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A Socio-Spatial Perspective

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DOI
10.3390/land13070916

Publication date
2024

Document Version
Final published version

Published in
Land

land

Article

Towards Just and Integrated Energy Transition in Taiwan: A Socio-Spatial Perspective

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Abstract: Energy justice remains relatively under-researched outside of the Western context, especially in Asia. This paper addresses that gap by investigating the process of energy transition in Taiwan through the socio-spatial lens and institutional points of view. The paper underscores the urgency of recognizing and addressing the overlooked social injustices across different territories, advocating an integrated planning approach that incorporates a just energy transition perspective to reduce the uneven negative impacts of deploying renewable energies across communities and regional territories. Drawing on a case study of the Changhua region, the paper identifies conflicts arising from the rapid deployment of renewable energy, such as land use changes that displace farming activities and negatively affect rural stakeholders. The findings suggest the need to urgently address the gap between top–down goals in energy transition and bottom–up considerations to raise awareness and prevent injustices that risk deepening the existing socio-economic inequities. This paper also proposes a new framework for both new research and policy for (just) energy transition, incorporating distributional, procedural, and recognitional concerns together with a critical view on the cross-scale and cross-sectoral integration as part of the spatial planning process.

Keywords: energy justice; just energy transition; spatial justice; spatial planning; integration; Taiwan

Citation: Liu, K.-T.; Dąbrowski, M. Towards Just and Integrated Energy Transition in Taiwan: A Socio-Spatial Perspective. *Land* **2024**, *13*, 916. https://doi.org/10.3390/land13070916

Academic Editor: Thomas Panagopoulos

Received: 29 April 2024
Revised: 9 June 2024
Accepted: 11 June 2024
Published: 24 June 2024

1. Introduction

Energy justice is a topic that has been widely discussed in Europe over the past few years, especially in the context of efforts to address energy poverty (i.e., the conditions under which households find it difficult to access essential energy services and products) and the just sustainability transition policies developed by the European Union and European governments. Energy justice involves both a substantive and a procedural dimension: it entails efforts to equitably share both the benefits and burdens of energy production and consumption while including people and communities in decision-making concerning energy [1].

However, energy justice as a policy and planning issue beyond Europe is much less debated and researched. For instance, in the context of Taiwan, on which we focus in this paper, the hidden injustices triggered by deficiencies in energy planning and within the spatial planning system go mainly 'under the radar'. Energy transition towards renewable sources, including solar and wind energy, is rapidly advancing on the ground, yet leading to work rights loss and food security challenges [2], exacerbating environmental and ecological threats [3], and risking deepening the unbalanced regional development. There is little academic research exploring these conflicts and unfair situations. Therefore, this paper aims to reveal the urgency of recognizing the inequities arising from current energy transition planning in a non-Western Taiwanese context. This study underlines the need to incorporate spatial and social perspectives to address the inequitable outcomes of transition processes at the regional and local scales, using Changhua County as an example.

1.1. The Context: The Taiwanese Energy Plan

Taiwan's energy transition policy was proposed in 2017, moving towards clean energy transformation based on a nuclear-free and low-carbon emissions energy system [4]. The Energy Transition White Paper was published in 2020, aiming towards a 20% renewable energy generation rate for electricity by 2025 [5]. More specifically, 20 GW of solar energy and 6.8 GW of wind energy were set as targets. As Taiwan relies on imported energy, with up to 98% of its energy being imported from abroad in 2020 [6], the expectation of increasing the energy autonomy rate from 2% to 6% in such a short time is a considerable challenge, underlining the difficulties and the urgency of the renewable energy development in Taiwan, especially against the background of raising geopolitical tensions. However, while the Energy White Paper sets ambitious goals, it provides little indication of how they would be realized practically and equitably [7]. In addition to setting a top–down goal, the White Paper lacks comprehensive planning provisions [7] that include both vertical and horizontal governance and completely ignores the intractable spatial and social problems that have already caused conflict within Taiwanese society, especially in rural and peripheral areas. Since its release, the plan has been criticized on multiple grounds in the public sphere, especially concerning environmental conflicts [8,9], food security concerns, and the fragmentation of agricultural land, which the Ministry of Agriculture has underscored [10]. The reason for this shortcoming, highlighted in this article, is the lack of discussion on integrating energy and spatial planning. For instance, solar and wind energy, as the two primarily discussed energy sources, are mainly to be deployed in non-urban areas, which puts pressure on agricultural lands. However, this potentially huge landscape change is being planned without involving the government branch responsible for agriculture in the decision-making [11].

1.2. The Gap between the Taiwanese Energy Plan and the Separated Planning Systems

Energy requires space to deploy infrastructure that produce, transmit, and store power, while space is also shaped by the energy and infrastructures that it requires [12]. Space as a 'product of interrelationships' has become fundamental to various research strands in human geography and the social sciences [13]. The complexity of land management and the lack of a holistic planning system exacerbate the challenges of cross-disciplinary collaboration. Especially in the field of energy transition, different policy sectors often have different claims regarding integrating renewable energy in particular areas. Land use in Taiwan is managed through three independent planning systems: urban planning, regional planning (non-urban), and national park planning. As illustrated in Figure 1, the regional planning system oversees most of Taiwan's territory (indicated by the shaded grey area). Each system operates under different laws and regulates land use types differently. Despite a Marine Spatial Management law draft being under assessment at the time of writing, there is currently no planning system for managing marine spatial areas. This lack of an integrated planning perspective and the conflicting views on land use in the energy transition context have led to an uncoordinated deployment of renewable energy infrastructure.

Specifically, the inadequacy of the spatial planning system has resulted in developers collaborating with landowners to change land use from agricultural or aquacultural purposes to non-agricultural uses [14], as depicted in Figures 2 and 3 showing rapid growth of areas covered with photovoltaic panels. These changes have infringed upon the original renters' rights to work on these lands and raised concerns about food security [2] and ecosystem threats [15]. Many southwestern cities in Taiwan, where urbanization is less prominent and there are more agricultural lands, have been involved in this transition process. In contrast, more prominent cities in the north with higher population densities have remained observers, shifting the transition burden to rural and peripheral areas. This strategy, which overly emphasizes the placement of renewable energy infrastructures within non-urban areas [11], exacerbates the imbalance in socio-economic development at the local and regional scales. Additionally, the ambiguous status of marine spatial planning has escalated disputes between fishers' rights and offshore wind power project development, leading to unresolved conflicts [16].

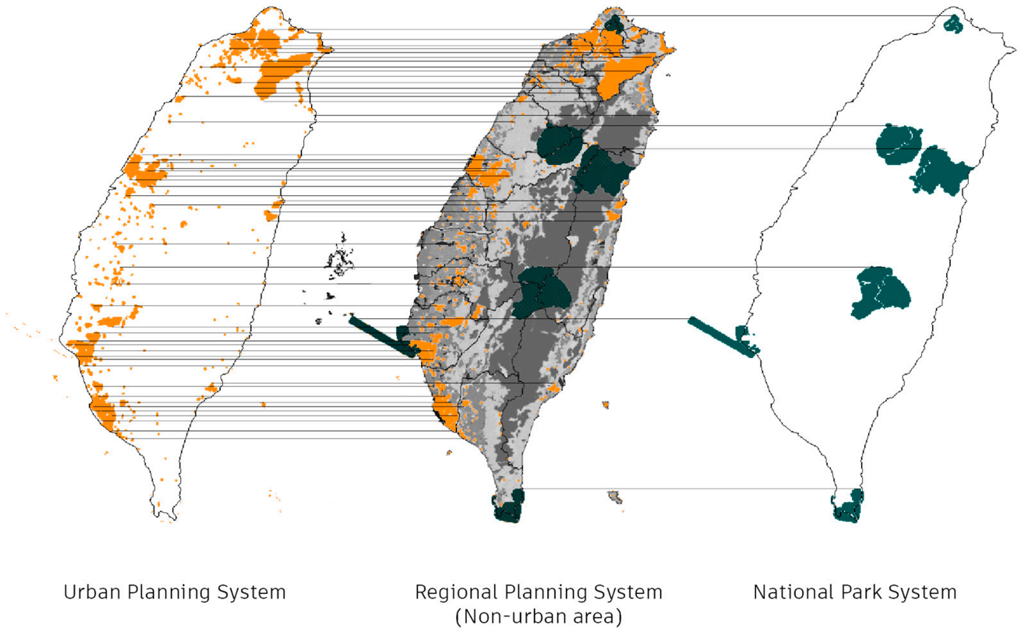

Figure 1. Separated planning systems and the absence of marine spatial planning [17].(areas in orange are urban areas covered by the Urban Planning System, the areas in teal correspond to the boundaries of national parks, whereas the grey areas are non-urban areas covered by the Regional Planning System) (areas in orange are urban areas covered by the Urban Planning System, the areas in teal correspond to the boundaries of national parks, whereas the grey areas are non-urban areas covered by the Regional Planning System).

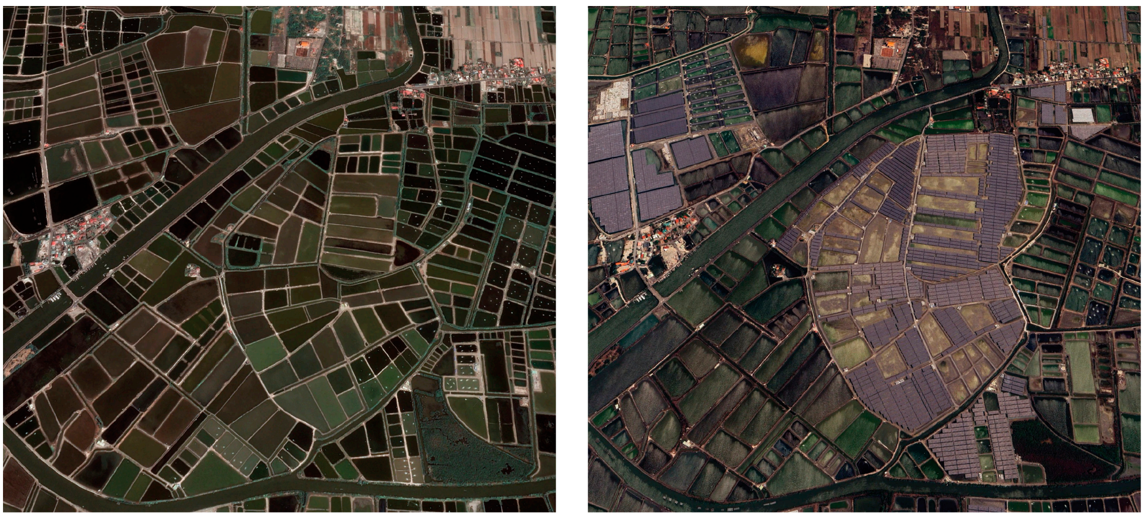

Figure 2. The landscape changes from 2018 to 2024, Tainan, southwestern part of Taiwan [18].

Figure 3. The landscape changes from 2017 to 2024 in Pintung, southwestern part of Taiwan, [19].

To address the challenges of spatial coordination, Taiwan has proposed a new spatial planning system scheduled for implementation in 2025 [20]. This integrated planning system aims to provide a comprehensive framework encompassing urban and national park planning while integrating the principles of land use from the regional planning system. Additionally, this system will include marine spatial areas, as shown in Figure 4. Unlike the disparate planning systems used before 2025, the new system offers opportunities for advanced collaboration among relevant governmental sectors through shared spatial principles and values.

According to news sources and interviews conducted as part of this research, this new planning system can potentially support energy transition [21,22]. However, the extent to which this synergy with energy planning will happen remains a question [15]. Given that the new planning system is still under revision, the full implementation of its concepts is beyond the scope of this research. Therefore, this article applies only the marine spatial zoning concept in the analysis of the case study area, demonstrating the potential for more extensive future research.

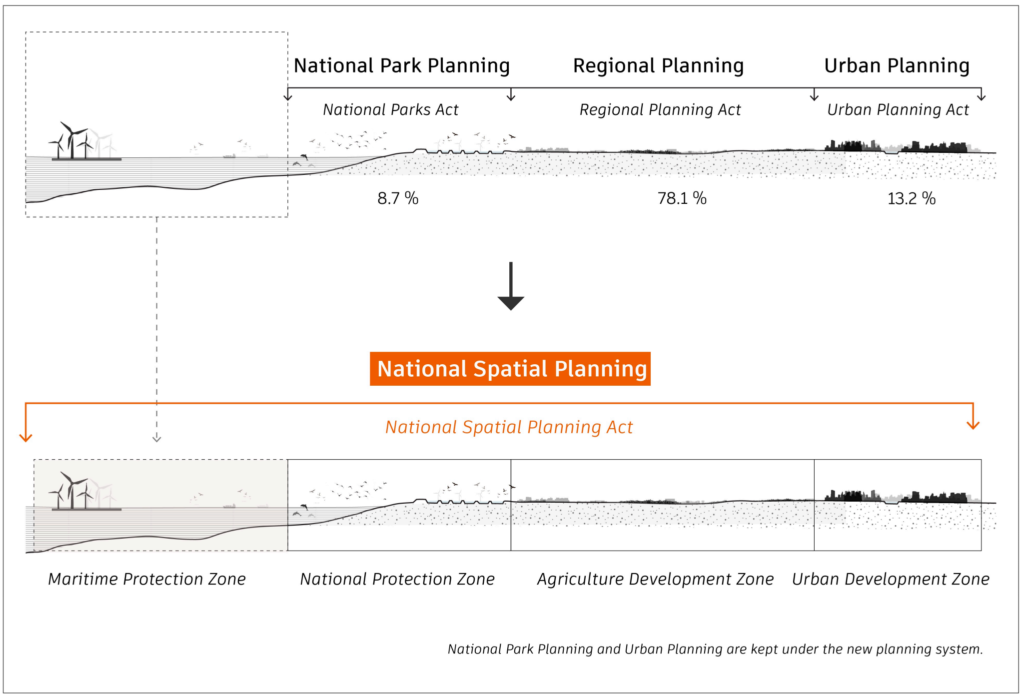

Figure 4. Changes in the spatial planning system. Source: Authors.

1.3. Research Question and the Article's Structure

Most academic research has focused on the technical and political aspects of the energy transition, with limited attention on the social dimensions. Gao et al. [7] introduced the concept of energy justice in Taiwan to evaluate policymaking, emphasizing the need to recognize this concept to achieve more comprehensive outcomes. However, there is a notable gap in the literature regarding incorporating energy justice from a spatial aspect in energy planning, particularly in being aware of its impacts at regional and local levels. This article highlights the importance of understanding the complex consequences of the energy transition, particularly the injustices it creates for the inhabitants of the already disadvantaged territories. It attempts to provide insights to bridge this gap in policy by incorporating spatial and social considerations into energy transition planning.

The research question of this study is as follows: What are the socio-spatial and institutional barriers to an integrated approach to planning a just energy transition in Taiwan? This paper investigates socio-spatial injustices and unbalanced development exacerbated by the energy transition, focusing on the Changhua region. The study aims to shed light on the challenges hindering a more integrated and equitable energy transition by utilizing various qualitative research methods, including desk research, spatial analysis, field visits, and interviews. Examining Changhua as a case study elucidates broader trends and the interconnectedness of local and regional energy transition processes. Neglecting social and spatial aspects in planning further marginalizes vulnerable groups, minimizing their ability to advocate for change. This study underscores the importance of integrated planning in addressing social inequalities and the context of rebalancing uneven regional development. It identifies socio-spatial and institutional barriers to a just energy transition and suggests avenues for future research and policymaking.

2. Literature Review and Conceptual Framework

This study builds on three strands of literature that help us conceptualize the spatial dimension of energy transition and how the injustices can be prevented in the process. These include the energy–space nexus, spatial and energy justice, and an integrated perspective on spatial planning as a connector between policies in space.

2.1. Energy and Space

Understanding space as a 'product of interrelationships' has become fundamental to various spatial ideas throughout human geography and the social sciences [13]. Moreover, these relations are constantly being produced rather than given. Energy needs space to deploy infrastructures to produce, transmit, and store power, while space is also shaped by energy [18]. Energy may be invisible but has direct and indirect impacts on spaces. The direct influence entails relationships with spaces through physical energy infrastructure. Whenever energy sources change, indirect impacts influence economic, political, and social domains, which eventually also challenge spatial organization. There is thus a need to integrate policies that deal with energy and with spatial development. However, creating synergies between both policy sectors has been challenging in practice due to siloed policy processes and risk aversion, leading to limited collaboration and unconnected policies [13]. That said, in recent years, more attention has been paid to the energy–space nexus both in research and policy practice. Space as a 'product of interrelationships' has become fundamental to various research strands in human geography and the social sciences [13]. As a container, space creates and hosts social activities, and consideration of spatial conditions and changes is needed to evaluate the consequences of major socio-technical transitions, such as the energy transition. Space is not a neutral container for the social world to 'happen'. Instead, it is constructed through social connections and processes [23].

2.2. Spatial Justice and Energy Justice

Space shapes, produces, and sustains inequalities actively [23,24]. Alderman and Inwood (2013) state that "social (in)justice does not simply have geographical outcomes; instead, space plays a fundamental role in constituting and structuring broader processes of discrimination or equality" [25]. The concept of spatial justice helps us understand how spatial development processes create inequalities. Despite this, most research and policy debates on energy transition have focused on technological innovations. As a growing emphasis on the human-centered and social science dimensions of renewable energy development, which affects energy generation, consumption, distribution, and their associated benefits and challenges, scholars and policymakers increasingly consider energy justice as both an analytical framework and a guide for decision-making on the energy transition [1].

Energy justice has gained increasing attention in policy and research debates due to recognizing the inseparable relationship between energy and space [26]. Addressing this relationship through a place-based approach is essential for context-specific factors such as geography, economic disparities, policy, and cultural aspects. This growing recognition has rooted the concept of spatial aspects in energy transition processes, as decarbonization efforts tend to reproduce pre-existing injustices, especially in situations with spatially inequitable land uses, whereas more vigorous attention to the role of space in energy transition and the distribution of benefits and burdens that it brings may bring out more effective, fair, and inclusive transition policies [27].

Based on the conceptual review proposed by Jenkins and others [26], or more recently taken up by the European Environment [28], three aspects of energy justice are well recognized [29]: (1) distributive aspect, (2) procedural aspect, and (3) recognition. Distributive justice highlights the outcome of the distribution of benefits and burdens within society [26]. The procedural aspect underlines the decision-making process or the outcome if it stands on a fair and equal principle [26]. The recognition aspect emphasizes understanding societal, cultural, racial, and gender differences [29]. Moreover, this understanding might help to bridge the gaps in distributive and procedural aspects [26].

Since the European Commission launched the Energy Poverty Observatory [30] in 2016 and introduced the Just Transition Fund [31] to support regions facing socio-spatial challenges from the energy transition, European countries have increasingly recognized energy justice as a guiding principle.

Although the United Nations has proposed a just energy transition in the Asia-Pacific region [32], Asian countries have yet to develop specific approaches or conduct comprehensive research on this topic. Despite significant growth in studying the social perspective of energy planning over the past five years [33], piecemeal and rushed policymaking has often overlooked the societal injustices and conflicts hidden in the process. Consequently, "energy justice" in non-Western cultures still requires more attention from researchers [34].

2.3. Integrated Planning

According to Counsell et al. [35], integrated spatial planning helps integrate sectoral policies and break down institutional or disciplinary barriers to achieve specific goals in a territorial context. The integration involves horizontal collaboration across policy sectors and disciplines and vertical collaboration among actors or different government levels. The trend of integrated spatial planning can be traced back to the early 2000s in the UK and Europe, with the national tier of spatial planning guiding collaboration through scales and policy sectors. Nadin et al. [36] evaluated the trends in spatial planning in 32 European countries. This study showed that since the start of the 21st century, policy integration in order to support multidisciplinary goals and topics has become a trend in most of these countries. This research also pointed out that spatial planning helps to coordinate territorial impacts of sectoral policies such as environmental or transport policies.

Integrated spatial planning is thus needed to address the many wicked problems affecting cities and regions worldwide, especially those related to climate change adaptation and mitigation. In a similar vein, the United Nations Development Program published an Integrated Spatial Planning Workbook in 2022 [37], which defined integrated spatial planning as a whole-government approach, providing multiple paths for sectoral policies with a shared vision. Several case studies demonstrated the possible methods that can be used to implement integrated spatial planning to mitigate climate change impacts and help improve the ecosystem, explicitly addressing the energy transition through a spatial lens. There is also a growing emphasis in the literature on the role that integrated planning could play in steering energy transition in the built environment [38–40].

Beyond that, according to Stoeglehner et al. [41], in the energy field, holistic strategies need to be established to develop spatial planning policies for energy transition. To be more specific, energy strategies are heavily influenced by local and regional spatial structure. In addition, spatial contexts also determine both energy efficiency performance and renewable energy potentials. Therefore, considering these factors leads to more realistic energy strategies and calls for integrating spatial planning with energy planning to accelerate the efforts to achieve Sustainable Development Goal 7 7—clean and affordable energy [42]. That said, integration between spatial planning and energy planning is hindered by a number of barriers and challenges.

2.4. Conceptual Framework: Integrated Planning for Spatially Just Energy Transition

The literature review above informs the conceptual framework used to structure this research and provides practice guidance, as Figure 5 shows. The framework is applied here to the case of Taiwan, even though its possible use is not restricted to this context. The framework emphasizes the need to consider vertical (cross-scale) and horizontal integration that conditions a shift towards a more just and space-sensitive approach to the energy transition. At the heart of the framework are two overarching elements: (1) a focus on integrated planning and coordinating activities in space across policy sectors (energy, spatial development, economic development, environmental protection, and agriculture, to name just a few relevant policy areas) and across scales, from Taiwan, regional to local; and (2) the emphasis on spatial justice as a 'compass' for steering decision-making on how to ensure a more fair distribution of positive and negative externalities of the transition across space and communities, for designing a more fair and inclusive process of decision-making, and for recognizing the need to involve the communities that are directly affected by the transition in a dialogue on this process.

At the Taiwanese level, we highlight the importance of recognizing the socio-spatial challenges and injustices that the energy transition may produce at the regional and local levels. These considerations should inform decision-making on energy transition in Taiwan while decentralizing the process and giving agency to the actors at the regional and local levels. At the regional levels, we underscore the importance of an integrated approach to plan for a just energy transition that strives to consider both the spatial conditions for the deployment of renewables and the consequences of this deployment across the regional space in terms of an uneven distribution of benefits and burdens of that process (distributive spatial justice), while engaging in decision-making on the transition process the communities in regional spaces that may be negatively affected by the changes in the energy structures (procedural spatial justice). Finally, at the local level, this requires acknowledging the place-specific features of the space–energy nexus, which should inform decisions on the deployment of renewable energy infrastructures while recognizing the voices and the needs of the local communities, creating room for a bottom–up approach to planning the transition (recognition justice).

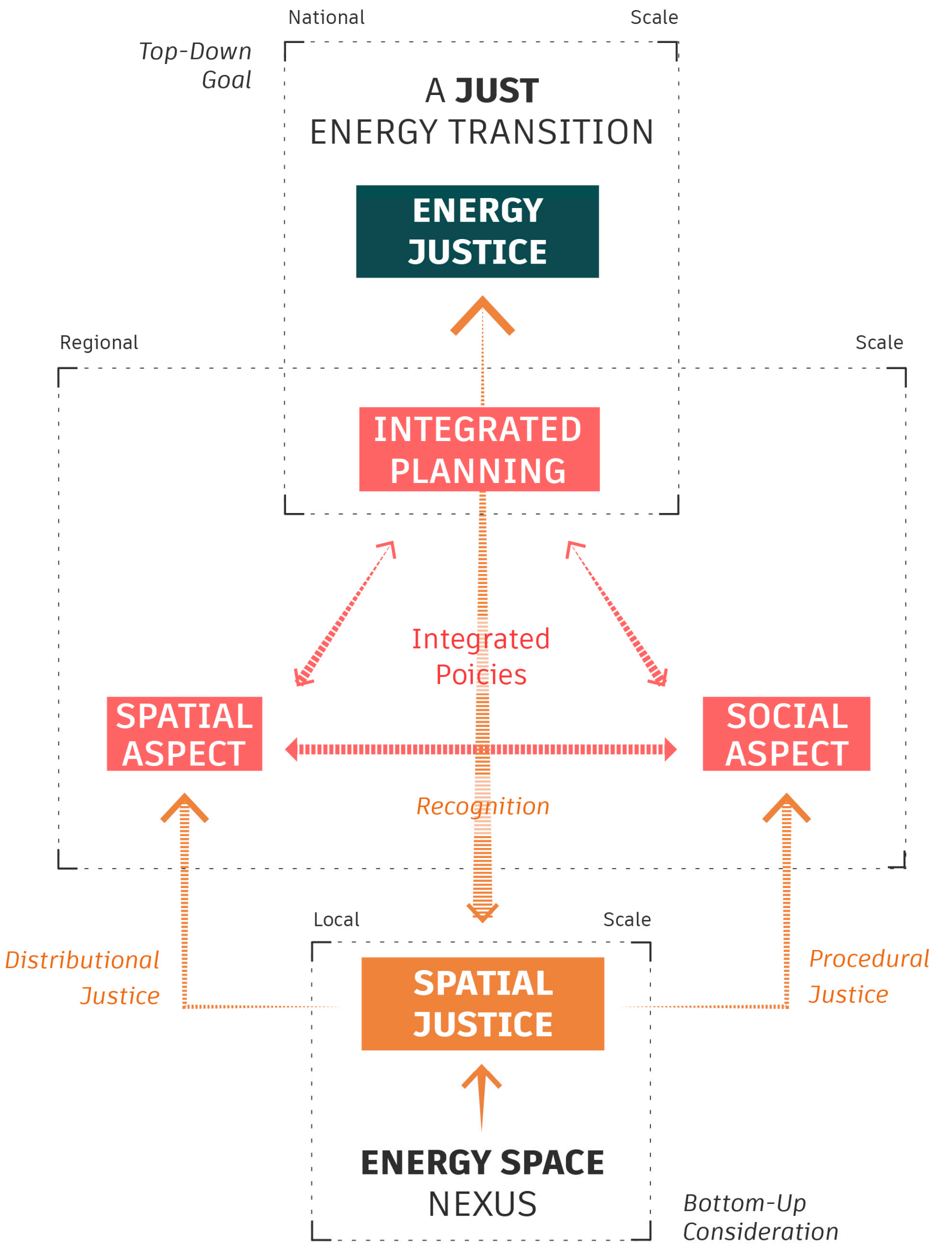

Figure 5. Conceptual framework: towards an integrated planning for just energy transition. Source: Authors.

This conceptual framework identifies a set of elements that need to be in place to enable a shift towards an integrated and more spatially just energy transition planning. In practice, these are seldom present, which is why, in this research, we seek to explore what it would take to move closer to that model, identifying context-specific barriers for this in the case of the Changhua region, Taiwan. We explain the methodology for that research in the following section.

3. Materials and Methods

3.1. Analysis of Transition Challenges across Taiwan

Based on the literature review, the idea of integrating concepts that recognize the link between space and energy and the notion of energy justice was solidly constructed. As the 2025 goal is close at hand, it is crucial to recognize the current contradictions and the causes of these problems. Therefore, analyzing the scope of Taiwan's energy transition from spatial, social, and institutional perspectives can provide clues to current struggles and potentials. However, in order to bridge the gap between the top–down goals of the Taiwanese government [5] and the bottom–up considerations, it is necessary to understand the hidden threats in the short term in the regional context.

3.2. Case Study Selection: Changhua, Taiwan

Changhua County has the most efficient wind power potential in Taiwan. Out of 36 planned offshore wind farms, 21 are located here. In addition, Changhua also has the best solar power potential in Taiwan [43], and it is expected to become an energy hub in the future. As an administrative region, Changhua has the smallest land area, 3% of Taiwan's total. While corresponding to 5% of Taiwan's population [44] and energy use [45], Changhua is expected to generate 21% of renewable energy for the whole of Taiwan in 2025 [43], as presented in Figure 6. Although it possesses great potential and is expected to become an essential region for new emerging green industries, Changhua is one of the least urbanized regions in Taiwan [46], with significant population loss. Specifically, Changhua has vast agricultural lands; that is, based on the central strategies focusing on energy development in the non-urban areas, the deficiency of the spatial planning system is a critical threat that Changhua might face with agricultural land loss, stakeholder work right exclusion, landscape changes, and environmental concerns that have happened in other southwestern regions of Taiwan in a short time. Beyond this, the exacerbation of the unbalanced regional development will only become more severe as the stakeholders become marginalized. Therefore, the location of the case study was chosen to point out the hidden threats and highlight the potential mitigation approaches.

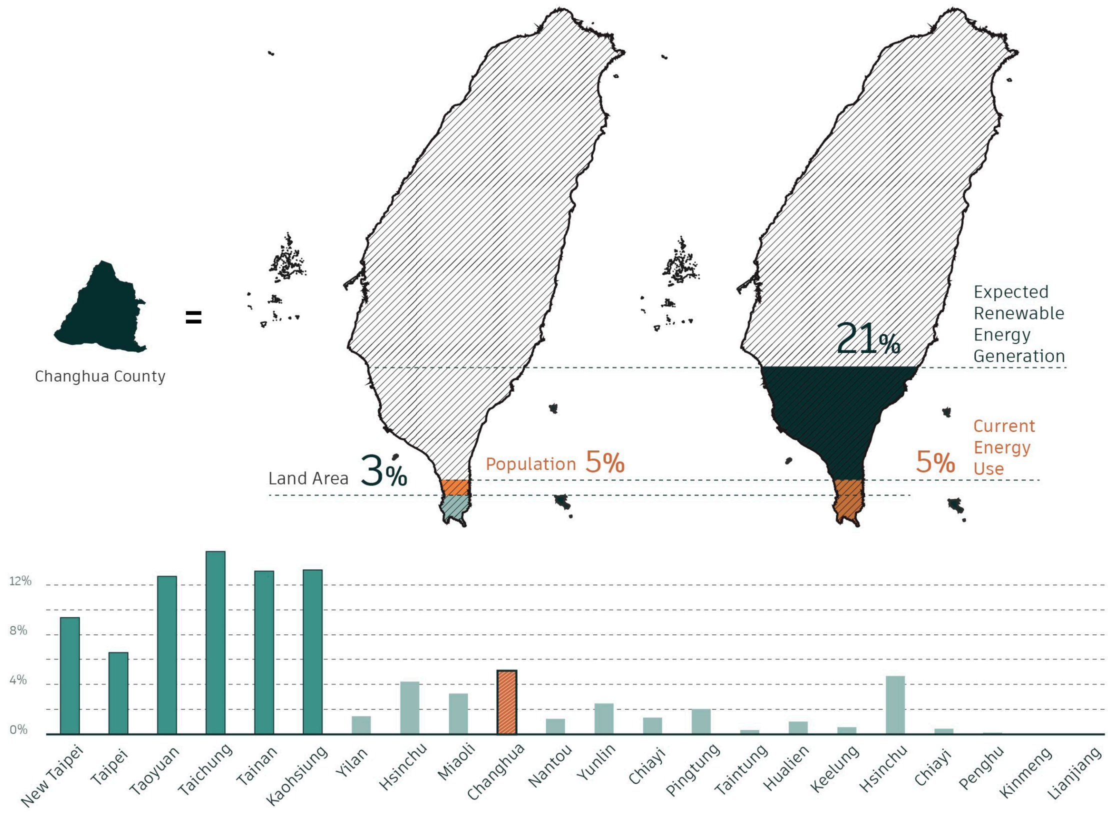

Figure 6. The primary context of a comparison between Changhua and Taiwan's average population, land area, expected energy generation in 2025, and current energy use [43–45].

3.3. Research Methods

The empirical research conducted in Taiwan and Changhua combined several research methods, allowing for the development of a rich and nuanced perspective on the social and spatial barriers to energy transitions and an in-depth understanding of how the above regional, regional, and local contextual features result in injustices produced by the energy transition. First, the study relies on secondary sources. These were collected through a literature review and analysis of a range of policy and planning documents from the Taiwanese government and regional-level authorities. This analysis informed our understanding of the policy context and identified socio-spatial tensions that the planned investment in renewables would bring forward. In addition, Taiwan-wide and local news outlets were reviewed for reports of conflicts surrounding the deployment of renewables in rural areas. This step is presented in Section 1, Introduction, the Literature Review in Section 2, and in Section 3.1.

Second, statistics databases provided by the Taiwanese government and regional authorities were used to collect data for spatial analysis while providing additional insights on the socio-demographic trends in the Changhua region, conditioning the injustices produced by the energy transition. This process uses QGIS Desktop 3.16.14 software to export the data and further visualize the data in Adobe Illustrator. Third, this was complemented by fieldwork involving a combination of qualitative methods. This enabled the triangulation of the insights from the literature review, policy analysis, and spatial analysis, as well as the development of richer insights on the case study region. In particular, five semi-structured expert interviews (two academic and three industry experts) were conducted to gather background information on the energy transition policy and its socio-spatial impacts and explore the underpinning rationales and perceptions of these. This relatively small number of interviews conducted only with experts is a limitation of this study; however, this research method was not central in the methodology and was used mainly to verify and deepen the insights of the importance of incorporating integrated planning in the energy transition. The insights from interviews mainly informed the critical discussion of the findings in Section 4. Then, site visits across Changhua County were conducted, emphasizing the rural areas where renewable energy infrastructure is most rapidly deployed and causes the most acute tensions. The site visits involved site observation for collecting evidence on the state of deployment of renewables on the ground, impacts of renewables on spatial qualities, environment, social life, and vitality of rural areas, as well as the scope for practicing agricultural activities, documented through field notes and photographs.

4. Results: Unpacking the Barriers to Just Energy Transition

4.1. Institutional Barriers at the Taiwanese Scale

4.1.1. The Lack of Integrated Planning

The Taiwanese government divides the administration into different levels according to their powers and duties. The Bureau of Energy is the third tier under this structure. As the Taiwan Energy Transition Plan is led and developed by the Bureau of Energy, they are challenged to coordinate the impacts and conflicts between economic, social, environmental, and spatial aspects through all sectors with many other sectors (the second tier), such as the Ministry of the Agriculture, Ministry of Interior Affairs, Ocean Affairs Councils, etc.; the lack of integrated planning harms the vertical collaboration capacity, leaving sectoral bureaus pushing each other around. In the face of the urgency of achieving the ambitious goal in a short time, finding available lands to build up renewable energy infrastructure has led to a massive burden for the non-urban areas. Gao et al. (2022) argue that the absence of sufficient legal instruments will hinder achieving the 2025 goals. Therefore, it is critical to develop legal frameworks that can improve coordination and guide the deployment of renewables [7].

As shown in Figure 7, conflicts between sectors can be found in four main areas: the built environment in urban areas, agricultural areas, aquacultural areas, and marine spatial areas. The conflicts and challenges related to agriculture and aquaculture are explained in the following paragraphs, and the conflict in the marine spatial areas is highlighted in the results of the Changhua case study.

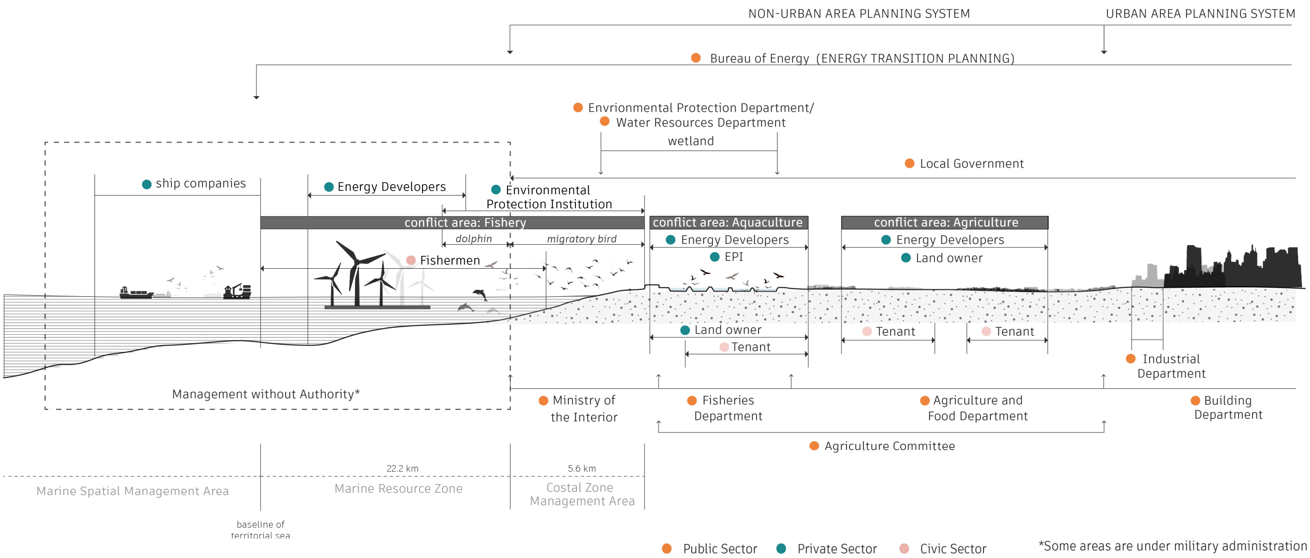

Figure 7. Conflicts within society due to the lack of integrated planning. Source: Authors.

Given the higher energy demand, urban environments are expected to take on greater responsibility for renewable energy generation during the transition process. However, there are currently no specific plans or procedures to guide the integration of renewable energy into urban areas. As previously mentioned, local governments have no collaboration requirements to achieve Taiwan's energy transition goals. Consequently, there is concern about disproportionately placing the burden on non-urban areas under the jurisdiction of the Ministry of Agriculture. This ministry faces significant pressure to implement multifunctional land use strategies without adequate preparation for capacity and feasibility assessments while simultaneously addressing the potential impacts on food security that these changes may cause.

4.1.2. The Hidden Threats for Agriculture and Aquaculture Due to Excessive Focus on Multifunctional Land Use in Non-Urban Areas

Due to the limited land area to develop renewable energy in Taiwan, the Taiwanese government has focused on the potential of multifunctional land use under time pressure. Besides industrial areas, agriculture and aquaculture are the most compelling sectors to combine with renewable energy generation due to the vast areas. There were many proposals regarding the combination idea. However, due to the loopholes in the regional planning system, incomplete regulations have caused many agricultural lands to be changed into mainly renewable energy generation areas (Figure 8), leading to a situation that has often been described as "fake farming, real electricity sales [47]". Beyond this, food security is the main problem that such encroachment on farming land creates. As a result, the Ministry of Agriculture has banned multifunctional land use on farmland and shifted the focus to combining renewable energy with aquacultural lands.

It is essential to consider factors, such as the crop types, orientation, and slope degrees of the panels, that influence crop growth to better integrate agrivoltaic systems [48]. Crop types partly decide technology implementation, such as shadow-tolerant crops providing more options through the choice of low-height structures, which are more beneficial in terms of costs and have fewer environmental concerns and landscape conflicts. However, it is undeniable that in the current situation, due to the insufficient research and studies on the integration of agriculture development and energy generation in Taiwan, it is too early to propose any particular solution because the local climate conditions and crop types create different demands and concerns of agrivoltaic systems. That is to say, it is urgent to start the experiment to explore the opportunities and define what types of applications fit with what kinds of crops. Otherwise, the multifunctional agricultural land use might fail to deliver its promise, threatening food security, damaging the landscape, and making farmers lose their rights to work the land.

Since 2018, fishery–electricity symbiosis has brought new opportunities for energy transition, claiming to improve aquaculture and produce renewable energy, providing a win–win situation [49]. Fish farms in Southern Taiwan serve as valuable ecological habitats for many migratory birds. However, the positive results of the experiments released by the government did not achieve the same opinions as those of the local farmers [50] and environmental stakeholders. In addition, due to inadequate supporting measures and the lack of total control, many outdoor fish farms have become indoor ones [51] in order to increase efficiency, causing a vast landscape change and threats to the ecosystem. According to Taiwan's energy target of installing 20 GW of solar panels by 2025, a quarter of the current fish farms will be affected [52]. This means that—in the absence of control over this process in the region—many fishing villages will be overwhelmed by PV panels encroaching on aquaculture (Figure 9), possibly leading to an ecological crisis. On top of that, there is also injustice caused by the cooperation between renewable energy developers and the landowners, expelling original renters and depriving them of their rights to work, which is possible without regulations to protect their livelihoods.

Figure 8. Example of multifunctional land use combining energy production with farming [53].

Figure 9. The current encroachment of PV panels on farming land in the southwestern part of Taiwan, displacing farming activities [54].

4.1.3. Lack of Understanding of the Local Scale

One of the main drivers behind significant landscape changes is the higher land rent prices offered by energy developers [55]. Specifically, in the case of aquaculture lands in southern Taiwan, rent prices can be more than eight to ten times higher [56]. This disparity incentivizes landowners to cooperate with energy developers rather than individual farmers, causing the immediate displacement of tenant farmers upon the signing of contracts. Without adequate legal protections to ensure the working rights of stakeholders during this process, the result is not only socio-economic injustice but also disruptions in production ratios, market prices, and supply–demand balance, potentially leading to a long-term food security crisis.

Another challenge arises in the marine spatial areas. Many planned areas for offshore wind development overlap with traditional economic fishing zones [16] or ecologically sensitive areas [57]. Currently, Taiwan's offshore wind power planning is governed only by administrative rules rather than regulatory acts. This absence of clear guidelines creates a grey area of spatial development for offshore wind power. From a socio-economic perspective, even though, in theory, the government has compensated local fishermen when the construction excludes their rights to work, the definition of "public water" creates an ambiguous status of debating how to compensate the loss of the fishermen [58]. Moreover, the compensation is based on registration in the Taiwanese government system, and most of the funds and compensation go to the association, leaving individuals and artisanal fishermen behind [14].

4.2. Socio-Spatial Barriers to Transition: The Case of Changhua

When examining the conflicts arising from local renewable energy development (marine spatial areas and multifunctional use of aquaculture and agricultural land), Changhua emerges as one of the pressing regions facing this dilemma. Figure 10 illustrates marked disparities between Changhua's northeastern and southwestern parts regarding population density, individual income, average aging index, and electricity use [59]. Despite these disparities, current central strategies primarily focus on non-urban areas to deploy the renewable energy infrastructure, predominantly in the southwestern regions, which are generally less developed. This raises the question of whether these changes will bring new opportunities to these regions or further exacerbate developmental imbalances due to the NIMBY (Not In My Backyard) effect [60].

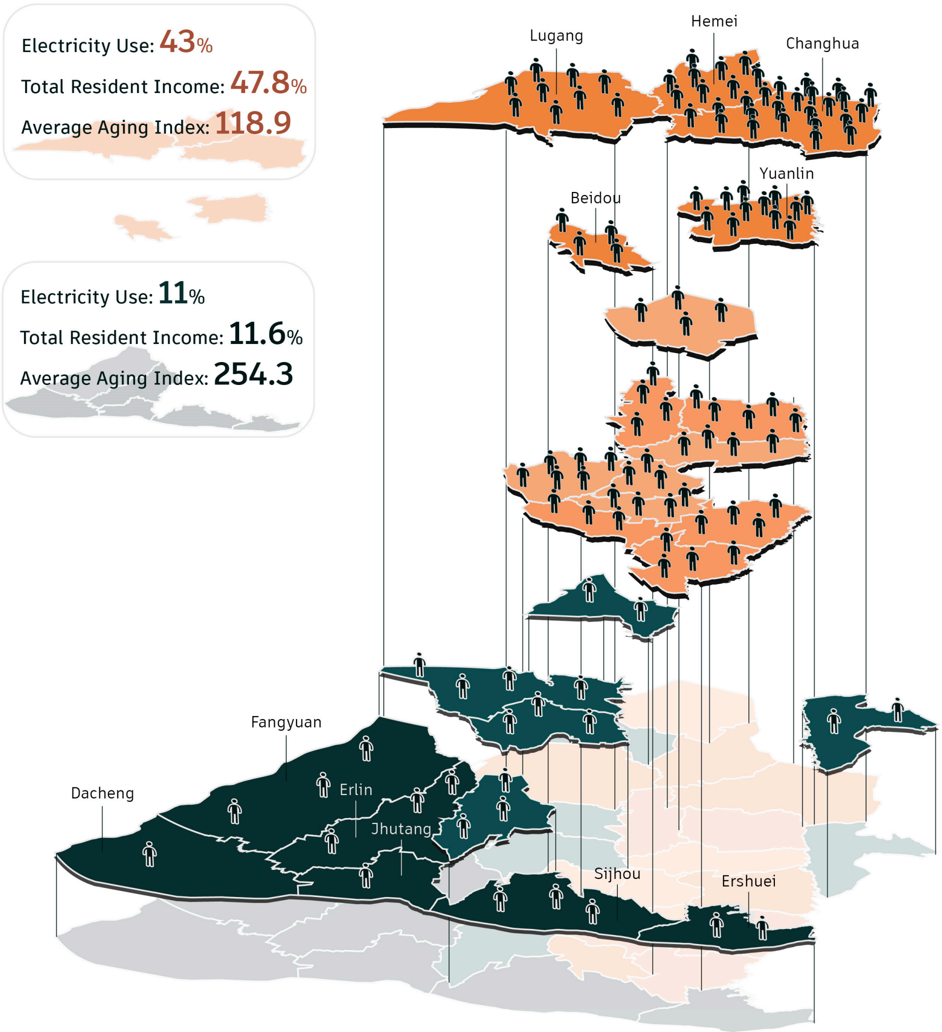

Figure 10. Uneven development between the northeastern and southwestern regions [59]. Source: Authors.

4.2.1. Central Strategies Exacerbating the Uneven Spatial and Socio-Economic Development in Changhua

The uneven spatial development of Changhua has led to unequal socio-economic conditions (Figure 11). In the northeastern part, there is more industrial development, a denser population, higher incomes, and a smaller share of elderly people. Conversely, the southwestern part focuses on agriculture, which lacks investment, has a high aging index, and has low immigration rates, potentially leading to labor shortages. Emigration trends in Changhua show two patterns [59]: migration from the north to Taichung for better prospects and internal migration from the south to the north due to better opportunities.

Although school density is uniform, highly skilled educational institutions are concentrated in the northeast. This highlights the low competitiveness of the southwestern regions, indicating a need to reassess resource distribution in Changhua.

In general, renewable energy projects are often viewed as opportunities for industrial improvement; however, it remains uncertain whether Changhua will benefit from this. Energy infrastructure plays a crucial role in electricity transmission. It starts from power stations, goes through high-voltage plants, and is then distributed to primary and secondary substations before reaching end-users via feeders. These processes rely on substations and grid compatibility to deliver electricity to neighborhoods. The Taiwanese government's strategy focusing on rural areas might threaten over 67% of Changhua's agricultural land for solar energy projects. However, as indicated in Figure 12, the current energy infrastructure in the southwestern regions barely preserves enough compatibility to integrate advanced grids compared with the northeastern sites, as shown in Figure 13. The lack of infrastructure upgrades and cohesive neighborhood development plans risk worsening the "Not in My Backyard" (NIMBY) effect, causing residents to move away and further exacerbating regional inequalities (Figure 14).

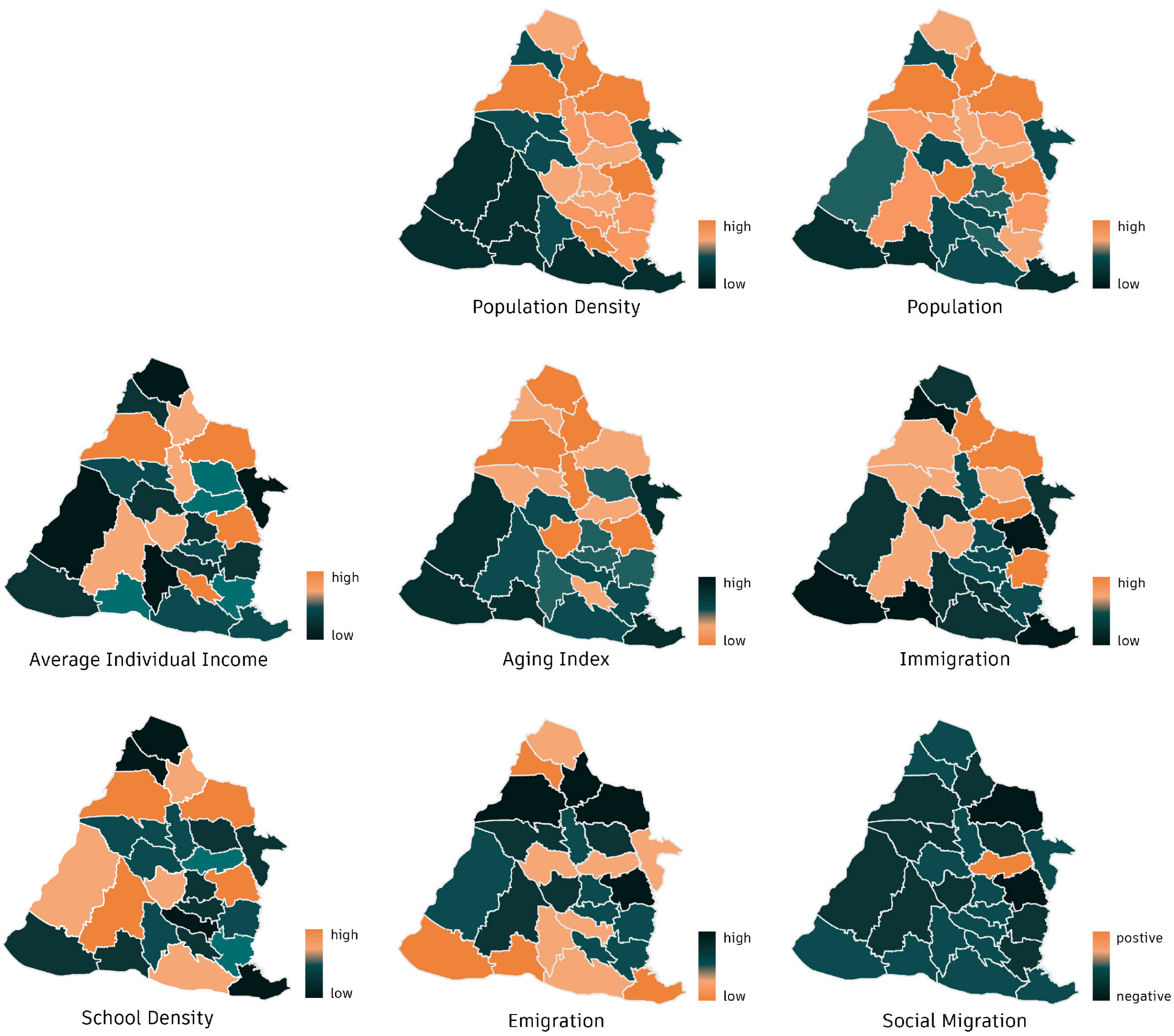

Figure 11. Socio-spatial development of Changhua [59].

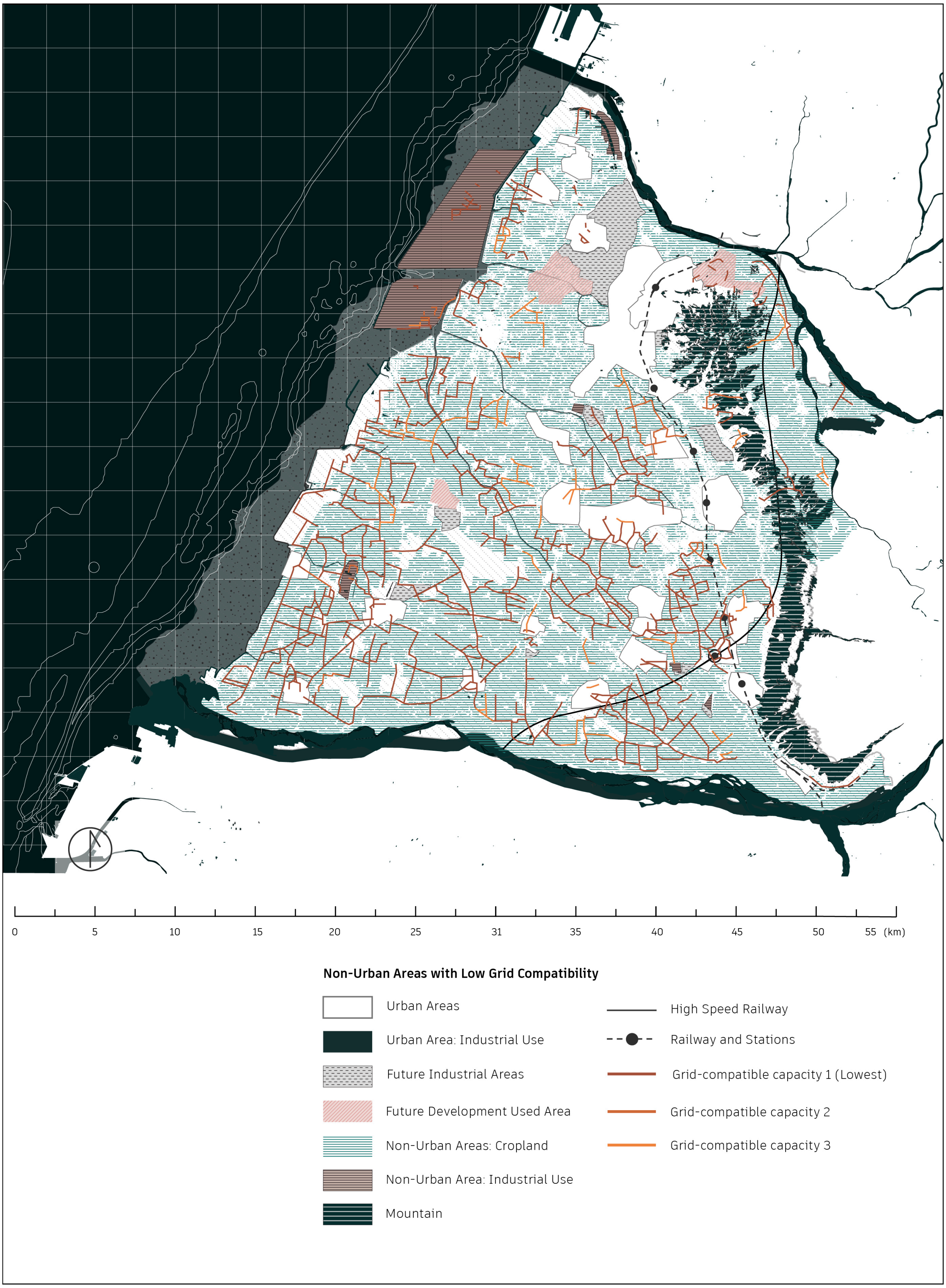

Figure 12. Non-urban areas with lower grid capacity [17].

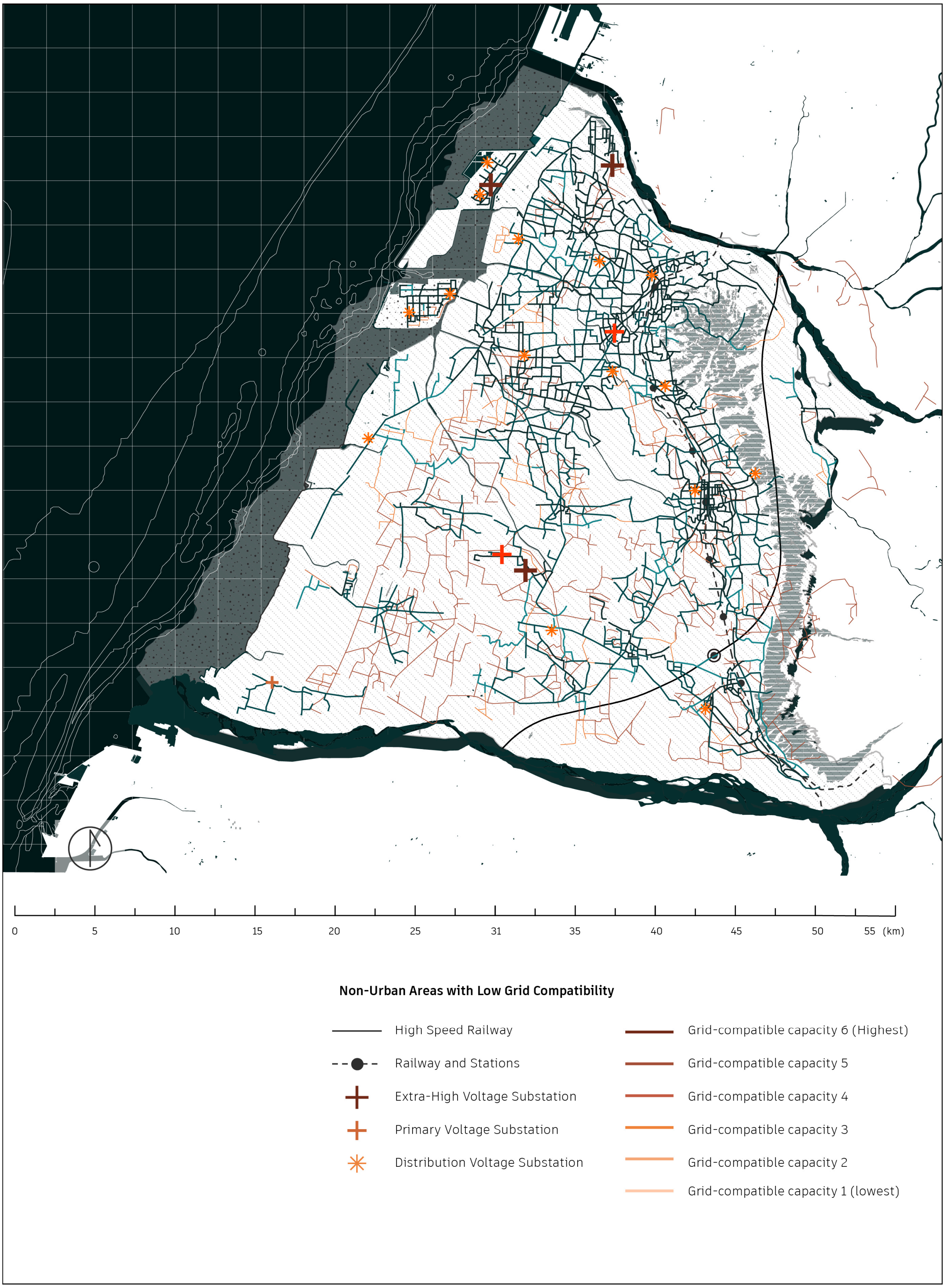

Figure 13. Energy infrastructure and capacity of Changhua [17].

Figure 14. Installed wind turbines in the peripheral rural areas of Changhua. Source: Authors.

4.2.2. Hidden Injustices on the Local Scale: The Marginalization of Local Stakeholders Due to Institutional Barriers

The proposed multifunctional use of solar energy primarily targets non-urban areas (agricultural and aquacultural lands, etc.). No direct evidence exists that this strategy was chosen to minimize conflicts during the transition. However, this study shows that agriculture, aquaculture, and fishery stakeholders have limited power and capacity to tackle rapid and significant changes.

According to the data released by Executive Yuan in 2022 [61], almost half of Taiwanese are educated to college level or above. However, less than 20% of stakeholders in the agriculture and fishery industries have gained the same education level (Figure 15). Moreover, these industries have a high aging index. More than 90% of farmers and 84% of fishermen are over 44. In addition, more than half of agriculture are non-fixed workers, indicating the instability of the work environment (Figure 16). Changhua accounts for more than one-tenth of the Taiwanese population working in the agriculture and fishery industries [10] while owning the smallest share of land in Taiwan. The share of the Changhua population working in agriculture compares with the average of 5% of the Taiwanese society, which is more than double (12%). Based on several studies, less educated citizens with lower incomes tend to be less politically and socially engaged [62]. Educational levels are essential factors in predicting the likelihood of engaging with participatory activities [63]. Lack of time, money, or relevant knowledge might decrease their confidence in participation, shedding light on the powerless influence of a top–down decision. Several handicaps characterize the southwestern part of the region, where a substantial share of land will be used for renewable energy development.

Additionally, twenty-one planned or built offshore wind farms take up more than 60% of Changhua's marine spatial areas, excluding areas designated for waterways and limited access zones, significantly hindering fishery activities. Current and planned offshore wind energy infrastructures confine fishing areas to the remaining undefined zones, as illustrated in Figure 17. Due to institutional deficiencies, this drastic change in the fishers' working environment threatens the livelihoods of many local stakeholders, highlighting their lack of involvement of these groups in the early stage of planning and raising questions about procedural justice within the process [7,58].

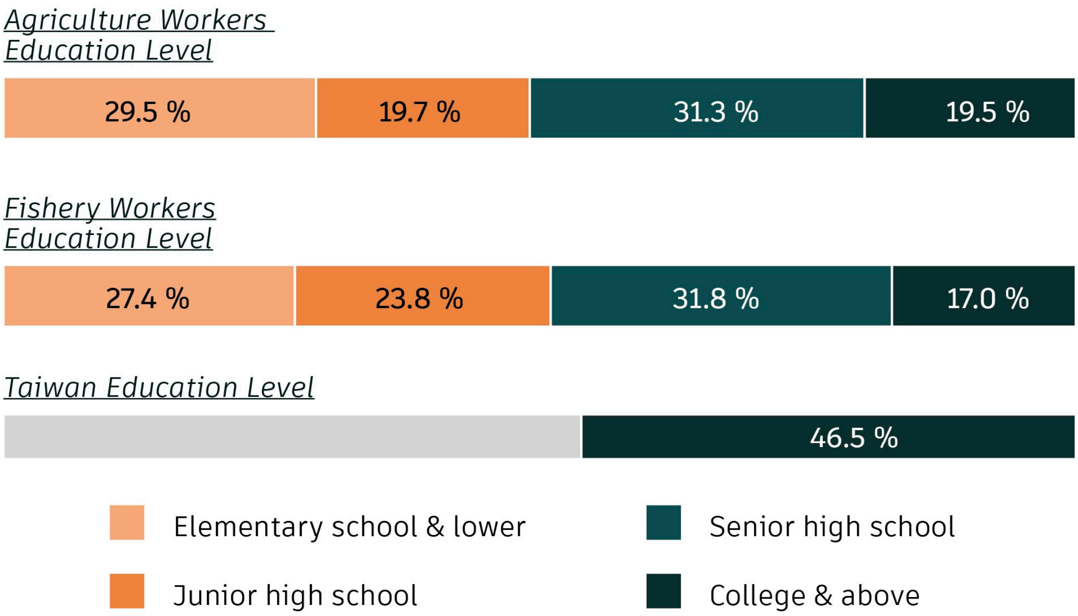

Figure 15. The average level of education in agriculture, fisheries in Taiwan [61].

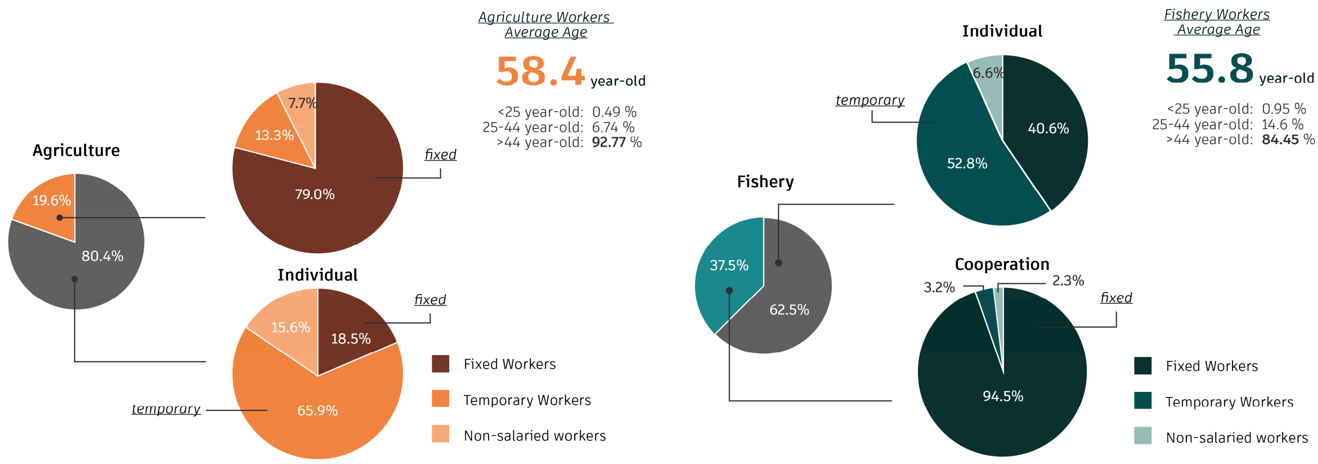

Figure 16. The average working age in agriculture and fisheries [61].

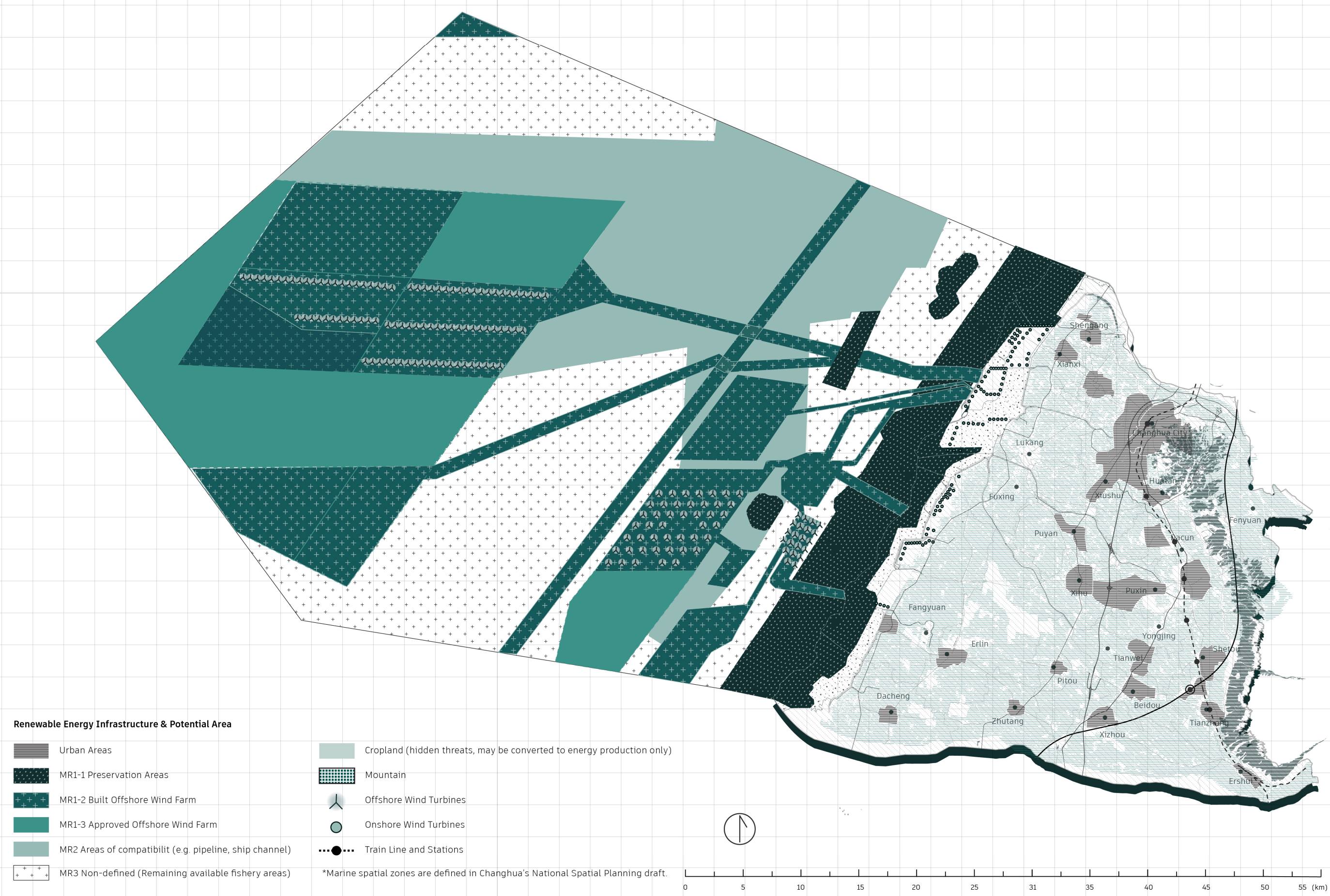

Figure 17. Renewable energy development areas of Changhua. (MR3: Remaining available fishery areas; Cropland: hidden threats, may be converted to energy production only) [17,64].

5. Discussion

5.1. Towards Integrated Spatial Planning for Energy Transition

5.1.1. Filling the Governance and Practice Gap through Integrated Planning

Taiwan's energy planning system suffers from significant gaps in strategy and structure, employing a simplistic, ill-equipped model to manage the complex transition process. The current approach revolves around energy generation targets, overlooking the need for comprehensive integration across sectors and government levels to address complexities and mitigate local adverse effects. The key challenge lies in developing an integrated strategy to facilitate cooperation between sectors and expedite the transition process.

Moreover, the existing policy framework hinders collaboration with higher-level policy sectors and various industries. The Bureau of Energy, with limited administrative authority, struggles to foster cross-sectoral cooperation. In the face of the oversimplified approach to energy transition planning, the institutional barriers we exposed in our research contribute to regional and local injustices. Top–down approaches fail to align with local needs, exacerbating burdens and confusion while highlighting planning uncertainties and disorganization. As argued in Section 2, addressing these issues requires integrated planning based on collaboration across policy sectors and government levels to align goals and strategies and account for the local impacts of renewable energy deployment.

As stressed by our interviewees, to bridge vertical and horizontal cooperation gaps, it is imperative for the government to broaden its recognition of the socio-spatial implications of the energy transition, viewing it not merely as a technical shift in energy generation and usage but as a transformative process impacting socio-economic and environmental conditions (recognition justice). Integrating spatial and energy planning offers a perspective to enhance governance through improved vertical and horizontal collaboration. Specifically, it clarifies lines of responsibility within sectors and provides better guidance on the actions in spaces for inter-sectoral cooperation. Moreover, closer vertical coordination is needed to improve communication across levels of government. Lastly, the framework we proposed helps to understand the impacts of transition policies at the regional and local scales, allowing for the assessment of the distribution benefits and burdens across space (distributional justice) and for informing the establishment of more fair and inclusive participation within the decision-making process (procedural justice).

5.1.2. The Importance of Integrating Spatial and Social Perspectives

Energy requires space to be produced and distributed, while space is also transformed by energy [8]. Defining how and what type of space and land could be used to host renewable energy infrastructure needs a central agreement between government departments. The current challenges we are exposed to are caused by converting many general agricultural lands in non-urban areas to a particular land use purpose (energy production). It has prevented the use of multifunctional land use purposes in the energy transition strategy, threatening the local stakeholders' fundamental work rights, balanced local and regional development, and food security in the long term. There is an urgent need to find common ground among policy sectors to integrate the concept of justice into energy transition planning.

From a social perspective, in the absence of government support measures, many farmers and fishermen have been compelled to leave their lands because of market pressures. However, the employees of Taiwan's agricultural and fishery industries, especially the individual farmers and tenants, cannot overcome the system's unfairness, regardless of their educational background or financial conditions. In addition to the lack of transparency of information about the transition process and farmers' rights provided by the authorities from top to bottom (procedural justice), or the lack of knowledge on the local conditions from the bottom to the top (recognition justice), this marginalized minority struggles to receive the attention and access to opportunities (distributional justice).

5.2. Seizing the Potential of the New Spatial Planning System in Taiwan

The new Taiwanese planning system to be implemented in 2025 [65] is expected to be an integrated planning system with completed re-identified zoning that merges the previously separated land use systems to align land management concerns. One of the new system's principles underlines the importance of integrating energy planning [20], which can be seen especially in marine spatial areas that include offshore construction activities. However, there are no clear strategies for cooperation with energy planning. How zoning decisions related to energy development are made, particularly at the regional and local levels, still needs to be clarified. Specifically, the draft release of Changhua's new integrated spatial planning in 2023 suggested that marine resource areas 1–2 and 1–3 will be used for offshore wind infrastructure [64]. However, discussions regarding integrating renewable energy in the agricultural and urban development zones have yet to be held at the time of writing, which was also highlighted in the interviews we conducted. Standardized guidance and active collaboration from the highest administrative level, such as the Ministry of Agriculture, the Bureau of Energy, and the Ministry of Interior Affairs, are needed to ensure consistency in integrating energy planning across space.

5.3. Limitations and Future Research

This study points to at least three avenues for future research. First, our research remains limited to a single regional-scale case study and is bound by a limited time perspective. We need more comparative research, contrasting the experiences and the patterns of spatially and socially uneven distribution of benefits and burdens of deploying renewable infrastructures in several regional contexts. More research is also necessary to shed light on the longer-term aspects of the socio-spatial conflicts we explored in our case study and to understand how the changing planning practices and regulations facilitate or constrain more integrated and inclusive planning for the energy transition. In addition, future research should also focus on urban areas and explore how to engage urban dwellers to deliver a more just energy transition.

Second, to understand the barriers to a just energy transition, it is essential to explore the factors that cause conflicts and disagreement within society. In this study, we shed light on the spatial conflicts that renewable energy produces. However, more research is needed to understand the factors better—from spatial, economic, and socio-cultural to aesthetic ones—that make renewable energy infrastructure acceptable (or not) by the citizens from different social groups across the territories in question. There is a vivid strand of literature on that topic in the Western context [66–68], showing that the factors behind social acceptance of renewables vary across energy sources, as well as the economic and territorial contexts. Similar studies focusing on Taiwan or other Asian countries are lacking. At the same time, we need more insights into this matter to ensure a more transparent conversation about the energy transition in specific territories in the Asian context. Our research showed that place and cross-scale interdependencies in institutional and socio-spatial factors may matter for the acceptance of renewable energy. We also posit that a better understanding of the socio-spatial impacts of energy transition, which remain uneven across space, provides valuable insights that can help improve social acceptance of renewables. However, we need more empirical research to draw firmer conclusions on these relationships, especially through research methods directly involving the affected communities and other regional stakeholders through interviews, focus groups, or workshops.

Lastly, we pointed out the implications for the new integrated system under development at the time of writing. Due to the incomplete data and information, this research could not provide a more in-depth analysis of this reform. However, in order to build up an integrated energy planning system, the new Taiwanese planning system could be a critical component that assists in the improvement of collaboration between vertical and horizontal governance. It has highlighted the integration between different current planning systems and includes the marine spatial areas. Moreover, it could provide guidelines for regional governments to systematically plan and rebuild the principle of the proposed land use and functions. The planning system reform offers the opportunity to amend the specification of energy infrastructure integration on land and prevent the messy development that has threatened agriculture, aquaculture, and fishery. Future research should explore the possibility of integrating this new spatial planning system and the Taiwanese energy plan.

6. Conclusions

6.1. Main Findings

The two main messages of this study are (1) the necessity for more research on the social and spatial impacts of the transition process at regional and local levels and (2) the need to develop an integrated energy planning approach to enhance vertical and horizontal collaboration of strategies and actions related to the deployment of renewable energy infrastructures.

Based on the case of Changhua, this study emphasizes how top–down decision-making on energy transition without consideration of spatial and social consequences can exacerbate resource inequality and unbalanced regional development. The development discussed in this paper illustrates how land use planning and the Taiwan government's policy decisions have major spatial impacts but do not always ensure a fair distribution of resources and burdens across the territory. Urban dwellers, who consume most of the energy, currently do not contribute proportionately to this process, leaving rural dwellers to face the negative consequences of the transition. The allocation of renewables significantly impacts the quality of life, ecosystem health, and livelihoods of local communities, especially in rural areas. Such implications and consequences should be considered in contexts where local development is deeply uneven to prevent further exacerbating the existing socio-spatial injustices.

On top of that, the current spatial planning system has loopholes that allow developers and landowners to change the land use type from agricultural lands to particular land use purposes in non-urban areas. Landowners often gain much higher rent by leasing land for energy production rather than to farmers while marginalizing the local stakeholders. Thus, the vertical and horizontal governance of the energy transition needs to be reassessed to set up a common goal of the main strategies, distribute the benefits and burdens more fairly, and set up a transparent communication process that includes local stakeholders' considerations in the decision-making process.

6.2. Contribution to the Literature

6.2.1. A Framework for Rethinking Just Energy Transition through Socio-Spatial Lens

This study proposed a new framework for a spatially just energy transition, developed through the specific case of Taiwan but applicable to other contexts. The framework highlights three interrelated components of just energy transition planning: distributional, procedural, and recognitional justice.

Integrating spatial aspects ensures a fair distribution of the transition's benefits and burdens within the regional development context, helping to prevent the exploitation of specific areas and deepening the existing uneven development. The recognitional dimension calls for acknowledging the injustices and how different communities are (negatively) affected on the ground, while the procedural dimension calls for a fair and inclusive process to engage these communities in decision-making on a transition that heavily affects them. We applied this framework to shed new light on the previously overlooked aspect of energy transition in Taiwan, building on new empirical evidence and drawing recommendations for a more integrated and just energy transition process.

6.2.2. Rethinking Rural–Urban Relations for Just Energy Transition

In the Taiwanese context, due to the relatively low electricity prices, most people are unaware of the preciousness of energy and the burdens that a transition towards renewable energy may entail. Since 2009, more than 80% of Taiwanese have lived in urban areas, accounting for only 13% of Taiwan's land [46]. However, governmental strategies prioritize renewable energy production in non-urban regions. Consequently, residents of rural areas, as a minority, bear a disproportionate responsibility for energy generation due to the larger rural land area that seems available for renewables.

Thus, this study underscores the necessity of enhancing public awareness regarding the energy transition by revealing the injustices it creates in non-urban areas, particularly within the agriculture and fishery sectors. It is imperative to acknowledge that when rural minorities encounter conflicts and experience loss of livelihoods, societal reflection on this and supportive discourse in the public sphere are limited. Our study shows that energy transition planning needs to respect the rights of these stakeholders, as failure to do so risks deepening the urban-rural divide and fueling discontent and societal conflict.

Author Contributions: The research informing this paper was conducted by K.-T.L. in 2022–2024 under the supervision of M.D. Contributor roles—according to CRediT taxonomy—were as follows: conceptualization—K.-T.L. (lead), M.D. (supporting); investigation—K.-T.L.; formal analysis—K.-T.L.; methodology—K.-T.L. (lead), M.D. (supporting); supervision—M.D.; visualization—K.-T.L.; writing—original draft K.-T.L. (lead), M.D. (supporting); writing—review and editing—K.-T.L. (supporting), M.D. (lead). All authors have read and agreed to the published version of the manuscript.

Funding: No funding was provided to support this research.

Data Availability Statement: This study analyzed publicly available datasets. QGIS Data can be found in the Digital file of the 2021 reconstructed topographic map (Scale 25,000), DATA.GOV.TW: https://data.gov.tw/dataset/152109 (accessed on 9 June 2024). Changhua analysis data can be found at https://gas.chcg.gov.tw/pxweb/dialog/statfile9l.asp (accessed on 9 June 2024).

Acknowledgments: We would like to express our appreciation for the open data provided by the Taiwanese government and our interviewees for their time and input.

Conflicts of Interest: The authors declare no conflicts of interest.

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89%B2%E8%A1%9D%E7%AA%81%E3%80%8D%E7%9A%84%E6%95%B4%E9%AB%94%E6%A1%86%E6%9E%B6 (accessed on 9 June 2024).
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