EV - Smart Charging - optimised operational management for EV charging stations

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Photovoltaics and Electric Vehicles are experiencing a worldwide boom. This will lead to an increased demand for smart energy solutions in terms of matching production from photovoltaic power stations and energy demand of electric vehicles. The present work shows, how the own consumption of PV energy can be increased and peak loads reduced, employing an energy management system controlling charging stations, using irradiation forecasts and live data from PV power plants.

Introduction

In Switzerland, a new record of 430-450 MW of yearly added solar power has been registered in 2020. Also, the share of newly registered electric cars is growing exponentially and has reached a new record of 8.3% in 2020, growing by +48.2% for battery electric cars and 238.6% for plug-in-hybrids last year. The update to the "Energy Strategy 2050", called "Energy Perspectives 2050+", published by the Swiss Federal Office of Energy in 2020, expects 3.6 Mio electric cars on Swiss roads by 2050. It also expects covering the increased energy demand of those cars primarily by photovoltaics. The Swiss government plans with a total of 34 GWp installed by 2050.

Concept

To reduce network cost and help sector coupling, this present work investigates the possibilities to smartly combine PV systems with electromobility. In December 2020, six Janitza 604-UMG Pro electricity meters have been installed on three PV systems (total power: 39 kWp) and on three different charging stations (two of them Typ 2 – 1-3 phase AC chargers, 22kW, one DC charger, 10 kW, bidirectional), all located at the parking lot of Campus Tiergarten at Berner Fachhochschule (BFH) in Burgdorf, Switzerland. Two out of three charging stations can be controlled with a self-developed python script and charging power can be specified, which has been tested with a Renault Zoé 2017 and a Nissan Leaf 2014, which is bidirectional and can also be discharged.

Goals

The goal of the conceptualized energy management system is to reduce peak loads (positive or negative) and to maximize the share of solar power transferred to the electric vehicles. The algorithm to control the energy management system includes weather forecast data to predict PV power levels in hourly resolution, 24 hours ahead. As the programming of the energy management system turned out to be highly complex and therefore couldn't be tested, this work focuses on the analysis of the collected data from December 2020 to May 2021. The collected data were collected at a frequency of 1 Hz. The measurement system was programmed to save different digests of the most important parameters, such as a list of all performed charging processes and a daily digest of the registered energy sums of all measured installations. The charging processes were analyzed by using down sampled data to a frequency of 1/60 Hz.

Results

In total 8% of the produced solar energy could be absorbed by the charging stations which have been in use without taking the measurement into account. 33.5% of the solar energy produced at the same time as the charging processes took place could be charged as own consumption. The potential to increase this share has been analyzed with a self-developed excel-based energy manager and reached 41.7% for the time span from December 2020 to May 2021. On the basis of the presented data we can anticipate, that an energy management system with accurate irradiation forecast and the ability to pause and delay the charging processes, implicating the energy demand as measured, could get a total share of solar-charged energy up to 80-95%.

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