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Feasibility Study of Songao's Low Carbon Town Planning, China

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Abstract

For the past two decades, low-carbon planning has been one of the main energy planning topics of research at both city and district scales. The attention has for long been on energy consumption reduction by alternative means (such as renewable energies), smart grid systems and measures of CO_2 emission reductions and climate change mitigation and adaptation. For developing countries like China, achieving these in a short period is a challenging task. For low carbon planning, there are measures of sustainability, mainly environmental, that can be considered at three scales of 'target plan', 'masterplan' and 'construction phase (or implementation)'; some of which are purely focused on energy sector and achieving low-carbon built environments. In here, some of these are studied as part of a feasibility study of a small-scale low carbon town planning case study in Zhejiang Province, East China. This paper is based on a research case study and is divided in to three sections, case study introduction, case study analysis, results and discussions. The conclusions are made based on outcomes of the conducted feasibility study for the case of Songao's low carbon town planning. More importantly, this study highlights the importance of feasibility study for low carbon planning projects and also argues in favour of pre-assessment case of research prior to planning and implementation phase.

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Keywords: Low Carbon Planning; Pollution Dispersion; Energy Planning; Sustainable Development; Sustainability Measures.

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1. Introduction

In planning, low carbon strategies are often driven at city scale, while they appear more feasible and progressive at a smaller scale of district or town level. In this respect, we can argue that the main reason of not meeting the objectives of low carbon planning is often the large scale approach, which also limits possibilities for flexibility and adaptation of strategies during the implementation phase. As a result, there are often disparities between the proposal and the final implementation. A considerable factor is the economic factor, which is often related to lack of budget or/and uncertainty in securing investment for sustainable continuation of the development. Moreover, the lack of adaptation in such process is due to large scale planning and lack of flexibility in decision making.

Cities are far too complex to integrate all low-carbon aspects at large scale while aiming to minimise GHG emissions, implement strategies for production of green energy and materials, dispose and recycle efficiently, and remain economically viable at a same time (Cheshmehzangi et al, 2010). Therefore, there is often a complex contradiction between environmental and economic factors of sustainability, particularly in the context of developing countries where economic growth is a priority. At a city scale, majority of such strategies are widely dependent on advanced technologies and are often cost effective. On the other hand, at a smaller scale, we have existing global examples of rural villages and towns that are either self-sufficient or with least impact on the environment or climate change. In this study, however, the focus is on one particular low carbon town planning case study in the context of East China. As part of a multi-disciplinary research study, this paper focuses on findings at three levels of: a) environmental performance; b) proposal analysis; and c) implementation framework. This study is conducted through simulation and analysis of the case study, calculation of daily and annual CO_2 emissions from the main industrial pollution sources with the impact on existing and new zones, and development of a framework for the future steps of low carbon town planning development. Success stories in the field of low-carbon town planning focus on three aspects of: 1- community energy (TCPA & CHPA, 2008); 2- planning practice for renewable and low-carbon energy (DCLG, 2013); and 3- integrated design and planning. The first two are focused on energy domain with potential emergence in the latter, which is proposed through a feasibility study as in this research paper.

This paper demonstrates the importance of feasibility study for low carbon town planning projects, particularly that such projects are often taken place without long-term plans and strategies. This study also demonstrates the effectiveness of environmental simulation for pollution dispersion and the wind environment and how such data enables a better decision making in planning. Such simulation also highlights the current status of the area before taking any consideration for a new zone development. This study focuses more on low-carbon planning aspect of the project and pollution issues than energy systems that are partially discussed at a later section. However, the two factors of low-carbon planning and deployment of energy systems are greatly interlinked. Furthermore, the planning part remains a substantial stage as it can be considered as a precursor to any energy solution that may be implemented at a later stage of detailed design.

2. Case of Songao's Low Carbon Town Planning, China: Feasibility Study

2.1 Case Study Introduction

Songao is a small town in the Southern region of the City of Ningbo, Eastern coast of China. At township level, future development plans of Songao are focused on a new development zone, which is

proposed as a low-carbon town at the costal part of the area. In a larger scale, majority of the area is mountainous with highest peaks towards North and West and up to 500m high from sea level (located at North of Songao town). With South-Easterly summer and North-Westerly winter wind directions, the area has a fairly moderate weather conditions. Nevertheless, the area has major pollution sources from the northern side and coastal areas, covering a substantial part of the area.

Fig. 1. Mock-up model for 'the new development zone and existing town and industrial areas' in the context

Songao's new development zone is a proposal for a larger scale, but less compact, area of a low-carbon town towards the Southern region and coastal part of the existing town. Currently most of these lands are allocated for fisheries and aquaculture. The intention for planning of this new low-carbon town is to provide better living quality environments, tourist attraction to the area and more income generation for the region. The proposal for low carbon town would require inclusive strategies for 'renewable energy and energy efficiency' (REN21, 2010), smart grid, and integrated built environment and design.

2.2 Case Study Analysis

The initial model of the assessment was conducted based on three criteria of: 1) heights (both natural and the built environments); 2) layout of both the existing and proposed built environments; and 3) environmental performance based on the existing conditions. Due to the area's geographical features, particularly as it is a combination of a mountainous context, a fairly flat area of development, and a coastal zone, the simulation of the wind environment and pollution dispersion is more complicated than initially anticipated. The study of pollution dispersion was proposed as part of the initial feasibility and assessment study of the existing conditions prior to planning of the new low-carbon town (figure 2). Also proximity and type of main pollution sources were assessed as part of the overall analysis for the impact of pollution dispersion on the new development zone (figure 3).

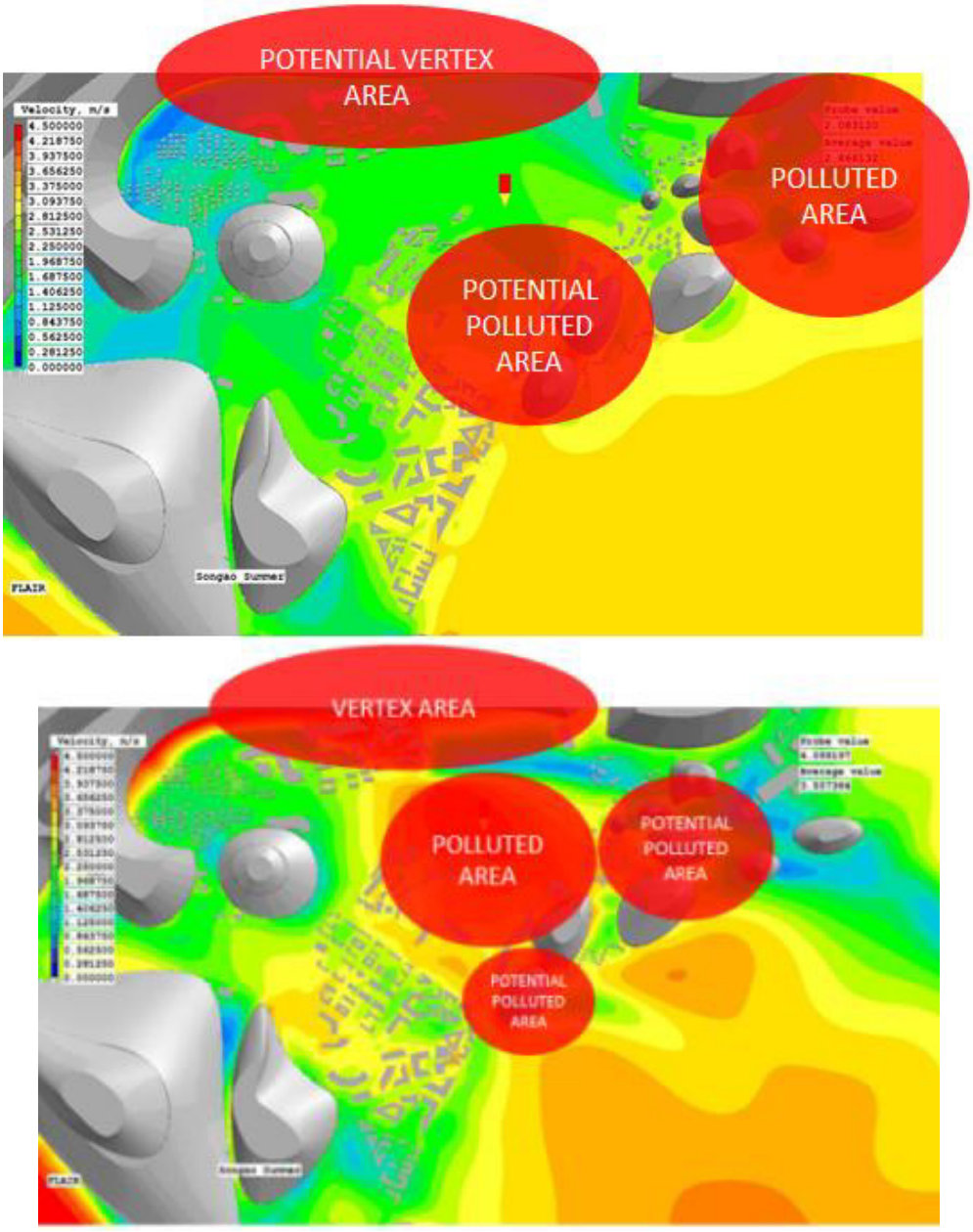

Fig. 2. Pollution dispersion simulation for winter (above) and summer (below) seasons and identification of polluted areas and potential vertex areas

Based on the analysis of main industries in the area, the overall daily CO_2 emission from 24 main sources were calculated at approximately 480 tons per day (or more than 175k tons per annum). This is a very significant amount for such small area, bearing in mind the existing and new development zones are both located at basin of a mountainous area. The likelihood of pollution dispersion is even higher with

this geographical condition. The calculation is based on types of sources of pollution (e.g. from diesel, petrol, etc.) and the annual production of industries as point sources. This is then calculated to estimate the overall annual and daily CO_2 emission for each main industry in the area.

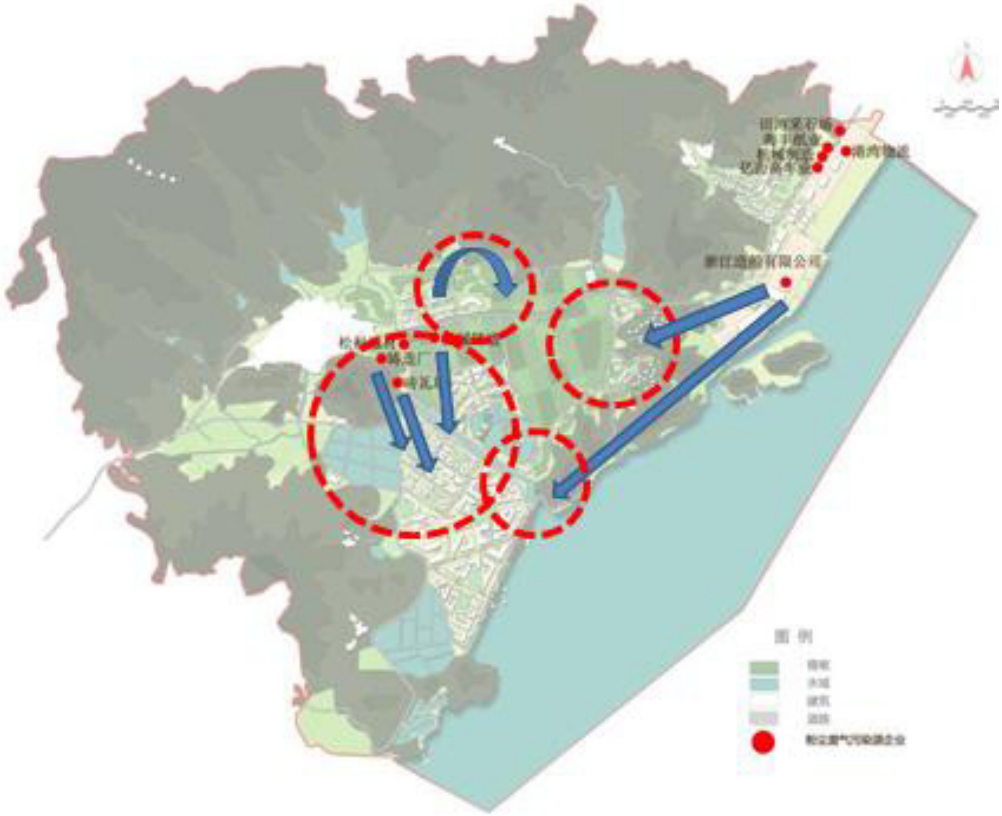

Fig. 3. Proximity of major industrial areas and main pollution sources to new development zones and potential polluted areas with the current situation and location.

Furthermore, the analysis included propositions for low-carbon planning and strategies with focus on energy planning of the proposed low-carbon development. An overall analysis was provided based on China Energy Efficiency and Green Energy Financing Programme's three key aspects of 'incentives', 'technical assistance' and 'financing' (2015). The proposed action plan followed 'key areas of pollution prevention and control measures', as means of achieving low-carbon development. Finally, the focus for the case of Songao has been on five central dimensions of:

1) Optimisation of energy mix – this is crucial for town and rural areas and industrial zones (of China);

2) Emission reductions - particularly from industrial sources and power sectors, where majority of economic development is concentrated in the region and is also expected to remain the same for the following years;

3) Technological innovations – for future implementation of grid systems, building services and energy use reduction; 4) Improvement of environmental standards – where the impact is significant on livelihood of the area;

5) Strengthening policies on environmental monitoring and pollution with measures on achieving low carbon economy for the wider context.

Furthermore, an integrated framework for energy planning was proposed as part of the overall green energy and energy efficiency strategy of the development areas.

3. Results and Discussions

In this study, the feasibility study of Songao represents a case of multiple dimensions. First, the requirements for relocation of existing industrial units that are the main economic mechanism in the region would seem rather impossible. Second, the proposal for a low-carbon town planning appears unusual for such context with mixed industrial pollution. This perhaps becomes more feasible when the first objective of industrial relocation (or reduction) occurs in a short-scale timeframe. Furthermore, a framework is provided with three timeframes (short-term, medium-term and long-term) to demonstrate implementation strategies and potential [low-carbon] achievements for the proposed town (Table 1).

Table 1. Framework for the proposed low-carbon town

Phase	Implementation Strategies	Potential Achievements
Phase 1, 2-5 years	Relocation of major polluting industries or finding alternative modes of production	Substantial reduction of pollution and industrial activities towards low-carbon energy production & security
Phase 2, 5-10 years	An integrated planning for the new development zone with comprehensive analysis of ecological and environmental dimensions with a smart grid system	Development of a phasing plan with right implementation of green technologies, energy systems and towards a Low Carbon Economy (LCE) plan; District energy planning
Phase 3, 10+ years	Extension on low carbon strategies based on the overall growth plan and climate change mitigation strategies	An integrated model of a low-carbon town planning with sustainability measures; Integrated framework for energy planning.

While the shipyard remains as the most polluting industry in the area, the measures to reduction of CO_2 emissions are: 1- making a more energy-efficient and green production system; 2- relocation of some of the production, such as fixing and painting; and as a result, decentralising some of the activities to reduce the overall impact of the factory in the area; and 3- the feasibility to utilize [more] renewable energies, such as wind turbines or wave turbines as energy sources of the new development zone. In addition, the proximity of several factories is very close to the new development and the existing town. Although pollution (particularly air pollution) may appear minimal, it is suggested to consider green production system to reduce the amount of pollution dispersion in the area, which over time becomes more critical. As the central area (i.e. between the existing and new zones) experiences the highest rate of pollution (particularly in winter), further design considerations need to be given to the new proposed housing and/or villas, including careful spatial arrangement, topographical considerations and the overall

built form. This will partly help to reduce the impact in the living environments but is not advisable at the planning level. Furthermore, the framework enables the authorities to prioritise key parameters for new development, as well as consideration of existing situation and the phasing plan. A detailed plan (on new clean technologies) can then be implemented as part of the overall planning process.

Decarbonizing the built environment is a major challenge for planners and policy makers, but is also a major factor to achieving low carbon development. For the case of Songao, the process is more complicated due to the existing polluted conditions, mainly from heavy industrial production in the area or in the vicinity. For this case, we can summarize the decarbonization process in two parallel scenarios of: 1) economic; and 2) environmental. Each parallel scenario is divided into two parts of 'existing' and 'new', as the new zone development cannot solely develop the area in to a low-carbon development. Table 2 below summarizes the proposed two parallel scenarios.

Table 2. Proposal for two parallel scenarios for decarbonization process of Songao Area

Scenario	Decarbonization process
Economic	A. Consideration of the existing This should mainly occur in the proposed phase 1 (as shown in table 1). B. Development of new industries This should occur in the proposed phase 2 and get enhanced in phase 3.
Environmental	A. Cleaning up the existing and reductions This should mainly occur in the proposed phase 1. B. Enhancement of efficiency for the new This should occur in the proposed phase 2 and get enhanced in phase 3.

This parallel proposal aims to develop two cases of 'balancing' (for CO_2 emissions) and 'enhancement' (for sustaining the economy in the area); both of which are essential for the sustainability of the existing and new development zones, and ideally towards a Low Carbon Economy (LCE) strategy.

The concept of low carbon development (mainly low carbon city) is no longer new in China and has been developed since its first introduction in 2007. However, this study proposes for feasibility assessment of a low-carbon town planning case, which is not previously done in the context of China. At most occasions, proposals are given based on aims and objectives of the new development zone, but not necessarily based on the existing conditions of the area (i.e. prior to any new added development). Therefore, this study highlights the importance of feasibility study prior to planning stage, details design and the construction phase. Finally, we can argue that the pace of development and phasing planning should go under further revision for similar cases of development in the future.

4. Conclusions

While the case of Tianjin's explosion in August 2015 initiated conspiracies about mixed planning of industrial and residential zones, there still remain many new town planning developments with a similar trend of mixed planning zones that are not necessarily sustainable or physically resilient. In here, the low

carbon approach to planning of Songao's new development zone need to occur at both ways of top-down and bottom-up with planning and design meeting each other at various levels.

The given suggestions are more towards a Low Carbon Economy (LCE) strategy, which is efficient and environmentally sound for a more sustainable development; thus, should be considered as the backbone of low-carbon planning and decarbonization process for both the existing and new zones. However, global examples demonstrate that low carbon societies are usually not populated or heavily industrialised. The later still remain as a major challenge for this region where majority of the economy is dependent on industrial production, some of which are globally known such as the neighbouring shipyard for vessel manufacturing. In here, a framework is provided for a step-by-step low-carbon development; for policy makers to be able to make the right decisions; and for planners/designers to be able to make the right approach for a low carbon sustainable development.

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Biography

Dr Ali Cheshmehzangi has qualifications, practice experience and a research profile in urban design, sustainable urban planning and development. He currently works at The University of Nottingham Ningbo China. He is also a founder member/director of International Network for Urban and Rural Research (INURR) in China.