**Pilot description:**

The Norwegian pilot consists of 7 residential buildings based in the test zone for urban sustainability,[Svartlamon](https://svartlamon.org/" \t "_blank), located in Trondheim. These experimental households are in an ecological research area with the goal of forming an environmentally friendly community. The houses are equipped with meters measuring the hourly energy consumption. The metered hourly consumption is available from January 2020 to March 2022[[1]](#footnote-1). The metered data from 2021 is used to perform the analysis in the following. Table ... shows the total consumption of houses over 2021.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **H1** | **H2** | **H3** | **H4** | **H5** | **H6** | **H7** |
| **Consumption [kWh]** | 5918 | 6368 | 7475 | 13366 | 23481 | 16179 | 6762 |

We assume there exist five units of 5 kW and one unit of 3 kW PV systems in the neighborhood owned by different houses. Under this assumption, the energy generated by renewable resources is around 30 percent of the consumption over the year, i.e., 23079 kWh. It is assumed that the solar units are distributed between the houses based on their consumption. Therefore, the houses with higher consumption do have bigger PVs. Accordingly, houses H3 to H7 (the first five consumers with the highest consumption) have a 5 kW solar unit each, and H2 has the 3 kW PV system. Also, an EV is connected to H5 during its availability period. The pattern of EV availability has been estimated based on [a]. In addition to the consumption and generation data, the price signal for buying/selling from/to the grid is another parameter required for the analysis. The price of energy consumption for the end-users consists of the spot price plus the energy term () determined by local DSO [b]. The first term of … shows the amount the houses should pay for their consumption over a period. Where and , and are spot price, energy term, and the energy consumed by house *h* at time t respectively. Moreover, a marginal loss rate (6.5% winter day, 6% winter night/weekend, 5% the rest of the year) is used to calculate the Feed-in tariff. The feed-in price is then calculated by subtracting the marginal loss rate from 100 percent and multiplying the resulting term () by the spot price. Therefore, the second term of … indicates the amount the houses get paid for selling energy to the grid. is the energy fed into the grid by house *h* at time t. These two terms together form the objective function of the Norwegian pilot.

**Results:**

In this pilot, three cases have been compared to demonstrate the benefits of installing solar panels and forming energy communities. In the first case, called “No RES”, the houses minimize the cost of their consumption separately. The second case, called “No Community”, is similar to the previous case in the sense that the houses do not interact with each other and do optimize their energy consumption separately. The difference between this case and “No RES” is the presence of PV panels in this case. In the third case, “Community”, the houses form a community and optimize the total consumption at the community level.

The analysis is performed for a period of three months, from April to June. Table … shows key performance indicators related to the study.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **No RES** | **No Community** | **Community** |
| **Total cost [NOK]** | 20763 | 14290 | 12808 |
| **Average monthly cost [NOK]** | 989 | 680 | 610 |
| **Total grid consumption [kWh]** | 16941 | 12004 | 10829 |
| **Sold to the grid [kWh]** | - | 5479 | 4174 |
| **Self-consumption [kWh]** | - | 4921 | 6227 |

According to the table, the average monthly cost of energy consumption is slightly less than 1000 NOK per household. However, installing the mentioned PV panels reduces this average cost to 680 NOK (more than 30 percent). The reason is that the energy generated locally covers some parts of the consumption and reduces the energy imported from the grid. Also, the energy surplus will be sold to the grid at the feed-in tariff price. The cost reduction is even higher in the “Community” case as, in this case, the houses are able to share their energy surplus with others, and the locally produced energy is consumed by the community. It is worth mentioning that 1611 kWh of internal energy sharing brings these extra benefits to the community. The internal energy transactions take place at a price higher than the feed-in tariff and lower than the grid tariff. Figure … shows the aggregated daily net cost of the houses for different cases and demonstrates how PV systems and energy communities lead to cost reduction for pilot households.



[a] Lakshmanan, Venkatachalam, & Bjarghov, Sigurd. (2021). Versatile electric vehicle charging profile generation tool for home charging scenarios for regional case study. Zenodo. https://doi.org/10.5281/zenodo.4599635

[b] Marthe’s paper

1. It is worth mentioning that the data has some missing values during the mentioned period. [↑](#footnote-ref-1)