Economic analysis of renewable energy production with photovoltaic- and solar thermic systems for small and medium-sized enterprises

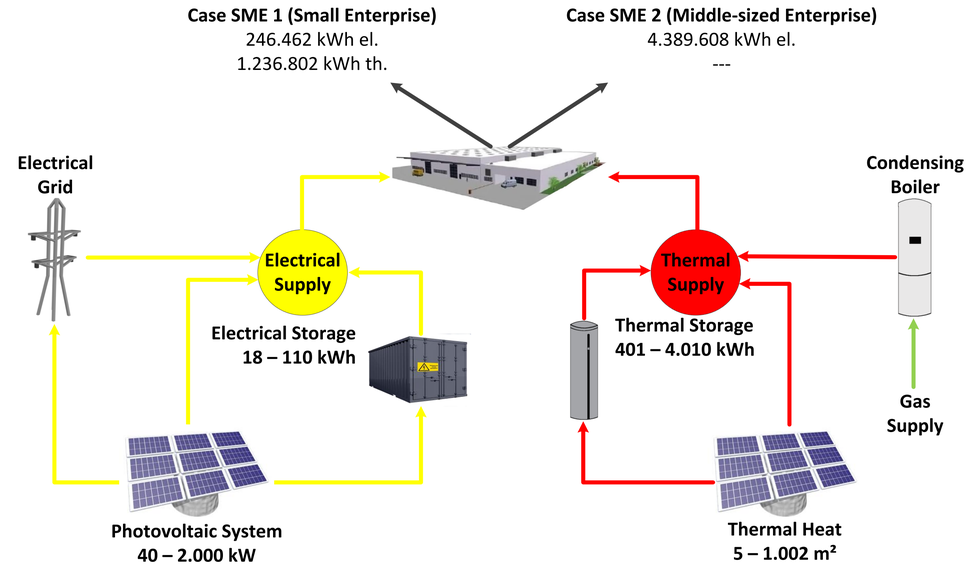
Introduction

The German EEG manages the expansion of RE producers and sets tariffs for the feed-in of RE into the grid for new RE producer installations. The EEG was first introduced in 2000. Initially, investors benefit from the high feed-in tariffs and lower taxes. But the regulations are constantly revised over the years. Certain conditions have drastically reduced and restricted the feed-in tariffs, bringing self-consumption into focus. For SMEs which are willing to invest in RE, complex decision problem has to be solved. Once the technical and legal feasibility of installing and operating one or more RE producers has been verified, the issue of how the optimal RE system fits the SME's energy demand and profile has to be decided.

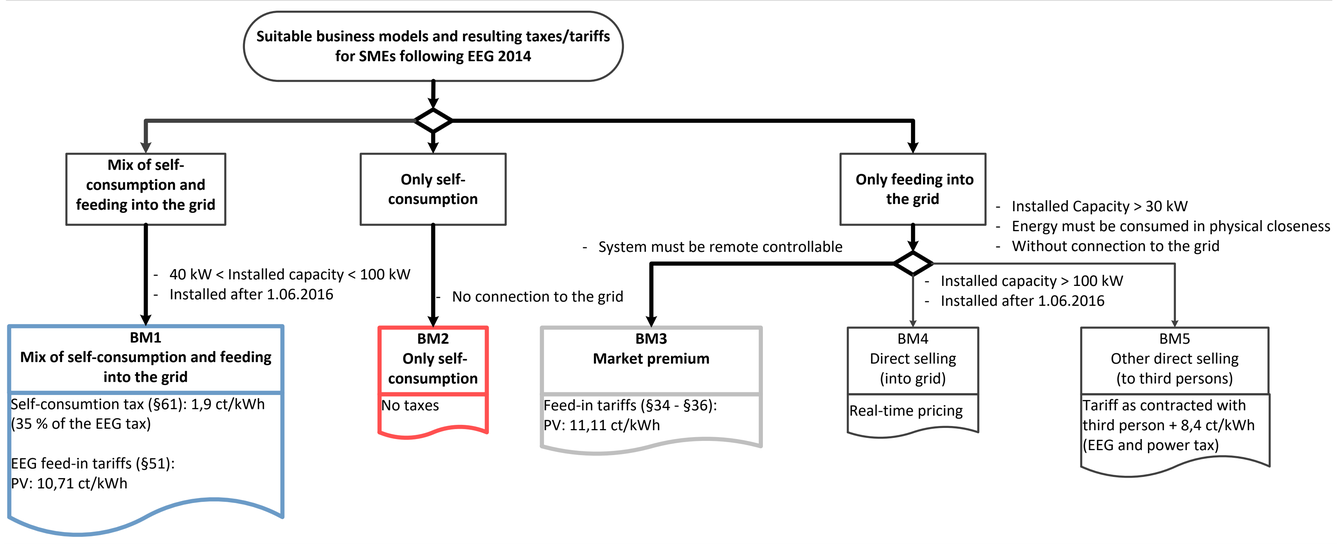
- Does optimal RE system consist of one type of RE producer or of different types of RE producers?
- In what combinations do the RE producer occur, and of what size are they?
- How is overproduction handled?
  - Is it suitable to store it or can it be fed into the grid
  - Under which conditions are such efforts possible?

Two distinct cases are investigated under the rubric to achieve the best financial return for the investment within the restrictions of Germany's 2014 EEG.

Specification of the PREmdeK Simulation



Suitable Business Models under German EEG 2014



Research Design

The research group, "Energy Efficiency in Production," (www.e-pps.de) has developed the agent-based simulation, PREmdeK . It simulates a local energy system that consists of one major industrial consumer (e.g., an SME), a multi-source renewable power plant (PV, solar heat), and storage entities. The simulation runs on data produced at 15-minute intervals for the duration of a year. [1, 2]

For the two cases, historical data regarding energy demand and local weather conditions were used. The simulation employed various machine designs of the RE plant that were calculated to balance RE generation with the company's consumption while using storage entities and the grid. The scenarios served as input for an economic analysis that employed economic indicators: Internal Rate of Return (IRR) and Net Present Value (NPV).

Szenario Evaluation Results

Results valid all Szenarios

- The self-consumption ratio increases as the storage capacity increases and decreases as the machine design value increases
- A comparison of BM1 and BM2 with BM3 shows that BM1 and BM2 offer higher benefits
- It is possible to increase the self-consumption of the electrical RE with storage systems, but that cannot compensate for the higher capital cost and higher taxes for self-consumption

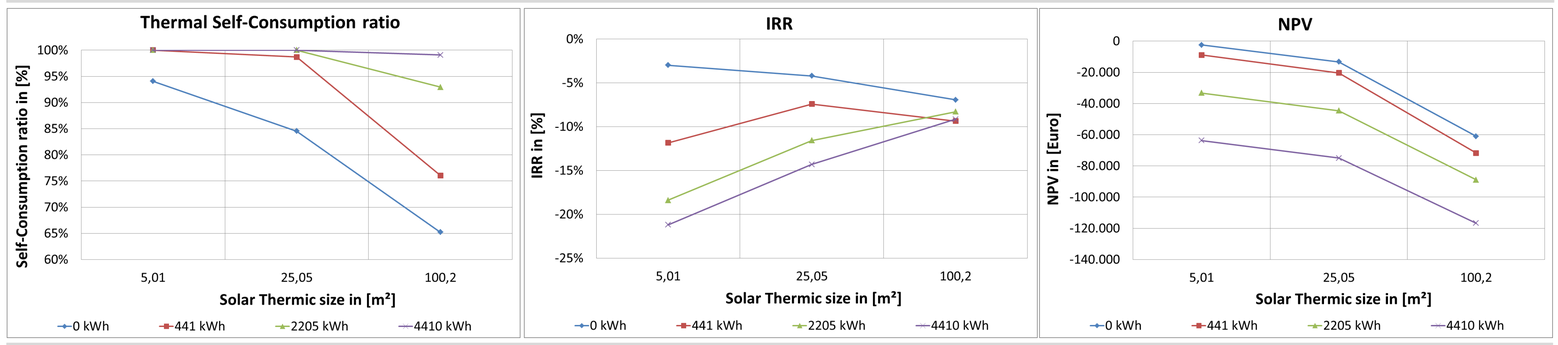
Results SME 1 (Small enterprise)

- BM2 has the best IRR is at 40 kW and there is also a maximum point for the self-consumption ratio. BM1 has the best IRR at 70 - 99 kW
  --> *The combination of high self-consumption ratio and RE overproduction feed-in leads to an enhanced benefit*
- In contrast to the IRR, the NPV achieves the maximum points at different machine design values: BM1 at 99 kW and BM2 at 70 kW
  --> *Bigger machine design values save more electrical energy in total*
- The profitability of the thermal RE producer is for all indicators in the negative range

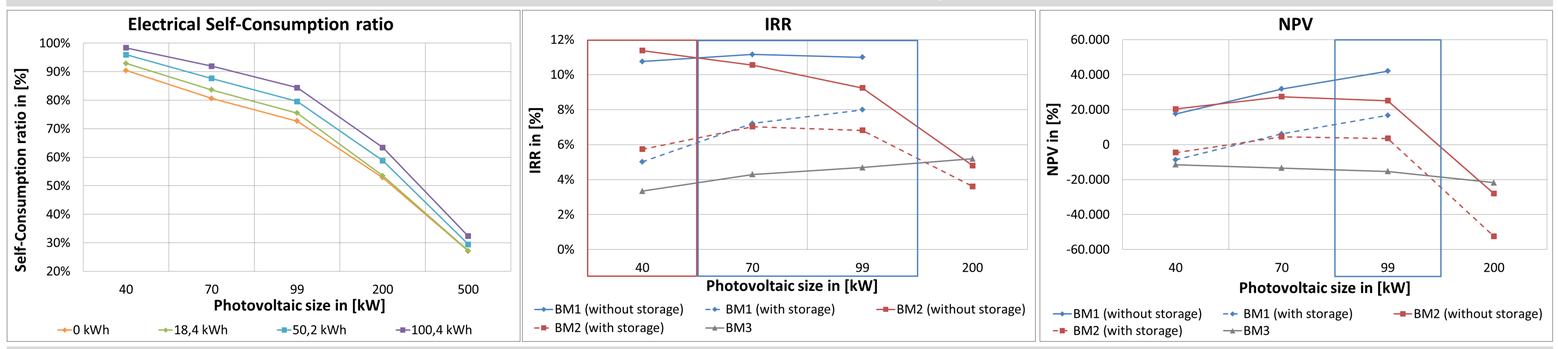
Results SME 2 (Middle-sized enterprise)

- The benefit of BM2 is always higher than for BM1 -->*The advantage due to BM1's feeding of overproduced RE into the grid is not applicable because the self-consumption ratio is still 100% for the 99-kW PV system*
- BM2 has the best IRR at 200 kW and the best NPV at 1.000 kW

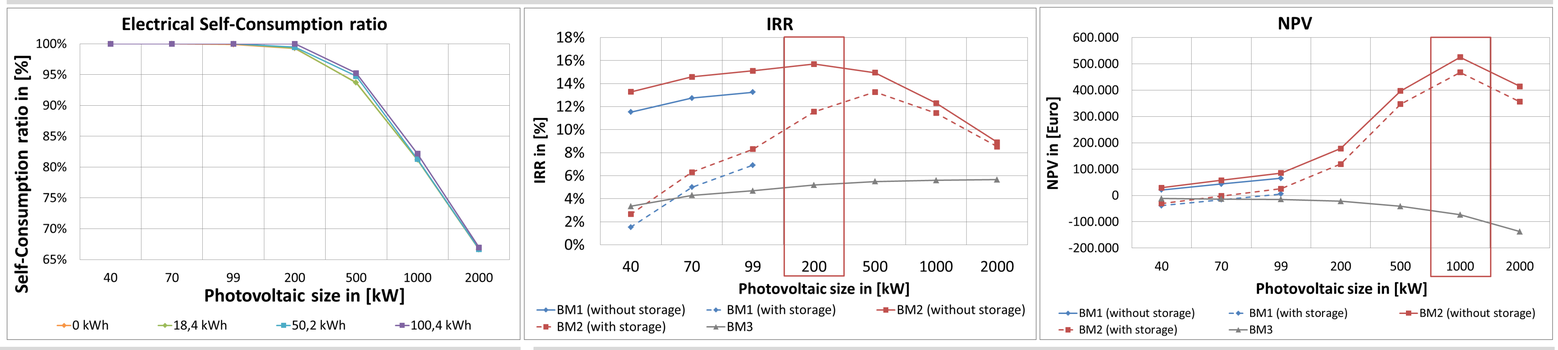
Results SME 1 Solar Thermic



Results SME 1 Photovoltaic System



Results SME 2 Photovoltaic System



Recommendation to SMEs

- Avoid storage capacities and maximize self-consumption
- Pure self-consumption (BM2) and mix of self-consumption and feeding into the grid depends on:
  - Energy profile and energy consumption
  - Preferred analyzing methods from the analyst

References

[1] Pechmann, A., Schöler, I., Ernst, S., 2016. Possibilities for CO2-neutral manufacturing with attractive energy costs. Journal of Cleaner Production.

[2] Ernst, S., Hackmann, R., Pechmann, A., Schöler, I., 2013. A simulation based feasibility study to satisfy the energy demand of SME production sites by their own multi-source renewable power plants. IEEE International Workshop

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