Appendix I

SINGAPORE'S INTENDED NATIONALLY DETERMINED CONTRIBUTION (INDC) AND ACCOMPANYING INFORMATION

In accordance with Decisions 1/CP.19 and 1/CP.20, Singapore communicates that it intends to reduce its Emissions Intensity by 36% from 2005 levels by 2030, and stabilise its emissions with the aim of peaking around 2030.

<table>
<tr><th colspan="2">Quantifiable information on the reference point (including as appropriate, a base year)</th></tr>
<tr><td colspan="2">Emissions Intensity in 2005: Singapore's greenhouse gas (GHG) emissions per S$GDP (at 2010 prices) in 2005 is 0.176 kgCO_2e/S$.
Projected Emissions Intensity in 2030: Singapore's GHG emissions per S$GDP (at 2010 prices) in 2030 is projected to be 0.113 kgCO_2e/S$.</td></tr>
<tr><td colspan="2">Time frames and/or periods for implementation: Beginning 2021 to end 2030</td></tr>
<tr><td rowspan="3">Scope and coverage</td><td>Sectors covered: Energy, Industrial Processes and Product Use, Agriculture, Land Use, Land-Use Change and Forestry, Waste.</td></tr>
<tr><td>Greenhouse gases covered: Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur Hexafluoride (SF_6).</td></tr>
<tr><td>Percentage of national emissions covered: 100%</td></tr>
<tr><td>Planning processes</td><td>Singapore's Inter-Ministerial Committee on Climate Change (IMCCC) drives the whole-of-government effort to develop Singapore's climate change mitigation measures. These take into account Singapore's national circumstances and challenges. Studies and technology roadmaps developed in collaboration with industry stakeholders, academic experts and technical consultants, served as additional inputs on the potential of future technologies for long-term mitigation in Singapore. Public consultations were also carried out to obtain feedback on possible measures to reduce carbon emissions, and to promote green growth.
Singapore's broad strategies are reflected, inter alia, in the National Climate Change Strategy 2012 and the Sustainable Singapore Blueprint 2015. Legislation and regulations are also regularly reviewed to respond to new developments.</td></tr>
<tr><th colspan="2">Assumptions and methodological approaches including those for estimating and accounting for anthropogenic greenhouse gas emissions and, as appropriate, removals</th></tr>
<tr><td colspan="2">Inventory methodology: Singapore's emissions for carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) were derived using the Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories and based on the Sectoral approach. The Tier 1 methodology was used for most emission calculations.
The emissions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) from industrial processes were derived using the Tier 2 methodology from the 2006 IPCC Guidelines.</td></tr>
<tr><td colspan="2">Metric Applied: Global Warming Potential on a 100 year timescale in accordance with the IPCC's 2nd Assessment Report.</td></tr>
<tr><td colspan="2">GDP (2005) at 2010 prices: S$232.77 billion (Source: Department of Statistics, Singapore)</td></tr>
<tr><td colspan="2">GHG emissions (2005): 40.9MTCO_2e
(Source: Singapore's 3rd National Communications and 1st Biennial Update Report, 2014)</td></tr>
</table>

International market mechanisms: Singapore intends to achieve the mitigation objectives under its INDC through domestic efforts, but will continue to study the potential of international market mechanisms.

Accounting for emissions and removals from the land sector: Singapore has begun a long-term programme to monitor and report carbon storage and carbon fluxes related to land use change and forestry. As there are no commercial forestry or plantations in Singapore, emissions or carbon storage from land use change and forestry are expected to be small.

Consideration of fairness and ambition, in light of national circumstances and how it contributes to the ultimate objective of the Convention (Article 2)

Singapore's National Circumstances and Challenges. Singapore currently accounts for around 0.11% of global emissions. Its mitigation contributions must be viewed within the context of its national circumstances, limited access to renewable energy, and early actions. As a low-lying island state of 716 km² with no natural resources, Singapore has to accommodate not only housing and commercial centres, but also power plants, reservoirs, air/seaports and industries within city boundaries. Singapore has one of the highest population densities in the world (7,540 persons per km^2).

Singapore's urban density and limited land area, relatively flat land, low wind speeds and lack of geothermal resources present serious difficulties in pursuing alternative energy options such as nuclear, hydro-electric, wind or geothermal power. Harnessing solar energy in a significant way is a challenge due to competing uses for limited land. These serious difficulties which severely limit the use of alternative energy sources mean that Singapore is dependent on fossil fuels. Such circumstances are recognised in Article 4.10 of the UNFCCC.

Singapore's Efforts. While Singapore is heavily dependent on fossil fuels, given its severe limitations on using alternative energy, Singapore had made early policy choices to reduce its GHG footprint by switching from fuel oil to natural gas, the cleanest form of fossil fuel, for electricity generation, even though it meant higher cost. Today, over 90% of electricity is generated from natural gas. Singapore prices energy at market cost, without any subsidy, to reflect resource scarcity and promote judicious usage. On top of this, and despite the challenges, the government is significantly increasing the deployment of solar photovoltaic (PV) systems.

Singapore had in 2009 pledged unconditionally to reduce emissions to 7% to 11% below its business-as-usual (BAU) level by 2020. Contingent on the conclusion of a universal legally binding agreement in 2015, Singapore will further reduce emissions to BAU-16% by 2020. As a result of continued mitigation efforts, Singapore's emissions are expected to grow at a lower rate compared to GDP growth for 2005-2020. For the 2021-2030 period, Singapore intends to build on its previous mitigation efforts to stabilise its emissions with the aim of peaking around 2030. In 2012, Singapore's Emissions Intensity (EI) ranked favourably at 113 out of 140 countries[1] despite Singapore's limitations in using alternative energy. Singapore's EI is projected to decline further by around 2.5% annually from 2021-2030, compared to the already planned reduction of around 1.5% annually from 2005-2020.[2]

Alongside efforts to reduce emissions and achieve sustainable development, Singapore is also implementing measures to address sea-level rise and above-average warming temperatures.

(See Annex for details)

ANNEX

ACCOMPANYING INFORMATION ON SINGAPORE'S NATIONAL CIRCUMSTANCES AND ADAPTATION EFFORTS

SINGAPORE'S NATIONAL CIRCUMSTANCES

1) Singapore is Alternative Energy-Disadvantaged

Singapore is a small island city-state with relatively flat land, low wind speeds and lack of geothermal resources. These limit access to alternative energy options such as hydro-electric, wind or geothermal power. Given Singapore's small land area and high population density, the risks of nuclear energy currently outweigh the potential benefits.

Although Singapore is located in the tropics, there are challenges to harnessing solar energy in a significant way, given its small size and dense urban landscape. Despite the limited surface area for deploying solar PV, the Government of Singapore is pressing ahead to promote solar PV deployment through the provision of an enabling environment which: (a) facilitates system integration of intermittent sources to ensure grid stability and security; (b) addresses non-market barriers to entry without subsidising the consumption of any form of energy; and (c) supports continued investment in research, development, and demonstration (RD&D) to reduce the cost of solar PV modules and improve their efficiency. By 2030, it is estimated that renewable energy could potentially contribute up to 8% of Singapore's peak electricity demand.

2) Singapore is Carbon Efficient

Singapore is an advanced manufacturing hub, and more than 60% of its manufacturing output is exported to meet the needs of the region and the world.[3] Energy efficiency is a key strategy for carbon emissions reduction and Singapore aims to produce goods in an energy- and carbon-efficient manner. As energy costs are not subsidised in Singapore, companies use energy judiciously and embrace new energy efficient technologies. Strong pollution control laws also encourage industries to switch to cleaner fuel sources such as natural gas. The Government facilitates the adoption of energy efficient technologies through grants and other policy tools to overcome high upfront capital investments and other non-market barriers. As a result, Singapore contributes to 2.2% of global trade, but only accounts for around 0.11% of global emissions.

3) Singapore's INDC is a Stretch Goal

Singapore's aim to reduce its Emissions Intensity by 36% from 2005 levels, and to stabilise its emissions with the aim of peaking around 2030 is a stretch goal. As one of the most globalised economies and a trading nation with no indigenous resources, Singapore is heavily dependent on the global supply chain for its food and energy security. Its economic activity and emissions are also highly sensitive to the volatility of regional and global developments. Even so, Singapore's early actions to reduce emissions, despite its lack of alternative energy options, have allowed it to achieve one of the lowest emissions

intensities globally while still maintaining economic growth. Singapore ranks favourably at 113th out of 140 countries. Singapore's mitigation efforts include a green growth strategy, promoting low carbon trajectories, and pursuing new energy efficiency measures over and above those already extensively deployed. Singapore will continue to invest significantly in research and development to explore new innovations in low carbon technologies. These efforts entail economic and social opportunity costs[4], but nevertheless will be funded domestically.

4) Singapore Collaborates Internationally

Singapore recognises its responsibility to contribute to international collaborations to address climate change. Singapore hosts regular international forums such as the World Cities Summit, Singapore International Water Week, Singapore International Energy Week, and the Singapore Green Building Week/International Green Building Conference, for the sharing of experiences in city planning, climate change adaptation, transport, as well as waste and water management. Singapore also actively shares its developmental experiences as an island city-state in the C40 Cities Climate Leadership group (C40)[5]. Partnering the United Nations Environmental Programme (UNEP), the Building and Construction Authority (BCA) of Singapore established the Centre for Sustainable Buildings – a first in Asia – to support regional efforts to develop green building policies and actions.

Singapore also works closely with many partners including the UNFCCC Secretariat, ASEAN member states, the United Nations Development Programme (UNDP), the World Meteorological Organisation, the US Government, the UK Government, UK Carbon Trust, the Australian Department of Foreign Affairs and Trade and Germany's Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH to provide platforms to share experiences, best practices and technical knowledge on climate change and green growth issues. Singapore has also broadened and deepened its own technical cooperation programmes to share experiences with other developing countries. To date, Singapore has conducted programmes for over 10,700 officials from other countries in climate change and sustainable development issues alone.

SINGAPORE'S ADAPTATION EFFORTS

1) Adaptation Challenges

As a small country without natural resources, Singapore has developed as an open economy that imports the bulk of its food supply, making it sensitive to disruptions to global supply chains. Domestically, Singapore has experienced changes in rainfall patterns and temperature. The annual maximum rainfall intensity in an hour increased from 80 mm in 1980 to 107 mm in 2012. National projections also reflect an upward trend in seasonal mean rainfall during the wet season, and greater dryness during months that are already drier. For temperature, the rate of warming over Singapore from 1951 to 2012 was 0.26°C per decade, more than double the global rate over the same period (0.12°C). Similar to other members of the Alliance of Small Island States (AOSIS), as a low-lying country, Singapore is exposed to rising sea levels (the mean rate of global averaged sea level rise was 1.7 mm per year between 1901 and 2010; the global mean sea level is projected to continue to rise during the 21st century[6]). Singapore's location within Southeast Asia, where there is a lack of observational climate data, is also a challenge to local climate modelling work in projecting climate change impacts. These characteristics make adaptation planning in Singapore both complex and challenging.

2) Singapore's Longstanding and Future Actions to Increase Resilience

Recognising that adaptation solutions cannot be implemented overnight, Singapore started early to integrate long-term adaptation planning into national policies. Listed below are some key adaptation measures Singapore is undertaking:

a. **Food Security:** As a country that imports over 90% of its food supply, Singapore is exposed to a variety of risks. Climate change could potentially result in fluctuations in food supply and prices. Singapore's main strategy is to diversify sources for food supply resilience. This is supplemented by limited local production of key food items and rice stockpiling. The Singapore Government encourages food security research and development, and incentivises the adoption of technology to increase productivity and resilience of local farms.

b. **Infrastructure resilience:** Singapore's Building Control Act requires buildings to undergo periodic structural inspections to ensure structural resiliency. All road and rail structures also undergo regular inspections by registered professional engineers. To protect critical transport infrastructure from flood risks, flood barriers have been installed at subway stations that may be affected, with ongoing work to do so for the remaining ones. For energy and telecommunication services, private operators are required to meet performance standards and ensure network resilience, including through monitoring and maintenance. The Singapore Government constantly reviews and revises design codes, regulations and policies to account for new information and the latest climate projections.

c. **Public Health:** Climate change could contribute to increased risks of transmission of dengue and other vector-borne diseases in Singapore. Singapore has an integrated

regime of environmental management and intensive source reduction to suppress the mosquito vector population. A surveillance programme – anchored in human case, virus, mosquito and weather monitoring – has been established for the early warning of increased risks. Contingency plans are also in place to deal with the anticipated impacts of climate change (including during haze episodes and heat waves), which result in short-term surges in healthcare demand.

d. **Addressing flood risks:** Over 30 years, substantial investments in drainage infrastructure have been made to reduce flood-prone areas from around 3,200 hectares to 34 hectares by end-2014. For example, the S$226-million Marina Barrage project was a part of a comprehensive flood alleviation scheme, which also created Singapore's 15th reservoir in the heart of the city. Drainage improvement works are continuous, with 190 enhancements completed in the last cycle and another 154 locations being upgraded under present plans. With more intense rainfall, a holistic "source-pathway-receptor" approach was adopted. This covers the entire drainage system, addressing not just the pathway through which storm water travels (i.e. "pathway" solutions like widening and deepening drains and canals), but also where run-off is generated (i.e. "source" solutions such as on-site detention) and the areas where floods may occur (i.e. "receptor" solutions like platform levels and flood barriers). Commercial, industrial, institutional and residential developments and redevelopments greater than or equal to 0.2 hectares are required to implement on-site storm water detention measures to reduce the peak discharge into the public drainage system.

e. **Enhancing water security:** Singapore has developed a robust, diversified water supply system through "The Four National Taps": namely, local catchment water, imported water, NEWater[7] and desalinated water. Since 2011, with the completion of three reservoirs in urbanised areas, the total water catchment area has been increased from half to two-thirds of Singapore's land surface. Not being dependent on rainfall, NEWater and desalinated water can be used to supplement water from local reservoirs in extended dry spells. Singapore plans to expand NEWater and desalination capacity to meet up to 80% of its water demand in 2060. Variable salinity[8] technology can be used to help expand Singapore's water catchment to up to 90% of its land area by tapping on the streams and rivulets near the shoreline.

f. **Protecting the coastline:** 70–80% of Singapore's coastline is protected against coastal erosion by hard structures such as sea walls and stone embankments. The rest are soft coasts, such as sandy beaches and mangrove swamps. Since 1991, all new coastal lands have been reclaimed to 1.25 metres above the highest recorded tide level. In 2011, minimum reclamation levels were raised by an additional 1 metre to be more resilient to long-term sea level rise. A range of technologies are also being deployed to enhance coastal infrastructure at specific locations for the long term, while continued efforts are made to protect Singapore's critical logistics supply infrastructure (located in coastal regions) against the risk of increased flooding.

g. **Safeguarding biodiversity:** Enriching Singapore's urban biodiversity and extensive greenery is part of the national vision for a "City in a Garden". Extensive roadside tree

planting contributes to moderating temperatures in the heart of the city. Over 300 parks and a network of park connectors provide relief from the hot urban tropical climate. Large freshwater bodies surrounded by forested catchments help to ameliorate the urban island heat effect and conserve our rich natural heritage of flora and fauna. Singapore will continue efforts to safeguard its biodiversity despite an urban environment. The array of natural ecosystems (including evergreen rain forest, mangroves, freshwater streams, freshwater swamp forest, coral reefs and mudflats) will continue to be conserved, with targeted programs for habitat enhancement and species recovery where required. Singapore recognises the need to track its rich urban biodiversity in a manner which can integrate conservation and adaptation actions. Working with the Secretariat of the Convention on Biodiversity in 2009, Singapore developed the Singapore Index on Cities' Biodiversity to give international focus to biodiversity tracking in urban environments. In 2015, the SGBioAtlas smartphone application was launched to engage and allow members of the public to easily report sightings of biodiversity (e.g. birds, butterflies) in their daily lives. The data collected will help Singapore monitor its biodiversity and develop biodiversity management plans.

h. **Regional Climate Modelling:** Singapore has developed essential climate science capabilities within the Meteorological Service Singapore (MSS), through the establishment of the Centre for Climate Research Singapore (CCRS). CCRS focuses on tropical climate and weather research, including work to improve prediction of convective thunderstorms (responsible for some extremes of weather in the tropics), understand the behaviour of the monsoons in Southeast Asia, and to better describe the drivers behind other complex climate system processes.

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[1] Source: IEA Key World Energy Statistics, 2014. Comparisons based on available carbon emissions per US$GDP data.

[2] To achieve the 2030 Emissions Intensity level, Singapore's emissions are expected to stabilise at around 65 $MTCO_2e$ based on current projected growth.

[3] Singapore's total trade (in goods and services) is 350% of its GDP.

[4] For example, more than 90% of Singapore's electricity today is generated by natural gas, even though there are far cheaper options such as coal. If Singapore had used coal instead of natural gas for power generation, energy costs could have been potentially reduced by over S$2 billion a year.

[5] Singapore is an observer city in the C40.

[6] Source: Fifth Assessment Report of the Intergovernmental Panel on Climate Change

[7] NEWater is high-grade reclaimed water produced from treated used water that is further purified using advanced membrane technologies (microfiltration, reverse osmosis and ultraviolet disinfection), making the water ultra-clean and safe to drink. NEWater exceeds the Environmental Public Health (EPH) and United States Environmental Protection Agency (USEPA) drinking water standards as well as the drinking water guidelines established by World Health Organisation (WHO).

[8] Through careful design of the Variable Salinity Plant, the same set of membranes and equipment can be used to treat water of varying salinity. The plant is thus able to process water from different sources of varying salinity (e.g. stream or sea water) without stopping production.