Artículo de revista:

Garha, Nachatter Singh. 2022. "From Decarbonization to Depopulation: An Emerging Challenge for the Carbon-Intensive Regions under the Energy Transition in Spain." *Sustainability* 14 (22): 14786. https://doi.org/10.3390/su142214786.

sustainability

MDPI

Article

From Decarbonization to Depopulation: An Emerging Challenge for the Carbon-Intensive Regions under the Energy Transition in Spain

Nachatter Singh Garha

Centre for Demographic Studies, Autonomous University of Barcelona, 08193 Barcelona, Spain; nachatter.singh1@gmail.com

Abstract: Since 1990, Spain has undergone a rapid decarbonization process focused on closing carbon-intensive facilities such as coal mines and coal-fired power plants and promoting renewable energy sources. These facilities have been the main source of income and employment in the regions where they were located, in addition to being a major source of carbon emissions. Their closure can have a huge impact on the socioeconomic and demographic composition of these carbon-intensive regions, damaging the social fabric and accelerating the process of depopulation. Based on a detailed analysis of policy documents and demographic data (from municipal registers and the 1991–2011 census), this article aims to: first identify and delineate the main carbon-intensive regions in Spain that are vulnerable to the negative impacts of the ongoing decarbonization process; second, examine the different policy responses and phases of the decarbonization process in Spain; and finally, examine the impact of the decarbonization process on the demographic (size, structure, and composition of the population) and socioeconomic configuration of the different carbon-intensive regions in Spain.

Keywords: decarbonization; depopulation; carbon-intensive regions; energy transition policy; Spain

Citation: Garha, N.S. From Decarbonization to Depopulation: An Emerging Challenge for the Carbon-Intensive Regions under the Energy Transition in Spain. *Sustainability* **2022**, *14*, 14786. https://doi.org/10.3390/su142214786

Academic Editor: Andrea Nicolini

Received: 8 October 2022
Accepted: 7 November 2022
Published: 9 November 2022

1. Introduction

Decarbonization is primarily about closing and reducing all activities that contribute significantly to carbon emissions, such as coal-fired power plants. According to the IPCC Fourth Assessment Report on Climate Change (2007), "decarbonization denotes the declining average carbon intensity of primary energy over time" [1]. To a lesser extent, this is a process that has been ongoing for two centuries [2]. In Spain, the process of decarbonization has accelerated over the last two decades. Carbon-intensive activities in Spain are concentrated in certain areas, mostly with high reserves of fossil fuels and good transport facilities, which are referred to as carbon-intensive regions (CIRs) in this study. These activities support the whole economic sector and are a good source of income for a large part of the population. In addition, they serve as a magnet for new immigrants and as the glue that binds the population to the area. As the process of decarbonization directly or indirectly affects the livelihoods of a large part of the population, it is expected to have a significant impact on the demographic and socioeconomic configuration of these regions, which is the focus of this article.

Over the past decade, Spain's prospects for carbon-intensive activities such as coal mining and coal-fired power plants have deteriorated due to a variety of regulatory, economic, environmental, and technical concerns. The implementation of Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 [3], which requires power plants that do not make investments to reduce air pollutant emissions to close before 2020, has been one of the main developments in terms of regulatory factors. Power plants, which have been operating at a loss for 20 years and rely on government subsidies to survive, were under great pressure as a result. The so-called "winter package" of the new European energy directives takes a similar line by discouraging the use of fossil fuels

and encouraging the inclusion of renewable energy sources in the energy mix. As far as economic reasons are concerned, the competitiveness of coal in the energy market has been lowered by the increase in the price of carbon dioxide in the market for emission rights. Due to the bleak future of the coal industry, investors are also reluctant to put their money into the industry, which has reduced its ability to attract new investment. In terms of environmental factors, the Kyoto Protocol [4], signed in 1997 and enacted in 2005, was an important step in supporting the decarbonization of the global economy. In addition, the signing of the Paris Agreement [5] in 2015, ratified by the European Union in 2016 and Spain in 2017, was an important turning point for energy policies to decarbonize the economy in all EU Member States. The agreement emphasized that it is crucial to keep the increase in global average temperature well below 2 °C above pre-industrial levels and continue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels. The second notable event was the publication of the IPCC's 2018 Special Report on Global Warming of 1.5 °C [6], which states that greenhouse gas emissions must be reduced by about 45% by 2030 and net zero by 2050 to reach the 1.5 °C target. This has accelerated Spain's progress towards decarbonization. On the technical side, the share of coal-fired power plants in the energy mix has decreased significantly due to the increasing inclusion of renewables (wind, solar, and tidal). The gap in the energy supply created by the phase-out of coal can now be filled more cheaply and easily thanks to existing technical know-how and the falling costs of renewable energy generating plants.

The closure of carbon-intensive industries in Spain is inevitable due to the changes mentioned above. Coal mining already ceased in 2018, and the remaining carbon-intensive units (thermal power plants) are expected to close by 2030. Although this is a positive measure to mitigate climate change, it will result in a loss of revenue and jobs for the CIRs and a gap in the labor market that will be difficult to fill with the jobs created in renewable energy projects. The majority of people living in the CIRs who rely directly or indirectly on these carbon-intensive industries for their livelihood will be negatively impacted by the lack of employment opportunities in these areas. Local businesses and households that rely on these plants for their energy needs will also be affected. As these plants are the largest taxpayers in local municipalities, this will also affect their income. The Spanish government has put in place a number of policies and programs over the last decades to mitigate the impact of this decarbonization process [7]. Its main objective has been to prevent communities from falling behind in the conventional energy industry, especially in coal mining and electricity generation. However, the question of how these policies have affected regions that have been heavily dependent on the fossil fuel industry for decades and are not yet ready for this transition has sparked debate in policy circles and civil society. The current war between Russia and Ukraine has affected the energy market in all EU countries, including Spain. It has also caused many uncertainties about the future of coal mining and coal-fired power plants, which in turn affects the process of decarbonization of the Spanish economy. These delays and uncertainties will also affect the demographic structure of the CIRs in the coming years.

In previous studies, some authors have examined the impact of the closure of large industrial plants in the regions where they were located and served as an important source of employment for the local population [8–10]. These impacts can be economical [11–15], social [16–18], or political [19,20]. There are some studies on the impact of decarbonization measures on the socioeconomic makeup of the CIRs in Spain [21], but few on their demographic makeup [22]. This study attempts to shed light on the evolution of decarbonization initiatives in Spain and their impact on the demographic composition of CIRs in transition. The main objectives of this study are: (1) to identify the main CIRs in Spain that is vulnerable to the negative impacts of the ongoing decarbonization process; (2) to examine the different policy responses and phases of the decarbonization process in Spain; and (3) assess the impact of the decarbonization process on the demographic (population size, structure, and composition) and socioeconomic configuration of CIRs in Spain.

Spain was chosen as the study country mainly because it is one of the frontrunners in the EU when it comes to creating and implementing decarbonization policies that will have a significant impact on people in several of its provinces. Many coal mines and thermal power plants in Spain have already been closed or are about to be closed. Therefore, the impact of this change is more visible in Spain, and we now have the opportunity to study how they have affected and are affecting the socio-demographic composition of the areas where these mines and plants were located. The evidence from these regions can help us understand the immediate and long-term impacts of the closure of large industrial plants, which in turn will help policymakers create regulations that can lead to a fair and orderly transition from coal to renewable energy sources.

The article consists of five sections. Section 2 provides a comprehensive overview of the data sources and methodology used in this article. Section 3 presents the geographical dimensions of the CIRs and a detailed description of the Spanish decarbonization plans. Section 4 presents the impact of decarbonization policies on the demographics of CIRs, and finally, Section 5 presents some discussion and conclusions.

2. Data Sources and Methodology

The Spanish government has developed and implemented numerous plans over the last three decades to mitigate the negative impacts of the cessation of carbon-intensive activities. All these initiatives and their regional impacts have been studied to understand how Spanish decarbonization policies have changed over the three decades. This provides an excellent summary and roadmap for Spain's decarbonization process and highlights its benefits and shortcomings.

In order to examine the demographic dynamics (change in population size, age structure, sex ratio, and ethnonational makeup) of CIRs in transition, this paper uses data from the Municipal Registry (*Padrón Continuo*). These data provide details of the total resident population of each census tract. Similarly, the Residential Variance Statistics (*Estadsticas de variación residencial*) are used to examine population migration into and out of the CIRs. By documenting inflows (*altas*) and outflows (*bajas*) from the Municipal Register, this procedure collects data on the movements of people between municipalities.

Finally, data from the 1991, 2001, and 2011 censuses, which are the main sources of information on the socio-economic profile of people living in different parts of Spain, are used to examine the other socio-economic characteristics of the population living in the CIRs.

A hybrid methodology combining qualitative and quantitative methods of analysis is used to analyze the textual material (policy documents) and the data from the population registers. I analyzed all the textual material with the qualitative data analysis software MAXQDA, which served as a hermeneutic tool to identify individual trends that were then combined into a collective political discourse regarding the decarbonization process. All the textual material was coded with a series of primary codes to identify the different actors and policy responses in support of the people and sectors affected by the decarbonization process. I then looked for the different policy responses over the last three decades and their impact on mitigating the impact of decarbonization policies on the demographic and socio-economic configuration of CIRs. Quantitative methods are used to quantify population dynamics (changes in population size, structure, and composition) and changes in the socio-economic and demographic profile of the selected CIRs.

3. Carbon-Intensive Regions and Decarbonization Plans in Spain

3.1. Carbon-Intensive Regions in Spain

In this study, the first challenge was to delineate the limits of CIRs. In Spain, carbon-intensive activities are spatially concentrated in some specific areas due to the location of coal mines and the availability of port facilities (useful for importing coal). These areas include several municipalities, most of which are close to each other and have varying degrees of impact on local employment, population, and territory. In February 2019, the Spanish government presented the Strategic Framework for Energy and Climate, which

aims to facilitate the Just Transition of CIRs through "Just Transition Agreements" with all affected regions. These agreements define the boundaries of the CIRs with employment as a key indicator and include the cities where thermal power plants and coal mines used to be located. Some neighboring municipalities are also included in the CIRs, taking into account geographical continuity between municipalities, pre-existing and recognized regional structures, or membership of municipalities in rural development groups. This paper follows the geographical delimitation established in the Just Transition agreements and focuses on the 11 CIRs in six autonomous communities in Spain (Figure 1).

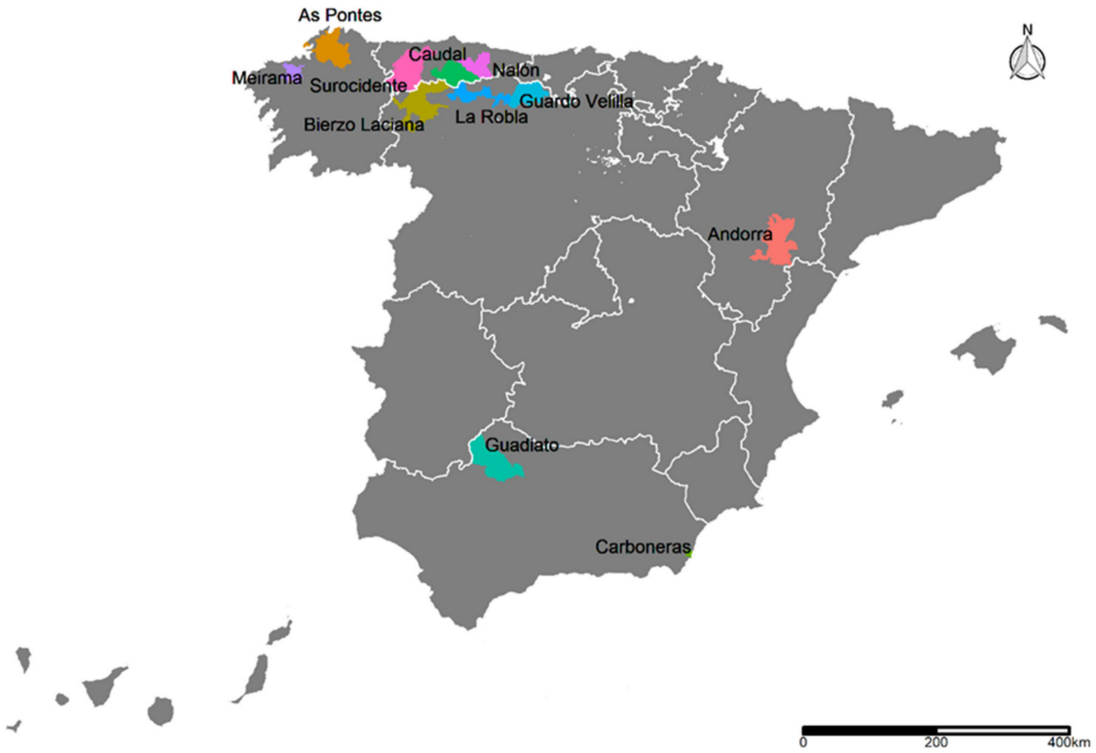

Figure 1. Carbon-intensive regions of Spain. Source: Own elaboration.

Table 1 shows the names of the main carbon-intensive activities in the selected CIRs, their owners, the date of submission of their closure application, and the number of jobs lost due to their closure. All the CIRs in the table share some characteristics: industrial monoculture, lack of occupational and professional diversity, large gender gaps in the workplace, lack of economic alternatives, high average income, lack of infrastructure and entrepreneurship, high levels of dependency, powerful trade unions with the strong anti-change sentiment, and a deteriorating local environment. These characteristics severely limit their ability to diversify their economies and make them vulnerable to the negative impacts of changes in the energy sector.

3.2. Decarbonization of the Spanish Economy

In the second half of the 20th century, Spain experienced a sharp increase in the consumption of coal as a primary energy source due to the growing demand for energy and the rising price of oil on the international market during the oil crisis in the 1970s [23,24]. This increased the Spanish economy's dependence on coal-fired thermal power plants in different regions of Spain. Several new thermal power plants were commissioned in different mining districts, transforming them into "boom towns" [25]. Most of the CIRs mentioned above experienced a period of massive growth in the 1970s and 1980s. After the 1980s, the mining sector started to decline. The Spanish government made several plans to support mining regions that had lost their competitiveness in the international market [26].

Table 1. Major carbon intensive facilities in CIRs in Spain.

Carbon-Intensive Regions	Province (# of Municipalities)	Industrial Facilities	Owners	Year Closed	Jobs Lost
Carboneras	Almeria (1)	-Litoral thermal plant	-Endesa Generación	2019	269
Guadiato	Cordoba (11)	-Puente Nuevo thermal plant	-Viesgo Producción S.L.	Dec. 2020	129
Aragón	Teruel (36)	-Central térmica de Teruel	-Endesa Generación	June 2020	246
		-Mines in Ariño and Foz-Calanda (Bajo Aragón)	-SAMCA Group	Jan. 2019	26
		-Mines in Estercuel and Foz-Calanda	-Compañía General Minera de Teruel S.A.	Dec. 2018	19
Caudal	Asturias (8)	-Pozo Santiago	-Hulleras del Norte, S.A.	Dec. 2018	275
Nalón	Asturias (7)	-Lada thermal plant.	Iberdrola, S.A.	June 2020	150
		-Pozo Carrio	-Hulleras del Norte, S.A.	Dec. 2018	165
Sur-ocidente	Asturias (6)	-Narcea thermal plant.	-Naturgy Group, S.A.	Dec.2020	129
		-Mines in Cangas del Narcea	-Carbonar, S.A.	Dec. 2018	27
		-Mines in Tineo	-Unión Minera del Norte, S.A.	Dec. 2018	75
		-Mines in Degaña	-Compañía Minera Astur Leonesa, S.A.	Dec. 2018	53
Bierzo-Laciana	León (18)	-Central Térmica de Compostilla	-Endesa Generación	Dec. 2018	308
		-Central Térmica de Anllares	-Naturgy Group, S.A.	May 2017	124
		-Gran Corta, Salgueiro and Alinos mines	-Unión Minera del Norte, S.A.	March 2018	166
		-La Escondida mines	-Hijos de Baldomero García	June 2018	62
Guardo-Velilla	Palencia (17)	-Central térmica de Velilla	-Iberdrola Generación	Nov. 2017	143
		-Mina de Muñeca	-Unión Minera del Norte, S.A.	March 2018	11
La Robla	León (11)	-La Robla thermal plant	-Naturgy Group, S.A.	Dec. 2018.	120
		-Mina Santa Lucía	-Hullera Vasco Leonesa	Dec. 2018.	78
		-Lavadero de La Robla		Dec. 2018.	102
As Pontes	Coruña (8)	-La Central thermal plant	-Endesa Generación	Dec. 2019	176
Meirama	Coruña (5)	-Meirama thermal plant	-Naturgy Energy Group, S.A.	June 2020	112

Source: Own elaboration.

The process of decarbonization in Spain started in the early 1990s. However, it was mainly motivated by economic reasons. At the request of the European Commission, the Spanish government adopted the Coal Sector Reorganization Plan (*El Plan de Reordenación del Sector del Carbón, 1990–1993*) [27]. This plan aimed to reduce the compensatory measures for the coal sector and to ensure its competitiveness. A plan for compensatory payment was established, which the mining and electricity companies could join if they could prove a reduction in the production of at least 40% by 1993. Job losses due to this reduction in production were estimated at 4600 jobs (44% of the workforce of these companies). Under this plan, no effort was made to retain the population by creating alternative job opportunities in the CIRs. The result was that the majority of the dismissed workers accepted early retirement or left the CIRs in search of work in other sectors. This began the exodus of miners and the process of depopulation in these regions.

After the completion of the first plan, a new plan was launched in 1994, the Plan for Modernization, Rationalization, Restructuring, and Reduction in Carbon Industry (*El Plan de Modernización, Racionalización, Reestructuración y Reducción de Actividad de la Industria del Carbón, 1994–1997*) [28]. This plan was conditioned by the significant changes in the regulatory guidelines for the coal sector, in particular Decision 3632/93/CECA, 28 of December 1993 [29], which recognized the need to restructure the coal industry without

forgetting the social situation of mining regions. This plan provided for the reduction in aid to coal-producing companies for the sale of coal and was based on three different axes. The first corresponded to aid linked to the improvement of productivity by decoupling the compensation received from the cost of international coal and linking it to real growth in the consumer price index. The quantities to be supplied were agreed upon in advance with the thermal power plants. The second measure was related to the reduction in the companies' activity. They were intended to cover the production costs of enterprises that could not improve their economic permeability. In order to benefit from this aid, a plan had to be drawn up, which led to the closure of the plant by mid-2002. The third measure was aid for reindustrialization through the creation of an economic fund to finance measures aimed at creating economic alternatives to energy mining in the basins affected by the decline in activity. While this plan achieved the objectives of increasing productivity and reducing costs, it failed to improve the competitiveness of the domestic coal industry, leading to a steady decline in the coal sector, the dismissal of coal workers, and the acceleration of the emigration process.

To solve the situation of population decline, the Spanish government launched a new plan in 1998, the 1998–2005 Plan for Coal Mining and Alternative Development of the Mining Regions (*El Plan 1998–2005 de la Minería del Carbón y Desarrollo Alternativo de las Comarcas Mineras*) [30]. This plan focused on issues related to the reduction in production and employment in the coal sector and the future of miners [30,31]. It was a continuation of the previous plan, with a more drastic reduction in coal production [32]. It provided for three lines of support: infrastructure development, employment-generating enterprise projects to provide jobs for redundant workers, and education and training to facilitate the technical and human adaptation of miners to enterprises in other sectors. This plan was developed between 1998 and 2005 and coincided with the adoption of the European Directive on the internal electricity market (Directive 2003/54/EC) [33], which gave Member States preferential access to electricity generation plants with indigenous combustion sources. Thermal power plants received aid for their operation and restructuring. Among the motivations for this plan was the need for the alternative development of the mining regions to avoid the problems resulting from economic monoculture. The number of people employed in the coal sector fell from 24,500 in 1997 to 8310 at the end of 2005. Although the results of the plan vary for the different mining regions, in general, the aid for the reactivation of the regions has not succeeded in promoting a sufficient and diversified level of economic activity to overcome the dependence of these regions on coal mining. The jobs created were of lower quality than those lost. The plan also failed to retain the population in the CIRs.

The next plan to come into force was the Strategic Coal Reserve Plan 2006–2012 (*El Plan Nacional de Reserva Estratégica de Carbón 2006–2012*) [34]. The aim of this plan was to restructure the coal sector, taking into account its social and regional aspects, and to preserve a certain share of domestic coal production as a strategic reserve. Particular emphasis was placed on the need to promote alternative employment opportunities to coal by supporting new business projects. Aid was given to reduce production and staff (through early retirement schemes for over 52, paid leave of €60,000 per employee, and transfer to other companies). Various types of aid were introduced for companies, such as direct aid to cover production losses under the closure plan, aid for access to coal reserves granted to companies with the best economic prospects, aid to cover exceptional costs related to the reduction in production units authorized by the Institute for the Restructuring of the Coal Mining and the Alternative Development of Mining Regions (IRMC). In addition, aid was approved for environmental protection and the development of new technologies for the clean combustion of coal, underground storage of carbon dioxide, and technologies for other uses of coal. Aid is also granted for mining safety. As a result of the plan, production was reduced to 8.5 million tonnes between 2009–2010 and part of 2011 (700,000 tonnes less than planned). The number of employees at the end of 2011 was 4,434, a decrease in 3876 persons.

In 2010, the Spanish government adopted the Council of Europe Decision (2010/787/EU) [35] on State aid to facilitate the closure of uncompetitive coal mines. According to this directive, State aid to the coal industry was to be phased out in 2010. However, at the request of the Spanish government and trade union organizations to the European Commission, the aid was finally extended until 2018. Under this decision, State aid to the coal industry is permitted only to facilitate the closure of a mine and to cover production losses and exceptional costs arising therefrom. The decision was taken in the framework of the EU policy aimed at promoting renewable energy sources and a sustainable and safe low-carbon economy and reducing the role of domestic coal in the overall energy mix of EU Member States. The new guidance requires Member States to submit a closure plan, which must be approved by the European Commission, covering all uncompetitive production units that intend to cease operations by 31 December 2018. The decision restricts the granting of aid to coal mines whose closure is irrevocably foreseen and will be completed within the deadline set in the closure plan. Under the decision, mining operations that achieved competitive conditions before 2018 may continue to operate after the date specified in the decision but must repay aid received between 2011 and 2018.

The European Directive on Industrial Emissions of 2010–50 [3], which forced coal-fired power plants to make huge investments to reduce pollution, affected their future prospects. The National Transitory Plan gives companies until 2020 to decide whether to make these investments or close the plants. Following this decision, the Ministry of Industry, Energy and Tourism drafted a new framework—the Framework of Action for the Coal Mining and Mining Regions, 2013–2018 (*Marco de Actuación para la Minería del Carbón y las Comarcas Mineras, 2013–2018*) [36]—to grant aid to cover the losses in the current production of uncompetitive coal mines included in the closure plan presented by the Spanish authorities. This new framework was agreed upon by trade unions, employers, and the Secretary of State for Energy and approved by the European Commission in May 2016. The main objective of this framework was to mitigate the adverse impacts of mine closures on employment and the economies of mining regions. It includes some new elements, such as the creation of a framework for the development of renewable energy sources. It also specified that measures should be taken to mitigate the environmental impact of coal production. The production units included in the decommissioning plan were eligible for the aid established in this framework. In order to access the aid lines, mines had to submit the final closure project. Closure aid was intended to compensate for production losses. The workforce aid scheme was repeated and included compensation for voluntary sick leave continued employment of redundant workers not eligible for early retirement, early retirement for older workers (over 54 years, 11 years' contribution to the mining sector), and severance pay. The environmental aid was intended for the rehabilitation of the natural area after the closure of the mine and could be extended until 2021. Secondly, aid was granted to stimulate the economy in mining regions in order to create jobs. There were also two types of aid: for municipal infrastructure and for business projects. Three other lines of aid were established for training, mining safety, and support for the development of new carbon dioxide storage technologies.

In February 2019, the Spanish government adopted the Strategic Framework for Energy and Climate (*El Marco Estratégico de Energía y Clima*) [37], which aims to implement measures that facilitate the transition to a sustainable and competitive economic model and contribute to mitigating climate change. This strategic framework is divided into three pillars: The Preliminary Draft of Climate Change Law (LCCTE), the Draft of the National Integrated Energy and Climate Plan (PNIEC), and the Just Transition Strategy (ETJ). These three elements will provide Spain with a solid and stable strategic framework for decarbonizing its economy. The LCCTE provides an effective roadmap for the coming decades; the PNIEC lays the foundations for decarbonization in the period 2021–2030, in line with the goal of achieving net zero emissions by 2050; and the ETJ is a strategy of solidarity-based support for people and territories to seize the opportunities of this ecological transition without leaving anyone behind.

The two elements of the framework that significantly raise Spain's climate ambitions are the LCCTE, which proposes that the electricity system be 100% renewable by 2050 and be neutral in terms of greenhouse gas emissions for the whole economy. On the other hand, the PNIEC proposes a 23% reduction in greenhouse gas emissions by 2030 compared to 1990. This is proportionately much more than the current EU target of 40% and is in line with the 50–55% range that the EU is moving towards. In addition, the PNIEC envisages a 42% share of renewable energy in total energy consumption by 2030, which is double the level to be achieved this year, 2020. In electricity generation, the share of renewable energy would be 74%. The country's energy efficiency would improve by 39.5% in the decade 2021–2030. Opportunities offered by this ambitious plan include: the mobilization of €241 billion over the next decade through private, public, and mixed investments; savings of about €67 billion by 2030 through the reduction in fossil fuel imports, which will also improve energy security; annual GDP growth of between €16.5 and €25.7 billion between 2021 and 2030, equivalent to 1.8% GDP growth in 2030 compared to a no plan scenario; positive impact on employment as between 253,000 and 348,000 jobs will be created over the next ten years, mainly in manufacturing and construction; economic revitalization of depopulated areas through the creation of green jobs in these areas, contributing to addressing the demographic challenge, reduction in around 27% in premature deaths caused by air pollution. The third element of the framework, the ETJ, aims to maximize the social benefits and mitigate the negative impacts of this ecological transformation.

In this section, we have briefly discussed how the boundaries of the CIRs were set and how Spain's decarbonization strategies have changed over the last three decades. In the following section, we will look at how these decarbonization policies have changed the demographic composition of these CIRs.

4. Demographic Change in Spain's Carbon Intensive Regions

4.1. Changes in Population Size, Structure, and Composition

Over the last three decades, all CIRs in Spain have experienced the significant demographic change (population size, structure. and composition). The total population in the CIRs has decreased from 718.1 thousand inhabitants in 1991 to 522.3 thousand in 2021 (Figure 2), a decrease in 27.3% over the last three decades. In the decade 1991–2000, despite the implementation of the Coal Sector Reorganization Plan (1990–1993) and the Modernisation, Rationalisation, Restructuring, and Reduction in Carbon Industry Plan (1994–1997), the population of these regions declined by 11.1%, showing that these plans did not provide alternative employment opportunities for workers laid off from the coal industry, forcing them and their families to migrate from these regions. In the following decade (2001–2010), the depopulation process slowed down with the introduction of the Coal Mining and Alternative Development Plan for the Mining Regions (1998–2005) and the Strategic Coal Reserve Plan (2006–2012), which made special provisions for the affected populations but did not stop it. During this decade, the population decline was 7.2%. The EU directives on the closure of uncompetitive coal mines in 2010 and their implementation in Spain in the last decade (2011–2021) accelerated the process of depopulation. The Spanish central government introduced a Framework of Actions for the Coal Mining and Mining Regions (2013–2018) to control the demographic and socio-economic decay of these regions, but they failed to retain the population. The population decline was 11.9%.

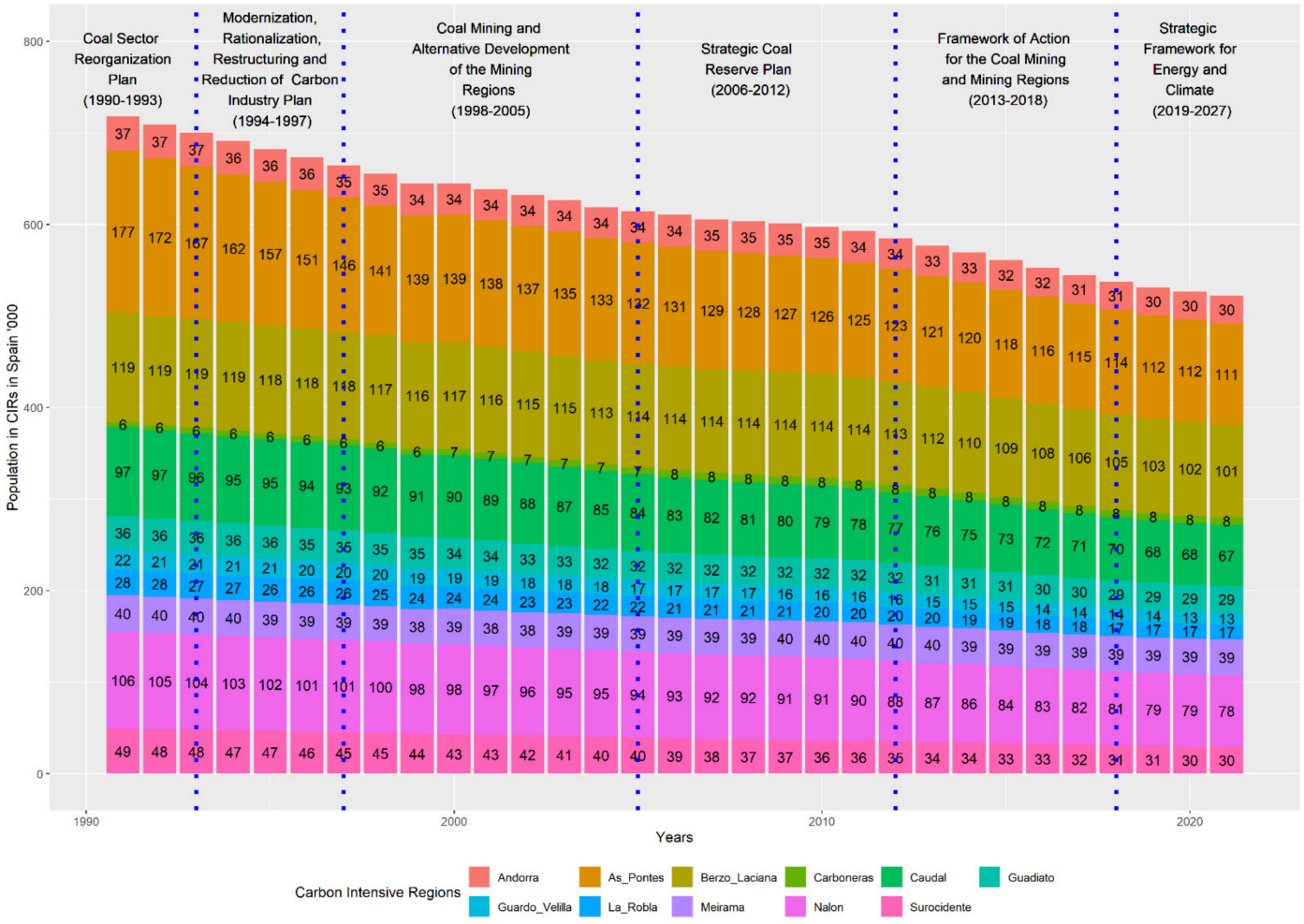

Figure 2. Changes in the population size of the CIRs during different decarbonization plans in Spain, 1991–2021. Source: Population Census 1991, Padrón Continuo 1998–2021.

This depopulation may be the result of other developments that have nothing to do with decarbonization. To check whether this depopulation was limited to the CIRs or also occurred in other municipalities, I compared population growth in neighboring municipalities with similar population sizes in the same provinces and provincial capitals that did not fall under the decarbonization process. Figure 3 shows that annual population growth remained negative in CIRs, while it remained positive in other municipalities and provincial capitals until 2011. After 2011, population growth became negative in other municipalities and provincial capitals due to the economic crisis in Spain. It becomes positive in 2019 in provincial capitals and in 2021 in other municipalities but remains negative in CIRs. In 2020, the provincial capitals also recorded a decrease in population growth, which can be linked to the COVID-19 crisis that encouraged many people to live outside the big cities. This shows that the process of decarbonization has an impact on the population decline in these regions.

It is now clear that most CIRs lost population after the closure of carbon-intensive industrial and mining activities. However, the population decline was not homogeneous in all CIRs (Figure 4). In absolute terms, the population decline between 1991 and 2021 was greatest in As Pontes (66.2 thousand), followed by Caudal (30.3 thousand), Nalón (27.7 thousand), Suroccidente (19.5 thousand) and Bierzo-Laciana (18.3 thousand). In relative terms, La Robla has seen the greatest decline in total population over the last three decades, by 40.9%. Suroccidente (39.7%), Guardo Velilla (38.9%), Caudal (31.2%), and Nalón (26.1%) were the other CIRs with a significant loss of resident population. Contrary

to the trend, the CIR of Carboneras has seen an increase in the population of 2.5 thousand people, a relative increase in 43.5%. This increase can be linked to the immigration of people from neighboring African countries such as Morocco and Algeria, who work in the growing agricultural and tourism sector in the province of Almeria. The CIR of Meirama recorded a rise in population in the first decade of the 21st century, but later, with the closure of mines in 2008, the economic crisis, and the staff reduction at the power plant, the population began to decline rapidly. Though it has begun to increase once more after 2015, it is still below the level of 1991, in part because of the return migration of native people.

In terms of age structure, all CIRs show signs of an aging population, mainly due to the out-migration of young people, low fertility, and increasing life expectancy at birth. Over the last three decades, the base of the population pyramids in all these regions has shrunk, and the top has expanded with an increasing proportion of older people (Figure 5). In 1991, the proportion of children (0–19 years) in the CIRs was 20.7%, which fell to 13.6% by 2021. In contrast, the proportion of adults (20–64 years) and the elderly population (65+) increased from 58.3% and 21% in 1991 to 58.5% and 27.9% in 2021, respectively. The largest increase in 6.9 percentage points occurred in the older age groups. The proportion of infants (0–4 years) decreased from 4.4% of the total population in 1991 to 2.74% in 2021. This decline in the number of infants reflects the lower fertility and out-migration of young people of reproductive age. In 2021, La Robla had the smallest share of infants (1.9%) in the total population, followed by Guardo Velilla (2.1%), Suroccidente (2.3%), and Caudal (2.4%). In contrast, Carboneras CIR had the highest proportion of infants (4.8%) in the total population, followed by Meirama (3.6%) and Andorra (3.5%). This higher proportion of infants is directly related to the immigrant population, which has a higher birth rate than the native population in Spain [30].

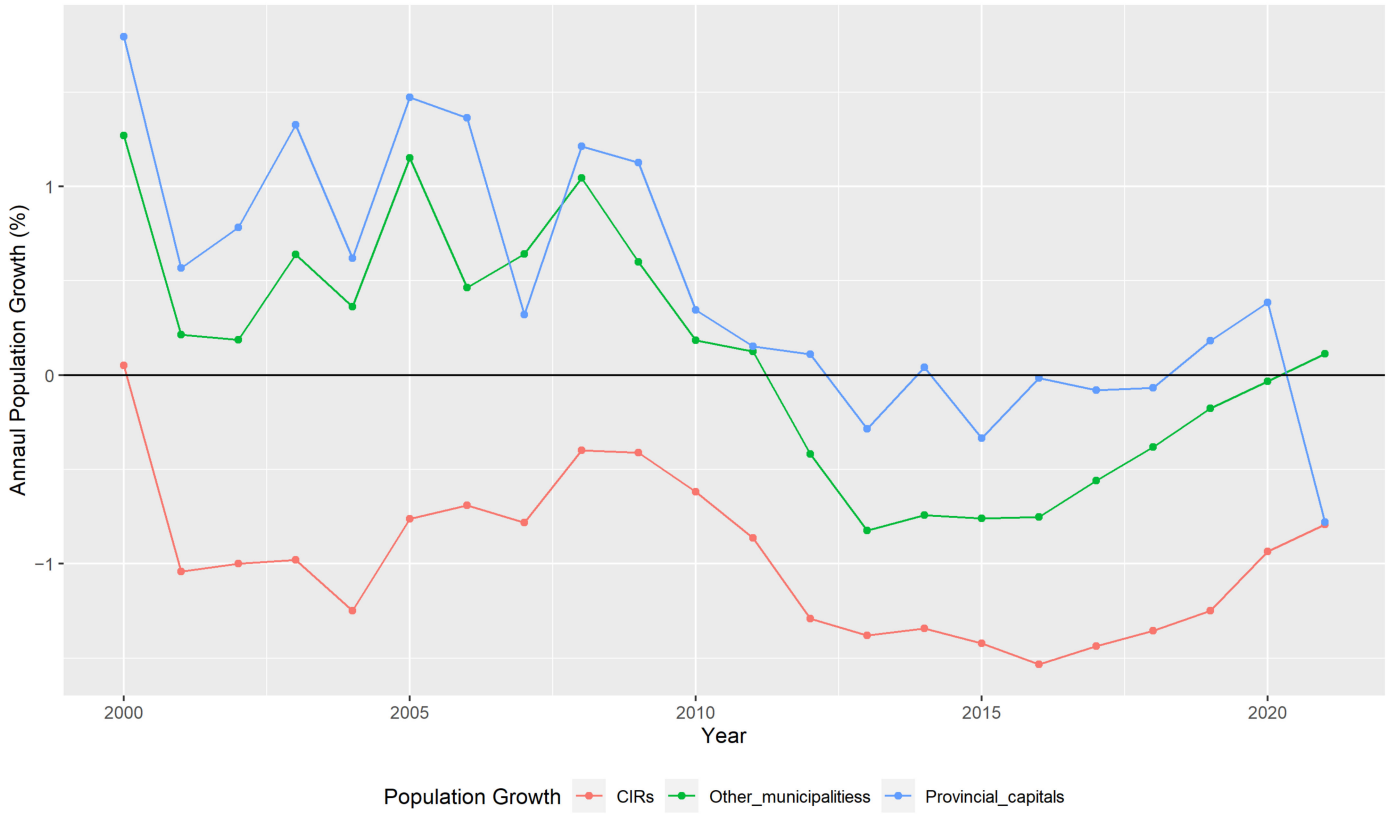

Figure 3. Annual population growth in the CIRs and other municipalities with the same population size in the province, 1998–2021. Source: Padrón Continuo, 1998–2021.

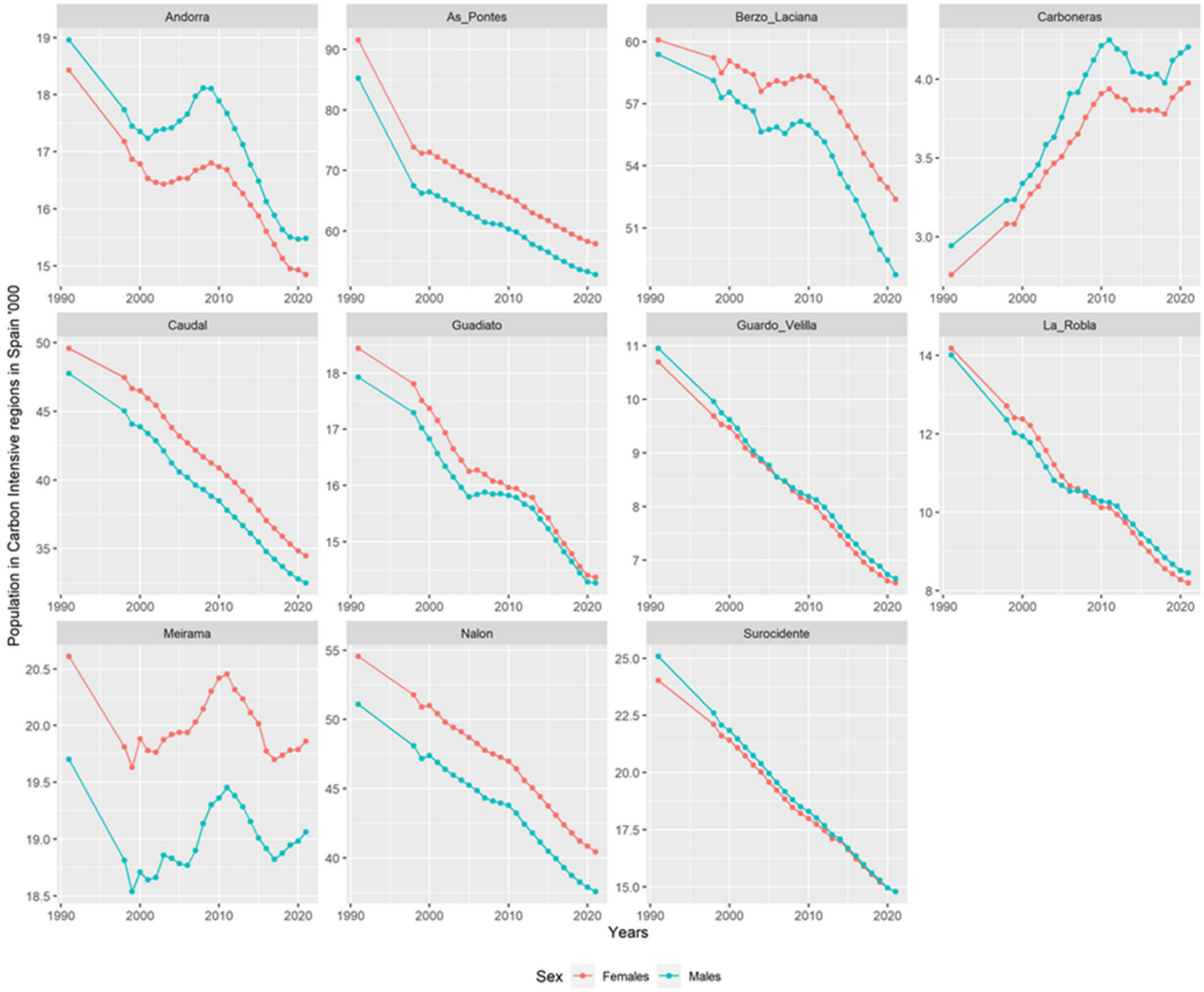

Figure 4. Population growth in different CIRs in Spain, 1991–2021. Source: Population Census 1991, Padrón Continuo 1998–2021.

The average age of men and women in the CIRs has also increased, from 35.4 years and 38.2 years in 1991 to 47.5 years and 50.9 years, respectively, in 2021. Comparing the average age of residents in the CIRs with that of residents in neighboring municipalities, the average age of men and women in neighboring municipalities in 2020 was 4.8 years and 4.6 years lower than that of the CIRs. This shows that the aging rate in the CIRs is much higher compared to other municipalities in the same provinces. This aging process could be related to the decline in the birth rate and the outflow of young people from these regions, which in turn could be related to the lack of employment opportunities and economic stability in these regions. Among the CIRs, La Robla is the one with the highest increase in the average age of men and women, from 35.4 and 39.1 years in 1991 to 50.5 and 54.3 years in 2021, respectively. In contrast, the Andorra region has the lowest increase in the average age of men and women, i.e., from 36.4 and 38.4 years in 1991 to 45.7 and 47.4 years in 2021. In 2021, Carboneras CIR had the lowest average age for both sexes, mainly due to the young immigrant population filling the gap left by the out-migration of the native population and the low fertility of the native population.

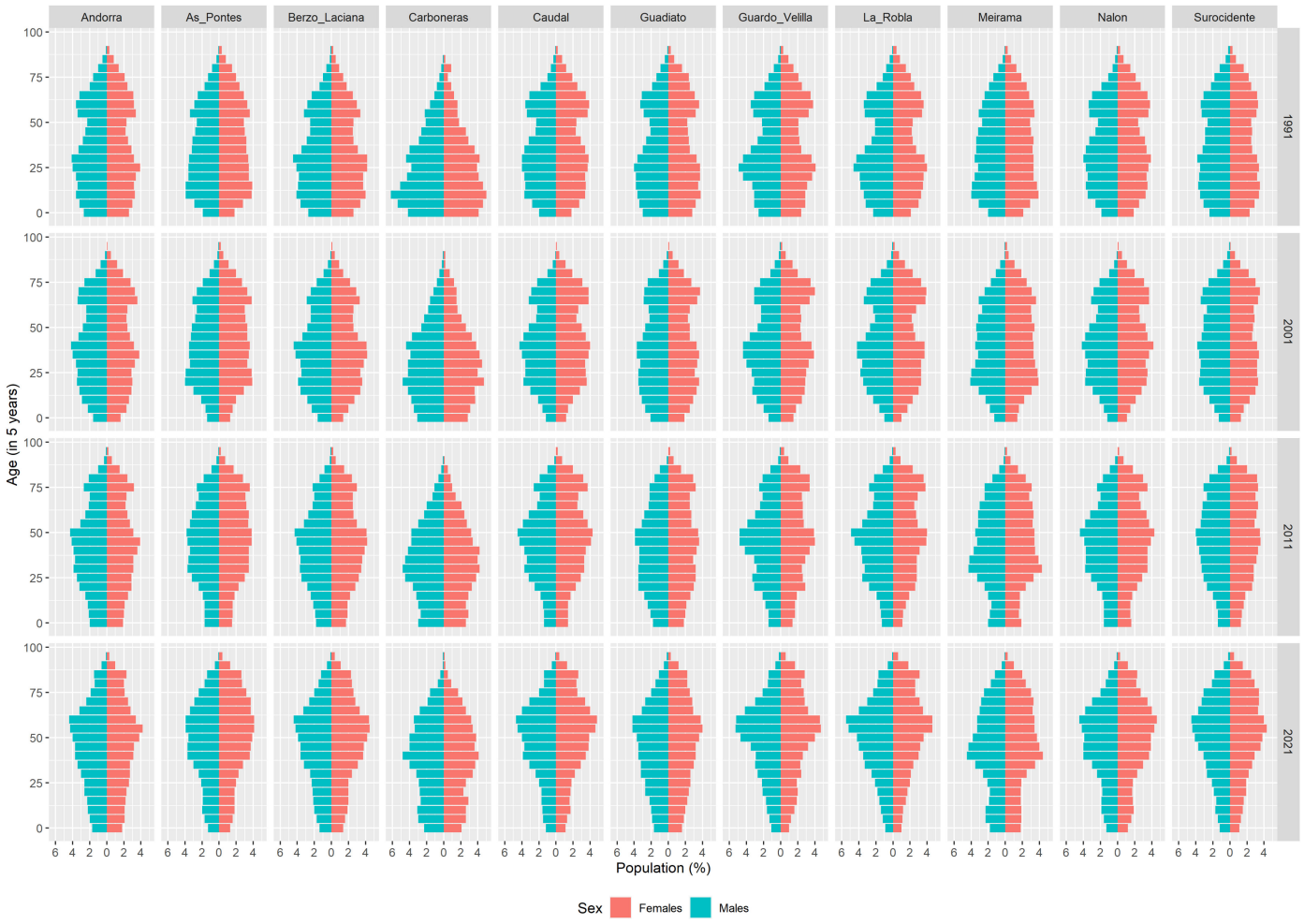

Figure 5. Age structure and sex composition of the population in the CIRs in Spain, 1991–2021. Source: Population Census 1991, Padrón Continuo 1998–2021.

Historically, carbon-intensive activities have been mainly dominated by men [38], so the decarbonization process has a significantly greater impact on job losses for men than for women. The out-migration triggered by the closure of carbon-intensive industries has influenced the gender ratio in these regions. The sex ratio (men to women) of the population in the CIRs has also changed slightly over the last three decades. In 1991, the sex ratio in the CIRs was 0.97 males per female, which will decline to 0.95 males per female by 2021. It is below the national sex ratio of 0.97 males per female in 2021. In the last three decades, the sex ratio in the CIRs of Andorra, Carboneras, Guardo Velilla, and Suroccidente was in favor of men, while in As Pontes, Bierzo Laciana, Caudal, Guadiato, Meirama, and Nalón it was in favor of women. In La Robla, the sex ratio was in favor of women until 2008 and then shifted in favor of men.

This section shows that despite the measures taken by the Spanish government to mitigate the impact of decarbonization policies on the demography of these regions, Spanish CIRs are losing population, and the aging process has accelerated. This proves that government policies and decarbonization plans are not able to provide new opportunities for the inhabitants of these regions and keep the population in these regions. If this process continues in the coming decades, these regions will become ghost towns, and the population will bear the brunt of displacement and loss of territorial identity.

4.2. Migration Pattern

The decarbonization process has also affected migration patterns in all CIRs. In the initial phase of the construction of the carbon-intensive industrial plants, these regions attracted migrant workers (both skilled and unskilled) from different parts of Spain and other countries. Net migration in these regions was positive, and the population grew. With the beginning of the decarbonization process and the loss of jobs and future prospects, the young population started to emigrate from these regions, turning the net migration negative. According to the Residential Variance Statistics, in the last three decades (1991–2020), 423.5 thousand people migrated from the CIRs, of which 213.6 thousand were men and 209.9 thousand were women. With the exception of the Mierama and Carboneras CIRs, all the others have recorded negative annual net migration in most years (Figure 6). Bierzo-Laciana CIR had the largest negative net migration (−9.2 thousand), followed by Caudal (−8.3) and Suroccidente (−7.2). In contrast, the CIR of Meirama had the highest positive net migration of +4.8 thousand, followed by Carboneras (+1.2 thousand). Most immigrants in Meirama and Carboneras came from other countries, with the majority in Meirama coming from Latin American countries and in Carboneras from neighboring Morocco.

Figure 6. Net migration from the CIRs in Spain, 1991–2020. Source: Estadísticas de Variaciones Residenciales (EVR) 1990–2020.

The age structure of emigrants from the different CIRs shows the economic nature of this migration system (Figure 7). Almost half of the emigrants (43.4%) belong to the 18–35 age group, where people move mainly for higher education or in search of job opportunities. The CIR of As Pontes has the highest percentage of emigrants (46.1%) in the working age group, followed by Meirama (45.8%) and Suroccidente (45.7%). In contrast, Carboneras CIR has the lowest proportion of emigrants (39.5%) in the working-age population. In the CIR of Andorra, net migration in the working age group is positive for men and negative for women, which means that the number of women leaving the region is greater than the number of women entering it. The Meirama, Andalusia, and Andorra regions had the lowest concentration of migrants in the working age group. The Guadiato and Bierzo-Laciana regions had a small positive net migration in the post-retirement age groups (65–75 years), showing the return of people to their hometowns after retirement.

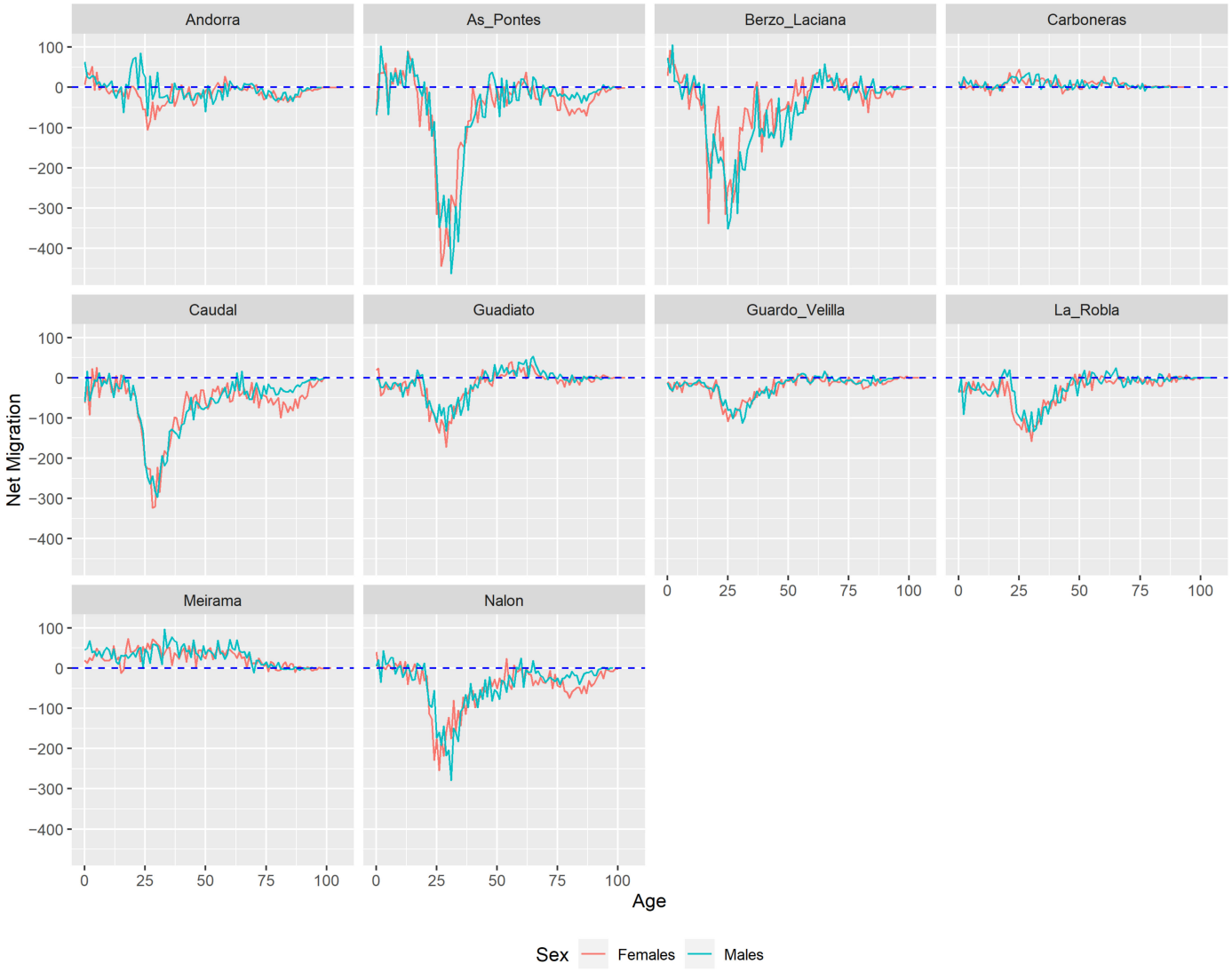

Figure 7. The age structure of the emigrant population from the CIRs, 1990–2020. Source: Estadísticas de Variaciones Residenciales (EVR) 1990–2020.

The main destinations of emigrants from the CIRs were the main cities near these regions (Figure 8). The main destination of emigrants from the CIR of Carboneras was the province of Almeria. However, a small number also moved abroad. For emigrants from the Caudal, Nalón, and Suroccidente CIRs, the province of Asturias was the main destination, followed by Madrid and Leon. Most of the emigrants from the CIR of Guadiato moved

to the province of Cordoba. The province of León was the main destination for emigrants from Bierzo-Laciana and La Robla, followed by Madrid and Asturias. Most emigrants from Guardo Velilla moved to Palencia. Finally, A Coruña was the main destination for emigrants from the regions of As Pontes and Meirama. With the exception of Meirama and Carboneras, the province of Madrid, which comprises the capital region of Spain, received emigrants from all CIRs. This shows the importance of Madrid in attracting people from areas experiencing economic difficulties due to the closure of carbon-intensive industries. The province of Barcelona, which is the economic capital of Spain, has also received emigrants from the CIRs of Guadiato, Andorra, Caudal, Nalón, Bierzo-Laciana, and As Pontes. A significant proportion of emigrants also moved to other countries, which shows the weakening ties between the population and the territory, accelerating the process of depopulation and increasing the number of displaced people inside and outside the country.

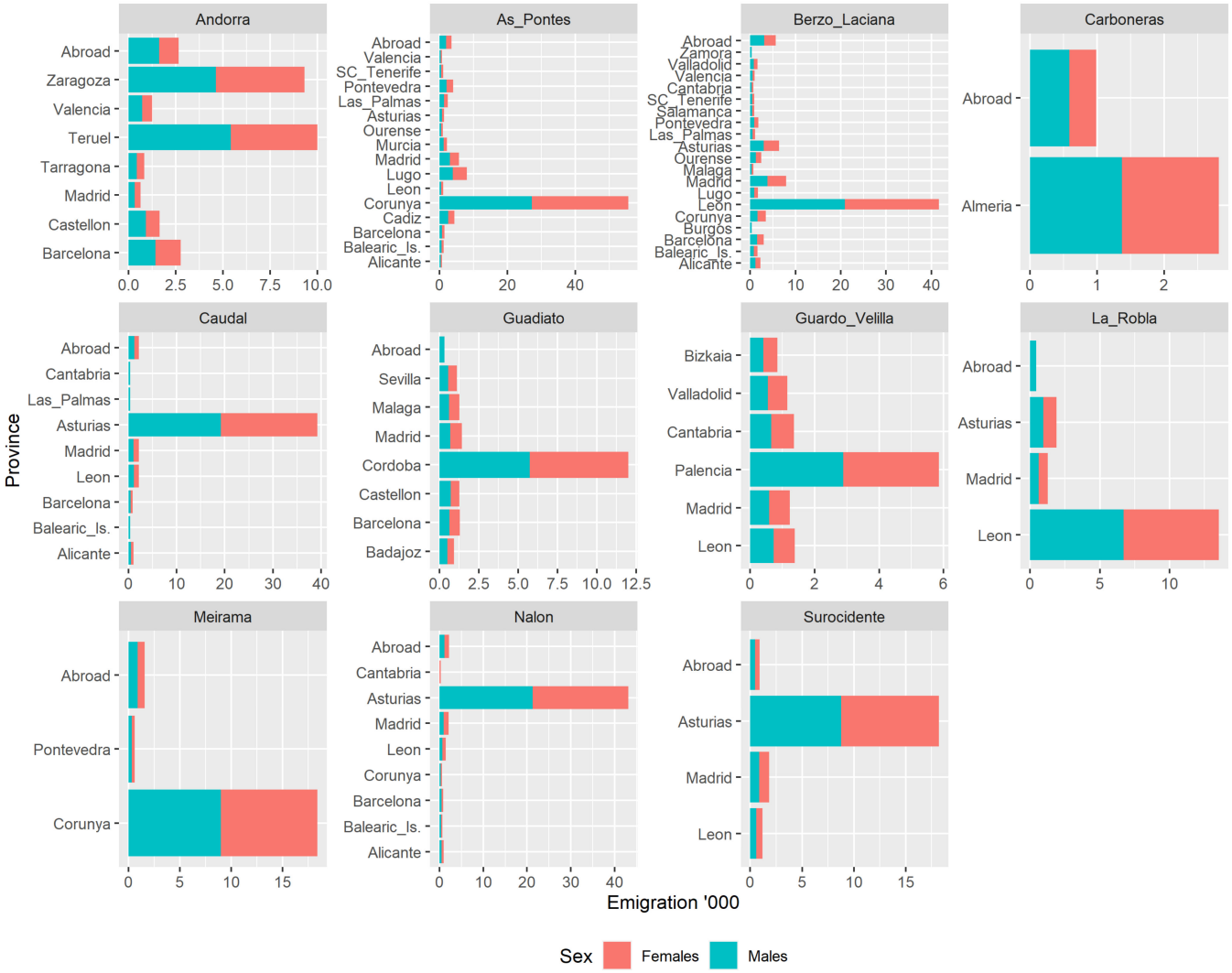

Figure 8. Main destinations of the emigrants from the CIRs in Spain, 1990–2020. Source: Estadísticas de Variaciones Residenciales (EVR) 1990–2020.

The migration pattern of the last three decades shows that, with the exception of Mierama and Carboneras, all other CIRs have experienced an exodus of the population to the main metropolises and capitals of Spanish autonomous regions and other countries. This exodus has mainly consisted of working-age men and women who have migrated to

other regions in search of job opportunities and better living conditions. This is the main cause of the acceleration of depopulation in these regions.

4.3. Socio-Economic Profile

Over the last three decades, in addition to demographic changes, the socio-economic profile of the population in all CIRs has also changed significantly.

4.3.1. Income Profile

Prior to the opening up of coal mines and the establishment of heavy industry, all these regions were predominantly rural areas, where agriculture and forestry were the main occupations, and most people were living with limited resources. Emigration of youth was a common concern, and the regions had low economic prospects. In the boom time of the coal industry, these regions accumulated a lot of wealth, which raised a large share of the population out of poverty and improved the standard of living and level of social security. Coal mining and electricity generation created lots of jobs for both skilled and unskilled workers, which attracted a large number of workers from different parts of the country and abroad, which in turn contributed to the development of these regions. Growing population and wealth also contributed to ingraising the importance of these regions in national politics. According to income data published by INE [39], the population in the CIRs still has a higher net personal income compared to the provincial average (Figure 9). The economic shock caused by the closure of coal mines has affected a large number of miners' families who have left without jobs, and the closure of power plants has started to impact the quality of life in these regions.

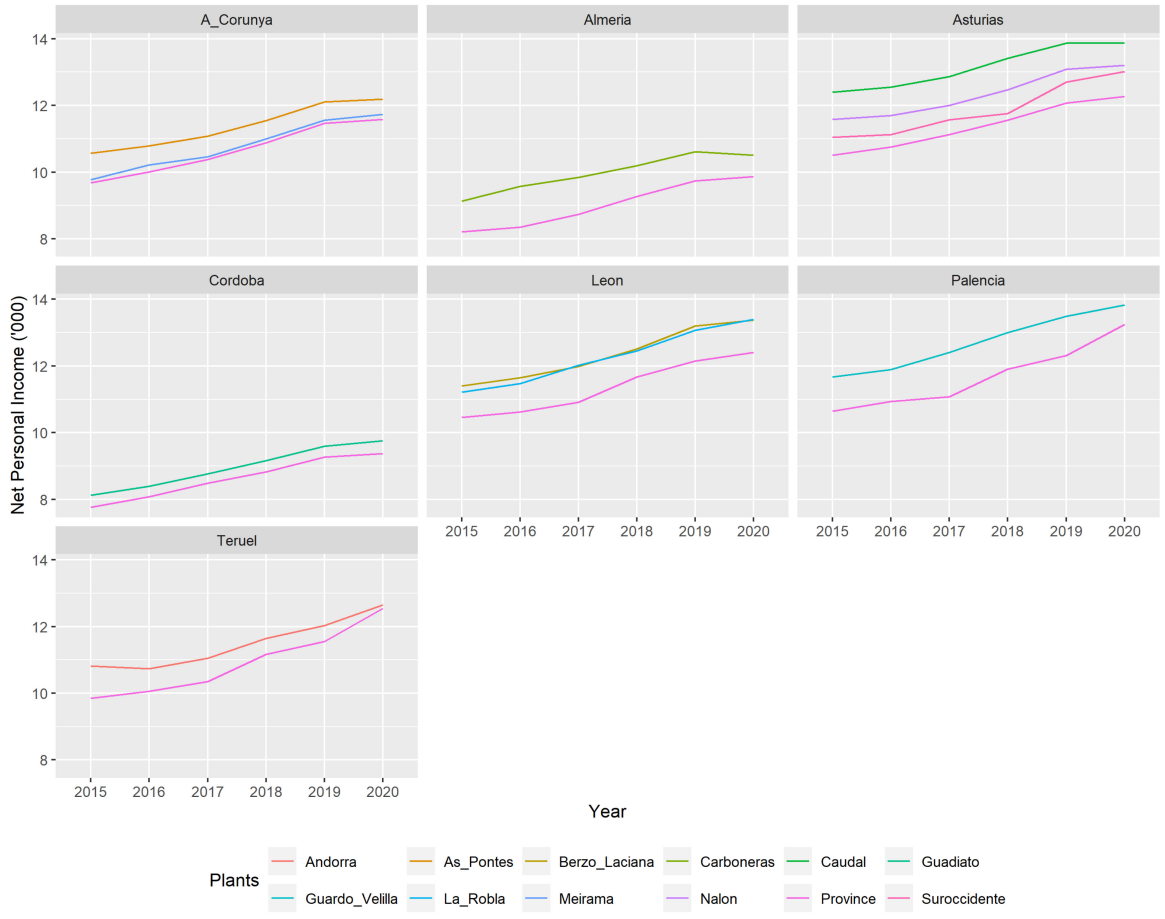

Figure 9. Net personal income in the CIRs of Spain, 2015–2020. Source: Instituto Nacional de Estadística (INE).

4.3.2. Education Level

Education is an important indicator of the level of human development. Improvement in the level of education in a region indicates improvement in the human capital and socio-cultural growth of the region and vice versa. During the period 1991–2011, the level of education improved significantly in all CIRs. The proportion of illiterate people, people without formal education, and people with primary education have decreased significantly. However, the proportion of people with secondary and university education has increased in all CIRs (Figure 10). When we compare the improvement in educational attainment in the CIRs with that of the provinces as a whole, we find that the proportion of people with secondary education at the provincial level in the Meirama, Guadiato, Andorra, Guardo Velilla, La Robla, Suroccidente, and Nalón CIRs has risen above provincial levels. However, the proportion of university graduates has only increased in the As Pontes, Carboneras, and Bierzo-Laciana CIRs. Here it is worth mentioning that ENDESA, which is the top electricity producer in Spain, has contributed a lot to the higher education of the children of miners and plant workers. The scholarships provided by the company helped many children of mining families to obtain university degrees from national and international universities. Overall, the data shows that the level of education has improved in all CIRs, but if we compare the level of higher education, most still lag behind the average performance at the provincial level.

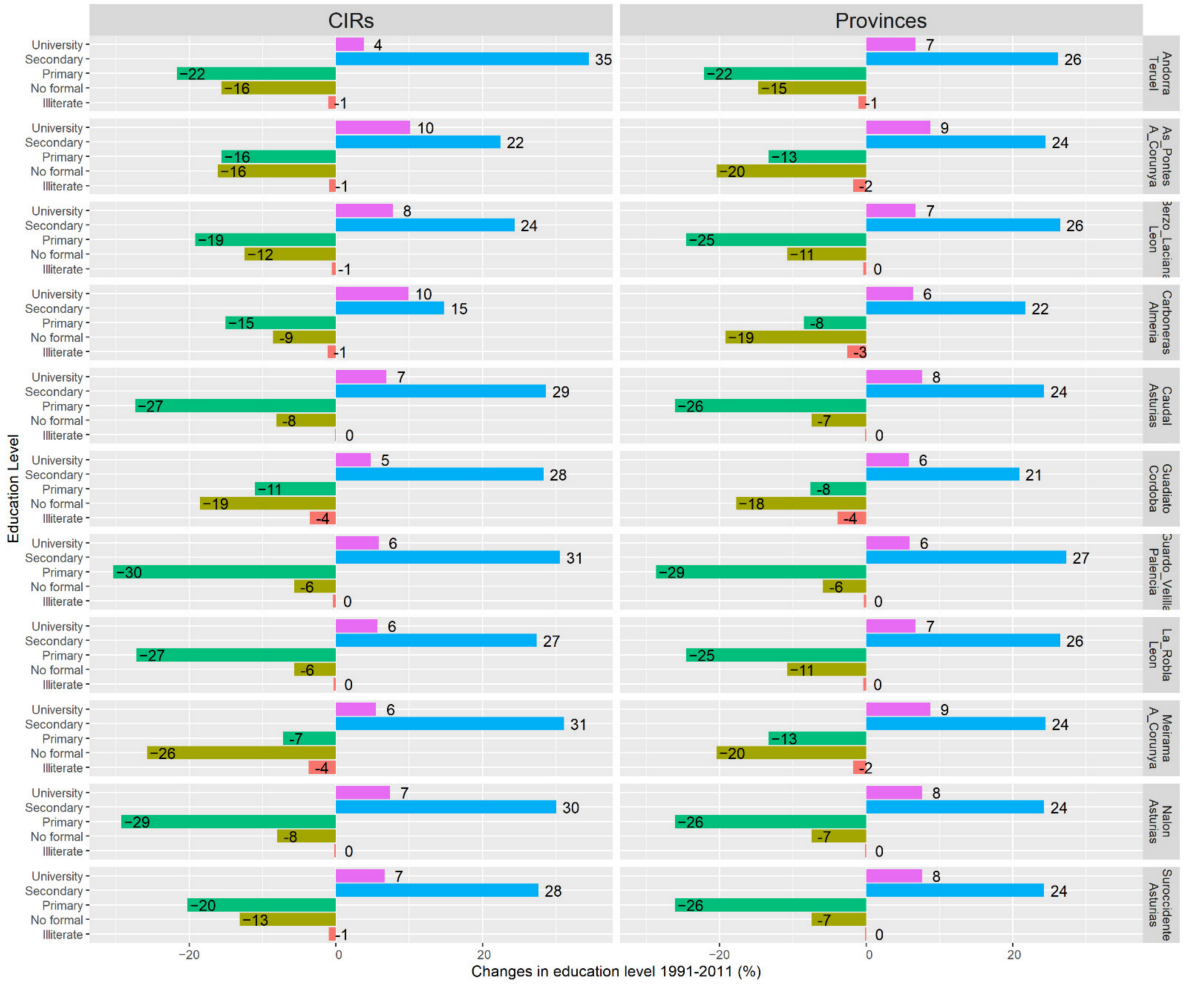

Figure 10. Education level in the CIRs of Spain, 1991–2011. Source: Population Census 1991–2011.

4.3.3. Employment Status

Decarbonization policies have a significant impact on the employment structure of the population in CIRs (Figure 11). Between 1991 and 2011, the share of domestic workers and students in the population declined significantly in all CIRs. The largest decrease in the category of domestic workers was recorded in the Carboneras CIRs (17.1%), followed by Andorra (16.5%) and Guadiato (14.9%). On the other hand, the largest decrease in the student category was recorded in La Robla CIR (11.4%), followed by As Pontes (11.1%) and Carboneras (11.1%). On the contrary, the proportion of pensioners and unemployed has increased in all CIRs. The largest increase in the proportion of pensioners was recorded in CIR of Suroccidente (11.3%), followed by Meirama (10.8%), As Pontes (10.7%) and Bierzo-Laicana (10.7%). The percentage of people looking for their first job has decreased in all CIRs, except Carboneras, Andorra and Bierzo-Laciana. If we compare the employment structure in the CIRs with that of the provincial level, we find that the proportion of the employed population in all CIRs is higher than at the provincial level. Similarly, the proportion of people looking for their first job at the provincial level is much higher than in the CIRs, indicating the outflow of young people from these regions.

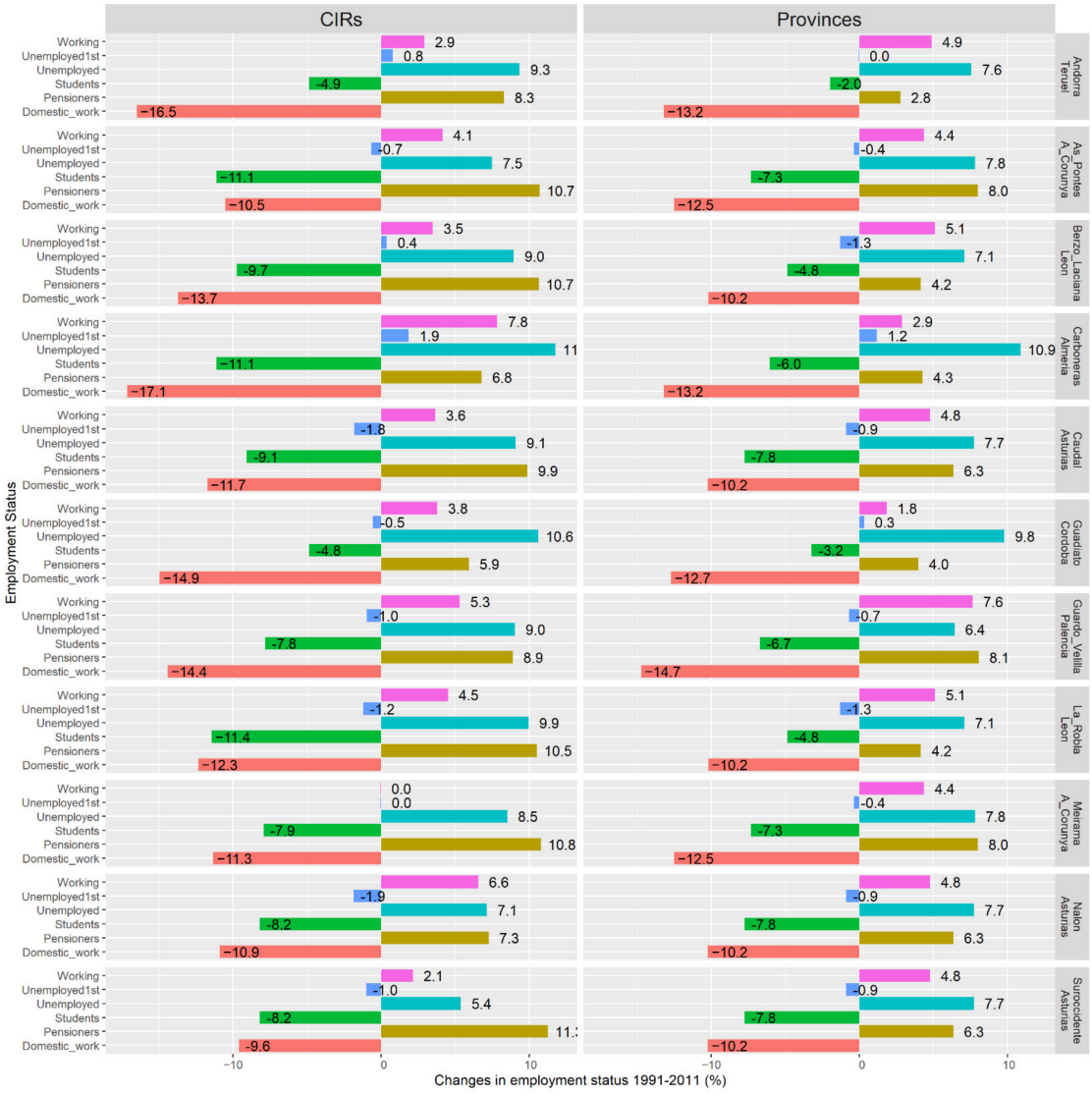

Figure 11. Employment status in the CIRs of Spain, 1991–2011. Source: Population Census 1991–2011.

4.3.4. Occupational Sectors

The occupations in the CIRs have also changed considerably (Figure 12). In the last two decades, all CIRs have seen a decline in agriculture and industry. The largest decline in the industrial sector was recorded in the CIRs of Caudal (33.8%) and Nalón (32.1%). Similarly, the largest decline in the agricultural sector was recorded in the CIRs of Meirama (22.6%) and Suroccidente (20.3%). In contrast, the services and construction sectors recorded significant growth in all CIRs during the same period.

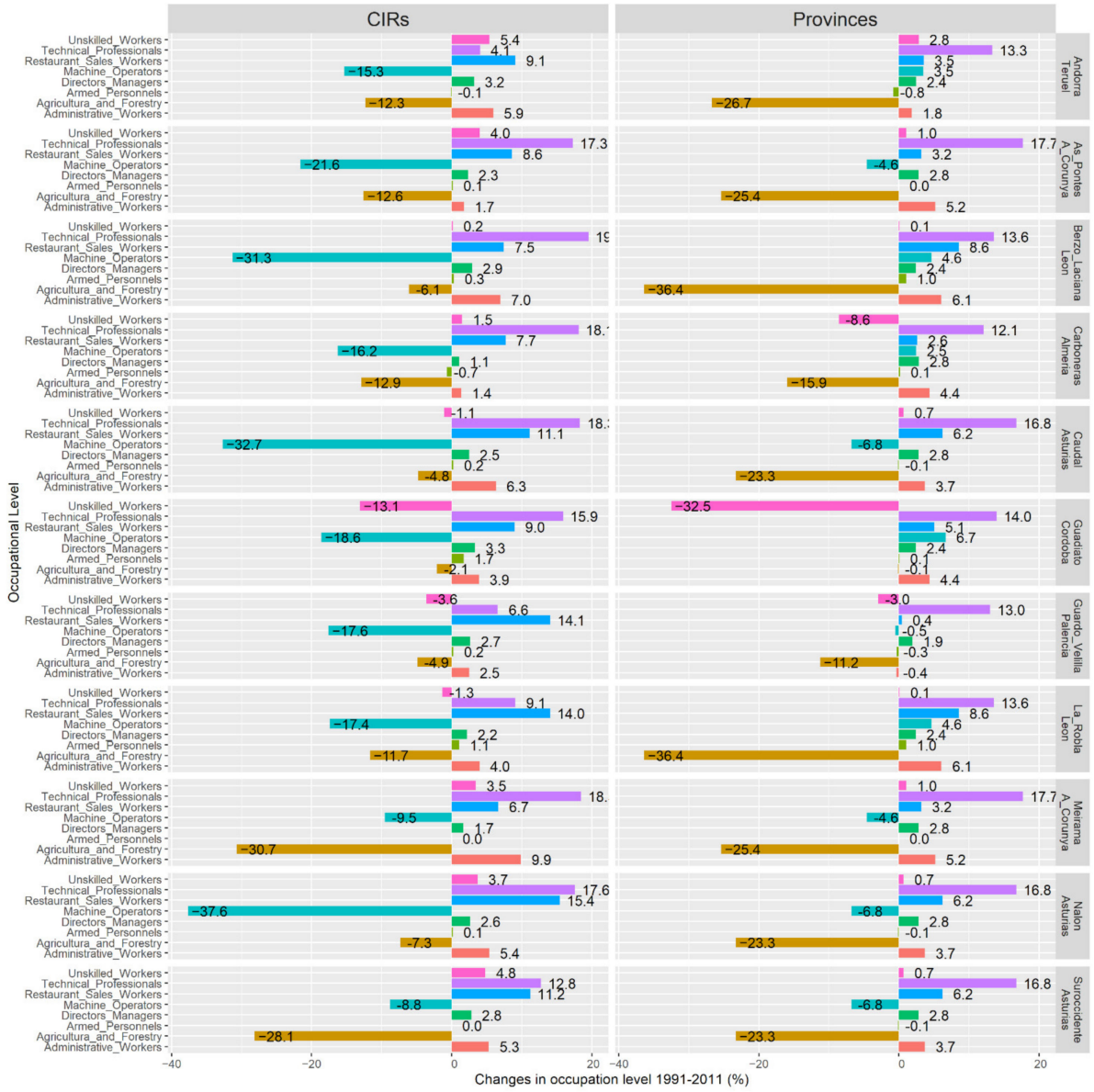

Figure 12. Evolution of different occupations in the CIRs of Spain, 1991–2011. Source: Population Census 1991–2011.

The CIRs of Nalón (28.1%) and Caudal (26.4%) recorded the highest growth in the services sector, and the CIRs of Andorra and Caudal showed the highest growth in the construction sector. The share of the employed population in the different employment categories has also changed significantly. The largest decrease was recorded in the share of the workforce in agriculture and related activities and machine operators. The CIRs of Meirama (30.7%) and Suroccidente (28.1%) recorded the largest decrease in the share of employed persons in agriculture and related activities. Similarly, the Nalón (37.6%), Caudal

(32.7%), and Bierzo-Laicana (31.3%) CIRs recorded the greatest decrease in the proportion of machine operators. Most of these machine operators were employed in coal mining and power generation. All CIRs recorded an increase in the proportion of technical professionals, with the largest increase in Bierzo-Laicana (19.5%), Meirama (18.5%), and Caudal (18.3%). If we compare the occupational structure in the CIRs with that at the provincial level, we find that the proportion of machine operators in all CIRs has decreased faster than at the provincial level. The largest decreases were registered in Nalón (30.8 percentage points) and Caudal (25.9). On the other hand, the municipalities neighboring the CIRs Bierzo-Laicana (+4.6%), Andorra (+3.5%), Carboneras (+2.5%), Guadiato (+6.7%) and La Robla (+4.6%) announced an increase in the proportion of machine operators. Moreover, the increase in the proportion of employees in the restaurant and sales sectors was higher in all CIRs than at the provincial level, reflecting their transformation from industrial to service centers.

In summary, we can say that the decarbonization process of the last three decades has affected the socioeconomic profile of these regions. The net personal income in the CIRs is converging to the provincial level; the level of education has improved but is below the provincial average in most CIRs, especially in higher education; the share of unemployed and retired people in the total population has increased significantly, but the proportion of young people looking for their first job has decreased due to youth out-migration; most new jobs are created in the service sector, which is of low quality and poorly paid; and finally, the proportion of the labor force in the industrial sector, especially machine operators, has decreased significantly and the proportion of technical professionals has increased.

5. Concluding Remarks

CIRs have played an important role in Spain's economic development over the last four decades. For many years, coal mining and electricity generation were the main sources of income and employment for the population living in these regions. Due to the high wages in the mining sector, the per capita income in these regions was higher than the national average. This brought a lot of prosperity and economic stability to these regions. This industrial monoculture provided the population with a steady income stream but also made them totally dependent. The closure of mining and other carbon-intensive activities had a devastating impact on the demographic and socio-economic sustainability of these regions and put their future in question.

Based on a detailed analysis of the policy documents and socio-demographic data of 11 CIRs in Spain, we conclude that the plans and measures adopted by the central government to support the CIRs have failed to retain the population and have stunted the socio-economic growth of these regions. All CIRs are facing a serious problem of depopulation. The total population of the CIRs has decreased significantly, and the average age of the population has increased, showing the acceleration of the aging process in these regions.

The outflow of young people and the brain drain have become another important feature of all CIRs. The younger generation is forced to leave their homes because there are no jobs and future prospects in these areas. The investments that the government is making in various programs to create new jobs are not enough for the entire population. In addition, the newly created jobs are marginal and insecure, so they are not attractive to the young population. Most emigrants moved to big cities, especially provincial capitals and other metropolitan cities like Madrid and Barcelona. The big cities are growing at the cost of CIRs. Some of them also emigrated to other countries in search of well-paid jobs.

In 2019, the Spanish government launched a new plan to decarbonize the Spanish economy and support people affected by the closure of carbon-intensive activities in all CIRs. This plan is still ongoing and targets all CIRs in Spain with the primary goal of creating a just transition. The current war between Russia and Ukraine has delayed the decarbonization process in Spain. It has created uncertainty about the future of CIRs. In the future, it will be interesting to see how the war and the recent plan will help these regions

to maintain their demographic reproduction and create new employment opportunities and healthy living conditions for their inhabitants.

Funding: This research is a part of the I+D project Demographic metabolism, migration, and social change in Spain (MethaMigra) funded by the Ministry of Science and Innovation (PID2020-113730RB-I00).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: We collected published material from different online sources which are publically available.

Conflicts of Interest: The author declares no conflict of interest.

References

1. IPCC Fourth Assessment Report: Climate Change 2007. Working Group III: Mitigation of Climate Change. 2007. Available online: https://archive.ipcc.ch/publications_and_data/ar4/wg3/en/ch3s3-4-1.html#:~{}:text=Decarbonization%20denotes%20the%20declining%20average%20carbon%20intensity%20of%20primary%20energy%20over%20time (accessed on 13 March 2021).
2. Smil, V. Examining energy transitions: A dozen insights based on performance. *Energy Res. Soc. Sci.* **2016**, *22*, 194–197. [CrossRef]
3. Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on Industrial Emissions (Integrated Pollution Prevention and Control). 2010. Available online: https://www.eea.europa.eu/policy-documents/directive-2010-75-eu-of (accessed on 10 March 2021).
4. The Kyoto Protocol. 1997. Available online: https://unfccc.int/es/kyoto_protocol (accessed on 15 June 2021).
5. The Paris Agreement. 2015. Available online: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement (accessed on 15 June 2021).
6. IPCC Special Report on Global Warming of 1.5 °C. 2018. Available online: https://www.ipcc.ch/sr15/ (accessed on 15 June 2021).
7. Rabanal, N.G. Importancia de los planes de reordenación en la reconversión del carbón en España. *Pecvnia* **2005**, *1*, 67–92. [CrossRef]
8. Jolley, G.J.; Khalaf, C.; Michaud, G.; Sandler, A.M. The economic, fiscal, and workforce impacts of coal-fired power plant closures in Appalachian Ohio. *Reg. Sci. Policy Pract.* **2019**, *11*, 403–422. [CrossRef]
9. Jofre-Monseny, J.; Sánchez-Vidal, M.; Viladecans-Marsal, E. Big plant closures and local employment. *J. Econ. Geogr.* **2018**, *18*, 163–186. [CrossRef]
10. Betz, M.R.; Partridge, M.D.; Farren, M.; Lobao, L. Coal mining, economic development, and the natural resources curse. *Energy Econ.* **2015**, *50*, 893–896. [CrossRef]
11. Raimi, D. Decommissioning U.S. Power Plants: Decisions, Costs, and Key Issues. 2017. Available online: http://www.rff.org/research/publications/decommissioning-uspower-plants-decisions-costs-and-key-issues (accessed on 13 November 2021).
12. Haggerty, J.H.; Haggerty, M.N.; Roemer, K.; Rose, J. Planning for the local impacts of coal facility closure: Emerging strategies in the U.S. West. *Resour. Policy* **2018**, *57*, 69–80. [CrossRef]
13. Fuentes Salazar, P.; Alejandro Cardenete, M.; Vega Cervera, J.A. *Impacto Económico de la Clausura de Una Planta Nuclear, Almaraz (España)*; Orkestra-Instituto Vasco de Competitividad; Fundación Deusto: Bilbao, Spain, 2013.
14. Sartor, O. Implementing Coal Transitions. In *Insights from Case Studies of Major Coal-Consuming Economies*; IDDRI: Paris, France, 2018.
15. Besser, L.T.; Recker, N.; Agnitsch, K. The impact of economic shocks on quality of life and social capital in small towns. *Rural Soc.* **2008**, *73*, 580–604. [CrossRef]
16. Strambo, C.; Thazin, A.M.; Atteridge, A. Navigating Coal Mining Closure and Societal Change: Learning from Past Cases of Mining Decline, SEI Working Paper. July 2019. Available online: https://www.sei.org/wp-content/uploads/2019/07/navigating-coal-mining-closure-and-societal-change.pdf (accessed on 16 November 2021).
17. Kovacs, I.; Simion, S.; Irimia, A.; Tuhuţ, L.I.; Florea, G.D. The social impact of mine closure in the Jiu Valley. *E3S Web Conf.* **2021**, *239*, 00004. [CrossRef]
18. Rosenfeld, E. Transition plans for coal-fired power plant closings: Stability, opportunity, & community. *J. Energy Environ. Law* **2015**, *6*, 71–82.
19. Brauers, H.; Oei, P.-Y. The political economy of coal in Poland: Drivers and barriers for a shift away from fossil fuels. *Energy Policy* **2020**, *144*, 111621. [CrossRef]
20. Oei, P.-Y.; Hermann, H.; Herpich, P.; Holtemöller, O.; Lünenbürger, B.; Schult, C. Coal phase-out in Germany—Implications and policies for affected regions. *Energy* **2020**, *196*, 117004. [CrossRef]
21. Prado-Domínguez, A.J.; González-Laxe, F.; Escourido-Calvo, M.; Martín-Bermúdez, F. Initial Impact and Socioeconomic Compensation for the Closure of a Coal-Fired Power Plant in a Local Entity. *Sustainability* **2021**, *13*, 7391. [CrossRef]
22. Caballero-Gonzales, E. Cambios demográficos y reconversión industrial asociados al cambio de modelo energético: Fin de la actividad minera en Asturias. *Rev. Eubacteria* **2011**, *27*, 271–277.
23. Arlt, D.; Zeise, R. Review of the History of the Electric Supply in Spain from the Beginning up to Now. 2011. Available online: https://e-archivo.uc3m.es/handle/10016/13718 (accessed on 14 December 2021).

24. Garriga, J.M. The Spanish economy and oil: A close relationship. In *Dossier: Oil: Past, Present and Future*; CaixaBank Research: Valencia, Spain, 2016.
25. Malamud, G.W. *Boomtown Communities*; Von Nostrand Reinhold: New York, NY, USA, 1984.
26. Rabanal, N.G. Coal restructuring in Spain: Continuity and uncertainty? *Energy Policy* **2009**, *37*, 4373–4378. [CrossRef]
27. El Plan de Reordenación del Sector del Carbón, 1990–1993. Available online: https://www.boe.es/buscar/doc.php?id=BOE-A-1990-26961 (accessed on 6 June 2021).
28. El Plan de Modernización, Racionalización, Reestructuración y Reducción de Actividad de la Industria del Carbón, 1994–1997. Available online: https://www.boe.es/buscar/doc.php?id=BOE-A-1998-4453 (accessed on 6 June 2021).
29. Decisión Núm. 3632/93/Ceca de la Comisión, de 28 de Diciembre de 1993, Relativa al Régimen Comunitario de las Intervenciones de los Estados Miembros en Favor de la Industria del Carbón. 1993. Available online: https://www.boe.es/buscar/doc.php?id=DOUE-L-1993-82231 (accessed on 8 June 2021).
30. El Plan 1998–2005 de la Minería del Carbón y Desarrollo Alternativo de las Comarcas Mineras. Available online: https://www.boe.es/diario_boe/txt.php?id=BOE-A-2005-16015 (accessed on 8 June 2021).
31. González-Ferrer, A.; Martín, T.C.; Kraus, E.; Eremenko, T. Childbearing patterns among immigrant women and their daughters in Spain: Over-adaptation or structural constraints? *Demogr. Res.* **2017**, *37*, 599–634. [CrossRef]
32. Maurín, M.; Maurín, M. Un caso especial de planificación regional: El Plan 1998–2005 de la minería del carbón y desarrollo alternativo de las comarcas mineras. En actas del XVI Congreso de Geógrafos Españoles. In *El Territorio y su Imagen*; Universidad de Malaga: Malaga, Spain, 1999; Volume 2, pp. 867–875.
33. Directive 2003/54/EC of the European Parliament and of the Council of 26 June 2003 Concerning Common Rules for the Internal Market in Electricity and Repealing Directive 96/92/EC–Statements Made with Regard to Decommissioning and Waste Management Activities. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32003L0054 (accessed on 6 June 2021).
34. Plan Nacional de Reserva Estrategica de Carbon 2006–2012 y Nuevo Modelo de Desarrollo Integral y Sostenible de las Comarcas Mineras. Available online: https://www.transicionjusta.gob.es/common/Plan_Carbon.pdf (accessed on 6 June 2021).
35. Council Decision of 10 December 2010 on State Aid to Facilitate the Closure of Uncompetitive Coal Mines (2010/787/EU). Available online: https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:32010D0787 (accessed on 13 July 2021).
36. Marco de Actuación para la Minería del Carbón y las Comarcas Mineras, 2013–2018. Available online: https://www.transicionjusta.gob.es/Noticias/common/Nuevo-Marco-2013-2018.pdf (accessed on 6 June 2021).
37. Marco Estratégico de Energía y Clima. Available online: https://www.miteco.gob.es/es/cambio-climatico/participacion-publica/marco-estrategico-energia-y-clima.aspx (accessed on 6 June 2021).
38. De Perceval Verde, M.; Martínez Soto, Á.; García Gómez, J. Female Workers in the Spanish Mines, 1860–1936. *Int. Rev. Soc. Hist.* **2020**, *65*, 233–265. [CrossRef]
39. INE. Indicadores de Renta Media y Mediana, Resultados por Municipios, Distritos y Secciones Censales. Available online: https://www.ine.es/dynt3/inebase/index.htm?padre=7132 (accessed on 12 August 2022).