Singapore's National Climate Change Strategy

March 2008

EXECUTIVE SUMMARY

Environmental sustainability and economic growth have been key drivers of Singapore's socio-economic development. As a small country with few natural resources, it is important that we optimise the use of our available environmental and energy resources, and at the same time achieve synergies across the policy objectives of environmental sustainability, economic competitiveness and energy security.

2. A similar approach is required to address climate change. This ***National Climate Change Strategy*** presents Singapore's current and future efforts to address climate change in vulnerability and adaptation, as well as mitigation of greenhouse gas emissions. The strategy also outlines our local competency-building efforts and our participation in international climate change discussions.

3. The ***National Climate Change Strategy*** reiterates Singapore's commitment to do our part in the international effort to address climate change. The challenge of mitigating greenhouse gas emissions is not one that we can tackle alone. It requires the commitment and participation of all countries, under the auspices of the United Nations Framework Convention on Climate Change.

4. All countries have to play a role consistent with their unique national circumstances. Singapore will do its part, in particular by improving the energy efficiency of our major energy sectors, namely power generation, industries, transport, buildings and households. We are also committed to the global research effort on climate change and energy technologies and are investing to develop technologies that can help the world meet the climate change challenge, in the areas of solar energy and water.

Background

Science of Climate Change

5. There is no longer any serious doubt that climate change is taking place. The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4)[1] in 2007 concluded that most of the warming of our climate is very likely due to increasing greenhouse gas (GHG) concentrations in the atmosphere resulting from human activities such as the burning of fossil fuels in power stations for electricity and in vehicles, as well as deforestation.

6. The AR4 projects that global temperatures will rise by 1.1 to 6.4°C over 1990 levels, while global mean sea levels are projected to rise by 18 to 59cm by around 2100, depending on future scenarios of varying global emission

[1] The IPCC AR4 is available online at http://www.ipcc.ch/

levels. Temperature extremes, heat waves and heavy rainfall events are projected to become more frequent as well.

Reasons for Climate Change Action

7. There are several co-benefits to climate change action. For example, our efforts to mitigate GHG emissions, most notably in the power generation, industry and transport sectors, can help to reduce air pollutants, resulting in cleaner air for all in our environment.

8. Climate change actions can also generate economic opportunities, for example, in the clean energy and energy efficiency services sectors. At the same time, being more energy efficient can help both businesses and households reduce their energy consumption costs. At the national level, this helps to mitigate Singapore's dependence on imported fossil fuels, thereby enhancing our energy security.

Our Vulnerabilities and Adaptation Efforts

9. As a relatively low-lying, densely populated island in the tropics, Singapore is vulnerable to climate change. As a result of our environmental and developmental planning in the past, some of our existing measures can already address certain potential climate change impacts. However, to better understand the implications for Singapore, the National Environment Agency (NEA), in consultation with other government agencies, has commissioned a study on Singapore's vulnerability to climate change. This study will project (i) the climate change effects such as the changes in temperature, sea level and rainfall patterns in Singapore, and (ii) the resulting impacts such as increased flooding and impacts on water resources.

10. Going forward, government agencies will continue to work closely together to assess the possible impacts of climate change on Singapore, regularly review the sufficiency of Singapore's existing adaptation measures, identify new measures as necessary and establish national systems to actively monitor and manage these impacts.

Our Mitigation Efforts

Our National Circumstances

11. The main contribution to Singapore's greenhouse gas (GHG) emissions is carbon dioxide (CO_2) from the use of energy to meet development and human needs.

12. Singapore is a city-state with limited natural resources. Due to our geographical constraints, large-scale adoption of alternative energy beyond oil

and gas is unlikely. We lack the natural endowments to tap hydropower or geothermal energy. For wind, based on current technology, there is limited scope due to our low wind speeds as well. The forms of renewable energy that will be more applicable to Singapore besides waste-to-energy would thus comprise solar energy and biofuels. However these sources of renewable energy are not yet cost-competitive with conventional fossil fuels. Hence, we are reliant on fossil fuels to meet our energy needs at present.

13. Singapore is also an export-oriented, energy intensive economy. Much of the energy used by our industry is not used to make products for local consumption but rather products for export. Nonetheless, we produce less carbon in the process of generating each dollar of GDP compared to other countries. Singapore's CO_2 intensity (CO_2 per dollar GDP at 2000 PPP prices) is below the world average, according to the International Energy Agency (IEA).

Mitigating GHG Emissions

14. In general, countries can reduce their GHG emissions in the following ways:

a. Increasing energy efficiency;

b. Using less carbon-intensive fuels; and

c. Increasing carbon 'sinks' such as forests

15. In Singapore, our GHG emissions are mostly a result of the combustion of fossil fuels for energy. Our small size also limits the possibility of increasing forest cover domestically. In addition, by 2007, 79% of the electricity we use was already generated by natural gas using highly efficient combined cycle technology. This is amongst the highest in the world. Our key strategy to mitigate GHG emissions in Singapore is thus to increase the energy efficiency of our various sectors.

Support Efforts to Use Less Carbon-Intensive Fuels

16. With the liberalisation of the electricity market, Singapore has moved significantly towards using natural gas as an electricity source. As natural gas emits 40% less CO_2 than fuel oil per unit of electricity generated, this has led to lower CO_2 emissions from the power sector. We are also focusing our efforts in promoting renewable energy, by investing in R&D and test-bedding to improve their performance and cost-effectiveness. This includes the setting up of research institutes, provision of funds and test-bedding platforms.

Increasing Our Energy Efficiency

17. Singapore's policy of not subsidising energy costs provides a market incentive for energy consumers to be more energy efficient. This policy, together with our past energy efficiency efforts, has led our energy intensity to improve by 15% between 1990 and 2005. Singapore also supports the

APEC[2]-wide regional aspirational goal of a reduction in energy intensity of at least 25% by 2030 from 2005 levels.

18. To drive our future energy efficiency efforts in the various sectors of our economy, the National Environment Agency (NEA) chairs the Energy Efficiency Singapore Programme Office (E^2PO) comprising members from EMA, EDB, LTA, BCA and A*STAR. The E^2PO has developed a national plan to promote energy efficiency, also known as Energy Efficient Singapore (E^2 Singapore).

19. E^2 Singapore comprises actions in the following areas:

a. Promoting the adoption of energy efficient technology and measures by addressing the market barriers to energy efficiency;

b. Raising awareness to reach out to the public and businesses so as to stimulate energy efficient behaviour and practices;

c. Building capability to drive and sustain energy efficiency efforts and to develop the local knowledge base and expertise in energy management;

d. Promoting research & development to enhance Singapore's capability in energy efficient technologies.

Competency Building

20. To facilitate Singapore's efforts to mitigate CO_2 emissions and adapt to climate change in the most environmentally sustainable and cost-effective way possible, there is a need to build up a broad range of competencies, in technology, skills and expertise.

CO2 Mitigation Technology

21. Research into clean and renewable energy will help decrease our reliance on carbon-intensive fossil fuels, while developing energy-efficient technology will reduce the impact of our growing energy needs. The objective of our research efforts (e.g. energy efficiency, solar energy, green buildings, etc.) is to improve the current state of technology, and to bring down production costs to a level that would make large-scale adoption commercially viable.

Energy Management and Carbon Expertise

22. With the nation-wide drive on energy efficiency and worldwide move to reduce CO_2 emissions, there will be a demand for energy management

[2] Asia-Pacific Economic Cooperation

capabilities and services and carbon consultancy services. The establishment of the relevant training courses, accreditation schemes and institutes will help to ensure a continued build-up of such skills and expertise in Singapore in the future.

Vulnerability Assessment and Adaptation Technology and Expertise

23. Research into better vulnerability assessments and adaptation technologies will help us better understand climate change effects as well as address our vulnerabilities to climate change more effectively.

International Participation

24. Beyond domestic efforts to combat climate change, the global nature of the climate change problem requires global solutions. A strong and effective international effort is needed to address climate change and every country must play its part.

25. There is a need for the international community to discuss and to reach an agreement on a long-term global target, to give a clear signal of the global commitment to tackle climate change. The Bali Roadmap adopted by the international community in 2007 is an important part of the process and represents a step forward in establishing a post-2012 climate change agreement. Any future climate change regime must have the commitment and participation of all countries, and take into account national circumstances. The world has to pursue pragmatic and cost-effective ways to reduce GHG emissions, protect the world's carbon sinks, and set overall targets to reduce emissions.

Going Forward

26. As a result of our careful long-term planning and sound policies, Singaporeans today enjoy a clean and healthy living environment that is admired internationally. Going forward, we will continue to be committed to climate change action which allows us to develop in an environmentally sustainable manner compatible with economic growth. We will continue to review our ***National Climate Change Strategy*** in line with advances in technology, further evidence on climate science and international commitment to climate change.

1. Background

Environmental Sustainability and Climate Change

1.1. Singapore has always sought to balance the twin goals of environmental sustainability and economic growth. As a small country endowed with few natural and physical resources, it is important that we optimise the use of our available environmental resources such as clean air, land, water and energy. We have therefore adopted an action-oriented approach to environmental sustainability that recognises our environmental resources are finite and valued. Our development is underpinned by long-term vision, holistic urban planning, sound environmental policies and high regulatory standards. Over the years, we have strived to do the following:

- Maintain our good ambient air quality;
- Manage our waste to reduce the need for landfill;
- Conserve our water resources; and
- Increase our energy efficiency.

1.2. This practical approach has enabled Singapore to achieve economic prosperity, social progress and a quality living environment.

1.3. A similar approach is required to address climate change. It is a multi-dimensional challenge that cannot be disconnected from policies in other areas, such as energy and economic policy. Synergies have to be achieved across the policy objectives of environmental sustainability, economic competitiveness and energy security.

Science of Climate Change

1.4. There is widespread international consensus that climate change is a major global environmental challenge. According to the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4)[3] released in 2007, there is no longer any serious doubt that our climate is warming. The report also concludes that most of the warming is very likely[4] due to increasing greenhouse gas (GHG) concentrations in the atmosphere resulting from human activities such as the burning of fossil fuels in power stations for electricity and in vehicles, as well as deforestation.

1.5. The build-up of greenhouse gases, in particular carbon dioxide (CO_2), in our atmosphere leads to global warming by enhancing the greenhouse effect. Global CO_2 concentrations are now higher than they have been in the past 650,000 years. The 2005 CO_2 concentration was 379 parts

[3] The IPCC AR4 is available online at http://www.ipcc.ch/
[4] The IPCC defines "very likely" as having a >90% likelihood.

per million (ppm), while historically, CO_2 concentrations in the last 650,000 years ranged from 180 to 300ppm.

The Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is recognised as the foremost authority on climate change science, and received the Nobel Peace Prize in 2007. It was established by the World Meteorological Organisation (WMO) and the United Nations Environmental Programme (UNEP) to provide objective information about the causes and potential impacts of climate change. IPCC reports on climate change science are authored and reviewed by hundreds of experts around the world.

Rising Temperatures and Associated Impacts

1.6. According to the IPCC AR4, global average temperatures have risen by about 0.74^{o}C in the last 100 years. While this may not seem like much, it has already led to a sea level rise of an estimated 17cm in the 20th century. The frequency of heavy rainfall events has also increased, consistent with scientific models of a warming climate.

Future Climate Change

1.7. If global CO_2 emissions continue to grow unabated, climate change is projected to occur at an even faster rate in the future. The IPCC AR4 projects that if atmospheric CO_2 concentrations ranging from 600 to 1550ppm are reached, global temperatures would increase by 1.1 to 6.4 ^{o}C in the next 100 years. This can lead to worldwide impacts on coasts, water supply, ecosystems, food supply, and health. Even if global GHG emissions are capped at 2000 levels, global temperatures will still increase by about 0.3 – 0.9 ^{o}C in the next 100 years.

Necessary Response

1.8. Urgent international action is needed to reduce the amount of GHG emissions worldwide and thereby limit climate change. At the same time it must be noted that the world is likely to face climatic changes in the near future as a result of GHG emissions over the past few decades. Adaptation measures are needed to prepare countries for them.

Reasons for Climate Change Action

Better Preparedness for Climate Change

1.9. As an island state, Singapore will be affected by climate change impacts. For example, due to rising sea levels and more frequent heavy

rainfall events, Singapore may face increased flooding and coastal land loss. Supporting international actions to mitigate climate change and undertaking adaptation efforts will help address projected climate change effects and impacts (see Chapter 2).

Cleaner Air

1.10. The burning of fossil fuels in power stations, industries, and vehicles is the main source of both CO_2 emissions and air pollution in Singapore. Adopting cleaner fuels and more energy efficient technologies to reduce CO_2 emissions will contribute significantly towards cleaner air, as well as a better quality of life for Singaporeans.

1.11. For instance, the move towards using natural gas in our power generation plants, has not only reduced our CO_2 emissions but also our emissions of key air pollutants such as particulate matter and sulphur dioxide. Using fuel-efficient hybrid or compressed natural gas (CNG) cars can similarly reduce air pollutant emissions.

Economic Opportunities

1.12. Measures to address climate change can also generate economic opportunities. There are opportunities in providing energy efficiency services such as energy audits, developing alternative energy solutions, as well as in the Clean Development Mechanism of the Kyoto Protocol.

Energy Cost Savings

1.13. Being more energy efficient can translate into lower energy consumption for both businesses and households. For businesses, this will lower their production costs and increase their competitiveness. For households, this will mean lower energy bills.

Enhanced Energy Security

1.14. Singapore is almost entirely dependent on imported fossil fuels. Making more prudent use of energy through increased energy efficiency will help reduce this dependence.

Singapore's National Climate Change Strategy

1.15. Singapore is a city-state with limited natural resources. We are heavily dependent on imported fossil fuels as the forms of renewable energy applicable to Singapore (e.g. solar energy) are not yet cost-competitive with conventional fossil fuels. As an export-oriented economy, much of the energy used by our industry is not used to make products for local consumption but rather products for export.

1.16. Nevertheless, the government is committed towards addressing climate change in an environmentally sustainable manner that is compatible with economic growth. We have become a Party to the Kyoto Protocol in 2006. As a further sign of our commitment towards addressing climate change, the government has developed this National Climate Change Strategy (NCCS).

1.17. The NCCS represents Singapore's comprehensive and holistic response to climate change. It documents our ongoing efforts and future plans to address climate change in (i) vulnerability and adaptation (V&A) and (ii) mitigation of greenhouse gas emissions. To support our V&A and mitigation efforts, we will engage in local competency-building efforts. As no country can address climate change alone, we will also participate actively in international climate change discussions and efforts (see Figure 1.1).

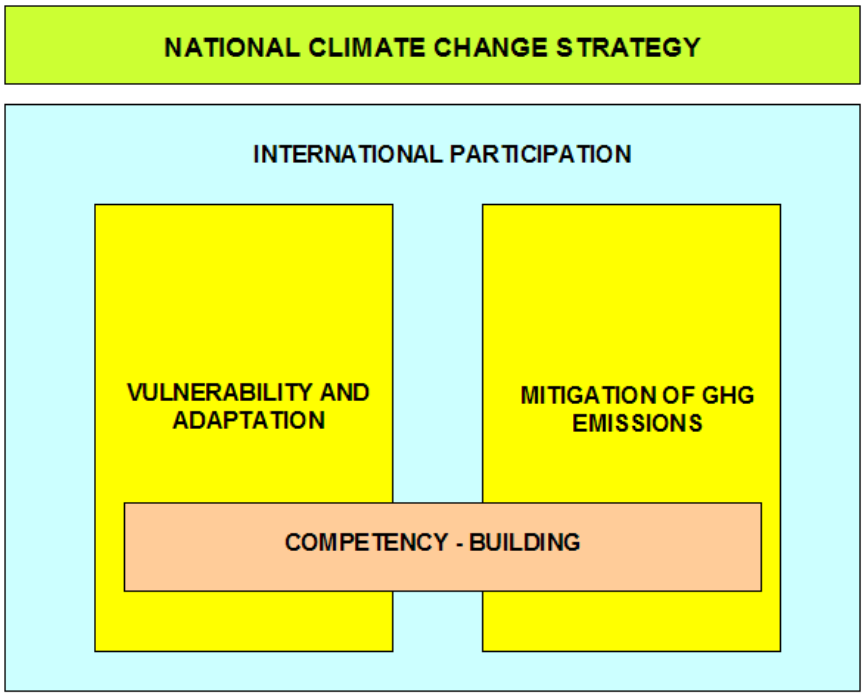


Figure 1.1 Schematic of National Climate Change Strategy

Guiding Principles

1.18. In developing the NCCS, we have adopted these guiding principles:

Climate change response must be sustainable

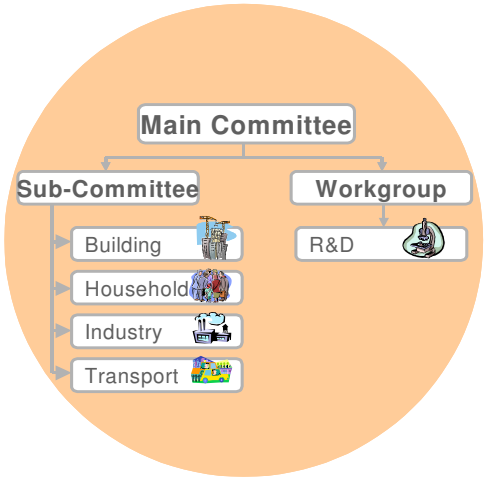
We will adopt actions that address climate change, are environmentally sustainable and are compatible with economic growth and social development. Measures that yield complementary benefits such as cleaner air, cost savings and industry development will be pursued where possible.

Climate change response needs individual, corporate and government effort

Due to the pervasive nature of energy use, effective measures to mitigate climate change begin at the individual and business level through personal and corporate decisions on energy use. Meeting the challenge of climate change cannot solely be a government initiative. Singaporeans have to join in this national effort and take action in their daily lives, at work, at play, or at home, to become more energy efficient and choose cleaner fuels.

The National Climate Change Committee

To bring together efforts by all sectors on climate change, the Ministry of the Environment and Water Resources chairs a National Climate Change Committee (N3C) with representatives from various government agencies, industry representatives (e.g. from the Singapore Manufacturers' Federation and the Real Estate Developers Association of Singapore), academia, and non-governmental organisations (e.g. the Singapore Environment Council). The N3C comprises several subcommittees and workgroups as shown below. It is a platform for policymakers to engage the private and people sectors on climate change issues and policies, gather feedback and provide the platform for key stakeholders to debate and share ideas on climate change issues.



Consultative approach

As climate change has implications for many sectors of the economy and society, we developed the NCCS through a consultative, multi-stakeholder approach. The views of our stakeholders and the public at large were sought through the following channels:

- E-Consultation
  A draft NCCS consultation paper was posted on the website of the Ministry of the Environment and Water Resources (MEWR), along with a questionnaire for the public to provide feedback over a 4-month period. Over 1300 comments were received from the public.

- Dialogue sessions with stakeholders from the private and people sectors
  MEWR and the National Environment Agency held dialogue sessions with the representatives from the private and people sectors in the National Climate Change Committee (N3C) and various environmental/youth groups. The N3C comprises of members representing the following sectors: buildings, households, industry, transportation and academia. (Please see Acknowledgements.)

- NCCS consultation forum
  A consultation forum was held with in early 2007 with our key stakeholders from the N3C and environmental/youth groups, to seek their comments. (Please see Acknowledgements.)

1.19. Going ahead, the NCCS will be a strategy roadmap that will continually be updated to reflect public awareness and action, as well as developments in technology and climate science.

2. Vulnerability and Adaptation

Climate Change Projections

2.1. According to the IPCC Fourth Assessment Report (AR4), global temperatures are projected to rise by 1.1 to 6.4°C, while global mean sea levels are projected to rise by 18 to 59 cm over 1990 levels by around 2100, based on future scenarios of varying global emission levels. Temperature extremes, heat waves and heavy rainfall events are projected to become more frequent as well. For Southeast Asia, the IPCC AR4 projects a warming similar to global mean warming. Annual rainfall in Southeast Asia is also projected to increase by about 7%[5].

Singapore's Vulnerability to Climate Change

2.2. As a relatively low-lying, densely populated island in the tropics, Singapore is affected by climate change. Much of the island is less than 15m above sea level, with a generally flat coast. With a population of about 4.7 million within its 193km coastline, Singapore is one of the most densely populated countries in the world. In addition, Singapore has a relatively high uniform temperature and abundant rainfall, and is also situated in a region in which communicable diseases such as dengue are endemic.

2.3. Given these circumstances, the potential impacts of climate change on Singapore include:

a) Increased flooding
b) Coastal land loss
c) Water resource scarcity
d) Public health impact from resurgence of diseases
e) Heat stress
f) Increased energy demand
g) Impacts on biodiversity

These potential impacts are not due solely to climate change, but can be aggravated by adverse global climate change.

2.4. We are aware of these vulnerabilities to climate change. As a result of our environmental and developmental planning in the past, we have existing measures in place that help address the potential climate change impacts. These are elaborated in the section on "Adaptation Measures" below.

[5] Based on the projections of 21 models, the predicted annual rainfall changes for Southeast Asia range from -2% to +15% with a median change of +7%.

2.5. At the same time, we recognise the need to continue improving our understanding of the detailed effects and resulting impacts of climate change on Singapore. NEA, in consultation with other government agencies, has commissioned a study of Singapore's vulnerability to climate change. This study will project climate change effects such as temperature, sea level and rainfall patterns in Singapore in the next century, and the impacts of such effects like increased flooding and impacts on water resources.

2.6. The study team is led by the Tropical Marine Science Institute of National University of Singapore (NUS), and comprises both local and foreign experts. A number of the foreign experts have been actively involved in the drafting and review of IPCC reports as well. The results of the study will facilitate the identification of new adaptation measures as well as the review of existing adaptation measures.

Adaptation Measures

Flooding

2.7. A higher sea level will make it more difficult for rainwater to drain into the sea. This can aggravate inland flooding during storm surges (when seawater is pushed toward the shore by the force of the winds swirling around the storm) and rainstorms. Since 1991, the Public Utilities Board (PUB) requires new reclamation projects to be built to a level 125 cm above the highest recorded tide level. This addresses the IPCC AR4's sea level rise projection of 59 cm by the end of the 21st century under the worst case scenario assessed.

2.8. The development of drainage infrastructure in Singapore over the last 30 years has also reduced flood-prone areas from 3200 ha in the 1970s to 124 ha today. PUB will reduce it to less than 66 ha by 2011 through the development and improvement of drainage infrastructure in Singapore (e.g. widening and deepening of drains and canals), the completion of the Marina Barrage, as well as other flood alleviation projects. This will reduce the possibility of increased inland flooding due to climate change.

2.9. In addition, PUB has a deliberate policy to raise low-lying areas in conjunction with redevelopment proposals.

Coastal Land Loss

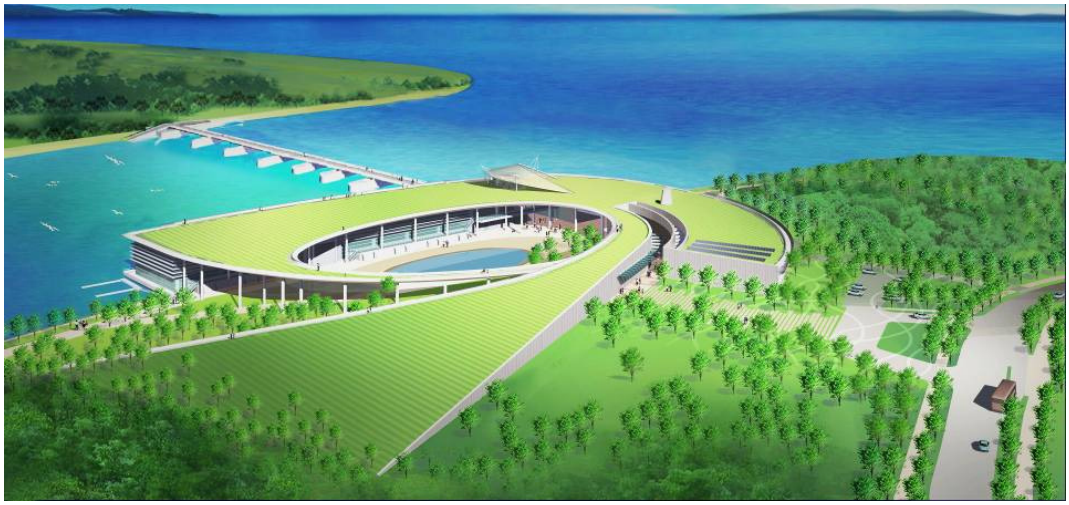
2.10. A sea level rise of up to 59 cm can result in some coastal erosion and land loss in Singapore, particularly as Singapore has a relatively flat coastline. Currently, about 70% to 80% of Singapore's coastal areas have hard wall or stone embankments, which help protect against coastal erosion. The rest are either natural areas such as beaches and mangroves. Increased erosion could impact recreational areas at the coasts, such as East Coast Park, Sungei Buloh, Pasir Ris Park, West Coast Park, and Sentosa. The

Government will look at adapting to sea level rise through the protection of our foreshore and coastal areas as the need arises. Existing revetments (which protect against erosion) may have to be strengthened and reinforced while natural areas may have to be protected using different coastal defense systems.

Water Resource Scarcity

2.11. A rise in sea level can also result in seawater flowing into some of Singapore's coastal reservoirs - a process known as saltwater intrusion. However, seawater intrusion into our reservoirs is unlikely as most of our reservoir dams are much higher than the AR4's projected sea level rise and if need be, the gate structures for the dams can be raised.

2.12. Rising global temperatures can also change rainfall patterns and affect the amount of water stored in reservoirs. The unpredictability in rainfall can cause difficulties in capacity planning of water resources. However, the introduction of NEWater and desalination, which are not rainfall dependent, has diversified and increased the resilience of our water supply, even during prolonged dry spells.



Marina Barrage

Coming True

"In 20 years, it is possible that there could be breakthroughs in technology, both anti-pollution and filtration. Then we can dam up, or put a barrage at the mouth of the Marina, the neck that joins the sea. And we will have a huge fresh water lake."

These words, expressed by Minister Mentor Lee Kuan Yew about two decades ago, will be realised. At the mouth of the Marina Channel, the construction of the $226 million Marina Barrage will be completed by end 2007. The unique 3-in-1 Marina Barrage project will not only help to increase Singapore's water supply and alleviate flooding, it will also create a lifestyle attraction right in the heart of the city.

Water Supply

The Marina Barrage will increase our local water supply source, which is one of the four national taps. With the Barrage in place, the Marina Basin will turn into a body of freshwater through natural flushing in one to two years, similar to the Kranji and Lower Seletar Reservoir schemes. The new Marina Reservoir will add to the local water supply and increase the water catchment from half to two-thirds of Singapore.

Flood Control

The Marina Barrage is also part of a comprehensive flood control scheme to alleviate flooding in the low-lying areas in the city, such as Boat Quay, Shenton Way, Geylang, Chinatown and Jalan Besar. The barrage will separate the seawater from the freshwater and act as a tidal barrier to keep out the high tides.

Lifestyle Attraction

The Marina Basin will become a scenic water body no longer subjected to tidal variations. The entire reservoir is envisioned to be a lively, vibrant and exciting place where people can enjoy themselves not only on land but the waters. In addition to the cruises and water taxis today, the new Marina Basin can be the venue for many international and local sporting events and activities, adding to the vibrancy of the Basin.

Heat Stress

2.13. Warmer temperatures due to both climate change as well as the urban heat island effect[6] can lead to greater use of air-conditioning and increase Singapore's energy demand. Higher annual temperatures may also mean more frequent and more severe episodes of warm weather, leading to increased occurrences of heat stress and discomfort, particularly among the elderly, the sick and those without access to air-conditioning.

2.14. Measures that can lower ambient temperature include increasing the amount of greenery in the city (e.g. city parks, rooftop gardens, vertical greening in buildings) and modifying building layouts and designs (e.g. using building materials with better thermal properties, lighter-coloured building surfaces, designing building interiors and exterior building layouts for better ventilation and maximising the wind tunnel effect).

2.15. The Urban Redevelopment Authority (URA) and the National Parks Board (NParks) have been working closely to plan and provide greenery islandwide, such as providing parks and green open spaces, and planting along roads and around developments. URA and NParks have also been promoting rooftop and vertical greenery on our residential and commercial

[6] The urban heat island effect refers to the phenomenon whereby urban areas are warmer than rural areas, largely due to the replacement of natural land cover with pavement, buildings and other infrastructure.

buildings through planning guidelines and incentives. The Housing Development Board (HDB) is in the process of introducing rooftop greenery to multi-storey carparks and residential buildings where feasible.

Planning our City in a Garden

Although Singapore has long been known as the Garden City, keeping our greenery healthy and verdant requires continual care and nurturing. The National Parks Board's (NParks) comprehensive programme of greenery maintenance and upgrading saw the planting of 62,600 trees in 2006. Meanwhile, Singapore residents can look forward to a seamless green mantle of tree-lined avenues and boulevards as NParks further intensifies our streetscape greenery.

To give greater character and differentiation to Singapore's streetscape greenery, which forms the backbone of the Garden City, NParks will be implementing the Streetscape Greenery Master Plan (SGMP) along major roads across the island. The SGMP will intensify our streetscape greenery along various ecological themes and character. Examples include *Coastal Treatment* for roads near the coast, and *Forest Treatment* for roads near forested areas.

Community In Bloom

To nurture a gardening culture, NParks launched the 'Community In Bloom' programme aimed at inculcating a passion for gardening and developing a greater appreciation for greenery. There are currently over 200 active gardening groups under the 'Community In Bloom' Programme. NParks advises participating gardeners on how to maintain their plants well, and also offers horticultural expertise such as gardening advice and guidelines for residents on how to start their own gardens. This encourages community bonding where residents will come together to exchange gardening tips.

Higher Energy Demand

2.16. To mitigate the increase in the amount of energy used by air-conditioning, the Building & Construction Authority (BCA) and NEA are implementing measures to further improve energy efficiency in our buildings. For example, under the Building Control Act, air-conditioned buildings must be designed with a high-performance building envelope that meets the prescribed Envelope Thermal Transfer Value (ETTV), currently set at 50W/m^2. BCA has completed a study with NUS to review the ETTV standards and to explore the possibility of extending the ETTV regulations to residential buildings. The findings from the study were taken into consideration in the proposal to stipulate minimum Green Mark standards for new buildings, leading to amendments to the Building Control Act. The minimum Green Mark standards take effect in early 2008.

Green Mark

BCA Green Mark is a green building rating system to evaluate a building for its environmental impact and performance. It provides a comprehensive framework for assessing building performance and environmental friendliness. From early 2008 onwards, all new buildings and existing buildings undergoing major retrofitting works with gross floor area above 2000m^2 must meet the Green Mark Certified standard.

Buildings are awarded the BCA Green Mark based on five key criteria:

a) Energy Efficiency
b) Water Efficiency
c) Site/Project Development and Management (Building Management and Operation for existing buildings)
d) Good Indoor Environmental Quality and Environmental Protection
e) Innovation

Under the Green Mark assessment system, points are awarded for incorporating environmentally-friendly features. The total number of points obtained indicates the environmental-friendliness of the building design.

The assessment process consists of an initial assessment leading to the award of the Green Mark. Subsequently, buildings are required to have triennial assessments. This is to ensure that the Green Mark building continues to be well maintained.

Green Mark Award Rating

Green Mark Points	*Green Mark Rating*
85 and above	Green Mark Platinum
80 to <85	Green Mark Gold^{PLUS}
70 to <80	Green Mark Gold
50 to <70	Green Mark Certified

Apart from achieving the minimum points in each rating scale, the project has to meet all requirements, and score a minimum of 50 per cent of the points in each category, except the Innovation category.

Public Health Impact from Resurgence of Diseases

2.17. Singapore is situated in a region in which vector-borne diseases, particularly dengue, are endemic. Dengue patterns are affected by many factors, including climate. NEA is studying the link between climatic factors such as temperature, humidity and rainfall with dengue cases. Preliminary results indicate that the number of dengue cases in Singapore are correlated with the ambient temperature.

2.18. To address dengue, NEA has put in place a comprehensive mosquito surveillance, control and enforcement system, which includes pre-

emptive action to suppress the mosquito vector population, dengue-related research undertaken by the Environmental Health Institute and a review of building designs to reduce potential breeding habitats (e.g. roof gutters in new buildings have been prohibited except in special circumstances).

Impacts on Island and Marine Biodiversity

2.19. A rise in sea level can lead to loss of mangroves, which will not only represent a loss of biodiversity, but can also further aggravate coastal erosion rates. A rise in seawater temperature as a result of global warming can also have a negative impact on marine life e.g. coral bleaching.

2.20. The National Parks Board (NParks) is looking into the role of our nature reserves in carbon sequestration and is monitoring long-term tree diversity, tree growth and survival in marked study plots. The role of coral reefs around our southern islands is also acknowledged, both for sequestering carbon and mitigating storm damage and erosion. A coral nursery has therefore been established off Palau Semakau. This coral nursery will enable us to proactively enhance existing marine habitats by maximizing the survival of naturally occurring corals.

2.21. Mangroves help to protect coasts against erosion and NParks is developing pre-emptive management strategies to counter mangrove erosion at some coastal areas. Singapore cannot prevent global trends from affecting seawater temperatures locally, but will seek to mitigate any additional influences on seawater quality through measures such as the release of cooling water or sedimentation.

Further Measures to Adapt to Climate Change

2.22. Climate change is a long-term phenomenon and its impacts will be felt for decades. The Ministry of National Development leads an inter-agency Taskforce to review existing infrastructural adaptation measures, as part of the overall government's approach to address climate change. Government agencies will continue to work closely together to assess the possible impacts of climate change on Singapore, regularly review the sufficiency of Singapore's existing adaptation measures, identify new measures as necessary and establish national systems to actively monitor and manage these impacts.

3. MITIGATION OF GREENHOUSE GAS EMISSIONS

Singapore's Greenhouse Gas Emissions

3.1. The main contribution to Singapore's greenhouse gas (GHG) emissions is carbon dioxide (CO_2) from the use of energy to meet development and human needs. Singapore's methane emissions are negligible, as Singapore has no agricultural base. We also incinerate all our waste and the little methane emitted from the existing landfill is flared off.

3.2. Singapore's CO_2 emissions in 2005 were 40 Mt, accounting for less than 0.2% of global CO_2 emissions. Table 3.1 shows our 2005 CO_2 emissions from the power generation, industry, transport, buildings and households sectors in terms of both primary and secondary consumption[7].

Table 3.1: Breakdown of CO_2 Contribution in 2005[8]

Key CO_2 Contributors (2005) (kilo tonnes)

	Electricity Generation	Industry	Transport	Buildings	Consumers/ Households	Others
Primary Consumption (combust fuel)	19,315 (48%)	13,465 (33%)	7,056 (17%)	325 (1%)	216 (1%)	-
Secondary Consumption (use electricity)		8,328 (21%)	930 (2%)	5,910 (15%)	3,415 (8%)	732 (2%)
Overall		21,793 (54%)	7,986 (19%)	6,235 (16%)	3,631 (9%)	732 (2%)

TOTAL CO_2 = 40,377 kilo tonnes

Our National Circumstances

3.3. Singapore is a city-state with limited natural resources. Due to our geographical constraints, we have very little alternative energy sources beyond oil and gas. We lack the natural endowments to tap hydropower or geothermal energy. Based on current technology for wind energy, there is also little scope due to our low wind speeds. The forms of renewable energy

[7] Primary users are those which combust fuel directly while secondary users are those which use the electricity generated from fuel.
[8] Data from National Environment Agency

that will be more applicable to Singapore besides waste-to-energy would thus include solar energy and biofuels. However these sources of renewable energy are not yet cost-competitive with conventional fossil fuels. We are thus heavily reliant on fossil fuels to meet our energy needs at present.

3.4. As an export-oriented economy, much of the energy used by our industry is not to make products for local consumption but rather products for export. Singapore's industry sector accounts for about half of Singapore's total energy use in 2005, most of it due to our key exporting industries such as our refining, petrochemical, pharmaceutical and wafer fabrication industries. For instance, Singapore is one of the largest refining centres in the world and the three oil refineries account for about 20% of Singapore's total energy use. These oil refineries support our oil-trading hub, which serves the global market, and an ever-growing petrochemicals industry chain.

3.5. Despite having an export-oriented, energy-intensive economy, Singapore's CO_2 intensity (CO_2 per dollar GDP at 2000 PPP prices) is below the world average, according to the International Energy Agency (IEA). In other words, we produce less carbon in the process of generating each dollar of GDP compared to other countries.

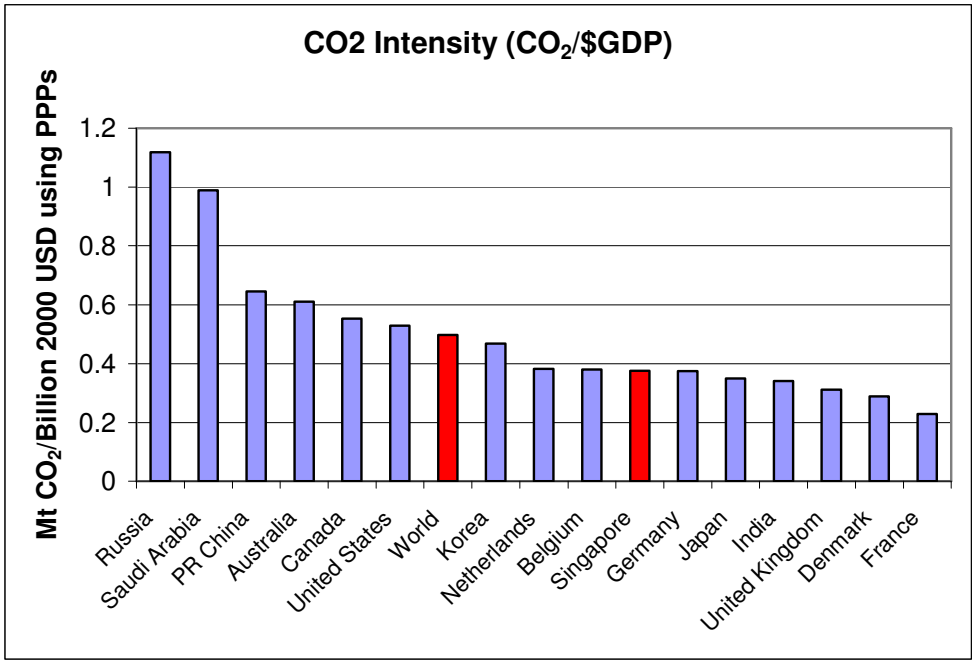


Figure 3.1. Comparison of CO_2 intensity
Source: IEA 2005

3.6. This is partly because about 80% of the electricity we use is generated by natural gas using highly efficient combined cycle technology. The remaining electricity is generated by fuel oil or other renewable energy sources (see Figure 3.1 below).

3.7. In addition, the Singapore government does not subsidise energy prices; hence businesses have an inherent incentive to be energy efficient.

There is also relatively widespread use of public transport in Singapore due to integrated land use planning, the provision of an efficient and reliable public transport system, combined with policies to manage demand and usage of vehicles.

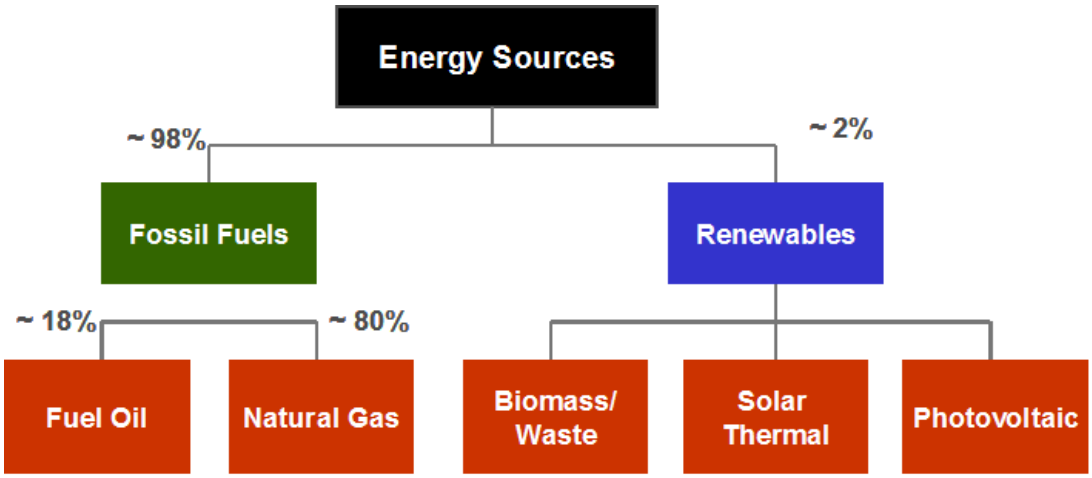


Figure 3.2. Singapore's Energy Sources

Carbon Intensity Improvement

3.8. Our historical absolute CO_2 emissions and CO_2 intensity trends are shown in Figure 3.3 below. By 2006, our carbon intensity reached 30% below 1990 levels, due to a rapid switch to natural gas for power generation and ongoing improvements in energy efficiency. In 2007, the proportion of electricity generated by gas using highly efficient combined cycle turbines in Singapore was already 79%, amongst the highest in the world.

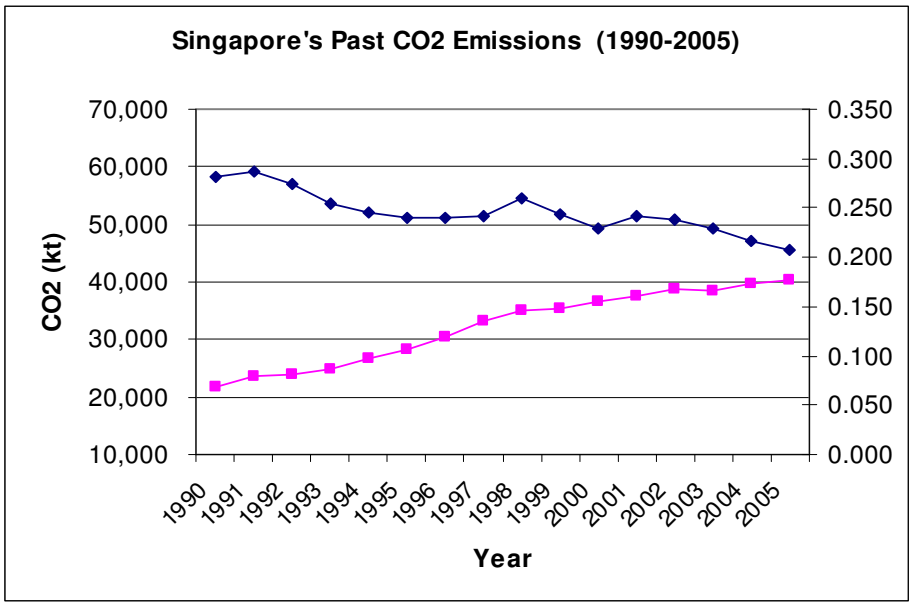


Figure 3.3: Singapore's Carbon Dioxide Absolute and Intensity Emissions 1990 – 2005

Our Strategy for Mitigating Greenhouse Gas Emissions

3.9. Countries can reduce their GHG emissions through

(a) Increasing energy efficiency;

(b) Using less carbon-intensive fuels; and

(c) Increasing carbon 'sinks' such as forests.

3.10. Singapore's small size limits the possibility of increasing forest cover domestically. As the Southeast Asian region is home to large areas of tropical rainforest, Singapore supports efforts to preserve and restore these carbon sinks through international, regional, bilateral and national platforms.

3.11. In Singapore, our GHG emissions are mostly a result of the combustion of fossil fuels for energy. Our strategy to mitigate GHG emissions from Singapore is therefore to:

a) Support efforts to use less carbon-intensive fuels (e.g. natural gas, renewables); and

b) Improve energy efficiency in all sectors of the economy.

3.12. Increasing energy efficiency in Singapore would help to reduce Singapore's CO_2 emissions, improve our air quality, reduce energy costs for companies and consumers, and help to improve our energy security by mitigating our energy demand growth. Energy efficiency is therefore Singapore's key strategy to reduce CO_2 emissions.

Support Efforts to Use Less Carbon-Intensive Fuels

Increased Use of Natural Gas

3.13. Singapore has restructured and liberalised our electricity market. As the government does not subsidise energy prices, generation companies have an inherent incentive to choose the most efficient technology. Within just a few years, the proportion of electricity generated by gas using highly efficient combined cycle turbines in Singapore grew from 19% in 2000 to 79% in 2007 (Table 3.2). This led to significantly lower CO_2 emissions from the power sector, as natural gas emits 40% less CO_2 than fuel oil per unit of electricity generated.

3.14. Efforts are underway for Singapore's first LNG terminal to be ready by 2012. This will support the increased use of natural gas to help meet increases in energy demand.

Table 3.2: Electricity Generated by Natural Gas

	2000	2001	2002	2003	2004	2005	2006	2007
Electricity Generated by Natural Gas	19%	29%	44%	60%	69%	74%	78%	79%

Waste-to-Energy

Singapore is one of the few countries that incinerate almost all their waste. This practice minimises the amount of waste dumped into the landfills and generates electricity in the process. Since Singapore recycles or incinerates almost all its waste, the amount of decomposable waste in the landfills is minimised. As such, Singapore's landfills generate negligible amounts of methane (which is also a GHG), unlike landfills in other countries.

Since 2000, Singapore's waste-to-energy plants have been contributing about 2-3% of our energy supply. At the moment, there are four waste-to-energy plants. By 2009, Singapore will have five such plants when the new Keppel Seghers Tuas Waste-to-Energy Plant begins operations.

Promoting Renewable Energy

3.15. Our efforts in promoting renewable energy such as biomass and solar energy are focused on promoting R&D and test-bedding to improve their performance and cost-effectiveness. These efforts are elaborated in Chapter 4 on competency-building.

3.16. To facilitate the adoption of renewable energy, government agencies are working together to review the policies pertaining to distributed electricity generation using renewable energy sources in Singapore while at the same time ensuring this does not cause disruption to our electricity network. This will serve to encourage take-up of small-sized renewable energy generation systems by companies and individuals.

Improve Energy Efficiency

3.17. Singapore's policy of not subsidising energy costs provides a market incentive for energy consumers to be more energy efficient. This policy, together with our past energy efficiency efforts, has led our energy intensity to improve by 15% between 1990 and 2005. Singapore also supports the APEC[9]-wide regional aspirational goal of a reduction in energy intensity of at least 25% by 2030 from 2005 levels.

3.18. However, today there are still energy efficiency measures with cost-effective returns that are not implemented due to certain market failures and barriers, some of which are described below:

a) Lack of information
   Companies or individuals may be unaware of technologies or actions that could bring about energy savings. There may also be a lack of data on lifetime cost savings and payback periods on energy efficient products or equipment.

b) Lack of capabilities
   Many companies may lack the technical expertise to effectively improve energy efficiency.

c) Split incentives
   In some cases, the people who are in a position to make decisions to improve energy efficiency are not the ones who benefit from such actions.

3.19. To drive future energy efficiency efforts in the various sectors of our economy, the National Environment Agency (NEA), chairs an Energy Efficiency Singapore Programme Office (E^2PO) comprising members from EMA, EDB, LTA, BCA and A*STAR. The E^2PO has developed a national plan

[9] Asia-Pacific Economic Cooperation

to promote energy efficiency, also known as Energy Efficient Singapore (E^2 Singapore).

3.20. E^2 Singapore comprises actions in the following areas:

a) Promoting the adoption of energy efficient technology and measures by addressing the market barriers to energy efficiency;

b) Raising awareness to reach out to the public and businesses so as to stimulate energy efficient behaviour and practices;

c) Building capability to drive and sustain energy efficiency efforts and to develop the local knowledge base and expertise in energy management;

d) Promoting research & development to enhance Singapore's capability in energy efficient technologies.

3.21. The policies and measures for each sector under areas (a) and (b) are elaborated below. Efforts under areas (c) and (d) are elaborated in Chapter 4 on competency-building.

Sustainable Energy Fund

3.22. To support implementation of the E^2 Singapore, a Sustainable Energy Fund (SEF) of S$50 million over 5 years has been established, administered by the E^2PO. A portion of the SEF will be used to incentivise energy efficiency improvements in the different sectors such as industry and buildings. The SEF will also be used to fund energy efficiency studies to improve data availability across all sectors.

Power Generation

3.23. The power generation sector is the single largest primary source of carbon dioxide emissions in Singapore, accounting for 48% of our carbon emissions in 2005[10]. Due to market competition in the electricity market, power generation companies (gencos) have an incentive to be energy efficient. Gross efficiency of power generation in Singapore increased from 39% in 2001 to 44% in 2006. Further efforts to help improve the energy efficiency of power generation in Singapore include the use of cogeneration and trigeneration.

Increasing the Use of Cogeneration and Trigeneration

[10] Primary users are those which combust fuel directly while secondary users are those, which use the electricity generated from fuel.

3.24. Cogeneration and trigeneration can significantly improve the energy efficiency of generating power and steam (and chilled water in the case of trigeneration). However, a combined demand for electricity and heating (and cooling in the case of trigeneration) is needed for such technologies to be viable.

3.25. To maximise efficiency, government agencies such as the Economic Development Board (EDB) and Jurong Town Corporation will plan industrial land and site facilities with cogeneration and trigeneration in mind, particularly for energy-intensive sectors such as power generation, petrochemicals and pharmaceuticals.

Cogeneration and Trigeneration

In the power generation process, a significant amount of heat produced from fuel combustion is often not captured and is wasted. Cogeneration, or combined heat and power (CHP), refers to capturing both the heat and electricity produced from fuel combustion, which can increase the energy efficiency of power generation from about 50% to more than 75%. The efficiency of a trigeneration plant is even higher, when chilled water is also produced using the waste heat. While cogeneration and trigeneration are more commonly used in industrial facilities, they can also be used by power plants and buildings.

Industry

3.26. The industry sector accounts for about 54% of Singapore's carbon dioxide emissions. Singapore is one of the top oil refining centres and oil trading hubs in the world, and our refineries support an ever-growing petrochemicals industry chain. We also account for 10% of the global market for semiconductor wafer output.

3.27. Improving the energy efficiency of our industries is a win-win strategy as this not only lowers their carbon emissions but renders them more cost-competitive in a high oil price environment. While the processes in our various industries are differentiated, there are common approaches to improving their energy efficiency. Going forward, we will encourage our industries to:

a) Design their facilities to be efficient;

b) Use energy efficient equipment;

c) Have trained personnel who can recognise and implement energy efficient measures.

3.28. The global concern with climate change also brings with it new business opportunities, such as the export of carbon-efficient technologies to support sustainable development in other countries and the provision of carbon services such as carbon trading. These opportunities match Singapore's environmental, engineering, and financial expertise, and we will work with local industries to seek out such opportunities. This would contribute to global efforts in mitigating climate change. Chapter 4 expands on the efforts to build up our technological and human competencies related to climate change.

Design for Efficiency Scheme

3.29. To help new industrial facilities incorporate energy efficiency considerations at the design stage, NEA will introduce a Design for Efficiency scheme. This pilot scheme will co-fund design workshops for new industrial developments to meet high standards of energy efficiency.

Texas Instruments Case Study
After participating in design workshops conducted by the non-profit, energy efficiency consultant Rocky Mountain Institute, Texas Instruments (TI) in the USA was able to design a super efficient green wafer chip factory. The factory is expected to cost $220 million less to build than TI's last wafer chip factory, and to use 20% less electricity and 35% less water usage compared to wafer chip factories built previously.

Source: Breakthrough Design^{TM} Team, from Rocky Mountain Institute

Energy Audits

3.30. In July 2002, an Energy Audit Scheme was introduced for major industrial consumers of energy, such as oil refineries. To date, six major facilities from the petroleum refining and petrochemicals industries have voluntarily signed up to the scheme, committing to carry out energy audits in their premises and formulate action plans to improve their energy efficiency over a period of five to seven years.

3.31. In April 2005, MEWR and NEA launched the $10 million Energy Efficiency Improvement Assistance Scheme (EASe) to co-fund the cost of energy audits. Under EASe, funding of up to 50% of the cost for energy audits, subject to a cap of $200,000, will be provided to any Singapore-registered company with a building or manufacturing facility in Singapore. As of end Jan 08, 87 companies in the power, industry and building sectors have obtained grants under EASe to conduct energy audits. The recommended energy efficiency measures from the energy audits are projected to result in annual energy savings of $23.4 million, energy savings of 296,402 MWh and 150 kt of CO_2 savings per year for the companies, if implemented.

Incentives for Energy Efficiency Measures

3.32. EASe will be supported by the Investment Allowance (IA) Scheme. It is a capital allowance of 50% of the capital expenditure on qualifying equipment, that is deductible against chargeable income. The IA can be awarded if the capital expenditure results in greater energy efficiency.

3.33. In addition to the IA scheme, there is a one-year accelerated depreciation allowance for energy efficient equipment and technology. Companies that replace energy-consuming equipment with more energy efficient ones or invest in energy-saving equipment can depreciate the qualifying capital equipment in one year instead of three.

Grant for Energy Efficient Technology

3.34. To further encourage our companies to adopt energy efficient technologies and equipment, NEA will establish a Grant for Energy Efficient Technology. This grant, also known as GREET, will provide funding for companies to offset part of their investment cost for energy efficient equipment.

Awareness-Raising

3.35. To promote the uptake of energy-efficient equipment and implementation of energy efficiency practices, NEA will develop an energy efficiency website that will provide industry with details on the available energy efficiency schemes and energy efficiency case studies.

3.36. To facilitate the sharing of knowledge, expertise and best practices in energy efficiency, NEA together with other agencies such as the Building Construction Authority (BCA) will periodically arrange energy efficiency seminars and workshops that bring together local and overseas experts and various stakeholders (e.g. companies and building owners).

Singapore Certified Energy Manager Training Grant

3.37. NEA will provide a Singapore Certified Energy Manager Training Grant to help equip facility owners and technical staff with the necessary knowledge and skills to manage energy services within their facilities. We will also study the feasibility of making the appointment of energy managers mandatory for large manufacturing and building facilities in the next 3 to 5 years.

Transport

3.38. The transport sector in Singapore accounts for about 19% of greenhouse gas emissions. Improving the energy efficiency of the transport sector is achieved through the following key strategies:

a) Managing vehicle usage and traffic congestion;
b) Improving and promoting the use of public transport;
c) Improving fuel economy; and

d) Promoting green vehicles.

Managing Vehicle Usage and Traffic Congestion

3.39. Singaporeans are undoubtedly familiar with the various means of controlling vehicle usage in our city. While implemented in order to manage traffic congestion, these measures have also helped to reduce our energy use as traffic congestion results in fuel wastage. Conversely, smooth flowing traffic allows cars to achieve better fuel economy.

3.40. Car ownership in Singapore is discouraged through the imposition of taxes on vehicle ownership such as the Additional Registration Fee, and through the Certificate of Entitlement (COE) system, which limits the number of vehicles registered. From May 2009, LTA will lower the vehicle population growth rate from the current 3% to 1.5%. This growth rate will be reviewed after 3 years to assess whether a further reduction will be necessary.

3.41. Beyond managing ownership, we have managed vehicle usage in Singapore through integrated land-use planning, congestion control measures such as electronic road pricing (ERP) and our efficient public transport system, which is a much more energy efficient way of moving the masses compared to private cars.

3.42. Other schemes that help to reduce the need for vehicle ownership and usage include the Off-Peak Car scheme and the Park-and-Ride Scheme, which allows drivers to park their cars at a discounted rate at car parks near public transport hubs such as MRT stations or bus interchanges, and to continue their journey by MRT or bus.

3.43. Due to the combined effect of these policies, private vehicle ownership is well controlled, and there is widespread use of public transport in Singapore.

3.44. To manage road congestion, LTA will continue to employ a multi-pronged approach, which includes increasing the carrying capacity of the roads through infrastructure development, harnessing technology to increase throughput, as well as utilising ownership and usage restraint measures like the COE and ERP.

Improving and promoting the use of public transport

3.45. The Government will continue to promote public transport as it is the most efficient form of transport in densely populated and land-scarce Singapore, and aims to make public transport a choice mode to attract more car-owners to consider using it for their daily commute.

3.46. LTA will continue to improve public transport by making significant public transport infrastructure investments and planning the entire system as an integrated whole from the commuters' perspective, with bus and rail

working in close partnership to provide more seamless and convenient transfers. Through these public transport improvements coupled with our vehicle demand management measures, LTA aims to increase the public transport modal share during morning peak-hours from 63% in 2004 to 70% by 2020.

Energy Consumption of Different Forms of Transport

The environmental merits of public transportation can be seen from a comparison of the relative energy use by the different modes of transport. It is estimated that to transport one person, a car carrying only one driver uses 9 times the amount of energy used by a bus, and 12 times the energy used by an MRT train.

Improving Fuel Economy

3.47. The Fuel Economy Labelling Scheme (FELS) was launched as a voluntary programme in 2003 with the aim of providing buyers of passenger cars with fuel economy information at the point of sale. As of end 2007, less than 20% of all vehicle models in the market were participating in FELS. The effectiveness of FELS was limited, as consumers were only able to compare between limited vehicle models that are participating in the FELS.

3.48. To improve the effectiveness of FELS, the government will introduce mandatory fuel economy labelling for passenger cars from 1 April 2009. All automobile retailers will have to display the fuel economy labels of passenger car models at the showroom..

Promoting Green Vehicles

3.49. To encourage the purchase of hybrid and compressed natural gas (CNG) vehicles, a Green Vehicle Rebate (GVR) has been in place since 2001. CNG vehicles also enjoy special tax exemption until 31 Dec 2009. The GVR was further enhanced in Dec 2005, whereby green vehicles can enjoy an Additional Registration Fee (ARF) rebate of 40% of the Open Market Value (OMV) of the car, up from 20%. Since the enhancement of the rebate, which is valid until 2009, the number of green vehicles has increased substantially from about 140 in 2005 to more than 1500 by end of 2007. NEA and LTA will continue to encourage more motorists to switch to green vehicles which are cleaner and more fuel-efficient.

Promoting Fuel-Efficient Driving Habits

3.50. Fuel-efficient driving habits, such as avoiding hard braking and acceleration, maintaining the appropriate tyre pressure and reducing idling, can save up to 10% of the fuel without any increase in travel time. These habits also result in safer driving, better comfort, less pollution and less noise.

The Government will promote such fuel-efficient driving habits to motorists more actively.

Buildings

3.51. The buildings sector contributes about 16% of Singapore's greenhouse gas emissions. Most of the electricity used by buildings in Singapore is for air-conditioning (40-50%), mechanical ventilation (about 20%) and lighting (15-20%). Results from energy audits co-funded by NEA have shown that there is room for the energy efficiency of buildings in Singapore to improve.

Building Regulations

3.52. Although a green building may cost more to build, they are more cost effective over the life cycle of the building, and energy savings of 20 – 30% are possible. To promote the construction of energy efficient green buildings in Singapore, all new buildings and existing ones that undergo major retrofitting will be required in April 2008 to meet minimum requirements on environmental sustainability that are equivalent to the Green Mark certified standards.

3.53. Due to the prominence of energy usage due to air-conditioning in Singapore, the BCA established the Envelope Thermal Transfer Value (ETTV), which sets a limit on the amount of heat gained by an air-conditioned building through its roofs, external walls and windows. The ETTV was tightened in January 2004 and will be regularly reviewed.

3.54. As there has been a rise in residential buildings adopting facades with high ETTV (e.g. glass panels), BCA will require new residential buildings with a gross floor area of 2000m^2 or more to comply with the Residential Envelope Transmittance Value (RETV), in early 2008. This will reduce the energy used for cooling by residential buildings.

3.55. The SS Code of Practice 24 or SS CP 24 also set minimum efficiency requirements for commercial air-conditioners and lighting. NEA led a working group to review CP 24 and announced the Singapore Standard 530 on Energy Efficiency for Building Services and Equipment or SS 530 in January 2007. SS 530 sets minimum energy efficiency standards for building equipment such as air-conditioning equipment, water heaters, electric motors and high efficiency lightings. Air-conditioning chillers in compliance with the new SS 530 will use up to 30% less energy, compared to the requirement in SS CP24.

Building Labels

3.56. Building labels provide an incentive for developers to build energy-efficient, environmentally-friendly buildings. BCA introduced the Green Mark in January 2005 to recognise new buildings designed with environmentally-

friendly features. Buildings are awarded Certified, Gold, Gold^{PLUS} or Platinum rating depending on the points scored on a set of criteria including energy and water efficiency. From 2008 onwards, all new buildings and existing buildings undergoing major retrofitting works with gross floor area above 2000m^2 must meet the Green Mark Certified standard.

3.57. The Energy Smart Building Labelling Scheme was launched in Dec 2005 to accord recognition for existing office buildings with good energy performance. NEA and the Energy Sustainability Unit (NUS) have extended the Energy Smart Buildings Scheme to the hotel sector in early 2007. In the future, the label will be expanded to other building types including shopping complexes and hospitals.

A Green Mark Platinum Building - National Library Building

The National Library Building, which won the Green Mark Platinum Award and the Energy Smart Label, has several design features that keep the temperatures inside as low as possible to save energy. These include the use of computer modeling to optimise the building orientation and to maximise the use of daylight and natural ventilation, sunshades to shield against solar heat gain, and the use of light sensors that dims or switches off the lights when there is sufficient natural lighting. About two thirds of the building façade are double-glazed to minimize the heat transfer. There is also extensive landscaping, sky terraces and roof gardens to lower local ambient temperature.

An Energy Smart Hotel - Regent Hotel

The Regent Singapore used to rely on diesel boilers to produce hot water at a cost of $29,000 a month. In 2006, a new heat recovery system was implemented. This system uses a small capacity chiller that also acts as a heat pump to produce hot water. They are now enjoying savings of $500,000 annually. This Energy Smart hotel has also switched to a higher-efficiency lighting system as well as LEDs without compromising light quality. Besides being an Energy Smart hotel, The Regent Singapore has also won the ASEAN Green Hotel Award in 2008.

Incentives for Energy Efficient Design and Green Building Design Guide

3.58. To incentivise building developers to achieve the higher awards of Green Mark, MND established the $20 million Green Mark Incentive Scheme in 2006. Under this scheme, new and retrofitted buildings that achieve the Green Mark Gold ward will be given a cash incentive of up to $3 per m^2 of GFA. Those that achieve the Green Mark Platinum Award can enjoy an incentive of up to $6 per m^2 of GFA.

3.59. BCA has released a free Green Building Design Guide for air-conditioned buildings compiling the design features of buildings that have achieved Green Mark, to disseminate information on environmentally sustainable building designs as well as ways to improve energy efficiency.

Building managers will also be encouraged to select energy-efficient appliances and operate buildings efficiently. The energy efficiency website that NEA will develop will also cover energy efficiency equipment and practices applicable to buildings.

Grant to Upgrade Building Envelopes

3.60. BCA is also introducing a new grant to encourage existing buildings to upgrade their building envelopes. The grant will help offset the cost of upgrading façade features to improve the overall energy efficiency of the building. For a start, $9 million has been set aside to fund these grants.

Promoting Energy Audits and Energy Efficiency Measures

3.61. The Energy Efficiency Improvement Assistance Scheme (EASe) scheme, accelerated depreciation scheme and grant for energy efficient equipment and systems described in the power generation section also applies to buildings.

Government Taking the Lead

3.62. The public sector is a significant energy consumer in the buildings sector, accounting for approximately 19% of the electricity consumption of non-residential buildings in Singapore. To take a leadership role by improving the energy efficiency in its buildings, all public sector agencies have incorporated Green Mark certification into the procurement and design process for new and retrofitted Government buildings and schools since April 2007. All large air-conditioned Government office buildings as well as polytechnics and ITEs, will also undergo energy audits by FY 2010.

Households

3.63. The households sector represents about 10% of total energy use, with the bulk of energy consumption being used for air-conditioners and refrigerators, followed by appliances such as consumer electronics (e.g. TVs, DVD players, computers), lighting and water heating.

Mandatory Energy Labelling

3.64. Mandatory energy labelling informs consumers of the energy efficiencies of different models of an appliance, thereby helping them choose a more energy efficient model. Starting from 1 Jan 2008, all air-conditioners and refrigerators sold in Singapore have to carry an energy label. Together, the air-conditioner and the refrigerator make up about 50% of the average household electricity bill. The Mandatory Energy Labelling Scheme will be extended to clothes dryers by April 2009, and we will consider extending the scheme to other appliances including household lightings and water heaters by 2010.

Overseas Practice and Public Perception

Nearly all developed countries and many developing countries have mandatory labelling schemes for refrigerators and air-conditioners, and many extend these schemes to other home appliances. Savings in operating costs through the use of energy-efficient appliances often more than offset higher purchase prices.

In a poll conducted by NEA in 2005, 80% of the respondents (132 out of a total 164) indicated that they found the energy labels useful in comparing the electricity consumption of different models and in confirming that the model that they have selected is energy efficient. In an online survey conducted by MEWR in 2005, some 93% of the respondents supported mandating energy labelling.

Minimum Energy Performance Standards

3.65. Minimum energy performance standards (MEPS) are a complementary tool to mandatory labelling. Performance standards ensure that all models of an appliance sold in a country meet a basic level of energy efficiency and eliminate inefficient appliances from the market. Such standards are already in place in many countries, particularly for energy-intensive appliances. Going forward, based on the results of mandatory labelling, NEA will look into imposing Minimum Energy Performance Standards on household air-conditioners and fridges over the next 2 to 3 years.

Electricity Vending System

3.66. EMA is studying the feasibility of a scheme called the Electricity Vending System (EVS). The EVS enables consumers to buy electricity from any electricity retailer and allows consumers to monitor their electricity consumption figures by the half-hour. By being more aware of electricity use patterns, consumers can reduce their electricity bills through more prudent use of electricity.

Electricity Consumption Tracking Device

3.67. NEA is also looking into introducing an electricity consumption tracking device that not only displays electricity consumption in dollar terms but also tracks the electricity usage of key energy intensive household appliances such as air conditioners.

Public Awareness Programme

3.68. The Climate Change Awareness Programme (CCAP) was launched in April 2006 by the Singapore Environment Council and supported by NEA.

It aims to raise awareness among households and motorists on how simple and relatively painless changes in daily habits can save money, save energy and help to address climate change. Moving forward, NEA will enhance the public awareness efforts to encourage households and motorists to move from awareness to adopting these simple energy efficiency habits and reducing their energy consumption.

Simple Energy-Saving Habits At Home*

1. Use a fan instead of an air-conditioner. Save about $50 a month or $600 a year**.

2. If you use an air-conditioner, set the temperature as high as comfortable. For every degree raised, save $20 a year***.

3. Switch off appliances at the power socket. Do not leave them on standby. Save $50 a year****.

4. Buy energy efficient light bulbs (e.g. compact fluorescent lamps) instead of incandescent light bulbs or halogen torchieres. Using a compact fluorescent lamp (7W) instead of an incandescent bulb (40W) can save about $15 per bulb per year.

5. Buy an energy efficient appliance by checking the energy labels. The more ticks it has, the more energy efficient it is. A 4-tick air-conditioner saves you about $350 in electricity bills a year compared to a 1-tick model***, and a 4-tick refrigerator saves you about $100 a year over a 1-tick model*****.

**Based on electricity tariff of about $0.2262 per unit (kWh).*
***Comparing electricity used by a single-split, 1000W air-conditioner and a 75W electric fan.*
****Assuming a single-split, 1000W air-conditioner used 365 days a year.*
*****Assuming 35W of standby power in a home.*
******Assuming a 400 litre refrigerator.*

Summary

3.69. A summary of the policies and measures currently being implemented or considered under the E^2 Singapore plan are in Table 3.3 below.

Table 3.3: Summary of Policies and Measures in E^2 Singapore

<table>
<tr><th></th><th>Power Generation</th><th>Industry</th><th>Buildings</th><th>Transport</th><th>Households</th></tr>
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Government take the lead

Energy Smart

Mandating Green Mark certified

$20 million Green Mark Incentive Scheme

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4. Competency-Building

4.1. To facilitate Singapore's efforts to mitigate CO_2 emissions and adapt to climate change in an environmentally sustainable and cost-effective way, there is a need to build up a broad range of competencies together with our private sector, most notably our industries and research community, in technology and expertise.

CO_2 Mitigation Technology

4.2. Research into clean and renewable energy will decrease our reliance on carbon-intensive fossil fuels. Developing energy-efficient technology will reduce the impact of our growing energy needs. The objective of our research is to improve the current state of technology, and bring down production costs to a level that would make large-scale adoption commercially viable.

Research and Development

4.3. Research in energy and climate-related activities are already being carried out by several research institutions in Singapore. For example, A*STAR's Institute of Materials Research and Engineering, NUS and NTU are looking into novel materials for solar cells. Nanyang Polytechnic and Temasek Polytechnic have set up fuel cell R&D programmes. Temasek Polytechnic further plans to invest over S$5 million to establish a Fuel Cell Application Centre, to engage start-ups in collaborative R&D.

4.4. In the private sector, the world's top wind technology company, Vestas is setting up a global wind R&D centre in Singapore. Rolls Royce is working with various research organisations in Singapore to develop stationary fuel cells. In October 2007, Renewable Energy Corporation (REC) from Norway announced an investment of about Euro3 billion (S$6.3 billion) to build an integrated solar wafer, cell and module manufacturing facility in Singapore. Slated to be the largest solar manufacturing complex when completed, REC is expected to also undertake R&D in Singapore related to manufacturing automation and improvement, as well as solar cells.

4.5. Government is also taking an active role in driving R&D investment. In March 2007, the Research, Innovation and Enterprise Council, or RIEC, chaired by our Prime Minister, endorsed Clean Energy as a key growth area for Singapore with the target of generating S$1.7 billion in value-added by 2015. The Economic Development Board (EDB) thereafter set up the inter-agency Clean Energy Programme Office (CEPO)[11] to grow the Clean Energy industry in Singapore by focusing on cluster development, technology

[11] CEPO is led by EDB and comprises the following agencies: MTI, A*STAR, BCA, EMA, IE Singapore and NEA.

development and internationalisation, with an emphasis on solar energy. In the area of energy efficiency, NEA is working with relevant government agencies, academics and industry to identify suitable areas and technologies for research to support Singapore's energy efficiency efforts.

4.6. Key government initiatives on energy and climate-related research are given below.

National Research Foundation

4.7. The National Research Foundation has set aside $170m for research into clean energy to boost the development of the local Clean Energy industry over the next five years, focusing on research and manpower. Through this funding, CEPO has launched a S$50 million competitive funding initiative known as the Clean Energy Research Programme (CERP) as well as the S$25 million Clean Energy Scholarships.

Energy Technology R&D Programme

4.8. To coordinate and enhance existing R&D efforts in clean energy technologies, A*STAR established an Energy Technology R&D Programme. This programme will act as the focal point to coordinate, integrate and expand our efforts and capabilities in clean energy, especially in the areas of fuel cells, alternative fuels such as biofuels and hydrogen, as well as solar PV technologies. The programme will also identify and develop research focus relevant to Singapore. For example, as energy storage is an important component in the harnessing of renewable energy, A*STAR is starting a new research focus into "intelligent distributed energy systems". In addition, the programme aims to develop the necessary talent and manpower for R&D in the energy sector and to develop Singapore as a vibrant centre for energy research.

MND Research Fund for the Built Environment

4.9. In 2007, MND set aside $50 million over the next five years for a new "MND Research Fund for the Built Environment". The MND Research Fund is to intensify R&D efforts in green building technologies and energy efficiency.

<u>Test-Bedding</u>

Innovation for Environmental Sustainability Fund

4.10. To encourage test-bedding of new technologies, NEA set up a S$20 million Innovation for Environmental Sustainability (IES) Fund in 2001. The IES fund provides financial grants for companies to test-bed innovative technologies, which would contribute to environmental sustainability. For instance, NEA funded S$1 million through the IES Fund to test-bed building-integrated photovoltaics (BIPV), an innovative PV technology in which solar

PV cells are integrated into the façade of buildings, at the Biopolis. The IES Fund also provided funding support for Pfizer Asia Pacific Pte Ltd and Schering-Plough Ltd to build a 5 MW and a 9.2 MW trigeneration facility respectively. These facilities are expected to help Pfizer and Schering-Plough reduce their CO2 emissions by 17% and by 24% yearly.

Clean Energy Research & Test-bedding Programme

4.11. In August 2007, a S$17 million Clean Energy Research & Test-bedding Programme was also launched by CEPO. Under this programme, the facilities and buildings in Singapore can be used as a "field laboratory" for clean energy technologies to be tested and integrated, before commercialisation. The lead R&D organisations are Singapore Polytechnic and the National University of Singapore. The initial batch of government agencies providing infrastructure for test-bedding include PUB's Marina Barrage, National Parks' Gardens by the Bay and Singapore Polytechnic's campus, while BCA's zero-energy building and HDB's eco-precinct will be the test-bedding sites in the second phase of CERT. The goals of the test-bedding include examining the prospects of large-scale renewable energy adoption in Singapore, particularly in solar energy.

Market Development Fund

4.12. EMA also established a S$5 million Market Development Fund to facilitate test-bedding of non-traditional generation technologies that have significant value in the electricity market and other ideas/technologies that have development potential in the electricity market.

Singapore Initiative on New Energy Technology

4.13. Going forward, to provide a platform for the development and test-bedding of clean energy technologies and sustainable energy solutions, A*STAR will establish the Singapore Initiative on New Energy Technology (SINERGY) Centre. The SINERGY Centre will be a test-bedding facility and a platform for R&D collaboration and development of thought leadership in alternative energy and distributed generation. It will work with independently-funded research groups from both the public and private sectors. Through these collaborations, the Centre will look to develop expertise in systems integration and evaluation of technologies, with the eventual goal of providing this expertise in the form of consultancy services to address issues such as energy efficiency, fuel as well as grid management.

Energy Management and Carbon Expertise

4.14. With the nation-wide drive to improve energy efficiency and the worldwide move to reduce CO_2 emissions, there will be a demand for energy management capabilities and services and carbon consultancy services. The

establishment of relevant training courses, accreditation schemes and institutes will help to build up a pool of such skills and expertise in Singapore.

Energy Management

4.15. The Singapore Certified Energy Manager (SCEM) programme, jointly developed by NEA, ESU, EDB, EMA and BCA in consultation with industry, is the first of its kind to be launched in the region. The SCEM programme establishes a Training Curriculum and a National Certification System for energy engineers and managers in Singapore.

4.16. The Energy Sustainability Unit of NUS currently administers an energy service company (ESCO) Accreditation Scheme. Accrediting ESCOs enhances the professionalism and quality of services offered by ESCOs. This, in turn, will enhance confidence in the energy services sector and help to promote the growth of the industry.

4.17. Moreover, to facilitate the sharing of knowledge, expertise and best practices in energy efficiency and carbon markets, NEA together with other agencies such as BCA will hold energy efficiency seminars and workshops that bring together local and overseas experts and various stakeholders.

Energy Policy

4.18. As energy policy is multi-faceted and complex, energy policy research will help to provide thought leadership and analysis in the complex issues of energy and climate change. The Government therefore launched the Energy Studies Institute (ESI) under the NUS on 12 November 2007. ESI will examine the economic, environmental and geopolitical implications of energy use and will be a focal research node for energy policy, including its relationship with the environment and climate change, in Singapore.

Clean Development Mechanism and Carbon Trading

4.19. Under the Kyoto Protocol, a series of market mechanisms have been set up to allow countries to achieve cost-effective emission reductions. The Clean Development Mechanism (CDM) is a market mechanism that allows an Annex I country to invest in emissions reduction projects in a non-Annex I country and to count the emission reductions (known as Certified Emission Reductions or CERs) towards their KP emission targets. In exchange, the non-Annex I country can benefit not just from the revenue from the sale of CERs, but also from foreign investments with potential technology transfer.

4.20. Carbon trading refers to a system in which parties buy and sell carbon credits. It has been established in Europe and the US. Australia and New Zealand have also announced plans to set up carbon trading systems.

4.21. Singapore acceded to the Kyoto Protocol in April 2006. As a non-Annex I Party to the Kyoto Protocol, we can host CDM projects. NEA is the Designated National Authority on CDM, which ensures that CDM projects support sustainable development in Singapore. Potential CDM projects in Singapore include waste-to-energy projects and energy efficiency projects.

4.22. Asia alone represents about 70% of global CDM potential for emissions reduction, and Singapore is keen to grow a carbon services sector to service the Asian market. There is interest from the private sector in different parts of the carbon value chain to start operations in Singapore to support the development of CDM projects in the region. For example, project origination teams from companies like Deutsche Bank, the Development Bank of Japan, and Morgan Stanley have also located themselves in Singapore. Carbon advisories like Environmental Resource Management Services and EcoSecurities have gathered here as well.

4.23. To assist companies in taking advantage of the numerous CDM projects in Asia that generate carbon credits, International Enterprise Singapore has designated carbon credits as a qualifying product under the Global Trader Programme (GTP). This would allow qualifying companies to enjoy a tax concession on qualifying income from emissions trade. This incentive aims to build up a critical mass of companies along the carbon value chain, anchoring their emissions trading in Singapore.

4.24. To foster interest in CDM, carbon trading, and related opportunities in Singapore, NEA and IE Singapore have organised meetings, seminars and workshops with industries that have an interest in CDM projects. The private sector is playing a role too. For example, the International Emissions Trading Association and Koelnmesse organised Carbon Forum Asia 2007 in Singapore, which is a major regional conference and trade fair on carbon trading and carbon abatement technologies. This forum, which managed to attract over 1000 participants from 46 countries, was hosted by the Sustainable Energy Association of Singapore and supported by various government agencies including EDB, IE Singapore and NEA.

4.25. NEA will continue to raise awareness amongst companies to facilitate CDM projects in Singapore[12]. To date, NEA has issued a Letter of Approval to Bee Joo Industries Pte Ltd for its waste heat recovery project, a first step in its application for Certified Emissions Reductions (CERs) from the United Nations CDM Executive Board. In another first for our power industry, PowerSeraya Ltd plans to apply for CERs for their impending replacement of three oil-fired steam units with more efficient cogeneration combined cycle units.

4.26. In 2006, the Renewable Energy Exchange Capital Asia (ReEx Capital Asia) was also set up in Singapore to help bring together investors looking for projects in renewable energy and project developers seeking

[12] Companies who are interested in participating in CDM projects can refer to the NEA website at www.nea.gov.sg/

funding. The Renewable Energy and Energy Efficiency Partnership and the Development Finance arm of the German Government have committed to provide funding support for the initial establishment and operation of the Exchange.

Vulnerability Assessment and Adaptation Technology and Expertise

4.27. Research into vulnerability assessments and adaptation technologies will help us address our vulnerabilities to climate change more effectively.

4.28. In February 2007, NUS set up the Environmental Research Institute to look into climate change and other environmental issues. The institute is researching issues such as how people respond to temperature, humidity, pollution and ventilation, and is developing technologies such as energy efficient air-conditioning. The Tropical Marine Science Institute is also conducting research in physical oceanography, marine biology and climate change. NUS also established the Singapore-Delft Water Alliance, with Delft Hydraulics, and one major research theme is environmental modelling which is key to understanding the effects of climate change on Singapore and the region.

4.29. NRF, in a partnership with ETH Domain, is setting up the Singapore-ETH Centre (SEC) on Global Environmental Sustainability under NRF's Campus for Research Excellence and Technological Enterprise initiative. The SEC will undertake research in areas such as human health, future cities, environmental monitoring and modelling, as well as clean water.

4.30. Climate change is expected to have a global impact on water supply worldwide. To enhance Singapore's capability in water policy research, PUB is collaborating with the Lee Kuan Yew School of Public Policy to establish an Institute of Water Policy (IWP). The IWP will engage in research, education as well as consultancy work in water management and policy for public sector organisations.

4.31. In March 2007, NTU also developed the Nanyang Environment and Water Research Institute (NEWRI), which will coordinate research in environmental and water technologies in various centres and programmes. The first of NEWRI's centres is the Singapore Membrane Technology Centre.

4.32. In addition to the numerous international collaborators and peer reviewers in the vulnerability study team, our local researchers also exchange information and collaborate with international experts on climate change-related issues. For example, in December 2007, the Tropical Marine Science Institute and the Department of Civil Engineering of NUS, and the British High Commission in Singapore jointly organised an expert symposium on "Climate Change: Modelling, Impacts and Adaptations". The symposium drew

speakers and participants from the IPCC as well as renowned institutes such as the UK Met Office Hadley Centre and the Tyndall Centre for Climate Change Research.

4.33. The various government agencies, research institutes and our private sector have introduced a range of initiatives and programmes, which will build up our manpower expertise and technical competencies in Singapore. These efforts, along with the available funding for R&D and test-bedding, will enable us to mitigate CO_2 emissions and adapt to climate change in an environmentally sustainable and cost-effective way.

5. INTERNATIONAL PARTICIPATION

5.1. Beyond domestic efforts to combat climate change, the global nature of the climate change problem requires global solutions. A strong and effective international effort is needed to address climate change and every country must play its part.

5.2. The UN Framework Convention on Climate Change (UNFCCC) arose from the Earth Summit of 1992, chaired by a Singaporean, Professor Tommy Koh. The UNFCCC sets the framework for governments to cooperate on the issue of global warming, and it adopted the Kyoto Protocol (KP) in 1997. Singapore ratified the UNFCCC in 1997 and acceded to the KP in 2006. Going forward, Singapore will continue to support and actively participate in the UNFCCC and KP negotiations.

5.3. Singapore also promotes the sharing of climate-friendly practices wit the region to facilitate emission reductions beyond our borders. The Germany-Singapore Environmental Technology Agency (GSETA) has been organising seminars and conferences on environmental issues including climate-change-related issues such as renewable energy and possible efforts by the tourism sector to address climate change. These seminars and conferences are attended by participants from the Asia-Pacific region. Singapore is also an active member of the ASEAN Working Group on Multilateral Environmental Agreements, which discusses climate change issues of concern to ASEAN.

5.4. In addition, Singapore supports international, regional and national efforts to preserve and restore carbon sinks, such as the Asia-Pacific Economic Cooperation (APEC) aspirational goal to increase forest cover in the APEC region by at least 20 million hectares by 2020 and the discussions under the UNFCCC on ways to encourage developing countries to reduce deforestation. Singapore also supports the APEC-wide regional aspirational goal of a reduction in energy intensity of at least 25% by 2030 from 2005 levels. In November 2007, when Singapore hosted the 13th ASEAN Summit and 3rd East Asia Summit (EAS), regional leaders declared their resolve to work closely with one another on a fair, flexible and comprehensive multilateral agreement in addressing climate change beyond 2012. Singapore also secured agreement among ASEAN countries and our EAS partners to work to achieve a common understanding on a long term aspirational global emissions reduction goal, to pave the way for a more effective post-2012 international arrangement, as well as reforestation targets in ASEAN and the greater EAS region.

5.5. On a bilateral basis, we have collaborated with the Jambi Government and Indonesia's State Ministry of Environment to develop a Master Plan to deal with land and forest fires, which will help reduce carbon emissions from burning peatland forests. The Master Plan was completed in April 2007. It includes the use of modern technology to improve the productivity of certain fishery and agricultural activities to create a more

sustainable alternative livelihood for the farmers, which is the key strategy to prevent land and forest fires in Jambi. The Master Plan is currently in the implementation phase by Jambi and Indonesia's State Ministry of Environment, with technical assistance from Singapore for certain programmes. If successfully implemented, the Master Plan can be used as a model for other fire-prone districts in Indonesia.

5.6. In the years ahead, there is a need for the international community to discuss and reach an agreement on a long-term global target on emissions, to give a clear signal of its seriousness to tackle climate change. The global community needs to work towards this target collectively through the UNFCCC, while taking into account national circumstances. To effectively tackle climate change, the world has to adopt differentiated approaches and pursue pragmatic and cost-effective ways to reduce GHG emissions as well as protect the world's carbon sinks.

6. Going Forward

6.1. As a result of our careful long-term planning and sound policies, Singaporeans today enjoy a clean and healthy living environment that is internationally recognised. For instance, Singapore was ranked first in "Cleanliness" for four consecutive years from 2003 to 2006 in the Conde Nast Traveller's Readers' Travel Awards. We have also been consistently rated best for the overall quality of our environment among Asian countries for the past 6 years in surveys conducted by the Political and Economic Consultancy (PERC). We share our environmental experience and expertise with other countries. For example, NEA's Singapore Environmental Institute regularly conducts capacity building training on environmental protection and management for international participants. Our Singapore Cooperation Programme also helps to train foreign officials on the various aspects of water, waste management as well as public health.

6.2. Going forward, Singapore's challenge, as a nation with no indigenous energy resources, is to ensure that our energy supply is not just affordable and reliable, but also generated and used in an environmentally sustainable manner. At the same time, as a low-lying island state, Singapore will need forward-looking policies to prepare for and adapt to the impacts of climate change.

6.3. With the challenge of climate change today, environmentally sustainable development has taken on increased importance. In Singapore, we have already switched much of our power supply to natural gas, which is relatively less carbon-intensive. Singapore's small size however limits the possibility of increasing forest cover domestically. As the Southeast Asian region is home to large areas of tropical rainforest, Singapore supports efforts to preserve and restore these carbon sinks through international, regional, bilateral and national platforms. Domestically, our key strategy in addressing climate change will be to improve our energy efficiency. While our economy is expected to expand in the future and our population is expected to grow, much of the growing energy demand can be avoided if we use energy more efficiently.

6.4. Through the NCCS, we underscore our commitment to climate change action which can allow us to develop in an environmentally sustainable manner compatible with economic growth. Our climate change strategies and measures will evolve with developments in climate change. We will continue to review our national climate change policies and measures in line with advances in technology, further evidence on climate science and international commitment to climate change.

Acknowledgements

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National Climate Change Committee

Mr Edwin Khew
Chair of the Households Subcommittee

Dr Josephine Kwa
Chair of the Industry Subcommittee

Mr Anthony Seah
Chair of the Buildings Subcommittee
(to September 2007)

Mr Wong Hooe Wai
Chair of the Buildings Subcommittee
(from September 2007)

Mr Yang Ban Seng
Chair of the Transportation Subcommittee
(to September 2007)

Mr Michael Wong
Chair of the Transportation Subcommittee
(from September 2007)

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Chair of the R&D Workgroup
(to September 2007)

A/Prof Lee Siew Eang
Chair of the R&D Workgroup
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Chair of the Chemicals Workgroup

Mr Francis Tan Thin Guan
Chair of the Electronics Workgroup

Mr Lee Chin Hoo
Chair of the Pharmaceuticals Workgroup

Organisations and Institutes

Climate Change Organisation

ECO-Singapore

Halogen Foundation

Nature Society Singapore

Scholastic Environment Fund

Singapore Environment Council

Singapore Institute of International Affairs

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