YASKAWA
SOLECTRIA SOLAR

APPLICATION NOTE: REPOWERING PROJECTS AND INVERTER REPLACEMENT VIABILITY

February 20, 2025

Repowering a legacy PV system presents three major challenges: (1) DC voltage differences, (2) grounding differences and (3) AHJ/ NEC requirements. This document discusses the challenges and explains the steps to determine the feasibility of repowering a legacy PV site. This document intends to guide Yaskawa Solectria Solar's customers, but is not intended to be a comprehensive, step-by-step design guide for retrofitting a system. Repowering PV systems can be a costly and lengthy process, especially if the existing PV system is of the 600Vdc class. In most cases, a third party engineering/design firm is engaged to take a close look at the details of the specific system. Yaskawa Solectria Solar is pleased to provide the following guidance on how Solectria's inverters can help with repowering projects.

1. DC Voltage:

The allowable open-circuit DC voltage of PV systems has risen over the years. In the U.S.A., all PV systems started with a limit of 600Vdc. The limit rose to 1000Vdc for non-residential rooftops and most recently rose for ground-mounted systems to 1500Vdc. At these higher DC voltage classes, the inverter's MPPT voltage window, the voltage range where the inverter outputs at rated power, has shifted upward as a result. Below is a chart that shows the evolution of the MPPT voltage window from 600Vdc to 1500Vdc using Solectria inverters as an example.

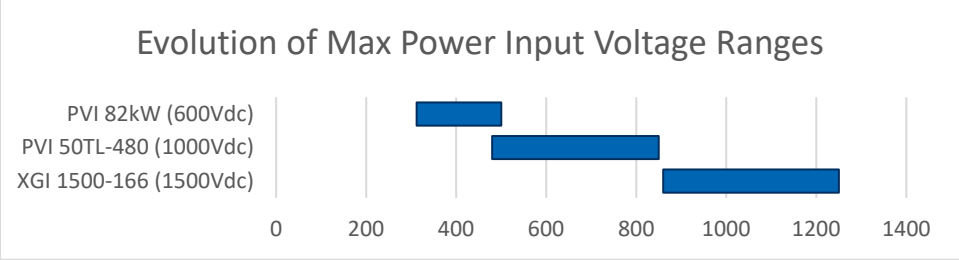

Figure 1: Evolution of Max Power Input Voltage Ranges

In a 600 VDC PV system, the PV array maximum power voltage (Vmp) was designed to fall in the range ~300 - 450Vdc, with specific values depending on the inverter used. However, based on the age of the system and the PV modules used, the existing DC Vmp could be significantly lower than the original Vmp due to module performance degradation.

Currently available commercial and utility-scale string inverters are of the 1000Vdc or 1500Vdc class, with a maximum power voltage range between ~540 - 850Vdc and ~860 - 1250Vdc, respectively. Connecting a 600Vdc PV array to a 1000Vdc or 1500Vdc inverter will typically cause the inverter to run at a de-rated output power or potentially to not run at all. It is important to check the new inverter's DC derating curve in order to determine whether the inverter will be running at a de-rated power. Below is

an example of the PVI-36TL-480-V2 inverter's power de-rating curve in relation to DC voltage. These graphs are located at the end of all of Yaskawa Solectria Solar's Installation and Operation Manuals.

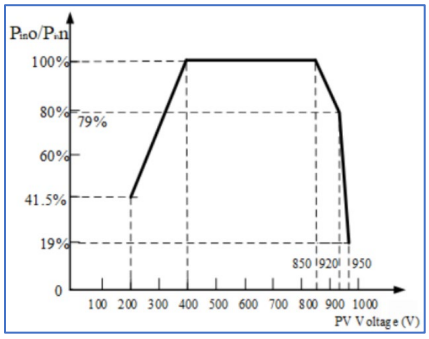

Figure 2: Power de-rating due to DC voltage for the PVI-36TL-480-V2

2. PV Array Grounding:

Most legacy PV systems installed before 2011 are solidly grounded, where one DC pole is bonded to ground in the inverter. Modern string inverters are generally functionally grounded and non-isolated, which means that both DC poles have no solid bond to ground.

While retrofitting a site, check to see if the PV modules are required to be negatively or positively grounded. If so, it may not be recommended to upgrade that system to a modern inverter that is functionally grounded since it could cause the PV module to suffer from potential induced degradation (PID), lowering their production rapidly over time. Consult with the module manufacturer for more information.

3. AHJ and NEC requirements:

If a new interconnection agreement is required, the PV system may need to be upgraded to comply with the version of the National Electrical Code that is applicable in that jurisdiction. These upgrades may include module-level rapid shutdown functionality, if the PV array is located on a building roof or has conductors entering into a building. For ease of installation and compliance, all Yaskawa Solectria Solar 1000Vdc inverters are compatible with APsmart module-level rapid shutdown devices and have the option of including an APsmart transmitter pre-installed inside the wirebox.

For Older 600Vdc Systems:

- **Option 1 - Restring the system**: Check to see if the modules can be used in series strings appropriate for 1000Vdc inverters. Some older PV modules were UL listed for 600V and IEC listed for 1000V. Some PV module manufacturers and AHJs will allow such PV modules to be used up to 1000Vdc. It is the customer's responsibility to verify this allowance with the relevant parties.

  If the PV modules are being re-arranged into longer series strings, the conductors and other equipment between the modules and the inverter may need to be upgraded to be rated to at least 1000Vdc. See the section discussing older 1000Vdc system retrofitting below for more information on options and tools available.

- **Option 2 – Use a 1000Vdc inverter with a wide Vmp operating range:**
  - Calculate the original designed Vmp of each string based on the PV module specifications.
  - Measure the actual Vmp of the strings on site; PV module efficiency degrades over time.
  - Check the DC voltage derating curve in the inverter's manual to see whether the inverter will output at an acceptable percentage of rated power based on the Vmp of the PV module strings. The best 1000V inverters that Solectria offers for repowering are the PVI-36TL-480-V2 (100% rated power down to 400Vdc) and the PVI-50TL-480 (100% rated power down to 480Vdc).

For Older 1000Vdc Systems:

The good news about retrofitting 1000Vdc systems is that these inverters are still offered and off-the-shelf. Yaskawa Solectria Solar offers a wide range of 1000Vdc inverters, as in Fig. 3.

	480Vac	208Vac
25kW	PVI-25TL-480-R	PVI-25TL-208
36kW	PVI-36TL-480-V2	
50kW	PVI-50TL-480	
60kW	PVI-60TL-480	

Figure 3: Table of Solectria 1000Vdc Inverter Models with Corresponding Output Vac

- Check that the existing stringing works for the current 1000Vdc inverters. As a convenience, Solectria offers a string sizing tool that can be found here: https://stringsizing.solectria.com/PVBuilderProd/PVBuilder/PVBuilder3.php
- Ensure that the new inverter Vac matches the site Vac.
- Check the Interconnection Guidelines Document for the corresponding models to confirm that the transformer winding that is currently on site is compatible with the new inverters.

Disclaimer: The information in this Application Note is intended for general informational purposes only. As noted above, it is generally advisable to engage a qualified third party engineering/design firm to take a close look at the details of the specific system and make specific recommendations. Yaskawa Solectria Solar would be pleased to provide additional information on how Solectria's inverters can help with repowering projects.