

Impacts of green transition on employment: an analysis based on "brown jobs"

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Executive summary

The transition to a low-carbon economy is an existential imperative facing humanity. Policies for transitioning to a decarbonized economy have impacts on employment, potentially generating and/or reproducing inequalities. In Portugal, 85% and 70% of greenhouse gas emissions are concentrated in 20% and 10% of jobs, respectively. Among the jobs that are on average associated with higher levels of emissions – the so-called “brown jobs” – there are heterogeneous socioeconomic profiles that exhibit different levels of vulnerability to the climate transition. The first, larger cluster presents a profile with a low incidence of higher education, slightly older, with lower remuneration, and whose average greenhouse gas emissions – measured by the Occupational Emissions Score (OES) – have decreased at a slower pace in recent years; the second cluster is characterized by incorporating workers who have higher education, are younger, earn significantly above the national average, and whose OES has declined more markedly.

Recommendations

- Creation of a multi-year compensation mechanism;
- Strengthening the governance of the just transition;
- Expanding access to social protection instruments, including subcontracted workers;
- Integration of *ex-ante* diagnoses and binding territorial plans into the closure and restructuring processes of large companies in the energy sector.

Recipient(s) of the policy brief

Policymakers; Trade unions; Employers' confederations; Business associations.

Introduction and Problem Statement

Climate change represents one of the main global threats, stemming from the intensification of greenhouse gas emissions that derive from human activity, with severe impacts on ecosystems and society. The

planet's average temperature has been increasing at historically high rates, and this trend is related to human activity. In the decade 2011-2020, the surface temperature was 1.1 °C above that recorded in the period 1850-1900

(IPCC, 2023). According to the World Meteorological Organization (WMO, 2025), the temperature increase relative to the pre-industrial period was 1.55 °C in 2024. This value is above the 1.5 °C set by the 2015 Paris Agreement as the first threshold whose transgression should be avoided – the second, more serious threshold, is 2 °C.

The international response to global warming has been progressively structured since the end of the last century, with a more recent decisive impetus given by the United Nations' 2030 Agenda (2015), the Paris Agreement (2015) and, at the European level, the European Green Deal (2019) and the European Climate Law (2021). These agreements and instruments converge on the assumption that it is imperative to decarbonize the economy in the face of evidence of a climate emergency, and they point to targets and strategies for this.

In line with international and European objectives, Portugal has developed a structured climate policy. The Roadmap for Carbon Neutrality 2050 (2019) and the Framework Law on Climate (2021) acknowledge the climate emergency and enshrine principles such as climate justice, a just transition, and the protection of vulnerable populations. The country has also approved the National Strategy to Combat Energy Poverty 2023-2050 and the National Energy and Climate Plan 2030 (2024), which reinforce the need to ensure territorial and social equity during the energy transition. In particular, the National Energy and Climate Plan 2021-2030 sets a reduction of between 45% and 55% in greenhouse gas emissions by 2050 and an incorporation of 47% of energy from renewable sources in gross final energy consumption.

Climate change poses existential challenges to humanity, but it also tends to reproduce and exacerbate existing inequalities. Phenomena

such as rising average temperatures, rising sea levels, and flooding caused by heavy rainfall disproportionately penalize populations in low- and middle-income countries – especially those living on the coast – as well as low-income families. Additionally, climate action policies can potentially generate and/or exacerbate inequalities, ranging from regressive fiscal effects to negative impacts on employment in certain occupational categories or sectors of activity.

There is a growing consensus that a green transition requires, on the same level, a just transition. According to the ILO (2015), a just transition implies a concerted multidimensional approach that reconciles the pursuit of environmental objectives, the economic development strategies of countries and regions, and guarantees of decent work – in particular, skills development, health and safety at work, social protection, active employment policies, and social dialogue. In this sense, the ILO states that “A just transition means promoting a green economy in a way that is as fair and inclusive as possible to everyone concerned – workers, enterprises and communities – by creating decent work opportunities and leaving no one behind.” (ILO, 2023, p. 12).

The fact that territories and social groups that contribute least to greenhouse gas emissions tend to be the most penalized by climate change, but also the fact that certain more vulnerable social groups may be the main victims of climate action policies, appear to be “double or triple inequalities” (Dwarkaning, 2013). It is therefore important to ensure that the green transition is simultaneously a just transition.

Analysis / Key Findings

The analysis of greenhouse gas emission concentrations is typically done at the sectoral level. However, it is important to consider that employment within a sector is not homogeneous. On the contrary, it generally involves very different occupations, in terms of the specialization of their functional content, the

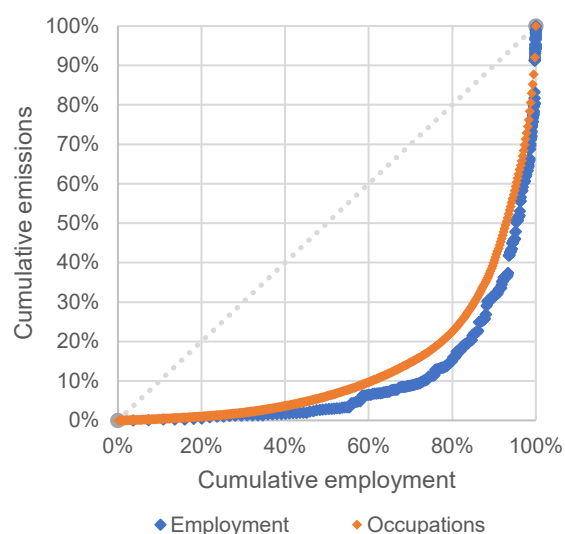
qualifications that grant access to them, and the skills required and developed. These characteristics directly interfere with processes of change in the functional content of a occupation or occupational retraining. For these reasons, it is necessary to measure the impacts of the transition to a low-carbon

economy on employment from the perspective of occupations.

For this purpose, this study relied on the Occupational Emissions Score (OES) metric, which can be interpreted as the average volume of emissions associated with each job in each economic activity.

The average emissions associated with each private sector job in a given occupation, in Portugal, between 2018 and 2022 (OES1822), were quite concentrated: 80% of the employed population is associated with 15% of OES1822 – meaning that the remaining 85% of emissions are concentrated in only 20% of the employed population. Furthermore, 80% of occupations are associated with only 22% of total OES1822 – meaning that the remaining 78% of emissions are concentrated in just 20% of occupations.

Figure 1 – Concentration of the Occupational Emissions Score (OES), by employment volume and occupations (CPP10 – 4 digits) (2022)



Source: Authors' calculations based on INE and Quadros de Pessal.

Within the universe of people employed in occupations that register a high level of OES1822, it was possible to identify two clusters that differ from each other with respect to gender, age, education level, earnings of their workers, and rate of emission reduction.

The first cluster is characterized by being composed mostly of men, older people, with low levels of higher education, earnings below the national average, and who register a lower average reduction in emissions. This cluster includes, depending on the chosen OES threshold, between 126,000 (top decile of the OES distribution) and 300,000 jobs (top quintile of the OES distribution) in occupations that are and/or will be subject to considerable transformations in quality and number to keep pace with the imperative of drastically reducing greenhouse gas emissions.

The second cluster is balanced from a gender perspective, composed by workers who are slightly younger than those in cluster 1, with higher education, who have significantly higher average monthly earnings than the national average, and who recorded a more significant reduction in their OES2018-2022.

Table 1 –Characterization of the occupational clusters in the top quintile of the Occupational Emissions Score (OES) distribution (2022)

	Cluster 1	Cluster 2
Employment (k)	298,9	65,5
Men (%)	82,1	54,9%
Age (years)	43,6	39,8
Higher education (%)	9,4	81,1
Mean earnings (€)	1250	2215
Δ OES 2022-2018	-26,0	-38,8

Source: Authors' calculations based on INE and Quadros de Pessal.

Policy Options and Recommendations

The current institutional and policy framework of the Just Transition highlights the need to strengthen the temporal consistency of income protection mechanisms, improve institutional coordination, and mitigate the risks of uneven implementation, both at the territorial level and in the design and application of instruments

intended to ensure contributory protection, labour transition, and social protection along the value chain.

To address this situation, the following public policy recommendations are put forward:

1. Establishment of a multi-year **compensation mechanism** (3–5 years), with periodic review, ensuring income stability and social protection throughout the labour transition, independent of annual fiscal decisions and guaranteeing continuity in access to income protection instruments. The mechanism should:

- **Guarantee the automatic updating of compensation** indexed to inflation;
- Ensure **full contributory protection**;
- Allow **partial suspension of compensation**, aligning income protection with incentives for temporary labour market integration.

2. **Strengthening the governance of the Just Transition**, based on effective coordination with the institutions of the tripartite social dialogue and a territorially anchored approach, through:

Consolidation of the role of the Permanent Commission for Social Dialogue in relation to its pronouncements and monitoring of this issue;

- **Creating Regional Just Transition Commissions**, with representation from unions, businesses, local authorities and the Government, responsible for coordinating local investment plans, professional retraining, monitoring compensation and identifying employment opportunities;
- Effectively integrating the **Just Transition Mechanism** with Social Security, IEFP (Institute for Employment and Vocational Training) and the Environmental Fund, overcoming the current institutional fragmentation.

3. To guarantee **equitable access to social protection instruments for all workers** affected by closure or retraining processes, including subcontracted workers, through the principle of joint and several liability throughout the employment chain. To ensure the completion of preparatory assessments that identify all workers and service providers covered, in order to guarantee effective coverage and access to protection and retraining mechanisms.

4. **To guarantee a fair, continuous, and territorially anchored labour transition** through the following means:

- Invest in **preventive retraining initiatives**, involving workers with employment profiles vulnerable to the green transition;
- Offering **tailored reskilling options** and **suitable job search assistance**;
- **Ensuring the adequate duration of support**, maintaining compensation and social protection mechanisms until the effective existence of employment, and not only up to predefined administrative limits;
- **Integrating ex-ante diagnoses and binding territorial plans**, with clear employment, professional retraining, and local social return targets in the closure and retraining processes.
- **Incentives and support for establishing economic activities that generate quality jobs** in the territories most affected by the green transition, contributing, whenever possible, to environmental sustainability and the promotion of the circular economy.

Conclusion

The targets set for reducing greenhouse gas emissions will put more severe pressure on certain sectors of activity and the occupations that are most intensely concentrated within them. These occupations may potentially undergo significant changes – either in the

reduction of the number of people practicing them or in the transformation of their content.

One of the fundamental elements for anticipating and adapting public policy responses is related to the assumption that among the occupations that contribute most to

greenhouse gas emissions, there are **different socioeconomic vulnerability profiles**.

This study demonstrated that among workers who perform occupations that could be classified as "brown", there are two main profiles: one more vulnerable and with a greater quantitative representation; a second, consisting of more qualified workers with higher salaries, which has a smaller representation.

The suitability of public policies to climate transition processes also depends on **identifying priority areas** for intervention and strengthening resources for locations that are expected to be most exposed to the imperatives of decarbonizing the economy.

Mitigating the effects of the green transition on employment should be accompanied by an **integrated strategy for the development of the green economy**. "Green" jobs represent approximately 13% of total employment in Portugal (Cantante et al., 2025), and the potential for their increase is very high. Decarbonizing the economy will require very significant investments in technologies, products, and infrastructure, but it will also need a workforce of sufficient quantity and quality to guarantee this transition. Therefore, this change requires profound coordination between sectoral public policies, but also between public policy and the private sector.

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