MORE SOLAR POWER

Use Solar energy sustainably with power storage units. A practical guide.

Hochvolttechnologie vom Bodensee

Technology and Design
Made in Germany

Imprint

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WHY THIS GUIDE?

Photovoltaics is booming. Many homeowners already have a photovoltaic (PV) system installed or are planning to get one.
Solar power represents the future and independence. It just feels right to use your self-generated solar power.
Independence is not the only reason for installing a PV system: solar energy is a sustainable energy source and a major component for the climate-friendly change of our society. Photovoltaics are indispensable for transitioning away from nuclear and fossil fuel-based energy sources.

Solar energy is cost-effective, technically mature and has the potential for expansion. Owners of a PV system will get electricity at a predictable price over decades - with free delivery!

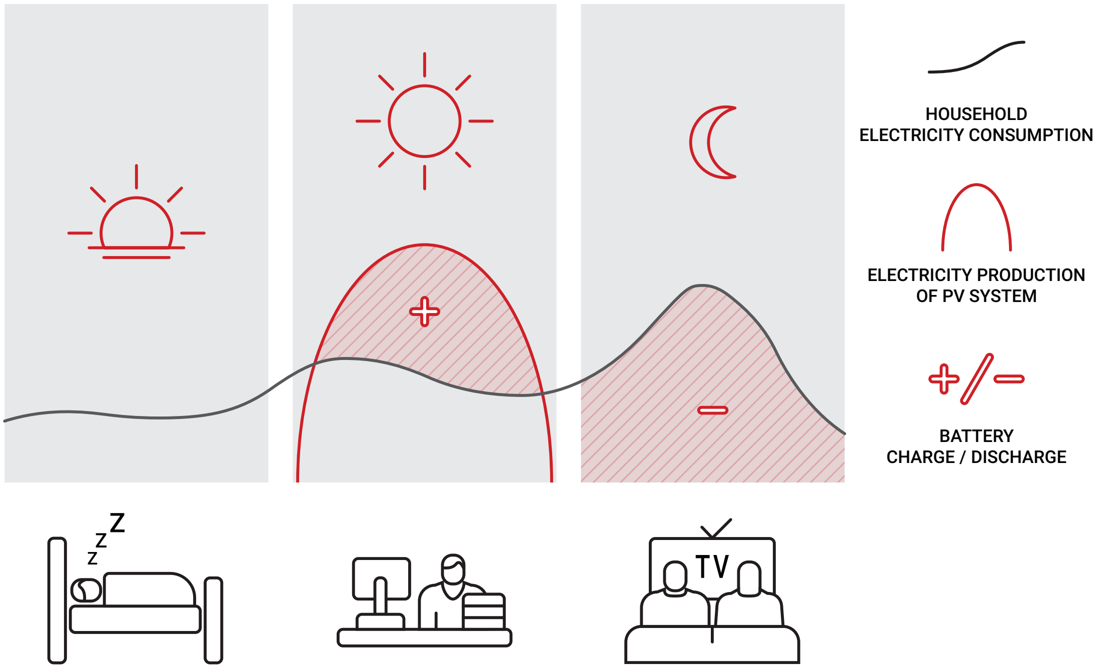
PV systems generate electricity. To have self-generated solar power constantly available storage systems are required. They balance the daily and seasonal fluctuations in solar radiation.On sunny days, solar power generation exceeds your consumption, whereas on overcast, rainy days the PV system only generates a fraction of its nominal power output. A high-performance and demand-oriented power storage system will level the mismatch between power production and consumption.

In this guide, you will learn more about how solar energy storage systems work, battery technologies and their technical differences. We inform you about available subsidy and financing options and provide tips to help you find the right storage system for your home.

Do you like a quote? Do you have questions about power storage installations?

You will find your contact person on our website:

www.rct-power.com



TV
HOUSEHOLD
ELECTRICITY CONSUMPTION
ELECTRICITY PRODUCTION
OF PV SYSTEM
BATTERY
CHARGE / DISCHARGE

WHAT IS A POWER STORAGE UNIT?

With a power storage unit, you consume self-generated solar power when you want it. And everyone benefits from this.

In principle, a power storage system consists of nothing more than a rechargeable battery directly connected to the PV system. During the day, when the sun is shining, the system stores the energy you do not directly consume. During bad weather and in the evening hours, your household appliances draw their power from the battery.
You increase your solar power self-consumption, and over the year, you reduce the amount of electricity you buy in addition. In everyday life, we need a lot of electricity, especially in the morning and evening hours. For light, for heating, to fill up the electric car or pedelec, and for the washing machine, which is switched on after work.

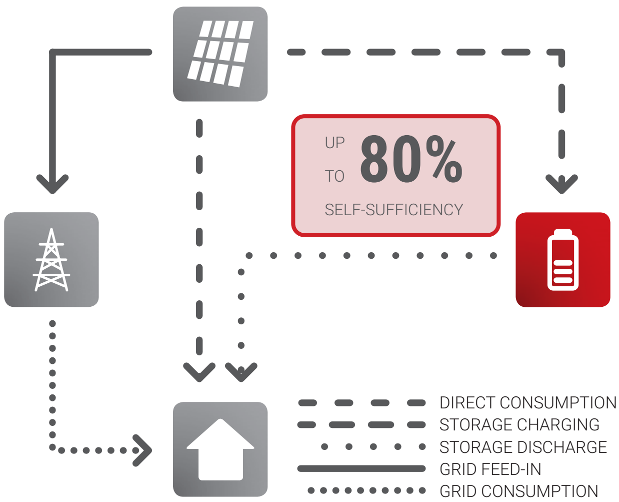
Without a power storage unit, you have no choice but to buy additional electricity. This electricity is more expensive than self-generated solar power. You, therefore, save money with every kilowatt hour of self-generated and stored solar power.

The power output of these “solar batteries” is now so great that a power storage unit can supply your house with electricity for several hours. In addition, solar power storage units are becoming more efficient. In a future energy system determined by small, decentralised generation units, solar power storage units for the home will play a key role.

GOOD REASONS FOR POWER STORAGE UNITS

MORE INDEPENDENCE

If we ask owners of solar power storage systems about the main reason for acquiring the system, the answer is independence from electricity suppliers.
A significant portion of the electricity consumed in the household is now generated by the PV system or drawn from the storage system.
It makes no difference whether the power storage system is completely or only partially charged. The energy available in the storage can be used to cover demand before electricity has to be purchased from the grid operator. The electricity supplier is left out of the loop.



BOOST SELF-CONSUMPTION

A power storage unit will increase your self-consumption rate. You can use up to 80 % of your self-generated solar power.
For a PV system without power storage, the self-consumption rate is only about 15 % to 30 %. This difference will be noticeable in your power bill.

INCREASED PROPERTY VALUE

Photovoltaic and power storage systems make your property more attractive. As the supply of electricity gains in importance, more buyers will attach value to such systems. Keywords: e-car or heat pump. PV and storage systems already boost the real estate value of your home.

FALLING FEED-IN TARIFFS

The feed-in tariff for excess solar power is falling while consumer electricity prices are rising. The pendulum from feed-in to self-consumption is pointing more and more to self-consumption.

STATE SUBSIDY PROGRAMMES

The federal, state and local governments regularly set up subsidy and financing programmes for power storage. They make the acquisition of a power storage system economically even more attractive.

CONTRIBUTE TO THE ENERGY TRANSITION

Power storage systems are an important building block in the transformation of the energy supply - away from centralised, carbon-based energy to decentralised, renewable energy.

Scientists at the International Energy Agency (IEA) state it pint-blank: without efficient power storage systems, there can be no energy transition. The importance of storage for the energy transition is moving to the centre of political and societal discussions. The more electricity is generated by wind and sun, the more need for systems that compensate for weather-related fluctuations. Up to now, electricity can only be stored to a limited extent - unlike coal, gas or oil. Storage capacities for renewables must be increased - preferably on a decentralised basis.

In addition to the necessary large-scale storage systems, private solar power storage systems connected to domestic PV systems, play a key role in the public power grid. According to experts, solar power generation utilizing PV systems could exceed the private electricity demand in Germany on sunny days.
The excess solar power can be put to good use through decentralized storage solutions. Power storage systems limit the feed-in power and thus protect the grid from overload if they are designed to serve the grid. Excess power is stored locally, and local voltage problems are compensated. Ergo: With a solar power storage system, you make an important contribution to society.

TRENDY: POWER STORAGE UNITS

The rapid growth of privately owned power storage systems in Germany shows how popular they have become. According to the German Solar Industry Association (Bundesverband Solarwirtschaft e. V.), the number of installed storage units grew by 141,000 to a total of 413,000 in 2021. The average capacity of private solar power storage systems in 2021 was 8 kWh. Retrofitted storage systems accounted for 14 per cent of the total.

The profitability of a power storage unit is calculated from the sum of the additional kilowatt hours of electricity consumed from your self-generated solar power and the lifetime of the storage unit compared to the investment costs minus possible subsidies. However, this calculation must consider the future development of the consumer electricity price, self-discharge and self-consumption.
Forecasts assume that both the consumer price of electricity and domestic consumption will increase due to new electrical appliances.

Decisive criteria for profitability:

- Electricity price development
- Acquisition and installation costs
- Subsidies
- Lifetime of the batteries
- Efficiency of the power storage system
- Self-consumption rate
- Suitable storage capacity

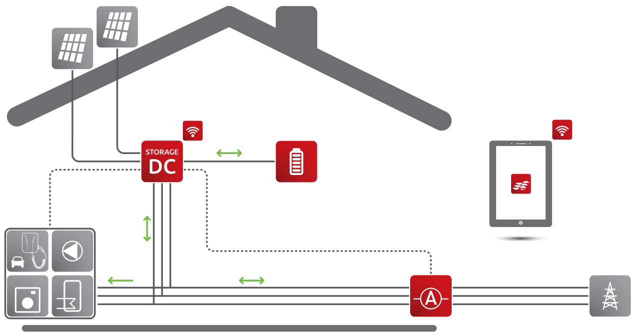
Self-generated and consumed solar energy is significantly cheaper than purchased energy. The difference between the cost of grid energy and that of solar energy fed into the grid makes your power storage unit profitable over the years. This difference will continue to grow in the years to come. Also, consider possible subsidies and KfW loans. The higher

POWER STORAGE UNITS: DO THEY CUT MY ENERGY EXPENSES?

Is the purchase of a power storage system financially viable? That depends primarily on how much power you consume and when and on the type of power storage system.

the self-consumption rate, the higher the savings. The usual self-consumption rate, without storage, is 15 to 30 per cent. With a solar power storage system, this percentage can be doubled, if not tripled. An important aspect is the power storage itself: the initial cost, its longevity and efficiency. The more efficiently a battery can store solar power, the less energy is lost. That saves cash.
Solar storage units with lithium iron phosphate cells are particularly durable and offer maximum safety. A service life of 15 to 20 years is realistic.
Larger batteries have higher acquisition costs, but at the same time offer greater potential for savings in electricity procurement. In short, the ratio should be right.
You should have an answer to the following questions before buying:

- How much electricity do I use on average per year?
- When do I use the most electricity?
- How high is my annual electricity bill?
- How has the price of electricity changed over the last few months/years?
- What would be the total amount for the next 25 years?
- Are there any large electricity consumers coming on line?



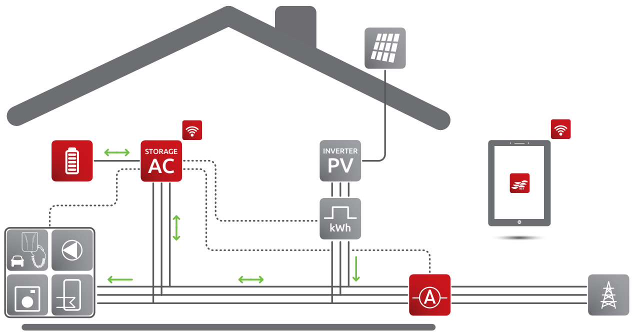
DC-COUPLED STORAGE SYSTEMS

DC-COUPLED STORAGE SYSTEM - IDEAL FOR NEW INSTALLATIONS

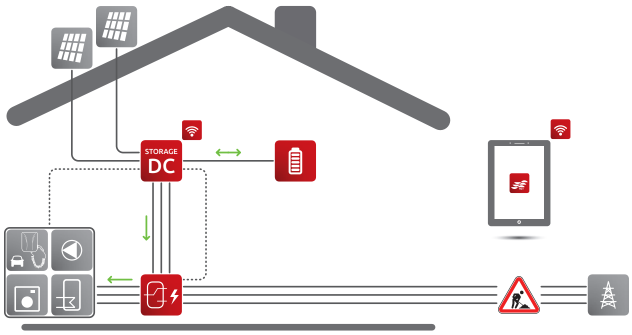
If you are planning a new PV installation, the DC-coupled storage system is the right option for you. The PV system generates direct current, which is converted by the inverter of the DC-coupled system into alternating current or stored directly in the battery storage system. Self-generated solar power is used in an optimised and efficient way. This inverter also controls charging and discharging. It covers domestic consumption, charges the battery and feeds the remaining surplus into the grid.
The generated energy remains in the house, respectively in the storage unit. Only the remaining excess power is fed into the public grid.

POWER STORAGE UNITS: ARE THEY ALSO SUITABLE FOR MY HOUSE?

The question is: Is my PV system suitable for power storage? The good news is that you can combine both a new and an existing PV system with a storage system.



AC-COUPLED STORAGE SYSTEMS



BACKUP POWER SYSTEMS

AC-COUPLED STORAGE SYSTEM - IDEAL TO RETROFIT EXISTING PV SYSTEMS

If the feed-in contract for your PV system is due to expire soon and your previous feed-in tariff will no longer apply, or you want to increase your self-consumption share, then you should use an AC-coupled system. This allows you to retrofit most PV systems with a solar power storage system. An additional battery inverter is connected to the existing solar inverter and is then connected to the electricity storage system.

BACKUP POWER FOR BETTER SECURITY OF SUPPLY

Modern solar power storage systems have a backup power function. It increases your security of supply, for example, in the event of power outages. Important electrical appliances such as refrigerators or WLAN routers are supplied with power during a power failure.
Your PV system also remains functional, so that you can continue to generate solar power. As soon as the power grid fails, a controller, the Power Switch, automatically switch from grid power to stored power. To optimize the security of supply, the device is equipped with two outputs:
One for power consumers that absolutely must be supplied with backup power, and one for those devices that can be dispensed with.

BATTERY TECHNOLOGY: SAFE AND ENVIRONMENTALLY FRIENDLY

Today, most power storage manufacturers rely on lithium-ion batteries. Lithium iron phosphate batteries ($LiFePO_4$) are particularly suitable. They convince by their safety, longevity and environmental compatibility.

SAFETY

$LiFePO_4$-based batteries score highly on the subject of reduced fire hazards. The energy density is lower for this technology. Mechanical damage does not lead to thermal overheating due to internal short circuits, which can lead to a fire. The batteries have slightly larger unit sizes, but this is not usually an issue for solar power storage systems. And: The oxygen required for a fire is particularly strongly bound in the battery cells. Therefore, these batteries are called intrinsically safe.

LONGEVITY

A long service life of a solar power storage unit means that the battery will continue to perform after many charges. A charging cycle includes one continuous charging and discharging process.We distinguish between full charging cycles and partial cycles. (Full cycle = discharge to a residual capacity of 0 per cent, subsequent charging to 100 per cent).
If you have a high level of self-consumption, you can assume that your battery will be charged and discharged around 250 times a year (= 250 charging cycles). The $LiFePO_4$-based storage units allow 5,000 charging cycles enabling a possible 20-year service life for the storage unit.

ENVIRONMENTAL SUSTAINABILITY

Lithium iron phosphate is a material that, in its chemical composition, occurs as a natural mineral. It is not a toxic heavy metal like cobalt, lead or nickel. Power storage systems using lithium iron phosphate-based technology are therefore not toxic, unlike batteries that use heavy metals. And just as significantly, the mining of cobalt takes place under questionable social and environmental conditions. Note: Because of their longevity, $LiFePO_4$ storage systems conserve valuable resources.

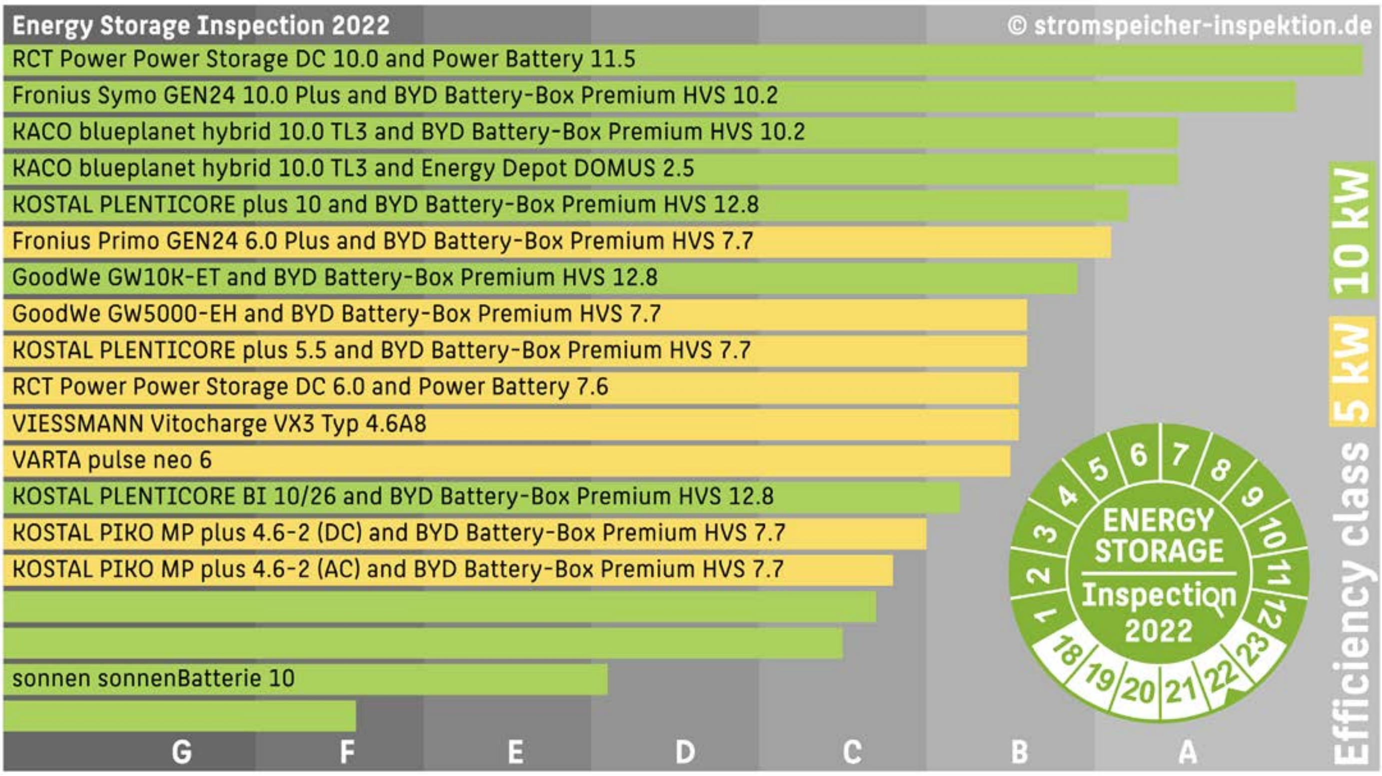
TECHNICAL KEY FIGURES: THESE DO MATTER

To evaluate the quality and sustainability of a power storage system, you should always check the most important key figures. For you as the end user, the “System Performance Index” (SPI) is particularly interesting.

KEY FIGURE: SYSTEM PERFORMANCE INDICATOR (SPI)

Since 2017, the Berlin University of Applied Sciences (HTW Berlin) has been evaluating the energy efficiency of solar power storage systems. For this purpose, the university has developed an efficiency indicator “System Performance Index” (SPI). This key figure allows us to compare power storage systems both technically and economically. Many manufacturers specify very different parameters that are difficult to compare with each other. The SPI shows what counts for the end user: the economic efficiency of the storage system.

The cost savings achieved by the power storage system are compared with the theoretical savings potential.
Using the SPI, you will discover whether a supposedly inexpensive electricity storage system, considering efficiency losses, ultimately becomes a more expensive storage system. And vice versa: Whether a higher-quality power storage system turns out to be the less expensive option over time.



The efficiency classification is based on the System Performance Index SPI (5 kW) and SPI (10 kW).

KEY FIGURE: EFFICIENCY

The efficiency of the solar power storage system is an important parameter. What is behind it? Energy loss is part of every storage process and cannot be avoided. The decisive factor is how high the loss is. Is it 5 %, 10 % or 40 %? Let's assume your PV system produces 1,000 kWh per year. If it loses 10% of energy during the storage process, you would only have 900 kWh available.
The solar power storage unit would have an efficiency of 90 %. At an efficiency of 80 %, you would only have 800 kWh available. A 10% lower efficiency rate per 1,000 kWh of generated energy equates to over 30 Euros at the current electricity prices (as of 2022).

KEY FIGURE: SETTLING TIME

Another key figure is the so-called settling time. It indicates how quickly the solar power storage system can provide the required energy. Why is this important?
The faster an end device can meet its demand from the solar power storage system, the less energy has to be drawn from the public power grid. This saves money. For example, the RCT Power electricity storage system has a settling time of fewer than 0.4 seconds.
By comparison, inferior power storage units have a settling time of more than 10 seconds. As a result, these systems have to draw more electricity from the public grid. And the battery will also discharge longer every time a connected consumer is switched off. The power drawn from the grid adds up and is ultimately reflected in the electricity bill.

KEY FIGURE: STAND-BY CONSUMPTION

Standby consumption is a key efficiency indicator that is often underestimated. underestimated. Since battery storage in residential buildings typically spends 2000 to 4000 hours per year in a discharged state, standby power consumption should be low. power consumption in standby mode should be low.

KEY FIGURE: STORAGE CAPACITY

Another important indicator is the storage capacity, also called the nominal capacity. This figure indicates the maximum amount of energy that can be stored in the storage unit during a recharge. It is given in kilowatt-hours (kWh).
The required storage capacity strongly depends on your consumption behaviour, the size of your household and the output of the PV system. With a smaller battery, you optimize the self-consumption of the PV system. A larger solar power storage system offers more flexibility and independence from the electricity supplier.
Therefore, the expected consumption must also be considered when calculating the battery capacity.

TIP:

Always compare the net capacity of solar power storage units!

KEY FIGURE: CHARGING CYCLES

How many times can a solar power storage system be charged and discharged before the battery loses power? Solar power storage units also lose capacity over time.
For a long service life, the number of available charging cycles is therefore an important key figure. In practice, a storage system is charged and discharged 220 to 250 times a year. Over 20 years this will amount to around 5000 charging cycles.

KEY FIGURE: DEPTH OF DISCHARGE

An important factor in improving the service life and environmental balance of a power storage system is the control of the depth of discharge (abbreviated as DoD).
A value of 100 % DoD represents a completely discharged battery, and 0 % DoD a fully charged storage unit. Manufacturers quote the maximum DoD values to indicate the usable storage capacity. Solar power storage systems cannot be completely discharged. Completely discharging the storage system would put a lot of stress on the battery and drastically shorten its service life.
$LiFePO_4$-based storage units have a DoD value between 80 and 90 %.

TIP:

When choosing your power storage capacity, keep in mind that you will not have 100% of the maximum stored power available.

OPTIMAL STORAGE SIZE: 7 FACTORS

You have now decided to install a grid-serving solar power storage system. But how big should the battery be, and what capacity should it have? Is it 4 kWh, 9 kWh or more?

The answer to this question is not simple and cannot be given in a generalised way. In principle, seven factors play a role:

1. YOUR CURRENT ELECTRICITY CONSUMPTION PER YEAR

The easiest way to determine your average electricity consumption is to look at your electricity bills. Take the average value of the last 2 to 3 years.

2. YOUR ANTICIPATED ELECTRICITY CONSUMPTION IN THE NEXT FEW YEARS

The future is electric (e-mobility, heat pumps, home appliances). Consider if you have plans to add more electric consumers in the future. If you do, go for a larger storage unit.

3. SIZE AND OUTPUT VOLUME OF YOUR PV SYSTEM

If you generate no or hardly any excess solar energy with your PV system, you will not need a storage unit. The greater the output of the PV system and the excess power generated, the larger the storage unit can be.

4. YOUR DESIRED DEGREE OF SELF-SUFFICIENCY

How much of your total electricity demand do you intend to cover with self-generated solar power to become more independent from electricity suppliers? A degree of self-sufficiency of 75% is a high value, while 100% is hardly achievable.

5. YOUR SELF-CONSUMPTION RATE

The self-consumption percentage tells you how much of the generated solar power you consume directly in your household. The power stored in the solar power storage unit is also taken into account.

6. YOUR ELECTRICITY CONSUMPTION TIMES

If you consume a lot of power in the morning and evening hours, you will need a larger storage tank, since your PV system generates little electricity during these times. If you mainly consume electricity around midday, the storage unit can be smaller, because your PV system produces less excess solar power.

7. ORIENTATION OF YOUR PV SYSTEM

If you consume a lot of power in the morning and evening hours, you will need a larger storage tank, since your PV system generates little electricity during these times. If you mainly consume electricity around midday, the storage unit can be smaller, because your PV system produces less excess solar power.

CALCULATING THE STORAGE UNIT SIZE

RULE OF THUMB TO CALCULATE THE SOLAR POWER STORAGE UNIT SIZE

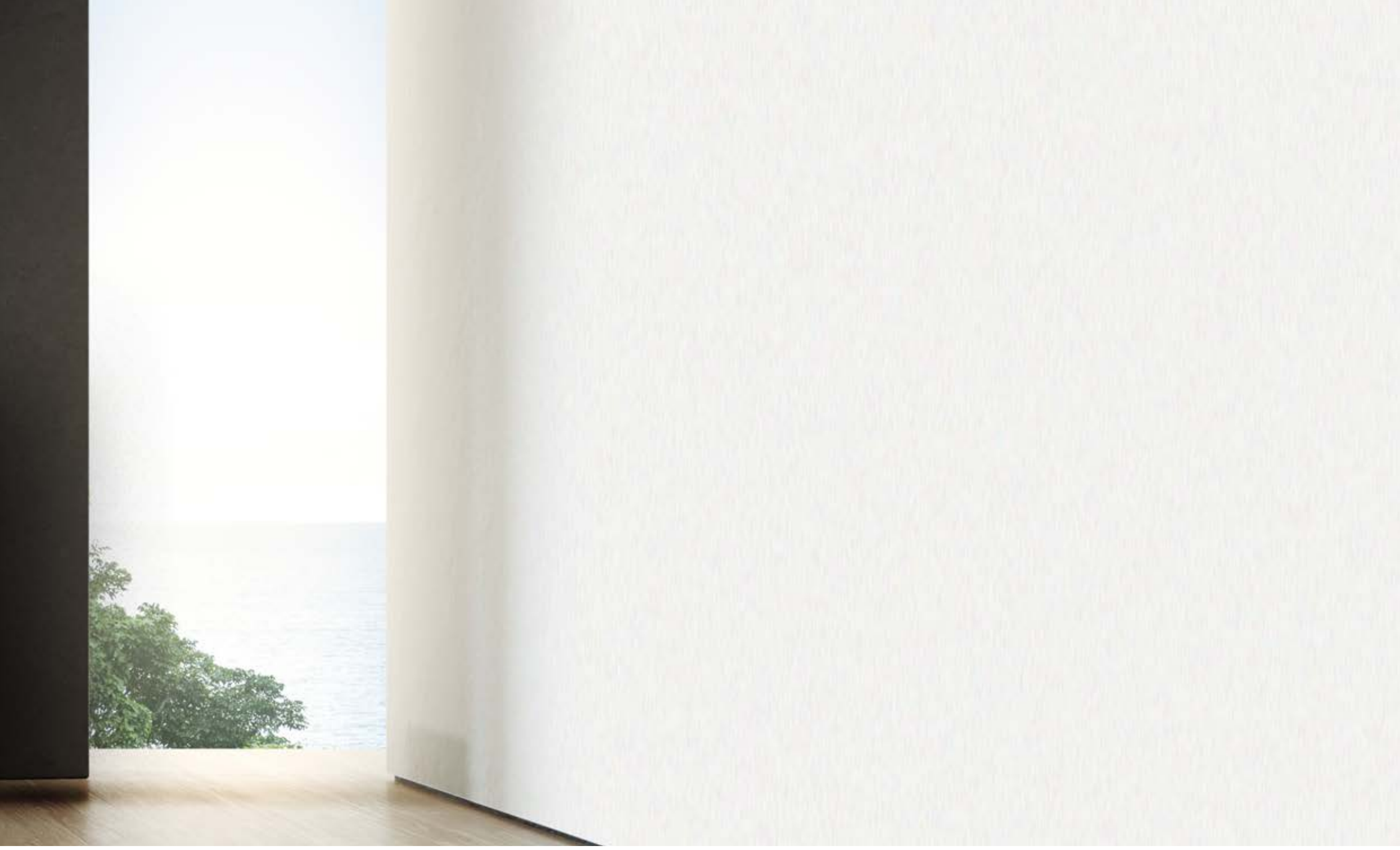
There are various calculation models and rules of thumb on how to calculate the optimal storage size. The following simplified rule of thumb helps to determine the maximum self-consumption: The power storage should cover at least 60% of the average daily power consumption in kilowatt-hours.

STORAGE SIZE = ANNUAL CONSUMPTION [KWH/A] / 365 [DAYS/A] X 60 %

The connected PV system should be at least of the same size in kWp as the power storage system to charge it accordingly. You should also consider the above-mentioned above and adjust the capacity if necessary.

CHARGING STRATEGY. GRID-SERVING FORECASTING

In addition to the conventional charging strategy - the sun shines, and the power storage is charged - an intelligent forecast-based charging strategy has been established.
The system calculates the optimum charging time based on weather data and past consumption behaviour. In simple terms: During sunny weather, the battery is charged later and therefore reaches its capacity limit later. Less electricity is fed into the public grid at midday, and energy losses due to regulation are avoided. These are the characteristics of a grid-serving solar storage system. Many subsidy programs insist on a grid-serving charging strategy. Grid-serving solar power storage systems protect the grid from overload and actively contribute to the energy transition.



INSTALLATION LOCATION FOR POWER STORAGE UNITS. KNOW THE BEST SITE

Setting up a solar power storage system does not usually pose a space problem as they are compact. The majority of the storage systems are installed as indoor systems inside the building.There is one limitation: The ambient temperature of the battery should be between 15 and 25 °C.

END-OF-LIFE? RECYCLING AND DISPOSAL

Power storage batteries have an average life expectancy of 15 to 20 years. If the battery is replaced at its end-of-life or a new storage system is installed, it will be supplied to recycling. According to the German Battery Act (BattG), the obligation to take back and recycle batteries rests with the distributor and manufacturer of the batteries.

6 TIPS FOR BUYING A POWER STORAGE

1. CHOOSE THE RIGHT BATTERY TECHNOLOGY

The gold standard in battery technology for solar power storage is lithium iron phosphate ($LiFePO_4$). These batteries do not overheat and have a very long service life.

2. CONSIDER THE SYSTEM PERFORMANCE INDEX (SPI)

The SPI describes the energy loss values of solar power storage systems providing a comparable benchmark for their performance.

3. CHOOSE THE RIGHT CAPACITY

The correct storage capacity for your power storage system depends on your power consumption patterns. A benchmark for the power storage capacity is 0.9 to 1.6 times the output power of the PV system. The RCT Power power storage calculator helps you to find the appropriate size.

4 .USE SUBSIDY PROGRAMMES

Federal, state and local governments regularly set up incentive programs for solar power storage. They are usually limited in time, and it pays off to monitor these programmes.

5.APPLY FOR KFW BANK FINANCING

The KfW Bank offers low-interest loans for financing a power storage system. Enquire about their credit lines and funding conditions.

6. CHOOSE GRID-SERVING POWER STORAGE SYSTEMS

A forecast-based, intelligent charging strategy charges the power storage battery by looking at weather conditions and power consumption patterns. This grid-serving charging avoids grid overload and boosts self-consumption. Many subsidy programs for power storage systems mandate a grid-serving connection of solar power storage units.

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ENERGY STORAGE Inspection 2022

Test Winner 2022

10 kW Storage Systems

ENERGY STORAGE Inspection 2018

ENERGY STORAGE Inspection 2019

ENERGY STORAGE Inspection 2020

ENERGY STORAGE Inspection 2021

GLOSSARY

A
The ampere is the SI base unit of the electric current. Its unit symbol is A.

AC COUPLING
The power storage system is connected to an existing PV inverter. The power storage system must now convert the alternating current (AC) arriving from the PV inverter back into direct current (DC). This process is reversed for energy withdrawal from the storage. AC-coupled power storage systems are particularly suitable for retrofitting existing PV systems.

ACTIVE POWER
Active power is the electrical power available for conversion to mechanical, thermal, or chemical power.

ALTERNATING CURRENT
An alternating current (AC) is an electric current that periodically reverses direction and changes its magnitude continuously with time. Inverters can generate alternating current from direct current. Household power supplies use alternating current.

APPARENT POWER
The apparent power is defined by the effective values of electric current and electric voltage and is composed of the actually converted active power and additional reactive power. The unit symbol of apparent power is volt-ampere (VA) and not watt (W).

BACK-UP POWER
During a public grid failure, a power storage system with a back-up power function will independently switch over consumers from grid supply to the in-house storage system. After a time lag of a few seconds, the storage unit or the PV system will supply selected consumers with power. The PV system continues to generate solar power. Surplus energy is stored in the power storage unit. Back-up power is not suitable where an uninterruptible power supply (UPS) is required.

BATTERY
A device that stores energy is generally called an accumulator or battery. Batteries that consist of an electrochemical cell or a combination of cells are broadly used. They come equipped with the required connectors and protective devices for safe usage.

BATTERY - DEPTH OF DISCHARGE (DOD)
The depth of discharge (DoD) of a battery refers to the size of the capacity range usually available for discharge. The units of DoD are percentage points. Battery manufacturers use the depth of discharge to define the usable percentage of the battery's capacity. The lower the depth of discharge, the more frequently a battery storage unit is charged and discharged. For example, a power storage unit with a 10kWh storage capacity and a DoD of 80 % can only store 8 kWh in the battery.

BATTERY MANAGEMENT SYSTEM (BMS)
The battery management system (BMS) is the key essential electronic component of a power storage unit. It monitors the computed "State of Charge" (SoC) during charging and discharging. It also acts as an interface between the device and the battery. Its sensors measure the currents, voltages, temperatures of the individual cells and of the entire system and are partly used for control. measured and partly also regulated. The BMS is a central safety component of the power storage unit.

BATTERY - STATE OF CHARGE (SOC)

The state of charge (SoC) of an electric battery is the current level of charge relative to its nominal capacity. The units of SoC are percentage points. If the battery is fully charged, it is 100 %, if it is empty, it is 0 %.

CAPACITY

The ability of a power storage unit to store an electric charge is referred to as its capacity. The measurement unit is the ampere hour (Ah).

CHARGING CURRENT

The charging current refers to the amperage with which a battery is charged. It is also common practice to use the rate of C-rate to describe the charge and discharge of batteries. It is defined as the charge or the discharge current (in A) divided by the battery's capacity to store an electrical charge (in Ah). The rate 1 C would theoretically fully charge or discharge the battery in one hour. Typical charging and discharging may occur at C/2 (two hours for full capacity).

CHARGING CYCLES

A charging cycle describes the connected charge and discharge process of a battery. The service life of a battery directly correlates to the number of charging cycles.

CONSUMER

Household appliances that require electrical energy are called consumers. The biggest electricity consumers in a household are usually water heating, space heating heat pumps, electric cookers, air conditioners and electric vehicle charging stations.

CONTROL SPEED

The control speed is the elapsed time before the power adjustment of the storage system starts after switching on a consumer. It is comprised of dead time and settling time and should preferably be as low as possible as it affects the power storage system efficiency.

DC COUPLING

In DC-coupled systems, the power storage system is connected directly to the PV modules. A conversion into direct current (DC) for storage is not necessary. DC-coupled electricity storage systems are particularly suitable for new PV system installations.

DIRECT CURRENT

Direct current (DC) is a one-directional flow of electric charge at a constant voltage in an electric circuit. Electrons move through an electric conductor from the negative to the positive pole. Rectifiers can generate direct current from alternating current. Batteries use direct current.

DISCHARGE CURRENT

The discharge current refers to the amperage that a battery can deliver over a defined period.

DEGREE OF SELF-SUFFICIENCY

The degree of self-sufficiency stands for the share of a household's energy demand that can be covered by the PV system. A 100 per cent degree of self-sufficiency represents the complete independence of energy suppliers. Private households are unlikely to achieve this level due to technical and meteorological framework conditions. For PV systems with power storage units, degrees of self-sufficiency between 70 to 80 per cent are, by all means, realistic.

EFFICIENCY

The efficiency (η) indicates how well photovoltaic components such as solar panels, inverters or power storage units perform stating their energy conversion losses. In theory, efficiencies can range from 0 to 100 per cent. In real terms, 100 per cent efficiency is impossible as there will always be energy conversion losses within the components that cannot be recovered, e.g. sunlight into electric power. Efficiencies are usually expressed as mean values or weighted mean values. In general, the higher the efficiency, the more efficiently the PV system and the power storage system operate.

EFFECTIVE STORAGE CAPACITY

The effective or usable storage capacity is, in practice, the significant parameter of a power storage unit. It indicates how much energy can be withdrawn considering the maximum permittable depth of discharge.

FORECAST-BASED CHARGING METHOD

The storage system's inverter uses weather data and individual power generation forecasts to optimise the charging of the storage unit with the forecast-based charging method. By matching weather and consumption data, the power storage system is charged to maximise household self-consumption and minimise the amount of curtailed power. A forecast-based charging functionality is usually a prerequisite for receiving subsidies for power storage systems.

FULL CYCLE

A full cycle is when a battery is fully discharged and then fully charged.

GRID-SERVING OPERATION MODE

The operating mode of a solar power storage system at limited storage capacity should create the maximum benefit for the user and provide the maximum possible stabilisation of the power grid. It is termed grid-serving.
If a PV system is set up to always charge the power storage system when the generated solar power exceeds the household self-consumption, the storage system would frequently be fully charged before noon when the PV system has its peak output. It is not grid-serving and likely to overload the grid.
To avoid this scenario, the charging process should be controlled to charge the power storage system around peak solar radiation. The exact timing can, neither for all installed PV systems nor for the individual storage system, be predicted with absolute certainty due to variable weather patterns. The forecast-based charging method of RCT Power's storage systems tracks the ideal time to charge and enables grid-serving operation.

HIGH-VOLTAGE BATTERY

Power storage units with high-voltage batteries have a high output voltage and high efficiency. It leaves the inverter to bridge only a small voltage difference. The battery can, due to its high voltage level, be connected directly to an intermediate circuit of the inverter.

LIFEPO$_4$

Lithium-ion batteries currently represent the most common cell chemistry for stationary battery storage systems. Lithium iron phosphate-based battery cells ($LiFePO_4$ or LFP) belong to this group of batteries. They have excellent performance features and are durable and safe. They have high cycle stability and can therefore be charged more frequently while at the same time delivering higher charge and discharge capacities. LFP battery cells do not use problematic and questionable cobalt as a raw material. The use in power storage units is judged to be non-hazardous, and above all, non-toxic.

MAXIMUM POWER POINT (MPP)

The optimal load characteristic of a solar cell providing the highest power transfer is called the maximum power point (MPP). It is not constant and depends on external factors such as available sunlight and the solar panel temperature.

NOMINAL STORAGE CAPACITY

The nominal storage capacity equates to the amount of energy that can be withdrawn from the power storage unit under certain conditions.

NOMINAL VOLTAGE

The nominal voltage is the voltage a consumer or device is designed to operate with. The correct nominal voltage must be used for a PV system to deliver its specified power output.

PARTIAL CYCLE

In a partial cycle, a battery is only incompletely discharged or charged. To calculate the total number of charging cycles, partial cycles can be added up and combined into full cycles.

PHOTOVOLTAICS

Photovoltaics is a collective term for the environmentally friendly way of generating electricity from sunlight. It exploits the physical phenomenon that sunlight can create a voltage between two selected semiconductors. Roofs of detached houses are an ideal location for the installation of a photovoltaic system.

REACTIVE POWER

In contrast to active power, reactive power cannot do any work and be usefully converted. However, reactive power plays a part in stabilising the voltage in power grids.

REGULATION LOSSES

To protect power grids from overload, power output from photovoltaic systems must be able to be remotely regulated or set up to only feed in 70% of the installed system output. If excess solar power cannot be fed to the power storage unit or to a connected consumer it must be curtailed. The result is regulation losses.

SELF-CONSUMPTION

Self-consumption means that the owner of a PV system uses the generated solar power directly and does not feed it into the public power grid. It is fed directly from the PV system to the connected consumers or temporarily stored in a solar power storage unit.

SELF-CONSUMPTION RATIO

The self-consumption ratio stands for the share of a PV system’s generated solar power that immediately either supplies household consumers or charges the power storage system. The higher the self-consumption ratio, the less solar power is fed into the grid.

SELF-SUFFICIENCY

Self-sufficiency in power supply stands for the independence of the public power grid. The more self-sufficient a household is in its power supply, the less energy it requires from energy suppliers.

SHADING MANAGEMENT

A PV system can only generate the full specified power if the solar radiation reaches the solar panels unobstructed. In practice, however, objects on the roof, such as chimneys, satellite dishes or vents, will lead to partial shading of the solar panels and create a yield loss. An inverter integrated shading management system can reduce the yield loss to a minimum and make using module optimisers redundant.

SINGLE-PHASE STORAGE SYSTEMS

Single-phase inverters are only rarely used in Germany. They might still be installed in small PV systems. They are likely to present obstacles to future upgrades and modernisation and are not recommended.

SOLAR POWER STORAGE

Solar power storage units are large rechargeable accumulators (batteries) for solar power. They allow us to store solar energy and use it when required. Energy generation and consumption are temporally decoupled. Solar power storage systems enable the efficient use of photovoltaic systems, which generate most of their electricity during the midday hours. The storage systems can compensate for the increased power demand in the evening hours caused by lighting and electrical appliances.
These days, solar power storage systems are increasingly equipped with lithium iron phosphate-based batteries.

STATE OF CHARGE

State of charge refers to the current level of charge of a battery in relation to its maximum capacity in per cent.

STORAGE CAPACITY

One of the most essential parameters of a power storage unit is its storage capacity. It indicates how much energy at nominal conditions can be withdrawn from the unit. The storage capacity is specified in kilowatt-hours (kWh). We distinguish between gross capacity (nominal capacity) and net capacity (usable capacity).

THREE-PHASE STORAGE SYSTEMS

The inverter of a three-phase power storage system connects to the household grid via all three phases. The application rule (VDE-AR-N 4105:2018-11) for the operation of PV systems mandates a general limit of 4.6 kilovolt amperes (kVA) per phase to avoid uneven loading of the outer conductors of a three-phase AC power system. Therefore, individual inverters with a rated power greater than 4.6 kVA may not be connected to a single phase. If the power of the PV system exceeds 4.6 kVA, a 3-phase inverter must be used.
The trend points clearly towards the deployment of 3-phase inverters.

V

The volt is the derived SI unit for the electrical voltage. The unit symbol is V. 1000 volts are equal to one kilovolt (kV).

VOLTAGE RANGE

Electric voltage is separated into two main voltage ranges. Voltages above 1000 V are called high voltage. Voltages below 1000 V are referred to as low voltage.

W

The watt (unit symbol = W) is a unit for power. In electrical engineering, the electrical power P computes as the product of the electric current (formula symbol I) and the given voltage (formula symbol U).
Physical formula: P = U x I

WATT (W); KILOWATT (KW)

Watt is a unit of power. It quantifies the rate of energy conversion in a defined time interval. The unit symbol for watt is W. A commonly used multiple of a watt is a kilowatt. 1 kilowatt (kW) equals 1000 watts (W). The letter P is the formula symbol for power and is an abbreviation of "power".

WATT-HOUR (WH); KILOWATT-HOUR (KWH)

A watt-hour is a unit of work or energy. The unit symbol for watt-hour is Wh. One watt-hour equals the amount of energy that a system with a power of one watt consumes or delivers in one hour. A kilowatt-hour is abbreviated as kWh, where kW stands for kilowatt and the h is the abbreviation of the Latin "hora".
An energy generator or consumer with 1 kW of power in operation for one hour generates 1 kW x 1h = 1kWh of energy or converts it into heat.
With one kilowatt-hour, for example, you can:

- Use a vacuum cleaner rated at 1000 W for one hour.
- Light a 12 W energy-saving bulb for about 83 hours.
- Use a 1400 W rated hairdryer for about 43 minutes.
- Work on a 20 W rated laptop for about 50 hours.

Energy suppliers use kilowatt-hours in their consumer energy billing.
The letter W is the formula symbol for work/energy and is an abbreviation of "work".

ZERO FEED-IN SYSTEM

A zero feed-in solar system either exclusively supplies the household power grid with the generated solar power or stores it in a power storage unit. No surplus solar power is fed into the public grid.

RCT Power GmbH
Line-Eid-Str. 1
78467 Konstanz
Germany

Tel.: +49 7531 99677 0
E-mail: info@rct-power.com

FIND OUT MORE AT:
WWW.RCT-POWER.COM