SolarEdge Inverters: DC Coupling, and STC eligibility through the Clean Energy Regulator

Scope:

This document outlines how SolarEdge sites with DC Coupled storage qualify for full SGU STC creation up to the warranted capacity of the inverter, through the Clean Energy Regulator's Rec Registry portal.

1. The Clean Energy Regulator (CER) permits creation of STC's for sites with PV modules <100kWp through the SRES. Note that it is the PV modules that are eligible for STC's.

System eligibility

Under the Small-scale Renewable Energy Scheme, eligible small-scale renewable energy systems may be entitled to small-scale technology certificates, which can be sold to recoup a portion of the cost of purchasing and installing the system.

Small-scale renewable systems which may be eligible for certificates include:

- solar photovoltaic (PV) panels
- wind turbines
- hydro systems
- solar water heaters, and
- air source heat pumps.

2. CER eligibility criteria:

Criteria

To be eligible for small-scale technology certificates, small generation units (including solar photovoltaic panels, wind turbines, and hydro systems) must:

- be installed no more than 12 months prior to the creation of certificates, and have its panels and inverter, listed on the Clean Energy Council list of approved components
- meet Australian and New Zealand standards
- use a Clean Energy Council accredited designer and installer and meet the Clean Energy Council design and install guidelines

3. Therefore "solar photovoltaic panels" are eligible for STC's, when listed on the CEC list of approved modules:

Building approved (fire-tested) modules

The following is the Clean Energy Council's database and website listing of photovoltaic (PV) modules which are rated Fire Safety Class C, and can be used in both building applications and ground-mounted applications.

*The search function accesses the current database. You can use * as a wildcard to broaden your search. Click on a column heading to sort the list by that column.*

Note: Modules showing 'Meets new CEC T&C's' in the table below have agreed to the new terms and conditions implemented in March 2016. These modules have been subjected to a higher level of assessment, and are subject to a tighter level of control over quality and compliance. All approved modules on the list below (whether they meet the new terms and conditions or not) can still be installed and are eligible for STCs.

4. System inverters and PCE must also be on the list, as per CEC list of approved inverters and PCE:

Currently approved inverters and PCE

Browse the Clean Energy Council's list of compliant inverters and power conversion equipment (PCE) suitable for installation under the Renewable Energy Certificate scheme.

5. AS/NZS 5033:2014 defines PCE:

> **1.4.40 Power conversion equipment (PCE)**
> An electrical device converting one kind of electrical power from a voltage or current source into another kind of electrical power with respect to voltage, current and frequency.
> NOTE: Examples include d.c./a.c. inverters, d.c./d.c. converters, charge controllers, etc.
> D.C. conditioning units are not considered to be PCEs (see Clause 2.1.5) for the purposes of this Standard.

6. The CEC approved equipment list includes 14 types of PCE:

Search inverters and PCE

Manufacturer / Certificate Holder

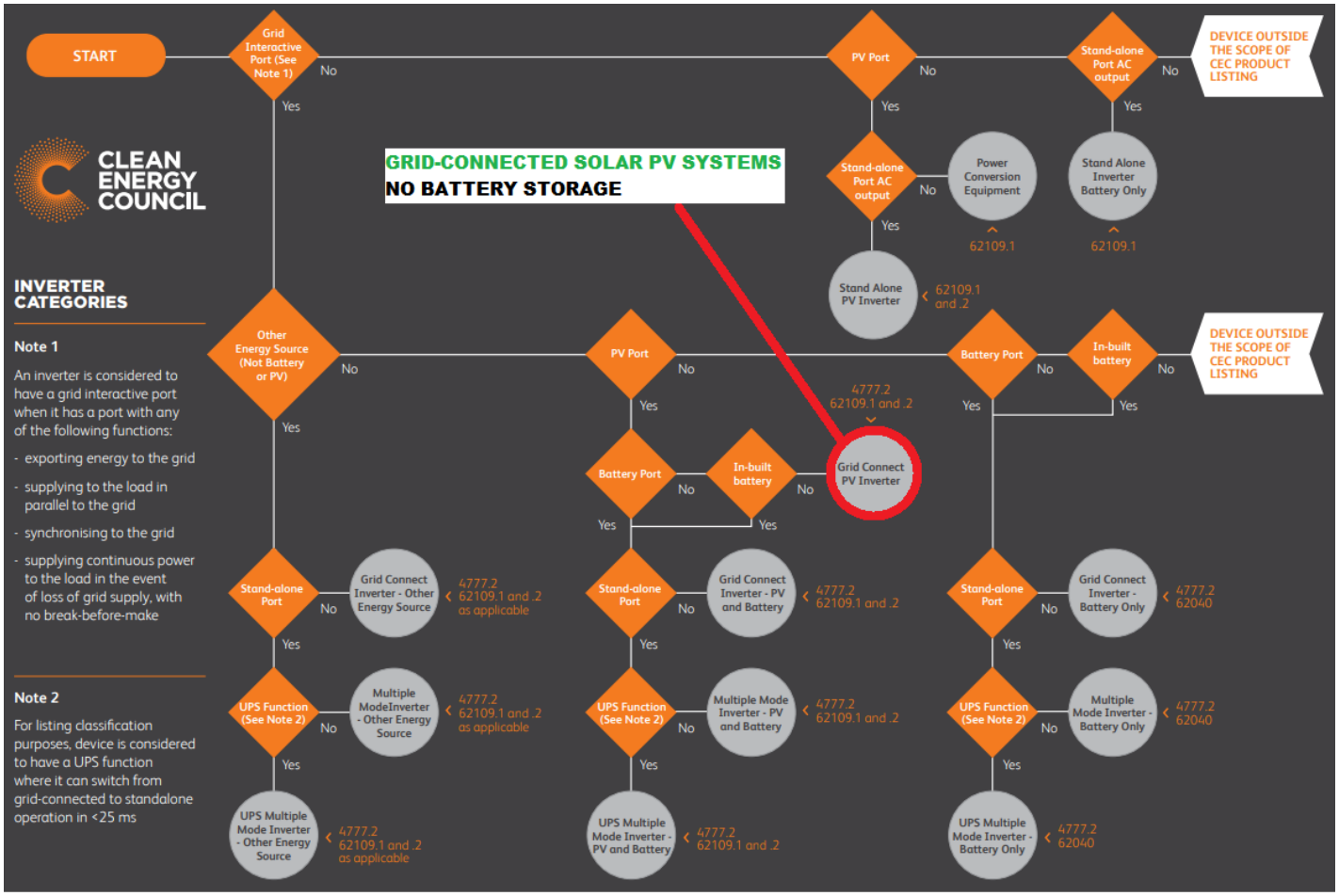
Model Number

Equipment Category

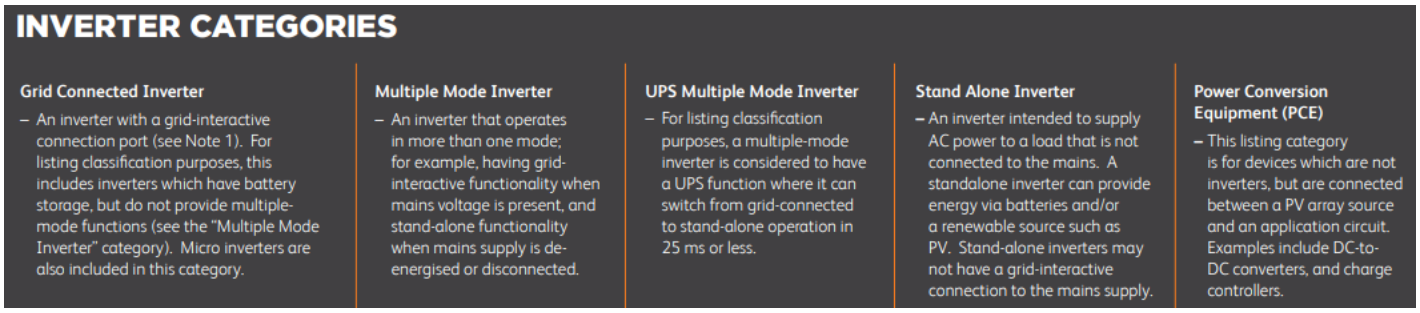
Please select

- Please select
- Grid Connect PV Inverter
- Stand Alone Inverter Battery Only
- Stand Alone PV Inverter
- Grid Connect Inverter - Other Energy Source
- Multiple Mode Inverter - Other Energy Source
- UPS Multiple Mode Inverter - Other Energy Source
- Grid Connect Inverter - PV and Battery
- Multiple Mode Inverter - PV and Battery
- UPS Multiple Mode Inverter - PV and Battery
- Grid Connect Inverter - Battery Only
- Multiple Mode Inverter - Battery Only
- UPS Multiple Mode Inverter - Battery Only
- Power Conversion Equipment
- Integrated Energy Storage System

7. CEC also provide a CEC Inverter Category flow chart, that helps to clarify PCE types:



8. The CEC flow chart also identifies the different categories including those with solar PV functionality - and as defined, there are many types of PCE with the ability to utilise PV and storage both with and without integrated inverters & kVA output, and with or without grid interactive ports:



INVERTER CATEGORIES

Grid Connected Inverter
– An inverter with a grid-interactive connection port (see Note 1). For listing classification purposes, this includes inverters which have battery storage, but do not provide multiple-mode functions (see the "Multiple Mode Inverter" category). Micro inverters are also included in this category.

Multiple Mode Inverter
– An inverter that operates in more than one mode; for example, having grid-interactive functionality when mains voltage is present, and stand-alone functionality when mains supply is de-energised or disconnected.

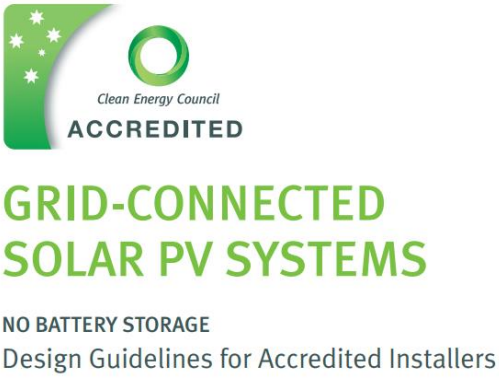
UPS Multiple Mode Inverter
– For listing classification purposes, a multiple-mode inverter is considered to have a UPS function where it can switch from grid-connected to stand-alone operation in 25 ms or less.

Stand Alone Inverter
– An inverter intended to supply AC power to a load that is not connected to the mains. A standalone inverter can provide energy via batteries and/or a renewable source such as PV. Stand-alone inverters may not have a grid-interactive connection to the mains supply.

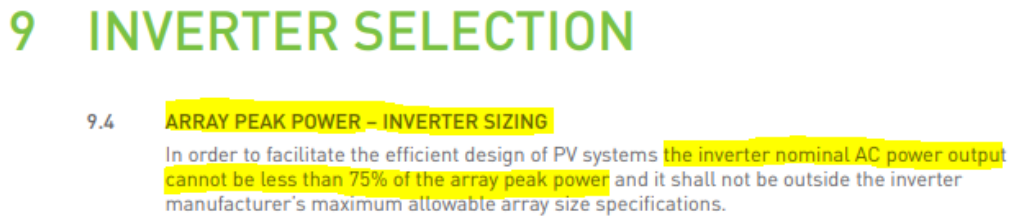
Power Conversion Equipment (PCE)
– This listing category is for devices which are not inverters, but are connected between a PV array source and an application circuit. Examples include DC-to-DC converters, and charge controllers.

9. As can be seen, Grid Connected Solar PV Systems without battery storage, make up only one of the many possible combinations and categories of solar PV systems

10. When considering the capacity of a system for STC creation, PV Systems without battery storage must follow the scope of the current CEC: Grid-Connected Solar PV Systems: No Battery Storage, Design Guidelines.



11. Section 9 of the "No Battery Storage" CEC guideline, is where the 75% (133%) rule applies:



9 INVERTER SELECTION

9.4 **ARRAY PEAK POWER – INVERTER SIZING**

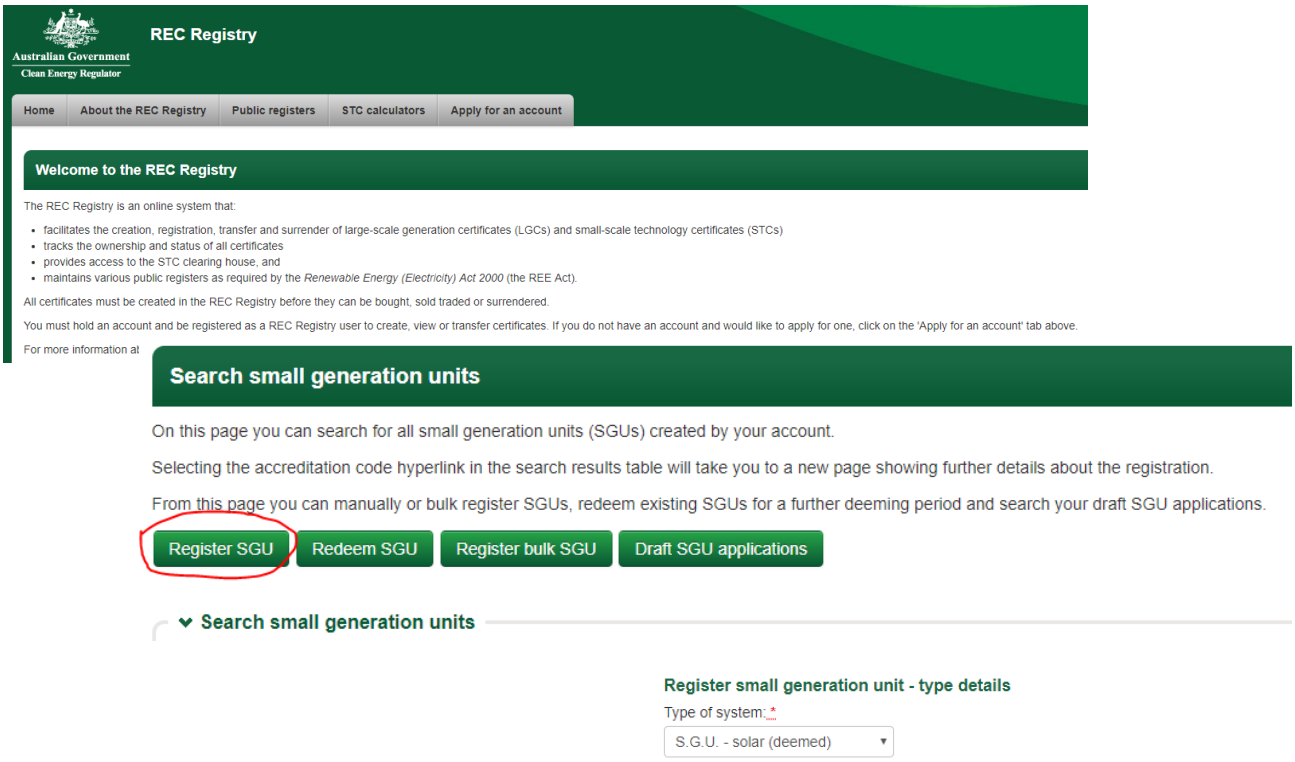
In order to facilitate the efficient design of PV systems the inverter nominal AC power output cannot be less than 75% of the array peak power and it shall not be outside the inverter manufacturer's maximum allowable array size specifications.

12. This rule dictates the minimum % ratio for an inverter to PV Array, of a PV only grid connected inverter. This is a relevant factor, as there is no parallel (DC Coupled) application cct for the connected solar PV modules, and excess PV beyond the inverter's management capacity is restricted and unable to be utilised effectively. This is however only one of the 8 different PCE types that utilize PV Solar Modules on the CEC PCE list of 14.

13. Alternatively, systems with DC coupled battery storage (PV path direct to battery) are able to effectively manage additional PV capacity, through a direct application circuit for PV utilisation. This parallel application path allows options such as the inversion from DC to AC at <100% kVA power, while simultaneously charging a DC coupled storage battery at <100% charge power.

14. Therefore, systems with battery storage do not restrict PV utilisation in the same way as PV only inverter systems, and fundamentally by scope, do not fall under the design rules of the CEC "GRID-CONNECTED SOLAR PV SYSTEMS – NO BATTERY STORAGE" design guidelines.

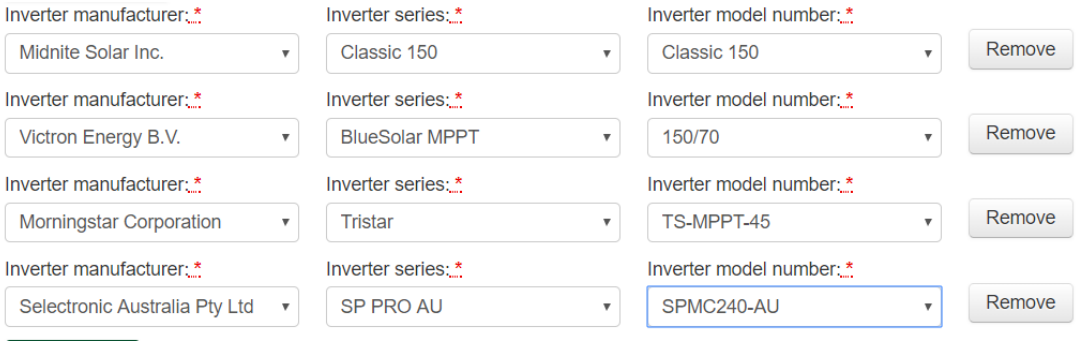
15. Many PV systems do not have GRID-CONNECTED PV inverters as scoped in the CEC guidelines, yet qualify for STC creation. The REC Registry is where Small Generation Units are registered. This includes LGC's and STC's:



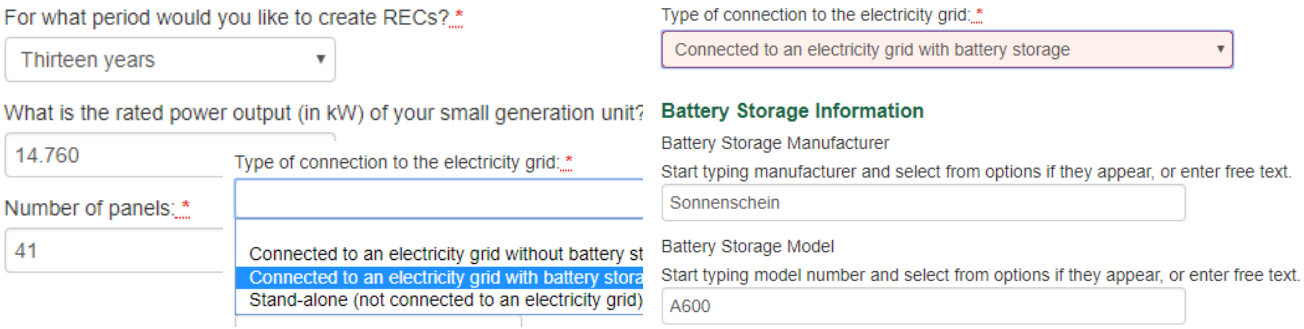
16. The Rec Registry contains many brands of PCE, which can be selected for STC creation:

17. Many of which have either no kVA rating due to being DC-DC regulators, or do not have PV input ports due to being battery only inverters for off-grid or grid-hybrid applications. Creating STC's for an off-grid or grid hybrid system does not require selecting a GRID-CONNECTED PV inverter.

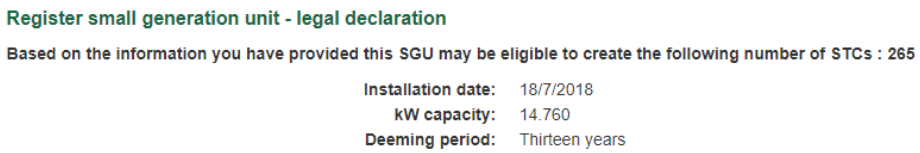
    Eg below is a 3kVA "UPS Multiple Mode Inverter - Battery Only" system with 14.76kW of PV, DC Coupled through 3x different charge controllers, as entered into the REC Registry for SGU STC creation:



18. Once the PCE has been selected, the rated SGU PV generator (PV Array) kW power can be selected, and battery storage can be added:



19. Upon completion of site details and declarations etc, the Rec Registry calculates the number of STC's the SGU is eligible to create. Note that the 3kVA inverter capacity does not restrict the PV Array eligibility for STC creation:



20. Is this a valid design for STC's?
    Consider that a site with 3kVA inverter system and continuous 80% load (2.4kVA), will consume >57kWh/day, requiring ~15kWp of PV Array capacity over 4.6 sun-hours to recover the consumed power on an average day, making the design 100% valid. The same load profile in a Stand-Alone system application may require up to twice the PV Array capacity (30kWp) to offset days of reduced PV yield.

21. If the 75% rule was applied to the SPS and Grid Hybrid site's 3kVA inverter, the max PV Array capacity could not exceed 4kWp without forfeiting all STC's, and the systems would be 100% ineffective.

22. Note that the same systems would not be able to utilise the additional PV if the battery storage system were AC Coupled, as AC Coupled batteries have no direct pathway for additional PV capacity to charge the battery, and the PV energy would be restricted to the lowest inverter maximum throughput, and further reduced by site AC loads. Therefore, PV Array capacity on AC Coupled battery storage systems is still rightfully restricted to the Grid-Connected PV inverter 75% kVA to kWP ratio.

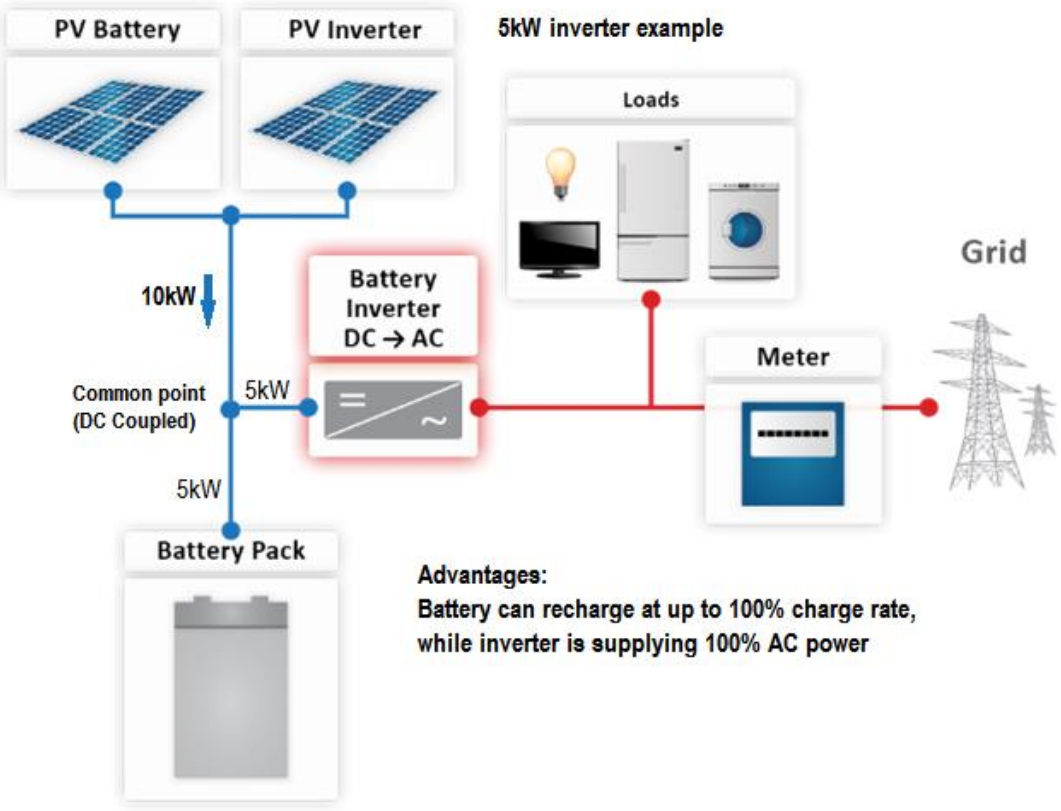
23. SolarEdge DC Coupled Battery Storage inverter systems operate in the same way as the above DC hybrid "UPS Multiple Mode Inverter - Battery Only" system example, in that the inverter kVA rating does not dictate the charge rate of the battery, or the PV Array utilisation ratio. Once the SolarEdge inverter has been selected, the LG Chem RESU7H or 10H battery is selected, and the process is much the same.

24. SolarEdge inverter systems can operate in five of the 14 different CEC listed categories of PCE, four of which are outside the scope of the CEC NO BATTERY STORAGE guidelines. Of these four, there are two categories which are able to manage additional PV capacity through DC Coupled Storage. These are:
    a. Grid Connect PV Inverter - PV and Battery, via add-on StorEdge Interface
    b. Multiple Mode Inverter - PV and Battery, via built-in StorEdge Interface

14x CEC defined PCE categories

1 Grid Connect PV Inverter
Stand Alone Inverter Battery Only
Stand Alone PV Inverter
Grid Connect Inverter - Other Energy Source
Multiple Mode Inverter - Other Energy Source
UPS Multiple Mode Inverter - Other Energy Source
2 Grid Connect Inverter - PV and Battery
3 Multiple Mode Inverter - PV and Battery
UPS Multiple Mode Inverter - PV and Battery
4 Grid Connect Inverter - Battery Only
5 Multiple Mode Inverter - Battery Only
UPS Multiple Mode Inverter - Battery Only
Power Conversion Equipment
Integrated Energy Storage System

25. The two identified battery storage + PV categories permit simultaneous AC and DC PV utilisation via the DC Coupled common point:



26. With this understanding of the different utilisation categories, a logical way to apply the familiar and existing 75% PCE ratio to DC coupled storage systems may be to divide the total continuous power utilisation capacity of the DC Coupled system by 75%.

SolarEdge inverter models + battery storage (kVA + kW PV) ÷75% vs Max rated kWp

SolarEdge Grid Connect Inverters:	Inverter rating kVA	Storage Charge Interface DC kW	Total PV kW utilisation	÷ 75% (133%) PV Array kWp	SolarEdge max rated PV	% below full 75% capacity
SE2200H	2.2	5	7.2	**9.6**	**8.4**	**12.5%**
SE2500H	2.5	5	7.5	**10**	**8.9**	**11%**
SE3000H	3	5	8	**10.6**	**9.6**	**9.4%**
SE3500H	3.5	5	8.5	**11.3**	**10.4**	**7.9%**
SE4000H	4	5	9	**12**	**11.2**	**6.6%**
SE4600H	4.6	5	9.6	**12.8**	**12.1**	**5.4%**
SE5000H	4.985	5	9.985	**13.3**	**12.7**	**4.5%**
SE6000H	6	5	11	**14.6**	**14.3**	**2%**
SolarEdge Multi Mode Inverters:						
SE5000-AUS	4.985	5	9.6	**13.3**	**11.7**	**12%**
SE6000-AUS	6	5	11	**14.6**	**13.1**	**10%**

27. Observing this chart concludes that SolarEdge DC Coupled battery storage inverter systems have a conservative (undersized) PV/PCE utilisation ratio due to the maximum warranted rating for DC Coupled PV kWp, ranging from 2% to 12.5% below a 75% PCE application threshold. That is, there is no oversizing above 133% on SolarEdge DC Coupled battery storage inverter systems.

Conclusion: For the purpose of SGU STC creation, the CEC 75% rule does not apply to SolarEdge DC Coupled battery storage inverter systems, and if considered – the conservative PV Array power to PCE utilisation ratio ensures there is no oversizing with SolarEdge DC Coupled battery storage inverter systems.

Perth		
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Place	Date	Name