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From Fukushima to fossil fuels: Carbon emissions, climate narratives, and grassroots movements in Japan's energy transition

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ABSTRACT

The Fukushima Nuclear Accident triggered an energy predicament in Japan, necessitating initiatives to decarbonise and denuclearise its energy landscape. This shift has intensified reliance on fossil fuels, notably coal, inciting widespread anti-coal disputes throughout the nation. This research scrutinises the dynamics of carbon emissions and their interrelation with climate activism narratives, emphasising the mobilisation of communities to confront issues of inequality and justice. Employing a club convergence methodology, this study analyses the patterns of carbon emissions from fossil fuels across 47 administrative divisions in Japan from 1990 to 2020. This quantitative analysis is enriched with a qualitative content analysis of anti-coal movements, utilising the comprehensive Global Atlas of Environmental Justice (EJAtlas) as a primary resource. The findings disclose pronounced sub-national disparities in energy transitions and carbon emissions. Narratives within anti-coal activism predominantly encompass themes of global warming, air and water pollution, social and cultural impacts, and health repercussions. We find that regions with historically high emissions predominantly embrace narratives of climate and environmental justice, whereas rural regions experiencing escalating emissions integrate these with narratives of peripheralisation. The opposition to technocratic resolutions and the endorsement for transitions to low carbon society are salient within these movements, resonating with the degrowth paradigm advocating for equitable and sustainable alternatives. This research underscores the pivotal role of social movements in mitigating regional emissions disparities and illustrates the evolution of grassroots movements towards embracing sustainable alternatives.

1. Introduction: contesting carbon emissions in Japan

The climate crisis is driving nations to transition away from carbon-intensive energy systems, under pressure from both domestic and international climate mitigation agencies. At the same time, grassroots movements that contest hydrocarbon industries for the removal of fossil fuels are gaining attention to have a profound impact on limiting emissions and promoting just transitions among countries [1–5]. In recent years, the significance of narratives in shaping energy transitions and climate actions has come to the forefront of discussion. Some scholars argue that prevailing narratives centred on technological solutions and economic growth fall short in addressing the profound systemic changes essential for a just and sustainable energy shift [6–9]. Others suggest that alternative narratives, such as those centred on

social movements and community-led initiatives, can challenge the dominant discourse and promote more transformative and equitable energy transitions [10–12]. However, there remains ongoing debate regarding the efficacy of these alternative narratives in mobilising public support and driving policy reform [13]. Critics of the economic growth paradigm caution against reinforcing existing inequalities, while critics of the urgency argument warn against promoting despair rather than constructive action. Both perspectives emphasise the need for a nuanced understanding of social movements and meaning-construction narratives in energy transition and climate action.

The concept of meaning-construction refers to creating or constructing meaning through interpreting and understanding events or experiences [14–16]. In the context of narrative framing, meaning-construction can be used to describe how individuals or groups

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interpret and make sense of issues affecting them directly or indirectly, such as climate change and environmental issues. Narrative framing is widely used in social movement theory, referring to how activists and social movement organisations create and communicate their message to the public [17–19]. It involves constructing a narrative or story that gives meaning to the movement's goals and actions and connects with people's beliefs, values, and experiences [20]. This framing can help shed light on the subjective experiences and perspectives of those affected by climate change and how they construct their narratives and understanding of the issue. It can also be used to explore how different groups construct and frame climate change differently based on their cultural, social, and political backgrounds. The meaning-construction framing can be a valuable tool for understanding the complexity of climate change discourse and its impact on different communities.

This study investigates a less-explored facet of climate activism in East Asia. Current dialogues around climate justice often overlook countries like Japan, despite its substantial annual CO₂ emissions per capita, reaching 8.4 tons in 2020 [21]. Japan, while having limited domestic fossil fuel reserves, plays a pivotal role in the global coal market. It ranked as the sixth-largest consumer of coal in 2022 for domestic energy production, stood as the second-largest greenhouse gas emitter among OECD countries in 2021, and has been involved in financing and technology transfer to expand coal-fired power plants (CFPPs) in developing nations [22–24]. After the Fukushima Nuclear Accident in 2011, the Japanese government confronted energy generation challenges amidst debates over nuclear and fossil fuel options. The Fukushima Nuclear Accident in 2011 complicated Japan's energy landscape, leading to the planning of 50 new CFPP installations nationwide with increased dependency on fossil fuels [25]. By 2016, the ratio of fossil fuels in power generation had surged from 65.4 % in 2010 to 83.6 %, with nuclear power accounting for a mere 1.7 % from 26 % before 2011 and renewables increased from 2 % to 12 % [26–28]. The share of renewables in electricity generation increased to 22.7 % in 2022, while the ratio of fossil fuels decreased to 72.4 %. However, fossil fuels remained the primary energy source at a high 84 % in 2019 [29].

Japan's climate policy has been rapidly progressing in recent years. The Prime Minister of Japan declared GHG net zero by 2050 in October 2020. The declaration was adopted and supported by ministries, political parties, and local governments. Subsequently, in the year 2023 Green Transformation Initiative (GX) was introduced, and the legislation for GX was passed by the national diet. The policy introduces a broad implementation of technological solutions and market-oriented policies, including 133 billion USD of transition bonds for the realisation of decarbonisation. On the other hand, there are movements and initiatives from non-state actors such as NGOs, civil society organisations and local governments [30]. Since the emergence of Japan's proposal to replace nuclear power with new CFPPs in 2012, global and local oppositions have grown, particularly within activist circles. Kiko Network, a local Japanese organization established in 1997 to combat climate change, has collaborated with communities across Japan in their resistance against the resurgence of coal. This movement has contributed significantly to scrapping 17 CFPP projects that would have collectively emitted millions of tons of CO₂ annually over their lifespans [25]. In addition, climate activists are resisting the building of new CFPPs and contesting over 168 active ones to be phased out by 2030 [31,32] While previous studies have examined Japan's coal regime and citizen awareness of justice in energy transition [23,33,34], there remains a gap in research concerning the narratives emerging from localised anti-coal movements and grassroots climate actions in Japan.

The narrative formations can differ across and within countries since they associate with local identities, experiences of the communities in industrialisation, climate politics and governance of the geographical location of conflicts [35–37]. Investigating the interplay between these narrative developments and the evolution of emissions disparities offers valuable insights into the structural challenges facing local economies and climate efforts at the sub-national level. In this context, our research

seeks to address two critical questions: How do narrative formations in climate activism and anti-coal movements vary within Japan, and how are these narratives interconnected with the changing landscape of emissions disparities? To achieve these objectives, we employ a club convergence analysis, following the approach of Phillips and Sul [106,107], to examine dynamics of carbon emissions and transitions across 47 prefectures from 1990 to 2020. Additionally, we analyse the mobilisation framing narratives of fossil fuels and energy conflicts showcased on the EJAtlas, focusing on different prefectures.

Our paper aims to contribute to the literature in several ways. Firstly, making methodological advancements by employing the emissions club convergence approach to analyse sub-national emissions disparities and their connection to climate action narratives. Integrating the concepts of social movements and ecological distribution conflicts enhances our understanding of the effectiveness of climate activism in mobilising public support and political commitment to decarbonisation. By exploring regional variations, particularly in the context of anti-coal movements in Japan, we aim to offer nuanced insights into the narratives of climate activists opposing coal-fired power plants. Our research refrains from establishing direct causal relationships between climate narratives and emissions fluctuations, focusing instead on contributing valuable perspectives to understanding regional dynamics. Furthermore, this research provides new insights from an underexplored domain of anti-coal movements in Asia [1].

The remainder of this paper is structured as follows: **Section 2** discusses our conceptual framework. **Section 3** presents the background of environmental movements in Japan. **Section 4** explains the data and methodology. In **Section 5**, we analyse the results to uncover the links between climate action narratives and carbon emission disparities, providing insights into the role of social movements' narrative framing in shaping just and sustainable energy transition. **Section 6** considers the broader implications of our main findings and concludes.

2. Ecological distribution conflicts, climate action narratives and emissions dynamics

Social movements, which have emerged in response to conflicts arising from the expansion of extractive industries due to industrial growth, are conceptualised as agents within 'ecological distribution conflicts' (EDCs), termed by Martinez-Alier and O'Connor [128]. EDCs represent disputes over the allocation and utilisation of environmental resources, often resulting in unequal and unjust outcomes for various societal groups. Scholars emphasise that effectively addressing EDCs necessitates a profound transformation of social and economic systems, surpassing mere adjustments to existing policies or technologies [38,39]. Furthermore, the movements that arise from within EDCs play a pivotal role in advocating for environmental and climate justice and advancing sustainability goals [1,4,5,40–42].

Understanding these social movements' narratives is essential for energy transition and climate change mitigation because it provides insights into how social actors construct and communicate meaning around the transition. The way in which actors frame the issue of energy transition shapes how the public understands and perceives the issue, as well as the range of possible policy solutions. As highlighted by social movement scholars, narratives are a vital tool for social actors to mobilise support for their cause and challenge the dominant discourse [17].

Scholars have explored the role of climate action narratives in shaping public opinion and political will towards climate action. For example, studies have found that narratives that emphasise the human impact of climate change, such as personal stories of those affected by extreme weather events, can be more effective in mobilising public support than abstract scientific data [43,44]. Climate action narratives increasingly feature themes of decarbonisation, climate justice, equity, and criticism of economic growth. Climate justice underscores that the most severe effects of climate change disproportionately affect

marginalised communities with minimal contributions to global greenhouse gas emissions [45,46]. Thus, climate action narratives highlighting the need for equitable and just solutions addressing systemic inequalities have gained momentum [46]. The term climate justice has been understood differently by different people depending on its context [47,48]. Moreover, grassroots organisations champion climate justice in various forms, including indigenous rights, gender intersectionality, intergenerational justice, traditional values, environmental coexistence, identifying root causes of injustice, promoting democracy, and preserving nature, as seen in slogans like “Leaving Fossil Fuels Underground” (LFFU) [47,49]. These notions of climate justice often intersect with discussions on post-colonialism, post-development, the degrowth movement, environmental justice, development, vulnerability, distributive justice, and equity [47,50–57].

This paper contributes to two key academic debates: (1) how past industrial development shapes contemporary climate change mitigation efforts and underscores the significance of geographical factors in understanding emissions [58–63] and (2) the ongoing discussions about the relevance of grassroots social movements in driving energy transition and climate change mitigation [1,4,5,64–66]. Moreover, it sheds light on anti-coal conflicts, offering valuable insights into grassroots mobilisation, the values and symbolism embedded in these movements, and how activists articulate narratives of injustice against the carbon industry [20,67–69].

3. Background of the case: environmental movements in Japan

The advent of industrial capitalism since the Meiji Restoration in 1868 has led to the marginalisation of numerous communities, giving rise to heightened internal migration, increased waste disposal, escalating pollution, and a surge in environmental conflicts [70–74]. Scholars have coined the term “Sacrifice Zone” to characterise these marginalised regions, alluding to communities shouldering a disproportionate burden of environmental harm, encompassing pollution, contamination, toxic waste, and heavy industrial activities [74–77]. Infamously known cases of ecological disasters include the Ashio copper mine (1890), Miike Coal Mine explosion (1963) and Minamata City from chemical contamination in the river (1956), Yokkaichi asthma from industrial air pollution (1961) and Fukushima Nuclear Disaster (2011) [70,78–80]. Moreover, Japan implemented an income-doubling plan and industrial development policies in the 60s, where Taiheiyō Belt Zone Regions¹ or the Pacific Belt Corridor, which faces the Pacific Ocean, were assigned as industrial zones to recover from the Second World War and promote economic growth [81,82]. These developmental strategies and the establishment of industrial complexes continue to exert significant influence on the spatial distribution of income, financial autonomy, as well as air pollution and health-related challenges [83–85].

From the 1900s to the 1960s, communities endured the devastating toll of pollution-related diseases, including mercury poisoning and asthma. In Japan, these environmental conflicts are commonly referred to as “early environmentalism” or “Kogai” in Japanese, which translates to “public harm” [86]. The label “Kogai” is applied when harm is inflicted “by the actions of private or public enterprises, causing suffering among nearby residents” [87]. However, by the late 1970s, the landscape of environmental issues was shifting. Japanese environmental movements evolved from mere confrontations between polluters and victims to citizen-led initiatives that instilled environmental awareness and promoted lifestyle changes. An example of this transformation is the anti-detergent movement initiated by women from Shiga Prefecture in 1977 [88]. Concurrently, the terminology used to describe these

environmental struggles expanded from the narrow confines of “Kogai” to encompass a broader concept known as “Kankyo Mondai”, which translates to “Environmental Issues” in English, also termed “contemporary environmentalism” by Mitsuda [86]. This new environmentalism is framed around more general environmental issues raised in post-industrialised societies, such as pollution and waste problems, which involve the responsibility of the consumer population and their potential to change their lifestyle [89]. The environmental movements that gained momentum in the 1980s and 90s embraced traditional values associated with landscapes and natural resource management. Examples include the “Satoyama Movements”² [90] and the “anti-dam movements” [91]. These mobilisations were steered by elites on nature conservation and ecosystem, although the ideas were deeply embedded in the local ethos [89].

Recent environmental conflicts in Japan have often been characterised as a “Not in my backyard” (NIMBY) phenomenon, suggesting that community opposition is rooted in an overestimation of risks, emotional reactions, and fears rather than a genuine concern for environmental or climate justice [92]. However, when viewed through the lenses of ecological distribution conflicts (EDCs) [4,38,94] and social movement theory [20,68,95], it becomes apparent that these conflicts are not simply the result of irrational fears but are driven by issues of unfair resource access and the unequal burden of waste disposal. The resistance from local communities is deeply intertwined with a complex web of political, social, and cultural structural conditions. Within the framework of ecological distribution conflicts (EDCs), it is crucial to acknowledge that the claims made by local resistance movements often extend beyond their immediate locality. These movements are responses to more extensive and systemic patterns of social injustice. Climate action and anti-coal movements, when viewed through the EDC perspective, not only address disparities in emission transitions at the sub-national level but also serve as a means to draw attention to and challenge broader systemic inequalities and social injustices related to energy governance and environmental policies. The following section provides an in-depth exploration of the data and methodology employed in this study.

4. Methodology and data

4.1. Methods and data collection

Scholars have proposed a practical approach to address climate justice, emphasising carbon budget equity, fund redistribution, and rigorous monitoring [47,50,54,96]. Among methods, club convergence analysis is notable for per capita carbon emissions. It evaluates historical trends and projects future emissions [97–99]. Initially for global income distribution and Solow’s growth model, convergence theory now spans environmental science. The existing literature uses club convergence techniques to explore emissions among countries, revealing geographical determinants [58,97,98,100]. While useful regionally (EU, Central America) and sub-nationally (USA, Spain, China) [101–106], its sub-national climate action discourse application is unexplored. It unveils local economy challenges. Club convergence assesses historical emissions, predicts trends, and identifies geographical determinants, offering a novel perspective on climate activism’s links to emission transitions.

In the first phase of our analysis, we conducted a carbon emissions club convergence analysis. This involved computing per capita carbon emissions for the 47 Japanese prefectures spanning the fiscal years from 1990 to 2020. The dataset encompasses information from April 1990 to March 2021, sourced from energy consumption data published by the Japanese government’s Ministry of Economy, Trade, and Industry (METI). This data covered primary energy consumption of fossil fuels

¹ The Taiheiyō Belt Zone includes Ibaraki, Saitama, Chiba, Tokyo, Kanagawa, Shizuoka, Aichi, Gifu, Mie, Osaka, Hyōgo, Wakayama, Okayama, Hiroshima, Yamaguchi, Fukuoka and Oita Prefectures.

² Satoyama refers to traditional Japanese agrarian landscapes and the movement to restore these traditional forest and agricultural settings [90,127].

(coal, oil, and gas) within various sectors, including agriculture, fishery, mining, construction, auto power generation, manufacturing, commercial industries, and residential use. Notably, we excluded secondary energy consumption to prevent distortion, as electricity can be imported from other prefectures. We analysed the total carbon emissions resulting from all fossil fuel combustion, further categorising them into coal, oil, and gas. For a detailed breakdown of the data, please refer to [Table 1](#). The convergence test and clustering algorithm follow the methodology of Phillips and Sul [106,107] to examine carbon emissions dynamics over time across different geographical locations [107,108]. Our methodology adopts a population-weighted approach to calculate per capita carbon emissions for each prefecture in Japan. Given the substantial variations in population size and the ongoing depopulation trends in rural areas, it is crucial to account for these demographic dynamics, and thus, focusing on per capita figures gives a more nuanced understanding of emissions trends between prefectures and over time. For a comprehensive understanding of our methodology and a detailed explanation of the validity of our approach using emissions in per capita terms, please consult the Supplementary material in the Appendix.

In the second phase of our analysis, we explored potential relationships between climate action narratives and dynamics of carbon emissions at the prefecture level, using the results from the club convergence analysis. This investigation focused on 28 coal-fired power plant units planned since 2012 in various prefectures. These plants faced resistance from citizens and environmental justice organisations. We sourced cases from the “Fossil Fuels and Climate Justice/Energy” category in the EJAtlas, a well-established online database for mapping environmental justice conflicts [17,109–112]. Additionally, we relied on secondary sources, including website content, reports, documents and calculations from local environmental organisations in Japan, such as Kiko Network, Beyond Coal Japan and other grassroots environmental justice groups. These sources complemented our data, enabling a comprehensive examination of the narratives surrounding the anti-coal movement.

To analyse this wealth of materials, we employed a content analysis approach, a systematic method for scrutinising written or visual content to identify recurring patterns, themes and meanings [113]. In the context of studying social movements and ecological distribution conflicts, content analysis helps dissect the narratives, discourse, and rhetoric employed by various stakeholders involved in a conflict. These stakeholders include environmental activists, government officials, industry representatives, and media outlets. The club convergence analysis has provided insights into the varying levels of carbon emissions across different prefectures, revealing disparities in environmental sustainability efforts. This quantitative observation is further contextualised and enriched by insights from content analysis, where we systematically analysed written and visual materials to identify patterns, themes, and meanings related to social movements and ecological distribution conflicts involving coal-fired power plant projects. Subsequently, the content analysis allows us to understand the narratives, discourse, and rhetoric used by social movement actors, such as

environmental activists and resisting communities in each conflict case. The detailed description of the cases analysed in this study, compiled and publicly available online, is listed in the Appendix in [Table A5](#).

By scrutinising how these actors framed climate action in their resistance against coal-fired power plant developments, we gained qualitative insights into the motivations, challenges, and dynamics that contribute to the observed quantitative disparities in carbon emissions across prefectures. Moreover, by correlating the quantitative patterns identified in the club convergence analysis with the qualitative themes uncovered in the content analysis, we have achieved a more nuanced and holistic understanding of the ecological distribution conflicts and social movements revolving around climate change issues. This integrated approach facilitated the examination of movement and emissions dynamics at the sub-national level.

4.2. Descriptive statistics for carbon emissions

The descriptive statistics provide a valuable snapshot of Japan’s carbon landscape, encompassing emissions from coal, oil and gas over nearly three decades. Notably, it sheds light on the regional variations and shifts in emissions profiles. [Table 1](#) displays statistics for per capita total carbon emissions and population figures in both 1990 and 2020, with further breakdowns for coal, oil and gas emissions. These emissions represent carbon output from fossil fuel combustion based on final energy consumption data. Carbon emissions per capita are calculated by dividing total emissions by the prefecture population. The data shows a slight overall decrease in total carbon emissions across the 47 prefectures from 1990 to 2020. However, variations exist among different fossil fuel types. The means for coal and oil emissions decreased by 25 % and 38 %, respectively, while gas emissions notably increased by 141 %. Interestingly, the prefecture with the lowest emissions experienced a decrease in total carbon emissions and oil consumption but saw increases in coal and gas emissions. Average emissions per capita for total emissions decreased from 1990 to 2020. Similarly, average per capita gas emissions increased while oil emissions decreased, with coal emissions slightly reduced. It is worth highlighting the shift in the prefecture with the lowest per capita emissions, transitioning from Nara in 1990 to Tokyo in 2020.

Meanwhile, shifts in demographics across prefectures are noticeable. The prefecture with the smallest population continues to experience a decline, while Tokyo, the most populous region, has witnessed growth over the past three decades (see [Table 1](#)). Recognising the potential interrelation between emissions and demographic changes, we acknowledge that regions with declining populations may exhibit reduced transportation, service industries, and overall energy use, whereas the opposite could be true for regions experiencing population growth. On the other hand, in some prefectures with a concentration of fossil fuel-intensive industries, demographic changes may have very little association with emission fluctuations. These dynamics suggest that variations in emissions might be associated with other factors, such

Table 1

Descriptive statistics of carbon emissions and population figures across Japanese prefectures: 1990–2020.

Variable (unit)	1990				2020			
	Mean	Std. dev.	Min	Max	Mean	Std. dev.	Min	Max
Carbon (thousands tC)	3978.96	4231.20	412.31 (Tottori)	19,809.29 (Chiba)	3179.34	3699.69	316.41 (Tottori)	18,249.25 (Chiba)
Coal (thousands tC)	1263.89	1899.31	3.48 (Tottori)	6540.91 (Chiba)	953.44	1471.49	3.53 (Yamanashi)	5215.34 (Hiroshima)
Oil (thousands tC)	2390.68	2492.03	376.49 (Tottori)	12,497.06 (Chiba)	1490.40	1782.81	253.08 (Yamanashi)	9613.70 (Chiba)
Gas (thousands tC)	324.39	442.21	24.25 (Kochi)	1928.28 (Osaka)	781.43	957.48	62.35 (Tottori)	4406.71 (Chiba)
Total (emissions per capita)	1.58	1.46	0.42 (Nara)	6.57 (Okayama)	1.3	1.38	0.32 (Tokyo)	6.67 (Oita)
Coal (emissions per capita)	0.49	0.76	0.00 (Kagoshima)	3.07 (Oita)	0.40	0.66	0.004 (Yamagata)	3.38 (Oita)
Oil (emissions per capita)	0.99	0.80	0.33 (Nara)	3.90 (Okayama)	0.66	0.66	0.12 (Tokyo)	2.88 (Oita)
Gas (emissions per capita)	0.10	0.06	0.03 (Kochi)	0.26 (Niigata)	0.27	0.21	0.09 (Okinawa)	0.93 (Yamaguchi)
Population (thousands)	2630.02	2423.08	615.72 (Tottori)	11,855.56 (Tokyo)	2694.77	2777.96	556.96 (Tottori)	13,843.53(Tokyo)

Source: Authors’ calculations using Carbon Emission Per Final Energy Consumption for the 47 Prefectures for the fiscal year 1990–2020 (April 1990 to March 2021) in Japan from the Ministry of Economy, Trade, and Industry (METI) and the Agency for Natural Resource and Energy.

as economic and energy policies.

The next section provides detailed results: convergence test outcomes for carbon emissions across prefectures and insights from the content analysis of specific cases.

5. Results: the dynamics of carbon emissions and coal contestations

In this section, we explore the core findings of our study, shedding light on the intricate dynamics of emissions and the multifaceted coal contestations that have shaped Japan’s energy landscape. Through rigorous analysis, we uncover the distinct patterns in carbon emissions across Japanese prefectures and explore the narratives and responses that have emerged in the face of the coal industry’s resurgence. These results provide valuable insights into the complex interplay between emissions, activism, and climate justice, painting a comprehensive picture of Japanese energy transition landscape.

5.1. Convergence club classification results for carbon emissions

The concept of “Overall convergence” means that various regions or entities, like Japan’s prefectures, are progressively becoming more alike in a specific aspect, like carbon emissions, over time. It signifies that, over a certain period, all regions are lowering their per capita emissions, moving towards a similar level.

Firstly, we examined the dynamics of total fossil fuel emissions to capture diverse narratives, as people’s experiences with air pollution are generally associated with overall emissions rather than specific sources like coal, oil, or gas. Subsequently, the analysis explored emissions from distinct sources. The analysis of Japan’s total fossil fuels carbon emissions dynamics spanning from 1990 to 2020, as revealed through the convergence classification of its 47 prefectures, unveils six converging subgroups or convergence clubs and five diverging prefectures, all moving towards different equilibria. These findings, represented visually in Fig. 1, shed light on the complex evolution of carbon emissions and the distinctive trajectories of these clubs. The figure shows the transition paths of each club and diverging prefectures relative to the cross-sectional mean, denoted with a relative transition parameter equal

to 1. At the highest emissions levels, Oita and Yamaguchi have always been above all other prefectures during the sample period considered.

Similarly, Clubs 1 and 2, along with Hiroshima, are on transition paths above the panel average. In contrast, Clubs 3, 4, 5 and 6, along with Kochi and Tokyo, diverge below the cross-section mean. The clubs and diverging prefectures at the upper and lower emissions levels are moving further apart from each other, demonstrating that these regional disparities have been increasing, especially over the last two decades. In this context, the results of our analysis suggest that the overall convergence in carbon emissions is not occurring in Japan. Instead, there are distinct groups or “clubs” of prefectures that are moving in different directions in terms of carbon emissions. Some are reducing emissions, while others are increasing them. This indicates that regional disparities in emissions are actually widening.

Furthermore, we observed the relative transition curves of individual prefectures within these identified clubs, providing valuable insights into the unique emissions patterns at the subnational level (see Fig. A1: a)–f) in the Appendix). The highest emission club, Club 1, comprises Okayama and Wakayama, with the latter increasing trends reaching closer to the former, diverging away and above the panel average. In Club 2, Chiba, Ehime, Ibaraki and Mie are rapidly converging among the clubs identified. We observed that some of these administrative divisions, such as Ehime and Ibaraki, have shown an upward trend since the beginning of the sample period. In contrast Chiba’s transition curve increased until the mid-2000s but exhibited a subsequent curbing; however, it continued to trend upward. Conversely, Mie’s relative transition path surpassed Chiba’s path by 2017, becoming the region with the highest carbon emissions within Club 2. These prefectures in Club 1 are characterised by a concentration of fossil fuel-intensive industries, such as Chiba, home to steel and refinery industries. Moreover, Mie Prefecture, with oil refineries, was once notorious for industrial pollution that led to the “Yokkaichi Asthma” in 1961.

Similarly, Hiroshima’s emissions were close to Club 1 but formed a diverging trend with a steady path. Club 3 includes eight prefectures that fluctuate around the panel average. While Hokkaido was initially known for its coal mining industries, Japanese domestic coal production declined, leading to a shift to imported coal. The surge in emissions in Hokkaido can be attributed to increased coal-fired power plants from the

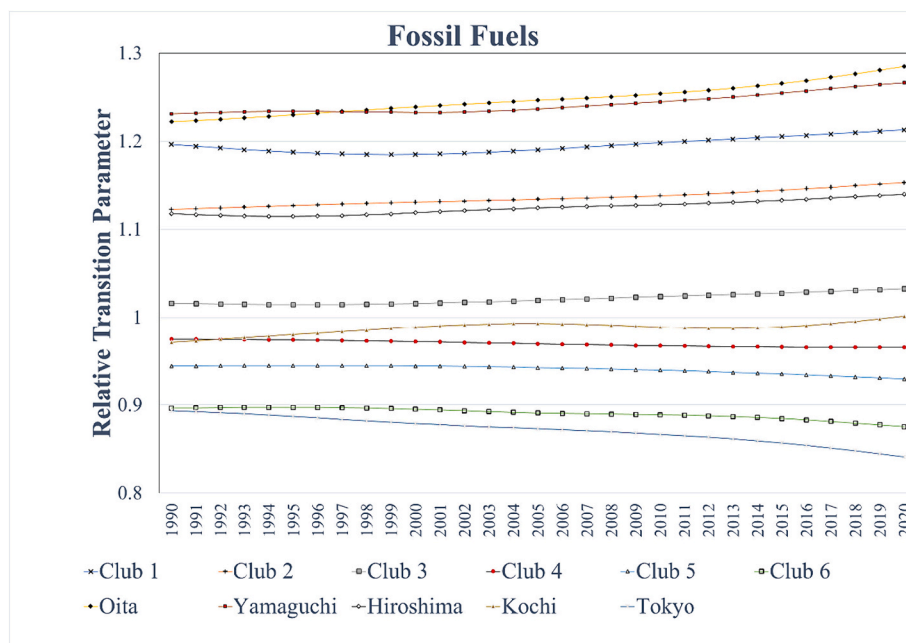


Fig. 1. Per capita emissions clubs and diverging prefectures: Total fossil fuels.

Source: Authors’ calculations using Carbon Emission Per Final Energy Consumption for the 47 Prefectures from 1990 to 2020 in Japan from the Ministry of Economy, Trade, and Industry (METI) and the Agency for Natural Resource and Energy.

mid-1990s to 2005. In Hyogo, emissions intensified with the emergence of steel industries during the mid-90s and 2000s. Aichi demonstrates a consistent trajectory, with emissions maintaining stability over time. In contrast, Fukuoka shows declining relative transitions, while Aomori displays an increasing trajectory, suggesting a comparably worsening trend in emissions, especially from the mid-2000s (see Appendix Fig. A1: a)–c)). This club encompasses prefectures with diverse characteristics, including Aichi, with an automobile industry, which is one of the wealthiest prefectures, Fukuoka with manufacturing industries, and Miyagi and Aomori, with a mix of agriculture, service, construction, manufacturing, and energy supply sectors [114].

Club 4 includes 10 prefectures, all exhibiting emission trends below the cross-sectional mean, including northeast regions and mountainous regions. In contrast, Club 5 includes 13 prefectures, mainly characterised by agricultural and manufacturing industries, including the

production of semiconductors and electronic components. Club 6, the lowest emission subgroup comprising Kyoto, Nara, Okinawa, and Saitama, presents a distinct profile. Notably, Nara stands out as the lowest carbon-emitting region per person within this club, while Okinawa and Saitama’s emissions decreased below Nara’s since 2018. On the other hand, Club 5 has significantly reduced its population-weighted emissions compared to other regions over recent decades, often serving as hubs for administration, culture and businesses, relying on manufacturing and tourism. Importantly, areas like Tokyo, Osaka, Kyoto, Nara and Okinawa are transitioning away from hydrocarbon-based industries, unlike many regions lagging in decarbonisation efforts. These areas were also excluded from the expansion of coal-fired power plants after the 2011 nuclear disaster.

Subsequently, the analysis explored emissions from distinct sources. When examining emissions from oil, gas and coal separately (Fig. 2),

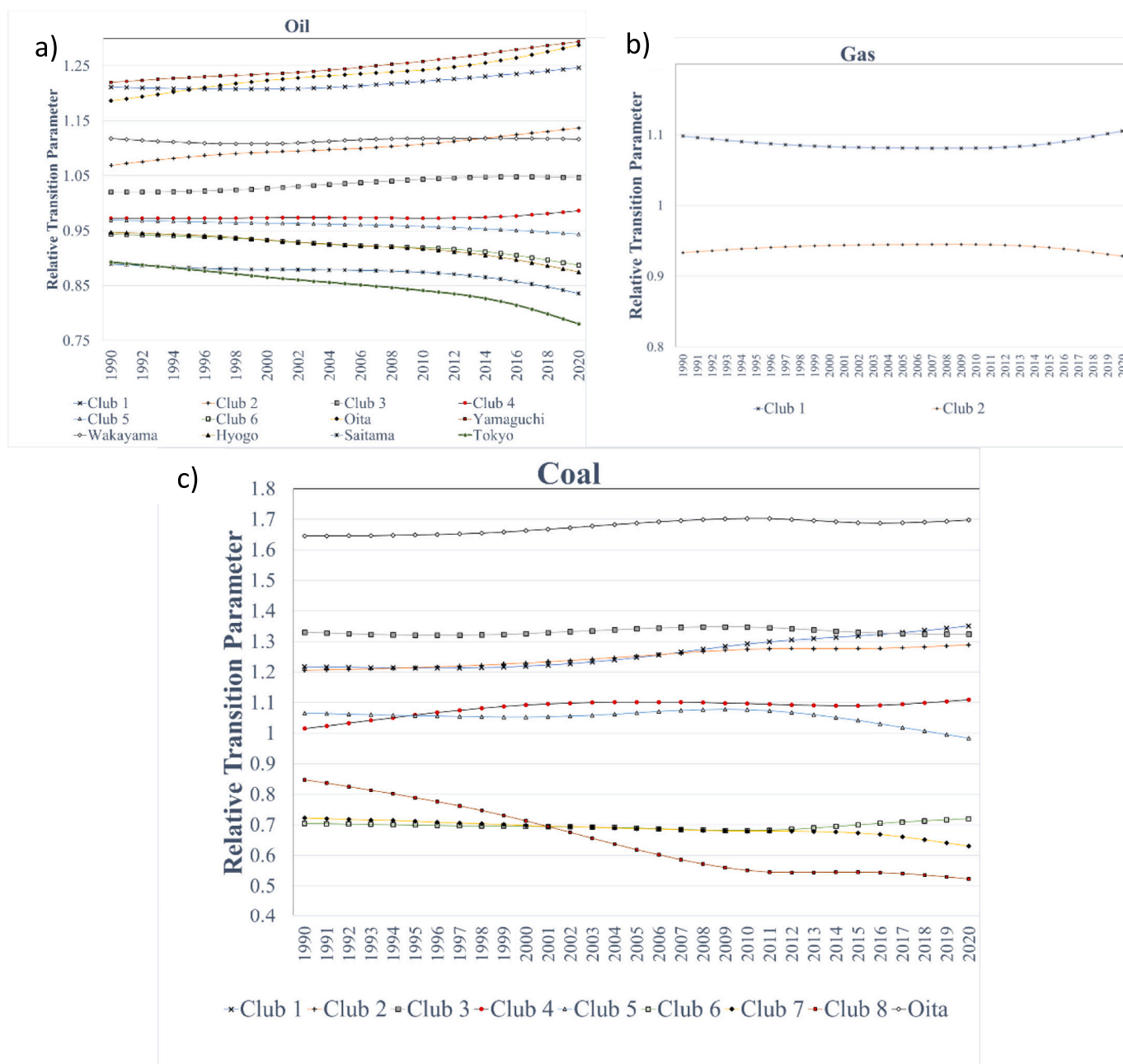


Fig. 2. Per capita emissions clubs and diverging prefectures: Oil, gas and coal.

Source: Authors’ CALCULATIONS using Carbon Emission Per Final Energy Consumption for the 47 Prefectures for 1990–2020 in Japan from the Ministry of Economy, Trade, and Industry (METI) and the Agency for Natural Resource and Energy.

distinct patterns emerge. Emissions from oil exhibit six clubs and six diverging prefectures, with slight variations in transition paths (Fig. 2: a)). Notably, similar to total emissions (Fig. 1), the highest and lowest emissions match those from total emissions, and widening gaps are observed among the lowest- and highest-emitting prefectures. Interestingly, in the case of emissions from gas, only two distinct clusters are observed. Club 1 mainly consists of industrialised prefectures, while Club 2 comprises prefectures most likely to be peripheral (Fig. 2: b)). In the case of emissions clubs from coal, eight clusters and one diverging prefecture, Oita, are detected (Fig. 2: c)). Oita, being the highest emitter from coal, is followed by five clusters of prefectures above the average transition path and three clubs curbing below the average. Among the clusters above the panel mean, Clubs 3 and 5 begin to curve downwards from around 2015, while the rest of the subgroups present upward transitions. Meanwhile, the clubs that fall below the panel average continue to diverge away from the highest emission clubs (see Appendix Tables A2–A4).

Figs. 1 and 2 consistently illustrate the sub-national emission disparities in Japan at the prefectural level. The convergence analysis highlights enduring discrepancies rooted in initial industrial structures, especially notable in Clubs 1 and 2 and regions trending upwards (emissions from total fossil fuels, oil, gas and coal). Oita, with its concentration of power generation units and carbon-intensive industries, stands out with the highest relative per capita emission transition path in all figures presented. Despite experiencing a population decline, Oita Prefecture's total emissions have consistently remained above the average since 1990. Similarly, prefectures around the central megalopolis, such as Chiba, Ibaraki and Okayama, exhibit relatively worsening per capita emissions post-2012. These regions mostly fall within the Pacific Belt Industrial Corridor, developed for rapid growth in the 1960s [81]. Throughout history, these regions have been at the forefront of environmental and civic movements since 1960s. These initiatives have spurred the implementation of pollution control policies and cancellation of refinery projects. For instance, Mishima City struggle against an oil refinery in Shizuoka Prefecture in 1963 and the Oita Prefecture citizen movement opposing the expansion of industrial complexes in 1977 are notable examples [115,116].

Conversely, regions historically characterised by limited urbanisation, grounded in primary industries such as agriculture, fishery, and forestry, are experiencing upward trajectories in emissions. Notably, northern and northeastern regions like Hokkaido, Akita and Miyagi, undergoing increased industrialisation, have observed a surge in hydrocarbon activities, both in total fossil fuels and specifically in coal, especially post-2000 and in the aftermath of the Great East Japan Earthquake and Tsunami. These areas are now affiliated with high-emission clubs, particularly regarding emissions from coal, reflecting their increased engagement in hydrocarbon activities. Following the tsunami disaster, proposals emerged for the construction of new power plants in Sendai, Miyagi Prefecture. However, these plans encountered oppositions from local residents [117].

These emission clusters are shaped by the prevailing industrial structure and a centralised political economy, leaving little space for the principles of energy democracy to thrive. Past and present experiences with air and water pollution, civic movements, and the changing landscape of energy transitions have led to distinct narratives and differences in movement framing. In the following section, we examine how these past experiences and the changing conditions are shaping the climate action narratives.

5.2. Contestations against coal-fired power plants to limit carbon emissions

In the evolving landscape of energy transition, the contention surrounding coal and its implications for climate change narratives is increasingly evident. This section explores the climate action narratives in Japan, particularly focusing on coal-fired power plants and the

carbon-intensive industries prevalent in various prefectures. In 2023, Japan hosted 168 operational coal-fired power plant units despite the target set by grassroots and environmental organisations to phase them out by the 2030s [118]. Among them, the most contested ones are the 50 coal-fired power plants planned for construction after 2012. We have identified these conflicts by a comprehensive review of web pages and reports from anti-coal stakeholders, revealing varying intensities of opposition at the community level. For our analysis, we identified a total of 28 coal-fired power plant units with visible contestations, drawing from contested statements by anti-coal stakeholders [114,119]. These statements, sourced from media, webpages and reports, were synthesised into both web content and a database using the EJAtlas web page and documentation tool. Content moderators thoroughly examined these materials before their public release online. While not all contested units were documented in the EJAtlas due to low opposition intensity and data requirements for the Environmental Justice Atlas Framework, we incorporated the analysis of these units using public statements from diverse sources. The examination extends to 17 withdrawn units and 11 operating units subject to ongoing conflicts manifested through campaigns, protests, litigations other forms of opposition. Refer to the Supplementary materials section in the Appendix Table A5 for detailed information.

Fig. 3 visually depicts coal-fired power plants cancelled between 2017 and 2021 and those involved in persistent conflicts since the planning stage following the nuclear disaster. It also showcases their respective emissions clusters resulting from coal combustion. Among the contested coal-fired power plants, 17 units, collectively accounting for potential annual emissions exceeding 58 million tons of CO₂, were prevented between 2017 and the end of 2021, in part due to resistance and civil society oppositions. Activists and citizens predominantly employed public campaigns, networking, and formal communication, such as official letters and complaints, as primary modes of opposition. The concept of “stranded assets” was frequently emphasised to raise corporate awareness. The instances of civil and administrative lawsuits were also observed first in 2017 in Miyagi, followed by Hyogo and Kanagawa Prefectures.

We have identified a spectrum of narratives through analysing conflicts related to Japan's coal-fired power plants, utilising the EJAtlas

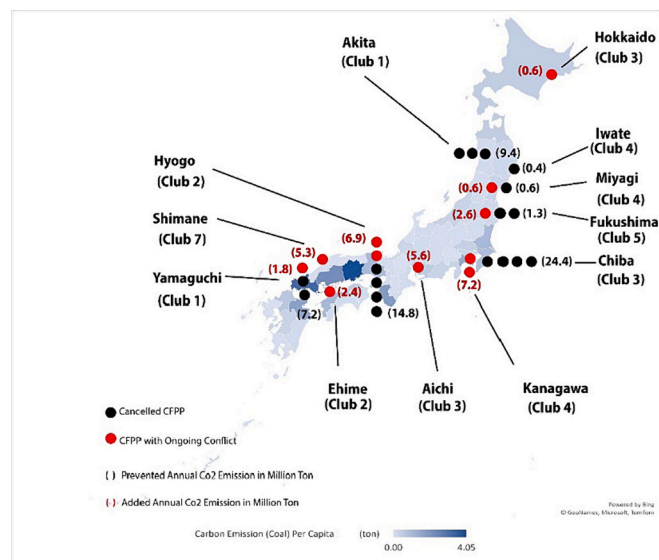


Fig. 3. Map of Japanese prefectures with the concentration of carbon emissions from coal and coal-fired power plants planned since 2012 but later cancelled. Source: Authors' calculations using Carbon Emission Per Final Energy Consumption for the 47 Prefectures for 1990–2020 in Japan from Ministry of Economy, Trade, and Industry (METI) and coal-fired power plants data from Japan beyond Coal 2021.

database and local NGO's media sources. These encompass concerns regarding air and water pollution, global warming and soil contamination. Additionally, issues such as health impact, human rights violations and disparities in pollution standards have been raised. Furthermore, narratives emphasise social impacts, encompassing loss of livelihoods, effects on women and children, and the erosion of local culture. Environmental degradation, which encompasses the loss of biodiversity and alteration of landscapes, is also a focal point. Finally, themes like climate justice, intergenerational fairness, and criticism of technology-driven solutions are prevalent. These narratives can be categorised into five major groups: Environmental Degradation, Health Related Impacts, Social and Cultural Impacts, Justice and Inequality, and Technocratic Criticism. We will explain each of them hereafter.

1) Environmental Degradation

Narratives in this category predominantly revolve around air pollution, water contamination, soil degradation and global warming, underscoring the detrimental environmental repercussions of coal-fired power plants. Global warming and air pollution narratives are the most prevalent, being identified in every case within the studied sample, highlighting their tangible and potential impacts on climate and air quality.

Additional discourses relate to surface water contamination and its impact on local fishers, especially in areas like the Tokyo Bay Area, with a history of environmental pollution. The opposition addresses not only climate change but also local pollution issues, involving diverse demographics like fishers impacted by marine life decline due to rising sea temperatures. In instances like the Kanagawa Prefecture, activists and citizens have contextualised their legal actions as preventative measures against the prospective impacts of global warming, air pollution from CO₂ emissions, and a reduction in fish catch due to warm wastewater discharge. However, the implications of coal-fired power plants on climate change are not confined to local contexts; they extend to broader framings, reflecting the damage induced by severe weather events in western Japan and the surge in heatstroke patients.

The narratives also highlight the impact on local biodiversity, particularly in the Sendai Bay area and Hokkaido. These narratives transcend historical emissions data and urban-rural divides. Cities with sensitive climates, like those prone to unusual weather events like the "Kushiro fog," emphasise their vulnerability to coal-fired power plants' environmental impacts [120]. This refined narrative provides a more nuanced understanding of the multifaceted environmental impacts of coal-fired power plants, emphasising the diversity in opposition and the varied consequences experienced by different communities [121].

2) Health and Safety-Related Narratives

Health-related narratives revolve around the coal-fired power plants' adverse effects on human health, discussing the direct and indirect health implications, such as respiratory diseases due to poor air quality, waterborne diseases due to water contamination, and mental health issues arising from living in proximity to these plants. The cases of Sendai City in Miyagi Prefecture and Chiba Prefecture illustrate the diverse health impact narratives related to coal-fired power plants. In Sendai City, concerns are heightened by the increased impact of PM 2.5. It also raised concerns about schools within close vicinity of a power plant, emphasising fears for children's health amidst air pollution. Similarly, the case of Kanagawa Prefecture also exhibits mothers' concerns over the impact of children's vulnerability to pollutants.

The narrative in Chiba Prefecture is deeply intertwined with the region's historical context, marked by longstanding battles against industrial pollution. The residents, having suffered from serious pollution since 1951 due to industrial activities, have a heightened sensitivity and opposition to air pollution. The formation of the "Organization to Eliminate Pollution from Chiba City" and the

subsequent "Aozora Trials" symbolise the collective resistance and pursuit of environmental justice by the residents. The legal recognition of air pollution's health hazards in 1988 reinforced the narrative of an ongoing struggle for clean air and public health. The construction of a new coal power plant in a region with such a tumultuous history of air pollution revives old wounds and fears, threatening the hard-earned "blue skies" and reinforcing the narrative of a continuous struggle for clean air and public health. These narratives are not just stories; they are reflections of lived experiences, struggles for health and well-being, and symbols of resilience and hope in the face of environmental adversities. They serve to inform, mobilise, and inspire actions aimed at mitigating the health impacts of coal-fired power plants and advocating for cleaner and healthier alternatives.

3) Social and Cultural Impacts

Social and Cultural Impact narratives explore the profound and multifaceted repercussions on communities and their ways of life, focusing on displacement, cultural heritage loss, and local livelihood disruptions. In Iwate Prefecture, the narratives are enriched by the residents' concerns over the ecological impact of high-temperature water discharge and the presence of harmful dioxins in exhaust gas, brought forth in public meetings. The discussions also extend to the alteration of landscapes and the installation of soundproof walls around the plant, symbolising the physical and metaphorical barriers between the community and the plant. Residents' inquiries and expressions of concern, such as the obstruction of view by the walls and the unsuitability of the plant in the location, reflect the deep-rooted apprehensions and the clash between industrial development and the preservation of local ethos and environment.

The narratives here encapsulate the struggles and oppositions from varying perspectives within the community, portraying a vivid picture of the social and cultural turmoil induced by the power plant. In Yokosuka, narratives are shaped by residents, such as local fishermen experiencing the impacts of rising water temperatures on their livelihood. The visible environmental changes and declining fish stocks symbolise the real consequences of environmental shifts on local traditions and livelihoods. These narratives illustrate the intricate tapestry of social and cultural impacts stemming from coal-fired power plants, highlighting community voices and the need for a balanced transition that respects and preserves the social and cultural fabric of the local communities.

4) Justice and Inequality

Narratives in this category address issues of justice and inequality stemming from coal-fired power plant operations. They highlight the disproportionate impact on marginalised and vulnerable groups and regions, emphasising themes like climate justice, intergenerational justice, and peripheralisation of rural areas. In some instances, as seen in Hyogo, Miyagi, and Kanagawa Prefectures, civil and administrative lawsuits have also been pursued as a strategy to combat the perceived injustices. In Hyogo Prefecture, residents of Kobe City have initiated lawsuits against coal power corporations and the government, framing their legal battles as "intergenerational justice litigation." These citizen lawsuits underscore the rights of younger generations to inherit a habitable environment [122].

Peripheralisation framings are particularly evident in rural areas like Hokkaido, Akita, Iwate, Fukushima and Miyagi [79]. For instance, in Hokkaido, local opposition is not only concerned with climate change issues but also with the region being exploited as a peripheral for electricity production for metropolitan areas. Local activists in these areas are inclined towards promoting tourism and traditional fishing livelihoods, contrasting with the push for coal mining and power generation [123]. Resisting citizens' concerns encompass local and global climate change impacts. In Miyagi, air pollution, waste disposal, and environmental degradation in the rural periphery are key issues alongside climate change [117].

5) Technocratic Criticism

Narratives under this category typically revolve around the critique and scepticism of technology-driven and technocratic solutions to address energy and consumption-related issues in the context of coal-fired power plants. Analysing the reports and campaigns from the environmental organisations and the mobilisation groups contended that despite ongoing research and initiatives aimed at future decarbonisation, such as Carbon Capture and Storage (CCS) and Carbon Capture and Utilisation (CCU), the proposed solutions and technological advancements are not realistically applicable in practical scenarios. They argued that these technological perspectives and advancements are being leveraged merely as justifications to perpetuate the utilisation of fossil fuels and sustain energy-intensive societies. This narrative underscores the scepticism and criticism towards the over-reliance on and the feasibility of technocratic solutions, highlighting the perceived use of technology as a façade to continue unsustainable practices.

Furthermore, aligned with the degrowth movement, these narratives often criticise the unsustainable levels of energy consumption and the continuous pursuit of economic growth at the expense of environmental and social well-being. They call for a reevaluation of consumption patterns and a shift towards more sustainable and equitable models of energy generation. This perspective was prominently observed in Ube City, located in Yamaguchi Prefecture, where dissenting factions persistently condemned the utilisation of coal technologies. This sustained opposition eventually compelled the involved companies to abandon the development of a new coal-fired power plant, attributing the termination to the diminished electricity demand in Western Japan [124].

5.3. Nexus between carbon emissions and climate action narratives

The club convergence analysis reveals disparities in decarbonisation efforts among prefectures. While per capita emissions for some regions are decreasing, others are increasing further away from decarbonisation targets. This divergence aligns with existing studies highlighting uneven energy transitions and the continued marginalisation of rural communities [59]. The analysis in the Japanese context unveils three clear patterns: regions with a historical legacy of high emissions, regions growing emissions and regions effectively reducing per capita emissions. These distinct scenarios give rise to varying narratives and responses.

In regions characterised by high emissions, exemplified by Yamaguchi, Chiba, and Hyogo—comprising the highest emission clusters in both total fossil fuel and coal emissions—where coal-fired power plants are undergoing expansion, there has been a notable emergence of citizen resistance and social mobilisation efforts. These areas often have economies deeply tied to fossil fuel and steel industries, leading to substantial political and economic pressure to maintain the fossil fuel-based status quo. Efforts to promote climate action and transition to cleaner energy sources can face oppositions from powerful industry stakeholders, resulting in visible conflicts and mobilisations. For example, Yamaguchi Prefecture, despite being structurally peripheralised since post-war development in the 1960s, saw local resistance leading to the cancellation of the Ube Power Plant [85]. The cancellation prevented approximately 7.2 million tons of annual emissions from diverging further from the transition path. Furthermore, residents in Chiba, Kanagawa and Hyogo prefectures, situated in close proximity to major metropolises like Tokyo and Osaka, vehemently resisted the construction of new power plants in their regions, totalling 17 projects. Chiba, in particular, curbed emissions by 24.4 million tons annually.

In contrast, peripheral regions with fewer visible oppositions have plans for 14 coal-fired power plants in the northeast, 4 in the central, and 14 in the western regions [23]. These areas often lack the extensive environmental movement history seen in regions with high emissions. Prefectures which belong to a high emission cluster from coal, such as Akita, witnessed the cancellation of coal-fired power plants while

maintaining their increasing emission patterns. In emission clusters in terms of coal and total fossil fuel emissions that are closer to the panel average, such as Clubs 3, 4 and 5, there is a persistent increase in carbon emissions, except for one cancellation in Miyagi Prefecture. In contrast, project cancellations in Iwate and Fukushima have the potential to keep emissions below the cross-prefecture average over time.

The anti-coal movement's themes consistently align with global warming, health impacts, social and cultural impacts, technocratic criticism and justice narratives. However, there are nuances in the intensity and focus of these narratives between regions. Regions with past experiences of industrial pollution have narratives against coal-fired power plants that are deeply informed by their historical traumas and the lessons learned from those experiences. These narratives are characterised by a commitment to environmental justice, a focus on health and well-being, and a determination to prevent the recurrence of past environmental injustices. Moreover, past experiences with industrial pollution can significantly influence the tactics and strategies employed by communities in their social movements against coal-fired power plants.

Their tactics often involve legal actions due to past successes, recognising the power of litigation in holding polluters accountable. These communities tend to adopt a multifaceted approach, blending legal actions with grassroots mobilisation, advocacy, and community education to accomplish their goals. Their past successes serve as a powerful catalyst in shaping effective strategies for social movements.

On the contrary, regions characterised by a concentration of intensive carbon industries and energy projects that have gradually emerged since the economic development policies of the 1960s present distinctive approaches and narratives. In contrast to regions with a history of industrial pollution, these areas tend to craft their narratives around issues such as rural peripheralisation, social injustice, local values, and a sense of belonging. Their mobilisations may be less visible but are deeply rooted in concerns about their communities' well-being and long-term sustainability. These communities feel marginalised in economic and political decisions, with their well-being and environments sacrificed for urban areas. They stress local values, cultural significance and land belonging, threatened by industrial expansion, unlike pollution-experienced regions. They advocate for local autonomy and use quieter tactics, such as community meetings, petitions, and engagement with local authorities.

Despite the limitation of in-depth exploration in this study, it provides valuable insights into Japan's anti-coal movements. In the past, injustice narratives in Japan were strongly centred around the deep-rooted concept of "Kogai" when the framing is against a single visible polluter and the identified victim groups. However, the climate justice movement in Japan moved beyond the narrow concept of "Kogai", and the framing became broader than "Kankyo Mondai", with more apparent potential and visible victims and antagonists such as the government or local administration. Previous scholars argued that the Japanese have a low interest towards climate change and environmental challenges compared to other industrial and post-growth societies [86]. Contrary to this, our study indicates that within traditional environmental movements, Japan is resisting the growth of new fossil fuel projects, aligning with the climate justice movements observed in other parts of the world. Scholars suggest a shifting energy and climate change mitigation landscape in Japan, with environmental NGOs and citizen groups becoming more active in mobilisation than in previous decades [125]. There is also potential for these movements to identify broader perpetrators of environmental harm, such as violation of human rights and structural injustices within the socio-political system and energy regime.

6. Demystifying climate action narratives in Japan: conclusion from an in-depth analysis of emissions dynamics and social mobilisation

This study employs club convergence analysis and EJAtlas mapping tools to investigate dynamics of sub-national carbon emissions and their relation to climate action narratives revolving around the expansion of coal-fired power plants in Japan. The analysis reveals converging clubs and diverging prefectures, with widening emission gaps over 30 years. The convergence analysis results exhibit the structural conditions of these emissions inequalities and allow us to visualise the transitioning paths throughout the years. Post-Fukushima, increased fossil fuel dependency exacerbates emissions inequalities, resulting in anti-coal conflicts in the country. We identified that some prefectures had increased carbon emissions before the Fukushima Disaster. However, the post-Fukushima energy crisis delivered a shift in energy power generation and has enhanced the region's unequal emission burden.

This inequality is mirrored in the varying intensities and focuses of anti-coal narratives across regions, with high-emission areas experiencing significant citizen resistance and social mobilisations due to their deep ties to fossil fuel and steel industries. These regions, structurally peripheralised since post-war development, have witnessed successful local resistances, such as the cancellation preventing further emission divergences. However, in rural regions experiencing gradual growth in emissions, the narratives and mobilisations, although less visible, are deeply rooted in concerns about community well-being and sustainability, emphasising rural peripheralisation, social injustice and local values. These communities often advocate for local autonomy and employ quieter tactics, like community meetings and petitions.

Notably, while some prefectures showed a decrease in relative per capita emissions and downward convergence in our analysis, others carried a disproportionate burden of carbon emissions. Despite the absence of appropriate policies in addressing these emissions disparities, grassroots organisations have effectively mobilised communities, symbolically contesting and shaping a path towards a just transition. Our findings emphasise the importance of addressing the sub-national environment and energy injustice as they identify structural emissions inequalities and their linkages to climate action contestations. In order to foster a just energy transition, policies should focus on inclusive policy design that enhances energy democracy—a more decentralised and participatory approach to energy decision-making. These policies involve community-owned renewable projects, incentives for local endeavours, and empowering local communities with a greater voice in designing energy sources and consumption patterns.

Our research findings corroborate and expand upon existing scholarly discussions, demonstrating that local mobilisation narratives encompass themes of intergenerational justice, the livelihoods of those dependent on resources, and climate risks at both local and global scales, as well as intra-national justice. Grassroots entities and communities tackle these justice-related issues through a bottom-up approach. Consequently, our study reinforces the proposition that movements originating from ecological distribution conflicts, which challenge hydrocarbon-intensive industries, have the potential to forge alternative routes towards a sustainable and equitable energy transition [1].

Moreover, the outcomes of the club convergence analysis depict a continuous intensification of hydrocarbon activities in rural locales despite discernible efforts to mitigate carbon emissions in principal hub areas. These outcomes reinforce the narrative of the unequal evolution of low-carbon energy transitions, a narrative deeply intertwined with ingrained geographical factors, developmental paths, resource allocations, and the perpetual sidelining of deprived regions [59]. In such scenarios, the increasing environmental pressures on vulnerable rural communities can potentially lead to social and environmental disasters [84,126]. This standpoint challenges preceding studies examining the stochastic dynamics of carbon emissions, which propose pollution as an incidental byproduct of income and industrial development, thus acting

as a marker for economic progress and development, as suggested by the Environmental Kuznets Curve [99]. However, utilising such hypotheses to decipher the nature of emissions at a sub-national scale is intricate, as emissions in marginalised, rural areas continue to diverge from those in wealthier regions. We argue that such persistent inequalities in emissions originate from dilemmas in climate governance and policy, deeply rooted in an industrial development paradigm that elevates economic growth. The study also contributes to the social movement literature by presenting an innovative approach to synchronising club-convergence analysis and social movements mapping analysis, providing a comprehensive understanding of the dynamics of carbon emissions and climate activism.

In conclusion, this research sheds light on the intricate dynamics of carbon emissions at the sub-national level and unravels the complexities of environmental conflicts in advocating for justice in energy transitions. By exploring the narratives within environmental conflicts, this study contributes significantly to the discourse on the contested politics of energy transition, offering nuanced insights into the challenges and opportunities inherent in sub-national climate governance and policy. Understanding these narratives is crucial as they shape perceptions, influence behaviours, and ultimately drive policy changes, reflecting the diverse concerns and aspirations of communities. For future research endeavours, there is a compelling need to further investigate environmental and climate-centric activism in Japan and the wider Asia Pacific region that is still understudied. Expanding this exploration will not only enrich our understanding of the diverse narratives and strategies employed in different cultural and socio-political contexts but also foster a more inclusive and informed global dialogue on climate justice and sustainable development.

CRedit authorship contribution statement

May Aye Thiri: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Mihály Tamás Borsi:** Writing – review & editing, Visualization, Validation, Software, Resources, Methodology, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.erss.2024.103520>.

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