



The promise and the performance of the world's first two zero carbon eco-cities



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ABSTRACT

In recent years two major attempts have been made to develop 'eco-city prototypes' the Dongtan City in China and the Masdar City near Abu Dhabi. Both attempts have revolved round the premise that advanced post-modern technology, innovative urban planning, reliance on renewable energy, and emphasis on 'total' reuse can combine to achieve 'zero carbon-zero waste' existence. The plan of the two cities had also integrated strong business interests into the system, aiming to make 'zero carbon-zero waste' a kind of catch-phrase or a fashion statement that would enhance the value of the real estate the two eco-cities were planning to offer.

The paper recapitulates the objectives that were set and assesses the present status of realization of those objectives. There is an already substantial and widening gap between the promise and the performance in both the cases; the review identifies the gaps and the possible reasons of their occurrence. It is highlighted that the expectation of a zero-waste existence is inherently flawed because the Second Law of Thermodynamics makes it impossible to attain.

The paper brings out that no 'eco-city' concept can be translated into reality unless and until the inhabitants of the eco-city are prepared to voluntarily and consistently observe certain restrictions on resource consumption and to sacrifice some of the basically illusory but highly fancied 'comforts' which drive consumption in conventional habitations. It follows that many of those measures that are sought to be introduced in the eco-cities to make them cleaner and greener can very much be implemented in existing cities if only the same extent of voluntary participation from the lay public can be invoked that is expected in the 'eco-cities'.

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1. Introduction

Living within fully closed material cycles—in other words living in a way that incoming solar energy is the only source of all energy consumed and no material is 'wasted'—is an enchanting dream.

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This dream was initially, and still is, pursued by space scientists [1–3], who aim to create human-centric mesocosms or 'life-support systems' within spaceships [4–6]. The hope has been that such mesocosms would enable human beings to live for several months or years on spaceship even when there is no possibility to supply them with the life's essentials from the earth, and when solar radiation is the only external source of energy available [3,7].

The tides of environmental consciousness that began sweeping across the world from the late 1960s onwards generated interest in the protection of the earth's ecosystems and the dream of 'zero waste' existence began to be pursued for terrestrial living as well [8]. But before mankind could develop a single truly 'zero waste' technology it is being challenged by the existing-threatening rise in global warming. This has led the catch-phrase to be modified into 'zero waste—zero carbon' existence.

Whereas attempts to set-up 'zero emission' buildings—such as the Adam Joseph Lewis Center at Oberlin College, Ohio, [9] 'zero emission' villages—such as the bioenergy village Juhnde, Germany [10,11] and low emission townships—such as the New Songdo City, South Korea [12,13] have been made from time to time. The Dongtan and the Masdar City projects have distinguished themselves by the scale of 'clean living' they had aimed to achieve when they had begun.

This paper charts the history of the two eco-cities. It begins with a recapitulation of the eco-city concept and then discusses the two eco-cities from the point of their conceptualization to the present state of their development.

2. The eco-city concept

The term 'eco-city' was reportedly coined during the winter of 1979–80 by the members of a voluntary organization Arcology Circle [14]. The term features prominently in a 1987 book [15] and is used interchangeably with the term 'sustainable city' [16]. The concept was proposed way back in 1898 [17–19] in the name of 'garden city' and has been described [20] as a city which 'is organized so as to enable all its citizens to meet their own needs and to enhance their well-being without damaging the natural world or endangering the living conditions of other people, now or in the future'.

Given that terms like 'sustainable', 'clean', 'green', or 'zero-emission' living are used rather fuzzily in scientific literature, often meaning different things in nature or degree to different authors, it is difficult to give a precise definition to the derived terms like 'sustainable city' or 'eco-city' which are themselves derived from imprecise terms [20]. The following ten attributes have been assigned to eco-cities [21,22]; they—

- (1) should have land-use priorities such that it creates compact, diverse, green, and safe mixed-use communities around public transportation facilities;
- (2) should have transportation priorities such that it will discourage driving and emphasize "access by proximity";
- (3) should restore damaged urban environments;
- (4) should create affordable, safe, convenient, and economically mixed housing;
- (5) should nurture social justice and create improved opportunities for the underprivileged;
- (6) should support local agriculture, urban greening, and community gardening;
- (7) should promote recycling and resource conservation while reducing pollution and hazardous waste;
- (8) should support ecologically sound economic activities while discouraging hazardous and polluting ones;
- (9) should promote simple lifestyles and discourage excessive consumption of material goods;

- (10) should increase public awareness of the local environment and bioregion through educational and outreach activities.

In a word, a sustainable city should be able to feed itself with minimal reliance on the surrounding countryside, and power itself with fully renewable sources of energy, thereby creating little or no ecological footprint. A sustainable city would use land with maximum possible efficiency and cleanliness, generate minimum possible waste and then fully recycle and reuse what it does generate. It would offer more space for people in a scenic, safe, quiet, rejuvenating and healthy environment.

These are all noble goals of an utopian existence and are certain to benefit humankind if only humankind can create and maintain the utopia. But wisdom of hindsight tells us that there are far too many cross-currents, layers, hues, aspirations, perceptions, and the resultant conflicts in the human societies to maintain any ideal state for long. Even the perceptions of what is ideal vary greatly from individual to individual, society to society, region to region in both time and space [20,23–25].

Interestingly many features which an eco-city is sought to have are the ones which have distinguished rural existence down the ages [24,26]. Classically, rural settling patterns have been such as to provide easily walkable access of the residential dwellings to public utilities like shops, schools, and prayer-houses. Villages have also relied almost exclusively on renewable energy in the form of biomass or biomass-derived charcoal as fuel, windmills, and watermills [7]. There was proximity to nature; wildlife and forest produce were used for human benefit but with sufficient moderation for it to remain sustainable. The relatively less sedentary and more socially well-knit existence generated lesser life-style diseases of the body and the mind. The village itself produced most of what it consumed and disposed its waste locally. Most of the biodegradable waste—which now goes to trash bins and then landfills or incinerators—was composted and returned to soil. The villages existed in a low-carbon, low-waste mode if not a zero-carbon, zero-waste one. The only apparent difference is that the eco-cities aim to realize all the positive features of a rural existence and yet aspire to maintain the dizzying pace of economic advancement which has brought great development alongside great eco-degradation in megacities like Shanghai and Mumbai. The cities of Dongtan and Masdar were conceived to achieve the union of the two apparently irreconcilable growth models.

3. Dongtan city, China

Dongtan was the first to break ground. In the publicity blitz that was mounted in 2005, Dongtan was projected as the 'world's first-ever zero carbon eco-city' [27,28]. At its initiation, on 9 November 2005, when China's Shanghai Industrial Investment Company (SIIC) and the British firm Arup signed an agreement to develop Dongtan, the British Premier and the Visiting Chinese President were in attendance [30]. This underscored not merely the uniqueness of the Dongtan initiative but the enormous profitability such a venture was perceived to carry at that time in terms of generating a hugely attractive and novel brand image.

The location chosen for Dongtan was the 86 Km² Chongming Island which is situated at the mouth of the mighty Yangtze River [27,31]. Like all other small islands, Dongtan also sports very rich and *fragile* ecological sub-systems. Its 6.3 Km² marshy eastern tip which was identified to be developed first, as a 'demonstration zone' for what the Dongtan eco-city concept stood for, is a migratory stop for several rare and threatened avifauna [32–34], including one of the rare water-bird species in the world—the black-faced spoonbill [14,35]. But this was not the reason for the choice of the Dongtan site; it, rather, was the Chongming Island's

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