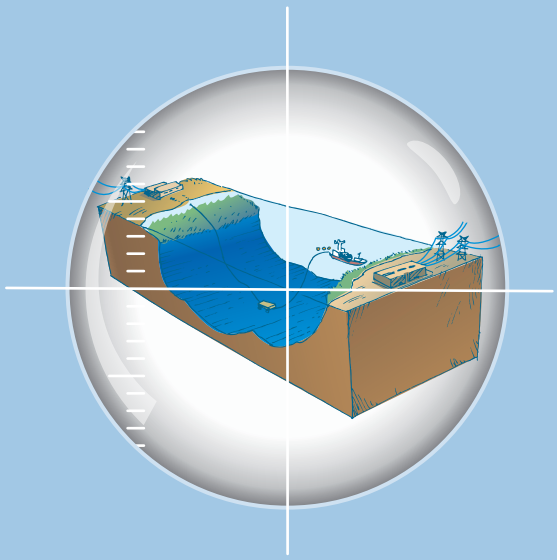
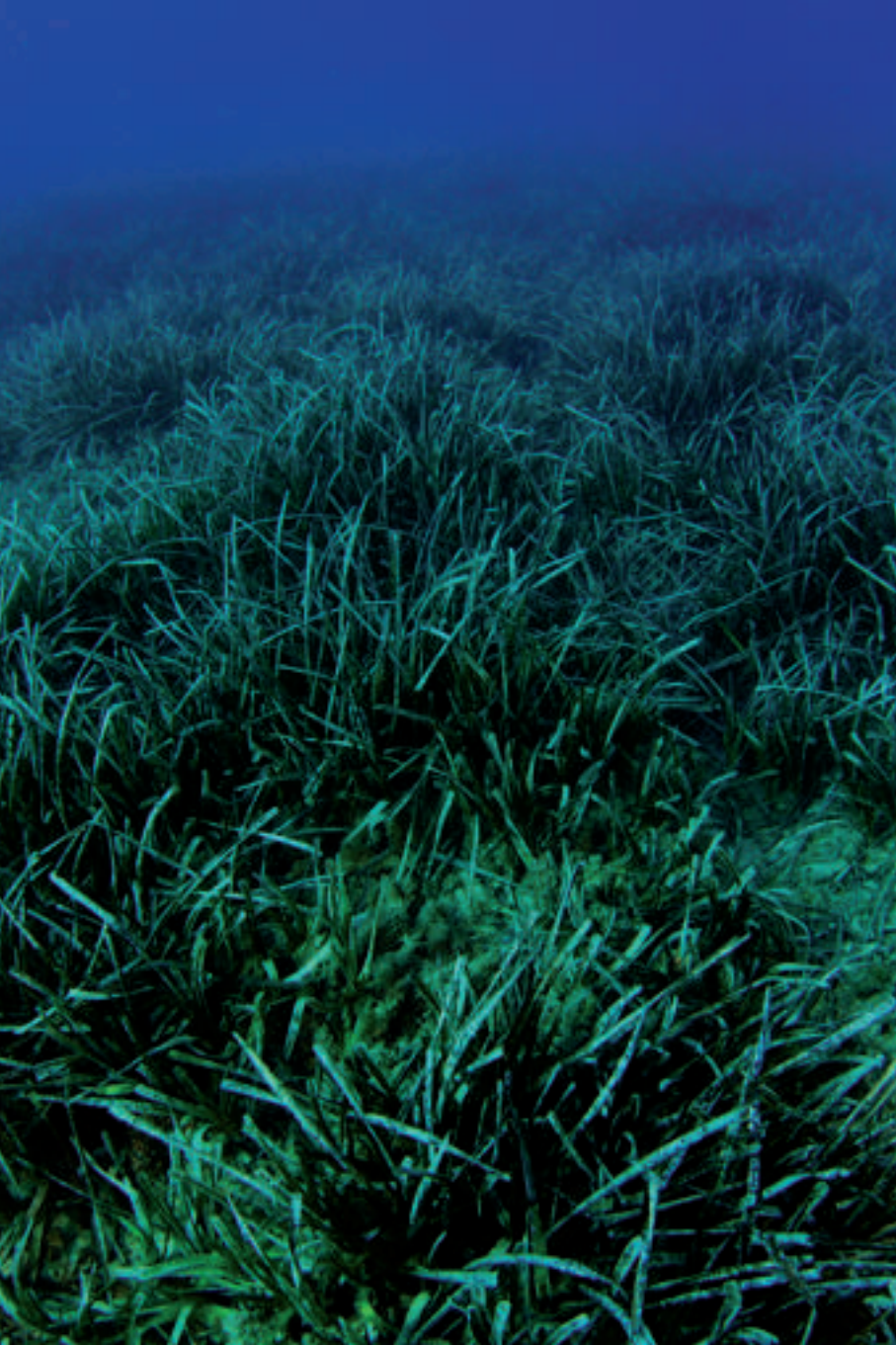
RED ELÉCTRICA DE ESPAÑA



RÓMULO

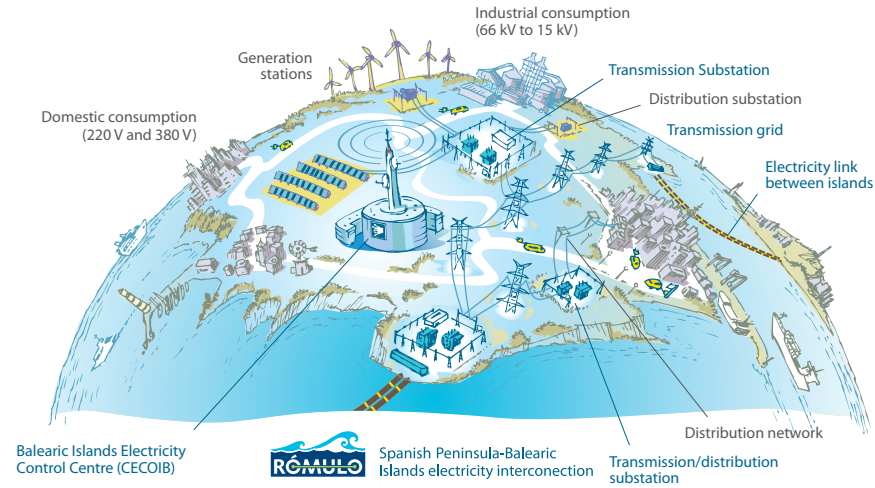
THE SPANISH PENINSULA
BALEARIC ISLANDS ELECTRICITY
INTECONNECTION



The Spanish Peninsula-Balearic Islands electricity interconection

The electricity interconnection between the Iberian Peninsula and the Balearic Islands, known as the RÓMULO project, is the first submarine interconnection for the transmission of electricity in direct current that exists in Spain.

This interconnection represents the largest investment ever made by Red Eléctrica in one single project and its development has represented a milestone, of world reference, due to its unique nature and technical complexity, which has demonstrated the remarkable technological capacity of Red Eléctrica.



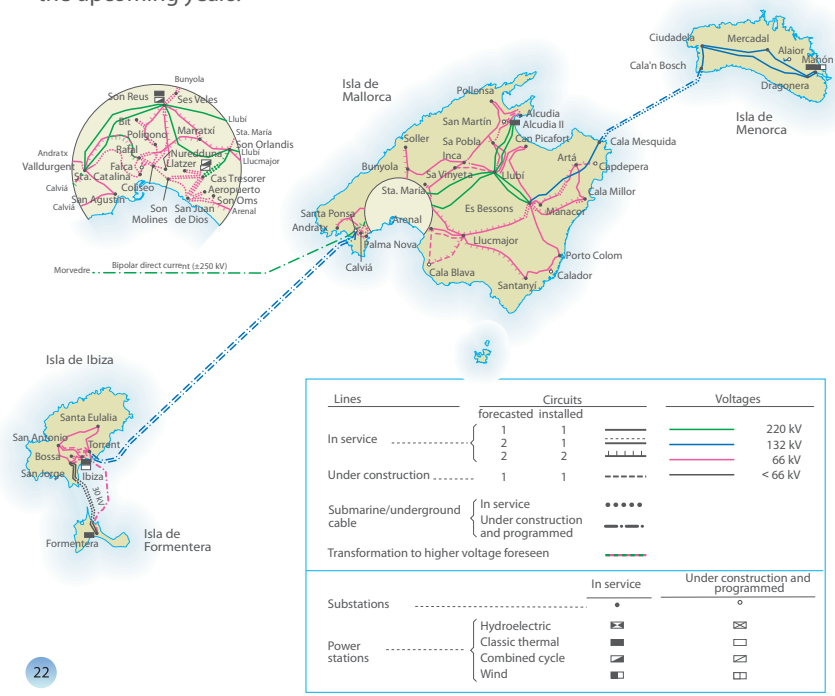
The Balearic Islands electricity system

The Balearic Islands electricity system was comprised of two smaller-sized subsystems which were electrically isolated, Majorca-Menorca and Ibiza-Formentera, which made it difficult to achieve similar stability and quality of service indices as those systems which are larger and more interconnected.

For this reason, Red Eléctrica undertook this electricity interconnection project to provide a link with the Iberian Peninsula transmission grid, with the aim of improving the quality and security of the Balearic Islands electricity supply and to guarantee coverage of the demand on the islands.

The interconnection with the peninsula, in addition to representing a complementary option to the construction of new power stations in the Balearic Islands, will also allow competition in the Islands' generation market to be increased, with the consequent improvement in energy efficiency and sustainability of the Balearic Islands electricity system.

Additionally, the current electricity infrastructure plan also contemplates linking both electricity subsystems of the Balearic archipelago in a redundant manner, by means of the Majorca-Ibiza dual link that Red Eléctrica will be undertaking in the upcoming years.

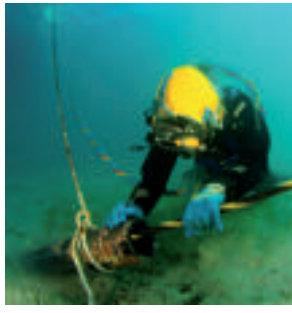


Technical characteristics

The route chosen for the electricity interconnection between the peninsula and the Balearic Islands links the Morvedre substation in Sagunto (Valencia), with the Santa Ponsa substation in Calviá (Majorca).

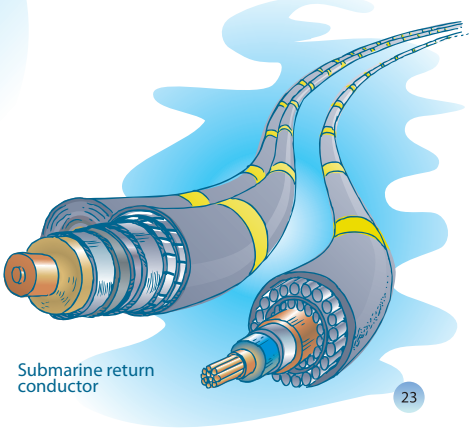
The project involved the installation of a high voltage submarine interconnection of ±250 kilovolts, carried out by means of a 400 megawatt bipolar link with a return conductor. That is to say, it is an interconnection which comprises of two power cables in addition to a third return cable to increase the availability of the electricity supply. The submarine link has an approximate length of 237 kilometres and runs at a maximum depth of 1,485 metres.

Due to the distances and power capacity necessary for this dual link, the interconnection was designed to use direct current technology, which allows the energy losses in transmission to be reduced, controls the bidirectional power flows and increases the power transmission capacity with respect to a cable using alternating current.



GENERAL DATA REGARDING THE PROJECT

System current:	direct(HVDC)
Nominal voltage:	± 250 kV
Transmission capacity:	400 MW (2 x 200 MW)
Nº of circuits:	bipolar link with metallic return
Nº of electricity cables:	2 power cables and one return cable
Fibre optic cables:	1 cable with 24 fibres
Total length of the interconnection:	244 km
• Morvedre underground section:	4 km (Morvedre)
•Submarine section:	237 km
• Underground section:	3 km (Santa Ponsa)



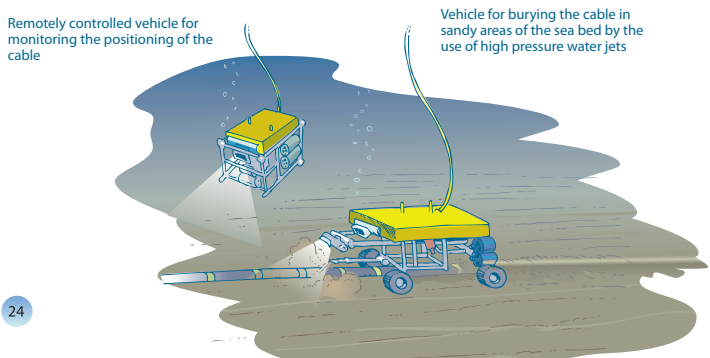
Laying of the cables

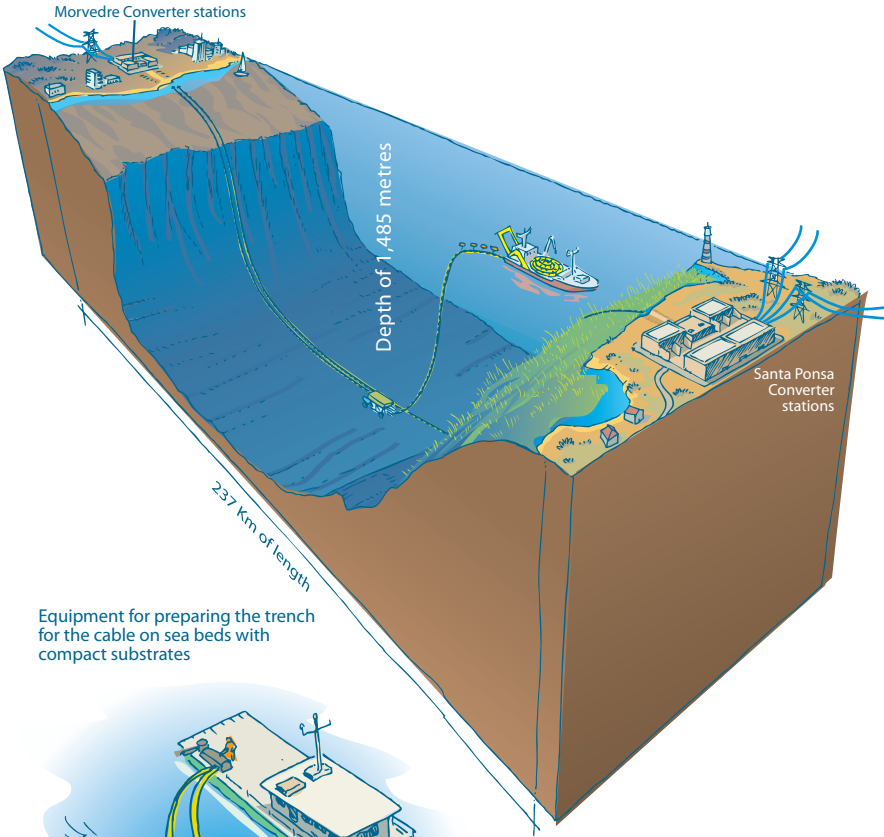
The laying of the submarine cables was performed using the only two ships in the world specialised in this type of work, the Norwegian ship, the Skagerrak, and the Italian ship, the Giulio Verne. These ships have dynamic positioning equipment to be able to exactly follow the established routes selected for the cables and are equipped with propulsion systems that allow them to remain perfectly stationary so they can carry out the positioning of the cables, a job that requires maximum precision.

The capacity of these two ships facilitated the transportation of the 6,700 tons in weight that each submarine cable weighs, which allowed the cables to be laid in one single length, without the need to use intermediate splices. For the correct positioning of cables on the sea bed, continuous monitoring of their position was carried out by means of a remotely operated vehicle. This made it possible to make minor adjustments to the route to avoid any irregularities in the sea bed.

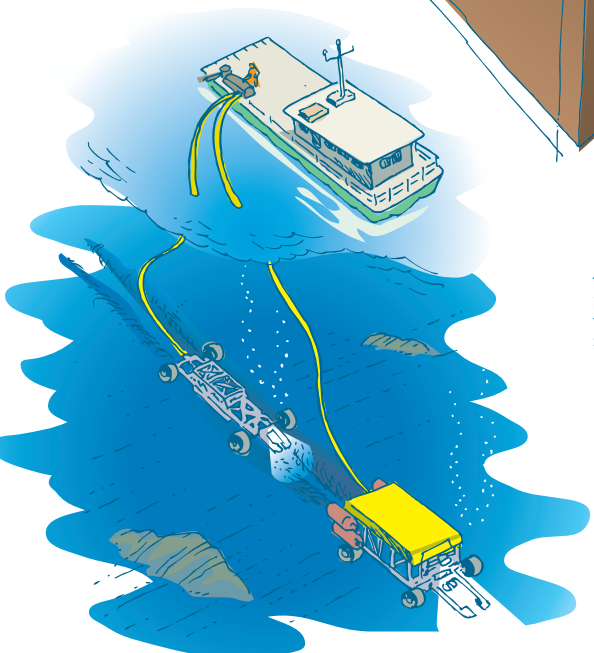
Near to the coast, the cable laying was carried out by means of floats, auxiliary boats and divers, and in deeper zones, (up to 1,000 metres) special underwater vehicles using high pressure water jets were used to bury the cables, in order to prevent possible damage to the cables that might occur by trawling or anchorages. Also, in rocky areas of the sea bed, or areas with a very thin surface layer of sand, narrow trenches were opened to house the cables and act as a protection system.

Additionally, underground sections of just over 3 kilometres in length were constructed at each end of the interconnection, and once connected to the submarine cables, the cables then pass through the underground section to their connection point in the converter stations. In addition a fibre optic cable was installed alongside the electricity cables, so as to guarantee communications between both ends of the interconnection.





Equipment for preparing the trench for the cable on sea beds with compact substrates



The submarine cables were laid in one single length, without the need to use intermediate splices

Converter stations

The unique nature of this project made it necessary to construct two converter stations, one at each end of the interconnection. Their function consists of transforming the alternating current that flows in both the peninsular electricity system and the insular system into direct current, which then flows through the submarine cable, and vice versa.

On the Balearic Islands side, the Santa Ponsa 220 kilovolts station has been located in Calviá (Majorca), whereas on the other side, the connection point to the peninsular grid, the 400 kilovolts station has been located in Morvedre in Sagunto (Valencia). Both stations are the first of this type to be constructed in Spain and one of the few with similar characteristics that exist in Europe.

The converter stations are equipped with state-of-the-art elements and technical devices that allow energy losses in the conversion process of the electrical current to be reduced to the maximum and have redundant backup systems to cover all possible eventualities which might occur in either of them. In addition, all electrical parameters of the interconnection are supervised via the converter stations, with the purpose of ensuring its total availability and reliability.

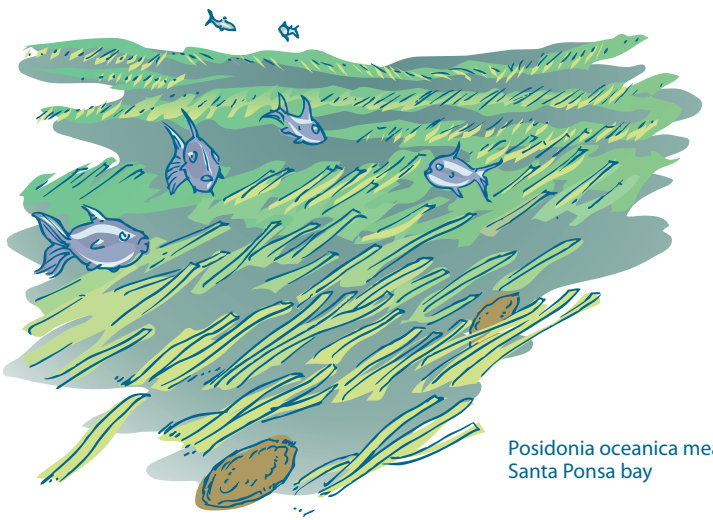
Images of equipment in the converter stations

Environmental actions

Maximum respect for the natural environment was one of the main priorities of the project. With this as an objective, a route was chosen that avoids archaeological sites and fish-farming areas, and reduces the impact on protected flora and fauna, as well as the possible effects on the tourism and fishing sector.

One of the elements analysed as being of greatest environmental value was the Posidonia meadows in Santa Ponsa bay, a species of seagrass which is endemic to the Mediterranean Sea, which is protected at a European level. This fact meant that in depths shallower than 60 metres the route for the cables and its protection system, by way of a narrow trench opened for this purpose, were carried out in a special way so as to guarantee the conservation of this species.

Similarly, in the construction of the converter stations the utmost care was taken to ensure that they were integrated into the landscape, using materials and building solutions that reduced the visual impact of the facilities and equipment on the environment in which they were located.



Posidonia oceanica meadows in Santa Ponsa bay

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