Technology ready, but acceptance pending for distributed energy systems

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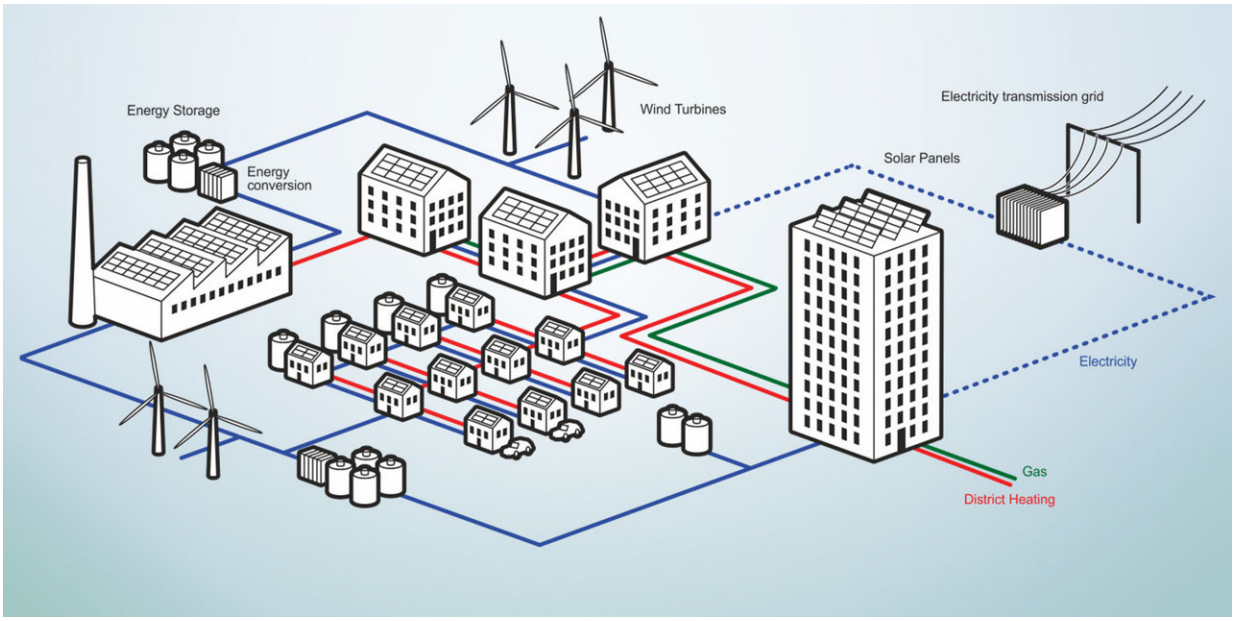

A network of energy producers and consumers. Credit: Sandro Bösch / ETH Zurich

Will we be able to do away with the classic centralized energy supply in the future? From a technological perspective: yes. Distributed multi-energy systems are feasible. But from an economic and societal perspective, many questions remain unanswered, blogs Roman Seidl.

Thermal solar energy systems heat the floor and water for the shower, an

elevator runs on solar and wind energy, and whatever electricity is not consumed today is stored in batteries for tomorrow or will be available next month in the form of gas. And if your own energy reserves are not enough, the battery from your neighbour's electric car can help out.

This is not a utopian scenario: distributed multi-energy systems or energy hubs work in individual buildings – such as single-family homes, apartment blocks or in the NEST research building of Empa and Eawag in Dübendorf – or in entire neighbourhoods. Regio Energie, for example, operates a large network in Solothurn, and the electric utility of the city of Zurich (EWZ) is also testing various concepts. An energy hub of this kind has existed since 2016, and arguably in its most extreme form: an energy self-sufficient apartment block in Brütten that is already fully decoupled from the electricity and gas grid.

Research has been carried out for some years at ETH Zurich on distributed multi-energy systems. The principle: energy consumption and energy production come closer together physically, exploit synergies and become more efficient.

H2 and batteries store solar energy

The energy technologies required for energy hubs are now commercially available, favourably priced and technically effective. Electricity from solar panels or other sources can be converted into hydrogen using electrolysers and stored in tanks or in the gas network. Fuel cells later turn it back into electricity and heat for when demand is especially high or the sun is not shining. Batteries compensate for short-term fluctuations. From a technical point of view, there is still the challenge of how to optimally regulate an energy network; the control technology for this is also being developed at ETH Zurich.

Energy hubs can play an important role in the energy supply of the

future. However, the concept still has to overcome societal and economic hurdles, such as those of privacy: if a house is part of a network in the neighbourhood, the consumers relinquish some of the control.

Would you be willing to let the control technology turn off your freezer for a short period of time, determine the charging time of your electric car or automatically regulate the temperature to between 20 and 24 degrees in the winter? Questions also arise with respect to the safety of the energy systems, the reliability of the energy supply and the protection of the data on individual energy consumption, which by necessity must be available to regulate the energy systems.

Who takes the first step?

What's more, distributed energy supply lacks an economically rewarding concept. Surveys conducted as part of our research show that potential users, i.e. homeowners and tenants, regard energy hubs as useful in principle. But it is only a minority of users that are currently taking the first step and participating in hubs on their own initiative, mainly because the required level of investment is high and the regulation of hubs is complex. Homeowners and tenants see the federal government and energy suppliers as responsible.

Distributed energy systems are often associated with grassroots initiatives such as energy communities or self-sufficient villages. A pilot project involving the general population has yet to be launched. Energy cooperatives are pursuing exciting approaches such as an "energy commons", which decentralised producers and consumers can join.

Transforming a highly complex system

Multi-energy systems are therefore no utopia – but it will take time until they arrive in the real world. The current sticking points are financing, networking with other households, implementation in the old building stock, data protection and control. Plus there is much more at stake than just a new technology. A distributed energy supply calls for the transformation of an entire energy system with all its societal and technical challenges.

More information: Paolo Gabrielli et al. Optimal design of multi-energy systems with seasonal storage, *Applied Energy* (2017). DOI: 10.1016/j.apenergy.2017.07.142

Timo von Wirth et al. Distributed energy systems on a neighborhood scale: Reviewing drivers of and barriers to social acceptance, *Renewable and Sustainable Energy Reviews* (2017). DOI: 10.1016/j.rser.2017.09.086

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