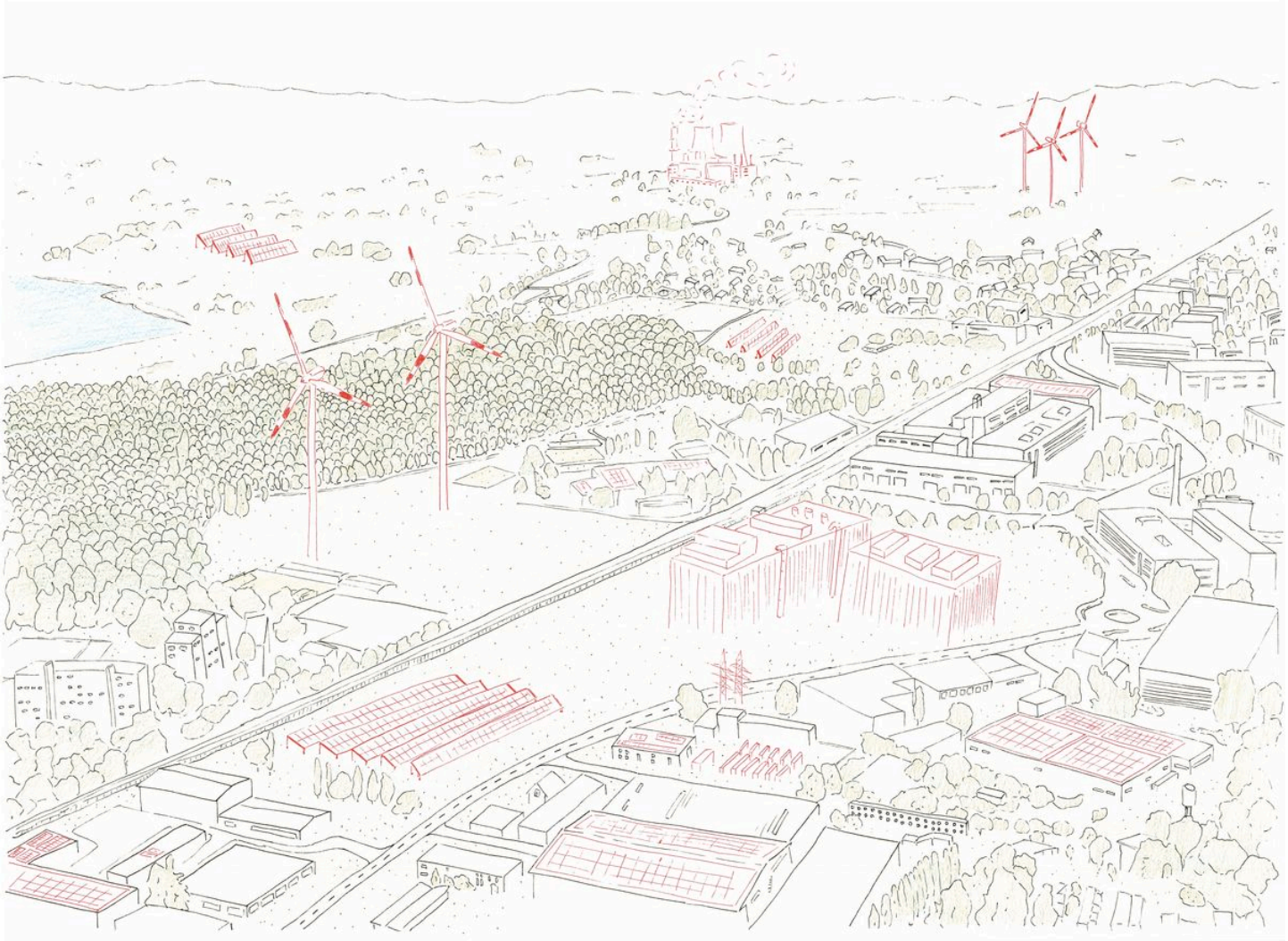
ETH Zurich Department of Architecture
ARCHITECTURE OF TERRITORY
Chair of Architecture
and Territorial Planning
Professor Milica Topalović

The Production of Cloud
Spring 2026

Energy Demand

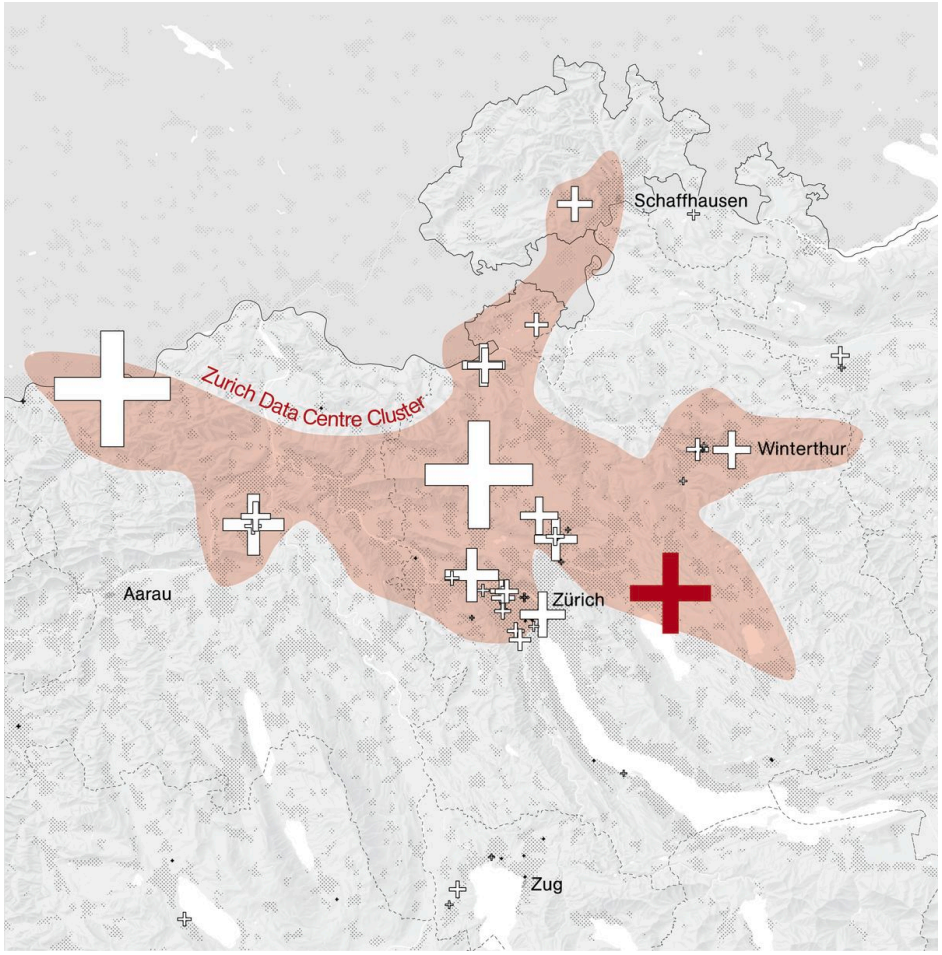
Energy Supply at Its Limits: Balancing the Expansion of Digital Infrastructure with Renewable Energy

Léa Wilson, Chanelle Pfenninger, and Adele Galli



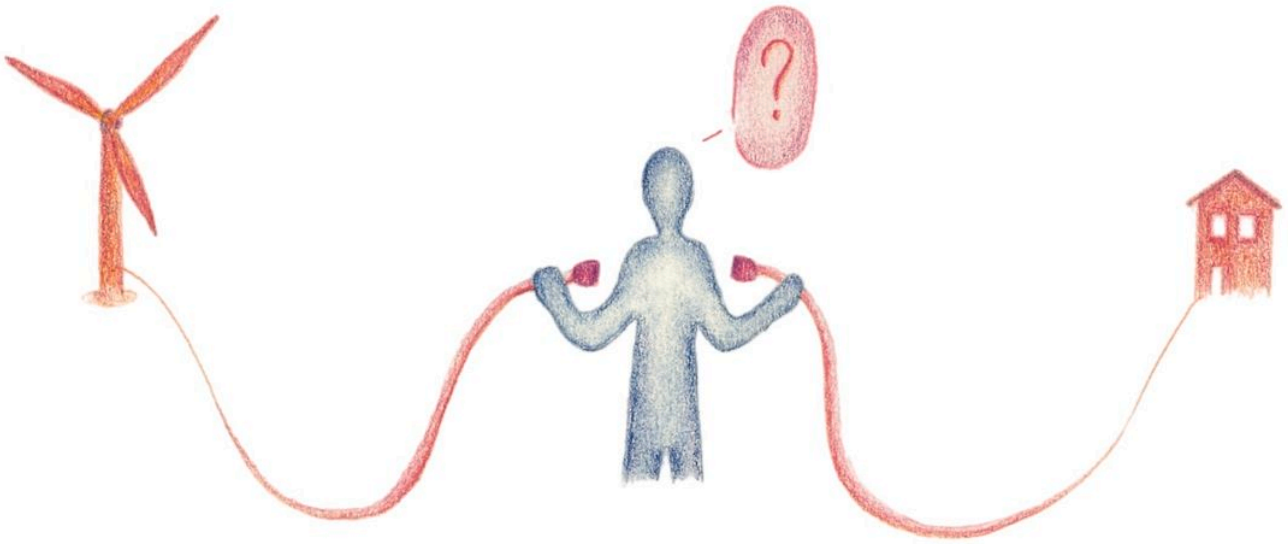
Where is the limit for the growing energy demand of data centres in Switzerland? Over the last seven years, the amount of energy demand caused by data centres has increased from 3.6 to 7.6 %, meaning that their energy consumption has more than doubled. Despite this rapid growth, energy providers such as EKZ are obligated to connect new customers to the grid, regardless of the building type or its energy demand. Now is the time to set limits.

This work proposes a limit in which data centres may not exceed 20 % of Switzerland's total electricity demand. Furthermore, large-scale Big Tech data centres should no longer be replaced or newly constructed after the end of their operational lifetime. Instead, they should gradually be replaced by intermunicipal data centres, where municipalities produce the required electricity locally through renewable energy sources.



NAME DATA CENTRE: Vantage ZRH 3
COMMUNE: Volketswil, ZH
TYPE DATA CENTRE: Hyperscaler
CAPACITY: 100 MW
OPERATOR: Vantage Data Centres
YEAR: Unknown
STATUS: In planning
WASTE HEAT USE: District heating

Electricity Production, Distribution, and Use in Switzerland



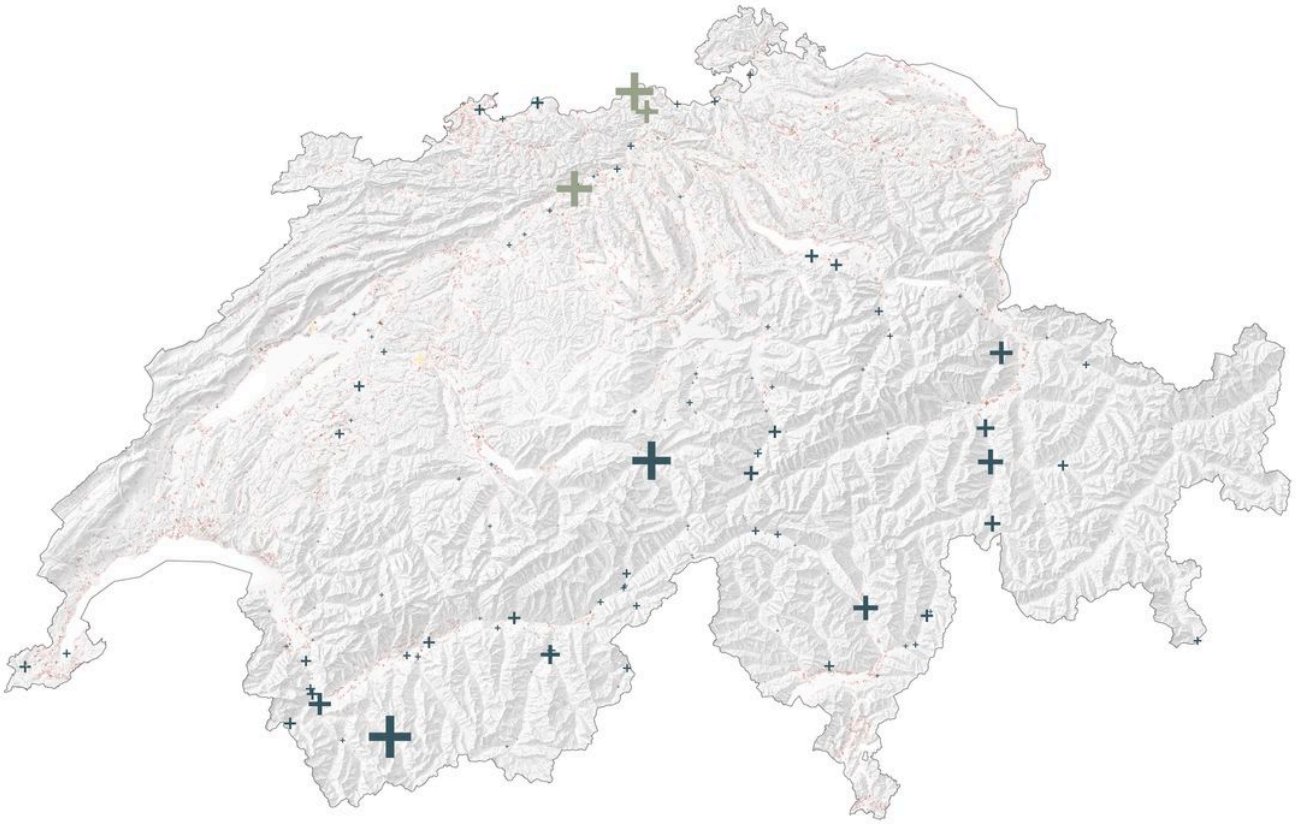
The Swiss electricity sector is defined by the co-dependency of various actors. Among them are Axpo, the main producer, who generates around 40 % of Switzerland’s electricity. Electricity transmission is managed by Swissgrid, the publicly owned national grid operator. Regional distribution to households and businesses is carried out by companies such as EKZ.



Video essay, *Electricity Production and Distribution in Switzerland,* 2026

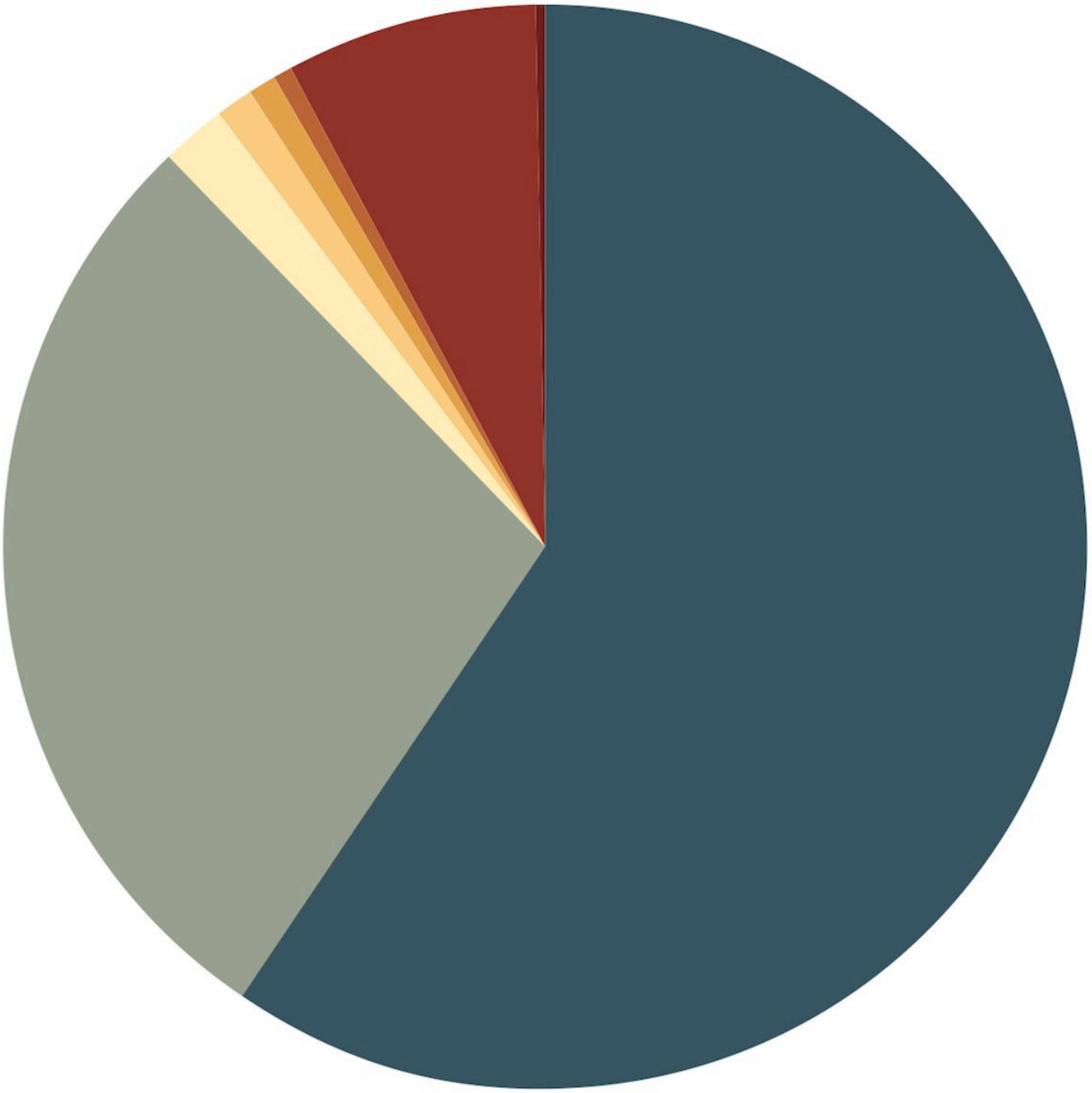
https://www.youtube.com/watch?v=Sco0m_6kdAs

Switzerland has a highly reliable electricity system, producing approximately 81.1 TWh of electricity per year. Most electricity comes from hydroelectric power stations (59.6 %), followed by nuclear power plants (28.4 %) and photovoltaic systems (7.4 %).



Location of electricity production facilities in Switzerland. Source: Bundesamt für Energie BFE, 2025.

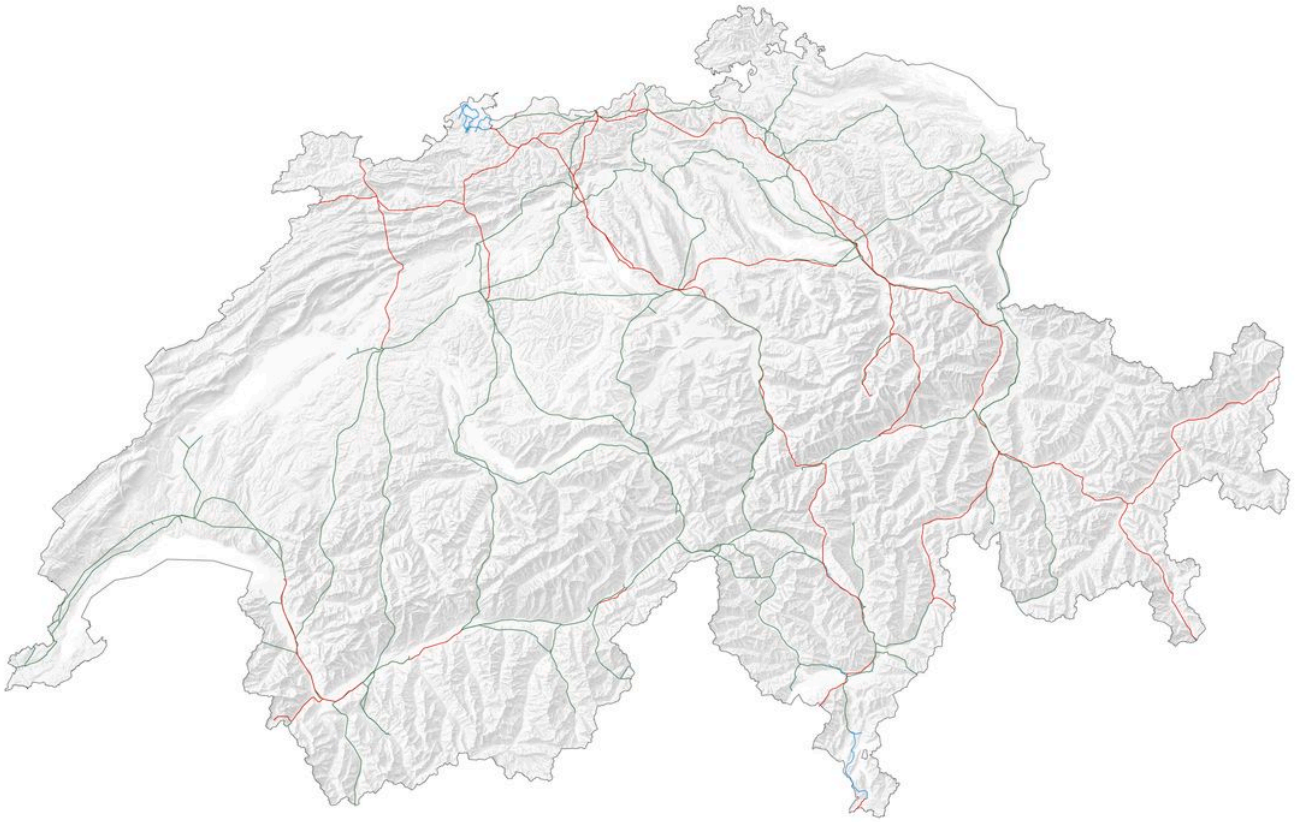
- Hydro
- Fossil
- Wind
- Solar



Energy production by source in Switzerland. Source: Bundesamt für Energie BFE, 2024

- Hydroelectric power stations—59.6 %
- Nuclear power stations–28.4 %
- Conventional thermal power stations and district heating plants (non-renewable)—1.8 %
- Conventional thermal power stations and district heating plants (renewable)—1.3 %
- Combustion with wood and wood-based materials
- Biogas plants–0.5 %
- Photovoltaic systems—7.4 %
- Wind turbines–0.2 %

The main producer is Axpo, who generates around 40 % of Switzerland’s electricity. Electricity transmission is managed by Swissgrid, the publicly owned national grid operator. Swissgrid operates approximately 6,700 km of high-voltage power lines and more than 120 substations. Regional distribution to households and businesses is carried out by companies such as EKZ. EKZ supplies electricity to roughly one million people through a network of 17,500 km of power lines and achieves a grid reliability of 99.997 %.



Swissgrid network. Source: Swissgrid, 2025.

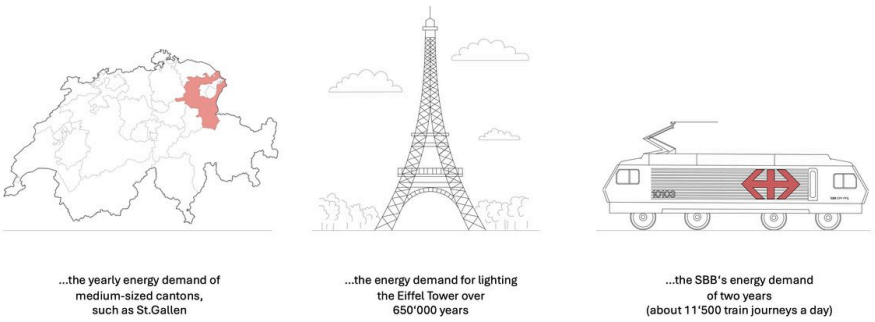
150 kV 220 kV 380 kV



Energy consumption by sectors in Switzerland. Source: Bundesamt für Energie BFE, 2024.

- Households–34.5 %
- Agriculture, horticulture–1.6 %
- Data centres–7.6 %
- Industry–21 %
- Services–25.6 %
- Traffic–9.7 %

In terms of energy consumption, households make up the largest part with 34.5 %, followed by industry with 21 %. Data centres already represent 7.6 % of energy demand, mostly as electricity. In 2019, they only made up 3.6 %, which demonstrates the rapid growth of digital infrastructure.



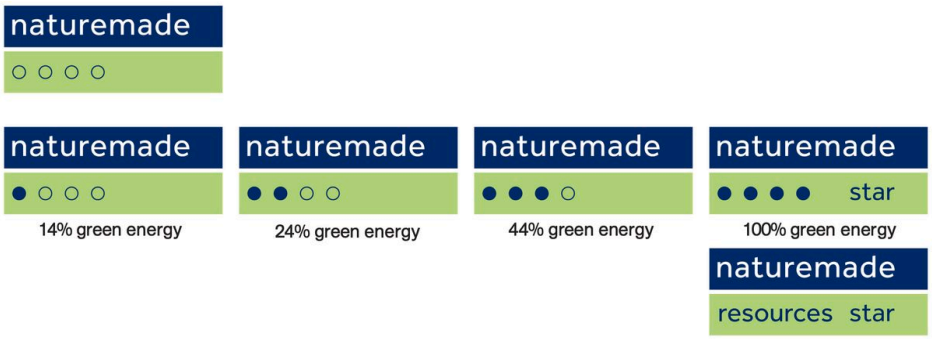
The energy demand of data centres equals…

Energy Demand of Data Centres



Energy Demand of Data Centres
https://www.youtube.com/watch?v=QKj6rvb_Pwo

When talking about the energy demand of data centres, an important question arises: What sources do they take their energy from? Researching the sustainability statements published on the websites of data centre companies often reveals vague claims such as: “Whenever possible, we use green energy.” While these statements may appear reassuring at first glance, they are imprecise and provide little transparency.



"Naturemade" labels with the respective share
of renewable energy. Source: naturemade, 2025.

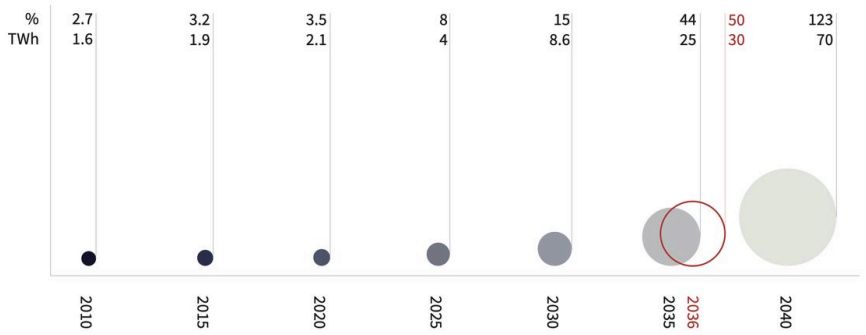
Even when companies claim to use “green” or “renewable” energy, this does not necessarily mean that the electricity is generated entirely from renewable sources. In many cases, sustainability labels and certifications can be misleading or difficult to interpret for the public. One example is naturemade, a certification provider for energy production facilities. Depending on the percentage of renewable energy in the energy mix, providers receive different certifications and are allowed to use specific terms. Terms such as “renewable”, “eco-friendly”, or “green energy” are not exclusively reserved for electricity generated from 100 % renewable sources.

The 50 % Scenario



What would happen if data centres consumed half of Switzerland’s electricity capacity? This scenario raises questions about energy demand, import of electricity, environmental impacts, rising electricity prices, and effects for local businesses.

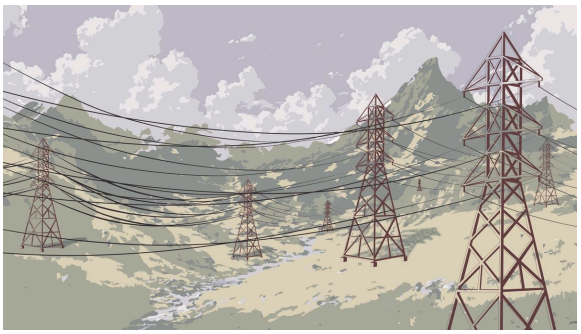
Data centres are growing at an exponential rate, currently consuming the equivalent of 7.6 % of Switzerland's electricity. If this trend continues, they could reach 50 % by 2035.



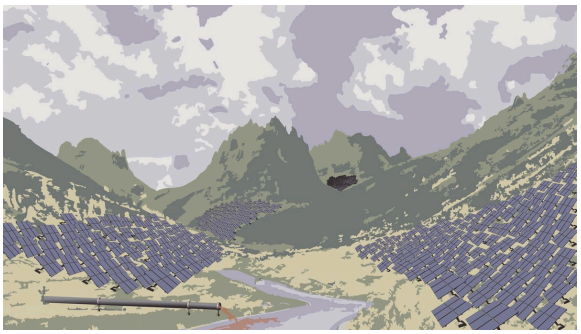
Energy consumption of Swiss data centres relative to national energy use 2010–2040. Source: EKZ, 2025.

High-voltage cables would appear across the mountains, carrying electricity from the Alps to data centres located in cities. The Alps, having become the main site of energy production, would be covered in solar panels. At the same time, data centres would generate more waste heat than could be reused. Excess heat would be channelled into rivers, threatening ecosystems. The economic gap between the various social classes would grow wider. People and businesses able to afford electricity, even at a high price, would gain power, whilst small businesses that cannot afford it would be left behind.

This is an alarming forecast that is not sufficiently discussed.



The energy demand would rise dramatically so that Switzerland would have to import massive amounts of electricity through power highways crossing the Alps.



Photovoltaic panels would spread across the Alps. At the same time, data centres would generate more waste heat than could be reused. Excess heat would be chanelled into rivers, threatening ecosystems.



As electricity demand increased, prices would rise significantly. Many small local businesses could no longer afford energy costs and would be forced to close, creating a growing economic divide between big tech companies, municipalities, and local communities.



In extreme situations, Switzerland could face load shedding. While homes and businesses sit in darkness, the data centres would continue running nonstop.

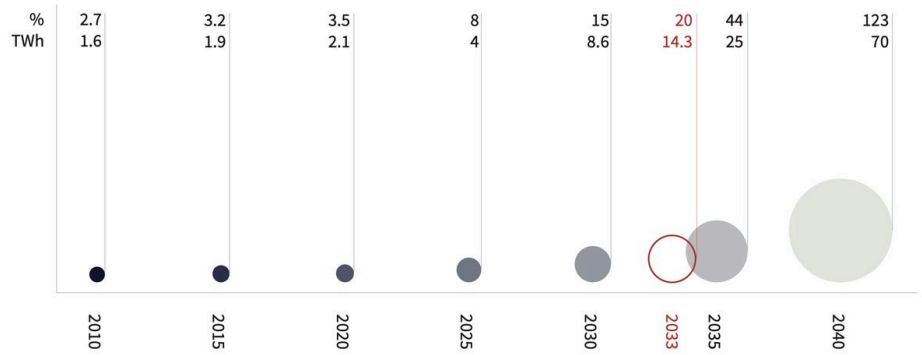
Defining Limits for Big Tech Data Centres in Switzerland



We demand stricter guidelines about energy consumption and the source of the energy used of the big tech data centres in Switzerland.

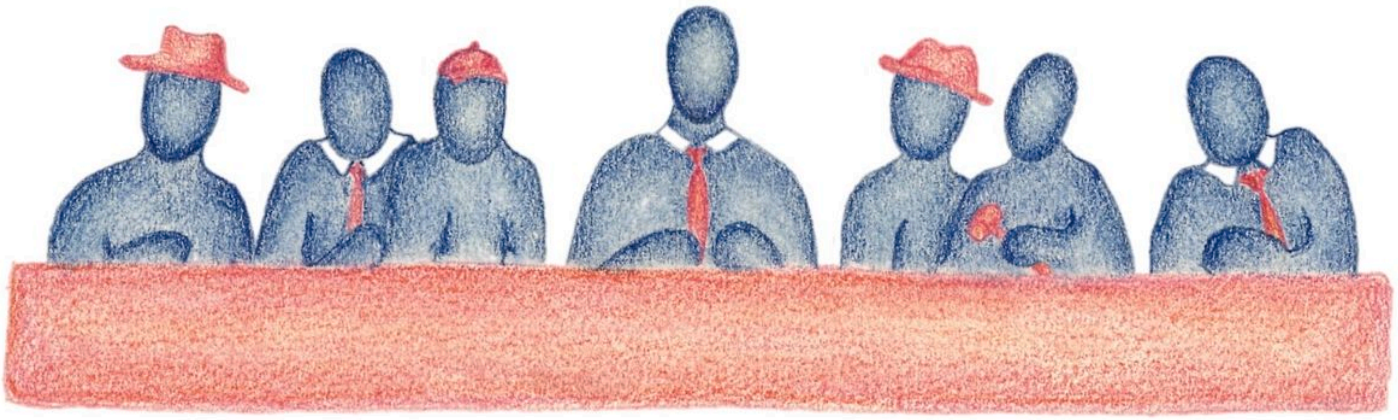
We set the expansion limit at 20 %. The idea behind this specific threshold is the following: Switzerland currently produces more electricity than it consumes, therefore exports a part of its produced electricity. We decided that data centres are permitted to expand only to the extent that their additional electricity consumption can be covered by the renewable electricity currently being exported. In this analysis, it is assumed that approximately 65 % of Switzerland's exported electricity originates from renewable energy sources.

In essence, data centres may continue to expand only so far as their increased electricity demand corresponds to the volume of renewable electricity that Switzerland currently exports.



Energy consumption of Swiss data centres relative to national energy use 2010–2040. Source: EKZ, 2026.

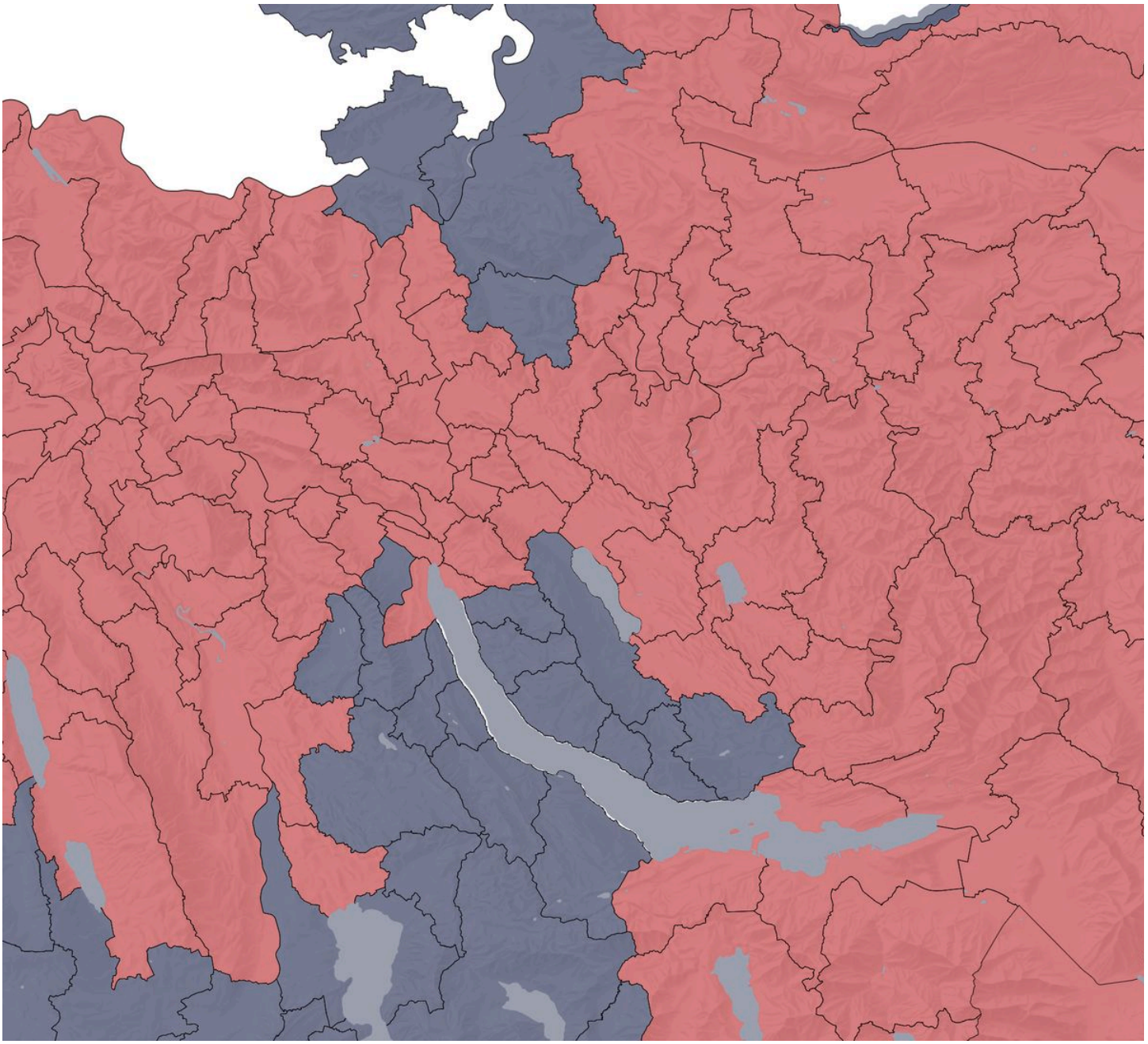
Energy for Intermunicipal Data Centers



The Intermunicipal Data Centres are supplied by renewable energy, produced by infrastructures located within the intermunicipal border. These locations create social interaction points for the community.

For the further development of data centres, we build upon the research by the student group Data Ecologies [https://topalovic.arch.ethz.ch/courses/student-projects/fs26-digital-commons], who were also part of the design studio The Production of Cloud [https://topalovic.arch.ethz.ch/courses/design-studios/fs26-the-production-of-cloud] in Spring 2026.

They proposed Intermunicipal Data Centres that are collectively owned by municipalities as an alternative to data centres owned by tech companies. In this model, the data of all residents is stored and managed locally within one of the municipalities. Representative associations of municipalities provide for the energy supply of the data centres, which is entirely based on renewable energy sources. Depending on the geographical location, the energy is generated either through wind or solar power.

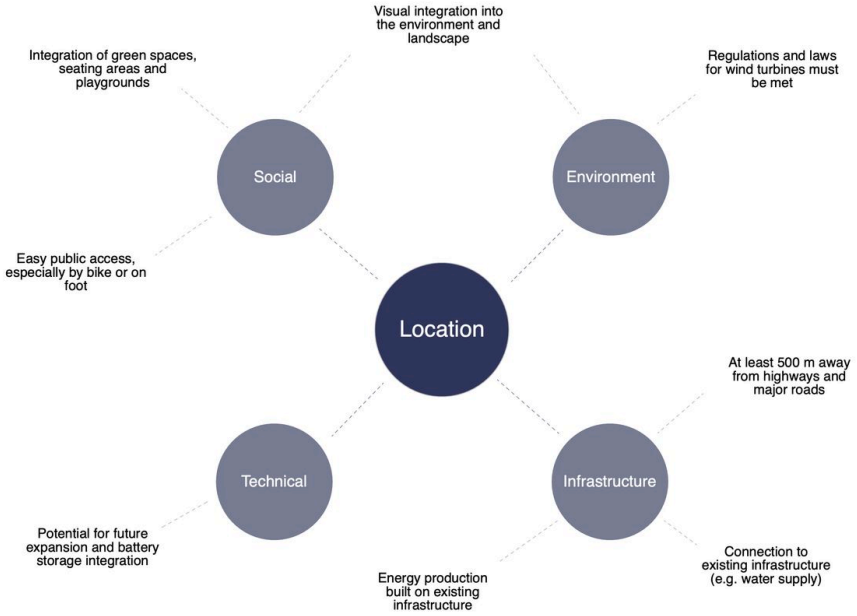


Classification of municipalities according to their solar or wind energy potential. Source: Bundesamt für Energie BFE, 2024.

Wind

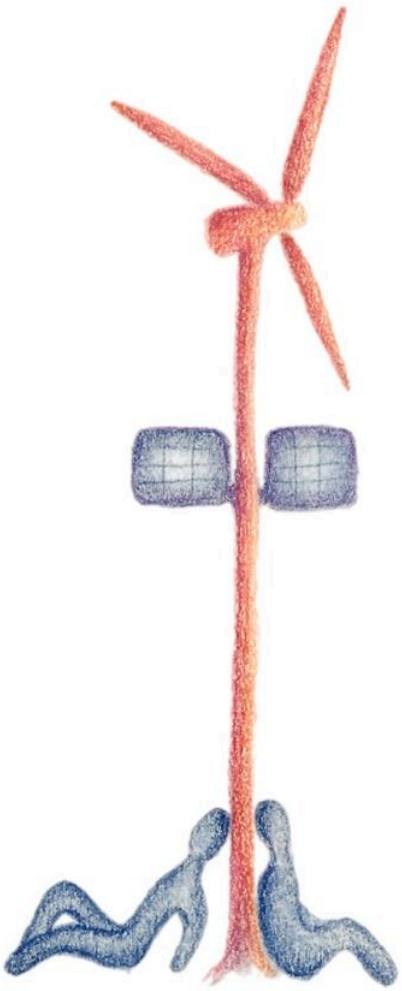
Solar

In order to identify a suitable location within the association of municipalities for the production facility, we established a set of guidelines and criteria. Due to the limited availability of land in some areas, it is not always possible to meet all these criteria. Compliance with legal requirements is mandatory, whereas the remaining criteria represent optimal conditions that should be fulfilled whenever possible.



Guidelines for selecting a suitable energy production location.

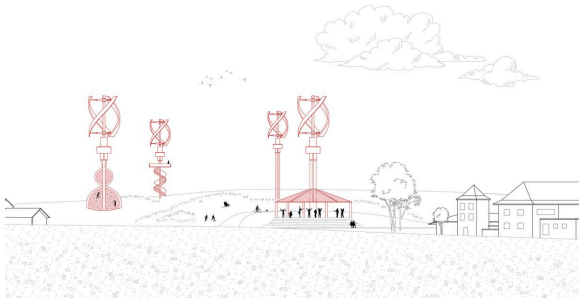
Wädenswil and Russikon: A Solar and a Wind Park for Intermunicipal Data Centres



Renewable energiues will power the Intermunicipal Data Centres in the future. The new solar and wind parks will be multifunctional sites of energy production and civic life.

For Wädenswil, we propose a wind park, for the municipality of Russikon, we propose a solar park. The installations are intended not only to serve as sites for energy production, but also as gathering spaces for local residents. The aim is to foster a positive perception of renewable energy within the community, while ensuring that energy consumption is no longer outsourced but instead generated where it is needed. In this way, local communities can develop awareness of the highly energy-intensive nature of data centres.

Wind Park Wädenswil



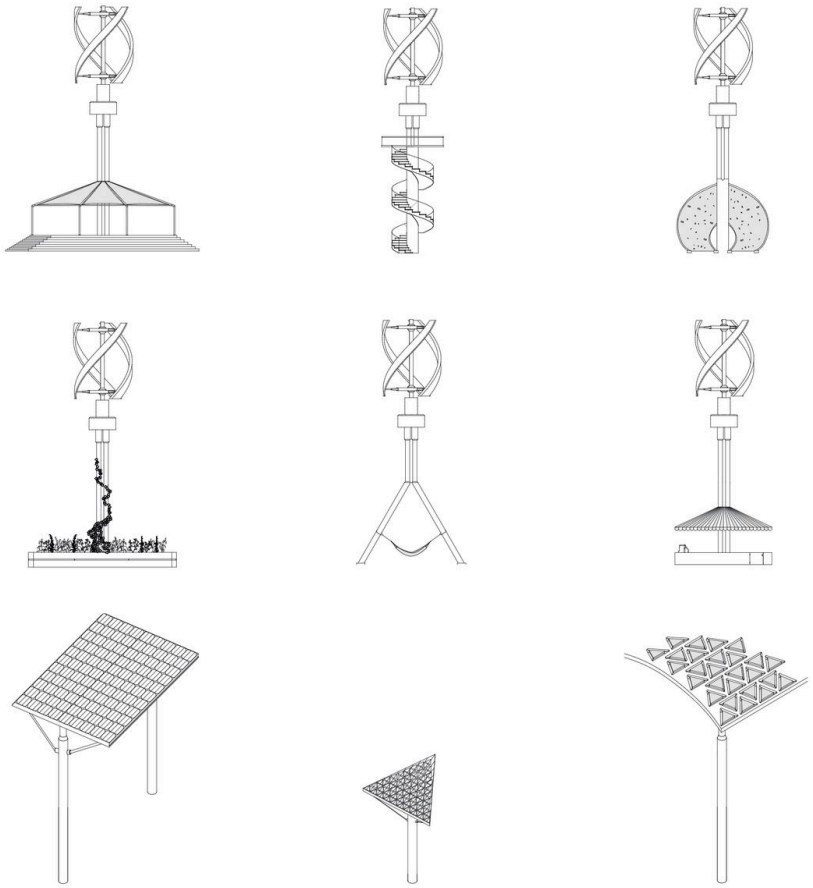
Section Through the Windpark in Wädenswil



Site Plan of the Windpark in Wädenswil

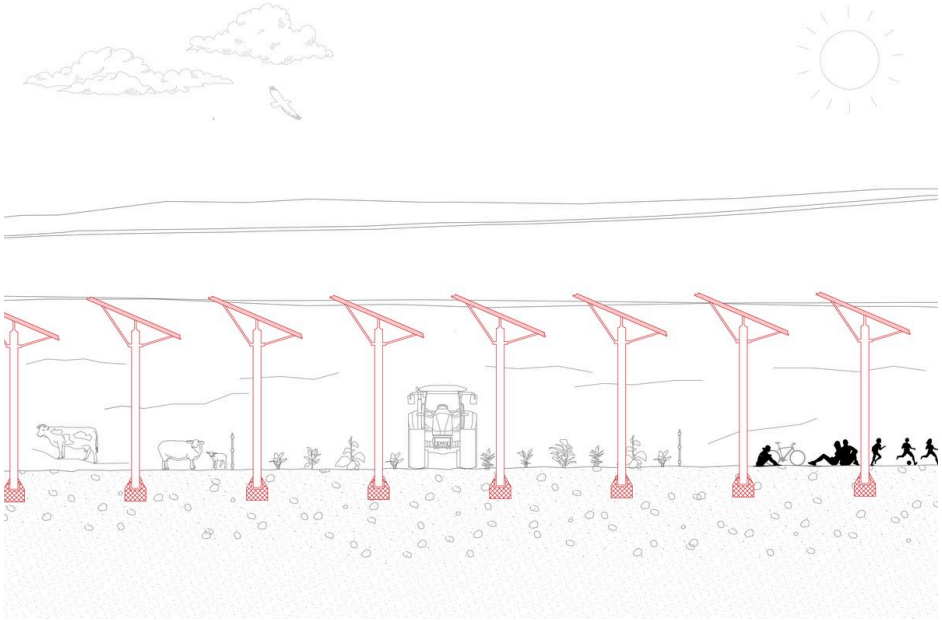
Wädenswil is a municipality on the south-western shore of Lake Zurich, approximately 25 km from Zurich. Its location between the lake and the nearby hills creates a mild climate with moderate winds and occasional foehn influences.

Until now, the meadow has no specific use. By adding wind turbines and recreation areas, it will become the new landmark of Wädenswil. The park invites visitors to dance in the shade of the turbines, enjoy beautiful views of the lake from a viewpoint, or even go bouldering on a wind turbine. Additionally, a network of paths and benches offers space to relax and stay a while. One thing is certain: it will definitely not be boring.



Design catalogue for mutlifunctional wind turbines and solar panels.

Solar Park Russikon

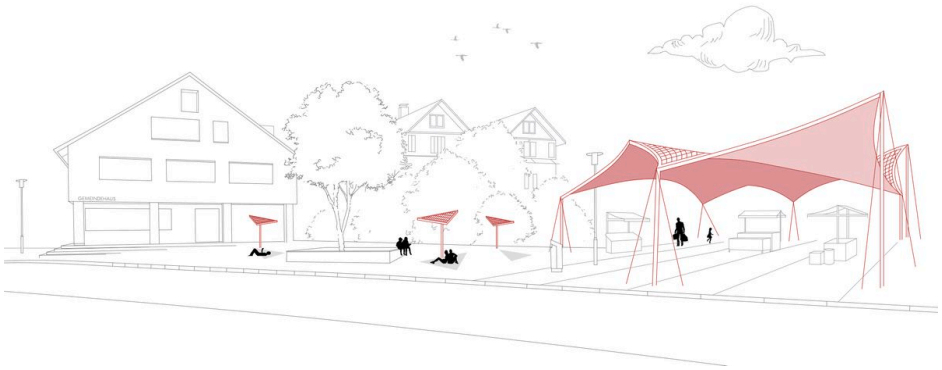


Proposal for a solar park in Russikon,
combining agricultural with energy production.

The municipalities of Russikon, Weisslingen, and Fehraltorf are located near the city of Winterthur and are predominantly characterised by a rural landscape.

Photovoltaics take on different forms in this case study. On the one hand, they are implemented as agrivoltaics at the edge of the municipality. Depending on the season and the farmer's needs, the land is either used as farmland or transformed into a recreational space for residents of the three communities. The lightweight structure of the solar panels provides shade and creates an ideal setting for a picnic on a warm summer day.

Solar Canopy Russikon



Proposal for the new municipality centre with, introducing a photovoltaic canopy for the municipality centre in Russikon.

The second application of photovoltaics is located in the village centre of Russikon. The municipal building features a forecourt and a large parking area. The parking space is covered by a steel structure filled with photovoltaic panels. This canopy is particularly well suited for hosting a monthly Sunday market or other community events. Additional shading structures are also installed on the forecourt.

Wind turbines and solar panels offer more possibilities than only functioning as energy generators. They can provide a wide range of additional functions and could become integrated into public space in more ways. Wind turbines, for instance, could serve as sources of shade, climbing structures, or even observation towers.

ACKNOWLEDGEMENTS

We would like to thank all our interview partners for making this research possible. We are especially grateful to Nils Beckhaus and Michèle Bättig for their time and for sharing their valuable expertise with us. We also want to thank our fellow students for the great discussions and shared insights throughout the semester. We are especially grateful to Professor Milica Topalovic for guiding us through the semester. We also want to warmly thank Martin, who helped us immensely and even came to ETH on Whit Monday to open the doors for us.

ChatGPT and DeepL were used for spelling correction.
Images by the authors if not otherwise stated.

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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