The impact of PV tilt angle and azimuth on the market value of PV systems and electricity generation costs

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(1) Overview

While currently it is common practice to seek for the maximum output of a Photovoltaic (PV) system over the lifetime of the module this might not be the optimal strategy in a situation with a significant share of PV in the electricity production of a region. This is true from a system perspective and from an investor´ s perspective assuming that feed-in tariffs might phase out and the produced electricity has to be sold on the spot market. With decreasing spot prices in times of high solar radiation around noon PV modules pointing towards east or west or steeper setting angle might be more profitable. (see Rowlands 2010) From a system´ s perspective a wider distribution of module-angles can lead to reduced generation costs as a whole. In this paper we estimate the cost saving potential of a wider distribution of angles for the electricity system in Austria and Germany under various PV expansion scenarios.

(2) Methods

In a first step PV-generation profiles are generated using a PV simulation tool which models the position of the sun to account for the effect of various module angels. (see Eicker 2011) The radiation data, which include direct and indirect radiation on a horizontal plane, is provided by satellite data with 15min resolution. This is done for 20 regions in Germany and Austria to account for different solar hours and angle effects due to the latitude of the regions. We generate 200 PV profiles with different combinations of inclination angles and azimuth for each of the regions. The profiles are then fed into a dispatch optimization model which includes the existing power plants of Germany and Austria and the corresponding electricity demand in hourly resolution. The model then implements the optimal mix of installed capacity for each profile in each region. In different scenarios we apply restrictions on the distribution of the installed capacity over the regions. The model output should theoretically reflect the most cost effective mix of the installed angels under the assumed conditions and restrictions. Under the assumption of perfect competition this should also reflect the maximum market value of all PV-systems installed.

(3) Results

Preliminary results show that at present the highest revenue still corresponds with the maximum energetic output if we assume spot market prices. However with a substantial increase in installed PV capacity the maximum revenue shifts towards steeper inclinations and also tends towards west to profit from higher prices in the afternoon. Of course the results also depend on the installed capacity of storage plants as they tend to smoothen out the price patterns throughout the day. The installed storage capacities also influence the savings in total electricity production costs compared to a scenario in which the installed PV systems are orientated towards an energetic maximum. Detailed results will be shown in the full paper.

(4) Conclusions

This analyses shows, that the inclination and orientation of PV-system influence the total costs of electricity production. It is clear that there can´ t be direct control on the decision of investors to opt for a certain angle of the installed modules but the prices on the spot market should give the right incentives for investors. However, most of the current feed-in tariffs schemes do not provide those incentives which would call for an adjustment of the subsidy design in the direction of direct marketing.

References

Ian H. Rowlands, Briana Paige Kemery, Ian Beausoleil-Morrison (2010) “Optimal solar-PV tilt angle and azimuth: An Ontario (Canada) case-study”, Energy Policy, 39, 1397-1409.

Ursula Eicker (2011) "Solare Technologien für Gebäude", 2. Auflage, Vieweg+Teubner