SAP 10 Technical Paper

S10TP-07

PV SELF-USE FACTOR CALCULATION

Issue 1.4

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DOCUMENT REVISION LOG

DATE	VERSION NO.	AMENDMENT DETAILS	APPROVED BY
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13/07/2018	1.1	Correction to formula on page 7, step 4.	Paul Davidson
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1. INTRODUCTION

SAP has for many years contained a method to estimate the amount of electrical energy generated by photovoltaic systems (PV). The method has included a fixed assumption about the percentage of the electricity generated that will be used within the dwelling, with the rest assumed to be exported. This ‘self-use’ figure, known as the β-factor, was originally 0.5, but was believed to be in need of review because PV systems have become larger on average since the original figure was added, suggesting the self-use factor could now be lower. Furthermore, battery storage systems are starting to become popular, usually alongside PV, which will clearly also have an impact on self-use by allowing a greater proportion of the generated electricity to be used in the home (e.g. after sunset).

A task for SAP 10.2 has therefore been to update the β-factor whilst incorporating the impact of battery storage.

This change should be considered in the context of another SAP 10.2 change, which was to reduce the assumed financial value of exported electricity from being equal to the import price to being set to the (much lower) average wholesale price of electricity. Thus, a lower predicted self-use factor will in future affect the SAP / EPC rating.

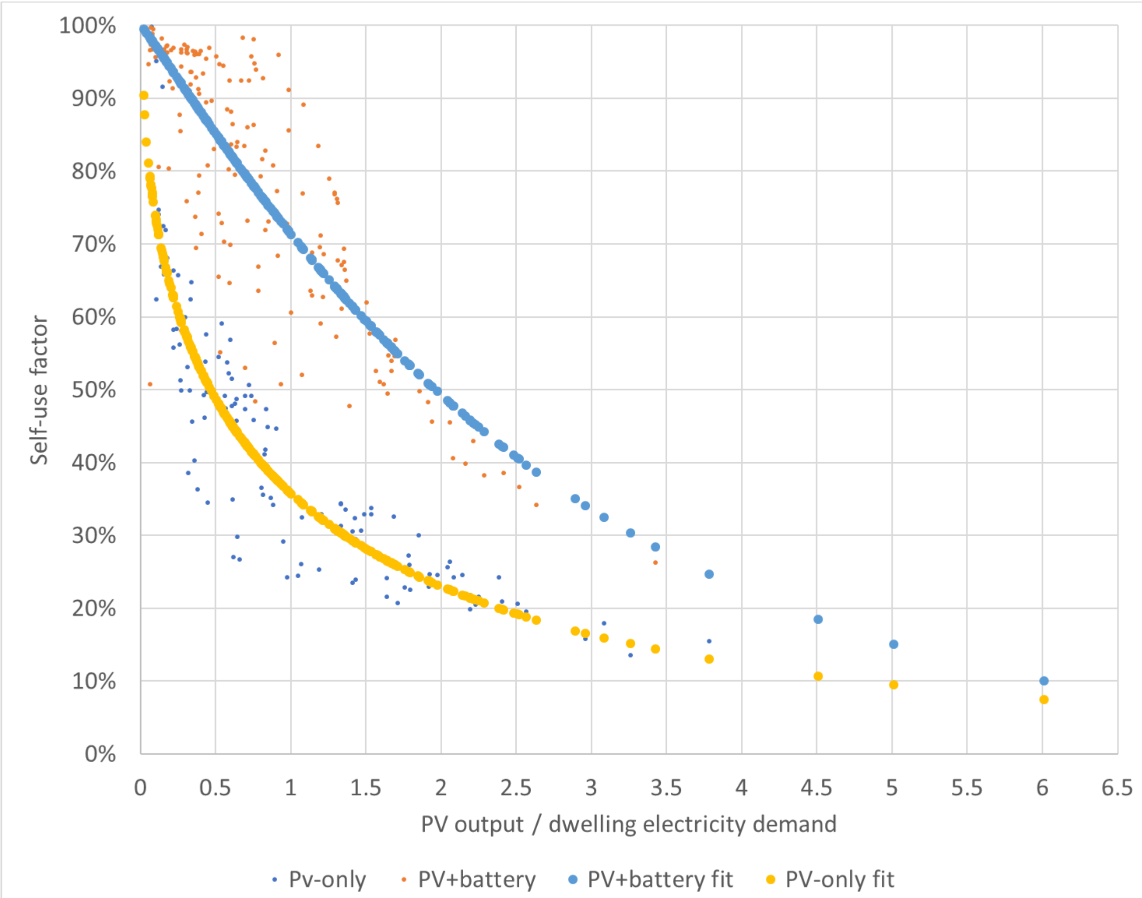
2. DERIVATION OF NEW METHODOLOGY

Suitable field data was made available to support this work by the Solar Trade Association and a private company. This contained data showing how the monthly proportion of self-use of PV generated electricity varies with PV generation and total electricity demand. In total, BRE obtained data for 15 homes with battery storage, and 18 with no battery storage, 4 of which contained hourly data. Not all homes had a full year of data, but this was enough to allow the analysis of 300 months of data.

A key fact about the homes with PV + battery was that they were all supplied with the same 6.4 kWh[1] battery.

[1] This is the usable capacity

By plotting the self-use factor as a function of the supply/demand ratio for each month of data it was apparent that there was a clear and fairly consistent trend, suggesting this could form a good basis for estimating the β-factor. A form of equation was devised which was able to give a good fit to the data for both the PV-only and the PV+battery data sets.



The equations for both fits had the form:

$\beta = EXP(-C1 * (C2\ E_{PV}/D_{PV})^{C3})$

E_{PV} is the electrical energy generated by the PV system (kWh/month)

D_{PV} is the electricity demand of the dwelling (kWh/month)

The values of the coefficients in each case were as follows:

	With no battery	With 6.4kWh battery	Rate of change with battery capacity (see next paragraph)
C1	1.610	0.987	-0.0973
C2	0.415	0.365	-0.00776
C3	0.511	1.065	0.0866

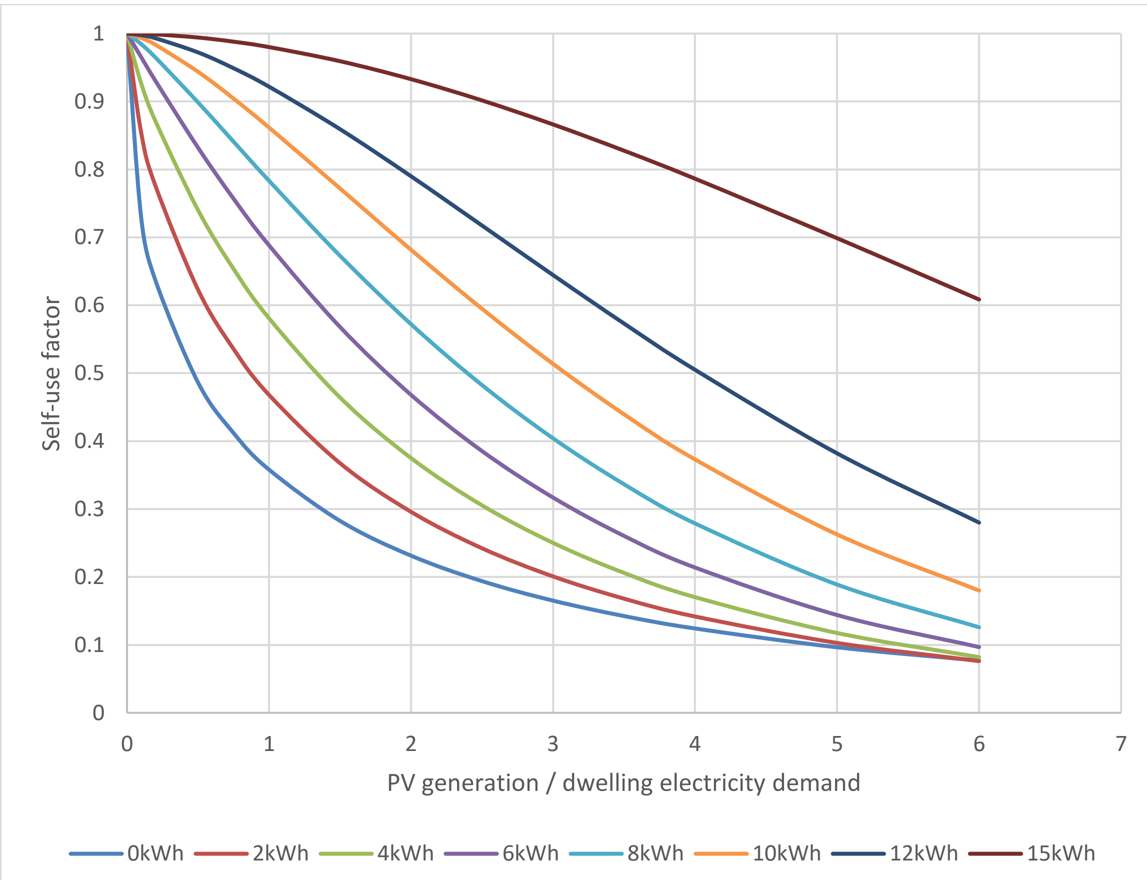
By making the assumption that the coefficients vary linearly with battery capacity (C_{bat}, kWh) at the same rate as between 0 kWh and 6.4 kWh, it is possible to derive a general formula for any size of battery. If more data for different sized batteries were available, it may be determined that a non-linear relationship exists, but with only two points (0 and 6.4 kWh), it has not been possible to examine this.

$C1 = 1.610 - 0.0973\ C_{bat}$

$C2 = 0.415 - 0.00776\ C_{bat}$

$C3 = 0.511 + 0.0866\ C_{bat}$

Sense checking this with a range of battery sizes up to a battery capacity of around 15kWh, the results are reasonable:



At 17 kWh and greater, unreasonable self-use factors above 1 are given. One possibility would be to simply cap the formula at 1 (i.e. assume all electricity generated can be used in the dwelling). However, given the lack of data for a battery anywhere near this size it seems sensible to cap the maximum battery size catered for to avoid speculating if and at what capacity full self-use does actually occur. We therefore propose capping at 15kWh.

The method for SAP 10.2 is therefore:

1. Calculate the amount of PV electricity generated, $E_{PV,m}$ (kWh/month) then split over the months of the year as normal.
2. Calculate the electricity demand of the dwelling by summing applicable[2] end-uses from the existing SAP calculation, $D_{PV,m}$ (kWh/month),
3. Calculate the coefficients C1, C2 and C3, based on the battery capacity.
   $C1 = 1.610 - 0.0973\ C_{bat}$
   $C2 = 0.415 - 0.00776\ C_{bat}$
   $C3 = 0.511 + 0.0866\ C_{bat}$
4. Calculate the self-use factor for each month, β_m
   $\beta_m = EXP\ (-C1 * (C2 * E_{PV,m}/D_{PV,m})^{C3})$

It is important to note that this method can only be applied to monthly values of E_{PV} and D_{PV}. (Since much more solar energy is available in summer, using annual figures leads to an incorrect average β for the year.) The resulting figures for consumed/exported energy can then be summed for the year, from which (if desired) it is possible to calculate an annual self-use factor.

3. IMPACT OF CHANGE

The electricity consumption of typical UK home is around 3,100 kWh/yr.
The output of a 2.5 kWp PV system is around 2,000 kWh/yr.
With no battery storage, this would give an (annual) self-use factor of 0.4.
With a 5 kWh battery, this would give a self-use factor of 0.65.
With a 10 kWh battery, this would give a self-use factor of 0.86.

[2] This must include electricity used for non-regulated uses such as appliances and electric cooking. For the time-being, until more data is available, BRE propose to exclude from this total any electricity calculated by SAP to be used at off-peak rates.

The use of a smaller PV system of, say, 1 kWp, would give a self-use factor of 0.54 with no battery storage, 0.83 with a 5 kWh battery or 0.96 with a 10 kWh battery.

Given the fixed assumption of a self-use factor of 0.5 in SAP 2012, and as shown in two examples above, if there is no battery storage this change could be positive or negative in terms of the amount of electricity generated and consumed within the dwelling.

If battery storage is present, the self-use factor is very likely to be greater than 0.5, so a greater proportion of use within the home will be predicted.

4. LIMITATIONS AND FURTHER WORK NEEDED

- Homes with other, or multiple, renewable generation systems are not catered for. In future, we should consider extending the self-use factor calculation method to work with wind turbines, micro-hydro generators, electricity from micro-CHP (mCHP) and combinations of these.
- The proposed method is not able to differentiate intelligently between homes with features that would be expected to affect the self-use proportion, such as different types of space and water heating. This would affect the amount of electricity used during daylight hours, which could have a sizable impact on homes without battery storage.