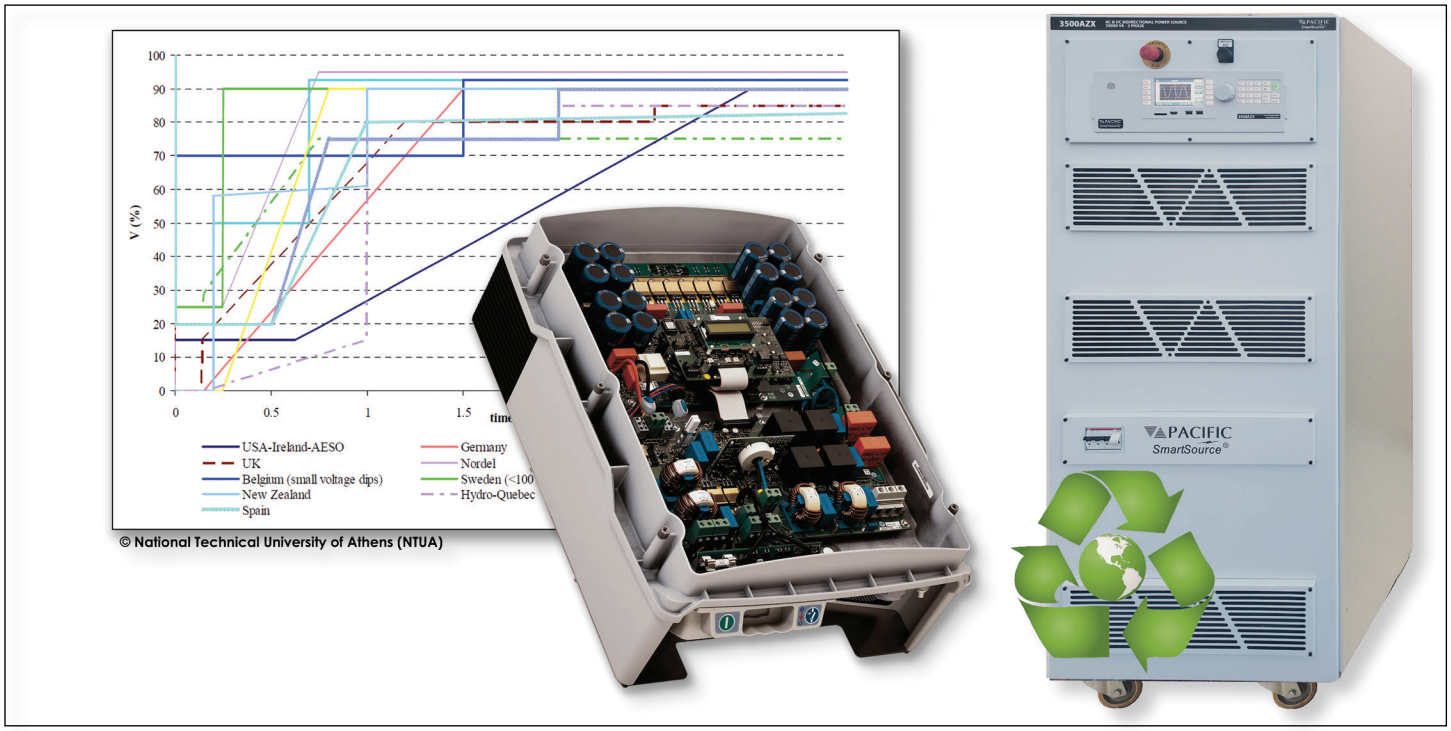
PACIFIC POWER SOURCE
17692 Fitch Irvine, CA, 92614 USA

APPLICATION NOTE

PV INVERTER TESTING USING A REGENERATIVE GRID SIMULATOR



Abstract

Fully regenerative AC & DC power sources like Pacific Power's AZX Series offer AC, DC and AC+DC output modes as well as energy recovery to the utility. This makes these programmable sources ideal candidates for solar or wind inverter development and test applications. This application note will explore the potential cost and energy savings that can be achieved using regenerative power sources.

Test Setups for Grid Simulation

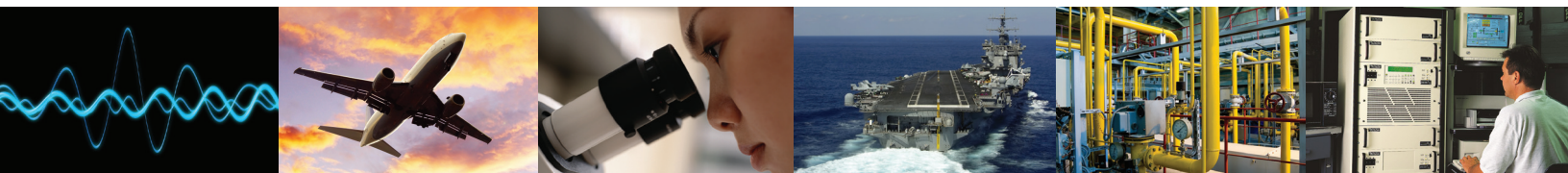
The emphasis on smart grids and renewable energy sources is a driver of distributed generators (DG) connected to the public utility. Examples of distributed generators are solar panel installations with PV inverters, wind turbines, instant start Gas Turbine generators to handle peak demand but also in home electric vehicle chargers that are bi-directional and can use the EV's battery energy to alleviate short term peak energy demands on the power grid.

This has resulted in a proliferation of grid connected products that can either demand energy from the grid, return energy to the grid or both.

Developing and Testing these types of DG products can be done using a conventional AC power source and AC load combination to handle the EUT's various operation modes (AC Source to source energy, AC load to sink energy). However, this conventional test setup (See Figure 1 on next page) is not very energy efficient as both the AC source and the AC load consume power during testing. While this can be acceptable for lower power EUTs, as power levels of DGs are on the rise, the power inefficiency can start adding up in terms of energy cost as well as HVAC cost if the AC load is dissipative and needs cooling.

A further drawback is that three test instruments are needed, an AC source, DC Supply and an AC Load.

At higher power level requirements, this can result in significantly higher costs. By using a regenerative AC power source like the AZX Series, sourcing and sinking is accomplished with a single instrument. The energy recycling flow is shown in Figure 2 (next page).



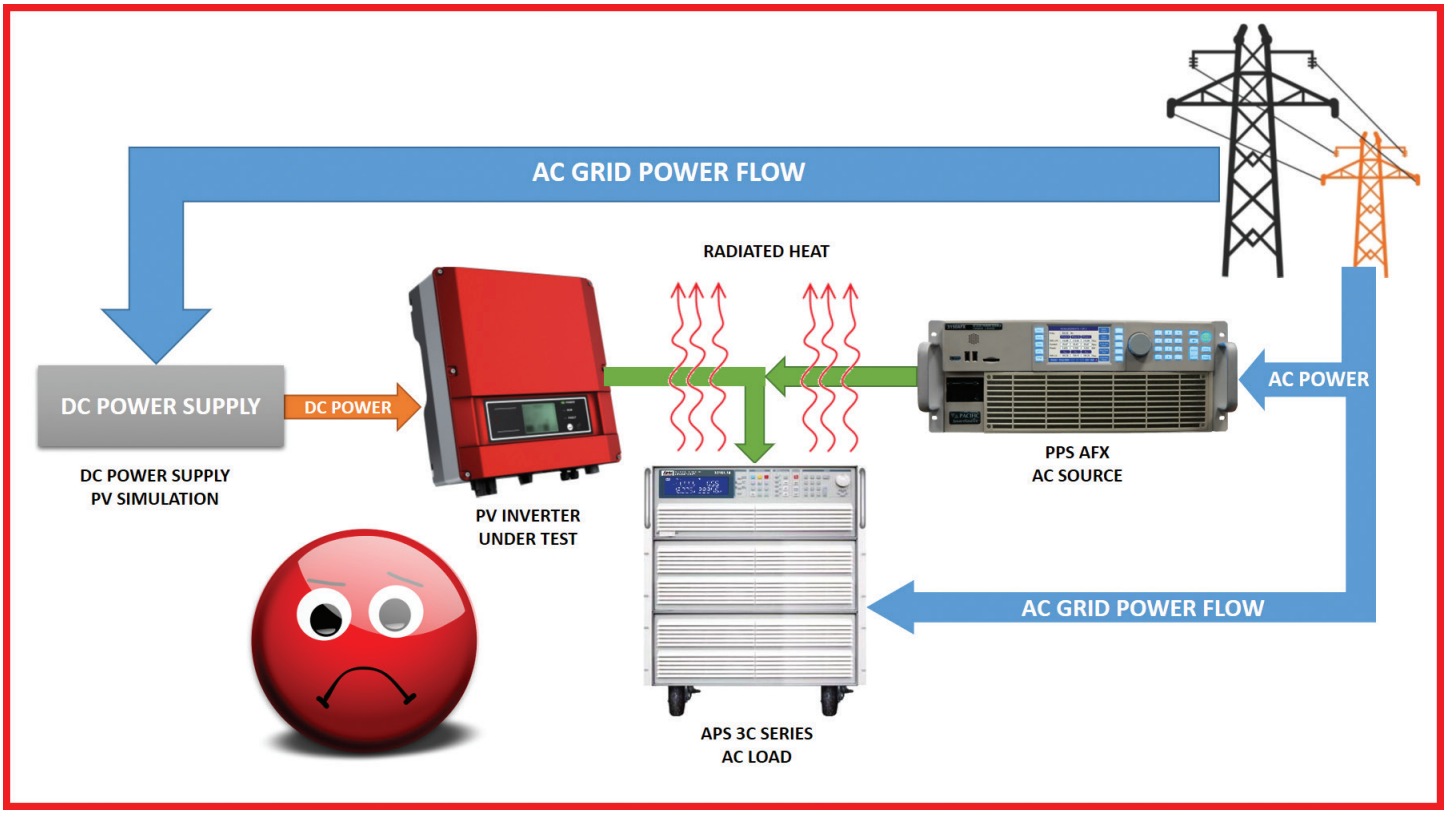


Figure 1: **Non-Regenerative** PV Inverter Test Setup

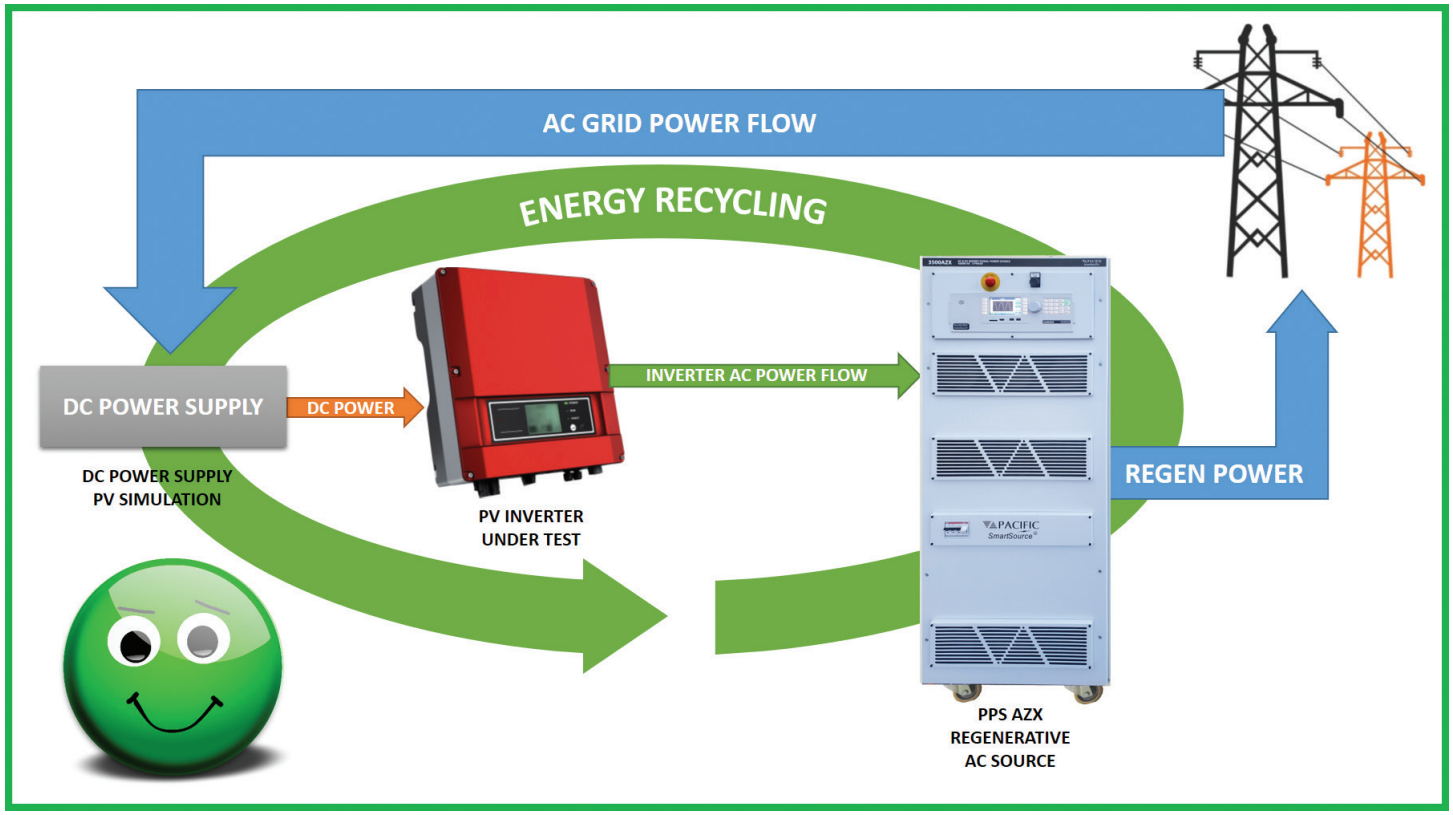


Figure 2: Regenerative PV Inverter Test Setup

Source versus Sink Mode Transition

During PV inverter testing, the AZX power source generates the required AC grid voltage and frequency for the PV inverter to synchronize to. In this mode of operation, little power is delivered by the AC Source as the PV invert is a source as well and not a load. Next, DC power is applied to the PV inverter solar array string DC input. If the DC voltage applied is within the inverter's input operating range, the PV inverter will start delivering current and thus power to the "AC Grid" or in this case, the AC power source. It does so by raising its output voltage above that of the AC source, resulting in current to flow from the PV inverter and into the AC power source. The AC Source detects this reverse current flow and changes its AC input current phasing to the AC grid it is connected to in order to allow the energy from the PV inverter to flow into the AC grid. This energy flow reversal process is seamless and transparent to the PV inverter under test.

Once this condition is established, the programmable capabilities of the AZX power source can be used to simulate voltage and frequency variations and transients to test the immunity of the EUT to common AC line anomalies.

LVRT Testing

One of the many immunity requirements PV inverters have to meet is the Low Voltage Ride Through (LVRT). This means the PV inverter must operate under various AC line conditions that can occur on the public utility grid. The LVRT requirements vary by country so for export requirements, many different tests may have to be applied. The transient programming mode of the AZX makes it easy for the user to define and run these LVRT voltage profiles using voltage level and slew rate parameter settings

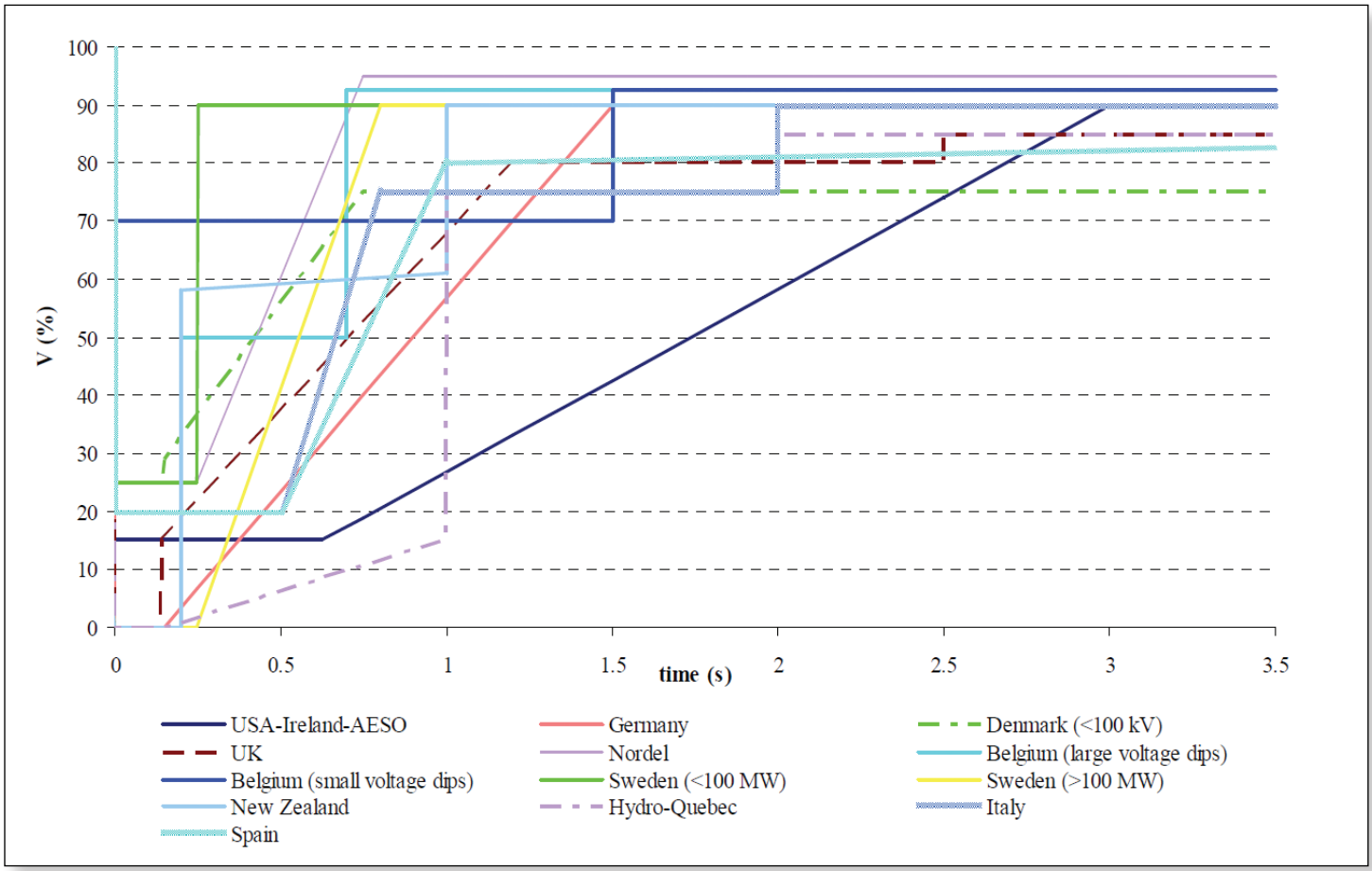


Figure 3: European LVRT Test Profiles by Country

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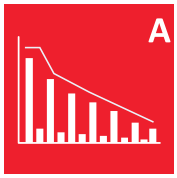
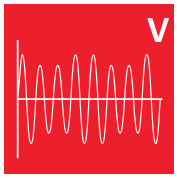
IEC Compliance Testing

Another typical requirement for Grid tied inverter is compliance to IEC standard for Power line Emissions and Immunity. This is needed to apply the CE mark for Export to the European Union (EU). Relevant IEC standards are:

Emissions: IEC61000-3-2, IEC61000-3-3, IEC61000-3-11, IEC61000-3-12



HARMONICS



FLICKER

Immunity: IEC61000-4-11, IEC61000-4-13 and IEC61000-4-34.

VOLTAGE DIPS

HARM & INTERHARM

Compliance to IEC standards can be tested by using the AZX based ECTS2-Z Series EMC compliance test systems from Pacific Power. These systems provide full compliance testing to harmonics and flicker as well as immunity testing. The harmonics and inter harmonics measurement system and Flicker Impedance modules are included in these systems.

Inter-Operability Testing

For installation in the US, PV inverters must be UL certified. That means compliance with the UL1547 Series, in particular UL1571.1, "Standard for Conformance Tests Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems".

Many of these tests can be performed using the AZX as an AC Grid Simulator although some additional equipment and loads are required as well.

DC Test Capabilities

Since the AZX Series can be operated in DC mode as well, a second AZX power source may be used to simulate PV panels up to 1000Vdc. This allows the same test equipment to be used for either side of the PV inverter test setup. See Figure 4 below.

Conclusion

The new AZX Series is very suitable for testing energy producing grid connected products like solar and wind inverters as well as bidirectional electric vehicle chargers.

To learn more, check out http://pacificpower.com/products/azx-series

Customer Support

For application support, contact Pacific Power Source's Customers Service - Toll Free US: +1 (800) 854-2433 or your local authorized Pacific Power Source distributor or send an email to support@pacificpower.com.

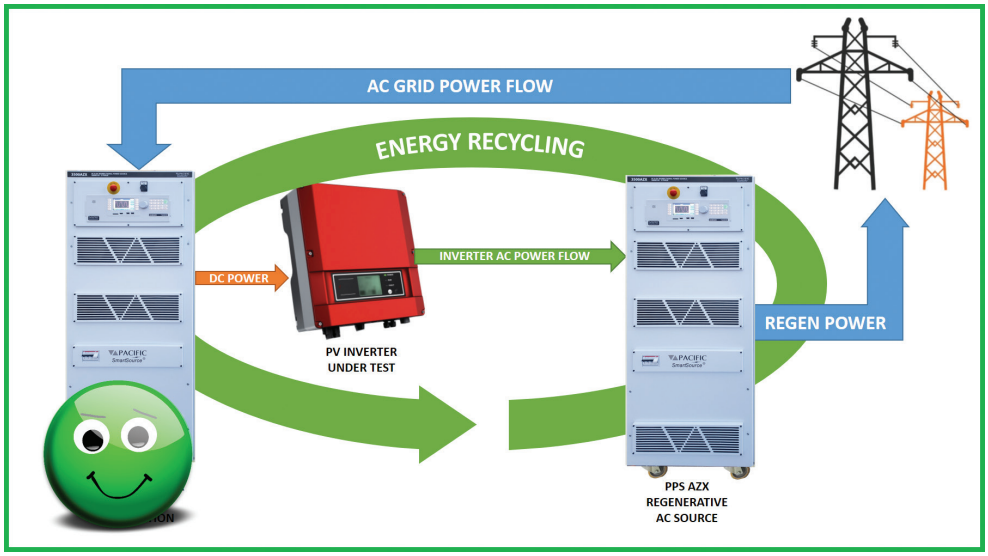


Figure 4: Dual AZX based PV Inverter Test Setup

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