

Visions, innovations, and justice? Transition contracts in Spain as policy mix instruments

Abstract

Coal phasing-out policies and the consequent closure of large coal infrastructures (mines and thermal power plants) have put coal dependent areas at a crossroads. This empirical study applies the policy mix analytic framework to discuss how transition contracts, as new instruments in Spain, could accelerate socio-technological regime change and promote a just transition; all of which from the analysis of the barriers for the economic, political, social, technological and environmental spheres. From a mixed research design, information from 43 stakeholders was collected, first to qualify just transition barriers and then to quantify their relevance and intergroup variance. The resulting policy implications highlight three essential factors, a strategic vision, an innovation approach and a transversal notion of justice. These factors must be considered in order to increase consistency, coherence, comprehensiveness and credibility of transitional contracts.

Keywords: phasing-out coal; just transition; policy mix; stakeholders; strategic vision; innovation.

1. Introduction

In Europe, the implementation of coal-restricting policies is leading to the consequent generation of structural problems with undesired local and regional repercussions, scarcely analysed by academic literature [1], [2], [3]. European policy strategies were aimed at minimising adverse effects [4], [5], encouraging Member States to articulate measures to alleviate the regional consequences of mine closures [5] and their social impacts [6].

In the fight against climate change, energy transition, understood as a long-term structural change leading to the energy sector global transition from fossil-based to low-carbon or zero-carbon energy systems, is a key factor. The European Union has taken on a gradual energy transition, clean and fair, as one of today's biggest challenges. The European Green Deal, signed last year 2019 [7], the 2020 agreements developing it, the Investment Plan for a sustainable Europe [8] and the Just Transition Fund [9], exemplify the European Union framework, with three essential premises. First, recognizing the relevance of establishing a balance between the decisions at all levels of government (EU, national and local) [6]. Vertical political integration [10] is especially relevant in systems such as Spanish, organized in 17 Autonomous Communities. Second, adopting increasingly demanding rules (EU energy targets by 2030: 40% decrease in greenhouse gas emissions, 32% increase in renewable energy consumption and 32.5% increase in energy efficiency).

Third, establishing a framework of respect for Member States independence, to choose their own energy mix and the path to reach their energy and climate targets [6].

Countries such as Denmark, Luxembourg, UK, and Austria, [11], [12] have significantly reduced their coal consumption in recent decades. Others, such as Germany, Poland or the Czech Republic, which jointly account for 57% of the EU total coal consumption, are at the heart of European decarbonization efforts [13]. Spain is in an intermediate position in terms of consumption, impact on employment and articulation of measures for the ecological transition [14].

From the energy point of view, Spain is a highly dependent country as it imports 70% of its primary energy (compared to European average of 55%) [15], and 60% of the electricity generated in the country depends on carbon-emitting technologies [16], of which 5% from coal. The debate over energy change from a model based on the production of electricity by fossil fuels to a model where renewable energies take the priority in the Spanish national energy mix remains open and polarized, as in other contexts [17], [18]. The destabilization of the coal regime is conflicting in many countries, where certain groups cling to pre-established lines of reasoning, hindering the actors' implementation of strategies that could ease the change of socio-technical regime and a positive story [19]. In Spain, the answer and local resistance has been located mainly in the three historic coal-dependent areas: Principado de Asturias, Castilla y León and Aragón [3]. In 2018, the Spanish socialist government proposed the “Just Transition Contracts” as a way to boost alternative activities in the territories affected by thermal plants and coal mining closures. The objective is addressing the energy and ecological transition impact, and sign agreements expressing the national, regional and local administration commitment with the affected territories, through projects and investments with specific financing schemes. The intervention protocol includes a public participation procedure and methodology, still not concluded. These tools for the energy and ecological transition should be designed as policy mixes combining

instruments that can destabilize the existing regimes while creating space for innovative alternatives [20], thus bringing in speed and direction to energy transitions [21].

This work contributes to the specialized literature by connecting the barriers to a just transition with the characteristics of a combined policy, thus overcoming some gaps observed in research [21]. On the one hand, the literature has highlighted the need for conceptual, normative and comparative studies in relation to the notion of just transition and transitional policies [22]. On the other hand, different authors have recently highlighted the need for further research to analyse the co-evolutionary of policy mix in sustainability transitions and socio-technological changes [23], as well as the actors' perspective [24]. These authors assume that the development of transition pathways and socio-technology change is a result of the actors' ongoing struggle towards policy objectives and instruments [21].

This paper focuses on researching the political dimension and, in particular, the barriers to a just transition in the Spanish and European new political framework, with the strategic objective of providing recommendations for the design of transition contracts in Spain as a more consistent, coherent, comprehensive and reliable combined policy instrument. The analysis incorporates the stakeholders' perspective, being essential accelerators of the ecological transition at the local level and key agents in the realization of policy mix instruments.

There is a main reason justifying the exploration of the Spanish case. At present, the National objective, in complicity with territories, is the elaboration of the so-called transitional contracts as a roadmap and political instrument to accelerate the transition in coal-dependent territories with high demographic vulnerability. The cessation of coal mining activity and the closure of thermal power plants has had a strong impact on the

economy and demography. Within 25 years, these territories have lost between 20 to 25% of their population [3].

Some structural problems characterizing mining basins such as industrial monoculture, shortage of investment, unemployment, and heavy reliance on State, are aggravated by unstoppable emigration, especially of young and qualified population. Depopulation, redefinition of identity [25], [26] and social mobilization have also been an effect of long-term public policies aimed at closure and production dismantling. The announcement of closure prompted social mobilizations with great impact on media in 2010, 2012, 2016, 2018, 2019 and, to a lesser extent, in 2020, claiming for a chance to remain in the territory [27], [3].

The Spanish government is interested in designing a governance and an energy/territorial policy that mitigate the adverse effects of decarbonization. Spain endorsed the controversial "Declaration of Silesia on Solidarity and Just Transition" at the Katowice Climate Change Summit (December 2018), with the aim of promoting the social and labour aspects associated with the Economies decarbonisation. Within a few months, the Government put on the table: The Framework Agreement for a Just Transition of Coal Mining and the Sustainable Development of the Mining Regions for the period 2019-2027, the Strategic Framework for Energy and Climate (2019), the preliminary draft of the Climate Change and Energy Transition Act (2019), the National Integrated Energy and Climate Plan (PNIEC) 2021-2030, and the Just Transition Strategy, together with an Urgent Action Plan (2019-2021).

In the Coal Regions in Transition Initiative [6], Spain appears as one of the seven Member States (along with Germany, Poland, Czech Republic, Romania and Greece), in which Europe is going to focus, not to leave any region behind on the process of coal deindustrialization. In 2018, there were 207 coal-fired power plants in the EU [28].

Spain joined the first wave of power plants dismantling (2020-2025) due to the age of its plants and their low efficiency. This wave is forecasted to bring in a loss of 15,000 jobs, mainly in the UK, Germany, Poland, Czech Republic and Spain [11]. Spain is the European country with the largest number of companies, including all those that provide indirect services (mostly SMEs) [28] linked to coal large infrastructures, so both economic and cultural/ identitarian independence are at stake [29], [30], [3].

Currently, some initiatives have already started in several regions, as a result of the transitional contracts. Its evaluation will allow deepening in the efficiency of all these tools for a just transition.

With this contribution, we answer the following research questions:

- What are the main barriers to overcome to move forward in a just transition?
- How can transitional contracts be designed as combined policy instruments, to accelerate the transition?

Both questions allow advancing in the conceptualization of the just transition, permanently under construction, and of some key elements to design policy mix instruments based on the analysis of the analytical framework characteristics, as proposed by [31].

The article structure is as follows: Firstly, we introduce the theoretical approach and background to analyse the just transition barriers and key elements of the policy mix. Secondly, we present the case study of a coal historical area in the Spanish region of Aragón. Thirdly, we describe the mixed method design used for data collection and analysis from the stakeholders' perspective. Consequently, the main empirical results of the study are discussed in reference to the main policy mix dimensions. Finally, we provide the conclusions and subsequent political implications.

2. State of the art and analytic framework

The role of the coal industry in the new energy model, facing climate change, is under recent discussion around the world [32], contributing to make fossil fuel reliance as one of the most contested areas in policy-making and politics [33], [20]. Studies in countries where coal has a relevant weight such as Colombia, [35], [34], China [36], [37] or Australia [38], [39], among others, highlight the serious contextual pressures [40].

In Europe, transition studies have appeared in regions under deindustrialization processes, both from a national comparative approach [41], [42], and from a regional approach. They focus on analysing resistance [43] and barriers, risks and opportunities of the coal-dependent regions [19], [44], [2], [18]. Many of the studies focus on the displacement of coal towards renewable energy-oriented re-specialization mainly [45], [46], but also towards sustainable new business models [47]. All this research is a necessary and useful basis for the design of transitional policies addressing the individual, community, regional and sectoral levels [22].

Our analytical framework is based on the notion and theory of sustainability transitions [48] as the general theoretical construction to explore and explain the change of socio-technical regime [49], [50] and to re-think the energy politics supporting it [51]. Two additional conceptual "lenses" [52] are used to complement it: the conceptual framework of just transition and the conceptual framework of policy mix for the design of combined policy instruments. They provide greater depth of analysis as well as a strategic approach (Figure 1).

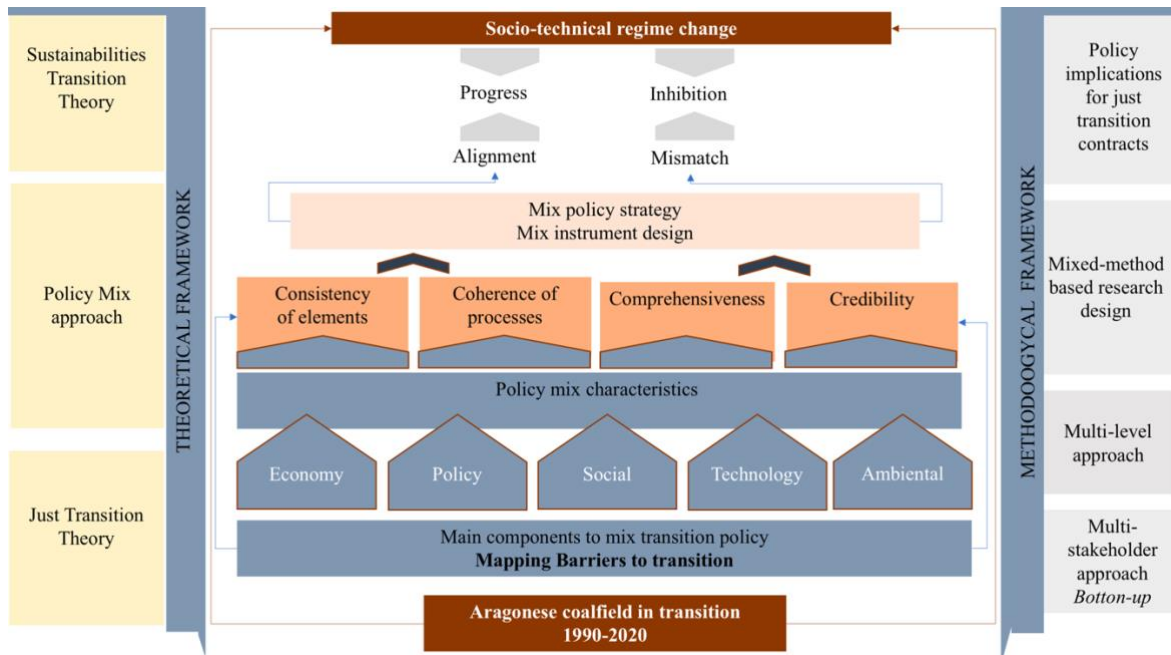


Figure 1: Theoretical and methodological framework

Previous research suggests that the actors' views and preferences around policy instruments largely depend on the priority and importance they assign to problems [53], [54]. Therefore, it is based on the idea that stakeholders' view about the barriers reflects the relevance of the main dimensions of just transition as a notion. We will argue in the discussion that the most relevant interpretive categories are articulated around three organizing factors: a strategic vision, an innovation approach and a crosscutting notion of justice.

2.1 Sustainability transitions, vision and agency

The authors agree to highlight the complexity of deciding on the timing and ways to implement coal-based technology withdrawal policies, aligned with the introduction of clean technologies and new business models, in a framework where different socio-technical regimes co-exist [55]. In Spain, there is a wide gap between the efforts made by coal withdrawal policies and progress or success in the process of change. Thirty years of policies aimed at alleviating employment effects and seeking rapid

replacements have had consequences, which are now visible in form of opposition and resistance against new processes for decision-making and actions towards transition (barriers). The question of agency has been repeatedly addressed in the research, starting with whether sustainability transitions are, can or should be guided by vision [56], [52], and continuing with the difficulty of predicting or controlling transitions in territories [57] given the complexity and dynamism of socio-technical systems. However, it can be understood that transitions may be intentional [58], even if the direction of processes and, especially, their effects on inhibiting or impulsing change are not [52]. The reconfiguration for the alignment of the institutional processes that drive decisions and action with a collective strategic vision may be partly conditioned by the counteractive processes from a political game that defines who wins and losses in the contested and competitive socio-technical regime [52].

In any case, there is an important margin for reflection, decision and action of all actors in the political [58], [49] and governance arenas. Studies focused on actors' relationship with policy mix [53], [24], [54] suggest which the best supports are and where transition processes should be strengthened. More studies are needed, however, on how divergent views of stakeholders can provide relevant keys to design better political instruments.

2.2 Transition based on justice

International literature documenting the transition of territories from coal to emerging/alternative economic activities has been revisiting the idea of equity since the 1980s [59] to recent formulations such as the 2030 Agenda, [60]. Precisely in 2015, an explosion of reports and manifests on just transition took place [22], followed by the interiorisation of the notion in numerous regulatory and strategic frameworks of different countries, including Spain.

The adoption of a just transition approach [61], [62], [63] from the perspective of policy mix responds to:

- a) The embryonic state of academic literature on just transitions and the subsequent need to generate studies in this line [22],
- b) The perspective adopted in energy policies both European level in general, and at Spanish level in particular; and
- c) The coalfield context itself that, since the decarbonization process has drawn attention to regional vulnerability and need for justice and opportunities to remain in the territory [3].

Just transition is a multidimensional and complex notion [64], [65] and there is no unanimity in the operationalization of the elements that a just transition policy should contain because a demand for justice can only be understood in its own empirical and normative context [66], knowing the relative levels of support for energy transition [67]. Justice frames are built at social and political level, and are under permanent discussion [68]. Therefore, those transitions in which policies incorporate the stakeholders' interests will have a stronger perception of justice [69], [70]. Here, the notion of justice in relation with the territory is highlighted, essentially recognising people's ability to make decisions in the process of change that improve the quality of life in the place where they want to live. This focus is useful for analysing threats associated with phasing out coal, incorporating the social cultural dimension, because the energy system is fully analysed as a multi-factorial and complex system [71], [72].

2.3 Policy mix, innovation and socio-technical regime change

Economic growth objectives go along with social challenges, as priorities in recent discussions about policy orientation. Within those, research, technology and innovation

play a central role [66]. Multi-level perspective and innovation system approaches coexist with new, more strategic approaches such as policy design for transformative change after the notion of 'failures' (in market, in structural system and in transformative system), including barriers and bottlenecks [74], [73], or the approximation of policy mixes. This approach advocates for the suitability of combining different policy instruments to accelerate technological change rather than single policy instruments [31], [75] and has aroused growing interest among researchers and organisations such as the OECD [76], the European Commission or the International Energy Agency [21].

The research about policy mixes for energy transitions from different disciplinary traditions, has been focused on five key research themes distinguished by Rogge et al. [77]: 1) The policy mix rationales [78], [79], [20], 2) the interactions and coordination of policy instruments [80], [81], 3) the design of policy mixes and their characteristics, [82], [83], 4) the policy mixes for creative destruction, [84], [55], and 5) the role of actors and institutions in shaping energy transition policy mixes.

Most of this research is focused on the relationship between policy mix and technological change. Originally, the literature on policy termination recommended strategies to reduce the shock and search for quick replacements [85]. Subsequent literature on destabilization of the regime highlighted the role of innovation in the dismantling of entire technologies and industries [85] or the usefulness of creative destruction [55], [86].

The most recent work addresses gaps in literature of policy mix such as how destabilization can articulate and accelerate ways of innovation [84] or the extent to which the introduction of policy mix instruments can boost renewable energies and destabilize the fossil-based electricity production [55].

Nevertheless, academic literature also shows an evolution from the consideration of technological innovation as an axial element in sustainability transitions to other approaches where key accelerating dimensions, such as transformative innovation policies [87], innovation in business models [47] or social innovation, become relevant. From this perspective, the involvement of individuals and institutions in change and active creation [75], [88], [89] is stressed, assuming that public investment alone cannot generate the necessary transformation of the system [90]. In this same line, the studies on “energy democracy approach” focus on the complex analysis of the relationship between integration of policies linking social justice and economic equity with energy transitions, combining the resist-reclaim-restructure goals [20].

Here, we focus on the relationship between the policy mix and change in a broader and more holistic sense, although respecting Rogge and Reichardt (2016) proposal. They describe the policy mix as ‘a combination of the three building blocks: elements, processes and characteristics’, although in fact, the four identified features explain ‘both elements and processes’ [31: 1622]. These characteristics and their main features [82], [91] have constituted the theoretical reference for the coding and final analysis of just transition barriers in the Aragonese mining basin (see table 2).

3. Case study

In Spain, the political decisions forced the industry dismantling, a labour conversion of mining areas and the conversion of coal-fired power plants into combined cycle gas plants [92], looking for an early development of renewable sources in the country. However, erratic and ambiguous policies during the economic crisis [93], [3], the effects of the Spanish Coal Decree 143/2010 [93] and Government direct intervention, revitalised the use of coal at a relatively late point in the energy transition route, slowing

it down [41]. Currently, a 62.5% of the electricity generated in Spain still comes from non-renewable sources; this percentage has been reduced just by two percent since 2015, yet renewable energies are consolidating as the decarbonization process advances (Figure 2).

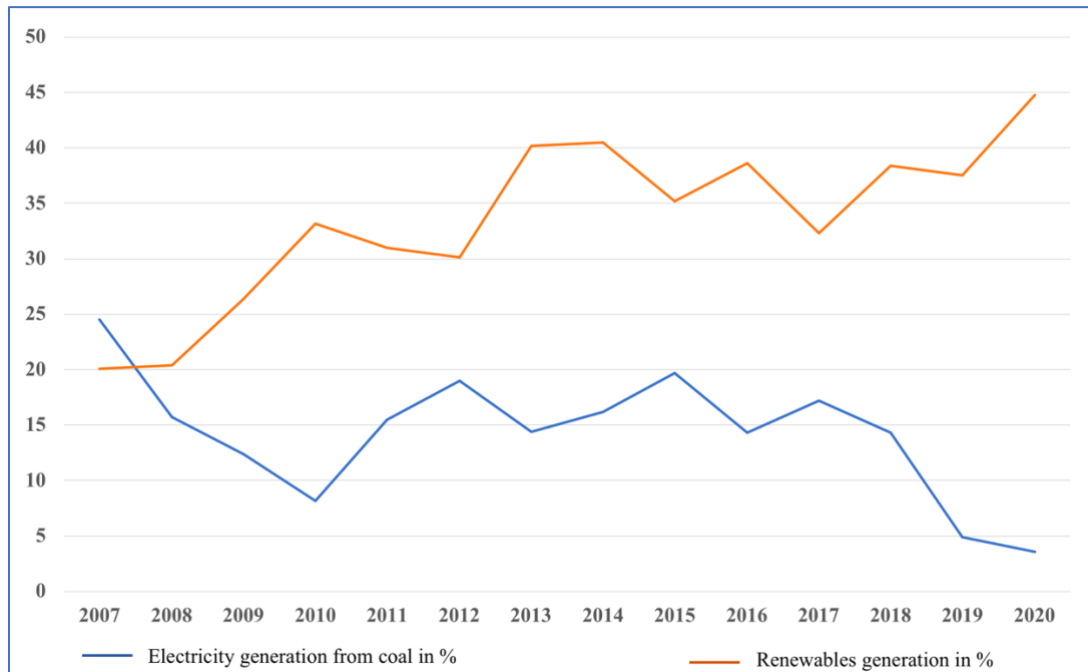


Figure 2: Spanish electricity system evolution for energy generation based in coal and renewables, after REE data (www.ree.es)

Spanish domestic coal, such as the European one, has always struggled to compete in the international market, requiring state support in different ways. Sector support programmes began in the 1970s, prevailing until today. From 1987 to 2014, utilities and power companies were offered a guaranteed retribution price in exchange for buying domestic coal. Since 1990, however, some 150 coal mining sites have been closed in Spain, resulting in the disappearance of nearly 30,000 jobs, according to the Geological and Mining Institute of Spain (2018).

The sector employed 100,000 people in the 1950s, decreasing to 45,000 in the late 1980s and has nearly disappeared today (1,562 miners in March 2019, of whom 71 in

Aragón [94]. European regulations and national restructuring plans have not prevented the closure of the large energy-mining installations in Aragón (figure 3).

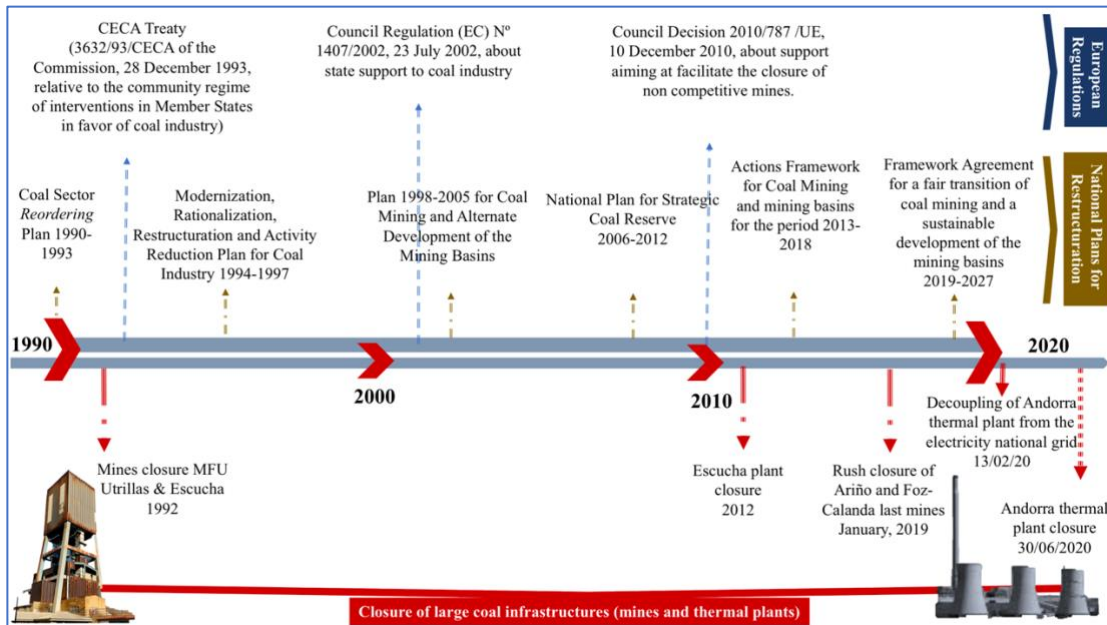


Figure 3: Milestones in the dismantling process of the Aragonese coal mining (1990-2020)

In 2012, Spain drew up a Closing Plan up to 2020; that same year it closed the Aragonese thermal power plant of *Escucha*. The action plan, agreed by trade unions, entrepreneurs and the Secretary of State for Energy for mining regions, was for the period 2013-2018, although some aid was extended until 2021.

At the end of 2018, Government and Trade Unions signed another agreement for the closure of coal mining sites and the Secretary of State confirmed the closure of most of Spain's 14 thermal plants, thus virtually ending coal-based electricity generation (figure 4).

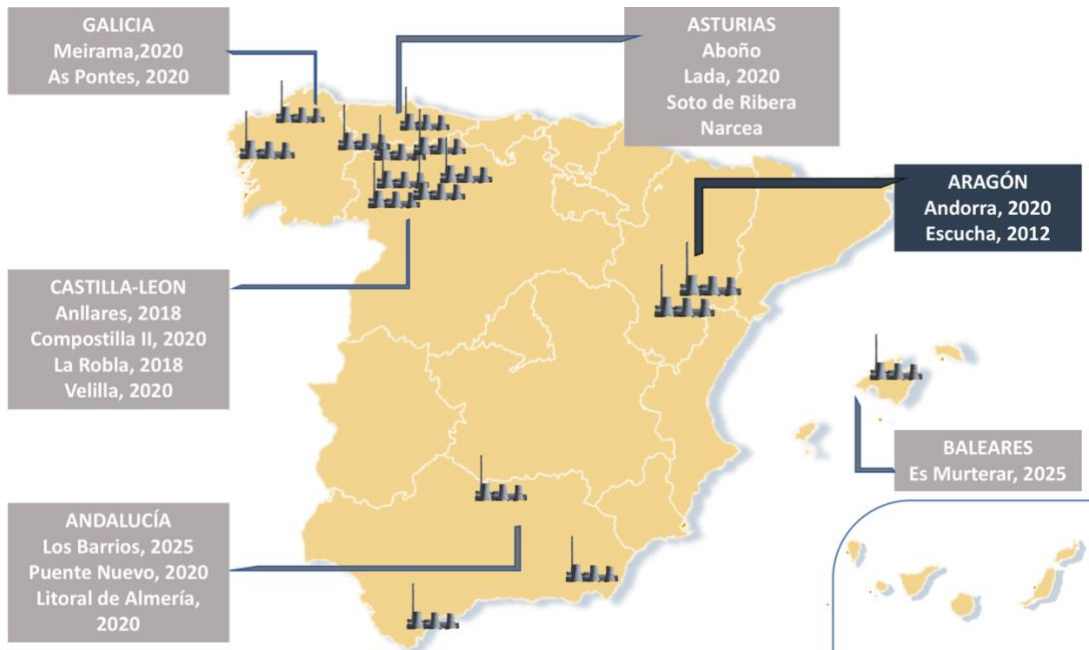


Figure 4: Foreseen calendar for Spanish thermal plants and closure.

Finally, on the 17 April 2020, the national government, unions and plants owners signed the “Agreement for a just energy transition in closing thermal plants”, addressing each part commitments [95].

The closure of the last Aragonese mines, as part of the widespread phenomenon in Europe from which it seems difficult to subtract, occurred in January 2019 shortly before the decoupling of *Andorra* power plant from the national electricity grid. The closure of companies linked to the sector and the dismantling of industrial areas in the region has been inevitable despite investments to promote the use of local coal, support to revive the sector, and exceptional measures targeting enterprises and aiming to mines and environment restoration. In the social section, pre-retirements, relocation plans for other activities and training initiatives towards new sectors were proposed. Being important and necessary measures, their scope is perceived to be limited and their results ineffective, in the light of certain structural factors that act only as hinderers and barriers to a just transition (table 1).

	2000	2008	2018	Period 2000-2018	Period 2008-2018
Population	11397	11542	9890	-13,22%	-14,31
Gross added value (thou. €)	280.212	337.636	301.962	7,8%	-10,6%
○ Extractive, energy and water (thousand € and %)	217.260 77,5%	158.962 47,1%	128.897 42,7%	-40,7%	-18,9%
○ Remaining sectors (thou. €)	62.952	178.674	173.065	174,9%	-3,1%
– Agriculture	5.257	4.076	6.329	20,4%	55,3%
– Industry manufacture	7.792	19.023	36.664	370,5%	92,7%
– Building/ construction	14.143	57.585	24.077	70,2%	-58,2%
– Services	35.760	97.990	105.995	196,4%	8,2%
Employment (%)					
○ Extractive, energy and water	23,9%	16,2%	18,1%	-24,2%	11,3%
○ Remaining sectors	76,1%	83,8%	81,9%	7,6%	-2,2%
– Agriculture	10,6%	4,1%	5,6%	-46,9%	37,3%
– Industry manufacture	8,1%	10,5%	13,3%	64,1%	27,3%
– Building/ construction	19,1%	22,1%	9,8%	-48,9%	-55,8%
– Services	38,3%	47,1%	53,2%	38,7%	12,9%

Table 1: Population evolution, the sectoral structure of Gross Added Value and employment in the region of *Andorra Sierra de Arcos*. Period 2000-2018. Source: Own after *Martínez, M.I., Parrondo, F., 2016, referred to year 2000), and IAEST*.

As in other coalfields the productive structure of the Aragonese region shows the effects of industrial monoculture; it is a territory still heavily dependent on the coal industry which, although slightly increasing in generated added value, has lost more than 10% of employment and continues to lose population (21.5% since 1990) while the provincial capital city (Teruel) has won 23.8%. In addition, the population with university studies does not stay to live in the region. The region fails to retain its younger and more qualified population or to attract it from elsewhere, thus hindering a just transition based on innovation.

4. Method

From our point of view, a combination of instruments for a just transition must not only address the instruments of technologies dismantling or substitution by others, but must also cover all actors' concerns from a system perspective [31: 1632]. The work aligns

with Ossenbrink's bottom-up proposal [96], appropriate to capture the differential perception of stakeholders and/or deepen the internal dynamics of a focused policy mix with a given strategic intent, and a wide spectrum of policy (economic, political, social, technological and environmental) and governance levels (local, regional, national and European).

Our analysis focuses on the time point at which the destabilizing policies of unsustainable regimes [84] converge with transition policies for the configuration of a new carbon-free socio-technical regime, yet to be defined. In addition, an analytical pathway is assumed, reflecting the staticity of the stakeholders' view at a given time, with a certain degree of dynamism that contributes to the fact that their manifestations contain the experience of the applying previous decarbonization policies, especially since 1990.

The work is based on a mixed research design combining qualitative interviews with quantitative surveys [97], [98], to give a broader and deeper perspective of what each method would achieve separately [44], [2].

Two phases were conducted in the research (figure 5), one for research and definition of the just transition barriers with a significant role of local stakeholders (n=10), and a second one quantifying the barriers relevance with a larger sample of 43 stakeholders (n plus 33 more stakeholders, out of the 55 invited to participate).

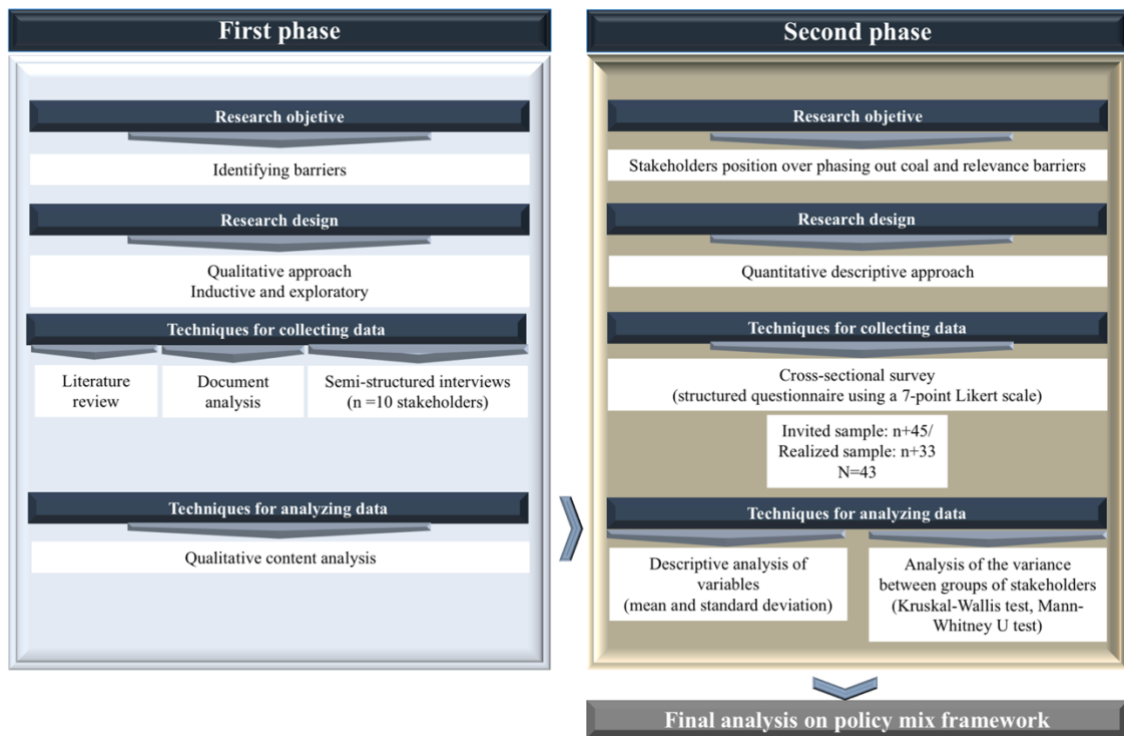


Figure 5: Mixed-method based research design for data collection and analysis

In the phase of identifying barriers to the formulation of just transition contracts, a qualitative approach was chosen, assuming the relevance of the institutional [99] and the cultural context, where the impacts of change occur [100]. Three different sources were used to identify barriers (semi-structured interviews to 10 stakeholders, literature review and documentary analysis), to reduce the subjective local approach and to incorporate those informational elements (barriers) that could be less visible to the local population.

After a qualitative content analysis to find out what was blocking the decision-making process and the action towards a just transition (barriers), a second phase in data collection was undertaken to realize the stakeholders' position about phasing out coal, and to measure the relevance of each of the 94 barriers identified. A cross-sectorial survey technique was chosen for data collection, designing a structured questionnaire that started with personal and demographic questions (age, gender, address, education,

profession and stakeholders' group), and continued asking every stakeholder to use a 7-point Likert scale to score a) his/hers phasing-out level of acceptance and b) the relevance of each barrier.

The selected stakeholders have a direct knowledge of the process of deindustrialization in the area, and belong to groups representing a wide range of interests. They cover the full spectrum of local stakeholders suggested by different approaches in the literature [101], [45], [89] and by recommendations from the European Commission to identify the best ways for transition in the Coal Regions [6]. The first phase of fieldwork and semi-structured interviews helped the research team to meet and engage to thirds of the stakeholders participating in the second phase. The other third was contacted and engaged by phone or email. In order to complete and grant the coverage and representation of the sample, a theoretical conducted method was applied. Although 55 stakeholders were invited to participate (invited sample), only 43 completed the second phase (realized sample) [98] (figure 6); most of the no-answers come from the regional and municipal government

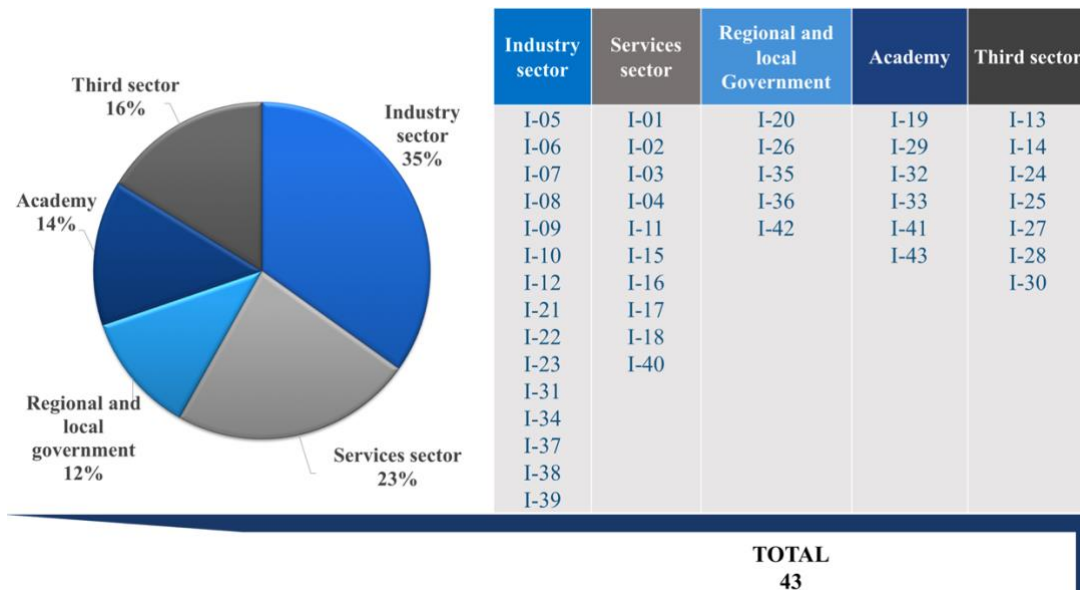


Figure 6: Sample distribution, stakeholders and groups to which they belong to: 1. Industry sector (IG) (including coal companies and utilities), 2. Services sector (SG) (banking financial sector, tourism, culture and retailing), 3. Government (GG) (regional and local government), 4. Academia (AG) (research institutes, University and education centres), and 5. Third Sector, (TSG) (Civil society, NGOs and social associations).

The data used in the first phase were collected between July 2019 and October 2019; the second phase was conducted between November 2019 and March 2020. During this period, there was still an active debate at different levels about the just transition, being a public issue. In addition, the evaluations from the stakeholders were collected when different alternatives still existed on the political agenda and the most relevant components of the transition were being discussed in a non-electoral context [102], [54].

The quantitative analysis in the second phase was based on a descriptive analysis of variables (mean and standard deviation) and an analysis of the variance between groups of stakeholders from the Kruskal-Wallis test to the five groups, and the Mann-Whitney U test for comparison of peer groups.

Finally, the characteristics of the combined transition policies were analysed globally from both qualitative and quantitative data, using the codes and subcategories shown in Table 2.

CODES (description) (Rogge and Reichardt, 2016)		SUBCATEGORIES	BARRIERS (n°)		
Consistency in elements Absence of contradictions and existence of synergies among elements	No contradictions		14,15,16,17,18, 29, 49, 54, 58, 84		
	Synergies		5, 8, 9		
	Complementarity		12, 13, 63		
	Unidirectionality (Howlett and Rayner, 2007)		24, 31, 43, 44		
	Temporal policy coherence (Huttunen, Paula y Virkamäki, 2013)		7, 82, 83, 87, 88		
Coherence in processes. Political processes synergic and systemic	Aspects	Harmonious Development		1, 7, 11, 22, 23	
		Organizational capabilities of policy makers	Strategy articulation (vision)		33, 34, 35, 38, 45, 55, 86, 91
			Knowledge generation and diffusion (Jacobsson y Bergek, 2011)		10, 28, 32, 71,77, 85, 92, 93
			Leadership and governmental management		41, 65
			Actors' networks management (Quitow, 2011, 2015)		53, 61, 62, 80

		Coherence among governance levels	36, 37, 40, 42, 47, 48, 49, 63, 70
	Tools	Political integration (Martin, 2016; Flanagan et al., 2011)	56
		Coordination	38, 46
Comprehension Captures how extensive and exhaustive its elements are and the degree to which its processes are based on extensive decision-making		Extension in political environments	34, 50, 51, 52, 60, 66, 77, 89, 94
		Width of attended demands [Institutional and actors demands, system failures (Sovacool, 2009; Weber y Rohrer, 2012) and/or perceived barriers in different policy fields, levels and actors].	23, 30, 64, 79, 90
Credibility Reliability in policy mixes as well as in political agents		Trust	57, 59
		Efficacy	56

Table 2: Codes and subcategories in the analysis of barriers to a just transition and policy mix, adapted after the analytical proposal from Rogge and Reichardt (2016).

5. Results. Barriers to a just transition as a starting point to improve the policy mix

How actors deal with new contracts depends in part on the vision of previous experiences. Therefore, the analysis of barriers, from a policy mix characteristics approach, gives us a characterization of the elements and political processes of transition to date, as well as certain keys to improve the four features that describe them. The results are shown below, integrating in this subsection the analysis of phasing out coal acceptance, the relevance of the identified barriers and the perceptual variance of the different groups of stakeholders, wherever statistically significant.

5.1. Disorganised and delayed transition. Improving consistency

The transition, perceived by stakeholders as a whole, presents clear contradictions, fundamentally in terms of the objectives to be addressed and the timing for implementation of the most urgent policies. The study has identified 94 different

barriers of the just transition (Appendix A) that conform the local conceptualization of what a just transition means. The identification of obstructing components has generated a rich variety that only reflects the multiplicity of sensitivities of all groups, there being quite a consensus regarding relevance. The abundant presence of economic aspects (9 in the first quartile) can be observed, followed by the social, political, technological components and, lastly, those related to the environment.

However, if we look at the relevance attributed to the barriers of greater weight (quartile 1), those in the technological field are as prominent as the economic ones (Figure 7).

Barrier	RELEVANT BARRIERS	Code	Mean	Economy (E)			Policy (P)			Social (S)			Technology (T)			Environment (En)		
				Variable	Mean	SD	Variable	Mean	SD	Variable	Mean	SD	Variable	Mean	SD	Variable	Mean	SD
B84	Absence of commitment to invest in improving communications	T4	6,28	E1	5,61	1,69	P1	5,16	1,89	S1	4,87	1,88	T1	4,79	1,75	En1	4,23	1,81
B12	Disordered transition: Lack of complementarity of industrial projects	E12	6,23	E2	5,71	1,41	P2	4,38	1,53	S2	5,36	1,80	T2	5,26	1,59	En2	5,68	1,49
B55	Vagueness of model for the region after coal	S3	6,21	E3	5,65	1,58	P3	5,60	1,74	S3	6,21	1,26	T3	6,02	0,99	En3	5,55	1,48
B57	Growing scepticism by local community	S5	6,08	E4	5,70	1,62	P4	5,68	1,34	S4	5,79	1,30	T4	6,28	1,24	En4	5,32	1,34
B27	Public investment lacks from territorial perspective	E27	6,05	E5	4,53	1,86	P5	5,85	1,17	S5	6,08	1,14	T5	5,13	1,58	En5	3,21	1,63
B83	Delayed transition to other technologies	T3	6,02	E6	3,91	1,62	P6	5,05	1,72	S6	4,39	1,90	T6	5,59	1,41			
B9	Scarcity of private investment	E9	5,98	E7	5,80	1,47	P7	5,82	1,17	S7	5,29	1,21	T7	4,54	1,52			
B45	Short-sighted policies with no strategic territorial vision	P15	5,98	E8	5,31	1,44	P8	5,68	1,21	S8	4,64	1,78	T8	4,93	1,66			
B25	Lack of companies with R&D capacity	E25	5,87	E9	5,98	1,35	P9	5,70	1,26	S9	5,15	1,49	T9	5,71	1,19			
B35	Lack of strategic vision and support policies to identify emergent or latent sectors	P5	5,85	E10	5,45	1,80	P10	5,64	1,69	S10	5,03	1,55						
B37	Lack of complete acceptance of gradual phase out of coal	P7	5,82	E11	5,27	1,66	P11	5,33	1,49	S11	5,51	1,64						
B7	Deficit of small and medium enterprises (SME)	E7	5,80	E12	6,23	0,92	P12	5,36	1,65	S12	5,58	1,15						
B56	Perception of inefficacy in measures and support	S4	5,79	E13	5,39	1,35	P13	5,41	1,57	S13	5,32	1,47						
B30	Absence of productive models inclusive and alternative to extractive industries	E30	5,78	E14	5,61	1,64	P14	5,06	1,16	S14	5,71	1,43						
B26	Inexistence of technological innovation hubs	E26	5,74	E15	4,98	1,99	P15	5,98	1,35	S15	4,89	1,68						
B2	Great diversity in economic interests of main interested parts	E2	5,71	E16	5,20	1,98	P16	5,45	1,63	S16	5,33	1,36						
B66	Lack of integral programs to rejuvenate the region (employment, housing, services, training, etc.)	S14	5,71	E17	4,92	1,80	P17	5,10	1,66	S17	5,46	1,29						
B89	Scarce exploitation of environment and resources through new technologies in non-energy sectors	T9	5,71	E18	4,79	1,84	P18	5,29	1,61	S18	5,15	1,71						
B4	National financial funds not sufficient to undertake in-depth regional diversification processes	E4	5,70	E19	4,38	1,77	P19	5,29	1,68	S19	5,33	1,41						
B39	Lack of regional strategy for a transition to a more sustainable socioeconomic model	P9	5,70	E20	4,63	1,68	P20	4,33	1,87	S20	4,31	1,66						
B34	Lack of national political will to undertake in-depth reforms in other sectors	P4	5,68	E21	3,95	2,07	P21	4,54	1,80	S21	3,84	1,52						
B91	Lack of vision of the environment as an opportunity	En2	5,68	E22	4,49	1,97	P22	5,10	1,64	S22	4,39	1,71						
B38	Regional government system cannot solve large problems of national importance	P8	5,68	E23	4,55	1,66				S23	4,40	1,93						
				E24	5,50	1,66				S24	5,08	1,53						
				E25	5,87	0,98				S25	4,27	2,04						
				E26	5,74	1,35				S26	4,00	1,89						
				E27	6,05	1,21				S27	3,51	1,68						
				E28	5,54	1,35				S28	4,47	1,76						
				E29	5,56	1,37												
				E30	5,78	1,19												

Figure 7: Relevant components for a just transition (first quartile (excel) (25%), mean and standard deviation).

Within the environmental sphere, the study has identified barely five elements obstructing the way towards a just transition, although with a significant intergroup divergence. The boxplot graph (figure 8) shows the diversity of opinions between the stakeholders' groups, especially for environmental barriers, which present a wide range of relevance scores for Services, Industry and Academia. However, a look to the means and the range of answers shows how the different barriers acquire more or less importance depending on the stakeholder's group. Among Services, for instance, economic and technological barriers are the most relevant ones in terms of both score

and homogeneity of opinions, while among Academia the political ones are far more relevant.

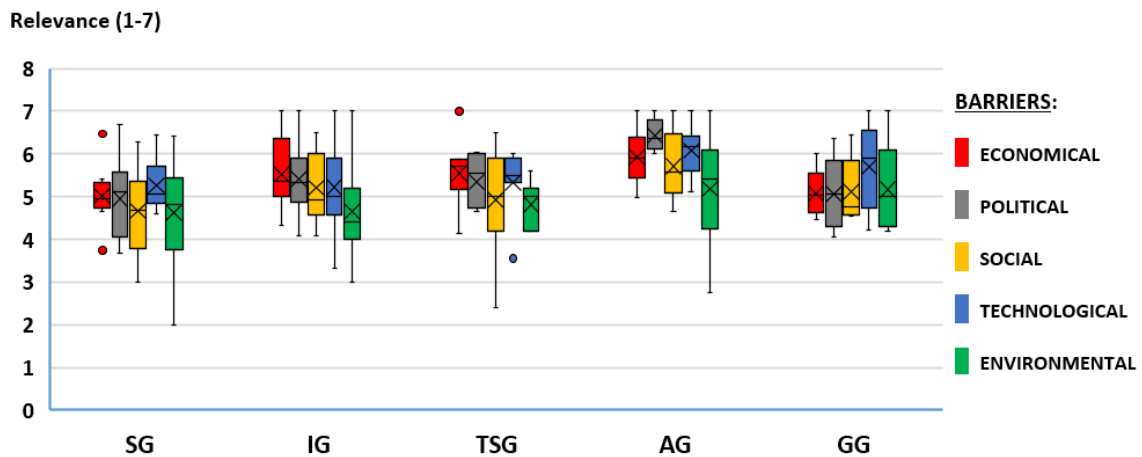


Figure 8: Diverging responses by stakeholder groups

From the stakeholders' point of view, the transition will be just if the outstanding political commitments and basic demands not yet addressed by the dismantling policy were considered first (communications, infrastructure or basic services). All groups agree on the centrality of communications (barrier No. 84, B84), although they differ in the relevance of the different infrastructures and services, with TSG (5.84 for infrastructure and 6.0 for services) and IG, versus AG (3.67). This component is reinforced in technology with the need to accelerate the implementation of other technologies (not necessarily outside coal) and the articulation of new dynamics in innovation to apply endogenous resources and technological applications to new sectors. Some isolated sources of innovation come from local companies developing innovative projects to use coal in different ways such as fertiliser in the framework of circular bio-economy. In the territory, the articulation of some sort of innovation hub based on public-private collaboration and focused on identifying the next waves of technological opportunities in combination with the analysis of social, economic and environmental impacts, is seen as necessary too.

Second, the establishment and prioritization of policy mix objectives becomes complicated by political, economic and social polarization around the disappearance of coal (B49), and the fact that a certain part of the population understands the transition as an external imposition (5.36 for B54, with no significant intergroup differences). These opinions reflect frustration and dispossession of community future control, depicting those groups less committed to a sustainable vision. [3].

The long period of stagnant uncertainty associated with the possible continuity of coal in the national mix and the effects of dismantling policies for 30 years have significantly contributed to the breadth of community division and political polarization. About 31% of respondents are clearly in favour of phasing out coal compared to 23% who are openly in favour of keeping it, even with mines already closed and the thermal power plant uncoupled (Figure 9).

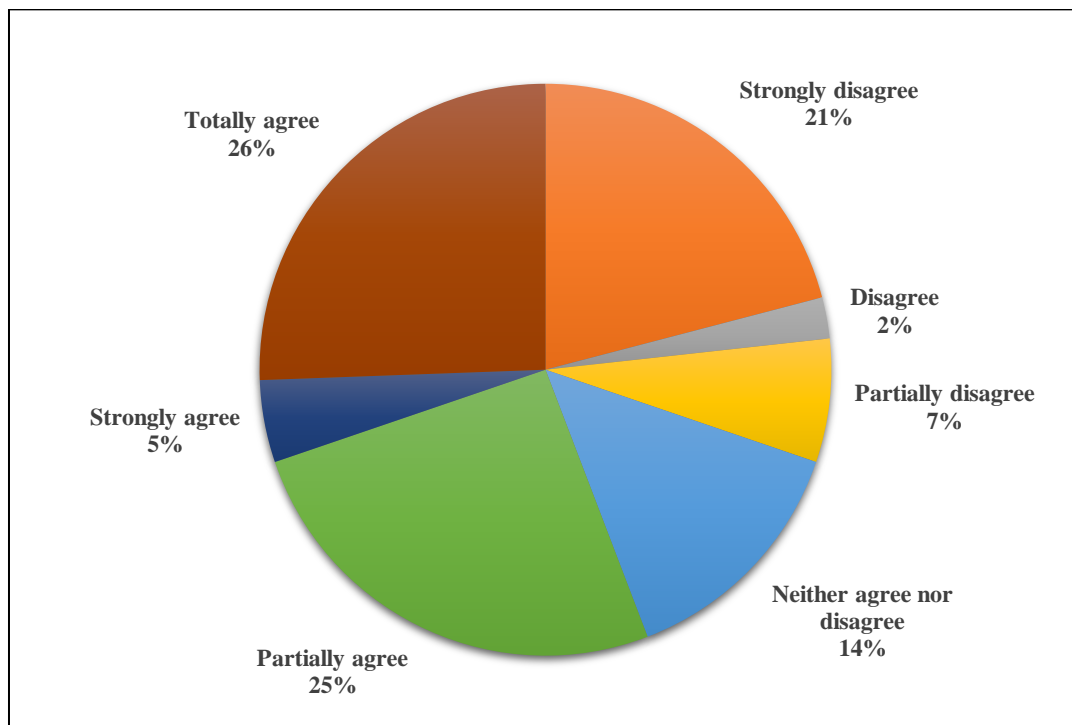


Figure 9: Stakeholders' level of acceptance of phasing out coal.

The lack of unidirectionality between objectives and instruments is embodied in the excessive prominence of incentive and aid instruments (B24, B31, B43, and B44). The 83% of IG considers that the inadequacy of the allocation of EU restructuring funds for coal industry (B1) represents a major barrier, in line with the expectation of more aid. While services and academia are the groups with the greatest perceptual differences, SG (3.86 on average) assigns the lowest score to this component.

Improving consistency could also be possible through the establishment of synergies and complementarities and the reduction of tension derived from the diversity of economic interests of key stakeholders. The first implies the need for collaboration between public and private investors (B5, B8 and B9). All respondents agree on the importance of public investment and the scarcity of private investment as a barrier; however, for TSG it is extremely relevant (100% have given it the highest score). There is also a shared vision over the need for projects from different sectors to be complementary among them (B12 and B13), so as to avoid a disorderly transition (second most relevant barrier).

The delayed transition. New transition contracts should ensure temporary consistency to improve the effectiveness of instruments. Local and regional policy and business developments are very important, but they should consider decision and actions timing. The temporal consistency of policies is not linked to immobility but to continuous readjustment, based on an assessment of its effects. The stakeholders perceive a delayed transition (B82, B83), for different reasons. Firstly, due to the lack of a clear and sustained national policy on renewables (B87). This is a particularly relevant barrier for the academy, which shows a difference with IG (6.17 and 4.86). Second, confidence in the advancement of clean coal technologies (B81) is especially emphasized as a barrier by the Government, (as compared to IG and SG responses). The third relevant reason is

the absence of previous successful experiences in the Aragonese region (B87 and B88). Business failed attempts at introducing new technologies (B87) are most relevant from the academy (showing a significant difference with IG, SG and GG). The same is true for component B88, which is highlighted as a fundamental component by GG (6.0 average: 100% of responses between 5 and 7) and AG (6.0 average, 83% of responses between 5 and 7); IG and SG are the ones that give less relevance to this component as a blocking element.

Consistency in this case would require clarity and support of objectives in national policy but also coherence between local effects and the scope of the global transition. This is what Meckling et al. [103] call 'policy sequencing', referring to the dynamics of change over time in line with the progress of transition. Therefore, avoiding contradictions in combined policies objectives, coupled with the correct delimitation of deadlines for objectives and measures implementation, would increase the consistency of transition contracts.

5.2. Disharmonious transition, ungoverned and out of focus. Improving coherence.

Improving the coherence of processes necessarily involves addressing three essential aspects: harmonic development, organizational capacity and coherence between levels of governance, with two basic tools, political integration and coordination.

The disharmonious transition. We believe that the process consistency is improved by seeking more harmonious development between economic sectors and between sizes of companies. The stakeholders have different views on the weight that different economic sectors should have in the new policy, and in particular, the energy-mining sector, but they generally agree to highlight the lack of political will to undertake reforms (B34), innovate in technologies to exploit non-energy resources in the area (B89) or support

the cultural and tourism sector (B60). In addition, the respondents consider that a deficit of small and medium-sized enterprises (SME) was derived from the coal regime model itself (generator of industrial monoculture and reduction of entrepreneurial culture). It is AG that differs from the other groups, by highlighting the importance of generating a SME network that would enhance economic diversification processes and reduce external dependence (6.33, compared to the overall average of 5.06 - B44).

The ungoverned transition. A political dimension repeatedly mentioned by stakeholders is the absence of qualified leadership, which is realized in the absence of other government organizational capacities. Precisely the relevance for success of a just transition of the political dimension (7 in the first quartile) has been noted, highlighting, in the first place, the inability to articulate a vision and a strategy (B55, B15), either due to lack of skills or to lack of political will (B33, B34 and B35). The absence of a post-coal model and the lack of vision and strategy in transition policies at the three administrative levels involved: local (B45), regional (B39) and national (B34) appear in relevant prioritization positions. This perception is reinforced with a double consideration: first the short scope of transition policy, and secondly the absence of support lines for the identification of emerging or latent sectors (innovation).

The process coherence in transition policies would improve by incorporating skills and motivations, especially at the regional and local levels, to manage the different moments of acceptance of the transition in which actors are located, and to design an inclusive territorial strategy with the support of a national government with economic capacity (B38). For AG and TSG, the inability of the regional government to address regulated issues at national level (B8) also appears to be a very relevant component (6.33).

The strategy should encompass the interests of those believing that the energy-mining sector should continue to have great prominence and those believing the model should

drastically change. There is a substantial difference in perception of the energy-mining sector weight and the role it should play in the future (B1). The industrial sector (with respondents of different sectors) aligns with the Government in this valuation, but distances itself in its perception from the other groups. They call to stop replicating deciduous productive models (B29), particularly AG which differs from IG, to stop looking at policies which locate large industries in a territory where they have no roots (B63 - significant difference between IG and TSG) and to work for a 'new brand or identity for *Andorra* and its region, forgetting old stigmas' (SG).

Secondly, there is a need to increase the capacity to generate, manage and disseminate knowledge about a) resources and potentials of emerging sectors with links in the territory (B92), (b) successful experiences in processes of conversion in other sectors, and c) risk assessment through comparison with other mining conversion processes in other environments (B93). AG has quantified most of these components as highly relevant, showing a significant statistical difference with IG in B92.

Government management capabilities also refer to the so-called temporal coherence in influencing the need for continuous policy adjustment (B41) and the fact that policy instruments are designed and introduced on a pre-existing portfolio of measures [104], [99], within a given supranational framework.

The stakeholders expect greater leadership at all levels of government to rejuvenate the region (B65), to activate instruments capable of establishing populations, and to equip the population with skills enabling a more orderly and governed transition. For example, transition policies have encountered, and still do, serious barriers to implementation such as lack of professional skills qualified for a post-coal scenario (B71). New contracts should give priority to vocational training targeting new skills and retraining (B85). One of the effects of the policies implemented today is the low

permanence of young people in the educational system (B77). AG and TSG emphasize that this idea of strengthening government leadership should also focus on the dynamization of stakeholders' networks to increase the low participation (B53), the activation of social creativity (B61) and the promotion of community projects (B62), which appear to be current relevant barriers.

Out of focus transition. First, the stakeholders emphasize that investment has lacked a territorial perspective; this feature is even more relevant than the adequacy of national financial funds to carry out deep regional diversification processes. They emphasize the lack of harmony between local, regional (B48) and national interests, and the limited prominence of local government (B47) in decision-making and transition related action; all of which may be behind the perception of out of focus policies, away from local and even regional reality (B40, B63). Consistency would therefore imply a balanced presence of each level of governance, so that greater harmony can be achieved between the objectives of different political levels and groups. We see that political parties and governments have differently contributed to fuelling sympathy for coal (B70), often with a short-term approach, and have hampered full acceptance of phasing it out (B37), presenting coal-based arguments as one more option for energy security (B36) or by drawing comparisons with the phase out policies in pro-coal countries.

Thus, all stakeholder groups agree that the discourse of political actors is not coherent in time or within the different political parties. Furthermore, they also agree on the over-reliance on public aid, the low private investment, and the need to place the debate on a territorial level and not exclusively in the business or individual level.

Uncoordinated transition. The respondents clearly perceive a lack of coordination between government levels (B46). New contracts should bring in mechanisms facilitating and articulating it. Vertical (competitive allocation by governance levels)

and horizontal (departmental) political integration, sustained by effective coordination, is even more necessary to provide synergies and policy effectiveness (B56) on the national and regional scenario described with coalition governments and fragmented competitive allocations. Precisely, the current Spanish Government has integrated the policy on ecological and demographic transition into one single ministry with a structural coordination approach aiming to channel tensions between autonomous communities and tackle those two urgent challenges.

5.3 Misunderstood transition. Improving comprehensiveness

The stakeholders are at different stages in accepting the transition and have different visions of a) the political areas that transition policy should address, (b) the demands to respond to, and (c) the role of actors. First, everyone agrees that transitional contracts should integrate policies in a coherent and consistent way that makes the transition a just and more extensive process: gender equality (B50), social inclusion (B51) and youth (B52, B66, B77) among other. However, compared to economic aspects, priority attention to certain social inclusion policies (old age, dependence, gender-based violence, children - B21, B4 and B54) is not perceived as very relevant in the context of a just transition. It is not because this type of policy shall not be incorporated into the mix, but mainly because it is understood that coverage is not scarce at present, being precisely SG who grants a differential score (2,71 average). On the contrary, incorporating more comprehensive programs for rejuvenation of the region is considered a priority (employment, housing, services, training, etc. - B66). Surprisingly, the lower relevance score in this component is obtained from the Government group (4.40), versus a higher sensitivity of IG and academy (both with an average of 6).

In the social sphere, the stakeholders identified a broad list of components (B28) in the first phase, to which, however, respondents did not prioritize over others. Only four appear in the most relevant 25% (B33, B35, B34 and B44), referring to the lack of a post-coal agreed social model, the growing scepticism of the local community, and the perception of inefficiency in applied policies. These three refer us to a negative history, a 30-year experience of transitioning with few collective successes that undoubtedly complicates the design of new policy mix instruments.

Secondly, it follows that transitional contracts, to be just, should be articulated so that all the demands of the different groups are met; that is to say it must be human and social, and therefore inclusive (B30). For example, fostering more opportunities and greater representation of women in the labour world (B30, B64), caring for the most vulnerable population (B79 and B90) and ensuring human, social and environmental health (B90, B94).

One last contribution from stakeholders concerns the attention to the role and prominence of each social actor. For example, some respondents consider that there has been excessive weight and prominence in decision-making, even in more social and focused on community and territorial development decisions. In fact, the position of trade unions has been identified as a barrier to a just transition (B58). Arguably, this has reduced the comprehensiveness of the policies implemented, by under-addressing or downplaying demands from other groups.

5.4. Not reliable transition. Improving policies credibility

The design of new instrument mixes should be undertaken by approaching the effects from previous policies. In the analysed region, these effects are shown by structural indicators, sometimes recurrent and sometimes new, such as the impoverishment of

families (B67) aggravated by the economic crisis started in 2008 and especially relevant to IG and TSG. Secondly, the effects are also linked to perceptual and cultural attributes that affect decision making and action, especially the growing scepticism (B57), the sense of inequity and social injustice (B69 - of great relevance to GG and AG with 80% and 83% of stakeholders giving this component a score of 6 or 7, respectively), the perceived territorial vulnerability (B68), the distrust about not-always-transparent linkage between politicians and the economic elite (B59), the loss of local identity and pride (B72), and citizens lack of courage to support closure (B75 - especially relevant to AG, 5.83 on average and GG, 5.5). These attributes are linked to a widespread perception of past policies inefficiency (B56) and poor credibility over the political capability to successfully advance towards a just transition.

It may be presumed that the best way to improve credibility in transition policies and achieve support for politicians is to make progress that effectively responds to the population demands. Therefore, addressing the socio-cultural dimensions must also make part of key actions in boosting transition contracts. Progress (or failures) should be also measured through impact assessment to ensure readjustment of policy mix instruments.

6. Discussion. Lessons, findings and political implications.

The decarbonisation in Spain has led to a loss in the weight of the mining-energy sector in terms of both labour and contribution to GDP. The outcome of the national energy policy evidences a disalignment [20]: reduction, closing and dismantling of large infrastructures (coal mines and thermal plants), cessation of subsidies to fossil fuels, drastic reduction in employees, families and coal dependent communities, questioning

of the legitimacy of the mining-energy industry, legislation for more environmental protection and redirection of public resources to green sectors.

The combined policy new instruments continue to be of great interest for the affected territories, even though a large part of the employment has already been destroyed, or precisely because of that. It is urgent to accelerate and set a direction to the just transition with long-term restoring policies based in innovation. The decarbonisation is leaving communities and territories under a situation of vulnerability, and they must be placed in the heart of the policy mix instruments design, so as to decrease that significant proportion of frustrated and sceptical people who have lost confidence in the governance systems [20].

One of the findings of this study confirms the polarisation and ambivalence in the acceptance of coal removal. This complicates restoring lost confidence in transition policies and overcoming scepticism about transitional contracts. National energy policy, with notorious discontinuities, and the coal industry dismantling policy since the late 1990s, have ignored the reality of the territory according to local stakeholders, without having yet shown a gain of accumulated environmental efficiency that justifies a deep conversion.

The social expression and communication of the community emergency is now linked to the economic sphere, shadowing the verbalization of the environmental one, as seen in similar studies from other contexts [2]. However, despite its limited number, the environmental barriers show the highest intergroup difference, reinforcing the idea of a dichotomization in the commitment of its population with a sustainable vision, and the existence of competing and obstructing positions in relation with sustainability. This can be attributable to a moment of change from local identities of resistance to project-identities, as highlighted by recent studies in the region [3].

The attitude towards change has been revealed in a differential manner. Stakeholders from IG, and some from GG, seem to be more reluctant to change, and their proposals for new instruments align with already well-known policies (investment, large companies, centrality of the energy sector, etc.) against more comprehensive policies highlighted by the rest of groups. AG, TSG and SG show significant differences in this regard, paving the way to novel projects requiring a greater degree of agency from individuals and institutions, in sectors yet to be explored. Some put into question the excessive weight of some actors (such as trade unions) in the design of transition policies. In fact, the three stakeholders interviewed who represented trade unions (within IG), did align with resistance positions to closure.

Two significant findings referred to the potential obstructing role of GG and the local trade unions, are especially relevant. The first one for the political and electoral dynamics and the second one for its nature. The historical strength of trade unions in the region has been associated to the mining-energy sector, and so the unions' local agents may have contributed to silence those options diverging from the dominant regime. Therefore, the replacement of unions' representatives in the co-construction of new instruments for a just transition or a union supra-local vision may be a key factor, while the new sustainable sectors employees reinforce their positions.

Consequently, the study highlights what policy strategies must act now, not only to bring in the necessary public resources to the territory or to attract private investment, but also to redefine the democratic structures, the power relationships and the roles of actors. Likewise, the visibility of positions and ways to sustainability must be supported, improving the capabilities for anticipation, planning and construction of future scenarios, and strengthening the public sector and other agents' ability to play a central role in the new regime.

In addition to the polarization of the debate in permanent movement and change, the parallel process of transitioning the mining basin and closing the Andorran thermal power plant faces other barriers that complicate the just transition. Each one of the identified barriers reflects elements lost throughout the long process of coal deindustrialization, and relevant lessons and recommendations can be extracted to improve policy strategies. Some are presented in Appendix B, mainly related to three categories: vision, innovation and justice. These should be the organizing axes of transitional contracts in response to the stakeholders' request for a radical shift in implemented transition policies.

The first involves the construction of a territorial strategic vision assumed by all levels of government (local, regional and national) with a social base, which redirects the change of socio-technological regime in the long term. The stakeholders demand sufficient investment in communications, infrastructure and services, for an inclusive, long-term, complementary and territorial model, and the articulation of measures to reduce collective scepticism. The long-term transition cannot be based solely on palliative and shock-absorbing instruments; it must lay the foundation for the generation of innovative internal dynamics from the territory itself. Mix instruments should incorporate accompanying elements to facilitate the assessment of structural change and policy readjustment.

The second focuses on accelerating *dynamics related to innovation processes* and designing an innovation oriented policy mix. The stakeholders' ability to generate a shared and competitive project is undermined by the lack of previous successful experiences in the territory itself, the lack of information about progress in other contexts, the lack of awareness of potential innovative options to replace the

technological basis of the current coal-based regime and the weak culture of entrepreneurship.

The third is paying attention to the notion of justice and articulating more comprehensive mix instruments to overcome the coal regime captivity of the territories, and to respond to the demands and interests of all individuals and groups. Despite numerous efforts to communicate debate and reflect on the need for change, decision-making and action, the stakeholders highlight the territory poor prominence and decision-making capacity, as well as the lack of qualified leadership and government capabilities to lead. In the process of reflexivity around the losses or gains involved in the transition, they should stop feeling losers [105] and become actors taking on greater commitment and responsibility.

7. Conclusions

The paper focuses on the socio-technological change that occurs in the process of phasing out coal by extending the interdisciplinary and systemic analytical proposal of Rogge and Reichardt [31] to the sociocultural field. It points out the policy mix potential to accelerate the positive impacts of the ecological transition, and the capacity of mixed methods research designs to extend the empirical evidence. The theoretical framework of policy mix serves to map the contextual dynamics from the stakeholders' vision, with two general objectives: to better understand the barriers in a changing socio-technical regime environment, and to provide transition contracts (new policy mix instrument) with consistency, coherence, comprehensiveness and credibility. Research into the design of combined policy instruments can be enriched by this empirical case in the Aragonese mining basin with its approach from perceived barriers to a just transition.

The study has some limitations. The abundance of information provided by the study paves the way to suggesting reflections to improve the policy-maker's strategies and to new research questions based on the identified barriers and their interactions.

However, the exhaustive list of barriers has implied a methodological limitation, complicating the dialogue with stakeholders in the second phase, which may have been a cause for some stakeholders' refusal to participate.

Some of the barriers may have been difficult to understand due to their technical character or their specificity, requiring the researcher's intervention to grant the quality of data collection.

Likewise, the analysis depends first of the process of barriers identification (thus, the triple way to detect them), and then of the methodological rigour in selecting the sample. A larger sample in the second phase would increase the statistical significance and reinforce the results based on percentages.

Finally, three research lines continuing this work are at sight. First, further empirical work would bring a clear vision of the mechanisms to express or silence in the environmental dimension and the conditions required to its emergency and visibility.

Secondly, more empirical fieldwork at local and regional level is required to delve into the connections between the disinvestment/reinvestment initiatives and the emerging social movements of resistance related to regional wind farms, remunicipalization initiatives or renewable energy community cooperatives.

Thirdly, we see it appropriate to indicate that whether the correlation between the different variables analysed, or a specific study of each one of the characteristics of the policy mix, especially for credibility, should be further explored. Reliability can be studied by mapping in more detail the cognitive-cultural components of the selected

context to promote these new policies capable of generating positive feedback, as a better mechanism to strengthen support to policy mix and to politicians.

References

[1] M. Navarro, J.M. Valdaliso, M.J. Aranguren, E. Magro. 2014. A holistic approach to regional strategies: the case of the Basque Country. *Sci. Public Policy*, 41, 532–547.

DOI: 10.1093/scipol/sct080

[2] T., Skoczkowski, S. Bielecki, M. Kochsndki. 2020. Climate-change induced uncertainties, risks and opportunities for the coal-based region of Silesia: Stakeholders' perspectives. *Environmental Innovations and societal transitions*, 35, 460-481,

<https://doi.org/10.1016/j.eist.2019.06.001>

[3] A. Sanz-Hernández. 2020. How to change the sources of meaning of resistance identities in historically coal-reliant mining communities. *Energy Policy*, 139, 111353.

<https://doi.org/10.1016/j.enpol.2020.111353>

[4] European Commission, (EC). 2002. Council Regulation (EC) No 1407/2002 of 23 July 2002 on State Aid to the Coal Industry. *Official Journal of the European Communities English Edition*, no. L 205, 1–8.

[5] European Comission, (EC). 2010. Accompanying Document to the Proposal for a Council Regulation on State Aid to Facilitate the Closure of Uncompetitive Coal Mines. Accompanying Document to the Proposal for a Council Regulation on State Aid to Facilitate the Closure of Uncompetitive Coal Mines.

[6] European Comission, (EC). 2019. Clean Energy for all Europeans. Available on: https://op.europa.eu/en/publication-detail/-/publication/b4e46873-7528-11e9-9f0501aa75ed71a1/languageen?WT.mc_id=Searchresult&WT.ria_c=null&WT.ria_f=3608&WT.ria_ev=search (Accessed 8 December 2019).

- [7] COM 640 final. 2019. The European Green Deal. Available on: <https://eur-lex.europa.eu/legal-content/ES/TXT/?uri=COM:2019:640:FIN> (Accessed 29 June 2020).
- [8] COM 21. 2020. Sustainable Europe Investment Plan. Available on: <https://eur-lex.europa.eu/legal-content/ES/TXT/?uri=CELEX:52020DC0021> (Accessed 29 June 2020).
- [9] COM 22 final. 2020. Regulation of the European Parliament and of the Council establishing the Just Transition Fund. Available on: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020PC0022> (Accessed 29 June 2020).
- [10] P. Huang. 2019. The verticality of policy mixes for sustainability transitions: A case study of solar water heating in China. *Res. Policy* 48 (10), 103758. <https://doi.org/10.1016/j.respol.2019.02.009>
- [11] EC, 2018 b. 2030 Energy Strategy. Available on: <https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2030-energy-strategy>. (Accessed December, 20, 2019).
- [12] International Energy Agency. 2017. Real-World Policy Packages for Sustainable Energy Transitions. Int. Energy Agency. Available on: <https://www.iea.org/reports/real-world-policy-packages-for-sustainable-energy-transitions>. (Accessed December, 20, 2019).
- [13] L. Lehotsky, F. Černoch, J. Osíčka, P. Ocelík. 2019. When climate change is missing: Media discourse on coal mining in the Czech Republic. *Energy Policy* 129, 774–786. <https://doi.org/10.1016/j.enpol.2019.02.065>
- [14] European Commission. 2020. Statistical Office of the European Communities. Available on: https://ec.europa.eu/info/departments/eurostat-european-statistics_es (Accessed December, 29, 2019).

- [15] CESA, Consejo Económico y Social de Aragón. 2019. Informe sobre la situación económica y social de Aragón. Panorama económico. 2018. Available on:
https://www.aragon.es/documents/20127/15107535/Informe_2018_Panorama_economico_CESA.pdf/5cd336a4-d68c-865d-b8be-e7e1323d494b?t=1569835755486 (Accessed March, 18, 2020).
- [16] Red Eléctrica Española (REE), 2020. Seguimiento de la demanda eléctrica en España. Available on:
<https://demanda.ree.es/visiona/peninsula/demanda/acumulada/2020-03-18> (Accessed March, 18, 2020).
- [17] D.J. Hess, Q.D. Mai, R. Skaggs, M. Sudibjo. 2018. Local matters: political opportunities, spatial scale, and support for green jobs policies. *Environ. Innov. Soc. Transit.* 26, 158–170. <https://doi.org/10.1016/j.eist.2017.03.003>
- [18] M. Antosiewicz, A. Nikas, A. Szpor, J. Witajewski-Baltvilks, H. Doukas. 2020. Pathways for the transition of the Polish power sector and associated risks. *Environmental Innovation and Societal Transitions*, 35, 271-291. <https://doi.org/10.1016/j.eist.2019.01.008>
- [19] A. Leipprand, C. Flachsland. 2018. Regime destabilization in energy transitions: The German debate on the future of coal. *Energy Research & Social Sciences*, 40, 190-204. <https://doi.org/10.1016/j.erss.2018.02.004>
- [20] M. J. Burke, J. C. Stephens, 2017. Energy democracy: Goals and policy instruments for sociotechnical transitions, *Energy Research & Social Science*, 33, 35-48, <https://doi.org/10.1016/j.erss.2017.09.024>.
- [21] F. Kern, K. S. Rogge, M. Howlett. 2019. Policy mixes for sustainability transitions: New approaches and insights through bridging innovation and policy studies. *Research Policy*, 48. <https://doi.org/10.1016/j.respol.2019.103832>

- [22] F. Green. 2018. Transition Policy for Climate Change Mitigation: Who, What, Why and How. CCEP Working Paper. Available on:
<https://coaltransitions.files.wordpress.com/2018/05/transition-policy-for-climate-change-mitigation-2.pdf>.
- [23] L. Edmondson, K. Duncan, F., Rogge, S. Karoline, 2019. The co-evolution of policy mixes and socio-technical systems: Towards a conceptual framework of policy mix feedback in sustainability transitions. *Res. Policy* 48 (10), 103555.
- [24] B. M. Lindberg, J. Markard, D. A. Andersen. 2019. Policies, actors and sustainability transition pathways: A study of the EU's energy policy mix. *Res. Policy*, 48 (10), Article 103668. <https://doi.org/10.1016/j.respol.2018.09.003>
- [25] O. Peñafiel. 2013 ¿Y dónde está el mundo feliz? Violencia patronal: mayordomos y policías; paternalismo patriarcal en la cuenca carbonífera. 1910-1920. Ponencia presentada en IV Reunión Comité Historia, Regiones y Frontera, de la Asociación de Universidades Grupo Montevideo (AUGM), Universidad de Santiago de Chile, Santiago.
- [26] A. Sanz-Hernández, M. E. López-Rodríguez. 2017. Mujeres del carbón. Protestas y emociones en la reestructuración minera española. *Aposta revista de ciencias sociales*, 74, 84-110. Available on: <http://apostadigital.com/revistav3/hemeroteca/alex sanz.pdf>
- [27] A. Sanz-Hernández. 2012. Cierre de minas y patrimonialización. Microrresistencias reivindicativas institucionalizadas. *Sociología del Trabajo*, 77, 7-26.
- [28] European Commission, 2018 a. Gonzalez Aparicio et al. 2018. EU Coal Regions: Opportunities and Challenges Ahead. <https://doi.org/10.2760/064809>. (Accessed December, 9, 2019).

- [29] S.E. Bell, R. York. 2010. Community economic identity: the coal industry and ideology construction in West Virginia. *Rural Sociol.* 75, 111–143.
<https://doi.org/10.1111/j.1549-0831.2009.00004.x>.
- [30] A. Mayer, 2018. A just transition for coal miners? Community identity and support from local policy actors. *Environ. Innov. Soc. Transit.* 28, 1-13.
<https://doi.org/10.1016/j.eist.2018.03.006>
- [31] K.S. Rogge, K. Reichardt. 2016. Policy mixes for sustainability transitions: an extended concept and framework for analysis. *Res. Policy*, 45,1620-1635, <https://doi.org/10.1016/j.respol.2016.04.004>
- [32] D. Gray, D. Bernell. 2020. Tree-hugging utilities? The politics of phasing out coal and the unusual alliance that passed Oregon's clean energy transition law. *Energy Research & Social Science*, 59, <https://doi.org/10.1016/j.erss.2019.101288>
- [33] A. Stirling. 2014. Transforming power: social science and the politics of energy choices. *Energy Res. Soc. Sci.*, 1 83-95, <https://doi.org/10.1016/j.erss.2014.02.001>
- [34] C. Strambo, A. C. González Espinosa, A. J. Puertas Velasco, L. M. Mateus Molano. 2020. Contention strikes back? The discursive, instrumental and institutional tactics implemented by coal sector incumbents in Colombia, *Energy Research & Social Science*, 59, 101280, <https://doi.org/10.1016/j.erss.2019.101280>
- [35] A. Cardoso, E. Ethemcan Turhan. 2018. Examining new geographies of coal: Dissenting energy scapes in Colombia and Turkey. *Applied Energy* 224, 398–408
<https://doi.org/10.1016/j.apenergy.2018.04.096>

- [36] X. Liu, X. Guo, P. Guo, L. Nie. 2020. Applying emergy and decoupling analysis to assess the sustainability of China's coal mining area. *Journal of Cleaner Production*, 243, 118577. <https://doi.org/10.1016/j.jclepro.2019.118577>
- [37] J. Mijin Cha. 2020. A just transition for whom? Politics, contestation, and social identity in the disruption of coal in the Powder River Basin. *Energy Research & Social Science*, 69. <https://doi.org/10.1016/j.erss.2020.101657>
- [38] G. Evans, L. Phelan, 2016. Transition to a post-carbon society: Linking environmental justice and just transition discourses. *Energy Policy*, 99. <https://doi.org/10.1016/j.enpol.2016.05.003>
- [39] R.M. Colvin. 2017. Social identity in the energy transition: an analysis of the “Stop Adani Convoy” to explore social-political conflict in Australia. *Energy Research & Social Science*, 30, 43-52, <https://doi.org/10.1016/j.erss.2017.05.041>
- [40] G. Verbong and F. Geels. 2012. Future electricity systems: visions, scenarios and transition pathways. *Governing the Energy Transition: Reality, Illusion or Necessity?*, Routledge, New York, 203-219.
- [41] G. Rentier, H. Lelieveldt, G. J. Kramer. 2018. Varieties of coal-fired power phase-out across Europe. *Energy Policy*, 132, 620-632. <https://doi.org/10.1016/j.enpol.2019.05.042>
- [42] P. Johnstone, S. Hielscher. 2017. Phasing out coal, sustaining coal communities? Living with technological decline in sustainability pathways. *Extr. Ind. Soc.* 4, 457–461. <https://doi.org/10.1016/j.exis.2017.06.002>
- [43] B. Arifi, P. Späth. 2018. Sleeping on coal: Trajectories of promoting and opposing a lignite-fired power plant in Kosovo. *Energy Research & Social Science* 41, 118–127. <https://doi.org/10.1016/j.erss.2018.04.012>

- [44] J. Lieu, S. Hanger, O. van Vliet, A. Sorman, M. Stua, G. Mackerron, A. Wanitschke, 2018. Mixed methods to assess risk and uncertainty in transition pathways. *Environ. Innov. Soc. Transit No. Special Issue on “Assessing risks and uncertainties of low-carbon transition pathways”*.
- [45] M. Ivanov. 2019. Governed by tensions: The introduction of renewable energies and their integration in the Bulgarian energy system (2006–2016). *Environmental Innovation and Societal Transitions* 32. 90–106.
<https://doi.org/10.1016/j.eist.2018.10.002>
- [46] H. X. Li, D. J. Edwards, M. R. Hosseini, G. P. Costin. 2020. A review on renewable energy transition in Australia: An updated depiction. *Journal of Cleaner Production*, 242, 118475. <https://doi.org/10.1016/j.jclepro.2019.118475>
- [47] S. Hall, C. Mazur, J. Hardy, M. Workman, M. Powell. 2020. Prioritising business model innovation: What needs to change in the United Kingdom energy system to grow low carbon entrepreneurship? *Energy Research & Social Sciences*, 101317, 60,
<https://doi.org/10.1016/j.erss.2019.101317>
- [48] J. Markard, R. Raven, B. Truffer. 2012. Sustainability transitions: an emerging field of research and its prospects. *Res. Policy*, 41, 955–967. <https://doi.org/10.1016/j.respol.2012.02.013>.
- [49] J.C. van den Bergh, B. Truffer, G. Kallis. 2011. Environmental innovation and societal transitions: introduction and overview. *Environ. Innov. Soc. Transitions*, 1, 1–23. <https://doi.org/10.1016/j.eist.2011.04.010>.
- [50] F.W. Geels. 2014. Regime resistance against low-carbon transitions. Introducing politics and power into the multi-level perspective. *Theor. Cult. Soc.*, 31, 21–40
- [51] C.A. Miller, A. Iles and C.F. Jones. 2013. The social dimensions of energy transitions. *Sci. Cult.*, 22 (2), 135–148, <https://doi.org/10.1080/09505431.2013.786989>

- [52] R. Huxley, A. Owena, P. Chattertonb. 2019. The role of regime-level processes in closing the gap between sustainable city visions and action. *Environmental Innovation and Societal Transitions* 33, 115–126 <https://doi.org/10.1016/j.eist.2019.04.001>
- [53] S. Borrás, J. Edler. 2015. The governance of change in socio-technical and innovation systems: three pillars for a conceptual framework. In: Borrás, S., Edler, J. (Eds.), *EuSPRI Forum on Science, Technology and Innovation Policy Series. The Governance of Socio-Technical Systems. Explaining Change*. Edward Elgar Publishing, Cheltenham, 23–48.
- [54] K. Ingold, I. Stadelmann-Steffenb, L. Kammermann. 2019. The acceptance of instruments in instrument mix situations: Citizens' perspective on Swiss energy transition. *Research Policy* 48, 103694. <https://doi.org/10.1016/j.respol.2018.10.018>
- [55] M. David. 2017. Moving beyond the heuristic of creative destruction: Targeting exnovation with policy mixes for energy transitions. *Energy Research & Social Science* 33, 138–146. <http://dx.doi.org/10.1016/j.erss.2017.09.023>
- [56] F.W. Geels, J. Schot. 2007. Typology of sociotechnical transition pathways. *Res.Policy* 36, 399–417. <https://doi.org/10.1016/j.respol.2007.01.003>
- [57] D. Loorbach, N. Frantzeskaki, R.L. Huffenreuter. 2015. Transition management: taking stock from governance experimentation. *J. Corp. Citizsh.* 48–66
- [58] M. Mendizabal, O. Heidrich, E. Feliua, G. García-Blanco, A. Mendizabal. 2018. Stimulating urban transition and transformation to achieve sustainable and resilient cities. *Renewable and Sustainable Energy Reviews* 94, 410-418. <https://doi.org/10.1016/j.rser.2018.06.003>
- [59] G. H. Brundtland.1991. Our common future. In M.K. Tolba, A. K. Biswas (ed.), *Earth and us*. Oxford, Butterworth-Heinemann, 29-31.

[60] United Nations Framework Convention on Climate Change, 2015. Historic Paris Agreement on Climate Change: 195 Nations Set Path to Keep Temperature Rise Well below 2 Degrees Celsius, December 15th, 2015 (2015). Available on:

<https://unfccc.int/news/finale-cop21>. (Accessed, January 9, 2020)

[61] A. Rosemberg. 2010. Building a Just Transition. *International Journal of Labour Research* 2(2): 125–62.

[62] P. Newell, M. Dustin. 2013. The Political Economy of the ‘Just Transition’. *Geographical Journal* 179(2): 132–40. <https://doi.org/10.1111/geoj.12008>

[63] J. Wiseman, S. Campbell and F. Green. 2017. Prospects for a “just Transition” Away from Coal -Fired Power Generation in Australia: Learning from the Closure of the Hazelwood Power Station. Canberra. Available on:

https://ccep.crawford.anu.edu.au/files/uploads/ccep_crawford_anu_edu_au/2017

[11/wiseman_campbell_green_prospects_for_a_just_transition_away_from_coalfired_power_generation_in_australia_ccep_wp1708.pdf](https://ccep.crawford.anu.edu.au/files/uploads/ccep_crawford_anu_edu_au/2017/11/wiseman_campbell_green_prospects_for_a_just_transition_away_from_coalfired_power_generation_in_australia_ccep_wp1708.pdf)

[64] N. Healy, J. Barry. 2017. Politicizing Energy Justice and Energy System Transitions: Fossil Fuel Divestment and a ‘just Transition’. *Energy Policy*, 108: 451–59. <https://doi.org/10.1016/j.enpol.2017.06.014>

[65] H. Mertins-Kirkwood. 2018. Making Decarbonization Work for Workers: Policies for a Just Transition to a Zero-Carbon Economy in Canada. Available on: <https://www.policyalternatives.ca/sites/default/files/uploads/publications/NationalOffice/2018/01/Making Decarbonization Work.pdf>.

[66] G. Walker. 2014. Editorial: environmental justice as empirical and normative. *Anal. Krit.*, 36 (2), 221-229. <https://doi.org/10.1515/auk-2014-0202>.

- [67] J. A. Crowe, R. Li. 2020. Is the just transition socially accepted? Energy history, place, and support for coal and solar in Illinois, Texas, and Vermont, *Energy Research & Social Science*, 59, 101309. <https://doi.org/10.1016/j.erss.2019.101309>
- [68] M. Eames, M. Hunt. 2016. Energy justice in sustainability transitions research. In: Bickerstaff, K., Walker, G., Bulkeley, H. (eds.), *Energy Justice in a Changing Climate: Social Equity and Low-Carbon Energy*, Zed Books, 46–61.
- [69] M. Reed. 2008. Stakeholder participation for environmental management. *Biological Conservation*, 141 (10), 2417-2431. doi: 10.1016/j.biocon.2008.07.014.
- [70] B. Simpson , C. Basta. 2018. Sufficiently capable for effective participation in environmental impact assessment? *Environmental Impact Assessment Review*, 70: 57-70. <https://doi.org/10.1016/j.eiar.2018.03.004>
- [71] K. Jenkins, D. McCauley, R. Heffron, H. Stephan, R. Rehner. 2016. Energy justice: A conceptual review. *Energy Research & Social Science*. 11, 174-182. <http://dx.doi.org/10.1016/j.erss.2015.10.004>
- [72] B. Sovacool, M. Burke, L. Baker, C. Kumar, C. Kotikalapudi, H. Wlokas. 2017. New frontiers and conceptual frameworks for energy justice. *Energy Policy*. 105, 677-691. <https://doi.org/10.1016/j.enpol.2017.03.005>
- [73] K. M. Weber, H Rohracher. 2012. Legitimizing research, technology and innovation policies for transformative change combinig insights from innovation systems and multi-level perspective in a comprehensive ‘failures’ framework. *Res. Policy*, 41, 1037-1047. <https://doi.org/10.1016/j.respol.2011.10.015>
- [74] B. K. Sovacool. 2009. The importance of comprehensiveness in renewable electricity and energy efficiency policy. *Energy Policy*, 37 (4), 1529-1541.

[75] J. Schot, , W.E. Steinmueller. 2018. Three frames for innovation policy: R&D, systems of innovation and transformative change. *Res. Policy*, 47, 1554-1567.

<https://doi.org/10.1016/j.respol.2018.08.011>

[76] OECD, 2016. Policy Mix for Business R&D and Innovation.

https://doi.org/10.1787/sti_in_outlook-2016-22-en.

[77] K. S. Rogge, F. Kern, M. Howlett. 2017. Conceptual and empirical advances in analysing policy mixes for energy transitions, *Energy Research & Social Science*, 33, 1-10, <https://doi.org/10.1016/j.erss.2017.09.025>

[78] S. Jacobsson, A. Bergek, B. Sandén. 2017. Improving the European Commission's analytical base for designing instrument mixes in the energy sector: Market failures versus system weaknesses, *Energy Research & Social Science*, 33, 11-20.

<https://doi.org/10.1016/j.erss.2017.09.009>

[79] M. Grubb, W. McDowall, P. Drummond. 2017. On order and complexity in innovations systems: Conceptual frameworks for policy mixes in sustainability transitions, *Energy Research & Social Science*, 33, 21-34,

<https://doi.org/10.1016/j.erss.2017.09.016>

[80] K. Palmer, A. Paul, M. Woerman, D. C. Steinberg. 2011. Federal policies for renewable electricity: Impacts and interactions, *Energy Policy*, 39, 7, 3975-3991,

<https://doi.org/10.1016/j.enpol.2011.01.035>

[81] D. Maosheng, T. Zhiyu, Z. Yongqiang, L. Mengyu. 2017. Interactions and coordination between carbon emissions trading and other direct carbon mitigation policies in China, *Energy Research & Social Science*, 33, 59-69,

<https://doi.org/10.1016/j.erss.2017.09.008>

- [82] M. J. Howlett, J. Rayner. 2007. Design principles for policy mixes: cohesion and coherence in ‘new governance arrangements’, *Policy Soc.* 26, 1–18.
[https://doi.org/10.1016/S1449-4035\(07\)70118-2](https://doi.org/10.1016/S1449-4035(07)70118-2)
- [83] M. Howlett. 2014. From the ‘old’ to the ‘new’ policy design: design thinking beyond markets and collaborative governance, *Policy Sci.* 47 (3), 187–207,
<http://dx.doi.org/10.1007/s11077-014-9199-0>
- [84] P. Kivimaa, F. Kern. 2016. Creative destruction or mere niche support? Innovation policy mixes for sustainability transitions. *Res. Policy* 45 (1), 205–217.
<https://doi.org/10.1016/j.respol.2015.09.008>
- [85] E. Bardach. 1976. Policy termination as a political process, *Policy Sci.* 7 (2), 123–131.
- [85] B. Turnheim, F.W. Geels. 2013. The destabilisation of existing regimes: confronting a multi-dimensional framework with a case study of the British coal industry (1913–1967), *Res. Policy* 42 (10), 1749–1767.
<https://doi.org/10.1016/j.respol.2013.04.009>
- [86] M. David. 2018. The role of organized publics in articulating the exnovation of fossil-fuel technologies for intra- and intergenerational energy justice in energy transitions. *Applied Energy* 228, 339–350,
<https://doi.org/10.1016/j.apenergy.2018.06.080>
- [87] J. Fagerberg. 2018. Mobilizing innovation for sustainability transitions: A comment on transformative innovation policy. *Research Policy.* 47, 1568-1576.
<https://doi.org/10.1016/j.respol.2018.08.012>
- [88] M. Mazzucato. 2016. From market fixing to market-creating: a new framework for innovation policy. *Ind. Innov.*, 23 (2), 140-156.
<https://doi.org/10.1080/13662716.2016.1146124>

- [89] A. Sanz-Hernández, M. V. Sanagustin-Fos, M. E. López-Rodríguez. 2019. A transition to an innovative and inclusive bioeconomy in Aragon, Spain. *Environmental Innovation and Societal Transitions*, 33, 301-316. <https://doi.org/10.1016/j.eist.2019.08.003>
- [90] D. Foray, D.C. Mowery, R.R. Nelson. 2012. Public R&D and social challenges: what lessons from mission R& D Programs. *Res. Policy*, 41 (10), 1697-1702. <https://doi.org/10.1016/j.respol.2012.07.011>
- [91] R. Quitzow. 2015. Assessing policy strategies for the promotion of environmental technologies: a review of India's national solar mission. *Res. Policy*, 44, 23-243. <https://doi.org/10.1016/j.respol.2014.09.003>
- [92] J. E. Zafrilla. 2014. The mining industry under the thumb of politicians: the environmental consequences of the Spanish Coal Decree. *Journal of Cleaner Production*, 84, 715-722. <https://doi.org/10.1016/j.jclepro.2014.02.031>
- [93] T. Haas. 2018. Comparing energy transitions in Germany and Spain using a political economy perspective. *Environmental innovation and societal transition*, 31, 200-210. <https://doi.org/10.1016/j.eist.2018.11.004>
- [94] Instituto Nacional de Estadística (INE). 2019. Afiliación a la seguridad social. Marzo 2019. Available on: <https://revista.seg-social.es/wp-content/uploads/2019/04/DATOS-AFILIACIÓN-MARZO-2019.pdf> (Accessed, March 19, 2020).
- [95] MITECO. 2020. Agreement for a just transition for coal power plants: jobs, industry and territories. Available on: <https://www.miteco.gob.es/es/transicion-justa/default.aspx> (Accessed June, 29, 2020).
- [96] J. Ossenbrink, S. Finnsson, C.R. Bening, V.H. Hoffmann. 2019. Delineating policy mixes: Contrasting top-down and bottom-up approaches to the case of energy-

storage policy in California. *Res. Policy*, 48 (10), 103582.

<https://doi.org/10.1016/j.respol.2018.04.014>

[97] Bryman, A. 2006. Integrating quantitative and qualitative research: how is it done? *Qualitative Research*, 6 (1), 97–113. <https://doi.org/10.1177/1468794106058877>

[98] B. K. Sovacool, J. Axsen, S. Sorrell. 2018. Promoting novelty, rigor, and style in energy social science: Towards codes of practice for appropriate methods and research design, *Energy Research & Social Science*, 45, 12-42.

<https://doi.org/10.1016/j.erss.2018.07.007>

[99] K. Flanagan, E. Uyarra, M. Laranja. 2011. Reconceptualising the ‘policy mix’ for innovation. *Res. Policy*, 40, 702-713. <https://doi.org/10.1016/j.respol.2011.02.005>

[100] W.N. Adger, J. Barnett, K. Brown, N. Marshall, K. O’Brien. 2013. Cultural dimensions of climate change impacts and adaptation. *Nat. Clim. Change* 3 (2), 112–117. <https://doi.org/10.1038/nclimate1666>

[101] T.J. Foxon, P.J.G. Pearson, S. Arapostathis, A. Carlsson-Hyslop, J. Thornton. 2013. Branching points for transition pathways: assessing responses of actors to challenges on pathways to a low carbon future. *Energy Policy* 52, 146–158.

<https://doi.org/10.1016/j.enpol.2012.04.030>

[102] C. Dermont, K. Ingold, L. Kammermann, I. Stadelmann-Steffen. 2017. Bringing the policy making perspective in: a political science approach to social acceptance. *Energy Policy*, 108, 359–368. <https://doi.org/10.1016/j.enpol.2017.05.062>

[103] J. Meckling, T. Sterner, G. Wagner. 2017. Policy sequencing toward decarbonization. *Nat. Energy*, 2, 918–922. <https://doi.org/10.1038/s41560-017-0025-8>

[104] B. Martin. 2016. R&D policy instruments – a critical review of what We do and don’t know. *Ind. Innov.*, 23 (2), 157-

176. <https://doi.org/10.1080/13662716.2016.1146125>

[105] M.J. Trebilcock. 2014. *Dealing with Losers: The Political Economy of Policy Transitions*. Oxford, Oxford University Press.

APPENDIX A
Barriers of Just Transition in Aragonese coalfield

Barrier (B)	Description	Spheres
B1	1. Excessive prominence of energy-mining sector	Economy
B2	2. Great diversity in economic interests of main interested parts	
B3	3. National financial funds not sufficient to undertake an in-depth energy reform	
B4	4. National financial funds not sufficient to undertake in-depth regional diversification processes	
B5	5. Public investment predominance	
B6	6. Commercial risk to invest in local energy industry	
B7	7. Deficit of small and medium enterprises (SME)	
B8	8. Lack of public-private collaboration	
B9	9. Scarcity of private investment	
B10	10. Insufficient follow-up of large public investment effects	
B11	11. Disharmonious development: by sectors and Company size	
B12	12. Disordered transition: Lack of complementarity of industrial projects	
B13	13. Absence of sectorial convergence and industrial symbiosis	
B14	14. Weakness of road communication network	
B15	15. Inexistence of other means: Train	
B16	16. Deficient Access to information technologies	
B17	17. Deficiencies or inexistence of basic infrastructures	
B18	18. Deterioration or inexistence of basic services	
B19	19. Loss of closeness to raw materials	
B20	20. Distance to a consumption market	
B21	21.Distance to abundant workforce	
B22	22. Inexistence of qualified workforce	
B23	23. Underrepresentation of women in the regional labour market. Masculinised labour market	
B24	24. Excessive dependence on support	
B25	25. Lack of companies with R&D capacity	
B26	26. Inexistence of technological innovation hubs	
B27	27. Public investment lacks from territorial perspective	
B28	28. Insufficient evaluation of social impacts in investments	
B29	29. Inertia to replicate deciduous productive models	
B30	30. Absence of productive models inclusive and alternative to extractive industries	
B31	1. Insufficient allocation of EU restructuring funds for coal industry	Policy
B32	2. Lack of comparable experiences in other countries/regions with demographic vulnerability	
B33	3. Lack of national political will to undertake reforms in the energy sector	
B34	4. Lack of national political will to undertake in-depth reforms in other sectors	
B35	5. Lack of strategical vision and support policies to identify emergent or latent sectors	
B36	6. Perception of coal as one more option for energy security	
B37	7. Lack of complete acceptance of gradual phase out of coal	
B38	8. Regional government system cannot solve large problems of national importance	
B39	9. Lack of regional strategy for a transition to a more sustainable socioeconomic model	
B40	10. Industrial reconversion plans are distant of regional reality	
B41	11. Lack of governmental management skills in face of the continuous	

	need of adjustment	
B42	12. Persistent political support to coal due to short-term political interest	
B43	13. Excessive prominence of subsidies policies to sustain employment and income	
B44	14. Policies generate dependency over actors and regions	
B45	15. Short-sighted policies with no strategic territorial vision	
B46	16. Lack of coordination among governmental levels	
B47	17. Low presence of local level	
B48	18. Lack of tuning between the regional and the local economic interests	
B49	19. Contradictory positions facing the dismantling of coal industry: polarized debate within and between groups	
B50	20. Scarce attention to gender equality policies	
B51	21. Scarce attention to social inclusion policies (old age, dependency, gender violence, childhood)	
B52	22. Scarce attention to youth policies	
B53	1. Scarce social participation in change	
B54	2. External imposition of transition	
B55	3. Vagueness of model for the region after coal	
B56	4. Perception of inefficacy in measures and support	
B57	5. Growing scepticism by local community	
B58	6. Trade union opposition	
B59	7. Distrust in complex links, frequently not transparent, between politics and economy.	
B60	8. Lack of economic support of cultural and touristic initiatives	
B61	9. Lack of social creativity to promote community projects	
B62	10. Structures with no decision capacity for social dialogue and promotion of community projects	
B63	11. Political focus in large dimension industry with no roots in the territory.	
B64	12. Scarce working opportunities for women	
B65	13. Local leadership weakness to rejuvenate the region	
B66	14. Lack of integral programs to rejuvenate the region (employment, housing, services, training, etc.)	
B67	15. Impoverishment of families	
B68	16. Feeling of vulnerability	
B69	17. Feeling of inequity and social injustice	
B70	18. Social sympathy for coal	
B71	19. Abilities of labour forces not adjusting to post-coal scenario	
B72	20. Loss of local identity and pride	
B73	21. Scarce rooting of population	
B74	22. Scarce workforce for other sectors	
B75	23. Lack of citizens courage to promote coal industry phase out	
B76	24. High average age of population	
B77	25. Low permanence for youngsters in the educational system	
B78	26. 'Ghost' population, registered but living in cities	
B79	27. Vulnerable population in risk and dependency situations (addictions, illnesses, violence, etc.)	
B80	28. Absence of effective dynamics for social innovation	
B81	1. Insufficient progress in clean coal technologies	
B82	2. Delayed decision for renewables launching	
B83	3. Delayed transition to other technologies	
		Social
		Technology

B84	4. Absence of commitment to invest in improving communications	
B85	5. Absence of training plans, human resources insertion and reconversion to new technologies.	
B86	6. Lack of global strategy to take advantage of existing energy infrastructures.	
B87	7. Lack of motivation in new technologies for large sunk costs of business failed attempts.	
B88	8. Absence of previous successful experiences from the local level.	
B89	9. Scarce exploitation of environment and resources through new technologies in non-energy sectors.	
B90	1. Deterioration of the environment	Environment
B91	2. Lack of vision of the environment as an opportunity	
B92	3. Lack of reconversion dynamics linked to natural resources of the territory	
B93	4. Lack of know-how and adaptation of external dynamics and practice for territory reconversion	
B94	5. Risk situation for mental and physical health derived from extractive industry.	

Appendix B

Main organizing axes and policy implications

Main organizing axes	Findings	Recommendations
Vision	Political objectives overly focused on addressing structural problems arising from the short-term impact (especially employment).	Agenda with transformation goals: to replace not to add or mitigate. Long-term restoration policies
	Poor effectiveness of anticipation strategies, forward-looking orientation and lack of clarity of objectives.	Anticipate scenarios in policy design and their potential impacts.
	The investment made so far has not had the expected results, generating social scepticism.	Effective investment policies that address territorial deficiencies
	The policies developed have been based on expected results but have not incorporated lessons learned from the lack of depth in the assessment of the actual impacts derived	Mix policies should clearly look at indicators for monitoring and assessing territorial impacts
	Poor visibility of the environmental dimension	Improved sustainability communication policies. Support for the development of new social alliances to transition (e.g., unions, environmental groups, municipalities).
	The population does not express a strong vision of sustainability or full acceptance of the decarbonization process	Policies should incorporate programming for the study and advancement in cultural and attitudinal population change to achieve the required levels of engagement at all levels and areas for community-wide innovation and corporate change.
	An obstructing role of important actors in the process of decarbonization and in articulating a strategic vision, especially some representatives and political parties, and trade union representatives.	Design of policies that contemplate: A) Agreeing on a territorial vision that allows green jobs to be created B) Re-alignment of trade union objectives by incorporating the fight for energy transition and support for the unionization of new green jobs as a way to strengthen workers' commitment to the new regime.
Innovation	Policies for destabilizing coal regime have not been efficiently combined with policies for simultaneous innovation and disruption	Design of combined policies sets rather than individual policy tools. Creating synergies and improving effectiveness.
	Local external innovation dependence	A needed policy shift towards regionalization of innovation and experimentation. Policies should be designed to support innovations at community level, which in turn increase local capacity and resilience.
	Emerging innovation hubs in local businesses	Articulation of facilitating conditions of public-private partnerships to establish synergies and amplify impacts.
	No strong local structures for change management based on technological, social and political innovation.	Strengthening roles and competencies of local actors and decentralization of management and decision-making structures.

Justice	Policy efforts for decarbonization are often isolated from other social issues	Social dimension should be at the heart of policy transitions
	Reproduction of power and prevalence relationships of old representatives (e.g. trade unions).	Review of power relations and restructuring of relationships and roles in interlocution.
	Scarce authority claim by the community	Strengthening community networks and citizen empowerment. Changing focus on the policy and internalization that sustainability transitions is part of a project to improve democratic policy.
	Despite the participatory processes developed in the area, there is no organized claim for greater participation in energy decisions	Policies that address: -Participation of citizens in all stages of the energy sector, (from production to distribution) and in all areas, infrastructure, finance, technology and knowledge. Suggested rethinking involves reducing the concentration of the political and economic power of the energy sector in the electricity industry. -Empowering the population to replace monopolised fossil fuel energy systems with democratic and renewable structures, for example in line with the energy democracy approach, to promote new production practices, consumption and prosumption (community energy production, community energy cooperatives, remunicipalization of property, etc.)
	Some of the population feels at will of companies and governments. Feeling of loss to the misalignment of coal and the questioning of the sociotechnical regime coupled with the mining-energy sector.	Local policies especially must rebuild faith in the future with projects capable of breaking scepticism and frustration. Regional and national policies must contribute to sufficient funds, investments and programmes efficiently to make the impacts positive. Consideration of fair transition regions should provide the means and public funds as well as other sources for developing projects in these regions.
	The social movement in defence of coal has not been replaced by another one able to mobilize a claim for sustainability positions and in-depth reforms.	Engage actors and support other ecological transition routes both inside and outside the mining-energy sector.