

# Taking Grids to the Next Level

Demographics and industrialization in the developing world and the modernization of aging infrastructure in mature markets have increased demand for electricity infrastructure. Udo Niehage, Chief Executive of Siemens' Power Transmission Division, believes that innovative grids for integrated smart infrastructures are needed to meet the challenges ahead.

By Haig Simonian

## What factors will determine demand for transmission technology in the future?

NIEHAGE: There are three major factors: new infrastructure in emerging markets, where demand is driven by industrialization and population growth; the need to replace mature equipment, often 30 or 40 years old, in existing markets; and, increasingly, the need to restructure power grids to accommodate renewable energy sources.

## By how much will demand rise, and what volume of investment is required?

NIEHAGE: Electricity consumption worldwide is forecast to climb from 20,000 TWh today to about 33,000 by 2030. We are entering a whole new era in electricity that makes it crucial to have an intelligent and flexible grid infrastructure. We estimate the annual market is worth around 40 billion US dollars in power transmission solutions and products alone, excluding cables and other lines.

## How do you expect that demand to be divided between the various sources?

NIEHAGE: It's hard to be precise. But I estimate about 40 percent of demand in the next years will come from emerging markets, 30 percent from replacement needs in mature regions, and up to 30 percent from investment to integrate renewables and strengthening the existing transmission grids for long-distance and cross-country power exchange.

## What technologies are becoming available to meet these new challenges?

NIEHAGE: There is a range of solutions, depending on applications. Broadly speaking, we can expect significant developments in the way electricity grids are configured; in the distances and power levels at which electricity can be efficiently transmitted; and in the amount of power that can be fed into sensitive locations like burgeoning city centers.

Udo Niehage: Smart infrastructures of the future will include super grids.





Udo Niehage with *Financial Times* correspondent and *Living Energy* author Haig Simonian in front of HVDC long-performance test equipment in Erlangen, Germany.

## Biography

**Udo Niehage** (55) is Chief Executive Officer of the Power Transmission Division in the Siemens AG Energy Sector, a position he has held since January 2008. After studying electrical engineering (power systems) and general business administration at the Technical University (TU) of Munich, Germany, and at the Technical University (RWTH) in Aachen, Germany, he received a doctorate in engineering.

Niehage started his career at Siemens in 1988 as Head of Sales Engineer and Product Manager. In 1992, Niehage moved to ABB in Mannheim, Germany, where he worked as Head of the Engineering and Technology Department. After various management positions at ABB, he accepted a position as Head of Sales and Energy Trading at BEWAG AG in Berlin. In 2000, Niehage returned to Siemens as Head of the Medium Voltage Switchgear Subdivision. One year later, he became responsible for the whole Medium Voltage Division. From October 2003 until December 2007, he was President of the Siemens AG Power Transmission and Distribution Group.

### What specific changes will we see in grid technology?

NIEHAGE: People are talking broadly about “super grids” – though the term hasn’t been strictly defined yet. The term refers generally to new, much more sophisticated electricity grids fulfilling far broader requirements than their predecessors. One obvious difference is the much greater need for connectivity between different countries. The best example here is Seatec – the idea for a grid under the North Sea that would link power grids in the UK, Scandinavia, and continental Europe. Initially, Seatec would represent a massive expansion of rather modest links between countries, such as the Netherlands and the UK. But it would go much further, by offering far more potential to expand and adapt the grid, thanks to much greater standardization.

With sufficient “smart” technology, such a grid could, for example, include all the new wind parks expected to be built in the North Sea. Two-way flows could be used to exploit time and demand differences in the countries connected to allow potentially attractive electricity trading. Similar ideas are being aired for a super grid in the Mediterranean, namely with the project Transgreen. Such a grid could be used to steer the power flows expected from the Desertec Industrial Initiative – the vast planned solar and wind power scheme in Africa designed to generate power for Europe. We are still in the early days, but a group of “Friends of the Supergrid,” comprising utilities, manufacturers, and grid operators, has already been formed to consider feasibility studies.

### You mentioned renewables. What strains do developments like offshore wind parks place on a grid?

NIEHAGE: Because fluctuations within the power flows they generate are hard to predict, being subject to natural forces such as wind and sun, such sources are radically different from traditional power stations. Grids dealing with them must be much more flexible, and balancing supply with demand will be much harder.

### What sort of grid can provide the flexibility required?

NIEHAGE: That requires new technologies or the adaptation of existing ones. Take high-voltage direct current (HVDC) transmission lines. These have been around for a while. But the technology has been refined massively to meet new applications – specifically China’s huge thirst for power and its need to transmit electricity over vast distances, and the challenges arising from power generated by renewables. Let’s start with renewables. HVDC is a much more efficient way of transmitting electricity over long distances than conventional alternating current, because line losses are much lower. For cable connections, once the distances involved exceed 80–90 kilometers, HVDC is the best economical solution. So if you’re hooking up an offshore wind park far from the coast, you’ll need HVDC. As a further refinement, our HVDC PLUS technology offers all of the advantages of conventional HVDC and even more, and is suitable for use in much more compact surroundings, whether in a wind park or an offshore oil or gas platform.

### Why is HVDC particularly suitable for China?

NIEHAGE: The real boost for HVDC has come from China’s industrialization and the mismatch between demand,

which is concentrated in the cities and manufacturing zones of the east coast, and the major sources of power, which are far away to the west, at the Three Gorges Dam project, for example. Each new contract from China has stretched HVDC technology further. Voltages have risen from 500 to 800 kV, the distances are up to 2,000 kilometers and more, while the world’s first 1,800-kV DC line from Yunnan to Guangdong has been operating since December 2009 without any interruptions. Line losses with 800-kV HVDC are as little as around 3.5 percent per 1,000 kilometers at this power, and less than 1.5 percent losses for both converter stations at the sending and receiving ends of the transmission line.

### Are there any limits?

NIEHAGE: China would like to go further. There’s talk of 1,000-kV DC lines and power ratings of 10,000 MW. But eventually there will be barriers. The sheer size of the equipment involved will make transportation alone challenging. And there’s always a risk in putting too many eggs into one basket: Just imagine – a 10,000-MW line failing would be the same as having ten nuclear power stations going down simultaneously. Just think of the consequences.

### You also mentioned cities. How do they fit in?

NIEHAGE: Urbanization is a key factor. As cities get bigger and demand ever

more power, we will need to feed in ever more power into urban locations. But we obviously can’t build power plants in city centers, and there are limits to installing high-voltage overhead lines. So we have to think of other solutions, such as gas insulation technology. Cities already have underground substations, with gas-insulated switchgear. We’re now working on gas-insulated line technology that will allow high voltages to be transmitted within limited space requirements. Six pipes handling 500 kV can be laid underground to carry up to 5,000 MW of power, all in a relatively small space, depending on the configuration.

### Do all these innovations mean traditional grids will become obsolete?

NIEHAGE: Not at all. The term “smart grid” has been identified increasingly with distribution to end consumers, rather than transmission from power stations to substation, and the potential for consumers to become much more sophisticated in using power. But it’s also valid for transmission. There is a clear move from the old adage of “generation follows load” to “load follows generation” – especially with ever more use of renewables and all they imply in terms of steering demand.

To ensure such energy sources can be exploited as efficiently as possible, we have to create more sophisticated grids. The key concept is “congestion

management” – adding active elements to existing grids, based on power electronics technology, to make them much “smarter.” At Siemens, we talk about FACTS (flexible alternating current transmission systems). The need for such devices is growing all the time. There is a huge potential here.

*Haig Simonian is Switzerland correspondent of the Financial Times.*

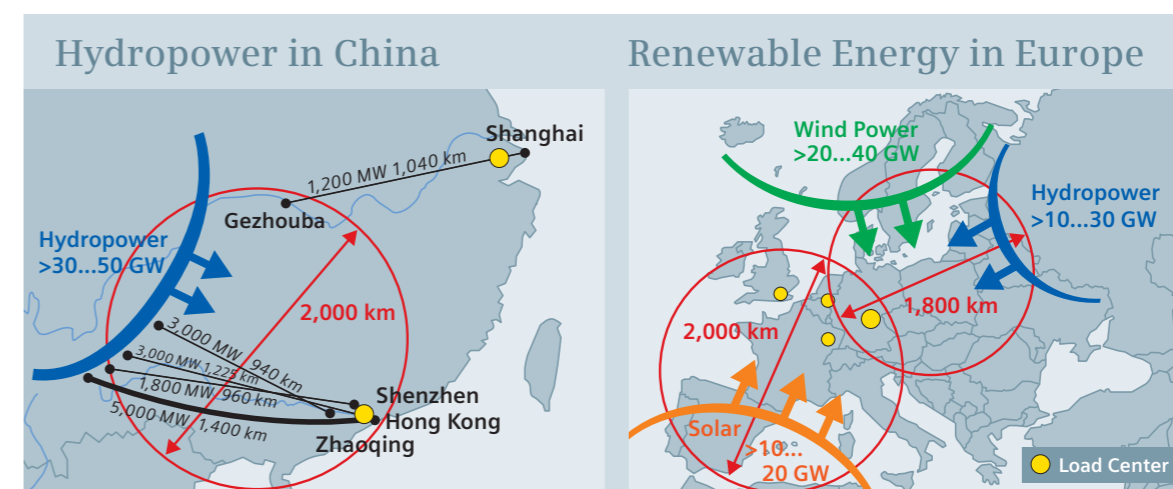
## Glossary

■ **Super Grid:** The term “super grid” is used to describe networks that offer higher performance than conventional electricity grids. Super grids incorporate smart technology to steer and manage the system, enabling it to deal with the unpredictable supplies from renewable power sources like wind and sun. Super grids span across multiple countries, unlike the (almost) purely national grids currently in operation.

For further glossary terms, see: [www.siemens.com/energy/living-energy](http://www.siemens.com/energy/living-energy)

## Further Information

[www.siemens.com/energy](http://www.siemens.com/energy)



China’s hydro-power loads must be transmitted over long distances. Europe’s decentralized renewable energy needs flexible grids.