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ENERGY FOR THE FUTURE. ITALIAN EXCELLENCE

TECHNOLOGY AND HI-TECH SOLUTIONS
WORLD-RECORD ELECTRICITY GRID IN SARDINIA

The island is a leader for know-how and engineering solutions: storage systems, synchronous condensers, record-breaking undersea cables and the Sulcis innovative hub

Hi-tech and innovation: Sardinia is confirmed as an example for Italy and for the world in terms of technology and the advanced technical and engineering solutions used by Terna in its work to develop and modernise the electricity grid. Thanks to a series of cutting-edge plants and equipment, in some cases unique at the international level, the island has become a laboratory of high performance technologies for 'smart grids', intelligent networks capable of securely integrating and balancing the growing energy production from renewable sources.

An area of more than 250 thousand square metres, equivalent to more than 30 football pitches, where more than 100 people worked on the construction site, with more than 40 companies involved and a total investment of more than € 70 million hosts the **multi-technological hub of Codrongianos** (in the province of Sassari), the largest plant in Sardinia and of global importance: it is here that Terna has created its Storage Lab for testing energy storage systems, synchronous condensers to stabilise the electricity grid and the Sardinian terminal of the SA.CO.I. the historical high-voltage direct current connection (HVDC) which carries the electricity exchanged with the Italian peninsula and Corsica. Energy storage is a technology in which Italy, thanks to Terna, is at the cutting edge globally. In particular, the Storage Lab project represents the largest multi-technological battery site in Europe, and the first storage project supporting and protecting electricity grids, which makes Codrongianos the electrical hub with the largest number of technologies in the world. In addition, near Codrongianos stands the terminal station of the modern high-voltage direct current power line, SA.PE.I. Which connects Sardinia directly with the Italian peninsula thanks to a record-breaking installation.

At about 200 kilometres further South, instead, is the **Sulcis innovative hub**: an open-air laboratory for testing the operating characteristics of electrical-current insulators. It is called *Lanpris* and is an experimental test field that Terna has created within the Sulcis electrical substation: it is one of the few plants in the world of this kind for studying insulators and will serve to identify innovative technological solutions to improve the safety of both power lines and electrical substations.

STORAGE LAB - WORLD RECORDS IN NEW TECHNOLOGIES FOR ENERGY STORAGE

The Codrongianos site hosts Terna's Storage Lab, the first project at the international level for energy storage systems to support and protect electricity grids. An experimental project, of a significantly innovative nature, designed by Terna and developed in agreement with the AEEGSI, to maximise the use of resources from renewable sources and improve the robustness of the high-voltage and very-high-voltage system. For years, Terna has considered as necessary the creation of battery-based storage systems, above all in the South and on the larger islands, to stabilise and balance the typical intermittence of renewable sources, which in Sardinia cover more than 40% of energy consumption.

The Storage Lab carries out field testing of the efficiency and performance of the most advanced technologies in circulation and refines grid management and monitoring tools, for greater security and lower costs. The large majority of technological storage solutions currently available, in fact, need adequate testing before being judged suitable. The testing of storage systems at the Storage Lab has the objective of identifying the right mix of technologies capable of optimising the cost/benefit ratio and the characteristics of each of the technologies such as useful life, construction times, efficiency, performance, as well as possible 'smart grid' solutions associable with each technology.

With around 12 technologies tested, Terna has the greatest know-how on the subject of grid-scale energy storage at the global level. At Codrongianos, where it is testing seven technologies, Terna has already completed the installation and commissioning of the first 7.4 MW storage systems and a further 0.4 MW of capacity is being built, as provided for by the company in the electricity grid Defence Plan. 8 suppliers have contributed to this first stage of the project: the Italian Fiamm, Samsung, Byd, Saft, General Electric, Toshiba, Siemens and Ghildemeister.

ELECTRICAL STORAGE IN THE SERVICE OF SECURITY AND RENEWABLES

Storage systems can be used in different ways, depending on the technologies adopted. Firstly they are needed to store energy, in particular renewable energy, which as it is intermittent cannot be modulated or programmed. Therefore the use of batteries enables Terna to store energy during the hours of maximum wind or solar production, a phenomenon that often causes congestions on the critical nodes of the grid, before releasing it in moments of low productivity. In this way, the security of the grid is increased, and a reduction in energy costs is obtained; in fact, batteries enable the storage of energy from renewable sources which, in the event of congestion, has to be 'cut'. Another use is for applications related to the security of the grid, and that is to support defence systems through the supply of ultra-rapid power surges to compensate for the low inertia typical of systems on islands or those which are not highly interconnected.

Those in operation at Codrongianos are batteries that mainly use Lithium (Li-Ion) technology, i.e. systems capable of absorbing and releasing energy very rapidly for emergency situations, useful,

therefore, for intervening almost instantaneously when there is a need on the grid, and Zebra technology which, if called upon, is capable of providing electricity for several hours.

SYNCHRONOUS CONDENSERS - MORE SECURITY AND SAVINGS FOR THE ELECTRICITY SYSTEM

Sardinia holds the record, hosting Terna's first two synchronous condensers, specially designed for better management of renewables. The Codrongianos site was chosen for its strategic position with respect to the objective of regulating and stabilising the Sardinian grid which these complex devices are called upon to achieve.

They are large machines, weighing 320 tonnes each, produced by Ansaldo Energia (leading group internationally in the production of power stations) connected to the grid with complex plants built by ABB (leading group in energy and automation technologies) which make it possible to improve the stability and security of the electricity grid in the region. As in the rest of Italy, also in Sardinia the development of renewable sources - which by their nature are intermittent, and therefore non-programmable, and create power surges - is increasingly involving the local electricity grid: this can entail, above all in grids which are not highly interconnected with each other and not very large (as in the case of Sardinia) difficulties in their management and in regulating voltage. Condensers are thus a valid solution for avoiding these problems: **their task is to guarantee greater control and more flexible operation, and therefore to improve grid functioning by avoiding power surges, and also lower energy losses, preventing critical situations**. Besides Terna, several European and American utilities already use this type of technology to stabilise the electricity grid.

LANPRIS - GLOBALLY UNIQUE EXPERIMENTAL LABORATORY FOR ELECTRICITY LINES

A true experimental test field for effectively and reliably testing the characteristics of insulators, important devices - usually made of glass and ceramics in electrical substations - which have the function of isolating very-high-voltage electrical cables from the pylons that support them. It is called *Lanpris* (Laboratorio Naturale Prova Isolatori - Natural Insulator Testing Laboratory) and is located in the electrical substation that Terna manages in the Sulcis area. There are very few plants like this in the whole world: just one in France and one in South Africa.

It is in the Sulcis innovative hub that Terna is studying new technical solutions for improving the installation, operation and maintenance of electrical current insulators. Insulators, which are tasked with isolating very-high-voltage cables, must keep working properly in adverse weather conditions and with serious agricultural and industrial saline pollution. They are also exposed to the action of wind and salt spray (especially in coastal areas). This mix of conditions, if persistent, can prejudice the normal functioning of a power line, compromising its safe operation. Owing to the particular environmental conditions and its geographical position, the Sulcis area was ideal for the installation of this plant, which is well-suited to recreating the saline pollution conditions typical of certain zone coastal areas subject to strong winds coming from the sea that deposit salt on insulators.

The *Lanpris* laboratory thus enables Terna's technicians to test and study insulators effectively in a natural environment and one which is therefore more realistic compared to a laboratory. In this way it will be possible to obtain more detailed and precise information on the technical characteristics of insulators and their useful life, and compare different technologies to be able to use those that best respond to the needs of the grid in the future. **Among the different types of insulators that Terna is studying there are also those made of organic material and those made of glass with silicone rubber**.

SA.PE.I. - THE RECORD-BREAKING POWER LINE BETWEEN SARDINIA AND THE ITALIAN PENINSULA

The SA.PE.I. is a world-record-breaking project. It is, in fact, the first direct electrical connection between Sardinia (Fiumesanto) and the Italian peninsula (Latina), and therefore the continent, and the most important and technologically-advanced high-voltage power line ever created in Italy.

With 435 km direct-current line, of which 420 km in undersea cable, it is today the longest "electrical bridge" in the world with power of 1,000 MW. Laid at a maximum depth of 1,640 metres on the bed of the Tyrrhenian Sea it is the deepest undersea cable in the world. At € 750 million, it is the most important investment ever made in Italy for a single electrical infrastructure. Operational since 2011, the SA.PE.I. has brought notable environmental benefits and enables savings of € 70 million a year for the benefit of Italian households and businesses, thanks to the removal of the "bottlenecks" between the Sardinian zone and the rest of the electricity market and the elimination of the price spread with the rest of the peninsula (since it came into operation there has been a gradual alignment of the zonal price of Sardinia with the SNP).

At the environmental level, the SA.PE.I., created with the maximum respect for the marine and terrestrial habitats it crosses, enables a reduction of more than 500 thousand tonnes of CO_2 in the atmosphere as a result of the greater use of renewable energy.

SA.CO.I. - THE FIRST AND ONLY THREE-TERMINAL DIRECT-CURRENT CONNECTION

Codrongianos hosts the electrical substation of the SA.CO.I., the direct-current electrical connection between Sardinia, Corsica and the Italian peninsula, which came into operation in 1966 and has been operating commercially since 1967.

390 km long, of which 120 km is undersea and 270 km on land, and capable of transferring up to 300 MW of electricity, it is even today the first and only three-terminal power line in the world: since 1987, in fact, the power line has connected the terminals of Codrongianos (Sardinia), Lucciana (Corsica) and Suvereto (Tuscany).