

Shaping
a Better Energy
Future



CESI



A Trusted and Innovative Partner for Shaping your Energy Future

CESI is a world-leading energy, technology and innovation consulting company with more than 60 years of experience.

We work hand in hand with our worldwide clients to shape the future of electricity through innovative and ad-hoc solutions.

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CESI: more than 60 years of innovation

CESI is a world-leading technical consulting and engineering company in the field of technology and innovation for the electric power sector

Through its Division KEMA Labs, CESI is the world leader for the independent Testing, Inspection and Certification activities in the electricity industry. With a legacy of more than 60 years of experience, CESI operates in 70 countries around the world and supports its global clients in meeting the energy transition challenges. CESI also provides civil and environmental engineering services.

The company's key global clients include major utilities, Transmission System Operators (TSOs), Distribution System Operators (DSOs), power generation companies (GenCos), system integrators, financial investors and global electromechanical and electronic manufacturers, as well as governments and regulatory authorities.

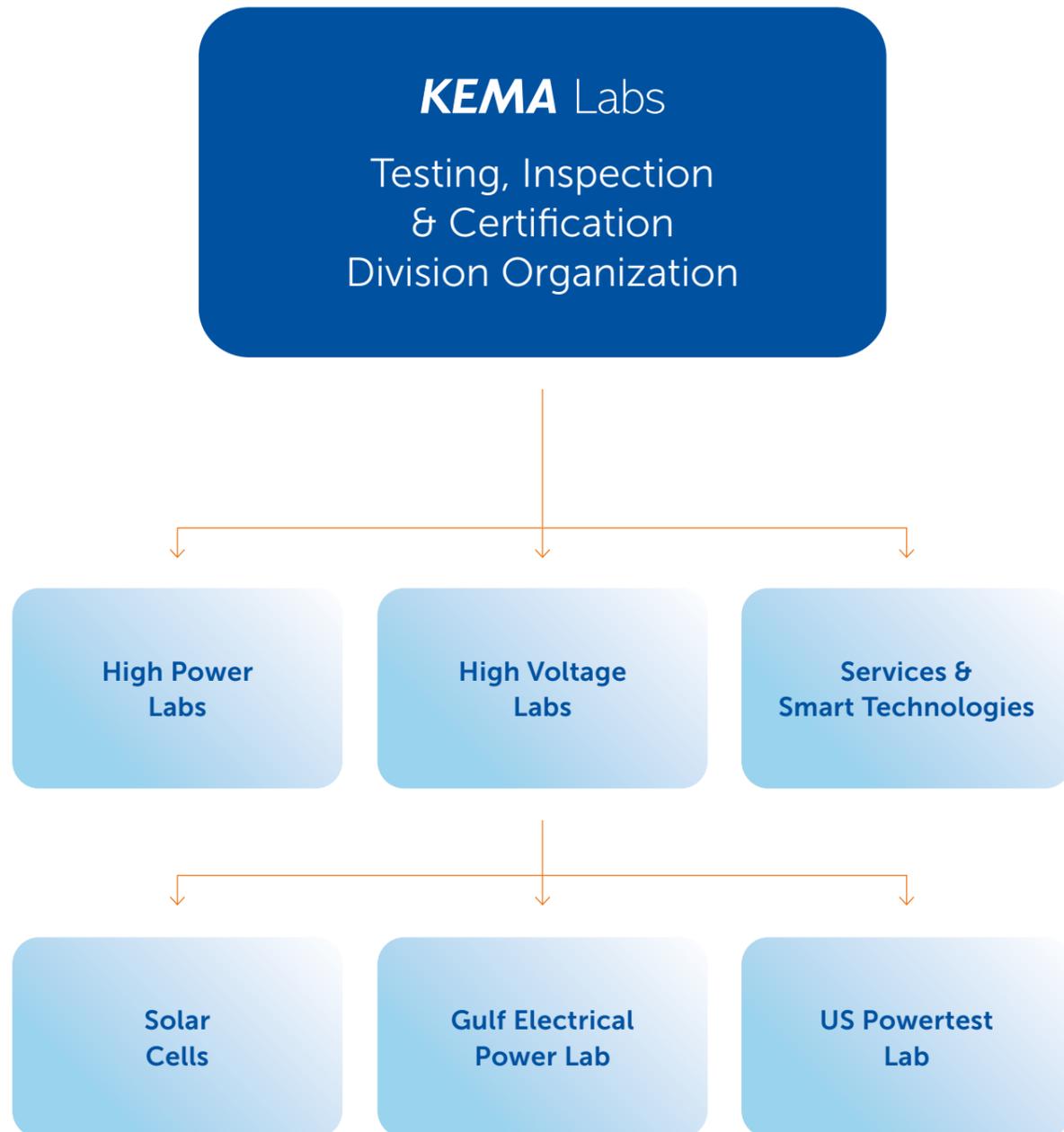
In addition, CESI works in close cooperation with international financial institutions such as, among others, the World Bank Group, the European Bank for Reconstruction and Development, the European Investment Bank, the Inter-American Development Bank, the Asian Development Bank.

CESI is a fully independent joint-stock company headquartered in Milan and with facilities in Arnhem, Berlin, Prague, Mannheim, Dubai, Rio de Janeiro, Santiago de Chile, Knoxville (USA) and Chalfont (USA).

To learn more, please check all of our references on www.cesi.it.



Business Lines





Facts & Figures

Shareholders Ownership Percentage on April 24, 2020

PRYSMIAN CAVI
E SISTEMI S.r.l.
6,479%

ABB POWER GRIDS
ITALY S.p.A.
5,675%

CESI S.p.A.
2,000%

TOSHIBA
TRANSMISSION
& DISTRIBUTION
EUROPE S.p.A.
0,357%

SEDIVER S.p.A.
0,094%

ENEL S.p.A.
42,698%

TERNA S.p.A.
42,698%

Our References Worldwide



● Representatives | ● References



● References described in the present document

Our Group's Story

The need to carry out research, tests and network studies persuaded Italy's large electromechanical companies along with the most important Italian electricity distribution companies that they needed a "Great Power Laboratory" to guarantee quality and efficiency of the Italian electricity sector. In the early 50s, the "X Laboratory" was born. It was later renamed Centro Elettrotecnico Sperimentale Italiano (CESI). CESI designed the first Italian nationwide interconnected power grid.

1956
CESI is founded

1962 - 1980s
CESI key player in the energy sector development

Enel became a shareholder of CESI. Under the boost of the increase in electricity consumption, CESI led the "1000 kV's Project", which was realized for the transport of high voltage energy on the Italian electrical networks. A step in the history of electrical industry's research, not only in Italy but also in the world. In 1982 the Synthetic Laboratory went live.

Since 2000, CESI has enlarged its fields of activity covering all sectors in the electro energy fields from generation to transmission, distribution, end-use of electricity, as well as environment and renewable energies. With a groundbreaking approach for the time, in the early 2000s, CESI has also begun to support Enel in implementing and testing smart meters.

2000
Enel digital meter is engineered and tested with CESI

2004
The assessment of environmental risks

In October 2004 CESI took over ISMES, a Company that enables CESI to expand the range of services by working in the fields of environmental risk, design support and structural assessment on buildings and structures, with tests and studies on mechanical and industrial components.

Through the acquisition, in 2005, of IPH (Berlin) and FGH(Mannheim), CESI becomes leader of the international market in the testing of electromechanical equipment, with expertise in testing high, medium and low voltage electric components.

2005
CESI expands its international testing market share

2012
CESI bolsters its worldwide presence

In 2012 and 2013 CESI opened their regional headquarters in the UAE and Brazil, enhancing the effectiveness and responsiveness in these areas, symptomatic of a long term commitment to these important, dynamic and highly attractive regions.

After the acquisition of the U.S. company EnerNex in 2018, the portfolio of activities concerning engineering and power system consulting services offered by CESI has been extended. EnerNex is a leading U.S. electric power engineering and consulting firm that provides top-quality services in grid modernization, cybersecurity, and power systems consulting. The combination of CESI and EnerNex portfolios bolsters planning, implementing, and operating power assets and electric infrastructures, offering to our clients a one-stop-shop solution for all their needs related to energy transition challenges.

2018
The modernization of electric grids with EnerNex

2019
KEMA Labs joins CESI, the testing world leader is born

The acquired KEMA Labs testing and inspections facilities include the world's largest high-power laboratory, with the highest short circuit power of 10,000 MVA, and the world's first laboratory capable of testing ultra-high voltage components for super grids, as well as the Flex Power Grid Laboratory, for advanced testing of smart grids components. The acquisition of KEMA Laboratories makes CESI the world's leading provider of independent testing of power components.



KEMA Labs

The new giant of testing, inspection and certification

KEMA Labs is CESI's world-leading testing, inspections and certification division.

With sites across the globe, we offer a combination of tradition and experience allied to state-of-the-art testing equipment. This enables us to test all kinds of grid equipment from low- to ultra-high-voltage so that our clients can meet today's increasingly demanding performance and safety requirements.

Utilities have the challenging task of ensuring that their grids operate reliably, while product manufacturers need to ensure their equipment performs to the highest standards. KEMA Labs offers vast expertise, impartiality and a long history of technical experience gained through our testing activities and participation in technical committees.

It makes us the ideal partner and the benchmark for testing in your sector. KEMA Labs has test locations around the world and has been testing products for more than 100 years.

We have the strongest facilities ever built and we test more than 200,000 products every year. It is no surprise we are the market leader.

As the energy business undergoes a deep transformation towards greener, smarter grids, KEMA Labs is focused on the new technologies that are emerging. We play a crucial role supporting our customers during the R&D phase at our state-of-the-art facilities, including our Flex Power Grid Laboratory.

KEMA Labs, The World Leader
 for Independent Testing, Inspection & Certification
committed to support the Full Product Lifecycle

more than
4,000

Global customers
 every year

over
2 mln

Customer Products
 Tested over
 the last 10 years
 in our Global Facilities

more than
1,000

Highly Experienced
 Professionals supporting
 Clients to overcome
 their challenges

Services for Clients Product Development & Innovation:

- › Testing Laboratories
- › On-Site Services
- › Inspections & Product Certification
- › Digital Labs & Smart Technologies

Research and Development:

- › R&D
- › Type Tests
- › Design Review
- › Cyber Modelling

Production

- › Routine Tests
- › Commissioning
- › Qualification
- › Witnessing
- › Explosion emulation laboratories
- › Functional Compliance

Field Operations

- › Diagnostics
- › Technical Investigations
- › Interoperability
- › Assessment

Enhanced Grid Safety and Stability

Client *Siemens AB*

Region/Country *Germany*

Job Type *Testing*



Ensuring grid resilience close to generation hubs is mission-critical for every system operator. Only by testing products under actual working conditions manufacturers can give utilities complete confidence that their products will work in real-world situations.

When Siemens wanted to test its 24kV 10,000A 80kA Generator Switchgear, which is designed to protect power plants' most critical transformers against failure of generating systems, it relied on to KEMA Labs' High Current Test Laboratory.

The lab carried out a complete type testing of this critical equipment under actual network conditions, enabling it to meet IEEE Standard requirements. The Vacuum-Generator-Circuit-Breaker was tested in accordance with IEEE C37.013.

This equipment is designed to be placed in a part of the grid which has the highest rated current. From a testing point of view, the biggest challenge was how to perform the temperature rise test at both 50Hz and 60Hz, both because of the need to supply 10,000A of steady current and because of the huge amount of space required (the test itself required almost 30 m³).

The High Current Test Laboratory gives CESI the capability to test equipment with permanent current up to 50,000A and with frequencies between 15 and 65 Hz.

Expert Quality Assurance Services for China

Client Electromechanical Manufacturers

Region/Country China

Job Type Certification



Many electromechanical manufacturers have moved production to Asia, to take advantage of fast-growing markets and lower labor costs.

KEMA Labs provides Quality Assurance services during the manufacturing process of 660kV and 800kV HVDC pilot projects in China and other Asian markets.

KEMA Labs has designed processes to review the qualification of manufacturers, to pre-inspect production lines and test laboratories, carry out in-production inspections (production supervision) and witness type tests and routine tests of transformers.

Safety in Hazardous Areas – a KEMA Labs priority

Client European Customers

Region/Country Europe

Job Type Certification

International standards require electrical and non-electrical equipment installed in hazardous areas to prove that it can withstand particular external events such as explosions, spark ignition, extreme heat and high impacts.

KEMA Labs operates as a notification body for the certification of equipment that is used in potentially explosive atmospheres, according to ATEX directive 94/9/CE and/or IECEx certification.



KEMA Labs as technology incubator for HVDC sector

Client Mitsubishi Electric, ABB and SciBreak

Region/Country Europe

Job Type Testing

HVDC grids are crucial for conveying massive quantities of renewable energy long distances with the highest efficiency and lowest power losses. A meshed HVDC Grid will be a crucial step to decarbonising electricity generation. KEMA Labs carried out full-scale testing of the first HVDC circuit breakers and HVDC gas-insulated switchgear for the Horizons 2020 European project Promotion (Progress on Meshed HVDC Offshore Transmission Networks). The project involves global manufacturers such as Mitsubishi Electric, ABB and SciBrek. This milestone reinforces the leadership of KEMA Labs not only in testing for certification purposes, but also as a strong R&D partner for every manufacturer.

We perform this partnership role with system operators too, for example in the prequalification project for Germany's HVDC corridor project, where KEMA Labs tested over 1000m of DC cables for the equivalent of 40,000hrs, for a number of cable manufacturers.

Our portfolio of testing and expertise services for HVDC cables, Thyristor valves and converters now also includes the first HVDC breaker technologies.



Take up the challenge of Green Energy FLEXibility

Client Several Customers

Region/Country Europe

Job Type Testing



With a growing proportion of power being generated from renewable energy and electric mobility becoming more important, voltage control is becoming more complex and it will be more challenging to maintain adequate levels of power quality for all users.

In the KEMA Labs FLEX Power Grid Laboratory, manufacturers of electric vehicles, battery storage systems and PV Inverters can test their products in a fully controllable grid-equivalent lab that is able to operate over a wide range of frequencies, harmonics, voltages and power levels.

Testing products during the R&D phase under real grid response conditions is crucial to enable manufacturers to market products that are already debugged.

Other global KEMA Labs facilities include a test bench for EV supply equipment that can replicate electric vehicle charging operations, emulate the grid response to different events, test whether equipment has electromagnetic compatibility with other products and equipment, and reproduce a wide range of climatic, mechanical and heavy conditions. Building a more sustainable and green future is your challenge and our mission.

Our automotive lab promotes greener and safer mobility

Client Several Customers

Region/Country Worldwide

Job Type Testing



The rapid development of new technologies in the automotive market, with a special focus on e-mobility, demands the highest quality levels. KEMA Labs prioritizes driver and passenger safety, and the reliability of mobility systems.

Our brand-new Automotive Lab offers cutting-edge test benches for EV supply equipment, pyroswitches, battery packs and other products in the automotive value chain.

As DC technology develops, especially in automotive applications, new DC test stands must be designed.

The short current paths in automotive applications require a very low circuit inductivity, which can be easily emulated in our automotive lab, along with high power supply to completely reproduce the real network and operational conditions of the vehicles.

KEMA Labs is the only player with the necessary combination of innovative facilities and expert senior engineers.





KEMA Labs increases its activity in the Russian market

Client Russian Customers

Region/Country Russia

Job Type Testing

The electricity market is facing increasing demands for reliable services all over the world: this creates big opportunities in a large country with heavy environmental challenges like Russia. KEMA Labs is fully able to cover all the requirements of National Product Standards GOST and other organizational standards (which are known as STOs) for companies such as Rosseti,

Rosatom, Gazprom, RZD and Transneft. KEMA Labs has also been accredited by the federal railway transport agency as a competent third-party body for testing fixed installation railway components such as DC switchgear and electric equipment for rolling stock. The accreditation covers both product certification and declarations of conformity.

KEMA Labs co-ordinates high-voltage and high-power tests for components with the R&D centres of:

Federal Grid Company UES (Rosseti)

- ▶ HV power transformers
- ▶ HV circuit breakers
- ▶ HV switchgears
- ▶ HV and MV cables, protocol IEC 61850 testing for digital substations and other testing

Federal Testing Center (Rosseti)

- ▶ HV and MV Switchgears
- ▶ HV and MV components
- ▶ HV and MV Cables

VEI (Rosatom)

- ▶ Power transformers and other electrotechnical equipment for nuclear power plants

RASU (Rosatom)

- ▶ GCBs and other electrotechnical equipment for nuclear power plants

Profotech

- ▶ Optical, digital and conventional instrument transformers

VNIKP

- ▶ Testing and inspections for the cable industry

KEMA Labs has already signed co-operation agreements with most of the listed companies.



Consulting, Solutions & Services

CESI delivers practical solutions that help to interpret and shape a world that is becoming more and more interconnected and complex.

Our expertise covers almost every aspect of the Energy and Infrastructure sectors:

- ▷ Power transmission and distribution: HVDC/HVAC infrastructure, distribution infrastructure and smart grids
- ▷ Renewable energy and storage: hydropower, solar and wind generation and storage systems
- ▷ Conventional power generation: open and combined cycle gas turbine, coal-and oil-fired thermal power plants, industrial facilities
- ▷ Infrastructure: roads, bridges and cultural heritage

With more than 1,000 consultants worldwide, we provide technical assistance to utility, energy & infrastructure investors, governments, regulators and financial institutions in more than 50 countries throughout Europe, the Middle East, Asia, Africa, The United States and Latin America. Our services cover the entire life cycle of infrastructure projects, from early stage feasibility studies to the complete support during construction, commissioning and operation.

more than

15,000 km
HVDC

Studies and technical assistance in more than 15,000km of HVDC links worldwide

more than

30 GW
of renewables

Studies for grid integration of more than 30GW of renewables

more than

300

Systems and structural analysis for dam safety and environmental protection

Our advisory services include:

- ▶ Planning and operational studies
- ▶ Environmental and sustainability studies
- ▶ Regulatory and market studies
- ▶ Civil studies

During the implementation of a project, we offer a full set of owner's engineering services:

- ▶ Technical specification & procurement assistance
- ▶ Design Review
- ▶ Construction and commissioning supervision
- ▶ Support during environmental permitting

And we can help to optimize the safety and performance of existing infrastructure with flagship services and innovative solutions focused on:

- ▶ Monitoring systems for structures and plants
- ▶ Environmental monitoring
- ▶ Site remediation
- ▶ Asset management and maintenance optimization

Synchronization of the WAPP Interconnected System

Client *WAPP (West Africa Power Pool)*

Region/Country *Western Africa*

Job Type *Network Operation Study*

CESI acts as technical consultant to the national electricity companies in the West Africa Power Pool (WAPP), helping them to improve the exchange of electricity among the countries in the pool (Senegal, Mali, Ivory Coast, Ghana, Togo, Benin, Nigeria, Burkina Faso, Niger and Mauritania). The project, financed by the World Bank, is an important milestone for electricity trading in the region.

CESI's consultancy services include:

- ▶ Static and dynamic system simulations in order to optimize equipment settings
- ▶ Proposing adaptations to the operating rules to ensure the system operates jointly reliably

- ▶ Developing and implementing a complete package of procurement services
- ▶ Supervising the supply, installation and commissioning of equipment
- ▶ Assisting Synchronization

CESI was also commissioned to carry out a study to support the development of an ancillary services market within WAPP's unified wholesale electricity market.



Creation of a single electricity and gas market for 20 Arab countries

*Client Arab Fund for Economic
and Social Development*

Region/Country Middle East

Job Type Feasibility Study

The Arab Fund for Economic and Social Development (AFESD) selected CESI Middle East to undertake a feasibility study to determine how best to create a single energy market for 20 Arab Countries by 2030 using electrical and gas interconnections.

The project established a strategy and master plan to develop electricity and gas trading among the Arab countries, and to determine the tradeoffs between export of electricity and/or natural gas and using it domestically.

The study analysed the current status of the energy sector and future scenarios, assessing the exchange of energy across the 20 countries, identifying the best gas and electric interconnection options and creating a time schedule and cost estimation for implementation.

CESI Middle East is also helping the AFESD to develop the Interconnection Grid Code for the Pan-Arab electricity market. This will define rules for coordinated planning of generation and transmission capacities and the coordinated operation of each national power system within the region.



Innovative options for power delivery: multiple microgrids

Client United Illuminating

Region/Country USA

Job Type Microgrids Consultancy



CESI's US company EnerNex has developed use cases, requirements and RFPs for multiple microgrids with various primary and backup generation options.

These solutions help to ensure power delivery to critical facilities, including fire stations, police stations, city halls, emergency shelters and nursing homes.

EnerNex determined the best options and developed business cases, performed cost benefit analyses for generation options including combined heat and power (CHP), natural gas and propane fuels. It also calculated the total electric load and wrote the generator specifications for a number of community microgrids.

Additional design considerations included the need to support cold load pickup, to operate in hurricanes, floods and other severe weather situations and the need to integrate into existing communications and electric distribution systems.

New power interconnection in the Gulf area

Client Gulf Cooperation Council

Interconnection Authority

Region/Country Middle East

Job Type Interconnection Studies



CESI Middle East has signed an agreement with the Gulf Co-operation Council Interconnection Authority (GCCIA) to provide technical support to help the Authority reach its strategic goals, particularly stabilizing electricity interconnections between the GCC members.

The agreement was inspired by and builds upon decades of successful economic co-operation between the six countries of the GCC – Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

Under the three-year agreement, CESI will provide GCCIA with consultancy and technical services in system operations and planning studies, pre-feasibility and feasibility studies for the development of international transmission and interconnection networks in the Gulf region.

Grid expansion plan for Bolivia

Client Comite' Nacional de Despacho

de Carga (CNDC)

Region/Country Bolivia

Job Type Masterplan

CESI won an international tender to develop a study for determining how to expand generation, transmission and distribution capacity in Bolivia over the next 20 years.

The study included:

- ▶ Analysis of the current state of the electrical system and definition of assumptions for the study
- ▶ Forecast of power and energy demand
- ▶ Analysis and recommendations for improvements to the Network Code
- ▶ Distribution plan study (sub-transmission 69kV and higher)
- ▶ Study of the optimum penetration of non-conventional renewable generation
- ▶ Generation master plan
- ▶ Transmission master plan
- ▶ Project implementation scheduling and relevant budget evaluation
- ▶ Sensitivity analysis



MED-TSO

Power system studies

Client Association of the Mediterranean

Transmission System Operators

Region/Country Mediterranean area

Job Type Power System Study

CESI was selected by MED-TSO, the Association of Mediterranean Transmission System Operators, to evaluate grid connectivity in the Mediterranean area (Algeria, Cyprus, Egypt, Greece, Israel, Italy, Jordan, Lebanon, Libya, Morocco, Palestine, Portugal, Spain, Syria, Tunisia, Turkey) and develop a 10-year Interconnection Master Plan. CESI built four alternative scenarios to evaluate the effect of several different interconnection clusters on the exchanges among countries.

The study involved:

- ▶ Reference network model building
- ▶ Load flow analysis in normal and contingency situations
- ▶ Assessment of the grid reinforcement required in different scenarios
- ▶ Loss variation calculation
- ▶ Analysis of network studies and investment costs



Integration of non-programmable renewable energy in Kenya and Ethiopia

Client RES4Africa Foundation

Region/Country Kenya - Ethiopia

Job Type RES Integration



The RES4Africa Foundation asked CESI to examine how to integrate renewable energy generation into the Kenyan and Ethiopian power systems.

Both Kenya's and Ethiopia's renewable energy visions create significant opportunities for private investors, but also need technical investigations to identify possible issues in relation to the operation of the power system and what network reinforcements may be necessary to enable new renewable power plants to be connected while ensuring power system security.

CESI's study:

- ▶ Assessed the maximum amount of non-programmable renewable generation that could be installed without compromising the reliability, integrity and efficiency of the power system
- ▶ Executed reliability and market-based analyses to assess the benefits to the electric power system of integrating new renewable energy capacity and the impact it would have on the cost of energy
- ▶ Evaluated the ability of the transmission and sub-transmission system to transport the power generated by the new renewable power plants

Cost Benefit Analysis for the EuroAfrica Interconnector

Client EuroAfrica Interconnector

Region/Country Europe and Africa

Job Type Cost-benefit Analysis



CESI helped prepare a cost-benefit analysis of the 2,000MW HVDC submarine power interconnection that will connect Egypt to Europe via Cyprus. At 3,000m deep and 1,700km long, the EuroAfrica Interconnector will be the world's deepest and longest submarine cable interconnector.

This corridor will enhance security of supply in Europe by giving the region access to electricity produced from the recently-discovered gas

reserves of Cyprus and Egypt and renewable energy sources in connected countries, and it will contribute to the growth of the MENA energy market, with Egypt as its hub.

CESI is assessing the project's economic feasibility, and analyzing how integrating renewables into the network will cut CO2 emissions and make the electrical systems of the countries involved more resilient.

Making a modern grid cybersecure

Client Southwest Transmission

and Distribution Utility

Region/Country USA

Job Type Cybersecurity

EnerNex, a CESI US company, is helping a US transmission and distribution utility to create its security architecture and comply with NERC CIP requirements for grid management and operational assets. The client wants appropriate security measures to be implemented as technologies and operational practices change.

EnerNex is providing cybersecurity expertise, including both field and back office equipment, within the transmission and distribution areas. The activities include:

- ▶ Assessing and providing solution designs according to NERC CIP standards

- ▶ Supporting the development and refinement of security architecture associated with the client's Telecommunication Refresh Programme involving fibre, microwave, and MAS infrastructure, along with third-party cellular infrastructure. Areas include IP-based substation security architecture, distribution automation security architecture, secure remote device access, monitoring, logging, and alerting.



Next Generation Demand Response

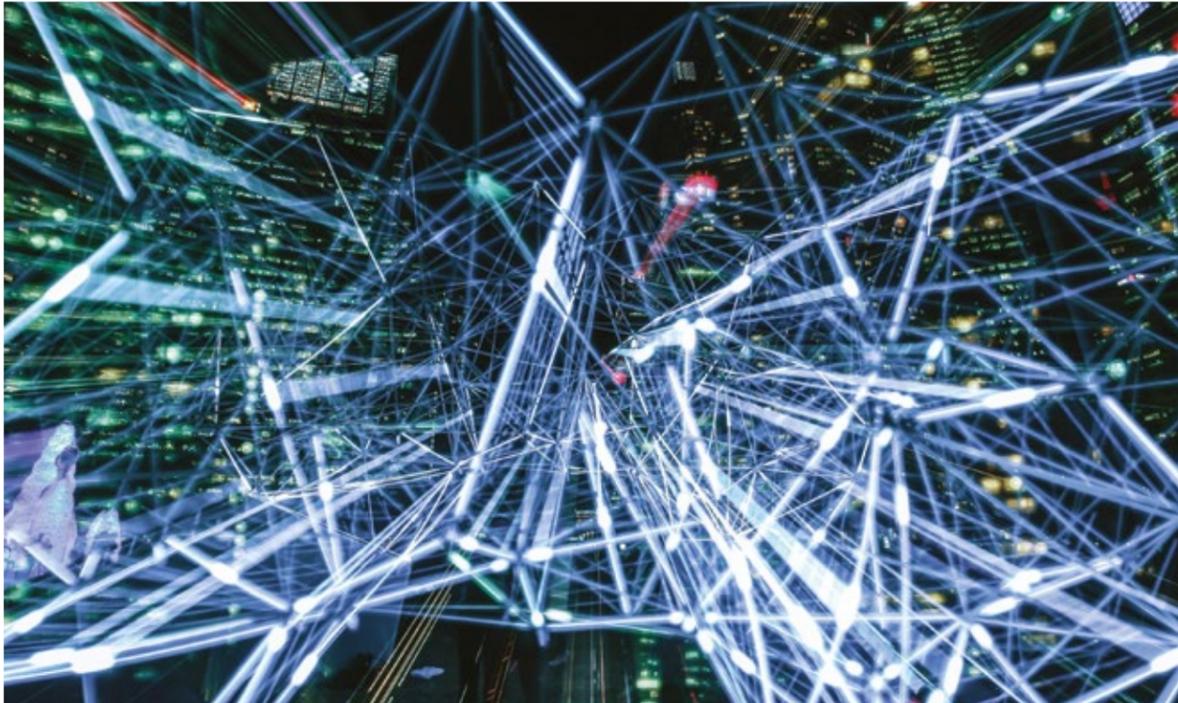
Client Southern California Edison (SCE)

Region/Country USA

Job Type Demand Response

EnerNex, a CESI US company, evaluated demand response (DR) as a resource for California Independent System Operator (CAISO) integration. The client needed to identify the technologies that align with different demand response applications, based on the ability to respond quickly and with precision, both in magnitude and location.

EnerNex balanced the potentially competing interests of distribution grid management, customer tariffs and program support. EnerNex's long history of assisting Southern California Edison, the primary electricity provider in Southern California, allowed it to provide context on the current demand response landscape.



AMI Infrastructure in Pakistan

Client IESCO, LESCO

Region/Country Pakistan

Job Type Advanced Metering Infrastructures

Consultancy



The government of Pakistan, funded by the Asian Development Bank, is introducing advanced metering infrastructure (AMI) in Pakistani distribution companies. The program will achieve significant AMI coverage across Pakistan's major cities and industrial hubs. CESI has been selected as the implementation consultant for the first and second stages of the project, which will introduce modern metering and billing systems for 1.8 million customers of the Islamabad Electricity Supply Company (IESCO) and 1.8 million customers of the Lahore Electricity Supply Company (LESCO).

CESI consultancy services include:

- ▶ Procurement processes and preparatory activities
- ▶ Supervising the supply and installation of smart meters and systems for meter data management, billing and databases
- ▶ Post-installation oversight and support to optimise performance

Standards for Rooftop solar in Oman

Client Authority for Electricity Regulation (AER)

Region/Country Oman

Job Type RES Consultancy

CESI supported the Authority for Electricity Regulation in Oman (AER) to develop standards for rooftop solar PV systems to be connected to the distribution network.

Oman has ambitious renewable energy investment plans for both small-scale and utility-scale projects and has a robust incentive scheme to support the development of small-scale distributed PV. The AER, aware of the risks and challenges related to a rapid deployment of distributed renewable energy, wanted proper rules and regulations for connecting PV plants from the outset, in line with international best practices.

CESI consultancy services include:

- Development of standards for rooftop solar PV through a review of international standards and rules and critical analysis of Oman's electrical standards
- Creation of guidelines for a typical connection process, including a flowchart process for distribution companies and applicants and description of activities, roles and responsibilities for each step of the process
- Definition of requirements for solar PV system designers and installers
- Study of net metering schemes, comparing different net metering arrangements and providing recommendations in relation to metering arrangements, energy accounting and settlement.



E-Mobility Project

Client Confidential

Region/Country Europe

Job Type E-mobility Consultancy



CESI actively contributes to the development of the e-mobility sector in Europe and the US, carrying out consultancy studies, testing activities and collaborating with relevant international institutions.

In Italy, CESI analyzed the potential for electric vehicles (EVs) to provide vehicle grid integration (VGI) services with a focus on technical regulatory and market aspects.

CESI's tasks included:

- Developing scenarios based on the current regulatory framework and technical characteristics of EVs and charge points

- Defining use cases based on public charge point availability
- Evaluating participation in demand response, Frequency Containment Reserve, ancillary and day-ahead market for EV aggregates based on current and potential future regulations
- Identifying benefits for the electric system and defining costs associated with implementation

CESI also assessed the business models for installing charging stations in three European countries.

CASA 1000 HVDC – Owner's engineering & operating strategy

Client Barqui Tojik, NTDC, DABS

Region/Country Tajikistan - Pakistan - Afghanistan

Job Type HVDC Owner's Engineering

CESI is providing owner's engineering services related to the construction of two HVDC converter stations in Tajikistan and Pakistan and the ± 500 kV HVDC transmission line between them. This is a crucial part of the \$1.2 billion CASA-1000 project, the biggest energy project in Central and South Asia, which will enable the transmission of electricity from hydro-electric power plants in Kyrgyzstan and Tajikistan to consumers in Pakistan, via Afghanistan. The interconnection is a cornerstone of Pakistan's strategy to meet its increasing demand for electricity and will allow Kyrgyzstan and Tajikistan to profit from their surplus energy.

CESI is supporting the TSOs of the three countries with a full range of owner's engineering services, including design review, contractor management, quality assurance, construction supervision and witnessing during testing and commissioning of the infrastructure.

Under a parallel USAID-supported project, CESI is helping the CASA-1000 Secretariat to set the operational strategy of the interconnector, develop its technical code and support its harmonisation with the existing grid codes of the interconnected countries.



Potential for power trading in the GCC states

Client GCC Interconnection Authority (GCCIA)

Region/Country GCC Countries

Job Type Power Market Studies



CESI has been supporting the GCC Interconnection Authority (GCCIA) to develop and improve the regional electricity market between the GCC members – Bahrain, Kuwait, Qatar, Oman, UAE and Saudi Arabia. The countries can already operate their power systems jointly and trade power, thanks to an existing high-voltage GCC electrical interconnection owned and operated by GCCIA.

CESI has provided support to increase regional power trading and to identify the trading potential of different market products in the short- and mid-term, including:

- ▶ Assessing the most profitable market products, using quantitative simulations based on the variable generation costs of each member state and analyzing the volumes and exchanges prices for the day-ahead market, long-term bilateral contracting and intra-day markets
- ▶ Studying how the interconnector can enable the integration of significant amounts of renewable energy
- ▶ Reviewing existing regional and national laws and regulations to identify gaps and propose solutions to enable smooth and successful regional power trading
- ▶ Business and organisational analysis on how to create a trading department inside GCCIA to deal with the planned evolution of the GCC regional market
- ▶ Creating a strategic roadmap for the evolution of the regional electricity market in the short-, mid- and long-term

Owner's Engineering Services for the Mindanao-Visaya HVDC power transmission project

Client National Grid Corporation

of the Philippines (NGCP)

Region/Country Philippines

Job Type HVDC Owner's Engineering



CESI is supporting the National Grid Corporation of the Philippines (NGCP)'s implementation of the Mindanao-Visayas HVDC Interconnection Project (MVIP). The project, a strategic milestone in the country's energy strategy, aims to unify the Philippines' power transmission networks, eventually linking together highly populated islands to create one grid and ensure energy resources can be shared across the country. The HVDC infrastructure comprises around 220km of overhead lines and 92km of submarine cable, which runs from Dumanjug converter station in Cebu to Lala converter station in Mindanao, with a capacity of around 900MW at ± 350 kV.

CESI is providing full owner's engineering services for the HVDC converter and electrode stations as well as for the HVDC submarine and communication optical cables, including:

- ▶ System study review
- ▶ System design review
- ▶ Assessment of equipment design
- ▶ Supervision of construction and management of implementation
- ▶ Supervision of testing and commissioning and verification of trial operation
- ▶ Knowledge transfer

Power Network Defence plan in Senegal

Client SENELEC

Region/Country Senegal

Job Type Network Operation Study

In recent years, Senegal's network has suffered blackouts that can lead to the collapse of all or part of the network. It is also gradually integrating renewable energies onto its interconnected network and strengthening its transmission and distribution grids. SENELEC, the national TSO, selected CESI as technical consultant to set up a defence and restoration plan for its high voltage network to increase the reliability and continuity of electrical supply and minimize the risk of blackouts.

CESI's consultancy activities include:

- ▶ Developing a defence plan
- ▶ Developing a restoration plan
- ▶ Preparing specifications for implementing the defence and restoration plan
- ▶ Implementing a training program to enhance the capacity of SENELEC's dispatchers and experts



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Grid modernization strategy for 100% renewable energy generation

Client Hawaiian Electric Companies (HECO)

Region/Country USA

Job Type Grid Modernization

EnerNex, a CESI US company, was contracted by Hawaiian Electric Company to help establish a scenario-based, comprehensive grid modernization strategy to enable the state to achieve 100% renewable energy generation by 2045.

EnerNex, which has recognised expertise in grid modernization, drafted a strategy that prioritised grid, customer-facing and communications investments to improve grid operations in the short term and build for the future. Stakeholder input was influential in shaping the strategy.



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Environmental Impact Study for the EuroAsia Project

Client DEH – Quantum Energy Ltd

Region/Country Europe and Asia

Job Type Environmental Studies



CESI was selected to conduct an environmental impact study (EIA) for the EuroAsia project, an underwater 2,000MW HVDC interconnector that will connect Israel, Cyprus and Greece (via Crete), representing the first energy bridge between Europe and Asia.

The interconnector, part of the Energy Priority Corridor 3 project under the European Union's Connecting Europe Facility (CEF) – Energy Programme, will help to end Cyprus and Crete's energy isolation, develop renewable energy sources and reduce CO2 emissions.

CESI conducted an environmental impact study of the project, according to European and national law.

Tackling sedimentation problems in a hydropower plant

Client Enel Generación Peru

Region/Country Peru

Job Type Environmental Monitoring



CESI carried out a preliminary study for Enel Generación Peru to identify possible solutions to heavy silting problems in the Huampaní and Matucana hydropower plants.

These plants have to deal with large amounts of sediment deposition, which builds up in intake structures, loading tanks, sand traps and sedimentation tanks, limiting plant productivity and operation.

CESI carried out an on-site inspection, identified the critical issues and developed technical solutions to prevent sedimentation, remove sediment from loading tanks and improve the management of the hydropower plant.

For both plants, CESI developed a dredging system that included suction pumps, a sediment release system and a pipeline with controlled turbidity levels.

Monitoring the backbone of Italian renewable energy

Client Enel

Region/Country Italy

Job Type Civil Engineering / Monitoring

Italy was a pioneer in the hydroelectric sector, where it has been active since the end of the 1800s. Today, hydro provides between 12% and 17% of Italy's electric energy needs, making a considerable contribution to renewable energy's share of the national energy mix. Guaranteeing safe hydroelectric operability requires constant, ongoing monitoring efforts.

Enel chose CESI, which has assessed and monitored the safety of more than 200 dams all over the world, to assess the safety level of the dams relevant to hydroelectric plants in Italy, verifying:

- ▶ Safety and seismic structural stability, in compliance with new Italian legislation
- ▶ Design and execution of investigations through field surveys and laboratory tests
- ▶ Seismic tectonic analysis



Safeguarding Cultural Heritage

Client Various

Region/Country Italy - Mexico

Job Type Civil Engineering / Monitoring

CESI specializes in civil and environmental monitoring, including the protection of cultural heritage. The company's experience in this area began in the 1950s, with initial work on the Mole Antonelliana in Turin, and has evolved over subsequent decades on some of the most significant Italian and international sites. CESI recently developed a monitoring system for the Santa Maria del Fiore Cathedral in Florence. This included a feasibility study for a new monitoring design aimed at assessing the structure of the Baptistery, paying particular attention to foundation and sub-surface soil of the wall of the entire Piazza del Duomo area in Florence.

Other CESI cultural heritage projects include:

- › the San Marco Basilica and Santo Stefano bell tower in Venice
- › the Leaning Tower of Pisa
- › the Cenacolo Vinciano in Milan
- › the San Marco Basilica and Santo Stefano bell tower in Venice
- › the Metropolitan Cathedral in Mexico City
- › the Chapel of the Shroud in Turin
- › the Sisto Bridge in Rome
- › the Tower of Ravenna



Monitoring system for one of the biggest hydro-electric plants in the world

Client International ITAIPU Binacional

Region/Country Brazil - Paraguay

Job Type Dam Monitoring



With an installed generation capacity of 14GW, 20 700MW generating units and a hydraulic design head of 118 metres, the Itaipu dam located between Brazil and Paraguay, is one of the biggest hydro-electric dams in the world.

CESI, which has more than 50 years of experience in designing dam monitoring systems, was selected to improve safety and optimise maintenance planning. CESI designed and installed a monitoring system with more than 300 sensors and 24 data acquisition systems, including a communication system, CESI's proprietary INDACO control and data processing system and a Mistral® expert system to provide hourly information on the status of the dam.

Power Plant Remediation project in Italy

Client Enel

Region/Country Italy

Job Type Remediation Services

Enel selected CESI to investigate how organochlorine compounds have contaminated groundwater at a decommissioned thermoelectric power plant in Italy, delaying a long-planned industrial reversion program. CESI's advanced environmental forensic investigations, using MIPs (Membrane Interface Probes), showed that the source of the pollution is external to the plant.

CESI developed several possible intervention scenarios to establish the most cost-effective solution, comparing different technologies, and proposed a remediation project.



Floating PV on hydro-electric reservoirs

Client Confidential

Region/Country Italy

Job Type RES Consultancy



An electricity company asked CESI to create guidelines for assessing the potential for installing floating solar photovoltaic (PV) installations on hydroelectric reservoirs from sustainability, technical and economic perspectives.

Floating PV is more efficient than land-based PV and reduces land use. However, it is important to know if there are any potential negative impacts of the technology on the environment and whether particular reservoirs are suited to hosting a floating PV plant.

The guidelines provide a quick and easy way to assess whether a particular basin is suitable for floating PV projects.

Space Solar Cells



CESI has more than 30 years of experience in the research, development and production of high efficiency space solar cells for civil applications and is one of the top global suppliers of multijunction cells based on III-V semiconductors.

Our standard triple junction space cells (InGaP/InGaAs/Ge) are state of the art with a typical efficiency of 30%. They are qualified for both Low Earth Orbit (LEO) and Geostationary Orbit (GEO) satellites according to standard ECSS E ST20-08C. We continuously seek to make our cells more efficient and our research suggests we will be able to produce four junction cells with space efficiencies beyond 35%.

We manufacture space solar cells at our facilities in Milan using our proprietary technology.

CESI has manufactured more than 200,000 solar cells that have powered more than 70 civil satellites for clients from over 25 different countries.

CESI has developed close and lasting links with international space agencies and players around the world. Our investments in research in this field have been supported by funding from the Italian National Space Agency (ASI) and the European Space Agency (ESA). CESI is well regarded for its expertise in the development and manufacturing of advanced and proven space solar cells within the ESA European space program frames. Additionally CESI has contributed to many interplanetary missions (e.g. to Mercury, Mars and Jupiter).

One of the top manufacturers
of Triple Junction Solar Cells for Space Application

more than
200,000
Solar Cells

more than
70
Civil Satellites

over
25
Countries served

Our space product commercial portfolio includes:

- ▶ Our standard triple junction space cells are state of the art with a typical efficiency of 30%: these cells have an extensive flight heritage in LEO, MEO and GEO orbits
- ▶ We offer a range of sizes up to Large Area, either as bare cells or Solar Cell Assembly (SCA; also known as Cell-Interconnect-Coverglass (CIC).
- ▶ **Low Cost Triple junction solar cells, fully qualified for LEO and GEO missions:** these cells are suitable for the new mini/micro/cube satellite macro-constellation emerging market, where cost is key. CESI is the only manufacturer selling this class of product
- ▶ We can combine all the above product features to manufacture and supply space solar cell products fine-tuned to the requirements of any space program
- ▶ **Thin Triple junction solar cells fully qualified for LEO missions:** these cells are aimed at New Generation Array (NGA) designs that require flexibility and light weight

For more information,
please contact us at solar@cesi.it

CESI Space Cells for the Express Project

Client Kvant

Region/Country Russia

*Job Type Supply of high efficiency solar cells
for space applications*



Kvant, a long-history customer of CESI, is in charge for the realization of the Solar Arrays that will power the satellites of the Express constellation (Russian Federation). The mission of the Express satellites, which will last 15 years, is to provide fixed and mobile communications, digital television and radio broadcasting, high-speed Internet access and data transmission services.

CESI was in charge for the production of a large volume of Triple junction InGaP/InGaAs/Ge bare solar cells, 29% minimum average efficiency, which Kvant used as "building blocks" for the manufacture of Express's solar arrays.

Our Multi Junction space solar cells are fully qualified for Low Earth Orbit (LEO) and Geostationary Earth Orbit (GEO), and are manufactured using proprietary and innovative know-how. CESI's Triple Junction space solar cells were demonstrated to have 30% efficiency, and have already been used to power more than 70 satellites for over 25 different countries. CESI is currently investing in Research & Development for Four Junction new generation solar cells.

CESI Space Cells for the New Space Economy

Clients ISRO, GomSpace

Region/Country India, EU

Job Type Supply of both high efficiency

and low cost solar cells for space applications

ISRO is the Indian Space Agency, department of Space, Government of India that is in charge of the development of Indian space programs, including Earth observation satellites (EOS) and communication satellite (CMS) like the Indian National satellites (INSAT) for telecommunication services and the Indian Remote Sensing satellites (IRS) for management of natural resources. ISRO also develops the satellite launch vehicles (namely GSLV for the INSAT; and PSLV for the IRS) and is working on longer-term Moon and Mars programs.

GomSpace is a globally leading manufacturer and supplier of cubesat & small satellite solutions including systems integration, cubesat platforms, advanced miniaturized radio technology and satellite operations to customers in the academic, government and commercial markets.

CESI has been involved in providing ISRO with the Triple Junction High Performance and more recently the new Low Cost solar cells, and GomSpace with the new Low Cost solar cells. These cells will be utilized to manufacture solar arrays for their satellites. This paves the way for CESI to enter the Indian space market and to strengthen the position of CESI in Europe in the emerging New Space Economy.



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