ABB Electrification Solar Offering
OEM/Residential/Commercial/Utility Offering

ABB offers the industry’s most comprehensive portfolio of products, systems, solutions and services. Optimize the performance, reliability and return on investment of any solar installation. From residential rooftops to commercial and industrial applications and utility-grade power plants. With a proven track record in solar since the 1990s, ABB offers the industry’s broadest portfolio in solar. Global presence and expertise from solar systems to grid connection and integration to smart grids. We are your expert partner.
ABB solar competitive offerings
Explore the industry’s broadest portfolio in utility scale solar

From low voltage to medium voltage

ABB has over 140 years of experience developing power electronics equipment. With the most sophisticated engineering and power electronics professionals.

ABB has expertise and experience needed to deliver a complete solution to maximize revenues by optimizing the efficiency and uptime of the PV plant.

Successfully manufacturing, deploying, connecting, integrating and deploying solar PV plants requires a deep understanding of utility-scale applications.

ABB can connect everything from the direct current (DC) output of the PV panels up to the medium voltage grid, along with system design and optimization expertise.

And, don’t forget about Service, ABB offers a wide range of services to help you get the most power from your plant – ranging from remote monitoring to full operation and maintenance (O&M).
## Systems and solutions for successful utility plant design

### ABB key offerings in utility segment

<table>
<thead>
<tr>
<th>Electrical balance of plant</th>
<th>Turnkey stations</th>
<th>Grid connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABB’s solutions for PV power plants are designed to maximize plant performance and provide owners with a rapid return on investment and long plant operating life. Optimized standard concepts for each stage of the PV power plant process and a complete capability in design, engineering, and commissioning.</td>
<td>ABB turnkey solutions capitalize on ABB’s long expertise in the development and manufacturing of secondary substations and medium voltage (MV) components.</td>
<td>ABB offers a range of products and solutions that help to efficiently connect PV plants to the grid. In-depth knowledge of renewable power generation technologies and comprehensive experience with grid codes and utility practices in use around the world enables us to provide grid connection solutions for PV plants of all sizes.</td>
</tr>
</tbody>
</table>

### Grid integration

As an intermittent, widely dispersed source of energy, solar presents a challenge to power grids. It demands sophisticated solutions to balance supply and demand and avoid stress on the grid. ABB has the advanced technologies needed for successful grid integration for installations of all sizes both at the connection point and at the system level with our smart grid solutions.

### Energy storage

With our range of dynamic battery energy storage systems for solar applications, ABB has developed an effective and efficient approach that enables energy produced from a PV system to be stored and then used when required. Our battery systems do not produce any CO2 emissions. They also maximize the efficient use of renewable energy sources.

### Plant automation

ABB offers a versatile and scalable automation solution designed for monitoring and control of PV power plants. The solution spans from plant automation including panel position control, plant diagnostics and power management, with ABB Ability enabling remote operations and management of PV plants.
<table>
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<th>Low voltage</th>
<th>Medium voltage</th>
<th>Substations</th>
<th>Energy Storage / Chargers</th>
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<td>Switch gear</td>
<td>Air-insulated switchgear</td>
<td>AIS substations</td>
<td>Energy storage:</td>
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<tr>
<td>Breakers’ Disconnects</td>
<td>Gas-insulated switchgear</td>
<td>GIS substations</td>
<td>– EssPro PCS</td>
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<tr>
<td>Safety switches</td>
<td>Dead tank circuit breaker</td>
<td>Hybrid substations</td>
<td>– EssPro EBOP</td>
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<tr>
<td>Contactors and Relays</td>
<td>Reclosers, contactors</td>
<td>Mobile substations</td>
<td>– EssPro Grid Tie</td>
</tr>
<tr>
<td>Insulation monitors</td>
<td>Breakers and disconnects</td>
<td>Containerized and prefabricated substations</td>
<td>Battery chargers:</td>
</tr>
<tr>
<td>Meters and timers</td>
<td>Voltage and current sensors</td>
<td>Energy storage solutions</td>
<td>– Integritas wall, and floor mounted</td>
</tr>
<tr>
<td>Fuse holders</td>
<td>Packaged solutions</td>
<td>Power quality improvement solutions</td>
<td>– Infinity Industrial</td>
</tr>
<tr>
<td>Power supplies,</td>
<td>Transmission line and current limiting fuses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power monitoring</td>
<td>Transmission line connection and protection relays</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connecting and grounding</td>
<td>Automation and SCADA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wire and cable management;</td>
<td>Connecting and grounding solutions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable tray, nonmetallic flex conduit, cable ties and ground connectors</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Successfully deploying solar PV plants as well as connecting and integrating these into the grid requires a deep understanding of utility-scale applications.

ABB has the expertise and experience needed to deliver a complete solution to maximize revenues by optimizing the efficiency and uptime of the PV plant.

ABB can provide every element you need – connecting everything from the AC output of the inverters up to the medium voltage grid, along with system design and optimization expertise.

We also offer a wide range of services to help you get the most from your plant – ranging from remote monitoring to full operation and maintenance (O&M).

ABB offers you a broad portfolio, reliability, innovation and economic efficiency so that you can achieve even more with your solar projects.

“Count on us because they count on you”
Utility applications: power-plant products

Solutions - products, systems, software and services


★ = ABB offering

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ABB’s offering for collection and connection
Solar PV plant grid connection - electric balance of plant

Value added

Consulting/Engineering package
S/S Automation
S/S engineering
MV equipment

Product delivery

Consulting/Engineering package
S/S Automation
S/S engineering
MV equipment

Turnkey AC PV plant
S/S
AIS, GIS, PASS

Electric BoP (eBoP)
S/S + CSS + MV + FACTS + communication + BESS

Electric BoP EPC
eBoP + OHL + CW

Solar Utility

Complexity

ABB can deliver from products to engineering packages or turnkey S/S BoP available in specific markets
Solar applications: power-plant products

Typical Solar plant diagram – power sections

**PV modules**
- Power source
- Multiple modules in sequence

**Inverter station**
- Inverting of DC current to AC
- Up to 2 MW per inverter

**MV station**
- Stepping up to medium voltage

**Grid connection substation**
- Collection point for all strings
- Step up to utility grid voltage
- Feed into utility grid

---

**Low Voltage**
(1000-1500V DC / 400-800V AC)

**Medium Voltage**
(12-38kV)

**High Voltage**
(acc. to utility grid)
Utility applications: power-plant products

Utility scale solar plant diagram using central inverters – main components

- **PV modules**
- **Inverter station**
  - Central inverter with MV transformer
- **MV station**
- **Grid connection substation**
  - Storage
  - Step-up transformer
  - Energy Storage Modules

**ABB solution**

**E-house options**

**CSS/pad mounted**

**Outdoor solutions**

**Switchgear**
Utility applications: power-plant products

Utility scale solar plant diagram using string inverters – main components
Offering for the OEMs: Combiner Boxes, Inverters, Skids
Electrification products in solar
OEM offering: solar combiner boxes, inverters/inverter skids, panel builders
Offering for the Solar distributors and rooftop installers
Electrification products in solar
Residential and commercial rooftop used as AC junction boxes

Spec Setter* general duty
AC general duty safety switches
- Fusible, non-fusible
- 30-600A, 240VAC
- N1, N3R

Spec Setter* heavy duty
AC heavy duty safety switches
- Fusible, non-fusible
- 30-1200A, 240 & 600VAC
- N1, N12, N3R, N4X 304/316
- Clear line shield 30-200A
- Viewing windows 30-200A
Meet the largest window on the market*

With its enhanced window enabling at-a-glance safety checks, the all-new ABB safety switch with extra large viewing window helps deliver premium safety for your customers.

* As of March 1, 2021
**Extra Certainty**

See the difference for yourself

**Existing viewing window (30-200A)**
- Small window (1.5”x 3” to 1.5” x 6.5”)
- Stainless steel construction suitable for some mill duty
- Obstructed view of contacts
- No view of fuses

**New extra large viewing window (30-200A)**
- Premium window is 190% to 850% larger
- Rugged and dust-tight design robust enough for indoor and outdoor use
- Clear view of contacts and fuses for instant verification

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Electrification products in solar
Residential and commercial rooftop solar panel clamps and grounding

**Kindorf solar panel products**

Application: residential and commercial rooftop
Hold down clamps and grounding washers
Corrosion resistant materials
Ease of installation-slotted design
Works with all brands of solar panels

*Kindorf Channel/Strut*
*And pre-engineered systems*

- **Solar Panel Hold-Down Clamp: SHC-T-SSH**
- **Solar Panel Hold-Down Clamp: SHC-L-SSH**
- **Solar panel grounding washer: DTSW14**
- **Kindorf Channel/Strut And pre-engineered systems**
Electrification products in solar
Residential and commercial rooftop solar wire management

**TnB Ty-Rap Cable Edge Solar Clips**
- Application: residential and commercial rooftop
- Solar panel wire management
- U-style cable management parallel to frame
- Holds up to four #10 AWG solar cables
- Corrosion resistant materials
- Temperature rated: -85 to +194 deg F
- Heat stabilized Nylon 6.6 option: -85 to +220 deg F
- Quick and easy installations - no tools required
- 90-degree installation available

**Ty-Rap® High Performance Cable Ties**
- Polyamide 12 UV-resistant version, remains flexible in cold & dry environments
- Ages better and has a better chemical resistance than Polyamide 6.6
- Lower moisture absorbing material than 6.6 nylon
- For use in temperatures from -40°F to 185°F (-40°C to 85°C)

Ty-Rap GD-001-TB  Ty-Rap TC 402  Ty-Rap TC 403

Ty-Rap TYC28MX
Offering for Utilities, Developers, EPCs and distributors
Low & medium voltage components and systems
Utility applications: power-plant products

Medium voltage solutions

- Electrical houses
- Compact secondary substations
- Energy storage modules
- Skid mounted unit - substations
# Utility applications

## Medium Voltage Switching Products

<table>
<thead>
<tr>
<th>Air-insulated primary switchgear</th>
<th>Gas-insulated primary switchgear</th>
<th>Gas-insulated secondary switchgear</th>
<th>Dead tank vacuum magnetic CB</th>
<th>Recloser</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
<tr>
<td>Metal-clad and arc-resistant ANSI switchgear:</td>
<td>Full line of gas insulated primary switchgear:</td>
<td>SafeRing is a ring main unit (RMU) for the secondary distribution network. SafePlus is a metal enclosed compact switchgear system for distribution applications.</td>
<td>ANSI, Magnetic actuator, Vacuum interruption</td>
<td>Mechanically ganged operation</td>
</tr>
<tr>
<td>Arc-resistant SafeGear®:</td>
<td>ZX2:</td>
<td></td>
<td></td>
<td>— OVR-15, OVR-27</td>
</tr>
<tr>
<td>— up to 4000 A, 63 kA, 15 kV</td>
<td>— 38kV (85kV/200kV), 4000, 40kA</td>
<td></td>
<td>— R-Mag 15.5kV, ...3700A</td>
<td></td>
</tr>
<tr>
<td>— smallest footprint available in the industry</td>
<td>— Flexible/adaptable design, ETL labeled</td>
<td></td>
<td>— R-Mag 27kV, ...2000A</td>
<td></td>
</tr>
<tr>
<td>ReliaGear® ND:</td>
<td>ZX2.2</td>
<td></td>
<td>— R-Mag 38kV, ...2000A</td>
<td></td>
</tr>
<tr>
<td>— ABB’s narrow-design</td>
<td>— 38kV (85kV/200kV), 4000, 40kA</td>
<td></td>
<td></td>
<td>— Controller: ABB Relion</td>
</tr>
<tr>
<td>— 31.5kA, 5 and 15 kV</td>
<td>— Disconnect &amp; earth switch on cable side of CB</td>
<td></td>
<td></td>
<td>— 3ph network</td>
</tr>
<tr>
<td>Advance®:</td>
<td></td>
<td>— RMU Safering: up to 40.5 kV, 630A</td>
<td></td>
<td>— Pole &amp; substation</td>
</tr>
<tr>
<td>— up to 50kA, 15kV, 4000A</td>
<td></td>
<td>— Compact switchgear SafePlus: up to 40.5 kV, 630A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Utility applications
Outdoor apparatus – fuse cutouts and disconnectors

### Fuse cutouts for distribution applications

<table>
<thead>
<tr>
<th>3 Types</th>
<th>Overhead disconnect switches</th>
</tr>
</thead>
<tbody>
<tr>
<td>– ICX, fuse holder interchangeable with S&amp;C, Cooper, ..</td>
<td>Up to 38kv, ..900A , ..25kA</td>
</tr>
<tr>
<td>– ICX LBU, fuse switch application (breaking chamber)</td>
<td>– SID, single insulator disconnect</td>
</tr>
<tr>
<td>– NCX, non interchangeable fuse holder (ABB type only)</td>
<td>– LSID, load break single insulator disconnect</td>
</tr>
<tr>
<td>– Ratings</td>
<td>– DCD, double insulator single phase disconnect switch</td>
</tr>
<tr>
<td>• 15, 27, 38kV</td>
<td>– RBD, single phase by-pass disconnect switch</td>
</tr>
<tr>
<td>• Up to 200A , ...20kA</td>
<td>– Sectionalize and isolate OHL or equipment for maintenance</td>
</tr>
<tr>
<td>– Insulators types; porcelain, silicon rubber, polymer concrete.</td>
<td>– Isolating CBs, etc. reclosers by-pass</td>
</tr>
<tr>
<td>– Protection of overhead lines (laterals) and loads such as distribution transformers</td>
<td></td>
</tr>
<tr>
<td>– Protection and visible break</td>
<td></td>
</tr>
</tbody>
</table>

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Utility applications
Indoor circuit breakers and switches

**ADVAC / AMVAC**
Generator breakers: ADVACG, VD4G
- 15KV 4000A 63KA
Distribution breakers:
- ADVAC – spring actuator
  15KV 4000A 63KA
- AMVAC – magnetic actuator
  27KV 4000A 50KA

**VD4-CS**
Safe and relentless operation of 38KV power quality
VCB with servomotor drive for 20,000 transient free operations
- 20,000 operations with extreme low probability of re-strike
- No inrush reactors
- Optimize assets combines protection (circuit breaker) and switch (frequent operations) features
- 1200A capacitive current

**DS1**
Synchronous transient-free capacitor switch
The first diode-based MV switch worldwide at 15KV
- Transient free
- 50,000 maintenance free operations
- No inrush reactors
- Compact solution
- Embedded diagnostics
- 600A capacitive current
Utility applications
Automation and communication

Protection and numerical relays
Based on the use of microprocessors. Electromechanical and static relays have fixed wiring, and the setting is manual. Numeric relays are programmable, and the characteristic and behavior can be programmed. Most numerical relays are also multifunctional. Multi-function relays for device protection, switch control, arc flash protection, sync and load shedding applications.

Communication devices
Used when connecting protection relays to wired communication media (fiber-optic, galvanic), to convert between communication protocols or between communication systems.

Test switch and accessories
Designed and manufactured to allow quick and easy multi-circuit testing of switchboard relays, meters and instruments by any conventional system. They have been especially designed for the measurement of potential elements, current elements and make-before-break short-circuit elements related to current transformer (CT) circuits.
Utility applications
Special solutions

Alternative relays
Electromechanical and solid-state relays
Solid state electronic components provide a similar function to electromechanical relays but do not have any moving components, increasing long-term reliability.

Arc fault protection
Solutions designed to detect an internal arc in 1.5 ms and eliminate it in less than 4 ms, improving safety and availability of the power system.
Operating the network with a conventional solution with an operating time of 80 – 100 ms results in cable fire and copper and steel melting.

Ultra-Fast Earthing Switch UFES
Innovative arc quenching
Highest level of safety for LV and MV systems against the internal arc faults
In case of an internal arc fault the arc detection relay trips the UFES, which initiates a three-phase earthing to break the arc voltage immediately.
The switching time is less than 1.5 ms, the arc flash is extinguished in less than 4 ms.
Offering for Utilities, Developers, EPCs and distributors
Instrument transformers and sensors
**Instrument transformers (ITs)**

Traditional primary measurement solutions proven through the ages

100+ year old technology

Uses ferromagnetic circuit to tightly couple primary and secondary, with special attention to maximizing accuracy of translation of voltage and current signals

Able to transfer power from primary to secondary

Typically 1 or 5 amp current output, 120 or 240 volt voltage output

Wide array of meters and relays supporting (electromechanical and solid state)
## The role of instrument transformers

Dry type ITs in ABB’s indoor and outdoor portfolio are used in a three main types of applications

<table>
<thead>
<tr>
<th>Metering applications</th>
<th>Protection and control applications</th>
<th>Power supply applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Providing voltage and current signals to power and energy meters for both revenue (tariff) metering and non-revenue (non-tariff) metering applications.</td>
<td>Providing voltage and current signals to protection and control relays and controllers for protecting and managing the power grid.</td>
<td>Small dry type form factor of ITs perfect for supplying power to protection and control apparatus. May be used for both measurement and supply in the same application.</td>
</tr>
</tbody>
</table>
### IT product lines for utility applications

#### Overview

<table>
<thead>
<tr>
<th>LV applications (600 V)</th>
<th>Outdoor medium voltage</th>
<th>Station post CTs</th>
<th>Generator CTs</th>
</tr>
</thead>
<tbody>
<tr>
<td>600 V metering</td>
<td>Utilized in utility substations</td>
<td>15 – 34.5 kV, 110 – 200 kV BIL</td>
<td>Indoor and outdoor</td>
</tr>
<tr>
<td>– Current and voltage transformers</td>
<td>Designed for metering and relaying on outdoor circuits</td>
<td>Window and bar type designs</td>
<td>Metering and protection</td>
</tr>
<tr>
<td>– Used for secondary revenue metering</td>
<td>AccuRange® high accuracy extended range (HAER) CTs</td>
<td>Metering accuracy 0.3</td>
<td>Board mounted and resin cast</td>
</tr>
<tr>
<td>600 V plastic case Its</td>
<td>ResiVolt™ VFT resistant VTs</td>
<td>LG and LGX</td>
<td>Basic impulse level: 0.6 kV</td>
</tr>
<tr>
<td>– Offered in a variety of internal window diameter sizes</td>
<td>Combination CT/VT ITs</td>
<td>– Inner diameter = 4.5 – 8.75”</td>
<td>Extensive product offering of proven designs with decades of field experience</td>
</tr>
<tr>
<td>– Used in switchgear and outdoor vacuum breaker applications (R-Mag)</td>
<td></td>
<td>– Metering accy 0.3 &amp; 0.15S, relaying to C800</td>
<td>Durable design against water intrusion and vibration</td>
</tr>
</tbody>
</table>

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IT product lines for utility applications

Special solutions

### Split-core CTs – monitoring, metering and protection

- Metering accuracy to 0.3 class
- Relaying accuracy to C800
- Convenient mounting around primaries which cannot be opened
  - Common for retrofit solutions
- SP window sizes up to 41"
- CO window sizes of 2½", 5½", 9

### Submersible VTs

- Indoor VT for use in a subsurface installation
  - VIL-95/12
    - Designed with secondary junction box for intermittent submersible operation where VTs are not permanently submerged under water
- VIL-95/12
  - Designed with secondary wires directly encapsulated into the polyurethane for a water-tight connection allowing installation where they are permanently submerged
- Uses dead-front elbow connectors for primary
**IT product lines for utility applications**

**Ferroresonance mitigation**

**FSR-983 outdoor saturable reactor**

- 600V class
- Matched to specific PT
- Ideal for retrofit applications to passively damp circuit to avoid resonance

**VT Guard Pro**

- Ideal for active elimination of ferroresonance risk in new deployments
- Used in open-delta connection of three single-phase VTs
- Requires additional LV winding on PT
### ABB AccuRange® technology

Extended range high accuracy current transformer technology

- 600 V to 34.5 kV voltage classes
- ABB was the original developer of this technology
- Accuracy of +/- 0.15% from 1% of the rated current to the rated factor
  - Exceeds the highest accuracy 0.15S IEEE accuracy class
- Increase revenue, most prominently on MV products
- Reduce part numbers and inventory, MV and LV
- Reduce meter multiplier diversity – simplify operations with less chance of billing errors
ResiVolt technology

World’s first dry-type voltage transformers designed for very fast transient (VFT) resistance

Enhanced withstand to VFT overvoltages
- Common in renewable and frequent line switching installations
- Near reclosers, solar/wind farm interconnections, etc.

Optimized using advanced mechanical and electrical modeling for field performance
- ABB testing exceeds IEC 61869-3, class 7.2.3 and CAN/CSA 411.1, class 6.6 requirements for basic impulse and fast impulse transient withstand
- Large multi-year global effort to investigate models and designs to mitigate the effects of VFT

Global ABB collaboration and collaboration with a Swiss university to create the software model which had not existed previous to this
- Multiple aspects of design changes – design details are trade secret and cannot be shared

Improved safety
- Withstand VFT without insulation degradation, reducing the chance of catastrophic failure

Unparalleled reliability
- Minimizes failures at critical interconnection or metering points

Extended factory warranty (36 months instead of normal 12/18 months) included on all ResiVolt VTs

For more information on the VFT phenomenon – contact the factory
Voltage transformer type designations that end in “R” are part of ABB’s ResiVolt product family
CVC combination ITs
Application benefits

Streamlined footprint
- Lighter weight, less complicated 3 phase installations – safer, simpler, more fool proof
- Significant operational savings
- Lightest combination units in the industry

HCEP encapsulant
- Superior to all other HCEP and CEP in market
- ABB helped invent HCEP and has a special formulation that is the best in the industry

Application variety
- Standard accuracy – metering + protection/relaying
- HAER – high accuracy on CT with extended range current capability for metering only
Sensors for utility applications
Advanced primary measurement solutions responding to emerging challenges

25+ years old technology
Use solid state components and little or no ferromagnetic material in circuit
Lack of magnetic core – very low energy output – cannot typically transfer power to secondary
Numerous form factors for indoor and outdoor applications (voltage only, current only, combination)
Wide variety of outputs – from 0-10 V, 120V and 600 A
## Sensors for utility applications

### Features

<table>
<thead>
<tr>
<th>Hybrid Rogowski coil</th>
<th>Low-power CTs</th>
<th>Resistive voltage dividers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rogowski coil with some iron in magnetic circuit</td>
<td>Current transformer based on iron core with optimized output power</td>
<td>Accurate voltage sensing provides 3-10 V or 120 V outputs</td>
</tr>
<tr>
<td>Accurate current sensing provides a 10 V output</td>
<td>1A output for real-time reading of the current wave form</td>
<td>Voltage sensing 0.5% to 1% accuracy, depending on design</td>
</tr>
<tr>
<td>Current sensing 1%-2% accuracy depending on design</td>
<td>Current sensing 1%-2% accuracy depending on design</td>
<td>Compatible with wide selection of intelligent electronic devices</td>
</tr>
<tr>
<td>Compatible with wide selection of intelligent electronic devices</td>
<td>Compatible with wide variety of controllers</td>
<td></td>
</tr>
</tbody>
</table>
Key benefits of sensors vs. traditional ITs

- **Reduced chances of failure**
  - Simpler construction, fewer internal failure points.

- **Safe**
  - Increased safety for personnel during testing/operation.

- **Easy, affordable upgrade**
  - Indoor sensors can often be retrofitted in existing structures with new relays.

- **Integration**
  - Typically no risk of ferroresonance (voltage sensor vs PT).

- **Efficient**
  - Reduced energy use, esp. in tight compartments.

- **Flexibility toward varying load**
  - Linear response, extensive dynamic range (no core saturation).

- **Simplified installations**
  - Less wiring, smaller footprint, lighter weight.

- **Standardization**
  - One sensor covers full voltage or current range of traditional IT family.
Sensors for utility applications
ABB DistribuSense® MV sensor offering

- VLS: Voltage sensor
  Voltage output
- KLS: Current sensor
  Current output
- VKS: Current sensor
  Voltage output
- VCS: Combination – voltage and current
  Voltage outputs
- WLS: Combination – voltage and current
  Current and voltage outputs
Introducing the world’s first **truly hermetically sealed**, rustproof, waterproof submersible, split core current sensor

- **True hermetic sealing** – no exposed metal parts, truly submersible without degradation

- **Low energy output** – no safety risk from open circuit

- **Voltage clipping** – output limited in faults to protect receiving device from damage, yet gives enough magnitude for fault indication

- **Crosstalk mitigation** – unique winding structure to ensure accuracy without degradation from current “cross talk” from adjacent conductors

- **Easy install** – quick “tools free” install, easy to deploy even with PPE typical in the application

**RATINGS SUMMARY**

- 600A : 10V
- Accuracy 1%
- RF 2.0 cont.
- NEMA Type 6P/IP68W compliant (2 meters depth)
- 5.5 lbs (10 lbs with 75 ft cable)
Battery Energy Storage Systems (BESS) and Battery chargers
Battery Energy Storage applications

Applications

Renewables
ESM (Energy Storage Module) aligns solar and wind generation peaks with demand peaks.

Utility distribution grid
ESM balances fluctuating demand without oversizing equipment.

Industrial loads
ESM provides back up power, improves load factor and manages demand peaks.

Residential and commercial
ESM lowers energy costs and provides backup power for critical loads.

Electrification of transportation
Reduces demand on grid and enables fast DC charging without increasing demand charges.
Battery Energy Storage Systems (BESS) components for the OEM

Sold to PCS (Power Conversion System) OEMs, BMS (Battery Management System) OEMs, EMS (Energy Management System) OEMs, ESM (Energy Storage Module) OEM’s and their distributors
Components for the Energy Storage Systems OEMs

Sold to PCS (Power Conversion System) OEMs, BMS (Battery Management System) OEMs, EMS (Energy Management System) OEMs, ESM (Energy Storage Module) OEM’s and their distributors

Selection parameters

**Battery side – DC**
- Voltage: up to 1500VDC
- Protection device*: semiconductor fuse or MCB/MCCB
- Duty: load break and short-circuit fault level/w withstand rating
- Short-circuit: fault level or withstand rating required

**DC Main disconnect/isolation**
- Voltage: up to 1500VDC
- Isolation: Disconnect switch or breaker disconnect
- Duty: load break/no-load break
- Short-circuit: fault level or withstand rating required

**AC Side**
- Voltage: up to 690VAC
- Protection device: MCCB/ACB/Fusible switches
- Duty: load break
- Short-circuit: fault level or withstand rating required
- Automatic AC or DC disconnection (optional)**

---

* Subject to high fault currents on battery type and withstand rating required (Flow: 2-5xIn, Lead-acid: >100xIn, Li-ion: 45-55xIn)

** MC: miniature circuit breaker | MCCB: molded case circuit breaker

ACB: air circuit breaker
Breaker disconnect: breaker working as a disconnect switch w/o protection
** can be accomplished with motorized devices or contactors
Battery Energy Storage System (BESS), Utility & Commercial

Sold to Utilities, Developers, Municipalities, EPCs and their distributors
Energy storage solutions
Scope of a typical energy storage module (ESM)

Enclosure options for wide array of site conditions:
- Compact secondary substation (CSS), EcoFlex eHouse or skid
- Modular design for tight or complex spaces

Productized solution for improved delivery and startup time

Proven ABB technology
- Power conversion system (PCS)
- Medium voltage/low voltage switchgear
- Transformer
- Energy Management System (EMS) and local HMI

Ratings
- Power: starting at 25kW (not residential)
- Energy: configurable by battery parallel connection
- Grid connection voltage: up to 40.5kV

Typical customer base is utilities, industrials, EV, buildings
The global need for energy storage is growing at a rapid rate driven by items such as economic growth, increasing solar and wind resources, the electrification of transportation and backup power needs. Energy storage modules (ESM) from ABB offer an integrated engineered and tested system solution for a wide variety of applications across industry, infrastructure, residential and utility sites.

Choosing ABB solutions with proven technology enables:

- **Fast project completion** - System engineering, factory system testing and reduced or eliminated site preparation costs, lowers schedule risk and improves project benefits.

- **Reliable solutions** - Internal arc tested MV equipment to IEC standards for safety, enclosure offerings for harsh environments and years of global installed base experience provide peace of mind.

- **Communication** - From local monitoring and control to dynamic optimization of resources, the platform supports a wide range of monitoring and control needs and will support advancements over the life of the equipment.
Selecting the correct energy storage solution
5 steps – major questions to consider

Step 1: Required standard?
- IEC/ANSI

Step 2: Required power and energy, and its application?
- Required power [kW]
- Required energy [kWh]
- Application (examples: load shifting, backup power, etc.)

Step 3: Network connection voltage?

Step 4: Site conditions?
- Installation in public domain
- Indoor access to equipment for maintenance
- Seismic requirement
- Transportation and site work condition
- Temperature and altitude
- All-in-one or modular type

Step 5: Control system?
- EMS (Energy Management System, which has control algorithm in ESS) without HMI (display, report, data storage)
- EMS with HMI
- External SCADA communication
- Integration with renewable or other system
## Energy Storage Module Package Selection

### Selection logic

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## Energy storage module other auxiliary selections

Overview of optional selections available for all the packages

<table>
<thead>
<tr>
<th><strong>A. Power electrical</strong></th>
<th><strong>B. Control system</strong></th>
<th><strong>C. Ancillary equipment</strong></th>
<th><strong>D. ABB Ability™</strong></th>
</tr>
</thead>
</table>
| Different electrification technologies can be selected | PLC options Comm600 controllers ZEE600 controller with the EMS | eHouse or EcoFlex:  
- Natural cooling  
- HVAC cooling  
- Fan cooling  
- Fire detection and suppression | All the packages can be ABB Ability enabled |
| **Products** | **Sample** | **Overview** | **Overview** |
| MV transformer | Oil or dry SafeRing SafePlus | ESM control system can be monitored and controlled by SCADA system for ease of interface between all the electrical equipment | Control power and battery connection panel (BCP) for protection and control |
| Low voltage | Breakers | It can then connect through existing 3G/4G broadband | UPS for protection and control power |
| Control power distribution board | Various control power | | The whole system can be monitored, controlled, and commanded from remote locations |

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# Energy storage form factor module package selection

## Enclosure type and features to consider

### Skid

- **Open air secondary skid unit** is an ideal power conversion solution system for a high-power Energy Storage Module with outdoor equipment design.

  - Pre-engineered solution reduces delivery time
  - Economical and fast installation solution
  - Pre assembled and tested single piece solution
  - Easy to install and operate

### EcoFlex container

- The **metal enclosed EcoFlex** is utilized for mid and high-power energy storage, and is a modular design, type tested to withstand internal arc according IEC 62271-202

  - Stackable, expandable ISO standard enclosures
  - Easy to ship, load and offload
  - Robust and scalable solution
  - Relocatable solution can be adapted for temporary power

### Compact secondary substation (CSS)

- **CSS** is ideal for low power Energy Storage.

  - Available in multiple materials: metal or new innovative glass reinforced polyester (GRP), and type tested to withstand internal arc according IEC 62271-202.

  - Pre engineered solution to minimize project engineering
  - Available in multiple configurations, and a variety of sizes and materials to cover all requirements
  - Simple and quick installation
  - Internally arc tested, to provide maximum safety
# Energy Storage Module Packages

## Overall offering

### Low-power offering

<table>
<thead>
<tr>
<th>ESM Type</th>
<th>Community Energy Storage (CES)</th>
<th>CES</th>
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<tbody>
<tr>
<td>Power</td>
<td>Up to 100kW</td>
<td>Up to 300kW</td>
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<tr>
<td>Energy</td>
<td>Up to 250 kWh</td>
<td>Up to 300 kWh</td>
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<tr>
<td>Enclosure type</td>
<td>Indoor panel</td>
<td>CSS</td>
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<tr>
<td>Layout</td>
<td>SLD</td>
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**Key feature**

- One-piece delivery
- Compact design, simple indoor installation
- One-piece delivery Internal arc tested for safety, metal and GRP option

### Mid-Power offering

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<th>ESM Type</th>
<th>Distribution Energy Storage (CES)</th>
<th>DES</th>
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<tr>
<td>Power</td>
<td>Up to 1.0 MW</td>
<td>Up to 1.8 MW</td>
</tr>
<tr>
<td>Energy</td>
<td>Up to 1.0 MWh</td>
<td>Up to 1.8 MWh</td>
</tr>
<tr>
<td>Enclosure type</td>
<td>CSS</td>
<td>EcoFlex</td>
</tr>
<tr>
<td>Layout</td>
<td>SLD</td>
<td></td>
</tr>
</tbody>
</table>

**Key feature**

- One-piece delivery Internal arc tested for safety, metal and GRP options
- One-piece delivery Robust for easy transportation and installation

---

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## Energy Storage Module Packages

### Overall offering

### High-power offering + complete solutions

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<th>Connection Energy Module (CEM)</th>
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<th>DES</th>
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<td>Power</td>
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<td>Up to 4.6MW</td>
<td>Up to 4.6MW</td>
<td>Up to 4.6MW</td>
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<tr>
<td>Energy</td>
<td>N/A (w/o battery)</td>
<td>N/A (w/o battery)</td>
<td>Configurable (with battery)</td>
<td>Configurable (with battery)</td>
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<td>Enclosure type</td>
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<td>Robust for easy transportation and installation</td>
<td>Scalable solution, ease of installation</td>
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<td>Internal arc tested</td>
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<td>Internal arc tested</td>
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Abbreviations:
- CEM: Connection Energy Module
- DES: Distribution Energy Storage

- Key feature: Economic solution, ease of installation
- SLD: Schematic Line Diagram
- Enclosure type: Skid, EcoFlex

Details:
- Power: Up to 4.6MW
- Energy: N/A (w/o battery), Configurable (with battery)
- Enclosure type: Skid, EcoFlex
- Key feature: Economic solution, ease of installation, internal arc tested

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<thead>
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<th>Key feature</th>
<th>Economic solution, ease of installation</th>
<th>Robust for easy transportation and installation</th>
<th>Scalable solution, ease of installation</th>
<th>Scalable solution, robust structure for easy transportation and installation</th>
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**Energy Storage Module**

Community energy storage - indoor

**Electrical specifications**

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<th>DC input</th>
<th>Description</th>
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<td>DC operating voltage range</td>
<td>Energy storage module for low voltage connection.</td>
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<tr>
<td>Max. DC operating current</td>
<td>This equipment is integrated into an enclosure suitable for use in indoor</td>
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<td>DC grounding</td>
<td>conditions including the fans, HMI, control and communication equipment for</td>
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<td></td>
<td>local and remote operation.</td>
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<tr>
<td></td>
<td><strong>AC output</strong></td>
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<tr>
<td>Output power (S)</td>
<td>High reliability with extensive risk and failure mode analysis</td>
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<tr>
<td>Output energy</td>
<td>Maximize the return of investment with pre-engineered and factory tested</td>
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<tr>
<td>Nominal voltage</td>
<td>solution.</td>
</tr>
<tr>
<td>Frequency</td>
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<tr>
<td>Power factor range</td>
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</tbody>
</table>

- **Values**
  - DC input:
    - DC operating voltage range: 633-822 V (at PF=1)
    - Max. DC operating current: 1200A
    - DC grounding: Floating only
  - AC output:
    - Output power (S): 100kVA
    - Output energy: 250kWh
    - Nominal voltage: up to 690V
    - Frequency: 50/60Hz
    - Power factor range: 4-quadrant, 0 to 1
Energy Storage Module
Community energy storage (CSS)

**Electrical specifications**

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<th>DC input</th>
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<td>DC operating voltage range</td>
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<td>Max. DC operating current</td>
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<td>DC grounding</td>
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<table>
<thead>
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<td>Output energy</td>
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<td>Nominal voltage</td>
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<td>Frequency</td>
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<td>Power factor range</td>
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**Equipment**

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**Description**

Energy storage module for low voltage connection with CSS enclosure in multiple materials with metal or new innovative glass reinforced polyester (GRP). The enclosures are designed to protect the equipment from external environmental influence and to be located in public areas. The different versions of the pre-engineered and industrialized ESM allow scalability, reduction of installation costs, high reliability and reduced project execution times.

**Values**

- Internally arc tested, and electrically compartmentalized to provide improved safety
- Available in multiple configurations, sizes and materials
- Maximize ROI with pre-engineered and factory tested solutions
- Simple and quick installation
Energy Storage Module
Distribution energy storage (DES)

**Electrical specifications**

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<tr>
<td>Nominal voltage</td>
<td>up to 40.5V</td>
</tr>
<tr>
<td>Frequency</td>
<td>50/60Hz</td>
</tr>
<tr>
<td>Power factor range</td>
<td>4-quadrant, 0 to 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Equipment</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Enclosure</td>
<td>CSS</td>
</tr>
<tr>
<td>Transformer type</td>
<td>Oil-filled, dry type</td>
</tr>
<tr>
<td>Medium voltage switchgear</td>
<td>ABB SafeRing/SafePlus</td>
</tr>
</tbody>
</table>

**Description**

Energy storage module for medium voltage connection with CSS enclosure in multiple materials with metal or new innovative glass reinforced polyester (GRP). The enclosures are designed to protect the equipment from external environmental influence and to be located in public areas. The different versions of the pre-engineered and industrialized ESM allow scalability, reduction of installation costs, high reliability and reduced project execution times.

**Values**

- Internally arc tested, and electrically compartmentalized to provide improved safety
- Available in multiple configurations, sizes and materials
- Maximize ROI with pre-engineered and factory tested solutions
- Simple and quick installation
Energy Storage Module
Distribution energy storage – EcoFlex eHouse

**Electrical specifications**

<table>
<thead>
<tr>
<th>DC input</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC operating voltage range</td>
<td>845-1096 V (at PF=1)</td>
</tr>
<tr>
<td>Max. DC operating current</td>
<td>2400A</td>
</tr>
<tr>
<td>DC grounding</td>
<td>Floating only</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AC output</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Output power (S)</td>
<td>1800kVA</td>
</tr>
<tr>
<td>Output energy</td>
<td>1800kWh</td>
</tr>
<tr>
<td>Nominal voltage</td>
<td>up to 40.5V</td>
</tr>
<tr>
<td>Frequency</td>
<td>50/60Hz</td>
</tr>
<tr>
<td>Power factor range</td>
<td>4-quadrant, 0 to 1</td>
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</tbody>
</table>

<table>
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<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Enclosure</td>
<td>EcoFlex</td>
</tr>
<tr>
<td>Transformer type</td>
<td>Oil-filled, dry type</td>
</tr>
<tr>
<td>Medium voltage switchgear</td>
<td>ABB SafeRing/SafePlus</td>
</tr>
</tbody>
</table>

**Description**

Energy storage module for medium voltage grid connection with EcoFlex enclosure. The enclosures are designed to protect the equipment from external environmental influences and to protect operation personnel. The different versions of the pre-engineered and industrialized ESM allow scalability, reduction of installation costs, high reliability and reduced project execution times.

**Values**

- Internally arc tested, and electrically compartmentalized to provide improved safety
- Maximize ROI with pre-engineered and factory tested solutions
- Easy to ship, load and offload
- Robust and scalable solution
- Relocatable solution adaptable for temporary power needs
## Energy Storage Module
Connection equipment modules with skid

### Electrical specifications

<table>
<thead>
<tr>
<th>DC input</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC operating voltage range</td>
<td>680 to 1500V (at PF=1)</td>
</tr>
<tr>
<td>Max. DC operating current</td>
<td>2400A</td>
</tr>
<tr>
<td>DC grounding</td>
<td>Floating only</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>AC output</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output power (S)</td>
<td>Up to 2300kVA</td>
</tr>
<tr>
<td>Output energy</td>
<td>N/A</td>
</tr>
<tr>
<td>Nominal voltage</td>
<td>up to 40.5V</td>
</tr>
<tr>
<td>Frequency</td>
<td>50/60Hz</td>
</tr>
<tr>
<td>Power factor range</td>
<td>4-quadrant, 0 to 1</td>
</tr>
</tbody>
</table>

### Equipment

- **Enclosure**: Skid
- **Transformer type**: Oil-filled, dry type
- **Medium voltage switchgear**
  - ABB SafeRing/SafePlus

### Description

ABB’s connection equipment module (CEM) is a packaged power conversion system for energy storage applications that performs the bidirectional AC/DC energy conversion between the grid and the battery system. The secondary skid unit is an economical way for high-power energy storage with outdoor equipment design.

### Values

- Easy to install and operate
- Optimized solution to maximize ROI
- Flexible, modular concept allows for ease of scalability
- Pre-engineered solution reduces delivery time
- Pre-assembled and tested single piece solution
## Energy Storage Module
Connection Equipment Modules with EcoFlex

### Electrical specifications

<table>
<thead>
<tr>
<th>DC input</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC operating voltage range</td>
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</tbody>
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### Equipment

<table>
<thead>
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</tr>
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<tbody>
<tr>
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</tr>
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<td>Medium voltage switchgear</td>
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</table>

### Description

ABB’s Connection Equipment Module (CEM) is a packaged power conversion system for energy storage applications that performs the bidirectional AC/DC energy conversion between the grid and the battery system. The enclosures are designed to protect the equipment from external environmental influences and operation personnel. The pre-engineered solution allows scalability, reduction of installation costs, high reliability and reduced project execution times.

### Values

- Internally arc tested, and electrically compartmentalized to provide improved safety
- Easy to ship, load and offload
- Robust and scalable solution
- Maximize ROI with pre-engineered and factory tested solutions
- Relocatable solution adaptable for temporary power needs
Energy Storage Module
Distribution energy storage – modular design

Description

ABB’s Energy Storage Module is a packaged solution that stores energy for use at a later time to maximize system efficiency. The different versions of the pre-engineered and industrialized ESM allow scalability, reduction of installation costs, high reliability and reduced project execution times. This design utilizes a Connection Equipment Module and battery modules for a complete solution.

Values

- Improved safety with arc tested equipment
- Easy to install and operate
- Maximize ROI with pre-engineered and factory tested solution
- Flexible with modular concept to allow ease of scalability in power and capacity
- High reliability with extensive risk and failure mode analysis

EcoFlex + EcoFlex

Skid + EcoFlex
Wind solution
Integrated energy storage with solar/wind generation

Customer challenges
- Solar/wind power hard to properly forecast
- Renewable generation not aligned with the demand
- Renewable mandates and incentives
- Tax benefit for storage systems

Application
- Battery energy storage system with solar/wind power generation
- Peak shaving, supplement power quality, store excess power

Value
- One-piece delivery
  - Simple installation
- Factory assembled and tested
  - Reduce site testing and commissioning.
- Safety
  - Mitigate site safety risk.
- Capacity firming
  - Increase reliability and improves efficiency of the renewable plant
- Tax and regulatory incentives
  - Potential tax benefits or incentives for clean grid technology

Typical equipment
- V switchgear
- Distribution transformer
- Renewable integration
- Local control
## Large-scale utility solution
Scalable energy storage for grid utility customer

<table>
<thead>
<tr>
<th>Customer challenges</th>
<th>Application</th>
<th>Value</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic and population growth leads to increasing demand for power</td>
<td>Scalable energy storage with modular system</td>
<td><strong>Pre-engineered solution</strong></td>
<td><img src="image1.png" alt="Pre-engineered solution" /></td>
</tr>
<tr>
<td>Coal plant retirements, reducing baseload power capacity</td>
<td><strong>Continuity and power resilience</strong></td>
<td><strong>Schedule improvement</strong></td>
<td><img src="image2.png" alt="Pre-engineered solution" /></td>
</tr>
<tr>
<td>Growth in renewables, reducing reliability on the electrical grid</td>
<td></td>
<td><strong>Modular design</strong></td>
<td><img src="image3.png" alt="Pre-engineered solution" /></td>
</tr>
<tr>
<td>New power generation plant costs too much and takes long time</td>
<td></td>
<td><strong>Transportation</strong></td>
<td><img src="image4.png" alt="Pre-engineered solution" /></td>
</tr>
<tr>
<td>Economic power generation by load leveling</td>
<td></td>
<td><strong>Robust structure (EcoFlex)</strong></td>
<td><img src="image5.png" alt="Pre-engineered solution" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Factory assembled and tested</strong></td>
<td><img src="image6.png" alt="Pre-engineered solution" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Reduce site commissioning</strong></td>
<td><img src="image7.png" alt="Pre-engineered solution" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Safety</strong></td>
<td><img src="image8.png" alt="Pre-engineered solution" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Mitigate site safety risks</strong></td>
<td><img src="image9.png" alt="Pre-engineered solution" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Frequency regulation</strong></td>
<td><img src="image10.png" alt="Pre-engineered solution" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Increases reliable operation</strong></td>
<td><img src="image11.png" alt="Pre-engineered solution" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Load leveling</strong></td>
<td><img src="image12.png" alt="Pre-engineered solution" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Postpone investments in grid</strong></td>
<td><img src="image13.png" alt="Pre-engineered solution" /></td>
</tr>
<tr>
<td>Trustworthy partner</td>
<td>Maximize the return of investment</td>
<td>High reliability</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------------------------</td>
<td>-----------------</td>
<td></td>
</tr>
<tr>
<td>World leader in digital industries to serve customers</td>
<td>Pre-engineered and industrialized products with reduced project engineering</td>
<td>Protected equipment from environmental influences</td>
<td></td>
</tr>
<tr>
<td>Pioneering technology leader focused on digital industries</td>
<td>Reduced installation and transportation costs</td>
<td>Factory tested solution</td>
<td></td>
</tr>
<tr>
<td>Strong global team</td>
<td>Maximized uptimes due to factory assembled and tested solutions</td>
<td>Designed to withstand severe environmental conditions</td>
<td></td>
</tr>
</tbody>
</table>

- Undergone extensive risk and failure mode analysis
- Advanced and efficient temperature control provided for the inverter and battery system.
- IEC compliant
Why choose ABB for your energy storage solution needs

Value proposition

**Flexible**

- Modular concept to allow ease of scalability in power and capacity
- From low-voltage to a wide range of AC medium-voltage levels
- Engineered footprint to optimize customer’s requests
- Different options of MV switchgear from ABB’s SF6 gas-insulated secondary switchgear portfolio (also available with air-insulated switchgear)
- Performs all energy storage applications in given power range

**Safe and easy to install and operate**

- Internally arc tested for public and service personnel
- No live parts accessible
- Locking system for all enclosure doors prevents unauthorized entry of personnel
- Local and remote monitoring and control, easy integration to customer SCADA and ABB Ability™
- Ease of transportation due to standardize solutions
- Pre-assembled and tested at ABB premises to reduce on-site times
Industrial and utility products: switchgear battery chargers

Integritas wall chargers

- Large capacity (20-150A), small footprint
- Modular with hot-swappable rectifiers
- Only 3 Phase 480V wall mounted charger in industry
- Markets:
  - Utility substation and switchgear control-renewables
  - Pumping station and motor operation

Integritas floor chargers

- Large capacity (20-800A), small footprint
- Configurable distribution
- Modular with hot-swappable rectifiers
- Markets:
  - Utility substation and switchgear control-renewables
  - Heavy industrial, marine, off-shore
  - Power generation and distribution

Infinity industrial

- Configurable communication DC system
- Configurable distribution
- Modular with hot-swappable rectifiers
- Markets:
  - Utility communication systems-renewables
  - Power generation control power
  - Oil and gas communication and control
## Wall mounted battery chargers

### General features / options
- Modular design for easy upgrade and maintainability
- Advanced controller with secure protocols (SNMPv3, HTTPS, SSL, SSH), MODBUS, IPv6, NERC compliance with full remote access. DNP3 and IEC61850 options.
- Input and output surge protection and ground fault detection
- -40°C to 75°C operation

### Single phase chargers (infinity based)
- Modular rectifier constructions
- Nominal input: 120 – 277 VAC
- Input AC type: 1F, 3F unbalanced Delta (3PH,G) or WYE (3PH,N,G)
- Outputs:
  - 24V: 21 – 29VDC; 100A modules
  - 48V: 42 – 58VDC; 50A modules
  - 125V: 95 – 160VDC; 20A modules

### True three-phase chargers (GP based)
- Modular rectifier constructions
- Input Voltage: 380 – 480 VAC
- 3F Delta (3W+G)
- Outputs:
  - 24V: 21 – 29VDC; 100A modules
  - 48V: 42 – 58VDC; 100A modules
  - 125V: 95 – 160VDC; 50A modules
  - 250V: 180 – 290VDC; 25A modules

### Info
- Dimensions and mounting
  - H: 28.25” (718mm) W: 17.5 – 23” (356 - 584mm) D: 14” (356mm)
  - Reversible mounting brackets for wall or rack mount
- Battery support / monitoring
  - Complete suite for capacity and battery health testing
  - VRLA, lead calcium and NiCad support
Floor mounted battery chargers

General features and options:
- Modular design for ease upgrade and maintainability
- Multi-voltage operation to support controls, fire systems and equipment drives
- Designated advanced controller with secure protocols (SNMPv3, HTTPS, SSL, SSH), MODBUS, IPv6, NERC compliance with full remote access per Charger Group
- Sectionalized input surge protection with AC breakers
- Output distributions with surge protection and ground fault detection
- Remote and local emergency shutdown
- -40°C to 75°C operation

Outputs and capacities:
- Each 1RU shelf can provide the following output capacity:
  - 24V – 300A
  - 48V – 150 to 225A
  - 125V – 60A
- Sample P&W LM6000: two independent 24V systems with 600A capacity and one 125V system (5 shelves) with 375A capacity.
- Configurable output distribution with up to 12 breaker outputs per row of distribution

Configurable parameters:
- Input and output voltages
- Output capacity and type
- Battery connectivity
- Output distribution for field configurations
- Motor starter
- Input transformer for wider range operation
Infinity-S dual voltage

Features:
- Low cost
- High density
  - -48V 800A +300A +24V
  - +24V 800A +240A -48V
- Flexible distribution – 1 or 2 panels, 26 selectable voltage positions each
- Flexible growth scenarios
- Universal power shelf
- High efficiency
- ECO priority ready
- Advanced controller features

Rectifiers:
- NE050AC48TEZ – 50A, 48V
- NE100AC24TEZ – 100A, 24V
- 96-97% efficiency

Converters:
- NE030DC48 – 30A, 48V
- NE075DC24 0 75A, 24V
Solar plant construction and connection components
Sold to Solar distributors, installers and contractors
Utility applications: power-plant products

Construction and connection components:

**Grounding systems**

**Solar panel-installation products**

**Nylon Conduits and fittings**

**Solar clips**

**Cable ties UV rated**
Conduit and piping

- P&C flex
- Fittings
- Elbows
- Straight pipes
Conduit and piping continued
Carlon PVC Products

- Straight pipes
- P&C flex conduits
- Fittings
- Elbows
- Junction boxes
- PVC cement
Lugs and wire termination

Lugs and wire termination

- Color-Keyed® Connectors for Aluminum/Copper Code Conductor
  - Designed and Approved for Use with Either Aluminum or Copper Conductors
  - Temperature rating of 90°C
  - Filled with oxide-inhibitor compound
  - Rated for 600V to 35kV applications
  - Material: High-conductivity wrought aluminum
  - Finish: Electro-plated tin

- Color-Keyed® Connectors for Copper Code Conductor
  - Designed and Approved for Use with Copper Conductors
  - Rated for 600V to 35kV applications
  - UL® Listed for flex strandings
  - Color coded to help installer select the proper application dies
  - Material: High-conductivity wrought copper
  - Finish: Electro-plated tin

**Color-Keyed Battery Smart Tool Dieless Crimper**

- Dieless Crimper
- #8-750kcmil
- (2) Milwaukee Tool batteries
- 30% faster than previous model
Utility applications: power-plant products

Construction, connection and protection components

**Construction Solutions**
- Blackburn: ground connectors and lugs
- Joslyn: MV capacitor switches, 15-38KV
- Fisher Pierce: indicators, sensors and controls
- Kindorf: cobra clamp, metal framing and strut
- PMA: fittings, conduits and strain relief
- Elastimold: MV connectors
- Elastimold: MV surge arrestors
- Elastimold: MV overhead terminations
- Elastimold: MV multi-point junctions
- Elastimold: MV molded vacuum interrupters
- Ocal: conduit; straight, elbows
- OPR: external lightning protection
- Kindorf: strut and pre-engineered framing
- Hi-Tech: MV current limiting fuses, 15KV, 35KV
- Joslyn: lightning and surge protection
ABB in the growing renewables market – Solar & Battery Energy Storage
Solutions Low to Medium Voltage- Products, systems, software and services

Allen Austin
Sr. Market Development Manager-Americas
Renewable Energy & Power Generation
Electrification business

ABB Inc.
3645 Marketplace Blvd. Suite 130-153
Atlanta, GA 30344(USA)
Phone: +1 940 235 2407
E-Mail: allen.austin@us.abb.com
Website: www.abb.com/solar

Customer Service: 1 888-862-3290
Email: abb.support@tnb.com
Technical Support: 1 888-385-1221
Email: eppc.support@us.abb.com
Additional technical slides
## What you must know
Minimum information when specifying ITs

<table>
<thead>
<tr>
<th><strong>Basic information</strong></th>
<th><strong>... specifically for CTs</strong></th>
<th><strong>... specifically for VTs</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor or outdoor use</td>
<td>Primary current, taps if applicable</td>
<td>Primary voltage, taps if applicable</td>
</tr>
<tr>
<td>System voltage and BIL</td>
<td>Secondary current, taps if applicable</td>
<td>Secondary voltage, taps if applicable</td>
</tr>
<tr>
<td>Metering class and rated burden</td>
<td>Window, bar, or wound primary type</td>
<td>L-L or L-G connected</td>
</tr>
<tr>
<td>Protection/relay class</td>
<td>Gapped core, remanence control</td>
<td>Primary fuses</td>
</tr>
<tr>
<td>Frequency (if other than 60 Hz)</td>
<td>Continuous current rating factor (RF)</td>
<td>Thermal capacity – VA (for light power use)</td>
</tr>
<tr>
<td>Operating ambient temperature (if other than 30°C)</td>
<td>Short-time thermal and mechanical ratings</td>
<td>Over-voltage ratings, continuous and short-time duty, IEEE Group class</td>
</tr>
<tr>
<td>Mounting orientation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
IT product lines for utility applications
LV applications (600 V)

600 V metering
- Current and voltage transformers
- Encapsulated in thermoplastic rubber (TPR)
- Available in current and voltage designs
- Used for secondary revenue metering
- AccuRange high accuracy extended range (HAER) CTs

600 V plastic case ITs
- Offered in a variety of internal window diameter sizes
- Used in switchgear and outdoor vacuum breaker applications (R-Mag)
IT product lines for utility applications

MV applications (5 – 34.5 kV)

Outdoor medium voltage

- Utilized in utility substations
  - Designed for metering and relaying on outdoor circuits
- Materials
  - HCEP (hydrophobic cycloaliphatic epoxy)
  - PUR (polyurethane)
- AccuRange® high accuracy extended range (HAER) CTs
- ResiVolt™ VFT resistant VTs
- Combination CT/VT ITs
- Station post CTs
IT product lines for utility applications

Station post CTs – metering and protection

LG and LGX
- 15 – 34.5 kV, 110 – 200 kV BIL
- Window (4.5-8.75” ID) and bar type designs
- Metering accy 0.3 & 0.15S (AccuRange CT), relaying to C800
- CEP tube

KOTD-110, -150, -200
- 15 – 34.5 kV, 110 – 200 kV BIL
- Window (4-5” ID) and bar type designs
- Metering accy 0.3, relaying to C800

KOT-60, -75, -11, -15
- 15 – 34.5 kV, 110 – 200 kV BIL
- Window (3.25” ID) and bar type designs
- Metering accy 0.3, relaying to C200

Marketing message
- Optimizing pricing to promote business across station post CT product family
- Working to develop better selection guide for these ITs
IT product lines for utility applications
MV and HV applications

**Bushing current transformers (indoor)**
- Ring-type current transformers
- Polyester or cotton tape wrap
- Typical applications include high voltage circuit breakers and power transformers

**Bushing current transformers (outdoor)**
- Urethane insulation
- Basic impulse level: 0.6 kV
- 15 kV – 765 kV Application:
  - Slips over the primary bushing of power transformers and oil-filled breakers
  - Substation metering and protection
IT product lines for utility applications

Generator applications

Generator CTs – metering and protection

- Indoor and outdoor
- Board mounted (155°C insulation, up to 32” ID) and resin cast (130°C insulation, up to 51” ID)
- Basic impulse level: 0.6 kV
- Extensive product offering of proven designs with decades of field experience
- Durable design against water intrusion and vibration
- Highly customizable
- Application:
  - Mounted over generator bushing
  - 2000 amperes to 50,000 amperes
  - Proprietary shield windings to prevent stray flux interference
  - IEEE/IEC designs sold worldwide
**IT product lines for utility applications**

Split core, retrofit applications

**Split-core CTs – monitoring, metering and protection**

- Metering accuracy to 0.3 class
- Relaying accuracy to C800
- Convenient mounting around primaries which cannot be opened
  - Common for retrofit solutions
- SP window sizes up to 41"
- CO window sizes of 2½", 5½", 9", sq. (custom sizes available)

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IT product lines for utility applications
Submersible VTs

**VIL-95/95S and VIL-12/12S – control power, relaying, or metering applications.**

- Indoor VT for use in a subsurface installation
- VIL-95/12
  - Designed with secondary junction box for intermittent submersible operation where VTs are not permanently submerged under water
- VIL-95/12
  - Designed with secondary wires directly encapsulated into the polyurethane for a water-tight connection allowing installation where they are permanently submerged
- Uses dead-front elbow connectors for primary
ABB AccuRange technology
Extended range high accuracy current transformer technology

Excellent linearity over wide dynamic range

Field study of ABB Pinetops, NC facility

How it works – increase current flowing into the meter
Benefits – more current leads to increased revenue

<table>
<thead>
<tr>
<th>CT Type</th>
<th>KWH</th>
<th>% improvement</th>
<th>Add'l revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>High accuracy</td>
<td>8,384,070</td>
<td>0.82%</td>
<td>$8,404</td>
</tr>
<tr>
<td>Standard accuracy</td>
<td>8,315,880</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$8,400 in additional annual revenue for a minor increase in CT selling price – use this in value added selling
Primary metering units
Pre-configured and flexible options

5 – 34.5 kV, 60 – 200 kV BIL
Pre-configured configurations available
- Three-phase, four-wire (3CTs & 3VTs, or 3CTs & 2VTs)
- Three-phase, three-wire (2CTs & 2VTs)

Other configurations available upon request, can also include sensors
Any CT/VTs can be used
Pole-mount or padmount cabinet options are available
- Both are growing areas of interest in the market and we are continuing to expand our portfolio
Sensor challenges

Cabling
- May be sensitive to magnetic fields
- May be sensitive to magnetic fields
- Sensor and cable impedance must be matched (less sensitive at high ratio, LEA output voltages)
- Current cross talk and line sag may affect accuracy
- Percentage error still not comparable to traditional ITs
- Lack of power transfer to secondary to power devices
- Secondary devices such as relays, controllers and other IEDs must be connected to an external power supply
- Linearity is much better, but correction factors must be used to improve accuracy
- Standards exist in Europe (added to IT standards) but are limited in N. America
- No standard for “burden” – using impedance values (e.g., 1 M-ohm) vs. VA ratings as with traditional ITs
- Lack of standardization in IEEE
- Standards exist in Europe (added to IT standards) but are limited in N. America
- Limited selection today of meters and relays compatible with sensors
- Limited selection today of meters and relays compatible with sensors
- General understanding of sensors is less as opposed to ITs
- To ensure accurate measurement and proper performance, the sensor and IED must be compatible.
- To ensure accurate measurement and proper performance, the sensor and IED must be compatible.
- Contact the manufacturer or sales representative to ensure sensor compatibility.
- Contact the manufacturer or sales representative to ensure sensor compatibility.
- Varied output and current voltage levels
- Varied output and current voltage levels
Sensors
Standards for ANSI markets

ITs are primarily covered by IEEE C57.13-2016; this standard does not cover sensors

IEEE standards / guides for current & voltage sensors

- IEEE PSIM Working Group formed recently to work on an IEEE Guide that will be focus on testing of end-to-end sensor systems
- IEEE C37.92-2005 - Standard for Analog Inputs to Protective Relays From Electronic Voltage and Current Transducers
- Recent switchgear standards (IEEE C37.20.2-2015) explicitly address the use of current and voltage sensors

However, this should not limit your applications

- IEC standards cover sensor physical device characteristics and is likely to be referenced in forthcoming IEEE guides

<table>
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<tr>
<th>Current sensors</th>
<th>Voltage sensors</th>
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VLS – voltage sensor
15kV, 25kV and 34.5kV

Weight:
- 15kV: 10 pounds
- 25kV: 15 pounds
- 34.5kV: 21 pounds

Installs live
Lightweight, simple retrofit
3-10V or 120V output
1% accuracy

Used for
FDIR – reclosers/distribution switches
VVO/VVC/CVR – capacitor banks
Outage management – padmount switchgear
VCS-110 current and voltage combination sensor

15kV

- Voltage sensing 1% accuracy, <1.5° phase error
- Current sensing 1% accuracy, <1° phase error with LEA output
- Weight: 35 pounds
- Line sag and current crosstalk immune
- 120V or 3-10V output for voltage
- 10V output @ 600A current (Includes voltage clipping to protect controller)
- Acts as a line post insulator, allowing for easy installation without primary taps or cutting the line
- Options with fault current measurement to 12kA and improved harmonic response to 33rd harmonic
- Primary cable capture feature – “V design” is easier to install the cable
- Larger creep than competitive designs for this voltage class
- ABB assisted in development of HCEP with Huntsman and has the longest experience in the industry with this material

Combo sensor

Used for

- FDIR (fault detection, isolation and recovery)
- VVO/CVR – capacitor banks, independent feeder monitoring, distribution switches

VKS-110 is the current only equivalent of VCS

25 kV, 34.5 kV – planned