Plant electrical system services
Seamless integration of electrical and process automation systems
ABB’s integrated solutions combine our full scope of products, technology leadership and services with system engineering to create real customized value, tailored to customer unique needs. ABB’s capability level of customization and integration sets its electrical system services high above the standard provision of stand-alone products.

ABB is the world’s leading supplier of nearly every available product in the power and automation scope of supply, from generator circuit breakers, transformers, switchgear, motors and drives to field instruments, process analyzers, distributed control systems, substations and power management and optimization systems. Combined with ABB’s unparalleled domain competence and experience, the result is a portfolio of innovative, integrated electrification solutions for power and water plants.

Customization and integration are key elements of an ABB electrification solution, and together create value for utilities or EPCs.

Benefits of integration

ABB electrification solutions minimize risk with turnkey, tailored solutions, and maximize the value of existing assets through lower life cycle costs. Modernized equipment results in the highest plant reliability, as well as improved safety and availability of plant operations.

Experienced ABB engineering know-how delivers fast project execution by integrating products from across the company via ABB’s global network. ABB also maintains system lifecycles with local service support.

Certified project managers balance the requirements of scope, schedule and cost by means of effective resource allocation, risk management, quality assurance, and health, safety and environmental procedures. Customer satisfaction is always the primary focus.

ABB site-specific installation supervision includes all necessary issued for construction documentation, permits and approvals, equipment installation expertise, cabling know-how and coordination of pre-qualified installation contractors. ABB’s consultative and collaborative approach is to work closely with client’s project engineering and plant maintenance teams to ensure safe, timely and non-disruptive execution of all planned activities at site.

Specific examples of how smart technologies can impact the operation and overall health of the grid include the following:

- Real-time situational awareness and analysis of the distribution system can change operational practices and improve reliability.
- Fault location and isolation can speed recovery after a fault by connecting reserve power or automatic rearrangement of power supply.
- System automation (SA) facilitates the safe local and remote control and monitoring, as well as the protection of the electrical system for optimal supply quality and improved system reliability.
- Smart metering and Energy management allow optimal balance and cost control between the bought external power and own production.
- Distributed automation and monitoring systems provide operators with advanced decision support and control functions.
- Power quality control by special functions, such as reactive power compensation and possible load shedding.

Electrical systems and solutions
Seamless integration – ABB keys to success at each stage

ABB’s project execution follows a set of structured processes based on well-defined project stages. Internal processes and management oversight ensure these processes meet the highest quality assurance standards. At each project stage, the focus is on customer requirements, critical technical interfaces, detailed documentation and accurate planning. ABB’s team has the necessary experience and know-how required to timely deliver well-integrated and cost-effective electrical systems to our clients. The following shows the unique and proven ABB keys to success at each execution stage.

<table>
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<tr>
<th>Conceptualization stage</th>
<th>Design stage</th>
<th>Implementation stage</th>
<th>Acceptance stage</th>
<th>Operation stage</th>
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<tr>
<td>• Assess in detail all required interfaces</td>
<td>• Specify all interfaces</td>
<td>• Procure equipment with special attention to unique and custom interfaces</td>
<td>• Commission each sub-system and its interfaces per the integrated site acceptance test plan</td>
<td>• Prepare customized operator training to plant personnel</td>
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<td>• Define the most cost effective interface by looking into possible alternatives</td>
<td>• Expand design requirements for equipment suppliers to cover necessary interfaces</td>
<td>• Conduct pre-inspection</td>
<td>• Conduct an integrated test during Factory Acceptance Test</td>
<td>• Conduct a hand-over to local field service organization for long-term support</td>
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<td>• Verify chosen interfaces between the existing and new equipment</td>
<td>• Verify with factory/OEM/supplier all interface requirements and confirm costing</td>
<td>• Conduct an integrated test during Factory Acceptance Test</td>
<td>• Provide experienced site commissioning manager to oversee activities and ensure all testing is complete per plan</td>
<td>• Agree on maintenance support contract with customer</td>
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<td>• Conduct site assessment and identify changes required at site</td>
<td>• Review interfaces with customer and obtain approval</td>
<td>• Execute pre-defined changes at site to prepare for timely and smooth installation</td>
<td>• Prepare final user documentation with instructions on how to operate integrated system</td>
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<td>• Create comprehensive site test procedures</td>
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<td>The purpose of a conceptual design study is to develop a roadmap for building and maintaining an optimum power system that serves present and future plant operating needs.</td>
<td>ABB works closely with the client to ensure a full understanding of the engineering solution, and confirm that all engineering considerations are incorporated at the earliest stages of project development.</td>
<td>A key component of a conceptual design study is the ability of the engineer to understand existing conditions, future needs and equipment and system capabilities. For example:</td>
<td>Studies</td>
<td>Power flow studies determine active and reactive power flows and bus voltage magnitude and their phase angle at all the buses for a specified power system configuration and</td>
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<td>Studies provide information that help ABB customers understand the root of present or future power system problems, and to make the correct planning decisions for upgrades or extensions to a power system. This careful groundwork leads to reduced operating costs and increased availability, supporting decisions about proper equipment sizing and selection that can help prevent future equipment or system failures.</td>
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operating condition subject to the generation or regulating capabilities of generators, synchronous condensers, tap changing under load transformers.

**Short circuit studies** provide currents and voltages on a power system during fault conditions. This information is required to design an adequate protection system and to determine interrupting requirements for circuit breakers at each switching location.

**Motor starting studies** can help with selecting the optimal method of starting, the proper motor application, and the proper system design.

**Harmonic analysis programs** compute indices such as total voltage harmonic distortion factor at system buses to evaluate the effect of the harmonic sources and to evaluate the effectiveness of the harmonic filters. Also, driving point impedance plots of the buses of interest are generated to identify whether series or parallel resonance phenomenon occurs at any harmonic frequency of interest.

**Technical analyses**
To plan new installations or to improve the performances of existing power plants through an upgrade or an expansion, ABB experts support customers in analyzing, specifying and designing network systems to meet customer specific requirements. The conducted studies allow them to make the appropriate decision to set up an effective power plant system design, which complies with customer, local or international regulatory requirements and standards.

ABB experts visit the customer’s facility, inspect network interfaces and gather any information necessary to prepare cost-effective solutions and appropriate alternatives. ABB services include:

- **Power quality analysis:** ABB engineers document the symptoms, examine damaged equipment, assess the power and grounding in an area, collect data using temporary monitors, and develop a report of findings that identifies the most probable cause of any issues. The report includes mitigation recommendations to prevent future occurrences.

- **Power system grounding evaluation:** Lack of proper grounding translates into an increased chance of fire, data and equipment losses, process anomalies, plant shutdowns, and workplace safety hazards. ABB power system engineers will develop a scope of work to address all areas of concern.

**Site assessment:** Electrical equipment is subject to degradation due to age, environmental stresses and heat. ABB engineers will perform a basic equipment condition evaluation by visually inspecting the equipment during a walk-through of the facility.

**Feasibility**
Depending on the present condition of a customer’s electrical equipment, ABB will recommend suitable repairs, maintenance, upgrades or replacement schemes. Customers benefit from ABB engineering and power process experience, as well as unrivaled expertise in electrical and automation systems. ABB's goal is to define a plan that is both reliable and cost effective by reusing existing equipment whenever possible, and purchasing new equipment wherever necessary.

**Interfaces**
ABB electrical system solutions incorporate all electrical equipment and systems from generator terminals to high-voltage grid connectivity, ensuring power plants run efficiently, safely and reliably.

To create a complete operating asset, ABB brings an in-depth understanding of electrical system requirements and the capacity to seamlessly integrate individual electrical components using well-defined management interfaces between the electrical equipment solution and the civil works, logistics and utilities.

The benefits of this approach are substantial, including reduced exposure to technical and commercial risk, elimination of multi-vendor interfaces, and improved resource leveling. ABB integrated solutions save customers time, reduce costs and manage risks.

![Figure 1: System model in ETAP for power flow analysis.](image)
Design stage

Electrical system engineering

ABB’s electrical system solutions cover the entire power path, from generator terminals to high-voltage grid connections. Regardless of the type of plant, ABB integration experts can design an electrical system specific for specific power process needs, and deliver a safe, reliable and economical system integration.

The core value of ABB’s optimized solution is integrated engineering. Based on broad experience and the implementation of a wide range of electrical equipment and automation systems, ABB’s engineering team has developed engineering tools, standards and modular packages that quickly adapt to specific applications.

This single-source capability in the electrical systems of a hydropower plant, for example, translates into a unique competency in delivering cost-effective solutions with the highest possible levels of equipment availability, reliability and safety.

ABB’s broad expertise with power and automation integration includes the following equipment, systems and services:

- Generator Step-Up Transformers
- Station Service Transformers
- Auxiliary Supply Transformers
- Generator Circuit Breaker
- Excitation System
- Synchronization
- Isolated Phase Busduct
- Nonsegregated Phase Busduct
- Electrical Protection
- MV/LV Switchgears
- MV/LV MCCs
- LV/MV Drives
- DC System and Inverters
- Emergency Power Supply
- Lighting System
- Cable and cable trays
- Grounding
- Lightning Protection
- Modular Buildings (Power Distribution Centers)
- Facility management system
- Condition monitoring system
- Integrated automation platform for power generation
- Instrumentation
- Demolition and site works

Cable engineering

ABB provides complete solutions for cable and cable tray systems, with an engineering team that performs a number of studies to fully define a proper solution.

Cable sizing requires comprehensive calculation for every current circuit, by software analyses. With the aid of program parameters, the range of cable types to be used can be limited and the number of parallel cables for a given cable cross-section can be determined, and approach that ensures the most economical solution.

Protection with ABB or third party protection relays

ABB offers a complete portfolio of generator protection solutions for all types and sizes of generators and generator-transformers units. As members of the Relion protection and control product family, the generator protection IEDs REG670 and REG650 are designed to implement all the core values of the IEC 61850 standard. The protection IEDs also support other types of interfaces to the plant control system.

Figure 2: Example of generator and transformer protection

Figure 3: Example of LV switchgear and Transformer interface with non-segregated phase bus duct

ABB’s engineers offer also solutions using third party protection relays, for redundancy and interface with existing protection relays.
Excitation system

Excitation systems have a powerful impact on generator dynamic performance and availability. These systems ensure the quality of generator voltage and reactive power, in other words, the quality of the delivered energy to consumers. ABB supplies state-of-the-art, microprocessor-based voltage regulators for synchronous machines with rotating exciter and static excitation systems that deliver high-performance control for all kinds of synchronous machines (motors and generators). ABB’s broad product range includes the UNITROL 1000 and UNITROL 6000 static excitation system family, which provides the flexibility needed to comply with nearly any customer specification.

Synchronization

Synchronizing devices are widely used in power stations or industrial installations with local power generating facilities, where the generators need to be paralleled with an island line or a public line, or in power distribution systems.

Synchronization systems safely, quickly and reliably connect the generator to the grid, whether as a monitoring element for manual paralleling, or as an independent, fully-automatic synchronizing device. ABB has the flexibility to provide a synchronization system solution with SYNCHROTACT or third-party synchronization relay.

Application:
- Synchronizing system for automatic synchronizing and paralleling generators with the grid
- Redundant manual synchronizing equipment
- Optional measuring and metering equipment in the synchronizing cubicle

Condition monitoring systems

ABB offers a wide range of products and solutions that monitor vibration and assess the condition of turbines and generators. The solution enables users to perform a graphical analysis of rotating machinery data. It presents historical vibration data and selected process variables graphically to machinery personnel so that significant patterns and trends can be quickly recognized.
Grid connections
ABB provides a complete portfolio of products and systems to connect a power plant to the power grid. This includes the bus ducts to connect the generator, generator circuit breaker, power transformer and the complete high-voltage substation, including all protection and control facilities.

Electrical plant auxiliaries
ABB provides medium- and low-voltage systems consisting of transformers, switchgear, motor control centers, variable frequency converters, DC Systems. For reliable back-up power, ABB can integrate complete emergency backup systems consisting of emergency and black start diesel generators and uninterruptible power supply (UPS) systems that include rectifier/battery charger, batteries, inverters, DC switchgear and distribution.

Facilities management
From cables and accessories to security system integration, ABB provides a full facility management system consisting of communication, fire protection, lighting and power distribution and security systems. By integrating facility management needs into power plant design and implementation, ABB provides the operations team with a consistent and logical organization of sub-systems, expediting plant services in the long run.

Seamless electrical and process automation integration
ABB’s ability to supply a complete and fully integrated instrumentation, control and electrical solution is the key to a successful project and the efficient and cost-effective operation of a power plant.

Designed to meet the most stringent requirements of all types of power generation, ABB’s total plant automation platform integrates the entire plant in a simple, scalable, seamless and secure system. These modular systems will manage automation of the units, plant auxiliaries, substation, regulation of basins and hydraulic works, as well as the speed/load control of the turbines.

An optimal solution for integrating process control and substation control systems in a single system can be implemented by using the IEC 61850 standard. Although IEC 61850 was developed to enable communication between all substation functions, it is far more than just a communication protocol. Its chief benefit is interoperability: protection and control devices from one or several manufacturers can exchange information with each other and utilize the data for their own functions. The IEC 61850 standard supports all substation communication requirements, both horizontally and vertically.
Plant electrical system services

Integrated automation platform for power generation
ABB’s automation platform delivers a number of performance-enhancing benefits to power plants:

- Integrates automation and electrical systems in a single control environment
- Supports the latest interface protocols like IEC 61850, IEC 60870-5-103 and 104
- Open architecture enables integration of many third-party devices and systems; single platform simplifies asset management and extends equipment life
- Future-proof capability smooths systems evolution and protects previous investments in process graphics, control applications and historical data
- Highly scalable — including different levels of redundancies and eminently suitable for either the smallest or the most complex configurations in new and existing plants

- Offers comprehensive suite of functionality at the plant control level, including OPC connectivity, mass data processing, self-sustaining redundancy, and usual functionalities like alarms, audit trail and trends
- Integrates equipment protection systems for generator and transformer units, high-voltage switchgear, and medium- and low-voltage systems

Symphony Plus and System 800xA each have a secure and open architecture, which allows for complete and seamless integration of a wide variety of devices and systems that provide a single window of the entire plant. The complete integration of systems, intelligent devices and fieldbus technology reduces installation costs, and enhances maintenance capabilities.

Figure 5: Electrical integration: Symphony Plus horizontal and vertical integration

**Horizontal integration**

- Time-critical communication among IEDs is integrated into control configuration via GOOSE messaging.
- Integrated into Symphony Plus system via CI850 — electrical integration master module.
- CI850 behaves like IED on the IEC61850 network and communicates horizontally with other IEDs.
- Horizontal integration enables fast load shedding with GOOSE in the event of a power glitch.

**Vertical integration**

- Non time-critical data such as alarms and events, circuit breaker status and disturbance recordings are integrated through vertical integration into S+ Operations server.
- All IEC61850 data integrated into S+ Operations is available for use in process graphics, historian as well as reporting.
- Accomplished through MMS communication.
- Enables a single plant-wide sequence of events list.
Implementation stage

Procurement
A single supplier that is responsible for total project delivery eliminates organizational interfaces. ABB can leverage a global network of manufacturing plants, and its global presence can significantly reduce shipping cost and time. Procurement costs are decreased by eliminating individual proposals, bidding and negotiations. Standardized and reusable documentations reduces cost and confusion.

Factory Acceptance Test (FAT)
The Factory Acceptance Test is usually performed at the vendor’s facility prior to shipping to the site. This is a way to ensure that equipment/systems being purchased meet the agreed-upon design specifications, or address any issues prior to shipping to the site or client.

As a system integrator, ABB carries out all FAT activities as a single point of contact for the customer. An Integrated Factory Acceptance Test (IFAT) is an option, based on customer need, which tests and validates selected equipment/systems in a single space. Conducting an IFAT provides important advantages and benefits including time and cost savings, improved ability to meet compliance requirements, and increased comfort level with integrated solutions.

Installation
ABB prepares the schedule for delivery and installation in close cooperation with project partners, and we plan and procure site facilities and provide complete installation. Correct installation ensures a high level of operational reliability. To achieve a problem-free start-up, it is required that ABB installation procedures are followed. ABB also offers installation supervision.
Site acceptance stage

Delivery
ABB’s expertise and partnerships with world class logistics companies ensures our deliveries are conducted safely, on time, and all the necessary road and transportation permits are secured. ABB works in collaboration with the customer site to make sure all the necessary equipment is on hand for a smooth offloading process. In order to ensure on time equipment release from customs, ABB works only with licensed customs brokers to provide the required documents, customs and shipping forms, and incoming material documentation.

Site Acceptance test (SAT)
During site acceptance, the system is tested in accordance with the client’s approved test plans and specifications. The results demonstrate that the system is properly installed and interfaces correctly with other equipment and peripherals in its working environment. As a system integrator, ABB provides all SAT schedules, plans and procedures, and coordinates with all other equipment/system suppliers. The customer benefits from ABB’s capacity as a single point of contact.

Commissioning
Count on certified ABB commissioning experts for high reliability and optimum life cycle performance from first operation. Correct commissioning ensures a high degree of operational reliability. To achieve a problem-free start-up, it is necessary that ABB commissioning procedures are followed. The use of service personnel from ABB ensures the equipment/system is installed and put into operation safely and correctly.

ABB’s global presence means the presence of local engineers who understand the challenges unique to customer markets. They are backed by an international global knowledge base that has been built up over many decades in every corner of the world. While every project is different, ABB’s broad knowledge and experience ensure customers will get a robust and reliable solution.
Operations stage

Training
ABB offers comprehensive training for engineers, operators, programmers and maintenance personnel.

Training is available at ABB facilities worldwide, at plant sites and online. ABB’s hands-on training programs educate customers about the proper maintenance and service of ABB electrical power equipment. A large selection of specialized training programs are available and training programs can be tailored to meet specific customer needs.

Hand over to local field service
ABB operates locally but is also connected to a vast resource of experience and know-how from around the globe, which supports our comprehensive, modular service portfolio and ensures the highest plant availability.

Life cycle management
Power Generation Care is a comprehensive, site-based service solution, providing application, technical, product and site support along with management and full-time support from a trained technical account manager. This ABB service solution matches specific support needs to different customer sites. Support levels target varied customer profiles, from “self-sustainer” (Core Level) to large, fleet-based customers (Enterprise Level). At each program level the range of support and service increases, building upon the previous program level.

Major maintenance tasks are covered by our service modules, including expert hotline, diagnostic and remote servicing, preventive and predictive maintenance, and spare parts storage. Our experienced service teams also carry out plant inspections, plant optimization, upgrades, retrofits and migrations. In addition, we provide specialized teams for consulting services and training.
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