

INVESTMENT DECISIONS IN RENEWABLE ELECTRICITY GENERATION TECHNOLOGIES

INTEGRATING TECHNICAL, ECONOMIC, SOCIAL
AND ENVIRONMENTAL DIMENSIONS

PALLOMA DA COSTA E SILVA

Master in Economics and Business Management

DOCTORATE IN CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT

NOVA University Lisbon

March, 2026

ABSTRACT

The transition towards low-carbon energy systems has become a central pillar of global climate mitigation strategies. Renewable electricity technologies, particularly solar photovoltaic and wind power, play a key role in reducing greenhouse gas emissions and supporting the objectives of international climate agreements. However, the analytical frameworks that guide renewable energy investment decisions tend to focus on the factors that drive capital mobilization rather than on how investment allocation translates into broader macroeconomic and social outcomes. Financial evaluation tools commonly used in investment analysis typically prioritize private profitability and risk-management criteria, while from a public policy point of view, the investment decisions should be evaluated in terms of their macroeconomic impacts, namely externalities, distributive effects and environmental outcomes. This multidimensional perspective is particularly relevant in the European context, where the energy transition is framed as both climate mitigation and a socially just. In addition, despite the growing importance of renewable energy, its broader socioeconomic implications remain less systematically assessed within energy policy analysis. Most energy system modeling frameworks focus primarily on techno-economic optimization and emissions reduction. As result, macroeconomic performance and distributional effects of renewable energy deployment are rarely evaluated in an integrated manner. This fragmentation highlights a broader analytical challenge: integrating climate, economic and social dimensions into energy policy and investment decisions within a coherent public analytical framework.

This research aims to analyze the macroeconomic and distributional implications of renewable electricity deployment and to develop an analytical framework capable of supporting more comprehensive and policy-relevant investment decision in renewable electricity generation technologies. To achieve these objectives, the research combines complementary analytical approaches across several empirical analyzes. First, a critical review of financial evaluation methodologies used in renewable energy investment decisions examines their capacity to capture multidimensional impacts beyond private profitability criteria. Second, econometric analysis based on panel data using fixed effects models combined with cluster analysis, categorizes a group of 32 countries in order to examine the relationship between renewable electricity generation and key socioeconomic indicators, including economic growth, employment, emissions per capita and income inequality (measured by Gini Index). Third, the analysis explores the relationship between renewable electricity expansion in five key indicators serving as proxies of just energy transition, covering the EU-27 and UK from 2007-2022. Finally, an integrated modeling framework is developed by combining the TIMES_PT energy system model with econometric estimates to evaluate alternative renewable electricity deployment scenarios for Portugal up to 2030.

The results indicate that renewable electricity expansion is positively associated with economic growth and employment, with gross domestic product (GDP) emerging as the main economic variable positively affected in countries with higher installed renewable capacity. Economic benefits appear more consistent when installed capacity reaches levels of 35,000 MW or more. However, the effects on income inequality remain limited and heterogeneous across technologies and countries. Scenario analysis for Portugal further shows that different renewable technology portfolios generate distinct

socioeconomic and employment outcomes. In particular, although the Technological scenario produces the largest increases in GDP and employment, the Policy scenario combines more institutionally feasible deployment levels with substantial economic benefits while maintaining more balance employment gains.

By bridging energy system modeling with empirical socioeconomic analysis, this thesis contributes to the literature by proposing an analytical framework capable of simultaneously assessing technological feasibility, economic performance, environmental and social outcomes. The findings suggest that renewable electricity planning should not be treated solely as a decarbonization strategy but rather as part of a broader economic and social development framework, providing relevant insights for policymakers seeking to design sustainable and inclusive energy transition pathways.

Keywords: renewable electricity, technological choices, macroeconomic impacts, just energy transition, econometric analysis, energy system modeling