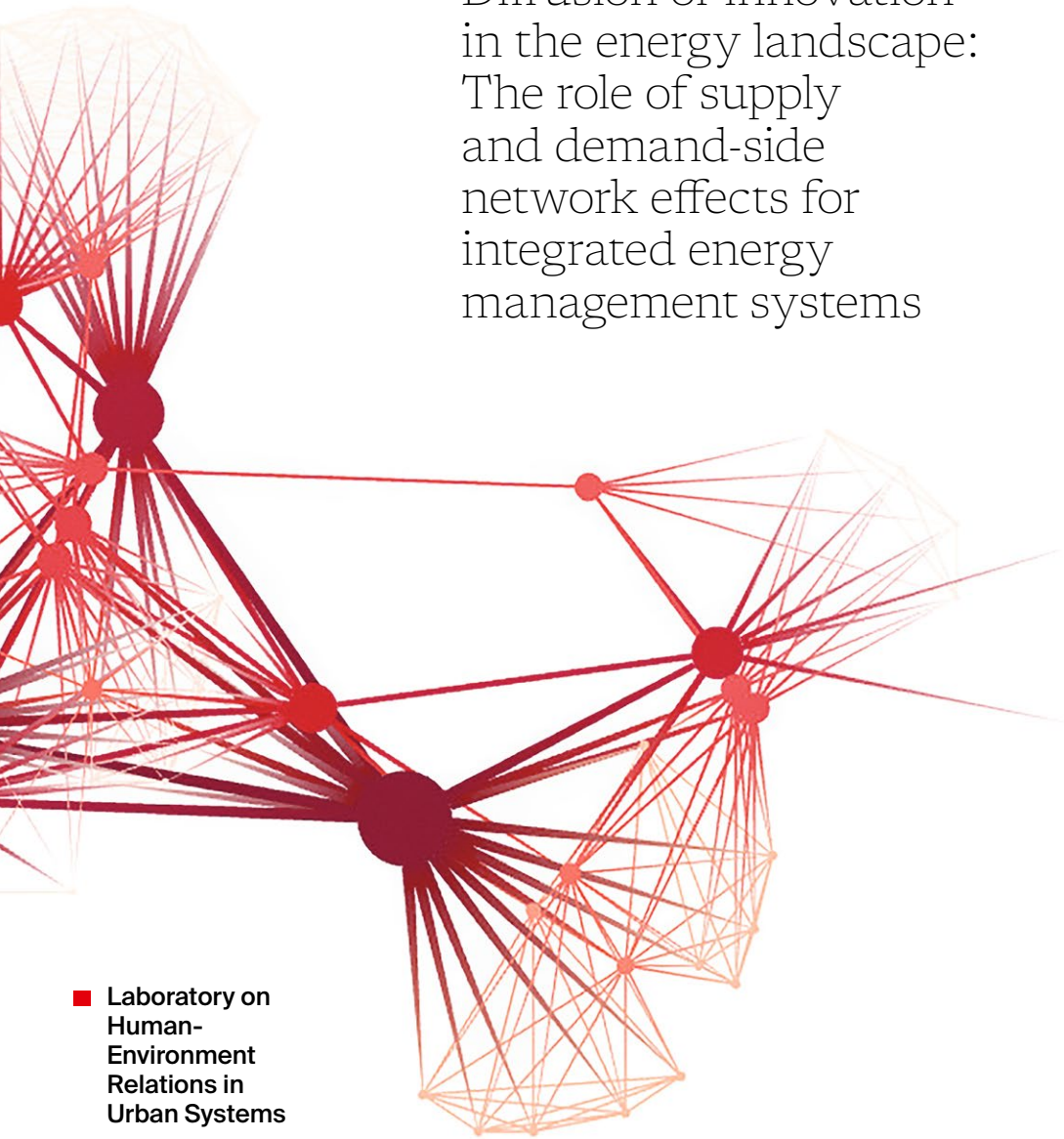
InnoNet-Energy

Diffusion of innovation in the energy landscape: The role of supply and demand-side network effects for integrated energy management systems



Laboratory on Human-Environment Relations in Urban Systems

Project

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Project partners:
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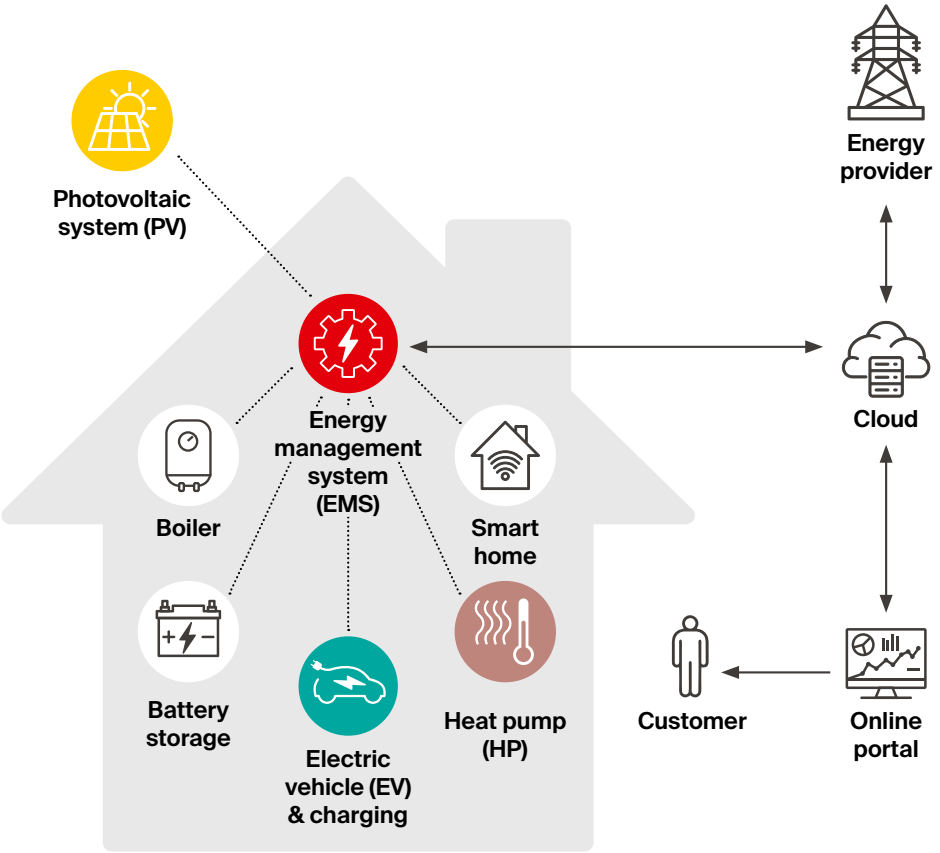
The main goal of the project is to understand information networks of actors on the supply and demand-side of energy management systems in Switzerland.
We particularly focus on social and spatial proximity effects and its role in the diffusion of energy technologies in the residential building sector.



Energy management systems

An effective management of energy within a building is facilitated by energy management systems, serving as pivotal tools for monitoring and regulating energy production and consumption. They enable the automatic control of several appliances, such as charging stations for electric vehicles, heat pumps, battery storages, or other household devices.

Energy management systems can relieve power grids by shifting the operation of non-essential appliances to off-peak hours. This prevents an overload of the building network connection and stabilizes the grid as a whole.

ENERGY TECHNOLOGY ADOPTER PROFILES

Energy technology adopters are mostly homeowners

Compared to the general Swiss population, energy technology adopters tend to be older, have higher levels of education and income, and frequently live in a partnership with children.

Those who adopted multiple energy technologies (EMS, PV, and EV) and those who solely adopted PV, are homeowners, and the great majority of them live in single-family houses. Around one quarter of them adopt energy technologies during building renovation.

	Survey respondents who have...			
	EMS, PV and EV N=1076	**only PV** N=630	**only EV** N=800	Swiss population
Socio-demographics				
Mean age	**56**	**61**	**50**	**43**
Tertiary education level	**47%**	**37%**	**51%**	**25%**
Employed	**74%**	**56%**	**82%**	**59%**
Retired	**22%**	**41%**	**15%**	**23%**
Monthly household income > CHF 9000	**61%**	**33%**	**56%**	**12%**
Couple with children	**61%**	**49%**	**48%**	**34%**
Buildings				
Homeowners	**98%**	**100%**	**62%**	**36%**
Single-family building	**82%**	**83%**	**44%**	**57%**
Renovation with technology adoption	**25%**	**24%**	**8%**	**–**

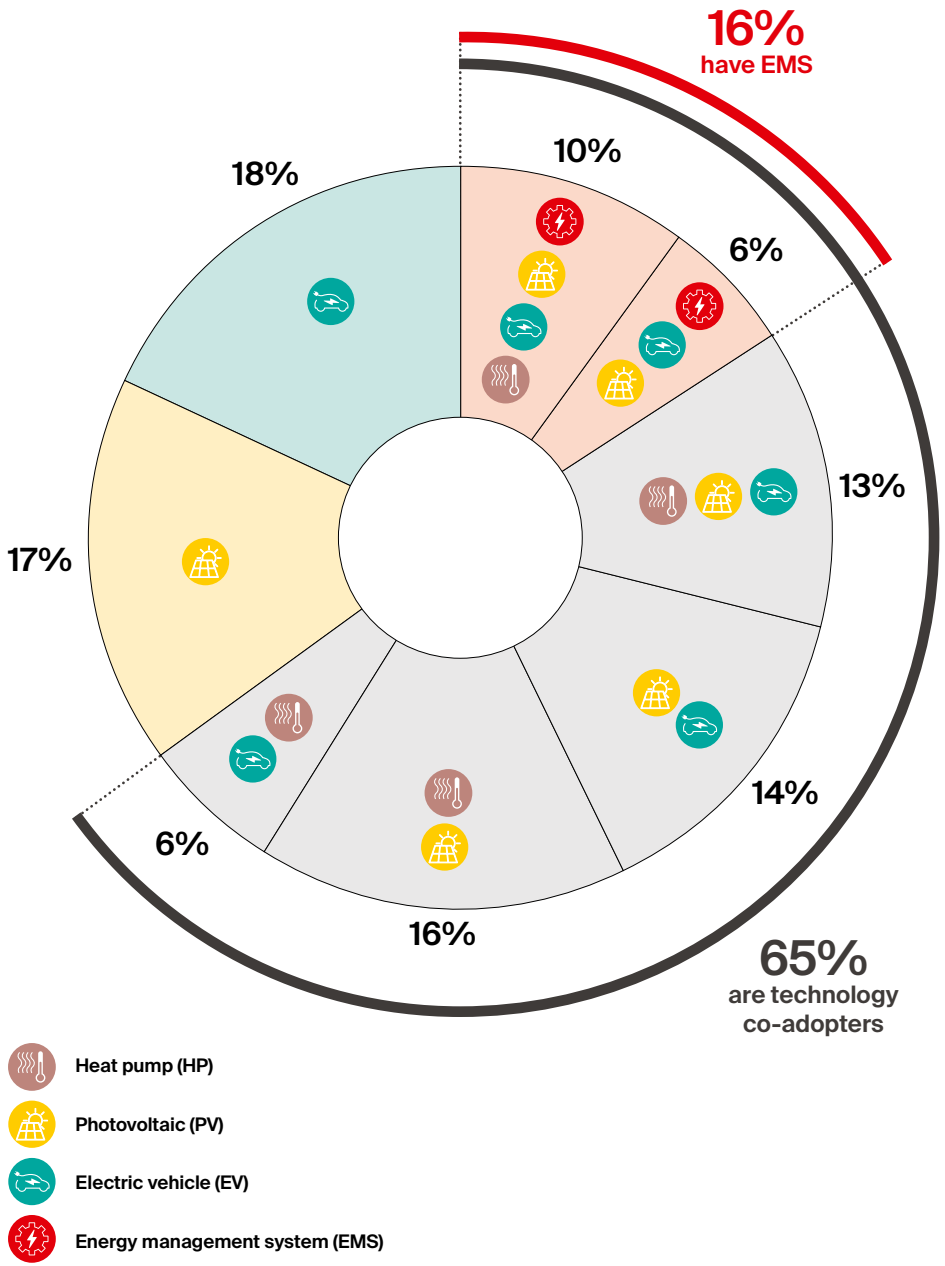
ENERGY TECHNOLOGY CO-ADOPTION PATTERNS

High share of energy technology co-adoption reveals EMS potential

Among the survey respondents, 65% are energy technology co-adopters using multiple technologies, whereas 35% of them exclusively use either PV or EV.

Already 16% of the respondents have EMS installed which indicates an uptake of EMS in the Swiss residential building sector. The significant share of energy technology co-adoption indicates a promising potential for the further diffusion of EMS.

Installations of energy technologies
N=4850

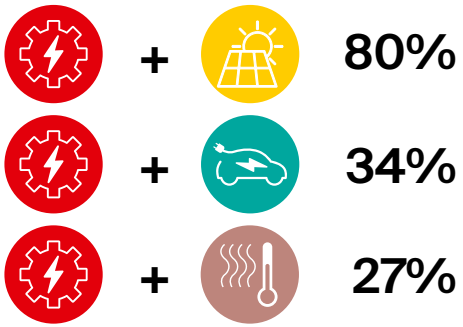


Energy technology bundles are highly relevant while PV triggers EV

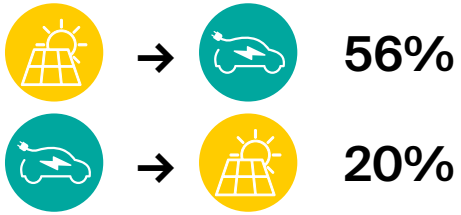
The findings reveal that EMS is mostly installed as a bundle, i.e., at the same time together with other energy technologies. In 80% of the cases, EMS is installed in a bundle with PV. In 34% it is installed together with the purchase of an EV, and in 27% it is installed with HP.

PV seems to be an important trigger technology for co-adoption. In 56% of the cases, PV is adopted before EV, while EV is adopted before PV in only 20% of the cases.

Energy technology bundles
Installation at the same time
N=1480



Sequence of energy technology adoption



Note for both graphs:
To analyze the order of energy technology adoption, we focused on homeowners who adopted PV or EV in 2021.

RECOMMENDATION

Promote energy technology co-adoption through bundles

- → Offer bundles whenever PV installations or large consumer technologies are purchased or registered.
- → Use windows of opportunities, especially moments when PV is installed, or when buildings are renovated.

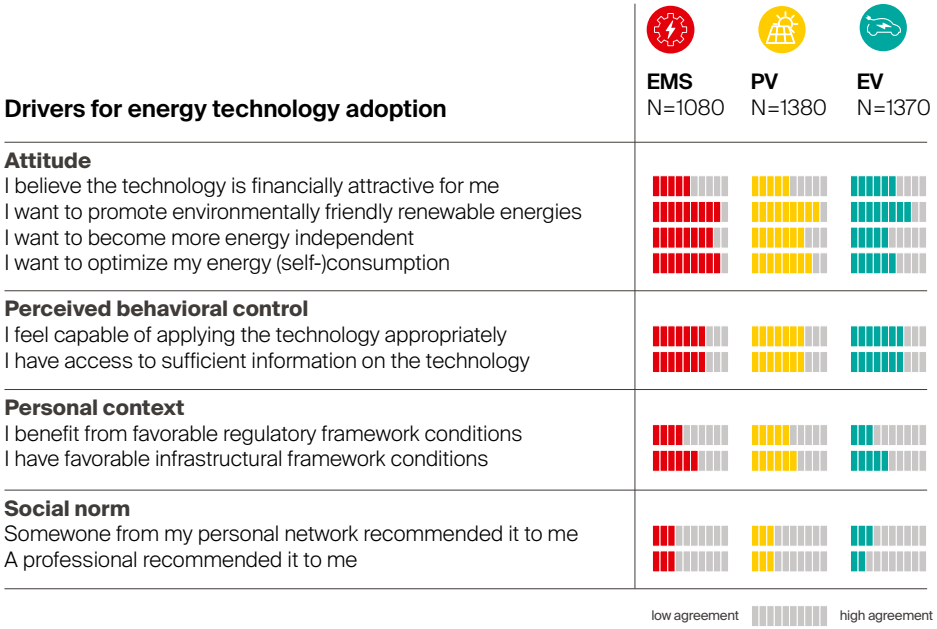
Possible action point
Energy technology providers and energy utility companies are key for promoting bundles. Besides, architects and engineers could raise awareness of integrating energy technologies when buildings are renovated.

DRIVERS AND BARRIERS FOR ENERGY TECHNOLOGY ADOPTION

Perceived financial viability of energy technologies is low

There is little variation in the factors influencing the adoption of different energy technologies. We find that technology adopters of EMS, PV and EV want to engage in the energy transition. They are all mostly driven by their positive attitude towards renewable energies, energy independence and optimizing energy self-consumption. Nevertheless, energy technologies are not (yet) perceived as financially attractive.

For EMS, the lack of financial viability is mentioned as the primary barrier for adoption. Besides that, the lack of harmonized technical standards for system integration and the complexity of actors' landscape were identified as relevant barriers for the diffusion of EMS.



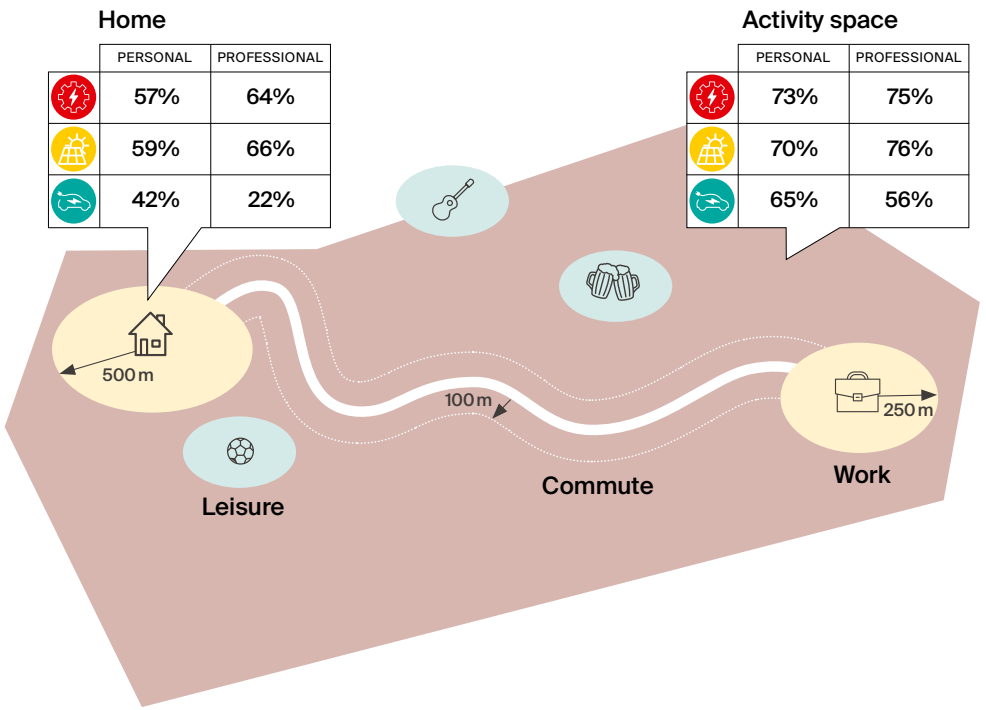
RECOMMENDATION

Raise awareness about long-term profitability

- → Enhance awareness about innovative and renewable energy technology solutions and their long-term profitability.
- → Steer processes to harmonize technical standards and protocols for securing system compatibility and interoperability.
- → Sensitive energy technology providers to leverage their synergies, so that they can assist potential energy technology adopters along the process from the initial idea to the actual implementation of the technology.

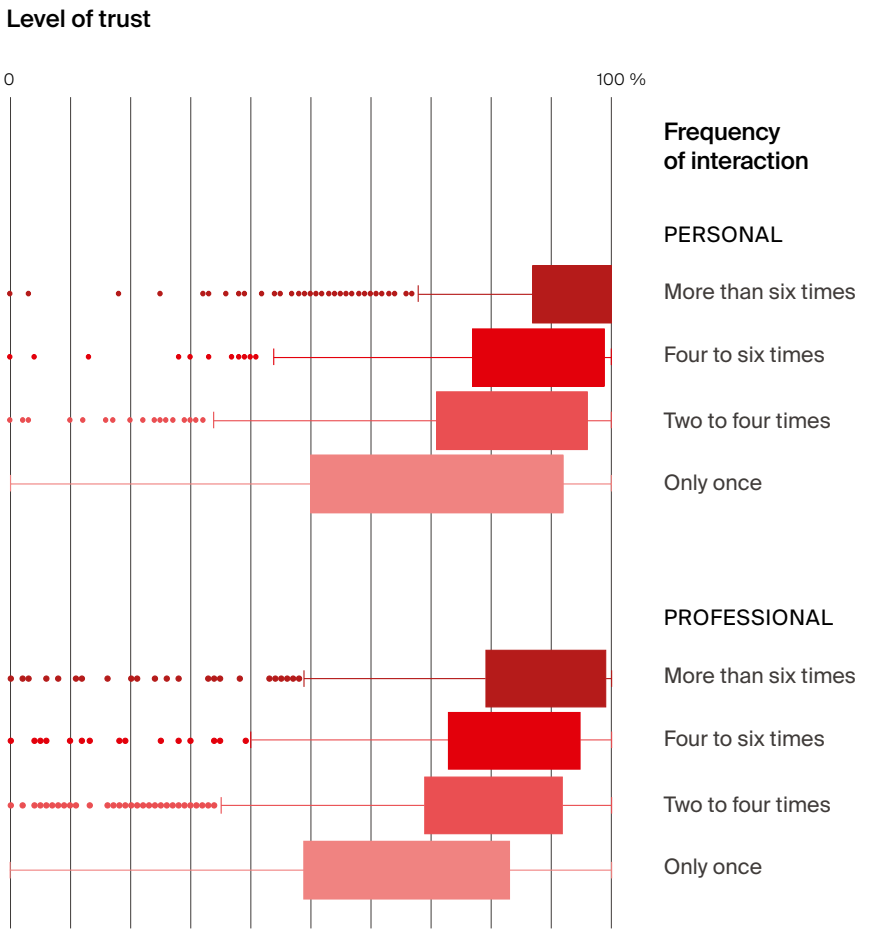
Possible action point
Public authorities as well as associations could provide a platform to harmonize technical standards. For example, the association *SmartGridready* is developing a label to ensure reliable communication between appliances.

INFORMATION EXCHANGES OF ENERGY TECHNOLOGY ADOPTERS



Exchanges take place within personal activity space and around the home

The most relevant information exchanges during the decision-making process of energy technology adopters take place within the area where they conduct their regular activities, especially around their home. We can observe this pattern for both exchanges with professionals and personal contacts. EV adopters exchange less frequently around these places than PV and EMS adopters.



Trust correlates with frequency of interaction

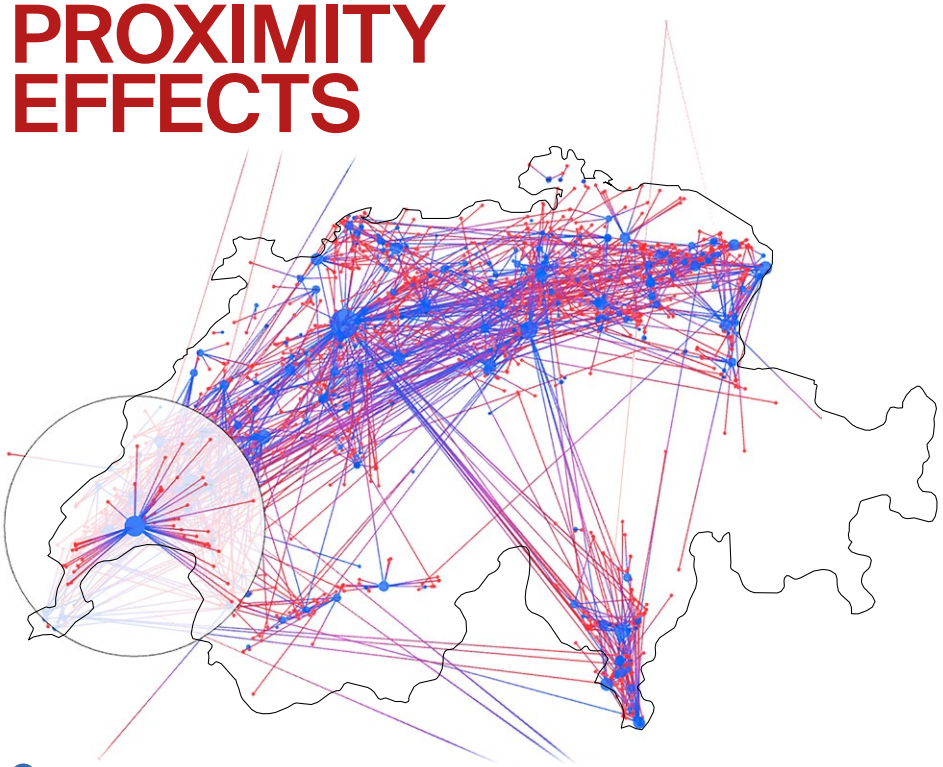
The more often energy technology adopters exchange information with a professional or a person in their personal network, the more they trust this person. EV adopters have less interactions with lower levels of trust.

Build trust to increase the effectiveness of information campaigns

- → Plan events with people who already adopted energy technologies, encourage them to bring family, friends, or acquaintances.
- → Identify socially active members of the community and leverage their connections to spread information.
- → Organize information or marketing campaigns with repetitions, e.g., several events in the same location or reaching out to the same people several times.

Possible action point
Municipal events could be organized where local energy technology adopters in collaboration with local energy technology providers inform the community and showcase the feasibility of innovative energy solutions.

SOCIO-SPATIAL PROXIMITY EFFECTS



Energy technology adopters mostly exchange information with local supply-side actors

Energy technology providers are by far the most relevant information sources for energy technology adopters, while energy utility companies rank second. They mostly exchange information with local supply-side actors, which showcases the importance of spatial proximity.

Together with the results shown before, we can highlight the importance of social and spatial proximity for the diffusion of energy technologies. We identify an accelerating triad: spatial proximity, frequency of interaction and trust.

Socio-spatial proximity is key

"Yes, it was very important that the energy utility entity was local. The **proximity of the energy utility to the people has been important** for the general decision of the community. I could imagine that if the same presentation had taken place with strangers, the dynamics would have been very different."

"Yes, **we favour spatial proximity**. This generally means a faster intervention, with less issues. We are not going to search for a provider on the other side of Switzerland unless we cannot find him around here."

"Interpersonal human relations are the most important thing. Seeing each other **face-to-face** (...). We cannot work alone anymore, we need to cooperate. With close relations one develops trust, and **trust is crucial** to work together."

"Personal exchange is important and it's easier if you are closer, but **cultural proximity** is even more important."

RECOMMENDATION

Leverage local energy technology providers as change agents

→ Inform energy technology providers about their leverage on the local level.

→ Provide energy technology providers with technical, financial, and regulatory information material which they can use to inform potential energy technology adopters.

Possible action point
Associations could play a key role to sensitive energy technology providers and provide them with information material for potential technology adopters.

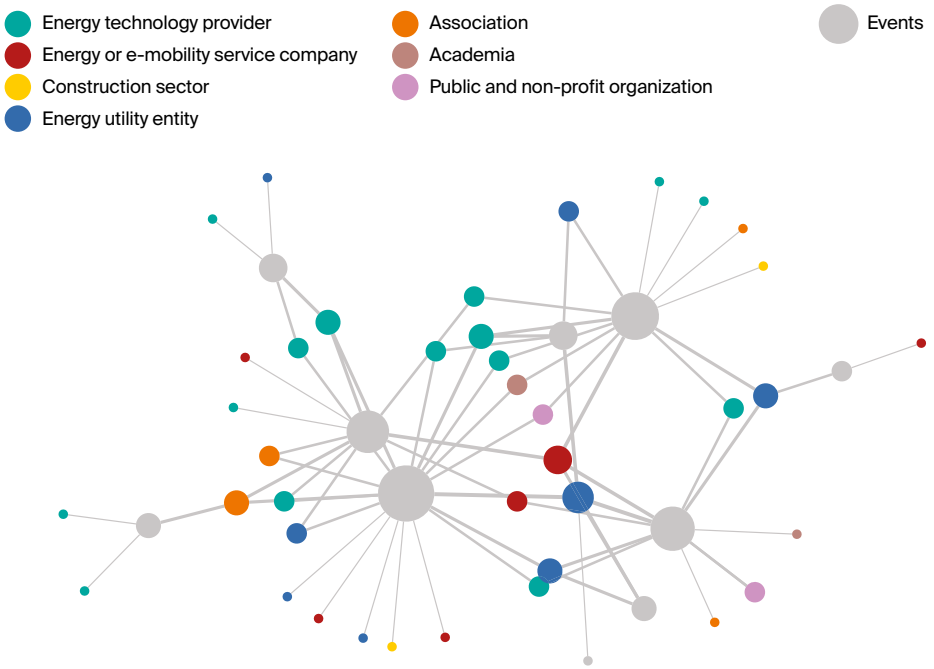
SUPPLY-SIDE INFORMATION NETWORK

Events and associations have a brokerage role and connect actors from different fields

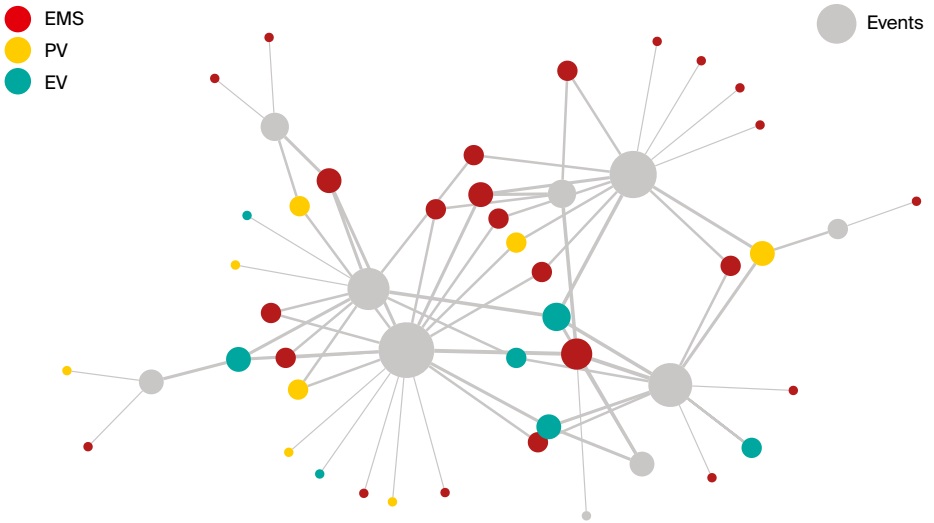
Events and associations connect a diverse range of actors, such as energy technology providers, energy utility entities, associations, academia, etc. They also bring together actors working with different energy technologies.

A tight supply-side actor network that links both different types of actors and energy technologies, can be used as leverage to rapidly diffuse new information.

Types of supply-side actors



Energy technologies supply-side actors work with



RECOMMENDATION

Strengthen supply-side actor network through events and associations

→ Leverage events and associations to improve coordination among supply-side actors and to discuss the harmonization of technological standards and protocols.

→ Utilize the network of supply-side actors to collect their specific needs to support potential technology adopters regarding technology integration.

Possible action point
Learn from existing events and associations such as the event *Powertage* and the association *Swissolar* which were identified to have a key diffusion role in the current supply-side actor network.

Methods

In this study, we followed a mixed-methods approach, conducting 36 qualitative expert interviews involving actors on the supply-side of EMS such as energy utility entities, energy technology providers, academia, consultancy firms, and advocacy groups. In addition, interviews were held with demand-side actors within the residential building sector, including homeowners, condominium owners, institutional owners, engineers, and architects.

Drawing on the insights gained from these interviews, we launched two quantitative surveys. One survey targeted Swiss households that recently adopted PV and EV, while the other targeted organizations working with EMS, PV and EV. The surveys provided data from approximately 5'000 energy technology adopters and 160 organizations.

German interview partners

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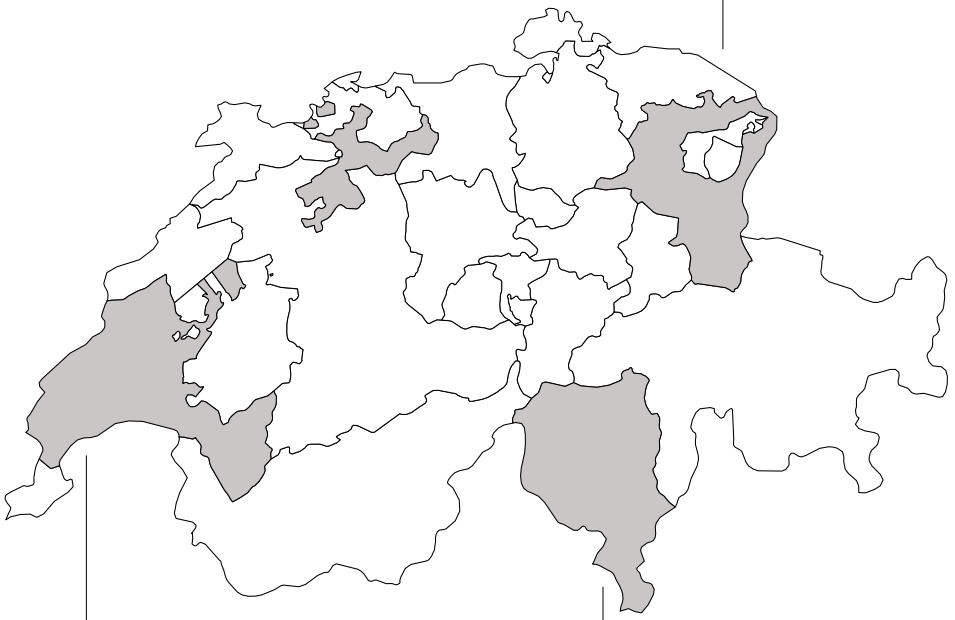

French interview partners

HEIG-VD, ROMANDE ENERGIE, PLANAIR, greenmotion

Italian interview partners

ail, BORGO DIASCONA, AEM, enerti, HIVE POWER, SUPSI

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