Chapter 8
Green Urbanism: Holistic Pathways to the Rejuvenation of Mature Housing Estates in Singapore

Steffen Lehmann

Abstract Cities play a crucial role in the way out of the environmental crisis. This chapter argues that our fast growing cities need to develop as more compact, polycentric mixed-use urban clusters, strongly inter-connected by public transport and highly mixed-use, towards sustainable "network city" models (Castells, *The rise of the network society.* Oxford: Blackwell, 1996). Cities are systems already under stress; cities are resource-intensive, and can sometimes be messy and chaotic. Not everything in cities can always be planned to last more than 25 or 30 years; mature components, such as housing estates, have to be re-engineered and retrofitted. Today, many mature housing estates, which play such a significant role of Singapore's urban fabric, are over 3 decades old and in need of urgent rejuvenation and retrofitting. Some of them are relatively energy-inefficient and highly air-conditioning dependent – but what could be the most appropriate model for such rejuvenation? It is timely to rethink and re-conceptualize these aged estates and districts of Singapore, in order to future-proof them for a fast approaching low-to-no-carbon society. Eco-city planning and the retrofitting of existing inefficient housing estates involves the introduction of mixed-use programmes and smart densification of the urban form. These concepts go far beyond environmental aspects; they include systems' integration and holistic thinking, rather than piecemeal approach or single-minded "techno-fix" approaches. System-integration and holistic conceptual approaches are necessary to ensure that these rejuvenated estates become part of a larger sustainable ecosystem, in regard to their management of waste, energy, water, public transport, materials and food supply. What is needed is a practical strategy for re-energising tired housing, to undergo radical modernization, to meet the changing aspirations and lifestyles of contemporary Singaporeans. It also requires new typologies for both public and private housing, appropriate to the

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tropical climate, with terraced gardens, courtyards, and environment friendly solutions. This study explores the typology and findings of a German case study: the city of Freiburg, where two recently completed eco-districts are analysed, as they could inform urban developments in Singapore. This case study shows that cities need to always find local solutions appropriate to their particular circumstances, and that government is key in driving the outcome. The argument is that good urban governance and governmental leadership is crucial to eco-development. In connection with this, the paper also examines a study conducted by the author at the National University of Singapore: an architecture master class, which was looking at careful neighbourhood re-configuration and the integration of the existing estates, avoiding the negative impact of demolition of these estates, to maintain the social community networks.

8.1 Introduction

As more and more of the Earth submits to urbanization, urban planners and architects are being confronted with a series of design challenges and an urgent need to act on them. Among the most significant environmental challenges of our time is the fossil-fuel dependency of existing cities, districts and buildings, and their growing demand for energy, land water and food security. In this context, retrofitting of the existing building stock has widely been recognized as a matter of urgency (Rees and Wackernagel 1995, Jenks and Burgess 2000, Lehmann 2006, Head 2008).

It is increasingly understood that avoiding mistakes in urban development at the early stages could lead to more sustainable, polycentric and compact cities, avoiding car traffic and therefore releasing less greenhouse-gas emissions. This paper presents research in *Green Urbanism* as a holistic pathway towards the rejuvenation of existing city districts, and introduces concepts for the urban intensification of neighbourhoods, to show how cities can transform from out-dated fossil-fuel based models to models based on renewable energy sources and mixed-use densification.

We can observe now strong moves by the government to establish Singapore as a green building hub for the tropics and as a best practice model of "sustainable city" for the Asia-Pacific region (URA 2009, BCA 2009). Singapore Government's first "zero-energy building" (ZEB) in Braddell Road, a retrofit project launched in 2009, is a good example for such an effort. It is now timely to expand these initiatives and explore emergent forms of urbanism, as well as models of affordability, based on new paradigms that will guide the transformation of the shape of districts and housing estates to come.

As the public housing authority of Singapore, the Housing and Development Board (HDB) has played a key role in meeting the housing needs of Singaporeans since its foundation in the early 1960s. Today, around 85% of Singapore's population live in HDB flats, out of which more than 90% own their flats (this is some of the highest home ownership ratio worldwide). The high degree of home ownership has been an advantage, as home owners take usually better care of their neighbourhood.

Since the 1960s, the HDB has constructed large-scale new towns as housing estates, starting with the Toa Payoh Estate in 1961, still following Le Corbusier's model of the "Unité d'Habitation" modernistic slab typology, isolated residential towers in a garden landscape (as coined by the Swiss architect in 1955).

8.2 Singapore's Urban Transformation and Leadership

In a global context, Singapore has done very well over the last two decades in re-inventing and positioning itself as "global city" and living laboratory for good infrastructure and urban planning (sometimes even called a "First World oasis in a Third World region", aiming to differentiate themselves from the rest of the region). Big cities are always in a global competition with each other. According to the recent *Global Liveable Cities Index* (2010), the city state is ranking on place three as one of the most liveable cities in the world, behind Swiss cities Geneva and Zurich, but well ahead of Hong Kong, Tokyo and Osaka. However, Singapore only ranked 14th out of 64 cities in the area of environmental friendliness and sustainability, one of the criteria used in the index. Today, Singapore is seen as one of the global leaders in the following planning areas:

- Achieving a competitive economy and strong real-estate market
- Developing housing typologies for multi-apartment living
- Implementing efficient, affordable public transport
- Leading in urban water management
- Ensuring the integration of urban greenery into planning.

However, in a situation where almost 90% of all materials and food need to be imported to the city state, the situation is fragile and new thinking about urban agriculture, local food supply ("agricultural villages") and resource recovery has gained strong momentum. There are also research initiatives into intergenerational neighbourhoods and behavioural change, in order to find strategies to reduce consumption without reducing lifestyle. In 2010, National Development Minister Mah Bow Tan flagged the idea of a "Learning Network for Cities", where best practice of sustainable urban development, liveability and green technology is identified on a global platform, led by Singapore. "Singapore is in a great position to lead this emerging global discourse on cities", he said at the World Cities Summit in June 2010. He also acknowledged that Singapore has to identify its own urban solutions based on its unique situation as a city state, and commented in discussion with Dr. Dieter Salomon, mayor of the German city of Freiburg: "Singapore is not Freiburg. So we need to understand what has worked well at a smaller, innovative place like Freiburg and see if there are lessons to be learnt, and if these can be transferred to Singapore's situation" (Mah 2010). Despite its differences in scale and cultural context, the second half of this paper will have a closer look at the sustainable urban development

principles that were applied in Freiburg and evaluate which lessons could be learnt from it that might be relevant for Singapore.

With the number of city dwellers in Singapore expected to increase from 4.8 million to around 6.5 million by 2035, accompanied with significant demographical shifts (in-migration, ageing population, increase of single households, reduced fertility rate, etc), it is essential to identify strategies for maintaining the current quality of life in Singapore. While incomes of Singaporeans have significantly gone up, lifestyle adjustments have been lagging behind. Singapore has emerged "as major centre for shipping and transport, as well as a major financial trading centre and hub of investment banking, in a matter of decades" (Girardet 2008). However, Singapore needs now to develop an urban vision that goes beyond the common "City in a Garden" concept, and find new pathways to rejuvenate its mature housing estates without entire demolition of these estates. Every demolition means the loss of community history and damages in terms of social sustainability, as all community ties and active networks in these estates are lost. Once residents have been relocated for demolition of the mature estate, they rarely move back to their former estate's location, but settle in another area of Singapore.

The HDB new towns consist of neighbourhoods and precincts, the latter being the smallest unit of 3–5 ha in size, with around 1,000 families, and plot ratios around 1:5–1:8. Singapore is losing its image as a "place for families", becomes more and more unaffordable to bring up a family, and the question that is now frequently asked: How can we create dense urban spaces that can also accommodate families?

8.2.1 HDB Initiatives: From New Towns as Global Post-WWII Phenomenon to Punggol 21

In 2007, Mr. Tay Kim Poh, former CEO of the Housing and Development Board, announced an eco-demonstration project in the north-eastern part of the Singapore Island: A major milestone in the overall plan to transform the HDB towns and estates was the unveiling of the "Remaking Our Heartland (ROH)" blueprint in August 2007. Mr. Tay said: "The coastal town of Punggol was selected as one of the pilot ROH towns, with new strategies and plans formulated to reinforce and realise the vision of "A Waterfront Town of the twenty-first century", or *Punggol 21*. This is HDB's first demonstration eco-precinct, *Treelodge@Punggol*, launched in March 2007, with the first waterfront housing precinct to be launched in mid-2010. When the town is substantially completed in the near future, *Punggol 21* will set the new benchmark for quality living and environmental sustainability for HDB towns" (HDB 2008).

This paper suggests, what Singapore needs is not only luxury housing developments on greenfield sites in the north, far away from the city centre (which increases

the need for residents to commute), but to keep the population close to the centre through practical concepts to achieve affordable retrofitting of existing housing estates. HDB estates are (since the 1970s) dispersed all over the southern part of the island, with many of them still close to the city centre. Pedestrian connectivity is everything, and the right densification of these estates towards a more compact, polycentric Singapore will help to improve the walkability of the city.

"Redevelopment" means usually demolition of the entire existing estate. However, rejuvenation solutions (keeping the existing and integrating it in a *retrofit-master plan*) are most of the time lower both in environmental impact and whole-life costs than comparative redevelopments. Paul Sloman from Arup notes in this regard: "These retrofits can reduce energy use by 20–50% in existing buildings, and pay for themselves over several years through the resulting cost savings on energy bills. The greenest buildings may actually be well-managed, retrofitted existing buildings" (Sloman 2008, Arup 2008).

After the Second World War, a large series of *New Towns* was built all over the globe. These towns were planned from scratch, based on the combined ideologies of the Garden City, CIAM-Modernism and the British neighbourhood principle. From Western Europe to Asia, from Africa to the former communist countries, the original universal model of the *New Town* was only slightly adapted to local cultures, economics and politics (from the "superquadras" in Brasilia, to the neighbourhood-modules in Milton Keynes and Almere New Town). It is surprising to realize that one model could simultaneously lead to Scandinavian cleanliness, Indian visual richness, Singaporean repetitive planning lay-out, and Chinese high density.

Typical for these *New Town*s is that they were designed for a new district or quarter, on a very large scale – which is most likely the reason why they often went wrong. In addition, these *New Towns* failed to take into account the various local traditions. Singapore's particular version of new towns is based on the concept of "Housing in a Park", which sets public housing slab and towers within a scenic park-like environment, where residents can enjoy lush greenery close to home. It complements Singapore's vision of the "City in a Garden" (see Figs. 8.1, 8.2, and 8.3).

8.2.2 The Historical Development of Singapore's Housing Estates

In addition, Mr. Tay Kim Poh (HDB) noted: "Soon after Singapore attained self-government in 1959, one of its key challenges was to ease a severe housing shortage. The Housing and Development Board, which was set up a year later to handle this task, opted to provide small and utilitarian flats, which it was able to build quickly and at low cost to house a fast-growing population. Once the housing shortage eased, the Board's challenge was to keep up with the changing needs and aspirations of the people, who were beginning to seek bigger and better flats, and more comprehensive

Fig. 8.1 (**a**) Typical Singapore tower housing estates – built reality (*left*); (**b**) Typical Singapore tower housing estates – urban model (*right*). Note: The modernistic planning concepts have been a mix of slab and point tower typologies (sometimes also courtyard typologies). How to best transform these mature estates into sustainable models, without "tabula rasa" demolition? The mature estates represent a socially healthy microcosm, occupied by a mixture of multi-national communities. (Photos by S. Lehmann 2009)

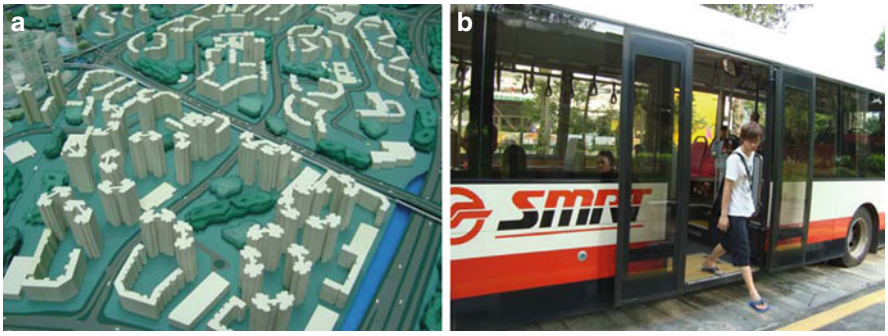

Fig. 8.2 (**a**) *Top left*: Model photo of a typical Singapore HDB housing estates. (**b**) *Top right*: Singapore is an example for efficient and affordable public transport. *Note*: As lifestyle of Singaporean people has changed, there is now a need to transform these ones step-by-step and upgrade the spaces between the buildings. Higher densities are appropriate around transit nodes and public transport corridors. (Photos by S. Lehmann 2009)

facilities. This is a critical challenge since living in HDB flats is a way of life for most Singaporeans" (Tay HDB 2008).

Singapore has now 4.8 million population (data 2009. Ethnical mix: 75% are Chinese, 15% Malay origin, 10% of other origins), and the population is targetted to increase to 6.5 million within the next 25 years. The lifestyle of Singaporeans has gone through significant changes. We need to ask:

- How do Singaporeans want to live in the next decade?
- How can we adapt the existing estates to climate change?

Fig. 8.3 (**a**) La Salle Art School courtyard (*left*); (**b**) Roof garden on Vivo City shopping centre (*right*). *Note*: While Singapore is experimenting with new types of "quasi" public spaces, most of these spaces are not truly public/civic, but located on roof tops of shopping centres or semi-internalised spaces, which are privately owned and controlled. (Photos by S. Lehmann 2009)

8.3 Learning from Germany's Policies: Why State Is Key

Most urbanization in the next 20 years will occur in the Asia-Pacific region. With climate change, Asia has to lead with new urban models, and Singapore is well placed to play a key role in this. Singapore Government has recently started using policies, such as the "2nd Green Building Masterplan" as drivers to implement sustainable development, and has set the key target for "at least 80% of the buildings in Singapore to be green by 2030" (BCA, 2009). Germany has been using similar policies and a system of incentives successfully over the last two decades: for instance, one much quoted example is the "electricity feed-in tariff" for renewable energy sources, legislated in 1999 (Herzog 2007).

The German Federal Government has specified in its fifth energy research programme (2005) the goal for all new buildings to reduce the primary energy demand, i.e. the energy demand for heating and cooling, domestic hot water, ventilation, air-conditioning, lighting and auxiliary energy by half – compared to the current state of the art. The long-term goal is net-zero emission buildings. A recent EU-Directive (2009) requires all new buildings in the European Union to be net-zero energy buildings by 2020. These are good examples, how policies can accelerate the required paradigm shift and drive the implementation of sustainability measures.

8.3.1 Good Governance and Governmental Leadership is Key to Eco-development

The German case studies show that good governance is crucial to urban development, especially in the introduction of innovative thinking regarding the development of eco-districts, if we want to transform existing cities into sustainable compact communities.

Government and municipalities have to provide public transport, public space and affordable housing, and without political support change will not happen. City council needs therefore strong management and political support for a strategic direction in order to manage sustainability through coherent combined management and governance approaches (including decision-making and accountability), which include evolutionary and adaptive policies linked to a balanced process of review. Public consultation exercises and grassroots participation are essential to ensuring people-sensitive urban design and to encouraging community participation. Empowering and enabling people to be actively involved in shaping their community and urban environment is one of the hallmarks of a democracy. Therefore, a city that leads and designs holistically, that implements change harmoniously, such as Freiburg has done, and where decision-making and responsibility is shared with the empowered citizenry is a city is on its road to sustainable practices (Boddy and Parkinson 2004).

8.3.2 Applying Best Practice: Freiburg's Inner-City Eco-districts

There are two innovative solar city estates in the City of Freiburg, which display well the current approaches towards eco-district development: The green district Vauban, and the Solarsiedlung am Schlierberg. The city of Freiburg in the south-west of Germany is one of the sunniest places in the country (lat. 48°, longitude 7.5°), with an annual total irradiation of about maximum 1.100 kWh/m^2 (in comparison, Singapore receives over 50% more sun radiation) and an average temperature 10°C. Freiburg is a university town with some 30 years of environmentally sensitive policies and practices, and has often been called the "European Capital of Environmentalism".

The two model projects close to the city centre, on the former area of a French barrack site (brownfield), are smaller compared to most housing estates in Singapore; and they have around half the density of a typical Singapore HDB housing estate. However, the applied concepts are highly replicable and pragmatic. Together with the Hammarby-Sjöstad district in Stockholm, it is probably Vauban and Schlierberg that have set the most replicable benchmarks for eco-districts up until today (see Fig. 8.4).

Both estates were built as pilot projects on an inner-city former barracks area, integrating some existing buildings; they have been an ongoing testing ground for holistic sustainable thinking and ecological construction, e.g. the estates include innovative concepts of water management and eco-mobility.

The Solarsiedlung am Schlierberg estate (built during 1999–2006), is located three kilometres south of the historic centre, bordering directly on Vauban. The architect of this estate is Rolf Disch, a pioneer of "solar architecture", who invented the *plus-energy house*. The solar PV-covered roofs of these houses produce more energy than the building consumes: around 15 kW/m^2 per year surplus.

Fig. 8.4 (**a**) The two solar districts in central Freiburg (South Germany) (*top left*); (**b**) The two solar districts in central Freiburg (South Germany) (*top right*); (**c**) Images showing Vauban and Solar District Schlierberg inner-city densification estates, with solar roofs and a light railway (*bottom*). (Photos by L. Lehmann 2009)

Today, about 170 residents live in the 59 terrace houses at Schlierberg. Nine of the houses are placed on the roof of the so-called Sonnenschiff ("Sun Ship"), a block of offices and shops, acting as noise barrier to the nearby main road. The terrace houses are of different widths and extend over two or three storeys, so that the living areas vary from 75 to 200 m^2. In accordance with classic solar building principles, the living and dining rooms are oriented to the southern (sunny) side, access is via a central core and the service zones are on the northern side, including kitchens, bathrooms and building services.

The larger city district of Vauban is interesting for its strong guiding principles and implementation model for the planning and design phase. Vauban comprises a 38-ha former barracks site that was purchased by the city in 1994 with the goal to convert it into a flagship environmental and social demonstration project (size 38 ha; density 140 persons/ha). It is a mixed-use estate, including 2,200 homes (20% of the 2,200 units are public housing), accommodating around 5,000 people, as well as business units to provide about 600 workplaces. The project was completed in 2006 and is widely seen as one of the most positive examples of environmental thinking in relation to urban design. The concept offers an increased building density, social and functional mixes, flat roof greening, and rainwater disposal within the building boundaries. The reused, renovated barrack buildings offer affordable housing for students and special functions to service the quarter, such as schools, shops and

workplaces. The main goal of the project was to implement a green city district in a co-operative, participatory way which met ecological, social, economic and cultural requirements.

8.3.3 A Social Agenda for Better User Participation

The city of Freiburg had bought the area from the Federal Authorities. As owner of the Vauban area, the city was responsible for its development and realized the importance of design thinking in policy. The principle of "learning while planning", which was adopted by the city, allowed flexibility in reacting to the developments and to start an extended citizen participation that went far beyond the legal requirements; it enabled citizens to participate directly in the planning process. The citizen's association "Forum Vauban" (which has NGO-status) became the major driving force for the development of Vauban, with the commitment of the future residents to create a sustainable, flourishing community (it turned out that the project was particularly appealing to academics and the middle-class population segment).

In Vauban's new apartment buildings, innovative plan layouts were applied, that allow for openness and a multitude of uses through flexibility, so that changes in family room type and furnishing composition are possible. There was a strong focus on the public space between the buildings, at different scales, created with an emphasis on public safety and reduced car-traffic. Vauban is a car-reduced neighbourhood both through removing the need for automobiles as well as restrictions to car parking. Tramlines form the backbone of public transportation, linking the new city quarter with the rest of the city, while many amenities and public institutions are located within walking distance.

From the beginning, Vauban has been designed to reduce the need for car use and to cut overall journey distance. Tram and bus stops are placed not more than 200 m from any residential building. Car parking garages are located at the edge of the development and car access is restricted to the main access road. A free bus runs through the district and there is a car speed limit of 30 km/h on the main thoroughfare, while the side access roads inside the estate have a limit of 10 km/h and are no-parking zones, except for set-downs and deliveries.

Many of the environmental measures at Schlierberg and Vauban even exceed the strict German regulations: for instance, all buildings (new and retrofitted) must meet low energy house requirements of an annual heating energy consumption of 65 kWh/m^2 or less.

Most buildings were restricted to a height of four to five floors to ensure good climatic performance and day-lighting of the outdoor spaces. Most buildings are equipped with solar panels, others have green roofs. Buildings consume only 30% of the energy compared with conventional buildings, and 65% of the energy comes from renewable energy sources. About two thirds of Vauban's buildings are served by a combined heat and power (CHP) plant, which is powered by a mix of wood-chips (80%) and natural gas (20%). Most of the new buildings at Vauban

and Schlierberg fulfil the German "Passive House" standards: walls and roofs are insulated with 400 mm of mineral wool or polyurethane insulation, windows are triple-glazed (See: www.passiv.de).

8.3.4 The Main Concepts of Freiburg's Eco-districts

In the fields of energy, traffic and mobility, user participation, public spaces and social interaction, a series of new concepts were successfully put into practice. In the Vauban district:

- the project's structure integrates legal, political, social and economic actors from grassroots-level up to the city administration;
- all houses are built at least to an improved low energy standard (max. 65 kWh/m^2 per annum); in addition at least 100 units with "passive house" (15 kWh/m^2 per annum) or "plus energy" standard (houses which produce more energy than they need;
- a highly efficient co-generation plant (combined-heat-power CHP) operating on wood-chips, connected to the district's heating grid (the wood-fired community power plant supplies heating);
- solar collectors and photovoltaics (about 2,000 m^2 installed by 2008) are the common element on the district's roofs; the LED-street lighting is solar-powered;
- an ecological traffic and mobility concept was implemented, with a reduced number of private cars, to be parked in the periphery (about 40% of the households are car-free, or agreed to live without owning a car; car ownership is only 150 cars per 1,000 persons; compared to adjacent Freiburg city centre, with 400 cars per 1,000 persons). There is a good public transport system (free bus loops and light rail), and a convenient car sharing system, where car sharers get a free annual pass for the tram;
- car-reduced streets and other public spaces act as playgrounds for kids and for places for social interaction;
- joint building projects (about 30 groups of building owners, the "Geneva Co-operative" and a self-organized settlement initiative) are the fertile ground for a stable community, raising ecological awareness; and
- there is a far-reaching participation and social network organized by "Forum Vauban", giving a voice to the people's needs, supporting their initiatives, promoting innovative ecological and social concepts, and setting-up a communication structure, including meetings, workshops, a 3-monthly district news magazine, publications on special issues and internet-presentations. Social aspects include a co-operative organic food store and a farmers' market initiative.

More information is available: Freiburg's two model districts have been described to great detail by a series of researchers, including Schroepfer and Hee (2008), as well as Heinze and Voss (2009).

8.4 Reducing Greenhouse Gas Emissions in Fast Growing Asian Cities

For the protection of food security, ecosystems and biodiversity, and to enable sustainable urban development, we need to carry out urgent and large greenhouse gas (GHG) reductions (Brundtland 1987, UN – IPCC 2007). It is now understood that nowhere will the impact of climate change be felt more than in Asian cities, where urban growth will far outstrip other regions, and more than double the population by 2050, with a staggering increase of almost 2 billion people (UN-Habitat 2008). The direct link between urbanization and climate change is widely accepted: In general, cities now cater for 3.4 billion people worldwide, using about 2% of the global land area, with over 1 million people migrating to cities each week (Stern 2007, Arup 2008).

8.4.1 Rapid Urbanization: Asian Cities Are Different

It's important to note that the cities in Asia have an entirely different history and development scenario compared with their US, European, or Australian counterparts. Today, most Asian cities are characterized by the following unsustainable trends (see Lehmann 2010a,b):

- There is a high number of inefficient older districts in need of regeneration, with mature housing estates desperate for rejuvenation;
- The existing building stock is out-dated and not energy-efficient;
- Structural problems, e.g. expansion of large shopping malls, but lack of non-commercial, catalytic, mixed-use, socially sustainable city projects;
- High carbon energy supply, and the need to de-carbonize this supply;
- Inefficient water, waste and transport operations; and
- Population growth, aging population trends, combined with job losses and demographical shifts.

However, these cities also share the more resilient characteristics of:

- Lesser impact on the surrounding land for agricultural/food and waste, compared to cities in the US, Europe, or Australia;
- Closer community ties, with a strong attachment to history and place (which is often in need to be better protected);
- Due to the higher population densities, a high percentage of residents in Asian cities are using efficient public mass transit; and
- Public space is here usually more lively and vibrant than in the US or Australian cities.

In addition, over the last decade, Singapore has emerged as leader in thinking about urban greenery ("skygardens") and the role of plants in the sustainable city, as mitigators for the urban heat island effect (NParks 2009).

8.5 Design Studio: A Master Class on the Neighbourhood Re-configuration of Dawson

The raised concerns in regard to Singapore's new town estates and the question of the most appropriate model for rejuvenation were used as starting point for a master class:

Field studies and a design master class, conducted at the National University of Singapore from August to September 2009, further explored the issue of a typical mature housing estate: Dawson Estate in Queenstown, at Commonwealth Avenue, was chosen as field of exploration. Dawson currently houses around 22,000 people and is in many ways testing ground for the identification of possible future approaches (Low 2006).

The specific aim of the master class, involving a cohort of 30 final year students, was to identify best practice and study holistic urban and architectural design solutions for the intensification, rejuvenation, retrofitting, re-energising, compacting and future-proofing of a typical Singapore's housing estates. The aim was to illustrate approaches to design inquiry, which might inform better policy-making in eco-development.

The starting hypothesis was that the lifestyle of the Singaporean people has gone through significant change over the last 20 years; however, over 80% of Singapore's population (over 3.5 million people) still live in HDB apartments that do not properly reflect this demographical shift or change of lifestyle. Furthermore, around half of the estates are mature building stock that is highly inefficient, inappropriate for natural cross-ventilation and highly air-condition dependent. Much of the building stock fails to deal with the tropical climate and the challenges that emerge from climate change and peak oil, as well as the increasing expectations of comfort by its residents (see Figs. 8.5 and 8.6).

While the outcome of such master class exercises and charrettes are usually limited by nature, they have the potential to contribute quickly with a series of suggestions. The students identified a wide variety of solutions – from practical and unachievable – for the transformation of mature housing estates towards self-sufficient, zero carbon districts. Suggestions included:

- Inventing new programmes of mixed use intensification, which allow working from home, leading to new housing typologies;
- Enhancing social sustainability for "aging in place", including community gardens and amenities for all generations;
- Intensifying the use of rooftops for urban farming (hydroponics) and urban heat island mitigation, as well as improving the space between the buildings.

Fig. 8.5 (**a**) Dawson Estate at Queenstown built in the early 1970s (*top left*); (**b**) Typical wide space between the slabs in older housing estate (*top right*). *Note*: The estate is currently too homogeneous and mono-functional; the buildings themselves are not dealing well with the tropical climate, lack proper balconies and western façade shading devices. Today, there are around 900,000 HDB flats across Singapore, housing over 80% of the population (this is around 3.5 million people). HDB has played a unique and significant role over the last four decades and has been crucial to Singapore's urban growth. However, we are now at a point where we have to rethink these existing typical 1960s–1980s new town housing estates, many of which have issues of energy-ineffectiveness and inappropriate, out-dated design lay-outs for living and working in a global city in the tropics

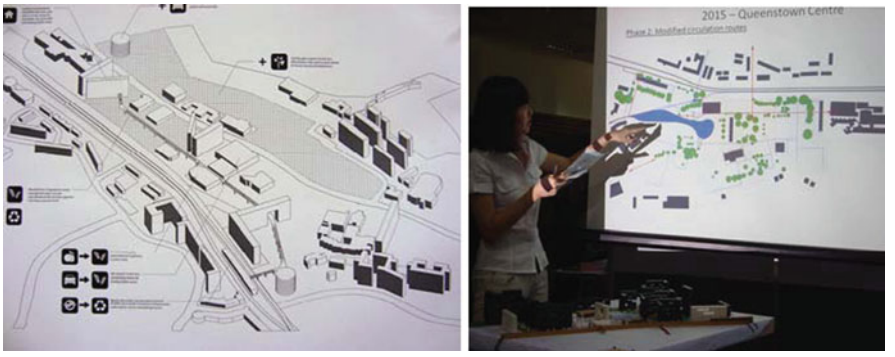

Fig. 8.6 (**a** and **b**) Some images from the final presentation of the students' work, at NUS in September 2009

8.5.1 Re-adaptation Efforts of Singapore New Town Estates

There are now multiple re-adaptation efforts going on in Singapore's housing estates. While the initial planning intention for the adoption of Le Corbusier's compact urban form (predominantly through the *Unité d'Habitation* model, willingly adopted in the 1960s–1970s) was originally meant to save land-take by going high-rise and high-density, this high density model might be seen as environmentally sustainable. However, new policy measures towards eco-development of public housing are required and currently developed. These include the innovative integration of greenery into high-rise buildings, rooftop greenery, concepts of urban farming, increased practice of recycling, water collection and storage, the use of solar energy, ecologically-friendly building materials, and the revitalization of passive design principles.

Wong has extensively researched on indoor thermal comfort and cooling loads of high-density public housing in Singapore. He found that thermal comfort varies between residents living in flats with different sizes and vertical positions (for instance, there are differences in energy consumption caused by urban geometry: if the unit is located in a high point tower, or in a less high slab block or courtyard typology; the unit's orientation and sky view factor of the adjacent street canyons have also an effect on energy consumption). Other findings point out that building design and how an apartment is used are paramount to reducing the environmental impact of the Singaporean home, not so much the walling materials used in construction. Since air-conditioning accounts for a significant portion of energy consumption, passive cooling and natural cross-ventilation are understood as major strategies for reducing energy consumption in tropical housing (Wong et al. 2002, Ng et al. 2006).

Reduced cooling load is often achieved by enhancing air circulation and reducing solar heat gain through façade design and external shading devices. West-facing apartments have in general higher cooling loads, while high point towers offer a better air circulation. Leung points out that in high-density housing clusters in Singapore, where considerable urban obstruction exists, passive cooling potential is also influenced by the geometry of adjacent buildings. Due to their proximity, adjacent buildings modify the amount of sunlight and wind that individual flats are subject to. Therefore, the urban geometry of the housing type becomes an indispensable component in the evaluation of the indoor thermal environment in high-density housing (Wong et al. 2002, Leung and Steemers 2010).

8.5.2 Queenstown: A Resilient Housing Estate in Its Transformation

Queenstown was, when built in 1970–1972, one of the test beds for Singapore's public housing initiatives. Today, life expectancy in Singapore has significantly risen from 64.5 years in 1965, to 79.7 years in 2009. A growing aging population

combined with falling birth rates are a serious concern for the city state (Singapore's fertility rate in 2009 was only 1.28).

In many Singaporean estates, such as Dawson Queenstown and Red Hill, there is a need to attract younger families back to these estates (where they grew up, but left). It is also recommendable to generally rethink the role of greenery and landscape, in order to maximize biodiversity and introduce principles of urban farming for local food production. Models of "international best practice" and successful neighbourhood re-configuration were analyzed at the beginning of the studio, and ideas for new types of productive urban landscapes developed, where local food production and improved food security play an essential role.

8.5.3 Growing Population, Changing Lifestyles: Towards a More Resilient Singapore

The main research question, which the students were asked to address, was to identify appropriate and practical solutions for the rejuvenation of mature housing estates, with strategies and concepts suitable to the tropical climate.

The ecological footprint of an estate can easily be calculated, using established methods (such as the "EF" method developed by Rees and Wakernagel (1995). Most of the future energy demand will have to come from on-site renewable energy sources (over 50% as target, from solar and biomass), through the integration of PV-cells into the buildings and infrastructure, and the introduction of innovative solar cooling technology.

8.5.4 What Is Already Happening: The Two HDB Programmes, Remaining Structural Discrepancies?

Building a new estate on greenfield sites from scratch is always easier than dealing with the complexity of existing ones, hence certain reluctance by HDB to change its practice and the preference in the development of entire new estates. HDB has currently the following two different programmes for dealing with mature housing estates:

- First one is the renovation of the existing buildings (*Main Upgrading Programme*, called MUP/HIP, launched 1989); this includes upgrading of access, e.g. putting in elevators, and other pragmatic measurements. However, the main urban problems in the estates remain: for instance, MUP does not improve the lack of mixed-use (the estates remain too homogeneous and mono-functional), and the often unpleasant space between the buildings is not changed.

- The second programme, the *Selective En Bloc Redevelopment Scheme* (called SERS, introduced in 1995), is the demolition of the entire existing estates en bloc, to make way for new redevelopment of the precinct. However, this has significant disadvantages for social sustainability; for instance, that residents have to be resettled and that the existing community ties, which developed and evolved over decades, are destroyed and lost forever.

For a long time, these two models have served Singapore well in meeting the housing needs of its people, while providing them with a quality living environment through provision of adequate social spaces and other amenities. However, in the context of our explorations and from speaking to residents, it became obvious that there is a need for a third way today, with a different emphasis: the reconfiguration of the existing estates, whereby most of the buildings are kept and integrated in an energy and densification master plan.

8.5.5 Identifying a Third Way: Starting Questions for Neighbourhood Re-configuration

The starting point of the design studio was the following three questions:

Q1: How can the entire estate become energy independent, by producing its own energy, cleaning its own water, growing its own food supply?
Q2: How can we attract younger residents, such as young married couples back, to improve the demographic and socio-economic profile mix of the residents (e.g. to live near their aging parents)? How can we maintain the social and historical memory of place?
Q3: There is a high percentage of older residents living in Queenstown; so how will the retrofitted estate better provide for the elderly and cater for all three generations (e.g. with new mixed-use typologies)?

8.6 Concepts for Regenerating the Mature Housing District of Queenstown

Learning from the German examples and in regard to achieving self-sufficiency of mature housing estates, students were asked to address aspects, such as:

- Energy (especially decentralized energy generation, where every citizen can generate energy locally, with small solar units);
- Urban water management (with consequences in regard to roof scapes and landscaping);

- Transport: new concepts of eco-mobility to be introduced into the estate, with a strong focus on walking, cycling, and link to mass transit;
- Material flow and holistic concepts in regard to waste management (McDonough and Braungart 2002);
- Landscape, biodiversity and urban food production, including biomass facilities for organic waste composting;
- Construction systems for retrofitting, with a focus on modular prefabrication of entire building elements, such as add-on balconies or double-skin façade systems;
- A full understanding of the historical and social circumstances in the mature housing estates, including aspects of changing demographics and inter-generational relationships; estates representing a socially healthy microcosm; and
- Not to limit ourselves to the upmarket styling that is bound to come over the existing estates, where many will simply get demolished; but to search for an alternative that maintains the character and network of the existing.

8.6.1 Holistic Approaches for a Pathway to Low-to-Zero Carbon Are Needed

The students were introduced through lectures to the conceptual model of "green urbanism". It became soon obvious to the teams that what is needed is a robust, generic framework for future-proofing the existing, "to achieve an optimal relationship between footprint and population density" (Burton 1997, Hall 2005).

New technologies of decentralized energy generation (energy produced close to the point of consumption, using solar PV, solar thermal, and biomass) are understood as particularly promising concepts, with the potential to achieve a better symbiosis between the urban environment and the precious surrounding garden landscape of Singapore.

Singapore will take on a leadership role for the entire region, by mitigating the environmental impact through:

- Application of international best practice in urban developments and climate-responsive urbanism (introduced, tested and embedded via demonstration and pilot projects);
- Innovation and utilization of key technologies, such as renewable energy technologies, prefabrication and the integration of information technologies;
- Proper incentives and regulations, so that all existing and new housing estates can become carbon-neutral;
- Strong leadership by national and town council leaders, local community groups, planners and academics; and
- Enhanced knowledge transfer, training and awareness of all citizens.

8.6.2 The Conceptual Model of "Green Urbanism" and "Energy Master Planning"

Rather than demolish sections of a city, or build completely new suburbs, more GHG-emissions will be saved through remodelling and densifying the existing districts. Significant environmental, economic and social benefits can be expected in developing more sustainable urban districts and rejuvenating mature housing estates to attract residents of all ages and classes back, to live in these inner-city residential centres closer to their workplaces. More sustainable urban districts will better capitalize on the existing infrastructure of buildings and public transport, and allow population increase using less embodied energy. Highly sustainable city district adaptations will lead to re-energized estates that enable the city's residents to live a high quality of life whilst supporting maximum biodiversity and using minimal natural resources.

Connaughton points out: "New sustainable buildings use more embodied energy than refurbished ones, due to the high embodied energy of constructing new buildings and infrastructure" (Connaughton et al. 2008). However, since it is easier to build new, we find that there is frequently a great reluctance to innovate in the housing sector (JLL 2005).

8.6.3 Green Districts and Exergy Principles: Turning the Estates and City Districts into "Power Stations"

Low-emission energy generation technologies can turn the entire city districts themselves into power stations, where energy is generated close to the point of consumption. Localized energy generation on-site is using renewable energy sources (in Singapore especially solar and biomass), and complemented by distributed cooling systems and solar hot water systems: this has a huge potential to reduce Singapore's built environment's energy demand and emissions. Such decentralized, distributed systems, where every citizen can generate the energy needed, will eliminate transmission losses and transmission costs (which always occur with the large grid and inefficient base-load power stations outside the city) for the local consumer. The *exergy* principles look at capturing and harvesting waste heat and waste water streams, and how the strategic arrangement of programmes within mixed-use urban blocks and estates can lead to unleashing the currently unused energy potential. Currently, Singapore uses only 3.5% of energy from renewable energy sources (data: 2009). However, with a large population and a high number of biomass from greenery, there is a great potential for micro-biogas plants to be integrated in the new districts for local power generation.

These concepts can be considered for both existing and new buildings: Small power generators are positioned within communities to provide electricity for local

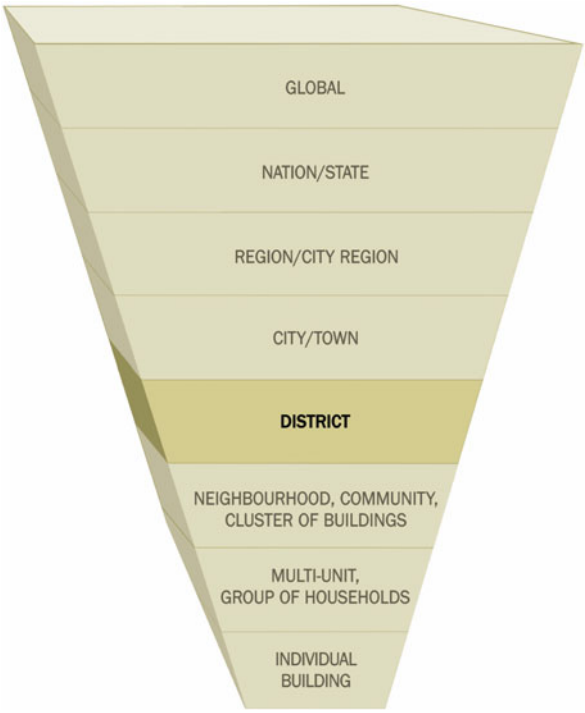

Fig. 8.7 District level energy supply (*left*). Rather than on the building-scale, working on the district-level of energy-effectiveness is most promising. This is highly relevant to the need to retrofit the existing cities and to de-carbonise the energy supply, on a district-scale (Lehmann 2006)

consumption, and the waste heat they produce is captured for co-generation (CHP; or for tri-generation, where the waste heat also produces chilled water for cooling), used for space conditioning via a local district cooling system (see Figs. 8.7, 8.8, 8.9, and 8.10).

8.6.4 Further Issues, the Students Considered

In addition, we asked the students to consider the following issues:

- Increasing the compactness and reconsidering the spaces between the buildings (to achieve a better public space network and stronger connectivity for pedestrians), overall more appropriate to the tropical "outdoor lifestyle", which is less based on air-condition dependency;
- Introducing intensive uses for roof tops, including urban farming and greening, for mitigation of the Urban Heat Island (UHI) effect;
- Modular prefabrication of building elements that are to be inserted or attached to the existing housing slabs, including large balconies, link-ways, break-out spaces, sun-shading devices, solar arrays, planting, and other elements;

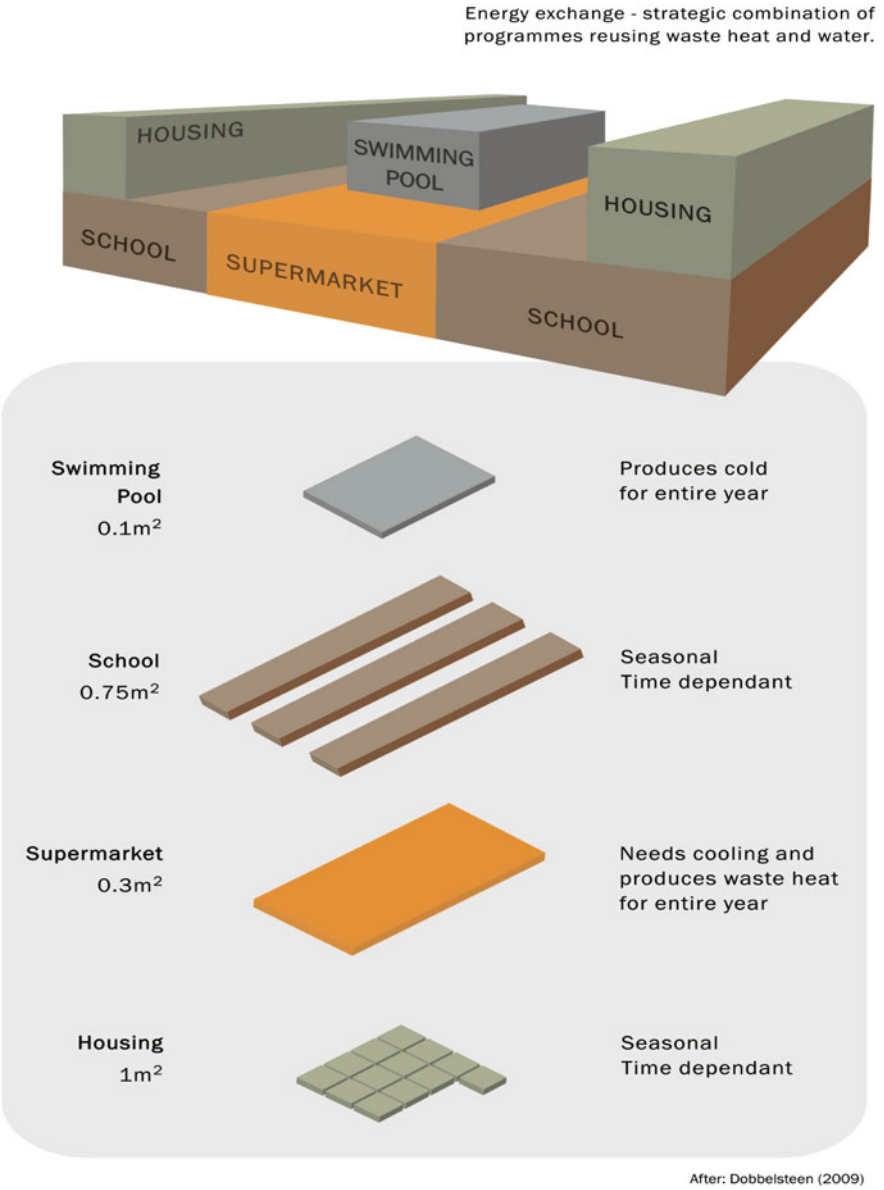

Fig. 8.8 Energy exchange through the strategic combination of programmes reusing waste heat and waste water. Currently, Singapore uses only 3.5% of energy from renewable energy sources; more tri-generation and cascading technologies should be used (Lehmann 2006)

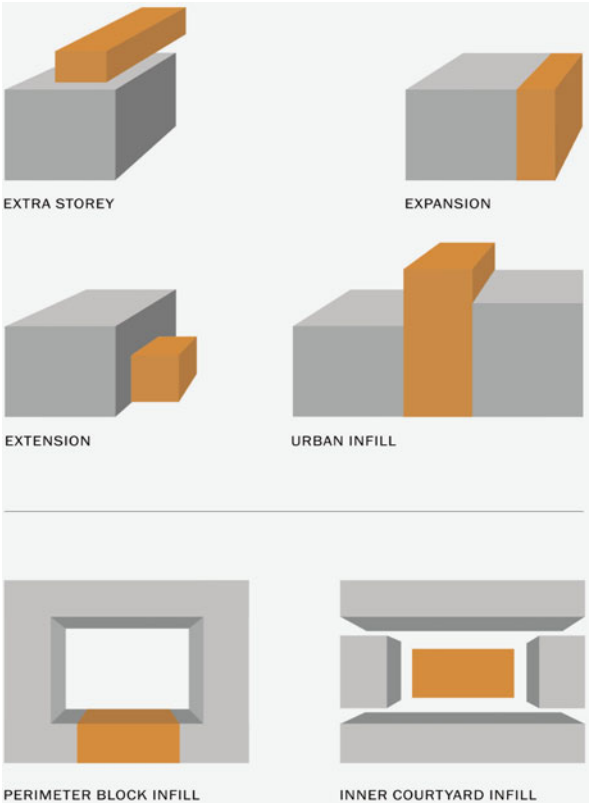

Fig. 8.9 Neighbourhood re-configuration: different arrangements for infill and densification are possible

- Inserting new types of recreational or commercial/non-commercial facilities, as supported by an overall vision for the precinct;
- Using large bodies of water to improve the micro-climate and give delight to the spaces between the buildings (Gehl 1971);
- Improving sun shading and natural cross-ventilation, as well as introducing other passive design strategies that contribute to a better overall building performance;
- Activating solar renewable energy resources in all its forms (solar thermal, solar PV, solar cooling, passive solar design principles, biomass), with a focus on local energy production, to turn the district into a "power station";
- Developing short and long-term strategies for the transformation of the existing district (a plan in 2 or 3 stages); clarifying which densities are required and recommendable; and
- Including other innovative strategies that deal with the particular challenges of Singapore (limited land, resources/materials/food supply), which we will need to develop, in order to future-proof the city against climate change impact (for instance, Singapore currently recycles less than 20% of its waste; this figure is too low and needs to double within the next 10 years).

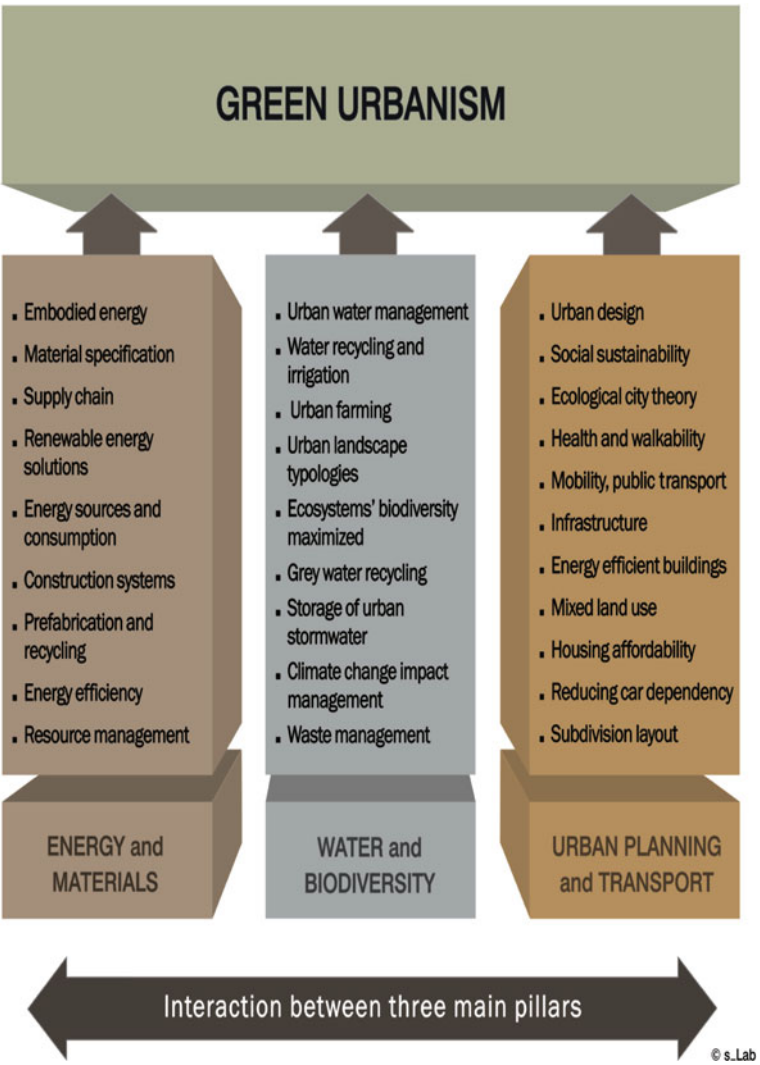

Fig. 8.10 Diagram shows the conceptual model of "Green Urbanism". The optimum interaction of the three pillars of energy and materials, water and biodiversity, and urban planning and transport improves the environmental and social sustainability of cities. It is a holistic model, which identifies 15 core principles (Lehmann 2006)

Very soon, a couple of challenges for the urban design emerged in the Queenstown study; for instance:

- A focus on local energy generation, urban farming and concepts of waste management started to drive the master planning;
- The poor connectivity between the MRT station and the inner precinct area was recognized as major issue that needed to be rectified; and

- The urban design had to resolve the contrast of two very different sides: noisy Commonwealth Avenue on one side, and quiet, slow Margaret Drive on the other.

8.6.5 Pedagogical Strategies for the Master Class

This workshop was interested to address all these topics in a holistic and integrated way and use it to inform the urban designs. The students were asked to be mainly "strategic thinkers" on the urban scale and to invent new programmes as part of an overall vision, while avoiding to "get stuck in details". Being aware that this is a risky exercise, we were mainly interested in discussing initial concepts that would lead to further individual explorations. Throughout the master class, the Singaporean students were challenged with the thought that architectural "highlights" or spectacular designs contribute very little to the city's urban development in regard to the real issue of climate change.

8.7 Concluding Remarks

The problem of city-making today is as much about making new cities as it is about transforming our existing metropolises, especially housing estates, suburban building stock and edge city developments, which are too mono-functional and which need to become more mixed-use. This understanding is relatively young. We have yet to develop coherent strategies for transforming metropolitan agglomerations into urban configurations that are ecologically, economically, and socially sustainable while creating environments that are memorable and provide architectural delight. Social interaction is best created through intensification of mixed-use programmes and pleasant outdoor spaces, with high quality landscaping between the buildings.

Any vibrant authentic city has grown over years and has buildings which date from different eras. Redevelopment and retrofitting of the existing, mature housing precincts (without demolition of these estates, but integration) includes the increase of densities and other large-scale strategies, which need to be clearly redefined for Singapore's particular condition.

There is a re-affirmation of the following three thoughts:

- *Cities* and urbanization play a mayor role in the battle against climate change;
- *Cities* are resource-intensive and systems already under stress; and
- *Cities* need to be re-engineered to become more sustainable and resilient.

Today, an urban low-emission future is already technically feasible. How will Asian cities adapt, if countries are to meet international obligations such as those outlined in international emission agreements? There is urgency; without

incentives, policy directions and updating the building codes, the stationary energy demand across all sectors is projected to increase further. What is needed are some cutting-edge demonstration projects that showcase how these available concepts and technologies can be brought together and set new benchmarks. These practical and achievable solutions for pilot (demonstration) projects would have generic, replicable strategies as outcome, with the potential to be applied to other similar housing estates and rolled-out in large scale, over the next decade.

One of the main arguments is that governmental leadership, good governance and strong guidance by the state is crucial to the development of eco-districts. This became obvious from the German cases. Any city leadership applying best practice for urban governance and sustainable procurement methods will accelerate the transition towards eco-planning. The question is: which networks and skills can be activated and utilized through engaging the local community and key stakeholders, to ensure sustainable outcomes?

8.7.1 Good Urban Governance and Policies Are the Lesson from Freiburg

The German cases illustrate that good urban governance is extremely important if we want to transform existing cities into sustainable compact communities. It has to provide public transport, public space and affordable housing, and without political support change it will not happen. City council needs therefore strong management and political support for their urban visions to be realized. It needs strong support for a strategic direction in order to manage sustainability through coherent combined management and governance approaches, which include evolutionary and adaptive policies linked to a balanced process of review, and public authorities overcoming their own unsustainable consumption practices and changing their methods of urban decision-making. A city that leads and designs holistically, that implements change harmoniously (such as Freiburg), and where decision-making and responsibility is shared with the empowered citizenry is a city that is on the road to sustainable practices. Public consultation exercises and grassroots participation are essential to ensuring people-sensitive urban design and to encouraging community participation. Empowering and enabling people to be actively involved in shaping their community and urban environment is one of the hallmarks of a democracy.

Like in Freiburg, every city leadership needs to ask itself: which are the networks and skills that can be activated and utilized through engaging the local community and key stakeholders, to ensure sustainable outcomes? City councils need strong political support for their strategic direction in order to manage sustainability through coherent combined management and governance approaches, which need to include evolutionary and adaptive policies linked to a balanced process of review. A city that leads and designs holistically, that implements change harmoniously, and where decision-making and responsibility is shared with the empowered citizenry,

is a city on the road to sustainable practices. In balancing community needs with development, public consultation exercises and grassroots participation are essential to ensuring people-sensitive urban design and to encouraging community participation. Enabling local residents to be actively involved in shaping their community and urban environment is one of the hallmarks of a democracy.

A good public space network is essential for the liveability of a city. Easy pedestrian connectivity is the backbone of environmental sustainability and open spaces always change to respond to new needs, acting often as catalysts for urban renewal. Cities are a collective responsibility. As far as bureaucratic urban governance and best practice is concerned, authorities could consider many of the following: updating building code and regulations; creating a database of best practice and worldwide policies for eco-cities; revising contracts for construction projects and integrated public management; improving planning participation and policy-making; implementing anti-sprawl land-use policies; legislating for controls in density and supporting high quality densification; implementing environmental emergency management; introducing a programme of incentives, subsidies and tax exemptions for sustainable projects that foster green jobs; eliminating fossil-fuel subsidies; developing mechanisms for incentives to accelerate renewable energy take-up; implementing integrated land-use planning; having a sustainability assessment and certification of urban development projects. Urban design requires multi-disciplinary approaches, where design and engineering are fully integrated with all other disciplines throughout all phases of each project. This concept must be supported; and new policy frameworks should be created, which accelerate behavioural change, waste reduction and the uptake of renewable energy, which increase cultural diversity and economic opportunity.

This case study shows that cities need to always find local solutions appropriate to their particular circumstances, and that government is key in driving the outcome. The argument is that good urban governance and governmental leadership is crucial to eco-development. In summary, we can identify the following essential points for achieving sustainable urban development: Five basic concepts, to transform districts and housing estates towards low-to-no-carbon urbanism.

(a) The battle against climate change must be fought in cities. Sustainable urban design has the potential to deliver significant positive effects. The quality of a city's public transport and waste management services are hereby good indicators of a city's governance;
(b) It is particularly important not to demolish existing buildings, due to their embodied energy and materials. There needs to be a focus on integration, on adaptive reuse and on retrofitting of the existing building stock;
(c) A compact urban form with mixed-use programmes and a strong focus on low-impact public transport will deliver the best outcomes. To de-carbonize the energy supply, we need to install small distributed systems in the estates, based on renewable energy sources;

(d) Stop enlarging the urban footprint and halt sprawl, and protect the precious landscape and agricultural land. Therefore increasing the density of the districts and intensifying uses within the existing city boundary is recommended; and
(e) Change includes a whole range of different initiatives that will deliver significant CO_2-emission reductions – it is not one strategy or measure alone.

8.8 Related Web Sites

8.8.1 German Case Studies

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