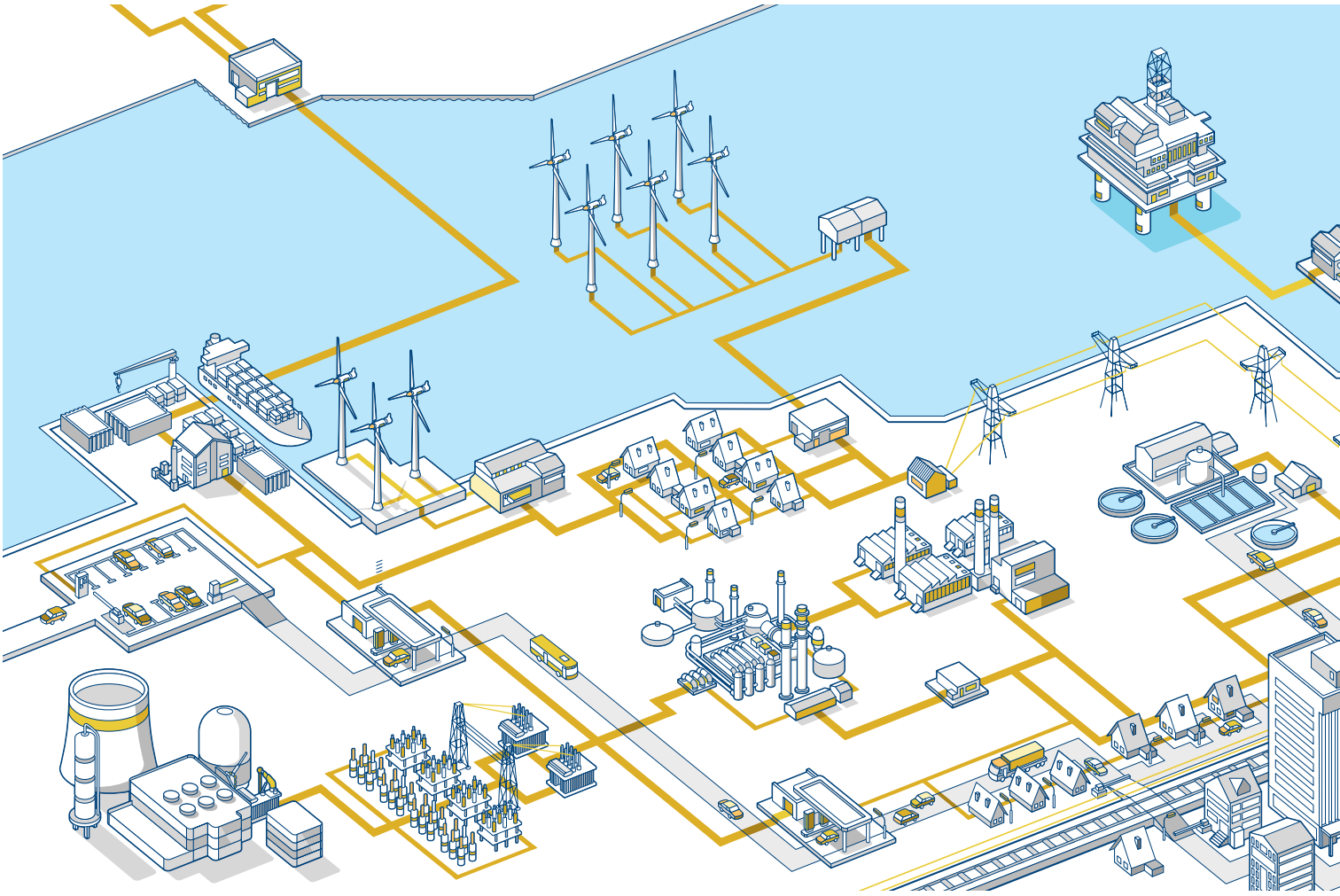
Overview brochure

Distribution Grid Automation
Raising the bar in grid efficiency and reliability

Power and productivity
for a better world™

Unlocking the benefits of smart grids



As an increasing proportion of our energy is generated from renewable sources, grid automation grows in importance. It provides the insight and controllability needed to ensure that high-quality power is reliably delivered wherever it's needed, as generation sources become increasingly distributed, intermittent and volatile.

Achieving the levels of control and performance needed requires an intelligent, efficient and reliable distribution grid. This is now possible thanks to significant advances in technology in recent years in areas such as sensing, data processing, control and communications (especially wireless) that come together with the latest power distribution equipment in ABB's suite of Distribution Grid Automation solutions.

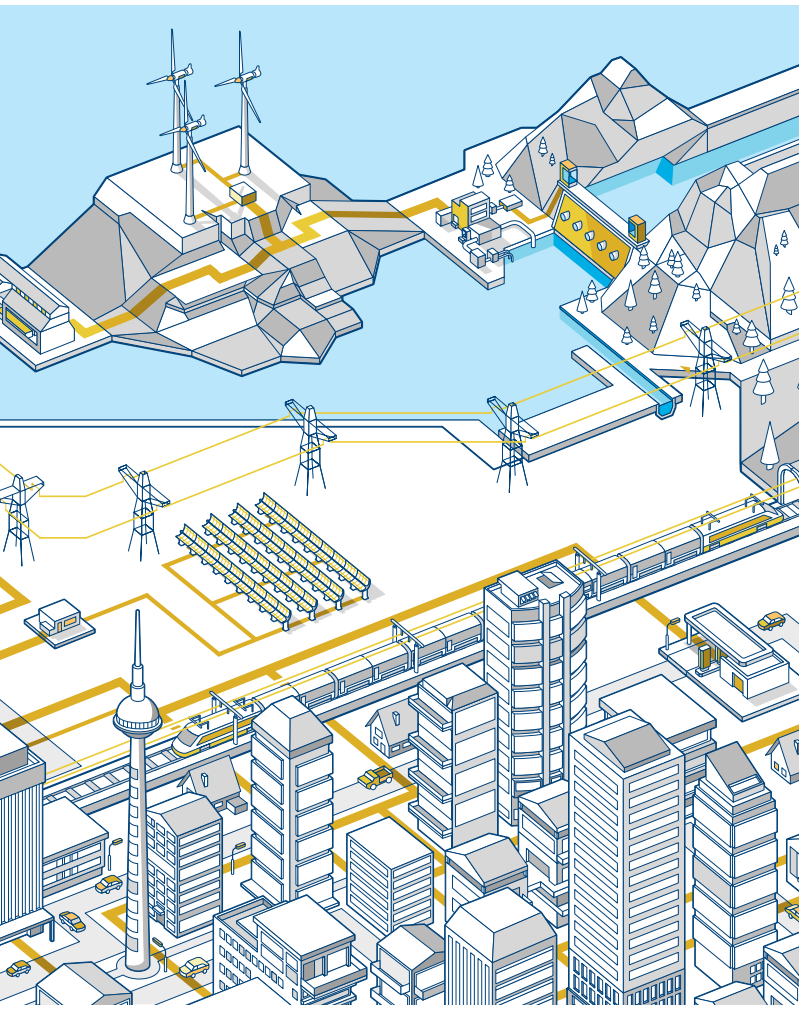
Renewable growth

According to the International Energy Agency's (IEA) Medium-Term Renewable Energy Market Report in 2013, one quarter of the world's total power generation will come from renewables by 2018.

The continuing shift to highly distributed, variable power generation sources demands a new kind of distribution grid. One that enables the control protection schemes needed to ensure safety, continuity and quality of supply to customers. One that offers a seamless integration of operational technology (OT) with information technology (IT). And one that enables grid operators to deal with local power issues, while taking the bigger picture into account.

Step-change benefits

ABB's latest Distribution Grid Automation solutions enable distribution organizations to deliver control, performance and integrate renewables by providing a step-change benefits in two key areas.



First, they provide greater real-time visibility and finer control by taking automation further out into the distribution grid – from primary distribution substations into the medium-voltage feeders, or to secondary distribution substations, depending on grid topology. This offers improved capabilities in outage management and Volt/VAr management, where VAr is reactive power.

Second, they improve the operational efficiency of the distribution organization itself through the integration of OT and IT.

ABB Distribution Grid Automation solutions enable operators to manage day-to-day local grid operations efficiently and reliably through advanced applications such as:

- Outage management to identify system faults and manage work crew response
- Automated switching to reconnect customers during storms
- Automated controls to optimize the grid in real time to improve reliability and grid efficiency.

Our suite of products and services is designed to ensure distribution grids are ready to meet the challenge of delivering high-quality, reliable power from a wide variety of generation sources, today and tomorrow.

01 Rooftop solar installation | 02 ABB smart compact secondary substation

Smart and efficient across every distribution application

Storm outage restoration

ABB Distribution Grid Automation solutions offer the tools grid operators need to monitor, manage and automate processes across a wide range of distribution grid applications.

Management of unplanned outages

Whatever the cause of an unplanned outage, our solutions will help pinpoint the issue, minimize disruption and restore power to customers fast. They offer tools to handle and in many cases, automate the four steps of: detecting the fault; locating the fault in the grid; isolating the area around the fault and restoring power to those not directly affected; and repairing the fault and restoring power to all.

Management of planned outages

Planned outages are a fact of life for all grid operators: they are needed to enable scheduled maintenance and replacement of distribution grid assets. Nonetheless, they still result in a loss in power to customers. Our solutions help minimize disruption to customers by streamlining the four main steps of managing planned outages: preparing and planning the maintenance operation; communicating with the customers concerned; network switching to isolate the assets to be maintained; and maintenance of the assets and restoration of power.

Storm outage restoration

Our solutions help grid operators prepare for and restore power after, storm outages by combining the steps needed to deal with unplanned outages with the planning and customer communication steps needed to manage planned outages.

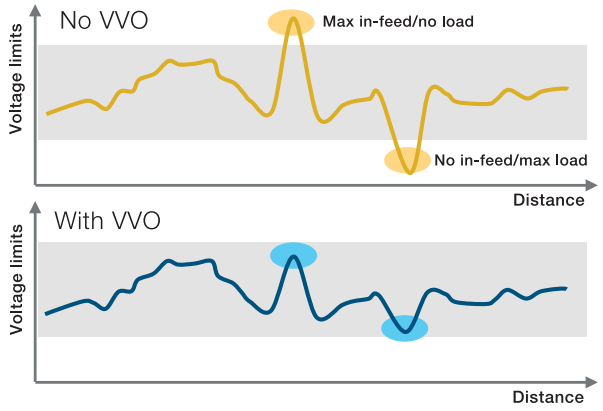
With the inclusion of an Outage Lifecycle Management system, ABB solutions can also help operators prepare for storm damage by predicting the areas most likely to be affected and the probable consequences. The system is able to take inputs such as meteorological data and learn from past events, increasing the accuracy of forecasts over time and minimizing the risk of applying an inappropriate switching sequence.

Volt/VAr management

ABB Distribution Grid Automation solutions enable grid operators to maintain network voltage within acceptable limits through model-based Volt/VAr management. They measure real-time voltage and current levels across the distribution grid and then use a model of the grid to mathematically optimize the settings for each device.

By moving to a full distribution system optimization solution – with equipment such as power electronic active voltage regulators and battery energy storage systems – operators get true dynamic control of voltage and power factor and, ultimately, a holistic and self-healing interconnected grid. What is more, the entire distribution organization can work with the same, real-time updated model of the grid.

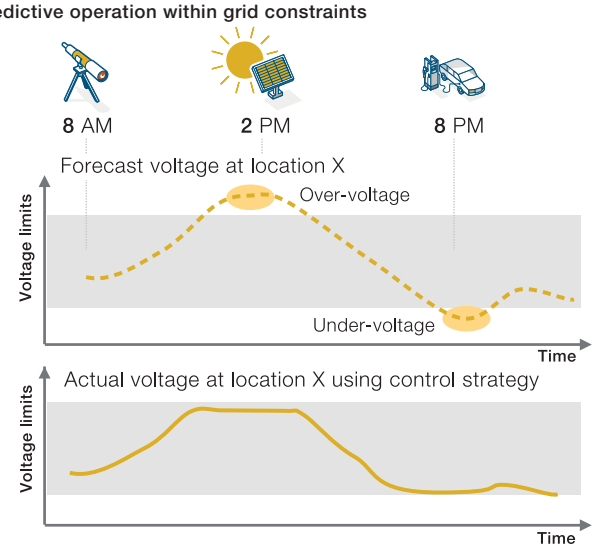
Volt/VAr optimization (VVO)



Predictive operation within grid constraints

The need to dynamically adjust voltage and reactive power is growing more critical as the proportion of distributed power generation, such as wind farms and photovoltaic arrays, increases in the distribution grid. ABB Distribution Grid Automation solutions enable operators to run the distribution grid within existing constraints through forecasting and management of supply and demand. They help operators forecast over- and under-voltage events and locations, optimize control strategy to keep voltage within acceptable limits and implement a longer-term control strategy.

Predictive operation within grid constraints

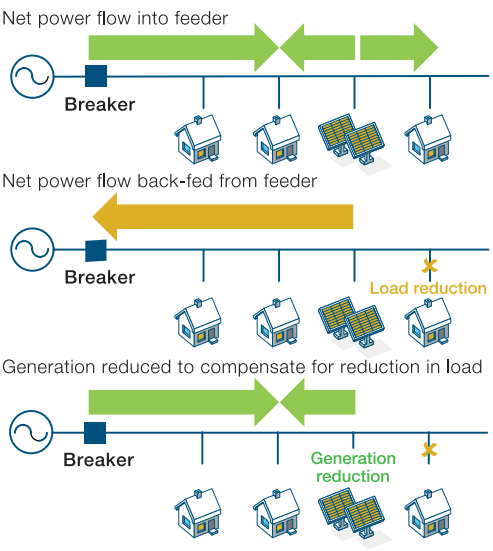


Power flow management

With consumer-owned generation, such as solar photovoltaic panels, growing in popularity, it is increasingly likely that there will be reverse power flows, back from the feeder, further out in the distribution grid. With ABB Distribution Grid Automation solutions, operators can monitor and control the true power flows in the distribution grid, taking measurements from multiple points within an area. This enables operators to adjust protection schemes accordingly.

Operators can even extend the reach of control beyond the distribution grid, to the consumer load. With the necessary agreements in place with consumers, operators can use demand response functionality to control consumer loads in real time to support optimal grid operation. This can only be efficiently achieved through seamless integration of OT with other processes and IT systems.

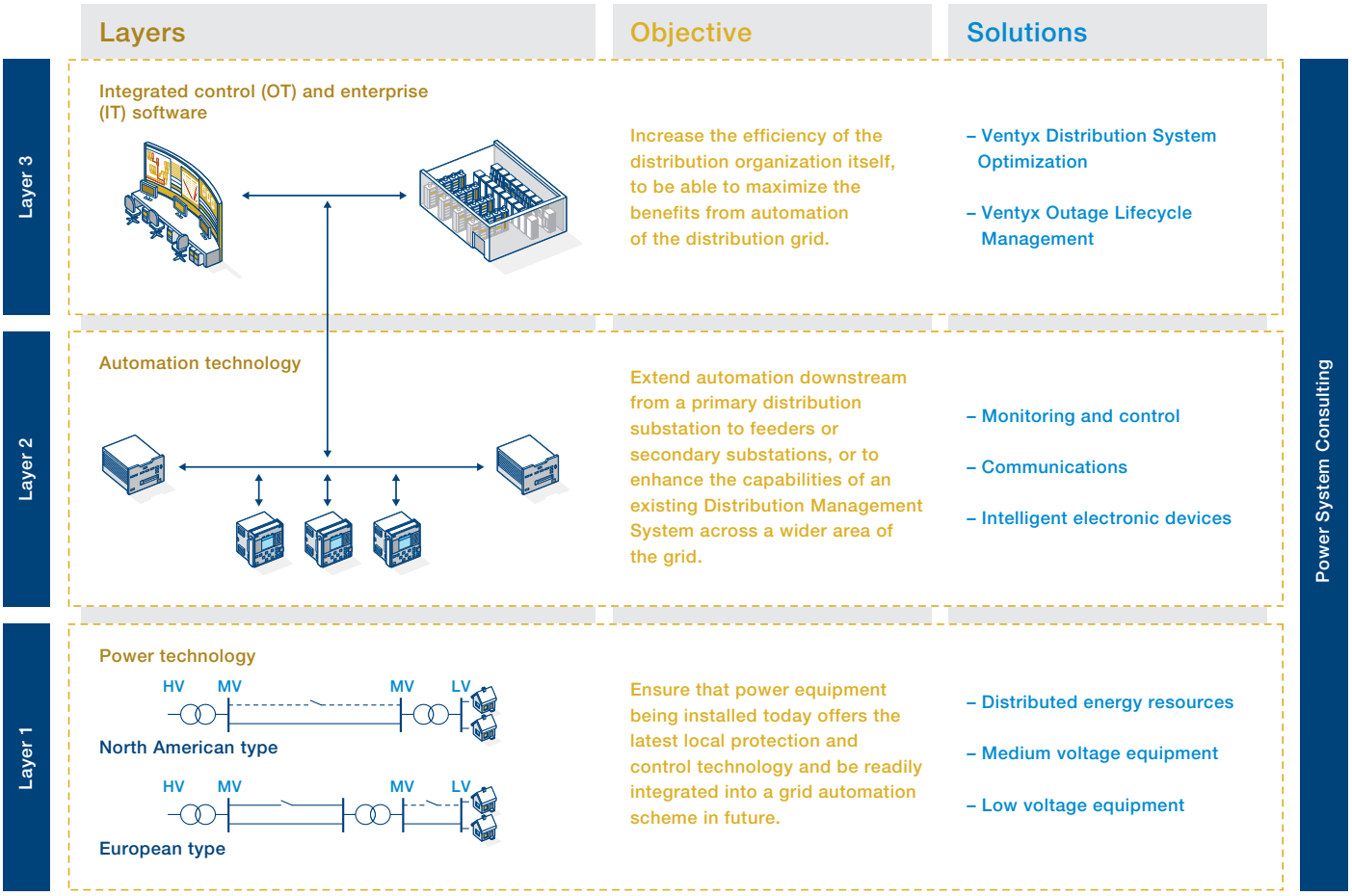
Power flow management



Implementing Distribution Grid Automation

ABB's Distribution Grid Automation solutions contain a broad portfolio of hardware, software and services.

Distribution Grid Automation solutions



With such a broad grid automation portfolio and broad range of starting points and goals for distribution organizations, it is helpful to consider the distribution grid automation architecture as consisting of three layers:

Layer 1, power technology, ensures that the power equipment operators install today offers the latest local protection and control technology, with the ability to be readily integrated into a grid automation scheme.

Layer 2, automation technology, extends automation downstream from a primary distribution substation to feeders or secondary substations, or enhances the capabilities of an existing Distribution Management System across a wider area of the grid.

Layer 3, integrated control (OT) and enterprise (IT) software, increases the efficiency of grid operations to maximize the benefits from distribution grid automation.

Underpinning all these layers is ABB's range of power systems consulting services that help operators get the most out of any grid automation scheme. These services can determine the optimum technical solution to meet operator needs and design the ideal solution to maximize value generation and return on investment.

Ensuring our solutions are future-proof was a key consideration in the development of the entire ABB Distribution Grid Automation portfolio. All these products and systems follow industry practices and standards, such as IEC 61850, which ABB helped to develop and implement.

Power technology

Our products and solutions benefit from the deep knowledge and expertise built up over more than a century of innovation in power technology. ABB is a world leader in all core power technologies and we have a comprehensive portfolio of power equipment, for all voltage levels and for all standards.

We understand that distribution grid topologies vary significantly between different regions of the world. These different topologies call for different technologies to perform the distribution task.

For regions such as North America where overhead medium-voltage feeder lines are common, ABB has a broad range of outdoor apparatus such as reclosers and pole- and pad-mounted transformers and capacitor banks.

For regions such as Europe, where switchgear-based secondary substations are common, ABB has an equally broad range of switchgear and compact secondary substations.

All ABB power equipment is designed to be interoperable and future-proof, incorporating the latest control and protection technologies while being compliant with all relevant industry standards.

01 Low voltage SACE Emax2 | 02 REF 615 in Unigear Digital switchgear concept | 03 GridShield® recloser and control cabinet | 04 Battery energy storage

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Implementing Distribution Grid Automation

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Automation technology

The second layer of the distribution grid automation architecture is the automation technology. ABB provides dedicated Intelligent Electronic Devices (IEDs) for the protection, control, measurement and supervision of all power equipment or ‘actuators’ such as reclosers, breakers, switchgear, capacitor banks and tap-changing transformers, across all industry standards and grid topologies. When deployed and integrated with the power technology layer, these IEDs impart local intelligence to the grid.

Two-way communications between different locations in the grid and between those locations and the control center is needed to unlock the full potential of IEDs and bring system intelligence into the grid. Several options are available, but the preferred technology for secure communications within a distribution grid is wireless, as it offers lower costs and better scalability than wired technologies.

Coordinating devices in an automated grid requires a Distribution Management System, with a geographic model of the grid. This may either be deployed in a control room or on substation-grade computers, installed in the main distribution substations that feed the area to be automated.

The higher the number of sensors and actuators that can be addressed and controlled within the area, the greater the effectiveness of the application. However, it may be preferable to determine the optimum number of sensors and actuators to integrate and their locations, to achieve the desired performance. This can be achieved through analysis of the distribution grid using simulation techniques.

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01 Relion® family of intelligent electronic devices (IEDs) | 02 Packaged solution for remote monitoring of a distribution substation

Integrated control and enterprise software

The integrated control (OT) and enterprise (IT) software available in ABB Distribution Grid Automation solutions eliminates traditional OT and IT silos, enabling operators to benefit greatly from convergence and data sharing that contributes to improved system performance, reduced costs and enhanced customer satisfaction.

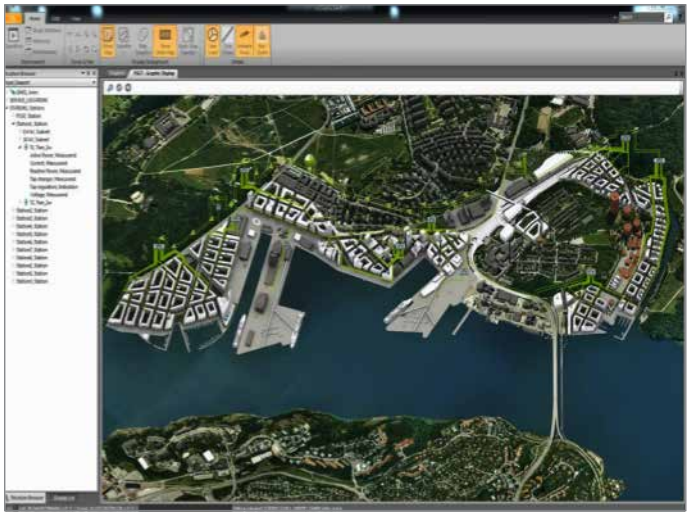
Ventyx, the software business inside ABB, has developed a total distribution management concept based on this principle. It combines real-time and near-real-time data, system modeling, visualization, simulation and integration of all major systems used in distribution operations, to provide a new way of managing and operating distribution networks. The result is two comprehensive IT/OT integrated software solutions:

– Ventyx Distribution System Optimization solution
– Ventyx Outage Lifecycle Management solution.

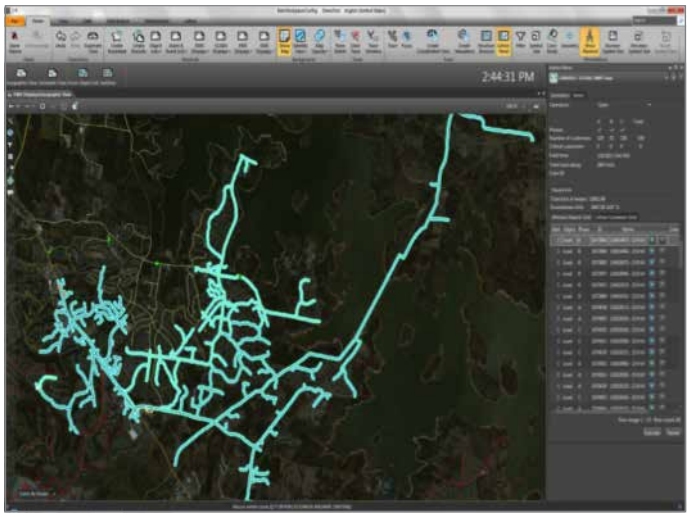
In these solutions, Advanced Metering Infrastructure (AMI) data is combined with network data from the supervisory control and data acquisition (SCADA) system to construct a single network model. This model, which explicitly represents the system connectivity and electrical characteristics, is shared across both the Outage Management System (OMS) and the advanced Distribution Management Systems (DMS) applications. The integrated SCADA, OMS, and DMS interface with other IT systems.

An advanced business intelligence system, with KPIs developed specifically for distribution grid operators, connects to all the systems and provides meaningful analytics and information, tailored to individual needs.

Furthermore, integration of DMS applications with other enterprise systems (such as demand response management systems, business intelligence applications and Outage Management Systems) delivers additional value.



Distribution Management System view



Volt/VAr Optimization view

Real-world Distribution Grid Automation solutions

All of the ABB core technologies needed for advanced Distribution Grid Automation are proven, commercially available and installed in distribution networks around the world.

The installations described here demonstrate the scope of applications, benefits and advantages of ABB technology and expertise in real-world projects. The individual circumstances, starting points and goals of each project were different. However, the benefits have been the same in all cases: access to unmatched expertise in Distribution Grid Automation has delivered the efficiency and intelligence to improve customer service and ensure high efficiency and reliability.

Outage lifecycle management

Outage lifecycle management – CenterPoint Energy, Texas, USA

CenterPoint Energy in the USA has deployed an ABB Ventyx Outage Lifecycle Management solution as part of an initiative to significantly increase power reliability in the Houston metropolitan area. This provides advanced DMS functionality, integrated with outage management, business intelligence and mobile workforce management software. CenterPoint has been able to improve fault detection, outage management and maintenance of grid assets.

CenterPoint's program also includes networking more than 2.2 million smart meters, automating up to 200 distribution feeders and around 30 substations and constructing an intelligent self-healing grid based on Ventyx software.

Mesh communications – Avista, Washington State, USA

US utility Avista has implemented a smart grid demonstration project in Pullman, Washington State, encompassing an automated distribution system, advanced metering infrastructure, a customer web portal and a demand response pilot project.

Avista installed an ABB Tropos private distribution area wireless broadband network as the foundation of smart grid communications. This enables real-time communication between the utility's data center, substation controllers and distribution grid automation devices – for applications including automated metering, SCADA and mobile workforce automation.

Avista is now able to manage the distribution system and provide both automated and operator-initiated response to faults in distribution circuits and has benefited from increased efficiency and reliability.

Towards self-healing grids – Fortum Oy, Masala, Finland

ABB has deployed its fault detection technology and applications at the Masala substation operated by Fortum Oy in Finland. The substation relays have been completely renewed with ABB's Relion 615 Series and the automated grid equipped with cellular communications.

This solution has been extensively field tested, with 100 different types of faults induced in the Masala grid area (mostly earth faults) – near the substation, at the midpoint of the feeder and at each end of the feeder. Faults can now be located in real time to within 1–2 km, enabling the grid operator to isolate the right zone very quickly, with no need for manual sectionalizing. ABB's solution is also unique in being capable of also locating transient faults.

The success of the Masala field tests represent a significant step towards self-healing grids, with the long-term goal of automatic fault location, isolation and restoration across the whole distribution grid.

Renewables integration – MeRegio, EnBW, Karlsruhe, Germany

MeRegio is a collaborative project between EnBW (one of Germany's largest utilities), ABB and other industrial and academic partners. Using an area of southwest Germany as a model network, the project makes use of IT, OT and communications technology to minimize CO_2 emissions. As part of the pilot project, 1,000 smart meters with bidirectional broadband communication interfaces have been installed: 800 for private and industrial consumers, 150 for generation units and 50 for energy storage systems.

ABB provided the expertise in distribution grid automation and control, including the detection of bottlenecks and the optimization of network operation, for example, by minimizing switching operations during maintenance and the provision of forecasting nodal generation and demand.

The project successfully demonstrated how bottlenecks in the low-voltage distribution grid can be reliably predicted a few hours in advance – enough time for the advanced DMS and demand response functionality of the Distribution System Optimization solution to work to relieve the bottleneck.

Distribution system optimization, E.ON, Elnat, Sweden

ABB is helping E.ON in Sweden to build on its existing SCADA system, using its Distribution System Optimization solution for business analytics, network optimization, load forecasting, demand response and distributed resource management.

By combining IT and OT in E.ON's smart grid control center, the utility will achieve a higher degree of grid automation, sensing and visibility, giving it greater control of distributed generation and supporting regulatory compliance.

E.ON's new smart grid control center will provide greater awareness of the state of the network through improved forecasting based on real-time and near-real-time operational data, weather data and neural network algorithms. It will also optimize reactive power flow and voltages (helped by more accurate forecasts of load and distributed resources, combined with network switching analytics) and provide more accurate monitoring and control of power flows between the transmission and distribution systems through load control/ demand response. Furthermore, it will also provide accurate prediction of congestion caused by renewable generation (mainly wind farms) based on weather forecasts.

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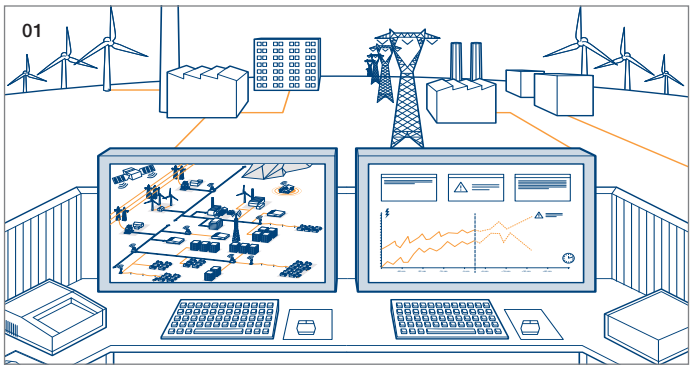

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01 Smart grid control center I 02 Renewables integration I 03 Self-healing grids

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