Background information

Smart grids
A far-reaching evolution in the power supply system

The grid we know cannot support the increasing demands we place upon it. Renewable energy, small-scale power generation and a variety of other factors are converging to drive the development of the intelligent grid of the future.

The most versatile and widely-used form of energy is electricity, which is accessible to more than five billion people around the world. The power grids that make this possible are the largest machines ever constructed and at night are even visible from space.

Today's power systems are based primarily on large-scale fossil fuel, nuclear and hydropower generation plants that supply electricity over long-established transmission and distribution systems. These systems have served the world well for more than a century, however times are changing. Demand for electricity is growing fast because of rapid social development in many parts of the world, but also because modern, digital economies increasingly depend on electricity. This dependence increases the requirement for utilities to avoid disturbances to the grid, which are already costly for economies.

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At the same time, societies have come to understand that energy consumption must generate fewer emissions to combat climate change. Traditional power sources must be used in the most optimal manner possible and new electrical capacity must be derived from a greater variety of non-traditional sources including wind, tidal, solar, biomass and geothermal plants. This is creating a greater variety and number of generation sources that present significant challenges for the power system.

Weather patterns affect the availability of wind and solar power, and the emergence of distributed power generation (small-scale rooftop solar panels, for example) will complicate matters further, requiring local networks to receive as well as deliver power. The grid itself is also being used in new ways. Instead of serving a relatively small geographic area with connections to other regions primarily to ensure reliability, the grid is now being used as a highway for energy trading over longer and longer distances.

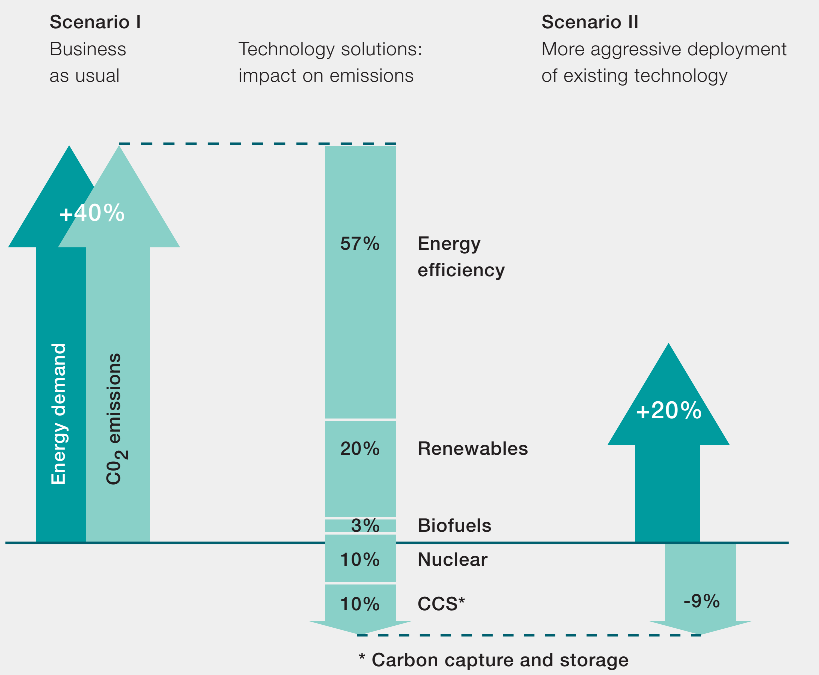
The grid as we know it today was not designed for any of these changes, and as such is simply unable to meet our demands over the long term. The grid must evolve, and that evolution must be comprehensive and far reaching.

The measures required include:

- the use of new design concepts and advanced materials in system components like transformers and circuit breakers to improve efficiency, safety and operational performance
- the more widespread use of power electronic devices to maximize existing assets and make the grid more resilient in the face of disruptions
- energy storage technologies for use at all levels to mitigate peaks in demand and enable more renewable energy sources to come online
- more flexible methods of transmission and distribution to accommodate fluctuations in supply, increase efficiency and optimize system operations
- powerful monitoring and control systems to prevent disruptions before they occur

The term "smart grid" refers to all of these features, linked together into a system by communication technologies.

A. Evolution of energy demand and carbon dioxide emissions, 2007-2030



Source: IEA World Energy Outlook 2009
World leaders at the climate conference in Copenhagen in December 2009 agreed to work toward limiting the increase in global temperatures to 2ºC by the end of the century compared with the pre-industrial era. The IEA's scenario II would set the world on course for achieving this target. However, the successful deployment of the technology solutions identified here will require considerable development and adaptation of the power grid.

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Pike Research, a market researcher, estimates that about $200 billion will be invested in smart grid infrastructure worldwide from 2010 to 2015.[1] More than four-fifths of this will be spent in areas of ABB expertise, namely power transmission, substation automation and distribution automation.

The big picture

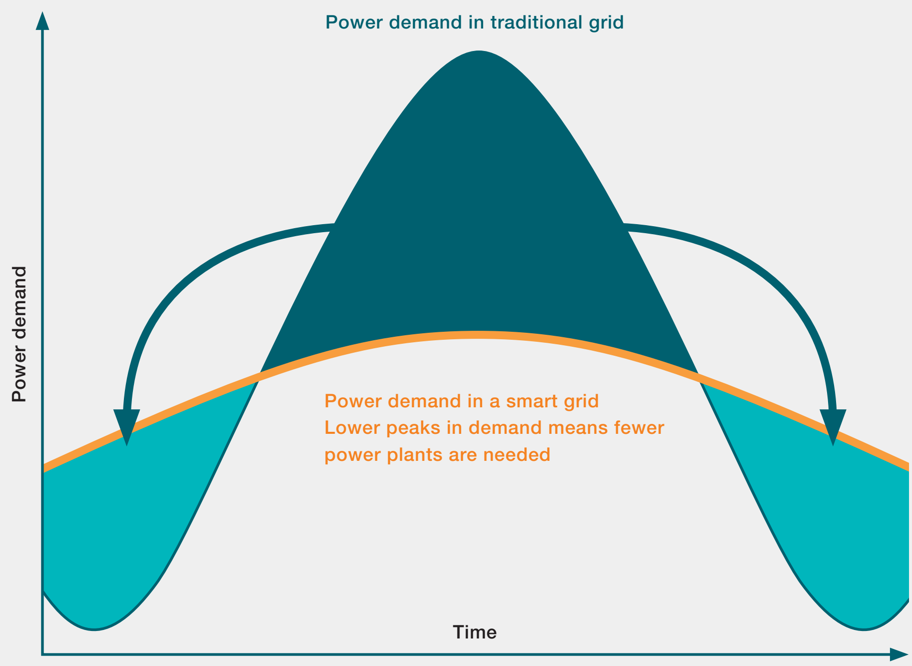
Under current policies and trends, global energy demand is predicted to increase by 40 percent by 2030, and carbon dioxide emissions are expected to rise in tandem.[2] The scientific consensus is that an increase in emissions on this scale is likely to have a significant economic, environmental and social impact.[3]

The engines of energy demand are population growth and rising living standards in emerging markets, which will continue to drive up energy consumption. The challenge is to break the link between economic growth and energy demand and the link between energy and carbon dioxide emissions.

The International Energy Agency has mapped out a strategy for the next two decades that would address both of these goals by more aggressively deploying a range of existing low-carbon technologies (see Figure A). In this strategy, more than half of the savings come from the implementation of energy efficiency measures and a fifth come from an increase in renewable power generation.

Adapting the electricity supply system is crucial to the success of this strategy for two reasons. First, power generation accounts for the largest share of man-made emissions of carbon dioxide, and contributes more than 40 percent of global energy-related CO_2 emissions. Second, electricity consumption is growing almost twice as fast as overall energy consumption, making it increasingly urgent to curb the emissions associated with generation.

B. A smart grid can level peak demand, reducing costs and emissions



In a smart grid, "demand-response" technology shifts some demand to periods when power is cheaper
In a traditional power grid, spikes in consumption at certain times of day are partly met by switching on power plants that are kept on standby to meet such peaks. This approach is both costly and inefficient, much like how stop-and-go city driving is less fuel-efficient than driving long distances at a constant speed. In a smart grid, data sharing between users and suppliers allows electricity use to be spread over a longer period, flattening demand peaks and reducing the number of power plants needed to meet demand.

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Rethinking the way we manage electrical energy

Reducing emissions at the source is only one approach to cutting CO_2 levels. As the IEA analysis illustrates, improving energy efficiency is by far the single most important means of curbing primary energy consumption. Using energy more efficiently is therefore the primary goal of the future electrical system, requiring the deployment of energy-efficient technologies at every stage, from the generation, transmission and distribution of power to its end use in industrial, commercial and residential facilities.

In addition to lowering consumption, the intelligent grid of the future must be capable of lowering peak levels of demand by distributing consumption more evenly throughout the day. In this way, less reserve capacity will have to be kept on standby to meet maximum consumption levels, and utilities will gain the flexibility they need to manage sudden changes in the supply of electricity from their growing portfolio of renewable energy plants.

This will require some significant changes in the way supply and demand are managed.

Electricity is perhaps the most perishable of all commodities—it must be consumed as soon as it is generated, but it also must be generated at the moment it is required.
Today, demand is largely uncontrolled: utilities increase production of electricity when demand rises, (eg, when people return home in the evening and switch the lights on, cook, watch TV, etc.) and decrease production when demand subsides.

In an intelligent grid, demand will be more actively managed, allowing grid operators to more easily balance it with supply. In order for this to happen, monitoring and control features must be available to the end users of electricity, providing individual consumers with detailed information on how and when they use electricity, and showing them how they could actively contribute to a reduction in peak demand.

Real-time communication between suppliers and consumers of electricity will enable users to react directly to changing conditions and prices, although they might sometimes opt to allow the utility to curtail their consumption, cycling certain appliances to ensure demand doesn't exceed the available supply of electricity.

This is the essence of what the utility industry calls "demand-response," which aims to flatten peak demand as consumers shift their non-essential energy consumption to off-peak periods (see Figure B). It remains to be seen to what extent such direct, two-way communication will be used and how much it can contribute to reducing peaks in demand, but the underlying technology is already available.

The challenges of renewable energy

The IEA predicts that global electricity generation from renewable sources will rise significantly by 2030 through a cumulative investment of $5.5 trillion,[4] which represents about half of all projected investments in electricity generation for the period.

While the environmental benefit of reducing dependence on fossil fuels is clear, incorporating large amounts of renewable power and small-scale power production is a big challenge for the stability and availability of electrical energy.

The greatest challenge stems from the intermittent nature of renewable energy. Although hydropower provides a very predictable electricity supply, the availability of most renewable resources can quite literally change with the wind. Power generation in wind farms is characterized by periods of high productivity followed by lulls in calmer weather, and the performance of solar plants wanes during cloudy weather and at night (see Figure C).

In addition, there is no widely available, practical and affordable way to store large amounts of electricity generated in periods of low demand, which means what is not used as it is produced goes to waste. The most cost-effective storage method involves pumping water uphill into dams, but is only available in mountainous regions with hydropower capacity.

Businesses suffer huge inefficiencies if power is interrupted, even for a short time, through loss of production time and the additional energy cost of resuming normal operating conditions. A 2005 report[5] estimated that electric power outages and blackouts in the US cost the national economy about $80 billion a year. The bulk of the losses, $57 billion, was in the commercial sector where large numbers of consumers are affected by each interruption. An estimated $20 billion was lost in the industrial sector, where the disturbances affected fewer individual consumers, but each at a greater individual cost. Additional problems are caused by dips in power quality, voltage surges and sags that can affect the performance of electronic devices and even permanently damage valuable equipment. Utilities are therefore keenly aware of the importance of maintaining a reliable supply of high-quality power, and they go to great lengths to ensure that supply remains intact.

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Adding large amounts of renewable power will not necessarily mean more blackouts, but it will mean more investments in smart grid technologies that enable fast and effective containment and correction of disturbances in the power system. A “self-healing” grid will only become more important as the world’s economies become increasingly reliant on electricity. A further challenge of renewable energy is the location of these sources. Large-scale sources, offshore or out in the desert, are often far from the centers of demand, while small-scale producers are often in light-industrial or residential areas where the local distribution grid is not set up to receive as well as deliver electricity.

Compared with the highly predictable performance of more traditional generation plants, most of which can be built near to the communities they serve, renewable power seems less than perfect. But many of the technologies needed to overcome the challenge of using renewable power are already in use, while others are being developed. As more renewable generation comes online, the grid is evolving to accommodate it and provide reliable electricity supplies that will meet demand, sustainably.

Electric vehicles and storage

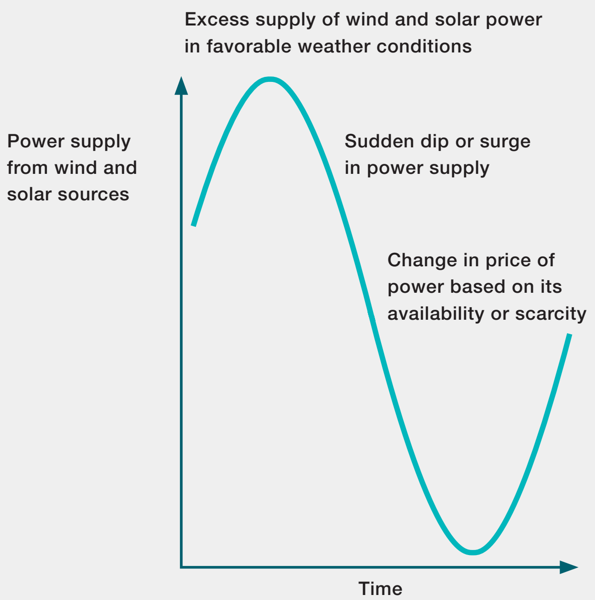
Electric vehicles could sizably reduce greenhouse gas emissions in the transport sector. The size of the reduction would depend on the fuels consumed to generate the electricity they use. In the UK, carbon emissions resulting from the use of electric vehicles would be about 40 percent less than those from conventional vehicles,[6] while the carbon abatement potential of electric vehicles in China, where power generation is more dependent on fossil fuels, would currently be only about 19 percent.[7]

Yet if electric vehicles become widespread, they will have an impact on the electricity network. If, for example, 20 percent of all new vehicles were electric (which may happen over the next 10 years in highly motivated localities such as southern California),[8,9] recharging them could represent up to 2 percent of total electricity demand.

Charging facilities for electric vehicles are becoming more widely available, but to realize the full potential of these vehicles, a number of technology advances need to be made. The cost of car batteries must be reduced significantly and

C. Renewables pose special challenges that need to be managed by technology

Challenges:



Technology solutions:

Largely available | Progressing | Emerging

- Interconnections between grids enable export of excess supply or import of other regions' excess power when supply drops (Largely available)
- Storage allows excess power to be used in less favorable weather conditions (Emerging)
- Transmission technologies ensure sudden fluctuations in demand don`t affect quality of power supply (Largely available)
- Information technology enables utilities to manage fluctuations by forecasting supply and demand planning capacity, and automatically adjusting power generation (Progressing)
- “Demand-response” technologies enable consumers to adjust their consumption automatically (Emerging)

The growing use of weather-dependent sources of electricity will introduce new variation in the supply and quality of power in the grid. Many of the technologies needed to overcome the challenge of using renewable energy on a large scale are already in use, and others are under development.

many more charging stations must be built.

When it comes to creating a smarter grid, the concept of using electric vehicles to store surplus electricity as a back-up source of power is particularly interesting. Most cars are driven only for an hour or two a day, and are otherwise idle.

Utilities could potentially use the batteries of parked electric vehicles while they are connected to the grid to store electricity when it is plentiful. When on the other hand electricity is in short supply, electric vehicles could provide short-notice reserve power to meet demand peaks – both relieving pressure on utilities to provide reserve generating capacity and providing monetary reward to car owners.
Whether such a scenario will be realized is uncertain, but the idea is attracting interest because few other means of storing electricity on a large scale are available.

D. The future electrical system must meet four requirements of society

Capacity

The International Energy Agency expects demand for power will almost double by 2030. That would require building a 1 GW power plant and related grid infrastructure every week for the next 20 years.

Sustainability

Expanding capacity with the current power generation mix dominated by fossil fuels would increase CO_2 emissions. The grid of the future needs to accomodate alternative forms of power generation, especially renewables.

Efficiency

The IEA says that using energy more efficiently has a greater potential to curb CO_2 emissions over the next 20 years than all the other options put together.
The future grid must help consumers do more with the power they use.

Reliability

Disturbances to the power supply are costly ($80 billion annually in the US alone[10]).
Rising demand and the use of renewables that depend on the weather pose challenges to stability which must be mastered.

Smart grids
ABB solutions

The grid of the future will be an enhanced version of today's network, with more extensive monitoring and communication systems, new grid interconnections, two-way flow of power and information, electricity storage facilities, and a larger portion of distributed and renewable generation. The system will be highly automated to ensure the availability of reliable, energy-efficient power supplies to industrial, commercial and residential consumers, on demand.

ABB's vision for a smart grid is an intelligent system, based on industry-wide standards, that provides stable, secure and environmentally sustainable electrical energy. The system will be able to cross national and international boundaries, so that power systems in neighboring regions can trade energy, and it will be equipped with rapid-response monitoring and control systems that will automatically contain and correct faults to ensure that high-quality electricity is available to consumers, balancing supply and demand.

This vision is now being put into practice. For example Denmark, which derives 20 percent of its electricity from wind, is able to operate a stable power grid with the help of high-voltage DC connections to the networks of neighboring Norway, Sweden and Germany, all supplied by ABB. Denmark exports excess electricity via these interconnections, and imports power when its wind farms are generating too little.

Another example is the way utilities are using recent advances in computing and communications technologies to process detailed up-to-the minute information on network conditions at literally thousands of points in the grid. These data will give consumers the opportunity to play an active role in the grid, enabling them to make informed decisions about how and when they use electricity, even helping them to generate their own power and feed surpluses back into the system.

While a fully smart grid is still a vision for the future, the technologies and standards that will be needed have been the subject of research at ABB for some years now and many are already in use. With a broad range of power and automation technologies, ABB is taking a leading role in providing an integrated solution for the development of the smart grid. The following section provides an insight into some of the ABB technologies already in use that are turning the vision of the smart grid into reality.

Optimized power generation

The efficiency of power generation varies widely with the fuel and technology used. In traditional coal-fired plants, 30 to 35 percent of the fuel consumed is converted into electricity. In combined heat and power plants, which use a variety of fuels and share the heat they produce with nearby buildings, efficiency can reach 85 percent.

Significant efficiency gains can be made by optimizing operations and auxiliary systems in all types of power plants, using sophisticated control systems and energy-efficient equipment. ABB is the market and technology leader in most such auxiliary systems, which can reduce the energy consumption of an existing facility by 10-30 percent.

The development of more intelligent power systems, with detailed consumption data and more accurate forecasting of renewables, will help generation companies to make better use of existing generation capacity. Control systems within power plants can now help even large-scale generators to respond more rapidly to changes in demand and reduce the reliance of utilities on less efficient reserve capacity to meet peaks in demand.

Network management and wide-area monitoring

ABB network management and utility communication technologies enable the evolution of smart grids by providing real-time management of transmission grids, distribution networks, power plants and energy trading markets.

In 2009, such a solution integrated transmission and distribution networks in the southern Indian state of Karnataka into a single system. Energy audit and billing systems for 16 million customers are now available in a single platform.

These technologies collect, transmit, store, analyze and reliably communicate critical data from thousands of data points across power networks and over large geographical areas. Large-scale integration of renewable resources, regulation of two-way distribution grids, long-distance transmission, and incorporation of electric cars and charging facilities would be impossible without these technologies.

Wide-area monitoring improves performance of network management systems by enlarging the area the systems can see. Satellite communications can quickly access information from neighboring grids, and use it to prevent the development of widespread faults.

Automated substations

Substations monitor, protect and control the transmission and distribution of electricity. In future, these vital installations will need increasingly sophisticated communications systems to share data with different parts of the grid, coordinate power flows, and deliver power to consumers reliably and efficiently.

ABB helped develop and implement IEC 61850, the first global communications standard for substation equipment and a

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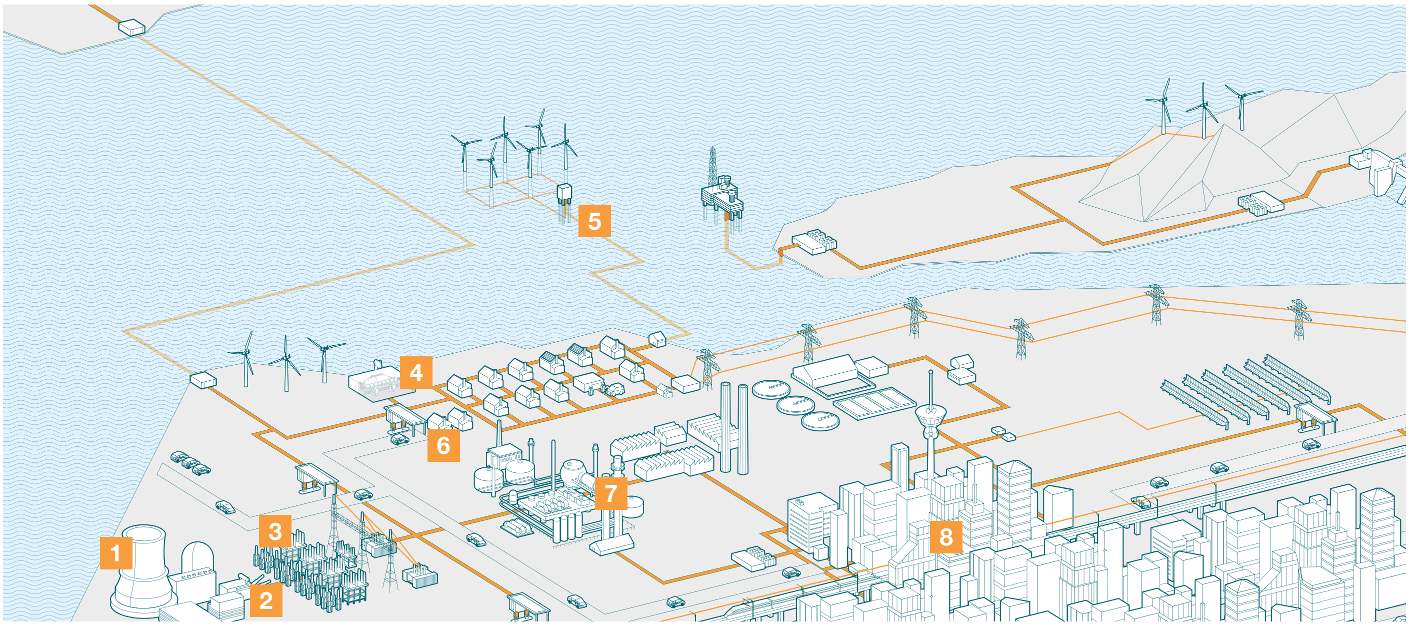

[1] Optimized power generation
[2] Network management
[3] Automated substations
[4] FACTS and energy storage
[5] High-voltage DC transmission (HVDC)
[6] Electric vehicle infrastructure
[7] Energy management systems
[8] Active buildings

significant breakthrough in substation automation technology. It makes possible real-time communication between substation devices, regardless of the manufacturer, and as a result is a key component of smart grid development.

ABB has delivered hundreds of IEC 61850 systems and thousands of products for new and retrofit installations in more than 60 countries, enhancing the performance, efficiency and reliability of substation operation.
These include the world's first multivendor IEC 61850-compliant substation, as well as the substations serving the world's largest operating hydropower plants: Itaipu in Brazil and the Three Gorges in China.

FACTS and energy storage

FACTS (Flexible Alternating Current Transmission Systems) is a generic term for technologies that dramatically increase the capacity of existing electrical transmission lines, while maintaining or even improving a power system's stability and reliability.

They make long-distance power transmission more efficient by removing bottlenecks, and safely feed intermittent energy sources like wind and solar power into the grid. FACTS installations are making an important contribution to the development of smarter grids.

In addition to stabilizing current and voltage, ABB's latest FACTS technology provides energy storage capacity, an important feature as renewable energy becomes a larger part of the generation mix.
Large-scale storage capacity (up to 50 MW for an hour or more) can smooth the erratic productivity of renewable power plants, and provide emergency power after a blackout.
ABB has delivered more than half the world's FACTS installations (over 700). Using existing capacity more efficiently and safely results in a smooth-running, reliable grid.

High-voltage direct current (HVDC)

Pioneered by ABB in the 1950s, high-voltage direct current is a revolutionary transmission technology that will become increasingly important as smart grids develop.

With HVDC, power providers improve the reliability of their networks by interconnecting neighboring grids (even those running at different frequencies) and by trading electricity.
The technology also ensures that power from intermittent sources of renewable energy is fed into the grid at a voltage level which maintains stability of the power supply.

In addition, HVDC can transmit large amounts of power efficiently over long distances, making it the ideal technology to deliver power from remote sources to the centers of demand.

In this way, offshore wind farms and hydropower plants in distant mountainous regions become commercially feasible. Major cities like Los Angeles, São Paulo, Shanghai and Delhi already rely on HVDC to deliver electricity, often from thousands of kilometers away, with remarkable efficiency and minimal environmental impact.

Electric vehicle infrastructure

ABB is developing technologies to prepare smart grids for the challenge of electric vehicles, and provide practical charging solutions to meet the needs of car owners, service providers and grid operators.
Residential charging units need to deliver an efficient, low-power service that recharges a battery overnight, with minimal grid impact at a viable cost. Such units are available now, but the standards for widespread implementation are still being developed, and must ensure compatibility with vehicles of all types.

Public charging facilities must be robust and able to recharge a battery in a matter of hours, while the driver is at work, for example. They will also need to incorporate user authentication and/or payment systems. Ultrafast charging will provide a highway “fuel-stop” equivalent for electric vehicles, recharging a car battery in minutes.

ABB has installed basic charging stations in Scandinavia, which are now being developed to incorporate more sophisticated communication functions.

Energy management systems

In the grid of the future, more and more users of electricity will also become producers as they add solar panels or small wind turbines to their rooftops. Today, the only users that can participate in electricity markets in any significant way are energy-intensive industrial plants with sizable power generation facilities of their own.

Energy management software, such as ABB’s cpmPlus Energy Manager, helps industrial companies to manage their energy usage to maximize efficiency and cost savings. Opportunities for cost reduction are greatest when both electricity consumption and prices vary over time, which is common in the process industries and in the open electricity market environment.
The software indicates the cost of electricity and helps plant operators to schedule electricity consumption for off-peak hours. It coordinates electricity purchases and sales with its own generation capacity, then schedules this generation during on-peak hours, when purchased electricity is most expensive, to provide additional cost savings.

Active buildings

Commercial and residential buildings account for about 38 percent of global end-user energy demand, mainly for heating, cooling and powering electric appliances.

The consumption of buildings can be reduced with energy efficient technologies such as intelligent controls that adjust the heating temperature, lighting and energy consumption of electric appliances to the actual requirements. ABB products and systems provide energy savings of between 30 and 60 percent in these areas.

Today, such intelligent building systems operate independently of the power grid. In a smarter network, they will interact with the grid to give consumers greater control over the amount of electricity they use as well as when they use it. For example, customers will be able to configure their building automation systems so that the heating is lowered during periods of peak demand, or they may authorize a third-party or their utility to take such action on their behalf. This would help customers lower their electricity bills as well as enhancing the overall efficiency of the system.

To become fully integrated into the power supply network, buildings have to be equipped with meters capable of collecting more precise data about electricity consumption and of communicating with the utility’s distribution automation or network management solutions. ABB has a small business making smart meters under the Striebel & John brand in Germany, and in July 2010 announced it is taking a minority stake in US-based Trilliant Inc., which provides software solutions capable of integrating all home appliances into the grid.

Smart grids
Projects supporting the grid's evolution

ABB has delivered a large number of installations to raise the performance of existing power systems.

These help to deliver more power, including more renewable power, to more consumers, more reliably and more efficiently, by linking power generators to the grid, linking grids to each other, and raising the capacity, efficiency and stability of the grid as a whole.

But the projects delivered so far are only part of the story. ABB is also working on more than 20 pilot projects across the world to test new solutions and explore how existing solutions work on a large scale. These projects are looking at all aspects of the smart grid, from energy storage through network management, metering and communication, to distribution automation and home automation systems.

Boulder, Colorado: A smart grid comes to life

In 2010 ABB acquired Ventyx, a leading provider of industrial software for sectors such as energy, utilities and communications. The acquisition complements ABB's own energy management offerings, and the combined software solutions of both companies are useful in many energy sector applications, in particular the development of smart grids.

Ventyx software is at the heart of SmartGridCity in the city of Boulder, Colorado (pop. 95,000), which went online in 2009. SmartGrid City is the first complete and fully functioning smart grid demonstration project in the world, according to Xcel Energy, the American utility which designed and delivered it.

About 200 miles of fiber optic cable connect about 50,000 residential, commercial and light industrial customers to this automated grid, which provides much greater interactivity between customers and the utility. Real-time data gives customers more insight and control over their energy consumption, and helps Xcel to re-route power around bottlenecked lines, and identify and respond to outages much faster.

One of Ventyx's key software applications gives utilities and grid operators the information they need to better match electricity generation with consumption, even at the household level. By generating real-time information on electricity demand, pricing and availability, Ventyx's software enables a practical business model for utilities to generate revenues from smart grids and carbon trading.

Other Ventyx solutions such as load forecasting software can help power grids integrate large amounts of unpredictable renewable energy, such as wind and solar power.
The Boulder demonstration project is also a testing ground for "virtual power plants," a software innovation which precisely tracks and aggregates consumer demand and on-site generation, such as power from solar panels or wind turbines. This real-time information creates a new virtual power resource for utilities, and is a powerful tool for managing the complexities of a smarter grid.

The software operating SmartGridCity is confirming some smart grid theories about reducing power outages in the distribution system, and the value of monitoring grid status in real time. Early results indicate that smart grid technology is helping Xcel Energy predict equipment failure and proactively make the necessary repairs before an outage occurs.

Xcel Energy expects SmartGridCity to deliver some ambitious targets, including:

- 55 percent reduction of peak residential electricity demand, and 10 percent reduction of energy consumption
- 30 percent reduction in electrical distribution losses
- reduced carbon footprint

Stockholm, Sweden: A low-impact development in the heart of the city

ABB is working with the Finnish utility, Fortum, on a research and development project whose goal is to test the concept of a flexible, low-emission power network in the Royal Seaport section of Stockholm, a former industrial area which is now one of Europe's largest urban regeneration projects.

Developers rejuvenating this part of the Swedish capital want to produce a residential and commercial district where clean technologies will thrive and deliver high-quality living space with low environmental impact. A top priority for the new development is to make the best possible use of natural resources, including renewable power.

ABB and Fortum are working together to provide a power network that will ensure power generated from within the district (from sources such as rooftop solar panels or micro wind turbines) can be fed into the power grid for use in local homes and businesses. The project also hopes to provide charging facilities for electric vehicles, enabling them to both recharge their batteries and return power back to the grid, if needed.

In terms of scale, the Royal Seaport project marks a big step forward in the development of a smarter and more flexible urban grid that can integrate distributed and renewable energy sources. The new district will have 10,000 homes and 30,000 office spaces.

At the waterfront, boats will be able make use of shore-to-ship power connections similar to those ABB installed at the port of Gothenburg, so that they no longer need to use their onboard diesel generators when docked.

In addition to accommodating renewable power generation and electric vehicles, Fortum and ABB hope to establish a community of “active” consumers in Stockholm. This will mean equipping both residential and commercial premises with energy management technologies to enable consumers to monitor and control the way they use power. The aim would be to minimize waste and spread energy consumption across the day, avoiding periods of peak demand whenever possible. In May 2010, ABB announced a similar agreement for the Finnish capital, Helsinki. ABB, local utility Helsingin Energia and Nokia Siemens Networks will together design and install a smart grid network in the new Kalasatama district.

Friedrichshafen, Germany: More accurate balancing of supply and demand

In order to drive the development of particular smart grid technologies, ABB is collaborating with specialist partners in communications and information technology. In one such project, ABB is combining its expertise in power and automation technologies with those of communications specialist T-Systems, a subsidiary of Deutsche Telekom.

The aim of this partnership is to develop technologies that will provide electricity consumers and electricity producers with the information they need, in a form they can use, to change the way they interact with the electricity supply system. The project is centered in the southern German city of Friedrichshafen. The skills of ABB and T-Systems complement each other. ABB’s experience in power transmission and distribution, network management and energy trading systems, and T-system’s knowledge of broadband communications and telecommunications billing systems, will combine to help consumers and producers of electricity to balance supply and demand more effectively. Flexible tariffs that reflect real-time demand patterns, coupled with more sophisticated appliance control functions that enable consumers to take advantage of cheaper electricity will make better use of existing resources and accommodate energy sources such as wind and solar power, which are less predictable than traditional power stations.

Balancing supply and demand more accurately and making better use of renewable power sources are essential if the ambitious carbon reduction targets that have been set in many countries are to be achieved. Some industry observers predict that the share of power from renewable energy in Germany will be as high as 35 percent by 2020.

A level of renewable generation as high as this will add complexity to electricity distribution systems, resulting in fluctuating levels of power that will have to be carefully controlled. Without careful control, the system will operate inefficiently or suffer frequent interruptions.

Introducing more sophisticated communications and automation systems into the power system – developing a smarter grid – will help to stabilize supplies, accommodating renewable power and supporting efforts to combat climate change.

Smart grids
Further reading

From ABB:
www.abb.com/smartgrids
www.abb.com >> About ABB >> History >> ABB technologies
www.abb.com >> About ABB >> Technology >> Publications >> ABB Review >> ABB Review 1/2010
www.ventyx.com >> News >> Smart Grid News

Other:
US Department of Energy
www.oe.energy.gov >> Our Work >> Smart Grid >> The Smart Grid: An Introduction

European Union
www.smartgrids.eu >> What is a SmartGrid? >> Benefits

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1 Pike Research, December 2009. See: http://www.pikeresearch.com/newsroom/smart-grid-investment-to-total-200-billion-worldwide-by-2015
2 International Energy Agency, 2009. World Energy Outlook.
3 Intergovernmental Panel on Climate Change, 2007. The Fourth Assessment Report.
4 International Energy Agency, 2009. World Energy Outlook.
5 Lawrence Berkeley National Laboratory, February 2005
6 UK Department for Transport, 2008. Investigation into the scope for the transport sector to switch to electric vehicles and plug-in hybrid vehicles.
7 McKinsey and Co., 2008. China Charges Up: The Electric Vehicle Opportunity.
8 McKinsey and Co., 2009. Electrifying cars: How three industries will evolve. McKinsey Quarterly
9 More general predictions suggest that 10 percent of new vehicles in 2020 will be electric. Multiple sources, 2009: CS Investment Bank, Boston Consulting, Renault-Nissan, Roland Berger
10 Lawrence Berkeley National Laboratory (February 2005)