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Real-Life Load Profiles of PV Battery Systems from Field Measurements

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Abstract

The definition of universal load profiles for Photovoltaic (PV) battery systems is an important factor in understanding and optimizing system efficiency, sizing and operating strategies. This publication gives detailed information on the load distribution of 16 households featuring PV battery systems in Germany that were measured in the course of a scientific monitoring program since mid-2015. Statements on the frequencies of high- or partial-load range of the different electronic components (for both, AC- and DC-coupled systems) as well as the batteries are given. Using the given data, a method to develop a generally accepted definition of an averaged operating efficiency for those systems is proposed.

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Keywords: PV battery systems; KfW funding; load profiles; field measurements; efficiency

1. Introduction

Decentralized PV battery systems that increase local self-consumption have been in the spotlight of public interest, research and product development for several years. As guaranteed feed-in tariffs for solar power

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continuously decrease while retail electricity prices rise, the interest in locally consuming PV power grows steadily. The German federal funding program for grid-relieving PV battery systems (*KfW funding*) that started in May 2013 further enhanced this trend and led to an extension of the market: Within a few years, small storage systems emerged from a niche product to a mass market where today international major corporations compete for market shares [1].

The KfW funding is accompanied by a scientific monitoring conducted by the Institute for Power Electronics and Electrical Drives (ISEA) at RWTH Aachen University. In the scope of this monitoring, reports about current market trends are regularly published and can be accessed through the project website www.speichermonitoring.de. Beyond the analysis of the market development, the focus of the monitoring program lies on the technical performance of this still new technology: To the present day, no generally accepted procedure for a holistic performance evaluation of PV battery systems has been agreed on. Therefore, this article proposes a process of defining an averaged operating efficiency factor for PV battery systems similar to the existing performance indicator of PV inverters, the so called European Efficiency Factor ("Euro-Eta", see Fig. 1).

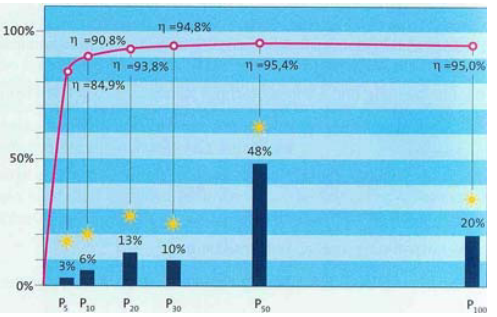

Fig. 1. Schematic illustration of the European Efficiency Factor ("Euro-Eta") for PV inverters [2]: To obtain the averaged operation efficiency, the measured efficiency curve of the PV inverter is multiplied with weighting factors derived from the typical yearly power distribution corresponding to mid-European climate conditions.

In order to determine the typical load distributions needed to establish a universal performance indicator, high-resolution measurements of the individual components of various privately operated PV battery systems are evaluated (see chapters 2 - 5). As soon as typical load distributions of the individual system components are agreed on, the averaged operating efficiency of small storage systems ("Euro-Eta") can be determined by measuring the efficiency curves of the components under laboratory conditions and multiplying them with the respective weighting factors corresponding to the load distribution (see chapter 8).

In contrast to PV inverters, however, the occurrences of individual operating points here depend on a higher number of parameters. These include the sizing of the components (PV system, inverter and battery), the consumer's load profile and the operating strategy of the observed storage systems. Finding representative operating patterns within the range of individual use cases is the essential goal of this research. To guarantee a non-discriminatory process, the definition of the weighting factors from the measured load distributions shall be conducted in an open process including all interested shareholders. Therefore, RWTH Aachen University will continuously publish the measured load distributions on the project website of the monitoring program (www.speichermonitoring.de) and consult manufacturers and research institutes about their findings. In close collaboration of all interested shareholders, a practicable definition of an averaged operating efficiency for PV energy storage systems can be found in the medium-term. It is the intention of this article to make a first step in this direction by presenting the selected method and the used input data.

Nomenclature

P_{PV}	Nominal power of the PV System
C_{annual}	Annual energy consumption of the household
$P_{Batt,max}$	Maximum contiuous power of the battery