



Smart City Power Distribution

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The power distribution network is facing new challenges due to accelerating urbanization and evolving requirements for improved reliability and availability of power supply. The growing demand for deploying new and intelligent technology to be able ensure smart city infrastructure requires an increase in automation throughout the network.

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Abbreviations used in this brochure

BESS	Battery Energy Storage System
CB	Circuit Breaker
CSS	Compact Secondary Substation
DC	Direct Current
DMS	Distribution Management System
EV	Electrical Vehicle
FLIR	Fault Location, Isolation and Restoration
GOOSE	Generic Object Oriented Substation Events
HV	High Voltage
LV	Low Voltage
MV	Medium Voltage
RMU	Ring Main Unit
SCADA	Supervisory Control And Data Acquisition
VPN	Virtual Private Network

Intelligent technology for Smart City Power Distribution

Operators in urban power distribution are faced with ever increasing efficiency and supply quality requirements. To meet these demands operators need to introduce automation throughout the entire network.

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01 Power and automation for critical city infrastructure
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02 The future urban environment demands even more secure and flexible power distribution

Intelligent technology for smart cities

Cities today are home to more than 50 percent of the world's population and by 2050 it is estimated that 2.9 billion people will be living in cities. These cities will need new and intelligent infrastructure to meet the needs of their citizens and businesses. An effective way to support these city goals is by using technology to more intelligently monitor, optimize and control key systems and infrastructure. In other words, to operate as a 'smart city'.

ABB offers power and automation products and solutions throughout the technology value chain. This includes supporting essential city services with reliable, high bandwidth communications, enabling utilities to deliver reliable electric, water, heating and cooling services to their customers. ABB also offers more sustainable solutions for transportation providers. ABB's solutions for critical city infrastructure is outlined in image 01.

Challenges facing urban network operators

Urban power distribution network operators are facing a growing number of challenges and demands from both consumers and the authorities. The commercial consequences of power discontinuities are becoming more severe, urging operators to seek a feasible network upgrade solution. New needs emerging, such as charging stations for electrical vehicles (EV), integration of distributed power generation, and support for demand response programs. In short, in urban power distribution, existing cable networks have to take on continuously increasing power consumption.

When the decision to upgrade and build networks with the ability to meet today's efficiency and supply quality requirements, the operators typically face the challenge of a huge existing network, which includes different generations of primary and secondary substations, provided with a wide variety of equipment. In most cases, this infrastructure is aging, which adds the subsequent risk for increased component failure rates. Additionally, automation is a desired functionality, as dense traffic makes it difficult to access the secondary substations.

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01
ABB solutions

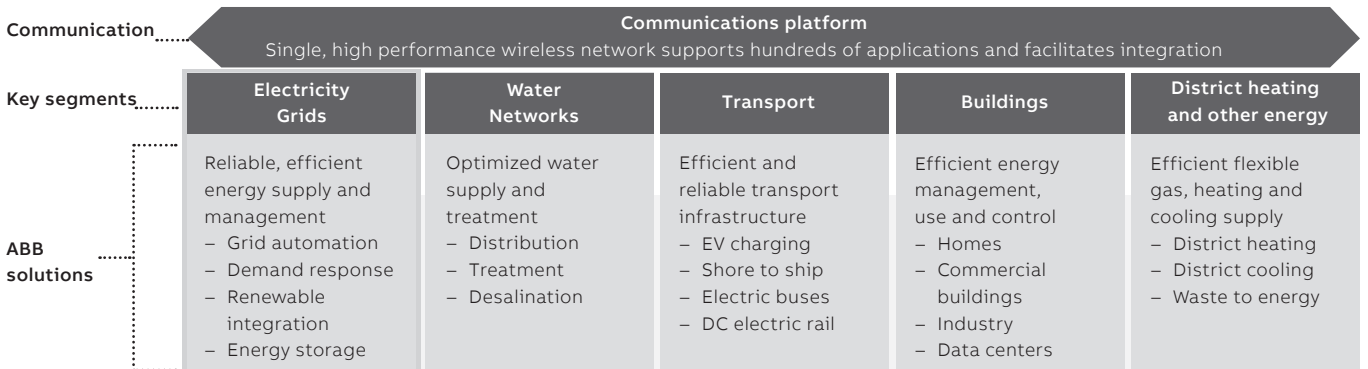


ABB solutions for electricity grids

ABB IT/OT	Common Information and Operational Technologies (IT/OT), typically deployed per application: SCADA, control operations, asset management, workforce management, business analytics
ABB devices	Common device types for measurement and control, deployed per application: Sensors, protection and control relays, LV and MV apparatus and switchgear
ABB services	Comprehensive range of services: Engineering and consulting, installation and commissioning, maintenance outsourcing

Benefits of Smart City Power Distribution

Highest security of supply

The focus in distribution grid automation is on preventing interruptions in power supply. It is possible to spot problems before they cause interruptions, via introducing measurements and other monitoring throughout the distribution network. If a fault occurs, it can quickly be isolated and the power supply is restored, using the remote control system for fast network reconfiguration.

Operational efficiency

Effective use of the entire network is ensured via including all central equipment in the SCADA/ Distribution Management System (DMS). This ensures that real-time monitoring, control and communication solutions are widely available in the network. Disturbance situations can be resolved effectively with the help of accurate fault location and DMS functions.

Supporting green values

Remote access to the entire distribution network eliminates traveling, which lowers fuel consumption and thus reduces emission of greenhouse gases.

Short payback time for investments

Smart City Power Distribution investments have a broad impact on the urban grid and there are immediate cost savings, as a result of fewer power distribution interruptions and more efficient grid operation. This leads to short payback time for the investment. Improved asset management, with the use of device condition monitoring functions, further adds to the benefits of implementing smart distribution solutions.

Adapting to changes in the environment

Smart City Power Distribution grows along with the requirements, offering a solution both for today and the future. The investment into a smarter grid can be done step-wise (levels 1-4, see image 04) and directed towards those actions that are the most critical for the consumers. Step-by-step continuous improvement and creation of long-term programs serve to improve efficiency and reliability of the grid. The concept also adapts to situations where there are distributed power production requirements or when new significant power consumers are connected to the grid.



Smart City Power Distribution concept

03 Example of early detection of intermittent earth faults in the protection and control devices

Developed for the demanding urban environment

The Smart City Power Distribution concept, with its intelligent equipment solutions, has been developed for the demanding urban power distribution environment. Undisturbed power distribution is required not only to guarantee normal life and business conditions, but also to ensure availability of electricity to emergency services. To secure undisturbed power distribution to critical areas, such as commercial centers, it is necessary to receive early pre-fault warnings and to have a network where alternative supply routes can be arranged. In emergency situations, it is essential to have fast and accurate fault localization, fault isolation and power restoration via remote reconfiguration of the network. Further, emerging needs for energy savings, demand response, integration of distributed generation and support for the charging of electrical vehicles have to be met with real-time grid information.

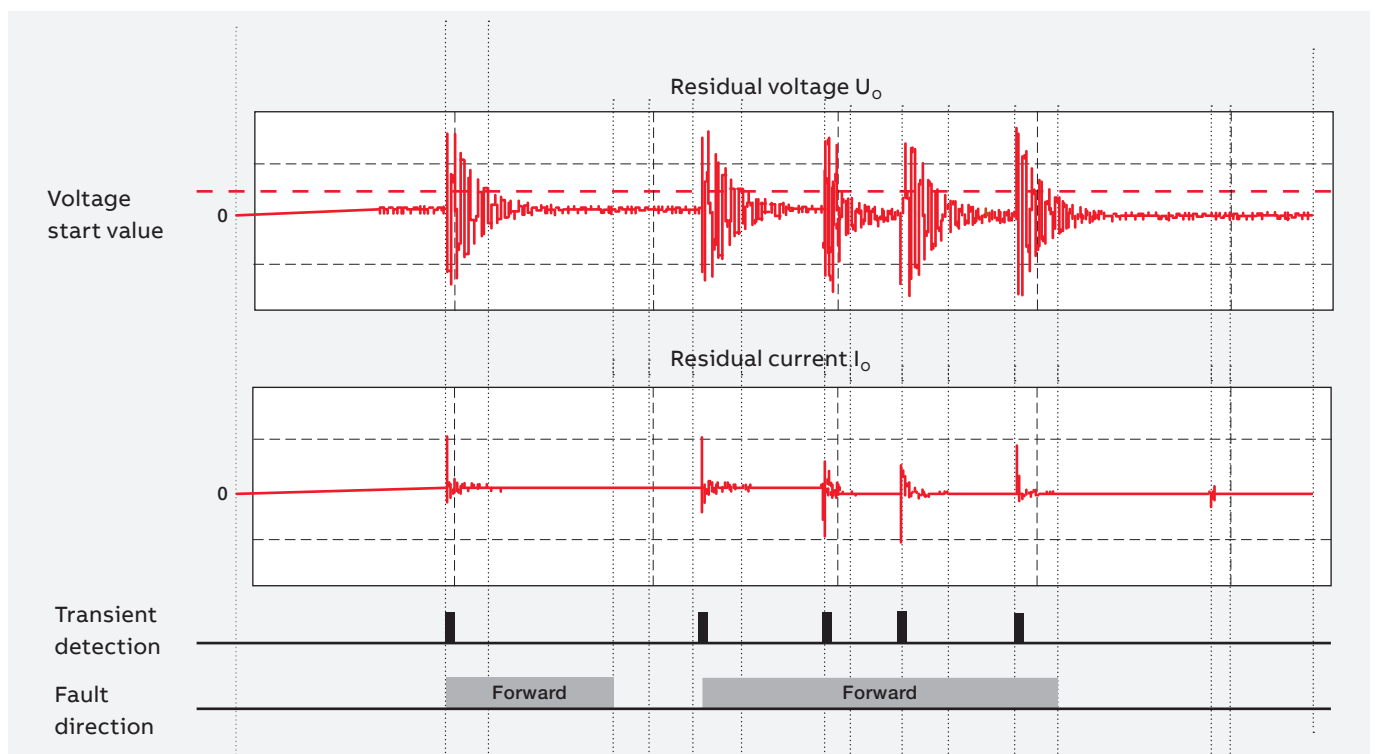
The Smart City Power Distribution concept:

- Meets the total needs of urban power distribution, but allows step-wise, situation-sensitive implementation to gain the most feasible solution
- Relies on a coordinated range of primary and secondary ABB equipment
- Relies on standards, which allows for integration into existing systems, as well as ensuring adaptability as there are new developments and the needs change

Early detection of evolving faults

When you are able to identify evolving faults early on, and detect equipment operating close to its limits, it is possible to reroute the power supply, before the consumers experience power supply disturbances. Image 03 shows how detection of developing earth faults is achieved with advanced algorithms.

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In urban environments, with extensive and aging cable networks, it is essential to constantly monitor the condition of the cables. By compensating earth fault currents, it may be possible to run the grid with a developed single-phase earth fault for a limited time, thus providing time to arrange for an alternative power supply, before decoupling and repairing the faulty section.

Equipment condition monitoring spots risks, enables proactive actions and increases security

Condition monitoring data from the grid node stations (e.g., from transformer stations) can be collected and analyzed in the central automation system. Based on these results, maintenance actions can be initiated and you avoid unplanned supply interruptions. This data, when included in the system, facilitates appropriate asset management.

Enhancement through automation

The specialized distribution grid automation components include the essential functions for the grid nodes. These components are able to carry out automatic functions, either on their own in a local automation scheme or in cooperation with a remote system, either automatically or manually. Local automation systems can be used for automatic supply changeover in transformer stations and by utilizing GOOSE messages (based on IEC 61850). Advanced distributed automation schemes can be built across several secondary substations.

In disturbance situations, it is crucial to have the ability to quickly and accurately locate the fault, applying selective fault isolation and quick restoration of power. Smart City Power Distribution provides superior fault location, isolation and restoration (FLIR) to lower the frequency and shorten the duration of faults. These solutions have been developed to achieve high-performance fault management, both automatically and manually, at appropriate levels in the distribution system.

Measuring fault current in the medium voltage (MV) nodes enhances the fault localization provided by the high voltage (HV)/MV substation devices and the DMS. The FLIR sequence may be carried out automatically or manually utilizing the remote control system. Remote access is essential to achieve high-performance fault management. Further, in an environment with heavy traffic, it is often difficult and time-consuming to travel to the grid node stations to perform manual switching actions.

Secure and reliable communication

A complete solution requires versatile communication and data transfer options, which provide secure and reliable connectivity. For existing networks, the easiest and most feasible method is often to implement public wireless communication solutions. In Smart City Power Distribution the grid nodes can be attached to a control system using two-way GPRS/EDGE/3G/4G LTE communication for cost-effective and secure packet-switched data transfer. Thus, all the active components in the grid are easily connected to the SCADA/DMS.

To eliminate the danger of external unauthorized access, all of our communication solutions have integrated firewalls and utilize the VPN technique. Additionally, the communication solutions have built-in and continuous end-to-end supervision. The system is further protected by all-covering monitoring, including access supervision for the secondary substations.

Flexible implementation of smart distribution solutions

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04 Flexible implementation with smart distribution solutions

Priority and level of automation per section

The level and roll-out order of smart distribution solutions tends to be prioritized differently in different grid sections, as supply criticality, the likelihood of faults, and the need for remote control varies. ABB offers a flexible approach to meet this requirement. The available smart distribution solutions are grouped based on their capabilities into four levels: (1) situational awareness, (2) fault isolation and power restoration, (3) power flow management and (4) protection selectivity. In most automated power grids, a combination of all four levels exists simultaneously.

Level 1: Situational awareness

On level 1, we have the need to monitor the network. Monitoring is provided via remotely accessible fault passage indicators in the ring main units. Further, the secondary substations may also be provided with LV measurement functionality, as a crucial aspect here is to supervise the transformer loading and possible abnormal service conditions to prevent equipment breakdown. Generally, level 1 monitoring equipment provide fault localization and, in some cases, also condition monitoring information. Fault localization is used for clearing post-fault situations, whereas condition monitoring information can be used to proactively avoid supply disturbances.

Level 2: Fault isolation

On level 2, fault isolation capability is available. The devices at the MV nodes are equipped with motorized remotely controllable MV switches. These switches make it possible to act on the monitoring information received and provide the means to carry out fault isolation, network reconfiguration and power supply restoration remotely.

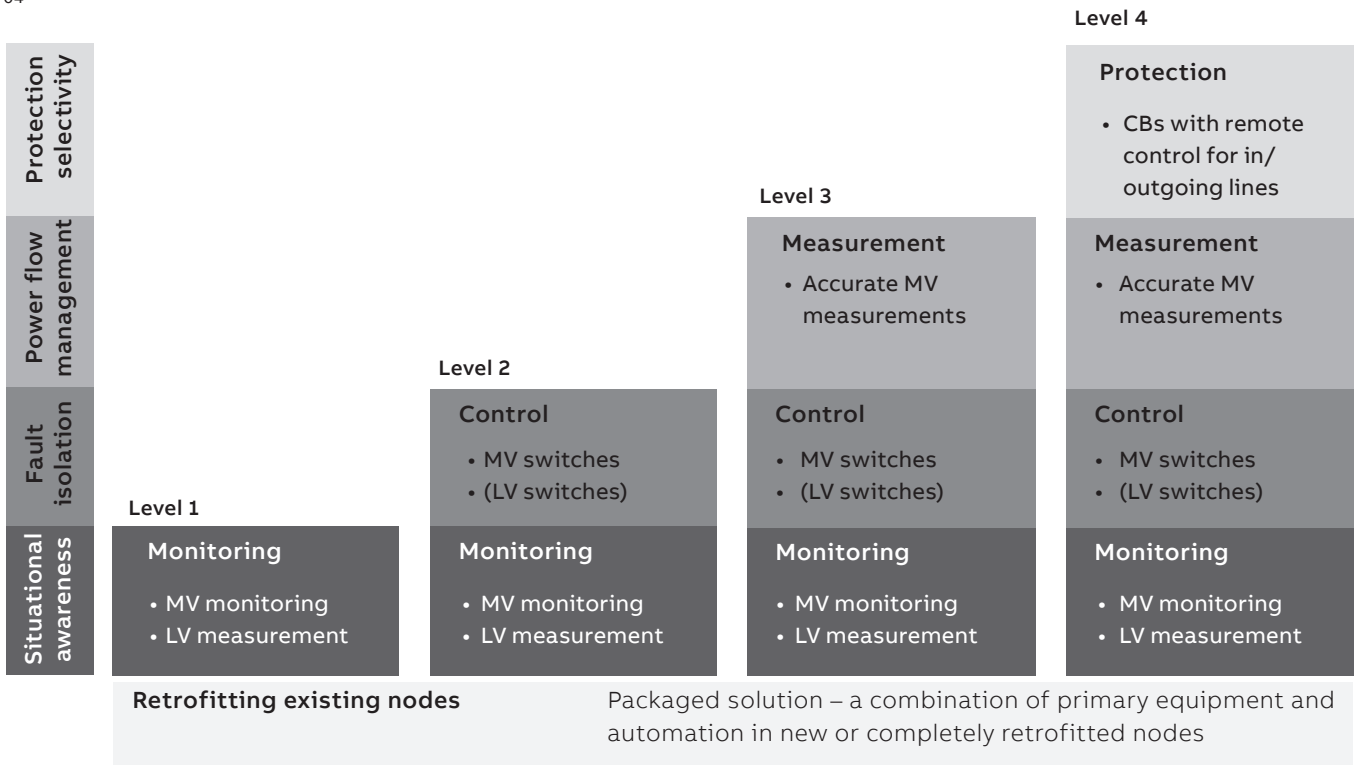
Level 3: Power flow management

On level 3, power flow management is added. The devices at the MV nodes enable measurements, which makes it possible to actively monitor and manage the power flow. This is especially important in networks, where distributed generation, energy storages and ad hoc charging of electrical vehicles is included. Without proper power flow management, it is likely that an overload situation and subsequent interruptions occur. Power flow control also facilitates power loss minimization.

Level 4: Protection selectivity

On level 4, we add protection selectivity. The equipment at the central MV nodes is connected to circuit breakers (CB) and protection devices, which enable a distributed, fast and selective tripping of faulty network sections. The central control system and the protection at supplying HV/MV stations do not need to be involved. When the protection devices include condition monitoring functions for the spotting of erupting faults, it is possible - already in advance - to reconfigure the network and isolate a problematic section without supply interruption.

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Smart City Power Distribution in an urban power distribution system

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05 Urban power distribution

Suits a wide variety of urban power distribution systems

Smart City Power Distribution fits, regardless of the size and age of the urban power distribution system in question. The solutions combine sensible topology of the primary network, appropriate primary equipment and intelligent protection, as well as control and automation features into one optimal functional entity.

The offering ranges from a single component to total systems, including related services. Combined with the possibility for a step-wise implementation (image 04), it is easy to adjust to the overall development of the urban infrastructure and the distribution grid and its gradual renewal.

The flexibility of smart distribution solutions makes them feasible for both new and existing installations.

Primary HV/MV substations

Depending on the population density, and the availability of space, the HV/MV substation technology may vary from air-insulated substations to underground gas-insulated substations. ABB can offer both solutions. Regardless of the secondary technology chosen for the substation, it will fit with the smart distribution solution, and at the desired implementation level. Further, it will always be possible to upgrade the functionality according to growing needs.

Secondary substations (in buildings)

Larger buildings, for commercial, industrial or residential purposes, normally have a dedicated MV/LV secondary substation within their premises. As for HV/MV substations, ABB offers feasible solutions for most in-building substations. Within these secondary substations the capability of the secondary technology is extremely important. These consumption sites

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1. Primary HV/MV substations
2. Secondary substations (in buildings)
3. Compact secondary substation (CSS)
4. Control center
5. Battery energy storage system (BESS)

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are increasingly provided with energy saving functions and microgeneration may also come into the picture. Thus, the information and control capabilities of the smart distribution solutions become a prerequisite.

Compact secondary substation (CSS)

In residential areas, LV power consumers are normally supplied with LV electricity from CSSs. MV/LV transformers and the required protection and control devices are located in the CSS. The secondary technology of these substations is very important to follow-up on the supplied voltage quality.

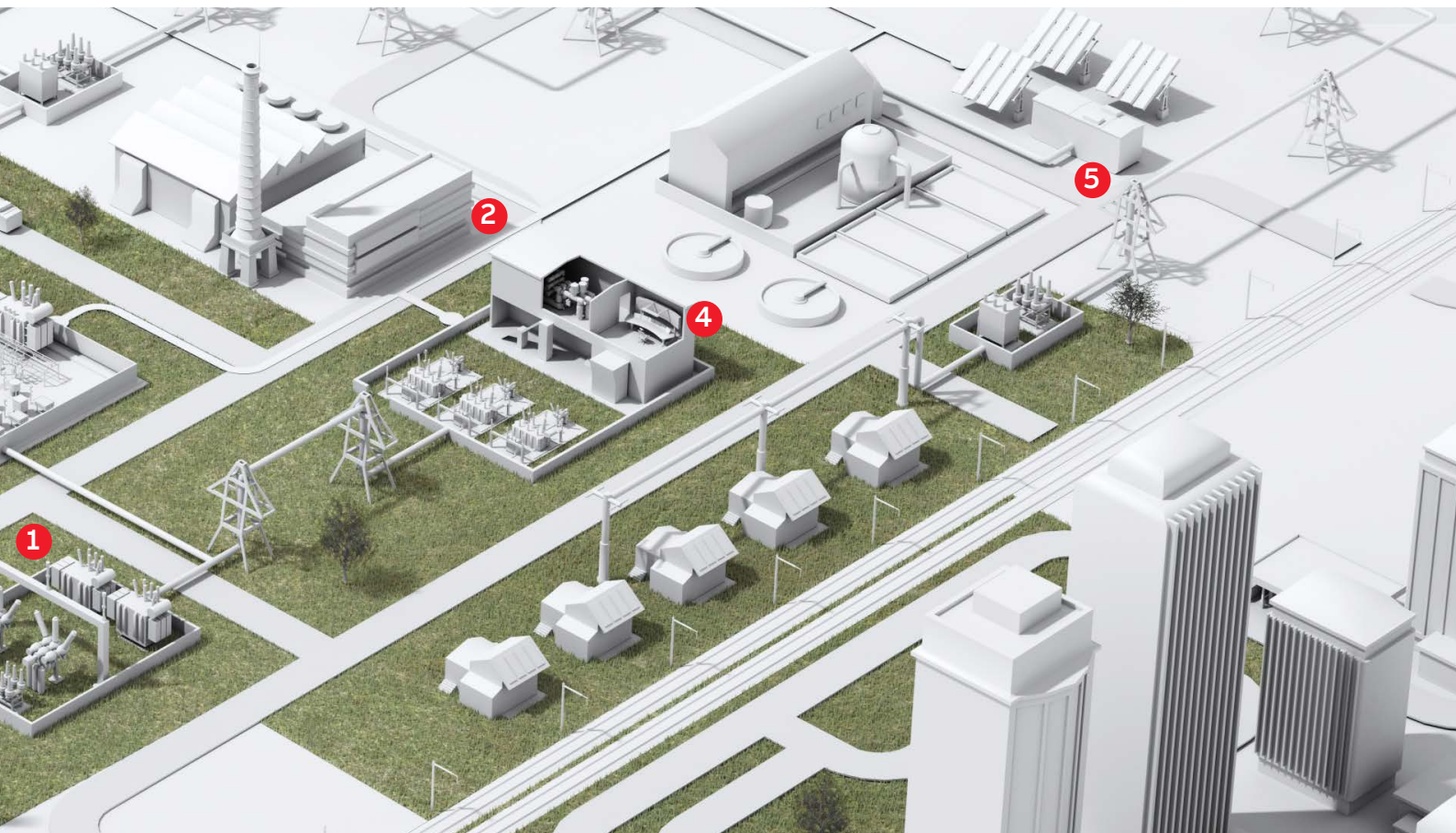
Microgeneration is also growing, that is, the small-scale generation of heat and electric power by individuals and small businesses. Thus, the capability to measure and handle power flows is also becoming a must here.

Control center

For urban power distribution the capability of the control center is crucial. The smart distribution solutions can, as such, be integrated into an existing control center. ABB also offers new control centers, either complete or as a subsystem with the desired functionality and extension.

Battery energy storage system (BESS)

The demand for grid distributed energy storage systems has become a reality, as the need to secure the continuity of power supply and to even out power peaks in the network. Peaks are caused by upstream disturbances, fluctuations in consumption and by intermittent generation. ABB offers a range of BESSs, which can be equipped with the necessary secondary technology. For proper functionality in the distribution grid, it is essential that the operation of the BESS is coordinated with the operation of other elements in the power distribution system.



Smart distribution solutions

06 Smart distribution solutions meet the challenges of the demanding urban power distribution environment

Solutions for all levels in the network

Distribution grid automation is a key contributor and a prerequisite to building the smart grids of the future.

ABB has for decades been driving the development of advanced protection, supervision, control and management products and systems for the complete power delivery process. As a forerunner also in the development and manufacturing of primary equipment, ABB is able to create the best integration between the primary and secondary distribution to move towards more efficient and reliable grids.

The smart distribution solutions are built on smart products for protection and control, monitoring, measurement, and communication. There are solutions available for urban, rural and mixed power distribution networks. The solutions can be applied to new secondary switchgear, ring main units (RMU), pole-mounted reclosers/breakers or load-break switches, or utilized as a cost-efficient upgrade of an existing installation.

The smart control cabinets are based on standardized ready-to-be-deployed solutions. There are cabinet variants for both overhead line and underground cable networks. The cabinets are suitable for all applications, ranging from monitoring and control solutions to more advanced solutions with accurate measurements and protection functionality.

The comprehensive protection and control product portfolio enables accurate measurements, which ensure scalable monitoring, control and protection functionality. Standard solutions include secure communication, centralized supervision and user account management over cost-efficient public networks.

ABB makes smart distribution solutions available for all customers in the technology value chain - from protection and control devices and solutions typically required by switchgear manufacturers, to switchgear solutions and complete compact substation deliveries typically required by system integrators and utilities.

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Solutions, components and services

Primary distribution substations

A wide product range of ABB primary equipment is available. Even if they have not initially been fitted with secondary equipment, they are easily adaptable to incorporate grid automation secondary technology.



Secondary distribution substations

The smart distribution solutions offer a cost-efficient upgrade of an existing CSSs (retrofit) or applicable to new secondary distribution substations.

Our smart distribution solution components can be integrated into switchgear and ring main units or be an integrated part of a complete CSS delivery.



Smart control cabinets

ABB's grid automation control cabinets are based on one standardized plug-in solution, which is suitable for both indoor and outdoor use.

There are models for both overhead line and underground cable networks. The cabinets are suitable for all applications, ranging from monitoring and control solutions to more advanced solutions with accurate measurements and protection functionality. The pre-tested cabinets are delivered ready for installation and are suitable for both retrofit and new installations.



Protection and control devices

Our comprehensive portfolio of protection and control devices provide accurate measurements and can be applied to new or already existing secondary distribution substations. With these devices scalable monitoring, control and measurements are available from one interface. Our standard solutions include secure communication, centralized supervision and user account management over cost-efficient public networks.



Services

ABB offers a wide selection of services for managing increasingly complex equipment and systems. The Clonet® – Online Service offers access to a database where you can access documents, guidelines and tips on how to best optimize the use of ABB's protection and control devices.



For additional information about the offering, see the detailed product brochures and leaflets. You can access the information online, please go to <https://new.abb.com/medium-voltage/distribution-automation/grid-automation>
To learn more about increasing the intelligence and efficiency of the grid, go to <https://new.abb-distributiongridautomation.com>

Life cycle management and quality

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07 ABB offers support at each phase of the product's or solution's life cycle

ABB life cycle management

The life cycle of a solution and the products included in it, starts with specification and design, followed by manufacturing, installation and commissioning. To get the best result it is essential that this is done according to verified processes and applying the best known quality standards. Further, life cycle management also includes maintenance, spare parts, extensions, upgrades and retrofits and end-of-life services.

ABB has for decades applied standardized processes to offer support at each phase of the product's or solution's life cycle. There are services for various stages in the process, such as installation and commissioning, life cycle assessment for an existing installation, maintenance and end-of-life services.

Quality and sustainability

By means of quality assurance programs and international standards, ABB aims to provide the best products and services on the market and building strong business relationships with customers and suppliers.

For ABB, sustainability is about balancing economic success, environmental stewardship and social progress to benefit all of 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 the communities where we operate and towards one another, while striving to ensure the health, safety and security of our employees, contractors and others affected by our activities. You can learn more about sustainability at ABB at <https://new.abb.com/sustainability>

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