

HITACHI
Inspire the Next



HITACHI ENERGY

Solving tomorrow's challenges today

Power consulting



 **Hitachi Energy**

Safe, reliable, clean, and cost-effective electricity is paramount to your bottom line success.

Table of contents

004 - 005	From generation to consumption
006 - 007	Meeting the challenges of the modern grid
008 - 009	Grid modernization
010	Regulations and policies
011	Physical and cyber security
012	Climate change
013	Evolving business models
014	Emerging economies
015	Asset management
016	Disruptive technologies
017	Power Consulting: your local expert worldwide
018 - 019	Case studies
020	References and contact information

From generation to consumption

Power Consulting understands your electric power challenges

Unique challenges call for unique solutions, and the first part of problem solving is knowing what you're up against.

The energy industry is in the midst of rapid change, which create new challenges for our customers to face. Currently, there are many disruptors such as decarbonization, decentralization, and digitalization that are shaking up the industry. Power systems need to be prepared for this inevitable change.

From generation to consumption, our consultants can help customers meet the challenges of the modern grid with their extensive knowledge and diverse experience in power systems. Our team has extensive digital simulation expertise, develops specialized software, and uses a variety of commercially available power system software modeling packages. In addition, we utilize proprietary Hitachi Energy-developed software for specialized analysis of power systems and associated economic and financial analyses.

Hitachi Energy Power Consulting works with customers to create unique solutions that cater to the customers' needs. Our consultants operate as an independent organization that is product- and system-agnostic with deeply embedded knowledge of technologies, standards, and local grid codes worldwide. Together, we can work together to identify your challenges and recommend solutions for your specific needs.

Mitigate risks. Maximize performance. Optimize operations.

- Feasibility and system impact studies
- Economic analysis and project justification
- Business model impact analyses
- Analysis of upgrade vs. replacement strategies
- Transmission capability and utilization analysis
- HVDC and FACTS applications
- AC/DC interactions
- Economic and stability impact of increased penetration of variable renewable energy, centralized and distributed
- Industrial systems reliability analysis and improvements
- Asset life-cycle management
- Distribution systems planning
- Grid modernization planning and investment
- Power quality studies
- Rail and transportation studies
- Cyber security
- Electric railway transaction assessments
- Maintenance operations assessments
- Earthing studies
- Technical training
- Smart cities planning
- E-mobility Infrastructure Planning & Integration



Meeting the challenges of the modern grid

Many of the technologies on the grid were deployed more than a half-century ago, at a time when concepts like renewable energy or the widespread use of air conditioning were only vague dreams. The demands of today's power systems require judicious use of new technologies integrated with old.

Who could imagine the physical and cyber security challenges organizations would face in our modern world? Or the opportu-

nity to improve operational efficiency through increased grid intelligence? Or the types of business models that open up when technologies like distributed energy resources blur the line between producer and consumer?

In the following pages, we'll explore eight areas where Power Consulting is helping organizations address these unique challenges to capitalize on great opportunities.



An aerial photograph of a city skyline, likely New York City, taken from a high vantage point. The image shows a dense cluster of skyscrapers, many of which are illuminated with warm yellow lights, suggesting dusk or night. In the background, a large body of water is visible, with a small island or peninsula in the distance. The sky is a pale, overcast grey. The overall scene conveys a sense of a bustling, modern urban environment.

Modernizing the U.S. electrical grid is essential to reducing carbon emissions, creating safeguards against attacks on our infrastructure, and keeping the lights on.” Ernest Moniz, U.S. Secretary of Energy¹.



Grid modernization

Integrating the old with the new

Aging assets. Increased penetration of renewables. Shifting power usage demands. Distributed energy resources. New regulations. The increasing stresses on the grid seem almost endless. While the goals of the grid, such as operational efficiency and grid resiliency, haven't changed, meeting performance targets is becoming more challenging.

Reliability

Even a momentary interruption of power can endanger lives and impact local economies. Yet, as demand goes up in developing regions and the nature of loads becomes more challenging, avoiding blackouts and brownouts, even in countries with advanced grid technologies, becomes more difficult.

Efficiency

Improving grid efficiency by just 5% would eliminate the fuel and greenhouse gas emissions from 53 million cars². In addition, the best sites for new renewable generation are often far from the load centers for which they are intended. New, high-efficiency lines are needed to reach these population centers.

Stability

Renewable sources of energy, such as wind and solar, can create potentially destabilizing power fluctuations on the grid. Even so, as more traditional sources reach end of life, renewables are vital to meeting the world's future energy needs. Even the nature of stability concerns is shifting from the traditional concerns of stability between power plants, to the stability of loads, the stability of generation lacking inertia, and the stability concerns arising from various power electronic devices controlling nearby voltages.

The Smart Grid can reduce emissions by 60 to 211 million metric tons of CO₂ a year by 2030.³

Resiliency

Whether man-made or natural, disasters happen around the globe—and with seemingly increasing frequency. Many regional grids need to be modernized to minimize outages and ensure uninterrupted access to high-quality electrical power.

Laying a strong foundation

The best way to prepare for an exciting, but unpredictable future is by laying a strong foundation. Power Consulting offers studies to help you analyze challenges and prioritize investments:

- Capital project planning
- Grid modernization planning and investment analyses
- Enterprise budget optimization analyses
- Generation and transmission systems adequacy assessments and planning
- System stability studies
- Root-cause analyses and disturbance simulations
- Energy market simulation, planning, and analyses
- Economic studies
- Feasibility studies



WHERE WILL YOU INVEST?

By 2030, 6.8 trillion (USD) will need to be spent on grid transmission and distribution to keep up with demand.⁴



Regulations and policies

All eyes are on the grid

As the number and complexity of industry regulations and policies go up—both locally and regionally—the costs and risk of non-compliance rise as well.

Around the globe, generation, transmission, distribution, and use of energy are under intense scrutiny. Executives must mitigate both monetary risks, (e.g., fines and lawsuits), and even personal repercussions (e.g., career disruption and personal liability) in a constantly changing regulatory environment.

Maintaining compliance while managing operational costs is a tough challenge for any organization. Because our consultants live and work in the geographies they serve, they understand the local challenges.

Here are some of the services we offer:

- Violation resolution and mitigation
- Asset management
- Compliance assessments and remediation
- Impact assessment
- Compliance project planning

In 2005, 3% of the world was covered by mandatory power efficiency regulations. Today, it is more than one third and growing.⁵



ARE YOU IN COMPLIANCE?

86% of global power executives are concerned or very concerned about the unpredictability of power regulations and policies.⁶



Physical and cyber security

Now is the time to prepare

Around the globe, there are millions of intelligent electronic devices on the grid, and the number is growing exponentially as new devices are introduced to the market. While these devices are a vital component of future energy- distribution models, each represents a potential security loophole.

However, risk is not limited to cyber space Substations and other potential grid weak spots are prime targets for pranksters and terrorists who seek to cause cascading system power failures.

Hitachi Energy Power Consulting can help you be better prepared. Our studies help organizations find ways to limit the damage and restore power as quickly as possible.

- System restoration studies
- Contingency simulations
- Analysis of interconnections and alternate power sources
- Communications infrastructure analysis

Globally, the cost of cyber crime in the energy sector is second only to the financial services sector.⁷



ARE YOUR SYSTEMS SECURE?

More than 40% of cyber attacks investigated by the U.S. Dept. of Homeland Security in 2013 were in the energy sector.⁸



Climate change

A clean energy future requires strategic thinking—today

Around the globe, governments are mandating the increased use of renewables to combat CO₂ emissions. Germany is one country leading the way. In 2021, 221 million tonnes of carbon dioxide equivalents were avoided through the use of renewables almost eight times as much as the savings in 1990.⁹

While good for the environment, increasing renewable penetration creates a number of challenges for utilities and industry including:

- Determining the best sites for renewable generation
- Evaluating the economic impact of site construction and power transmission
- Predicting output from sources like solar and wind
- Controlling power fluctuations and protecting grid stability
- Managing the decommissioning of traditional generation sources



ARE YOU READY?

The long-term temperature goal of the Paris Climate Agreement is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels and to achieve a climate neutral world by mid-century.¹⁰

To help utilities and grid operators meet renewable mandates while maintaining grid reliability, Hitachi Energy Power Consulting offers the following studies:

- Renewable site selection
- Assessment of potential impact on system reliability
- Generation replacement studies
- Analyses of potential reductions in NOX, CO₂, and other emissions
- Retirement planning for traditional generation sources
- Renewable integration studies
- Load studies
- Powerflow studies
- Voltage stability studies
- Dynamic stability studies
- Transfer limit studies
- Economic cost/benefit analyses
- Economic market simulation forecasting analyses



Evolving business models

New markets. New opportunities.
New challenges.

A number of technologies have the potential to change the way power is sold and consumed around the world. Distributed energy resources, such as rooftop solar, small wind farms, and microgrids, allow consumers to generate their own power as well as sell it back to the utility. This has given rise to concepts like transactive energy, which IEEE Xplore magazine editor, Mel Olken, describes as “an enabling environment for any number of users to partner with traditional providers to produce, buy, and sell electricity using automated control.”¹¹

For example, energy storage helps during peak consumption periods. Advancements in energy storage are causing regulators to take a fresh look at how they can allow utilities to charge for the service they provide. For example, the U.S.'s Federal Energy Regulatory Commission issued FERC 755, a ruling that implements a “pay for performance” plan where suppliers can charge more for power supplied by fast-responding sources like battery energy storage.



HOW WILL YOU ADAPT?

35% of power industry executives in Europe and 43% in North America say current business models are broken.¹³

In a global power and utilities survey, 94% of respondents said they anticipate a complete transformation or at least important changes to the power utility business model.¹²

Technology challenges are one thing. Business model challenges can be even harder to solve. You need business-savvy consultants who understand the technologies that contribute to viable economic roadmaps.

Power Consulting offers a number of systems studies to help you weigh options and anticipate potential hurdles:

- Distributed generation modeling
- Reliability analyses
- Substation and sub-network modeling
- Secondary grid network analyses
- Economic and technical feasibility assessments
- Power systems simulations
- Valuation models
- Market simulation forecasting



Emerging economies

Fulfilling the needs of an energy-hungry world

For growing populations, a safe, reliable power source is key to a prosperous future. However, because of location or other geopolitical factors, remote communities often don't have easy or stable access to a central grid. In addition, rapidly growing urban centers often have outdated grids that cannot handle the higher level of demand and increasingly complex loads.

Power Consulting has participated in resolving challenges for countries that are quickly surpassing the capabilities of their current grid as well as remote island communities, and industrial sites such as mining and defense operations.

We offer power systems studies and solutions that can be instrumental in developing effective holistic business solutions.

- Microgrid feasibility studies
- Grid simulation modeling
- Load flow and system protection analyses
- Optimal equipment selection and placement
- HVDC & FACTS planning
- Network planning and operation guidelines development

More than 1.3 billion people have no access to electricity at all or only have access to limited or unreliable sources.¹⁴



HOW WILL YOU PREPARE?

The Gulf Cooperation Council (GCC) countries will require as much as \$316 billion by 2020 to meet their growing power needs.¹⁵



Asset management

Turn information into actionable insights

To make the right investments, grid operators, utilities, and industry leaders need visibility into the health and operational performance of current assets. Monitoring can keep everything operating at peak efficiency as well as alert operators to problems that could lead to unplanned outages.

Comprehensive asset management can also help organizations decide what to do with assets reaching end of life. Sometimes, modernizing the grid requires replacing an aging or failing asset with more modern equipment; but often, asset life can be extended and capital budgets conserved with repair or refurbishment services.

Hitachi Energy offers a number of software applications to help grid operators and industry ensure their assets are operating at peak efficiency. In addition, Power Consulting studies can identify improvement opportunities and help map an implementation plan that addresses key objectives.

- Centralization and integration of asset data
- Monitoring and control of system health
- System planning and risk analyses
- Condition management and maintenance prioritization
- Advice on investment decisions



ARE YOU SPENDING MORE THAN YOU NEED TO?

38% of manufacturers delayed investments in capital equipment with Asset Management.¹⁶



Disruptive technologies

No matter what the future holds

New technologies put the dream of providing safe, clean, reliable power within reach. Hitachi Energy Power Consulting helps our customers turn this dream into reality.

Renewables

When Falcon Ma'an Solar Power needed to ensure grid code compliance for a proposed 23 MW solar power plant in Jordan, they contacted Hitachi Energy. The Power Consulting team simulated the potential impact under steady-state and dynamic conditions and recommended a 10MVAR STATCOM to meet the grid code's dynamic stability criteria.

Energy storage

To improve reliability of service to its members, The Golden Valley Electric Association of Fairbanks, Alaska, needed an energy storage solution that would produce up to 27 MW for 15 minutes. Power Consulting developed a specialized model of battery energy storage system controls and performed dynamic analyses to confirm the solution could support their power system during a contingency event. Our studies confirmed that the BESS would be effective in improving the reliability of the GVEA system and help it ride through critical outages. It was determined after successful commissioning that the number of power supply type outages decreased by more than 60%.

Supergrid

Seeing an opportunity to export power to the UK market, Ireland decided to expand its wind power generation. Power Consulting conducted a number of studies to assess the feasibility and im-

pact of integrating a dual-flow, long-distance HVDC transmission system into the AC network. With the system now in place, Ireland can sell and buy power not only from the UK National Grid, but also from the European mainland.

Big data

Power Consulting is leveraging analytics technology to mine data from past storms to analyze how the grid might be impacted, estimate restoration times, and predict the type of equipment inventory and crew resources that will be needed to handle grid restoration. Combined with other services like contingency simulations and an analysis of network connections and alternate sources, Hitachi Energy can help decrease restoration times even further.

Electric vehicles

When Chancellor Angela Merkel set the ambitious goal of having one million electrical cars on Germany's roads by 2020, Hitachi Energy was called in to study the effect of charging stations on the low voltage grid. Among other conclusions, Power Consulting recommended ways to make the grid more economical as well as reduce the frequency and duration of interruptions.



Power Consulting: your local expert worldwide

Your success is our business

For nearly a century, Hitachi Energy has staked its business on the principle that we must measure success by what matters to customers. Our consultants combine global industry expertise with a commitment to helping clients achieve electrification objectives safely and efficiently. We help address issues of network strategy, planning, operations, capacity, efficiency, stability, security, reliability, and resiliency.

Power Consulting has deployed solutions across six continents, so we have a unique, first-hand perspective on the complex political and regulatory environments our customers face. We have helped every type of business— from large, multinational utilities to small- and medium-sized municipals and cooperatives to businesses like manufacturers and hospitals—solve their toughest power challenges.

The convergence of innovations such as distributed energy resources, demand-side management, and information technology has introduced a pace of change unimaginable in this historically slow-moving industry. GreenTech Media.¹⁷



Case studies



Power Consulting helps transmission operator minimize cyber security risk

In 2014 a new US regulatory standard was approved (NERC-CIP 014) that created a host of new physical- and cyber-security mandates for grid operators. For assistance in complying with this new standard and minimizing its risk to cyber attacks, a major North American transmission operator with 500 substations turned to Power Consulting. Among the services Hitachi Energy provided was help in implementation of a new management system so the grid operation could better manage its cyber-asset life cycle operation workflow.



Power Consulting helps EU reach “Twenties” targets

The European Union set out to achieve a 20% reduction in CO₂ emissions, a 20% improvement in energy efficiency, and a 20% increase in energy consumption from renewable generation sources. Achieving these goals meant applying new technologies and re-thinking grid system architecture. For example, prior to 2010 a region of the Spanish transmission grid was forced to curtail wind-power production because, under certain conditions, it was experiencing power-capacity issues. To assess the situation and design a new solution that would improve power flow control efficiency and optimize network capacity, the European Commission contracted Power Consulting. Among Hitachi Energy's recommendations was the installation of a new FACTS design, the Overland Line Controller (OLC), that has since eliminated the primary obstacle that prevented the addition of more renewable power generation sources.



Power Consulting helps optimize wind farm investments and ensure grid code compliance

In Brazil, Galvão Dreen turned to Power Consulting to conduct a number of system studies to better understand the potential impacts of this country's grid compliance regulations and protect the project's bottom line. Hitachi Energy conducted feasibility studies as well as studies in system layout and dimensioning of equipment, grid integration and system stability, compensation definition, and power-quality evaluation. Based on the results, Hitachi Energy recommended implementation of a reactive power optimization solution, plus defined the need for the inclusion of harmonic filters. By demonstrating how they could avoid unnecessary investments and lower lifetime maintenance costs, Power Consulting was able to help Galvão Dreen improve the project's ROI and meet Brazil's stability and reliability grid code requirements.



Power Consulting helps oil refinery reduce unplanned downtime

When the reliability of their power supply started affecting productivity, UK-based Petrolus Coryton Refinery turned to Power Consulting to help determine the root causes and make recommendations to fix the problem. By executing a series of system studies, Hitachi Energy was able to identify and recommend a combination of operational changes, network configuration modifications, and updates to key protection devices that together significantly improved the refinery's power availability and resolved its power-related productivity issues.



Condition monitoring services help Indian chemical company keep the power flowing

For a chemical manufacturer, an unplanned power outage can potentially mean scrapping in-process throughput, jeopardizing its ability to fill customer orders, and putting serious pressure on bottom line financial performance. To minimize the risk of power disruptions, Indo Rama Synthetics, a chemical company in Butibori, Nagpur, India, contracted Power Consulting to monitor the condition of its 22 kV switch yard equipment. Hitachi Energy ran a number of diagnostic tests that identified an increasing trend of % Tan Delta observed in a 245 kV CT unit and a higher resistive leakage current in a 198 kV LA unit that made the plant's power supply vulnerable. To avoid the potential a power outage, Power Consulting recommended that both pieces of equipment be replaced.



Power Consulting helps Saudi Arabia meet growing power demands

Saudi Arabia has some of the most challenging load characteristics in the world. There is high variability between peak and light load levels (80% of its output powers air conditioners during the summer), plus generation is connected to load centers over long distances with few intermediate stations. In the early 2000s, Power Consulting was engaged to examine the western part of the system that was experiencing frequent blackouts and recommend solutions. Hitachi Energy's studies demonstrated the blackouts could be traced to the nature of their loads served by long distances, so it recommended deployment of some of the largest Static VAR Compensators (SVCs) in the world. Implementation led to significant improvements in network performance. Further Hitachi Energy studies extended the deployment of FACTS devices to the remaining regions in the Saudi system with similar positive results. Since the early phases of the project, Power Consulting has been working on an almost continuous basis with the Saudi Electric Company's planning and operations engineers to adapt and visualize future network needs.

References

¹DOE Announces \$220 Million in Grid Modernization Funding, Energy.gov, January 14, 2016.

²U.S. Department of Energy, The Smart Grid: an Introduction.

³The Green Grid: Energy Savings and Carbon Emissions Reductions Enabled by a Smart Grid, Electric Power Research Institute (EPRI), June 2008.

⁴International Energy Agency, World Energy Outlook, 2015.

⁵ibid.

⁶PWC, 2015 Global Power and Utilities Survey.

⁷2015 Global Cost of Cyber Crime Study, Ponemon Institute, September 2015.

⁸Cyber threats put energy sector on red alert, The Hill, July.

⁹Greenhouse gas emissions avoided by renewable energies (Umweltbundesamt, UBA, March 2022).

¹⁰United nations, Climate Change website

¹¹Transactive energy, providing an enabling environment, IEEE Xplore, April 2016.

¹²2015 Global Power & Utilities Survey, PWC.

¹³ibid.

¹⁴Renewables to lead world power market growth to 2020, International Energy Agency, October 2015.

¹⁵World Bank Group, Enterprise Surveys.

¹⁶Cover Your Assets, Automation World, February 2015.

¹⁷Reinventing the Power Business: An Actionable Roadmap for Utility Self-Disruption, GreenTech Media, September 10, 2014.

Power Consulting Hitachi Energy, Inc.

901 Main Campus Drive,
Suite 300
Raleigh, North Carolina
27606, USA

Power Consulting Asea Brown Boveri, S.A.

San Romualdo 13
28037 Madrid
Spain

Power Consulting Hitachi Energy Limited

Oulton Road
Stone, Staffordshire
ST15 0RS
United Kingdom

Power Consulting Hitachi Energy AB

Mäster Ahls gata 16,
Mimer T7
72212 Västerås
Sweden

Power Consulting Hitachi Energy Ltda.

3411 - Vila São Roque
Av. Monteiro Lobato,
Guarulhos, SP
Brazil

Power Consulting Hitachi Energy AG

Kallstadter Straße 1
68309 Mannheim,
Germany

Power Consulting Hitachi Energy India Ltd

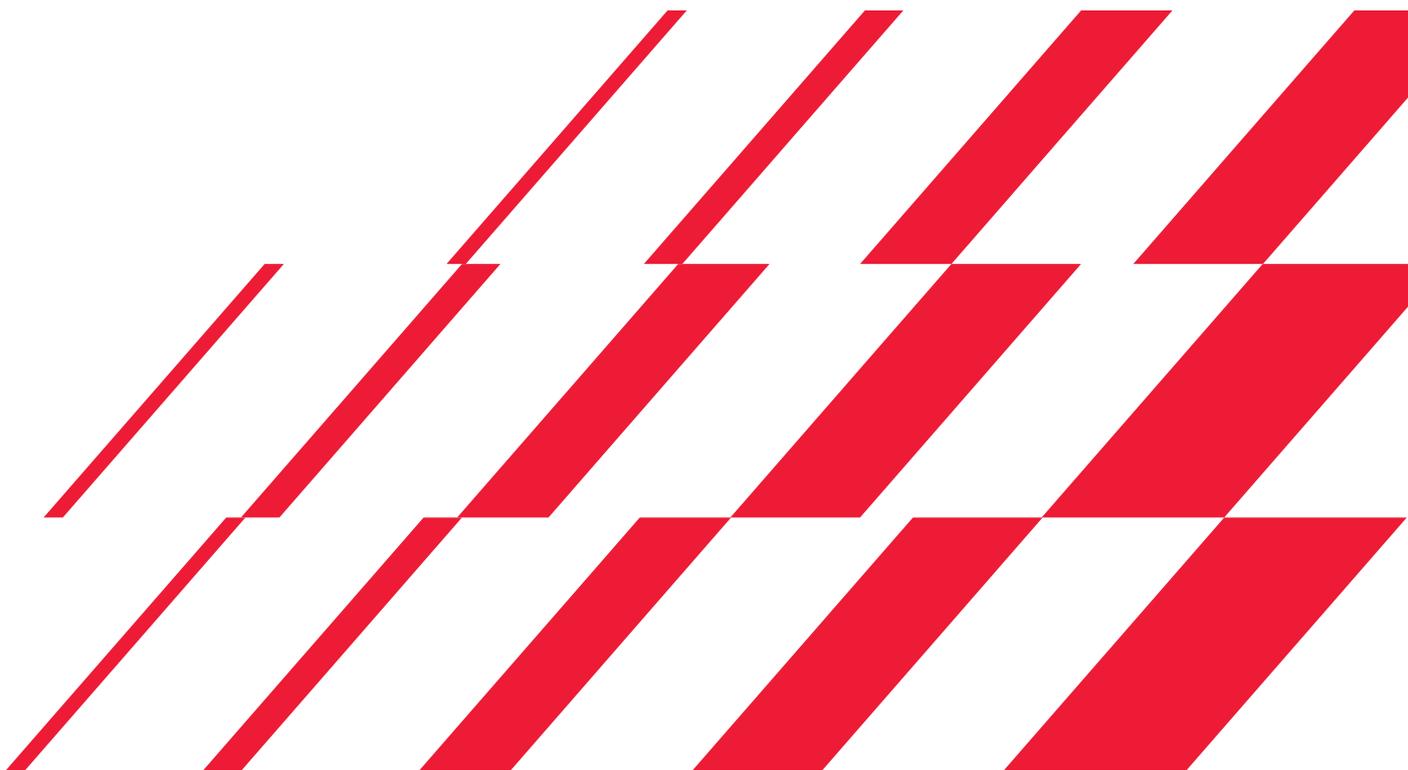
Maneja, Vadodara – 390013,
Gujarat,
India

Power Consulting Hitachi Energy (China) Ltd

10 Jiuxianqiao Lu
Beijing, 100015
China

Power Consulting Hitachi Energy (UAE)

Concord Tower Media
City, Dubai, United
Arab Emirates



For more information please contact:

Hitachi Energy, Power Consulting

**[www.hitachienergy.com/
power-consulting](http://www.hitachienergy.com/power-consulting)**

©Hitachi Energy 2021. All rights reserved.
Specifications subject to change without notice.

Additional information

We reserve the right to make technical changes or modify the contents of this document without prior notice. With regard to purchase orders, the agreed particulars shall prevail. Hitachi Energy Ltd. does not accept any responsibility whatsoever for potential errors or possible lack of information in this document.

We reserve all rights in this document and in the subject matter and illustrations contained therein. Any reproduction, disclosure to third parties or utilization of its contents – in whole or in parts – is forbidden without prior written consent of Hitachi Energy Ltd.