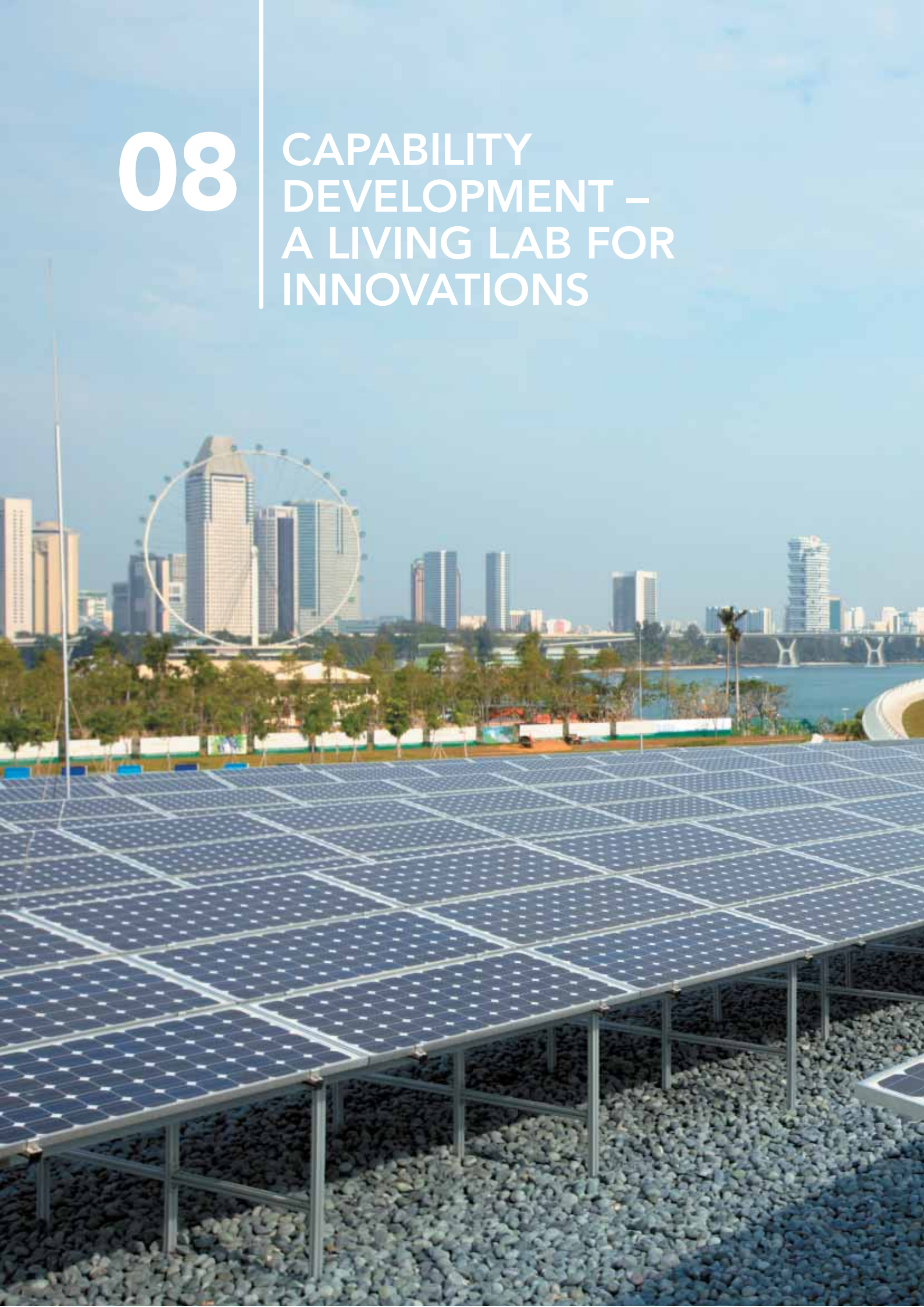


08

CAPABILITY
DEVELOPMENT –
A LIVING LAB FOR
INNOVATIONS





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CAPABILITY DEVELOPMENT – A LIVING LAB FOR INNOVATIONS



Since independence, Singapore has made a virtue of its constraints, and its limitations, a source of competitive advantage. Singapore's resource and size constraints are not a handicap. Instead they serve as the impetus for us to innovate and become a leader in resource-efficient technologies.

Our goal is to establish Singapore as a Hub for sustainable development solutions in the next decade and beyond.

We seek to achieve this goal in two ways:

- Develop key capabilities and technologies, especially in resource efficiency and urban planning and design
- Develop Singapore as a knowledge hub and provider of services relating to environmentally sustainable urban development

Key Recommendations

- 1 Conduct research to improve Singapore's effectiveness in maximising our sources of water, as well as increase the energy efficiency of water treatment.
- 2 Establish a new \$5 million incentive scheme to develop prototype building designs that achieve at least 50% improvement in energy efficiency.
- 3 Develop Marina Bay and Jurong Lake District as our new generation of sustainable high-density districts.
- 4 Establish a five-year research program to adapt water sensitive urban design concepts and technologies to local use.
- 5 Invest in R&D and manpower in clean energy and water technologies.
- 6 Expand R&D in other clean environment technology areas such as waste management.
- 7 Promote international exchange of ideas in sustainable development.
- 8 Contribute Singapore's expertise to help build environmentally sustainable cities across the world.

DEVELOPING CAPABILITIES AND TECHNOLOGIES

Technology and innovation can help us achieve both economic growth and a good living environment. Singapore will continue to invest heavily in research and development (R&D). We will learn and adapt the latest technology to our local needs, while developing new knowledge in areas such as resource efficiency, clean energy and urban planning, which we can share with other cities that face similar challenges as us in managing future growth.

Water Technologies

Singapore has limited land to store water. PUB, Singapore's national water agency, will conduct further R&D to improve Singapore's effectiveness in water treatment as well as to maximise our sources of water.

A key research priority of the PUB is to find ways to increase the energy efficiency of water production processes, which currently use up a significant amount of energy. PUB will promote research to improve the energy efficiency of seawater desalination processes in order to make desalination a more viable source of water. It will also study low-chemical or zero-chemical water treatment processes, such as ultraviolet disinfection, to improve safety, water quality and resource utilisation in water treatment. In addition, sludge produced by used water treatment processes can be a useful source of energy or materials. PUB will study an integrated anaerobic-aerobic treatment process to reduce sludge production and increase biogas that can in turn be used to power the water treatment plant.

MAKING EACH DROP COST LESS

Under a Challenge Request-for-Proposal for energy-efficient seawater desalination technologies, the Environment and Water Industry Development Council (EWI) awarded \$4 million in June 2008 to Siemens Water Technologies to develop an innovative electro-chemical process that uses only 1.5kWh of energy per m³ of seawater – much lower than current standards – to purify seawater to meet drinking standards. Unlike conventional reverse osmosis processes which extract the water, this technology removes the salt from seawater, which consists of 97% water and only 3% salt.

Another emerging water technology is membrane distillation, which utilises low-grade steam or waste heat from power stations or incineration plants to supplement the energy requirements for producing drinking water from seawater. This enables the membrane distillation process to utilise a net energy input of less than 1kWh/m³ of freshwater produced. PUB is working closely with the private sector to test-bed and commercialise these technologies.

Energy-Efficient Building Technologies

The Building and Construction Agency (BCA) will continue to promote R&D and test-bedding of green building technology.

The Ministry of National Development (MND) has established a \$50 million Research Fund for the Built Environment to support such research.

An international panel of experts comprising green building experts from around the world was also formed in October 2008 to advise BCA on promoting and implementing green buildings in Singapore.

Going forward, BCA will establish a new \$5 million incentive scheme to encourage developers to collaborate with experts worldwide to develop prototype building designs that can achieve at least 50% improvement in energy efficiency.

Urban Planning and Design

Singapore is able to achieve sustainable growth within our limited land area because we have a long-term land use planning framework that integrates infrastructure, policies and technology to meet the development needs of the country.

Going forward, the Urban Redevelopment Authority (URA) will seek to develop Marina Bay and the Jurong Lake District as our new generation of sustainable high-density districts. It will conduct further research and studies of new technologies and our physical landscape and use the results to refine its land use planning framework. It will apply the enhanced planning framework to the overall planning of these new districts to make them even more sustainable.

The URA, the National Parks Board (NParks), the Land Transport Authority (LTA), the Housing and Development Board (HDB) and the National University of Singapore (NUS) will also conduct further research on high-density living to develop new urban planning and design guidelines that can help us achieve economic, social and environmental development in a more balanced way.



Planning for a sustainable high-density mixed-use district at Jurong Lake

Water Sensitive Technologies and Urban Design

NParks and PUB will embark on a research programme to adapt water sensitive urban design concepts and technologies to local use. The project will evaluate the performance and local application of “Active, Beautiful, Clean (ABC) Water” design features¹ like bio-retention swales, rain gardens and constructed wetlands. These could act as natural purification systems to improve water quality in our reservoirs and waterways. NParks and PUB will launch pilot projects to evaluate the use of these sustainable water features.

¹ ABC Waters design features are engineering features that mimic natural systems to mitigate the impact of urban stormwater run-off on the environment. ABC Waters Design Guidelines will integrate planning and design of such features with the urban environment.



Artist impression of Marina Bay

MARINA BAY – A SUSTAINABLE DISTRICT

Marina Bay will be a vibrant and sustainable high-density district with a mixed-use live, work, play environment. The district hosts the Marina Bay Financial Centre, Marina Bay Sands Integrated Resort, the Gardens by the Bay and the Marina Barrage. The Urban Redevelopment Authority (URA) is working closely with various government agencies such as the Building and Construction Authority (BCA), National Parks Board (NParks), Land Transport Authority (LTA), the national water agency PUB and the National University of Singapore (NUS) to further enhance the sustainability of Marina Bay.

Sustainable Planning

- The District is planned following sustainable development principles. For example, the area is being developed as a seamless extension of the existing Central Business District, allowing the new developments to tap into the existing infrastructure and integrate with existing developments.
- URA intends to develop an urban bio-climatic map for the area to allow its planners to take advantage of prevailing wind flows to

improve pedestrian comfort, increase the use of external spaces and manage the effects of heat gain through appropriate urban design and landscape planting.

Better Energy Efficiency

- The government will require all new developments at Marina Bay to achieve a minimum Green Mark Platinum or Gold^{plus} standard.
- A District Cooling System (DCS) is also in place within the Common Services Tunnel network. The DCS achieves savings through economies of scale and reduces the amount of space needed for a mechanical plant within individual developments.
- The new Waterfront Promenade around Marina Bay will include design features to cool the ambient air temperature and improve pedestrian comfort. The LED lighting, outdoor fans and the Visitor Centre will be powered by solar energy. The Visitor Centre will include sustainable design features such as natural daylighting and natural ventilation.

Greenery and Water Management

- The Marina Barrage and the Marina Reservoir will collect all rainwater within the urban catchment area to increase our water resources and to control flooding. The barrage includes resource-efficient design and features.
- URA will require all new developments within Marina Bay to provide skyrise greenery and ground level communal landscaped areas which are equivalent to the site area of the development. NParks will operate a new Skyrise Greenery Incentive Scheme to incentivise existing developments in the City Centre to green up their roofs.
- The 101ha world-class Gardens by the Bay and extensive landscape planting within the district will provide the public with green spaces for recreation and allow for biodiversity. URA will work with NParks and PUB to incorporate more biodiversity, water recycling and water sensitive design features in Marina Bay.

Sustainable Transport

- A comprehensive public transport network, planned to be in place by 2020, will allow commuters to be within an average of 5 minutes walk from their destinations. The Rapid Transit System (RTS) Stations will be seamlessly integrated with a comprehensive pedestrian network at the Bay that is part of the larger planned pedestrian network within key districts in the city centre. The comprehensive pedestrian network, including underground, street-level and upper level walkways, will facilitate inter-building connectivity and encourage the use of public transport.
- An intra-district network of cycling paths, which can link with the larger island-wide Park Connector Network, is also being studied.

A Place for All to Enjoy

- There will be an extensive waterfront promenade and a network of covered and open spaces for people to gather in and enjoy.
- The Marina Bay Development Agency will manage the public areas and continue to work with stakeholders to coordinate a year-round calendar of events with the aim of enhancing the sense of identity and vibrancy of Marina Bay.
- Singapore's first Art Park will foster a greater sense of community ownership and will feature a number of art works by students.

Heritage Conservation

- The conservation and adaptive re-use of key heritage buildings around Marina Bay, including the former Clifford Pier and Customs Harbour Branch Buildings, Change Alley Aerial Plaza, Fullerton Hotel and the Asia Insurance Building, will provide a historical reference to the past.

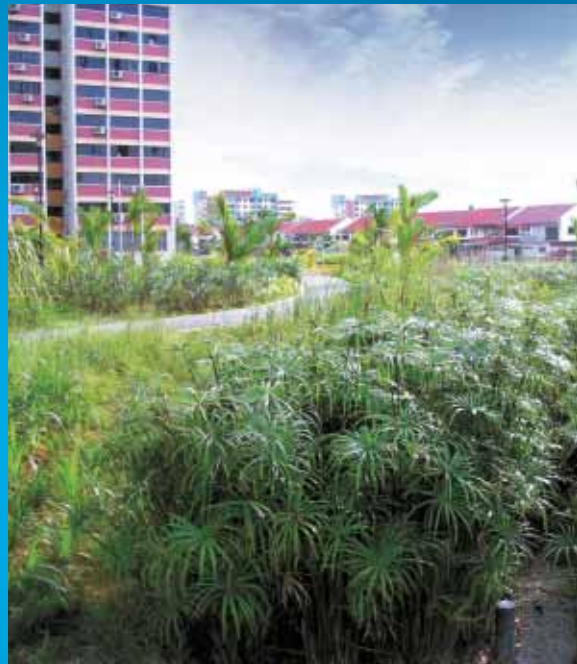


Conservatories, Gardens at Marina South

CLEANING WATER THE NATURAL WAY

The PUB and the Housing and Development Board (HDB) have set up an experimental rain garden at Balam Estate. The rain garden creates a garden habitat, promotes biodiversity and provides an aesthetically pleasing landscape. Stormwater interacts with the soil and plants in the rain garden and is cleansed of litter and pollutants.

The Sengkang Riverside Park Constructed Wetland System consists of two sedimentation basins and a macrophyte zone designed for a catchment area of 9.35ha. A macrophyte zone is an area where water is naturally cleansed of nutrients that are absorbed by aquatic plants. It uses wetland plants to cleanse stormwater runoff. The sedimentation ponds collect fine particles and sediments from the stormwater runoff before discharging it into the macrophyte zone where wetland plants



The rain garden in Balam Estate filters stormwater naturally, creates a natural habitat for biodiversity, and adds to the landscape

such as Typha and Cyprus treat the water to improve its quality. The treated water can then be reused for irrigation in the park.

THE VARIABLE SALINITY PLANT: MAXIMISING EVERY SINGLE DROP

Conventional water treatment processes are able to treat freshwater or seawater but not both. PUB developed a patented Variable Salinity Plant (VSP) that is able to treat feed water of varying salinity to potable water. The VSP can potentially enable Singapore to tap on marginal sources of water from our fringe catchments to further increase the water catchment area in Singapore. PUB successfully proved the technical feasibility of the VSP through a 240m³ per day pilot plant at Bedok



Water Reclamation Plant in 2004. Following this, a medium-scale demonstration plant of 4560m³ per day was built and has been operating since July 2007.

POSITIONING SINGAPORE AS A SUSTAINABLE DEVELOPMENT HUB

Singapore is a good place for companies and research organisations to develop and test their ideas in an urban setting because it has skilled people with environmental management and system integration expertise. Going forward, we will continue to invest in R&D and manpower development programmes to further enhance Singapore's attractiveness as a base for research and export of new technologies, as well as an innovative thought-centre on high-density urban living and sustainable development.

Research and Test-Bedding Programmes

The government has set aside \$680 million to build new capabilities in Clean Energy and Water Technologies. The funding supports both research and test bedding programmes as well as manpower development programmes. The Clean Energy and Water Technology sectors can potentially create an economic value-add of \$3.4 billion and generate employment of 18,000 by 2015.

The government provides funding incentives and infrastructure for Institutes of Higher Learning, Research Institutes and companies to conduct basic and applied research and to demonstrate innovative solutions in Singapore. It has launched several schemes to facilitate the entire technology development lifecycle, from basic and applied research, pilot and demonstration trials to commercialisation. This includes an incubator programme that helps to nurture clean energy and water technology start ups through business mentoring and financial support. The \$20 million

Solar Capability Scheme (SCS) encourages innovative design and integration of solar panels into buildings. This scheme helps to build up the capabilities of designers, architects and system integrators in solar energy companies.

Manpower Development Programmes

Singapore has launched a number of initiatives to train specialist manpower and research talent for the clean energy and water technology sectors. NUS and the Nanyang Technological University (NTU) have set up several R&D centres of excellence such as the DHI-NTU Water and Environment Hub, Singapore Membrane Technology Centre (SMTTC), Singapore Delft Water Alliance (SDWA) and the Solar Energy Research Institute of Singapore (SERIS). Scholarships are also awarded to promising individuals to train the next generation of researchers to support the growth of the industry.

Clean Environment Technology

Singapore will also build up capabilities in other areas of clean environment technology, such as urban waste management technologies. This will augment our existing initiatives and strengthen our positioning as a provider of sustainable urban solutions.

Facilitate Global Knowledge Exchange

Although Singapore is a small country, we can help to promote and build environmentally sustainable cities beyond our shores.

We will continue to organise international conferences to facilitate open dialogue and



The Singapore International Water Week provides a global platform for water solutions

sharing with the global community on technologies and policies related to sustainable development. The biennial World Cities Summit brings together leaders, city mayors, policy-makers, urban planners, experts, industry and international organisations to discuss challenges facing cities and share best practices to promote vibrant and liveable cities. The Singapore International Water Week provides a global platform for water solutions. It brings together policy makers, industry leaders and experts to discuss water solutions, showcase technologies and celebrate technological achievements in water management.

The Ministry of National Development and the Ministry of the Environment and Water Resources have also set up the Centre for Liveable Cities (CLC), a policy-oriented think tank. CLC brings together Singapore's expertise on sustainable urban development in the areas of good governance, urban planning, effective resource management,

quality living environment, affordable housing and sustainable transport solutions. CLC will distil and deepen Singapore's urban development expertise through developing case studies and undertaking projects and research of an interdisciplinary nature. It will facilitate the sharing of knowledge and best practices among cities in the region through workshops, seminars and training programmes. CLC will also develop links and strategic partnerships with key regional and international organisations, cities and other centres of excellence.

Singapore is also happy to partner other nations and cities to design and build environmentally sustainable townships in other parts of the world. In doing so, we hope to encourage more cities to grow in a clean and resource efficient way. The URA has set up the URA Consulting Group and the PUB has set up WaterHub to provide training and consultancy in urban planning and water management respectively to cities that require such services.



MOVING TOWARDS ZERO ENERGY BUILDINGS

Singapore has embarked on a Zero Energy Building (ZEB) project to showcase and test-bed green building technologies. The project involves retrofitting an existing building to serve as BCA's academy, which will house offices, classrooms, a library resource centre as well as a visitor centre. This ZEB@BCA Academy is designed to be 100% powered by solar energy and will be about 60% more energy-efficient than the norm. It will also incorporate advanced green building

technologies. These include personalised cooling for occupants, integrated facade devices to shade the building and bring daylight to the interior, and vertical greenery to reduce solar gains and glare. The ZEB@BCA Academy is scheduled for completion in the second half of 2009. It is a joint project between BCA, the National University of Singapore (NUS) and key industry players DP Architects, Beca Carter and Davis, Langdon & Seah.

CONCLUSION

The environmental challenges ahead open up opportunities for Singapore to innovate and create sustainable development solutions with partners across the globe. Together, we can use technology to improve lives and protect the environment, not only in Singapore, but across the world.