Iberian Electricity Market Performance under European Energy Transition Scenarios for 2050

Vivian Sousa, António Couto, Pedro Graça, Ana Estanqueiro
Renewable Energy and Energy Efficiency Unit,
LNEG - National Laboratory of Energy and Geology,
1649-038 Lisboa, Portugal
{vivian.sousa, antonio.couto, pedro.graca,
ana.estanqueiro}@lneg.pt

Konstantin Löffler, Nikita Moskalenko
Technische Universität Berlin, Straße des 17. Juni, 10623 Berlin, Germany
{kl, nim}@wip.tu-berlin.de

***Abstract*—The Man0EUvRE project analyses the required energy transition in Europe, extending beyond typical scenarios focused only on renewable integration pace by incorporating key uncertainties such as geopolitical fragmentation, limited cooperation, and technological innovation. This study evaluates the performance of the Iberian Electricity Market (MIBEL) between 2030 and 2050 under four distinct scenarios. Long-term capacity expansion is modelled with GENeSYS-MOD, while hourly day-ahead market clearing prices are simulated using PyMIBEL-DAM, capturing both strategic investment decisions and operational dynamics.**

The results highlight strong growth of variable renewable energy sources (vRES) through 2050, particularly solar photovoltaic, and the resulting price cannibalisation that challenges the economic viability of solar generation in a market environment. Wind generation, in contrast, maintains more stable capture prices showing differences in the market value across vRES technologies. Therefore, a carefully designed transition pathway, by integrating a balanced generation mix, robust flexibility solutions, and reinforced cross-border interconnections between Portugal and Spain, is essential. Such integration will provide the necessary market signals for sustainable decarbonisation of the Iberian power system while ensuring overall system efficiency.

***Index Terms*—Day-ahead and balancing markets, Energy modelling, Iberian Electricity Market, Market simulation, Renewable energy.**

I. INTRODUCTION

As climate change accelerates and extreme weather events intensify, the urgency to achieve carbon neutrality continues to grow. In Europe, ambitious policy frameworks, such as the European Green Deal, and REPowerEU, address this challenge by targeting greenhouse gas reductions, strengthening energy security, and positioning the European Union (EU) to become the first climate-neutral continent by 2050 [1]. Despite the limited timeframe, the 2030 National Energy and Climate Plans (NECPs) of several countries already reflect this commitment, emphasising variable renewable energy sources (vRES), particularly, wind and solar photovoltaic (PV), as central technologies for decarbonising power systems in the coming decades [2].

To support the development of these frameworks, energy system models, such as eTIMES_PT [3] and Global Energy System Model (GENeSYS-MOD) [4], provide sector-wide scenarios by identifying, for instance, optimal capacity expansions, generation portfolios, and flexibility requirements. However, these models make simplifications, *e.g.*, the simulations are performed for representative periods, which can overlook important operational challenges, especially under scenarios with large-scale integration of vRES. Therefore, it is essential to bridge the gap between high-level policy modelling and technical feasibility by assessing the impact of these long-term scenarios using dedicated country/region-specific power system and market specification simulations.

This assessment is becoming increasingly important as the world experiences growing geopolitical fragmentation, limited international cooperation, and rapid technological changes [1]. On the other hand, electricity markets remain anchored to some principles developed in an era dominated by dispatchable thermal generation. For instance, the marginal cost-based pricing principle does not fully accommodate the operational characteristics of vRES, that have low or near-zero marginal costs and depend on power forecast with limited accuracy [5]. Therefore, this market design can drive electricity prices to zero or even negative values through the so-called “merit order effect” [5], [6]. This effect can reduce the incentives for investment in new capacity and distort the development of efficient energy mixes and flexibility solutions, potentially hindering the achievement of renewable energy targets in Europe [7]. For instance, for 2050, on a pan-European scale, the authors identify flexibility enabled through sector coupling and cross-border interconnections as a key determinant of the economic value of vRES [8]. Similarly, Hugo et al. [9] also highlight that achieving an equilibrium between demand-side