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## A simulation-based research on passive district

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### Abstract

This paper is aiming to propose a new design concept named passive district which assists designer to improve district energy efficiency and reduce energy demand by smart urban design without mechanical dynamics method. Furthermore, specific simulation-based experiment is implemented to demonstrate the research methodology on correlation between urban form and energy performance, in which the workflow is summarized as follows: definition of constants and variables, modeling, simulation, data sorting and decision making. This urban modeling integrates the morphological factors together including grid size, floor area ratio, cover ratio, passive zone ratio, surface to volume ratio and so on and compares the energy impact respectively. Particularly a method of multi-disciplinary design optimization (MDO) is applied to analyze how multiple factors affect energy use comprehensively and support scientific decision making. Finally, as conclusion the application potential of passive district is discussed.

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*Keywords:* Urban form; Energy consumption; Passive district; Multi-disciplinary design optimization; Simulation

### 1. Introduction: from architecture to district

Design strategies for green architecture can be categorized into two branches, passive design strategies and active design strategies. Passive architectural energy-saving technique is strategy that utilize no or very few mechanical devices but passively absorb or directly utilize renewable energy to reduce energy consumption [1,2]. Energy issue is the core to distinguish passive technique and active technique.

Energy consumption in building, however, is not only influenced by building performance but also inevitably influenced by surrounding urban context or natural environment. These influences consist of shading from adjacent buildings, the air ventilation condition determined by urban structure, urban heat island effect, etc. In other words, even the same building may perform obviously differently when locates in high-density are and low-density area. Only considering of single building in simulation without

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impact from urban context would result in great inaccuracy. Fortunately the concept of ecological district originating from New Urbanism makes people rethink the energy issue in district level comprehensively, the middle scale between architecture and city. On one hand, district is the fundamental unit that connects urban space with human sense, providing us with integrated environment experience; on the other hand, comparing with the entire city, district is easier to be realized and controlled for development.

This research is aiming to propose the concept and define the research framework of passive district and take an experiment based on ideal model simulation in the climate condition of Shanghai as examples to explore the correlation between urban form and energy use. The research methodology on energy-efficient urban design is established during the process.

## 2. Research question

### 2.1. Concept definition

Passive district is defined as that in the planning process the district utilizes no or very few mechanical dynamic equipment but passively absorbs or directly utilizes renewable energy to reduce transportation energy, infrastructure energy and building energy in terms of achieving energy efficiency. It is required that the performance of impact factors, such as district capacity, structure, texture, building typology, urban mixed use and other related aspects, should be evaluated and compared with its competing alternatives respectively according to human behaviors and interior and exterior climate adaptability so that the feedback can be used to direct design optimization.

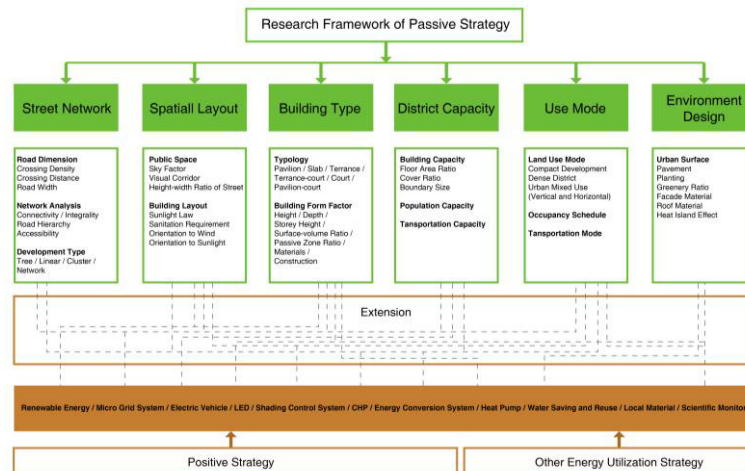


Fig. 1. Research framework of passive strategy

### 2.2. Research framework

From the perspective of urban planning, the concern towards passive neighborhood is supposed to address three questions as follows. The first question is how to build up a scientific model on the scale of district to analyze the correlation between urban morphological factors and energy use. The second one is how to instruct and optimize complicated urban design by methods of performance analysis to drive the urban form generation basing on ecological concept. The third one is how to set up a feasible research procedure of experimental research and knowledge accumulation for design optimization according to local climatic environment.

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