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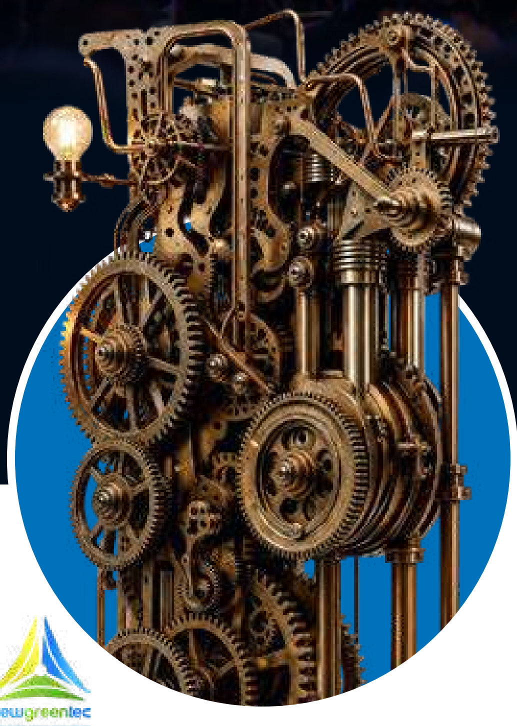
Whitepaper • 2026

SECTOR COUPLING

The Key to a Successful Energy Transition in Switzerland



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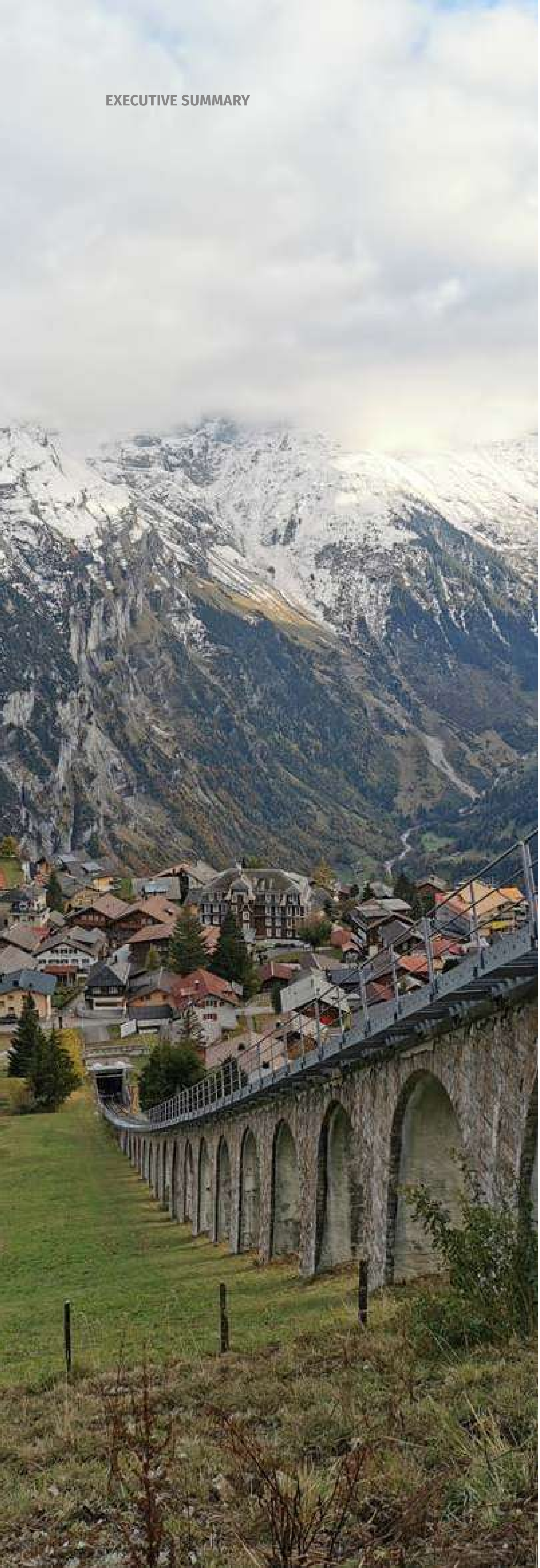

Executive Summary

Switzerland's energy transition is entering a new phase. 2025 was about demonstrating — 2026 is about implementation and scaling. The first edition of the Whitepaper "Sector Coupling" has been accessed more than 100,000 times since September 2025, achieving an exceptionally high level of resonance. Since then, new projects have been initiated, existing initiatives further developed, and additional practical experience gained. The second edition builds on this and consistently shifts the focus from the question of whether sector coupling works to how it can be scaled systematically and nationwide.

The pressure to act remains high: Switzerland currently imports 68 percent of its heat, cooling, and electricity; for petroleum products and gas alone, a net CHF 8.1 billion per year flows abroad. Sector coupling is therefore not merely an instrument of climate policy but increasingly a question of security of supply, economic resilience, and competitiveness. The whitepaper demonstrates, through more than 30 real-world examples, that the technologies required for this are fundamentally available and already in use.

The projects also make clear that the transformation must take place at all system levels: from individual buildings, through sites and municipalities, to cantons, regions, the national level, and large international projects. At the building and site level, photovoltaics, heat pumps, thermal and electrical storage, waste heat recovery, e-mobility, and intelligent control are being combined into integrated systems. Municipalities and cantons are increasingly taking on a coordinating role between energy supply, grids, heat planning, mobility, and spatial development. At regional and national level, seasonal flexibility, power-to-X, and renewable gases come into play; international projects show how large-scale solutions that have already been proven can be transferred to Swiss conditions. The connection between these levels is decisive: sector coupling is not a single technology but a system architecture.

The development since 2025 reveals an important maturation process. Projects that were documented as pilot approaches in the first edition are now delivering insights for standardisation and replication. For example, the renovation projects in Stallikon and Aesch documented in 2025 were used to test an integrated one-stop-shop approach, standardise processes, and identify implementation potential. The next step is to move such individual solutions out of project mode and into repeatable business, planning, and infrastructure models.

The central challenge is therefore no longer primarily technological. The barriers increasingly lie in the framework conditions: lengthy approval processes, rigid spatial planning, fragmented expertise, a lack of collaboration between business, academia, public administration, and politics, short-term investment horizons, and insufficient political continuity. Added to this is the challenge of digitally orchestrating an increasingly decentralised energy system and coordinating electricity production, consumption, storage, heat, and mobility in time and space.

These same areas also hold the greatest opportunities. Intelligently coupled decentralised generation, storage, and flexible consumers can reduce the need for costly grid expansion, increase local value creation, and lower dependence on energy imports. The electrification of heat, mobility, cooling, and new consumers such as data centres increases electricity demand but simultaneously opens up considerable flexibility potential through intelligent control. Research findings in the report illustrate the scale of individual levers: increasing the annual rate of building energy retrofits from 1.1 to 2 percent could reduce the modelled 2050 winter electricity gap from around 11 to 6 TWh.

The strategic message for 2026 is therefore clear: Switzerland has the technologies, know-how, projects, and investment capacity. What is needed now is a reliable framework for scaling them. This includes policy planning certainty, simpler approval and support procedures, local energy communities and dynamic tariffs, long-term-oriented financing, digitalisation, and early cross-sector planning. The next phase of the energy transition will not be decided by whether further individual technologies are invented, but by whether existing solutions are consistently interconnected, replicated, and scaled from the building to the national energy system.

Energetic regards

Frank Schürch & Daniel A. Oechslin

SECTOR COUPLING

The Key to a Successful Energy Transition in Switzerland

CONTRIBUTORS

Concept: Daniel Oechslin (oe.energy), Frank Schürch (energie-cluster.ch)

Editorial work: Alexandra Moser (Green Energy Venture AG)

We thank the following partners for contributing their projects and expertise:

Ulrich Nyffenegger (Kanton Bern)

Daniela Decurtins (gazenergie)

Janos Kick (gazenergie)

René Scotzniovsky (Gemeinde Allschwil)

Adrian Altenburger (HSLU T&A)

Marc Bätschmann (Tend AG)

Massimiliano Capezzali (HEIG-VD)

Dominik Clauss (a energie AG)

Sjef de Bruijn (Biral AG)

Raymond C. Decorvet (Everllence Schweiz AG)

Claudio De Giacomi (Joulia SA)

Manuel Marti (Joulia SA)

Alfons De Stefani (ADapt GmbH)

Luigi Di Cola (Hoval AG Schweiz)

Rahul Gupta (EPFL)

Michel Haller (OST)

Krisztina Kelevitz (OST)

Daniel Meier (EVTEC AG)

Stefan Minder (Weisskopf Partner GmbH)

Philipp Erdmann (Weisskopf Partner GmbH)

Maike Schubert (Weisskopf Partner GmbH)

Alina von Allmen (Regionalkonferenz Oberland-Ost)

Pascal Peter (GUNEP AG)

Laurent Raeber (Swiss Energypark)

Martina Rechsteiner (ZHAW)

Norbert Rücker (Bank Julius Baer)

Sandro Schopfer (sun2wheel AG)

Frido Stutz (NewGreenTec International AG)

Silvan Suter (Thermal Transformer AG)

Kamil Szostek (Jobst Willers Engineering AG)

Roger Walther (EBP Schweiz AG)

Timon Wanzenried (B-Solartec AG)

Gregor Zust (eRevo AG)

Marc Meyer (eRevo AG)

Deniz Akman (BLS Schifffahrt AG)

Thank you to the extended team of energie-cluster.ch for their valuable support and coordination.

FOR MORE INFORMATION

Green Energy Venture AG (part of OE-EN group) | amo@green-energy-venture.com | www.green-energy-venture.com

energie-cluster.ch | info@energie-cluster.ch | www.energie-cluster.ch

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Methodology

This year's report is the result of a broad-based collaboration involving a total of 78 partners from business, politics, public administration, research and education. Through regular exchanges between February and August, selected projects were discussed, new insights gained and valuable synergies created. The report brings together the results of this exchange and provides a structured overview of the projects and topics addressed within the initiative.

Across 7 cross-cutting contributions, the report examines key technical, societal, economic and political aspects of sector coupling. Drawing on 18 concrete projects, it demonstrates how sector coupling can serve as a lever for economically viable and implementable solutions at different levels – from individual buildings and sites to the municipal, cantonal, regional, national and international levels. Together, the projects illustrate the variety of approaches to sector coupling and how these can be translated into concrete and implementable solutions.

The report combines overarching topics with practical project examples. This allows broader questions surrounding sector coupling to be considered alongside concrete experiences from project development and implementation, while highlighting the connections between different levels and approaches.

The topics and projects presented are deliberately not intended as an exhaustive representation of sector coupling in Switzerland, but rather as an impetus for its further development. They provide a snapshot of current approaches and experiences and a basis for continued exchange and collaboration. We therefore very much look forward to continuing the initiative in 2027 together with new projects, perspectives and partners.

After all, the energy transition needs people who think ahead, shape ideas and put them into practice – a strong crew capable of staying on course even when the winds change.

Kind regards, your sector coupling team!

PARTICIPANTS OF OUR INITIATIVE AND THEIR RESPECTIVE PROJECTS (in alphabetic order):

a/energie AG: District Heating and District Cooling: Climate-Resilient Thermal Networks for Switzerland — a/energie AG examines how district heating and cooling networks can serve as the thermal backbone of sector coupling — connecting electricity, heat, and cold across communities in a system resilient to climate change.

ADapt GmbH: Warm Building Mass: the Overlooked Short-Term Store in the Energy Transition — ADapt GmbH demonstrates how the thermal mass of buildings can function as a short-term energy buffer, reducing peak loads and enabling smarter integration of renewable electricity.

B-Solartec AG: Sustainable Ground Source Heat: Regenerating Geothermal Probes with PVT Hybrid Collectors — B-Solartec AG presents a system that regenerates geothermal probes using PVT hybrid collectors — combining photovoltaic and thermal output on one panel to sustain long-term ground source performance.

Bank Julius Bär: When Geopolitics Runs into the Energy Transition — Julius Bär examines how geopolitical disruption is reshaping energy markets and investment flows, and what this means for Switzerland's approach to energy security and infrastructure financing.

BLS Schifffahrt AG: BLS Schifffahrt: From Electric Fleet to Energy Platform of the Future — BLS Schifffahrt AG describes how the electrification of its lake shipping fleet is evolving into a broader energy platform, combining shore-side charging, grid services, and operational flexibility.

EBP Schweiz AG: The Energy Transition Needs Professionals with Systems Understanding — EBP and partners at SPF/OST examine what competences and educational frameworks professionals need to design, operate, and govern coupled energy systems — and where Switzerland currently falls short.

eRevo AG: Triewald DMES — Decentralised Multi-Energy Systems as Infrastructure for Sector Coupling and Long-Term Storage — eRevo AG presents the Triewald decentralised multi-energy system as a scalable infrastructure model that integrates electricity, heat, and gas storage to enable long-duration flexibility.

EVTEC AG: Efficient Urban Charging Infrastructure: Grid-Friendly DC Charging Concept for Municipal Fleets and Public Space — EVTEC AG presents a DC charging concept designed for dense urban environments — combining high-power charging for municipal fleets and public users with grid-friendly load management to avoid costly network upgrades.

gazenergie, Swiss Gas Industry Association: Biomethane Imports in Switzerland: Potential, Challenges and Regulatory Framework — gazenergie examines the conditions under which Switzerland can import biomethane as a renewable gas at scale — covering sourcing potential, infrastructure requirements, and the regulatory changes needed to make cross-border green gas trade viable.

St. Gallen City Utilities: Building a Smart Energy System — St. Galler Stadtwerke presents its approach to building a smart, integrated urban energy system in St. Gallen — coupling electricity, heat, mobility, and data infrastructure to deliver reliable, low-carbon supply across the city.

Gemeinde Allschwil: From Ventilation Replacement to Heat Network: How a Public Pool Advanced the Energy Transition in Allschwil — The municipality of Allschwil shows how a ventilation replacement project in a public swimming facility became the catalyst for a local heat network, demonstrating what community-scale sector coupling looks like in practice.

GUNEP AG: Hohrain Heat Network: From Wood-Chip Boiler to Sector-Coupled Energy Platform — GUNEP AG documents the evolution of the Hohrain heat network from a biomass heating system to a fully sector-coupled local energy platform integrating renewables, storage, and smart control.

Hoval AG Schweiz: Data Centre Ostschweiz: Sector Coupling Asset and Regional Energy Hub — Hoval and RZO AG present a data centre in eastern Switzerland designed not just as a consumer but as an active energy hub, feeding waste heat into the local district heating network and participating in grid services.

Joulia SA: Waldegg Sports Pavilion Horgen: Solar Self-Sufficiency and Wastewater Heat Recovery in Sports Facilities — Joulia presents the Waldegg sports pavilion in Horgen as a showcase for sector coupling at the building level: solar energy covers all demand, and an innovative shower drain heat recovery system captures otherwise wasted thermal energy.

Kanton of Bern & EBP Schweiz AG: Climate-Neutral Tourism Region Bernese Oberland — East: Promoting Sustainable E-Mobility — EBP and the Canton of Bern present a cantonal project to decarbonise mobility in the eastern Bernese Oberland, integrating e-mobility infrastructure with renewable energy supply in a tourism-intensive alpine region.

NewGreenTec International AG: PowerPyramid — Hybrid Wind-Solar Micro Power Plant for Decentralised Energy Supply — NewGreenTec International AG presents the PowerPyramid, a compact hybrid wind-solar micro power plant designed for decentralised energy supply in locations where grid connection is costly or unavailable.

OE-EN AG: The Energy Transition Becomes an Infrastructure and Capital Question — OE-EN AG argues that the next phase of the energy transition is no longer primarily a technology challenge but a question of financing and infrastructure — and presents Capital Transition Networks as a model for mobilising long-term investment at scale.

SPF Institute for Solar Technology, OST: Building Insulation Balances Winter Electricity through Sector Coupling — SPF Institut für Solartechnik at OST quantifies the contribution that higher building insulation rates can make to Switzerland's winter electricity balance, showing that envelope improvements are a direct lever on the seasonal supply challenge.

sun2wheel AG: AutoHedge — Bidirectional Charging Under Dynamic Grid Tariffs — sun2wheel AG presents AutoHedge, a system that uses bidirectional EV charging to hedge against dynamic grid tariff fluctuations — turning electric vehicles into an active financial and grid flexibility asset for their owners.

Swiss Energypark & EPFL: From AI Around the Grid to the Grid Inside the AI — Swiss Energypark and EPFL present a platform that moves AI from an analytical tool operating around the grid to a real-time intelligence embedded inside it — enabling regional energy systems to optimise generation, storage, and demand at speed.

Tend AG: Serial Renovation in Switzerland: from Pilot Project to Systemic Model — Tend AG documents how its serial renovation approach — standardising building envelope upgrades and heat system replacements — has moved from individual pilot projects to a replicable model ready for nationwide rollout.

Thermal Transformer AG: Waste Heat-Driven Cooling for Data Centres and Industry — Thermal Transformer AG presents a technology that uses waste heat from data centres and industrial processes to drive cooling — turning what would otherwise be a thermal liability into a resource, and closing the loop on industrial energy flows.

Weisskopf Partner GmbH: Herisau: Thermal Network as a Flexible Energy System — Waste Heat, Borehole Arrays and Cross-Sector Control — Weisskopf Partner GmbH presents the thermal network in Herisau as a case study in flexible district energy design, integrating waste heat, geothermal borehole storage, and cross-sector control to balance variable renewable generation with stable local supply.

ZHAW & HSLU: Positive Energy Districts in Practice — ZHAW and HSLU document the Hard Areal in Winterthur as a Positive Energy District living laboratory, measuring and analysing the energy flows of a mixed-use urban site to generate transferable insights for district-scale sector coupling.

Political Continuity: The Cornerstone of Swiss Prosperity

Frank Schürch
Political Scientist, MBA, CEO energie-cluster.ch

Switzerland owes much of its prosperity to reliable frameworks. Companies invest, municipalities plan, homeowners renovate, and energy providers build infrastructure only when the political direction remains recognisable across electoral cycles. This holds true for energy, infrastructure, education, research, and innovation: their effects are not measured in campaign cycles but over years and decades.

The starting point for energy policy is clear. In 2024, petroleum products accounted for 45.7 percent of Switzerland's final energy consumption, natural gas for 12.3 percent, and coal for 0.3 percent; renewable energy sources reached 29.9 percent. At the same time, net spending on imports of petroleum products and gas alone exceeded CHF 8.1 billion. This money generates limited domestic value and keeps Switzerland dependent on world market prices, geopolitical risks, and supply chains beyond its control.

Decarbonisation is therefore not only climate policy but industrial policy. Every oil heating system replaced, every more efficient building, every kilowatt-hour of domestically produced renewable energy, and every storage unit strengthens security of supply. Switzerland has committed by law to net-zero by 2050; in 2024, 68.7 percent of voters approved the Federal Act on a Secure Electricity Supply. A government that implements this course consistently mobilises private capital, reduces risk, and creates jobs at home.

Continuity does not mean rigidity. Policy must be able to respond to new technologies, price shifts, and security conditions. But abrupt subsidy cuts, constantly changing approval procedures, or politically watered-down targets raise project costs and unsettle investors. Following Russia's invasion of Ukraine, Germany was forced to reorganise its gas supply rapidly and at enormous cost. France demonstrated in 2022 that even a highly centralised electricity system can be vulnerable. The lesson: spread risk broadly and trigger investment in time.

INNOVATION CREATES PROSPERITY

Switzerland's capacity for innovation and its consistent investment in research, development, education, and entrepreneurship have made it wealthy. In the 2025 Global Innovation Index, it ranked first for the fifteenth consecutive year. Switzerland spends around 3.2 percent of gross domestic product on research and development. Its four major neighbours compare as follows: Germany at around 3.1 percent, Austria at 3.3 percent, France at 2.2 percent, and Italy at 1.4 percent; the United States reaches around 3.4 percent. These figures show that Switzerland is among the leaders — but its advantage cannot be taken for granted.

China is investing comprehensively and strategically in innovation. In 2025, its research and development spending rose to 2.80 percent of GDP; in the Global Innovation Index, it entered the top ten most innovative economies for the first time. In absolute terms, China is also closing the gap on the United States rapidly. This development underscores the value of Swiss innovation but simultaneously raises competitive pressure on Swiss companies, universities, and research institutions.

Switzerland must keep pace: through strong domestic investment in research and innovation, modern infrastructure, reliable conditions for businesses and start-ups, and an attractive environment for education and research. International cooperation on innovation is equally important. Scientific progress is increasingly produced in cross-border networks; renewed participation in European research programmes is therefore not a secondary concern but a matter of economic policy. Isolation or cuts to research and technology transfer mean losing expertise, competitive advantage, and skilled professionals — while creating new dependencies abroad.

Switzerland can afford the necessary investments. According to the IMF's World Economic Outlook, its gross government debt in 2026 stands at around 38.5 percent of GDP. For comparison: Germany at approximately 64.6 percent, Austria at 82.1 percent, France at 118.4 percent, Italy at 138.4 percent, and the United States at 125.8 percent. Low debt is not a blank cheque for unconstrained spending. But it gives Switzerland exceptional strategic room for productive investment that strengthens future output, resilience, and tax revenues.

Energy and innovation policy thus follow the same logic. Political continuity builds trust; trust unlocks long-term investment; and investment secures prosperity, self-reliance, and room for manoeuvre. The alternative is a stop-and-go approach that raises the cost of capital, delays projects, and deepens dependencies. Investment in energy, research, and innovation is therefore not a burden on the future — it is an investment in it.

Sources

- *Swiss Federal Office of Energy: Swiss Overall Energy Statistics 2024.*
- *Federal Office for the Environment / Federal Chancellery: Net-Zero Target 2050; Vote on a Secure Electricity Supply 2024.*
- *Federal Statistical Office / OECD: Research and development expenditure in international comparison (most recent comparable figures).*
- *WIPO: Global Innovation Index 2025.*
- *National Bureau of Statistics of China: Statistical Communiqué 2025.*
- *International Monetary Fund: World Economic Outlook, April 2026 (gross government debt as a percentage of GDP).*

When Geopolitics Runs into the Energy Transition

Norbert Rücker
Head of Economics & Next Generation Research, Bank Julius Baer; President, energie-cluster.ch

Geopolitics made a comeback and left its mark on the energy world this year. The Iran war turned the oil market's nightmare — a closed Strait of Hormuz — into reality. Yet the feared oil crisis and recession did not materialise. It quickly became clear that the Strait of Hormuz was not truly closed and that exports could rapidly switch to alternative routes. Oil prices remained largely below 2022 levels. Even more striking is the comparison with the period from 2010 to 2015: adjusted for inflation and thus for purchasing power, today's prices are almost half what they were more than a decade ago. This can be read as a signal of calm despite the many geopolitical risks.

This is not surprising, as the market reacted much as it did during the 2022 energy crisis: oil and gas trade adapts extraordinarily quickly to new circumstances after shocks. The incentive is provided by the price premiums that compensate for the higher costs of alternative routes and temporarily dampen demand. Price is the conductor in the concert of supply and demand. Pragmatism and opportunism pave the way to resilience. Just now, as concerns about low gas storage levels are spreading again, we should not lose sight of the most important lesson from 2022. When Europe pays, the LNG tankers come and secure supply. Why? Because under these conditions, competition in Asia partly switches to coal. Gas storage levels were extraordinarily full from 2022 onwards, and this was not only due to weather. A power shortage requires a gas shortage, since gas-fired power plants are the last link in Europe's electricity supply chain. Risks should be recognised and understood. The past years show, however, that the global gas market rarely allows such a shortage to take hold. The flip side of security of supply is sharp, temporary price spikes.

Even less surprising is the influence of the energy transition. Rising prices at the pump reliably stir emotions, but their economic significance is declining. An ever-growing share of cars and trucks on the road is running on electricity. Even if this share is currently just under 5% in Europe and Switzerland, the impact of oil price shocks on the economy is weakening, compounded by improving combustion engine efficiency. This trend is very robust, as technological progress is rapid. Thanks to affordable Chinese models, the market share of electric vehicles among new registrations has grown strongly in emerging markets in Southeast Asia and South America, now standing

at 20% in Brazil or over 50% in Vietnam, for example. China dwarfs all others with over 15 million electric vehicles registered per year and market shares of over 60%. Europe and Switzerland are at just under 40%. An even stronger dynamic is visible in China in heavy goods transport: the share of electric trucks is likely to exceed 35% for the year as a whole. Reduced oil exports from the Middle East are being absorbed in part by reduced imports from China. Experts are currently observing and debating how large the energy transition's contribution to this is.

Comparably unsurprising are the consequences for the electricity market. The big theme remains the solar power glut. On the wholesale market, electricity is available at discount prices at midday. On exceptionally sunny and windy days, prices regularly turn negative, since renewable energies have no operating costs, are partly tied into fixed remuneration systems, and coal and nuclear plants have limited flexibility. This phenomenon is not confined to Europe but can be observed worldwide, from regional electricity markets in the US, to Australia, and China. The solar glut meant less demand for gas-fired power plants, which dampened the impact of higher gas prices — driven up by the Iran conflict — on electricity prices. The glut also offset a partial shortfall in hydropower and nuclear power as a result of heat and drought. Like the oil market, the electricity market is showing a resilience that should not be underestimated.

This midday electricity glut seems to contradict the narratives of scarcity driven by artificial intelligence and data centres, or electrification more broadly. This rollercoaster of intraday prices will intensify further. The expansion of renewables

is delivering more additional electricity than is demanded and is relegating fossil power plants to the role of extras — as intended by policy. This expansion is economically and return-driven and would likely take place even without the remaining subsidies. Yet the economics of solar energy are hard to pin down. In Germany, the government-run auction in July achieved an average price of below EUR 50 for ground-mounted installations. In Spain, privately concluded long-term solar power purchase agreements are trending towards EUR 30. Both figures are anecdotal examples implying unrivalled low costs. These costs are not only below those of alternative technologies, but also below today's market prices and those expected to fall even further in future. The picture is similar at lower grid levels. Rooftop installations on commercial buildings and single-family homes offer cheaper electricity than the grid. Higher installation costs are offset by higher grid fees.

The economics are extremely dynamic. The solar glut and the depression of daytime market prices would weigh on expansion and slow the energy transition — were it not for the wave of innovation in battery storage. Battery additions in Europe are estimated at around 20 gigawatts for this year, representing 20% of all investment in power generation and storage capacity. Ongoing scaling of production, advancing technology, and growing know-how in installation and integration promise further falling costs. Thanks to batteries, the solar glut is spreading into the less sunny morning and evening hours, when market prices are still higher — which supports the economics. Where this dynamic leads can be observed in the pioneering markets of California and Australia: better utilisation of large solar and wind capacities, flexible thermal power plants pushed into reserve and backed economically by the grid operator, and as a result, dampened price spikes in the morning, evening, and on average across the whole day. The trilemma of security of supply, affordability, and environmental protection appears solvable.

The midday electricity glut, the uncertainty in the gas market, and the momentum of road electrification are the breeding ground for so-called sector coupling — the linking of electricity with heat and mobility. Sector coupling is emblematic of the decentralisation that accompanies the energy transition, and illustrates the opportunities and challenges that come with it. Cheap solar electricity from a large commercial rooftop helps cut costs when used in electric trucks or heat pumps. The possibilities and applications are diverse, as this publication impressively shows, and with advancing innovation, the opportunities continue to grow. The challenges, however, remain familiar. Decentralisation means that instead of a few, many are now contributing to the energy future. Only with the appropriate awareness and know-how can businesses and municipalities seize the opportunities of sector coupling. However, the regulatory framework is lagging behind the reality of energy markets and creating unnecessary hurdles. The more actors are involved, the simpler and more straightforward regulation should be. In a high-wage country like Switzerland, bureaucracy weighs especially heavily on costs.

Sector coupling can fairly be described as the top league of the energy transition at the lower levels of the electricity grid. Every investment in sector coupling carries the promise of resolving the trilemma of security of supply, affordability, and environmental protection. The measures needed for improved framework conditions are well known. First, unrestricted access to the European market is crucial for controlling and making use of the electricity glut. According to all experts, a corresponding agreement is the most important pillar of security of supply. Second, full market liberalisation is a driver of innovation and the energy transition, since it allows simple and affordable products and services to reach the market more quickly. Third — and this is the debate still missing — a reform of grid fees is overdue. The existing system has outlived its purpose. The more solar and storage capacity emerges in every corner of the grid, and the more electricity flows in both directions, the less bureaucratic and discriminatory is a grid fee for all based on capacity (kilowatts) rather than consumption (kilowatt-hours). ZEVs and LEGs are commendable, but ultimately limited in effectiveness and resource-intensive workarounds. Switzerland demonstrates considerable pioneering spirit, entrepreneurship, and innovation. Politics could take its cue from this.

The Energy Transition Becomes an Infrastructure and Capital Question

WHY INVESTMENT IN ENERGY INFRASTRUCTURE IS NOW DECISIVE AND PRIVATE CAPITAL IS TAKING ON A NEW ROLE

Daniel A. Oechslin,
CEO / Chairman, OE-EN AG

For a long time, the debate about the energy transition was primarily a debate about technologies. Photovoltaics, wind energy, e-mobility, heat pumps, hydrogen — these were the central themes. The focus is now shifting. The decisive question is no longer just which technologies are available, but whether the necessary infrastructure can be planned, financed, built and integrated into the existing energy system quickly enough. The energy transition is thus increasingly becoming an infrastructure question — and, inevitably, a capital question.

The scale of this development is considerable. The International Energy Agency (IEA) expects global energy investment of around USD 3.4 trillion in 2026. Around USD 2.2 trillion of this is expected to flow into renewable energies, grids, storage, nuclear power, electrification, efficiency and other low-carbon technologies.

Yet the volume of investment alone tells only part of the story. What matters is where this capital is invested.

FROM GENERATION TO ENERGY SYSTEM

In recent years, a great deal of capital has flowed into new generation capacity. Solar and wind power have been massively expanded worldwide. At the same time, it is becoming increasingly clear that additional generation capacity alone does not create a functioning energy system.

Electricity must be transported, stored, time-shifted, locally distributed, and coordinated with consumers. The more weather-dependent and decentralised electricity production becomes, the more important grids, battery storage, flexible consumers, heating systems, energy management, and intelligent control become. These are precisely where the bottlenecks are emerging today.

Grid infrastructure is now explicitly seen as one of the critical bottlenecks in global electrification. More than 2,500 gigawatts of generation assets, storage, and new consumers are queuing worldwide for grid connection. At the same time, annual global investment in electricity grids would need to increase significantly. The problem is not only financial. A solar park or battery storage facility can be built relatively quickly. Planning, permitting, and constructing large grid infrastructure, by contrast, frequently takes many years.

The energy transition is thus moving from being a pure generation story to becoming an infrastructure story.

SWITZERLAND FACES THE SAME CHALLENGE

The pressure to act is growing in Switzerland too. The Federal Act on a Secure Electricity Supply from Renewable Energies has established binding expansion targets. By 2035, electricity production from renewable energies excluding hydropower should reach at least 35 TWh; by 2050, at least 45 TWh. But the demand side is changing at the same time.

Mobility and heat are increasingly being electrified. Companies are building charging infrastructure. Data centres and digital applications are creating new loads. And more and more buildings and sites are becoming both electricity producers and consumers. What matters is not only the annual energy quantity — increasingly decisive is when, where, and at what capacity energy is produced and consumed. This is precisely why flexibility and storage capacity are gaining in importance.

Since early 2026, further parts of Switzerland's new Energy Act (Mantelerlass) have come into force. The regulatory framework more explicitly accounts for the grid-serving use of flexibility and storage. Local electricity communities also enable new forms of local marketing and use of self-generated electricity. This is more than a regulatory detail. It is gradually changing the architecture of the energy system: away from a few central producers and passive consumers towards a network of production, storage, consumption, and local optimisation.

Infrastructure Must Keep Pace with Electrification

The scale of necessary investment is already visible in the Swiss transmission grid. Swissgrid has identified 31 major grid projects for its Strategic Grid 2040 and is planning investment of around CHF 5.5 billion. But the transmission grid is only one layer of the system. The real transformation is simultaneously taking place in distribution networks, industrial and commercial sites, real estate, mobility infrastructure, energy production, and storage. Thousands of individual investment decisions are emerging there.

An additional photovoltaic installation can, for example, simultaneously make a battery storage system, a grid connection upgrade, charging infrastructure, and an energy management system worthwhile. Surplus energy can be stored or marketed locally. Peak loads can be reduced and energy flows optimised over time. However, the broader context is often lacking the sound knowledge that is indispensable for the security of private investments. Good advisory services and reliable, validated models need to be developed.

Individual installations are increasingly becoming integrated energy infrastructures.

THE STATE CAN SET THE FRAMEWORK — BUT CANNOT FINANCE EVERY PROJECT

Public authorities and energy utilities remain central actors. Transmission and distribution networks, security of supply, and regulatory frameworks cannot simply be left to the capital market. At the same time, it is clear that the transformation of the entire energy system cannot be financed exclusively through public budgets or the balance sheets of traditional energy utilities — the number of necessary projects is too large and the infrastructure too decentralised.

This is where an increasingly important role is emerging for private and institutional capital. Insurance companies, pension funds, family offices, infrastructure investors, and other long-term-oriented capital providers are looking for investments with real assets, long-term economic utility, and transparent cash flows. Energy infrastructure can in principle offer exactly these characteristics. The challenge, however, is making projects investable. A single battery storage facility, an energy project on an industrial site, or a heat infrastructure is often too small for a large institutional investor.

At the same time, between a project idea and a financeable infrastructure asset there are several development stages: site, grid connection, permits, technical planning, contracts, financing, and finally construction and operation. Capital alone does not solve this problem. What is needed are structures that develop projects, reduce risks, bundle assets, and create investable portfolios from them.

DEVELOPMENT CAPITAL BECOMES THE CRITICAL LINK

Capital is fundamentally available for established infrastructure assets. More difficult is financing the phase in which a project idea becomes

a genuinely buildable and financeable asset. Yet it is precisely there that the question is decided of which projects can actually be built some years later. Private investment can therefore have the greatest impact where it does not only begin after an asset is completed, but already enables the development of new infrastructure.

Conversations between energy developers, industrial companies, and large infrastructure players also show that perceptions are changing. Energy is increasingly no longer viewed merely as a purchased commodity. Questions around production, storage, charging infrastructure, grids, flexibility, and supply are becoming part of companies' strategic infrastructure decisions. This is emblematic of a broader development: energy infrastructure is moving closer to real estate, mobility, industry, and capital markets.

INDIVIDUAL PROJECTS MUST BECOME INVESTABLE PORTFOLIOS

Against this background, new models are emerging between classical project development and traditional infrastructure investment. This is not primarily about financing individual technologies. What matters more is the ability to systematically develop a pipeline of different infrastructure projects, progressively reduce risks, and bring multiple assets together in an investable structure. This approach is gaining particular relevance in battery storage, decentralised energy production, charging infrastructure, and hybrid energy systems.

Investment platforms such as OE-CTN can serve as a possible bridge between project development and the capital market. The approach consists of bringing several energy infrastructure projects together in a shared structure, thereby creating the scale that can become relevant for professional and institutional investors. The underlying principle is transferable:

Projects become assets. Assets become portfolios. And portfolios become investable infrastructure.

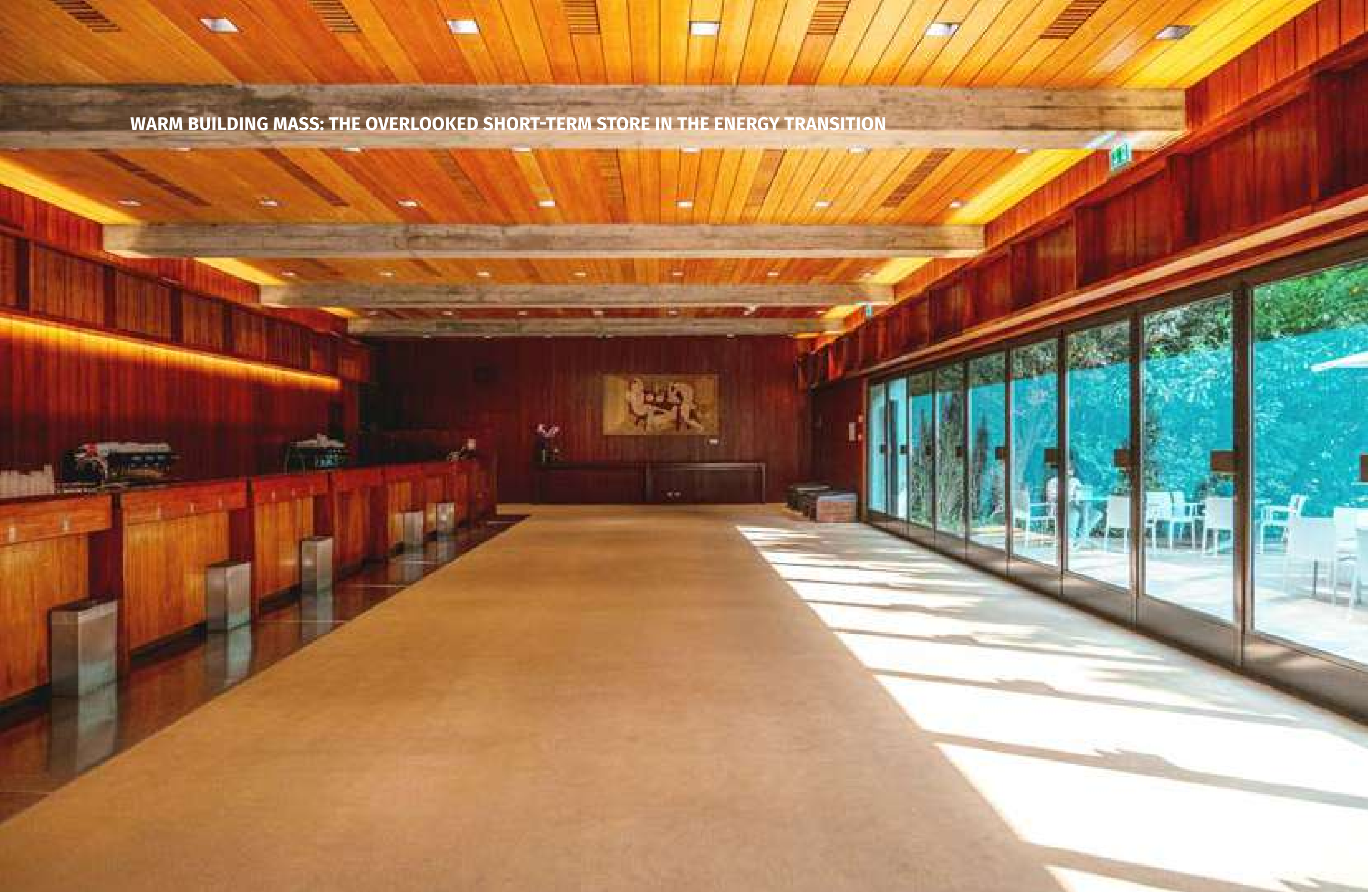
This creates a connection between two worlds that have long been viewed largely in isolation: energy development and capital markets.

CAPITAL BECOMES PART OF SECURITY OF SUPPLY

The energy transition is often discussed in terms of climate targets. Security of supply, competitiveness, and resilience have become at least equally important. An energy system with more volatile production requires additional flexibility. An electrified economic system requires more capable grids. Decentralised production requires storage and intelligent control. And an infrastructure that is to be fundamentally rebuilt within a few decades requires substantial amounts of long-term capital.

The technologies for this largely already exist. The decisive task of the coming years is therefore to translate technology, projects, regulation, and capital into functioning infrastructure.

For investors, this opens a new perspective: investments in energy infrastructure are no longer merely an opportunity to participate in the energy transition. They are increasingly financing a fundamental part of the infrastructure of the coming decades — and doing so economically. The energy transition is thus not only a technological transformation, but an opportunity in which bringing together the stakeholders described here will be key to success. It will become one of the largest infrastructure investments of our time.



Warm Building Mass: the Overlooked Short-Term Store in the Energy Transition

Alfonso de Stefani
ADapt GmbH

STORING AND ORCHESTRATING

Electricity is THE currency of technology. The balance between supply and demand is anything but accidental. Surpluses arise repeatedly — they must be redistributed or stored as locally as possible for later use. The need for storage is broadly recognised. What is less often recognised is the need to manage that storage to actually use its capacity. Access to both production (supply) and consumption (demand) is essential. This requires local-to-international orchestration in real time — and sufficient storage.

A STORAGE MEDIUM THAT ALREADY EXISTS

Discussions about energy storage tend to focus on batteries, pumped hydro, or hydrogen. One medium is almost always overlooked — even though it is present in every building: warm building mass. The warm building mass — floors, walls and ceilings of a heated building within the insulation perimeter —

is able to absorb surpluses and draw on them later to meet demand. Through control-based activation, this physical property can be used for load shifting – with a minimum of new materials and investment.

In the context of sector coupling, this potential takes on particular significance. Surplus solar or wind power can be stored in building mass via heat pumps whenever supply exceeds demand. This turns the building into an active element of grid stabilisation — at the lowest level of the energy system, widely distributed and highly scalable.

The rebound demand becomes controllable: the previous ON/OFF intervention was essentially open-loop rather than closed-loop control. Sector coupling with supply and demand at the respective level enables proportional load shifting – without the known disadvantages.

QUANTIFICATION: WHAT DOES THE STORE ACTUALLY HOLD?

Three independent sources converge on a remarkably consistent picture. A study by David Zogg (2022) on a multi-family residential development in Möriken-Wildegg found a thermal storage capacity of 100–400 kWh for the residential buildings, each accommodating around 20 people. This corresponds to 5–20 kWh(th) per capita with a temperature variation of ±0.5 K within the comfort zone. Converted through a heat pump with a coefficient of performance of 3 (in cold weather), this yields an electrical equivalent of 1.7–7 kWh(e) per person. The storage capacity of the building mass exceeded that of the water storage tank by a factor of five — even though the water tank had been deliberately oversized.

The ETH PATHFNDR study (Luca Baldini, 2025) quantifies the flexibility potential at system level: heat pumps could deliver around 5 TWh of load shifting in Switzerland by 2050, with electric vehicles contributing a further 3 TWh. The heat pump share corresponds to 2 kWh(e) per person at 270 annual cycles, covering all building categories.

An independent estimate based on the Swiss building stock yields a comparable result. Switzerland's total energy reference area (ERA) amounts to around 852 million m² — 579 million m² for residential buildings and 273 million m² for infrastructure, corresponding to around 95 m² per capita. Assuming an average heating demand of 40–45 W/m² ERA and a thermal inertia of the building mass of 2 to 20 hours per kelvin, this results in a thermal stor-

age potential of around 20 kWh(th) per capita. This corresponds to 7 kWh(e) per capita at a heat pump coefficient of performance (COP) of 3. An independent estimate based on the anthropogenic stock — around 90–100 tonnes of material maintained at indoor temperature per capita, with an average specific heat capacity of 0.8–0.9 kJ/kg·K — confirms this value, yielding 20–25 kWh(th) per capita.

Looking ahead to future buildings with improved external insulation, a greater thermal penetration depth and a thermal inertia of 10 to 20 hours per kelvin can be expected — while heating load decreases. These two effects compensate each other: building refurbishment increases the storage capacity.

COMPARISON WITH THE SWISS ENERGY STORAGE PLAN

The Swiss Energy Storage Plan (PSI / ETH) calls for short-term electrical storage capacity to grow from today's 1.6 GWh(e) to 15–17 GWh(e). The re-

Thermal Storage Capacity of Warm Building Mass

per capita (50 m² NFA/person)

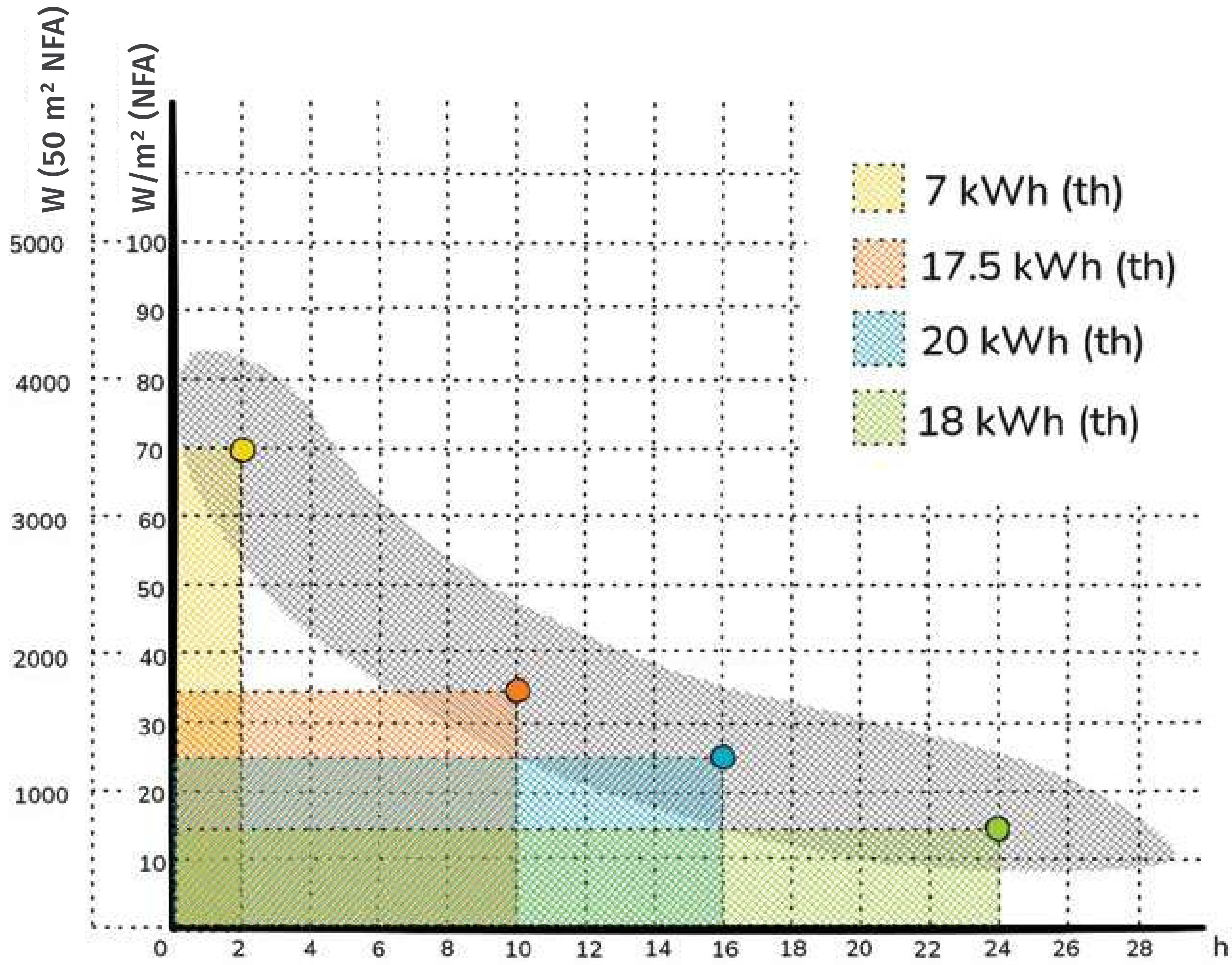


Fig. 1: Thermal storage capacity of warm building mass — per capita (basis: 50 m² NFA/person). Four estimates from studies and calculations (coloured rectangles) with their respective operating points (circles). Grey shaded area: total potential range.

quired addition of roughly 15 GWh(e) equates to 1.7 kWh(e) per person. The storage potential of the building mass – converted via a heat pump with a coefficient of performance (COP) of 3 – can be quantified at between 2 and 8 kWh(e) per capita, depending on the study and assumptions, and thus exceeds the required additional storage capacity by up to a factor of four. This capacity already exists. It does not need to be built; it needs to be unlocked (Fig. 1).

PREREQUISITE: CONTROL INFRASTRUCTURE FROM GRID TO ROOM

In concrete terms, this means room sensors and actuators that can respond to external setpoint specifications, as well as a communication interface between the energy system and building technology. What was previously hindered in existing buildings by the effort required for wiring can now be implemented more cost-effectively using energy-harvesting technologies and wireless sensors.

Precision is essential: a setpoint shift of ±0.5 K is sufficient to activate the short-term storage capacity without compromising occupant comfort. Control technology also enables the integration of weather forecasts, further optimising self-consumption. Warm building mass does not compete with chemical or other storage solutions — it complements them as a low-cost, resource-light element of an integrated storage strategy.

KEY FIGURES

Swiss building stock (total NFA)	approx. 852 million m² (~95 m²/person)
Thermal storage potential (Zogg study)	5–20 kWh(th)/person at ±0.5 K swing
Electrical equivalent (COP 3)	1.7–7 kWh(e)/person
HP flexibility potential (ETH PATHFNDR)	~2 kWh(e)/person, 270 cycles/year
Independent estimate (heat load × inertia)	20 kWh(th)/person → 7 kWh(e)/person
Anthropogenic stock (heated)	approx. 90–100 t/person → 0.8–0.9 kJ/kg·K → 80–90 MJ(th)/person → 20–25 kWh(th)/person
Thermal inertia (future buildings)	10–20 h/K (min: >2 h/K, best: >20 h/K)
Required storage addition (CH Energy Storage Plan)	~1.7 kWh(e)/person
Building potential vs. storage requirement	approx. 2x -4 × coverage
Activation requirement	Room control with ±0.5 K setpoint shift

CONCLUSION

Warm building mass is a short-term storage medium that has received little attention in Swiss energy strategy — despite being physically present, inexpensive to activate, and scalable across the entire building stock. The studies and estimates reviewed here suggest that the electrical equivalent potential exceeds the required storage additions by a significant multiple. Deeper scientific investigation and the systematic deployment of room-level control technology are a worthwhile next step on the path to an interconnected energy transition. ■

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Maike Schubert (Weisskopf & Partner) with participants of the first “Sector Coupling” course at Eastern Switzerland University of Applied Sciences (OST) in November 2025.

From silos to systems thinking: education for the networked energy future

Dr. Michel Haller,
Eastern Switzerland University of Applied Sciences (OST)
Roger Walther,
Member of the Management of the Sustainable Building Unit, EBP Schweiz AG

The energy transition is often understood as a technological challenge. Photovoltaics, heat pumps, electric mobility, battery storage and smart grids are shaping the energy systems of the future. But what matters most is not the individual technologies — it is the collaboration of professionals from different sectors to develop viable solutions that integrate them.

FORMERLY SEPARATE, NOW CONVERGING

Electricity, heat and mobility were once largely independent energy infrastructures. Decarbonisation is changing that. Planning a heat pump today means influencing the electricity grid at the same time. Sizing a photovoltaic installation requires thinking through storage, electric mobility and electricity prices in parallel. Buildings are shifting from pure energy consumers to active components of a networked energy system.

A modern residential district illustrates this well: photovoltaic panels supply electricity for buildings, heat pumps, battery storage and electric vehicles. Surpluses are stored or fed back into the grid. Electric vehicles may themselves serve as flexible storage in future. Systems like these create new opportunities for efficiency and security of supply — but they also increase complexity. Decisions in one area have immediate consequences in others. This is why renewable energy, storage, electric mobility, heat pumps and full electrification must be thought through together and integrated from the outset into the planning process.

SHIFTING DEMANDS ON EDUCATION

This convergence is reshaping the skills required of energy professionals. Training programmes are still largely organised along classical disciplinary lines — electrical engineering, building technology, energy economics. What will be needed are professionals who can identify connections across those boundaries and integrate different systems with one another.

This is not about replacing specialist knowledge. Deep expertise in a given field will remain essential. What matters is that specialists understand how their decisions affect the overall system and can collaborate across disciplines. Increasingly in demand are systems thinking, forward-looking and design competencies as well as communicative and cooperative skills — so that complex solutions can not only be planned but actually implemented. Systems thinking and sector coupling are becoming core competencies of the energy transition.

OPTIMISATION THROUGH DIGITALISATION

Digitalisation reinforces this shift. Smart metering systems, energy management platforms, digital twins, artificial intelligence and automated control systems enable increasingly precise coordination between generation, storage and consumption. Professionals must therefore not only understand energy flows but also apply digital tools and support data-driven optimisation processes.

NEW LEARNING FORMATS

Educational institutions face new tasks as a result. Degree programmes and continuing education should do more to bridge disciplinary boundaries and promote practical, interdisciplinary learning

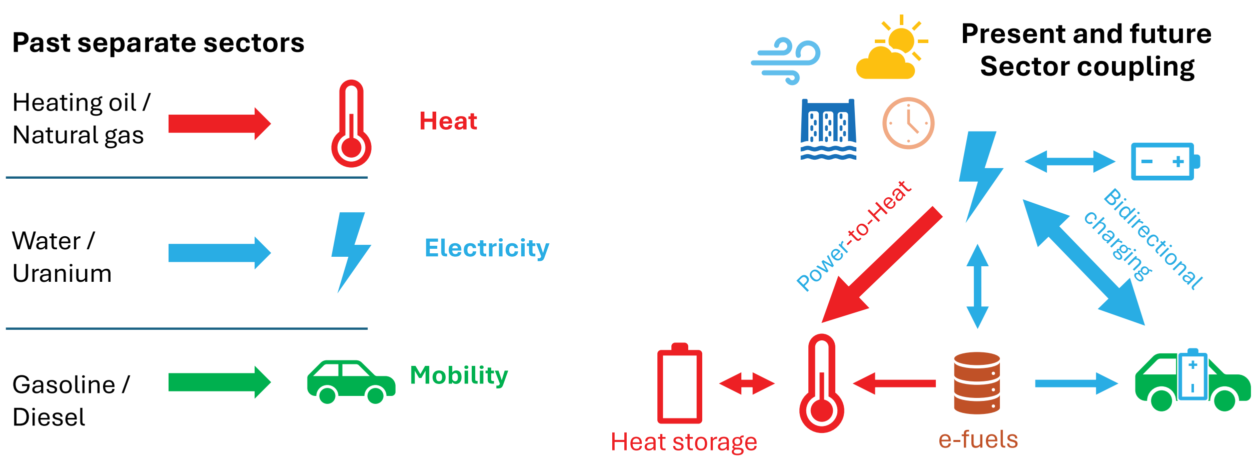


Fig 1. Previously separate sectors of electricity, heat and mobility are becoming increasingly interconnected.

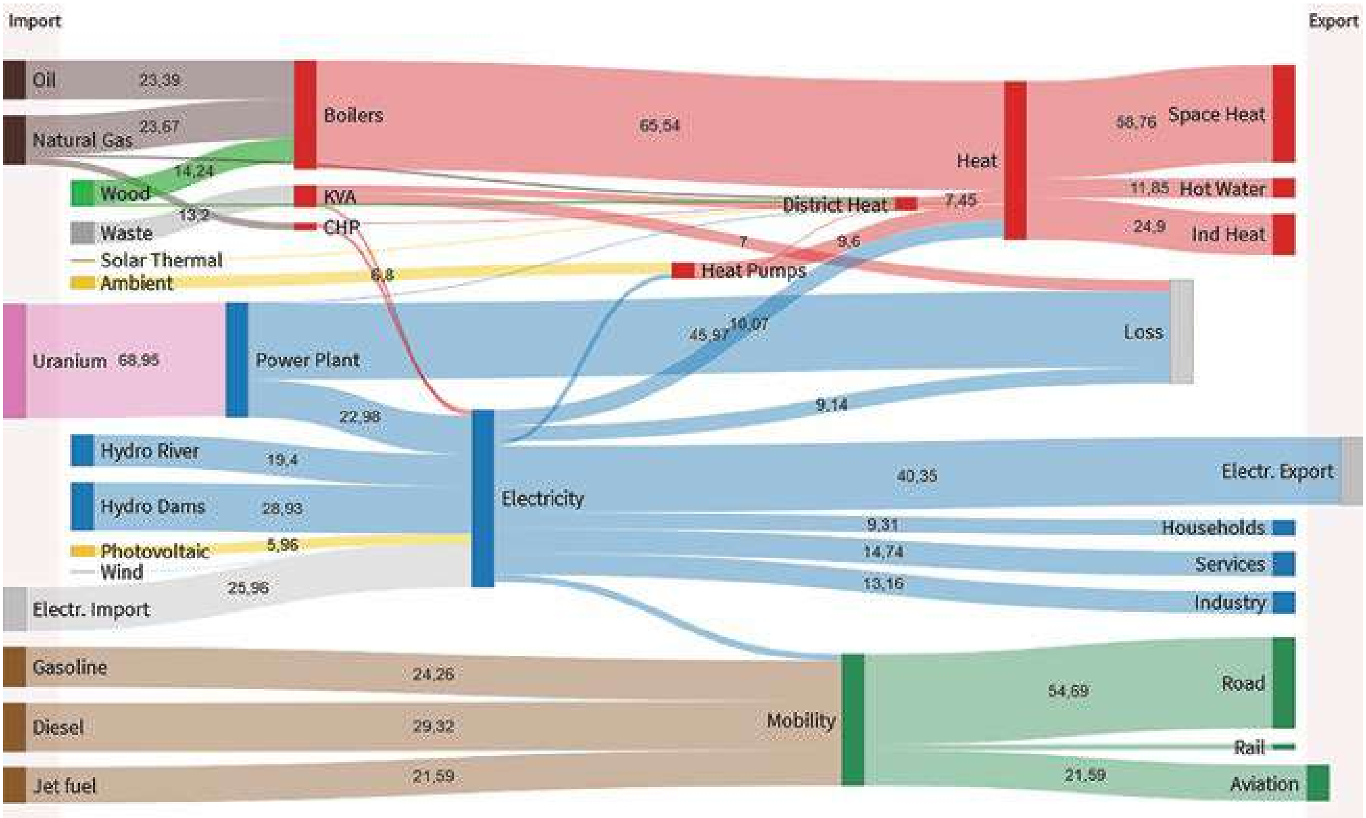


Fig 2. Sankey diagram of Switzerland's energy flows in 2024 — the interconnection between sectors is becoming increasingly visible. Source: www.energysankey.ch

formats. Increasingly, the goal is to translate specialist knowledge into actionable competencies — going beyond mere knowledge and insight. What matters is that what is learned leads to decisions, implementation and concrete progress. Partnerships between universities of applied sciences and private companies offer ideal conditions for this: integrating real projects and applied experience from industry into continuing education on the one hand, and transferring research and development findings into new projects in the private sector on the other, creates substantial added value.

The energy transition is therefore not only an infrastructure project but an educational one. International organisations have long pointed to skills shortages as one of the greatest risks to its success — not just in terms of the number of professionals available, but also their qualifications. One thing is clear given the increasing pace of sector coupling: the energy system of the future will be shaped by people who can connect technical disciplines and understand the system as a whole.

Those who want to prepare specifically for these demands will find a practice-oriented programme in the two-day specialist course on sector coupling at Eastern Switzerland University of Applied Sciences (OST), developed together with private companies. The course covers the fundamentals and interdependencies between electricity, heat, mobility and digitalisation, and builds precisely the systems competencies increasingly required for the planning, operation and further development of future energy systems.

Building Insulation as a Key to Winter Grid Resilience

Dr. Michel Haller, Dr. Krisztina Kelevitz
Eastern Switzerland University of Applied Sciences (OST)

Switzerland has committed to reaching net-zero greenhouse gas emissions by 2050 — a target that requires a fundamental transformation of how energy is produced, distributed, and used across all sectors. Central to this transformation, alongside the expansion of renewables and electrification, is sector coupling: the deliberate integration of electricity, heat, and mobility into a coherent, mutually reinforcing energy system. A study conducted at Eastern Switzerland University of Applied Sciences (OST) — examined how decisions in the building sector, specifically the rate at which building envelopes are thermally renovated, will directly shape Switzerland's winter electricity demand by to mid-century.

ELECTRIFYING HEAT AND MOBILITY

The electrification of heat supply through heat pumps and of transport through electric vehicles represents the two central demand-side shifts in Switzerland's path to net-zero. Together, these transitions will add approximately 18 TWh of annual electricity demand — while at the same time roughly 200 TWh imported fossil fuels and uranium are eliminated.

THE WINTER GAP: THE CENTRAL CHALLENGE

Heating demand peaks in winter, precisely when solar electricity generation is at its lowest. This seasonal mismatch between domestic supply and demand cannot be bridged by short-term storage technologies such as batteries, pumped hydro, or building-level heat storage. Meeting the additional winter demand will require wind power, imports, or – still costly -seasonal energy storage.

Several studies from Swiss and international universities conclude that a full exit from fossil fuel imports and domestic nuclear power, combined with broad electrification and a large-scale expansion of photovoltaics but without seasonal storage, could result in a winter electricity deficit of around 10 TWh per year by 2050. Options currently under discussion for meeting this demand - other than imports - include wind power and large-scale seasonal pit thermal energy storage integrated into district heating networks. The latter reduces heat pump electricity demand during winter. Wheth-er these technologies will gain traction in Swit-zerland given land-use planning constraints and public acceptance is still an open question. Chemical storage options such as hydrogen, methanol, ammonia, or metals like iron and aluminium are also conceivable, though they tend to be significantly more expensive per kilowatt-hour of winter electricity than wind-energy or pit storage.

The study that was carried out by OST explored a different angle: what if building renovations were accelerated so that buildings need significantly less heating in winter, and the heat pumps installed within them consume correspondingly less electricity?

THE POWERCHECK MODEL AND ITS 60-CATEGORY BUILDING STOCK

To quantify how building-sector decisions translate into electricity system impacts, the authors extended the energy system simulation tool PowerCheck with a detailed bottom-up model of the Swiss building stock. The model captures hourly heat and electricity demand across 60 building categories, defined by climate zone, usage type, and insulation standard. The six climate zones range from low-altitude urban settings to mountain regions above 1,000 metres; usage types distinguish between single-family and multi-family buildings (including also offices); and insulation standards span four historical construction periods (pre-1960, 1961–1980, 1981–2000, and post-2000) plus a fifth category for passive houses introduced for future scenarios.

Despite population growth, Switzerland's total annual building heat demand is expected to fall from

87 TWh in 2019 to 59 TWh by 2050, driven by better insulation standards. Yet the share of electricity used specifically for building heat — space heating and hot water — could rise from 11 TWh to over 12 TWh in the baseline scenario. This apparent paradox — less heat demand, but more electricity used for heat — is the direct consequence of replacing oil and gas boilers with heat pumps, which are far more efficient but run on electricity.

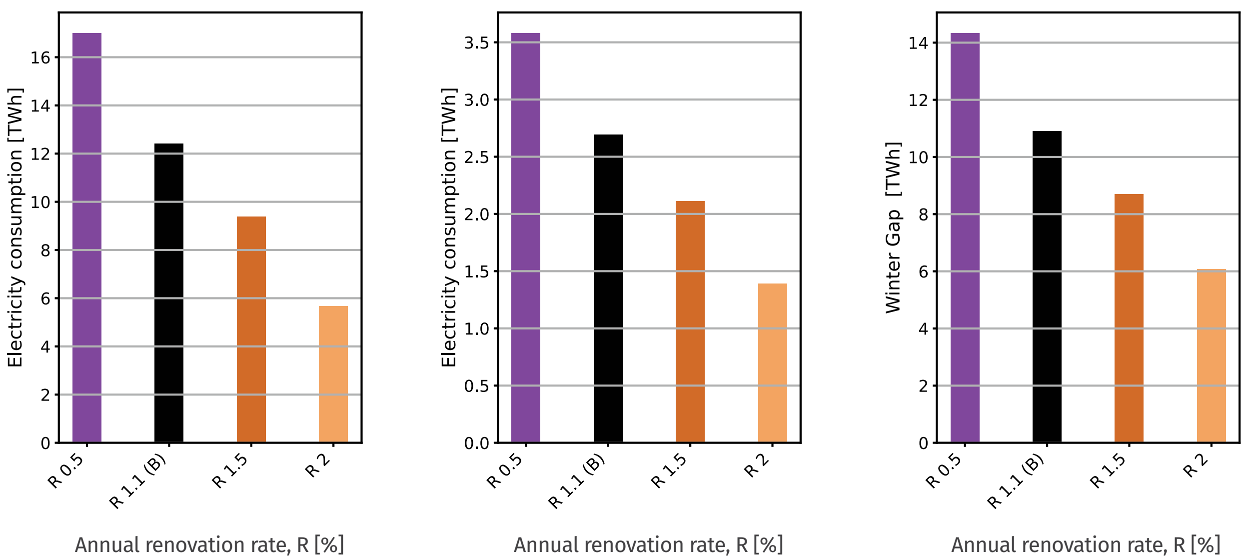
TWELVE SCENARIOS, FOUR PARAMETERS

The study examined twelve scenarios by varying four parameters: the annual thermal renovation rate of building envelopes; the share hot water demand met through wastewater heat recovery; the split between ground-source and air-source heat pumps; and projected temperature increases due to climate change.

THE LEVER THAT OVERSHADOWS EVERYTHING ELSE

The building envelope renovation rate emerges from the simulations as by far the most powerful lever. Raising the annual thermal renovation rate from the 1.1% assumed in the baseline scenario to 2% can reduce the winter electricity gap from approximately 11 TWh to 6 TWh — a reduction of 44%. At a rate of just 0.5%, the gap widens to 14 TWh. This is not a marginal difference: a gap of 6 TWh presents a fundamentally different planning challenge than one of nearly 14 TWh, with very different implications for import capacity, reserve power, and storage infrastructure.

Climate change and heat pump technology are the next most important factors. While climate change reduces heat demand in general, ground-source



(a) Yearly building **(b)** January building **(c)** Winter gap heat pumps draw on a relatively stable subsurface temperature, while air-source heat pumps become less efficient on cold winter days — precisely when heating demand peaks. Shifting towards a high-er share of ground-source heat pumps offers additional potential to reduce the winter gap, though the effect remains well behind that of the renovation rate. Hot water heat recovery contributes only modestly on its own but delivers meaningful reductions in combination with higher renovation rates and more ground-source heat pumps.

THE CASE FOR ACTING EARLY

Thermal renovation of Switzerland's building stock is a long-term undertaking. A 2% annual renovation rate — already ambitious — cannot be deferred to 2040: reaching the 2050 targets from that starting point would require entirely unrealistic rates in the final decade. Current evidence suggests that Switzerland's actual renovation rate does not yet reach even the 1.1% of the baseline scenario. This makes clear that building policy and energy policy are inseparable in the context of net-zero.

CONCLUSION: THE BUILDING ENVELOPE AS A STRUCTURAL ASSET FOR WINTER RESILIENCE

The study demonstrates that thermal building insulation is far more than a comfort or efficien-cy measure confined to the construction sector — it is a structural determinant of the Swiss electricity system's ability to balance supply and demand in winter, in 2050 and beyond. Sector coupling connects the building stock directly to the electricity grid through heat pumps, and the energetic quality of that building stock determines how much electricity those heat pumps will need, and when. A Switzerland that renovates ambitiously will substantially reduce the winter electricity gap through this measure alone. The study positions the building envelope as a critical — and frequently underestimated — asset in the Swiss energy transition.

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District Heating and District Cooling

CLIMATE-RESILIENT THERMAL NETWORKS FOR SWITZERLAND

Frank Schürch
Chairman of the Board, a/energie AG

KEY MESSAGE

New district heating networks should plan for cooling from the outset and include it as an option or mandatory variant in tenders. The additional investment prevents costly retrofits, makes use of local sources year-round, and improves public health, security of supply, and economic viability.

1. WHY COOLING BELONGS IN HEAT PLANNING

By 2024, Switzerland had warmed by around 2.9 °C compared to the pre-industrial period — roughly twice the global average.[1] Heatwaves are becoming more frequent, more intense, and longer; warm nights impede recovery for both people and buildings. In June 2026, the Swiss average temperature was 3.5 °C above the 1991–2020 norm. MeteoSchweiz described the late-June heatwave as “of historic proportions”.[2]

CH2025 shows that in a 3-degree world, the warmest Swiss day could be on average 4.4 °C warmer than in 1991–2020. In Geneva, cooling days would rise from around 72 to 115, and cooling degree-days from 216 to 543.[3] Cooling is therefore becoming an infrastructure challenge for residential buildings, hospitals, schools, care homes, offices, and businesses.

SWISS TREND

Figures vary with weather conditions and adaptation: heat-related deaths were estimated at 747 in 2015, 474 in 2022, 556 in 2023 (revised), 326 in 2024, and 410 in 2025. 84% of those affected in 2025 were at least 75 years old.[4]

Looking ahead: accounting for an ageing population, the federal government expects around 1,000 heat-related deaths per year in 2045–2074 with global climate action, and up to 2,500 without.[5] Definitive mortality data for 2026 is not yet available.

Europe: Comparable Model Estimates

Country	2022	2023	2024
Italy	18’801	13’790	19’038
Spain	12’135	8’335	6’743
France	5’839	3’614	2’451
Europe	67’873	50’798	62’775

Uniform multi-country model, June–September 2022–2024.[6] Swiss monitoring figures are not directly comparable in methodological terms.

2. TECHNICAL DESIGN: FROM HEAT NETWORK TO ENERGY SYSTEM

District heating distributes hot water; district cooling distributes cold water. Combined systems carry both media separately, or circulate water close to ambient temperature in a low-temperature/anergie network.

Local heat pumps generate heat in winter; heat exchangers or chillers supply cooling in summer. Their condenser heat flows into the network, into domestic hot water preparation, or into storage rather than being released unused to the outside air.

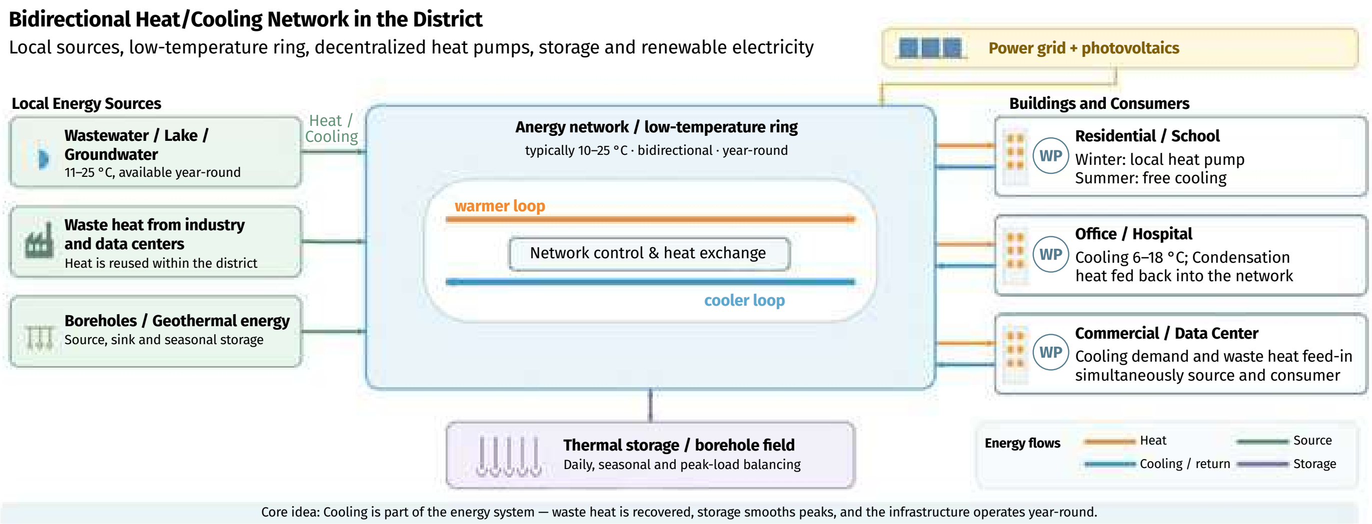

Diagram: Bidirectional low-temperature network (author’s own illustration based on SFOE/EnergySwitzerland and ewz).

SUITABLE SOURCES AND SINKS

Priority 1: unavoidable waste heat from cooling systems, industry, data centres, and treated wastewater.

Priority 2: lake, river, groundwater, and soil heat — seasonally stable, usable as both source and sink.

Priority 3: geothermal, solar thermal, waste incineration plants, and sustainable biomass for high temperatures and peak loads.

WHY SECTOR COUPLING IS DECISIVE

Heat pumps couple electricity and thermal networks; summer PV covers part of cooling production.

Storage and digital control shift loads, reduce peaks, and take advantage of low-cost electricity periods.

Simultaneous heating and cooling demand increases efficiency: heat is transferred between buildings.

Swiss case study: Altstetten-Höngg uses treated wastewater from the ARA Werdhölzli plant year-round. At full build-out, 172 GWh of heat and 35 GWh of cooling are planned; anergie pipes and power cables partly share the same tunnel.[9]

Cost and Lifecycle Comparison (planning index, heat network = 100)

Until tenders are received, the pre-study can work with the following network-side ranges:

Option	Index
Cooling-ready	105–115
Integrated from the outset	130–160
Later retrofit with separate cooling network (cumulative)	180–220

Indicative figures only, not a tender.

Example 5 km: At CHF 10 million in distribution costs, the figures come to approximately CHF 10.5–11.5 million, CHF 13–16 million, and CHF 18–22 million respectively. If the separate cooling network is only built in year 10, the combined net present value at 3% real interest is CHF 16.0–18.9 million.

Value over 20/30 years: shared civil works, permits, and routes reduce capital requirements; cooling revenues increase summer utilisation; heat recovery saves energy; fewer individual installations reduce replacement, noise, and peak load costs. Prerequisites: sufficient cooling demand, anchor customers, phasing, and sensitivity analysis.[10][11]

3. PLANNING, SPATIAL GOVERNANCE, OPPORTUNITIES AND RISKS

Thermal networks are economically viable where heat/cooling demand is dense, anchor customers are secured, and long-term routes are available. The Swiss Federal Office of Energy (SFOE) identifies spatial energy planning as a central prerequisite for heat/cooling networks and anergie grids.[8]

CHALLENGES

Reliably forecasting loads and simultaneity factors.Coordinating building temperatures, connections, and densification. Addressing permits and environmental questions at an early stage.

OPPORTUNITIES

Year-round utilisation and summer revenues. Heat recovery; fewer individual installations. Local value creation, predictable costs, and resilience.

RISKS

Over-investment if connection rates are too slow. Electricity, capacity, and source risks. Lock-in from high temperatures or closed interfaces.

4. RECOMMENDATIONS FOR IMPLEMENTATION

Investors: Evaluate lifecycle costs rather than initial investment; finance cooling readiness and modular expansion; limit risks through anchor customers and phasing.

Municipalities / Utilities: Align planning processes. Require a cooling option, a variant price, and expandability in tenders; use public buildings as anchor customers.

Network Builders / Operators: Design for low temperatures, heat recovery, storage, reserves, and open interfaces; build connections cooling-ready.

Planners: Incorporate climate scenarios, summer peaks, water bodies, and the electricity grid; compare heating-only, cooling-ready, integrated, and later separate solutions over 20/30 years.

CONCLUSION

District heating without a cooling option leads to costly retrofits and electricity demand spikes later on. Despite higher upfront costs, integrated solutions only have a market chance if municipalities, the federal government, investors, operators, and planners already require the cooling option — with a variant price, an expansion pathway, and 20/30-year costs — in studies, tenders, and concessions. Only what is tendered can be offered and financed. The goal is an expandable system combining heat, cooling, local sources, heat recovery, storage, and renewable electricity. ■

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Scope level: Building

At the building level, decarbonization efforts target the systems that directly affect a site's energy performance: heating and cooling infrastructure, ventilation, building envelope, and the integration of renewable energy sources. Buildings are both producers and consumers of energy—and often hold untapped potential for efficiency gains, heat recovery, or on-site generation. Whether newly built or undergoing renovation, a building's role in energy transition depends on detailed system knowledge, long-term planning, and the ability to connect technical measures with operational needs. The following examples illustrate different approaches to decarbonization at the building level.

Data Centre Ostschweiz: Sector Coupling Asset and Regional Energy Hub

Luigi di Cola
Hoval AG Schweiz

Digitalisation and the energy transition are among the most fundamental transformation processes underway in Switzerland. Data centres are often perceived primarily as major electricity consumers. Yet a systemic perspective reveals that they are increasingly becoming integral components of regional energy infrastructures: by coupling the electricity, heat, and data sectors, they are evolving into genuine sector coupling assets.

The Eastern Switzerland Data Centre (RZO) in Gais, Canton Appenzell Ausserrhoden, is a nationally relevant real-world example of this development. The combination of renewable electricity supply, adiabatic cooling, waste heat utilisation, and a local heating network creates economic value that goes well beyond mere data storage.

THE BUILDING AS AN ENERGY SYSTEM

The RZO was not conceived as a conventional data centre but as an integrated energy, infrastructure, and data system. The building – a striking black cube with a façade and rooftop almost entirely covered in photovoltaic panels – simultaneously functions as a data centre, a solar power plant, and a heat supplier. It has been in operation since January 2018, holds Tier IV certification (availability 99.998%) and operates as a colocation data centre – a "hotel" for server infrastructure used by companies and public institutions. It is operated by Rechenzentrum Ostschweiz AG, which is majority-owned by St. Gallen-Appenzell Power Works (SAK) and the St. Gallen municipal utilities (sgsw).

The site's elevation of 912 metres above sea level in Gais plays a key role in the energy concept. Four elements work in concert:

- **Photovoltaics on roof and façade:** annual yield of approx. 230,000 kWh, used directly in the building.
- **Free and adiabatic cooling:** the altitude allows ambient air cooling for much of the year. At higher temperatures, adiabatic evaporative cooling (Hoval ServeCool) is used – without an energy-intensive compression refrigeration unit.
- **Waste heat utilisation:** heat generated during IT operations is not wasted but fed into the local anergy and district heating network.
- **Heat network:** the heat supplies the neighbouring Bergkäserei Gais alpine dairy and, at full build-out, can serve additional buildings in the region.

Key metric	Value
PUE (Power Usage Effectiveness)	1.15
Installed PV capacity	310 kWp
Annual PV yield	approx. 230,000 kWh
Total electricity demand	6,700 MWh/year
Heat fed into the grid	1,500 MWh/year
CO_2 savings	approx. 360 t CO_2/year
Investment costs	approx. CHF 28.5 million
Start of operations	January 2018
Certification	Tier IV
Location	Gais AR, 912 m above sea level

From a sector coupling perspective, the building itself is the primary driver of innovation. Energy flows follow a closed loop: electrical energy → data processing → waste heat → heat network → building supply. This makes the RZO a multi-utility hub rather than simply a data centre.

WASTE HEAT AS A REGIONAL RESOURCE

Almost all electrical energy consumed by a data centre is ultimately converted to heat. Whereas this heat was previously released unused into the environment, at the RZO it is deployed as a renewable heat source. The heat is fed via heat exchangers into a low-temperature network and raised to the required temperature level by heat pumps.

According to SAK, at full build-out approximately 1.5 MW of continuous heat output will be available. This is sufficient to supply: the Bergkäserei Gais alpine dairy, several commercial businesses, nearby public buildings, and up to 150 single-family homes. The data centre thereby becomes a regional heat energy producer.

ECONOMIC VALUE

Direct benefits:

- Data security and cloud infrastructure for regional businesses and public institutions
- Digital sovereignty
- Support for around 100 customers, including a university, several cantons, and banking service providers

Indirect benefits:

- Utilisation of previously unused waste heat
- Reduction of fossil heating systems in the region
- Strengthening of regional value creation
- Higher utilisation of existing energy networks

The data centre is becoming part of an integrated regional energy system. Through the intelligent use of waste heat, the integration of renewable energies, and connection to thermal networks, the RZO is evolving from a pure data storage facility into an infrastructural hub of the energy transition.

CHALLENGES

- **Grid expansion:** the growing electricity demand of data centres requires high-capacity network infrastructure.
- **Economic viability of waste heat utilisation:** this requires planned or existing heat networks, along with nearby customers and long-term investment security.
- **Regulation:** integrating the electricity, heat, and data sectors requires coordinated regulatory frameworks.

In a next development step, the RZO's sector coupling could be extended to include power-to-heat, battery storage for grid stabilisation, and AI-supported grid optimisation.

REPLICATION POTENTIAL

The RZO represents a highly replicable reference model for sustainable data centres in Switzerland. The interplay of high energy efficiency, renewable energy supply, waste heat utilisation, and security infrastructure provides a template for future projects. Replication is particularly viable wherever high-capacity energy and communications infrastructure meets demand for data centre services. In the long term, similar regional data centres could make a significant contribution to digital sovereignty and the sustainable digitalisation of Switzerland.

The next data centre is currently in planning. Its efficiency can be further increased by delivering its waste heat to a large geothermal probe field for seasonal thermal storage, so that in winter this heat can be used efficiently by surrounding consumers. Offtake of the waste heat is already secured at 100%.

Triewald DMES – Decentralised Multi-Energy Systems as Infrastructure for Sector Coupling and Long-Term Storage

Marc Meyer, Gregor Zust
eRevo AG

THE PROJECT

The energy transition has an unresolved core problem. In summer, photovoltaic systems produce more electricity than can be used locally. Surpluses are curtailed, given away, or sold at negative prices. In winter – when heat demand, electric mobility, and industrial loads peak simultaneously – capacity falls short, while grid connection capacity in urban areas is already under strain. What is missing is not primarily more generation, but infrastructure that stores energy across days, weeks, and entire seasons and returns it precisely when needed.

This is the problem eRevo AG addresses with the decentralised multi-energy system (DMES) called Triewald. Buildings, industrial sites, and districts are no longer treated as passive consumers, but as active energy infrastructure that generates, stores, and thermally uses electricity while interacting intelligently with the wider grid. Triewald integrates photovoltaics, short-term storage, electrolysis, metal hydride-based hydrogen storage, a fuel cell, heat recovery, and digital control into a local energy hub. Hydrogen is produced on-site from renewable electricity, stored, and converted back into electricity and heat on demand – without any external supply chain.

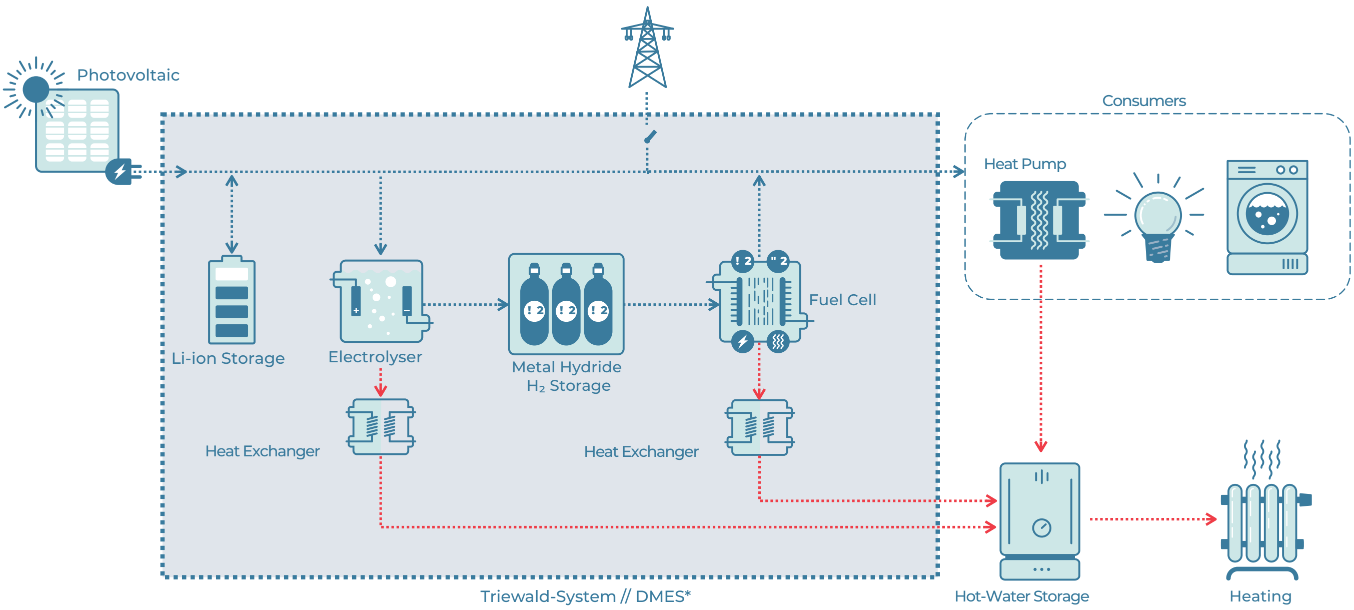
The technological core is a solid-state metal hydride storage system. Hydrogen is not stored as high-pressure gas but chemically bound within a metal lattice. This fundamentally changes the safety profile and allows high storage volumes directly within occupied buildings — where battery storage and high-pressure solutions reach their limits. Triewald complements battery storage rather than replacing it: batteries handle short-term flexibility, peak loads, and day-to-night shifting, while the metal hydride storage covers multi-day and seasonal shifting. The heat generated during electrolysis and power reconversion is systematically channelled into hot water, heating, district heating networks, or industrial processes. Sector coupling is not an added benefit here — it is the core logic of the system.

PARTNERS

eRevo AG, Eich (canton of Lucerne), www.erevo.ch acts as system architect and integrator. Industrially established, series-manufactured components are combined with a proprietary system architecture, reducing both technological and supply chain risk.

TRIEWALD DMES

Electricity, Heat, Storage and Consumers in One System — Building-Integrated



*DMES = Decentralised Multi-Energy Systems

POWERED BY eRevo

Implementation draws on a specialised partner network: GRZ Technologies (metal hydride storage, Switzerland), electrolyser manufacturers from Germany and Italy, Qynn Energy (data-driven energy economics and ROI modelling), enerpeak (energy engineering), RISAM (safety and fire protection), saprom (compliance with Swiss regulations), Hälg Group (HVAC), and SyEnergy and Maréchaux (electrical, battery, hybrid inverters). Market development partnerships include Integral Design Build and the Halter Group, as well as a strategic exchange with GETEC for industrial and contracting structures.

OBJECTIVES

- Enable seasonal and multi-day energy shifting, building-integrated, safe, and permittable.
- Achieve sector coupling of electricity and heat at a combined efficiency of over 75 percent.
- Absorb local grid overcapacities and return them on a time-shifted basis, reducing grid expansion and curtailment.
- Demonstrate economic viability without subsidies and without speculative price spreads.
- Establish an AI-supported control layer across all energy flows through Energy Intelligence.

STATUS AND KEY FIGURES

Since April 2024, the world's first fully building-integrated DMES installation based on metal hydride with thermal recovery has been running at full load in Eich, canton of Lucerne. The demonstrator serves as a reference for technology, operation, safety, and permittability, and reduces key risks in system integration and regulatory approval.

- **Demonstrator Eich:** 508 kWh electrical (480 kWh H_2 storage and 28 kWh short-term storage), 250 kWh thermal, 7.2 kW electrolysis, 8 kW fuel cell.
- **Triewald INDUSTRY:** Modular 0.5 to 16 MWh per room; reference configuration 3,200 kWh electrical and 2,000 kWh thermal; service life over 30 years, warranty up to 20 years.
- **Triewald AREAL:** Energy hubs from around 100 MWh; reference design 12 MW / 92 MWh electrical plus 20 MWh short-term storage and 25 MWh thermal, integrated within just 440 m² of floor space.

- **Combined efficiency:** over 75 percent for combined electrical and thermal use.
- **EWL site study, Lucerne:** configurations of 774 to 3,200 kWh assessed. Economic optimum at around 1,700 kWh, self-consumption above 90 percent.
- **Circularity:** metal hydride materials consist largely of recycled metals and are recyclable at end of life.
- **Supply chain:** the majority of key components sourced from Europe — specifically Switzerland, Italy, and Germany.
- **Pipeline:** SFP site Root (with Integral Design Build), high-rise project in the Basel-Landschaft region, logistics blueprints with GETEC, initial AREAL approaches with the canton of Lucerne.

BENEFITS AND CHALLENGES

Triewald makes renewable energy plannable, storable, and thermally usable. The system raises self-consumption, reduces grid purchase and grid expansion costs, strengthens local security of supply, and absorbs grid overcapacities where they arise. Since only a minimal proportion of the hydrogen exists as free gas, integration into existing buildings and urban sites is possible — where large-scale battery storage increasingly runs into fire safety, space, and permitting constraints. At area level, the energy hubs act as active buffer nodes between local generation, consumption, and the grid.

The challenges lie less in the technology than in project cycles and regulatory conditions. Twelve to eighteen months from project initiation to commissioning require capital discipline and a robust pipeline. eRevo addresses regulatory uncertainties surrounding hydrogen installations in buildings through its active participation in the SVGW working group on the recently published guideline H10001, helping to shape future regulatory frameworks rather than merely applying them. Investment decisions in practice often proceed in stages: short-term storage first, long-term storage as a pre-planned expansion — as the SFP site in Root illustrates.

ECONOMIC OVERVIEW

A typical Triewald INDUSTRY project involves around CHF 2 million in investment, with larger installations reaching CHF 3–4 million. ROI modelling for the EWL site in Lucerne shows payback of ten to fourteen years over a 30-year operating period — calculated without subsidies and without speculative revenues. Value drivers are increased self-consumption, heat extraction, avoided grid costs, and storage flexibility. Dynamic electricity prices and grid tariffs offer additional upside. The addressable Swiss market comprises 50 to 80 DMES-relevant site and industrial projects annually.

Energy Intelligence underpins economic performance across the full lifecycle: forecast-based dispatch over 24 to 72 hours, multi-asset optimisation across electricity, heat, hydrogen, and grid purchase, grid services such as peak shaving and balancing within collective self-consumption (vZEV) and local energy community (LEG) structures, and a self-learning operational layer that continuously analyses operating data and adapts control parameters.

KEY TAKEAWAYS

- System logic cannot be reduced to electricity prices alone. Economic viability comes from the coupling of electricity, heat, and storage flexibility.
- Metal hydride storage fundamentally shifts the permitting and safety logic, opening urban space to hydrogen.
- Short-term and long-term storage are complementary. Effective DMES installations combine both time horizons.
- Software is decisive. Without data-driven orchestration, the potential of coupled systems goes unrealised.
- Early regulatory engagement reduces project risk more effectively than case-by-case approval after the fact.

REPLICATION POTENTIAL IN SWITZERLAND

The Swissgrid white paper of March 2026 notes that integrating up to 40 GW of photovoltaics under current conditions is barely conceivable. The answer lies in distributed storage and system integration. Triewald DMES offers a proven, replicable infrastructure approach — building-integrated for commercial, industrial, and multi-family residential use, and at area scale as an energy hub for districts, industrial clusters, and collective self-consumption or local energy community structures. With the new legal framework for local electricity communities and growing pressure on the grid, a structural market segment is emerging in which buildings and sites become active nodes in the energy supply system.

Serial Renovation in Switzerland: From Pilot Project to Systemic Model

Marc Bätschmann
Tend AG

Multi-family buildings in Switzerland generate over 3 million tonnes of CO_2 per year. Yet this environmental challenge is compounded by a structurally inefficient renovation practice and a set of well-documented barriers: existing business models remain profitable without renovation; building owners lack information and awareness; returns are low without immediate pressure to act; payback periods are long and compete with alternative investments; mid-range locations offer no locational advantage; and complexity — from regulations to the number of parties involved — is high. Technical solutions, know-how, and realised references do, however, exist.

The serial renovation approach overcomes these barriers by treating energy renovation as a standardisable, industrialisable process — modelled on the Dutch Energiesprong concept, with all-in-one solutions, serial prefabrication, and integrated system thinking that together bring down renovation costs.

FROM CUSTOM WORK TO STANDARD PRODUCT

Energy renovation today still relies heavily on manual on-site work. The new approach is built on digitalised, standardised processes and prefabricated building and technical elements, making it possible to achieve a climate-neutral energy standard at socially acceptable cost.

The central shift is from individual case-by-case planning — where every building is a prototype — to a managed care model: instead of property owners coordinating dozens of specialists and tradespeople individually, a one-stop-shop integrates planning, delivery, and operations. A reference example shows cost reductions of around 20%, with higher quality, faster construction, and fewer implementation problems.

From the Energiesprong principle, the approach adopts the goal of a high-quality net-zero renovation that can be delivered cost-neutral for tenants. From an organizational standpoint, a neutral intermediary identifies similar buildings, brings property owners a comprehensive offer, and accompanies them through flat-rate, potentially pre-financed preliminary services up to the investment decision. Key success factors: a free preliminary study, cost savings of 10–20%, and renovation carried out while the building remains occupied.

The Energiesprong model is a digitalised process using prefabricated facade, roof, and building services elements. The target is a net-zero standard; renovation is carried out within weeks in the occupied building and should ideally be cost-neutral for tenants. The model cannot be transferred directly to Switzerland and must be adapted to local requirements — particularly regarding building appearance after facade renovation.

Alongside serial prefabrication, the approach uses cluster formation: groups of property owners developing joint, longer-term renewal strategies for spatially connected energy concepts (as defined by Jakob et al., Energy Research City Zurich 2012). HSLU studies show potential cost savings through economies of scale of up to 20% of investment costs.

The implementation roadmap comprises three distinct phases: (1) detailed analysis and building strategy; (2) execution of the energy renovation as main contractor at a fixed price (heating replacement, photovoltaics, storage, charging infrastructure, building envelope); and (3) operations — monitoring, billing, and performance reporting via a coordinating energy management system. By systematically integrating photovoltaics, heat pumps, storage, and charging infrastructure, the renovated building becomes part of a cross-sector energy system — producing, storing, and managing energy across previously separate sectors.

THE BUSINESS MODEL

The business model consists of the following elements:

- A neutral intermediary identifies similar buildings according to defined criteria.
- It actively connects building owners with a comprehensive renovation offer.

- The intermediary accompanies owners through clearly defined, potentially flat-rate preliminary services to establish the basis for an investment decision. These preliminary services may be financed by the business model itself.
- The owner decides in favour of a net-zero-compatible building renovation.
- The provider manages project delivery with a single point of contact.
- The impact of measures is tracked and documented through collected cost and operational data.
- A new marketplace with all-in-one contractor offers provides affordable housing at net-zero standard.

PILOT PROJECTS

In Stallikon (ZH, 22 units) and Aesch (21 units), energy renovations with photovoltaics, borehole heat exchanger fields, and heat pumps were completed in 2025 under the main contractor model (see Sector Coupling Whitepaper 2025).

These projects tested the one-stop-shop model as an offer for property owners. Implementation made it possible to standardise and significantly streamline processes, while generating further insights into where efficiency potential lies and how it can be realised together with the companies involved.

BENEFITS AND CHALLENGES

The model benefits private, institutional, and public property owners alike. Private owners often lack sufficient capital or prioritise other expenditure, so renovation only happens when the incentive is strong enough. Institutional investors often lack the resources for a holistic approach to energy renovation and the well-founded basis needed for an investment decision.

KEY BENEFITS:

- A single point of contact for property owners
- A comprehensive, all-in-one offer
- Cost and schedule certainty
- Future-proof operations
- Documented economies of scale

The main challenges remain the barriers identified at the outset, together with — specific to the cluster approach — coordination across property boundaries and the different financing logics of private, institutional, and public owners.

INSIGHTS AND SUCCESS FACTORS

Key insights from practice:

- The approach works when collaboration creates financial value for all parties. Ecological benefits alone are not sufficient motivation.
- Realisation often only happens through the involvement of a neutral third party.
- The engagement of institutional investors drops as soon as the project perimeter exceeds their sphere of influence or the decision-making structure becomes too complex for an integrated approach.

Key success factors:

- A central point of contact for property owners.
- Lifecycle optimisation rather than individual measures.
- Standardized combinations of proven products and systems.
- Standardised processes in planning and execution.
- Comprehensive operational monitoring as a basis for oversight and optimisation.
- Prefabrication of as many components as possible.
- Clear allocation of risk to the system integrator

The approach builds on several research projects: ClustSan (SFOE/HSLU, 2020–2023), RENOWAVE (Innosuisse Flagship, 2022–2026), IEA EBC Annex 75, and the Cluster Handbook of Energy Research City Zurich (2018).

REPLICATION POTENTIAL IN SWITZERLAND

The greatest replication potential lies in the multi-family residential stock built during the post-war construction boom. The approach scales to professional and private property owners, cooperatives, and municipalities alike. According to the Building and Housing Statistics (FSO 2022), multi-family buildings account for 27.6% of all buildings but 53.8% of residents — buildings with ten or more units alone house 28.4% of the population, underscoring the scale potential of this segment for Switzerland's energy transition.

Waldegg Sports Facility, Horgen: Solar Heat, Shower Drain Recovery and Local Energy Sharing

Claudio De Giacomi, Manuel Marti
Joulia SA

Changing facilities are often treated as secondary buildings in sports complexes — useful but rarely considered from an energy perspective. The new locker room building at the Waldegg sports facility in Horgen ZH shows that even such structures can serve as showcase projects for sector coupling.

The municipality of Horgen, an Energiestadt with Gold label since 2020, decided in 2022 to build a new facility with a clear ambition: fully cover heating and hot water demand from solar energy, no fossil fuels, no water-based space heating distribution. The building is primarily used by ice hockey club Horgenberg Hammers and FC Horgen — weekday evening training sessions and all-day tournaments at weekends. It has been in operation since 15 May 2025.

ENERGY CONCEPT AND SECTOR COUPLING LOGIC

The energy concept is built on the principle of reduction: as little technical equipment as necessary, as much self-supply as possible. Sector coupling manifests on three levels.

First, solar-thermal coupling: a 183 m² rooftop PV array generates around 28,600 kWh per year, powering an air-source heat pump that charges two central 5,000-litre hot water storage tanks. In winter, the process heat from the tanks radiates outward through the surrounding clay brick enclosure, heating the building from the inside out — like a tiled stove.

Second, wastewater heat recovery: Joulia shower drain heat exchangers recover up to 60% of the residual heat from warm shower wastewater, using it to pre-heat incoming cold water. This sharply reduces the energy demand for showering and smooths peak loads — including during periods of low solar yield.

Third, local electricity sharing: surplus PV power generated particularly during summer and holiday periods is fed into the neighbouring school building for use on-site.

TECHNICAL IMPLEMENTATION

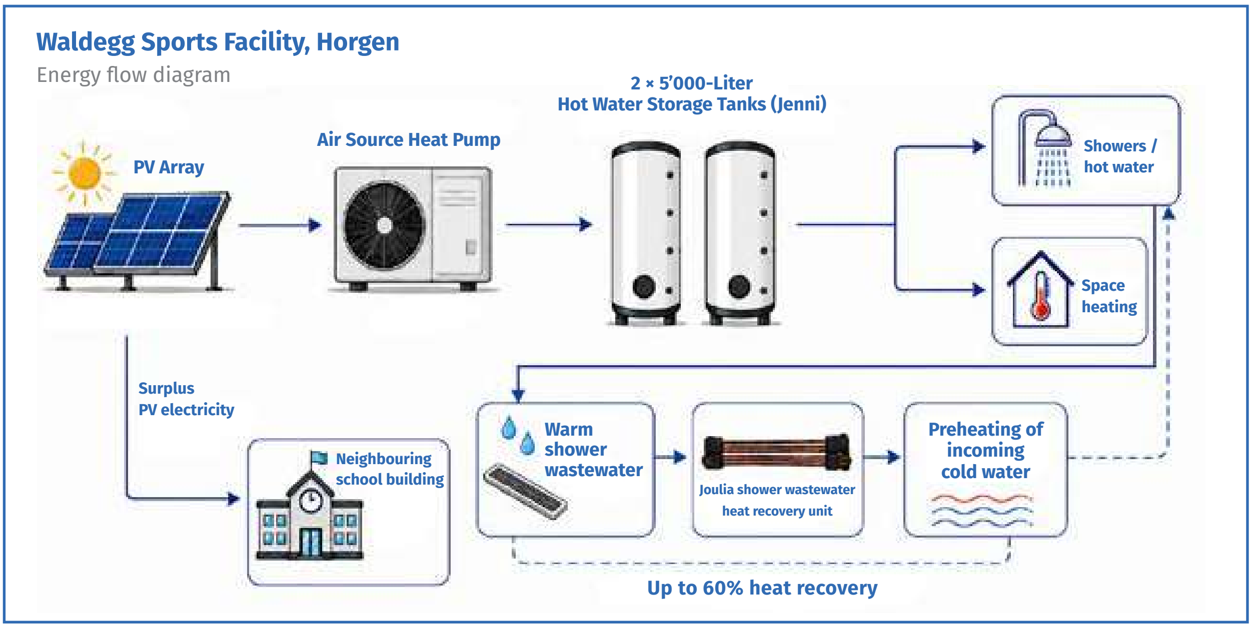
The centrepiece of the system are two Jenni hot water storage tanks (5,000 litres each, 1.2 m diameter, 5 m height), positioned at the core of the building and enclosed in solid clay bricks. This approach merges architecture and energy technology: the clay bricks store heat and release it gradually into the surrounding rooms.

The four group shower rooms are fitted with Joulia shower drain heat exchangers recovering up to 60% of wastewater heat (peak output max. 20 kW). The referee's individual shower uses a smaller inline unit (up to 40% recovery). Two Hoval fresh water stations ensure hygienic drinking hot water. Self-closing thermostatic mixer taps limit shower duration and reduce uncontrolled water consumption.

Four mechanical ventilation units with heat recovery handle the temporarily high humidity

KEY FIGURES

PV array:	183 m², ~ 28,600 kWh/year
Air-source heat pump:	COP 2.8
Hot water storage:	2 × 5,000 litres (Jenni)
Heat recovery showers:	Joulia (up to 60%, max. 20 kW peak)
Joulia drain payback period:	1.2 years
Hot water demand:	approx. 70,000 kWh/year (up to 200 showers/day)
Space heating demand:	approx. 13,000 kWh/year
In operation since:	15 May 2025
Certification:	Minergie (in progress)



after showering. A comprehensive metering infrastructure — PV yield, heat pump output, hot water consumption, ventilation, general electricity, room temperatures — enables ongoing operational optimisation.

LOCATION AND PARTIES INVOLVED

The building sits adjacent to the Waldegg school grounds on the edge of Horgen's settlement area (approx. 25,000 residents, district capital on Lake Zurich). Owner and client is the Properties and Sport department of the municipality of Horgen, which ran an architectural competition won by Hotz Partner AG (Zurich/Wädenswil). Building physics was handled by Wichser Akustik + Bauphysik (Zurich) and sanitary engineering by Josef Moser AG (Cham). The input for shower water heat recovery came from the Canton of Zurich's Office for Waste, Water, Energy and Air (AWEL).

BENEFITS AND CHALLENGES

Changing facilities typically have short periods of intensive use but high energy demand — driven above all by hot shower water. Technical installations are often hidden and their energy consumption rarely optimised. This project demonstrates the opposite approach: with a somewhat higher planning effort upfront, buildings and systems can be optimised so that long-term operating costs are low and external energy demand is minimised.

The main challenge, as with all new integrated systems, is commissioning and fine-tuning the interconnected components — a process still underway.

REPLICATION POTENTIAL IN SWITZERLAND

The need for changing and shower infrastructure is growing across Switzerland: football alone has over 1,337 clubs with 18,043 teams. If consumption data over several seasons confirms the expected savings potential, the Waldegg building can serve as a blueprint for replacement and new builds across the country. The model is transferable to other sports centres, school facilities, and leisure pools with similar usage profiles. ■

Scope level: Area

From January 1, 2026, Switzerland's revised electricity law will enable Local Electricity Communities (LEGs), allowing locally produced solar power to be used on-site or sold directly to nearby consumers. This opens new opportunities for industrial areas, commercial facilities, and mobility providers to improve energy self-sufficiency and reduce grid dependency, often with better returns than traditional feed-in tariffs. The revised legislation fosters a favourable environment for integrated projects that combine rooftop photovoltaic systems, e-charging infrastructure, e-mobility solutions, energy management, and local partnerships between private enterprises and energy distributors

Figure 1: GeHa AG's Hard Areal in Winterthur, comprising 45 households (apartments) and 40 businesses. (Google Earth)

Positive Energy Districts in Practice

Martina Rechsteiner, Pascal Kienast, Matteo Spada, Yousra Sidqi, Tania B. Lopez Garcia, Lucas Truniger, Lona Tulinski, Vicente Carabias, Matthias Haase
ZHAW Zurich University of Applied Sciences, reca@zhaw.ch

Energy supply in urban districts and neighbourhoods is undergoing rapid change. Rising demands for climate protection, security of supply, and economic viability are making local and renewable energy production, energy efficiency, and flexibility into key success factors. Positive Energy Districts (PEDs) offer a comprehensive approach to meeting these demands.

A PED is a district or neighbourhood that produces more energy over the course of a year than it consumes. This is achieved through a combination of renewable energy sources, smart storage, load management, and the sector coupling of electricity, heat, cooling, and mobility. The goal is not only a positive energy balance, but also the active integration of the district into the wider energy system.[1]

A PED is therefore far more than a neighbourhood that generates as much energy as possible. Beyond technical infrastructure, digital systems, economic incentives, regulatory frameworks, and the active participation of local residents all play

a decisive role. The challenge lies in integrating these different elements into a functioning overall system.

An important regulatory development is the introduction of Local Electricity Communities (LECs — in German: *lokale Elektrizitätsgemeinschaften, LEG*) available since January 2026 under Switzerland's revised electricity law. These allow locally generated electricity to be shared within a broader geographic perimeter, opening new possibilities for organising and commercially developing local energy systems.

The Hard Areal in Winterthur offers a particularly interesting setting to study these developments in practice. The site already has a variety of energy generation facilities, a shared organisational structure, and an active user community. At the same time, it faces concrete transformation challenges. As a living lab, it provides ideal conditions for studying new technologies and business models under real-world conditions.

THE HARD AREAL AS A LIVING LAB

The Hard community (GeHa AG) is located on the edge of Winterthur and consists of renovated 19th-century buildings. It is organised as a non-profit, self-governing entity. GeHa AG was founded in 1986 and incorporated renewable energy and ecological thinking into the development of the site from an early stage. In 2026, the community celebrates its 40th anniversary.

The Hard community has its own hydropower plant with a capacity of 525 kW, which feeds electricity directly into the Stadtwerk Winterthur grid at voltage level five. Annual energy output ranges from approximately 2,000 to 3,500 MWh — equivalent to the annual consumption of around 725 households. Heating and domestic hot water needs of approximately 800–900 MWh per year are met by a central gas boiler (450 kW, running on biogas) and a solar thermal system (around 100 m², 10,000-litre storage tank), with heat distributed to individual buildings via a local district heating network. In late 2021, GeHa AG installed a photovoltaic (PV) system (48 kWp) producing approximately 35–45 MWh of electricity per year. Six charging stations for electric vehicles are available in a nearby car park; these can be directly and optimally charged from the PV system using a shared electricity meter and a manufacturer-independent load management system. To measure the site's energy consumption, the majority of households and businesses are connected to smart meters via the regional grid operator.

The site's priorities centre on sustainable heat supply, optimising energy flows and costs, promoting electric mobility, and increasing solar energy use. The decision by the City of Winterthur to phase out its gas network sets the framework for a new heating solution at the Hard Areal. Several options are currently being evaluated; a groundwater heat pump solution has been ruled out due to various technical and site-specific constraints, and the specific solution for future heat supply is still being developed.

The transformation of the site is not solely a technical challenge. Alongside energy-related changes, GeHa AG is also navigating social and technological shifts — including demographic change, heat mitigation measures, and the application of artificial intelligence. Major decisions are made democratically at three to four general assemblies per year, and all members contribute approximately 20 hours of voluntary work annually. This form of communal governance creates a distinctive starting point for implementing change.

It is precisely this combination of technical infrastructure, community governance, and real transformation challenges that makes the Hard Areal a suitable living lab. The three research projects described below examine different aspects of future energy supply at the district level. Together, they demonstrate that sector coupling extends far beyond the technical connection of electricity, heat, cooling, and mobility systems. It also encompasses the digital coordination of installations, the economic organisation of energy flows, appropriate regulatory frameworks, user engagement, and resilience.

PEDVOLUTION: TECHNICAL AND DIGITAL INTEGRATION OF SECTOR-COUPLED ENERGY SYSTEMS

A central prerequisite for a PED is the ability to coordinate different energy sources and consumers. Photovoltaics, hydropower, heat supply, electric mobility, storage, and building consumption are today often operated as separate systems. For optimal use of locally generated energy, however, they must be aligned with one another.

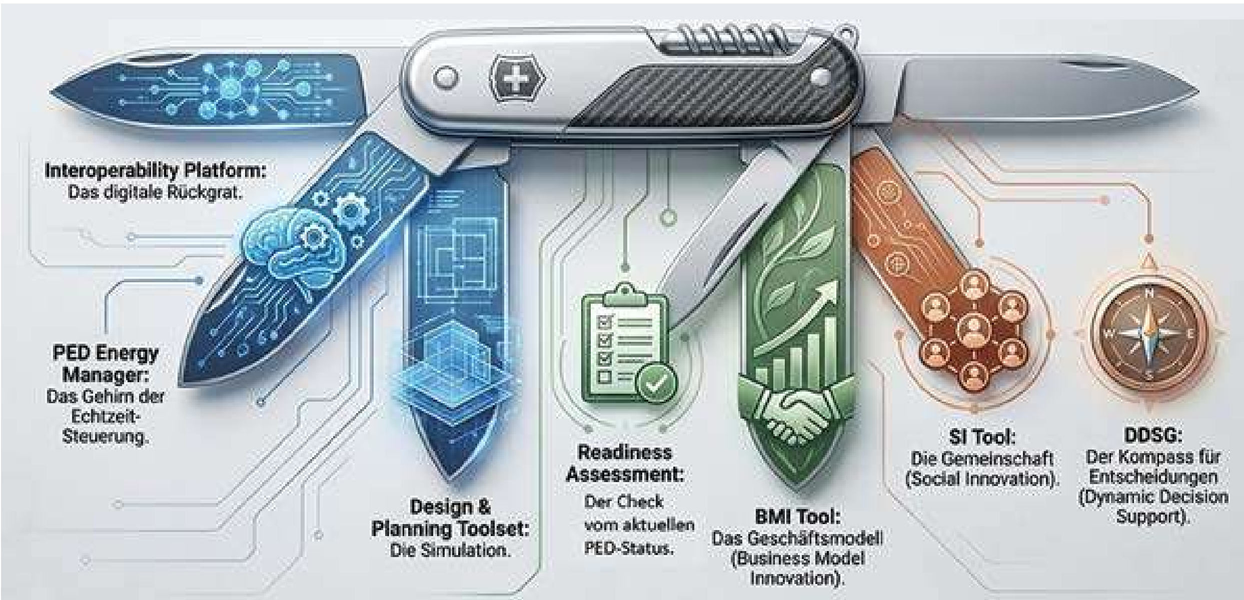


Figure 2: The seven synergetic PEDvolution solutions (Visualisation: Lona Tulinski, created with NotebookLM (Google), 2026).

The Horizon Europe project PEDvolution[2] is developing seven interconnected solutions to continuously advance and scale PEDs. An overview is shown in Figure 2. All seven PEDvolution tools are conceptually ready and technically in the feedback loop of the development phase, but do not yet substantially influence site operations. At the Hard Areal, the current focus is on capturing baseline data, measuring performance, and digitally connecting the existing energy systems. In parallel, strategic work is underway on the gas phase-out, PV and grid expansion, and the site's future development.

Digital integration via an "Interoperability Platform" creates the foundation for operational and strategic sector coupling. This enables generation and consumption within the PEDs to be recorded and, in future, coordinated more efficiently. What matters is not only the technical connection of individual systems, but their integration into an overall system and its continued development. The platform aggregates data from the site's existing energy sources (hydropower, photovoltaics, solar thermal) and consumers (gas heating, commercial and residential use, and electric mobility).

PED READINESS ASSESSMENT: WHERE DOES A DISTRICT STAND ON ITS PATH TO BECOMING A PED?

One important instrument developed by ZHAW within the project is the PED Readiness Assessment (PED RA). It evaluates not only whether a district meets the technical prerequisites for a PED, but assesses its overall state of development. Four dimensions are taken into account: Technology, Market, Social, and Interoperability. This approach captures not only technical con-

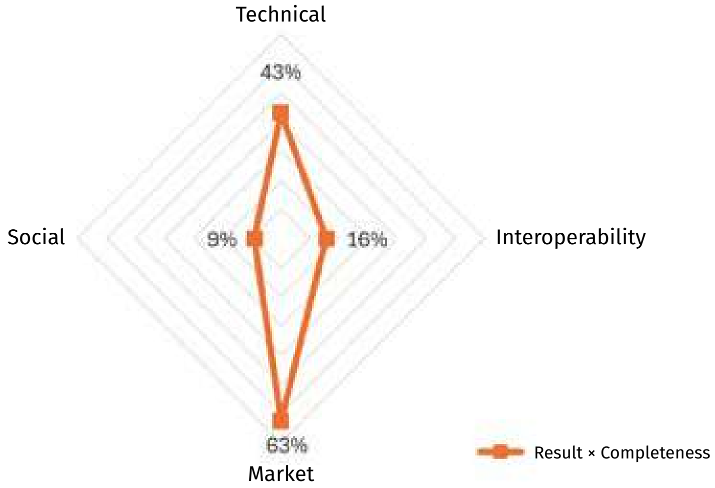


Figure 3: Radar chart showing the four dimensions of the PED Readiness Assessment, developed by ZHAW (2026).

ditions but also the economic, social, and digital aspects of PED development.

The PED RA thus serves as a strategic tool for identifying a district's strengths and gaps and deriving concrete development pathways. At the same time, it creates a shared assessment framework for different actors — such as municipalities, energy utilities, planners, and property owners — establishing a common language for evaluating the conditions for PED development and scaling.

PEDvolution demonstrates how the technical and digital integration of sector-coupled energy systems can be implemented. This holistic view is crucial in practice. A district may, for example, have high potential for renewable energy production while simultaneously failing due to missing business models, insufficient acceptance, or incompatible data systems. The PED RA makes such gaps visible and shows where targeted action can be taken.

POSITIVE ENERGY DISTRICTS DRIVEN BY CITIZENS: HOW DO LOCAL ELECTRICITY COMMUNITIES WORK ECONOMICALLY, REGULATORILY, AND ORGANISATIONALLY?

The technical ability to generate energy locally and share it within a community does not automatically make a Local Electricity Community (LEC) attractive for all parties involved. For the long-term implementation of Positive Energy Districts, a central question arises: how must local energy systems be organised so that investments pay off, generated electricity is used as efficiently as possible, and different actors can derive concrete benefits?

The Driving Urban Transitions project PERSIST[3] examines how Positive Energy Districts can be designed to be economically viable, resilient, and socially accepted. A key focus is on the active involvement of local actors and the development of practical decision-making tools.

GRIDLY: SIMULATING LOCAL ENERGY SYSTEMS INTERACTIVELY

The Lucerne University of Applied Sciences and Arts (HSLU), in collaboration with various practice partners including the City of Winterthur, has developed the simulation tool Gridly. It models local electricity markets created by LECs and makes visible how tariff structures, community composition, and flexibility determine economic viability. Tariff structures, LEC composition, the availability of different technologies, and members' willingness to engage in flexible demand management are all taken into account.

Gridly enables interactive simulation of various scenarios and can be adapted to the needs of dif-

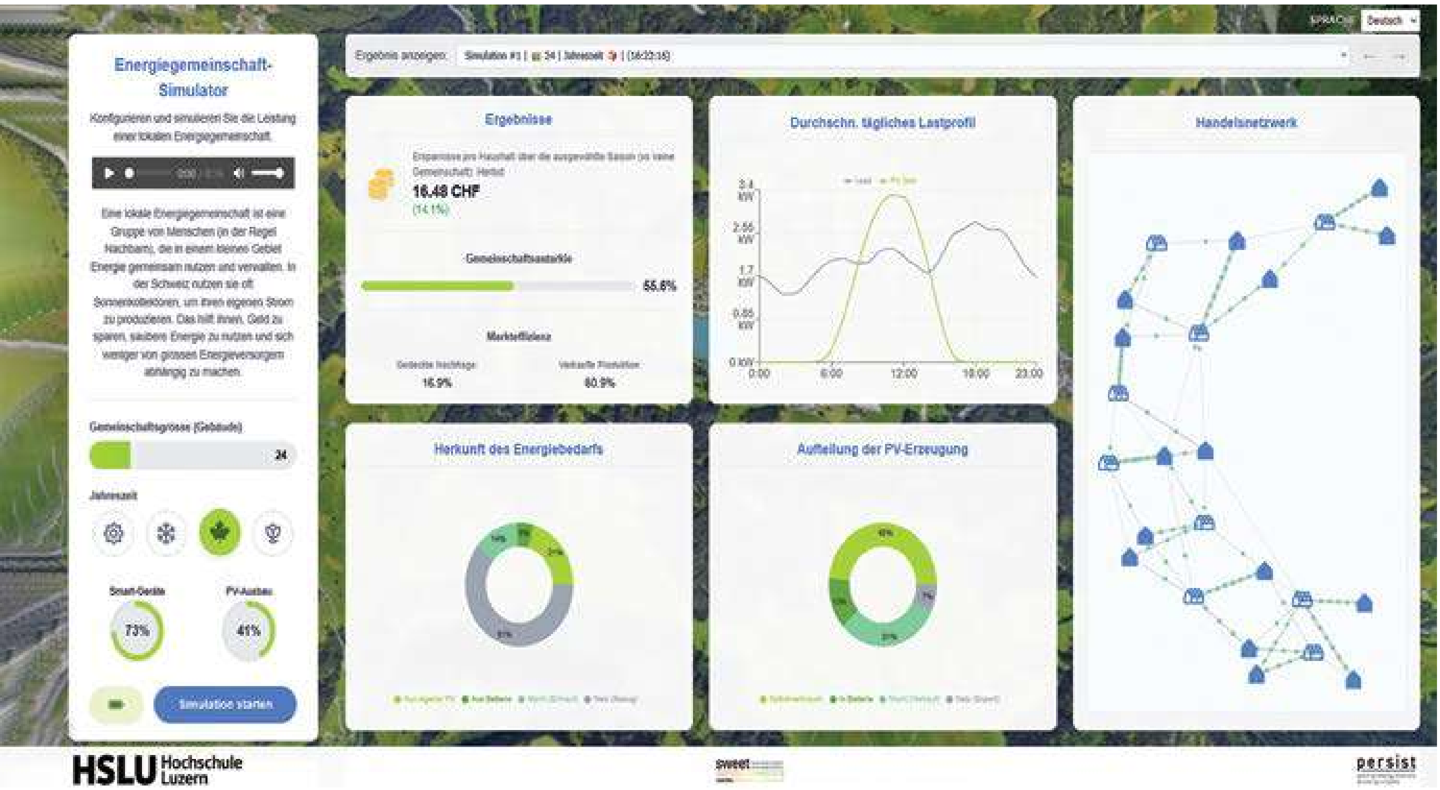


Figure 4: Screenshot of the Gridly tool (first version).

ferent user groups. As such, the tool is designed not only for specialists, but can also be used by residents, planners, and other stakeholders.

Gridly pursues two goals: making the functioning and benefits of different LEC configurations understandable and enabling their quantitative assessment. At the same time, it supports dialogue between LECs and distribution grid operators by showing how local energy communities can be structured to benefit both their members and the electricity grid, while treating the LEC as part of the broader energy system.

SECTOR COUPLING AT THE LOCAL LEVEL

Gridly illustrates how sector coupling can also be approached economically and organisationally at the local level. The simulation captures the interplay of photovoltaics, battery storage, smart appliances, and flexible demand within a shared electricity infrastructure.

This is particularly clear in the context of electrifying heat supply. When fossil heating systems are replaced by heat pumps, for example, local electricity demand increases — particularly in winter. This changes the load profiles of a district. With Gridly, it is possible to examine how such changes affect local electricity supply, self-consumption, energy exchange within the LEC, and electricity costs.

A key prerequisite for implementing sector coupling emerges: individual technologies must not only be technically available, but also economically and organisationally coordinated in a meaningful way. Tariff design and members' behaviour play just as important a role as technical equipment. Gridly therefore connects the technical logic of sector coupling with the economic and regulatory conditions necessary for its operation.

LOCAL ELECTRICITY TRADING AND FAIRNESS

Gridly also addresses the question of how locally generated electricity is distributed within a community. The model uses a maximum-flow optimisation algorithm that maximises the volume of locally traded electricity. At the same time, fairness conditions are incorporated to ensure that the benefits of the local electricity market do not accrue disproportionately to individual members.

This distinction is relevant to the practical design of LECs. Pure technical optimisation could lead to individual members handling a disproportionately large share of local electricity trading, while others barely benefit. The fairness conditions ensure that benefits are distributed more broadly across the community.

Figure 5 compares electricity trading in an LEC with and without fairness criteria. The hypothetical scenario assumes that 25% of members have their own PV systems (using synthetic PV profiles), while real load data from the Hard community are incorporated. The upper part of Figure 5 shows that the assumed PV generation in this case is insufficient to cover the bulk of the community's electricity demand. As a result, the upper chart shows little difference between the cases with and without fairness conditions, since most members must draw electricity from the grid anyway. The lower chart is particularly striking: without fairness conditions, a small number of users sell their entire seasonal output to the LEC, while many others sell almost nothing. With fairness conditions, most members sell approximately 30 to 50% of their PV output.

FLEXIBILITY AS A KEY FACTOR

Another central finding concerns the flexibility of consumption. Photovoltaic generation occurs primarily during the day, while part of electricity consumption falls at other times. If certain consumers can be shifted in time, a larger share of locally generated electricity can be used directly within the community.

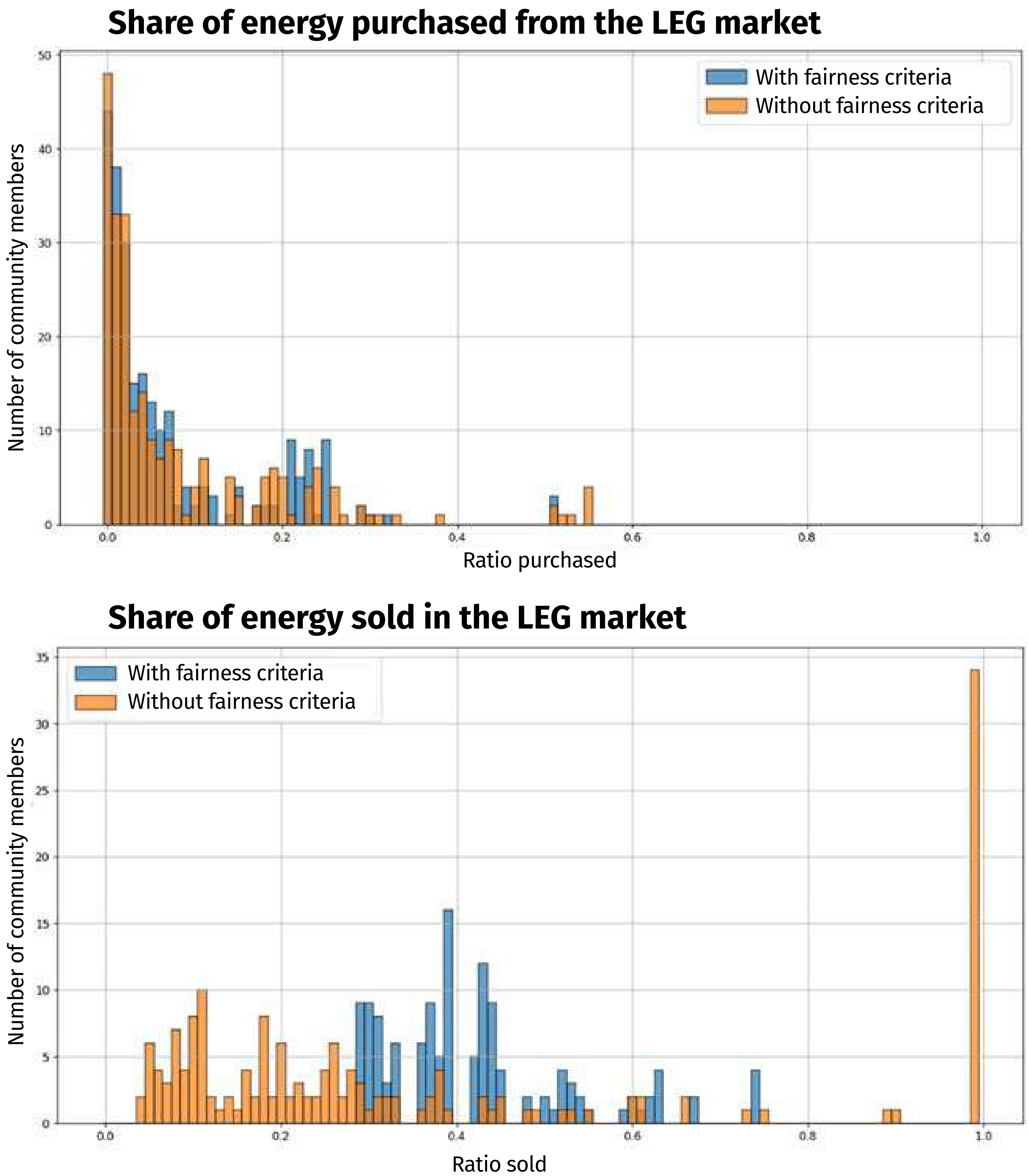


Figure 5: Comparison of the maximum-flow algorithm with and without fairness constraints.

The analyses show that the optimal configuration of an LEC depends less on its size than on its composition — particularly the share of members with their own PV systems and the level of available flexibility. In the case of the Hard community, the highest self-supply rate was achieved with a configuration in which around 30% of members have a PV system. Even under conservative assumptions, the importance of flexibility is evident: even when only simple household appliances such as washing machines are initially considered, the ability to shift consumption over time proves to be the second most important factor.

Three central factors for the efficient operation of an LEC can be derived from this:

- Community composition: What types of buildings are involved (e.g. residential, schools, offices, hospitals)? How many are equipped with PV systems?
- Cost allocation and electricity pricing: How are costs and electricity compensation divided among members?
- Available resources and members' willingness to provide flexibility.

PERSIST demonstrates that a local energy system does not succeed through available technologies alone. What matters is the interplay of technology, economic incentives, flexibility, and participation. PERSIST thereby complements the technical and digital perspective of PEDvolution with the question of how sector-coupled energy systems can be organised, used, and sustained by the actors involved.

UPCHANGE: RESILIENCE ASSESSMENT FOR BUILDINGS AND DISTRICTS IN SECTOR-COUPLED ENERGY SYSTEMS

The transformation of energy supply brings not only new opportunities but also new dependencies. The more tightly electricity, heat, cooling, mobility, storage, and digital control are coupled, the more a disruption in one area can affect others.

UPCHANGE[4] develops innovative solutions for Positive Energy Buildings and Districts. A key focus is on assessing the resilience of buildings and districts against events such as extreme weather, power outages, or technical failures. This section focuses on the resilience assessment framework, which examines how buildings and districts in

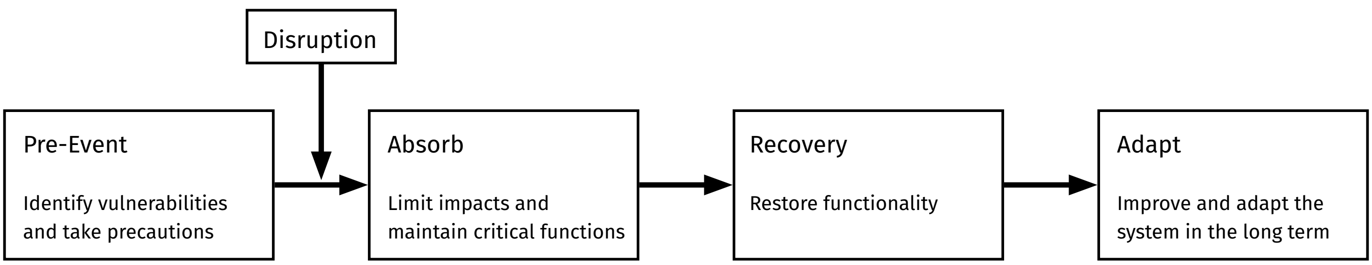


Figure 6: Phase-based structure of the resilience assessment framework, with the four complementary phases of Pre-Event, Absorb, Recovery, and Adapt (adapted from National Research Council. (2012). Disaster Resilience: A National Imperative. National Academies Press.).

sector-coupled systems respond to disruptive events and how interactions between electricity, heat, cooling, storage, ICT-based control, and operational strategies can be taken into account.

MAKING RESILIENCE MEASURABLE

The UPCHANGE resilience assessment framework considers four phases: Pre-Event, Absorb, Recovery, and Adapt (Figure 6). It evaluates how

Table 1: Selected KPIs of the resilience assessment framework

KPI	Resilience Phase	What the KPI Describes
Peak Load vs. Capacity	Pre-Event	Assesses whether available capacity is adequate relative to peak demand. At building level, this may refer to local heating, cooling, or electrical capacity; at district level, to district heating/cooling production or grid capacity.
Diversity of Supply Mix	Pre-Event	Measures the degree of diversification of the energy mix. Greater diversity indicates lower dependence on a single source and potentially higher redundancy.
Storage Coverage	Pre-Event	Indicates how long critical demand could be supported by available storage or buffer capacity.
SET-hours / Hours of Exceedance	Absorb	Measures how long indoor conditions exceed acceptable comfort or safety thresholds during a disruption. At district level, values can be aggregated across buildings.
Degree Hours	Absorb	Captures both the duration and intensity of thermal discomfort or threshold exceedances.
Passive Survivability	Absorb	Assesses how long a building can maintain acceptable or safe indoor conditions without active systems or external supply. At district level, results can be reported using statistical building-level indicators.
Energy Not Served	Absorb	Quantifies the amount of energy that cannot be delivered during a disruption. At district level, this can represent total unmet demand across the grid or portfolio.
Device Availability	Absorb	Measures the operational availability of critical components or subsystems — e.g. heat pumps, pumps, controllers, or grid components.
Supply-Demand Gap	Absorb	Describes the discrepancy between required and delivered energy services. Can be used to identify moments or periods of insufficient supply.
Recovery Time	Recovery	Measures how quickly the system restores acceptable service levels after a disruption.
Mean Time to Repair	Recovery	Describes the average duration of failure events for relevant components or subsystems.
Ramp-up Gradient	Recovery	Captures the speed at which service or system performance is restored.
Network Reconfiguration Time	Adapt	Measures the time required to restore supply by reconfiguring a district heating or cooling network.
Flexibility Index	Adapt	Measures the system's ability to shift, reduce, or adjust demand and supply while respecting defined constraints.
Future Climate Robustness	Adapt	Assesses how stable system performance remains under future climate conditions or more extreme weather scenarios.

well a system is prepared for a disruption, how significantly its performance is impaired during an event, how quickly it recovers, and how well it adapts to changed conditions over the long term.

Various key performance indicators (KPIs) are used for assessment. They make different aspects of resilience measurable and enable comparisons between disruption scenarios and possible technical and operational measures. A selection of KPIs is summarised in Table 1.

The individual KPIs are then combined into an overall assessment. Different priorities can be taken into account: for a building, thermal comfort during a heatwave may be especially important, while for a critical district system, security of supply or rapid recovery may be weighted more heavily. It is also possible to test how stable the assessment is under different weightings.

The central value of the framework lies in making resilience measurable, comparable, and transparent. In the use case, a lower resilience score indicates that the building is more severely affected under a given disruption scenario — for example in terms of thermal comfort, unmet energy demand, or recovery time. Comparing scenarios is particularly useful: if a heatwave leads to a significantly lower score than a short HVAC outage, critical vulnerabilities and priority areas for action become visible. The main challenges lie in the availability of suitable data, the quality of building and district models, and the interpretation of aggregated scores, which should always be read alongside the underlying KPIs, assumptions, and uncertainties.

APPLICATION EXAMPLE: RESILIENCE OF A REFERENCE BUILDING

A multi-storey reference apartment building was considered as an application example, featuring multiple residential units, shared circulation areas, and a small office zone on the ground floor. The model accounts for residential use, internal loads, infiltration, domestic hot water demand, and zone-specific heating and cooling systems — making it suitable for assessing energy demand, thermal comfort, and resilience at the building level.

The example focuses on the building's response to a seven-day heatwave in early July 2026, in which outdoor temperature was raised by +10 °C above the seasonal average. This scenario is particularly relevant, as heatwaves intensify critical indoor conditions, place additional strain on cooling systems, and test a building's ability to maintain thermal comfort under extreme conditions for as long as possible. Additional disruptive scenarios were also analysed: a cold spell in October 2025 (−15 °C), a one-day power outage, and a two-hour HVAC failure. The resulting resilience scores are shown in Figure 7.

The results show that all disruption scenarios reduce the resilience score compared to normal operation, with the steepest decline occurring under the heatwave. This indicates that the building is particularly sensitive to high temperatures and highlights potential areas for action — such as passive cooling, shading, storage capacity, or adapted control strategies. The uncertainty ranges show how strongly the overall assessment depends on the chosen priorities: depending on whether thermal comfort, security of supply, or rapid recovery is weighted more heavily, the overall score can change. The example clearly illustrates how the framework can accom-

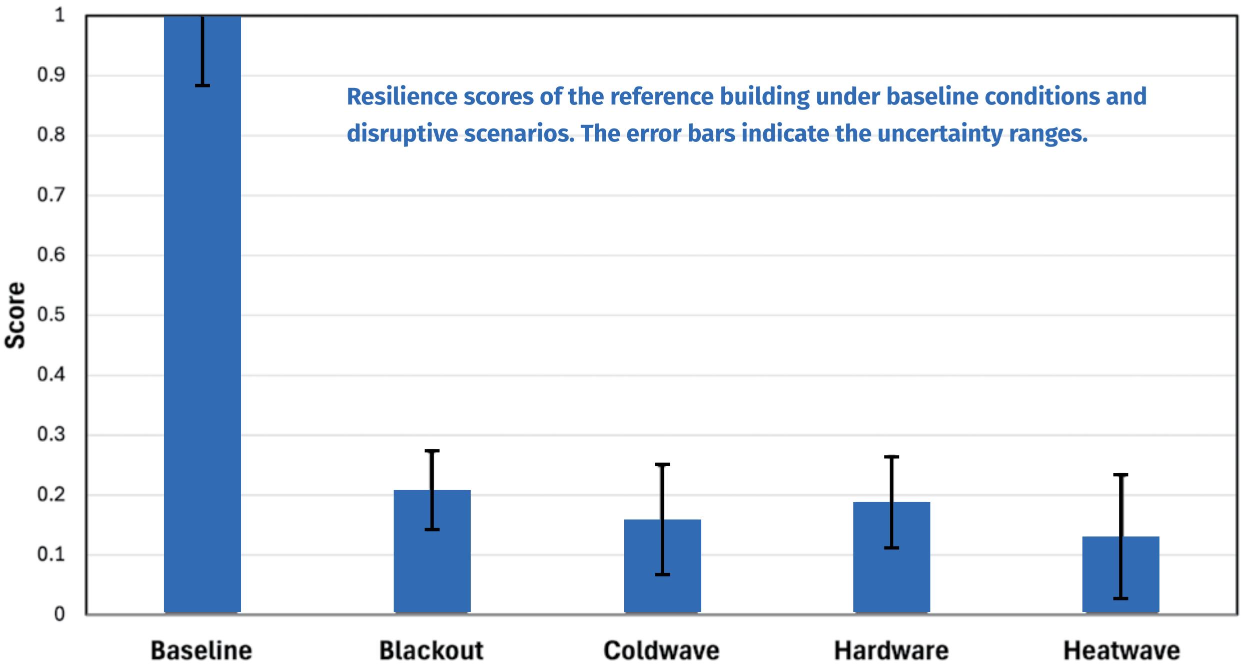


Figure 7: Resilience scores of the reference building under normal operation and various disruptive scenarios. Error bars indicate the uncertainty ranges[5].

modate different perspectives while simultaneously identifying concrete areas for improvement.

This same logic is then to be applied at the district and PED level. At the Hard Areal in Winterthur, the interactions between buildings, shared networks, local energy generation, storage, and ICT-based control can additionally be taken into account. UP-CHANGE thereby complements the technical and digital integration of PEDvolution and the economic and organisational perspective of PERSIST with a further central dimension: the resilience of the overall system.

The three research projects highlight different aspects of the transition to Positive Energy Districts, showing that it requires the integration of technology, digital solutions, economic and organisational structures, and resilience. As a living lab, the Hard Areal provides an opportunity to bring these perspectives together and test them in practice.

The international research community is working closely together to optimise the sector coupling of electricity, heat, cooling, and mobility so that the developed solutions can be deployed in the context of Positive Energy Districts. ZHAW supports these efforts as a Swiss research partner, accompanying applied research and development in demonstration projects in the city of Winterthur with case studies.

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Herisau: Thermal Network as a Flexible Energy System – Waste Heat, Borehole Storage and Cross-Sector Control

Maike Schubert, Philipp Erdmann
Weisskopf Partner GmbH

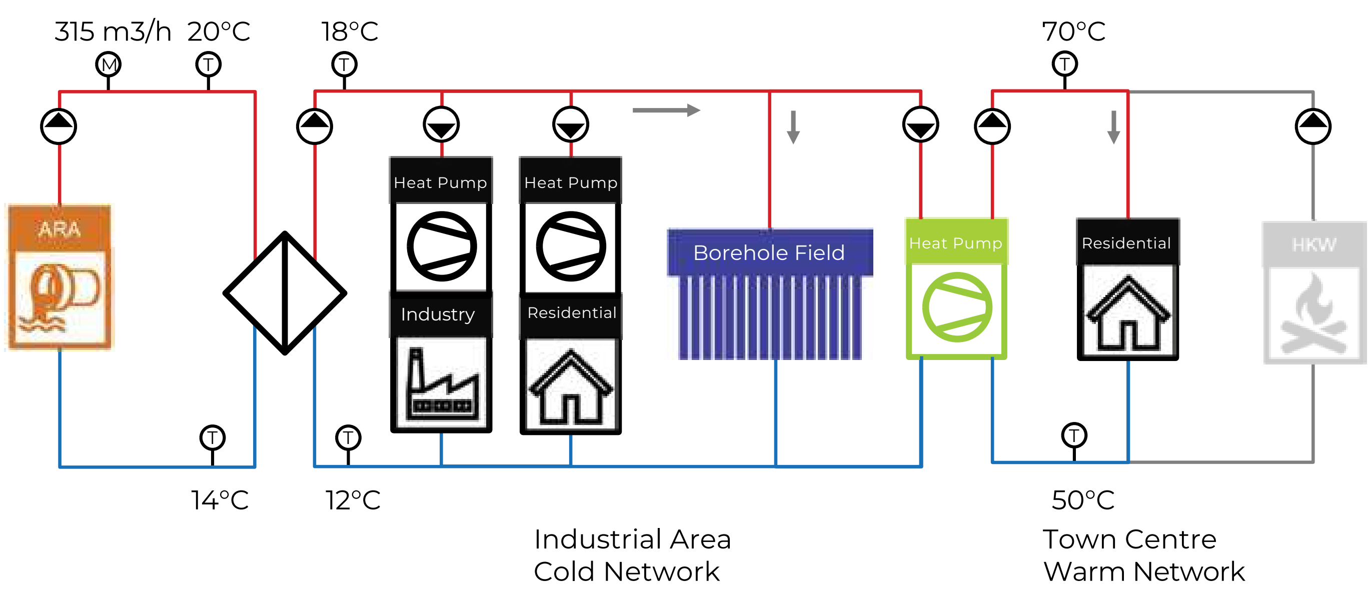
The municipality of Herisau covers its annual heat demand of around 261 GWh largely through gas and oil heating — over 220 GWh from fossil sources. SAK (St. Gallisch-Appenzellische Kraftwerke AG), together with the municipality, is developing a thermal network to replace this step by step. The result is more than a conventional district heating solution: the system is designed from the outset as a flexible, sector-coupled energy system that can actively respond to electricity prices, grid signals and seasonal storage states.

The feasibility study has been completed and technical viability confirmed. The project is now in the preliminary planning phase (Vorprojekt).

ENERGY CONCEPT AND SECTOR COUPLING LOGIC

The concept is built around a dual-network structure: a low-temperature anergy network serves the area around the wastewater treatment plant (ARA) and the Bachwis industrial zone; a high-temperature network supplies the town centre and the station area. The two networks are linked by a central

SUMMER OPERATION



heat pump station at Ebnet, which lifts the temperature from low to high level. Decentralised heat pumps at individual consumers on the anergy network perform the same function locally.

Sector coupling arises through the heat pumps as the bridge between the electricity and heat sectors. Thermal networks are typically operated heat-led — but the thermal inertia of buffer storage, seasonal storage and distribution creates significant flexibility potential. The heat pumps can be run precisely when electricity is cheap or PV surpluses are available, and throttled back during peak demand. In summer, surplus ARA waste heat regenerates the borehole field — effectively transferring that heat into winter, where the higher storage temperature makes heat pump operation more efficient and keeps ARA waste heat available on demand.

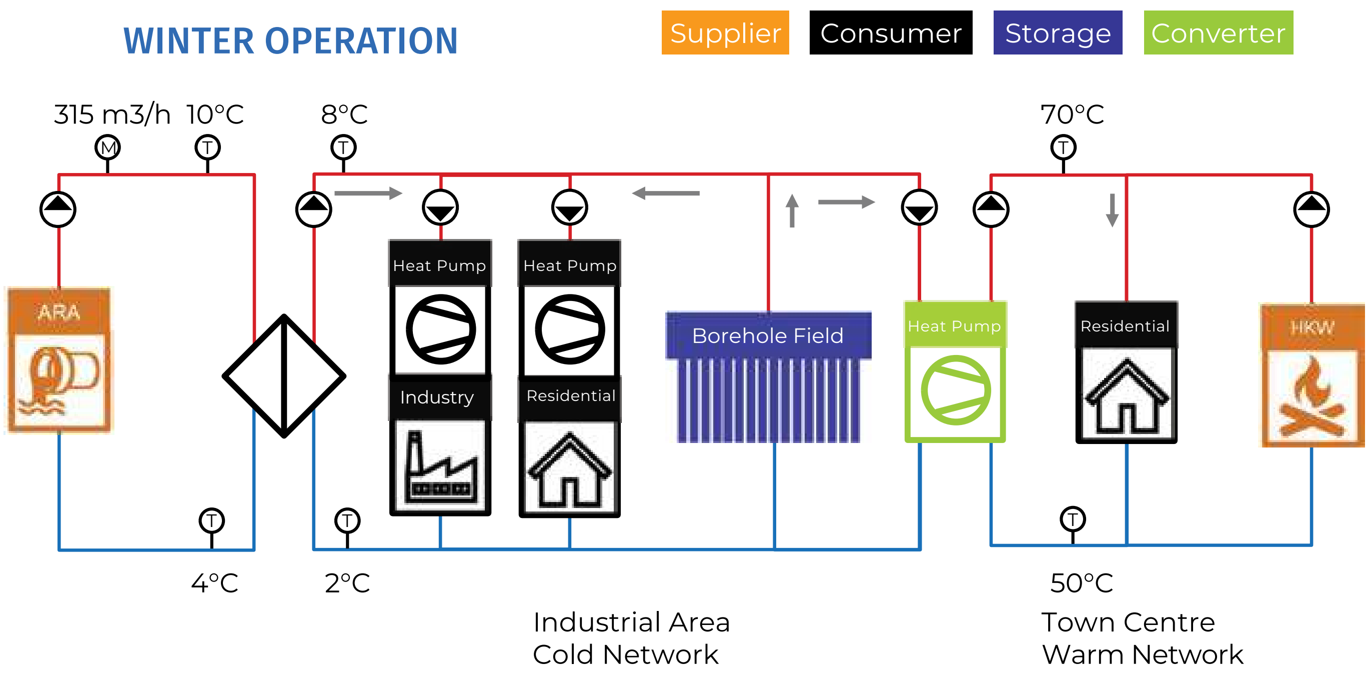
TECHNICAL IMPLEMENTATION

The Herisau ARA provides 19.3 GWh/a of waste heat, extracted via two heat exchangers of 800 kW each. The central Ebnet heat pump station (2.5 MWel) connects the two networks; decentralised heat pumps (approx. 1.5 MWel) raise the temperature level at consumers on the anergy network. The Nordhalde wood heating plant (12.9 GWh/a) covers winter peak loads. The borehole field acts as a seasonal thermal store with a capacity of around 12 GWh; the feasibility study analysed variants with 317 and 401 boreholes at depths of 300–400 m. Technical buffer storage at the heat pump station (approx. 3 MWh) and the wood heating plant (approx. 1.5 MWh) complement the system. In summer, the anergy network can also provide cooling (demand: 500 MWh/a).

LOCATION AND PARTIES INVOLVED

Herisau offers a distinctive combination of high heat density in the centre, industrial waste heat potential in the ARA/Bachwis area and suitable sites for central plant and storage. The proximity of the ARA, industrial zone, area and Ebnet enables a technically coherent system architecture. Data centres planned for the area could bring additional waste heat and cooling potential in the future.

WINTER OPERATION



KEY FIGURES

Heat demand:	ARA/Industry: 14.6 GWh/a | Centre: 28 GWh/a
Cooling demand:	500 MWh/a
Heat sources:	ARA waste heat 19.3 GWh/a | Heat pump station 15.1 GWh/a | Wood heating 12.9 GWh/a
Installed electrical capacity:	Heat pump station 2.5 MWel | Decentralised heat pumps approx. 1.5 MWel
Seasonal storage:	Borehole field approx. 12 GWh thermal
Buffer storage:	Heat pump station approx. 3 MWh | Wood heating plant approx. 1.5 MWh
CAPEX:	CHF 39 million
CO_2 savings:	approx. 40,000–50,000 t CO_2/year (estimate: 220 GWh fossil heat × standard gas/oil conversion factors; not yet confirmed by project team)
Project status:	Preliminary planning phase (feasibility study completed)

Planning constraints include existing utility corridors, the national road, potential contaminated sites and permit procedures; synergies exist with ongoing infrastructure projects for routing and cycling infrastructure. SAK is the central actor as contractor, client and future operator. The municipality of Herisau is the initiating public body. Weisskopf Partner GmbH led the feasibility study and is responsible for HVAC planning, electricity grid expertise and flexibility integration; Sollberger Ingenieure GmbH handles MSRL planning and the network control system.

BENEFITS, CHALLENGES AND REPLICATION POTENTIAL

The core value lies in combining decarbonisation with flexibility. Replacing fossil heat with ARA waste heat, geothermal energy and biomass substantially reduces CO_2 emissions from the heat sector. At the same time, the system can respond to variable electricity prices through demand-side management via the heat pumps, smooth PV surpluses in summer and relieve pressure on the grid during high-demand periods. Seasonal storage in the borehole field transfers summer ARA heat into the heating season when it is needed most.

Challenges lie in the high capital investment, multi-actor coordination and planning constraints. Evolving regulatory frameworks for electricity flexibility markets are a planning variable with open-ended development — but they must be anticipated early so that the necessary interfaces are built into the network from the start.

The replication potential lies not in copying the technical design but in the methodology: identify local waste heat sources, choose the right network structure, integrate storage from the outset, and treat flexibility as a design parameter — not a retrofit option. This approach applies to many Swiss municipalities with high heat density and available waste heat sources.

Sustainable Ground Source Heat: Regenerating Geothermal Probes with PVT Hybrid Collectors

Timon Wanzenried
B-Solartec AG

Ground source heat probes (GSHP) use the thermal energy stored in the ground to provide heating and hot water. Combined with a heat pump, they operate very efficiently, require little space, and can even provide passive cooling in summer. Geothermal probes are considered renewable, environmentally friendly, CO_2-free and sustainable — and almost inexhaustible.

But are they truly inexhaustible?
While the Earth's core holds enormous heat, the geothermal flux reaching the surface is around 250 times smaller than the heat extracted by an active probe over time. Without countermeasures, the ground gradually and continuously cools.

Probes are designed today so that ground temperature does not fall below -1.5 °C after 50 years of operation. But what happens after that? And what happens when an increasing number of probes are installed close together in the same neighbourhood?

This is exactly what is being observed in Switzerland. The number of boreholes has been growing steadily. The expansion is energy-politically sound and an important step for the energy transition — but in densely populated areas, installations are increasingly competing for the same ground. Specialists already speak of density stress: neighbouring probes influence each other and accelerate ground cooling.

To keep geothermal probes sustainable over the long term, heat must be regularly returned to the ground. This process is called probe regeneration. The goal is to restore extracted energy to the subsoil and stabilise the temperature of the heat source over time. Several heat sources are available for regeneration.

Heat from the environment:

- PVT hybrid solar collectors
- Thermal solar panels
- Outdoor air heat exchangers

Heat from the building:

- Passive building cooling (GeoCooling)
- Waste heat from air conditioning, ventilation, server rooms or other technical installations

SECTOR COUPLING IN A SINGLE COMPONENT

Both roof space and surrounding area are increasingly scarce. Rooftops today are typically already used for photovoltaic installations, while outdoor space is often unavailable for additional technical equipment — whether for design, economic, or planning reasons.

This is why multi-function solutions are in demand. B-Solartec AG works with PVT hybrid collectors that meet exactly this requirement: they generate electricity and heat simultaneously. The electricity is used directly or fed into the grid; the heat serves to regenerate the geothermal probes. No additional roof or open space is needed for separate thermal collectors or other regeneration systems.

In fact, PVT modules can increase the total energy yield of a roof surface — electricity and usable heat combined — by more than a factor of three compared to a conventional PV-only installation. While standard PV modules convert around 20% of incoming solar energy into electricity, PVT modules achieve an overall efficiency of around 80 to 90% through the additional heat capture.

On the front, PVT modules work like conventional PV modules. On the back, an absorber captures additional heat from solar radiation and ambient air.

This heat is particularly well suited for geothermal regeneration, as it is available at a comparatively low temperature level. Most regeneration occurs in summer, when surplus heat is available. A purpose-developed control system allows heat to be fed into the ground during other seasons as well. A further advantage: during the heating sea-

son, the cold fluid returning from the heat pump to the probe can be routed first through the PVT modules, where it is pre-warmed before re-entering the ground. This reduces heat extraction from the soil and protects the probe.

BENEFITS OF AN ACTIVELY REGENERATED PROBE

Active regeneration brings both technical and economic advantages:

- Higher ground temperatures improve heat pump efficiency and reduce operating costs.
- Probe performance is maintained beyond the 50-year design horizon.
- Sustainable use of the subsoil is secured over the long term.
- Depending on the project, boreholes can be shorter or installed at smaller spacing.
- The combination of heating, cooling, power generation and regeneration increases the overall value of the energy system.

PROJECT EXAMPLES

Wil, Untere Bahnhofstrasse — mixed commercial and residential new build (flat roof, extensive green covering): 386 hybrid collectors, 164 kWp electrical / 376 kWp thermal; 18 probes at 250 m depth; approx. 75% regeneration rate.

Winterthur, Hündlerstrasse — residential development, existing building (pitched roof, retrofitted): 249 hybrid collectors, 107 kWp electrical / 244 kWp thermal; 13 probes; approx. 85% regeneration.

Villa Küssnacht — residential building (in-roof installation): 38 hybrid collectors, 12.7 kWp electrical / 28.5 kWp thermal; 30% reduction in probe length.

CONCLUSION

Geothermal probes are an important building block of the energy transition. To retain their advantages over many decades, they must be treated as energy storage systems and regenerated regularly. PVT hybrid collectors combine power generation and heat return in a single system — a key contribution to the long-term sustainable use of geothermal energy.

Waste Heat-Driven Cooling for Data Centres and Industry

Silvan Suter
Thermal Transformer AG

BACKGROUND & MOTIVATION

Electricity demand for cooling is growing rapidly. In 2024, data centres in Switzerland consumed around 2.1 TWh of electricity, equivalent to approximately 3.6% of total national consumption; a study commissioned by EnergySwitzerland (SFOE) projects an increase to 2.5–3.2 TWh by 2030. A large share of this is attributable to cooling of server infrastructure. At the same time, data centres continuously generate waste heat — for example from liquid cooling of modern GPU racks — which Thermal Transformer AG's technology can use on-site to cool the remaining IT infrastructure, rather than drawing additional electricity: the data centre's own waste heat thus drives its own cooling. A second, independent application concerns industry: in gas compression plants, a large share of process heat is lost as unused waste heat, which can likewise be used for cooling. Thermal Transformer AG is developing an adsorption chiller for both applications that converts low-temperature waste heat directly into cooling output, largely replacing electrically powered chillers.

ENERGY CONCEPT & SECTOR COUPLING LOGIC

The chiller couples the heat and electricity sectors by using thermal energy — waste heat from 45 °C — as the driving energy for cooling production instead of electricity. Rather than dissipating waste heat unused or feeding it into a district heating network, it is converted directly on-site into cooling and covers the cooling needs of IT infrastructure or industrial processes. This reduces electricity consumption for cooling by up to 30% in data centres and lowers the energy demand of gas compression plants by up to 15%, relieving local electricity grids and closing the heat-cooling cycle directly on site.

TECHNICAL COMPONENTS

Unlike a conventional electrically powered chiller, an adsorption chiller requires no electricity-driven compressor. Instead, a special material — a so-called sorbent — is alternately loaded and unloaded: as the material adsorbs water vapour, cooling is generated; when it is subsequently “dried” again with heat, it is ready for the next cycle. Thermal Transformer AG has developed a novel, particularly rapid coating technology for this process (Rapid Thermal Swing Adsorption, RTSA), which enables efficient cooling production from comparatively low waste heat from 45 °C — significantly lower than existing market systems. The result is a compact chiller with 100–200 kW of cooling capacity that uses water as its refrigerant, avoids climate-damaging refrigerants, and opens up a broad spectrum of waste heat sources thanks to its low driving temperature.

LOCATION & FRAMEWORK CONDITIONS

The project is anchored in eastern Switzerland: Thermal Transformer AG is headquartered in Pfäffikon SZ, Konvekta AG (heat exchanger manufacturing) in St. Gallen, and Burckhardt Compression AG (industrial validation) in Winterthur. Target markets also include European data centre sites, where high rack power densities and grid bottlenecks make the need for waste heat-driven cooling particularly acute.

Burckhardt Compression AG

PARTNERS INVOLVED

The consortium combines research and industry: SPF-OST – Eastern Switzerland University of Applied Sciences (system design, vacuum technology) and HEIG-VD - School of Engineering and Management of the Canton of Vaud (evaporator/condenser design) as research partners; Thermal Transformer AG (sys-

KEY FIGURES & KPIs

Cooling capacity	100 kW (45 °C drive, data centres) / 200 kW (75 °C, industry)
Drive heat	200 kW from 45 °C – lowest drive temperature available on the market
System volume	5 m³
Electricity reduction	up to 30% (data centres) / up to 15% (industry)
CO_2 savings	approx. 42 t/year per 100 kW unit
TCO reduction (data centres)	51% over 10 years
TCO reduction (industry)	84% over 20 years

tem integration, coating technology, project management), Konvekta AG (heat exchanger manufacturing), and Burckhardt Compression AG (industrial integration and distribution) as implementation partners.

CURRENT STATUS

The project is being implemented as an Innosuisse innovation project. The aim is to advance the RTSA technology from early laboratory stage to industrial demonstration. To this end, a 10 kW demonstrator will first be built and characterised at SPF-OST in Rapperswil, before being operated and validated on Burckhardt Compression's industrial test field in Winterthur using real compressor waste heat. On this basis, the transition to a 100 kW pilot plant is planned by the end of 2027.

ECONOMIC ASSESSMENT

For data centres, the key economic lever is grid connection capacity: today this is often the limiting factor for expanding a site, not available floor space. Since waste heat-driven cooling operates with virtually no additional electricity consumption, significantly more server racks can be operated with the same grid connection — a direct economic advantage for operators who would otherwise reach their connection limit.

In the industrial context, using compressor waste heat to pre-cool intake gas — such as natural gas in LNG plants, CO_2, or hydrogen — increases the efficiency of gas compression plants: cooler gas requires less energy to compress, reducing electricity demand and translating directly into lower operating costs.

BENEFITS & CHALLENGES

The benefits lie in the drastic reduction of electricity demand for cooling, relief of congested distribution grids, and a total cost of ownership significantly lower than that of electric chillers. The technology also uses water as its refrigerant and avoids climate-damaging refrigerants. The central challenges are commercial in nature: procurement and decision cycles are long in both the data centre and industrial markets, and operators of cooling-critical infrastructure are reluctant to adopt a technology not yet established on the market. Building initial pilot installations with reputable reference customers is therefore crucial to create trust, demonstrate operational experience, and pave the way for broader commercial scaling.

LESSONS LEARNED & REPLICATION POTENTIAL

The project builds on two decades of IBM research and predecessor projects (THRIVE, RTSA-Carbon-Capture), demonstrating that close integration of research partners (SPF-OST, HEIG-VD) with specialised manufacturing and market partners (Konvekta, Burckhardt Compression) is essential to bring a technology from laboratory to industrial maturity. Since the solution is modularly scalable (from a few kW to several MW) and works sector-independently wherever low-temperature waste heat in the 45–90 °C range is available, its replication potential in Switzerland is large: in addition to data centres and gas compression plants, the technology is also suitable for supplying local cooling networks (district cooling) that provide cooling to several buildings or an entire site from shared waste heat — for example in mixed-use sites combining industrial, commercial, and residential uses. The technology thus makes a concrete contribution to sector coupling at site and plant level.

Scope level: Municipality

Municipalities play a central role in Switzerland's energy transition — both as infrastructure owners and as initiators of climate-resilient solutions. The following projects showcase how local authorities are driving forward innovative energy concepts, often in partnership with private actors and residents. From decentralized heat supply to integrated energy planning, these initiatives are scalable, replicable, and aligned with long-term net zero targets.

St.Gallen City Utilities: Building a Smart Energy System

St.Galler Stadtwerke (sgsw)
gazenergie / Swiss Gas Industry Association (VSG)

BACKGROUND & MOTIVATION

The City of St.Gallen has enshrined in its municipal charter the goal of becoming climate-neutral by 2050. The Energy Concept 2050 (EnK2050) has served for two decades as the central planning instrument to achieve this ambition. St.Gallen City Utilities (sgsw) have developed an energy policy vision that keeps the whole system in view and are implementing numerous measures envisaged in the EnK2050.

The “Virtual Power Plant St.Gallen” is the vision of an intelligently networked energy supply for the future. Numerous decentralised energy sources — photovoltaic systems, heat networks, storage, electric vehicles, and flexible consumers — are digitally connected and managed together. From individual installations, a high-performance overall system emerges that optimally coordinates electricity, heat, and mobility. The aim is to use locally generated energy as efficiently as possible, relieve the electricity grid, increase security of supply, and advance the city's decarbonisation. The "QuartierLab Russen/Hof" serves as the testing ground for developing and trialling this forward-looking approach to energy supply.

ENERGY CONCEPT & SECTOR COUPLING LOGIC

The "QuartierLab Russen/Hof" project is based on the principle of sector coupling, with all controllable components optimised jointly: PV systems, combined heat and power units (CHP), thermal storage, heat pumps, district heating (GSG heat network), electric vehicle charging infrastructure, controllable consumers, and digital metering and control systems.

Optimisation requires taking into account multiple parameters simultaneously: weather forecasts, consumption forecasts, PV generation, grid constraints, thermal storage levels, and EV state of charge. Energy is to be used as close as possible to where it is generated, with the highest possible degree of self-sufficiency. All available flexibilities are deployed in a coordinated manner.

In the "QuartierLab Russen/Hof", sgsw no longer aims to optimise individual installations, but rather to gain experience with an integrated energy system at neighbourhood level in existing buildings under real conditions — operating like a laboratory where measuring, testing, analysis, calibration, and experimentation take place continuously.

TECHNICAL COMPONENTS

Electricity generation is provided by photovoltaic systems and CHP units. Heat generation draws on the anergie network of energienetz GSG AG, CHP units (future operation with biogas, synthetic gases, or hydrogen), thermal storage, and heat pumps. Current storage consists of thermal storage systems, with large battery storage planned for the future. Mobility is addressed through integration into the flexibility management system, to be complemented by intelligent EV charging station control.

The distribution model is based on self-consumption communities (ZEV / vZEV) and local electricity communities (LEG). A dedicated data platform (DataHub / API) coordinates all energy flows and control processes.

LOCATION & FRAMEWORK CONDITIONS

The initial cluster is located in the Winkeln/Hof-Chräzeren area in the west of St.Gallen and encompasses 29 multi-family residential buildings from the 1970s and 1990s in the "Russen" and neighbouring "Hof" districts, to be extended to the whole neighbourhood in due course. The site combines

ideal conditions: existing buildings forming a large, practically contiguous development of nearly 290 residential units. The properties are equipped with either photovoltaic systems, CHP units, or heat pumps, as well as EV charging stations. The ownership is strongly involved and shows a high willingness to participate. As the area is occupied by residents, solutions can be tested in real everyday operation rather than merely simulated.

PROJECT PARTNERS

The project was established as a public-private partnership, with the goal of collaborative engagement between public authorities and private companies sharing resources and know-how. It was initiated by St.Gallen City Utilities (sgsw). Property owners and building managers make their buildings and installations available and act as a bridge to end customers, enabling innovative energy solutions to be tested, analysed, and optimised. Further partners include the City of St.Gallen, the Swiss Federal Office of Energy (SFOE, as a pilot and demonstration project in flexibility and congestion management), and technology partners for algorithms and control systems.

KEY FIGURES & KPIS	
Buildings in initial cluster	29
Photovoltaic installations	10 systems, 805 kWp total
PV electricity generation	approx. 740 MWh/year
EV parking spaces	43 prepared, 20 active charging stations
CHP units	9 units, ~350 kWel / ~640 kWth
CHP production	~1,500 MWh electricity / ~3,700 MWh heat/year
Residential units	approx. 290
Project start	Spring 2024

CURRENT STATUS

The project officially launched in spring 2024 and has been in the implementation phase since. sgsw view the “QuartierLab Russen/Hof” as an environment in which solutions can be tested and experience gathered over an extended period. Additional technical and digital components are being added step by step as part of a continuous improvement process. No defined end date has been set. The phases include evaluation and definition of project parameters, establishment of the living lab with role assignments and initial information, integration of metering systems, and commencement of pilot operations — running in parallel with the ongoing development of algorithms and integration of further components.

ECONOMIC ASSESSMENT

The economic logic is based less on selling additional energy than on optimising the overall system. Key value streams include higher self-consumption, lower grid offtake, and consequently a reduced need for balancing energy. Better use of existing infrastructure also means a lower or deferred need for grid expansion.

Particularly noteworthy is the potential to use grid capacity more efficiently, to postpone or avoid investment in grid expansion, and to market flexibility as a differentiating feature.

BENEFITS & CHALLENGES

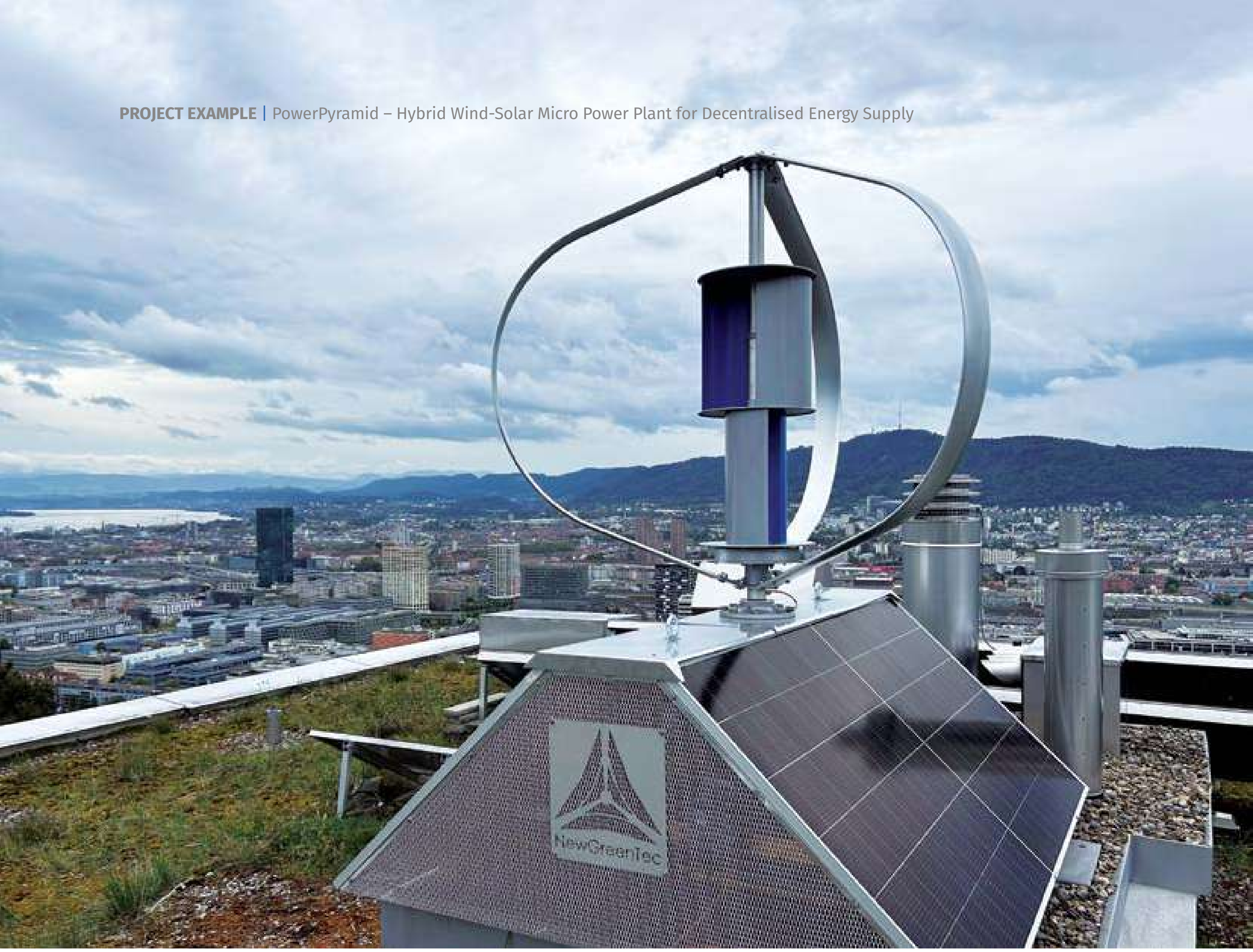
The project delivers economic, ecological, and grid-technical benefits. Optimised flexibility management reduces balancing energy costs, improves utilisation of existing assets, and increases self-consumption rates. Greater use of locally generated solar power and cross-sector optimisation of electricity, heat, and mobility reduce CO_2 emissions. Active congestion management and coordinated load control also improve security of supply.

These benefits come alongside significant challenges. Regulatory frameworks do not yet fully reflect cross-sector flexibilities. Technical hurdles include integrating a wide variety of systems, ensuring sufficient forecast quality, and achieving interoperability between components and platforms. Organisationally, the project requires coordination among numerous actors and clear data protection and operational governance arrangements.

LESSONS LEARNED & REPLICATION POTENTIAL

Findings from the project confirm the potential of integrated cross-sector operations at neighbourhood level. It has been demonstrated that flexibilities from electricity, heat, and mobility can be coordinated to increase self-consumption and reduce grid load. Predictive optimisation algorithms proved effective at identifying local grid bottlenecks early. Furthermore, local energy management can be largely automated without continuous manual intervention.

The approach has considerable replication potential for Swiss neighbourhoods — particularly those with high penetration of PV, heat pumps, and e-mobility, and with smart metering in place. Further development of the regulatory framework through LEG and vZEV structures creates additional conditions for unlocking flexibility potential economically and transferring the system architecture to further applications. ■



PowerPyramid – Hybrid Wind-Solar Micro Power Plant for Decentralised Energy Supply

Frido Stutz
NewGreenTec International AG

BACKGROUND AND ENERGY CONCEPT

The PowerPyramid was developed to make use of unused flat roof and infrastructure surfaces for decentralised, year-round electricity generation. Conventional photovoltaic systems generate their highest output during daytime hours and in the summer months; demand for renewable electricity remains unmet at night, in overcast conditions and in winter. The system addresses this by directly combining a wind-direction-independent vertical-axis wind turbine with tilted PV modules on a shared pyramid-shaped support structure — wind and solar energy are harvested on the same small footprint, with their complementary generation profiles working in tandem.

Generated electricity is used first within the connected building or site. Surplus can charge a battery, supply electric vehicles, power heat pumps, or be distributed to other consumers within ZEV or LEG (local energy community) structures. This enables links across several sectors: residential, office and commercial buildings receive local power; heat pumps and hot water systems are integrated; EV charging infrastructure can be connected; and self-consumption communities benefit from a source that delivers electricity outside typical solar hours.

TECHNICAL COMPONENTS

Wind power generation uses a low-noise, wind-direction-independent dual vertical-axis wind turbine designed for the changing and turbulent airflows that occur above roof edges and at low installation heights. Solar generation is provided by tilted PV modules arranged on the pyramidal substructure.

Key components include: pyramid-shaped support and structural frame, dual vertical-axis wind turbine with generator, integrated PV modules, micro-inverters, wind controller and switchbox, and a monitoring and ballast system. The shared structure bundles all components onto a footprint of around five square metres. Battery storage, heat pumps, charging infrastructure and energy management systems can optionally be integrated.

LOCATION AND BOUNDARY CONDITIONS

The PowerPyramid is particularly suited to flat, previously unused roof and infrastructure surfaces — flat roofs of residential, office, commercial and industrial buildings, as well as lift shafts, bridges and comparable load-bearing structures. Sites with good exposure to airflow, sufficient wind frequency and low shading are most suitable. Actual energy output depends strongly on wind conditions, building geometry and orientation, and must be assessed on a project-specific basis.

Structural loading is a key boundary condition. The standard unit weighs around 230 kg without ballast and just over 520 kg with ballast. Depending on roof construction, wind load zone and cantonal requirements, structural assessments and a permit process are required. NewGreenTec coordinates site assessment, electrical integration and liaison with structural engineers, electricians and planning authorities.

CURRENT STATUS

The PowerPyramid is offered as a standardised, project-configurable wind-solar micro power plant. The current standard version has a footprint of approximately 2.3 × 2.2 metres and a height of around 2.5 metres. A larger variant, the PowerPyramid L, offers a footprint of approximately 4.6 × 4.6 metres and a height of around 5.5 metres, combining eight 700 Wp PV modules with a 3 kW wind turbine. Further variants are available with different turbines, without a turbine, or without PV modules. Monitoring, battery integration and use within LEG and ZEV models are being continuously developed.

ECONOMIC ASSESSMENT

The economic case rests primarily on reducing grid electricity purchases through local self-generation. The temporal complementarity of wind and solar is the key advantage: wind power is generated particularly when photovoltaic output is low or absent. This can spread self-consumption across more hours of the day and year, and reduce the required battery storage capacity.

Payback period is highly site-dependent. Determining factors include wind availability, self-con-

KEY FIGURES

Footprint (standard):	approx. 2.3 × 2.2 m (around 5 m²), height approx. 2.5 m
Weight:	approx. 230 kg (without ballast) / approx. 520 kg (with ballast)
PowerPyramid S:	approx. 2,000 Wp rated output; up to approx. 2,500 kWh annual yield at good sites
PowerPyramid L:	eight PV modules at 700 Wp each, 3 kW wind turbine; footprint approx. 4.6 × 4.6 m, height approx. 5.5 m
Expected technical lifetime:	approx. 20–30 years

sumption profile, electricity tariffs, feed-in compensation and permitting costs. Sites with high daytime and night-time consumption and good roof airflow are economically most attractive.

BENEFITS AND CHALLENGES

The PowerPyramid harvests wind and solar energy on the same small footprint, extending local electricity generation to periods of low or absent sunshine. The wind-direction-independent vertical-axis turbine is designed for variable roof airflows and requires no active tracking. Ballasted installation can reduce penetration of the roof membrane, where structural and wind load conditions allow.

Challenges remain. Actual wind yield on buildings is highly site-specific and should be assessed through site analysis, measurement or simulation before investment. Noise, visibility, turbulence and local planning requirements may affect feasibility. Roof structure, storm resistance, electrical protection concepts and system integration all require careful planning.

REPLICATION POTENTIAL AND KEY CONSIDERATIONS

Replication potential is significant, particularly on flat roofs of residential, office, commercial and industrial buildings. Lift shafts, bridges and other load-bearing infrastructure can also offer suitable installation surfaces where wind, structure, safety and permitting align.

Careful micro-site analysis is a critical success factor. Even a few metres of positional difference on a roof can significantly affect airflow, turbulence, shading and yield. Early involvement of structural engineers, electricians, grid operators and planning authorities is equally important. Battery systems should be sized on the basis of measured generation and consumption data.

The PowerPyramid follows a modular approach to decentralised energy supply: wind and solar power are combined on a small footprint, optionally extended with storage and energy management, and integrated into self-consumption, ZEV or LEG structures. The system can contribute to winter electricity generation, higher local self-sufficiency and better use of existing building infrastructure.

From Ventilation Upgrade to District Heating — How a Swimming Pool Drove Allschwil's Energy Transition

Andreas Dill
Municipality of Allschwil

When the ventilation system at the Neuallschwil school centre's indoor swimming pool came up for renovation in 2019, nobody expected that what looked like a routine maintenance project would set the municipality of Allschwil on course to meet its 2050 climate targets.

As planning got underway, it quickly became clear that a simple like-for-like replacement of the ventilation shafts would fall short — both in terms of energy efficiency and the municipality's climate commitments. A specialist firm was brought in to plan a comprehensive refurbishment with the goal of recovering the substantial waste heat from the pool ventilation system. HLK Consulting of Dornach proved to be a partner who never settles for standard solutions, always looking for pragmatic, unconventional and efficient approaches. The planning revealed that new ventilation units could significantly improve energy performance. The catch: the units were located in the basement directly beneath the pool. Installing replacements from above through the pool floor would have been straightforward — but would have required closing the facility for an extended period. The alternative, fitting units later-

Fig. 1: The wood-chip heating plant "Neuallschwil".

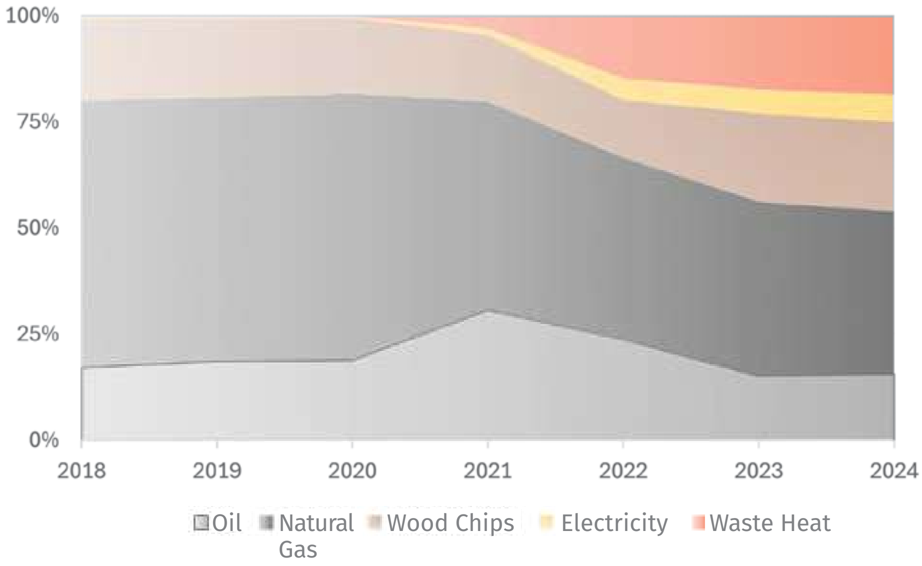


Fig. 2: The realisation of this district heating network — and the consequent replacement of further fossil heating systems — has reduced the share of fossil heat energy across Allschwil's 8 existing networks from over 80% to nearly 50%.

ally from outside, would have meant excavating a large temporary shaft at considerable cost.

A PROBLEM BECOMES AN OPPORTUNITY

The question arose: should the energy efficiency upgrade be abandoned, or was there another way? There was: if the existing gas-fired heating plant were removed and replaced with a wood chip boiler system, the excavation needed for the lateral installation could double as the foundation pit for a large wood-chip heating plant.

The municipality approached Primeo Energie, the operator of the existing gas heating for the school complex, and succeeded in convincing them of the project's potential. This was partly thanks to a long-standing working relationship, and partly because Primeo Energie had already been operating a wood chip heating plant at another local school — Schule Gartenhof — since 2016, supplying several school buildings, sports halls and the adjacent neighbourhood. The municipality also helped its case by presenting data on current and projected heat demand in the surrounding districts.

ENERGY PLANNING MADE THE DIFFERENCE

The municipality was simultaneously developing a local energy plan, and the maps already prepared clearly showed that surrounding neighbourhoods had high heat demand density. Rather than a straight replacement of the gas heating, Primeo Energie decided to install two wood boilers and a heat pump, laying the groundwork for a new district heating network. The fuel: untreated regional wood.

The municipality benefited from the partnership in several ways. First, the Neuallschwil school complex — including the indoor pool, the music school and a day-care centre — was switched to renewable heat. Two years later, two further municipal administration buildings, the fire station and a civil defence facility around one kilometre away were also connected to the network. And crucially, the ventilation system's heat recovery unit was integrated into the heating plant, feeding recovered waste heat into the network and contributing around 7% of total heat energy.

The combination of wood boilers and a heat pump is also significant from a sector coupling perspective: the heat pump links the electricity grid to the district heating network, while condensation heat recovery from the boiler flue gases extracts additional energy. The result is a system that intelligently combines local biomass, waste heat and electricity.

By 2025, 44 properties were connected to the network, with the heating plant delivering nearly 6 GWh/a of renewable heat. More than 20 additional properties are set to join within the next two years.

APPETITE FOR MORE

The Neuallschwil school centre project has rightly been called a success, with both the municipality and Primeo Energie proving to be reliable partners. The natural next step was to develop a further district heating network in the commercial zone. The area's high heat density makes it well-suited, but space for a new heating plant is extremely limited given the dense built fabric. Attention turned to the municipal works yard, which still has available land and sits ideally on the boundary between the commercial and residential zones. Initial plans centred on groundwater or geothermal energy as the heat source — but investigations showed that groundwater flow was too weak, and the open land area too small for a borehole field of the required size. The existing building stock also requires high supply temperatures. Primeo Energie therefore proceeded to plan a wood chip heating plant. While biomass produces renewable heat, it must be used carefully and efficiently.

The plant is therefore designed so that the wood boilers operate only during the heating season from November to March. For the remaining months, a 1 MW air-source heat pump takes over the heat supply.

During boiler operation, the same heat pump also recovers the condensation heat contained in the flue gas moisture. This maximises the energy yield from the wood and significantly increases heat output compared to a conventional wood boiler operation.

Early in 2025, the municipal council signed a letter of intent with Primeo Energie for construction of the heating plant and the "Bachgraben" district heating network. The municipality provides the site for the plant; Primeo Energie commits to supplying the works yard itself, the Schönenbuchstrasse primary school, the sports facility, municipal youth and cultural buildings, and two further municipal properties with renewable heat. The building permit application for the installation — with over 6 MW of renewable generating capacity — has been submitted, with construction set to

193 District Heating Connections Still to Go

Total District Heating Connections

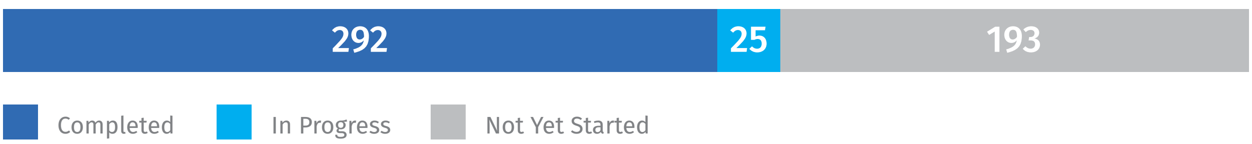


Fig. 3: The "Werkhof" heating plant is set to supply a further 193 properties with district heat by 2035 *(data source: Primeo Energie).*

District Heating Supply Areas in Allschwil

- Existing
- Supply and Expansion Underway
- Supply from 2028 at the Earliest
- Supply from 2030 at the Earliest
- Potential Expansion Areas

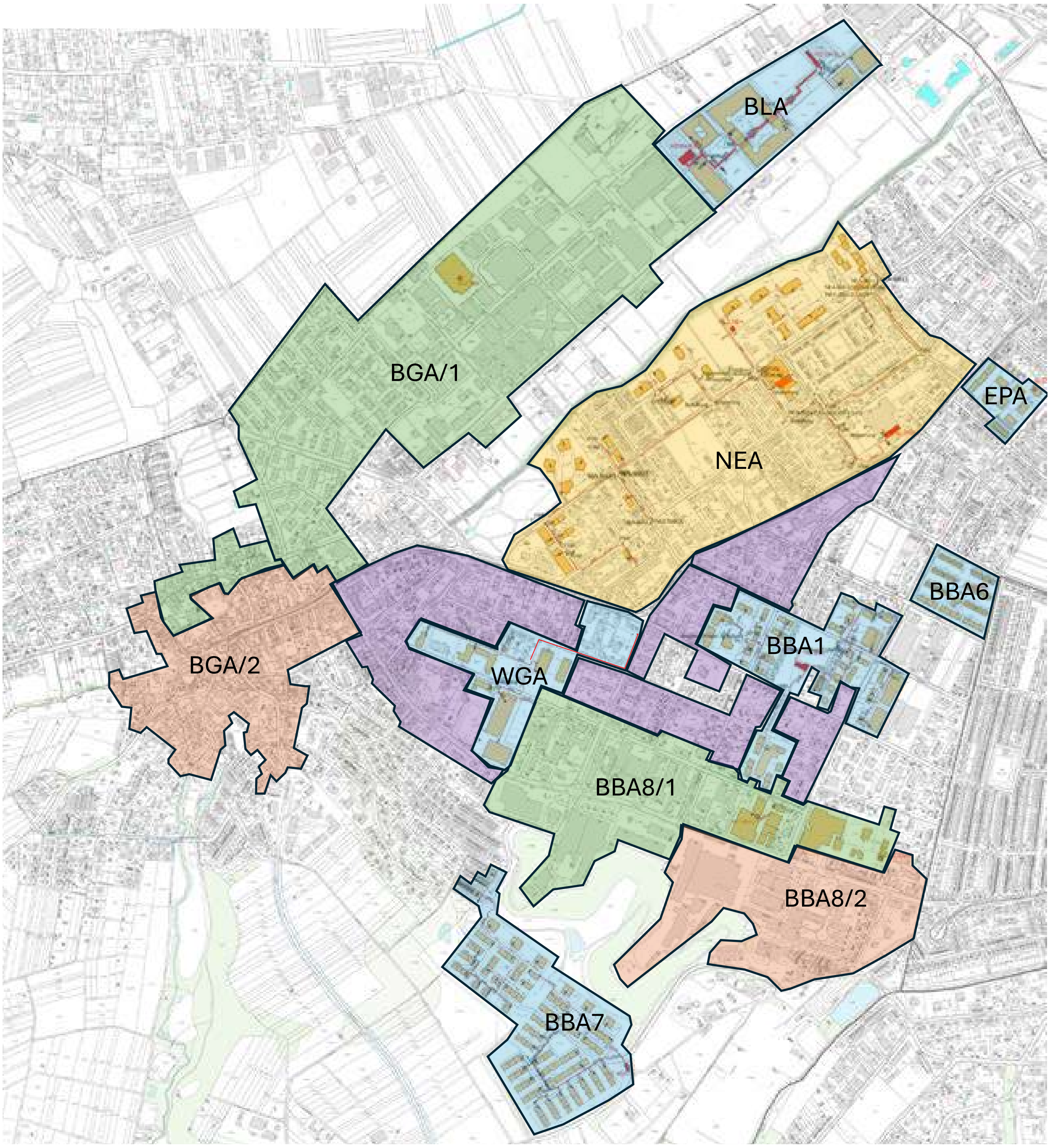


Fig. 4: Together, the Neuallschwil (NEA), Bachgraben (BGA) and planned Binningerstrasse (BBA8) networks will bring renewable district heat to a large part of the municipality of Allschwil.

begin in autumn 2027. The project not only advances the municipality's own shift to fossil-free heating, but also offers an attractive alternative to oil and gas for the many private property owners within the large planned network perimeter.

Particularly welcome for the municipality is Primeo Energie's commitment to connect properties in the listed historic village centre — where individual solutions are often extremely difficult to implement. This too speaks to the mutual understanding at the heart of this partnership.

THE STORY CONTINUES

The Bachgraben network will not only make Allschwil's district heating greener — together with the Neuallschwil school centre network, it will substantially reduce the share of fossil heat in the municipality. The community also has high hopes for the Binningerstrasse masterplan, following the vote in favour of the partial zoning plan. This 28-hectare development zone is set to combine commercial use with attractive housing for around 1,500 residents. The municipality's development strategy aims to establish a large district heating network there too, with geothermal borehole technology as the primary heat source.

With the two networks described above already built or in planning, and the Binningerstrasse development on the horizon, Allschwil is well placed to meet its 2050 climate targets in the heat sector. The projects also open new doors for Primeo Energie to replace remaining fossil heating systems. Hydraulic interconnection of the individual networks could unlock synergies, balance peak loads, create redundancy and improve security of supply — a feasibility study is currently under way.

KEY FIGURES

Neuallschwil network (NEA):	In operation since 2021
Connected properties (2025):	44
Heat output NEA:	approx. 6 GWh/a renewable
Waste heat share (pool ventilation):	approx. 7%
Fossil share (8 networks):	Reduced from >80% to ~50%
Bachgraben network (BGA):	Building permit submitted; construction autumn 2027
Generating capacity BGA:	>6 MW renewable (wood boilers + 1 MW heat pump)
Target connections BGA by 2035:	193 further properties
Binningerstrasse network (BBA8):	In planning; geothermal boreholes as heat source

The Neuallschwil story shows that successful energy projects often begin not with a master plan but with a concrete problem. What matters is the readiness to see that problem as an opportunity — and to connect it to a long-term energy strategy. It is precisely this combination of municipal vision, technical expertise and partnership with Primeo Energie that is driving Allschwil's heat transition today.

Alongside these decarbonisation successes, the municipality is equally committed to improving the energy efficiency of its own properties. It has commissioned condition assessments and GEAK Plus reports with concrete renovation steps for all municipal buildings. Together with property management partner Stratus, Allschwil is well equipped to plan building and energy refurbishments systematically and with clear focus on CO_2 reduction.

Hohrain Heat Network: From Wood-Chip Boiler to Sector-Coupled Energy Platform

Pascal Peter
GUNEP AG

BACKGROUND

Decarbonising heat supply is one of the central challenges of Switzerland's energy transition. Around half of total final energy consumption is used for heating, most of it still fossil-fuelled. Against this backdrop, Wärmeverbund Hohrain AG was established to build a sustainable, future-proof energy infrastructure for the municipalities of Mattstetten and Urtenen-Schönbühl, based on renewable energy sources. Rising grid fees, falling solar feed-in tariffs, and increasing electrification are fundamentally reshaping the economics of energy projects. To adapt, the project plans to integrate a battery storage system and a power-to-heat unit (P2H) in successive stages, creating a sector-coupled system that uses locally generated solar power as fully as possible within its own energy system rather than exporting it to the grid.

ENERGY CONCEPT & SECTOR COUPLING LOGIC

The project is built on the principle of sector coupling: electricity and heat generation are not managed in isolation but optimised within a shared system. Base-load heat comes from a 1,650 kW wood-chip boiler, supplemented by a flue-gas condensation unit for additional heat recovery. A 780 m² solar thermal array covers demand during summer, while a 330 kWp photovoltaic installation supplies the energy centre's electricity needs.

Expansion proceeds in two steps. First, a 200 kWh battery (planned) increases time-shifted self-consumption and reduces grid electricity purchases. In a second stage, a 160 kW power-to-heat unit (planned) converts surplus solar electricity directly into heat, stored in the 120,000-litre thermal buffer. Locally generated electricity is therefore no longer primarily exported to the grid, but used directly within the system.

SELF-CONSUMPTION AS THE KEY ECONOMIC DRIVER

The PV system produces around 305 MWh of solar electricity annually, against an energy centre demand of just 102 MWh. Today, self-consumption stands at 14% (42 MWh) — the majority of generated electricity flows to the grid. The battery raises this to around 25% (75 MWh), covering most of the centre's electricity needs between April and November through solar power alone. In winter, generated solar electricity is already fully consumed on-site (Fig. 1).

The decisive leap comes from the power-to-heat system: it enables a self-consumption rate of around 84% (257 MWh) by converting summer surpluses directly into heat for the heating network. It also flattens export peaks, enabling the grid operator Elektra Jegenstorf to apply its TOP40 tariff model without significant financial disadvantage for Hohrain AG (Fig. 2). The coupling of solar power and heat supply creates a double benefit: greater self-sufficiency and a less burdened grid.

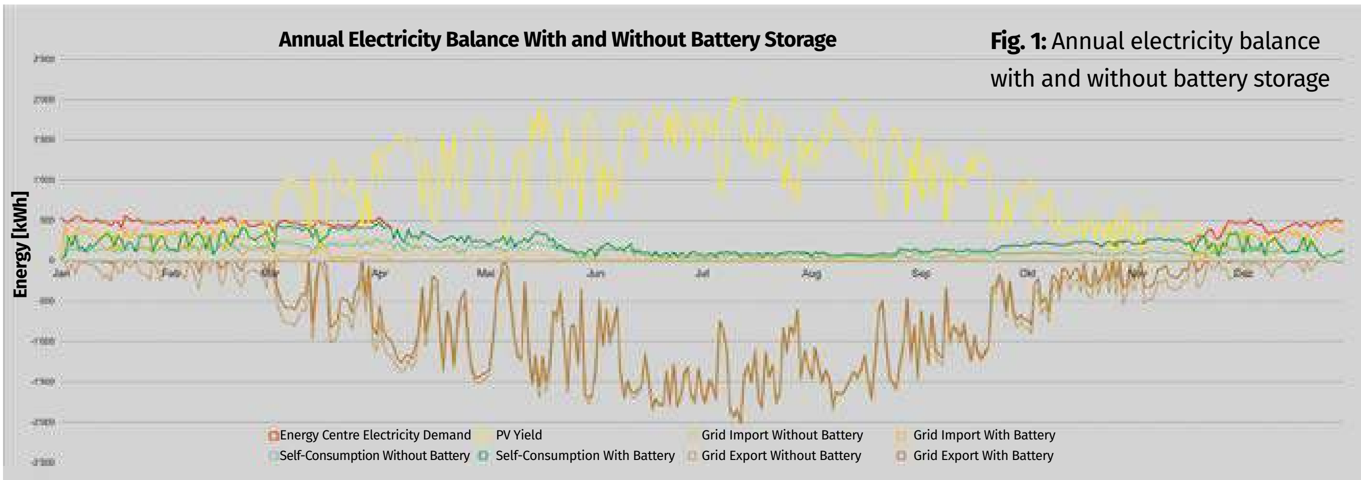


Fig. 1: Annual electricity balance with and without battery storage

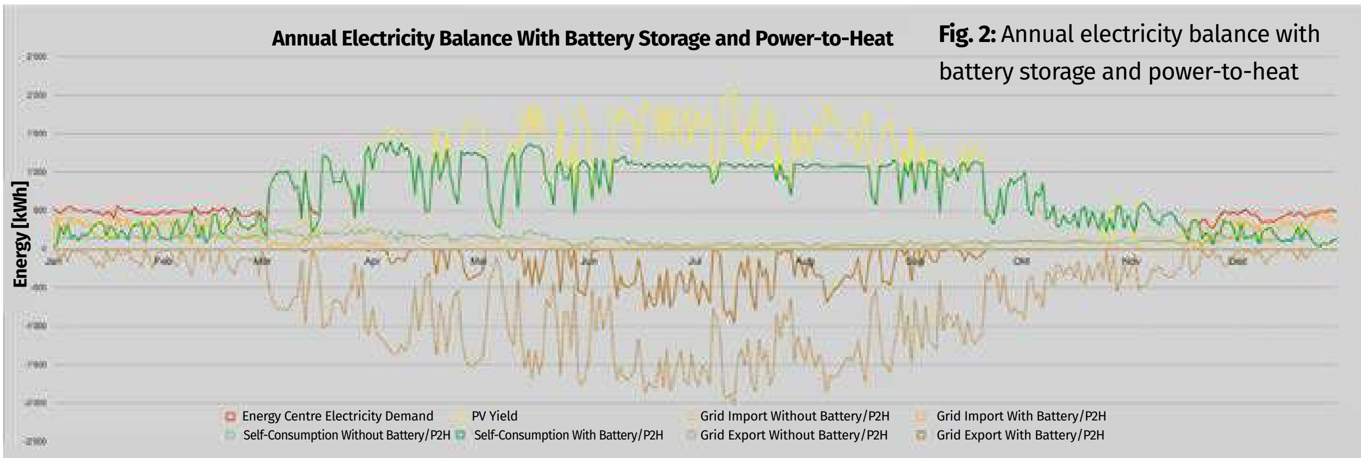


Fig. 2: Annual electricity balance with battery storage and power-to-heat

KEY FIGURES

Wood-chip boiler	1,650 kW
Thermal buffer	120,000 litres
Solar thermal	780 m² collector area
Photovoltaics	330 kWp / 1,624 m² module area
Annual PV yield	approx. 305 MWh
Energy centre electricity demand	102 MWh/year
Self-consumption today	14% (42 MWh)
Self-consumption with battery (planned)	25% (75 MWh)
Self-consumption with battery + P2H (planned)	84% (257 MWh)
Battery storage	200 kWh (planned)
Power-to-heat unit	160 kW (planned)
CO_2 savings	approx. 1,600 t/year
Location	Mattstetten / Urtenen-Schönbühl BE
Grid operator	Elektra Jegenstorf

PARTNERS & LOCATION

The energy centre is located in Mattstetten and supplies residential, commercial and industrial buildings in Urtenen-Schönbühl via a heat network. The project was initiated and is owned by Hohrain AG; the energy centre, photovoltaic system and solar thermal system were planned and constructed by GUNEP AG. Additional partners include the municipalities of Mattstetten and Urtenen-Schönbühl, regional construction companies and the Elektra Jegenstorf cooperative as the grid operator.

BENEFITS & CHALLENGES

The heat network replaces fossil heating systems and avoids around 1,600 tonnes of CO_2 per year. The use of regional wood resources strengthens local value creation, and increasing self-sufficiency reduces dependence on the public electricity grid. At the same time, reducing summer export peaks provides meaningful grid relief. The main challenges lay in the technical integration of multiple energy and storage systems and in coordinating the many project partners. The first phase of the system is successfully in operation; battery storage and power-to-heat are in the planning stage.

LESSONS LEARNED & REPLICATION POTENTIAL

The Wärmeverbund Hohrain project demonstrates that modern energy infrastructure extends well beyond the provision of renewable heat. The greatest added value comes from coupling electricity, heat and storage technologies: solar self-consumption becomes the central factor in economic success.

The concept has strong replication potential for municipalities, urban districts, and industrial sites with comparable conditions — wherever suitable roof areas, regional biomass, and sufficient heat density can be combined.

Efficient Urban Charging Infrastructure: Grid-Friendly DC Charging Concept for Municipal Fleets and Public Space

Daniel Meier
EVTEC AG

BACKGROUND & MOTIVATION

Many Swiss cities and municipalities face a dual challenge in implementing their energy master plans and climate targets: they must rapidly electrify their own municipal vehicle fleets (maintenance, waste management, administration) while also responding to growing public demand for high-performance charging infrastructure in dense urban and semi-public spaces — particularly for residents without access to private charging.

Conventional approaches frequently fail in urban contexts due to three typical barriers: historically grown distribution grids in residential areas offer little reserve capacity for uncontrolled simultaneous loads; large transformer stations or bulky charging columns conflict with limited public space and strict planning requirements; and high civil engineering and grid connection costs deter municipalities when utilisation in the early phase is still uncertain.

This reference concept from EVTEC AG demonstrates how cities and municipalities can use compact, intelligently controlled DC charging solutions to integrate both their own vehicle fleets and public charging infrastructure into the local energy system — cost-efficiently and with minimal footprint.

ENERGY CONCEPT & SECTOR COUPLING LOGIC

The energy concept is based on temporally and functionally layered multi-use of the same infrastructure, combined with intelligent integration of municipal PV generation, building loads, and mobility.

The integration logic rests on three pillars: during the day, municipal service vehicles and commercial users charge via opportunity charging; in the evenings and overnight, the same charge points are available to residents for overnight charging. Solar installations on public rooftops feed power directly into the DC charging stations or connected local area networks. A real-time dynamic load management system continuously monitors the grid connection load of adjacent municipal buildings and adjusts available charging power to ensure the existing connection is fully utilised without ever being overloaded.

TECHNICAL COMPONENTS

Generation: Municipal PV installations on maintenance depot and school rooftops, with a calculated capacity of approximately 250 to 300 kWp.

Charging infrastructure: Space-efficient EVTEC DC fast-charging stations (crema&charge / cappuccino&charge) with outputs of 50 kW to 100 kW. The compact power electronics allow installation in tight public spaces or directly on building walls. Dynamic power sharing enables flexible simultaneous charging of two vehicles at a single charge point.

Control and software: Integration via OCPP 2.0.1 with the municipal energy management system and the charging network operator's backend. Interfaces for metering compliance and tariff processing for public use, and automated billing for internal fleet vehicles.

LOCATION & FRAMEWORK CONDITIONS

The concept is designed specifically for dense urban centres in Swiss cities and Mittelland municipalities — mixed-use urban areas combining commercial, administrative, and residential functions. At such locations, a conventional fast-charging station would typically require costly upgrades to the local transformer substation. By using a dynamically controlled EVTEC DC solution with integrated load management, the system connects directly to the existing grid connection of a municipal maintenance depot or administrative building.

PROJECT PARTNERS

Owner / initiator: Municipality or city administration (Department of Construction and Environment, civil engineering office). Grid operator: Local utility as network infrastructure operator and billing partner.

Technology partner: EVTEC AG (development, DC hardware, power electronics and interface integration).

Planning / installation: Regional electrical installation and grid construction partner.

CURRENT STATUS

The technological model and OCPP 2.0.1 control logic have been fully developed and validated by EVTEC AG. Hardware components are available as production-series devices. The concept currently serves as a field-proven blueprint for implementing initial pilot and rollout projects in collaboration with Swiss municipalities and regional energy suppliers.

KEY FIGURES

Planned PV capacity	approx. 280 kWp (on municipal rooftops)
Max. DC charging power	100 kW (dynamically controlled)
Projected grid expansion savings	approx. CHF 100,000 to 140,000
PV self-consumption on site	from approx. 35% to over 65%
Charging infrastructure utilisation	up to 12–14 hours/day
CO_2 reduction	approx. 85 to 100 t/year
CAPEX (charging infrastructure & connection)	approx. CHF 140,000
Payback period	approx. 5.5 to 6.5 years

ECONOMIC ASSESSMENT

The business case differs fundamentally from purely commercial charging hubs. Economic viability arises from the synergy of three effects: intelligent load management prevents costly civil engineering works and grid expansion; switching municipal diesel and petrol vehicles to power from on-site PV installations significantly reduces fleet operating costs; and opening charge points to the public during off-peak hours generates revenue contributions that offset ongoing operating costs.

BENEFITS & CHALLENGES

DC fast charging becomes viable even at technically challenging grid connection points, without lengthy permitting procedures. The compact form factor of EVTEC systems ensures no valuable public space is lost. The system can be scaled modularly with additional charge points as fleet or public demand grows.

The key challenges lie in coordinating usage times between municipal operations and the public, and in cleanly separating internal fleet electricity from public charging revenue — both metrologically and in accounting terms.

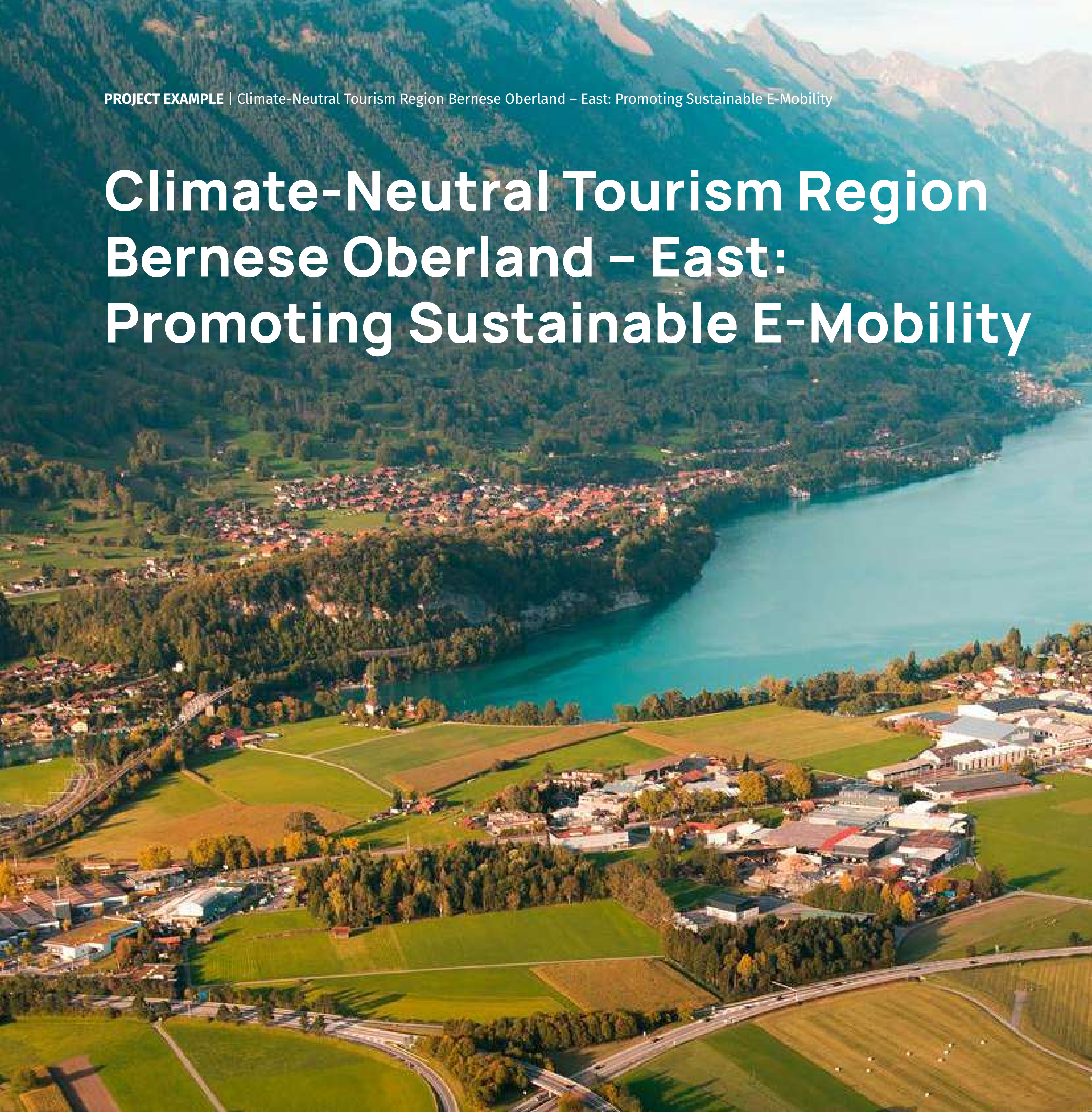
LESSONS LEARNED & REPLICATION POTENTIAL

Municipalities should not view charging infrastructure as isolated installations but as an integral part of the municipal site energy supply. Compact DC charging solutions bridge the gap between fast charging and grid-friendly operation. A key factor is the role of standard interfaces (OCPP) in guaranteeing integration with urban control systems. ■

Scope level: Canton

At cantonal level, decentralized renewable expansion requires proactive coordination: without it, electricity grids face costly and inefficient upgrades. By aligning major consumers, mobility hubs, heat networks, storage facilities, and generation sites, cantons can reduce transport needs, avoid unnecessary grid investments, and capture synergies across sectors. Their role goes beyond setting guidelines: by embedding energy planning in spatial development, and steering cooperation between municipalities, utilities, and industry, cantons ensure that the energy transition is implemented cost-effectively and system-wide.

Climate-Neutral Tourism Region Bernese Oberland – East: Promoting Sustainable E-Mobility



Ulrich Nyffenegger, Canton of Bern
Roger Walther, EBP Schweiz AG
Alina von Allmen, Regionalkonferenz Oberland-Ost

Background & Motivation

The project is of central importance to the Bernese Oberland tourism region. Alongside heat generation, mobility is the largest source of emissions in the Oberland-Ost region, accounting for around 38% of regional CO_2 emissions. At the same time, the region is topographically demanding, settlement structures are dispersed, and roads are heavily congested during peak periods. Climate-friendly mobility solutions can therefore deliver multiple

benefits: reducing emissions, easing traffic bottlenecks, and strengthening the long-term viability of the tourism region. The project brings together private companies, energy suppliers, and tourism stakeholders across the municipalities. The aim is to develop and demonstrate practical e-mobility solutions that can serve as a model for other tourism regions in the Swiss mountains.

ENERGY CONCEPT & SECTOR COUPLING LOGIC

The project lays the groundwork for implementation. It identifies suitable sites for fast and slow charging infrastructure across 28 municipalities in the Bernese Oberland and examines the feasibility of e-charging stations combined with solar energy and battery storage at five prioritised locations. Site criteria include: high traffic volumes, good accessibility, sufficient parking, reliable grid-connected power supply, and planned or existing solar installations. The goal is to promote transport electrification and use locally generated solar power for e-charging stations through local electricity communities (LEG).

TECHNICAL COMPONENTS

The central technical components include targeted expansion of charging infrastructure in Bernese Oberland-Ost, electrification of public transport, and increased use of locally generated solar power for mobility applications in a tourism region. The use of batteries is also being assessed, as scaling, technological development, and falling costs through industrial mass production are expected to improve economic viability in the coming years. Viable business models are being developed for private companies, alongside the legal and organisational foundations for the LEG structure.

LOCATION & FRAMEWORK CONDITIONS

The Bernese Oberland – East region comprises 28 municipalities with around 48,000 inhabitants, approximately 40% of whom live in the Interlaken area. Meiringen is the second-largest regional centre. Tourism, with around 5.5 million overnight stays per year, is a key economic driver. At the same time, the demanding topography and dispersed settlement structure result in long travel distances and congested roads during peak periods. New mobility solutions, e-charging infrastructure, and solar energy are still used only to a limited extent.

PROJECT PARTNERS

The project is led by the Regionalkonferenz Oberland-Ost and financially supported by the Wyss Academy for Nature, the Office for the Environment and Energy of the Canton of Bern, and the Swiss Federal Office of Energy. Sub-projects are implemented together with municipalities, the Canton of Bern, cable car operators such as Jungfrau Bahnen and Rothornbahn, energy suppliers including IBI and BKW, and regional businesses such as Ballenberg and Aareschlucht. EBP is responsible for project organisation and coordination.

CURRENT STATUS: TWO SUB-PROJECTS

In a first step, a data-driven and coordinated e-charging infrastructure plan was developed for the 28 municipalities of Bernese Oberland-Ost. The aim was to identify potential sites for fast and slow charging stations, dimension the infrastructure to match demand, and coordinate it across the region. This involved forecasting e-mobility and travel behaviour trends, analysing future charging needs, and identifying suitable sites for fast-charging hubs. Results were validated and refined together with project partners. The coordinated approach creates synergies and enables economically viable operation of e-charging stations.

In a second step, five sub-projects were identified based on the regional plan, two of which were developed in depth:

Regional E-Mobility Hubs Bödeli (Interlaken) and Brienz-Haslital: In the Interlaken (Bödeli), Brienz, and Meiringen areas, forward-looking e-mobility hubs are being created. Existing car parks — such as Parkplatz Bödeli, the Brienzer Rothorn Bahn, or the Ballenberg Open-Air Museum — will be equipped with solar installations and fast and standard charging stations. The solar power generated is used directly on-site as charging power and marketed through local electricity communities (LEG).

E-Charging Stations in Oberland-Ost and LEG for Property Owners in Wengen and Mürren: A key focus is on the Lauterbrunnen car park, the central access point to the car-free terrace villages of Wengen and Mürren. Charging infrastructure with fast and standard charging stations will be expanded there — available to residents, guests,

and second-home owners. Through a local electricity community (LEG), property owners will be able to use or market surplus solar power generated on the terraces via the charging infrastructure in the valley.

ECONOMIC ASSESSMENT

Initial results show that e-charging stations at suitable solar-powered locations can be operated economically given the high tourist numbers. Depending on the option considered, payback periods range from five to seven years. Additional subsidies available in the Canton of Bern reduce these further.

The economic viability of the business model is influenced by the following key factors: traffic volume and demand for e-charging, electricity tariffs, grid electricity costs, and investment in infrastructure, grid connections, and civil works.

BENEFITS & CHALLENGES

The project contributes to climate-neutral mobility in the Bernese Oberland-Ost tourism region. Shifting to e-mobility significantly improves energy efficiency and can save around 300 to 400 MWh of fossil energy per year even with a shift of just 1 million vehicle kilometres. By combining charging infrastructure, photovoltaics, battery storage, and local electricity communities, renewable electricity is used on-site, regional value creation is strengthened, and tourism infrastructure is enhanced. At the same time, CO_2 emissions from transport fall, new business models emerge, and the region positions itself as an innovative pilot region for sustainable mobility solutions.

Implementation requires close coordination between municipalities, energy suppliers, tourism stakeholders, infrastructure operators, and private property owners. Key challenges include suitable site selection, new business models, regulatory questions around local electricity communities, and acceptance among residents and guests.

LESSONS LEARNED & REPLICATION POTENTIAL

Interdisciplinary teams are essential: successful project teams combine expertise in photovoltaics, charging infrastructure, and legal, regulatory, and organisational matters. This allows interfaces to be clarified and disciplines to be effectively connected.

Plan DC charging stations with spatial differentiation: since charging prices vary considerably by operator, analysis across municipal, regional, and cantonal boundaries is needed to properly assess demand, competition, and suitable sites.

Use tendering processes early: requirements for billing systems, responsibilities, data access, and costs should be clearly defined in the tender from the outset. Tendering also enables transparent comparison of suitable technology, backend, and billing partners.

Scope level: Region

Regional initiatives demonstrate how complementary renewable sources, intelligent system operation, and applied experimentation contribute to building resilient energy systems ahead of large-scale deployment. Rather than highlighting individual technologies, the focus lies on the interaction of different sources, the integration of flexibility, and the ability to derive practical insights from real-world operation.

An article about AI, illustrated by AI - Abstract visualization generated by AI from the full text of this article.

From AI Around the Grid to the Grid Inside the AI

FROM AI THAT BUILDS THE TOOLS TO AI THAT BECOMES THE TOOL

Laurent Raeber, Swiss Energypark
Prof. Rahul Gupta, EPFL

Artificial intelligence is transforming the energy sector in ways that go far beyond automation. Over the past two years, it has crossed three successive frontiers. First, it learned to build engineering software. Then it learned to orchestrate increasingly complex analytical workflows. Today, it is beginning to learn the physics of the power grid itself. Each step extends the role of AI — and, in doing so, reshapes the work of engineers. These three levels do not replace one another: they coexist and mature at different speeds — the first is already standard practice, the second is being demonstrated on real systems, and the third remains a research frontier.

This evolution is already tangible at the Swiss Energypark. Every year, its infrastructure collects close to 400 million measurements from real energy systems. At that scale, the challenge is no longer acquiring more data, but extracting useful knowledge quickly enough to support decisions. AI is progressively changing how this can be done.

AI FIRST LEARNED TO BUILD THE TOOLS

The first transformation was almost invisible. It did not affect the grid itself but the way engineers develop software. Instead of painstakingly writing every line of code, they increasingly describe what they want to achieve. Large language models generate the software, propose architectures, write tests and even correct their own mistakes. With the emergence of agentic coding, AI no longer acts as a coding assistant but as a collaborator capable of managing significant parts of the development process under human supervision.

The Swiss Energypark adopted this approach to develop its own data platform. In only a few weeks, a secure three-layer architecture combining time-series measurements, analytical services and geographical information was assembled to support applications ranging from neighbourhood load forecasting to heat-pump deployment scenarios and the analysis of Local Energy Communities. AI did not analyse the power system; it accelerated the creation of the tools needed to understand it.

THEN AI LEARNED TO OPERATE THE TOOLS

Once software itself became easier to build, the next bottleneck shifted elsewhere.

Operating a modern electricity network requires chaining together a large number of specialised analyses: load-flow calculations, contingency studies, planning scenarios, reliability assessments and optimisation models. Each relies on different software, different expertise and different workflows. Increasingly, AI is taking responsibility for coordinating this complexity.

Rather than manually launching every calculation, an engineer can formulate a question in natural language. An agentic system decomposes the problem, selects the appropriate simulation engines, executes the analyses and assembles the results into a coherent explanation. The engineer is no longer occupied with managing the workflow itself, but with validating and interpreting its conclusions.

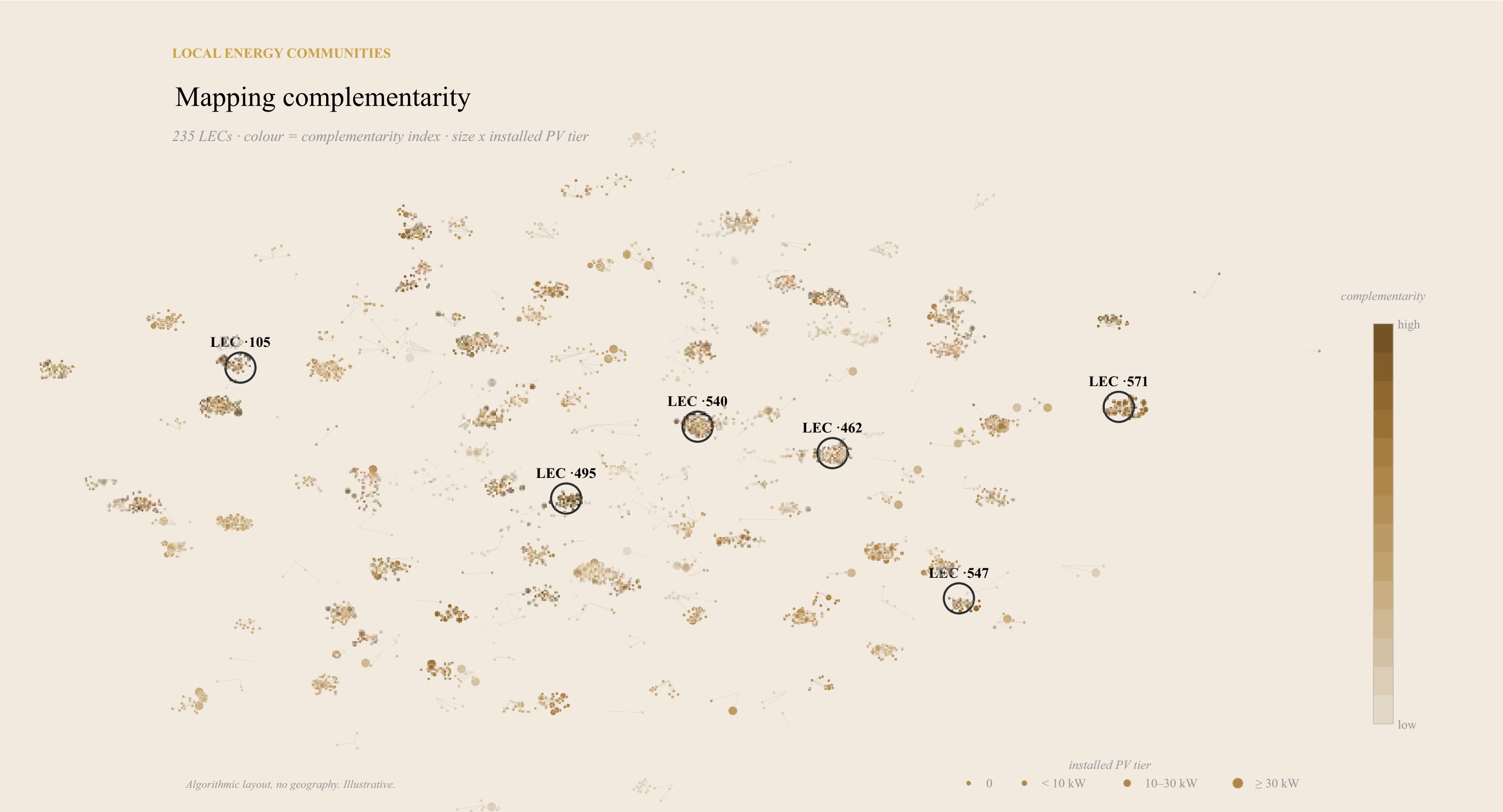
One principle, however, remains fundamental. AI reasons; the physics does not. Every numerical result still comes from trusted simulation tools whose physical validity is well established. AI does not replace these models; it removes the friction around them, making sophisticated analyses dramatically faster and easier to perform.

For infrastructures such as the Swiss Energypark, this represents a profound change. Studies that today require several days of engineering effort could soon be completed automatically in minutes, combining demand forecasts, electrification scenarios within a single reasoning process.

GRID-ESS lab at EPFL has demonstrated an agentic AI framework that integrates a locally deployed large language model (LLM) with a retrieval-augmented generation (RAG) knowledge base grounded in power-system physics. Through natural-language instructions, the framework can autonomously formulate and execute power-system studies, including power-flow analysis, contingency analysis, and optimal power flow.

NOW THE FRONTIER IS SHIFTING: THE GRID INSIDE THE AI

Until recently, the relationship between AI and the grid was straightforward: AI surrounded the physical models. It generated software, coordinated simulations and helped engineers make sense of the results, while the actual knowledge of the electrical system remained embedded inside conventional numerical solvers.



The Local Energy Community analysis taken to scale: the 235 candidate LECs of the Swiss Energypark mapped by the complementarity of their production and consumption profiles. Preliminary work, illustrative values.

That distinction is now beginning to disappear.

A new generation of foundation models is being trained directly on power-system topologies and operating data. Rather than repeatedly solving the governing equations, these models learn the physical behaviour itself and can approximate solutions in milliseconds instead of minutes. The consequence goes beyond faster computation: it changes the scale of what engineers can explore.

When a single simulation costs milliseconds, engineers no longer compare a handful of scenarios; they can explore thousands. Planning and operation begin to converge, and real-time optimisation moves from ambition to realistic objective. The engineer's role evolves once again, away from producing calculations and towards exploring alternatives, assessing risks and making decisions.

Yet two essential questions remain unanswered. The first concerns physical guarantees. A conventional solver guarantees that every solution satisfies the physical laws governing the grid — voltage limits, thermal constraints, and system stability are respected by construction. Can a model that has learned those laws provide the same guarantees, particularly under operating conditions that differ from those represented in its training data?

The second question concerns generalizability and adaptability across networks, topologies, operating conditions, and scenarios. A conventional solver works for all possible networks, topologies, and scenarios and does not require any retraining that AI/ML based algorithms require when confronted with a new grid, a reconfigured topology, or a distribution of operating conditions that differs substantially from the training set.

The answer to these two questions may well define the next generation of intelligent power systems. It is precisely at this frontier, where machine learning meets physical guarantees and generalizability, that Swiss research is now opening one of its most promising directions.

Recent work at the GRID-ESS lab at EPFL on topology-adaptive power-flow learning schemes, such as modular Gaussian process (GP) models, offers an approach that has demonstrated promising performance in predictive accuracy and generalizability across network topologies, scenarios, and operating conditions [1]. Another development is hybrid physics-informed learning methods, where machine learning does not replace the physical solver entirely; instead, it improves the accuracy, speed, or feasibility of simplified, computationally efficient power-flow models and offers greater interpretability and potentially stronger transfer across operating conditions and network topologies [2].

These developments are converging in emerging foundation models for power grids such as Grid-FM and OpenGridFM initiatives, which aim to support a broad range of computational tasks, including power flow, optimal power flow, state estimation, contingency analysis, and unit commitment. These foundational models combine graph-based representations such as graph neural networks (GNNs), transformer architectures, and physics-informed neural networks (PINNs). GNNs leverage the inherent graph structure of power systems, whereas PINNs incorporate physical equations and constraints into the loss function during training, thereby encouraging physically coherent outputs.

Open-access grid models, synthetic network data, and synthetic time series facilitate the development of these models. These resources make it possible to train models across a much broader range of system sizes, parameter values, operating conditions, and contingencies. Recent research at the GRID-ESS lab at EPFL on generating probabilistic synthetic power networks using Bayesian models is particularly relevant in this context [3]. This work provides a large open dataset representing Swiss power networks, while the underlying methodology can also support the generation of synthetic networks for other regions, including Europe, Asia, and the United States. The probabilistic generation of these synthetic networks captures substantial variation in topology, equipment parameters, demand patterns, and generation portfolios, which is essential for training grid foundation models that can generalize beyond a single system and adapt to previously unseen network configurations and operating conditions.

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BLS Schifffahrt: From Electric Fleet to Energy Platform of the Future

Deniz Akman
BLS Schifffahrt AG

BACKGROUND & MOTIVATION

Switzerland faces a dual challenge: fossil fuels in the transport sector must be systematically phased out, while the expansion of photovoltaics, e-mobility, and heat pumps is driving up demand for flexibility in the electricity system. While the debate is often dominated by new power plants, stationary battery storage, or grid expansion, a more fundamental question arises: how can existing infrastructure serve multiple functions simultaneously — increasing both its operational value and its broader economic contribution?

This is precisely where BLS Schifffahrt comes in. The company aims to gradually decarbonise its motor vessel fleet on Lake Thun and Lake Brienz by 2050 at the latest, while simultaneously developing it into an active component of the future energy system. The project therefore goes well beyond simply electrifying fleet operations. The ships' batteries are intended not only to enable emission-free propulsion, but also to function as flexible energy storage. In this way, a traditional tourism and mobility infrastructure becomes an integrated platform linking mobility, energy storage, and grid integration.

ENERGY CONCEPT & SECTOR COUPLING LOGIC

At the heart of the concept is the intelligent linking of mobility and energy supply. Due to seasonal and operational conditions, the ships' battery systems spend a large portion of their time at moorings — potential that today goes entirely unused. Through bidirectional charging infrastructure and intelligent energy management systems, the batteries will in future be able to absorb surplus renewable energy, store it, and release it when needed. At the same time, this opens up prospects for future flexibility and grid ancillary services.

The vessels thus become mobile large-scale storage units that — alongside their primary function — contribute to the integration of renewable energy and the stabilisation of the electricity system. All energy flows are closely coordinated with operational requirements and timetables. BLS Schifffahrt thereby links tourism, mobility, energy storage, and electricity supply in a shared infrastructure — a new approach to cross-sector use of existing assets.

TECHNICAL COMPONENTS

The technical architecture is based on battery-electric drive systems in the megawatt-hour range, charging infrastructure in the megawatt range, and an overarching energy management system. With the full fleet build-out, an installed battery storage capacity of over 20 MWh will be created. The storage systems are dimensioned primarily for vessel operations and integrated into the charging infrastructure via bidirectional interfaces. An intelligent energy management system coordinates charging and discharging processes taking into account timetables, energy prices, weather forecasts, and grid requirements. This creates a dynamic overall system that continuously optimises both mobility and energy needs.

LOCATION & FRAMEWORK CONDITIONS

The project is being implemented on Lake Thun and Lake Brienz in the Bernese Oberland — a region of high tourism importance and growing relevance for the energy and mobility transition. The necessary infrastructure will be built up in stages, allowing technological developments to be incorporated on an ongoing basis and investments to be triggered as needed. A first major expansion step is planned for the Thun shipyard site. In parallel, the new Interlaken Ost shipyard is being designed to accommodate future expansion stages.

PROJECT PARTNERS

The project is initiated by BLS Schifffahrt AG. Concept development is carried out in collaboration with ecoforce GmbH. Energy suppliers, technology partners, public institutions, and infrastructure operators are also being brought into the further development. Successful implementation requires close collaboration between the mobility and energy sectors — in particular long-term partnerships that jointly advance the technical, regulatory, and economic prerequisites for new cross-sector business models.

CURRENT STATUS

The strategic concept for the future energy platform has been completed. Technical, economic, and regulatory analyses are currently underway with potential partners. In parallel, a preliminary study on the development of energy infrastructure at the Thun shipyard site has been launched. The findings will form the basis for the planned tender of the implementation phase from 2027. The project is thus at the interface between strategic planning and concrete implementation preparation.

ECONOMIC ASSESSMENT

The economic significance of the project lies in the multiple use of the same infrastructure. The battery storage systems serve primarily for emission-free vessel operation. Outside operating hours, they can additionally be used for energy storage, load management, self-consumption optimisation, and future flexibility markets — generating additional value without the need to build separate storage infrastructure.

The same investment fulfils multiple functions simultaneously, significantly increasing both operational and macroeconomic efficiency. This principle of multiple use is internationally recognised as one of the key success factors for economically viable sector coupling projects.

KEY FIGURES & KPIS

Total fleet battery storage capacity	> 20 MWh
Bidirectional charging infrastructure	megawatt range
Available flexibility	several MW
Primary storage availability	autumn to spring and overnight hours
Infrastructure investment	single-digit millions (CHF)
Storage potential	equivalent to several hundred electric vehicles
Full fleet decarbonisation target	by 2050
Estimated CO_2 reduction	approx. 2,500 t/year

BENEFITS & CHALLENGES

The greatest challenges today lie less in the technology than in the regulatory and economic framework. Missing standards for grid-serving use of mobile energy storage, normative requirements, and complex approval procedures complicate implementation. At the same time, the transformation requires substantial upfront investment. However, the phased approach makes it possible to spread investments over several years and ensure economic viability.

These challenges are offset by considerable benefits: the project supports the integration of renewable energy, increases flexibility in the electricity system, and improves the use of existing infrastructure — helping to reduce the need for additional storage and grid expansion over the long term while strengthening security of supply. For BLS Schifffahrt, new long-term revenue streams emerge in energy storage, flexibility provision, and grid ancillary services. The company also strengthens its appeal as an innovative employer and contributes to the Bernese Oberland as a sustainable tourism destination.

LESSONS LEARNED & REPLICATION POTENTIAL

The project illustrates that the real innovation lies not in electrifying vehicles or vessels, but in integrating them into a broader energy system. Ships become mobile energy storage units. Charging infrastructure becomes intelligent grid interfaces. And transport infrastructure becomes an additional flexibility resource for energy supply.

As renewable energy continues to expand, demand for storage capacity and flexibility is growing considerably faster than demand for additional electricity generation. Existing mobility infrastructure offers largely untapped potential in this regard. The approach developed is fundamentally transferable to other modes of transport: ferries, bus depots, rail infrastructure, and logistics sites share similar characteristics and could in future also make an active contribution to integrating renewable energy.

Scope level: National

At national level, sector coupling is essential to balance Switzerland's energy system across seasons. Power-to-X technologies link electricity with gas, heat, and industry, offering both storage capacity and flexibility. By converting surplus renewable electricity into synthetic fuels and integrating them into existing infrastructures, such projects help bridge the winter supply gap, reduce CO_2 emissions, and diversify system resilience.

AutoHedge – Bidirectional Charging Under Dynamic Grid Tariffs

Sandro Schopfer
sun2wheel AG

BACKGROUND & MOTIVATION

Switzerland is electrifying its mobility and expanding photovoltaics at a pace that is increasingly straining distribution grids. The intersection of these two developments represents one of the largest untapped flexibility reserves in the energy system.

For the first time, appropriate price signals are available: several distribution grid operators now offer dynamic grid tariffs that incentivise time-shifting of consumption. Until now, decentralised installations had little reason to respond to grid conditions.

Earlier projects such as V2XSuisse tested bidirectional charging on national balancing energy markets. These markets are small and are increasingly served by large batteries and hydropower with lower marginal costs. The real bottlenecks lie in the distribution grid — at the local substation, in the neighbourhood, at the building connection point. AutoHedge shifts the focus there. Simulations from the predecessor project TEC-OFF suggest savings of approximately +/- CHF 500 per year, even without on-site solar generation — though whether this holds in everyday operation remains to be seen.

ENERGY CONCEPT & SECTOR COUPLING LOGIC

An electric vehicle sits idle for over 90% of the time on average. During that time it is a battery of 60 to 80 kilowatt-hours — comparable to several home storage units, but already paid for, since it was purchased for mobility in any case.

The integration logic operates on two levels. On the time axis, a predictive charging planner combines three signals: the grid operator's tariff curve, the forecast residual load at the site, and the user's mobility requirements. Charging takes place when electricity is cheap; discharge back into the building occurs when consumption and price are simultaneously high.

Crucially, the optimisation does not work against mobility: the planner guarantees a minimum state of charge at agreed times.

TECHNICAL COMPONENTS

Vehicles: 30 to 50 electric vehicles, primarily from Volkswagen and other brands on the MEB platform. One sub-objective is to determine which models can actually be operated bidirectionally — manufacturer specifications are inconsistent.

Charging infrastructure: Bidirectional charging stations at existing and newly equipped sites, multiple vehicles per site.

Metering and control: Smart meters at the grid connection point capture load flows as input for local load management. The predictive planner "V2X Oracle" operates on a 15-minute cycle, with load management running in real time; coupling the two levels is a central technical challenge, as load forecasts vary considerably.

Tariff integration: An abstraction layer harmonises the tariff interfaces of the participating grid operators. Standardised APIs do not yet exist.
On-site solar generation is possible but not required. The heat sector is not part of the project; the coupling links mobility, electricity procurement, and storage.

Fig. 1: Illustration of the prototype of a simple online simulator. The customer can specify a minimum state of charge at any time, within which the optimisation calculates the charging schedule with the highest savings or revenues.

LOCATION & FRAMEWORK CONDITIONS

The field trial takes place at four to five sites in distribution grid regions that already offer dynamic tariffs — in the service areas of CKW, Primeo Netz, and the Elektrizitätsgenossenschaft Aettenschwil. The distribution of sites is methodologically intentional: tariff structure, price spread, and load profile differ considerably by region, and it is precisely these differences that determine economic viability. Both urban areas and rural cooperative networks with high PV density are represented.

PROJECT PARTNERS

sun2wheel AG (Kriens-Obernau) leads the project and develops the control and optimisation systems. Bern University of Applied Sciences is responsible for battery analysis. CKW Gebäudetechnik AG, Primeo Netz AG, and the Elektrizitätsgenossenschaft Aettenschwil provide tariffs, sites, and access to fleet operators as distribution grid operators. The Swiss Federal Office of Energy funds the project; an advisory group including representatives from TCS and Swisspower provides technical review.

CURRENT STATUS

The project launched in spring 2026. Site selection, fleet operator recruitment, and tariff interface integration are well advanced; site equipment and vehicle commissioning will follow in autumn 2026. A one-year field operation phase will begin thereafter, running in parallel with laboratory trials. The final report is scheduled for November 2027.

ECONOMIC ASSESSMENT

The business case rests on three value streams: tariff arbitrage on electricity procurement, hedging against volatile feed-in revenues, and avoided investment in stationary storage.

Battery degradation is often assumed to be the main cost driver. Bern University of Applied Sciences is replicating real field profiles in the laboratory on the same cells installed in the vehicles. Our expectation, however, is that the additional cycles will have little impact. The primary driver of degradation is not cycle count but time spent at very high or very low states of charge — and this applies equally to unidirectional charging. A vehicle left overnight at 100% degrades more than one cycled twice a day in the mid-range. The widespread belief that every battery has a fixed cycle budget that bidirectional operation depletes faster is precisely what the project aims to disprove. The findings will feed back into the optimisation as an ageing-aware strategy.

BFE funding is a prerequisite at this stage: a multi-grid field trial with accompanying laboratory analysis cannot be financed privately while the revenue side remains unresolved.

BENEFITS & CHALLENGES

For grid operators, the benefit lies in load relief: consumption during hours of high local solar generation, discharge during the evening peak, resulting in lower load spikes and greater utilisation of solar power within their own grid area. This can delay network expansion. These avoided costs are difficult to quantify — many grid operators know their own marginal network costs only approximately — but they are real. The alternative would be to finance the integration of renewable energy entirely through grid reinforcement, a cost borne by all through network charges.

The greatest non-technical challenge is awareness. Dynamic tariffs are opt-in products; most users do not switch because they cannot assess the benefit, and grid operators market them cautiously due to lack of experience. A variable electricity price is intuitively perceived as a risk, similar to a variable mortgage rate — in reality, for anyone who can shift consumption, it is primarily an opportunity. AutoHedge is developing a public online simulator: users who enter their usage patterns can see their own savings potential within seconds.

It remains open whether a price signal without mandatory control leads to reliable load shifting. Grid operators need planning certainty; providers of energy management systems warn of feedback effects if all installations respond simultaneously to the same cheap hour.

LESSONS LEARNED & REPLICATION POTENTIAL

The most important finding of the preparation phase concerns the revenue side. Dynamic tariffs today apply exclusively to electricity procurement. A purchase obligation for return flows exists only for photovoltaic electricity — not for battery storage or bidirectional vehicles. From 2027, grid operators will also be able to introduce hourly variable feed-in tariffs for PV electricity: voluntary for procurement, mandatory for feed-in.

This leads to the central policy demand: if distribution grid operators are not required to accept surplus electricity, independent market participants must have the opportunity to do so — surplus from storage and, where necessary, from PV. The legal framework for trading return flows is open; in practice the barriers are high. Anyone wishing to market decentralised surpluses needs balance group responsibility, suitable metering infrastructure, and correct management of guarantees of origin — overheads that are barely viable for volumes of a few kilowatt-hours per vehicle per day. It also remains open who bears the revenue shortfall when guarantees of origin cannot be utilised or forecast deviations trigger balancing energy costs. It is precisely this friction that prevents a market for small-scale flexibility from forming. Lower access barriers for independent traders would be the most effective lever for creating competition around the intelligent marketing of decentralised surpluses — rather than leaving them unused or surrendered under unilaterally set conditions.

Replication potential is nonetheless high, because the results are transferable: to managed charging without vehicle-to-grid, and to stationary storage — both simplifications of the bidirectional case. The condition for scaling is less about technology than about framework: comparable tariff structures, standardised interfaces, and practicable market access for independent actors. ■

Scope level: International

At international level, sector coupling projects demonstrate how large-scale, proven technologies can drive deep decarbonisation while setting standards for replication elsewhere. Cross-border examples show how Switzerland can both learn from and contribute to global innovation.

Biomethane Imports for Sector Coupling

gazenergie / Swiss Gas Industry Association (VSG)

PROJECT DESCRIPTION

Renewable gases make an important contribution to sector coupling. They can be used across a wide range of applications and sectors, stored seasonally, and transported, distributed and used via existing gas infrastructure. They can also complement the fluctuating generation of renewable electricity.

The Swiss gas industry has set itself the goal of increasing the share of renewable gases in the gas grid to at least 15 percent by 2030, 50 percent by 2040 and 100 percent by 2050. This target can only be achieved if domestic production is supplemented by imports, as the domestic potential is currently estimated at around 4 to 5 TWh.

A key challenge is that the emission reductions associated with imported biomethane cannot today be automatically credited to Switzerland. Pipeline-imported biomethane can be physically and on a balance sheet basis integrated into the European gas network, but is not automatically treated the same way as domestic biomethane under Swiss regulations: imported biomethane is subject to the CO_2 levy and is treated on a par with fossil gas. As a result, a significant potential for cost-effective emission reductions remains untapped.

To change this, a state-recognised transfer of emission reductions from the exporting country to Switzerland must be ensured. This would allow imported biomethane to be credited under Swiss climate policy, subject to appropriate conditions. The Swiss gas industry is therefore advocating for pipeline-imported renewable gases to be recognised as renewable energy under clear regulatory conditions.

The Swiss CO_2 Act, under certain conditions, provides for the crediting of emission reductions from imported biomethane for industrial applications in Switzerland. A key requirement is that Switzerland has an appropriate intergovernmental framework with the exporting country that prevents double-counting of emission reductions.

The Swiss Gas Industry Association (VSG) is currently conducting preliminary soundings with various export countries in coordination with the Federal Office for the Environment (FOEN) and making initial contacts. Once an enquiry takes concrete shape and the competent authorities of the exporting country show a basic interest, the next steps will be coordinated with the FOEN and pursued at the governmental level.

ACTORS INVOLVED

On the Swiss gas industry side, the VSG takes the lead. The relevant ministries and authorities of the respective exporting countries are also involved. On the Swiss government side, the FOEN is the responsible federal authority.

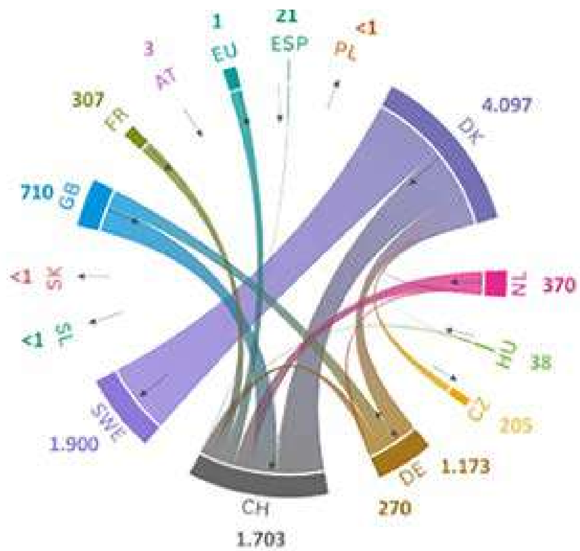
During the sounding phase, the VSG is assessing whether, depending on the circumstances, additional actors in the exporting countries should be involved — for example producers, industry associations or other political and economic stakeholders. Since the VSG initially pursues controlled pilot projects with interested partner countries, producers, traders and potential Swiss buyers are also involved.

OBJECTIVES

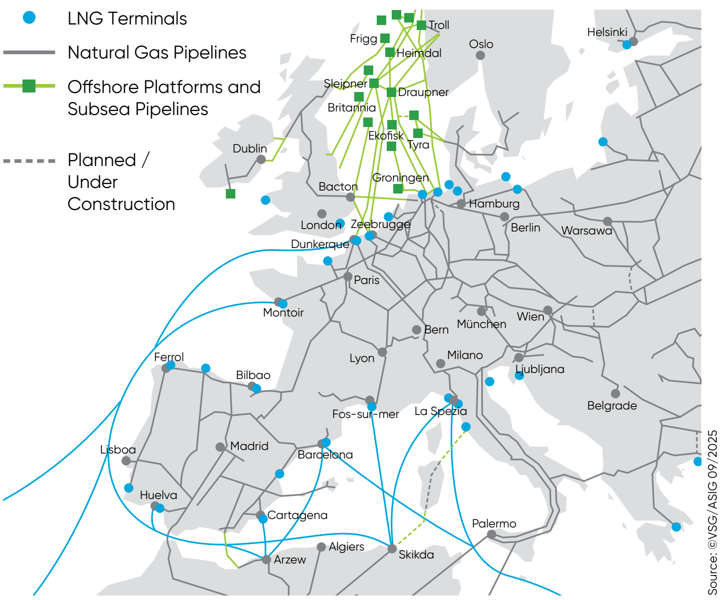
The goal of the collaboration with the FOEN is to make the existing legal possibilities for recognising imported biomethane concretely usable. The focus is on concrete pilot projects and on clarifying the legal, regulatory and methodological prerequisites for the recognition of biomethane and the cross-border transfer of associated emission reductions.

Depending on the partner country, this may require a new bilateral agreement, an amendment to an existing agreement, or a project-specific authorisation within an existing framework. Article 6.2 of the Paris Agreement and Internationally Transferred Mitigation Outcomes (ITMOs) can provide a basis for this. ITMOs are mitigation outcomes authorised by the transferring country for international use and accounted for through corresponding adjustments.

The longer-term goal of the VSG is to enable sustainable, mass-balanced biomethane imports that are recognised as regulatory equivalents to domestic biomethane under comparable conditions. This requires practical and scalable procedures



Source: dena (2025) – Branchenbarometer Biomethan 2025: Imported certificates. Figures in GWh.



with partner states, compatible registries, a reliable methodology and broader regulatory recognition beyond the company groups currently covered.

At the same time, expanding Swiss biomethane production remains a central objective. Import and domestic production are closely linked and complement each other.

STATUS AND KEY FIGURES

Thanks to existing national and European biomethane registries, guarantees of origin can today be reliably traded. These allow the origin, quantity and production method to be documented and prevent the same energy volume from being sold twice.

However, a guarantee of origin does not automatically transfer the climate impact between countries. Without a state-backed transfer, the emission reduction is in principle attributed to the country of production.

The revised CO_2 Act, in force since 2025, allows crediting under clearly defined conditions for companies in the emissions trading system and for companies with reduction obligations. However, general cross-sector equivalence with domestic biomethane does not yet exist.

The situation is also highly dynamic. Two success factors are decisive: policy and the market. On one hand, the fundamental political willingness of the exporting country is required; without it, no governmental framework or project-specific authorisation can be established. On the other, sufficient volumes of unsubsidised biomethane produced from residues and waste materials must be available and thus suitable for export to Switzerland.

CHALLENGES AND BENEFITS

The energy industry, and the gas sector in particular, is undergoing profound transformation. To achieve the net-zero target by 2050, some demand for gas is expected to remain. According to the SFOE's currently applicable Energy Perspectives 2050+ of November 2020, gas demand in 2050 is expected to be around 15 TWh. The long-term exploitable potential for domestic biomethane production is estimated at around 4 to 5 TWh.

The existing legal crediting pathway currently focuses on companies in the emissions trading system and those with reduction obligations. These customer groups often have a more limited willingness to pay for renewable gases compared to other market segments. This is attributable to their exposure to international competition. The short-term market opportunities for imported biomethane may consequently be constrained.

A partner state must agree to the transfer of the emission reduction and ensure that the same reduction is not simultaneously credited in the exporting country.

Building additional biomethane production capacity in a market environment with little or no subsidies requires substantial investment. Long-term supply agreements with Swiss buyers can increase investment security and facilitate the financing of new plants. This can create additional production capacity and generate economies of scale that potentially also benefit the domestic market of the producing country. Renewable molecules, alongside renewable electricity, are an important component of the energy transition. Biomethane can be used across a wide range of sectors, stored, and transported, distributed and used via existing infrastructure.

ECONOMIC ASSESSMENT

Enabling the creditable import of renewable gases requires considerable regulatory, administrative and economic effort. To achieve the 2050 net-zero targets and to defossilise the gas sector, reliable imports of renewable gases are needed to complement domestic production.

These imports should not only be accounted for as renewable on a balance sheet basis, but must meet high and verifiable sustainability requirements — in particular the use of appropriate residues and waste materials, full traceability and an unambiguous climate-policy attribution of the emission reduction.

Long-term Swiss demand can trigger additional production and investment in partner countries. The VSG's approach is therefore: start pragmatically, learn from controlled pilot projects, and on the basis of these experiences develop a reliable and transparent market.

LESSONS LEARNED & REPLICATION POTENTIAL

International cooperation is key: recognising emission reductions from biogas imports requires robust governmental agreements. Existing experience with Article 6, the accounting of emission reductions and international climate reporting provides an important foundation.

Clear government attribution of emission reductions: the producing country must agree to the transfer and make a corresponding adjustment to its climate accounting under Article 6, to avoid double-counting.

Robust methodology and independent verification: emission reductions must be calculated using broadly supported, transparent methods, fully documented and independently verified.

Existing registries: established biomethane registries and guarantees of origin can cover key aspects of commercial traceability — in particular preventing double-selling and documenting production. However, the climate-policy transfer of emission reductions must additionally be governed at state level.
Digitalisation as a success factor: digital systems such as the European Union Database (UDB) can increase traceability, transparency and efficiency while reducing manual processes.

Conclusion

Two editions in, a pattern is emerging that the data alone does not fully capture.

Every project in this volume began with a person, or a small group of people, who decided to do something differently — not because the policy was ready, not because the financing was straightforward, and not because the technical risks were negligible. They started because someone concluded that waiting for perfect conditions was itself a choice with consequences. The energy transition is frequently framed as a problem of technology, capital, or political will. The projects here suggest something more specific: it is, at its core, a problem of first movers. Technologies that exist on paper need someone willing to deploy them in a real building, on a real site, in a real municipality. The first deployment is always harder than the tenth. These projects exist so that others can skip ahead.

What struck us, working through these submissions, is the diversity of the actors involved. A cooperative housing community in Winterthur. A gas utility in Central Switzerland. A private bank in Zurich. A cantonal energy office in Bern. A research team. A startup. None of these actors would describe their primary role as doing the energy transition. They are building operators, financiers, researchers, planners, engineers. The transition is what happens when the right knowledge reaches the right person at the right moment. That is what this project is for.

The second edition has made one thing clearer than the first: the bottleneck has moved. It is no longer the technologies that are missing, nor, primarily, the capital — financing is available for well-structured proposals. The bottleneck is the institutional layer: approval processes, grid connection procedures, expertise concentrated inside too few organisations, political cycles that make decade-long commitments difficult. These are real constraints. They are also changeable ones — which is a different kind of problem from a missing technology, and in some respects a more tractable one.

The work ahead is therefore less about invention and more about replication: moving solutions out of project mode into standard practice, turning first deployments into repeatable models. The next edition will need to look harder at exactly that.

In the meantime, this is an open invitation. If you have a project that belongs in these pages, bring it. If you are at the beginning of something and want to learn from those already further along, the network is there. The work is not short. But it is clearly under way.

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OE-EN AG
Schochenmühlestr. 6
6340 Baar
Switzerland
www.oe.energy
backoffice@oe-en.com
+41 41 511 70 10

energie-cluster.ch
Gutenbergstrasse 21
3011 Bern
Switzerland
www.energie-cluster.ch
sekretariat@energie-cluster.ch
+41 31 381 24 80