Energy storage: behind the data sheets

An annual inspection of the performance of energy storage products that are available in Germany, conducted by HTW Berlin – University of Applied Sciences, has shown how important it is for buyers to know how effective their devices are at providing electricity during low nighttime loads.

HTW Berlin's "Energy Storage Inspection 2024" study compares laboratory measurement results of usable energy storage capacities with manufacturers' data sheet specifications. Although usable storage capacity is an important characteristic of battery energy storage systems (BESS), only 75% of the participating battery manufacturers provide this data. The others state the higher nominal storage capacity, which often lacks any direct consumer benefit and misleads users about the amount of available energy.

Limitation of discharge depth serves, among other things, as protection against aging and deep discharge. Usually, only 90% to 95% of nominal capacity can be discharged to protect batteries, as was the case with tested products from RCT Power and Dyness, respectively. When interpreting data sheets from battery manufacturer BYD, for example, it should be noted that although a depth of discharge (DOD) of 100% is possible, many compatible inverter manufacturers limit DOD to 95%.

In 15 of the 20 systems tested by HTW Berlin, the measured capacity was lower than stated on the data sheet, and the average divergence was two percentage points. In 2024, the energy storage inspection compared the conversion efficiency of several hybrid inverters at very low partial loads for the first time. The efficiency of several BESS at low electrical energy flows was analyzed using additional laboratory tests from the Austrian Institute of Technology (AIT) and the Karlsruhe Institute of Technology (KIT). This is important because at night, and therefore for several thousand hours per year, household electricity consumption typically lies in the range of a few hundred watts.

Nighttime loads

The basic purpose of a PV storage system is to store excess solar power during the day and then release it in the evening and at night to supply electricity. The electrical load profiles of different households sometimes differ considerably. There is usually only a "base load" at night caused by the refrigerator and the standby consumption of various devices.

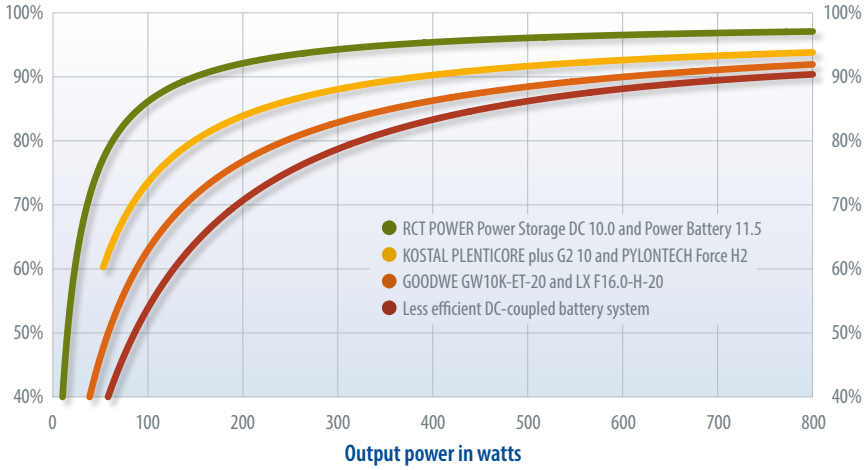
The electrical load profiles of 28 single-family homes were compared to analyze the nighttime consumption behavior of various consumers. Data obtained from the Institute for Solar Energy Research in Hamelin (ISFH), Germany, showed that electricity demand at night was characterized by particularly low power flows of 50 W to 300 W. High inverter efficiencies are particularly important for discharging capacities of a few hundred watts.

Partial load efficiency

In general, all four devices under investigation showed increasing efficiency with rising output power. The Power Storage DC 10.0 hybrid inverter from RCT Power, in combination with the Power Battery 11.5, stood out particularly in this power range, with an outstanding partial load efficiency. Even at a power output of 150 W, the device achieved an efficiency of 90%. The two runner-up systems had efficiencies of 80% (Kostal) and 72% (GoodWe) at the same operating point. The least efficient of the four DC-coupled battery storage systems (referred to as "system J1" in the 2024 Energy Storage Inspection) only achieved an efficiency of about 64%.

Efficiency in discharge mode (%)

Source: solar.htw-berlin.de

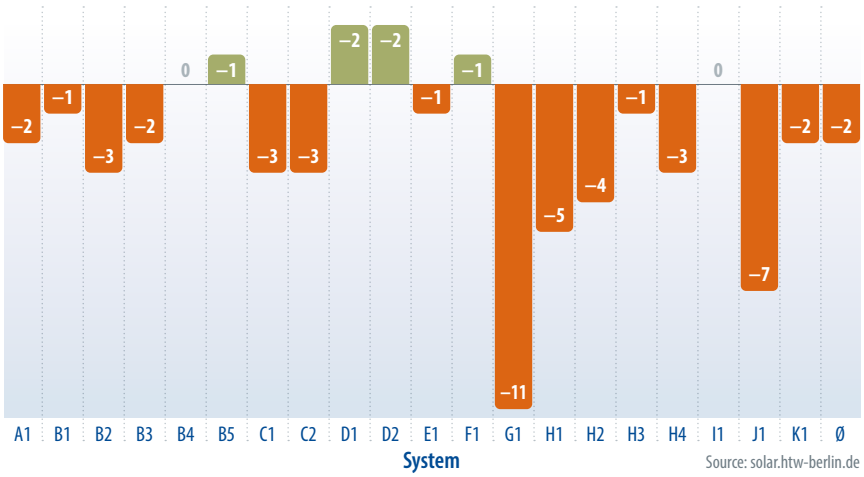


In contrast to the other devices, the J1 system must, consequently, provide considerably more power to cover an electrical load of 150 W. By comparison, the system from RCT Power discharged 167 W, meaning that only 17 W were lost in the form of heat. The less efficient J1 system, on the other hand, must provide 234 W to cover the same electrical load of 150 W, meaning a loss of 84 W in the form of heat.

This means that inefficient BESS are discharged faster for the same usable storage capacity and consumers draw more electricity from the public grid. Households with a low nighttime electricity consumption of 300 W or less should therefore look for high partial load efficiency when searching for suitable inverters.

Furthermore, if household electricity demand is low at night, it should be clarified whether a BESS can cover it at all. The minimum alternating current power output of an inverter in discharge mode defines the smallest electrical load that can be covered. For some hybrid inverters, that value is between 40 W and 50 W. Other devices switch to discharge mode at just a few watts.

Deviation of usable battery capacity from data sheet specifications (%)



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