

# **CREATING FUTURE-PROOF CITIES**

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**MURALI RAM & REXY PRAKASH CHACKO**

# **CREATING FUTURE-PROOF CITIES**

**How to Navigate the Climate Crisis**



**ARECA BOOKS**

*Polar bears don't lie  
 Politicians do....  
 Penguins can't fly  
 will surely die  
 It's up to me, up to you.*

Flame & famine  
 Flood & fire  
 there's no denying  
 we are melting....  
 2 degrees over  
 & we all go under  
 What to do? What to do?

When rich nations  
 from poor relations  
 can buy permits  
 to release green-  
 house gases....  
 we're all screwed!  
 What to do? What to do?

Where political resolutions  
 like carbon emissions  
 remain little more than  
 puffs of hot air -  
 smog pies in the sky....  
 you can breathe your last sigh  
 What to do? What to do?

*Polar bears don't lie  
 Politicians do....  
 Penguins can't fly  
 will surely die  
 It's up to me, up to you.*





Flowers of the rare *Maingaya malayana* tree, commonly called the witch hazel, which can be found on Penang Hill. The *Maingaya malayana* is of great scientific interest because it is the sole species in the genus.

*Climate resilience:*

Strengthening the ability of human and non-human systems  
to withstand and respond to changes in the earth's climate;  
Also as a way to bridge the conceptual divide  
between mitigation approaches to climate change on the one hand  
and adaptation approaches on the other.

— Bill Kakenmaster, 2018, What is Climate Resilience?  
IMPAKTER, accessed October 2018, [impakter.com/what-is-climate-resilience](http://impakter.com/what-is-climate-resilience)





Sungai Ara Linear Park, a community-led collaborative effort that turned a stream valley into a popular park in Sungai Ara, Penang Island.



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## ACRONYMS

°C	Degree Celsius
CO <sub>2</sub>	Carbon dioxide
CO <sub>2</sub> e	Carbon dioxide equivalent
COP	Conference of the Parties to the UNFCCC
EV	Electric Vehicle
GHG	Greenhouse Gas
Gt	Gigaton
GW	Gigawatt
IPCC	Intergovernmental Panel on Climate Change
MESTECC	Ministry of Energy, Science, Technology, Environment and Climate Change (Malaysia)
PV	Solar Photovoltaic
SDGs	UN Sustainable Development Goals
SEDA	Sustainable Energy Development Authority Malaysia
tCO <sub>2</sub>	Metric ton of CO <sub>2</sub>
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organisation

## GLOSSARY

This glossary is compiled drawing on glossaries and other resources available on the websites of the following organisations and projects: Intergovernmental Panel on Climate Change, United Nations Environment Programme, United Nations Framework Convention on Climate Change and World Resources Institute.

**Baseline:** The current state, against which change is measured.

**Bioenergy:** Energy derived from any form of biomass such as recently living organisms or their metabolic by-products

**Black carbon:** The substance formed through the incomplete combustion of fossil fuels, biofuels, and biomass, which is emitted in both anthropogenic and naturally occurring soot. It consists of pure carbon in several linked forms. Black carbon warms the Earth by absorbing heat in the atmosphere and by reducing albedo – the ability to reflect sunlight – when deposited on snow and ice.

**Carbon dioxide equivalent (CO<sub>2</sub>e):** A way to place emissions of various radiative forcing agents on a common footing by accounting for their effect on climate. It describes, for a given mixture and amount of greenhouse gases, the amount of CO<sub>2</sub> that would have the same global warming ability, when measured over a specified time period.

**Carbon intensity:** The amount of emissions of CO<sub>2</sub> released per unit of another variable such as gross domestic product.

**Climate crisis:** The sum total of human-caused environmental problems such as accumulation of carbon dioxide and other greenhouse gases in the atmosphere, global heating, deforestation, over-fishing, freshwater

depletion, soil erosion, loss of biodiversity, chemical contamination, and water pollution leading to an apocalyptic panorama.

**Conference of the Parties (COP):** The supreme body of the United Nations Framework Convention on Climate Change. It currently meets once a year to review the Convention's progress.

**Deforestation:** Conversion of forest to non-forest.

**Greenhouse gases:** The atmospheric gases responsible for causing global warming and climatic change. The major greenhouse gases are carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O). Less prevalent but very powerful GHGs are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF<sub>6</sub>).

**Kyoto Protocol:** An international agreement, standing on its own, and requiring separate ratification by governments, but linked to the UNFCCC. The Kyoto Protocol, among other things, sets binding targets for the reduction of greenhouse gas emissions by industrialised countries.

**Mitigation:** In the context of climate change, a human intervention to reduce the sources, or enhance the sinks of greenhouse gases. Examples include using fossil fuels more efficiently for industrial processes or electricity generation, switching to solar energy or wind power, improving the insulation of buildings and expanding forests and other 'sinks' to remove greater amounts of CO<sub>2</sub> from the atmosphere.

**Nationally Determined Contribution (NDC):** Submissions by countries that have ratified the Paris Agreement which presents their national efforts to reach the Paris Agreement's long-term temperature goal of limiting warming to well below 2°C. New or updated NDCs are to be submitted in 2020 and every five years thereafter. NDCs thus represent a country's current ambition/target for reducing emissions nationally.

**Offset (in climate policy):** A unit of CO<sub>2</sub>e emissions that is reduced, avoided, or sequestered to compensate for emissions occurring elsewhere.

**Plausible Scenario:** Plausible scenario of total atmospheric CO<sub>2</sub>e reduction (gigatons) between 2020 and 2050 based on suggested mitigation actions.

**Source:** Any process, activity or mechanism that releases a greenhouse gas, an aerosol or a precursor of a greenhouse gas or aerosol into the atmosphere.

**Sustainable development:** Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

## FOREWORD

It is the year 2019. Malaysia and Southeast Asia has been suffering from the seasonal transboundary haze problem for the last twenty-two years. No immediate actions are taken to future proof the region against this human-induced environmental hazard. People have indeed died due to the adverse effects of the haze as well as climate change. We can only take comfort in Greta Thunberg's impassioned plea to the world.

With every passing year the looming shadow of the climate crisis grows ever larger. Doubtless, the worsening environment and our ability to develop a more sustainable way of life, and to live in harmony with our surroundings, will be the major issues of our times. Changes in our daily discourse are slowly beginning to reflect this reality. As *The Guardian* poignantly noted in their new editorial policy: the world is dealing with a “climate emergency” instead of the more neutral, milder sounding “climate change”.

The price paid is very real – school closures, respiratory problems, massive impacts on

businesses. Real costs in healthcare for the treatment of haze-related illnesses or hits to our country's GDP help us to quantify our environmental mishaps. Clearly these alarming events have not been enough to make us change our ways.

The words we choose are important. The right words help convey the seriousness of this issue whereas milder terms merely normalise problems. Words have also determined that the responsibility of climate change lies with the individual: it is you and I who must act to reduce our carbon footprint by adapting our lifestyles and consumption patterns.

While individual responsibility is commendable, the biggest contributors to climate change are big fossil-fuel dependent enterprises and other polluting industries. Words have now started to shift the burden of responsibility in their direction. It is with words and positive action that we will redirect our efforts to address this issue head on.

This book offers a framework for how we can build more resilient cities in Malaysia. It





provides a comprehensive blueprint for steps that we can take to begin to undo the damage we have done. It even categorises goals based on the ease of practical implementation. It offers us the steps that can be taken immediately to build momentum for further future success.

Critically, the book is benchmarked to global standards whilst providing a framework, tailored to local context, for governments and organisations to act. Local context is key as it accounts for the environmental problems that are unique to Malaysia and offers specific solutions, evidenced by Penang as a case study. I have a huge stake in Penang, which is not only my fatherland, but also the location of my constituency, Permatang Pauh.

Mitigating natural disasters, or those caused by land use changes, has been a feature of Penang conversations for a while now. What kind of Penang do we wish to have? One that is on the precipice of overdevelopment? One that is lagging behind more liveable cities in the region? Or worse, one that is submerged by seawater or consumed by excessive land reclamation?

We must ensure that Penang manages to achieve the balance needed for sustainable development, as envisioned by the Chief

Minister's Penang2030. The desire to meet long-term economic and development goals must be wedded to a sustainable approach in dealing with the environment, if we wish to avoid shooting ourselves in the foot.

The policy decisions we make in the next few years will greatly determine the path we will take. Indeed, we cannot aim to be competitive or flourish economically without climate resilience or regard for being adaptive to future needs. We must act now.

I commend the authors for their painstaking work in producing this valuable manuscript. It is one thing to have the prescience to address this issue in such a concise manner, but they have gone beyond that to compile an executable piece of work. We cannot allow this book to be ignored. It should and must become a cornerstone of the conversation that propels the importance of climate action into the Malaysian consciousness.

Whatever we need to do is here in this book. The problems are obvious, the solutions are available. All we need is the political will to act.

**Honorable Nurul Izzah Anwar, MP**  
8th November 2019



Canopy Walk, The Habitat.

# PREFACE

By all accounts, the climate crisis is set to become the biggest existential threat to humanity. All around we see the effects of it being manifested through erratic weather patterns, rising sea levels, ever increasing floods, and falling crop yields. The Special Report on Global Warming released by the IPCC in 2018 identifies Southeast Asia as one of the regions that stands to be most affected by the climate crisis in the near future.

Standing at our current crossroads, we need to understand climate science and adapt to the new climate norms in order to remain relevant and thrive. It is with this intention that we present '*Creating Future-Proof Cities: How to Navigate the Climate Crisis*,' a practical and easy to comprehend future-proofing strategy. With Malaysia's Penang State as a case study, this document is intended to serve as a guide for cities throughout the region to face the challenges of a changing climate.

Addressing local problems with holistic solutions and global examples, this strategy document presents the hard realities and the best practices which policy makers, communities and individuals can act upon. As unprecedented change is required to keep global temperature rise within 2°C; beyond adapting to the climate crisis, we also need to act proactively to stop our contribution to the rise of greenhouse gases.

This document highlights impactful climate action which is broadly described under an overarching framework covering culture, energy, mobility, waste, water and land use, that institutions and individuals alike can work upon. Actions can be as simple as transitioning to an increasingly plant based diet or more institutional, like incentivising rooftop solar installations and gazetting new forest reserves.

It is hoped that this strategy document will help serve as a guide to communities and cities to step up action to curb the rise of global temperatures and prepare them to be more resilient. Climate action begins with us and in our cities, so we need to work individually as well as collectively to navigate past this crisis that is now rapidly unfolding.

**Murali Ram and Remy Prakash Chacko**  
November 2019



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A rewilding programme in New Orleans, that also acts as a bio-swale.



The constant pressure to build affordable housing for sale is pushing development up the hill slopes in Penang.



# 1 • WHY DO WE NEED A CLIMATE RESILIENCE STRATEGY?

Cities consume about 78% of the world's energy and produce more than 60% of all carbon dioxide (CO<sub>2</sub>) emissions. Their actions are thus central to minimising the rise in global mean temperature. Extreme and changing climate triggered by the accumulation of CO<sub>2</sub> and other GHG emissions over the years is increasingly piling pressure on people and the cities they live in. Each city has its own issues to grapple with depending on, among others, its location, topography and land use history.

Cities around the world are dealing with extreme weather shocks such as storms, floods, drought, and heatwaves. Vulnerabilities can also come in the form of stresses that slowly weaken the fabric of a city, such as inefficient public transportation systems, chronic water shortages, air quality problems, heat island effect, insufficient city revenues, and sea-level rise, subsidence and coastal erosion. Loss of biodiversity is another cause of concern as it affects pollination, food production, and food security.

Building stronger infrastructure to hold back sea water, retaining stormwater while facilitating flow of river water, and preventing landslides are one aspect of climate resilience dealing with adaptation. In parallel, we must also work towards reducing our contribution to global heating. To this end, we must build a culture of awareness of, and action about, the climate crisis. Recent scientific reports from around the world demand that greenhouse gas emissions must halve by 2030 to avoid even greater risks of drought, floods, extreme heat

and susceptibility to poverty for hundreds of millions of people.

Cities and organisations across the globe are taking actions broadly based on targets set by the UN Sustainable Development Goals ("SDGs"). City action is the key to addressing any meaningful reductions in GHG emissions, for cities are sites where energy use, transportation pollution, waste production, and cultural practices are interdependent. City governments are thus uniquely positioned to set agendas, develop cross-sectoral partnerships, and send market signals to address the climate crisis.

Collaborating with residents, community organisations, and businesses, cities worldwide are rethinking how they contribute to the climate crisis. One such city is New Orleans, Louisiana, which has introduced a Climate Action Strategy, called *Climate Action for a Resilient New Orleans*.

Research for this publication took into account the latest best practices from cities around the world, with an emphasis on showcase solutions that are applicable to tropical cities. This publication is intended to provide policy makers, local governments, community organisations and individuals practical strategies that they can apply in their cities and daily lives as part of their climate mitigation and adaptation strategies. It provides a basic overview of the key actions needed to increase climate resilience as part of an overall pathway to achieving sustainable development.



## 2 • PENANG AS ILLUSTRATION

*“There is really no alternative to balanced development. A well-kept balance between economic growth and ecological protection can help make Penang the model state that we all want it to become,”* said Penang Chief Minister Chow Kon Yeow in August 2018.

Penang State (“Penang”) in Malaysia is located on the northwestern coast of Peninsular Malaysia. It consists of Penang Island, and a strip on the Peninsula called Seberang Perai. The island has a hilly topography, while Seberang Perai is mostly flat, and roughly 2.5 times larger than the island. Penang grew from a tropical port city, engaged in the spice trade, into a renowned electronics manufacturing hub. Penang is the densest state in Malaysia, with 1.77 million people living in an area of 1,048 km<sup>2</sup>.

Penang Island is managed by the Penang Island City Council (MBPP) while Seberang Perai is managed by the Seberang Perai City Council (MBSP). The MBSP is targeting to turn Seberang Perai into a low-carbon and smart city by 2022. According to MBSP Mayor Dato Sr. Rozali Mohamud, the council is formulating a strategy towards creating a low carbon city by achieving a 70 per cent recycling rate and a 50 per cent reduction in the tonnage of rubbish disposal into landfills by 2022.

The MBPP has also been moving towards a similar direction. In terms of waste management and recycling rate, MBPP is looking towards organic waste from hotels, restaurants, malls and factories being

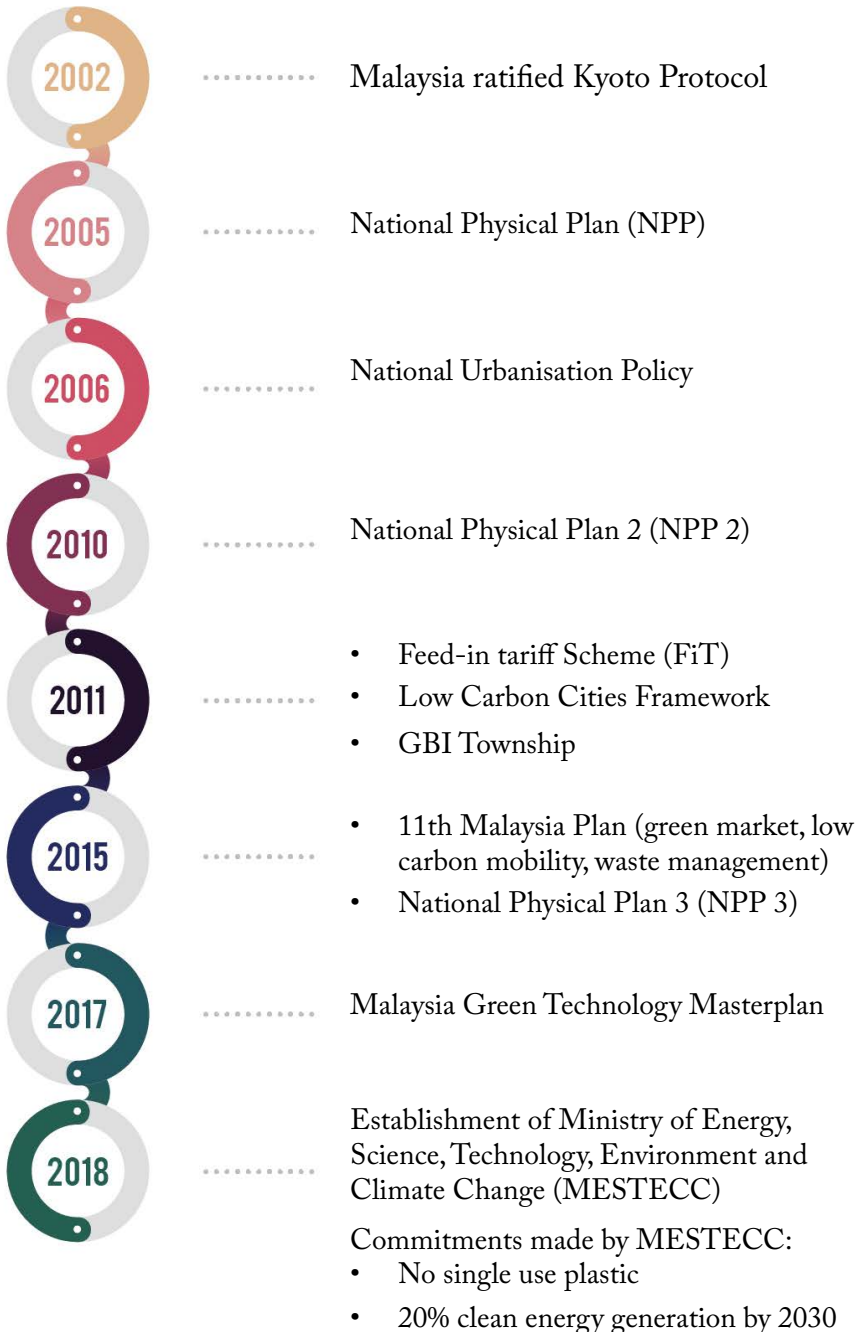
converted into energy and fertiliser. MBPP Mayor Dato Ar. Yew Tung Seang has been pushing through with proposed bicycle lanes for the whole island as part of the state’s green agenda to encourage more people to cycle to work. To date, the council has put into place 24 km of dedicated cycling lanes all over the island with a target of increasing this to 39 km by 2020.

On 29 August 2018, the Chief Minister of Penang unveiled his policy plan titled *PENANG 2030: A Family-focused Green and Smart State to Inspire the Nation*.

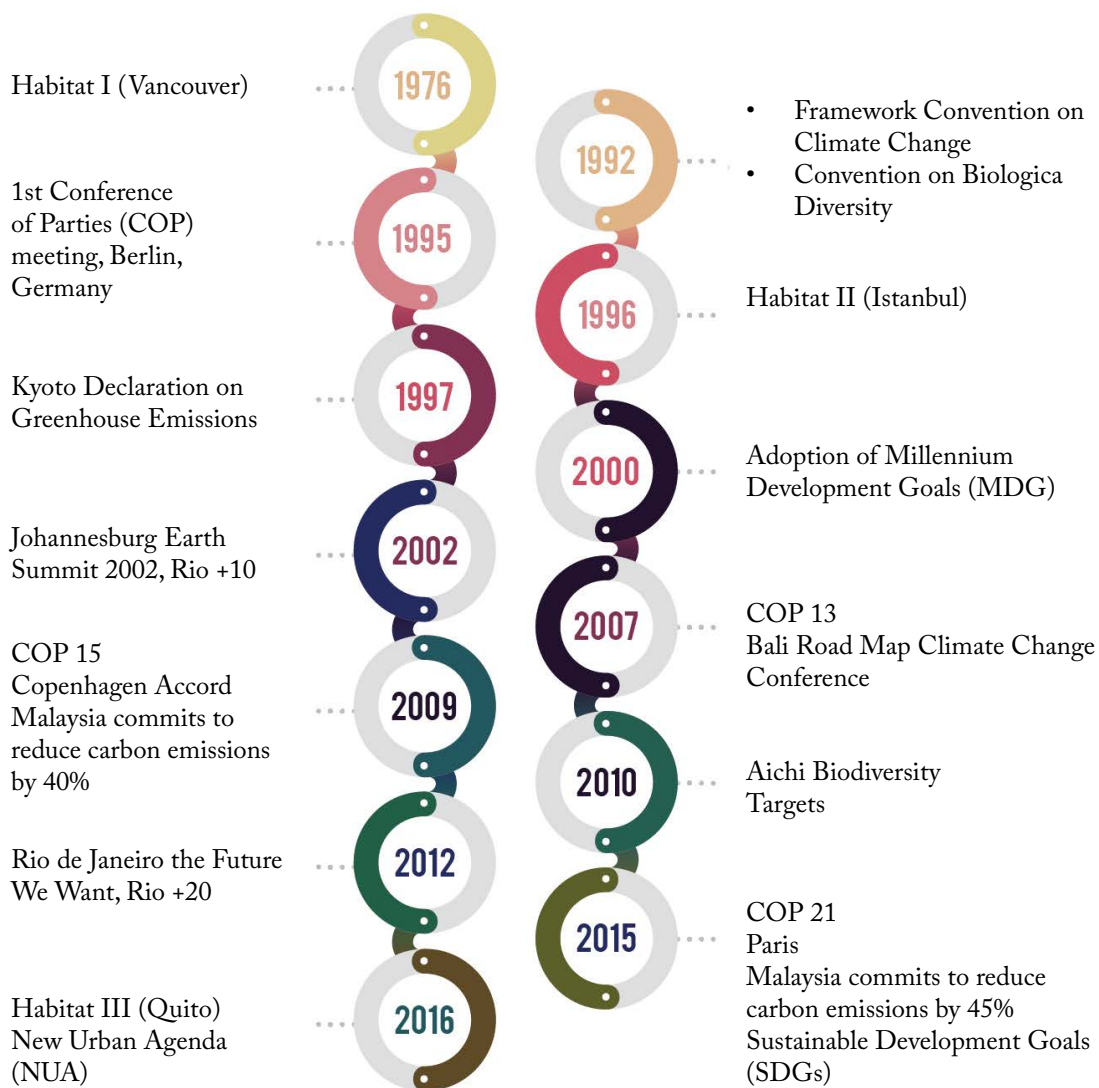
In his policy plan, the Chief Minister emphasised that, “as Penang is not a big place, it is all the more important that our overall environment is considered whenever policies are made.” On adapting to climate change and other environmental concerns, he stressed that, “Penang will look seriously at new solutions that have been tried with success in other cities. This includes waste-to-energy and composting technologies; and where flood mitigation is concerned, the exploring of long-term solutions such as the *Sponge City* technology.”

Penang is already seeing patterns of extreme weather that lead to flooding caused by intense rainfall and/or sea-level rise, increased incidences of landslides, and on separate occasions, hotter months and prolonged droughts. In early November 2017, Penang experienced its heaviest rainfall event in recorded history (315 mm), followed by devastating floods.

## MALAYSIA'S POLICIES ON SUSTAINABLE DEVELOPMENT



## MALAYSIA'S COMMITMENTS ON SUSTAINABLE DEVELOPMENT



## International Commitments Relevant to Malaysia

The Convention on Climate Change targets the lowering of industrial and other greenhouse gases emissions, especially carbon dioxide. The spatial strategy adopted by the Malaysian government is to maintain an effective and sustainable forest management programme, thus decreasing the urban footprint, and to encourage the use of public transport.

The Convention on Biological Diversity aims to protect ecosystems, maintain natural habitats, particularly the tropical rainforest and wetlands, and to establish wildlife corridors. This follows from the Rio+20 outcome document, which reaffirms “the intrinsic value of biological diversity and its critical role in maintaining ecosystems that provide essential services, which are critical foundations for sustainable development and human well-being”.

At the national level, trans-boundary threats relating to climate are being addressed through policies such as the National Renewable Energy Policy and Action Plan (2008), National Policy on Climate Change (2009), National Green Technology Policy (2009) and Green Technology Master Plan (2017), with agencies such as the Ministry of Energy, Science, Technology, Environment and Climate Change (“MESTECC”) and Sustainable Energy Development Authority Malaysia (“SEDA”) as designated drivers.

Amongst the pledges made by the Malaysian government are:

1. To cut the country’s emissions by as much as 45% by 2030 (based on 2005 emission levels);
2. To be a key part of the global transition to a low-carbon, and eventually carbon-neutral society, with ambitions of achieving this by 2050; and

3. To preserve the remaining primary forests on at least half of Malaysia’s land area so that these forests can continue to serve as effective carbon sinks.

The key principles from the above commitments are embodied in Malaysia’s National Physical Plan 3, which provides the overall framework for the drawing up of State-based detailed Development Plans.

Over half of the world’s population live in urban areas. By 2050, that figure will have risen to 6.5 billion people – two-thirds of the human population. Sustainable development depends on our ability to transform the way we build and manage our urban spaces. Making cities sustainable involves investments in public transport and improving urban planning and management.

## SDG 11 Targets relevant to Malaysia

By 2030, ensure *access* for all to adequate, safe and affordable housing (*Note: access does not imply home ownership*).

By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport.

By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.

By 2030, provide universal access to safe, inclusive and accessible, green and public spaces.

By 2020, adopt and implement integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, and resilience to disasters.

The climate crisis is a broad range of global phenomena created predominantly by burning fossil fuels, which add heat-trapping gases to Earth’s atmosphere. These phenomena include increased temperature trends, sea level



rise, ice-mass loss in Greenland, Antarctica, the Arctic and mountain glaciers worldwide, and extreme weather events.

Greenhouse gas pollution, also referred to as carbon emissions, is the primary cause of climate change. These emissions are largely derived from the energy we use, how we transport ourselves and our goods, and the decomposition of our waste.

Key greenhouse gases include carbon dioxide (CO<sub>2</sub>), methane and nitrous oxide. The main source of excess CO<sub>2</sub> emissions is the burning of fossil fuels, while deforestation has reduced the amount of plant life available to absorb CO<sub>2</sub>. Methane, a more potent but less abundant greenhouse gas, enters the atmosphere from farming – both from animals such as cattle, and arable farming methods, including traditional rice paddies.

As of 2017, humans have caused over 1.0°C of global warming above pre-industrial levels, i.e. as compared to a baseline of 1720–1800. In order to limit warming to 1.5°C, global net CO<sub>2</sub> emissions must be halved by 2030, and reach net zero around 2050 – a target that is increasingly appearing to seem unattainable.

As for global sea levels, they have risen by about 20cm since 1880 and are projected to rise another 30cm to 122 cm by 2100. Along

the coasts, many communities are already experiencing tidal flooding with increased frequency. There is no country in the world that is not experiencing first-hand the drastic effects of the climate crisis, such as hotter summers, prolonged drought, and flooding from heavier rainfall.

### SDG 13 Actions relevant to Malaysia

Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters.

Integrate climate change measures into policies, strategies and planning.

Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.

Achieving economic growth and sustainable development requires that we urgently reduce our ecological footprint by changing the way we produce and consume goods and resources. The efficient management of our shared natural resources, and the way we dispose our toxic waste and pollutants, are important targets to achieve this goal.

Encouraging industries, businesses and consumers to recycle and reduce waste is equally important.



## SDG 12 Targets relevant to Malaysia

By 2030, halve per capita food waste at the retail and consumer levels.

By 2020, achieve environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.

By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.

Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle.

By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.

Develop and implement tools to monitor sustainable development impacts for sustainable tourism.

## 3 • CLIMATE ACTION—WHAT CAN WE DO

Globally, national governments' responses are two-fold: mitigation in the immediate-term, and adaptation for the longer-term. With respect to mitigation, there are two means by which we can address this: a radical decrease in human-caused emissions and widespread adoption of proven land practices that sequester carbon from the air to be stored for centuries.

### Mitigation – Priorities

Based on research and data made available by Project Drawdown, the efficacy of current solutions to potentially avoid GHGs and to sequester CO<sub>2</sub> over a 30-year period are ranked as follows:

	Solutions	Gigatons reduced worldwide (plausible scenario)
1	Management and destruction of chemical refrigerants, HFCs, already in circulation at the point of disposal of refrigerators, air conditioners and supermarket cases.	89.7
2	Reducing food waste – on the farm, near the fork and in between.	70.5
3	Plant-rich diet – by making vegetarian options the norm (at home and public institutions, e.g. schools and hospitals); and reframing meat as a delicacy, rather than a staple.	66.1
4	Restore degraded land to forest cover.	61.2
5	Educating girls – 13 years of schooling greatly influences family size and global population.	59.6
6	Increased adoption of family planning – essential to achieve the UN's 2015 medium global population growth projection of 9.7b people by 2050. A higher population growth projection with an additional 1b people will result in 119 gt of increased GHG emissions.	59.6
7	Solar Farms	36.9
8	Rooftop Solar	24.6
9	Protection of peatland, wetlands (mangroves) and marshes.	21.6
10	Afforestation – strategic planting of trees and forests in degraded lands, e.g. former mining land, eroding slopes, industrial properties, abandoned lots and highway medians.	18.1

## Top 20 Suggested Actions

	Action	Ease of Implementation*
1	Prepare the institutional setting at the level of the State cabinet and the city. Appoint a Chief Resilience Officer, or equivalent, and sub-teams at the city level charged with raising public awareness, convening all actors, crafting programmes, setting targets, and driving implementation.	5
2	Conduct a carbon emissions inventory of the city, stated in CO <sub>2</sub> equivalent measuring the emission of primary GHGs: CO <sub>2</sub> , CH <sub>4</sub> (methane), and N <sub>2</sub> O (nitrous oxide). Conduct an inventory of carbon capture eco-system services, recording hectares of carbon sinks such as peat swamps, mangrove swamps, and rainforests.	4
3	Set up, or pay for, the services of e-waste establishments that have the capability of recovering refrigerants, such as CFC and HFC, and have them properly destroyed, reclaimed for resale, or stored safely, to prevent their emissions into the atmosphere.	5
4	Embark on mangrove protection and restoration programmes along coastlines and riverbanks. Create incentives to rope in private companies to participate. Gazette new forest reserves and protected green spaces.	5
5	Ensure that government events go zero waste, by doing away with single-use plastic bottles and cutlery, paper plates and cups, and insisting that caterers and suppliers use reusables. Food offerings at government events should be at least 80 per cent vegetable-based.	5
6	Introduce an In-Home Audit programme to help home and business owners assess their current energy usage and obtain recommendations on more efficient options. Residential, commercial as well as industrial entities ought to know their own carbon footprints, and that of their suppliers.	5
7	Support business training to incorporate sustainability practices into daily operations. Encourage environmental Corporate Social Responsibility activities, partnering with public and private organisations, e.g. schools, residents' associations, and businesses to develop initiatives that highlight our community's connection to climate change, promoting actions that can reduce GHG pollution.	4
8	Establish a city-wide low carbon energy target to make renewable energy a priority and progressively phase out carbon-intensive fossil fuels.	4
9	Create a programme to incentivise rooftop solar panel installations by means of offering grants and soft loans. Each landed property in the city should be equipped with solar panels by 2030.	4
10	Implement Urban Growth Boundaries (UGBs). Urban sprawl is controlled by designating urban development areas almost exclusively within UGBs, and allowing areas outside UGBs to be preserved in their previous or natural state.	4

11	Increase the modal share of public transport by making it more efficient and reliable. Using a telematics system, provide users with real-time information on bus arrivals and departures which are coordinated with rail and ferry schedules. Create bus lanes on existing main roads, reducing road space for private vehicles in order to increase the relative speed of buses, hence making the public transport option more attractive to commuters. Introduce policies to disincentivise car use and reduce motor vehicle dependency.	4
12	In designing the urban environment, prioritise mixed-use development and land use for transit-oriented development. Encourage rentals in place of home ownership, putting special focus on building affordable rental units near workplaces and within walking distance to public transport nodes and transit hubs.	3
13	Implement a long-term (10-year) Urban Forest Strategy to introduce thousands of strategically chosen and placed trees in urban settings aimed at increasing canopy cover, urban forest diversity, and urban biodiversity.	4
14	Set air quality targets for 2030. Install sensors as part of smart city infrastructure and, based on data collected concerning pollution sources, adopt emission-reduction measures. Establish Clean Air Action Plans for the city, its ports and industrial estates.	4
15	Ban food waste by preventing wet markets, supermarkets and hotels from throwing away unsold food, which should instead be distributed to charities, food banks and animal shelters, with the remainder being sent to composting centers. Incentivise restaurants to donate unsold food.	3
16	Increase the uptake of family planning by way of providing sex education, and by ensuring children receive at least 13 years of schooling.	3
17	Remove bottlenecks in the city's water drainage system. Introduce or restore natural riparian zones along riverbanks. Increase water retention capacity by using green spaces, fields and public facilities.	3
18	Reduce the city's reliance on development-dependent contributions so as not to exceed 25 per cent of its revenue base. Cap spending on Solid Waste Management and Public Cleansing to 20 per cent of the city's expenditure. Gradually increase the city's incomes from sources such as rents, compounds, licences, and permits.	3
19	Invest in new technology to better compost organic waste and to recover energy and nutrients from organic waste and wastewater. Explore construction of Waste to Energy plants as alternative to landfilling.	2
20	Maximise fuel efficiency of public vehicles and public transit fleet, for instance, by changing fuel mix from diesel to less polluting alternatives such as battery-operated and Low Carbon Emission Buses.	2

\*Ease of implementation listed on a scale of 1 (challenging) to 5 (manageable) based on responses from public officers.

## What We Can Do as Individuals

	Action
1	Transition to a plant-based diet, or at least reduce by 50 per cent the consumption of meat from cows, sheep and goats, and dairy products.
2	Go Zero-Waste by altering consumption patterns and reducing food waste and packaging waste. Practice the 5R mantra: Rethink (the need to acquire, and to dispose), Reduce (consumption), Reuse, Repair, Recycle.
3	Avoid having more than 2 biological children.
4	Practice active transportation (walking/cycling) and use public transport whenever possible. Aim to reduce private vehicle travel by 50 per cent.
5	Reduce long-distance aviation travel by 50 per cent: utilise latest communication technologies for business meetings and choose short-distance vacations. Avoid cruise-ship vacations.
6	When purchasing goods, give preference to goods produced locally or in the local region.
7	Avoid purchasing more than one real estate property per household, and avoid using real estate as an investment portfolio.
8	Embark on conversations about the climate crisis and good environmental practices with schoolchildren, residents' associations and businesses to raise awareness; develop initiatives related to reducing meat and energy consumption, and waste production.
9	Conduct an in-home and in-office audit to assess current energy usage and obtain recommendations on more efficient options available.
10	Call upon elected representatives and the local council to embark on peat swamp, mangrove swamp and rainforest protection and restoration.
11	Plant fruit trees and/or practice urban farming in home, school, and community gardens.
12	Install rooftop solar panels on house or office building.

## 4 • BECOMING CARBON NEUTRAL

There are several GHGs that are emitted as a result of human activity. These include:

Carbon dioxide (CO<sub>2</sub>) from the combustion of coal, petroleum, natural gas, solid waste, trees, and wood products, and certain manufacturing processes (e.g. cement);

Methane (CH<sub>4</sub>) from municipal landfills, petroleum and natural gas systems, coal mines, and agriculture;

Nitrous oxide (N<sub>2</sub>O) from the use of nitrogen fertilisers, burning of fossil fuels, and from certain industrial and waste management processes (e.g. nitric acid production);

High global warming potential (GWP) gases, which are man-made fluorinated industrial gases, including hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF<sub>6</sub>).

Of the GHGs emitted, CO<sub>2</sub> is emitted in the largest quantities, making up over 90 per cent of the annual GHGs reported. Methane emissions represent 7 per cent of reported GHG emissions, N<sub>2</sub>O represents 0.9 per cent, and fluorinated gases 0.7 per cent.

Many cities publicly declare their ambition to become “zero-carbon”. Carbon neutrality, or having a net zero carbon footprint, refers to achieving net zero carbon emissions by balancing a measured amount of carbon released with an equivalent amount sequestered or offset. The best practice for organisations and businesses seeking carbon neutral status entails reducing and/or avoiding carbon emissions first, so that only unavoidable emissions are offset. Carbon

neutral status is commonly achieved in two ways:

- a. Transitioning to using only renewable energy sources that do not produce any CO<sub>2</sub>;
- b. Carbon offsetting by removing or sequestering 100 per cent of the CO<sub>2</sub> emitted from the atmosphere – e.g. by funding reforestation.

### The Role of Our Forests

Deforestation and forest degradation contribute about 17 per cent of the global GHG pollution, more than the entire transportation network and second only to energy- and industry-related emissions. This is due to the release of the carbon stored in one or more of four carbon pools:

1. aboveground biomass,
2. belowground biomass,
3. soil carbon, and
4. dead organic matter.

Terrestrial sequestration efforts include tree plantings, no-till farming, wetlands restoration, land management on grasslands and grazing lands, fire management efforts, and forest preservation. Ranges of CO<sub>2</sub> sequestration rates for chosen biomes are shown below:

Biome	Sequestration Rate (Metric tonnes/Acre/ Year)
Swamp/floodplain/ wetland	2.23–3.71
Forest	0.05–3.9
Grassland	0.12–1.0
Cropland	0.2–0.6



Peat swamp in Miri, Sarawak



Mangrove swamp in Seberang Perai

### Peat swamps

The tropical peat swamp forests of Indonesia and Malaysia are ecosystems that are rich in endemic species of flora, fauna and microbes. It has been estimated that 5,800 tonnes of carbon per hectare can be stored in a 10m deep peat swamp forest, compared to 300–500 tonnes per hectare for other types of tropical forests.

Peat swamp forests are highly sensitive to the impacts of logging, drainage and fire, and rely on the maintenance of adequate water and canopy cover. Even minor disturbances can increase the likelihood of peat swamp fires, which is a major cause of CO<sub>2</sub> emissions. Safeguarding them, through land preservation, and ensuring they are waterlogged is key to managing GHG emissions. Rewetting drained peatlands is a priority, as waterlogged soil prevents dead leaves and wood from fully decomposing.

Peat swamps have large water storage capacity, which slows the passage of floodwaters in wet seasons and maintains stream base flows during dry seasons. These forests are of global importance, yet they are inadequately protected and are vanishing due to land conversion for oil palm and logging.

*“Mangroves are being destroyed at an alarming rate. This needs to stop. Our research shows that mangroves play a key role in climate change mitigation strategies.”* – Daniel Murdiyarso, Senior Scientist at The Centre for International Forestry Research (CIFOR).

### Mangrove swamps

According to a 2011 study, deforestation of mangrove forests account for 10 per cent of the world's carbon emissions, even though they make up less than 1 per cent of the world's forests. Mangroves contribute 10–15 per cent to coastal sediment carbon storage and export 10–11 per cent of terrestrial carbon to the ocean. Mangroves can sequester four times more carbon than rainforests can. Most of this carbon is stored in the soil beneath mangrove trees. Through restoration of coastal mangroves and riverbank swamps, greater carbon sequestration benefits can be achieved.

Mangroves also provide a host of benefits for coastal communities by acting as storm barriers, protecting inland areas from flooding and erosion by dissipating the energy of big waves. They help filter river water of pollutants





Stilt roots of a mangrove tree

and trap excess sediment before it reaches the ocean. Their role as fish nurseries have big impacts on local economies and food production.

Mangroves can be sustainably harvested for their wood, but mangrove areas are often cleared to make room for shrimp farms and other forms of aquaculture, as well as for land reclamation. A few hundred hectares of mangrove are still found in Penang, on the mainland along the Kuala Muda–Teluk Air Tawar coast as well as between the estuaries of Sungai Juru and Sungai Krian, and on the island along the Balik Pulau coastline.

*“Decarbonization is the great task of our generation and Costa Rica must be one of the first countries to accomplish it... to make way for the use of clean and renewable energies.”*

– Costa Rica’s President Carlos Alvarado, May 2018.

### Lessons from Costa Rica

Costa Rica, nestled between Nicaragua and Panama, is making plans to be entirely free of fossil fuels in the very near future. With a population of 5 million, Costa Rica has made great strides in its campaign to rely strictly on renewable energy for its electricity. In 2017, renewables met its entire demand for electricity for 300 days of the year. It has also taken a leading role in the world community when it comes to banning plastics.

With its rich biodiversity, Costa Rica has demonstrated far-sighted environmental leadership by pursuing reforestation and designating a third of the country protected natural reserves. The country is also part of the Wellbeing Economies Alliance – a coalition that also includes Scotland, New Zealand, and Slovenia. Instead of emphasising countries’ GDP, countries in this Alliance seek to ensure that public policy advances citizens’ wellbeing in the broadest sense, by promoting democracy, sustainability, and inclusive growth.





Tropical rainforest in Seberang Perai

### Tropical rainforests

*“Tropical forests are like Earth’s air conditioner. When it comes to rehabilitating forests to fight global warming, carbon dioxide might be only half of the story; we also have to account for whether they help to reflect sunlight by producing clouds,”*

– Ken Caldeira, Carnegie’s Department of Global Ecology.

The average tropical tree sequesters a minimum of 22.6 kg of CO<sub>2</sub> each year, depending on its size and growth rate. For example, each tree planted in Costa Rica sequesters one tonne of CO<sub>2</sub> over 25 years. This calculation does not account for the additional CO<sub>2</sub> captured in the biomass or fertile topsoil. Over 50 per cent of a tropical tree’s woody biomass is sequestered carbon, which is why tropical trees are so important in the fight against global warming and climate change.

These forests store about 46 per cent of the world’s living terrestrial carbon pool

and about 11 per cent of the world’s soil carbon pool. Thus, any form of destruction or reduction in area of these forests will lead to a substantial increase of CO<sub>2</sub> concentration in the atmosphere.

Other than acting as a carbon sink, tropical rainforests serve as water catchment areas and sites for recreational activity. Each tree transpires or recycles over 200 gallons of rainwater each year. By the time the trees reach 20 years old, they would have formed a canopy which transpires 20,000 gallons of water per acre per year.

Tropical rainforest, in the form of hill dipterocarp forest, still covers large parts of Penang Island’s central spine, much of which are protected as water catchment areas or permanent forest reserves. For example, the Bukit Kerajaan Forest Reserve protects the largest tract of hill dipterocarp forest in the land covering Penang Hill and stretching to Batu Ferringhi.

## Data-Driven Decision Making

Moving towards evidence-based decision making, city governments should assemble and make data available for analysis and action. Harnessing data can help multiple stakeholders understand how energy, transportation, and waste systems work, and where savings and improvements can be made.

*Action* Conduct a carbon emissions inventory, to be stated in million metric tonnes of CO<sub>2</sub> equivalent (CO<sub>2</sub>e), measuring the emission of primary greenhouse gases: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O), all converted into the same base measure of CO<sub>2</sub>e. Each city should embark on a baseline inventory using the Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC) to record the baseline at a given year.

*Action* Concurrently, conduct a baseline inventory of carbon capture eco-system services. This inventory should record coverage/area of carbon sinks such as peat swamps, mangrove swamps, and rainforests in hectares and convert them into their respective carbon capture capacity (-CO<sub>2</sub>e).

# City externalities

## Energy

- Greenhouse Gas Emissions (CO<sub>2</sub>e) produced by energy generation, broken down into the sources of energy supplied by the energy utility company: Coal, Petrochemicals, Natural Gas, Renewables
- Amount of energy generated in the city through renewable sources (solar PV, etc.)
- Amount of energy generated in the city through waste to energy projects such as biomass and methane extraction
- Amount of energy use in the city, broken down into industrial, commercial, residential, and common municipal uses (streetlights, traffic lights, etc.)

## Waste

- Volume of municipal solid waste generated
- Volume of organic waste generated
- Volume of municipal solid waste diverted from landfill
- Volume of matter sold for recycling, broken down into paper, glass, metal, plastics, and construction waste

# nalities

## Carbon capture

### *Transportation*

- Distance travelled in private vehicles daily, to include rideshare trips
- Volume of fossil fuel sales across the city, with a breakdown of fossil fuel use for public transportation
- Number of commuters utilising public transportation

### *Water*

- Volume of water generation
- Volume of water consumption
- Volume of wastewater recycled
- Water quality data of the city's primary rivers

### *Air Quality*

- Air quality data (PM 2.5) in dense parts of the city
- Median Air Quality Index (AQI)
- Air quality days unhealthy for sensitive groups (AQI of 101 and above)

### *Population*

- Number of city dwellers
- Number of visitors to the city per annum

### *Green cover*

- Hectares of protected peat swamps
- Hectares of protected mangroves swamps
- Hectares of protected forests
- Inventory of street and park trees

## 5 • ENERGY DIVERSIFICATION

Energy is an indispensable part of our lives. We use it to cook, run our varied modern appliances, light our homes, and drive our cars. In a larger context, energy helps automate complex processes, run manufacturing lines, as well as light up our neighbourhoods and streets. Energy is the very ingredient that powers our cities. Usage of energy can be divided into four main economic subcategories: residential, commercial, transportation and industrial. A major source of high energy consumption in Penang comes from energy-intensive industries in the Industrial Zones on the island and the mainland. As Penang has a warm equatorial climate, many commercial, residential and industrial buildings also expend a lot of energy in cooling their internal spaces through air-conditioning, which is energy intensive.

Electricity generation in Malaysia is significantly dependent on three major non-renewable sources: coal, natural gas and fuel-oil, which all generate GHGs. Nationally, about 32 million metric tonnes of coal are burnt to generate electricity, with forecasts showing that this figure will hit 37 million metric tonnes by 2020. Another major source of GHGs is direct usage of petroleum and natural gas to power vehicles and for cooking.

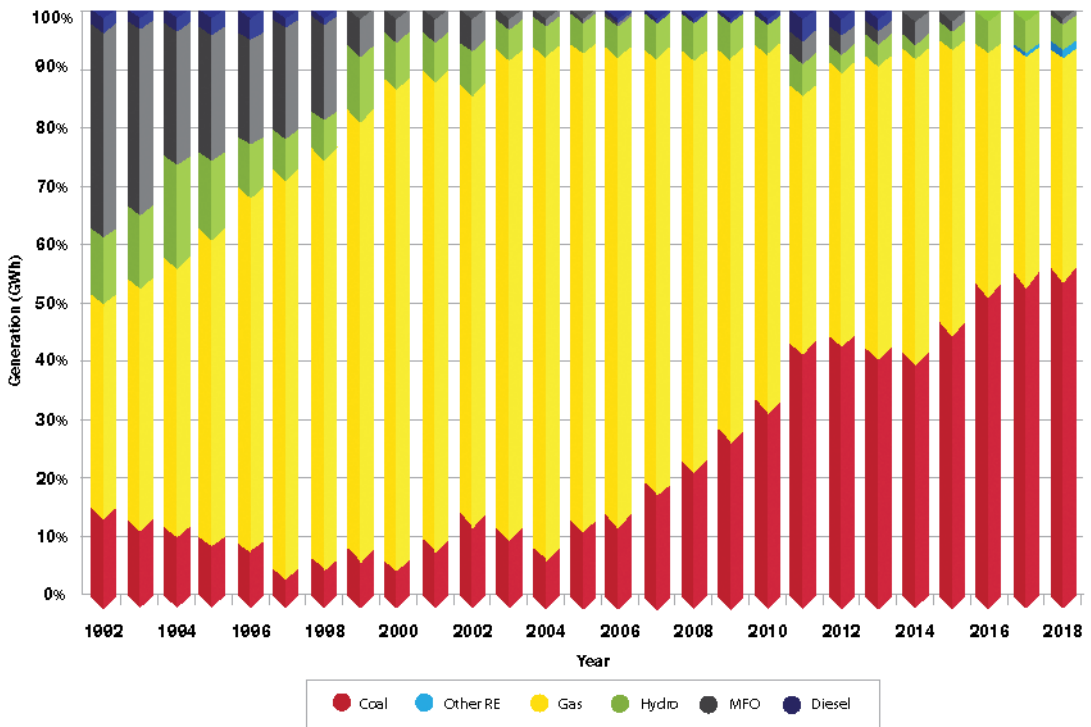
In building a resilient and sustainable future for Penang, a paradigm shift is required in the way we generate energy – by increasing energy efficiency and diversifying to alternatives which are less GHG intensive. This ties in with the targets of SDG Goal 7 to “increase the share of renewable energy” and “double

the global rate of improvement in energy efficiency”.

At the Singapore International Energy Week 2018, Minister of MESTECC, Hon. Yeo Bee Yin, announced that the government of Malaysia is planning structural changes to the energy market to increase competitiveness, specifically in the transmission and distribution of electricity. A new Energy Efficiency Conservation Act will be tabled (in 2019) to achieve energy savings and ensure compliance with building energy codes in the industrial, commercial and residential sectors. The Malaysian government aspires to supply half of the country’s electricity needs with renewable energy by 2050, with an interim target of 20 per cent by 2030. Active consideration is being given to micro hydropower, solar energy, biomass and biogas projects. The government is also implementing renewable energy related regulations, new Feed-in-Tariff (FiT) projects, including for small hydro, biogas and biomass projects, and solar leasing through Supply Agreement of Renewable Energy (SARE).

While Penang has much to improve in terms of transforming its energy sources, it has made strides to achieve more efficient energy usage. Penang was the first state in Malaysia to embrace the Green Building Index (GBI), and today, it has the third highest number of GBI certified buildings in the country. GBI is a nationally recognised green rating tool for buildings to promote sustainability in built environment, and one of its aims is to improve Energy Efficiency by optimising

### Percentage (%) of Generation Fuel Mix for Peninsular Malaysia, 1992–2018



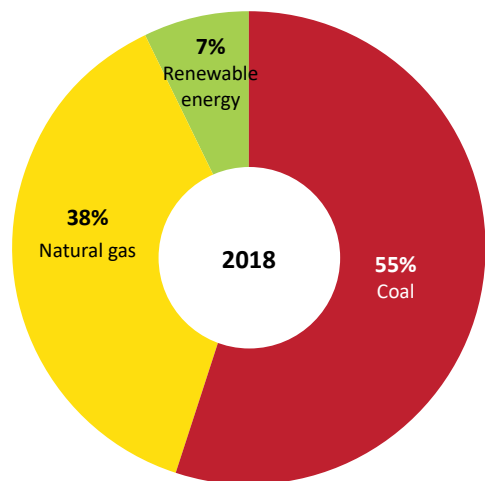
Source: Energy Commission

building orientation, using natural lighting, and promoting the use of renewable energy.

Penang is also embarking on an initiative to install 20,000 energy-saving LED streetlamps, which aims to save 60 per cent of municipal power bills and reduce statewide energy use. The state is taking steps to have all its government agencies certified as Penang Green Offices with carbon reporting by 2020, which will include measures in saving energy and improving efficiency.

The state's policy of advocating for clean technology enterprises has also made Penang a hub for renewable energy businesses, with about 20 such businesses operating in Penang as of 2017. Solar power is one of the areas in which Penang is seeing growth.

### Malaysia's Current Energy Mix, 2018



Source: Energy Commission

In 2012, Bosch Penang installed the largest solar photovoltaic (PV) system in Malaysia, with 2300 solar PV modules which had a total installation capacity of 647 kWp and a production capacity of 832 MWh of solar power per annum.

National-level initiatives like SEDA's FiT programme, where residential dwellings which installed solar PV panels could sell back to the grid at a fixed premium price, gained traction in Penang during the time it was implemented. Currently, Net Energy Metering (NEM), where solar energy is consumed first by the household, before any excess is sold to the distribution licensee, has replaced FiT. Solar for Own Use is another initiative where a home can generate solar power for its own use.

Phase out dependence on carbon-intensive fossil fuels

**Action** Establish a state-wide low carbon energy target to make renewable energy a priority and progressively phase out carbon-intensive fossil fuels. In line with national targets, the goal should be to reduce fossil fuel usage by 20 per cent by the year 2030. Concurrently, this standard should also address quadrupling the usage of renewable, clean energy by the year 2030.

Emphasis of renewable energy should primarily focus on solar, apart from other sources like biomass and waste-to-energy (e.g. from wastewater and organic waste methane extraction). Currently, less than 5 per cent of Penang's energy is sourced from renewable energy sources. Setting a low carbon energy framework will help guide regulations and energy procurement decisions, making clear Penang's commitment to a carbon-neutral future.

**Action** Aggressively promote and nurture adoption of solar energy. Solar energy is one of the greenest energy sources. In Peninsular Malaysia, Penang has the highest irradiance (power per unit area, produced by the sun) value. This can be seen in the higher returns on investment from installing solar panels for homes in Penang, as compared to those in the Klang Valley or the southern side of Peninsular Malaysia. Thus, Penang ought to:

- i. Incentivise the installation of rooftop solar panels on landed residential properties in Penang. High costs of solar panel installation (Estimated at RM30,000–RM70,000) and a long duration to recoup the investment (>7 years) discourage medium and low-income homeowners from setting up solar panels on their homes. The state could create a program of incentivising solar panel installations by means of offering grants and soft loans. The goal should for each landed property in Penang to be equipped with solar panels by 2030.
- ii. Establish “community solar” projects throughout the state. Community solar projects could be established by the state government in affordable housing schemes, schools and colleges. This will allow members of a community to share the benefits of solar power even if they cannot install solar panels on their property (e.g. flats, apartments).
- iii. Install solar panels on public buildings and facilities. Government agencies should spearhead the use of renewable energy in this way in order to reduce spending of public funds for energy bills and set an example for private commercial and residential buildings.





Solar farm in Seberang Perai.



Chowrasta Public Market in Penang being prepared for PV solar panel installations.

## Energy conservation

**Action** Conserve energy through implementation of smart energy solutions. Apart from reducing emissions, it saves money through less use of energy. It also creates jobs – a win-win situation for the climate, government and the people. Energy-saving technology is widely available and the installation of energy efficient lighting and equipment needs to be extended to all commercial buildings.

**Action** Employ consumer energy education. This is vital for changing consumer behavior. It should cover aspects of saving energy as well as helping consumers make more energy efficient decisions. An In-Home Audit programme should be introduced to help home/business owners to assess their current energy usage and obtain recommendations on more efficient options available to them. Residential, commercial as well as industrial entities also ought to know their own carbon footprints (and that of their suppliers), and thus the carbon-reporting initiative should be extended beyond the limits of government departments and offices.

**Action** Evaluate critical energy infrastructure to address vulnerabilities. The September and November 2017 floods resulted in numerous substations across the state malfunctioning, triggering power outages across large areas of the state which put much stress on the utility provider, TNB, to restore power supply post floods. This raises the need to improve the reliability and quality of electric transmission throughout the existing general distribution grid within the state.

**Action** Proactively fortify transmission and distribution systems that are vulnerable. This can be done by strengthening sections of grid which are vulnerable through segmenting transmission networks and substations to distribute failure risk (so that if disconnection happens, it only affects sections of the network), making transmission networks and poles more robust, and securing substation DC battery banks in safer flood-proof (higher) environments.

## What is the Green Economy?

The green economy is defined as an economy which aims at reducing environmental risks and ecological scarcities, and favours sustainable development without degrading the environment. The 2011 UNEP Green Economy Report argues that “to be green, an economy must assure a just transition to an economy that is low-carbon, resource efficient, and socially inclusive.”

A green economy is based on a few main sectors, such as:

- Land management, such as habitat conservation, urban forestry, and reforestation;
- Waste management, such as zero-waste and recycling projects;
- Renewable energy, such as solar;
- Water management, such as wastewater recycling, grey and rainwater systems, and stormwater planning; and
- Sustainable transport, such as electric vehicles, public transport and rideshare programmes.



Langur Way Canopy Walk and the circular Curtis Crest Tree Top Walk at The Habitat, Penang.



## 6 • SUSTAINABLE MOBILITY

Our transportation modes directly impact our greenhouse gas pollution. The transport sector is the fastest growing contributor to climate change, currently responsible for about 20 per cent of global energy-related carbon emissions, which come from the use of private cars and heavy-duty transport machines used in trucking, shipping and aviation.

Sustainable mobility refers to a transport system that is able to achieve the goal of getting people to their destinations through a variety of transport means such as public transport, walking, and cycling in order to reduce the adverse effects of automobiles usage on the environment, while not reducing transport demand itself. In other words, sustainable mobility explores the environmental, economic, and social sustainability of transport in the pursuit of sustainable development.

Suggested actions:

- Introduce infrastructure and policies to reduce car dependence
- Encourage active transportation
- Increase clean fuel use, and shared-use mobility services
- 2030 Goal: 50 per cent non-automobile trips

In Penang, much transit happens in cars, and often in single-occupancy vehicles. In fact, Penang records one of the highest car-modal shares in the world, with 97 per cent on Penang Island, and a slightly lower figure in Seberang Perai. Statistics from the Penang Road Transport Department show that the cumulative number of vehicles in Penang has increased from 1.75 million vehicles in 2009

### Visions and Goals for sustainable mobility

Visions	Goals
Sustainability	Environment-friendly transport facilities, energy saving network
Efficiency	Improve accessibility, speed and reliability of public transportation.
Equity	Transport accessibility for groups such as the elderly, handicapped, and those in a low-income bracket who cannot own a car; diversification of transport choices.
Integration	Knitting interrelationships among transport means, nodes, and regions; public transport-oriented development.
Safety	Minimising casualties from traffic accidents.
Participation	Community participation from the initial planning stages.

to 2.56 million vehicles for a population of only 1.77 million, in 2015.

This increase in the number of cars on the road has also meant more traffic congestion, inadequate parking spaces and lesser pedestrian-friendly roads, as more cars cramp into the limited road space in Penang, especially in the inner city of George Town and Bayan Lepas.

In combating the climate crisis, one of the most effective actions individuals can



A proposed street redesign of Chulia Street, George Town, to accommodate pedestrian walkways on both sides, a dedicated bicycle lane and a bus lane, with one lane for cars and another for parking.

take is to switch from private cars to public transportation or active transportation, e.g. walking and cycling.

**Action** Design streets that are safe and useful for all modes of mobility.

Cumulative improvements to the road network/streets in public spaces in order to encourage walking, biking, and transit can reduce vehicle distance travelled by making it safer and easier to travel by these modes rather than by car.

In order to prioritise safety on our streets, the State is pushing its “Pedestrian is King” policy state-wide; this prioritises public realm right-of-way use in the following order: walking, cycling, public transit, and only then riding a motorcycle and driving a motor vehicle.

Street design must therefore consider all users. Guidelines for such design will help identify which alternate modes to prioritise when redesigning a street to augment existing streets to accommodate pedestrians, bicycles, and transit.

**Action** Make walking a convenient, realistic and comfortable option.

Making active transportation convenient, realistic and comfortable would help encourage more Penangites to embrace walking as a transportation option. This calls for well-connected, unhindered streets with a safe network of pedestrian and cycling paths, where last mile connectivity is not compromised. One of the major challenges in Penang is that many urban areas still lack unhindered pedestrian walkways, making it necessary for pedestrians to go onto the road, mingling with mixed traffic even though it is unsafe and inconvenient to do so. Thus, what is needed is a network of connected pedestrian walkways which are safe, shaded by trees, and with street furniture to allow for a comfortable experience.

**Action** Invest in safe, dedicated and comprehensive bicycle infrastructure.

While there has been great effort in building cycling lanes throughout Penang (especially on the island) a safety-oriented focus

appears to be missing. In order to increase ridership, dedicated and protected bicycle lanes are needed on most cycling stretches, while junctions where cyclists often have to share with motorcycles and cars should be designed as protected intersections. Cycling infrastructure to park bicycles should also be available at frequent intervals as this is currently limited to areas within George Town. Future development projects should also seek to connect existing routes as well as key business and economic centers, for example between the Coastal Cycling route and companies in the four phases of the Bayan Lepas Free Industrial Zone.

Designing bike lanes that are protected from moving and parked cars can be as simple as using vertical plastic posts to meet those safety needs. These links and new corridors connecting other parts of the city will attract more riders, which would increase safety and inspire more people to ride.

**Action** Incentivising public transit.

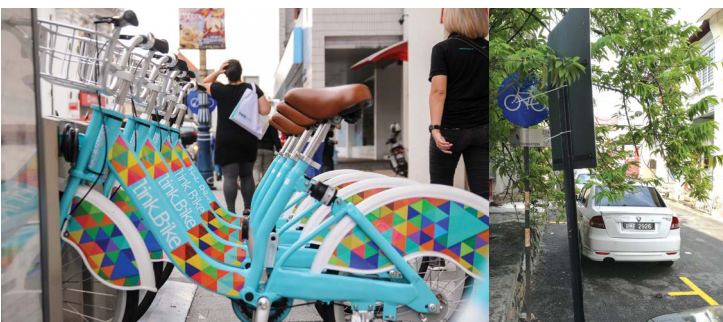
Building awareness through incentive programmes and campaigns is necessary to get locals to switch to modes of active transportation. To encourage commuters to drive less, local employers can be encouraged to discontinue offering subsidized parking to employees and instead offer them cash



Bus Lane in Sri Lanka

allowance in lieu of a parking space; employers can also be asked to encourage employees to take the bus, cycle, or car-pool to work. By offering flexible working hours, shower facilities, and getting involved in 'Cycle/Public Transport to Work' campaigns, as well as setting up Workplace Bicycle User Groups, employees can be made aware that their decision to cycle is facilitated and encouraged.

New developments should push for less driving by encouraging bicycle parking and car sharing. Councils should also explore lowering minimum parking requirements or instituting maximum parking requirements for new developments, to limit the total number of parking spaces made available, and work on increasing public transit ridership instead.



A bike-share programme on Penang Island



A non-existent bicycle lane



George Town's Pitt Street, where bicycle lanes, pedestrian walkways, bus parking lots, and car lanes all merge into one





Ferry and bus integrated terminal, Penang.

The above should be augmented by the creation of bus lanes on existing primary thoroughways, effectively reducing spaces for cars and providing more area for public transport in order to avoid traffic congestion caused by cars.

**Action** Maximise fuel efficiency of public transit fleet.

While increasing public transport has been touted as an effective strategy in reducing GHG emissions, it is also important to note that much of Penang's public transport fleet (in particular, buses) run on diesel, which produces unhealthy levels of GHG emissions. Idling buses which are left running, a common sight in bus stations, also add to unnecessary release of GHGs. We can address reduction of GHG emissions from public transport by changing the fuel mix of the transit fleet from diesel to less polluting alternatives, such as Battery Electric Buses (BEBs), which are driven by electric motors and have almost zero emission when in transit. Low Carbon Emission Buses (LCEB) are another option, with 30 per cent less carbon emissions

compared to Euro-3 Diesel buses (Rapid Penang runs on Euro-3 diesel engines).

**Action** Expand access to clean fuel and electric vehicles for private mobility.

Electric vehicles, hybrid electric vehicles, and clean-fuel vehicles like those powered by natural gas emit less GHG pollution. The State can develop policies to support the expansion of electric vehicle charging around the city to increase the accessibility and convenience of electric vehicles. These include enabling third-party companies to provide charging facilities and requiring new developments to be "charge-ready." The State can start by encouraging adoption of electric vehicles for MBPP, MBSP, and other state agencies.

**Action** Improve access to, and efficiency of, public transport

One of the ways in which car dependence can be reduced is by increasing the modal share of public transport. A public transport system which is fast, reliable, and a short distance from working or residential areas makes it

an attractive option. The existing road space and transport networks in the state should be better used by reorganising bus routes into a series of core and secondary routes with feeder buses which serve residential and industrial areas. Reorganisation of routes is an opportunity to plan for ridership growth and thus it needs to address changes in the city and economy, as well as shifts where people, jobs and services are increasingly located.

A reliable GPS tracking application, with real-time information (rather than an estimate) on bus arrival and departure information needs to be launched with a feedback mechanism, so that users can be updated if there are any changes in the transit timing. This application should also be integrated with information from ferry and rail (KTM Komuter/ETS), enabling users to seamlessly switch from one mode of public transportation to another.

#### **Action** Vehicle-share services

A vehicle share program is part of a new trend which can reduce the number of vehicles on the road. There are two types one is ride-sharing, wherein users heading to the same direction or route use one car together; and the other is a model whereby people rent cars for short periods of time on a needs basis, thus only using cars when they really need to. Penang could work with ride hailing providers like Grab, MyCar, MULA and others to develop a system similar to UberPOOL, where riders heading in the same direction are matched and grouped so that they can ride together and share costs. This enables the car fleet to carry multiple passengers together in the same car rather than having multiple cars servicing passengers individually.

### **Planning for Low Carbon Cities**

Solutions that improve fuel efficiency of trains, buses, cars and trucks will be countered by increased consumption. The use and sustainability of transportation, therefore, cannot be separated from how and where people live, work, and partake of leisure activities. The design of the urban environment and reduction of excess consumption are therefore closely linked, making transit-oriented development and mixed-use development all the more important.

The State and both local councils should thus place special focus on building or making available affordable rental units in transit hubs and near work hubs to limit travel distances between workplaces and homes. This should be augmented by providing short distance bus loops to and from work hubs like the Bayan Lepas and Mak Mandin Industrial Zones during work start and end hours to discourage driving.



Public transport in New Orleans.

## Transport Nightmare turns Dream in Mexico City

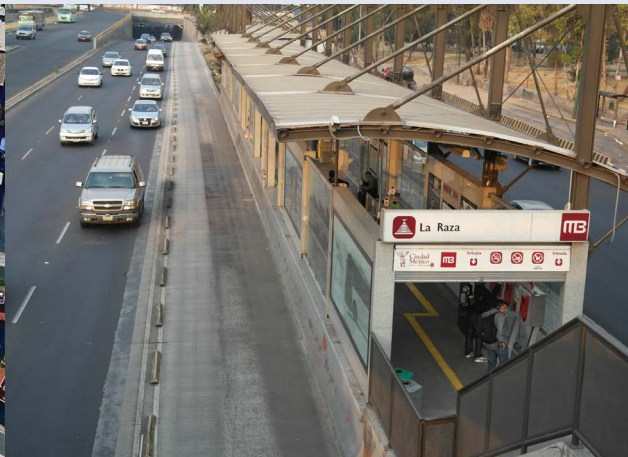
With a metropolitan population of more than 21 million and growing, Mexico City faces a common challenge that many cities in developing countries face: urban sprawl coupled with growing car ownership. These have been contributing to terrible traffic jams and increasing air pollution, a major threat to public health. To curb these problems, Mexico City invested US\$150 million in expanding and modernising sustainable public transport systems. These actions have collectively transformed parts of Mexico City from a traffic nightmare to a commuter's paradise. The city won the 2013 Sustainable Transport Award for its leadership and visionary achievements in sustainable transport and urban livability.

### *What Mexico City did:*

- Expanded the Metrobus bus rapid transit (BRT) system, connecting narrow streets in the historic center to the airport. The city currently has the longest BRT in Latin America.
- Created urban streetscapes around the Metrobus BRT system to accommodate safe cycling and walking, safely connecting residents to mass transport.
- Added 90 stations and 1,200 new bicycles to its bike-sharing programme, reformed on-street parking, improved sidewalks, and established new walkways in the city. As of 2015, there were more than 6,500 bikes in the city.
- Entirely banned cars from select narrow streets and the historic center. Instead, buses and pedestrians are given the right to access these streets. Market places were established for street vendors in these car-free areas.



Aerial view of merging bus lanes in Mexico City



A bus lane and station in Mexico City



## 7 • TRASH TO CASH; WASTE TO ENERGY

*“If I were to give one piece of advice to help in preserving the planet, I’d say “don’t waste”: don’t waste food, don’t waste power, and don’t waste time.”*

– Sir Richard Attenborough.

Managing waste is of paramount importance to the environment and public health. A good waste management system protects depleting resources through resource generation from waste upgrading, provides economic opportunities like jobs in the recycling industry, and reduces pollution and contamination of soil, water bodies and the atmosphere.

Economic and industrial development, as well as population rise and affluence over the last few decades have overstretched waste management systems in numerous cities. Many cities suffer from failed waste management systems that cause significant negative consequences for local communities and their immediate environments. It is critical that we reduce waste generation, effectively reuse or recycle waste, and manage non-recyclable waste sustainably.

The average generation of waste per person in Penang is about 1.1kg per day, which is significantly higher than the national average of 0.5 to 0.8kg per day. The amount of waste produced has increased, partly because of the “throwaway lifestyle” which is widespread in Penang. In 2016, an estimated 677,572 metric tonnes of waste was disposed in the Pulau Burung landfill, which correlates to about 1,800 tonnes of waste produced each day. A study on the composition of municipal solid

waste (MSW) found that about 43 per cent of waste that ends up in landfills was food waste, while the second largest component was plastics at 18 per cent.

The amount of total food wasted in Penang stood at a staggering 700 tonnes daily in 2017. This is not just a social concern but also raises an environmental alarm because the decomposition of organic material in landfills result in both carbon dioxide and methane emissions, and these gases are emitted even after a landfill is closed. Methane as a greenhouse gas is up to 34 times more powerful than carbon dioxide over a 100-year period.

Non-governmental organisations and start-ups in Penang, like The Buddhist Tzu Chi Merit Society and Green Hero, have played a key role by running successful recycling programmes and by giving a second life to food which has lapsed its expiration time or dates.

The treatment of our wastewater also produces nitrous oxide (N<sub>2</sub>O), a much stronger heat-trapping gas than carbon dioxide or methane in aggravating the climate crisis.

### Waste Reduction

In order for Penang to reduce its GHG emissions, it needs to reduce its waste generation, manage waste wisely, and integrate it into a circular economy. To that end, Penang should aim to develop a zero-waste culture and enhance the circular economy over the long-term. Progress can be measured with a goal to divert 50 per cent of its waste from

landfills by 2030 (an SDG 12 Target).

**Action** Reduce food waste. As food and organic waste contributes to the largest share of waste in our landfills, along with releasing the most potent GHGs, a strategy needs to be developed to reduce it at source. Penang should ban supermarkets and convenience stores from throwing away unsold food, and instead channel these to charities, food banks and animal shelters. Restaurants that consistently donate unsold food should be incentivised through assessment rebates. New technology in composting organic waste, aerobic degradation of organic waste and nutrient recovery from waste should be explored in order to convert organic waste into energy and fertilisers. Increasing the production of organic fertilisers in this manner would also reduce the dependency on chemical fertilisers, which pollute the soil and our water sources.

**Action** Ban unnecessary packaging and replace single use plastics with reusables and biodegradable alternatives. Packaging and single use plastic waste form a significant chunk of our MSW. While it is laudable that the Penang Government is planning to ban single use plastics, such as straws, biodegradable or more recyclable alternatives must be provided for what is being banned: e.g. metal, paper, pasta and bamboo straws; paper and seaweed bags; and other means of alternative packaging. The state should also extend the *No Free Plastic Bag* campaign to council-managed wet and dry markets, and the ubiquitous food and drink vendors.

Convenience stores and supermarkets in Penang should also be incentivised to set up plastic-free aisles, where consumers can choose plastic-free, or more environmentally-friendly packaged options. Selling food in bulk without individual packaging should also be encouraged, as is practiced in our wet



Gotong-royong, a community clean-up at Robina Beach in Seberang Perai, followed by waste separation.

markets. In New Zealand, since supermarket chain *New World* stopped wrapping fruit and vegetables in plastic as part of its *Food in the Nude* campaign, sales of some vegetables have increased by 300 per cent. It was found that people were more likely to buy fruit and vegetables that were not wrapped in plastic – as they could see, smell and touch them.

### Expand recycling initiatives

As Penang currently has the highest reported recycling rate in the country, an implemented waste segregation at source policy, as well as a comprehensive network of NGOs which promote recycling, the state ought to expand and deepen the current network and services.

**Action** Create recycling partnerships between communities, businesses and the government. This initiative should look at local and regional recycling economies and how businesses and government departments can be involved in recycling programmes. Large businesses which operate in Penang could be invited to fund pilot recycling initiatives within the local community by sponsoring or setting up recycling infrastructure.

**Action** Introduce comprehensive recycling education. Many people are still unsure about what can be recycled. This often results in unrecyclable waste like plastic bags, dirty food containers and Styrofoam ending up in

recycling bins, which contaminate recyclable waste. This can be addressed through a comprehensive education programme to improve understanding of how and what to recycle.

A campaign on *How to Recycle Right* could be organised targeting all sectors of society in Penang. This could include simple tips, live community demonstrations and effective multimedia. Enforcement also needs to come hand in hand with education, with individuals who contaminate recyclables facing due punishment.

### Making waste a resource

As a strategy for managing our trash, waste-to-energy (WTE) plants are better than the landfill alternative when state-of-the-art facilities are employed. There are four methods used by industry to convert waste to energy: incineration, gasification, pyrolysis, and plasma. WTE plants create energy that is otherwise sourced from coal or gas-fired power plants. Their impact vis-à-vis the creation of greenhouse gases is positive when compared to methane-creating landfills.

**Action** Turn our municipal organic waste and wastewater into energy sources. Decomposition of wastewater in sewage treatment plants, and landfill waste, emit gases which can be used to generate electricity. Anaerobic digestion of sewage sludge in wastewater treatment creates biogas that can be used for energy generation. The resulting solid waste can be sterilised for agricultural use.

**Action** Explore construction of WTE plants as alternative to landfilling. A WTE plant burns waste at high temperatures, extracting gases for fuel, while producing heat that turns water into steam to generate electricity.

**Action** Explore landfill gas recovery at the Pulau Burong landfill. This focuses on methane capture and works by collecting

gases emitted from the landfill. These gases are collected via a network of vertical and horizontal wells, header pipes and gas vents, which are then channelled to produce fuel, heat and electricity.

### Treating Hydrofluorocarbons (HFCs) at air-conditioning disposal points

HFCs are manmade chemicals used mainly in air-conditioning and refrigeration, and in fire retardants, aerosols and solvents. HFCs were developed to replace Ozone Depleting Substances, but they are now recognised as a powerful greenhouse gas, growing at a rate of 8 per cent per year. HFCs' heat trapping properties are estimated to be thousands of times worse than CO<sub>2</sub> per unit mass. Leakage from, and end of life disposal of, refrigeration and air-conditioning equipment are major sources of HFC emissions.

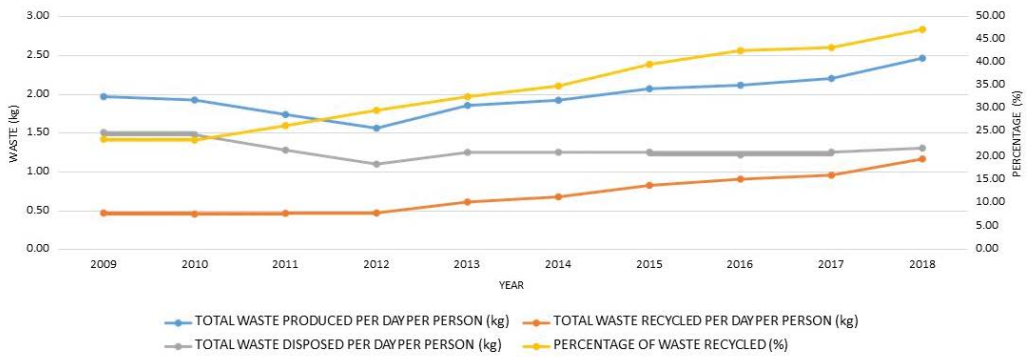
In Japan, CFCs, HCFCs, and HFCs are controlled and they must be recovered from home appliances, cars, and commercial equipment when equipment containing these gases are discarded. Recovered gas must be recycled or destroyed, instead of being released into the atmosphere. There are more than 40 home-appliance recycling plants, more than 20 F-gas recycling facilities and more than 60 F-gas destruction facilities in commercial operation using various technologies such as superheated steam, municipal waste incinerator, and cement kiln.

More than 7,000 tonnes of refrigerant CFC, HCFC and HFC were recovered from equipment in Japan in 2014, while about 965 tonnes of refrigerant were recycled and about 4,800 tonnes were destroyed in Japan in 2015.

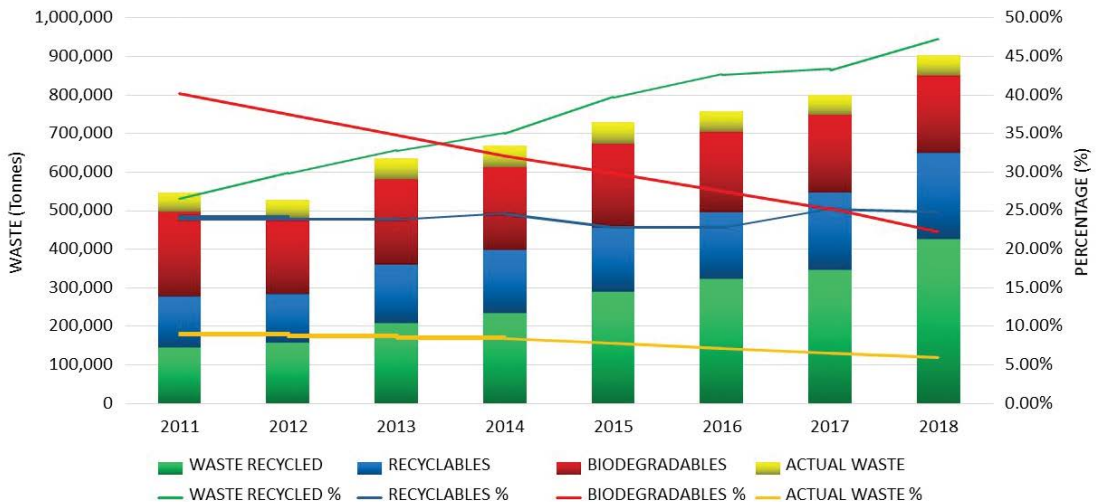
While e-waste recycling is not new in Malaysia, white waste (large household appliances) recycling was introduced relatively recently. Most e-waste recyclers do not have the desired technology and facilities

### Waste produced, recycled and disposed per capita per day in Seberang Perai from 2009 to 2018

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
<b>Total Waste Produced Per Day Per Person (Kg)</b>	1.96	1.92	1.73	1.56	1.85	1.92	2.06	2.11	2.20	2.46
<b>Total Waste Recycled Per Day Per Person (Kg)</b>	0.46	0.45	0.46	0.46	0.60	0.67	0.82	0.90	0.95	1.16
<b>Total Waste Disposed Per Day Per Person (Kg)</b>	1.50	1.47	1.27	1.09	1.24	1.25	1.25	1.21	1.25	1.30
<b>Percentage Of Waste Recycled (%)</b>	23.55	23.35	26.48	29.77	32.70	35.00	39.64	42.61	43.25	47.16



### Waste Compositions in Seberang Perai from 2011 to 2018





to deal with recycling, destroying or storing refrigerants. It is currently up to the owner (of the e-waste) to go through the proper channels and contact a recycler for e-waste collection in exchange for a sum of money (usually by weight). However, there may be instances where the recycler will not pursue collection if the volume is not deemed to be worth the effort.

If a recycler is not called in, or refuses to come due to poor returns, e-waste would then be sent to the landfill by waste contractors. As Malaysia's informal recycling sector is efficient at sorting recyclables (in exchange for money), the metal parts end up being recovered and recycled, but not the refrigerants (due to low demand and high cost). Leaks are bound to occur during the process of recovering metal, or due to mishandling.

Even if white waste is picked up by an e-recycler, it is likely that the refrigerants will not be recycled as the e-recycler may not have the proper facility to recycle, destroy or store the refrigerants. It is likely that such gases are simply released into the air. As there is little incentive or penalty for the proper treatment of HFCs, payment for proper disposal or storage facilities needs to be addressed.

At *Shan Poornam Metals Sdn. Bhd.* (the establishment that purchased the nation's first e-waste and CFC recovery machine from a German firm, *Andritz*), refrigerants are properly destroyed as part of their Corporate Social Responsibility programme to their customers. In Japan, consumers pay for such disposal: fees are imposed upon purchase of appliances containing HFCs.

In Malaysia, where there is government reluctance to pass on disposal costs to the consumer, the local or state government should pick up the tab for the proper disposal of refrigerants as part of their responsibility to society, the environment, and their commitments towards climate action.

**Action** In place of setting up e-waste facilities for the public, the local or state government should pay for the services of e-waste establishments that have the capability of recovering HFC refrigerants, so that they can be properly destroyed, reclaimed for resale, or stored safely, to prevent their release into the atmosphere.

### River pollution and illegal waste dumping

In March 2019, Malaysia was rocked by the dumping of chemical waste into Sungai Kim Kim in Johor, resulting in toxic fumes containing methane spreading into the Pasir Gudang township, disrupting day to day activities, causing respiratory problems and the closing of 111 schools. More than 6,000 people were affected and the decontamination exercise for the 1.5 km stretch of the river cost RM 6.4 million.

A few days after the Sungai Kim Kim incident, Bukit Teh in Seberang Perai became the focal point, when mounds of discarded furniture, plastic waste originating from China, construction debris and agricultural waste were found dumped in a 6.5ha site. The site, hidden away in an area of oil palm estates, remained off the radar for a long time.

In October 2018, an illegal recycling operator was found operating along the banks of Sungai Perai, with canopies, steel frames,



River pollution in Penang.

plastic chairs and furniture strewn over an area which was once a teeming wetland. It was soon revealed that there were some 200 enterprises recycling plastic waste in Penang, out of which only 27 had licenses. Penang and Klang have been identified as the top hotspots for illegal plastic recycling in Malaysia.

**Action** Put in place more effective monitoring and enforcement to prevent pollution and environmental disasters. Some suggested actions to boost our current monitoring and enforcement apparatus include:

1. Allocating more resources and commitment for monitoring. For example, in August 2018, the MESTECC minister revealed that the Department of Environment (DOE) lacks equipment and vehicles to conduct enforcement. The departments within local councils also lack the manpower, capacity and skill set to conduct constant monitoring, which result in cases slipping through the cracks. This can only be solved by providing adequate resources, capacity building and expanding enforcement personnel.
2. Initiating more cross collaboration and coordination between departments in monitoring and enforcement of cases relating to the environment. One of the major hindrances in monitoring activities are the jurisdictional silos which exist between local government departments, as well as between state and federal apparatus. To solve this, better coordinated mechanisms need to be in place for monitoring. For example, joint monitoring exercises can be done wherein expertise from different departments can be pooled to respond to cases of pollution. Funding for monitoring and enforcement activities should be made available to local councils – by the State government, by the Federal Government through the MESTECC, or
3. Initiating community river monitoring programmes. Local communities living near rivers can be roped in to conduct biological and watershed pollutant load monitoring programmes. Partnerships should be forged between the DOE, Department of Irrigation and Drainage (JPS) and water NGOs like Water Watch Penang to proactively engage the local community to conduct river monitoring for rivers in their vicinity. This can help timely identification of pollution, which can then be tackled at source.
4. Complementing monitoring with drone technology. Drones are useful monitoring tools as they reduce the need to go on foot into areas which pose hazards or allow limited mobility. Their small size also makes them suitable for remotely monitoring illegal activities. Drone surveillance with flame and smoke detection capability can help enforcement to pinpoint locations of fire sources, while drones with high resolution cameras can detect potential changes in colour occurring in water bodies (e.g. rivers and lakes) as early indicators of pollution. Both examples are already being implemented in Spain. In effect, these would mean continuous monitoring and early warning of incidences like open burning and river pollution, thus helping to curtail their spread.
5. Creating a map-based citizen's pollution reporting channel, which allows citizens on the ground to quickly report river pollution and illegal dumping cases with their approximate location to the authorities. This should leverage on current social media platforms to get maximum participation from local communities. Communication needs to be two-way, whereby citizens who lodge reports receive responses to their reports.

## Making Good of Waste in Los Angeles

At the Puente Hills Materials Recovery Facility in Los Angeles, a lot of good comes from garbage. Organic waste is treated for gas extraction (together with sewage) and landfill gases are converted to clean burning fuels with which power is generated. Valuable materials are recovered to conserve landfill capacity. As landfills close, new parkland and recreational areas are created for communities to enjoy.

Landfill recycling programmes include:

- Green Waste Recycling – waste from gardening is processed and recycled at the landfill as alternative daily cover and mulch.
- Asphalt and Treated Ash Recycling – Asphalt waste from road construction, along with treated ash from waste-to-energy facilities, are used to build roads.
- Clean Dirt Recycling – Clean dirt is accepted at the landfill free of charge, and is used on-site for construction and daily cover operations.
- Refrigerant, Appliance and Metal Recycling – Refrigerants are extracted from refrigerators and air conditioners, and recycled. The remaining metal from these and other appliances is sold to scrap salvagers.
- Wood Pallets Recycling – Wood pallets are sorted and sold back to local businesses. Pallets not purchased are broken down and recycled.

The company operating the Materials Recovery Facility constantly engages with residents who live near their facilities to address issues such as odour management. It is a lucrative business which treats waste as a commodity.



Puente Hills Materials Recovery Facility in Los Angeles. On the far right, organic waste is being separated.

## 8 • CONNECT CULTURE AND CLIMATE ACTION

*“A vegan diet is probably the single biggest way to reduce your impact on planet Earth, not just greenhouse gases, but global acidification, eutrophication, land use and water use. It is far bigger than cutting down on your flights or buying an electric car,”*

– Joseph Poore, Department of Zoology,  
University of Oxford.

A 2013 to 2018 study from the University of Oxford modelled the climate benefits of a worldwide transition to plant-based diets. It found that cutting meat and dairy products from our diets could reduce an individual’s carbon footprint from food by up to 73 per cent; for a vegetarian diet that includes dairy and eggs, a reduction of up to 63 per cent is possible.

Meat and dairy production are responsible for 60 per cent of agriculture’s greenhouse gas emissions, while the products themselves provide just 18 per cent of the calories and 37 per cent of protein levels around the world. If 50 per cent of the world’s population restricts their diet to a healthy plant-based 2,500 calories per day, emissions of 66 gigatonnes of CO<sub>2</sub> can be reduced by 2050; this includes avoidance of deforestation for animal farming.

The connection between our daily choices and habits and their collective contribution to the climate crisis is not well understood by most people. Each of us contributes to our own greenhouse gas pollution (also called our carbon footprint) and we can each reduce our impact if we know what to do. Policy initiatives which support and socialise cultural action on

the climate crisis provide the framework for collaborations – schools, local communities and businesses all play a role in improving awareness and encouraging action.

**Action** The State, the MBPP and the MBSP can partner with the Penang Green Council (PGC) and with public and private organisations, including schools, residents associations, and businesses, to develop initiatives that highlight our community’s connection to the climate crisis and promote actions that can reduce greenhouse gas pollution. This may range from environmental education campaigns to action projects related to waste reduction and energy saving.

**Action** Locally hosted conferences and event facilities must take steps to be more energy and waste efficient, such as making commitments towards going zero-waste. Many initiatives to save energy, reduce waste and reduce our emissions can be done behind the scenes at conferences, hotels, and events. The Penang Convention & Exhibition Bureau (PCEB) can work with hotels, event spaces, and attractions to explore ways to reduce emissions related to our hospitality industry.

**Action** Government events should go zero waste and offer vegetable-based menus. This can be achieved by doing away with single-use plastic bottles and cutlery, paper plates and cups, and insisting that caterers and suppliers use reusables. The culture of providing meals for meetings could also be transitioned to first providing just light eats, and later, biscuits and drinks only. To the greatest extent possible, food, when provided, should be vegetarian



with plenty of fruits, except on special occasions where they can come with just one or two meat options – but always avoiding meat from cows, sheep and goats.

**Action** Support businesses with training to incorporate sustainability practices into their daily operations to reduce their impact on the environment. Local colleges and professional associations can be roped in to provide technical assistance to support job creation and workforce skills development. This is in line with the Malaysian Government's aim to boost growth in the green technology sector, one which seeks to create more than 200,000 green jobs by 2030.

### A Breath of Clean Air

Air pollution causes around seven million deaths a year worldwide. Growth and concentration of population in cities, as well as the way in which we consume energy in urban areas through transport and air-conditioning systems, among others, result in the emission of huge quantities of gases that are harmful to our health. The main causes of air pollution are emissions from different transport modes (that include cars, trucks, airplanes and cruise ships), the burning of fossil fuels for electricity, industrial production, forest fires, cooking and open burning.

Such emission sources release gases and substances that are toxic for human beings, the most harmful of which are: tropospheric ozone (O<sub>3</sub>), sulphur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>), benzo(a)pyrene (BaP), suspended particulate matter (PM) and black carbon. Black carbon is the sooty black material emitted from gas and diesel engines, coal-fired power plants, and other sources that burn fossil fuel. It comprises a significant portion of PM. Black carbon is very effective at heating its surroundings. Per unit of mass, it has a warming impact on climate that is 460–1,500 times stronger than CO<sub>2</sub>.

Consequences of air pollution to human health include respiratory diseases, cardiovascular damage, fatigue, headaches, irritation of the eyes, nose and throat, and damage to reproductive organs. Urban populations are more exposed to the effects of air pollution, with children and the elderly being more vulnerable.

To alleviate the negative effects of atmospheric pollution on health, the World Health Organization (WHO) and the Climate and Clean Air Coalition (CCAC) – made up of the UNEP and 54 nations – launched the *BreatheLife* initiative. This is a programme that “aims to mobilise cities and individuals to protect our health and our planet from the effects of air pollution” and has fixed the objective of cutting by half the number of deaths linked to air pollution before 2030. Actions are meant to be local and focused on improving transport, waste management, energy supply, industry, and agriculture.

Asian members of the *BreatheLife* network include four cities in the Philippines, two cities in India, and one each in the Maldives, Seoul, Singapore, and Mongolia. There are yet to be any Malaysian cities in this network, and Penang could become the first if the State government so wishes.

The air quality in Penang varies from place to place. On the island, one can experience



South Coast Air Quality Management Districts laboratory - monitoring air quality to enforce compliance.



Cultural practices leading to poor air quality

The practice of open burning in Penang

poor air quality in George Town and Bayan Baru, but better air quality in Batu Ferringhi. On the mainland, one can experience poor air quality in Seberang Prai and Butterworth, but better air quality in Bukit Mertajam. The air quality in any given locality depends on the presence and proximity of air pollution sources. For instance, in George Town, poor air quality can be experienced when there are cultural activities involving open burning of joss sticks and paper, peak hours of vehicular traffic congestion and, at times, of multiple cruise visitations.

Unfortunately, there is no accurate data of air quality in George Town and Bayan Baru, as the data sources are located neither close to pollution sources nor near areas with high population density; instead these data sources are placed at low-density residential neighbourhoods such as Minden, Balik Pulau and Batu Ferringhi on the island, and in Seberang Jaya and Simpang Ampat on the mainland.

Two measurements of air quality are currently in popular use: PM<sub>2.5</sub> (particulate matters smaller than 2.5 micrometers); and PM<sub>10</sub> (particulate matters smaller than 10 micrometers). PM<sub>2.5</sub> concentration can be smaller than PM<sub>10</sub>, but the corresponding converted Air Quality Index (AQI) value can be higher.

There are now studies presenting evidence that PM<sub>2.5</sub> is more harmful than PM<sub>10</sub>. The smaller the particle, the higher the probability that it will go deeper into the lungs. The WHO is pushing for all countries to have standards for PM<sub>2.5</sub>. For most cities, one non-combustion source is dust re-suspension (from road dust and dust storms), which forms part of the coarser fraction (PM<sub>2.5</sub> to PM<sub>10</sub>). Measurement of PM<sub>10</sub> is therefore still needed so as not to neglect such sources.

**Action** Make a commitment to ensure clean air in Penang and set air quality targets for 2030 and 2050. Based on data concerning Penang-based pollution sources, adopt emission-reduction measures. Improve public transit and introduce policies to reduce motor-vehicle dependency. Working in partnership with the Road Transport Department (JPJ), conduct regular emission tests on trucks, buses, and old vehicles, and commit to removing polluting vehicles from operation.

**Action** Establish Clean Air Action Plans in respect of (a) Penang Port's operations on the island (cruise terminal and passenger ferries) and the mainland (cargo and chemical operations); (b) the Bayan Lepas passenger and cargo airport; and (c) each Industrial Zone on the island and mainland.

**Action** Arrest open burning. Burning of materials such as paper, trees, leaves, grass

and other debris, which are directly released into the air without passing through a ventilation structure like a chimney or stack, is harmful to humans. Open burning results in the generation of haze, smoke, dust, and toxic fumes. Estimates show that almost 30 per cent of small particulate matter, 10 per cent of mercury emissions and 40 per cent of polycyclic aromatic hydrocarbons (PAHs) originate from open burning of unwanted materials. The high number of open burning cases in Malaysia during the dry spell of early 2019 were also responsible for creating the unseasonably fierce bushfires in parts of the country as well as reducing visibility. During the dry spell of 2019, about six locations of open burning were identified in Penang, with

521 cases over a two-month period, much higher than the 367 cases in the same period in 2018.

The Environmental Quality Act 1974 prohibits open burning and stipulates punishment for the offence. Nonetheless, open burning cases are still rampant. More enforcement and preventive action need to be taken to curb open burning. Mostly, open burning happens due to lack of awareness among the public. The state and local governments and NGOs can work together to educate people on the ill-effects of open burning in parallel with heightened enforcement activities.



Haze in Penang

## A Clean Air Action Plan

The Port of Los Angeles is America's leading gateway for international commerce. Located in San Pedro Bay, 20 miles south of downtown Los Angeles, the Port encompasses 7,500 acres of land and water along 43 miles of waterfront. Handling diverse commodities, the Port of Los Angeles features both passenger and cargo terminals, including cruise, container, automobile, breakbulk, dry and liquid bulk, and warehouse facilities that manage billions of dollars' worth of cargo each year.

This seaport is also known for its groundbreaking environmental initiatives and remains committed to conducting operations in both an environmentally and fiscally responsible manner. For the last decade, the Port has also been at the forefront of rejuvenating the LA Waterfront, improving public access to the water, developing public amenities, and transforming the harbour shoreline into a visitor destination.

The San Pedro Bay Ports Clean Air Action Plan (CAAP) is an air quality action plan that establishes a strategy for reducing port-related air pollution and related health risks, while allowing port development, job creation and economic activity associated with that development to continue. The plan, a collaboration of the Port of Los Angeles and Port of Long Beach, ushered in a host of strategies concerning every pollution source, including ships, trucks, trains, harbour crafts such as tugs and workboats, and cargo-handling equipment such as cranes and yard tractors.

The plan rolled out a clean truck programme, vessel pollution reduction programmes, and new technology such as the world's first hybrid tugboat. The plan was originally adopted in 2006, with updates in 2010 and 2017. Since 2005, port-related air pollution emissions in San Pedro Bay have dropped 87 per cent for diesel particulate matter, 56 per cent for nitrogen oxides, and 97 per cent for sulfur oxides.

The CAAP 2017 Update is a strategy for accelerating progress toward a zero-emission future while protecting and strengthening the ports' competitive position. The document calls for the ports to reduce GHGs by 40 per cent below 1990 levels by 2030, and 80 per cent below 1990 levels by 2050. For details, visit: <http://www.cleanairactionplan.org/strategies/>





## Los Angeles' War on Smog

In July 1943, the city of Los Angeles was engulfed by a combination of smoke and fog, commonly referred to as smog. Smoke and fumes descended on its downtown, cutting visibility to just three blocks. Coinciding with a heat wave, the smog was unbearable, gripping residents with an eye-stinging sensation. That incident triggered a war on smog: from a ban on backyard trash incinerators to reformulated gasoline and to developing zero-emission fuel-cell electric vehicles, the fight against air pollution has catalysed technological advancements.

In the city of London, in December 1952, a thick killer smog claimed 4,000 lives. Fearing a similar catastrophe in Los Angeles, a committee was convened to recommend air pollution reforms. One year later, the committee recommended the establishment of automobile exhaust standards, the switching from diesel to propane for diesel trucks, the banning of open burning of trash and the development of a rapid transit system. They also proposed that heavily polluting industries consider slowing their growth.

During the 1950s and 1960s, Southern California air quality officials tackled a host of pollution sources: petroleum-based solvents containing hydrocarbons, landfills, power plants, and even animal waste processing plants. Air quality regulations significantly reduced emissions, but experts acknowledged that the rapidly increasing number of motor vehicles – fueled by a lack of public transit, long distances between communities, a widespread freeway network and a relatively prosperous economy – was a major cause of the smog problem.

As the smog was not bound by political boundaries, there were calls for establishing a regional air pollution control agency that encompassed all four counties in the Los Angeles basin. In July 1976, a bill was passed creating the South Coast Air Quality Management District (AQMD). After developing a set of regulations for the four-county area, AQMD adopted several significant emission-reductions measures, including rules to control man-made dust and reduce nitrogen oxides from power plants by 90 per cent. After 50 years, clean air is now within sight.

The city of Los Angeles covered in smog.  
*Massimo Catarinella.*



## 9 • URBAN COOLING STRATEGIES

The climate crisis will have a significant impact on Penang, most so in terms of increase in number of extreme weather events and rise in average temperatures, and due to the urban heat island (UHI) effect. The term “UHI” describes urban built up areas that are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1–3°C warmer than its surroundings. In the evening, the difference can be as high as 12°C. Heat islands can affect communities by increasing peak energy demand, air conditioning costs, air pollution and greater GHG emissions, and heat-related illnesses and mortality.

Malaysia is on track to have a temperature rise of 1.5°C by 2030 and 3°C by 2050. What can Penang do now to help cope with the projected temperature increases?

### Natural systems

*“Natural climate solutions can help us achieve 37 percent of our climate target, even though they currently receive only 2.5 percent of public climate financing.”* Han de Groot, CEO of the Rainforest Alliance.

**Action** Increase tree shade with connected canopy. Tree planting can cool cities between 2°C to 8°C through shading, evapotranspiration and enhancing wind flows. Planting can take the form of afforestation of denuded or disused land and car parks, urban parks, street trees, green facades, rooftop gardens, and pocket parks. The benefits of street trees include storm water interception,

air pollutants removal, and carbon dioxide uptake.

**Action** Create wind corridors to reduce temperatures and promote air circulation. This strategy was successfully implemented in Stuttgart, Germany, through the strategic planting of trees.

**Action** Introduce more green and blue surfaces in order to reduce UHI effect. By introducing water surfaces in the city, we can increase the impact of various actions to reduce temperatures. It also provides habitat for certain wildlife and provides recreational spaces for city dwellers.

### Artificial systems

**Action** Use light coloured pavements that reflect light and/or heat. Such materials can increase reflection, reducing absorption and the UHI effect. When established as a standard by city councils, its impact is easily multiplied.

**Action** Open obstructed five-foot pathways to allow for continuous shaded pedestrian circulation. They are inexpensive, since existing structures are being used, and they enhance the character of the city. They also help release on-street space for other uses.

Of all the suggested interventions above, the planting of street trees has shown to be the most effective in reducing surface temperatures. Tree shade with connected canopy also helps improve air quality and provides corridors for wildlife.



Lebuhraya Gereja



Lebuhraya Chulia



Lebuhraya Carnarvon



## Cooling down Melbourne

Melbourne is getting hotter due to global heating and the urban heat island effect. The millennium drought, higher temperatures and an ageing tree population were challenges facing the city of Melbourne. The city's response was the creation of an Urban Forest Strategy, which promised thousands of newly-planted trees with its growing tree canopy helping Melbournians survive the intense heat of summer.

In their resolve to cool down the city, the city administration decided in 2012 to create a 20-year Urban Forest Strategy to:

- Increase canopy cover
- Increase urban forest diversity (The urban forest will be composed of no more than 5 per cent of any tree species, no more than 10 per cent of any genus and no more than 20 per cent of any one family)
- Improve soil moisture and water quality
- Improve urban ecology (Protect and enhance a level of biodiversity that contributes to a healthy ecosystem)
- Inform and consult the community

The AUD30 million initiative aimed to double the city's canopy cover from 20 per cent to 40 per cent by 2040, planting 42,000 trees over 20 years. Since 2012, the city council has planted nearly 12,000 new trees across the city in disused car parks and roads. About 70,000 trees have been mapped in the Urban Forest Visual, with each tree assigned an identification number, and the initiative aims to cool the city's summertime temperatures by 4 degree Celsius.



Flagstaff Garden in Melbourne



## 10 • RESILIENCE INFRASTRUCTURE TO ADDRESS FLOODING

Besides erratic weather, other factors that have contributed to the worsening floods in Penang include urban sprawl, a lack of pervious surfaces in urban areas, local drainage issues and bottlenecks along rivers. A Dutch Risk Reduction scoping mission visited Penang after the floods of early November 2017. Key findings from their July 2018 report are:

- The presence of waste and the poor state of maintenance had decreased the capacity of the drainage systems
- Due to urbanisation, water level rise peaks are likely higher than before
- Bottlenecks in the system need to be removed

**Action** For the whole drainage system, the removal of bottlenecks should be systematically undertaken. This can be carried out in the short term and has a major impact on reducing floods.

**Action** Reinstate riparian zones (green spaces) and create a network of linear parks along rivers. Rapid concrete development along Penang's riverbanks hinder the natural flow of water as they are impervious surfaces and reduce the ability of the riverbanks to absorb and retain water. This results in the rivers overrunning their concrete banks when there is an unusual amount of rain. Thus, hard impervious surfaces around rivers and the canalisation of their banks should be replaced by natural or semi-natural riparian zones. A riparian zone is permeable, acting like a sponge, reducing erosion and regulating overland flow of water, releasing water back to the stream slowly.

Such zones can be in the form of linear parks fitted with rain gardens and space for water retention, which, when it does not flood, can be used by the public for recreational purposes. The Sungai Ara Linear Park is a good example. Water retention capacity can also be increased by using these green spaces, as well as fields and stadiums near rivers as additional water storage areas in the event of flooding.

**Action** In the upstream areas of natural, river-based systems, explore possibilities to enlarge water storage capacity and increase water retention. Additional water storage can be channeled to large sporting facilities, soccer fields and playgrounds. For example, the City Stadium car park can be used to store water underground during peak flooding events.

**Action** In the inner city, the lack of water storage can be addressed by the re-introduction of permeable pavements and development of underground water storage. Permeable pavements stop buildup of surface water during heavy rain, and water stored underground can then slowly seep away into the soil. Underground water storage can be achieved through the usage of "soak-away crates" which are an effective way of draining surface water runoff. They are capable of carrying a significant load and can be fitted under pavements in the city, especially in areas prone to flooding.

**Action** Audit and apply tight control over agricultural practices in hill ranges. Where there is natural vegetation in hilly areas, a larger amount of rainfall is captured on its downward journey by the soil and vegetation.





Sungai Ara Linear Park









Rain garden in Butterworth, Penang



Sungai Ara Flood Retention Pond

However, when surface vegetation is cleared, and the soil is exposed by unsuitable farming practices, the capacity of the slope to absorb rainwater is reduced, resulting in higher runoff that causes soil erosion, landslides and downstream flooding. As Penang Island has a backbone of hills and the mainland has clusters of hills, due diligence needs to be exercised in minimising the cutting and exposure of slopes, especially in areas where major townships flank the hills.

In tackling floods, city authorities should use an evidence-based decision making approach, taking into account vulnerabilities arising from climate change. This approach is also useful in planning precautionary measures and guiding development appropriate to the site.

In the west coast of Peninsular Malaysia, sea level rise leading to the year 2100 is expected to be in the region of 0.5m. At this rate of sea level rise, parts of Nibong Tebal along the banks of Sungai Kerian and parts of Batu Kawan will see increased flooding. It is predicted that other cities like Alor Setar, Teluk Intan and Batu Pahat are also likely to be severely affected by flooding.

**Action** Conduct topographical surveys of Nibong Tebal and Batu Kawan to identify flood-prone areas due to future sea-level rise of between 0.5m to 1.0m. Devise action plans to include “no-development zones” and the expansion of riverine systems to accommodate rising sea levels. The MBSP should also look into preservation of existing mangroves along



Agriculture on slopes





Flooding after a heavy downpour in Penang.

the riverbanks and coastlines in Nibong Tebal. In places where such wetlands have been destroyed, they ought to be rebuilt – studies have shown that rebuilt wetlands can protect shorelines better than seawalls.

In a study focused on damages from Superstorm Sandy, which battered New York and New Jersey in 2012, scientists showed that wetlands prevented USD 625 million worth of flood damage from the storm. This was surprising given that the coasts in the region had already lost 60 to 90 per cent of their protective wetlands over time. In areas that flooded, the few remaining wetlands lowered flood damage by 11 per cent on average. In one local study, properties behind marshes suffered 16 per cent less annual flood damage than properties that had lost their marshes.



Hillslope and road collapse due to movement of underground water after heavy rains.

## Sponge Cities of China

### *Qunli Stormwater Wetland Park, Harbin City*

The once-dying wetland in the middle of the city was transformed into a 'green sponge', an urban storm water park. The multi-functional storm water park collects, filtrates and stores stormwater, which replenishes the aquifer while being a recreational spot for locals.

### *Rooftop gardens, Shanghai*

In 2016, the city of Shanghai announced the creation of 400,000 square meters of rooftop gardens. The objective was to absorb more rainfall so that drains do not choke with water, and to reduce dust and increase humidity.

### *Yanweizhou Park, Jinhua*

Located at the confluence of two rivers, this park was a fragmented wetland damaged by sand mining. It has since been transformed into a vibrant public park with the primary function of controlling floods in an ecological way. The previous concrete flood walls were torn down and replaced with water resilient, terraced river embankments that are covered in riparian vegetation as well as floodable pedestrian paths. During the monsoon season, the park area floods, absorbing water which otherwise would have inundated the city.



Cheonggyecheon stream restoration, 10.9 km of public recreation space in downtown Seoul, which also acts as flood mitigation measure.



Green roof of the CU Centennial Park, which absorbs rainwater and offers open space in Bangkok. The park has been built to flood and can hold nearly 1m gallons of water.



## Combating Floods in the People's Republic of China

*"In the past, humans have taken the land away from the water; now we need to give the land back."* Prof Hui Li from Tongji University

In China, sprawling urban development, impervious pavements, and waterway degradation combined with climate change unleashed a vicious cycle of flooding in the nation's cities. In 2012, floods killed 673 people and left another 159 missing. Floods inundated 184 cities and affected about 120 million people. The damage caused by floods and droughts cost China USD 51.49 billion in direct economic losses in 2012, and resulted in more than 16 million people lacking access to clean drinking water.

China's response to this was *The Sponge City Initiative*, which covers 30 cities. Advocating an ecologically friendly alternative to traditional flood defences and drainage, it has an ambitious goal: 80 per cent of urban areas in China should be able to absorb and re-use 70 per cent of rainwater by 2020.

### Aspects of The Sponge City Initiative

- **Promote Urban Ecosystem Protection.** Natural rivers, lakes, wetlands and other water bodies are protected to act as natural sponges in the event of intense rainfall.
- **Ecological Restoration and Repair.** Restoration of damaged wetlands, interconnected waterways and expansion of urban greenery.
- **Low-Impact Development.** Construction applies development controls, retains sufficient green land within the city, and controls the urban impervious area ratio.



A mangrove swamp

## Coastal and Wetlands Protection in Sri Lanka

*"No nation in history has ever protected all of its mangrove forests and Sri Lanka is going to be the first one to do so,"* Sri Lanka President Maithreepala Sirisena in a BBC interview, May 2015

On 26 July 2016, the Sri Lankan President announced that the island nation would become the first nation to grant protection to all its surviving mangrove forests. This ambitious project, valued at USD 3.4 million, called the Sri Lanka Mangrove Conservation Project, sought to work with local communities and NGOs to deliver economic, environmental and educational benefits.

What is being done under the Sri Lanka Mangrove Conservation Project?

- Protection of the remaining 8,815 hectares of mangroves left in Sri Lanka through gazettement, legal protection and patrol rangers.
- Replanting 3,800 hectares of mangrove forests that have been cut down.
- Training and microloans to 15,000 local people living near mangrove lagoons to safeguard mangroves in their area.
- Establishing the world's first mangrove museum which aims to be an educational tool for Sri Lankan school children to value mangrove forests. The Seacology-Sudeesa Mangrove Museum opened, in Pabbala, Chilaw, in 2016.

Through this project, Sri Lanka will make coastal communities resilient by protecting fishing and agricultural areas, fostering sustainable livelihoods and ensuring a healthier environment.



Breathing roots of mangrove trees



## 11 • PRESERVING ECO-SYSTEM SERVICES

Resilience infrastructure in the most natural sense incorporates our hills, coastline, and riverine systems. It is the ecology within which our economy thrives. Protection of existing green cover helps to manage stormwater and reduces the Urban Heat Island effect to help residents cope with warmer temperatures.

**Action** Implement the concept of Urban Growth Boundaries (“UGBs”). UGBs control urban sprawl and work by allowing areas inside the boundary to be used for urban development while areas outside it are preserved in its previous or natural state. UGBs focus on denser places for people to live, work and play, which also serves to reduce the need for, and the distances of, commutes for residents.

UGBs, which are suggested in the Malaysian National Physical Plan 3, apply to Penang state. Penang has varied and diverse landscapes which are important ecologically and culturally. Thus, implementing UGBs will ensure that its hill lands continue to provide crucial eco-system services. Meanwhile, land in Balik Pulau and a large part of North Seberang Perai could remain agricultural land to ensure that Penang does not compromise its food security.

**Action** Embark on mangrove protection and restoration programmes. Mangrove restoration programmes can be started by creating incentives to rope in private companies to conduct mangrove planting as part of their CSR initiatives. In the case of Penang, tracts of mangrove forests like the ones in Pantai Acheh, Sungai Perai, Sungai

Juru, and Teluk Air Tawar as well as remaining stands in Batu Maung and Balik Pulau ought to be gazetted as permanent forest reserves or mangrove parks.

**Action** Gazette new forest reserves and protected green spaces. In Penang, most of what remains unprotected are the areas which are covered in secondary forests mixed with orchard land, like hillslopes in Balik Pulau and Paya Terubong. They are covered in tree crops and should be gazetted as green areas, which enable landowners to continue working their orchards as long as the trees are not felled for development purposes. The 6 satellite islands of Penang: Aman, Jerejak, Gedung, Kendi, Rimau, Betong, mostly covered in forest, should also be gazetted as permanent forest reserves.

**Action** Engage in the reforestation and rehabilitation of denuded land especially on hill slopes. Exposed hill land is prone to cause landslides and floods. Reforestation efforts should be focused on planting native species rather than fast growing non-native species, because native species enhances the local biodiversity. A restored forest never fully recovers its original biodiversity and takes decades to sequester the amount of carbon lost in one fell swoop of deforestation. Thus, reforestation is no replacement for forest protection.

Targeted areas for reforestation could include the denuded portions of the Penang Hill Range, Bukit Relau, Bukit Kukus and the quarried hills in Central and South Seberang Perai.







Above:  
*Geostachys penangensis*, a ginger  
endemic to Penang Hill.

Opposite page:  
Bee Hive Ginger (*Zingiber spectabile*)  
Sea Lettuce (*Scaevola taccada*)  
Orchid (*Calanthe pulchra*)  
False Coffee Tree (*Fagraea racemosa*)  
Malay Tropical Chestnut (*Sterculia coccinea*)  
Wild fig (*Ficus sp.*)  
Penang Slipper Orchid (*Paphiopedilum barbatum*)



## Density Amidst Biodiversity in Hong Kong

Spanning just 1108 km<sup>2</sup>, Hong Kong is home to almost 7.5 million people making it the fourth most densely populated region in the world. For an exceptionally dense city with a large area of hilly land, Hong Kong has surprisingly only developed 25% of its land area, while the remaining 75% has been left in a relatively natural state. How has it been able to do so?

Hong Kong's natural areas and biodiversity at a glance:

- Hong Kong's 230 islands are home to 3,300 types of plants and 2,400 animal species.
- 44,300 hectares of protected land constituted by 24 country parks and 22 special (nature conservation) areas make up 40% of Hong Kong's landmass. Protection categories range from country parks, special areas, water gathering grounds and conservation zoned areas of special scientific interest.
- An additional 7,700 hectares subject to stringent planning and development controls under conservation zonings include Sites of Special Scientific Interest, Conservation Areas and Coastal Protection Areas.
- 4 marine parks and 1 marine reserve covering 2,430 hectares of Hong Kong waters.



Hills untouched: 75% of Hong Kong remains in its natural state



Flora, fauna and density, Hong Kong





A walking and cycling park in Hong Kong

### **The Hong Kong Biodiversity Strategy and Action Plan (2016–2021)**

In December 2016, the Hong Kong government announced the first city-level 5-year Biodiversity Strategy and Action Plan (“BSAP”) that outlined the strategy and actions taken to conserve biodiversity and support sustainable development. It mentions 67 specific actions in the areas of enhancing conservation measures, mainstreaming biodiversity, and promoting community involvement.

The BSAP aims to bring nature back into urban areas through:

- Sustainable slope greening through the planting of native species on slopes and hillsides.
- Greening Master Plans, which is a planting framework to enhance urban environments.
- Promoting urban forestry.
- Enhancing the management of protected areas through ecological monitoring, and comprehensive biodiversity management plans for each type of protected area.
- Protecting ecologically important habitats outside protected areas by promoting conservation in rural areas and the designation of new country parks.
- Incorporation of biodiversity considerations in planning and development by integrating it in the Hong Kong 2030+ vision, in order to support sustainable growth and address ecological impacts.



An urban forest in Hong Kong

## 12 • SECURING OUR WATER ASSETS

Water – we drink and cook with it, we use it for agriculture, manufacturing as well as sanitation. Potable water is a basic human need. Providing access to potable water and to basic sanitation is the foundation of public health and development. Water usage can be divided into 5 categories: domestic (cooking, drinking etc.), agricultural (farming, gardening etc.), industrial (manufacturing etc.), recreation (swimming etc.) and energy generation (hydropower etc.). The climate crisis has a profound impact on our water resources and sanitation services as a result of increased occurrence of droughts, floods and less predictable rainfalls.

SDG Goal 6, which addresses clean water and sanitation, highlights the need to improve water-use efficiency, water quality, the integration of water resource management and the protection of water catchments and related ecosystems through cooperation at all levels.

A lackadaisical attitude towards water usage has resulted in Penang's water consumption being consistently the highest in the country, topping 290 liters per capita in 2017, almost two times more than the UN's suggested usage of 165 liters per capita. While Penang might have the highest water consumption in Malaysia, it has the lowest percentage of water loss (Non-Revenue Water, "NRW") between treatment plants and meter positions, which, at 18%, is less than half the national average of 36%. Perbadanan Bekalan Air Pulau Pinang ("PBAPP") is considering to expand its NRW management programme to further minimise water loss.

The Penang State Government has initiated mandatory installation of water-saving devices ("WSDs") in all new developments across the state from 2018. The use of WSDs will improve water usage efficiency as it will help consumers to save water usage with little or no change to their routines. In 2017, Penang announced plans to increase its water conservation surcharge from RM0.48 to RM1.00. This is a welcomed move as it will, hopefully, influence consumers to decrease domestic water consumption.

Penang is a relatively small state with no significant mountain range, and its streams and rivers can only supply about 20% of the state's water needs. The rest of Penang's water supply comes from one river, the Muda River, sourced in neighboring Kedah State. However, logging in the Ulu Muda Forest Reserve is a constant threat to Penang's water supply. In September 2018, Kedah has stopped the issuance of new logging permits and revoked existing ones which is a first step in protecting Ulu Muda.

While the protection of the Ulu Muda Forest Reserve as a water catchment is of great importance, so is the potential use of Sungai Perai in Seberang Perai and Sungai Perak in Perak State as possible second and third water sources for Penang. The proposed Sungai Perak Raw Water Transfer Scheme will be able to supply an additional 1,300 million litres of water per day and ease dependency on Sungai Muda. Unfortunately, due to increased intensity of droughts, the latest being in

### Penang's Water Usage Water Production and Consumption between 2014-2018

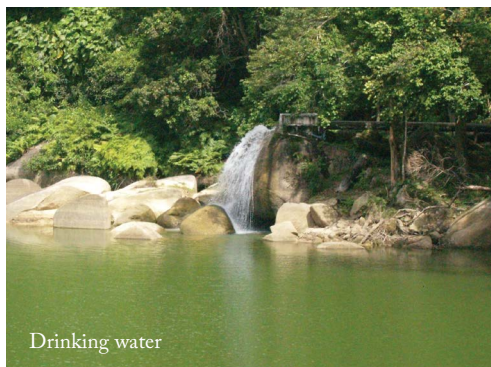
	(million litre)	
Year	Production	Consumption
2014	363,198	296,898
2015	370,286	296,662
2016	385,641	302,627
2017	386,052	301,617
2018	391,652	306,574

### Consumption per Consumer between 2014-2018

Year	Average daily consumption per consumer ('000 litre)			Number of Consumer		
	Total	Domestic	Industrial	Total	Domestic	Industrial
2014	1.45	1.00	4.26	561,811	484,118	77,693
2015	1.41	0.98	4.06	575,747	494,737	81,010
2016	1.40	0.98	3.93	589,797	504,400	85,397
2017	1.37	0.93	3.97	604,547	-	-
2018	1.36	0.93	3.99	616,082	-	-

### Based on the above data:

Annual production capacity (million litres)	Water available for consumption (million litres)	Annual industrial consumption (million litres)	Water available for domestic consumption (million litres)	Penang's carrying capacity (no. of residents, not including tourists)
392,000 – with current infrastructure, without factoring droughts and loss of catchment areas.	314,000 – allowing for 20% reserve of water.	150,000 – allowing for 20% growth from 2016.	164,000/year; or 449/day	At the current 290 litres per capita, <b>1,548,000 residents.</b>  At a reduced 230 litres per day, <b>1,952,000 residents.</b>



March 2019, Kedah and Perak are among the states facing severe water shortages.

Unpredictability of rainfall patterns has impacted on Penang's water resources, with the El Nino effect of early 2016 straining the state's water supply and forcing it to rely on strategic drought reserves; while the extreme rains which led to the November 2017 floods resulted in technical breakdowns in three water treatment plants across the state.

For Penang's own water security, it should take a holistic view and devise actions to increase its in-state water production capacity, reduce per-capita water consumption, and ensure that its population numbers and industrial water needs are kept within permissible limits so as not to stress its residents.

The current draft State Structure Plan 2030 projects Penang's population at 2,450,000 residents in 2030. If this projection were to come true, the per capita (per day) use of water has to be reduced to 183 litres per capita, a 38% reduction from the current rate of water use. Alternatively, the State could either generate more water if possible, or choose to limit population growth to 2,245,000 residents (using 200 litres per capita) and instead ensure efficient and swift public transport connectivity to cities of neighbouring states such as Kulim, Sungai Petani and Taiping to

spread population density across the cities in the George Town conurbation.

### Safeguarding and expanding our water sources

**Action** Monitor and protect our water catchment areas. The total catchment area in Penang covers 6,288 hectares and they overlap with the existing forest reserves in the state. A significant portion of the catchment area comprises privately-owned land and agricultural land. For example, the Teluk Bahang Dam has catchment slopes (on its south and east) which are heavily cultivated with a mix of fruit trees and annual crops. If left unchecked, land works on privately owned land within catchments might contribute to erosion which ultimately silts catchment streams; while uncontrolled use of pesticides and herbicides within catchment areas will pollute streams feeding into reservoirs and dams.

It is thus imperative that:

- a. Agriculture in catchment areas be restricted to the planting of perennials and fruit trees.

Planting of annuals within catchment areas will result in increased exposure of soil to the elements and this will result in soil erosion within catchments, especially on slopes with an inclination of more than 25%. Only the planting of fruit trees and perennial shrubs ought to be permitted in areas which have been gazetted as agricultural land within a catchment area. A buffer of at least 15 meters between cultivated land and catchment stream should be imposed. Existing forests within catchment areas must be preserved and areas which have been newly cleared or disturbed should be reforested.

- b. Total ban of chemical pesticides, herbicides and fungicides within catchment areas.



Many agricultural crops today are grown with the use of chemical pesticides and herbicides which may seep into streams and groundwater when it rains. In order to ensure our water supply is not polluted, a strict ban should be imposed on the usage of chemical pesticides in catchment areas. As an alternative, the government should make organic (non-toxic) pest control techniques available to farmers and landowners in catchment areas, at a subsidised price.

c) No construction or development in catchment areas.

No new residential, commercial or industrial development should be permitted inside catchment areas. As for eco-tourism within catchment areas, only low impact activities should be permitted. Private landowners who have pre-existing structures or homes inside catchment areas should be made to install proper wastewater treatment systems and not discharge untreated water into the catchment basin.

**Action** Expand our catchment areas. The current network of water catchment areas in Penang is restricted to the hilly central zone of Penang Island and two separate zones in Central and South Seberang Perai. A few streams and rivers radiate from these hills. Relatively unpolluted streams like Sungai Nipah, Sungai Pulau Betong, Sungai Burung and Sungai Kongsu which flow through the Balik Pulau plains can serve as catchments for small reservoirs which can store and act as back-up water supply in the event of water shortages. In the long term, these reservoirs can also supply the surrounding communities as a permanent supply. In Seberang Perai, rivers like Sungai Perai and Sungai Kerian could be explored as alternatives. This may need transboundary cooperation with neighboring Kedah and Perak, and thus Penang could champion a northern region

water supply security plan which should address the creation of new water catchment areas, while safeguarding existing ones.

**Action** Implement grey water and rainwater harvesting. Reusing greywater and harvesting rainwater are two ways in which we can reduce water consumption from the mains as well as reduce the amount of water discharged into the sewage system. While greywater and rainwater in its raw form is unfit for human consumption, it can be used for a variety of other needs, for example, flushing toilets and watering gardens. Public and government buildings ought to spearhead the installation of such systems starting with the use of greywater for watering municipal trees and plants.

Cape Town sprawl as seen from Table Mountain



### Taps Run Dry in Africa's Tourist City

Visitors entering the city of Cape Town in 2018 were greeted with warning signs of a city grappling with the worst water crisis in recent memory, complete with a countdown clock to “*Day Zero*,” i.e. May 20, 2018 “the day the taps will be turned off,” according to the city’s own calculations. Eventually, the city was saved thanks to successful consumption reduction efforts and some unexpected rain. The city implemented severe water restrictions, which banned the use of municipal water for non-essential purposes. For homes it meant reducing water consumption to just 50 litres per person per day.

Cape Town’s population grew from 2.4 million residents in 1995 to an estimated 4.1 million in 2015, representing a 71 percent population increase in 20 years, whereas dam water storage only increased by 17 percent in the same period. The impact of population increases on water demand is often underestimated, as forecasting fails to take full account of the individual’s indirect uses of water through food and consumer goods production.

The 2018 water crisis resulted in the loss of 37,000 jobs and an estimated 50,000 people being pushed below the poverty line due to job losses, inflation and increases in the price of food.

A view of Cape Town as seen from Table Mountain



## Water Scarcity in Egypt

Among the most urgent questions for Egypt is finding enough water to support its 100 million people. According to UN standards, a population of Egypt's size needs around 100 billion cubic meters of water. Today, it only has around 60 billion cubic meters – a 40 per cent deficit. That shortage is already wreaking havoc on farmers who cannot find enough clean water for their crops and are being forced to reuse damaging wastewater.

With population growing by 2.5 million people each year, projections show the country could top 150 million by 2050. Egyptian authorities have launched a “*Two Is Enough*” campaign to convince people to have no more than two children. Egypt's president has warned that the dangers of overpopulation are the second greatest threat to his country after terrorism.



View on Nile river under Aswan Low Dam, Egypt. *Karelj.*



## 13 • IMPLEMENTATION, CITY FINANCING AND FUNDING

It is the norm to establish milestone goals for each strategy laid out in this document and key performance indicators (“KPIs”) to track reduction in greenhouse gas emissions. As we strive to deliver the set targets, it is essential to put a person or team in charge of implementation. One model that can be considered is that of a Chief Resilience Officer (“CRO”) appointed by the State and made answerable to the State cabinet or legislature.

The CRO is a position that was introduced through *100 Resilient Cities*, an initiative of the Rockefeller Foundation. A CRO can help set a “resilience framework” to shape thinking about how decisions and priorities affect the ability of their city to adapt and thrive no matter what kinds of stresses and shocks experienced.

A CRO often reports directly to the city’s mayor or chief executive, or in the case of Penang – the Chief Minister or an EXCO member – and acts as the city’s point person for preparing the city for its risks, helping to coordinate all of the city’s resilience efforts. The CRO also works to ensure that the city applies resilience thinking to local decision making to deliver multiple benefits in any policy or project.

The exact nature of the CRO position varies from city to city, but the following are fundamental to the role of a CRO:

1. Working across government departments to help a city improve internal communications, and to address its own complexities. By facilitating communication that reaches across

internal divisions, the CRO promotes new collaboration.

2. Bringing together a wide array of stakeholders to learn about the city’s challenges and help build support for individual initiatives. These stakeholders include government officials and representatives from the private sector, non-profit organisations, and community groups.
3. Engaging in defining policy and project initiatives, and under some circumstances, leading their implementation.

Effective CROs perform all the above functions, while collaborating externally to integrate lessons other cities have learned.

### City Financing

In putting together a plan to execute the many climate resilience strategies set out in this document, city financing plays a key role to ensure (a) there is a sufficient amount budgeted for the execution of resilience promoting programmes; and more importantly, (b) the city transitions away from the “non-sustainable” funding sources that may be impacted by these very resilience-promoting programmes. In other words, managing city financing helps to future-proof a city.

By way of example, we look at the two cities of Penang:

In the year 2017, the MBPP raked in revenue of RM359 million and its expenditure was RM291 million, posting a healthy surplus of RM68 million. Solid Waste Management and cleaning amounted to 18% of the city’s

expenditure. The primary source of revenue were assessments, which amounted to 54%, while “others”, i.e. planning permissions, infrastructure contributions and rezoning charges stood at 35%. Without these development-dependent contributions, the MBPP would have turned a deficit of RM58 million.

In the same year, the MBSP raked in revenue of RM263 million and its expenditure was RM280 million, posting a deficit of RM17 million. Solid Waste Management and cleaning amounted to a staggering 40% of the city’s expenditure. The primary source of revenue were assessments, which amounted to 66%, while development-dependent contributions stood at 20%.

As a matter of good policy, both city councils should implement and make public a revenue and resourcing policy, the purpose of which is to provide predictability and certainty about sources and levels of funding available to the council looking into the future.

**Action** It is recommended that the reliance on development-dependent contributions be capped to 25% of each city council’s revenue base. It is also recommended that spending on Solid Waste Management and cleaning be capped to 20% of the city’s expenditure; and that strategies be put in place to increase their incomes from sources such as rents, compounds, licences, permits and such to 20% of their revenue.

Many cities have diversified asset portfolios that provide predictable and “renewable” income. For instance:

The Ports of Auckland is a container port owned by the Auckland Council. It provides container terminal handling, bulk cargo handling, freight hubs, and support for the cruise industry and other services.

The City of San Antonio, Texas, owns CPS Energy, the municipal electric utility provider. CPS Energy serves over 841,000 electricity customers and more than

353,000 natural gas customers in its 4,060 km<sup>2</sup> service area.

The Penang Island water utility service was owned by the George Town City Council (now MBPP) up until 1973, when it was turned into a statutory entity belonging to the State.

The Penang Hills Funicular Railway was managed and maintained by the George Town City Council since its opening in 1924 until 1977, when it was taken over by the Penang State Government.

In the absence of strong revenue generating assets, as listed above, it makes for a good case that the State or Federal government allocates grants for each of the city councils, corresponding to the number of residents living in each council.

Auckland Council in New Zealand and the City of Parramatta in Australia, provide good examples of revenue and resourcing policies that explain the rationale for, and the process of selecting various tools to fund the operating and capital expenditures of councils.

Ideally, in Malaysia, the Federal Ministries of Local Government, MESTECC, and Natural Resources, respectively, should give grants to States and/or Local Governments to ensure preservation of all critical ecological assets, to include water catchments and carbon-sequestering sinks such as mangroves, wetlands and rainforests within their respective boundaries. This will encourage individual states to act in meeting Malaysia’s federal-level international commitments to address the universal threat that is the climate crisis.

### Funding for Climate Resilience

There exists several climate resilience focused global grants that are open to cities in developing countries such as Malaysia.

The Green Climate Fund (“GCF”) is a fund established within the framework of the





Langur Way Canopy Walk,  
The Habitat, Penang



UNFCCC to assist developing countries in adaptation and mitigation practices to counter climate change. The Fund is a platform to respond to climate change by investing in low-emission and climate-resilient development. GCF was established to limit or reduce GHG emissions in developing countries, and to help vulnerable societies adapt to the unavoidable impacts of climate change.

The World Bank Group's ("WBG") City Resilience Program ("CRP") is an effort to assist city governments to build greater resilience to climate and disaster risks. For many cities in the world, strengthening urban resilience requires strong partnerships and new sources of capital. The CRP assists by designing urban resilience projects and better connecting cities to the necessary financing. Such financing facilities include (a) sovereign wealth funds with significant allocation for infrastructure; (b) local development investment vehicles; and (c) guaranteed loan and grant programmes.

The Global Environment Facility ("GEF") provides grants to countries on wide-ranging topics of sustainability such as climate change, land, forests, water, and biodiversity.

Other such funding opportunities are launched periodically by the likes of the Asian Development Bank ("ADB"), ICLEI – Local Governments for Sustainability, United Cities and Local Governments ("UCLG"), United Nations Human Settlements Programme ("UN-Habitat"), UNDP, The Global Facility for Disaster Reduction and Recovery ("GFDRR") and various embassies of the developed world.

Funds obtainable through bilateral cooperation with national or international organisations are often assessable through NGOs working in the community, and with links to those entities, e.g. Sahabat Alam Malaysia, Third World Network, WWF Malaysia, and Think City.

## Implementation Steps

1. Prepare the institutional setting at the highest level (i.e. State cabinet/EXCO). Appoint an entity or team at the State level (like a CRO), and sub-teams at the municipality level charged with raising public awareness, convening all actors, crafting programmes, setting targets, and driving implementation.
2. Capture the necessary data by conducting baseline inventories in order to set informed indicators and targets.
3. Develop a Climate Resilience Action Plan: setting out priorities, goals, indicators and targets. Publish the plan and disseminate it to the public in easy-to-understand (multiple) languages. Ensure that State and local governments commit to incorporate the Action Plan's goals and targets into the State's Structure Plan and the two cities' Local Area Plans.
4. Define the responsibilities and roles of all city actors – and secure financing (from State, City, or external) for the implementation of the Action Plan's projects.
5. Allow actors to take ownership of the Action Plan.
6. Develop a monitoring, evaluation and assessment strategy for the implementation of the Action Plan. Involve local communities and NGOs to give feedback.
7. Communicate progress to different actors about problems and achievements. Expand communication state-wide to announce progress (and failings) in order to secure the involvement of local communities.

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