Quick guide to domestic rooftop solar PV and storage

Market overview

Rooftop solar PV is the most popular form of microgeneration renewable technology in the UK with over 1.2 million systems installed[2]. Despite concerns that the domestic solar industry would suffer with the withdrawal of the Feed in Tariff in 2019, the industry is experiencing a boom, with over 130,000 solar PV systems installed in 2022, more than double the number installed in the previous year[3]. With increasing concern about energy security and energy price volatility, demand for solar PV is expected to continue to remain high[4].

Standards and certification

The Microgeneration Certification Scheme (MCS) is an independent certification scheme for microgeneration products and installers. For solar PV, there are over 1,800 certified installers on the MCS database across all regions of the UK.

Suitable homes

Most homes with sufficient un-shaded roof space can accommodate solar PV. South-facing roofs are ideal, although the yield from east and west-facing roofs is still around 80% of the output of a system facing due south. Typical domestic systems range between 1.5kWp and 4kWp[5], and each kWp of PV requires around 7m^2 of available roof space[6]. Flats with available roof space can also install solar PV but gaining freeholder consent can sometimes be a barrier.

kWp refers to peak (p) output of the solar PV array in kilowatts (kW)

The average rooftop system size in the UK is around 3kWp.

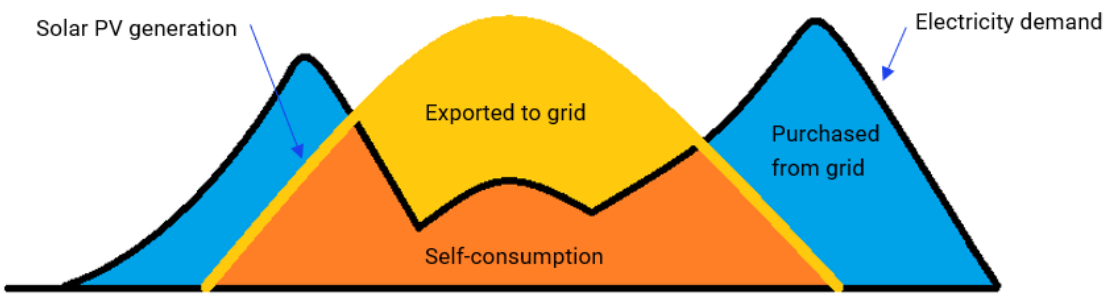
The average load factor for a UK PV system is 10% meaning **an average system will generate around 2,600kWh per year[1].**

On-site consumption vs export

The financial benefits of Solar PV will vary depending on how much of the generated electricity is consumed on-site vs exported to the grid. On-site consumption will currently save homeowners £0.34 per kWh (standard domestic energy price cap tariff March 2023) whereas exported electricity currently provides an income of between £0.01 - £0.24 per kWh depending on your electricity export tariff[7].

On-site consumption for rooftop solar PV varies depending on how occupants use electricity during the day and across the year. System size also has an impact; the smaller the PV installation, the lower the energy generated, but the higher the proportion that will be used on site. Studies of UK solar installations have shown that on-site consumption can vary between 10% and 80%; more typical on-site consumption rates were found to be between 15%[8] and 42%[9]. However, evidence indicates that the amount of electricity imported from the grid reduces by a lower amount of 14%[10] - 24%[11]. This is thought to be due to occupants increasing their energy use in response to the installation of solar PV.

Image 1: Household electricity demand, solar PV generation, self-consumption and export; illustrative example



Changes in behaviour, such as using appliances during the day, can lead to modest increases in on-site consumption. However, charging large electric loads such as electric vehicles, domestic batteries, hot water

cylinders, thermal stores or heat pumps will result in much higher levels of on-site consumption when coincided with PV generation. This can be achieved through active user management or, increasingly, through automation.

Battery Storage

To increase on-site consumption, it is becoming more popular for domestic scale batteries to be installed alongside solar panels. The impact of battery storage will vary but a well-designed and optimised battery system could make it possible to double on-site consumption to around 50 – 80% depending on system size.[12],[13],[14]. The market for battery storage is nascent with high up-front costs and therefore batteries typically will not yield a return on investment within the expected lifetime of the battery of between 5 – 15 years. However, high electricity prices and greater availability of time of use tariffs are improving the economics of domestic battery storage.

Thermal storage

A further option for storing PV generation is to use a thermal store, such as a hot water cylinder or dedicated heat battery. Due to the consistent year-round demand for hot water and good alignment with the daily levels of PV generation[15],[16], the addition of a solar diverter control to an immersion heater can be a relatively low-cost way to increase on-site consumption where homes already have a hot water cylinder. Where this displaces the use of imported electricity, the financial savings will be large but where gas heating is being displaced the financial savings will be lower. For homes with heat pumps, using solar PV to generate hot water via the heat pump will reduce imports from the grid even further as every kWh of electricity can generate around 2.5kWh of hot water[17],[18].

Overall costs and savings

The Energy Saving Trust provides a solar energy calculator to help homeowners understand the savings they could make given their specific roof orientation, size and usage profile. For example, at current electricity prices, a home with a South facing roof installing a 3.5kWp system could save between £370 and £650 depending on how occupants use electricity during the day and depending on their export tariff. Although it should be noted that this annual saving could decrease in the long term if electricity prices decrease in line with government estimates[19]. The saving would also decrease if homeowners chose to increase energy consumption in response to the installation of PV. The following table provides some indicative costs and savings for a 3.5kWp solar PV installation generating 3,112 kWh of electricity per year, based on March 2023 prices.

Table 1: indicative costs and savings for typical 3kW solar PV system with storage options (Mar 2023 tariffs)

Technology package	System size	Indicative up-front cost[20]	Potential annual savings (range)	Measure lifetime
Solar PV	3.5kW	£5,150 - £7,050[21]	£370 - £650[22]	20 – 30 years
Solar PV plus battery storage	3.5kW + 5kWh battery	£8,150 – £14,050[23]	£490 - £730[24]	5 – 15 years (Battery)
Solar PV & solar diverter displacing electric immersion	3.5kWh + solar diverter	£6,150 - £8,050[25]	£435 - £870[26]	15 - 20 years (Solar diverter)
Solar PV & solar diverter displacing gas	3.5kWh + solar diverter	£6,150 - £8,050[27]	£440 - £635[28]	15 - 20 years (Solar diverter)

References

[1] BEIS (2021) 'Feed in tariff load factor analysis' (**https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1043318/Feed-in_Tariff_load_factor_analysis_2020-21.pdf**)
[2] MCS (2022), 'Press Release: 2022 Solar, So Good' (**https://mcscertified.com/2022-solar-so-good/**)
[3] BEIS (2023) 'National statistics: Solar Photovoltaic Deployment' (**https://www.gov.uk/government/statistics/solar-photovoltaics-deployment**)
[4]Santander (2022) 'Buying in to the green homes revolution' (**https://www.santander.co.uk/about-santander/media-centre/press-releases/a-green-premium-house-buyers-willing-to-pay-almost-10**)
[5] See 4
[6] Climate Biz (2023) 'What size is a standard PV panel?' (**https://climatebiz.com/250-watt-solar-panel-size/**)
[7] EcoExperts (2023) 'The Best Smart Export Guarantee Rates 2023' (**https://www.theecoexperts.co.uk/solar-panels/smart-export-guarantee**)
[8] Energy Saving Trust (2023) 'Solar Panels Advice' (**https://energysavingtrust.org.uk/advice/solar-panels/**)
[9] University College London (2018) 'Solar photovoltaic self-consumption in the UK residential sector: new estimates from a smart grid demonstration project' (**https://discovery.ucl.ac.uk/id/eprint/10047969/1/McKenna%20PV%20self-consumption%20in%20UK%202018%2005%2008.pdf**)
[10] See 3
[11]BEIS (2021) 'National Energy Efficiency Data Framework (NEED) Summary of Analysis Great Britain 2021' (**https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1008681/need-report-2021.pdf**)
[12]University College London (2021) 'Policy options for increasing economic profitability of residential solar PV with battery storage' (**https://discovery.ucl.ac.uk/id/eprint/10127839/1/Dodds_Dodds_Policy%20options%20for%20enhancing%20economic%20profitability%20of%20residential%20solar%20photovoltaic%20with%20battery%20energy%20storage_VoR.pdf**)
[13] University of Warwick (2018) 'Operational Study of Domestic Battery Energy Storage System' (**https://www.researchgate.net/publication/333707347_Operational_study_of_domestic_battery_energy_storage_system**)
[14] NEA (2022) 'Innovation technical evaluation Solar PV & Batteries' (**https://www.nea.org.uk/who-we-are/innovation-technical-evaluation/solarpv/solarpv-batteries/**)
[15] For a typical home, a hot water cylinder may require between 4kWh and 11 kWh of energy for water heating per day. This aligns well with a 3kWp PV installation, where average daily generation rates can range between 1kWh in winter and 10kWh per day in summer.
[16] Energy Saving Trust for Defra (2009), 'Measurement of domestic hot water consumption in dwellings' (**https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/48188/3147-measure-domestic-hot-water-consump.pdf**)
[17]The high efficiency of the heat pump may technically reduce the percentage of on-site solar PV consumption relative to a direct immersion heater. However, the requirement for import from the electricity grid is likely to reduce further with the heat pump because, although both the heat pump and direct immersion heater are capable of meeting 100% of hot water demand in the summer months, a heat pump increases the percentage of total hot water demand that can be met via the solar in the winter, spring and autumn when the daily kWh of PV generation is typically lower than the required daily kWh for hot water.
[18] Solar Power Europe (2023) 'Solar Powers Heat 2023' (**https://api.solarpowereurope.org/uploads/0523_SPE_Solar_Heating_report_09_mr_98b11ef7ab.pdf**)
[19] HM Treasury (2023) 'Green Book valuation of energy use and greenhouse gas emissions for appraisal; Data Tables 1 – 19' (**https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal**)
[20] Please note that technology costs can vary significantly by region, by brand/ manufacturer and depending on the specific circumstances of each home and so these should be treated as an illustrative example only.
[21] BEIS (2022) 'Solar PV cost data' (**https://www.gov.uk/government/statistics/solar-pv-cost-data**)
[22] Assumes annual generation of 3,112kWh with a range of on-site consumption between 15% and 50% with an electricity tariff of £0.34 per kWh and an export tariff of £0.08 per kWh.
[23] Assumes Solar PV cost plus cost of 5kW battery estimated between £3,000 and £7,000. Battery equipment costs sourced from a combination of: 'Which Solar PV and batteries customer survey' (**https://www.which.co.uk/reviews/solar-panels/article/solar-panels/solar-panel-battery-storage-a2AfJ0s5tCyT**); 'Midsummer wholesale website battery storage kit page' (**https://midsummerwholesale.co.uk/buy/huawei-storage**); Greenmatch installation quote comparison site blog: How much does a solar PV battery system cost' (**https://www.greenmatch.co.uk/blog/2018/07/solar-battery-storage-system-cost**); 'EDF Energy battery storage installed system costs' (**https://www.edfenergy.com/solar/solar-battery-storage**);
[24] Assumes annual generation of 3,112kWh with a range of on-site consumption between 30% and 60% with an electricity tariff of £0.34 per kWh and an export tariff of £0.08 per kWh.
[25] Assumes a £500 equipment cost and £500 installation fee for the solar diverter into an existing hot water cylinder. (**https://midsummerwholesale.co.uk/buy/solar-immersion-controller**). Also Energy Saving Trust (2023) 'Solar Panel Advice' (**https://energysavingtrust.org.uk/advice/solar-panels/**)
[26] Assumes annual generation of 3,112kWh with a range of on-site consumption between 15% and 30% with an electricity tariff of £0.34 per kWh and an export tariff of £0.08 per kWh. In addition, assumes that further 700 – 1,400 kWh of electricity is displaced by the solar diverter at £0.103 per kWh.
[27] See 24
[28] Assumes annual generation of 3,112kWh with a range of on-site consumption between 15% and 30% with an electricity tariff of £0.34 per kWh and an export tariff of £0.08 per kWh. Assumes that 700 – 1,400 kWh of gas is displaced by the solar diverter at £0.103 per kWh.

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