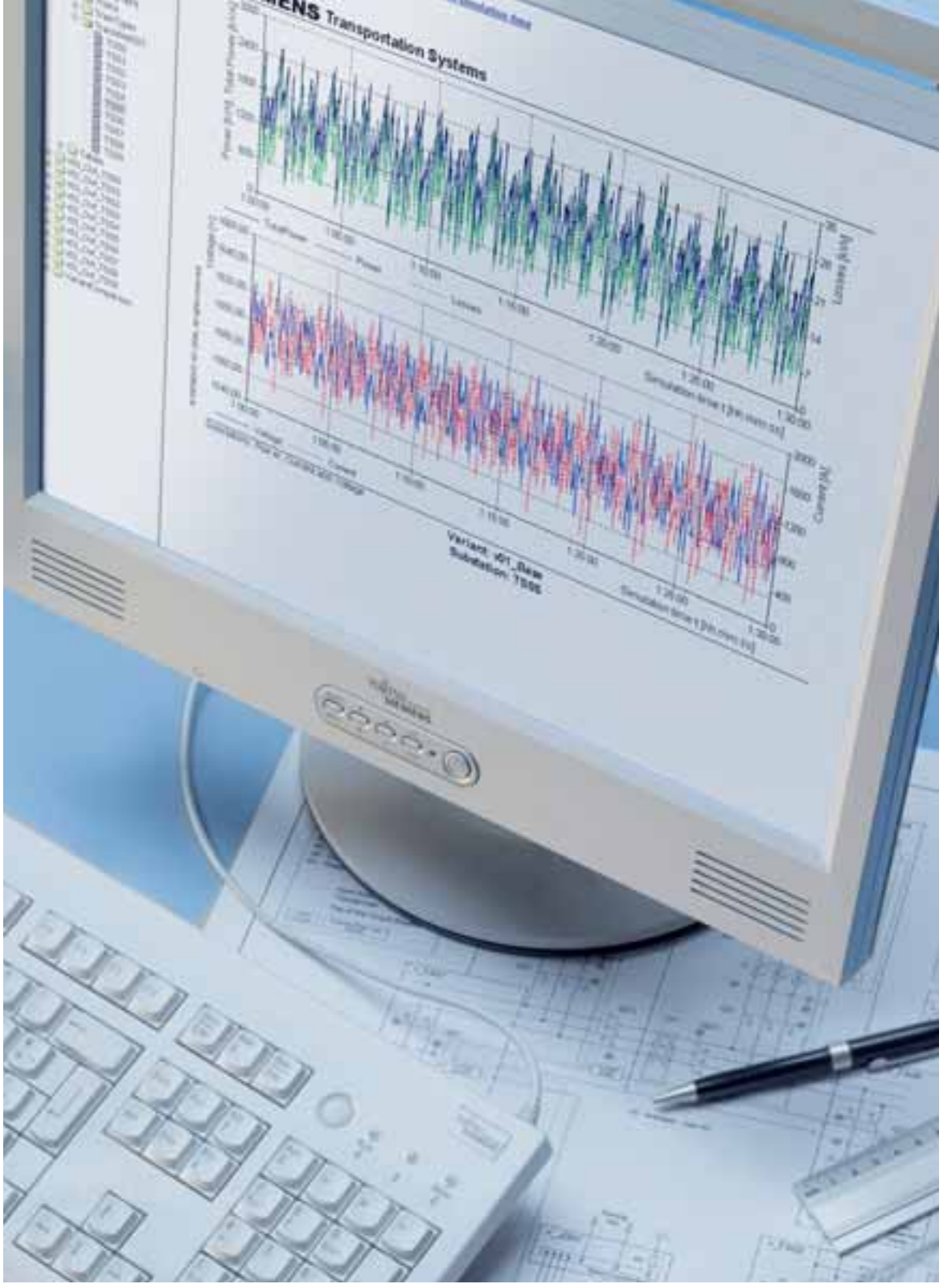
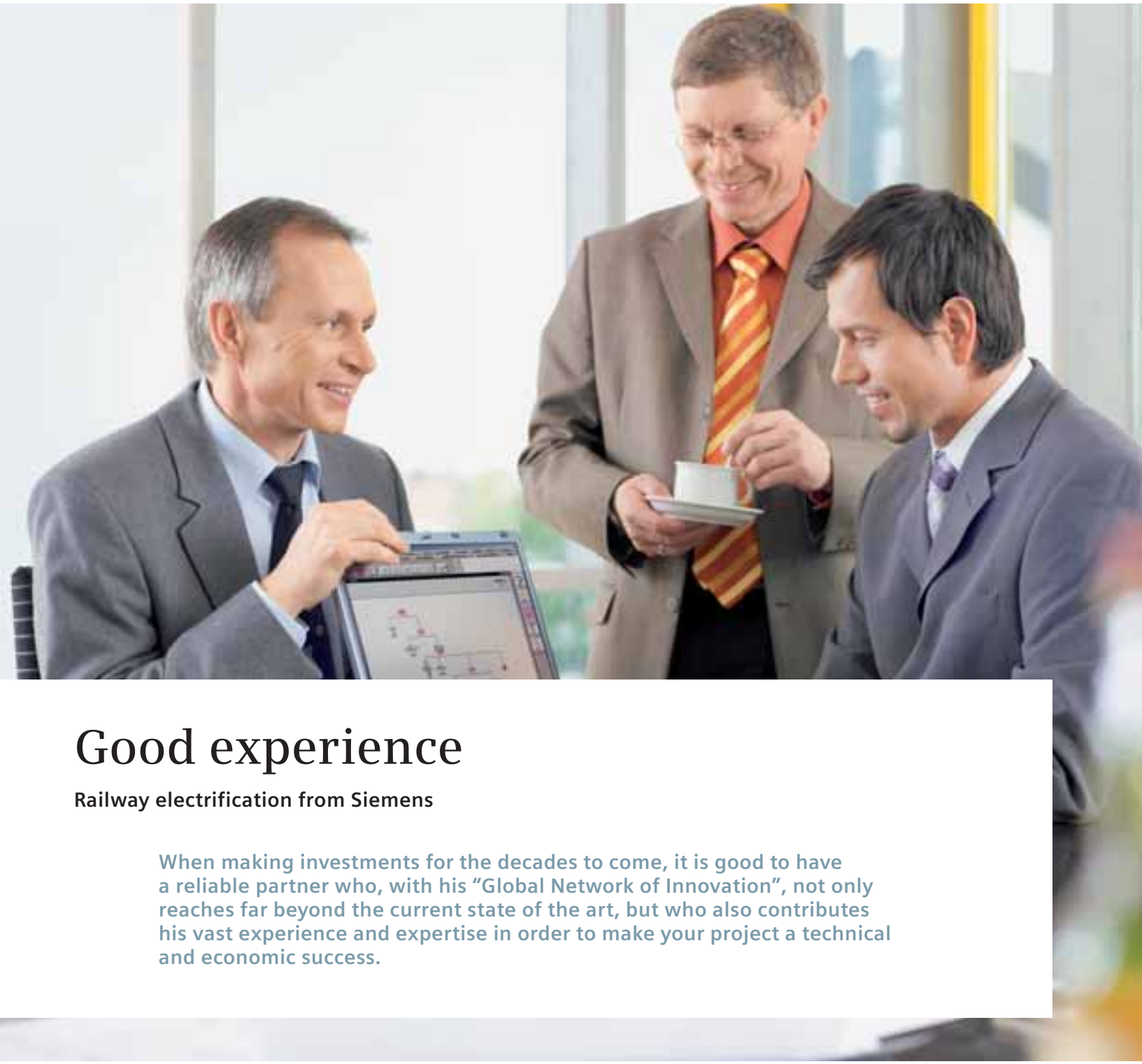


Competence in Railway Electrification

The reliable and economical solution from Siemens

Transportation Systems

SIEMENS



Good experience

Railway electrification from Siemens

When making investments for the decades to come, it is good to have a reliable partner who, with his "Global Network of Innovation", not only reaches far beyond the current state of the art, but who also contributes his vast experience and expertise in order to make your project a technical and economic success.

Sustained innovation
Siemens is a leading global provider of electrical equipment – and this is also true for rail-bound transportation. It is our versatility that is most beneficial to our customers because it is often the results from our basic research that are consistently developed further in various business segments with great success. This takes pioneering spirit as well as the capability to discover the technological possibilities of a newfound solution and to exploit them for various applications. Also within the Transportation Systems Group, our customers benefit from our comprehensive portfolio of vehicles, fixed trackside installations for railway electrification, control and signaling equipment as well as turnkey systems.

Competent support
Our customers need customized support at all stages of their projects. We help you put your project on a sound planning foundation. This also extends to assistance in formulating the call for tenders so that the offers you receive are really comparable and that all general conditions are considered. Even during installation or operation of the equipment you benefit from our comprehensive know-how, such as if you want to alter the operational speed of a line. Our simulation tools and measuring methods show you the possible performance reserves of your existing equipment.

Milestones in railway electrification – set by Siemens

1879 First electric railway

1889 First electric tram to use a pantograph

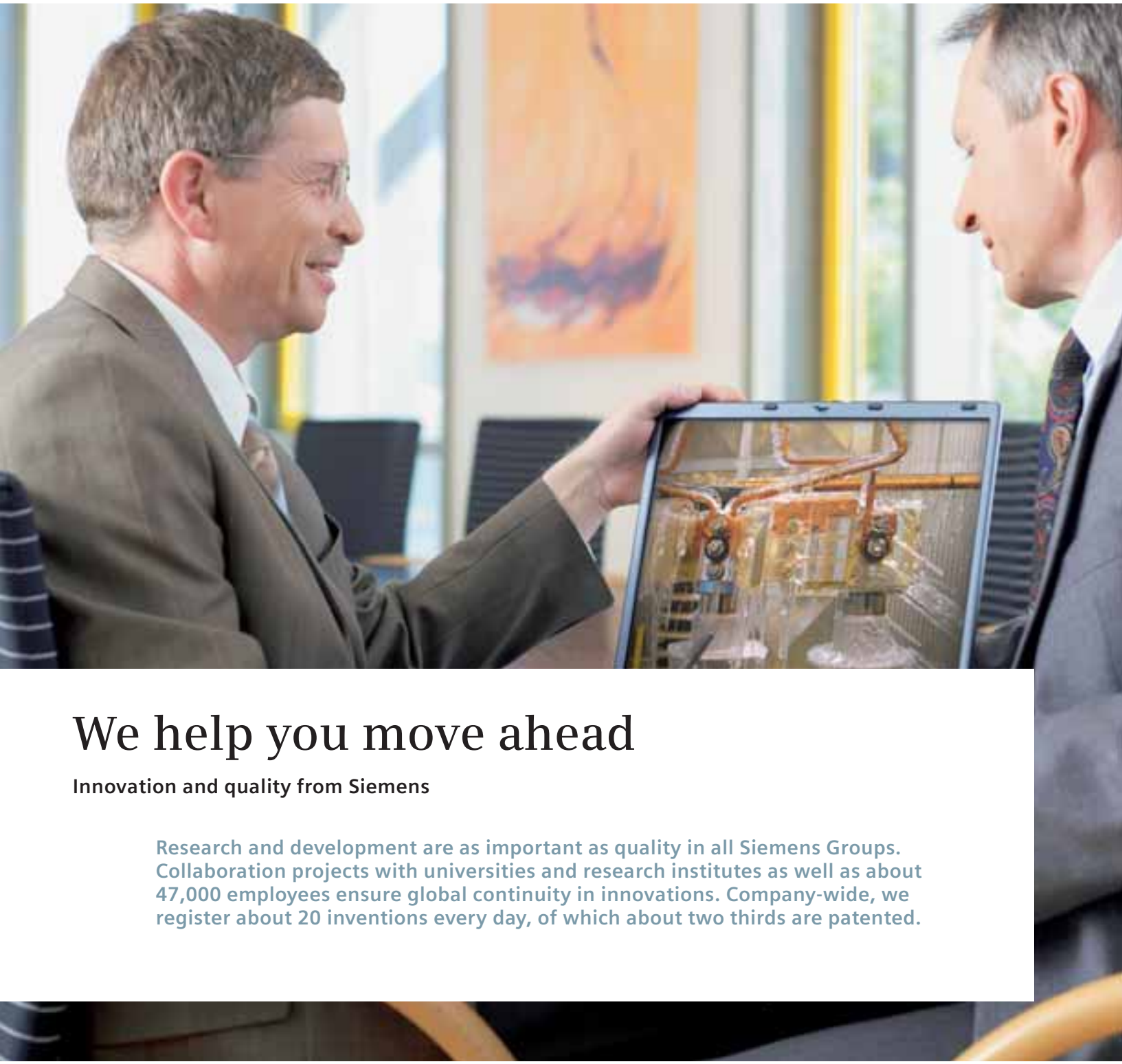
1905 First overhead contact lines with catenary suspension

1957 First silicone rectifier used to supply power to DC railways

1988 World record speed of 406.9 km/h set on rails with standard overhead contact line

1994 First fully numerical protection equipment used in traction power supply

2001 First static energy storage system for mass transit



We help you move ahead

Innovation and quality from Siemens

Research and development are as important as quality in all Siemens Groups. Collaboration projects with universities and research institutes as well as about 47,000 employees ensure global continuity in innovations. Company-wide, we register about 20 inventions every day, of which about two thirds are patented.

Quality is more than just good products
It is a basic requirement, which also applies to our processes. It starts in research and development, where precisely defined processes ensure that a good concept is turned into an equally good product. And it continues through all areas of our company, in production and inspection reports and in the position of someone who is responsible for quality assurance and whose task it is to constantly check all production steps and processes. We also prefer to work with standardized system platforms that have been tested in everyday operations and in which all elements are fully harmonized, e.g. the rectifiers being perfectly matched to the switchgear. Project processing, too, follows a precisely worked out plan using traceable milestones and Quality Gates. It is therefore not surprising that several of our projects have won awards for their excellent results in international competitions. And it goes without saying that all of our locations are certified according to DIN EN ISO 9001:2000.

Best material
And just because we produce for a global market, our products must use materials that are resistant to the harshest of conditions: from severely cold temperatures down to –45 °C to humidity readings of up to 98 % in the tropics, from sandstorms in the deserts to salt spray on the coast. With us, you can be assured that the mechanical, hydraulic and electric functions of our system have been verified and successfully tested under the conditions existing at the actual installation site.

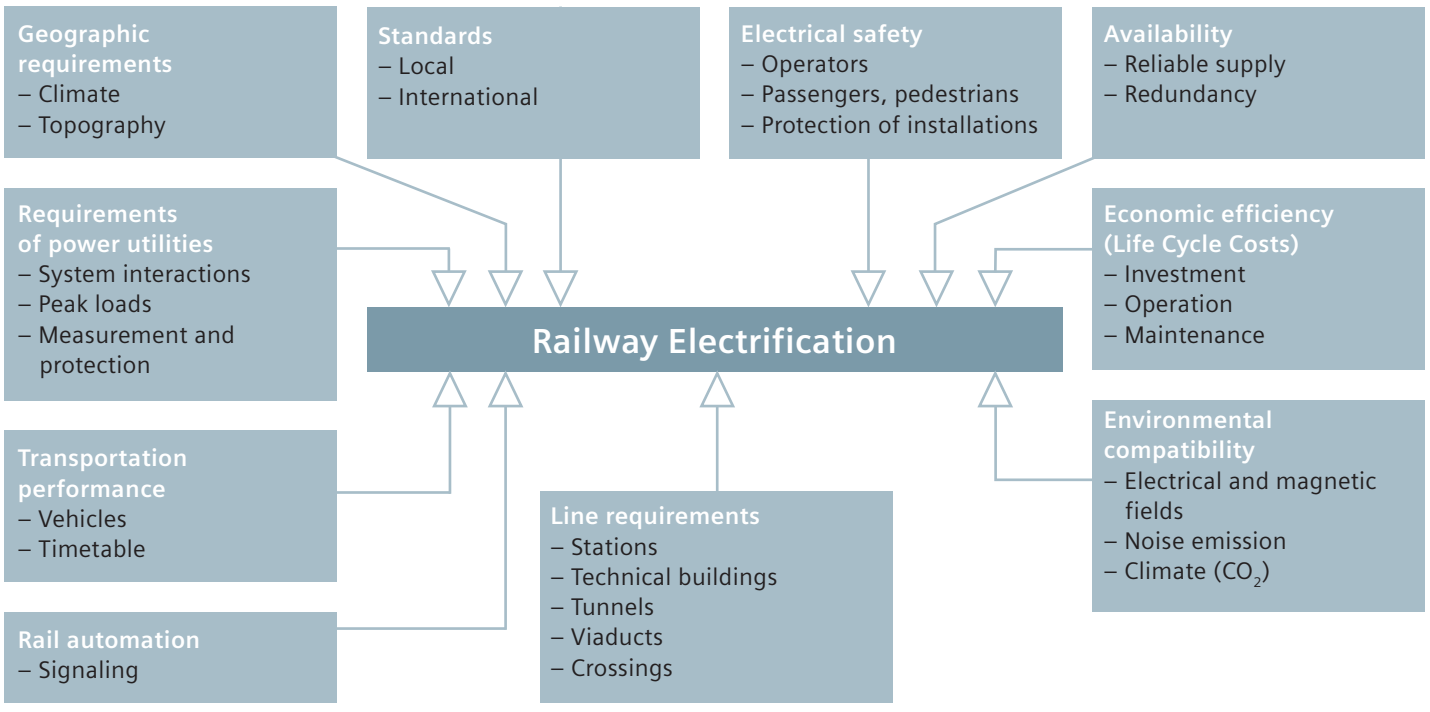
A wide variety of factors

Custom solutions are required

Railway electrification projects usually involve extremely complex requirements for planners, builders and operators. Required is custom equipment that fits easily and harmoniously into a larger infrastructure – equipment from Siemens.

Rely on our expertise
We have a simple formula for success in railway electrification: We combine comprehensive expertise in planning and implementation of traction power supplies and overhead contact line equipment with the use of validated and verified software tools. Your big advantage: We can experiment with nearly any scenario and evaluate its impact on your equipment before you decide on a specific alternative. Due to the complexity of the matter, many of the programs used are in-house developments, e.g. for electrical calculations or for the calculation of mechanical, static or dynamic loads. This is complemented by the use of standard CAD tools.

Engineering excellence
The diagram on the following page illustrates the complexity of railway electrification projects. The task of our engineering is to define the basic system requirements and develop possible solutions to meet them. This concerns fundamental requirements such as the power supply system, the desired running speeds, the spacing of substations, the composition of the contact line, climatic conditions as well as route-related requirements and many more. This forms the basis on which a detailed solution for the traction power supply and the contact line are subsequently devised. In this process, several other general conditions need to be taken into account, such as requirements of electric utilities with respect to system perturbations or local environmental protection regulations (electromagnetic compatibility, noise emission of transformers, CO_2 emission, etc.)

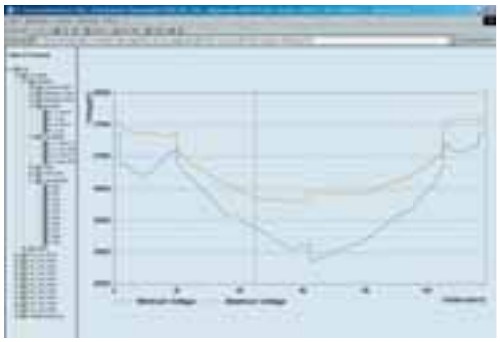


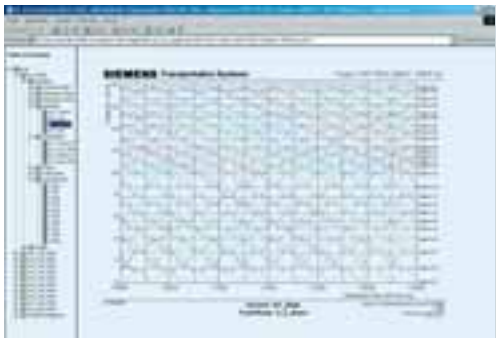
System requirements for railway electrification

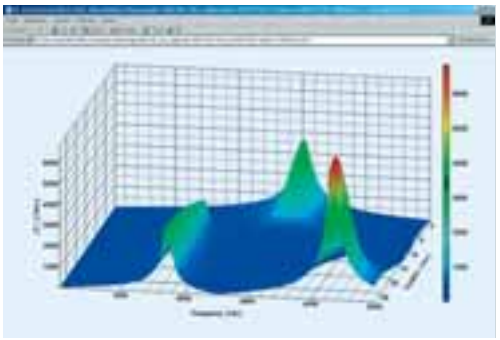
Calculable success

Railway electrification from Siemens

System design and the calculation of railway electrification are among our core competencies. This is where we combine our comprehensive system expertise with the latest results of research and development work in the relevant Siemens Groups and with the capability to properly evaluate the calculations delivered by our IT tools.





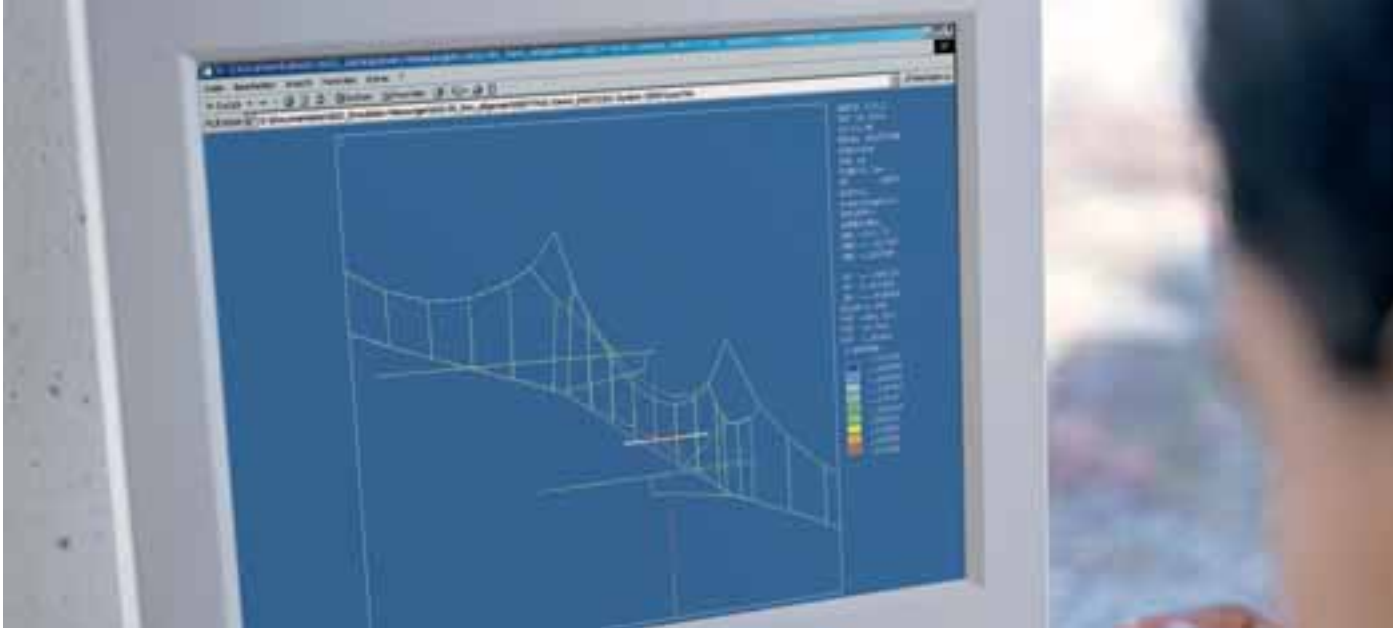


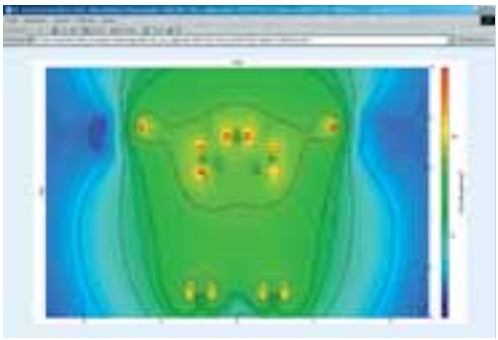
Full program
Sitras® Sidytrac is a program that allows us to calculate the power supply network using train run simulations. We can compare traction power systems under realistic conditions of use and configure new or existing ones and evaluate their performance. This forms the basis for an informed system decision that optimally meets your requirements. We can also plan performance reserves for future development or tune the system for maximum cost-effectiveness. By dimensioning the key components, we also define an initial cost structure.

Realistic simulation
The calculations and design studies are performed on the basis of realistic route, vehicle, network, and timetable data. This supplies us with information about the number, position and power rating of the substations, the voltage at the pantograph, the operating currents and the current load on contact line and cables, etc. These results can be used in feasibility studies and system comparisons that will also include more accurate data about energy consumption and energy recovery.

Earthing and bonding
At the same time, we also create an earthing concept in order to provide an optimum degree of protection of individuals and electric equipment. For this purpose, we initially define the traction current return on the route as well as in depots and workshops. Then we consider each component for the construction phase, i.e. at-grade sections, tunnels, bridges, underpasses and buildings. The earthing concept includes the calculation of touch voltages and rail potentials as well as statements about lightning protection and protection against stray currents (in DC applications).

Electromagnetic compatibility
We also investigate the electromagnetic compatibility of the planned installation or of parts of an existing installation that are to be replaced. The goal is to eliminate any health hazard for employees and passengers due to electrical or magnetic fields as well as any disturbance of equipment. Especially for the extension or enabling of existing installations, Sitras Sidytrac and Sitras EMF can also be used to verify the compliance with the relevant limits before the actual investment takes place at all. In this context, an important part of our analysis is also to offer alternatives by means of compensation conductors or the optimization of the conductor arrangement so that the admissible limits are not exceeded.





System interactions and voltage quality
When designing a system, it is frequently required to consider limiting regulations of the high voltage feeding network with respect to voltage quality and its impairment by system perturbations. Sitras Sidytrac can analyze

- system interactions due to harmonics,
- 3-phase current imbalance with 1-phase load,
- voltage fluctuations and flicker as well as the
- resonance performance of railway lines under realistic service conditions.

Special aspects of traction power supply
Leverage our expertise for all aspects of traction power supplies. Benefit from the comprehensive know-how of our engineers when it comes to

- detailed examinations for planning,
- the assessment of existing installations,
- questions of protection,
- the dimensioning of cables,
- the dimensioning of static converters,
- aspects of perturbation between different systems,
- system comparisons,
- electrical safety stipulations.

We are sure to find the right solution for every task, extending our own resources in cooperation with leading universities in order to fully meet your expectations.

System design for your contact wire
The contact wire system is defined as required by the specific projects and on the basis of the results of our comprehensive feasibility study. This also includes the specification of the required wires and tension forces. By using Sicat® Dynamic, we can simulate the interaction of catenary and pantograph, under realistic conditions in order to demonstrate the interaction quality you want. The final step consists in defining the type of cantilevers, the pole foundations and the poles themselves and complemented with the remaining system components (tension wheel assemblies, disconnectors, etc.).

From system concept to project

Engineering services from Siemens

The system design with Sitras Sidytrac and Sicat Dynamic has set the general conditions, such as the power supply and contact line systems, or the number and rating of the substations. In the configuration phase, it is now necessary to design all parts of the system that they also meet future requirements or, in case of failure of a substation, still deliver enough power to the system according to the specific requirements of each case.



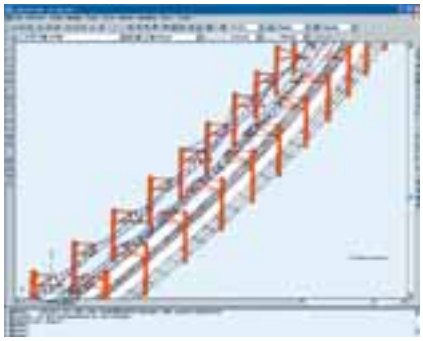


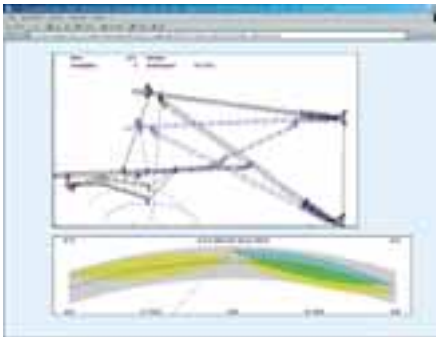
Configuring your traction supply system
In this step, we assemble the components of your traction supply system and match then to the respective requirements from the system design phase. In addition to high-voltage and medium-voltage switchgear, this will include rectifiers, DC switchgears, short-circuiting devices as well as control panels and low-voltage distribution boards. Concurrently, we design the required buildings and define the necessary construction work or the respective requirements, followed by electrical and mechanical construction. By engineering the interfaces, we ensure that all components harmonize and can be integrated to form the complete system.

The system protection concept
This concept is designed to achieve a multi-level coordination of the different protection tasks within your system. What sounds pretty easy is actually a complex task because, after all, it is the protective systems to decide what parts of the system will be disabled and what parts will remain in service in case of a problem. The results of these considerations are recorded in the switching logbook of the protective system. The subsequent parametrization of the protective devices is performed by means of the DIGSI® and Sitras PRO SW software tools.

Station control
When building the station control system, we use WinCC® for the extremely efficient visualization of the system. This allows us to describe the system data in the language of the operator who will be able to use the standard Windows user interface. Parametrization of the protection and control systems is followed by the interfacing of the bus and remote control equipment to the remote control and operations control system (SCADA).

The next step: Configuration
Using Sicat Master, the first step is to create the contact line diagrams that include the positioning of poles, catenaries, and traction power cables. These diagrams usually include the earthing system as well as topographic particularities around the track. The position and type of foundations as well as the type of poles are described using a list of poles and foundations with the special IT tool Sicat MatLog that is also used to generate the equipment lists and the quantity framework of the project. The concepts for availability, feed and operations control form the basis for the generation of the circuit diagrams that cover the electrically separable zones of the contact line system to facilitate service and maintenance. Since cantilevers and catenary droppers are not prefabricated due to the variable span lengths, they are





calculated for each particular application using Sicat Candrop. Finally the entire system is recorded with all relevant data in an 'as-built' documentation.

Perfection in details: The construction process
In the construction phase, we check first if any existing drawings match the Sicat contact lines. The next step is the creation of the necessary system and assembly drawings including the bills of material. Special designs, such as special assemblies or mounting fixtures (e.g. in structures, on bridges or in tunnels), are designed in a second step.

A solid foundation: Structural engineering
Contact line systems require comprehensive static calculations in order to maintain their stability under all conditions of use. This includes the evaluation of soil examinations, foundation soil and structural expert opinions in order to optimize the dimensioning of all components. We are committed to providing you a perfect combination of functionality, cost-effectiveness and safety. This guides the detailed design of cantilevers and support structures, poles and foundations. Fixing loads on structures are also determined and processed by the responsible planner for consideration in the subsequent dimensioning steps. A final comparison matches all data to the installed system and recorded in an 'as-built' documentation.

The bottom line:
The right solution for your application
Our comprehensive system expertise, which utilizes the latest results of the research and development activities of the various Siemens Groups, combined with our ability to draw the right conclusions from the calculations performed by our IT tools ensure perfect results that fully match your requirements.

Siemens AG
Transportation Systems
Electrification
P.O. Box 32 40
91050 Erlangen
Germany

electrification.ts@siemens.com
www.siemens.com/transportation/
electrification

Printed in Germany
TH 179-060192 204393 WS 09061.0
Dispo 21711 c4bs 3894
Order No. A19100-V300-B680-X-7600

www.siemens.com/transportation