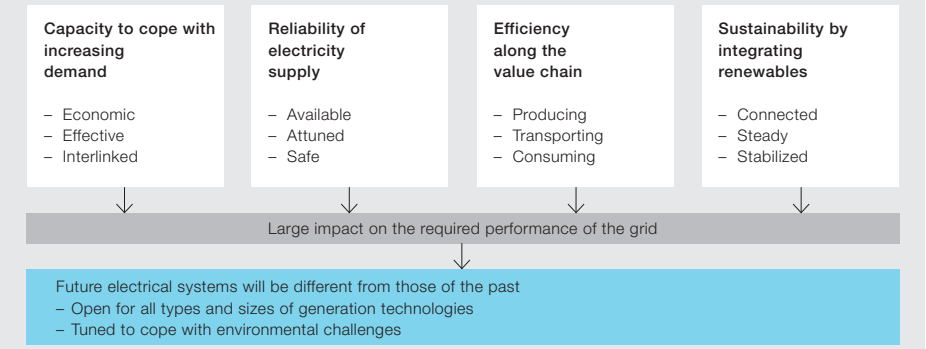
Smart electricity

Efficient power for a sustainable world

BRICE KOCH, BAZMI HUSAIN – Electricity is the most versatile form of energy used around the world. The infrastructure necessary to generate, transmit, distribute and consume electricity was conceived and designed more than 100 years ago and ABB has been at the forefront of technological innovations for electrical infrastructure from the very beginning. This infrastructure has served us well and has been a significant contributor to the industrialization and economic growth of the world in the last few decades. There is hardly any process in industry or any application in private life that does not use electricity. The demand for electricity is growing faster than any other form of energy in all parts of the world – most notably in countries undergoing rapid industrialization, such as China and India. At the same time, increasing digitization of economies is placing higher demands on the reliability of electric supply – even momentary disruptions cause huge economic losses.

Smart grid value proposition – four main areas of emphasis



A sobering fact today is that coal fuels more than 40 percent of the world's electric supply, making electricity generation the single largest and fastest rising contributor to CO_2 emissions. This fact combined with the growing need for electricity is driving a fundamental and exciting change in the electrical industry.

To successfully address the challenges new solutions are needed along the electrical value chain – generation must increase but at the same time contribute less to greenhouse gas emissions. Transmission, distribution and consumption of electrical energy must become more efficient.

Today, the way electrical energy is generated, transported and used is not efficient enough. Inefficiencies along the whole value chain lead to around 80 percent of losses from the primary energy sources to the useful consumption of electricity.

Although the growth rate of renewable energy generation is high, the contribution of renewable energy in the overall energy mix is still quite small. Renewable energy, especially that originating from intermittent and variable sources (eg, wind and solar) pose additional challenges. Not least of these is availability, which highlights the need for energy storage as well as systems to coordinate available sources of power generation with sinks of consumption. To integrate the growing amount of renewable energy generation and, at the same time, significantly improve efficiency along the value chain, requires massive changes in the whole electrical system and the way it should be structured and operated.

This future evolving system has been coined by the term "smart grid".

Smart grids

The future electrical system (or smart grid), must be designed to meet four major requirements of the global society:
– Capacity
– Reliability
– Efficiency
– Sustainability

Capacity

As long as societal will does not limit the growth of energy consumption, it is expected that the consumption of electrical energy will grow substantially in the future. If the forecast of the International Energy Agency holds, it means that we will need to add one 1 GW power plant and related grid infrastructure every week for the next 20 years. The future electric system must cope with this capacity increase in an economic way.

Reliability

The larger the amount of electricity transported the closer the system will operate to its stability limit. Yet blackouts or even smaller disturbances are becoming increasingly unacceptable.

Reliability of the electrical system has always been a priority to engineers and has improved dramatically over the last few decades. Nevertheless, electricity interruptions are still a real risk. Dramatic events such as massive rolling blackouts that can cut a whole country from its electricity supply are only the small tip of a far larger iceberg. It is the large number of short disturbances that contribute to significant economic disadvantages. A recent study performed for the United States reported that unreliable electrical systems cost $80 billion annually [1].

Today coal fuels more than 40 percent of the world's electricity supply making electricity generation the single largest and fastest growing contributor to CO_2 emissions.

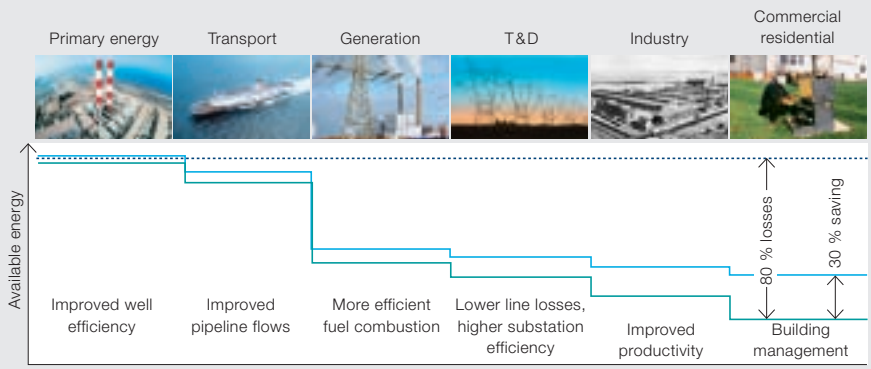
A more reliable electrical supply not only helps the economy and improves the quality of life, but it also has a positive influence on climate change. If an electrical system can safely handle and stabilize grid disturbances, then that system will require fewer generating plants available in reserve. This means lower emissions.

Energy efficiency

Projections by the International Energy Agency show 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 [2].

Yet out of the financial sector's $119 billion invested in clean energy around the

Efficient generation, transport and better utilization of electricity



– Up to 80 percent losses along the energy value chain
– Some losses inherent to the generation of electricity

Energy efficiency along the value chain can reduce losses by 30 percent

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world in 2008, just $1.8 billion was spent on improving energy efficiency, according to a study by the UN Environment Program and New Energy Finance [3].

The reluctance to invest in energy efficiency is surprising. Investments can usually be recouped through lower energy costs in less than two years, and under other circumstances, businesses would normally leap at such prospects of rapid returns. A major obstacle is a lack of knowledge in private households, companies or public authorities concerning energy-efficient equipment. This challenge is further compounded by the variety of available options.

Another obstacle is a lack of incentives. Why should a landlord invest in energy efficiency if the tenant will reap the benefits? Why should a purchasing manager spend more of his budget on efficient equipment if the savings all go to the department that pays the electricity?

In addition, energy efficient solutions are rarely photogenic, and many have obscure names. Variable-speed drives, which raise the efficiency of electric motors, sit in plain metal boxes, belying the fact that their energy saving potential is many times greater than the much touted compact fluorescent light bulb. The drive systems installed by ABB alone save as much as 170 million metric tons of CO_2 every year globally. This corresponds to 20 percent of all emissions in Germany.

The European Union took an important step in June 2009 when it set efficiency standards for most of the electric motors used in industrial applications. The move was barely noticed, yet it is expected to save 135 billion kilowatt-hours per year by 2020. That is three times more than the savings expected from phasing out incandescent light bulbs in the European region and equals more than Sweden's total electric power consumption (which in 2007 amounted to 132 billion kWh).

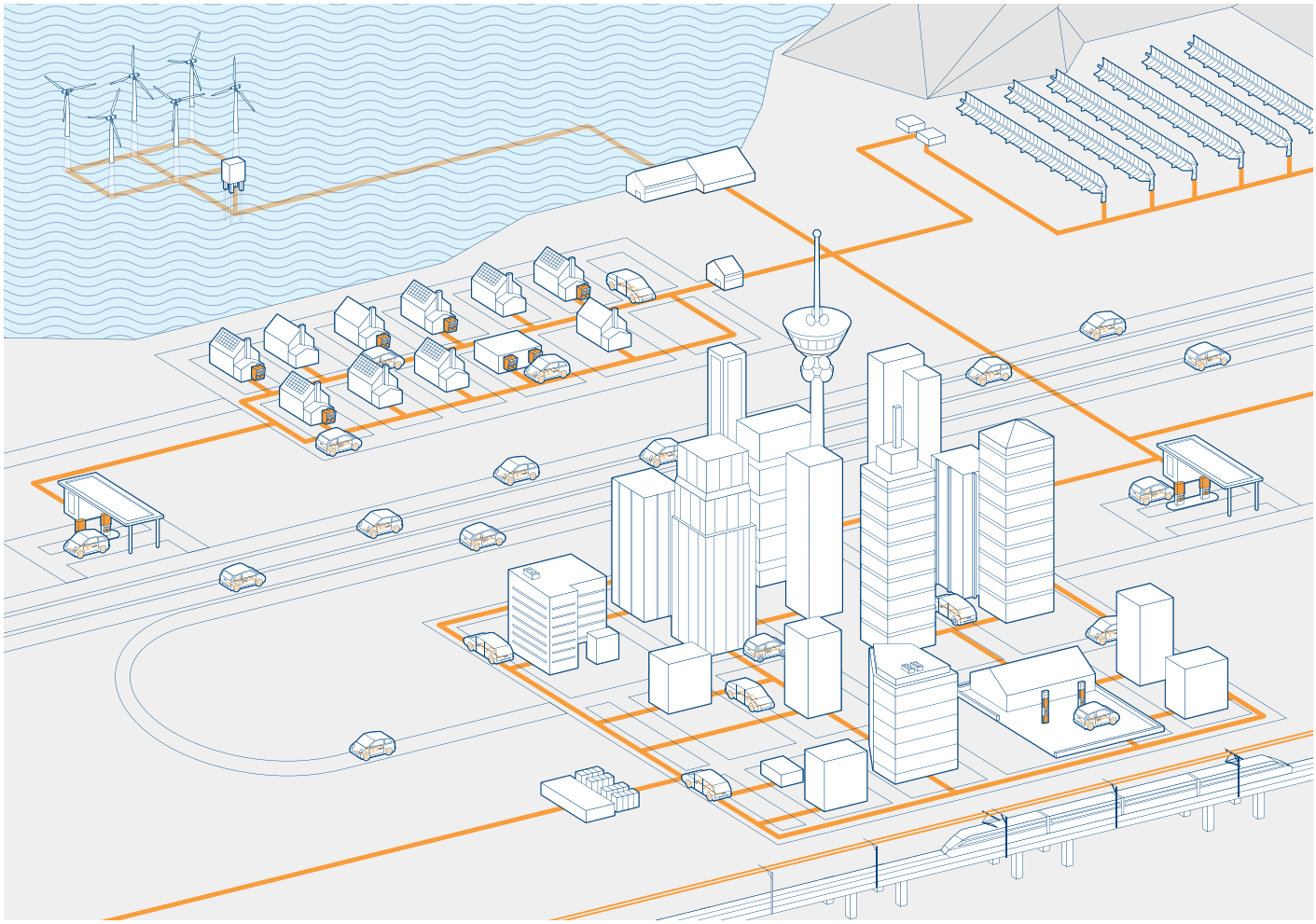
Sustainability

Generating electricity with solar, wind, wave or geothermal energy is without doubt a powerful way to avoid CO_2 emissions. There is hope that with improving technology, better conversion efficiency and sinking production costs, the contribution of such sources to the future energy mix will increase.

Hydropower is the traditional CO_2 free source of electrical energy and according to the IEA this will continue to be the case for the next 20 years.

Generating electricity in this way is one task; the other equally important requirement is to connect it to the electrical grid. Huge distances have to be bridged to carry electrical power from hydropower plants to the centers of consumption. In China, for example, bulk power is being transported more than 2,000 km with low transmission losses.

Intermittent wind-power generators pose another challenge on grid stability and the need for additional reserves, but adequate technology is also required to connect them from remote places far offshore. Energy storage will ultimately help



to overcome the issues of intermittency and HVDC cable technology is the way to cross the sea.

The final influence, however, is the end consumer who decides how much and in which way he wants to consume energy. At the present energy costs and in view of the difference between high and low tariffs, the incentives to save energy or use it at times of lower cost are limited. Technology could provide greater transparency regarding consumption at any moment in time and its associated cost to the consumer. The resulting demand-response relationship between generators and consumers makes a further contribution to the reduction of the required generating reserve.

ABB has the full portfolio of products, systems and services to further improve and develop the electrical system. Wide-area control systems, flexible AC transmission systems, substation control, HVDC systems, cable connections, distribution control and low-voltage systems address the grid. Drive systems, efficient devices and a broad application of process control technologies help to increase the efficiency in industrial and commercial applications. Building automation and control is another area with energy saving potential served by ABB. ABB meters and the connected communication technology that facilitates demand-response interactions and the software to operate energy markets is in use in many locations worldwide.

Generating electricity with solar, wind, wave or geothermal energy is without doubt a powerful way to avoid CO_2 emissions.

ABB is committed to lead further development of smart electricity, providing efficient power for a sustainable world.

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[1] Lawrence Berkeley National Laboratory (2005, February 11). Berkeley lab study estimates $80 billion annual cost of power interruptions.

[2] International Energy Agency World Energy Outlook 2008 and 2009 editions.

[3] UNEP and Global Energy Finance (2009, July). Global trends in sustainable energy investment 2009.