# QUO VADIS ENERGY COMMUNITIES – OPPORTUNITIES AND CHALLENGES OF SHARED ENERGY SYSTEMS

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## Overview

The current developments at EU level in the new version of the Renewable Energy Directive 2018 and the Directive on common rules for the internal market for electricity 2019 are driving Energy Communities. In particular, current development focuses on the terms renewable energy communities and citizen energy communities. Even if these energy communities have many similarities, they differ in essential aspects such as the geographical proximity to the project and the considered form of energy (electricity, heating and cooling vs. pure electricity). Both energy communities, by definition, are not characterised by the achievement of financial profits, but by the achievement of environmental, economic or social community benefits.

The results presented in this paper are based on findings from the Pocket Mannerhatten Ottakring project supported by the Climate and Energy Fund in Austria. In this analysis, we focus on a use case of a renewable energy community in the district of Ottakring in Vienna, where the proximity to the project of all stakeholders involved is given and, in addition to the generation of electricity and heat, the energy distribution within the pilot block plays a role. The results reveal not only the opportunities offered by such an energy community, but also the challenges that still have to be taken up especially with regard to the regulatory and legal framework.

## Methods

The modeling focuses on cross-building power and heat exchange. In doing so, the buildings' potential for renewable energy generation systems as well as its electricity and heat consumption based on the age and usage structure are investigated. The optimal distribution of electricity and heat is derived from a linear optimisation model. The objective function of the model minimizes the costs of energy purchase along a time period of 25 years. The possibility of interlinking electricity, heat and mobility is implemented by using photovoltaic systems, solar thermal systems, heat pumps including buffer storage and electromobility for the purpose of consuming as much of the generated renewable energy as possible in the focus block, see concept in Figure 1.

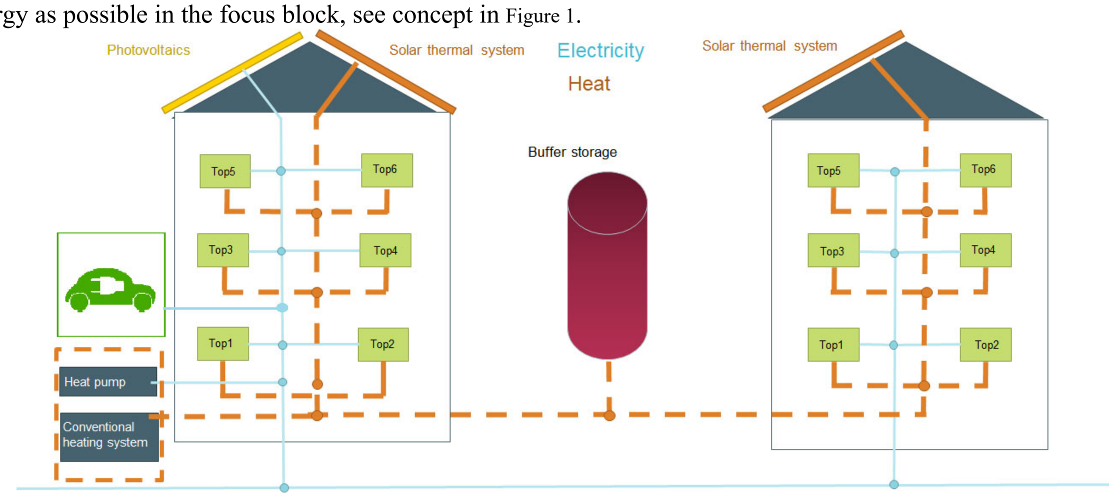


**Figure 1: Modelling concept for integrated simulation of sharing electricity and heat**

The electricity load per household is based on measured load profiles which are extrapolated to the desired consumption. The annual heat consumption is, as mentioned above, derived from the usage behaviour and the age of the building (taking any refurbishment into account) and compiled into a load profile based on outside temperature. The PV electricity, as well as the solar thermal energy generated on site are distributed to the residential units based on their current load in relation to total building load. The economic calculation uses the internal rate of return (IRR) as an approach, in which the investment costs have to be equal to the discounted cash-flow:

$$NPV = -(I_{PV}) + \sum_{t=1}^{25} \frac{C_t}{(1+IRR)^t} = 0$$

The cash-flow ($C_t$) is mainly affected by self-consumption, energy tariffs, feed-in remuneration and operation and maintenance costs.

## Results

The theoretical potential for solar thermal and photovoltaic energy in a block of houses can be limited quite substantially by the actual roof area potential due to shade, unfavourable roof structure or difficulties in the ownership structure requiring unanimity for any changes or investments in the building. This is also true for some areas of the focus block in this research.

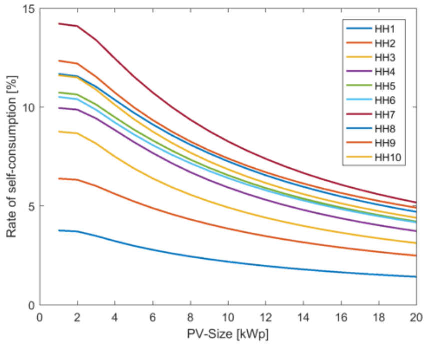


**Figure 2: Share of self-consumption of households in apartment buildings**

Figure 2 shows the share of own consumption and coverage of 10 residential units in a block assuming different PV sizes. The total consumption of these apartement buildings was assumed to be 20,000 kWh/a. When we add up the share of own consumption per unit, see Figure 2, we see that especially for small PV systems almost 100% can be achieved. With a PV system expansion, however, the share of own consumption naturally decreases. In energy communities, the share of own consumption as well as the coverage ratio in a larger block can be increased significantly, by making use of the variation in the load profiles and user behaviour within one block,. In addition, further synergies can be levied when electricity is exchanged between two or more buildings with photovoltaic systems, only charging the actual balance.

Adding solar thermal and buffer storage, results in a similar picture on the heat side. Figure 3 shows a typical summer week for heat generation on the left and the buffer storage level on the rightin which large parts of the energy can be used for hot water preparation or stored in the buffer storage. Still, depending on the storage size, it may happen on the one hand, that the solar thermal surplus can neither be used directly nor stored in the buffer tank or that at least for several weeks no recharging by the conventional heating system is necessary. This is the case in summer, when the buffer storage can be fully charged by the solar thermal system, see Figure 3 on the right hand side.

On the other hand, it may occur that the primary heating system also has to operate in summer if there is not enough solar thermal energy available.

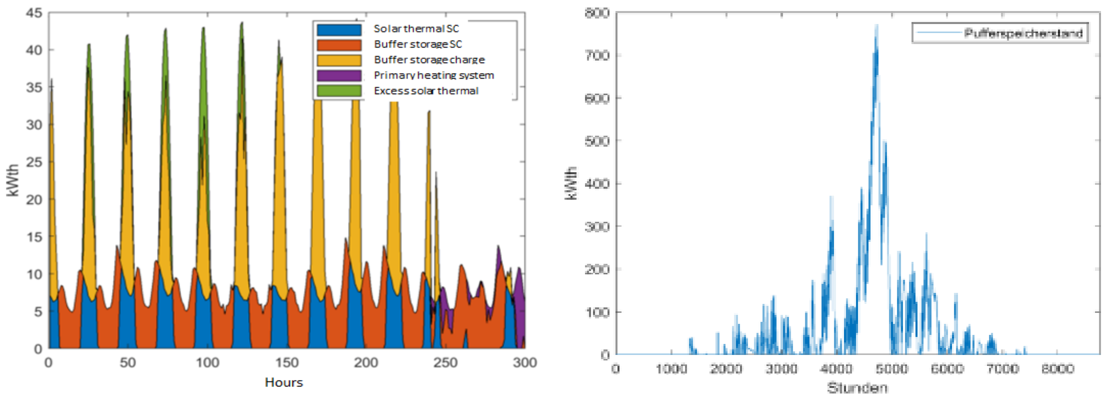


**Figure 3: Left: Solar thermal generation and demand in a typical summer week, Right: Storage level during one year**

## Conclusions

Collaboration concepts can bring significant advantages with regard to the utilization of the decentralized renewable energy sources. On the one hand, the locally consumed energy can be increased and on the other hand, the costs can be shared. The final version of this paper will further discuss the effects of the interlinking of electricity, heat and mobility and the practical hurdles that still exist for energy communities as well as the economic outcomes of this analysis