

SIEMENS

Ingenuity for life



**Reliable, efficient
and future-proof power
supply concepts**

**Professional power system consulting and
planning services from trusted experts**

siemens.com/power-technologies/consulting

Electricity systems are changing faster than ever

A well-structured, highly reliable energy-related infrastructure is vital for the functioning of our society and economy and is one of the most important elements of any profitable energy related business. Cost-efficiency, power quality and reliability, along with sustainability and resource-efficiency, are the main demands on today's energy systems.

With the ongoing trends of decarbonization, decentralization and digitalization, these goals are threatened by challenges such as fluctuating infeed from renewable energy generation, increased low and medium-voltage grid infeed from distributed energy generation and so-called prosumers, aging power grids and generation equipment, and market liberalization. At the same time, the emergence of new technologies, like storage and new concepts for system design and operation requires new technical solutions and also impacts the established business processes. In this environment of challenges and change, system operators and stakeholders are facing disruptive opportunities and risks which necessitate transparent and specific evaluations of potential value propositions and new planning and operation principles.

New technological solutions and concepts, such as virtual power plants, decentralized energy systems or micro grids, but also meshed high-voltage alternating current (HDAC) and high-voltage direct current (HDVC) power transmission systems, as well as flexible AC transmission system (FACTS) technologies for AC network stabilization, are becoming mature, economic and widespread. New components, network design approaches, and communication technologies are being introduced – finally transforming the grid into a highly digital and automated smart infrastructure.

Proven professional support from power system experts is vital in this promising, but demanding environment. Thorough understanding of the current trends together with insight into the latest technological advances needs to be applied in the concrete context of the relevant projects, in order to be able to ensure the "old" – but still valid – values of security, reliability and efficiency in electricity systems. Comprehensive insight of the use-cases, processes and challenges in today's power grids is essential to provide customer-specific solutions and concrete added value.

A strong partner for reliable and efficient power grids



Broad experience secures success: ~1000 international projects per year



Large team of consulting experts: Proven processes and rapid results



Leading PSS^{®1)} Portfolio software ensures simulation and modeling accuracy



Global offices provide local support in project execution and beyond



Renowned experts innovating technologies and technical standards



Knowledge base for digitalization and innovative energy system solutions



Access to business strategy consultants ensures profitability of investments



Vendor-neutrality for independent decision making and flexibility



Long-term partnerships and direct access to grid consultants

¹⁾ PSS: Power System Simulator

Siemens is a world leader for innovative products, solutions and services that ensure highest efficiency and reliability of power grids. The Siemens PTI team draws upon more than 60 years of experience and continuous innovations in power system planning. We provide vendor-neutral consulting, allowing us to customize our services for maximum flexibility and cost-effectiveness. With our leading simulation software, strong competencies in energy business advisory and with regional offices around the world, Siemens PTI offers a comprehensive portfolio to master the transition to a new energy reality.

Diverse challenges arising from a transforming energy landscape

1 Integration of renewable energy sources

Successful integration of renewable energy sources (RES) into distribution grids relies heavily on effective planning and operational strategies. Our offering includes:

- Techno-economically optimized RES placement and integration
- Distribution system analyses to ensure reliability and stability
- Interconnection studies to ensure compliance with grid codes
- Business case studies to leverage (new) businesses, roles and applications

2 Designing of distributed energy systems

If properly designed, distributed energy systems allow for a more efficient, highly resilient and sustainable power supply. Our integrated design approach covers:

- System definition: data acquisition and aggregation
- Generation analysis: simulation of generation mix
- Network analysis: grid concepts and simulations
- Supply system analysis: interactive integration of generation and network analysis for optimized system design
- Detailed implementation roadmap

3 Optimized voltage control

Through increasingly decentralized generation, compliance of the voltage quality of public networks becomes more and more challenging. We derive the optimum solution based on technical reliability and cost-efficiency:

- Determining the number, type, properties and possible location of newly required voltage regulation equipment
- Coordination with existing control systems
- Solution based on an optimization model and innovative software



4 Strategic distribution grid planning

Due to the energy transition, many grid owners are facing several challenges to maintain secure and economical grid operation. We provide support in:

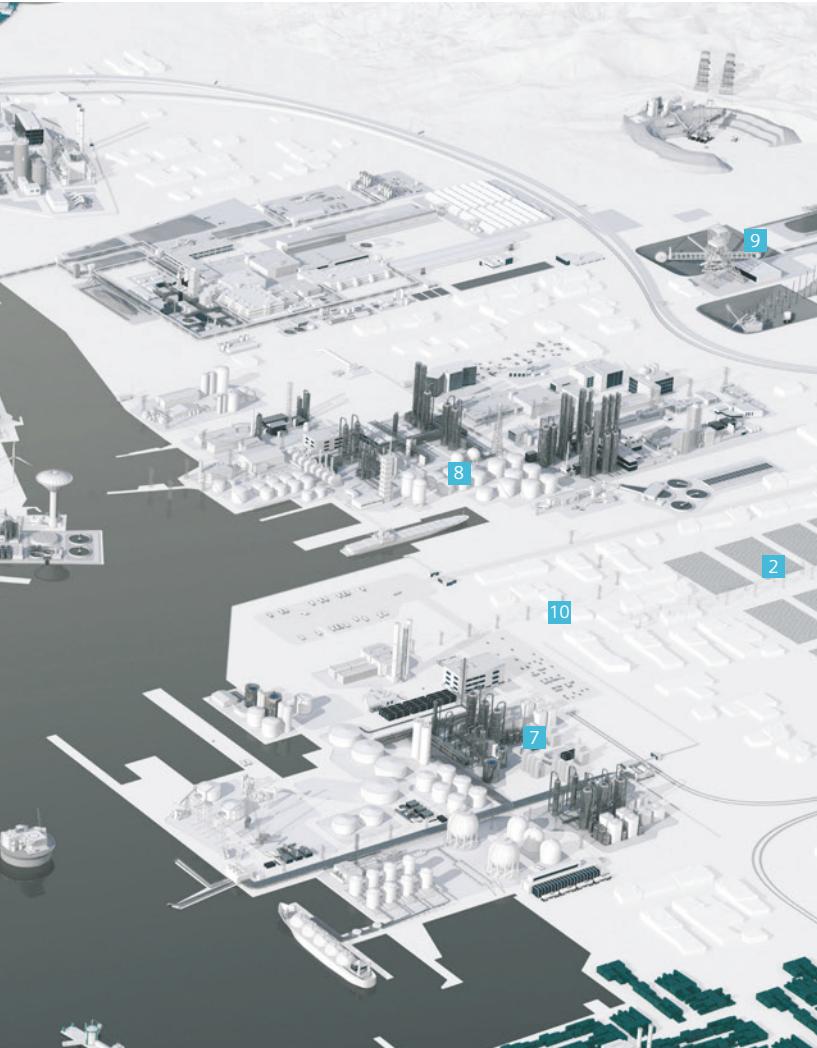
- Identifying weak points in the existing system
- Designing an optimal grid concept
- Verifying appropriate system performance
- Developing optimized grid concepts and investment plans
- Reducing costs by using standardized equipment and suitable asset management strategies

5 Grid access and grid code compliance

When connecting new generation units to the transmission grid, interconnection criteria and grid codes have to be met in order to safeguard the system's operational performance. Our services include:

- Verification of grid code compliance considering all relevant operating scenarios
- Assessment of interactions with the power system
- Definition of suitable measures to ensure stability
- Training for operational personnel to increase efficiency

Across all voltage levels, the performance of our power systems is challenged by the integration of new technologies, increasing grid interconnections and changing regulatory frameworks.
Backed by Siemens' knowledge base for modern technologies and digitalization, our consultants support customers in achieving their technical and economic targets.



6 Power system dynamics and machine modeling

To meet the high demands on grid stability as well as safe and efficient operation, a variety of control tasks needs to be performed. We can offer support with:

- Controller and machine measurements
- Highly accurate dynamic modeling and analysis
- Identification of the optimum positioning of controllers and of controller parameters
- Demonstration of the effectiveness of the control strategies

10 Protection security assessment

Protection systems are crucial for system security. Quickly changing operating conditions make it a complex task to calculate, verify, and validate protection settings. With SIGUARD® Protection Security Assessment (PSA) we offer:

- Simulation of selectivity, sensitivity and speed of the protection system performance for different operating conditions
- Performing fast protection security assessments for reliable protection-setting determination
- Protection system improvement by rule-based correction or system-wide optimization of settings

9 HVDC in power systems

HVDC is the technology of choice for transporting large amounts of power over long distances. We are your partner in planning new HVDC applications by providing:

- Assessment and verification of HVDC solutions for long-distance power transmission
- Solutions for grid coupling and system stability improvement
- Analyses of the impact on frequency and voltage stability and definition of suitable control strategies
- Dynamic analyses of island grids with HVDC as main infeed and verification of black start capability

8 Power quality in industrial power supply

Power quality related problems can lead to interruptions and damage to grid assets, resulting in costs for the operator. Our services include:

- Power quality measurements with high resolution and automated data transfer
- Continuous remote monitoring of harmonic and transient phenomena
- Development of mitigation measures (e.g. grid optimization, harmonics filter design)

7 Energy supply concepts for industry

Industrial power supply deals with conditions that are more extreme than in typical public systems. Still, high power quality is required to ensure reliability of the industrial processes. Our studies include:

- Utilization of equipment according to relevant standards
- Determination of appropriate circuit arrangements, voltage levels, and switching and protection devices
- Evaluations of arc flash, motor start, harmonic resonance, shunt compensation, series compensation, power quality, voltage flicker, stability and efficiency

Successful partnerships which create sustainable value

Backed by in-depth project management skills and practice-proven processes, our expert consultancy services deliver distinct studies that meet all quality, time and budget objectives. Learn about some of our project examples and how we have supported our customers in enhancing their power supply systems.



Strategic roadmap for Egypt's national transmission grid

- Digital model for simulating grid scenarios as part of the megaproject for the expansion of the Egyptian power system
- Grid expansion improving overall performance and dynamic stability
- Full-spectrum system approach

Highly reliable power supply for Titan cement plants

- Complete data survey, documentation and modeling of the power and protection system
- Performance assessment of the existing system and development of new improved grid structures
- Know-how transfer in customized workshops

Development of customer-oriented business models

- Increasing digitalization of low-voltage networks offers new business opportunities
- Guided business ideation and modeling, identification of new value propositions for consumers
- Analysis of business model costs revenue streams and viability

"The Masterplan project performed by Siemens PTI not only gives insight into the future development of the Egyptian Transmission Grid, but also supports EETC engineers in their planning tasks through knowledge transfer."

Eng. Khaled Abdelkareem H. Mohamed, EETC,
Board Member for Studies and Design, Egypt

"Siemens PTI delivered a comprehensive project report. The study results provide valuable information and verified measures for further improving our power system's reliability."

Amaxopoulos Christos, Titan Cement
Company, Electrical Department Manager,
Group Engineering & Technology, Greece

"Together with Siemens, we developed new, innovative business ideas based on our longstanding experience in the field of network operation and digital technologies. With their technical-economic knowledge and ethodological competence Siemens supported us to achieve a transparent view on possible business opportunities."

Giorgio Di Lembo, Enel Global I&N, Head of
Remote Control and Protection Solutions, Italy

Technical expertise and a broad range of services for pinpoint solutions

Siemens offers a unique combination of industry leading expertise and software that can successfully deliver on our customer's needs across the complete lifecycle of projects and power systems. In customer projects, experts from the various fields in power system engineering work together to meet the requirements of any individual project.

Portfolio	Steady-state analyses <ul style="list-style-type: none">• Calculations and simulations of present grid structures and configurations• Development and performance validation of alternative structures and configurations• Neutral grounding concepts and configurations• Grounding system design• Technical-economic analyses ensuring profitable business models	Dynamics <ul style="list-style-type: none">• Modeling and analysis of the dynamic performance of equipment, e.g. generators and motors• Power electronics modeling and analysis including AC/DC power converters, HVDC or FACTS• Modeling and performance analysis of controllers• Assessment of the impacts of transmission congestion
Transients <ul style="list-style-type: none">• Modeling and analysis of overvoltages and other transient phenomena• Analysis of switching actions and their impact on system performance• Evaluation of voltage stresses• Determination of appropriate insulation levels for equipment and systems	Protection and control <ul style="list-style-type: none">• Development of suitable protection schemes• Coordination of protection devices• Development of appropriate settings for protection relays• Dimensioning of instrument transformers• Concepts and configuration of equipment for communication, automation and control	Power quality <ul style="list-style-type: none">• Measurement, evaluation and analysis of power quality-related phenomena, especially harmonics• Filter design and performance validation• Analysis of interferences from power supply systems on other networks and systems

Services	Consulting studies Modeling, analysis and optimization of power systems	Advisory services Continuous and rapid support from a dedicated grid consultant	Technical workshops Know-how transfer in customized hands-on training
Grid data management Improving the automated interoperability of power system data for planning, operation, protection, asset management etc.	Disturbance investigation Post-event disturbance analysis and proposal of suitable mitigation measures	Field measurements Measurements of specific soil resistivity and harmonics on-site	Expert testimony Expert testimony in technical discussions with other stakeholders

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