How does the addition of a Solar PV installation effect the rating of a consumer unit?

Determining the ratings of assemblies when we are using a generating set (Solar inverter) in parallel with the public supply.

A look at a regulation that must be taken literally and as a result, could present some design issues when it comes to the installation of a Solar PV system to an existing domestic installation. The Solar inverter converts DC from the panels to AC for use in the installation and is as such, classed as a generator according to BS 7671.

Modern consumer unit assemblies are designed by the manufacturers to operate safely only up to a pre-determined maximum level of current. This is given the term I_{nA} and problems can arise when there are two channels of input after an inverter is installed, rather than just the supplier's cutout. You must check the manufacturer's data sheet, because "100 A" printed on the CU doesn't automatically mean the I_{nA} is exactly 100 A

These two ways of supplying current to our assembly need to be added together to confirm that the total current remains equal to or below the assembly rating, regardless of whether the customer is ever likely to use the full capacity!

It is the designer's responsibility to determine this I_{nA} rating by contacting the assembly manufacturer and to ensure that the assembly maximum rating is not exceeded.

What is diversity?

This is a factor we use to make a reasonable estimate of the current demand of an installation. In other words, not every circuit is running at full load all the time. If we added all the breakers together for most installations, we would likely have a potential current demand that would exceed not only the rating of the assembly (I_{nA}), but the I_n of the supplier's cutout fuse itself!

There are some fairly simplistic formulas available, for example, taking the largest breaker and adding 40% of the rest or applying a given factor to the whole installation in an attempt to determine a reasonable figure.

If the designer has knowledge of the load characteristics of the installation a more accurate result can be obtained. Continuous loads like thermostatically controlled water heaters can draw current for a considerable amount of time and so no diversity would be allowed.

Unfortunately, this method does not apply to rating the assembly when we have two routes of current input!

Adding a solar PV installation which is classed as a "generator".

Now we are going to turn diversity on its head!

Compliance with Regulation 551.7.2 is now necessary, and the following formula must be applied: $I_{nA} \geq I_n + I_{g(s)}$.

I_{nA} is the rating of the assembly or consumer panel

I_n is the rating of the OCPD protecting the assembly or consumer panel in our case, the supplier's cutout fuse rating.

$I_{g(s)}$is the total output of the generating set or (sets) connected to the assembly

A lot of domestic consumer units have a maximum rating (I_{nA}) of 100 Amps. This means that if you also have a 100 A fuse (I_n) in the cutout, no generation can be added to that assembly if we are going to comply with the above formula!

This means that despite having determined diversity and the customer is not going to use anywhere near 100 Amps, we must take the regulation literally, for example:

The same customer would like to have a Solar PV installation with a rating of 3600 Watts (16A). When this is connected via a breaker into the consumer unit, there are potentially two inputs of current: one from the grid and one from the Solar inverter.

$$I_{nA} \geq 100 + 16 = 116A$$

The consumer unit is thus no longer compliant, not only with the regs but also the manufacturer's instructions. Consumer units are tested and rated to a certain level of current and here we are using the assembly for something it has not been designed for.

It will be necessary to consider some other options to achieve a compliant installation.

One option would be to arrange for the DNO to fit a fuse of lower rating; in this case it would likely need to be 60 Amps, which may be a bit of a backwards step, especially with advent of electric vehicles where we prefer a 100A fuse.

If the designer is genuinely confident that the customer will not use the full 100 Amps, a switch fuse unit with a suitably lower rating can be installed between the cutout and the consumer and the 100A DNO fuse can be left as is.

Let's say that a 60 Amp switch fuse were to be fitted into the tails supplying the consumer unit:

$$I_{nA} \geq (60 + 16) = 76\,A\ (< 100A)$$

The installation is now compliant with **Regulation 551.7.2 (v).**

The three options that are currently available are:

- Protection against overcurrent using an overcurrent protective device on the grid side of the assembly.

- Protection against overcurrent using a G100/2 customer export and import limitation scheme
- Protection against overcurrent by limiting the load connected to the assembly.

The designer of the installation could leave the existing consumer unit as it is and install a second smaller dedicated consumer unit from which the inverter is powered. A join can be made in the tails with Henley blocks in the usual manner; however, we still need to ensure compliance with **Regulation 551.7.2 (v),** which means that fused connection units downstream of the supplier's cutout still need to be installed.

Let's say that we take the previous example with the consumer unit that has an I_{nA} rating of 100 Amps; we install another smaller panel, also with an I_{nA} of 100 Amps to supply the inverter that has an output of 16 Amps.

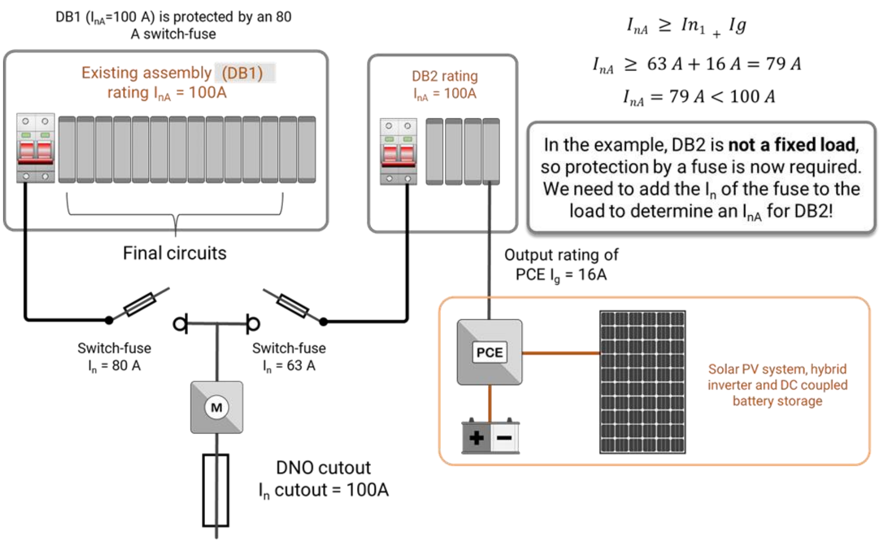
We will retain the supplier's 100 A cutout and install two FCU's One of 80 Amps to look after the main consumer panel (DB1) and a 63 A fuse to protect DB2.

Both consumer units need to be checked for compliance.

$$DB1\!:\ I_{nA} \geq \left(I_n + I_{gs}\right) = 100 \ \geq \ (80 + \ 0) = 80A < 100A$$

$$DB2 : I_{nA} \geq \left(I_n + \ I_{g(s)}\right) = 100 \ \geq \ (63 + 16) = 79A < 100A$$

The 80 Amp fuse will also prevent the "*potential*" of 16 Amps getting through to DB1 as the 80 Amp fuse will limit the current to DB1, thus ensuring compliance with the Regulations.



Check out the diagram below.

Regulation 551.7.2 also concerns the sizing of the conductors that we use to connect our inverter generator to the installation.

Fortunately, it is a little simpler than determining the requirements to keep the consumer units within their ratings that sae illustrated in the previous example.

Regulation 551.7.2 (i) states:

The conductors of the final circuit shall meet the following requirement:

$$I_z \geq I_n + I_g$$

On initial inspection, for say a 16A inverter which is protected by a 20 A device, the I_z or cable current-carrying capacity would need to be (20+16) = 36 Amps which would require $4mm^2$ cable!

Fortunately, the ***Code of Practice for Electrical Energy Storage Systems,*** **Section 9.3.4.2** allows us a bit of leeway by acknowledging that an inverter cannot be a load and a source at the same time!

"A battery storage inverter, or a hybrid solar PV inverter that permits the battery to be charged from AC as well as DC, acts as either a load or a source. However, they cannot be a load and a source at the same time. Provided the inverter is connected via its own dedicated circuit, then the formula in Regulation 551.7.2 (i) need not be applied to the current-carrying capacity of the cable. Instead, the current-carrying capacity should be selected to meet both of the following conditions:"

$$(\boldsymbol{a})\ I_z \geq I_n \geq I_g$$

$$(\boldsymbol{b})\ I_z \geq I_n \geq I_b$$

$$That\ is{:}\ I_z \geq I_n\ selected\ so\ that\ I_n \geq \{largest\ of\ I_g\ or\ I_b\}$$

where:

I_z is the current-carrying capacity of the cable connecting the inverter.

I_n is the nominal rating of the overcurrent protective device at the origin of the AC circuit connecting the EESS to the consumer unit or distribution board.

I_g is the nominal generating output rating of the generator (in this case, an inverter).

I_b is the design current of the AC circuit connecting the EESS to a consumer unit or distribution board, being the maximum current supplied when the battery is charging.

To return to our example where we have a 16 A inverter protected by a 20 A breaker, the largest is the 20A breaker, so the I_z of the cable supplying the inverter can be rated at 20 Amps, not 36A!