Economic PV potential in the Germany Industry – a sector and regional specific analysis

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(1) Overview

The present paper looks at the specific roof-top potentials for Photovoltaics (PV) in the German industry sector. Considering the targeted energy system transition, Germany aims at a high rate of renewable energy (RE) installation in the long run. However, the current Feed-in-tariffs (FiT) for RE are subject of ongoing discussions. In the case of PV, its scalability and suitability for roof-top installation makes self-consumption one of the first-hand opportunities to implement PV systems without requiring the FiT to refinance the investment. So far, a research focus has been on self-consumption of residential households as for residential customers, the levelized cost of electricity (LCOE) of PV is already below their energy tariff. However, residential customers only constitute one quarter of the German electricity consumption, whereas the majority is consumed by industrial consumers who pay lower electricity rates ranging from 4 to 21 €cent/kWh.

Considering the high amount of residential PV systems in Germany, the question arises which potential exists within the remaining customer groups. So far, the potential for PV on-site generation of industrial customers, who usually possess relatively large buildings, has not been analyzed in much detail. Nevertheless, this analysis would not only determine the potential's magnitude but could also indicate how to tap the potential making it available for the energy system transition. For PV systems to be considered by industrial customers, they not only have to show technical potential but also economic viability. Therefore, the present paper analyses the economic potential of PV systems for industrial customers. The assessment specifies the potential according to branch and administrative districts as well as of temporal match of electricity generation and demand. Most potential analyses are dedicated to overall estimations of technical potential, but none differentiates between certain industry sectors, their location or temporal aspects of supply. This investigation contributes to a deeper understanding of techno-economic viability of PV in certain customer groups and regions.

(2) Methods

For the investigation 25 sectors of the manufacturing industry are considered. To conclude on the PV potential, a number of factors (roof-top area of companies, local irradiation, company demand profiles, generation profiles and cost of electricity) have to be assessed which affect the technical and economic opportunities.

The analysis is based on a sector specific analysis of the potential roof-top area. The applied method is based on the methodology derived by Quaschning [1] and Kaltschmitt [2], who both assessed the German roof-top potential for photovoltaics. [1] allows determining the amount of area suitable for PV from the gross roof-top area. The gross area is calculated from the number of employees of the company and their required specific area as it was done by [3]. As no detailed data for specific building types and industry sectors and their building stock is available, this method was used as best approximation.

The available roof-top area limits the installable PV capacity for the related businesses. Therefore it is a crucial parameter to conclude the achievable PV electricity generation. Using data from [4], which provides regional irradiation data with a high resolution, the generation can be modeled in hourly resolution and for each administrative district where the considered industry sector is present.

To determine the amount of possible self-consumption, the generation profile is compared to demand profiles which have been modeled based on available standard demand profiles for commercial manufacturing businesses. Using the average annual electricity demand in the industry sector within the administrative district, its range and median, the standard demand profile is scaled according to these parameters. This leads to specific demand profiles, which are then matched with the PV electricity generation. This factor determines the amount of saved electricity consumption from the grid.

Based on the system size and annual electricity generation, the LCOE of the system is calculated using the method as described in [5]. The LCOE serve as a basis to calculate the achievable income or savings from the electricity generation. To calculate the financial value of the amount, it is also necessary to specify the electricity price for the different industrial customers and the share of self-consumption. As the rates depend on the industrial customers' annual electricity consumption, the businesses are categorized according to the classes used by Eurostat [6]. Furthermore, it is assumed that excess electricity can be fed into the grid, receiving the spot market price at the specific point in time, valued by the hourly resoluted auction prices of the EEX electricity price index Phelix from 2012 [7].

If the accumulated income generated from the energy savings and excess feed in exceeds the initial investment within a period of 25 years, the installation is evaluated as economically feasible. The presented procedure is carried out for each industry sector and each administrative district, allowing an aggregation of the potential to conclude on regional and national potentials as well as sector specific information.

(3) Results

The analysis shows that the economic potential highly depends on the electricity rate and the degree to which real-time demand and supply are in phase. Figure 1 shows the generation and demand profile of a fictitious sample company belonging to the equipment manufacturing sector. It is located in the region of Stuttgart, south Germany and has 160 employees and a roof-top area inferior to 12,000 m². With the methodology described above, this leads to 3700 m² roof-top area suitable for a PV installation. It can be seen that the match of generation and demand varies significantly between summer and winter. Of the total demand, 36% can be supplied by on-site solar energy. In the presented case, 65% of the total electricity generated can be consumed on-site, whereas the other 35% have to be fed into the grid due to time differences in supply and demand. Hence, although industrial customers have a significantly higher total energy demand than residential customers, a feed-in possibility is still essential to create a favorable regulatory environment for on-site PV electricity generation.

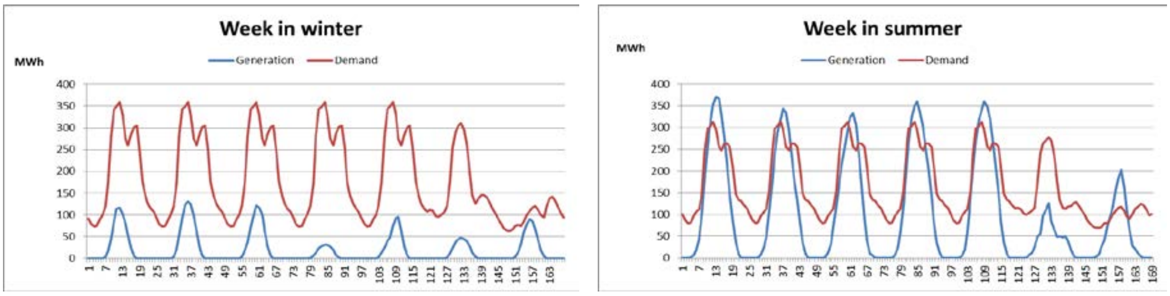

Fig. 1: PV electricity generation and on-site energy demand for a sample week in summer and in winter

As the surplus energy is fed into the grid and it is assumed to be compensated with the spot market price, it contributes to the achievable return on investment. This varies between the industry sectors and regions due to demand and irradiation constraints.

The sectors machine construction, automotive, metal products and food and animal feed show a high technical attractiveness. The results include a detailed economic analysis of the technical potential and a ranking of sectoral and regional attractiveness for industrial on-site PV installations will be given.

(4) Conclusions

Previous analyses of PV potentials looked at it from a more general point of view, considering neither temporary fluctuations of generation and demand nor customer sector or local potentials. For this reason the present paper delivers a more in-depth analysis of industry potentials for solar electricity generation.

The investigation shows that there is a significant technical potential for on-site PV electricity generation. Especially for industrial consumers with high electricity demand, the amount of surplus energy is relatively small. However, in many cases a feed-in of excess generation occurs if PV system without storage is installed. Therefore, it will still be beneficial to ensure regulatory opportunities to feed surplus energy into the grid or find economic viable local storage or demand shifting solutions in order to avoid wasting generated electricity.

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