

Popular Science Summary

This present study shows that trading electricity in residential communities in Sweden is a way to make supplementary financial benefits for PV owners. The results of this research also showed that profit increases as individuals are trading their electricity with more households. By saving money on purchased electricity and making more money on selling their surplus electricity, owners sharing their PVs are able to gain extra benefits. This study also demonstrated that sharing PV systems within households makes larger systems more profitable over time and leads to reduction of the payback time for the system's initial investment.

One of the Swedish government's sustainable goals is that 100 % of the country's electricity will come from renewable sources by 2040. The government created incentives to enhance the use of renewable electricity sources such as solar panels. As a result, the use of PV panels has been increasing in Sweden since 2006. Using PV electricity became a way to cover part of the electricity use in households, consequently reducing the user's electricity bill cost. However, this cost reduction is limited. Without electricity storage, due to the time difference between when electricity is used and when it is produced, PV electricity supply cannot completely cover electricity use. In most cases, a large part of surplus electricity must be sold to the main electricity grid.

To increase the usage of locally supplied electricity, previous studies have investigated several methods of sharing PV systems within a group of users. While some of those studies addressed the benefits conceptually, others used numerical models to calculate the profitability. However, there was still scant research about how much an individual household can profit when sharing a PV system with different numbers of users. Additional research gaps included potential difference in payback time and possibility to achieve higher profit by owning a larger PV system. By presenting financial benefits of PV sharing, this study aimed to not only raise awareness about benefits of owning PV systems but also motivate individuals to make decisions towards solar renewable electricity sources. If applied, these findings can contribute to a future increase of PV electricity usage in Sweden, and therefore help the Swedish government to achieve their sustainability goals.

This research was designed to evaluate profitability of PV shared systems in residential communities of different sizes in Sweden. To observe the impact of weather on the results, the present study was primarily focused two disparate geographical locations in Sweden: north (Kiruna) and south (Karlstad). The groups of households, previously referred to as communities, were formed using random selection. It was done by randomly selecting individuals from initial database that contained hourly measured electricity use of 1 067 residential apartments located in Karlstad. Based on the simulated PV supply of different system sizes and the measured electricity use of each household, the hourly amount of sold or bought electricity per individual household was calculated. Further on, the trading process between multiple households in the community was simulated, where calculations of hourly costs for purchased and sold electricity within the main grid and between households were performed. Finally, all cases were assessed financially through performing Life Cycle Cost assessment (LCC) for each household individually. To observe the impact of future scenarios on the results, the sensitivity analysis was performed for each case, considering increased electricity price growth rate and applied tax reduction to individually owned PV systems. Based on the financial assessment, the profitability for both shared PV systems and individually owned systems was calculated and compared to each other.