A blurred photograph of a high-speed train moving through a tunnel. The train is red and yellow, and the background is a blur of tunnel walls and lights, suggesting speed.

SIEMENS

Ingenuity for life

Increasing Energy Efficiency

Optimized traction power supply
in mass transit systems

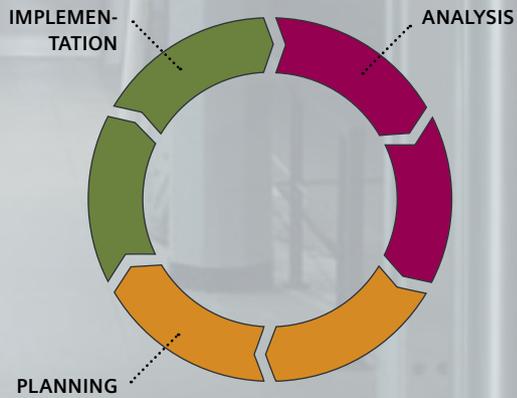
[siemens.com/rail-electrification](https://www.siemens.com/rail-electrification)

From virtuality to reality

Intelligent and efficient rail electrification solutions

Concepts that make transport more efficient are in demand with the ever-increasing need for mobility. With our long-standing transport expertise and our IT know-how, we are constantly developing new, intelligent mobility solutions that increase availability of infrastructure, optimize throughput and improve passenger experience. It's in how we electrify, automate and digitalize infrastructure that we're setting the benchmark for tomorrow's mobility – today.



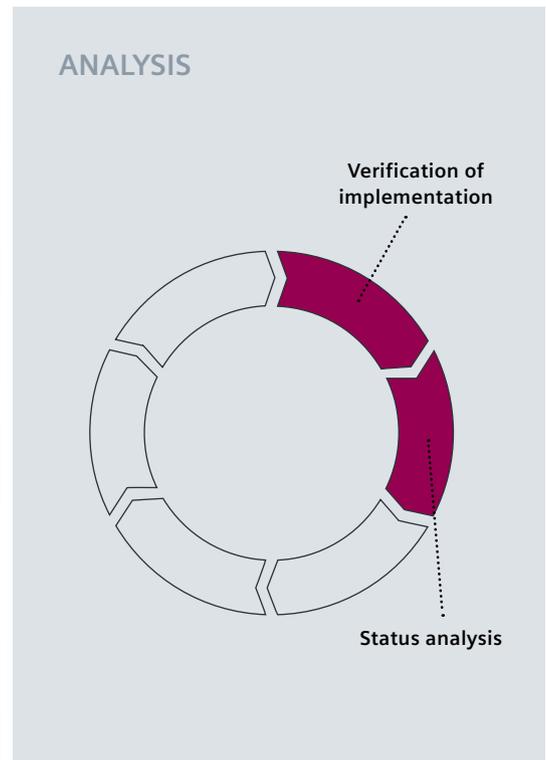


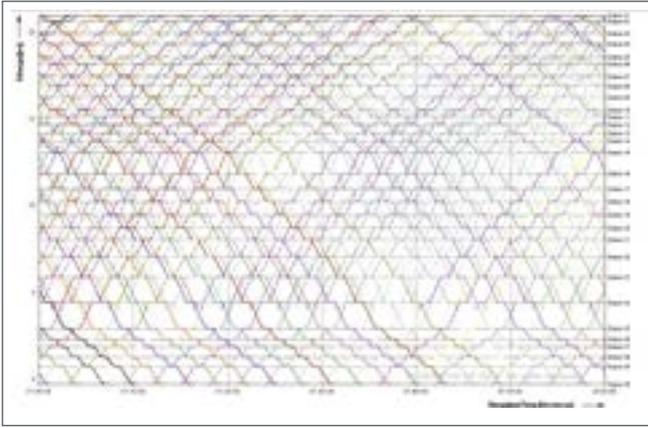
A HOLISTIC ELECTRIFICATION PROCESS

Thanks to our defined and holistic process, we ensure transparency and clarity in each phase of a project. In three steps, we help you to analyze your needs, plan your individual configuration and then concretely implement your tailor-made electrification solution.

Virtuality|1

Siemens is one of world's leading suppliers of innovative railway electrification systems. The design and calculation of installations are among our core areas of competence. System know-how and the latest IT tools enable us to achieve a precise definition of your particular needs.





Sample calculation: Payback period

The energy saved with Sitras PCI can give a return on investment in just three years.



Profitable analyses

It's good that we're so calculating. After all, the complex requirements involved in the creation of an economically efficient and stable electrification system call for an in-depth analysis. Our experts work with the latest software modules and apply the experience they have gained from decades devoted to the development of such solutions worldwide.

Providing advice and finance:

A good starting basis for growth

Our highly competent engineers and partners provide you with advice on all aspects of planning and system configuration from the very beginning. With our global network of innovation, we not only look beyond our own field of technology know-how, but also have local needs closely examined by our worldwide network of on-the-spot experts. This enables a flexible variance analysis to be obtained on an international level. We consult with you closely to define the general parameters of the project, right from the very first consulting session. To this end, we draw up an individual financing concept that is tailored to your situation and developed in close cooperation with local authorities, government offices and commercial banks all over the world.

Data acquisition:

The value added is in the details

Irrespective of the infrastructure, topography or climate, our experts collect your data straight from the actual source. In doing so, they are making use of data that is already available. However, it is frequently necessary to obtain new data as well in order to reliably evaluate the viability of a planned project. We carry out specific software-supported analyses, the results of which are incorporated as important parameters in the project simulation.

First planning unit:

Laying the foundations for decisions

With our Sitras® Sidytrac software tool, our experts generate crucial advantages that work out to your benefit. In an early phase of cooperation, you decide on the quality of the solution and the continuation of the project. On the basis of the acquired data, we draw up an initial project outline that allows alternatives at any time and thus creates a solid basis for a concrete offer to be made to you.

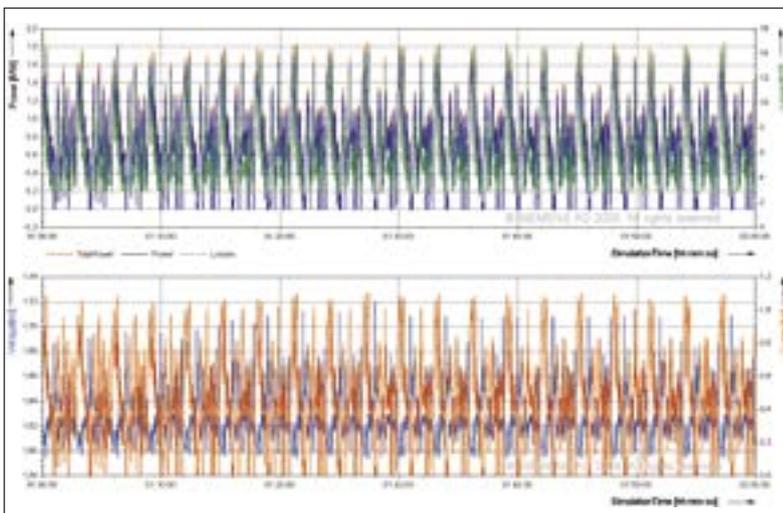
The result:

The right solution for the job in hand

Our extensive system know-how is based on the latest results from research and development by the relevant sections within Siemens as well as on our ability to draw the right conclusions from the calculations performed by our IT tools. These factors combine to ensure an optimal result ideally suited to satisfy your requirements.

Virtuality|2

Efficient rail electrification systems are the result of exact planning. Long before work is started on site, we simulate your individual project under realistic conditions on the computer. This saves you from any surprises and allows us to take all contingencies into consideration.

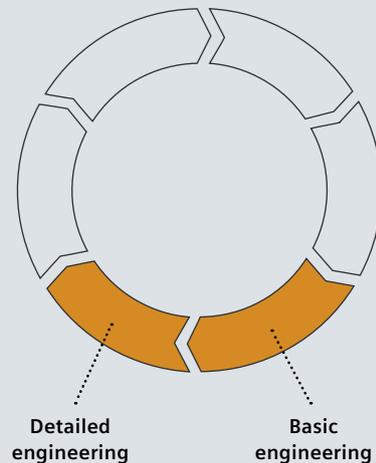


Planning example: Energy storage units tap saving potential

The storage of braking energy by stationary energy storage units enables the primary energy demand of a rail vehicle to be reduced by as much as 30%.

30%

PLANNING



Planning is knowing what the result will be

We always consider a project from a holistic point of view. Our experts plan your traction power supply system embedded in a larger context. On the basis of the data obtained and taking into account your special needs, we incorporate the relevant infrastructural parameters into the simulation of your system from the very beginning. As regards energy efficiency, the potential for savings can thus be determined as early as the first stages of calculation. This ensures a configuration that is both individual and easy on resources.

Sitras Sidytrac:

A little less, if you please?

Sitras Sidytrac is a simulation software that enables us to carry out an exact power-system calculation with train operation simulation for your particular project. In addition, workflows are standardized and automated, which means sources of error can be reduced and efficiency increased considerably. And that is regardless of whether you need a completely new system concept or simply want to know your existing system's potential for improvement. The software calculates your individual configuration and even goes a step further: due to the optimization of power consumption, power recovery behaviour and energy-saving

potential, your resulting traction power supply system is not only exemplary in terms of ecology but also offers the beneficial side effect of substantially reduced life cycle costs.

The following additional aspects of your system can be simulated and planned with Sitras Sidytrac:

- The electromagnetic compatibility of your planned installation or the parts of the installation to be upgraded.
- An earthing concept that guarantees optimum protection for people and electrical equipment.
- The network reaction and voltage quality based on the analysis of
 - system interactions due to harmonics
 - three-phase imbalance because of single-phase railway loads
 - voltage fluctuations and flicker
 - resonance behaviour of line sections under realistic operating conditions.

Concrete planning procedure: Energy efficiency in three steps

Sitras Sidytrac wins over customers with its three-part program structure composed of input block, calculation block and output block. The input block is used to process the line data, the timetable, the vehicle data and the data of the electrical power supply system.

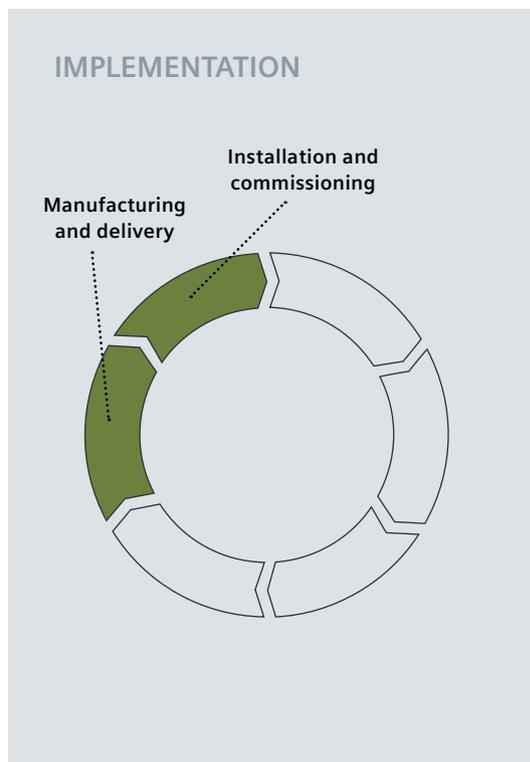
The calculation block is the heart of Sitras Sidytrac. First of all, the drive cycle program calculates the location of the vehicles in the power supply network as well as the power they consume and deliver. These electrical loads are then incorporated in the static network and provide the basis for calculation of the dynamic electrical network. Then, the system determines the electrical load flow and incorporates the values in the drive cycle.

The electrical data for the detailed design of the main components are finally evaluated in the output block. The results can then be shown in the form of predefined lists and graphics and stored in a database.



Reality|1

The energy efficiency of rail electrification is mainly measured in terms of its energy saving potential. Siemens possesses a path-breaking range of products with the latest technologies for high environment-compatibility and greater economic efficiency. Once integrated in your system, our products enrich the ecological attribute of your electrification solution.



Efficiency you can grasp

With braking energy into the future? Modern technologies in the area of traction engineering considerably improve the drive system of rail vehicles and thus reduce energy consumption enormously. The self-commutated IGBT inverters of the Sitras family are the heart of your custom-made electrification system. They save energy in daily use by feeding back the braking energy that is released and thus make a decisive contribution to the reduction of life cycle costs as well.



**Inverter Technology Sitras PCI:
Additional power for reuse**

The self-commutated IGBT inverter Sitras PCI enables transmission of train's braking energy into the superordinated medium-voltage grid.

At the same time, the increased requirements on power quality are fulfilled and the quality of energy recovery is increased.

By recuperation of the braking energy into the medium-voltage grid, braking resistors on the vehicles can be minimized or avoided, thus the vehicles overall weight and efficiency is improved. Also existing substations can be enhanced for recuperation by integration of a Sitras PCI and its reliable IGBT technology allows an optimal power transfer. State-of-the-art communication protocols and interfaces facilitate remote parametrization, control and diagnosis.

**Continuous optimization:
Life cycle under the microscope**

Our work is by no means over when your mass transit project has been implemented. After commissioning, we continue to provide support for your system, subjecting the measured data and configurations to ongoing checks. Rationally based improvements can therefore be carried out at any time, assuring you that your mass transit system is operating efficiently.

**Intelligent energy management system
Sitras iEMS:**

Full transparency of energy flow

Sitras iEMS supports you with your efforts to increase energy efficiency, for example by processing and evaluating of energy data which are necessary to fulfill requirements by an ISO 50001 energy management system. Additionally, Sitras iEMS focuses on active management of loads and intervention.

Reality|2

In use worldwide

The energy efficiency of rail electrification is mainly measured in terms of its energy saving potential. Siemens possesses a path-breaking range of products with the latest technologies for high environment-compatibility and greater economic efficiency. Once integrated in your system, our products enrich the ecological attribute of your electrification solution.





**Beijing Metro
Beijing, China**

Beijing, the host city of the Olympics, has been using the energy saving power and stabilizing capacity of four Sitras SES stationary energy storage units since February 2007. The stationary energy storage units are being used at a total of four installations.

Scope of services:
Four turnkey systems, including engineering, manufacture, installation and commissioning

Commissioned: 2007

Main components:
Double-layer capacitor bank, converter, control system, connection unit

Supply voltage: 750 V

Mode: Energy saving



**VAG Verkehrs-
Aktiengesellschaft
Nuremberg/Fürth, Germany**

Since 2007 VAG in Nuremberg has been able to rely on the energy saving potential and stabilizing capability of Sitras SES stationary energy storage units.

Scope of services:
Four turnkey systems including engineering, manufacture, installation and commissioning

Commissioned: 2007, 2011

Main components:
Double-layer capacitor bank, converter, control system, connection unit

Supply voltage: 750 V

Mode: Energy saving



**Bayerische Zugspitzbahn
Bergbahn AG
Zugspitze, Germany**

The installed Sitras TCI inverter has transformed the braking applications for vehicles operating on Germany's highest mountain. Part of the braking energy created by vehicles travelling downhill used to be dissipated at the brake resistor but can now be fed into the customer's own medium-voltage ring.

Scope of services:
Turnkey system, including engineering, manufacture, installation and commissioning

Commissioned: 2007

Main components:
B6 thyristor bridge, autotransformer, control electronics

Supply voltage: 1,500 V

Mode: Energy recovery for optimized power distribution



Metro Transportes do Sul S.A. (MTS)
Lisbon, Portugal

This hybrid energy storage system has been in operation for passenger services since 2008. And it has proved a great success – the vehicle is able to run without an overhead contact line on gradients of up to 2.6% and saves energy.

Scope of services:
Engineering, manufacture, installation and commissioning

Commissioned: 2008

Main components:
Hybrid energy storage system – consisting of a mobile energy storage unit and traction battery

Supply voltage: 750 V

Mode: Operation without overhead contact line



RET
Rotterdam, Netherlands

Since 2010, a Sitras SES stationary energy storage unit has been making sure that braking energy is absorbed, stored and released for acceleration purposes.

Scope of services:
Turnkey system, including engineering, manufacture, installation and commissioning

Commissioned: 2010

Main components:
Double-layer capacitor bank, converter, control system, connection unit

Supply voltage: 600 V

Mode: Energy saving



Toronto Transit Commission
Toronto, Canada

The Toronto Transit Commission has placed its trust in a Sitras SES stationary energy storage unit to reduce the primary energy demand of its vehicles and increase the reliability of its system.

Scope of services:
Turnkey system, including engineering, manufacture, installation and commissioning

Commissioned: 2011

Main components:
Double-layer capacitor bank, converter, control system, connection unit

Supply voltage: 600 V

Mode: Energy saving



**Innsbrucker Verkehrsbe-
triebe und Stubaitalbahn
GmbH
Innsbruck, Austria**

Innsbrucker Verkehrsbetriebe has been benefitting from the energy saving potential provided by a mobile energy storage unit since 2011.

Scope of services:
Vehicle retrofitting: energy storage unit, modification of vehicle converter and control system

Commissioned: 2011

Main components:
Mobile energy storage unit, vehicle converter

Supply voltage: 600 V

Mode: Energy saving



**Land Transport Authority
(LTA)
Singapur**

In 2014 a Sitras TCI was installed in Singapur for an optimized energy recovery. The system could convince: additional inverters Sitras TCI will be commissioned in 2015 and 2016.

Scope of services:
Integrated in DC substation including engineering, manufacture, installation and commissioning

Commissioned: 2014 (1 out of 8 TCI), rest in 2015 und 2016

Main components:
B12 thyristor bridge, 12-pulse transformer, control electronics

Supply voltage: 750 V

Mode: Energy recovery for optimized power distribution



**TriMet
Portland, USA**

In May 2015 a stationary energy storage unit Sitras SES with double-layer capacitor was commissioned to optimize energy saving potential in Portland.

Scope of services:
Turnkey system, including engineering, manufacture, installation and commissioning

Commissioned: 2015

Main components:
Double-layer capacitor bank, converter, control system, connection unit

Supply voltage: 600 V

Mode: Energy saving



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