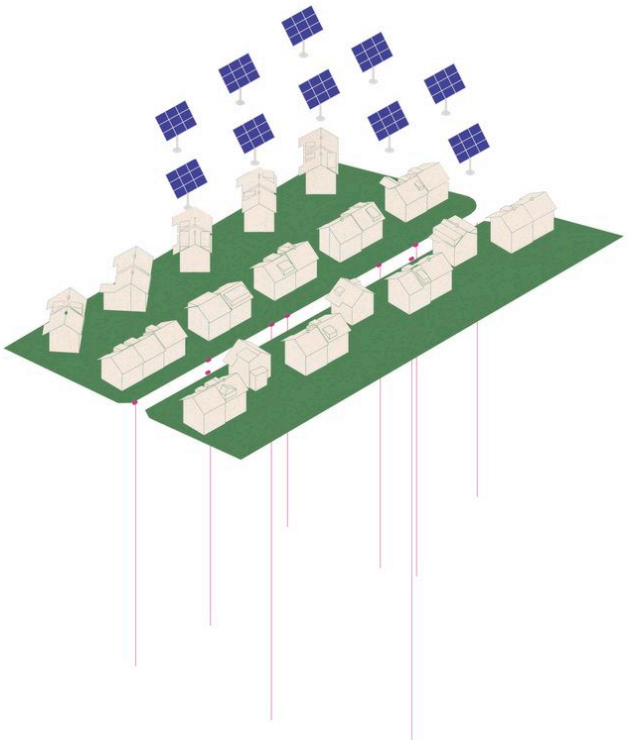
ETH Zurich Department of Architecture
ARCHITECTURE OF TERRITORY
Chair of Architecture
and Territorial Planning
Professor Milica Topalović

Kraftwerk Schweiz
Spring 2024

Oil

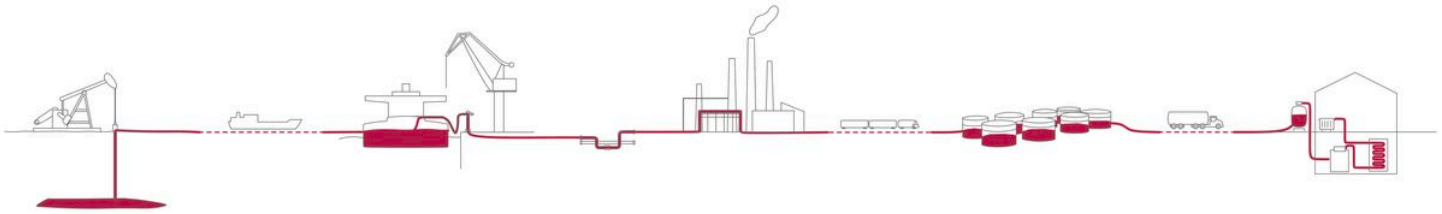
Transition Beyond Oil: From Fossil Individuality to Communal Energy Solutions

Meta Hunold and Tina Solé Borda

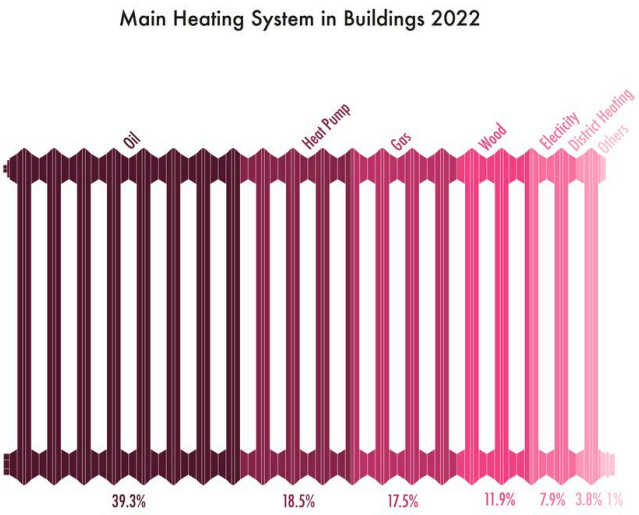


Switzerland’s households nowadays still heat mostly with fossil energy. This goes hand in hand with the single-family house, petroculture urbanism. Changes and incentives are being made to change to a more renewable future. Though, are they coming fast enough to meet the 2050 Zielbild of being net-zero Switzerland has planned?

The Lifecycle of Oil

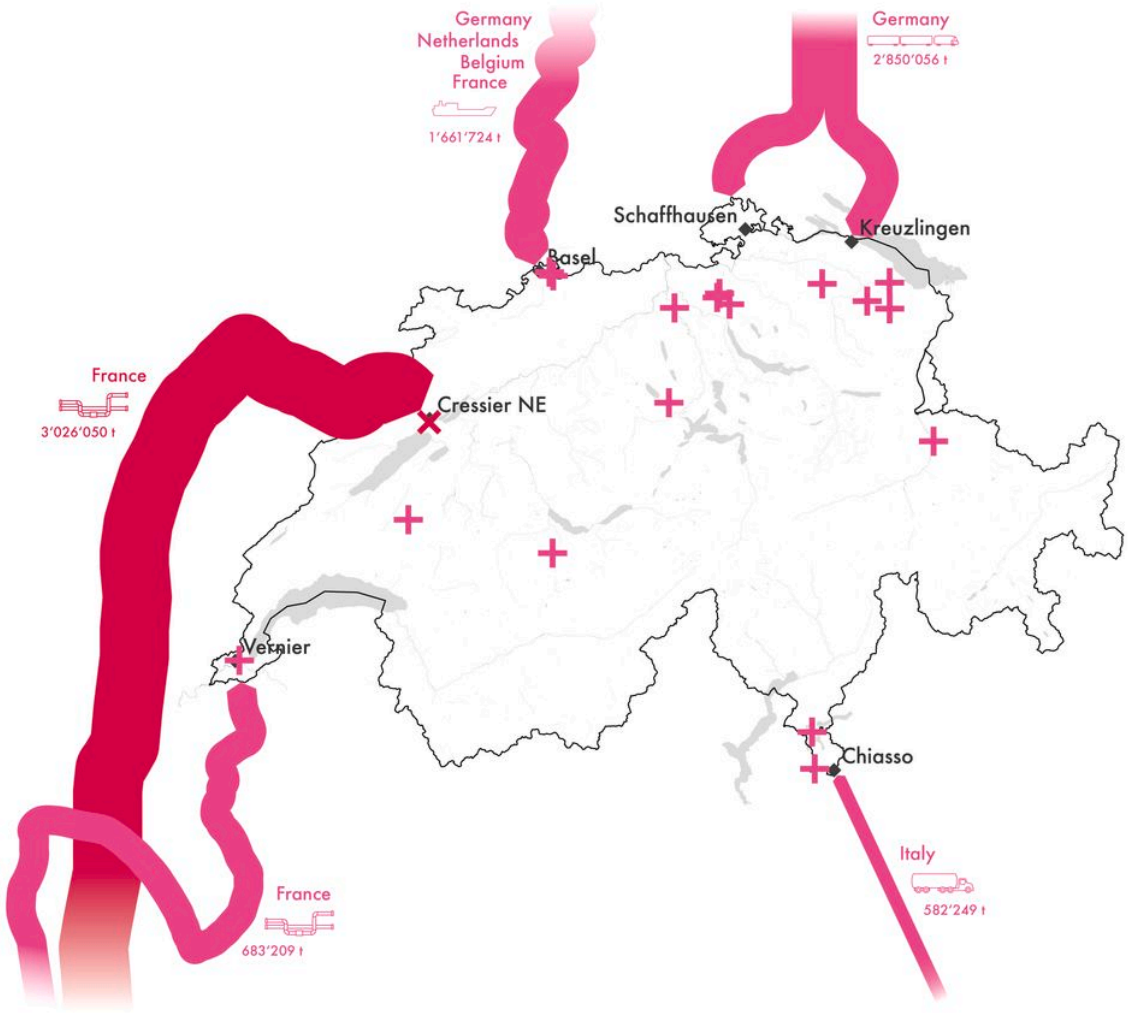


Around 40% of all households in Switzerland currently still use oil heating systems. It fuels our everyday lifes, but its repercussions are only partially recognized. The origin and cycle of oil takes place mostly outside the countries boarders and is therefore invisible to many.



Main Heating System in Buildings 2022.
Source: BFS, 2022.

The cycle of oil involves a lot of production, storage and transport methods, starting from the oil well and ending up in the house. In Switzerland, around two thirds of the oil is imported as raffinated products. So, the first step which takes place inside the country is its storage. One third comes as crude oil through pipeline and is raffinated in the only oil refinery in Switzerland located in Cressier.



Switzerland's Oil Import.
Source: Avenergy Annual Report 2022.

Import of crude oil

Import of petroleum products

In our research, we have analysed and reported the cycle from the storage, the delivery and finally, the final stop inside the house. We visited the biggest oil depot in Switzerland, the Mellingen oil depot. It was built in 1965 by the AVIA association, BP and Esso Standard, in a time where a limit of fossil fuels wasn't in sight. A couple tenths of oil companies store oil in Mellingen. The heating oil is transported directly from the depot to the households. We were able to be present in an oil delivery from the company AVIA Osterwalder/Hürlimann.

Lifecycle of Oil in Switzerland.
https://youtu.be/IR5vs-ZR2jQ

The video only showcases what is visible to Switzerland population, what happens inside its borders.

Oil Supply Chain: From the Oil Well to the Heater.

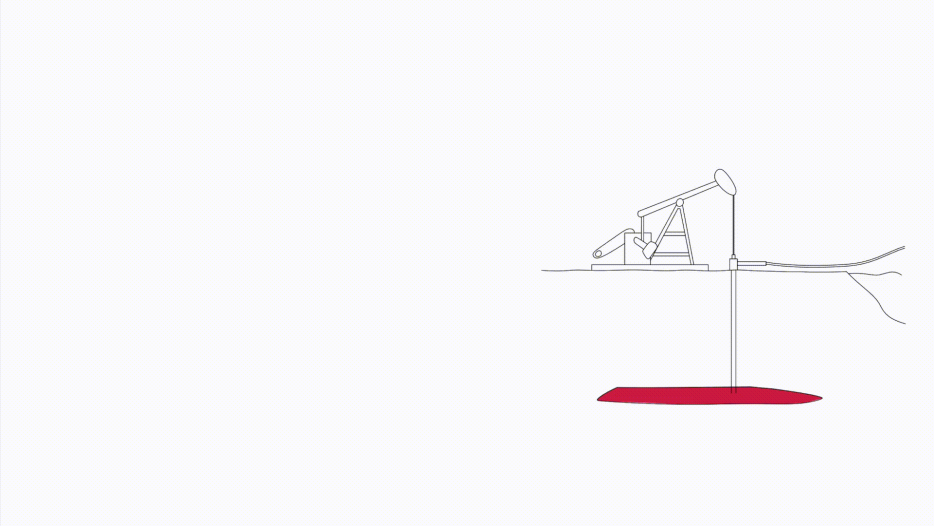
Oil Supply Chain: From
Switzerland's Borders to the Heater.

Oil Supply Chain: From
Switzerland's Borders to the Heater.

Oil Supply Chain: From
Switzerland's Borders to the Heater.

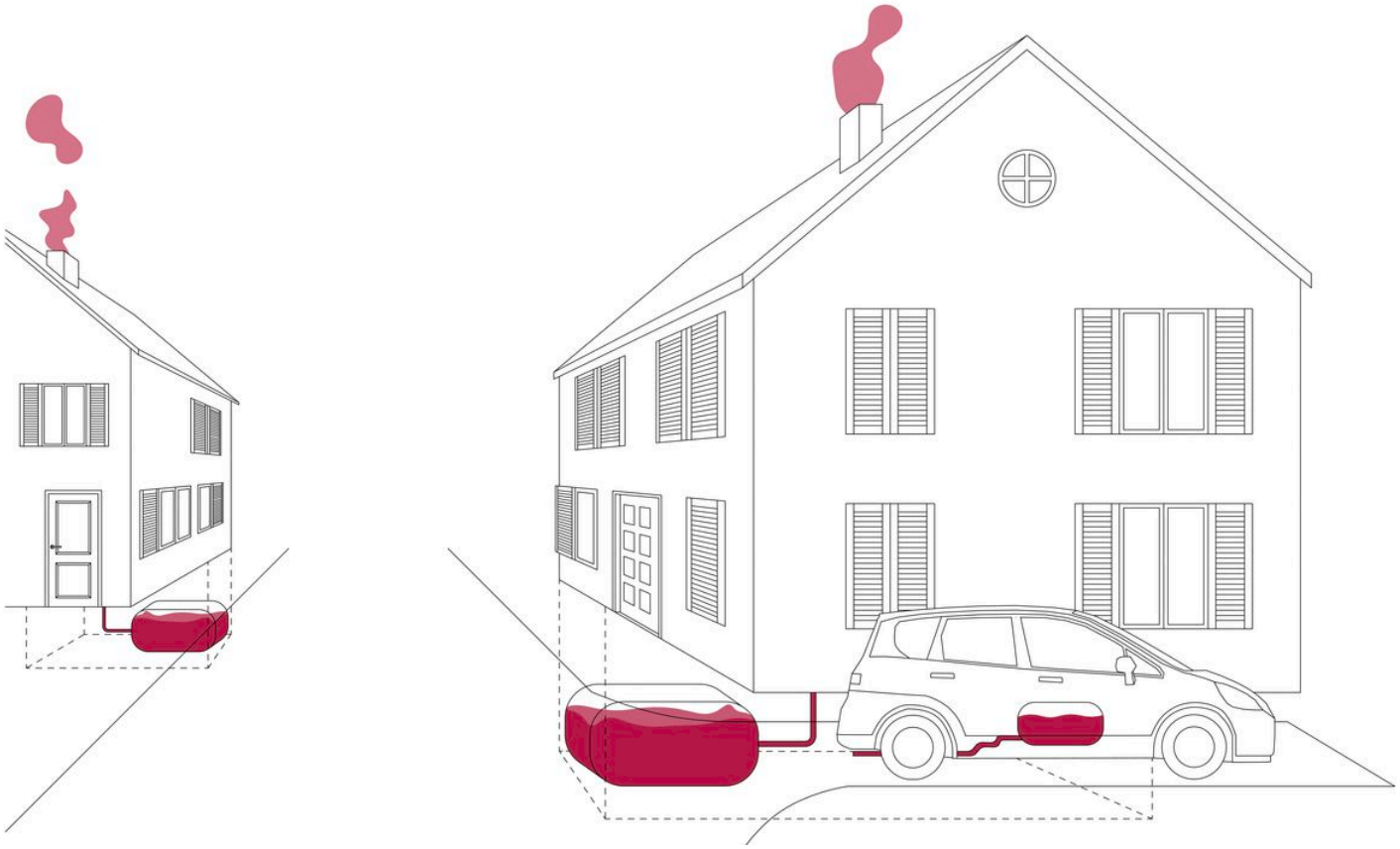
Oil Supply Chain: From
Switzerland's Borders to the Heater.

The whole cycle of oil is much more complex and involves many stops along the way, connecting big distances through various continents.



Usually this spatial separation is the reason the negative impact of oil is forgotten in the countries where only the final oil product is imported. The problems of oil get lost along the way.

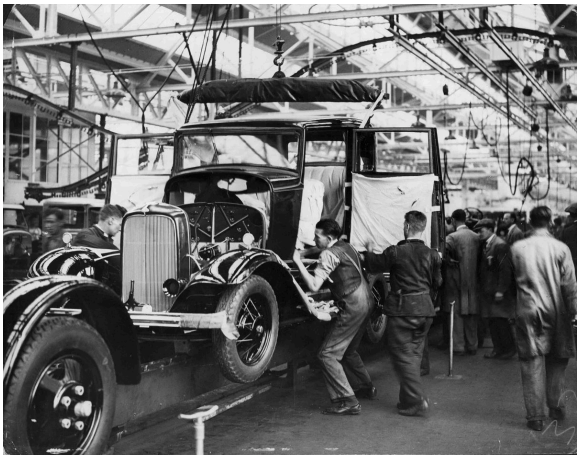
The Petroculture of the Einfamilienhaus-Siedlung



The idea of owning a single family home in the countryside has been a popular dream of many people for several past decades. Besides the political and social change to multifamily houses and living in the city, this dream is still well sought out as a living situation for many families. But how was this typology established as the ultimate goal? And why exactly this type of housing?

Henry Ford, 1919.
Source: Encyclopædia Britannica, Inc.

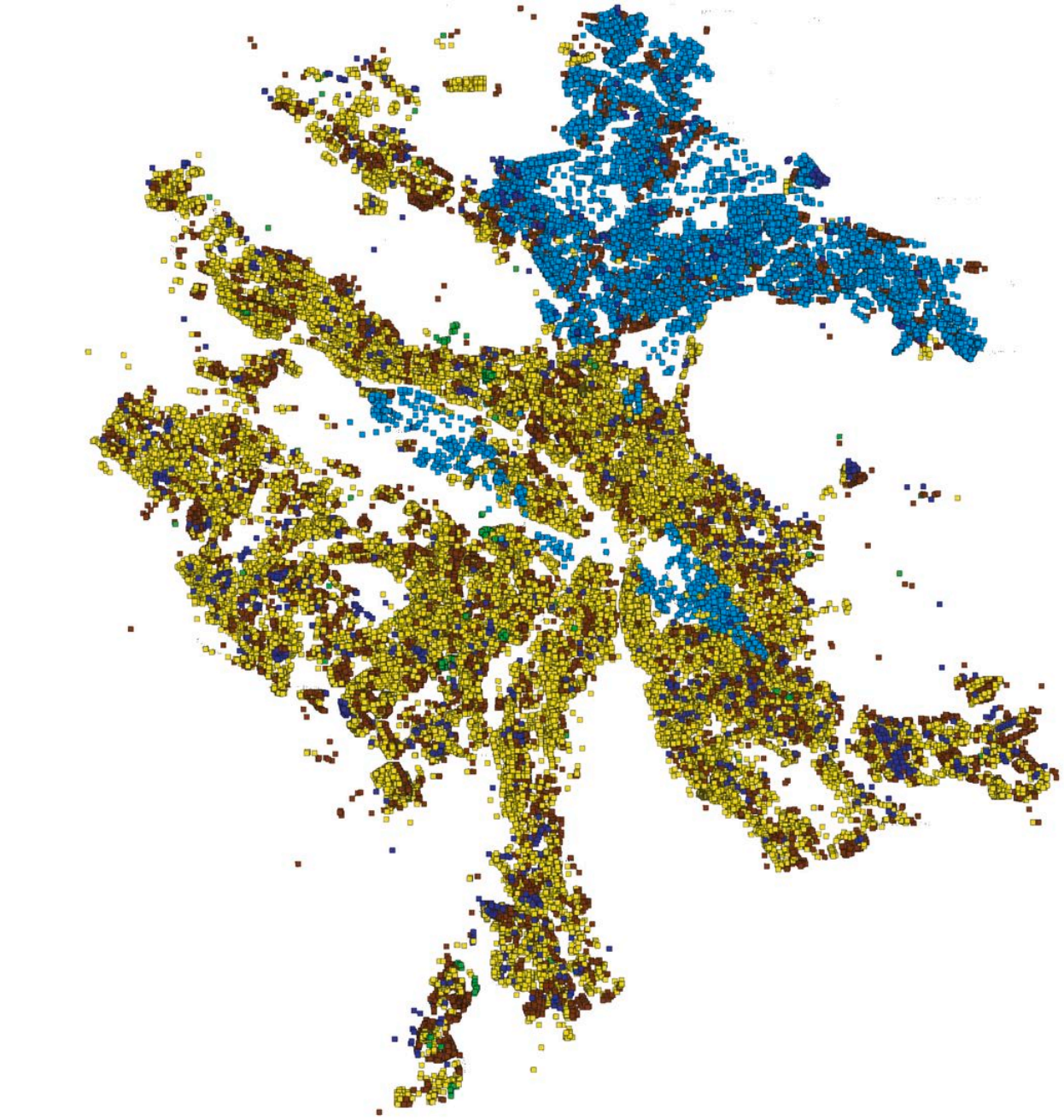
Workers at the Ford Assembly Line, 1932.
Source: Encyclopædia Britannica, Inc.



Workers at the Ford Assembly Line, 1932.
Source: Encyclopædia Britannica, Inc.

In the early 20th Century Henry Ford went into the automobile business and transformed the working system and society. He introduced mass production, labour division and the standardization of products. His practices also brought societal changes. Due to the system of increasing wages and a vast quantity of affordable goods, people started to buy more. This led to the rise of consumer culture. Suburban living got an uprise in popularity, as every family owned a car and was able to afford it's own house.

This phenomenon can also be seen in Switzerland. Many individual or row houses of single-family homes can be found in and around Zurich. The dependance of a car to commute from and to work vanished over the years, as the city underwent periods of growth and urban densification since the 1940s. Yet the ideal still remained. Oil heating originates from a time where fossil fuels were considered an infinite resource, but they also work with this ideology of having everything independent – a full oil tank in the cellar, which can last for over a year.



Main Heating Source of every Building.
Source: Energis Stadt Zürich, 2024.

In our quest to get the users perspective of an oil heater. We located the Street of Wickenweg. It is a quiet street with single-family homes with gardens, containing a kindergarten and a small playground.

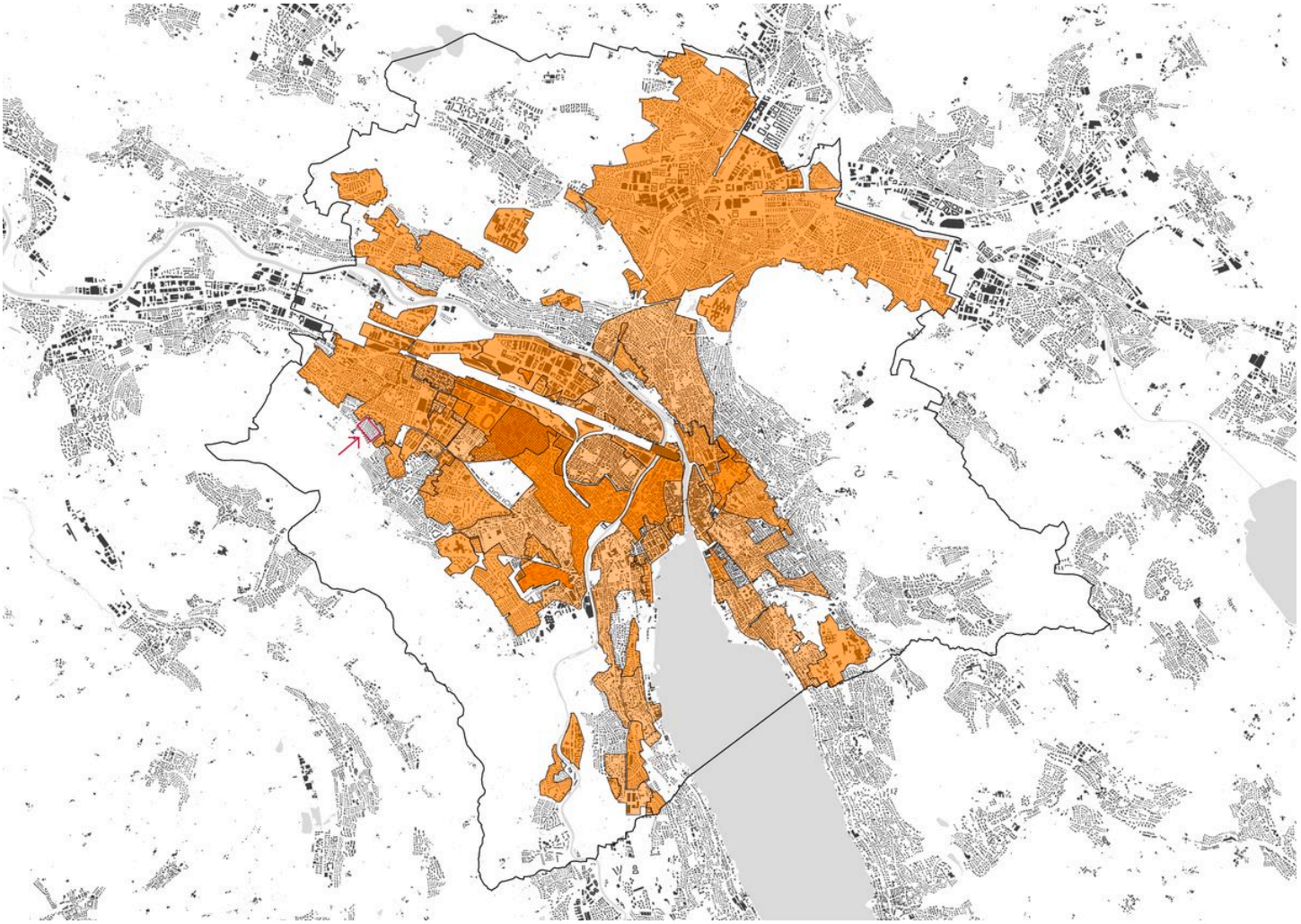
Introduction Wickenweg.
https://youtu.be/wydjkgDQ74k

Energy Sources of Wickenweg.
Source: Energis Stadt Zürich, 2024.

Heating oil

Gas

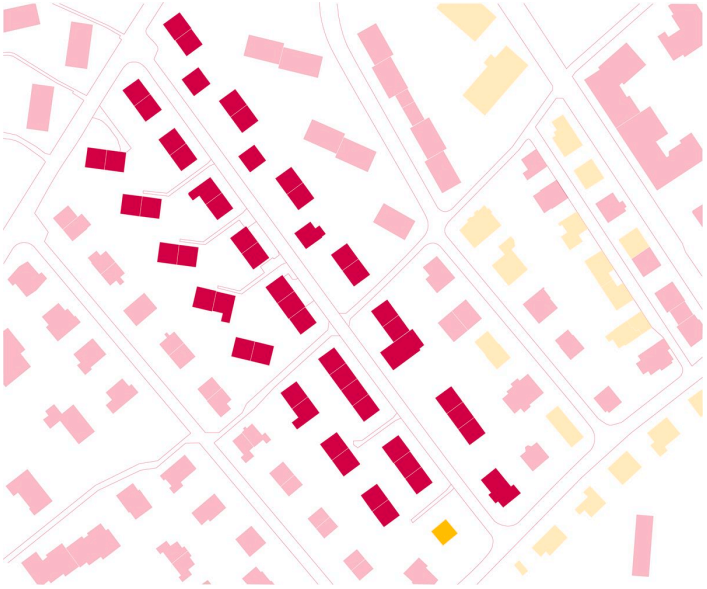
According to the city of Zurich almost all the houses heat with oil and the street lies outside of any active or planned district heating systems. The area is considered a development zone with focus on decentralized sources of renewable energy.



District Heating Zoning Plan of Zurich.
Source: Kommunale Energieplannung Stadt Zürich, 2024.

Existing district heating Planned district heating Planned district heating

Due to the majority of the residents being house owners, we counted on good knowledge and involvement with their heating systems. What we found wasn't what we suspected.



Energy Sources of Wickenweg.
Source: Energis Stadt Zürich, 2024.

- Heating oil
- Gas

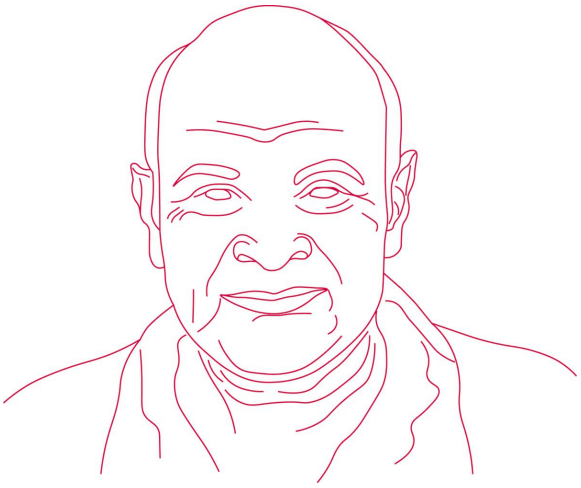
Actual Energy Sources of Wickenweg.
Source: Energis Stadt Zürich, 2024 / Interviews, 2024.

- Heating oil
- Gas
- Heat Pump
- Pellets

During interviews with the residents we came to the astonishing conclusion that the map we downloaded from the city hasn't been updated recently. Several families have already transitioned to a heat pump in the last couple of years. Many of the locals admitted embarrassingly that they hadn't transitioned yet, even when our main interest at this point of research was the comfort provided by oil.

Mr Clayduck
Mr. Clayduck still uses an oil heating system as he is only a tenant and doesn't have a say in it.

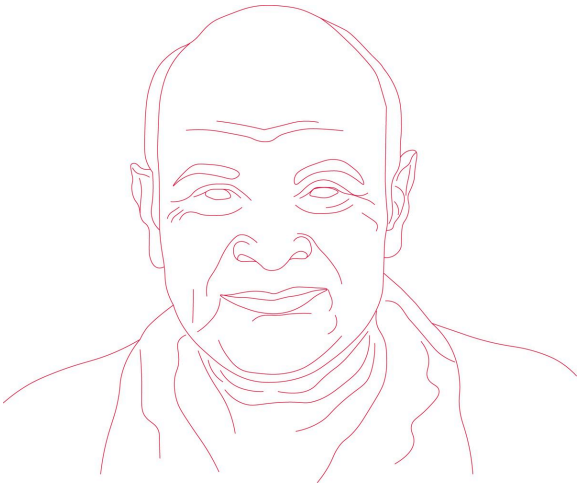
Ms Bonsai
Ms. Bonsai hopes her oil heating system will outlive her, so she won't have to go through the hassle of changing it.



Mr Architect
Mr. Architect wants to change his heating system from oil to a heat pump, but needs to fulfil insulation guidelines first.

Ms Cat
Ms. Cat can’t afford to change their oil heating system.

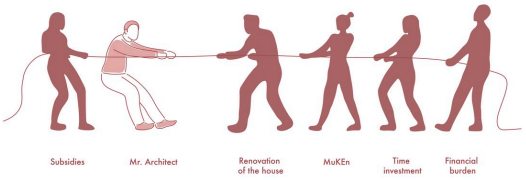
Mr Piano
Mr. Piano unhappily changes his heating sysetm from oil to a heat pump at the end of the year.



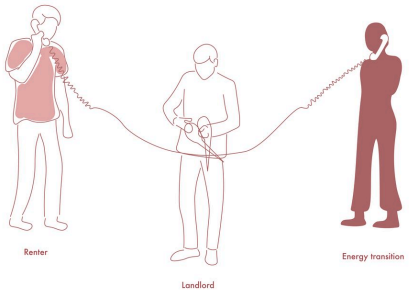
Mr Easter
Mr. Easter would like to change to something else, but he is only a tenant and the owner isn't interested yet.

The Complexity of Single Cases

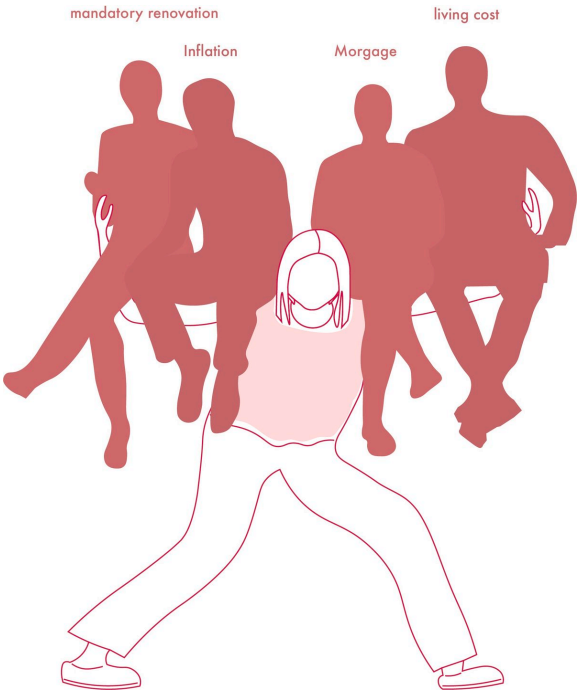
While there were many different factors as to why they hadn't transition yet, there were some reoccurring arguments. We took a special interest in those as they seemed to be the problems responsible for a slow transition.



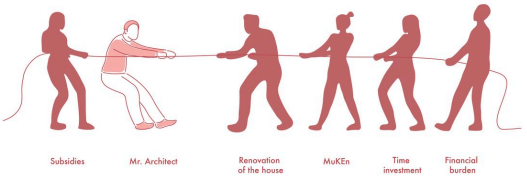
The case of Mr Architect: The lengthy process of transition.



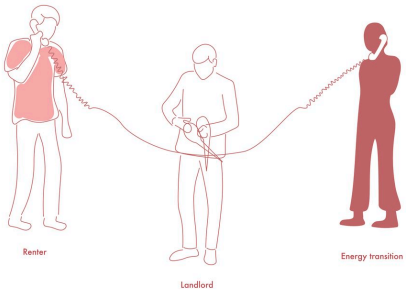
The case of Mr. Easter: The struggle of a tenant with no saying.



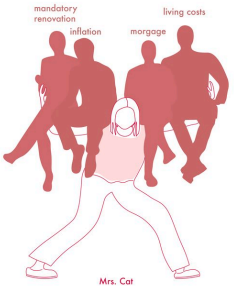
The case of Ms. Cat: The financial burden of transition.



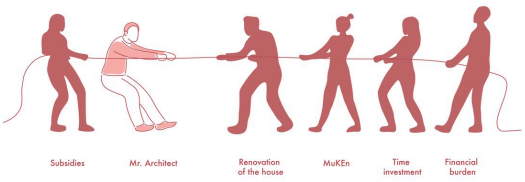
The case of Mr. Architect: The lengthy process of transition.



The case of Mr. Easter: The struggle of a tenant with no saying.

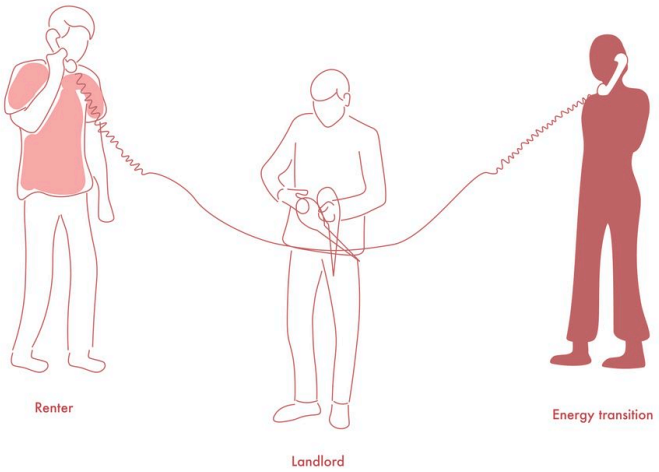


The case of Mrs. Cat: The financial burden of transition.



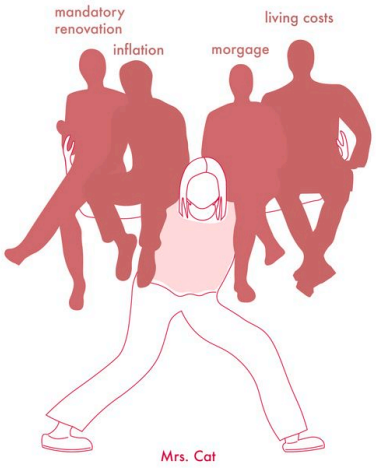
The Case of Mr. Architect: The Lengthy Process of Transition.

The case of Mr. Architect is one of many, who are in the same situation. He moved into the house in an old state and an incorporated oil heating system. The house is not energy efficient, so even though of his wish to change his oil heating system, he before needs to renovate and correctly insulate the whole house, so that he meets the energy efficiency to make a change to a heat pump worth it. He told us he has to build an outside insulation and replace the windows. That is dictated by the model regulations of the cantons in the energy sector (MuKEn), which says a one-to-one replacement of fossil heating systems is only permitted if the building in question has a certain level of energy efficiency. That brings with it a huge money and time investment.

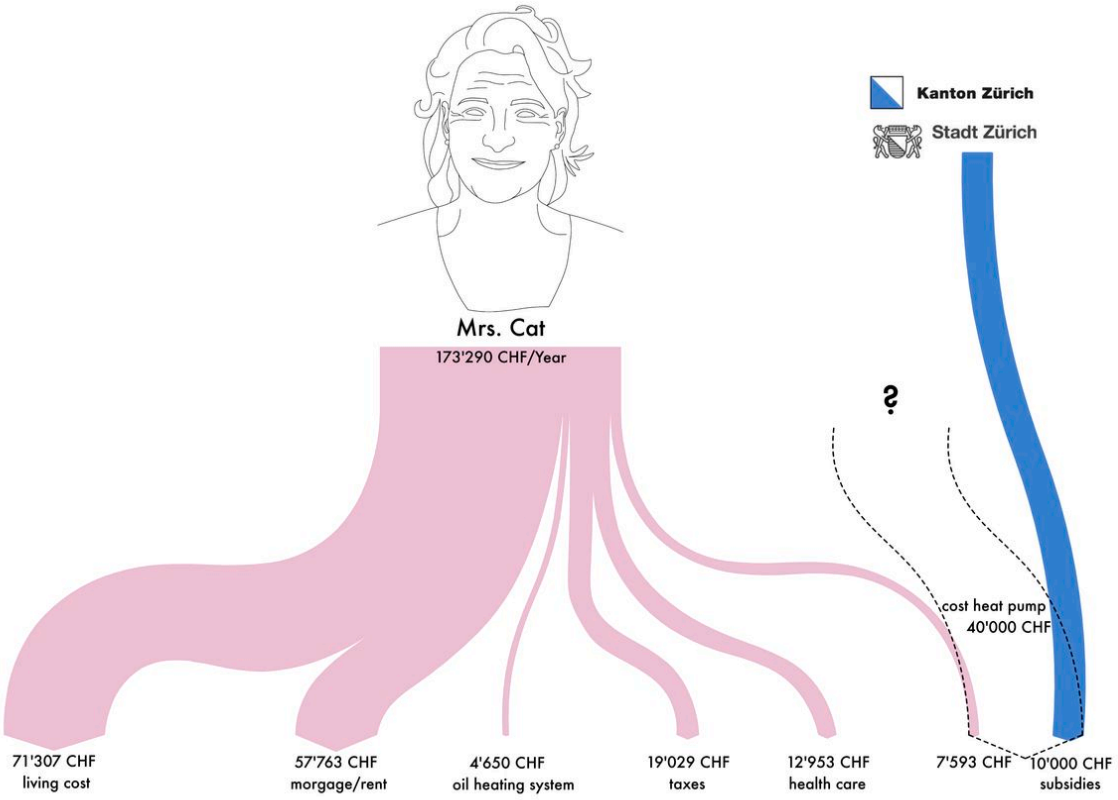


The case of Mr. Easter: The struggle of a tenant with no saying.

Around 90% percent of the inhabitants in the city of Zurich are renters. This makes it difficult to make changes to the house, as the energy system is already installed in the house and the monthly energy bill is paid to the landlord. This is the case of Mr. Clayduck, Mr. Easter and Ms. Trampoline. They told us they would be very interested in changing their current heating oil system to renewable energy, but it is not possible as they do not own the house.



The cost of a heat pump is around 40.000 CHF depending on the model. That would be the total amount in the case the building doesn't need renovation. The city and canton pay for installing a new heat pump roughly ¼ of this (10'000 CHF). This seems like much, but compared to an average household it paints a different picture.

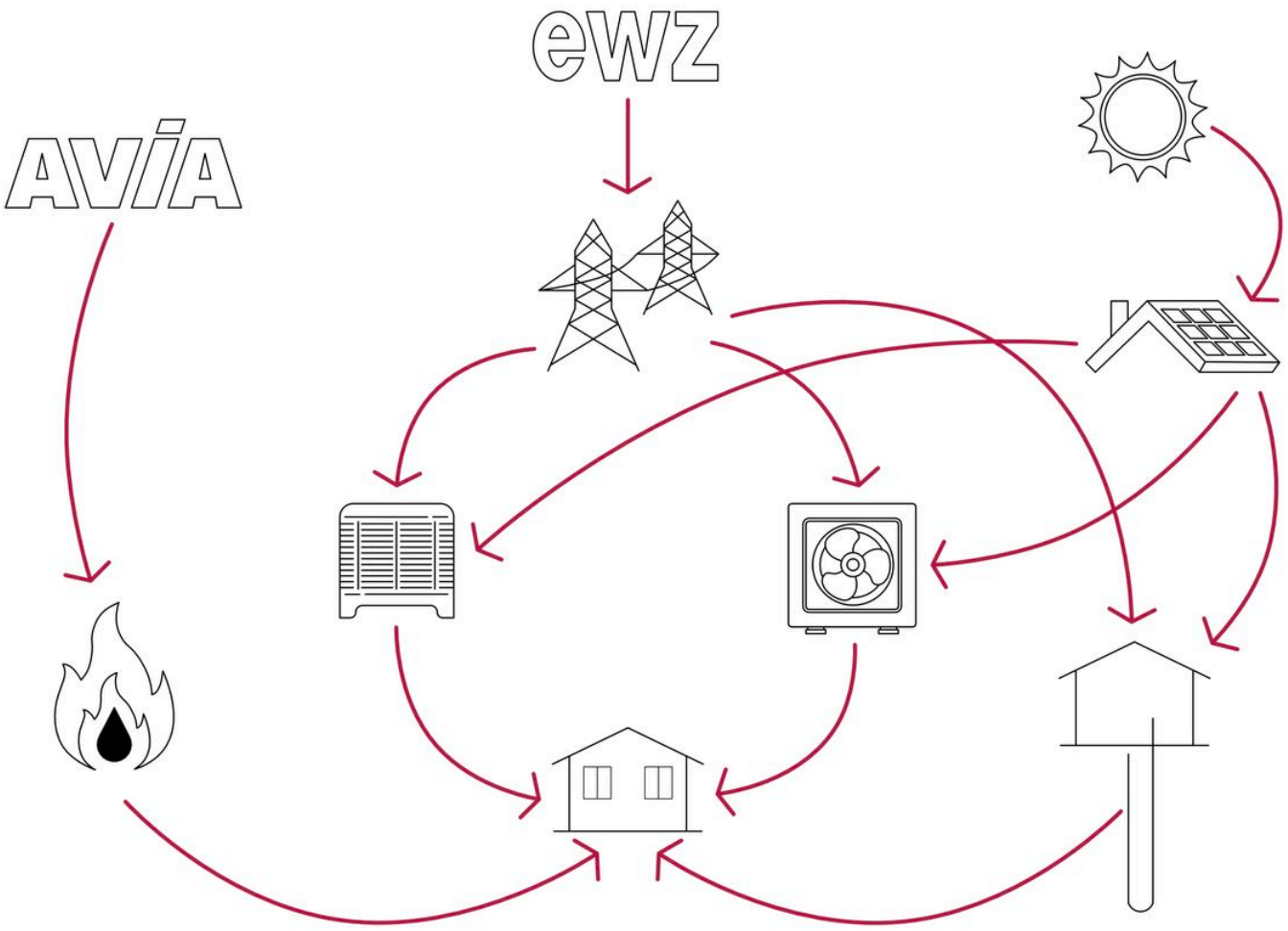


The Finances of a Household.
Source: BFE, 2024.

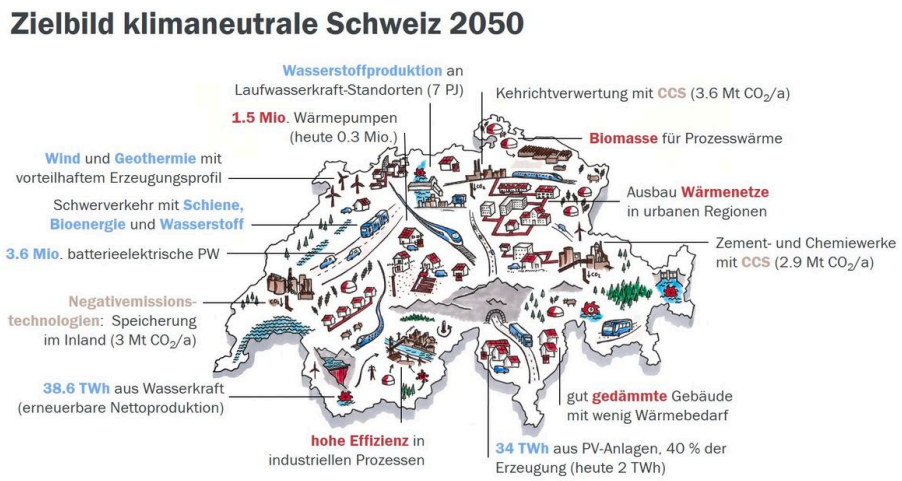
In a case of a family with two young children, aged four and six, and two working parents, both around 35, we assume maximum ⅓ goes towards mortgage or rent. Roughly 70'000 are general living cost, such as food, education, clothes, hobbies, 20'000 CHF have to be paid for taxes and around 13'000 are needed for health care. This leaves roughly 8'000 CHF saved up money per year. Considering the subsidies, the family would have to save up for 4 years to be able to afford a heat pump. This is calculated with the median income with two full working adults. What would it look like for households with only one working parent or with less income?

So, the question stands: Are Mr. Architect, Mr. Clayduck, Mr. Easter and Ms. Cat excluded from the energy transition?

Networks of Energy: The Question of Independency

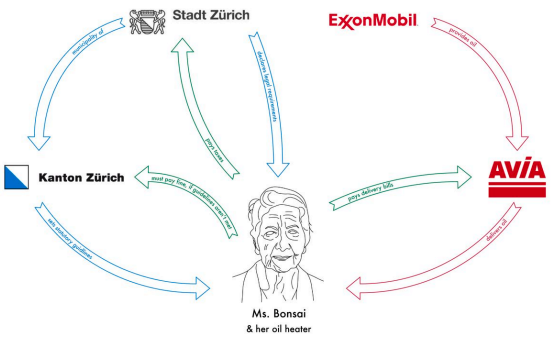


In our daily lives, we encounter energy in all its forms: mobility, ventilation, electricity, heating and cooling. Understanding the complexity of the energy network is essential to help people with the energy transition. Therefore one also has to understand their needs and wishes for a tranquil transition.

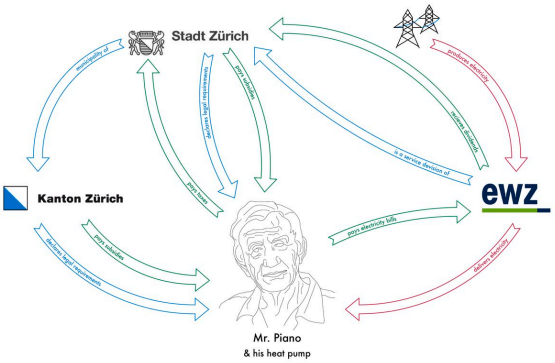


Climate-neutral Switzerland 2050.
Source: Prognos AG, Dina Tschumi, 2023.

A transition from fossil fuels to renewable energies is inevitable if Switzerland wants to achieve their goal of being net-zero by 2050. While some people wanting to switch are hindered by their financial or housing situation, others have problems giving up certain qualities and conveniences of oil heating or do not want to switch at all. One of the favorited recurring mentioned side-effects of oil heating was the independence that this system brought. But is an oil heating system really independent of anything? And if the idea of independency seems to be a valued token of this society how does the newly installed system, the heat pump, fulfill this wish?

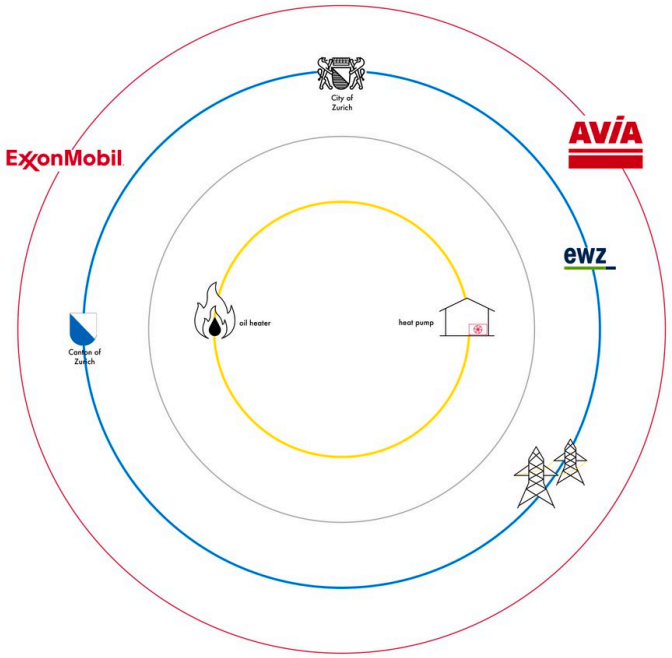


Network of Oil.



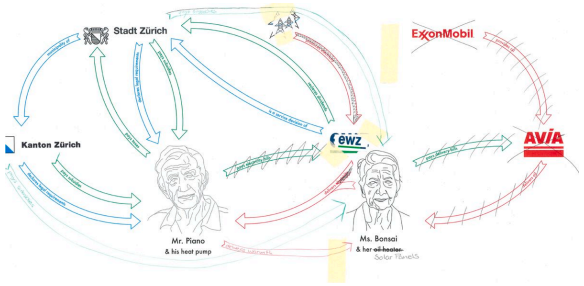
Network of Heat Pumps.

Astonishingly, this independence is not really given with either an oil heating system or a heat pump. The oil tank does provide temporary independence from the oil companies and the oil market, but that is gone as soon as the tank needs refilling. In this case, one is highly dependent on the oil market and its fluctuating prices.

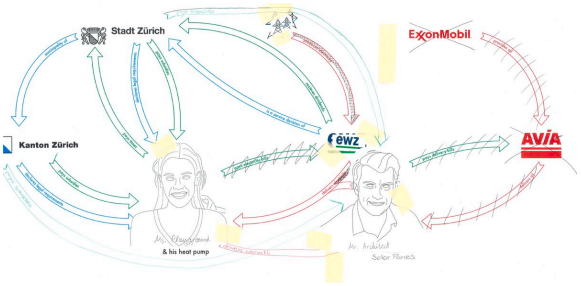


Network of Energy.

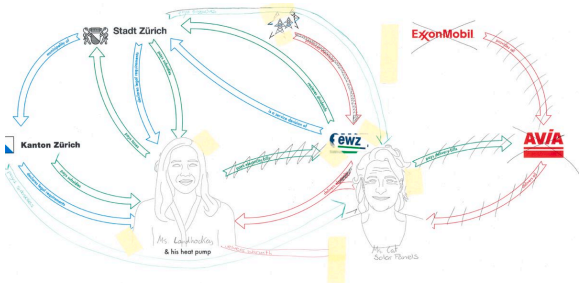
With a heat pump, one is not dependent on the global market, but is still dependent on cantonal governments and energy companies. If the reduction of those connection to smaller radius is desired, a neighbourly solution looks to be good solution.



Network of Energy: Exchange.



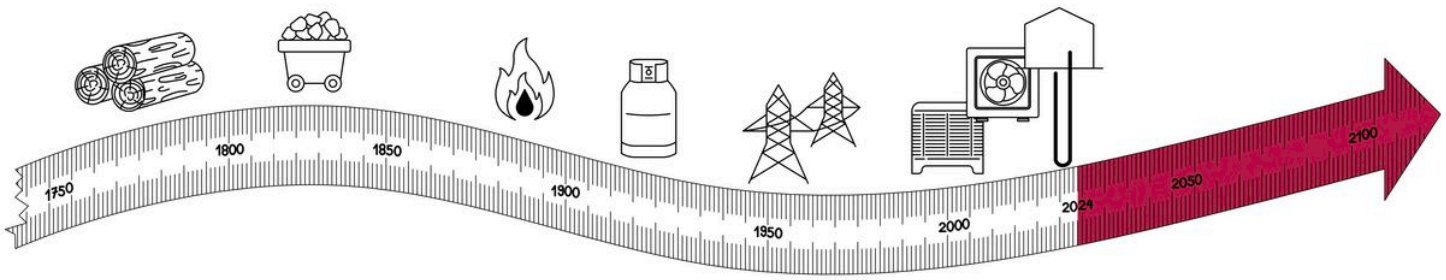
Network of Energy: Exchange.



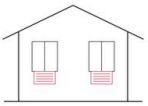
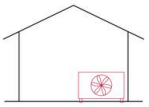
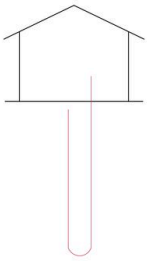
Network of Energy: Exchange.

A system based on dependency or energy exchange between neighbors could strengthen the voice of the population and enable them to participate more in the energy transition. Such a solution could take the form of electricity from solar energy in exchange for heating and cooling from a heat pump powered by the traded electricity. This would also grant two or more net-zero households.

Future Scenarios: Visualizing the Energy Transiton



Even if an agreement has been reached on renewable energy, this still leaves a lot of room for discussion. Choosing the perfect ecological, economical and technical solution is not easy and yet something that every homeowner faces sooner or later.

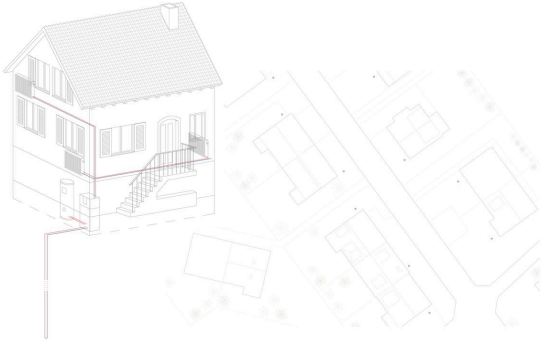
	Air - Air Heat Pump	Air - Water Heat Pump	Geothermal Probe
			
Efficiency	low	middle	high
Visual Dominance	high	middle	very low
Initial Expenditure	low	middle - high	high
Return of Investments	low	middle	high

Portfolio of the Technologies.
Source: ?

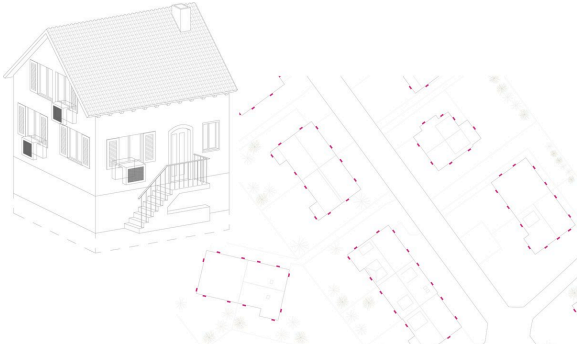
Heat pumps are the most popular solution in Switzerland. But this alternativ for oil is not as straight forward as it might seem at the beginning. There are different categories of heat pumps, which are then subdivided into different technical models. Some solutions are air-air, air-water, and a brine-water heat pumps. The later is primarily known under the term ‘geothermal probe’, but the probe is only one technical application of this type of heat pump. These present various advantages and disadvantages. The systems are installed in the house and can replace the oil heater. The individuality of the heating system persists.

Technical Drawing: Air-Air Heat Pump.

Technical Drawing: Air-Water Heat Pump.



Technical Drawing: Geothermal Prove.



Technical Drawing: Air-air heat pump.

Technical Drawing: Air-water heat pump.

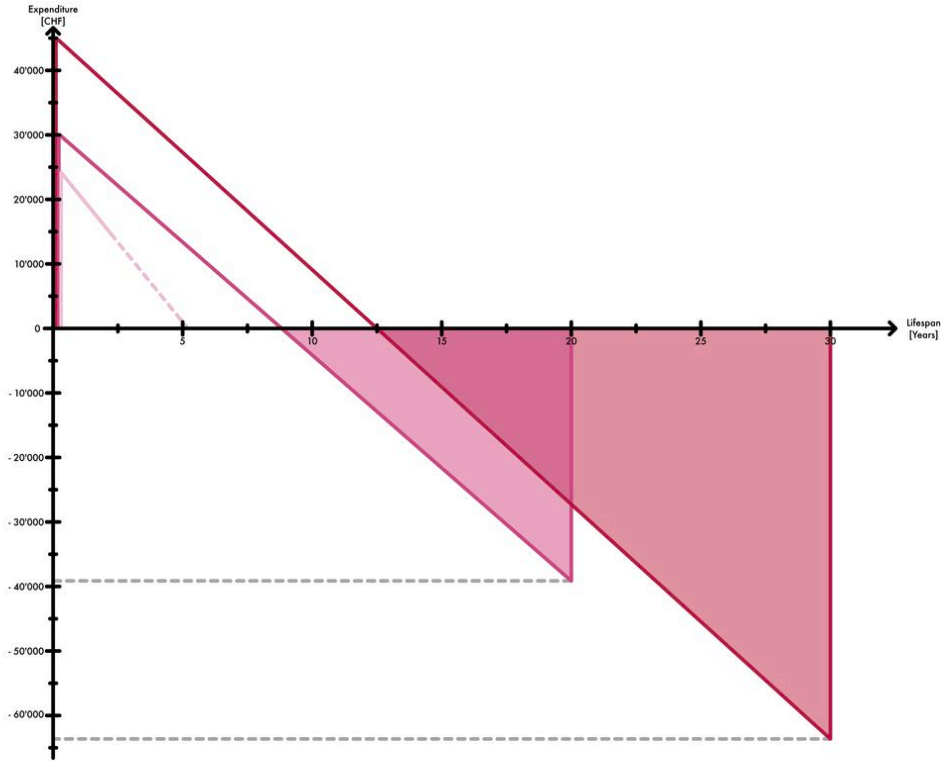
Technical Drawing: Geothermal probe.

The visual dominance seems to be an important factor Swiss citizens take into account when choosing their heating system. These systems show different visual aesthetics. The air-air and air-water heat pump influence the house exterior outlook while the geothermal probe is left unseen.

Edited Street Picture.

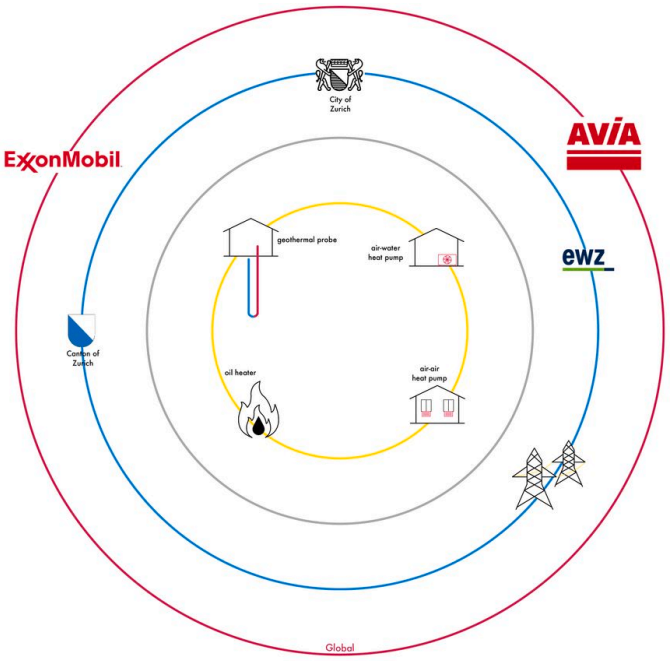
Actual Street in France with above ground Electricity Cables. Source: Jean-François Vaizand, Mesinfos.

In addition to the technical aspect, there is also the economic aspect to consider. Many people are put off by the high initial costs of a geothermal probe. About 2/3 of homeowners opt for an air-to-water heat pump. However, the geothermal probe proves to be the most financially profitable. In contrast, air-to-air heat pumps isn't a wide spread technology which results in there not being enough information available yet to calculate a more accurate amortization rate. This system presents another level of hyper individuality and is with nowadays technology not advanced enough for Swiss customers.



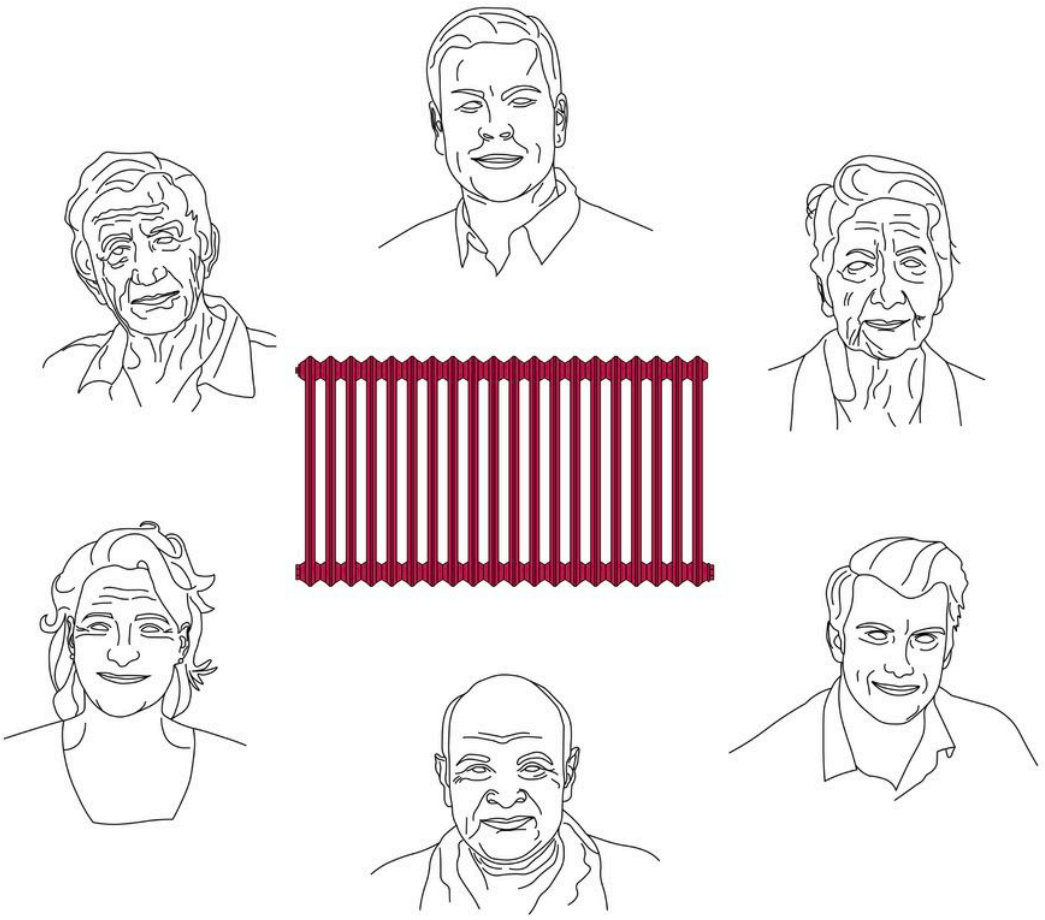
Amortisation of the Heat Pumps.
Sources:?

Nevertheless, many of the residents of Wickenweg felt that even air-to-water heat pumps were too much of a financial burden to transition. This describes the situation of a large part of the population of Switzerland. There is an unspoken notion that every household must finance and overcome the energy transition individually. However, in order to reduce the costs of an individual household, a neighborly solution would be possibility.



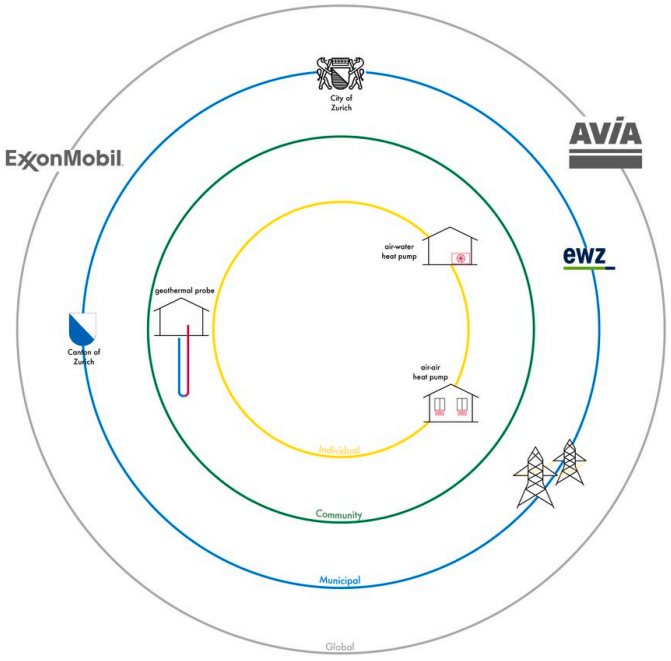
The desire to reduce the radius of dependency and the desire to expand the radius of costs in order to reduce the financial burden on the individual household leads to a meeting of those wishes at a communal level.

The Heating Community of Wickenweg

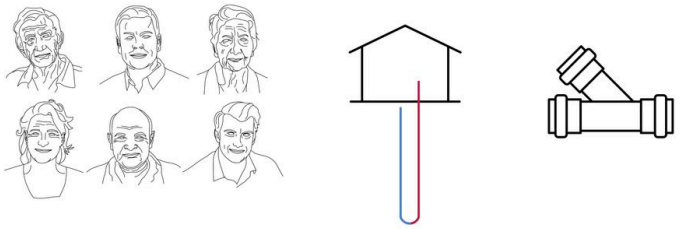


Building cooperatives offer a good financial and social solution to the lack of affordable housing. This system can also be modified to provide solutions to the slow and expensive energy transition.

A solution at a communal level would loosen the dependency on the canton and spread the costs over several people. We would see this solution in the form of a co-operative, which would first solve the transition to a renewable heating source and in a further step could also operate independently of the cantonal electricity companies.



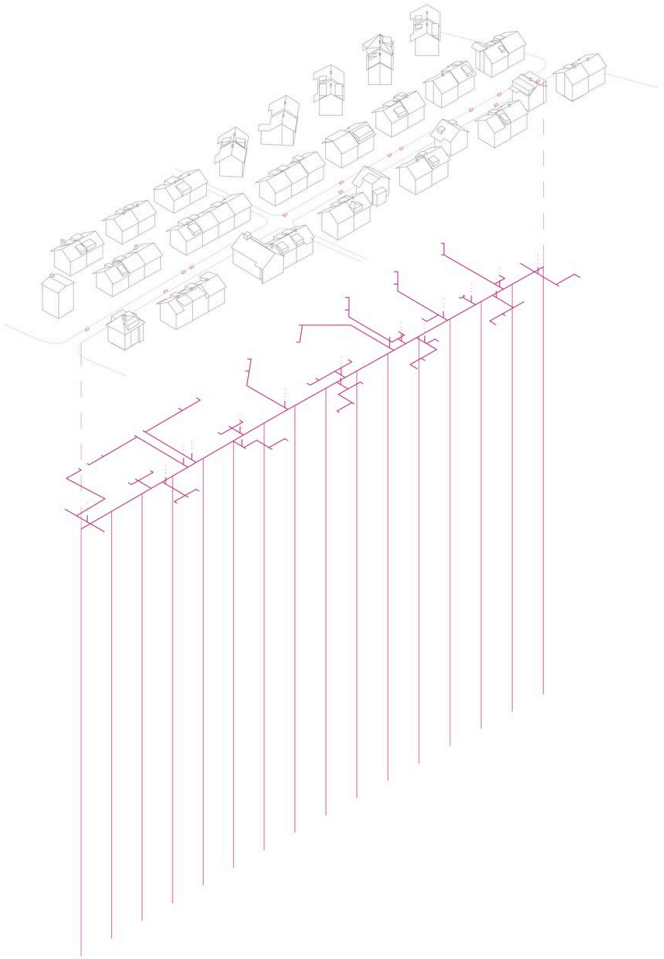
Network of Energy: Heating Community.



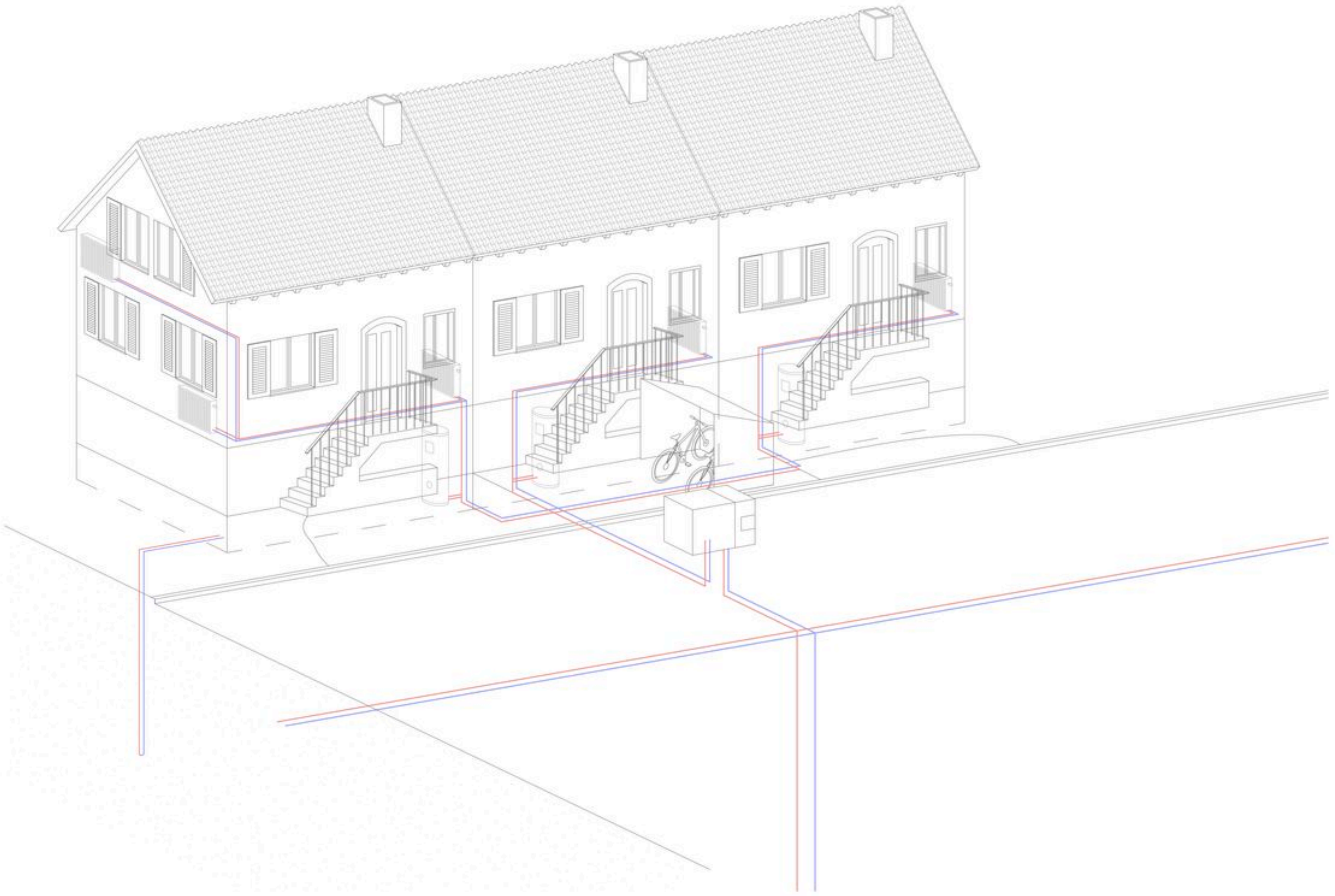
Key data of the design.

Our urban development proposal includes 53 households, 16 geothermal probes and around 970 meters of pipes. The geothermal probes would be drilled underneath the road. This would require the city's consent. However, the city would benefit from a rapid energy transition.

Map of the Heating Community.



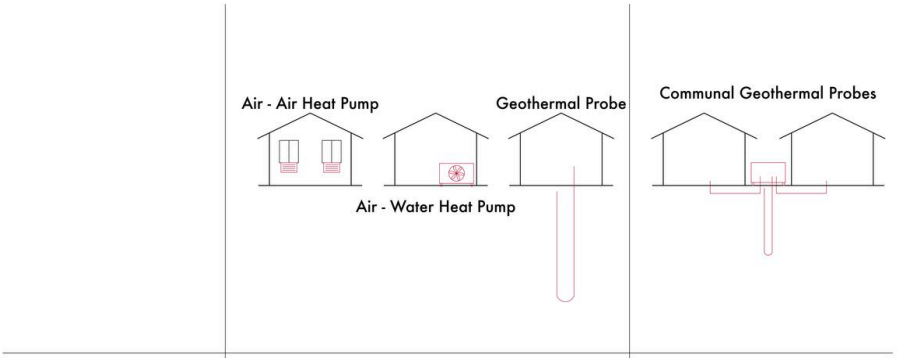
The conversion of the heat/cooling obtained from the ground into a building system takes place in heat exchangers, which would also be shared. These would visually characterize the streetscape.



Technical Drawing: Heating Community.

However, this could be compared to an electricity box. Those are hardly visible in everyday life out of sheer habit. Our heat pumps would have the height of a table which could be used and adapted by the neighbours and enhance social interaction.

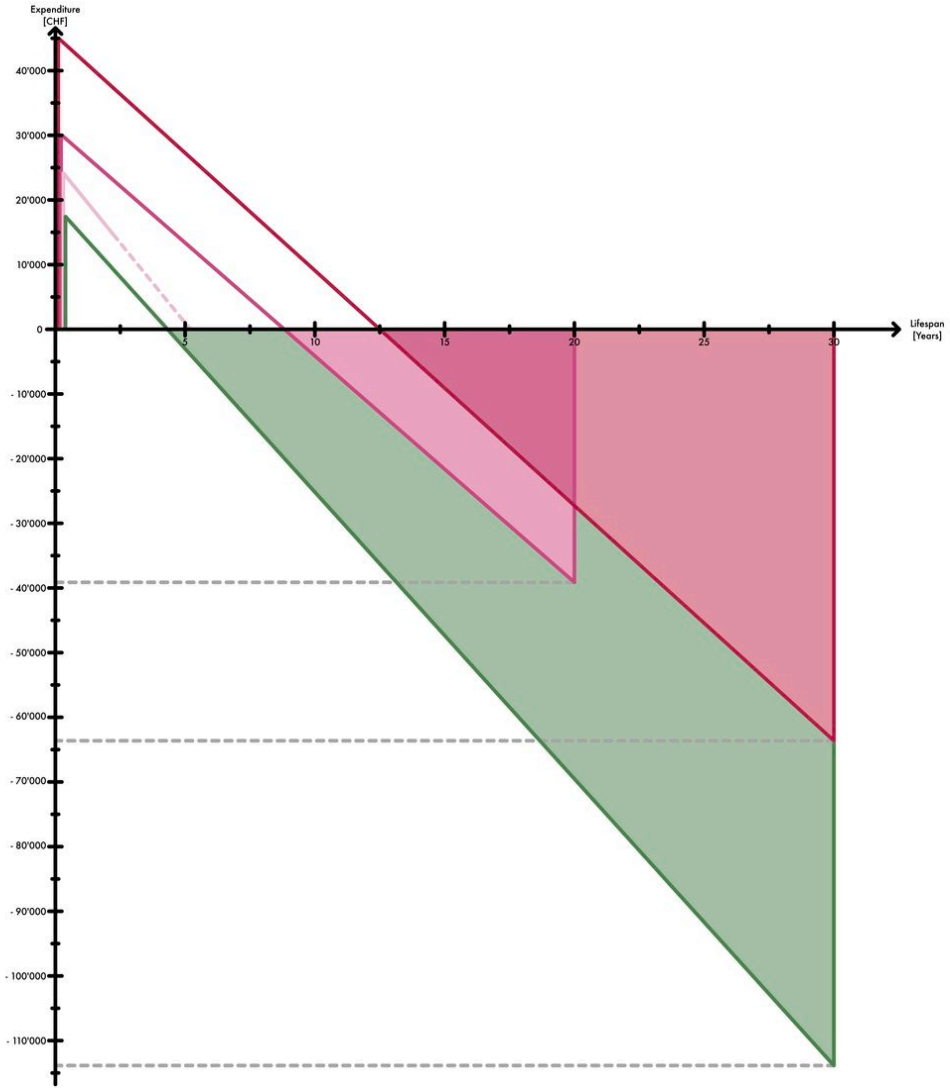
Visualization Heating Community.



Efficiency	low	middle	high	high
Visual Dominance	high	middle	very low	middle
Initial Expenditure	low	middle - high	high	middle
Return of Investments	low	middle	high	high

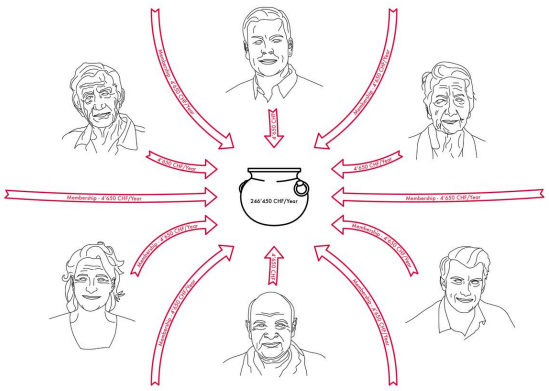
Portfolio of the Technologies.
Source: ?

This system would combine the highest technical performance with a lower price for each individual. However, all this would have a greater visual impact.

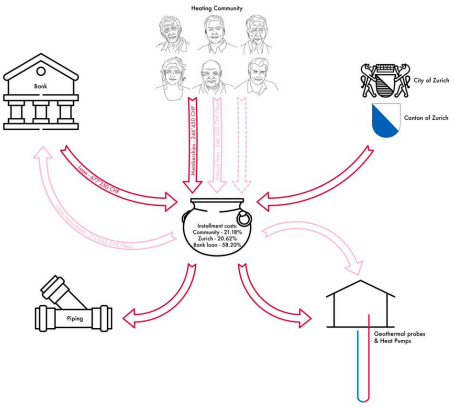


Amortisation of the Technologies.
Sources:?

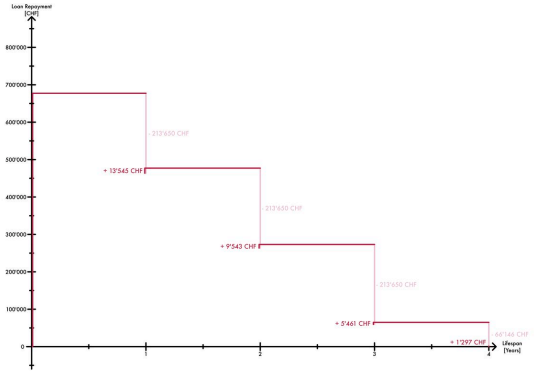
Due to the cost sharing, the amortization of the communal geothermal probe would be reached after 3.5 years compared to 12.5 years for an individual one. As both systems have an equally long life expectancy, our proposal would pay off financially.



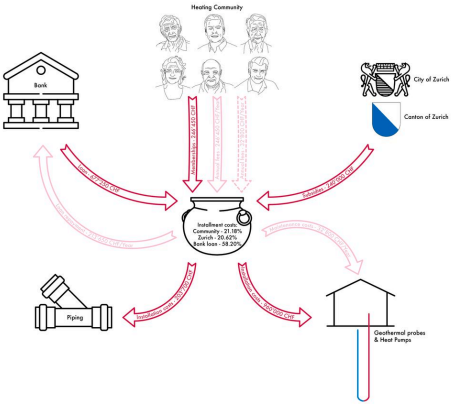
Financing the co-operative: The Community Pot.



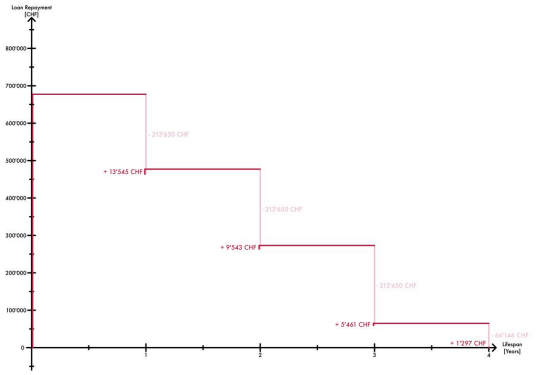
Financing the co-operative:
Financing the Heating System.



Financing the co-operativ: Paying back the Loan.



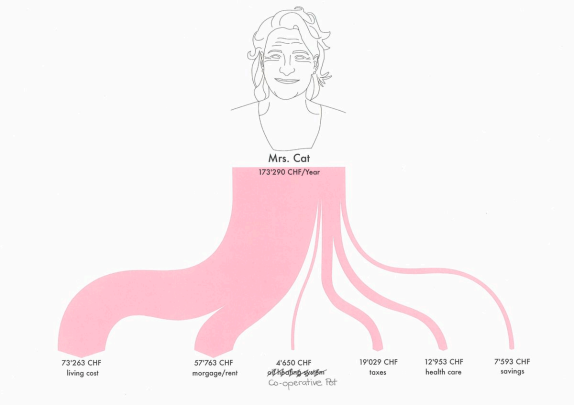
Financing the co-operative:
Financing the Heating System.



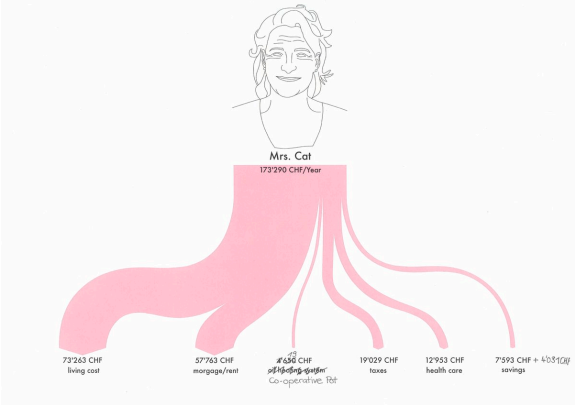
Financing the co-operativ: Paying back the Loan.

The cooperative would be structured in such a way that each household would contribute CHF 4,650 to the cooperative pot. In addition, the subsidies for 16 geothermal probes would come from the city and canton of Zurich. In order to keep the construction costs low for the residents, a loan would also be taken out from a bank. Assuming that cooperatives would have better conditions than an individual person due to their lifespan, our research has shown an approximate interest rate of 2%. The amount contributed to the co-operative is used for the repayment of the loan and the maintenance costs of the system.

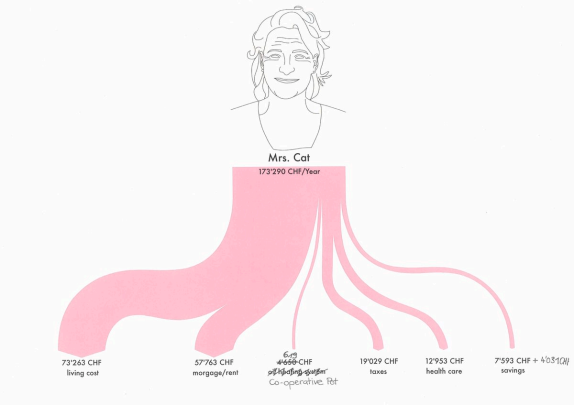
In case of a individual household the contribution to the co-operative is the exact amount previously used for the oil heating system. After 4 years, this would be paid off and the annual costs would fall to 619 francs per household.



The finances of a household during loan repayment.
Source: BFE, 2024.



The finances of a household after loan repayment.
Source: BFE, 2024.



The finances of a household after loan repayment.
Source: BFE, 2024.

Since in our case some people have already switched to a heat pump, the first step would only include the households with oil heating. The other residents would join after 15-20 years, when their air-to-water heat pump reaches the end of its life.

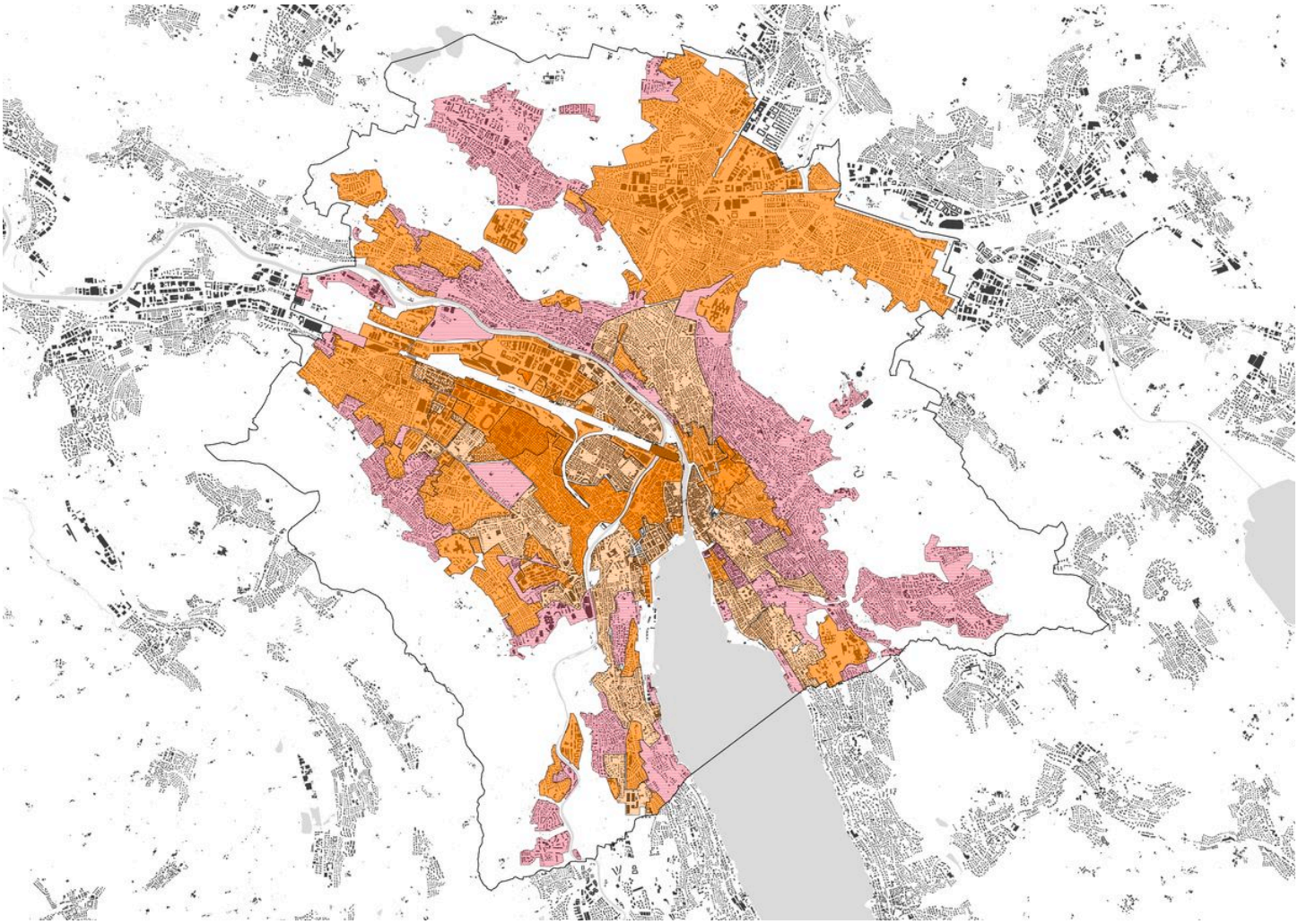
First Step of the Heating Community.

The concept could also be applied to neighbouring streets. Several of these could then be connected in a further step by local electricity producers. This can have a larger radius, as electricity needs to be produced and used less locally than heat. A self-sufficient energy community model could be achieved.

Proposal of an Energy Community.

- Heating community - main pipes
- Heating communities - secondary lines
- Public infrastructure with photovoltaic systems
- Houses inside of the energy community
- Houses outside of the energy community

This could be possible in all regions of the city of Zurich that are outside the district heating zones and would present an alternative.



District Heating and Heating Communities.
Source: Kommunale Energieplannung Stadt Zürich, 2024.

- Existing district heating
- Planned district heating
- Planned district heating
- Planned heating communities

ACKNOWLEDGEMENTS

We want to thank everyone who assisted us on our project. In particular to Titus Kamermans, Managing Director of then Oil Depot Mellingen, and to AVIA Osterwalder/Hürlimann for helping in our analysis of the oil industry. Thanks to Manuel Schmid from the Klimabüro of Zürich and to Dr. Illias Hischier from the chair of Architecture and Building Systems for their support in the design process. We are especially thankful to the residents of Wickenweg for being so welcoming in answering our questions. Most importantly, thanks to the chair of Milica Topalović with Jan Westerheide, Jakob Walter and Dorothee Hahn for their persistent support during the semester.

SOURCES

- “Die Murrbahn – Güterverkehr”. Schienenstraenge.de. 2007. Accessed April 2024. http://www.schienenstraenge.de/Murrbahn/Gueter.htm
- “Die Sole-Wasser-Wärmepumpe: Unser Erdwärmepumpen Guide für die Schweiz”. Buildigo online. 2023. Accessed May 2024. https://www.buildigo.ch/de/article/sole-wasser-waermepumpe
- “Euroqualität”. Avenergy. 2023. Accessed April 2024. https://www.avenergy.ch/de/heizen-mit-oel/heizoelqualitaeten/euroqualitaet
- “Haushaltsausgaben”. Bundesamt für Statistik online. 23. November 2023. Accessed May 2024. https://www.bfs.admin.ch/bfs/de/home/statistiken/wirtschaftliche-soziale-situation-bevoelkerung/einkommen-verbrauch-vermoegen/haushaltsbudget/haushaltsausgaben.html
- “Heizung”. Energieheld Schweiz online. 2024. Accessed May 2024. https://www.energieheld.ch/heizung
- “2 Hinterland, Image: Singapore Straights, Bas Princen 2011”. NSL Network City and Landscape. 2011. Accessed April 2024. https://www.nsl.ethz.ch/en/projekt/2-hinterland/2-hinterland/
- “Kanalisations und Wasserleitungbau Preise”. Daibai online. 2024. Accessed May 2024. https://www.daibau.ch/baukostenrechner/kanalisations_und_wasserleitungbau
- “Kommunale Energieplanung – Energieplankarte”. Opendata Swiss online. 17. April 2024. Accessed May 2024. https://opendata.swiss/de/dataset/kommunale-energieplanung-energieplankarte
- “Kreditrechner mit Tilgungsplan”. Finanzen-Rechner online. Accessed May 2024. https://www.finanzen-rechner.net/kreditrechner.php
- “La raffinerie de Cressier remise en marche”. Arcinfo. 2017. Accessed April 2024.https://www.arcinfo.ch/neuchatel-canton/littoral/la-raffinerie-de-cressier-remise-en-marche-681399
- “Leakage of a pipeline in a nature reserve”. ARIA. 2009. Accessed April 2024. https://www.aria.developpement-durable.gouv.fr/fiche_detaillee/36654_en/?lang=en
- “Ölheizung ersetzen – Das sind die Kosten und Preise” Ofri online. 30. November 2022. Accessed May 2024. https://www.ofri.ch/kosten/olheizung-ersetzen#Iheizung-ersetzen-und-kosten-sparen
- Macdonald, Philip. “Energiewende für alle? Fenster Wärmepumpen als Lösung”. Home&Smart online. 30. April 2023. Accessed May 2024. https://www.homeandsmart.de/fenster-waermepumpe
- “MedianlohnSchweiz”. Schwiizer Franke online. 2024. Accessed May 2024. https://www.schwiizerfranke.com/medianlohn-schweiz
- “Nigeria: The Cost of Oil” . The Atlantic. 2011. Accessed March 2024. https://www.theatlantic.com/photo/2011/06/nigeria-the-cost-of-oil/100082/ “Ogoniland’s oil history”. UNEP. 2024. Accessed April 2024. https://www.unep.org/fr/node/1343
- “Our Products”. Gradient online. 2024. Accessed May 2024. https://www.gradientcomfort.com
- “Pipeline Sud Européen et pipeline du Jura : la CPEPESC demande communication des études de sûretés”. Cpepesc. 2009. Accessed April 2024. https://cpepesc.org/6-nature-et-pollutions/les-news/pipeline-sud-europeen-et-pipeline-du-jura-la-cpepesc-demande-communication-des-etudes-de-suretes/
- “Pipe-line sud européen 1961: Les Berliet au travail!”. Fondation Berliet. 1961. Accessed April 2024. https://www.fondationberliet.org/ressources-documentaires/archive-article-dossier-camion-berliet/pipe-line-sud-europeen-berliet-tbc8rm-petrole/
- “Prämienrechner 2024”. Priminfo | Bundesamt für Gesundheit online. 13. May 2024. Accessed May 2024. https://www.priminfo.admin.ch/de/praemien
- “Raffinerie de Feyzin”. Commons Wikimedia. 2019. Accessed 2024. https://commons.wikimedia.org/wiki/Category:Raffinerie_de_Feyzin?uselang=de
- “Ratgeber Heizung – Wärmepumpen”. Vaillant online. 2023. Accessed May 2024. https://www.vaillant.ch/privatkunden/ratgeber-heizung/heiztechnologie-verstehen/warmepumpen/
- “Saudi Arabia expands share in China oil market, Russia lags”. Reuters. 2022. Accessed April 2024. https://www.reuters.com/markets/europe/saudi-arabia-expands-share-china-oil-market-russia-lags-2022-01-20/

- “SBB: Schwerer Oelzug”. Igschieneschweiz.de. 2014. Accessed April 2024. https://igschieneschweiz.startbilder.de/bild/schweiz~e-loks~re-6-6/373209/sbb-schwerer-oelzug-mit-re-620\.html
- “Steuerrechner”. Eidgenössische Steuerverwaltung. 2024. Accessed May 2024. https://swisstaxcalculator.estv.admin.ch/#/calculator/income-wealth-tax
- “Tanklager”. Fotoarchiv Mellingen. 1999. Accessed April 2024. https://www.fotoarchiv-mellingen.ch/building?id=138
- “Wie finanzieren?”. Wohnbaugenossenschaften Schweiz online. 2024. Accessed May 2024. https://www.wbg-schweiz.ch/information/wohnbaugenossenschaft_gruenden/wie_finanzieren
- “Wärmepumpen”. Stadt Zürich online. 2024. Accessed May 2024. https://www.buildigo.ch/de/article/sole-wasser-waermepumpe

Architecture of Territory
Professor Milica Topalović

TEACHING TEAM
Dorothee Hahn
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