



ADVANCED POWER  
TECHNOLOGIES

# Photovoltaic (PV) Solar AC Balance of Plant Power Collection & Intertie System



BrightPwr  
Engineered Power Systems  
Solutions Brochure

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**SAFE SMART SERVICEABLE SWITCHGEAR &  
ENGINEERED POWER SYSTEM SOLUTIONS**



ALN: 560 Rev. 04

# Solar Power Plant Equipment



Figure 1: BrightPwr - 1MW Community Power Engineered Solar Power Collector & Protection System Pad mount NEMA 3R Non-Walk-In



Figure 2: Pole Mount Fused Cutouts & Disconnect Switch

## Engineered Equipment & Assistance Services

- ⦿ APT has the resources and expertise to provide safe, reliable, and cost-effective solutions for the collection of solar generated power for utility scale grid tie and microgrid applications.
- ⦿ No matter how large or small, simple or complex the site is, APT has you covered from inverter output to Point of Common Coupling (PCC) in utility applications or connection to a microgrid for power distribution with the following:
  - Solar Site Planning, One-Line Diagram Development, Engineering and Design Review
  - Outdoor Walk-In PV Combiner & Utility Intertie Switchgear Modules with sheltered working and maintenance rooms
  - Remote Monitoring SCADA systems
  - Pole Mounted or Pad Mounted Low and Medium Voltage Gang-Operated Disconnect Switches, Fuses, Surge Arresters, and Cut-Outs
  - Low and Medium Voltage Utility Intertie Switchgear according to IEEE 1547 and Utility Company requirements
  - Outdoor NEMA 3R Non-Walk-In Solar Application Specific Solar PV Power Combiner Switchgear, AC Switchboards and AC Panels
  - Advanced microgrid controls for peak shaving, paralleling with utilities, generators, & islanding
  - Integration of battery storage and motor-generators for increased microgrid stability, transient response and improved motor starting
  - Valve Regulated Lead Acid Energy Storage Systems
  - Low to Medium Voltage Solar Step-up Transformers
  - Solar PV Effective Grounding Equipment including grounding transformers
  - Go Solar California! approved Solar Power Metering & Revenue Grade Customer & Utility Metering:
    - For more information on the California Solar Initiative (CSI) and Go Solar California!
  - On-site Commissioning Assistance, Training, Troubleshooting & more!

# BrightPwr-MED Grid Intertie Switchgear



Figure 3: Solar Disconnect Hookstick Drawout Circuit Breaker with Utility Isolation Switch NEMA 3R



Figure 4: 5MW Solar Farm & BESS Integrator Utility Intertie Switchgear



Figure 5: MED-Series - 10MW Utility Intertie & Solar Aggregator Protection Switchgear

## MED-Series Solar Generation To Utility Tie Switchgear

- ⊙ Eliminates the need for external individually mounted and wired, pole mount equipment with unmatched reliability
- ⊙ System Voltage Range:
  - 2.4 kV – 38 kV, 60/50 Hz
- ⊙ Design Amperages:
  - Up to 1200A
- ⊙ Produced to the following standards:
  - MetalClad Type Construction
  - ANSI/IEEE C37.20.3 – Metal-Enclosed Switchgear
  - IEEE 1547 – IEEE Standard for Interconnecting Distributed Resources with Electric Power
- ⊙ Main bus:
  - Insulated silver plated copper, with bolted connections covered by insulating boots
- ⊙ Symmetrical Interrupting Capacity (5-15 kV):
  - 25kA, 40kA or 50 kA
- ⊙ Visible circuit disconnect with draw-out vacuum circuit breakers
- ⊙ Potential Transformers (PTs):
  - Fused, draw-out mounted, potential transformers connected in wye configuration
- ⊙ Surge Protection:
  - One set of three distribution, intermediate, or station class surge arresters for incoming permanently connected cables from switchgear
- ⊙ Current Transformers (CTs):
  - Dedicated Revenue Grade CTs with 0.3% Accuracy @ B0.1 Burden for Revenue Grade Meters or as required
  - One set of three dedicated overcurrent protection CTs for each circuit breaker
  - Mounting assembly insulated for the full voltage rating of the switchgear
- ⊙ Protective Relay Functions as required
- ⊙ Voltage & Current Test Switches per utility requirements
- ⊙ Self-derived control power with on-site 120VAC convenience receptacle
- ⊙ Integrated 24VDC Battery System
- ⊙ Internal Climate Control to include Space Heaters with a Thermostat
- ⊙ Optional Features:
  - Undervoltage release
  - ANSI/IEEE C37.20.2 – MetalClad Switchgear

# Utility & Customer Metering



Figure 6: Revenue Grade Metering (left) and PS-EH Multi-Function Power Metering (right)\*

## PS-EH Advanced Multi-Function Power Metering

- ⦿ UL recognized Advanced Power Metering
- ⦿ Go Solar California! approved Solar Power Metering
- ⦿ True RMS, 3 Element Power Quality Metering:
  - Metering accuracy shall be in accordance with ANSI C12.20-1998, rated an with accuracies as follows:
    - Class 10 0.5% for energy.
    - 0.2% of reading and 0.02% of full scale for voltages and currents.
    - 0.3% of reading and 0.02% of full scale for active and apparent power
  - Dedicated high-brightness digital LED displays are visible in the bright sun light or in the dark
- ⦿ Environmental Conditions
  - Operating temperature:
    - -20°C to 60°C (-4°F to 140°F)
  - Humidity:
    - 0 to 95% non-condensing
- ⦿ For more information on the California Solar Initiative (CSI) and Go Solar California!, visit <http://www.gosolarcalifornia.ca.gov/>

Parameter	Full Scale @ Input Range	Accuracy			Range
		Reading	% FS	Conditions	
Voltage	120VxPT @ 120V 400VxPT @ 690V	0.2	0.02	10% to 120% FS	0 to 1,150,000 V Starting voltage 1.5-5.0% FS (selectable)
Line current	CT	0.2	0.02	For In = 5A 1% to 200% FS For In = 1A 5% to 200% FS	0 to 50,000 A Starting current 0.1% FS
Active power	0.36xPTxCT @ 120V 1.2xPTxCT @ 690V	0.3	0.02	PF  ≥ 0.5 <sup>1</sup>	-10,000,000 kW to +10,000,000 kW
Reactive power	0.36xPTxCT @ 120V 1.2xPTxCT @ 690V	0.3	0.04	PF  ≤ 0.9 <sup>1</sup>	-10,000,000 kVAR to +10,000,000 kVAR
Apparent power	0.36xPTxCT @ 120V 1.2xPTxCT @ 690V	0.3	0.02	PF  ≥ 0.5 <sup>1</sup>	0 to 10,000,000 kVA
Power factor	1.000		0.2	PF  ≥ 0.5, I ≥ 2% FSI	-0.999 to +1.000
Frequency	50/60 Hz 25 Hz, 400 Hz	0.02 0.04		V <sub>L-N</sub> > 25V	40 Hz to 70 Hz 15 Hz to 40 Hz 320 Hz to 480 Hz
Total Harmonic Distortion, THD V (I), %Vt (%If)	999.9	1.5	0.2	THD ≥ 1%, V ≥ 10% FSV and V <sub>L-N</sub> > 25V, I ≥ 10% FSI	0 to 999.9
Total Demand Distortion, TDD, %	100		1.5	TDD ≥ 1%, I ≥ 10% FSI, V <sub>L-N</sub> > 25V	0 to 100
Active energy Import & Export				Class 0.5S under conditions as per IEC 62053-22:2003	0 to 999,999,999 kWh
Reactive energy Import & Export				Class 0.5S under conditions as per IEC 62053-22:2003,  PF  ≤ 0.9	0 to 999,999,999 kVARh
Apparent energy				Class 0.5S under conditions as per IEC 62053-22:2003	0 to 999,999,999 kVAh

<sup>1</sup> @ 80% to 120% of voltage FS, 1% to 200% of current FS and frequency 50/60 Hz

PT - external potential transformer ratio  
CT - primary current rating of external current transformer  
FSV - voltage full scale FSI - current full scale

# Solar/BESS Power Transformer



Figure 7: PTX-Series - 2000kVA Solar Step-Up Power Transformer NEMA 3R



Figure 8: PTX-Series - 1000kVA Solar Step-Up Power Transformer

## PTX-Series Low to Medium Voltage Power Transformer

- ⊙ Built to all applicable IEEE C57.12.34
- ⊙ Pad Mount, Step Up Solar Application Specific
- ⊙ Cooling class: ONAN
- ⊙ High Voltage Side:
  - Aluminum windings
  - 2.4kV - 34,500 V Delta or Wye Connected
  - BIL up to 200 kV
  - Tap changer:  $\pm 2, 2.5\%$
  - Live front, Radial feed
  - Optional Bushing wells
- ⊙ Low Voltage Side:
  - Aluminum windings
  - Single Low Voltage Winding
  - 208V - 1200 V Delta or Grounded Wye Connected
  - BIL up to 60 kV
  - Epoxy 2 piece-bushings with 4-holes blade
- ⊙ 5-legged Core
- ⊙ Ratings:
  - 500kVA - 3,000 kVA
  - Frequency: 60 Hz
  - Impedance:  $5.75\% \pm 7.5\%$
  - Temperature rise: 65°C
- ⊙ Electrostatic Shield:
  - Allows transient surges present in the HV network to be filtered, preventing them from being transferred to the LV side and affect the electronic circuits in the inverter
  - Prevents a capacitive coupling between both windings
  - Provide a pathway to ground for any residual resonance
- ⊙ Enclosure
  - Outdoor NEMA 3R
  - Mild steel tank & cabinet
  - Powder paint system; Color: ANSI 70 or Green Munsell 7GY 3.29/1.5
  - Weights: 7000 – 17500 lbs

# PV & BESS Neutral Grounding



Figure 9: ZGR-Series - Neutral Grounding Reactor



Figure 10: ZZX-Series - Zig-Zag Grounding Transformers



## ZGR-Series & ZZX-Series Effective Grounding

- ⦿ System Ratings:
  - Voltage: 208-13,800 V (3Ø)
- ⦿ Neutral Grounding Reactors provide “low impedance grounding” of the neutral of your power transformer or generator:
  - Reduces the magnitude of the ground fault & harmonic currents, circulating in the neutrals due to the differences in the winding pitches, armature reaction, and other system conditions
  - Increases transformer life expectancy by reducing the stress and amount of damage to your transformer by controlling the magnitude of the ground fault currents
  - Lower losses arising from the unbalance currents
  - Increased voltage drop in the ground return path
  - Raises the temporary overvoltage on the unfaulted phases and deepens the voltage sag on the faulted phase during a ground fault causing a faster trip and better identifies the faulted phase
- ⦿ With the rapid increase in the construction of solar farms and the conversion of DC voltage to AC voltages, the question of how to provide effective grounding to the AC side of the system has taken center stage
  - ⦿ Zig-Zag Grounding Transformers create an “effective ground” from the three phases of the inverted generated PV power:
    - Provides effective grounding of the ungrounded system
  - ⦿ Designed & factory tested to IEEE Standard 32-1972
  - ⦿ Many utilities are requiring that solar installations are effectively grounded
  - ⦿ An appropriately engineered ZZX-Series Photovoltaic Effective Grounding System will provide the hardware and controls necessary to effectively ground the AC side of the system and provide detection of the ground fault
  - ⦿ The ZZX-Series is designed to satisfy stringent utility requirements for impedance, fault current, X/R ratio, and continuous current
  - ⦿ Complying with these requirements with the proper protection scheme, will make your solar installation act more like traditional three phase AC grounded neutral systems

# LV Collector/Intertie Switchboard



Figure 11: SBU-Series – 2000A AC Collector & Ground Fault Protection Switchboard

Figure 12: SBU-Series – 3000A Utility Intertie AC Collector Switchboard

Figure 13: Side View – Isolated PT & CT Test Switch Compartment

## SBU-Series 480-600V Solar Aggregator Switchboard

- ⊙ Combines Power from Multiple Collector Panels
- ⊙ System Voltage Range:
  - 480V – 600V, 60/50 Hz
- ⊙ Insulated case Main Circuit Breaker:
  - 1200A – 4000A
  - NEC 2017 - Energy Reduction Maintenance Switch
- ⊙ UL 891 Listed Standard for Switchboards
- ⊙ Main bus:
  - Silver-plated copper bus (1000A/in<sup>2</sup>)
  - NEMA standard hole pattern
  - 65kAIC bracing min
- ⊙ Symmetrical Interrupting Capacity:
  - 35kA, 65kA or 100kA
- ⊙ Unit Mounted MCCBs offer the Ultimate in flexibility, serviceability, and troubleshooting
  - Molded Case Solar Power Aggregator Circuit Breakers
  - One (1) Zig-Zag Grounding Transformer Breaker
  - One (1) Auxiliary Feeder Circuit Breaker
- ⊙ Self-derived control power with on-site 120VAC convenience receptacle
- ⊙ Internal Climate Control to include Space Heaters with Thermostat
- ⊙ Service Entrance Utility Intertie Options
  - IEEE 1547 – IEEE Standard for Interconnecting Distributed Resources with Electric Power
  - Visible circuit disconnect with draw-out main circuit breaker
  - Surge Protection Device:
    - Type 1 & Type II Available
  - Utility Intertie Protective Relay Functions as required
  - Isolated Side Access Operator Control Cabinet
  - Voltage & Current Test Switches per utility requirements
  - Potential Transformers (PTs):
    - Fused, Fixed mounted, revenue grade potential transformers connected in wye configuration
  - Current Transformers (CTs):
    - Dedicated Revenue Grade CTs with 0.3% Accuracy @ B0.1 Burden for Revenue Grade Meters as required

# Power Collector Panel



Figure 14: 800A Solar Combiner Panelboard NEMA 3R



Figure 15: 600A Solar Combiner Panelboard Installed

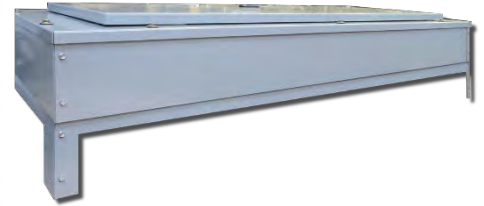


Figure 16: Low Profile Roof Mountable Horizontal Design NEMA 4

## PBU-Series 480-600V Solar Aggregator Panels

- ⊙ Combines Power from Multiple String Inverters and Micro Inverters
- ⊙ Designed for supply applications
- ⊙ Previously faulted circuits can be reset without the need to replace blown fuses
- ⊙ Maintenance free panel design
- ⊙ Available standards (based on ratings & options):
  - UL 67 Standard for Panelboards
  - UL 891 Standard for Switchboards
  - UL 508A Standard for Industrial Control Panels
- ⊙ Voltage:
  - 208V – 600V, 3Ø, 4 Wire
- ⊙ Frequency:
  - 60 / 50Hz
- ⊙ Symmetrical Interrupting Capacity:
  - 18kA, 35kA, or 65kA
- ⊙ Surface Mountable
- ⊙ Bus Options:
  - Tin-plated Aluminum
  - Silver-plated Aluminum
  - Silver-plated Copper
- ⊙ All Circuit Breakers are suitable for reverse feed
- ⊙ Available Main:
  - Molded Case Circuit Breaker
  - Molded Switch
  - Main Lugs Only
- ⊙ Collectors:
  - Up to Fourteen (14) 3-pole breakers maximum per section
- ⊙ Bottom & Side Entry for ease of connections
- ⊙ Fuse Options Available Upon Request

# Battery Energy Storage

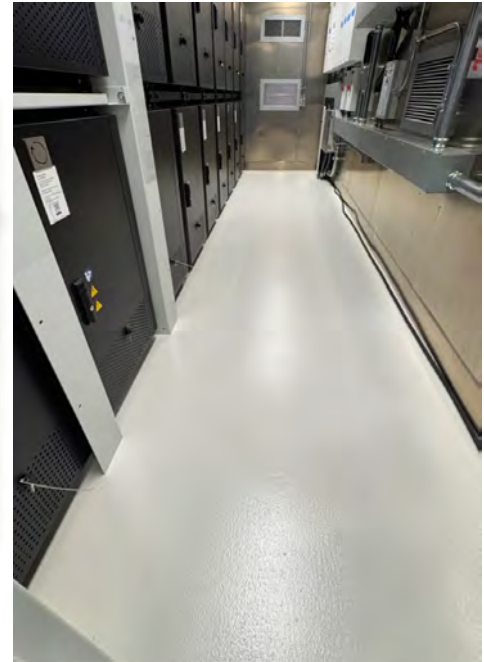


Figure 17: Solar Generated Power Battery Energy Storage System (BESS) - PwrContainerized Solution (left)

## EnerStore Battery Energy Storage

- ⦿ APT EnerStore Battery Energy Storage System (BESS) provides state-of-the-art grid/microgrid stabilization for solar generated power
- ⦿ APT Solar Generated Power Battery Energy Storage System (BESS) can be stand alone, outdoor NEMA 3R or fully integrated with low voltage switchboards, transformers, and medium voltage switchgear all in a single Outdoor Walk-In ISO Container Based Solar Power Combination Module
- ⦿ APT EnerStore Battery Energy Storage System (BESS) can be configured to automatically provide the following functions and major modes of operation simultaneously:
  - Black start
  - Utility Grade Uninterruptible power supply system
  - Peak Shaving
  - Frequency regulation
  - Voltage/Reactive Power support
  - Optimization of the operation of the renewable power sources
- ⦿ APT EnerStore Battery Energy Storage System (BESS) is designed to use most of the known or commercially available battery types and technologies
- ⦿ EnerStore DC Battery Energy Storage Systems (BESS) are equipped with the APT Battery Energy Storage DC to AC inversion Generators. APT Battery Energy Storage Generators main Benefits and Features:
  - High available fault current (therefore improve motor starting and inrush loads capability)
  - Enables the automatic use of battery energy storage as a source of emergency power during power grid outages
  - Modes of operation include automatic, closed transition, bumpless load transfer between the utility grid and Battery Energy Storage Generator
  - Enables the automatic use of connected renewable sources as a source of emergency power during utility grid outages to increase the available batteries run time
  - Can be configured as a power conditioner to provide galvanic isolation between the utility grid and critical site loads while serving as an uninterruptable source of power to the site load

# Outdoor Walk-In & Skid Modules



Figure 18: PwrContainer - Pre-wired Outdoor Walk-In ISO Container Based Solar Power Transformer & Combination Modules



Figure 19: PwrSkid - 2.5MW Pre-wired Outdoor Skid-mounted Transformer & AC Combiner Switchgear

## PwrContainer & PwrSkid for Solar Rapid Deployment

- ⊙ Fully integrated solar power module (fully enclosed walk-in equipment enclosure) or open skid, come with equipment pre-installed and pre-wired from the factory and only external connections need to be made upon installation
- ⊙ Fast and clean installation allows for less installation time and more generation time
- ⊙ The following system components can be interated in the power module or on the open skid:
  - Medium voltage and low voltage utility intertie switchgear
  - Power Collection Switchboards and Panelboards
  - Grounding transformers
  - Power transformers
  - Utility Company metering and RTU
  - System control panels
  - Energy Storage and conversion components
  - Diesel and Natural Gas generators
  - Control and Maintenance rooms
- ⊙ Use of the PwrContainer & PwrSkid systems shifts large part of the installation from on-site to the controlled, factory environment, increasing the quality of the installation and allowing for the rapid deployment of the solar balance of plant equipment

# About Advanced Power Technologies



Advanced Power Technologies (APT) is on the cutting edge of the latest engineered power system smart technologies, as it relates to microgrid & storage management, renewable & conventional energy source deployment, demand peak shaving, and facility back-up and co-generation power systems. Located in the central United States and headquartered in Lafayette, Indiana with solutions development engineers around the country, APT provides domestic and international products and services to industry leading companies from around the world. APT engineers have decades of power system experience from working with some of the largest companies in industry. Over the last two decades, we have produced successful solutions for hundreds of large-scale electric power projects involving utility/generator paralleling, transfer, peak shaving, and distribution. We pride ourselves in providing electrical power systems that are engineered and custom built, utilizing state-of-the-art technologies to fit our customer's exact needs. The core of our business is low & medium voltage engineered power systems for a wide range of indoor & outdoor applications, such as:

- ⊙ Utility(ies) and Generator(s) Paralleling/Transfer/Peak Shaving/Distribution Switchgear
- ⊙ Microgrids, Microgrid Master Control Panels, SCADA systems
- ⊙ Containerized Battery Energy Storage Systems (BESS)
- ⊙ Photovoltaic (PV) Solar Power Collection/Distribution & Renewable Energy Storage Systems
- ⊙ Low & High Resistance Grounding Systems, Grounding Systems for Photovoltaic Effective Grounding
- ⊙ High Efficiency Combined Heat and Power Switchgear & Control Systems (CHP, Co-generation)
- ⊙ Outdoor Walk-In Electrical Houses (E-Houses) & Skid-Mounted Switchgear
- ⊙ Motor Control Centers & Motor Control Switchgear
- ⊙ Automatic & Manual Load Transfer Switchgear
- ⊙ Bypass/Isolation & Power Distribution Circuit Breaker Switchboards
- ⊙ Generator/Loadbank Quick Connection Switchgear, Switchboards, & Tap Boxes
- ⊙ Industrial Control Panels

Please see our product webpages on [www.appt-power.com](http://www.appt-power.com) for product brochures and relevant information. Actual products may look different from images shown on the website and in brochures, based on actual specifications.

APT cares and understands that each power system is different. We will evaluate various solutions in order to develop the best solution for a site. APT focuses on our ability to a combine several traditional pieces of equipment/functionality into as little of a footprint possible. This saves on space, the cost of equipment, cost of installation, and accomplishes the most optimal/state-of-the-art design your facilities. APT's desires to foster and grow a culture of continued open communication with each customer. Let APT be your source to provide fully engineered power system equipment solutions for the full customer facility on time, on or under budget, and in the smallest footprint possible. We are always available to assist customers and engineers representing customers in the development of complex power solutions for all facility types.