Cabling for Power Utilities Whitepaper

Bridging the energy gap

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Synopsis

This report is intended to give a general overview of the global Power Utilities, and provide information about how Nexans is serving this market.

It opens with a review of industry projections, which will have an impact on Power Utilities, both private and public, national and international; then focuses on some major trends which will ultimately affect the cable supply industry as well. Next, it focuses on some major challenges. It also draws up a comprehensive list of what the industry expects from a cable supplier. Finally, the third section presents Nexans overall product offer and explains Nexans service approach.

This report is followed by an Appendix containing a list of recent Nexans success stories.

INTRODUCTION: NEW POWER PERSPECTIVES

"As we move to a new, low carbon economy, there are major opportunities for our businesses to become world leaders in the technologies we will need for the future…we need access to a wide range of energy sources and technologies, and a robust infrastructure to bring the energy to where we want to use it."

Tony Blair, Foreword, *Our energy future*, 2003

1. The dynamics of growth in a powerful industry

Electrical energy is at the very heart of modern society, since nearly all human activities depend on electricity. We need it for warmth, light, the ability to cook, wash, travel, work, survive and amuse ourselves.
Short of a world catastrophe, there is little likelihood that the hunger for electrical power will diminish, and most recent major studies take this as a basic operating premise. If there is occasional disagreement, it occurs when considering how best to provide electricity in terms of primary energy consumption (gas over oil, wind over nuclear power), and how this "commodity" can be equitably shared, in a sustainable manner, without disruption to users (i.e blackouts).

In one recent Energy Information Administration report (2004), it was noted that the **rapid growth in demand for electricity** was due to computers, electronic payment, appliances and telecommunications. Although the tertiary sector was showing the fastest growth worldwide, industrial energy demand was still increasing, and so was the demand for household energy.
A 2003 European Commission Report reminds readers that the world population is growing by 1% annually, which means that there will be **8 billion people on the planet by 2030**, with the highest populations in Africa, Asia and Latin America.
At present, the World Energy Council estimates that there are 1.6 billion people throughout the world who do not have access to electricity, and this number is unlikely to increase by 2020. This burgeoning population, clamoring for electricity to power everything from satellite radios to rock concerts, accounts for a series of 25-year forecasts that see worldwide consumption going in one direction only:

- An **increase in electricity demand** of 2.4% annually, with an increase coming from Asia
- By 2025, total world energy consumption will have expanded by 58% (mostly due to developing countries), with Asia consuming 2.5 times as much electricity as today
- In China, electricity consumption is growing on average 4.3% annually
- Growth in Central and South America is rated at 3.3% per year
- Meanwhile, the developed world has stabilized at a more modest 1.7% growth due to existing infrastructure and energy conservation policies

Already, a clear and striking distinction appears between the **developing world** and the **developed world**. The pressure is on to "electricity" at all possible wherever electricity is equated with high-growth and economic opportunity. Developing countries are moving ahead at breakneck speed with mega-projects like the Three Gorges Dam on the Yang Tze river in China. As the world's largest dam, it will eventually produce the equivalent of 20 nuclear plants.
Another country seeing intense activity is **Brazi**l, which has promised to connect all of its people by 2008 (20% of its 170 million population still do not have access to electricity). To achieve this, there is a need to integrate Brazil's four grids (mostly hydro) into a **coordinated "supergrid"** and run higher voltage lines between big cities. This philosophy is also shared by the **Greater Mekong Subregion** (GMS) supergrid, which will link six countries (China, Cambodia, Lao PDR, Myanmar, Thailand and Vietnam).

2. The shift of fuels and its impact

This rate of growth in developing countries impacts the kind of fuel chosen in the next quarter of a century. Traditional fossil-fuels are not about to disappear, and nor is the nuclear option. Of the 31 nuclear reactors currently under construction worldwide, most are in developing Asia (8 in India, 4 in China, 2 each in South Korea and Taiwan, and one in North Korea). Both China and India have large reserves of coal.
Meanwhile, the developed world, prodded by the Kyoto Protocol, is doing some serious soul-searching about **green issues and sustainability**. Nothing is more indicative of this than the recent **White Paper** commissioned by Tony Blair, which aims at a 60% reduction in carbon emissions by 2050, with renewables contributing over 40% of electricity generation.
A recent European Wind Energy Association document claims that 12% of the world's electricity could be generated by wind power by 2020. Although there is continuing vigorous debate on the "primary energy consumption" issue (i.e. what fuel to use for electrical production), some significant trends are already appearing:

- **Coal** is still dominant today (34%), but it will fall a third by 2025
- **Oil** is stable today (7%), and will continue to be so
- **Natural gas** is rising because combined-cycle gas turbines are cheaper to produce, and burn more cleanly than other fossil-fuel-fired generation; it will be the fastest growing primary energy source worldwide (2.8% annually), with consumption to triple in Europe by 2025
- With most **nuclear plants** aging, and few new ones planned in the developed world, nuclear sources will decline from 19% today to 12% by 2025
- **Hydropower** is growing at a steady rate of 1.9%
- Among other renewables, **wind** is the leader, with installed capacity growing at 30% annually; optimists predict that 12% of the worlds electricity needs could be met by wind by 2020

Green advocates predict that we are going to see a wide and complementary **mix of energies** in the next two decades, and say that better management and technical innovation will make the energy market more stable and productive. They proclaim the eventual demise of dirty coal-burning plants and nuclear power.

The opposition contends that renewable energy is often unreliable energy since it is subject to weather conditions, draughts, etc. and is incapable of assuring grid stability.
It calls for massive reinvestment in infrastructure and power plants, since both are over 30 years old.

At a Power Plants Congress in Copenhagen, 2003, the VGB (German Association of Power Plant Operators) President, Dr. Gerd Jäger, bluntly affirmed:
"To herald regenerative energy as the main girder of tomorrow's energy supply is a hopeless, exaggerated, and false representation."

Energy conservatives claim that renewables will simply drive the price of power sky high, and destabilize power production. They would prefer to see moves towards smaller but safer "pebble bed" high temperature reactors (HTRs), and superconducting rings for prolonged electrical "storage" of excess capacity.

The jury is still out concerning **unbridled development versus sustainability**, and enhanced traditional production as opposed to renewable methods. However, one thing is evident. If **gas is moving ahead** as a sort of compromise in efficient and environmentally-friendlier "primary energy consumption," we may well see the oil & gas industry getting heavily into electrical energy production.
Putting a new electrical generation plant into a densely-populated area can give rise to permit problems; and shipping natural gas can be very expensive.
Some visionary oil & gas outfits could simply buy an island off the continental US, generate electricity on the spot, and then ship it via submarine cables landwards.

With today's high-voltage cabling technology, a 100 km DC feed poses no problem as long as the ocean depth is no more than 1,000 meters. One recent study even examined the feasibility of "shipping" electricity by cable from Nova Scotia to New York, some 1,100 kilometers.

3. Deregulation and blackouts

Another area of concern to power utilities and their suppliers is **deregulation** and its long-term impact on business. Deregulation in the eighties gave birth to a string of mergers and acquisitions in the nineties which saw the emergence of producers with a truly national and international presence. This trend is by no means restricted to the US.

In Korea, KEPCO (Korea Electric Power Corporation) is now being privatized, subdividing into six separate power-generation entities.
In Europe (under the European Electricity Directive issued in 1997) there were over 35 mergers, especially in Germany (E.on and Ruhrgas).

Already, some experts are predicting that the replacement of all state-owned monopolies by **transnational oligopolies** will eventually give rise to a **"supergrid"** stretching from Lisbon to Warsaw, and perhaps beyond, including large parts of the Former Soviet Union and North Africa.

This kind of consolidation has important consequences both upstream and downstream. In 2003, a series of dramatic **energy blackouts** occurred in both North America and Europe, largely due to a sudden demand for air-conditioning or heat.
In the old days, these surges would have been handled by a regional utility having the plant margin necessary to immediately rectify a sudden rise in demand.
However, once electricity became a commodity purchasable anywhere, according to best price and the time of the day, power utilities started to squeeze their plant margin in order to make savings both in power generation expenses, and infrastructure reinvestment.

When demand suddenly rose, the situation was further complicated by component failures, slow corrective action, low water levels, untimely power plant interruptions (for maintenance), storms, misrated fuses, and undersized transmission lines. Inadequacies like these caused overheating in transmission lines which quickly sagged onto poorly trimmed trees. Then further non-action and computer failures quickly cascaded these energy failures upwards, so that massive areas were affected, like the American Midwest, Northeast and a large part of eastern Canada. In Italy, the same sort of cascading events, together with overloads, created the largest blackout in Europe since the Second World War.

However, unknown to the public at large, the real reasons behind these events were not insufficient generating capacity, but rather inadequate transmission and distribution networks (due to underinvestment) and the inability of various grids to smoothly manage power handoffs. This was the real wake-up signal that the blackouts provided. Power Utilities or Transmission Operators have to start upgrading their grids, especially for critical high-voltage, long-distance transmission. In the dense city environment, new technologies like **superconductivity** can contribute to increasing power potential.

4. Summary of trends for power utilities

Traditional power utilities, new power providers, electrical commodity traders, the engineering, procurement and construction (EPC) sector, installers and cable suppliers have had to face a complex market situation:

- **Worldwide electricity consumption** will continue to increase indefinitely
- **The developing world is investing heavily** in generation, distribution/transmission facilities, but it is not necessarily respecting the green agenda of developed countries
- **The developed world** is seriously considering moves to **renewable fuels**; however investment in both new forms of generation and transmission/distribution upgrades are under-financed because of cost pressures due to deregulation
- **Natural gas** is the rising "primary energy consumption" fuel for power generation
- Oil & gas companies are rapidly moving into **offshore electrical energy** production
- Blackouts have been a "wake up" call for the industry worldwide; better and more reliable **infrastructure and line management** are urgently needed
- There is a definite move away from national and regional grids, towards **supergrids**, managed by transnational companies and organizations
- Longer and higher voltage transmission lines are needed, as well as product innovations **to increase efficiency and productivity** in power-hungry cities
- **Renewable energy**, especially hydropower and wind, will continue to play an important role in the long-term strategies of developed nations, and as affordable options for developing ones, if government or international support is forthcoming

II. CHALLENGES AND CUSTOMER EXPECTATIONS

Cables are not just an adjunct to world power production, they are its **nerve system and lifeblood**, providing often the only visible sign of an almost invisible commodity. That is why any change in power plant or infrastructure often involves a change in types of cable and a demand for installation expertise.

As developing countries strive to build their systems, and developing countries continue to upgrade and consolidate them, they are looking for **long-term reliability** and **a financial payback on their investment.**

1. Quality versus price

The first major challenge facing both developing and developed countries alike is how to achieve **quality at the lowest possible cost**.
In China alone, there are 6,000 cable suppliers, and it is obvious that most projects will draw on their local resources to boost the economy and achieve important import-replacement capability. Whether one is building up a power grid, or consolidating it, there is a willingness to use **higher quality**, **value-added products** if the extra cost is justified.
That is why cable suppliers must aim at important niche-markets, where proven expertise can be brought into play. Today, a dictum circulating in the energy business is that low-voltage and medium-volt are definitely "commodity" products, and it is assumed that quality is more or less the same, with cost as the determining factor.
Real product differentiation occurs with high-voltage products which are harder to produce and complicated to install, and special products (like fire-performance cables).
Since most of the big utilities are becoming more and more global, with subsidiaries all over Europe and in the US, they are often comparing cable types between countries, and are centralizing purchasing across many markets.
Above all, they want to pay one price for a given product everywhere, so as to obtain savings from bulk purchasing. This is why **online auctions and e-shopping** opportunities are being increasingly integrated with logistics and supply worldwide.

2. Expanding plant generating capacity

Secondly, since electrical production is bound to grow, the industry needs to **expand generating capacity**.
The generation side involves many factors: What kind of fuel or technology should be used? Where should electrical production be located? All of these considerations have an impact on cable.
In North America and some European countries (Germany) there is **a moratorium on new nuclear plants**, and existing plants are difficult and expensive to upgrade, costing up to three to ten times the original construction cost. In some places, like Toronto, Canada, there are plans to **convert coal-burning plants into gas-burning plants**.

The wind sector, too, is deeply involved in this challenge, not only in its efforts to produce bigger and more cost-efficient windmills, but also in the location of plants.

In many European countries, wind turbine saturation has occurred on land, and now there is a real effort to establish massive windparks off the coasts of Germany, Belgium, England, Spain, etc.

This demands a major shift in cable types, and additional maritime expertise. Not to be forgotten, the manufacturers of large turbines for **hydro or fossil-fuel-fired plants** are generally high-tech world players (like Alstom, Siemens, GE and ABB), and these manufacturers, too, are looking for new ways to increase turbine capacity, and improve efficiency.
Finally, generating plants, themselves, are looking to vastly improve power management by upgrading in-plant cabling, and control and communications systems.

3. Upgrading transmission, distribution and grid interconnectivity

The third challenge comes from the trend towards **deregulation**, and the need for **steady and reliable flows of energy**, often over long distances and between countries.
There is a pressing need to upgrade transmission/distribution networks, and to improve grid interconnectivity so that electricity can be widely shared and traded. There is an obvious need for higher voltage lines; but few developed countries are allowing new overhead transmission facilities to be built.
A temporary solution is to use existing and approved infrastructure (i.e. towers and pylons) to carry new kinds of higher voltage cables. This means innovation in conductor types, and improving the power electronics that control the new lines. A new generation of accessories for extra-high-voltage (EHV) lines is also required.
The infrastructure question is further complicated by the fact that due to deregulation – and this is especially prevalent in the US – there has been a trend to separate generation from transmission and distribution.

The same evolution is underway across Europe. The reason behind this is that once electricity can be purchased from any "merchant plant" at the lowest price, the big utilities no longer enjoy a monopoly at a set price. Thus, some divested themselves of generation entirely, while others jettisoned transmission facilities.
For cable suppliers, the main customers are no longer the public utilities, but a whole range of different players: from thousands of small investor-owned companies, some generating and some transmitting electricity, to large giants who do virtually everything, including research.
Since the grids are expanding both inside and between countries, bottlenecks are bound to occur wherever existing grids interconnect. What is needed is **long-term vision**, based on interconnective cabling, to make future supergrids a reality.

4. Installations underground, undersea and overhead

A fourth challenge is **installation**. Underground installation may have to be done in remote, tough terrain, and under severe climatic conditions. For mega-projects, Engineering Procurement and Construction (EPC) firms expect onsite delivery and expertise in accessories, especially joints and terminations.
System expertise, which includes not only cable and accessories, but also jointing and connections to the grid, as well as engineering design, is becoming so specific that Utilities or Transmission Operators are moving towards turnkey supply, particularly in the Extra High Voltage field.

Undersea, the long and heavy cables require specialized transport vessels and laying equipment. Cables must be resistant to salt-water corrosion and abrasion caused by sea currents and waves.
In deep waters, they must withstand extremely high pressures. Marine and plant life, too, can pose a serious threat. Human attack can come from everything from drag anchors to fishing tackle, requiring cable protection even in deep water, down to 2,000 meters.
This trend has needed new technologies, such as water-jetting, rock-dumping, plowing, concrete mattress protection, etc. Submarine cables must withstand great mechanical strain during laying, to ensure the longest possible life and avoid costly recovery and repair procedures.

Overhead conductors are subject to winds, temperature variations, stress, and sag due to ice and joule loss. It was, in fact, overheated lines sagging onto untrimmed trees that were responsible for several recent blackouts.
Aerial conductors must also be custom designed to suit country-specific climactic factors: heavy rain, high winds, extreme cold.
Despite public protests, overhead solutions will continue to be used in developing countries (because they are cheaper), and in the developed world (because the support structures are already there).
The real challenge lies in boosting performance through new designs and improved thermo-resistance.

5. Environmental and safety concerns

The fifth major challenge is to find **the right technologies to meet environmental and safety concerns**.
On the one hand, utilities are expected to improve the flows of energy in national grids, increase "throughput," and reduce grid bottlenecks and congestions that give rise to cascading system failures.
On the other hand, the public and governments would prefer to see lines buried, and this is very expensive, an option for rich countries only. Two grid-related problems are how to make lines, installations and transformers more secure during both rain and snowstorms; and how to make sure that grids are coherent between different countries and regions.
In the Italian blackout, the incident initially began with a tree falling in Switzerland and bringing down an important line. The reaction time and communications were extremely slow, causing a sequence of escalading failures.
There is a definite need to improve not only the **mechanical safety** of overhead lines, but also to **install control and communications systems** to reinforce information flow within and between grids. Given the likelihood that the life of nuclear reactors will be extended through upgrades – there are still about 430 of them operating around the world – or that a new generation of "pebble bed" high temperature reactors (HTRs) will be introduced, there is the challenge of assuring a steady stream of replacements for existing plants, and developing a new range of cables and accessories to serve the total life management of this sensitive market.

6. Customer expectations of cable suppliers

Whether it is in the area of generation or infrastructure (transmission and distribution), **cables play a central role in the provision of electrical energy**. Not only do they carry an invisible "commodity" that is difficult to store, they also serve important communications and control functions, at every stage critical for reliability, safety and performance. Whether a power utility, an engineering contractor, an installer, or an energy trader, all have high **expectations** of a cable manufacturer:

- A wide **awareness** of all power plant types: coal-fired, oil, gas-turbine, hydropower, nuclear, or renewable energy plants (e.g. wind turbines)

- The ability to provide **extremely reliable, state-of-the-art cables** for new projects, and to assure a steady stream of replacement cables for existing generation plants and networks

- Familiarity with both the **energy and the telecom side of cable**, since the latter is an important part of network management

- **Advanced connectivity solutions**, since joints, terminations are critical to network and grid reliability

- **Turnkey expertise** for both underground and submarine high-voltage links
- The ability to meet **rigorous safety standards** and **handle harsh environments**, which can range from desert to arctic conditions, marine and land-based.
- **High-voltage turnkey expertise** in design, installation, connectivity and innovation: extra-high voltage transmission, superconductivity
- **Fast delivery and high reactivity** in the case of accidents breakdowns, blackouts, line failures, etc.
- **Advanced installation expertise** for power plants, underground and submarine cables, and overhead lines, using custom software and specialized equipment
- **Environmental responsibility**, in terms of how the cables are produced, their impact on the environment, and eventual recycling issues

III. NEXANS: A GLOBAL LEADER IN THE INDUSTRY

Nexans' global offer is an important one for the power industry. Unlike many of its competitors who provide niche items to separate suppliers and sub-contractors, Nexans has the capacity **to produce virtually every type of cable** used in power utilities worldwide, often dealing directly with the energy authority or entrepreneur on major turnkey projects.

1. From standard products to custom-designed cabling

To meet the "commodity" nature of the power utilities market, Nexans supplies an **extremely wide range of standard products**, especially in the area of low and medium voltage. In the area of high-voltage, there are no off-the-shelf products.
All cables are custom-designed for the client, especially as a part of important turnkey projects. It is here that Nexans stakes its claim as a **world leader**.
The club of players in the global Extra High Voltage market is a select one, with less than 9 or 10 cable manufacturers. Nexans is a leader in this small community, with **a multidisciplinary expertise** in both underground and submarine cables. This not only includes cables, accessories, joints and terminations (which are extremely demanding in the HV environment) but also system design, installation, civil engineering, and testing.
Since standards are so important to this international, yet highly regulated industry, **Nexans is compliant with most of the world's electrical standards**: IEC, NF, BS, CSA, ASTM, EDF, ICEA, IEEE, NEK 606, ISO 9001 quality, Qualified Products List (QLP), advanced fire performance specifications, etc.

2. After Europe, the Middle East and the Americas, some new Asian initiatives

Today, Nexans cables are being installed in generation plants and transmission/distribution networks around the world. Since **Asia** is expected to consume two and a half times as much electricity in the next quarter of a century, and is a prime market Nexans has launched several initiatives in the Far East.

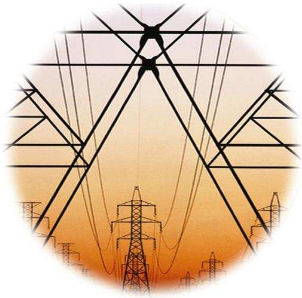
In China, Nexans is pursuing a dual strategy of importing cables with strong added-value, and reinforcing its presence by building plants locally.
Already, Nexans has a plant making winding wires (CTC) for power transformers in Tianjin, near Beijing. In 2006 a new plant will be set up to produce HFFR cables. For HV up to 110 kV the Chinese are self-sufficient, but beyond this, Nexans has **a real strategic advantage** both on land and undersea.
Furthermore, Nexans established an accessories facility for high voltage in 2001 to take local advantage of its technological expertise. At present it employs 400 persons in China; and about half of our cables installed in China are produced locally.

Kukdong Electrical Wires Company, located in South Korea, was acquired in 2003. The company's business is predominantly dedicated to marine and electric cables for the Korean, Chinese and Japanese markets.
According to Nexans' **CEO, Gérard Hauser,** *"This acquisition corresponds to two of our main strategic directions: of realigning Nexans towards high value-added products, and of developing high-growth markets in the Far East and Asia."*
Kukdong and the Nexans Korea plants currently produce both LV and MV energy conductors, including STACIR cables which can withstand 300 °C with same cross-section to transmit more power in bare overhead lines. There is also currently an upgrade from 345 kV to 765 kV, using bundled normal conductors in Korea; and XLPE cables are being phased in for MV distribution

In Vietnam, the state-owned power company, EVN, is both a customer and a partner for Nexans since it owns 41% of Davipco, a joint venture.
Nexans Korea owns the other 59%. Although there are 50 power cable companies in Vietnam, Nexans is the only one to partner in this way. Nexans is presently selling aluminum rod, aluminum-alloy conductors, and arrester wires, and has been deeply involved in the 2,000-km-long 500 kV line running from north to south, which will branch out to the provinces on 110 and 220 kV after 2005.
Nexans also has a close working relationship with the team building the Greater Mekong Subregion (GMS) supergrid, which will link six east-Asian countries

3. A wide range of products for the energy industry

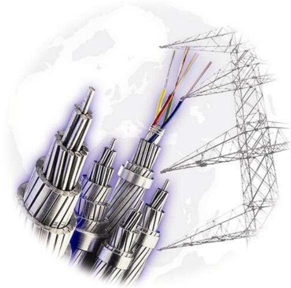
Nexans produces **HV fluid-filled cables** which have been constantly refined to improve their performance, and the mass-impregnated type which is especially adapted to long-distance submarine HVDC applications. These cables have been proven extremely reliable under tough conditions and can deliver high voltages in a host of environments, including underground, tunnels, shafts and deep ocean depths to link up a distant power plant to a local substation.



It also manufactures **XLPE HV cables** which consists of a stranded copper or aluminum conductor with an extruded insulation system, and various shields, sheaths and armoring. These cables can be equipped with optical fibers integrated in the screen to allow the utilities to do thermal monitoring, or even an optimization of the real carried ampacities. XLPE cables were originally designed for underground networks, but are now gradually replacing fluid-filled cables undersea. Their usage for underground applications is now extended to high voltage, with a standard of 400 kV, and beyond. Nexans is one of the few manufacturers qualified to install this type of cable, which requires a high level of technical skills.

Similar to the above are **XLPE MV cables** which are widely used by power utilities in both developed and developing countries. These cables provide practical solutions to most network problems, and are favored for inter-generator connections on wind farms.

For overhead applications, Nexans provides a full range of bare **overhead lines** which come in several types according to structure and composition. All must strike a balance between mechanical resistance (strength) and electrical resistance (conductivity). Aluminum conductor steel reinforced (ACSR) offer high strength and allow high voltages in large span runs.



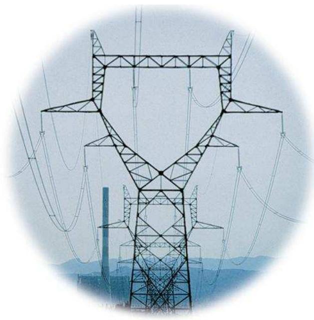
Corrosion-free all aluminium alloy conductors (AAAC) are ideal for severe conditions. New technologies, such as z-profiled **AERO-Z® conductors** allow for greater amperage to be carried on the same cross-section, and/or a better and faster return on investment (ROI). They also offer reduced drag, lower galloping in high winds, no internal corrosion, less noise generation, fewer line losses, resistance to snow and ice accretion, and in some cases, fewer towers. Also**, new thermo-resistant conductors** allow for conductors to operate up to 200% without increasing the sag, thus carrying more electricity on standard-dimension lines in hot countries. Nexans has also developed a new generation of insulated aerial lines.

Unlike many of its competitors, Nexans manufactures **a full range of medium and high-voltage accessories**. For MV, accessories are often sold apart from the cable. Nexans produces **MV rubber-molded connectors** for connecting insulated cables with distribution equipment (transformers, switches), as well as joints and terminations. Nexans has available all cable accessory technologies; however, the medium-voltage joints and terminations are using more and more so-called cold-shrink technology which does not require any special tooling, and guarantees a safe and durable connection. All joints are protected, solid, easy-to-install, and pre-tested in the factory. For HV, accessories are an integral part of a high-performance network. For HV terminations, Nexans pioneered the move from SF6 gas accessories, to oil; and today is marketing “dry” sealing ends. It is now moving from porcelain to composite insulators with epoxy and silicon to reduce pollution and offer greater safety in the event of damage.

An entire family of **rubber-insulated or rigid low-voltage cables** are used within generating plants, while another series are used for subscriber distribution in the last mile. **Underground LV cables** provide optimum safety and environmental-friendliness in cities. Aerial bundled cables provide a reliable and cost-effective alternative solution for rural electrification. As for low-voltage accessories, Nexans produces **low-voltage cabinets as well as low-voltage straight** and **branch joints for underground cables**, using a series of internationally recognized technologies.

For power plants and generating stations, substations, etc., there are **various power and control cables** for all turbine/generator functions, switching operations, and network management; and there is a new generation of instrument, sensor and fieldbus cables for monitoring purposes, and creating a new level of digital control for all electronic and mechanical devices over a widely distributed area. Coaxial and data cables linked to energy cables provide power to surveillance cameras and transmit vital information for security, emergencies and fire-monitoring. They allow a command function to control camera movement, and guarantee non-stop surveillance.

Fiber optic cables and accessories allow power utilities and operators to meet the need for higher data capacity, for the control and management of power generation, as well as transmission and distribution. To create a cost-effective, parallel telecom network, Nexans has available an **Optical Ground Wire (OPGW)** in both standard slotted core designs, and also in an AERO-Z® version. This Right of Way (ROW) solution makes it easy for power utilities to generate additional revenue by becoming a telecom provider in their own right (as is the case in Norway) by offering broadband potential to remote customers via its own infrastructure.



Nexans is an expert in both copper and/or fiber **Local Area Networks and Wide Area Networks** (supporting 10 Gigabit and beyond) to support operational platforms and provide telecommunications capacity needed to run a complete power plant, or network control center. In addition to fiber, Nexans can provide Category 7 cable for future-proofing copper networks.

Nexans has developed and produced a complete family of specialty **winding wires**, including fine and ultra-fine wires for timers, valve relays and small transformers, but also self-bonding wires for electrical motors of all sizes, including large generators. Continuously Transposed Cable (CTC) is especially designed for medium and high-voltage power transformers. These easy-to-wind wires greatly enhance performance and reduce electrical loss.

Using new superconducting materials, Nexans is developing a **cryogenic** (i.e. low-temperature) **cable** within which liquid nitrogen is circulated to achieve ultra-low temperatures and thus increase current capacity in much smaller conductor diameters. These superconductive solutions make possible devices like Fault Current Limiters (FCLs) which better control dips and surges on the grid, and Superconducting Magnetic Energy Storage (SMES) which can store excess energy nearly indefinitely by having it circulating around in a superconductive loop.

For the power plant/reactor environment, all Nexans cables are available **in halogen-free, low-smoke, low-corrosive and fire-retardant versions**. They have been designed to operate over the lifetime of a plant. In the case of nuclear reactors, they can sustain radiation for a 40-year span, and survive loss-of-cooling accidents. Thermal power plants and substations have turned to these ultra-safe and reliable **HFFR cables** to protect both personnel and the workplace.

4. Key Nexans Plants

- **High voltage**: for land cables, Lens (France) Charleroi (Belgium), Cortaillod (Switzerland), Halden (Norway), Hanover (Germany); for submarine cables, Halden (Norway); for accessories; Cossonay (Switzerland); for overhead transmission lines, Lorena (Brazil), Lens (France), Mohammedia (Morroco), Davipco (Vietnam), Weyburn (Canada), Elouges (Belgium), Cheongwon (Korea)

- **Medium voltage**: for cables, Namsos (Norway), Hanover (Germany), Charleroi (Belgium), Bourg-en-Bresse (France), Cortaillod (Switzerland), Latina (Italy), Lamia (Greece), Denizli (Turkey), Weyburn (Canada), Quebec City (Canada), Lorena (Brazil), Mohammedia (Morocco), Cheongwon (Korea); for accessories, Erembodegem (Belgium), Nexans Interface (France), Offida (Italy), GPH (Germany).

- **Low voltage**: Grimsås (Sweden), Vacha (Germany), Jeumont (France), Cortaillod (Switzerland), Quebec City (Canada), Weyburn (Canada), Mohammedia (Morocco), Lamia (Greece), Denizli (Turkey), Lorena (Italy), Cheongwon, Eumsung (Korea), Battipaglia (Italy).

5. The service dimension

Nexans does more than just sell cables and accessories to a complex global industry; it is always investing heavily in **research & development** to find ways to improve generation, transmission/ distribution and grid interconnectivity.
The presence of Nexans in over 65 countries gives it a full mastery of both national and international standards.
Its 10 **Competence Centers and International Research Center** work closely with customers to constantly improve its standard range of products and technologies, and to develop customized, industry-specific solutions.

Increasingly, customers delegate their technical studies to preferred suppliers so that they can make the necessary calculations and recommendations, and then cooperate closely in engineering and installation.
Nexans has a proven background in installation. Nexans developed special reels and drums for **easy and safe delivery**, and is adept at handling exceptionally long lengths of cables, including pulling operations.

To meet the submarine challenge, Nexans operates dedicated cable laying vessels, trenchers, excavators, Remote Operated Vehicles and other specialized underwater equipment. Navigation, positioning and tracking equipment has been developed to make sure that cable is safe and secure at touchdown.

Nexans Norwegian-designed **CAPJET** has buried over 3,500 km of cable as deep as 800 meters in seas around the world.

For aerial positioning, Nexans uses PLS CAD software for transmission line design. After choosing a specific conductor type, the terrain profile and the desired power capacity is entered. The program calculates where the best position for the towers would be, the distance of the span, the safest height of the towers, etc.

Since today's energy decision-makers come from a diverse background, **Nexans is increasingly called upon to give its considered opinion** regarding cable type, configuration, and so on. This kind of technical support, especially at the project design level, allows power providers to choose the best solution for projected use.
Increasingly, Nexans is taking a turnkey approach, especially on high-voltage projects, often assuming both underground and submarine responsibilities, including extra-high-voltage or superconductor links for power utilities.
Nexans considers that it is not just selling a product but an **"energy solution"** that includes cables, accessories, joints, terminations, installations, connections, civil engineering (through subcontracting), testing and commissioning. Line design and compatibility to meet the demands of supergrid configurations are always an overriding concern.

Recent blackouts have taught everyone an important lesson. In the new electrical "commodity" environment, power providers have tended to focus on their immediate needs, rather than the needs of the total grid. This has entailed a certain amount of underinvestment over the past decade, and a philosophy of "we'll fix it when and if it breaks." However, when a major blackout does occur, the expense in lost national and international productivity largely outdistances timely preventative investment. Instability versus availability are the two horns of the energy dilemma.

By offering complete solutions, based on a long experience, not only within the world of energy, but also from the world of telecommunications, Nexans provides the resources needed to help power utilities **bridge the Energy Gap of the 21st Century.**

IV. APPENDIX:

Some recent Nexans success stories

- After two years of negotiations, Nexans obtained a large contract with **Tunisia's national power company STEG** for cold shrink joints for 12, 17.5 and 36 kV underground cables. This "first" will provide a reference for introducing cold shrinks elsewhere on the African continent.

- In Brazil, **Nexans pioneered a multi-colored low-voltage, 3-phase drop cable** which makes identification much easier for installers. This cable has now become a standard on the South American market.

- Nexans was the first in Brazil to manufacture long-lasting **All Aluminum Alloy Conductors (AAAC).**

- To connect Northern Ireland and Scotland, Nexans provided two unique **High-Voltage Direct Current (HVDC) submarine cables** with an Integrated Return Conductor (IRC) which eliminates the magnetic field. The system can still operate if one cable is out because of maintenance or damage.

- Nexans delivered and installed a **composite 145 kV three-phase AC high-voltage cable and fiber optic communications and control cables** for a windfarm on the island of **Smøla in Norway**. When completed it will be one of Europe's largest. Its 68 wind turbines will produce enough electricity to power some 90,000 households.

- Nexans has a **joint venture with EVN**, the Vietnamese state-owned power company, to produce aluminum rod, and aluminum alloy conductor and arrestor wires. It is also taking part in the Greater Mekong Subregion (GMS) supergrid project.

- Nexans is conducting **tests on a bundled 765 kV bare overhead line**, in an experiment to find ways of meeting Seoul's high power needs.

- To upgrade the DK6 thermal plant owned by the Solac Industrial Site in Dunkirk, Nexans provided the contractor, Alstom, with **18.5 kilometers of 225 kV XLPE cables** comprising 2,000 mm2 copper conductors with enameled wires. This was **a world first** since this technology allows a gain of 15% in current capacity.

- Nexans was awarded an order to supply **23 km of 35 kV submarine power cables** to transport the power generated by wind turbines of the Arklow, **Ireland**, windfarm to an onshore cable station, as well as the links between the turbines.

- For **Union Fenosa,** a Spanish power utility, Nexans designed and installed two **30km 400 kV cables** to replace a portion of an existing overhead line in the Madrid Airport extension.

- Nexans provided **MV interconnections** between turbines and the composite 170 kV three-phase power cable with integrated fiber optic elements between land and the world's largest offshore wind park, **Horns Rev, Denmark**. The service voltage of 170 kV for a three-core XLPE represents at present a world record for submarine cables.

- For **Pacific Gas and Electric (California)**, Nexans provided **30 kilometers of 230 kV XLPE cable** for San Francisco.

- Nexans **doubled the existing HV line between Spain and Morocco** for the two utilities involved: REDELECTRA and ONE. This turnkey, € 100 million project includes pumping stations and installation at 700 meter depths in moving sea currents.

- For the **Long Island Power Authority (LIPA)**, Nexans is designing a 138 kV superconductive cable, including superconductive accessories capable of handling up to 161 kV. At 600 meters, the LIPA cable will be **the longest superconductor ever installed** on a grid at transmission voltage level.