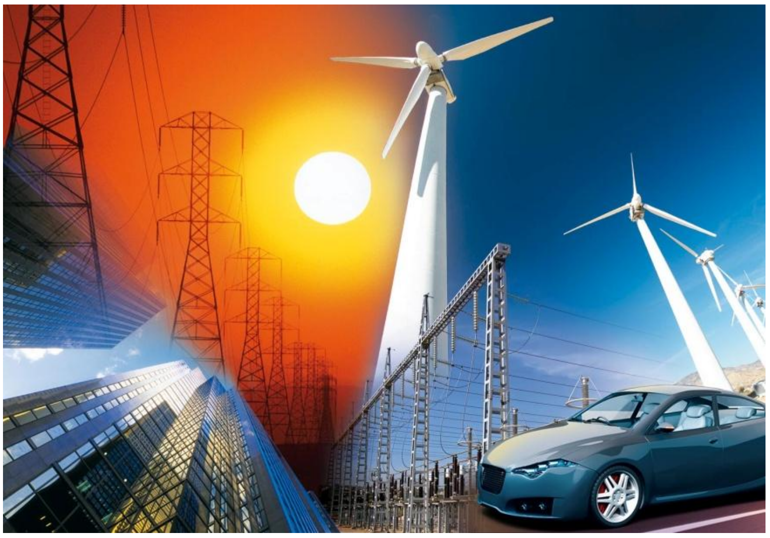
Smart Grid White Paper



Deploying a smarter grid through cable solutions and services

(March 2010)

PRESS CONTACTS

Sabrina Bouvier
sabrina.bouvier@nexans.com
Tel.: + 33 1 73 23 84 12

Pascale Strubel
pascale.strubel@nexans.com
Tel.: + 33 1 73 23 85 28

For more information: www.nexans.com/power

CONTENTS

Synopsis

This report is intended to give a contextual overview of "smart" and "smarter grids".

It opens with some "electrifying statistics" showing how power grids have evolved over the years, and the extraordinary pressures that are coming to bear on network renewal, which includes estimates of projected national investments. It explores some dilemmas that power utilities face in the area of distribution, transmission and generation. It then focuses on what a "Smart Grid" really means and examines benefits not only to utilities, but to installers, operators, maintenance personnel, and consumers. Next, the White Paper outlines the challenges and expectations of utilities. Finally, the importance of grid evolution is dealt with and specific Nexans solutions and services are briefly detailed stage by stage, concluding with the important service dimension.

This report is followed by an Appendix containing some recent Nexans success stories, and some helpful definitions of Smart or Intelligent Grids that will be of interest to anyone wanting to compare scientific, corporate and public visions on the subject.

I. INTRODUCTION: THE COMING WORLD OF SMART NETWORKS

"A smart grid will allow quicker service restoration after outages, it will enable new technologies, it will help the environment, it will facilitate plug-in hybrid vehicles, it will reduce our dependence on oil, and it will lead to smarter rates."

Thomas Kuhn, CEO, Edison Electric Institute

Some electrifying statistics

We have come a long way since 1882, when Thomas Edison wrapped copper rods in jute and placed them in rigid pipes filled with a bituminous compound to distribute power to 59 people in New York City for some rather feeble and unsteady domestic electric lighting.

Back then, there were 1.5 billion people on the globe, and only a handful of families had electricity.[1] By 2020, there will be 7.5 billion on the globe and consumption will have increased by 75% (compared to 2000), equally split between developing and developed countries.[2] This means a 37.5% increase every 10 years.

Besides providing creature comforts and industrial opportunities, a new source of demand – computer electronics – is putting tremendous pressure on the grid. Increased load from chip technologies and automated manufacturing has risen to 40% and the load is expected to increase to more than 60% by 2015.[3] Industrial automation, the Internet, online banking operations, and consumer electronics need more and more power.

This kind of exponential growth puts a strain on existing power networks, or grids, which are becoming increasingly large, interconnected, international… and vulnerable. Not only will new transmission and distribution lines need to be built, combining conventional fuels with renewables, but a new level of technology will have to be built into the system to guarantee efficiency, reliability and security, flexibility and eco-friendliness.

Already, massive investment is occurring in all quarters. In 2010, the Chinese government is poised to invest more than $7.3 billion (5.4 billion Euros) in the development of Smart Grid technologies, while the United States has earmarked some $7.1 billion (5.2 billion euros). Meanwhile, the annual investment in Europe is estimated to be approximately 5 billion Euros.[4]

The EU's blueprint for financing its Strategic Energy Technology SET Plan estimates that the cost of upgrading interconnections and building new super grid connections to supply Europe securely would cost over 200 billion Euros by 2050.

The worldwide picture seems to concur with these hefty estimates of regional infrastructure investments, with one study concluding on an optimistic note:

---

[1] From UN Report, 2004

[2] Figures from "Getting Smart" by Thomas F. Garrity, VP, Sales and Business Development, Siemens Power available at https://w3.energy.siemens.com/cms/us/whatsnew/Documents/Getting%20Smart_Garrity.pdf

[3] American Department of Energy figures quoted in "2010 Power Quality Forecast: Are improvements on the horizon?" by Utility Systems Technologies at http://www.ustpower.com/Files/Power%20Quality%20Forecast%20-%202010.pdf

[4] Reported by the Gerson Lehrman Group at http://e360.yale.edu/content/digest.msp?id=2252

Electricity utilities will reportedly receive the best return on investment by adopting smart grid technology. This then could lead most of their capital budgets to be invested in grid infrastructure projects, including transmission upgrades and substation and distribution automation.[5]

Powerful dilemmas

Like many urban networks, the NYC grid's cables are over 50 years old (well beyond their 30-year projected lifespan) and they are continuing to age under stress, which includes extreme temperatures, vibrations, water ingress, and injury from civil works. With electricity demand growing at 2% a year, there is an urgent need for an upgrade.

Similarly, larger regional and national grids are under constant pressure, since they were never meant to transfer large amounts of electricity between distant points, especially in the face of sudden surges of demand. The result was a series of massive blackouts affecting millions of people. In 2005, there were 13 major blackouts; in 2006, there were 19; in 2007, there were 13; in 2008, there were 21; in 2009, there were 14.[6] Quality issues are said to cost American business more than $100 billion (74 billion euros) on average each year[7], a sum that would surely be matched in the European Union and other major economic regions.

Ironically, long-distance grids are failing at the very moment that materials science has been extending feasible transmission distance, which has now achieved 2,500 kilometers for AC and over 7,000 km for High-Voltage DC lines. This allows utilities to reach across continents, oceans and time zones and compensate for variations in daytime/night-time and seasonal demands.

Moreover, using high-voltage valves, it is now possible to transmit DC power at higher voltages over long distances with lower transmission losses (typically around 3% per 1,000 km). It has been proven that an HVDC could be laid from Morocco to London, a distance of approximately 2,700 km, with losses of well under 8%. At present, only about 2% of electricity is transmitted along HVDC lines in about 100 projects around the world, linking large energy projects to centers of high demand.[8] And so there is great potential here.

This brings us very close to the 1969 dream of the futurist world electrical grid designer, Buckminster Fuller, who in his visionary book, *Utopia or Oblivion*, argued that "because energy is wealth, the integrating world industrial networks promise ultimate access of all humanity everywhere to the total operative commonwealth of earth."

Fuller's vision included an internationally-shared vast power network that would make wars (often based on the struggle for natural resources, like oil and gas) obsolete, since it would create a new basis of wealth, i.e. kilowatt hours:

> "This now feasible, intercontinental network would integrate America, Asia and Europe, and integrate the night-and-day, spherically shadow-and-light zones of Planet Earth. And this would

---

[5] Consult http://www.ecoseed.org/en/general-green-news/green-business-news/green-busines-news/5714-Gobal-smart-grid-investment-to-reach-$-w00-billion-by-2015

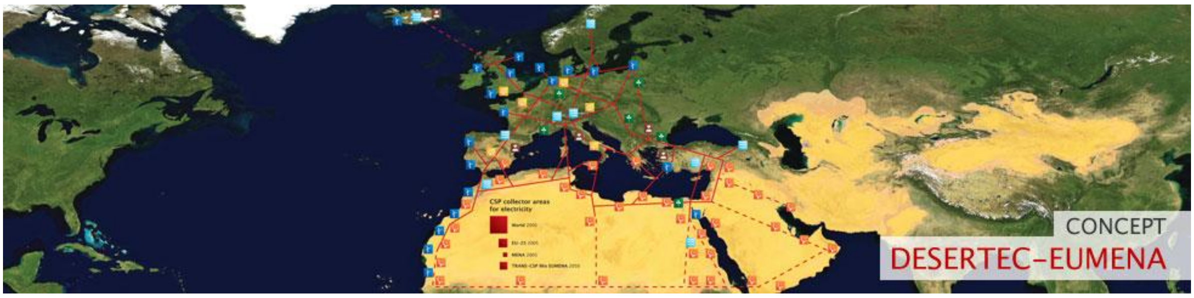
[6] For detailed information about world blackouts since 1965, consult Wikipedia's "List of power outages" at http://en.wikipedia.org/wiki/List_of_power_outages#Largest

[7] See "2010 Power Quality Forecast: Are improvements on the horizon?" by Utility Systems Technologies at: http://www.ustpower.com/Files/Power%20Quality%20Forecast%20-%202010.pdf .

[8] For more information about long distance transmission, consult "The future of electricity: liberalization, long distance transmission, HVCD and supergrids" by Polly Higgins: published by the Claverton Energy Research Group: http://www.claverton-energy.com/the-future-of-electricity-liberalisation-long-distance-transmission-hvdc-and-supergrids.html

occasion the 24-hour use of the now only fifty per cent of the time used world-around standby generator capacity, whose fifty per cent unused capacities heretofore were mandatorily required only for peakload servicing of local non-interconnected energy users. Such intercontinental network integration would overnight double the already-installed and in-use, electric power generating capacity of our Planet."[9]

Already new cooperative efforts, like TREC (Trans Mediterranean Renewable Energy Co-operation), have promoted the DESERTEC concept of building Concentrating Solar Power (CSP) plants in the Sahara to provide clean renewable electricity.[10]



In addition, under the recent French Presidency of the European Union, a new cooperative effort, the Mediterranean Union (UMed), was formally launched in 2009. It is planning construction of a 45 billion Euros HVDC grid to transfer electricity produced by Saharan and North African solar installations to European consumers.

In another area, Airtricity have formulated proposals to link offshore windfarms throughout Europe via a high-voltage subsea transmission network which would link six seas: the Baltic, the North Sea, the Irish Sea, the English Channel, the Bay of Biscay and the Mediterranean to resolve wind power fluctuations for the supergrid, since there would always be a wind blowing somewhere.[11]

[9] From Buckminster's telegram to Senator Edmund Muskie, 1973. Both quotes are available at http://www.geni.org/globalenergy/library/newsletters/1995/buckminster-fuller-on-the-global-energy-grid.shtml

[10] Consult http://www.desertec.org/en/concept

[11] These figures and project summaries are once again drawn from "The future of electricity: liberalization, long distance transmission, HVCD and supergrids" by Polly Higgins, published by the Claverton Energy Research Group http://www.claverton-energy.com/the-future-of-electricity-liberalisation-long-distance-transmission-hvdc-and-supergrids.html. For the offshore and solar supergrid, also consult: http://friendsofthesupergrid.eu

This brings us to the dilemma of power generation, which can be briefly stated. Every year, exciting new ways are found for generating electricity: everything from feeding back energy into the local power grid from an electric vehicle's hydrogen fuel cells or photovoltaic rooftop arrays on consumer houses, to new ways of generating massive electrical power, like CSP and eventually nuclear fusion technologies (the ITER project in southern France).

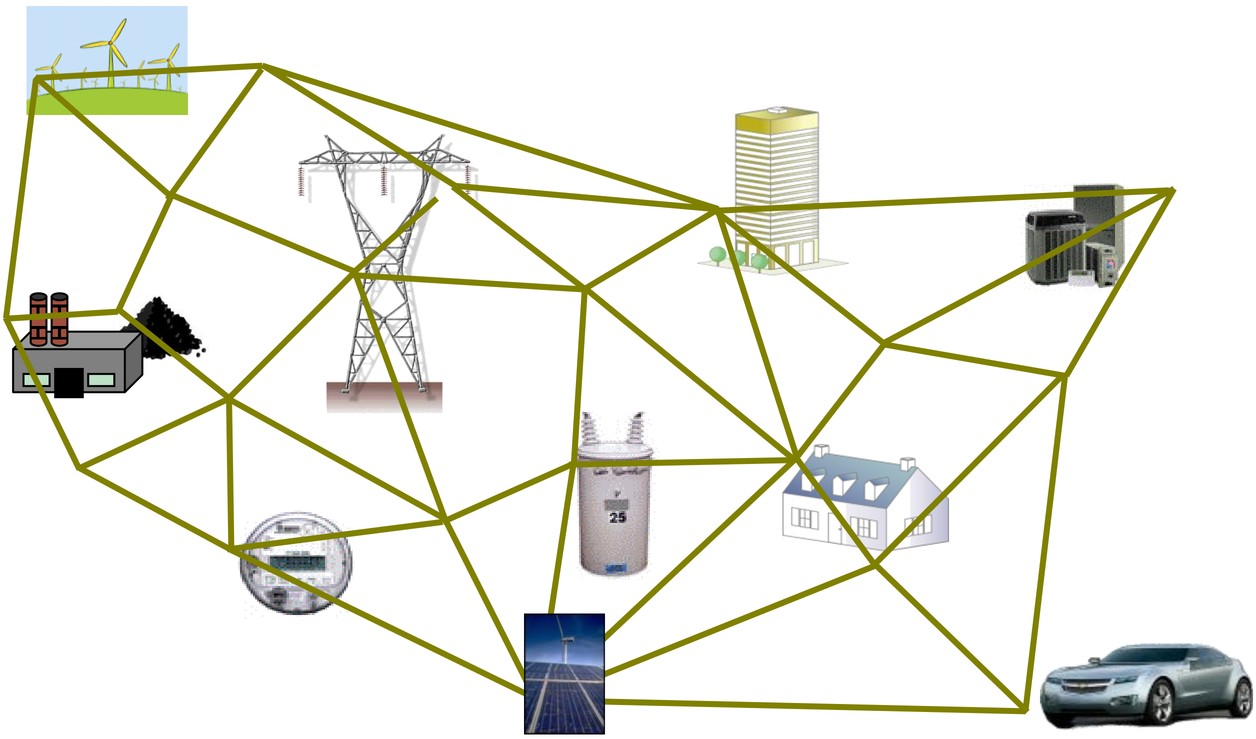
The generation dilemma stems from the fact that electrical generation is growing four times faster than available transmission and distribution infrastructure.

Why invest in more energy, if you can't move it?

What is a Smart Grid?

It is not the intention of this White Paper to explain in detail what a Smart Grid is and how it works. There is already a wealth of information in numerous publications, books, studies, scientific monographs, white papers, etc. in print and on the Internet. The aim is rather to give contextual support to the inevitability of creating smarter networks and to show how Nexans can contribute to this evolution.

Although no two definitions of a Smart Grid are quite the same (see "Seven Definitions" in this White Paper's Appendix), a simple definition compares the old and the new, and points to the topological change that will be needed to make a grid "smarter":



Networks of Smart Grid

Today's power systems are designed to support large generation plants that serve faraway consumers via a transmission and distribution system that is essentially one-way. But the grid of the future will necessarily be a two-way system where power generated by a multitude of small, distributed sources – in addition to large plants – flows across a grid based on a network rather than a hierarchical structure.[12]

This two-way decentralized vision of the grid has led many commentators to compare it to an "Internet" of the power network. Also, many experts concur that Smart Grids are much more than smart metering, or Automated Meter Reading (AMR) systems, which are only a preliminary first step.

Communications will play a big role in Smart Grids, allowing two-way information exchange, monitoring, control and maintenance in real time. Customers will interact extensively with the network, both in providing power consumption data and even feeding back domestically produced energy into the grid. Metering will no longer be electromechanical, but rather digital, which will enable real-time pricing and net metering. In addition, the market mechanism for exchanging energy between utilities and countries will be enhanced by better communications.

Daily operations will shift from manual equipment checks to remote monitoring, and predictive time-based maintenance. Generation will no longer be centralized, but will be distributed, often drawing on renewable sources of energy coming from mini-grids: for example, combinations of solar panels, wind turbines, fuel cells, etc.

Power flow control will be comprehensive and automated with pro-active protection. In other words, outages will be prevented before they start. Monitors and sensors will be ubiquitous in the smarter network. Finally, the system will be self-healing.

Achieving this will require more than just cables. It requires advanced types of control and management technologies, new kinds of network services, and an overall approach which combines new monitoring and control infrastructures embedded in transmission/distribution networks and information and communication technologies to control loads.

As "Toward a Smarter Grid" states: "The result will be a grid that is largely automated, applying greater intelligence to operate, monitor, and even heal itself. This "smart grid" will be more flexible, more reliable and better able to serve the needs of a digital economy."[13]

Benefits

The benefits of building a smarter grid for utilities depends on many factors, including existing electrical infrastructure, load dynamics, customer needs and the regulatory environment. However, the benefits on customer satisfaction, energy efficiency, operational efficiency and the environment will be significant. It will:

- Reduce onsite premise presence and field work;
- Enable customer self-serve and reduce Call Center enquiries;
- Improve revenue collection;

[12] This is in fact the definition given in ABB's White Paper: "Toward a smarter grid" available at http://www02.abb.com/db/db0003/db002698.nsf/0/36cc9a21a024dc02c125761d0050b4fa/$file/Toward_a_smarter_grid_Jul+09.pdf

[13] Ibid.

- Shorten outages;
- Reduce energy losses;
- Reduce greenhouse gas emissions;
- Optimize transformer operation;
- Improve network operations;
- Lower integration and IT maintenance costs;
- Reduce peak demand directly by allowing certain loads to be turned off;
- Replace period equipment inspects by condition-based maintenance;
- Rationalize tree-trimming according to weather conditions.
- Delay capital investment by optimizing existing assets.[14]

There is a consensus among experts. In more general terms, grid operators are promised a "quantum improvement" in monitoring and control capabilities that will enable them to deliver a higher level of system reliability, even in the face of ever-growing demand:

- Utilities will experience lower distribution losses, differed capital expenditures and reduced maintenance costs;

- Consumers will gain greater control over the energy costs, including generating their own power, while realizing the benefits of a more reliable energy supply;

- The environment will benefit from reductions in peak demand, the proliferation of renewable power sources, and a corresponding reduction in emissions of CO^2, as well as pollutants such as mercury.[15]

To qualify these benefits in financial terms, the Electric Power Research Institute (US) estimates that an investment of $165 billion (121 billion Euros) in smart grid technology, integration and development will produce between $638 billion (467 billion Euros) and $802 billion (588 billion Euros) in additional revenues.

This means a cost-benefit ratio of between 4:1 and 5:1 for those willing to invest in change.

[14] These benefits were abstracted from "What is the real potential of the Smart Grid." For more detail, consult http://www.gepower.com/prod_serv/plants_td/en/downloads/real_potential_grid.pdf

[15] These three points are made by ABB in their "Toward a smarter grid" white paper, quoted earlier.

II. THE FOUR DRIVERS OF CHANGE

Challenges and expectations

Incumbent power utilities, new energy providers (including renewables), power transporters, energy traders, and consumers have told us that they are faced with many challenges and would like to see improvement in four key areas:

- **Efficiency**
  Power providers want to transport the most energy possible, with minimal loss or bottlenecks. They need to discover hidden congestion problems due to cable type and capacity, or network architecture, and assess potential risks, like changing climatic conditions. They want to know how much energy customers use and when, according to region. They also want renewable energy resources feeding into their network at every level with improved load management, possibly via dynamic control.

- **Reliability and Security**
  Electricity must be delivered reliably, meaning no cuts, breakdowns, cascading failures or blackouts, and without frequency variations or quality fluctuations (spikes and dips). Utilities want to reduce equipment failure and decrease the quantity and duration of faults and outages so that distant or thinly populated areas can be protected. Security means quickly spotting overheating to prevent lines from sagging onto trees, or freezing rain which can lead to ice accretion and power failure. Energy theft may be a problem; substation operations need enhanced control. Wherever possible, abnormal situations (e.g. overheating, short-circuits) need to be detected and remedied automatically.

- **Flexibility**
  Where congestion creates delivery problems, energy providers want to reroute, share or import power so as to manage the ups and downs of the business. This requires continuous monitoring, network supervision, and smarter transmission tools to assess a situation and take immediate action, like turning on gas micro-turbines or drawing on wind power. Vital user data needs to be accessed through Advanced Metering Infrastructure (AMI) and exchange information through high speed optical fiber.

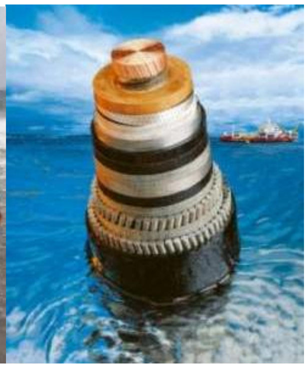
- **Eco-friendliness**
  Because utilities and their customers are environmentally-sensitive, they need to be reassured that buried and overhead lines are safe, and generate minimum losses and CO_2, with low Electro-magnetic Interference (EMI). The smarter network should allow interaction with multiple types of electric vehicle and clean generation/consumption at customer level. When networks are upgraded, obsolescent cables must be removed with no damage to urban areas or natural habitats, and materials recycled safely and efficiently.

III. NEXANS: ENABLING NETWORK EVOLUTION THROUGH SOLUTIONS AND SERVICES

Meeting the four challenges

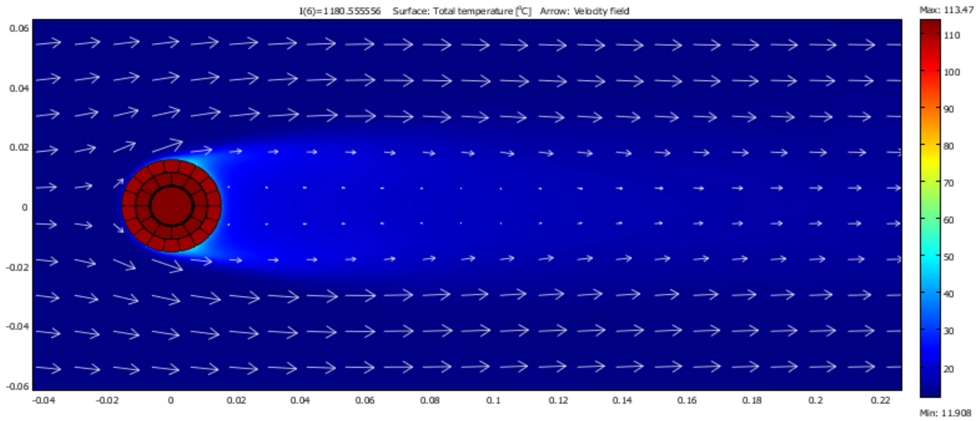
►To improve **efficiency**, Nexans strives to understand overall network architecture through load contouring to see what solutions are most appropriate, for example, high-tech cables which can incorporate measurement of temperature. Other special cables are adapted to energy convergence and bidirectional flows to serve renewable energy resources. For example, Nexans recently laid a 576km-long NorNed HVDC cable between Norway and the Netherlands, the world's longest submarine energy cable. More than just a cable manufacturer, Nexans is also developing solutions which will allow utilities to offer new services to their own customers, like high-speed Internet.

Laying of the HVDC cable



HVDC cable

►To ensure **reliability and security**, Nexans offers services to improve networks immediately, like ongoing maintenance and replacement of fluid-filled cables. Customer needs are studied in actual conditions. Simulation shows how temperature can be monitored in real time to better manage the grid or overloaded sections. Sophisticated software makes it possible to simulate the entire environment so as to suggest appropriate monitoring systems or advanced conductors that provide low sag, high-temperature or anti-robbery solutions. In addition, a new overhead line solution (thermal aluminum conductor composite core), allows for spans of 2.5 km, reducing the number of pylons in the landscape and significantly lowering the height and cost of towers spanning broad rivers. Under overloaded conditions, they are more reliable and secure because of lower sag.



FEM temperature simulation:
Temperature distribution OHL: wind blowing at 0.5m/s

►To provide **flexibility**, Nexans joints and accessories are customized according to cable type and use, which can merge existing technologies (like fluid-filled and XLPE) so that everything does not have to be changed at once. Superconducting Fault Current Limiters allow the regulation of energy flow without danger to protect both plants and grids and also facilitate cross-border energy sharing. Flexibility means finding the best place to install lines, joints and equipment and then managing them intelligently on a daily basis, and often in real time, through advanced telecommunications.

►To promote **eco-friendliness**, Nexans has developed solutions for sustainable energy, from windfarms and photovoltaics to safe nuclear energy. Nexans pioneered protected seabed installations and new cable designs eliminate hazardous materials (lead) and take into account CO_2 impact. Solutions allow security to be improved while decreasing kilowatt losses. When networks need upgrading or replacement, Nexans offers a full recycling program to protect the environment and reuse materials.

The importance of grid evolution

Nexans is committed to grid evolution, and this applies both to legacy networks, and new constructions; or networks with basic internal communications, as well as highly-developed digitalized networks based on fiber optics.

Unlike telecommunication networks, "leapfrogging" technologies is not always possible with energy grids. As Marshall McLuhan, communications theorist and "patron saint" of *Wired* magazine, remarked in the late sixties: non-industrialized societies sometimes have an extraordinary opportunity to adopt the latest and most efficient technologies without having to revamp intervening ones. This is well-exemplified in the present-day proliferation of sophisticated cellular phone networks on the African continent.

However, most countries in the world have a basic power structure already, and would avoid scrapping it completely for a brand new network. Indeed, this would be unfeasible if not impossible, due to the high costs of right-of-ways, civil engineering, and outlay for new lines and equipment, not to mention the prolonged interruption to service that an overlay network would occasion.

In short, evolution seems to be the safest and least costly road to improvement, except in exceptional cases where isolation or the non-existence of infrastructure, could justify an entirely new power system built from the ground up.

The five progressive stages

This is why Nexans solutions and services are focused on five stages of improvement, which begin with the basics, and rise progressively in complexity to conclude with the latest technologies and applications.

Stage one includes all basic products, solutions and services: advanced overhead/underground and subsea cables, link design (size/type of cable), accessories, merged energy/data solutions, turnkey installation, ongoing maintenance, new wind/photovoltaic technologies, and recycling. In other words, stage one includes all the basic building blocks of any functioning power network.

Stage two is simulation. By simulating part or all of a network, Nexans shows how improvements can reduce losses and remove bottlenecks. Solutions are compared and evaluated for cost-effectiveness. Life-cycle analysis highlights environmental impact. Simulation inspires power utilities to understand the constraints of their networks.

Stage three involves sensors in overhead and underground lines to measure hot spots and humidity, and monitor current load and congestion around-the-clock, so that load can be safely increased. Sensors also detect substation failures without human intervention for fast corrective action. Sensors give an even deep understanding about network operations.

Stage four is communications. Transmission/distribution is enhanced with switches and optical fiber to provide real-time command and control of substations (via Ethernet) and/or Smart Metering. Hybrid energy-optical fiber cables can be blown into existing tubes to customer premises for Internet services. Communications would make little sense without sensors already installed.

Stage five comprises high-tech solutions to ensure network safety at all times, with flexible energy transactions and power sharing. Grid connections are enabled through Fault Current Limiters and direct current import/export. Superconductors allow more amps to be carried in dense urban areas. High-tech solutions are the ultimate guarantee that the grid will remain eco-friendly and future-proof.

Moving towards a smarter, interactive, integrated network

Stage 1: The Basics

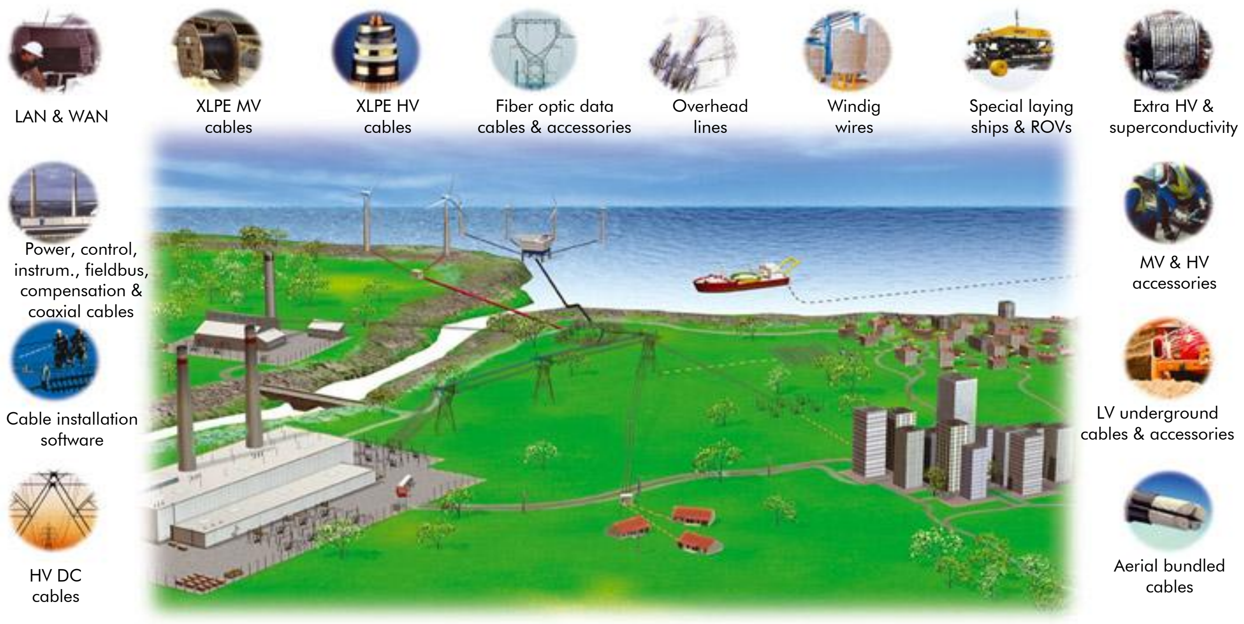
To assure operational flexibility for overhead lines, Nexans offers a range of high-capacity conductors and accessories for the most varied climatic conditions. Aluminum Conductor Steel Supported (ACSS) cables eliminate sag at very high temperatures (250°C).

To counter significant, non-operational energy losses by utilities (sometimes up to 25-30%) and dangerous overloading, Nexans developed a concentric low voltage copper cable which causes a short circuit when pierced by "jaw" clamps. An economical aluminum version discourages copper theft and comes in various designs, with "cool" connectors.

Temporary construction site cables are high voltage replacement cables that are used during the maintenance, repair and modification of overhead lines, transformers and substations. They provide a temporary "bridge" or a source of emergency power. They can either be purchased or rented, and make it possible to reduce outages and increase the availability of all network assets.

A Nexans retrofitting solution saves civil engineering, installation costs and the time required to expand a network. Existing pipes for housing fluid-filled cables are re-used to accommodate next-generation XLPE cables. With a vast range of high-voltage cables available, a power transmission network can continue to grow flexibly according to actual power needs, and in a sustainable way.

When quick repairs are necessary, Nexans provides medium voltage customized accessory kits on site for greater flexibility. They contain all needed equipment and pre-connectorized, pre-cut cables needed to splice in replacement cable or make a connection. This decreases outage time, and lowers the risk of error and repeat failures.



Energy networks: full portfolio of solutions

Nexans supplies a full range of WINDLINK® cables to virtually every wind turbine manufacturer worldwide, and has been instrumental in developing environmentally-friendly infrastructure solutions both onshore and offshore.

Because power utilities want to assure low impact on the environment, Nexans has long begun eliminating lead in its screens, and has now pioneered a new compact high voltage cable with a welded aluminum laminated screen. This makes it possible to have much longer lengths on reels during installation, fewer connections and less maintenance.

For distribution, Nexans has several medium voltage underground applications. Directly Buried Cables free the skyline from overhead lines, and reduce truck movement and burial activities to a minimum.

Stage 2: Simulation

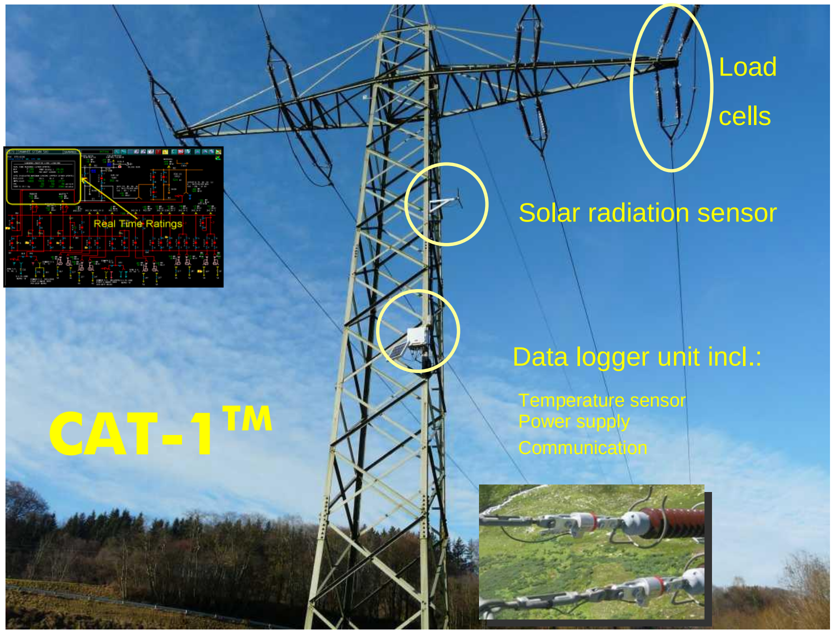
When a network is over-congested, Nexans can replace saturated cables with cables that carry more energy. For example, replacing some ACSR conductors with AAAC-Z conductors reduces overload and can decrease losses by more than 20%. In certain conditions, replacing saturated ACSR OHL with superconductor underground cables which can carry more energy would even cut global losses by more than 40%.

Stage 3: Sensors

Nexans provides tension-based Dynamic Line Rating for overhead transmission lines, increasing power load by up to 30% for 95% of the time.

Nexans makes it possible to adapt load management through real time temperature rating systems for cables. Cable Distributed Temperature Sensing uses optical fiber units in the surrounding sheath to determine temperature profiles, detect hotspots, and control and monitor cable load. Temperature measurement is possible at 2 meter intervals over a 30 km length of cable.

Smart accessory developments will soon provide information for continuous surveillance of the network.



Real time temperature monitoring

Stage 4: Communication

To merge energy and data networks, Nexans has developed compact Ethernet i-switches especially designed for energy providers. Within an integrated network (including optical fiber and passive components), i-switches support all security mechanisms: customer identity, authentication, access, surveillance, telecontrol, transformer monitoring, automatic metre reading, etc.

Hybrid power and fiber-optic cables provide important multifunction capacity for enhanced monitoring and control.

Stage 5: Breakthrough solutions

High-voltage DC cables, either fluid filled or XLPE insulated, deliver high power capacity over longer distances, in both terrestrial and submarine conditions.

Nexans installed the world’s first Superconducting Fault Current Limiter in a power plant to provide short-circuit protection for the internal medium voltage power supply (12kV) that feeds power plant machinery. This system can get a 63 kA short-circuit current down to 30 kA instantaneously and down to 7 kA in less than 10 milliseconds, thus providing unparalleled protection.

Nexans Superconducting Fault Current Limiters in Germany

Nexans is a world leader in Superconductivity. Nexans installed the world’s first high-voltage superconducting cable making it possible to transfer a much higher power than a standard underground cable. Not only does the system allow bi-directional power links, it has no thermal or electromagnetic impact on the environment.

A further service dimension

Only an active manufacturer of traditional fluid-filled cables and accessories and latest-generation XLPE cables can provide Through-Life Support, either as single modules adapted to special needs, or as a complete service package which includes predictive, preventive and corrective maintenance, and emergency intervention. Nexans is maintaining networks for power utilities worldwide.

Nexans is also dedicated to keeping expertise alive through special training programs for its customers. The Nexans high voltage Training Center, based in Switzerland, and medium voltage Power Accessories in France aim at standardizing installation and methodology, and providing theoretical and basic training for everyone involved in cable systems: jointers, engineers, maintenance personnel, network managers, etc.

Nexans has patented a safe way for draining oil in cables with a special eco-friendly mixture that reduces residue to a minimum. Cables are recycled as secondary raw materials (copper, aluminum and plastics) through Recycable (owned jointly with Sita). Comprehensive recycling means that recycled materials are often reincorporated in other products.

Nexans Life Cycle Assessment makes it possible to compare and determine the best environmental solution for a network. Using this method, the ecological footprint of a product can be measured, from raw material extraction to end-of-life disposal, and includes production, distribution and use. An environmental declaration allowed Iberdrola (Spain) to choose the best solution with confidence.

Nexans Life Cycle Assessment

With its simulation facilities, Nexans can simulate the network, virtually replicating components, connectivity and the cables themselves, so as to identify constraints and sensitive zones. It then proposes solutions and suggestions, often giving several choices, according to cost, installation, and performance. This service resembles very much the process used when designing and laying out a completely new network, but is also an important decision-making tool for upgrades.

With energy as the basis of its development and a strong telecommunications background, Nexans is uniquely placed to supply complete cables and cabling solutions for power generation, transmission and distribution. It also furnishes the decisional tools, technical means maintenance, and services required to meet the challenges of smarter networks.

IV. APPENDIX:

Some recent Nexans success stories

- Nexans has installed tension-based Dynamic Line Rating for overhead transmission lines for many customers, including Manitoba Hydro, Hydro Québec and is currently supporting installations in Texas for ONCOR within the framework of the American Recovery and Reinvestment Act of 2009.

- For the Long Island Power Authority (LIPA) in NY, Nexans installed the world's first high-voltage superconducting cable, making it possible to transfer much higher power than a standard underground cable, using an existing right-of-way.

LIPA: world's first high-voltage superconducting cable

- To counter energy theft, Brazil's Eletropaulo installed 120 km of Nexans new anti-robbery cable. Five different sizes were installed for the Paraisopolis Social Project in São Paolo (Brazil).

- Nexans high voltage DC submarine cables are connecting Northern Ireland and Scotland, while another cable runs under the Channel between Dover and Calais.

- For Vattenfall in Germany, Nexans installed the world's first Superconducting Fault Current Limiter in a power plant to protect medium voltage power supply (12kV) feeding coal grinders and crushers in a brown coal power plant. This system takes 10 milliseconds to eliminate a short-circuit.

- To expand and develop Qatar's electricity utility, Kahramaa, to meet the rapid increase in demand, Nexans implemented six underground power links to reinforce and extend the high-voltage network serving Doha, the country's capital. This major turnkey project included design, development, supply and installation of 96 km of 66 kV and 132 V singlecore cables and accessories.

- Nexans have provided hundreds of kilometers of high-capacity overhead lines (including accessories) to European and North-American Transmission System Operators.

- Nexans WINDLINK® expertise and cables have played a significant role in projects like Horns Rev (Denmark), Sheringham Shoal (UK) and Alpha Ventus (Germany).

- Nexans non-lead welded aluminum laminated screen high voltage cables has been used widely by France's RTE.

Seven definitions of Smart(er) or Intelligent Grids

"The smart grid entails a transformation to an information-enabled and a highly interconnected network between electricity consumers and electric suppliers embracing transmission distribution, and generation. Simply stated, in this transformation, the operation of power systems evolves from a static-as-designed infrastructure to a dynamic infrastructure using proactive supply and delivery management."

From "Getting Smart" by Thomas F. Garrity
published in *IEEE power & energy magazine*
https://w3.energy.siemens.com/cms/us/whatsnew/Documents/Getting%20Smart_Garrity.pdf

"An Intelligent Grid refers to an electricity transmission and distribution system that incorporates elements of traditional and cutting-edge power engineering, sophisticated sensing and monitoring technology, information technology, and communications to provide better grid performance and to support other utility business processes especially service delivery and customer service. In general, an Intelligent Grid should not be defined by what technologies it incorporates, but rather by what it can and does for utilities and their customers."

Ethan Cohen of UtiliPoint
Quoted by Byron Flynn in "What is the real potential of the Smart Grid"
AMRA International Symposium, 2007
http://www.gepower.com/prod_serv/plants_td/en/downloads/real_potential_grid.pdf

"ABB's list of smart grid criteria focuses on broad characteristics rather than specific functions. Under this model, the smart grid is:
- Adaptive, with less reliance on operators, particularly in responding rapidly to changing conditions.
- Predictive, in terms of applying operational 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 attack and naturally occurring disruptions."

From "Toward a smarter grid:
ABB's Vision for the Power System of the Future"
http://www02.abb.com/db/db0003/db002698.nsf/0/36cc9a21a024dc02c125761d0050b4fa/$file/Toward_a_smarter_grid_Jul+09.pdf

"The electric industry is poised to make the transformation from a centralized, producer-controlled network to one that is less centralized and more consumer-interactive. The move to a smarter grid promises to change the industry's entire business model and its relationship with all stakeholders, involving and affecting utilities, regulators, energy service provider, technology and automation vendors and all consumers of electric power. A smarter grid makes this transformation possible by bringing the philosophies, concepts and technologies that enabled the Internet to the utility and the electric grid."

"The Smart Grid: an Introduction"
U.S. Department of Energy
http://www.oe.energy.gov/DocumentsandMedia/DOE_SG_Book_Single_Pages.pdf

"Electricity grids of the future are Smart in several ways. First, they allow the customer to take an active role in the supply of electricity. Demand management becomes an indirect source of generation and savings are rewarded. Secondly, the new system offers greater efficiency as links are set up across Europe and beyond to draw on available resources and enable an efficient exchange of energy. In addition, environmental concerns will be adressed, thanks to the exploitation of sustainable energy sources… These developments buck the trend of a 50-years grid evolution. Information exchange is developed and customers take on an active role."

European SmartGrids Technology Platform (EC)
"Vision and Strategy for Europe's Electricity Networks of the Future"
ftp://ftp.cordis.europa.eu/pub/fp7/energy/docs/smartgrids_en.pdf

"Smart grids incorporate embedded computer processing capability and two-way communications to the current electricity infrastructure. Smart grids operate across the utility value chain and should not be confused with smart meters… A smart uses sensing, embedded processing and digital communications to enable the electricity grid to be observable (able to be measured and visualized, controllable (able to be manipulated and optimized), automated (able to adapt and self-heal) and fully integrated (fully interoperable with existing systems and with the capacity to incorporate a diverse set of energy sources)."

"Accelerating Smart Grid Investments"
World Economic Forum
http://www.weforum.org/pdf/SlimCity/SmartGrid2009.pdf

"A smart grid is an electricity grid that connects decentralized renewable energy sources and co-generation and distributes power in a highly efficient way. It uses distributed energy resources and advanced communication and control technologies to deliver electricity more cost-effectively, with lower greenhouse gas intensity and in response to consumer needs. Typically smaller forms of electricity generation are combined with energy management to balance out the loaf of all users on the system. Small renewable energy generators can be closer to the users, rather than one large centralized source a long way away."

"[r]enewables 24/7: infrastructure needed to save the climate"
The European Renewable Energy Council & Greenpeace
http://www.greenpeace.org/raw/content/international/press/reports/renewables-24-7.pdf