From EnergyScape To Energy Justice

Rethink Approahces For A Just Energy Transition

Revitalize the neglected regions through integrated planning:
a case study in Changhua, Taiwan

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Thesis P5 Report
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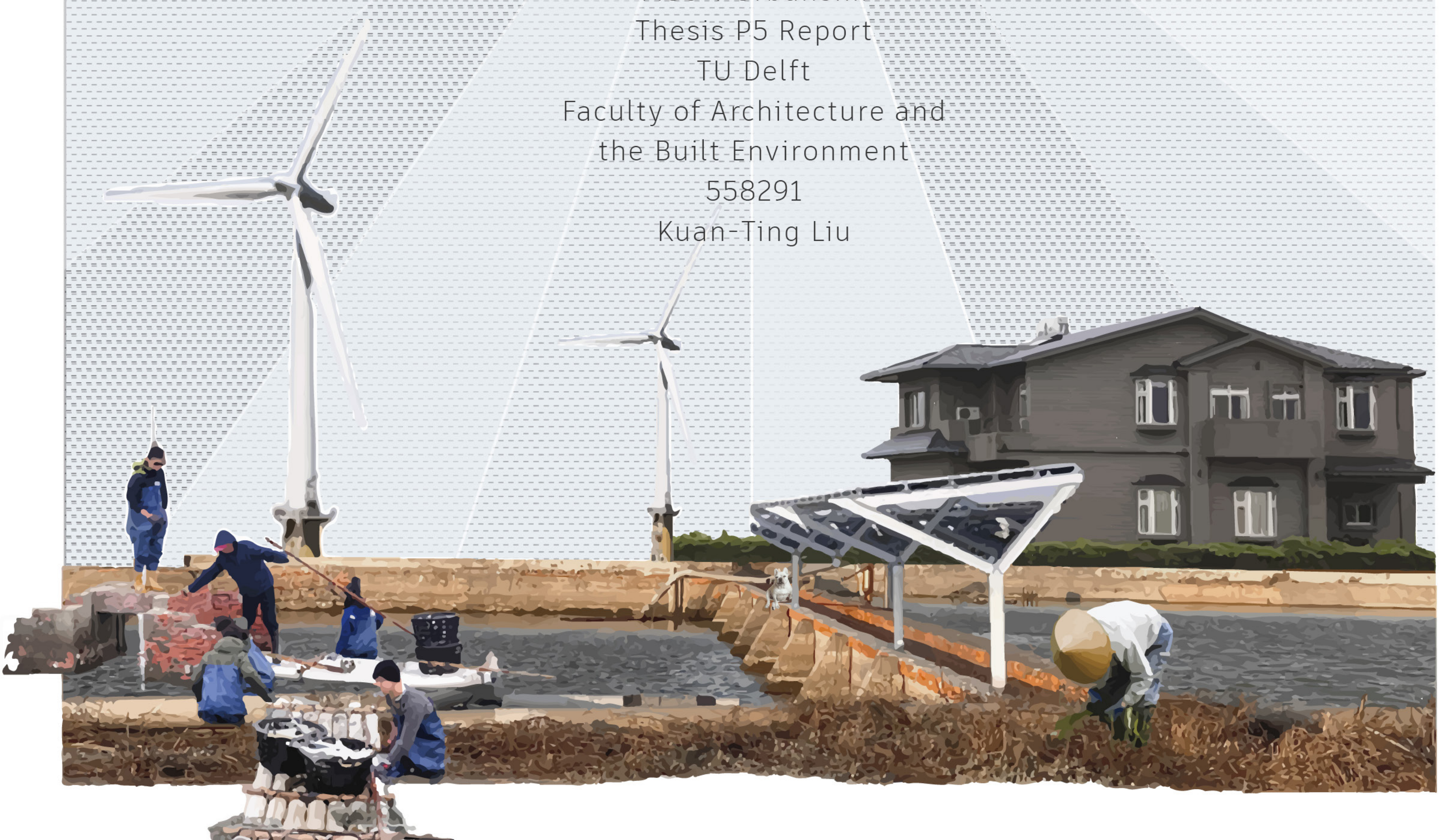

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From EnergyScape To Energy Justice: Rethink Approaches For A Just Energy Transition

Revitalize the neglected regions through integrated planning; a case study in Changhua, Taiwan

Masters Thesis P5 Report
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/ Abstract /

Taiwanese landscape has dramatically changed since 2018, when the Energy Transition White Paper was published. Due to the land limitation, the Taiwanese government has focused on the multifunctional use of land to create renewable energy and maintain the original activities on the ground at the same time, especially on agricultural lands. However, realistic situations are far from the ideal proposed. Tons of aquacultural and agricultural lands have become fragmented, damaging the landscape and even causing hidden threats: farmers' work rights losses, food security issues, and ecosystem hazards.

The reason for these derivative problems is complicated and cannot be blamed on a single factor. But the key argument in this thesis is because of the lack of integration of spatial and social perspectives in energy transition programs. Therefore, energy justice in this thesis focuses on the discussion of the derivative problems led by the consequence of neglected perspectives in the energy transition.

From a spatial perspective, Taiwan currently has three separate spatial planning systems, urban, regional, and national park planning systems. Each of them follows different laws and manages the land use type in its own way. Due to the development-oriented planning, some land use types have more flexibility and looser regulation in terms of construction. And due to this fact, energy developers work with landowners to apply for changes in land use from aquaculture or agriculture to specific land uses to generate the most renewable energy, losing the purpose of multifunctional use and resulting in absurd landscape changes.

More specifically, the lack of holistic spatial planning and the integration with the energy transition plan makes responsibility unclear that causing collaboration between sectors more difficult. The systemic deficiency has led to social consequences with the injustice mentioned above that have yet to have specific orders and measures to be addressed, exacerbating the public's untrust of the energy transition.

In 2025, a new integrated planning system called National Spatial Planning will be implemented as a holistic spatial planning system. It merges current planning systems and includes the marine spatial area. Thus, this thesis chose Changhua County, an area with high renewable energy development but huge hidden threats in various domains, as the case study area to test how to integrate this new spatial planning system based on purposes of different zoning with energy strategies that include spatial and social aspects.

There are three products in this thesis. First, the energyscape template design demonstrates how to prevent hidden threats and create procedural and distributional justice based on the considerations of societal factors that influence people's acceptance of the energy transition. Second, regional strategies with spatial and social perspectives to examine value creation that rebalances regional development, bringing back identities to uncompetitive areas that are neglected or sacrificed within the energy transition process. Lastly, developing National energy transition advice, operational or strategic, to help create a justice energy transition in Taiwan.

Contents

01 Introduction

1.1 Energy Transition In The World

International Trends

The first World Climate Conference, held in Geneva in 1979, called on all nations to support the proposed World Climate Programme and proposed the establishment of immediate strategies to foster greater use of climate information by governments for planning their social and economic development (WMO, 2009).

Subsequent world climate conferences have been held. For example, one of the major conferences, the United Nations Framework Convention on Climate Change (UNFCCC), held in Kyoto in 1997, set greenhouse gas reduction targets for developed countries (the agreement expired in 2020). In addition, the 2009 Copenhagen Accord, which attempted to set a target for greenhouse gas emissions, was adopted only by notation (take note of), triggering two schools of thought in the world about the approach to climate change.

However, only when the signing of the Paris Agreement in 2018 did people realize the pressing need for an energy transition to confront the aggravating climate crisis. The Paris Agreement aims to limit global warming to a level well below pre-industrial levels of 2 degrees, preferably 1.5 degrees (UNFCCC, 2022).

In order to meet the targets set by the conference, member countries must reduce their greenhouse gas emissions to 40% by 2030 compared to pre-industrial development. In other words, this is the only way to achieve a carbon-neutral world by 2050.

Similar to Taiwan as a developing country, Japan and Korea have also indicated that they will reach the goal of carbon neutrality by 2050. The European Union, on the other hand, requires member states to achieve a 55% reduction in carbon emissions by 2030 compared to 1990 emissions.

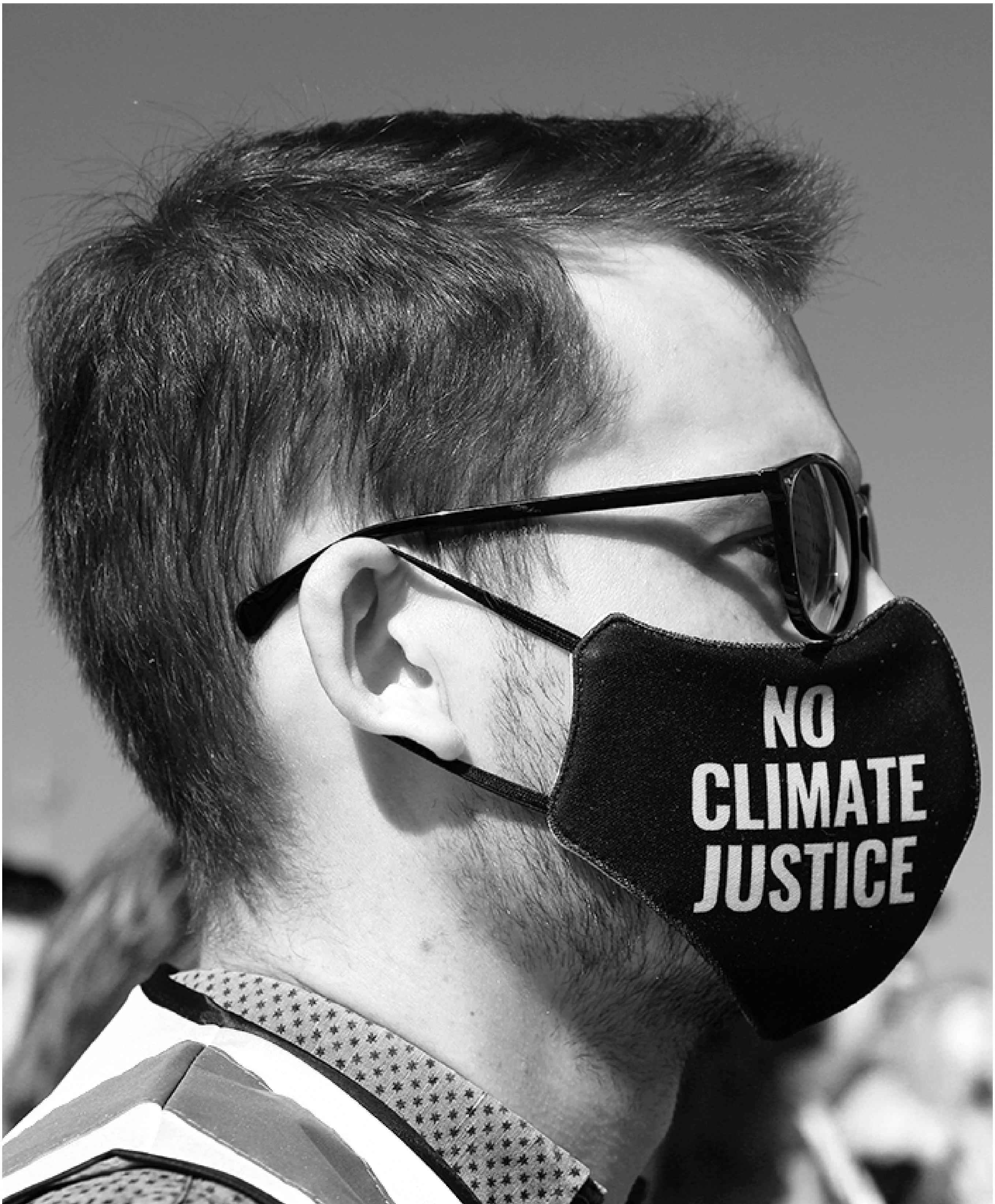


Fig 1.1: calling for justice (UNFCC,2022)

1.2 Topic Deconstruction

Energy & Space

Space has traditionally and intuitively been thought of as an objective surface or container that locations can be marked out on or in it. However, understanding space as a "product of interrelationships" has become fundamental to various spatial ideas throughout human geography and the social sciences (Massey, 1999). And these relations are constantly being produced rather than given.

Energy needs space to be deployed; in turn, space is also reformed by energy (Lefebvre, 1999). It is undeniable that energy as an invisible component has inevitable connections and direct and indirect impacts on spaces.

From the direct influence perspective, from the energy sources they occupy in certain areas to the conversion and distribution processes, energy has established relationships with spaces through their physical infrastructure. And in the indirect impacts, whenever the time faces a change of energy sources, it appends with the influence on various fields such as economic, political, and social perspectives, eventually changing the space organization.

Since the issue of energy transition came up around the world, the concept of Energy-space has been extended to various branches of theory and research topics. Such as energy geography, energy landscape, and energyscape.

Energy Geography & Energy Landscape

Energy geographies and energy landscapes are two major-discussion topics. Bridge et al. (2013) emphasized that energy transition should be considered a geographical process. It is essential to understand that transition as a geographically-constituted process will present numerous policy implications, which cannot just be seen as a process that might affect places. In his study, six geographical components will affect the energy transition: location, landscape, territoriality, spatial differentiation, scaling, and spatial embeddedness.

Compared to Bridge et al. presented more complicated and broad perspectives on energy transition, Pasqualetti and Stremke (2018) have studied focus on a specific subject: landscape. Their study defined the energy landscape as " Observable landscapes that originate directly from the human development of energy resources." Besides, they categorized three features that could help the development of energy landscape typologies: Substantive Qualification, Spatial Qualification, and Temporal Qualification. Both concepts of terminologies emphasized the relationships between energy transition and human activity. Socio-economic development is undeniably connected to energy, or should it be said: energy impacts socioeconomic.

Energyscape

Energyscape, on the other hand, as a new concept that had not appeared until 2007 in New Zeeland's national energy project as a concept to assess energy flows (de Vos & NIWA, 2009) brought out a new discussion that includes the perspective of environment and the local-scale of ecosystem service (Howard et al., 2013; Indre Siksnelyte et al., 2022). Before Howard et al. (2013) started discussing the definition of " Energyscape", scholars made various definitions depending on their backgrounds and research areas. Commonly, the definitions in most studies are based on the geographical scope and temporal framework, in the sense that they originally defined Energyscape: as the complex spatial and temporal combination of the supply, demand, and infrastructure for energy within a landscape.

As mentioned above, Energyscape includes a discussion on the environmental impact and has a more detailed consideration of changes in energy demand and supply, sourcing, and technology, which can build up a more practical discussion term based on a specific area, especially on a local scale. Besides, because of the flexibility in changing scale differences and the encouragement of stakeholders in the planning process, it helps to focus on integrated planning and participatory to solve various conflicts, including the trade-off within the environment and socioeconomic.

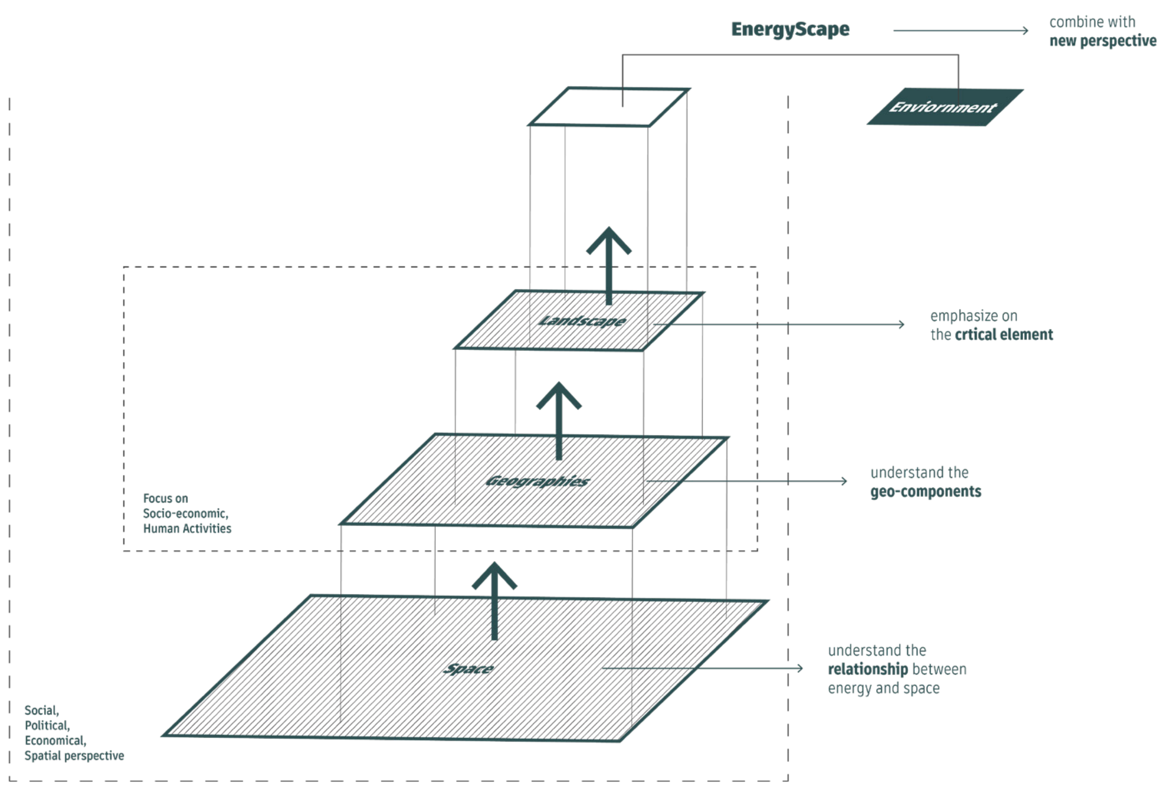


Fig 1.2: theories building up one of the thesis key concept

Energyscape with Ecosystem service

According to National Geographic, “An ecosystem is a geographic area where plants, animals, and other organisms, as well as weather and landscapes, work together to form a bubble of life.” While Ecosystem services are defined as goods, people benefit from ecological systems and are generated by a combination of interactions among ecological systems and society (Balvanera et al., 2017). It has been categorized into four types of services by the Millennium Ecosystem Assessment, which are: provisioning, supporting, regulation, and cultural (Reid et al., 2005). This classification provides a clear picture of what value ecosystems provide to society.

Importance Of Studying Energyscape Impact

Several scholars have confirmed that aesthetics is critical for a society to interpret the implementation of renewable energy (Cohen et al. 2014; Devine-Wright & Batel 2013; Salak et al. 2021; Valtchanov & Ellard 2015). One of the conflicts within Taiwanese society during the energy transition is the potential damage of energy infrastructure to the landscape. It is believed that renewable energy infrastructure threatens the traditional landscape of villages and may even affect ecosystems due to the ripple effect of landscape change. However, energy landscapes are not a topic of conflict simply because of differences in aesthetic awareness but rather because of the direct and indirect effects that may occur in different regions.

In the study by Picchi et al., it is emphasized that future research should establish spatial reference systems. As ecosystem services can provide a framework for assessing renewable energy implementation, if participatory mapping and landscape visualization are incorporated, this will help to give principles for landscape design further. More specifically, this understanding reinforces the importance of studying the impacts behind changes in energy landscapes caused by decisions and planning systems within society.

Energy Justice & Space

Space is not a neutral container for the social world to “happen”-instead, it is constructed by society through social connections and processes (Dikeç, 2002). In other words, space not only creates a context that shapes inequalities but also produces and sustains them actively (Dikeç, 2001; Soja, 2010).

As the idea that social practices generate energy demand becomes commonplace, energy issues are increasingly discussed from a social perspective. Since justice theory has been used to assess energy systems, energy justice has emerged as a concept and gained increasing attention in policy and research (Jenkins et al., 2016). Alderman and Inwood (2013) state, ‘social (in)justice does not simply have geographical outcomes; instead, space plays a more fundamental role in constituting and structuring the broader processes of discrimination or equality.’

On top of that, in Bouzarovski and Simcock’s research in 2017, they studied the relationship between ‘spatial justice’ and ‘energy poverty.’ And in their conclusion that one of the highlights is that ‘Energy justice is spatialized via landscapes of material and socio-economic inequality.’ Besides, they also advocated that area-based approaches should include interventions for the injustice drivers.

Dikeç (2001) and other scholars have proposed that thinking about how inequality is produced and by whom is crucial. That is, when the understanding that energy and space are inseparably related becomes solid, discussions of justice and consideration of the fundamental structural mechanisms in energy should not be ignored.

Fig 1.3: nuclear waste in Taiwan (Shutterstock, 2015)

Integrated Planning

According to Counsell et al. (2006), the definition of integrated planning in spatial is that a spatial planning system helps integrate sectors within departments and break down institutional or domain barriers to achieve specific goals by guiding other streams of spatial expressions. The integration is presented through integrated policies, bridging collaboration across policy sectors and disciplines horizontally and approaching actors or different government scales vertically.

The trend of integrated spatial planning can be traced back to the early 2000s in the UK and Europe. Countries started establishing a national tier spatial planning to guide collaboration through scales within departments and sectors.

In Nadin et al. (2021) study, they evaluated the trends of spatial planning in 32 European countries. They assessed three capacities of spatial planning: policy integration, adaptiveness, and citizen engagement. Among these, it shows clearly that policy integration in order to support multidisciplinary goals and topics has become a trend in most of these countries. They also pointed out that spatial planning helps to coordinate territorial impacts such as environmental or transport topics through sectoral policies.

That is, if we view spatial planning as a tool to help coordinate sectors within different fields with a mutual goal, it answers why integrated planning has become more critical recently due to many wicked problems, especially climate change, worldwide.

For example, United Nations Development Programme published an Integrated Spatial Planning Workbook in 2022. It defined integrated spatial planning as a whole-of-government approach, providing multiple paths for sectors with a shared vision. Several case studies demonstrate the possible methods to implement integrated spatial planning in order to mitigate climate change's influence and help improve the ecosystem.

Beyond that, according to Narodoslawsky et al. (2020), the study of integrated spatial and energy planning also emphasizes the importance of establishing holistic strategies in order to develop a complete and well-concerned plan for energy issues. To be more specific, energy strategies are influenced by local and regional in terms of spatial structure heavily. Besides, spatial contexts also determine both energy efficiency and renewable energy potential.

Therefore, considering these factors leads to more realistic energy strategies, bringing integrated spatial planning with energy planning becomes essential, echoing to achieve SDG 7 - clean and affordable energy (Stoeglehner, 2020).

Participatory Planning

In traditional planning, the main procedure is to create a blueprint with a top-down goal that carries out through different scales of government and directly impacts the neighborhoods. However, this one-direction of decision-making has created many conflicts within society because local conditions and concerns might not be recognized and understood from a topper's perspective.

Therefore, after the idea of participatory planning was developed, many countries have worked on this practice. It can be seen as a tool to merge the gap between top-down goals and bottom-up considerations by including stakeholders' participation to voice their opinions and create a fair distribution of resources (Smith, 1973).

'Participation ladder' is first introduced by Arstein (1969), providing an index to show the degree of public engagement. There are eight ranges: manipulation, therapy, informing, consultation, placation, partnership, delegated power, and citizen control. After that, there were many discussions in Western planning, which can be seen as pragmatic and normative. (Nadin et al., 2021).

From the pragmatic perspective, it emphasizes the need to overcome complex issues by increasing the knowledge of stakeholders in order to distribute responsibility and build trust within society. Normative discussion, on the other hand, highlights the importance of presenting good practices in governance in order to create a planning process that prevents unfairness and injustice.

In other words, if planners do not integrate tools or perspectives such as procedural and distributional justice to assess the engagement process (Shipley & Utz, 2012), then the debate of failing to establish better democratization through participatory might remain the stain (Sorensen & Sagaris, 2010; Nadin et al., 2021).

Even though the debate of participatory planning still exists, according to Nadin et al. (2021) research, it shows the undeniable truth that most European countries have a trend to improve their citizen engagement. That is, it is inevitable to face criticism on the success of implementing participatory planning within the planning process. However, it is still worth trying in order to increase public awareness and trust, which is the most common factor to decrease public participation (Rudge, 2021), that might lead to better results, especially when facing a wicked problem like climate change.

Social Acceptance For Energy Development

In the early stage of discussion related to the acceptance of energy development, wind infrastructure due to the efficiency of energy generation, but various conflicts within society have been the topic mainly discussed. People generally support wind energy development, but specific wind farm projects might get opposed locally (cf. Wolsink, 2000). Several studies even pointed out that opposition might not cause by physical reasons but by social or cultural factors (Firestone et al., 2015).

For example, in the case study of Ireland and Scotland, Warren et al. (2005) showed that aesthetic aspects influence people's attitudes most. It is also why many researches focused on aesthetics to evaluate the public's attitude to renewable energy. But, it is clear that the factors of acceptance of renewable energy are more complicated.

Based on Scherhaufer et al. (2017) research, they took Astrian as the case study and defined eight patterns that impact the acceptance and non-acceptance of the wind energy landscape changes. Besides, they also emphasized that the opposition to wind energy is a complex situation that cannot be pointed to a single factor. However, the keynote is that fair decision-making processes and distribution of the positive and negative economic or environmental effects will help to get a better discussion with the public. Eight patterns are: (1) effects on the landscape scenery (2) nature and wildlife conservation (3) impact on human ecology (4) public participation (5) distribution of financial benefits and losses (6) energy strategies and political leadership (7) impact on tourism (8) repowering

Besides the research on the social acceptance of wind energy, other concerns and factors exist against other energy sources. According to Rodríguez-Segura et al. (2023), the case study based on one province in Spain concluded some crucial recommendations regarding wind, solar, and biomass for policy-makers, planners, and researchers to take into consideration.

They stated that the energy infrastructure's type, size, and locations are essential factors influencing local societal acceptance of the renewable energy project. Besides, people prefer the implementation to happen in a location with no environmental sensitivity issues. However, the acceptance degree is also influenced by other criteria, such as economic effects on the neighborhoods or the transparency of the project's information.

Beyond that, the main factor in accepting general renewable energy development can show differently in countries (Delicado et al., 2016). For example, northern European countries might lose social acceptance locally because of landscape modification.

At the same time, southern Europe might be the reason of lacking economic benefits or sharing. Therefore, it is worth noticing that Taiwanese energy development also requires related study to help smooth the conflicts and improve the public attitude to the transitional process due to the possible different acceptance factors in society.

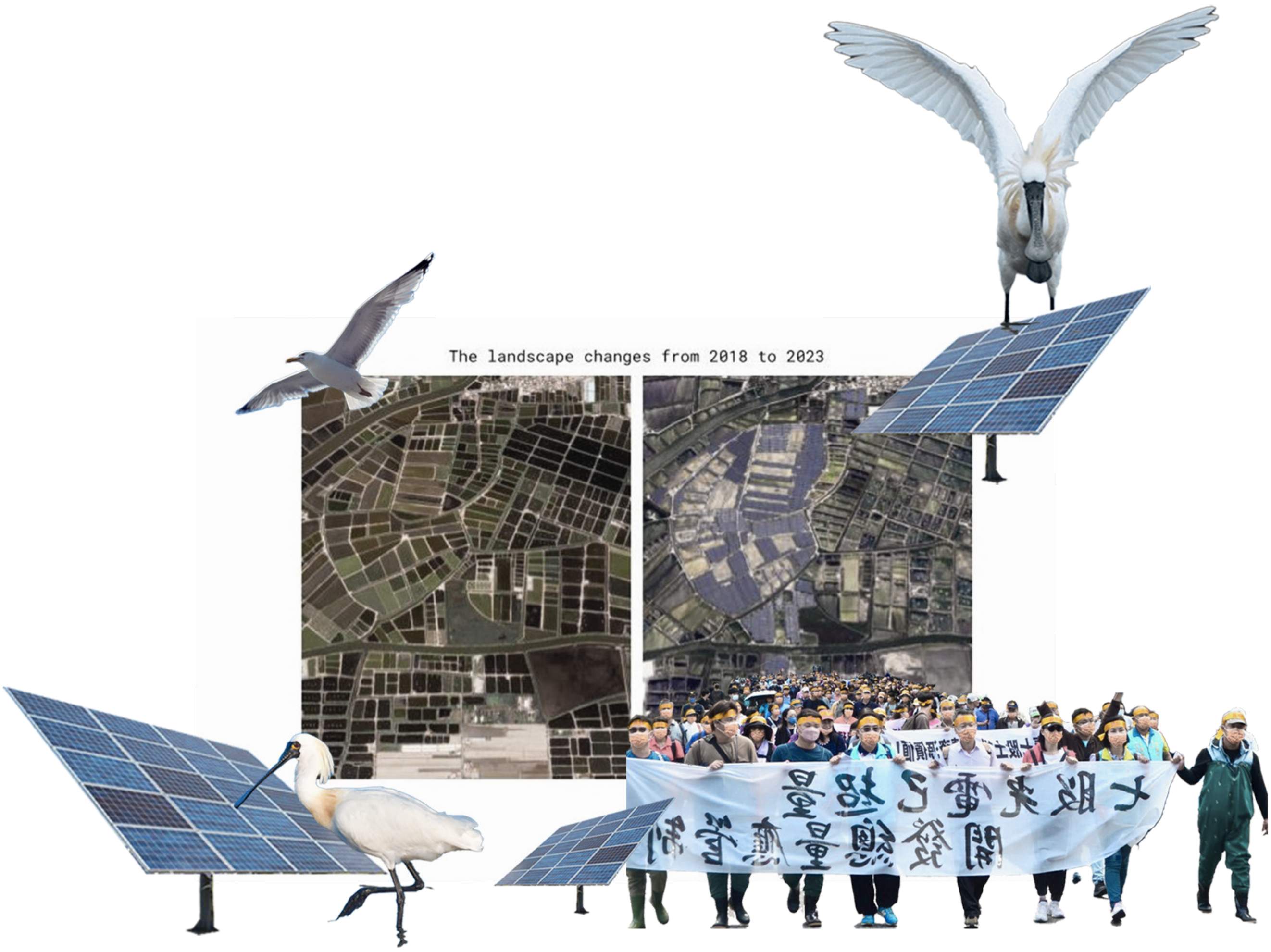


Fig 1.4: Social Conflicts in Taiwan

02
Problem Field

2.1 Energy Transition In Taiwan

History of Development

In 1980, Taiwan began building nuclear waste storage sites on Orchid Island, causing a wave of protests at the expense of human rights. Later, in 1987 (one year after the Chornobyl disaster), the proposal to revive Taiwan's fourth nuclear power plant was reintroduced in the Legislative Yuan and passed in 1992, triggering a series of anti-nuclear movements. In 2012, the candidate for the then president of Taiwan (also the incumbent 2016-2020; 2020-2024) proposed the slogan "Zero Nuclear Homeland" and has been actively promoting related projects since 2016 when she took office.

The world finds itself at a crossroads regarding the transition to sustainable energy with its primary goals: reducing CO2 & greenhouse gas emissions and steering away from fossil sources. Taiwan has also responded to the situation by initiating Taiwan's energy transition. However, unlike most countries, Taiwan has not joined the Paris Agreement. Thus, in 2018, the first edition of Taiwan's White Paper on Energy Transition was released with the primary goal of abolishing nuclear power and increasing the amount of renewable energy generation, with no clear discussion on the purpose of carbon reduction and other climate change mitigation strategies.

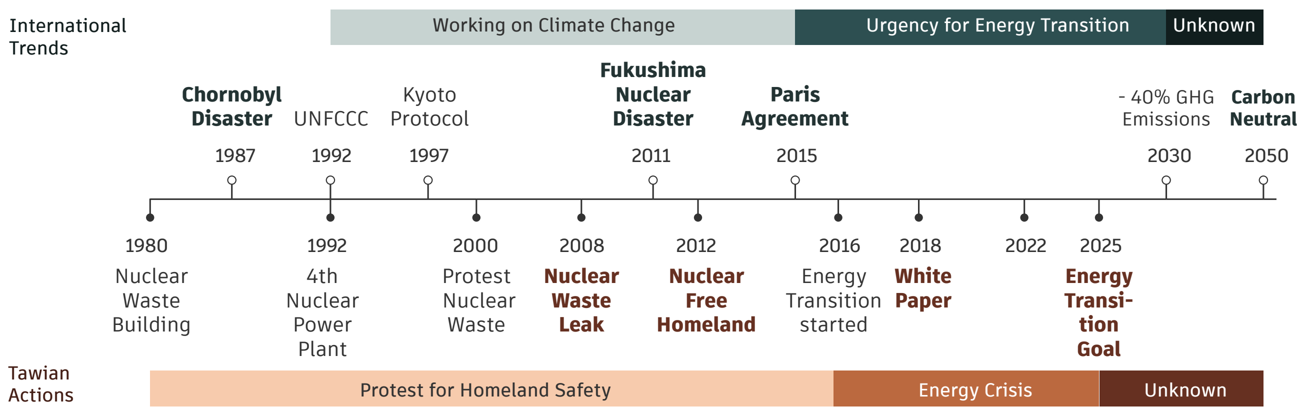


Fig 2.1: Chronology of Energy Development Trends in Taiwan and the World.

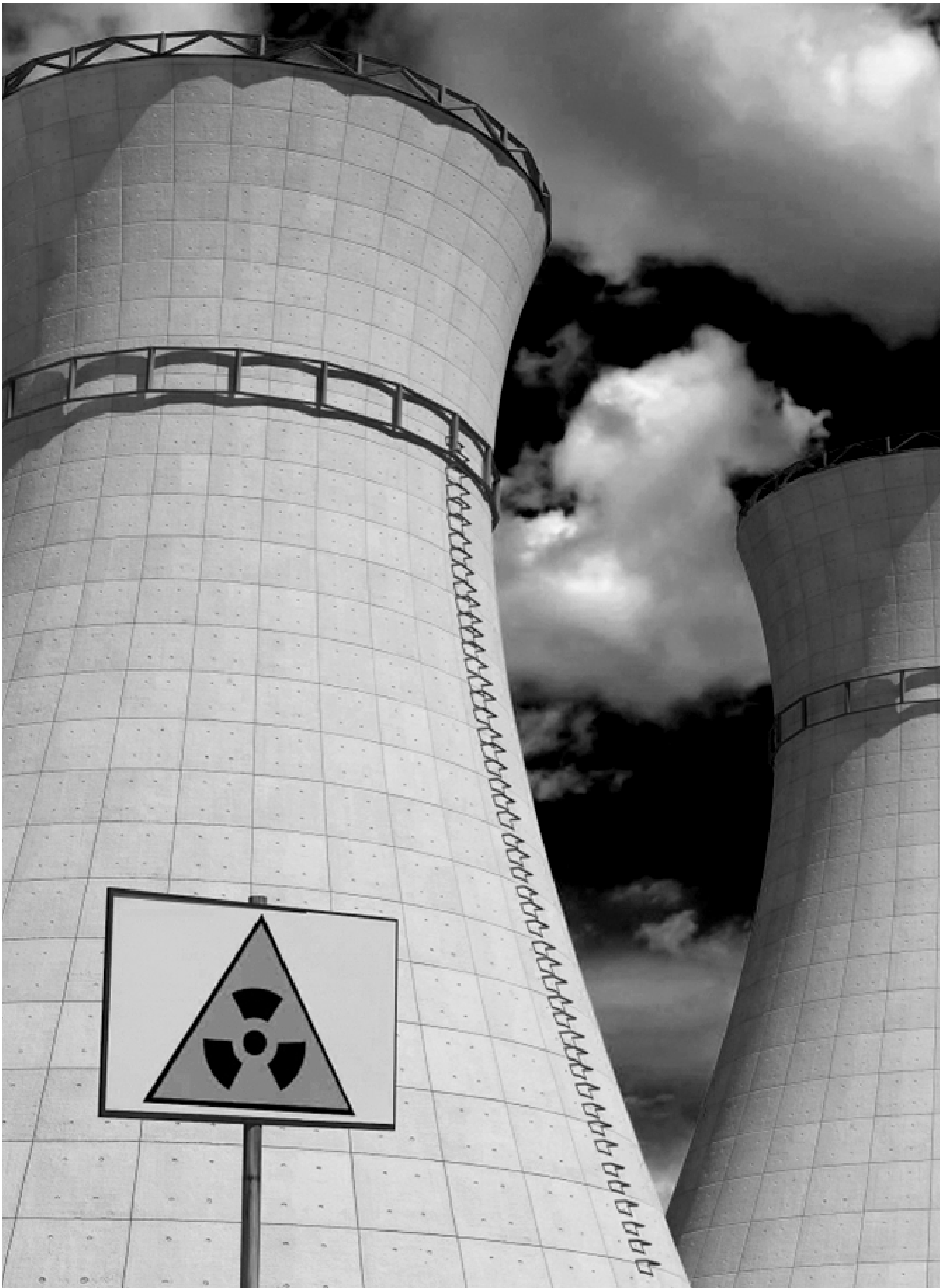


Fig 2.2: nuclear power plants. (Business Today, 2021)

In light of global climate change and the frequent occurrence of extreme weather, the average temperature in Taiwan has increased by 1.5 degrees over the past two decades. This has increased the cold room degree days by nearly 1.5 times over the past few years. Combined with the energy source structure change, it reveals more uncertainty of electricity demand.

On the other hand, by reducing coal dependency, the use of natural gas in Taiwan has increased almost two times compared to 2010. It is expected to account for 50% of Taiwan's electricity supply by 2025. However, the natural gas market is volatile in the face of global instability. These circumstances illustrate the difficulty of a nuclear abolition mission to fill the gap in nuclear power generation without increasing fossil fuel use. That is, it underscores the importance of Taiwan's renewable energy autonomy and its difficulty.

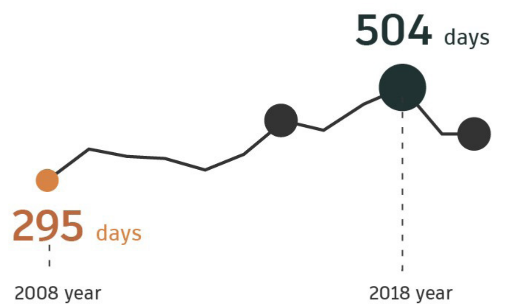


Fig 2.3: Cold-room degree days in Taiwan. (MEA, 2020)

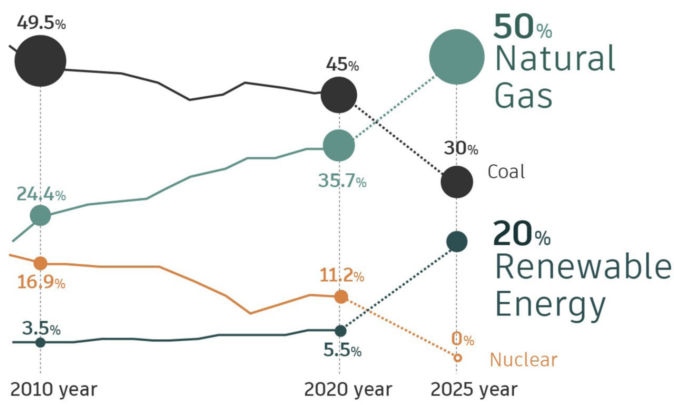


Fig 2.4: Energy use proportion in Taiwan. (MEA, 2020)

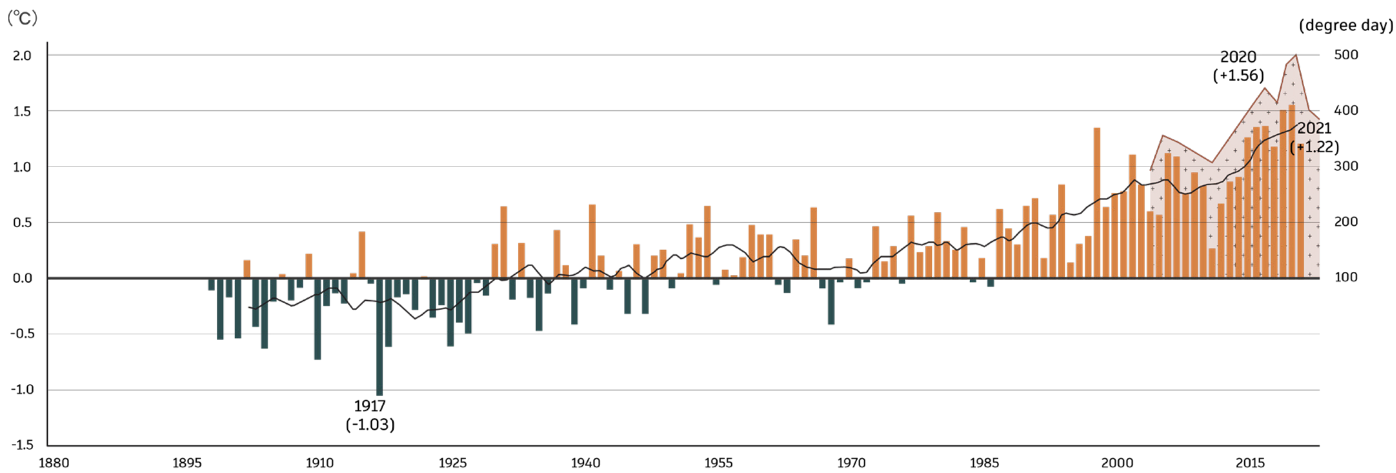


Fig 2.5: Average temperature in the world. (NOAA, 2018)

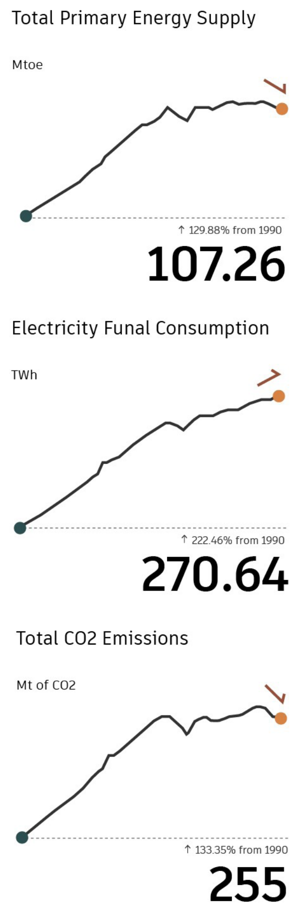
Fig 2.6: Transformer box next to the small-scale wind farm.

2.2 Energy in Taiwan

General Energy Use

The total energy use decreased in 2019 due to the pandemic, which derivated in a significant decrease in CO2 emissions due to the decline in industrial and commercial activity. However, this effect did not occur for electricity use, as average temperatures worldwide continued to increase, adding to the number of cool room days in Taiwan. Taiwan's energy supply was 138.48 million KLOE in 2020. Compared to the 2000 year, it has increased by almost 36% (IEA, 2020).

Crude oil and coal have been the two primary energy resources. Although the proportion of these two energy sources has decreased slightly, they still accounted for 74.2% by 2020. In addition, the use of nuclear power has been reduced to 6.6% by 2020 due to the political goal of creating a nuclear-free country(IEA, 2020). Yet, to supplement the energy supply, the use of natural gas has increased significantly.



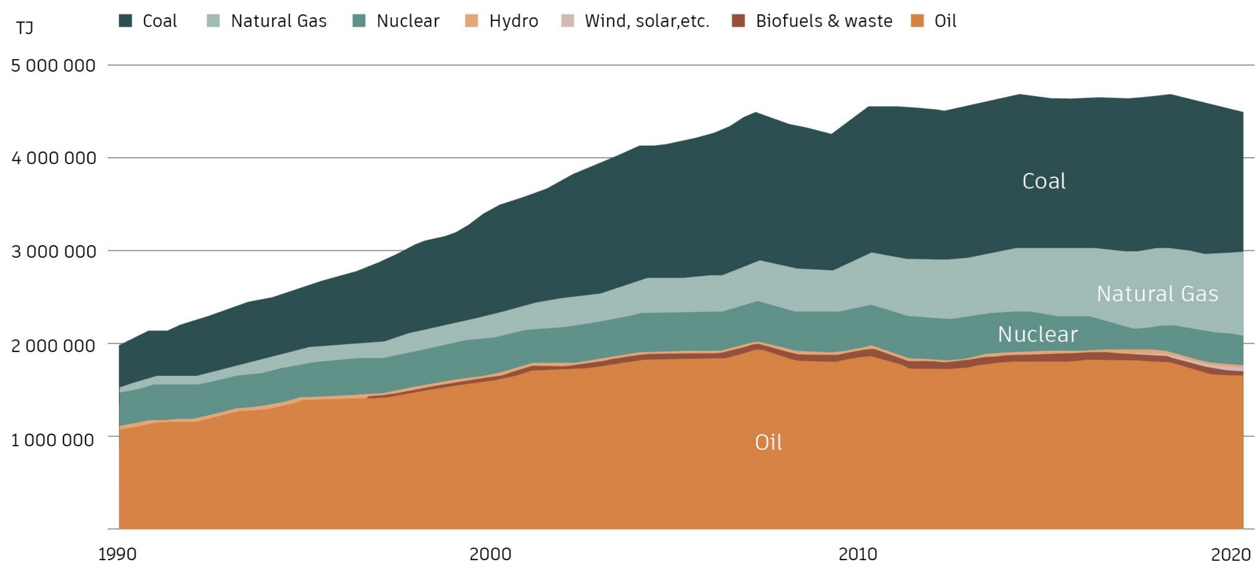


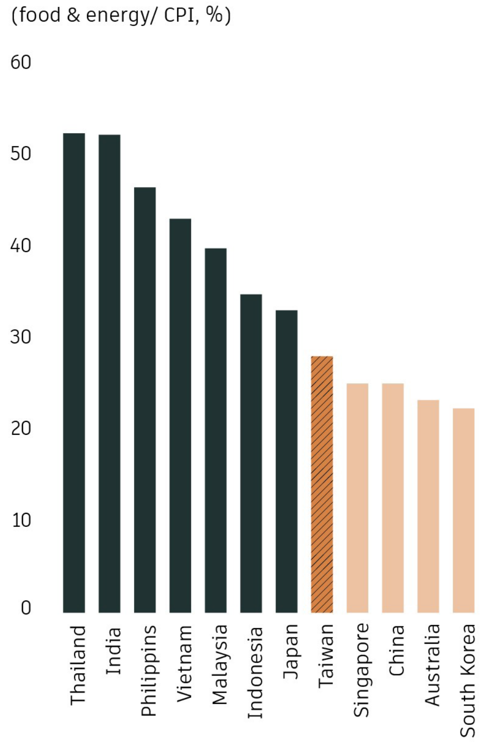
Fig 2.7: Changes in Taiwan's Energy Vital Index. (IEA, 2020)
Fig 2.8: Structure of energy use by type. (IEA, 2020)

Compared to Asia Pacific

Asian countries are usually heavily dependent on imported energy, with only a few coming close to being a net exporters of energy. ING's study in 2021 assessed the impact of the war between Russia and Ukraine on Asian countries. The report notes that Thailand, Taiwan and South Korea are the top three economies with increasing reliance on imported energy. However, the index of food and energy in each country's consumer price index (CPI) shows that Taiwan's index is about 28%. Compared to other countries, it has not been affected much.

The total energy supply per capita in the Asia Pacific was 61.5 GJ in 2020, which has increased by 99% compared to 1990. On the other hand, the Taiwanese total energy supply per capita, 188.4 GJ, was almost three times than the average of Asia Pacific. Yet, The growth rate was slightly fewer than in the Asia Pacific.

Countries with similar types of development to Taiwan, Japan and South Korea, have had markedly different growth paths. Japan's energy supply per capita has decreased by 9% from 1990, while Korea's has increased by 161.3%.



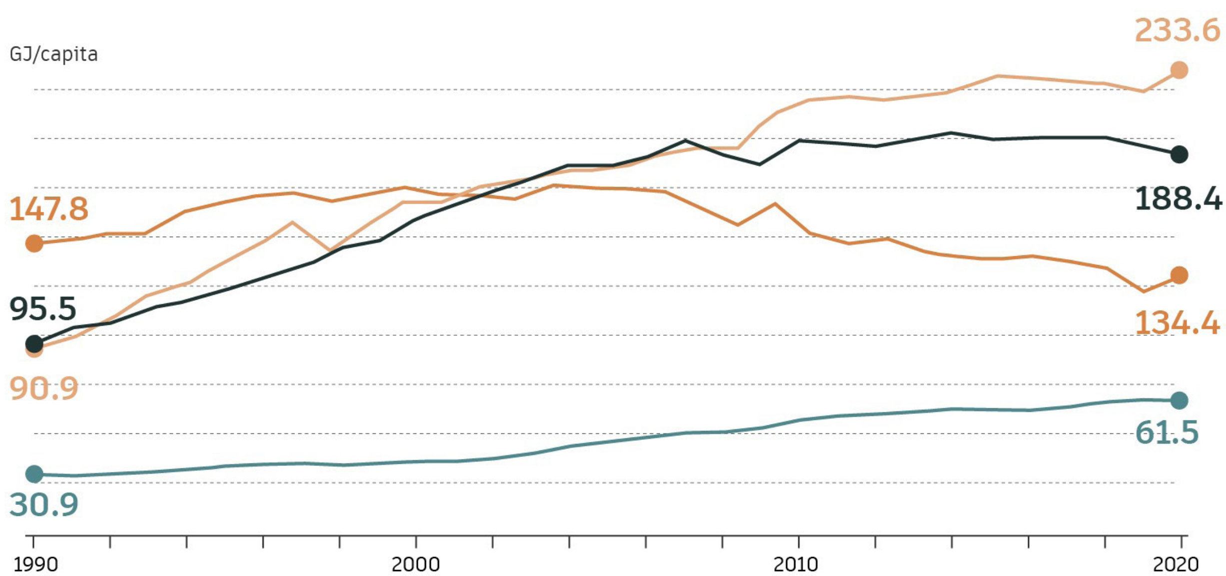


Fig 2.9: Food and energy in Asian countries' CPI. (ING, 2022)
Fig 2.10: Comparison of energy use capita. (IEA, 2020)

Energy Use By Types

Energy consumption by sector can be divided into five components: industrial, transportation, residential, services, and others.

Since 2000, industrial energy consumption has increased by 8%. However, transportation consumption has decreased from 20.4% in 2000 to 15.8% in 2020. This decrease may be due to policies that promote greater energy efficiency in public transportation.

On the other hand, the share of energy consumption by energy form has not changed significantly in the last 20 years. In detail, the use of alternative energy sources and natural gas has increased due to the decrease in the use of coal and oil. However, the proportions of both sides balanced each other making the overall structure more or less stable.

It is worth noting that although the share of electricity in energy consumption has increased by 3% in the last 20 years, its total volume has not increased significantly.

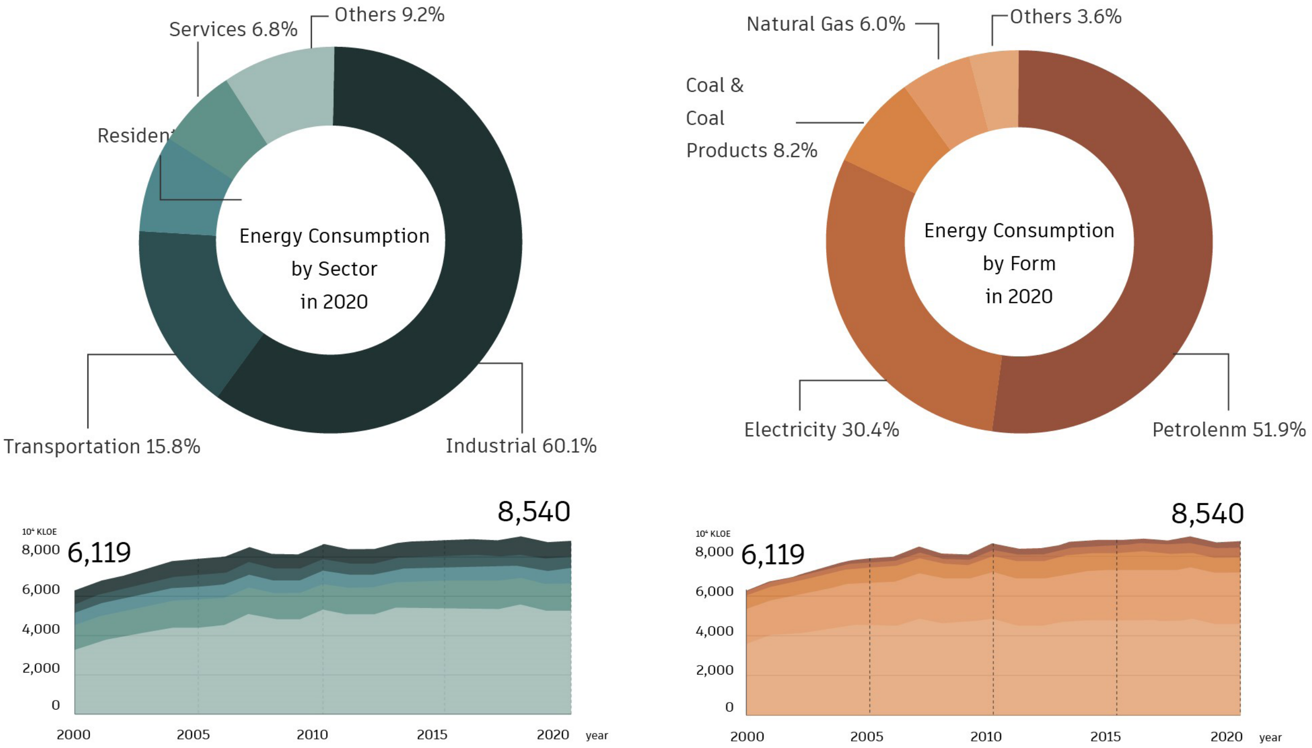


Fig 2.11: 2020 Energy consumption by sector. (MEA, 2020)

The Energy Transition White Paper

In order to deal with climate change around the world and domestic air pollution issues, Taiwan's energy transition policy was proposed in 2016, expecting to create a low-carbon and clean energy transformation path for development.

The target for 2025 is a 20% renewable energy generation rate for electricity. More specifically, 20GW of solar energy and 6.8GW of wind energy are the essential missions. In addition, the energy autonomy rate is expected to increase from 2% to 6% to decrease the reliance on imported energy.

As renewable energy generation increases, it is expected to reduce air pollution from electricity generation by 45 %. It also indicates that the transition could provide 140 thousand jobs in green industries.

There are five main chapters in the energy transition white paper:
1. Local energy governance and citizen participation
2. Sectoral Energy Efficiency Improvement Program
3. Electricity structure innovation
4. Renewable energy introduction accelerated
5. Technological development of the green energy industry promotion

Reflection On The Hidden Problems

However, all the chapters are built up by words only and do not include any spatial considerations at all. For example, in the chapter on renewable energy introduction, there is no clue about how much space will be needed. More specifically, solar and wind energy are the primary proposed renewable energy for electricity generation, which needs to be distributed in many non-urban areas such as agricultural land. Yet, the agricultural department is not included in the department program, which has presented why many conflicts and challenges have been happening within society recently.

Moreover, the discussion in the building environment department only mentions advocating green building construction. Yet, the large-scale planning for the energy transition has no clue.

Taiwan uses the independent grid and has the risk that if any power plant becomes unstable, it will cause huge regions that are out of electricity. Still, in the chapter on improving the electricity grid lacks a discussion of the spatial aspect.

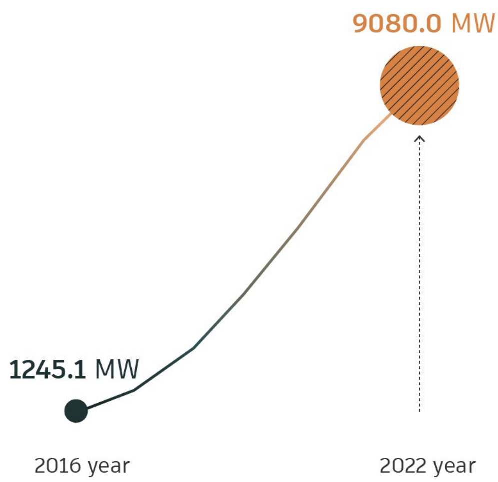
On top of that, it is clear that the white paper has shown that most of the actions will need different sectors' collaboration. And the need for integrated planning to restructure the energy transition and create a vision that includes spatial and social perspectives is undeniable.

Potential of Solar Energy

Taiwan is occupied by the mountain area up to almost 70%. Most of the building environments are located on the west side of Taiwan. Mid and South Central regions have the greatest solar potential. However, most of these regions have concentrated agricultural avticity. Besides, the middle part of Taiwan is surround

In the central part of Taiwan, there are several high mountains, which are not only high but also very steep. Therefore, even though the sunlight hours are high, it is still challenging to develop solar power generation due to technical problems.

According to the target set for 2025, in order to generate 20GW of solar energy, at least 300km of land area in Taiwan will need to be used.



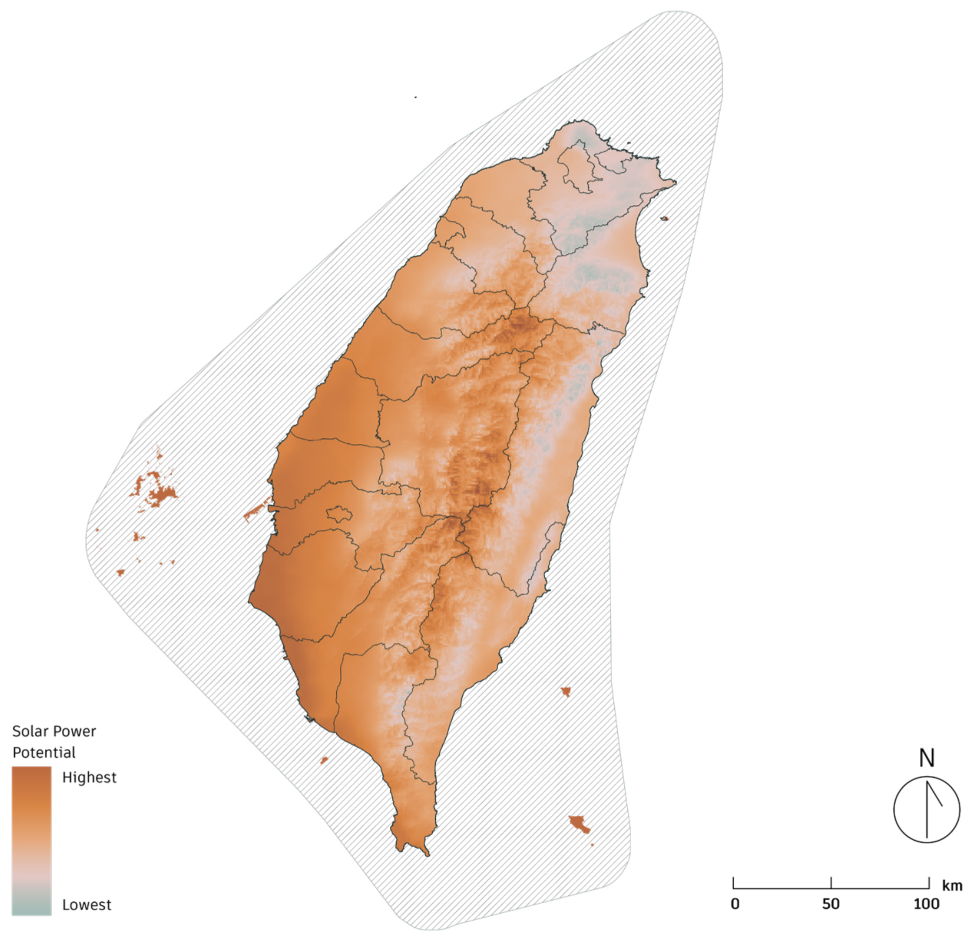


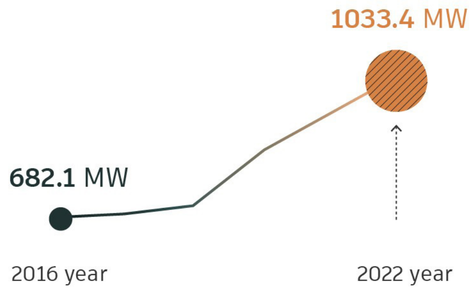
Fig 2.12: The goal of solar energy generation.
Fig 2.13: Solar energy potential in Taiwan.

Potential of Wind Energy

The Taiwan Strait is rich in wind resources. According to the 4C Offshore database of over 2,580 offshore data collected worldwide, 16 of the 30 most deep wind resources are located in the Taiwan Strait (4C Offshore, 2022).

Of the 36 most efficient offshore wind farms in Taiwan, 21 are in Changhua County. In addition, the northern and central coastal areas are excellent areas for onshore wind turbine construction.

So far, only two offshore wind farms have been completed. Even by 2022, only 15% of the wind power generation target has been achieved. In addition to the lack of mature technology, poor policy development and evaluation mechanisms have caused many conflicts and dragged the bottom line.



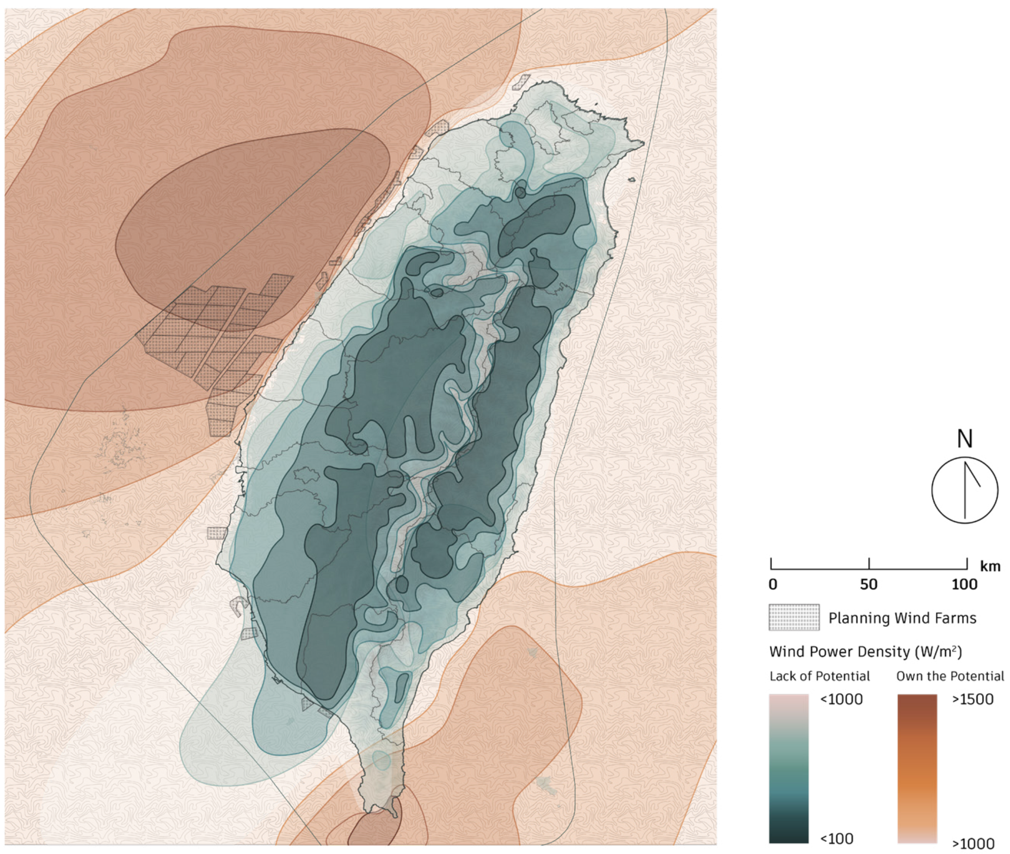


Fig 2.14: The goal of wind energy generation.
Fig 2.15: Wind energy potential in Taiwan.

2.3
The Urgency Of The Changing Energy Landscape

Huge Changes In Energy Landscape

Due to the limited land area to develop renewable energy in Taiwan, the Taiwanese government has researched multifunctional land use. Besides industrial areas, agriculture and aquaculture are the most potential sectors to combine with renewable energy generation. In the beginning, agriculture and electricity symbiosis got much attention due to the vast land areas. There were many proposals regarding the combination idea (example pictures are shown on the following pages). However, due to the incomplete regulations to support the implementation, many agricultural lands had been changed into mainly renewable energy generation use, leading to the social chaos of “fake farming, real electricity sales.” Beyond this, food security is the main threatening problem.

Because of this failure, the government started searching for new possibilities in combining renewable energy with aquacultural lands. The positive result of the experiments has brought more attention and hopes to this transitional process. In order to create a wise use in fish farms, regulations set the limitation of the installation rate and provide different installation types. Yet again, because of the inadequate supporting measures and the total amount of control, many outdoor fish farms have become indoor ones or even applied for land use type change in order to gain a higher proportion of installation rate, causing a vast landscape change.

In addition, the issues behind the changes are not only landscape changes but also derived issues that affect the socio-economic, living environment, and ecosystem. The early studies on the energy landscape focused more on the perspective of social acceptance due to the conflicts caused by the perception of aesthetics or the influence the onshore wind turbine might bring on humans. However, the case in Taiwan is more than that. It is a problem linked to more hidden aspects of injustice, revealing that studying the hidden issues is urgent because it will lead to a long-term and complicated effect that needs more attention and research to help revise.

Fig 2.16: Construction of solar panels in the aquacultural lands. (Wang, 2023)


Fig 2.17: Ideal stiuation of multifunctional use on the agricultural lands in Japan. (UEUE Cooperation, 2023)


Fig 2.18: Current stiuation of multifunctional use on the agricultural lands in Taiwan. (News&Market, 2020)

Fig 2.19: Ideal stiuation of multifunctional use on the aquacultural land area. (News&Market, 2020)

Fig 2.20: Current stiuation of multifunctional use on the aquarcultural land. (MEA, 2021)

The Importance Of Studying The Energyscape

The deficiency in spatial planning can be traced back to the fact that Taiwan's planning system is independent and divided into urban, non-urban, and national park planning systems. Beyond this, none of them can manage areas of marine space. Each plan follows a different law and operates independently.

In addition, being development-oriented, some land use types have more flexibility and looser regulation in terms of construction. Therefore, many development projects have applied for land use type changes. Due to the lack of a higher-level planning system to regulate the guidance of land use purposes, systemic loopholes have caused conflicts in society.

Systemic Loopholes:
Most of the vast landscape changes happen in the agricultural land zone, as the pictures shown on the previous page. In conclusion, there are three approaches that have led to uncontrolled landscape change and the following socio-economic issues.
(1) Small-scale installation (<660 m^2): No permit is required. In this case, the developer works with the landowner to reduce the size of the land parcel by parcel to meet the requirement of less than 660 square meters, and then purchases or leases the land parcel by parcel to install the solar panels to avoid government assessment.

(2)Medium-scale installation (<2 hectare): Apply for the land use type change to particular land use type in order to install full-cover solar panels on the ground. (but still in the agricultural land use zone) This approach had been the most used case; however, this approach got canceled in 2020 due to tons of applications threatening food security.

(3) Large-scale installation (2-30 hectares): The land use zone change application is necessary in this case. Due to the complicated assessment process, this is not a common approach.

Derivative Issues:
Due to the new cooperation between developers and landlords, many renters cannot extend the contract anymore; In some countrysides, because of social customs, many elderly renters even only have an oral commitment with the landlords. As a result, many of them have even fewer powers to fight the sudden change or ask for compensation.

In addition, this consequence contradicts environmental protection and the ecosystem, such as many fish farms have been the habitats for migratory birds. However, due to the limitation of outdoor fish farms combined with solar energy have more strict regulations; thus, many fish farms have turned to indoor ones to gain higher installation rates, affecting the ecosystem due to the vast landscape change.

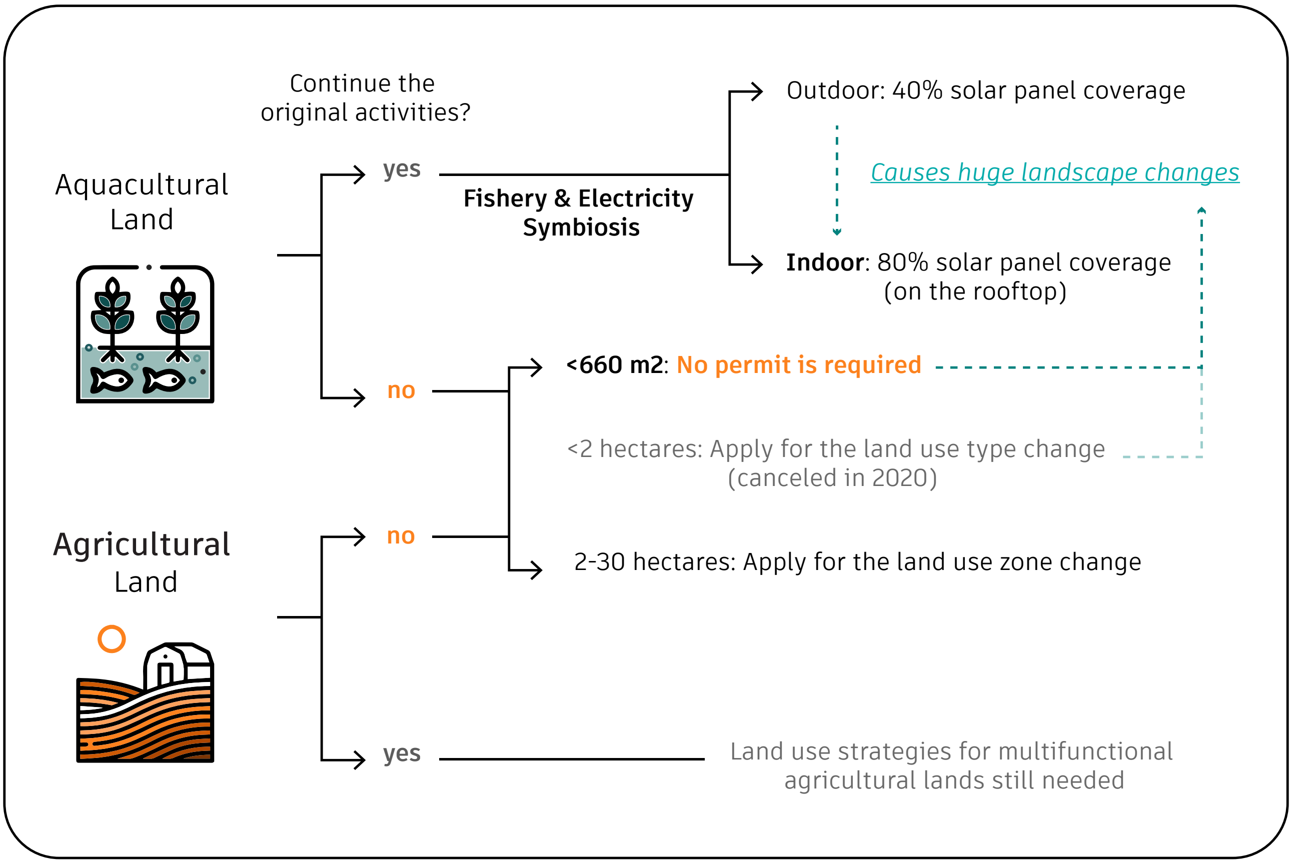


Fig 2.21: Conclusion of the energy landscape analysis

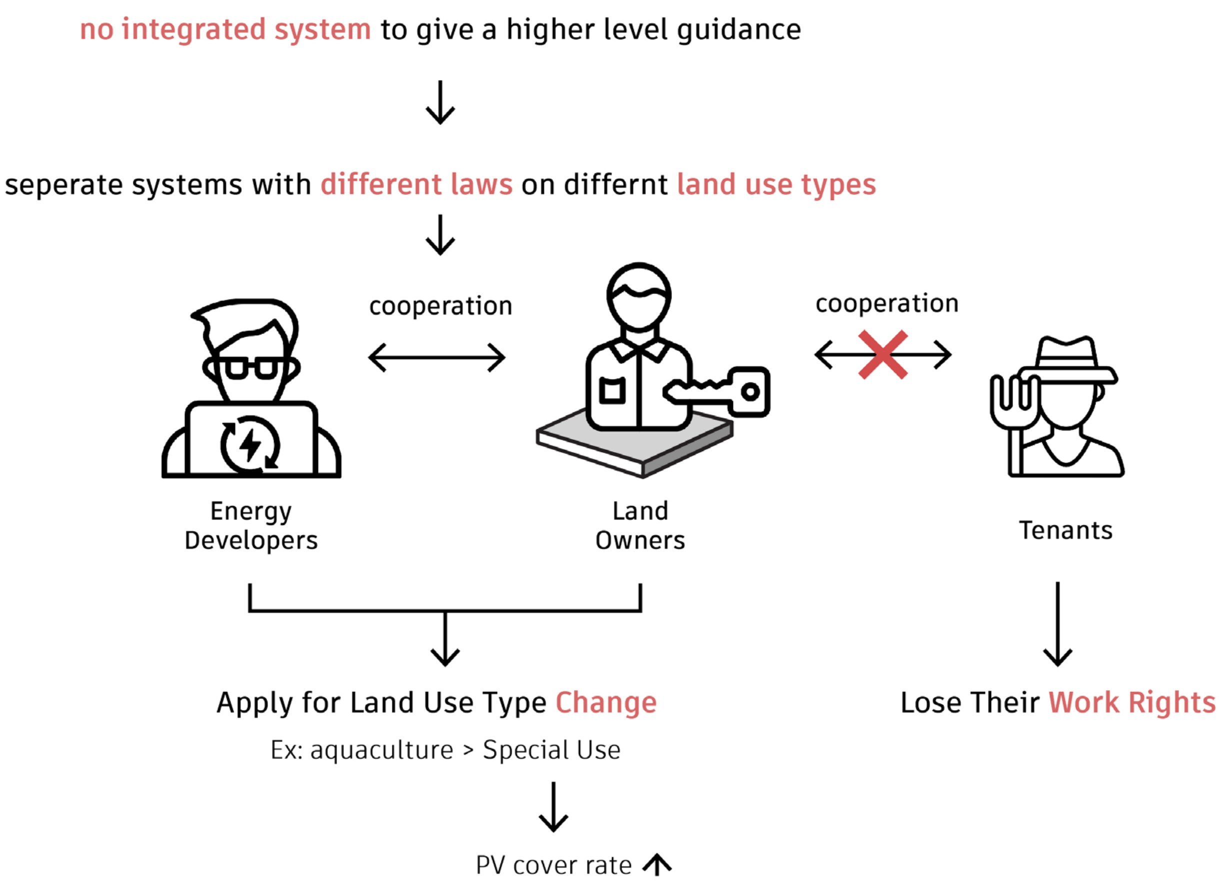


Fig 2.22: Explanation of the derivative issues: tenats' work rights losses

2.4
Challenges Behinds The Changing Energy Landscape

Natural Limitation

First, the natural limitation by mountain area occupies almost 70% of the land area, which limits the available land. At the same time, up to 80% of the Taiwanese population lives in urbanized areas, showing the pressure of finding large and available land landing on non-urban sites.

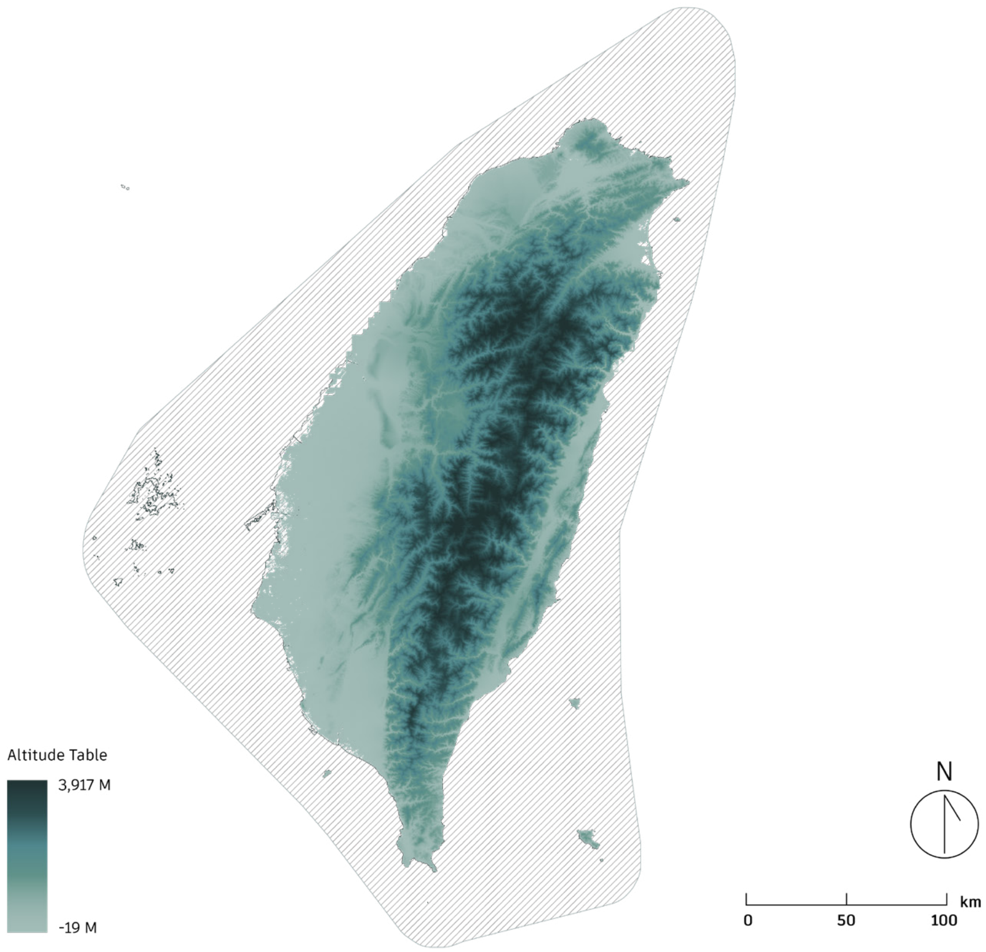


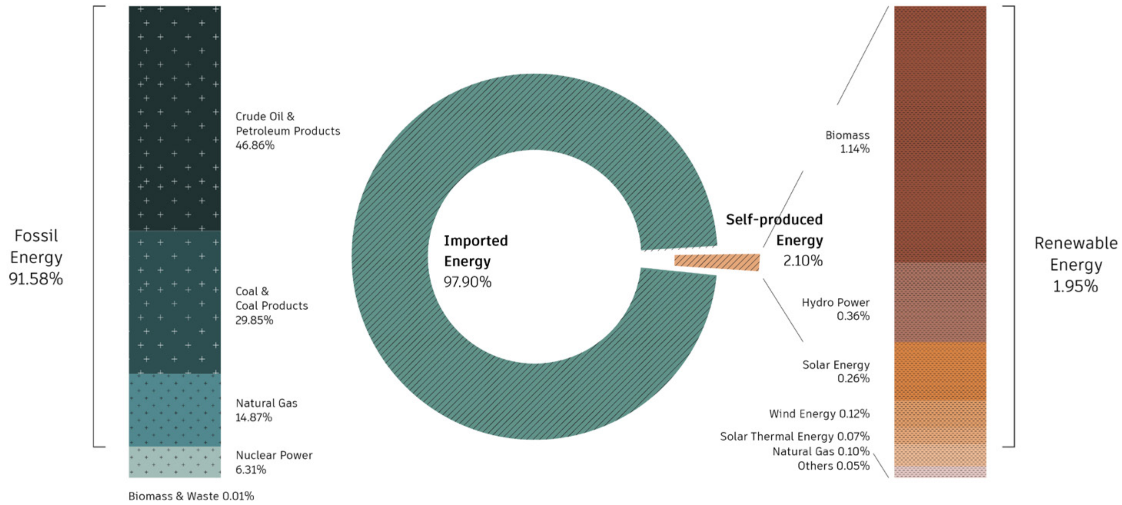
Fig 2.23: Taiwan contour map

High Reliance On Imported Energy

Taiwan is a country that highly relies on imported energy. Even until 2020, the dependent energy rate remains up to 98% (MEA, 2020).

Due to unstable situations worldwide, international energy prices have increased dramatically. In addition, Taiwan's electricity consumption has risen significantly in recent years; At the same time, the government continues to promote coal and nuclear power reduction, leading natural gas consumption has increased by more than 30% in the past seven years. As a result, the load factor of the two existing receiving stations is as high as 108%, while Japan and Korea are only 30% to 40% (CPC, 2022).

The domestic natural gas receiving station load factor is much higher than the international average level, while the safety stock is much lower than the international level. If any unpredictable situation happens, it will not only be an **energy risk** but might lead to a **national security risk,** as shown in the indicator graph below (Leung, 2019).



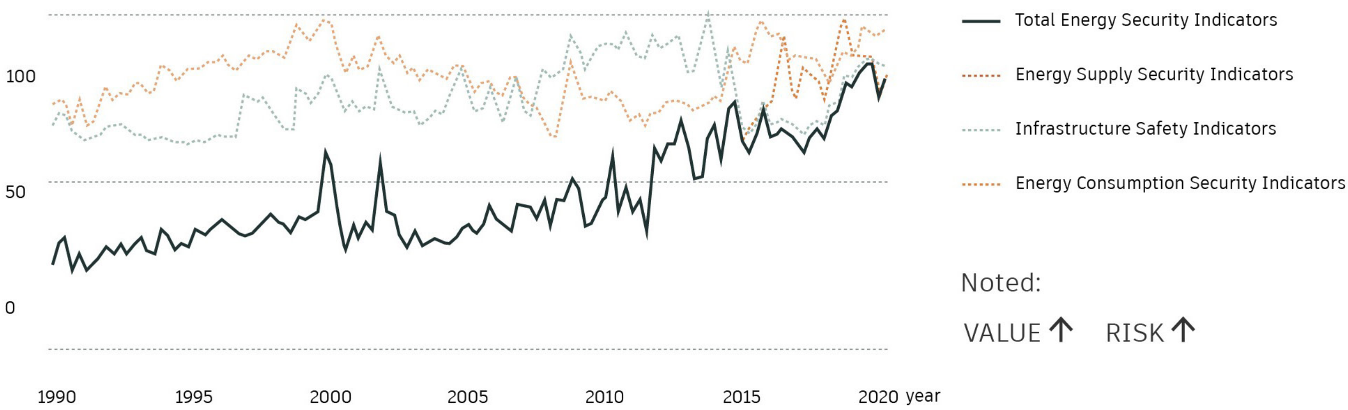


Fig 2.24: Energy imported rate and proportion of energy use by type. (MEA, 2020)
Fig 2.25: Energy safety index. (Leung, 2019)

Sperated Planning System

There are three planning systems in Taiwan: Urban Planning, Regional Planning (Non urban) Planning, and National Park Planning. Each planning system follows by different laws and regulate their land use types in different ways.

Regional planning sysytem (non-urban area) follows with the regional planning act. It manages 78% of the land in Taiwan. There are 11 land use zones under this system and follow by 19 land use types. Land use types regulate the different permitted uses and intensity of use.

Urban Planning system manages 13% of Taiwan's land. Land use zones and land use types are at the same level and the concept of land use zones guiding land use types does not apply in this system. In addition, under each land use zone and land use type can be divided into subclasses and regulated with varying intensities of cover and volume ratios. Moreover, there are different land use classifications according to different plans.

The National Park Planning System manages ten national parks, which account for 9% of Taiwan's total land area. There are five use zones, and they are regulated with different permitted uses and intensities.

As shown in the figure 2.27, each system manages land in a different way and detialed functional areas are controlled

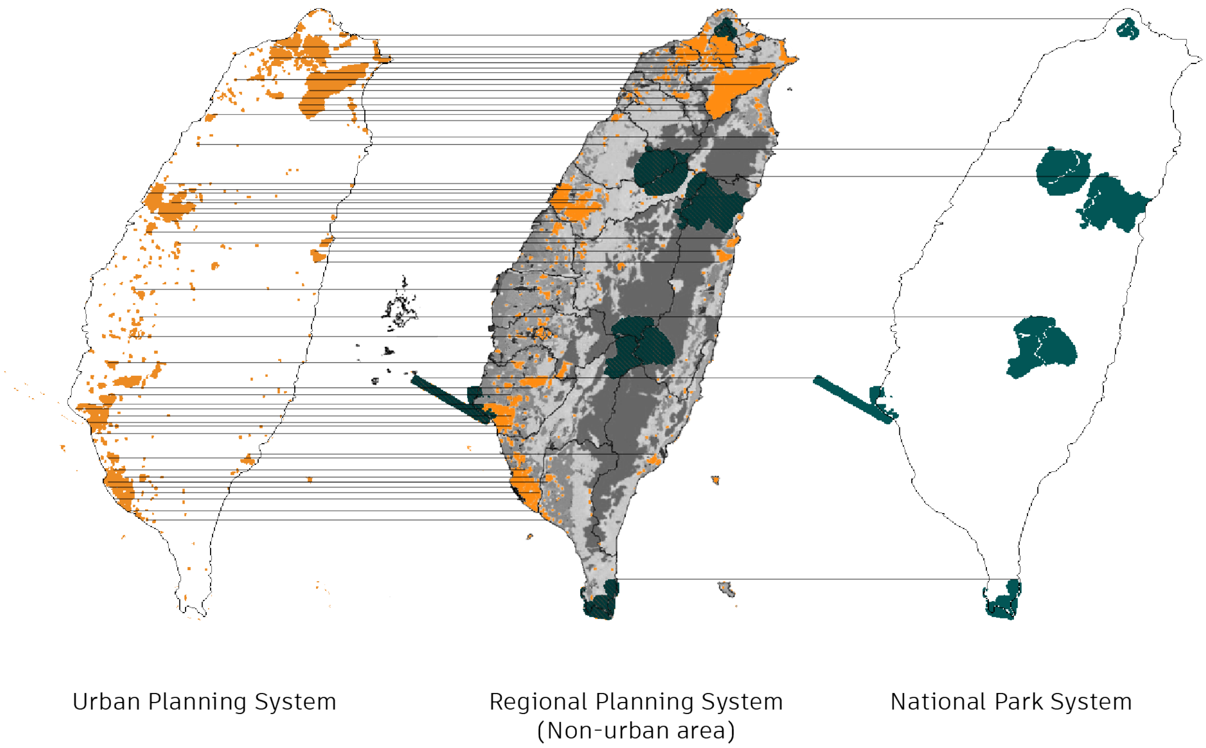


Fig 2.26: Taiwanese seperated planning systems

by different administrations at various levels. Furthermore, these systems focus only on the management of land-based regions. This means that there is no planning system to manage the marine spatial areas and there are no legal texts to follow.

Since the complexity of the land area management, the lack of holistic planning system exacerbate the collaboration when it comes to the cross-displinaries project, especially like the energy transition.

More specifically, there are different criteria and assessment processes for the consolidation or establishment of renewable energy infrastructure in an area, as systems follow different laws.

Furthermore, this complexity slows down the process of forecasting the total potential land use for renewable energy, as each sector has its own expectations and requirements, and the lack of an overall plan to organise and follow leads to the sectors passing the buck to each other.

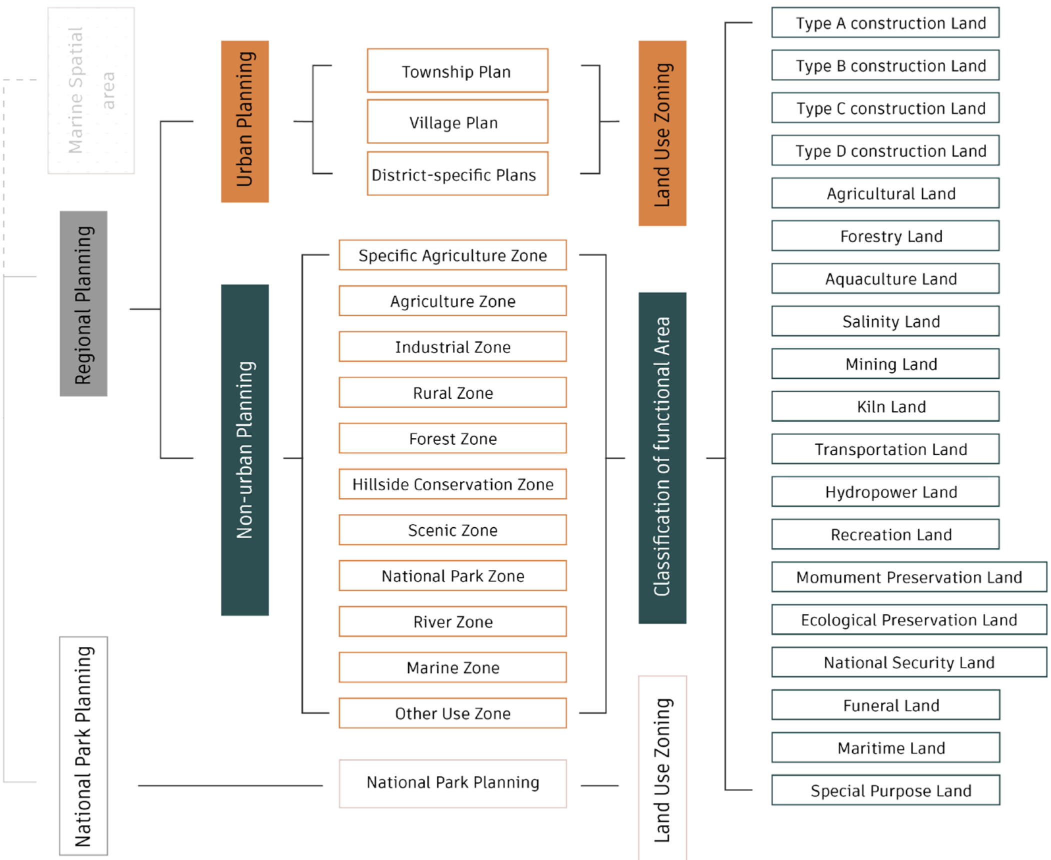


Fig 2.27: The relationship between planning systems and land use types

Energy Bureau: Lack Of Administrative Power

The central 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 shown in the diagram on the right. As the National Energy Transition Plan is led and developed by the Energy Agency, they are tasked with coordinating the economic, social, environmental and spatial aspects of cooperation with renewable energy development across all sectors. However, as their administrative level is lower than most of the other cooperation sectors (second tier) and there is no higher level administrative regulation to govern their decisions, cooperation is inefficient and the sectors are pushing each other around.

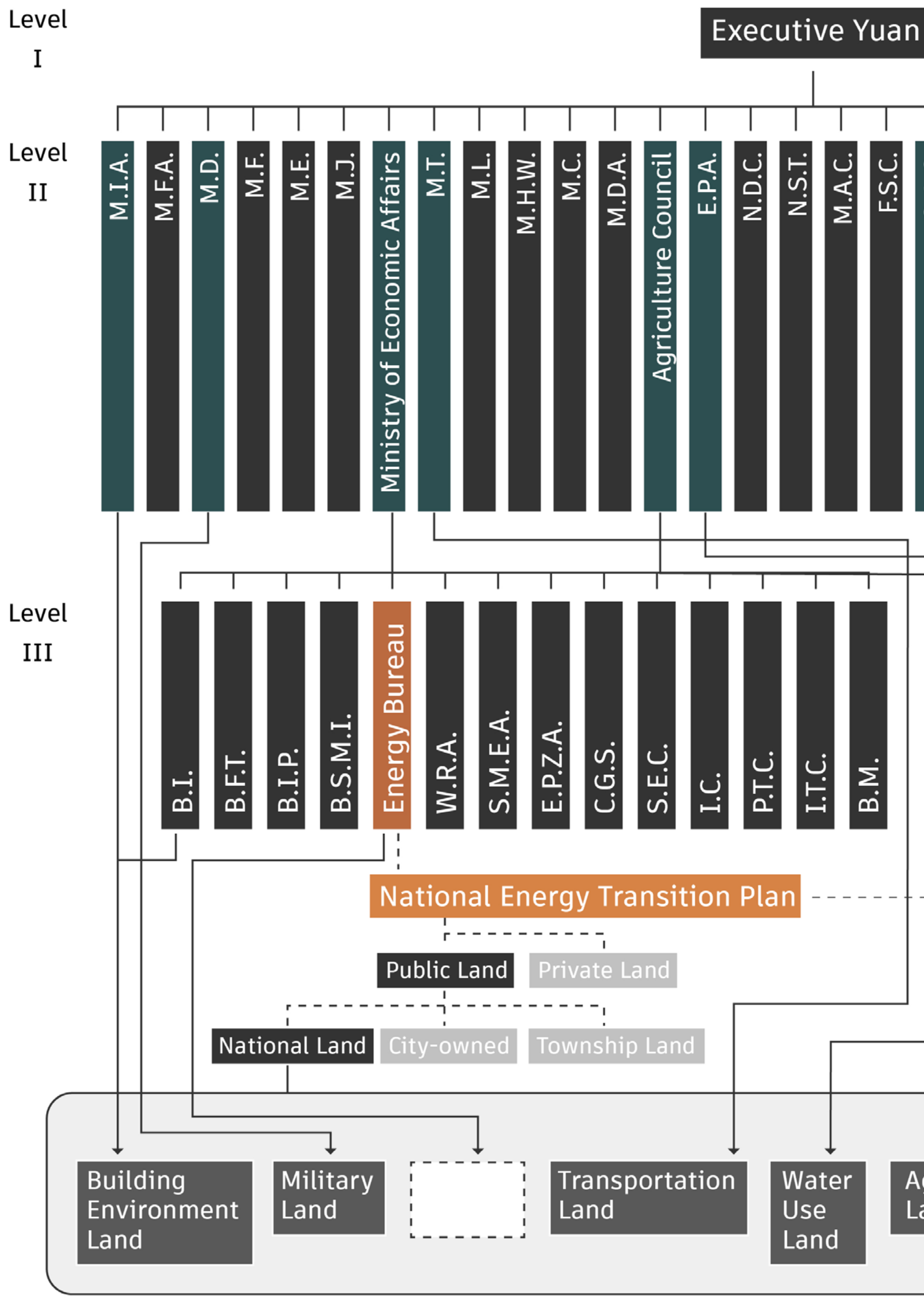
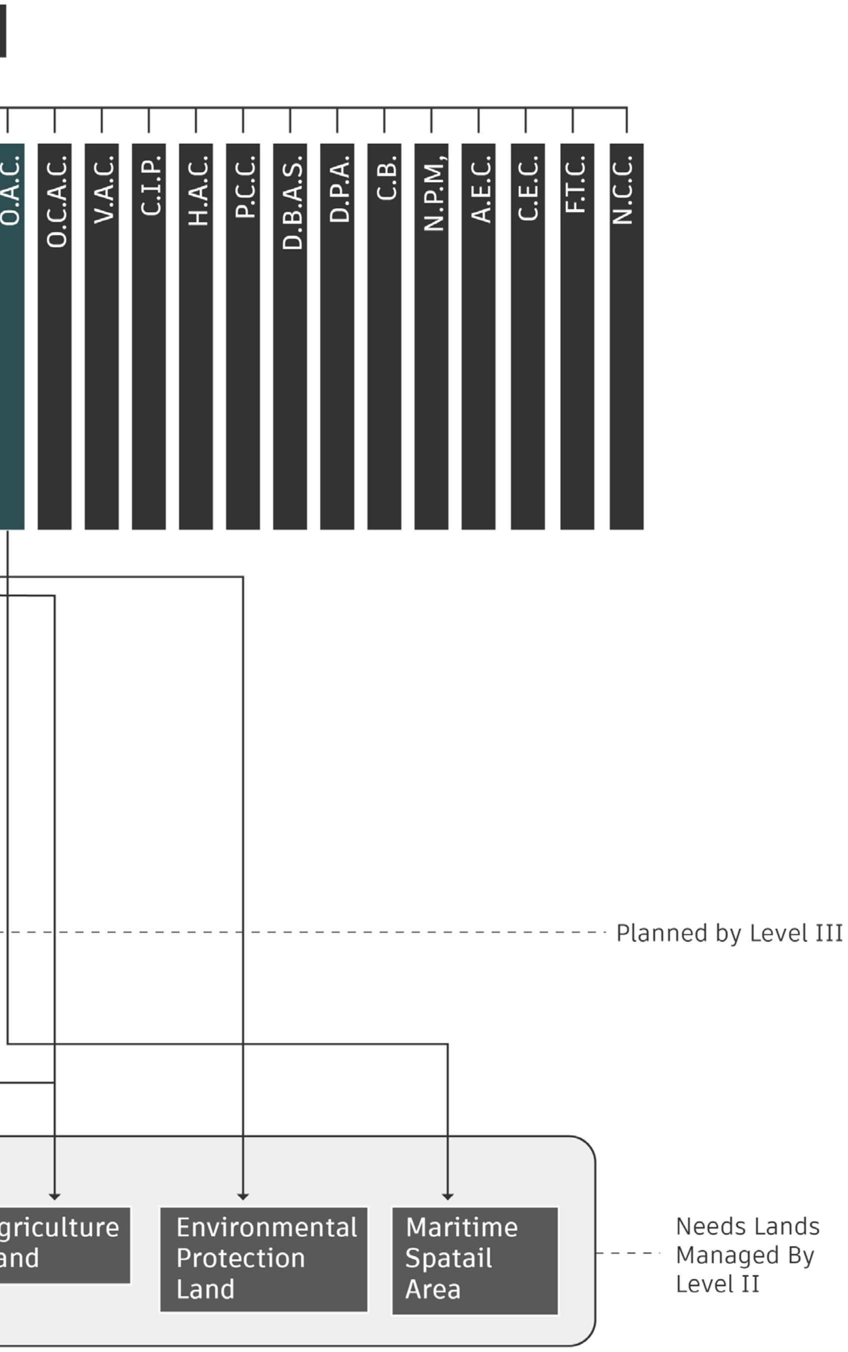


Fig 2.28: Execuative Yuan's administrative structure



M.I.A.=Ministry of Internal Affairs
M.F.A.=Ministry of Foreign Affairs
M.D.=Ministry of Defense
M.F.=Ministry of Finance
M.E.=Ministry of Education
M.J.=Ministry of Justice
M.E.A.=Ministry of Economic Affairs
M.T.=Ministry of Transportation
M.L.=Ministry of Labor
M.H.W.=Ministry of Health & Welfare
M.C.=Ministry of Culture
M.D.A.=Ministry of Digital Affairs
C.A.=Council of Agriculture
E.P.A.=Environmental Protection Administration
N.D.C.=National Development Council
N.S.T.=National Science & Technology
M.A.C.=Mainland Affairs Council
F.S.C.=Financial Supervisory Commission
O.A.C.=Ocean Affairs Council
O.C.A.C.=Overseas Community Affairs Council
V.A.C.=Veterans Affairs Council
C.I.P.=Council of Indigenous Peoples
H.A.C.=Hakka Affairs Council
P.C.C.=Public Construction Commission
D.B.A.S.=Directorat- General of Budget, Accounting and Statistics
D.P.A.=Directorate-General of Personnel Administration
C.B.=Central Bank
N.P.M.=National Palace Museum
A.E.C.=Atomic Energy Council
C.E.C.=Central Election Commission
F.T.C.=Fair Trade Commission
N.C.C.=National Communications Commission
B.S.M.I.=Standards, Metrology & Inspection Bureau
S.M.E.A.=Small and Medium Enterprise Administration
E.P.Z.A.=Small and Medium Enterprise Administration
S.E.C.=State-owned Enterprise Commission
I.T.C.=International Trade Commission
B.I.P.=International Trade Commission
P.T.C.=Professional Training Center
B.F.T.=Foreign Trade Bureau
W.R.A.=Water Resources Agency
C.G.S.=Central Geological Survey
I.C.=Investment Commission
B.M.=Mine Bureau
B.I.=Industrial Bureau

Specifically, different land use areas are managed by various authorities. Yet, the coordination and quantitative forecasting of potential land for multifunctional use of renewable energy are limited because the Energy Authority does not have the right to manage these lands.

Conflict areas can be seen, as this section shows, overlapping within sectors' authorities. Another noticeable thing is that the current spatial planning systems do not include marine spatial areas.

This means the governance in the maritime spaces is out of order, revealing the urgency of establishing a holistic plan and system to organize the collaboration.

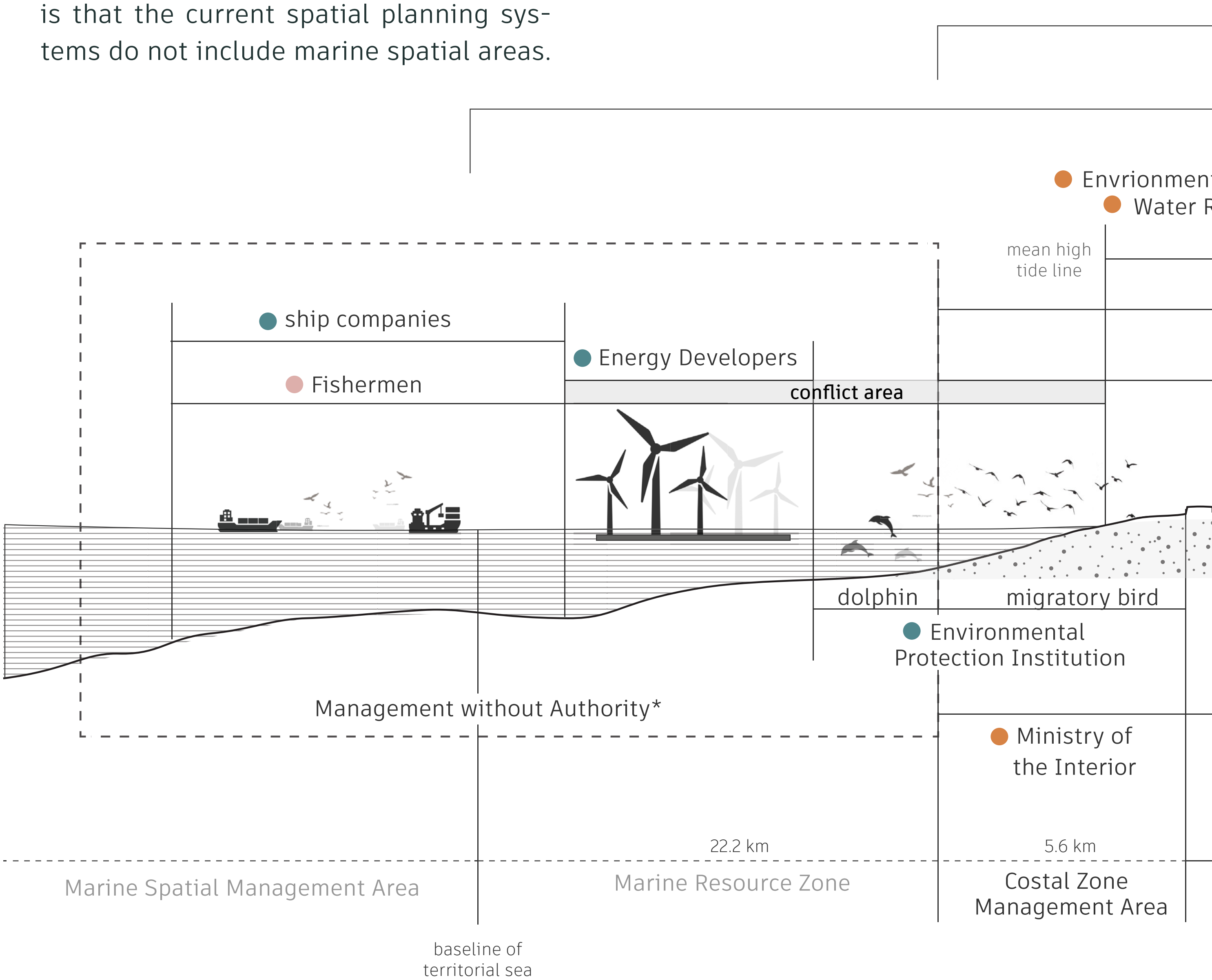
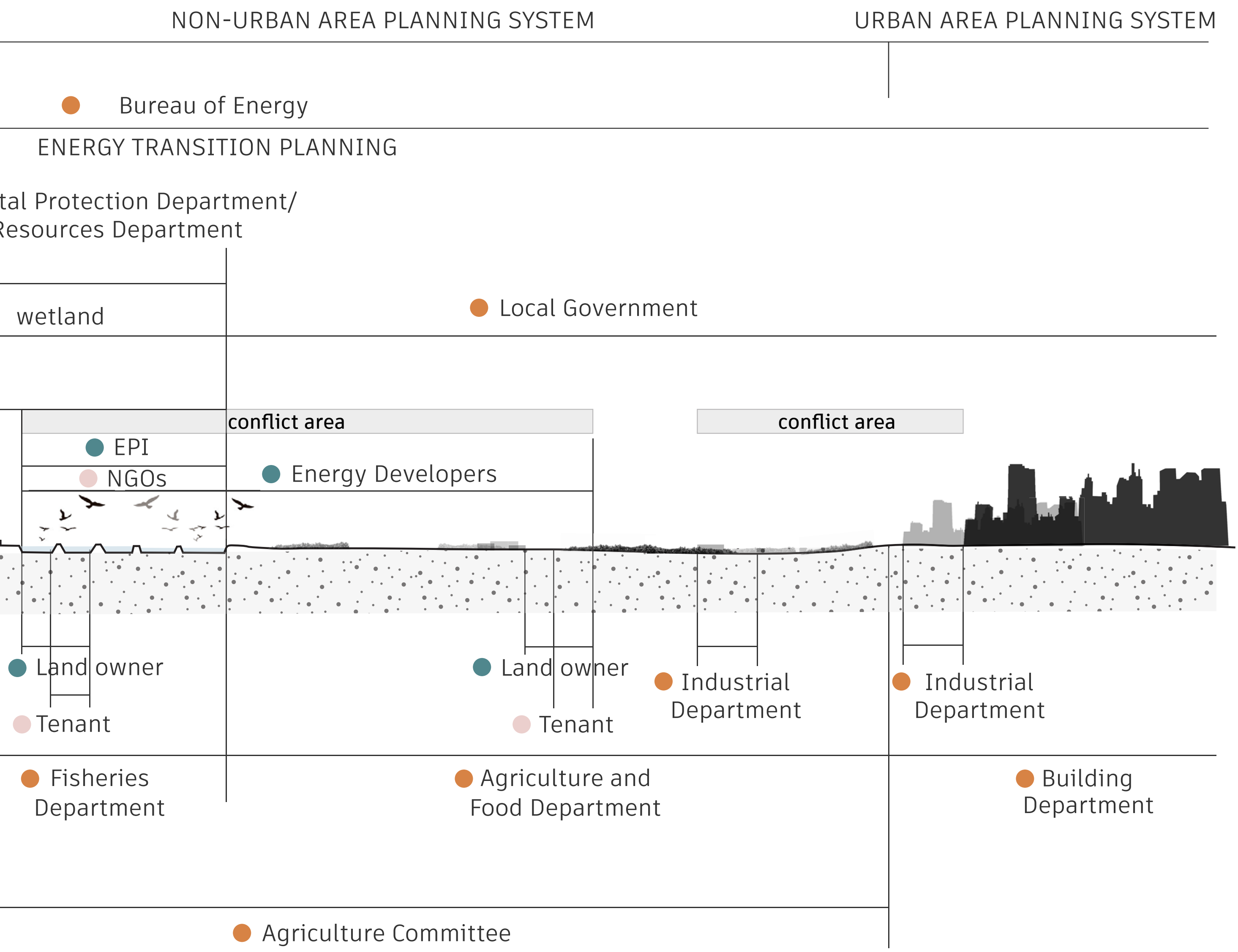


Fig 2.29: Complicated management between sectors and planning systems



Public Sector Private Sector Civic Sector

*Some areas are under military administration

Complicated Onwership

Due to the high population density, the land area is divided into tiny proportions. For example, comparing two photos of the same ratio in Taiwan and the Netherlands shows the two extremes. Furthermore, because of the cultural background of families raising many children in the past, a piece of land has often been divided among several people during the inheritance process.

These contexts have therefore led to the complexity of land ownership in Taiwan. The diagram on the right uses agricultural land as an example to explain why this situation leads to difficulties in the energy transition. Agricultural lands are managed by the Agricultural Council, regarding the type of activities on the land and the permission for land use. However, land use also needs to follow the planning systems under different laws. It is usually easier to require public-owned lands than private-owned ones.

In addition, in many cases, a plot of land does not belong to the farmer but is leased from the owner. Working with renewable energy developments can be more challenging if there are multiple owners of a piece of land. Furthermore, tenants are often overlooked in the transition process in terms of the lease relationship, as the partnership between energy developers and landlords is a mutual contract. If they apply for a change of land use type, the agricultural activities will not continue. Yet, there is no fixed and strong protection against losing the tenant's right to work.

Fig 2.30: A comparison of the complexity of land ownership between Taiwan and the Netherlands. (Google Earth, 2022)

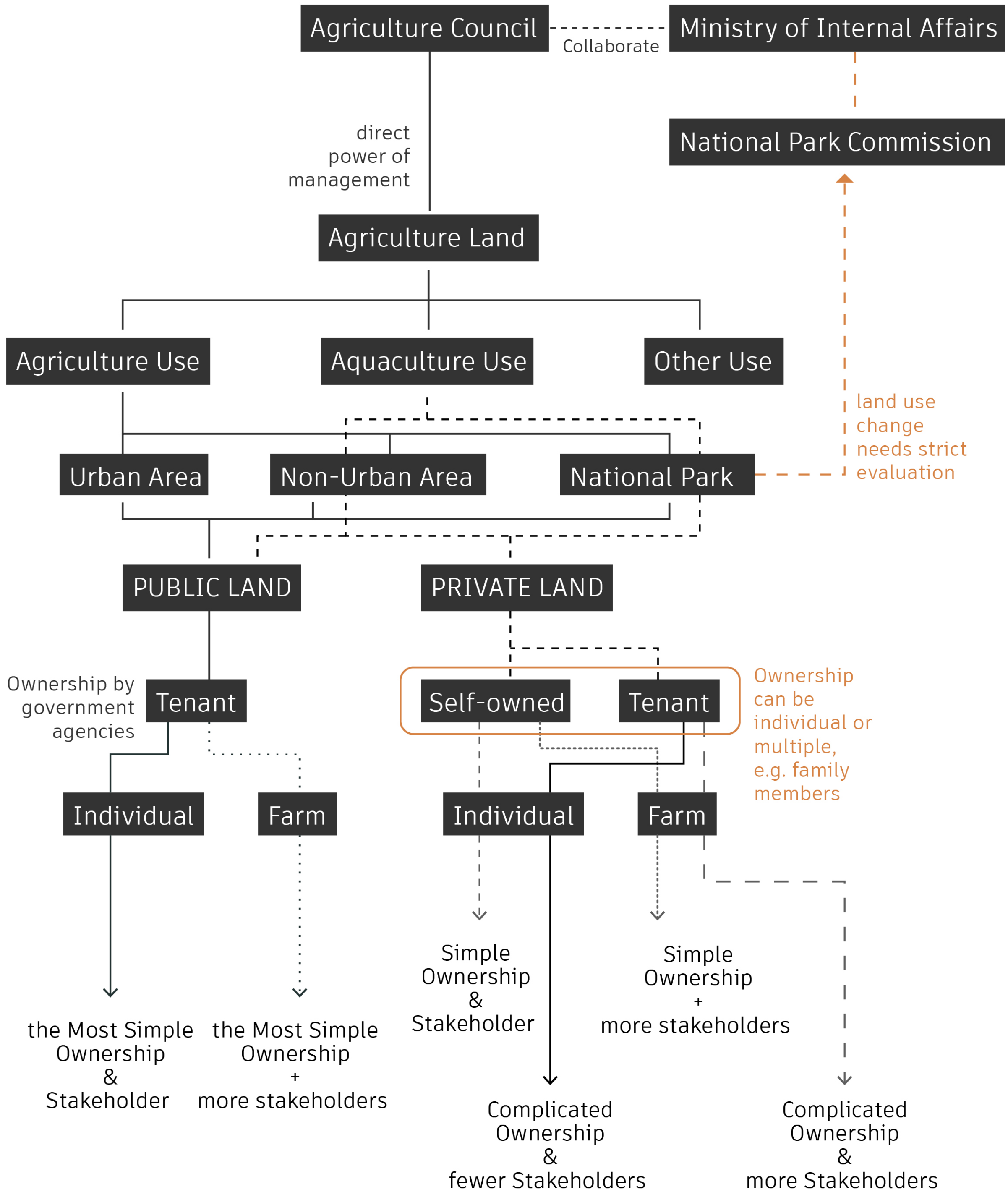


Fig 2.31: Explanation of the complicated onwership in Taiwan by using the agricultural land as an example

Injustice Within The Transition Process

The systemic deficiencies and mismanagement mentioned earlier have led to a number of conflicts in society.

(1) Wind Energy: The Taiwan Strait is rich in wind resources. However, due to the lack of marine spatial planning and related laws, many offshore wind farms have been established without incorporating the rights of fishermen and ecological protection assessments, leading to many conflicts (Zhang, Zhang, Zhang, Liu, Zhang, 2017).

This is particularly true in Changhua County, where 21 of the 36 planned offshore wind farms are located. The planned offshore wind farms occupy more than 50% of the marine spatial area. Local fishermen have lost their rights to work due to incomplete regulations that limit their working space.

In the case of onshore wind turbines, there are no laws but only administrative recommendations regarding the distance to residential areas, which affects the living environment of the inhabitants and makes the rural landscape in some regions irreversible.

(2) Solar Energy With Agriculture: In the early stages, solar power integrated with agriculture received much attention. However, many developers bought small plots of farmland block by block through legal loopholes, "faking farming and selling electricity," causing the fragmentation of farmland in south-central Taiwan that has threatened food security.

As a result, the Agriculture Council has banned multifunctional land use on farmland. Even though this action has stopped the potential food security issue, it has also sacrificed the rights of individual sectors to gain additional profits from the multifunctional use of agricultural land.

(3) Solar Energy with Aquaculture: Since 2018, "Fishery and Electricity Symbiosis" has brought new opportunities for energy transition, claiming to improve aquaculture and produce renewable energy, providing a win-win situation (Fisheries Research Institute, 2019) .

Fish farms in Southern Taiwan serve as valuable ecological habitats for many migratory birds. However, due to poor policies, many outdoor fish farms have been converted into indoor fish farms, leading to massive landscape changes that threaten the ecosystem.

Furthermore, according to Taiwan's energy target of installing 20GW of solar panels by 2025, a quarter of the current fish farms will be affected (Chiu, 2021). This means that in the absence of total control in the region, many fishing villages will face a crisis of PV panels everywhere and lead to an ecological disaster.

Beyond this, it is mainly the developers and landowners who can benefit from the scheme. After developers and the land owners cooperate and change the land use type from the agriculture, tenants have lost their work rights, and do not have method to stop of the change. On the otehr hand, the compensation for the fishermen work lost is also usually goes to specific sectors .

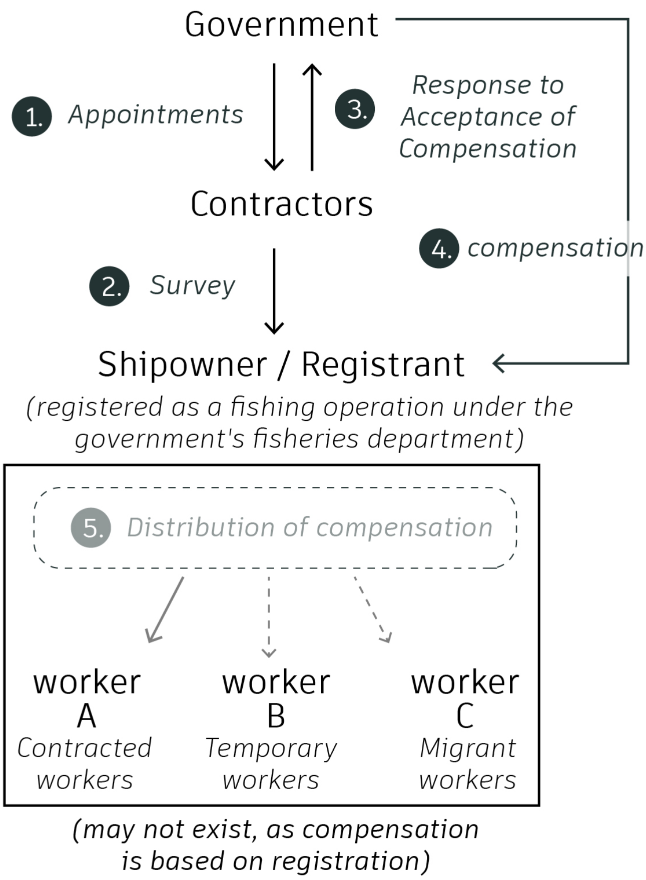


Fig 2.32: Explanation of compensation for fisheries from offshore wind farm construction.

Fig 2.33: Aquaculture landscape transformed into solar panel farms. (PTS+, 2022)

The injustice situations have shown especially in the agriculture and fishery industry. Workers in these two fields have lower education. More than 80% of them do not have university diploma. Besides, almost half of them are under high school education. Specifically, Taiwanese average education level is two to three times than workers in agriculture and fishery industry.

The average age of agricultural and fishery workers is 58.4 and 55.8 years. Furthermore, those over 44 years of age are in a state of extreme ageing at 92.8% in agriculture and 84.5% in the fishing industry. Combined with the level of education, this also shows that even when their right to work is threatened in unfair situations, the voices of protest remain light. Many of them are too old and do not have enough knowledge to fight in these conflicts and have no choice but to accept unfair compensation and leave.

Currently, most of the conflicts are in the fisheries sector as many marine areas are prohibited from work due to the planned offshore wind farms. On the other hand, conflicts in agriculture are mainly in aquaculture due to the government's promotion of the policy of fishery and electricity symbiosis. This means that a large number of farmers will be affected if the restrictions on the multifunctional use of agricultural land are lifted.

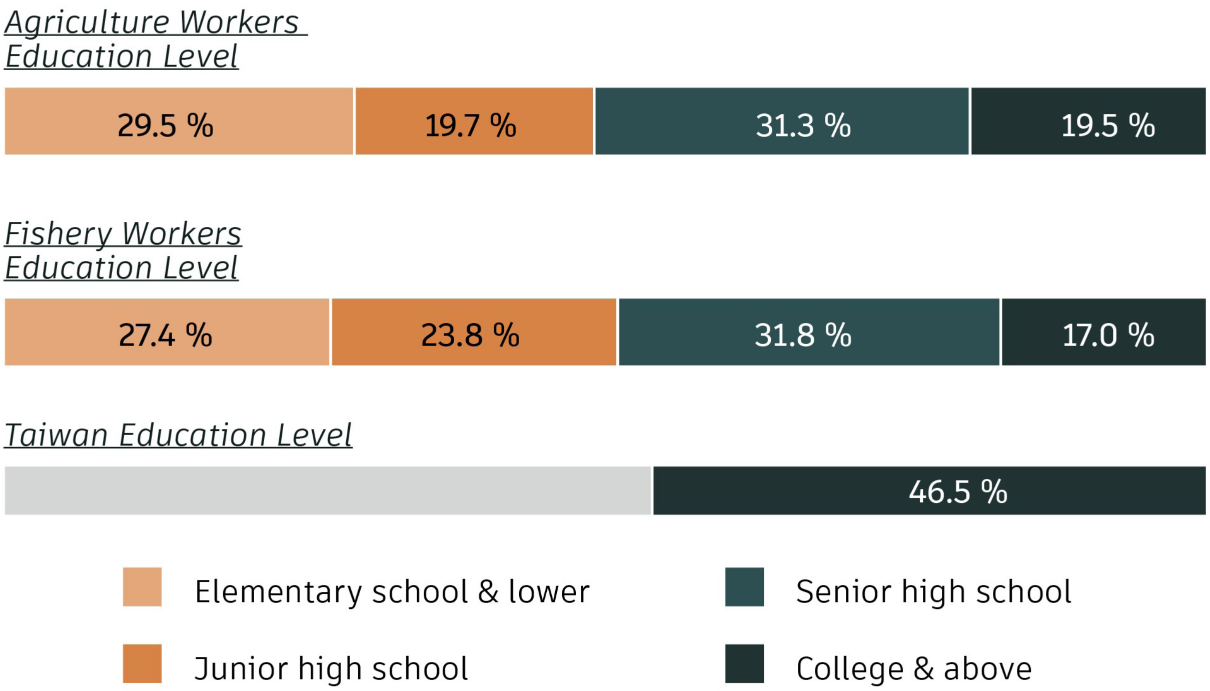
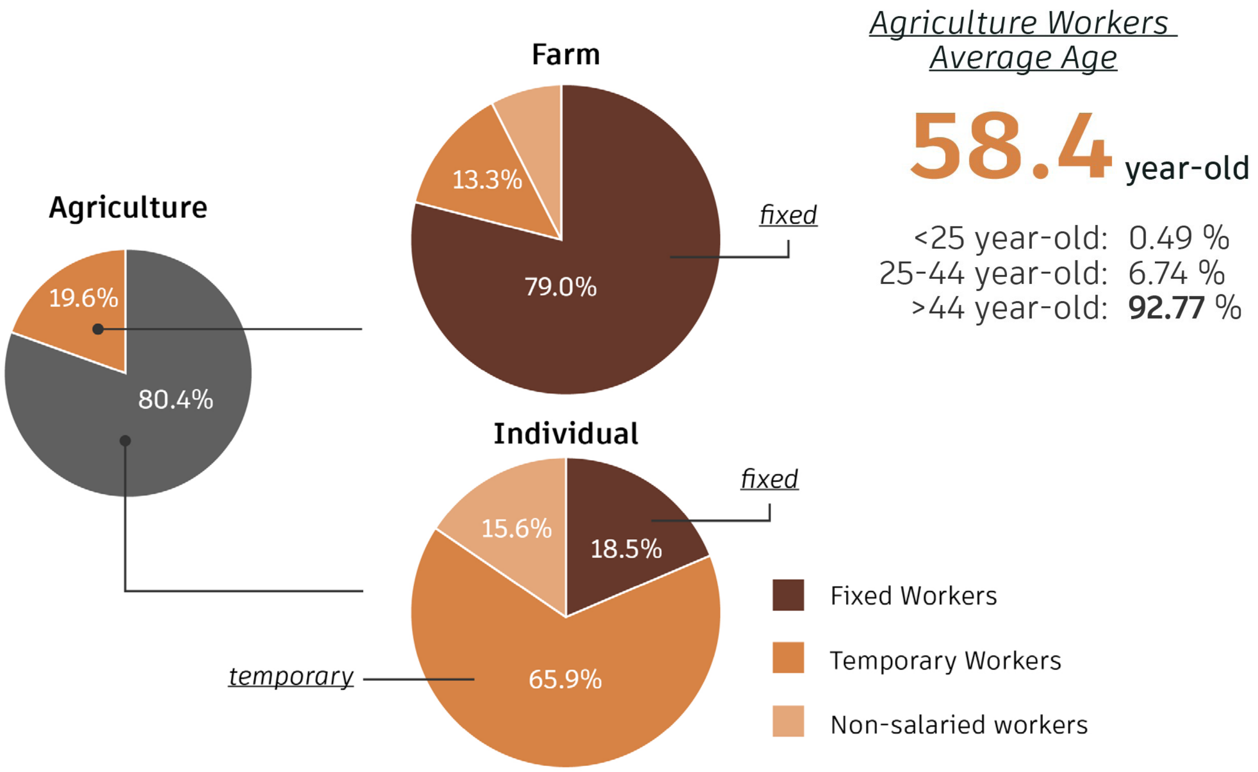


Fig 2.34: Education level in agriculture, fishery, and Taiwan (Executive Yuan, 2022)



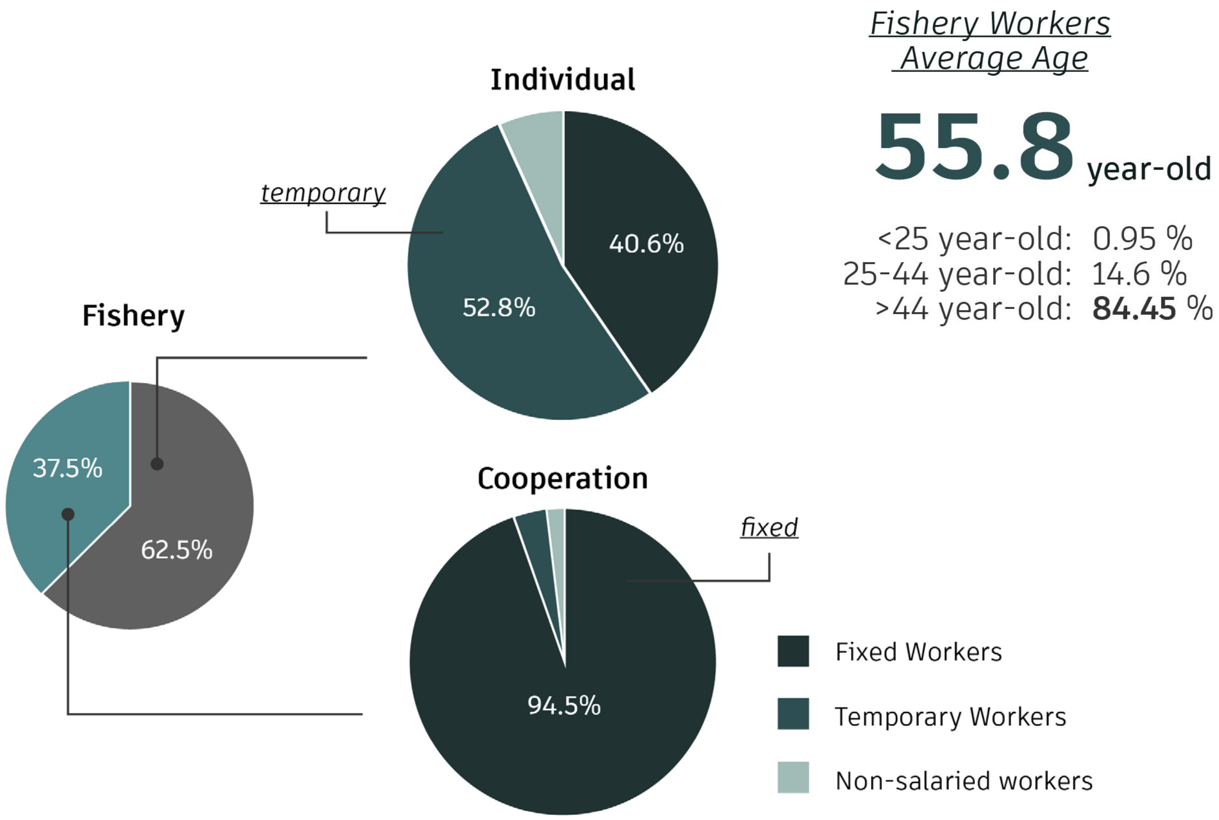


Fig 2.35: Average age of workers in agriculture, fishery, and Taiwan (Executive Yuan, 2022)

Conclusion

Based on the previous analysis, here are the key points that summarise the context of the problems:

1. Lack of a holistic planning

(1) Horizontal cooperation in central government is inefficient. Sectors do not establish a common goal and practical planning principles. Due to the executed sector having a lower administrative level, coordinating higher-level sectors' collaboration is more challenging.

(2) Local governments cannot support top-down energy transition goals because the planning lacks interdisciplinary elements that could guide local governments to prevent or mitigate conflicts.

2. Lack of spatial perspective and planning in the energy transition process

(1) There is no spatial planning vision for the energy transition plan to show the possible implementation location, derivating to social inequalities and threatening ecosystem protection due to interest conflicts.

(2) The land available for the multifunctional use of renewable energy is limited, and no proper experiments support the scientific feasibility.

(3) Planning lacks visualization for visions and goals, which is challenging for stakeholders to associate and imagine the potential impact.

3. Lack of studying on the social impacts of the transition process

(1) Local considerations and challenges are not responded.

(2) Tenants and fishermen are losing their work rights within the transitional process.

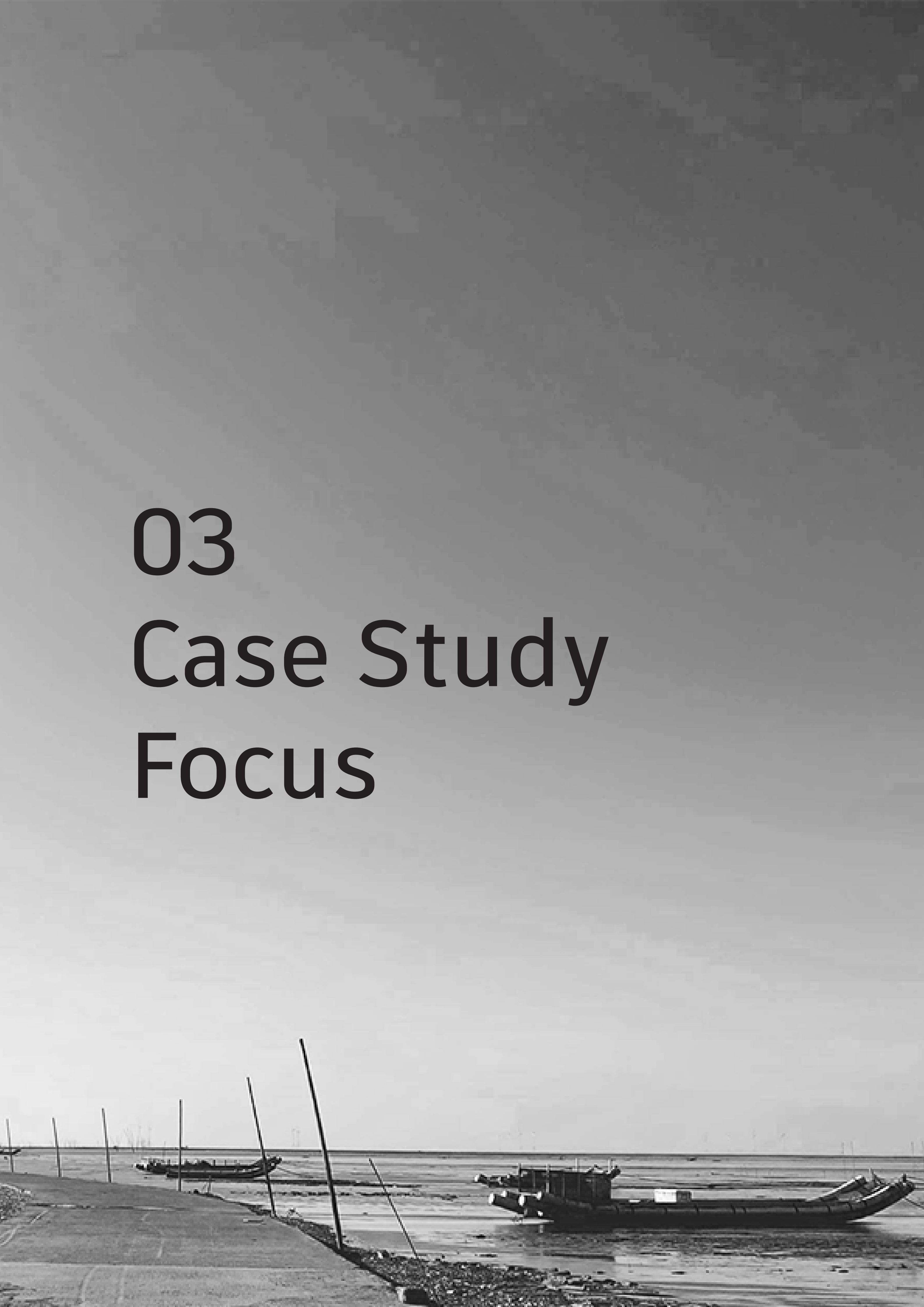
(3) Landscape changes in the village without effective public communication have led to opposition and protests from residents.

(4) An inadequate compensation mechanism has caused unfair distribution, resulting in powerless stakeholders not receiving compensation.

(5) The benefits accrue mainly to energy developers and landowners.

Fig 2.36: Collage of conflicts

03
Case Study Focus



3.1 Introduction: Changhua

General Context of Changhua

Changhua county locates in the middle-west part of Taiwan with 26 townships. Besides the six municipalities, it is the administrative region with the **largest population** and the only one with more than one million residents. Still, Changhua has the **smallest land area** in Taiwan

The topography of Changhua County is dominated by **plains**, with the Changhua Plain on the north and the Turbid River Alluvial Plain on the south. It is one of the essential agricultural development regions known as **Taiwan's Rice Warehouse**.

Due to being close to Taichung municipalities, providing many opportunities, there is a massive immigration to Taichung.

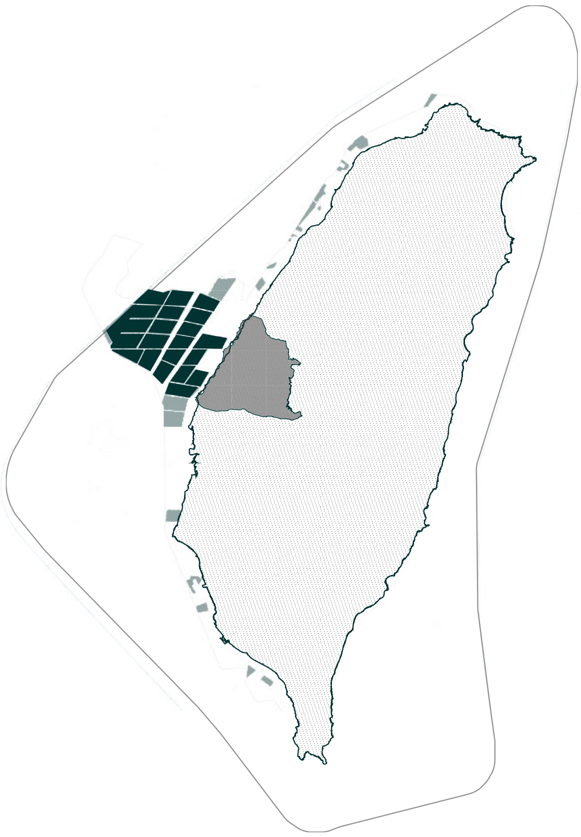


Fig 3.1: Changhua County location

Potential & Threats In Energy

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 owns the **best solar power potential** in the country, which is expected to become an **energy hub** in the future.

Although owning a great potential and is expected to become an essential region for the new emerging green industries, most plans with these new "**opportunities**" are located in **neglected areas** that do not get any attention and dicussion about what can be brought into those communities.

These areas are considered abandoned sites suitable for renewable energy infrastructure. However, there is a lack of planning to prevent **hidden threats in the changing landscape**, which has already happened in other cities. This unpreparedness may only sacrifice the living environment of these left-behind areas.

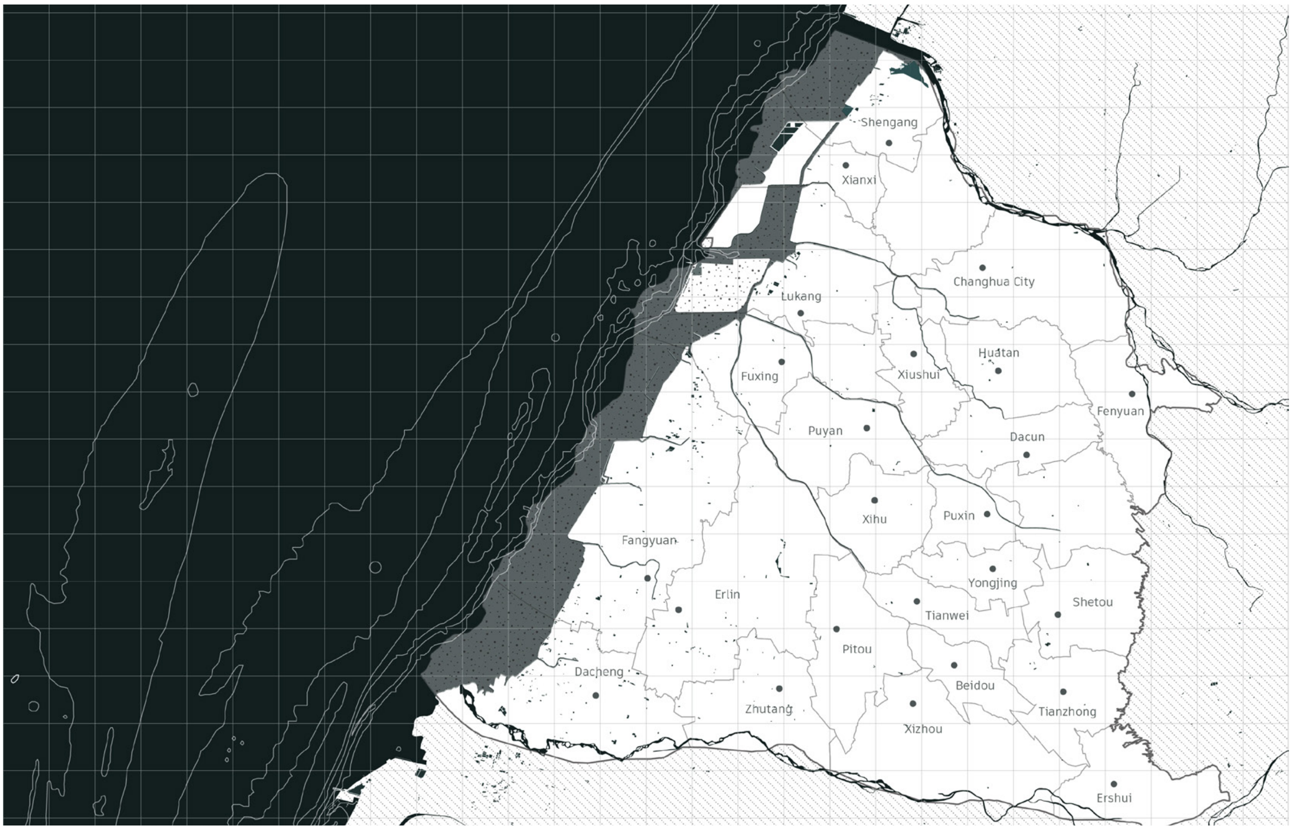


Fig 3.2: Changhua County Township Map

Fig 3.3: Hidden threats of landscape change:Agriculture, aquaculture and seaside areas in Changhua.

Current Situation

As an administrative region, Changhua has the smallest land area, 3% of the total, in Taiwan. While only owning **5%** of Taiwan's population and energy use, it is expected to generate **21%** of renewable energy for the whole country.

Changhua's population has been **declining** since 2012, as in Taiwan in general, with a decreasing number of newborns. However, its **migration** rate has been increasing since 2016.

Most immigrants move to Taichung due to more opportunities for work and study and a more convenient and attractive living environment.

Changhua's **aging index** is much higher than the average in Taiwan, which means the gap between the proportion of elders and the young population is getting more and more significant. Also, some districts' aging index is even **three times** than Taiwan's average.

In addition, the dependency ratio in this region is up to 30%. If the immigration situation can not be reversed, the burden on the prime-age population will grow heavier.

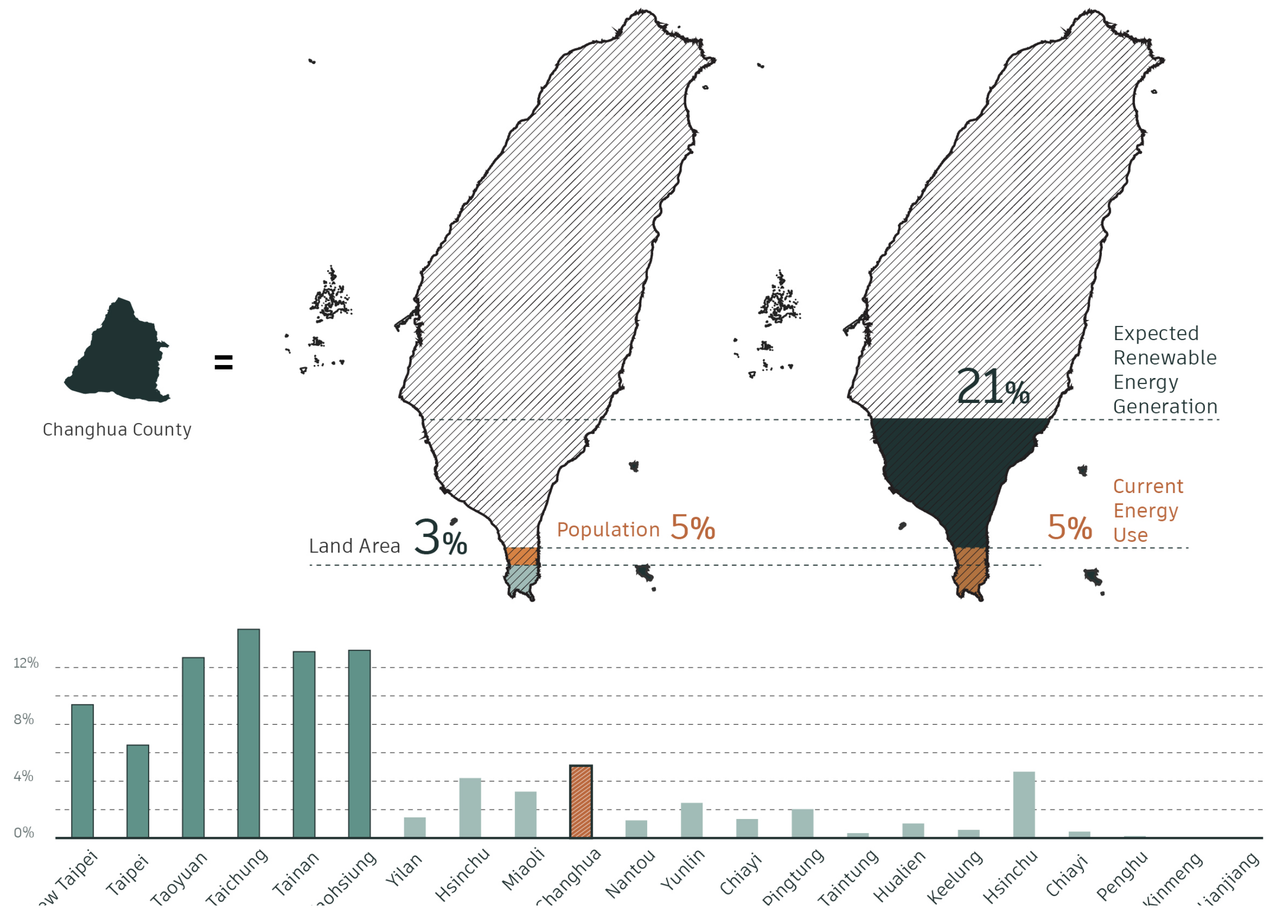
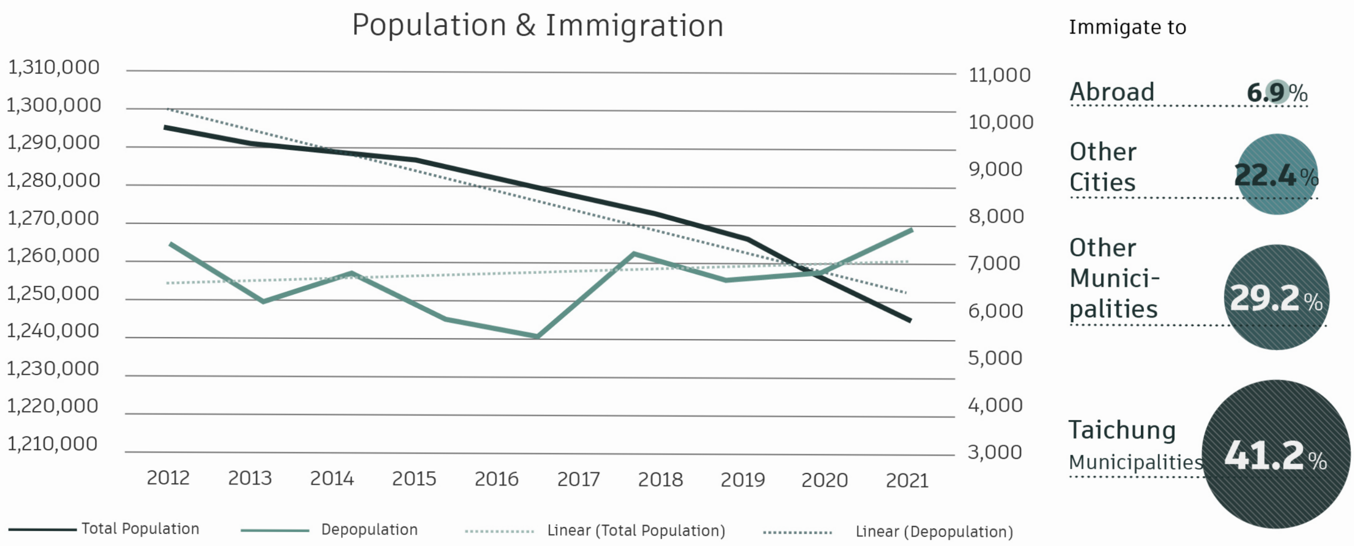


Fig 3.4: basic context of comparasion between Changhua and Taiwan's average: population, land area, expected energy generation in 2025, and current energy use (MEA, 2020)



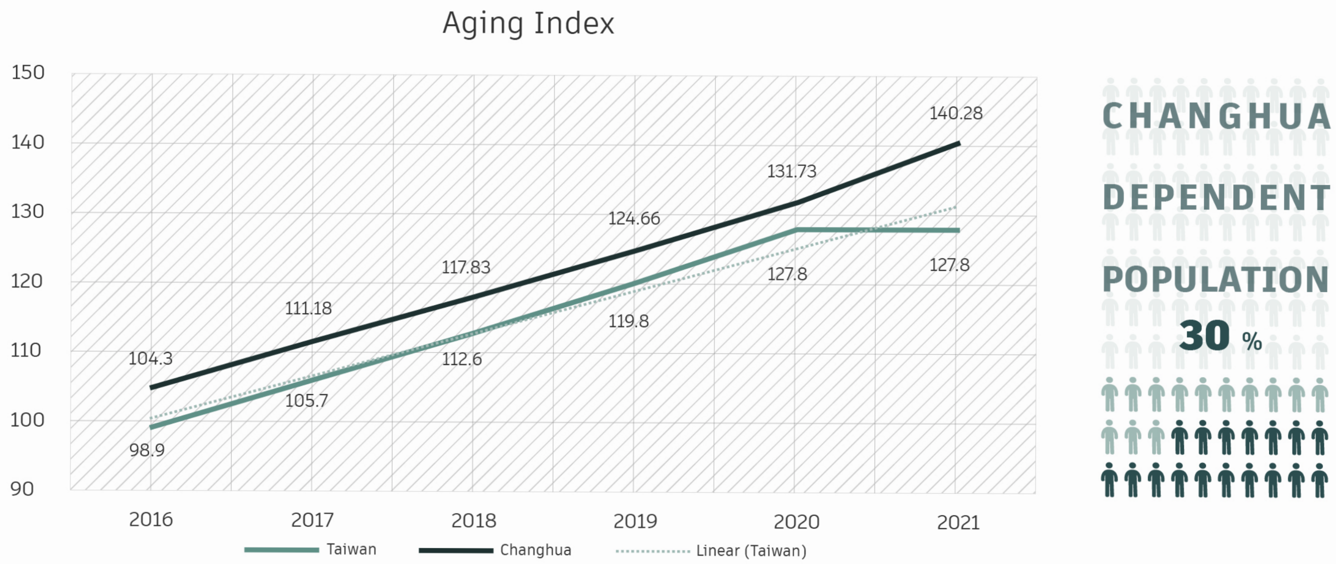


Fig 3.5: Population & immigration rate in Changhua. (Changhua County Office of the Comptroller, 2021)
Fig 3.6: Aging index in Changhua and Taiwan's average. (Changhua County Office of the Comptroller, 2021)

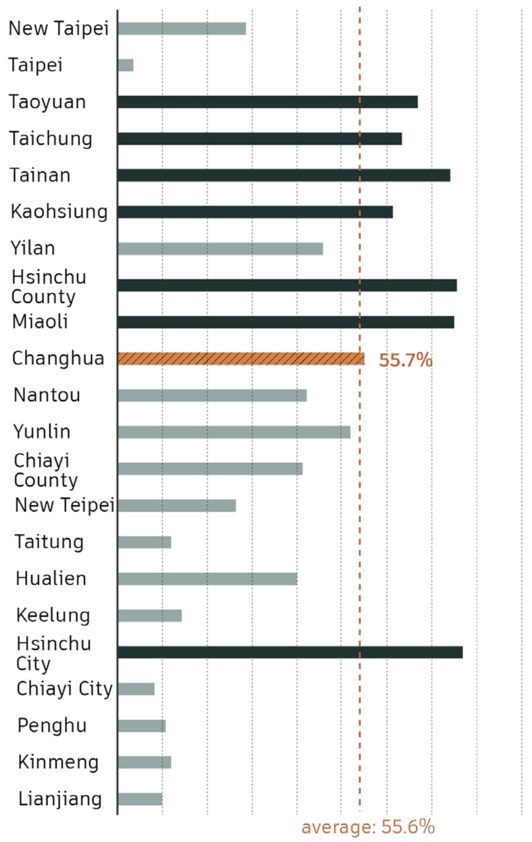
Uneven Development and Resource Allocation

As mentioned previously, Changhua is expected to generate more than **one-fifth of all electricity used** in Taiwan from renewable sources by 2025. When looking at Changhua's energy use mix in more detail, more than half of the energy is used for industrial activities. In comparison, non-industrial uses account for 44%. Of the energy used for non-industrial purposes, 49% is used for residential, 34% for commercial, 10% for agriculture, and 7% for administration.

However, most renewable energy programs are located in areas that are not competitive, also known as neglected areas, such as the darkest blue area in the graph shown on the right page.

In general, this type of development may lead to more opportunities or perceived chances for revitalization. However, there is no discussion of relative development to improve the living environment or create value through this process. **Instead, it only leaves the infrastructure that surrounds the neighborhood, as there is a social stereotype that infrastructure is an unpleasant existence.**

This uneven development will only lead to more **socio-economic injustice** due to the **inequitable distribution** of resources and infrastructure within the county.



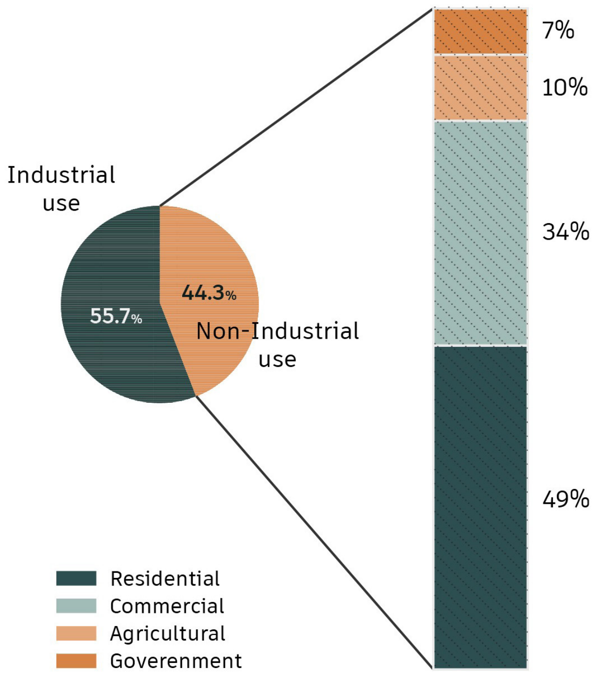


Fig 3.7: Industrial nergy use in different cities. (MEA,2021)
Fig 3.8 Energy use structure in Changhua (Changhua County government, 2021)

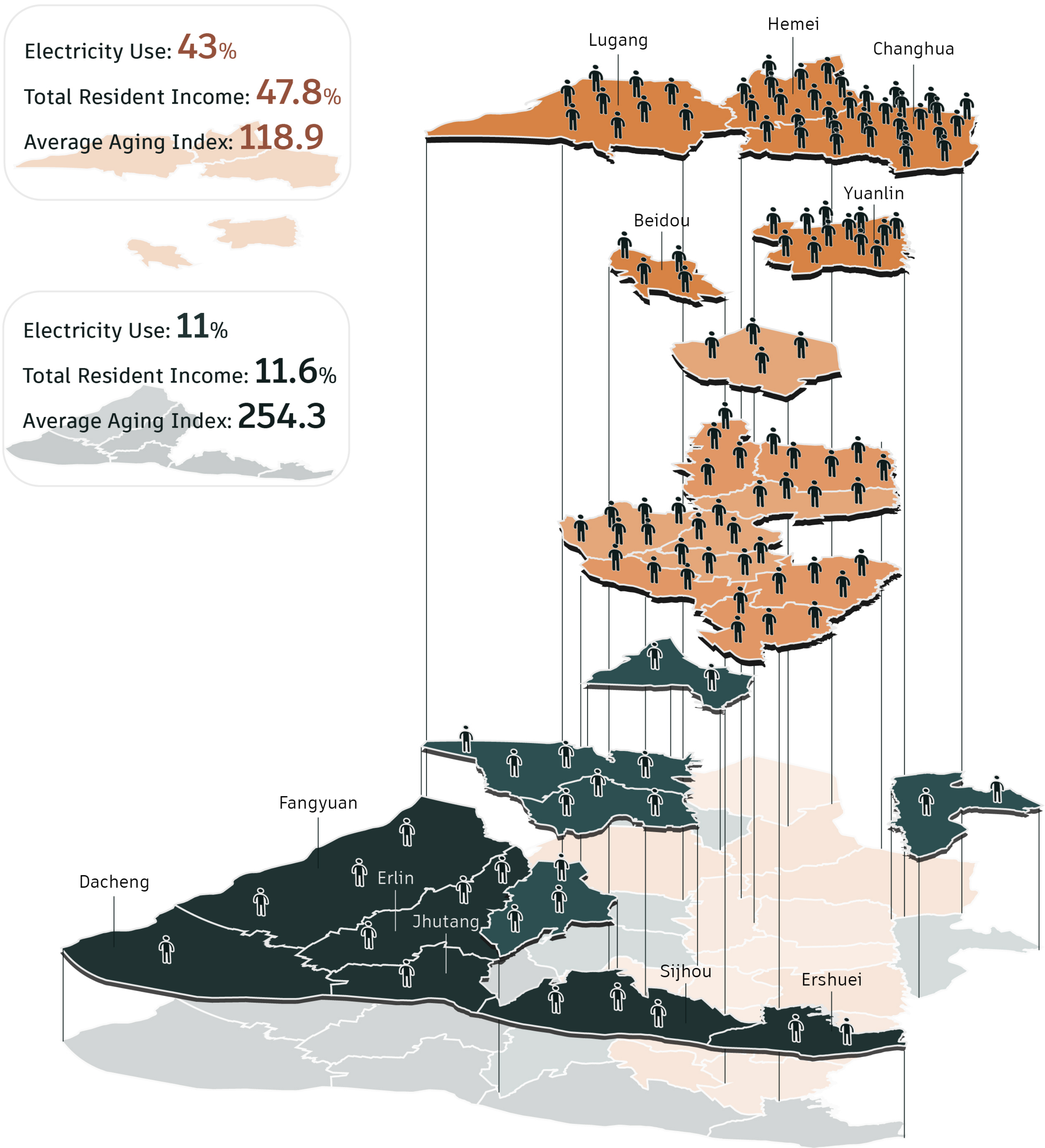


Fig 3.9: Population density and population mapping, showing the uneven development.

3.2 Problem Statement

Taiwan's energy transition process has been facing several difficulties. Besides the natural limitation and the government's focus on particular types of renewable energy, the **fragmenting cooperation** between departments at various levels has hampered the transition. The **lack of holistic** energy transition **planning** involving spatial, social, and governance aspects has led to a dichotomy between sectors at all levels. In addition, there is **no clear guidance** for local governments to follow on the energy transition, leading to top-down goals that are not supported from the bottom up.

Changhua has an abundant wind energy potential. Of the 36 most efficient offshore wind farms in Taiwan, 21 are in Changhua. In addition, this region's solar potential is the best in Taiwan. However, Changhua is one of the least urbanized regions in the country, with significant population loss.

Due to the **inequality** of **regional development,** there are considerable differences in the distribution of resources among townships in Changhua. Many townships are coded uncompetitive areas, allowing rural elders to continue working in "undesirable**"** industries.

Coupled with mistrust and misunderstanding, most energy infrastructure is built in these "neglected" and "unpleasant" areas to support the needs of most other "important" areas. The absence of research on the relationship and **potential impact** on the surrounding environment only **exacerbates the unequal development** within Changhua, scarring poorer groups and ignoring the potential benefits to society.

These **inequalities** are not only found in Changhua. The lack of dialogue with stakeholders, especially local residents and powerless individuals, has already created many conflicts in society. In other words, if **social and spatial considerations** are not included in the energy transition process, more and more people will lose their right to live and work. And due to the systemic deficiencies, the whole industrial structure may be threatened in the long run.

Fig 3.10: energy landscape caused the conflicts within society (Xu Zhen Tang& Lin Ji Yang, 2021)

3.3 Research Question

Main Question

The main research question aims to overcome the absence of inclusion within the top-down planning of **spatial** and **social aspects**, which has led to several conflicts in the community. And based on the energyscape study, which includes the environmental perspective, about the **impacts** on society at a local scale to help **bridge** the **top-down goal** from the bottom, providing the path towards a just energy transition.

Sub-Questions

The sub-questions can be divided into two parts: the "**what**" foundation and the "**how**" exploration.

As shown on the right, the colors match the different research scales and keywords.

Pink is based on analyzing **spatial** and **social** perspectives at the **local** scale. Orange implies the concept of **regional** scale and **integrated** planning. Finally, dark blue represents a top-down perspective that allows for the study of **national-scale** planning and the concept of **justice.**

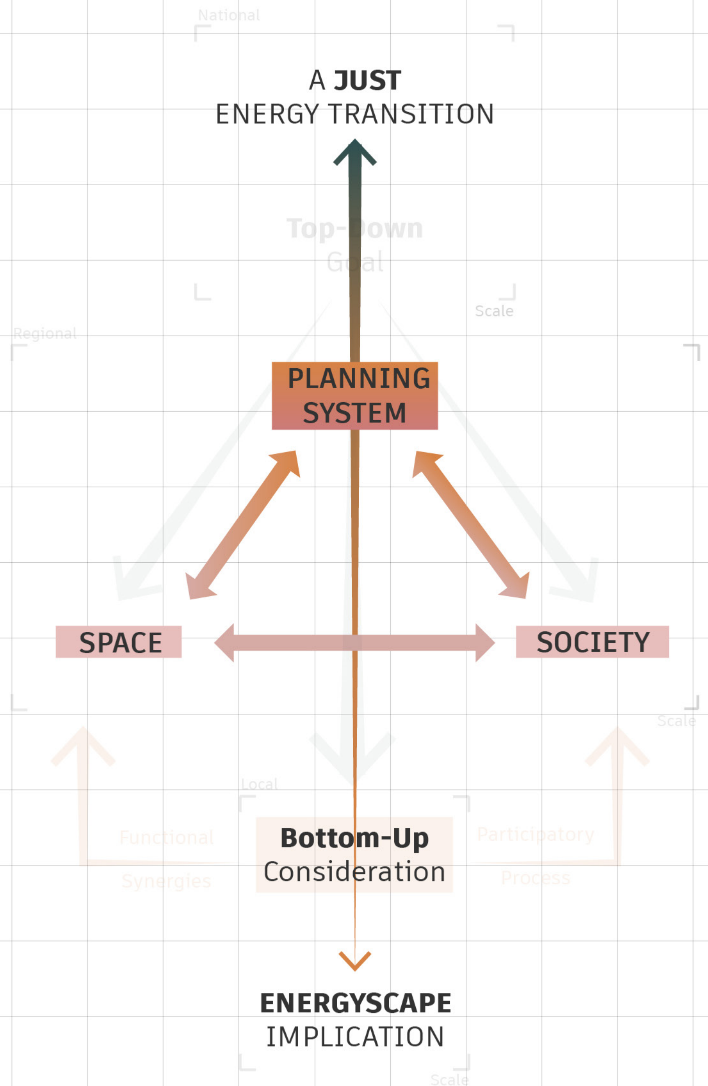


Fig 3.11: Research questions

Research Question

What **spatial** and **social** **needs** and considerations should be included in regional planning and design, building up the systemic changes for **integrated planning** for **a just** energy transition in Taiwan?

Sub-Questions

What are the impacts of the energyscape on the surrounding environment?

What systemic deficiences are hidden in the current energy transition planning that needs to be changed?

How can regional planning and design drive systemic change to develop an integrated plan for the energy transition?

How can resources be reallocated to create value and rebuild social equity for neglected areas?

How can research on the implications of energyscapes help redistribute the power and interests of stakeholders in the energy transition?

3.4 Conceptual Framework

Conceptualize: The Current Situation

The separated planning system has caused several conflicts within society. Even though there is a specific goal in the energy transition, it has yet to come with spatial and social perspectives. Besides, local considerations can not be heard and tackled due to systemic deficiencies.

In the previous explanation of the relationship between energy and space, energy geography, energy landscape, and energyscape, energyscape is chosen as an essential concept in this thesis because it includes the consideration of the environmental perspective.

The misunderstandings and confusion about the changes by energy transition happen not only locally but also at the top. That is, the gap between the top-down goal and bottom-up considerations should be bridged by understanding the implications of energyscape: what it will bring to the environment and society, and what should be included and rethought in the top-down guidance to mitigate the conflicts within the community.

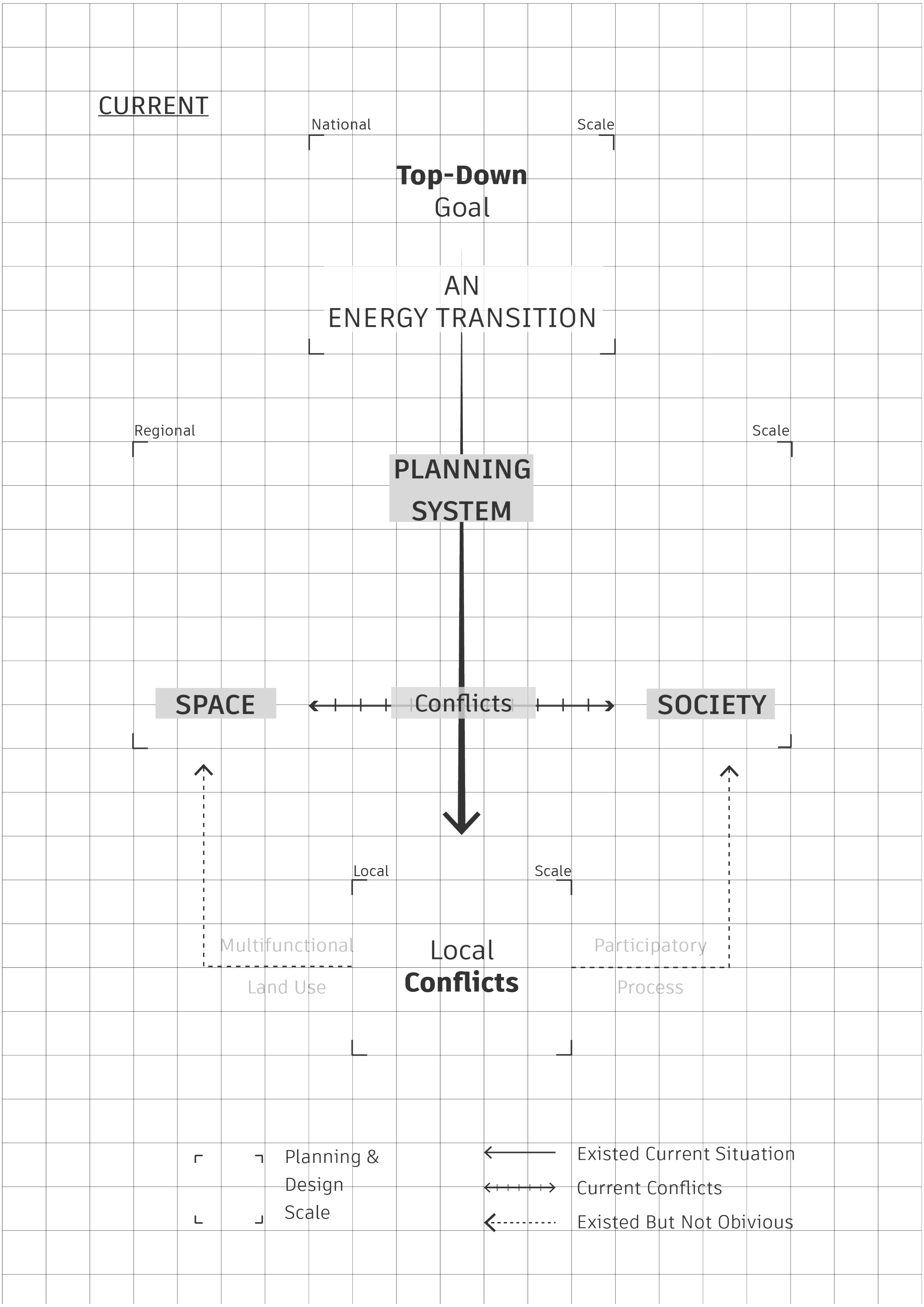


Fig 3.12: Conceptualize current situation

Conceptual Framework For Proposal

A conceptual framework is developed from the analysis of the problem fields, the case study focus, and the conceptual framework of the current situation. The proposed conceptual framework is shown here. See below for definitions and explanations of key words.

Energy landscape impact studies from the local scale provide **bottom-up considerations** in spatial and social perspectives to **bridge the gap** between top-down goals with the principles of establishing **distributional and procedural justice**. As a result, an **integrated planning system** can be redefined with the value creation of **spatial adaptability** and **social inclusivity** through functional synergies and participatory processes. That is, resources can be reallocated, power and benefits can be redistributed, and collaboration can improve governance and help to create a **just** energy transition.

Distributive justice implies the fair distribution of resources and the creation of results. **Procedural justice** means a fine process of creation and decision-making with consideration of the fairness of the rules. Other key values, **Integration**, **Adaptability**, and **Inclusivity**, are defined below based on the literature review.

Integration in this project is to define that through policy integration to help reorganize and build up collaboration between different sectors at all levels. Besides, a particular focus is the purpose of promoting coordination on the horizontal and vertical spectrums of policy (Nadin, V., et. al., 2020).

Adaptability: the adaptiveness component means to adopt in order to deal with instabilities in the decision mechanism and tackle uncertainties derived from imperative zoning models. As for this study, it is used to emphasize on creating capacity for space to adjust and adapt for the uncertainty.

Inclusivity: emphasizes on the inclusion of the entire community in the planning process. Pariticipation is one of the key point to support the value of inclusicity. The concept of participatory emerged in response to the centralized and rationalistic approaches that defined early urban planning work (Marcus B., 2005). Participatory in this thesis aims to increase the public awarness and engagement, creating inclusivity for stakeholders.

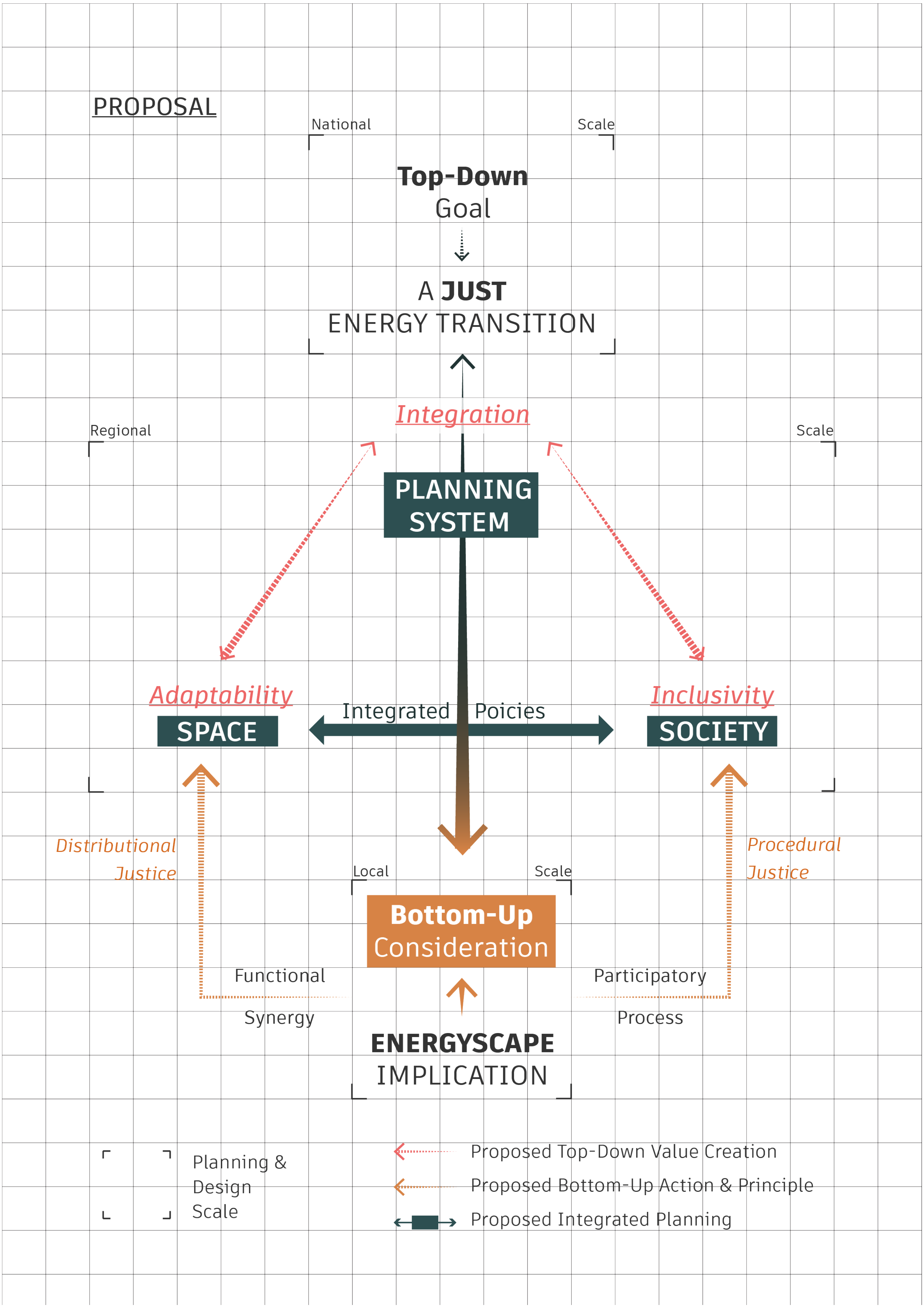


Fig 3.13: Conceptual Framework: proposal

Expected Products

The expected products of this research are three: (1) energy transition integrated policy advices; (2) integration strategy for spatial planning; and (3) energyscape template design. These products are matched with different scales from local, regional, to national. Explanation will be listed from the local scale to the national scale.

(1) Energyscape Template Design: this product is a proposal for use in the participatory process. The templates are designed based on an integrated planning system (National Spatial Planning). It develops variables with criteria for integrating renewable energy based on different land use zones, such as the choice of energy sources, the rate of cover allowed, minimum distances from settlements, and the flexibility for further detailed design with stakeholders. These templates can also be seen as a prototype of a design methodology that can be refined and improved after the regulations and laws of National Spatial Planning are complete.

(2) Integration Strategy For Spatial Planning: This product will be based on the case study area, Changhua County. It presents the principles from the vision of this study and shows the possibilities for change in the area. There are three categories of integrated strategies: systemic, spatial, and social. In other words, they are used to present the possibility of creating a just energy transition in Changhua County, focusing on approaches implementation to maximize opportunities and reverse vulnerabilities.

(3) Energy Transition Integrated Policy Advices: Based on the integration strategies of the case study areas, it provides recommendations for key points of integration into national energy transition planning to create a just energy transition process with values. In addition, the proposal discusses approaches to improve the current planning system and considerations that a new integrated planning system could include.

*The Integrated Planning System is a new planning system, to be implemented in Taiwan in 2025, that combines marine spatial planning with three existing spatial planning systems: urban planning, non-urban planning and national park planning.

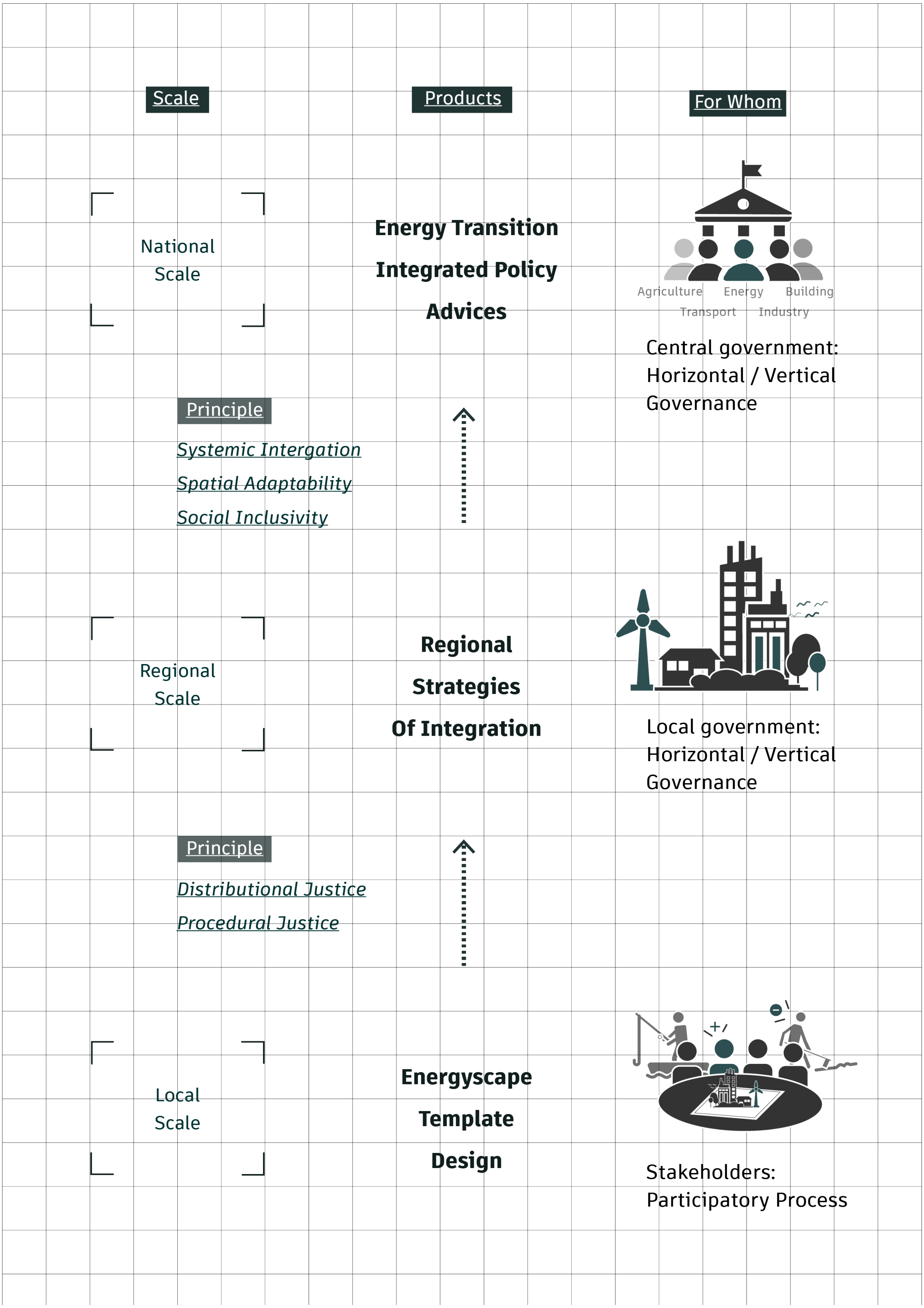


Fig 3.14: Expected products: scale & target groups

3.5 Methodology

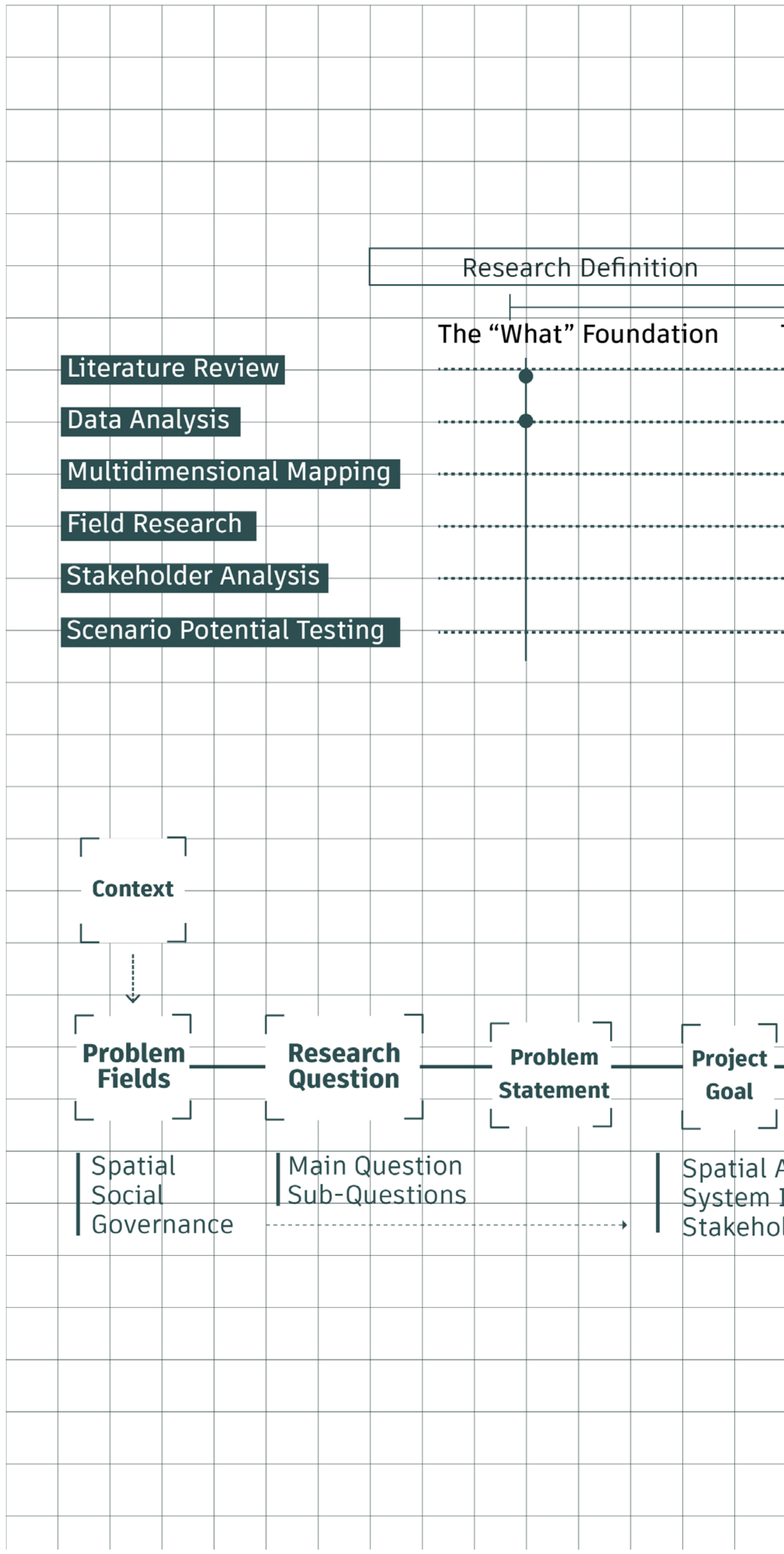
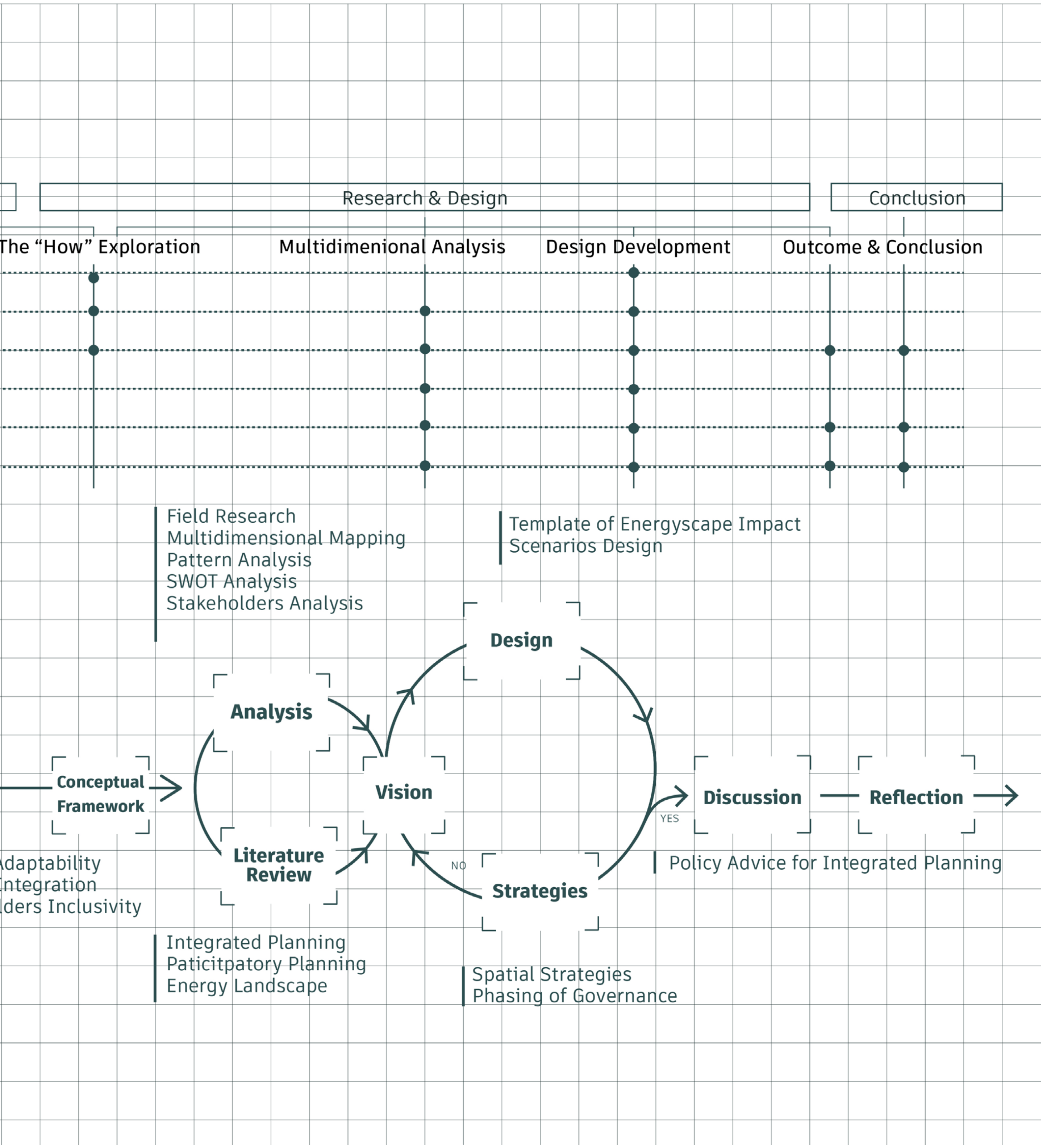


Fig 3.15: Methodology

The thesis will be divided into three main parts: research definition, research and design, and conclusion. Five phases support these three parts:
1. the “What” foundation
2. the How” exploration
3. multidimensional analysis
4. design development
5.conclusion

Throughout the stages of this research, primarily six methods will be used: Literature review, Data analysis, Multidimensional mapping, Stakeholder analysis, and scenario potential testing.


Research & Design
Conclusion
The “How” Exploration
Multidimenional Analysis
Design Development
Outcome & Conclusion
Field Research
Multidimensional Mapping
Pattern Analysis
SWOT Analysis
Stakeholders Analysis
Template of Energyscape Impact
Scenarios Design
Design
Analysis
Conceptual Framework
Vision
Discussion
Reflection
YES
NO
Literature Review
Strategies
Policy Advice for Integrated Planning
Adaptability
Integration
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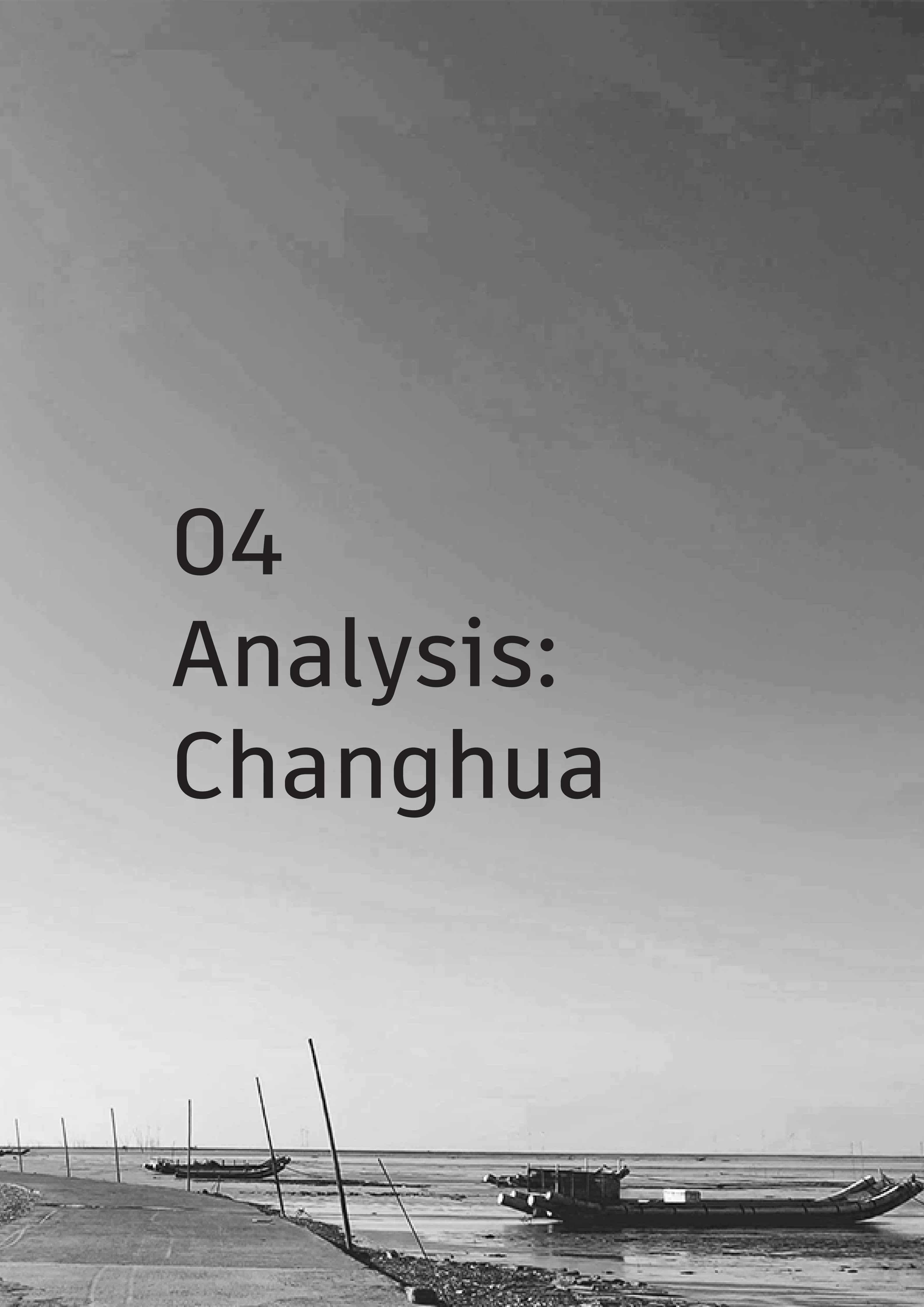
Integrated Planning
Paticitpatory Planning
Energy Landscape
Spatial Strategies
Phasing of Governance



04
Analysis: Changhua

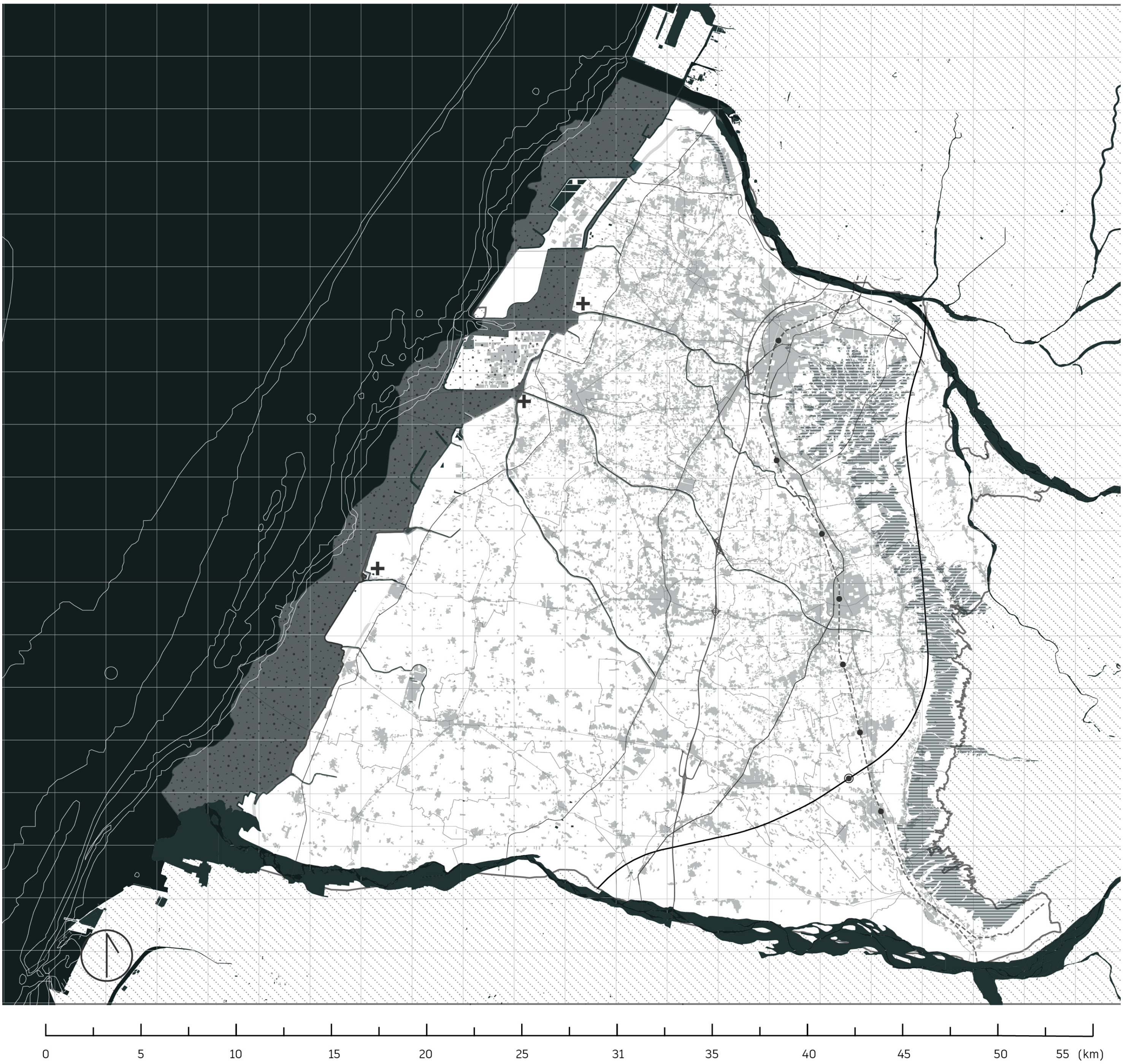
4.1 Spatial Analysis

Built Environment

Based on the density of the built environment shows the resources concentrated areas and also indicates the opportunities located and competitiveness. And based on the size of the built environment, which is developed due to urban expansion, it also presents the development degree.

Changhua has one city and twenty-three townships. People mainly live on the east and north sides of Changhua. It shows clearly that the pattern of the building environment is developing along the infrastructure lines in terms of the railway and primary roads. It is worth noticing that most of the high-density areas are centralized by the railway station, and the city has expanded outward like concentric circles. On the other hand, the south and west part has a smaller scale of urbanized areas, revealing the unbalanced development within the township.

HSRW, on the other hand, is a new type of transportation, and each big city in western Taiwan has one. In order to balance the uneven development in the north and south parts of Changhua County, the HSRW station is located in the south, which has brought some population to the south in the past few years.



Building Environment & Transportation

Building Environment

Mountain Area

High Speed Railway

Railway

Highway

Primary Road

HSRW Station

Railway Station

Port

Fig 4.1: Building environment map.

Agricultural Land

Agricultural land area in Changhua Couty is accouted for 63.71% within urba area and non-urban area, which accouts for 89.2%. Besides, the land use can be divided into agriculture and aqualculture activities.

In agricultural development, rice is the majority product, mainly grown in the northern part of Changhua.

Aquaculture is mainly concentrated along the coast. Outdoor fish farms also provide an essential environment to support the ecosystem of many migratory birds, waterfowl, and various species of organisms.

However, there are hidden huge amounts of illegal factories in this vast area of agriculture. According to the government's investigation, illegal factories account for a quarter of the agricultural land without agricultural use. Even so, it might provide a chance for collaborating with multifunctional use of renewable energy on the agricultural land area.

On the other hand, many farm areas are unused or abandoned within this vast agricultural land, especially in the southwest of Changhua. That is, the actual available regions for the multifunctional still need to be evaluated.

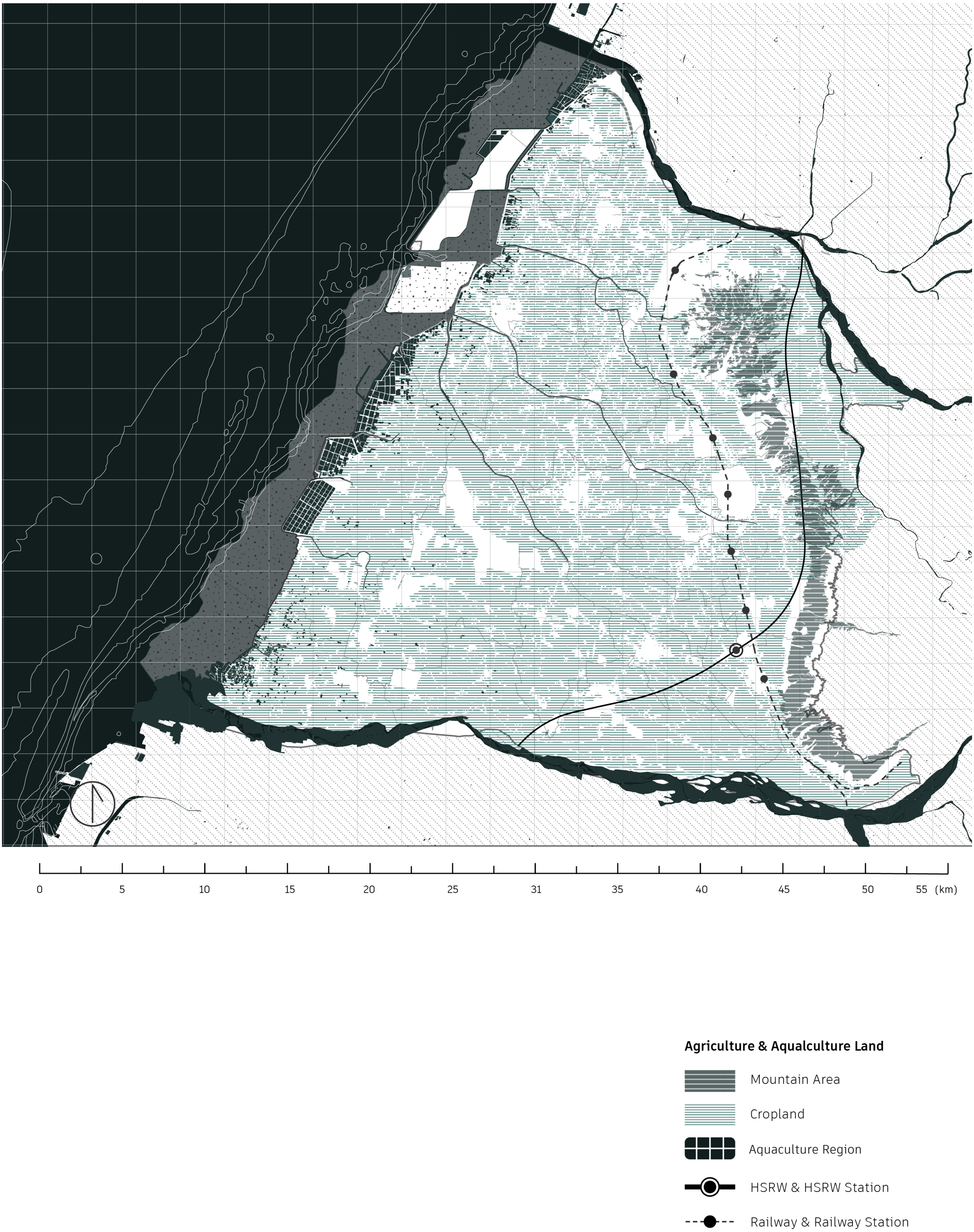


Fig 4.2: Agricultural land map.

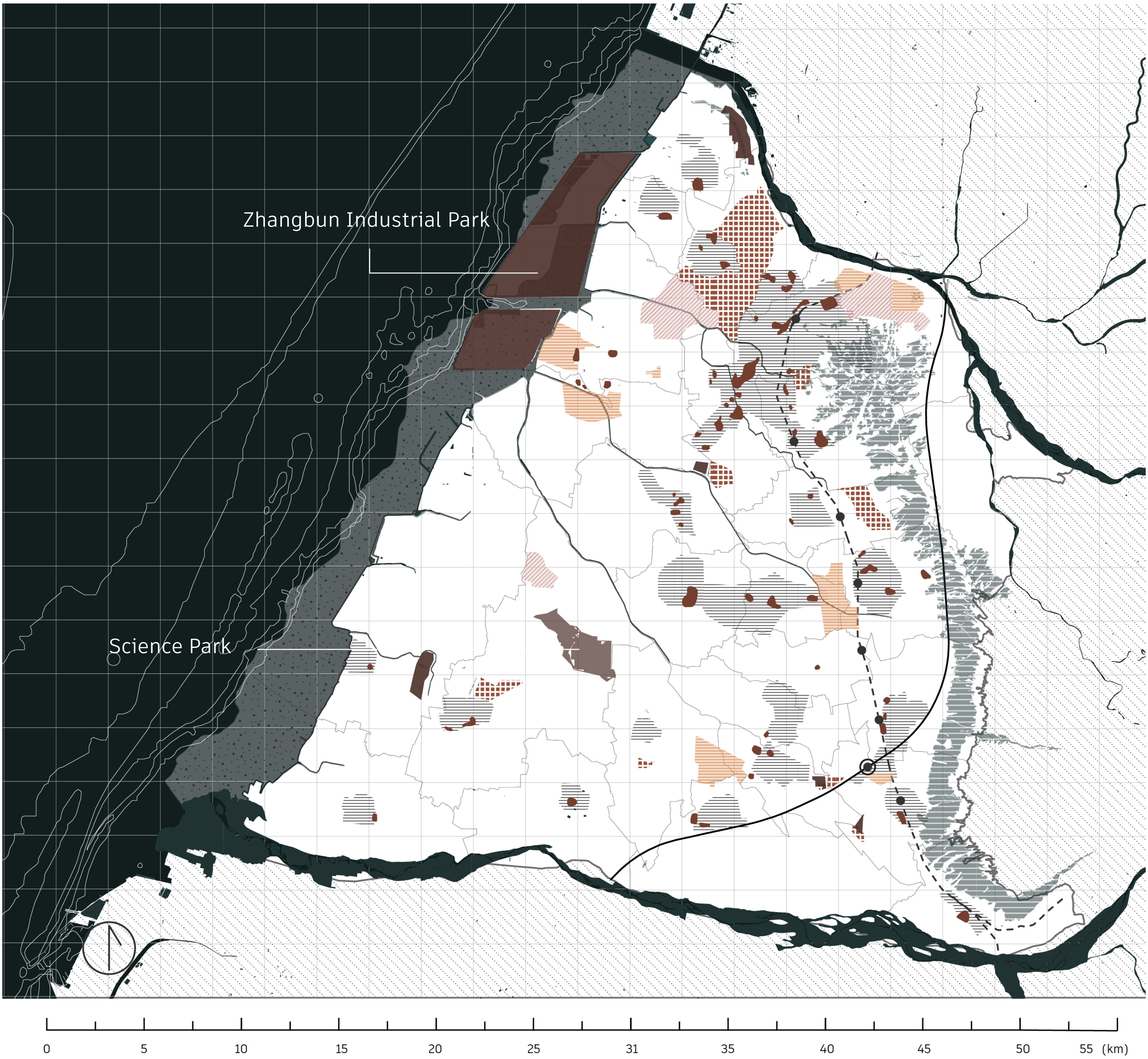
Industrial & Development Zone

The main industrial activities are located in the north, such as the most significant industrial zone, Zhangbun Industrial Park, located in Siansi Township and Lugang Township, and Shengang Township. The park is an off-island industrial zone developed from newly reclaimed land.

It is a mixed-use area, partly light industrial and somewhat heavy industrial, but it also promotes recreational and tourist activities. On top of that, the largest solar power plant in Changhua is also located here. On-shore wind turbines are also allocated around the park.

The second sizable industrial zone in Changhua County is located in Erlin Township and will be put out to tender to start in 2023. It is expected to be a park capable of supporting high-tech work for Taichung Science Park, which may create opportunities to improve southern Changhua's living and working environment. Most other industrial zones are located along the railway lines and the primary road for better accessibility.

It is noteworthy that many of the development areas under planning are in the northern and eastern parts of Changhua. However, judging from the apparently unbalanced development in the northeast and southwest, there is no solid reason for this investment distribution, which only underlines the inequitable resource deployment.



Industrial Zone & Development Map

- Urbanized Area
- Industrial Zone or Area
- Planning Industrial Zone
- Planning for Future Development Use Zone
- Planning New Residential Area
- Mountain Area
- HSRW & HSRW Station
- Railway & Railway Station

Fig 4.3: Industrial and development areas map.

4.2 Socio-Economic Analysis

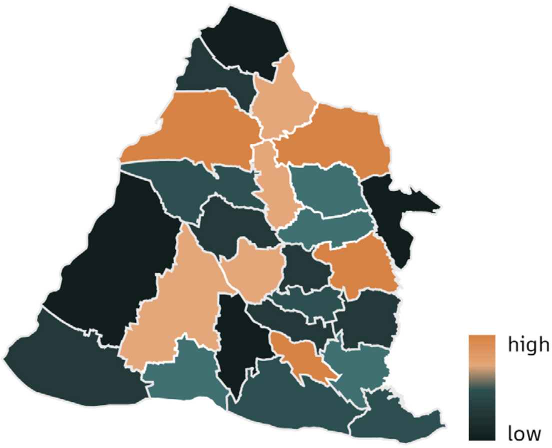
Current Socio-Economic Situation

This eighth graph of mapping results shows that the uneven development is not only happening in the spatial domains but also has led to an unequal socio-economic situation.

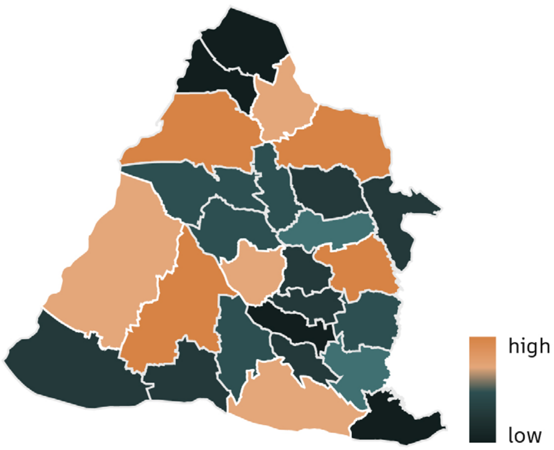
Population and density are generally concentrated in the northeastern part of Changhua, which also comes with a high migration rate. Dacun is the only positive migration township because the location is next to one of the primary districts, Yuanlin Township, caused by an urban spillover effect.

Compared with the aging index and the average individual income, it is evident that those areas with a high aged index also combine with lower annual income.

On the other hand, school density does not have a noticeable difference in the spatial perspectives; some low-developed townships still have a similar number of schools with more urbanized areas. Yet, if we zoom into the area, higher education is still distributed only in the northeastern side.



Average Individual Income



School Density

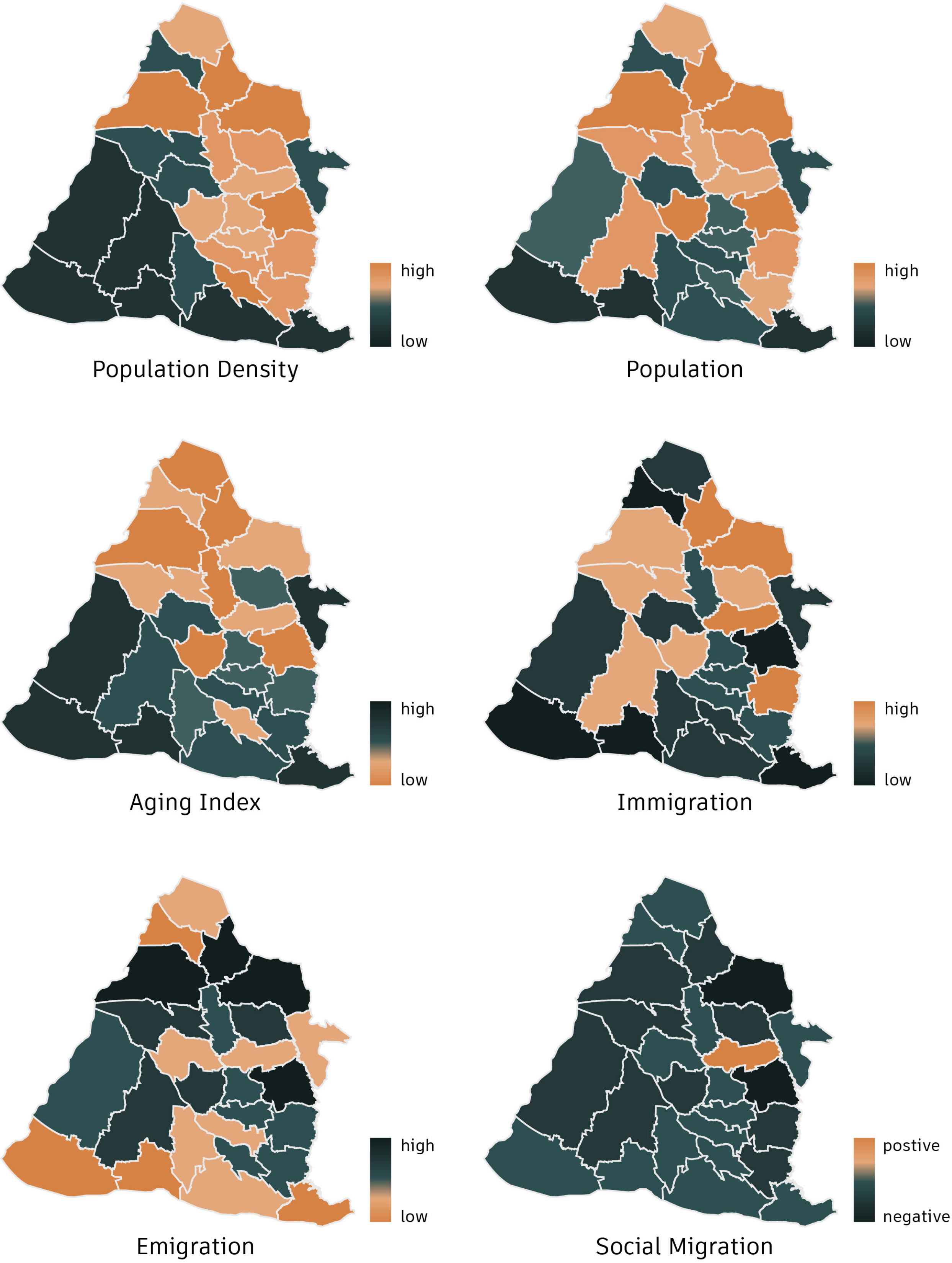


Fig 4.4: Socio-economic analysis map.

4.3 Environmental Analysis

Environmental Disasters From The Sea

Faced with climate change and rising average temperatures, Changhua, as a plain area, also faces a high potential disaster risk of sea level rise.

Based on the most widely known scenario currently used in Taiwan, if the sea level rises by 2 meters by 2100, all townships near the sea will be influenced. More specifically, most fish farming areas will disappear. However, whether it will also affect the renewable energy infrastructure in fish farms, i.e., solar panels, still needs to be studied in more depth.

Suppose the rise in average temperature exceeds the estimated value and causes a 5-meter rise in sea level. In that case, almost half of the areas near the coastline will be inundated. In comparison, the reclamation land in the northwestern park remains well if the sea level rise is not more than 3 meters tall.

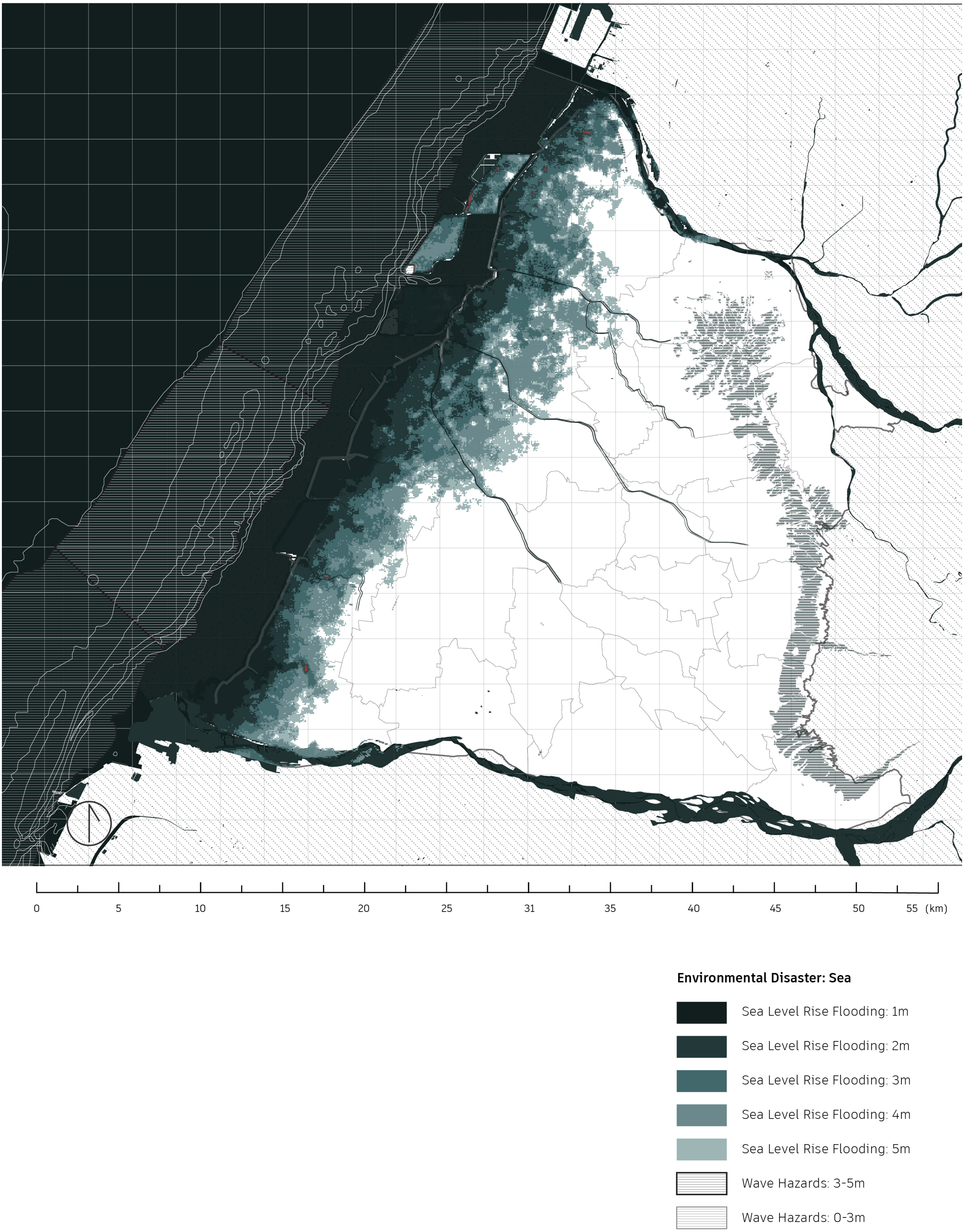


Fig 4.5: Sea-level rise scenarios of flooing map.

Environmental Disasters On Land

Changhua has many river branches distributed in plain areas. According to the scenario test of intensive rainfall, Changhua's northern and southeastern areas will be at greater risk than other places. One of the reasons is the geographical location of the branches, and another reason is the higher degree of urbanization. Because these areas have a high density of built environment, the land permeability is worsening. Combined with the current drainage system cannot support when it comes to intensive rainfall, flooding happens very often during the rainy season and typhoons.

In addition, there have been five landslides in history due to poor environmental protection combined with intensive rainfall or typhoons. These sites are concentrated in the highest urbanized areas in Changhua County. It underlines the fact that risk management and disaster adaptation will be critical in the planning.

Changhua County has a long history of groundwater extraction. But the over-pumping has caused severe subsidence on the southwest side, especially in Dacheng and partially in Fang Yuan and Erlin townships. Therefore, many people moved away from these areas due to safety concerns, leaving behind large abandoned areas.

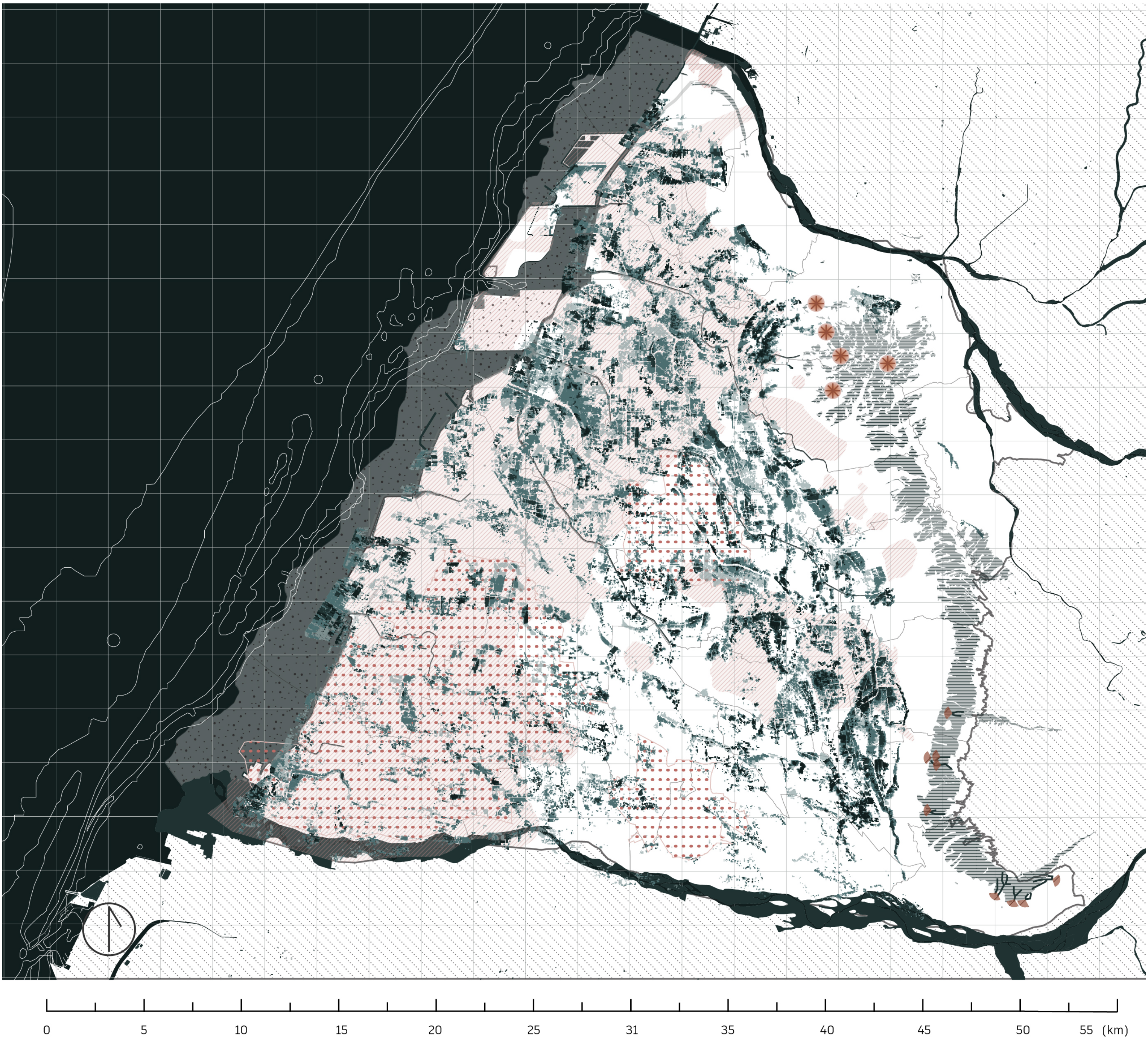


Fig 4.6: Environmental disasters on land Map.

4.4 Ecological Analysis

Ecological Sensitive Area

Pagua Mountain is located on the eastern side of Changhua County; this mountainous region is rich in ecological resources. As shown in the map on the right, the mountain's northern side is one of the most concentrated ecological hotspots.

On the other hand, the extensive wetlands along the coastline provide a great environment, especially for waterfowl. Even though the migratory bird population is not as pronounced as the cities in southern Taiwan due to the industrial areas along the coast, it still retains an essential ecosystem along the coastline.

One of the national wetland reserves is located in the north. Still, due to the short distance from the industrial park, there are not as many hotspots as in the southwest, creating some historical conflicts.

In addition, the central Taiwan coastline is a precious environment for the endangered mammal Chinese White dolphins. Recently, however, the community has experienced large-scale conflicts due to the construction of offshore wind turbines.

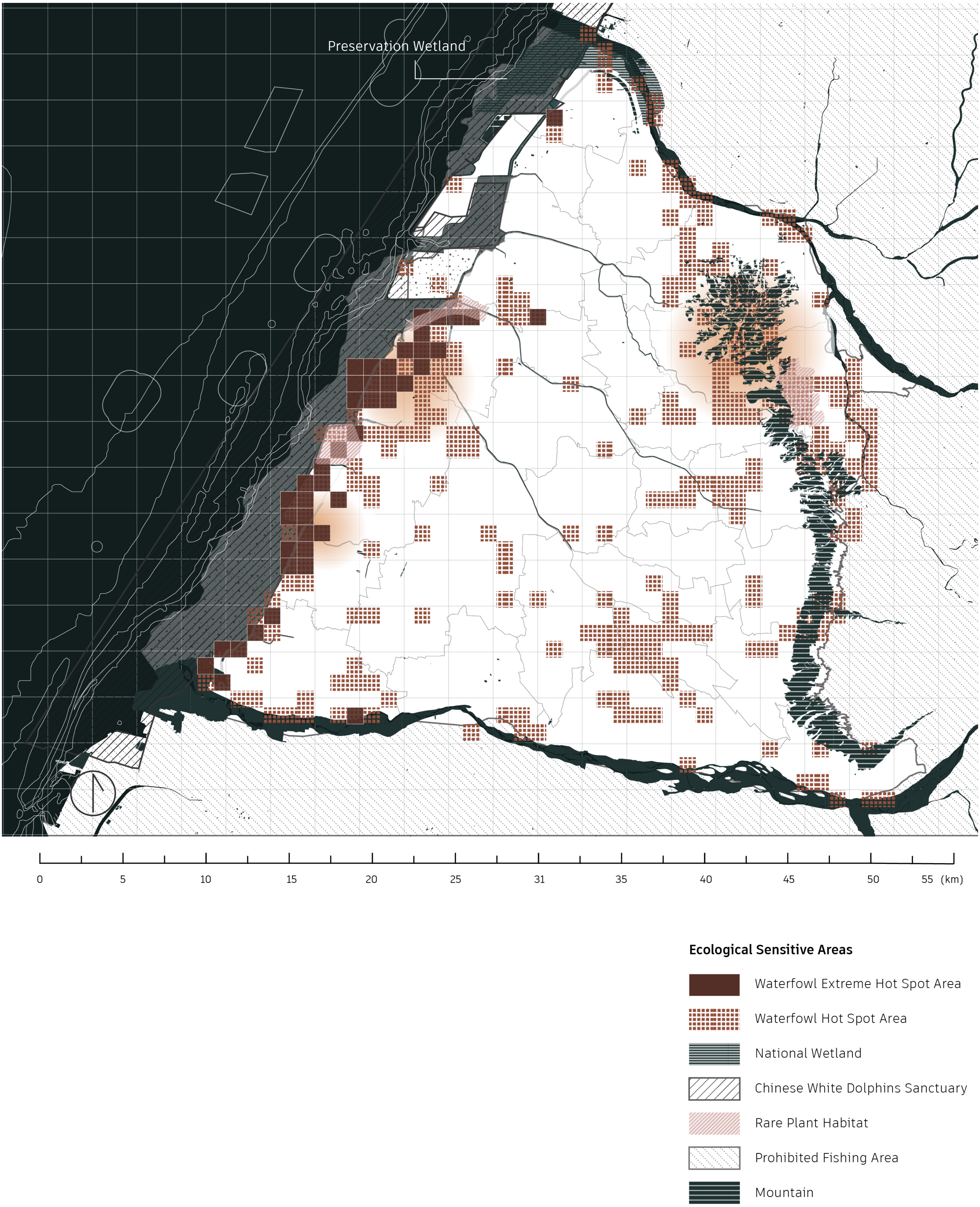


Fig 4.7: Ecological sensitive areas map.

4.5 Renewable Energy Analysis

Wind Energy

As the map shows, most of the installed wind turbines are located on the coastline. In addition, most of the wind turbines are located in industrial zones and sparsely populated areas.

According to the wind power potential map, there is potential for onshore wind turbines to be installed where wind speeds exceed 5 metres per second. This means that there is still considerable space along the coastline with potential for onshore wind turbines which is worth investigating as a possibility.

On the other hand, the central government has identified the location of 21 offshore wind farms covering an area of 2,263 km². However, due to the many conflicts and administrative delays related to wildlife protection issues, only three wind farms have been built and one is in operation by the end of 2022.

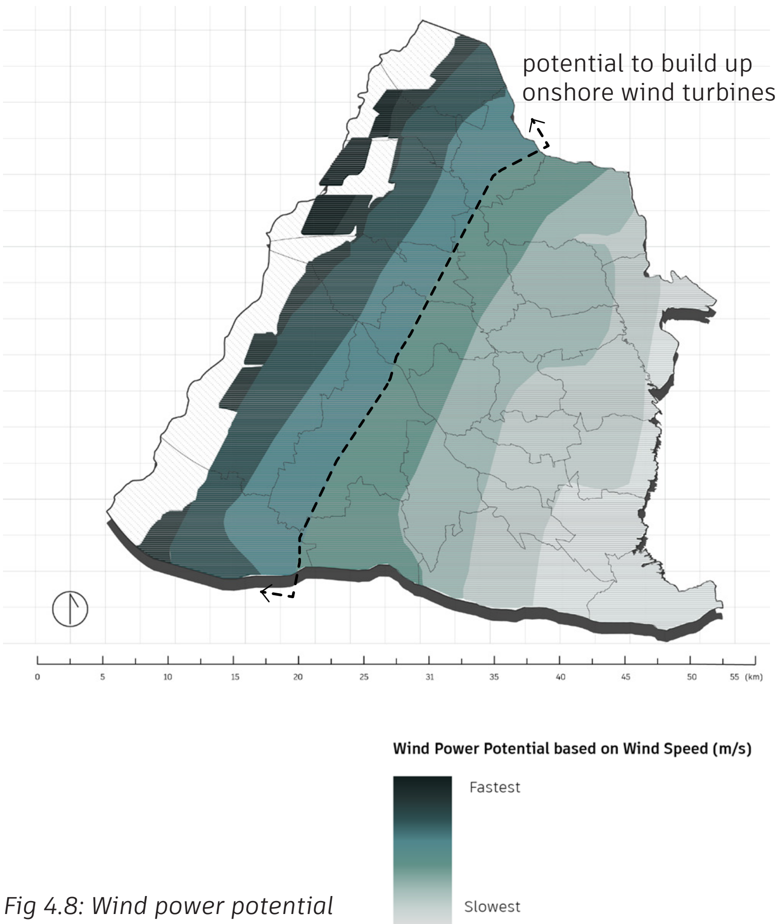
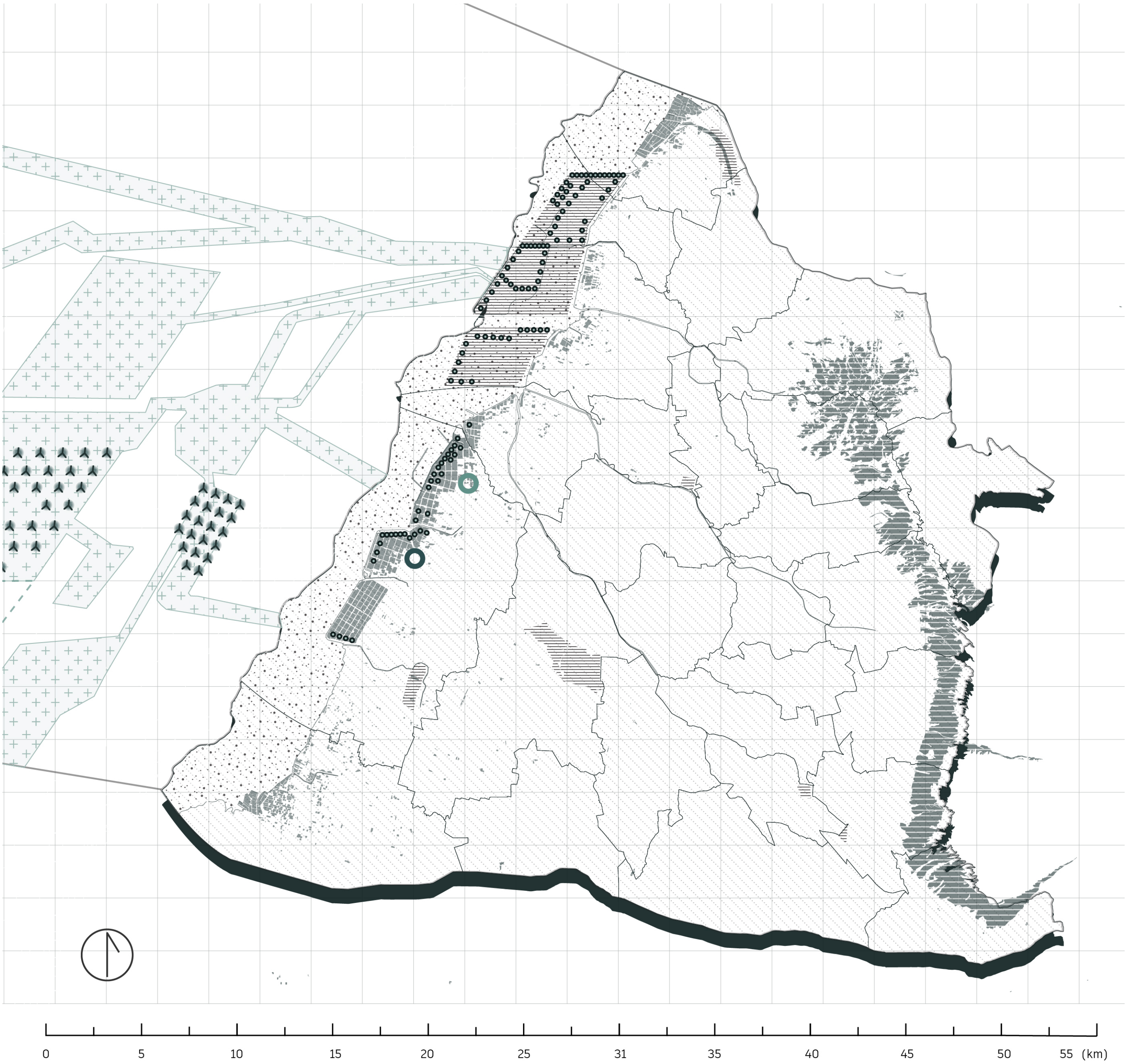
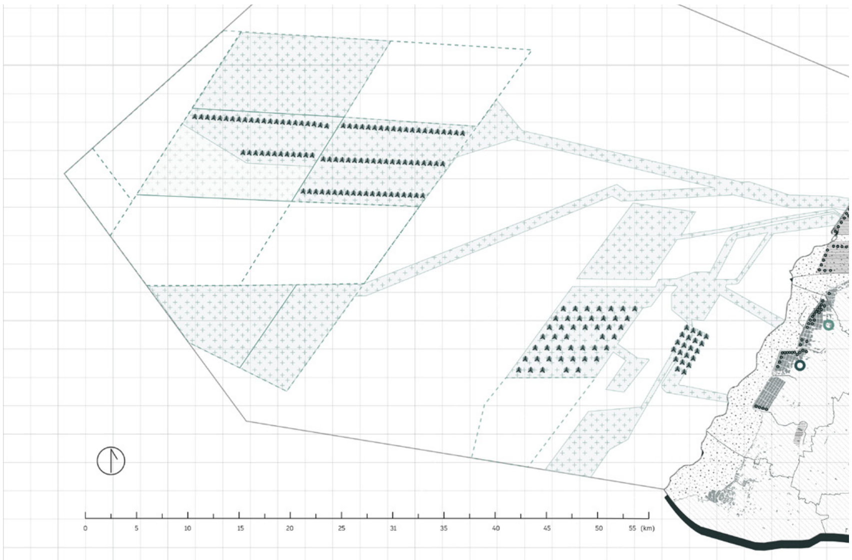


Fig 4.8: Wind power potential map.





Exist Wind Energy Infrastructure

Approved Offshore Wind Farm

Planned Wind Farm

Offshore Wind Turbines

Onshore Wind Turbines

Wind Energy Farm

Biomass Power Plant

Fig 4.9: current wind turbine and wind farm locations.
Fig 4.10: Planning offshore wind farms.

Solar Energy

Due to the lack of data of solar energy potential assessment, the map shows on the right bottom is based on the ease of acquiting land estimated by the Changhua government.

As past regulations did not restrict the combination of small-scale land with photovoltaic installations, many energy developers have worked with landowners to turn farmland into land used only for electricity generation and not for agricultural activities, leading to the fragmentation of farmland and threatening food security. As a result, the Ministry of Agriculture has banned the multifunctional use of farmland from 2020, which limits the huge potential for solar energy (as the map showing with the lightest orange color).

The current solar power stations are mainly located in industrial areas along the coastline, with some sites built up in the southwest as a result of subsidence. There are further cases where solar panels are installed on roofs, however, there is no database to collect these installations.

Therefore, the map on the right only shows solar panels on the ground. However, according to field research, many more rooftop solar panels can be found in southwest livestock facilities, which can be checked in the next part, energy landscape analysis.

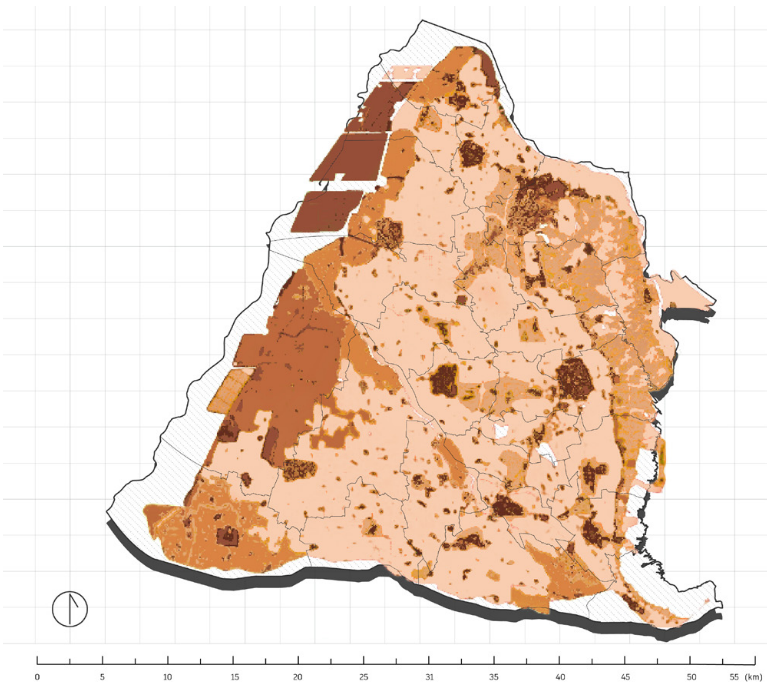


Fig 4.11: Solar power potential map.

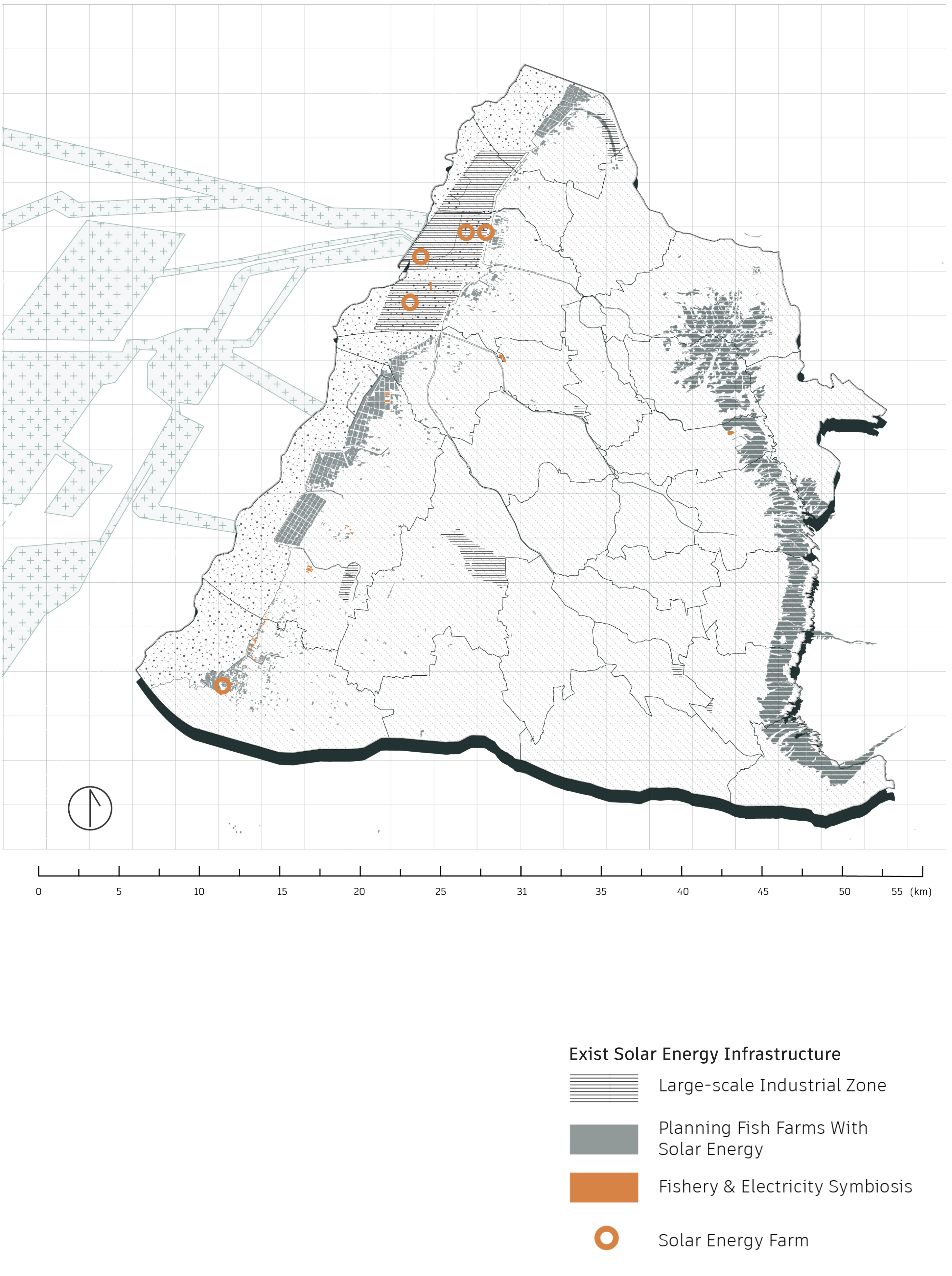


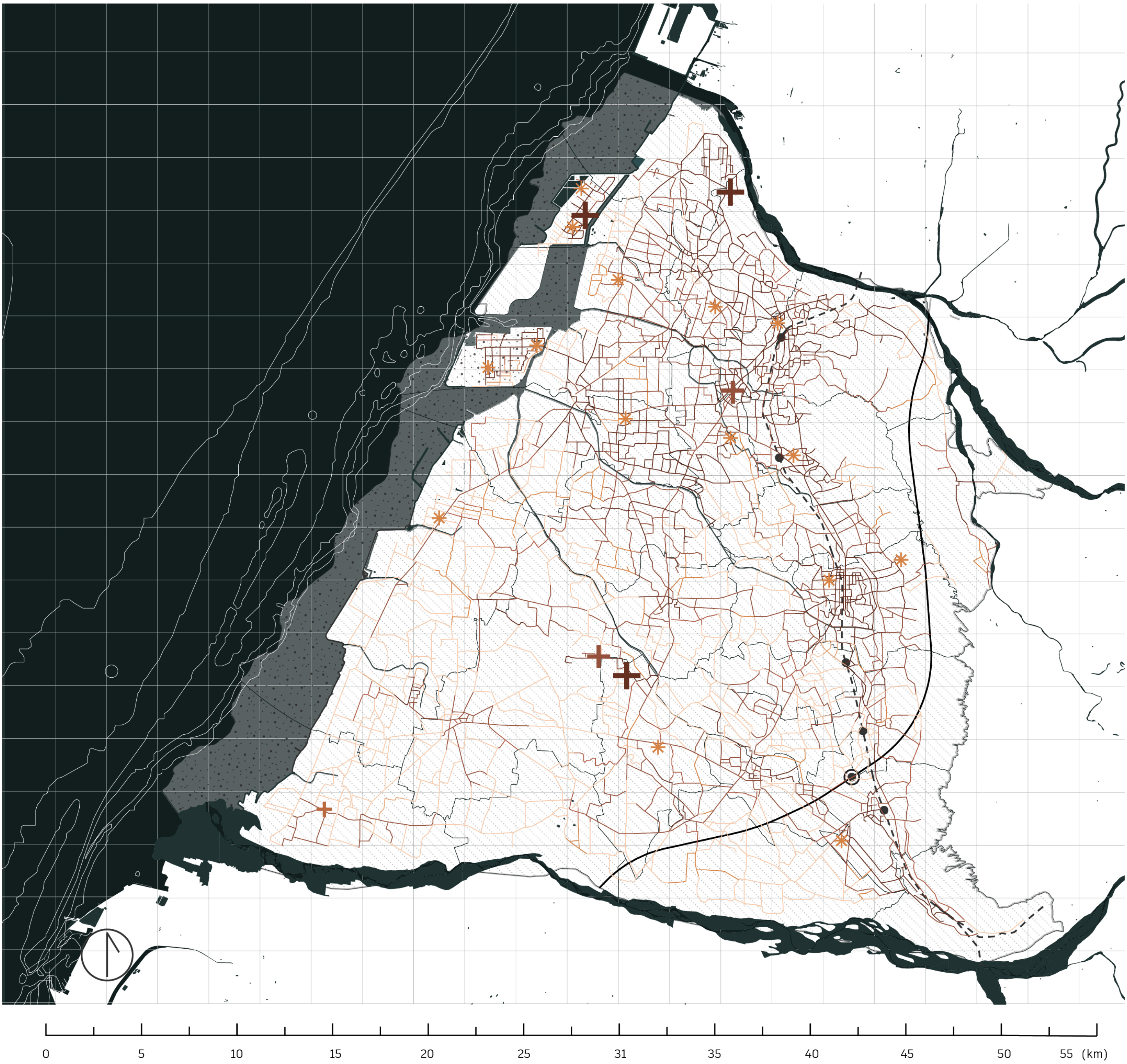
Fig 4.12: Current location of the solar panel farm.

Energy Infrastructure

The energy infrastructure is the backbone for transporting electricity. From the power station to the high-voltage plant, it is stepped down and transmitted to primary and secondary substations, and then through feeders to the end user. All these processes rely on the distribution of the substation and grid network to deliver electricity to neighbourhoods. This means if the substations are not enough, the transmitting will be inefficient.

As the map shows, voltage substations are mainly located in the north and east of Changhua. Also, the grid compatibility shows that the north and east have a high capacity, while the southwest has almost no compatibility. This means most feeders in these areas cannot carry additional power if new-build energy generation infrastructures are built.

However, most of the aquaculture sites, subsidence sites, and potential multi-purpose use of agricultural land where renewable energy development is discussed are located in these areas. Increasing the grid's capacity in the southwest of Changhua is inevitable as reallocating substations to support the development.



Voltage Substation & Grid- Compatible Capacity

- Extra-High Voltage Substation
- Primary Voltage Substation
- Distribution Voltage Substation
- Grid-compatible capacity 6 (Highest)
- Grid-compatible capacity 5
- Grid-compatible capacity 4
- Grid-compatible capacity 3
- Grid-compatible capacity 2
- Grid-compatible capacity 1 (lowest)

Fig 4.13: Energy Infrastructure & Grid-compatible capacity map.

Energy Landscape

Pasqualetti and Stremke (2018) stated that “One of the main engines of landscape change is the demand for the energy we need. We term the consequence of this transformation the “energy landscape.” Their studies concluded three qualifications that lead to the typology of different expressions of the energy landscape. Three qualifications are:

(1) Substantive factor: means that different energy sources lead to various landscapes. For example, the landscape built by biomass is the short rotation coppice, yet, the landscape developed by wind energy will be the significant component of the wind turbine.

(2) Spatial factor: means the degree of spatial dominance. For example, a small-scale solar energy park in the agricultural zone shows the different components that build a landscape. Conversely, strip mine coal landscape where resource extraction is the only land use function.

(3) Temporal factor: presents the degree of permanence. Specifically, solar panels can be removed in a shorter time, while the influence of nuclear energy is permanent, showing the time of landscape appearance is different.

This section analyzes the energy landscape within Changhua County to understand the relationship between the energy infrastructure and the surrounding environment. Besides, in order to build up a design proposal to mitigate the conflicts caused by the systematic deficiency. Thus, this part zoomed into 28 locations with different conditions, studying the similarities and differences in the current system structure.

The study elements of the energy landscape: type of energy, scale, distance with the built environment, land use type, land use zone, and the dominant planning system. From this, it is clear which planning system has more built-up infrastructure and under what conditions.

The following pages explain the condition of the infrastructure with the built environment, land use type, and land use zone.

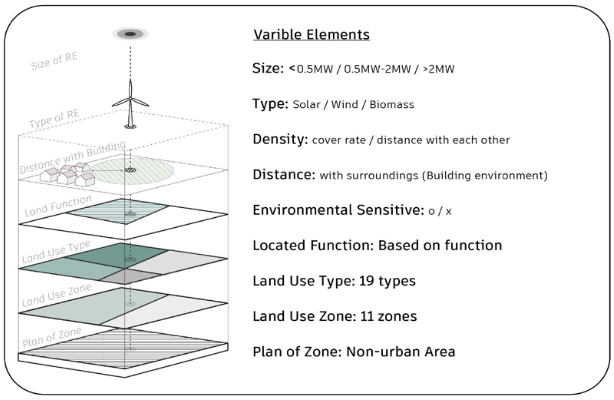


Fig 4.14: Analytical structure of the energy landscape

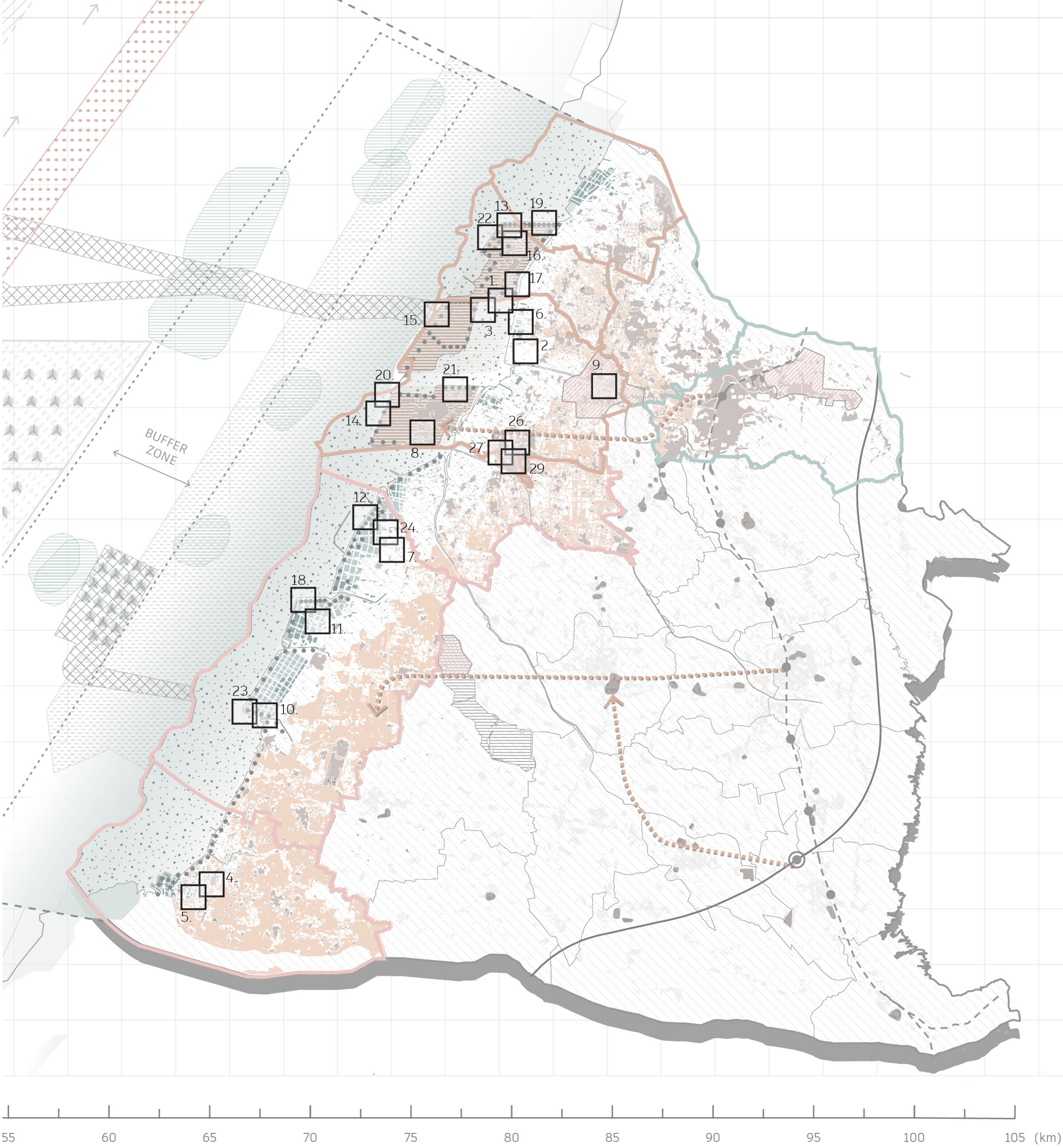


Fig 4.15: Location of analysis of energy landscape.

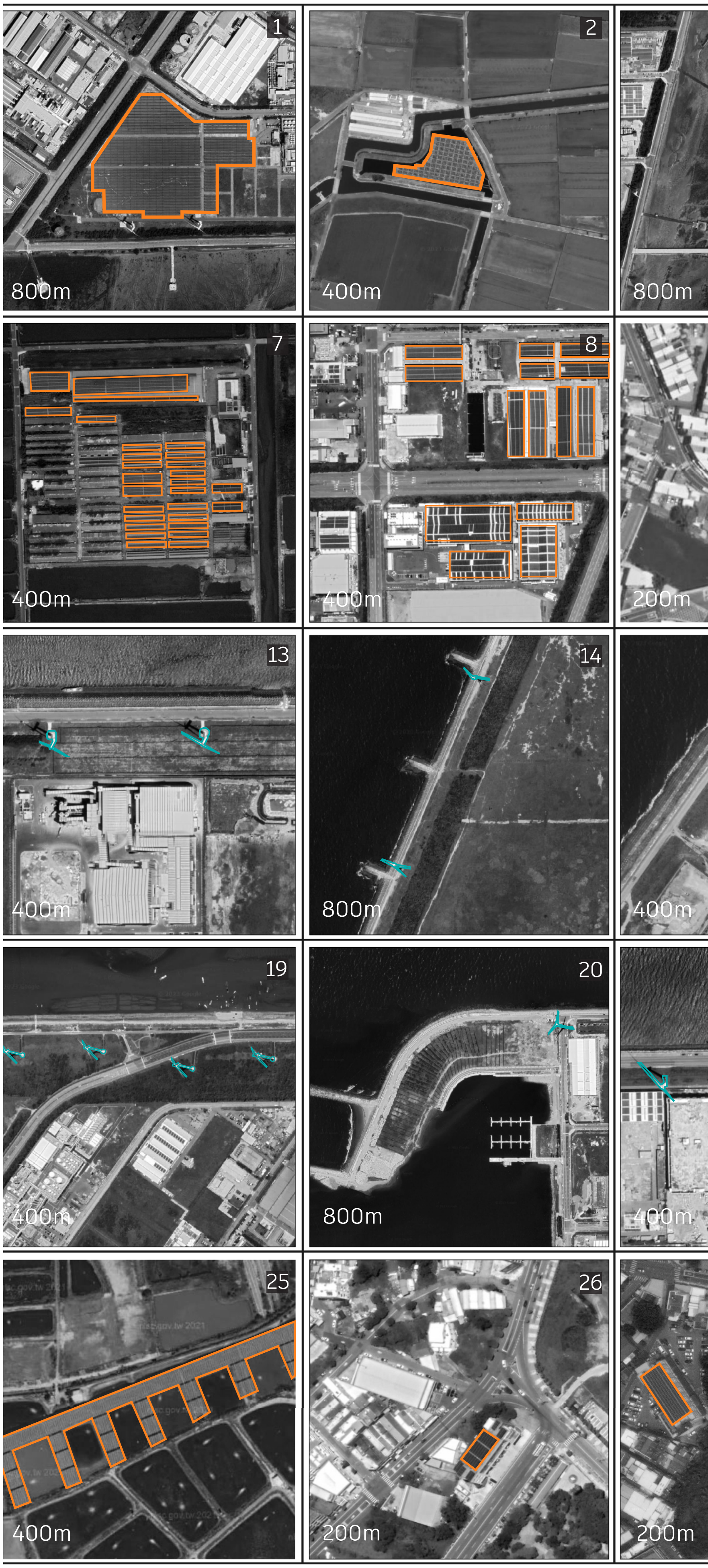
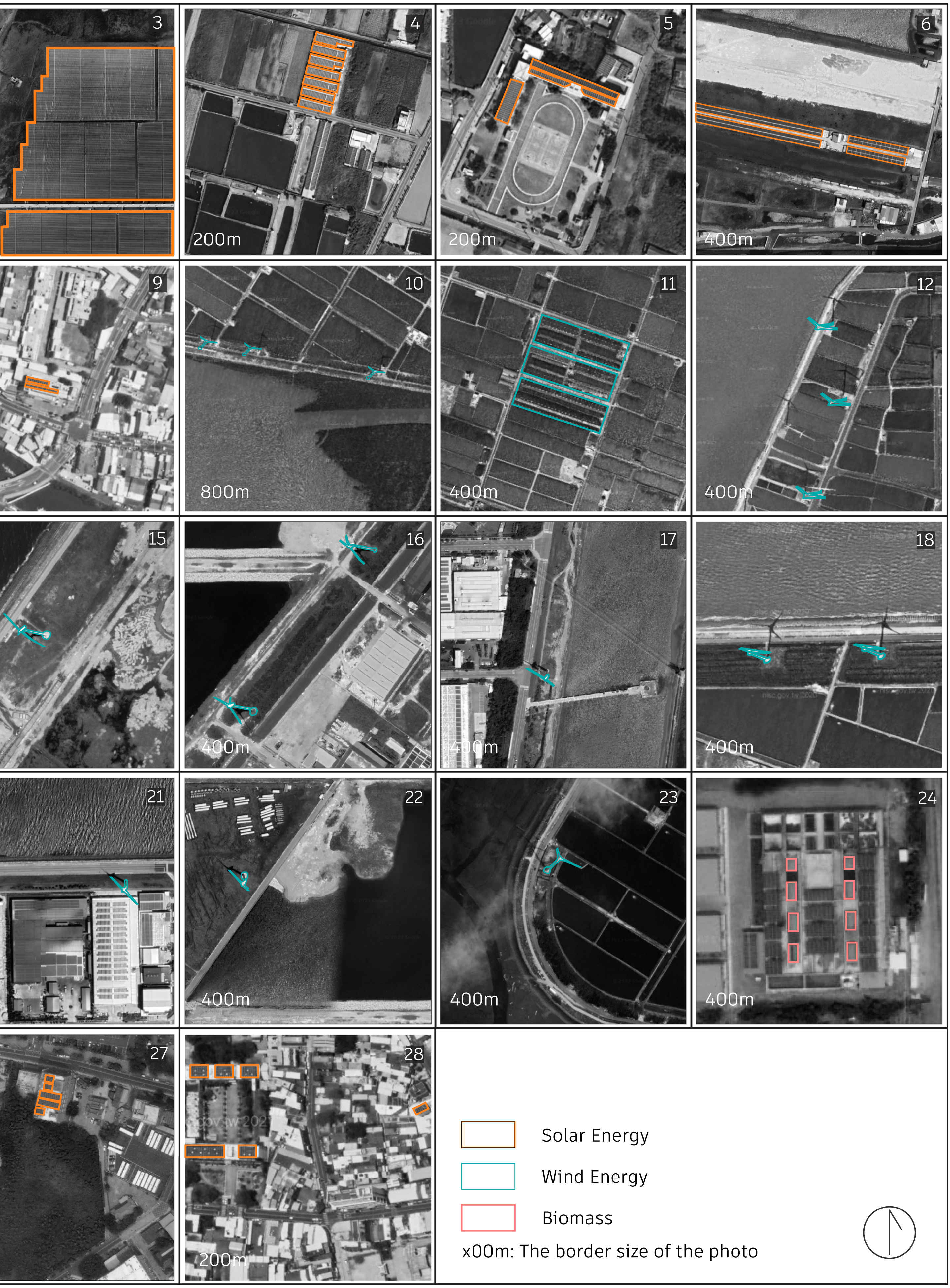


Fig 4.16: Twenty-eight locations of the current energyscape study

28 Energyscapes

The analysis presents at least 28 different conditions of the current energy landscape. Three types of energy sources can be found here: solar, wind, and biomass.

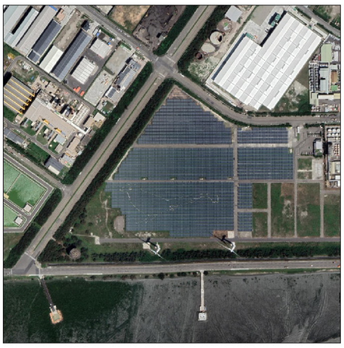
The analysis results of each energy landscape can be checked regarding type, scale, distance with the built environment, whether overlapping with the environmentally sensitive area, land use type, zone, and planning system.



3
4
200m
5
200m
6
400m
9
10
800m
11
400m
12
400m
15
16
400m
17
400m
18
400m
21
22
400m
23
400m
24
400m
27
28
200m
Solar Energy
Wind Energy
Biomass
x00m: The border size of the photo

(1) Distance means the distance between energy infrastructure and the built environment but not includes solar panels on the rooftop.
(2) The density of solar panels on the ground is determined by the proportion of the energy infrastructure divided in the cadastral area.
(3) The density of solar panels on the rooftop is based on the maximum installation rate of the administrative regulation.
(4) The density of a wind turbine means the distance from other wind turbines.
(5) site no. 25 is located in Tainan City due to there is still no case of fishery and electricity symbiosis in Changhua.

800m



·Size: >2 MW
·Type: solar on the ground
·Density: 51.6%
·Distance: 66 m
·Environmental Sensitive: x
·Others: 8.77 ha (estimated to produce 5.87 MW)
·Functions: electricity; green space; road; manufactory
·Land Use: industrial use zone
·Plan of Zone: non-urban planning

1.

400m

·Size: <0.5 MW
·Type: solar on the water surface
·Density: 23.6%
·Distance: 40m
·Environmental Sensitive: x
·Others: 0.46 ha (estimated to produce 0.31 MW); public owned
·Functions: ditch; green space
·Land Use: special agriculture zone
·Plan of Zone: non-urban planning

2.

800m

·Size: >2 MW (181MW)
·Type: solar on the water surface
·Density: 89.7%
·Distance: 300 m
·Environmental Sensitive: x
·Others: 167 ha; public owned
·Functions: electricity
·Land Use: industrial use zone
·Plan of Zone: non-urban planning

3.

200m

·Size: <0.5 MW
·Type: solar on rooftop
·Density: 80%
·Distance: x
·Environmental Sensitive: subsidence
·Others: On the livestock house
Functions: livestock
Land Use: general agriculture zone
Plan of Zone: non-urban planning

4.

200m

·Size: <0.5 MW
·Type: solar on rooftop
·Density: 80%
·Distance: x
·Environmental
·Sensitive: subsidence
·Others: On the school's rooftop; public owned
·Functions: school
·Land Use: rural area zone
·Plan of Zone: non-urban planning

5.

400m

·Size: <0.5 MW
·Type: solar on rooftop
·Density: 80%
·Distance: x
·Environmental Sensitive: x
·Others: livestock
·Functions: livestock; unused land
·Land Use: general agriculture zone
·Plan of Zone: non-urban planning

6.

400m

•Size: <0.5 MW
•Type: solar on rooftop
•Density: 80%
•Distance: x
•Environmental Sensitive: x
•Others: the larger size of livestock farm, mixed with biomass generation (example NO. 24)

•Functions: livestock
•Land Use: other or special use zone
•Plan of Zone: non-urban planning

7.

400m

•Size: <0.5 MW
•Type: solar on rooftop
•Density: 80%
•Distance: x
•Environmental Sensitive: x
•Others: in the industrial park (reclamation areas)

•Functions: manufactory
•Land Use: industrial use zone
•Plan of Zone: non-urban planning

8.

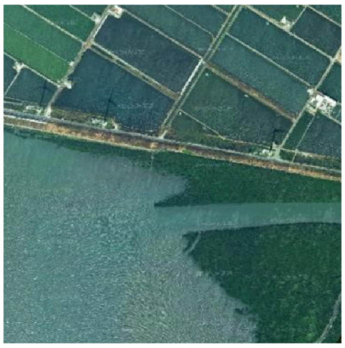
200m

•Size: <0.5 MW
•Type: solar on rooftop
•Density: 80%
•Distance: x
•Environmental Sensitive: flooding by intensive rainfalls
•Others: public owned

•Functions: government agencies
•Land Use: rural area zone
•Plan of Zone: non-urban planning

9.

400m



•Size: >2 MW (3MW)
•Type: wind turbine
•Density: 160-400m
•Distance: >1000m
•Environmental Sensitive: high waterfowl hot spot area
•Others: national protecional land use type; public owned

•Functions: green space
•Land Use: other or special use zone
•Plan of Zone: non-urban planning

10.

400m

•Size: >2 MW (23MW)
•Type: small wind turbine
•Density: 13m
•Distance: >700m
•Environmental waterfowl hot spot area
•Others: stopping operation

•Functions: electricity
•Land Use: general agriculture zone
•Plan of Zone: non-urban planning

11.

800m

•Size: >2 MW (3MW)
•Type: wind turbine
•Density: 210-370m
•Distance: >500m
•Environmental Sensitive: high waterfowl hot spot area
•Others: water conservancy land use type; public owned

•Functions: aquaculture; road; ditch
•Land Use: general agriculture zone
•Plan of Zone: non-urban planning

12.

400m

•Size: >2 MW (3MW)
•Type: wind turbine
•Density: 200m
•Distance: 150m
•Environmental Sensitive: x
•Others: public owned; in the industrial park (reclamation areas)

•Functions: abandoned farm land
•Land Use: industrial use zone
•Plan of Zone: non-urban planning

13.

800m

•Size: >2 MW (3MW)
•Type: wind turbine
•Density: 530m
•Distance: >500m
•Environmental Sensitive: x
•Others: public owned; in the industrial park (reclamation areas)

•Functions: unused land
•Land Use: industrial use zone
•Plan of Zone: non-urban planning

14.

400m

·Size: >2 MW (3MW)
·Type: wind turbine
·Density: 500m
·Distance: >1000m
·Environmental Sensitive: x
·Others: public owned; in the industrial park (reclamation areas)
·Functions: under construction
·Land Use: industrial use zone
·Plan of Zone: non-urban planning

15.

400m

·Size: >2 MW (3MW)
·Type: wind turbine
·Density: 600m
·Distance: 60m
·Environmental Sensitive: flooding by intensive rainfalls
·Others: public owned; in the industrial park (reclamation areas)
·Functions: green space
·Land Use: industrial use zone
·Plan of Zone: non-urban planning

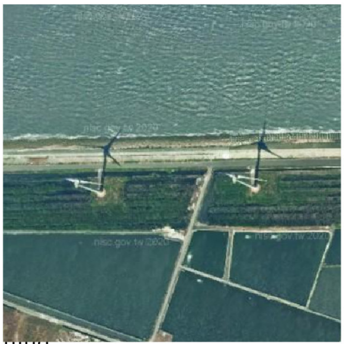
16.

400m

·Size: >2 MW (3MW)
·Type: wind turbine
·Density: 540m
·Distance: 85m
·Environmental Sensitive: x
·Others: recreational land use type; public owned; in the industrial park (reclamation areas)
·Functions: unused land
·Land Use: industrial use zone
·Plan of Zone: non-urban planning

17.

400m



·Size: >2 MW (3MW)
·Type: wind turbine
·Density: 180m
·Distance: >1000m
·Environmental Sensitive: waterfowl hot spot area
·Others: public owned

Lorem ipsum

·Functions: green space
·Land Use: forest zone
·Plan of Zone: non-urban planning

18.

400m

·Size: >2 MW (3MW)
·Type: wind turbine
·Density: 210m
·Distance: 180m
·Environmental Sensitive: x
·Others: national protecional land use type; public owned (reclamation areas)
·Functions: green space
·Land Use: industrial use zone
·Plan of Zone: non-urban planning

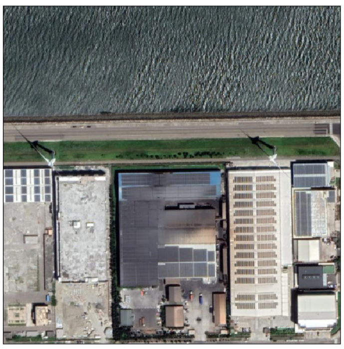
19.

800m

·Size: >2 MW (3MW)
·Type: wind turbine
·Density: 470m
·Distance: >500m
·Environmental Sensitive: x
·Others: exclusive land use type; public owned (reclamation areas)
·Functions: port area
·Land Use: industrial use zone
·Plan of Zone: non-urban planning

20.

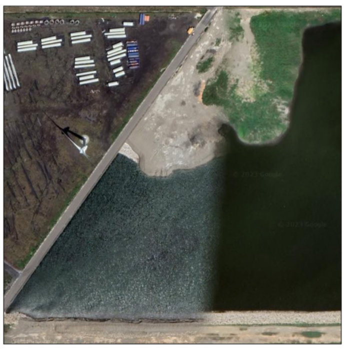
400m



·Size: >2 MW (3MW)
·Type: wind turbine
·Density: 430m
·Distance: 100m
·Environmental Sensitive: x
·Others: water conservancy land use type; public owned (reclamation areas)
·Functions: unused land
·Land Use: industrial use zone
·Plan of Zone: non-urban planning

21.

400m



·Size: >2 MW (3MW)
·Type: wind turbine
·Density: 220m
·Distance: >500m
·Environmental Sensitive: x
·Others: private owned (reclamation areas)
·Functions: unused land; close to water space
·Land Use: industrial use zone
·Plan of Zone: non-urban planning

22.

400m

·Size: >2 MW (3MW)
·Type: wind turbine
·Density: 480m
·Distance: >1000m
·Environmental Sensitive: high water-fowl hot spot area
·Others: public owned;
·Functions: unused land
·Land Use: other or special use zone
·Plan of Zone: non-urban planning

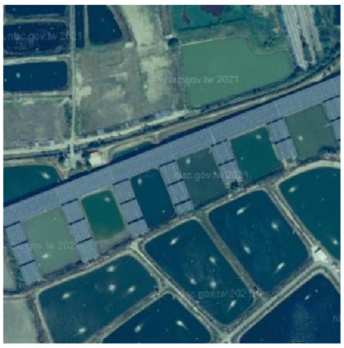
23.

400m

·Size: >2 MW
·Type: biomass
·Density: 28%
·Distance: >800m
·Environmental Sensitive: waterfowl hot spot area
·Others: the larger size of livestock farm
·Functions: livestock
·Land Use: other or special use zone
·Plan of Zone: non-urban planning

24.

400m



·Size: <0.5 MW
·Type: solar panels in the fish farms
·Density: 40%
·Distance: x
·Environmental Sensitive: waterfowl hot spot area
·Others: aquacultural land use type; fishery and electricity symbiosis
·Functions: aquaculture
·Land Use: general agriculture zone
·Plan of Zone: non-urban planning

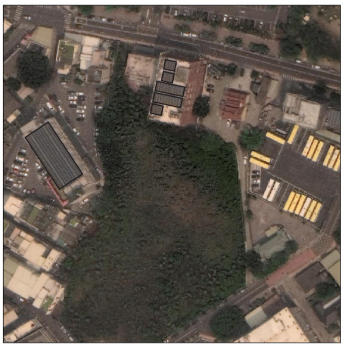
25.

200m

·Size: <0.5 MW
·Type: solar on rooftop
·Density: >80%*
·Distance: x
·Environmental Sensitive: x
·Others: public owned
·Functions: government agency
·Land Use: residential zone
·Plan of Zone: urban planning

26.

200m



·Size: <0.5 MW
·Type: solar on rooftop
·Density: >80%*
·Distance: x
·Environmental Sensitive: x
·Others: both public owned
·Functions: social welfare facilities; religion
·Land Use: social education land; machinery land
·Plan of Zone: urban planning

27.

200m

·Size: <0.5 MW
·Type: solar on rooftop
·Density: >80%*
·Distance: x
·Environmental Sensitive: x
·Others: public owned; private owned
·Functions: school; residential and commercial
·Land Use: school land use; commercial zone
·Plan of Zone: urban planning

28.

Urban Planning

From the result, it is clear that the current situation relies on building wind energy within the industrial site. On the other hand, solar energy has gained fewer implementations, which is also shown in the fact that the urban area has very few interventions, revealing unbalanced development. Also, the integration of solar panels in urban areas is most built on publicly owned buildings, which means that public awareness about renewable energy development still needs to develop a lot. Therefore, increasing the participation of renewable energy generation in the urban area is another critical point that needs to be realized. Besides, even in the rural area, due to the high density of the built environment, the distance between the wind turbine with the habitant or farm houses still short, revealing the fact that the distance setting could not be a fixed number as the current policy-making proposed (500m). It is also essential to adjust based on different land use zone. On the other hand, the multifunctional use in agricultural and aquacultural lands still need more experiment to test for a better combination plan.

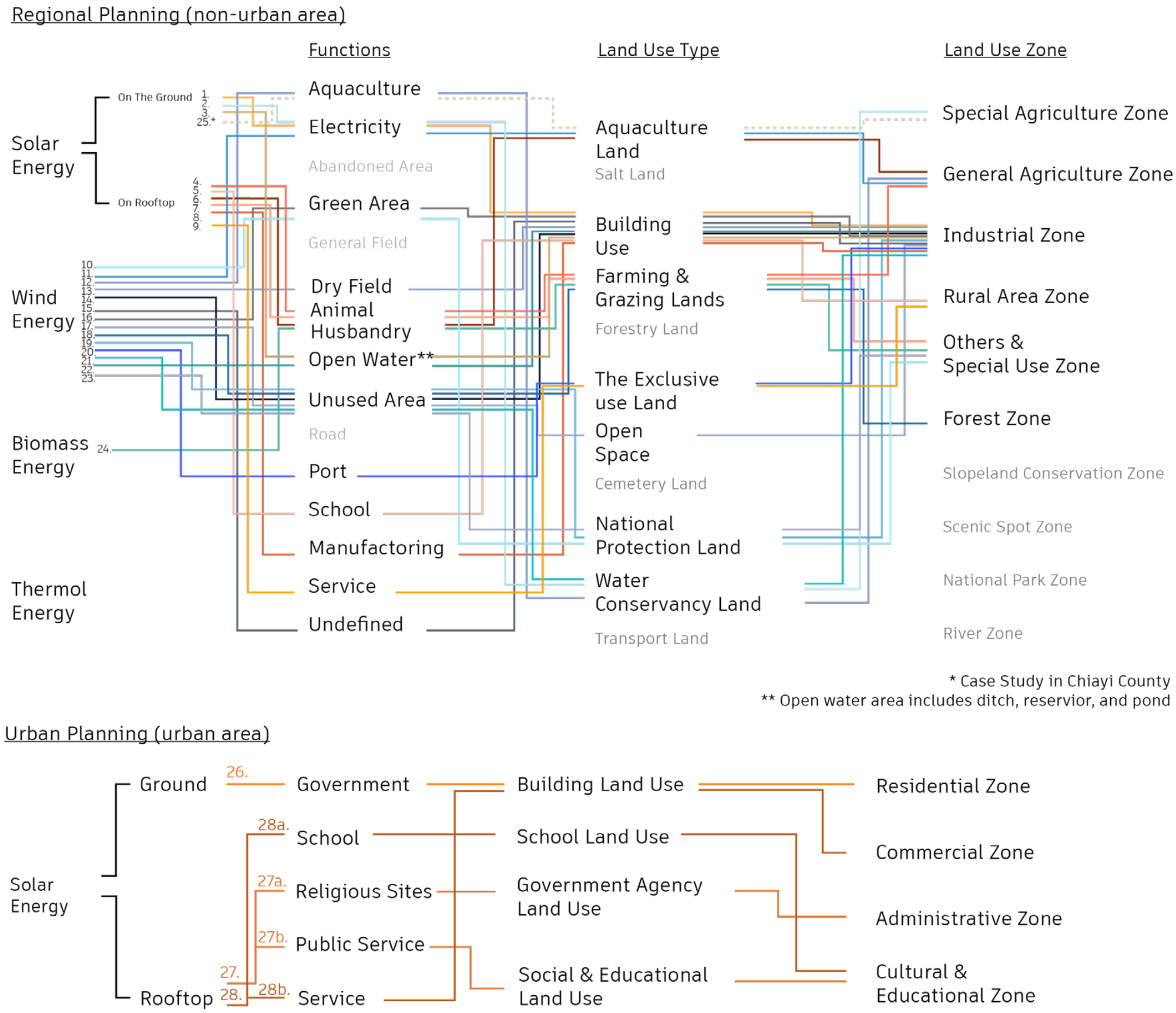


Fig 4.17: The relationship between current energy infrastructure and land use.

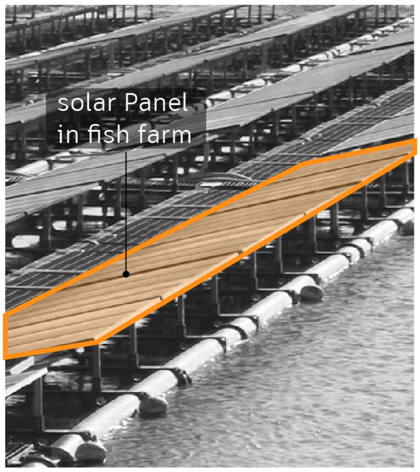
Wind Turbine

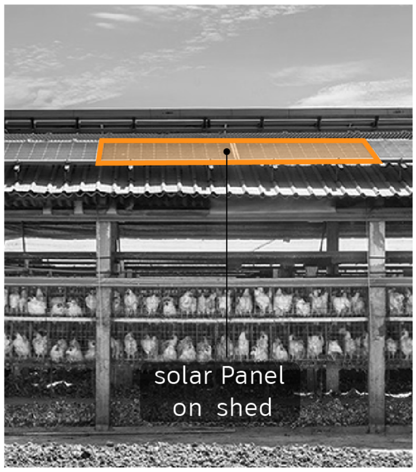
I. Density: (1) 3MW: 160-540m (2) <3MW: 13m

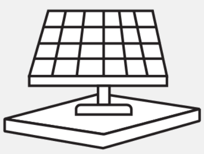
II. Distance with Surroundings:

- Industrial Land Zone
  - with Factory: 60-200m
  - with Road: 10-60m (mostly 10-30m)
  - with Residential: >800m
- General Agriculture Zone
  - with Farm House: >200m
  - with Road: 10-30m
  - with Residential: >500m
- Special Use Zone
  - with Factory: x
  - with Road: 10-15m
  - with Residential: >1000m

III. Ownership: Mainly Public Owned







Solar Panel

I. Density: (1) Rooftop: 40-80% (2) Ground: 23-90%

II. Located Situations:

- Urban Area
  - More on Public Owned Lands
  - Mostly are Rooftop
  - More with Public Used Functions
- Non-Urban Area
  - More on Private Owned Lands
  - Mostly are Rooftop
  - More with Farming & Grazing Function
  - Have Caused Many Land Changes

III. Few Multifunctional Situations:

- Aquaculture Land: planning process
- Agriculture Land: experimental process
- Residential Area: less discussion

Fig 4.18: A summary of the wind and solar landscapes.

4.6 SWOT Analysis

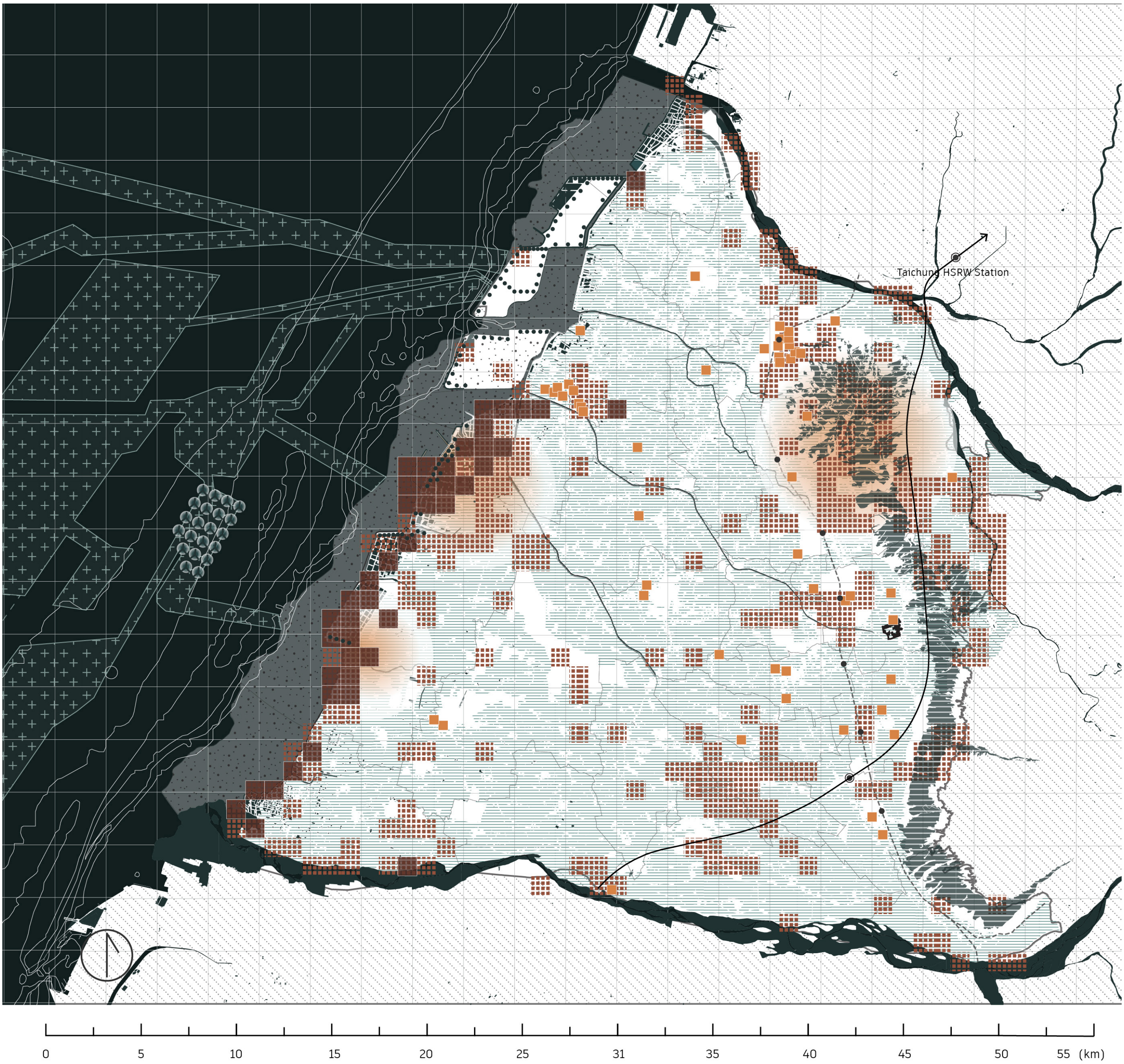


Fig 4.19: SWOT analysis: strengths

Strengths

-High potential of solar energy

-Most efficient wind power in Tawian

-Owning msot of the offshore wind farms

-Onshore wind energy is 25% of Taiwan's total

-Close to Taichung municipalities

-Tawian's agricultural barns

-Vast area of agriculture

-Rich ecological & cultural resources

-Historical value county

SWOT Map: Strengths

- Waterfowl Extreme Hot Spot Area
- Waterfowl Hot Spot Area
- Wetlands with Fish Farms
- Agricultural Land Aarea
- Mountain Area
- Offshore Wind Farm
- Offshore Wind Turbines
- Onshore Wind Turbines
- Hsitorical Site
- Railway and Railway Station
- HSRW and HSRW Station

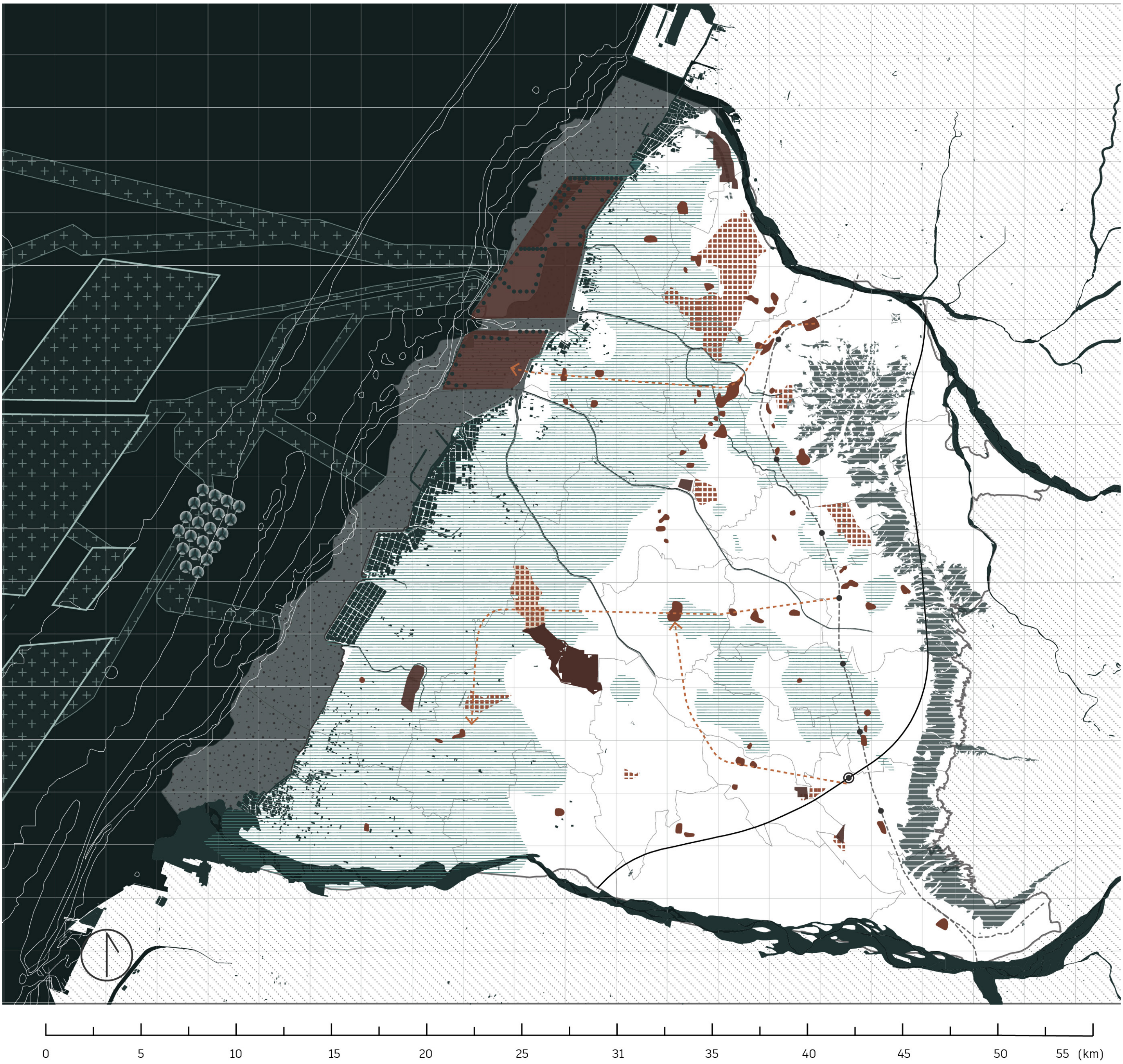


Fig 4.20: SWOT analysis: opportunities

Opportunities

- Offshore wind farms building provide work opportunities
-New planning development areas attracte people to move into Changhua County
-Infrastuction building within regions to improve the accessibility
-Fishery and Electricity Symbiosis is starting to be implemented at the fish farms
-Agricultural land has the potential to bring multifunctional use with solar energy

SWOT Map: Opportunities

Existed Industrial Zone
Approved or Planned Indeus-trial Area
Fish Farms with Potential
Agricultural Land with Potential
Mountain Area
Approved Offshore Wind Farm
Offshore Wind Turbines
Onshore Wind Turbines
Planning Light Railway Line
Railway and Railway Station
HSRW and HSRW Station

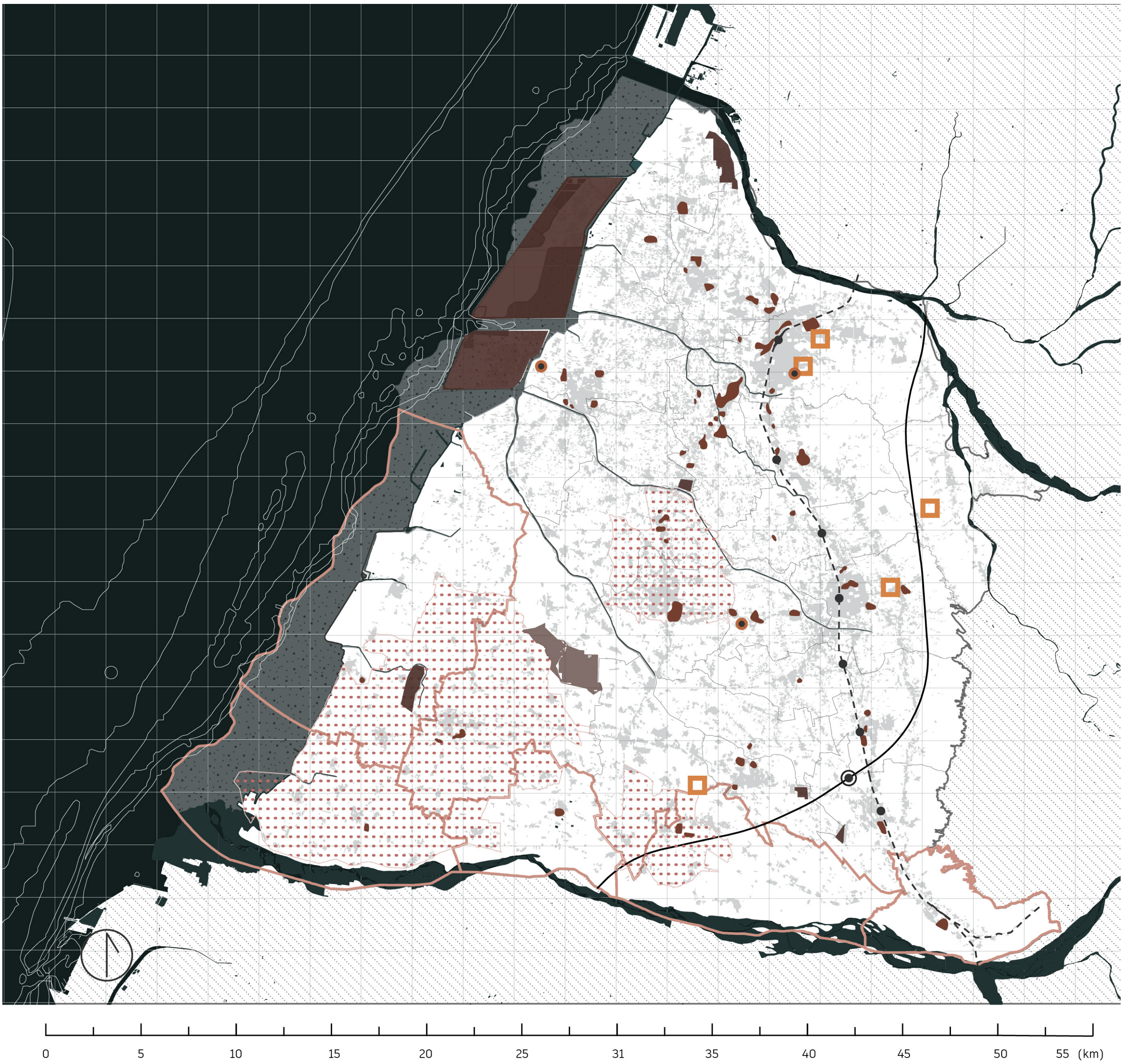


Fig 4.21: SWOT analysis: weaknesses

Weaknesses

-High popluation loss rate (high emigration)

-Lower level of urbanization

-Uneven resource allocation and development

-Huge subsidence area in the southwest

-Lack of knowledge network

-Over reliance on the first tier industry

-High aging index

-Many unregistered factories

SWOT Map: Weaknesses

Existed Industrial Zone

Building Area

High Emigration & Aging Index

High Subsidence Area

University or College

Regional Scale Hospital

Railway and Railway Station

HSRW and HSRW Station

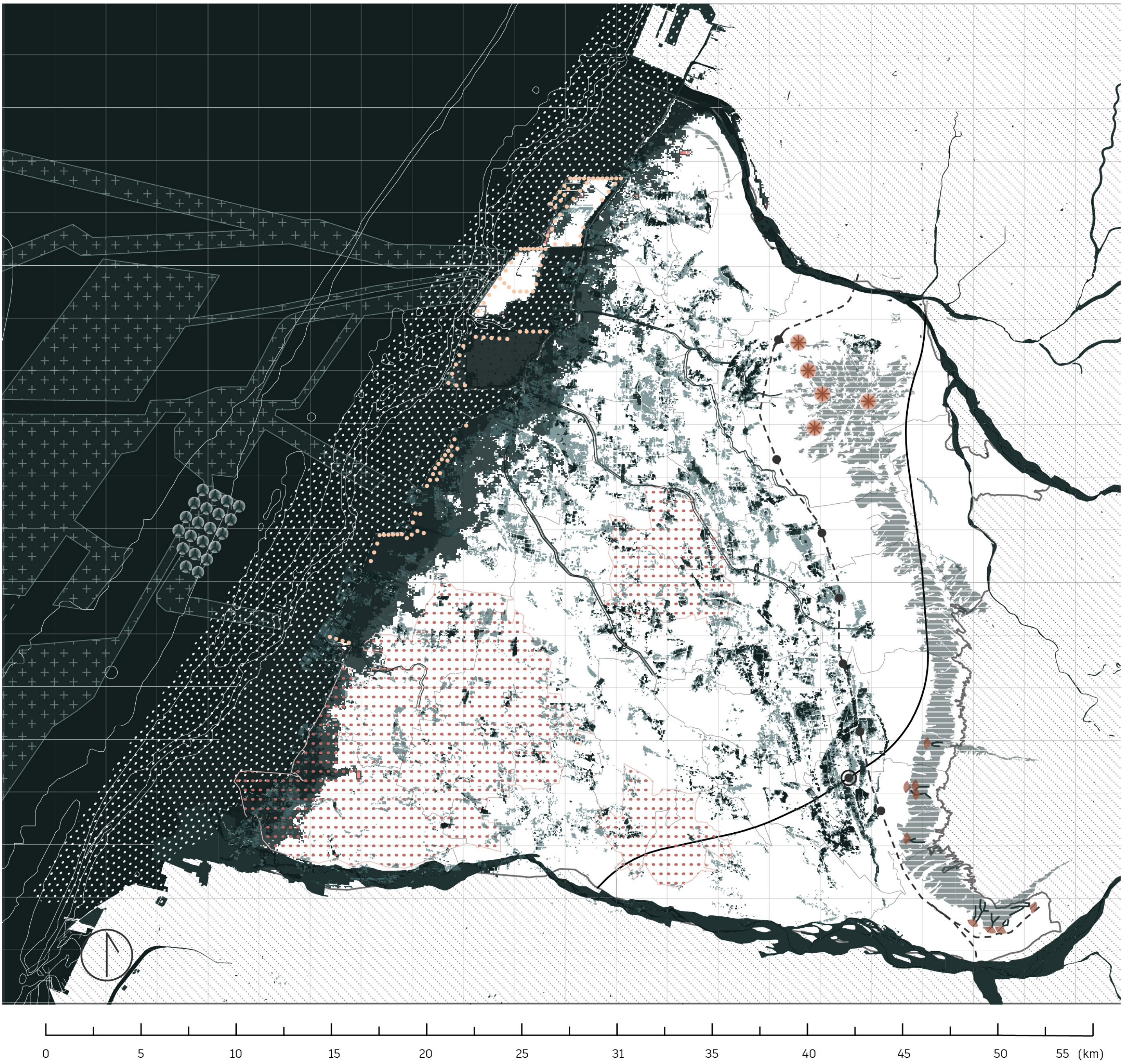


Fig 4.22: SWOT analysis: threats

Threats

-Soil liquefaction affects life safety
-Wind farms building threatens environmental protection zones
-Fishing industry is threatened by offshore wind farm development
-Flooding potential
-Coastline threatened by typhoons
-Land Subsidence in the south-western part
-Fishermen's work rights is threatened by energy developers

SWOT Map: Threats

Flooding: sea level rise 2m
Flooding: sea level rise 1m
Intensive Rain 250mm_24hr
Intensive Rain 500mm_24hr
Mountain Area
Offshore Wind Farm
High Subsidence Area
Chinese Dolphins Protection Area
Onshore Wind Turbines
Offshore Wind Turbines
Historical Landslide Site
Landslide Potential River and affected area
Railway and Railway Station
HSRW and HSRW Station

4.7 Potential Multifunctional Area

Potential Multifunctional Use: Agricultural Land

More than 60% of Chanhwa's land area is agricultural. As the multifunctional use of this type of land is limited by food security constraints, it limits the development of the energy transition. However, multifunctional land use may create a win-win situation if regulations are improved to prevent large-scale land use changes to solely renewable energy. Therefore, the possibility of introducing multifunctionality in potential areas is examined here. The priority experimental areas, based on flood risk, soil liquefaction, subsidence and sea level rise, are shown in step 9.

step 1

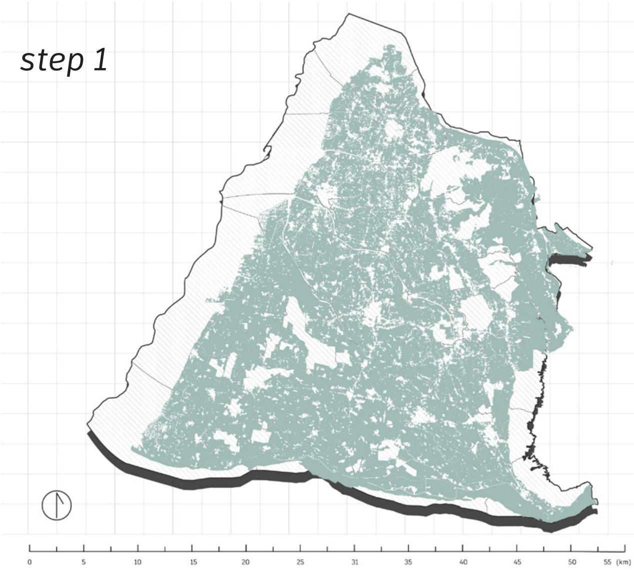


Fig 4.23: Agricultural land

step 2

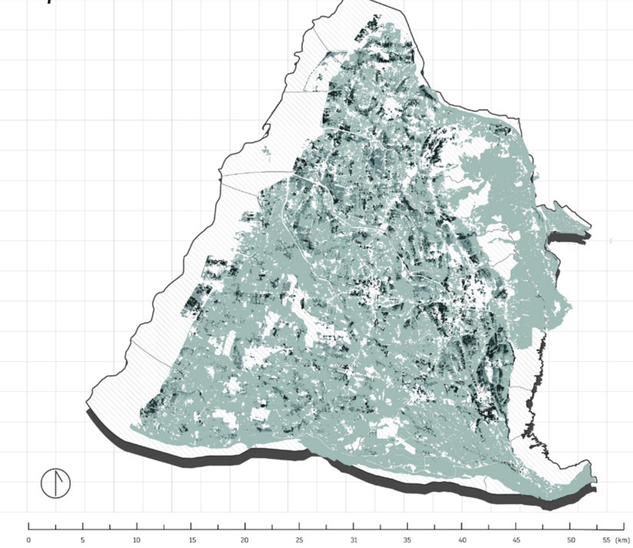


Fig 4.24: Agricultural land overlaps with river flooding (500 mm_24 hours).

step 3

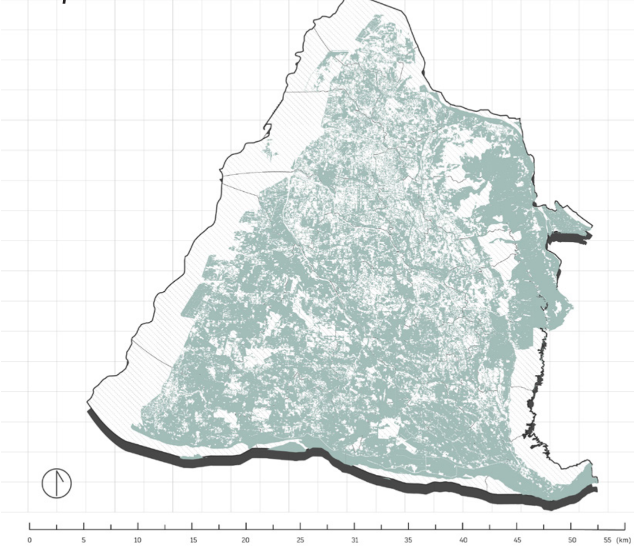


Fig 4.25: Land after elimination of potential flood zones

step 4

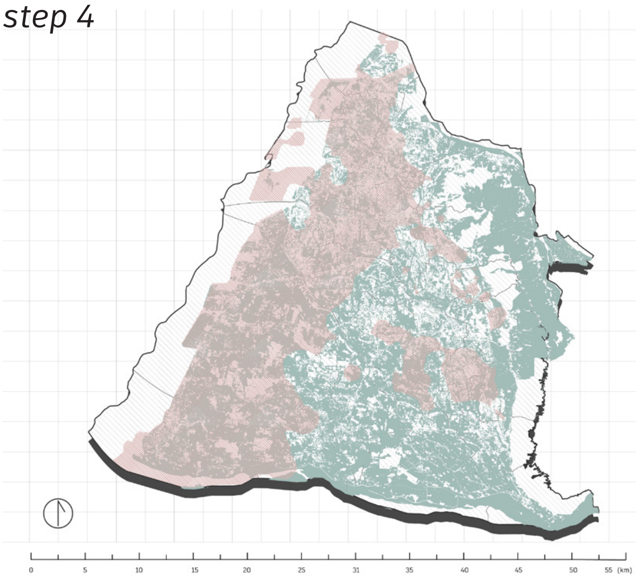


Fig 4.26: Land in step 3 overlaps with soil liquefaction zone

step 5

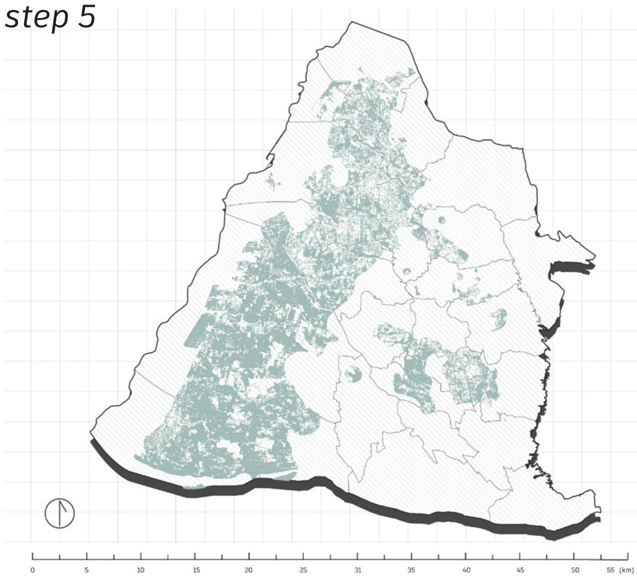


Fig 4.27: Land after elimination of soil liquefaction zones

step 6

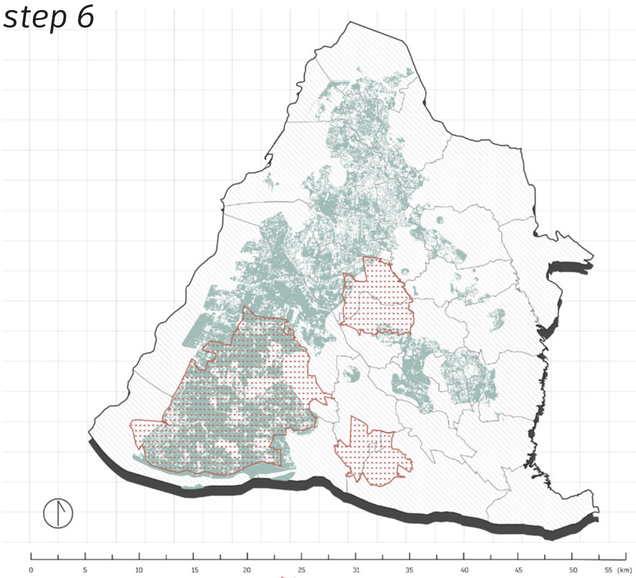


Fig 4.28: Land in step 5 overlaps with subsidence zone

step 7

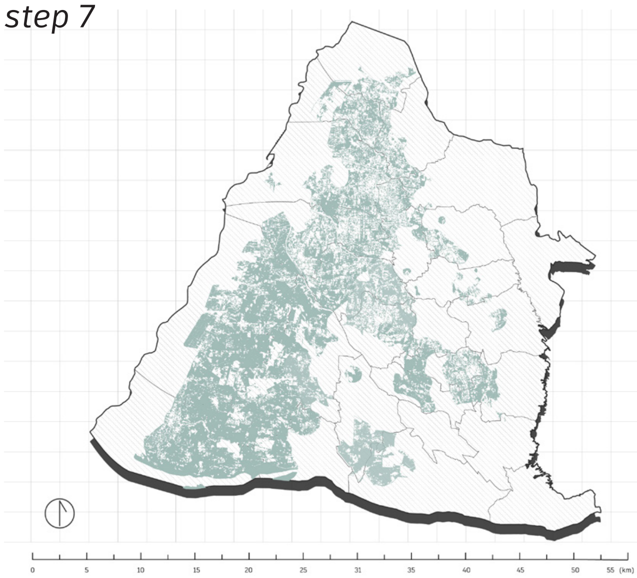


Fig 4.29: Land after summing with subsidence areas

step 8

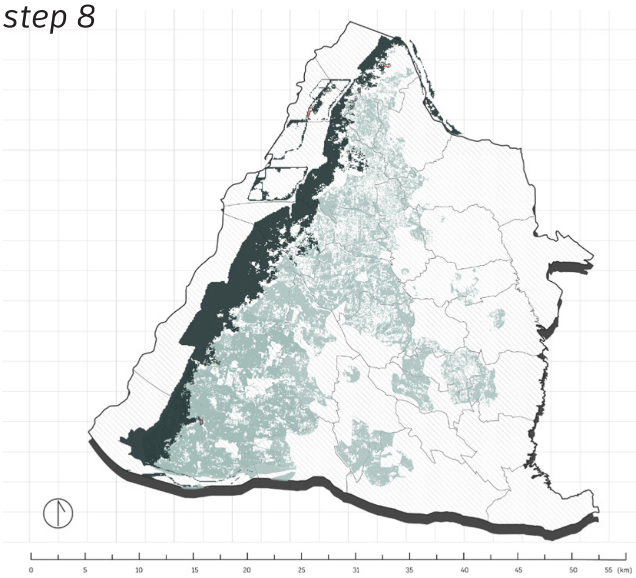


Fig 4.30: Land in step 7 overlaps with the area of sea level rise (2 m height scenario)

step 9

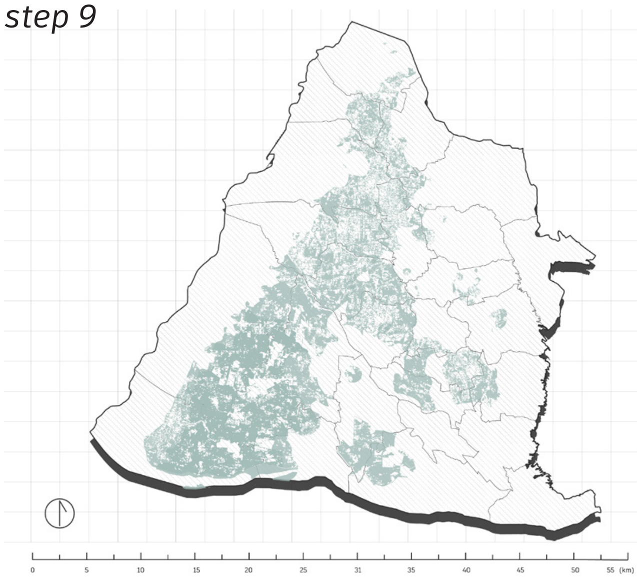


Fig 4.31: Land after elimination of sea level rise zones (Final Results: priority experimental areas)

4.8 Stakeholders Analysis

Current stakeholders'relationships

The current energy transition is facing several conflicts within society and governmental departments. This part examine the relationshp between each other in order to find out approaches to rebuild the collaboration.

Stakeholders can be divided into three parts, which are: **public sector, private sector,** and **civic sector**s. Relative stakeholders are listed on the right.

Public sectors have more connections through collaboration, conflicts, or coexisting relationships than private and Civic sectors. Most at the same administrative level lack collaboration and have more disputes with the Bureau of Energy.

The reason behind this can be seen from the analysis in the previous chapter, as the energy transition targets are set by the central government. While other higher authorities manage lands with potential for multifunctional land use, the Bureau of Energy, as the executive unit, does not have the power to manage or require multifunctional use of these lands from other authorities due to its lower administrative level. Thus, for example, the agricultural sector and the Energy Agency can see conflicts due to food security and renewable energy development, which is a challenge for cooperation.

PUBLIC SECTORS

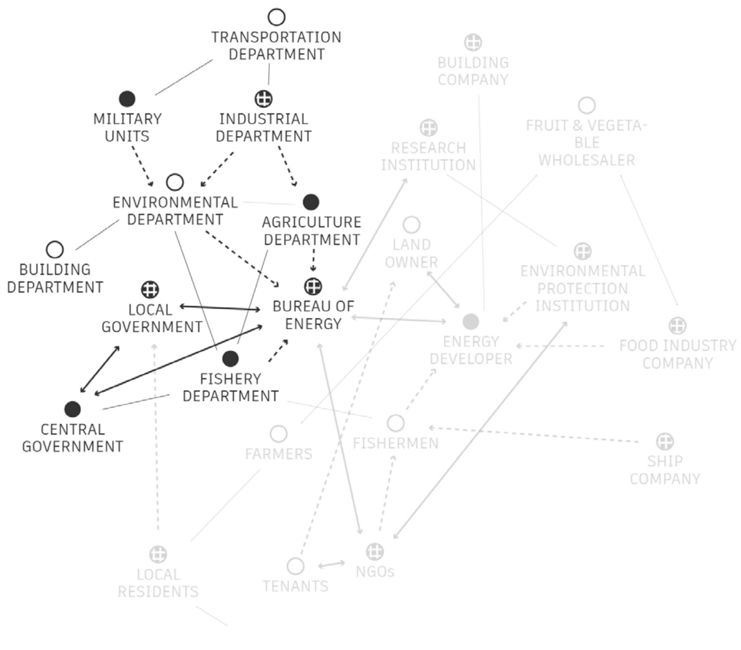
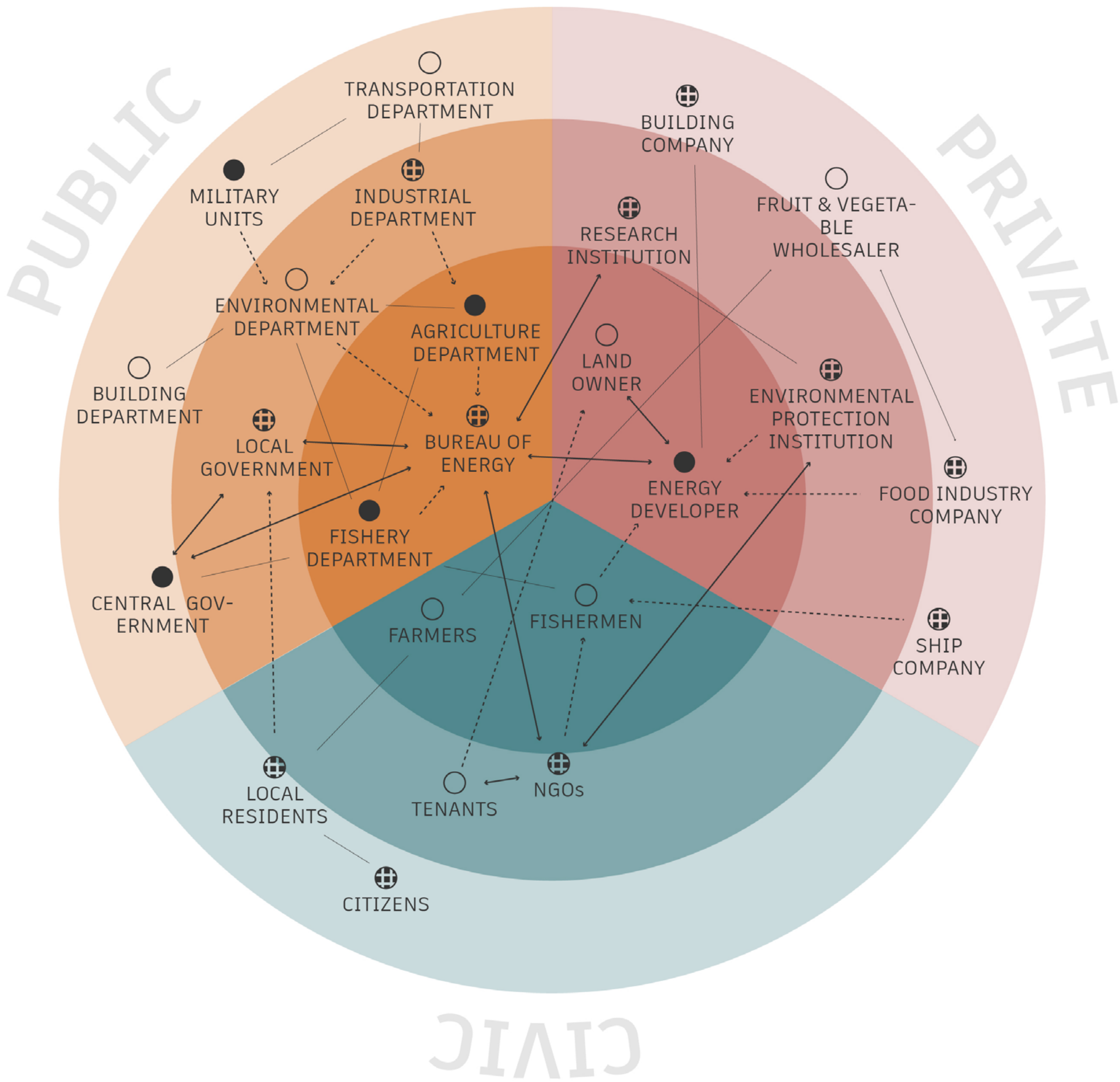


Fig 4.32: Stakeholders analysis: relationship between public sectors



PUBLIC SECTORS	PRIVATE SECTORS	CIVIC SECTORS
Bureau of Energy	Energy Developer	Farmers
Fishery Department	Land Owners	Fishermen
Agriculture Department	Research Institutions	Tenants
Industrial Department	Environmental Portection Institutions	Local Residents
Environmental Department	Building Company	NGOs
Building Department	Ship Company	Citizens
Transportation Department	Fruit and Vegetable Wholesaler	
Central Government	Food Industry Company	
Local Government		
Military Units		

RELATIONSHIP

- COLLABORATION
- CONFLICT
- CO-EXIST

INFLUENCE ON DECISION

- HIGH
- MEDIUM
- LOW

SECTOR INVOLVEMENT

Fig 4.33: Stakeholders analysis: relationship between public, private. and civic sectors

In the **Private sectors**, there are few links with each other, but there are more links with the public and private sectors. Specifically, cooperation between landowners and energy developers is more evident, as both parties have a great deal at stake. However, this has also led to conflict between landowners and tenants, as tenants can lose their right to work immediately and without any practical and relative protection.

There are also many conflicts between energy developers and environmental protection agencies, as the threat of development will significantly alter the environment and lead to the destruction of ecosystems.

Civic Sectors: The development of renewable energy in Changhua started in the industrial area and in the southwest where there is subsidence, so the residents and the local people have not yet experienced a huge change in their lives, so conflicts and cooperation are not yet evident.

In the fishing industry, however, many fishermen, whose right to work is threatened by the massive construction of offshore wind farms, do not have the strength or knowledge to protest. At the same time, there is more discussion about the protection of the ecosystem than about the loss of these people.

PRIVATE SECTORS

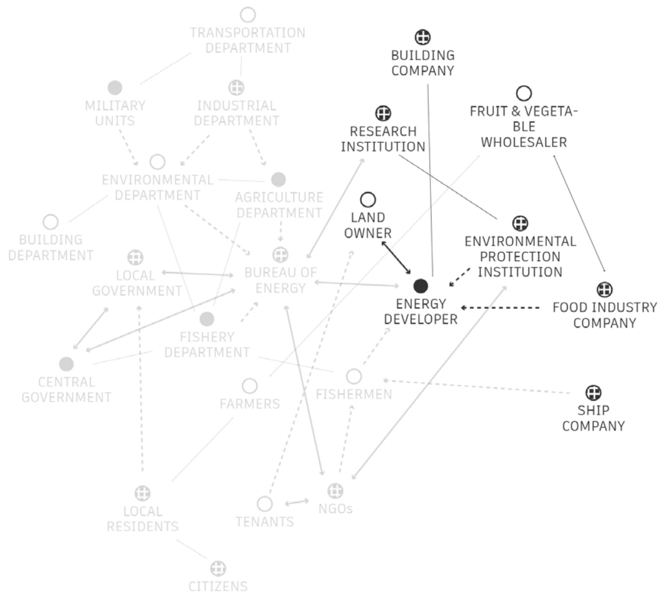


Fig 4.34: Stakeholders analysis: relationship between private sectors

CIVIC SECTORS

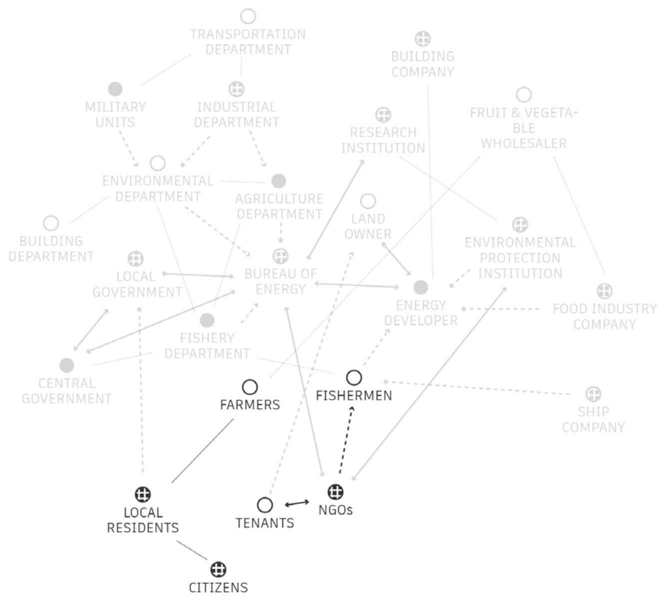


Fig 4.35: Stakeholders analysis: relationship between civic sectors

Collaboration

Collaboration between stakeholders mainly depends on a small number of actors, such as the Bureau of Energy and NGOs. Even though the central government has a more significant influence on decision-making, it has not been involved much in the transitional process. In terms of other public sectors have more conflicts because of different goals, as the diagram shows on the right side. The other sectors trying to build up collaboration, if not the sector lacking actual power, are those with only one-way partnerships.

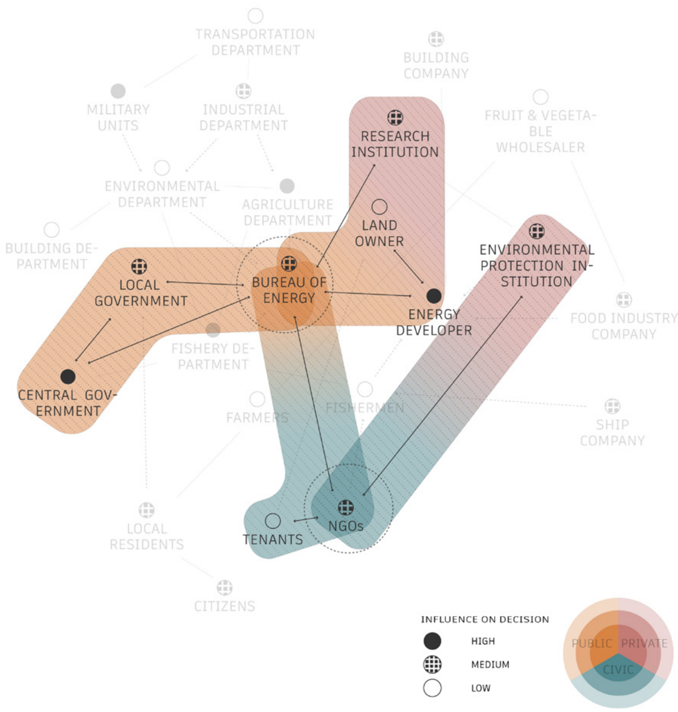


Fig 4.36: Stakeholder Analysis: collaborative relationships.

Conflicts

Conflicts have happened more frequently within public sectors or private sectors themselves. Conflicts within public secotrs are due to the absence of a holistic planning system as the guildline for negotiation. Other conflicts between local government and residents or land owners and tenants can be found due to uneven potential interest or lacking legal regulation to protect their rights. For example, tenants have lost their rights to rent the lands without notification, and fishermen are losing their economic because fishing areas are decreasing.

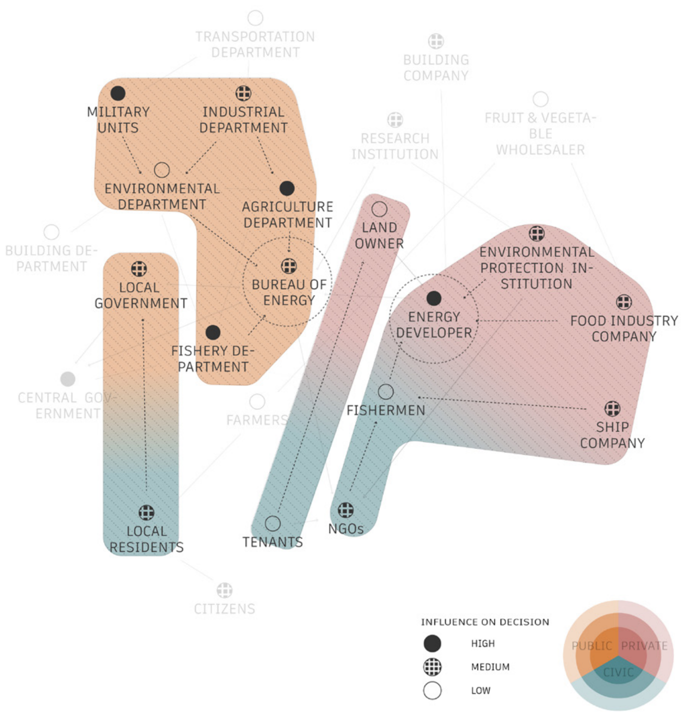


Fig 4.37: Stakeholder Analysis: Conflict relationships

Power and Interest

The current situation is that the civic sector has less power and interest in this transition process, despite the huge social and economic changes they are facing.

However, the private sector, such as energy developers, earns high profits from the sale of electricity on the market as the government promotes the development of renewable energy.

In addition, the public sector, such as the Ministry of Agriculture and local governments, have been less cooperative and responsive to the Bureau of Energy because there is no overall plan to establish rules of the road to follow.

Therefore, a proposal is made for the private sector, especially farmers, fishermen and tenants,

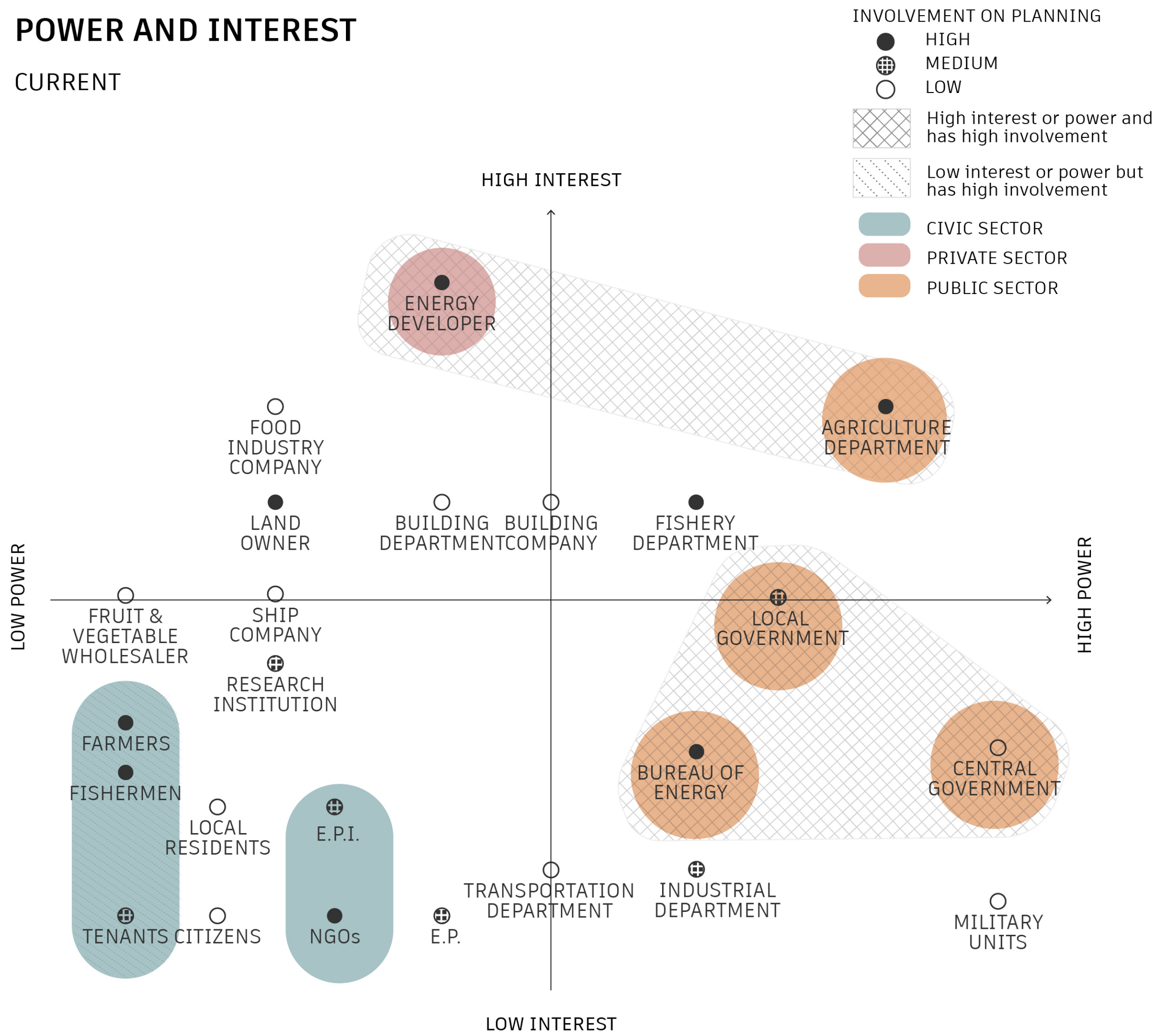


Fig 4.38: Power and interest between stakeholders: current

to increase their power in the decision-making process in order to counteract the power of energy developers and to obtain higher benefits from the market and reverse their loss of the right to work.

The private sector, like environmental protection agencies, can increase their interest, improve their capacity and help raise public awareness.

In addition, by establishing a holistic plan, it helps the Energy Agency to increase its powers of implementation. On the other hand, it is important to increase the interest of central government and encourage more investment in improving the planning process for the energy transition.

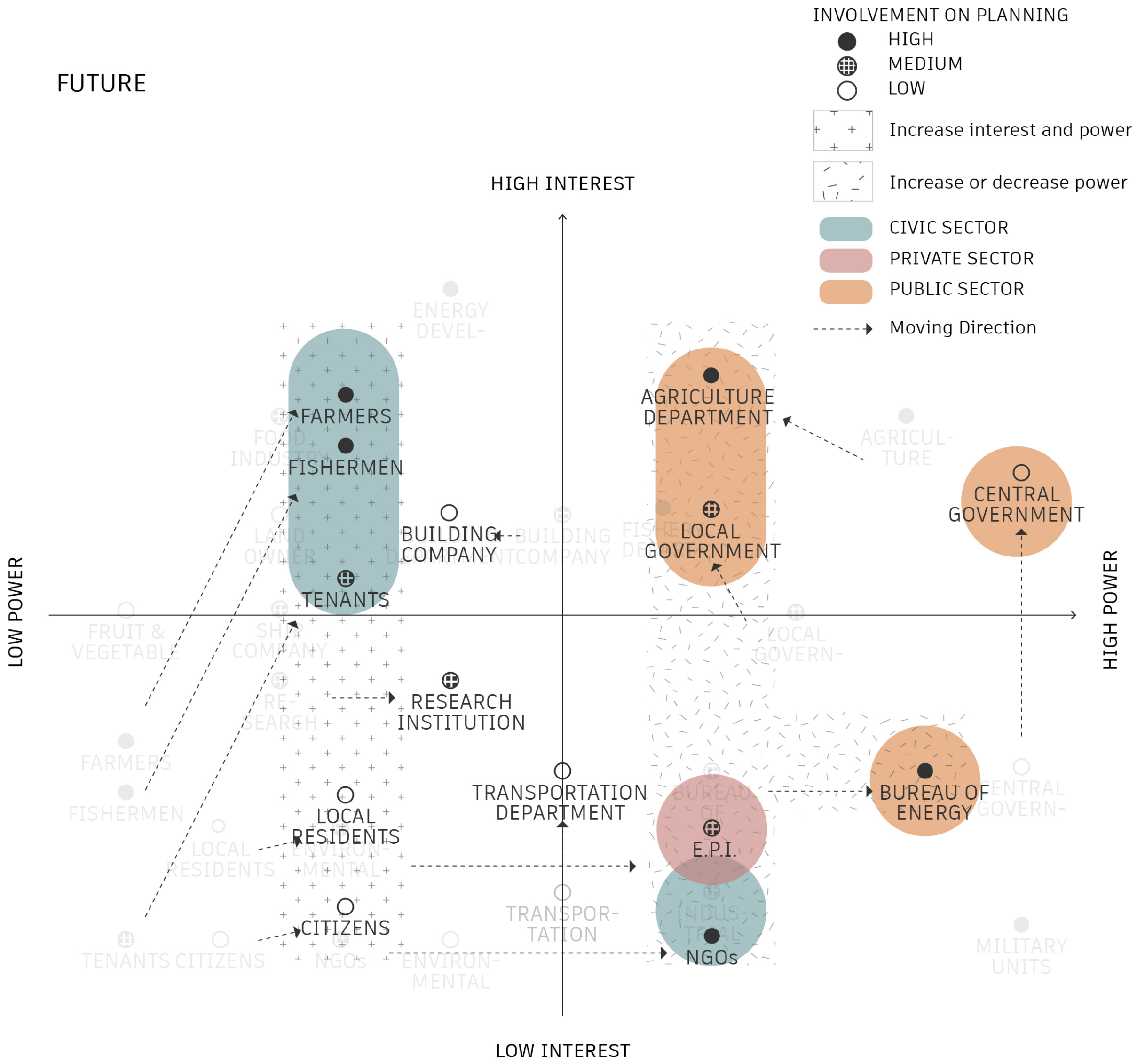


Fig 4.39: Power and interest between stakeholders: proposed

4.9 Conclusion

Potential Area

Based on the previous analysis, the potential areas in Changhua can be divided into four sections: (1) industrial areas and newly planned development zones; (2) potential multifunctional uses for agricultural land; (3) potential multifunctional uses for aquaculture land; and (4) planned offshore wind farms.

(1) Industrial areas and newly planned development areas: According to the Changhua government's plans, several new development areas will be built for industrial development use and residential and commercial use zones. This means that these areas offer opportunities for the integration of planning with renewable energy. In addition, there are several smaller industrial areas along the transport routes that could also work with renewable energy installations and slowly influence to urbanised areas.

(2) Potential multifunctional uses of agricultural land: Based on the analysis in the previous section, the priority experimental use of multifunctional agricultural land is shown on the map. Due to the constraints of natural conditions and potential risks, these areas have a lower capacity for agricultural development and offer space for experimentation with multifunctional uses.

(3) Potential multifunctional uses of aquaculture land: Most fish farms are located along the coastline and there are a number of aquaculture specialist areas in the Fangyuan District. The integration of aquaculture land with solar panels has been demonstrated in government experiments to be beneficial for both energy generation and improved aquaculture performance. However, consideration must also be given to what type of aquaculture will be combined with renewable energy. Overall, it shows the opportunities for multifunctional use on aquaculture land.

(4) Planned offshore wind farms: According to the central government's plans, 21 offshore wind farms will be built in the Changhua offshore area. However, site planning still needs to take into account environmental sensitivities and the planning of the surrounding area.

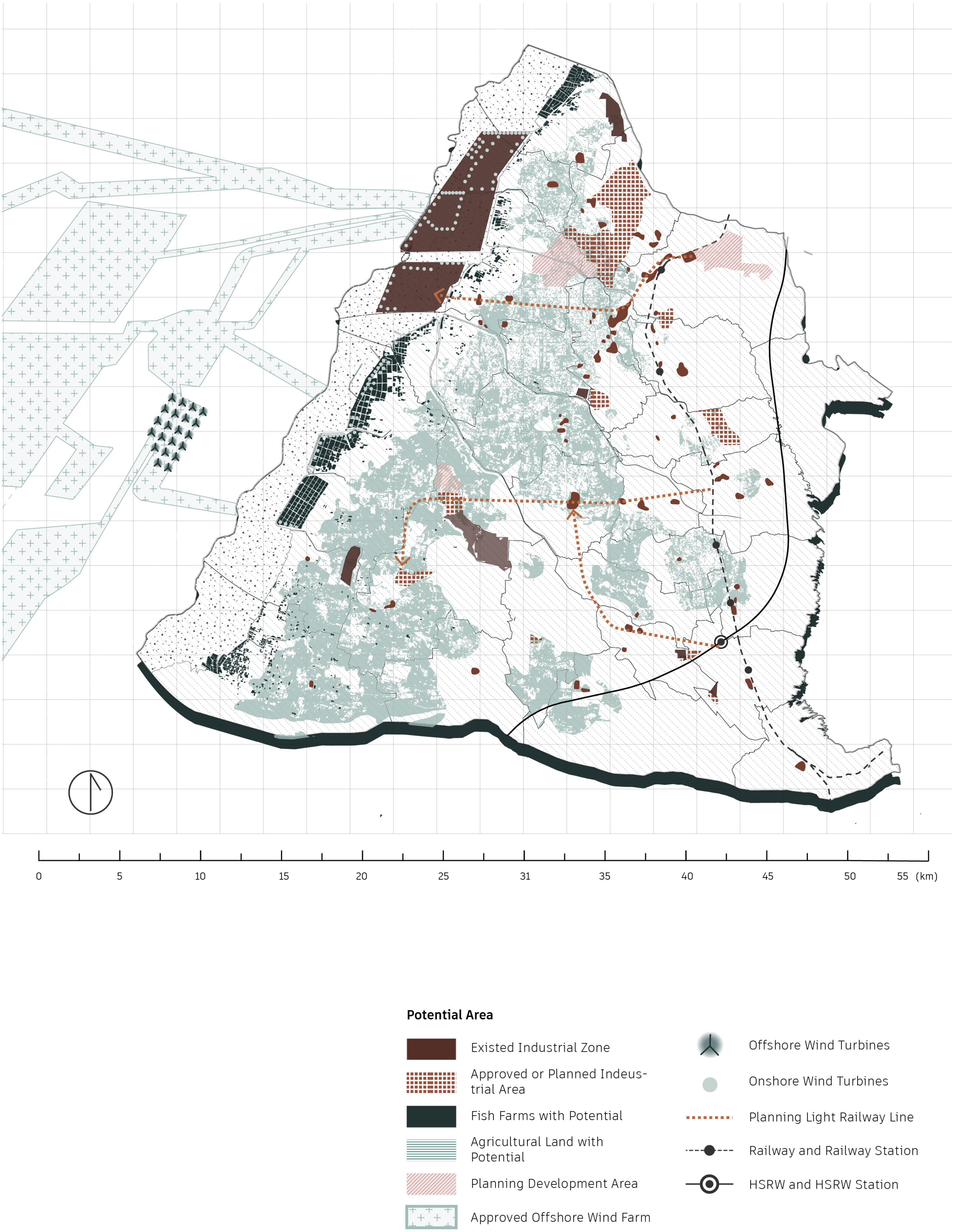


Fig 4.40: Conclusion map: potential areas.

Vulnerabilities Area

The vulnerable areas can be divided into three parts: (1) north-west to south-east (along transport routes); (2) parts of the south-west; and (3) offshore areas and settlements on the coastline .

(1) North-west to south-east: This area has a higher vulnerability to river flooding and sea level rise. This vulnerability overlaps with the more urbanised areas, or in other words, the urban areas of most regions are already exposed to the risk of natural hazards due to the high density of man-made infrastructure and development.

Considering the integration with renewable energy development, this type of vulnerability must be prevented from the impact of natural disasters on the infrastructure, as well as the possible impact on the neighbourhood.

(2) South-west region: This area has more heavily subsided land due to groundwater being pumped out for aquaculture in earlier years. In addition, the energy infrastructure in terms of substations and grid capacity is underdeveloped compared to the rest of Changhua. The construction and upgrading of these infrastructures is necessary if the region has plans to develop renewable energy sources.

(3) Offshore areas and settlements on the coastline: Areas near the coastline will be at risk given the 2m sea level rise. In addition, offshore areas are also wildlife sanctuaries, which means that offshore wind farms need to be planned and built at a distance from this area and follow noise reduction regulations during operation in order to prevent irreversible situations .

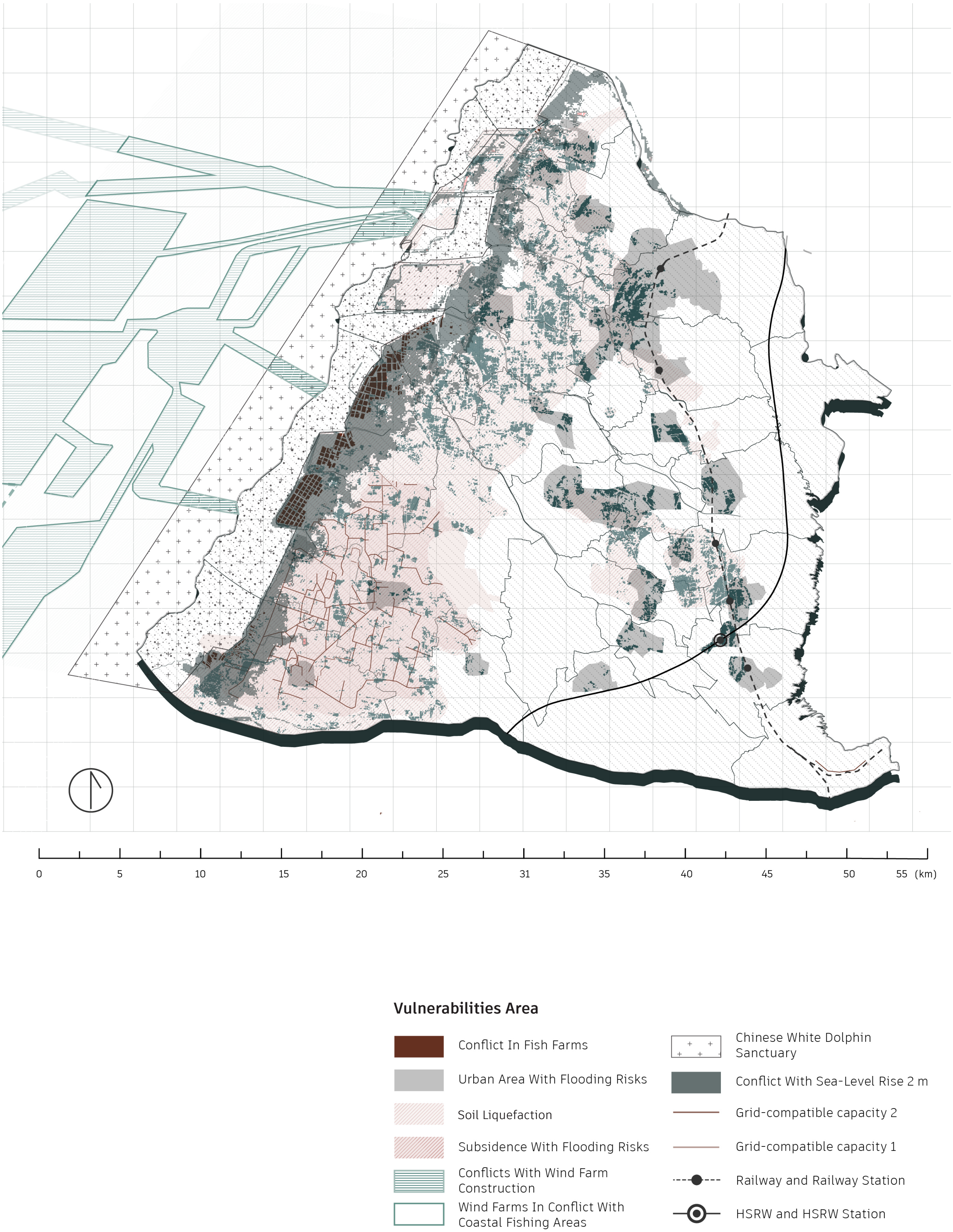


Fig 4.41: Conclusion map: vulnerabilities areas.

05 Vision

5.1 Vision Statement

Vision Statement

In 2050, Changhua's vision will serve as an energy hub and role model to help envision what is possible in Taiwan's energy transition process. This model will create value that is **adaptive**, **collaborative**, and **universal.**

The impact of the energyscape will be analyzed, visualized, and tested in terms of social, economic, and environmental impact scenarios for Changhua and serve as sustenance for **stakeholder inclusion**, **spatial adaption**, and **planning system integration**.

Changhua will be revitalized, reversing the "county for city" concept, achieving resource redistribution, and representing Taiwan's energy transition model with full consideration of **spatial justice**.

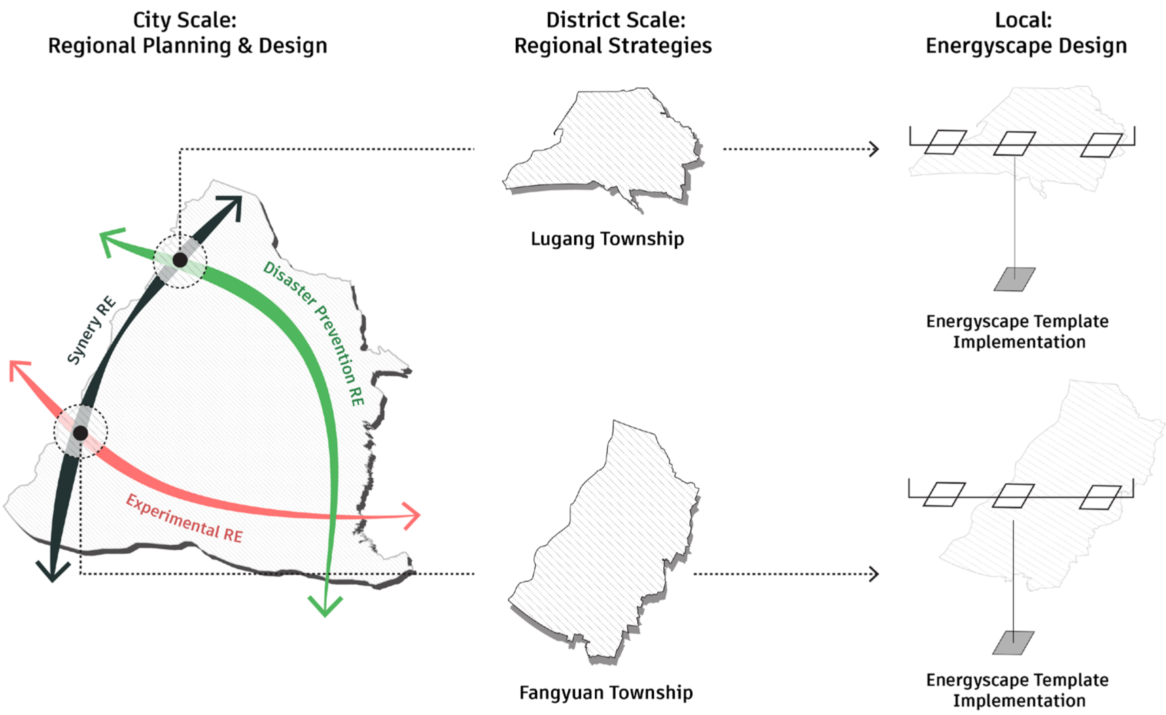


Fig 5.1: Intervention through scale.

Fig 5.2: Vision of Changhua: before.
Fig 5.3: Vision of Changhua: after.

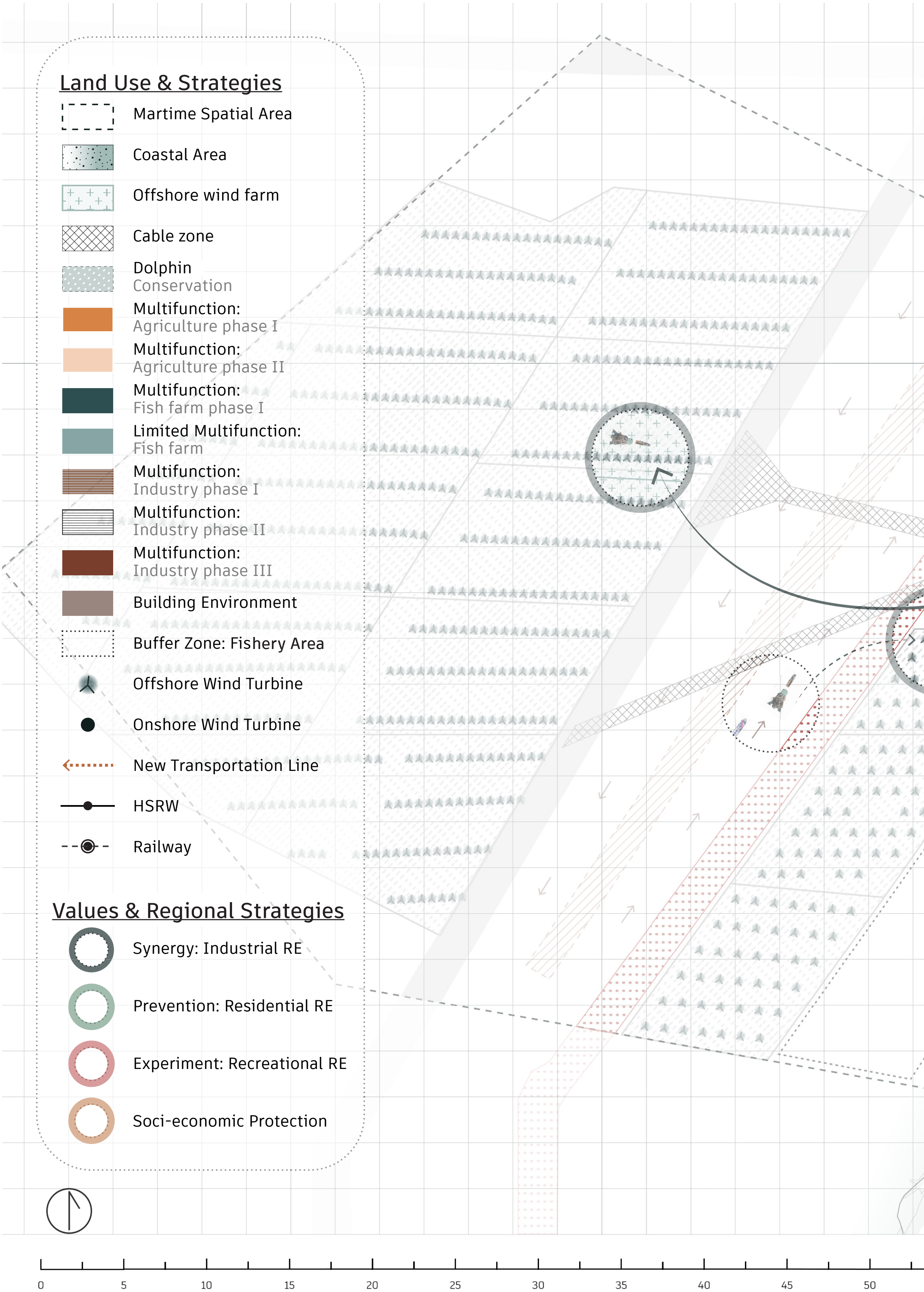
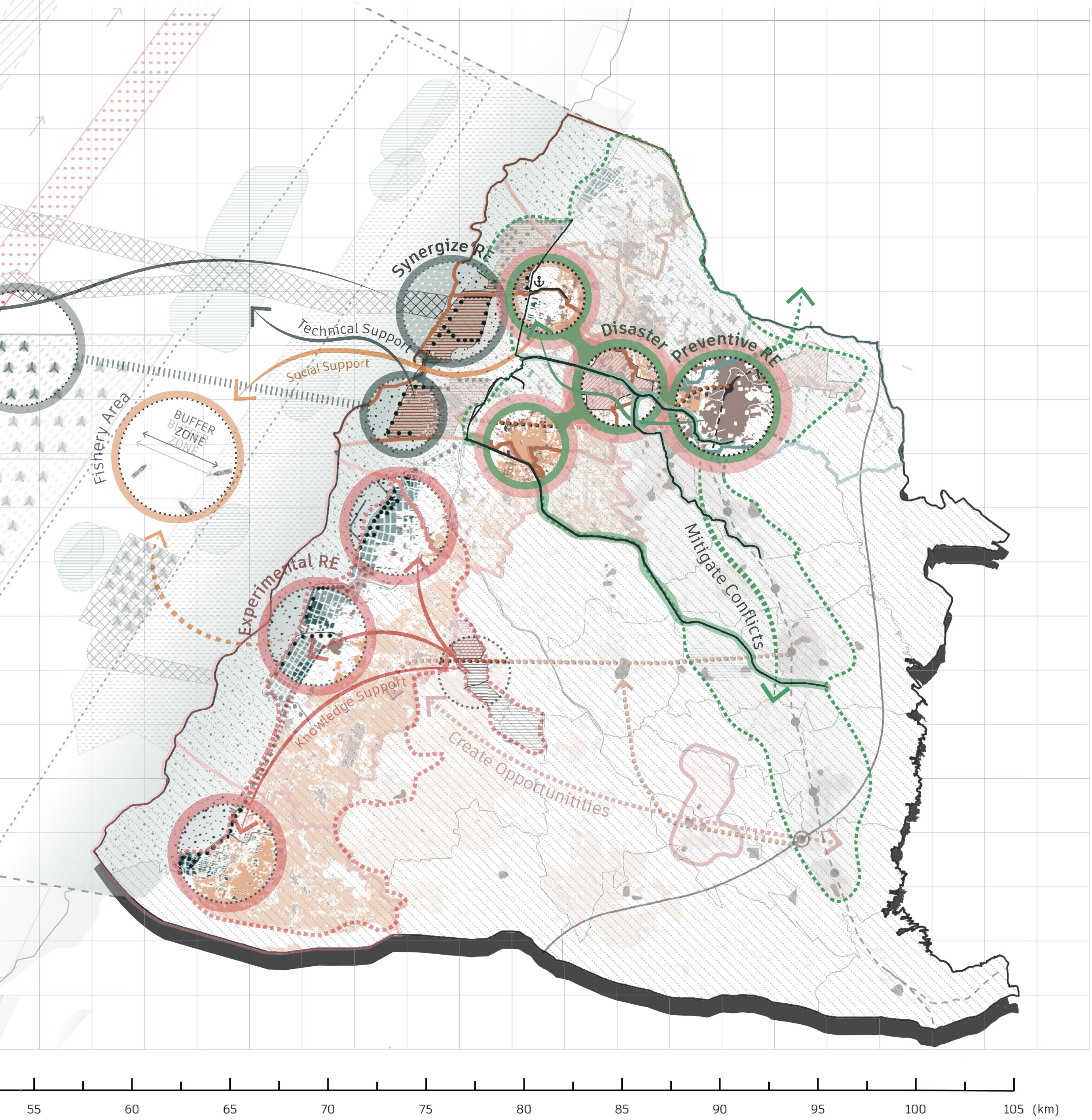


Fig 5.4: Vision Map.

5.2 Vision Map

There are three vision strategies: **Synergy**, working on renewable energy and industrial zones to create the most effective cooperation; **Prevention**, preventing disasters and integrating them with renewable energy in residential and urbanised areas; and **Experimentation**, working on potential multifunctional projects on different lands to maximise value. The regions within the circle present the main problem areas where these strategies will play the greatest role in creating a new vision. Based on this, the impact of the changes will be presented in stages to continuously improve the rest of Changhua and to achieve the vision of creating an energy hub.



Disaster Prevention RE

According to the analysis in chapter four, there is a more intensive natural disaster in the north and east side of Changhua due to the higher degree of urbanization. Besides, even though these areas have more demands on energy, there have been fewer actions regarding renewable energy generation; thus, this strategy focuses on the areas with higher urbanization and more economic activities.

Disaster prevention will be the first implementation of this strategy, focusing on Changhua City and Lugang Township, the two highest urbanized areas.

The experiment of installing renewable energy within the high-density area will be in the second phase, testing the possibility of installation in the new and old built environment.

The last step will extend the implementation along the railway, which is also the distribution of other high urbanization areas in the north and east side of Changhua County.

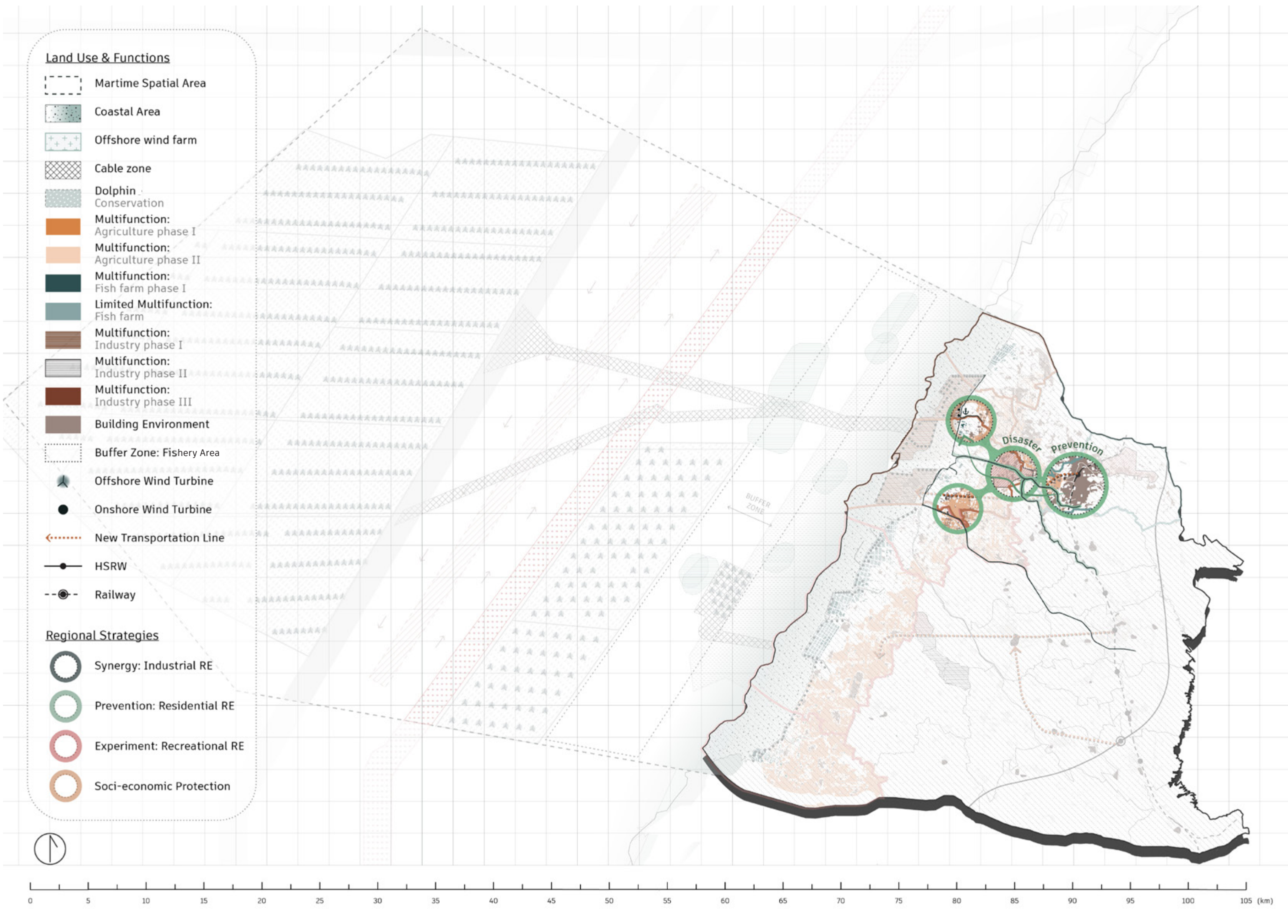


Fig 5.5: Disaster prevention RE: phase 1.

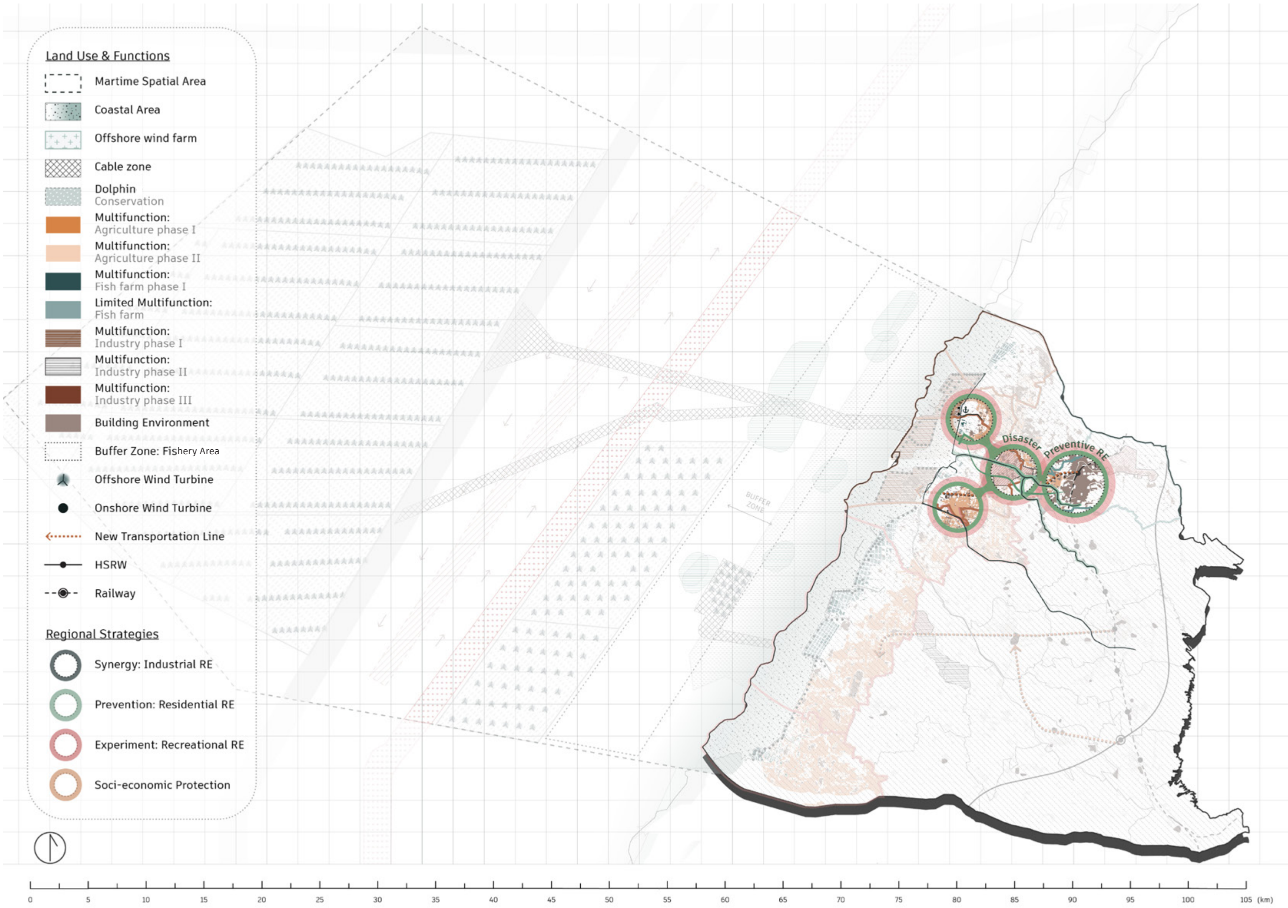


Fig 5.6: Disaster prevention RE: phase 2.

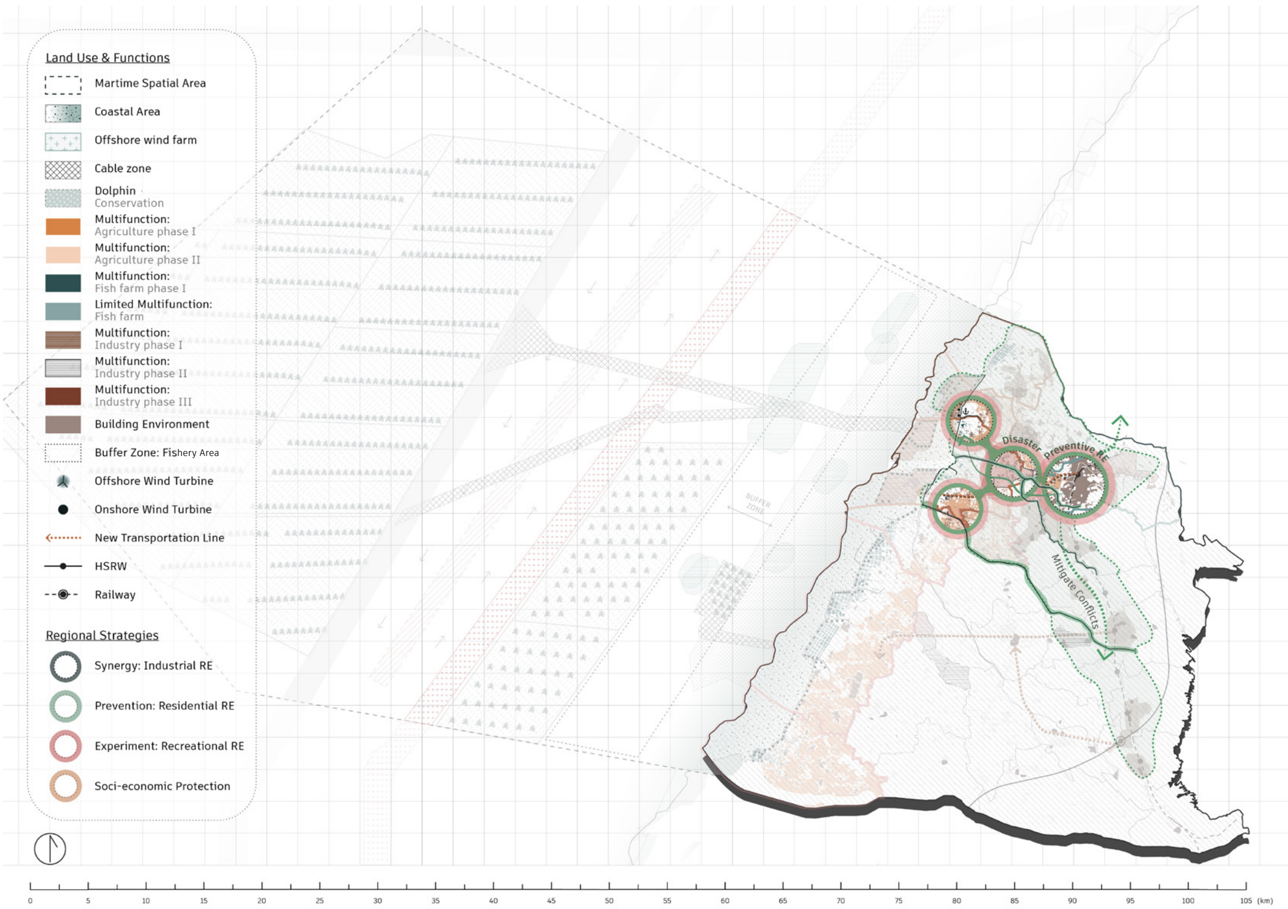


Fig 5.7: Disaster prevention RE: phase 3.

Complex Experimental RE

The complex experimental RE strategy focuses on creating the multifunctional use of land. Based on the condition and the national energy strategies, more predicted projects are located in the southwestern part than in other regions in Changhua County. Due to the land use types in this area being mainly for first-tier industry use; thus, the experiment will focus on aquacultural and agricultural lands. However, this region also possesses several potential conflicts. Aquacultural lands are also the critical environment for the ecosystem; Agricultural lands are the key to preventing the food security issue. Thus, the complex experiment will divide into three phases in order to avoid irreversible results in terms of landscape change.

The first phase will experiment with the multifunctional use of aquacultural land due to the positive outcomes from other cities' experiment results. Yet, it is essential to see the influences on the ecosystem in this area and how to set up the regulation for these specific areas.

The second part will be the experiment in the agricultural lands, and the analysis results in Chapter 4 define the testing area. After the investigation is favorable and the regulation setting is complete, the action will continue and expand to the east side.

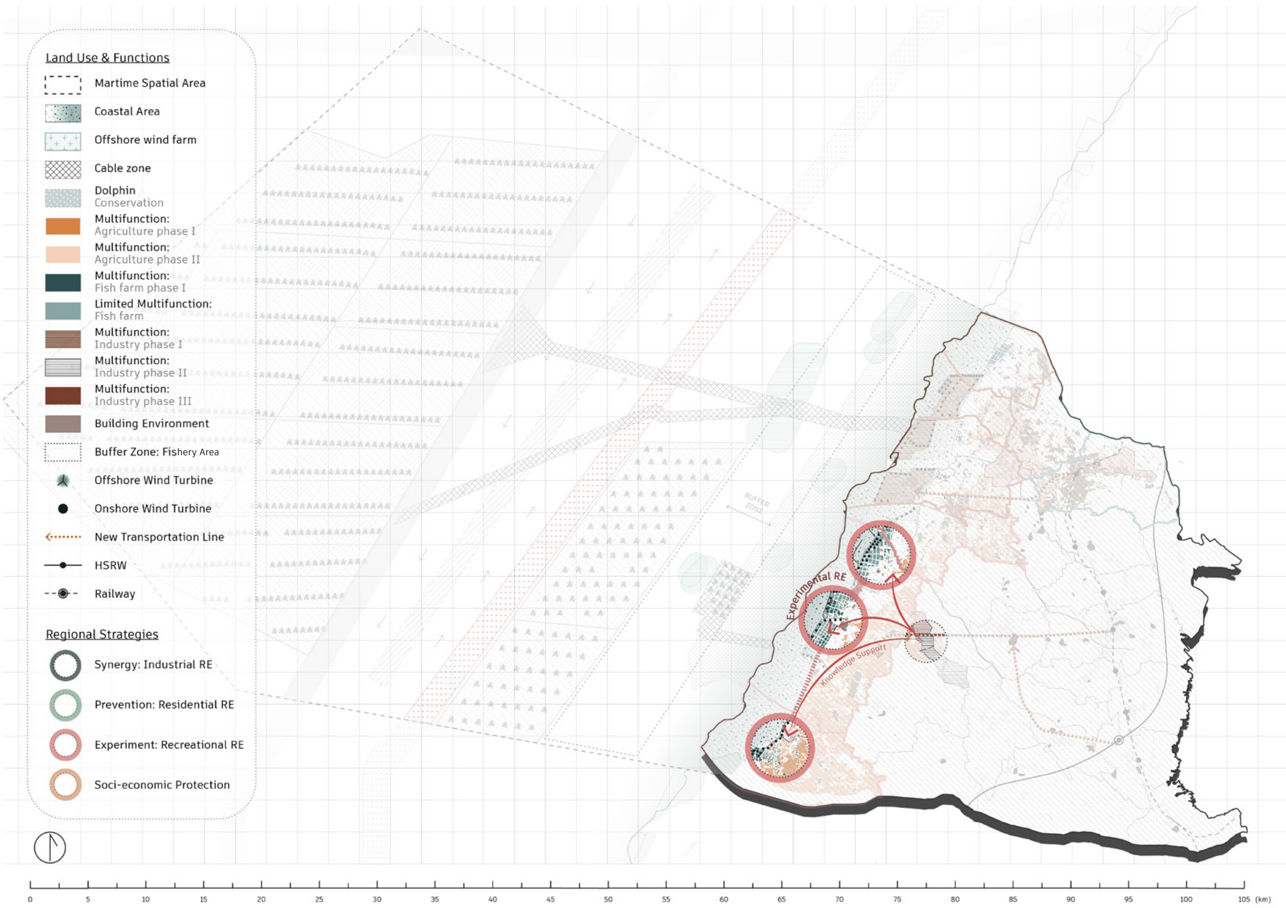


Fig 5.8: Complex Experimental RE: phase 1.

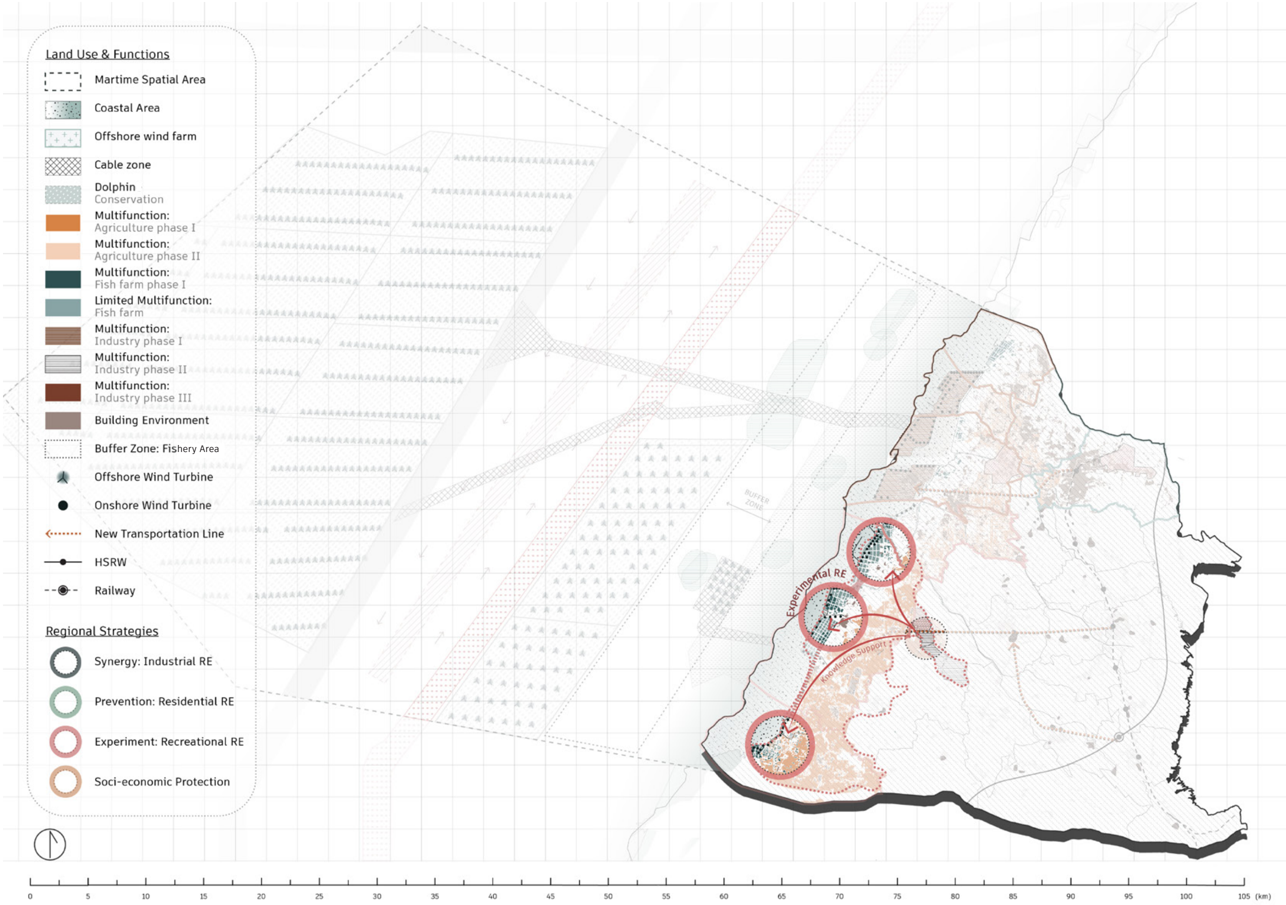


Fig 5.9: Complex Experimental RE: phase 2.

Fig 5.10: Complex Experimental RE: phase 3.

Synergy RE

Synergy RE strategy is based on the areas that connect the inland and maritime activities. The implementation of renewable energy has enormous potential on both islands and offshore. However, the zoning planning in the marine spatial area affects the activities on land, especially the impact on the fishery.

Therefore, the first phase of the strategies is building up the support center for the offshore wind in the industrial zone, strengthening the infrastructure for technical support.

The second phase is to reborn the village port, preserving and improving the individual fishermen's work environment. Based on the buffer zone creation, fishermen can continue working along the coastal areas.

And the Last phase will complete the zoning separation within the offshore wind farms, providing spaces for fishery activities and transportation instead of forbidding any fishery activities and threatening individual fishermen's work rights. In this zone, it separates the shipping direction to avoid potential traffic accidents and improve the management of maritime activities.

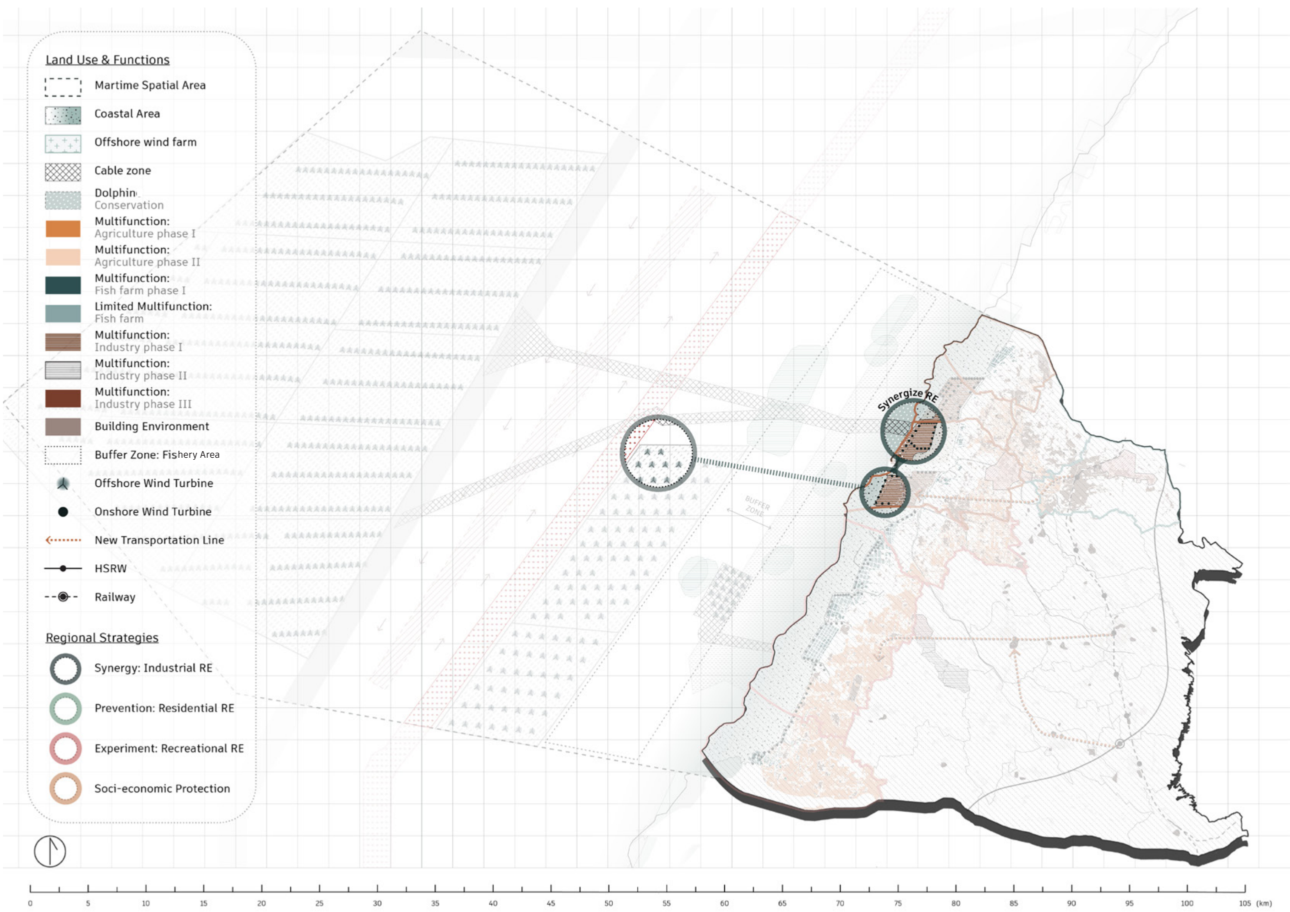


Fig 5.11: Synergy RE: phase 1.

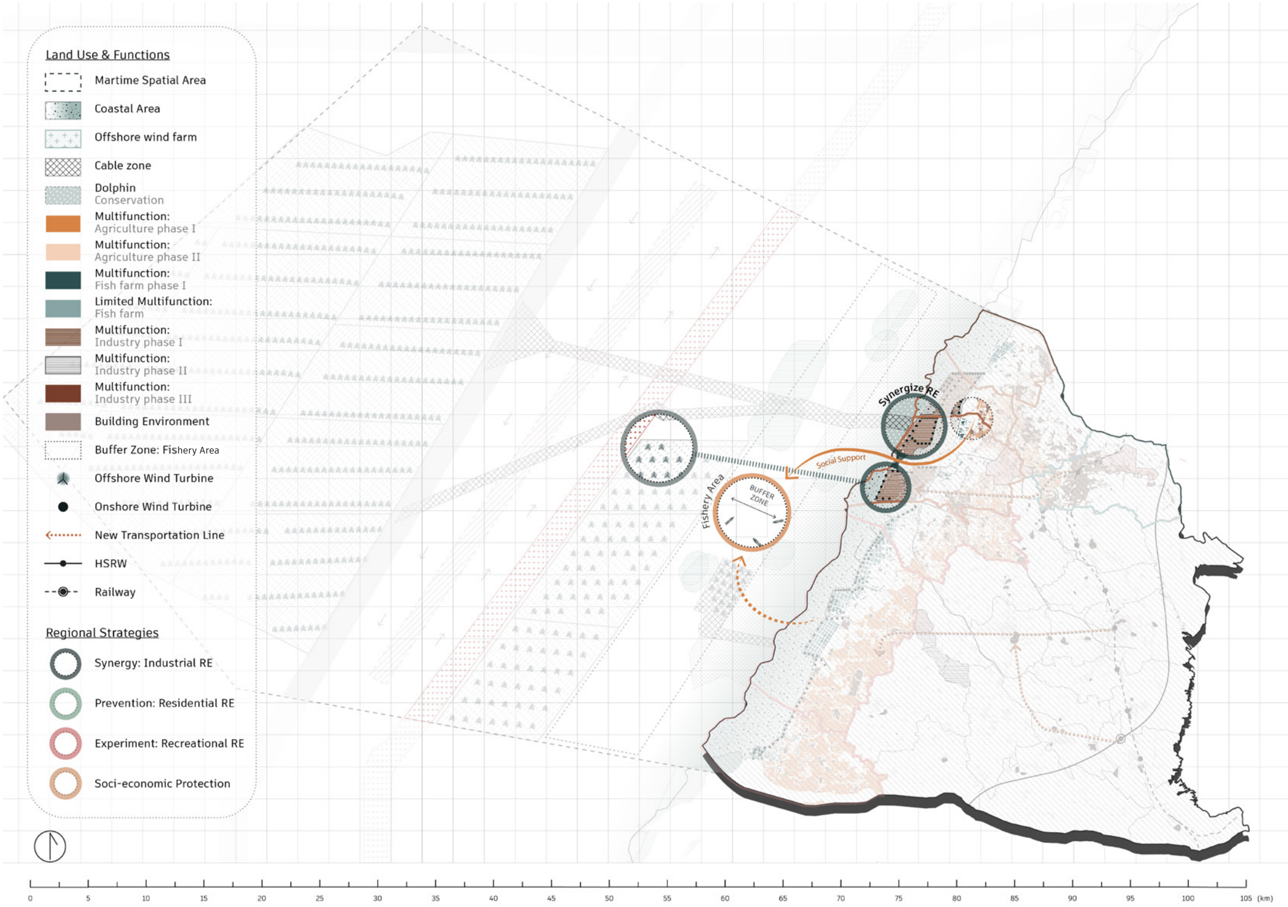


Fig 5.12: Synergy RE: phase 2.

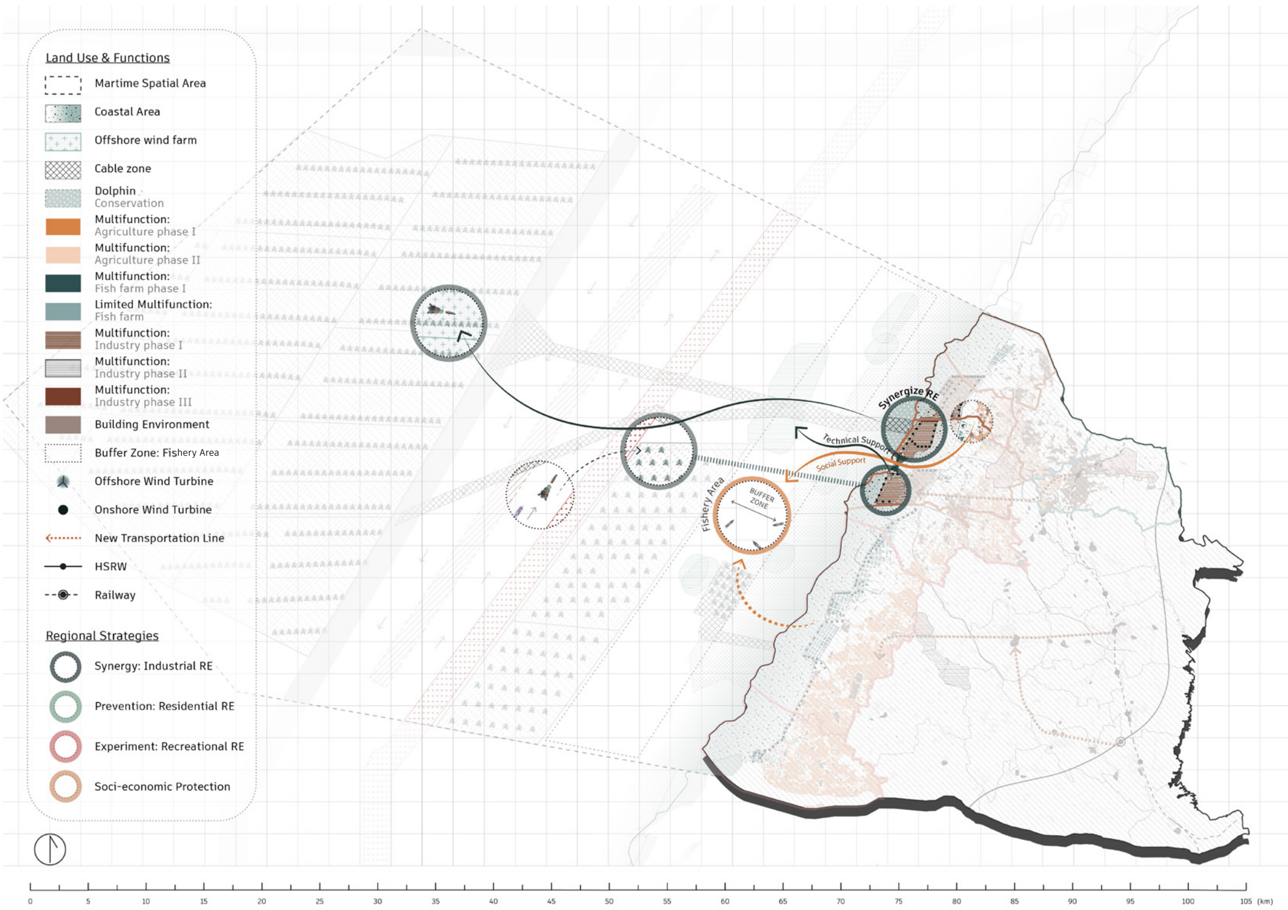


Fig 5.13: oSynergy RE: phase 3.

06.
Research & Design

6.1 New Planning System As A tool

National Spatial Planning System

There are three systems for spatial planning now, which are: (1) Urban Planning; (2) Regional Planning (Non-urban Planning); and (3) National Park Planning. Each plan follows different laws and has various departments managing lands within systems.

The National Spatial Planning System is a new proposed planning scheme that will be implemented in 2025. This new integrated planning system will become the holistic plan above the urban and national park planning plan. It will also include the marine spatial area, providing rules and building up structure in maritime management. Besides, the regional planning system will be eliminated after the integrated plan starts. Under this system, lands are being redefined into four functional land zones, which are: (1) National Protection Zone; (2) Urban Development Zone; (3) Agriculture Development Zone; and (4) Maritime Resource Zone.

Chapter 2 showed that separate planning systems increase the challenges in the energy transition process. Due to planning systems managing different types of land areas and following different laws, it lacks the order to organize the collaboration between departments and the principles set to prevent adverse effects and predict the outcomes in spatial.

As the maps show on the right side with Changhua County as an example, the top one demonstrates that only highly urbanized areas are managed under the urban planning system. At the same time, most of the other regions belong to the regional planning system. However, there is no planning system to manage the marine spatial areas. If a project crosses through these three types of land, collaboration will be difficult because there is a lack of principles for cooperation and a need for a higher system level to provide a structure for organizing.

The bottom is the map showing the National Spatial Plan of Changhua County. Based on the need for conservation, utilization, and management, and according to the characteristics of land resources, it integrates lands and provides identities for them. Functional zones highlight the purpose of the lands in terms of development or preservation, creating the potential to set up rules for renewable energy implementation that match the definition of the land zones.

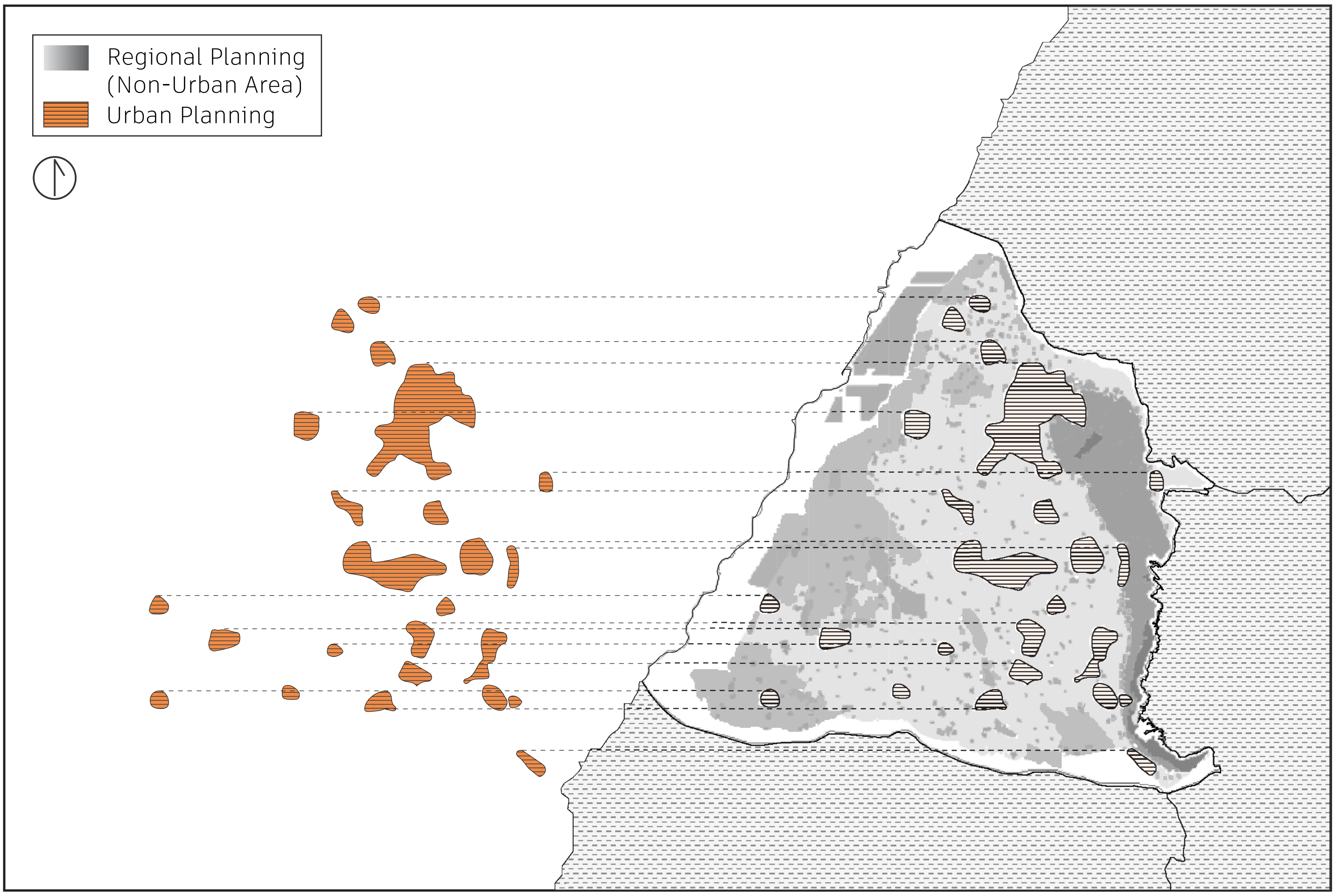


Fig 6.1: Planning systems in Changhua.

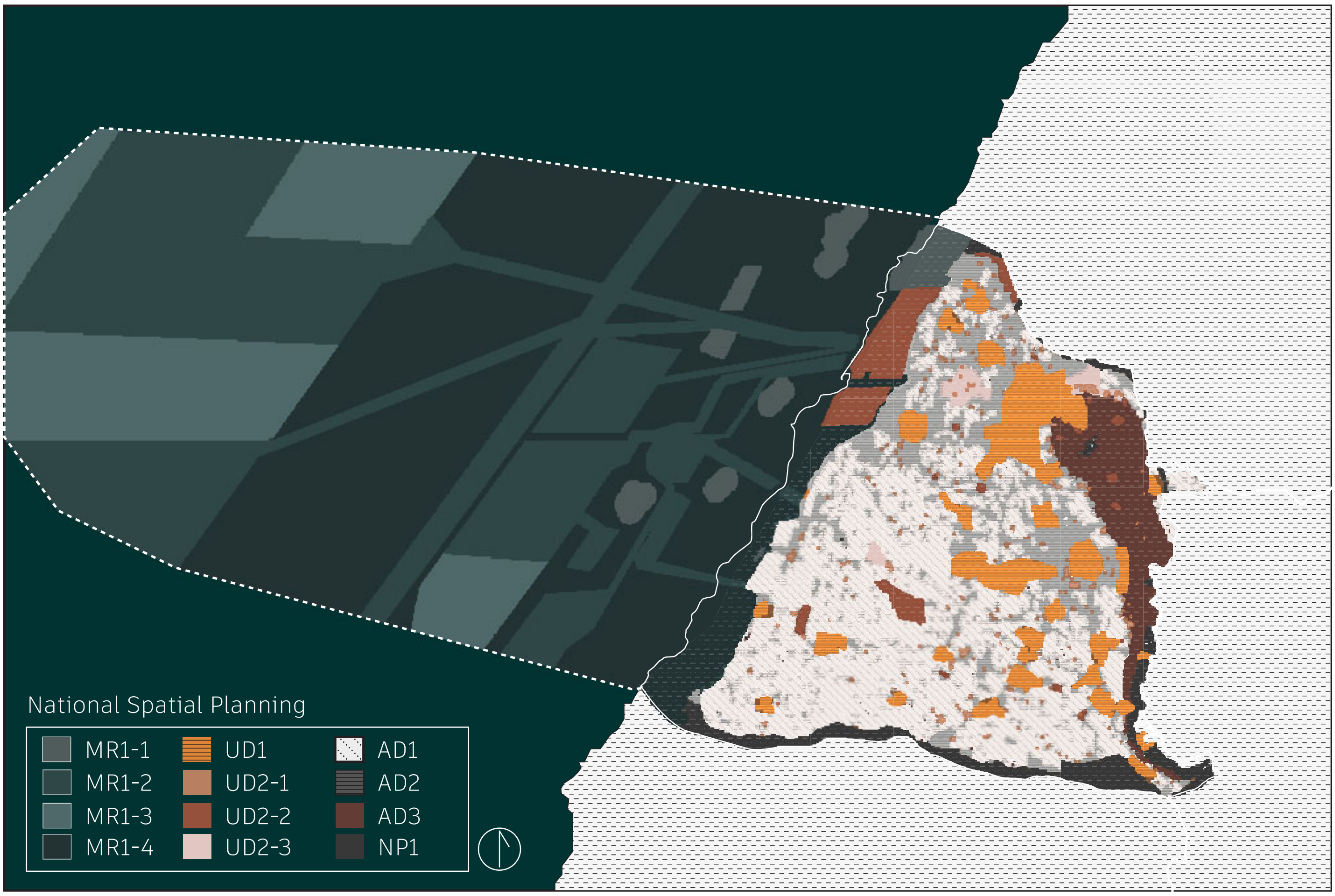


Fig 6.2: National Spatial Planning System in Changhua.

How can it help?

As mentioned above, the definition of functional zones is based on the purpose of land use. In addition, this new system changes land use from development permits to utilization permits. The elimination of development permits limits the application of unrestricted development to all types of land (which is the main reason why tons of agricultural land have been changed to only renewable energy generation).

Furthermore, the use permit mechanism can indicate which land can be used for renewable energy production and which cannot. In other words, it shows that it is possible to develop regulations for the implementation of renewable energy sources depending on the type of area, due to differences in the intensity of use.

According to Article 6, Item 1, Paragraphs 3-6 of the National Spatial Planning Act, the following are the definitions of the four functional zones.

(1) National Protection Zone: based on the principles of conservation and security and may prohibit or restrict uses and behaviors within the area. Based on the environment's sensitivity, this zone has four categories.

(2) Maritime Resource Zone: integrate multiple demands and establish an order of use based on the principle of sustainable use of resources. Based on the exclusivity and compatibility of the areas, there are three categories and five divisions.

(3) Agriculture Development Zone: this zone should ensure food security, protect critical agricultural production environments and infrastructure, and avoid sporadic development. Based on the quality of the farming lands and the locations, there are five categories in this functional zone.

(4) Urban Development Zone: should be based on intensive development and growth management principles to create a tranquil and harmonious living environment and an efficient production environment to ensure complete supporting public facilities. Three categories can be divided into five divisions based on the degree of urbanization.

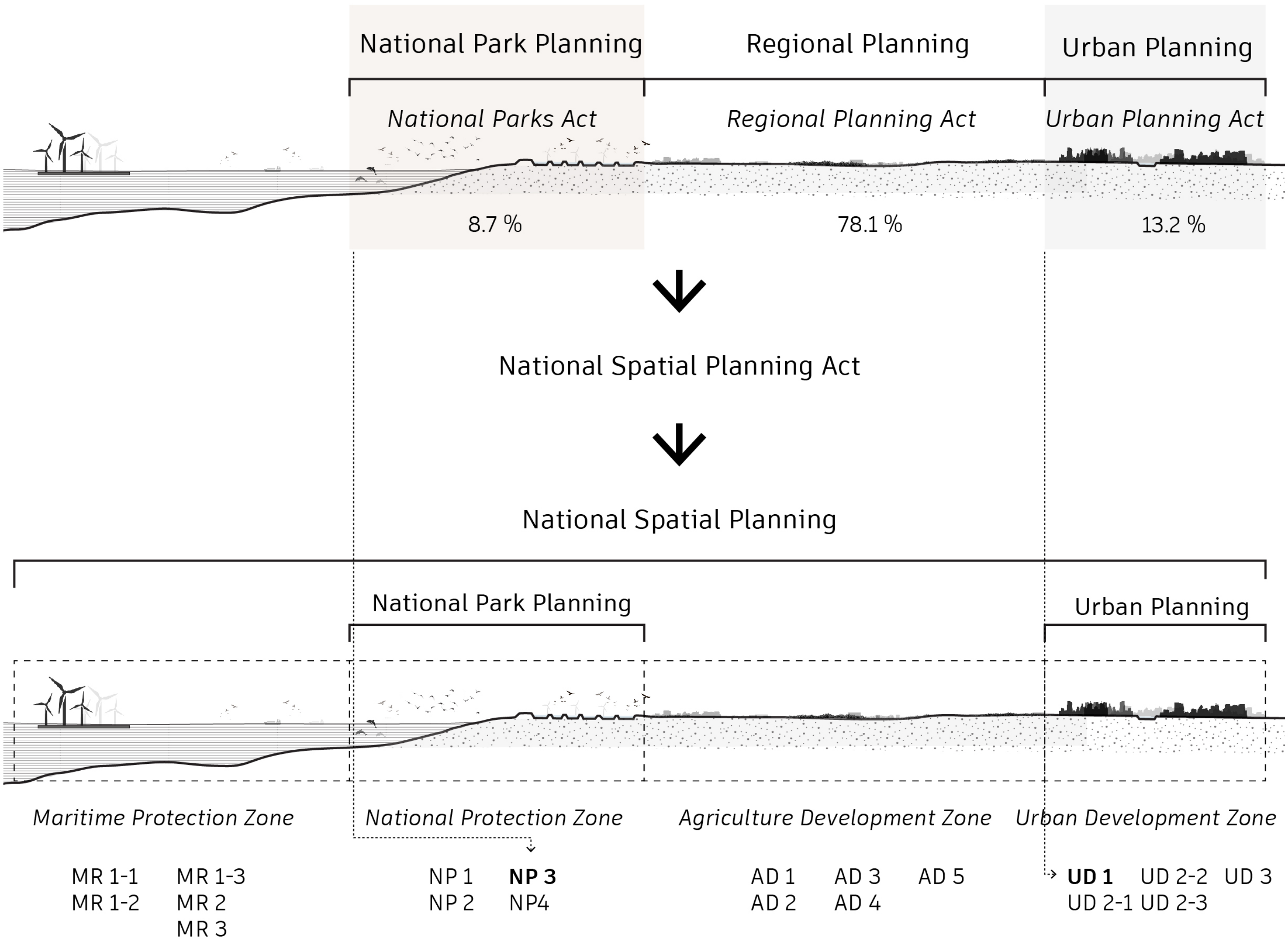


Fig 6.3: Explanation of the planning system changes from separate planning systems to an integrated one.

6.2 EnergyScape Design Principle

Foundation of The Design Principle

Landscape change is considered a primary limiting factor in the energy transition process. On top of this, wind energy is most discussed due to the environmental and social impacts on both land and sea.

Several studies mention that aesthetic perceptions strongly influence the acceptance of wind farm schemes by individuals (Warren, Lumsden, O'Dowd, & Birnie, 2005). However, aesthetic perceptions can have not only harmful but also positive effects. For example, when local people strongly support technology, there is a more favorable response.

On the other hand, Gross (2007) notes that people who feel fairly treated in the planning process are more likely to accept the decision-making process and develop trust in the institution. Several literature has concluded two main strands that influence society's attitude towards the change: (1) **procedural**; and (2) **distributional justice**.

In the first case, it can equal the construction of the decision-making procedure, with emphasis on acknowledgment, competence, and engagement, and in the second case, on the distribution of gains and losses (Gross,2007, Langer et al., 2016, Ottinger et al., 2014, Scherhaufer, et al., 2017).

However, in Taiwan's current energy transition condition, the contradiction is not only in the planning of wind farms but also in solar energy, i.e., the constant transformation of large-scale agricultural and aquaculture landscapes into solar panels. Building upon the analysis in the previous chapters, it is clear that the complexity of planning systems led to collaboration inefficiency and caused the neglect of injustice during the transitional process. Therefore, defining what factors must be considered during the planning process is inevitable.

According to Scherhaufer et al. (2017) and Rodríguez-Segura et al. (2023), several factors that influence the social acceptance of renewable energy development are discussed. An energyscape impact design template is constructed by combining the two aforementioned literature reviews, the current energy landscape analysis, and the national spatial planning system that will be implemented in 2025. This design solution aims to integrate energy policy with the spatial planning system to prevent problems caused by systemic deficiencies and to create an approach to improve social acceptance.

Thus, for the development of the template design and further regional strategy development, nine principles are defined:(1)Impact on human ecology; (2)Repowering; (3)public participation, trust, and transparency; (4)Impact on tourism; (5)Effects on landscape scenery; (6)Nature and wildlife conservation; (7)Distribution of Financial Benefits & Losses; (8) Energy Strategies; (9)Economic Effects (Ownership)

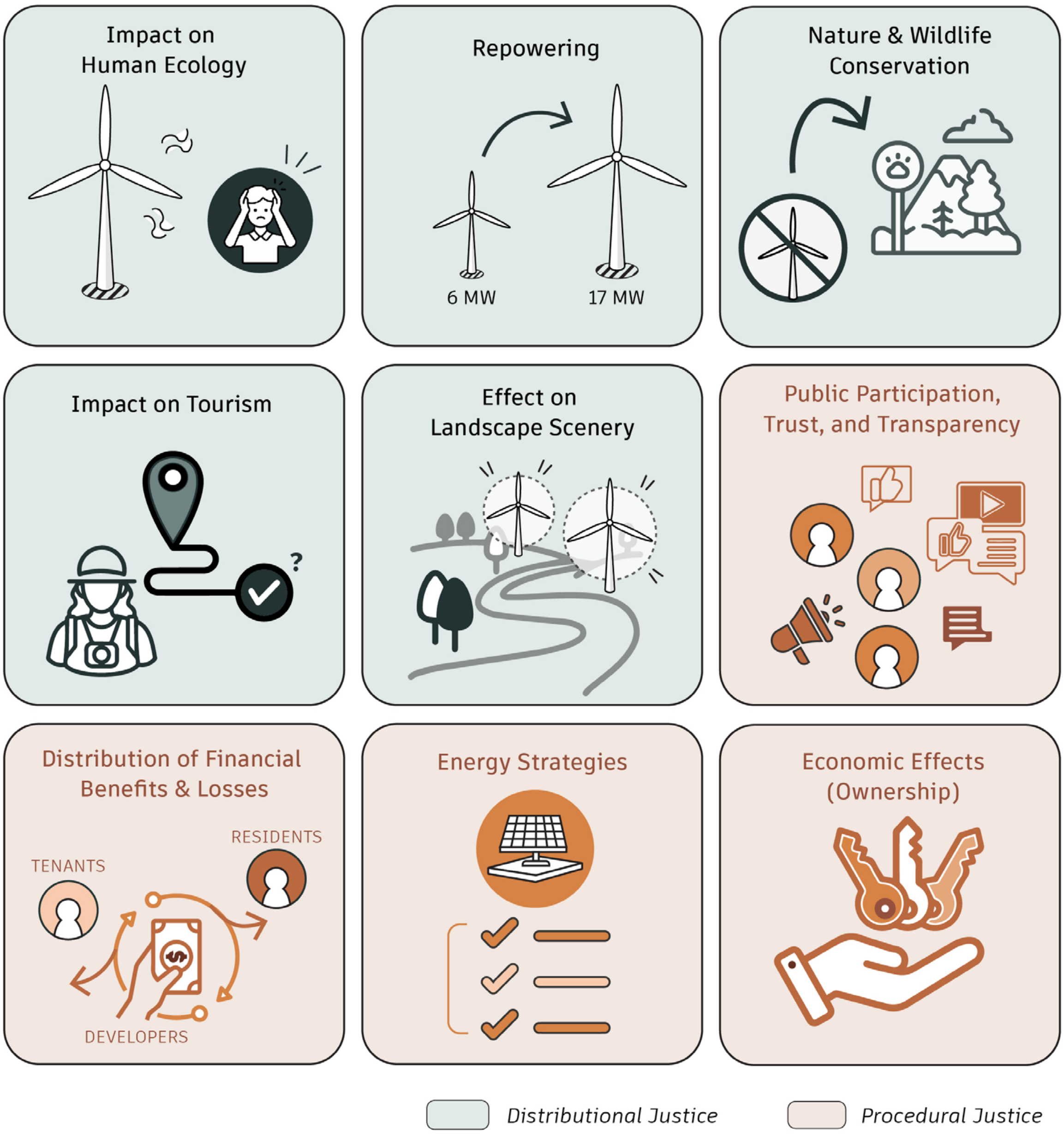


Fig 6.4: The design principles of the energy landscape template based on social acceptability derive from the literature review.

Typology of Energy Landscape

Pasqualetti and Stremke (2018) defined energy landscapes as " observable landscapes that originate directly from the human development of energy resources." Furthermore, they summarize three characteristics based on different energy and infrastructure contents that are factors that generate various energy landscape typologies. Since the typologies of energy landscapes have different impacts on their surroundings and inhabitants, the three factors that lead to diverse landscapes explained here can also be seen as factors that influence the nine principles of acceptance of energy development mentioned above.

1. **Substantial Qualification**: defined by the type of energy resources, such as power plants and wind turbines.

2. **Spatial Qualification**: means the degree of dominance of the energy in an area.

3. **Temporal Qualification**: based on the permanence rate, which can be dynamic or permanent.

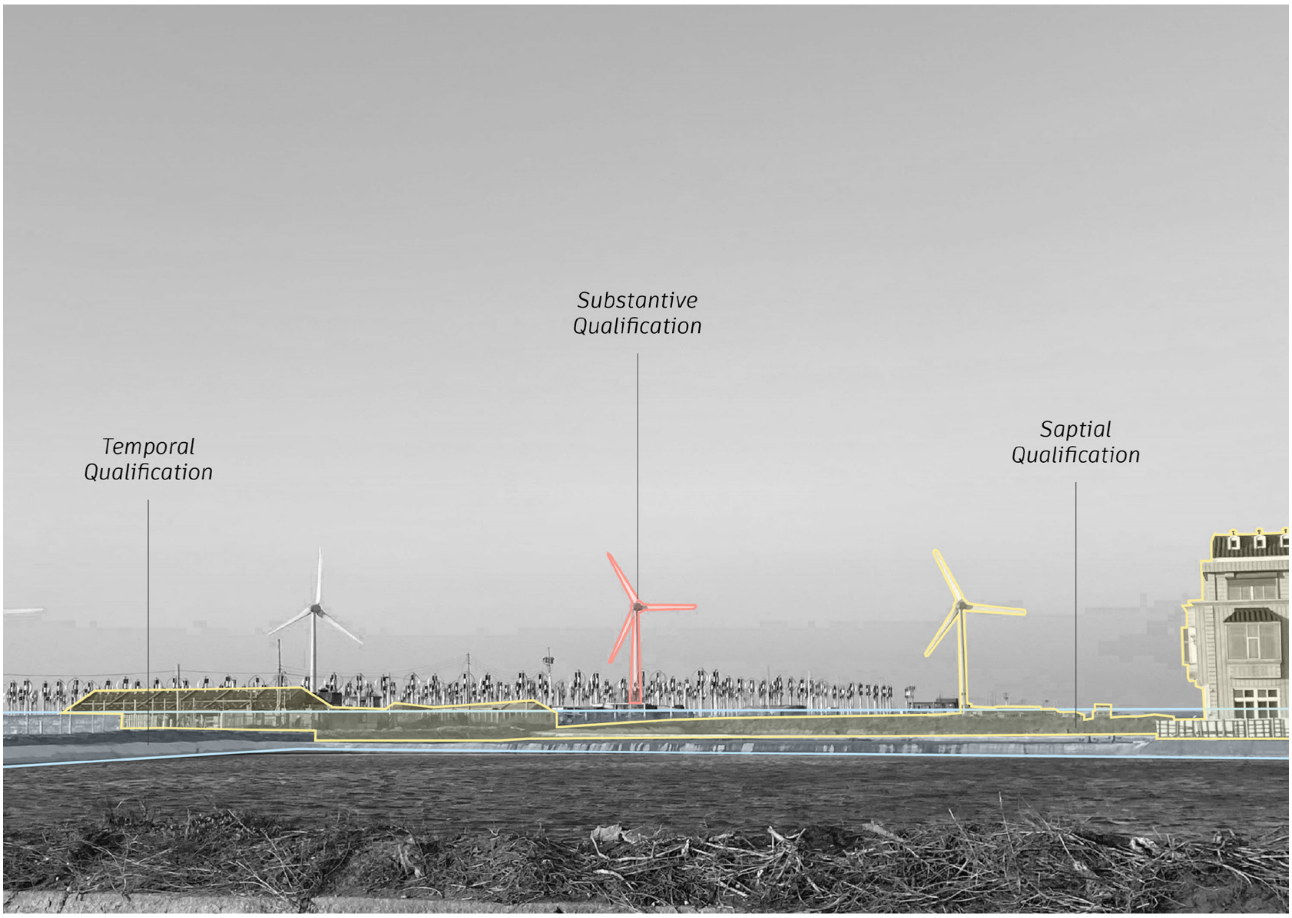


Fig 6.5: Qualifications for developing energy landscape typology.

Fig 6.6: Small-scale wind farm located in Fanyuan Township, Changhua County.

Energyscape Design Methodology

Based on Pasqualetti and Stremke's (2018) research on the energy landscape typology, they provided three classifications, which are:
(1) Substantive Factor
(2) Spatial Factor
(3) Temporal Factor

The study defines that the typology of the energy landscape is based on different qualifications due to the energy infrastructure. Combined with the previous studies researching the factors influencing people's acceptance of wind infrastructure and the analysis in Chapter 4, this study supposes that landscape qualifications might lead to different social acceptance factors.

Therefore, this part shows the relationship of each qualification that builds the energy landscape typology with the nine principles, which are made from the elements of the social acceptance of the infrastructure, testing how to combine theories and practices (National Spatial Planning System), and developing into the energyscape impact templates for future planning and design processes used. However, this study adjusts the definition of the qualification to match the Taiwanese conditions of the energy landscape issues and systemic differences.

Substantive factor means a landscape type is based on an energy source. This study defines it originates from the scale and type of renewable energy infrastructure.

The second qualification means the degree of dominance, but here redefining it originates from the relationship between constructed spatial entities and surrounding areas. This study's variables are the distance from the built environment to the infrastructure and the relationship with the environmentally sensitive areas.

The last one means the temporal manifestation of the impact on the site and its surroundings, from dynamic to permanent. In the case of Taiwan, due to the development-oriented planning system, many land use types can be changed quickly and cause long-term impacts on the environment and residents. Therefore, the last classification in this study corresponds to the planning system and land use zones to discuss the factors of social acceptability impacts implicated by the variety of land use zoning categories.

Based on the recognition of the relationship between energy landscape qualifications and the nine design principles, the energyscape impact template design is proposed with the integration of different land zone under the National Spatial Planning System. These proposed template cards can be used with stakeholders to clarify the regulating criteria in the planning process. Specifically, what land areas suit what types of renewable energy sources? How much density of infrastructure can be built? And What is the minimum distance between the infrastructure and the built environment?

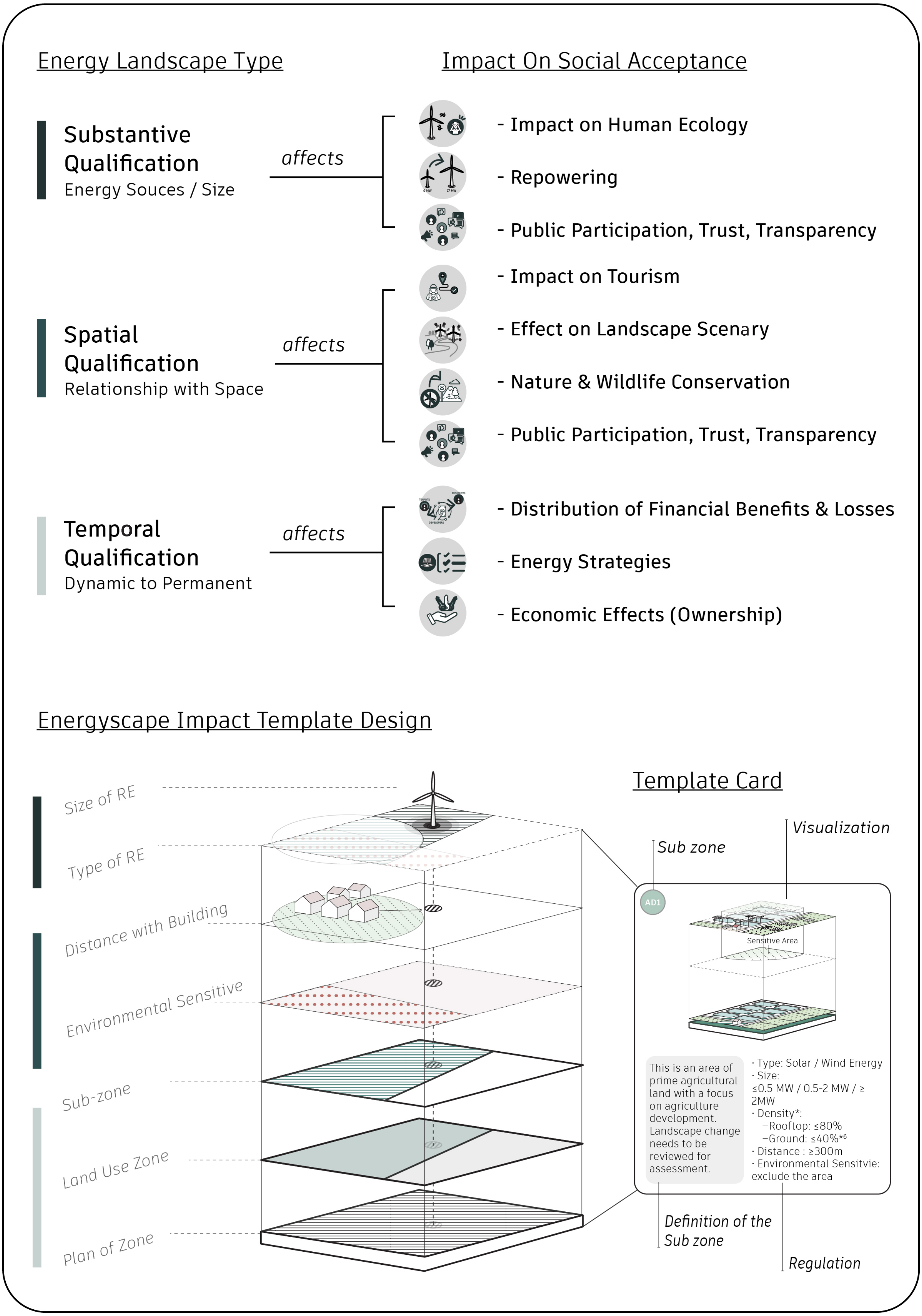


Fig 6.7: Methodology of energyscape template design.

6.3 Energyscape Impact Template Design Cards

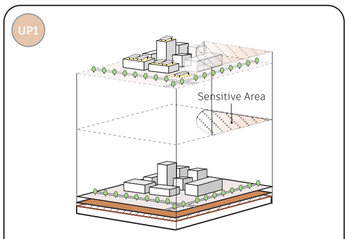
The proposal is based on a new integrated planning system that will be implemented in 2025. This planning system will integrate urban, non-urban, national park, and marine spatial area, and become a holistic system beyond the current separate systems.

The template cards are designed based on the zoning defined by the National Spatial Planning System. There are 19 sub-land areas under the four main zones. Definition of each zone and the combination meaning of cards are explained in the following pages. Regulations in terms of type of permit, size, density of installation, distance with the built environment, and environmenal sensitivities are based on experimental results, existing laws based on the land use type or planning systems, results from the current energyscape analysis, and the recommendation of case study of european countries.

Different cards come with different regulations due to the degree of urbanization and the definition of the land zone purpose. Some specific conditions are explained in details by note.

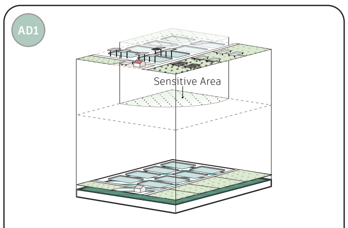
*Due to the complexity of the statutes and laws, the following pages explain the zoning definitions in a simplified version.

* Density for solar energy means the cover rate of the PV on the ground or the rooftop
*2 Needs to follow the regulation of height & width.
*3 PV on the ground needs to be assessed and comply with the provisions of the National Park Plan.
*4 Ground-based PVs need to be assessed and follow urban planning laws.
*5 Rolling corrections based on experimental results.
*6 PV on farmland is only permitted for multifunctional uses, with a coverage limit of 40%.
Exceptions can be made in subsidence and abandoned areas, which do not need to follow the rule.
*7 Based on the per-project design and science-based proof of efficiency.
*8 Based on German standard of maximum permissible sound level (160db)



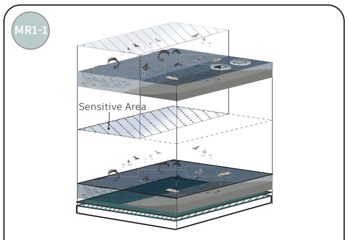
This area has a high population density and is not suitable for wind energy installations. Solar energy on rooftops is encouraged and less restricted.

· Type: Solar Energy
· Size:
≤0.5 MW / 0.5-2 MW
· Density*:
−Rooftop: flexible*2
−Ground: ≤70%
· Distance : x
· Environmental Sensitive: exclude the area



This is an area of prime agricultural land with a focus on agriculture development. Landscape change needs to be reviewed for assessment.

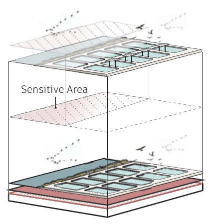
· Type: Solar / Wind Energy
· Size:
≤0.5 MW / 0.5-2 MW / ≥ 2MW
· Density*:
−Rooftop: ≤80%
−Ground: ≤40%*6
· Distance : ≥300m
· Environmental Sensitive: exclude the area



This is a protected area. Due to the sensitivity, wind farms are prohibited. Solar installations need to follow the project plan.

· Type: Solar Energy
· Size:
≤0.5 MW / 0.5-2 MW / ≥2MW
· Density*:
−Ground: project-based*7
· Distance : x
· Environmental Sensitive: exclude the area

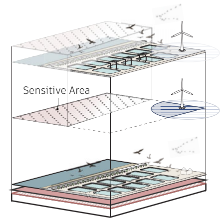
NP1



The area has a high degree of environmental sensitivity. Such as mountain conservation axis and national wetlands. There are few buildings nearby.

- Type: Solar / Wind Energy
- Size: ≤0.5 MW / 0.5-2 MW / ≥2MW
- Density*:
  - Rooftop: ≤70%
  - Ground: ≤10%
- Distance : ≥300m
- Environmental Sensitive: exclude the area

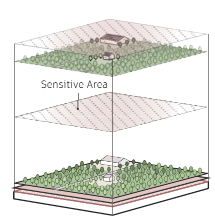
NP2



The area has an environmental sensitivity of Level 2. Close to the ND1 zone with relatively lenient rules.

- Type: Solar / Wind Energy
- Size: ≤0.5 MW / 0.5-2 MW / ≥2MW
- Density*:
  - Rooftop: ≤70%
  - Ground: ≤20%
- Distance : ≥300m
- Environmental Sensitive: exclude the area

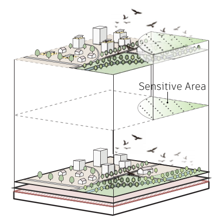
NP3



Areas in this region are national parks. Detailed regulations relating to renewable energy use follow each national park plan.

- Type: Solar / Wind Energy
- Size: ≤0.5 MW / 0.5-2 MW / ≥2MW
- Density*:
  - Rooftop: ≤70%
  - Ground: ≤10%*3
- Distance : ≥300m
- Environmental Sensitive: exclude the area

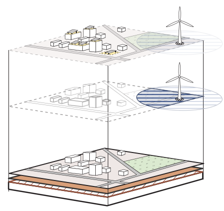
NP4



The area is located in an urban area with conservation area character. Higher environmental sensitivity compared to other urban areas.

- Type: Solar / Wind Energy
- Size: ≤0.5 MW / 0.5-2 MW / ≥2MW
- Density*:
  - Rooftop: ≤70%
  - Ground: ≤20%*4
- Distance : ≥350m
- Environmental Sensitive: exclude the area

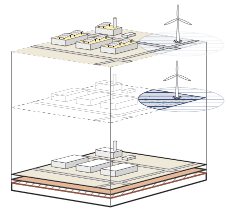
UP2-1



This area is located on urban area but with lower population density.

- Type: Solar / Wind Energy
- Size: ≤0.5 MW / 0.5-2 MW / ≥2MW
- Density*:
  - Rooftop: flexible*2
  - Ground: ≤70%
- Distance : ≥400m
- Environmental Sensitive: exclude the area

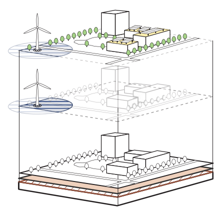
UP2-2



Mostly industrial use areas. Integration with RE requires following the development plan for the area.

- Type: Solar / Wind Energy
- Size: ≤0.5 MW / 0.5-2 MW / ≥2MW
- Density*:
  - Rooftop: flexible*2
  - Ground: ≤70%
- Distance : ≥300m
- Environmental Sensitive: exclude the area

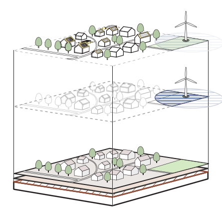
UP2-3



Less densely urban areas, reserved for future development. RE requires following Urban Planning Law.

- Type: Solar / Wind Energy
- Size: ≤0.5 MW / 0.5-2 MW / ≥2MW
- Density*:
  - Rooftop: flexible*2
  - Ground: ≤70%
- Distance : ≥400m
- Environmental Sensitive: exclude the area

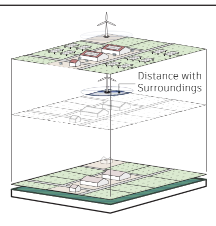
UP3



This zone is village that reserved for aboriginal people. Has lower density than UD1.

- Type: Solar / Wind Energy
- Size: ≤0.5 MW / 0.5-2 MW / ≥2MW
- Density*:
  - Rooftop: flexible*2
  - Ground: ≤70%
- Distance : ≥400m
- Environmental Sensitive: exclude the area

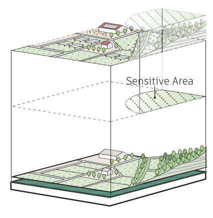
AD2



Mainly agricultural use, but less environmentally sensitive than AD1. Solar energy on the ground needs to be versatile for use.

- Type: Solar / Wind Energy
- Size: ≤0.5 MW / 0.5-2 MW / ≥2MW
- Density*:
  - Rooftop: ≤80%
  - Ground: ≤40%*6
- Distance : ≥300m
- Environmental Sensitive: exclude the area

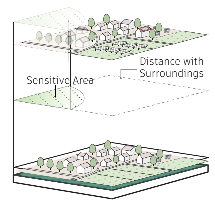
AD3



This is an area of sloping farmland. Construction requires assessment of the potential for landslides.

- Type: Solar / Wind Energy
- Size: ≤0.5 MW / 0.5-2 MW / ≥2MW
- Density*:
  - Rooftop: ≤80%
  - Ground: ≤40%*6
- Distance : ≥300m
- Environmental Sensitive: exclude the area

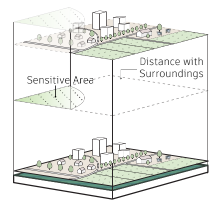
AD4



This area is a rural area or an indigenous settlement. It has a higher density than AD1-3 and is surrounded by agricultural land.

- Type: Solar / Wind Energy
- Size: ≤0.5 MW / 0.5-2 MW / ≥2MW
- Density*:
  - Rooftop: ≤80%
  - Ground: ≤40%*6
- Distance : ≥350m
- Environmental Sensitive: exclude the area

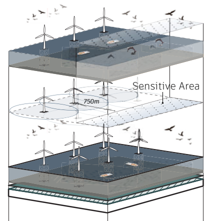
AD5



The area is in an urban area, but with agricultural activity. It is more densely populated than AD1~AD3.

- Type: Solar / Wind Energy
- Size: ≤0.5 MW / 0.5-2 MW / ≥2MW
- Density*:
  - Rooftop: ≤80%
  - Ground: ≤40%*6
- Distance : ≥350m
- Environmental Sensitive: exclude the area

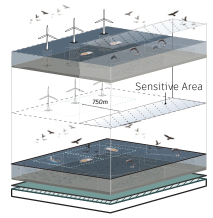
MR1-2



This area is a reserve area for major construction projects approved by the Central Government.

- Type: Solar / Wind Energy
- Size: ≤0.5 MW / 0.5-2 MW / ≥2MW
- Density*:
  - Ground: project-based*7
- Distance : ≥750m*8
- Environmental Sensitive: exclude the area

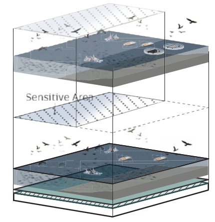
MR1-3



This area is a reserve area for major construction projects approved by the Central Government.

- Type: Solar / Wind Energy
- Size: ≤0.5 MW / 0.5-2 MW / ≥2MW
- Density*:
  - Ground: project-based*7
- Distance : ≥750m*8
- Environmental Sensitive: exclude the area

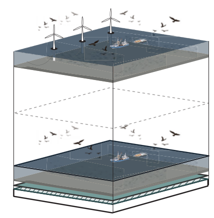
MR2



No man-made facilities are installed in areas where the nature of use is compatible. RE must be located at a distance from sensitive areas.

- Type: Solar / Wind Energy
- Size: ≤0.5 MW / 0.5-2 MW / ≥2MW
- Density*:
  - Ground: project-based*7
- Distance : ≥750m*8
- Environmental Sensitive: exclude the area

MR3



Other waters not yet planned or used.

- Type: Solar / Wind Energy
- Size: ≤0.5 MW / 0.5-2 MW / ≥2MW
- Density*:
  - Ground: project-based*7
- Distance : ≥750m*8
- Environmental Sensitive: exclude the area

Fig 6.8: Catalog of energyscape template design cards.

National Protection Zone

•NP1: high sensitivities areas, includes mountain conservation axes, river corridors, important coastal and estuarine wetlands, etc.

•NP2: The area around the mountain conservation axis, river corridors, important coastal important coastal and estuarine wetland areas. It is a conservation buffer space.

•NP3: National Park Planning Areas.

•NP4: Water source (reservoir) specific area, scenery specific area Protection and conservation-related zoning in the Urban Planning Area. .

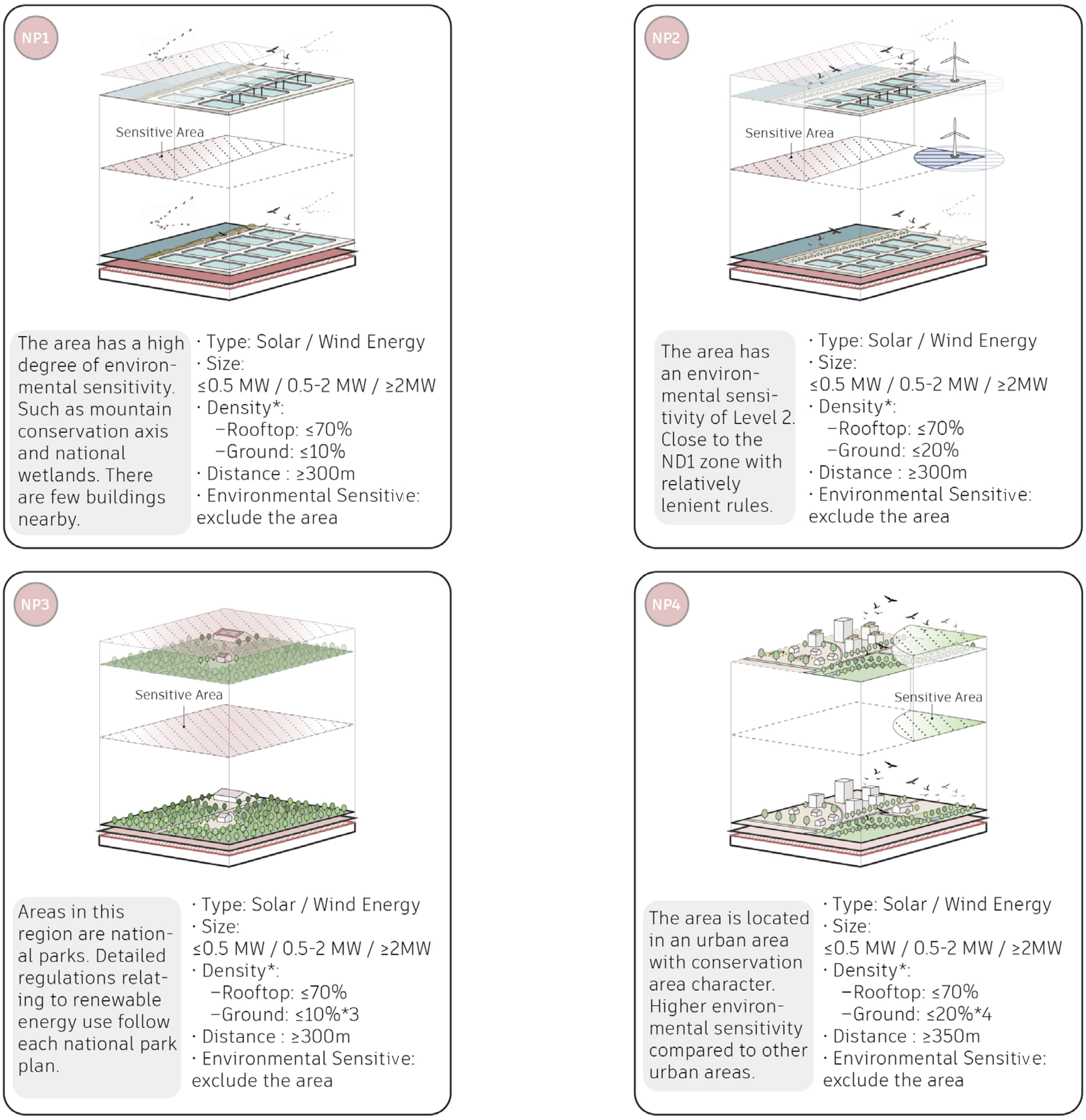


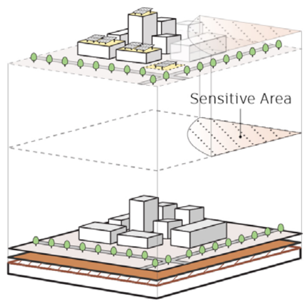
Fig 6.9: Energyscape template card: Natural Protection Zone (NP1-4).

Urban Development Zone

•**UD1**: Areas in Urban Planning. (highly urbanized areas)
•**UD2-1**: industrial zone, rural area*.
•**UD2-2**: Development permit areas approved in accordance*.
•**UD2-3**: Areas prepared for the future development use.
•**UD3**: Aboriginal land areas*.

* According to the original regional planning or law.

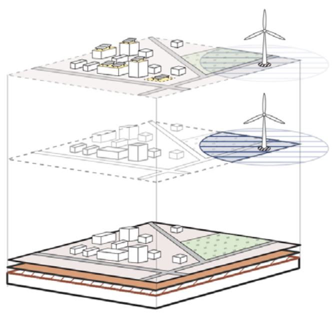
UD1



This area has a high population density and is not suitable for wind energy installations. Solar energy on rooftops is encouraged and less restricted.

· Type: Solar Energy
· Size:
≤0.5 MW / 0.5-2 MW
· Density*:
 −Rooftop: flexible*2
 −Ground: ≤70%
· Distance : x
· Environmental Sensitive: exclude the area

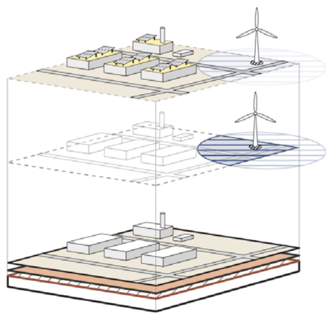
UD2-1



This area is located on urban area but with lower population density.

· Type: Solar / Wind Energy
· Size:
≤0.5 MW / 0.5-2 MW / ≥2MW
· Density*:
 −Rooftop: flexible*2
 −Ground: ≤70%
· Distance : ≥400m
· Environmental Sensitive: exclude the area

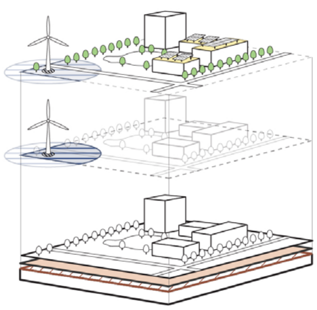
UD2-2



Mostly industrial use areas. Integration with RE requires following the development plan for the area.

· Type: Solar / Wind Energy
· Size:
≤0.5 MW / 0.5-2 MW / ≥2MW
· Density*:
 −Rooftop: flexible*2
 −Ground: ≤70%
· Distance : ≥300m
· Environmental Sensitive: exclude the area

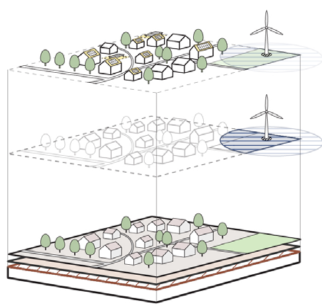
UD2-3



Less densely urban areas, reserved for future development. RE requires following Urban Planning Law.

· Type: Solar / Wind Energy
· Size:
≤0.5 MW / 0.5-2 MW / ≥2MW
· Density*:
 −Rooftop: flexible*2
 −Ground: ≤70%
· Distance : ≥400m
· Environmental Sensitive: exclude the area

UD3



This zone is village that reserved for aboriginal people. Has lower density than UD1.

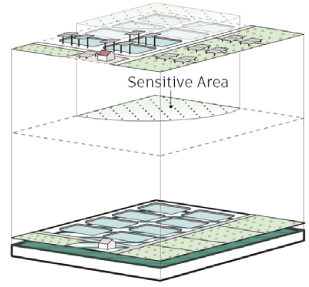
· Type: Solar / Wind Energy
· Size:
≤0.5 MW / 0.5-2 MW / ≥2MW
· Density*:
 −Rooftop: flexible*2
 −Ground: ≤70%
· Distance : ≥400m
· Environmental Sensitive: exclude the area

Fig 6.10: Energyscape template card: Urban Development Zone (UD1-3).

Agriculture Development Zone

•**AD1**: The area has an excellent agricultural production environment or has invested in the construction.(Over 25 hectares)
•**AD2**: Areas with good agricultural productions. Does not meet AD1 conditions.
•**AD3**: Agricultural land on hillside.
•**AD4**: Major population centers in rural areas. Production, living, and ecology are inextricably intertwined.
•**AD5**: Agricultural land in the urban area.

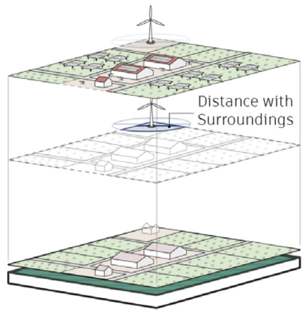
AD1



This is an area of prime agricultural land with a focus on agriculture development. Landscape change needs to be reviewed for assessment.

· Type: Solar / Wind Energy
· Size:
≤0.5 MW / 0.5-2 MW / ≥ 2MW
· Density*:
 −Rooftop: ≤80%
 −Ground: ≤40%*6
· Distance : ≥300m
· Environmental Sensitive: exclude the area

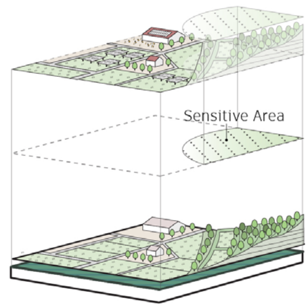
AD2



Mainly agricultural use, but less environmentally sensitive than AD1. Solar energy on the ground needs to be versatile for use.

· Type: Solar / Wind Energy
· Size:
≤0.5 MW / 0.5-2 MW / ≥2MW
· Density*:
 −Rooftop: ≤80%
 −Ground: ≤40%*6
· Distance : ≥300m
· Environmental Sensitive: exclude the area

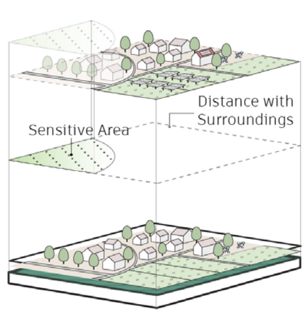
AD3



This is an area of sloping farmland. Construction requires assessment of the potential for landslides.

· Type: Solar / Wind Energy
· Size:
≤0.5 MW / 0.5-2 MW / ≥2MW
· Density*:
 −Rooftop: ≤80%
 −Ground: ≤40%*6
· Distance : ≥300m
· Environmental Sensitive: exclude the area

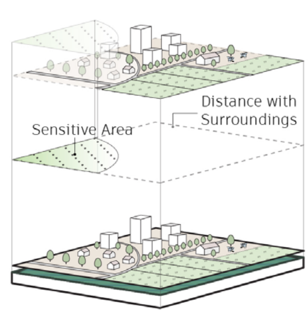
AD4



This area is a rural area or an indigenous settlement. It has a higher density than AD1-3 and is surrounded by agricultural land.

· Type: Solar / Wind Energy
· Size:
≤0.5 MW / 0.5-2 MW / ≥2MW
· Density*:
 −Rooftop: ≤80%
 −Ground: ≤40%*6
· Distance : ≥350m
· Environmental Sensitive: exclude the area

AD5



The area is in an urban area, but with agricultural activity. It is more densely populated than AD1~AD3.

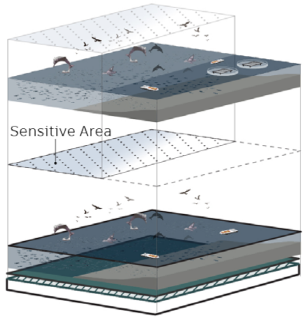
· Type: Solar / Wind Energy
· Size:
≤0.5 MW / 0.5-2 MW / ≥2MW
· Density*:
 −Rooftop: ≤80%
 −Ground: ≤40%*6
· Distance : ≥350m
· Environmental Sensitive: exclude the area

Fig 6.11: Energyscape template card: Agriculture Development Zone (AD1-5).

Marine Resource Zone

•**MR1-1**: Various types of protected areas in the sea according to other laws.
•**MR1-2**: Areas with exclusive land use.
•**MR1-3**: Area has approved huge construction plans, such as potential wind farms.
•**MR2**: Compatible areas for use.
•**MR3**: Sea area not yet planned or used.

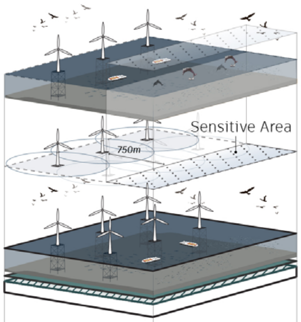
MR1-1



This is a protected area. Due to the sensitivity, wind farms are prohibited. Solar installations need to follow the project plan.

· Type: Solar Energy
· Size:
≤0.5 MW / 0.5-2 MW / ≥2MW
· Density*:
 –Ground: project-based*7
· Distance : x
· Environmental Sensitive: exclude the area

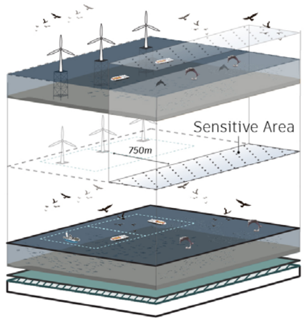
MR1-2



This area is a reserve area for major construction projects approved by the Central Government.

· Type: Solar / Wind Energy
· Size:
≤0.5 MW / 0.5-2 MW / ≥2MW
· Density*:
 –Ground: project-based*7
· Distance : ≥750m*8
· Environmental Sensitive: exclude the area

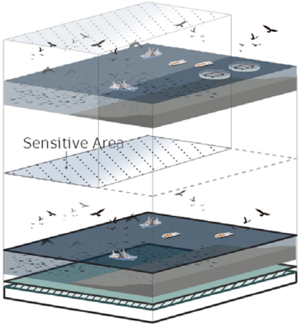
MR1-3



This area is a reserve area for major construction projects approved by the Central Government.

· Type: Solar / Wind Energy
· Size:
≤0.5 MW / 0.5-2 MW / ≥2MW
· Density*:
 –Ground: project-based*7
· Distance : ≥750m*8
· Environmental Sensitive: exclude the area

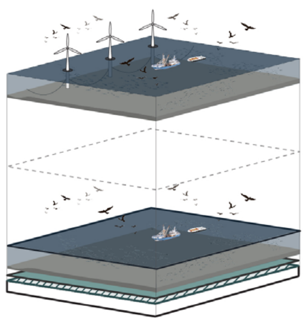
MR2



No man-made facilities are installed in areas where the nature of use is compatible. RE must be located at a distance from sensitive areas.

· Type: Solar / Wind Energy
· Size:
≤0.5 MW / 0.5-2 MW / ≥2MW
· Density*:
 –Ground: project-based*7
· Distance : ≥750m*8
· Environmental Sensitive: exclude the area

MR3



Other waters not yet planned or used.

· Type: Solar / Wind Energy
· Size:
≤0.5 MW / 0.5-2 MW / ≥2MW
· Density*:
 –Ground: project-based*7
· Distance : ≥750m*8
· Environmental Sensitive: exclude the area

Fig 6.12: Energyscape template card: Marine Resource Zone (MR1-3).

Implementation Method

Co-Exploration Process

Implementation Steps

❶ **Location Selection**

❷ **Land Zone Define**

❸ **Environmental Sensitive Checking**

Subsidence/ ecological sensitives

❹ **Land Use Type Define:**

define land funcitional activities

❺ **Regulations Checking**

permission Area
distance with the built environment

❻ **Energy Source Selection**

solar energy / wind energy / biomass / others

❼ **Energy Size & Type Selection**

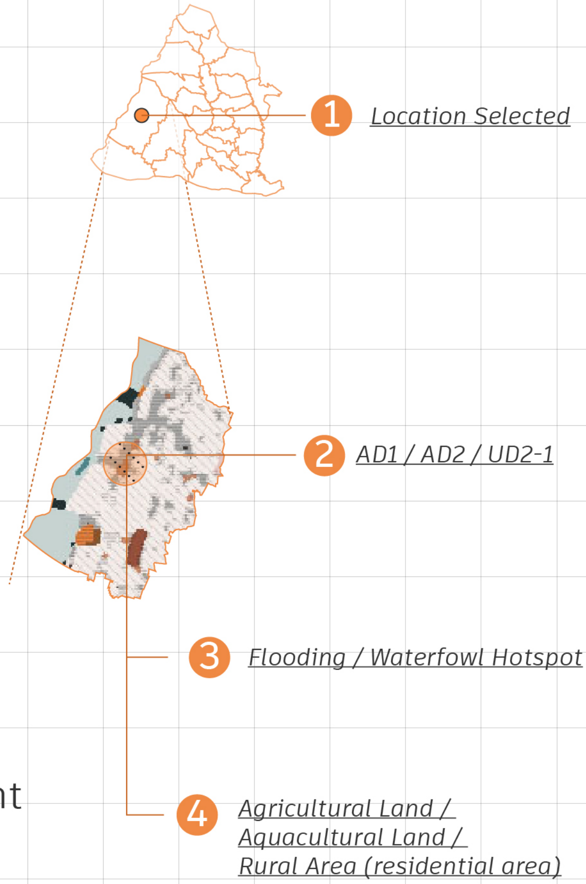
size
- < 0.5MW
- 0.5-2MW
- >2MW

Type
- Rooftop
- On The Ground

❽ **Cover Rate**

Check on the template cards

Visualization Example Steps



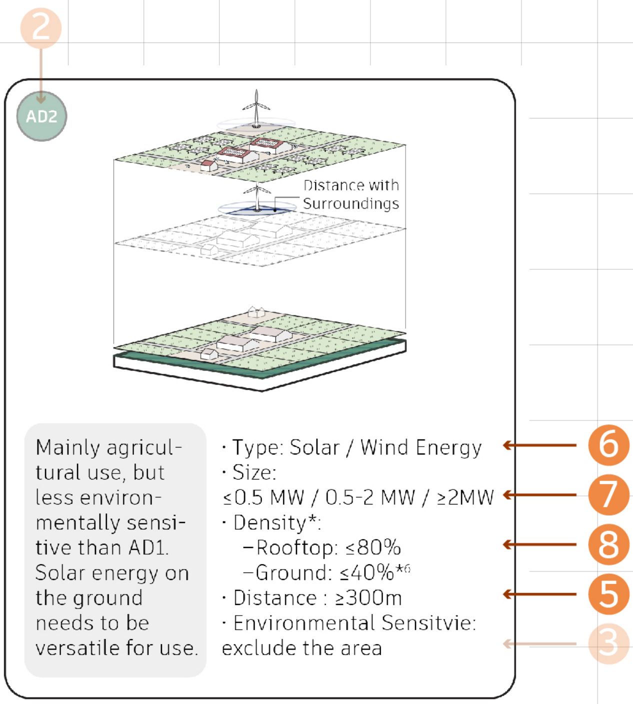


Fig 6.13: Implementation Method: Co-exploration process

Co-Desgin Process

Prerequisites: if the integration focuses on multifunctional use in agricultural or aquacultural lands, it needs experiment results based on scientific proof of potential integration methods to add up step 10 & 11.

⑨ Energy Integration Design

Third party guidance on the co-design process

Check on Appendix
(Only for Agrivoltaics & Aquavolaics)

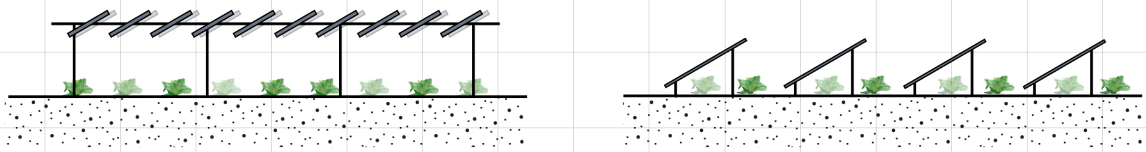
Technical Aspect
+Experts

⑩ Crop Type Define

Shadow-tolerance / Shadow-intolerance

⑪ Agrivoltaics Select

Example options: *Check on Appendix*



⑫ Social Acceptance Factors Define : 9 Factors

Social Aspect

+Low Power Stakeholders

Human Ecology
Repowering
Nature & Wildlife Conservation
Tourism
Landscape Scenery
Public Participation
Distribution of Financial Benefits & Losses
Energy Strategies
Economic Effects

⑬ Design Proposal Optimize

Based on social acceptance factors, revise the design proposal: other design or technology strategies (semi-transparent, the half density of PV Strip, etc.)

Fig 6.14: Implementation Method: Co-creation process

6.4 Implementation Of The Template Cards

Examples of energyscape impact template implementation are presented in five sections. Each section presents the current situation and proposals for change, suggesting possibilities for the ideal combination between space and renewable energy infrastructure. In addition, each section will show three zoomed-in locations and show how to use the template according to the zoning of the National Spatial Planning System and provide visualizations of different scenarios: current conditions, hidden threats, and proposals.

Each section exemplifies different environmental types. The same card could implement in various locations because it is based on the zoning defined by the spatial planning system. Still, due to different original conditions, the outcome also shows differently.

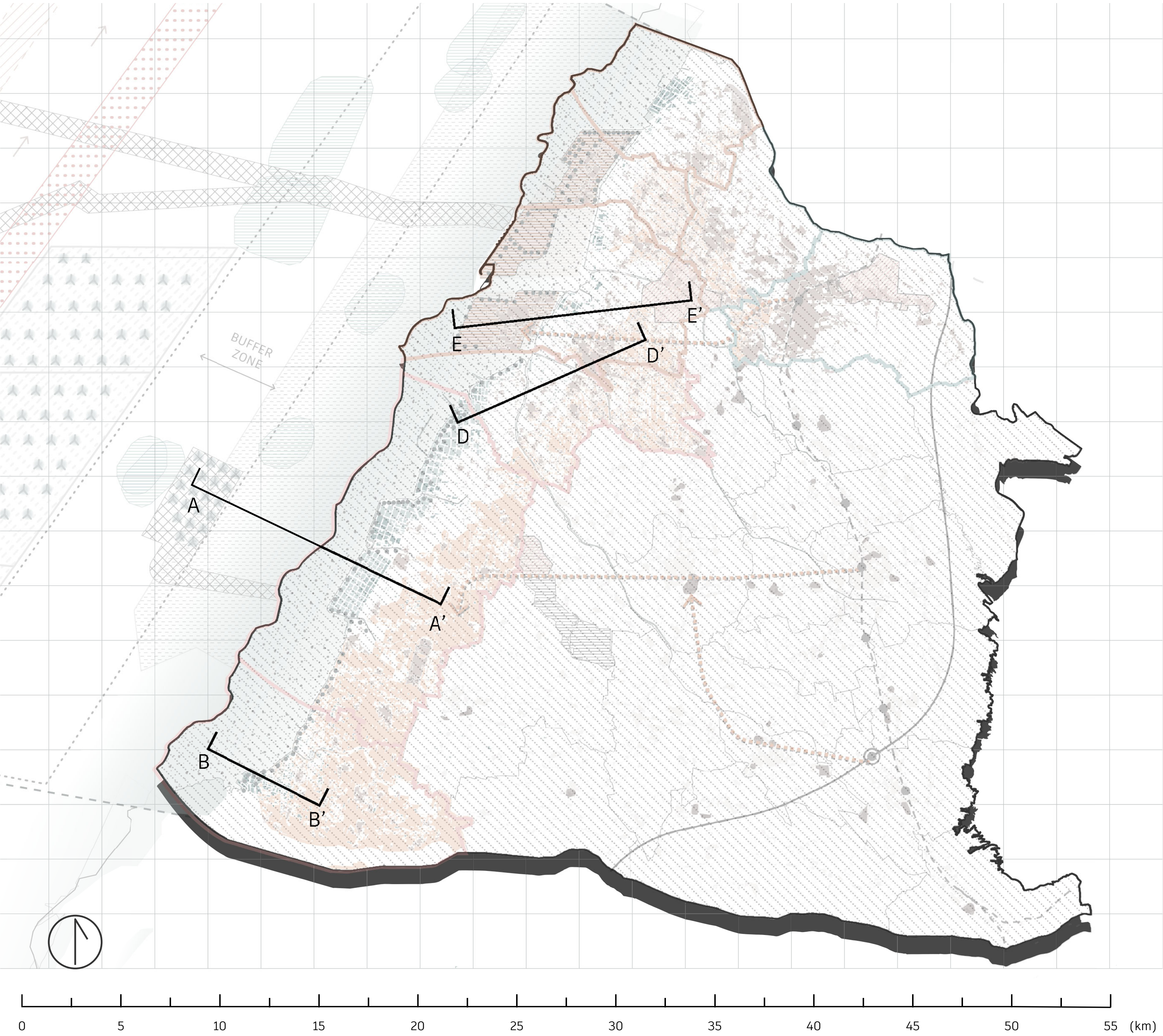
1. AA' Section: located in Fangyuan township, which has high migration, less competitiveness, and poor infrastructure. Mainly focus on the first-tier industry. This section examines changes in agricultural land, aquaculture land (large and complete), and marine space that is close to the ecologically sensitive area and connected to the land.

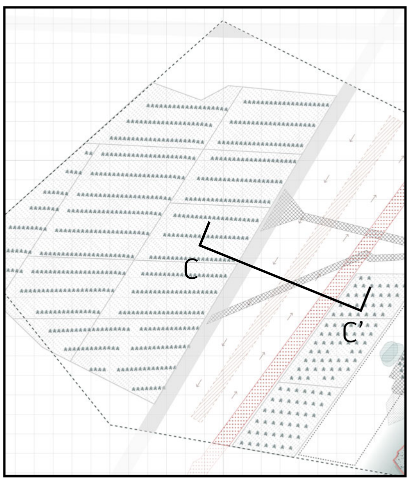
2. BB' Section: located in Dacheng Township, which has a severe subsidence problem. This section will also focus on the changes in agricultural land, aquaculture land, and marine spatial area. However, due to the subsidence, this area has a worse condition for general aquacultural activity and has more abanded lands than section AA'.

3. CC' Section: This part will test the change in marine spatial area from the higher environmentally sensitive zones to farther marine spatial zones. Besides, it examines the possibility of zoning design that help mitigate the maritime activities conflicts regarding fishery and offshore wind farm building.

4.DD' Section: across Fuxing and Lugang township. This section assesses the mixed-use area of first-tier and second-tier activities. Besides, it demonstrates the changes in urbanized areas, which is also famous for their historical value.

5. EE' Section: This section shows the changes in the industrial park and the expected new development areas in Lugang Township.





$\overline{AA'}$ Mainly Agricultural Activities: Less Developed Regions

$\overline{BB'}$ Severe Land Subsidence Areas

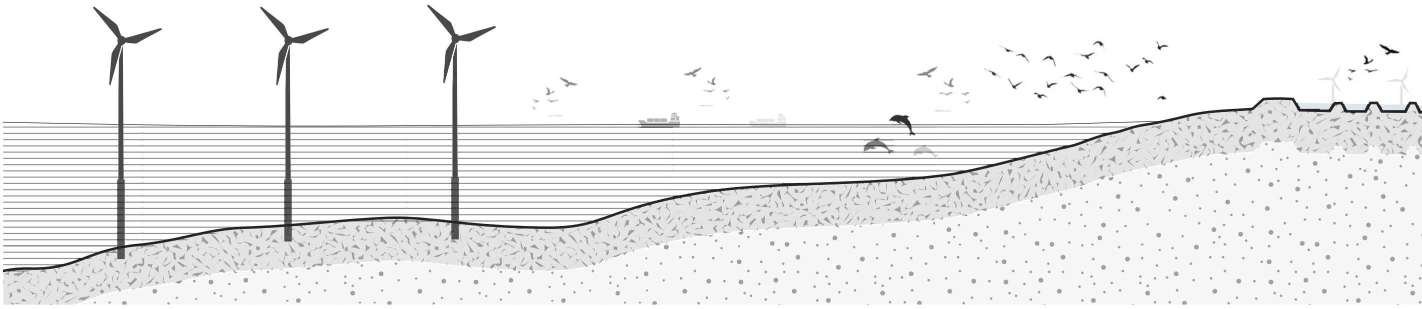
$\overline{CC'}$ Offshore Wind Farm Planning Zone

$\overline{DD'}$ Rural To Urbanized Areas

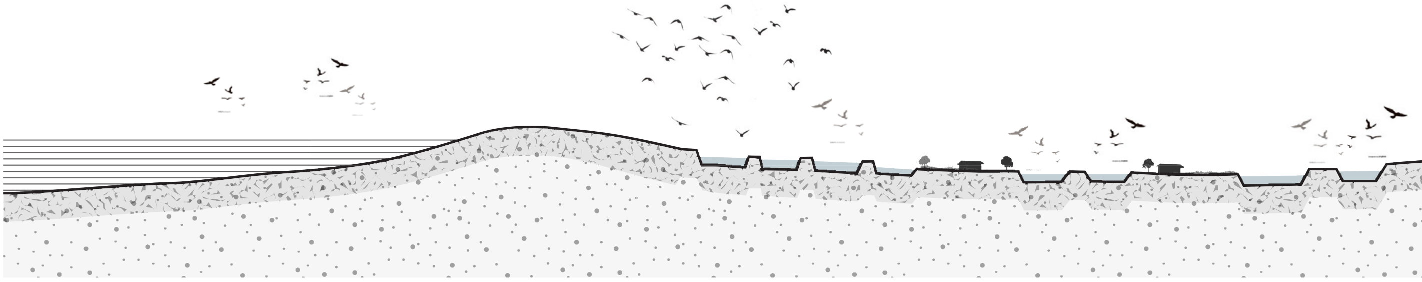
$\overline{EE'}$ Industrial Zone & New Development Area

Fig 6.15: Five zoomed-in sections show the template card use.

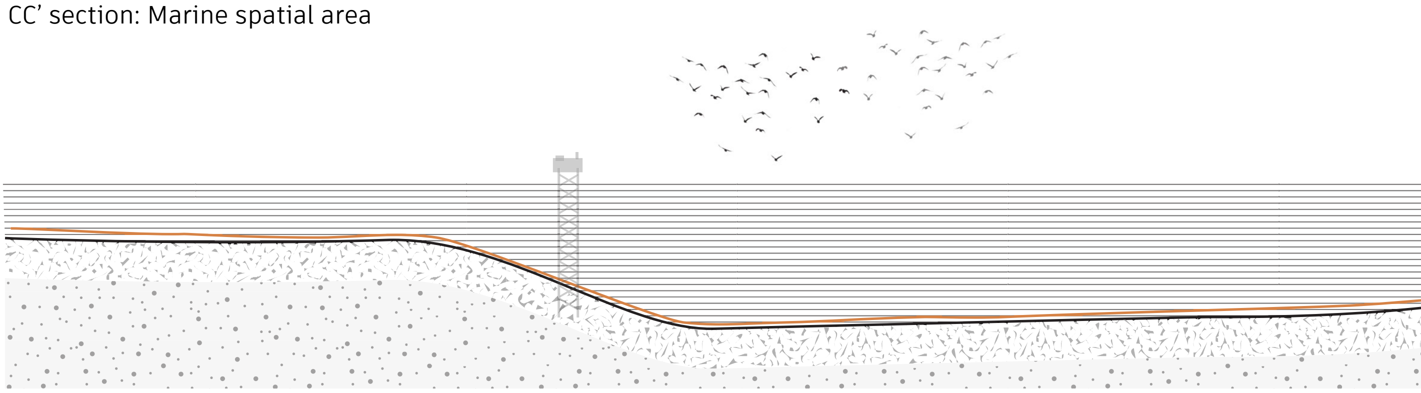
AA’ section: Fangyuan Township—uncompetitive rural area



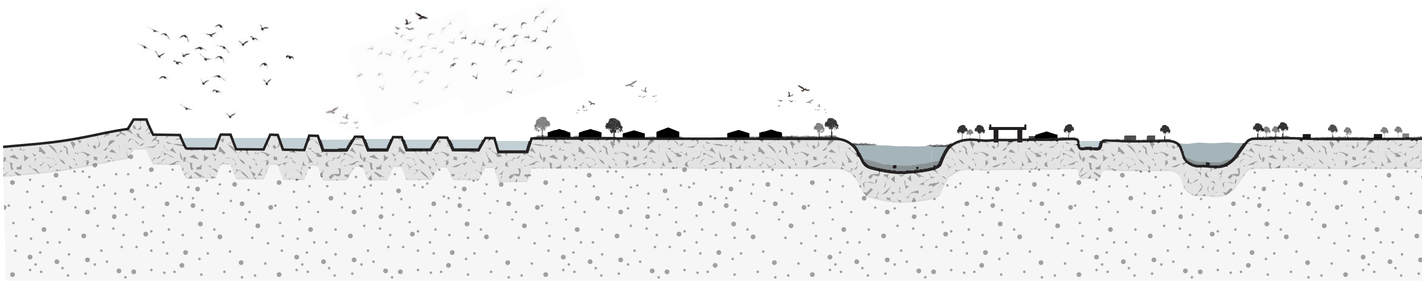
BB’ section: Dacheng Township—rural area with subsidence



CC’ section: Marine spatial area



DD’ section: Fuxing Township—mixed use area / Lugang Township—urbanized district



EE’ section: Lugang Township—industrial zone and expected new development district

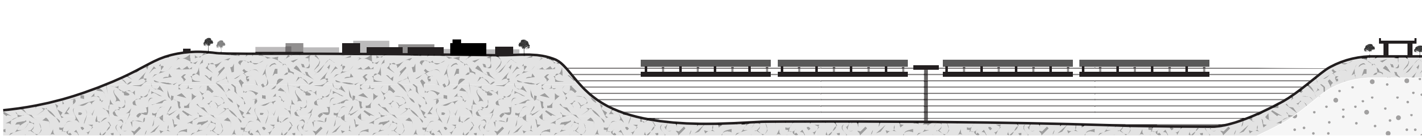
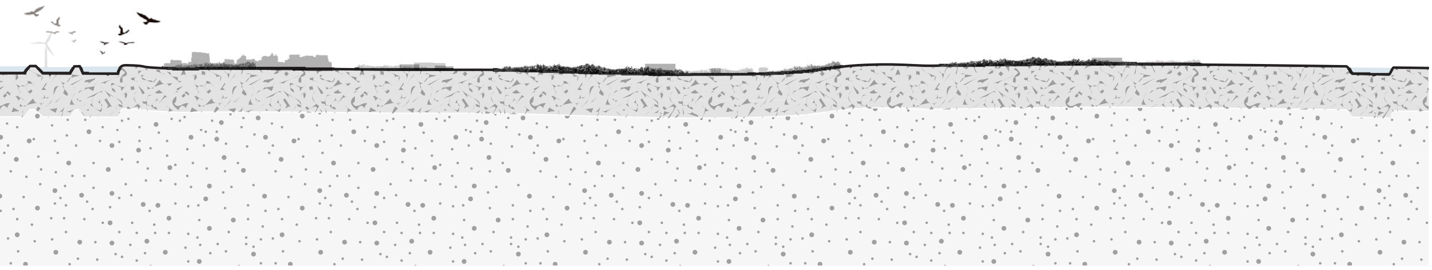
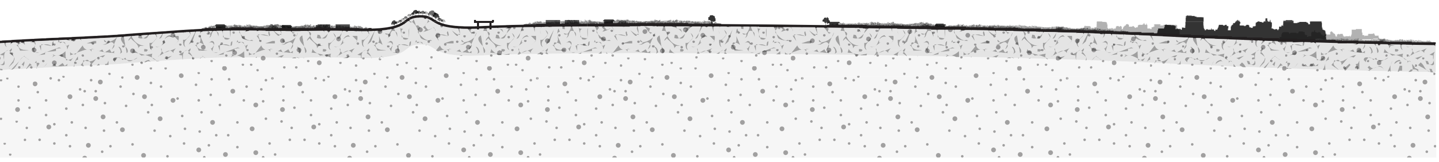


Fig 6.16: Five zoomed-in sections: before (current).

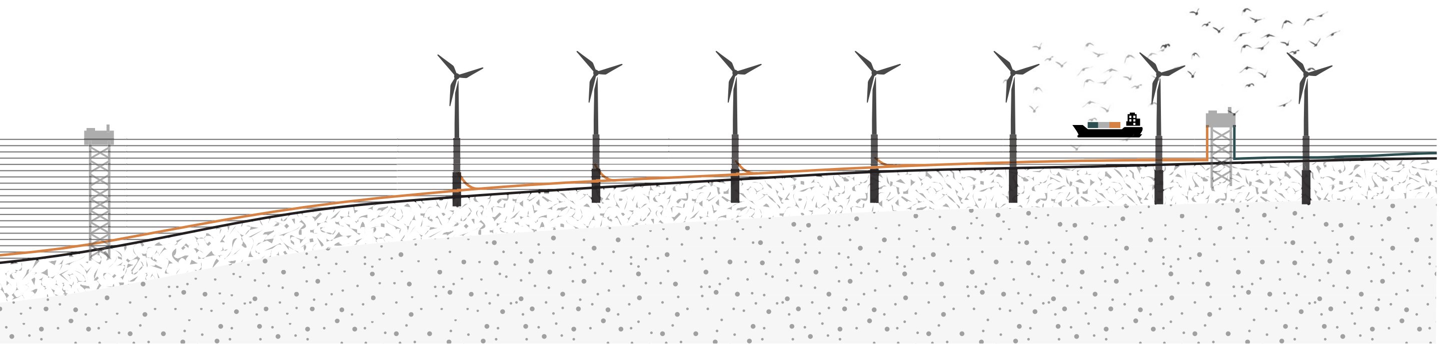
Before



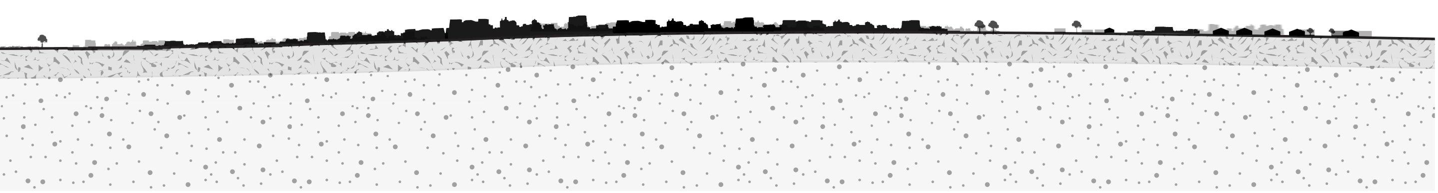
Before



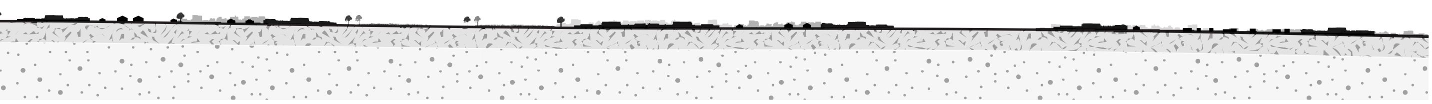
Before



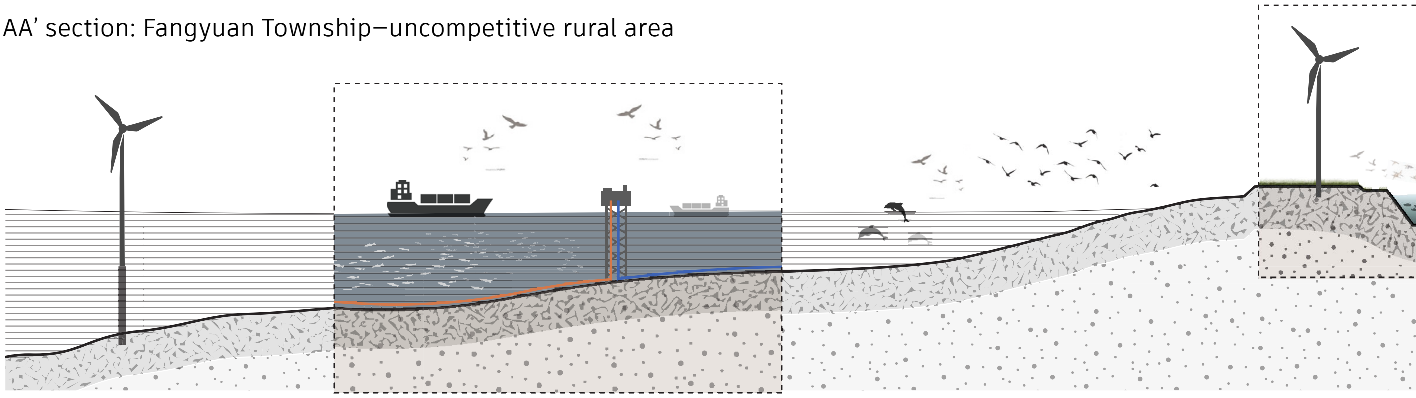
Before



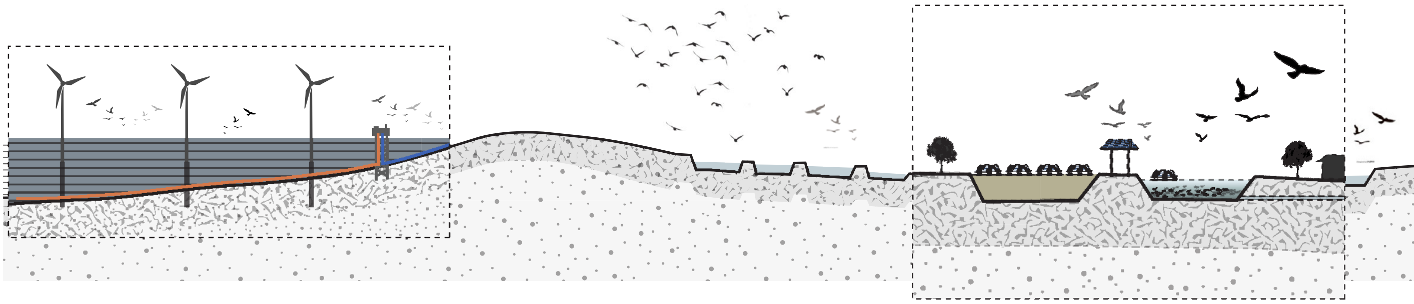
Before



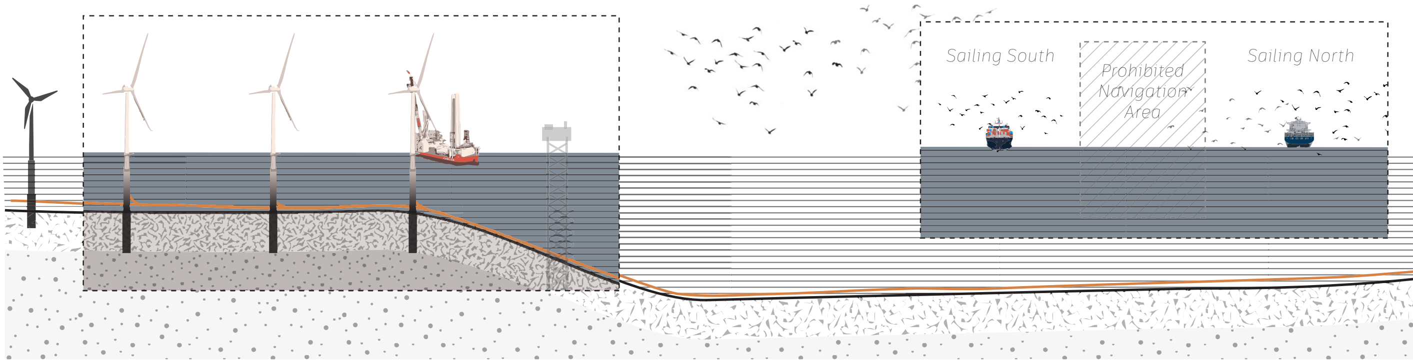
AA’ section: Fangyuan Township–uncompetitive rural area



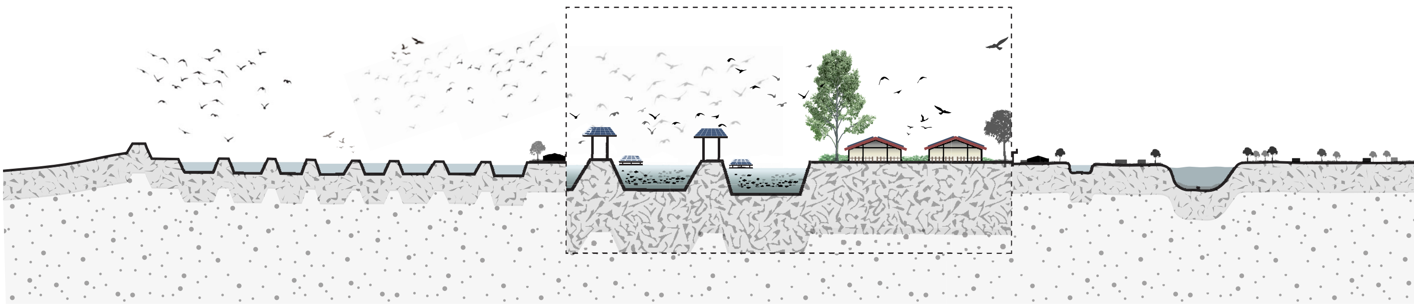
BB’ section: Dacheng Township–rural area with subsidence



CC’ section: Marine spatial area



DD’ section: Fuxing Township–mixed use area / Lugang Township–urbanized district



EE’ section: Lugang Township–industrial zone and expected new development district

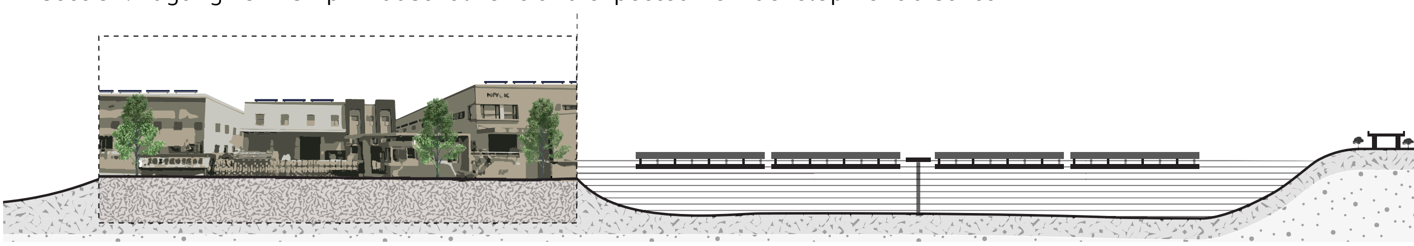
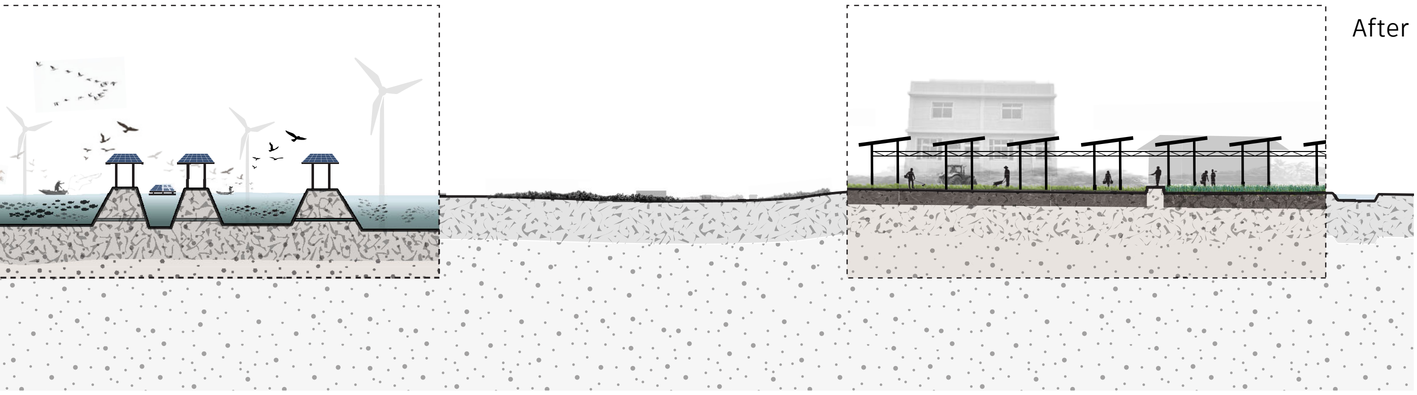
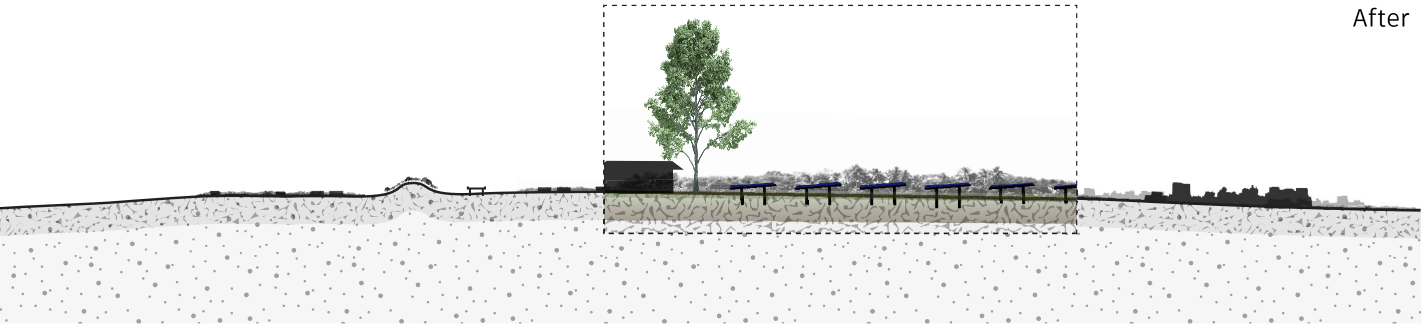


Fig 6.17: Five zoomed-in sections: after (proposed).

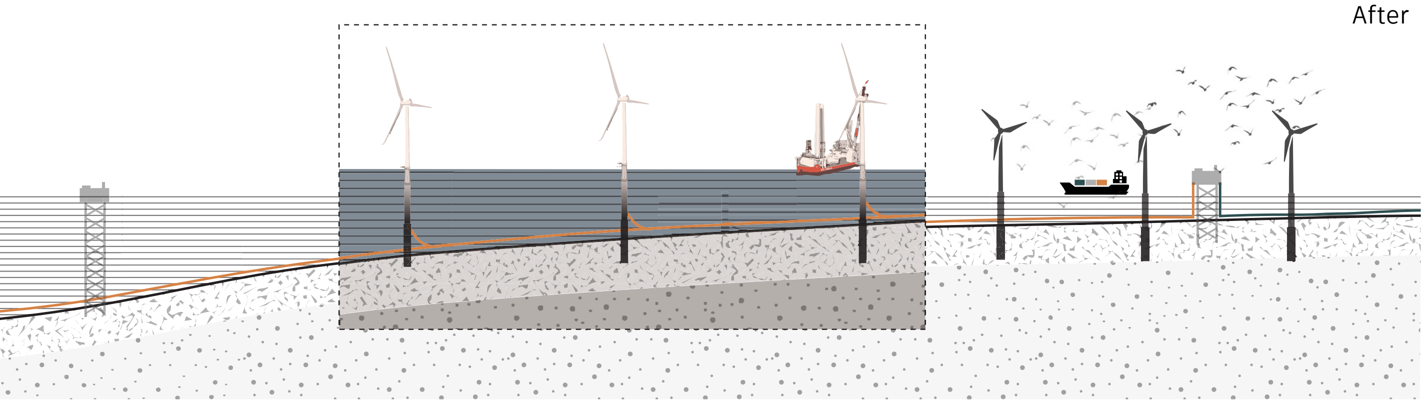
After



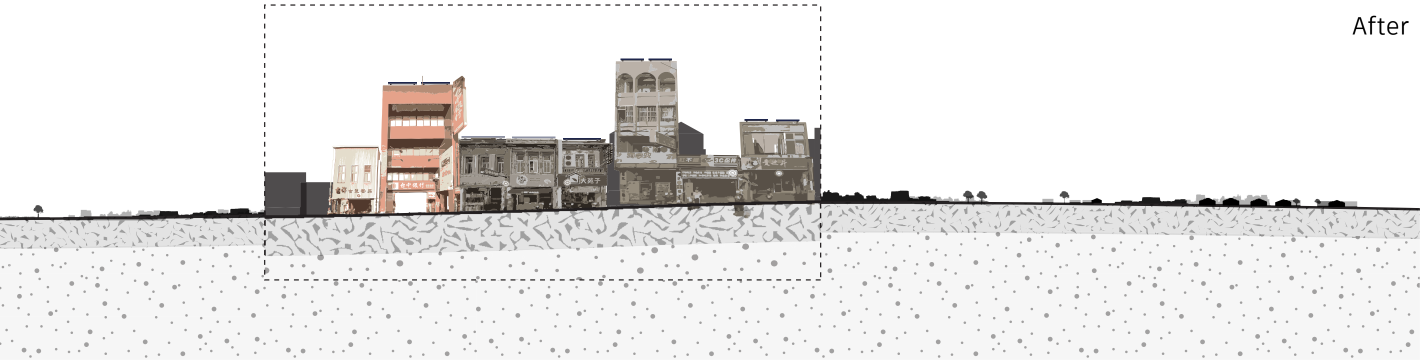
After



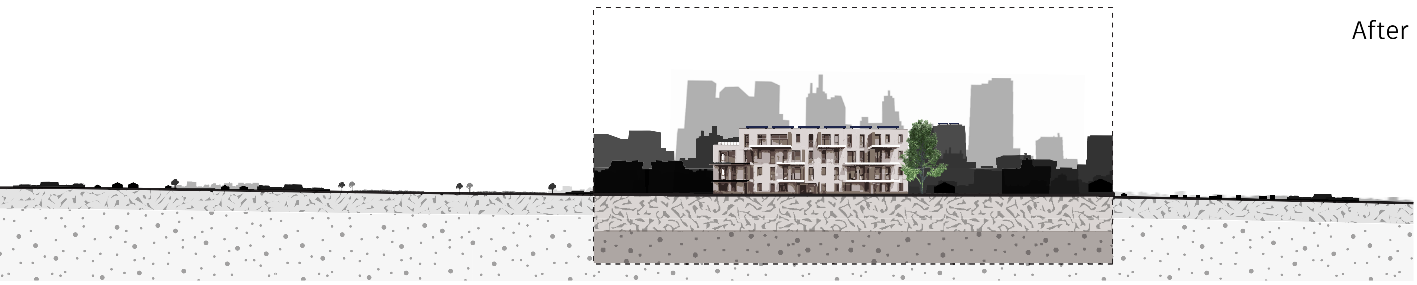
After



After



After



AA’ Section: Fangyuan Township—Uncompetitive Rural Area

This section shows three conflict situations in society today.

Firstly, in the marine sector, there is a conflict between wildlife conservation, fisheries, and the construction of offshore wind farms. However, no planning system and relative regulation currently exist to coordinate the problems.

Secondly, the fight concentrated on aquaculture land, of which there are already many cases in other cities, where much ground is covered by solar panels, threatening aquaculture and wildlife conservation.

And the last one is over areas of agricultural land. As in the previous case, many applications have been made to change the type of land use to create unlimited solar panels, threatening the issue of food security.

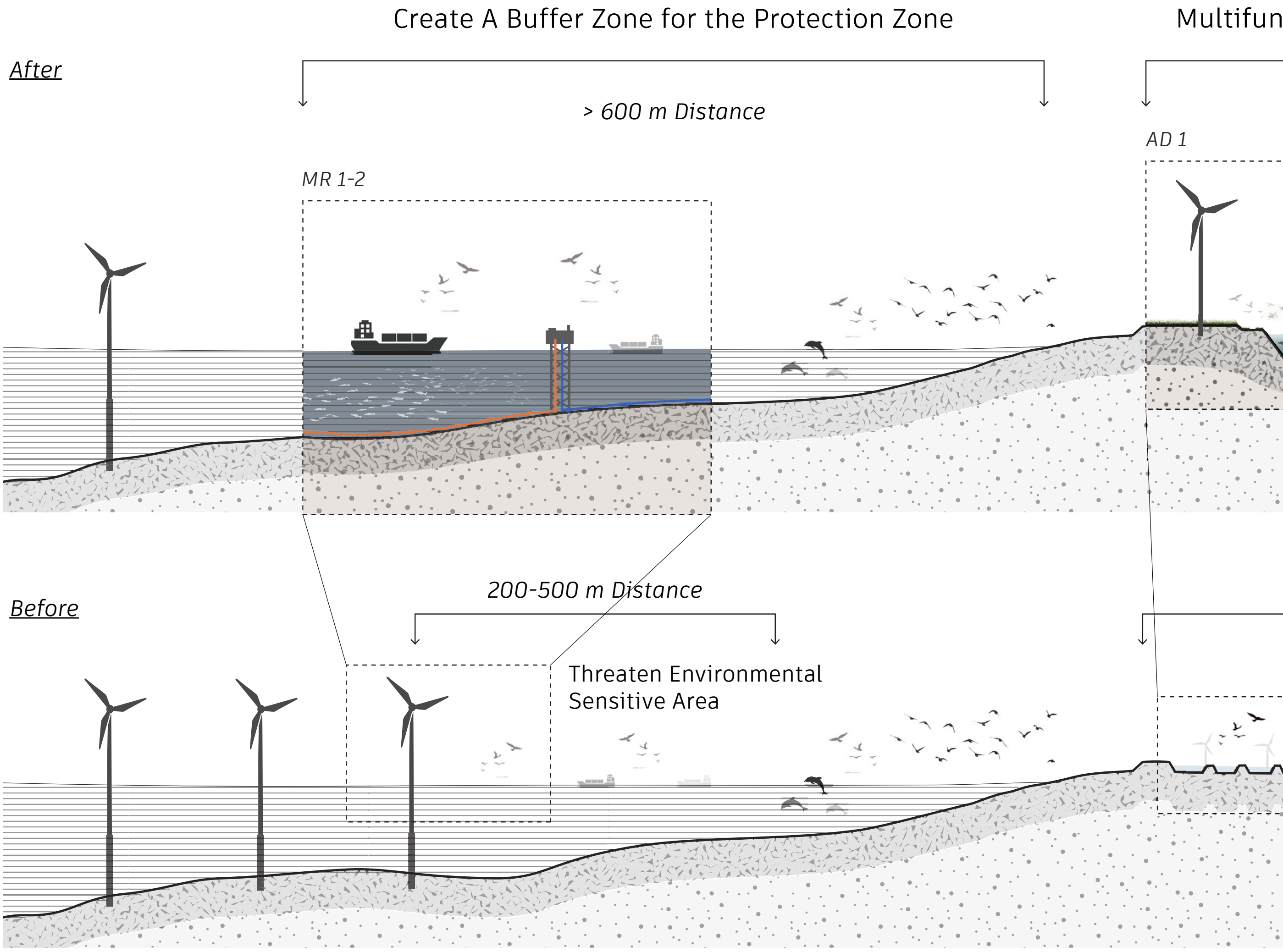


Fig 6.18: Before and after of the zoomed-in scenario: AA section / Fangyuan Township—Uncompetitive Rural Area

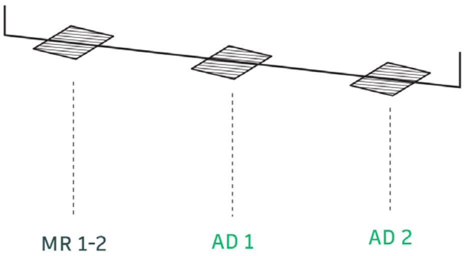


Fig 6.19: Land use zone of zoomed-in areas based on the National Spatial Plan.

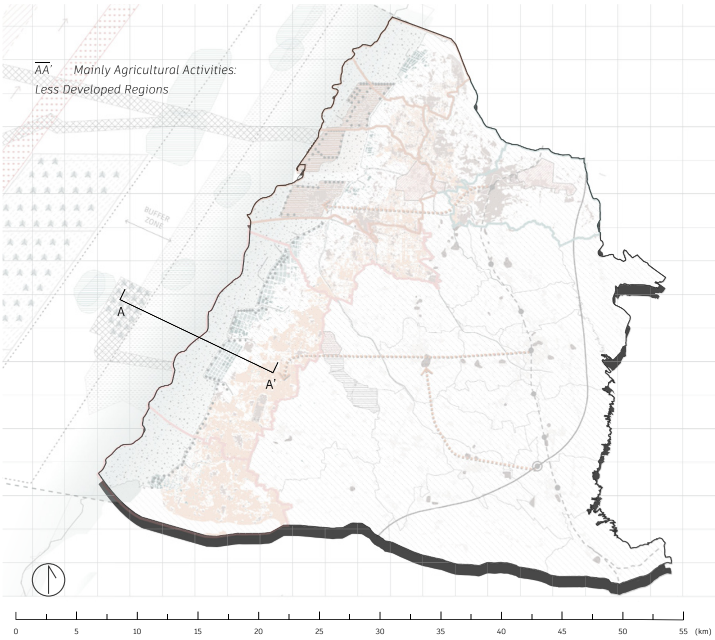
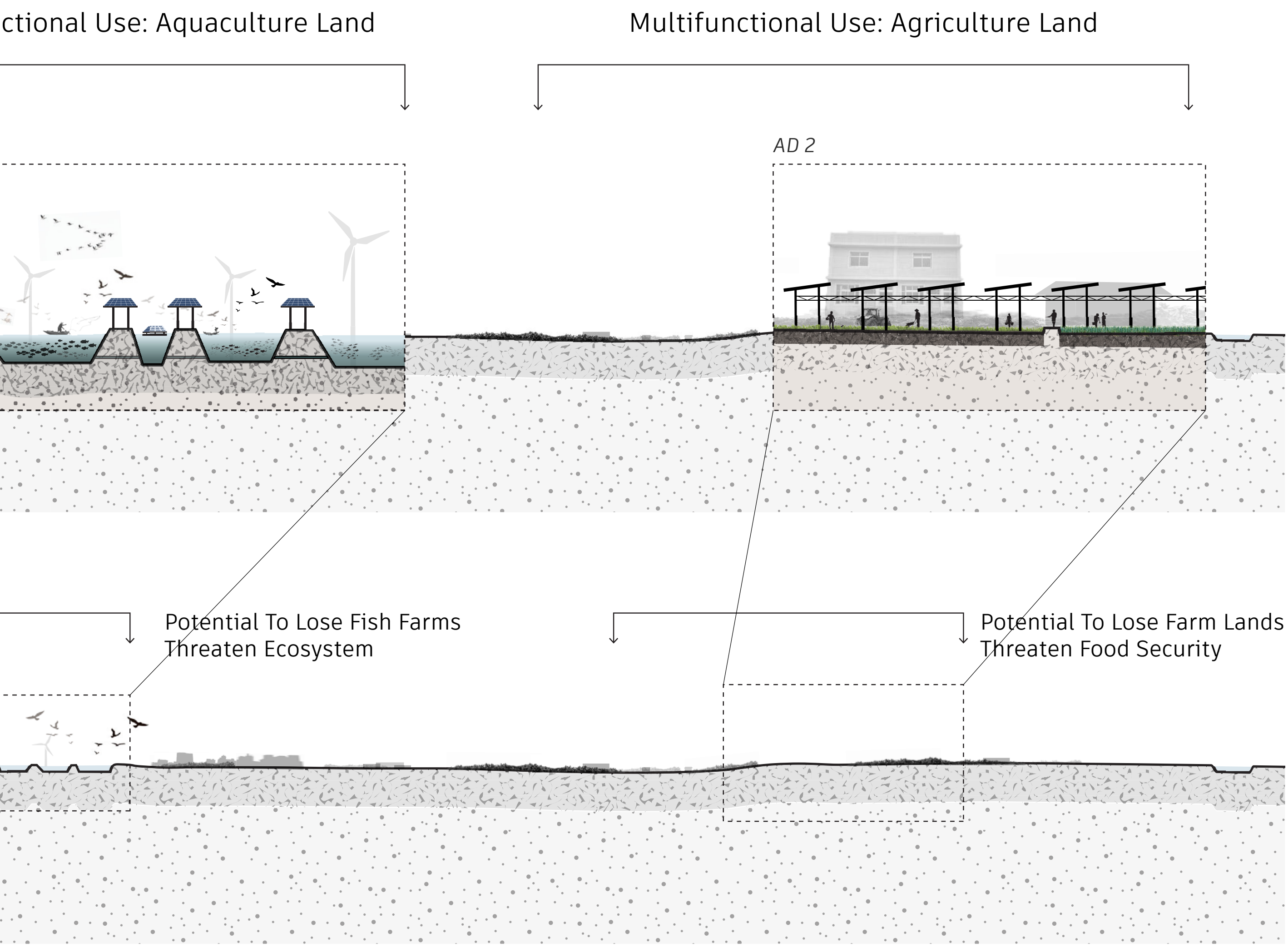


Fig 6.20: Location of the zoomed-in section.



AA’ Section-1: Marine Spatial Area

This zoom-in area focuses on the marine spatial site (MR1-2), which already had planned wind farms or executing offshore wind. The current conflicts have shown in the short distance with the wildlife conservation zones, threatening the endangered animals. Besides, offshore wind farms building has sacrificed the fishery industry because of the lack of laws to protect fishery activities.

This card, therefore, regulates the buffer zone between the offshore wind farm and the ecological reserve, providing the rules for revision in the future and preventing the same mistakes from happening in other MR1-2 zone with environmentally sensitive issues. At the same time, protecting fishermen’s right to work through a participatory process that encourages stakeholders to express their views.

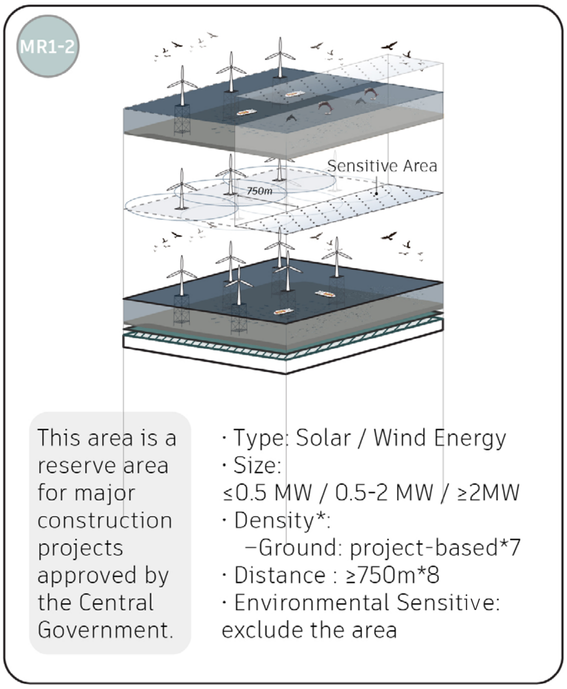


Fig 6.21: Implementation of energyscape template card: MR1-2.

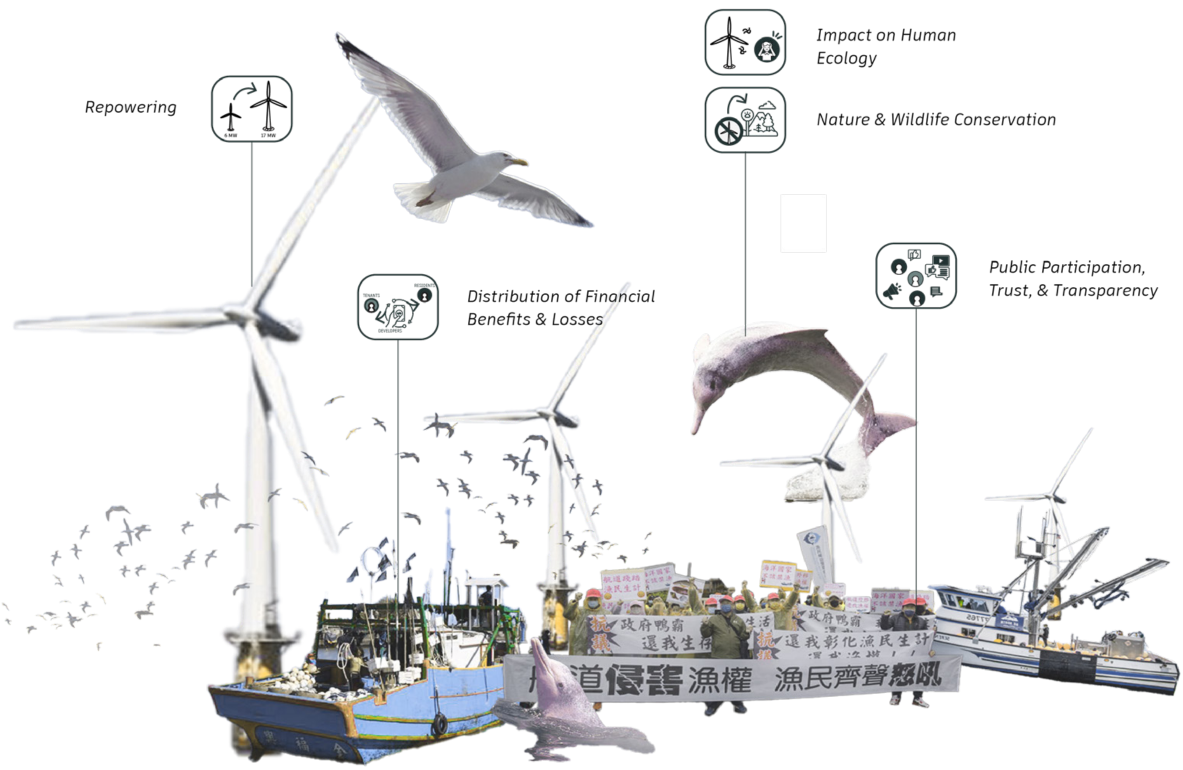


Fig 6.22: Collage of stakeholders and design principles that need to be implemented.

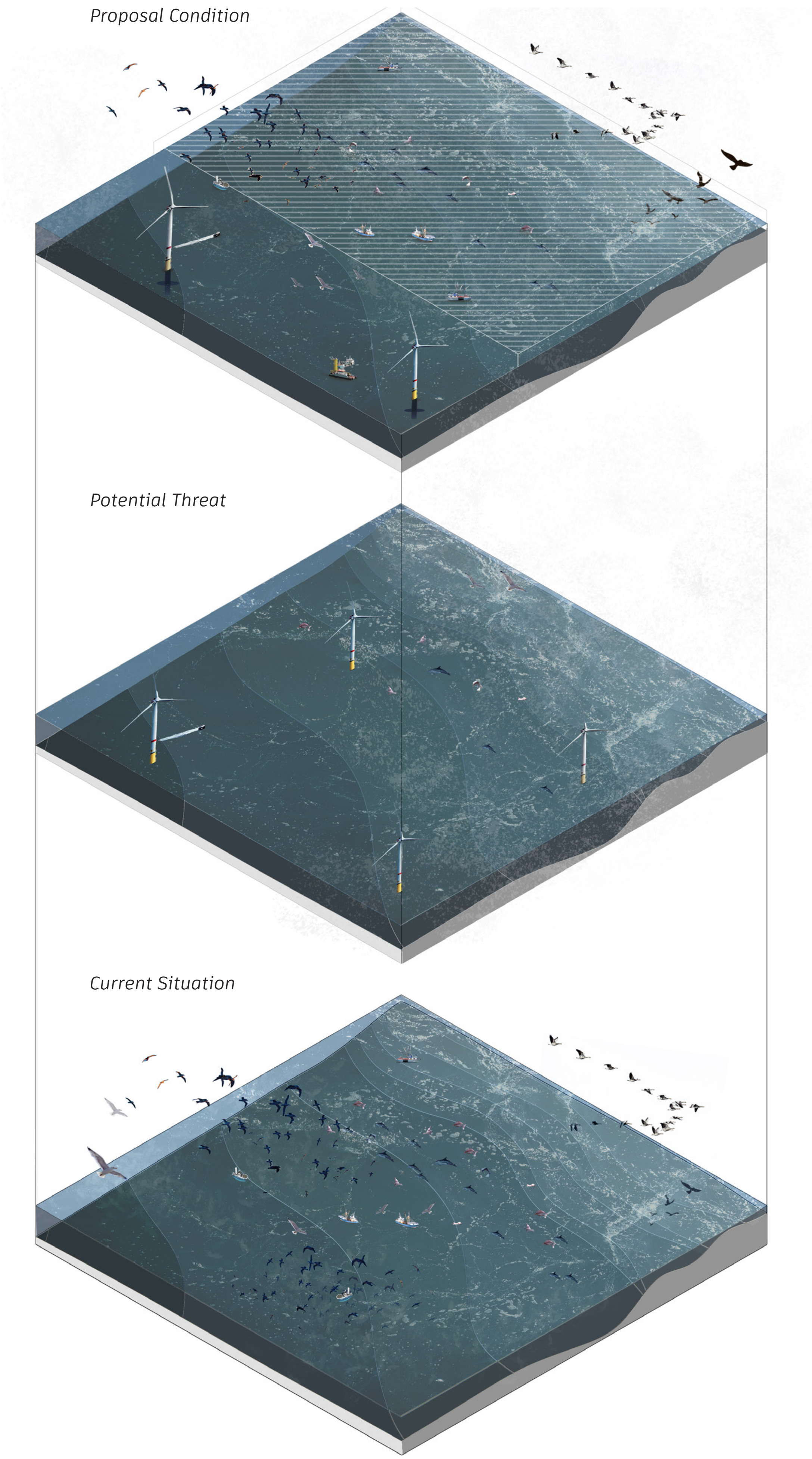


Fig 6.23: Energyscape scenarios: Marine spatial area (AA).

AA' Section-2: Aquacultural Land Area

This example focuses on the potential conflicts in the aquacultural land. If the current regulations are not revised, many land use types might be changed from aquacultural ground to particular land use types. This consequence will threaten the ecosystem and cause tenants' work rights to be lost.

Thus, implementing the AD1 card in the toolbox to prevent changes in land use types and, at the same time, regulate the kind of solar panels to implement and the coverage of solar panels on the ground.

From this, the total amount of energy installation can be predicted, and reduce the impact on landscape scenery. Besides, the inclusivity of stakeholders can also be seen in the sharing benefits of renewable energy generation.

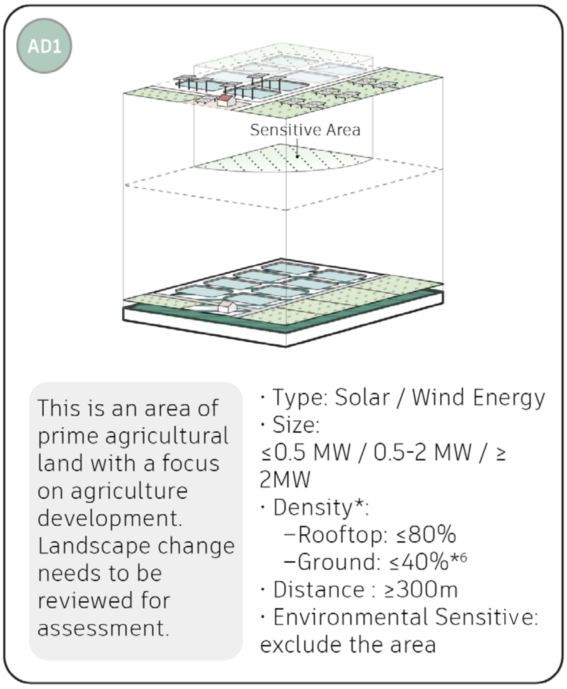


Fig 6.24: Implementation of energyscape template card: MR1-2.

Fig 6.25: Collage of stakeholders and design principles that need to be implemented.

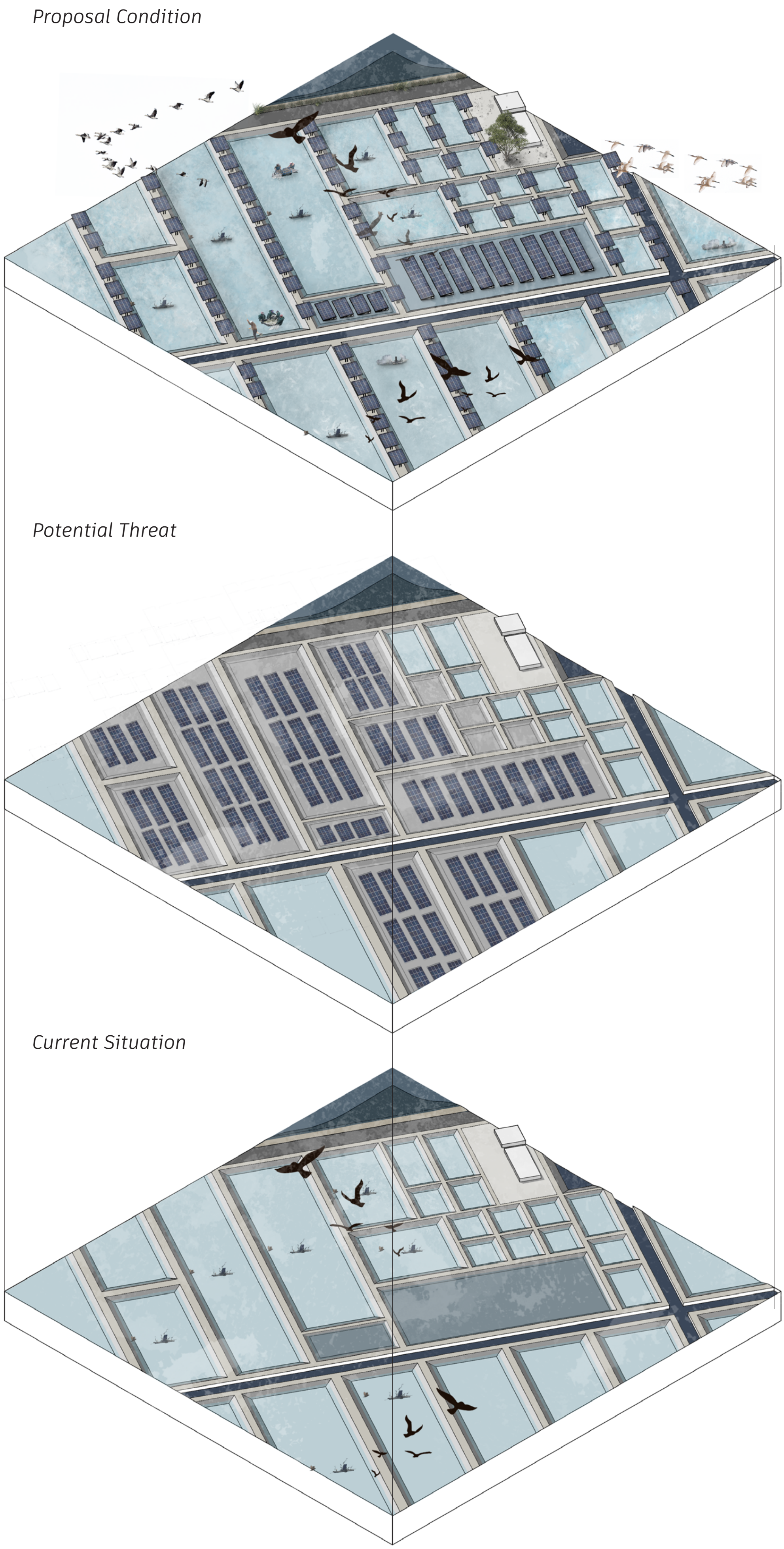


Fig 6.26: Energyscape scenarios: Aquacultural land area (AA).

AA' Section-3: Agricultural Land Area

The last zoom-in area is on the agricultural land in AD2 zone. By implementing AD2 card, it prevents the change of land use type in order to establish a large-scale solar panel farm. At the same time, considering the need for the agricultural land to maintain its agricultural development, it is proposed to use rotating solar panels in this zoning in order to balance the two actions.

At the same time, it shows the possible zones by following the minimum distance between the wind turbines on the land and the built environment. The factors impacting societal acceptance within the design include energy strategies, economic effects, and effects on landscape scenery.

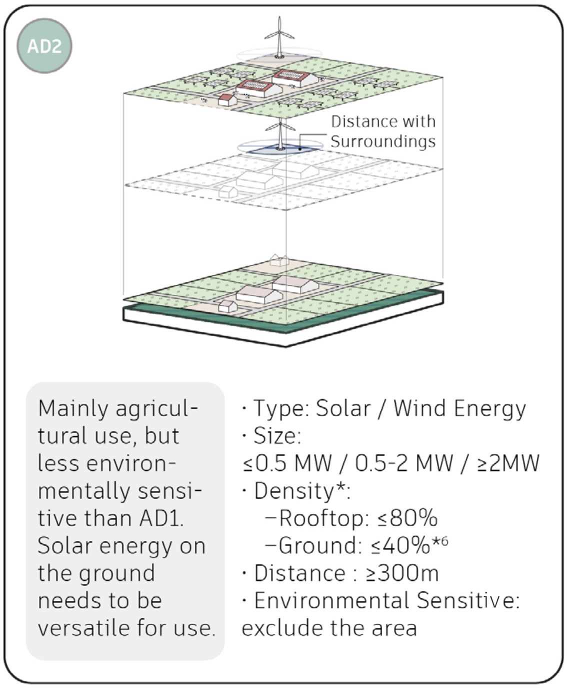


Fig 6.27:Implementation of energyscape template card: MR1-2.

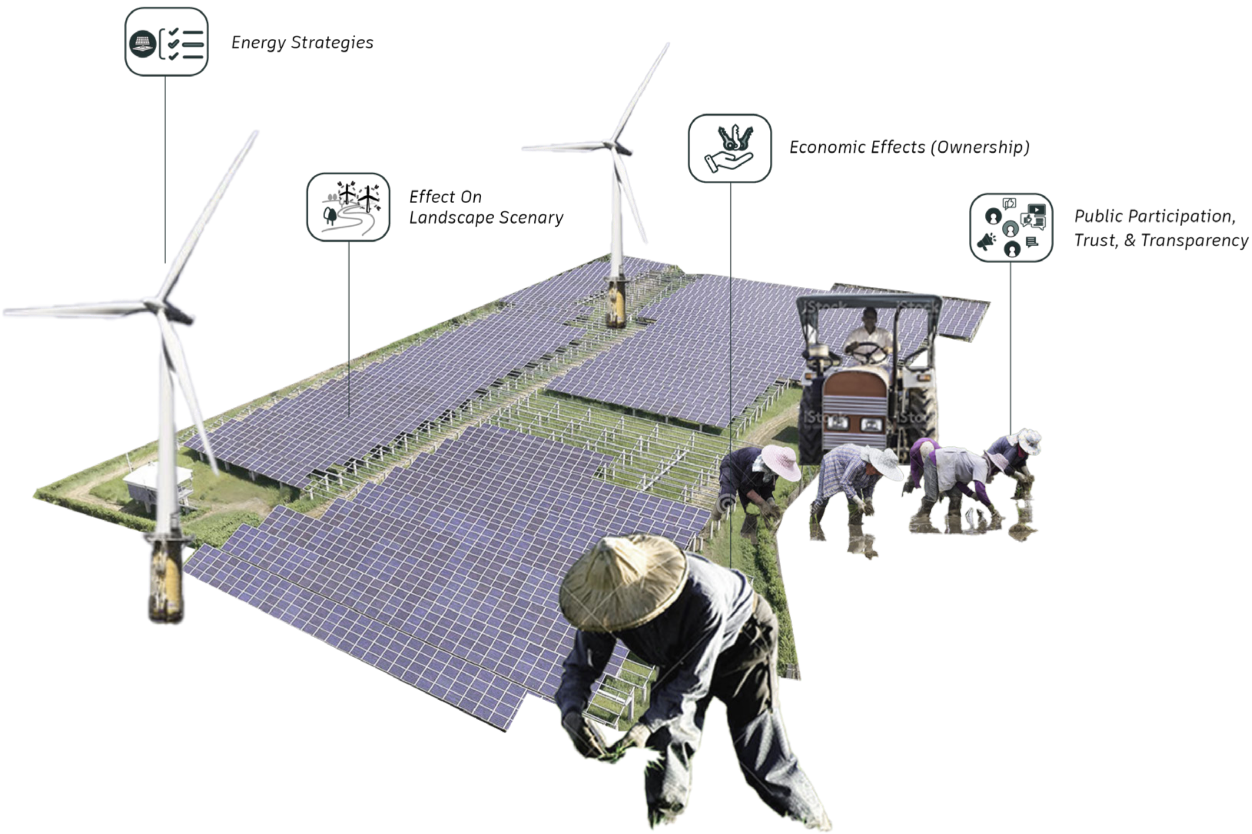


Fig 6.28: Collage of stakeholders and design principles that need to be implemented.

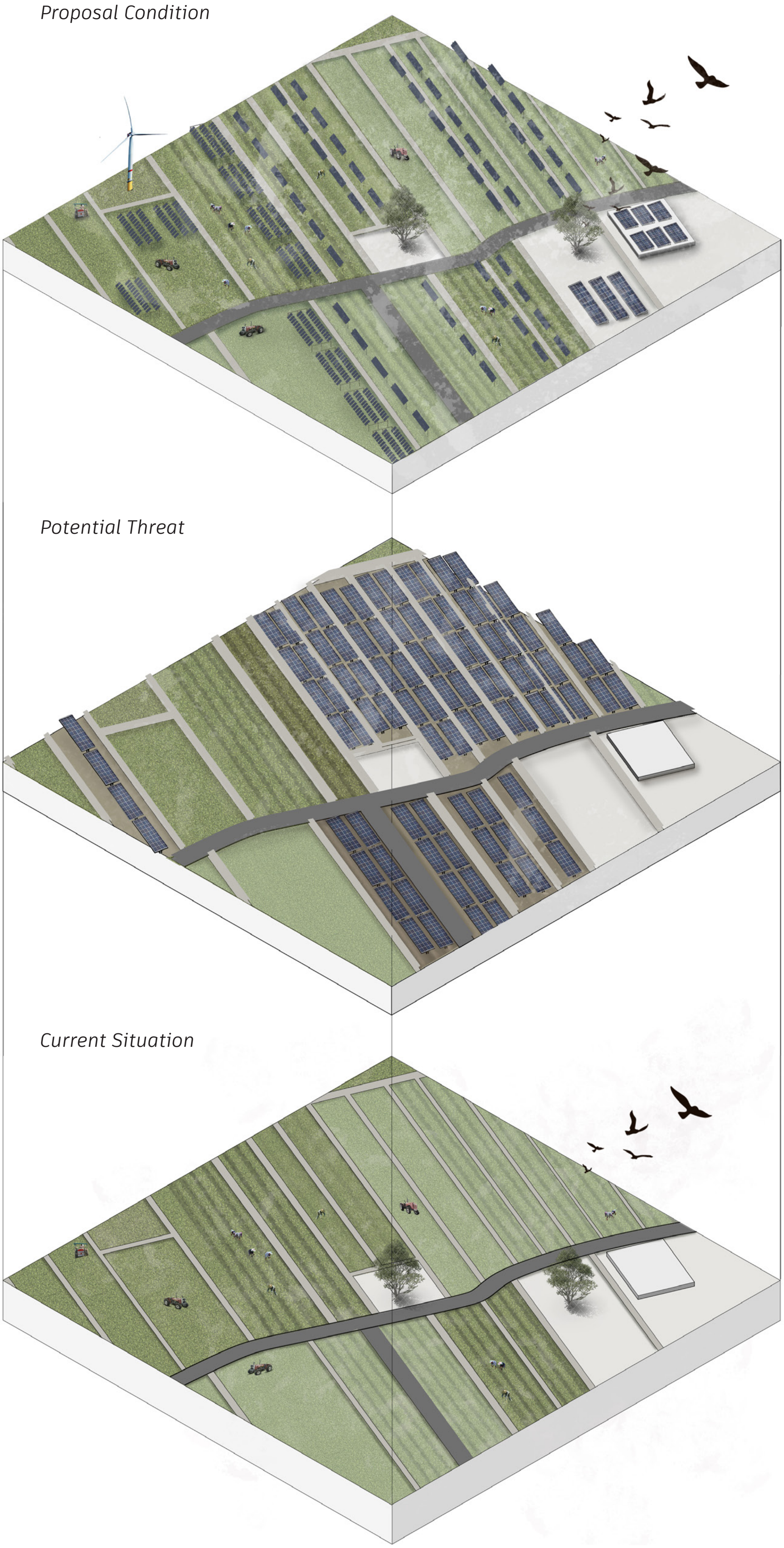


Fig 6.29: Energyscape scenarios: Agricultural land area (AA).

BB’ Section: Dacheng Township–Rural Area with Subsidence

Section BB’ is located in Dacheng Township, a township with less competitiveness due to land subsidence and poor infrastructure, especially the infrastructure for energy generation and transmission. There were abundant aquaculture activities in the early years, yet the over-pumping of underground water has caused many fish farms to lose their capacity for use.

However, this area still possesses high potential for renewable energy development in terms of wise land use. Thus, this section demonstrates the potential through the changes in the subsidence district in Dachen Township.

To be more specific, using those abandoned or unused spaces for renewable energy generation while letting the soil revitalize and prepare for future re-usage. During this period of time, it also provides the chance to bring in investment and create opportunities due to the development of renewable energy.

Three zoom-in areas are the Marine spatial area, abandoned aquacultural land, and agricultural land area.

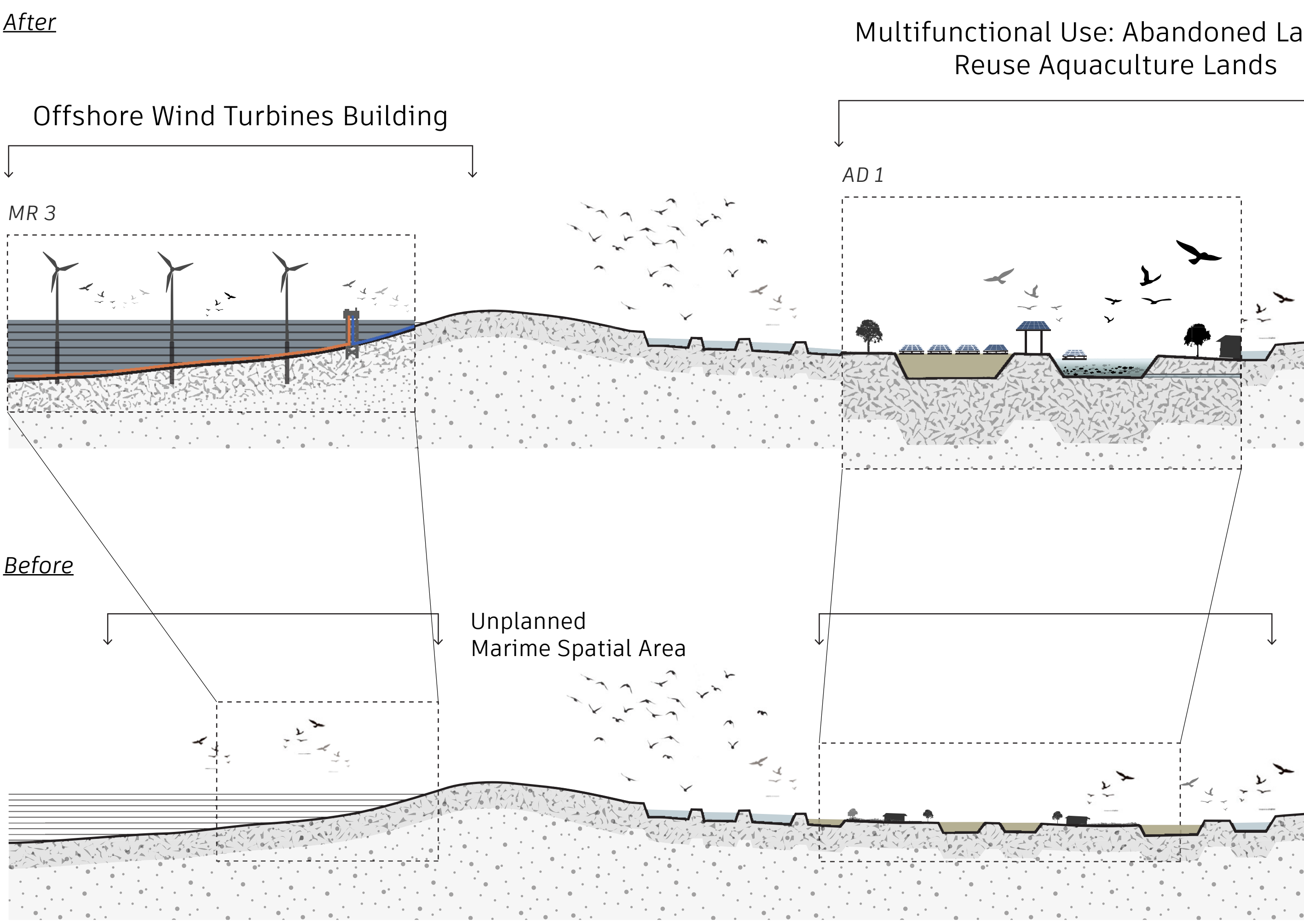


Fig 6.30: Before and after of the zoomed-in scenario: BB section / Dacheng Township–Rural Area With Subsidencetive.

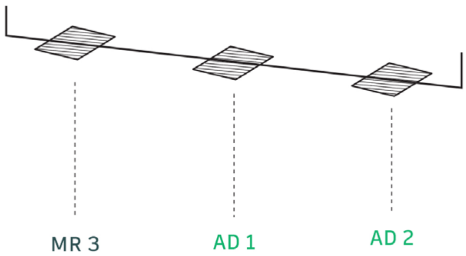


Fig 6.31: Land use zone of zoomed-in areas based on the National Spatial Plan.

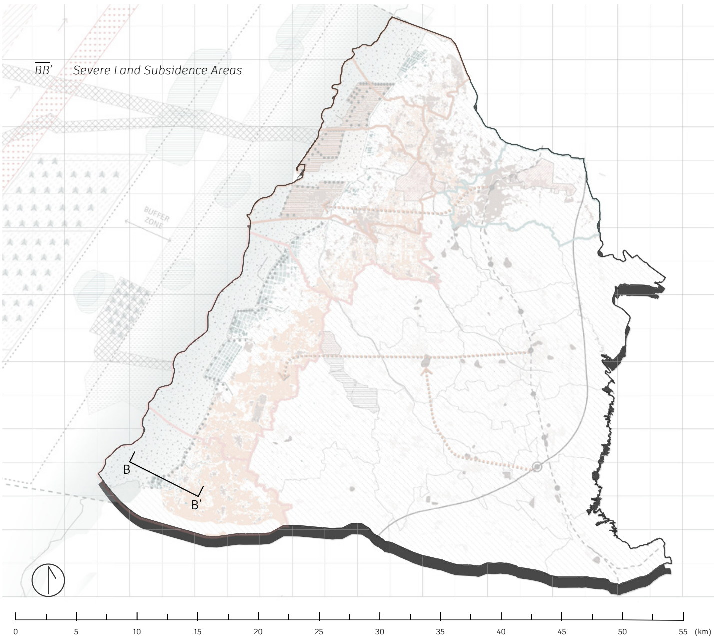
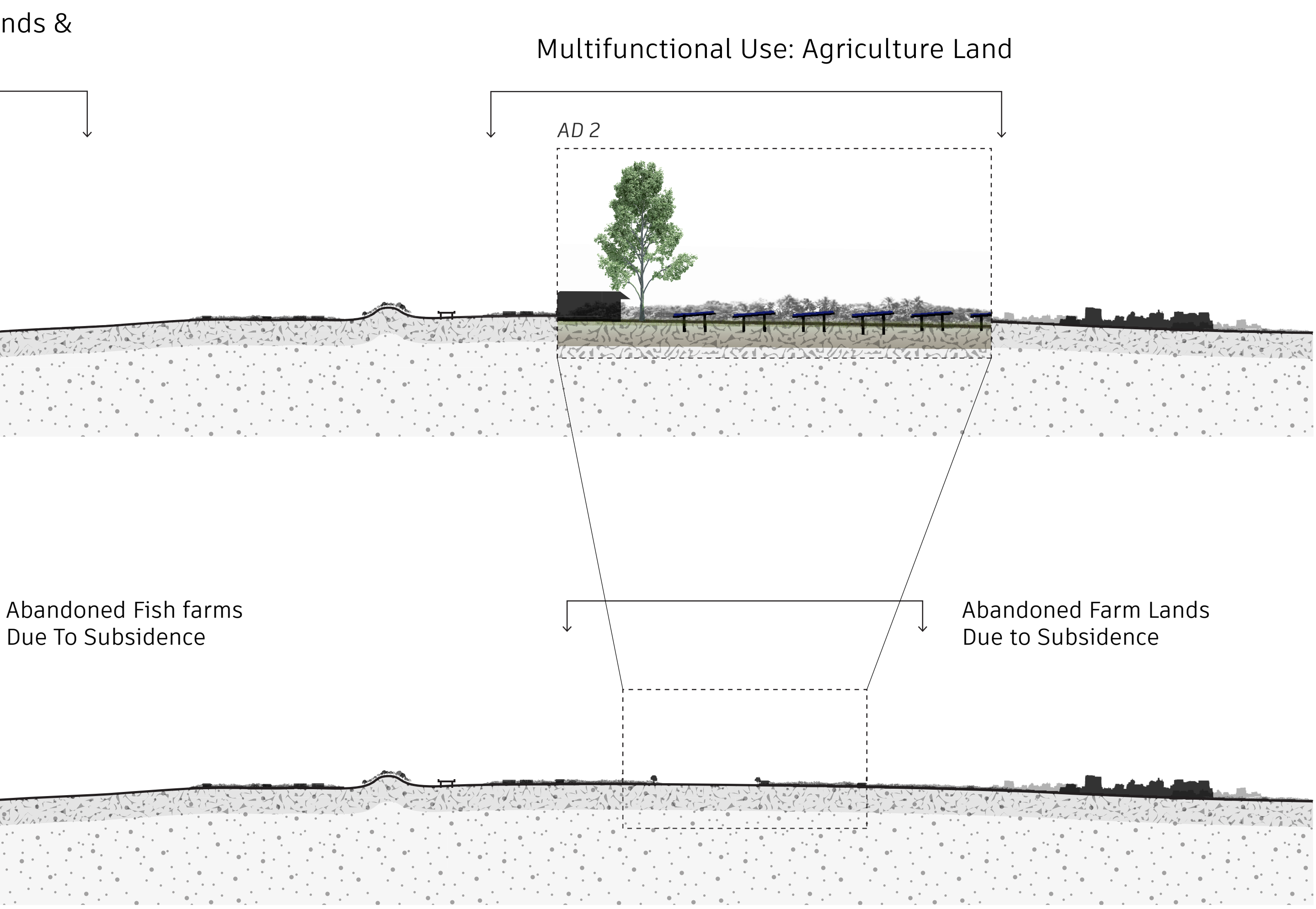


Fig 6.32: Location of the zoomed-in section.



BB’ Section-1: Marine Spatial Area

The first zoom-in area focuses on the marine spatial site. This area (MR3) does not currently have more in-depth planning regarding maritime activities. Yet, if the wind farm planning in the future is chosen for this area, it will threaten the endangered animals close to the conservation zone.

Therefore, setting up the distance with the environmentally sensitive area is essential, creating a buffer zone in between as the card regulates.

At the same time, the buffer zone creation process encourages stakeholders to join the planning, including their opinions, and integrate within the energy strategies.

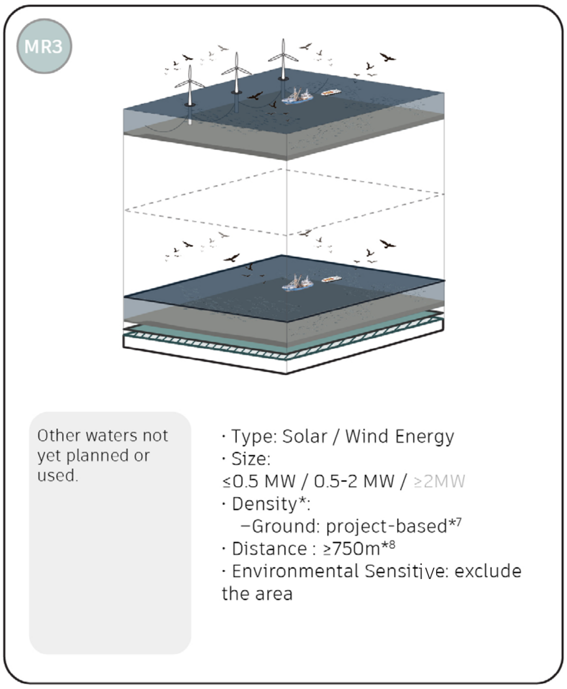


Fig 6.33: Implementation of energyscape template card: MR1-2.

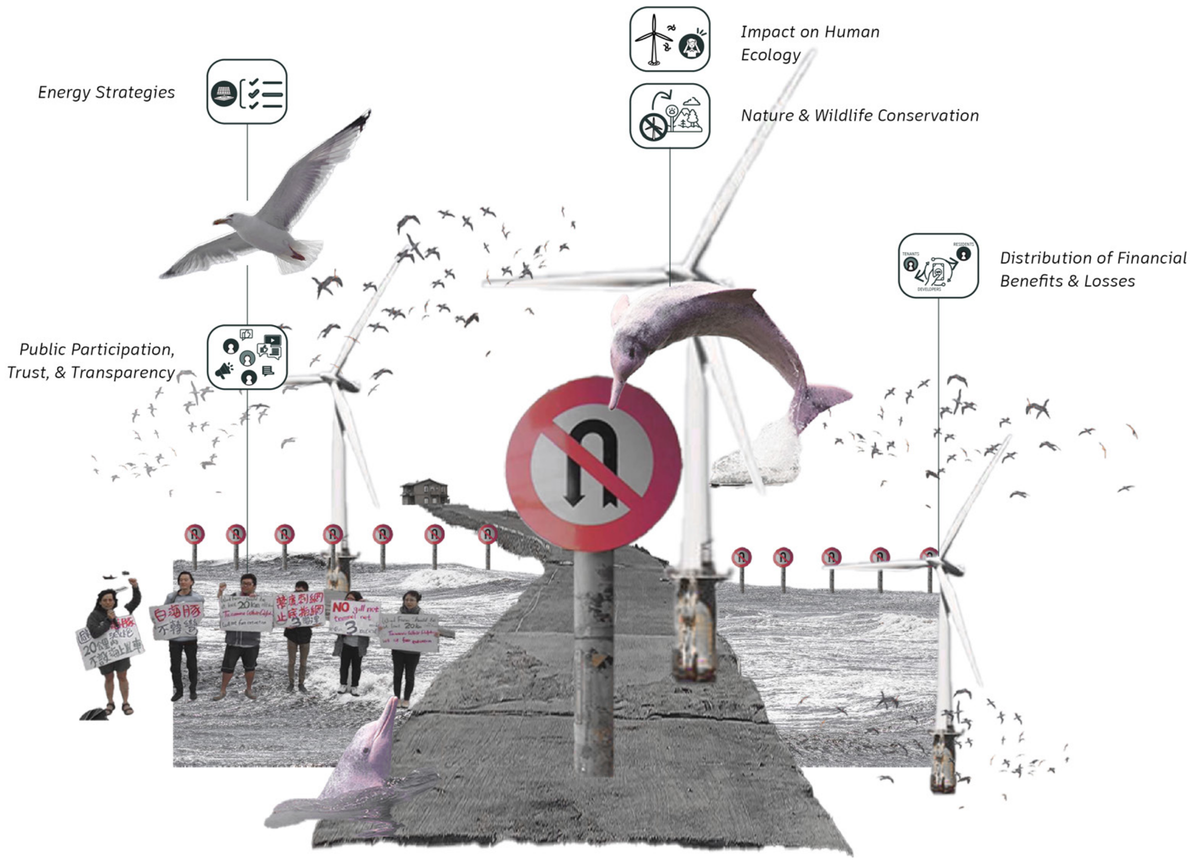


Fig 6.34: Collage of stakeholders and design principles that need to be implemented.

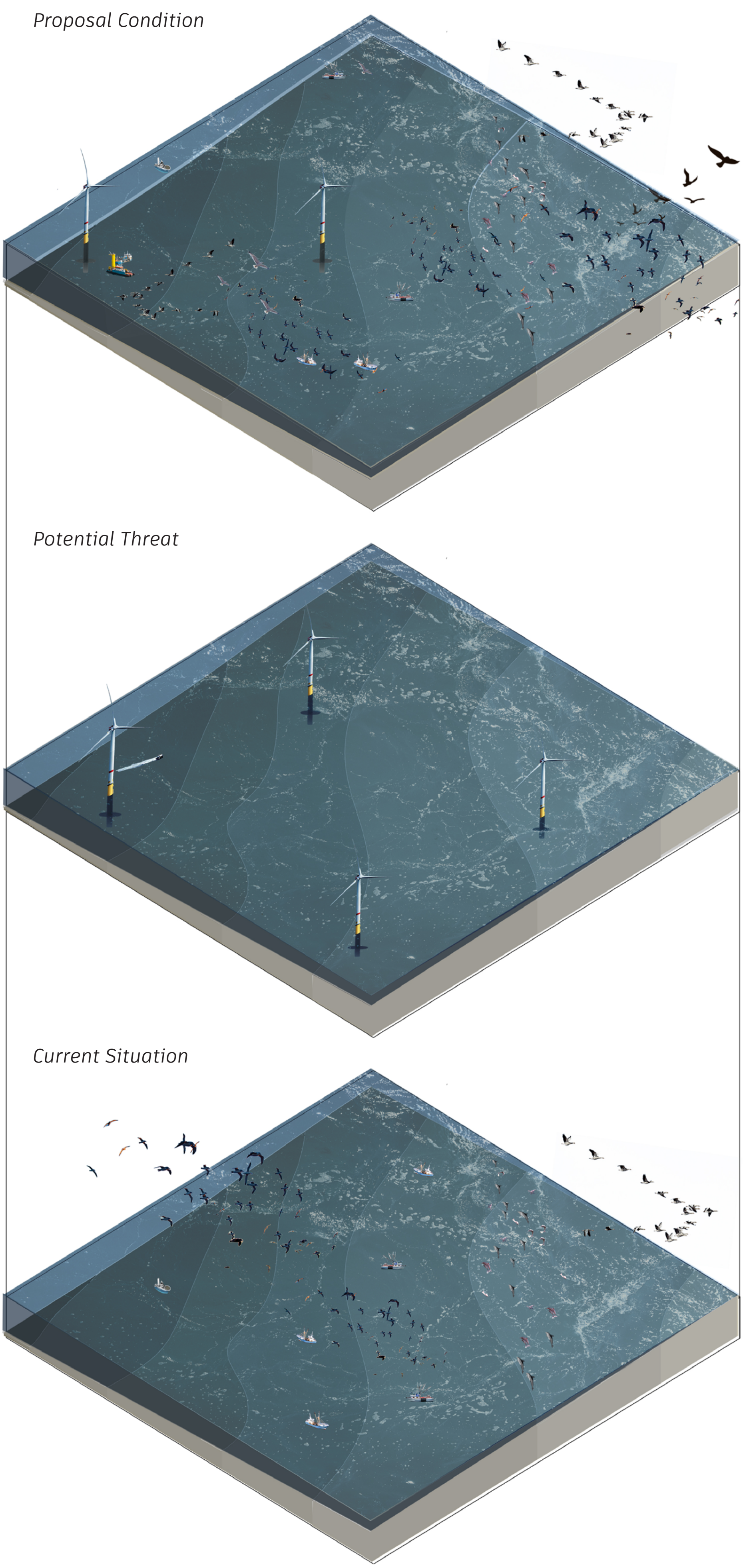


Fig 6.35: Energyscape scenarios: Marine spatial area (BB).

BB' Section-2: Aquacultural Land with Subsidence

This site has fewer complete fish farms than the one in the AA section.

Besides, due to the subsidence, many fish farms have become unused, providing spaces for solar energy generation. Yet, without the amount of control and the limitation of the land use type change, tons of land will only cover by solar panels in the future.

Thus, by implementing the AD2 card, the density of the solar panel coverage can be regulated, achieving the idea of amount control. Unused land with solar panels can give time for the soil revitalization, preparing for future land reuse.

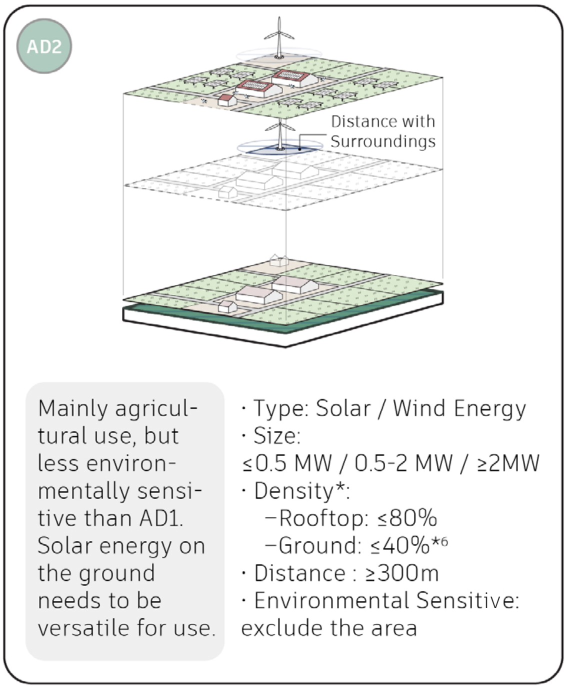


Fig 6.36: Implementation of energyscape template card: MR1-2.

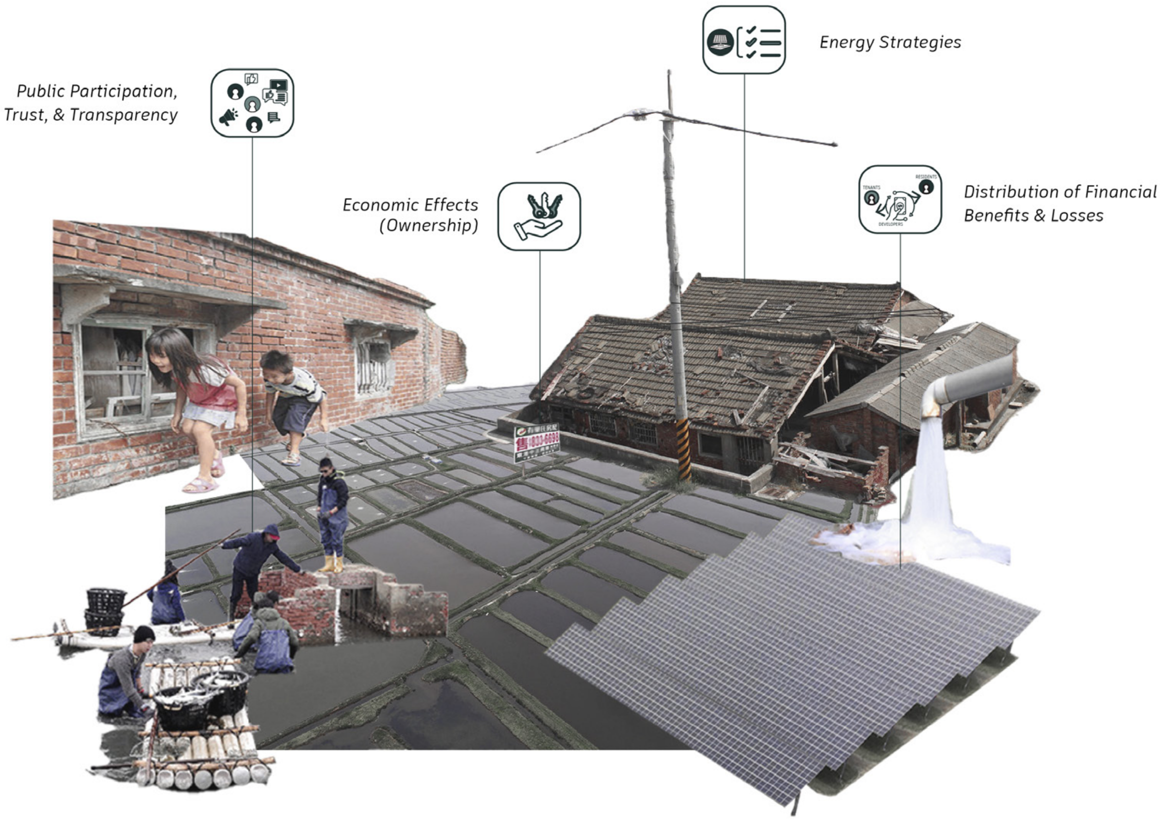


Fig 6.37: Collage of stakeholders and design principles that need to be implemented.

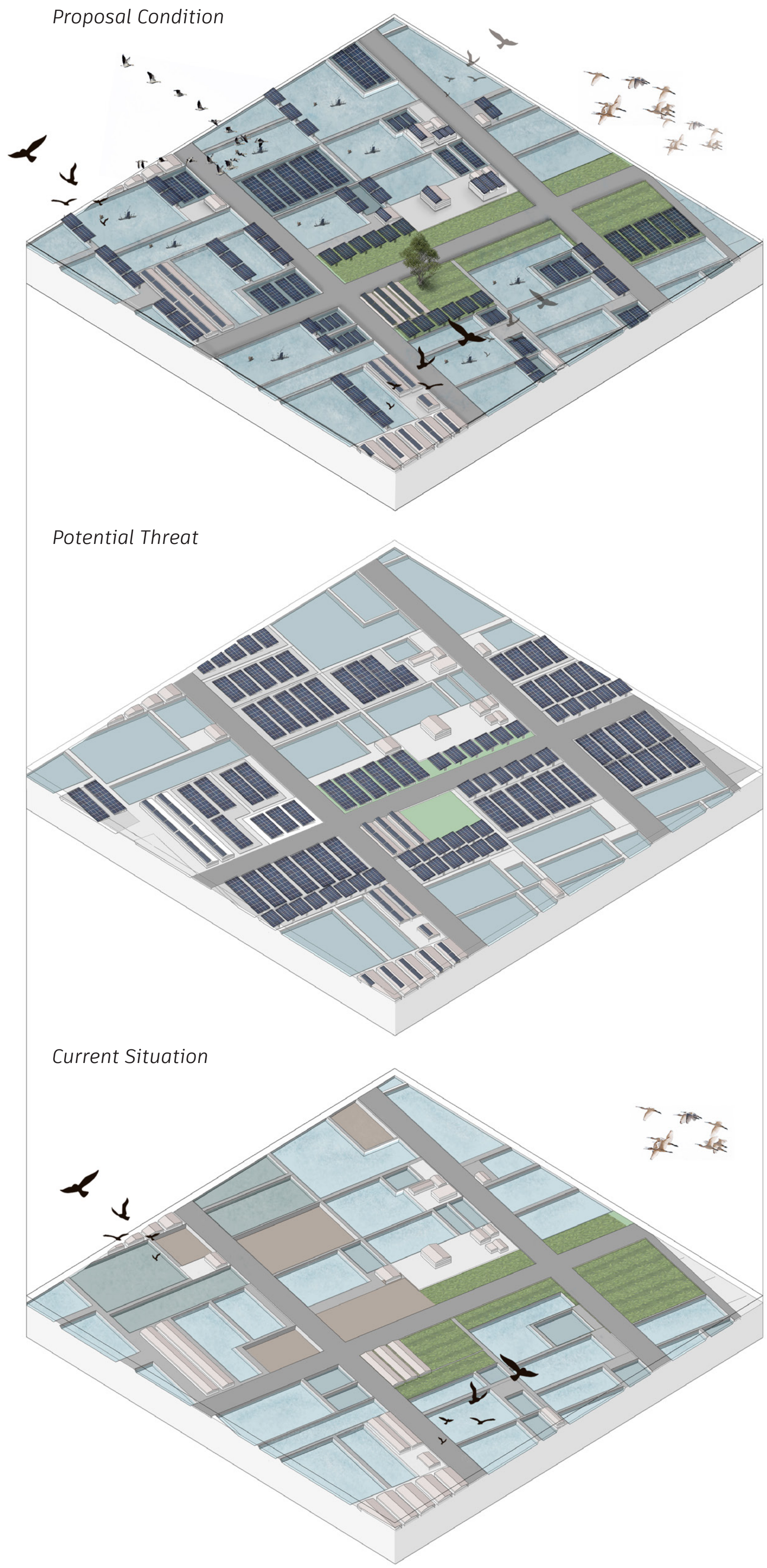


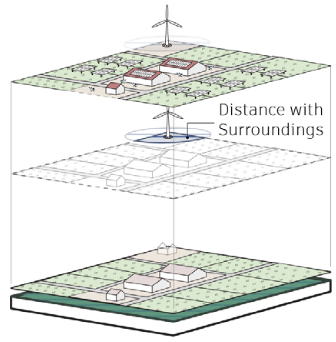
Fig 6.38: Energyscape scenarios: Aquacultural land area with subsidence (BB).

BB’ Section: Agricultural Land with Subsidence

The last zoom-in site in the BB section focuses on the agricultural land in the subsidence area. Compared to the farmland in the AA section, the one here has more unused or abandoned lands. And because of this, it has attracted many developers to rent lands, causing the high cover rate of solar panels on the grounds, affecting the living environment and landscape.

Thus, implementing the AD2 card regulates the solar panels’ density and allows installing wind turbines at a safe distance. Because there are few residents located in the AD2 zone, it provides more flexible regulation in terms of distance from the building environment.

AD2



Mainly agricultural use, but less environmentally sensitive than AD1. Solar energy on the ground needs to be versatile for use.

- Type: Solar / Wind Energy
- Size: ≤0.5 MW / 0.5-2 MW / ≥2MW
- Density*:
  - –Rooftop: ≤80%
  - –Ground: ≤40%*6
- Distance : ≥300m
- Environmental Sensitive: exclude the area

Fig 6.39: Implementation of energyscape template card: MR1-2.

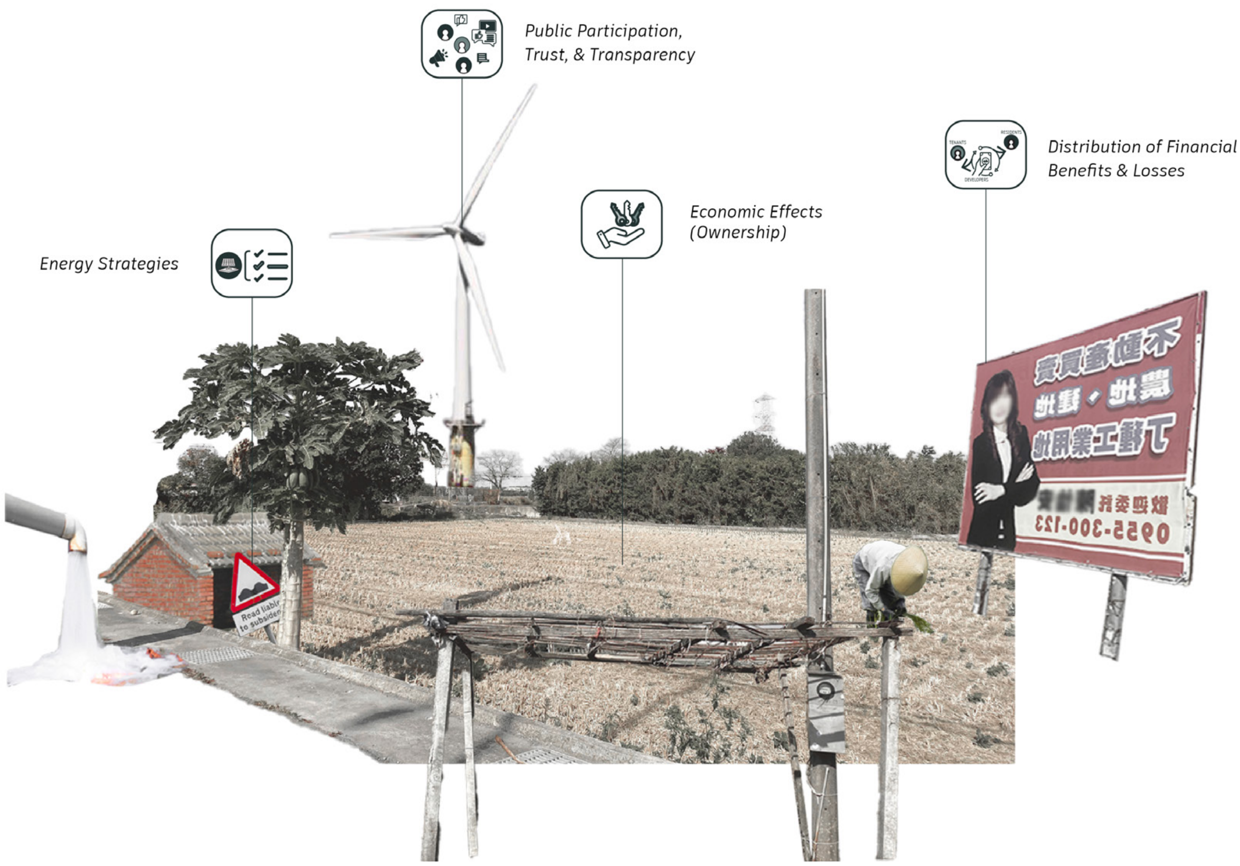


Fig 6.40: Collage of stakeholders and design principles that need to be implemented.

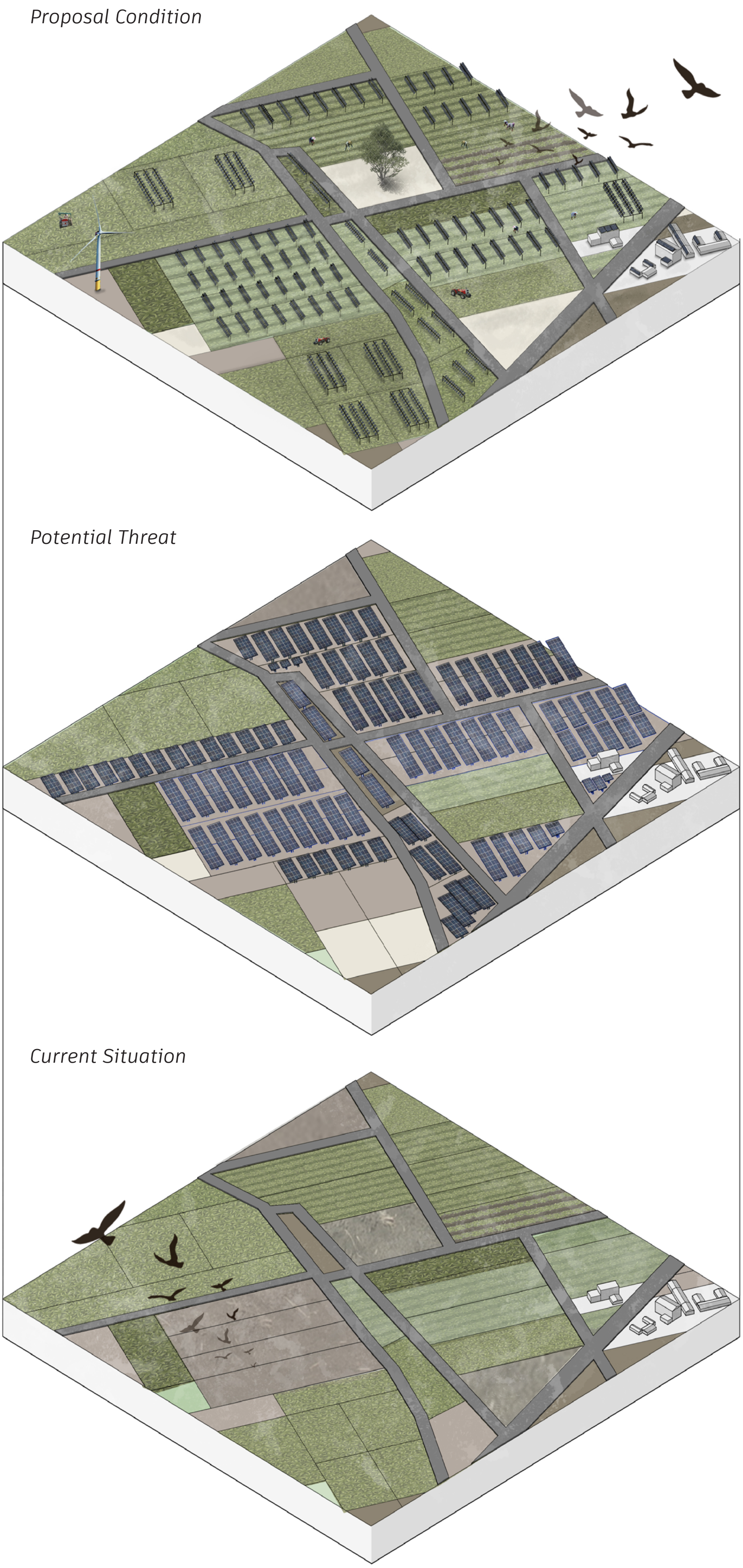


Fig 6.41: Energyscape scenarios: Agricultural land area with subsidence (BB).

CC' Section: Marine Spatial Area

The CC section shows the change in the areas of marine space that span offshore wind farms. In addition, the place in the middle (deeper waters showing in the section) is currently a restricted access zone, only allowing vessels with work related to offshore wind projects.

This limited zone causes fishermen to lose their rights to work, and combined with the fact that the offshore wind farms have already occupied many areas, the injustice situation is urgent to be changed.

Therefore, the proposal scenario includes creating separate channels and controlling accessing vessels' shipping direction to reduce the chance of collisions and incidents. That is, fishermen can still access this area and continue their work only under the condition of following the channel's control and management rules.

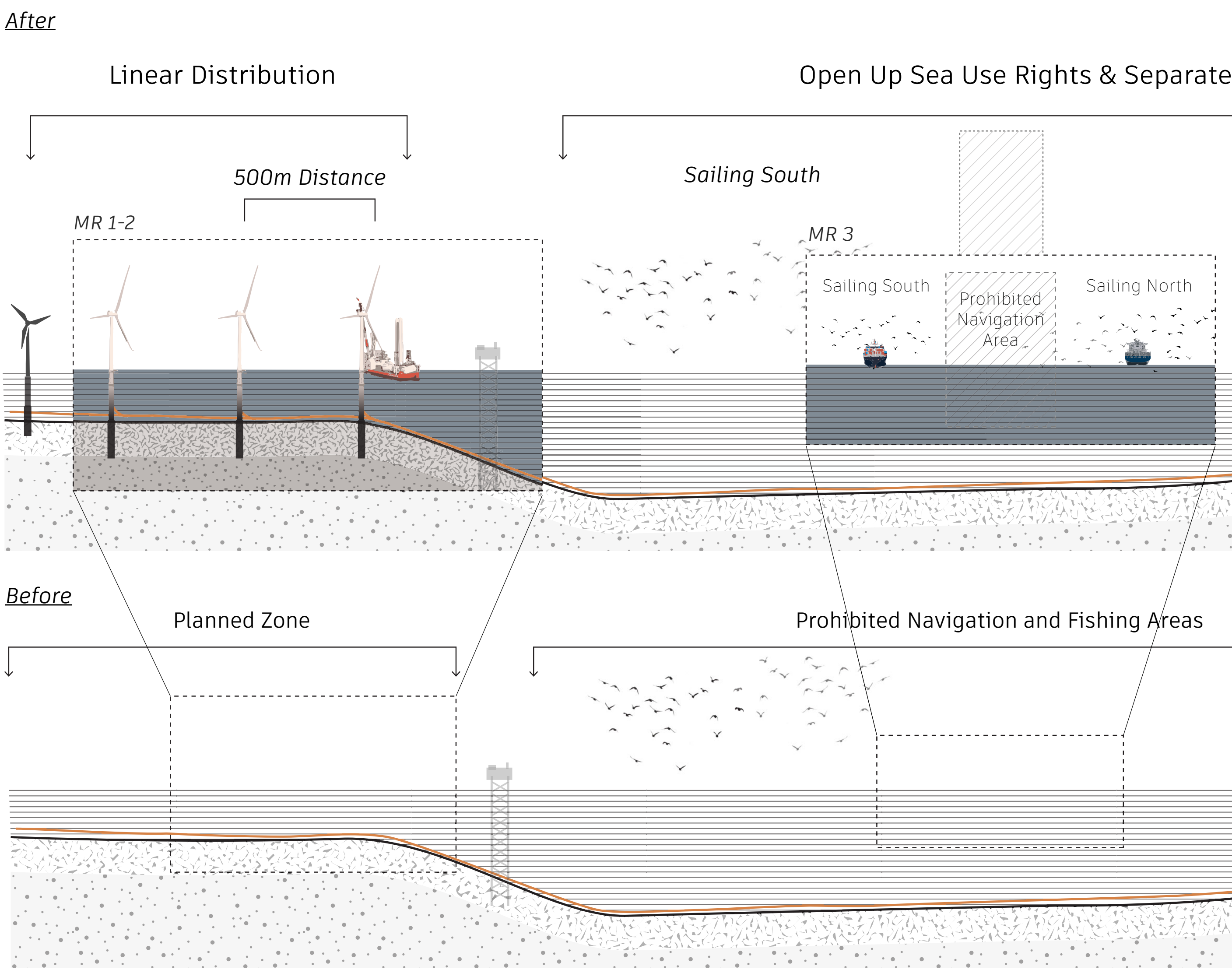


Fig 6.42: Before and after of the zoomed-in scenario: CC section / Marine Spatial Area

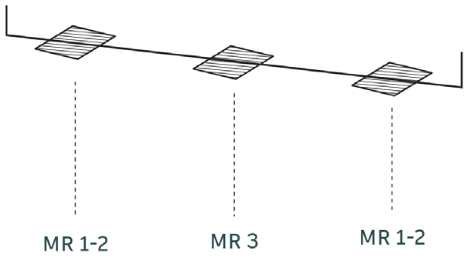


Fig 6.43: Land use zone of zoomed-in areas based on the National Spatial Plan.

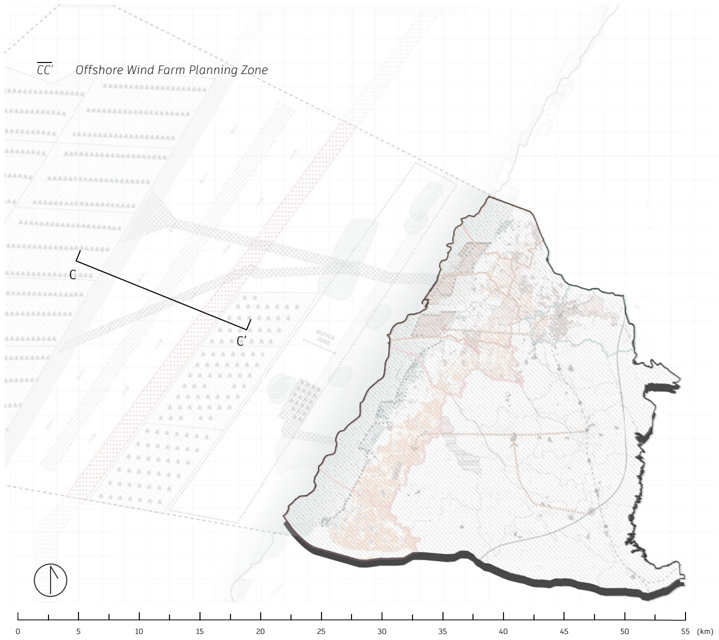
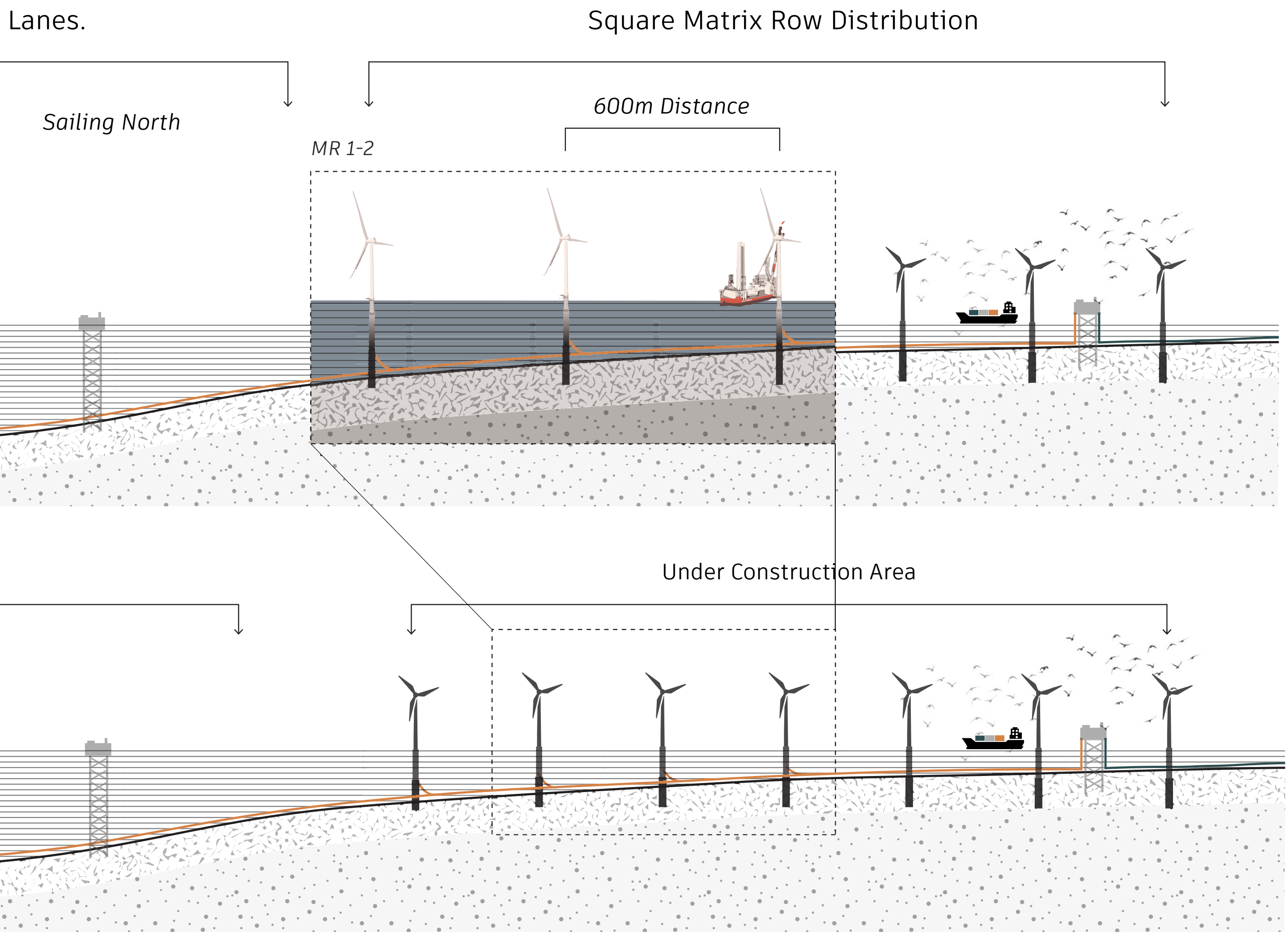


Fig 6.44: Location of the zoomed-in section.



CC' Section-1: Sea Area 50km Off The Coast

The first zoomed-in site is located in an offshore wind farm planning area about 50 km off the coast, in the MR1-3 zone of the national spatial planning system.

This zone is planned for potential wind farm development. This means it can create future participatory planning within wind farm projects that include stakeholders' opinions. Especially since this location is close to the limited access zone, the discussion regarding border control and vessel management will be essential.

More specifically, the collaboration can provide the shared use of maritime activities in the currently limited access use in the future if the planning process creates integrated strategies.

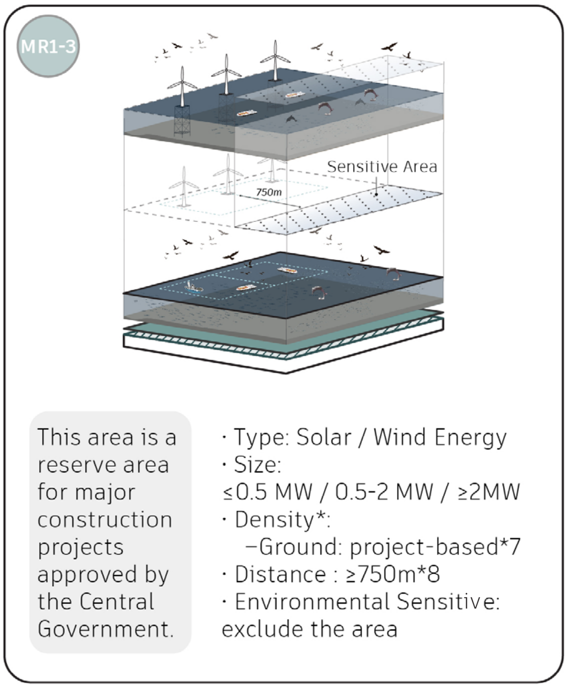


Fig 6.45: Implementation of energyscape template card: MR1-2.

Fig 6.46: Collage of stakeholders and design principles that need to be implemented.

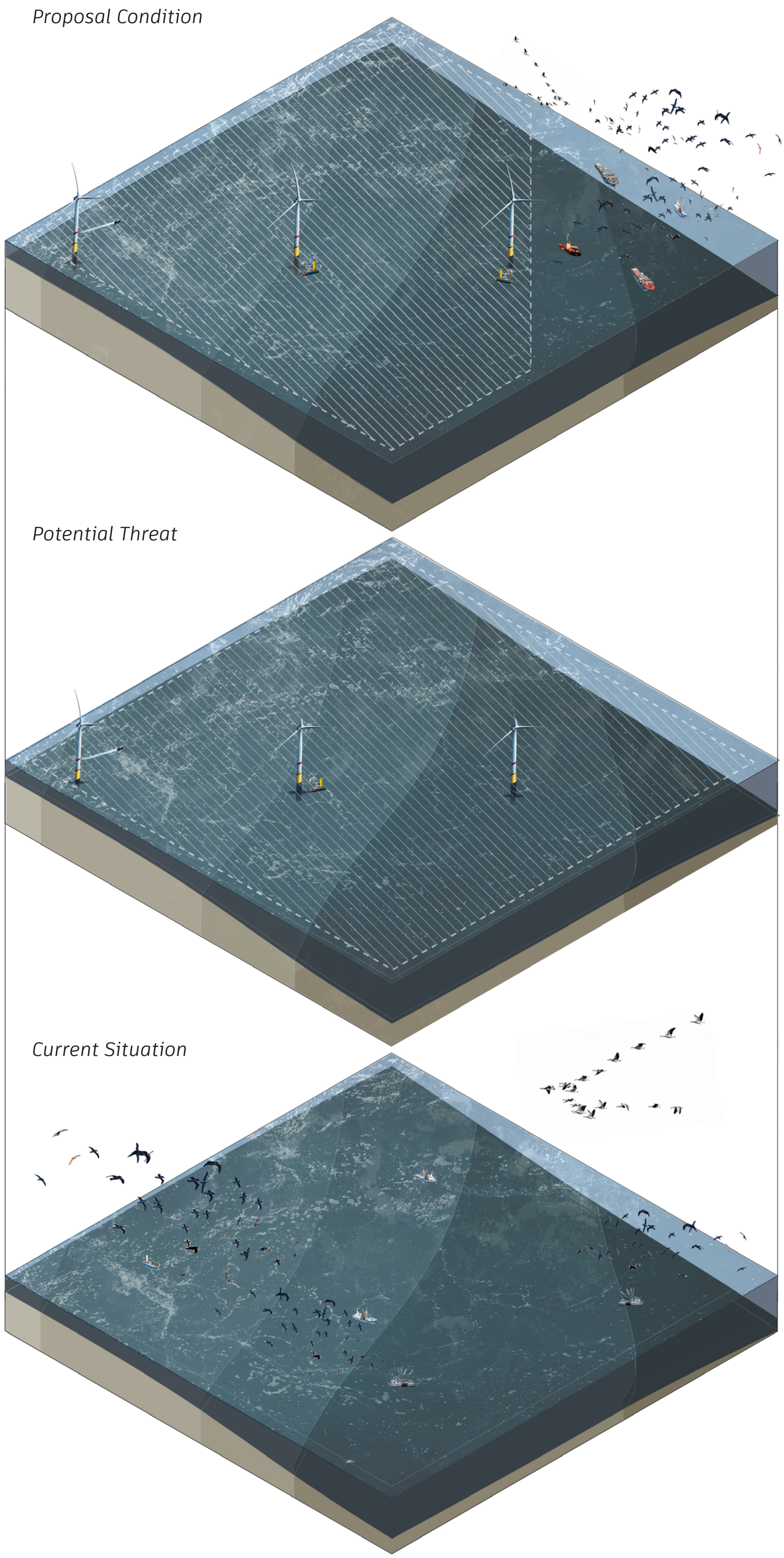


Fig 6.47: Energyscape scenarios: Sea area 50km off the coast(CC).

CC’ Secttion-2: Limited Access Zone

This site locates in the limited access zone, which only allows vessels with off-shore wind works to pass through. However, due to this restriction, this width 16 kilometers zone has threaten many fishermen’s rights to work. Besides, the zoning of this area is MR3, which means water areas without specific planning defined, bringing the chance for the participatory planning with stakeholders to build up regulations and strategies within this area in order to create a share space for various maritime acitivities.

The proposal of this zone is to create seperate channels to control vessel shipping direction to avoid collition and potential inccidents while provide fishery industry to maintain their fishing activities at the same time.

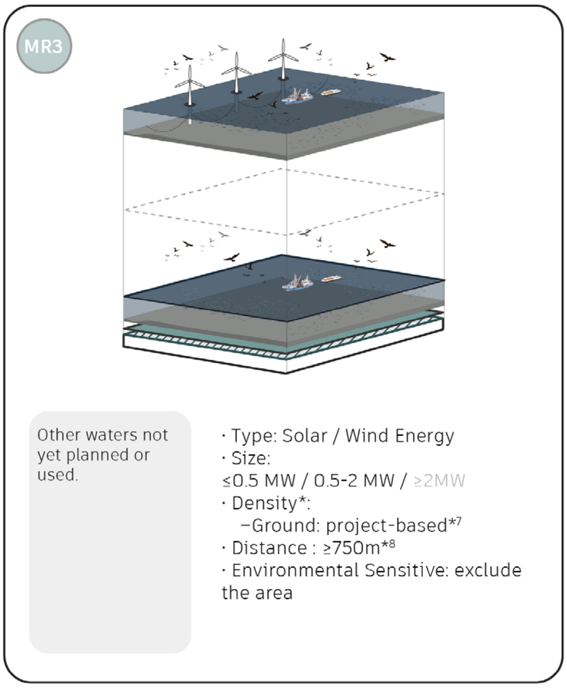


Fig 6.48: Implementation of energyscape template card: MR1-2.

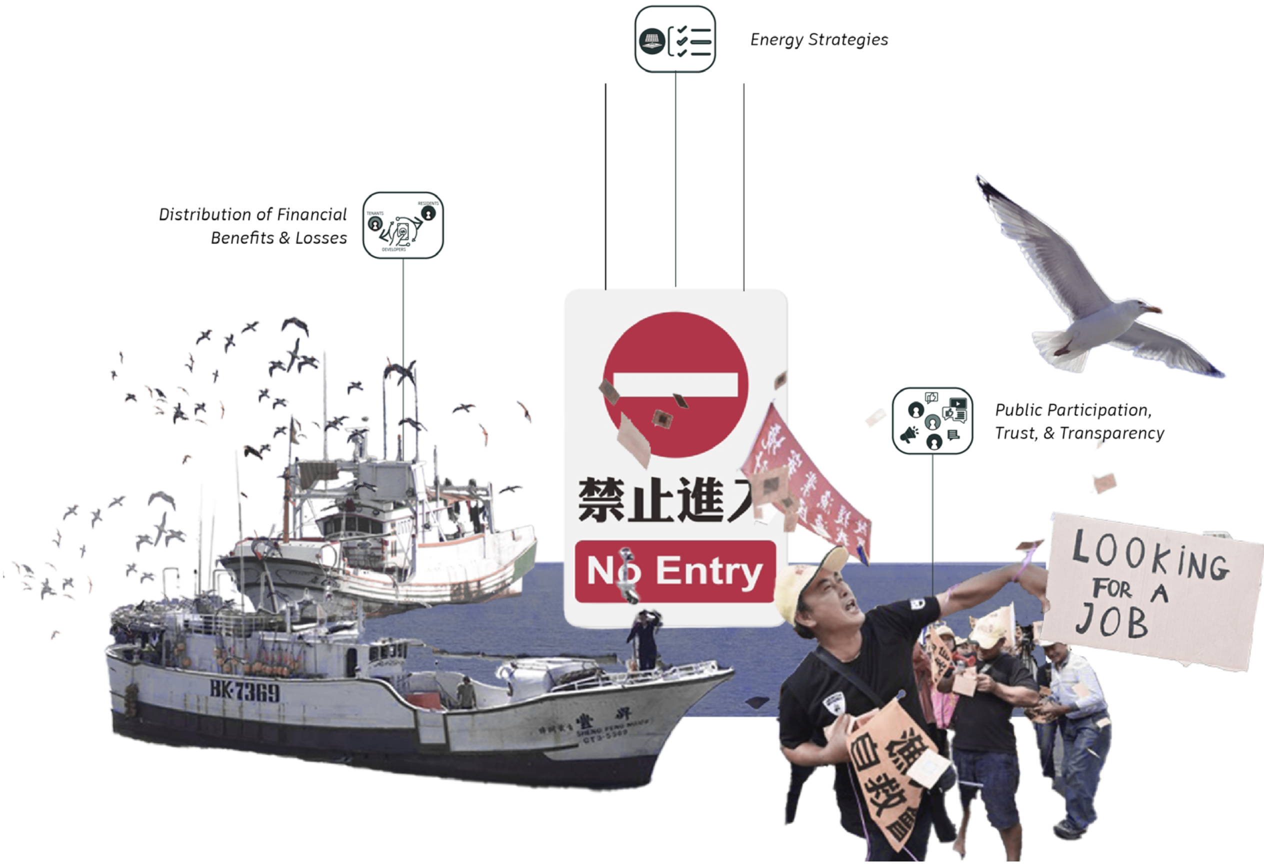


Fig 6.49: Collage of stakeholders and design principles that need to be implemented.

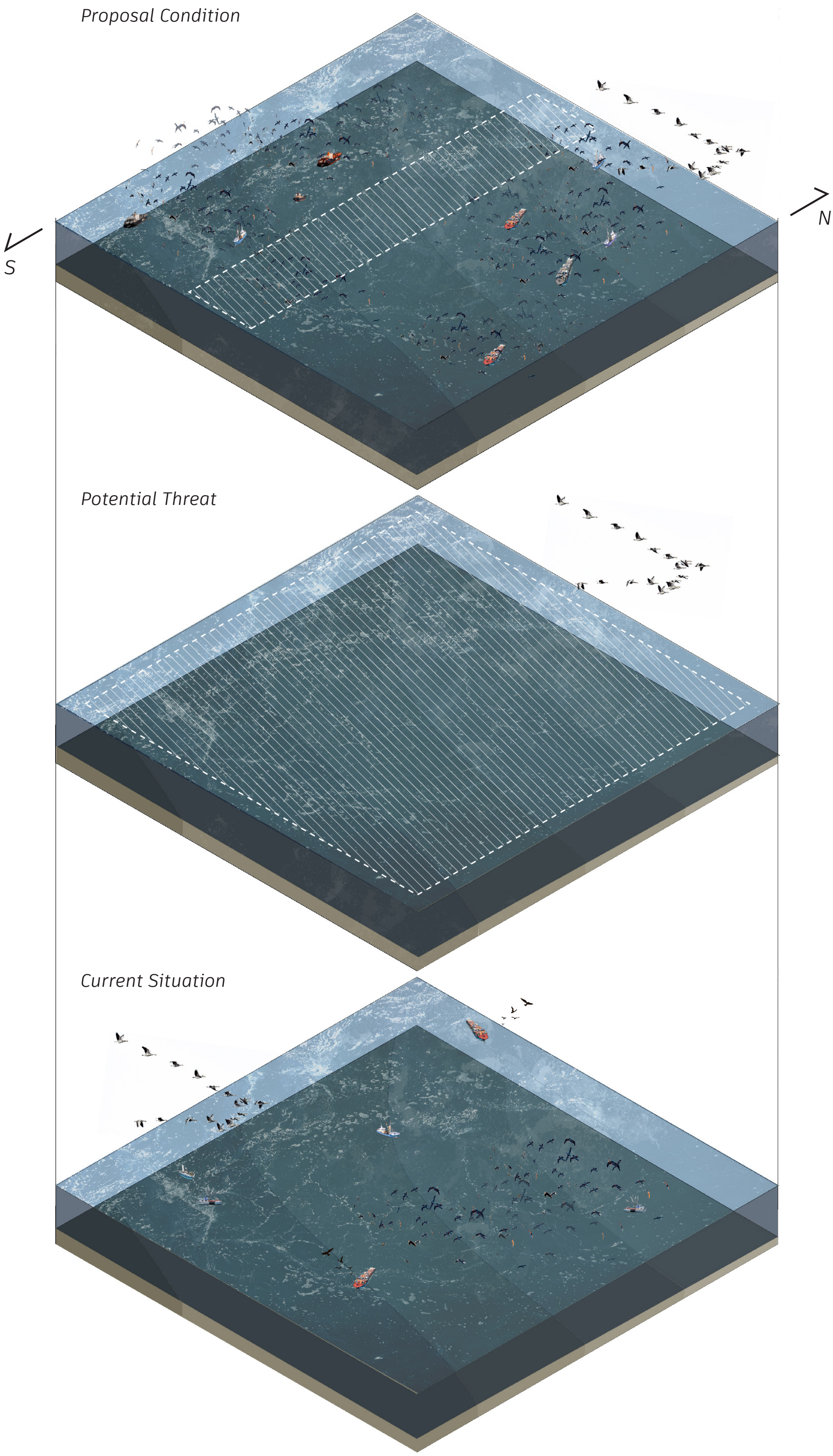


Fig 6.50: Energyscape scenarios: Limited access zone (CC).

CC' Secttion-3: Sea Area 30km Off The Coast

The last zoomed-in site locates in the MR1-2 zone, with many planned off-shore wind farms awaiting assessment for construction plan or implementation, demonstrating the importance of considering environmental sensitivities and potential conflicts.

On the other hand, due to the zoom-in area is also close to the limited access zone and the fact that wind farms here are already proven compared to the first example of the CC section, it is more urgent to take into consideration participatory to create an integrated strategy for the shared space use that includes various maritime activities, avoiding the neglection of the loss from the fisher industry.

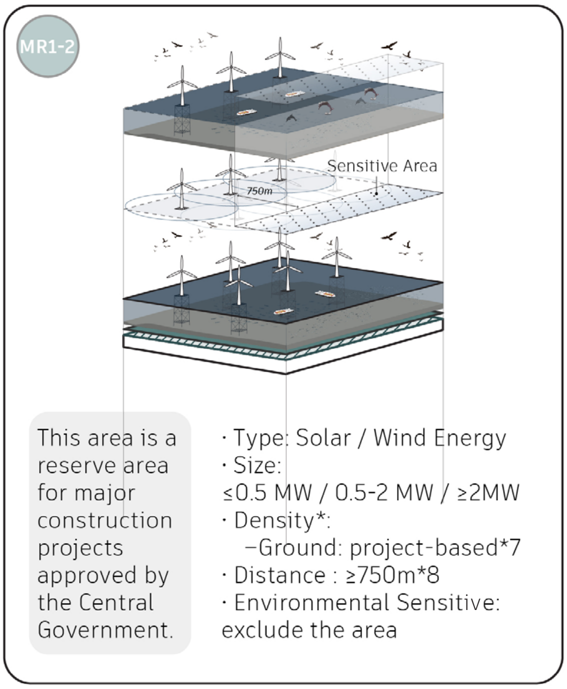


Fig 6.51: Implementation of energyscape template card: MR1-2.

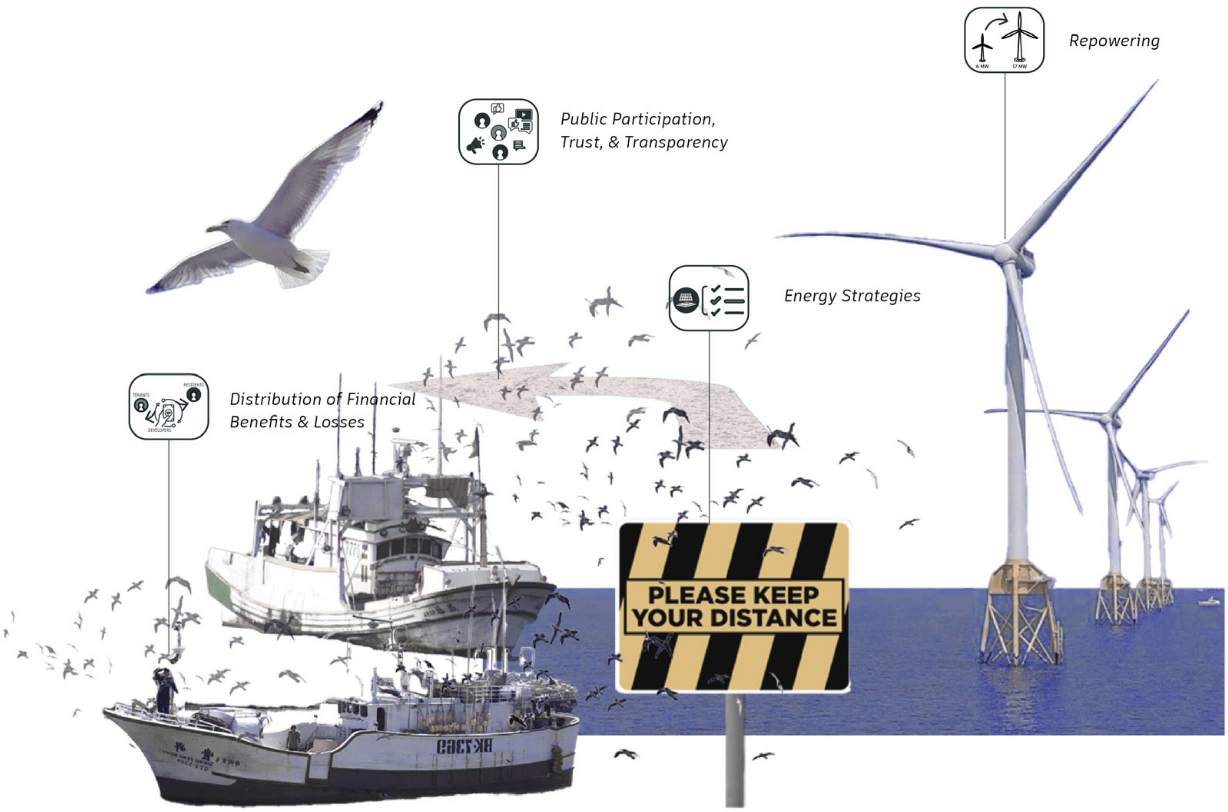


Fig 6.52: Collage of stakeholders and design principles that need to be implemented.

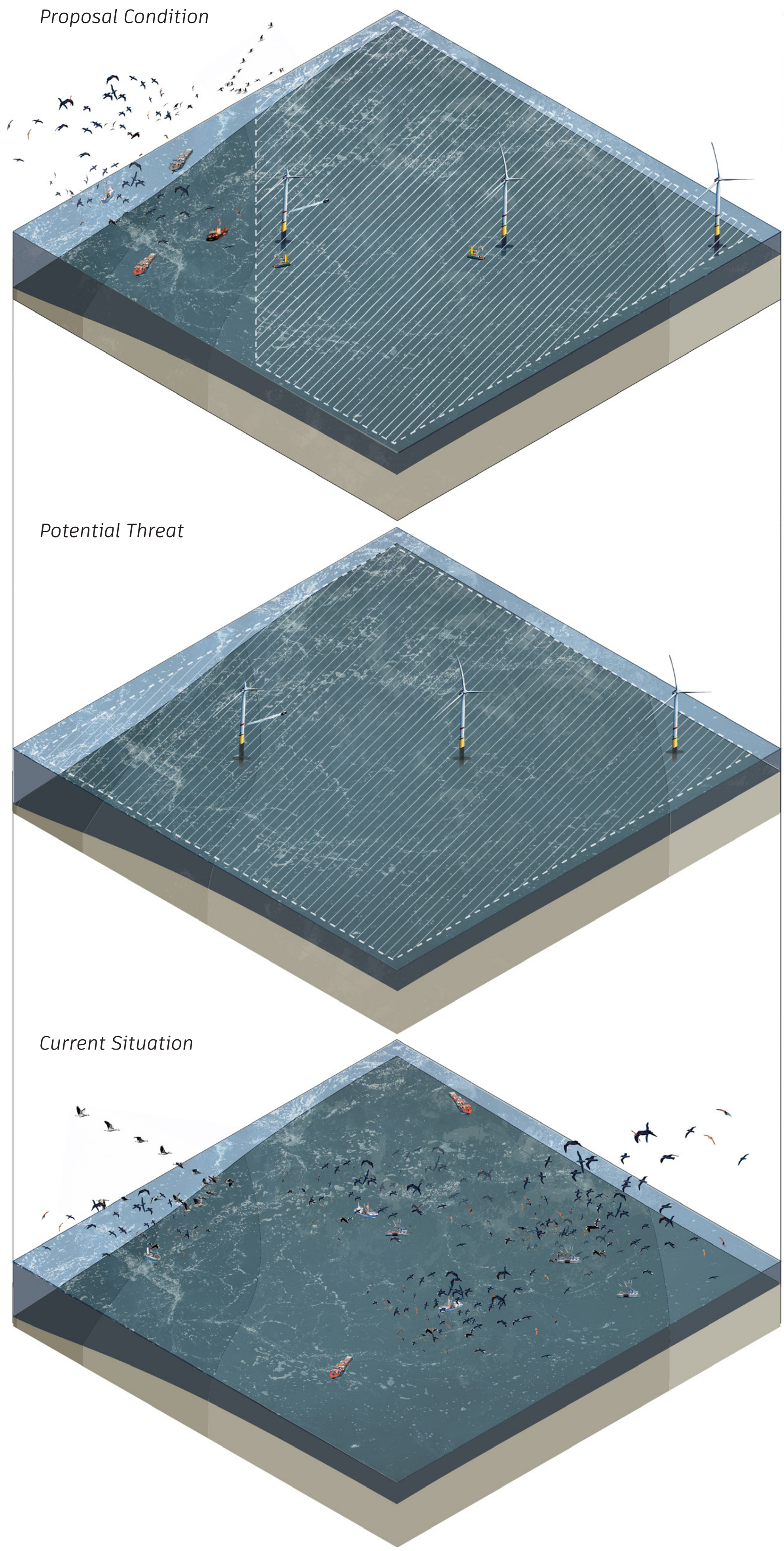


Fig 6.53: Energyscape scenarios: Sea area 30km off the coast (CC).

DD' Section: Fuxing Township–Mixed-Use Area / Lugang Township–Urbanized District

This section across two townships shows the proposed change in the mixed-use area and the highly urbanized district.

The first zoomed-in area locates in Fuxing Township. This site has more complicated first-tier activities than the AA and BB sections. Aquaculture, agriculture, and industrial activities are mixed within the area.

The second zoomed-in is chosen in one of the highest urbanized districts in Changhua County. At the same time, it is one of the most historic districts in Taiwan.

On the other hand, Lugang Township has a more severe natural disaster risk due to high urbanization. Especially when intensive rainfall comes, the historical zone is unavoidable for flooding.

Thus, this section shows the importance of combining natural disaster prevention strategies and renewable energy installation in urban areas simultaneously.

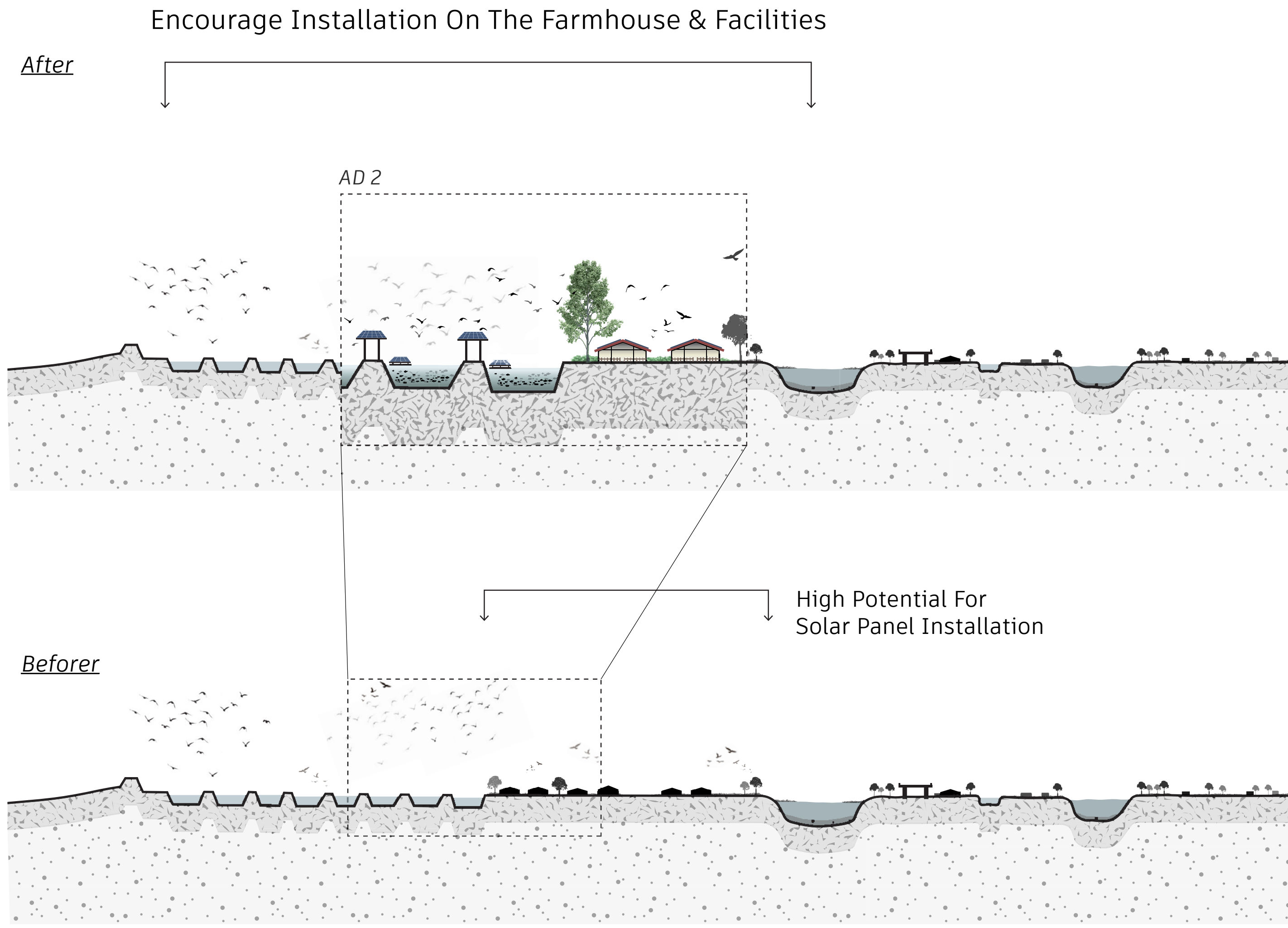


Fig 6.54: Before and after of the zoomed-in scenario: DD section / Fuxing Township–Mixed-Use Area; Lugang Township–Urbanized District

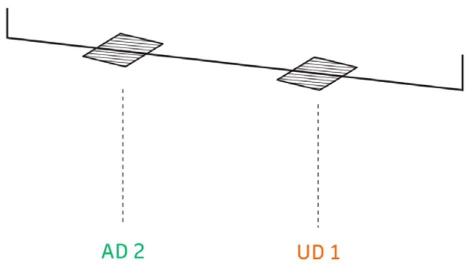


Fig 6.55: Land use zone of zoomed-in areas based on the National Spatial Plan.

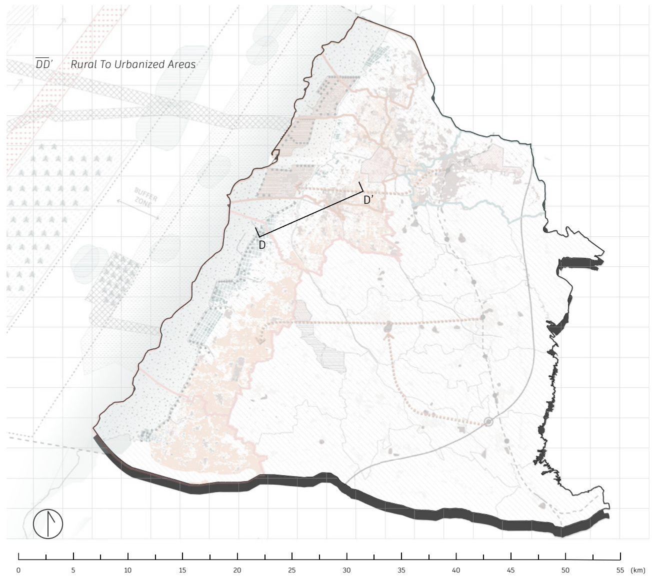
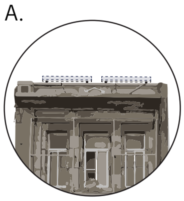


Fig 6.56: Location of the zoomed-in section.

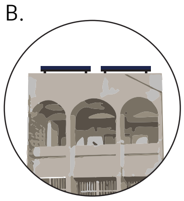
A.



Old Building

-Confirm the feasibility of renovating old houses
-Confirm the safety

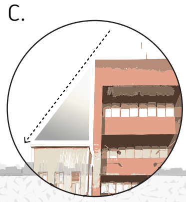
B.



New Building

-Encourage of installation

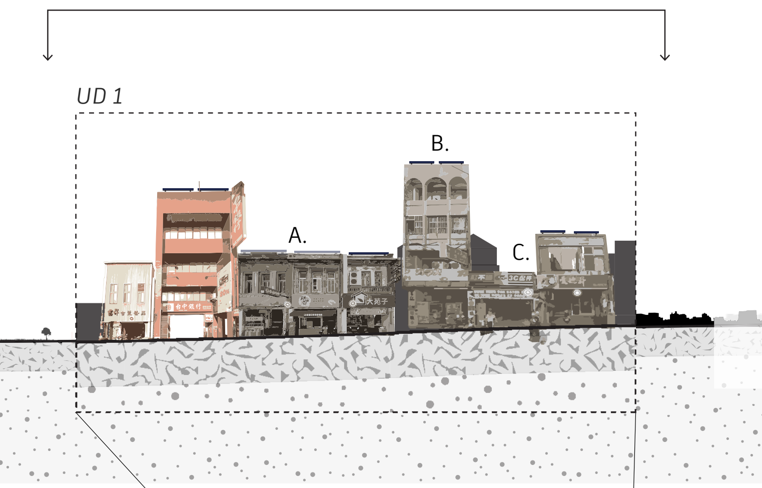
C.



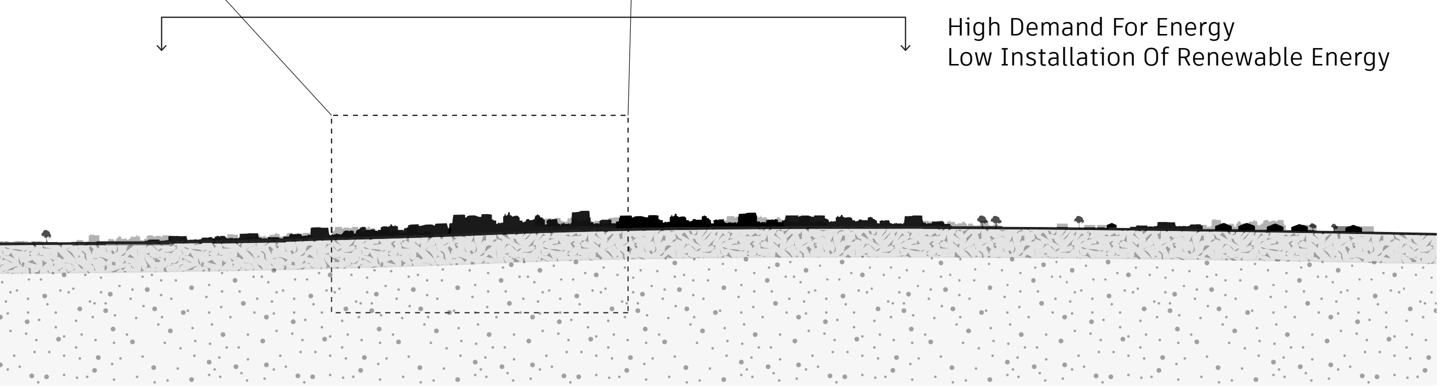
Height Difference

-Consider effectiveness and efficiency

Encourage Installation In Urban Areas



High Demand For Energy
Low Installation Of Renewable Energy



DD' Section-1: Mixed-Use Area

The first zoomed-in site locates in a mixed-use area. Aquaculture, agriculture, and industrial activities are mixed in this 1.6-kilometer-square district. Compared to other AD2 zones in sections AA and BB, this site has fewer ecological sensitivities but more residents.

As a result, the proposed scenario demonstrates the combination of solar panels within aquacultural and agricultural land and encourages the installation in factories and farmhouses. Due to the regulation set in the AD2 zone card of the density of renewable energy installation, it avoids the vast landscape change. But the condition of the site also shows that installing the wind turbine is more difficult in this scenario due to the closer distance from the built environment.

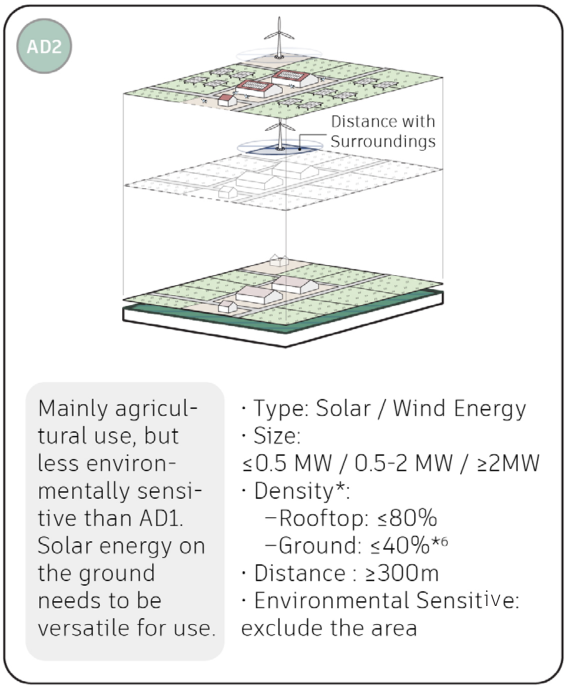


Fig 6.57: Implementation of energyscape template card: MR1-2.

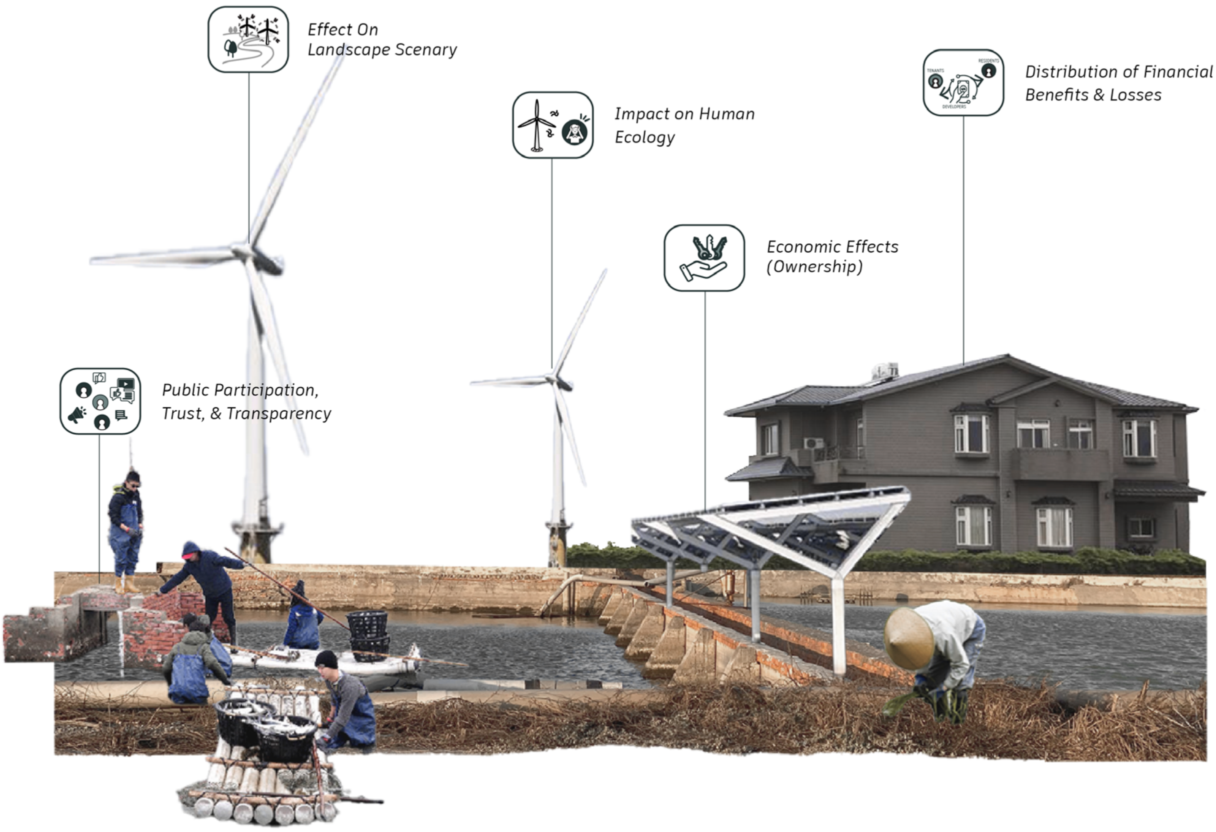


Fig 6.58: Collage of stakeholders and design principles that need to be implemented.

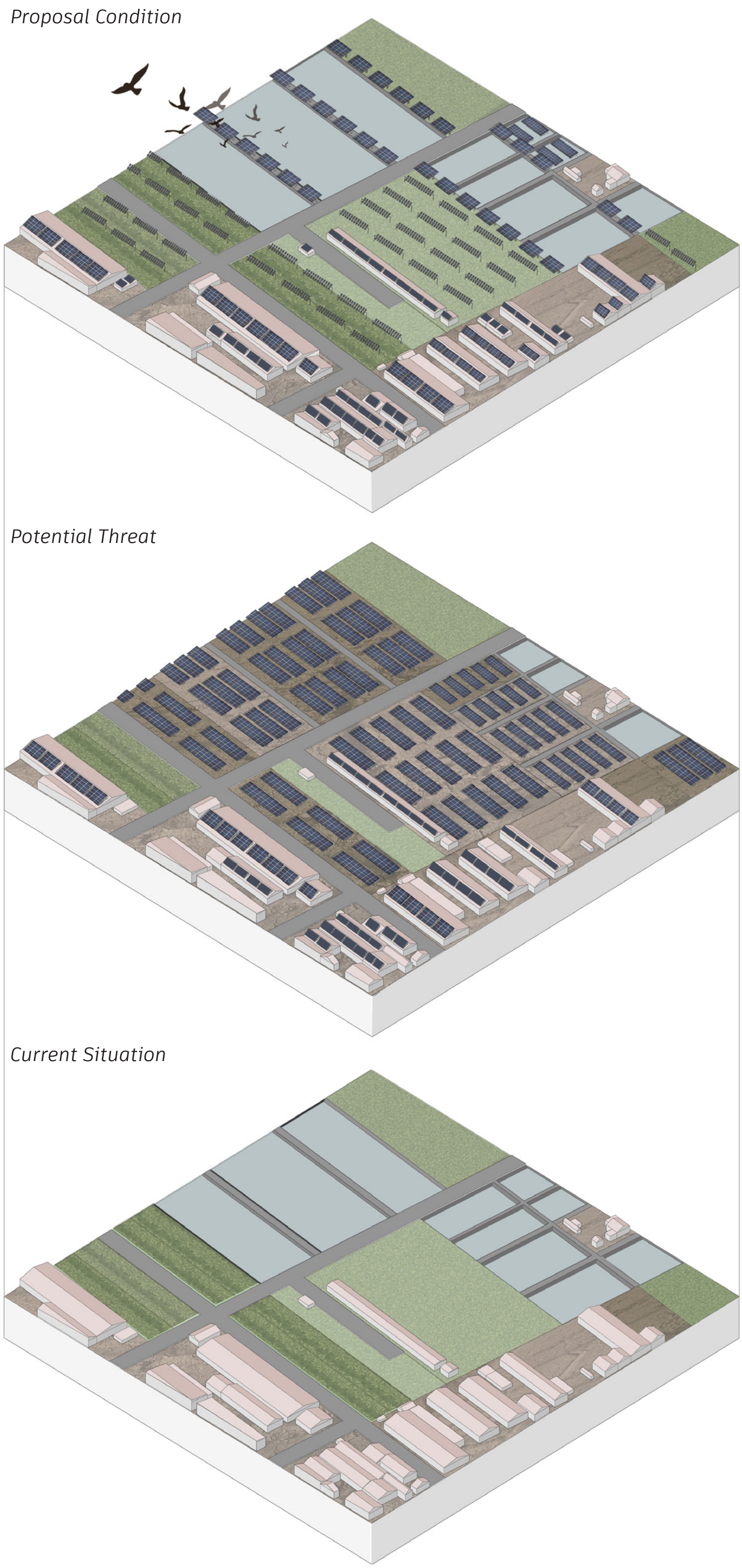


Fig 6.59: Energyscape scenarios: Mixed-use area (DD).

DD’ Section-2: Urbanized District

This zoomed-in area locates in Lugang Township, showing the highly urbanized district with a historic preservation zone. Due to the higher natural disaster risk, especially the flooding risk caused by the intensive rainfalls, this proposal shows the importance of combining the regional strategies (green patches creation) and the renewable energy implementation based on the UD1 card at the same time. Considering historic building conservation, renewable energy installation is only allowed in buildings not defined as historical buildings.

In addition, this section shows different regulations than in rural areas: higher installation density due to lower environmental sensitivity and limited types of renewable energy permits due to higher human ecological impacts.

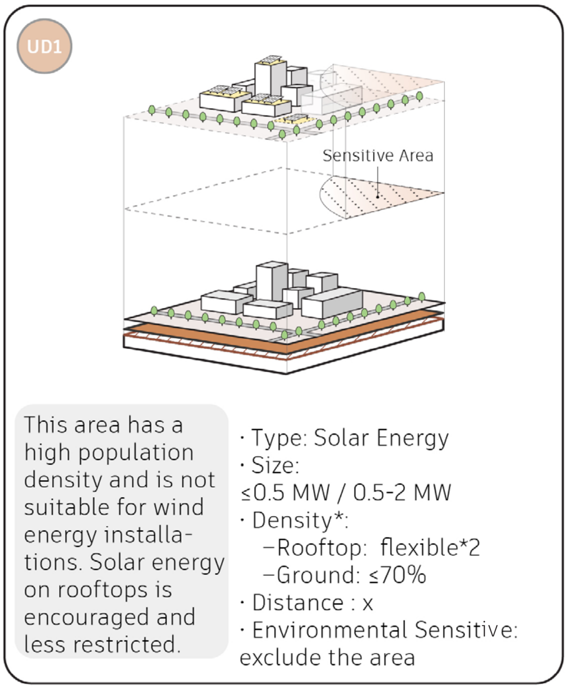


Fig 6.60: Implementation of energyscape template card: MR1-2.

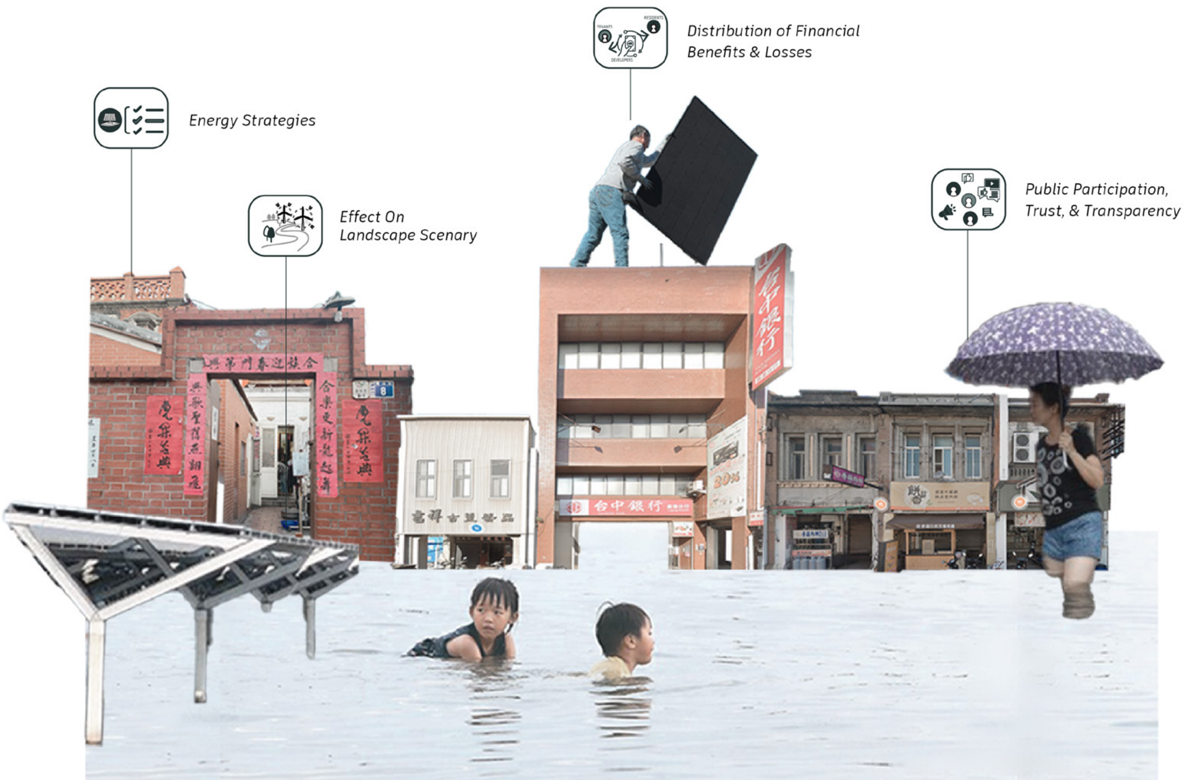


Fig 6.61: Collage of stakeholders and design principles that need to be implemented.

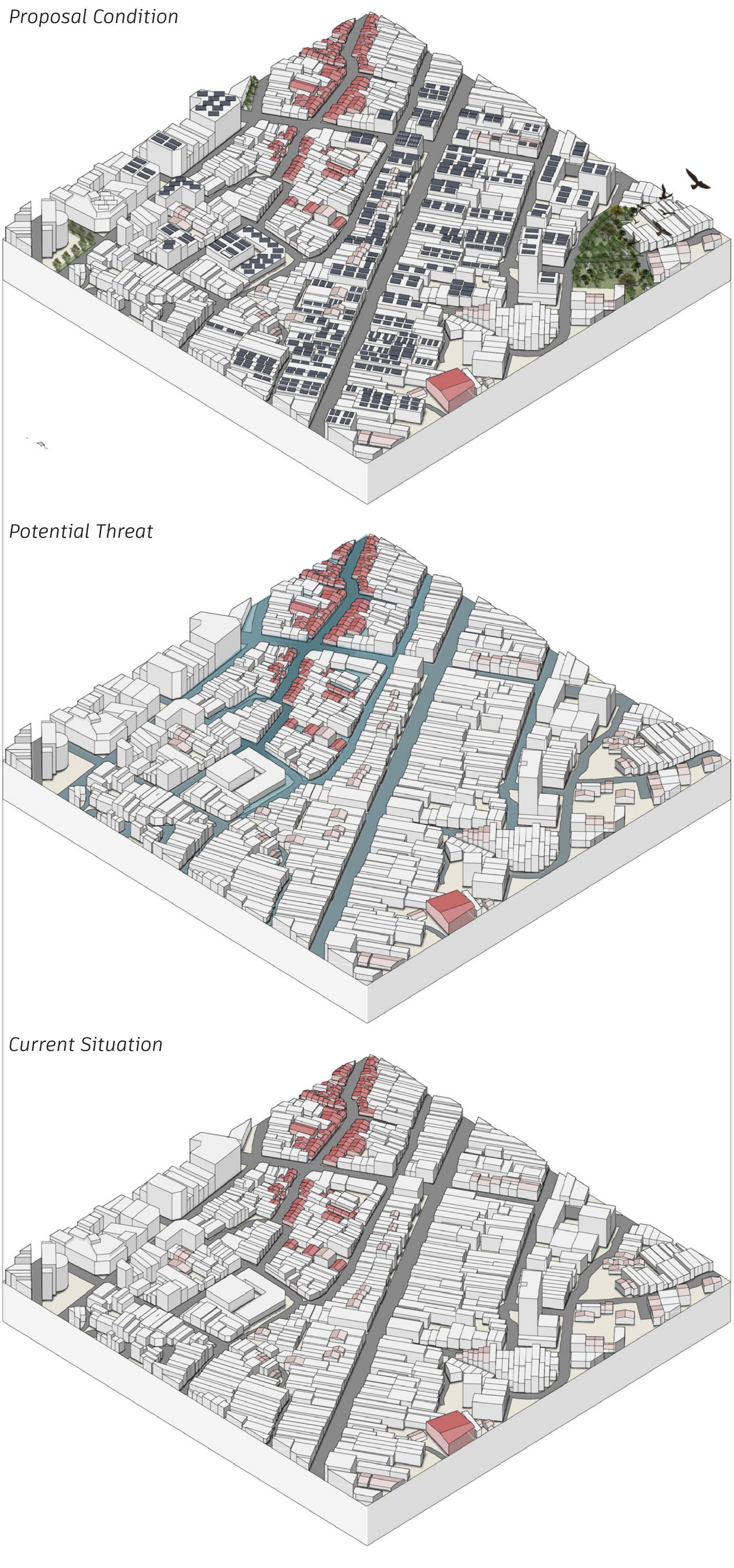


Fig 6.62: Energyscape scenarios: Urbanized district (DD).

EE' Section:
Lugang Township–Industrial Zone & Expected New Development District

The last section locates on the other side of Lugang Township. It exemplifies the change in one industrial zone and an area that is expected to become the new development district in the future regarding the expansion of the urbanized area.

The first zoomed-in section shows the possible combination of renewable energy in the industrial zone. Besides, this area is defined as the UD2-2 zone under the National Spatial Planning.

The second site chosen was an area that currently has a high level of mixed-use residential and agricultural situations.

According to the Changhua County government's prediction and plan, this area is defined as the UD2-3 zone, which means this area is chosen to absorb the expanding urbanized area.

To be more specific, the new residential area or large-scale city project will replace the agricultural lands and other types of activities in lands in the future.

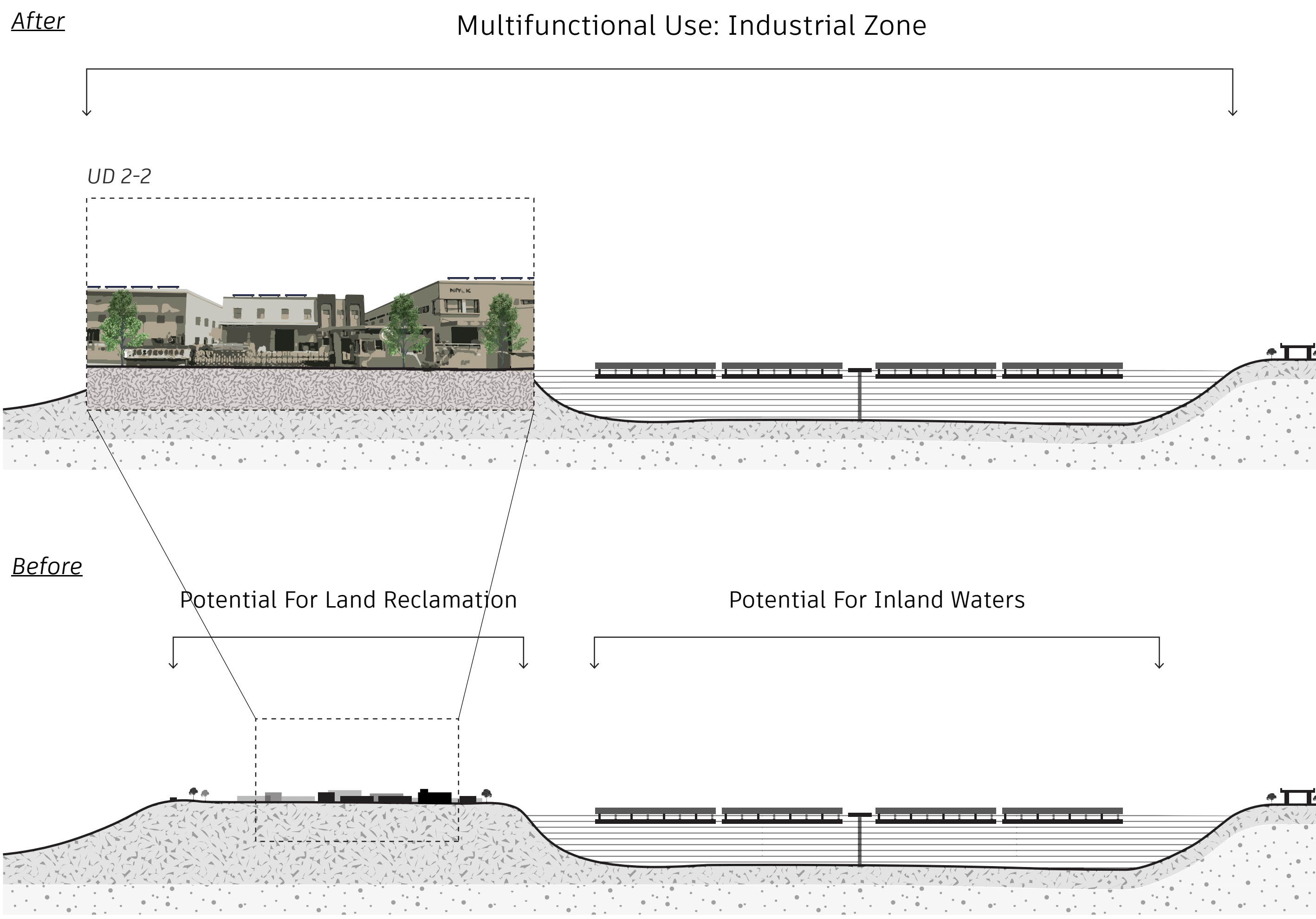


Fig 6.63: Before and after of the zoomed-in scenario: EE section / Lugang Township–Industrial Zone; Expected New Development District

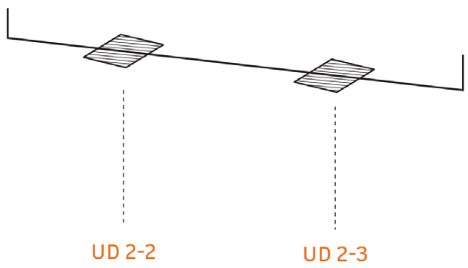


Fig 6.64: Land use zone of zoomed-in areas based on the National Spatial Plan.

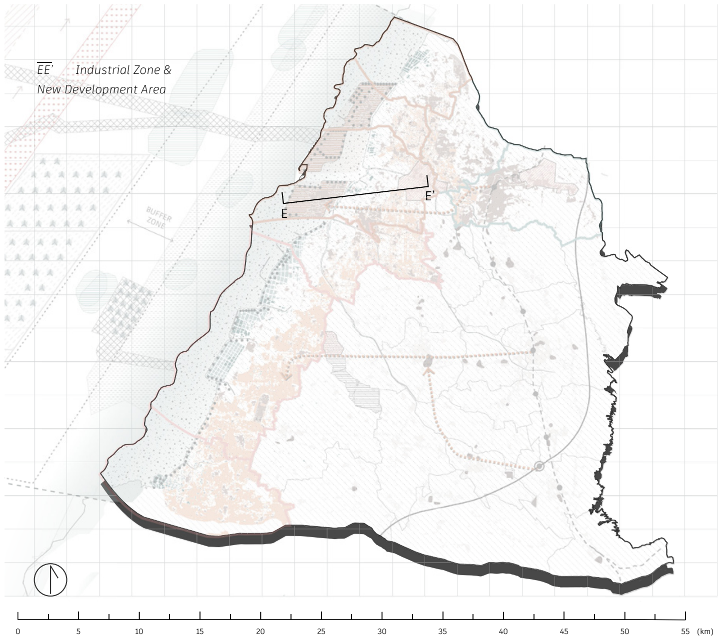
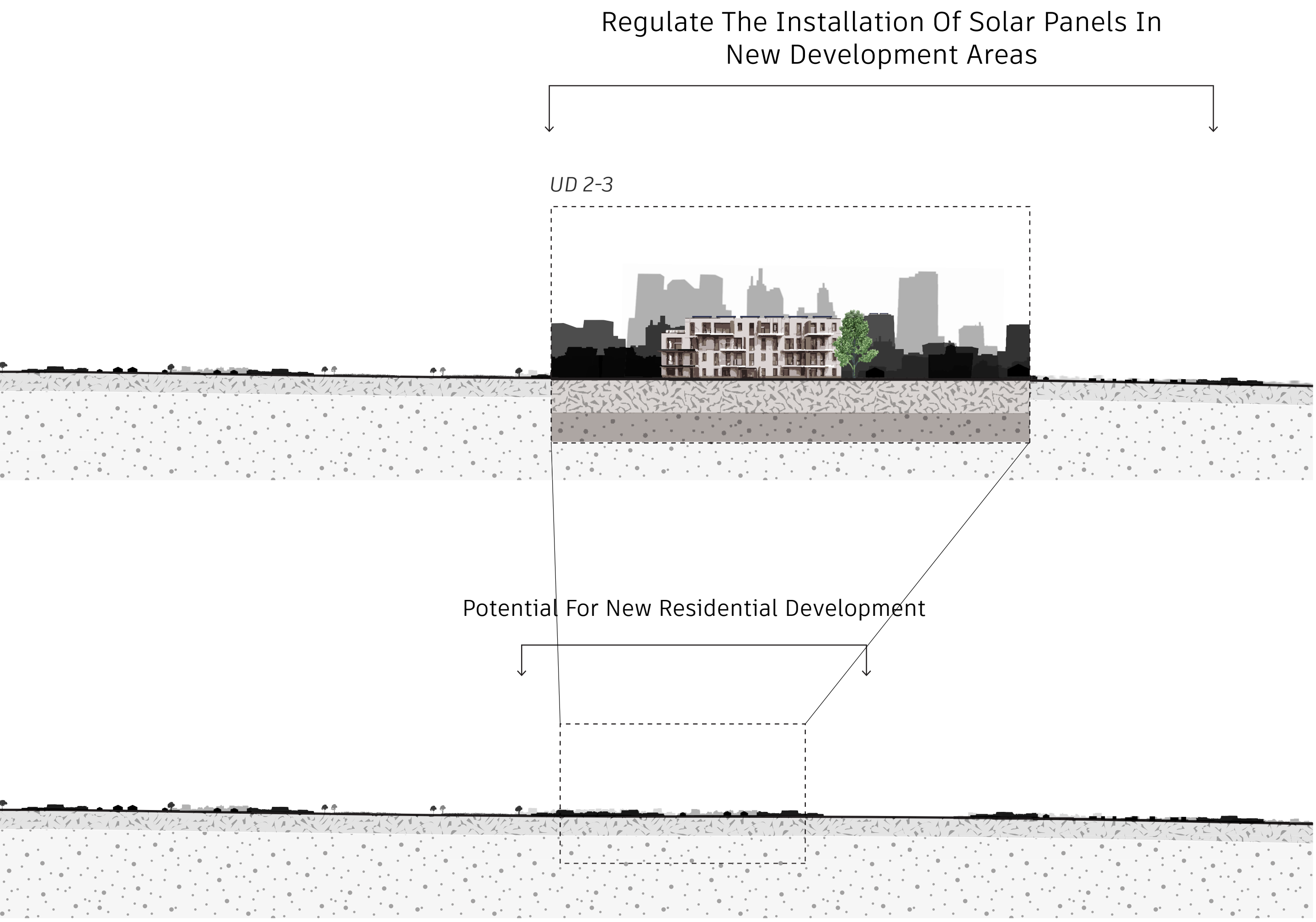


Fig 6.65: Location of the zoomed-in section.



EE' Section-1: Industrial Zone

This site locates in an industrial zone of the reclamation land. Due to the reclamation, more spaces have been made. Yet, due to the urgent need for renewable energy generation, some areas of this industrial zone are already occupied by large-scale solar panels.

Considering that building this industrial park supports the economic development of Changhua County, this rush action contradicts the purpose of this industrial park.

Therefore, the proposed scenario illustrates the ideal combination of renewable energy with factories. It also emphasizes the importance of the planning process, including stakeholders, to develop integrated energy strategies for this large-scale industrial zone with energy development.

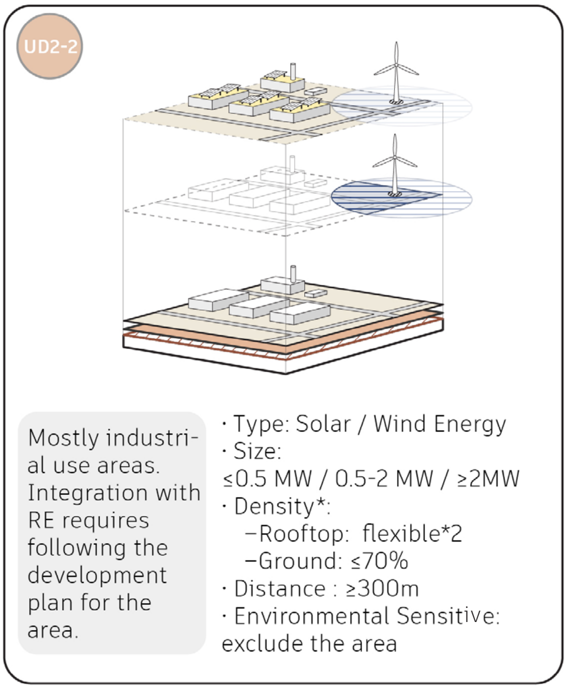


Fig 6.66: Implementation of energyscape template card: MR1-2.

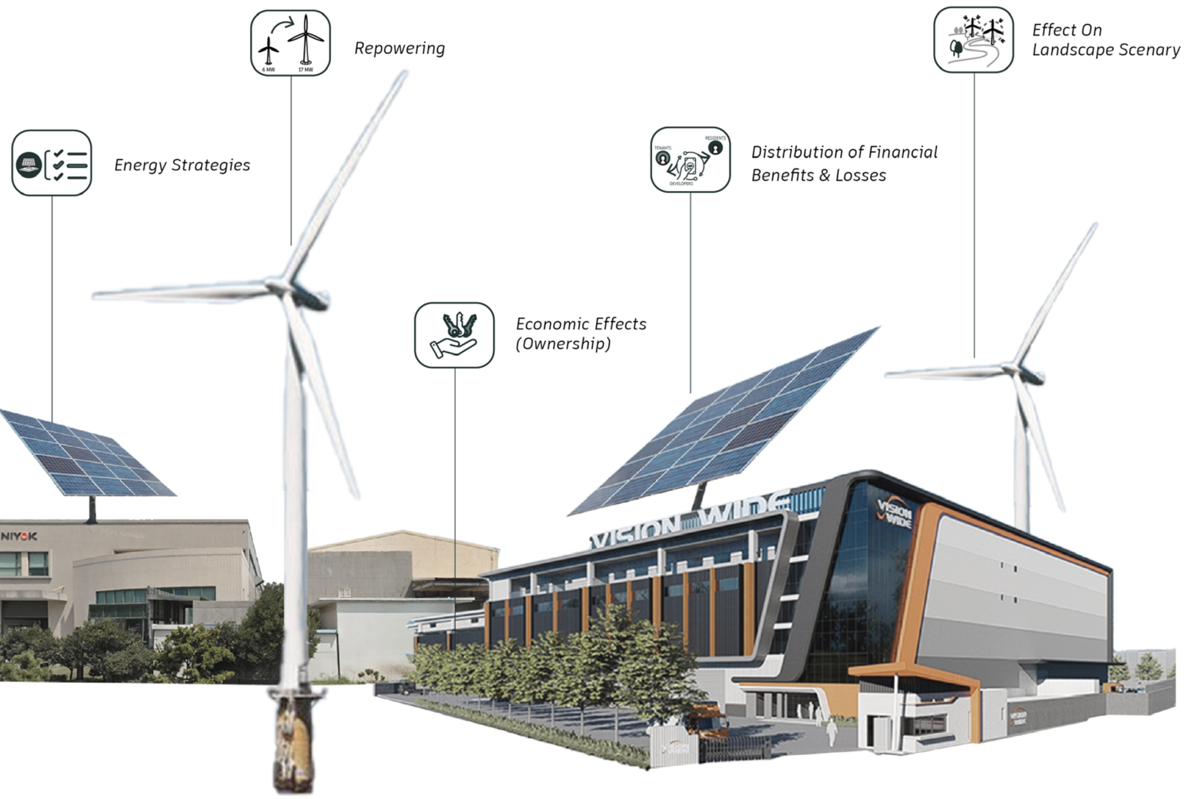


Fig 6.67: Collage of stakeholders and design principles that need to be implemented.

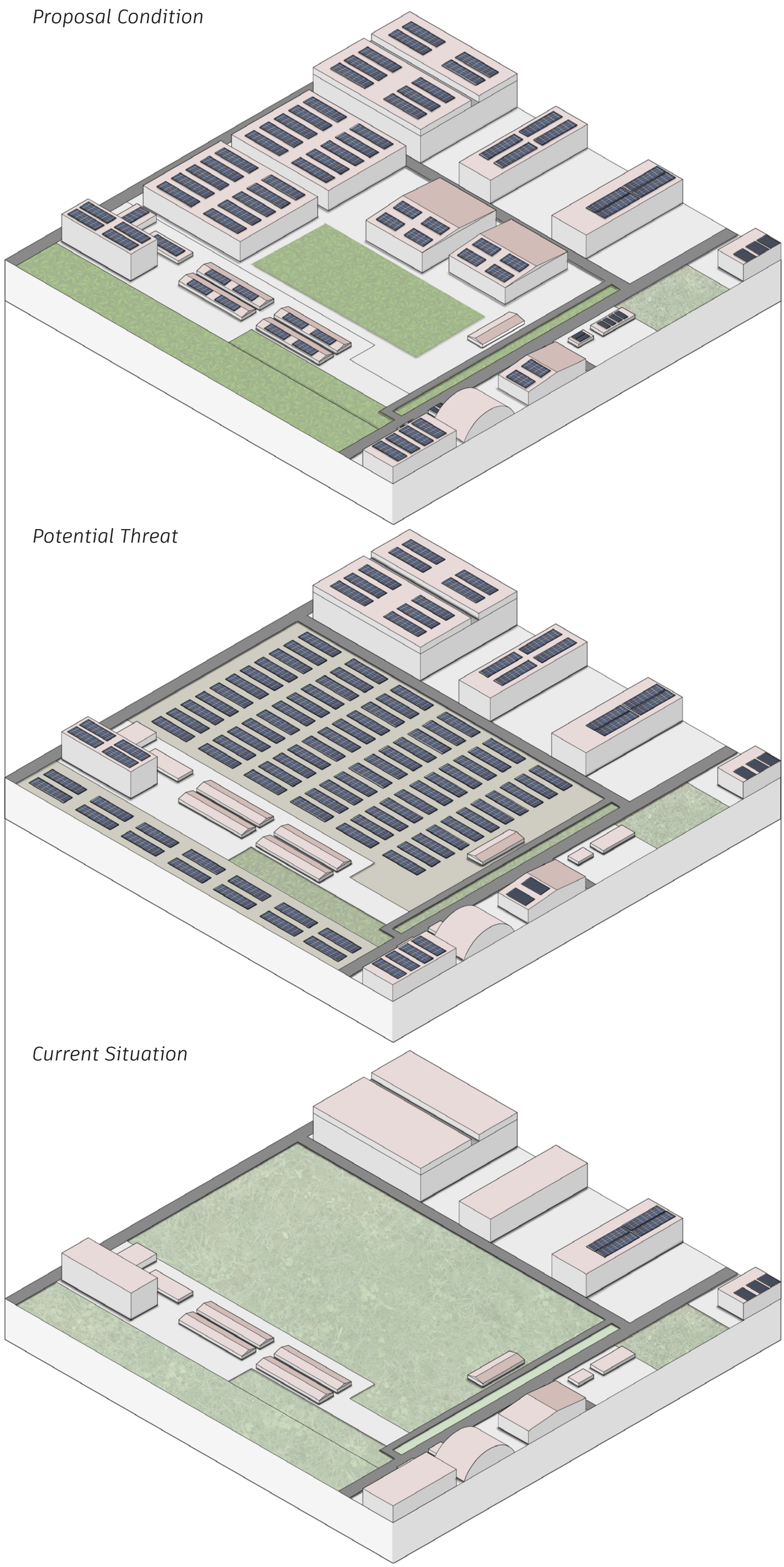


Fig 6.68: Energyscape scenarios: Industrial zone (EE).

EE' Section-2: Expected New Development Distirct

This site locates in the UD2-3 zone, which is expected to develop for futural large-scale projects or residential use. Currently, it is an area with residential and agricultural mixed-use.

The proposed scenario illustrates the possible change and the consideration of building regulations to integrate solar panels in the new buildings. From this, it will raise public awareness of the energy transition and help increase the participatory planning with stakeholders during the process.

Moreover, it prevents the vast landscape change in-between agricultural lands surrounding the built environment, which might cause conflicts between residents and developers.

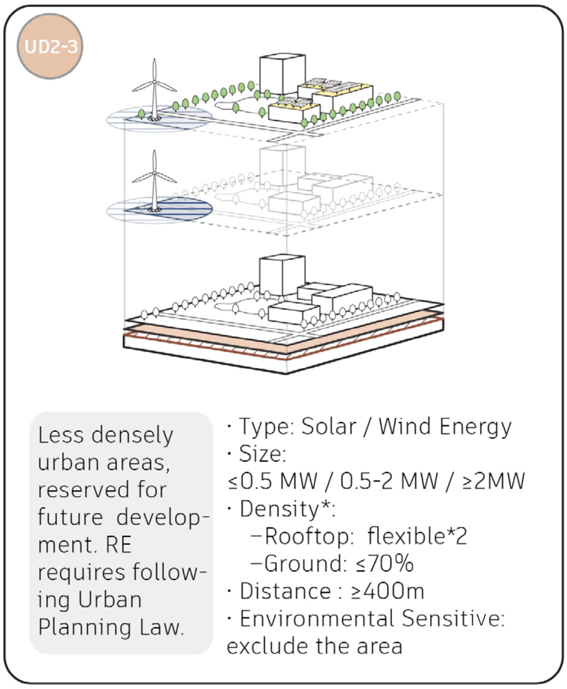


Fig 6.69: Energyscape impact toolbox cards in Urban Development zone

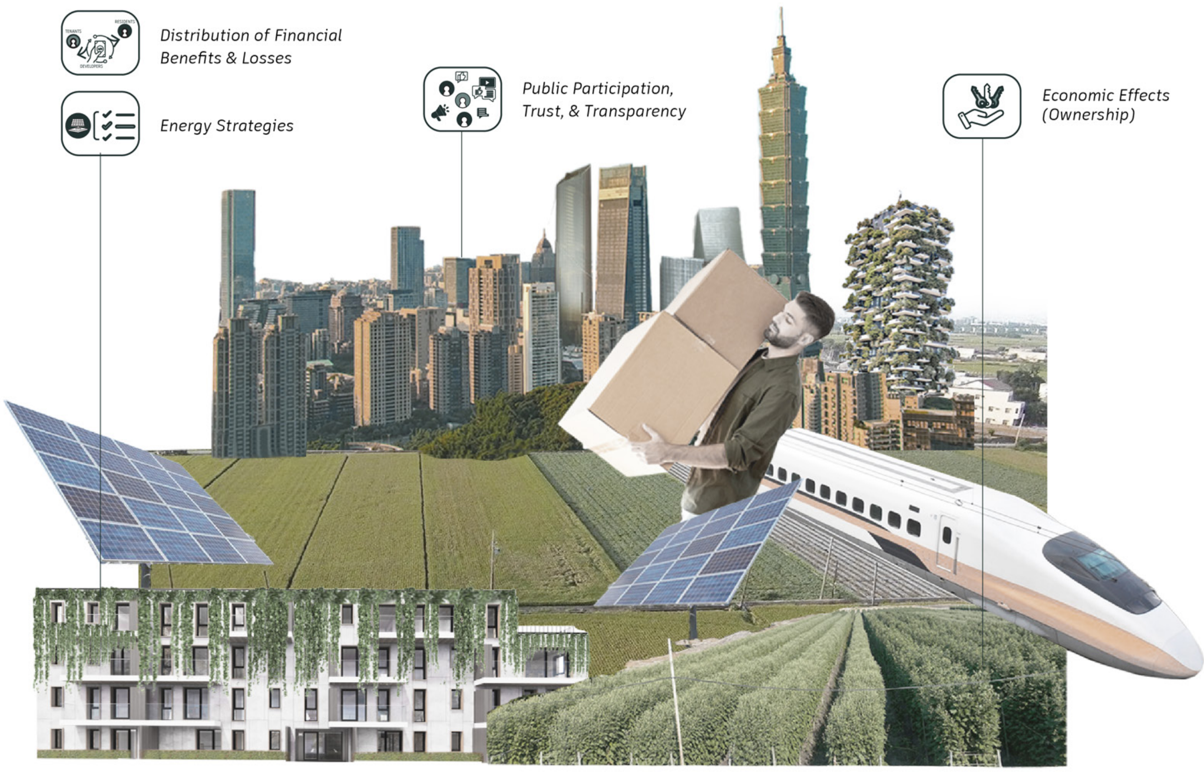


Fig 6.70: Collage of stakeholders and design principles that need to be implemented.

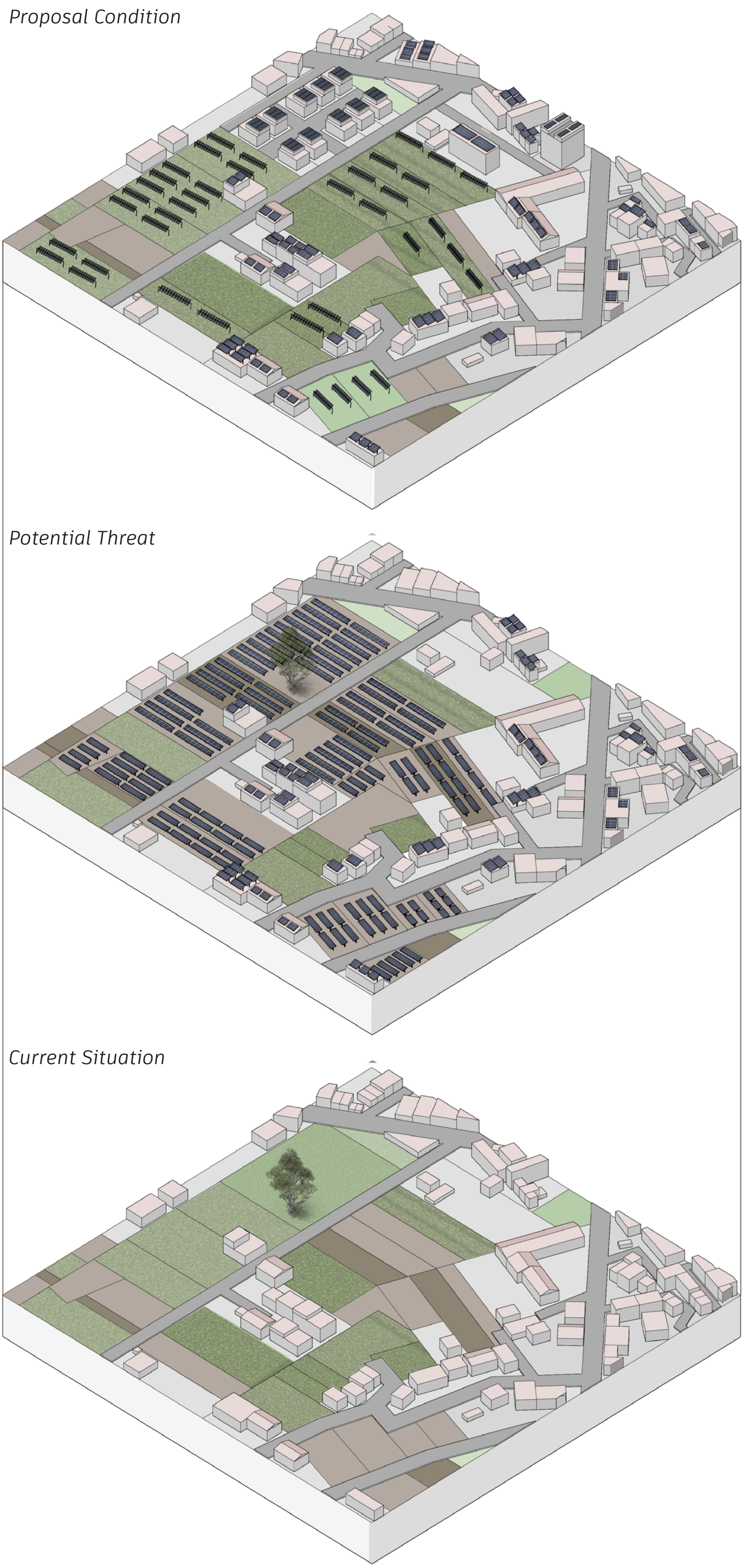


Fig 6.71: Energyscape scenarios: Expected New Development Distirct (EE).

07 Strategies

7.1 Strategies Structure

Value to Strategies

Based on the conceptual framework developed before, three main goals and corresponding values are set:

> **(1) Systemic Reformation: Integration**
> **(2) Spatial Restructure: Adaptability**
> **(3) Social Inclusivity: Inclusivity**

Design principles and detailed developed strategies exemplify values and the vision. Through the different phases, strategies are involved and integrate the impact with others.

Two Townships are chosen to demonstrate the expected outcomes. Spatial strategies illustrate through the map and combined with the governance phases present as a timeline, showing the integration of design.

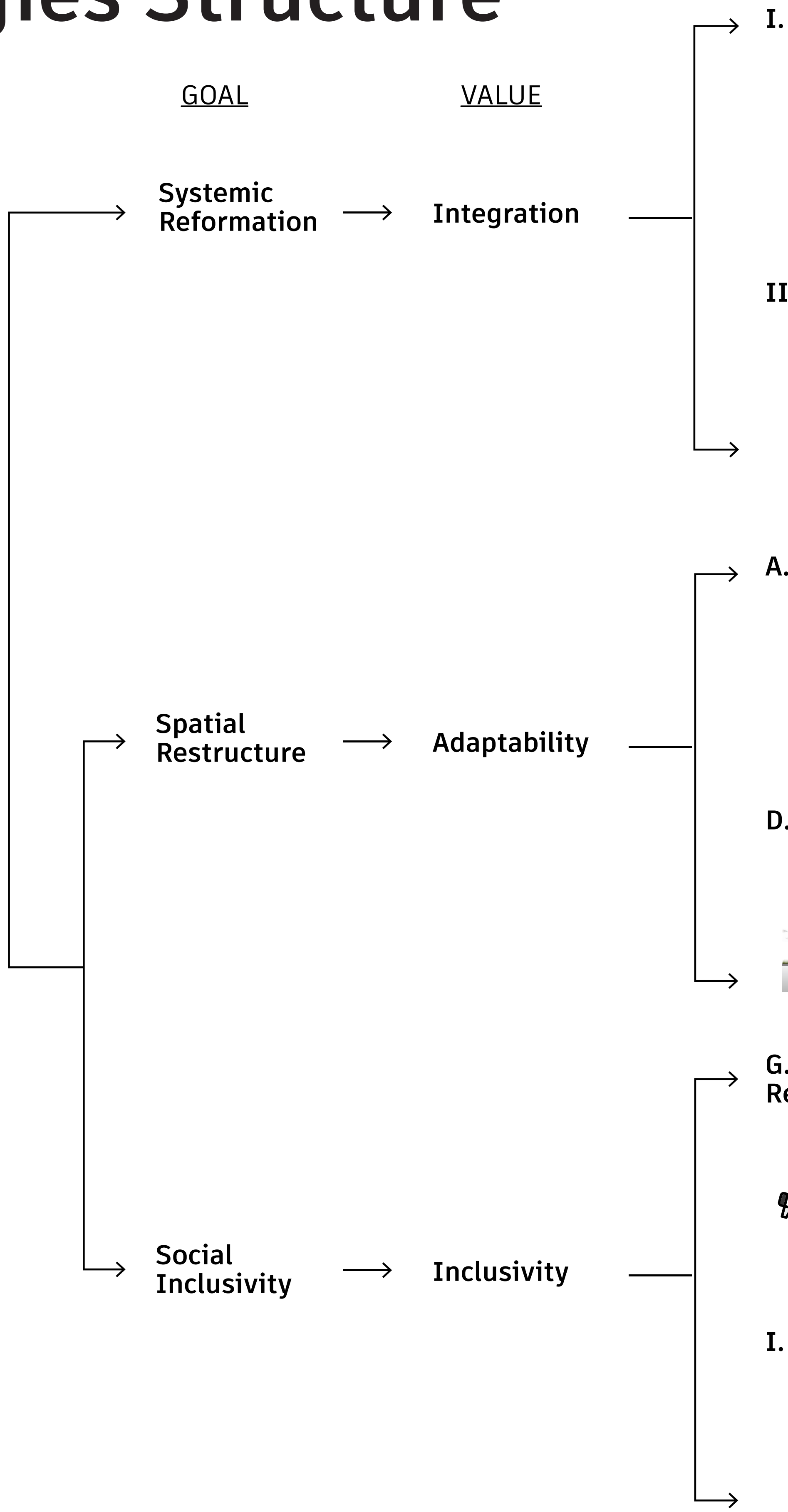
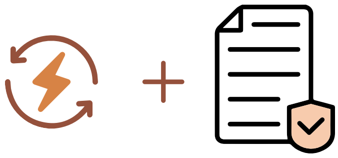


Fig 7.1: Strategies structure: goals, values, and design principles.

DESIGN PRINCIPLES

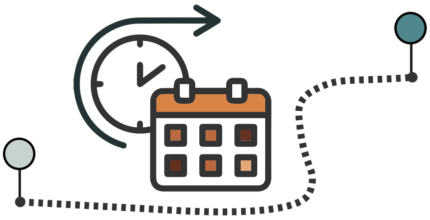
Collaborative Governance

II. Planning & Design Principles & Guidlines

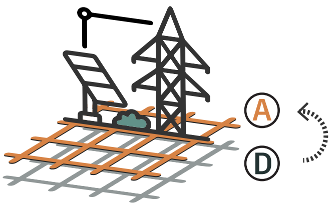


I. Policy Integration

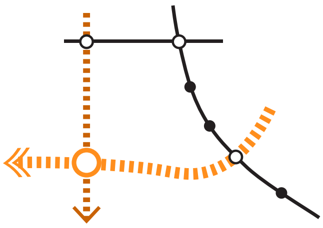
IV.Long-term & Performance Planning



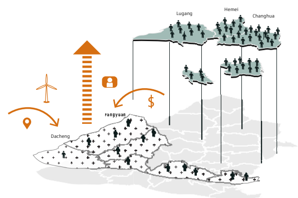
Infrastructure Updated



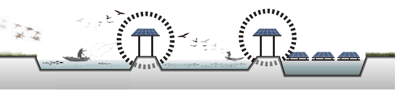
B. Increase Accessiblitiy



C.Equitable Development & Rural Areas Revitalization

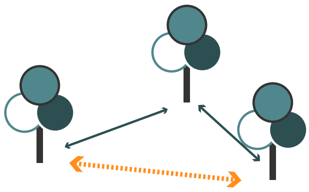


. Multi-functional Land Use



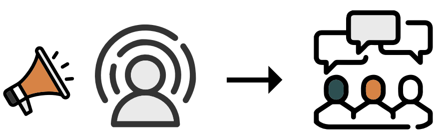
E. Natural Disaster Prevention

F. Green Network

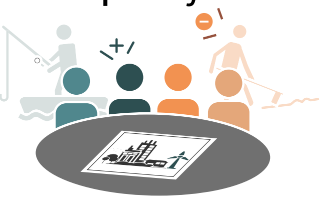


. Popularize & Educate elative Knowledge

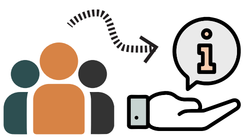
H. Improve Public Awarness



Participatory Process



J. Information Transparency



Principles of System Reform

Institutional reform to create the value of integration can be divided into two main parts: **the rise in power of the planning department** and **the revision of planning tools**. And the principles of building up these two components are explained on the right side.

The first component, **the planning sector's power risen**, means that the energy sector should gain more power at the administrative level due to the responsibility of the energy transition is a national scale project and the need to integrate and collaborate with other central governance sectors (energy sector is now having a level of administrative power lower than the others, causing the difficulties during the collaboration). And building on this, **strengthening horizontal and vertical cooperation** will also solidify policy integration.

Besides, **Planning and design principles and guidelines** can help reinforce vertical governance and improve participatory planning due to a complete and transparent structure for stakeholders' discussions and cooperation.

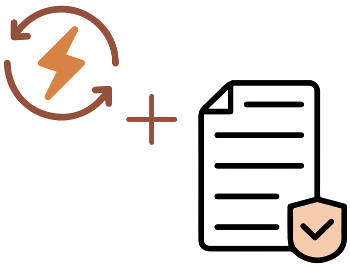
Lastly, building up **long-term and performance planning** is also essential for institutional change. The Taiwanese planning system has been implemented as a conformance planning for years. It has focused mainly on the effectiveness of the goal completion but has put less effort into creating values through plans. That means that due to the need to create a more convincing number of efficiency, the injustice might easily get ignored within the process due to the time and critical performance indicator pressures.

This also highlights the importance of shifting the main core and the purpose of planning and including other perspectives within the planning process to bring out more complicated issues, creating the step for integrating spatial and social attitudes within the process and building the path of creating values for the society.

I. Collaborative Governance

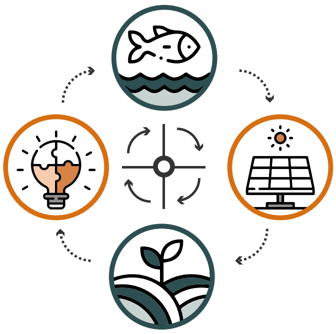
Collaborative governance emphasizes cooperation between sectors. Collaboration is manifested in both horizontal and vertical aspects. Horizontal cooperation refers to work between departments at the same administrative level; vertical refers to partnerships built up by sectors with different powers, which can be seen in the cooperation between central and local governments.

II. Planning & Design Principles & Guidlines



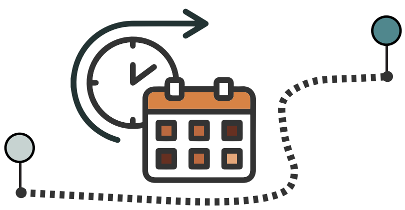
The planning of renewable energy development from the central government should provide planning and design guidance for the local government. Besides, the principle should integrate social, economic, environmental, and spatial considerations regarding the expected impact and potential effect on society and the environment.

III. Policy Integration



Collaborative governance brings sectors to work and exchanges ideas on the same goal. Yet, it is necessary to integrate policy from different domains to bridge the regulatory gap between various fields and support collaboration. The renewable energy policy should include social and environmental perspectives in the energy transition process to prevent potential conflicts and encourage changes that bring benefits.

IV. Long-term & Performance Planning



The energy transition planning should set goals with the expected values that can be brought out through the transitional process in different time zones and scales. The performance planning should build the path toward value creation instead of focusing on the KPI.

Fig 7.2: Principles of system reform.

Adaptive Spatial Strategies

Spatial Strategies correspond to the analysis in Chapter 4. Based on the vision map, six spatial strategies are developed into complex strategic interventions.

Infrastructure updates improve the living environment and increase infrastructure capacity for renewable energy development. Especially the improvement of the grid-compatible capacity is inevitable because it is the critical component to transferring electricity; otherwise, renewable energy generation will be worthless if there is no infrastructure to support it.

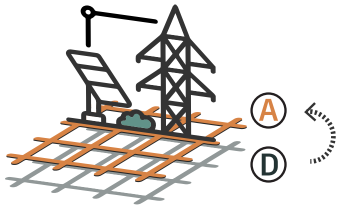
Accessibility increase will boost the movement between townships. This will also improve convenience, attracting opportunities creation. Transportation improvement also helps balance the development within districts.

The strategy of **equitable development &rural areas revitalization** emphasizes creating an identity for districts. Identity for an area will make further plans more specific, increasing the chance of investment and staying. For example, a research hub will not only increase the research capacity; it also provides a space for recreation and education for residents and tourists. On the other hand, this strategy also highlights the importance of combining renewable energy within the new-built environment. Through the system setting for mandatory, urban areas will start to integrate better with renewable energy development.

Multifunctional land use is a high-potential intervention to improve land use wisely and clearly. The main problem causing conflicts through the transitional process is the unclear regulation regarding the land use permit. Due to the light limitation of the land use type change and the activities on different land use types, many farmlands and aquacultural lands have been changed into only renewable energy generation use, threatening the landscape, ecosystem, renters' rights to work, and food security issues. Thus, these strategies emphasize creating the best combination of the original activities and renewable energy generation through the completed experiments as the scientific support. Even though these interventions take time to get the best results and need to adjust based on the location's condition, these actions must be taken step by step with an amount of control through phases.

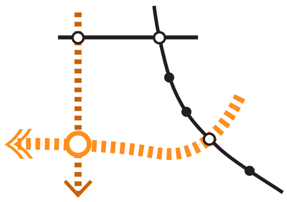
Lastly, **Natural disaster prevention** and **green network creation** are two main strategies for highly urbanized areas. Due to the built environment leading to more intensive disaster risk and less capacity to deal with hazards, these strategies are developed to deal with the most urgent risk, flooding caused by intensive rainfalls. Besides, green network creation can also simultaneously reduce the heat island effect, especially since the density of green space in Changhua County is limited.

A. Infrastructure Updated



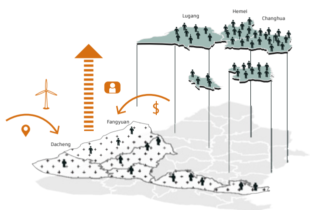
A1 Substation Building
A2 upgrade grid-compatible capacity
A3 Building retrofitting
A4 Drainage improvement

B. Increase Accessibility



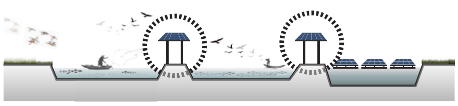
B1 Create public transportation line
B2 Create station
B3 create (strengthen) connection

C. Equitable Development & Rural Areas Revitalization



C1 Establish RE research hub
C2 Pilot site building
C3 Establish local RE museum
C4 RE installation in new-built project
C5 New residential area development

D. Multi-functional Land Use

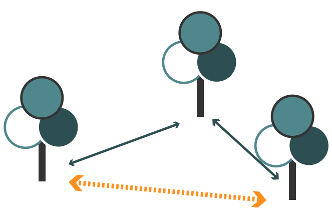


D1 RE in urban area
D2 RE in the industrial area
D3 RE in the aquaculture land
D4 RE in the agriculture land

E. Natural Disaster Prevention

E1 Strengthen dike
E2 Flood wall
E3 Wetland conservation (creation)
E4 Fish farms preservation

F. Green Network



F1 Create green patches
F2 Reservoir park
F3 Eccological park
F4 Creation of green connection
F5 Funtional rooftop

Fig 7.3: Adaptive Spatial Strategies.

Inclusive Social Strategies

In order to increase the inclusivity of society within the energy transition process, it is essential to intervene through different phases and strategies. Four main methods are developed to strengthen the transformation.

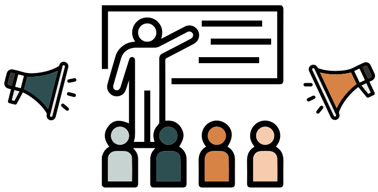
Popularizing and educating relative knowledge is a strategy that focuses on integrating renewable energy into the education system. The integration should start in the early stage of education, so the capacity to cultivate talents for the renewable energy industry can increase in the long term. On the other side, **improving public awareness** of the energy transition can increase the willingness for a participatory planning process. For example, holding an annual renewable energy conference offers technical knowledge and academic research exchanges; it also allows the public to evaluate the multifunctional use of renewable energy based on location.

On top of this, establishing a carbon tax system will be another critical step for the energy transition. This strategy will not only force the industries to adjust their business models that integrate the energy transition perspective to share the responsibility of energy generation but also merge into the international system in terms of carbon emission regulation and governance.

Participatory processes encourage stakeholders to join the planning process. Under this principle, cross-sector collaboration means that stakeholders can join the design phases based on projects, expressing their opinions and integrating their proposals within the projects. So on, the assessment meeting for the project can become more complete and have a discussion base to gain a more solid evaluation. Besides, regular citizen meetings highlight the societal issue and encourage people to provide their suggestions for policy making.

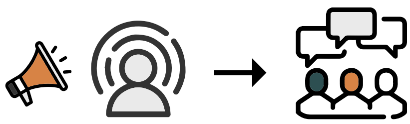
The last principle is to **increase information transparency**. The current public data is unorganized and separated within several websites with different data management and collection orders based on cities. Open databases should include more complicated perspectives and integrate data within a central website that can lead to specific databases. On top of this, a central standard to clarify the data in terms of collection and management content should also be built to create a nationwide or regional scale analysis. Besides, it is also essential to connect the dataset locally to collect the experimental results of the multifunctional land use within different areas for further strategies development use.

G. Popularize & Educate Relative Knowledge



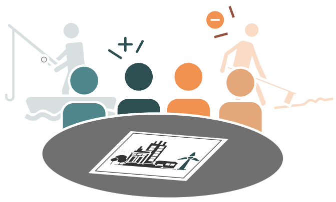
G1. Integrate RE knowledge in early education
G2. Promote highskill RE study and certification
G3. Establish local RE museum
G4. Pilot site building

H. Improve Public Awarness



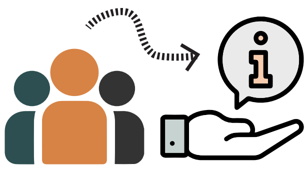
H1. Held annual RE conference
H2. Citizen meeting
H3. Physical and online promotion of RE issues
H4. Establish carbon tax
H5. Shift from carbon fee to carbon tax

I. Participatory Process



I1. Citizen meeting
I2. Stakeholder interviews & consultancy
I3. Cross-sectors collaboration workshop
I4. Cross-sectors assessment meeting

J. Information Transparency



J1. Open RE data (spatial, social, economic, environmental, & adminitrative)
J2. RE multifuntional use monitoring
J3. Integrated RE information website
J4. Consultancy of RE in local
J5. Exchange information with citizen

Fig 7.4: Inclusive Social Strategies.

7.2 Regional Strategies: Lugang Township

Preventive RE for Synergy

This township demonstrates the strategies of preventive and synergy RE of the vision. Due to the highly urbanized condition, there has a higher disaster risk, especially flooding caused by the intensive rainfall.

Therefore, the main goal for this zoomed-in area is to prioritize disaster prevention, building up a safe environment for further intervention, and installing renewable energy. Furthermore, Lugang Township has half of the industrial reclamation park along the coastal line, providing tremendous opportunities to support offshore wind activities.

Implementing different spatial and social strategies through phases will develop a place with a better capacity for natural disaster risk and renewable energy generation. Strategies settings are built on the base of the systemic changes shown on the previous page (integrated system reform principles).

Detailed strategies of implementation through phases are presented in the following pages. Different colors represent different principles of spatial strategy type. On the other hand, social strategies are present in the diagram corresponding to the actions in spaces.

Fig 7.6: Preventive RE for Synergy map in Luga

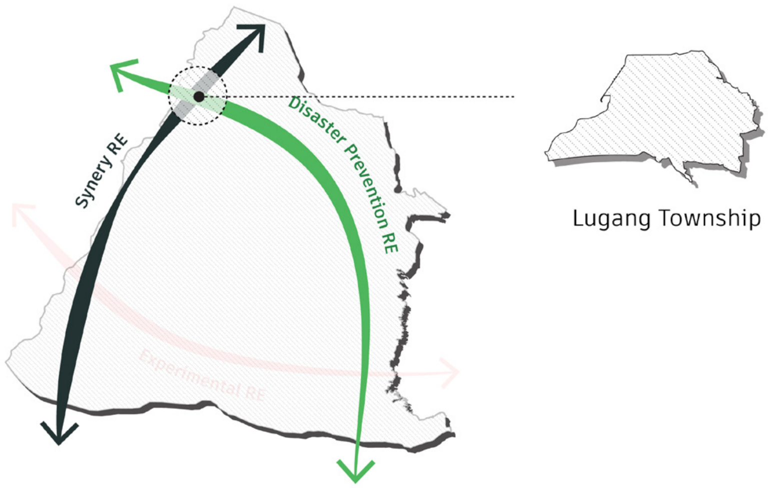
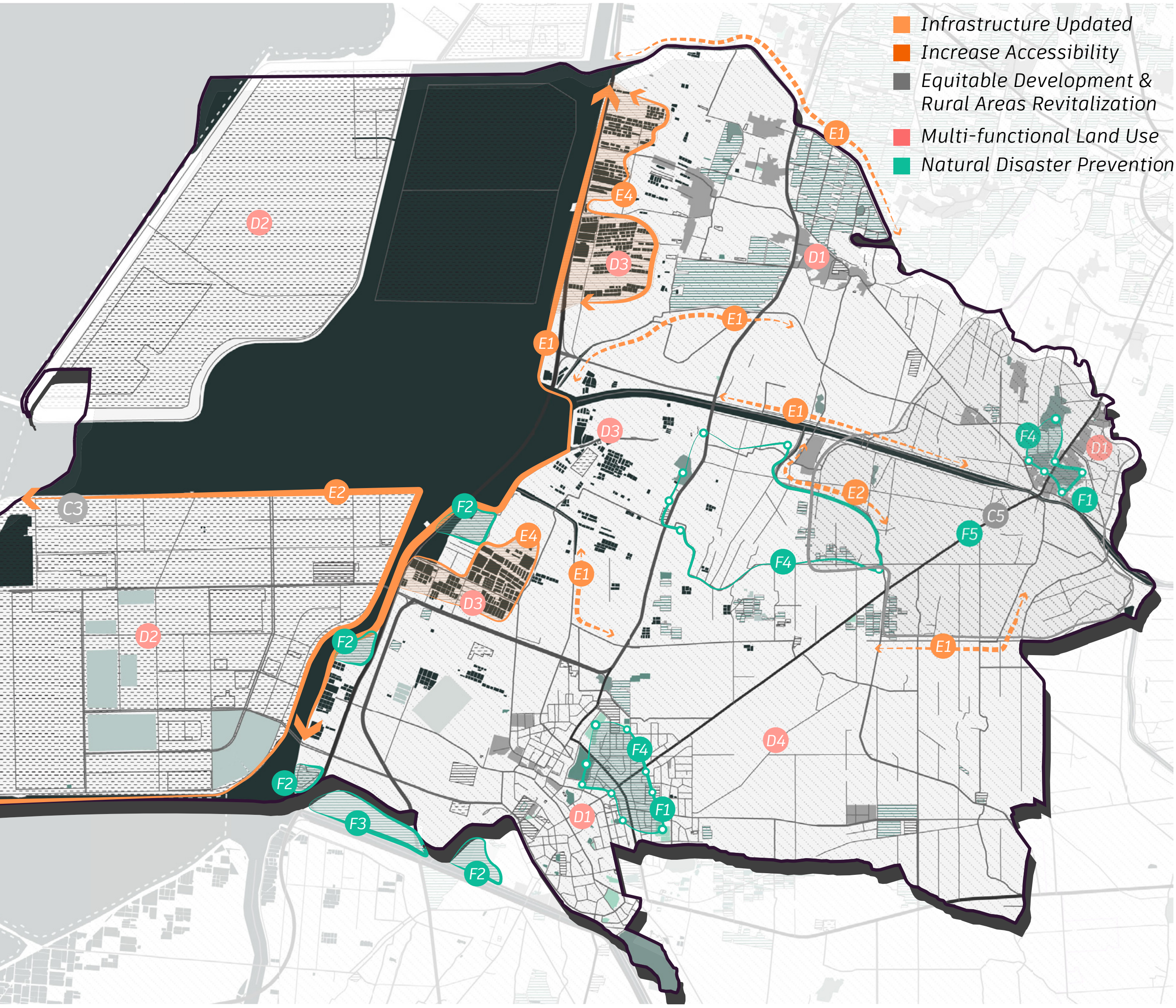


Fig 7.5: Strategy location: Lugang



ng Township.

Phase I – 2025: Preparation Stage

Spatial strategies in the first phase focus on the infrastructure update in order to build up a solid base for renewable energy combination in the next step, such as increasing disaster prevention capacity to strengthen dikes, flood wall building, and green patch creation within urbanized areas.

On the other hand, social strategies focus more on increasing information transparency and public awareness to build up recognition within society for further participation and preparation for integrating relative knowledge into the education system.

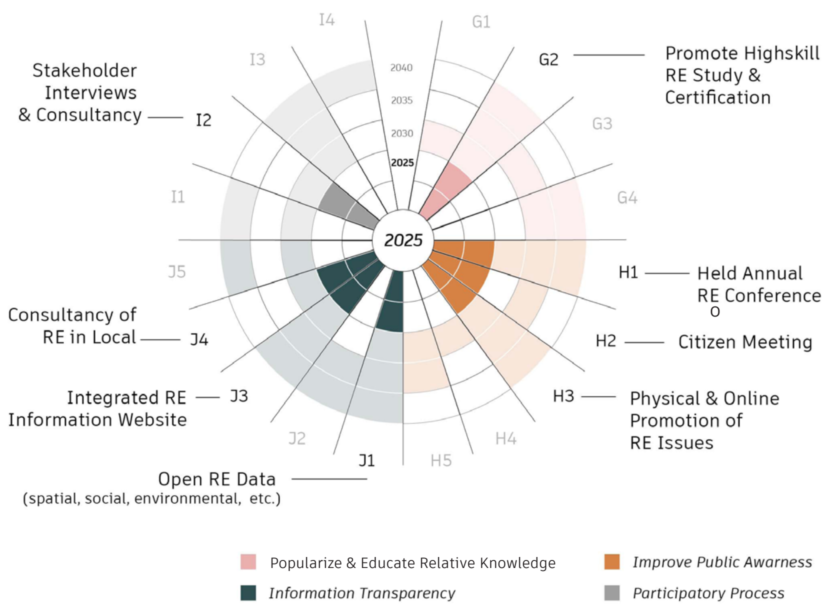


Fig 7.7: Social Strategies: phase 1.

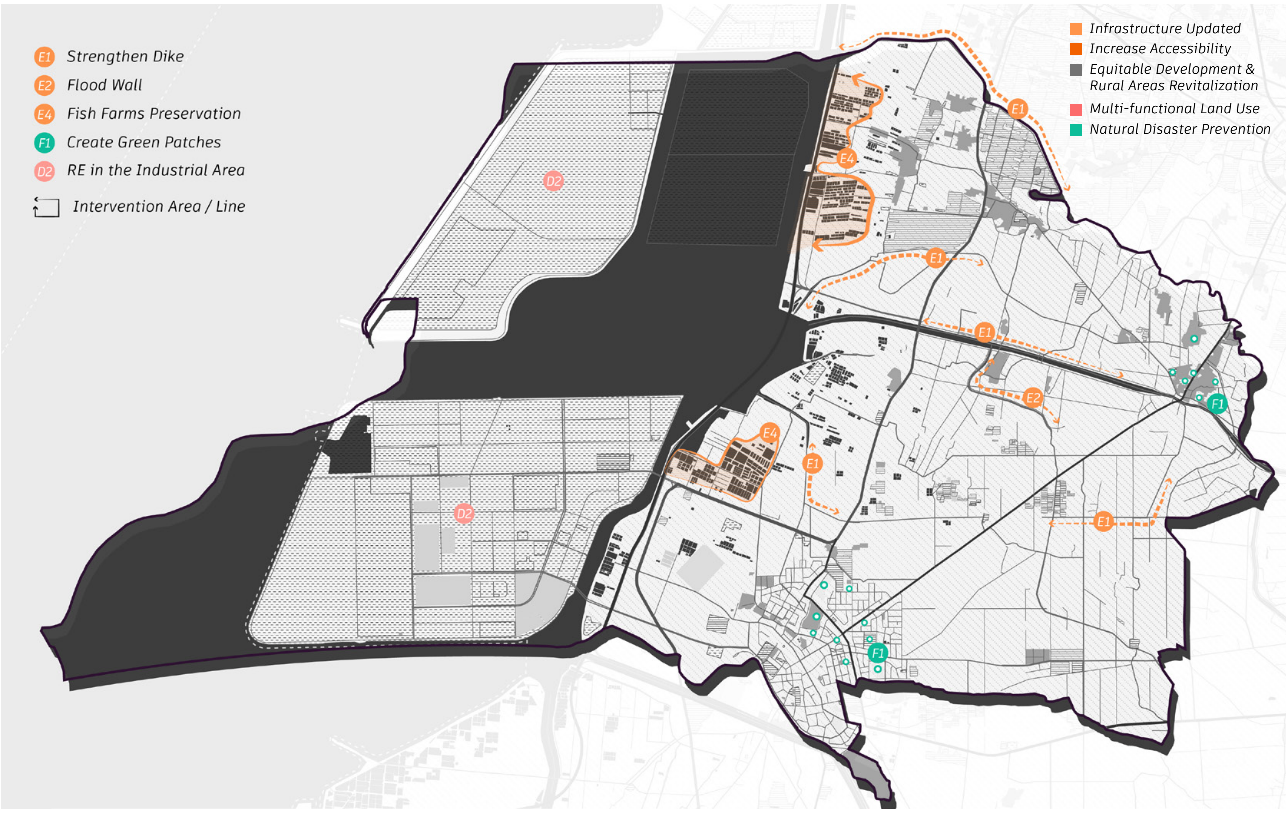


Fig 7.8: Spatial Strategies of phase 1: preparation stage.

Phase II – 2030: Implementation Stage

Spatial strategies in this stage start implementing multifunctional use in fish farms, based on the experiment results in the first stage in Fanyuang Township.
On the other hand, due to the implementation of multifunctional use, the participatory process in this stage will become more active.

Besides, since the multifunctional use in the industrial zone has been experienced, the discussion of the carbon tax establishment can develop.

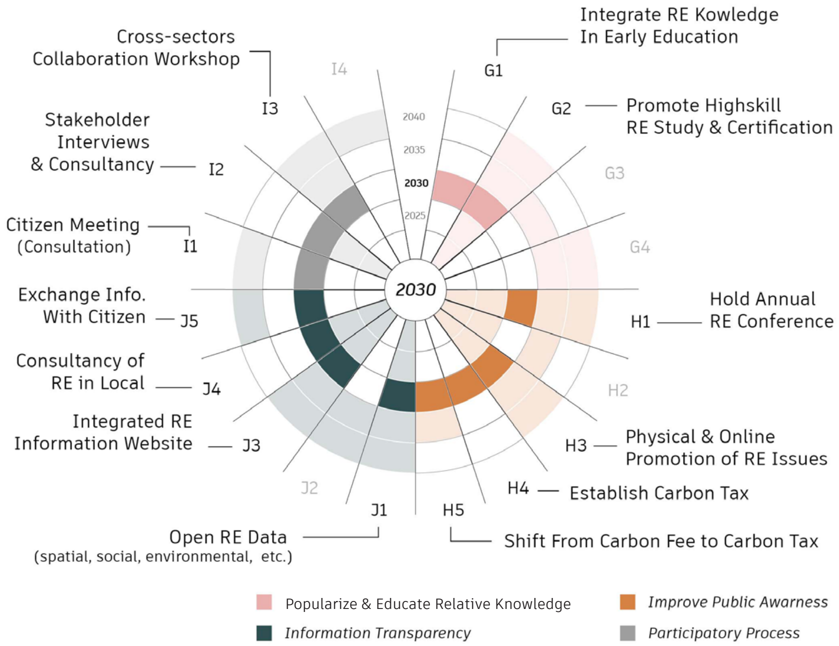


Fig 7.9: Social Strategies: phase 2.

Fig 7.10: Spatial Strategies of phase 2: implementation stage.

Phase III – 2035: Expansion Stage

Spatial strategies in this phase start to connect the green patches that were created in the first stage. At the same time, the implementation of the multifunctional use expands to the agricultural land area, which is based on the experiment results from the second phase in Fanyuang Township.

Social strategies expand to various interventions in popularizing and educating relative knowledge, improving public awareness, and increasing information transparency.

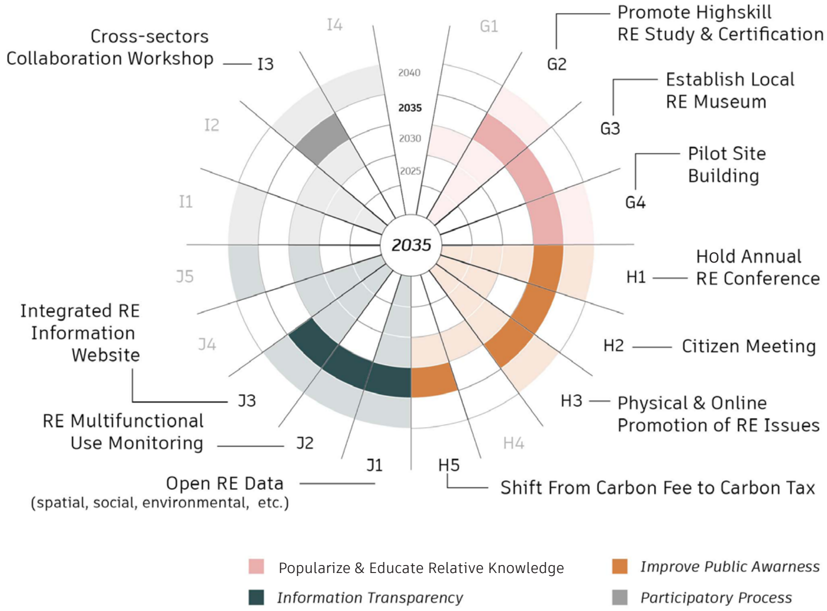


Fig 7.11: Social Strategies: phase 3.

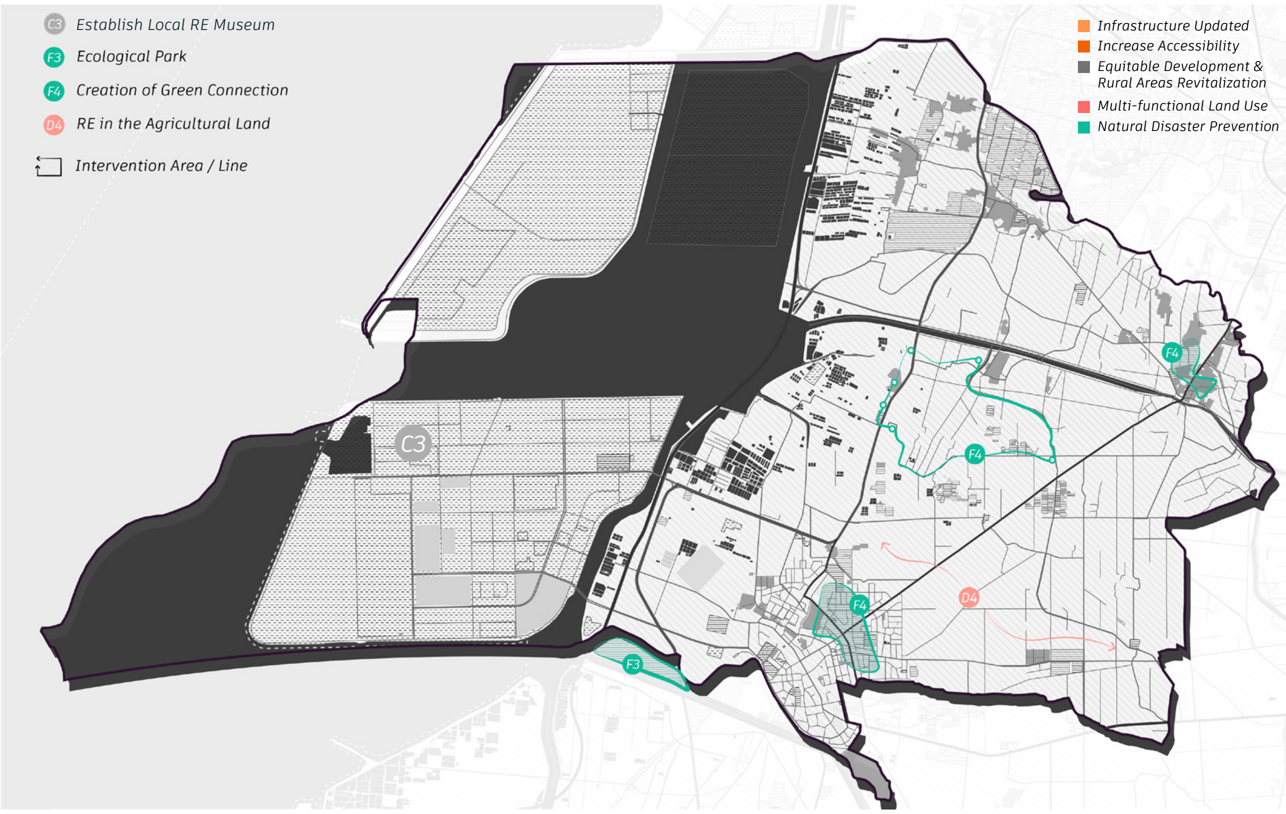


Fig 7.12: Spatial Strategies of phase 3: expansion stage.

Phase IV – 2040: Enhancement Stage

The final phase aims to enhance the effectiveness of the strategy. In this phase, the multifunctional use of land becomes more mature and the renewable energy portfolio within the urbanized area will receive more action due to the development of public awareness and education of relevant knowledge.

In addition, the strengthening of embankments will be extended to reclaimed land to maximize disaster preparedness.

At this stage, the social strategy becomes more complete; the participatory process also includes the evaluation of collaborative meetings with stakeholders.

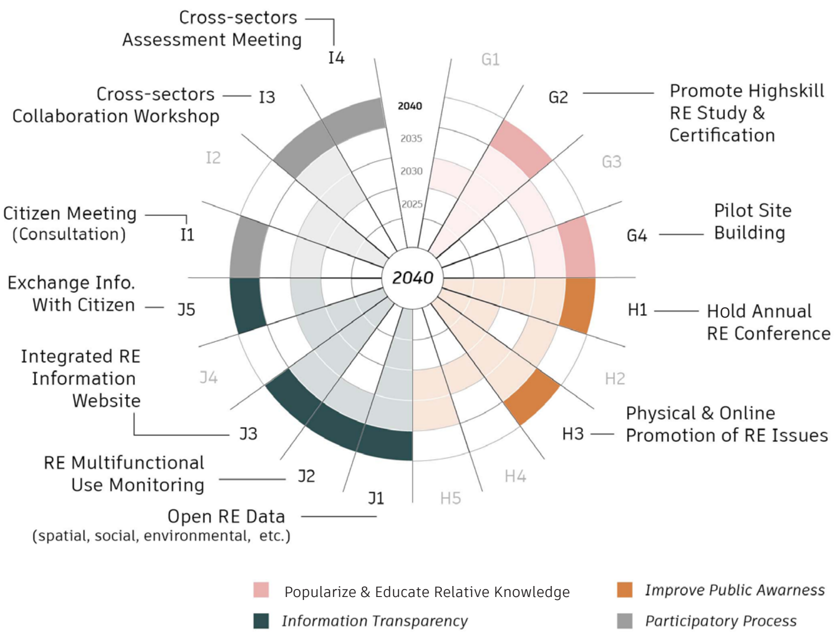


Fig 7.13: Social Strategies: phase 4.

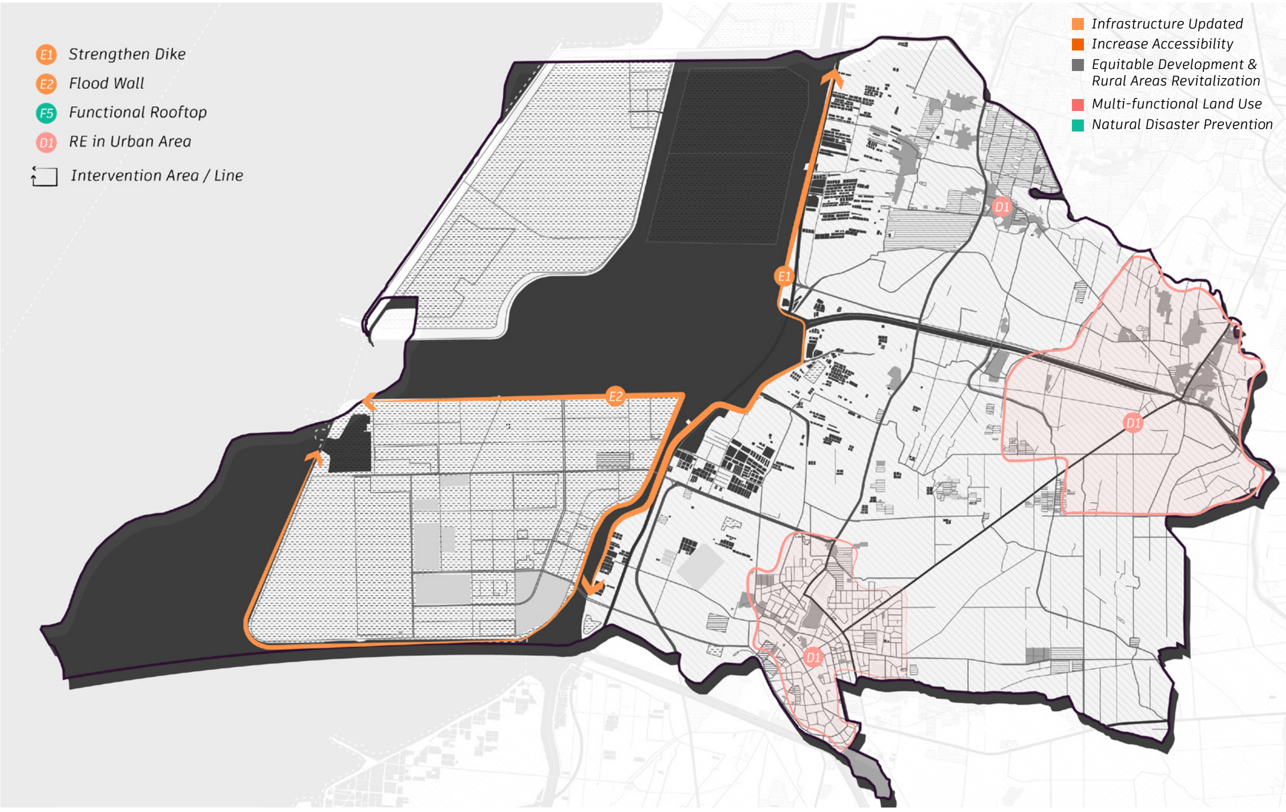


Fig 7.14: Spatial Strategies of phase 4: enhancement stage.

7.3 Regional Strategies: Fangyuan Township

Experimental RE for Synergy

Fangyuan Township has less competitiveness in terms of opportunities, living environment, infrastructure, and resources.

This Township has been expected to generate much energy due to more unused lands and the vast aquacultural areas, bringing opportunities for multifunctional land use. However, besides the ambitious goal of renewable energy generation, there are very few discussions on the values that could be created and bringing opportunities to these districts through the process. Therefore, the regional design in this township will show its potential and the procedures that need to be carried out.

Spatial and social strategies are illustrated through four phases. Each phase has a different purpose. Due to the visional approach in this district being to create experimental renewable energy development for synergy, different experiments of multifunctional land use with renewable energy are tested stage by stage. Each experiment will start from one pilot site to get scientific results for further implementation in other areas.

That spatial intervention will also provide synergies such as increased education and research capacity through pilot site-building. However, in order to maximize the effect of renewable energy development, the infrastructure update will be prioritized in terms of substation building and the grid-compatible increase.

Lastly, increased accessibility will be another highlight of this area. Public transportation line creation increases the chance of movement and convenience, providing more opportunities to be brought in. That is, this township is highly likely to be revitalized through proper development integrated with energy development.

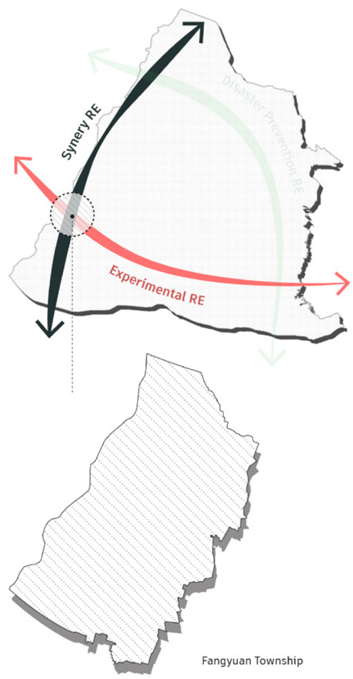


Fig 7.15: Strategy location: Fangyuan

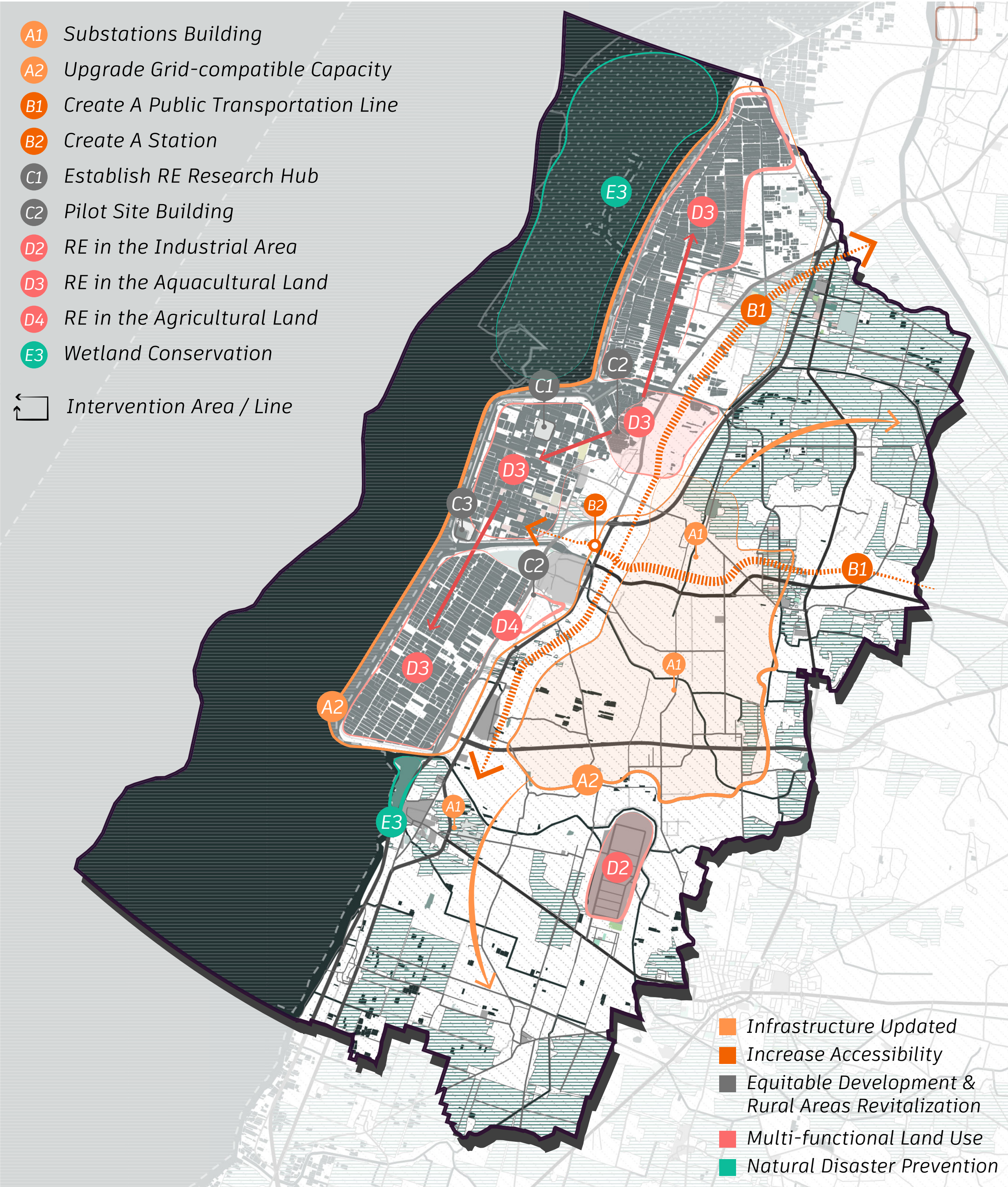


Fig 7.16: Experimental RE for Synergy map in Fanuang Township.

Phase I – 2025: Preparation Stage

The first phase focuses on preparing for renewable energy development; therefore, upgrading grid compatibility and substation construction are priorities.

A pilot site will test the multifunctional land use of solar energy on aquaculture land to build scientific evidence for developing an integrated energy strategy in the next phase. On this basis, an information transparency strategy will support the construction of a database for the solar multifunctional land use experiment.

Strategies for participatory processes are also incorporated in this phase to enhance cooperation on multifunctional land use. In addition, integrated knowledge of renewable energy can be embedded in education during this process to encourage the participation of the younger generation at an early stage. For example, the pilot project could be used as an outdoor museum for educational purposes.

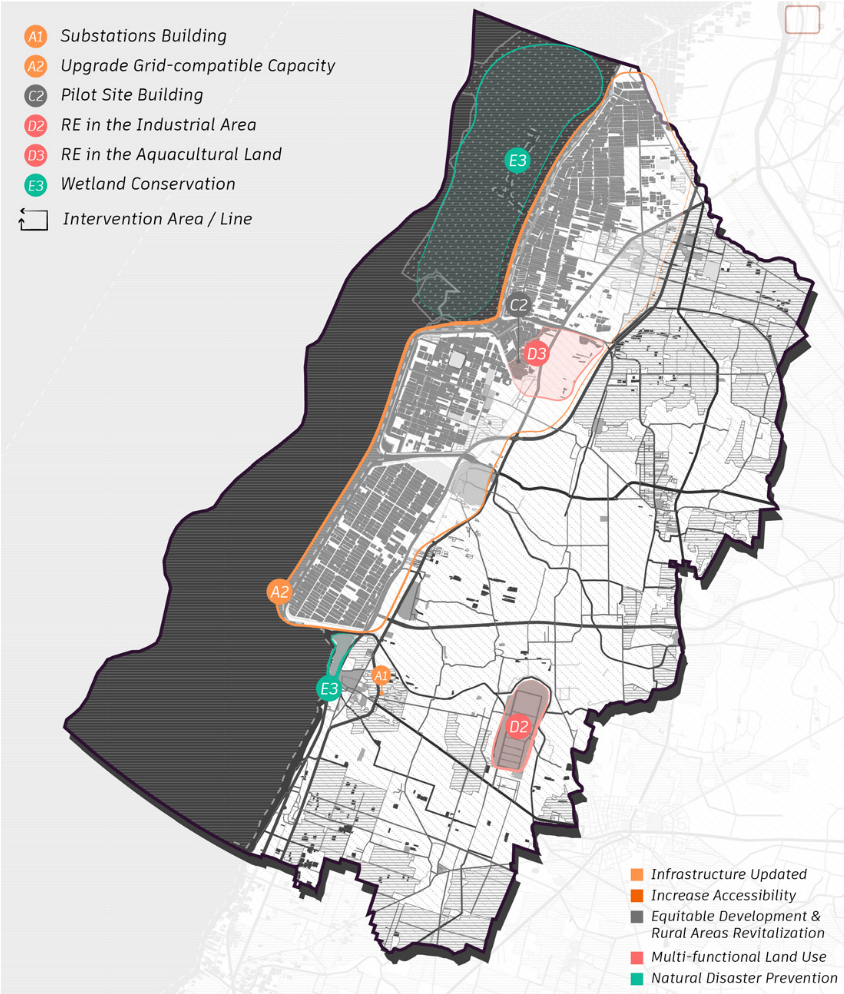


Fig 7.17: Spatial Strategies of phase 1: preparation stage.

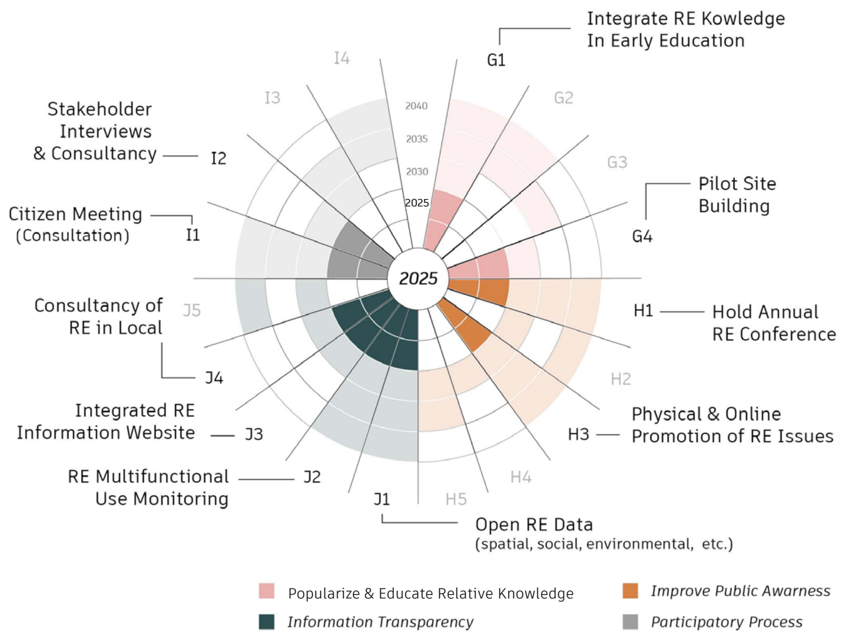


Fig 7.18: Social Strategies: phase 1.

Phase II – 2030: Implementation Phase

Based on the results of the first phase of experiments, the second phase will begin in higher-density fish farming areas. At the same time, experiments incorporating solar energy in farmland will also start in pilot areas.

The renewal of grid compatibility and the expansion of substation construction to the east side builds on the expansion direction of multifunctional land use with solar energy.

The social strategy of all parties becomes more active at this stage. More specifically, the design of the participatory process will expand from consultation to collaboration; information transparency will also include the exchange and collection of opinions and information from residents based on the interventions of the previous phase; increased public awareness is a crucial point to help improve the promotion of renewable energy in the commune, as the multifunctional land use of aquaculture land has been implemented in this phase.

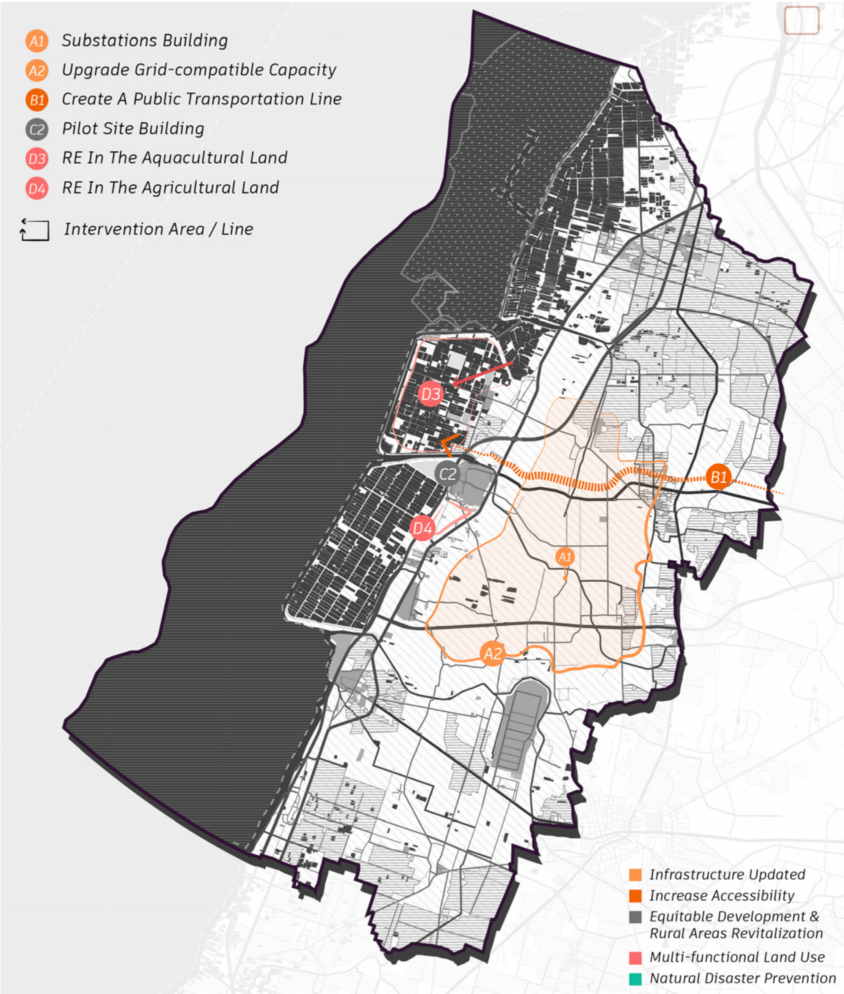


Fig 7.19: Spatial Strategies of phase 2: implementation stage.

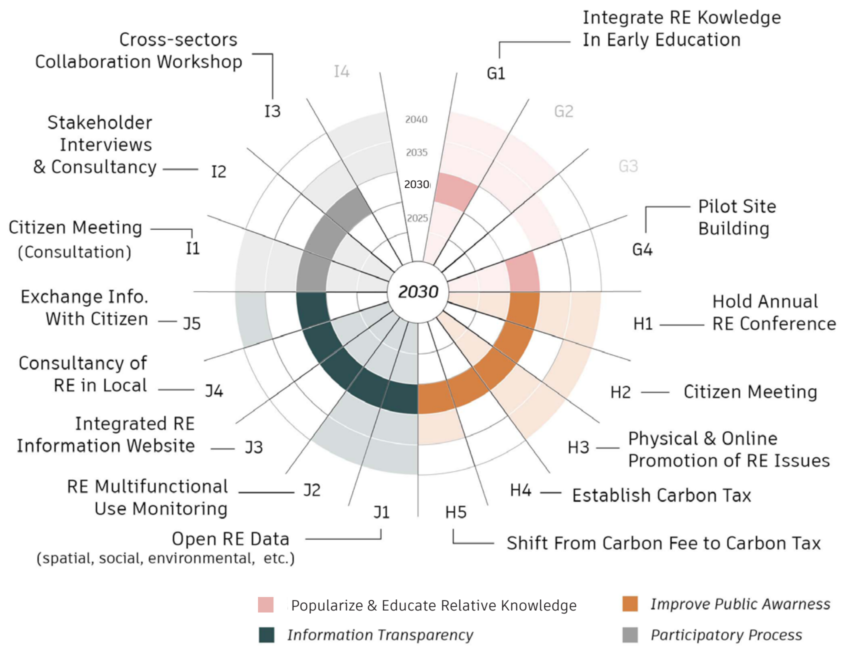


Fig 7.20: Social Strategies: phase 2.

Phase III – 2035 Expansion Stage

Experiments in multifunctional land use with renewable energy sources are further expanded. Updating grid compatibility capabilities will also be extended to the south. After the public transport line is completed, a new station will also be built near the pilot site where aquaculture and agriculture are combined with renewable energy generation to provide more accessible connections for tourism or education in other areas.

On the other hand, social interventions will begin to implement collaborative evaluation meetings to assess the results of experiments implementing solar energy within aquaculture and agriculture sites, providing adjustments and revisions.

Promoting highly skilled renewable energy learning and certification allows residents to join the energy industry. In addition, it provides new job opportunities for workers who may have lost their jobs during the energy transition.

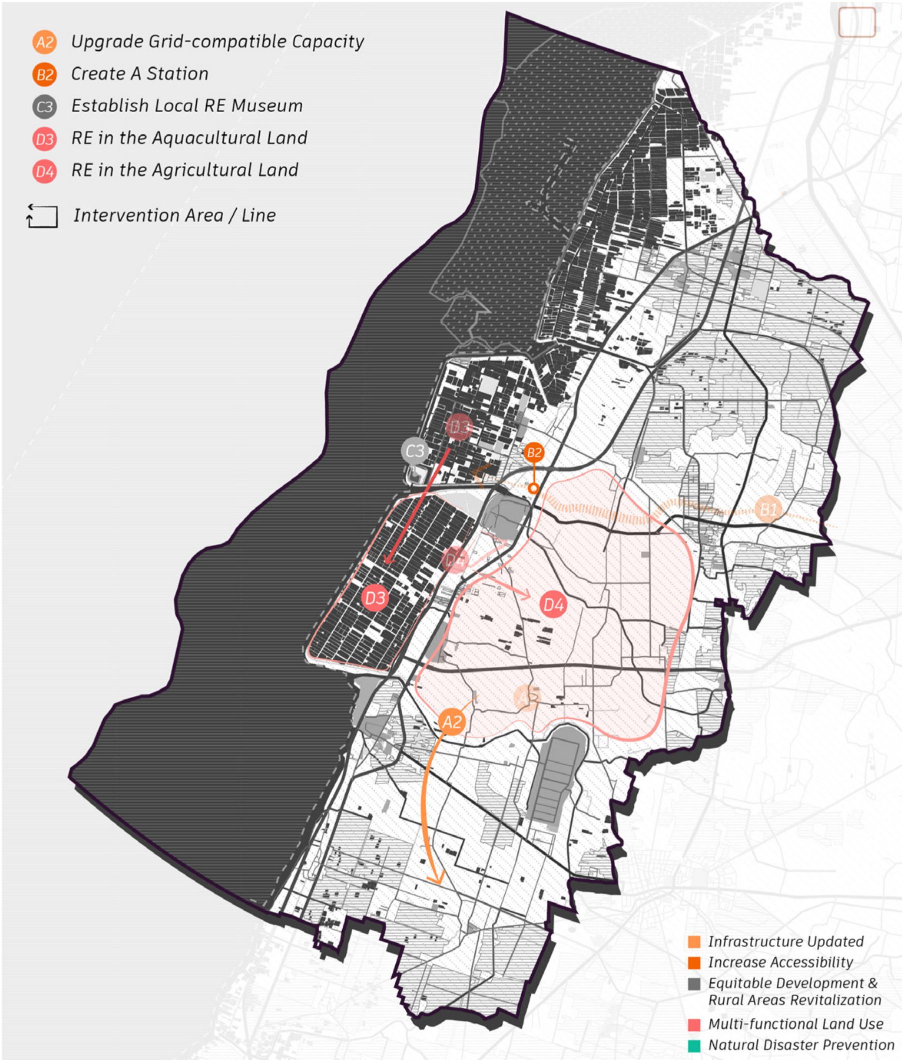


Fig 7.21: Spatial Strategies of phase 3: expansion stage.

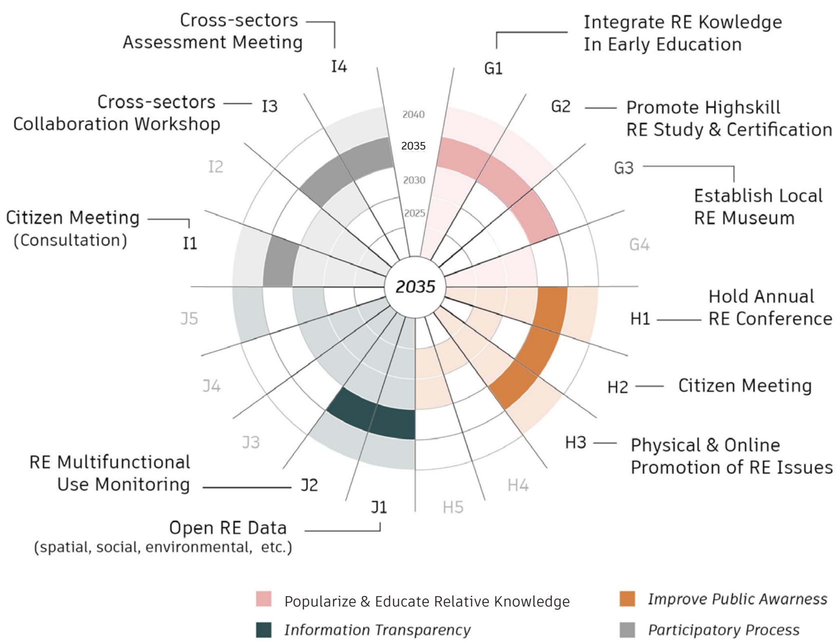


Fig 7.22: Social Strategies: phase 4.

Phase IV – 2040: Enhancement Phase

The last phase emphasizes the enhancement of the interventions. Thus, multifunctional use in aquaculture land will expand to the north, and so be the upgrading of the grid-compatible capacity.

After the increase of connection from the west side of Fanyuang to other districts on the east, another connection strengthening will be implemented in this stage to increase the connection between the north and south, leading to Lugang Township.

Social strategies can be seen in cross-sector assessment meetings, maintaining the quality of multifunctional land uses. Besides, data monitoring will keep running for the data collection and provide further adjustments in the future.

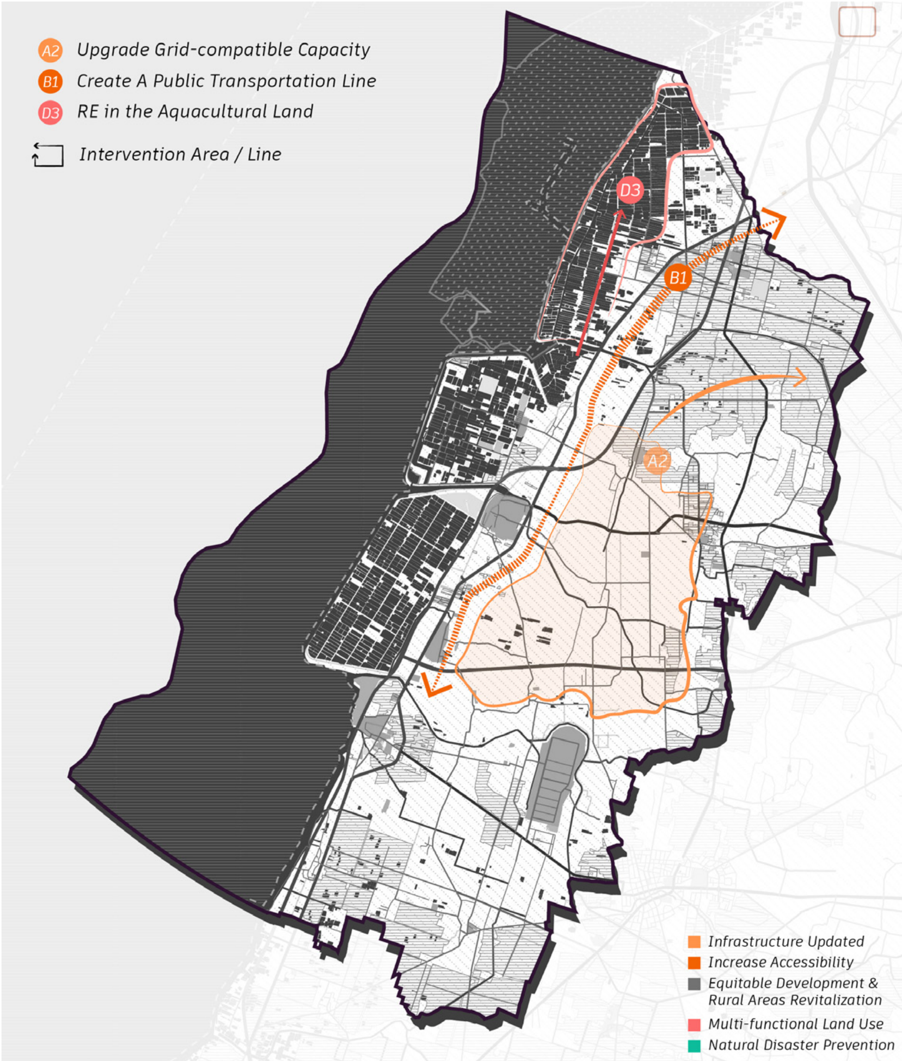


Fig 7.23: Spatial Strategies of phase 4: enhancement stage.

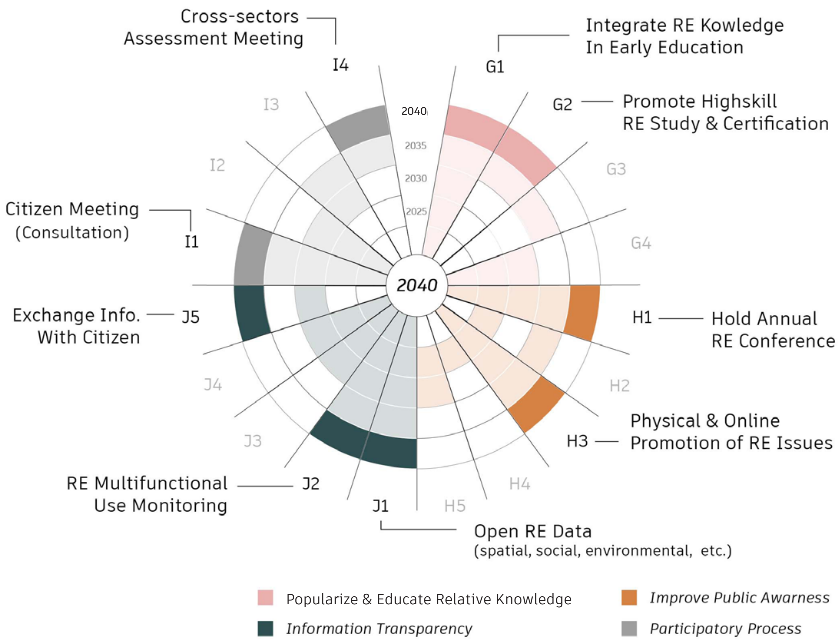


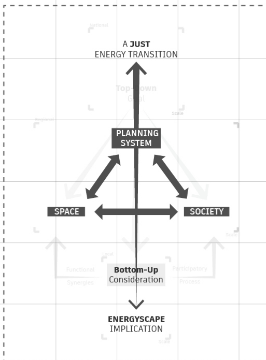
Fig 7.24: Social Strategies: phase 4.

08
Conclusion & Reflection

8.1 Conclusion

Main Research Question

What spatial and social needs and considerations should be included in regional planning and design, building up the systemic changes for integrated planning for a just energy transition in Taiwan?



Based on the literature reviews and the analysis of the energyscape influence, the two main ideas that need to be included within the planning process to support spatial and social perspectives are distributional justice and procedural justice.

These two concepts can more clearly demonstrate factors that influence society's perception of the energy landscape. More specifically, the study of the energyscape impact provides clues of factors influencing societal acceptance, which can help to revise and customize the strategies of functional synergies (multifunctional land use) and participatory planning for local through regional planning and design with the consideration of that two justice as principles. On top of this, values can be created through regional interventions and step-by-step building up a pathway toward a just energy transition in Taiwan.

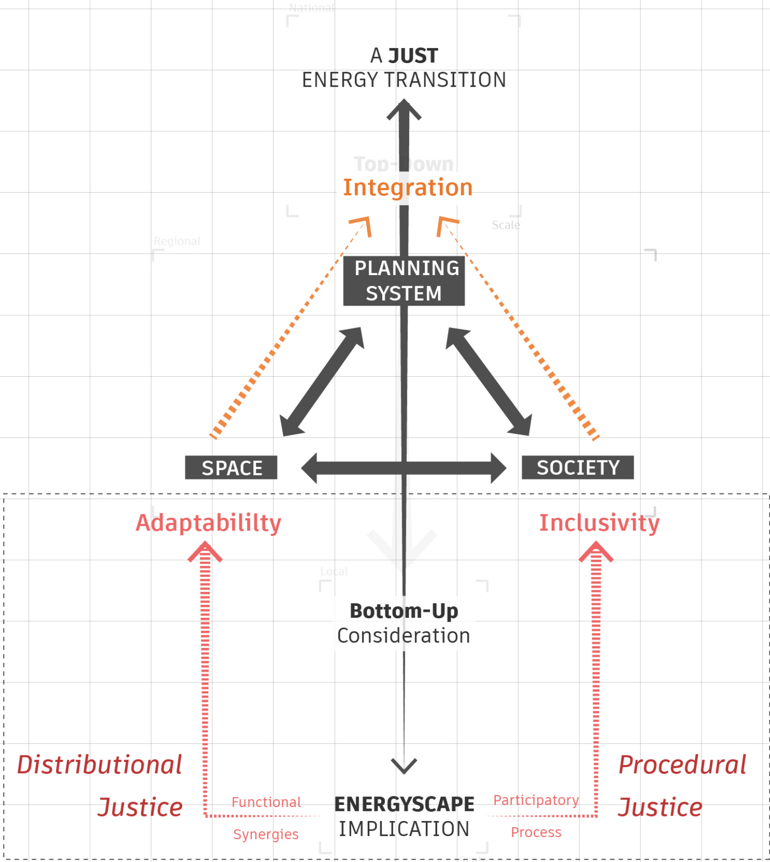
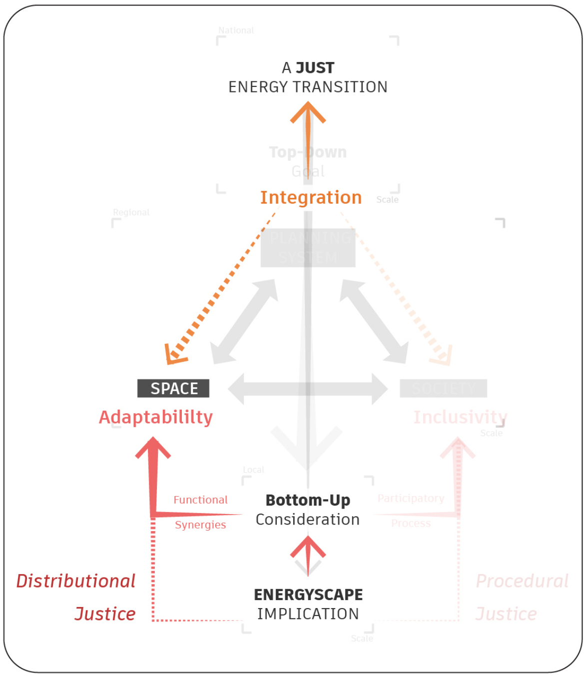


Fig 8.1: The answer to the main research question.

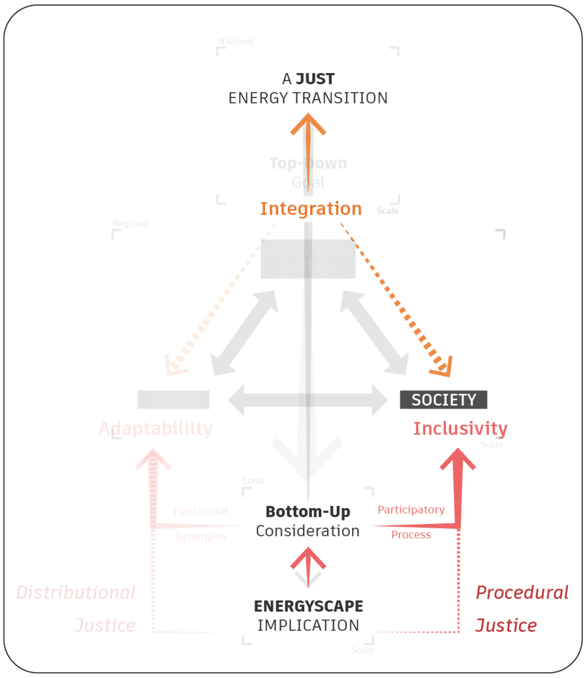
Spatial Pespective



In order to crearte adaptability in space, the strategies of multifunctional land use for renewable energy development should be well-prepared. That means the need to integrate spatial planning system within energy plan is inevitable. Only from this, the land us purpose can be defined thoroughly with clear guildline of which spaces are suitable for renewable energy development and what regulations need to be defined.

In order to meet the need to create a fair transition, distributional justice underlines the considerations that need to be included in the process, such as environmental or ecologically sensitive areas, regulations of the minimum distance between energy infrastructure with the built environment that impacts on the human ecology, and the strength of the land use by regulating the density or size of the installation.

Social Pespective

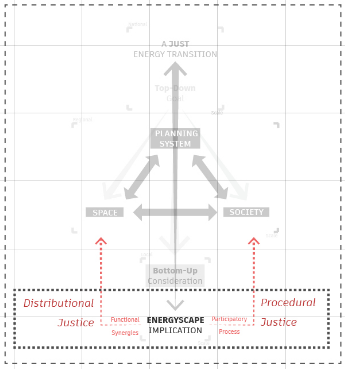


In terms of social perspective, participatory must be included in the planning process to create inclusivity within society. Analysis of winners and losers within the transitional process can help to understand that within stakeholders whose power or interest needs to be adjusted and how to redistribute.

In the research and design chapter, I argue the importance of establishing procedural justice to help mitigate conflict and increase trust in the transition process. That is, factors that influence social acceptance of energy development, such as consideration of the distribution of economic benefits and losses, should include renters and residents, or the energy strategy should regulate the transfer of assistance to stakeholders who have lost their jobs due to the energy transition process. Only by understanding the needs and considerations in planning can build up a just energy transition.

Sub Research Question 1

What are the impacts of the energyscape on the surrounding environment?



The impact of the energy landscape can be seen in nine aspects: human ecology, technology, natural and wildlife conservation, tourism, landscape scenery, trust, financial benefits and losses, governance, and economic effects. However, these impacts can also be positive by creating distributional and procedural justice. The relationship is shown below.

Distributional Justice

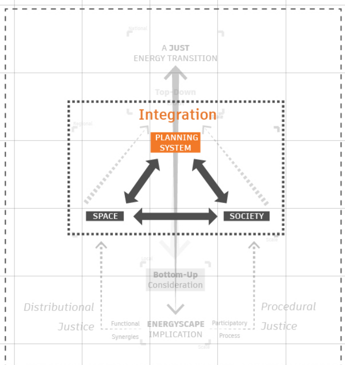
- Impact on Human Ecology
- Repowering
- Nature & Wildlife Conservation
- Impact on Tourism
- Effect on Landscape Scenery

Procedural Justice

- Public Participation, Trust, and Transparency
- Distribution of Financial Benefits & Losses
- Energy Strategies
- Economic Effects (Ownership)

Sub Research Question 2

What systemic deficiences are hidden in the current energy transition planning that needs to be changed?



First, the energy planning system has a gap in the governance strategies and a poor fit in the structure. More precisely, it is like a unidirectional mode of operation for complex, multi-faceted processes. This is because the planning sector does not have enough administrative power to build collaboration between industries.

Besides, there is a lack of integrated strategies to tackle the complicated effect that the energy transition brings. It is inevitable to include spatial and social perspectives within the process. In other words, integrating the spatial planning system with the energy transition strategies in order to establish integrated policy and prevent multi-dimension conflicts within society should be prioritized.

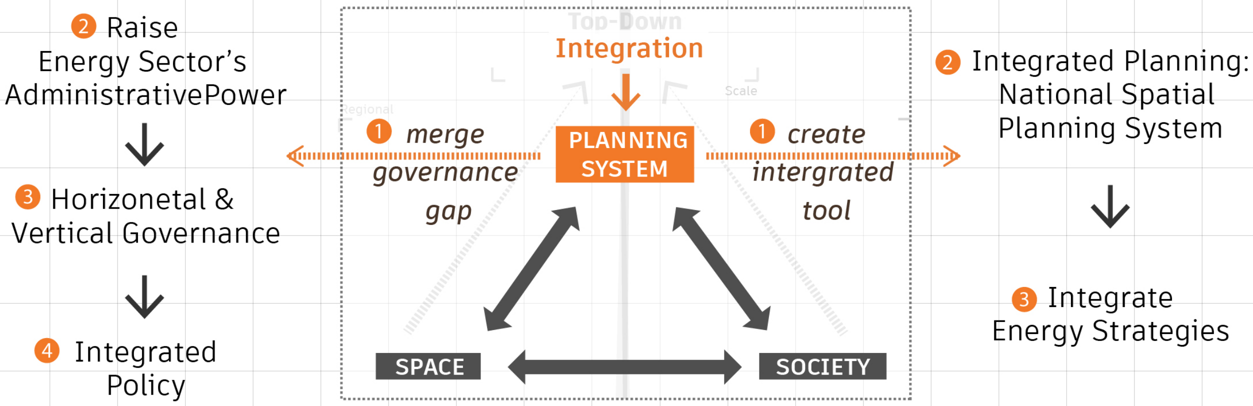
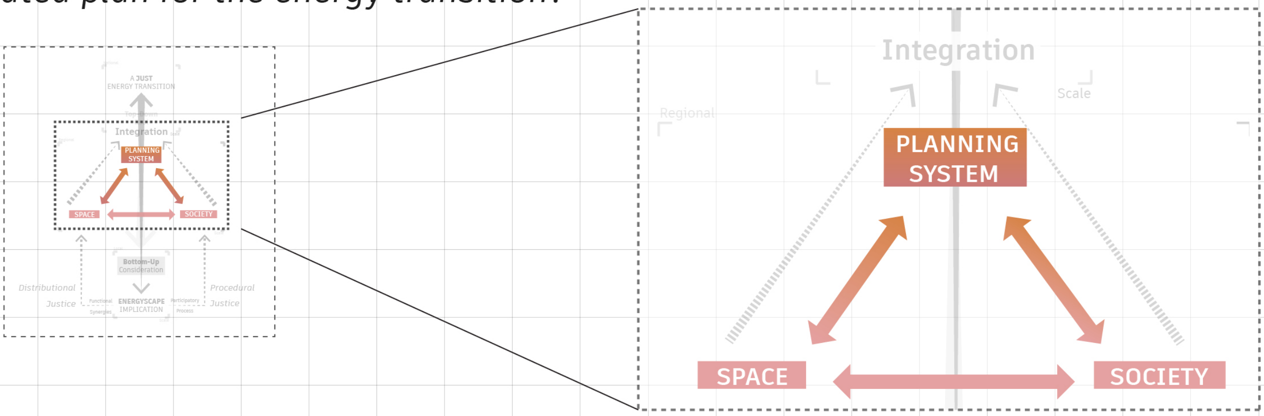


Fig 8.2: The answer to the sub-research question.

Sub Research Question 3

How can regional planning and design drive systemic change to develop an integrated plan for the energy transition?



The energy transition is a process of the energy source use change, a transformation within spaces. Energy needs space to be deployed; in turn, space is also reformed by energy (Lefebvre, 1999). Studying the relationship between space and energy is inevitable to create a practical plan with values and prevent conflicts. Based on multi-dimension research in an area can help to understand what, where, when, and how the project should be implemented. The strategies developed within the regional planning help to realize the imagination into practice with phases design. From this, regional planning and design can help for governance and driving a systemic change due to the understanding of the needs and lacks.

Sub Research Question 4

How can resources be reallocated to create value and rebuild social equity for neglected areas?

Systemic	Integration	4 Principles
	↑	↑
Spatial	Adaptability	6 Main Strategies
	+	+
Social	Inclusivity	4 Main Strategies

Based on spatial, socio-economic, environmental, ecological, and energy analyses, a SWOT analysis is conducted to determine the developed conditions of each district. In other words, the disadvantaged areas can be identified, and the reasons for their formation can be pointed out. For example, the southwest region of Changhua is less competitive due to poor infrastructure and high dependence on first-tier industries. In addition, there are fewer opportunities due to inefficient resources, forcing the younger generation to migrate to other urbanized areas. Therefore, through regional strategies that target spatial and social aspects of value creation, a phased approach to governance can be established to rebuild the uneven development of these areas. Also, the goal of rebalancing inequalities can be achieved by increasing the identity of these communes by taking advantage of the opportunities for renewable energy development.

Sub Research Question 5

How can research on the implications of energyscapes help redistribute the power and interests of stakeholders in the energy transition?

Based on the implication study of energyscape, factors that have led to conflicts and injustice within the transformation of the energy landscape can be identified. For example, the analysis of energyscape reveals the importance of considering the installation rate within different land use zones, distance from the built environment, and environmentally sensitive perspectives to improve the social acceptance of the landscape change. It also shows that energy planning can not be completed only by realizing the number of effectiveness (energy generation) because the derivative issues would show within society from different domains. And due to the understanding of the impact of the energyscape change, highlighting the inevitable question: how to improve these effects?

As the previous answer to the sub-research question, creating distributional justice and procedural justice can bridge the gap between the energy planning expectation and the real problems because it includes more perspectives within the planning process and establishes integrated strategies to tackle hidden issues. In other words, creating procedural justice encourages participatory planning and integrates stakeholders within the planning, design, and assessment process. Besides, improving the distribution of financial benefits and losses can also adjust the interest distribution. As a result, studying the impact of energyscape shows the path to help redistribute the power and interests of stakeholders in the energy transition process.

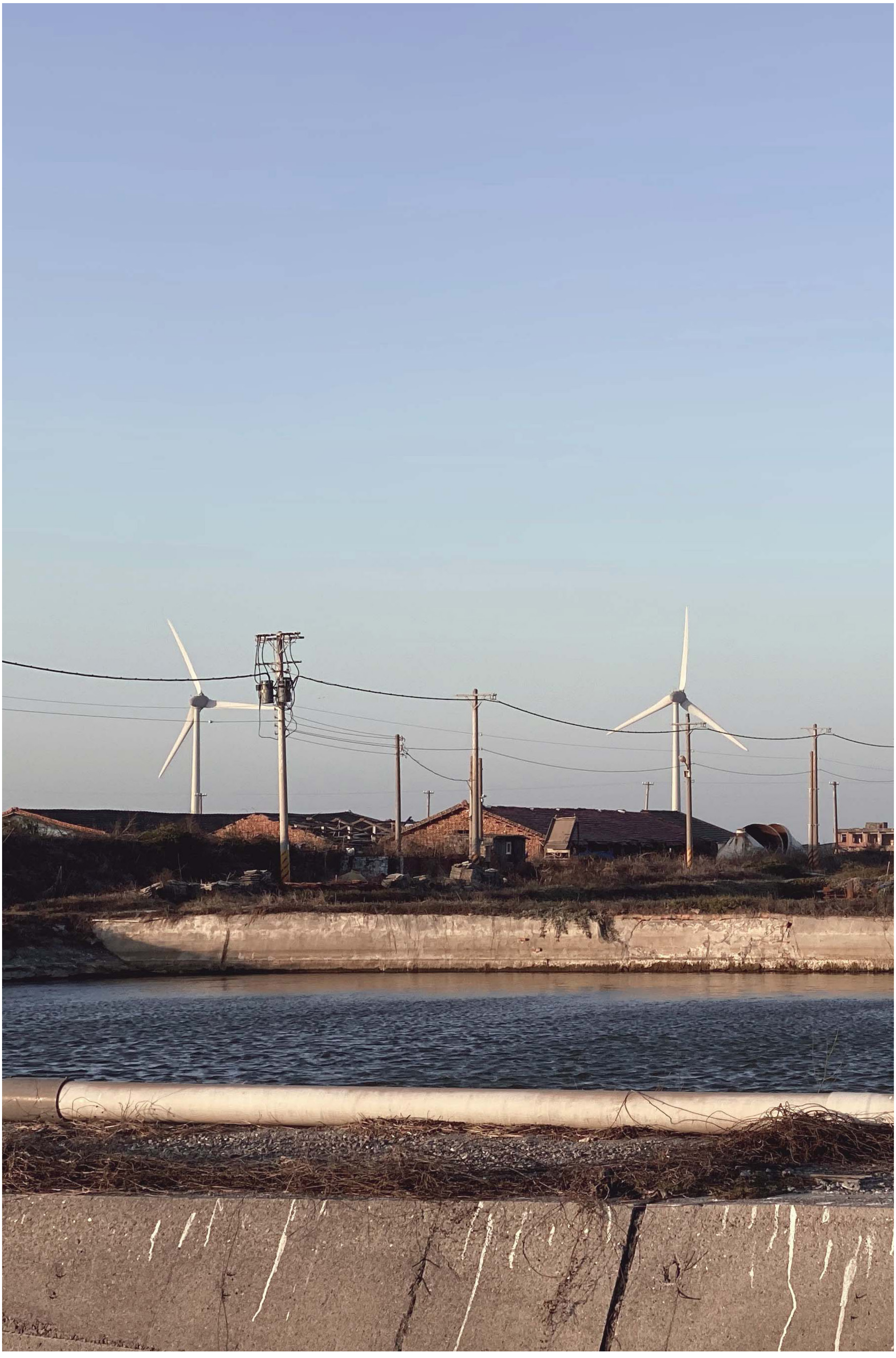


Fig 8.3: Neglected areas in Fangyuan Township

8.2 Energy Transition Integrated Policy Advices

Fig 8.4: High voltage towers near residences

1. Create a holistic plan, including spatial and social perspectives, and build up planning and design principles in the energy transition planning process.

Operational Advices

a. Increase the energy planning sector's administrative level to support the administrative effectiveness of the plan developed.
b. Integrate the plan with the National Spatial Planning.
c. Determine permitted zoning for energy development and permitted renewable energy development projects based on zoning in the National Spatial Plan.
d. Nationwide assessment of sites suitable for renewable energy use, including social and environmental sensitivity perspectives.
e. Establish planning and design principles for local governments executing local scale planning and implementation.
f. Establish planning and design principles for central governmental sectors in order to create departmental energy planning and implementation.
g. Establish protection laws for stakeholders such as rentors of farmers and individual fishermen losing their rights to work.

Strategic Advices

h. Create the plan through an integrated planning platform that integrates different aspects, including spatial, social, economic, environmental, and administrative.
i. Review and revise the plan content and methodology every 3 to 5 years.

2. Establish an integrated planning platform for horizontal and vertical collaboration.

Operational Advices

a. Platform I: collaboration between the energy governance sector, central government sectors, and local governments.
b. platform II: collaboration between the energy governance sector and sectors of the central government.
c. Platform III: collaboration between the energy governance sector and local government
d. Establish central and local conflicts solving groups, including governmental sectors, stakeholders, and experts.

Strategic Advices

e. Develop integrated energy strategies through collaboration governance.
f. Regular review of program progress and effectiveness within three platforms.

3. Establish a participatory planning process that includes stakeholders and encourages society to engage.

Operational Advices

a. Study the social acceptance of the energy transition.
b. Establish co-exploration mechanisms within the project preparation stage, including stakeholders and citizens.
c. Establish a third-party involvement mechanism to assist the participatory process.
d. Create a co-design mechanism within the project preparation stage to integrate perspectives from stakeholders, experts, and residents.
e. Establish a co-evaluation mechanism to evaluate the planning process and results with stakeholders, experts, and government.

4. Explore alternative renewable energy and increase the research and implementation capacity.

Operational Advices

a. Establish phases plan for renewable energy development.
b. Reassess and update the capacity of the infrastructure for the energy transition.
c. Experiment with multifunctional land use through phases.
d. Establish the criteria for multifunctional land use with renewable energy.
e. Establish assessment mechanisms for multifunctional land use with renewable energy.
f. Establish an audit mechanism to monitor the operation and effectiveness of multifunctional land use with renewable energy projects.

Strategic Advices

g. Encourage energy companies to research and invest in alternative energy studies or experiments, such as hydroelectric power, geothermal power, biomass power, tidal power, Hydrogen, and Methanol.
h. Provide funding for academic research and strengthen collaboration between academic and industry.

5. Promote digital governance that integrates energy transition information.

Operational Advices

a. Establish an integrated information website for the energy transition.
b. Provide a channel for the public to express their opinions and suggestions.
c. Developed smartphone software to provide integrated energy transition information query and personalized home energy usage management.
d. Collect data through the developed software that collects residents' energy use data.

Strategic Advices

e. Encourage people to assist in updating the energy plan information.
f. Regularly disclose renewable energy generation data, experimental processes, and related research information.

6. Raise public awareness of the energy transition and integrate knowledge into the education system.

Strategic Advices

a. Raise public awareness of integrating renewable energy generation in urbanized areas.
b. Increase funding to cultivate professionals to bridge government and local policy communication and consultation.
c. Include relative knowledge within the education and start in the early stage of education.
d. Invest in the high-skill study of renewable energy to cultivate talents.
e. Encourage stakeholders to participate in the workshop to educate energy transition knowledge.
f. Encourage local government to hold annual energy conferences for citizen participation and knowledge exchange.
g. Re-educate stakeholders and assist them in job transition.
h. Educate society on the responsibility of equitable distribution of renewable energy generation.

8.3 Reflection

Ethical Reflection On Energy Justice

Energy justice is a topic that has been discussed widely in Europe in the past few years, especially on the issue of energy poverty. Based on the definition from the European Commission, Energy poverty refers to conditions that make it difficult for households to obtain basic energy services and products. The Netherlands government also included this value within their national agenda but yet has concrete strategies to address it in the national policy (Feenstra et al., 2021).

Looking back to Taiwanese society, the injustice issue has shown differently, but within more complex conditions. Injustice has been led by the deficiency of the planning system and triggered results of work rights loss or environmental and ecological damage. However, there are very few academic discussions to reflect on these conflicts and unfair situations. Thus, based on this recognition, my design proposal focused on the planning system revision and combination with energy strategies instead of discussing policymaking to mitigate poverty like the common recognization.

The core of this thesis is to advocate the injustice effect of the current energy transition planning. The first-tier industry has been seen as an uncompetitive industry for years. Workers usually come from lower education backgrounds or live in low-income conditions. They do not know how to voice their grievances and fight for their rights.

Although an Environmental and Social Assessment mechanism is in place for the multifunctional use of aquaculture land. However, this mechanism is only used for aquaculture sites and is intended to mitigate conflicts, which are actually caused by flaws in the planning system. This means that all other remedial measures will not be sufficient if the underlying problems (from loopholes in the planning system that lead to substantial landscape changes and a chain reaction of loss of rights to work) are not addressed from the outset.

The Taiwanese government has been trying to include people's opinions in the planning process, yet this kind of change cannot be completed in a short time. Without public awareness and proper education to instruct students with relative knowledge starting from the early stages, the participatory process will only become an ideal slogan for movers and shakers but leave lower power stakeholders behind.

That is, one of the values that this thesis wants to transfer is to demonstrate the urgency of the hidden threats and the potential of irreversible results that might happen in the short future—advocating the importance of establishing an integrated planning mechanism that integrates— the energy strategies with the spatial planning system, reversing the problems that have rooted deeply for years and use the chance of implementing a new spatial planning system properly.

Fig 8.5: Collage of integration of renewable energy with aquacultural activities in the rural area.

Scientific and Societal Relevance

Scientific Relevance

The energy transition is a topic that has been discussed widely from technical perspectives for years; however, the impact on society and especially the relationship with space has had fewer discussions.

On top of that, most of the academic research on energy in space is discussed in terms of the aesthetic influence due to it is the most direct influence to the individual perception towards the wind infrastructure (Warren et al., 2005). Otherwise, the discussions are focusing on the wind energy much more than other energy sources.

Unlike other cases, Taiwan has recently been facing more severe energy landscape changes due to solar panel installation. This hidden threat is gradually eroding Asia and Southern Europe from socio-economic and environmental perspectives that need to be well discussed, which is also one of the main values that this thesis wants to deliver.

Even though the problem field started from the conflicts derived from the landscape changing caused by energy development, another value of this research and design is underlying the importance of integrated spatial and social perspective through a national level holistic planning, creating procedural and distributional justice that directly impact on neighborhoods. Besides, integrating spatial planning and energy planning provides a perspective to improve governance through better collaboration vertically and horizontally (Nadin et al., 2021). Specifically, the blurry lines of responsibility within sectors (horizontal) can have better guidance to cooperate, and the order and concerns within policy actors (vertical) can get complete communication.

Therefore, one of the products, the energyscape template design, is based on the (new) National Spatial planning system, which has been divided into four main land use zone and 19 sub-zonings. Planning principles and regulations for renewable energy installation in order to create procedural and distributional justice are then set based on the zoning definition. This means it emphasizes the purpose of the zoning creation that prevents unlimited develop-oriented actions on lands but also preserves flexibility for each sub-zoning template to adjust for specific areas and conditions at the same time.

In doing so, it shows the potential for transforming the planning system from conventional planning, which provides only a land use regulation function, to a tool that includes “spatial” aspects and contexts, which offers pathways for policy development and integration, stakeholder inclusion, and development management (Tewdwr-Jones, 2004, p. 593).

If we use Arnstein’s (1969) ‘participation ladder’ as an index, Taiwan currently might be between consultation and placation (degrees 4 and 5) within eight ranges. Very few cases might step into degree 6, partnership.

Societal Relevance

As the Environmental and social assessment mechanism working for the evaluation of Fishery and Electricity Symbiosis, the efforts to integrate stakeholders' opinions and suggestions cannot be denied. However, that mechanism only focuses on assessing multifunctional use in aquacultural lands now. On top of that, the conflicts of changing land use type to mainly solar panels installation use cannot be prevented by this mechanism, which has caused the main socioeconomic strife.

In other words, although the Taiwanese government has developed the awareness to increase the participatory planning capacity. Yet, more concerns and actions need to be considered and changed urgently, such as implementing spatial perspective through an integrated planning system mentioned above and creating information transparency to build social trust and recognition.

Take the product, energyscape template design, of this thesis as an example. The nine design principles for improving social acceptance of renewable energy development include the perspective of distributional and procedural justice (Scherhaufer et al., 2017), which are inevitable factors in improving participation capacity.

To be more specific, regulating the distance between infrastructure and the built environment is based on human ecological concerns and impacts on the landscape. Creating buffers for environmentally sensitive areas and setting coverage rates of the energy infrastructure is based on the principle of nature and wildlife conservation and the possibility of rescaling the infrastructure. On top of this, procedural justice underlines the importance of establishing participation from society, increasing information transparency, and establishing protection rules for economic effects to prevent low-power stakeholders' socioeconomic losses.

Once again, these factors established in this research are not just for the improvement in governance in order to achieve the energy transition's goal but the value of creating justice in the transitional process that helps prevent unfairness and the sacrifice of powerless people to make whole others.

Transferability

It is undeniable that, at present, those who use the most energy in the cities do not share the same responsibility for their usage because, in the countryside, there are always others who will make up for it because they are powerless to resist. How can we blame these people for unconsciously sacrificing those who are vulnerable? It's not worth it to argue without a mature public awareness. We can only look back at the systemic problems in governance and advocate the urgency of raising public awareness and reforming the planning system. Stop mindlessly pushing up the numbers to achieve the goal while ignoring the direct impact on the land and the people with no power or voice.

Therefore, in order to prevent the larger scale of conflicts within the society in spatial, socio-economic, and environmental aspects, the methodology of integrated planning with energy strategies needs to be implemented in other cities in Taiwan, especially advocating the urgency of changing planning perspective and methods in high conflicts areas in the southwestern part of Taiwan, Yunlin, Chiayi, Tainan, Kaoshiung, and Pintung. They are cities with well and large-scale agricultural lands, maintaining our food security and the first-tier industry domestically and internationally.

Changhua County contains many similar qualities to other southwestern cities in Taiwan, providing the vast potential to share the example of integrated planning with energy strategies. Yunlin has serious subsidence situations, similar to Changhua's southwest part. Chiayi and Tainan have more extensive and more organized fish farms than Changhua but already face the challenges of landscape changes and tenants' work rights losses. Kaohsiung and Pintung have large and fine agricultural lands but have also suffered from fragmentation of farmlands in the past few years. That is to say, due to these similarities, the case study of Changhua can provide some insights to other southwestern cities to rethink and readjust their energy planning with more comprehensive strategies that include spatial and social perspectives.

Landscape change has more hidden threats than we thought; Revealing the unfair and unjust sacrificing of powerless and voiceless people is the first step, and then it is to underline that intervention is needed as soon as possible. Otherwise, there will be nothing to go back to.

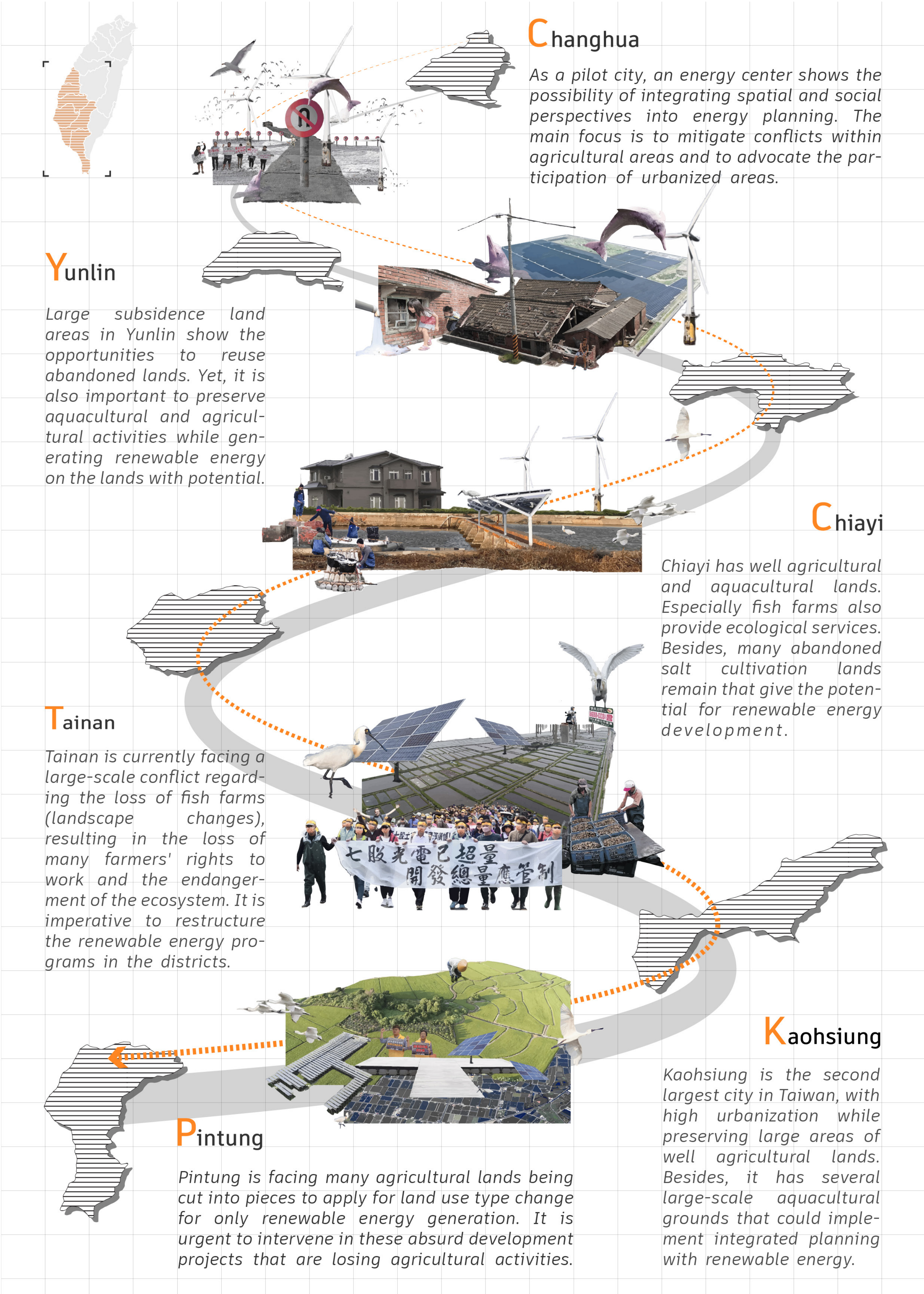


Fig 8.6: Transferability implementation locations.

Methodology & Research and Design

Through the design process, I also realized that even though a new integrated planning system that will be implemented in 2025 might be a tool to prevent conflicts within society, however, this type of enormous change needs much more consideration in reality, especially in the regulations and laws established to support the legality and legitimacy.

Besides, based on distinct locations and environments, there will be varied factors that need to take into consideration. Thus, I redefined my design through the research process and made the template for the planning process become a more flexible product showing principles that need to be considered and potential outcomes that can be expected.

My design proposes a new method integrating social and spatial perspectives within the energy transition planning process. I identified the current planning problem and pointed out the hidden threats from the national to the local scale. And based on the lack of in-between scales, I proposed a template for the planning process based on a national spatial planning system, integrating the local considerations and factors that help mitigate the hidden problems.

In order to present the potential values that can be created through the transition process, social and spatial considerations are included in the template design. The factors considered are based on academic studies of the influence on social acceptance of the energy transition. Regulations and principles in social and spatial perspectives are based on the existing laws, administrative regulations, existing spatial pattern studies, or the case study from other countries' recommendations.

These processes ensure that the template design is built up with references and studies and integrated essential factors that have been neglected in the transitional process. The deficiency of the planning system shows problems in different intensities within different cities. Due to the study's scale and the proposal's flexibility, I chose one city as the case study area to study detailed conditions for developing the design proposal.

The design proposal is based on the case study area, Changhua County, which has a higher proportion of first-tier and second-tier industries development; thus, the proposal will provide significant insights into cities with larger rural areas and agricultural activities, but it might create fewer benefits for other higher urbanized cities because there are fewer threats related to first-tier work rights loss and environmental hazards but more discussion on the integration with the built environment.

In addition, the collection of space-related energy data from municipalities or central government is limited or unpublished, especially for individual installations of renewable energy, the size of installations, the local potential of renewable energy development, etc. In other words, there are significant differences in data management methods and contents among counties and cities since there is no centrally set standard. This incomplete reduces the accuracy of the general situation analysis.

As a result, my methodology in terms of design proposal also changed the direction to show the prediction of the potential valued outcomes instead of assessing the outcome effectiveness.

Reflecting on the Studio and Course

Urbanism trains me to think and research multidimensions for spatial design. I have learned from projects with different planning and design methods through various scales. Planning Complex Cities studio focuses on large-scale planning with systemic thinking. It challenged me to think about the relationship between social and spatial perspectives, helping me to think above traditional planning (conformance planning) and hone my skills through the methodology of " Research and Design."

Like the name of this studio, my project focuses on energy transition, which needs to be solved within a complex condition because the issue cannot be solved within single factors but needs to be discussed through multiple dimensions that influence and intervene with each other; thus, it is critical to admit that it needs the interdisciplinary conversation and discussion of the impact. And that is what I have learned through this process from this track and studio. They provide me with the latest knowledge and well-refined methodology skills.

To be more specific, the main core of my thesis is the discussion on energy justice, which is a new and urgent issue that needs to be addressed. At the same time, the planning method, integrated planning, is also an innovative planning method that is tested and discussed within countries. I was surprised during an interview about the energy transition with an urban planning professor in Taiwan that she mentioned that the Taiwanese academic field is also studying this new planning methodology recently and thinking about how it might help with the energy transition process. And due to this, I am more confident that the topic and the methods chosen are the right roads for me to explore.

09
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Appendix

Techonology of Agrivoltaic & Aquavoltaic

Agrivoltaic

Agrivoltaic is one of the terms to describe the integration of solar panels and agricultural activity. It can be divided based on its technology, typology, or pattern with lands. But in general, we can seem it into two categories: open-field APV(Agrivoltaics) and PV greenhouse (Toledo & Scognamiglio, 2021). Based on Taiwanese agriculture situation, open-field agriculture is the majority. Moreover, PV greenhouse is a closed system that has different influnce factors to agriculture with open-field APV. Therefore, the explanation of potential researches for the future is focusing on the open-field APV.

According to research, it is clear that APV needs to consider more details than traditional ones. Because of the combination with agricultural development, it is essential to consider factors that influence crop growth and find a balance that can create a win-win situation. Specifically, it needs to include the considerations of the crop types, orientation, and slope degrees of the panels. Crop types partly decide the technology implementation due to shadow-tolerance crops having more options, such as using low-height structures, which is more beneficial to costs, fewer environmental concerns, and landscape conflicts. Yet, shadow-intolerance crop needs to consider more, such as implementing the elevated structure of APV or different technology, using the half density of PV strip to increase radiation.

On the other hand, 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 rush to propose any particular solution because the local climate conditions and crop types create different demands and concerns of APV (Toledo & Scognamiglio, 2021). That is to say, it is urgent to start the experiment to explore the opportunities and define challenges: What types of applications fit with what kinds of crops? Otherwise, the multifunctional agricultural land use might become another tragedy, threatening food security, damaging the landscape, and making farmers lose their rights to work.

For example, Chiba University in Japan has listed a categories of 120 crops the perfrom most successful with APV (Chiba University, 2019), and combing with their Solar Sharing Network (APC, 2020), it is helpful to understand which types

❶ Types of Crops

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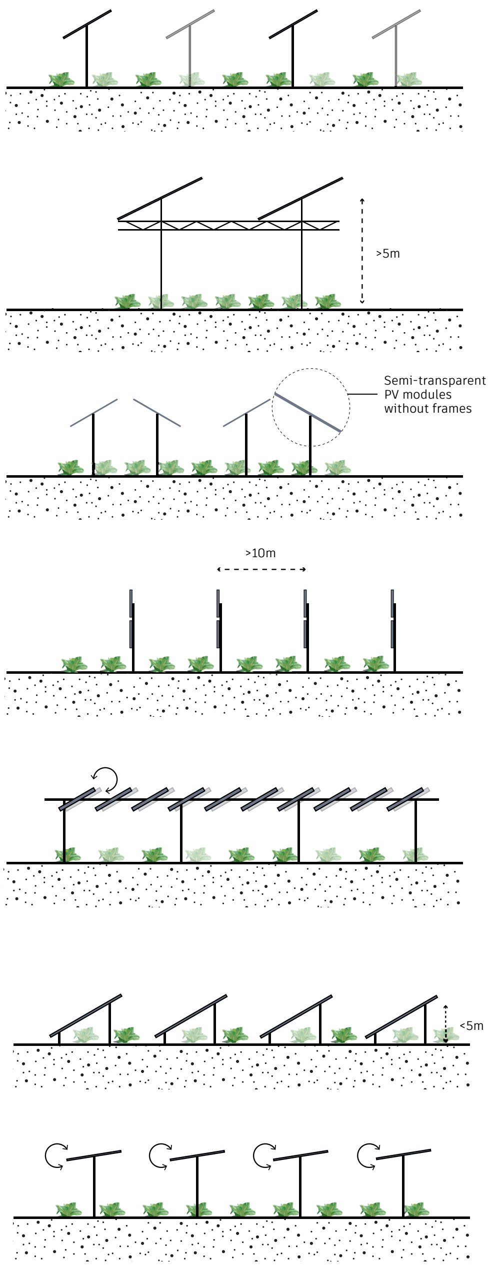
❷ Typology or Technology

Open-fields

Greenhouse

- Elevated Structure
  - Montpellier (France), full or half density
  - Heggeslbach (Germany), Fraunhofer®
  - Babberich (Netherlands), BayWa r.e.®
  - Guntramsdorf (Austria), Next2Sun GmbH®
  - Castelvetro (Italy), Agrovoltaico®
- Low Height Structure
  - Jodhpur (India), ICAR-Central Arid Zone Research Institute
- Others
  - Sun-tracking systems



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3a Energy Generation *Generation Factors* *Infrastructure Factors*

3b Social Acceptance *8 Factors of social acceptance to energy development*

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❹ Optimal Planning & Design

Fig 1: Agrivoltaic design framework

of APV suits with what kind of crops.

Fig 1 shows the design methodology for future local scale cases with a detailed design to develop multifunctional agricultural land use with solar energy. Toledo and Scognamiglio's (2021) study highlights that there are still no specific common factors that influence APV performance. Yet, the system pattern and the structure's height have the most effective results. Therefore, the proposal is based on the crop type to choose the design of the APV system. Then, combining the consideration of energy generation expectations, local situation (landform, local climate, etc.), and social acceptance (8 factors that influence societal opinions on renewable energy development) to optimize the design of the APV system.

Aquavoltaics

According to the Taiwanese government's proposals, there are three types of Aquavoltaics: Pillar type, Floating raft type, and Dikes type. However, the criteria of the design principles are few and fixed. To be more specific, the height of the PV structure is only demanded to be higher than three meters due to the only consideration of the potential flooding; the rotation is recommended to be between 6 to 8 degrees, overlooking the possibility of sun-tracking technology. Moreover, the morphology of the PV has yet to be detailed discussion on different design proposals for better implementation flexibility, such as different densities of panel strips or shapes and the distance between each structure.

Based on the experiment results, the ten most grown species in aquaculture in Taiwan are mostly able to maintain 70% of primary production under 40% of the cover rate with PV. This means the regulation of setting a 40% cover rate could be a practical proposal for Aquavoltaics. However, still needs more in-depth research to test the long-term production, environmental situation changes, and management plan.

Therefore, the discussion here presents the possibility of integrating more design variables for future testing to find a better combination of aquacultural and solar energy generation based on different types of species. To be more specific, including energy generation and social acceptance factors, such as landscape perspective or financial benefits distribution, to optimize the design, such as changing PV to semi-transparent PV to get more radiation.

❶ Types of Species

Outdoor Fishfarms

Indoor Fishfarms

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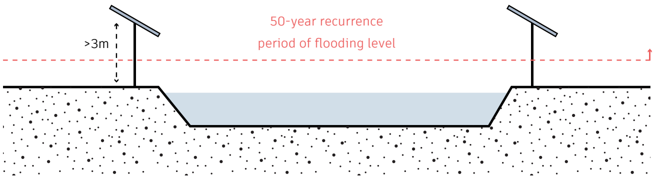
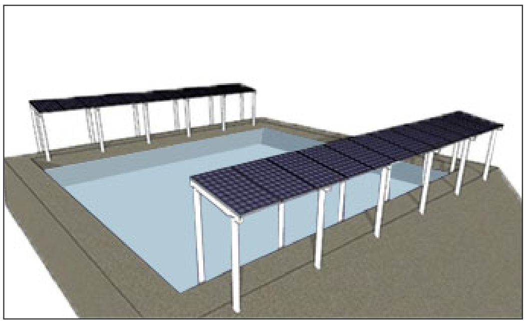
❷ Typology or Technology

Dike Type (Burea of Energy, 2023)

· *Height: >3m*
· *Inclination degree: 6-8 degrees*
· *Average wind speed to be withstood: 32.5 m/s^2*

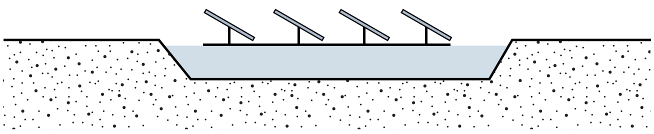


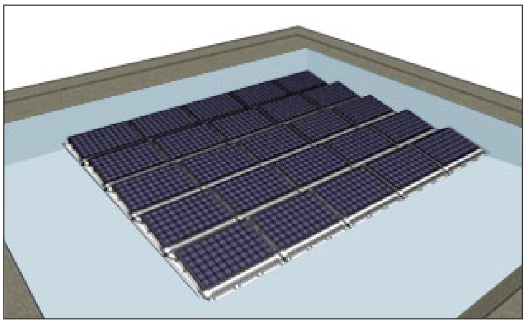


(Burea of Energy, 2023)

Floating Raft Type (Burea of Energy, 2023)

· *Material: HighDensityPolyethylene,HDPE*
· *Anchor structure: Based on wind tunnel experiment*
· *Average wind speed to be withstood: 32.5 m/s^2*

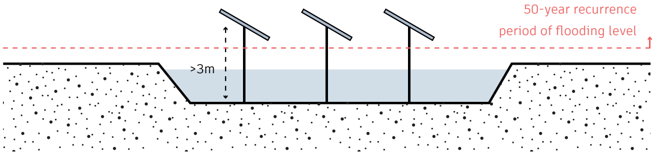


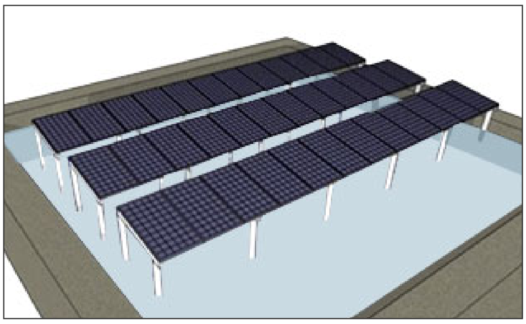


(Burea of Energy, 2023)

Pillar Type (Burea of Energy, 2023)

· *Height: >3m*
· *Inclination degree: 6-8 degrees*
· *Average wind speed to be withstood: 32.5 m/s^2*





(Burea of Energy, 2023)

Other Types: vertical typology; other shape designs

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3a Energy Generation — *Generation Factors*, *Infrastructure Factors*

3b Social Acceptance — *8 Factors of social acceptance to energy development*

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❹ Optimal Planning & Design sun-tracking techonology; Semi-transparent PV

Fig 2: Aquavoltaics design framework