BE SMART

Electricity is the most versatile and widely used form of energy and its global demand is growing continuously. However, because most of today’s electrical energy generation capacity relies on fossil fuels, it is currently the largest single source of carbon dioxide emissions, making a significant contribution to climate change. To mitigate the consequences of climate change, the current electrical system needs to undergo significant adjustments.

In the fight against climate change, clean renewable power generation by the pulp and paper industry as well as intelligent transmission and distribution network – Smart grid – may have an important role to play.

“Smart grid” cannot be strictly defined. It can be considered as a concept for modernizing power systems by integrating the electrical and information technologies. The integration covers the whole system, from generation, transmission, and distribution to consumption. At the low voltage level the solution is usually called a Microgrid.

When we speak about Smart grid, we have better networks with conventional distributed and, especially, renewable generation units and storage connected to the consumer point. The same customer may act both as a power producer and a consumer. This requires bi-directional power flow capability in the supply network connection point and in the other parts of the supply network, too.

With distributed intelligence and sophisticated information and communication technology (ICT) and with distributed intelligent devices (IED), more can be done locally at the switchgear or even at the device level, to allow operators and computing resources in the control room to operate more effectively.

The state of the system is known and monitored online constantly due to the increasing amount of information from the system. The system is provided with controllable intelligent devices, which can automatically operate to sustain the balance between supply and consumption, to keep power quality on a high level and to improve reliability and availability.

ABB describes Smart grid by broad characteristics rather than specific functions. So the Smart grid is:

**Adaptive:**
Automatically responding rapidly to changing conditions.

**Predictive** in terms of applying operational

*Fig. 1 - FUTURE GRID*
data to equipment maintenance practices and even identifying potential outages before they occur. 

**Integrated** in terms of real-time communications and control functions.

**Interactive** between customers and markets.

**Optimized** to maximize reliability, availability, efficiency and economic performance.

**Secure** from external attack and naturally occurring disruptions.

Specific examples of how smart technologies can affect 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.

This Smart grid differs from the conventional distribution system by two-way real-time communication, intelligent digital metering, remote monitoring and predictive, condition-based maintenance, distributed generation, power flow control, pro-active, real-time protection and islanding, self-healing capability, and network topology complexity.

**INDUSTRIAL SMART GRID**

**Industrial network specialities:** An industrial power distribution network forms a good starting point for the gradual development of Smart grid functionality. The Industrial power distribution network already has a great deal of intelligence and functionality. In many cases the equipment has local intelligence and processing capacity, and local data and measurement results are obtained from the equipment and the process. Devices in multi-vendor systems communicate and operate mill-wide with each other.

Most of the features of Smart grid concept are also desirable in an industrial power supply network, which can form part of a wide Smart grid. Smart grid is also easier to configure in an industrial distribution network than in a public utility network. There is only a limited number of common coupling points (CCP) to the external public power supply and usually only one consumer customer, which also has its own generation capacity (renewable or conventional). Besides, distribution distances are limited. Power density inside the factory site is often very high and the distribution network is heavily loaded. Two parallel network structures, power distribution network and communication and information network, together form the infrastructure for a Smart grid.

In this environment it could be easier to understand and implement the Smart grid concept, because some of the regulations for public power transmission and distribution, such as islanding, open market place, power quality requirement and so forth, are not valid here. Also there is no fluctuating
power generation to worsening the power quality in the system. Actually many of the Smart grid features and operations are already implemented inside the industrial network. Even the bi-directional power flow capability in CCP already has been realized in many cases.

Because electricity is a raw material for the production, it must be available in a reliable manner, whenever required by the process. Thus, availability and reliability are the most important features of an industrial power distribution network.

Power generation units in the industrial distribution network may be large (in a range of hundreds of MW). During disturbances in the external supplying grid, the transmission operator wants to keep these generator units connected to the network to support stable frequency and voltage levels in the transmission grid. During hazardous faults, short-circuit or earth faults, and during longer lasting interferences industrial plants want to keep their processes alive as far as possible. For this reason, during hazardous grid interferences, an industrial plant is operated in most cases in the islanding mode separated from the external power supply.

Power quality and energy efficiency are also important factors for keeping production costs at their minimum. Grid operators penalize consumers for too high reactive power and harmonics levels, which also reduce the active power distribution capacity of the network. It is profitable to provide industrial distribution networks with proper reactive power control and correct harmonic filtering.

Features of the Industrial Smart grid: The structure of the network must be carefully designed so that only the controlled short time overloading of the system may occur in some parts. Moreover, alternative supply paths and isolation of a possible faulty part of the network can be implemented if required. In many cases parallel CCP and main transformers are better than only one large unit. If the sum of the fault currents exceeds permissible limits, current limiters may be used between parallel systems or sufficient operational values may be selected. Self-generated power does not always cover 100% of the process power needs, so any shortage must be bought from the open markets and supplied from the external network. The amount is highly dependent on the market price. If the price is high enough the existing extra power may be sold to the markets and be fed into the external network. This needs two-directional capability (protection, power measurement and so forth) in the CCP.

Communication and control: IEC61850 is the leading communication standard. Different protocols and signals, such as simple binary I/O contacts, time-critical protection signals, voice communication, low speed SCADA, video surveillance, high-speed data transfer, Internet access, and LAN connections, are connected by multiplex technology for high capacity communications systems so that multi-vendor environment forms an unity with common information sharing. Both hard-wire and optical fibers as well as wireless solutions are applied. DCS/Scada connection may be implemented via older priority solutions and leading standards like IEC61850. At the limited department level controllers alone may have sufficient functionality for control and monitoring purposes.

Multi-parameter protection and control functions are more and more common. In the hazardous protection functions however the maximum operational speed of the protection is needed. In these cases the GOOSE solution is used for interlocking and fast operation of protection.

Intelligence: The "backbone" of the Smart grid is ICT. Coordinated control and distributed automation

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**ABB's Unified Integration Approach**

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**Fig. 3 COMMUNICATION AND INTELLIGENT CONTROL SOLUTION**
and monitoring systems, distributed intelligence of devices, interaction of control system and operational devices, and communication of the measured data for control and decision purposes make the grid smart. The operator may have different type of Artificial Intelligence supporting tools, which may automatically operate, or may give operational instruction in different cases. There are tools for power quality control, like load shedding, transformer on-load tap changer control, control of filtering banks, generator excitation control, reactive power control and so forth.

The state of the system and the operational condition of equipment must be known all the time. Information from different parts of the network and equipment must be delivered for estimation and decision-making. Predicting slow-growing faults may also be possible in specific cases, for example, decreasing operational capability of a motor may be predicted by a slowly increasing trend of the operational temperature.

The loading status of the network and individual equipment is required for optimal power flow control. Also, operational condition monitoring such as the circuit breaker operation calculator with the information of the value of breaking currents gives extremely valuable information for further service planning. Because the individual equipment may have an individual address of its own, the information of the unit may follow its master, even if the equipment moved into another position in the network. This is part of the assets management process.

Data for maintenance and service as well as for system monitoring are produced either by an additional measuring devices and sensors, or by using the existing intelligent devices in the system, such as protective relays, process controllers, intelligent motor controllers and so forth, which use the measured local information and are connected to the information fieldbus.

**Protection:** If the operational structure of the network is changed, operational parameters of the intelligent protection may be reset by the control system so that the sufficient protection level remains. Moreover, in hazardous cases, some overloading is permitted for avoiding larger damages, or for example, transformers may be overloaded temporarily in a controlled way.

If a fault (short-circuit fault for example) occurs, the protection operates immediately. Then the control unit may define the location of the fault, make automatically isolation of the minimal part of the faulty network, and rearrange the new power feeding routes minimizing the consequences.

If the external power supply collapses, the millwide network is operated in the islanding mode. Depending on the share of the self-generated power capacity, less important loads will be isolated by the emergency load shedding function. In this way the most important parts of the process can be kept alive and thus minimize consequences.

**What is possible today?**

ABB has a wide variety of intelligent communicating products and equipment, which match well with the present gradual development of the Smart grid.

Instrumentation solutions and sensors give direct measurement data about the process.

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**Where it has been implemented**

ABB has implemented several intelligent complete solutions for industrial power distribution around the world. The systems' level of intelligence has increased and it is one of the key factors for competitiveness, especially in large mills. Many of the above mentioned features, including load shedding, islanding operation and reactive power control, have been adopted by existing mills and greenfield projects, so called "Composite Plants", during the last 15 years, and ABB has implemented them by either adopting existing structure and technology or by using the state-of-the-art solutions all around the world.

ABB delivers to mills with Smart Grid capabilities in the electrical power distribution system, include:

- Visy Paper, Australia
- APRIL, Kerinci, Indonesia and Rizhao, China
- Stora Enso, Kvamsveden, Sweden
- UPM, Pietarsaari, Finland
- APP; Gold East Paper, Dangang, China
- SCA, Ciudad Sahagonin, Mexico
- Sappi Saimcor, South Africa.
Information about the status of the system is gained from intelligent devices like protective relays, or direct measurements by installed sensors.

The intelligent motor control center with motor starters gives valuable information from the process interface.

Distribution transformers give information about loading state and maintenance needs as well as temperatures and power flow distribution of the network.

IEC 61850 is a dominating concept for industrial communication today. This also guarantees the flexible use of multi-vendor equipment or earlier product versions of ABB products.

Power distribution control (PDC) concepts and solutions with distributed automation and monitoring systems consist of several solutions such as emergency load shedding (ELSS), reactive power control (RPCS), on-load tap-changer control, generator excitation, etc.

Protection is part of asset management. By a sophisticated protection the fault duration and consequences remain as minimal as possible and elimination of the faulty part and quick recovery of the production process are possible. The sequence of the incident may also be recorded for later analysis purposes.

CONCLUSIONS

Electricity energy demand will keep increasing. Climate change and energy efficiency requirements will be the dominating drivers when selecting electrical distribution solutions and devices. Only equipment based on low carbon impact and energy efficient technologies are recommended for the future markets.

For improving usability, reliability and availability of the future distribution network, new initiatives are needed, such as high efficient motors, low loss transformers and a Smart grid concept, which represents many of the desirable features of the ideal future grid.

At the utility level, standardization is seen as necessary at the early stage for getting equal procedures and products for Smart grid realization as a whole. It is the first step to open multi-vendor concept and a common understanding of necessary measures that must be taken to ensure the functionality, usability, reliability and safety of the system in commissioning and use. This has happened already in some other energy technology fields such as wind and hydro power.

First versions of the Smart grid are a reality today in power distribution networks in the pulp and paper industry. The intelligence level of the present technology in old sites and the interest in new investments into the functionality and energy efficiency of the distribution network define the schedule for Smart grid expansion inside the pulp and paper industry. The cost of energy as a raw material is getting higher and thus Smart grid will be profitable solution in the future.

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