



Solving the gordian knot

Understanding key
actors of the Swiss
energy system

Susan Mühlemeier, PhD



Socio-technical perspective of the energy transition

Multi-level perspective and social tipping points

Claudia R. Binder



Behavioral perspective

Diffusion of innovations and the role of proximity effects

Maria Anna Hecher and Glòria Serra Coch



Material perspective

Demand and supply materials of the energy transition

Francisco Xavier Felix Martin Del Campo



Actors' perspective

Complex actor network of the Swiss energy sector

Susan Mühlemeier



Theoretical learning points

- Diffusion of innovations: innovation + channels + time + social system
- Relevance of interpersonal communication
- Social network analysis
- Homophily vs. heterophily
- Strength of weak ties
- Vertical diffusion
- Proximity dimensions



Let's get our hands dirty
and see technical networks in the
Swiss energy sector



Goals of the lecture

- You will get to know the most important **players in the Swiss energy sector** and their roles
- You will learn what a network industry and how the **energy value chain** looks like
- You will see some **energy innovation examples** to inspire your potential professional future
- You can ask all your questions to a practitioner



Susan Who?

Susan Mühlemeier, PhD

#economicgeography, #sustainability,
#germanistics, #teaching

#PhDone in 2019 @EPFL | socio-technical
resilience & urban energy companies

@electricite.ch: Head of Training Suisse
romande 2019 – 2025

#sabbatical – book writing



The Swiss electricity sector today

Who is who?

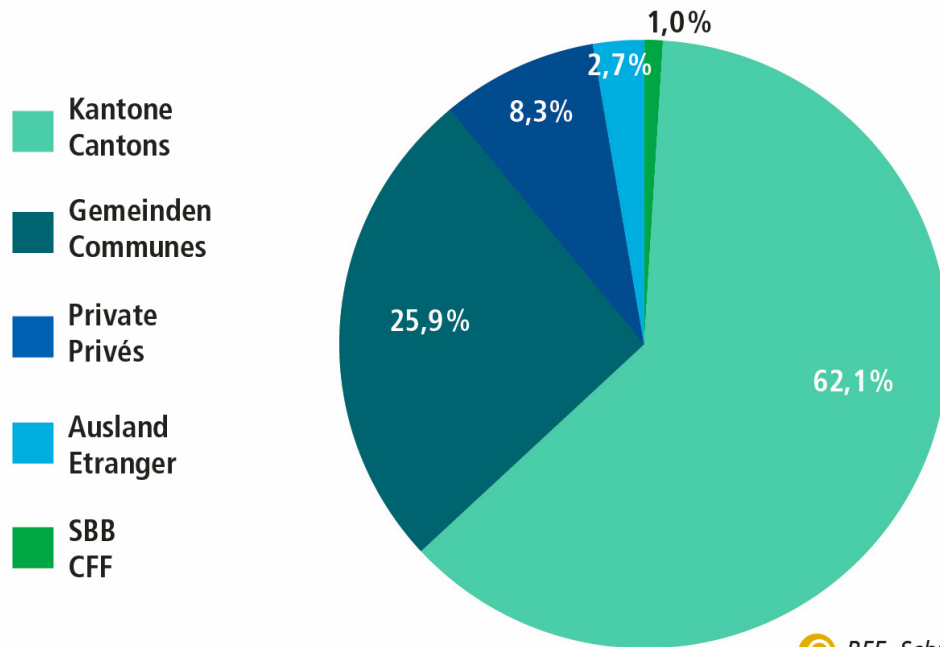
And who does what?

Who owns the largest part of the swiss Electricity infrastructure?

- Private investors (banks, pension funds)
- The federation
- The cantons
- The municipalities
- Foreign investors (public and private)



Fig. 21 Zusammensetzung des Grundkapitals 2017
Origine du capital social 2017



Capital in the Swiss Electricity Sector

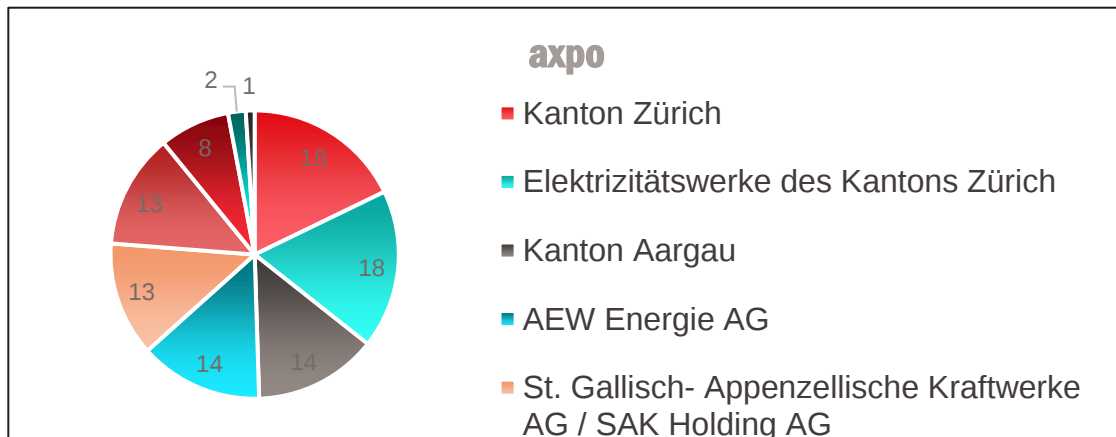
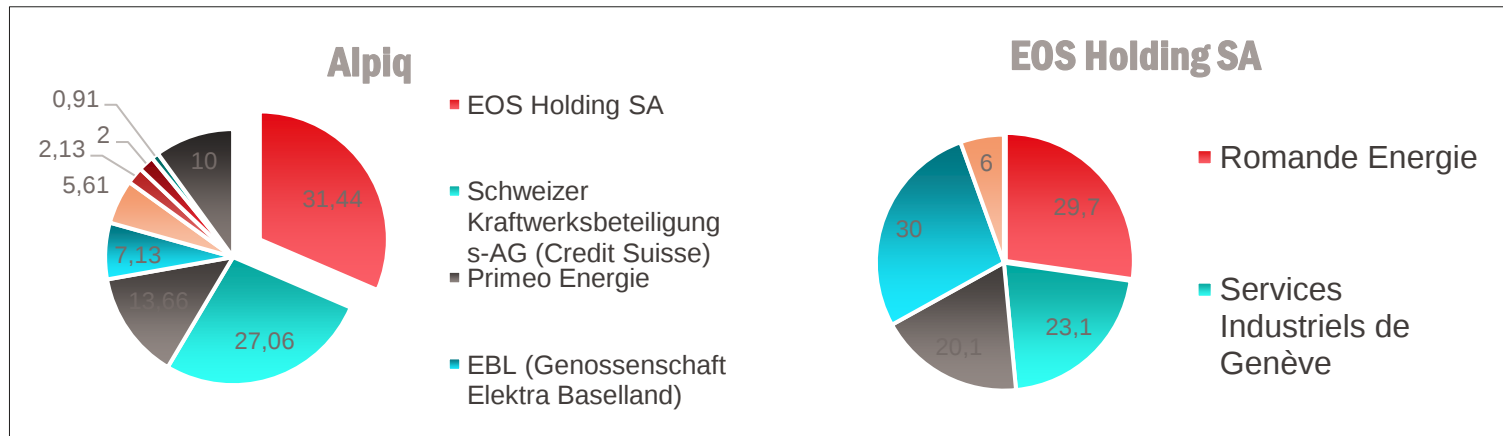
BFE, Schweizerische Elektrizitätsstatistik 2018 (Fig. 21)
OFEN, Statistique suisse de l'électricité 2018 (fig. 21)

- **Federal Parliament**
 - Energy strategy 2050/ EU relationship
- **BFE / OFEN**
 - Federal rules: grid tariffs, water rate
 - Funding schemes for renewables
- **Federal court**
 - Courts cases – mainly wind power
- **ElCom -> Regulator**
 - Surveillance TSO/DSOs
- **ENSI /IFSN -> Nuclear safety inspectorate**
- **Cantons**
 - Shares in Nuclear and hydro power production
 - Regulation building sector (cantonal energy directorates)
- **Cities**
 - Local renewables
 - Mobility



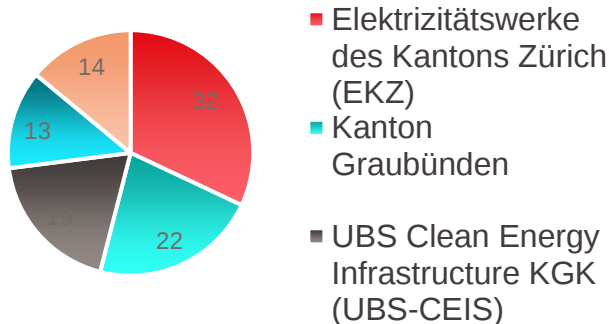
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra



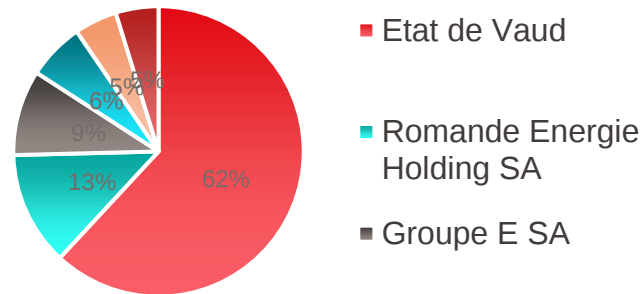


**Who owns
the large
production
firms?**

Repower

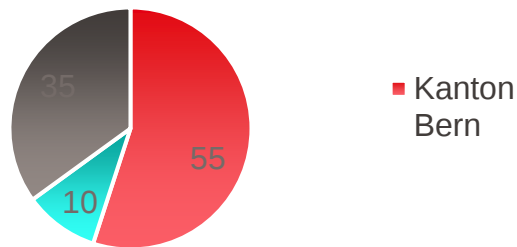


Romande Energie

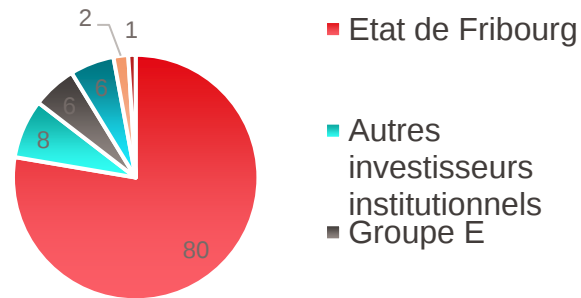


Who owns the cantonal energy companies?

BKW



Groupe E



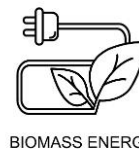
Production



- Large: Alpiq / axpo



- Medium: Repower / BKW / CKW / Romande Energie



- Small: Cities, industry, farmers, home owners



Partner Structure in large production

- Grand Dixence (60 % Alpiq, 13,3 % axpo, 13,3 % BKW, 13,3 % IWB)
 - Gimsel (50% BKW, 16% ewb, 16% IWB, 16% ewz)
 - Nant de Drance (39% Alpiq, 36 % CFF, 15% IWB, 10% FMV)
-
- Leibstadt (39 % axpo, 27 % Alpiq, 14 % BKW, CKW 14 % (axpo), AEW 5 %)
 - Gösgen (Alpiq 40 %, axpo 25 %, City of Zürich 15 %, CKW 12 % (axpo), ewb 7 %)
 - Beznau 1 & 2 (axpo 100%)

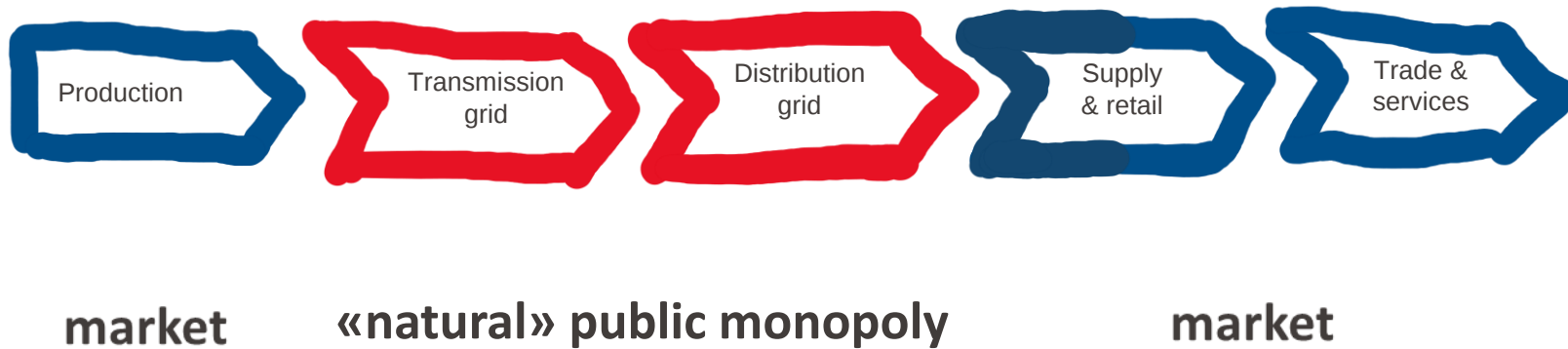


Stefan Mühlemeier





EUROPEAN ELECTRICITY VALUE CHAIN





Network industries and «natural monopolies»

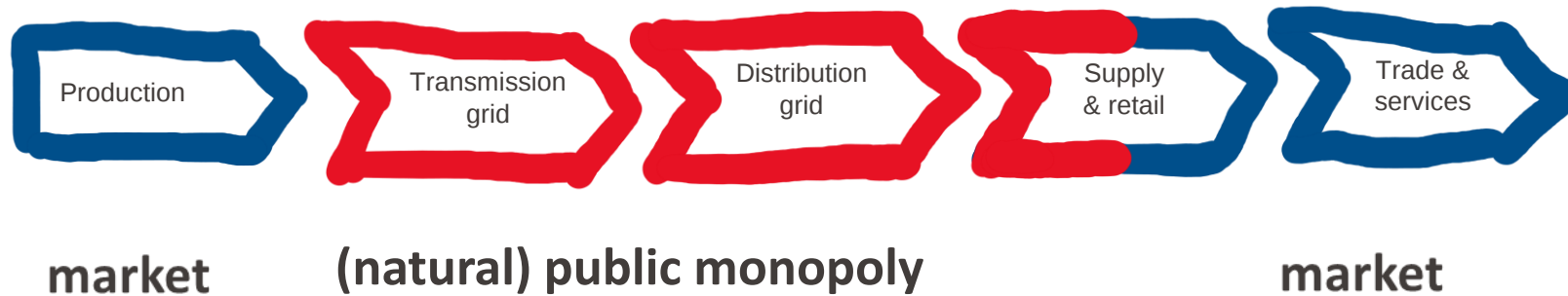
- Electricity grid, gas grid, railway network, road network etc.
- A parallel infrastructure would not make sense -> «**natural**» monopoly
- Competition for the market = concessions

! Liberalisation = of production, services and retail (e.g. trains, electricity production, gas retail etc.)

! Privatisation = selling a public asset (e.g. an electricity grid)

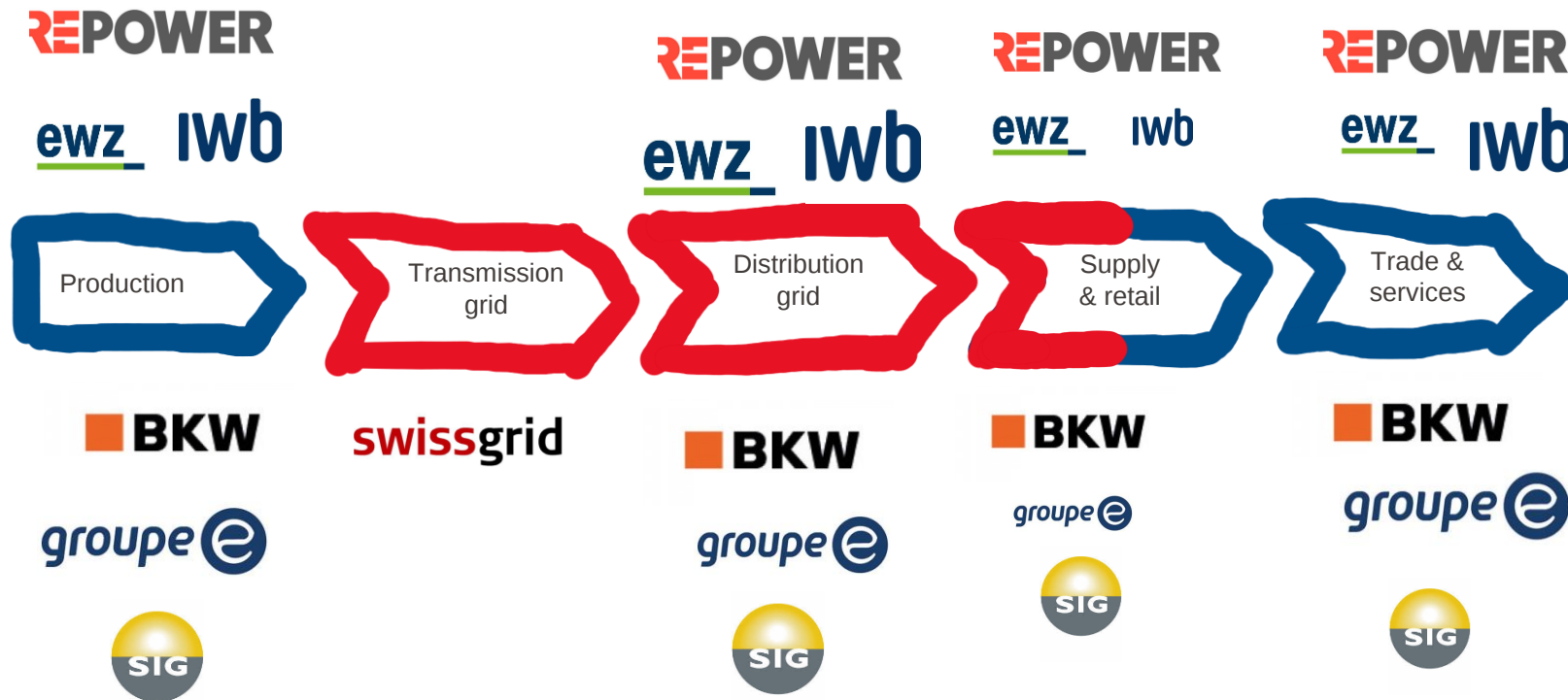
Further reading on network industries: Finger, Matthias; Jaag, Christian (2015): The Routledge Companion to Network Industries: Routledge.

SWISS ELECTRICITY VALUE CHAIN



The small but significant differences: households cannot choose their supplier
DSOs defines the electricity tariff independently for their distribution area

SWISS EXCEPTION: VERTICALLY INTEGRATED FIRMS

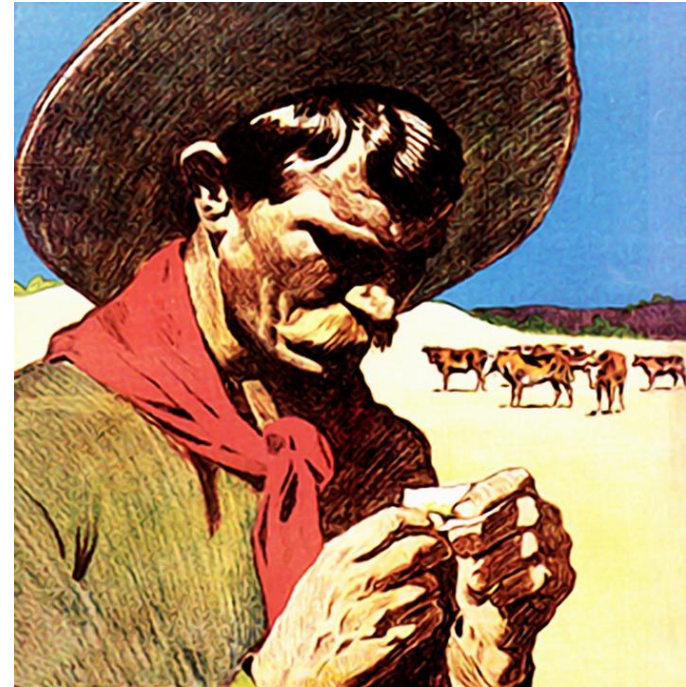


Organisational unbundling: two entities for market / monopoly BUT within the same holding

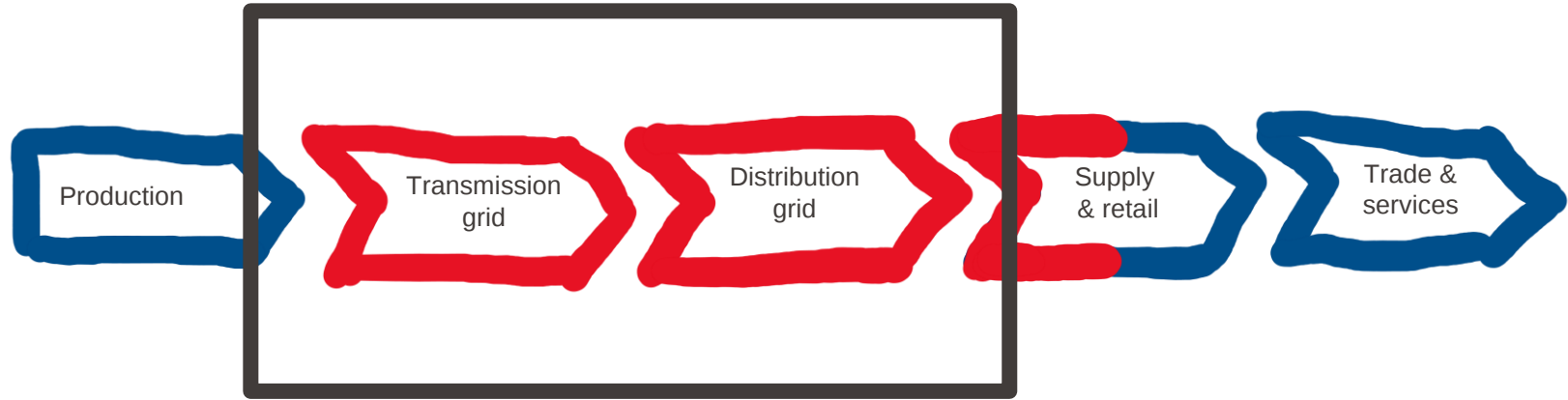
Do you think, running the electricity sector should be the task of the state or private actors?

- Electricity is a critical asset for a society, so **the state** should take care of it
- Electricity is a good as any other and can be organised **via private actors**

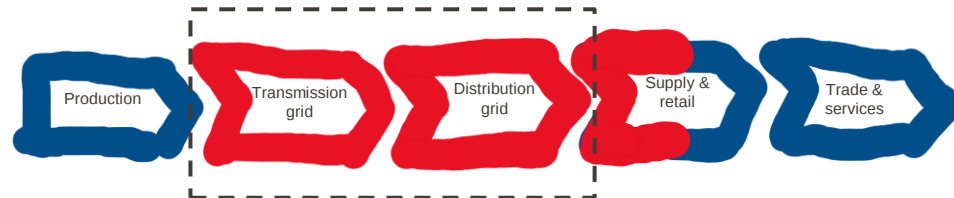
Keep in mind:
A monopoly can also be private!
Liberalisation ≠ Privatisation



THE GRID



Grid



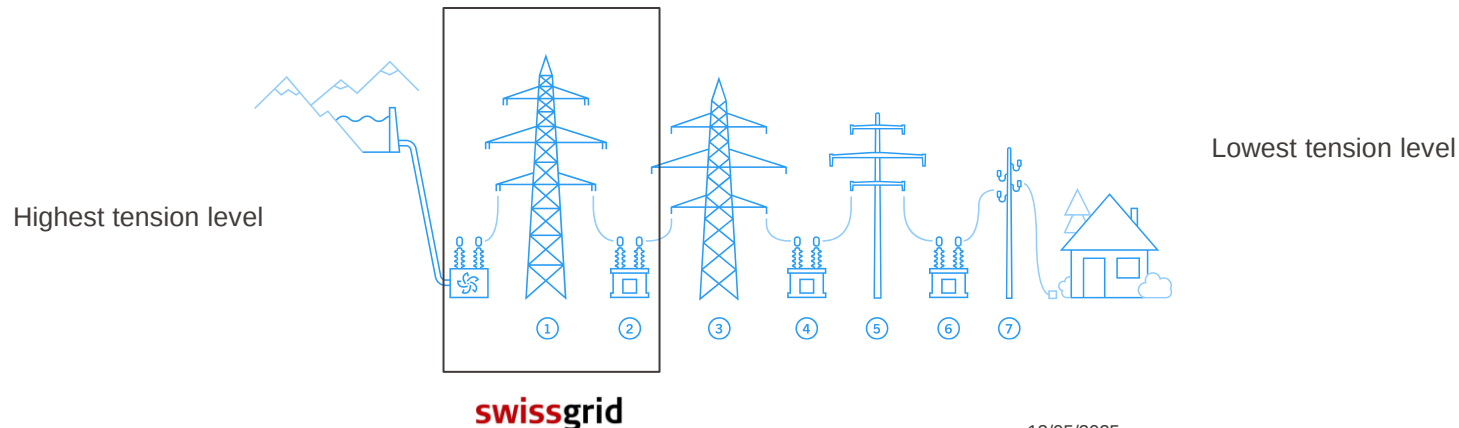
Susan Mühlemeier

TSO – Transmission Grid Operator = Swissgrid

- Balances transmission grid – 50 Hz
- Exchange with Europe
- Grid maintenance and extension

DSOs – Distribution Grid operator Cantonal / municipal utilities

- Distribute electricity in their **local territory**
- Balance new renewables
- Grid maintenance and extension



In the center of the European Electricity grid

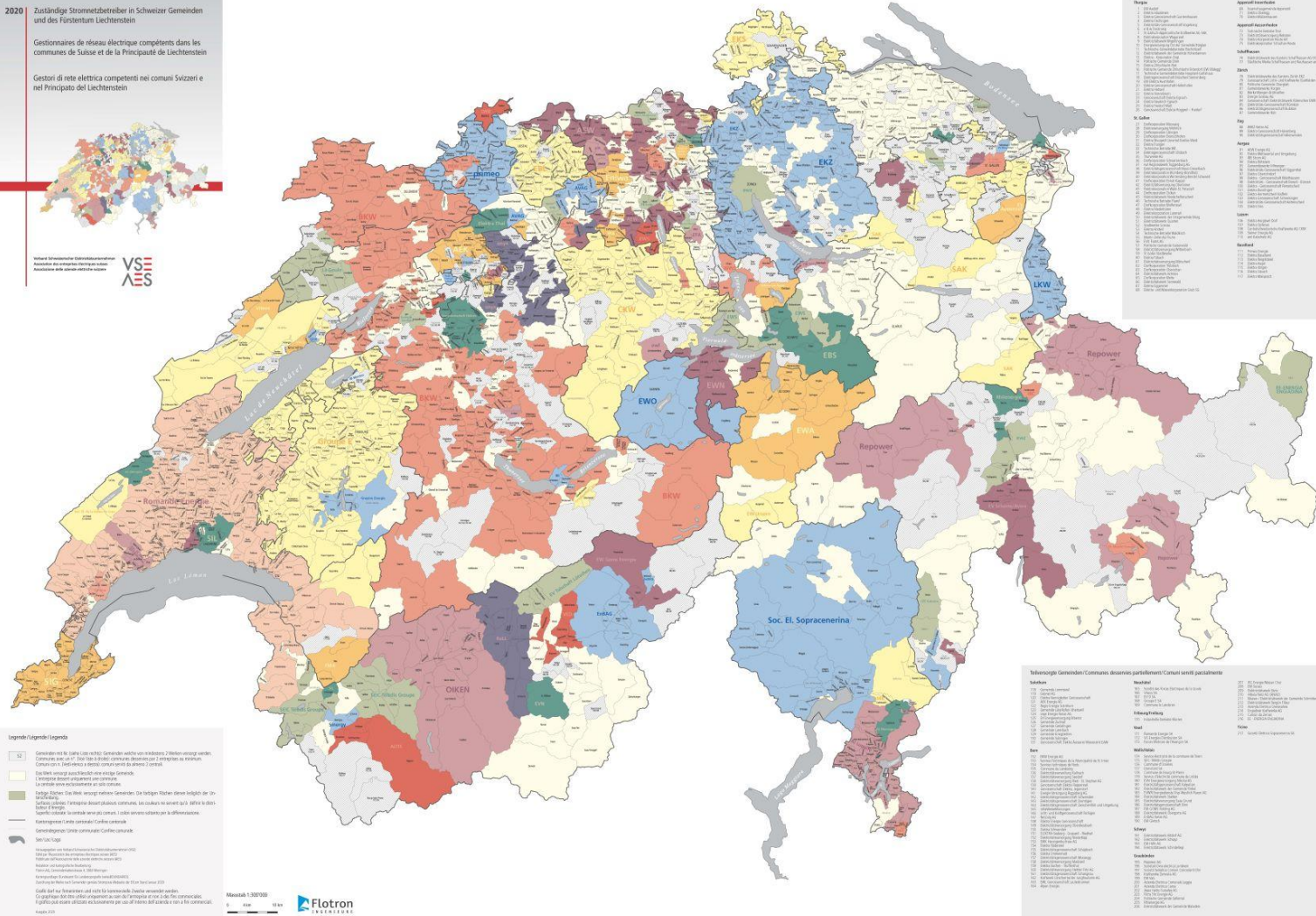


Gestori di rete elettrica competenti nei comuni Svizzeri e nel Principato del Liechtenstein



Verband Schweizerischer Elektrizitätsunternehmen
Association des entreprises électriques suisses
Associazione delle aziende elettriche svizzere

VSE



Maastab 1:300 000

European comparison

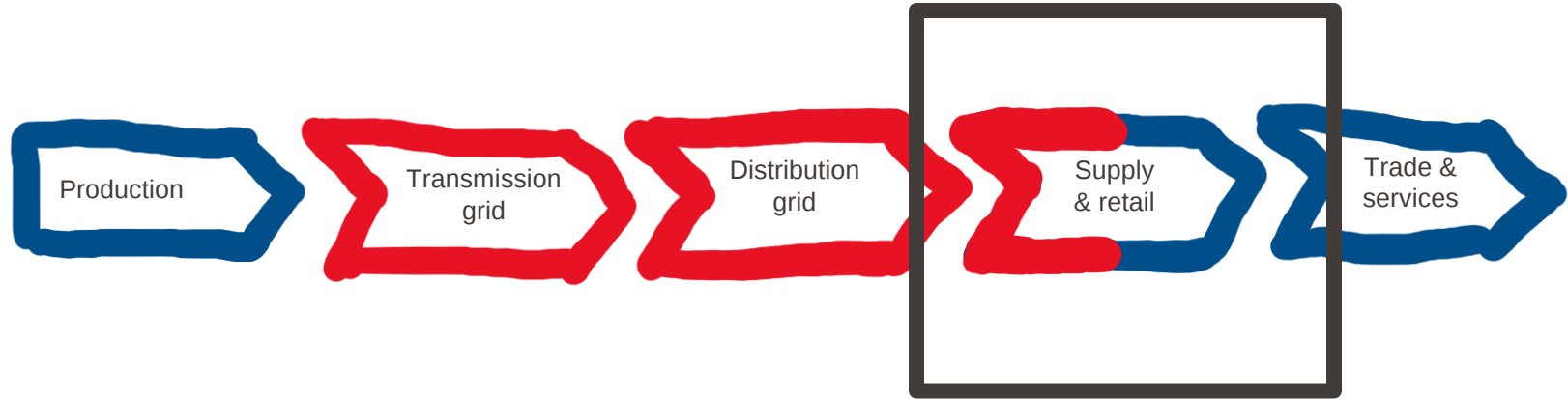
Country	TSO	Grid kilometer
France	RTE	105'000
Germany	TransnetBW TenneT Amprion 50Hertz	35'000
Italy	Terna	72'600
Austria	APG	6'971
Switzerland	Swissgrid	6'700

<https://www.next-kraftwerke.com/knowledge/european-tsos-list>

Country	Number of DSOs	DSOs > 100.000 customers
Germany	880	75
Switzerland	630	n/a (ca. 20)
France	158	5
Italy	144	3
Austria	138	13

https://publications.jrc.ec.europa.eu/repository/bitstream/JRC113926/jrc113926_kjna29615enn_newer.pdf

SUPPLY & RETAIL



Supply and retail



- Cantonal energy companies
- Municipal companies

Services industriels de Lausanne

Bienvenue dans le monde de l'énergie des Services industriels de Lausanne!
Electricité, chaleur, gaz et télécommunications, nous sommes à votre écoute et avons à cœur de vous offrir des services et des produits innovants qui correspondent à vos besoins, quel que soit votre profil.



Electricité



Chaleur



Gaz



Multimédia



Mobilité



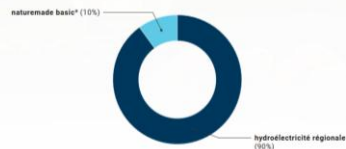
Solaire

nativa®

nativa® - Une énergie propre à prix doux

Cette électricité 100% renouvelable et 100% suisse (Vaud et Valais notamment) garantit une qualité d'énergie à un tarif modéré. Elle est composée d'un mix d'énergie solaire et hydraulique de la région, dont 10% labellisé naturemade basic.

naturemade
basic

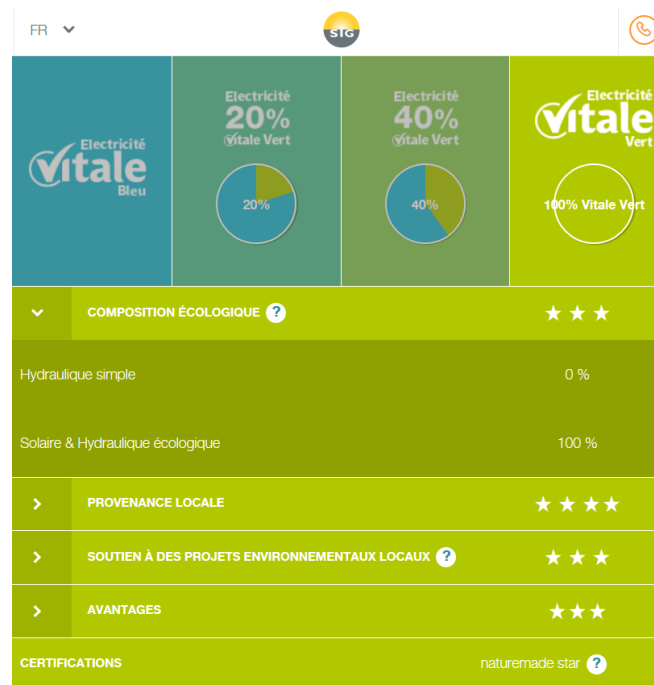


nativa®plus

nativa®plus - Pour plus d'engagement

Disponible sur demande, l'éco-courant nativa®plus est composé exclusivement d'énergie locale: solaire photovoltaïque, éolienne et petite hydraulique. Ce courant est certifié naturemade star, le label écologique le plus strict d'Europe.

naturemade
star

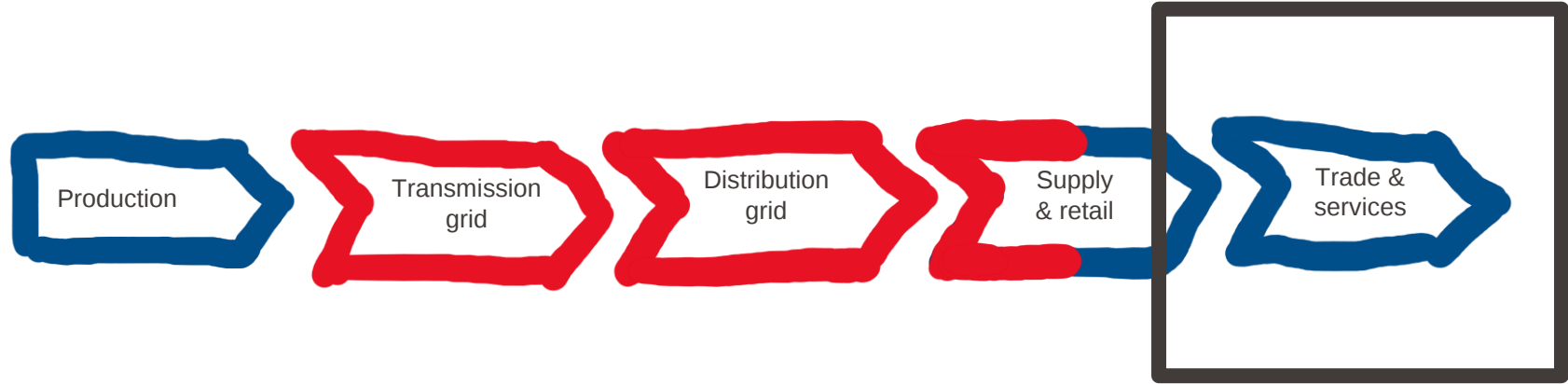


Honestly - Did you know before who your electricity provider is and what they offer?

- Yes for sure and I chose my product
- Yes I know who it is ... but no clue about the products
- No, I have no idea



TRADE & SERVICES





- Traders: Alpiq / axpo and the big cantonal utilities
- Electricity exchange in Switzerland:
 - **Spot** (EPEX Spot CH – short-term: hourly in two days)
 - **Futures** (EEX Swiss Power – long-term: up to six years ahead)
 - **Forward market** (Over the counter OTC – bilateral exchange – mid- to long-term)
- **No direct access to European Day-ahead und Intraday Markets** (15 min) due to lacking EU agreement
- Axpo, alpiq & co have subsidiaries in Germany or France to trade on the European markets
- Other trade products: gas, ressources and certificates

<https://www.suisse-next.ch/de/>
<https://www.energate-messenger.ch/markt/strom>

Swiss Members of EPEX Spot 2019

30 Schweizer EPEX SPOT-Mitglieder



https://www.strom.ch/system/files/media/documents/EPEXSPOT_Stromhandel_gestern_heute_morgen_20190306.pdf



Municipal and small cantonal utilities

- Local energy communities management & energy consulting
- Energy supply concepts for industry
- Building services (heat, cooling, installation etc.)



Big players (in addition to the services above)

- Retail for renewable energy producers
- Battery management and e-mobility
- Energy management services (portfolio in trading, power plant optimisation)





Pause



The Gas Sector

Where do Swiss Gaz imports come from?

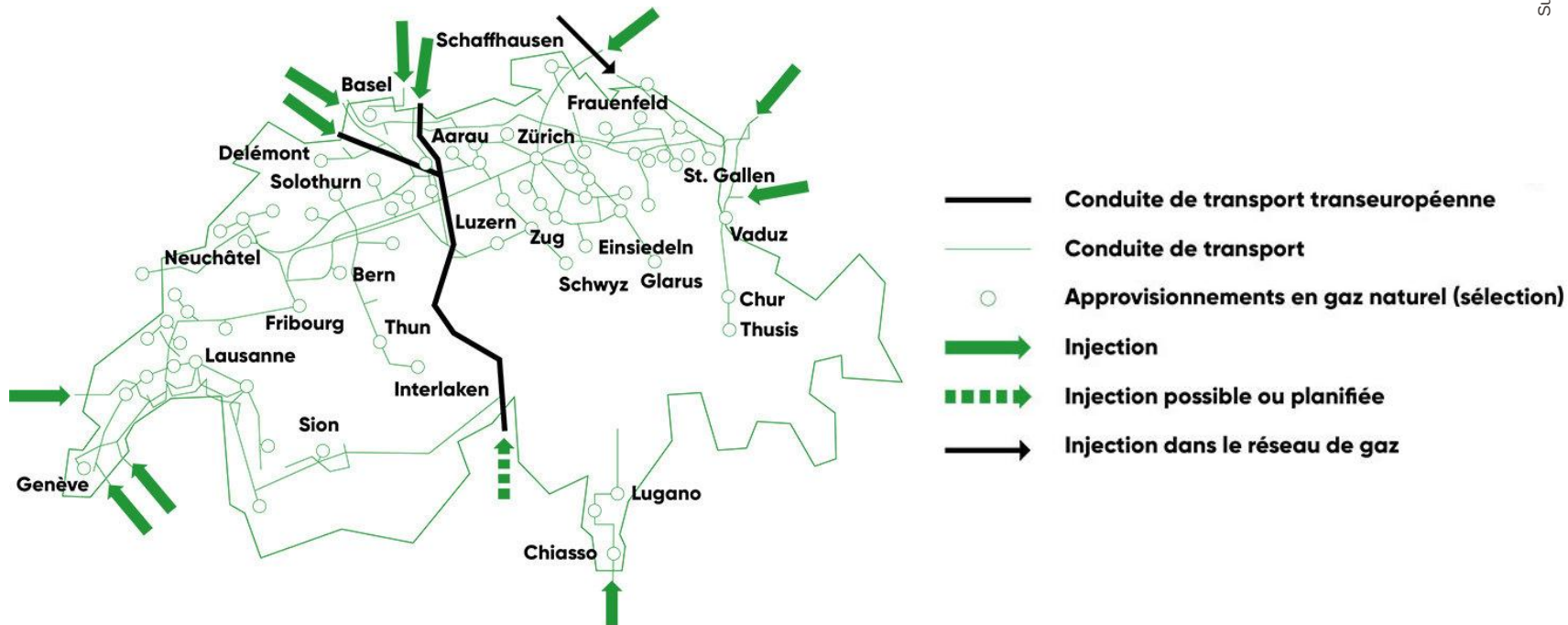
Sources d'approvisionnement en gaz de l'UE en 2023:

- LNG: 42%
- Norvège: 29%
- Algérie: 10%
- Russie: 9%
- UK: 6%
- Azerbaijan: 4%
- Libye: 1%

<https://gazenergie.ch/fr/>



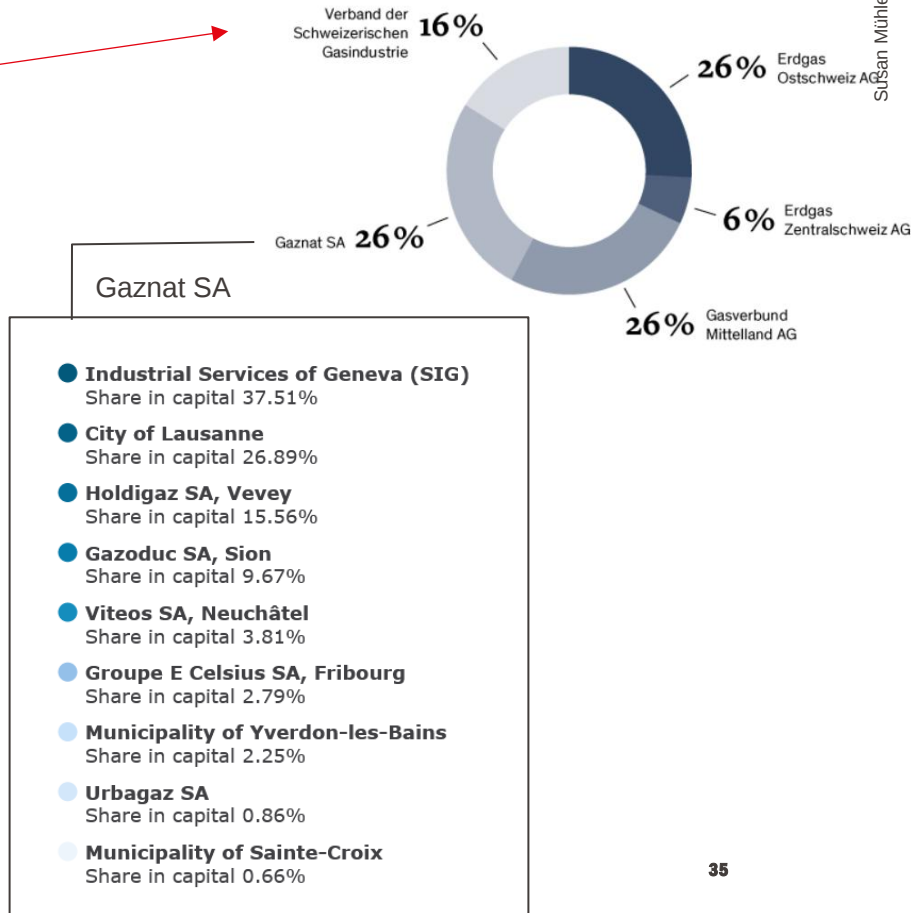
The Swiss Gas grid



Actors of the Swiss Gas «Market»

- **Swissgas – Transit**
 - **Regional gas consortia – Purchasing & Distribution**
 - (e.g. Gaznat S.A., Gasverbund Mittelland AG, Erdgas Zentralschweiz AG, Erdgas Ostschweiz AG)
 - **Local utility companies – Supply**
- Current debate in parliament about the (partial) market liberalisation

AKTIONARIAT SWISSGAS



Talking energy transition: Do you think electricity will dominate the future energy supply (also for heat and transport)?

- Yes, future energy supply will be purely electrified
- No, because we will still need natural and biogas
- No, electricity will go together hand in hand with hydrogen



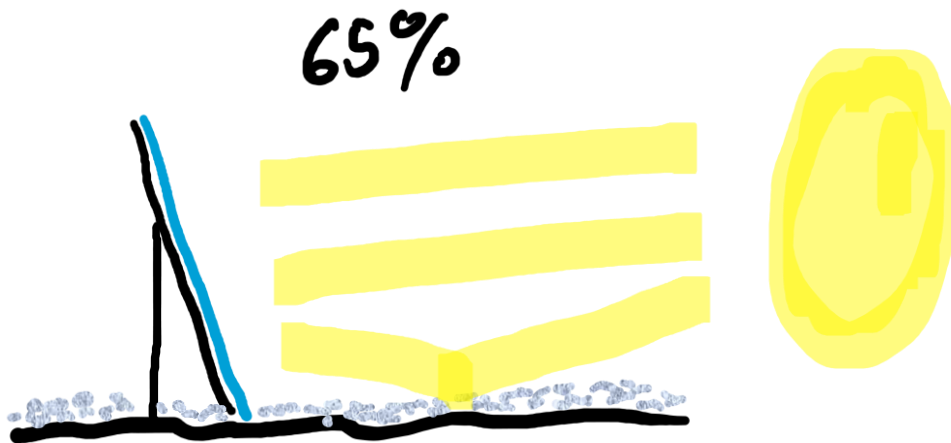


**The future –
Energy
innovation**

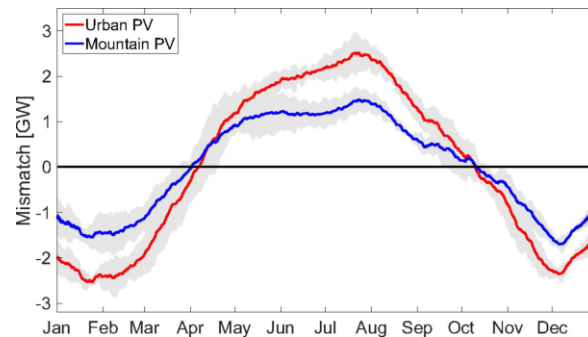
Technology: Winter photovoltaics



Summer



Winter



<https://www.pnas.org/content/116/4/1162#sec-1>

<https://doi.org/10.1073/pnas.1720808116>

<https://www.ewz.ch/solarzueri/de/karte.html#/>



Strom

Solaranlagen

Glasfaser

Liegenschaften

Elektromobilität

Einige unserer öffentlichen Solaranlagen



Schulhaus Riedtli

Die Solaranlage auf dem Schulhaus Riedtli im Kreis 6 hat eine Gesamtfläche von 270 m² und erzielt eine Leistung vo...



Stadtspital Waid

Auf der 1880 m² grossen Dachfläche des Stadtspitals Waid produzieren unsere Solarpanels rund 280'000 kWh...



Seewasserwerk Lengg

Das Seewasserwerk der Stadt Zürich befindet sich im Kreis 8. Es verfügt über 1743 m² Solarpanels, die eine Leistung...

Retail: District P2P Trading



1004 kWh

QS-Produktion

innerhalb der letzten 3 Tage

3305 kWh

QS-Verbrauch

innerhalb der letzten 3 Tage

62 %

QS-Eigenverbrauch

innerhalb der letzten 3 Tage

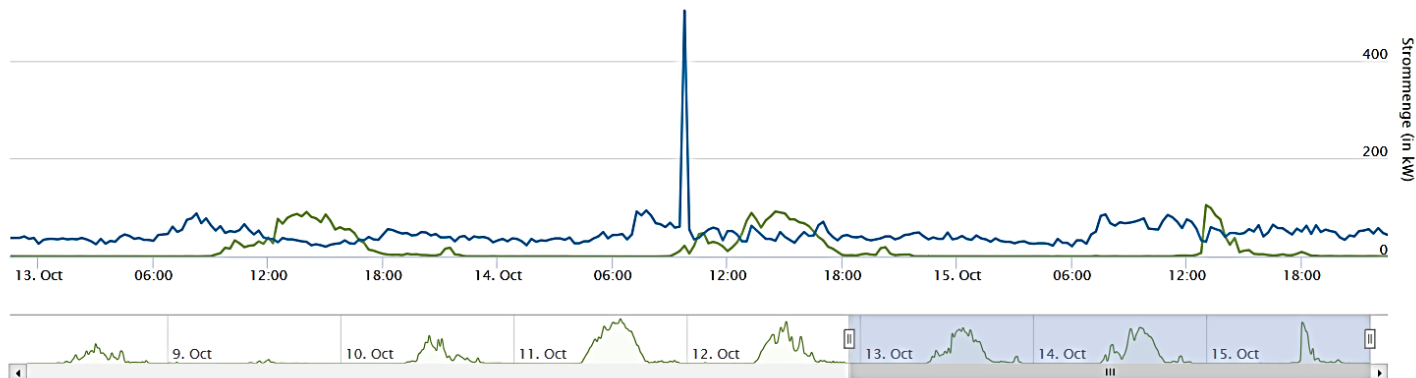
19 %

QS-Eigenversorgung

innerhalb der letzten 3 Tage

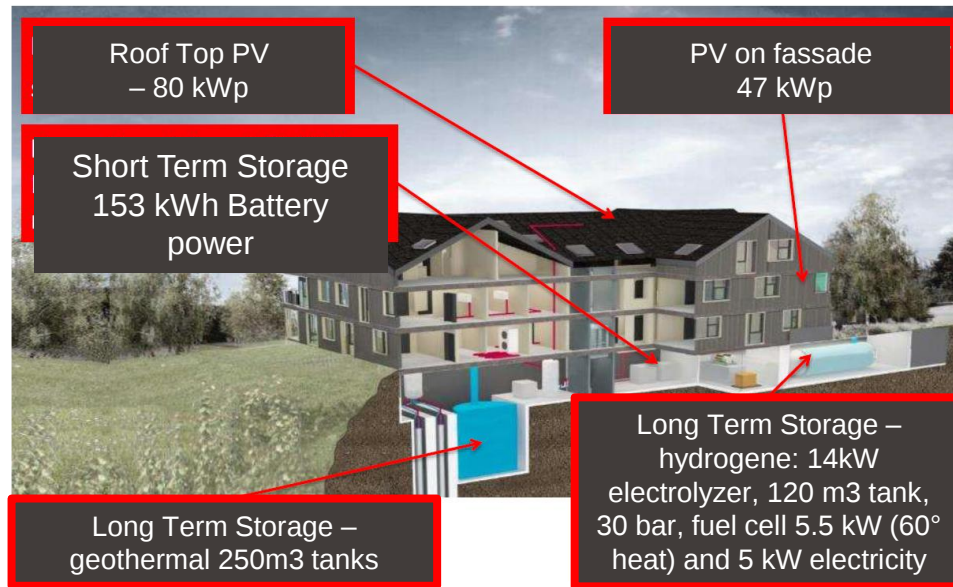
Zoom 1T 3T 1W

From Oct 12, 2019 To Oct 15, 2019



<https://quartier-strom.ch/index.php/en/homepage/>

Technology: 1st energy self-sufficient apartment building worldwide



Apartment Building Brütten
Architect – Rene Schmid

https://www.energie-experten.ch/de/wohnen/detail/ein-haus-ohne-stromanschluss.html?gclid=EAlaIqObChMlqOLq5M-S6QIVFeaaCh1qAQdWEAAAYASAAEgJhdfD_BwE#c374



Technology: Hydrogene

Hyundai bringt 1000 Wasserstoff-Lkw in die Schweiz

Gemeinsam mit H₂ Energy bereiten die Koreaner die weltweit erste Flotte von tausend Brennstoffzellen-Nutzfahrzeugen vor, die ab 2019 auf Schweizer Strassen rollen werden.

<https://h2energy.ch/en/>



ALPIQ UND H2 ENERGY PLANEN GRÖSSTE SCHWEIZER WASSERSTOFFPRODUKTION

SCHWEIZ 25.07.2019 - 16:15 - MARIO GRAF



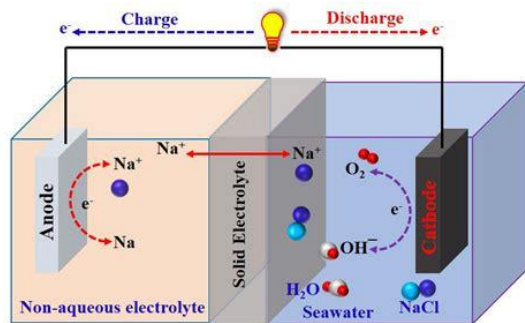
Hier in Gösgen soll grüner Wasserstoff für den Schwerverkehr produziert werden. (Foto: Alpiq)



Die erste öffentliche Wasserstofftankstelle der Schweiz



New battery technologies: «salt water batteries»



<https://pknergypower.com/salt-water-batteries/#toggle-id-1>

Comparing different battery technologies:

<https://www.isi.fraunhofer.de/en/blog/themen/batterie-update/alternative-batterie-technologien-lithium-ionen-potenztiale-herausforderungen.html>

Comparison of alternative battery technologies: technology maturity, market potential and sustainability benefits

Overview of alternative battery technologies

Technology	Technology readiness	Market potential	Sustainability advantage
LiB	■	■	■
SiB (Na)	■	■	■
SiB Salt (Na Saltwater)	■	■	■
MiB (Mg)	■	■	■
ZiB (Zn)	■	■	■
AlB (Al)	■	■	■
Li-S	■	■	■
Na-S RT	■	■	■
Na-S HT	■	■	■
Li-Luft	■	■	■
Zn-Luft	■	■	■
RFB	■	■	■

■ similar to LiB ■ lower ■ much lower ■ very much lower
for sustainability = yellow as benchmark

Technology: Electric aviation and ferry boats



Made in Valais : <https://silence-aircraft.de/en/aircraft/photos-and-videos/>



Fully electric 90-passenger plane could fly 500 miles



By Giacomo Frisco, CNN
© 6 minute read · Published 4:23 AM EDT, Mon July 15, 2024



The Dutch:

<https://edition.cnn.com/travel/elysian-electric-plane-90-passenger-spc>



The innovations making aviation greener

Elysian

The Norwegians do it already:

<https://www.siemens-energy.com/global/en/home/stories/electric-ferries.html>

Emotions: Formula E & MotoE – electric racing

<https://fiaformulae.com/de/video/487298>



Photo: Ducati



E-motions: Sound on



<https://www.youtube.com/watch?v=oPXfbZItlGo>



<https://www.youtube.com/watch?v=h1ovY8oSjDY>

Want to see an electric race?

<https://www.youtube.com/watch?v=xcL96OIK-90>



Key messages of the lecture

- The energy sector is a network industry – natural monopoly
- The energy value chains includes market and monopoly-based parts
- The swiss case is an exception in Europe (vertically integrated firms)
- **The future is to be designed (by us)**



Bikeberufene

– a book about female careers
in motorcycle technology

Contact



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Book project: www.bikeberufene.com
Insta: @teambikeberufene