The paper *Energy Transition system prospective and operability studies in Spain* presents the main results from the studies carried out by Red Eléctrica, (Spanish system operator), in the framework of the planning process 2021-2026 for the islanded systems of Canary Islands and Balearic Islands.

Due to its different nature and, mainly, distance to mainland Spain, the decarbonization strategy followed in these two archipelagos is rather different, and follows the principles applied, in general, throughout the world.

The distance between Mallorca (the biggest of the 4 Balearic Islands) to the Iberian Peninsula is just around 240 km. Nowadays an undersea HVDC link of 2x400 MW connects both systems. At the same time, Formentera, Ibiza, Mallorca and Menorca are linked with undersea AC cables. Being peninsular Spain one of the countries with a higher share of renewables in the electric system (48,4% in 2022) and expected to increase up steadily to more than 70% in 2030, increasing the interconnection capacity between Balearic Islands and the Iberian Peninsula is the most efficient choice to decarbonize the Balearic system.

This increase of interconnection capacity will be achieved by means of a second undersea HVDC link between Mallorca and mainland Spain of 2x400 MW which will allow to cover a great part of the archipelago energy needs with energy coming from mainland Spain (which, moreover, is part of Continental Europe system, also, expectedly highly decarbonised in the years to come).

As fully integrated assets in the Balearic system, two batteries (90 MW in Ibiza + 50 MW in Menorca) have been planned together with two synchronous condensers of 100 MVA each which will increase the possible power transfer between the Iberian Peninsula and the Balearic Islands, and also, the power transfer between islands .

An emergency control in the batteries will allow a fast ramp-up of back-up power in case of some link failure and will cover the energy needs until firm generation covers the gap. Besides, the two 100 MVA synchronous condensers provide the needed system strength and inertia to allow this emergency control to deploy).

On the other side, Canary Islands is a quite distant archipelago from mainland Spain. The decarbonization strategy there is quite different to the one in the Balearic Islands, and accounts on improving the system capabilities to provide the needed reserves and inertia to ensure balance feasibility and system stability by means of new hydro pump storage, batteries, synchronous condensers and, when feasible, by means of linking system with undersea AC cables.

Renewable integration in islanded systems is specially challenging. Adequacy studies have to combine with static and dynamic stability studies. A crucial fact to ensure a safe operation of these system is to carefully study the must-run synchronous units that are needed in these systems. These units support frequency and voltage stability, both in steady state and also in transient state when a perturbation happens. As renewable energy technologies (inverter based) get more mature, the need of a synchronous must-run (usually based on fossil fuels) gets smaller and, thus, improves the figures of renewable energy integration by diminishing renewable curtailment. This goes through the capability of these units to provide upwards/downwards reserves, ramp limitations, voltage control, fast injection of reactive power and fault ride through, inertia emulation, etc. as well as the provision of grid forming capabilities. In the case of the Canary Islands, specially, renewable energy resource variation (in different time frames, from seconds to minutes) sums up to the reserve needs that have to be sized at any time.

Bibliography shows a quite similar approach to facing these challenges in islanded systems throughout the world (Palau, Samoa, Antigua and Barbuda, Vanuatu, Fiji, etc.)

Red Eléctrica (Spanish TSO) is pioneer in facing challenges related to renewable energies integration and was the first system operator in having a control centre exclusively dedicated to the monitoring and management of renewables (CECRE).
Moreover, Red Eléctrica operates the system of one small Canary Island (El Hierro), which , since 2015, when Gorona del Viento hydro power plant was commissioned, is a cornerstone of renewables integration: energy produced by wind farms in this island is used to supply demand and to fill the upper reservoir of the hydro power plant. The coordinated operation of the hydro power plant with the renewable energies of the island makes possible the operation of such a small system with renewable integration levels higher than 50% at annual level, and with a record of 24 consecutive days fully renewable.