SIEMENS

www.siemens.com/power-transmission

Pathways to the global grid

Answers for energy.

Power

transmission.

The world is getting smaller: transportation and communication across vast distances are faster and easier than ever. Markets increasingly converge, trade extends globally. Exactly the same trends apply to the world of energy. And today's power transmission systems are expected to support this development. They need to bridge longer distances, transmit more and more power, and integrate an increasingly diverse generation mix.

At Siemens, we have anticipated these challenges. We have even developed answers before the questions were raised. And we are ready to deliver them.

Karlheinz Springer
Division CEO Power Transmission,
Energy Sector,
Siemens AG

Electrical power fuels development and prosperity.

New, powerful trans-mission grids are the basis.


Marry
me?
Diana

The challenge is to chart new connections on a bigger scale.

The passion to reach farther

Efficient power transmission is the backbone of energy systems that meet today's demands and expectations in terms of reliability, sustainability, affordability, and environmental compatibility. At Siemens we are committed to supplying everything it takes to meet and even exceed these expectations.

As a global leader in power transmission technology and a long-standing, trusted partner of public entities and private enterprises, such as utilities and grid operators, we have always been in the vanguard of technical development. We look back on a long history of trendsetting power supply projects around the world – projects that have proven over and over the reliability and the outstanding quality of our products, solutions, and services. The range spans the entire field of high-voltage power transmission: extraordinarily powerful and trendsetting DC transmission systems and innovative reactive power compensation systems for AC grids, complete grid access solutions for distributed power generation, air and gas-insulated switchgear, as well as entire turnkey substations, gas-insulated lines, transformers for various applications, and a comprehensive range of high-voltage products, such as circuit breakers, surge arresters, disconnectors, and bushings.

Various factors will dominate the power transmission market in the years to come: the drive toward renewable energy, the expansion and interconnection of grid infrastructures, and the need to gradually replace and upgrade aging grid infrastructures. Discover how our broad portfolio of innovative products and solutions expertly supports these transformations and contributes to the emergence of a high-performing global transmission infrastructure.

5,000
transmission capacity of the world's first 800 kV UHV DC transmission system, in MW

>286
cumulative bay-years of operation of Siemens gas-insulated switchgear, in thousands

This is how

we care.

Experience is the basis.

Our power transmission expertise is based on decades of practical experience in product, system, and solution design and construction. Our experts have constantly pushed the limits in AC and DC power transmission technologies in order to create more powerful, more efficient, more environmentally compatible, and more cost-effective transmission systems.

And we are committed to excel in each project – from the supply of products to the implementation of huge turnkey projects. Our careful project planning and handling ensures the superior performance of your assets throughout their entire life cycle. We have proven this promise numerous times in projects all over the world.

Whatever the challenge, our answers will convince you

At Siemens, experience, innovation, and a focus on quality always go hand in hand. During the long history of our company, we never gave in to the temptation to rest on our laurels. Innovation has never been an end in itself, and our products, solutions, and services have an impeccable reputation for performance and reliability.

We were the first to use thyristor valves in high-voltage power transmission (HVDC) and in reactive power compensation, for instance. In the mid-1970s we developed what have become time-honored standards in large-scale power transmission applications, such as the economical transmission of power over very long distances or between networks operating asynchronously and at different frequencies. Since that time, we have taken the technology even further with the development of an HVDC solution that operates on the ultra-high-voltage level of 800 kV. The first system of this kind went into operation in China and offers five gigawatts of transmission capacity, and we are currently working on 1,100 kV UHV DC solutions.

Another pioneering solution is the use of modular multilevel voltage-sourced converters for HVDC and reactive power compensation purposes. This technology is the basis for HVDC PLUS, SVC PLUS, and our grid access solutions for power produced from renewable sources. They provide answers to some of the challenges that will dominate the energy business in the years to come, and help improve the dynamic stability and power quality of power systems in a new, highly economical manner.

The development of gas-insulated high-voltage switchgear (GIS) is another success story. Our first high-voltage gas-insulated switchgear was introduced more than forty years ago, and it is still in operation. Today more than 26,000 of our switchgear bays have been installed worldwide. In view of the fact that especially in heavily populated areas and

city centers, space is increasingly at a premium, our space-saving switching solutions are in high demand today. Their compact design makes them suitable for even the most confined spaces, such as the basement of a high-rise building or the first floor of an old historic building. Our GIS can even be installed in mobile containers.

Our vast experience in gas-insulated high-voltage technology has also made possible another pioneering technology: gas-insulated lines for high-voltage transmission. They are the smart alternative whenever overhead lines or conventional cables are not an option, in environmentally sensitive areas, or places where electromagnetic fields are prohibited.

Our high-voltage products and devices are the basis for efficient, high-performing, safe, and reliable power transmission. They meet the highest expectations in terms of low life cycle costs with optimal availability in continuous operation. Many of them, such as our products and components for 1,200 kV AC transmission, are key technologies for the future. Energy efficiency, economy, reliability, and protection of the environment are their distinguishing characteristics.

Our transformers have been renowned for outstanding quality and unsurpassed performance in more than 100 countries and for more than 100 years. They unite innovative ideas, expert know-how, and unequalled experience in virtually all fields of application – from industries to HVDC transmission and to power transformation with ratings over 1,000 MVA. Our extensive practical experience has also made possible the development of a number of Transformer Lifecycle Management™ solutions that help mitigate the effects of aging and wear, avoid unforeseeable outages, and minimize downtimes.

Innovation powers the future.

Our solutions set the benchmark in many fields of power transmission, and we are widely renowned for innovative yet reliable and mature solutions that are trendsetting in terms of efficiency, cost-effectiveness, sustainability, and environmental compatibility.

This rare combination of an outstanding wealth of experience, innovative technologies, superior service, financing support, and long-standing, successful partnerships makes us unique – and can make the key difference in terms of achieving your transmission goals.


We provide
all it takes
to bring
power to
the people.
Wherever
they are.

Siemens gas-insulated high-voltage switchgear, notable for its high degree of versatility and reliability, is outstandingly economical thanks to its space-saving design, low weight, and low life cycle costs. With its low noise and field emission levels, it is suited for sensitive environments, such as residential quarters and city centers.

Reliable action: high-voltage substations

One of our strengths as a leading supplier of high-voltage substations is the service and support we can offer in all areas of high-voltage substation technology, thanks to our regional business units and a global network of technical experts and experienced engineers. This makes us a leading supplier of engineering, equipment, solutions, and services for all high-voltage substations, such as air-insulated substations, gas-insulated substations, and gas-insulated lines, which are the efficient state-of-the-art alternative for high-capacity high-voltage power transmission wherever overhead lines or cables are not an option. Our range of products and services comprises turnkey solutions for AIS substations and GIS in urban areas. Our GIS activities particularly focus on switchgear installation in buildings with architecturally attractive designs that suit each environment and on grid access solutions for renewables – an aspect that is increasingly gaining in importance. We may act as a system integrator, a turnkey provider, or even as a general contractor for large projects. Whatever the challenge, we can always provide our leading expertise and decades of experience from the world's largest installed base of GIS switchgear.

>26

installed Siemens GIS base worldwide, in thousands

19

number of Siemens centers of competence for high-voltage substations worldwide

In large countries like China, where CO_2-free hydropower can be produced on a large scale, the power generation plants are often far away from the centers of power consumption. Siemens' 800 kV UHV DC systems bridge the gaps efficiently, setting new benchmarks in the energy-efficient transmission of large amounts of power over long distances.

Efficient connections: power transmission solutions

Our state-of-the-art HVDC (high-voltage direct current) and UHV DC (ultra-high-voltage direct current) transmission technologies make possible the so-called energy superhighways, efficient transmission systems that transport vast amounts of electricity over enormous distances. In addition, HVDC systems can synchronize and stabilize existing AC grids, provide the only possibility of connecting two technically incompatible power grids, and facilitate the integration of renewable energy sources.

We also have a leading position in the development and manufacture of FACTS (flexible AC transmission systems). These solutions enable existing grids to meet increased power demands. They rely on modern power electronics to improve the voltage quality in grids while at the same time providing higher system efficiency. Used in conjunction with HVDC technology, FACTS is a key element in innovative transmission solutions.

We also supply AC and DC grid access solutions such as WIPOS®, which make possible the integration of renewable energy sources like offshore and onshore wind farms into power systems on a turnkey basis.

7.6
potential power transmission capacity of 800 kV UHV DC, in gigawatts

50
space-saving capacity of SVC PLUS in comparison with conventional SVC systems, in percent

The demand for high-voltage products will continue to grow in the course of the expansion and modernization of the world's power supply infrastructure. Siemens maintains a global manufacturing network that ensures that high-voltage products and know-how are available on short notice, around the clock and around the world.

Technical attractions: high-voltage products

Our high-voltage products, circuit breakers and disconnectors, surge arresters, instrument transformers, coil products, and bushings are essential elements of all power transmission systems. They meet the highest requirements in terms of availability, reliability, and low life cycle costs. Outstanding earthquake resistance and weatherproofness contribute to their long service life, which meets the highest expectations in terms of economy, safety, reliability, and availability. Moreover, our global service network and local branch offices worldwide ensure short commissioning times.

The technology in our products sets international standards. We continuously ensure the high quality of our products through optimized production processes, ongoing product development, and a certified quality management system.

Two of our latest developments are a complete range of UHV DC products for voltages up to 800 kV and a complete range of UHV AC products for voltages up to 1,200 kV. The 800 kV DC product range comprises several groundbreaking novelties in the 800 kV voltage range, including the first bypass circuit breaker, the first surge arrester, and the first pure epoxy resin-insulated 800 kV DC transformer and wall bushings.

Reliable and efficient ultra-high-voltage products are crucial to efficient and reliable power transmission systems. Efficient UHV solutions and products will help customers, especially in large countries, save considerable amounts of energy.

800
rated voltage for all DC products, in kV

1,200
rated voltage for all AC products, in kV

In 2009, Siemens built the world's largest HVDC transformer for the 800 kV voltage level for a converter station in China. HVDC transformers are key components in the inverter and converter stations that terminate the lines. Their valve windings are exposed to both AC and DC stress, which calls for a special insulation design.

Strong interaction: transformers

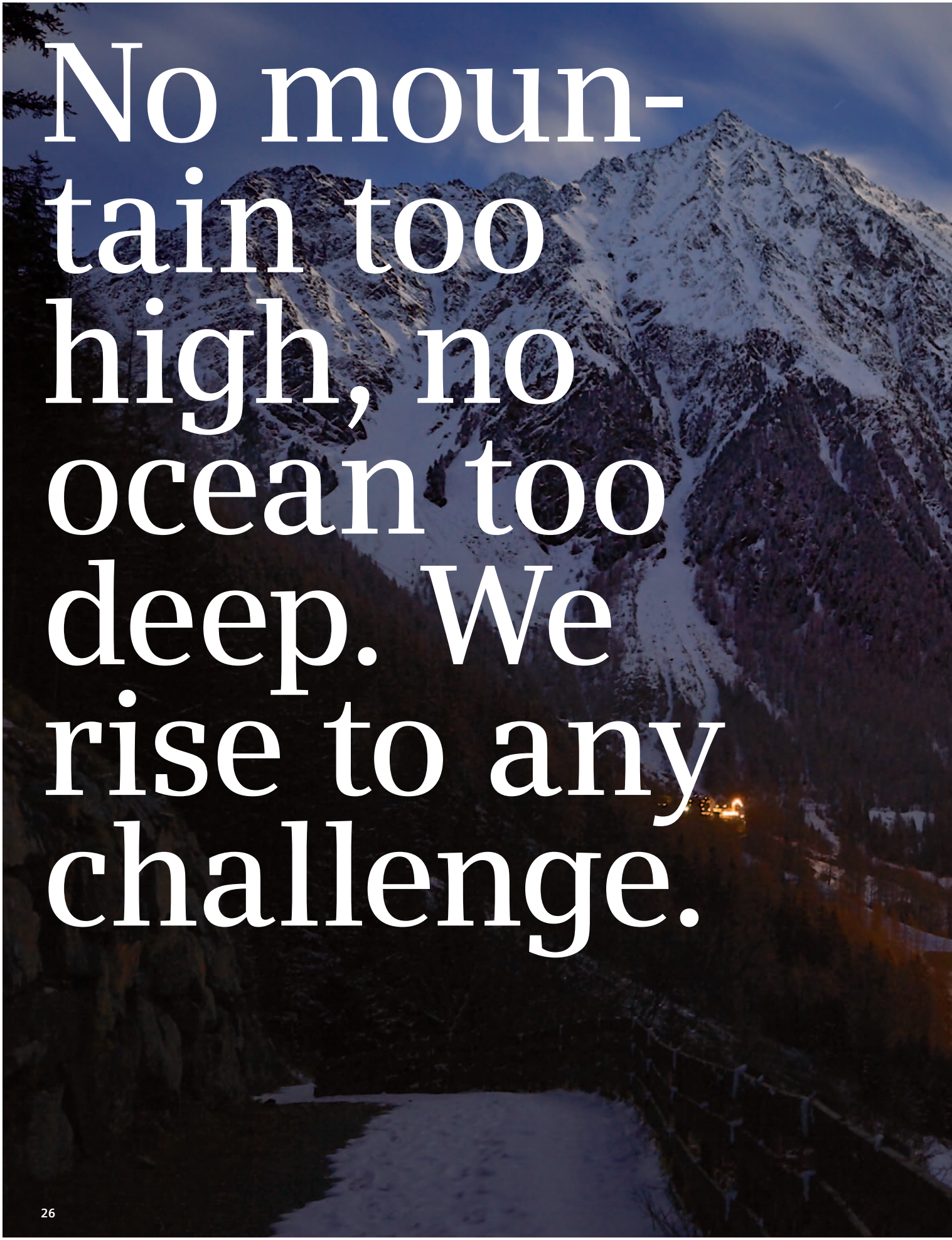
Transformer production is a highly individualized business. Even though the functional principle is quite clear, especially large transformers are precisely customized single-manufacture products designed according to individual specifications, such as voltage, power, system topography, and noise emission levels. Environmental conditions also play a key role in transformer design. Transformers are also relatively expensive long-term capital assets. That is why our knowledge and services throughout the entire transformer life cycle can make all the difference. Beginning with the initial design to the manufacturing, transport, installation, and commissioning and on through the entire transformer service life, we provide expertise and targeted solutions, from liquid-immersed distribution transformers, GEAFOL® cast-resin transformers, and voltage regulators to power transformers of all sizes, even with ratings over 1,000 MVA, transformers for various industrial applications, shunt and series reactors, phase-shifting transformers, HVDC transformers, and traction transformers. Moreover, we have developed a range of unique Transformer Life-cycle Management™ solutions that help ensure trouble-free operation and investment protection for decades, even for third-party products.

2,103

maximum performance delivered by a Siemens generator transformer, in MVA

100,000

number of GEAFOL transformers in operation since its market introduction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Siemens AG
Energy Sector
Freyeslebenstrasse 1
91058 Erlangen, Germany

For more information, please contact
our Customer Support Center.
Phone: +49 180 524 70 00
Fax: +49 180 524 24 71
(Charges depending on provider)
E-mail: support.energy@siemens.com

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