Towards a sustainable energy future by an Energy Supply Cooperative (ESC)

Introduction

Nowadays, it is accepted worldwide that substantial measures need to be taken to stop climate change. Reducing the amount of CO_2 that is being emitted is seen as a decisive measure to combat climate change and has high priority with politicians. During the climate summit in Paris December 2015, the participating 195 countries agreed that the CO_2 emissions need to be significantly reduced to keep global warming below 2°C. One important way to reduce the amount of emitted CO_2 is to reduce the amount of fossil fuels for energy production by introducing renewable energy sources.

In several European countries, especially in Germany, a lot of effort is being made to increase the usage of renewable energies. For many years, a reliable infrastructure has enabled the power transport between central power plants and domestic, commercial and industrial consumers. But the way of our energy provision and consumption is changing. First of all, we are using electricity for new energy intensive applications such as heating buildings and transportation. Secondly, we are introducing renewable energy technologies like solar panels, which do not provide steady levels of production. Finally, energy provided by distributed small-scale devices has to be inserted at many different locations into the power grid, such as households. In Germany, the decentralised injection of renewable energies is continuously growing as shown in the following figure for PV systems smaller than 1 MWp.

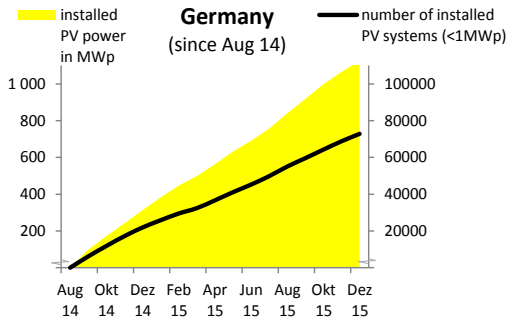

Fig.: *German development of PV systems smaller than 1MWp since August 2014 (obtained from German PV plant register).*

These issues call for economically reasonable concepts to use renewable electricity locally and when it's available. Therefore, companies, research institutions and universities come up with analyses and solutions in various different ways.

The ESC project

A concept for energy-efficient, environmentally friendly residential quarters has been developed by evohaus as entrepreneur with an experience over decades, specialised in building low-energy residences. In a consortium with TNO and the university research work of the KIT, evohaus has realised its idea of CO_2-free and energy-efficient residential living.[1]

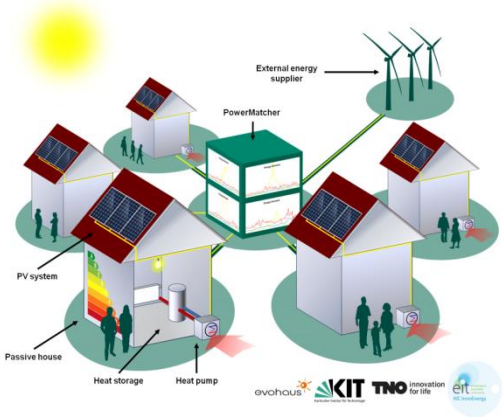

Fig.: *ESC concept for energy-efficient, environmentally friendly residential quarters.*

The concept is being demonstrated on two quarters of 150 units built in Cologne and Hilden that only use electricity for the main energy supply and the PowerMatcher as a smart energy management system developed by TNO, with standard interfaces. As a result, the energy consumption per head is effectively reduced and the own usage of photovoltaic energy is also increased from 30% (state of the art) up to 70%. These improvements could be essentially achieved by the cooperative energy consumption.

[1] evohaus, the initiator of the ESC project, is a housing society with a deep focus in energy-saving, CO_2-free energy production, high-level self-consumption of PV-energy, low-cost energy supply and energy management system solutions. TNO is a nonprofit Dutch national research organization that focuses on applied science. KIT, the Karlsruhe Institute of Technology, is a merger of the former Technical University of Karlsruhe with the large-scale Research Center of the Helmholtz Association.

Therefore, evohaus has formed a contractual basis for the private energy share within the quarter and to others. Further reasons for the improvements are the integrated modern passive house technology and new forecast algorithms of the energy supply and demand required for an optimal energy management. The general insight of the ESC project is that the combination of PV systems, heat pumps and thermal storages in such residential quarters proves to be viable for current and future markets. For further analysis purposes, the quarter is modelled as mixed-integer program that can take into account different energy production and storage technologies as well as different electricity tariffs. The optimal capacities of these quarter's components depend most on specific characteristics of the quarter like location, size, number of residents and others. In practice, storages for domestic hot water provide more useable load shift potential than for space heating due to constant demand over the year for hot water. The KIT has also computed that electrical storages with present market prices (status 2015) cannot be integrated economically. But the residents can achieve a higher degree of autarky and security energy supply for marginally increased energy costs. These energy costs can be reduced when maximum demand tariffs or dynamic spot prices from the electricity exchange will be obtained: Then the smart algorithm of the energy management system can better exploit the quarter's load shift potential by determining the best moments for energy consuming, producing or storing. For these smart algorithms, manufacturers of appliances have to cooperate in order to make it possible to actually control an appliance. Currently, this is not a topic that has a lot of attention from manufacturers.

A questionnaire to the residents has shown that half of them do not know their actual consumption or energy bill. But residents did indicate that their energy consumption behaviour can be influenced by financial reasons, a high degree of renewable energy supply and the comparison of their energy consumption to others. So the awareness of the energy consumption and costs results in quarter-inner competition and, consequently, in a higher PV self-usage and a reduced energy consumption from the public grid.

The questionnaire has additionally revealed that such a quarter is attractive to everyone: for singles, pairs, families and other living communities of any age, education and profession. Other than location, most important for the residents is the resource-saving, environmental-friendly coverage by renewable energy sources. Further reasons for buying an ESC living unit and becoming part of the cooperative are the possibility of a secure energy self-supply and the low variable energy costs for an affordable price. The integration of electrical storages and vehicles is also welcome.

What is needed

The ESC project shows that it is possible to use the flexibility in households to cope with fluctuations and uncertainties of renewable energy sources. However, in order to make a large-scale introduction possible, somethings need to change.

- **Easier access to the energy markets**

Access to energy markets helps to make the developed concept economically more attractive. Also, if the right incentives are offered and, e.g., included in the electricity price, such quarters might be a way to help to balance the energy supply and consumption and stabilise the electricity grid.

- **Standard interfaces for devices**

In order to make large-scale introduction of active control algorithms possible, two things need to happen. Firstly, manufacturers have to become aware of the urgency, and have to implement interfaces on their appliances to make external control possible. Secondly, standardised interfaces have to be developed in order to make it easy for different solutions to connect to different appliances, and vice versa.

- **Further research concerning the power connection between different properties**

In order to identify a balanced assignment of rights and duties between the involved parties, further research in the field of energy supply from one to another private property is needed.

In general, the cooperative concept of a low-energy quarter using renewable energy sources and storages in combination with the basic evohaus idea of an energy community can be one opportunity to support a sustainable, future energy system in Germany and in the entire European Union.