

Eco-city Planning: Pure Hype or Achievable Concept

Belinda YUEN
Singapore University of Design and Technology
Singapore

Synopsis - This paper seeks to investigate the case city of Singapore. In particular, it examines the planning and development of the Punggol eco-town through documentary research and onsite observation. The paper will interrogate the key strategies, results, lessons learned and replicability of Singapore's eco-city planning. The analytical lens is on illuminating the strengths and weaknesses of eco-city planning.

1. Introduction

Against the speed of urban expansion and the global push for sustainability, making existing cities and new urban development more ecologically based and livable has become a priority in an expanding number of countries around the world (Joss, 2012; UN-HABITAT, 2009). A similar growth trajectory is emerging across Asia, from China to India, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore and Vietnam even though the challenge is to mainstream sustainability in development plans and policies. Among Asian countries, Singapore seems to have assiduously promoted ecological modernization, which seeks to promote economic growth with environmental improvement.

As encapsulated in a series of government documents (especially after Singapore has committed itself to becoming a party to the Kyoto Protocol in late 2006), for example, in the 2009 Inter-ministerial Sustainable Singapore Blueprint and 2011 long-term Concept Plan, the aim is to plan for a sustainable Singapore. This will be effected through an environmentally responsible and sustainable approach to development where future development balances economic growth with environmental stewardship and social harmony. Sustainable development is not an after-thought in Singapore. It is an integral aspect of the urban planning process where the inherent circularity of the physical processes of resources, activities and residuals must be managed effectively while providing wellbeing and quality living. Towards this end, Singapore is developing the Punggol eco-town (2011) as a prototype for its future public housing development.

Even though the notion of eco-city planning is not new in international urban planning literature, it is being applied to the whole of government and all the actors of Singapore's community including households and businesses. Sustainable development is promoted as a way to grow Singapore more efficiently (to develop with less resources and waste), cleanly (to develop without polluting the environment), and green (to develop while preserving greenery, waterways and natural heritage). The approach is to introduce effective *planning and design* concepts to make it conducive for residents to adopt eco-lifestyles, exploit *urban solutions* to achieve stretched environmental targets, and engage, educate and enable *people* to be an integral part of the 'go green' efforts.

This urban planning paradigm shift can have far reaching effect at several levels. At the local level, public housing, at least in the Singapore context, is where the majority (over 80%) of

Singaporeans live. At the regional and international levels, Singapore's urban planning and development has been increasingly regarded as an inspiring model for many developing countries (Yeung, 1987; Yuen, 2011). In recent decades, Singapore has been exporting this urban knowledge. It is building eco-cities in the region in collaboration with local partners (e.g. Tianjin eco-city in China) while emphasizing that Singapore acts as a 'living laboratory' aimed at incubating and displaying new 'smart' environmental technologies and sustainable development urban solutions. Using the case study of Punggol eco-town, this paper will interrogate the key strategies, results, lessons learned and replicability of Singapore's eco-city planning. The analytical lens is on illuminating the strengths and weaknesses of eco-city planning.

2. The Basic Ideas of an Eco-city

An eco-city is developed as an aid to mainstreaming sustainability in urban development at the neighbourhood level (Kulshrestha, 2007). Its goals are to maximise (e.g. respect for nature) or minimise an attribute of urban planning (e.g. demand for land, transport or energy consumption). Its roots can be traced to the early work of the 19th and 20th century planning pioneers such as Lewis Mumford, Frederick Law Olmsted, Patrick Geddes and Ebenezer Howard who have variously argued for planning and building cities more sustainably while preserving nature and ecological surroundings (Mumford, 2004; Hall 1996).

As early as 1898, Ebenezer Howard has promoted the concept of developing 'garden cities' with carefully balanced areas of agriculture, industry and residences, surrounded by greenbelts. Patrick Geddes and Lewis Mumford, for example, have advocated the idea of an organic city where cities as living organisms evolve as they adapt to a changing environment while Ian McHarg developed the concept of ecological planning and a multi-layered approach on the regional scale with an ecological orientation to explicitly connect ecology theory to planning and design practice, thus laying yet another integration of human and natural environments in urban development, especially in Europe.

In the USA, since the mid-1970s post-oil crisis, the importance of compact urban structure, building with nature and other city planning approaches in saving energy and resources has been emphasized by Urban Ecology, a Berkeley-based non-profit organization, which later went on to coin the term 'eco-city' to address the sustainability of city development (Register, 2002). The advocacy is to 'rebuild cities in balance with nature'. In recent years, as urbanization deepens and greening urban growth becomes ever more urgent, there is renewed attention on the eco-city concept and practices (Susuki et al, 2010). The vision of eco-city is no longer a city architect's imagination but increasingly grounded in research and science of sustainability (Wong and Yuen, 2011).

Eco-cities are being built in different parts of the world, from North America and Europe to the Middle East and Asia. In the United Kingdom, the proposal is to build 10 new eco-towns by 2020 (Morris, 2011). The intention is to offer an opportunity to promote sustainable living and zero-carbon development while also maximising the provision of green space and potential for affordable housing. In the Middle East, Abu Dhabi is developing the world's first carbon neutral city, Masdar (US\$22 billion project). Masdar (6 sq km) is planned for a population of 45,000 to 50,000 with standards in green living that include clean power, desalination plant run on solar power, magnetic trains for transportation (cars are not welcome) and 100% waste recycling.

In Asia, China is embarking on a programme of building eco-communities. Eco-city building is proposed for not just the big cities like Beijing, Shanghai and Tianjin but also the small- and

medium-sized cities of Yuxi, Weihai, Rizhao and Changshu, among others. Many countries have offered to help China develop eco-cities. The most advanced of these developments is the 30 sq km eco-city at Tianjin for 350,000 residents, which started in 2007 as a joint collaboration between the governments of China and Singapore. The aim is to achieve harmonious living with man, economy and environment and on a wider scale, for the Tianjin eco-city to become a development model for other Chinese cities.

Eco-cities would characteristically comprise compact, pedestrian-oriented, mixed-use neighbourhoods that give priority to public transport and re-use of land (Roseland, 1997; Engwicht, 1992). They are designed with the consideration of socio-economic and ecological requirements dedicated to minimizing the inputs of energy, water and food, and waste output of heat, air pollution, etc so as to create an attractive place to live and work. It is not uncommon for eco-cities to have goals such as to minimize demand for land, particularly for greenfield sites, to minimize primary material and energy consumption, to optimize interaction with municipal and regional material flows, to minimize impairment of the natural environment, to maximize respect for natural context and to minimize transport demand, among others.

But, building eco-city also implies building a culture for change that is based on ethical behavior, social responsibility and clean capital so as to maintain a harmonious and non-exploitative relationship with the biosphere. The UK Sustainable Development Commission (2011), for example, has reported that the concept of sustainable lives is as yet not well understood among UK government officials and experts interviewed. The lack of definition, direction and vision for sustainable lives is a major challenge, especially when coupled with an overwhelming predominance of consumerism within present society and the mixed messages from inconsistent or contradictory policy decisions that create confusion and worse, undermine existing buy-in towards more sustainable behaviours.

3. Punggol Eco-town

Singapore, located 1° north of the equator in Southeast Asia, is an island-state with a land area of 714 km and a population of 5.3 million. Since 1960, its resident population has been progressively resettled from the once pervasive slums and squatter settlements to live in high-rise, high-density self-contained public housing new towns. By the 1990s, the city is almost slum-free. Still, as with many other fast growing coastal cities, Singapore faces several potential vulnerabilities including coastal land loss, increased flooding, water resource scarcity, increased energy demand, urban heat stress and public health threats (e.g. dengue, haze). Many parts of Singapore are less than 15m above sea level.

Recognizing that the environment is critical to economic growth and long-term development, Singapore has adopted an action-oriented approach to sustainable development with emphasis on long-term vision, integrated urban planning, sound environmental policies and high regulatory standards. For instance, in the transport sector, private vehicle ownership and usage are controlled to reduce energy consumption and traffic congestion. The Inter-Ministerial Committee for Sustainable Development (2009) formulated a blueprint with extensive public inputs, setting targets in several priority areas:

- Improving resource efficiency (e.g. to achieve a 35% improvement in energy efficiency from 2005 levels by 2030, attain a recycling rate of 70% by 2030, reduce domestic water consumption to 140L per person per day by 2030);

- Improving quality of the urban environment (e.g. to reduce level of fine particles in the air to 12µg/m³ and cap SO₂ levels at 15µg/m³ by 2020 and maintain same levels up to 2030, have 0.8 ha of green space for every 1000 persons and increase greenery in high-rise buildings to 50ha by 2030, improve accessibility for pedestrians and cyclists and have 70 per cent of all journeys made by public transport);
- Developing knowledge (to build key capabilities and technologies, especially in resource efficiency and urban planning and design and to develop Singapore as a knowledge hub and provider of services relating to environmentally sustainable urban development); and
- Encouraging community ownership and participation (to make environmental responsibility a part of Singapore's people and business culture, e.g. schools to step up their efforts in promoting environmental education, public sector to adopt more environmental sustainability practices).

The government has committed to invest S\$1 billion over five years to support these efforts including helping businesses reduce the upfront costs of investing in resource efficient buildings, systems and processes. Buildings will be made more energy efficient. Developers are encouraged to build green buildings and since 2005, their efforts are recognized through the Green Mark Scheme. The goal is to have 80% of buildings certified with Green Mark by 2030. For existing buildings, an S\$100 million Green Mark Incentive Scheme has been introduced to help owners undertake energy efficiency retrofitting. The government will take the lead by developing eco-friendly public housing. Solar technology will be piloted at 30 public housing precincts across the country. The Housing and Development Board (HDB) as Singapore's public housing authority and largest residential developer will reduce energy use of common areas in public housing buildings by 20-30% and build more eco-friendly public housing starting with development along Punggol Waterway in Punggol New Town.

Since its establishment in 1960, the HDB has constructed 23 new towns and more than 1 million residential units and a substantial volume of related commercial, industrial and institutional facilities. As early as 2004, the HDB has established a Committee on Environmental Sustainability, comprising representatives from public and private sectors, to formulate a long-term strategic direction and forward planning for the development of environmentally sustainable public housing towns. It has committed to having all its new projects Green Mark certified since 2007. A review of the HDB Green Housing Book (2007) revealed a combination of passive and active approaches towards creating a sustainable environment including:

- Creating a better environmental quality through design in retrospect to the site (taking account of the locality, existing topography and accessibility), design for comfort living (through passive design and facilities provision, e.g. greenery, pneumatic refuse collection system, low volatile organic compound paints to achieve acceptable air and noise quality) and earth control measures at development sites (through erosion control and sediment control);
- Achieving energy efficiency largely through the use of zero-energy and low-energy systems in every possible areas, e.g. designing in relation to nature, greenery provision (e.g. vertical greening), building elements such as building form and orientation with the windows facing North-South and gable ends facing the East-West direction, façade articulation, wall design (e.g. cool wall) and effective exterior envelopes, maximization of natural lighting and ventilation, monitoring of energy usage, low energy consumption systems and alternative energy;
- Promoting water conservation and reuse in view of Singapore's water resource shortage, starting from the design of water distribution system to the water fittings installed and more recently, the introduction of water sensitive urban design;

- Improving resource materials in the construction of buildings through design consideration (e.g. standardization of doors and windows), alternative construction, alternative materials, recycled materials and construction modularization by testing green technologies and innovations in its building developments.

On 28 March 2007, it started building an eco-precinct - Treelodge@Punggol (completed on 19 December 2010) as a pilot project to demonstrate that innovation and sustainable development can be both practical and cost-effective. The precinct comprises 7 16-storey apartment blocks with 712 units of 3- (98), 4-(600) and 5-room (14) flats. As with earlier developments, the basic unit of planning is the neighbourhood where the daily needs of life are accessible within 5 minutes' walk but with a strong urban design focus on public spaces, making the neighbourhood not only walkable and liveable but also improving human scale and the sense of place.

3.1 Starting with Eco-precinct

Treelodge@Punggol, a build-to-order public housing scheme, is designed with triple aims - to lower maintenance cost, to meet environmental targets in energy, water, etc and to enable the community to experience eco-lifestyle. The precinct is designed to harness the elements of nature (e.g. daylight, rainfall and wind) and technologies to promote sustainable green living. It incorporates passive design as well as a range of green technologies and innovations for effective energy, water and waste management. The 7 residential blocks are designed with a podium car park across their 1st storey where the roof of the car park is landscaped into an eco-deck, transforming it into an activity centre, a connector with a green spine connecting all precinct amenities and to public transport nodes and a large green footprint. The latter has enabled maximization of greenery in the eco-precinct, achieving a greenery provision of more than 4.0. The introduction of the podium car park-eco-deck has actualized several benefits:

- Allowing residential blocks to be spaced further apart, thereby providing larger inter-block spacing;
- Facilitating the introduction of a vehicle-free eco-deck on the roof of the podium car park, thereby allowing more greenery (a hybrid green roof system, vertical greening and large trees are grown at the car park level through air wells) to be introduced and creating a landscaped environment for residents to rest, relax and socialize while helping to absorb environmental noise;
- Providing direct car parking facilities at the immediate ground level of the blocks for residents, thereby increasing convenience to residents.

As part of the green living, the precinct is, however, designed with a reduced number of car parking spaces and co-location of land uses and facilities to reduce travel demand. The eco-precinct is located in proximity to the existing Punggol mass rapid transit station and Damai light rail station. Aside from public transport, residents are encouraged to car share; a car-sharing scheme is planned including hybrid cars. Other design strategies to improve residential environmental quality, energy, water and resource efficiency include:

- Strategic positioning of all residential blocks with facade windows to face the prevailing north-eastern winds and maximize natural lighting and ventilation;
- Use of cool building walls with enhanced thermal insulation to mitigate heat and radiation from the tropical sun;
- Solar panels on rooftop to power lighting of common areas;
- Energy saving light fittings in common corridors and car park deck, energy-saving machine roomless lifts that use 10% less energy than conventional lifts;

- Dedicated recycling refuse chutes within the flats;
- Rainwater harvesting system to support use of rainwater for washing common corridors and landscape irrigation;
- Integrated wash basin-toilet pedestal system to allow water used for hand washing to be redirected and recycled to the pedestal cistern for the next flush.

Another prime feature is the intensified greenery, which is expected to lower the surrounding temperature by as much as 4° Celsius while beautifying the precinct environment. Greenery takes several forms - the eco-deck above the car park, skyrise greening on building roofs, facade greenery and community gardens. To enhance site ecology and the green experience, lift lobbies at the car park level are also designed as landscaped courtyards while a green spine (with a tree-lined 650m jogging path, exercise stations, community pavilions, children's playground made from recycled materials) provides additional recreation spaces for all ages and connectivity within the precinct.

According to the HDB, the eco-features have increased overall construction costs by about 5-8% but the total estimated energy savings is about 2 gigawatt hours that could power some 400 four-room households for 1 year. Treelodge@Punggol has since received several sustainable development awards. It is Singapore's first BCA Green Mark Platinum Award public housing project, the highest rating given to promote energy savings, water savings, healthier indoor environments and adoption of more extensive greenery in the design and construction of green, sustainable buildings. In 2010, Treelodge@Punggol has also received the Chicago Athenaeum's Green GOOD Design Award, recognizing the importance of sustainable design. Initial reaction from the potential residents has been positive, with many looking forward to 'moving in to our own place and we are very pleased with the specially designed ecofriendly features here at Treelodge' (HDB Corporate Newsletter Jan/Feb 2011: Breaking Ground).

Following the Green Mark award of Treelodge@Punggol, in 2010, the HDB has announced plans to further promote the notion of sustainable township development, extending the notion of the eco-precinct to the entire new town, designating Punggol as Singapore's first model eco-town. Punggol, to be developed in two phases (phase 1: 2011-2015, phase 2: beyond 2015), will be designed to promote sustainable living based on three key principles - to introduce effective planning and design concepts to make it conducive for residents to adopt eco-lifestyles, to exploit urban solutions to achieve stretched environmental targets and to engage, educate and enable people to go green. It has recently launched an e-book to help residents learn more about the green features found in Treelodge@Punggol and a series of e-games to help residents keep the environment clean and green and make recycling their way of life.

A crucial aspect of the Punggol eco-town project is that it will serve as a 'living laboratory' to identify and test cost-effective new ideas and technologies in sustainable development, integrating urban solutions to create a green living environment and build local capacity to replicate these solutions in other HDB new towns (Table 1). A two-tiered test-bedding strategy is adopted - emerging technologies are test-bedded at one or two precincts within the Punggol eco-town, e.g. Treelodge@Punggol to prove their feasibility before they are implemented on a larger extent across the town. A multi-agency collaboration led by the HDB has been established to spearhead the development. The intent is to provide all participating partners with the planning insights and experience to replicate successful sustainable features of Punggol eco-town in other public housing towns and ultimately, the entire Singapore.

Table 1: Eco-urban Solutions in Punggol New Town

Area	Eco-urban solutions	Target over next 5 years
Energy	Solar photovoltaic system	To reduce energy consumption for the common areas by 20%.
	Elevator energy regeneration system	
	Energy efficient lighting in common areas	
	Smart grid/meters	
Urban mobility	Use of electric vehicles through the car-sharing scheme. Charging points for the electric vehicles to be located at strategic points to enhance the convenience to residents of using an electric vehicle.	
	E-bicycles to provide an environment-friendly alternative for residents to commute within the eco-town or simply just for leisure.	
Water	Water efficient fittings	To bring about a net water reduction of about 10%.
	Rainwater harvesting	
	Smart water meters	
	Water quality monitoring	
Resources and waste	Recycling points at every level in the residential blocks by building a second centralized refuse chute dedicated for recyclables to enhance convenience for residents to dispose their recyclable waste but also raise collection efficiency for waste collectors.	Three times increase in recyclables.
Maintenance	Fuel cell emergency power supply	To reduce maintenance costs.
	Self-cleansing paint	

Source: HDB website.

When examined against climate change actions, the various eco-features of the Treelodge@Punggol eco-precinct appear relevant to addressing climate change (Table 2). Some of them are mitigation measures and others are adaptation to climate change.

Table 2: Assessing Treelodge@Punggol Eco-precinct

Urban function	Eco-urban features	Relevance to climate change
Land	High-rise city living - a room with a view (compact city): 7 16-storey apartment blocks with 712 units of 3, 4 and 5-room flats. There are 98 units of 3-room flats, 600 units of 4-room flats and 14 units of 5-room loft units.	Increase green coverage and hence lower ambient temperature and reduce energy used for air-conditioning.
	Podium car park.	
	Accessibility to amenities and public transport: Located in Punggol New Town, at the junction of Punggol Road, Punggol Drive and Punggol Place, Treelodge@Punggol is just a few minutes' walk from the future Town Centre, Punggol MRT/LRT Station and the Punggol Bus Interchange.	Reduce need for travel and hence energy used for transport.
Water	Green Mark Platinum Award for water efficient buildings.	Reduce fresh water usage.
	Rainwater collection system: the building roof has 400 sq m of space to collect rainwater. Rain falling on the roof is first drained into a tank situated on the 16th storey of the block, and then treated using a chemical free system before stored in a tank for common area (common corridors) washing and irrigation. The water tank can store up to 7,000 litres of water, which is sufficient for a month's washing.	
	An integrated washbasin and toilet pedestal system in the flats for water used to wash hands to be recycled for the next flush.	
Energy	Green Mark Platinum Award for energy efficient buildings	Reduce energy usage and hence less greenhouse gas emission.
	Solar panels on the rooftop to tap on clean energy to power the lighting for the common areas, e.g. common corridors of the estates as well as the eco-deck. This will save 80 percent of energy used.	
	Units are designed with larger windows to allow more natural light.	
	Motion sensors for multi-storey and podium car parks to provide on-demand lighting.	
	LED Lighting.	
	A 'Car Sharing Scheme' will be introduced to provide residents with access to a fleet of cars, which also include hybrid cars.	
Environment	Unique to this eco-precinct is the 5-room loft unit that features a double-volume living room and an open terrace that can be converted into a sky garden.	Increase green coverage and hence lower ambient temperature and reduce energy used for air-conditioning. These features are expected to lower the surrounding
	Intensified greenery with an eco-deck above the car park, skyrise greening on roof decks and a community garden. Vertical greening along the columns	

Urban function	Eco-urban features	Relevance to climate change
	<p>of the residential blocks.</p> <p>Enhanced landscaping to intensify greenery.</p> <p>North-south orientation of the buildings.</p> <p>The buildings are designed to face the prevailing wind direction for cross ventilation.</p> <p>Designed to reduce noise transmission between rooms, the flats will be fitted with the patented FerroLite partition wall system. The wall is essentially non-load bearing and made of ferrocement. As compared to other cement-based partition walls, the hollow core of the FerroLite wall reduces the need for raw materials like cement (by 30%) and sand (by 20%), yielding overall savings of up to S\$1.5m per year. In addition, services can be installed and concealed within the wall with minimal wet works and without the need for hacking.</p>	<p>temperature by as much as 4° Celsius.</p> <p>Cool down the ambient temperature in the flats and hence reduces the need for air-conditioning.</p> <p>Reduced use of cement helps to reduce greenhouse gas emission in cement production. Hollow walls also help to insulate tropical heat.</p>
Health	<p>A 650m long tree-lined pathway that circles the eco-precinct to cater residents for jogging or taking leisurely walks in a lush environment.</p> <p>Exercise stations for the elderly.</p> <p>A children’s playground made from recycled materials.</p>	<p>Encourage healthy lifestyle to improve resilience to climate change.</p>
Waste	<p>A dedicated recyclable refuse chute at each block to encourage recycling.</p>	<p>Reduce inclination of recyclable waste and hence reduce GHG emission.</p>

Source: HDB website.

4. Conclusion

In contrast to many other Asian countries, Singapore has realized and fully accepted that unsustainable development will undermine long-term economic wellbeing. That is, economic growth and sustainability need not be mutually exclusive. A proactive approach is adopted to address sustainable development comprehensively and to mainstream sustainable development in its urban plans. Singapore has started to develop an eco-precinct and scaling up to an entire eco-town. Even though the eco-town is very much work in progress and also not the only smart growth solution, the development experience demonstrates how new neighbourhoods can be designed to be more sustainable. Urban planning strategies can play a critical role in improving environmental quality and addressing climate change by providing such housing and public infrastructure that minimizes transport and energy demands, maximizes respect for nature while satisfying basic needs. It can be a game changer. An integrated planning approach not only coordinates the spatial development of quality core living and working sectors with transport development but also unlocks sustainable living opportunities.

Though early days yet, through its eco-precinct and eco-town planning, Singapore is seeking to transform its current highly energy-intensive urban economic system into much less energy intensive and much less carbon intensive processes. Critical to the transition to lower carbon development is vision, supportive institutional framework and understanding of cross-sectoral issues as well as participation of the population whose lifestyle will eventually determine the extent of sustainable development achievement. In other words, while government commitment is crucial, sustainable development is not the lone action of government. So, it is imperative that every opportunity is made to engage the people, from policymaking (e.g. in the inter-ministerial sustainable development blueprint making) to planning and design of the eco-town and community education to raise awareness and promote a more sustainable way of living as the everyday 'default' way of life.

A key lesson for other fast growing Asian cities is that cities must and can be planned to develop more sustainably. Admittedly, this is not an easy task. As illustrated by the Singapore eco-town development, it will take time and costs. Even as we acknowledge that green development may be more costly than conventional development, its benefits in terms of longer-term energy and resource savings could align and better support the delivery of more productive and resilient built environment. Given the long gestation, the development is perhaps best approached in an incremental way, building up local knowledge and capability as well as the confidence in finding urban solutions that are suited to local conditions. But, crucially, underpinning the incrementalism would be the necessary requisite to look at the urban area as a whole to grasp the full meaning of sustainable urban development, having appropriate scale (start with a smaller area and test-bedding before scaling up), connectedness (to the community and cross-sectoral interests) and the fundamental principle of thinking and acting sustainably now, rather than later. Eco-city planning is a learning process. It should, therefore, also be monitored and reported upon to better understand how the settlement is functioning and where changes might be needed.

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