RURAL REVITALISATION UNDER THE NET-ZERO CARBON GOAL

DINGHAI, ZHOUSHAN, CHINA

Status | Strategies | Smart Actions

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FOR A BETTER URBAN FUTURE

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First Edition

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Acknowledgements

Project supervisors	Bruno Dercon, Zhenshan Zhang
Project manager	Sheng Ying
Principal authors	Jiang Wu
Co-authors	Xin Wang, Yu Shi
Additional authors	Hongtao Wang, Zhengwei Li, Ru Guo, Haifeng Wang, Han Yu, Tianpeng Guo, Xun Chen, Xiaojing Cao, Yidi Zhang, Chao Xu, Bowen Tian, Qian Jia, Zimo Zhu, Zidi Wang, Hui Ma, Ye Chen, Jingshu Liu, Shiying Yu
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Cover photo Xinjian village, Dinghai District, Zhoushan City©People's Government of Dinghai District

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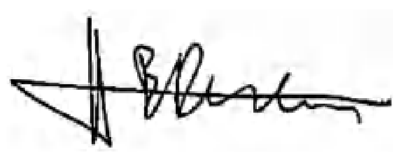
Foreword by UN-Habitat

Known as the "urban goal", Goal 11 of the Sustainable Development Goal (SDGs) aims to "make cities and human settlements more inclusive, safe, resilient and sustainable", with its specific target 11.a to "support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning". The New Urban Agenda also emphasized the importance of leveraging the opportunities for sustainable development within the urban-rural continuum, and the integration of SDGs into human settlements and urban planning at multiple levels and scale, including peri-urban and urban/rural settlements planning.

Despite worldwide urbanization acceleration, by 2020 more than 40 per cent of the world total population are still living in rural areas. The great and unleashed potential of a circular and dynamic circular economy cannot be neglected. To meet the carbon neutrality targets announced by governments, thorough investigation is needed to find net-zero carbon pathways for rural areas. Under the multiple pressures of socio-economic development, environmental pollution control and carbon reduction targets, the challenge of rural development and energy transition is drawing high attention.

In 2019, a joint team of UN-Habitat in collaboration with Tongji University produced the *Net-Zero Carbon Village Planning Guidelines for Yangtze River Delta Region.* I am pleased to see the ten principles set out in this report have now been implemented by the Dinghai District of Zhoushan City on a local village revitalisation programme, in collaboration with Tongji University. They developed the strategy of low-carbon-oriented development and revitalisation of Dinghai's villages, supported by 45 detailed indicators under ten aspects and four major categories. Economic, social and natural resource conditions of the villages were analysed under their current carbon emission status. Furthermore, a number of pilot projects were deployed and promoted in 79 villages of the district, on a variety of issues.

As an island region, Dinghai District is at the forefront of addressing climate change. I appreciate that the report explains Dinghai's emissions footprint and its exposure to extreme weather. The pathways and cases of rural revitalisation and zero carbon development in Dinghai District of Zhoushan City can provide valuable experience for rural low-carbon development in other small islands and coastal areas.



Bruno Dercon
Officer-in-Charge, UN-Habitat Regional Office
for Asia and the Pacific

Foreword by Zhoushan City

The rural revitalization strategy of China is crucial to achieving modernization in agriculture and rural areas, as well as to fully realizing socialist modernization and the accomplishment of the Second Centenary Goal. In 2020, rural population in Zhoushan accounted for around 34% of the total registered population. Making agriculture a promising industry, farmers an attractive profession, and rural areas a comfortable and prosperous home is what many Zhoushan people yearn for. Zhoushan city is sparing no effort to build a model of rural revitalization on the sea island under the scenario of common prosperity, and has embarked on beneficial explorations and practices through the implementation of "Five Major Actions," including deepening the high-quality development of agriculture, improving the overall quality of the rural areas, realizing common prosperity for farmers and rural areas, promoting digital reform in agriculture, rural areas and farmers, and invigorating agriculture and rural areas.
As the city of a thousand islands, Zhoushan takes the lead in taking actions to respond to climate change, which is highly forward-looking for its own development. Compared to the mainland areas in the Yangtze River Delta, the island areas have relatively scarce resources, such as freshwater, energy, and food. Therefore, water supply security, food security, tourism, local economy and human health are more vulnerable to the impacts of climate change. In 2020, China made a solemn commitment to the world to "strive for peaking carbon dioxide emissions before 2030 and achieving carbon neutrality before 2060," which further strengthens our confidence and determination to pursue net-zero carbon rural development.

Against this backdrop, Dinghai District of Zhoushan City takes the lead in responding to the national call and promotes rural revitalization under the goal of "net-zero carbon". It actively explores green, low-carbon, and sustainable rural development models. The low-carbon transformation to facilitate rural revitalization is in line with the natural resource endowment, industrial structure characteristics, and future development goals of rural areas in Zhoushan.

Cooperation with UN-Habitat and Tongji University provides international perspectives, professional advantages and comprehensive support for the practice of rural revitalization under the net-zero carbon goal in Dinghai. Dinghai fully considers various rural characteristics and establishes a systematic and differentiated approach to promoting net-zero carbon rural revitalization. Through the preparation of carbon emission inventories in villages, comprehensive research on rural industries and population development trends, Dinghai has classified 79 villages into four categories: Integrated Development Villages, Tourism-oriented Villages, Agriculture-based Villages, and Service-oriented Villages. Subsequently, strategies for promoting rural revitalization under net-zero carbon have been developed from four aspects: energy and resource utilization, low-carbon industrial development, low-carbon rural lifestyle, and governance. 10 categories with 46 development indicators have been proposed to promote the implementation of rural revitalization practices. These measures have made positive progress in pilot villages of Dinghai, such as building a net-zero carbon science popularization exhibition hall in Xinjian Village, promoting low-carbon and sustainable homestay tourism industry in Xinluotou Village, reducing carbon emission intensity in animal husbandry industry through renewable energy utilization like photovoltaic and biogas in Yandun Village, developing a light-driven circular water project in Maao Village, and increasing the proportion of renewable energy use in the redevelopment of agricultural market in Miaocun Village.

In the future, Zhoushan will continue to deepen the multi-stakeholder cooperation model among international organizations, academic institutions, local governments, and various enterprises, to bring new ideas, technologies, talents, and platforms to rural areas, and to continuously promote rural revitalization under the net-zero carbon goal, and fully build beautiful rural villages in the new era.

Jianming Jiang

Former Member of CPC Zhoushan Municipal Committee
and Deputy Mayor of Zhoushan

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During the research and preparation of this report, we have received great help from many institutions and experts, who provided valuable suggestions and comments for the consultation process.

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We would like to also thank the staff of Dinghai Tourism Development Group Co., Ltd, the staff of Mijing Hostel, Moze Qian of Lost Villa, the staff of Xin Qing Nong Fruit and Vegetable Co-operative, the staff of Shuoyuan Vegetable Co-operative, the staff of Yiran Eco Farm, the staff of Zhouda Agricultural Products Co-operative, the staff of Daman Aquaculture, the staff of Xuwang Aquafarm, the staff of Huasheng Ranch. The staff of these enterprises, rural hostels and farms, whio have first-hand experience of rural revitalisation in Dinghai, provided us with valuable experience and case materials in the study of rural revitalisation under the net-zero carbon goal.

Moreover, this report cannot be completed without the support in data collection from Kai Li of State Grid Dinghai Power Supply Company; the staff of Dinghai Tourism Development Group; Jthe staff of Natural Resources and Planning Bureau Dinghai Branch; the staff of Communication Department of Dinghai District, the staff of Policy Research Department of Dinghai District, and the staff of Statistics Bureau of Dinghai District.

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Executive Summary

To deliver the United Nations' 2030 Agenda for Sustainable Development and the Paris Climate Agreement, significant resources have been devoted to urban decarbonization and preferential policies have been made, and cities have seen many low-carbon transformation and development practices. Despite urbanization acceleration, the urban-rural gap is still significant worldwide, particularly in developing countries. How to respond to the challenges of climate change in revitalization and development calls for more attention in rural areas.

Villages in the island region are at the forefront of addressing climate change, and the exploration and practice of their net-zero carbon development path has strong representative and practical significance. Compared with the mainland area, the islands are relatively short of fresh water, energy, food, and other resources, and the economic and social development mainly depends on the supply from outside of the island, so they are more vulnerable to the impact of climate change on water supply security, food security, tourism, local economies, and human health. At the same time, the island has great potential to develop and utilize renewable energy, a strong willingness to improve the environment and develop tourism, which is conducive to promoting a green and low-carbon development model.

Dinghai District of Zhoushan, Zhejiang Province, China, pioneered in seeking rural revitalisation under the net-zero carbon goal. Based on a broad investigation, this report evaluated the planning and development in Dinghai, analysed and presented typical cases, summarized key experience, to provide a solution of low-carbon development of rural areas in the island.

Dinghai's practice in promoting rural revitalization under the net zero carbon goal is summarized as the 3S path as follows:

Status

Understanding the situation of carbon emission and development stage in detail is fundamental to making plans and taking actions. According to the trends of industrial development and demographic characteristics of the 79 villages in Dinghai District, the villages are classified into four types, namely, Integrated Development Village, Agriculture-based Village, Tourism-oriented Village and Service-oriented Village. Based on calculation standards of home and abroad and considering the data availability, this report develops a carbon calculation model for the villages in Dinghai, and summarizes its characteristics of carbon emission as follows:

1) In 2020, the net GHG emission of all villages in Dinghai is 614,900tCO_2e, of which GHG emission is 690,300tCO_2e and carbon sequestration is 75407.94tCO_2e. Energy consumption (electricity, LPG, petrol) contributes 93.25% of the emissions.

2) The per capita carbon emission in rural areas in Dinghai is 2.53tCO_2e, which is significantly lower than that in urban areas with 8.63tCO_2e. Analyzing the per capita emission intensity of 21 typical villages, it is found that the carbon emission intensity is closely related to the type of rural industry and the development of public services. Due to the high energy consumption of industrial and agricultural industries, the Per capita emissions of Integrated Development Villages and Agriculture-based Villages are higher, which are 0.92~5.31tCO_2e and 0.92~6.94tCO_2e, respectively. While the carbon intensity of Tourism-oriented Villages and Service-oriented Villages are 0.90~3.80tCO_2e and 0.83~1.35tCO_2e, respectively, which are lower. However, with the development of tourism and living standard, carbon emissions are expected to increase in these villages too.

3) In terms of the sources of carbon emissions in typical villages, the emissions from industrial and agricultural production account for 12%-84% of the total emissions of Integrated Development Villages and 38%-85% of Agriculture-based villages. And the emissions mainly come from agricultural processing and energy consumption such as electricity, diesel, and gasoline. Adjusting the industrial structure, Electrification of equipment and clean energy will reduce carbon emissions. Household and public facilities contribute 14-90% of the total emissions of Tourism-based Villages, and 54-94% of that for Service-oriented Villages, including the LPG used for cooking, petrol used for transportation, and electricity used by public facilities. Electrification of household equipment and vehicles, as well as sharing of public facilities will help cut the emissions.

Strategies

According to local characteristics and development needs, this report developed 46 detailed indicators under ten aspects and four major categories, namely, energy and resource, low-carbon industry, low-carbon lifestyle, low-carbon oriented governance, for the strategy of low-carbon-oriented development and revitalisation of Dinghai's villages.

1) Energy and resource. Dinghai mainly relies on coal for energy supply, to meet diversified and dispersed needs. It also has great potential of wind, solar, and biomass power. Water supply and waste treatment are dependent on the mainland, which consumes much energy. 14 indicators are established on renewable energy, water cycle and solid waste treatment.

First, to promote renewable energy, and increase its stability and use efficiency by smart microgrid. Secondly, to increase the capacity of rainwater harvesting, and water recycling. Moreover, to reduce garbage generation and promote recycling of organic waste as well as sustainable consumption.

2) Low-carbon industry. Under the net-zero carbon goal, industry upgrade needs to balance economy development and low-carbon emission. Large scale agriculture sectors of Dinghai, such as farming and aquaculture, generate relatively low carbon emission per GDP, while smaller-scale sectors including stock farming have higher carbon intensity. With the development of tourism, the carbon emission is expected to increase. Twelve indicators on agriculture and tourism are put forward in the model.

Firstly, to increase the efficiency of energy-water-food cycle, promote renewable energy and recycling of water and solid waste, and to create low-carbon agriculture brands. Secondly, based on current agricultural resources, to promote training and catering service and outdoor activities as well as low-carbon travelling.

3) Low-carbon lifestyle. Insufficient service facilities and inconvenient mobility still exist in Dinghai, particularly in remote villages. Newly built houses have higher carbon emissions during construction, while old houses have higher emission during operation due to their malfunction of insulation. Thus, 13 indicators were identified to cover fields of land use and transportation,., operation of building, and building materials.

Firstly, to increase the accessibility of public services and e encourage walking inside the village. Secondly, to promote

electrification of vehicles between city and villages, as well as inter-villages. Thirdly, to improve the environment of new public buildings including government buildings and tourism facilities. Fourthly, to make full use of idle building and reduce carbon intensity in the whole lifecycle of building, as well as encourage the use of recyclable and low-carbon materials.

4) Low-carbon oriented governance. Carbon inventory has been made for 21 villages in Dinghai, which are 1/4 of the whole district. Experts from UN Habitat and Tongji University have provided referential experience, strategy advise, and technical support. A governance model needs to be established at different levels. Seven indicators on awareness-raising and management of emission inventory have been initiated.

Firstly, to mainstream low-carbon concept and practice into daily life and tourism, to encourage the participation of local residents, tourists and urban residents. Secondly, to cultivate a Dinghai brand of low-carbon education, and promote the role of rural area in adapting and mitigating climate change. Thirdly, to keep improving the accounting and reporting of rural carbon emission inventories, build a regular evaluation mechanism for this workflow, and build grass-roots teams to support rural construction.

Smart Actions

Under the guidance of existing strategies, relevant departments of the Dinghai District government and local rural governance sectors cooperated to promote the construction of net-zero carbon. Through field investigation, this report selected 30 cases from four aspects: energy and resource, low-carbon industry, low-carbon lifestyle, and low-carbon oriented governance.

1) Circularity of resources and renewable energy. Mamu Island and Changbai Island deployed wind mills to make use of abundant wind and solar power (Case 1-3); Xinjian Village installed a smart micro-grid with wind-solar-storage (Case 1-1); Miaoqiao Village installed PV roofs in its wet market (Case 1-2); Maao recycled water and rainwater with Xikeng for villagers' daily life (Case 1-4), and water recycling in public toilets with PV installed roof (Case 1-5). In agriculture activities, Shuoyuan Vegetable Co-operative used ditches around their farm to collect rainwater (Case 1-6); In terms of recycling solid waste, Dinghai started to recycling pesticide bottles and mulch films for all villages (Case 1-7). and Huasheng Ranch reused their pig manure for organic fertiliser and supplied their own power with methane and PV panels (Case 1-8).

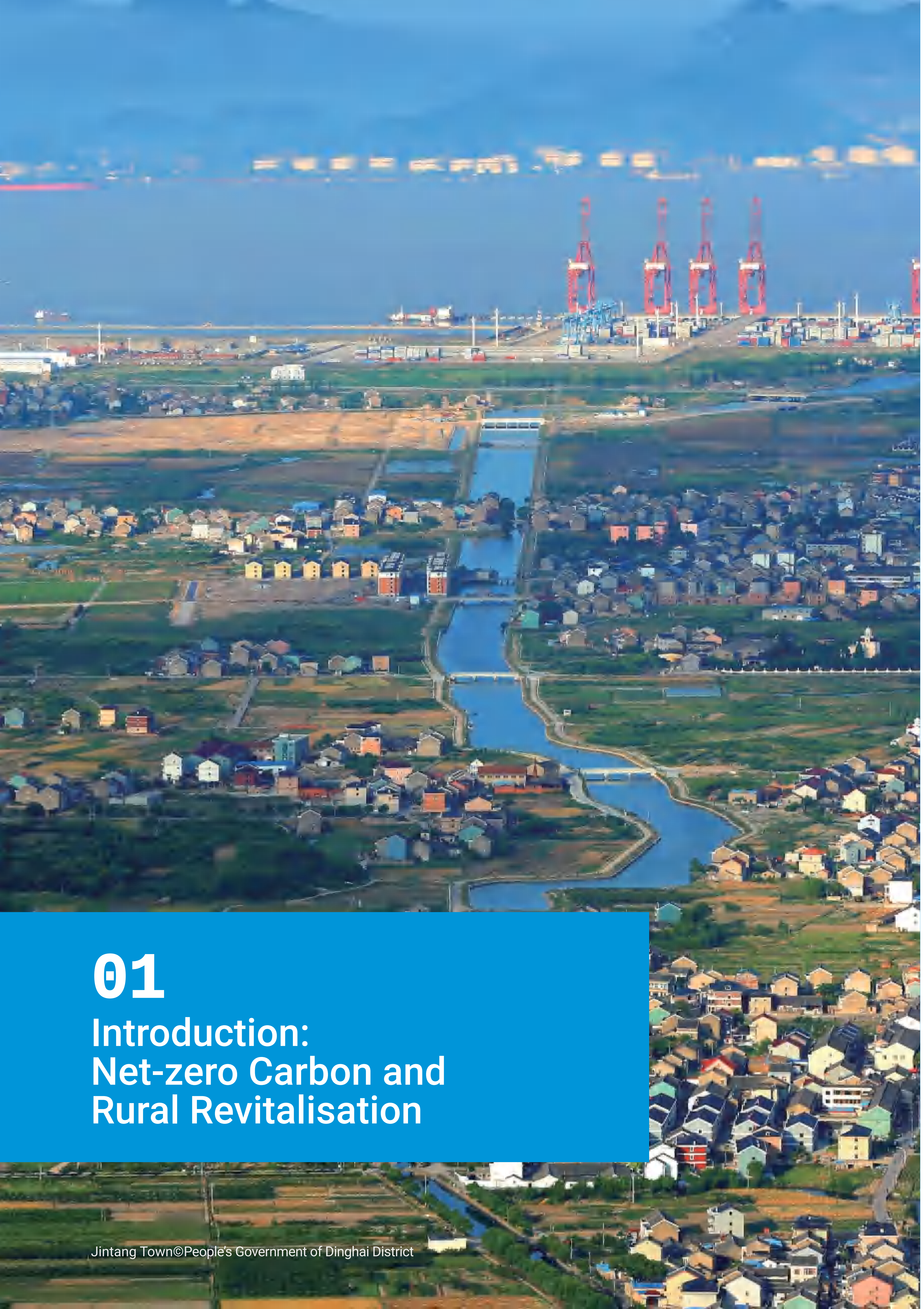
2) Low-carbon industry. To help the transition to low-carbon development of local agriculture, Dinghai Bureau of Agriculture and Rural Development has built a carbon emission management platform, to help cultivate the local brand "Dinghai Shan"(Case 2-3); By means of projects such as renewable energy utilization, organic fertilizer composting, reclaimed domestic wastewater for field irrigation, insulation performance improvement, and a zero-carbon digital platform, Yiran Farm endeavors to establish a zero-carbon farm (Case 2-1); Xuwang Aquafarm reduced their water and energy use efficiency with better management for their shrimp production (Case 2-2); Xinjian Village explored crafts making based on fishermen culture(Case 2-4); Xin Qing Nong Fruit and Vegetable Cooperative in Maao Village provided agriculture education for local students and companies (Case 2-5). To promote low-carbon tourism, Dinghai designed a tour route with electric vehicles (Case 2-9) and protected the carbon sink of forest in the newly developed tourism area (Case 2-6); Dinghai Tourism Development company linked the hiking routes of different villages and promoted outdoor activities which attracted numerous visitors (Case 2-8); Mijing Hostel also developed camping sites with a sustainable, low-impact way (Case 2-7).

3) Encourage a low-carbon lifestyle. Dinghai government encourages villages to make low-carbon development plan. Huangsha Ao invited experts from Tongji University to make the plan of rural revitalisation (Case 3-1), with a net-zero carbon goal including spatial planning, facility improving, low-carbon building design and tourism activity design (Case 3-2); Xinjian improved their spatial planning that villagers and tourists can reach service facilities easily, and designed transit parking area with solar powered car chargers in Huangsha Ao tourist area (Case 3-3); Maao Village also set up centralised parking area to create a nocar walking environment (Case 3-4); To reduce a lifecycle carbon emission reduction, Dinghai made use of available building, to convert old barracks into hostels (Case 3-5); Mijing Hostel also converted abandoned houses into hostels (Case 3-6), while Lost Villa employed smart energy management system for their tourist rooms (Case 3-7).

4) Enhance the capacity of low-carbon governance. By inviting a third party to provide professional consultancy, Dinghai used a multi participation governance mechanism (Case 4-1); Dinghai invited companies to jointly organise net-zero "Beautiful Countryside Week" (Case 4-2); Package-free stores promoted sustainable consumption (Case 4-3); local finance institutes provided "zero carbon loan" service (Case 4-4); Xinjian Village built a net-zero exhibition hall for tourists and villagers (Case 4-5); All levels of governments organised training sessions to raise the public awareness of low-carbon lifestyle. (Case 4-6).

Dinghai's strategies and practices under the net-zero carbon goal is an active response of island villages to the global climate crisis. In November 2021, eight villages including Xinjian Village in Dinghai are listed as provincial level Net-zero Model Villages, occupied 80% of all the selected villages in Zhoushan City and received further support from Zhejiang Province. The 3S path of Dinghai encourages active participation from multiple stakeholders, including the government, companies, organizations, and the public, which laid a solid and broad ground for the delivery of the 2030 Agenda. The strategy and practices of Dinghai can also provide experience for the development of similar island areas.


Aerial view of Dinghai District©People's Government of Dinghai District



Jintang Town©People's Government of Dinghai District

01
Introduction: Net-zero Carbon and Rural Revitalisation

1.1 Urban-Rural linkages in the context of sustainable development

Despite worldwide urbanization acceleration, 43.85 percent of the world total population is still rural. While urbanisation and urban growth is the main engine of economic development, most of the world's low-income population still live in rural areas and mainly rely on farming, livestock, aquaculture and other agri- cultural activities to make a living. Strengthening urban-rural linkages is essential for sustainable human settlement development.

It's undeniable that cities hold significant power in mitigating climate change. However, while most resources and policies are on cities' development and its carbon reduction potential, rural area is getting much less attention, neglecting rural is also the key to many Sustainable Development Goals (SDGs), including climate change.

Urban-Rural Linkages are nonlinear, diverse urban-rural interactions and linkages across space within an urban-rural continuum, including flows of people, goods, capital and information but also between sectors and activities such as agriculture, services and manufacturing. In general, they can be defined as a complex web of connections between rural and urban dimensions. In fact, many global development agendas put urban-rural linkages in emphasis. Known as the "urban goal", Sustainable Development Goal 11 aims to "make cities and human settlements more inclusive, safe, resilient and sustainable", with its specific target 11.a to "support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning"[8]. Moreover, healthy and productive urban-rural linkages can also contribute to rural revitalization, education for all, gender equality in rural areas, water safety, promotion of renewable energy, sustainable communities, responsible consumption and production, as well climate actions. The New Urban Agenda also emphasized the importance of leveraging the opportunities for sustainable development within the urban-rural continuum. [7]

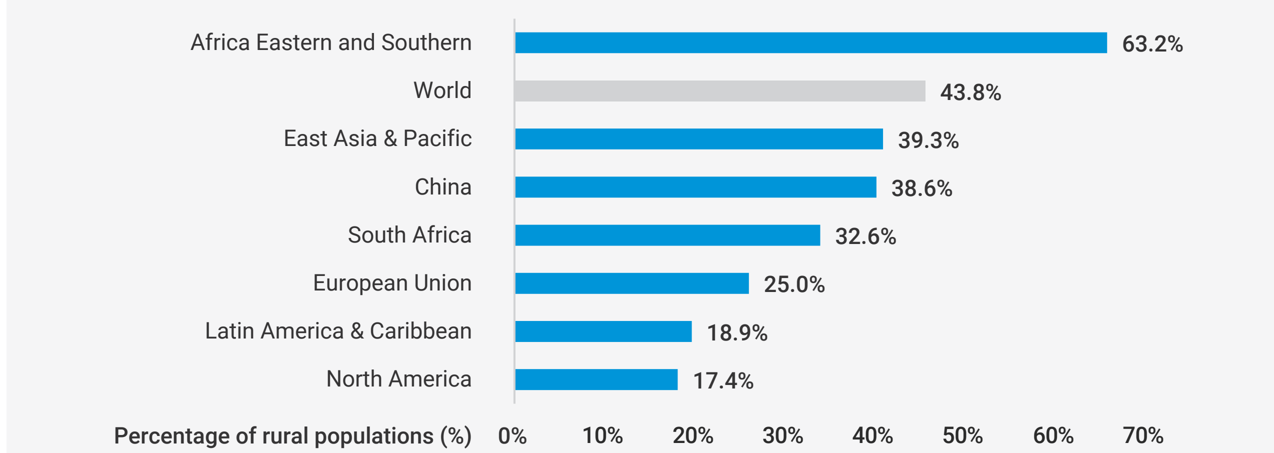


Figure 1-1-1 Percentage of rural population by continent in 2020 (Source: World Bank)

Many member states are fastening national efforts against climate change by passing carbon neutral commitments and legislations. The outcome document of COP26 climate negotiations in November 2021, first ever included standalone article about fossil fuels. Although with softened language at last minute, the document states "the phase-down of unabated coal power and of inefficient subsidies for fossil fuels". Member states also committed to firm up the global agreement to accelerate action on climate this decade, including halting and reverse deforestation by 2030, reducing methane emissions by 2030, ending the sale of internal combustion engines, and the United States and China pledged to boost climate cooperation over the next decade, all of which created a new era of low zero carbon development opportunities for urban and rural area.

Figure 1-2-1 Relevant SDGs under urban-rural linkages

1.2 Rural revitalisation under the net-zero carbon goal

A village that is both socially and economically revitalised, and at the same time with net-zero carbon emission, is perfectly aligned with the concept of circular economy that decouples resource from development. In fact, to build a net-zero carbon village provides enormous opportunities for rural revitalisation. The growth of economy and well-being can only come from better resource and energy efficiency, from increased investment to green innovation and higher ecosystem service value, which, on the other hand, bring about new economic growth entry points for sustainable rural revitalisation.

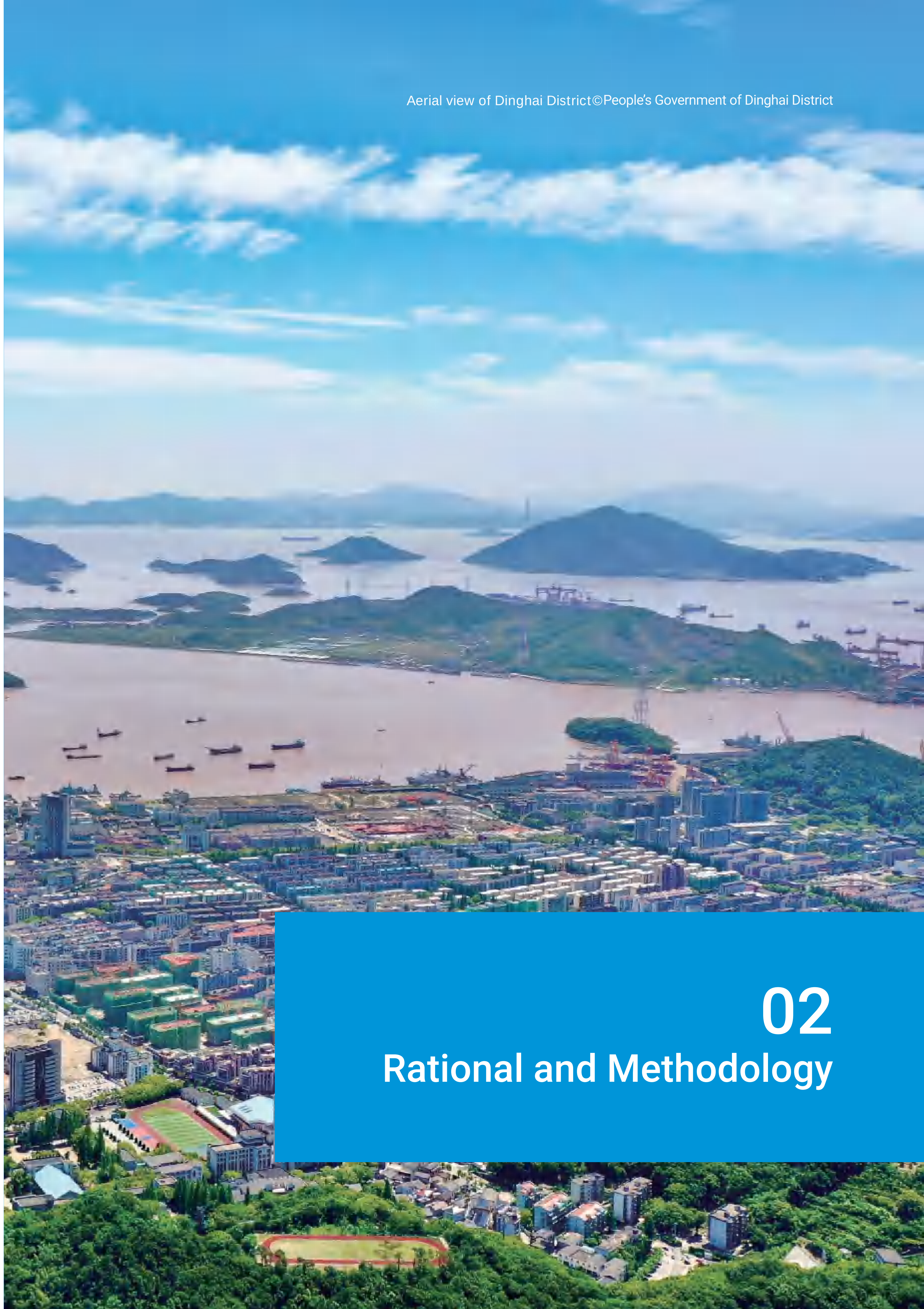
Every village, due to its geographic and demographic characteristics, economic structure and development status, is different from each other in terms of revitalising. Under China's carbon neutral target in 2060, many places have started reforms in their development path. There are numerous research studies on how urban area can better decarbonise. However, the practice and lessons learned from rural area are largely missing. Since 40% of the Chinese population are still living in rural area, the lens should be put there as well. Agriculture structure can be optimized according to resource distribution and global warming potential, while energy structure can be upgraded by utilising more renewable energy. Moreover, tertiary industry including eco-tourism and educational activities can be promoted to create more job opportunities. It would be useful to examine on the strategies of villages with different practices that may provide valuable cases for other rural areas to discuss and exchange.

1.3 Net-zero carbon village planning guidelines

Since 2018, UN Habitat and Tongji University started to work together to focus on a special area in China, the Yangtze River Delta, for its net-zero village planning. The report on Net Zero Carbon Village Planning Guidelines: Yangtze River Delta, China[9] analysed zero carbon village as a prototype of future sustainable rural settlements, and developed ten key principles for zero carbon village design, provided a framework from economic, social, and in particular, environmental perspective. The principles are:

1. *Climate data and greenhouse gas inventory*
2. *Well-connected mixed-use nodes*
3. *Heating and cooling*
4. *GHG emissions*
5. *Renewable energy sources*
6. *Water cycle*
7. *Solid waste*
8. *Energy, water, food and waste cycles*
9. *Employment opportunities and leisure*
10. *Ecological awareness*

The principles are also contextualized in the report in three selected villages in the delta, among which is Xinjian Community of Dinghai District, Zhoushan City. Based on the report, with third party's consultation, Dinghai District further expanded the contextualized village to all of its 79 villages and the ten principles into 46 specific targets, extended the efforts of rural revitalization and zero carbon village. The 79 villages have been grouped into Model Villages, Demo Villages and Pilot Villages. While Model Villages needs to implement all ten principles and Demo Villages needs to implement one or two of the principles.


Aerial view of Dinghai District©People's Government of Dinghai District

02
Rational and Methodology

Aerial view of Dinghai District©People's Government of Dinghai District

2.1 Dinghai as a unique case

Countries and cities on the island have unique development paths. Marine resource is drawing more and more importance on the national agenda, making island the forefront to marine development and a special link between urban and rural areas. Island villages face challenges of limited freshwater resource and unreliable energy supply. [1]In China, villages locate on islands have been developing rapidly in recent years, with changing land use and economic structure, as well as increasing energy demand.

On the other hand, island cities are among the most vulnerable hotspots against climate change. As indicated by the WHO report Human Health and Climate Change in Pacific Island Countries, "climate change in the Pacific is threatening the health of Pacific islanders, as well as economic and social development". Agriculture and fishery output will be affected by climate-induced natural disasters and rising sea levels in long term. Water and energy security will also be at risk. Thus, human health is vulnerable, along with water, energy, infrastructure, tourism, natural ecosystems, fisheries, forestry and agriculture.

Therefore, to revitalise island villages, shifting to circular economy with a low-carbon development path is the only sustainable option in the context of limited resources. Island villages have a unique opportunity and challenge to combine net-zero carbon target with revitalisation efforts.

Dinghai District of Zhoushan City in Zhejiang Province, China, is a typical island area at the East China Sea. Dinghai is facing this opportunity and challenge of decoupling resource and energy consumption when developing industries including agriculture, aquaculture and tourism while improving infrastructure and villagers' well-being. Dinghai has come up with its climate change mitigation and adaptation strategy, and made a scientific-based roadmap for low-carbon development. The case studies and lessons learned during this process will provide invaluable experience for other small islands and developing states with similar context. Moreover, rural revitalisation under net-zero carbon target will also encourage urban companions, through interactive urban-rural linkages, to reinforce more vigorous efforts in achieving the carbon neutrality together.

2.2 3S-Pathway to promote rural revitalisation under the net-zero carbon goal of Dinghai

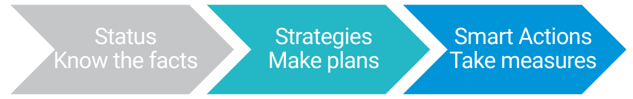


Figure 2-2-1 3S-Pathway to promote rural revitalisation under the net-zero carbon goal of Dinghai

The 3S-Pathway to promote rural revitalisation under the net-zero carbon goal of Dinghai can be summarised as below:

Status: to know the facts

Understanding the situation in detail is fundamental to making plans and taking actions. Facts include basic information on social and economic development, environment factors, as well as analysis of the carbon inventory, carbon emissions status, carbon sinks, and the key sectors with emission reduction potential in the process of development. This section will be described in detail in Chapter 3 of the report.

Strategies: to make plans

The strategy for rural is designed to promote rural revitalisation and reflect the requirements of net zero carbon at the same time. Dinghai District invited Tongji University, a professional third-party institution, to make the strategy based on PSR analysis and combine it with the ten principles proposed in the Net Zero Carbon Village Planning Guidelines: Yangtze River Delta, China by UN-Habitat. The joint team developed a strategy for energy and resource use, industrial development, lifestyle as well as governance. This section is elaborated on in Chapter 4 of the report.

Smart actions: to take measures

Guided by the strategies already in place, Dinghai District has promoted the construction of a net zero carbon village from top-down, where the district government works together with village leaders, state-owned enterprises, private enterprises, non-government organisations, and villagers. This report collects outstanding cases of low-carbon development in villages of Dinghai, which are also divided into four categories according to different strategies, as presented in Chapter 5.

2.3 Method and scope for accounting carbon emissions

2.3.1 Method for accounting

The overall carbon emissions status of the villages in Dinghai District was calculated and analysed. Model Villages and Demonstration Villages were selected to make carbon emission inventory and to explore their carbon emission characteristics from Integrated Development Village, Agriculture-based Village, Tourism-oriented Village and Service-oriented Village which represent different demographic characteristics and industrial types, were selected to make a thorough carbon inventory carry.

The method to calculate carbon emissions in Dinghai employed the carbon emission of villages in Yangtze River Delta region [3], the Provincial GHG Inventory Guidance in China [13], Zhejiang Province GHG Inventory Guidance [16], and Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) by the World Resource Institute (WRI) [10].

The factor for each GHG first refers to Zhejiang Province GHG Inventory Guidance[16], then the Provincial GHG Inventory Guidance in China[14], and the GPC.

2.3.2 Boundary of accounting

According to Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), the above-listed carbon emission can be divided into Scope 1, 2 and 3 according to whether it's directly or indirectly emitting.

Scope 1: Emission that happens within the boundary of rural area, e.g. nature gas combustion for cooking and heating, fuel combustion from villagers, agriculture and forestry.

Scope 2: Indirect emission from purchased energy.

Scope 3: All the other indirect emissions that are included in Scope 2, which can be considered as upstream emissions (raw material production, cross-boundary travel and purchased goods & service) and downstream emissions(cross-boundary travel, waste treatment and used goods & service).

Travel distance in the villages is rather short, thus GHG emissions from fuel-powered transport are included in Scope 1 and GHG emissions from electric transport are included in Scope 2 in the accounting. Given the availability of data,

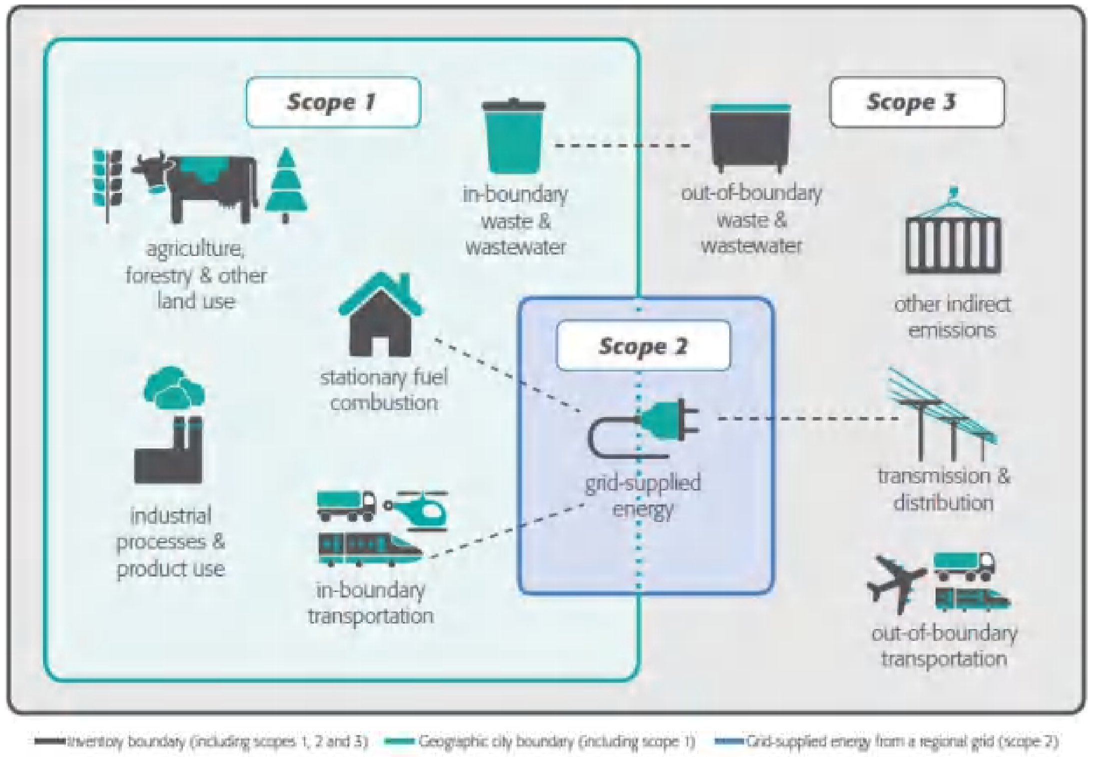


Figure 2-3-1 Three scopes of GHG accounting
(Source: GHG Protocol)

Scope 3 only considers the emissions from waste treatment in this report.
With all the above consideration, carbon accounting in this report consists of the following four sectors:

1.Energy: energy consumption from residential, industrial, commercial, agricultural and public service activities, such as household electricity consumption, electric vehicle charging and the use of LPG, gas and natural gas for heating, cooking and transportation. Combustion of petrol and diesel in industrial activities, commercial services, agricultural production. Electricity consumption in public service facilities, such as street lighting, sewage treatment facilities, government buildings, schools and hospitals.

Energy consumption consists of electricity use and fuel use. Electricity emissions fall under Scope 2 and emissions from local fuel use falls under Scope 1.

2.Agriculture: emission from the growing process of agricultural cultivation and the disposal of various types of waste including paddy rice (CH_4), other farmlands(N_2O), enteric fermentation (CH_4) and manure management (CH_4 and N_2O), which are included in Scope 1 since all agriculture activities happen locally.

3.Waste incineration: Since waste in Dinghai are collected and not treated locally, emissions from waste are included in Scope 3.

4.Forestry: Only carbon intake from the forestry and emission from land use change is excluded, so it's included in Scope 1.

In compiling the carbon emission inventory for rural areas in the entire Dinghai district, the main factors taken into consideration include the rural electricity consumption, the use of diesel fuel for agricultural purposes, the yield of agricultural products, and the rural resident population, based on the statistical yearbook of Dinghai district in 2020 . As for the compilation of typical village carbon emission inventories, the calculation is limited to the administrative boundaries of the village, excluding emission activities on non-village construction land[1]. There are industrial parks, wharfs, and warehousing facilities that mainly serve the development of the city in the non-village construction land of Dinghai's rural areas.

Therefore, the GHG inventory of Dinghai consists of energy activity (fixed and mobile fuel consumption) from Scope1, electricity consumption from Scope2 and waste incineration from Scope3.

2.3.3 Data source

The data for the carbon emission in Model Villages and Demonstration Villages was obtained mainly through surveys, and interviews with villagers, village managers and enterprise. District level data is obtained from Dinghai Statistical Yearbooks, as well as field investigation. The questionnaire is shown in Table 2-3-1.

Energy activities: Data on electricity consumption of Model and Demonstration Villages were mainly obtained through the electricity company, and other consumption data such as diesel, petrol and natural gas was obtained through survey on residents and companies. The Dinghai districtwide data for electricity and diesel came from the Dinghai District Statistical Yearbook (2020), and other energy use was extrapolated based on Model and Demonstration Villages.

Agricultural activities: Data of Model and Demonstration Villages was provided by the village office. Data on agricultural activities for the whole district were obtained from the Dinghai District Statistical Yearbook (2020).[21]

Waste treatment: In Model and Demonstration Villages, the data of household waste was mainly obtained from the survey on residents and village office, and the data of hazardous waste is obtained from the survey on companies. District level data was estimated from Model and Demonstration Villages.

Forestry: Data of forestry activities was from village statistical records. For the data of tree (arbor) stock, reference is made to the proportion of tree (arbor) stock is 71.09% of forest land, accord- ing to the "Bulletin of Forest Resources and their Ecological Value in Zhejiang Province" and the unit area storage of nat- ural tree (arbor) forest is estimated at 80.51m^3/ha.[17]

Figure 2-3-2
Survey on villagers

Figure 2-3-3
Survey on companies

Figure 2-3-4
Survey on village managers

1.According to the Land Use Classification Guidelines for Village Planning(Jiancun[2014]No.98) of the Ministry of Housing and Urban-Rural Development, non-village construction land includes two categories: land for external transportation facilities and state-owned construction land. Land for external transportation facilities includes land for village external contact roads, transit highways, railways, and other transportation facilities. State-owned construction land includes land for public facilities, special use land, mining land, and management and service facilities for border ports, scenic spots, and forest parks, etc."

Table 2-3-1 Data source

Type of activity	Type of specific activity	Type of emission source	Scope	Data source at village level	Data source at district level
Household activity	Residential	Electricity	Scope 2	Power companies	Statistical yearbooks
		Fuel	Scope 1	Survey	Estimation from Model and Demonstration Villages
	Transportation	Electricity	Scope 2	Power companies	Statistical yearbooks
		Fuel	Scope 1	Survey	Estimation from Model and Demonstration Villages
Agriculture activity	Cultivation	Fuel	Scope 2	Power company, survey on companies	Statistical yearbooks
		Electricity	Scope 1	Survey on village managers	
		Growing process	Scope 1	Survey on village managers	
	Aquaculture	Fuel	Scope 2	Power company, Survey on companies	
		Electricity	Scope 1	Survey on village managers	
	Livestock	Fuel	Scope 2	Power company, Survey on companies	
		Electricity	Scope 1	Survey on village managers	
		Growing process	Scope 1	Survey on village managers	
Industrial and commercial activity	Food processing	Electricity	Scope 2	Power company, Survey on companies	Statistical yearbooks
		Fuel (production)	Scope 1	Survey on companies	/
		Fuel (transportation)	Scope 1	Survey on companies	/
	Other	Electricity	Scope 2	Power company, Survey on companies	Statistical yearbooks
		Fuel (production)	Scope 1	Survey on companies	/
		Fuel (transportation)	Scope 1	Survey on companies	/
	Commercial and service activity	Electricity	Scope 2	Power companies, Survey on companies	Statistical yearbooks
Public service	Solid waste	Domestic waste	Scope 3	Survey on villagers and companies	Estimation from Model and Demonstration Villages
		Hazard waste	Scope 3	Survey on companies	/
		Sludge	Scope 3	Survey on companies	/
	Government	Electricity	Scope 2	Power companies	Statistical yearbooks
	Collective economy	Electricity	Scope 2	Power companies	
	Infrastructure and service	Electricity	Scope 2	Power companies	
Carbon sink	Standing forest stock	Standing forest stock	Scope 1	Survey on village managers	Statistical yearbooks

2.4 PSR analysis of Dinghai and strategy for rural revitalisation

Dinghai uses PSR model[2] to analyze Dinghai's situation in terms of rural revitalization in order to make scientific-based targets and strategies.

The pressure of building a net-zero carbon village comes from the challenge of developing rural economy and reducing carbon emissions. Like cities, villages are also in need of improving infrastructure and well-being, to reverse the population loss and care for the aging group. Although carbon emission may seem less worrisome in rural area when we talk about transportation or buildings in the cities, the main rural industries, including agriculture, forestry and aquaculture, are actually important sources of greenhouse gases. The agriculture, forestry, and other land use (AFOLU) sector is responsible for 25% of anthropogenic GHG emissions mainly from deforestation and agricultural emissions from livestock, soil and nutrient management. For example, nearly 40% of greenhouse gas (GHG) emissions in Latin America were from AFOLU sector in 2008. Agriculture alone contributed 15% GHG emissions in China in 2014. Rural area has a tremendous potential to mitigate climate change.

The analysis on the state, which covers economic, social and environmental aspects, gives scenario setting for choosing pathways for rural revitalization. To revitalize the rural villages under a net-zero carbon goal, the analysis needs to include not only conventional indicators like demographic and industrial features, but also localized greenhouse gas inventory.

Responding to the pressure based on the current status, measures must be taken from industries, energy structure, local lifestyle, and governance. Low-carbon development of rural industry needs to consider the current industrial base and its carbon reduction entry points, in order to increase the local income without heavy resource input and high emissions. To encourage traditional rural lifestyle that is usually frugal on resource and energy, the infrastructure needs to embed with low-carbon ideas as well to diminish environmental impact as much as possible. Energy and resource for rural area can stand relatively separate from the urban energy system, by renewable energy from local resource and recycling.At the same time, effective governance can be achieved through a specialised professional team and implementation strategy, to mobilise every stakeholder to take actions.

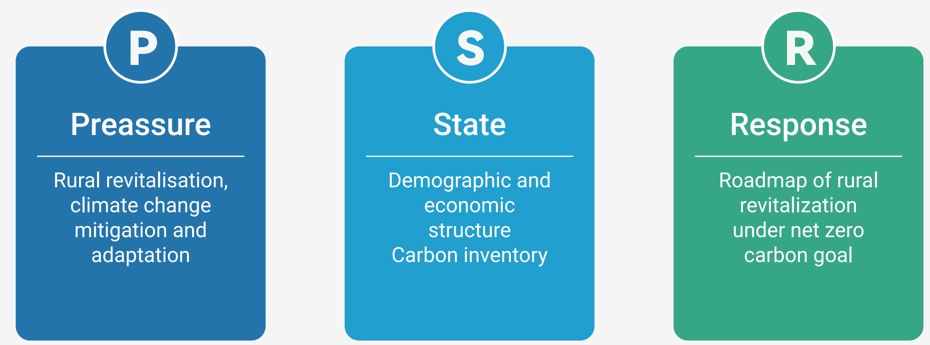


Figure 2-4-1 PSR analysis for rural revitalisation under the net-zero carbon goal

2.Pressure-State-Response (PSR) model were developed by Rapport and Antony Friend in the 1970's, then applied and promoted by OECD and UNEP. It can clearly describe existing pressure, the state of affairs and in turn calls for intentional response , which provides a way to articulate scenario with indicators.

2.5 Method of case studies

The assessment of case studies first introduces basic information of each case, including the location, implementer and related SDGs and net-zero carbon village planning principles. The concept of design provides the context and techniques applied in the case, and how the concept of net-zero carbon is embedded in each case.

Environmental benefits were evaluated in both qualitative and quantitative ways. Carbon reduction benefit is based on Regional Grid Baseline Emission Factors of 2019 Emission Reduction Project China, released by the Ministry of Ecology and Environment of China. [18]

Finally, according to the UN's Net-zero Carbon Village Planning Guidelines and the requirements of rural revitalization in China, suggestions for optimization and improvement are put forward for the project.

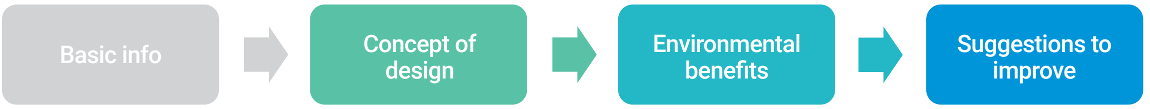


Figure 2-5-1 Case evaluation flowchart

Table 2-5-1 List of case studies

Type of case studies		No.	Name	Page
Energy and resource	Renewable energy	1-1	Wind-solar-storage micro-grid system	44
		1-2	Village farmers'market using new energy	46
		1-3	Cengang wind mill	49
	Water cycle	1-4	Xikeng water circulation system	50
		1-5	Eco restroom with PV installed roof	52
		1-6	Store rainwater for irrigation	54
	Solid waste	1-7	Collection and recycling of pesticide bottles and mulch films	56
		1-8	Reuse livestock waste	57
Low-carbon industry	Low-carbon agriculture	2-1	Low-carbon aquaculture through better management	60
		2-2	Low-carbon aquaculture through better management	64
		2-3	Branding of "Dinghai Shan" and build integrated carbon emission management platform	66
	Synergies between industries	2-4	Integrating fisherman culture to develop handicrafts	68
		2-5	Educational activities on the farm	69
	Low-carbon leisure activity and tourism	2-6	Protect carbon sink in tourism development	70
		2-7	Develop camping site	71
		2-8	Promote hiking and other outdoor sports	73
		2-9	Provide electric vehicle tour for tourists	75
Low-carbon lifestyle	Low-carbon oriented spatial planning	3-1	Low-carbon oriented spatial planning	76
		3-2	Spatial planning to optimise service distribution	79
		3-3	Transit parking lot for hostels	81
		3-4	Set up centralised parking area for a car-free village	83
	Reduce lifecycle carbon emissions of buildings	3-5	Convert old barracks into hostel	84
		3-6	Convert vacant houses to hostel	86
		3-7	Sound management of energy in hostel	87
Low-carbon oriented governance	Multiple participation	4-1	Professional insights from third-party	89
		4-2	Net-zero "Beautiful Countryside Week"	90
		4-3	Delivering the concept of sustainable consumption with packaging-free stores	91
		4-4	Green finance	92
	Ecological awareness	4-5	Practice and pilot of net-zero carbon villages	93
		4-6	Ecological awareness/knowledge training for government staff	96

03 Status: Fact-checking

Xinjian Village© People's Government of Dinghai District

3.1 Basic information of Dinghai

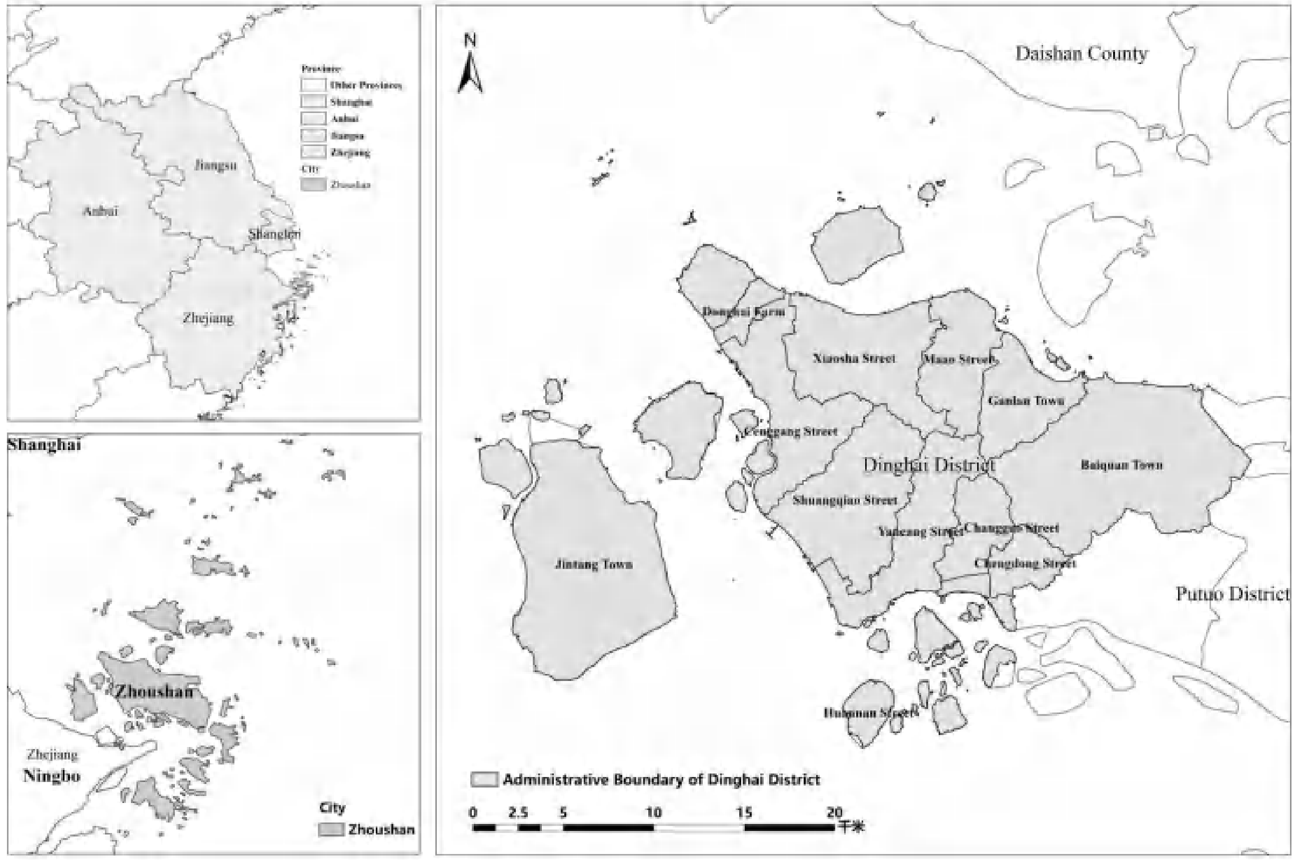


Figure 3-1-1 Location of Dinghai District

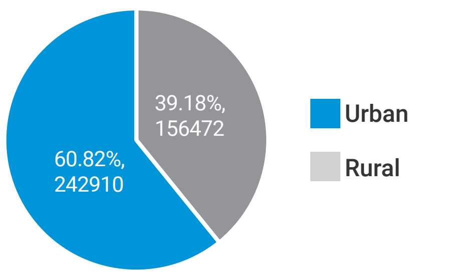


Figure 3-1-2 Rural and urban population of Dinghai (registered permanent population)

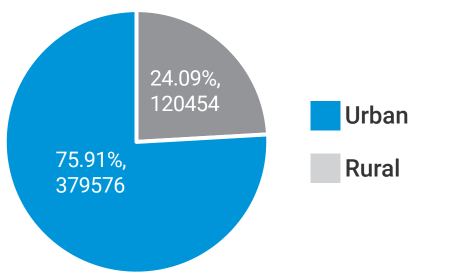


Figure 3-1-3 Rural and urban population of Dinghai (resident population)

Located in Zhoushan city, Zhejiang Province (Figure 3-1-1), Dinghai District has 128 islands with a combined area of 1444km^2 (568.8 km^2 of land and 875.2 km^2 of sea). It has a coastline of over 400km. There are 79 villages in this district under 11 street offices. Farmland covers 7710 hectares, and forest covers more than 22,000 hectares. Villagers mainly rely on agriculture, aquaculture, tourism, building and construction, and manufacturing. Quite a number of villagers migrate to cities to work.

More local people prefer living in cities. In 2019, the registered permanent population in Dinghai was 399,400, with 39.18% rural population. According to the 2020 National Census, the resident population in Dinghai is 502,100, while rural occupies 24.09%.

Rural areas differ in their natural, social, and economic characteristics. Therefore, based on the rural characteristics, the existing 79 villages in Dinghai district have been classified into four types: Integrated Development Village, Agriculture-based Village, Tourism-oriented Village and Service-oriented Village. The current classification of rural areas

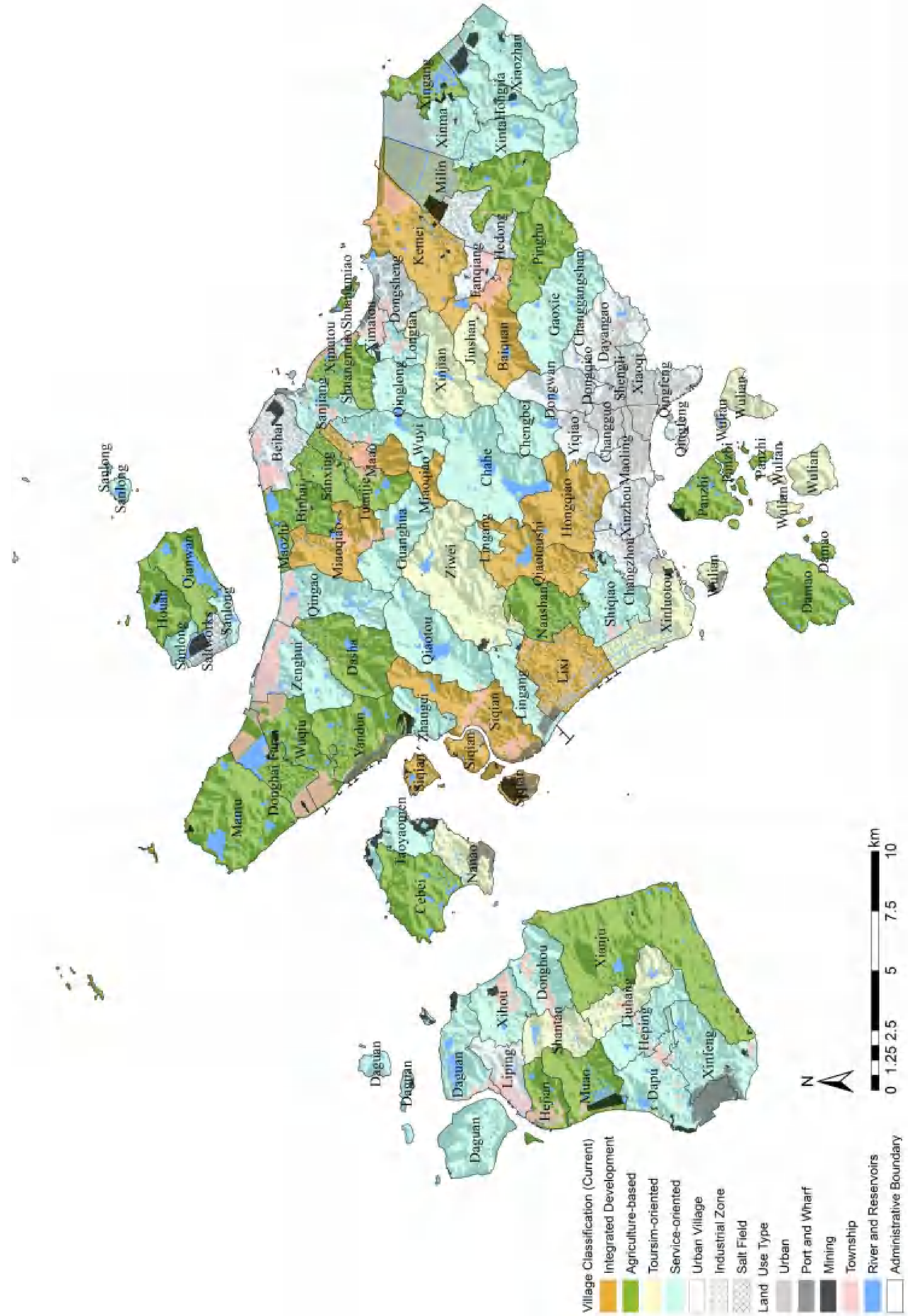


Figure 3-1-4 Classification of rural areas in Dinghai District (Current Situation)

takes their specific characteristics into account (as shown in Figure 3-1-4), as well as the development goals of different rural areas with the urban-rural development plan[3] in both the short and long term. For instance, villages that are close to cities will further urbanize, while villages with abundant resources will develop their tourism resources, village with less population will be merged in the future, which are considered by an adjustment to the classification of rural areas (as shown in Figure 3-1-5).

Integrated Development Village refer to the villages in the suburban areas and around Chengguan Town, where the infrastructure is well-equipped, the population is concentrated, the transportation is convenient and the overall development level is high. These villages have the advantage of being able to demonstrate the construction of a net-zero carbon village in all aspects.

Agriculture-based Villages have a good agricultural development base, with large-scale agricultural industries, including agricultural planting, fishery and livestock. Fishery and livestock consume relatively high amounts of energy and can be combined with renew able energy and technological innovations to explore ways to reduce carbon emissions. At the same time, agriculture can be combined with service industries such as education and tourism to increase farmers' income and raise the average land value.

Tourism-oriented Villages rely on the current natural landscape as well as historical and cultural resources, which can tap into the local cultural heritage, and focus on developing cultural tourism, and related supporting service industries. Some villages are currently facing the challenge of population loss. While promoting local culture, carbon emissions in development, construction and operation phase should be minimized. Pedestrian prioritised plan can be adopted in the plan, while preserving the nature carbon sink. Relatively low-carbon cultural and creative industries such as handicrafts and tourism should be introduced to increase employment.

Service-oriented Villages still have a large number of permanent residents who are engaged in agriculture and other activities on an individual basis, but the village does not have distinctive industrial characteristics and its main function is to provide supporting services and residential facilities. They need to focus on low-carbon household aspects, further improving the quality of the living environment, the accessibility of service facilities and public transport.

3.The Planning (Zoning Planning) of Dinghai District, Zhoushan Archipelago New District

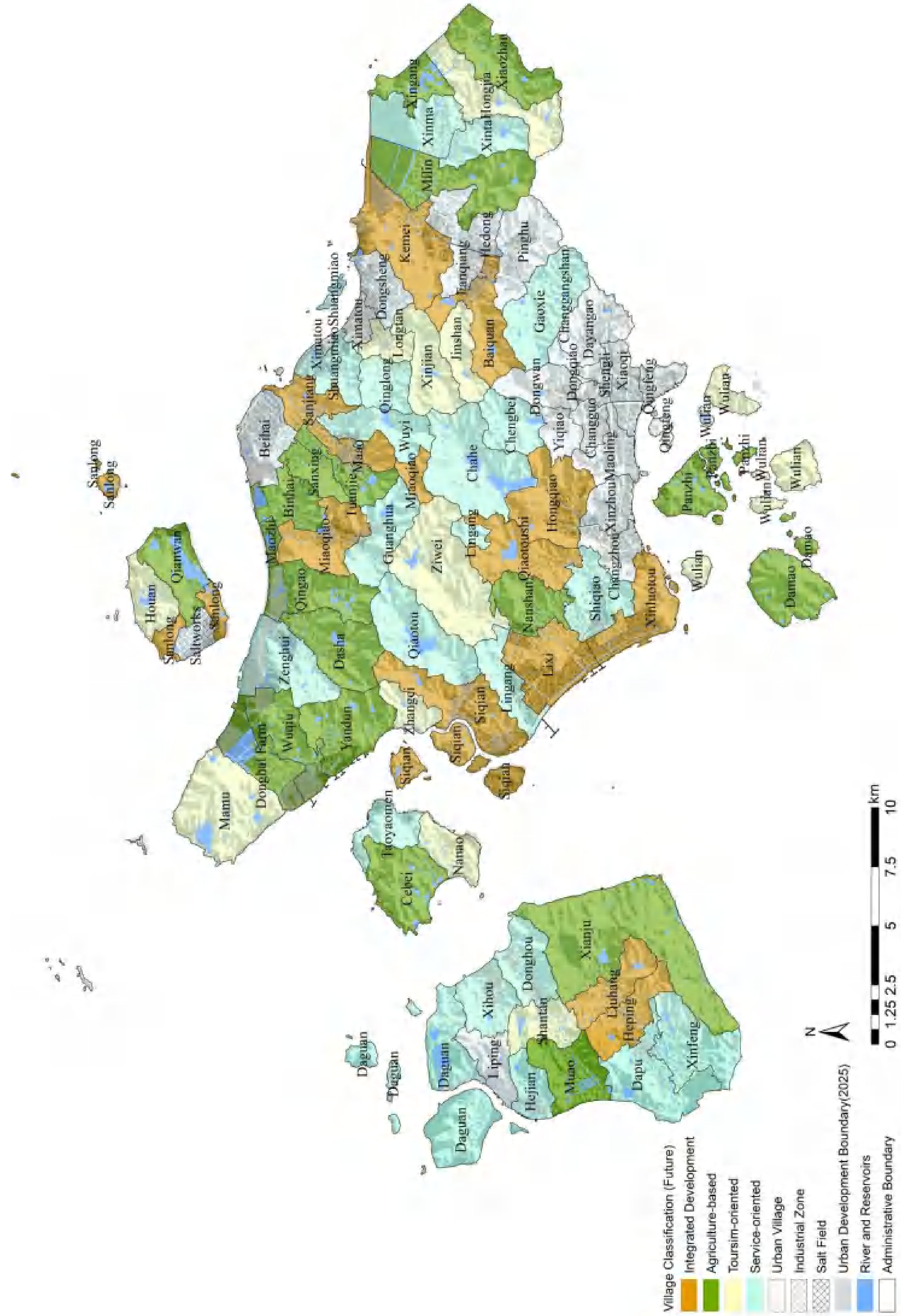


Figure 3-1-5 Classification of Villages in Dinghai District (Planning Vision)

3.2 GHG Inventory analysis

3.2.1 GHG Inventory analysis of villages in Dinghai

According to the calculation, the net GHG emission of all villages in Dinghai is 614,900tCO_2e, of which GHG emission is 690,300tCO_2e and carbon sequestration is 75407.94tCO_2e. Energy activities contribute the most emission, while waste treatment contributes the least. Details of each sector can be found in Table 3-2-1.

Among energy activities, electricity consumption has the highest emission (80%). Apart from energy consumption from industrial activities, household consumption is the main source of GHG emissions. Villagers usually use diesel for transportation, which contributes 12% of all emissions.

Table 3-2-1 GHG emission of different sectors in Dinghai (including carbon sink)

Emission sector (tCO_2e)	Energy	Agriculture	Forestry	Waste treatment
GHG emission	643,705.05	3,0604.73	-75,407.94	16,005.76
Net GHG emission	614,907.59			

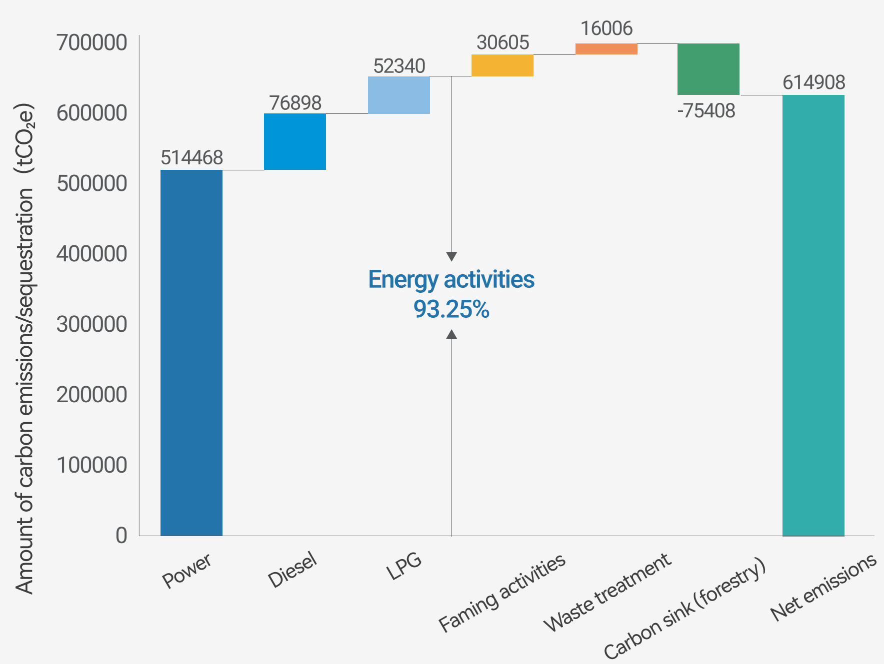


Figure 3-2-1 Carbon emissions/sequestration of different sectors for all villages in Dinghai

3.2.2 GHG Inventory analysis of selected villages

Based on the carbon inventory of 21 villages including the Model Villages and Demonstration Villages, all the villages are divided into four types, namely, Integrated Development Villages, Agriculture-oriented Villages, Tourism-oriented Villages and Service-oriented Villages, in order to analyse carbon emission intensity and provide scientific bases for low-carbon policy making.

01 Total emissions

Comparing the carbon emission of selected villages (Figure 3-2-2), most villages have higher carbon sequestration than carbon emissions. Among them, Wulian Village, Hongjia Village, Xinjian Village, Damao Village and Chengbei Village are already net-zero due to their large forest, and few residents. In general, Integrated Development Villages have higher carbon emissions, and Service-oriented Villages are usually lower.

Integrated Development Villages have relatively high total carbon emissions with a wide range of types. Due to the presence of large rural enterprises and being the regional administrative center, Miaoqiao Village and Ma'ao Village have higher total emissions with a larger proportion of industrial emissions. Lixi Village, also a regional administrative center, has already incorporated industrial enterprises within the boundary into industrial complex management. As a result, the proportion of public service emissions is relatively high while industrial emissions are relatively low.

Tourism-oriented Villages have low overall emission levels. Some villages have developed tourism projects such as homestays based on convenient transportation and natural landscapes, such as Xinluotou Village. Some villages have high carbon sinks due to their fewer residents but abundant natural resources. A few types of villages have achieved negative carbon emissions, such as Wulian Village and Xinjian Village. There are also villages that promote their cultural characteristics and have a long history with relatively high resident populations, resulting in higher life services emissions, such as Ziwei Village, Jinshan Village, and Liuxing Village.

Agriculture-oriented Villages have a large variation in total carbon emissions. The total emissions are closely related to the main agricultural types of the village, such as Yandun Village which mainly engages in animal husbandry, result-

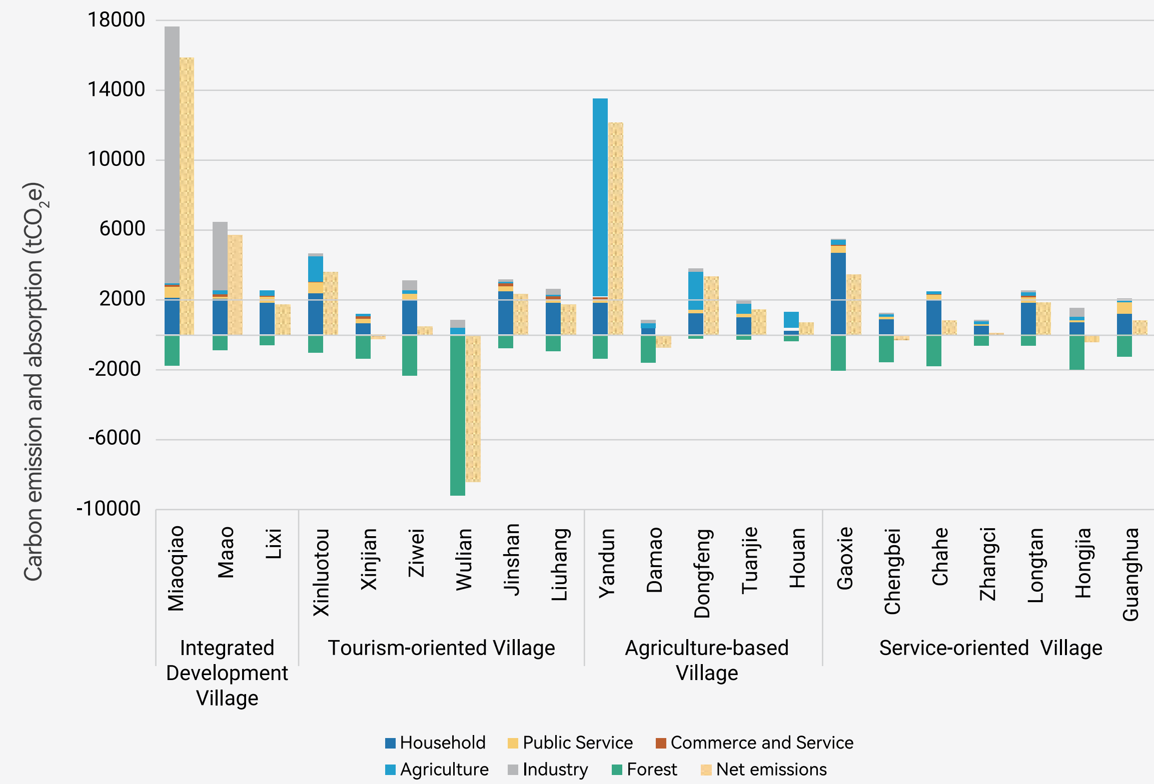


Figure 3-2-2 GHG emission and sequestration of the four types of villages

ing in the highest total emissions. Dongfeng Village has agricultural product processing enterprises, contributing to relatively high emissions. Hou'an Village is dominated by aquaculture enterprises, resulting in high emissions. However, villages like Damao Village and Tuanjie Village which focus on agricultural planting have the lowest total emissions. Service-oriented Villages have low overall emissions levels. Total emissions are strongly associated with the population of the village's service sector, such as Gaoxie Village having the highest emissions due to its higher population.

02 Carbon intensity

Emission intensity is measured by the carbon emissions per capita of the resident population (Figure 3-2-3). Household emissions per capita are the sum of household and transportation. Total emissions per capita are the total rural carbon emissions per unit of resident population.

The per capita total emissions of Dinghai is 2.53tCO_2e per person, which is much lower than the average value of that in Zhejiang Province and Zhoushan City (8.63 tCO_2e per person). The emission intensity varies significantly across villages, affected by industrial types, agriculture types and public service level. Among them, Integrated Development Villages and Agriculture-based Villages have higher carbon intensity, which is 0.92~5.31tCO_2e and 0.92~6.94 tCO_2e per person. Due to the industrial and agricultural sectors having relatively high energy consumption and various types, the carbon emissions intensity of these two types of rural areas is considerably greater and also shows great variability. The carbon intensity of Tourism-oriented Villages and Service-Oriented Villages are 0.90~3.80tCO_2e and 0.83~1.35tCO_2e per person, respectively. Currently, the per capita carbon emissions intensity is relatively low. However, with the rising living standard and the development of tourism, the value will probably increase.In terms of per capita household emissions, all villages have a value below 2tCO_2e/person, which is very small. There is no significant difference between the four different types of villages.

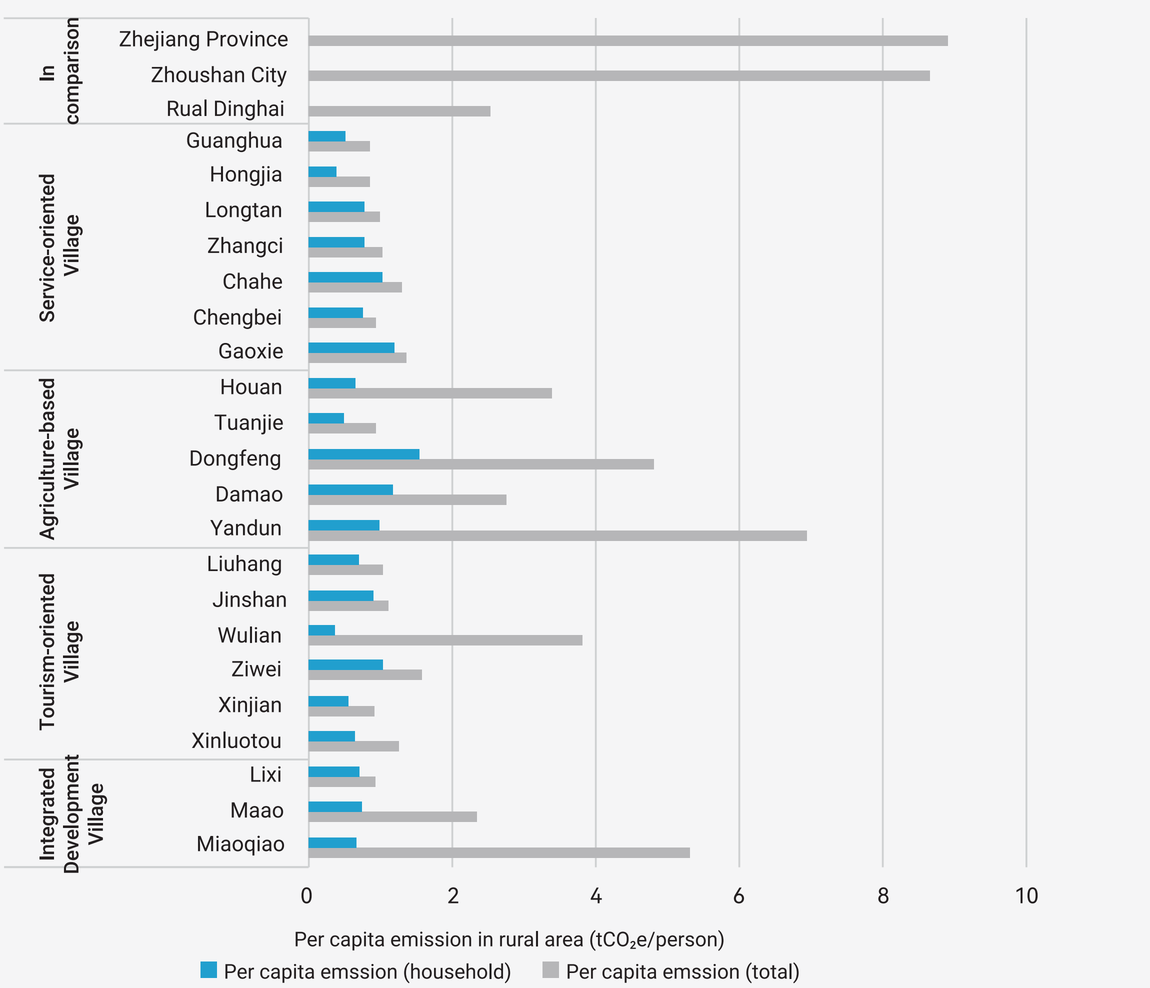


Figure 3-2-3 Carbon intensity of different villages

03 Source of carbon emissions

The sources of carbon emissions are divided into four categories according to the type of human activity, with residential living comprising home living and transport travel. Agricultural production includes farming, aquaculture and livestock farming.

Integrated Development Villages are centered around life and industry. There is a rich mix of emission activities, including rural industry, daily living, agriculture, and public services. Among them, the industrial manufacturing emissions of Mao'ao Village and Miaocao Village accounted for 62% and 83%, respectively. While the emissions in Lixi Village are primarily from residential living and public services, accounting for 74% and 14%, respectively. In order to reduce emissions, corresponding measures can be proposed targeting industrial enterprises, agricultural production, public services, and residential living.

Tourism-oriented Villages have a relatively high proportion of commercial and service industries. In addition to serving the villagers, it also has tourist service facilities for visitors. Residential and public facilities contribute 60% of the emissions. With the development of rural tourism, proposals for low-carbon tourism development are needed.

Agriculture-based Villages have a relatively high share of carbon emissions from agricultural activities, as well as the processing and manufacturing of agricultural products, which occupies 29%-84% of the total emissions. There is a need to propose emission reduction measures for different types of agriculture.

Table 3-2-2 Source of carbon emissions
(based on human activities)

Type	Details
Household	Residential
	Travel
Agriculture	Cultivation
	Aquaculture
	Livestock
Industry	Food processing
	Manufacturing
	Commerce and service
Public service	Solid waste treatment
	Government and institutions
	Collective economy
	Infrastructure services

The structure of emissions in Service-oriented Villages is similar, mainly from residential and living, public services, and together generate 46%-87% of the total emissions. Carbon reduction strategies need to be proposed for residential life and public facilities.

The structure of emissions in Service-oriented Villages is similar, mainly from residential living, public services and a small amount of agricultural cultivation. Among them, residential living and public services together generate 88%-94% of the total emissions. Carbon reduction strategies need to be proposed for residential life and public facilities.

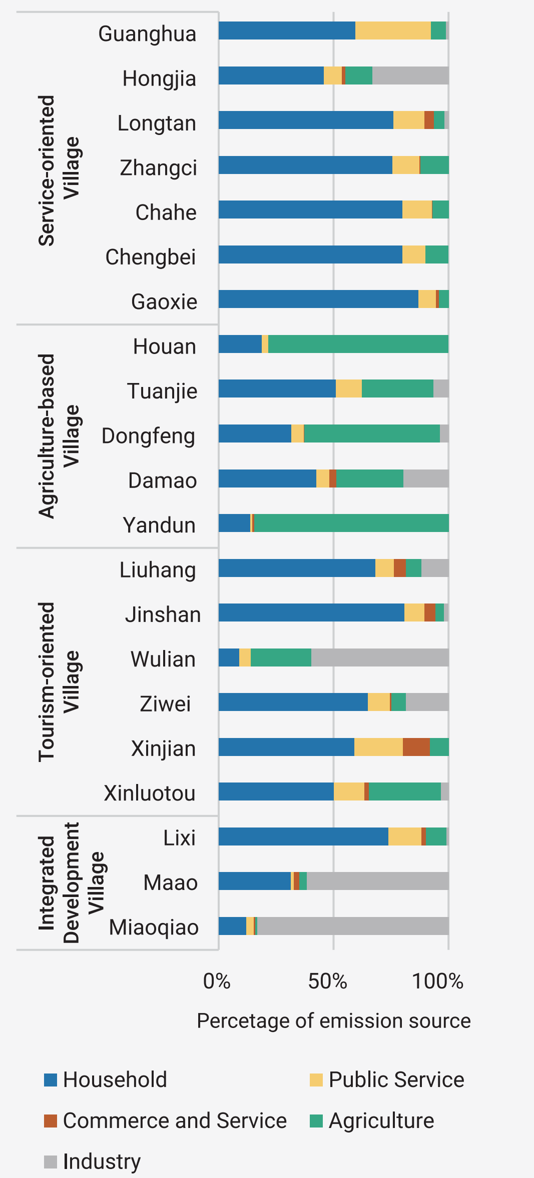


Figure 3-2-4 Percentage of emission source
(based on human activities)

The sources of carbon emissions are divided into three categories according to the type of emission behaviour, energy, agriculture and waste incineration. Energy use consists of electricity consumption and fuel combustion, while agriculture includes methane emissions from rice paddies, nitrous oxide emissions from agricultural land, as well as methane and nitrous oxide produced in animal gut and waste.

In terms of emission activities, the main source of rural emissions is electricity consumption, especially in Integrated Development Villages and Agriculture-based Villages where industrial and agricultural industries are more developed. In the context of carbon neutrality, clean power will greatly promote the process of reducing emissions in rural areas, and electrification of equipments will also fasten the efforts.

Secondly, carbon emissions from LPG and petrol. LPG is mainly used for cooking and petrol is mainly used by villagers to travel and business transport. Promoting the electrification of all kinds of household equipments and vehicles, as well as the sharing of public facilities can greatly reduce carbon emissions.

For Agriculture-based Villages, carbon emissions from agricultural processes depend on the type of agricultural industry. Rice cultivation in farming and livestock breeding produce large amounts of methane, which has 21 times the greenhouse effect of CO_2.

Table 3-2-3 Source of carbon emissions (based on emission activities)

Type	Details
Energy use	Electricity
	Fuel (gas, LPG, nature gas, petrol, diesel)
Agriculture	Rice paddies
	Farmland
	Animal gut
	Animal waste
Waste incineration	Household waste
	Hazardous waste
	Sludge

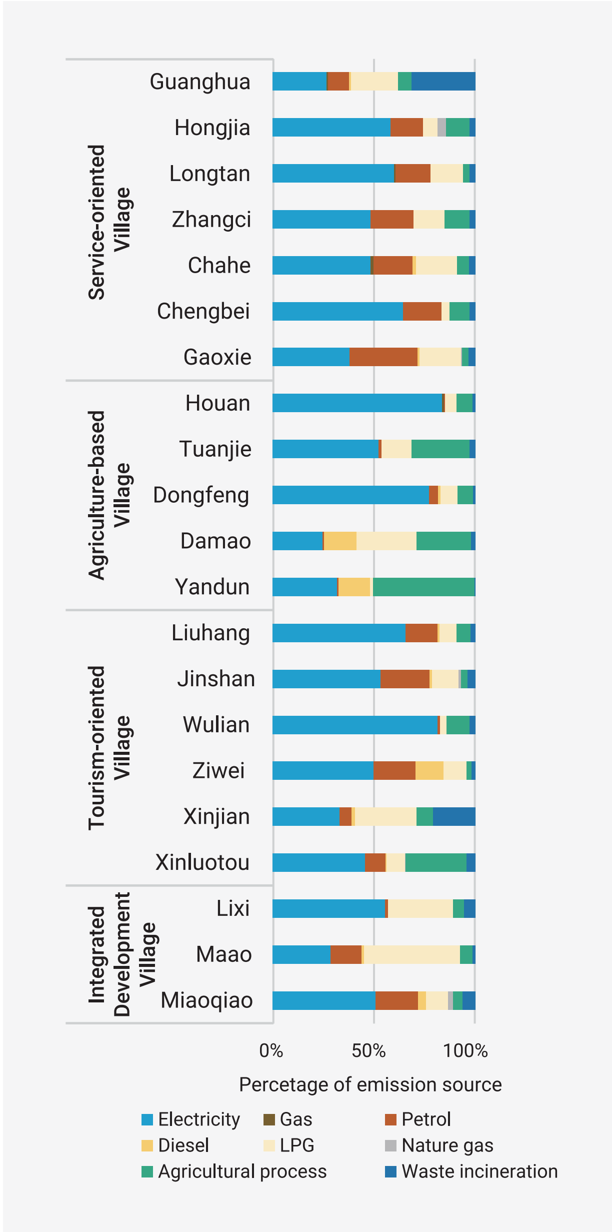


Figure 3-2-5 Percentage of emission source (based on emission activities)

04 Household emissions

The main categories of carbon emissions from residents are household and travel, and are predominantly driven by household activities. In most villages, household emission has a carbon emission share of 50% to 90%. The proportion of travel in Agriculture-based Villages is less than 20%, while Integrated Development Villages and Tourism-oriented Villages have more residents and tourists, thus with more travel needs, accounting for a higher proportion of emissions.

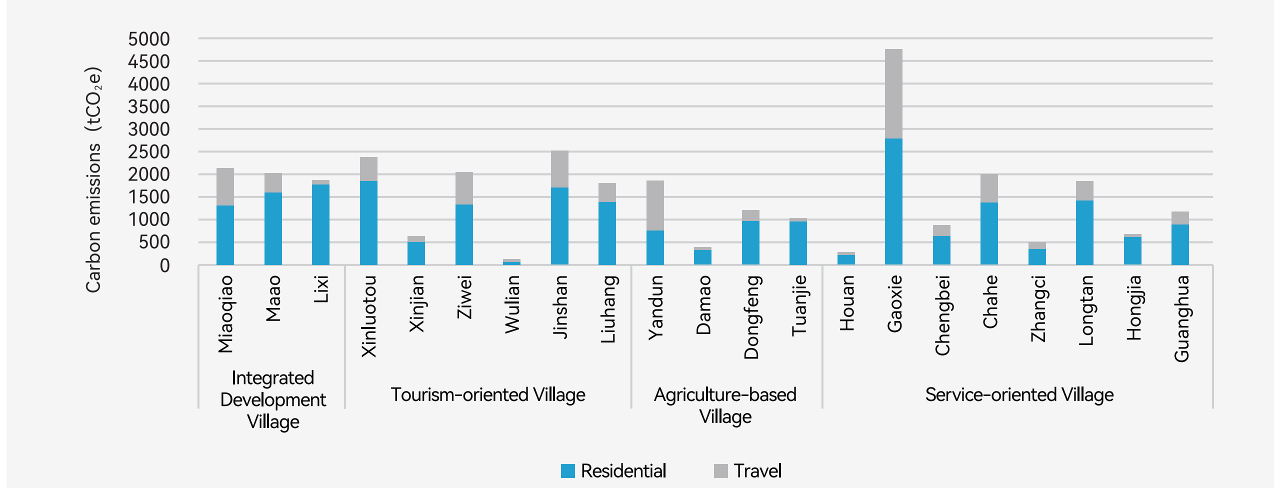


Figure 3-2-6 Emissions from household

05 Agriculture emissions

In agricultural production, the factors that determine carbon emissions are mainly the type and scale of agriculture. Carbon intensity per unit area in agricultural production of farming is less than that of aquaculture, which is further less than that of livestock[16]. In most villages, agriculture is dominated by self-reserved land cultivation, and agricultural production emissions are relatively low. However, in Agriculture-oriented Villages, such as the Yandun village, there are large-scale livestock and poultry farming enterprises where the agricultural emissions can far exceed any other rural area. Among the Agriculture-based Villages, Damao Village, Dongfeng Village and Tuanjie Village are engaged in rice cultivation on a larger scale. As rice produces a large amount of methane, its total carbon emissions in agricultural production are relatively high. Houan Village and Wulian Village have many in aquaculture enterprises, and the large amount of energy consumed in aquaculture generates a high total carbon emission.

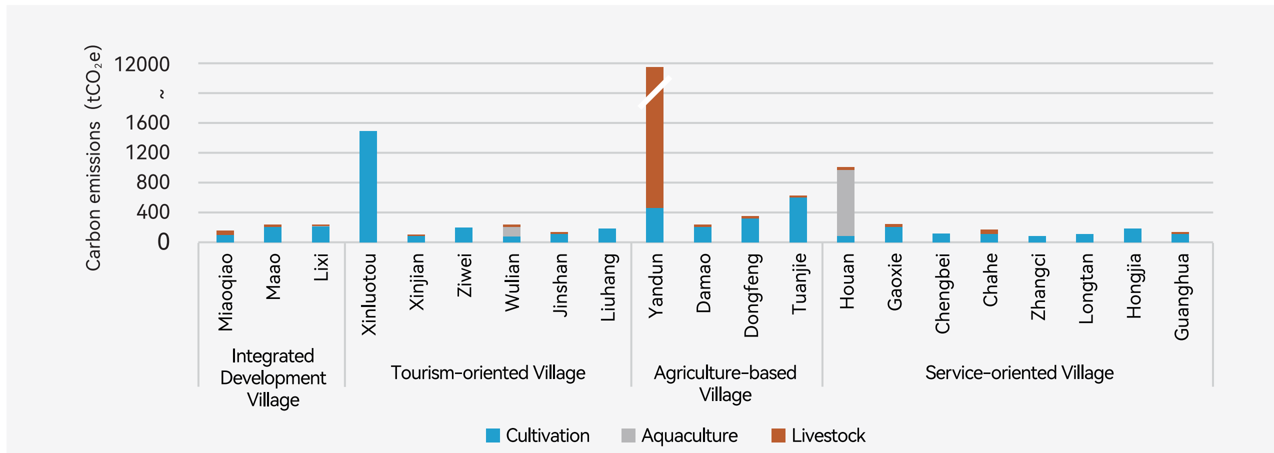


Figure 3-2-7 Emissions from agriculture

06 Industrial emissions

The carbon emissions from village industries reflect the development of the secondary and tertiary industries in villages. After comparative analysis, the level of industrialization is higher in Integrated Development Villages, among which Miaoqiao Village and Maao Village have higher emissions from industrial manufacturing and need to reduce the emissions of industrial enterprises. The total emissions of food processing and manufacturing in Dongfeng Village, which is an Agriculture-based Village, are relatively high. Tourism-oriented Villages and Service-oriented Villages basically do not have large manufacturing enterprises, emissions are mainly commercial and service industry.

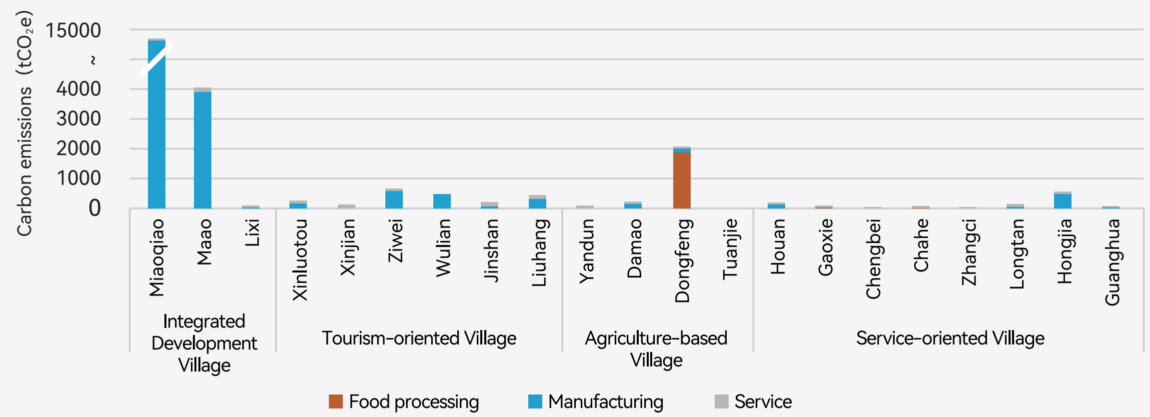


Figure 3-2-8 Emissions from industry

07 Emissions from public service

In terms of public service, the main sources of emissions are solid waste management, government agencies, and infrastructure. Villages with a high resident and tourist population respond with higher total carbon emissions. For example, Xinjian Village attracts over 400,000 visitors per year, thus the emissions from waste are high. It is necessary that government and tourism facilities to have a good demonstration effect of energy efficiency and renewable energy use, while promoting local treatment and sustainable consumption of organic waste in villages to reduce the amount of waste disposal.

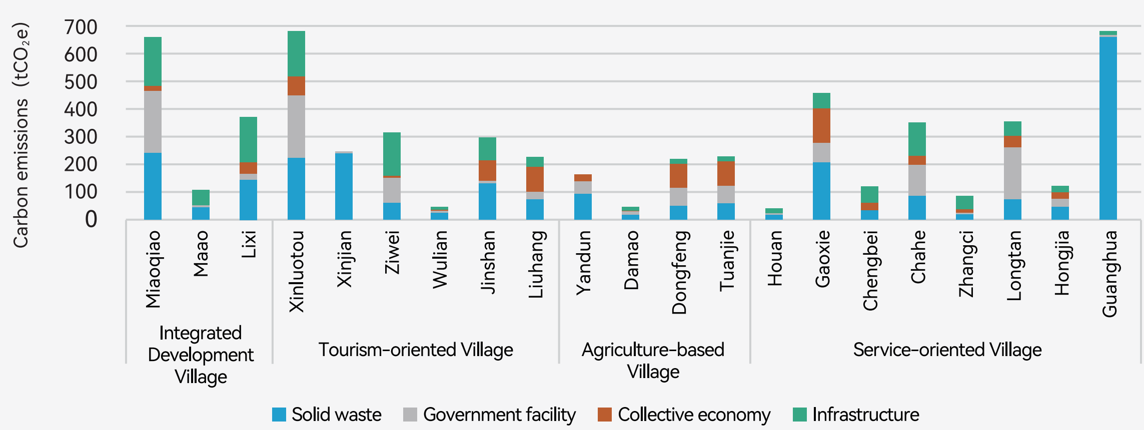
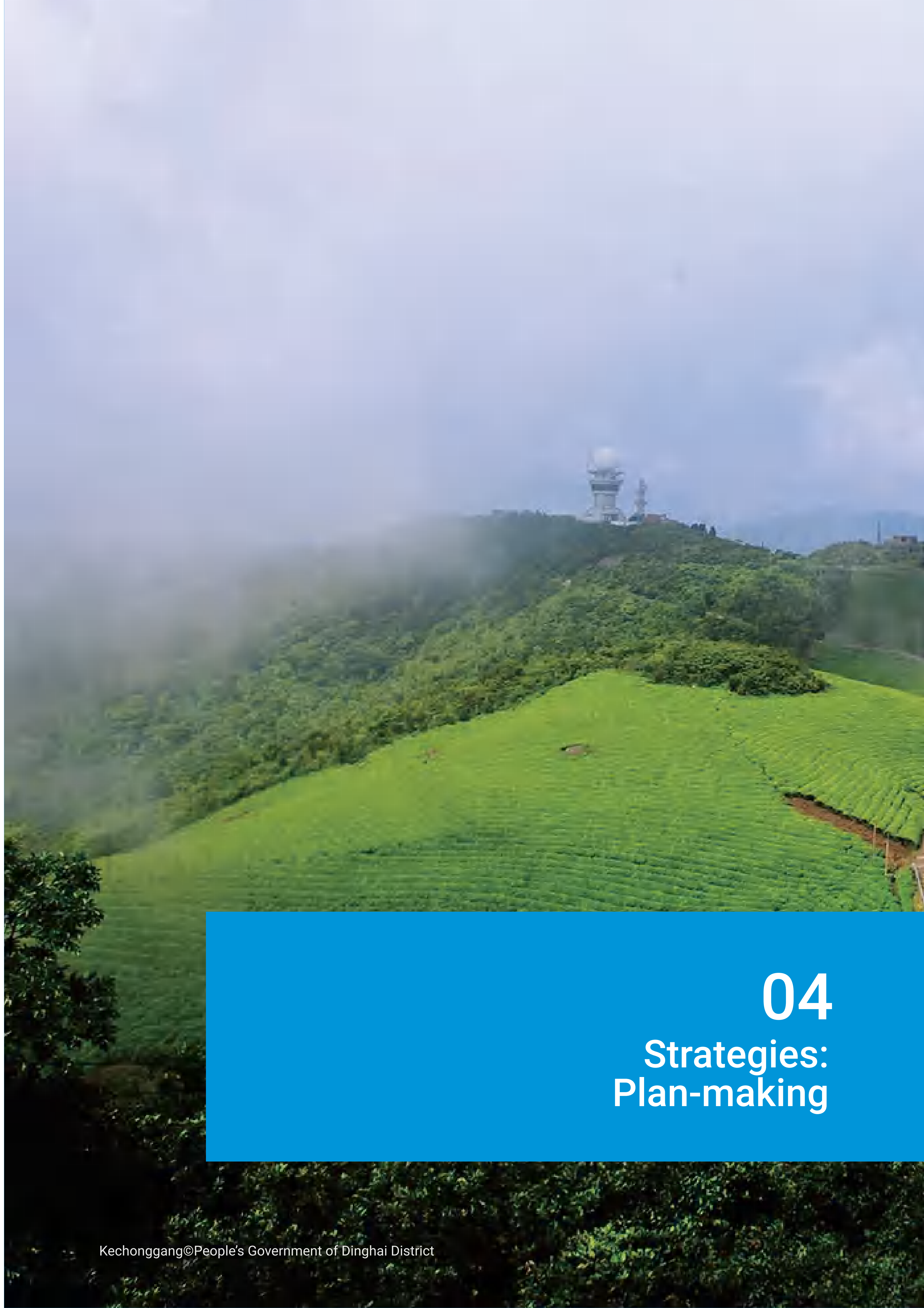


Figure 3-2-9 Emissions from public service



04 Strategies: Plan-making

Kechonggang©People's Government of Dinghai District

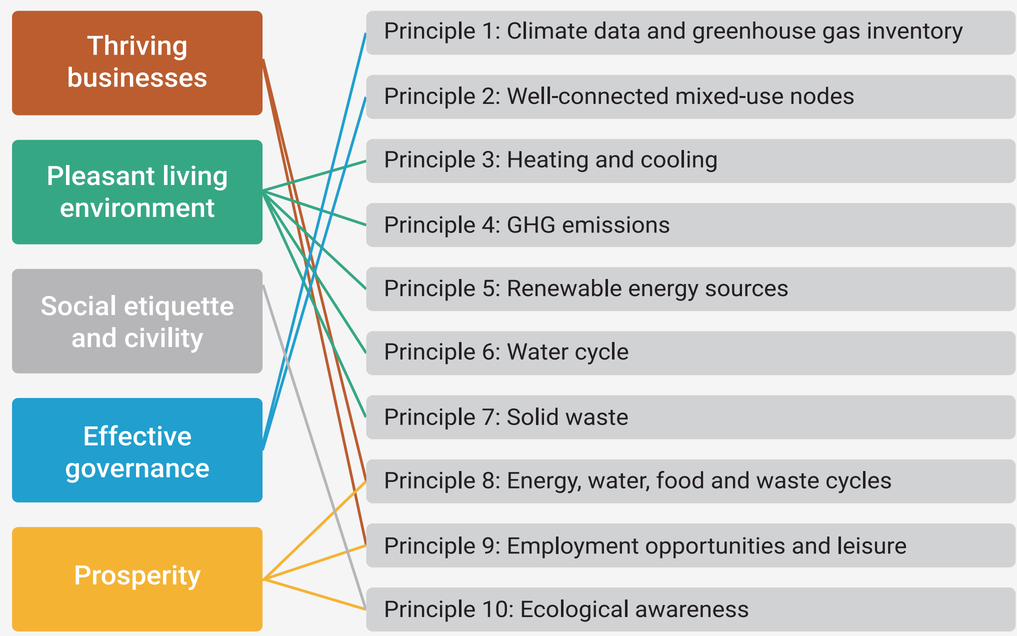


Figure 4-1 Interrelationship between net-zero carbon goal and rural revitalisation

Aiming at a thriving business, a pleasant living environment and an inclusive society with effective governance and prosperity, the strategy of China's rural revitalization is based on the current development opportunities and challenges of rural areas in China, which covers a comprehensive revitalization across industry, talents, culture, ecosystem and institutional management[20].

The revitalization of industry through thriving business is the backbone of rural development and in achieving the net-zero carbon target. The industry needs to shift away from conventional energy-intensive mode by optimizing structure. Ecosystem revitalization is the common requirement for overall development in order to embed environmental sustainability into every sector. At the same time, natural environment needs to be protected and treasured. A sustainable rural revitalization cannot be achieved without every local villager's participation through their low-carbon lifestyle and production practices. Prosperity, that everyone in the rural area can improve their livelihood will attract more young people to stay. Most importantly, effective governance that involves all stakeholders and third party is the key to securing a sustainable revitalization.

4.1 Strategy on energy and resources

Energy and resources relevant net-zero carbon village planning principles include:
1) Principle 5 (renewable energy),
2) Principle 6 (water cycle),
3) Principle 7 (solid waste).
The specific PSR analysis is illustrated as in Figure 4-1-2.

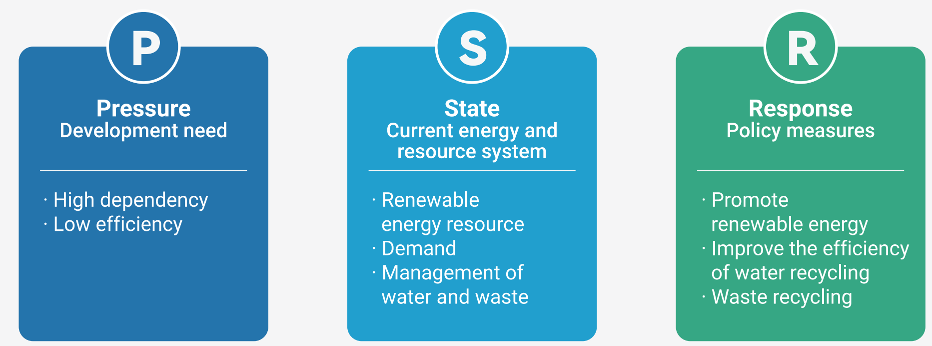


Figure 4-1-1 PSR analysis on energy and resources

4.1.1 Pressure

01 High dependence on mainland

Due the dispersed location of many islands, Dinghai is highly dependent on the grid from mainland to make sure villages on every island have stable power supply. Compared to cities, household and production activities are more decentralized.

To have a stable and low-carbon energy supply for future development and, villages in Dinghai need to act on their own advantages to enhance self-sufficient energy through a distributed clean energy supply system.

02 Low efficiency of resource utilization

Challenges also arise from water supply and waste treatment sector. The freshwater for Dinghai is from the nearby city of Ningbo through pipes, which causes high energy consumption during transportation and low level of water security, for remote islands in particular. On the main island of Dinghai, inorganic solid waste can be collected and treated in centralized plant, while that on remote islands need to be transported to the mainland.

4.1.2 State

01 Renewable energy

Power generation in rural Dinghai is still from burning coal. As indicated in Figure 4-3, the power generated in 2019 for Dinghai villages is 973.46 million kW·h in total, of which 862.40 million kW·h, nearly 90% is from thermal plant, while wind mill and waste incineration generated 65.10 million and 45.95 million kW·h, respectively.

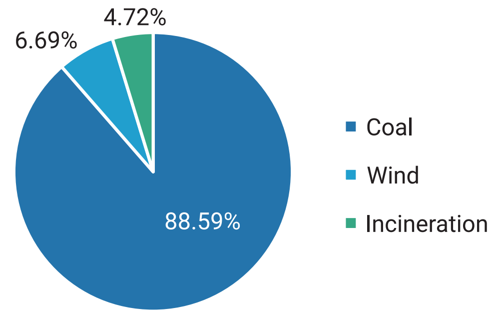


Figure 4-1-2 Power generation of Dingha

Wind, solar and biomass resource are actually abundant in Dinghai and provide a huge unleashed potential. The wind speed of Dinghai is between 6.89m/s~7.67m/s. Global Horizontal Irradiation all year round is between 1680~1724kW·h/m^2, which makes it a category II (very rich) area with sunlight. Various agriculture and forestry activities also provide significant amounts of biomass. Estimation of biomass standard coal can be found in Table 4-1-1.

02 Water resource

Dinghai is an area of severe to extreme water scarcity, with a water resource per capita of 591m^3. Drinking water is piped from the closest city, Yaojiang of Ningbo, with some local reservoirs. Water supply on the main islands is connected through pipes, while remote island can only supply water from reservoirs after treatment. Water security is challenged by extreme weather conditions.

There are three ways to treat wastewater in rural Dinghai:
1) for villages with lower pipe laying costs or villages with larger population, connect drainage pipes with urban drainage system that leads to urban wastewater treatment plants;

2) for remote islands with small population density, wastewater is treated through sedimentation tanks and PKA process and discharged or used for irrigation;

3) for villages visited by many tourists, the waste water, which has a high concentration of nutrients, needs to be treated through oil separator, regulation, A^2/O and sedimentation, before being used for irrigation.

03 Solid waste

Household waste and construction waste are sorted before centralized treatment. Household waste on remote islands needs to be transported first to the main island. Agriculture waste, livestock excrement and waste from seafood processing are reused by farmers and factories due to their high biomass. Straws and manure are put back to farmland. Seafood processing waste can be made into feed.

Table 4-1-1 Estimation of agriculture and forestry residue to standard coal

Type	Standard coal (10^4tce/year)
Corn straw	243
Wheat straw	10
Rice straw	777
Soybean straw	612
Fruit tree branches from pruning	1134

4.1.3 Response

01 Make full use of renewable energy to improve energy self sufficiency

Based on energy demand and resource distribution, Dinghai can make full use of renewable energies including wind, solar, biomass and hydropower. Energy-intensive users like aquaculture and livestock farms can apply solar panels and wind mills. Government can also provide consultancy for villages who want to adopt renewable energy.

02 Improve stability of renewable energy system by smart micro-grid

To improve the stability of renewable energy, water reservoirs can be used for pumped storage of solar and wind power. Photovoltaic and solar-thermal can be applied in public building and tourist facilities. Parking lots can deploy photovoltaic solar shelves, solar-storage-charging system, smart micro-grid based on its demand for electric cars.

03 Enhance rainwater harvesting capacity and increase water recycling while decreasing energy consumption for water supply and treatment

Rainwater harvesting capacity can be enhanced by fixing and expanding village-level reservoirs. It is encouraged that villagers and farm owners to collect rainwater from water ditches and tanks for flushing and irrigation. Household wastewater can be recycled and reused from ditches along farmland and orchard.

04 Explore a comprehensive solid waste management system.

Organic waste can be recycled locally on the farmland without transporting to centralized treatment plant, which will reduce the energy consumption and carbon emission from transportation and incineration. Agriculture straws compost can be applied innovative with higher efficiency and avoid taking too much space. Selling agriculture products in bulk and without package can also reduce waste.

Table 4-1-2 Relevant policies of Dinghai

Renewable energy	Use solar panels in building;
	Use solar panels in building;
	Increase solar power in agriculture and livestock business;
	Increase the use of methane and biomass;
	Provide consultancy for installing solar power;
	Promote the use of solar thermal;
	Build 4 or more smart micro-grids.
Water cycle	Increaser rainwater harvesting and storage capacity by 20% of the water reservoir in villages (doesn't include district level reservoir or ponds);
	Decrease household water (tap water) consumption by 5%;
	Increase water recycling rate to 18% for villages of distributed wastewater treatment;
	Encourage on-site treatment instead of building drainage system accordingly, and decrease energy consumption per unit by 20%.
Solid waste treatment	Achieve 100% organic waste reclamation;
	Achieve 100% reclamation of sludge (except bar screen) from distributed wastewater treatment;
	Increase the recycling rate of pesticide bottle and mulch film to 50%.

4.2 Strategy on low-carbon industrial development

Industry relevant principles include:

1) Principle 8 (energy, water, food and waste cycle);

2) Principle 9 (employment opportunities and leisure);

3) Principle 10 (ecological awareness).

The specific PSR analysis is illustrated as in Figure 4-2-1.

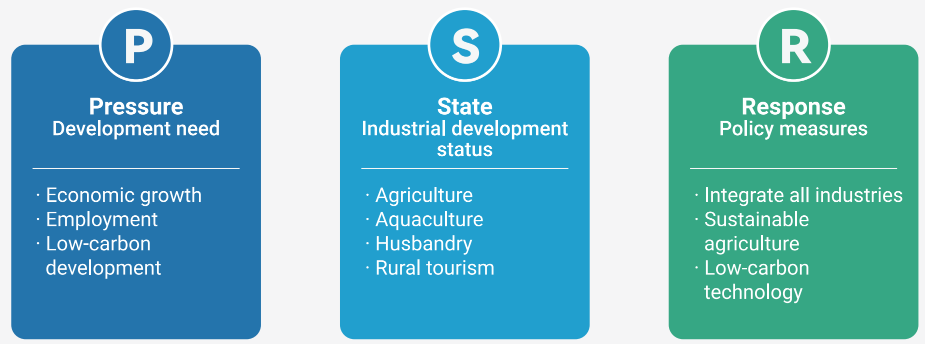


Figure 4-2-1 PSR analysis on industrial development

4.2.1 Pressure

01 Balance between economy, industry and low-carbon

To provide similarly attractive jobs to young people, industry in rural areas needs to reform. The development of Dinghai's primary industry has to shift to circular economy which may find a balance between growth and the net-zero carbon goal. For example, agriculture needs to embrace innovation and climate-smart solutions to provide not only steady income but also minimum environmental impacts.

02 Loss of labour force

Many villages around the world are facing the challenges of aging society and population loss. Without attractive job opportunities, young people will and have to move to cities. Industrial development is fundamental to creating employment and energizing the society.

Among the working-age population, 57% are based in Dinghai, while the rest are migrating to other cities, in which 33% are basically absent for the whole year round. Labour loss in Dinghai is critical.

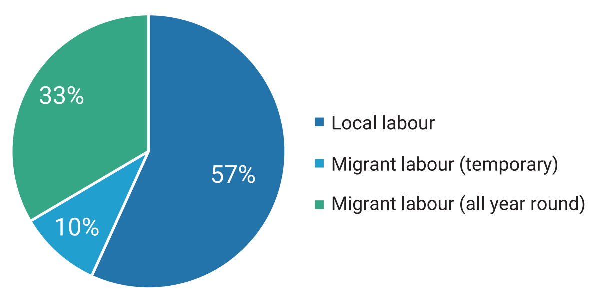


Figure 4-2-2 Local and outflow labour force of Dinghai (registered permanent population)

4.2.2 State

01 Main industry in rural Dinghai

The main industries in Dinghai are agriculture, aquaculture, fishery, husbandry, as well as tourism and handicrafts. Labour loss is a major challenge.

Among the industries in Dinghai, aquaculture contribute the biggest share to local economy, followed by agriculture. Husbandry is diminishing in recent year, while forestry has the lowest share. Although hit by the pandemic in 2020, tourism has been growing fast, with a peak season from May to November, and a low season from January to April.

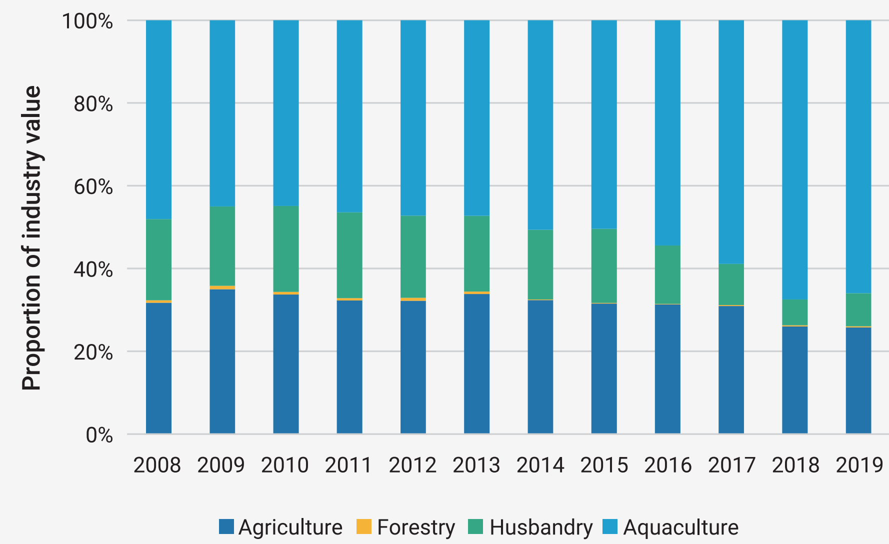


Figure 4-2-3 Proportion of industry value of agriculture, forestry, husbandry and aquaculture

Figure 4-2-4 Tourist person-times and incomes of Dinghai (2011-2020)[22]

02 Low-carbon level of different industries

In terms of the sources of carbon emissions, ranches primarily emit carbon through their consumption of electricity and fuel. These resources are mainly used for insulation of agricultural buildings, automated control systems, supporting staff livelihoods, as well as the consumption of diesel fuel during long-distance, high-frequency feed transportation and for heating agricultural buildings.Aquaculture farms have a high water consumption including water pumping and treatment. Carbon emissions from crop farming mainly come from irrigation, storage and transportation.

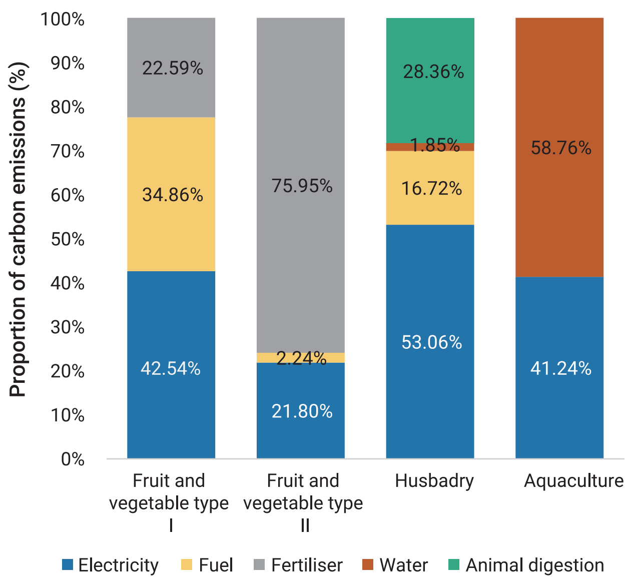


Figure 4-2-5 Carbon inventory offour typical agriculture activities

4.2.3 Response

01 Apply low-carbon technology for sustainable agriculture

Agriculture is a dominant industry in Dinghai with a large scale of different food products, and a relatively low carbon emission per unit. Livestock is less popular but with a high carbon emission. These industries both have a huge potential of redesign for circularity. An enhanced water, energy and food cycle can improve production efficiency, reduce energy and water consumption and promote recycling. Utilisation of renewable energy can also help shifting traditional agriculture to efficient and sustainable agriculture, with a low-carbon brand.

02 Explore the integration of the primary, secondary, and tertiary industries to increase local income, and reduce carbon emission

Per capita output needs to be increased with lower carbon emissions. Industry needs to provide more job opportunities to attract more talents. The interlinkages between first, second and third industries including farming and fishing culture, handicraft, training and education, local cuisine, outdoor activities can be explored to diversify local economic structure.

03 Promote low-carbon rural tourism

Tourism needs to be promoted with more attractions under zero-carbon target. Public transportation, touring on foot, energy saving hostels and low-carbon outdoor activities can be implemented.

Table 4-1-2 Relevant policies of Dinghai

Agriculture	Reduce the frequency of changing water of aquaculture and reduce water consumption by 10%;
	Reduce energy consumption per capita by 25%;
	Reduce water consumption for irrigation by 23%;
	Reduce water consumption of husbandry by 10%, and all farms with an annual output of more than 10000 pigs need to install water-saving facilities;
	Achieve 100% reclamation of fecal sewage in all large-scale livestock farms;
	Initiate zero carbon label/certification of Dinghai products
Culture and tourism	All vehicles for tourism are electrics;
	Achieve net-zero in tourism development projects;
	Develop low-carbon outdoor leisure activities;
	Increase the income of villagers engaged in cultural and tourism industry in the off-season;
	Encourage the combination of primary and tertiary industries to increase income;
	Develop creative industries that enables remote working

4.3 Strategy on low-carbon rural lifestyle

Lifestyle relevant net-zero carbon village planning principles including:
1) Principle 2 (well-connected mixed-use nodes),
2) Principle 3 (heating and cooling) ,
3) Principle 4 (hidden GHG emissions from buildings) .

4.3.1 Pressure

01 Carbon emission and energy consumption from improved living standard

Increases in income of local villagers, returned migrated workers and tourists will boost higher demand for infrastructure and living standard. The lack of accessible and user-friendly service facility needs to be tackled.

02 Reduce hidden carbon emissions in building and construction

The need for comfort may cause higher energy consumption. Service facilities may also lead to more transportation volume. Reasonable spatial planning of facilities and low-carbon transportation vehicles are of high importance.

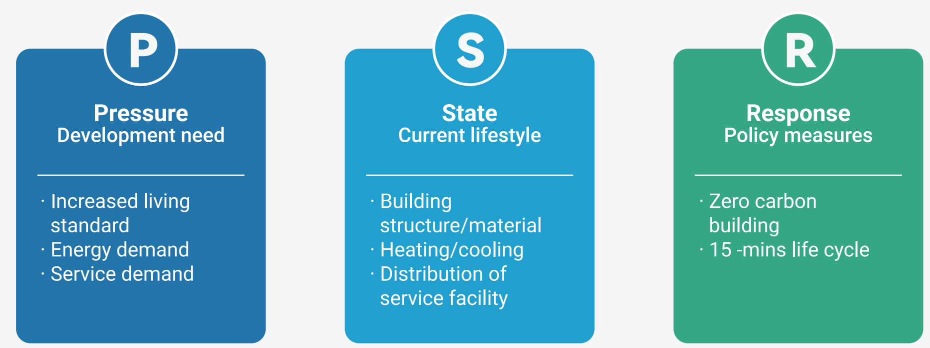


Figure 4-3-1 PSR analysis on rural lifestyle

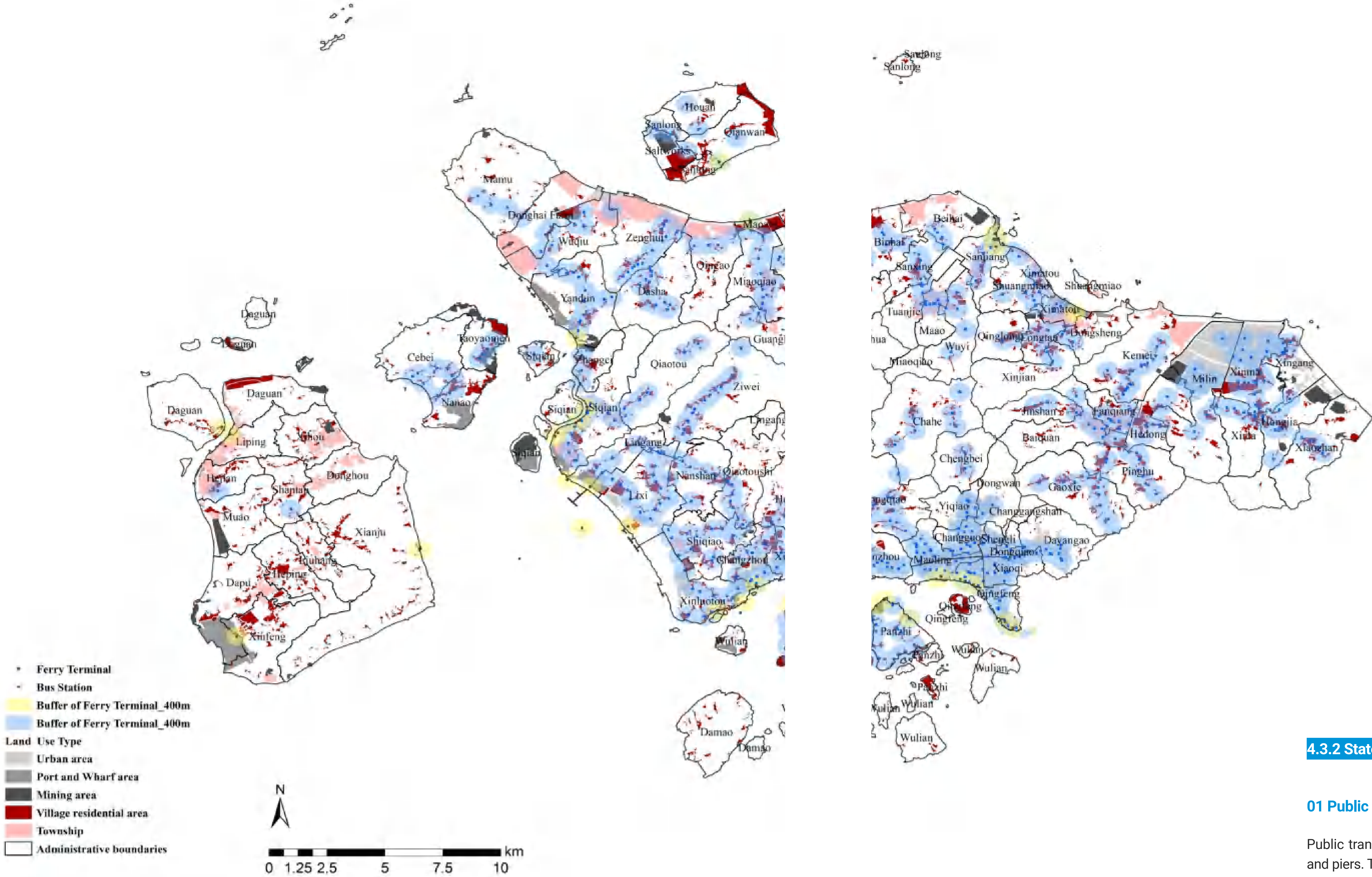


Figure 4-3-2 Distribution of public bus stations, piers and 400 meters service coverage

4.3.2 State

01 Public transportation system

Public transportation system in rural Dinghai includes bus and piers. To set a 400m radius again, bus system can cover 50.02% residents of the whole area, which still needs to be further expanded. Some of the remote islands have limited public transportation options, only through private boats to connect with the main island.

02 Service facilities

Service facilities of Dinghai can be divided into four types: food retail, community retail, daily service and community service provided by government (Figure 4-3-2). Density of service in urban areas is obviously higher than that in rural areas.Dinghai provides sufficient service for the whole area from the admin centre and community service centre, while insufficiency still exists on remote islands.

Considering the mountainous landscape of Dinghai, many villages have very different altitudes. Distance on the map is sometimes longer than walking. On 400m radius (15 minutes walking), many service centres cannot be reached by 50% of the residents[9], as recommended in the Net-zero Carbon Village Planning Guidelines. The four service facilities cover main centre villages while remote villages mainly rely on local facilities.

Table 4-3-1 Service provided by all four facilities

Types of service facility		Contents
Type I	Food retail	Supermarkets, food stores selling agricultural products and convenience stores
Type II	Community retail service	Clothing stores, farmers' markets, hardware stores, pharmacies, bookstores
Type III	Daily Service	Banks, gyms, health clubs, fitness studios, barber shops, laundries, dry cleaners, restaurants, coffee shops, snack bars
Type VI	Government and community service facilities	Adults and senior care, nurseries, community hospitals, community or entertainment centers, cultural and artistic facilities (museums, performance centers, etc.), educational facilities, family entertainment places (theatres and sports places), government offices providing public services, police stations and fire stations, post offices, public libraries, parks and social service centers

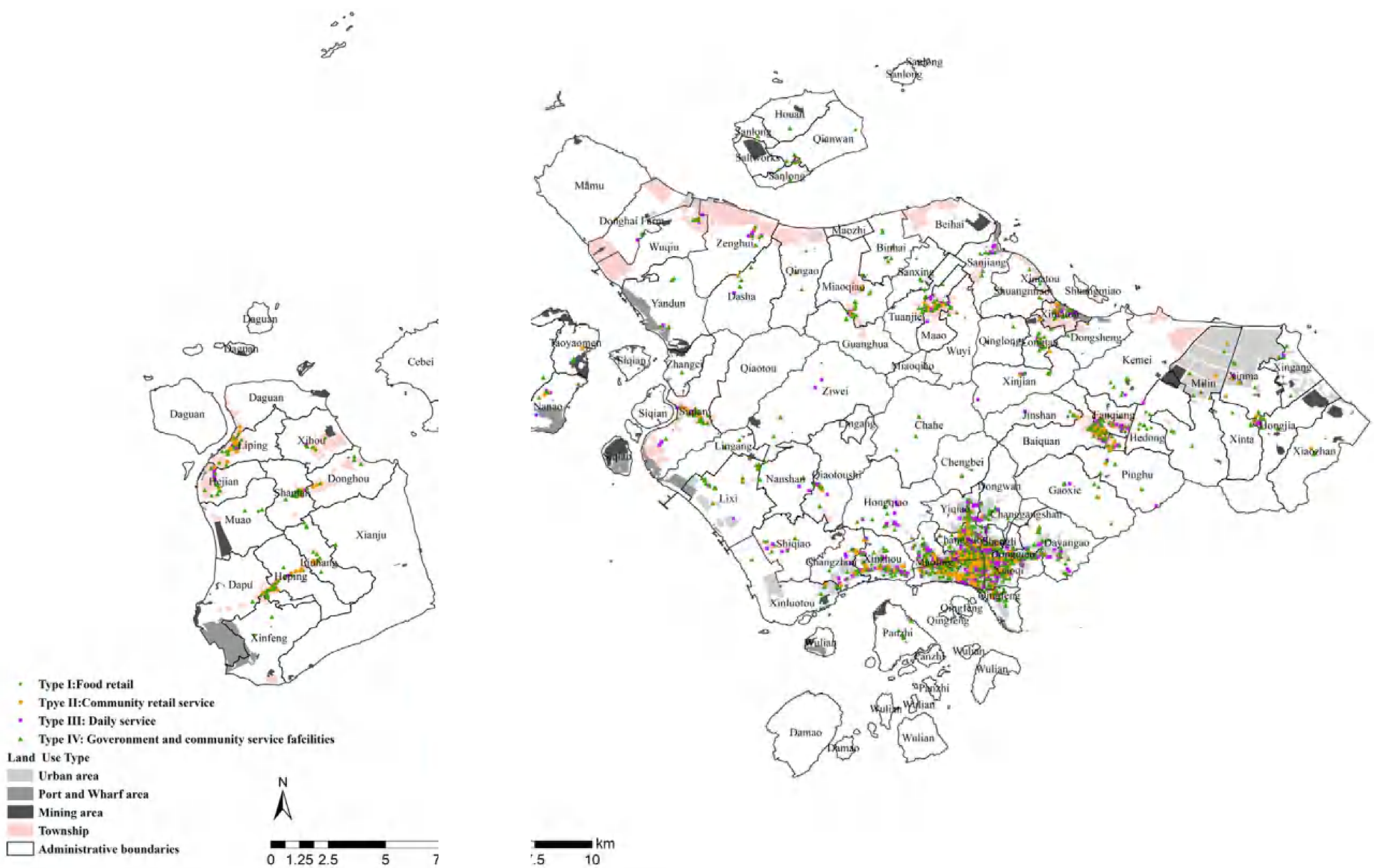


Figure 4-3-3 Distribution of four types of service facilities in Dinghai

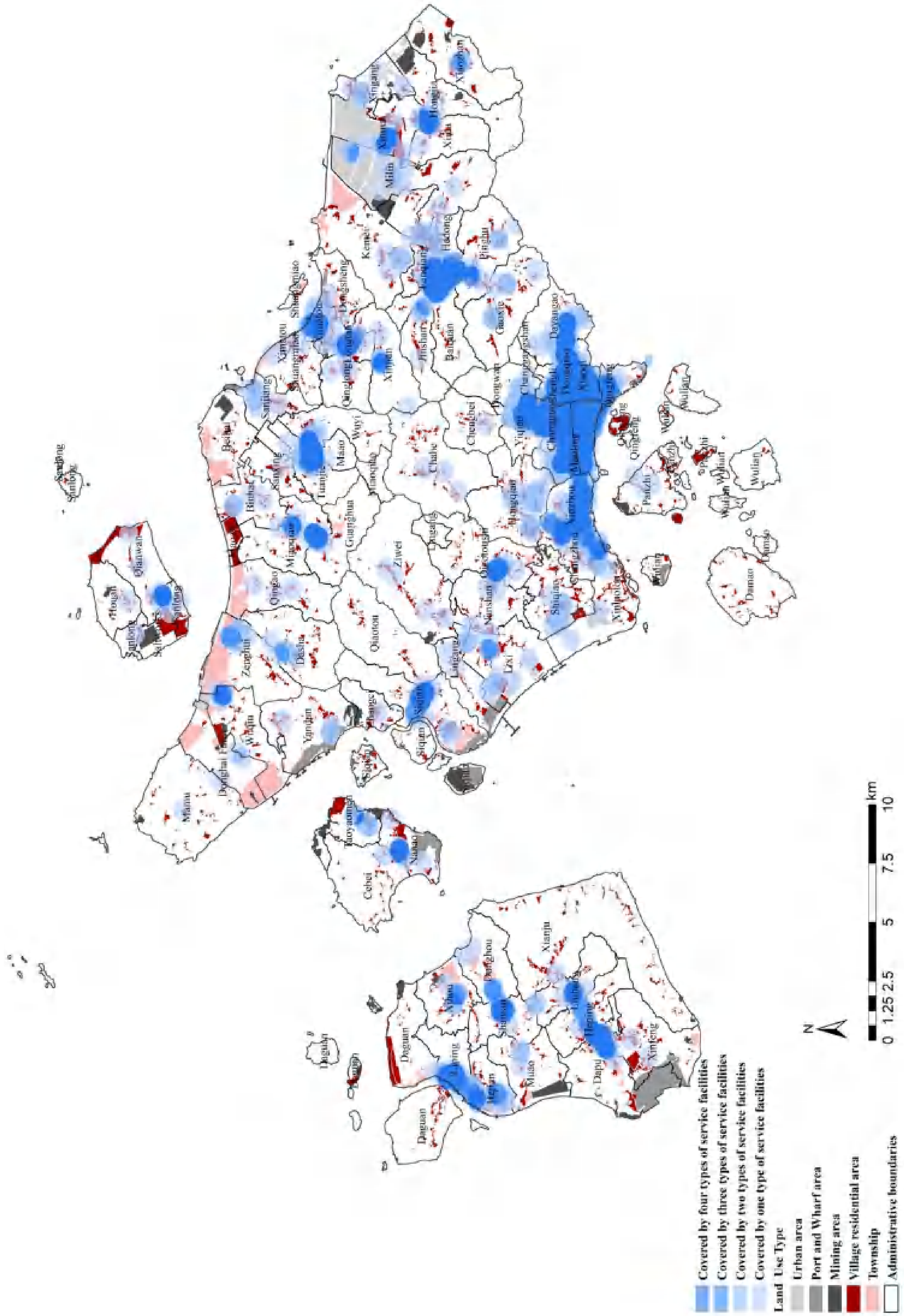


Figure 4-3-4 Coverage area of four service facilities

03 Different construction types

Based on field investigation and data collection, it is found that buildings in Dinghai are mainly single or two-storey, with a living area of 90m² and 220m², respectively. Single-storey buildings are mainly made of wooden-stone structure or brick structure, two-storey buildings are mainly brick structure and brick-concrete structure.

Dinghai is located at the largest alluvial delta, the Yangtze-River Delta, with a marine monsoon subtropical climate (hot and humid summers, cool and dry winters). Villagers install air conditioners in their bedrooms for heating and cooling. Building types with different requirements on heating and cooling area are shown in Table 4-3-2.

Figure 4-3-6 One-storey brick structure

Figure 4-3-5 One-storey wood/stone structure

Figure 4-3-7 Two-storey brick structure

Table 4-3-2 Percentage of different types of building and the heating/cooling indicator

Type of building	Percentage	Material	Area of heating/cooling	Energy consumption per m²
Single storey wood/ stone structure	16%	Natural stone, wood, gravel, tile, etc.	30m²	17.53 kW·h/m²
Single storey brick structure	39%	Brick, natural stone, tile, wood, concrete, sand, etc.	30m²	15.77 kW·h/m²
Two-storey brick structure	14%	Brick, natural stone, tile, wood, concrete, sand, etc.	60m²	13.40 kW·h/m²
Two-storey brick/ concrete structure	31%	Brick, stone, steel, concrete, etc.	60m²	11.33 kW·h/m²

04 Different construction materials and insulation properties

In terms of insulation properties, single-storey buildings with wooden-stone structure has the highest energy consumption level during heating and cooling. Most buildings use clay for the outside walls, and windows with single-layer glass/aluminum alloy, or wooden windows. Doors are mainly single layer wooden doors. Heat loss is mainly from walls, followed by doors and windows.

Sand, wood and gravel, as construction materials, have small global warming potential, and they can be recycled.

05 Lifecyle assessment emissions of different constructions

Heating and cooling contribute the most GHG emissions throughout the whole lifecycle of the buildings. Newly built two-storey ones with brick-concrete structure have a lower level of emissions due to their upgraded enveloped design, which is getting popular in Dinghai. Although traditional buildings with wood-stone structure have small hidden emission from the materials, the emissions during usage cannot be ignored.

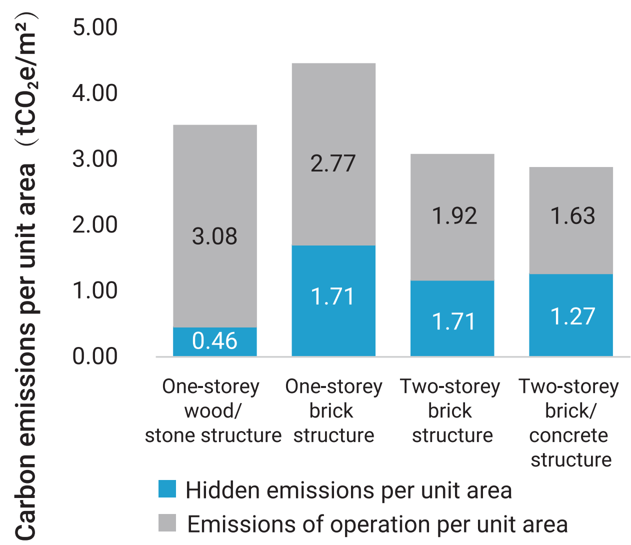


Figure 4-3-8 Lifecycle carbon emissions of different buildings in rural Dinghai

Table 4-3-3 Carbon intensity of construction material and transportation

Type	Coating	Steel	Clay brick	Aluminum	Glass	Cement	Lime	Wood	Sand	Stone
Carbon emission per capita (tCO_2/t)	2.60	2.00	2.00	1.60	0.40	0.80	0.70	0.20	0.10	0.10
One-storey wood/stone structure (t/building)	/	/	9.85	/	0.39	7.73	1.98	0.87	1.92	11.97
One-storey brick structure (t/building)	0.22	3.74	100.87	/	0.39	15.54	1.98	1.08	3.01	1.39
Two-storey brick structure (t/building)	0.35	5.78	167.75	/	0.63	25.62	4.85	1.57	6.54	2.30
Two-storey brick/concrete structure (t/building)	0.76	6.93	178.20	0.31	1.27	27.72	5.15	2.15	8.49	2.55

4.3.3 Response

01 Enhance rural service and develop 15 mins life circle

Service planning needs to be enhanced based on demographic changes and industry development trend. Considering accessibility by foot, residential area can also be redesigned to be close to service facilities and public transportation.

A pleasant, safe and convenient walking environment can help reduce emissions and improve community vitality. Parking lots can be put at the entrance of community, and to explore a car-free area. Roads should put pedestrians and non-motorized vehicles at priority and provide a safe walking experience. Pedestrians can be improved with plantation and shelter and provide maximum accessibility.

02 Low-carbon rural transportation system

A complete and low-carbon transportation system should be built between villages and to the cities. Public bus and ferry can use renewable energy. Charging systems should also be deployed to provide convenient charging services. No-go zone and no-go time can be set to restrict vehicles entering, and conduct different charges for cars with fossil fuels.

03 Reuse old buildings with new functions and improve insulation

The needs of tourism for new buildings can be met by converting old and empty buildings, which not only extend their life cycle, but also reduce carbon emissions from building new. The insulation of resident building can be improved through renovation on window and doors, and using of energy efficient house appliance.

04 Encourage low-carbon material and new technology

Pilot building can be explored with renewable energy, and low-carbon materials of local stones, woods and steel that can be recycled. Insulation can also be achieved through building orientation for sunlight, to further reduce hidden emissions.

Table 4-3-4 Relevant policies and measures

Land use and transportation	More than half of the villages can provide at least two service facilities within 400 m
	75% of villagers can reach bus station or pier within 400 m on foot
	Build super low emission zero in selected area
	Connect all hiking trails in the district
	Keep increasing living wood stock
	Provide at least 200m² area for activities promoting traditional handicrafts in every village
Operation of building	Increase 20% of the energy efficiency ratio for split AC in all buildings
	Promote comprehensive carbon emission reduction in current buildings
	Increase the environment standard for new buildings
Building material	Maintain a material recycling rate of no lower than 70%
	90% or more construction material of new buildings should be from recycling
	Encourage modern wood structure building
	Encourage construction companies to procure equipment that is more environmental-friendly

4.4 Strategy on governance

Governance relevant net-zero carbon village planning principles including:
1)Principle 1 (climate data and greenhouse gas inventory),
2)Principle 9 (employment opportunities and leisure),
3)Principle 10 (ecological awareness).
Based on this, the PSR analysis can be found as below:

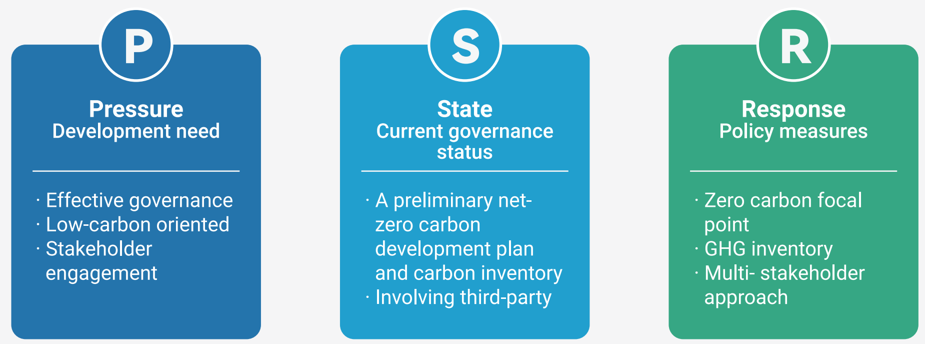


Figure 4-4-1 PSR analysis on rural lifestyle

4.4.1 Pressure

01 Effective governance is the fundamental key to build a successful net-zero carbon village

Effective, daily and detailed management, as well as embedded low-carbon awareness requires participation from all stakeholders. Sound governance can clarify the conflicts and opportunities between rural revitalisation and carbon neutrality, thus softening conflict points and leveraging opportunities by a comprehensive net-zero oriented mechanism.

4.4.2 State

01 Measures that have already been taken

Dinghai has established carbon inventories for twenty-one selected villages by the third party based on national and international carbon accounting guidelines. The inventory was used to make scenario analyses for Dinghai's carbon peak and carbon neutral target, thereby some low-carbon development strategies were given to the policymakers. The local government also appointed a small team of net-zero task force in pilot villages, who is responsible for promoting the work on the ground. At the same time, experts from international and domestic institutes, including UN Habitat and Tongji University, were invited to share case studies from international communities and provide technical support.

02 The awareness of local government staff and villagers needs to be improved

However, overall, the governance mechanism for zero-carbon rural revitalization in Dinghai is still inadequate. Rural officials and residents have insufficient understanding of low-carbon development.

4.4.3 Response

01 A localized and regular updated carbon inventory should be established

There is a need to establish a carbon inventory that is localized and regular updated for carbon accounting, verification, reporting and evaluation.

02 Social awareness needs to be raised at all levels

Dinghai needs to build a broader task force with specialists and third parties on low-carbon development, with awareness raising programmes. Climate change education should be embedded in all projects and events to mobilize local villager and tourists.

Table 4-4-1 Relevant policies and measures

Carbon inventory	Establish a carbon inventory/emission reporting and monitoring line
Education for sustainable development (ESD)	Build a net-zero tourist route in every village
	Set education area for garbage sorting
	Put up a low-carbon lifestyle show room can in the villager's hall
	Promote low-carbon diet
	Set education area for garbage sorting
	Make climate risk map to raise villager's awareness on climate vulnerable assets
Information technology	Information technology can be used in all aspects of governance with a service model of Internet+Grid Management. Data and information of villages can be collected, analysed, evaluated and managed, for different purpose of carbon reduction and social economic development.

4.5 Indicator system for Dinghai'srural revitalisation under the net-zero carbon goal

Based on the above analysis, an indicator system of "1 mechanism + 10 path ways" was proposed to Dinghai District, focusing on four aspects: energy and resource structure, low-carbon industrial development, low-carbon lifestyle and rural governance system, in order to continuously promote rural revitalisation under the net-zero carbon goal.

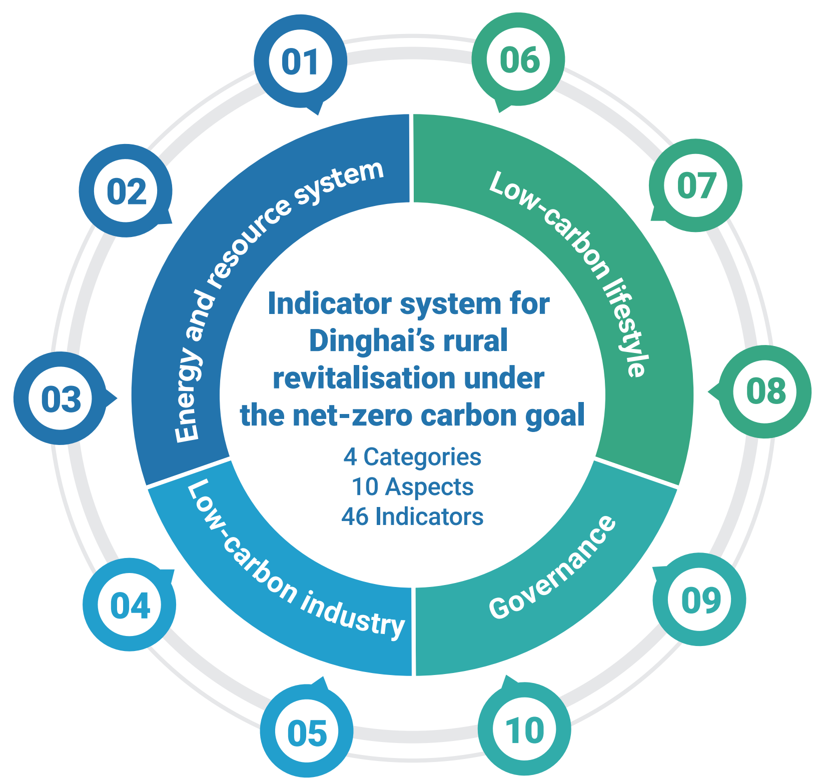
01 Renewable energy
- Use solar panels in building
- Use solar panels in parking lot
- Increase solar power in agriculture and livestock business
- Increase the use of methane and biomass
- Provide consultancy for installing solar power
- Promote the use of solar thermal
- Build 4 or more smart micro-grids

02 Water cycle
- Increaser rainwater harvesting and storage capacity by 20% of the water reservoir in villages
- Decrease household water (tap water) consumption by 5%
- Increase water recycling rate to 18% for villages of distributed wastewater treatment
- Encourage on-site treatment instead of building drainage system accordingly, and decrease energy consumption per unit by 20%

03 Waste treatment
- Achieve 100% organic waste reclamation
- Achieve 100% reclamation of sludge (except bar screen) from distributed wastewater treatment
- Increase the recycling rate of pesticide bottle and mulch film to 50%

04 Agriculture
- Reduce the frequency of changing water of aquaculture and reduce water consumption by 10%
- Reduce energy consumption per capita by 25%
- Reduce water consumption for irrigation by 23%
- Reduce water consumption of husbandry by 10%, and all farms with an annual output of more than 10000 pigs need to install water-saving facilities
- Achieve 100% reclamation of fecal sewage in all large-scale livestock farms
- Initiate zero carbon label/certification of Dinghai products

05 Culture and tourism
- All vehicles for tourism are electrics;
- Achieve net-zero in tourism development projects
- Develop low-carbon outdoor leisure activities
- Increase the income of villagers engaged in cultural and tourism industry in the off-season
- Encourage the combination of primary and tertiary industries to increase income
- Develop creative industries that enables remote working



06 Land use and transportation
- More than half of the villages can provide at least two service facilities within 400m
- 75% of villagers can reach bus station or pier within 400m on foot
- Build super low emission zero in selected area
- Connect all hiking trails in the district
- Keep increasing living wood stock
- Provide at least 200 m2 area for activities promoting traditional handicrafts in every village

07 Operation of building
- Increase 20% of the energy efficiency ratio for split AC in all buildings
- Promote comprehensive carbon emission reduction in current buildings
- Increase the environment standard for new buildings

08 Building material
- Maintain a material recycling rate of no lower than 70%
- 50% or more construction material of new buildings should be from recycling
- Encourage modern wood structure building
- Encourage construction companies to procure equipment that is more environmental-friendly

09 Education for sustainable development
- Build a net-zero tourist route in every village
- Set education area for garbage sorting
- Put up a low-carbon lifestyle show room can in the villager's hall
- Promote low-carbon diet
- Make climate risk map to raise villager's awareness on climate vulnerable assets

10 Carbon inventory
- Establish a carbon inventory/emission reporting and monitoring line in all 79 villages
- Appoint zero-carbon focal point

Figure 4-5-1 Indicator system for Dinghai's rural revitalisation under the net-zero carbon goal

05 Smart Actions: Measure-taking

Dinghai Port©People's Government of Dinghai District

5.1 Case studies on energy and resource system

5.1.1 Renewable energy

Case 1-1: Wind-solar-storage micro-grid system

Location: Xinjian Village	**Implementor:** Dinghai Tourism Development Co. Ltd., Dinghai Power
Related SDGs: **SDG 7:** Ensure access to affordable, reliable, sustainable and modern energy for all; **SDG 13:** Take urgent action to combat climate change and its impacts	**Related Principles:** **Principle 5:** Renewable energy

Figure 5-1-1-1 Parking lot shed with PV

Figure 5-1-1-2 Will power facility

01 Concept of design

The number of tourists and travellers in Xinjian Village is high, and there is a great demand for resting, parking and charging. Dinghai Power makes full use of the space resources of the parking shed roof in the parking lot of Xinjian Village and installs photovoltaic modules, which shade the sunlight for vehicles and also provide charging devices for tourists traveling with electric vehicles.

The north entrance of Xinjian Village is a place for tourists to gather, rest and take photos. Dinghai Tourism Development Co. Ltd. combines the resting corridor, large illuminated logo and bus stops on the small square to build an intelligent micro-grid system consisting of photovoltaic, wind power, batteries and lighting. The power generation and storage can be checked online in real tim.

Photovoltaic and wind power charge lithium batteries during the day, which supply power for lightning at night. In case of long cloudy and rainy weather, it can be switched to grid power. Many visitors may take pictures by the large logo illuminated low-voltage direct current, to avoid the risk of leakage from conventional AC power system on rainy days.

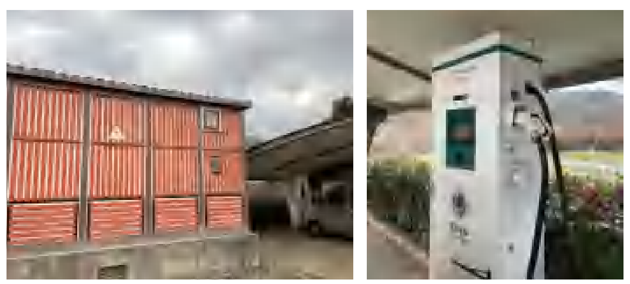


Figure 5-1-1-3 Charing and battery for electric cars

Figure 5-1-1-4 Solar roof and wind power at the entrance of Xinjian Village

Figure 5-1-1-5 User application of smart micro-grid

02 Environmental benefits

Based on the sunlight conditions, Dinghai District installed 21.6kW of photovoltaic panels at the parking lot of Xinjian Village, with the most widely used 450W monocrystalline photovoltaic modules, which can maximize the use of solar energy. Meanwhile, a set of 60kW fast charging stations and a set of 15kW slow charging stations were installed near the PV parking shed. To put the service life of photovoltaic panels module as 25years, this set can generate 21070kW·h every year and a total generation of 526750kW·h for 25 years. According to the average carbon emission factor of Zhejiang Province, which is 0.5264kgCO_2e/kW·h, the annual CO_2 emissions can be reduced by about 12.14t.

From the project completion to December 6,2021, the wind-solar-storage micro-grid system has generated 970kW·h, with a monthly power generation of 150kW·h, saving 0.948tCO_2e carbon emissions.

03 Suggestions to improve

1) Expand the use of solar energy resources

Solar power can also provide charging for electronic products such as cell phones and rechargeable batteries for tourists, as well as private and public electric cars, and electric bicycles in the parking lot.

2) Enhance the awareness-raising and seek technical assistance to promote renewable energy

There are still some misconceptions and biases about rooftop photovoltaic system. Practitioners of renewable energy and clean energy can organize training and awareness raising activities for local residents and government, so that the public can better understand the advantages of clean energy and make better use of it.

Case 1-2: Village fairs with renewable energy

Location: Miaoqiao Village	**Implementor:** Xiaosha Street Office
Related SDGs: **SDG 7:** Ensure access to affordable, reliable, sustainable and modern energy for all.	**Related Principles:** **Principle 5:** Renewable energy **Principle 6:** Water cycle **Principle 7:** Solid waste

01 Concept of design

Xiaosha farmers' market is located at Miaoqiao Village, where the town government is. The market has an area of 2242km^2, with a 2.8km^2 parking area. The market is providing retail service for local farmers and residents, with a daily flow of about 300-400 people.

Inside the market, there are 85 stalls selling vegetables, fruits, meat and fish, and 12 shops along the street.

During the renovation, PV panels have been installed on the roof of the market, with six electric vehicle charging stations in the parking area. The power from roof PVs is used for the daily need of the market and vehicle charging, while the rest of the power will be transmitted to the main grid.

Figure 5-1-1-6 Inside the market

Figure 5-1-1-7 Shops along the street

Figure 5-1-1-8 Sketch of the PV panel installed farmers' market

Figure 5-1-1-9 "produce and sell" stalls

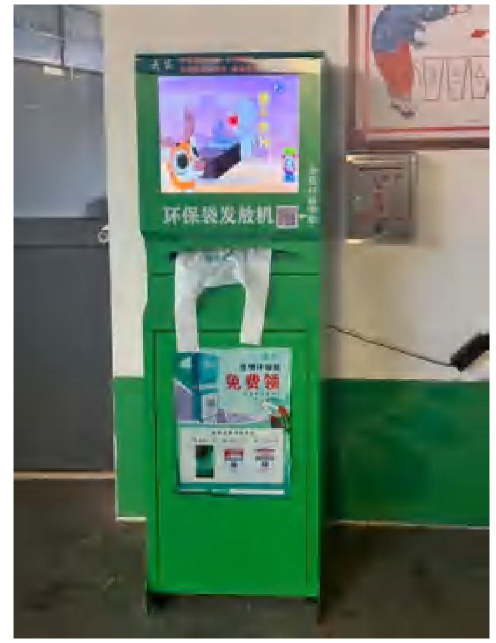


Figure 5-1-1-10 Vending machine for biodegradable bags

02 Environmental benefits

1) Renewable energy

The total area of the PV panels is 437.2m^2 and the installed capacity is 88.8kWp. Based on the annual effective sunshine time of 1430.9 hours in Zhoushan and the system efficiency at 80%, the annual power generation capacity is about 101,700 kW·h. Based on an emission reduction factor of 0.69 kgCO_2e/kW·h, this would reduce carbon emissions by 70.17 tCO_2e per year.

2) Sustainable consumption

The market has set up "produce and sell" stalls to allow qualified local fruit and vegetable farmers to sell directly in the season and charge a low stall fee.

The carbon emission from long-distance transportation of agricultural products sometimes exceeds those from the food production process. Choosing locally produced food can reduce the whole life cycle carbon emissions and at the same time promote local brands and boost the agricultural industry.

At the entrance of the food market, the management office provides eco-friendly reusable shopping bags, which are biodegradable ones made from materials such as corn and straw.

These bags are available in limited quantities that each person can get two free of charge. This can prevent the vendor from providing disposable plastic bags and reduce plastic waste, thus making carbon emissions from solid waste decrease and consumptions more sustainable.

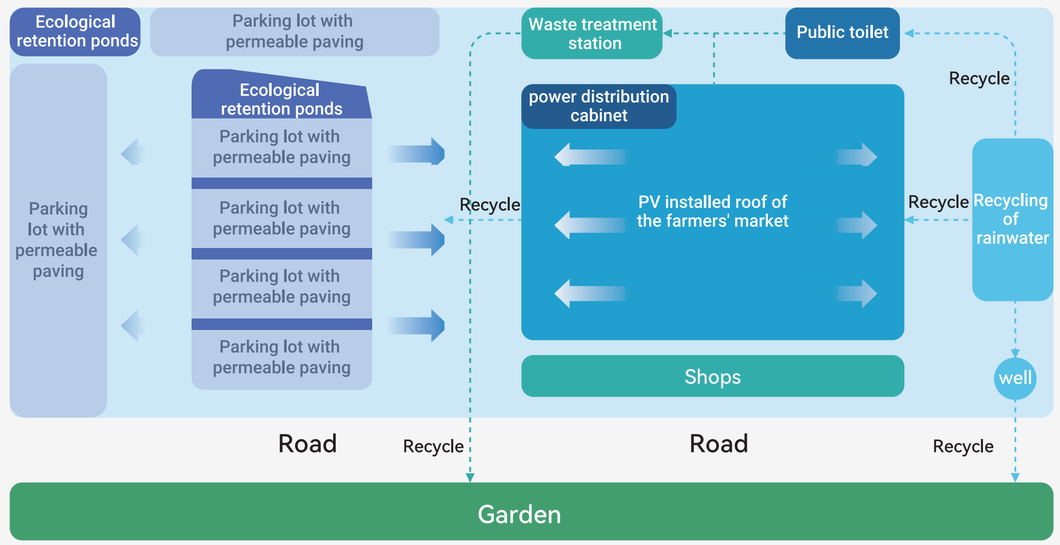


Figure 5-1-1-11 Design of the recycling system

03 Suggestions to improve

1) Establish recycling system

The market generates large amounts of food waste every day, and uses a lot of water. Food waste recycling and rainwater reuse system can be established to reduce carbon emissions from waste transportation, incineration and water usage.

Food waste from the market and organic waste from public toilets can be processed and used as organic fertiliser in the parks and roads nearby.

Rainwater from the roof and car park can be collected and treated, together with the water from the wells, to provide cleaning water for the market, garbage station, toilets and parking lot. The rest of the water can be used for watering the garden.

The rainwater from the PV roof is relatively clean and can be reused after disposal and simple sand filtration. The rainwater from the ground has more pollutants and can be purified by permeable paving and ecological retention ponds through sponge facilities before entering the rainwater pipe network for reuse.

2) Use of natural lighting

The market already has side windows for natural lighting, but the interior of the market is still dark. Skylights can be installed on the roof to make full use of natural lighting and reduce electricity consumption in the market.

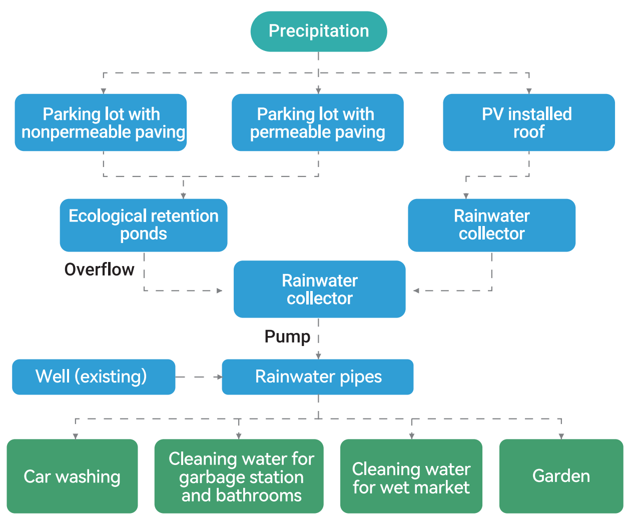


Figure 5-1-1-12 Design for water recycling

Figure 5-1-1-13 Current side windows in the market

Case 1-3: Wind Mill of Cengang

Location: Mamu Village	**Implementer:** Longyuan Power
Related SDGs: **SDG 7:** Ensure access to affordable, reliable, sustainable and modern energy for all **SDG 13:** Take urgent action to combat climate change and its impacts	Related Principles: **Principle 5:** Renewable energy

Figure 5-1-1-14 Wind mill in Cengang

01 Concept of design

Wind power is a sustainable and renewable form of energy that has significantly smaller environmental footprints compared to fossil fuels. With technology advancement, the cost of installing wind mills and power generation decreased significantly. In areas with abundant wind resource, the cost is lower than that of thermal power.

Using wind power in Dinghai can be an effective way to achieve carbon neutral. Zhejiang Longyuan Power installed distributed wind mills of 3MW and put the connect to the grid.

02 Environmental benefits

To estimate the carbon reduction benefits of the wind power in Mamu village, at the estimation of 20 year service life, annual power output is 9.9 million kW·h. According to the average carbon emission factor of Zhejiang Province, 0.5264kg CO_2e/kW·h, wind power can reduce around 5211.36tCO_2e carbon emissions. Increase wind power in the energy mix can also reduce ash, soot and wastewater pollution from burning coal.

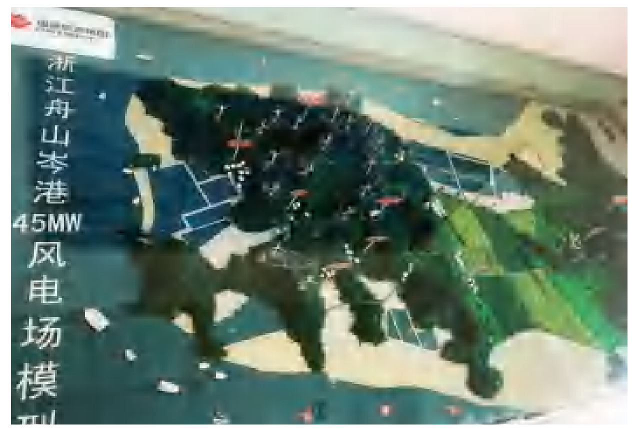


Figure 5-1-1-15 Model of the wind mill in Cengang

03 Suggestions to improve

1) Partner with private sectors

Dinghai can partner with professional wind investment platform and explore wind resource from offshore, along with consultation, research, implementation and operation.

2) Introduce a wind-solar hybrid storage system

Wind and solar can complement each other to provide a more stable and adaptable supply, together with power storage system.

Figure 5-1-1-16 Generation capacity of Cengang wind mill

5.1.2 Water cycle

Case 1-4: Xikeng water circulation system of Maao Village

Location: Maao Village	**Implementor:** Maao Village
Related SDGs **SDG 6:** Ensure availability and sustainable management of water and sanitation for all **SDG 15:** Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	**Related principles:** **Principle 6:** Water cycle

01 Concept of design

The total length of the water circulation system in Maao village is about 800m, with a height difference of 3.5m. The widest width is 4m, and the narrowest point is 2m, with an average width of 3.2m. The reservoir along the system uses the height difference from upstream to downstream, allowing residents to use and raise a small amount of livestock and poultry without extra energy consumption while maintaining the water quality.

The water system flows through four functional sections: the upstream low-disturbance area, the residential area, the poultry breeding area, and the downstream area. The upstream low-disturbance area uses three dams to intercept leaves, floating plastics and other solid waste in the ponds. The bottom of the pond is paved with cobblestones, planted with local water plants, and the bank is built with filtering walls and green plants to remove pollutants by efficient indigenous bacteria. The residential water area is for residents to wash clothes, farm tools, kitchenware, and other items in the stream. The pollutants such as petroleum, organic matter, suspended matter, ammonia nitrogen, total nitrogenand total phosphorus from this area are filtered and purified before entering the subsequent poultry breeding area. At the same time, filter walls are set up around the residential water area and poultry farming area to reduce the impact of rain and surface runoff, and to ensure that water quality is maintained at the level of Class IV water (except for total nitrogen).

Figure 5-1-2-1 Xikeng water circulation system

Figure 5-2-1-2 Illustration of Xikeng water circulation system

02 Environmental benefits

1) Reduced use of tap water

Research data shows the daily average person-time of washing things in the stream is about 100 times, with an average water consumption of 100 litres each time, which can save 10 tons of tap water per day. According to the average carbon emission factor of Zhejiang Province, which is $0.5264kgCO_2e$ /kW·h, the annual carbon emission saved is $0.5264*3650*1.05=2018kgCO_2$.

Meanwhile, about 15 ducks are raised in the pond, which discharge 10g of chemical oxygen demand (COD), 1g ammonia nitrogen and 0.2g total phosphorus per day on average, all these pollutants can be naturally purified by the system, which does not require extra energy and at the same time does not affect the water quality.

2) Tourism/leisure service and ecological awareness

Xikeng shaped the landscape of Maao village, visited by around 100,000 visitors every year. It not only increased employment opportunities from tourism, but also provided ecological education function.

03 Suggestions to improve

1) Maintain the pond landscape ecology through "water storage tank + new photovoltaic energy"

In view of the lack of rainfall during the dry period, a photovoltaic water storage upgrading system is set up at the end of the low disturbance area, and a water storage tank is set up to ensure that the energy generated by solar photovoltaic power generation is directly lifted from the storage tank to 75m upstream during the dry period to ensure that the water level of the pond is maintained above 0.15m to meet the landscape requirements.

2) Improve management tools

The type, quantity and mode of poultry breeding are controlled in the breeding area, while ecological purification devices such as artificial floating islands should be installed downstream of the breeding area to guarantee the water quality of the pit pond.

Table5-1-2-1 Energy consumption from tap water

Energy unit	Energy consumption (kW·h/ton)	Notes
Water supply from mainland	0.15	From Ningbo to Dinghai
Water transportation from reservoir	0.12	From reservoir to drinking water plant
Treatment in drinking water plant	0.13	Field investigation
Water transportation from treatment plant	0.15	From plant to tap
Wastewater treatment	0.5	Energy consumption from waste treatment
Total	1.05	Lifecycle assessment

Case1-5: Eco park with water recycling system and PV installed roof

Location: Maao Village	**Implementor:** Maao Village
Related SDGs **SDG 6:** Ensure availability and sustainable management of water and sanitation for all **SDG 7:** Ensure access to affordable, reliable, sustainable and modern energy for all	**Related principles:** **Principle 6:** Water cycle **Principle 2:** Well-connected mixed nodes

01 Concept of design

1) Layout of function areas

The resting point provides a space for visitors and villagers to rest, socialise with a landscape view. It is also a bus station for electric bus tour. The PV-installed roof provides power for the fountain, water treatment system for the toilets, as well as electric vehicles.

Auxiliary buildings to the resting points provide baby room and accessible restroom, which are equipped with hand basins, direct drinking water facilities and vending machines. Management and cleaning staff also have their resting place and equipment rooms.

Public toilets and artificial wetland. The public toilets serve visitors and residents and are also one of the low-carbon education places. Water for toilet flushing comes from the ecological pond, and the drainage enters the ecological pond after passing through the purification equipment and the artificial wetland at the north of the resting points.

The eco pond provides a recreational area for visitors and villagers, and also has the functions of rainwater collection, water recycling and storage, as well as ecological service.
Parking and electric vehicle charging station. A centralised parking area encourages visitors to park their cars first and switch to electric vehicles or walk into the village, in order to reduce carbon emissions from transportation. At the same time, the solar power generated from the PV-installed roof of resting points can provide chargeing to the electric vehicles.

2) Water recycling system

Public Toilet - Artificial Wetland - Eco Pond. Powered by the PV installed roof of the resting point, the pump takes water from the pond to flush the public toilets. The water lifting and flushing system adopts mechanical filtration + ultraviolet sterilisation and then passes through a constant pressure water supply system. The system uses an automated control system for easy management. After passing through the septic tank and sewage treatment equipment, the toilet sewage is purified by the artificial wetland and then re-entered into the pond to close the water cycle.

Car park - artificial wetland - eco pond - Xikeng water stream. Rainwater runoff from the car park is filtered through the artificial wetland and then enters the pond. In dry season, when some parts of the stream dry up, rainwater stored in the eco pond is pumped and distributed to the upstream, where the impurities are filtered and organic pollutants in the water are degraded by water plants and retaining dams. This circulation system aims to maintain the water flow of the Xikeng stream during dry season and supply water to the villagers for domestic use.

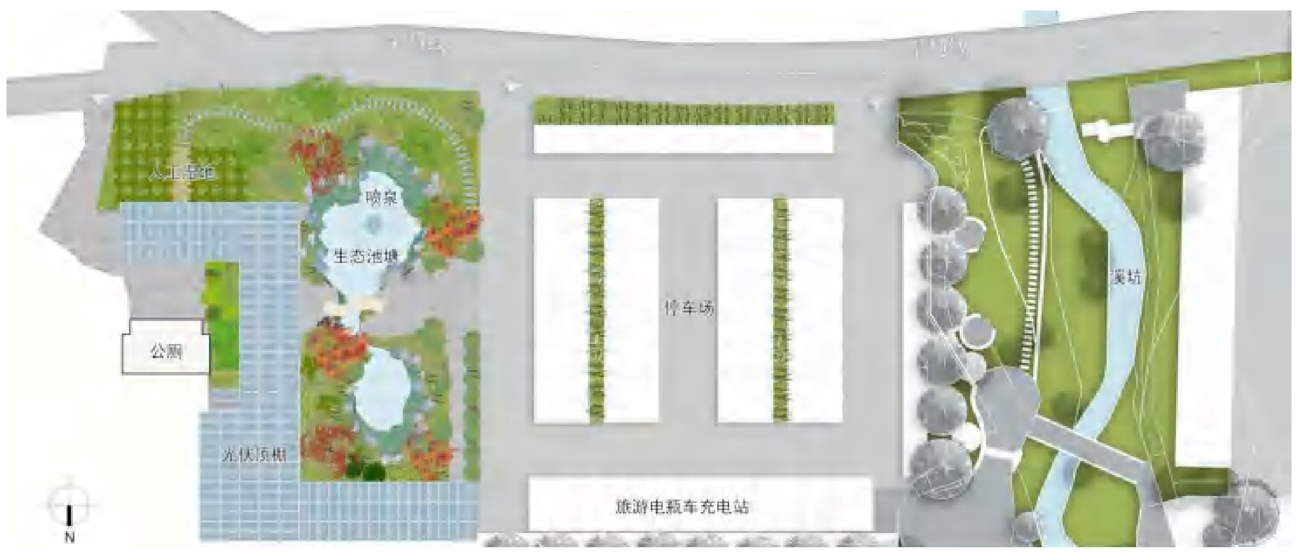


Figure 5-1-2-3 Layout of the Eco Garden of Maao Village

Figure 5-1-2-4 PV installed roof

02 Environmental benefits

1) PV installed roof

The roof of the resting points has 212 PV panels, with 2*2 meters each. Every panel can generate electricity of 350w, and the total power generation is 74kW. Based on the power generation capacity of 4kW·h/(1kW·d), the average daily power generation of these roofs is 296kW·h. The surplus power is transited to the grid, which can reduce approximately 107tCO_2e per year (according to the marginal emission factor of 0.79kg/kW·h for the power grid of East China in 2019, issued by the Ministry of Ecology and Environment).

02) Public Toilet - Artificial Wetland - Eco Pond recycling system

Figure 5-1-2-5Artificial wetland for water purification
This recycling system can save 1640 tons of tap water per year through. As the tap water source in Dinghai District needs to be transported from far away mainland, every ton of water implies 0.9kg of carbon emission. Thus, the water recycling system can reduce carbon emissions by 1476kg CO_2e per year.

3) Parking lot - artificial wetland - eco pond - Xikeng stream water circulation system

The annual rainfall in Zhoushan is 1300mm[21]. Based on the runoff coefficient of 0.8, the eco pond can collect 2080 tons of rainwater every year. The water used for the landscape of the park is stored and used with solar power. If it runs for 135 days per year during dry season, 32,400kW·h of grid power can be saved and by 25.6tCO_2e of carbon emissions can be saved.

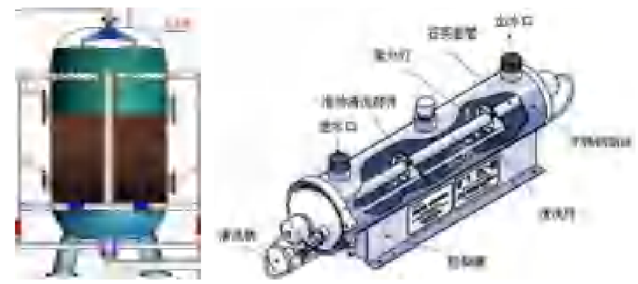


Figure 5-1-2-5 Filtration and disinfection system of eco restroom

Figure 5-1-2-6 Artificial wetland for water purification

03 Suggestions to improve

The whole system can be optimised to improve the efficiency of water use. At the same time, the data of power generation and usage can be displayed outside the eco restroom for educational purpose.

Case 1-6: Store rainwater for irrigation

Location: Shuangqiao Street Office	**Implementor:** Shuoyuan Vegetable Co-operative
Related SDG: **SDG 12:** Ensure sustainable consumption and production patterns	Related principles **Principle 8:** Energy, water, food and waste cycles

01 Concept of design

1) Using rainwater ditches for irrigation

The Shuoyuan Vegetable Co-operative is located in Shuangqiao Street Office area. The farm has a total area of about 60,000m^2, with an actual planting area of 40,000m^2 and 20,000m^2 for roads and rainwater harvesting ditches. The rainwater ditches are 5-6m wide and 1.5m deep, which can store rainwater for all the irrigation purposes on the farm throughout the year. When extreme weather such as typhoons and heavy rainfall happens, the ponds can be drained in advance to accommodate excess rainwater and prevent crops from being flooded. Some fish are also kept in the ditches to consume a small proportion of the organic agricultural waste.

Figure5-1-2-7 Layout of Shuoyuan Vegetable Co-operative

02) Employ drip irrigation

Meanwhile, during the irrigation process, the farm uses water and fertiliser integration technology, where the fertiliser solution is blended with irrigation water according to the nutrient content of the soil and the type of crop. Water is directly transported to the roots of the crop through a controlled pipeline and dripping system, which allows precise application of fertiliser for different crop growth stages, while saving fertiliser and water.

3) Other low-carbon measures

At the end of one season of cultivation, the farm uses a double layer of membrane to seal the greenhouse and makes full use of natural light and heat to sterilise it.

Figure 5-1-2-8 Greenhouses in natural sterilization

Figure 5-1-2-9 Solar powered insects catcher

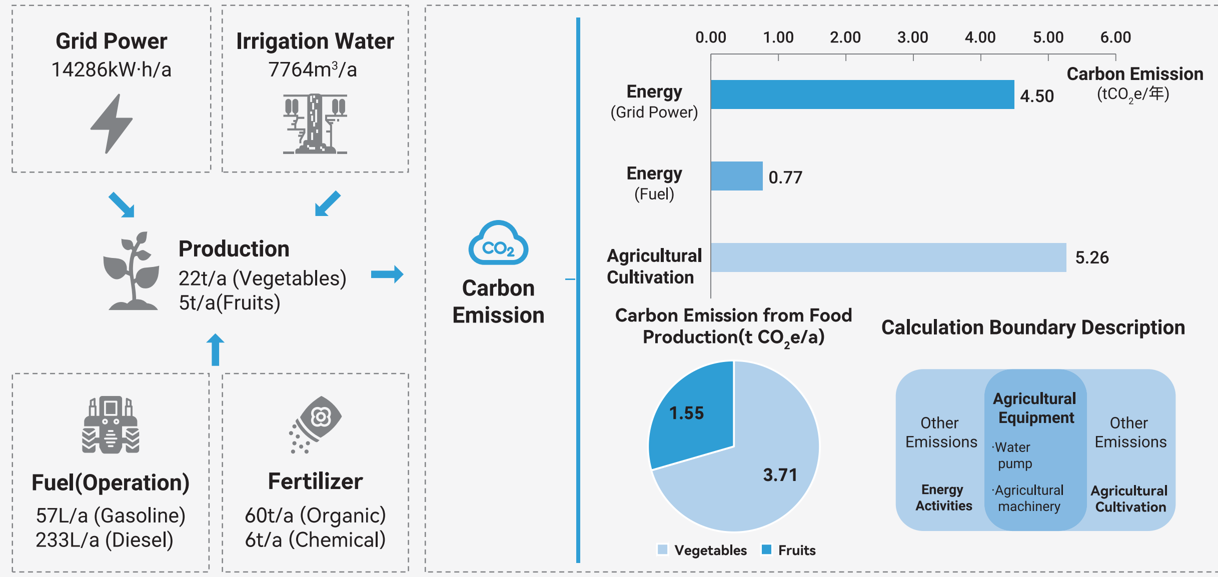


Figure 5-1-2-10 Energy-water-food nexus and carbon emissions at Shuoyuan Vegetable Co-operative

02 Environmental benefits

With a vegetable production of 27 t per year, Shuoyuan Vegetable Co-operative consumes 14286kW·h of electricity and 290L of fuel (diesel and petrol). It also applies 60t of organic fertilizer and about 6t of chemical fertilizer, 7,764m^3 of irrigation water, which makes the total carbon emission of energy activities around 5.27tCO_2e and that from farming activities around 5.26tCO_2e.

The farm irrigates 7,764m^3 of water per year for plantation, directly from surrounding man-made rainwater ditches (energy to pump the water is included in the farm's total power consumption) without any treatment, which saves a significant amount of carbon emissions from water consumption.

03 Suggestions to improve

As the carbon emission effect of chemical fertilizers is 30 times higher than that of organic fertilizers,[11]although the Vegetable Co-operative uses only 10% of chemical fertilizers, it results in 75.95% of fertilizer emissions. On the other hand, if the farm produces organic fertilizer through composting, it will increase land use and may not fully meet the fertilization needs.Composting techniques and equipment that occupy less land need to be introduced to reduce the pressure on the land from composting. During the harvest, a large amount of organic waste such as straw is left on the farm, causing challenges with straw disposal due to site, technology, experience, and time constraints. Expert research teams can be organised by the Bureau of Agriculture and Rural Development to select farms with an interest in straw reclamation pilot projects, and invite professionals specialised in organic waste treatment to convert straw waste into organic fertiliser through small and special processing equipment.

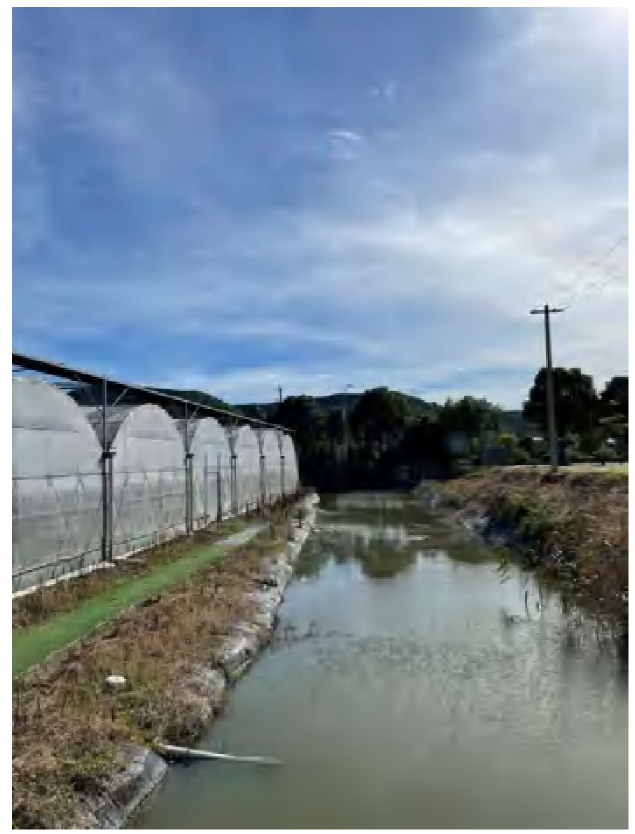


Figure 5-1-2-11 Rainwater ditch

5.1.3 Solid waste

Case 1-7: Collection and recycling of pesticide bottles and mulch films

Location: Dinghai District	**Implementor:** Bureau of Agriculture and Rural Development of Dinghai
Related SDG: **SDG 12:** Ensure sustainable consumption and production patterns	Related principles **Principle 7:** Solid waste

01 Concept of Design

In July 2015, Dinghai launched the recycling of pesticide packaging, with 41 shops as collection points, covering all towns and streets in the district. Farmers can gather the pesticide bottles and bags and take them to the recycling points for cash. At the same time, Dinghai has also started to collect waste mulch films (those cannot be used on the farm again) in 2019 for centralized treatment, through a network of trade-in and centralized treatment under regulation, monitoring and financial support from the government.

02 Environmental benefits

Discarded pesticide plastic bottles and agricultural films in the field, after exposure to UV light, will become microplastics[2]. The accumulation of microplastic content in the soil will affect soil properties, functions and biodiversity[6] and enter the food chain, causing impacts on humans and other organisms.

Statistics show that 90.14t of mulch films and 21.79t of pesticide packages were collected and treated in 2020, which reduce the pollution to the environment.

Table 5-1-3-1 Amount of pesticide packages and mulch films recycled (2016-2020)

	Pesticide package (tons)	Mulch film (tons)
2016	15.89	
2017	23.20	
2018	26.15	
2019	23.23	3.26(June to December)
2020	21.79	90.14

03 Suggestions to improve

1) Solid waste recycling

At present, pesticide bottles and solid waste are incinerated in Dinghai. It is calculated that 20.57 t of pesticide packaging was recycled in 2020, with the main materials being PP, PVC and PE. Based on a 95% incineration efficiency and an average carbon content of 80%, incineration will produce carbon emissions of about 57.32tCO_2e. 90.14t of mulch film was

Figure 5-1-3-1 Plastic mulch film used in agriculture

recycled in 2020. The incineration process produces emissions of approximately 251.20tCO_2e.
Depending on their calorific values, solid waste can be treated organically or inorganically and as hazardous waste. Instead of incineration, plastics can be made into pellets for further application.

2) Solid waste reduction

Solid waste on islands can be reduced through a redesign of supply chain.
① Transport vegetables to the island without or with light and reusable packaging;
② Promote sustainable consumption of buying less and wasting less;
③ Introduce monetary incentives to encourage recycling;
④ Enhance solid waste treatment infrastructure on the islands, and raise awareness through educational activities to reduce littering.

Case 1-8: Reuse livestock waste

Location: Yandun Village	**Implementor:** Huasheng Ranch
Related SDG: **SDG 12:** Ensure sustainable consumption and production patterns	Related principles **Principle 7:** Solid waste **Principle 8:** Energy, water, food and waste cycles

01 Concept of design

Huasheng Ranch covers an area of 200,000m^2, with a construction area of 56,000m^2 and a supporting planting area of approximately 104,000m^2. The main product of the ranch is pigs, which are transported by distributors directly. The ranch also plants crops for self-consumption by the staff canteen.

In terms of energy consumption, a total of 5 million kW-h of electricity is consumed every year, mainly from the national grid, solar power and biogas, pig barn insulation, lighting and environmental control facilities (odour treatment).

In addition to this, the farm consumes 288,000 liters of diesel fuel for feed transport and another 142,900 liters for pig barn insulation. The farm uses tap water for livestock consumption. In addition, there is a wastewater pre-treatment facility with a design size of 400m3.d^{-1}. After anaerobic and biochemical treatment, 2/3 of the wastewater is piped into the wastewater plant and 1/3 is used for irrigation of crops inside the ranch.

Huasheng Ranch invested 14 million RMB to develop and install a manure reuse and treatment system, with five fermentation tanks of 120m^3 each. The livestock wastes are treated through high temperature fermentation tanks, sewage anaerobic fermentation and then A_2O biological treatment, so that the wastewater can meet national standards and the manure can be used again. Under normal production conditions, the output of organic fertilizer is about 20t/day and the moisture

Figure 5-1-3-2 Thermal insulated barn

Figure 5-1-3-3 Vehicle for feed transportation

content of the fertilizer is about 30%. Part of the manure is used for planting within the ranch and the rest is sold to local growers. The ranch sales 3000t of the recycled manure every year. Urine of the livestock is packed to the farmland too.

02 Environmental benefits

Based on the annual pig stock on the farm, the main carbon emissions generated each year come from the whole life cycle emissions of feed, and energy consumption in its production and transportation. The farm can reduce the emissions by optimising energy management and making full use of renewable energy.

1) PV panel installed roof

The ranch installs PV panels on the roof to generate electricity for self-use. The total area of PV installed roof is approximately 14,300m^2, with a capacity of 1573.42kWp.
Using the standard sunshine hour method to calculate power generation, with the annual effective sunshine hours in Zhoushan City of 1430.9 hours, and the system efficiency at 80%, the annual PV power generation is 1.8 million kW·h.

The annual electricity consumption of the ranch in 2020 is 6.62 million kW·h, and the daily electricity load is stable, so the PV power generation can be basically consumed locally.

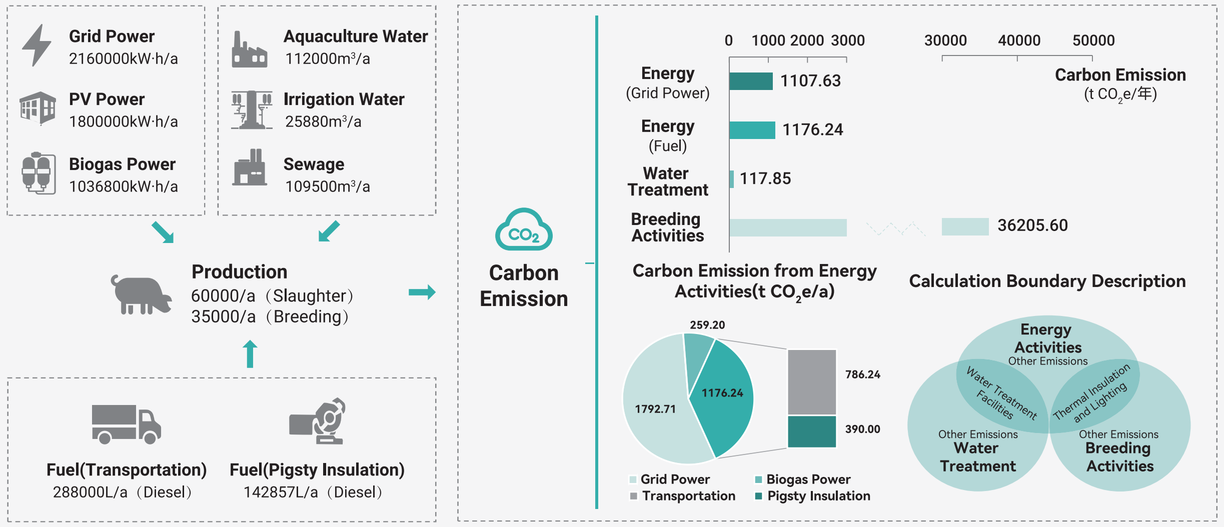


Figure 5-1-3-4 Energy-water-food nexus and carbon emissions at Huasheng Ranch

Based on an emission reduction factor of 0.69kgCO_2e·(kW·h)$^{-1}$, carbon emissions will be reduced by 1,242tCO_2e per year.

At the same time the reinforced concrete flat roof does not require structural modifications and at an investment unit price of 4 CNY.W^{-1}, a total investment of 6.29 million is required to build the PV. Based on an electricity price of 0.8 CNY·(kW·h)$^{-1}$, the annual saving in electricity costs is 1.44 million and the investment can be recovered in about 5 years.

2) Biomass energy

Huasheng Ranch uses biogas to generate electricity to supplement its own energy needs, of which the electricity generated from biogas is approximately 1,036,800(kW·h)Y^{-1}, effectively reducing carbon emissions in the process of energy consumption, and 284.71tCO_2e emission can be reduced every year.

Figure 5-1-3-7 Smart composting tank for organic fertiliser

Figure 5-1-3-5 PV panel installed roof

Figure 5-1-3-6 PV panel installed roof of Huasheng Ranch

03 Suggestions to improve

1) Energy sub-metering

Energy consumption of equipments for production, transportation, storage and operation can be measured separately to facilitate timely detection of abnormal energy consumption and reduce non-essential consumption.

2) Visualised platform for solar power

This platform can keep track of the status of solar power generation under different conditions, which facilitates instant control and deployment of energy.

At the same time, Internet of Things, cloud services and big data technology, can improve smart operation and maintenance for the whole life cycle of solar power.

3) Improve the quality of organic fertiliser

At present, the control of organic fertiliser materials input and production processes is still based on manual work, and recipe optimisation and automatic control are needed to improve the quality of the products.

5.2 Case studies on low-carbon industry development

5.2.1 Low-carbon development of agriculture

Case 2-1: Create a Low-Carbon Farm

Location: Xiaosha District	**Implementor:** Yiran Ecological Family Farm
Related SDG: **SDG12:** Ensure sustainable consumption and production patterns	Related principles **Principle 8:** Energy, water, food and waste cycles

01 Concept of design

The Xiaosha Yiran Ecological Family Farm, located in Dinghai District of Zhoushan City, has a total area of approximately 133,000 square meters. The farm is primarily engaged in the cultivation and sale of various vegetables, fruits, and melons, while also maintaining a moderate amount of ecological poultry breeding. Yiran Farm is the first fruit and vegetable farm in Zhoushan City to be managed through organic methods. It adheres to the concept of integrating land cultivation and animal breeding, using straw to return to the fields, and avoiding the use of fertilizers and pesticides. In 2018, the farm obtained organic certification. Meanwhile, it actively explores the CSA (Community Supported Agriculture) model and has become the first internet farm in Zhoushan City. Using the "online sales + local delivery" model, customers can learn real-time information about farm production online. After ordering agricultural products online, the farm can deliver directly to the customer's home within the same day or the next day, following harvesting and packaging in the afternoon.

02 Environmental benefits

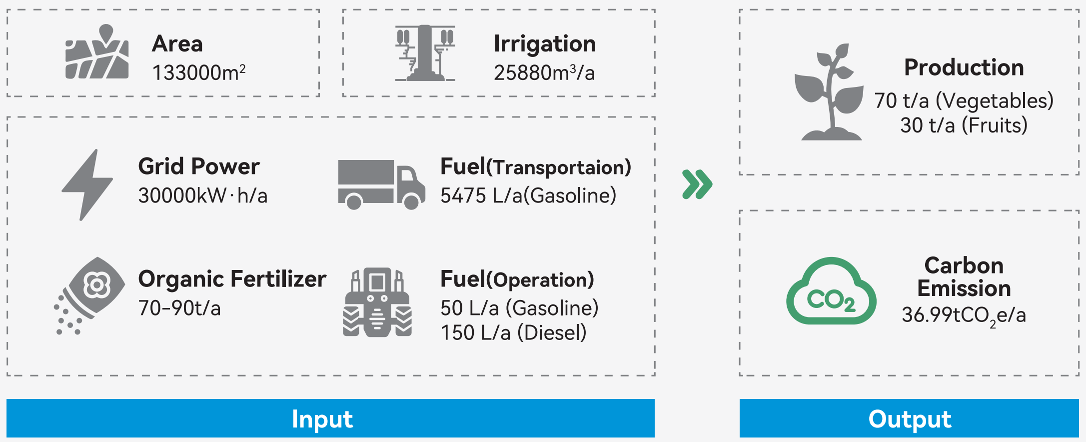


Figure 5-2-1-1 Energy-water-food nexus and carbon emissions at Xuwang Aquafarm

Carbon emissions before the reform

Before the low-carbon farm reform, the farm consumed a total of 30,000 kW·h of electricity annually for irrigation, refrigeration storage, and a small portion of residential energy needs. The cold storage used for storing fruits and vegetables accounted for the largest proportion of electricity consumption. Additionally, vehicles were used for product distribution, consuming 5,475 liters of gasoline per year, while agricultural equipment consumed 50 liters of gasoline and 150 liters of diesel per year. The farm, which uses entirely organic fertilizers, purchased 60-70 tons of organic fertilizers from outside sources and self-composted 10-20 tons of organic fertilizers. The irrigation water for the farm, totaling approximately 25,880 cubic meters per year, is drawn from nearby rivers. The farm produces approximately 70 tons per year of vegetables and 30 tons per year of fruit, resulting in a carbon emission of 36.99 tCO_2e.

Low-carbon reforms

In 2022, Yiran Farm advanced low-carbon reforms, as illustrated in Figure 5-2-1-2, including projects such as the adoption of new energy sources, the use of organic fertilizer composting, the recycling of domestic wastewater for irrigation, improving insulation performance, and the development of a zero-carbon digital platform. Comparatively speaking, the Farm is expected to reduce annual carbon emissions by approximately 85tCO_2 following the completion of these upgrades. These initiatives will achieve significant economic, social, and environmental benefits, and also demonstrate leadership in promoting wider adoption of low-carbon practices.

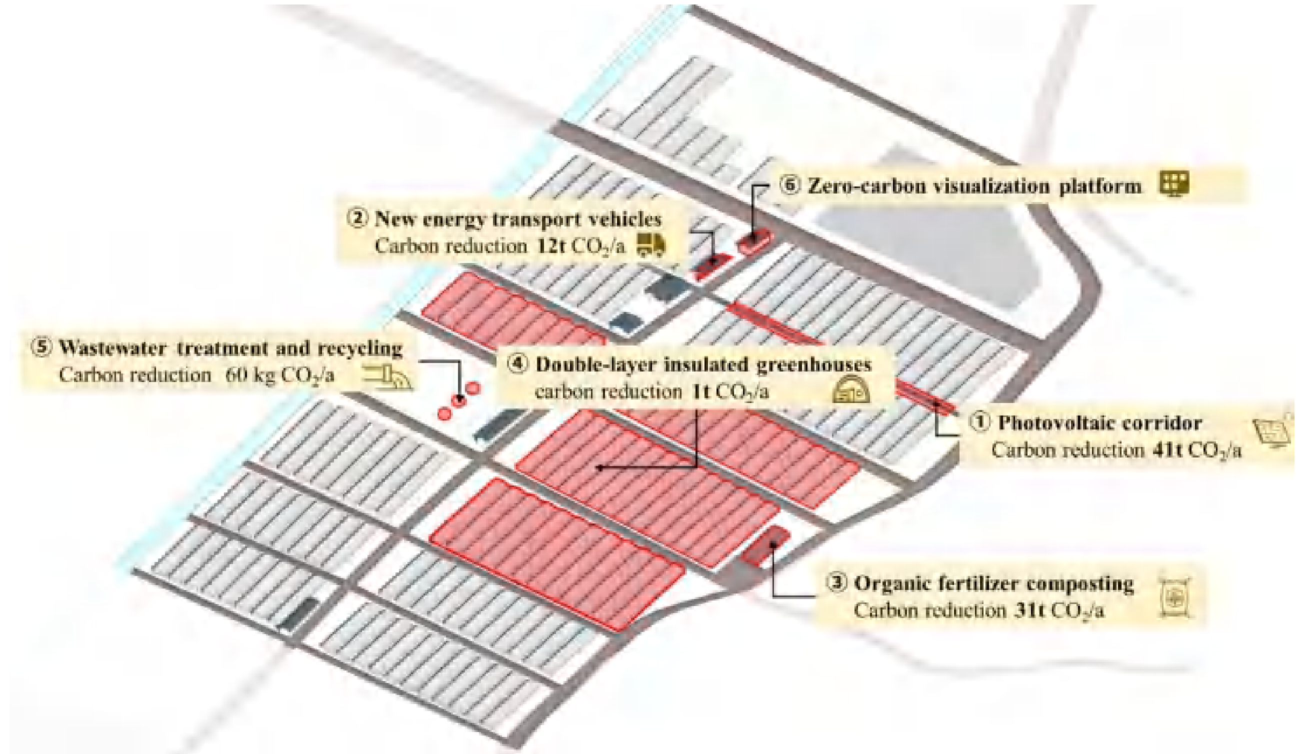


Figure 5-2-1-2 Distribution of farm reform projects and their carbon reduction benefits

1) Photovoltaic Corridor

A photovoltaic corridor has been installed by the farm along the greenhouse pathway, consisting of 110 solar panels with a total investment of approximately RMB 300,000. The photovoltaic system has a peak power output of 60.5kW, using the self-use and excess power grid connection method. Based on the annual sunshine duration levels in Zhoushan, approximately 1,000 hours of annual sunlight can be utilized for power generation, satisfying the farm's daily operating and refrigeration storage power needs. According to the emission reduction factors published by China's National Development and Reform Commission, the farm can reduce approximately 41 tons of CO_2 emissions through electricity generation using solar energy each year.

Figure 5-2-1-3 Before (left) and after (right) the installation of the photovoltaic corridor

2) New energy transport vehicles

The farm provides product distribution services using two vans. The total fuel consumption is 5,500 liters per year, resulting in fuel costs of approximately RMB 44,000 per year. By switching from fuel-powered delivery vehicles to two new-energy vans, the farm will consume 7,300 kW·h of electricity per year, with an associated electricity cost of approximately RMB 5,000 per year. This switch will lead to an annual reduction of carbon emissions by approximately 12 tons.

Figure 5-2-1-4 The new energy vans and their charging stations

3) Double-layer insulation for the greenhouses

Before the reform, during the coldest 10-20 days of the year, the farm had to use fuel to maintain greenhouse insulation, consuming approximately 500 liters of diesel. By carrying out the 10,284 m^2 greenhouse renovation project, the farm introduced double-layer insulation, which greatly improved insulation efficiency. Following this renovation, the double-layer insulated greenhouses require minimal fuel for heating, resulting in a one-ton-per-year reduction in carbon emissions.

Figure 5-2-1-5 The greenhouses before (above) and after (below) the double-layer insulation renovation

4) Organic fertilizer composting

Before the reform, the farm needed to purchase 60-70 tons of organic fertilizers from outside sources. By adding composting facilities and recycling solid waste such as wood and straw, the farm can produce around 200 tons of organic fertilizer per year, reducing carbon emissions by approximately 31 tons compared to burning straw. In addition to satisfying its own organic fertilizer needs, the farm can sell approximately 100 tons of organic fertilizer.

Figure 5-2-1-6 Composting schematic diagram

5) Domestic wastewater treatment and recycling

To account for the increase in domestic wastewater with expected increases in tourism, the farm has now added distributed wastewater treatment facilities. These facilities use a passive I-cell reactor and fixed plate packing that operate with minimal power consumption (120W). The facilities are buried underground, and the treated wastewater is pumped to the greenhouses for irrigation after undergoing anaerobic and aerobic treatment. Based on treatment of 1 ton of domestic wastewater per day, there is an annual carbon emission reduction of approximately 60 kg compared to centralized treatment alternatives.

Figure 5-2-1-7 I-cell reactor and installation effect

6) Zero-carbon visualization platform

The farm has established a zero-carbon visualization platform, supported by Internet of Things (IoT), cloud services, and big data technologies. This platform provides real-time access to information on daily photovoltaic power generation, electric vehicle power consumption, domestic wastewater treatment volume, agricultural waste utilization, and statistics on farm carbon emissions, providing comprehensive insights and analysis.

Figure 5-2-1-8 Energy data visualization platform

03 Suggestions to improve

1) Enhancing energy subcategory measurement

To optimize energy management, it is crucial to implement a refined approach to energy measurement. This involves an itemized catalogue of energy consumption, encompassing production equipment, transportation and storage facilities, as well as domestic appliances. Such meticulous monitoring enables prompt detection of energy wastage spikes, with the ultimate aim of successfully reducing non-essential power consumption.

2) Facilitating energy and water conservation upgrades

By aligning with equipment upgrades, there is potential to improve energy and water conversion rates related to equipment usage. This could include upgrading the efficiency of farming air conditioning from level three to level two status or higher. Additional conservation efforts could be realized by incorporating variable-frequency driven cooling apparatuses into farming cold-storage facilities, alongside the replacement of water-consuming appliances like flushing toilets and faucets with water-saving alternatives.

3) Development of carbon labeling for agricultural produce

Efforts aimed at reducing carbon footprint during farming operations can be further enhanced through the implementation of carbon labeling for agricultural produce. Through itemized measurement and a zero-carbon visualization platform, carbon emissions relating to the entire production-to-consumption process of fruits and vegetables will be meticulously calculated, and made known to consumers through labeling. This endeavor will serve to promote sustainable consumer practices, and reflect the farm's responsible approach to production with a focus on social responsibility.

Case 2-2: Low-carbon aquaculture through better management

Location: Xiaosha Street Office	**Implementor:** Xuwang Aquafarm
Related SDG: **SDG 12:** Ensure sustainable consumption and production patterns	Related principles **Principle 8:** Energy, water, food and waste cycles

01 Concept of design

Xuwang Aquafarm is specialized in keeping Pacific White Shrimp, while the main carbon intensive part is the energy used in the plant for aeration, to increase oxygen in the ponds. The sludge from the ponds is also collected, sun-dried and returned to farmland as organic fertilizer.

The aquafarm uses seawater (400m away) after treatment and changes the water every three days. The pond's water depth ranges from 30-50cm and is changed 30 times a year, with a total water usage of 1040 km^3/year. In order to ensure the water quality in the ponds, the water is put back into the sea again after treatment instead of reuse.

The company improved its management model by setting different aeration rates based on the fact that oxygen levels are higher during the day than at night. Additionally, the plant's solar-powered street lamps provide enough lighting at night.Given the energy consumption is still quite high in the plant, the company is considering installing solar power, wind mind and other reusable energy to further reduce carbon emission.

Figure 5-2-1-10 Oxygen supply equipment

Figure 5-2-1-9 Layout of Xuwang Aquacfarm

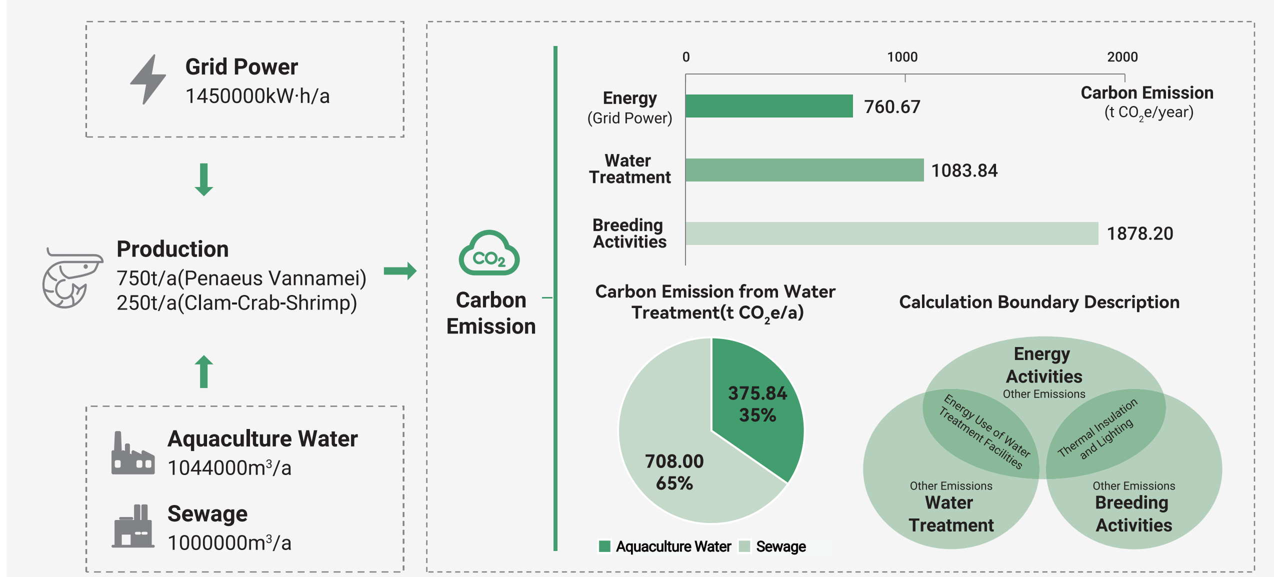


Figure 5-2-1-11 Energy-water-food nexus and carbon emissions at Xuwang Aquafarm

02 Environmental benefits

The farm consumes a total of 1.45 million kW·h of grid electricity per year, generating carbon emissions of 760.67 tCO_2e. In terms of water treatment activities, the carbon emissions from the water supply are approximately 375.84t CO_2e/year; the effluent from the farming process also needs to be treated before discharging. With a water treatment volume of approximately 1 million m^3/year, the carbon emissions from the effluent treatment process are approximately 708.00tCO_2e/year, accounting for 65.32% of the total carbon emissions from water treatment activities.

Considering both economic returns and carbon intensity, aquaculture is a more suitable industry for villages on the islands. The food production structure in rural Dinghai can be appropriately adjusted by replacing livestock and poultry farming, which has a higher carbon emission intensity, with aquaculture, thus reducing the total carbon emissions while ensuring economic development and meeting local food demand.

03 Suggestions to improve

1) Promote the use of renewable energy

The aquafarm employs standard units of shed, with each unit of 65m long and 25m wide. The height of the eave is 2m, and the highest point of the roof is 3.5m. The total area of the roof of each shed in the Xuwang aquafarm is 1,625m^2. If 60% of the space can be installed with photovoltaic panels, it will generate 97,500 kW·h of electricity throughout the year, reducing carbon dioxide emissions by 67tCO_2e/year. If the photovoltaic panels are installed between the barns, with a less investment in steel to put up the panels on the roof, 80 m^2panels can be installed, generating 0.8million kW·h per year.

2) Improve water management techniques for farming

Technical improvements can reduce the frequency of changing water from every 1-3 days to 3-5 days, saving energy and the loss of bait. It can also enhance the activity of algae in shrimp ponds, making full use of photosynthesis, and reducing the demand for bait. The algae can also absorb nitrogen/phosphorus in the ponds, further reducing carbon emissions in the shrimp farming process.

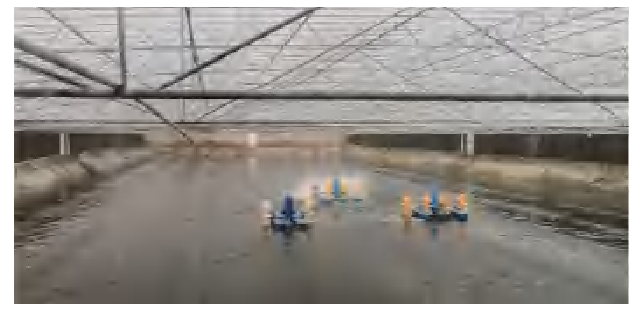


Figure 5-2-1-12 Shrimp pond

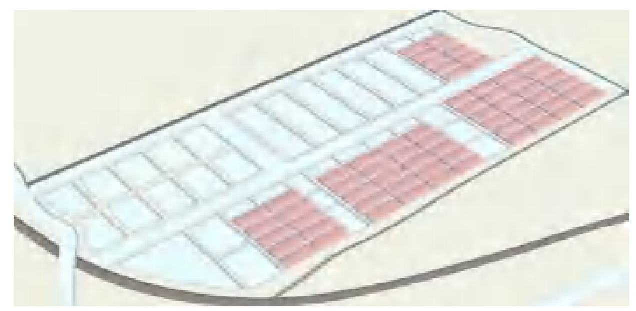


Figure5-2-1-13 Proposed PV installation plan for Xuwang Aquafarm

Case 2-3: Branding of “Dinghai Shan” and building a integrated carbon emission management platform

Location: Dinghai District	**Implementor:** Bureau of Agriculture and Rural Development of Dinghai
Related SDG: **SDG 12:** Ensure sustainable consumption and production patterns	Related principles **Principle 8:** Energy, water, food and waste cycles

01 Concept of design

Dinghai has been advertising the local brands by promoting agriculture upgrading. By 2020, more than 70 products under "Dinghai Shan" brand have been created and formed an agriculture product chain. The brand chain helps local agriculture industry to improve the quality, ensure food security, assist in packaging design and provide subsidies to farmers. A series of social media marketing, agro expo, agro promotion week and festivals were explored to increase exposure. Many products got famous and consumed locally, to avoid warehousing and transportation.

On the basis of the "Dinghai Shan" brand, the Bureau of Agriculture and Rural Development of Dinghai has established an online carbon emission management platform for agriculture. With carbon inventory as the core, the carbon emissions generated in the process of agricultural production are accounted and analysed based on raw data from farmers and suppliers. Blockchain technology is also used to regulate and account the carbon emissions.

02 Environmental benefits

1) Reduce carbon emissions from agricultural products

By promoting the local brand, it also allows more consumers to taste Dinghai's local high-quality agricultural products, promotes the development of the local industry, and also reduces carbon emissions from the long-distance transportation and preservation.

2) Promote green upgrading of the agricultural industry

The analysis of carbon emissions in the production process for farmers helps them to better understand their own carbon emission levels and identify carbon reduction opportunities, so that they can optimise their business management (e.g. use of fertilisers, low-carbon techniques, etc.) and accelerate the green upgrading of the agricultural industry.

3) Support companies and third-party organisations for low-carbon agriculture

Government can support agribusiness at different levels and regulate ones with high emissions, as well as encourage the participation of third-party organisations.

Figure 5-2-1-14 “Dinghai Shan” gift set

Figure 5-2-1-15 Local agriculture products

03 Suggestions to improve

1) Promote carbon labelling of agricultural products

Labelling can help consumers to choose low-carbon agricultural products and guide sustainable ways of consumption and production.

2) Introducing carbon trading mechanisms

Carbon trading mechanism can be introduced on the platform, together with preferential policies and financial incentives to encourage low-carbon production.

Figure 5-2-1-16 ‘CO_2 Measured’ label (Carbon Trust Fund)
Source:https://www.carbontrust.com/

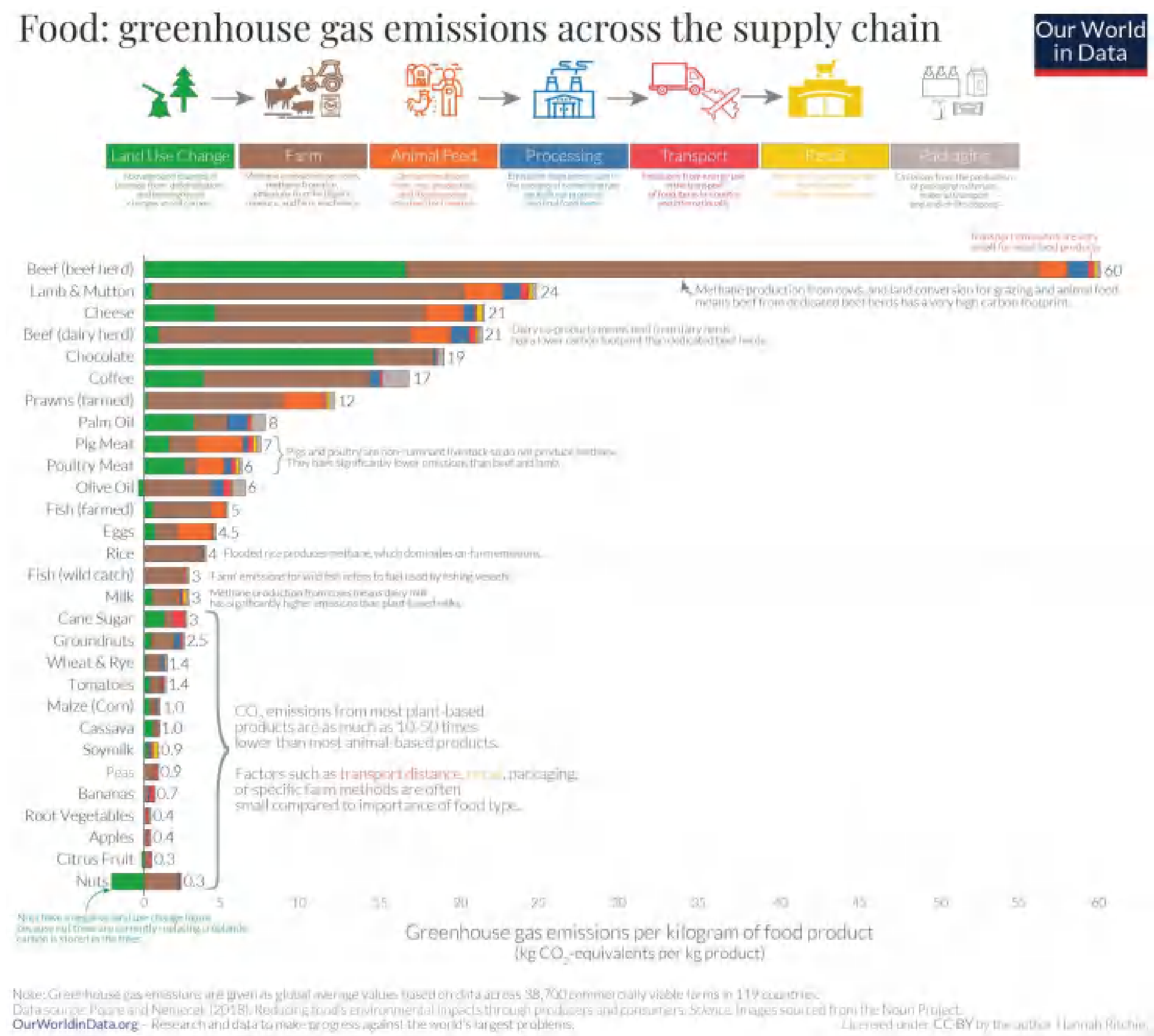


Figure 5-2-1-17 Carbon emission of different food[5]

5.2.2 Explore synergies between industries and increase income

Case 2-4: Integrating fisherman culture to develop handicrafts

Location: Islands Art Museum of Dinghai	Implementor: Xinjian Village
Related SDG: **SDG 5:** Achieve gender equality and empower all women and girls **SDG 12:** Ensure sustainable consumption and production patterns	Related principles **Principle 9:** Employment opportunities and leisure **Principle 10:** Ecological awareness

01 Concept of design

Zhoushan fishermen paintings are folk paintings of Zhoushan developed in the 1980s. Most of the authors are fishermen's sons and daughters, and their works reflect the daily life of fishermen and production scenes and island folklore, with original sea emotions.

In order to develop the special tourism of the island countryside, the secretary of Xinjian Village introduced artists to the countryside and provided the artists with an exclusive studio space. The workspace was originally a women's garment processing base. As small-scale garment processing gradually lost its advantage in the market, the secretary of Xinjian Village transformed the space into the Islands Art Museum to provide creative space for the artist and also encourage the participation of the village women's labor force, which continues to have the ability to earn money during the period.

02 Environmental benefits

Most of the fishermen paintings are made by local women, and the artist's workshop enriches the daily life by training the women who are idle at home. The fishermen villagers incorporate their own experience of fishing engagement and fishing culture into fishermen's paintings, using materials with local characteristics such as eggshells and shells. With the development of tourism, fishermen's paintings have become one of the tourist souvenirs of the islands and have also enhanced the source of income for local women.

The crafts made from fishermen's paintings, lacquer paintings, boat plates, and tourist goods derived from fishermen's paintings at the Islands Art Museum realize the recycling of discarded fishing boat wood, natural shells, and stone chips, and promote the concept of low-carbon and sustainable development while creating beautiful works.

03 Suggestions to improve

Plastic and fishing nets can cause irreversible effects on the marine ecological environment. In island areas, it is important to introduce professional third-party organizations to promote the renewable use of plastic and fishing nets and make them into tourist souvenirs with local characteristics for island villages to promote island culture and the revitalization of island villages.

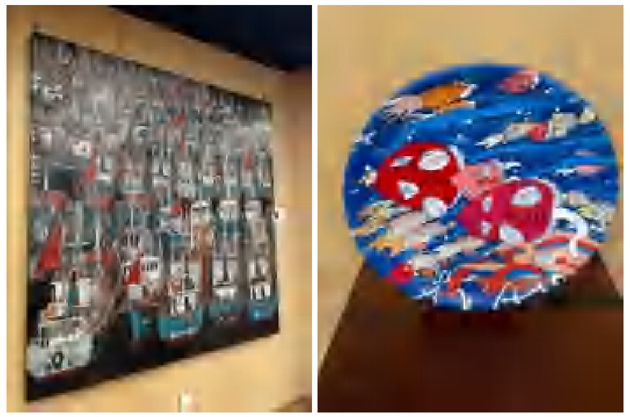


Figure 5-2-2-1 Fishermen paintings

Case 2-5: Educational activities on the farm

Location: Maao Village	Implementor: Xin Qing Nong Fruit and Vegetable Co-operative
Related SDG: **SDG 12:** Ensure sustainable consumption and production patterns	Related principles **Principle 10:** Ecological awareness

01 Concept of design

Xin Qing Nong Fruit and Vegetable Co-operative of Maao Village, was established in July 2012, with a total area of 130,000m^2. The farm is a pro-agricultural education base for schools, enterprises and others, receiving a total of 12,000 primary and secondary school students, corporate groups and 0.9 million casual visitors each year. The main months for agricultural education are March to May and October to January.

Participants work together to breed, cultivate, fertilise, harvest, thresh and process common crops such as rice and maize. The farm is an agricultural education centre, with its own social media account. It is now an education base for Zhoushan's primary and secondary schools. By incorporating "Smart Farm " STEAM education encompassing science, handicraft, art, herb medicine and fitness advice, the farm carries out various educational activities.

02 Environmental benefits

1) Promote creative low-carbon industry, increase the value of agriculture and job opportunities

Xin Qing Nong Fruit and Vegetable Co-operative links farming and service industry together. By providing agriculture education and training to students and private sectors, the agriculture output and income of farmer are increased. Revenues from educational activities now account for 60% of the whole. It also attracts young people to participate in course design, marketing and training.

03 Suggestions to improve

1) Created low-carbon farms

A low-carbon farm management platform can be developed to further explore the potential for emission reduction. Low-carbon and resource-efficient technologies can be applied the carbon intensity of the farm, and environmental-friendly products can be branded.

2) Expand more educational programmes

More education and training programmes can be conducted to enrich the curriculum and extend the impact chain.

Figure 5-5-2-2 Educational activities on farmland

Table 5-2-2-1 Output of agriculture co-operatives

Name	Products	Area (mu)	Annual output (million RMB)	Staff no.	Annual output per mu (RMB)	Annual output per person (RMB)
Xin Qing Nong Fruit and Vegetable Co-operative	Crop and agricultural education	200	4	10	2	40
Vegetable Co-operative A	Crop only	90	1	8	1.11	12.5
Vegetable Co-operative B	Crop only	100	1	7	1	14.2

5.2.3 Net-zero carbon tourism

Case 2-6: Protect carbon sink in tourism development

Location: Nan Dong Art Valley, Xinjian Village	**Implementor:** Dinghai Tourism Development Co. Ltd.
Related SDG: **SDG 4:** Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all **SDG 12:** Ensure sustainable consumption and production patterns	Related principles **Principle 9:** Employment opportunities and leisure **Principle 10:** Ecological awareness

01 Concept of design

Nan Dong Art Valley covers an area of 3km^2, surrounded by mountains and facing the sea. It is a green playground for children with a number of children-friendly amusement facilities installed, serving 12,000person-time. It not only offers the chance to engage with nature closely but also generates employment prospects for the local populace.

02 Environmental benefits

1) Keep the carbon sink

In the development, the number of trees retained in the garden can store more than 3,000 tonnes of carbon dioxide, while the greenery all over the valley can also play a role in other ecological service values such as water conservation and climate regulation.

2) Build a connection with nature and raise awareness of ecology and environmental protection

The design of the valley and amusement activities enable children to get close to nature, and establish a connection with nature. The playground provides non-powered amusement facilities for parents and children to play together. And the scenic spots provide walking trails and electric vehicles for transportation.

03 Suggestions to improve

1) Create an environmental education base

The amusement ground at the forest can be turned into a multi-functional education base, working with relevant institutions to organize educational games and lectures. Children and their parents can participate together.

2) Promote local farming and food culture

Local farming culture and cuisine can be promoted around the playground. Patch of farmland can be adopted for people to grow their own food. They can check online how the crop grows and collect their food after harvesting. People will be able to cherish food and may adopt low-carbon diet after this hands-on experience.

Figure 5-2-3-1 Protect trees in development

Figure 5-2-3-2 Camping site

Case 2-7: Develop camping site

Location: Cishan Island, Wulian Village	**Implementor:** Mijing Hostel
Related SDG: **SDG 12:** Ensure sustainable consumption and production patterns	Related principles **Principle 9:** Employment opportunities and leisure **Principle 10:** Ecological awareness

01 Concept of design

As an outdoor activity, camping is becoming more and more popular in China in recent years. Based on the landscape, resources and cultural advantages of island, Mijing Hostel has set up a camping site on the Cishan Island of Wulian Village, where there are few residents on the island.

Through unique activities, the camping site can spread the culture of fishing and promote low-carbon leisure, while also promoting local economy.

02 Environmental benefits

1) Minimize environmental impact

Going outdoor is the only way to get close to nature. Camping doesn't need permanent construction, reducing the carbon emissions during the construction, operation and disposal of buildings. At the same time, there is no permanent damage or impact on land and surface vegetation, protecting natural carbon sinks.

Figure 5-2-3-3 Camping site

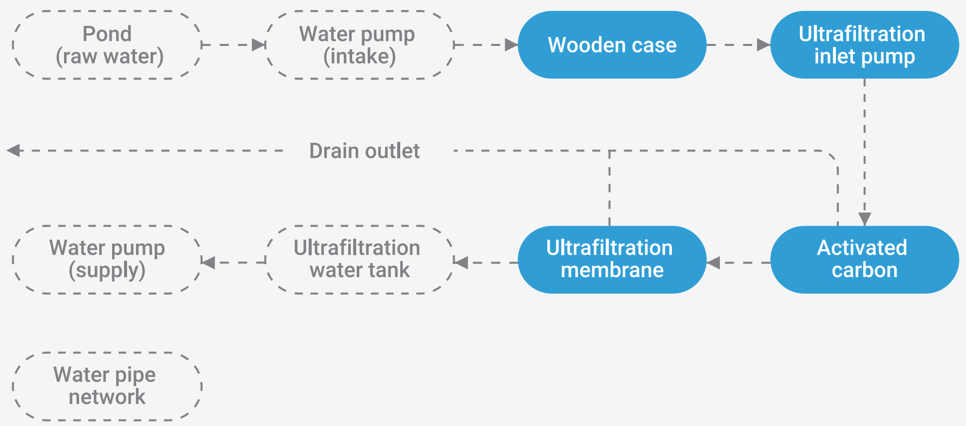


Figure 5-2-3-5 Proposed treatment process

2) Promote the development of rural tourism industry

The camping site can accommodate 18 people every day, which is always fully booked. More camping sites should be developed as a new direction for rural tourism.

03 Suggestions to improve

1) Water supply and waste management

Water is limited on the island with only one pond. Freshwater resources and water supply are the main challenges on the island. Low-carbon water supply and sewage treatment are needed in the development of camping, through distributed water/waste treatment facilities using renewable energy.

Water purification technology with ultrafiltration can be used. Ultrafiltration water purification technology is a purely green physical separation technology, known as the "third generation of drinking water purification process", which can avoid chemical and microbiological products in the first and second generation of water treatment. It presents the advanced technology in the field of drinking water purification.

2) Advocate low-carbon camping

At the same time, the island lacks solid waste treatment facilities and has limited treatment capacity. It's necessary to pro- mote low-carbon camping among campers by encouraging them to use less water and energy, and take away their own waste and other local waste when leaving.

Figure 5-2-3-4 Water pond on Cishan Island

Case 2-8: Promote hiking and other outdoor sports

Location: Xinjian Village	**Implementor:** Dinghai Tourism Development Co. Ltd.
Related SDG: **SDG 12:** Ensure sustainable consumption and production patterns	**Related principles** **Principle 9:** Employment opportunities and leisure **Principle 10:** Ecological awareness

Figure 5-2-3-6 Outdoor activities

01 Concept of design

Develop low-carbon outdoor activities

Xinjian Village has built a 55km long hiking trail along the mountain and hosts outdoor activities including hiking and camping, attracting 5000 participants every year. This not only promotes a healthy lifestyle for local people, but also stimulates local tourism and sports industry.

1) Improving trail connectivity

Before renovation, the connectivity of the trails was poor and difficult to reach without any directions. The renovation design connects all the trails to improve connectivity and accessibility, and to avoid breaks or dead ends.

2) Use of local materials

Different designs are chosen according to the conditions of different areas, topography, and landscape. Based on the original surface, other local materials are used for different types of roads such as pebble way, gravel way, slate stairs and earth/stone stairs.

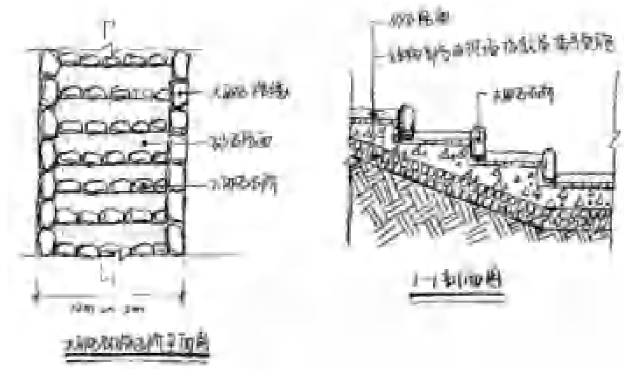


Figure 5-2-3-7 Stairs made of big pebbles

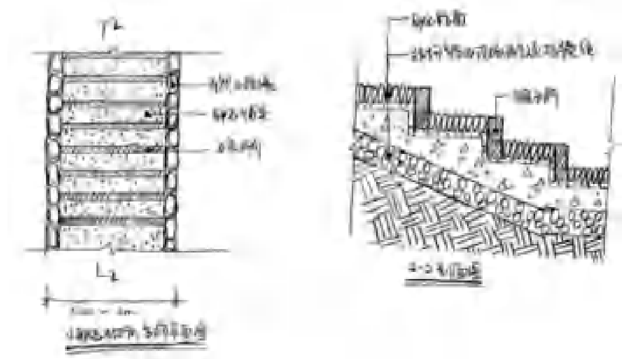


Figure5-2-3-8 Stairs made of small pebbles

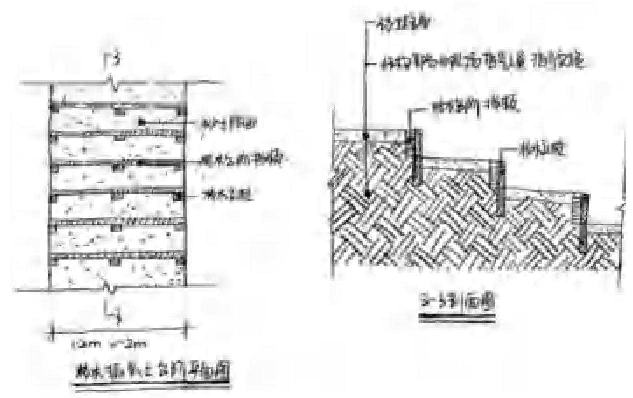


Figure 5-2-3-9 Stairs made of cedarwood

3) Rest and supply facilities along the road

Rest stations, service and rescue facilities are set up along the trail with plastic/steel windows that has a better insulation performance. Other service facilities include service centres, rest rooms and viewpoint. Safety and rescue facilities include early warning and rescue system, etc.

02 Environmental benefits

The hiking trail is built on old and abandoned trails, which kept the original outlook and reduced the damage to plantation. The materials are taken locally so the transportation emissions of materials can be avoided.

03 Suggestions to improve

1) Daily management and maintenance

Establish a long-term management and maintenance mechanism for hiking trails to ensure the safety of users, while extending the service life of the facilities through maintenance and reducing the life-cycle carbon emissions of buildings.

2) Enhance the integrity of facilities

Convert restrooms into ecological ones that use water circulation system and rainwater.

3) Improve guiding signs

Install signs to direct hikers and raise public's ecological awareness during hiking, trekking and camping.

Case 2-9: Electric tourism vehicle route

Location: Dinghai District	**Implementor:** Bureau of Transport
Related SDGs: **SDG 7:** Ensure access to affordable, reliable, sustainable and modern energy for all **SDG 12:** Ensure sustainable consumption and production patterns	**Related principles** **Principle 5:** Renewable energy

01 Concept of design

Electrification of all tourism-related vehicles: To promote public transportation of tourists, Dinghai has built a bus hub in Zhoushan, and developed a Y1 route that connects all the tourist spots in Dinghai villages, which is 20km long. The bus runs 38 times per day serving around 1600 tourists from 5:40AM to 8PM. There are 9 buses in total, which are all electric buses equipped with accessible facilities, adjustable airbags and cell phone charging points.

02 Environmental benefits

From a lifecycle perspective, an electric bus has a carbon emission of 1103.237tCO_2eq, which is 21.3% less than that of a diesel vehicle with 1401.319tCO_2. An electric bus also can save up to 30,000 RMB operation costs compared to a diesel one.

03 Suggestions to improve

Bus routes can be customized based on tourists' and villagers' needs and avoid running without passengers. An app can be developed for people to sign up if they want to use the bus and routes can be designed accordingly.

Figure 5-2-3-11 Electric buses

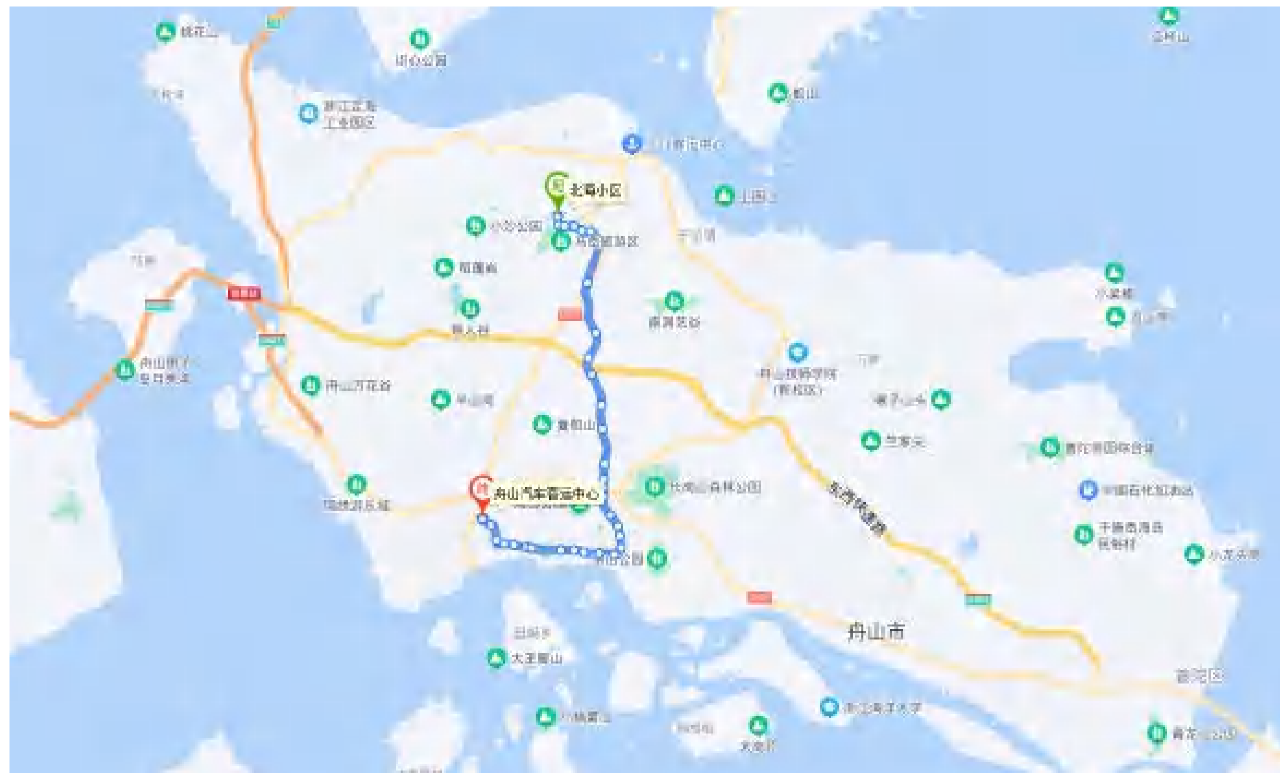


Figure 5-2-3-10 Route of electric buses

5.3 Case studies on low-carbon lifestyle

5.3.1 Spatial planning for low-carbon development

Case 3-1: Spatial planning of Huangsha Ao

Location: Huangsha Ao of Xinluotou Village	**Implementor:** Tongji University, Yancang Street Office, Mijing Hostel
Related SDG: **SDG 11:** Make cities and human settlements inclusive, safe, resilient and sustainable	Related principles: **Principle 9:** Employment opportunities and leisure **Principle 2:** Well-connected mixed nodes **Principle 4:** GHG emissions **Principle 6:** Water cycle

01 Concept of design

Huangsha Ao is a natural village located in Xinluotou Village, Yanchang Street, which has good natural and socio-economic conditions for the development of rural tourism. The local government has invited Tongji University to develop a net-zero carbon oriented rural revitalisation plan.

The strategic positioning of Huangsha Ao will mainly promote the development of low-carbon tourism. Therefore, the overall layout is designed as the accommodation area (hostel services for tourists), low-carbon residential area (local residents), and low-carbon leisure activity area that provides various service facilities for tourists and villagers. Agricultural education, handicraft events, and other leisure activities will also be held in this area. As well as low-carbon traffic area that mainly provides visitors and villagers with transfer and parking services.

02 Environmental benefits

1) Low-carbon buildings

Buildings for hostels are all converted from abandoned dwellings, using local timber as well as stone for minimum carbon emissions of the building materials.

For new service facilities, art galleries, villagers' activity centres and other public buildings, building materials are selected with the requirements of ultra-low energy consumption, heating and cooling options.

For buildings built by villagers themselves, villagers are encouraged to get doors and windows with better insulation, and energy-efficient electrical appliances.

2) Co-sharing of residential and tourism services

With private investment, tourism and hostel service started to develop in Huangsha Ao, which is accompanied by various rural infrastructures, including bookstores, cafes, public toilets, electric car charging piles, car washing facilities, etc.

Through a reasonable layout, all kinds of services and facilities can serve tourists and local residents at the same time.

3) A low-carbon transport and travel system

Separate centralised parking and transit parking were built to serve the different needs of long-distance travel of residents and short-distance travel of tourists respectively. Through the planning of vehicular roads and walking areas within the village, pedestrians and traffic can be separated, and a car-free zone can be set up to encourage low-carbon travel.

Figure 5-3-1-1 Functional sub-areas of Huangsha Ao

4) Water cycle system

Set up water storage tanks and use the stored rainwater for flushing toilets in public toilets. The flushing water is treated through artificial wetlands and then returned to the ecological organic farmland downstream.

In addition to being used as landscape water, the water from Xingyue Lake's stored rainwater can also supply water for car washing in the downstream car park for visitors in the hostel.

5) Low-carbon education

In addition to being a net-zero carbon building, the art museum, which is under construction, will also display various low-carbon artworks and reserve space for low-carbon education activities.

Relying on the local rural culture, there will also be a piece of farmland in the leisure activity area, where low-carbon agricultural education activities will also be conducted.

Figure 5-3-1-2 Distribution of new and reconstructed buildings in huangsha'ao

Figure 5-3-1-3 Distribution of service facilities in Huangsha Ao

03 Suggestions to improve

1) Energy management platform

Within the hostel, a building energy monitoring system (BEMS) can be established to track and evaluate the energy use of the rooms and public buildings, in order to optimise energy efficiency.

2) Create a low-carbon tourism route

Combine existing plans of net-zero carbon sites, and design a low-carbon tourism route. Explanatory signs can be installed at each site so that visitors and residents can learn about the low-carbon concepts and technologies used.

Figure 5-3-1-4 Low-carbon featured spots in Huangsha Ao

Case 3-2: Spatial planning to optimise service distribution

Location: Xinjian Village	**Implementor:** Zhoushan Urban Planning and Design Institute
Related SDG: **SDG 11:** Make cities and human settlements inclusive, safe, resilient and sustainable	**Related principles:** **Principle 2:** Well-connected mixed-use nodes

01 Concept of design

Located at the south of Ganlan Town, Xinjian Village consists of three villages, namely Huangsha, Lichen and Nandong, with a total administrative area of 4.5 km^2. Xinjian Village invited Zhoushan Urban Planning and Design Institute to make the Master Plan for 2015-2030, which optimises its spatial design.

The Plan increased the efficiency of land use by sorting and integrating the residential and service land. It also enhanced the functions of public service facilities, converting existing buildings or facilities to new purposes. One stop service centre and supermarket chains are integrated, with post and telecommunication offices.

A transport system that prioritise pedestrian is planned to serve for a convenient and comfortable environment. Road surface is renovated and roadside plants were specifically designed for a better walking experience.

Hiking trails are linked to village roads to provide easy-to-access fitness opportunities for hikers and local residents. Service stations are also designed along the trails.

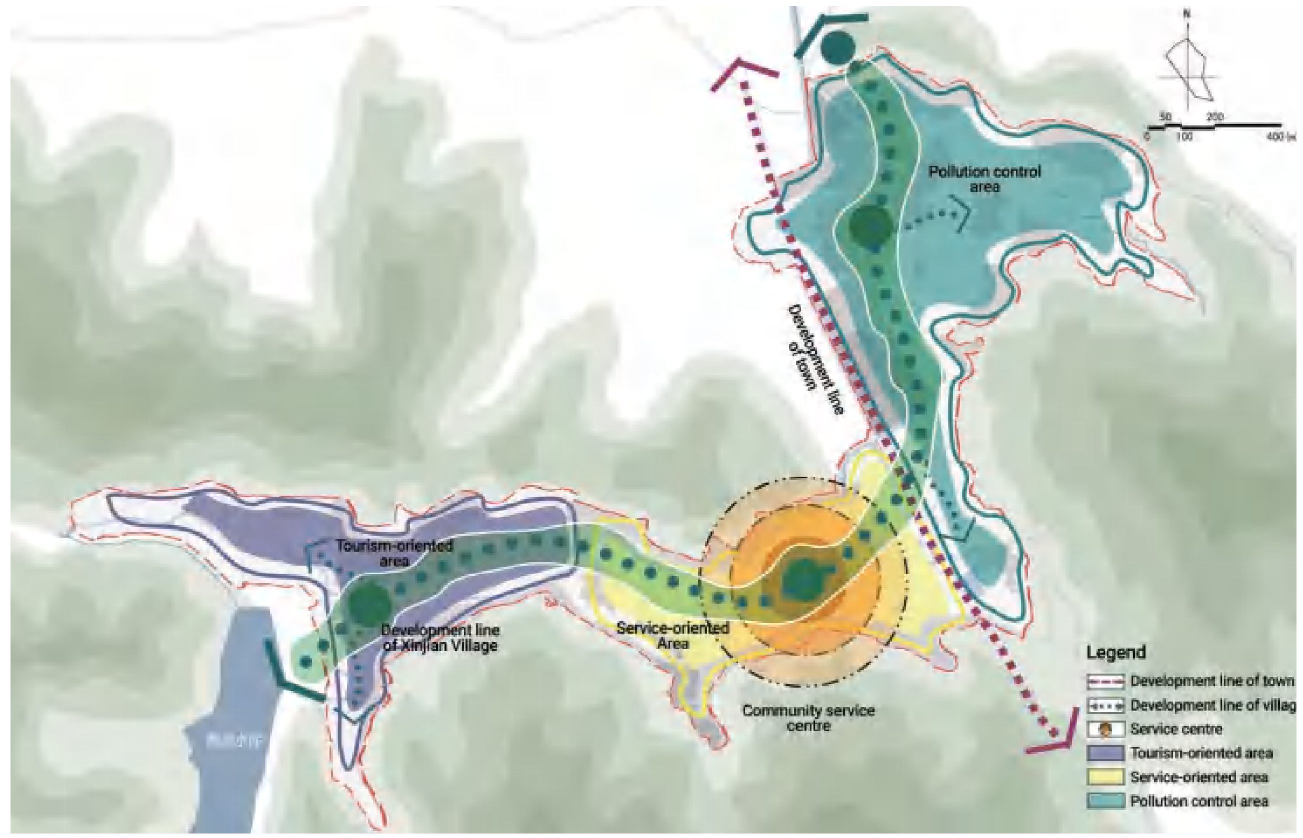


Figure 5-3-1-5 District planning of Xinjian

Figure 5-3-1-6 Pedestrian

02 Environmental benefits

1) Service facilities can be reached within 15-mins walk

By the end of the planning period, the resident population of Xinjian Village is 1,684, and according to the tourism development, the maximum number of tourists will be 1,000 per day. The planned construction land is 39.13 hectares and the residential density is 68.59 persons/ha, which meets the UN recommended density of 50-70 persons/ha livable residential density.

Through the plan of different facilities, all services can be reached within 15 minutes' walking, reducing the need for transportation. At the same time, the road surface of the village has been renovated to create a pedestrian-friendly environment with a rural landscape, encouraging walking and reducing the carbon emission from vehicles.

2) Make room for the development of low-carbon industries

The space needed for different industries is coordinated in the village area, based on crop plantation area, concentrated agricultural production area and tourism development areas, etc. To better serve the upgrading of industrial structure, a total of 3.56 hectares of extra space has been reserved for the promotion of cultural and creative industries and leisure industry, accounting for 9.10% of the total construction land.

03 Suggestions to improve

1) Increase environmental standards for new and renovated buildings

From a whole life cycle perspective, priority should be given to the reuse of buildings instead of new construction, and corresponding management standards should be set, requiring buildings to use materials that are more environmental friendly in the production process, while suggesting the use of local building materials to reduce carbon emissions from transportation and reflect local cultural characteristics. Encourage the construction of green, energy-efficient buildings to reduce the energy consumption of heating and cooling during operation.

2) Improve pedestrian system

To further improve current pedestrian system of Xinjian Village, it is necessary to expand it beyond the residential area, and make a clear separated space between pedestrian and motor vehicle driving to ensure safety. No drive zone and slow drive zone can be set up for further prioritise pedestrian system.

Table 5-3-1-1 Carbon emission factors of different transportation modes

Transportation mode	Carbon emission factor (gCO_2/km)
Private cars	178.6
Motorcycle	113.6
Electric bike	69.6
Public bus	73.8
Metro	9.1
Walking/bikeing	0

Figure 5-3-1-8 Rendering of parking lot

Case 3-3: Transit parking lot for hostels

Location: Huangsha Ao	**Implementor:** Tongji University, Yancang Street Office
Related SDG: **SDG 11:** Make cities and human settlements inclusive, safe, resilient and sustainable	**Related principles:** **Principle 2:** Well-connected mixed-use nodes

01 Concept of design

With the development of the hostels, the number of tourists visiting the village has increased, causing the problem of difficult and chaotic parking in the village. Yancang Street invited Tongji University to design a car park for Huangshaao, tackling the challenge of inadequate infrastructure, and at the same time meeting the parking needs of all kinds of tourists.

The parking lot is for temporary parking of eight cars at the same time. The visitors can drive to the nearest area of the hostel, and take the electric shuttle bus provided to the room, the hostel will then park their cars at the centralized parking lot down the mountain. A viewing point has also been set up to serve the needs of temporary parking and sightseeing visitors. This design enables travel with low-speed electric cars inside the residential area, ensuring a safe walking environment, while the solar photovoltaic panels in the parking lot can also charge the electric vehicles.

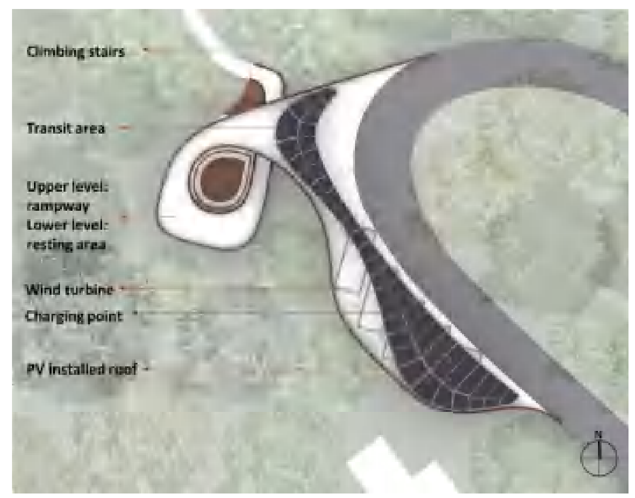


Figure 5-3-1-7 Functional analysis of the transit parking

02 Environmental benefits

1) Keeping the original ground surface and using recyclable materials

Through the new digital construction technology, the parking structure makes full use of the existing hardened road surface and does not destroy the existing greenery of the mountains and forests. At the same time, the construction mainly uses recycled building materials such as wood structures and steel plates, reducing carbon emissions throughout the life cycle of the construction.

2) Rainwater recycling system

Using spiral ramps, combined with ramp paths, a certain inclination angle is set so that rainwater can flow into the rainwater recycling pond and be used for irrigation through treatment.

3) Solar-wind power supply system

Photovoltaic panels on the parking shed can charge electric shuttle buses in the tourist area. The PV panels cover an area of approximately 118.67m^2 and the annual electricity produced is about 11,867 kW·h, with an annual emission reduction of 8,188.23 kgCO_2e.

Small wind power generation equipment is set up at the top of the shed to generate power for the street lights at night.

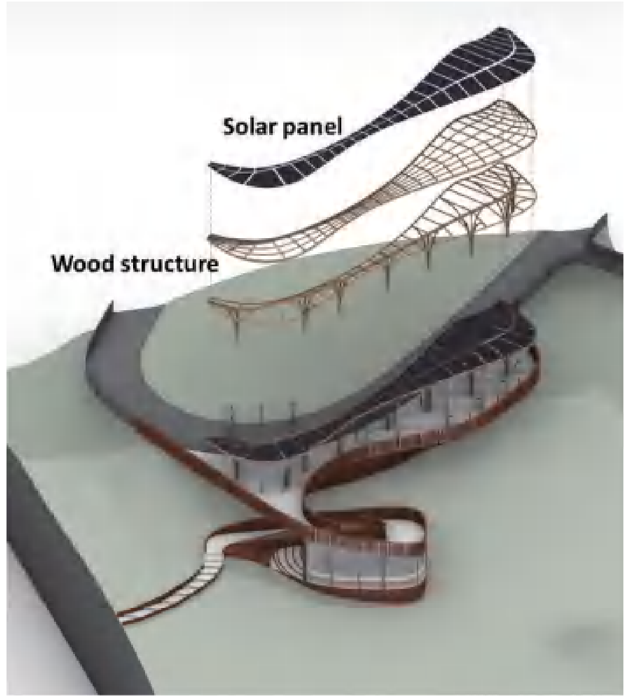


Figure 5-3-1-9 Material and structure of parking lot

Figure 5-3-1-10 Water recycle system

Figure 5-3-1-11 PV installed roof

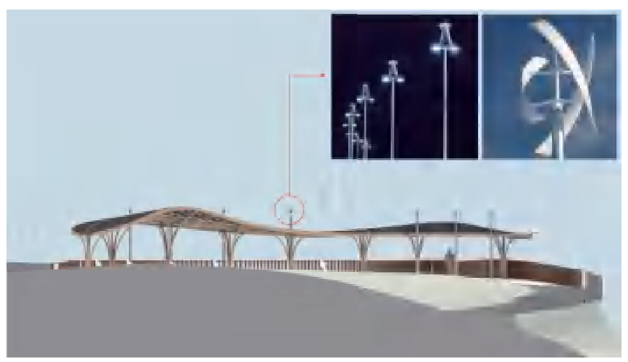


Figure 5-3-1-12 Wind power for lighting at the top of the shed

Case 3-4: Set up centralised parking area for a car-free village

Location: Maao Village	**Implementor:** Maao Village
Related SDG: **SDG 11:** Make cities and human settlements inclusive, safe, resilient and sustainable	Related principles: **Principle 4:** GHG emissions

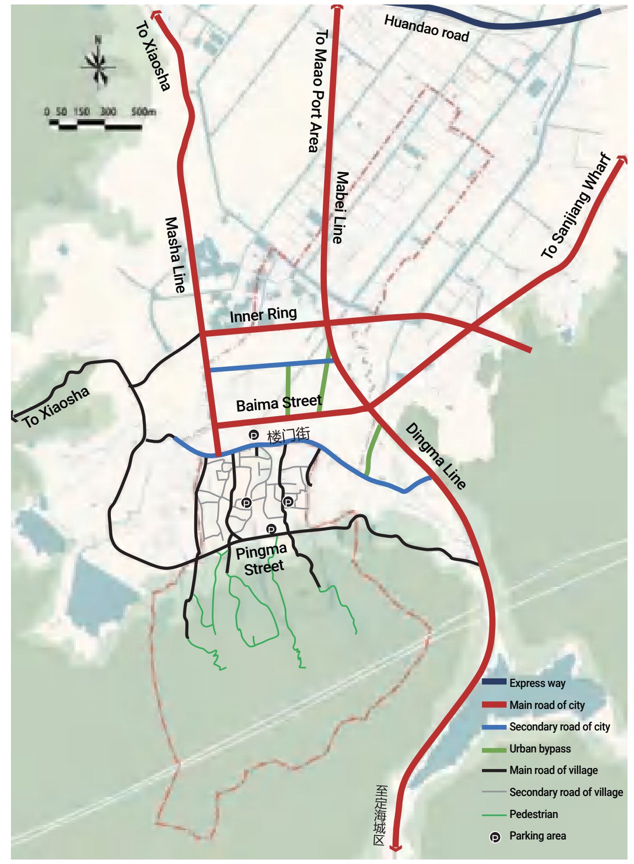


Figure 5-3-1-13 Location of the parking area of Maao Village

01 Concept of design

Maao village has set up a number of centralised parking lots around the village, which are connected to the road and pedestrian, so that residents and visitors need to park their vehicles and walk inside the village. The parking lot and the residential area are connected by a pedestrian road, constructed with an overall landscape design. Road surface is suitable for walking and water permeability.

02 Environmental benefits

1) A low-carbon living area in the countryside

By centralising the parking of motor vehicles, the village becomes a low-carbon travel area mainly for walking and cycling. The safety of pedestrians is enhanced and carbon emissions are reduced at the same time.

Figure 5-3-1-14 Parking lot in Maao

Figure 5-3-1-15 Eco pedestrian

2) Sponge city

Through permeable road surface, rainwater can be drained naturally, without harming the original water holding capacity of the land.

03 Suggestions to improve

Install electric vehicle charging piles and battery exchange stations.

When the demand for electric vehicle charging increases, charging piles and supporting facilities such as battery exchange stations can be installed in villages and tourist place.

5.3.2 Reduce lifecycle emission in buildings

Case 3-5: Convert vacant houses to hostels

Location: Xinluotou Village	**Implementor:** Mijing Hostel, Yancang Street Office
Related SDG: **SDG 11:** Make cities and human settlements inclusive, safe, resilient and sustainable	Related principles: **Principle 4:** GHG emissions

01 Concept of design

Xinluotou Village is facing population loss and aging, with fewer villagers living in the village and most of the residents' houses being left vacant. Through the efforts of Yancang Street and Mijing Hostel, some vacant houses were rented for a period of 20 years to create a hostel complex.

02 Environmental benefits

1) Retrofitting with recyclable building materials

The vacant houses were repaired on original brick/stone structure, using minimum new building materials. In the hostel complex, roads and public areas are constructed with wood, stones and recycled material from old, demolished houses, in order to increase recycling rate and reduce transportation.

Based on the average CO_2 emissions per unit area of 590.9 kg/m^2 for the production phase of building materials, and 76.7 kg/m^2 for the transportation phase of building materials in Zhejiang Province, the estimate is based on the average CO_2 emissions per unit area of a single building.

2) Promote passive houses

Four houses were taken as a pilot, through the reasonable selection of building orientation and window and door positions, the use of skylights for lighting and other measures to achieve passive lighting and ventilation as far as possible and reduce the energy demand of the building itself.

Figure5-3-2-2 Keep the original wood-stone structure

Figure 5-3-2-1 Hostels converted from vacant houses

Figure 5-3-2-3 Use recyclable material

Figure 5-3-2-4 Nature lighting

Figure 5-3-2-5 Public space in nature

03 Suggestions to improve

The hostel design team has fruitful experience in passive house design and technology application. With the professional consultation of a third party, they provided villagers with samples of low-carbon buildings using new technologies and concepts, encouraging and helping local residents to improve their living environment and reduce their energy consumption.

Case 3-6: Convert old barracks into hostels

Location: Xinjian Village	**Implementor:** Dinghai Tourism Development Co. Ltd.
Related SDG: **SDG 11:** Make cities and human settlements inclusive, safe, resilient and sustainable	**Related principles:** **Principle 4:** GHG emissions

01 Concept of design

The old barracks in Xinjian Village were abandoned when the location of the troops changed. In recent years, Xinjian village has been promoting its natural beauty and culture, and the development of tourism also boosted the demand for accommodation. Dinghai Tourism Development Company then converted the old barracks into hostel rooms.

The conversion of the barracks is a continuation and development of the countryside landscape and rural history. The hostel itself is not a seemingly simple accommodation building, it has an inseparable relationship with the surrounding rural life and environment, and is integrated with the culture of the location, which gives a new meaning to the surrounding area.

Figure 5-3-2-7 Barracks and its surrounding environment

Figure 5-3-2-6 Front of the barracks and its building material

02 Environmental benefits

1) Reduce hidden carbon emissions of buildings

To reduce the consumption of resources and energy, the building envelope of the barracks was well preserved and only the internal furnishings were adjusted. According to the average CO_2 emissions per unit area for building material production (590.9kg/m^2), and that of material transportation (76.7kg/m^2) in Zhejiang, it is estimated that if a new hostel with the same construction area of 350m^2 as the barracks is built, its lifecycle carbon emissions will be approximately 233.6t.

(2) Attract tourists and promote rural tourism

With a unique historical and cultural feature, the new hostel not only tackled the accommodation challenge in Xinjian Village, but also attract many tourists to visit, which also created new jobs for the local residents and increased their income.

03 Suggestions to improve

Due to factors such as building orientation, and the materials used for walls, doors and windows, the hostel rooms are not well insulated. Indoor wall-hung stoves and heating solutions through local biomass can be used to improve the comfort level without using air conditioning.

Case 3-7: Sound management of energy in hostel

Location: Xinluotou Village	**Implementor:** Lost Villa
Related SDG: **SDG 11:** Make cities and human settlements inclusive, safe, resilient and sustainable	**Related principles:** **Principle 4:** GHG emissions

Figure 5-3-2-8 Lost Villa

01 Concept of design

The hostel is located in Nan Dong Art Valley of Xinjian Village, and featured with various energy-saving technology and smart energy management system. The hostel works with professional operators, creating a net-zero sample, whose operation emissions are 15.7% lower than those of hostels in Shanghai.[12]

02 Environmental benefits

1) Application of low-carbon technology

The use of double-glazing windows reduced the indoor cooling requirement by 63.4% compared to the original window. The application of Heat Reclaim Ventilator minimised the loss of indoor temperature by recovering the energy from the exhausted outdoor air. With an air heat pump water heater, the energy consumption is 1/4 of that of an ordinary electric heater and 1/3 of that of a gas heater. The risk of leakage is also avoided as there are no electrical components in direct contact with the water.

2) Adopt intelligent energy management

The lights in the corridors and entrance of the rooms are equipped with automatic switches, which switches off automatically if no one is detected in 15 minutes.

The intelligent control panel can check and adjust the room temperature in real time, either locally or remotely, and to switch between different air supply systems and air volumes to meet the different needs of the room at any time.

Figure 5-3-2-9 Double glazing glasses

Figure 5-3-2-10 Exhaust air heat recovery unit

Figure 5-3-2-11 Control panel

Xinjian Village©People's Government of Dinghai District

03 Suggestions to improve

1) Unleash the potential of renewable energy use and establish a smart energy management platform

Add a solar water heater together with the air heat pump, to make full use of the solar thermal energy. Establish a smart energy management system and energy consumption monitoring system to accurately measure the operation efficiency.

2) Convey the concept of energy-saving to visitors

Promote sustainable consumption habits through signs and tips in the hostel to convey the concept of energy saving to visitors.

5.4 Case studies on low-carbon oriented governance

5.4.1 Participation of third-parties

Case 4-1: A multi-participation governance mechanism

Location: Dinghai	**Implementor:** Dinghai government, UN Habitat, Tongji University
Related SDG: **SDG 17:** Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development	**Related principles:** **Principle 10:** Ecological awareness

Figure 5-4-1-1 Signing ceremony of Dinghai, UN-Habitat and Tongji University

01 Concept of design

The government of Dinghai invited experts from UN-Habitat and Tongji University, as third-party organisations, to analyse the how to implement the 10 principles in Dinghai from Net-zero Carbon Village Planning Guidelines: Yangtze River Delta, issued by UN-Habitat in 2019. The team investigated the geographical, demographic, social and economic development, developed the 10 principles into detailed targets, and proposed short-, mid- and long-term action plans at village, street office and district levels, with corresponding design, implementation and operation measures for pilot projects.

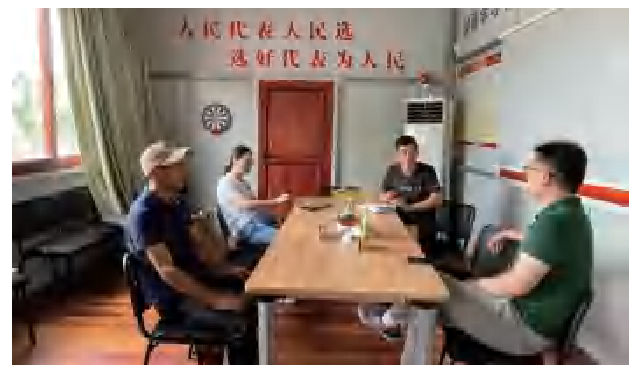


Figure 5-4-1-2 Field investigation

02 Environmental benefits

Experts from UN Habitat provided advice from a global perspective that gives the pilot projects in Dinghai potential replicability and scalability for other island villages.

Research team from Tongji University provided scientific-based evidence on how to establish carbon inventory and pinpoint the key emission sectors that can be further reformed. A top-down design of Dinghai government makes sure the plan can be implemented timely, systematically and accurately.

03 Suggestions to improve

Invite more specialized third-party organisations to participate in the construction and operation of villages, such as training centres, insurance companies, carbon label design institutes, and introduce green finance.

Case 4-2: Net-zero “Beautiful Countryside Week”

Location: Dinghai	Implementor: Dinghai government
Related SDG: **SDG 13:** Climate action	**Related principles:** **Principle 9:** Employment opportunities and leisure **Principle 10:** Ecological awareness

01 Concept of design

Dinghai sets May 25 every year as the “Beautiful Countryside Week”, choosing one village as the main venue and several villages for side events focusing on rural culture, tourism and products, etc.

In 2021, under the theme of “Net-zero Carbon”, villages organised various activities based on their own low-carbon projects.

Figure 5-4-1-3 Logo of "Beautiful Countryside Week"

Figure 5-4-1-4 Fun run

Figure 5-4-1-5 Outdoor music festival

02 Environmental benefits

Each village organises its own Net-zero carbon activities, to showcase its practices and efforts.

By hosting outdoor rural activities like rural cross-country runs, music festivals, and the promotion of locally-grown agricultural goods and environmentally-sustainable creative products, villages not only spearheads the development of rural tourism but also imparts the rural net-zero carbon concept to its visitors.

Figure 5-4-1-6 Paper bag

Figure 5-4-1-7 Glass bottle

Case 4-3: Delivering the concept of sustainable consumption with packaging-free stores

Location: Maao Village	Implementor: Maao Village
Related SDG: **SDG 12:** Ensure sustainable consumption and production patterns	**Related principles:** **Principle 10:** Ecological awareness

01 Concept of design

Yiguo, a food and grocery and packaging-free shop in Maao Village, encourages customers to bring their own containers for shopping to promote low-carbon consumption style. The shop only provides certain glass or plastic bottles for some goods based on a deposit, refund and credits system. The containers or other recyclable packages that customers bring back can be made into handicrafts.

02 Environmental benefits

It is estimated that 8 million tonnes of plastic wastes enter the oceans each year. Research shows that in the Beijing-Tianjin-Hebei region alone, food packaging accounts for 15.7% of municipal solid waste, of which more than 60% is plastic bags and boxes[4]. Packaging-free stores not only reduce package waste, but makes consumers adopt sustainable lifestyle.

03 Suggestions to improve

Packaging-free shops can be replicated and scaled-up to other villages, and explore more packaging recycling measures.

Figure 5-4-1-8 Front of the packaging-free store

Figure 5-4-1-9 Inside of the packaging-free store

Case 4-4: Green finance

Location: Maao Village	**Implementor:** Dinghai Ocean and Agriculture Commercial Bank
Related SDG: **SDG 17:** Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development	**Related principles:** **Principles 9:** Employment opportunities and leisure **Principle 10:** Ecological awareness

Figure 5-4-1-10 Contract signing ceremony

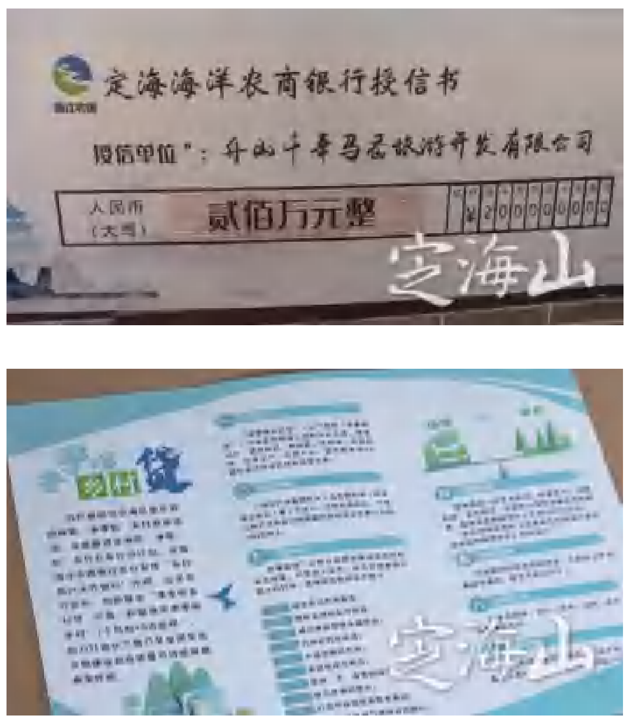


Figure 5-4-1-11 First loan for zero carbon project

01 Concept of design

Zero carbon loan of Dinghai is a product of green finance focusing on nine priorities including land use and water recycling. The total amount is 1 billion RMB.

02 Environmental benefits

Dinghai Ocean and Agriculture Commercial Bank signed the first zero carbon loan agreement with Maao street office that for the first time will support 6 net-zero carbon pilot projects in villages including Maao Village, Guanghuang Village and Yujia Village. Zhoushan Century Tourism Development Co. Ltd got the first 2 million RMB loan.

03 Suggestions to improve

Improve the evaluation mechanism of green loans: Green loan projects should be based on quantitative assessment of carbon reduction benefits and regular performance evaluation. The use of green finance in rural areas is the key to greening rural industries.

5.4.2 Ecological awareness

Case 4-5: Practice and pilot of net-zero carbon villages

Location: Xinjian Village	**Implementor:** Xinjian Village, Dinghai Tourism Development Co. Ltd.
Related SDGs: **SDG 4:** Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	**Related principles:** **Principle 10:** Ecological awareness

01 Concept of design

The first Net-zero Carbon Exhibition Hall was opened in Xinjian Village in 2021. Through interactive design, it collects pilot projects and case studies from every villages, and showcase the background info and road map to net-zero carbon, inspiring other rural communities to participate.
The design has several highlights as below:

1. Based on the concept of low-carbon
The exhibition hall presents a green environment through vertical plantation and resin glass artistic installation.

2. Reflecting the characteristics of the rural and coastal landscape of Dinghai
Through recreation of village road with the design of the exhibition walls, wooden frame and life scenes. The application of fishing nets and tiles from stone houses presents the characteristics of the fishery industry and the rural landscape of Dinghai, as well as the low-carbon concept by using second-hand local materials.

3. Immersed interactive experience
Through an interactive touch screen, simulations of the ocean and villages, and bicycles that visitors can ride to generate electricity, the exhibition hall strengthens interaction with visitors and enhances their participation.

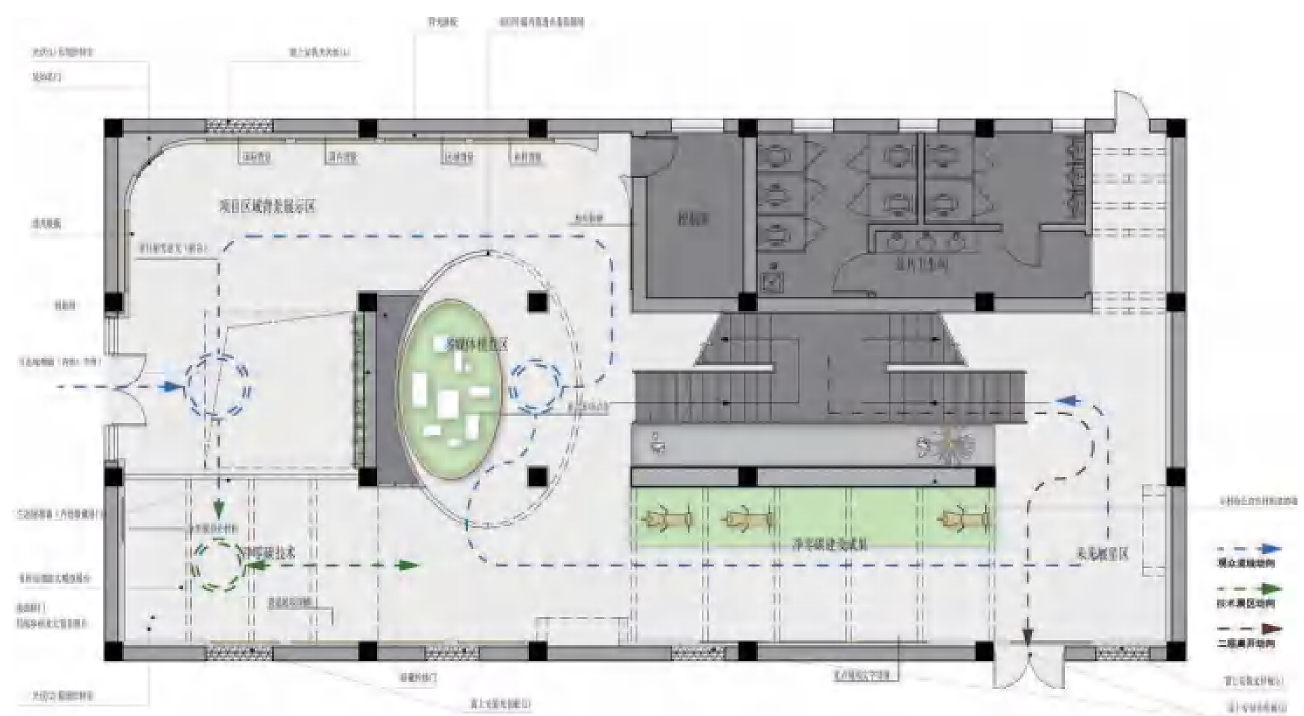


Figure 5-4-2-1 Layout and visit route of the exhibition hall

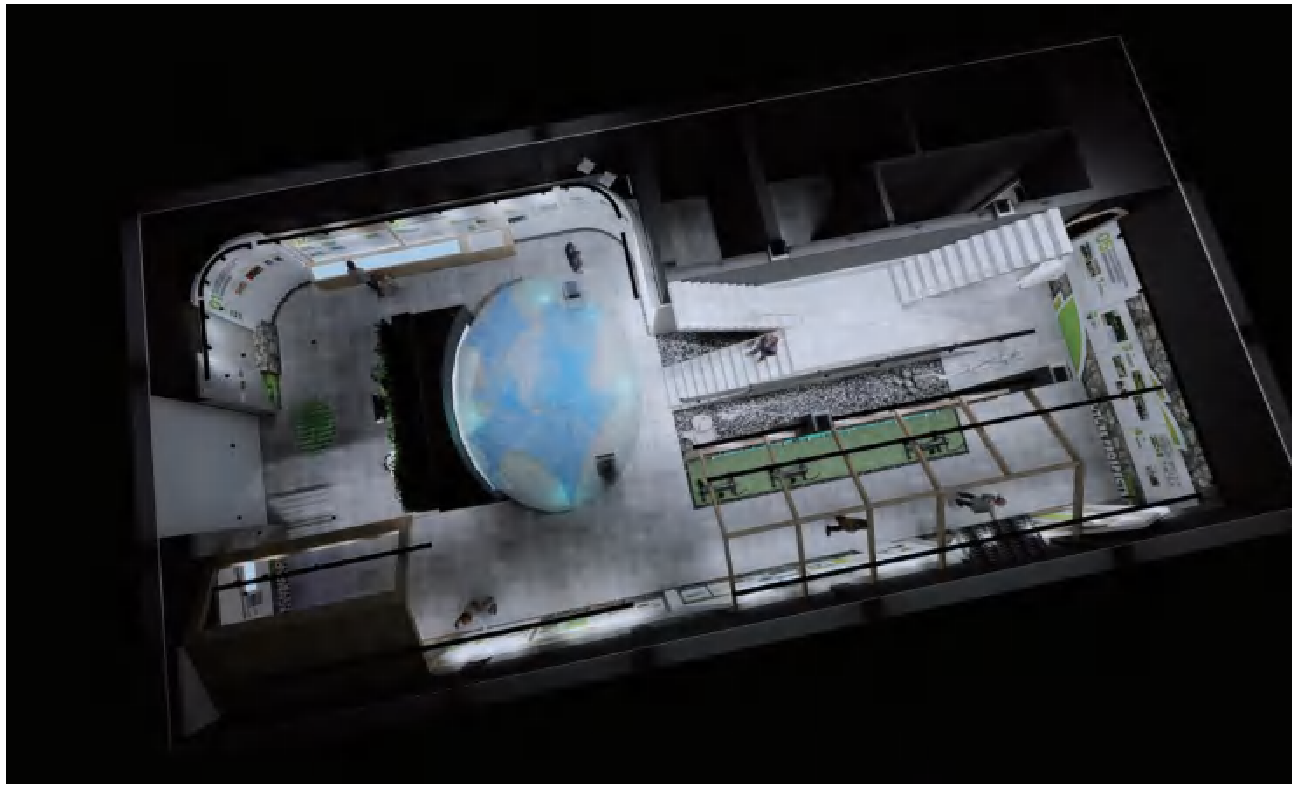


Figure 5-4-2-2 Rendering of the exhibition hall

02 Environmental benefits

The whole exhibition hall is divided into three sections: Net-zero carbon background introduction, roadmap and action plans to net-zero carbon village, and Net-zero carbon cases, with a focus on the natural appearance of the villages in Dinghai and some of the promising cases to achieve net-zero carbon village.

The showroom installed 3D technology to introduce cases on transportation, culture and tourism activities and installed interactive facilities including VR cycling for visitors.

03 Suggestions to improve

1) Continuously update the content of the exhibition hall

As the construction of net-zero carbon villages in Dinghai District continues to progress, the net-zero carbon practice exhibition hall needs to continue to collect and display new cases, and to extend the net-zero carbon concept and advanced practices of Dinghai to scale up the influence through the tourists spot nearby.

2) Organize special training activities

Low-carbon seminars and workshops can be organised to involve local residents and visitors.

Figure 5-4-2-3 Vertical Greening

Figure 5-4-2-4 Interactive screen showing sea level rising

Figure 5-4-2-5 Demonstration of net-zero carbon rural practice cases

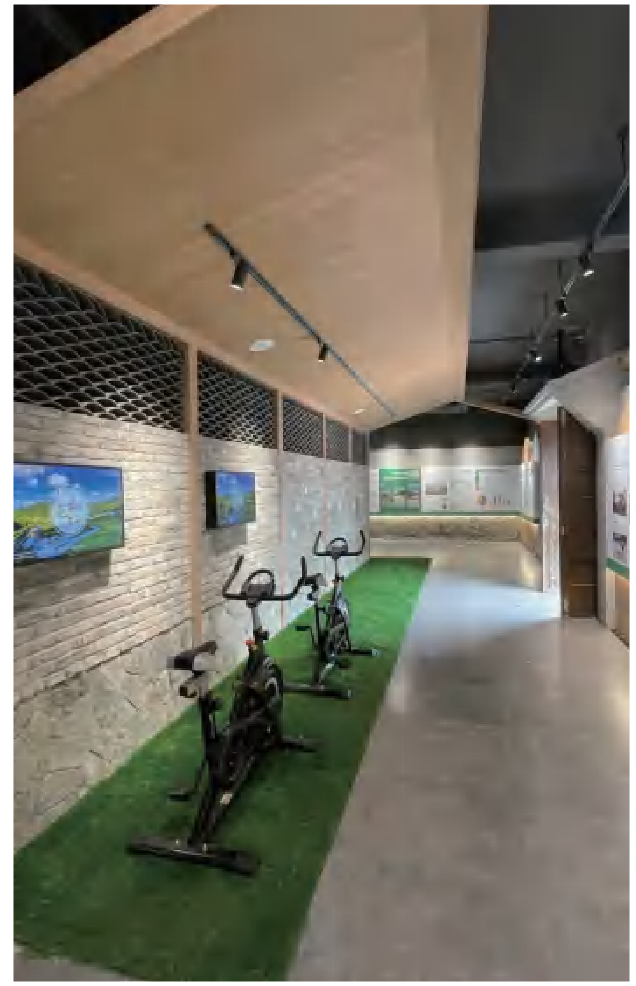


Figure 5-4-2-6 Interactive cycling area

Figure 5-4-2-7 Exhibition of carbon inventory

Case 4-6: Ecological awareness/knowledge training for government staff

Location: All level of governments in Dinghai	**Implementor:** Bureau of Agriculture and Rural Development of Dinghai, Yancang Street Office
Related SDGs: **SDG 4:** Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all **SDG 16:** Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	**Related principles:** **Principle 10:** Ecological awareness

Figure 5-4-2-8 Training programme

01 Concept of design

To better implement the work of net-zero carbon village construction in the future, as the management department and the implementer of net-zero carbon village construction, the Bureau of Agriculture and Rural Development of Dinghai and Yancang Street Office invited the research team of Tongji University to provide systematic training for government staff on the concepts of net-zero carbon.

02 Environmental benefits

On May 8, Yancang Street Office invited professor from Tongji University to explain the advanced concepts of "carbon peak", "carbon neutral" and "carbon sink", emphasizing the guidance and demonstration role of the government from various aspects including environment, energy, architecture, planning, greening and agriculture. A total of 150 staff from all levels of departments participated.

03 Suggestions to improve

More training sessions need to be organised for more people working at the front line, including teaching staff in schools, students, village leaders and local residents.

06 Experience from Dinghai's Case

Chahe Village©People's Government of Dinghai District

Due to unique ecosystems, environmental capacity, biodiversity and resource dependency, island areas have been one of the major concerns of the United Nations. For rural areas of islands, how to break through the barriers of resources limitation and backwardness of development, use the urban-rural relationship to re-distribute the industrial structure with industries of high added value, low resource dependence and low emission, and act on the opportunities brought by the trend of carbon neutrality, is an important issue worthy of discussion and active attempts.

Island regions are facing natural constraints, such as a high energy and resource dependency and a less resilient climate. In terms of socio-economic development, they also have to tackle problems such as a relatively low level of economic development, a lack of specialised personnel, and a low-carbon concept that is not yet widespread.

On the basis of professional technical support and multilateral cooperation, Dinghai has formulated specific strategies and action plans under the guidance of the Net-zero Carbon Village Planning Guidelines for the Yangtze River Delta Region as well as China's rural revitalisation guidelines, and has made useful and fruitful attempts in four areas: energy and resources, industrial revitalisation, low-carbon lifestyle and rural governance, which provide experience for the development of similar island areas.

Establishing a systematic 3S (STATUS - STRATEGIES - SMART ACTIONS) path

The first step is to identify the current characteristics of rural carbon emissions, the second step is to formulate targeted development plans according to the local situation, and the third step is to promote the implementation of plans through a combination of top-down approaches by the joint efforts of various stakeholders.

In the future, Dinghai should regularly evaluate the content of the guidelines according to the actual situation, form innovative cooperation with urban areas on the basis of organic urban-rural relationships, and continuously integrate new technologies and ideas, so as to gradually realize a net-zero carbon, vibrant and revitalised island village.

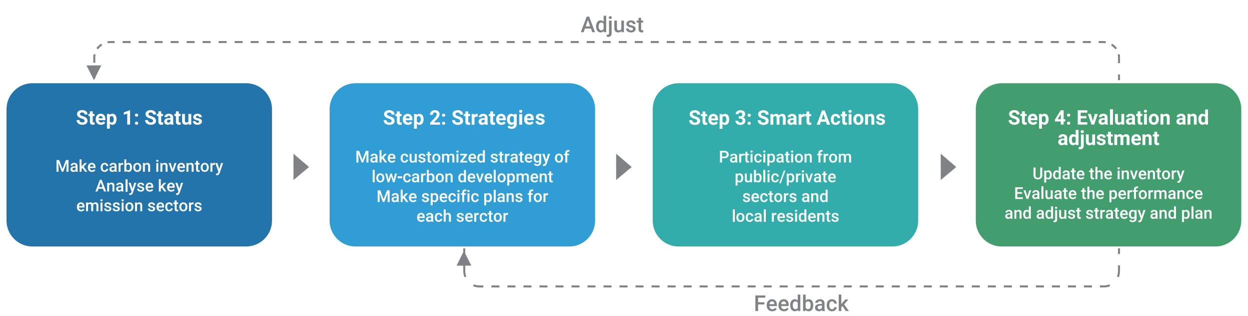


Figure 6-1 Rural revitalisation promotion path under the net-zero carbon goal

Seeking technical support and encouraging stakeholders' engagement

Zero carbon village is proposed in the context of climate change, and the revitalisation of Dinghai's rural vilalges under net-zero carbon goal actively deliver the Global Sustainable Development Goals and the requirements of the Chinese government's ecological civilisation and the "Two Mountains Theory".

Dinghai has worked with UN-Habitat and other international organizations to promote the integration of international and domestic advanced low-carbon concepts (Case 4-1). The introduction of Tongji University, a third-party professional institution to provide technical support, encouraging private capital to invest in rural development including hospitality industry (Cases 3-5 and 3-6), commercial banks, and financial institutions (Cases 4-4) are all innovative and effective measures.

Customised projects to empower local villagers

Dinghai's practices include piloting the use of renewable energy suitable for island areas according to local conditions (Case 1-1), improving the stability of energy systems in island villages through smart micro-grids (Case 1-2), applying renewable energy in public buildings such as local markets(Case 1-3) and reducing building energy consumption through refined management (Case 3-7).

Using fresh water supply systems (Cases 1-4, 1-5, 1-6) and low-carbon waste treatment systems (Cases 1-7, 1-8) that are appropriate for island villages were used to reduce maintenance and management costs. Taking full account of climate risks in island areas, the resilient level of energy and resource supply was increased, and campaigns were carried out to raise the awareness of climate change risks among residents and businesses in island areas.

Dinghai focuses on the promotion of low-carbon practices in rural industries, including the decarbonisation of the agricultural industry (Case 2-1, 2-2), and the decarbonisation of the tourism industry (Case 2-6), etc. Industrial development served as the advanced force to drive related actions in other fields. Developing traditional and creative handicrafts with local characteristics in conjunction with the local fishing industry (Case 2-4), and developing service industry such as agricultural education with traditional farming (Case 2-5). Using high-quality natural resources of the island countryside to promote the development of outdoor industries such as camping (Case 2-7) and hiking (Case 2-8).

While developing tourism, Dinghai also promoted the sharing of tourism facilities and service for local residents. Formulating village planning with a net-zero carbon orientation, Dinghai focused on improving the living standards of village res- idents (Case 3-1), optimised the spatial layout of villages (3-2), created a low-carbon transport system, and improved transport service facilities inside and outside the villages (Cases 2-9, 3-3, 3-4).

Continuously enhancing the ecological awareness and sustainable lifestyles of everyone

Dinghai launched comprehensive training programmes on low-carbon development concepts for government staff at all levels (Cases 4-5,4-6), created a low-carbon management platform for industries (Case 2-3) and put forward low-carbon management requirements for enterprises and managers engaged in rural industries.

Dinghai conveyed the concept of low-carbon lifestyle to villagers and tourists by organising rural tourism activities (Case 4-2) and setting up low-carbon scenic spots with educational purposes (Case 4-3) to upgrade infrastructure.

In the future, Dinghai needs to make regular assessments based on the 46 indicators from 10 aspects, and to make necessary adjustment accordingly. Through the interaction between urban and rural areas and joint development, island villages will keep employing new concepts and technology, to become net-zero, vibrant and revitalised.

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