



Power products and systems

# Intelligent solutions for power distribution Zone concept

# Securing continuous power supply

ABB is one of the world's leading power and automation technology companies whose products, systems and services help its industry and power utility customers to improve their productivity in a sustainable way. ABB offers power solutions vital for the reliable transmission and distribution of electricity and for the automation of the power system.

ABB's power products, power systems and services help to control and protect electricity transmission and distribution, improve the quality of electricity and ensure that our customers can distribute electricity in an effective way. In this way we can ensure reliable electricity transmission and distribution all the way, from the generation to the consumers.

**The main long-term objective for the development of the power distribution network is to increase the quality of the electricity and the continuity of supply in a cost effective way. With its intelligent equipment solutions, the zone concept creates a solid and flexible basis for this comprehensive development work.**

Uninterrupted power distribution is the primary element of the quality of power distribution. The reliability of the supply can be improved in a fast and cost-efficient manner through increasing automation and adding light substations, zone breakers and zone disconnectors to the existing network. This solution benefits both the consumers and the distribution network companies.

## **The Zone concept restricts the impact of supply disturbances**

The main principle of the zone concept is to confine the impact of a network fault to as limited an area as possible. A fault in the distribution network often interrupts distribution along the entire feeder and to all the consumers connected to it. Integrating protection and reclosing functions deeper into the network directs reclosing functions and interruptions selectively to the problematic parts of the network. Thus distribution interruptions on other sections of the network are avoided. To do this, the feeder is divided into sections, or zones.

According to research, the number of consumers experiencing interruptions is cut by as much as half compared to the case of no zone division.

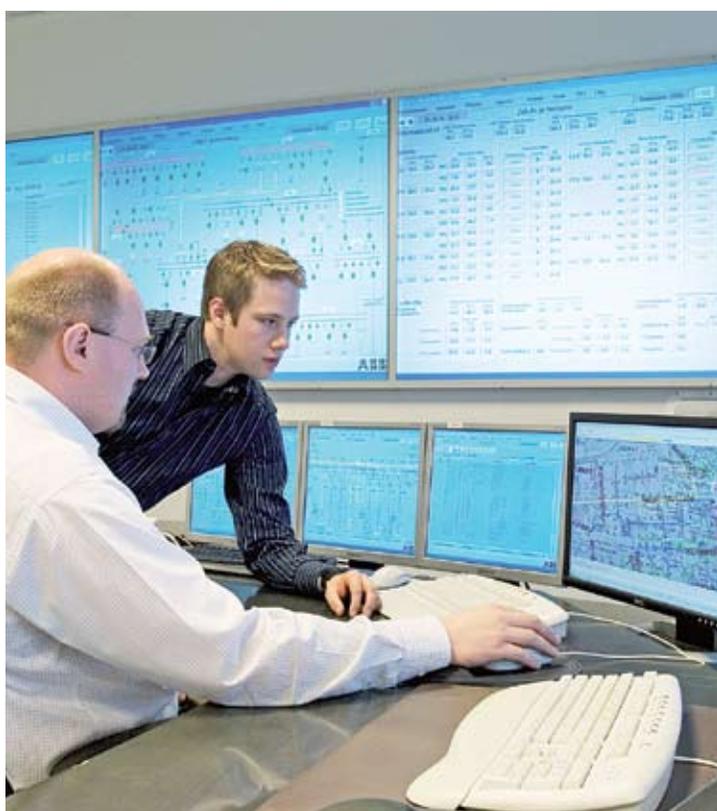
In the zone concept an outgoing main feeder is divided into zones using line reclosers, automatic sectionalizers and remotely controlled disconnectors as zone dividers. Depending on the capability of the zone divider the zone is either a protection zone or a control zone. Each main feeder zone, typically a protection zone, has a number of lateral feeders or branches, which can form their own protection and control zones.

## **The Zone concept provides several implementation alternatives**

A distribution network can be divided into zones in many different ways. The most traditional way is to increase the HV/MV substation density, or divide the network into sections fed by several substations. In this way even the nuisance caused by voltage dips in the distribution grid is restricted to a small part of the network.

On long, lightly loaded feeders, the latter part of the feeder can be galvanically isolated from the beginning of the feeder using an intermediate transformer introducing e.g. an 1000 V distribution zone near the consumption points. Thus the effects of any disturbance occurring at the end of the feeder are limited to the 1000 V zone of its own. To a large extent, the 1000 V zone can be designed using material intended for the standard LV distribution network.

The fault probabilities can be minimized by focusing on the construction of the primary network, e.g. by replacing overhead lines with cable feeders or by equipping transformers with surge arresters. To maximize the benefits of these efforts, the investment can be completed by implementing the zone concept.





### The Zone concept - enhancement through automation

The benefits of the zone concept can be fully utilized by using remote-controlled switching devices in combination with a Distribution Management System (DMS). Measuring the fault current at the network breaker enhances the fault localization provided by the substation devices and the DMS.

Due to the zone concept the average interruption time experienced by the consumers is shortened as the zone disconnecter isolates the faulty zone in case of a permanent fault. The zone breakers and disconnectors always have a remote control option. Remote control is useful e.g. in network reconfiguration for power restoration. If a fault occurs near the substation ahead of a zone breaker, remote control is used to restore the supply in the feeder section behind the fault location, using an alternative supply route.

It is not practical to install breakers on all the branches; a disconnecter is often enough. On a dead feeder, the branch is isolated either using remote control or automatically, if the disconnecter provides fault current measurement (automatic sectionalizer). On a live feeder the fault spot can as well be automatically isolated using load break switches and local automation.

### The Zone concept adapts to future challenges

The zone concept solution is perfectly suited for step-by-step implementation. The most important consumption objects are first formed into zones using light substations or zone breakers. As the network expands or diversifies, the new network sections become separate zones. For instance, distributed energy generation can be confined to a separate zone using a breaker with a disconnecting option.

Using a line differential relay with an optical cable connection to protect the feeder between the zone of distributed energy production and the substation provides both fast protection and fast communication between the energy production zone and the substation. This enables the optimal use of distributed energy generation as a part of the distribution network supply reliability.

### Communication and services for comprehensive management

A total solution requires versatile communication and data transfer options. Cost-effective and secure packet switched data transfer can be implemented using a satellite connection or a terrestrial GPRS/EDGE connection. In this way all the active components in the zone concept can easily be connected to the SCADA/DMS system. A reliable satellite connection is the best solution for substations. For remote-controlled switching devices e.g. a GPRS connection can be used. In the zone concept the communication can be offered as a service including commissioning, communication, maintenance and fault management services.

The zone concept can be used to optimize the long-term network development work. To achieve cost-effective results a development plan should be created for the entire distribution network. The actual implementation can be done in narrower patches optimizing the timing and implementation method of the various phases.

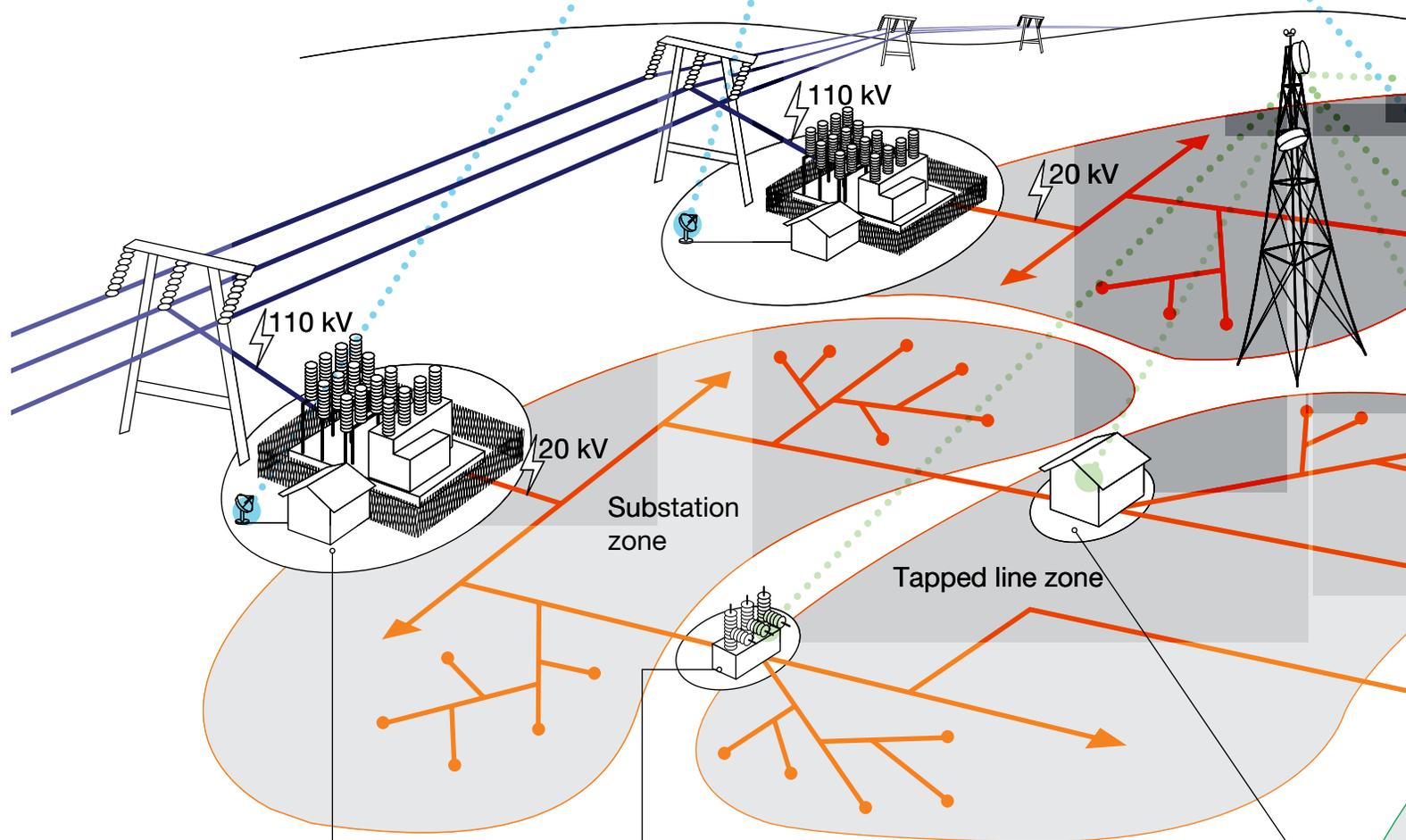
Implementing and testing the zone concept requires a good overall view of the system. The work can be purchased as a service including functionality testing of the field devices and up to the control room.

# Zone concept – optimal grid use

The aim of a distribution network company is to offer the consumers high-quality electricity in a reliable and cost-efficient way. Regulatory changes and other alterations in the operational environment have brought new challenges for achieving the targets. ABB offers a solution for proper allocation of development actions – the zone concept. The concept combines sensible topology of the primary network, appropriate primary equipment and intelligent protection, control and automation features into an optimal functional entity.

## Communication

A comprehensive communication network and versatile data transfer enable effective management of the power system. Communication helps to fully utilize the functionality of the versatile IED devices installed in the network and thus improve the effective operation of the network. Use of communication solution products enables cost-efficient and problem-free communication. It is also possible to purchase the entire communication solution as a service.



## Light substation

A light substation is a productized substation solution for being located under a subarea network feeder or at the end of a branch of a subarea network. Dividing the network into protection zones behind several substation restricts the propagation of voltage dips. The feeder lengths will be shorter, the fault areas are smaller and the number of consumers experiencing interruptions decreases.

## Pole mounted recloser

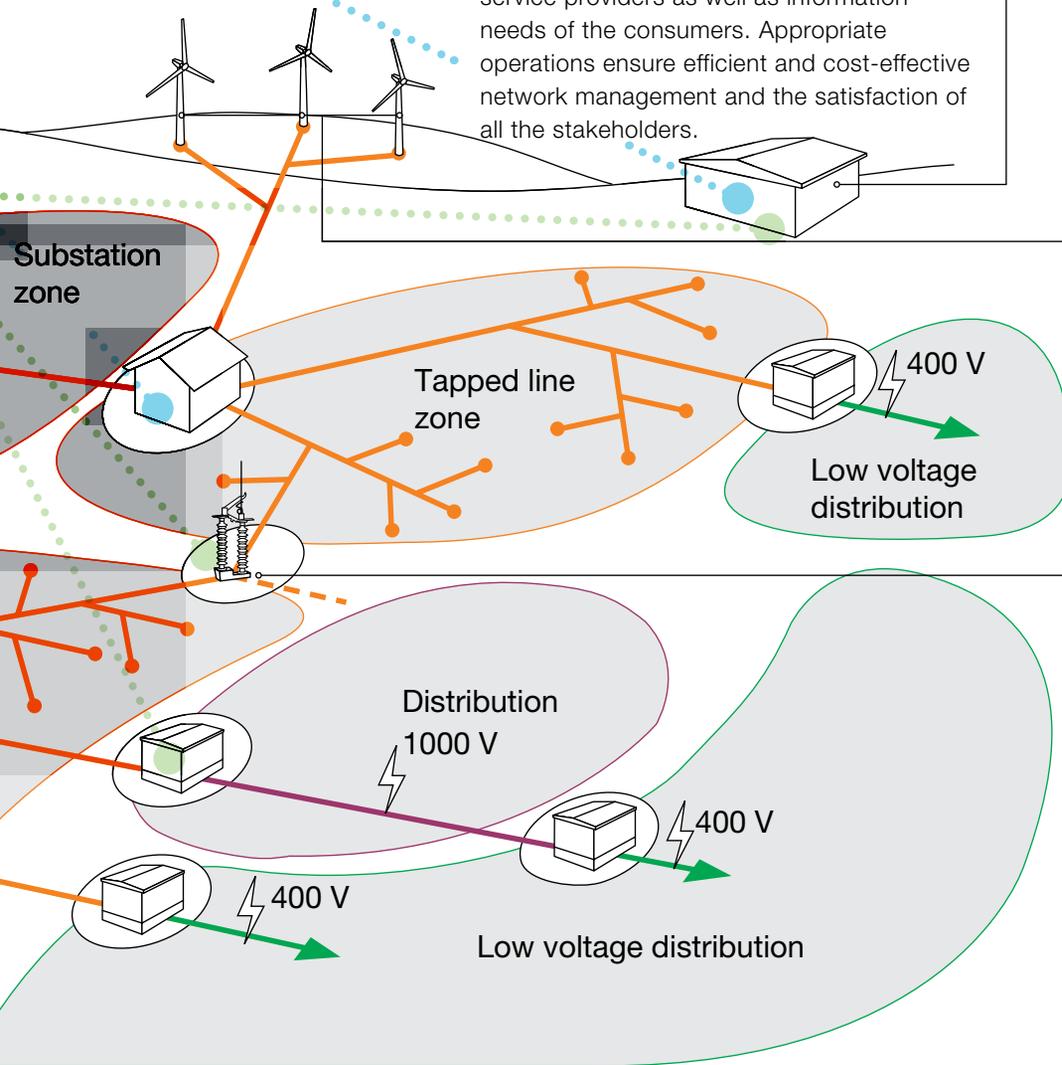
The recloser divides the feeders into protection zones. The recloser is installed in front of the feeder section prone to faults. Thus, the recloser limits any interruption to its own protection zone, and the interruptions occurring in zones in front of the recloser decrease significantly.





### Control room

The control room is the center for the management and control of the network. The SCADA and DMS systems give the operator the required information about the situation at different parts of the network and enable the optimal use. Control room operations also support the work of the field personnel, communication with internal and external service providers as well as information needs of the consumers. Appropriate operations ensure efficient and cost-effective network management and the satisfaction of all the stakeholders.



### Distributed power generation

Power generation connected directly to the distribution network is a new challenge in network protection and management. The figure shows an example of a wind power plant connected to the distribution network through a recloser station. The protection and management features of the recloser station support the specific needs of the wind power connection.



### Network disconnector

The disconnectors used in the zone concept are controlled remotely. In the figure, the disconnector station is located in the interconnection of two networks, enabling the disconnector to be used to connect alternative supply routes. A branch disconnector with measurement and automation features can even disconnect the faulty branch on its own.



### Services

ABB offers a wide selection of services for managing ever more complex systems. These services include expert services, device-related lifecycle services, remote diagnostics and comprehensive maintenance of different subsystems, etc.

### Recloser station

In the critical branch locations, the reclosers are installed in weather-protected ground structures. Besides protection and control, the versatile functionality of a recloser station also includes auto-reclosing. Arch-resistant switchgear, as well as the integrated disconnecting and earthing functions, provide improved safety for the personnel.



# Benefits of the zone concept

## High-quality electricity to the consumers

The solutions included in the zone concept significantly decrease the interruptions experienced by the consumers and shorten the duration of the interruptions. Also, fewer and fewer consumers have to suffer from the impacts of voltage dips. Automation makes fault management easier and faster. In case of a fault, the power distribution can be restored in a fast and controlled manner.

## Improved security of supply

The development actions are focused on the fault-prone parts of the network. This helps to restrict the impact of the faults to a single zone, which immediately improves the operating reliability of the entire network. With the versatile solutions in the zone concept the supply reliability of the network can be optimized by combining various partial solutions in a consumer-based manner according to the actual network situation.

## Effective use of the distribution network

Embedding the communication solutions deep in the network structure and including all the central equipment into the SCADA/DMS system enable the effective use of the entire network. Disturbance situations can be resolved effectively with the help of accurate fault locating and DMS functions. In case of a fault, the network circuit breakers with versatile protection characteristics automatically perform fast, zone-discriminative fault disconnection. In case of a major disturbance, the zone division significantly facilitates the use of the network. The operative actions can be performed in a safe way, and the use of earthing switches ensures secure and reliable earthing in all circumstances.

## Full benefits from your investments

The investment costs related to the zone concept are typically rather low. However, the investments have a wide impact on the grid and have an immediate decreasing effect on the costs related to power distribution interruption. In practice, this means rather short payback times for the investments. To enjoy the full benefits of investments in reliability of the critical network components, such as cables, zone circuit breakers can be used to restrict the impact of the faults to the components outside the network of enhanced reliability. Zone concept solutions decrease the stress on the network and thus increase the life-cycle of the network components. Improved asset management through use of device condition monitoring functions adds to the benefits of the zone concept implementation.

## Adapts to changes in the operational environment

The investments can be done in phases starting from the actions most critical to the consumers. Single investments can be made at any time of the year. The zone concept solutions can be fully utilized in the continuous improvement and creation of long-term development programs. The zone concept also adapts to situations where distributed power production or new important consumers are connected to the grid. The zone concept grows along with the requirements, offering a solution both for today and the future.





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