Entering a new age of electricity

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Not the least significant effect of last December's world climate conference in Copenhagen was to demonstrate the importance of a sustainable, reliable, cost-effective energy supply.

Where the 20th century was distinguished by growing energy demand, and thus a growing consumption of fossil fuels, today at the beginning of the 21st century we face the question of how we can put our energy system on a sustainable foundation in the face of demographic change, declining fossil fuel resources, and climate change.

Electricity is the future

The resulting challenge is to balance out what is known as the 'energy triangle'. That means ensuring a reliable, cost-effective, yet also environmentally friendly energy supply.

Paradoxically, the solution is to increase the consumption of electricity. The reason is simple: Electricity is the most flexible, most efficient energy source. And it is the only energy source that makes regenerative energy production directly usable, without detours. It can be used virtually anywhere energy is needed, and its efficiency is incomparably greater than that of fossil fuels.

Additionally, more electric energy is needed due to a simple equation of demographic change. More people need more electricity. In 2005, the world's population reached the 6.5 billion mark – by 2030 it will top 8.3 billion.

Put in simple terms: we are entering a New Electricity Age! By 2030, consumption of electrical energy will grow from 20,000 terawatt-hours today, to roughly 33,000 terawatt-hours – a dramatic 65 per cent increase!

But what does the soaring demand for electricity signify for the current technical development of infrastructure systems? For us at Siemens it is obvious: It is essential to optimise the entire energy chain – and every single component in the chain. Therefore, we have defined three clear steps for accomplishing this: First: an optimised energy mix, second: greater efficiency along the entire energy conversion chain, and third: a systemic optimisation of the energy system.

Step 1: Optimised energy mix

An optimised energy mix means tapping more renewables and retrofitting fossil-fuelled power plants with carbon capture and storage technology.

Offshore wind energy is an example. Here Europe has the potential for 100 GW – only 2 per cent of which is installed today. Which is why building the London Array offshore wind farm is such an important step into the future. Here Siemens Energy will build the largest offshore wind farm in the world, with a capacity of 630 megawatts (MW) in the first step and with the option to further expand up to 1,000 MW. Another outstanding example is Gwynt y Môr. When completed in 2014, this offshore wind farm will generate approximately 1,950 gigawatt hours of electricity annually, enough to supply around 400,000 British households.

But although renewable energy sources will play a bigger role in years to come, the dominance of fossil fuels will not change within the foreseeable future. In that regard, carbon capture and storage (CCS) technologies are a vital bridge technology for coal-fired power plants.

One example of an all-around approach to increasing the share of renewables used for the electricity supply is the Dii Industrial Initiative, which has the goal to provide 15 per cent of Europe's electricity needs by solar and wind power generated in the deserts of North Africa. Renewable energy bridging continents is the claim of this initiative. But for that, electricity first has to be conveyed for some 2,000 km into the European centres where it is consumed.

This is technically feasible with high-voltage direct current transmission (HVDC). The world's first HVDC system, at a voltage of 800 kV went online in China at the end of 2009. Thanks to 800 kV DC transmission, about 95 per cent of the energy fed into the system will arrive at the centres where it is consumed.

Step 2: Greater efficiency

Technical improvements can help reduce fossil fuel consumption and increase the yield of Renewable Energies. For example, the latest generation of combined cycle power plants, with efficiencies of more than 60 per cent, will save so much fuel compared to today's conventional plants (with 58 per cent efficiency) that each year each plant will save roughly the equivalent in carbon emissions of 10,000 cars driving 20,000 km. And in power grids too, the natural losses of electric power during transport can be reduced with power electronics components, meaning that significantly less electricity has to be produced.

But greater efficiency isn't limited to power generation and transport. Increasing the energy efficiency in end-use application is even more important. Buildings are a good example – as they are responsible for 40 per cent of the world's energy consumption. Especially in cities, where for the past two years more than 50 per cent of the world population is living, buildings provide the greatest energy saving potential – more than industry, transportation, or energy production.

For many years, Siemens has proven with its energy efficiency solutions that every building has already today an energy efficiency improvement potential of 20-30 per cent on average. This can be achieved by optimising the building envelope, lighting, heating and cooling system, water and energy distribution and many more areas. This not only lowers operating costs, but also cuts CO_2 emissions, increases property values and enhances operating safety. And energy-efficient buildings with guaranteed lower energy costs can be operated at no cost for the customer, because the savings pay for the investment. Siemens' 6,500 building projects alone have realised guaranteed savings of around €1 billion, as well as CO_2 reductions of 2.4 million tonnes.

Step 3: Systemic optimisation

The resulting steep expansion of society's use of electricity, with many small producers and consumers, will result in an increasingly decentralised type of energy production. As a key factor for success, this new configuration will require high-performance information, communication and sensor technology – a 'Smart Grid.'

And there emerges another central trend: Today's generally passive consumers in the energy system will develop into interactive 'prosumers' – who both produce and consume electricity. Balancing all these distributed generation units will require a flexible, intelligent and optimally controlled grid in a new bi-directional energy system.

This is needed because in the future, power consumption will follow generation, rather than vice-versa. And this is when e-cars come into play: Thinking in visionary terms, you can even imagine the e-car of the future as the buffer for the fluctuating loads on the grid. This can be illustrated by a simple example: 200,000 e-cars with 40 kW capacities apiece can quickly provide 8 gigawatts of power to the grid, if needed. That is more than all of Germany currently needs as controlling power for buffering load peaks.

The course has been set

Taken all together, the three segments of optimised energy mix, higher efficiency, and systematic optimisation paint a picture of a fascinating future – a new electric age when electricity becomes the all-around energy source. Electricity that is produced in extremely environmentally friendly ways, carried with high efficiency even across long distances, and used with little conversion loss. So electricity is an ideal basis for achieving a smooth transition over a few decades to a carbon-free, efficient energy industry, and thus countering climate change. ❑

The e-cars of the future could act as a buffer against fluctuating loads on the grid