

**SINGAPORE’S UPDATE OF ITS FIRST NATIONALLY DETERMINED CONTRIBUTION (NDC) AND ACCOMPANYING INFORMATION**

**Singapore intends to peak emissions at 65 MtCO<sub>2e</sub> around 2030.**

**Note: Based on current projections, this will allow us to achieve a 36% reduction in Emissions Intensity (EI) from 2005 levels by 2030.**

**ACCOMPANYING INFORMATION<sup>1</sup> ON SINGAPORE’S 1<sup>ST</sup> NDC**

**1. Quantifiable information on the reference point (including, as appropriate, a base year)**

(a) Reference year(s), base year(s), reference period(s) or other starting point(s);	Emissions level (in terms of CO <sub>2e</sub> ) in 2030: ≤65 million tonnes (Mt) CO <sub>2e</sub>
(b) Quantifiable information on the reference indicators, their values in the reference year(s), base year(s), reference period(s) or other starting point(s), and, as applicable, in the target year;	Singapore’s peaking of emissions will be demonstrated in the national greenhouse gas (GHG) inventory time series reported in its Biennial Transparency Reports.

<sup>1</sup> The accompanying information to clarify Singapore’s updated 1<sup>st</sup> NDC is provided taking reference from the guidance on “Information to facilitate clarity, transparency and understanding of nationally determined contributions, referred to in decision 1/CP.21, paragraph 28” as contained in Annex 1 of decision 4/CMA.1 adopted in December 2018.

<p>(c) For strategies, plans and actions referred to in Article 4, paragraph 6, of the Paris Agreement, or policies and measures as components of nationally determined contributions where paragraph 1(b) above is not applicable, Parties to provide other relevant information;</p>	<p>Not applicable. Singapore's NDC is an economy-wide absolute GHG emissions limitation target.</p>
<p>(d) Target relative to the reference indicator, expressed numerically, for example in percentage or amount of reduction;</p>	<p>See 1(a) above.</p>
<p>(e) Information on sources of data used in quantifying the reference point:</p>	<p>Not applicable. Singapore's NDC is an economy-wide absolute GHG emissions limitation target.</p>
<p>(f) Information on the circumstances under which the Party may update the values of the reference indicators:</p>	<p>Not applicable. Singapore's NDC target, which aims not to exceed an absolute emissions level, does not take reference from any baseline.</p>

<b>2. Time frames and/or periods for implementation</b>	
(a) Time frame and period of implementation:	Beginning 2021 to end 2030.
(b) Whether it is a single-year or multi-year target, as applicable:	Single-year target.
<b>3. Scope and Coverage</b>	
(a) General description of the target:	Singapore's NDC is an economy-wide absolute GHG emissions limitation target to peak its GHG emissions at 65 MtCO <sub>2e</sub> around 2030. Singapore's GHG emissions in 2030 are expected to amount to no higher than 65 MtCO <sub>2e</sub> .
(b) Sectors, gases, categories and pools covered by the nationally determined contribution, including, as applicable, consistent with Intergovernmental Panel on Climate Change (IPCC) guidelines;	<p>Singapore's NDC is an economy-wide absolute GHG emissions limitation target.</p> <p>Key sectors covered: Energy, Industrial Processes and Product Use, Agriculture, Land Use, Land-Use Change and Forestry (LULUCF) and Waste.</p> <p>Greenhouse gases covered are: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF<sub>6</sub>) and nitrogen trifluoride (NF<sub>3</sub>).</p> <p>The expansion of GHG coverage to include NF<sub>3</sub> is a new addition to Singapore's updated NDC.</p>

<p>(c) How the Party has taken into consideration paragraphs 31 (c) and (d) of decision 1/CP.21:</p>	<p>All categories of anthropogenic emissions or removals are included, and will continue to be included.</p>
<p>(d) Mitigation co-benefits resulting from Parties' adaptation actions and/or economic diversification plans, including description of specific projects, measures and initiatives of Parties' adaptation actions and/or economic diversification plans.</p>	<p>Not applicable. Singapore will account for any mitigation co-benefits from adaptation actions and/or economic diversification as mitigation actions in accordance with the assumptions and methodological approaches indicated in Section 5 of this document.</p>
<p><b>4. Planning Processes</b></p>	
<p>(a) Information on the planning processes that the Party undertook to prepare its nationally determined contribution and implementation plans, including: domestic institutional arrangements, public participation and engagement with local communities and indigenous peoples, in a gender-responsive manner.</p>	
<p>(i) Domestic institutional arrangements, public participation and engagement with local communities and indigenous peoples, in a gender-responsive manner;</p>	<p>The Inter-Ministerial Committee on Climate Change (IMCCC), which comprises Ministers from relevant Ministries, drives Singapore's whole-of-government efforts to develop and implement coherent and co-ordinated climate change mitigation measures. This includes the preparation and implementation of Singapore's NDC.</p>

	<p>The NDC was prepared taking into account Singapore’s national circumstances, challenges and opportunities for mitigation. Studies and technology roadmaps, developed in collaboration and consultation with industry stakeholders, academic experts and technical consultants, served as additional inputs on the potential of future technologies for long-term mitigation in Singapore. The Singapore Government also carried out stakeholder consultations, including with members of the public, in order to obtain feedback on possible measures to reduce carbon emissions.</p>	
<p>(ii) Contextual matters, including, inter alia, as appropriate: National circumstances, such as geography, climate, economy, sustainable development and poverty eradication;</p>	<p>a. National circumstances, such as geography, climate, economy, sustainable development and poverty eradication;</p>	<p>Singapore’s national circumstances include, among others, a relatively small land area, high population density, constraints in deploying alternative clean energy, and climate vulnerabilities. Please refer to Section 6 for more details.</p>
	<p>b. Best practices and experience related to the preparation of the nationally determined contribution;</p>	<p>In Singapore’s experience, a key best practice for preparing an NDC is to put in place effective and pragmatic institutional arrangements to coordinate domestic climate efforts. In particular, the IMCCC’s role in strongly coordinating Singapore’s climate change policies from a whole-of-government perspective facilitates opportunities for optimising Singapore’s climate efforts, including consideration of possible trade-offs or synergies across the sectors.</p> <p>A key focus of the planning processes for Singapore’s NDC is to develop a comprehensive suite of mitigation measures to achieve</p>

		<p>its NDC target. These measures are described in <i>Singapore's Climate Action Plan: Take Action Today, for a Sustainable Future</i>, published in 2016.</p> <p>The Singapore Government will continue to engage stakeholders (including businesses, civil society, youths, schools, and the research community) to co-create and co-deliver solutions, amplify awareness, and encourage a whole-of-nation effort to address climate change.</p> <p>The Singapore Government believes that setting out Singapore's climate policy aspirations and strategies well in advance will help provide a clear sense of direction, minimise any negative disruptions to the economy and workforce and keep Singapore competitive in a carbon-constrained world.</p> <p>In this regard, Singapore's climate strategies are reflected, inter alia, in the <i>National Climate Change Strategy 2012</i>, the <i>Sustainable Singapore Blueprint 2015</i>, <i>Singapore's Climate Action Plan: Take Action Today, for a Sustainable Future</i> (published in 2016), <i>Charting Singapore's Low-Carbon and Climate Resilient Future</i> (published in 2020), and various sectoral roadmaps and masterplans published by the respective government agencies.</p>
	c. Other contextual aspirations and	Nil.

	priorities acknowledged when joining the Paris Agreement;	
(b) Specific information applicable to Parties, including regional economic integration organizations and their member States, that have reached an agreement to act jointly under Article 4, paragraph 2, of the Paris Agreement...	Not applicable. Singapore is not part of any joint fulfilment agreement under Article 4, paragraph 2 of the Paris Agreement.	
(c) How the Party's preparation of its nationally determined contribution has been informed by the outcomes of the global stocktake, in accordance with Article 4, paragraph 9, of the Paris Agreement;	The first global stocktake will take place in 2023. Singapore participated in the Talanoa Dialogue in 2018, which generated political momentum for enhanced climate action, including calling for Parties to update their NDCs. The preparation of Singapore's enhanced NDC was informed by the recommendations of the Talanoa Call for Action, taking into account Singapore's national circumstances.	
(d) Each Party with a nationally determined contribution under Article 4 of	(i) How the economic and social consequences of	Not applicable. Please refer to Section 3(d) above.

the Paris Agreement that consists of adaptation action and/or economic diversification plans resulting in mitigation co-benefits consistent with Article 4, paragraph 7, of the Paris Agreement to submit information on:	response measures have been considered in developing the nationally determined contribution;	
	(ii) Specific projects, measures and activities to be implemented to contribute to mitigation co-benefits, including information on adaptation plans that also yield mitigation co-benefits...	Not applicable. Please refer to Section 3(d) above.
<b>5. Assumptions and methodological approaches, including those for estimating and accounting for anthropogenic greenhouse gas emissions and, as appropriate, removals:</b>		
(a) Assumptions and methodological approaches used for accounting for anthropogenic greenhouse gas emissions and removals	Singapore will account for its anthropogenic GHG emissions and removals using the <i>2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories</i> and <i>2013 Supplement to the 2006</i>	

<p>corresponding to the Party's nationally determined contribution, consistent with decision 1/CP.21, paragraph 31, and accounting guidance adopted by the CMA.</p>	<p><i>IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands</i> (collectively, the "2006 IPCC Guidelines"), specifically, by way of the Sectoral approach.</p>
<p>(b) Assumptions and methodological approaches used for accounting for the implementation of policies and measures or strategies in the nationally determined contribution</p>	<p>See 5(a) above. Singapore will also apply specific assumptions and methodologies, where relevant, when accounting for progress of various policies and measures in its Biennial Update Report or Biennial Transparency Report.</p>
<p>(c) If applicable, information on how the Party will take into account existing methods and guidance under the Convention to account for anthropogenic emissions and removals, in accordance with Article 4, paragraph 14, of the Paris Agreement, as appropriate</p>	<p>See 5(a) above.</p>

<p>(d) IPCC methodologies and metrics used for estimating anthropogenic greenhouse gas emissions and removals</p>	<p>Singapore's emissions for CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HFCs, PFCs, SF<sub>6</sub> and NF<sub>3</sub> will be derived using the 2006 IPCC Guidelines, via the Sectoral approach. The Tier 1 methodology will be used for most emission estimates.</p> <p>Higher tier methodology will be used, where relevant and depending on availability of data.</p> <p>The aggregation of GHG emissions and removals will be reported using the 100-year time-horizon global warming potential (GWP) values from the <i>IPCC Fifth Assessment Report</i>.</p> <p><i>(Note: This is a methodological update to Singapore's NDC, which previously applied the GWPs from the IPCC Second Assessment Report.)</i></p>	
<p>(e) Sector-, category- or activity-specific assumptions, methodologies and approaches consistent with IPCC guidance, as appropriate, including, as applicable:</p>	<p>Singapore will account for reporting of GHG emissions and removals from the LULUCF sector in accordance with the <i>2006 IPCC Guidelines</i>, up to Tier 3 level where available and covering all prescribed land-use categories and all carbon pools. The <i>2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands</i> will also be incorporated.</p>	
	<p>(i) Approach to addressing emissions and subsequent removals from natural</p>	<p>GHG emissions and removals from natural disturbances, if any, will be accounted for in accordance with the prescribed <i>2006 IPCC Guidelines</i>, coupled with field inventory measurements where applicable.</p>

	disturbances on managed lands;	
	(ii) Approach used to account for emissions and removals from harvested wood products;	Not applicable. There is no timber industry in Singapore. Hence, Singapore at present has no GHG emissions and removals from harvested wood products.
	(iii) Approach used to address the effects of age-class structure in forests;	Singapore will estimate GHG emissions and removals in the LULUCF sector with up to Tier 3 approaches where feasible, and apply high-resolution satellite images, coupled with collection of country-specific data resulting from field inventory measurements undertaken at regular intervals and estimated by modelling approaches. The field measurements will take into consideration tree growth information across the range of tree species and diameter classes for all forest types.
(f) Other assumptions and methodological approaches used for understanding the nationally determined contribution and, if applicable, estimating corresponding emissions and removals, including:		
(i) How the reference indicators, baseline(s) and/or reference level(s), including, where applicable, sector-, category- or activity-specific	To develop the NDC, extensive technical studies were undertaken, including an assessment of Singapore's economy-wide energy efficiency potential. These take into account Singapore's national circumstances and challenges (as outlined in Section 6 below). Studies and technology roadmaps developed in collaboration with industry stakeholders, academic experts and technical consultants, served as additional inputs on	

reference levels, are constructed, including, for example, key parameters, assumptions, definitions, methodologies, data sources and models used;	the potential of future technologies for long-term mitigation in Singapore. Stakeholder consultations were also carried out to obtain feedback on possible measures to reduce carbon emissions.
(ii) For Parties with nationally determined contributions that contain non-greenhouse-gas components, information on assumptions and methodological approaches used in relation to those components, as applicable;	Not applicable. The scope and coverage of Singapore's NDC, as indicated in Section 3(b) above, do not contain non-GHG components.
(iii) For climate forcings included in nationally determined contributions not covered by IPCC guidelines, information on how the climate forcings are estimated;	Not applicable. The scope and coverage of Singapore's NDC, as indicated in Section 3(b) above, do not include climate forcings not covered by IPCC guidelines.
(iv) Further technical information, as necessary;	Nil.

<p>(g) The intention to use voluntary cooperation under Article 6 of the Paris Agreement, if applicable</p>	<p>Singapore intends to achieve the mitigation objectives under its NDC primarily through domestic efforts, but will continue to study how it can leverage international cooperation under Article 6 of the Paris Agreement.</p>
<p><b>6. How the Party considers that its nationally determined contribution is fair and ambitious in the light of its national circumstances</b></p>	
<p>(a) How the Party considers that its nationally determined contribution is fair and ambitious in the light of its national circumstances;</p>	<p>The updated NDC and the accompanying information reflects Singapore’s commitment under the Paris Agreement in support of the multilateral framework of cooperation to address climate change. In particular, the updated NDC reflects the following enhancements:</p> <ul style="list-style-type: none"> <li>a) <u>An economy-wide absolute GHG emissions limitation target in place of the previous intensity target.</u> This will provide greater clarity and transparency of Singapore’s emissions level in 2030 and facilitate the tracking of progress;</li> <li>b) <u>A clear peaking level (i.e. 65 MtCO<sub>2</sub>e)</u> around 2030. This reflects Singapore’s efforts to support the objectives of Article 2a and Article 4.1 of the Paris Agreement. This is a challenging and ambitious target given Singapore’s national circumstances and anticipated growth in economic activity;</li> <li>c) <u>Inclusion of NF<sub>3</sub>.</u> With this inclusion, the coverage of gases in Singapore’s NDC has been expanded to include all seven gases within the same peaking level. This reflects an increase in the ambition of Singapore’s NDC and will require additional mitigation effort;</li> </ul>
<p>(b) Fairness considerations, including reflecting on equity;</p>	
<p>(c) How the Party has addressed Article 4, paragraph 3, of the Paris Agreement;</p>	

- d) Methodological updates to Singapore's NDC. These updates include, for example, the use of the 2006 IPCC Guidelines and the 100-year time-horizon GWP values from the *IPCC Fifth Assessment Report*. This demonstrates enhanced transparency in the reporting of Singapore's national inventory and climate actions;
- e) Updated information on implementation efforts. These efforts include more ambitious solar energy goals and the introduction of an economy-wide carbon tax with no exemptions for covered facilities; and
- f) Application of ICTU guidance. This will facilitate greater clarity, transparency and understanding of Singapore's NDC and implementation efforts.

Consideration of the fairness and ambition of Singapore's NDC must take into account the following:

- a) Singapore has taken ambitious early actions. Singapore made early policy choices that reduced its GHG emissions, for example by switching from fuel oil to natural gas – the cleanest form of fossil fuel – for power generation. In 2019, about 95% of its electricity was generated from natural gas, compared to 18% in 2000. Energy is priced at market cost, without any subsidy, so that households and businesses will use energy judiciously. Singapore was the first country to impose a vehicle quota system to cap vehicle growth, and the only country to set a zero growth rate for cars and motorcycles. As a result, these and other earlier initiatives make it harder for Singapore to achieve steep emissions reductions because many of the gains have already been reaped through early action over the years;

- b) Singapore is alternative energy disadvantaged. Singapore's urban density and limited land area (725 km<sup>2</sup>), relatively flat land, low wind speeds and lack of geothermal resources present serious difficulties in pursuing alternative energy options. Its limited land resources also make it challenging to deploy solar power on a large scale. Given Singapore's small land area and high population density, the risks of nuclear energy currently outweigh the potential benefits. Such circumstances are recognised under Article 4, paragraph 10 of the UNFCCC;
- c) Singapore has one of the highest population densities globally. Singapore has one of the highest population densities in the world (7,866 persons per km<sup>2</sup>). In addition, as a low-lying island state of 725 km<sup>2</sup> with no natural resources, Singapore has to accommodate not only housing and commercial centres, but also power plants, reservoirs, air/seaports and industries within its city boundaries. The limited land space and high urban density mean that there is limited scope for solar photovoltaics (PV) deployment and for the forestry sector to be a significant carbon sink;
- d) Singapore is dependent on the global supply chain for food and energy security. 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. These challenges mean that Singapore's climate strategies have to take into account international developments that may adversely affect its economy, and its food and energy security;

- e) Singapore is one of the top performers for carbon intensity globally. While Singapore's share of the global GDP is small at 0.4%, as an advanced manufacturing hub it plays a key role to meet the demands of the region and the world, accounting for 2.1% of the world's total merchandise exports.<sup>2</sup> Energy efficiency is a key strategy for emissions reduction and Singapore aims to produce goods in an energy- and carbon-efficient manner. As energy costs are not subsidised in Singapore, companies are incentivised to 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 Singapore 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. Singapore is already among the 20 best-performing countries in terms of emissions intensity, based on data published by the International Energy Agency (IEA) in 2019.<sup>3</sup> This reflects the substantial early action Singapore has taken to grow in an environmentally responsible way. While Singapore will continue to strive for sustainable growth, it will be increasingly challenging for Singapore to achieve additional deep emissions reductions. Singapore is continuing to invest significantly in research and development to harness the potential of low-carbon technologies and explore effective international cooperation;
- f) Singapore is pushing ahead on solar deployment despite constraints. Singapore is pushing ahead to spur the deployment of solar PV through continued investment in research, development, and demonstration (RD&D) to reduce cost, improve efficiency and enable innovative modes of deployment such as floating, offshore,

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<sup>2</sup> Source: World Trade Organization, Trade Profiles – Singapore (2019).

<sup>3</sup> Source: IEA, CO<sub>2</sub> Emissions from Fuel Combustion (2019).

and building-integrated PV. Singapore is well on track to achieve 350 megawatt-peak (MWp) in 2020 and aims to achieve at least 2 gigawatt-peak (GWp) by 2030.

While this level of renewable energy cannot match those of countries with abundant land for solar PV deployment and access to alternative energy resources, Singapore's context and constraints must be taken into account. 2 GWp of solar would require between 1,000 and 2,000 hectares of space, out of Singapore's land area of 725 km<sup>2</sup>, and would meet about 4% of Singapore's current annual electricity needs, and 10% of daily peak electricity demand today;

- g) Singapore is undertaking concrete implementation efforts. Singapore's carbon tax, the first in Southeast Asia, came into effect in 2019. The carbon tax is applied to direct emissions from facilities producing 25 ktCO<sub>2</sub>e or more of GHG emissions in a year, without exemption. This covers 80% of Singapore's carbon emissions and provides an economy-wide price signal to incentivise emissions reductions, supports other mitigation measures and facilitates transition to a low-carbon economy. Singapore is also implementing concrete measures within the various sectors. For example, for the transport sector, Singapore is taking steps to make public and shared transport and active mobility the preferred mode of travel; phase out internal combustion engine vehicles and promote the adoption of cleaner and greener vehicles, such as electric vehicles; and enhance the environmental friendliness of its transport infrastructure. For the buildings sector, Singapore has mandated minimum energy performance standards and developed the Super Low Energy Buildings Programme, which supports the research and adoption of cost-effective, energy-efficient and renewable energy solutions. For industry, Singapore has enhanced its grant schemes to help individual companies

improve their energy efficiency, and have sought to bring companies within a sector together to achieve systems-level efficiency gains across the sector;

- h) Singapore's climate vulnerabilities will require comprehensive adaptation efforts. As a small, low-lying island state, Singapore's vulnerabilities to the effects of climate change require it to pursue a comprehensive adaptation programme to protect its coasts, low-lying areas and communities (see Annex for details of Singapore's adaptation vulnerabilities and strategies). These adaptation actions will impose significant costs for the Singapore Government and people; and
- i) Singapore is working actively to support other developing countries in their efforts to build capacity for climate efforts. Singapore collaborates actively with international partners, such as the UNFCCC, the UN Development Programme (UNDP), the UN Environment Programme (UNEP), ASEAN and city-networks such as the C40, on sharing of best practices and experiences on climate change and green growth issues. To date, Singapore has trained more than 130,000 officials from fellow developing countries under the Singapore Cooperation Programme (SCP) in key areas such as sustainable development, urban planning, water, and transport management. Singapore also launched a dedicated Climate Action Package under the Singapore Cooperation Programme in 2018, to offer capacity-building support in areas such as climate change adaptation and mitigation strategies, flood management, disaster risk reduction, and green climate finance. Singapore will continue to deepen and broaden its technical cooperation programmes with other developing countries.

<p>(d) How the Party has addressed Article 4, paragraph 4, of the Paris Agreement;</p>	<p>Singapore’s updated NDC is an economy-wide absolute GHG emissions limitation target, which reflects its effort as a developing country Party to address Article 4, paragraph 4, of the Paris Agreement.</p>
<p>(e) How the Party has addressed Article 4, paragraph 6, of the Paris Agreement.</p>	<p>Singapore’s updated NDC is an economy-wide absolute GHG emissions limitation target.</p>
<p><b>7. How the nationally determined contribution contributes towards achieving the objective of the Convention as set out in its Article 2</b></p>	
<p>(a) How the nationally determined contribution contributes towards achieving the objective of the Convention as set out in its Article 2;</p>	<p>Singapore’s target to peak GHG emissions at 65 MtCO<sub>2</sub>e around 2030 is an important milestone, in line with the objectives of the Paris Agreement, and is aimed at achieving the long-term temperature goal set out in Article 2 of the Convention.</p> <p>Given its unique national circumstances and particular set of challenges, Singapore’s NDC is challenging and ambitious, and aims to support the collective effort to reach global peaking of GHG emissions as soon as possible, as set out in Article 4.1 of the Paris Agreement.</p>
<p>(b) How the nationally determined contribution contributes towards Article 2, paragraph 2(a), and Article 4, paragraph 1, of the Paris Agreement.</p>	

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**ACCOMPANYING INFORMATION ON SINGAPORE'S ADAPTATION EFFORTS**

To ensure that current and future generations continue to thrive in a low-carbon and resource-constrained future, Singapore has taken decisive steps to strengthen its climate, resource, and economic resilience. Given the complexity and challenges in adaptation planning, Singapore has integrated long-term adaptation planning into national policies. This will result in measures that will entail significant costs for the Singapore Government and people but will support global climate action.

**Investing in Research**

Singapore must meet the anticipated impacts of climate change with actions based on robust climate science and the latest projections. Singapore's location within Southeast Asia presents a challenge to local climate modelling work in projecting climate change effects, since there is a lack of observational climate data in the region. In fact, the Centre for Climate Research Singapore (CCRS), established in Singapore in 2013, is one of the few dedicated centres in the region that focuses on research in tropical weather and climate.

CCRS has expanded, with a new Programme Office that will drive the formulation and implementation of Singapore's national climate science research masterplan and build a vibrant climate science research landscape in Singapore. CCRS will also undertake a National Sea Level Research programme to develop more robust projections of sea level rise, and seek to enhance understanding of long-term sea level rise and its variability, regional patterns and extreme weather events.

CCRS will also cooperate with regional counterparts to study in further detail how climate change is affecting the region. In addition, the Meteorological Service Singapore/CCRS will work closely with the World Meteorological Organisation (WMO) Regional Office for Asia and the South-West Pacific in Singapore to implement WMO's programmes and capacity development initiatives in Asia and the South-West Pacific.

Given that climate science is constantly evolving, CCRS will continue to monitor the changes, refine existing measures and put in place new ones, where necessary.

### **Protecting Singapore from Sea Level Rise**

Sea level rise presents an existential challenge to Singapore, posing threats to Singapore's long-term future. Along with fellow members of the Alliance of Small Island States (AOSIS), Singapore, as a low-lying country, is particularly exposed to the adverse effects of rising sea levels. The dangers are compounded by the fact that Singapore is located in the tropics, since it is predicted that sea level rise in tropical areas could be up to 30% higher than the global average. The uncertainty of sea level rise projections presents significant planning challenges to protect Singapore.

Singapore has undertaken local measures to protect its infrastructure and living environment against the risk of rising sea levels. Since 2011, minimum platform levels for new development projects have been raised to four metres above the Singapore Height Datum (SHD).<sup>4</sup> New critical infrastructure, such as the Tuas Port and Changi Airport Terminal 5, will have platforms raised even higher, to at least five metres above the SHD. Singapore has also installed coastal protection measures on more than 70% of its coastal areas to manage coastal erosion.

Beyond these, Singapore has studied its coastline and developed a national, island-wide plan to protect itself from rising sea levels. Singapore will continue to explore innovative approaches to coastal protection measures, which may include a combination of conventional engineering solutions such as sea walls, tidal gates and pumping stations, and nature-based solutions. These various coastal protection measures will not only help overcome the challenges of sea level rise, but also present new exciting opportunities for new green and blue community spaces for Singaporeans. These comprehensive coastal protection efforts are estimated to cost S\$100 billion over 100 years. In view of this, the Singapore Government has set up a

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<sup>4</sup> The Singapore Height Datum is defined as the mean sea level determined at Victoria Dock, Singapore, between 1935-1937.

Coastal and Flood Protection Fund, with an initial funding of S\$5 billion, to support the substantial capital outlay. These are necessary to build up Singapore's resilience against climate change and safeguard its future in a fiscally sustainable manner.

### **Managing Singapore's Water, Minimising Floods**

Climate change also poses challenges to Singapore's water supply, security and resilience. To ensure a sustainable and reliable water supply, Singapore has diversified its water supply sources and now has four sources to meet its national water needs, namely, water from local catchment, imported water, NEWater or recycled water, and desalinated water. Singapore has embarked on an integrated and effective way to meet its water needs with investments in research and technology to treat, recycle and supply water in the most cost-efficient way possible. Singapore has also integrated the treatment of wastewater into its water system in a closed loop, and reuses every drop of water by recycling it. Today, NEWater and desalinated water provide Singapore with weather-resilient sources of water.

Singapore will experience more frequent and intense rainfall events with climate change, and will need to deal with the increasing frequency and intensity of floods. It has introduced a "Source-Pathway-Receptor" approach, which looks at catchment-wide solutions to achieve higher flood protection. The Singapore Government has spent almost S\$2 billion on drainage improvement works since 2011. An additional S\$190 million will be spent in 2020 to upgrade and maintain drains. Singapore will need to continually invest and manage its infrastructure to deal with the effects from climate change.

In addition, Singapore will be naturalising more waterways and waterbodies in its gardens and parks. Coastal and riverine parks will also incorporate designs such as floodplains to protect coastal and low-lying areas from sea level rise or flooding. Singapore is also conserving and restoring its mangrove forests. Mangroves help to dissipate waves and trap sediment, potentially serving as a flexible form of coastal defence while reducing erosion.

### **Keeping Singapore's Essential Services Running Well**

More frequent and intense rainfall could result in floods that disrupt Singapore's energy and telecommunications infrastructure and affect its air, land and sea connectivity.

Singapore is strengthening the resilience of its critical services. For example, the drainage system at Changi Airport which is located along the coast, is being significantly upgraded to protect the airport against flood risks. To protect the train network and commuters, flood barriers are installed at the entrances of underground Mass Rapid Transit train stations in low-lying areas.

### **Keeping Singapore's Buildings and Infrastructure Safe**

Studies have been commissioned on the potential effects of higher temperatures, rainfall and wind speeds on building safety and slope stability in Singapore.

The results indicate that the projected changes in climate are unlikely to have a significant impact on the integrity of buildings and building attachments in Singapore as long as they adhere to building codes and are properly maintained. The assessment will be reviewed periodically to account for changes in future climate projections.

### **Strengthening Resilience in Public Health, Protecting Singapore's Greenery and Biodiversity**

Higher temperatures will result in a warmer environment, and could lead to an increase in the mosquito population in Singapore.

Singapore is developing a heat stress information system for the public, and has implemented novel solutions such as the use of *Wolbachia* technology in controlling the mosquito population. Project *Wolbachia* trials have achieved up to 90% suppression of the *Aedes aegypti* population within the study sites.

In addition, Singapore's greenery and biodiversity may be at risk with long-term changes in temperature and rainfall, and more extreme weather.

Singapore has implemented new tree management measures in light of changing climatic conditions. First, the National Parks Board Singapore (NParks) replaces storm-vulnerable species with hardier trees. Second, NParks regularly prunes its trees to improve their structure and balance. Third, NParks uses technology to analyse risks and improve inspection processes. With this adaptive tree management programme in place, the annual number of tree failure incidents has fallen by about 85% between 2001 and 2018, despite more severe weather.

Singapore will conserve more native plants and animals by carrying out recovery plans for over 70 more animals and plant species, enhancing 30 hectares of forest, marine and coastal habitats, and restoring ecological habitats in at least half of its gardens, parks and streetscapes by 2030. Singapore will also be planting one million more trees across the island by 2030.

### **Ensuring a Resilient Food Supply**

As a small country without natural resources, Singapore has developed as an open economy that imports more than 90% of its food supply, making it sensitive to disruptions to global supply chains. Changing climate patterns pose risks to its food supply. To make food supply more resilient, Singapore is pursuing three strategies, namely: 1) Diversification of import sources; 2) Grow local; and 3) Grow overseas.

In particular, Singapore has set an ambitious target for local food production. By 2030, Singapore aims to meet 30% of Singapore's nutritional needs with food produced in Singapore. To do so, the Singapore Government will support the local agri-food industry to adopt innovative solutions and raise productivity. This includes building an R&D ecosystem to enhance

urban food production, develop production technologies for alternative proteins, as well as strengthen food safety capabilities and technologies. Farms can tap on the Agriculture Productivity Fund (APF) to co-fund systems to better control environmental variables and boost production capabilities, as well as to leverage technology to produce food sustainably.

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