.2-GW underground redox flow battery and a 480-MW AI “factory.”

This investigation decodes the profound territorial footprint and infrastructure of this corporate infrastructure project, highlighting the friction between its opaque, hyper-centralised gigantism and the regional energy heritage.

In response, we explore an alternative: a decentralised network of frugal, specialised data centres integrated into the Swiss Federal Railways (SBB) infrastructure. By anchoring data processing directly to SBB stations and its historic railway power grid, this model prioritises transparency and physical proximity to the population.

Ultimately, this study challenges the necessity of technological monoliths, proposing a user-proximate system woven into the existing fabric of Swiss territory.



Name Data Centre: FlexBase Technologie Zentrum
Commune: Laufenburg, AG
Type Data Centre: AI and battery storage
Capacity: 800 MW
Operator: FlexBase
Year: 2028
Status: In construction
Waste Heat Use: District heating

Introducing FlexBase, a Hybrid Data Centre

Within the Zurich data centre cluster, the FlexBase Technology Center stands out in size, matching international hyperscale standards. It also fundamentally redefines the conventional data centre typology by integrating Europe’s largest Redox Flow battery system alongside servers for AI computing.

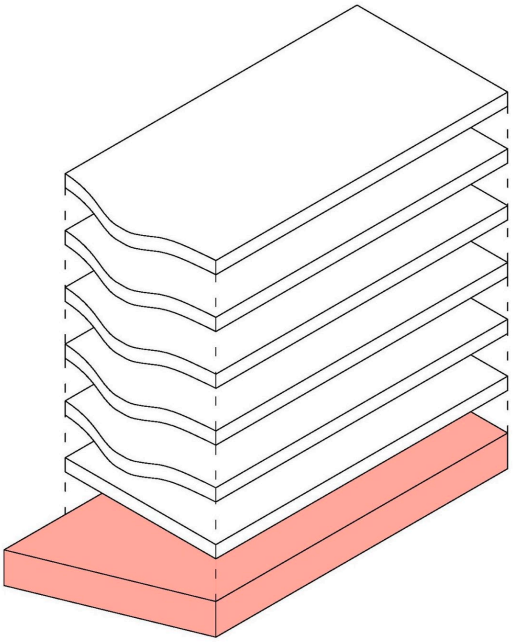
Introducing the Site: Laufenburg, an Infrastructure Node

https://www.youtube.com/watch?v=ZVvZzhe_M5E

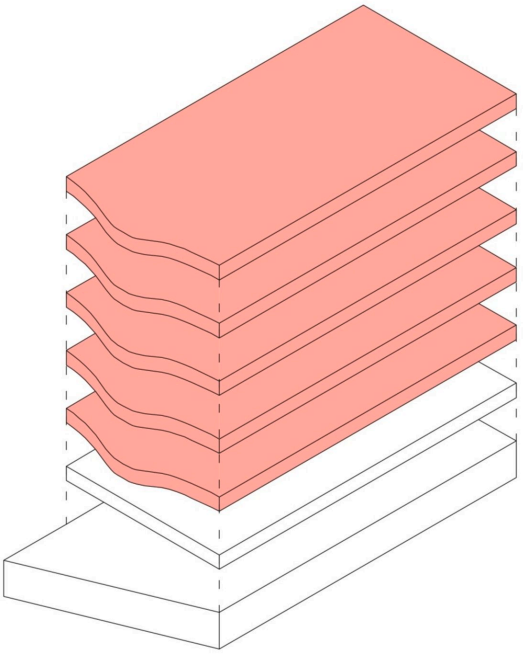
FLEXBASE BATTERY

One of the most critical components of the FlexBase data centre is its redox flow battery, one of the largest in the world. The battery provides a backup for the servers, eliminating the need for Diesel generators. Furthermore, thanks to its strategic location near one of the nervous centres of the European power grid, the Stern von Laufenburg, it acts as a buffer in the Swiss electricity market, balancing uneven electricity production of renewables and thereby stabilising the grid. The battery module is located in the basement of the new structure.

With 2.1 GWh capacity, the battery could store the energy for 210,000 households, comparable to the inhabitants of the City of Zurich, for 24 hours.



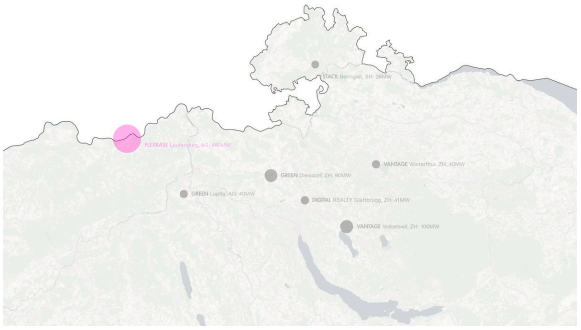
Redox Flow Battery



AI training

FLEXBASE AI

The upper floors will be dedicated to computing power, primarily used for training artificial intelligence models. This positions the facility on the market as one of the few centres for AI training within Switzerland. The facility will have 480 MW of computing power with a Power Usage Effevtiveness (PUE) of < 1.2n and water cooling.

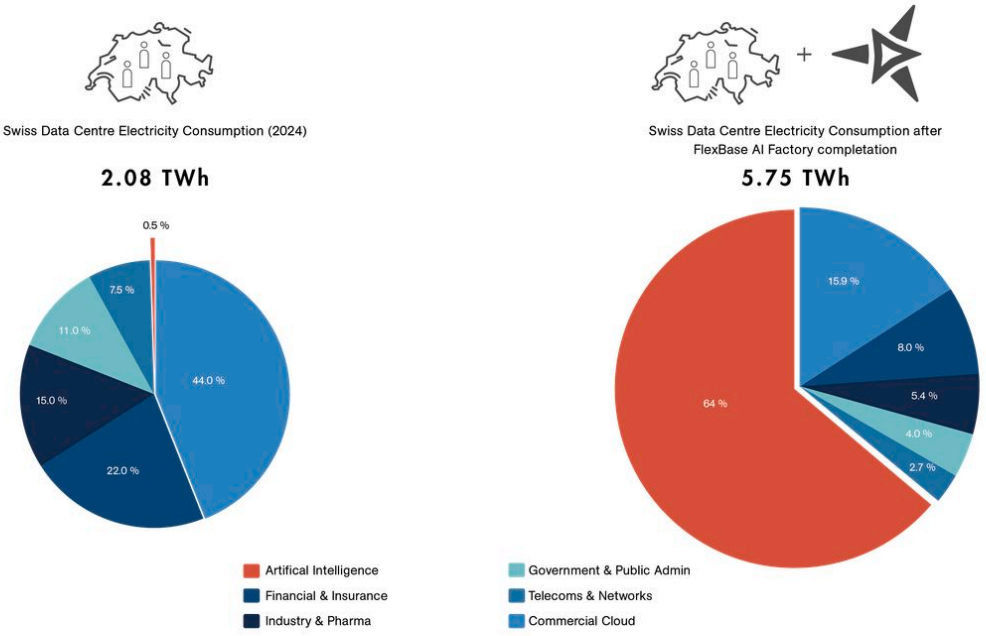


In the Zurich data centre cluster, FlexBase stands out in size.

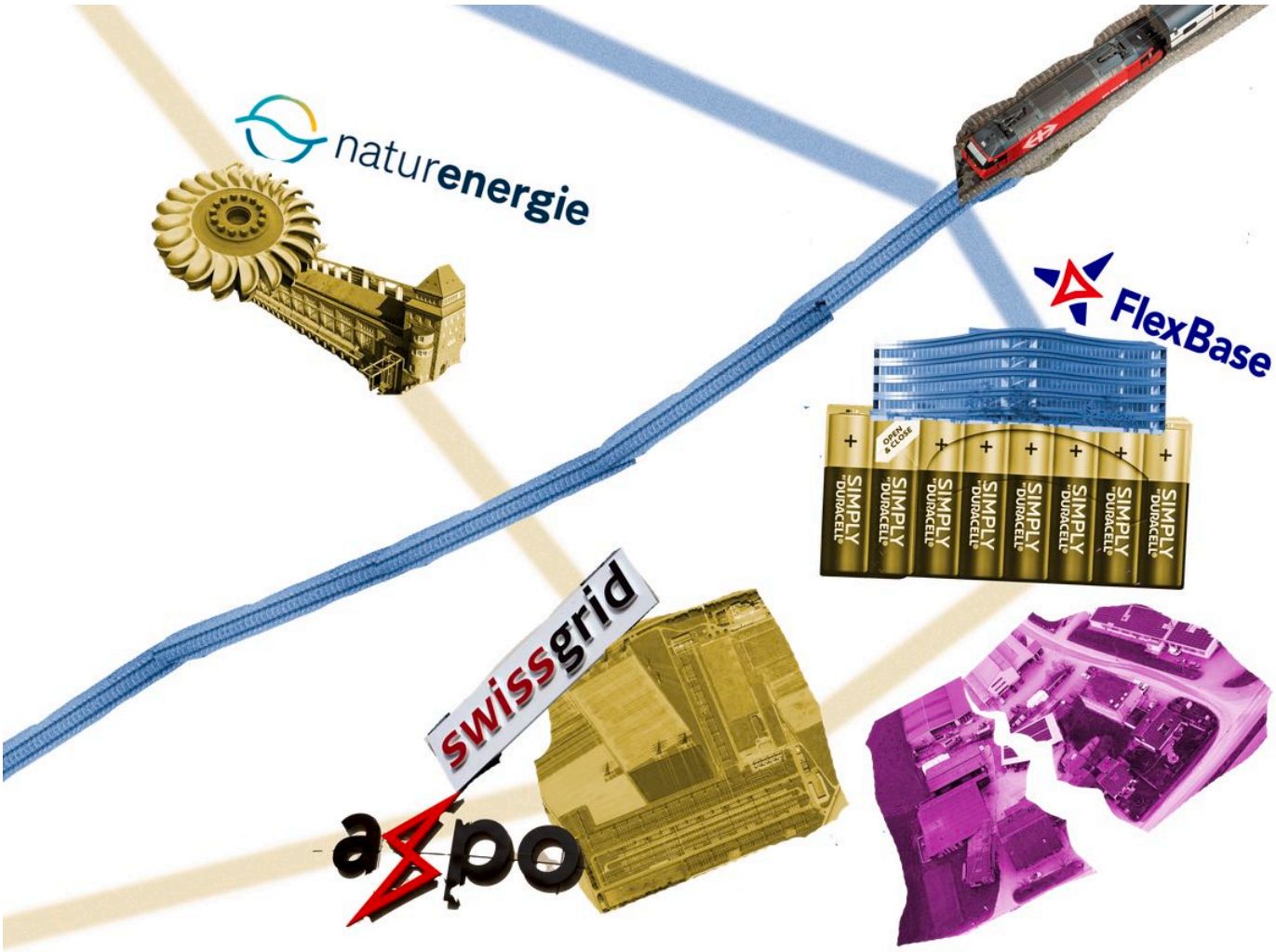
On a global scale the new data centre can keep up with some of the largest AI computing facilities.

ENERGY FOOTPRINT

Based on data from Energie Schweiz and the Federal Office of Energy (BFE), the future energy use of FlexBase AI will result in a more than the doubling of nation-wide energy consumption by data centres, from 2.08 to 5.75 TWh. In addition, commercial cloud computing will not be anymore the main energy consumer, but AI computing with a share of 64 % of total energy consumption of data centres.


Swiss Data Centre Electricity Consumption (2024)
2.08 TWh
0.5 %
7.5 %
11.0 %
44.0 %
15.0 %
22.0 %
Swiss Data Centre Electricity Consumption after FlexBase AI Factory completation
5.75 TWh
15.9 %
8.0 %
5.4 %
4.0 %
2.7 %
64 %
Artifical Intelligence
Financial & Insurance
Industry & Pharma
Government & Public Admin
Telecoms & Networks
Commercial Cloud

Grafting Infrastructure

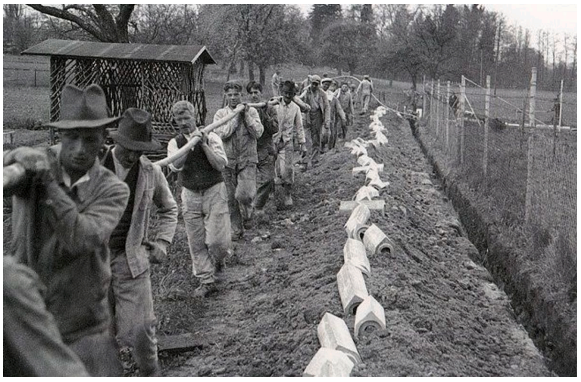


The site unites different important energy infrastructures such as the Stern von Laufenburg, an electrical substation, connecting the electricity grids of France, Germany, and Switzerland since the 1950s.

Timeline

SBB Aarebrücke Koblenz connecting Basel to Romanshorn, built 1892. Source: Wikimedia Commons.

Construction of the hydro powerplant Laufenburg, 1909–14.



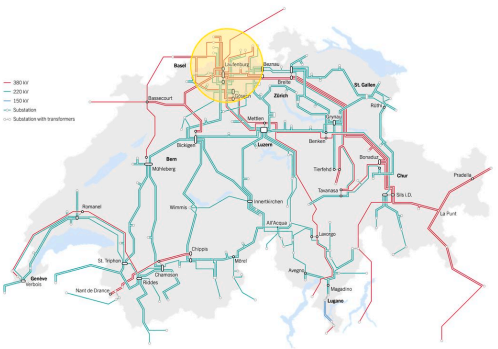
Construction of the Stern von Laufenburg, 1950s.

Construction of Flexbase, ongoing.

STERN VON LAUFENBURG AND THE SWISS ENERGY GRID

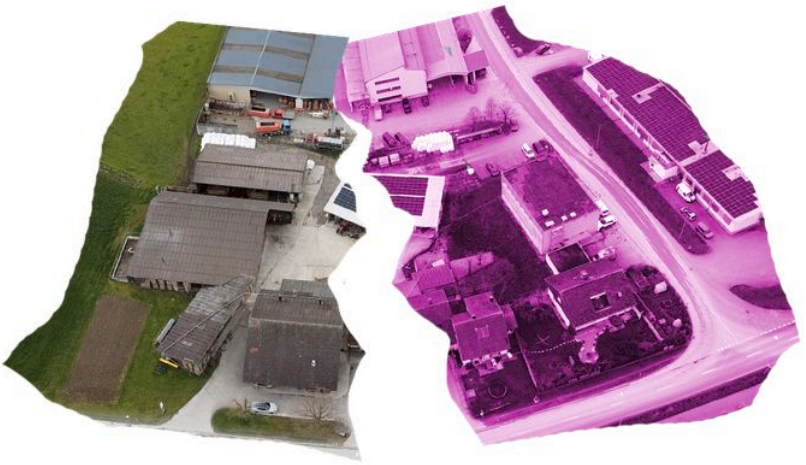
Commissioned in 1958, the “Stern von Laufenburg” is the historic birthplace of the European interconnected electricity grid. By linking the power networks of Switzerland, Germany, and France for the first time, this substation transformed Switzerland into an electricity hub of Central Europe. Today, it remains a vital node for continental grid stability, positioning FlexBase with its battery storage system as a “dynamic energy buffer” on the European electricity market.

Stern von Laufenburg.

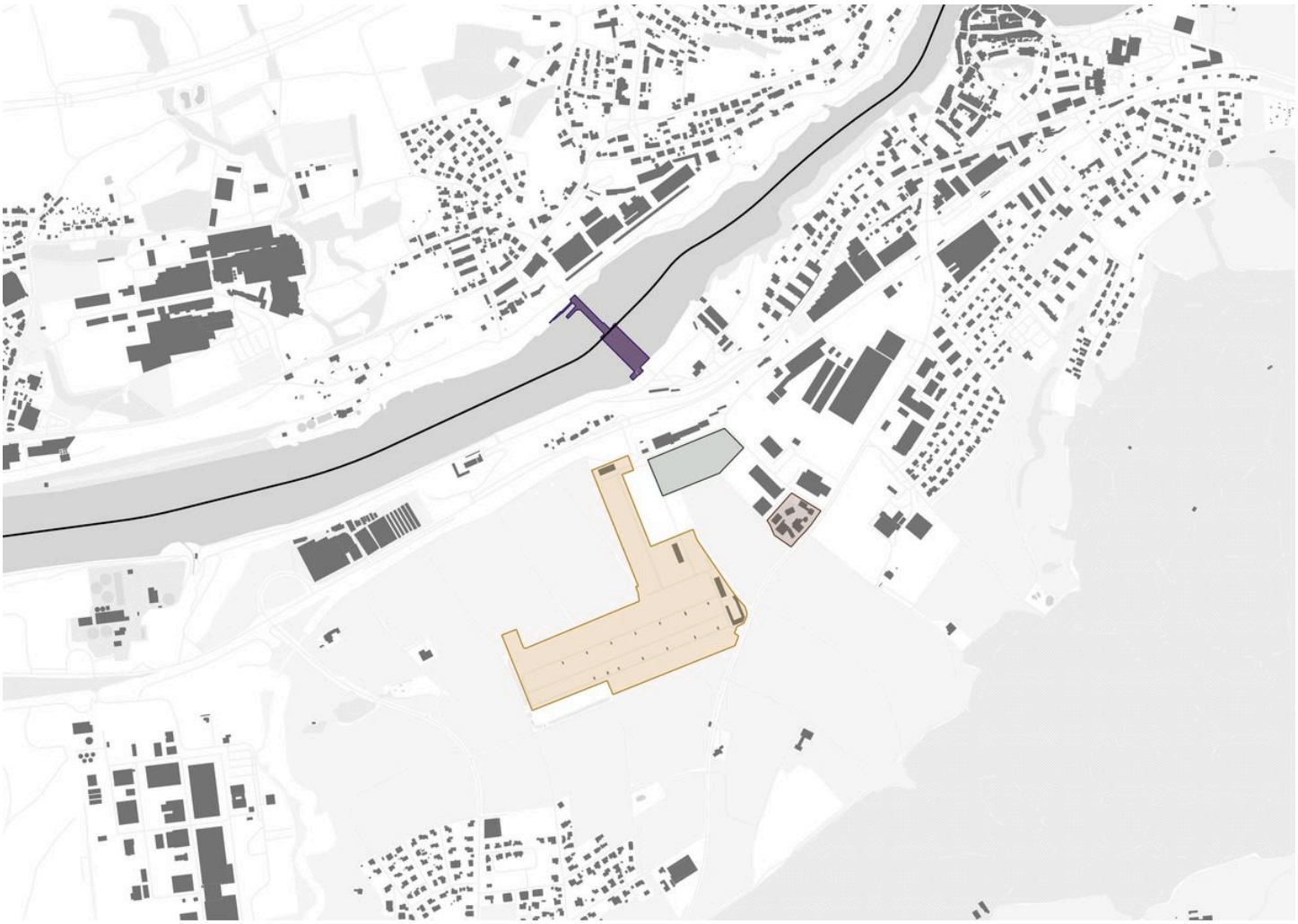


Source: Swissgrid, 2026.

Contested Land: Fron Agricultural Land to Data Infrastructure



Corporate giants like FlexBase and Axpo frame their massive infrastructural interventions under the banner of public good, national urgency, and technological progress, treating territory as a sacrificial zone. Consequently, local communities are subordinated to regional imperatives through displacement and the degradation of their livelihoods.



On the site, four main actors are crucial: Swissgrid (substation); Axpo (hydro powerplant); FlexBase (battery storage and data centre); and Bernhard Weiss, a farmer cultivating land on the site.

Stern von Laufenburg, Swissgrid

Battery storage and AI data centre, FlexBase

Hydro powerplant Laufenburg, Axpo

Farm of Bernhard (Beni) Weiss

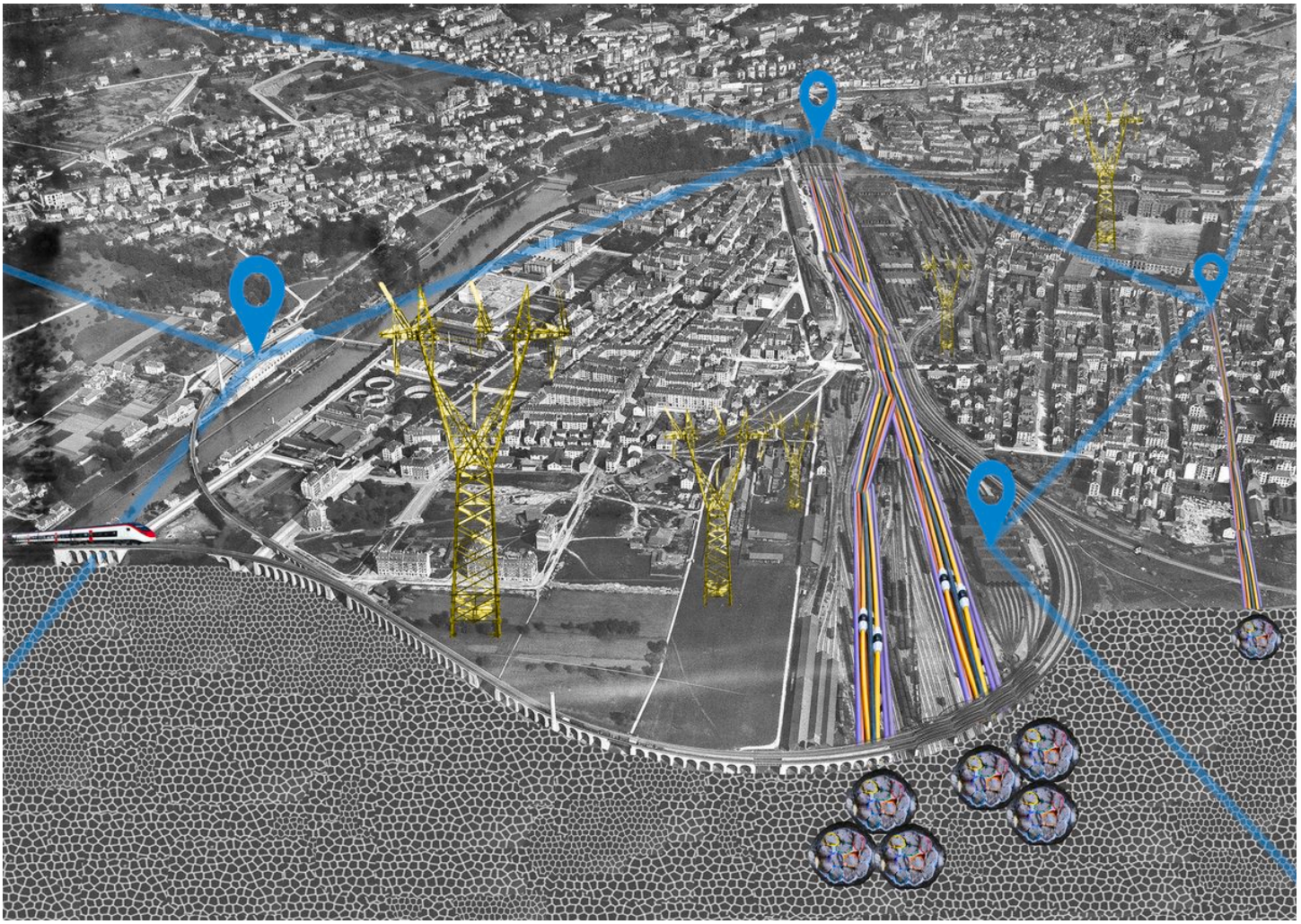
Land Grab for FlexBase

What Beni, the farmer, used to lease from Axpo.

His leasing contract was discontinued to make place for the construction of FlexBase. He was compensated with a piece of land further away from his farm.

During our interview with the local farmer Beni (Bernhard Weiss), we learned that part of the land he leased for hay cultivation and cattle grazing was located in an industrial zone owned by Axpo. To pave the way for the new FlexBase data centre, Beni’s lease was terminated, and the land was acquired by FlexBase for construction. Although this removed a critical piece of land located right next to his farm, he was provided with both financial compensation and an alternative land parcel to continue his operations.

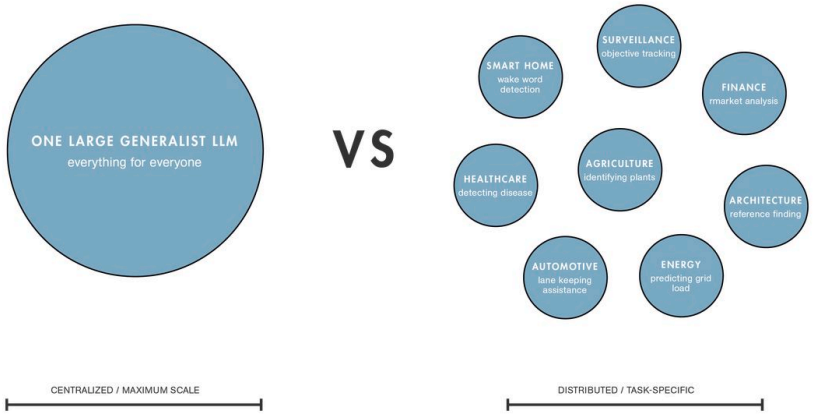
Introducing Frugal AI Computing



Our proposal challenges the paradigm of centralised, general-purpose AI factories. Instead, we introduce a decentralised, task-specific architecture deployed along existing infrastructure corridors. By embedding specialised computational nodes within already negotiated, high-density infrastructural zones and placing them in immediate proximity to electrical substations, we minimise spatial friction and optimise energy efficiency.

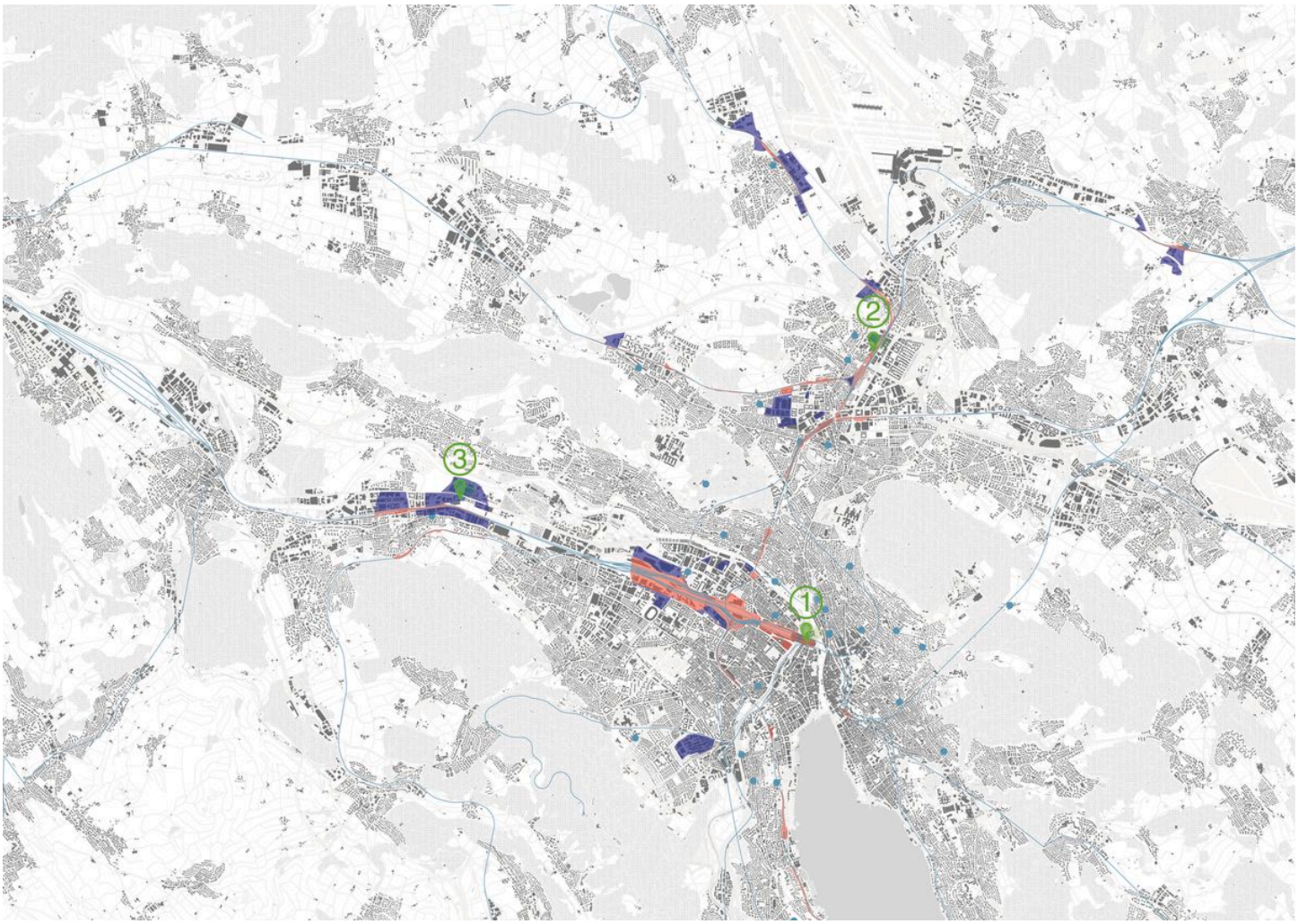
As pioneered by the Frugal AI initiative, Frugal AI is an approach focused on developing and deploying artificial intelligence models that are deeply mindful of resource constraints. Rather than constantly chasing larger data centres and massive, resource-heavy infrastructure, it advocates for environmental sustainability, energy efficiency, and cost-effectiveness.

Our research adopts this philosophy as a critique of current trends. Projects like FlexBase aim to solve the AI energy crisis by simply building bigger—constructing mastodonic data centres with giant batteries. In stark contrast, we propose a genuinely frugal approach: instead of endlessly expanding physical infrastructure to feed power-hungry models, we should focus on optimising the AI itself, making it smarter, lighter, and sustainable by design.



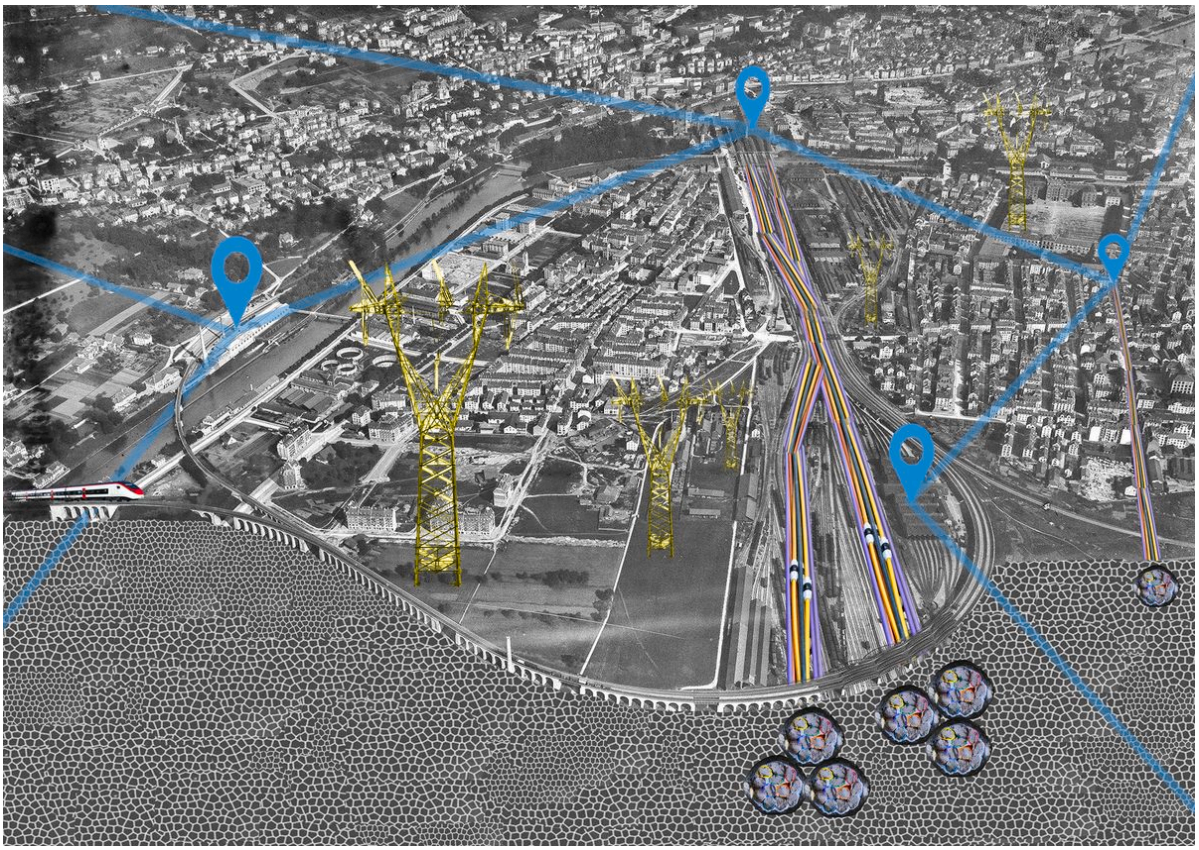
DEFINING LOCATION PARAMETRES

To keep the data centres in a frugal scale, we set a energy consumption to a maximum of 10 MW. This ensures, that no extra substations need to be built, which has a smaller economical impact and is less time consuming. To make sure that the fibre optic network of the railway grid is used efficiently, we limit our perimetre to 500 meters around the railway tracks. To ensure maximum efficiency regarding energy connection, we limit our perimetre to a 1 kilometre radius around existing substations. Finally, AI data centre construction is strictly limited to prenogotiated industrial zones.



Potential sites for frugal AI nodes: Zurich main station, Unterwerkstrasse 35 (Zurich), Bernstrasse 27 (Schlieren).

- Proposal locations
- Substations
- Railway
- Industrial zone
- Land owned by SBB



Test

ACKNOWLEDGEMENTS

We would like to thank Arist Volger, Sascha Manojlovic, Diego Ochsner, and Bernhard Weiss.

ChatGPT and Gemini were used for translation, text revision, and structure assistance.
Photographs, drawing, and diagrammes by authors unless otherwise indicated.

SOURCES

- Andy Klein, “These Aren’t Your Ordinary Data Centers.” *Backblaze* online. 3 April 2024. https://www.backblaze.com/blog/these-arent-your-ordinary-data-centers/
- “Bauland kaufen in Region Laufenburg.” *Homegate* online. https://www.homegate.ch/kaufen/bauland/region-laufenburg/trefferliste
- “Der Bundesrat verabschiedet Leitlinien für eine wirksame und sichere KI-Governance in der Schweiz.” *Eidgenössisches Departement für auswärtige Angelegenheiten (EDA)* online. 17 April 2026. https://www.eda.admin.ch/de/newnsb/GV-_d7OgllqjfQDGZqbkN
- “Der Stern von Laufenburg.” *Axpo* online. https://www.axpo.com/ch/de/wissen/magazin/energiemarkt/der-stern-von-laufenburg.html
- “Eduard Spelterini Collection.” *Schweizerische Nationalbibliothek (NB)* online. https://www.nb.admin.ch/en/eduard-spelterini-collection
- “Fiber Optic Cable.” *The Fiber Optic Association (FOA)* online. https://www.thefoa.org/tech/ref/OSP/cable.html
- “Flexbase-Mitgründer: ‘Es gibt keinen besseren Standort als Laufenburg’.” *Aargauer Zeitung* online. 20 March 2024. https://www.aargauerzeitung.ch/aargau/kanton-aargau/flexbase-mitgruender-es-gibt-keinen-besseren-standort-als-laufenburg-ld.4036426
- “Flexbase: Rollende Planung.” *Hightech Zentrum Aargau* online. 12 July 2024. https://hightechzentrum.ch/news/flexbase-rollende-planung
- *Frugal AI Association* online. https://frugalai.org
- “Landpreise im Kanton Aargau: Ein Leitfaden für Käufer und Verkäufer.” *Neho* online. 3 January 2025. https://neho.ch/de/blog/landpreise-aargau
- Lannelongue, Loïc, et al. “Frugal AI: Introduction, Concepts, Development, and Open Questions.” *HAL Open Science*. 11 April 2025. https://hal.science/hal-05049765/file/Frugal_AI_Introduction_Concepts_Development_and_Open_Questions_HAL.pdf
- “Rechenzentren in der Schweiz: Stromverbrauch und Effizienzpotenziale.” *Verband Schweizerischer Elektrizitätsunternehmen (VSE)* online. 1 December 2021. https://www.strom.ch/de/pressemitteilung/rechenzentren-der-schweiz-stromverbrauch-und-effizienzpotenziale
- “Redox Flow Batteries.” *Empa* online. https://www.empa.ch/web/s501/redox-flow-batteries
- “Riesenbatterie Laufenburg (AG) – ETH-Studie zweifelt an Technologie des Milliarden-Projekts.” *SRF* online. 27 February 2025. https://www.srf.ch/news/schweiz/riesenbatterie-laufenburg-ag-eth-studie-zweifelt-an-technologie-des-milliarden-projekts
- “SBB Energie.” *Trafimage* online. https://maps.trafimage.ch/ch.sbb.energie?layers=ch.sbb.energie.public.unterwerke&lang=en&x=947308\.67&y=6005944&z=14&baselayers=ch.sbb.energie.public.data
- “Switzerland builds world’s most powerful redox flow battery.” *Swissinfo* online. 21 February 2025. https://www.swissinfo.ch/eng/climate-solutions/switzerland-builds-worlds-most-powerful-redox-flow-battery/91181119
- “Verspätungen und Klimaanlagen: So kämpft die SBB gegen die Hitze im Sommer an.” *Tages-Anzeiger* online. 22 June 2024. https://www.tagesanzeiger.ch/verspaetungen-und-klimaanlagen-so-kaempft-die-sbb-gegen-die-hitze-im-sommer-an-796970777734
- “Wie viel Strom verbrauchen Rechenzentren wirklich?” *EKZ* online. 17 February 2025. https://www.ekz.ch/de/blue/wissen/2025/rechenzentren-stromverbrauch.html
- Zhong.Raymond. “The Global AI Divide.” *The New York Times* online. 23 June 2025. https://www.nytimes.com/interactive/2025/06/23/technology/ai-computing-global-divide.html

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