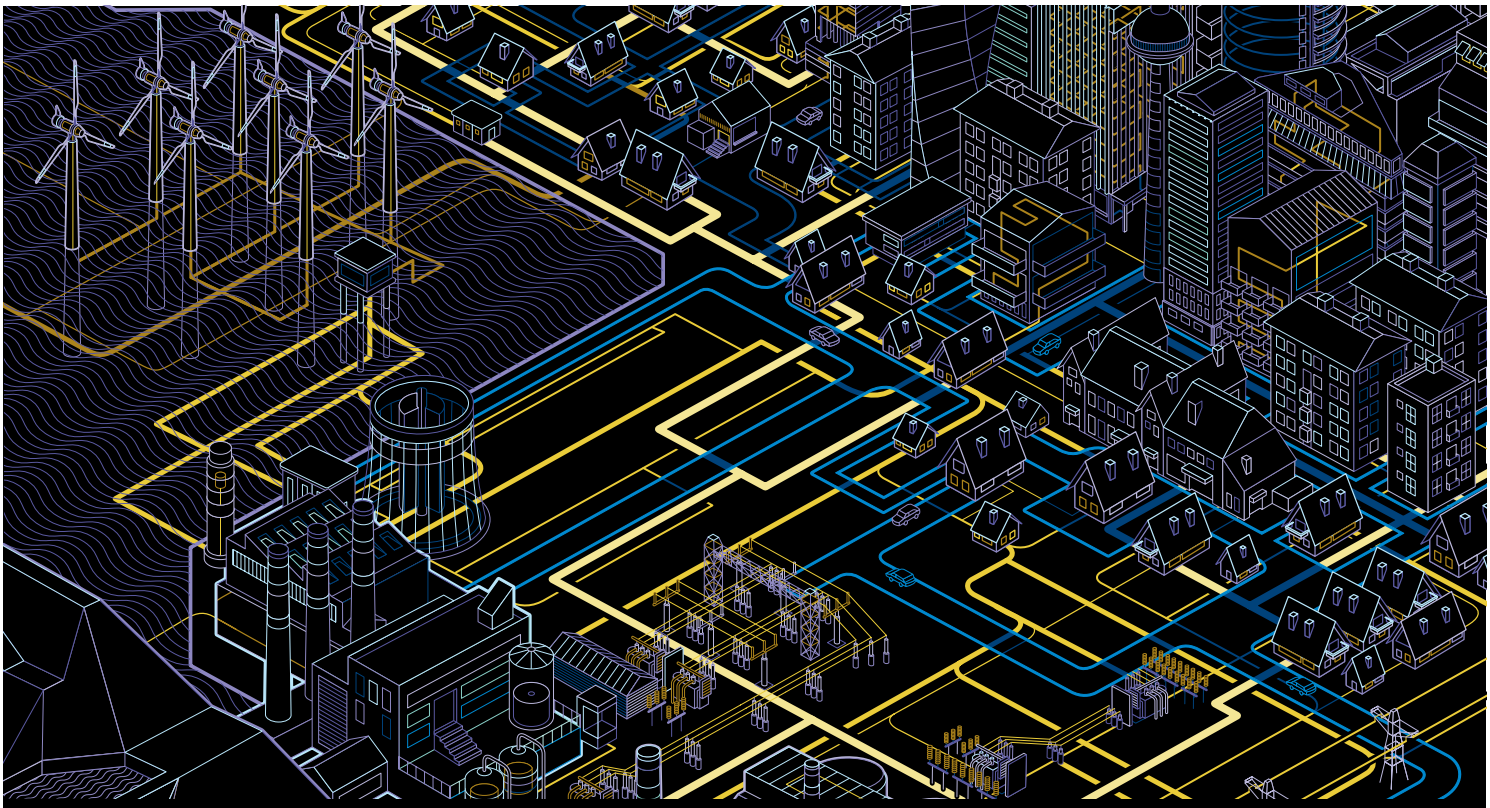


Product brochure

Energy Storage Inverters
Enhancing power quality and energy efficiency

Power and productivity
for a better world™

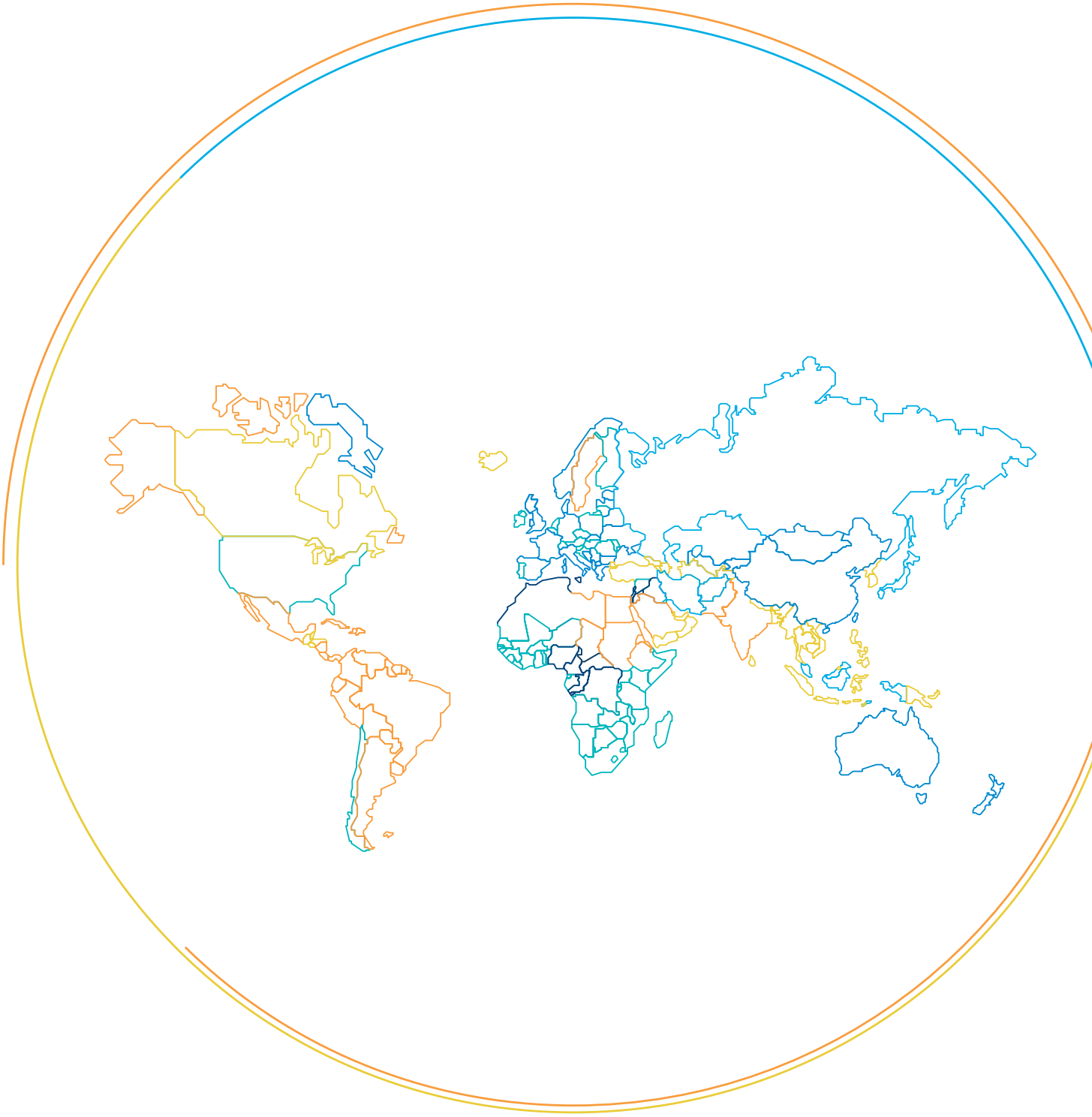


ABB delivers the complete value chain in low, medium and high voltage technologies for electrical power transmission, distribution and usage. The comprehensive range of products help enhance safety, reliability and efficiency of power networks. Our technology leadership continues to facilitate developments in areas such as ultra-high-voltage power transmission, enabling smart grids and enhancing eco-efficiency. With a large network of factories and service centers across the world offering life-cycle support, ABB remains a technology leader in the market for power grids.

Power Quality is a major concern for utilities, industries, transport and infrastructure sectors. It affects grid reliability, productivity, leads to higher operating costs and penalties for non-compliance. ABB is a pioneer in power quality solutions and offers a wide product portfolio that helps enhance the power quality of electrical networks in high, medium and low-voltage systems. These products and solutions help improve reliability and availability of power in the supply network, ensure

ABB is a leading global technology company in power and automation that enables utility, industry, and transport and infrastructure customers to improve their performance while lowering environmental impact. The ABB Group of companies operates in roughly 100 countries and employs about 135,000 people.

energy efficiency, industrial productivity and lower carbon emissions thereby leading to stronger, smarter and greener power networks.

The ever growing demand of electrical power is resulting in a complex network of generation and distribution network. In order to operate such a complex network with highest reliability and availability, the gap between the supply and demand of electrical energy must be minimized all the time. ABB's Energy Storage Inverter (ESI) plays a vital role in enhancing the performance of the electrical network.

Application in all areas of the power chain

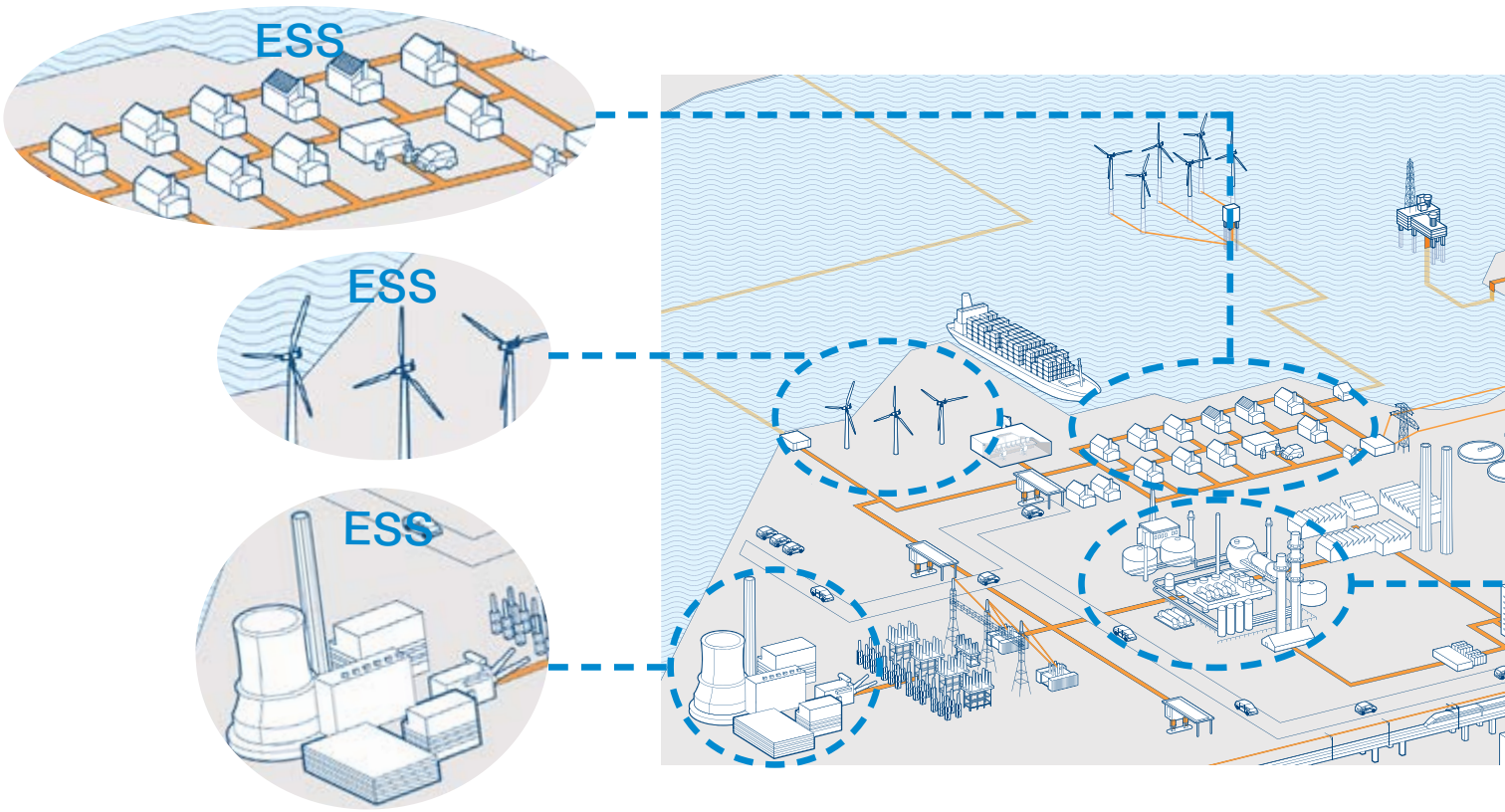
An energy storage system (ESS) is formed of several components like battery, inverter, controller etc. and are available in various forms like hydro, thermal and electrical which has the best “round trip” efficiency. The energy is stored as charge on a storage device such as battery or supercap and requires a bidirectional inverter which can easily convert the power from AC to DC for storage and vice versa for reuse in the distribution system. ABB’s ESI range of inverters are best suitable for such applications as well as offer several other benefits and features.

Maintaining voltage and frequency

With high capacity battery storage system becoming commercially viable, the network operators can rely on battery energy storage systems (BESS) to provide a fast support of electrical energy. By quickly bridging the gap between the demand and supply of electrical power, an energy storage system (ESS) helps in maintaining the grid frequency and voltages within acceptable limits. ABB’s energy storage inverter (ESI) offers several benefits which makes it the right choice for such application.

Integration of renewable energy in the grid system

Unpredictability is one of the key drawbacks associated with the green energy sources as such as wind and solar plants. A large renewable energy source imposes additional burden on the network operators due to its unpredictable behavior. An ESS can minimize the impact of renewables on the network by offering a “buffer” which can absorb excess power and release the same when the output from these sources fall short.



Peak shaving for commercial and residential loads

The energy consumption pattern in the commercial and residential sectors follows a cycle of peak and low load conditions. Peak load periods coinciding for several consumers can lead to a shortage of power from the supply utilities. This may result in temporary overloading of the network and even lead to tripping of some sensitive loads. ESS is used for peak demand shaving, resulting in a uniform load distribution around the complete load cycle. It saves penalty for the consumer by reducing their peak load demand and helps the utilities as they see a more uniform load distribution throughout the load cycle. Additionally ABB's ESI offers power quality features which are much needed for commercial and residential loads for harmonic filtering and load balancing. When the inverter resource is free, it makes valuable contribution by improving power quality of the network.

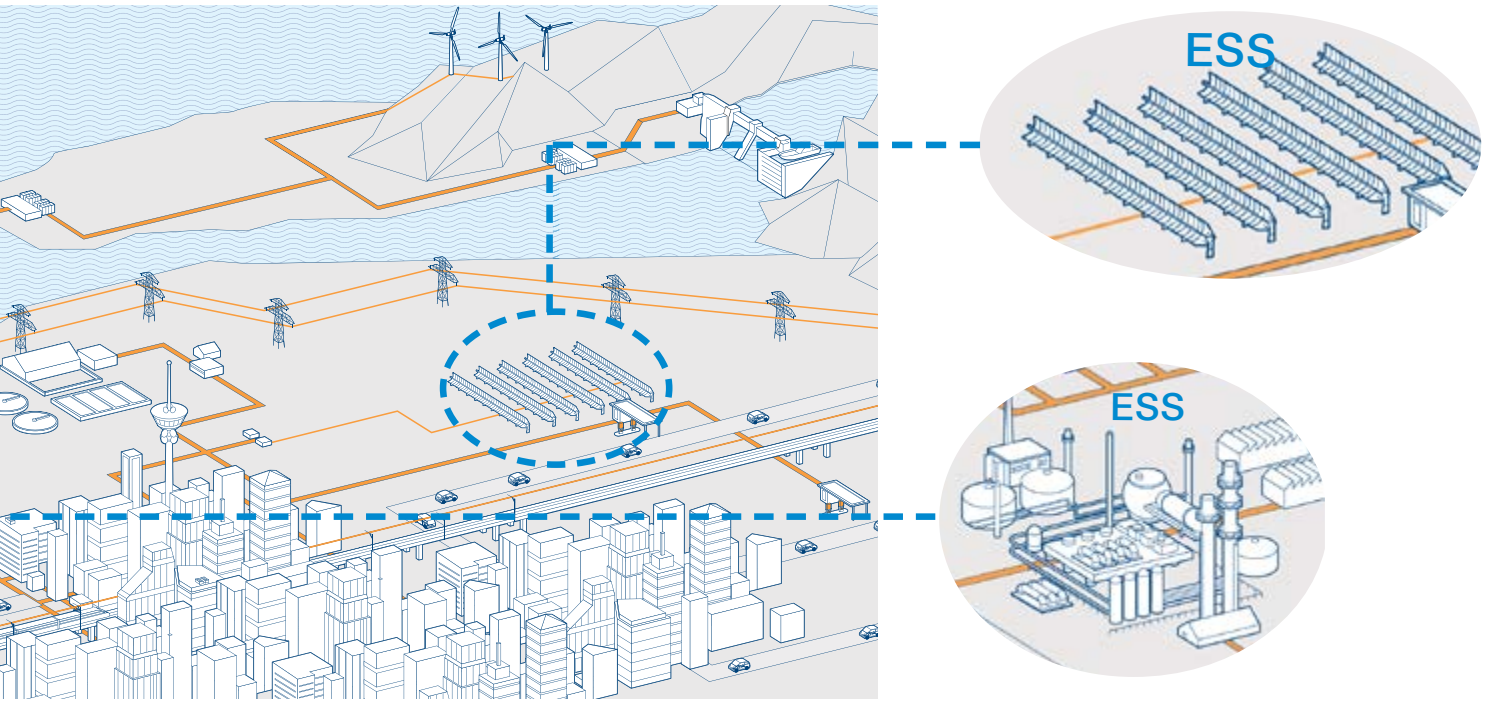
Renewable energy time shift

Solar energy, which is best form of renewable with least impact on the environment, is available only during the day time. An ESS is used to store the harvested energy in the battery and release it later, when required, thus creating a "time shift" in the availability of natural resources. This greatly helps the load centers located in remote places without any connection to the utility power network. Ability to work in islanding mode make ABB's ESI range of inverters ideal for remote areas or in those locations where there the network power interruptions are common.

Islanding operation

Occasionally, we need uninterrupted power supply for sensitive loads such as data centers etc. An energy storage system with ABB's ESI inverters can easily meet the needs of such demanding loads, thanks to its capability of operating in islanding mode as well as black start features.

Energy Storage Inverter from ABB is an ideal solution for system integrators



Exploring new possibilities with ABB's ESI

Enhancing power quality of the network

ABB's ESI range of inverters add much more value to any energy storage system. Packed with powerful features to enhance power quality issues such as harmonic mitigation, load balancing and reactive power compensation, the ESS with ABB's ESI doubles up as a much needed power quality improvement device in the electrical network. During off peak conditions, the user can utilize the resources of the ESS to enhance the power quality of their system resulting in improved operating efficiency for the loads as well as the complete electrical network.

Active Harmonic Filtering through ABB's ESI

Most of the loads, industrial or commercial, are non-linear in nature. It means, while they efficiently utilize the electrical energy, they draw the load current which is not pure sinusoidal. These load currents are highly distorted or, in other words, are rich in harmonics. The problems created by high harmonics include tripping of breakers, blowing of fuses, overheating due to excess losses in cables, transformers etc. These problems are not only technical in nature but result in severe financial losses as well. Hence filtering of harmonics gets top priority where power quality improvement is needed. Our energy storage inverters double up as an active harmonic filtering device and provide additional advantage to the users as an excellent power quality enhancement device.

Load balancing and reactive power compensation through ABB's ESI

Need for reactive power compensation is well known. Higher power factor reduces burden on the electricity supply network, reduces losses in the system, and avoids penalties imposed by utilities due to lower PF. As a top class power quality improvement device, our ESI is able to perform the crucial task of power factor improvement as well as load balancing. Unbalance in load is quite prevalent where a lot of single phase loads are used. Commercial loads such as offices, hospitals, shopping plaza, banks and other buildings fall under this category. By performing load balancing, the current in the neutral conductor is reduced. Also, the negative sequence current arising due to unbalance load which results in additional losses in the system and overheating of generators are reduced by balancing the loads.

ABB's ESI range of Energy Storage Inverters offers a complete package for your energy storage as well power quality solution requirements.

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Energy Storage Inverters from ABB

One stop solution for your energy storage needs and power quality problems

ABB's ESI are available for a wide range of power and battery voltage control. Charging and discharging the batteries with precision control is the key feature of our inverters.

Some important benefits for system integrators are:

Flexibility

– The ESI can be controlled by a wide range of controllers. It communicates through the Modbus RTU/ Modbus TCP-IP protocol. Any controller supporting this protocol can be integrated with it.
– The ESI range is suitable to work with a wide range of battery technology such as Li-Ion, Na-S to name a few.
– The ESI can work with Super-caps and any similar electrical energy storage device.

Unique power quality functionalities

– Load balancing in both 3 and 4-wire systems
– Designed to control power (P & Q) individually in each phase
– Unprecedented harmonic filtering efficiency (>97%)
– Reactive power compensation of both inductive and capacitive loads

Flexible communication platform

– Customer's algorithm can be embedded in our control system
– Better lifecycle: the software upgrade and the battery replacement can be managed by system integrators

Small footprint to a compact design

– High power density needs smaller footprint. Useful for applications where space availability is limited

Individual control of power in each phase

– ABB's ESI-S range of inverters when operating in 4-wire mode offer possibility to control power in each phase individually

Maintenance & service for the end users

For a system integrator, ABB's ESI offer the possibility to have a service agreement with the end users of the ESS. Ease of maintenance, availability of software to upgrade the firmware at site, easy diagnostic tools are some of the advantages which come with the inverters. These features of ABB's ESI enable long term business association for the system integrator with the end user.

Energy storage inverter

Modular design with redundancy

ESI inverter is a modular design. Up to 8 inverters can be connected together for a large range of power. Furthermore redundancy functionnality provides highest level of availability.

Proven and reliable inverter technology

ABB is a world leader in inverter technology. Based on our experience of PQF power quality filters, we propose a proven and reliable design for energy storage applications.

Product features

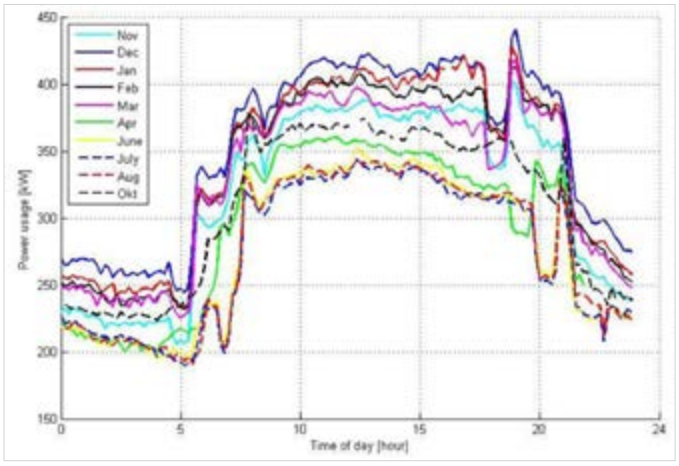
– Allows a range of energy storage devices to be coupled to the grids
– Dynamic power control (P) and dynamic reactive power control (Q)
– Harmonic mitigation
– Load balancing
– Islanding mode
– Black start
– Low Voltage Ride Through (LVRT)
– CAN communication
– Modbus RTU & Modbus TCP/IP
– Ethernet communication
– 1-Ph or 3-Ph system (with our without neutral)
– 1-Ph system with DC to DC conversion

The ESI-Manager: user friendly graphical user interface

The ESI-Manager is a touch screen, user interface which allows the user full access to the inverter parameters. It can be used to consult and set parameters. It can communicate with customer's controller through Modbus RTU as well as Modbus TCP/IP protocol. It has limited control feature built in as well which can be used effectively for peak load shaving or similar application. It is possible to communicate with BMS through CAN bus protocol directly through the main control board of the ESI.

Case study

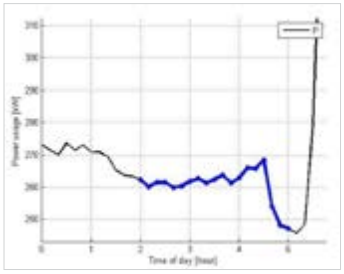
Energy Storage Systems find many applications in the present day power system. One of the most common applications for a mid-size ESS is to provide the necessary power during peak load demand period. Typically in a residential or commercial load center, the load peaks during certain period of the day and results in overloading of resources (generation, transmission and distribution system). Sometimes it may even lead to load shedding i.e. disconnection of non-essential loads during this period. The ESI range has built-in control system to cater for such requirements typically known as "peak shaving" features. The inverter discharges the battery during the peak load conditions thus providing the much needed power to the load and saves the network from getting overloaded. The peak shaving feature thereby avoids load shedding to take place.



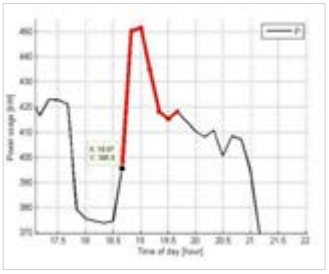
Yearly load profile

Load profile and customer's requirement

In one such installation, analyses at the site shows that the load cycle follows a fixed pattern, the lowest demand being during the early hours (2:0 AM till 5:00 AM) and a distinct peak in the evening which varied with the time of the year. The peak was found to be near 19:30 Hrs in the winter and approx. 20:30 Hrs during summer time.



Charging period for BESS



Discharging period for BESS

The typical charging period was selected to be between 2:00 Hrs till 5:00 Hrs when the load is minimum. The charging was decided to be at the rate of approximately 25kW. As the peak load occurs at different time during winter and summer, an external PLC based controller is programmed to change the discharge cycle time based on the time of the year.

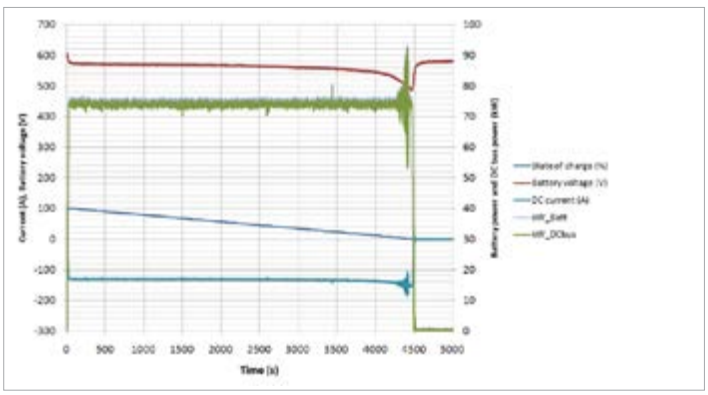
Performance of ESI

The ESS mentioned above was installed in a containerized substation, specially designed for the purpose. Taking into consideration the capacity of the battery and the inverter capacity, the system was designed to provide 75kWh of energy. When discharged at a controlled rate of 75 kW, the ESS was found to operate satisfactorily for longer than an hour.

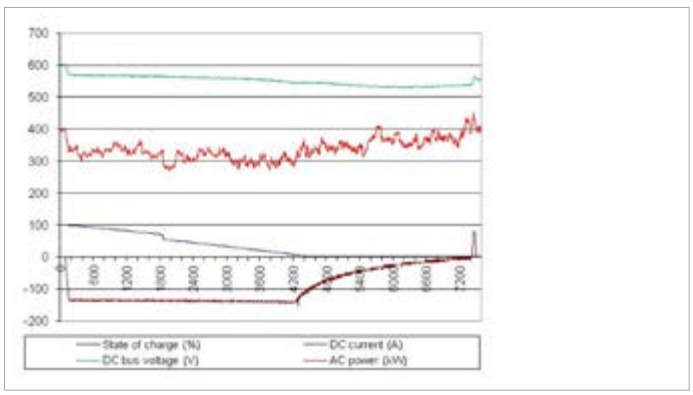
Also, at the site, when the AC power at the mains incomer were measured, it was found that during the active discharge period the total power drawn was lowered by similar level. After one hour of discharge operation the state of charge diminishes close to zero level, the battery current reduces and the power drawn from the network gradually increases.

The ESI range of inverters can also be used for harmonic filtering, reactive power compensation and load balancing, apart from its main task of managing the demand side of the load.

Battery power output under controlled discharge



BESS current and AC power from network



ABB’s commitment

Quality assurance

We are committed to provide the best products and services. Our products comply with or exceed the latest international standards. In addition to type tests in independent laboratories, our certified design and manufacturing process guarantee the highest quality.

Our products are type tested according to international standards:

- IEC 61439-1 (General Construction)
- IEC 61000-6-2 (EMC Immunity)
- IEC 61000-6-4 (EMC Emmission)

Sustainability

For ABB, sustainability is about balancing economic success, environmental stewardship and social progress to benefit all our stakeholders.Sustainability considerations cover how we design and manufacture products, what we offer customers, how we engage suppliers, how we assess risks and opportunities, and how we behave in communities where we operate and towards one another, while striving to ensure the health, security and safety of our employees, contractors and others affected by our activities. In line with our business practices, we publish environmental product declarations for each product we manufacture.

Technical specifications

Model	ESI-I	ESI-M	ESI-S
Ratings			
Maximum power at 400V_{AC} (3-phase)	Up to 315 kW in one unit	Up to 100 kW in one unit	Up to 85 kW in one unit
Battery voltage range	V1: 585-830 V_{DC} at 400 V_{AC} V2: 720-1200 V_{DC} at 480 V_{AC}	V1: 585-830 V_{DC} at 400 V_{AC}	V1: 585-830 V_{DC} at 400 V_{AC} (3-phase) 120-830 V_{DC} at 240 V_{AC} (single-phase)
Electrical characteristics			
Connection method	3-phase	3-phase	3-phase/3-phase + neutral/ single-phase
Inverter Range	V1: 725 V_{DC} (585 V - 830 V) 400 V_{AC} (380 V - 415 V) V2: 850 V_{DC} (720 V - 1200 V) 480 V_{AC} (440 V - 480 V)	V1: 725 V_{DC} (585 V - 830 V) 400 V_{AC} (380 V - 415 V) V2: 850 V_{DC} (720 V - 1200 V) 480 V_{AC} (440 V - 480 V)	725 V_{DC} (585 V - 830 V) 400 V_{AC} (380 V - 415 V) Please consult us for single-phase inverter power.
Network frequency	50 Hz/60 Hz - +/- 5%		
AC Power per inverter (kW)	V1: 200 kW, 315 kW V2: 150 kW, 270 kW	V1: 50 kW, 70 kW, 90 kW, 100 kW V2: 85 kW	V1: 20 kW, 30 kW, 40 kW, 50 kW, 55 kW, 60 kW, 70 kW, 85 kW Please consult us for single-phase inverter power.
Modularity	Maximum 8 inverters can be combined S-type : 4 inverters		
Redundancy[1]	Master/master or master/slave arrangement		
Equipment losses	3% of the equipment rated power typically		
Power Quality characteristics			
Reactive power compensation: target cos Φ	Programmable from 0.6 (inductive) to 0.6 (capacitive)[2]		
Harmonic mitigation[3]			
Harmonic range	Up to 2nd to 50th harmonic		
Harmonics selectable	20 individual harmonics		3-wire: 20 harmonics 4-wire: 15 harmonics
Filtering target	Programmable for each harmonic in absolute Ampere value		
Harmonic attenuation factor (I_H (source)/I_H (load))	Better than 97% at rated load		
Response time	P: between 450 ms and 550 ms Q: 2 seconds Harmonics: 2 networks cycles typically (10-90% filtering)		
Load balancing characteristics [3]	Balance the currents between phases and/or between phases and neutral		
Programming/Communication			
Digital I/O	2 digital inputs/6 digital outputs (potential free)		
Alarm contact	1 NO/NC alarm contact (potential free)		
Programming/Monitoring	Using ESI-Manager GUI Using Modbus RTU and Modbus TCP/IP interface (optional) Ethernet (RJ45) and USB ports provided Using PQF-Link software (optional)		
Energy Management communication	Modbus TCP/IP, Modbus RTU		
Battery Management System communication	CAN		
Islanding mode [4]	Available in both 3 and 4-wire		

[1] For full redundancy combine only master units. If limited redundancy is acceptable, master and slave units can be combined. The desired redundancy level can be obtained by selecting more or less master units.

[2] If cos Φ of the installation is higher than the target cos Φ, the filter will not downgrade the existing cos Φ

[3] CT's to be provided at the main incomer (source-side)

[4] Additional signal needed from customer

Technical specifications

Model	ESI-I	ESI-M	ESI-S
Physical aspects (per base unit)			
Mounting	Free floor standing cubicle (ESI-I/M) or IP00 plate (ESI-M)		Wall-mount enclosure
Dimensions per unit (W x D x H)	800 x 600 x 2150 mm	600 x 600 x 2150 mm (cubicle) 498 x 432 x 1697 mm (plate)	588 x 326 x 795 mm
Approximate weight (unpacked)	525 to 620 kg (depending on power rating)	250 kg	120 kg
Color	RAL 7035 (light gray)		
IP protection	IP21 Optional: IP41[1]	Plate version: IP00 Cubicle version: IP21 Optional: IP23, IP41[1]	IP30
Installation aspects			
Altitude	Indoor installation in clean environnment up to 1000 m altitude[2]		
Ambient temperature	-10°C to 40°C[2]		
Humidity	Maximum 95% relative humidity, non-condensing[3]		
Cable entry	Bottom	Top or bottom (to be specified at time of ordering)	Bottom
CT requirements	Only required for Power Quality features		
Protection			
DC Protection (between inverter and battery)	DC Contactor + fuse in the cable entry cubicle	DC Contactor + fuse	DC Contactor + fuse provided as loose items
AC Protection	AC Breaker included	AC Contactor + Fuse Disconnector provided. Circuit Breaker (optional)	AC Breaker (optional) offered as loose item [4]
Standards			
UL	UL-1741 (pending)		
IEC	IEEE 1547 (certification under process) 61439-1 EMC Immunity: 61000-6-2 EMC Emissions: 61000-6-4		

[1] For IP41 models, 10% derating applies.

[2] Higher altitudes (up to 2000 m/ 6600 ft max.) and temperatures (up to 50°C/122°F max.) with suitable derating.

[3] The maximum relative humidity for operational purposes is 95% (non-condensing). When the units are stored for a longer time, do not exceed a relative humidity of 85%.

[4] Cabling instructions provided.

Contact us

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