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Development of Sustainable Urban-Rural Integration: Dongtan Case Study

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Abstract: The environmental impact issues, such as global warming and expansion of the urban zone, seem more serious and have become the biggest defining challenges of the 21st century. Climate change can lead to water shortages, desertification, land degradation, air pollution, rising sea levels, accelerated deforestation, and exacerbated economic pressures. Global urban growth greatly impacts changes in sociability, humanity, and the environment of the Earth. The human presence, especially in cities, seriously affects resource use and waste disposal, and they are consuming natural resources faster than the planet can sustain during urbanization, changing how people live. China, with a population of 1.3 billion, has seen tens of millions of people living in the countryside migrate to cities, especially megacities, since the 1980s. As a result of its decision to industrialize and urbanize to boost the economy, China has become the world's second-largest consumer of energy. In recent years, China's government has quickly recognized the lessons of "limits to growth" and has taken action by initiating the construction process in Dongtan, Shanghai, China. They are making efforts to build urban-rural integration communities to promote sustainable development. Based on a literature review focusing on Dongtan, research questions are raised according to the research objective: (1) What are the challenges of sustainable development in urban-rural integration? (2) What practices has Dongtan implemented for sustainable development, or how is sustainable development being applied to Dongtan? (3) What are the social, political, environmental, and economic concerns regarding the sustainable development of Dongtan? The sustainable urban-rural integration concerns the ecological, economic, environmental, and psychological aspects of urban-rural integration design and management. The overall objective is to promote sustainable development in economic, social, ecological, and spatial dimensions. It will be a liveable, complete community that makes economic, environmental, and social sense locally while also contributing to national and global sustainable development. It will serve as a compelling model for how to build sustainable urban-rural integration worldwide.

Keywords: Environmental impact; Urbanization; Sustainable urban-rural integration; Sustainable development; Dongtan

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1. Introduction

Many changes and challenges are taking place in the 21st century. Globalization is among the greatest trends of the new century, leading to the development of some global cities that possess global functions in society, politics, culture, and economics. Although cities and countries are poised to integrate into the global system, they

face growing dangers from rapid financial and economic changes, risking the ruin of their healthy economic infrastructure and causing the loss of their specific cultures. Another significant problem is the environmental impact, such as global warming (see **Figure 1** to **Figure 4**) and urban expansion. These issues seem more serious and have become the biggest defining challenges of the 21st century, as cities expand in size, consuming more energy and leading to the decline of forest and agricultural land usability. Big countries with mega and modern cities bear more responsibility for fossil fuel combustion (see **Figure 5**). They are critical factors in causing climate change and eventually become its victims.

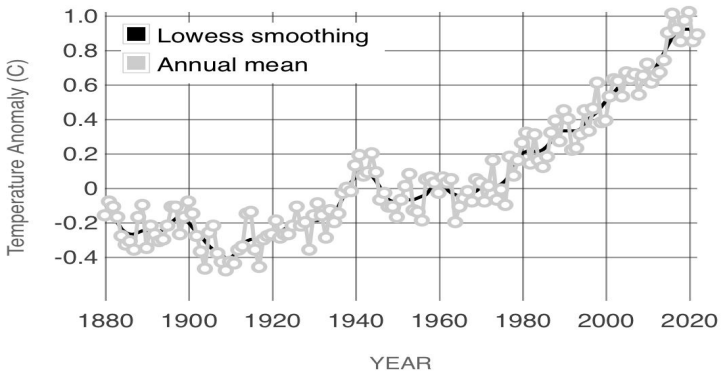

Figure 1. Global average near-surface temperatures (NASA's Goddard Institute for Space Studies)

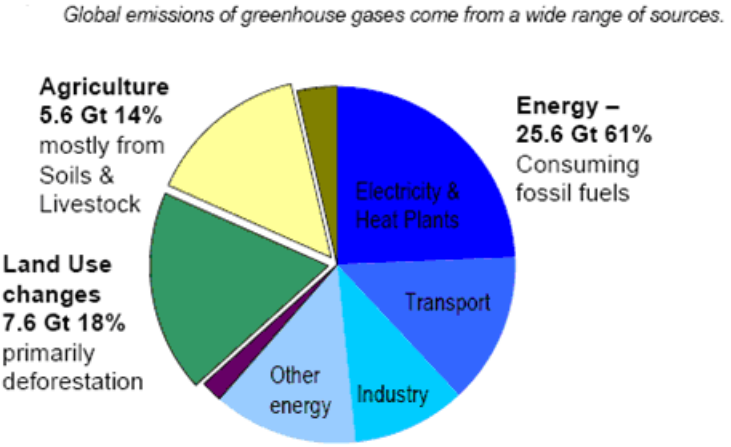

Figure 2. Global emissions of greenhouse gases come from a wide range of sources (World Resources Institute) Note: Chart shows the source of all greenhouse gases in carbon dioxide CO_2 equivalent. The unlabelled segments are industrial processes (purple) and waste (olive)

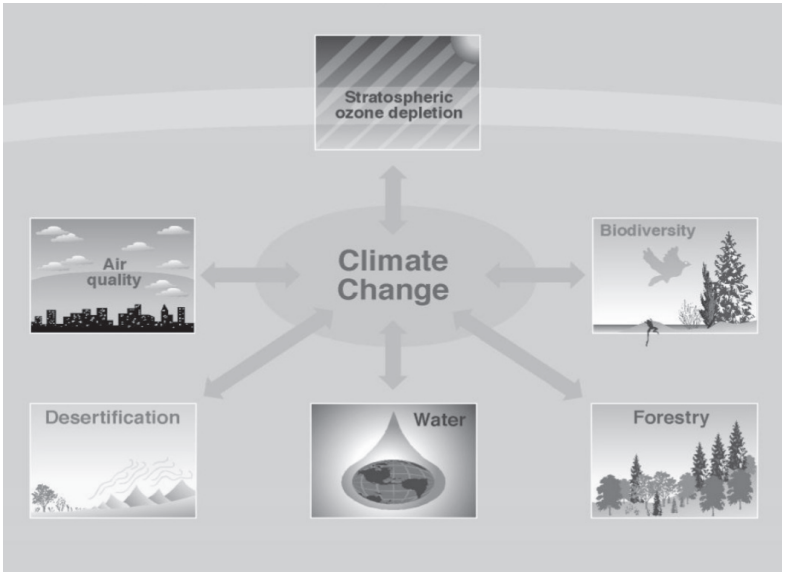

Figure 3. Climate change and the environment (Intergovernmental Panel on Climate Change, IPCC Synthesis Report)

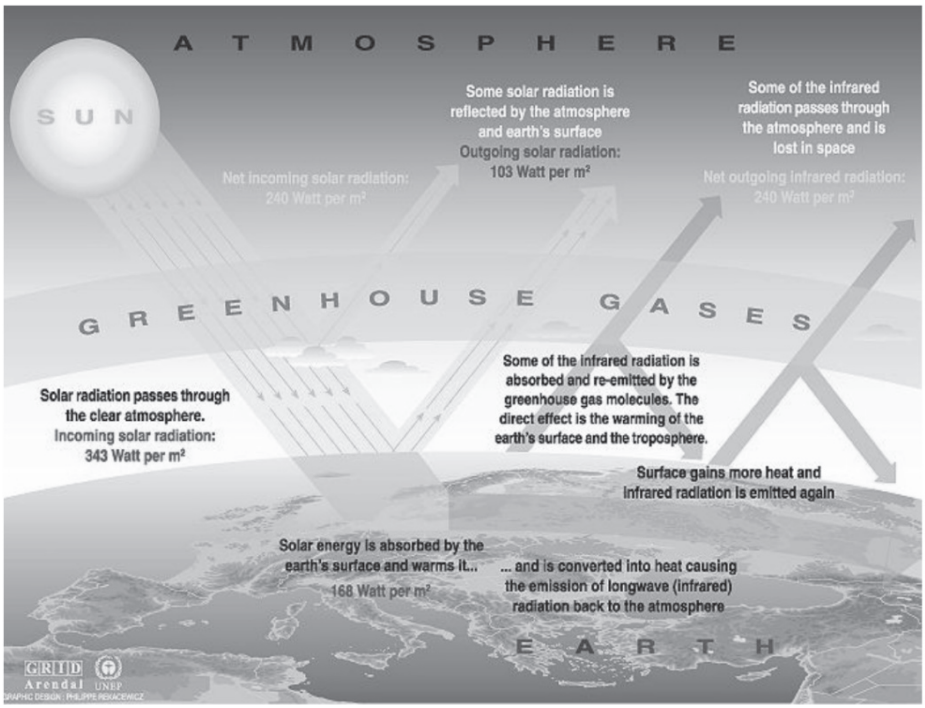

Figure 4. Greenhouse gas effect (Intergovernmental Panel on Climate Change, IPCC Synthesis Report)

Global urban growth has a significant impact on the changes in social dynamics, humanity, and the environment of the Earth. Megacities are the largest, most complex man-made structures, typically housing ten million or more people. They dominate the economies of countries and serve as central hubs for transportation and communication systems.

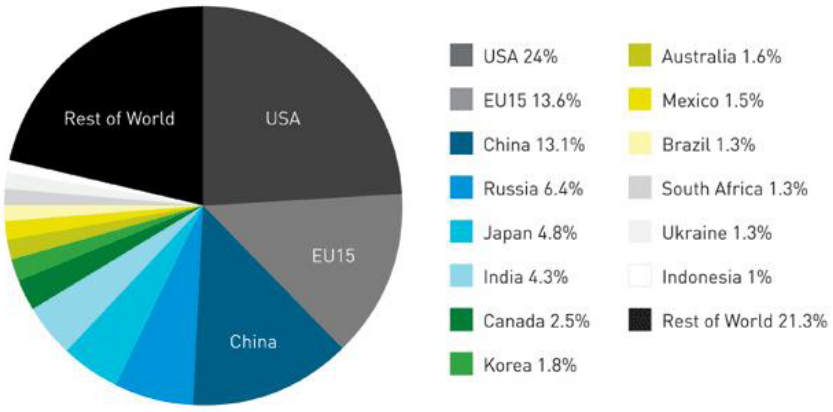

Figure 5. Shares of global energy-based carbon dioxide (CO_2) emissions, 2001 (Energy Future, Australian Government)

Unsustainable urbanization poses a threat to long-term security. As a matter of great urgency, we must recognize the need to integrate cities and countryside and remodel urban production, consumption, and transportation systems through recycling, remanufacturing waste materials, and composting organic materials. This new model, often referred to as zero-carbon, is essential.

Developing urban-rural integration faces the greatest growth challenges of the new century. To modify the structure of urban-rural integration to meet the significant needs of reducing their ecological footprint and improving energy efficiency, people need to be more aware of the need to protect the rural environment, prevent

pollution, decrease deforestation, and make the land usable. Additionally, efforts must be made to lower carbon emissions to adapt to climate change. Sustainable urban-rural integration should have significant competitive advantages and be developed with well-planned, designed, and managed methods that are compatible with the earth and rural environments, providing the natural resources and energy on which we depend to live. In the process of developing urban-rural integration, local governments are in a position to play a critical role in advancing reliable, affordable, and environmentally sustainable cities.

Although China has a splendid civilization spanning almost 5,000 years and has built many spectacular cities such as Beijing and Nanjing dating back many centuries, with a large population, the main support for the people's livelihood was the villages and the farmers before China opened its doors to foreign trade and emphasized efforts on rapid economic development and attracting investment from the West.

Like many countries around the world, China is becoming increasingly urbanized following the decision to industrialize and boost the economy. With a population of 1.3 billion, tens of millions of people living in the countryside have migrated to cities in search of job opportunities, especially in mega-cities, since the 1980s. As a result of this migration and expansion, cities are experiencing greater urbanization, leading to issues such as increased energy consumption and serious pollution.

China has become the world's second-largest consumer of energy, following the United States of America (USA). There are many distressing scenarios, such as urban sewage, polluted air replacing the bright sky and clear air, industrial chemicals poisoning rivers and lakes, and the widespread construction of coal-fired power stations causing significant environmental problems. Even carbon oxide emissions are poised to catch up with those of the USA. The current energy-wasting, resource-intensive way of living cannot continue.

In recent years, since President Xi Jinping came into power, China has raised more concerns about the environment. The government has begun to realize the lessons of "limits to growth" more quickly and has taken steps to tackle man-made environmental problems. It has launched policies on "harmony between humanity and nature" and "building a conservation-oriented and environment-friendly" approach based on the concept of sustainable development. The government has emphasized that economic development must consider its impact on the environment and society. Actions have been taken, such as in Dongtan, to build a good example of sustainable urban-rural integration. These efforts aim to prevent energy shortages and maintain the current growth rate.

Dongtan is invested by the Shanghai Industrial Investment Corporation (SIIC). It is built on Chongming Island in the Yangtze River Delta and covers an area three-quarters the size of Manhattan Island, totaling 86 km^2. Dongtan is a local project with a global perspective. It is designed to be a beautiful and sustainable city with a minimal ecological footprint. This design aims to attract a range of commercial and leisure investments, ensuring that China plays a critical role in the emergence of a world with ecologically and economically sustainable human settlements.

2. Materials and methods

2.1. Understanding sustainability and sustainable development

The principles of sustainable development combine concern for the quality of life, social, economic, and human dimensions, as well as a long-term view regarding the health and integrity of the environment and future generations. It encompasses broader concepts compared to mere environmental protection. Sustainable development emphasizes that further development should only occur within the limits of natural system capacity, as exceeding these limits could pose dangers and harm human livelihoods (see **Figure 6** and **Figure 7**). There are five principles with respect to sustainable development (see **Figure 8**).

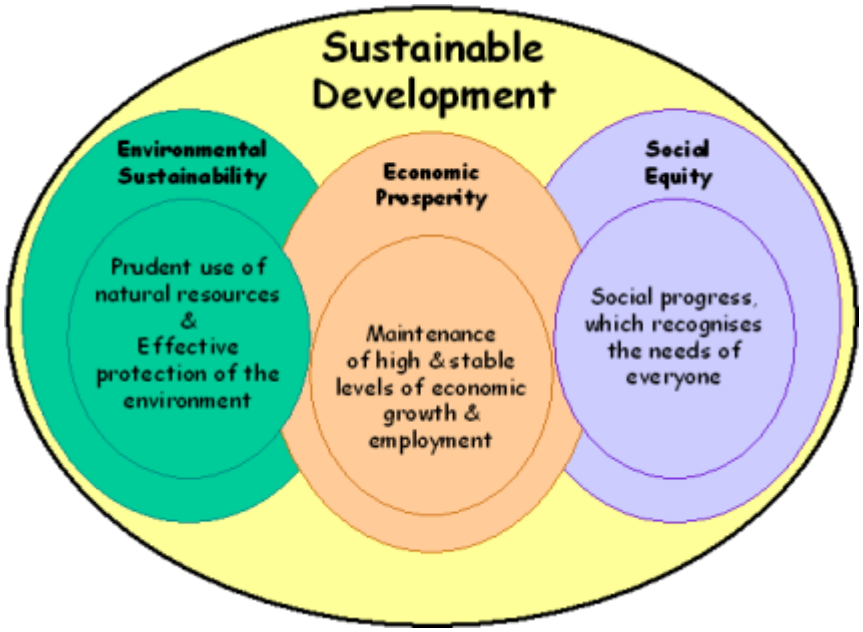

Figure 6. Impacts on sustainable development (Cornwall Community Strategy)

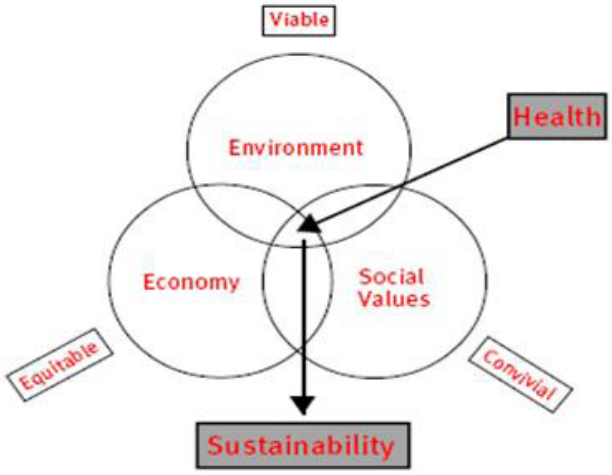

Figure 7. The conceptual model of sustainable development

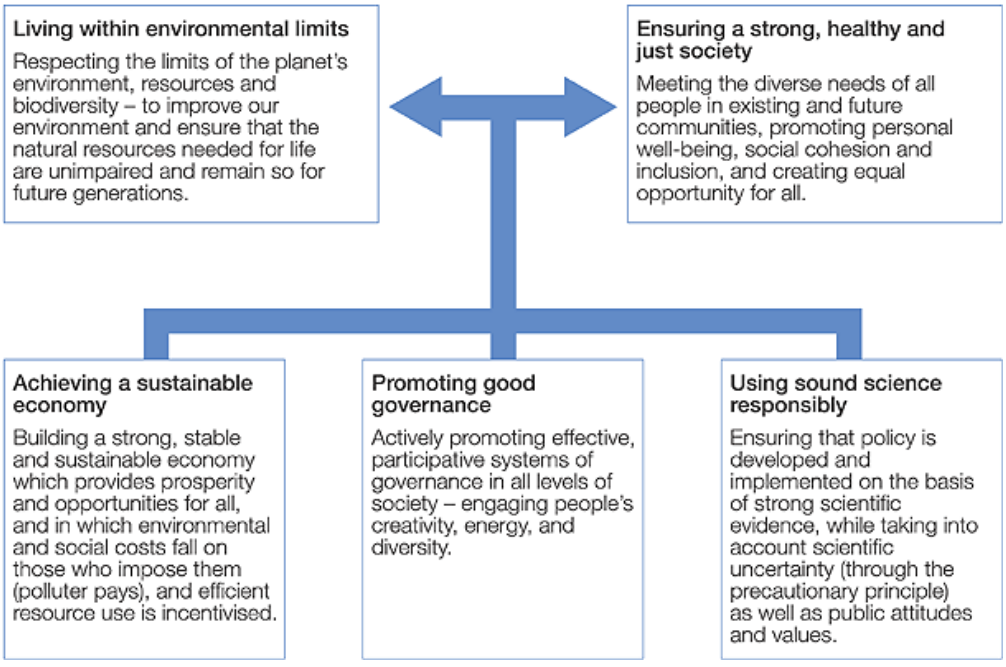

Figure 8. Four principles with respect to sustainable development (WHO Regional Office)

2.2. Sustainable development of urban-rural integration

2.2.1. Global trends in economics, demographics, and urbanization

With the development of the global economy, the impact of urban and rural areas on global systems is increasingly recognized. Cities and towns are affected by circumstances where strategies and decisions are often made far beyond their own borders. Understanding global and regional economic, social, environmental, and cultural trends is crucial for comprehending urbanization and other population distribution trends over the last two decades [1]. However, a significant challenge arises as natural resources decline while cities and towns worldwide face daunting environmental challenges on a global scale. The main characteristics of the globalization impact on economic and social transformation are as follows:

(1)Trade liberalization and structural reform

(2)Decline of manufacturing as the core economy

(3)Rise of electronic and information services

(4)Services becoming tradable

(5)Less capital-intensive compared to heavy industries

(6)Shift from old physical master planning to new strategic approaches

The world's population is predicted to increase from 6.5 billion to 9 billion by the middle of the 21st century. In less than twenty years, more than half of the developing world's population will be urban, with a fast-growing number of mega-cities, especially in developing countries (**see Figure 9** and **Figure 10**). With the rapid growth of the population, the global urban trend significantly affects economic, social, environmental, and political aspects worldwide. Some problems have emerged and are becoming increasingly serious, such as environmental deterioration, and lack of provision for piped water, sanitation, sewerage, roads, schools, and health centers. By 2035, urbanization is projected to cause a loss of 25% of agricultural land in China.

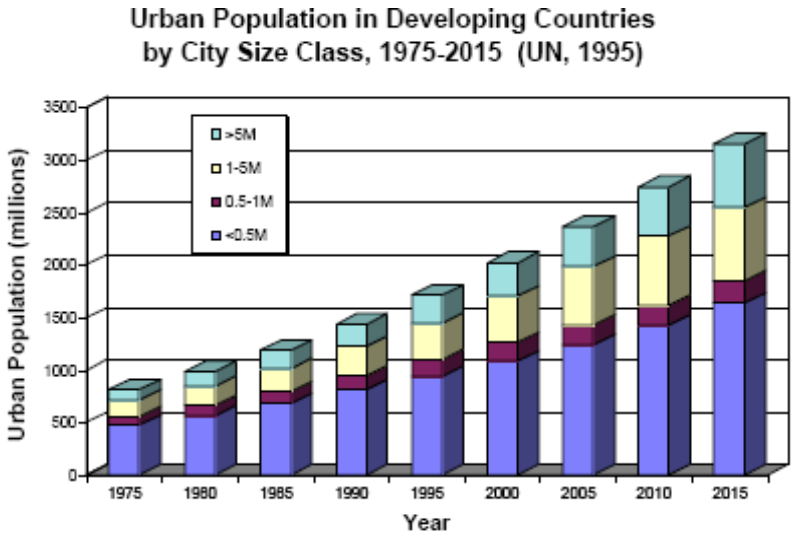

Figure 9. Urban population in developing countries by city size class, 1975 to 2015 (UN, 1995)

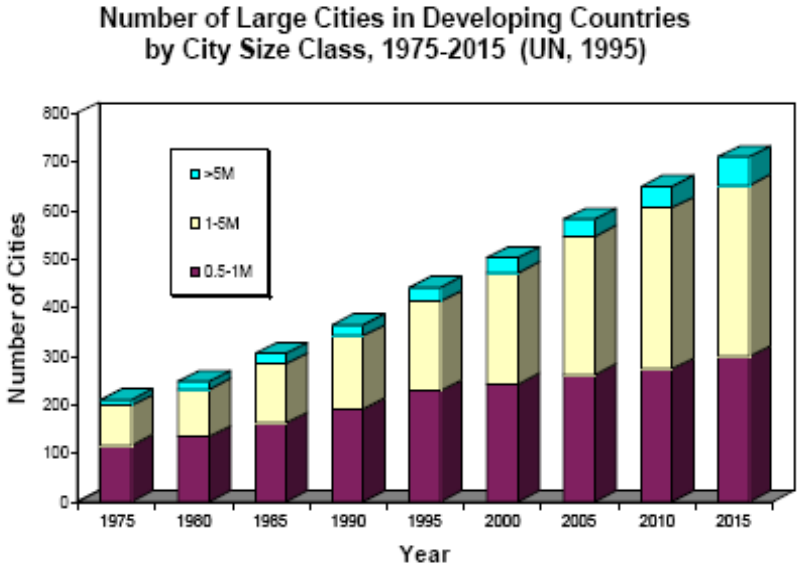

Figure 10. Number of large cities in developing countries by city size class, 1975 to 2015 (UN, 1995)

Like many other countries globally, China's cities face common problems during urban development. In fact, China has become one of the most urbanized countries in the world, with the largest population residing in cities and the highest number of mega-cities among nations. Furthermore, China ranks among the world's highest consumers of energy and water resources and is a significant generator of commercial and industrial waste.

2.2.2. The sustainable urban-rural integration policy design

Integrating policies at high levels aims to shift from sectional approaches to inter-sectional collaboration, promoting sustainability. Additionally, specific policies integrating rural land-use planning and practical project management ensure the utilization of natural resources within environmental capacity boundaries. Key strategies to support these goals include the following.

(1)Utilize tools and technologies to achieve a sustainable society by balancing and integrating various requirements and interests, advancing sustainable urban-rural integration planning.

(2)Utilize technology to manage flows such as water, energy, materials, and waste, aiming to enhance management effectiveness and efficiency to achieve sustainable resource use based on sustainable development principles.

(3)Implement physical approaches and economic instruments with local and regional legislation to manage environmental quality and amenity.

(4)Apply facilitative management techniques and best practices, including environmental and health impact assessments, environmental accounting, eco-auditing, green procurement, and economic instruments.

(5)Set sustainability targets as a powerful method to focus attention on critical challenges and provide a timed framework for action.

2.2.3. Sustainable urban-rural integration

2.2.3.1. What is the "Sustainable Urban-rural Integration?"

The "Sustainable Urban-Rural Integration" is a Swedish initiative with a holistic concept for the sustainable development of cities and rural areas. The concept of Sustainable City was developed by SWECO for the 2002

World Summit on Sustainable Development in Johannesburg, on behalf of the Swedish Government through the Ministry for Foreign Affairs, the Ministry of the Environment, and the Swedish environmental technology industry, facilitated by the Swedish Trade Council [2].

Within the growing economy of a developing country, "sustainable" means the ability to control spatially sprawling suburbanization. The definition of sustainable urban-rural integration is generally understood to encompass the ecological, economic, environmental, and psychological aspects of designing and managing urban and rural areas. The overall objective is to promote sustainable development across economic, social, ecological, and spatial dimensions within both urban and rural contexts (see **Figure 11**).

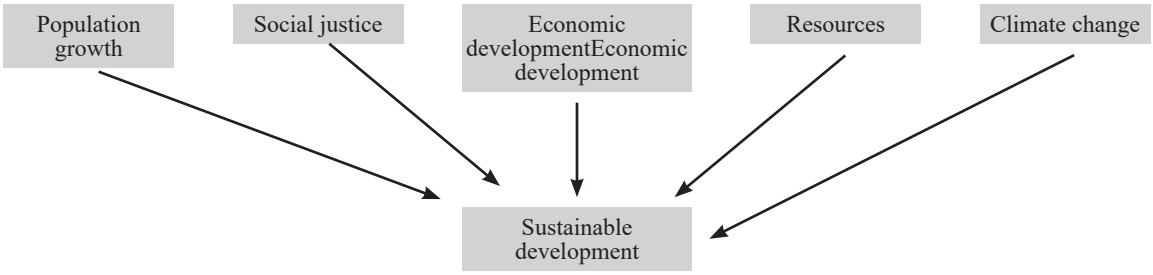

Figure 11. Impacts on sustainable urban-rural integration

The key points of sustainable urban-rural integration are presented as follows.

(1)Green architecture, sustainable planning, and enhancement of the city and rural environment

(2)Energy efficiency and renewable energy: an urban-rural response to climate change

(3)Sustainable transport systems

(4)Environmental psychology for sustainable urban-rural development

(5)Urban-rural biodiversity and resilience of urban-rural ecosystems

(6)Ecologically friendly social and economic benefits

(7)Urban-rural limits and risk analysis: material flows and ecological footprint

2.2.4. Design and develop sustainable urban-rural integration

2.2.4.1. Sustainability strategy

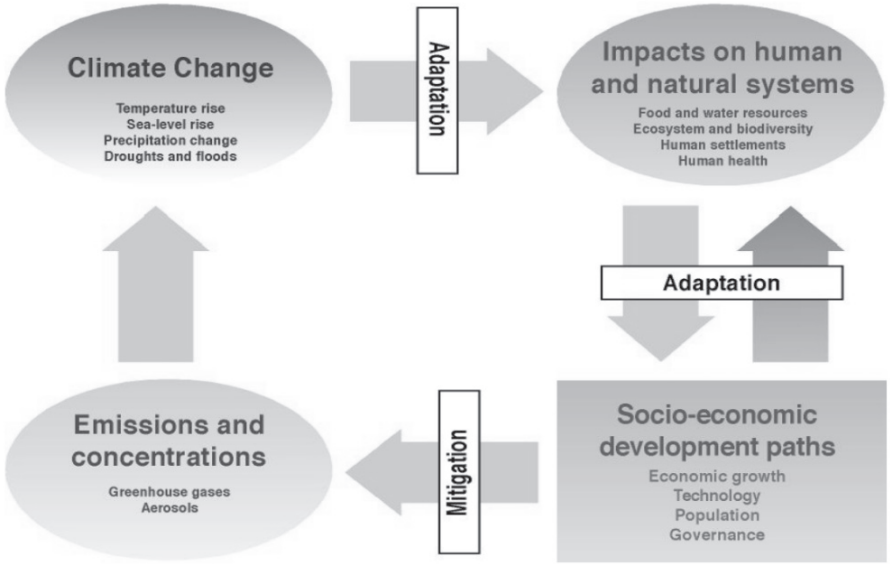

Figure 12. Climate change integrated framework (Intergovernmental Panel on Climate Change, IPCC Synthesis Report)

2.4.4.2. Plan and design sustainable urban-rural integration

Figure 13 shows the details of the elements of designing sustainable cities.

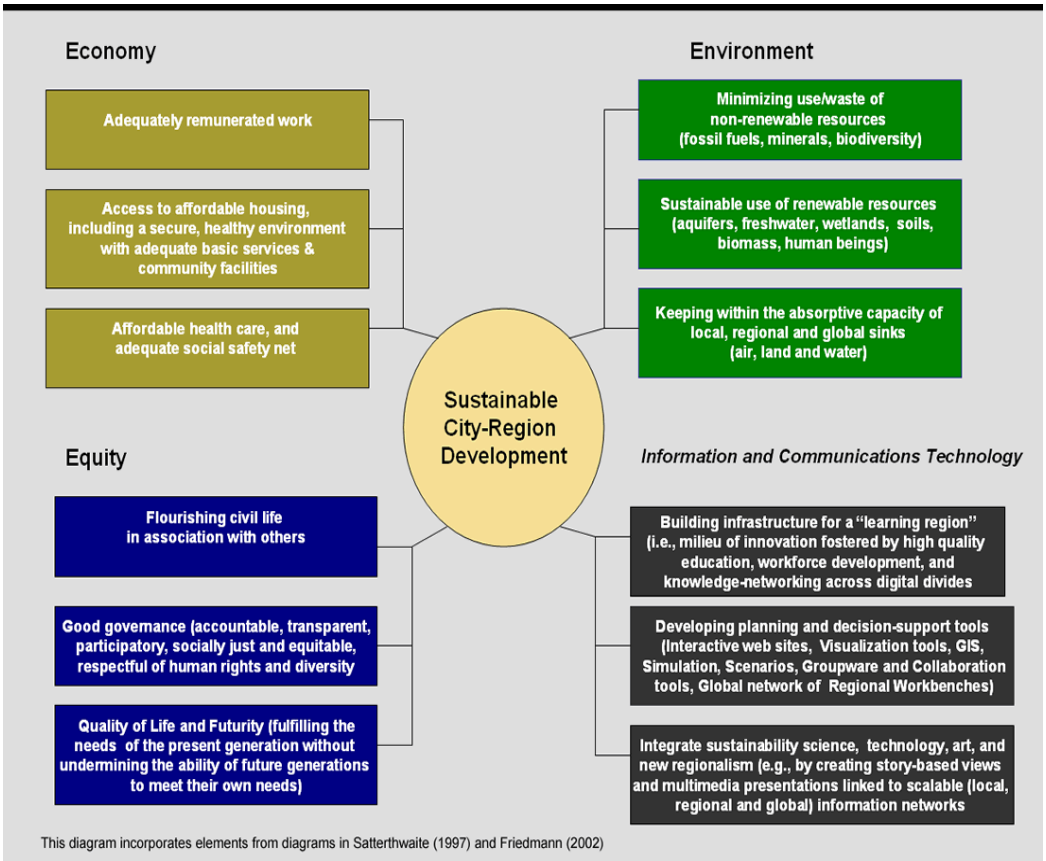

Figure 13. The elements of design sustainable urban-rural integration (Urban world system)

The following present planning and infrastructure issues, including sustainable technologies and management, for sustainable urban-rural integration.

(1)Urban and rural area planning and regulation

(2)Management of service networks

(3)Water, energy, communications, waste

(4)Transport systems

(5)Natural environment preservation

(6)Planning policies, regulations, codes, and standards

(7)Synergies and interactions between different sectors [3]

3. The holistic development of Dongtan

Figure 14. 21st-century sustainable Dongtan

3.1. Introduction of Dongtan

Dongtan is a new sustainable urban-rural integration area being planned in the Shanghai region of northern China. It aims to accommodate 80,000 people and serve as an example of sustainable development, addressing the challenges of the 21st century, including climate change and various environmental issues [4].

Dongtan is situated in an extremely strategic position very close to Shanghai. It is located on Chongming Island, which is the third-largest island in China and a sensitive wetland area at the mouth of the Yangtze River, just north of Shanghai.

Shanghai Industrial Investment Corp (SIIC), the largest international investment group company owned by the Shanghai municipal government, is the developer of Dongtan. SIIC partnered with Arup, a global design, engineering, and business consultancy, to plan and deliver the city and to undertake the integrated master planning for the Dongtan sustainable city. Founded by engineer Ove Arup in the 1940s, London-based Arup has 86 offices in more than 30 countries and a staff of nearly 9,000, including 1,500 in China [5].

Arup provides a full range of services for the project, including urban-rural integration design, planning, cultural considerations, sustainable energy management, waste management, implementation of renewable energy processes, economic and business planning, sustainable building design, architecture, infrastructure development, and even the planning of communities' social structures [6].

Eco-friendly Dongtan is arguably one of the most significant sustainable development projects being implemented anywhere on earth. Designed to be a diverse, mixed-use urban-rural integration environment, it will consist of compact villages set in parkland and intersected by canals and lakes. The project is intended to be carbon-neutral and zero-waste, while also providing employment, schools, and healthcare facilities within each urban district [7]. Dongtan will incorporate many traditional Chinese design elements and will be built in a "Chinese" style.

3.2. The strategy for sustainable Dongtan

The strategy for Dongtan is developed in several stages, with future development expected to accommodate up to around 500,000 people by around 2050, covering an area of around 30 km^2.

Dongtan is planned to develop into three pedestrian villages, each capable of accommodating about 30,000

people for living and working. These villages will include part of the marina and nearly a square kilometer of open space and parkland [8]. Dongtan aims to demonstrate that environmental sustainability and access to nature are integral parts of new development in China (see **Figure 15** and **Figure 16**).

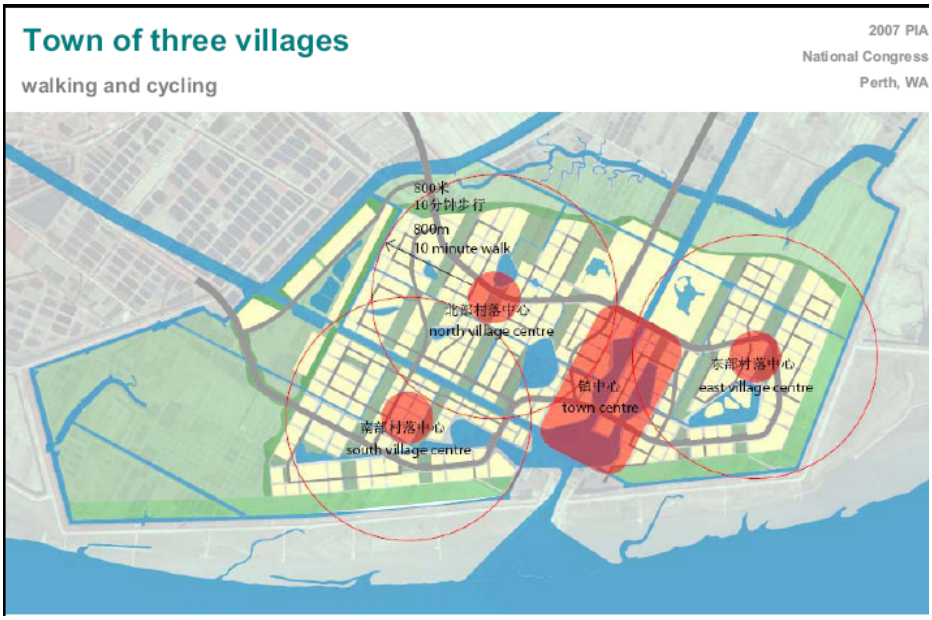

Figure 15. Town of three villages–walking and cycling

Figure 16. Town of three villages–clusters and centres

The overarching vision for Dongtan is to create a world-class sustainable urban-rural integration that is responsive to the needs of economic growth, accommodates demographic trends, and places environmental and social sustainability at the core of its development objectives. To achieve this vision, the following key

objectives have been identified.

(1)To preserve the wetland habitat

(2)To create an integrated, vibrant, and evolving community

(3)To improve quality of life and create desirable lifestyles

(4) To create an accessible city

(5) Managing the use of resources in an integrated manner

(6) Working towards carbon neutrality

(7) Utilizing governance to achieve long-term economic, social, and environmental sustainability [4]

3.3. Who will live in Dongtan?

The social sustainability plan includes integrating the current population, consisting of a small fishing community and agricultural workers, into the city design rather than displacing them. The strategy for attracting and determining who will make up the additional population and how they will move into Dongtan is still being developed. However, to ensure social sustainability, the population will need to come from a wide range of backgrounds and demographics.

3.4. What will Dongtan be like?

3.4.1. Sustainability

Figure 17. Sustainable Dongtan

The aim is for Dongtan to be self-supporting, generating all its energy needs, including transport, from renewable sources, and having zero emissions from the tailpipes of vehicles. Farmland around the city will grow food for the city, and there will be nutrient and soil conditioning recycling between city waste and the surrounding land. Additionally, efforts will be made to prevent pollutants from reaching the adjacent wetland areas.

3.4.2. Energy

The city region will primarily source its energy from wind turbines, biofuels, and recycled organic material. An Energy Center will serve as the energy supply hub for the entire city of Dongtan. Furthermore, it will function as a tourist attraction, leisure park, science exhibition, and education center.

3.4.3. Climate change

The potential to facilitate climate change mitigation should involve controlling and managing greenhouse gas emissions. Moreover, maximizing Dongtan's adaptive capacity will enable effective management of future climate changes.

3.4.4. Recycling

Most of the city's waste will be recycled, and organic waste will be composted or used as biomass for energy production. There will be no landfilling of waste, and human sewage will be processed for irrigation and composting purposes.

3.4.5. Buildings

Figure 18. The bird eye view of Dongtan residential buildings

Labor and materials will be locally sourced to reduce transport and embodied energy costs associated with construction. A combination of traditional and innovative building technologies will decrease energy requirements for heating and cooling buildings by up to 70%. Good public transport will lower air and noise pollution, enabling buildings to be naturally ventilated and reducing energy demand. Green roofs on buildings will improve insulation and water filtration, and offer potential storage for irrigation or waste disposal. A compact city made of villages will lower infrastructure costs and enhance amenity and energy efficiency of public transport systems.

3.4.6. Transport

Dongtan will feature urban-rural integration linked by a combination of cycle paths, pedestrian routes, and various modes of public transport, including buses and water taxis. Canals, lakes, and marinas will permeate the city, offering a range of recreational and transportation opportunities. Public transport will incorporate innovative technologies, potentially including solar-powered water taxis or hydrogen fuel-cell buses. Visitors will be encouraged to park their cars outside the city and utilize public transport while within the city limits.

Figure 19. The master plan for sustainable Dongtan

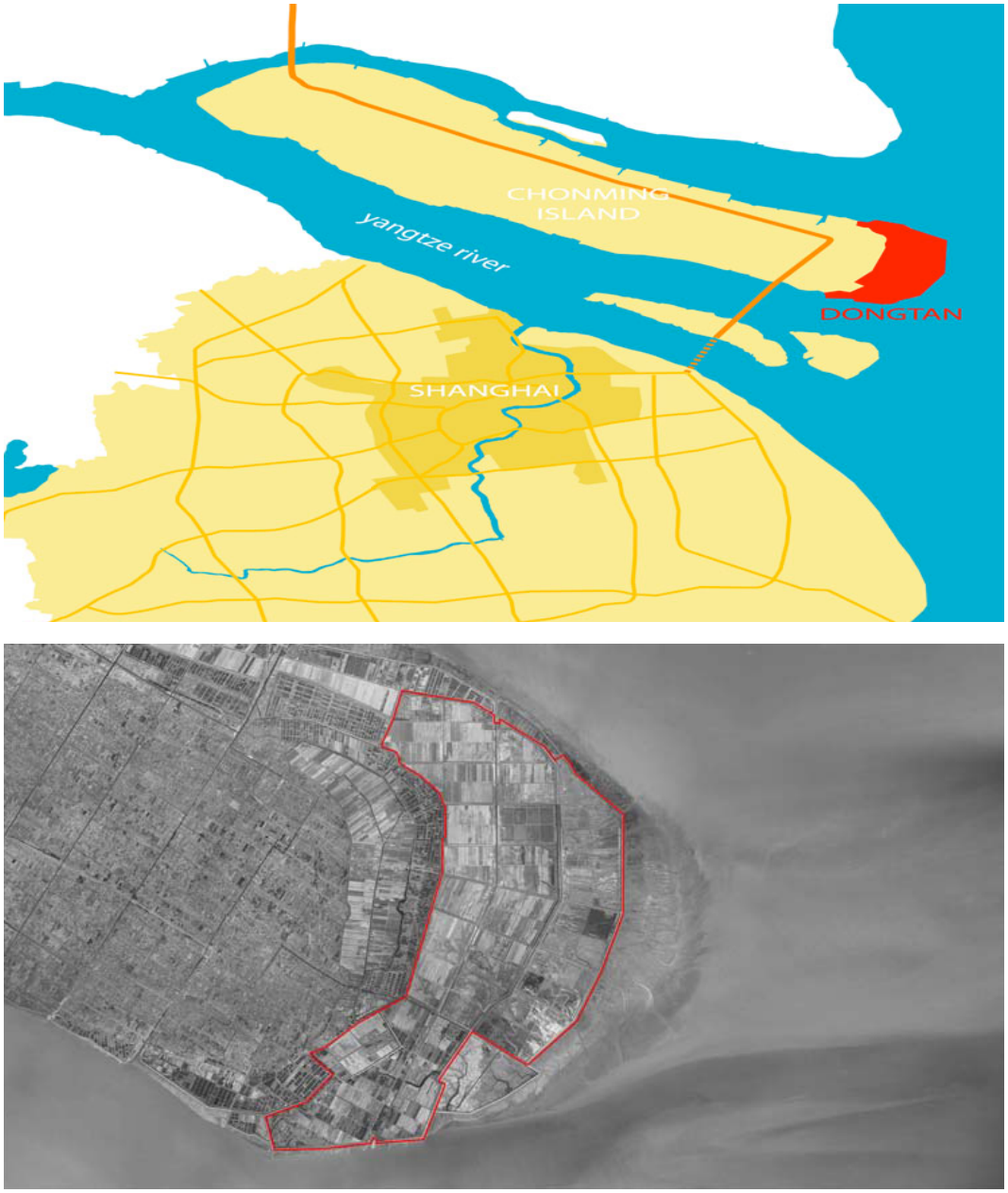

Figure 20. The geographical location of Dongtan

3.5. Science and technology

3.5.1. General design principles

3.5.1.1. Design proposal

Dongtan is designed as a modern, culturally rich, distinctly Chinese, and environmentally sustainable community. The design aims to provide a rich sensory experience—satisfying sight, sound, taste, smell, and touch—while aligning with an integrated sustainable development framework that addresses economic, environmental, and social objectives. This framework meets ambitious national, regional, and SIIC corporate goals, representing a new paradigm in urban-rural design in China, focusing on addressing environmental pollution, reducing emissions, and finding alternatives to fossil fuel depletion.

3.5.1.2. Design principles

(1) Minimising energy consumption in buildings and transport creating maximum use of renewable energy with the aim of energy self-sufficiency
(2) Closed-loop recycling where all waste is reused or recycled
(3) Maximum use of local organic fresh food
(4) Water self-sufficiency
(5) Design for zero particulate emissions from transport vehicles
(6) Design for accessibility, with homes near jobs and public services, connected dedicated safe walking and cycling routes and efficient public transport
(7) Green spaces and water features designed to increase bio-diversity and create a traditional Chinese sense of place throughout Dongtan
(8) World-class leisure, eco-tourism, health, and knowledge enterprise developments with a focus on emerging technologies
(9) Long-term robustness against the impacts of climate change

3.5.1.3. Design components

Dongtan aims to be the world's first purpose-built eco-friendly community. It is designed not only to be environmentally sustainable, but also socially, economically, and culturally sustainable. Its goal is to be as close to carbon neutral as possible, with city vehicles that produce no carbon or particulate emissions and highly efficient water and energy systems. Dongtan will generate all of its energy needs from renewable sources including biofuels, wind farms, and photovoltaic panels. A majority of Dongtan's waste will be reused as biofuel for additional energy production and organic waste will be composted. Even human sewage will be processed for energy and composting, greatly reducing or eliminating landfill waste sites.

3.5.1.4. Design

Dongtan is being designed as three village neighborhoods concentrated at the southern tip of the site. The infrastructure, including roads, public transport, schools, hospitals, commercial areas, and green spaces, will encourage inhabitants to travel by bicycle or public transport rather than cars. These villages will converge to create a city center where commercial activities will be concentrated.

3.5.1.5. Transportation

The city will be linked by a network of pedestrian walkways. Car-Pool, an intranet service, will connect people interested in carpooling and provide travel time forecasts. Only zero-carbon vehicles will be permitted within the city. Pollution-free buses, trams, or water taxis, powered by fuel cells or other zero-carbon technologies,

will run between neighborhoods. Traditional motorbikes will be prohibited, with electric scooters or bicycles replacing them.

3.5.1.6. Buildings

Buildings will be dense but limited to a maximum of eight stories. Turf and vegetation will cover roofs, creating green roofs, providing natural insulation, reducing runoff, and recycling wastewater. Photovoltaic panels and small-scale windmills integrated into building designs will provide up to 20% of the power.

3.5.1.7. Waste and energy

Up to 80% of solid waste will be recycled. Organic waste will be reused for compost and energy generation, fulfilling part of the town's electricity requirements. Rice husks, abundant in Chongming's rural area, will be burned in Combined Heat and Power (CHP) plants to generate heat, cooling, and electricity. Wind turbines positioned on the outskirts of the city will harness sea breezes to produce electricity. An energy center will manage generation via wind turbines, biofuels, and recycled organic material, also serving as an information resource center for inhabitants and visitors.

3.5.1.8. Flood protection

Existing flood walls surround the site, with provisions in the design to increase the defenses' height in response to sea-level rise. Protective cells within the city's basements will serve as additional flood protection. The Shanghai Municipal Government is constructing a bridge, tunnel, and high-quality road to connect Chongming Island and the Dongtan site to the Shanghai mainland .

3.5.1.9. Energy efficiency

Dongtan expects to use 64% less energy than a comparable city of its size built in a business-as-usual manner. Dongtan will achieve carbon neutrality, with its main grid designed for walking and cycling rather than cars. The city will be powered by solar and wind power, biofuels, and recycled organic material. Green roofs will be implemented for energy efficiency and insulation benefits, while rainwater capture systems will maintain landscaping. All vehicles will operate on clean fuels, and approximately one-fourth of the city will be designated as open green space. With fewer gas and diesel vehicles congesting the streets, residents should be able to open their windows and enjoy clean air. Additionally, about 20% of the city will be reserved for affordable housing, although some farmers express concerns that it may still be out of their price range.

3.6. Dongtan sustainable development

3.6.1. The framework of development of Dongtan

Table 1 outlines the comprehensive framework for Dongtan's development, which integrates environmental, social, natural resource, and economic objectives. This framework highlights the multi-dimensional approach required to build a sustainable urban-rural integration.

Table 1. Framework for the development of Dongtan

Environment	Social
(1) Physically and legally protect the internationally significant Dongtan wetlands from any man-made intervention such as physical encroachment, poaching of wildlife, and pollution of land, water, and air. Impose the strongest possible penalties on organizations and individuals in breach of these measures. (2) Protect and enhance the biodiversity and quality of the wilder Dongtan and its urban areas including the ecological communities and habitat, canals, and waterways. (3) Avoid any physical degradation of the island through Dongtan's activities and monitor the impact of others on the rate of deposition and erosion of the eastern wetlands. (4) Enable sustainable lifestyles that minimize negative environmental impacts on resource use, waste, and pollution through the provision of well-connected, public transport links, cycling and walking routes, and the availability of healthy food produced sustainably by local farmers and fishermen. (5) Create cleaner, safer, and greener neighborhoods with ecologically sound, open spaces and landscapes that encourage social interaction and healthy lifestyles. Build with people as the priority, not cars, and encourage sustainable alternatives for the transport of freight, goods, and food. Design for the likely effects of climate change for now and the future, incorporating sustainable drainage and flood management techniques.	(1) Create inclusive, cohesive and tolerant communities that recognize traditional and modern Chinese and other cultural values. (2) Ensure all citizens can engage with and are represented by governance systems that are accountable and that work towards the continued realization of Dongtan's full potential as an eco-friendly city. (3) Develop an urban-rural integration that enables healthy and safe lifestyles through the provision of key services and facilities accessible to all and which promote health, provide suitable healthcare when required, avoid car dependence, and reduce opportunities for crime. (4) Provide jobs and cultural, leisure, community, sporting, and educational facilities for all, regardless of age or ethnicity, and make everyone aware of these opportunities through world-class information and communication technology. (5) Create an internationally, regionally, and locally accessible city with user-friendly facilities and a sustainable mix of development and housing opportunities blend with green spaces to create vibrant communities and a real sense of place.
Natural resources	**Economic**
(1) Design for energy efficiency by utilizing renewable energy at both macro and micro scales and across all lifestyle energy uses to minimize Dongtan's contribution to climate change. Produce local biomass for energy production, and maintain flexibility for future changes in energy supply and consumption. Ensure the security of energy supply at an affordable cost while encouraging efficient use. (2) Design for the reduction, reuse, and recycling of natural and man-made materials and develop policies that encourage resource management, sustainable production and consumption, and the extraction of maximum benefit from residual wastes at Dongtan, through energy production and use in agriculture. (3) Design for water efficiency in all domestic, commercial, industrial, leisure, and agricultural applications and develop infrastructure and policies that allow for the application of potable water to only those applications that require it. Identify and protect reliable sources of fresh water for now and for the future and ensure the security of water supply at a cost that is affordable whilst encouraging efficiency of use.	(1) Aim for consistent economic progress, which recognize China's old and new economies and allows for the sustainability objectives of Dongtan to be met. (2) Develop an equitable balance and mix of uses to support sustainable investment and prosperity. (3) Provide intensives for businesses that meet the sustainability objectives of Dongtan and, conversely, ensure that environmental and special costs are met by organizations that are responsible for them. (4) Provide jobs diverse enough for all and maintain a culture of innovation and business creation, together with relevant life-long training and educational opportunities. Ensure economic benefits are realized within the local community. (5) Design and maintain suitable and flexible infrastructure, homes, buildings, transport links, and information and communications technology to sustain the economic objectives of Dongtan. Ensure the city is suitably protected from flooding and extreme events.

3.6.2. Dongtan sustainable urban development

In general, the sustainable development prospect for Dongtan will involve low-energy building design, effective management practices, promotion of renewable energy technologies, innovative integration of energy supply to buildings, increased awareness among individuals, and addressing transportation issues. Dongtan's sustainable

development encompasses all elements of the sustainable prospect, including land use, buildings, transport, energy, land conservation, employment/skills, viability, form and space, health, inclusion, and air quality (see **Figure 21**).

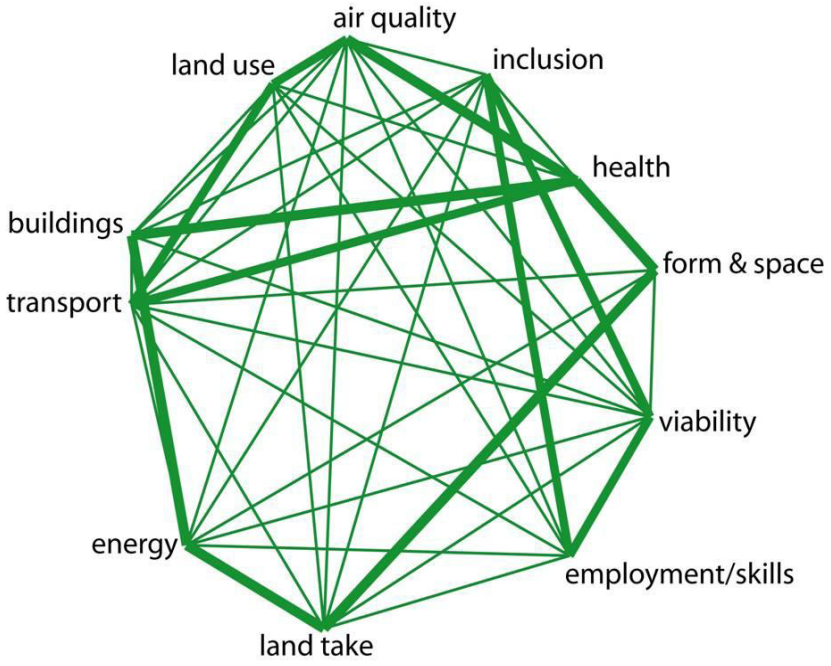

Figure 21. Elements of the Dongtan sustainable development

3.6.3 Environment

3.6.3.1 Water

Water in Dongtan is abundant, whether in canals or lakes, contributing to the city's landscape. To maintain this landscape, water in Dongtan is managed to provide a separate limited potable water supply. The water will be collected and recycled when discharged into the canals and lakes within the city boundaries. Greywater will be recycled and stored on-site. This recycled water will be used to grow green vegetables, as the intensive, relatively small amounts of water will directly reach the plants themselves. The water-saving technology can not only reduce water consumption but also further reduce energy demand and running costs while effectively controlling pollution.

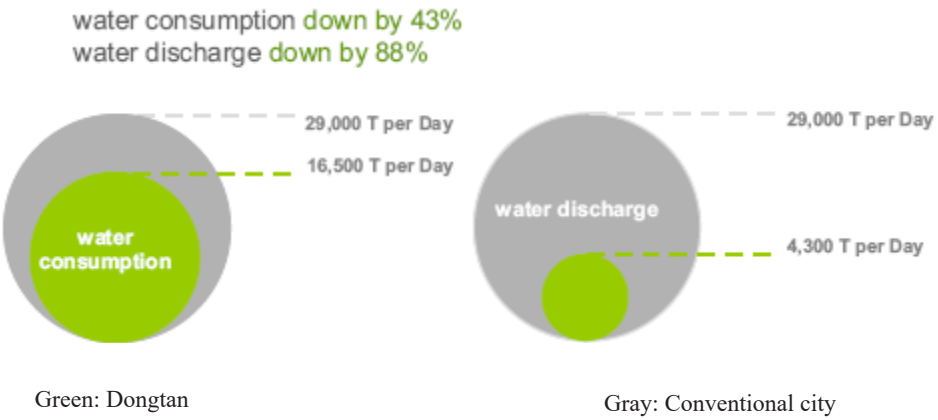

Figure 22. Water consumption and discharge

Conventional cities of this scale currently consume an average of 29,000 tonnes of water per day and discharge the same amount. It is estimated that Dongtan will consume an average of 16,500 tonnes per day, but only discharge 4,300 tonnes of water per day (see **Figure 22**).

3.6.3.2. Energy production, use and emission reduction

Dongtan expects to use 64% less energy than a comparable area of its size built in a business-as-usual manner (see **Figure 23**).

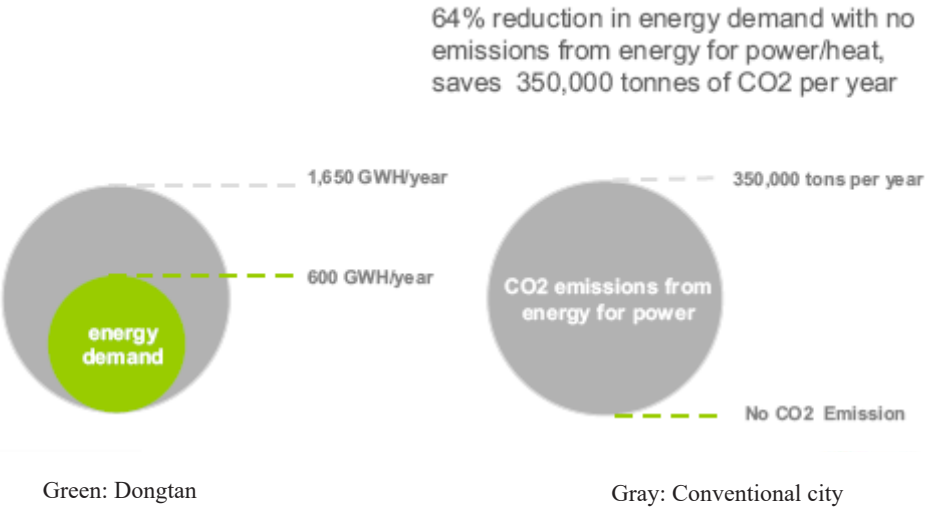

Figure 23 Energy production, use and emission reduction

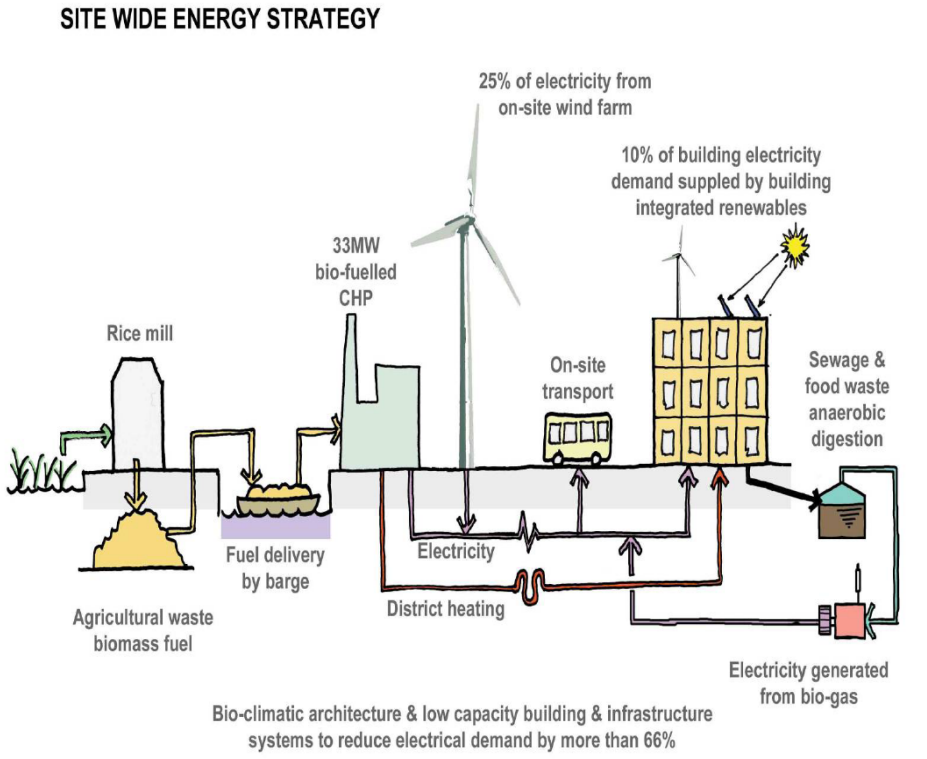

Figure24. Dongtan energy center (Mashford KJ)

3.6.3.3 Land use

Local food, organically farmed on the retained agricultural land, will be available all over the city. Traditionally, cities swallow farmland and grow at the expense of agriculture. In Dongtan, food will be grown in fields around the city and at high density using new technology in the city's food center. Though unlikely to be totally self-sufficient for food, Dongtan will produce as much food when it is built as the land did before. The agricultural industries already existing on Chongming will remain and be integrated into the way the city is run as a whole, ensuring no loss of productive land. By providing nine hectares of plant factories per 1,000 hectares of productive land utilized, the goal is to ensure Dongtan produces as much of its own food as possible.

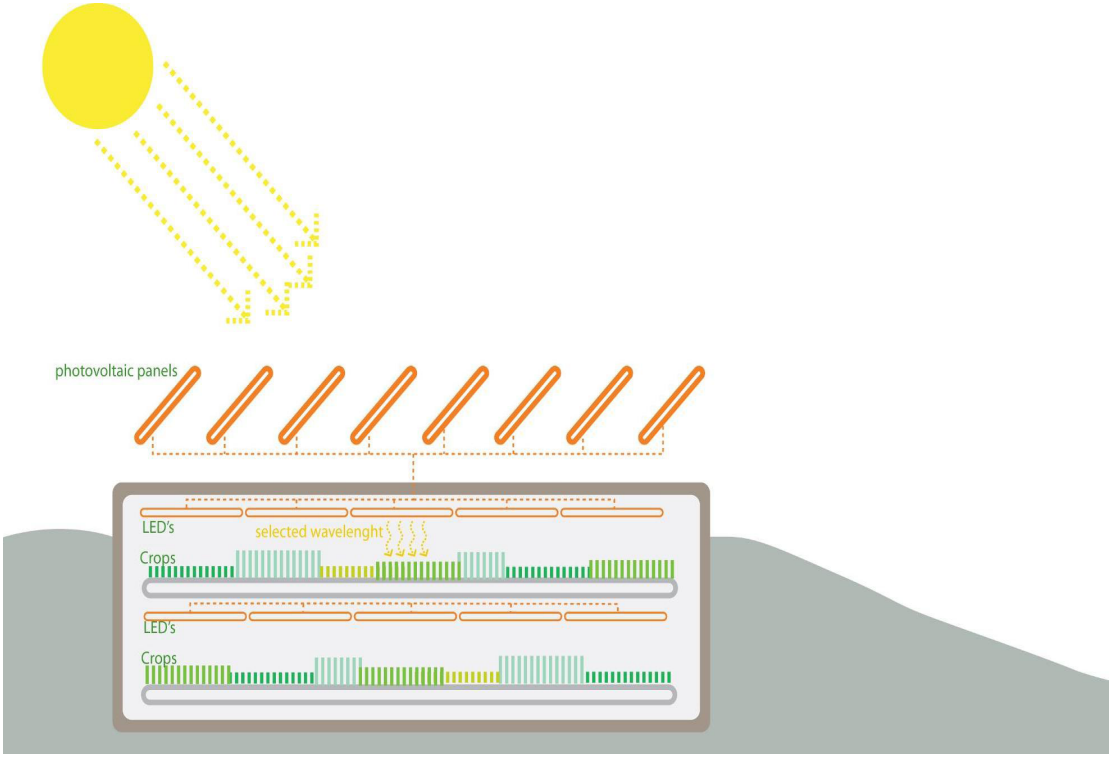

Figure25. Sustainable factory with no loss of production

3.6.3.4. Agriculture

Roughly 40% of Chongming Island will be urbanized, while 60% will remain agricultural. Sophisticated organic farming techniques linked to the waste and sewage recycling system are designed to create a sustainable cycle of local food production. Much food will be produced in innovative multi-story greenhouses lit by low-energy Light-Emitting Diode (LED) lights. The integrated approach to Dongtan's development should also mean that Chongming's existing local farming and fishing communities will have significant new business opportunities, enhancing the island's long-term environmental sustainability. Food will be processed on the island to add local value, and restaurants will also be a major feature of the local economy .

3.6.3.5. Ecology and biodiversity

The highest priority in the Dongtan development was to protect the island's precious wetland habitat and improve the prospects of the wildlife living there, thus the natural reserve will be expanded. Chongming serves as a crucial stopover point for wildfowl on migration routes across China. The wildlife reserve at Chongming's extreme eastern tip will remain untouched and will be buffered from Dongtan by a band of eco-farming and controlled wetlands. Buildings will feature green roofs, a small difference that will positively impact

biodiversity and local climate conditions. The continuous network of green spaces will create corridors for wildlife movement throughout Dongtan.

3.6.3.6. The ecological management of wetlands

The delicate nature of the Dongtan wetlands and the adjacent Ramsar site (www.ramsar.org) for migrating birds and wildlife has been one of the driving factors in Dongtan's design. The plan includes enhancing the existing wetlands by returning agricultural land to a wetland state and creating a "buffer zone" between the city and the mudflats. At its narrowest point, this buffer zone will be 3.5 km wide, with a 2-mile buffer zone of eco-farms between city development and the wetlands. Only around 40% of the land area of the Dongtan site will be dedicated to urban areas, aiming to prevent pollutants (light, sound, emissions, and water discharges) from reaching the adjacent wetland areas.

3.6.3.7. Transport

Residents in Dongtan have frequent public transport, buses, or water taxis never more than 500 m away forming a convenient accessible integrated service. Fewer roads are needed per person, reducing the up-front capital cost of development, and road layouts are arranged to serve local houses and not provide through routes, improving safety for children and cyclists. People can walk or cycle on a network of dedicated routes through the abundant green spaces to get to work, go shopping, or go to school. Dongtan will serve as the gateway to the entire canal network of Chongming. Canals are a traditional feature of Shanghai developments, and a bustling web, carrying freight, passengers, and tourists, will serve Dongtan.

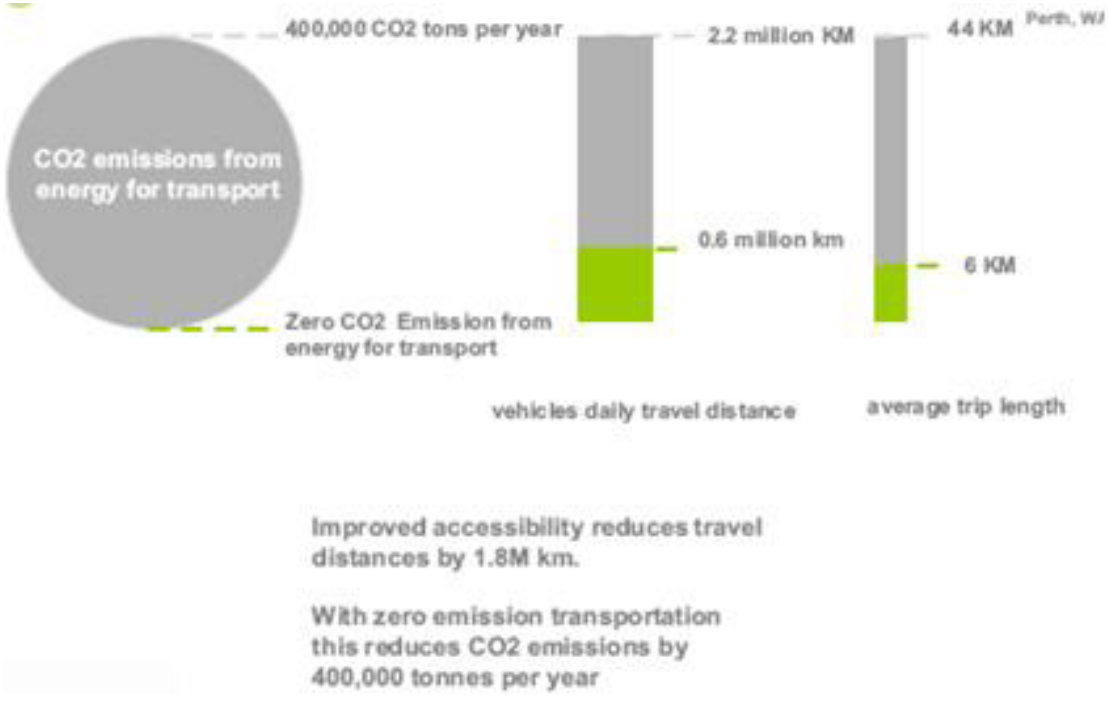

Figure 26. Accessibility and transport

3.6.3.8. Buildings

The buildings target low-energy designs, incorporating the following features.

(1) Modest window areas
(2) Building orientations optimized for the type of building, such as more glazing to the north to reduce cooling requirements
(3) Shading overhangs to minimize direct solar gain in the summer
(4) Passive cooling techniques using night ventilation provision coupled with exposed thermal mass to minimize cooling needs
(5) An airtight building envelope to reduce summer hot air infiltration and winter heat loss through draughts
(6) Entire structure contained within a thermal insulation "overcoat" building envelope to enhance thermal insulation and avoid envelope thermal bridging
(7) Internal heat gains minimized to reduce direct electricity use and the need for air conditioning
(8) Low-energy-rated domestic and commercial appliances, with labeling systems to assist purchasers and installers in selecting products with sufficiently low energy demand
(9) All electronics are designed with low standby power requirements [4]

3.6.3.9. Waste management

All waste in Dongtan will be reused or recycled, with minimal landfill. In addition to improving the current water supply, rainwater will be collected, recycled, and managed. Conventional cities of this scale currently consume an average of 500 tonnes of waste per year. It is estimated that Dongtan will consume an average of 30,000 tonnes per year (see **Figure 27** and **Figure 28**).

Green: Dongtan Gray: Conventional city

Figure 27. Waste management (1)

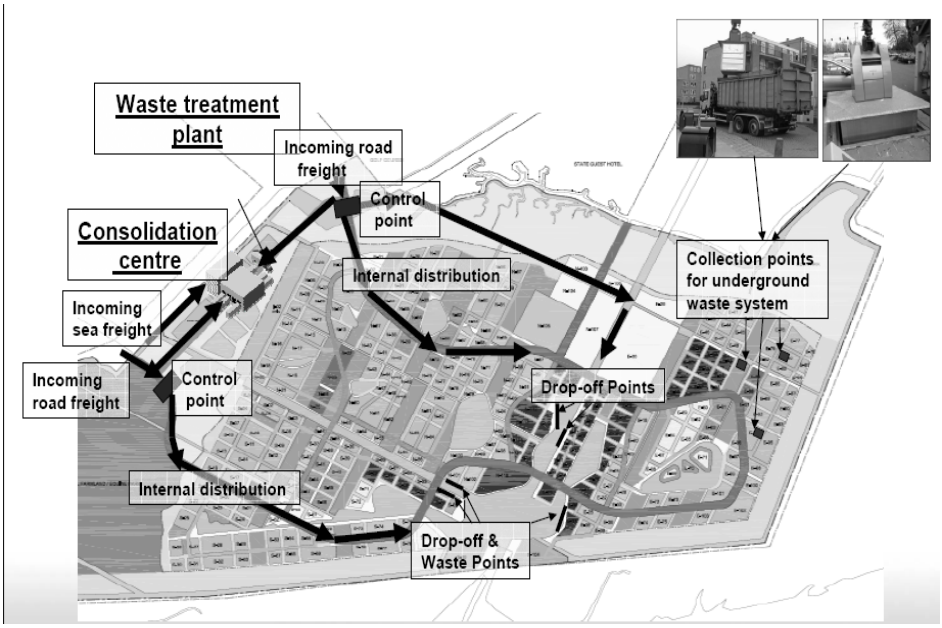

Figure 28. Waste management (2) (Briggs D)

3.6.3.10. Agriculture/city linkage

Local food, organically farmed on the retained agricultural land, will be available throughout Dongtan.

3.6.4. Social benefit

3.6.4.1. Mobility and access

Dongtan aims to attract companies focused on new technologies, food research and production, and healthcare. The developers plan to generate 50,000 jobs around Dongtan in tourism and research, focusing on a variety of "innovation-oriented industries."

3.6.4.2. Education

Schools are set up and available for people of any age in Dongtan. The workforce enjoys quality education, enabling them to become well-educated and creative workers.

3.6.4.3. Inclusion

Dongtan will provide plenty of open space for its residents, with 30 square meters per person. It will contain enough people to generate the critical mass needed for facilities such as hospitals, schools, jobs, and community groups. Keeping energy consumption for transportation to a minimum also requires the city to be compact and high density. In the city center, the intention is to have around 160 people per hectare, about four times lower than nearby Shanghai's central districts.

Contact with green spaces will be an everyday feature of life in Dongtan, with nowhere being more than a few minutes from a park. The condensed pedestrian centers will have easy access to farmland and parkland that will open out. A 142-hectare ecology park will be built to high standards in Dongtan, with a green area per capita of 27 m^2, surpassing London's 20.5 m^2 and Los Angeles's 6.6 m^2. People will enjoy a high quality of life largely dependent on the outstanding natural environment.

3.6.4.4. Health

High-quality health services can improve the urban ecological environment and protect citizens' health. Build-

ing hospitals that adapt to ensure social sustainability and the health of people is essential.

3.6.5. Economic benefit

It is expected that Dongtan will foster a vibrant and diverse economy, generating a rich variety of employment opportunities. It aims to attract people from a broad socio-economic spectrum who will contribute to a wide range of businesses. Dongtan will contribute to the region's sustainable prosperity by integrating economic development and environmental protection.

4. Conclusion

4.1. Challenges of sustainable development of urban-rural integration

4.1.1. Climate change and other environmental issues

Climate change is increasingly recognized as a significant threat, with predominant negative effects on the environment, quality of life, social cohesion, and economy. Sea-level rise, land desertification, climatic disruptions, and crop failures are among the consequences. As cities rapidly grow in number and size, and populations migrate, there is potential for unrest in the world's social and economic systems.

4.1.2. Global economic trends and urbanization

China's cities face common problems during urban development, exacerbated by the country's status as one of the most urbanized in the world, with a large population concentrated in cities and a high number of megacities. Additionally, China ranks among the highest consumers of energy and water resources globally and generates significant amounts of commercial and industrial waste.

As cities and their inhabitants increasingly recognize the significant impact of urban development, there is a growing urgency for action and solutions to address the unsustainable economic, social, and environmental problems created by human activities.

4.2. Sustainable development of urban-rural integration

The concept of sustainable urban-rural integration encompasses the ecological-economic and environmental-psychological aspects of urban-rural design and management. The overarching objective is to promote sustainable development of cities, addressing economic, social, ecological, and spatial dimensions.

4.3. Sustainable urban-rural integration design and development

The sustainable urban-rural integration plan and design should extend beyond the consideration of environmental, economic, and social factors. It should encompass aspects such as growth, green energy generation, transportation systems, community participation, land development, and ecological protection. This includes integrating sustainable technologies and management practices to ensure the holistic and long-term sustainability of urban-rural areas.

The elements of sustainable urban-rural integration design and development should include urban-rural planning and regulation, management of services networks (water, energy, communications, waste), transportation systems, natural environment preservation, planning policy development, regulations, codes, and standards, as well as fostering synergies and interactions between different sectors. These components are crucial for ensuring the comprehensive and integrated sustainability of urban-rural areas.

4.4. The case study of Dongtan

The overarching vision for Dongtan is to establish a world-class sustainable urban-rural integration that meets

the demands of global economic growth, demographic shifts, and urbanization trends, while simultaneously achieving environmental, economic, and social sustainability objectives.

4.4.1. Science and technology

4.4.1.1. Design principles and technologies

Dongtan is designed to embody environmental, social, economic, and cultural sustainability principles in line with the tenets of sustainable development. It encompasses various elements such as urban-rural design, transportation, buildings, waste and energy management, energy efficiency measures, flood protection, and more.

4.4.1.2. Dongtan sustainable development

The term "sustainable urban-rural integration" denotes its incorporation as a component of a comprehensive initiative aimed at reducing a town's environmental footprint. This objective entails the utilization of various eco-technologies in construction, energy production, water management, waste management, and other areas. The Dongtan sustainable project is advanced through the adoption of technologies and efficient management practices across environmental, social, and economic dimensions.

Disclosure statement

The author declares no conflict of interest.

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