

1+X Modular Inverter: Leading the Next Generation PV Plant Development

1. Overview

As the solar industry evolves rapidly and the demand for ultra-large PV plants surges, there emerge many new situations and requirements, including but not limited to different optimal block sizes in different countries, varied requests for ESS capacity, pressing needs for easier O&M, the pressure to lower LCOE, as well as more stringent grid-supporting requests. Such requirements set a higher threshold for the inverter.

Sungrow has launched its new-generation 1+X modular inverter to significantly innovate traditional inverters, which combines the advantages of both central and string inverters. It can be designed from 1.1MW to 8.8MW block size with modularized design, to provide extraordinary flexibility when designing PV power plants.



Fig-1: 1+X Modular Inverter

Extraordinary Flexibility

The 1+X inverter is modularly designed at component, inverter and system levels, which makes the PV plant design more flexible and the O&M more convenient. The main components in the 1+X inverter; like IGBTs, fans, capacitors etc. are modularized and designed to provide plug & play functionality, which makes the time efficiency of the O&M improve by about 70%, even the non-professional personnel can complete the component replacement procedure.

The 1+X inverter can be configured up to 8.8MW with 1.1 MW modular capacity and one MPPT for each unit, which makes PV plant design unprecedentedly flexible and doubles the number of MPPT in the inverter when compared to mainstream central inverters. Moreover, since every single unit of the 1+X works independently, in case of an unpredictable malfunction of one of the units, it will not affect other units and this will maximize the energy yield during O&M significantly.

Both Sungrow's 1+X modular inverter and newly launched Power Conversion System (PCS) share the same platform and have approximately 90% common components. As a result, customers, if using Sungrow's 1+X and PCS units in the PV and BESS hybrid projects, can benefit from the 50%-reduced spare parts catalogue and save considerable spare parts cost.

2. Modular Design at Different Levels, Easier O&M &

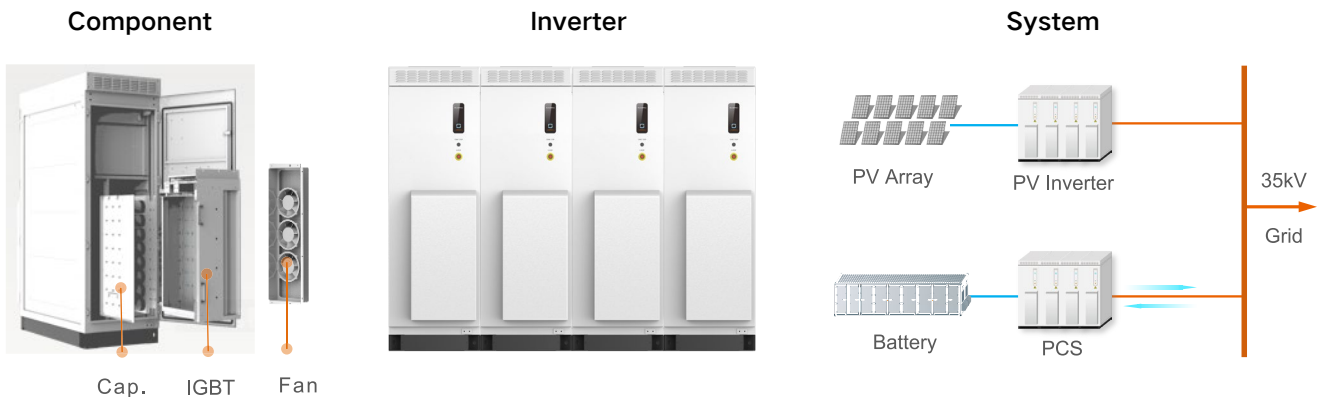


Fig-2: 1+X Modular design

3. Wireless Communication, Lower Cost

Apart from the traditional hardwired RS485 communication method, the 1+X inverter can also provide the wireless communication function as an option.

The 1+X inverter's wireless communication module supports a maximum of 50 combiner boxes, while the communication distance can reach up to 1000m. The auto frequency hopping function guarantees no cross-talk between blocks, and the mesh networking function makes wireless communication stable and efficient under a poor communication environment.

The wireless communication application not only helps to save cable costs and wiring labour costs but also makes the O&M easier. When communication fails, you can just check the communication modules instead of long-time troubleshooting in the long-wired communication circuit, unlike traditional RS485 communication.

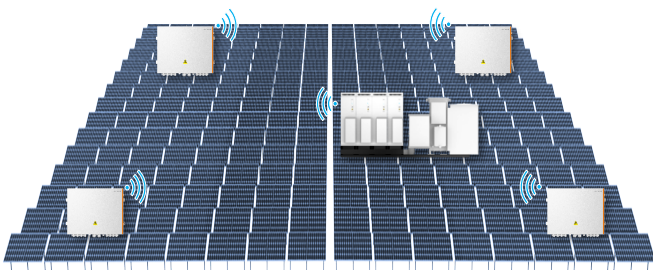


Fig-3: Wireless communication in a block

4. IP65 Protection Level, Better Adaption to Various Harsh Environments

To better adapt to various harsh environments, such as high levels of dust and sand, the 1+X modular inverter characterizes a high ingress protection level of IP65. The cabinet of the 1+X inverter comprises two

compartmental cavities, a heat dissipation cavity and an electronic cavity.

The heat dissipation cavity of the power module and reactor is cooled by the inbuilt smart forced air-cooled system while the electronic cavity transfers internal heat generated by the components, copper bars, and PCB boards to the outside through a heat exchanger located on top of the unit. The schematic diagram of the heat dissipation is illustrated in Fig-4.

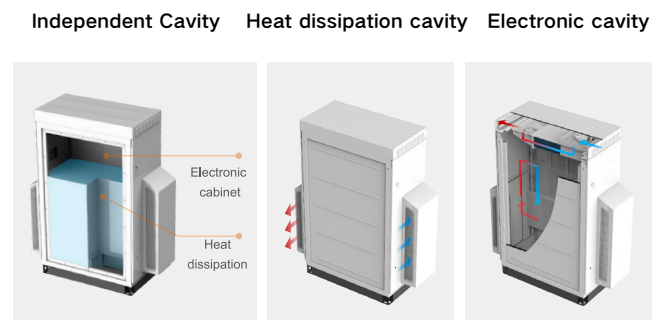


Fig-4: Independent cabinet design for heat dissipation

5. Real-Time Parallel Arc Detection, Improved Safety

When Arc happens, the majority of the heat will be released to cause extremely high temperature, which may lead to cables being burned, the inverter being damaged, a significant energy yield loss or even personal injuries. The 1+X solution can provide a real-time parallel arc detection function between the Smart DC Combiner Box (SCB) and the inverter to protect people and the site properties.

With the Arc Fault Detection function continuously monitoring the current and the voltage of the DC output loop, arc fault will be detected within 20ms, and then the SCB disconnects the switch within 20ms. Meanwhile, the 1+X inverter can disconnect the other SCB switches through the synchronized linkage to prevent further losses.

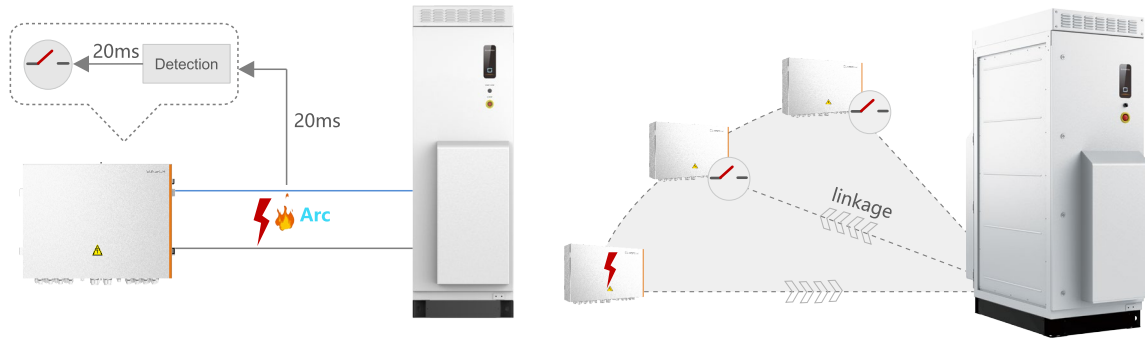


Fig-5: Synchronized linkage between the 1+X and SCBs

6. Self-constructed Grid Function, Earlier COD & Lower Investment

In the early stage of the power plant construction, most equipment has no access to the power supply and hence, cannot be debugged. Meanwhile, some

debugging tools need a power supply before the high voltage side is electrified. 1+X has a self-constructed grid function to construct AC power with a certain frequency and voltage by controlling the inverter to work in voltage frequency mode, thereby supplying AC power to debug the equipment. The self-constructed grid function is shown in Fig-6.

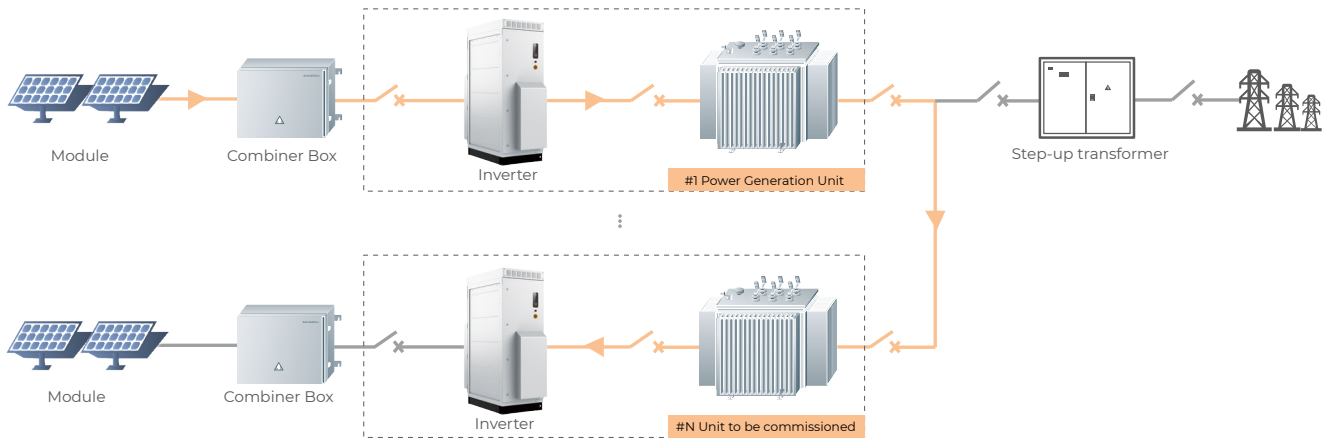


Fig-6: Self-constructed grid diagram

7. Intelligent String-Level Diagnosis, Safer and Higher Yield

As large numbers of components are installed in the ultra-large PV power plants, string failure rate may present and vary, including but not limited to string current mismatch, the serious current mismatch

between the components in a string, low string open-circuit voltage, high string series resistance, etc. How to precisely locate and rapidly troubleshoot the string fault status has become a challenge. By cooperating with SCBs, the 1+X inverter can scan, collect and analyze the voltage and current data of all strings, provide the intelligent one-key string diagnosis to ensure the asset's safety and increase the yield.

8. Strongly Enhanced Grid Supports, More Stable System

Renewable energy is expected to account for over 20%-40% of the global energy mix. However, renewable energy such as solar and wind energy features randomness, intermittence and volatility,

which will weaken the grid and lower the short circuit ratio (SCR). Normally, the lower the SCR is, the weaker the grid will be. Sungrow 1+X modular inverter can operate stably even if the SCR is down to 1.018. It also supports fast active and reactive power control, with < 20ms Q (reactive power) response time and <140ms P (active power) response time, which also helps in stabilizing the utility grid.

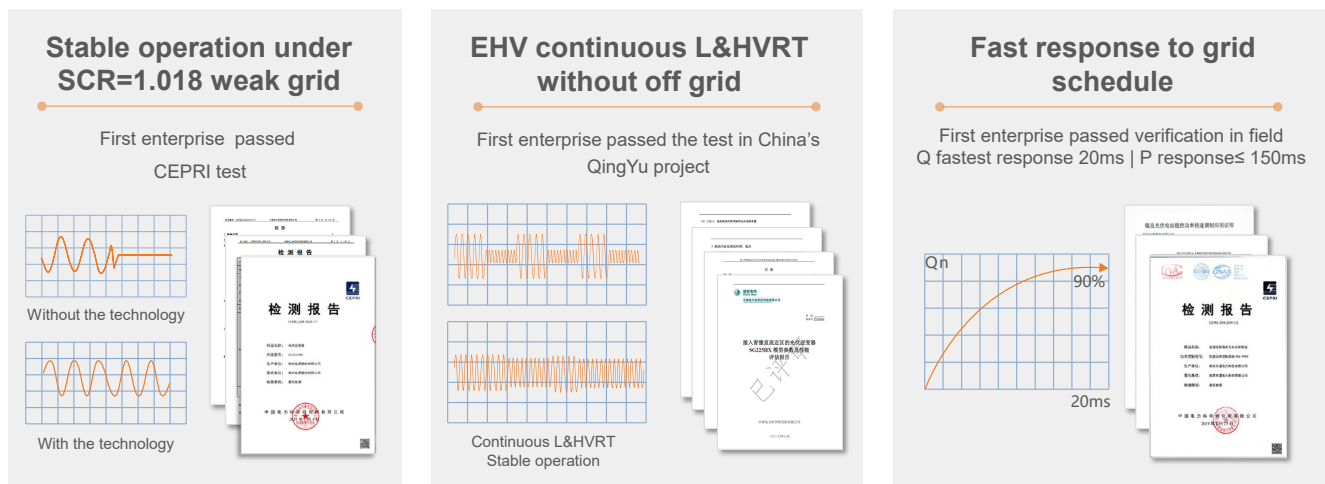


Fig-7: Strongly enhanced grid supports

9. DC Energy Storage System (ESS) Interfaces, No Further Modifications Required

Considering that Energy Storage System will see more applications in the future with its significant functions such as peak shaving, power smoothing, renewable energy curtailment, frequency regulation and voltage regulation etc., The 1+X modular inverter can be equipped with DC ESS interfaces. Hence, systems using the 1+X inverter with DC ESS interfaces no longer need further modifications if ESS is required later.

The 1+X modular inverter can realize the DC-coupled energy storage system by connecting the

DC/DC converter and the battery to the reserved ESS interface directly. In addition, the 1+X modular inverter supports PCS mode so that the battery can be charged by the grid. The energy regulation will be also more flexible, as shown in Fig-8.

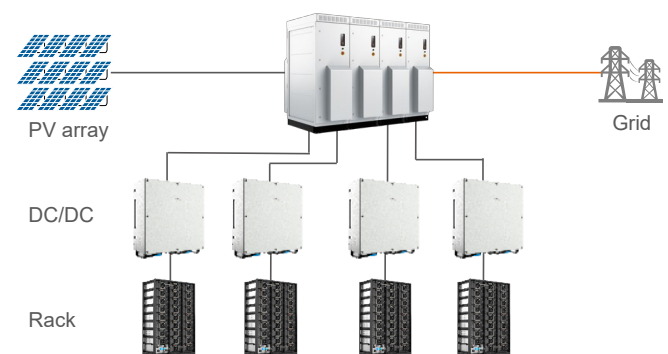


Fig-8: DC ESS interface and PCS mode

10. Higher Power Density + Bigger Block Size + SVG Replacement, Lower LCOE

The 1+X 8.8MVA Turkey MV Station solution includes the inverters, the MV transformer, the Ring Main Unit (RMU), the auxiliary panel, and the monitoring

system, all in a 40ft container. The 1+X inverter has higher power density and bigger block sizes, thus bringing customers a significant cost reduction in transportation, construction, equipment and O&M. With < 20ms Q (reactive power) response time, the 1+X inverter can also replace the SVG equipment to save initial investment. All these features of the 1+X bring the LCOE lower.

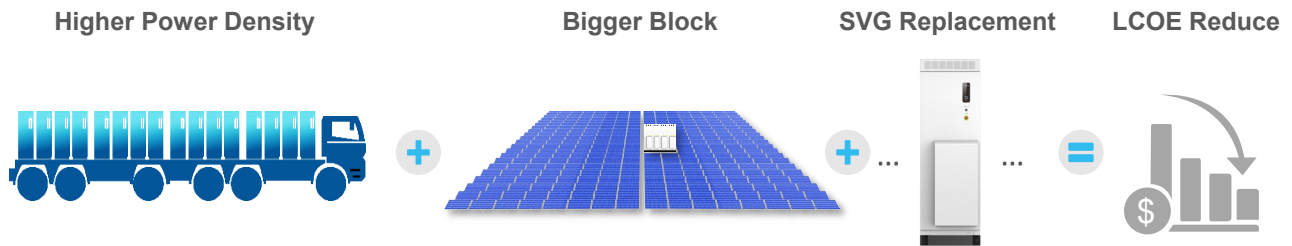


Fig-9: Higher Power Density + Bigger Block Size + SVG Replacement

11. Summary

The new-generation 1+X modular inverter combines the advantages of both central and string inverters, which presents a more flexible design for different block sizes and makes the on-site O&M easier. With intelligent string-level diagnosis and real-time parallel arc detection, the 1+X inverter can guarantee the equipment’s safety and increase the yield. When the wireless communication module and the self-structured grid function are applied,

the on-site commissioning will become both faster & easier. The application of the 1+X modular solution also adapts to the various harsh environment better with IP65 ingress levels.

In conclusion, Sungrow’s 1+X modular inverter satisfies various requirements and new situations of Utility-scale PV plants in the MENA region and brings customers a lower LCOE and higher ROI. Hence, the 1+X modular inverter, being the game-changer, is expected to lead the next generation of PV plant development and reshape future energy.



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