Economic Assessment and Business Models for Shared Use of Photovoltaic Systems in Multi-Apartment-Buildings - Case Studies for Austria and Germany

Introduction

Until recently in Austria, the usage of self-generated electricity was allowed in single-family homes only. Legislative amendments, come into force in July 2017, now authorize the shared use of PV systems in multi-apartment buildings too.

• This work aims at assessing the economic viability of shared PV systems in Austria, considering different consumer objectives ranging from minimizing annual electricity costs to maximizing the self-consumption rate.

• Therefore, we assume a fictitious multi-apartment building with ten residential apartments (allocation of ten real household load profiles).

• An optimization model (MILP) is developed in Matlab using a multi-objective optimization approach to combine conflicting consumer objectives.

• Optimizations are conducted for two scenarios:
  - Separate consideration of individual apartments (i)
  - Multi-apartment building considered as a total load (ii)

• Based on an optimised PV system, profitability analyses are conducted. Further, we developed applicable business models for Austria.

Methodology

Problem (1):

Minimization of annual electricity costs:

\[ E_{\text{Ann}} = \min_{\text{PV system}} \sum_{t=1}^{T} C_{\text{PV,gen}}(t) + C_{\text{PV,inst}} + \alpha_{\text{PV}} \times E_{\text{rel}}(t) \]

Problem (2):

Maximization of self-consumption (Minimization of annual grid consumption):

\[ SC_{\text{Ann}} = \max_{\text{PV system}} \sum_{t=1}^{T} \text{grid consumption}(t) \]

Problem (3):

Multi-objective optimization for conflicting objectives:

\[ MOP_{\text{Ann}} = \min_{\text{PV system}} \sum_{t=1}^{T} \left( C_{\text{PV,gen}}(t) + (1 - \gamma) SC_{\text{grid}}(t) \right) \]

Subject to:

- \( \gamma \in [0, 1] \)
- \( 0 \leq \alpha_{\text{PV}} \leq 1 \)

Results

Case study Austria

- Retail electricity price: \( c_{\text{elec, retail}} = 0.148 \text{EUR/kWh} \)
- Taking into account synergy effects by considering the building as a total load (ii) has a positive impact on the results leading to larger optimal PV system sizes and therefore to a higher cost saving potential.

- PV systems sized aiming at 100% cost minimization, show that by taking into account synergy effects (ii), marginal profitability can be achieved for consideration of individual apartments (i), no PV system is built; as there doesn’t exist any cost saving potential in this scenario.

- The difference in annual electricity costs \( (C_{\text{Ann}} = C_{\text{PV,inst}} + C_{\text{PV,gen}}) \) calculated for individual apartments (i) is clearly negative, meaning additional costs occur when installing a PV system.

- For the building considered as a total load (ii) costs can be saved to a moderate extent due to taking synergy effects into account.

- Profitability of shared use of PV systems is on the border. Additional occurring costs range in the worst case between 150 EUR/yr - 300 EUR/yr. These amounts have to be apportioned among ten consumers, leading to the worst case in marginal additional costs between 15 EUR/yr - 30 EUR/yr per household. Therefore, need for cost-efficient allocation methods.

Conclusions and Outlook

- The economic viability of shared PV systems strongly depends on the absolute value of the variable component of the retail electricity price, what is emphasised by comparison of the Austrian and German case study.

- Further adjustments of the legal framework will be necessary in the near future, in order to further expand existing business models.

- The development of profitable business models for all participants, as well as comprehensive accounting and billing methods will require special focus in future analyses.

- Solutions for consumers refusing participation in the shared PV concept have to be developed, as data regulations to deal with the consumers’ freedom of choice.

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