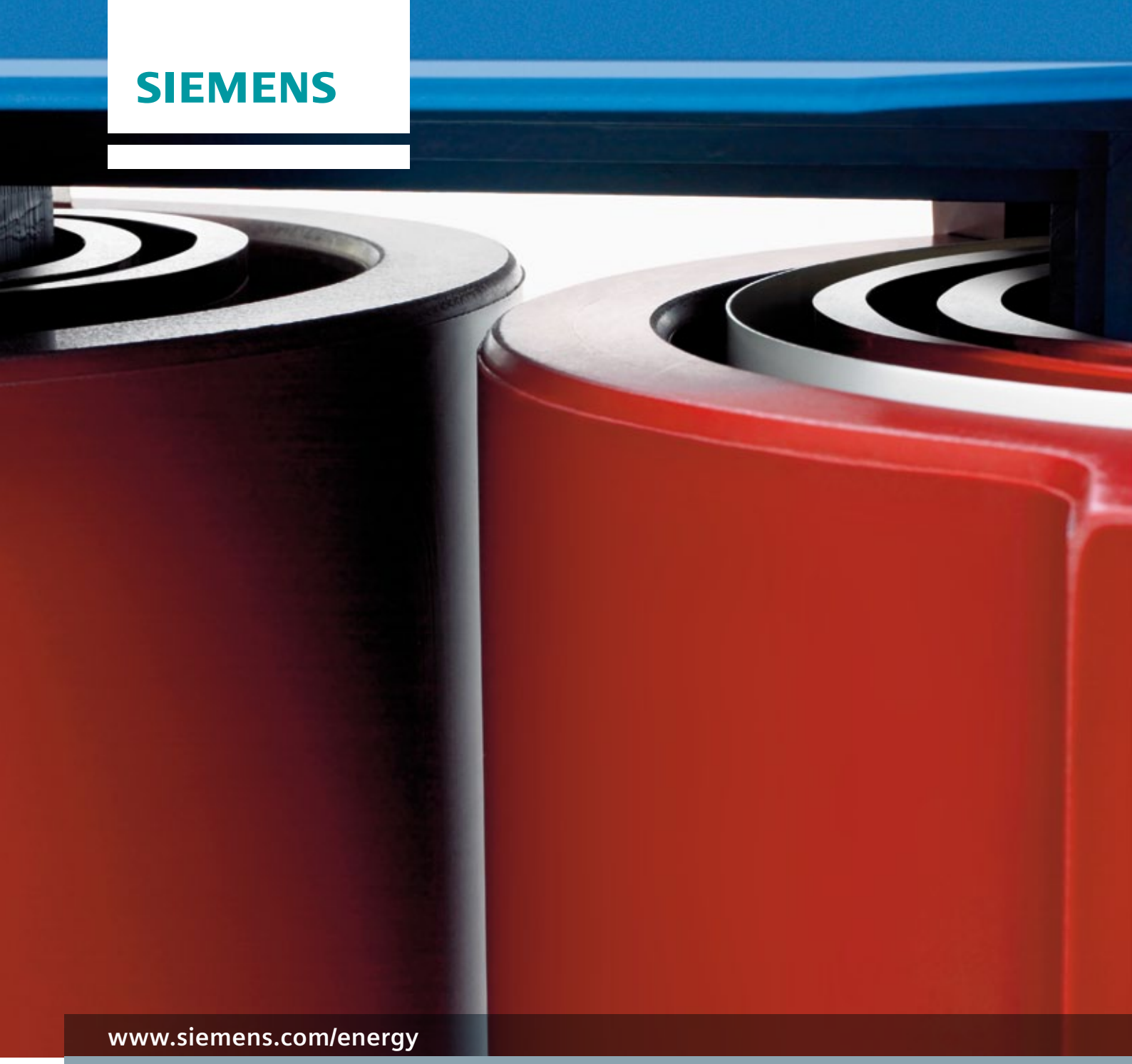
SIEMENS



www.siemens.com/energy

Transforming know-how into success. Siemens Transformers.

GEAFOL cast-resin transformers – in use around the world

Answers for energy.

GEAFOL cast-resin transformers –

all the benefits for power distribution

GEAFOL cast-resin transformers
Standard model with 1000 kVA

GEAFOL-Static Converter 3-tier design

7.5 MVA GEAFOL transformer for extremely low ambient temperatures down to – 55°C

The closer the power distribution is to the consumer, with the transition from the medium-voltage to the low-voltage level, the lower the losses are, and the less complex the cable network is. Therefore, for economic reasons alone, transformers should be as close as possible to the consumer.

On the other hand, the available space is usually very limited – a real challenge with respect to the often considerable dimensions of transformers. Transformers must also be safe and reliable – otherwise they are a potential danger to man and machine. Critical requirements must therefore be taken into consideration in order that transformers can be moved closer to buildings and industrial plants.

Siemens GEAFOL cast-resin transformers have fulfilled these high demands and proven themselvesfor over 45 years. Today, GEAFOL cast-resin transformers up to a rated power of approximately 50 MVA can be manufactured.

22 MVA GEAFOL transformer with oil-free on-load tap changer

23 MVA GEAFOL double-tier static converter transformer

40 MVA transformer, most powerful GEAFOL cast-resin transformer in the world

Compact design

The compact design and the comprehensive safety certification enable the use of GEAFOL transformers in almost every environment. The broad range of applications is supplemented by the flexible connection system and the especially economic, almost maintenance-free operation. GEAFOL transformers still have benefits even at the end of their life cycle, as they practically can be completely recycled without danger to the environment.

Certified safety

We produce cast-resin transformers in compliance with IEC 60076-11, EN 50541-1, ANSI, GOST and in compliance with special national regulations or customer wishes. The transformers satisfy the highest requirements for safe installation in residential and working environments with the climate category C2, the environmental category E2 and the fire resistance category F1.

Customized models

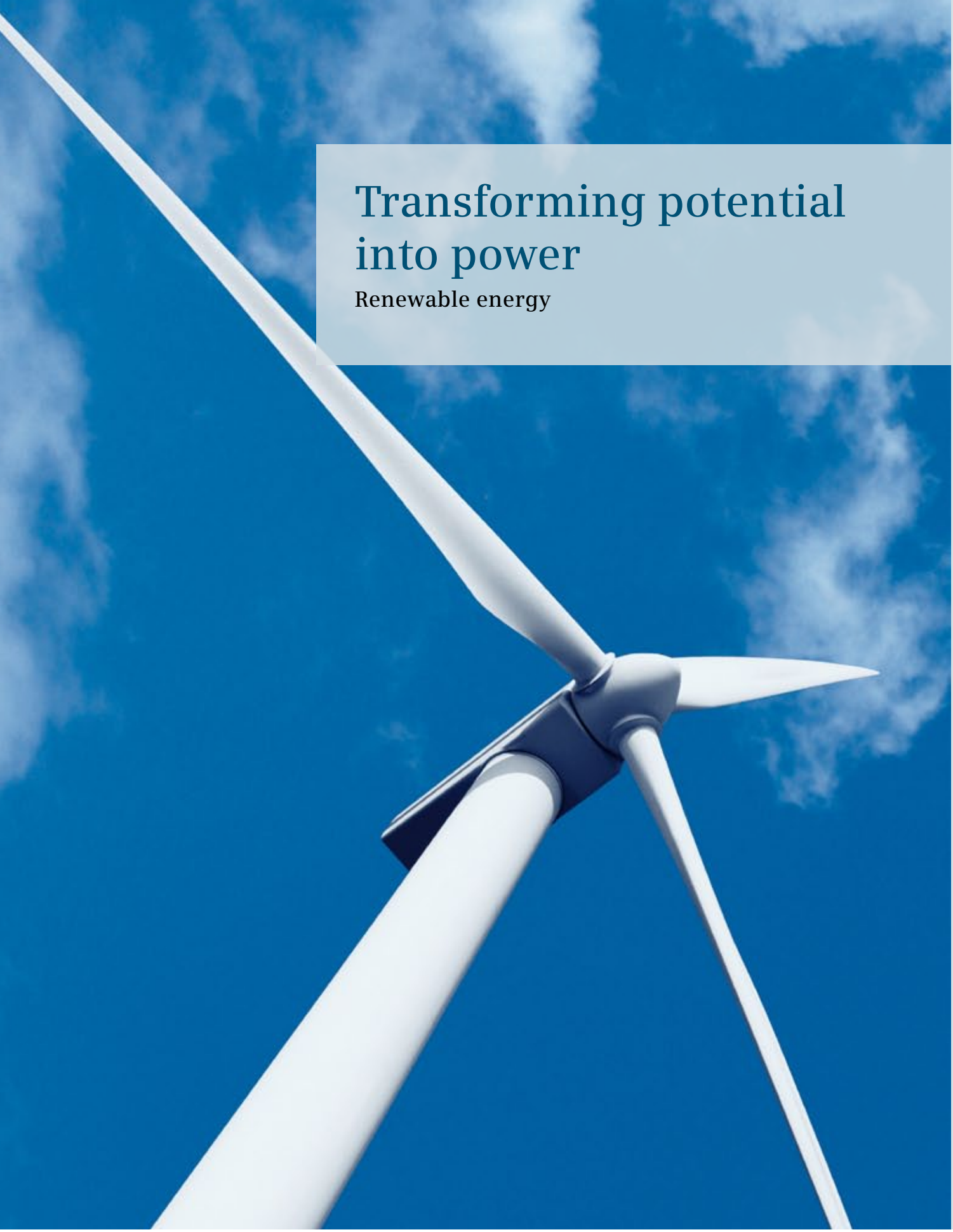
Individual problem solutions that satisfy all requirements with respect to operating mode, low noise level and power loss, connection system, cooling method as well as transport and installation are possible at all times. In addition, GEAFOL cast-resin transformers can also be modified for extreme conditions and made earthquake-proof.

Global use

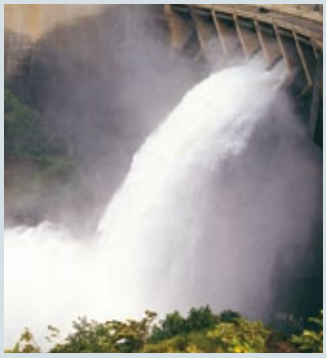
At present, well over 100,000 GEAFOL cast-resin transformers are in use throughout the world. This brochure provides an overview of their wide range of performance and application.

Transforming potential into power

Renewable energy



GEAFOL cast-resin transformers – the first choice for onshore and offshore wind power plants.



Mechanically strengthened GEAFOL transformers ensure that the power produced by the wind power plant reaches the consumer.

Whether in rural or urban environments: GEAFOL transformers ensure that power can be used.

GEAFOL transformers also function without problems under extreme environmental conditions.

Whether wind, hydroelectric or solar – renewable energy is a substantial business throughout the world. GEAFOL cast-resin transformers are a major part of this development. For example, wind. In the future, the Australian island of Tasmania will be able to significantly increase its share of renewable energy. A wind park is planned for the northwest coast of the island with a total power output of 128 MW. Participating in this ambitious project are Tasmania's power supply company, Hydro Tasmania, the world's leading manufacturer of wind power stations, and Siemens E T TR.

Mechanically reinforced version for vibration-resistant installation

Siemens is providing its expertise in two ways for the wind park project in Tasmania: in the wind park itself, GEAFOL cast-resin transformers ensure that the voltage supplied by the generator is stepped up to the required power supply voltage on-site. Each of these GEAFOL cast-resin transformers is mechanically reinforced and can be installed vibration-resistant in the pod.

Power Transmission and Distribution – service from one source

Siemens is also head of the syndicate for the entire technology of the new high-voltage direct current transmission line (HVDC) between the island of Tasmania and the Australian continent. The syndicate leadership comprises the delivery and installation of the entire HVDC line technology including converter transformers, smoothing reactors and high-voltage substations. The entire communication and control technology for the connection is also the responsibility of Siemens. The job is rounded off with the construction of the valve halls, the service buildings as well as the associated overhead lines and transfer points on both sides of the connection.

Transforming requirements into solutions

Industrial solutions

Safe, reliable and robust – GEAFOL cast-resin transformers for industrial applications

Twenty years of daily operation in an aggressive environment with low maintenance costs

Powerful and reliable: forced cooling ensures stable thermal conditions even under peak load

The numerous industrial requirements for transformers are enormous. However, although they seem so varied and comprehensive, they can be completely satisfied by GEAFOL cast-resin transformers in most cases. Standard requirements such as operating safety and optimum behavior with respect to fire safety are taken into consideration right from the start.

Economical in every respect

The high cost-effectiveness of the GEAFOL transformers is one of their exceptional features. With these transformers it is possible to bring the medium voltage much closer to the consumer and then convert it to low voltage in the direct vicinity. In this way it is possible to greatly reduce the power losses that occur on long low-voltage routes. In addition, the maintenance costs are kept low thanks to the reliable technology, proven over many years.

Our cast-resin transformers operate for decades almost maintenance-free – with minimum footprint. This saves valuable space which can then be used for the production. Cost-effectiveness also means the release of up to 50 % power reserves by means of forced cooling.

Last but not least, the transformers must also be environmentally friendly for industry – a requirement which is increasing in importance. The following application scenarios show that these performance features can be achieved by GEAFOL transformers without problems, and still leave enough leeway for special versions.

20 years – and then only cleaned

Seven GEAFOL transformers were in operation at an articulated-shaft manufacturer in Offenbach, Germany during two shifts per day, Monday to Friday, for 20 years – always at 90 % load and subject to heat, oil containing chlorine, and grinding dust. They were then completely cleaned and ready for the next decade.

High power requirement at the Tüpras refinery in Izmir, Turkey

Twelve of the twenty transformers in operation have power ratings of 16–25 MVA. A reliable power supply is ensured for the sensitive chemical processes even under peak load through the use of fans.

Transforming requirements into solutions

Maximum safety close to the consumer: GEAFOL cast-resin transformers are self-extinguishing and emit no toxic gases even when subjected to electrical arcing

Stable conditions in China

A rapidly growing infrastructure as in China can often lead to voltage problems. Medium-voltage systems can often not keep pace with the increasing power requirements and become instable. Our GEAFOL cast-resin transformers with on-load tap changer and a power rating up to 22 MVA are used in order to be able to supply the highly modern and sensitive plants with a stable voltage. These transformers with voltage control are connected on the load side of the medium-voltage system and supply the distribution transformers in the plant. This ensures a reliable supply in sensitive areas such as hospitals and industrial companies, but also in residential and business centers.

Stable conditions in China: GEAFOL cast-resin transformers with on-load tap changer satisfy all safety and environmental requirements in a Chinese semiconductor factory

Safe: the transformer is directly beside the assembly line

High-quality automobiles leave the assembly line in southern Germany less than four meters from the GEAFOL transformers – the transformers are on the same level as the assembly lines.

Outside or inside: resistant to humidity

Example paper mills: 52 GEAFOL transformers are installed in a paper production factory in South Africa, some of them directly alongside the machines. In Schongau, Upper Bavaria, Germany, 18 transformers for paper production machines were installed on the outside wall of a production shop.

630 kVA – in an area of only 1.6 x 2.6 m including housing

Successfully implemented in a domestic appliance factory: a GEAFOL in a very small area. It is on a platform directly above the switchgear and distribution cabinets. This 630 kVA transformer rating can be increased up to 900 kVA through additional cross-flow fans as part of a concept with decentralized stations not only for the general supply system, but also for the power-intensive production.

Safe: the transformer is directly beside the assembly line

Even when space is limited: room can be found for GEAFOL transformers – even on the roof

Three transformers in the crane: 6600 kVA, 37 m above the ground

Three transformers in the crane: 6600 kVA, 37 m above the ground

In order that this 85-ton ship unloading crane can load a freight car every 45 seconds, three GEAFOL converter transformers were mounted directly alongside the low voltage switchgear – 37 m above the ground in limited space.

Even when space is limited: room can be found for GEAFOL transformers

Limited space? A solution can also be found for this problem. The GEAFOL transformer was installed on the roof at a well-known automobile manufacturer in Rüsselsheim, Germany. The housing for the medium- and low-voltage switchgear was also included. Additional fans on the roof increase the performance by 40 %. A further transformer in the basement – directly below the motor testing bay – emphasizes the possibilities which result from the extremely compact construction: the transformer was assembled on-site and then equipped with integrated switches.

Transforming requirements into solutions

Dust, air humidity, diesel exhaust fumes, high temperatures: GEAFOL transformers are optimally equipped for the harshest operating conditions in mining

In the rolling mill directly alongside the consumer: GEAFOL in converter operation

Low and rugged: GEAFOL in a potassium mine

Underground use is very demanding and requires special features: the ability to resist heat and dust, and very high safety requirements with respect to the fire hazard – there was no alternative to a GEAFOL transformer. For this reason, the potassium mine in Wintershall, which produces more than 30,000 tons of potassium salt each day at a depth of 600 m, was equipped with GEAFOL.

In the rolling mill directly alongside the consumer: GEAFOL in converter operation

In Novolipetzk in Russia, GEAFOL transformers are working directly alongside the consumers in the cold rolling mill – in converter operation for mill stand and drive of a cold wide strip line. They are able to stand up to the strong dynamic and thermal loads caused by the quickly changing load cycle without problems.

1700 m below the surface: safe power supply at 90 % humidity

1700 m below the surface: safe power supply at 90 % humidity

In Doornfontein near Johannesburg gold is being mined at a depth of more than 3000 m. Four GEAFOL transformers provide a reliable energy supply at a depth of 1700 m at an ambient temperature of 40 °C and 90 % humidity.

Underground: on-site power supply in an ore mine

The environmental conditions in the Swedish underground ore mining industry are extremely demanding, but the GEAFOL cast-resin transformers installed on-site are able to stand up to the demands. Even when they are completely fouled due to high humidity, diesel fumes and dust, they are simply switched off and the dirt is washed off with hot water.

Transforming isolation into independence

Solutions on the high sea

New type of cooling system for the transformers of the “Grand Princess”: eight GEAFOL converter transformers supply the diesel-electric drive system of the “Grand Princess” with a rating of 9150 kVA each.

On the high sea: GEAFOL goes on board

North of the Arctic Circle: with GEAFOL on board the ice breaker

With GEAFOL below deck: the largest crane ship in the world

At sea, strict climatic and mechanical standards apply for technical equipment, including transformers. Quite apart from the fact that possible environmental hazards are eliminated by dispensing with insulating oil, GEAFOL cast-resin transformers offer a high degree of safety and reliability, even in heavy seas, thanks to special mechanical stabilizers.

GEAFOL goes on board

In 1984 it was the largest drilling platform in the world with 835,000 tons: the 110-m-high Norwegian drilling platform Statfjord C. Its power requirements correspond to that of a town with 30,000 people. Obviously extremely high safety requirements apply on the Statfjord C. The drilling platform was therefore equipped with 17 GEAFOL resin-encapsulated transformers.

Because of the positive experience gained with these transformers, the Oseberg platform was also correspondingly equipped in 1988. It has 23 transformers on board, corresponding to the power requirements of a town with 40,000 people. In the meantime, a large number of offshore platforms have been equipped with GEAFOL transformers and further platforms are being built.

New type of cooling system for the transformers of the "Grand Princess"

The "Grand Princess" is one of the world's largest cruise ships. With 15 decks, 100,000 gross registered tonnage and a length of 285 m, it has room for 2600 guests and a crew of 1100. Maximum comfort for the passengers is of great importance. One of the technical highlights is the new type of cooling for the GEAFOL cast-resin transformers. They are in an enclosed housing with IP 44 degree of protection, which contains two air-water coolers and four fans. The air heated up by the transformers is blown through the coolers within the housing and cooled down there by the water. This ensures that only the radiant heat and not the total heat loss of the transformers is dissipated to the machine room. The climate control can therefore be kept much smaller and more cost-effective – with significantly reduced weight.

North of the Arctic Circle: safely underway with GEAFOL

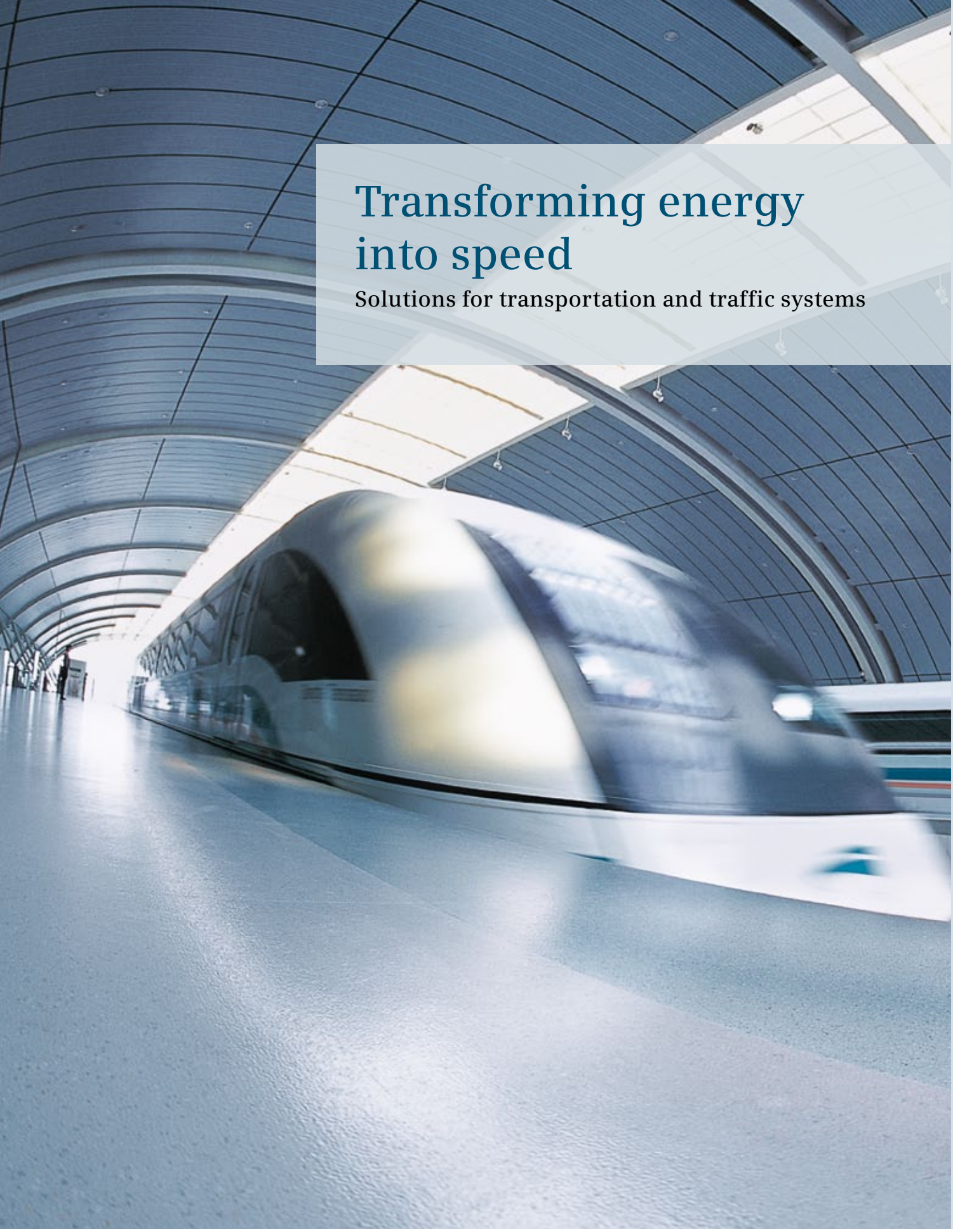
Canadian ice breakers and oil drilling ships of the CIS are operating in the Arctic Ocean with GEAFOL transformers on board; as these transformers are extremely resistant to vibrations and rolling, they can also stand up to extreme cold and are not susceptible to corrosion by salt water.

With GEAFOL below deck: one of the largest crane ships in the world

One of the largest crane ships in the world also uses GEAFOL transformers exclusively. 36 of our transformers below deck supply the necessary power for the drives of the 7000-ton cranes – in addition to the other power supply for the giant, which displaces 700,000 tons.

Transforming energy into speed

Solutions for transportation and traffic systems



Traveling to the airport at 430 km/h in Shanghai

Problem-free traffic: GEAFOL in the subway in Munich

Whether large airports, road tunnels or subway stations – the electrical supply and therefore the availability of the safety and control systems must be guaranteed at traffic intersections. Almost everything depends on the power supply, and without current the traffic quickly collapses. The requirements are therefore correspondingly high:

Functional reliability with low maintenance costs

- Fail-safe and fire-resistant devices for safety systems
- Easy to maintain and rugged – the smaller the dimensions, the easier it is to find installation space

An above average range of requirements can be satisfied by the GEAFOL transformers in close cooperation with the responsible planners.

Power supply for the Transrapid line between Shanghai and the Pudong international airport

Within the framework of the Transrapid project, Siemens is providing the following converter transformers for the supply of the linear motors and the reactive-power compensation systems:

- 36 single-phase transformers, 3290 kVA for 300 Hz, connected as three-phase bank for the supply of the linear motors
- 30 two-tier converter transformers, 4000 kVA for the supply of the inverters
- 8 converter transformers, 3150 kVA for the reactive power compensation systems

Special attention had to be paid to the key parameters of the linear motor, e.g. operating frequency, harmonics and converter-dependent DC current components. Because of the high reliability of the GEAFOL transformers, operation under these stringent conditions is not a problem.

Problem-free subway traffic

Several GEAFOL transformers provide a reliable power supply in the subway in Munich. The subway in Caracas also uses GEAFOL transformers for the lighting, air-conditioning and signal systems. The criteria are always the same: a high degree of reliability, reserve power for peak loads and a safe response to secondary fires without development of dangerous gases.

Transforming energy into speed

Power for the infrastructure: GEAFOL at Istanbul airport ...

At the top: GEAFOL on the Zugspitze

GEAFOL on the Zugspitze

Also on the highest mountain in Germany a dependable power supply is required for the Zugspitze railway, the weather and radio station, as well as for tourists.

Power for the airport infrastructure in Amsterdam

With more than 40 million passengers a year, Schiphol airport in Amsterdam is one of the largest airports in Europe. Seven GEAFOL transformers provide the power for a new section of the arrivals building. GEAFOL transformers are used in many other major airports throughout the world.

Street lighting in Saudi Arabia

The highway between Jeddah airport and the oasis town of Medina in Hejaz is one of the many roads in the world whose lighting is based on GEAFOL. Seven compact stations with 400-kVA or 500-kVA transformers ensure a reliable power supply even at very high temperatures.

... and at Amsterdam airport

Across the desert: GEAFOL in Saudi Arabia

Very high up: GEAFOL in Tibet at an altitude of 5000 m above sea level

Distributed for safety: GEAFOL in the Arlberg tunnel

GEAFOL on the roof of the world

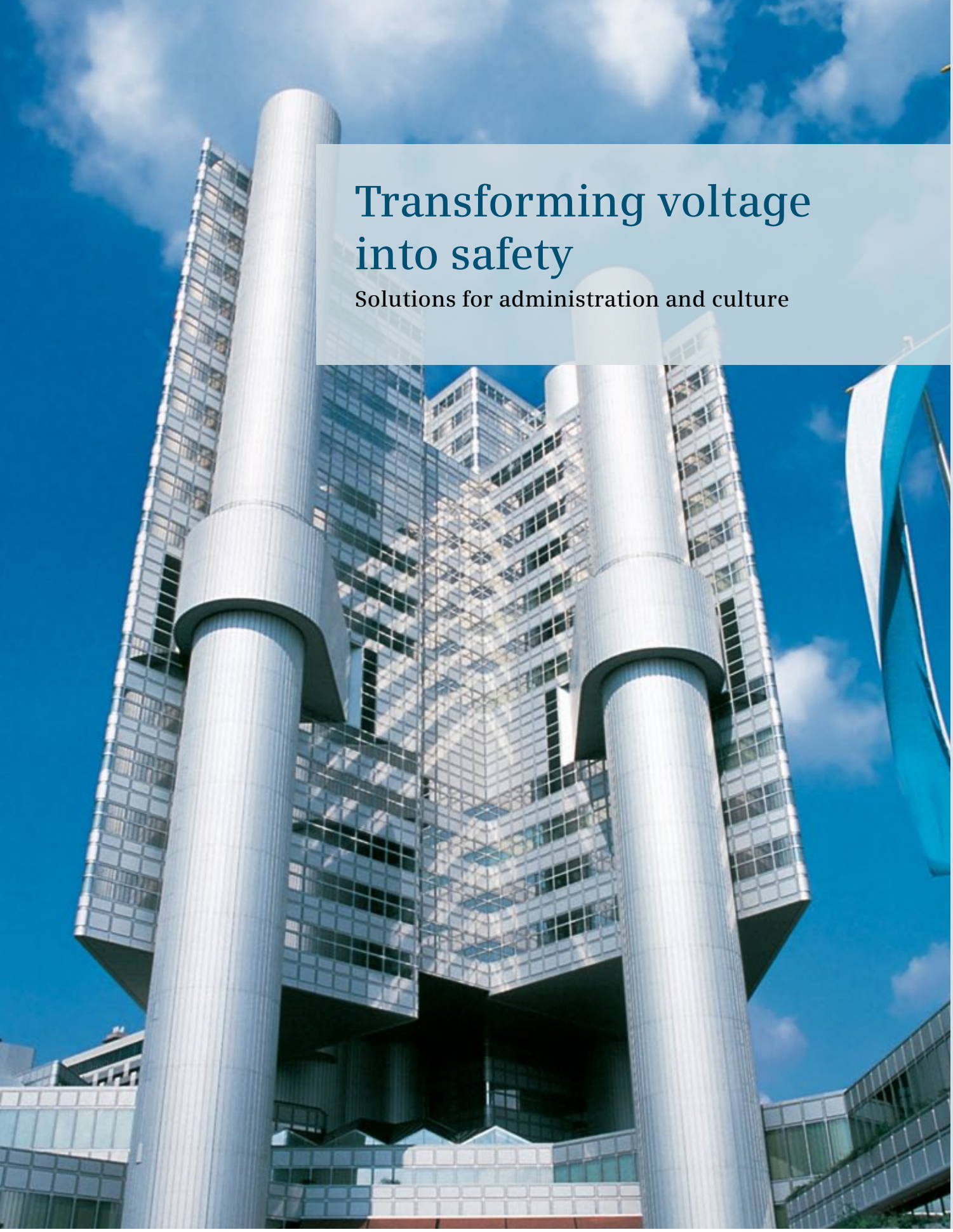
Even where the air is too thin for others, GEAFOL transformers are providing a problem-free service. For example, in several railway stations in Tibet at an altitude of 5000 m. A specially developed insulation system is used for the 33-kV transformers enabling them to operate reliably at all times under these extreme conditions.

GEAFOL in the Arlberg tunnel

With a length of almost 14 km, the Arlberg tunnel is the second longest tunnel in Europe. 18 GEAFOL transformers have been installed to ensure that the traffic flows without problems – distributed for the ventilation, lighting, safety and traffic control systems.

Transforming voltage into safety

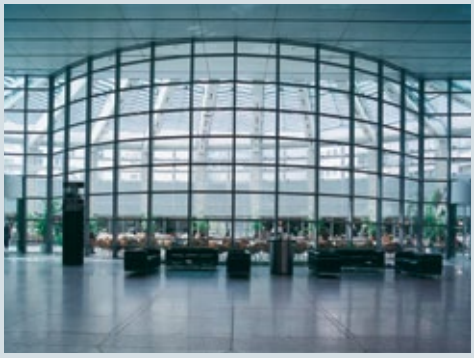
Solutions for administration and culture



Super-modern – with GEAFOL

Veltins-Arena, Germany – powered by GEAFOL

GEAFOL-BASIC, the innovative solution for maximum safety in modern functional buildings



Power supply for Europe's tallest office building with GEAFOL

Similar criteria for the transformer installation apply to the administration and cultural sectors, i.e. office buildings, banks, hospitals, stadiums, theaters etc., as to the industrial sector: proximity to the consumer, small space requirement and above all, safety.

Safe transformers must be self-extinguishing and may not develop any dangerous gases during secondary fires. There is also the demand for low maintenance. External service providers are often employed particularly in the administration and cultural sectors – and every service call is a cost factor.

If the transformers are also required to be quiet in operation and have to be disposed of or recycled without any danger to the environment after decades of operation, then the decision has usually already been made – for GEAFOL cast-resin transformers.

GEAFOL powers one of the tallest office buildings in Europe

At 298 meters, the Commerzbank headquarters in Frankfurt am Main is one of the biggest office buildings in Europe. High standards of safety and reliability of the power supply were also demanded. Siemens was successful against its competitors and received the order to supply the entire electrical equipment. In addition to low-voltage and medium-voltage switchgears, this also included our proven GEAFOL distribution transformers.

Transforming voltage into safety

Showing priceless cultural treasures in the right light. GEAFOL transformers at St Peter's in Rome provide a safe and reliable power supply

Power supply around the clock: GEAFOL in the hospital

Reliable:
GEAFOL in the Gulf

Embedded in the dome:
GEAFOL in St. Peter's Cathedral

Power supply around the clock: GEAFOL in the hospital

One of the many hospitals whose power is supplied via distributed GEAFOL cast-resin transformers is the SÖS hospital in Stockholm, Sweden. Today, GEAFOL transformers above and below ground provide a problem-free power supply.

Also the largest hospital in Hamburg, the University Clinic, has been retrofitted with GEAFOL transformers. One of the major reasons for the changeover to GEAFOL transformers is that special fire protection measures are eliminated. Special installations, such as oil collecting basins for normal transformers are no longer required. The comparatively short conversion times also made the decision easier.

Reliable: GEAFOL in the Gulf

The Trade Centre in Dubai in the Persian Gulf is one of the largest buildings in the region. GEAFOL transformers are distributed throughout the 33 floors and are responsible for the majority of the power distribution.

Ultramodern – with GEAFOL

The nine GEAFOL transformers in the futuristic building of a large bank in Munich are located on the fourth, eleventh and twenty-fourth floor and supply all floors with power. The cast-resin transformers are supplied via a 10-kV medium-voltage cable.

Culture on a grand scale – and with eight GEAFOL transformers

Everything's better at the Bolshoi – thanks in part to GEAFOL

Embedded in the dome: GEAFOL in St. Peter's Cathedral

This is one of the last places one would expect them to be, but nevertheless they are there: several GEAFOL cast-resin transformers are installed below the dome in St. Peter's Cathedral in the Vatican. An optimal solution for this world-renowned magnificent building.

Culture on a grand scale – and with eight GEAFOL transformers

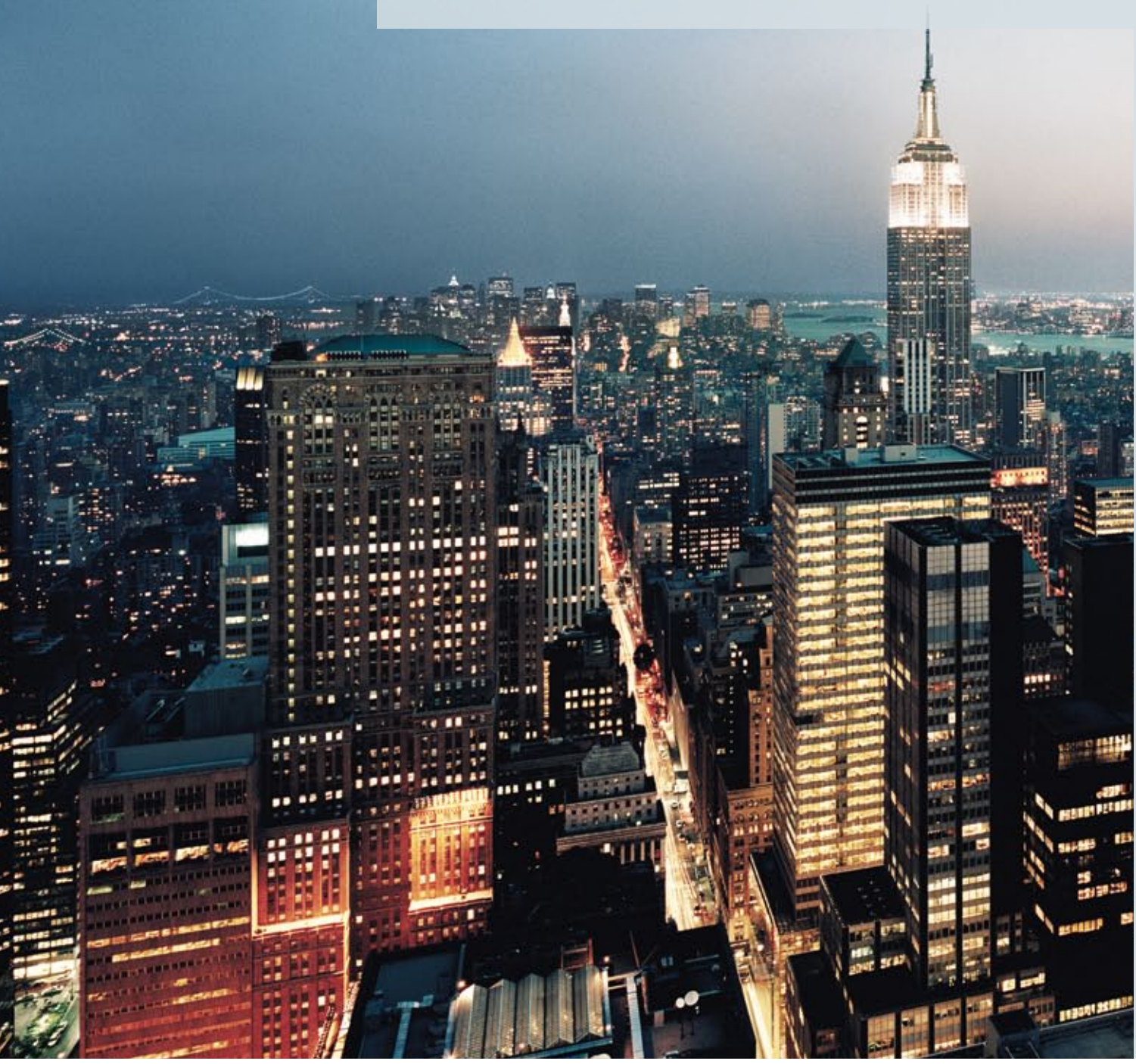
The National Concert Hall and the National Theater are located in Taipei in the heart of the island republic of Taiwan in the Far East. They were built in traditional Chinese style and each have a capacity of approximately 2000 seats. They also enjoy the benefits of GEAFOL technology.

Everything's better at the Bolshoi – thanks in part to GEAFOL

When the audience applauds in the renovated Moscow Bolshoi Theater, they're also applauding a little bit for the performance of the nine 1,600-kVa GEAFOL transformers, which are responsible for ensuring a safe, reliable supply of power for all electrical equipment and the lighting systems.

Transforming sources into streams

Solutions for power plants and power transmission



Safe supply in the heart of the city – thanks to GEAFOL

Reliable power supply for millions: GEAFOL in New York

Wherever power is produced, GEAFOL transformers are never far away

4 GEAFOL transformers each with a capacity of 23 MVA are in operation at the Moorburg power plant

Apart from eco-friendly power generation, low loss power transmission and distribution right to the consumer is another key aspect of a sustainable power supply. High-efficiency GEAFO transformers are indispensable not least because they can be installed closer to the point of consumption thereby minimizing transmission losses.

GEAFOL for power plant construction

Naturally, GEAFOL transformers are also used where power is generated: in high-capacity decentralized cogeneration plants and as excitation transformers for turbo generators in large power plants – including the Olkiluoto 3 nuclear power plant in Finland.

The new Moorburg power plant which has a capacity of about 12 billion kilowatt hours annually covers almost the entire electricity requirement of the city of Hamburg and supplies district heating to hundreds of thousands of homes. The four 23 MVA transformers each weigh 42 metric tons and are used to supply power for the controlled feed water pump drives of the Moorburg coal-fired power plant in Hamburg. The special feature of these double-tier transformers is that they have two secondary windings phase-shifted by 30° with respect to each other. Thanks to this phase shift, the system perturbations caused by the converter when controlling the speed and torque of the pump drive are reduced. As a result there is less harmonics interference of the supply network and there is no need for expensive filter systems.

Big transformer for the Big Apple: record Siemens transformer for New York

Siemens Power Transmission and Distribution has supplied one of the world's largest GEAFOL cast-resin transformers to the USA. The record transformer with a rated power of 25 MVA weighs 45 tons and was ordered by one of New York's largest power suppliers. The metropolis is following the trend: today, cast-resin transformers of up to 50 MVA are more in demand than ever.

Pioneering power transmission: most powerful cast-resin transformer in the world

A reliable power supply requires a well-developed power infrastructure with high-output transformers – whether it's in power plants, substations, HVDC systems or industry and transport. HVDC systems in particular can transport power very economically over long distances, thus playing a major role in reducing CO_2 emissions. Two 40 MVA GEAFOL cast-resin transformers – the most powerful cast-resin transformers in the world – are being used at a new Siemens AG test facility for HVDC systems.

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Power Transmission Division
Order No. E50001-G640-A205-X-4A00 | Printed in Germany |
Dispo 19201 | c4bs No. 7481 |
TH 101-110786 | BR | 472583 | WS | 10111.0

Printed on elementary chlorine-free bleached paper.