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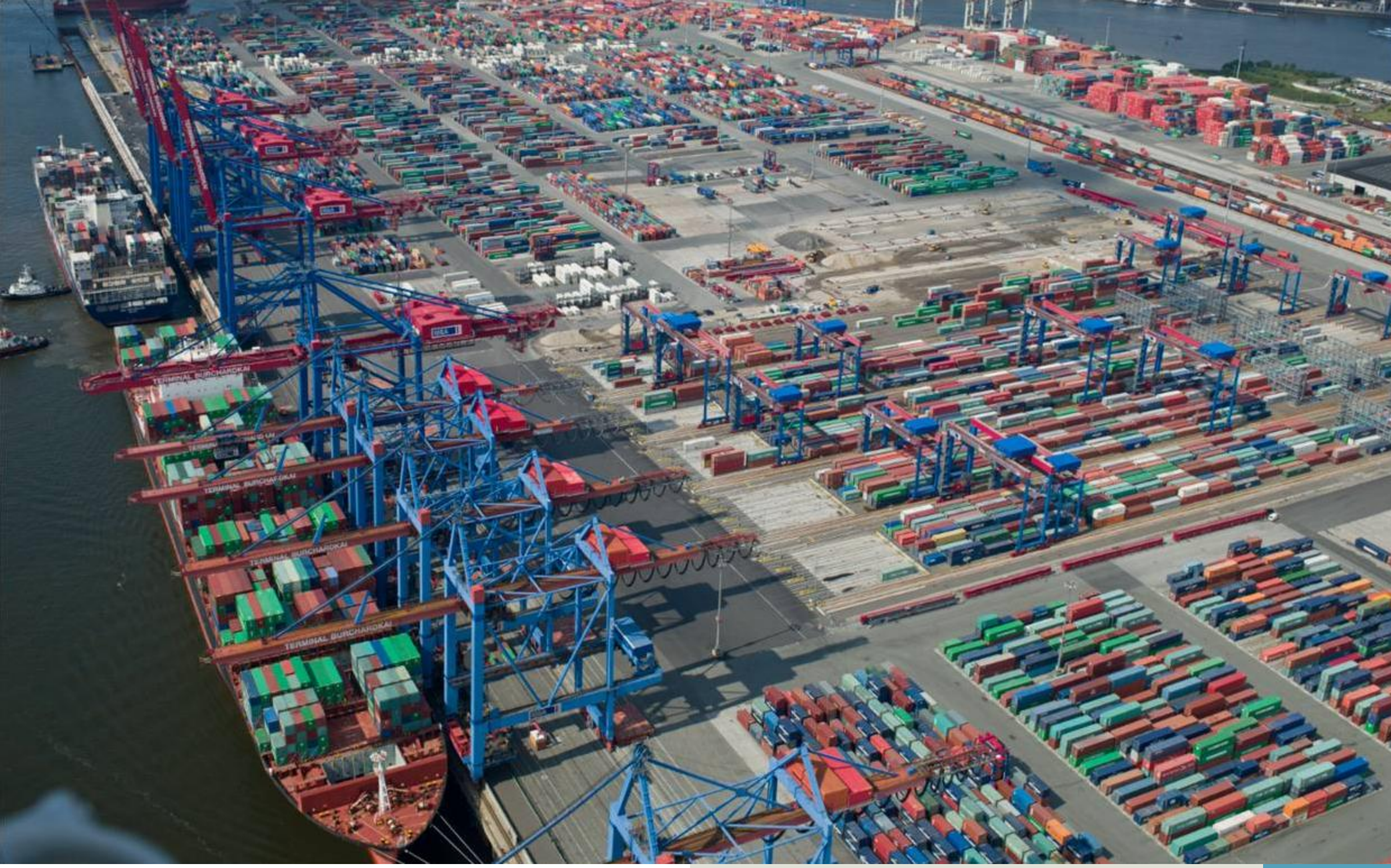
Ingenuity for life

Totally Integrated Power

Innovative power distribution for ports & harbors

Concept for profitable and safe electric power distribution

siemens.com/tip-ports



Contents

Integrated and future-oriented power supply solutions for ports

The importance of electric power as an energy source for industries, buildings, and infrastructures is increasing steadily. Each business has specific needs and challenges and requires a versatile, adaptable, and tailored power supply in order to optimize availability and profitability. Totally Integrated Power (TIP) from Siemens is a fully customizable and integrated power supply solution comprising software and hardware products, systems, and solutions across all voltage levels. TIP perfectly integrates into industrial and building automation systems and enables companies to focus on their core business while supporting their value chains with a reliable, safe, and efficient power supply. Because power matters.

Requirements and trends in the ports & harbors sector

Climate protection is one of the greatest challenges of our time. Maritime traffic and port operation have a significant impact on CO_2 emissions. Aboard ships and in port operation, there is now a move toward electricity as a source of energy. Globally, port operators have set themselves the goal to reduce CO_2 emissions significantly. European regulations stipulate that the EU's CO_2 emissions from maritime transport to be cut by at least 40 % by 2050, or even 50 % if possible, as compared to levels in 2005.

This definition of goals adds a completely new perspective to supplying power to ports. It is not only the availability of energy and its purchase price, but also the specific CO_2 emissions of the various energy types which must be included into power supply considerations.

New concepts of power generation are called for, where the co-generation of heat and power, wind and solar power as well as geothermal energy could play a part.

Ship traffic growth

Current studies forecast a moderate growth in the transportation of goods by ship as well as a continuing passenger increase, which calls for an appropriate adaptation of the existing infrastructure.

Despite growing passenger numbers, it is still intended to reduce CO_2 emissions based on international and national initiatives and targets.

If port operators are to meet these political demands, new strategies are called for.

Typically, the total energy demand of ports is divided into electricity and fuel consumption. Electricity is largely procured from the grid operator and used for Ship-to-Shore container cranes (STS), refrigerated container (reefer), electrical Rubber Tire Gantry (eRTG), lighting, air conditioning, etc. To a minor extent, concepts of independent power supply and microgrids are implemented. Heat is either generated within the port by burning mainly fossils such as oil and natural gas, or obtained from the district heating grid.

The main energy consumers of a port are its terminals with STS and reefer containers. They represent approximately 80 % of the total energy demand. The remaining 20 % is consumed by lighting, workshops and other ancillary buildings.

The costs of electricity are part of the operating cost; they vary from country to country and are thus location-bound.

A reduction of power consumption, however, is dependent on the port operator. Large ports are international traffic hubs and are exposed to cross-national competition.

Especially in Germany, a reduction of energy consumption – and thus operating costs – would increase the competitive edge over other European traffic hubs. Furthermore, CO_2 emissions could also be reduced, which would, in turn, meet the political demands.

In this context it is vital to measure all electrical values in order to control the whole power supply grid and safeguard continuous energy flow, avoiding peak loads which would cause additional energy costs.

Energy saving options

When analyzing optimization potentials, the entire property of a port must be looked into.

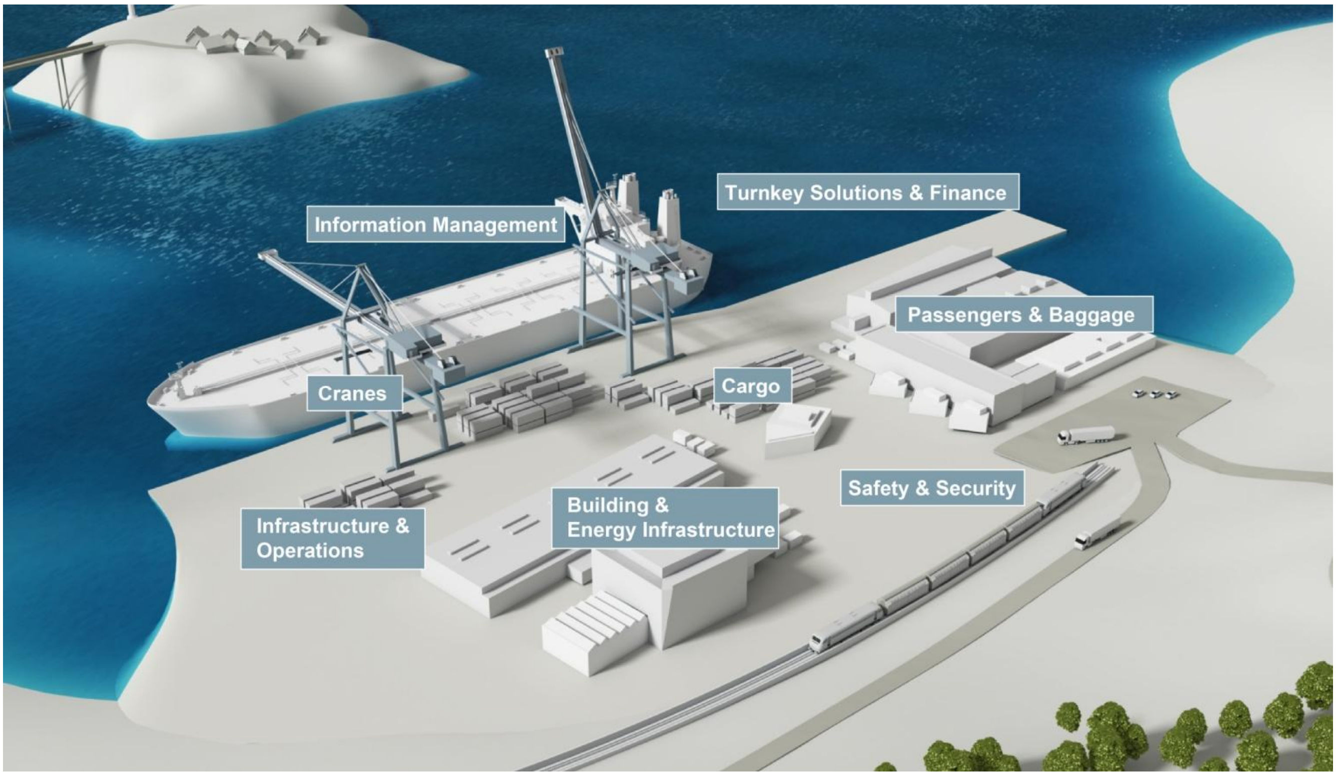
The building shell dissipates heat energy and consumes it through solar radiation. Heat insulation plays a particular part in this context. The better the building is insulated, the less energy needs to be consumed for heating and cooling it. Furthermore, heat energy sources such as lighting, motors and electronics must be considered. In order to create agreeable interior air conditions under the aspect of energy saving, energy saving equipment and efficient building control systems are indispensable.

Ports have largely unexploited resources – biomass such as green waste, organic waste and organic waste water components – which can be utilized for power generation. Unused areas on buildings could be used for solar power supply. Heat pumps, heat exchangers and heat stores are rarely utilized today. They also provide a potential for port optimization as regards energy efficiency.

To achieve a CO_2-neutral port, a holistic approach towards optimization of the entire property is in any case required.

Besides the electricity demand, the heating and cooling demand also need to be considered. Assuming a high proportion of in-facility power generation, energy management thus gets a particularly prominent part to play, since its operation must be holistically optimized. An intelligent infrastructure for power supply with a high degree of adaptability to rapidly changing requirements, which integrates distributed power generation into the local power grid, is the challenge to be faced. The integration of distributed power generation, power demand forecasts and plant monitoring are of increasing importance. An aggravating factor is here that heat energy must be produced on site, since its transportation across long distances would not be profitable. The use of combined heat and power generation plants (CHP) makes increasing sense. However, it must not be forgotten that CHP plants must be operated in a heat-controlled manner, this means that their dimensioning and mode of operation are determined by the heat demand. The electricity which is simultaneously produced is either fed into the grid or utilized in the facility itself. The updated requirements placed on power distribution systems and energy management software resulting thereof constitute part of the Smart Grid.

Diagram of a port and its properties



Smart Grids

Different international and national organizations have tried to formulate requirements to be placed on future grids in the form of definitions. The widely recognized and frequently used definition of the European technology platform "Smart Grids" describes the integration and intelligent interplay of grid users with the aim of developing grids in an economic, ecological, safe and sustainable manner.

The national Smart Grids technology platform defines Smart Grids in a modified form as "electricity grids which support energy- and cost-efficient system operation for future requirements by means of a well-matched management using real-time and bi-directional communication between grid components, producers, storage cells and consumers."

The advantages of Smart Grids are also seen in the reduction of CO_2 emissions and higher efficiency of the electrical system owing to optimal integration of energy generation from renewable energy sources close to the points of power consumption.

Systematic approach

A systematic view of the property is composed of three pillars – reduction, deployment and management. Each pillar bears the potential for energy saving and CO_2 reduction, but only a meshed interplay will result in an optimum state of affairs.

Reduction

Reducing energy consumption starts with a conscious on- / off-switching of loads. For example, lighting needn't be switched on all day long. Other options are building insulation, a more effective utilization of the air conditioning system and the use of energy-saving motors and/or speed-controlled drives. Further potential for reduction comes from the replacement of heat generators, heat distributors and investment in heat storage cells in order to optimally utilize the primary energy sources.

All offers that include energy efficiency solutions contribute to the reduction of the energy demand.

Deployment

The different types of energy can either be obtained from the distribution grid or deployed by "in-facility" generation, i.e. on the port premises.

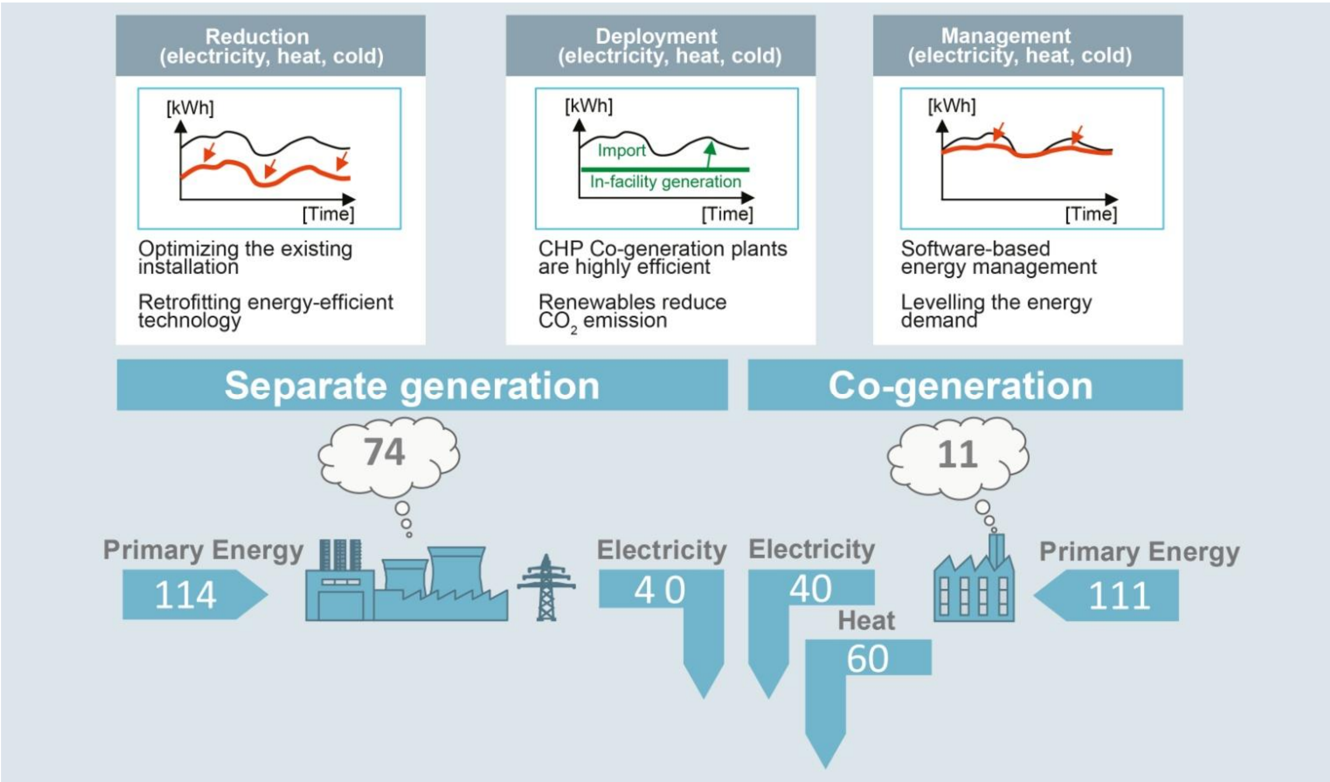
Since the heat demand of a port is very high, combined heat and power generation plants are the method of choice for in-facility power generation. Geothermal (deep drilling; close to the surface), thermal solar power stations and refrigeration are also suitable for in-facility generation.

Combined heat and power generation plants

In-facility power generation by combined heat and power generating plants has a 40 % better efficiency in relation to the primary energy demand than separate heat generation using boilers and electricity generation from power stations. Since the primary energy demand is also responsible for CO_2 emission, a CHP plant produces ~ 40 % fewer CO_2 emissions compared to traditional power generation.

If the primary energy is changed from fossil fuels to renewables (biomass, biogas), we speak of CO_2-neutral energy generation.

The three pillars of CO_2 reduction – separate energy generation versus co-generation



Energy management

Energy management coordinates the requirements of power consumers and generators of energy.

It comprises energy demand forecasts and deployment planning of generating units under the constraints of outdoor temperature, solar radiation, cargo movements and the expected passenger numbers. Characteristic parameters from energy generation and power consumption are indispensable for monitoring and evaluation.

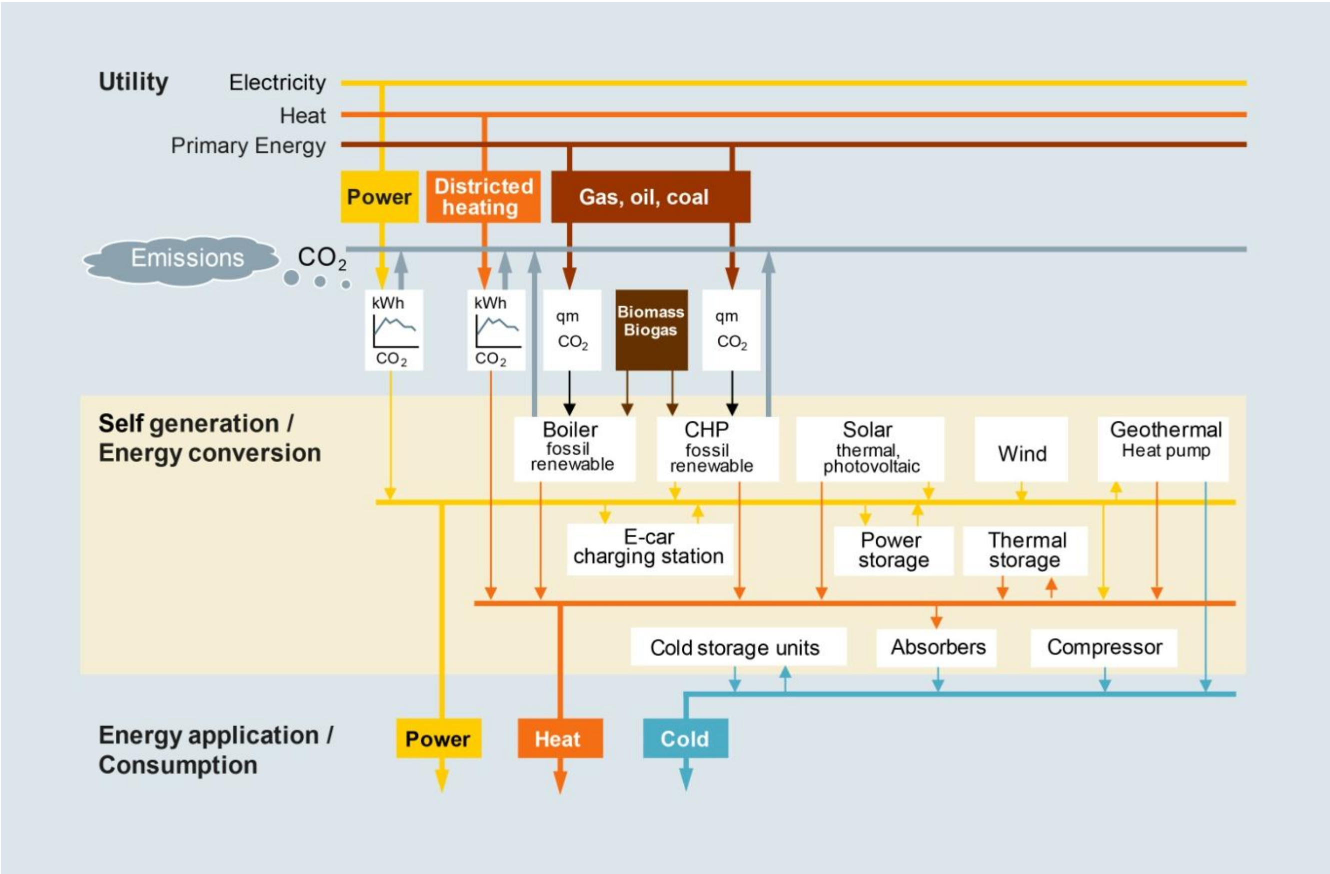
As mentioned before, heat must be generated on site. This means that demand must be covered under optimal conditions (business management view, minimization of CO_2 emissions). The operation of heat storage containers (filling and emptying) as well as the use of absorbers must also go into this consideration.

Electric power is normally obtained from the distribution grid, but it can also be generated on site. All heat processes require more or less power for their operation. If cold is to be produced using compressors, electrical energy is required on a large scale.

For optimal operation, we must precisely distinguish between in-facility generation and external purchasing. There are schedule clauses in energy procurement contracts. "... as far as required, the contract parties agree to draw up a supply schedule in due time before electricity is supplied. This schedule shall be based upon expected demand and shall be updated if necessary. In order to keep the required regulating energy as low as possible, the customer agrees to notify the supplier in writing of deviations from normal consumption one week in advance. ...". In-facility generation requires a deployment schedule for the individual systems in which the start-up and shut-down times as well as the service to be performed within the operating phase is described.

Considering the interrelationships of the various energy procurement and generation possibilities as well as the resulting CO_2 emissions, a complex structure is formed which needs to be balanced by the energy management system.

Energy procurement and in-facility generation possibilities



Integrated solutions for power supply

Software tools, products and systems

Totally Integrated Power comprises software tools for the design and configuration of power distribution systems and includes a complete portfolio of products and systems.

Using communication-capable components, they can be interfaced with building or industrial automation and higher-level management systems.

All products at a glance

Our product range comprises medium-voltage switchgear and low-voltage switchboards, transformers, busbar trunking systems, distribution boards as well as protection, switching, measuring and monitoring devices. We offer quality standards at the highest level in production worldwide, for the materials used, and the operability and functionality of our products and systems.

Qualified expert advice in your area

Totally Integrated Power provides personal and professional support for electrical designers in selected countries (www.siemens.com/tip-cs/contact). Experienced and competent experts on the spot and around the globe advise personally on every question of electric power distribution.

Concept for every type of project

Our specialist support ranges from determining the technical basis through all the various planning phases up to the preparation of specifications of work and services. It is independent of whether power supply plants are newly installed, extended or revamped.

SIHARBOR – onshore power supply for ships

New challenge in ports

Shipping is booming continuously, and more and more ships are docking at ports. Of course, this entails problems for the port operators, because the ship also has to generate power for onboard equipment, shops and air conditioning when berthed. This means that the diesel generators commonly used on board also have to run permanently in the port. This process generates large amounts of CO_2, NOX and dangerous fine particulate matter as well as noise and vibrations.

The emissions of a berthed cruise liner, for example, can be compared to the environmental pollution of a medium-sized city.

With regard to their own employees and the local residents of the port area, the port operators are determined to cut back the air and noise pollution. With SIHARBOR, Siemens offers a power supply solution with numerous advantages for the respective operators at the ports.

For all voltages and frequencies

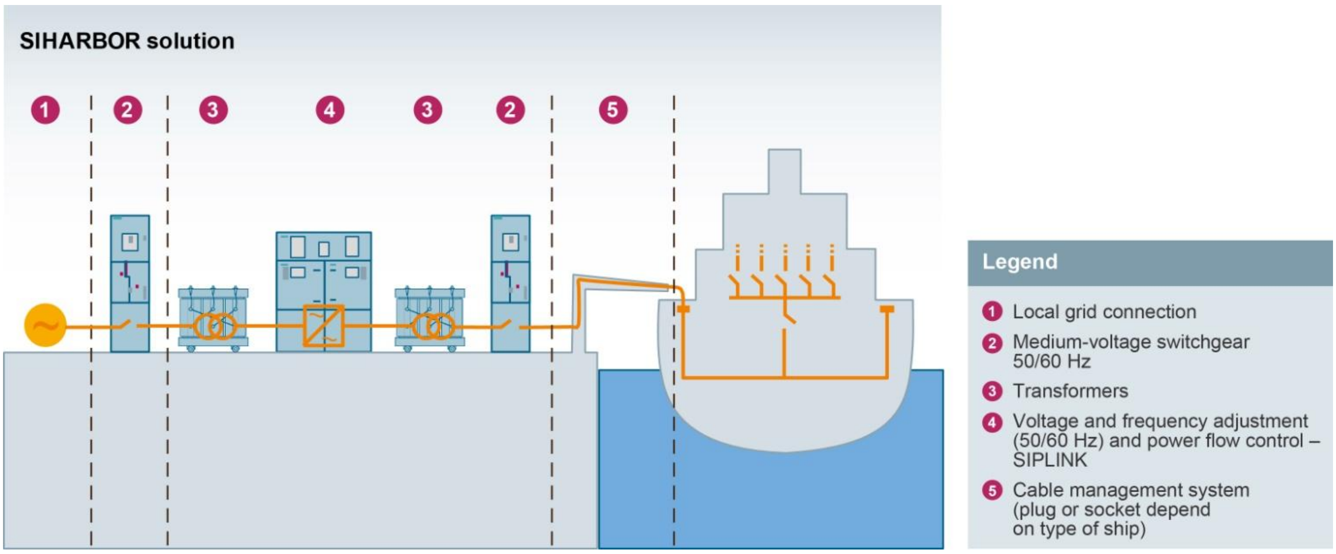
With its modular concept, the system is perfectly adapted to all power rating, voltage, and frequency requirements.

SIHARBOR uses an isolating transformer to galvanically isolate the ship's network from the onshore power grid and other ship networks.

SIPLINK: Siemens Power Link

SIPLINK is a converter system adapted for power system applications. It can connect two or more medium-voltage AC systems with different voltages, phase angles and frequencies. With SIPLINK, the voltage is adjusted by transformer tap changing and by modification of the converter output voltage. Thus, any required transfer voltage to the ship can be implemented.

SIHARBOR – Shore connection for berthed ships



SIHARBOR: Make ports eco-friendly and efficient

- Flexible solution for all kinds of onboard grids independent of frequency
- For all voltage levels of the shipping industry
- Conforms to the international standards IEC / ISO / IEEE 80005 and IEC 62613-2

SIESTORAGE – comprehensive competence for reliable power supply

New challenges for distribution grids

Wind and solar power have already become key power sources in today's energy mix. Their penetration and the growth of distributed generation have changed the structure of the power grid. Further, the unpredictability of generation capacities from renewables leads to fluctuations and imbalances between generation and load, influencing grid stability and power quality.

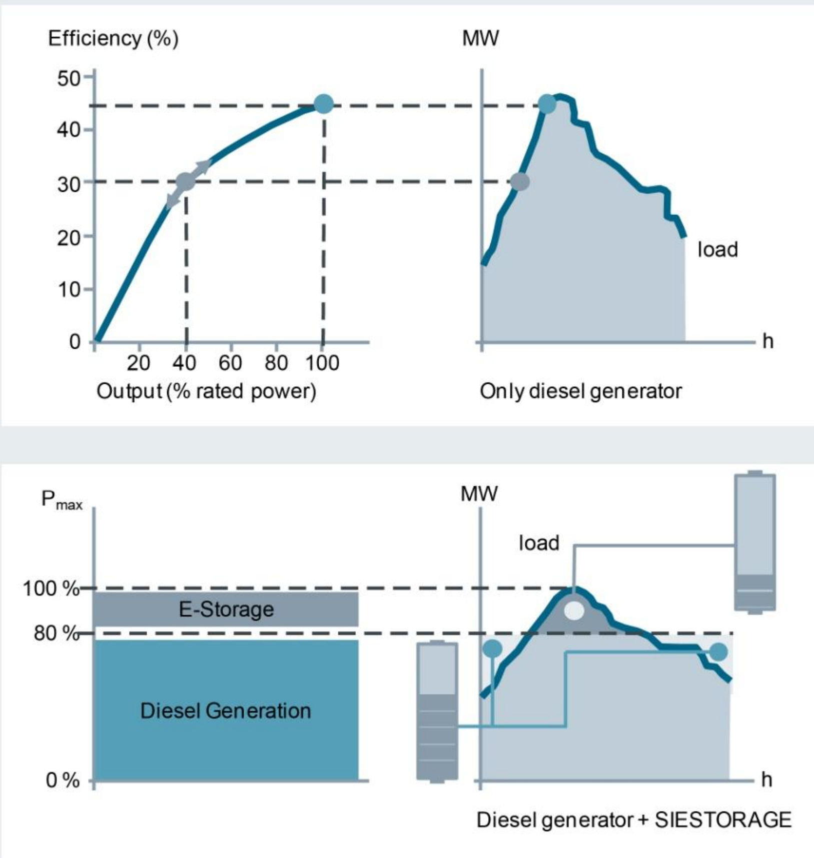
SIESTORAGE provides the solution

This modular electrical energy storage system from Siemens safeguards stable and reliable power supply. It integrates renewables and optimizes the usage of fossil generation to a modern eco-friendly grid.

SIESTORAGE combines cutting-edge power electronics for grid applications and high-performance Li-ion batteries.

The design of SIESTORAGE can be adapted to specific demands, and caters for a wide range of applications for port infrastructure.

Improvement of the size and efficiency of gensets



General planning

At the beginning of the planning process for a port power supply system, general technical solution options should be considered and the main components of the preferred solutions determined.

Medium-voltage switchgear

Medium-voltage switchgear can either be supplied in gas-insulated or air-insulated design. As a rule, gas-insulated switchgear needs less space than an air-insulated design. Gas-insulated switchgear requires no maintenance and can thus be evaluated more positively under life-cycle cost aspects.

Transformers

Transformers are available as cast-resin or oil-immersed transformers. Cast-resin transformers have a lower fire load and can thus be operated inside buildings without any problems. This means that medium voltage can be fed close to the load centers inside the building. Additional ventilation allows the cast-resin transformer rating to be increased by 40 %, which enables emergency power to be supplied in the event of a fault.

Oil-immersed transformers are less expensive and have lower no-load losses, but they must be operated outdoors.

Low-voltage distribution

In fixed-mounted design, the load feeder, comprising protective and switch units, is fixed-mounted into the low-voltage distribution board. In the event of a fault, the defective device must be isolated, mechanically removed and replaced. A restart is necessary.

The withdrawable unit design is the ideal solution when a high availability of feeders and quick adjustments of the power supply system are required. The load feeder comprising protection and switching devices is mounted inside a cassette or drawer which includes the associated wiring. Connection to the power supply and the control interface is made by movable contacts. In the event of a fault, the entire drawer is pulled out of the switchboard and replaced by an identically constructed unit during operation. This reduces downtime to a minimum.

Connections

Due to their design, cables have a much higher fire load than busbar trunking systems. In particular in port terminals the fire load should be kept as low as possible. Another advantage of busbar trunking systems is their variable adaptability to changes in use*). Busbar trunking systems consist of copper or aluminum bars, which are guided in a metal casing by means of spacer bolts. Apart from the spacer bolts and paint finish of the metal casing, there is no combustible material.

Since the equipment is powered from the busbar trunking using tap-off units – which can be placed elsewhere at any time during ongoing operation*) – it is easier to design routes and make wall/floor openings in flame-proof design. The costs of maintenance and operation are lower, since the protective components of the load feeders are placed inside the tap-off units. When tap-off units are moved, these protection and switching components go along with them.

Communication

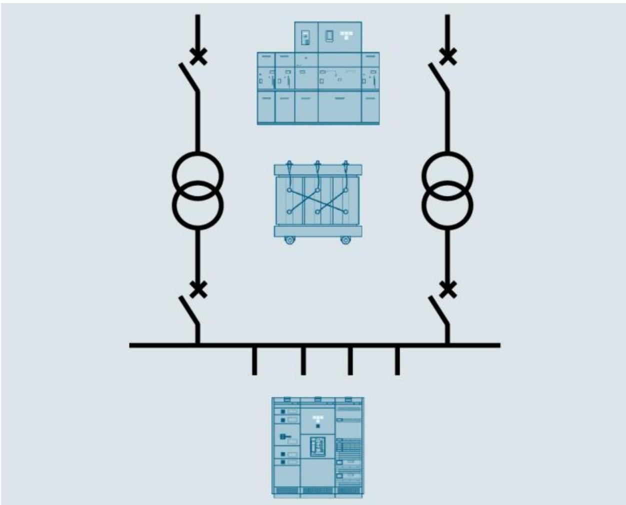
Basically, it is only possible to locally test and operate conventional power distribution systems. Therefore, measured values can only be acquired manually.

Communication-capable power distribution systems can be interfaced with operator control and monitoring systems at control desks. The status of the protective components can be detected and visualized, remote circuit-breaker switching is possible from the control desk. Besides status acquisition and control, measured values can also be taken, displayed and archived. The display and archiving of measured values relating to power distribution will become ever more important in the future, since characteristic energy values are based on these measurements – kWh per passenger or per TEU, kWh per sqm storage or reefer container.

*) In accordance with EN 50110-1 (VDE 0105-1); please always observe national regulations and standards.

General decisions at the start of planning

	Switchgear systems	
Gas	⟷	Air
	Transformer	
Dry-type	⟷	Oil-immersed
	Low-voltage distribution	
Withdrawable unit	⟷	Fixed mounting
	Connections	
Busbars	⟷	Cables
	Communication	
	Measuring / Control	
Yes	⟷	No



Energy consumption characteristics

As planning proceeds through its various phases from the establishment of basic facts and preliminary planning to the invitation to tender individual works and services, the technical and economic criteria are becoming increasingly refined and this is reflected in the general requirements.

Since these values are unique worldwide, they are suitable as reference values for existing ports.

Planning criteria

Planning electric power distribution as part of the port as a whole must fulfill defined principles.

First of all, the structure of power distribution shall be out-lined. Where are the load centers? Where shall the transformers be placed? How shall the individual supply systems – normal supply, emergency power supply, uninterruptible power supply – be designed?

When evaluating the availability and safety of the power supply to be installed, operational concerns as well as governmental stipulations must be included. Terminal Operating System (TOS), the beacons and all related safety and security equipment must never be without electricity, this makes emergency power supply as well as uninterruptible power supply mandatory. Inside the terminals, the emergency lighting, selected equipment and the lifts – as a minimum requirement – need to be connected to an emergency power supply system.

Planning criteria

Medium-voltage / low-voltage requirements	
Planning criteria	**Tendering**
▪ System configuration ▪ Availability / safety ▪ Protection against overcurrent (short-circuit, overload) ▪ Voltage drop ▪ Protection against electric shock (personal protection) ▪ Selectivity ▪ EMC (electromagnetic compatibility) ▪ Requirements imposed by the Safety Authority	▪ Cabling ▪ Manpower ▪ Cables ▪ Busbars ▪ Transformers ▪ Switchgear cabinets ▪ Protective devices

Protection against overcurrent includes the rating and setting of the circuit-breakers, miniature circuit-breakers and fuses. The short-circuit current calculation and the load flow calculation form the basis for this rating.

In accordance with EN 50160 and EN 16001, respectively, the operating voltage present at items of equipment in industrial plants must be in Electromagnetic Environment Class 2 within a tolerance band of ± 10 % of the normal operating voltage (230 V / 400 V AC). This requirement may necessitate a higher cable cross section with long cable routings.

Protection against electric shock implements the requirements placed on personal protection. Protection against electric shock is attained from a suitable earthing concept (Safety Class I) or by insulation (Safety Class II).

If there is a fault in the electric supply system (short circuit, overload), only that device is to trip which is directly upstream of the fault location. This applies to "communal facilities", i.e. areas where people congregate, or other customer-specified areas. This requirement is called selectivity. This criterion ensures that a short circuit in a socket, for instance, does not completely interrupt the power supply for the entire building corridor or even the whole building.

The observance of limit values for electromagnetic compatibility (EMC) protects third-party systems against electrical radiation which might cause faults. Problems arise in 50-Hz systems in case of incorrect earthing concepts for the power sources. This can be noticed, for instance, from crackling noise during loudspeaker announcements.

Besides the usual standards in the port sector, the specific requirements of the local Safety Authority must also be considered.

Planning ends with the tender specification for the electric power distribution system. This tender specification describes all the equipment – such as cables including dimensioning, length, design and installation type, busbar systems and their lengths and tap-off units, transformers including dimensioning and technical requirements; switchgear cabinets including their switching and protective devices, mounting instructions and technical requirements – as well as the manpower required for the complete installation, testing and acceptance procedure.

Diagram of a port-specific power distribution concept

Reliability of supply and availability are the principal requirements placed on electric power supply in all parts of a port. Generally, the feed-in systems are laid out redundantly, starting from a simple load transfer reserve (standard safety, e.g. yards, etc.) to an immediate reserve in the medium-voltage network or substations with safety supply (high safety, e.g. for terminals and shipping area, reefer container, etc.) up to the substations with safety power supply and uninterruptible power supply (maximum safety, e.g. for the beacons, IT (TOS), etc.; see diagram "Electric power supply design principles for a port").

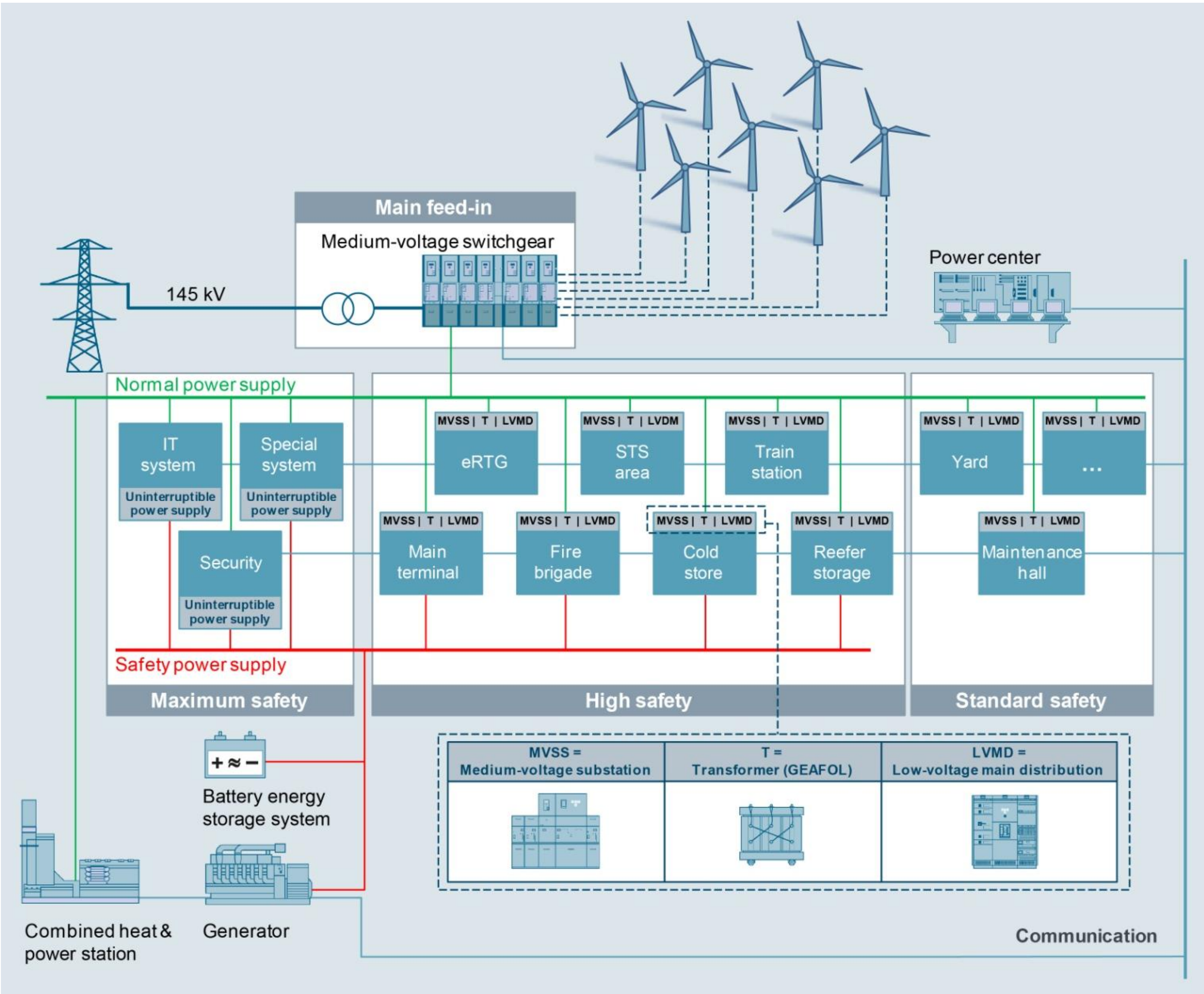
In this context, national standards and standards on the erection of electrical installations, International Maritime Organization (IMO) standards and customer/operator requirements must also be observed.

Depending on the power and energy demand, these feed-in systems can also be supplied directly from the medium-voltage grid of the line-side transmission system operator, from in-facility transformer substations (≤ 145 kV), or even from the ultra-high-voltage grid (≤ 400 kV).

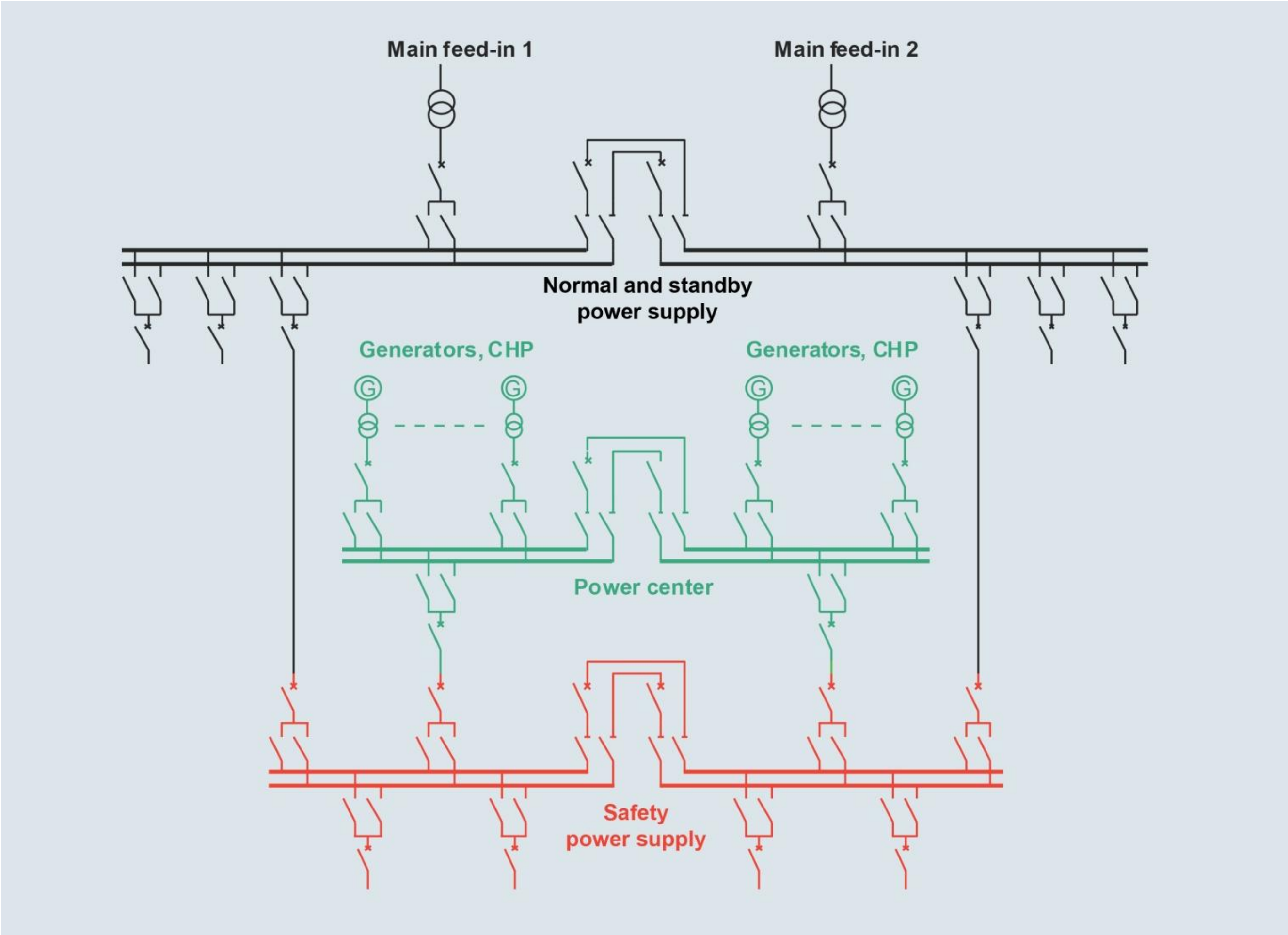
In-facility generation of any form of electrical energy on the port premises is comprised under the term of power center. Dependant on the degree of reliability of supply and the operating philosophy of the sub-ordinate medium-voltage distribution grid with its substations – even under fault conditions – the main feed-in systems and/or power centers are designed as single or double busbar system with several busbar sections. In case of central safety and standby power supply, several medium-voltage rings or lines are built up strictly separated according to their function as normal and standby power supply or safety power supply.

In addition to the generating units required for safety power supply, more power generating systems such as combined heat and power stations (CHP) and renewable energy sources such as photovoltaic systems, wind turbines, geothermal energy etc. can be integrated into the power center.

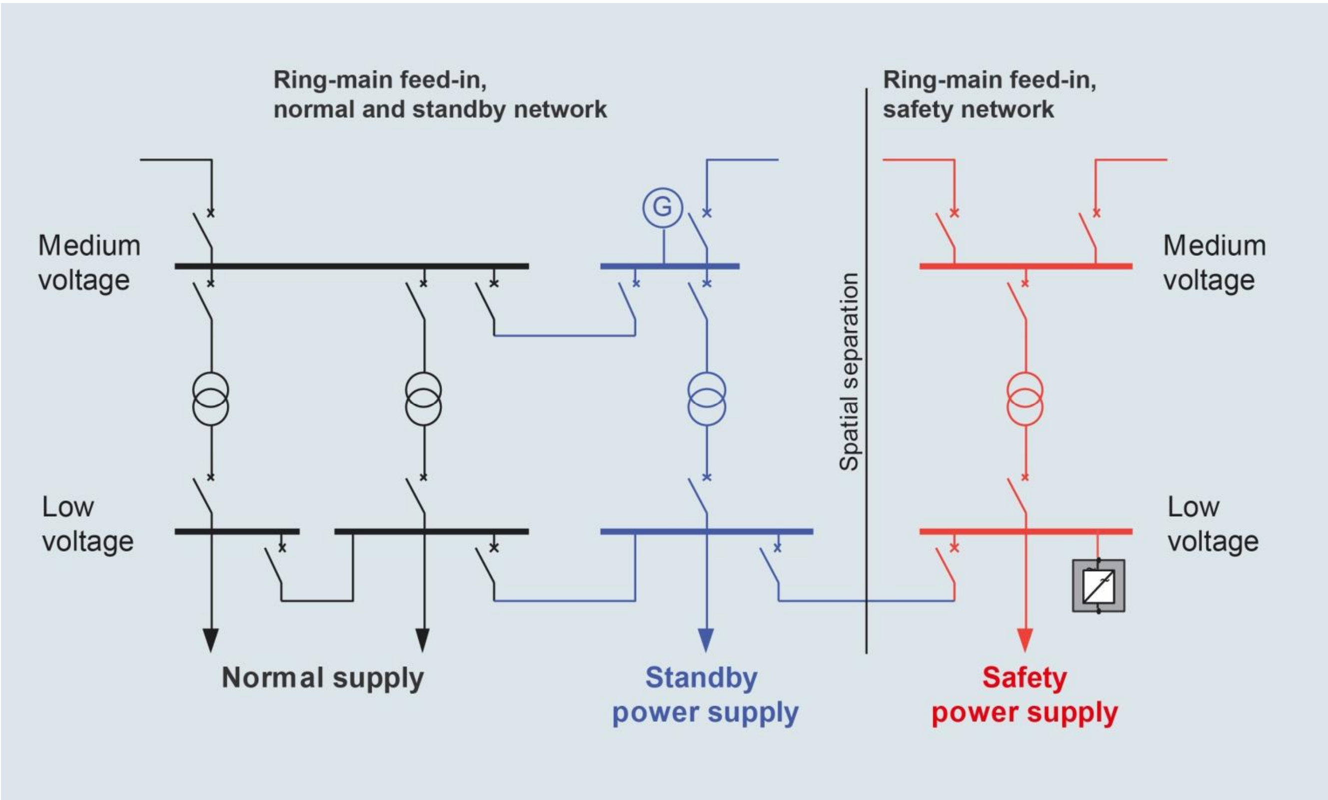
Electric power supply design principles for a port



Example for a main feed-in system with power center



Example for the layout of a substation in the maximum safety category



According to their importance and the supply philosophy of the system operator, the sub-ordinate substations in the medium-voltage rings are either designed as switches or circuit-breakers. This affects operation of the medium-voltage grid:

- as load transfer reserve with open rings or lines in case of switch design
- as immediate reserve with closed rings or lines with circuit-breaker design and appropriate protection

The layout of the substations themselves and their spatial allocation, or separation, must be matched according to their supply reliability and relevance (see diagram "Example for the layout of a substation in the maximum safety category", page 14, bottom).

Instrumentation and control

Depending on the size of the port, its power supply system will attain a dimension and an energy consumption that equals that of a small or medium-size town. However, much higher requirements are placed on its reliability of supply and reliability in general. The greater complexity of its substations is not to be neglected either. For this reason, the tasks of power system management are more diverse and complex. This, in turn, necessitates a high-capacity instrumentation and control system (I&C).

In addition to the aspect of supply reliability, the acquisition of energy flow data within the power system using measuring technology – on the medium- and low-voltage side – will play an increasingly important part in order, for instance, to use equipment to capacity, establish power consumption, allocate cost centers, and more.

A substation control system from the SICAM system is the right solution for small and medium-sized ports.

Larger ports should be controlled with the Spectrum Power control system for grids.

In addition, Spectrum Power has a forecasting function. This enables an energy demand forecast, as required by energy suppliers.

Operator control and monitoring

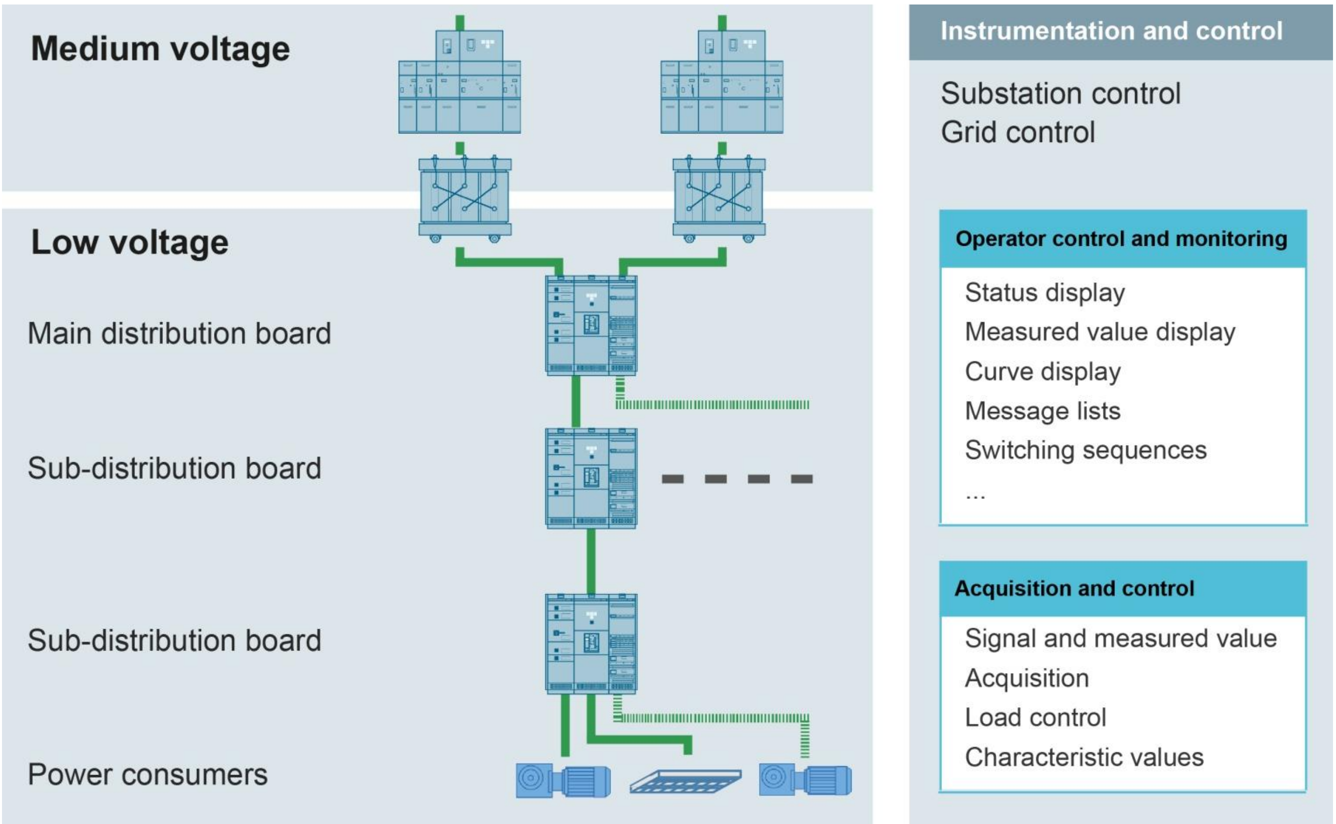
The electric power distribution system is operated and monitored from the I&C system. The operating and monitoring software is based on standard operating systems and standard applications. It has special features for the visualization and control of electric power distribution by means of measured value displays and the representation of switch component statuses. A fault and signaling log contains limit-value violations of measurands and documentation of switching operations from the control desk or on site. The graphic presentation of measured values in the form of curves is also part of the functional scope. Automatic switching sequences can be saved event-controlled, i.e. in case of a cable defect in open-operated ring systems, operation is automatically switched over to the unaffected half of the ring and supply is restored.

The advantage of closed-operated ring systems and their corresponding protection systems (cable differential protection) is that cable faults do not result in an interruption of supply. A status message allows cable repair measures to be initiated quickly.

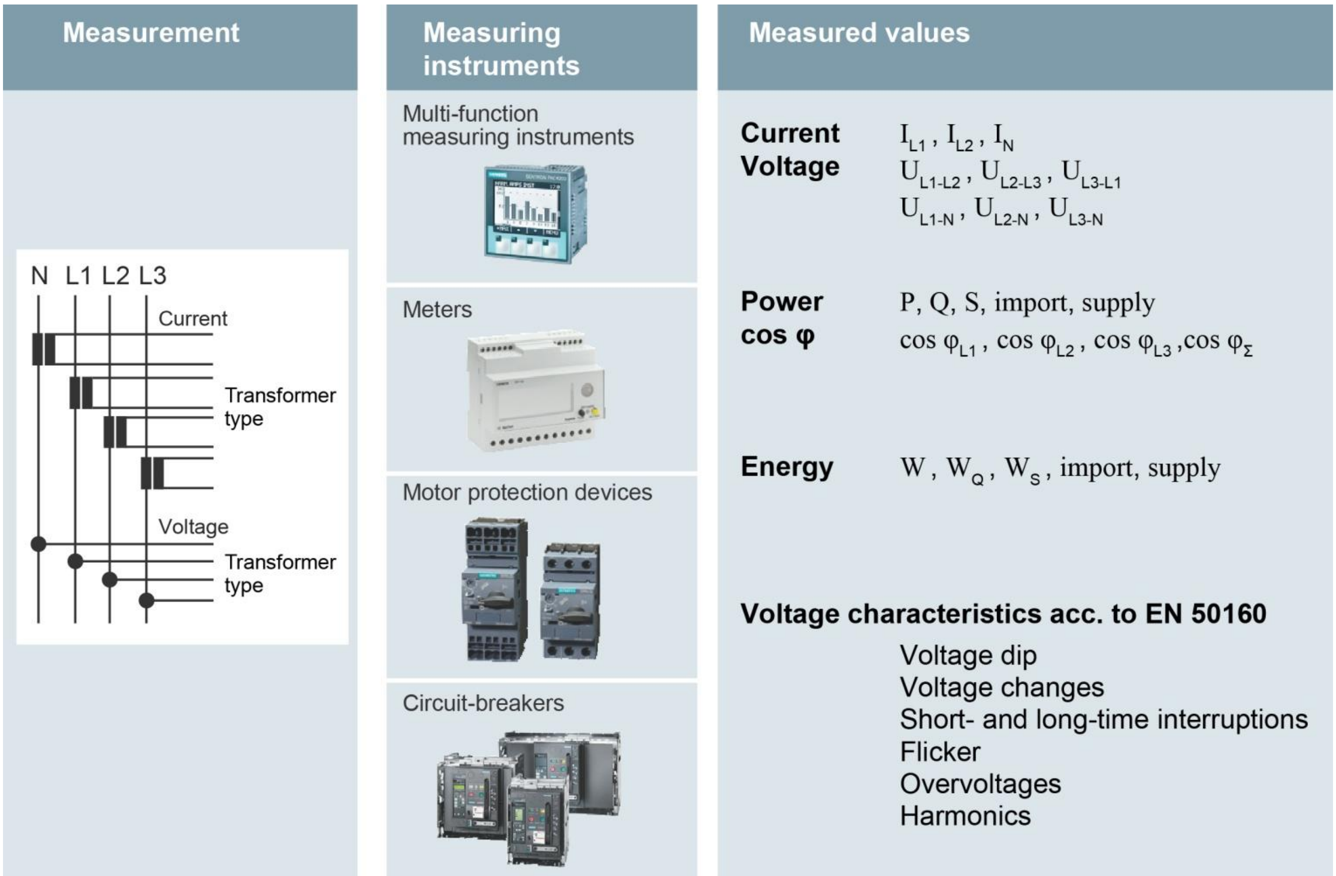
All data is stored in archives and can be exploited for cost-center allocations, utilization profiles, reserve evaluations etc. Furthermore, characteristic values, such as utilization as information about the ratio of overload current to maximum operating current, can also be created.

The special communication requirements of electric power distribution systems are specified in the IEC 61850 standard and IEC 60870-5, respectively.

Instrumentation & control for electric power distribution



Measurement procedures in electric power distribution



Measurement

Within the electric power distribution system there is only the option to take measurements of current and voltage. At the low-voltage level, voltages are directly applied to the measuring instruments; in case of higher voltages, voltage transformers are used which standardize to voltages in a measurement range of 0 to 100 V.

Currents are connected to the measuring instruments via current transformers. The currents to be measured are standardized to 1 A or 5 A.

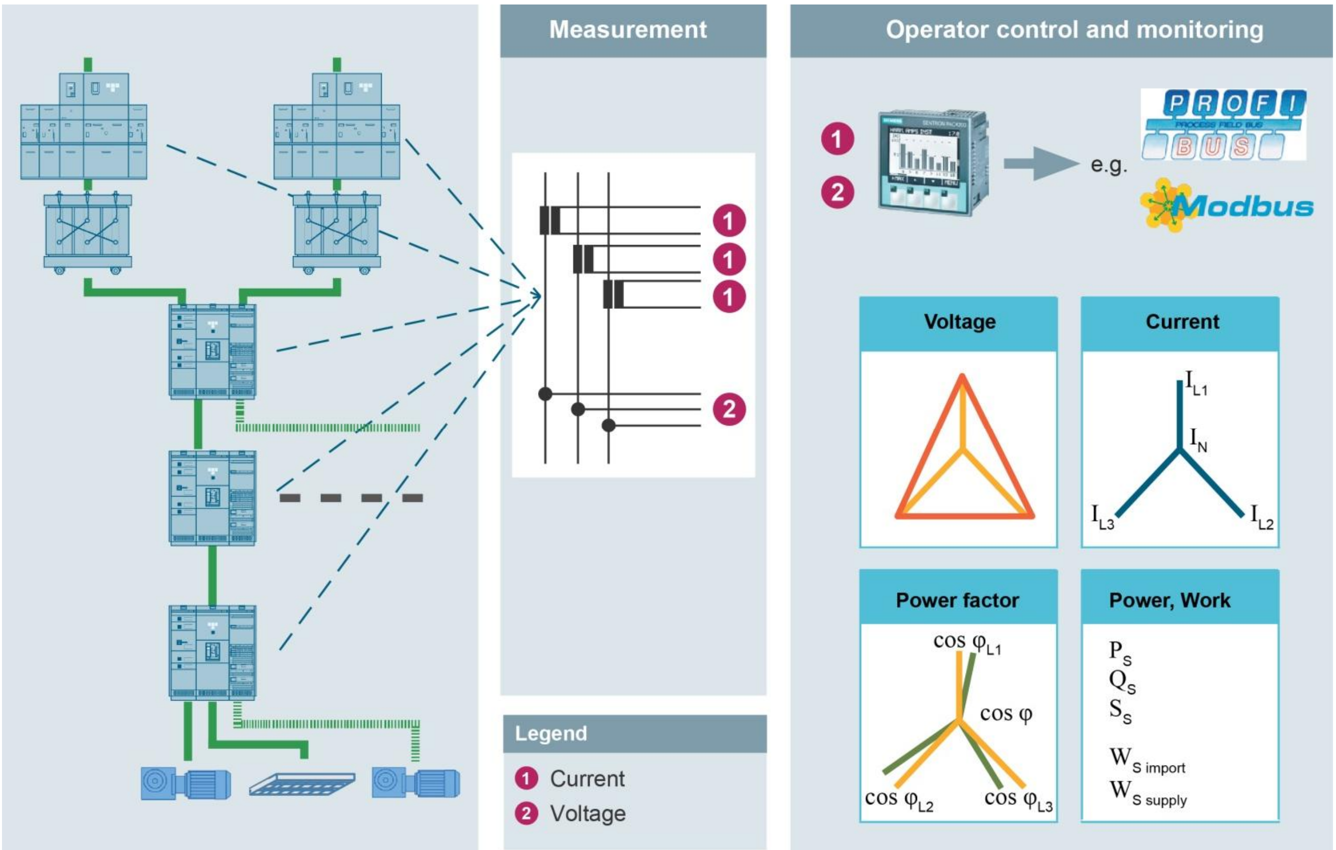
Measured values can be displayed as analogue values, as standardized signals (0 – 20 mA / 4 – 20 mA / ±10 V / pulses) or transmitted through an interface.

Equipment such as

- SENTRON 3VA molded-case circuit-breakers
- 3WL air circuit-breakers
- multi-function measuring instruments from the SENTRON PAC series or SICAM P
- motor protection using SIMOCODE
- SIPROTEC medium-voltage protective devices

can deploy measured values on a data interface. This data interface is supported by various protocols such as PROFIBUS, Industrial ETHERNET, BAC-Net, Modbus and IEC 61850.

Measurement procedures in electric power distribution systems



Status acquisition and control

Within the electric power distribution system, there is the option of performing the status acquisitions and control of switching devices from an operator control and monitoring system.

The auxiliary current switches for the digital signals "ON" / "OFF" / "tripped" can be optionally ordered or retrofitted into existing distribution systems. If withdrawable unit types are used, an additional signal 'Unit in operating position' can be implemented.

It is also possible to use a motorized operating mechanism for remote switching of circuit-breakers. This enables on-and-off switching and a reset after a breaker trip.

In many cases, circuit-breakers also feature off-switching by means of voltage or undervoltage releases. This switching is faster, since the voltage-undervoltage coil directly acts on the tripping mechanism.

When tripping on voltage is used, off-switching is performed by applying a voltage. When tripping on undervoltage is used, the breaker switches as soon as the voltage is interrupted. With this type of switching, the device always goes to OFF when the voltage is interrupted.

Characteristic values

Characteristic values, in particular characteristic energy values, assist in evaluating buildings, installations and users. They provide a good basis for making comparisons of different time ranges or comparable facilities.

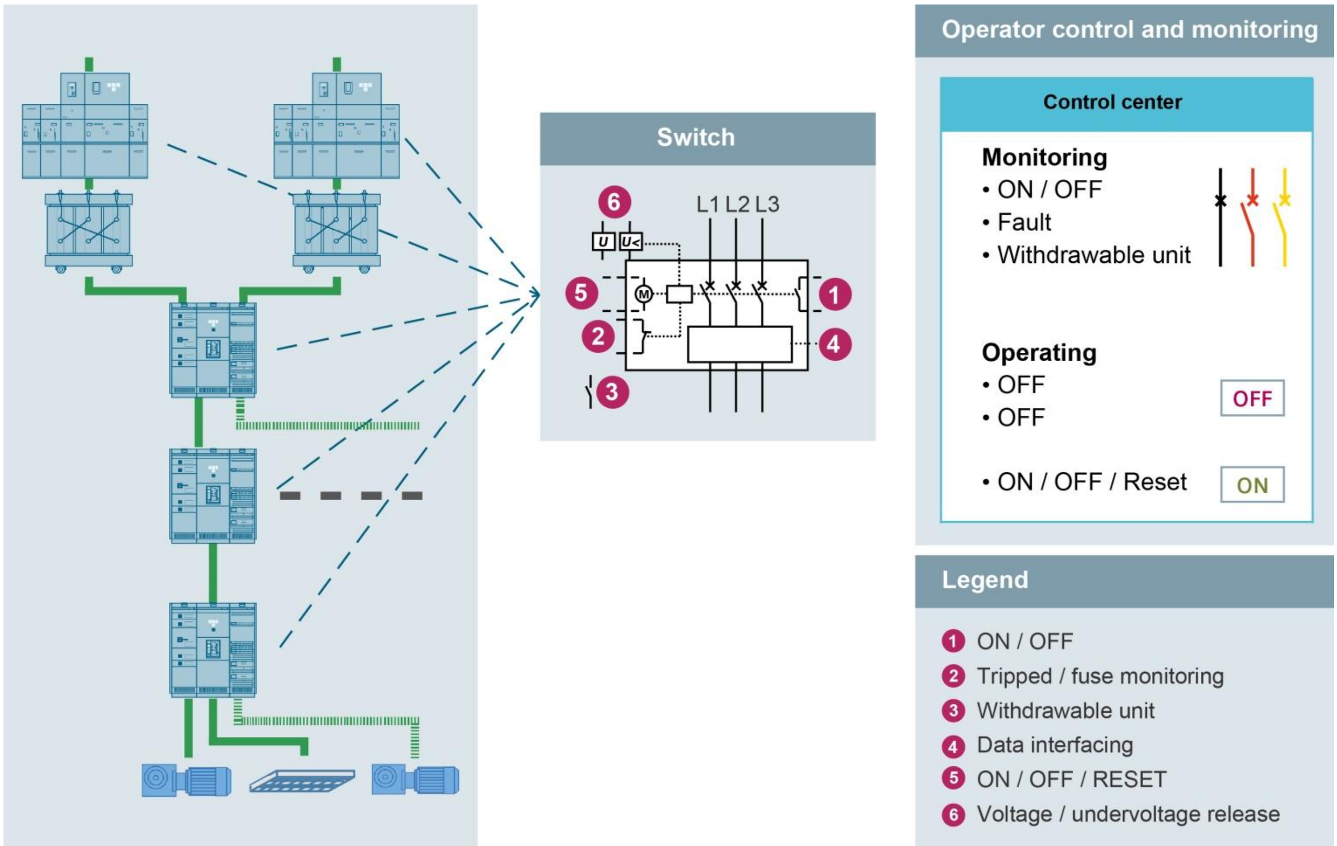
The energy purchase of the entire port, accumulated over one year as related to the number of passengers and / or cargo moved over the same period allows a comparison with previous years or other ports to be made. The same calculation and evaluation can also be applied to the heat consumed and to parts of the port property, such as terminals and buildings.

The analysis of energy consumption characteristics and the associated areas of the port produce a characteristic value which represents the energy efficiency of the port or its individual buildings.

The period of use is a characteristic value for the utilization of energy feed-in, but it can also be called on to analyze a generating unit.

The period of use is calculated from the quotient of total energy over e.g. 12 months and the highest load during this period (period of use: H = Work [kWh] / Pmax [kW]).

Status acquisition and control of electric power distribution systems

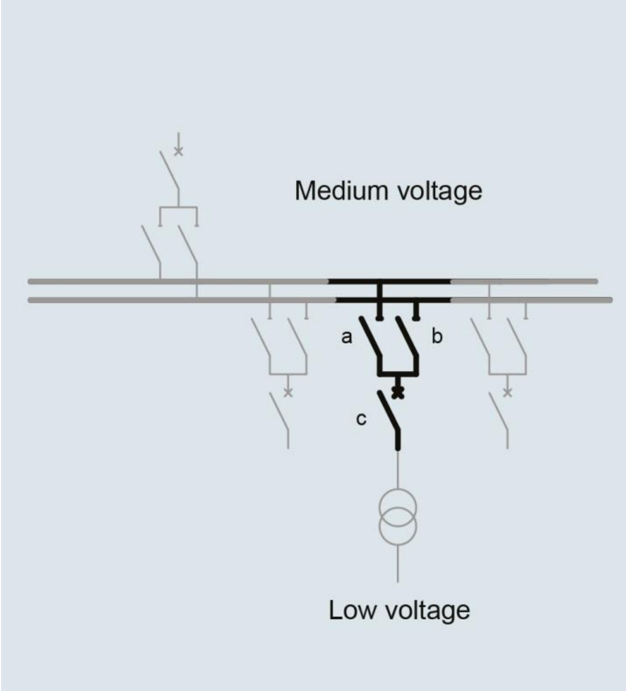


Selected examples:

Low-voltage feeder at the double busbar system

Inside ports, double busbar systems are common in the main power feed-in systems and in the power center. However, this redundancy is not carried on at the low-voltage level. The low-voltage feeder is connected by a combination of two disconnectors and a circuit-breaker.

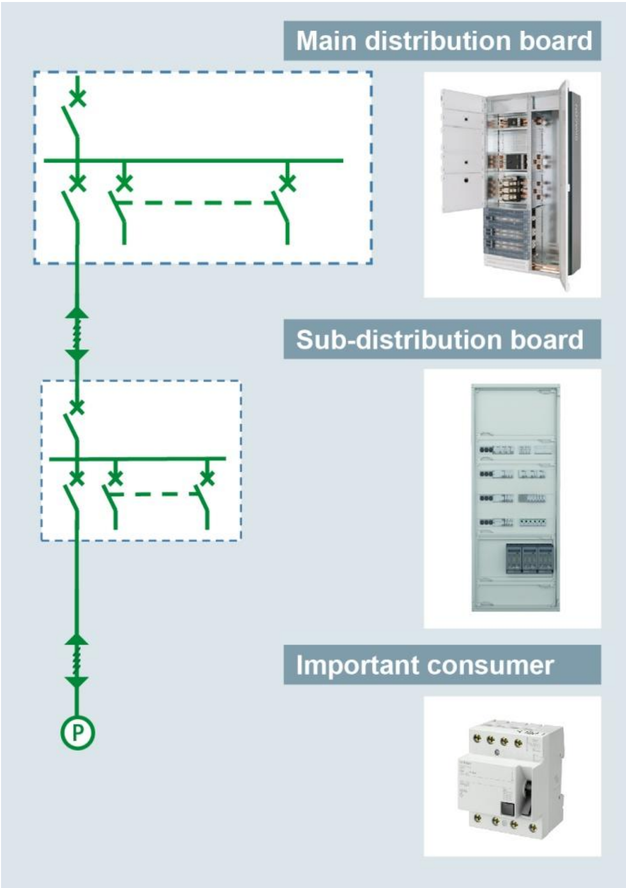
Both disconnectors (a and b) are interlocked in such a way (either / or), that only one busbar is enabled to supply the circuit-breaker (c) and thus the low-voltage feeder. The circuit-breaker (c) takes on transformer protection (also see "Example of a main feed-in system with power center" on page14).



Direct supply of important power consumers

Electricity supply to dedicated low-voltage power consumers (loads) is divided into lines. In each main distribution board, every line is assigned to one feeder. In the sub-distribution system, which is placed on the port premises close to the power consumer, every consumer is supplied through its own protective and switching device combination.

This method of supply corresponds to a radial network. A cable must be laid from the sub-distribution board to every important power consumer.



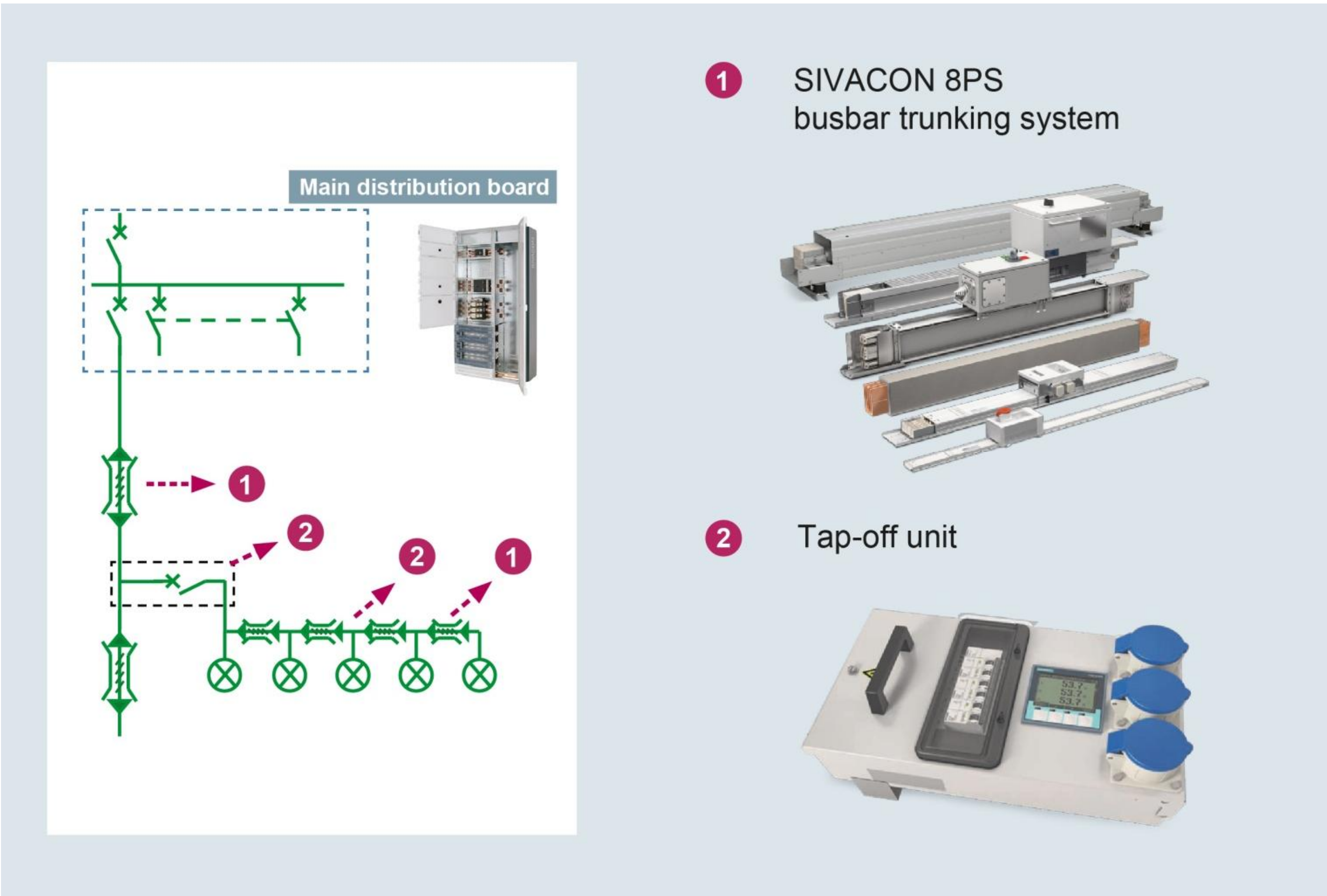
Use of busbar trunking systems

Busbar trunking systems are supplied from a feeder of the main distribution board. Each of the power consumers in the busbar system is supplied from a tap-off unit, in which the protective components for feeder protection are accommodated.

These features bring about a simple, clear-cut network topology. New requirements placed on the distribution, arising during use, retrofitting of new tap-off units or shifting of existing tap-off units is easily possible at any time*).

A variety of type sizes from 40 A to 6,300 A, a high degree of protection and a low fire load make busbar trunking systems the ideal supply systems for ports.

*) In accordance with EN 50110-1 (VDE 0105-1); please always observe national regulations/standards.

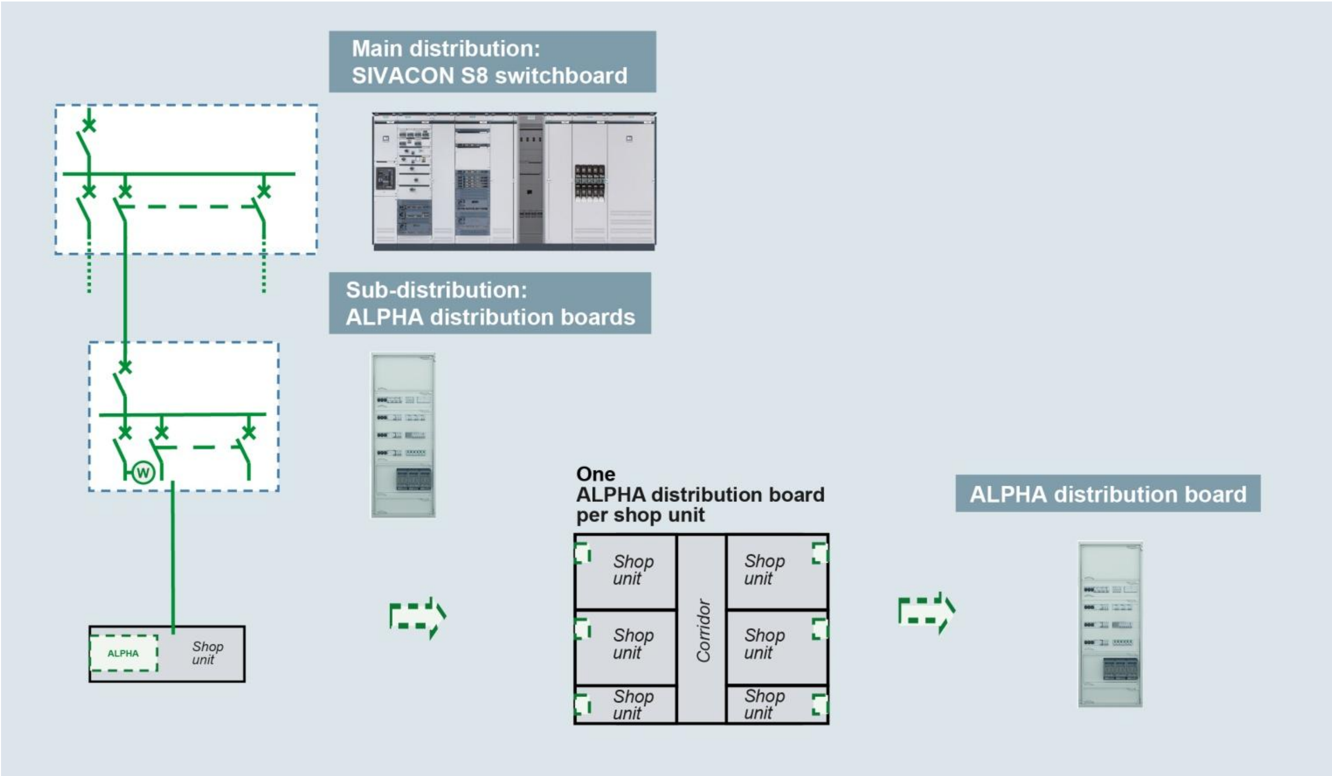


Supply concept for shop areas

Shop areas, e.g. in cruise terminals should be highly variable in terms of tenancy structure. It must be possible to quickly adapt these areas to changed tenancy sizes and power demand quantities. A common practice is splitting up the shop areas into fixed units, which are combined if required.
Every shop unit is equipped with an ALPHA distribution board which has a feed-in unit. Any further method of distribution is up to the tenants, who can design the distribution inside the ALPHA distribution board according to their own requirements. When a new tenancy is begun, the new tenancy structure can be implemented quickly.

The ALPHA distribution boards are supplied from sub-distribution boards. This is where the energy metering unit is to be installed as standard. This measurement allows for user-oriented energy billing.

Supply concept for shop areas in the port cruise terminal area



Supply concept for floor box sockets

... With distribution cube

Each floor box is power-supplied by distribution cubes in the false floor via two independent supply cables (3 x 2.5 mm²) cut to length that can be plugged from one side. The cubes themselves are wired through feeder leads to the tap-off units with integrated miniature circuit-breakers in the false floor. They are situated on the centrally routed busbar in the corridor. Each cube feeder lead is always assigned to one specific 1-pole miniature circuit-breaker.

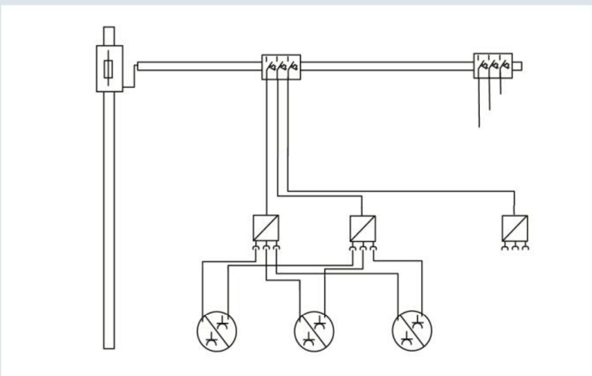
... With direct connection to the busbar trunking system

Each floor box is directly supplied from two independent supply cables (3 x 2.5 mm²) cut to length that can be plugged from one side. The supply cables are plugged directly into the tap-off units of the busbar in the false floor. This busbar is located at a central position, here in the corridor. On every busbar tap-off unit there are three plug points wired to one 1-pole miniature circuit-breaker.

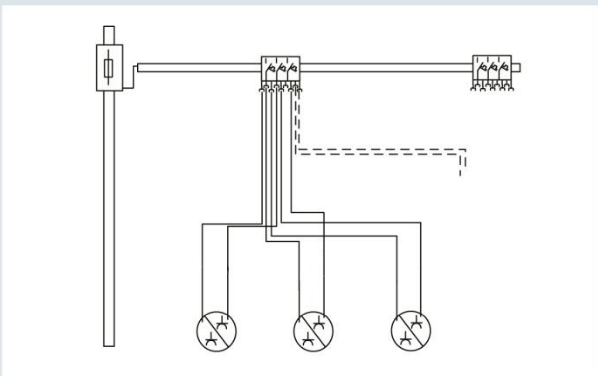
The supply concept for floor box sockets featuring direct connection to the busbar trunking system has the following advantages:

- Selectivity evaluation between protection of the floor box sockets to the super-ordinate feeder protection of the main supply busbar in the rising duct is simplified.
- The short-circuit current carrying capacity of the protective devices in the tap-off unit of the corridor busbar trunking can – under certain circumstances – be reduced in some areas compared to centrally located protective devices in the central distribution spot close to the rising zone. This solution result in cost savings when implementing VDE 0100 Part 410: "Use of RCDs (residual current-operated device) in socket circuit up to 20 A”. Moreover, this resolves space problems arising from the integration of RCDs into busbar trunking tap-off units.
- Selectivity in case of earth faults is limited to few feeders, a back-up fuse for the RCD can be abandoned. When the RCD trips, the switched miniature circuit-breaker to be reclosed is right there in the corridor at the level of the tripped floor box, i.e. at the workplace.
- Due to the fixed spatial assignment of the floor boxes to tap-off units, the operating personnel can respond more quickly when trying to locate the tripped protective device. It is no longer necessary to perform a time-consuming search in the architectural diagram for electrical installations, trying to identify those circuits and assign them to the distribution board plan.

Low-voltage feeder at the double busbar network



Supply concept for floor box sockets with direct connection



Floor box

BD01 busbar tap-off unit with miniature circuit-breaker

BD01 busbar tap-off unit with miniature circuit-breaker and prepared plug connection points

Distribution cube with plug connectors

Busbar tap-off unit

Main supply busbar in the rising duct

Totally Integrated Power –

Power for challenging environments – Reliable. Safe. Efficient.

Siemens has accumulated nearly 170 years of know-how in the field of electric power generation and distribution.

From power stations and generators, units for further power distribution including the required protective and switching components, and transformers, and down the line to switches and sockets, Siemens can offer a wide range of products.

Portfolio for electric power distribution

	Connecting		Switching and protecting			Energy automation	
High voltage > 52 kV	Overhead line						
High voltage > 52 kV	GIL *)		Transformers oil-immersed		Power transformer	Protecting, controlling and monitoring	SIPROTEC, SICAM
Medium voltage 1 kV – 52 kV	Overhead line		Switchgear	Gas-insulated	8DA / 8DB NXPLUS C NXPLUS C Wind 8DJH / 8DJH 36		
Medium voltage 1 kV – 52 kV			Switchgear	Air-insulated	8BT1 / 8BT2 NXAIR SIMOSEC		
Medium voltage 1 kV – 52 kV	Cables		Transformers	Cast-resin	GEAFOL		
Medium voltage 1 kV – 52 kV / Low voltage < 1 kV	Cables		Transformers	Oil-immersed	TUMETIC		
Low voltage < 1 kV	Busbar trunking systems	SIVACON 8PS	Power distribution boards		SIVACON S8		
Low voltage < 1 kV			Distribution boards		ALPHA		
Low voltage < 1 kV			Drives		SINAMICS SIMOTION		

*) GIL: gas-insulated transmission line

Electric power distribution

High-voltage transformers

The power transformers linking high- and medium-voltage grids are standardized oil-insulated transformers. Rated voltages up to 145 kV and transmission capacities up to 63 MVA (with forced-air cooling up to 100 MVA) are feasible.

Medium-voltage switchgear

Gas-insulated (SF_6) medium-voltage switchgear is factory-assembled, type-tested and requires no maintenance. It is available in single-phase encapsulated or 3-phase encapsulated panels in single or double busbar design and gas-tight for decades. 3-phase encapsulated design versions are based on the well proven completely welded, stainless steel tank concept.

Air-insulated medium-voltage switchgear is type-tested featuring 10-year-plus maintenance intervals.

Furthermore, the individual type series differ in the type of partitioning and their options as regards add-on modules and block-type design.

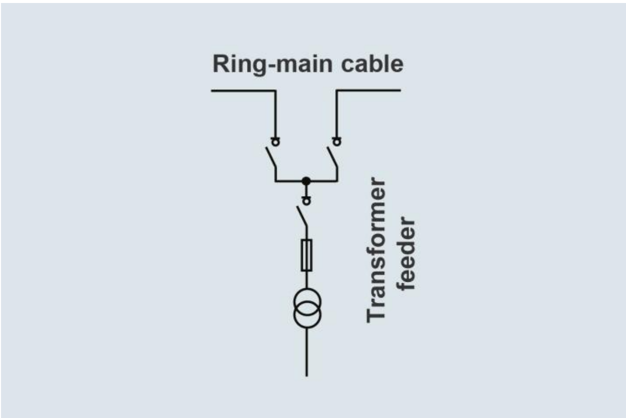
Gas-insulated medium-voltage switchgear

Type series	Rated voltage up to	Max. busbar rated current	Short-circuit current
8DA / 8DB	40.5 kV	4,000 A	40 kA
NXPLUS C	24 kV	2,500 A	25 kA
NXPLUS C Wind	36 kV	1,000 A	20 kA
8DJH	24 kV	630 A	20 kA
8DJH 36	36 kV	630 A	20 kA

Air-insulated medium-voltage switchgear

Type series	Rated voltage up to	Max. busbar rated current	Short-circuit current
8BT1	24 kV	2,000 A	25 kA
8BT2	36 kV	3,150 A	31.5 kA
NXAIR	17,5 kV	4,000 A	50 kA
NXAIR	24 kV	2,500 A	25 kA
SIMOSEC	24 kV	1,250 A	25 kA

Small transformer feed-in systems as provided by the transmission system operator are supplied by ring-main cable panels. They consist of a combination of switchgear – comprising two ring- main feeders and a transformer feeder. If this transformer feeder serves as a point of supply from the transmission system operator to the customer, then the medium-voltage side transformer feeder is extended by a metering panel. This metering panel contains current and voltage transformers and the kW-meter.



Ring-main cable panel

Distribution transformers

GEAFOL dry-type transformers are cast-resin-insulated and thus flame-retardant and self-extinguishing. They do not emit toxic gases in case of fire, thus fulfilling the highest safety category. This high quality standard is also demonstrated in absence from partial discharge up to double the nominal voltage. This substantially adds to their long service life. The use of external ventilation (cross-flow fan) can enhance the nominal power rating of the GEAFOL transformer up to 40 % without any impairments on its service life. In case of plant faults, emergency supply can thus be provided by the existing equipment pool.

GEAFOL transformers are available up to an operating voltage of 36 kV and a transmission power of 16 MVA.

Oil-immersed transformers of the TUMETIC series are designed with a hermetically sealed tank without conservator.

Oil-immersed GEAFOL transformers are available up to an operating voltage of 36 kV and a transmission power of 2.5 MVA.

More info: www.siemens.com/geafol

Low-voltage switchboards and switchgear cabinets

SIVACON switchboards are design verified in accordance with IEC 61439-2, arc-fault-tested for maximum personal safety, earthquake-resistant, certified for marine applications and available up to IP54 degree of protection. Within this system, feed-in panels, couplings and feeders in fixed-mounted design, plug design or withdrawable-unit design can be implemented. Feeder design may also be mixed, if required.

The SIVACON S4 type series is a pure delivery transaction. This means, the components and assembly kits are purchased from Siemens and assembled on site by a qualified installation company.

SIVACON S8 switchboards are rated for an operating voltage of 690 V and a maximum rated current of 7,000 A.

SIVACON switchboards are equipped with SENTRON switching devices. They ensure safe switching and protection of the feeders and power consumers.

More info: www.siemens.com/sivacon-s8

Low-voltage sub-distribution boards

The ALPHA product range comprises small distribution boards, meter cabinets, wall- and floor-mounted distribution boards as well as molded-plastic distribution systems. ALPHA distribution boards are rated for an operating voltage of 690 V and a maximum rated current of 1,600 A.

The SENTRON technology for low-voltage switching and protection provides a well-matched device range in the ALPHA distribution boards for line protection, personal and fire protection, lightning current and overvoltage protection as well as equipment and plant protection.

More info: www.siemens.com/alpha

Low-voltage busbar trunking systems

SIVACON 8PS as a no-maintenance, type-tested busbar trunking system is flame-retardant self-extinguishing and is thus characterized by maximum safety. These systems are rated for an operating voltage up to 1,000 V and a maximum rated current of 6,300 A.

More info: www.siemens.com/busbar

SIVACON 8PS busbar trunking systems

Type series	Rated current	Type of construction
BD01	40 – 160 A	Ventilated system
BD2	160 – 1,250 A	Ventilated system
LD	1,100 – 5,000 A	Ventilated system
LI	800 – 6,300 A	Sandwich system
LR	400 – 6,300 A	Cast resin system

Protecting, controlling and monitoring (energy automation)

SIPROTEC protective devices are the basis for energy automation. They cover the functional scope of overcurrent-time protection, differential protection, distance protection, generator and motor protection, transformer differential protection and busbar differential protection. Besides their protective function, SIPROTEC protective devices also handle measurements of electrical quantities and control functions of the switchgear.

SIPROTEC protective devices are configured and parameterized in an application-specific manner. They can be easily and flexibly adapted to current plant requirements. In addition, SIPROTEC devices also take on automating functions such as interlocking of switching devices if required. Users are enabled to create their own automation solutions with the integrated graphical logic editor. SIPROTEC provides powerful analysis options for fast analysis of operational malfunctions.

The SICAM and SPECTRUM power substation and grid control systems are operator control and monitoring systems featuring data archiving and special functions for energy automation, which typically are the management of switching sequences / interlocks, the monitoring of power quality, load management, generator management, synchronizations, and busbar coupling.

More info:
www.siemens.com/siprotec
www.siemens.com/sicam

Energy optimization

Building installations

Building management systems are responsible for the economic efficiency, safety, security and convenience inside a building. The GAMMA *instabus*-KNX building management system controls the lighting, shading, and room temperature.

Building control systems

Siemens offers a comprehensive product portfolio for the entire field of building control. This starts with heating, ventilation and air conditioning systems and their signal acquisition and automation components, safety systems including fire alarm systems as well as monitoring and video surveillance systems through to building contracting.

Lighting

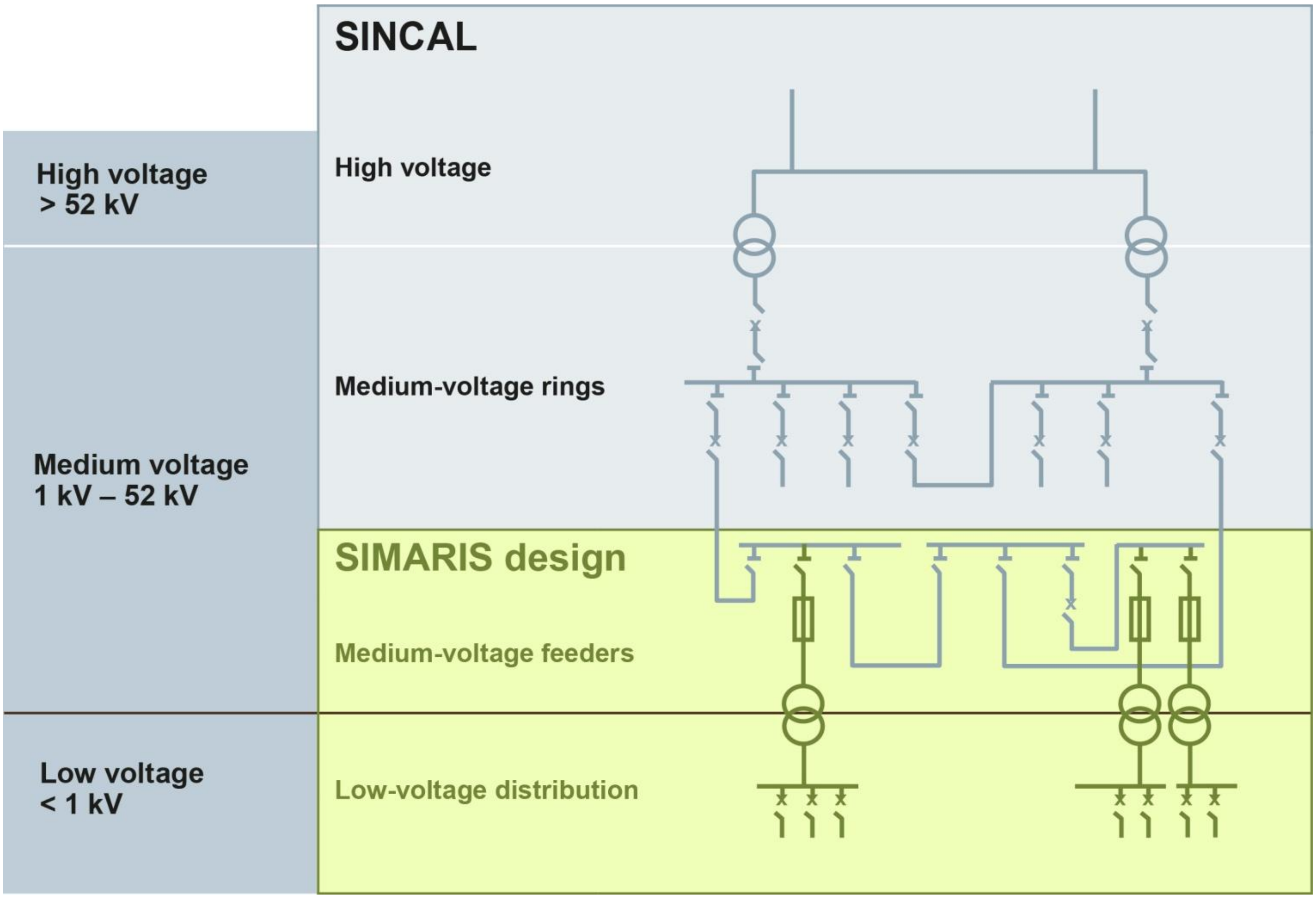
In the field of building lighting, as well as field and navigation lighting, the use of modern luminaries with effective luminous elements provides for a substantial saving potential. Navigation lighting is mentioned here as an example: navigation lights using LEDs as luminous elements require 65 % less energy compared to halogen-type luminous elements. Considering the numbers of lights required, this is a saving potential that should not be underestimated.

Drives

In process automation, such as in the container transport system, energy-saving motors and soft starters are available for jerk-free starting. If material quantities are not to be conveyed or moved continuously but in variable quantities, then speed-controlled drives are an absolute must for their energy-efficient operation.

Planning tools

Planning tools support electrical designers in both designing the electric power distribution system and in adhering to the statutory provisions.



SINCAL

PSS®SINCAL (Siemens Network Calculation) is a comprehensive, high-end power system analysis software solution for the simulation, evaluation and optimization of supply grids. It is not only capable of calculating radial networks, but can also calculate ring and meshed networks. Besides the analysis of symmetrical loads, the software also handles unsymmetrical loads.

Whilst SINCAL is mainly used at the high-voltage level and for medium-voltage grids, gas, water, and heating supply grids can also be calculated.

SIMARIS design

SIMARIS design is a power system calculation and dimensioning software for radial systems from medium-voltage feed-in to final consumers. It facilitates electrical planning, including short-circuit current calculation, on the basis of real products with minimum input.

In addition, the power system design software supports the calculation of short-circuit current, load flow, voltage drop and energy balance.

SIMARIS planning tools provide efficient support

It has never been easy to plan electrical power distribution systems for commercial, institutional and industrial buildings. This requires a lot of know-how and experience. Having an experienced partner at their side enables electrical designers to implement their conceptual knowledge faster and more easily and focus on what is important. To this end, Siemens renders comprehensive support with the SIMARIS design, SIMARIS project and SIMARIS curves software tools as well as with technical planning guides. This support ranges from the preliminary planning stage through to implementation planning.

Planning power distribution

The SIMARIS design dimensioning software for planning electric power systems determines an assured solution according to the accepted rules of good installation practice and all applicable standards (VDE, IEC) based on the specific requirements of the power distribution system. This solution is derived from the versatility of our product portfolio – ranging from medium-voltage feed-in to the power consumers.

Suitable components are selected automatically. Time-consuming research into specific product data in catalogs is a thing of the past.

Our free-of-charge SIMARIS project software tool helps you create configuration documents for suitable distribution boards and their associated protection and switching devices in a fast, easy and transparent way reflecting the space and budget requirements of the project. In addition, you can output a complete tender specification text in GAEB D81 or RTF format (either in German or English).

Our free-of-charge SIMARIS curves software visualizes the characteristic tripping curves and their tolerance bands related to the low-voltage protective devices and fuses (IEC). In doing so, device parameter settings can be simulated. Characteristic cut-off current and let-through energy curves are also available for display and documentation.

More info: www.siemens.com/simaris

Integration is the key

In cooperation with the electrical designer, Siemens develops solutions for power distribution in ports which take into account all operator requirements from the outset. Here, a single supplier provides the well-matched products and systems for an integrated solution. The following projects may serve as examples for the effective use and great benefit of Totally Integrated Power for power distribution at ports:

Reference project: Lübeck Port / TransAtlantic

Solution:

- SIHARBOR solution of 6.0 kV with complete integration of all the components in a container
- Shore side connection point at the jetty wall

Results:

- Complete integration from a single source
- Reduced noise and vibration in the neighbourhood
- Reliable and secured energy supply to the ships

Reference project: Qatar’s new Hamad Port

A megaproject, with a sizeable energy management package Siemens’ E-Houses are customized, fully equipped modular power substations for a fast and reliable power supply. They accommodate a comprehensive portfolio of medium-voltage switchgear, low-voltage switchboards, power management and auxiliary systems. This allows for fast and easy installation and can be upgraded, using available space optimally. They offer a time-efficient and cost-effective alternative to conventional site-built substations for a wide range of applications.

Flensburg Shipyard

Solution:

- Compact and flexible containerized solution with complete integration of the components erected at a height of 8 meters.

Results:

- Complete integration from a single source
- Reduced emissions
- Reduced noise and vibration in the neighbourhood
- Reliable and secure energy supply for the ships
- Saved energy costs during generator tests

SIESTORAGE installations at the grid of ENEL (Italy´s largest energy supplier)

- Installation and commissioning in 2012 – 1 MVA/500 kWh
- Reduced construction risks and reduced installation time
- Power supply solution including substation equipment (transformers...)
  Energy automation and integration into the grid

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