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# Power Conversion Solutions for Grid Tie Applications



ENGINEERING YOUR SUCCESS.

# Parker Hannifin

The global leader in motion and control technologies and systems

## Parker's Commitment

Parker technologies are critical to safeguarding the environment by helping to address the world's need for clean and efficient energy generation. Our technologies are critical for renewable energy platforms to become economical and effective. And our technologies are also critical for traditional energy platforms to become cleaner and more efficient. We actively engage in the reduction of resource use and have a significant environmental impact through developing and providing technology that reduces resource use in application.

At Parker, we are at the forefront of efforts to enable the development and commercialization of every renewable energy platform in the world. Partnering closely with our customers, we supply the engineering expertise and global supply base they desire.

## About EGT

Parker's Energy Grid Tie Division is dedicated to being a leading diversified solution provider for the energy market. Headquartered in Charlotte, NC, the EGT division is a center of excellence for power conversion systems used in numerous and diverse applications. Drawing from over 35 years of experience in electric power conversion, the division designs and manufactures grid tie systems that are used in renewable energy and smart grid applications across the globe. With tools including expertise in power electronics, energy storage, advanced cooling/thermal management and turn-key custom engineered systems, the Energy Grid Tie division provides solutions. Augmenting its design and manufacturing capabilities is a team of field service engineers who are available to see the project through to a successful commissioning.

## Grid Tie/Renewable Energy

Parker's Energy Grid Tie Division offers grid tie inverters and related equipment in numerous configurations and sizes for a variety of renewable energy applications. In the growing field of utility scale battery energy storage, Parker provides the PCS (Power Conversion System) and is the industry leader in lithium ion battery-based systems. In addition, Parker manufactures outdoor duty battery enclosures, complete with climate control, fire suppression, and monitoring systems. Energy storage is a natural addition to both wind farms and PV solar installations. It can facilitate the integration of renewable energy with the grid by virtue of its capacity firming and ramp rate control functions. The end result is more efficient utilization and availability. Direct drive permanent magnet generators and specialized inverters provide power conversion for wind and wave power. Parker's Energy Grid Tie division is committed to providing reliable and efficient solutions to all facets of the renewable energy market.



## About Parker Hannifin Corporation

With annual sales exceeding \$13 billion, Parker Hannifin is the world's leading diversified manufacturer of motion and control technologies and systems, providing precision-engineered solutions for a wide variety of mobile, industrial and aerospace markets. The company employs approximately 60,000 people in 48 countries

around the world. Parker has increased its annual dividends paid to shareholders for 56 consecutive years, among the top five longest-running dividend-increase records in the S&P 500 index. For more information, visit the company's web site at <http://www.parker.com>, or its investor information site at <http://www.phstock.com>





# Grid Tie Applications

## Energy Storage

### Power conversion for battery-based and other systems

To support the addition of renewable power generation sources, to maintain grid frequency stability, or for an economical alternative to traditional “spinning reserve”, many facilities are turning toward solid state energy storage systems. Due to advances in battery technology, battery based electricity storage systems are gaining in popularity compared to flywheels, compressed air, pumped hydro,

or other non-solid state systems. Capabilities of battery energy storage systems (BESS) include frequency regulation, ramp rate control, peak shaving, renewables capacity firming, black start, load following, power factor control, and deferred T&D upgrade investment. Parker offers the only refrigerant cooled energy storage PCS on the market for an efficient and compact solution.



## PV Solar

### Central inverters for utility scale solar farms

The result of over three decades of experience in power conversion and a commitment to sustainable energy, Parker offers unique solutions for solar power. The Outdoor Central Solar Inverter is a megawatt class free-standing package designed for utility scale PV solar field applications. A high efficiency design integrates proven IGBT power conversion, magnetics, and communications platforms

with Parker's ground breaking refrigerant cooling technology. No air conditioner is required, as power semiconductors, inductor, and internal ambient air are cooled by a two-phase refrigerant-based system. Multiple access panels make installation and scheduled maintenance a breeze, with no requirement for technician to enter the enclosure.



## Wind and Other Renewable Sources

### Grid tie inverters with flexibility and environmental protection

Parker offers flexible solutions for wind, ocean wave, and small hydroelectric applications. For wind power, there are a variety of products, including grid tie inverters, direct drive PMAC generators, and energy storage systems. To support the addition of wind resources to the grid, many wind farm operators are installing energy storage systems. Capabilities of battery energy storage systems (BESS) include capacity firming, frequency regulation, ramp rate

control, peak shaving, black start, load following, power factor control, and deferred T&D upgrade investment. Parker's product portfolio in wind power extends beyond electric power conversion, with solutions for turbine blade pitch controls and braking, hydraulic systems, cooling systems, and sealing/shielding technologies from other divisions. Wherever the need for electric power conversion and conditioning exists, Parker EGT has a solution.



# System Solutions

## Energy Storage

### Description

Parker has extensive experience in the energy storage arena, and can offer a number of technologies and systems for a wide range of architectures. Drawing on three decades of experience in power electronics, the Parker bidirectional grid tie inverter is the heart of the energy storage Power Conversion System (PCS). The PCS regulates the transfer of power between the grid and the storage element of your choice. Most commonly the storage element is a bank of batteries. Multiple battery chemistries exist, from lithium ion, to flow batteries, to more traditional lead acid. The Parker PCS is adaptable to any of the above.

To make easy work of installation and commissioning, Parker offers a pre-configured outdoor duty PCS design. Included are the modular inverters, connection points, climate control, and communication center. Depending on the desired configuration, these outdoor enclosures can control up to 4 megawatts each.

Parker also builds fully integrated battery enclosures, including advanced thermal management, low voltage wiring, and fire suppression. Typical battery enclosures are up-fitted shipping containers.

### Utility Scale, Modular Design

Parker power conversion technologies are scalable from 100kW to multiple megawatts of power. For typical utility scale installations, multiple megawatt-class modules are integrated into modified ISO shipping containers, buildings, or custom outdoor enclosures for quick delivery and commissioning.

### Application Specific Control Logic

Through the use of an industry accepted programmable logic controller (PLC) and the appropriate energy management interfaces, the Parker PCS can be customized to assume various application response profiles in order to meet specific utility duty cycles.

### Speed and Efficiency

The IGBT-based Active Bridge Bidirectional Inverter within the PCS is capable of delivering full power in either direction within 10ms, making it suitable for demanding applications like grid frequency stabilization.

### Parker Energy Storage System Benefits:

- **Extensive experience in multiple utility scale installations**
- **Compact and efficient Parker advanced cooling system for inverters and batteries**
- **Modular inverter design for easy field service and maintenance**
- **Turn-key system capability**
- **Transportable direct outdoor duty enclosures, suitable for extreme environments**



# System Solutions

## Solar Inverter

### Description

The result of over three decades of experience in power conversion and a commitment to sustainable energy, Parker offers unique solutions for solar power. The Outdoor Solar Inverter is a megawatt class free-standing package designed for utility scale PV solar field applications. A high efficiency design integrates proven IGBT power conversion and magnetics with Parker's ground breaking two-phase cooling technology. No air conditioner is required, as the power semiconductors, inductor, and internal ambient air are cooled by Parker's two-phase advanced cooling system. Integrated combiner panel and multiple access panels make installation and scheduled maintenance a breeze.

### Parker PV Solar System Benefits:

- **Direct outdoor installation, no shelter required**
- **IP65, dust-tight sealed enclosure**
- **Multiple panels for connections and components provide for accessibility from exterior of unit**
- **Field replaceable inverter modules**
- **Parker advanced 2-phase liquid cooling system**
- **Integral HMI touchscreen**
- **Meets ARRA "Made in America" requirement**



### VAR Control

In addition to its primary purpose of feeding active power ( $P$ , measured in watts) from the solar panels to the grid, the Parker Outdoor Central Solar Inverter is capable of providing **reactive** power ( $Q$ , measured in VARs) when called upon. Within the obvious limitations of rated current and power factor, a reactive power component can be produced on demand.

### Protection

The Parker Outdoor Central Solar Inverter is equipped with a comprehensive list of protective devices for safe and reliable operation.

DC Inputs: Fuse, current sensor on each leg. Contactor disconnect and ground fault current sensor.

DC Bus: Fuse protection.

AC Output: Circuit breaker, phase current sensors (2).

### Operating Modes

**Voltage Ride-through/Droop Response** - Available reactive current is automatically injected if line voltage droop is sensed

**FqRT/Frequency Ridethrough** - Output current is limited for increasing frequency

**VAR or Power Factor Control** - Command the power factor required

### BESS Integration

Ramp control algorithm for both active power and VARs makes the Parker Outdoor Central Solar Inverter easily adaptable to energy storage. With common communication platform and protocols, the inverter may be seamlessly integrated with Parker's energy storage PCS.

# Inverter Technology

## Modular Design

### Description

At the heart of every grid tie system is a reliable and efficient inverter. With over three decades of experience in power conversion, Parker meets these requirements. While the concept of the inverter may seem simple, the design and functionality is critical. Renewable energy sources are valuable, so high efficiency and maximum uptime are desirable attributes. The core of the system, Parker's AC890PX Inverter technology, provides quality power by incorporating an advanced Pulse-Width-Modulated (PWM) switching technology, automatically synchronizing to the AC power grid. Integral harmonic filters deliver pure sine wave power well within IEEE519 guidelines for Total Harmonic Distortion. Maximum uptime is achieved first by a robust and reliable design, but also by a design that makes maintenance and service quick and easy. By virtue of modular design, power components are provided in modular, lightweight, easily replaceable assemblies that can be swapped out by one person, with no ramps, rigging, or major disassembly required. Inverters are manufactured at our ISO9001:2008 certified facility in Charlotte, NC, and satisfy ARRA "Buy American" provision.



### Building Block Inverter

In both air cooled and refrigerant cooled systems, PowerPak modules plug into a rail system to form a complete inverter stack. Modules are easily accessible, and can be changed in the field with minimal equipment. Refrigerant cooled modules can be changed without requiring a cooling system charge, thanks to no-leak quick break fluid connectors.





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