ENVISION

EXPLORING HUMANITY'S ENVIRONMENT

2°C OR LESS
WHAT WILL IT TAKE TO LIMIT CLIMATE CHANGE?

THIS ISSUE

The "Paris Rulebook"–a look at what is at stake. ALSO: With changing weather patterns, is more flooding likely?

Inside Singapore's Year of Climate Action & the new Carbon Tax. PLUS: Emergent public health risks identified.

Singtel & SBTi: A progress report. ALSO: Marine pollution—the scale of the problem and the measures taken up for it.

ENVISION Magazine Issue 14 – May/June 2018 – A Biannual Publication of Singapore's National Environment Agency

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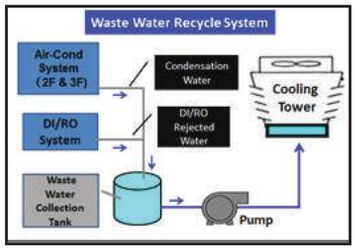

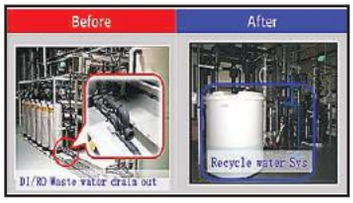

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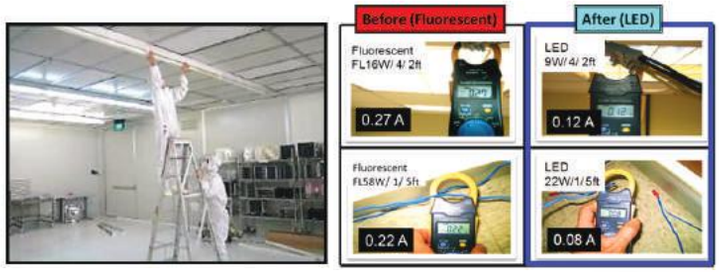

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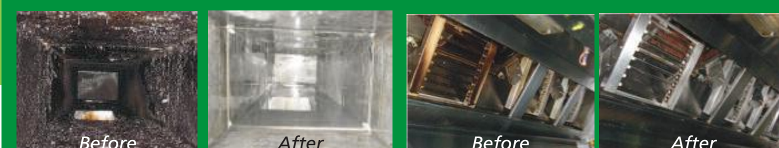

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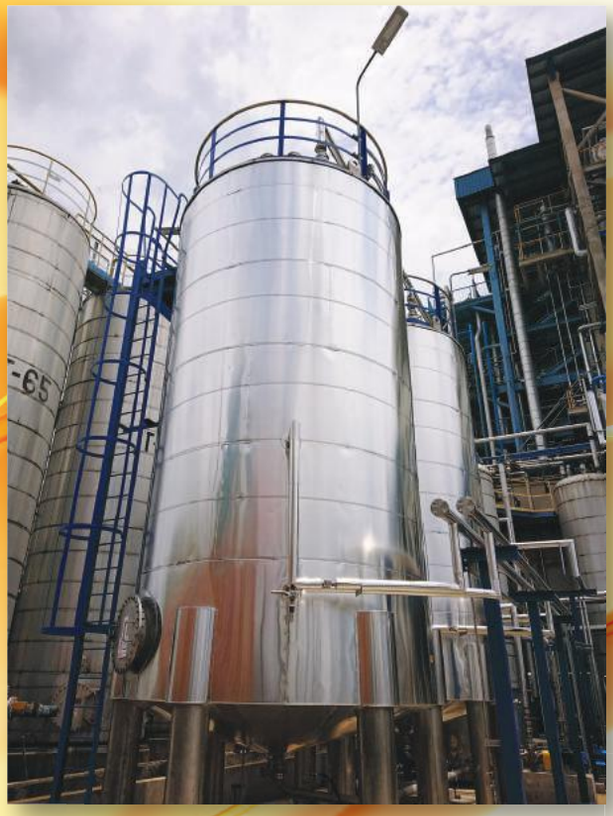

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The Issue

This year marks an important milestone as the so-called "Paris Rulebook"—the guidelines required to implement the Paris Agreement—is being negotiated. Against this backdrop, most countries are rallying for climate action.

There have been many positive signs. Oil and gas giant, Saudi Arabia, recently announced a pivot towards solar and renewables for its future. Territories in the US and Canada are joining together across borders to create carbon markets, and China's carbon trading market has also opened. The World Bank estimates the global value of carbon pricing schemes at US$82 billion, a 56 per cent increase from 2017. Cities from New York to Tokyo are taking action at the local level as well.

Singapore has stepped up to take responsibility. The country has recently launched their Year of Climate Action to rally public support and is introducing a carbon tax. In this issue, we will take a look at the impetus for both.

Activity has not only been on the part of governments. Worldwide, pressure has also mounted on businesses to get in gear. There is growing demand from NGOs on banks to stop financing coal-related energy projects. Institutional investors and sovereign wealth funds like Norway's have been moving towards divestment of fossil fuel related companies. Recently, about 60 large institutional investors, representing roughly US$10.5 trillion worth of assets, also demanded that oil and gas businesses scale up efforts to tackle climate change in line with the Paris Agreement.

There has also been traction by corporations towards climate disclosures, with the efforts of over 1000 companies noted in a recent report by environmental data organisation CDP. Companies like Singtel have even taken strides with the Science Based Targets initiative, setting emissions targets that are aligned to the Paris Agreement goal of keeping climate change to less than 2°C. Experiences of companies like these can be instructive to many of their peers, and we will continue to look at their journey.

Both the financial and environmental benefits of energy efficiency are also increasingly gaining recognition as companies take steps to cut emissions from energy use. Many exciting new technologies are further enabling industrial energy efficiency.

In the manufacturing sector, A*Star SIMTech's Model Factory provides a tantalising glimpse of what is possible, while researchers at NUS have also engineered a new air conditioning system prototype, one that reduces energy consumption to a fraction of typical consumption. Organisations could investigate innovations like these in their battle to slash energy use and emissions.

Renewable energy–especially solar–continues its ascent as costs plummet and energy prices move towards grid parity in many countries. However, in complex regions like Asia, a number of regulatory, government, infrastructure and funding challenges still exist. Taking a look at the problem, we will hear from industry veterans about what is needed to move forward.

Will efforts like these be enough, and in time, to stop climate change at 2°C or less and minimise the potential negative effects to humanity? Already, unseasonal temperatures have become widespread in many parts of the world. Since 2000, numerous heat records have been broken, including three since 2014.

Weather continues to get more unusual, with powerful storms reaching new territories and latitudes, and the propensity for flooding on the rise in many tropical countries around Asia. Both food and vector-borne illnesses are also increasing in range with worrisome consequences for global public health. How can we be better prepared?

These foreboding warnings remind us all to not be complacent. Unprecedented action on the part of corporates, governments, NGOs and citizens is required if there is any realistic hope of stopping runaway climate change. Greater education and clearer communication are urgently needed to help catalyse people's involvement. How are you playing your part?

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Publisher
National Environment Agency (NEA)
40 Scotts Road
Environment Building #13-00
Singapore 228231

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NEA Contributors and Assistance
Chan Chin Kai, Chan Shen Yin, Serene Chua, Sabrina Foong, Amanda Go, Lai Xian Han, Long Yan Wen, Rachel Meng, Tan Ying Xin, Darryl Teo, Wan Lek Kong, Cheryl Wong, Justin Wu

For advertising queries, contact

MULTININE

Trevor Teh
Tel: +65 6281 8888
sales@multi9.com.sg
multinine.com.sg

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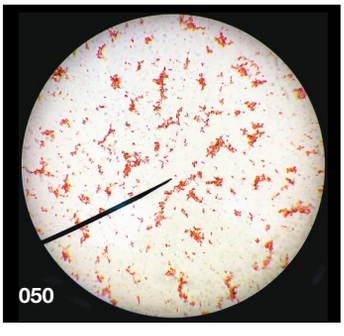

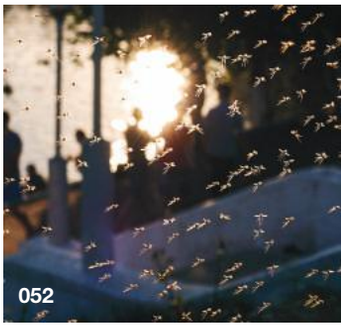

DOWA

motivate our planet

DOWA ECO-SYSTEM Co., Ltd. (Japan)

DOWA launched a new incinerator in Singapore, promoting safe and low-carbon treatment of solid hazardous waste.

DOWA runs Environment Management businesses in Singapore, Indonesia, Thailand, Myanmar, China and Japan. In Singapore, TEC possesses a distinct strength and advantage in the treatment of liquid waste, and has earned the trust of companies that place an emphasis on compliance. It plan to use the newly constructed incinerator mainly for treating solid hazardous waste, such as pharmaceutical and chemical complex hazardous waste.

The Introduction of this incinerator will double the current waste incineration capacity of the company. It also enable a system to be established that makes it possible to treat many different types of complex hazardous waste, both liquid and solid. This new incinerator is also capable of complete combustion of waste without auxilliary fuel (except for ignition), enabling a significant reduction in CO_2 emissions generated during the incineration treatment of solid waste.

Leveraging on its extensive experience in Japan and other countries, the DOWA Group, in Singapore, will promote safe detoxifying treatment of various types of hazardous waste, and low-carbon waste treatment, where the demand is increasing. DOWA will accelerate its business expansion and help solve environmental issues in Asia, where economic growth is expected to continue.

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2. Started date of acceptance – End of May 2017
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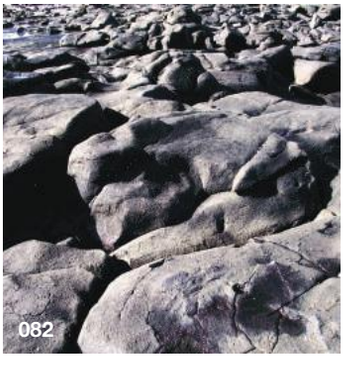


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Getting to 2°C or Less

What will it take to limit climate change?

Melissa Low, Energy Studies Institute

In 2017, the world commemorated the 20th anniversary of the 1997 Kyoto Protocol and the second anniversary of the adoption of the Paris Agreement on climate change.

As of today, 174 countries representing around 88 per cent (around 70 per cent excluding the United States) of global greenhouse gas (GHG) emissions have ratified the agreement. Global momentum on climate change is strong and growing in recent years, despite the United States' apparent intention to withdraw from the Paris Agreement.

For instance, in 2016, the International Civil Aviation Organisation announced new measures in the form of the Carbon Offsetting and Reduction Scheme for International Aviation to limit carbon dioxide emissions from international flights, which are not covered by the Paris Agreement.

That same year, Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer agreed to the Kigali Amendment to phase out the use of hydrofluorocarbons, a potent GHG, from 2019 onwards.

Rules of the road

2018 is slated to be a critical year for climate action as countries need to finalize the "Paris Rulebook"—the rules and working processes that will underpin the Paris Agreement's implementation. These rules are currently

01

being negotiated through a work programme alongside an Ad Hoc Working Group under the Paris Agreement (APA) set up in December 2015.

The Paris Agreement came into force on 4 November 2016, less than a year after its adoption in Paris on 13 December 2015. Countries, unfortunately, have not the luxury of time as they did back when they were negotiating the rulebook for the previous Kyoto Protocol. Indeed, having 174 countries with very different and diverse interests in the game can be tricky.

Aiming for the target

Additionally, the UN Environment Programme provides an update in its annual Emissions Gap Report every year. In the latest report, it highlighted that current pledges for 2030 would likely result in annual emissions of 54 to 56 billion tonnes of GHG, far beyond the pathways agreed in Paris, where the goal was to limit the increase in global temperature to below 1.5 or 2°C.

The assessed global scenarios demonstrated that if least-cost trajectories were followed, the emissions of all GHGs should not exceed 42 billion tonnes in 2030—given that the 2°C target by the end of the century is to be attained with higher than 66 per cent chance. The probability to attain 1.5°C comes in lower, at 50 per cent, that is if global GHG emissions do not exceed 37 billion tonnes in 2030.

The emissions gap related to the 2°C goal for the full implementation of NDCs for 2030 is 11 to 13.5 billion tonnes of GHG, for conditional and unconditional pledges respectively.

The Paris Rulebook's finalisation by the end of COP24 in December 2018 will first require several coherent decisions to be made.

Tall order

These discussions are complex and the existing negotiation text stands at a hefty 266 pages.

Nonetheless, this new rulebook is necessary for the implementation of the Paris Agreement. It should also include a comprehensive, detailed set of rules in several broad areas, such as:

1. How countries may communicate their efforts and how they should be held accountable for their commitments;
2. How to take stock of collective efforts and review them, so as to ensure that actions and support for these actions can be scaled-up every five years; and
3. How to create a process that would facilitate implementation and continuous improvement over time with respect to the quality, coverage, scope and level of detail of information reported, and prevent backsliding in reporting by countries.

To do this, countries must come to an agreement on the content and frequency of reporting while ensuring that these rules are not too onerous on countries that currently lack the capacity. Encouraging maximum participation by recognising different starting points of countries is key, but this is also making the task at hand particularly complicated and challenging.

For instance, will the negotiations be able to include "built-in flexibility" to accommodate countries' differing capabilities, thus allowing them to improve the quality, coverage, scope and level of detail of submitted information over time? Or will it fall back into a bifurcated approach and have two sets of rules for developed and developing countries separately?

These rules are critical to promoting robust, ambitious and effective action on the grounds across various countries. However, progress has been uneven, with the rule-making process moving faster on some issues than others. Failing to rectify this before December could even potentially jeopardize the entire outcome.

This year, countries launched the 2018 facilitative dialogue, now known as the

01 Katowice, Poland will host the upcoming COP24 Climate Change Conference in December 2018.
02 The Green Climate Fund has been tapped by countries like India to fund renewable energy projects.

02

Talanoa Dialogue, aimed at taking stock of the collective efforts of countries towards the long-term goal of the Paris Agreement, and to inform the preparation of further nationally determined contributions or pledges. Starting in 2023, aggregate progress on mitigation, adaptation and means of implementation will be reviewed every five years in a global stocktake.

Heeding the call

Countries are not just channeling their efforts towards global climate negotiations, but also making good on their pledges by initiating projects that tackle significant emitting industries.

In Bonn last year, 20 countries pledged to phase out coal usage by 2030 as part of a new international alliance. The Powering Past Coal Alliance, led by Canada and the United Kingdom, was launched to help accelerate clean growth and climate protection through the rapid phase-out of traditional coal-fired electricity before 2030.

Recently, green groups have been calling out Singapore's banks for funding coal projects in the Southeast Asian region. On the other hand, some banks have committed to cut back on coal investments. HSBC last year announced that it would no longer finance coal mines or new coal power plants in rich nations. Australia's four big banks have also sharply curbed lending to coal projects since 2015. Both the United Kingdom and France have announced plans to shut down coal plants by 2025 and 2021 respectively.

Indeed, a major setback to the momentum on climate action was when US President Donald Trump announced on 1 June 2017 that the US would be withdrawing from the Paris Agreement.

Nonetheless, it is important to note that Article 28 of the Paris Agreement permits a Party to withdraw by giving written notification to the Secretary-General of the United Nations, which may only be permitted "after three years from the date of which [the Paris Agreement] entered into force for a Party."

Withdrawal then only takes effect upon the expiry of one year from the date of receipt. For example, the Paris Agreement entered into force for the US on 4 November 2016, hence the earliest the US is able to give written notice is three years later—4 November 2019—and the earliest the US is able to leave the Paris Agreement is 4 November 2020.

Meanwhile the United States must still remain a Party to the Paris Agreement and is obliged under international law to refrain from frustrating or obstructing its implementation. Until such time as the US legally withdraws from the Paris Agreement, they will still be listed as accountable for its actions on climate change.

However, the worry is that the damage could already have been done by then, and the US' emissions could then be back on an upward trend. To counter this, all hands need to be on deck. All remaining 173 countries must continue to be conscientious in their efforts and to scale-up both climate mitigation and adaptation projects.

Presently, countries can tap on a number of resources to implement and scale-up renewable energy and resilience projects. The Green Climate Fund (GCF) has US$10.3 billion pledged with a current project portfolio of over 35 projects, worth more than US$1.5 billion.

The GCF pays particular attention to the needs of societies that are highly vulnerable to the effects of climate change, particularly in Least Developed Countries, Small Island Developing States, and African States. These countries may further build capacity through the Paris Committee on Capacity Building, the Capacity Building Initiative for Transparency, the Initiative for Climate Action Transparency, and the International Partnership for Mitigation and MRV.

All in all, 2018 will be a critical year for the adoption of the Paris rulebook, and doing it justice will put countries on a more robust pathway to keeping climate change below 2°C.

Tackling Climate Change

Singapore's move to designate 2018 our Year of Climate Action

Mr Masagos Zulkifli,
Minister for the Environment and Water Resources

Climate change is an important issue affecting Singapore and the international community. Our world is warming at an unprecedented rate due to the excessive emission of greenhouse gases—particularly carbon dioxide—primarily from the burning of fossil fuels.

Climate change poses an existential threat. The impact of rising sea levels and weather extremes such as droughts and flash floods caused by intense rainfall can have devastating consequences for lives and livelihoods. Singapore is already experiencing the impact—2017 was our warmest year on record that was not influenced by an El Niño event.

Our journey towards fighting climate change has been well embedded in our development policies: in our care for the environment, greening, public transport and investing in technology to half the energy needed to produce desalinated water. We are also aware that it is equally important to raise the level of national consciousness around the need to take individual and collective action to fight climate change for a sustainable Singapore—the government cannot do it alone. This is a year to join forces in Singapore and beyond to rally action to reduce our carbon footprint and fight climate change. Our vision is to ensure sustainability and make Singapore the best liveable city for our citizens as well as visitors.

To signify our collective action against climate change, we have launched the Climate Action Pledge and the Climate Action SG blog, a community blog carrying news and contributions by our partners. By taking the pledge, we make a public declaration of our commitment to take action and inspire others to do the same. We are very heartened by several initiatives adopted locally by numerous corporate and community players, schools, as well as passionate individuals on climate change.

Singapore has long-term plans to adapt to and mitigate the impact of climate change. We are strengthening our resilience and adaptive capacity, and integrating climate change measures into our policies, strategies and planning. These include significant investments in infrastructure, such as raising the height of coastal roads, building seawalls, widening drains and erecting flood barriers.

In addition, we are investing in solar energy, encouraging green buildings with more stringent standards, freezing growth of the car population and expanding public transport, and funding research and development for low carbon technology.

This year, we passed the Carbon Pricing Bill, which will give effect to the carbon tax in 2019 once in force. The carbon tax is part of our wide-ranging suite of climate mitigation measures. It will provide the price signal to catalyse economy-wide behavioural changes, preparing our businesses to be more energy and carbon efficient. This will help enhance the competitiveness of our industries and transition our economy to a low-carbon future. With our climate action policies and active citizen involvement, we aspire to make Singapore the primary choice for business development.

Internationally, there is an urgent need for all countries to work together to fulfil the goals and commitments of the Paris Agreement. Although Singapore contributes only a minuscule percentage of carbon emissions, we will continue to do our part as responsible global citizens to make reductions. The Year of Climate Action also supports the 2030 Development Agenda and we are working with countries around the world to help them achieve the UN Sustainable Development Goals.

As the ASEAN Chair this year, we are looking forward to leading discussions on climate action. In July, Singapore will host Special ASEAN Ministerial Meeting on Climate Action, an important gathering for member countries to show leadership on climate action.

From Singapore to ASEAN and the world, we want to work together as one global community to ensure that our planet remains liveable for generations to come. We call upon everyone to join and make this aspiration a reality.

To read more on MEWR'S Climate Action SG Pledge, visit http://bit.ly/2Da0X1W

Climate Change: A Taxing Issue

Singapore has recently announced further information regarding the carbon tax that will come into effect from 2019. *ENVISION* looks at these details, as well as the driving forces behind this development, and what it means for business

What You Need to Know About the Carbon Tax

- Carbon tax rate is currently set at S$5 per tCO_2e, from 2019 to 2023—tax rate to be reviewed by 2023.
- The Government intends to increase this tax rate to between S$10 to S$15 per tCO_2e by 2030.
- Tax is to be uniformly applied to all sectors, without exemption.
- Expected revenue is estimated at nearly S$1 billion in the first five years. That said, the government is prepared to spend more than this figure during the initial five years to support worthwhile projects that deliver the necessary abatement in emissions.
- Funds will be set aside from 2019 to enhance support for companies, including SMEs and power generation companies, to improve energy efficiency.

The Paris Agreement entered into force in November 2016. As of 9 March 2018, 174 countries representing 88 per cent of global emissions have ratified it and made commitments to reduce their greenhouse gas (GHG) emissions. Alongside countries such as China, India, Germany, and France, Singapore is also playing its part.

Under the Paris Agreement, Singapore has pledged to reduce its emissions intensity (emissions per dollar of GDP) by 36 per cent from 2005 levels by 2030, and stabilise emissions with the aim of peaking around 2030.

Singapore's Climate Action Plan, released in 2016, outlined four key strategies in order to fulfil this pledge–improving energy efficiency, reducing carbon emissions from power generation, developing and deploying cutting-edge low-carbon technologies, and encouraging collective action among government agencies, individuals, businesses, and the community.

Improvement in energy efficiency required

Singapore's GHG emissions in 2016 totalled around 51 million tonnes (Mt) of carbon dioxide equivalent (CO_2eq). The industry sector accounted for an estimated 59 per cent of Singapore's overall GHG emissions in 2012, of which 41 per cent was from direct emissions and 18 per cent from indirect emissions from electricity use.

Locally, companies have improved their energy efficiency rate by 0.4 per cent and 0.6 per cent in 2014 and 2015 respectively, in comparison to the one to two per cent improvement rates sustained by leading countries such as Belgium and the Netherlands. This goes to show that there is still more that Singapore can do in terms of energy efficiency.

About the tax

To incentivise greater improvement in energy efficiency and to facilitate a transition towards a low-carbon economy, Singapore will be introducing a carbon tax from 2019 onwards. The tax will be applied on facilities that emit 25,000 tCO_2e or more of emissions annually, and will cover the six GHGs that Singapore currently reports to the UNFCCC. Ultimately, it will cover around 80 per cent of national GHG emissions. This is one of the highest around the world. The nation will maintain a transparent, fair and consistent carbon price across the economy to incentivise emissions reduction.

To allow the industry more time to adjust and implement energy efficiency projects, the tax will start at S$5 per tCO_2e in the first instance, from 2019 to 2023. Additionally, the government will also review the tax rate by 2023, with a view to increasing the rate to between S$10 to S$15 per tCO_2e by 2030. By doing so, it may take into account international climate change developments, the progress of national emissions mitigation efforts, and economic competitiveness. The first payment of the carbon tax will be in 2020, based on emissions in calendar year 2019.

Singapore is not alone in pricing carbon. According to the World Bank, about 67 jurisdictions (42 national and 25 sub-national jurisdictions) have implemented, or have plans to implement, carbon pricing. These jurisdictions account for roughly half of global GHG emissions. A few of these jurisdictions such as Finland, Norway and Sweden have implemented carbon pricing since as early as the 1990s.

What it means for business

With regard to the tax, the extent to which a power generation company may pass on its incremental cost of producing electricity (including the cost of fuel and carbon tax) will depend on its overall cost structure and market dynamics.

Even if power generation companies pass on the full costs of a S$5 per tCO_2e carbon tax to consumers, the increase would be equivalent to a rise in electricity prices of about 0.21 cents per kWh, or about a one per cent increase from current electricity tariffs of 21.56 cents per kWh for the first quarter of 2018, compared to historical fluctuations in quarterly electricity tariffs of up to 10 per cent between 2010 and 2018.

Furthermore, from 2019 to 2023, the government is willing to enhance support for companies, including SMEs and power generation companies, to improve energy efficiency, and companies have been encouraged to tap on this pillar of support. Companies that improve their energy efficiency can reduce their energy costs, improve their profit margins, and consequently become more competitive globally.

Conclusion

The decision to implement a carbon tax as part of Singapore's suite of mitigation measures reflects the nation's commitment to addressing climate change. All stakeholders, even those beyond the government sectors, should participate in helping to mitigate this global issue.

Heavy Rain

Will climate change affect flooding in Singapore?

Bertrand Timbal, Thea Turkington, Muhammad Eeqmal Hassim and Elaine Gao, Centre for Climate Research Singapore

Extreme rainfall in Singapore calls to mind images of flooded roads and pedestrians struggling through water. These are termed flash floods and are usually short-lived events associated with heavy rainfall—for example, the 2010 Orchard Road floods, which caused damage to many buildings and businesses such as Lucky Plaza and Delfi Orchard.

In the case of the 2010 floods, the heaviest rainfall days recorded were 16 and 25 June, and particularly 17 July (Figure 2), when more than 130mm of rain fell in two hours. This last event is, to date, one of the most widespread and extreme rainfall events recorded in Singapore. More recently, on 8 January 2018, more than 110mm of rain was recorded at Tai Seng. Submerged cars were reported near Paya Lebar Square, and flooding occurred on Tampines Road and Upper Changi Road.

For a flood to occur, extreme rainfall is generally required. Nonetheless, other factors such as sea level at the time or factors related to the engineering and design of the drainage system also play important roles. At the Centre for Climate Research Singapore (CCRS), researchers are working to learn more about extreme rainfall in Singapore and Southeast Asia.

Researchers look at intensity, duration, and size to characterise these extreme rainfall incidents. Over many years, a statistical climatology of events can be built and analysed. For example, the rainfall recorded during the flood events previously mentioned are put in historical context in terms of the number of times a similar amount of rainfall has been recorded anywhere around Singapore (Table 1).

In the Year of Climate action, the important question is—will climate change affect the climatology of extreme rainfall in Singapore?

In the Year of Climate Action, the important question is—will climate change affect the climatology of extreme rainfall in Singapore?

Climate drivers

Climate change can be driven by both anthropogenic (man-made) and natural factors. Increasing amounts of greenhouse gases from human activity are influencing the rise in global temperatures, but these gases are only part of the story. Urbanisation and land use change can have a significant impact on the local environment, which in turn feeds back to the local climate. Both the changing climate and the changing urban landscape will influence Singapore's risk of flooding.

Therefore, climate change is a multi-faceted process involving changes across various time and spatial scales, not only in temperature, but also atmospheric and ocean circulation patterns, sea level, and notably the frequency and intensity of extreme weather, including extreme rainfall events.

Extremes in rainfall

Rainfall extremes are commonly framed in terms of multiple days, daily (the total amount of rainfall recorded within a 24-hour period), or sub-daily extremes (the highest total on hourly or sub-hourly time scales).

Heavy rainfall lasting for several days can lead to regional flooding that can affect a vast area—such as over a river basin. In this instance, rainfall rates are not necessarily very high, but the extreme rainfall volumes are a consequence of a series of intense rainfall spells interspersed with more moderate rain rates that are incessant throughout the day. This type of flood is frequent in the region such as the November-December 2014 floods over northern Peninsular Malaysia.

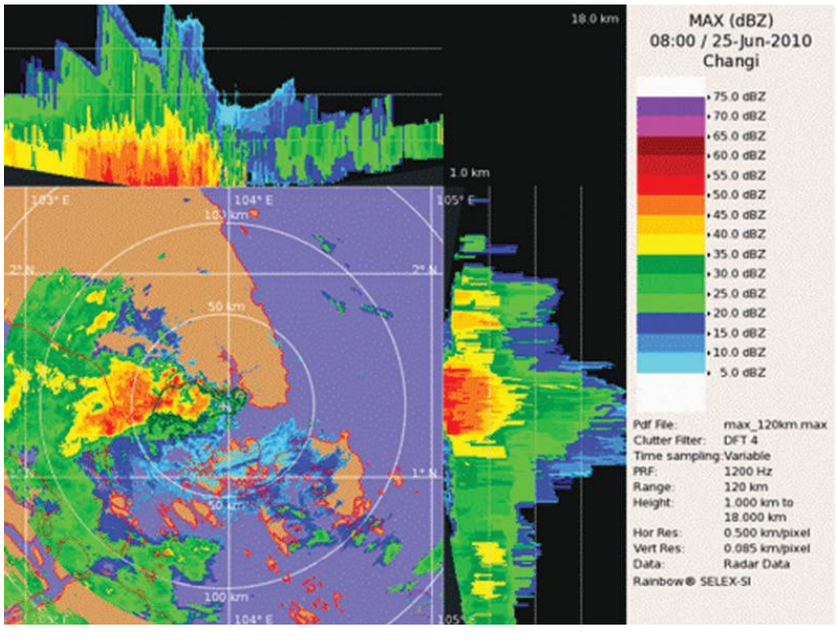
Singapore is most prone to cases of flash flooding. Such incidents result from the occurrence of extreme hourly and sub-hourly rainfall. These short durations, high intensity rainfall extremes occur when severe thunderstorms develop and organise to heights of up to 18km. These storms produce significant rain rates that are concentrated and sustained for up to an hour or more.

Despite their strong local signature, flash flood-producing thunderstorms are not necessarily isolated systems. Satellite observations reveal that most severe storm events in Singapore occur as part of a wider pattern of organised deep convective activity over Southeast Asia (Figure 1).

Meteorologically, these patterns can often be traced back to important large-scale factors. These include Northeast monsoon cold surges, and the Madden-Julian Oscillation, a large scale atmospheric disturbance in the tropics that travels eastward from the Indian Ocean to the Pacific Ocean, particularly from November to March.

The fact that we can link extreme rainfall to large scale factors is important in the context of climate change as it suggests possible large-scale drivers of extreme precipitation events.

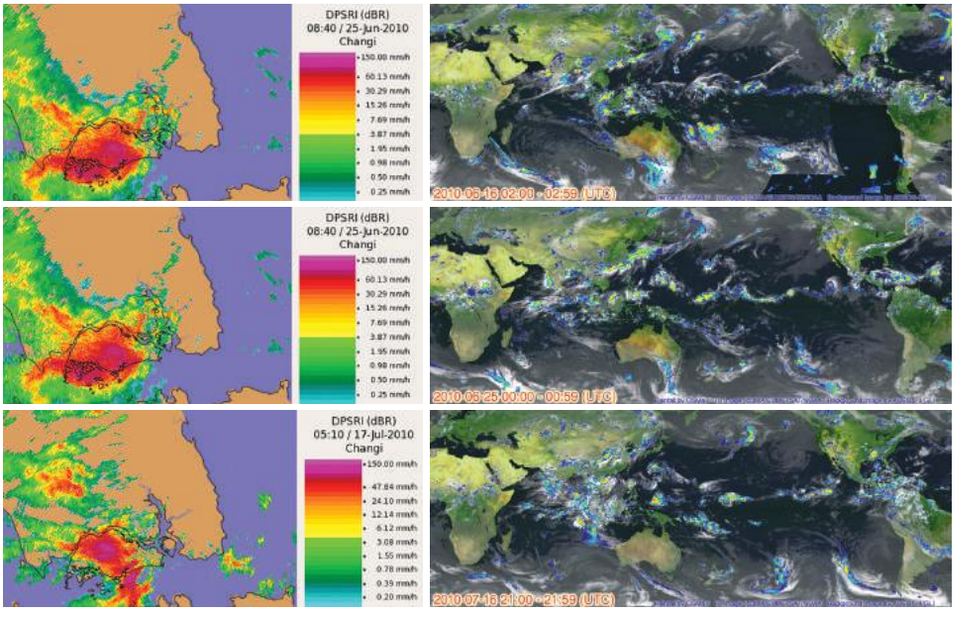
Figure 1 - Cross-section of severe thunderstorm on 25 June 2010



Weather radar image showing the cross-section of the very severe thunderstorm of 25 June 2010 that caused flash flooding over central Singapore.

Image shows maximum reflectivity values in dBZ at each height level. Values of 30dBZ are seen reaching 18km in altitude–such high values indicate the presence of very strong storm updrafts lofting ice and water particles high up into the atmosphere, and producing significant rain rates at the surface.

Figure 2 - Estimated rainfall rates on 16 June 2010



Weather radar images showing estimated rainfall rates for the severe thunderstorm events on 16 June 2010, 25 June 2010 and 17 July 2010 (left panels). Corresponding satellite images during these events are demonstrated on the right panels respectively.

Table 1 - Flash flood and associated extreme rainfall

Flash Flood Dates	Rainfall Amount	Duration	Location Recorded	Days Observed 1980-2016
16 Jun 2010	90mm++	2 Hours	Kampong Bahru, Queenstown, Sentosa	200+
25 Jun 2010	90mm++	2 Hours	Tengah, Serangoon	200+
17 Jul 2010	130mm++	2 Hours	Kampong Bahru, Upper Thomson, MacRitchie Reservoir	17
8 Jan 2018	110mm++	1 day	Tai Seng	150+

The climate connections

The impact of climate change on extreme rainfall, both on daily and sub-daily time scales, is a topic of current scientific interest. In response to global warming, the atmosphere's capacity to hold moisture increases, enhancing the potential for more extreme rainfall events. There is also theoretical understanding of the increased likelihood of extreme rainfall from climate change, known as the Clausius-Clapeyron scaling hypothesis.

This hypothesis notes that moisture content of the atmosphere increases at about seven per cent per °C. Indeed, the magnitude of daily extreme rainfall worldwide has been found to have risen between 5.9 to 7.7 per cent per °C of globally-averaged, near-surface air temperature, but with substantial variations depending on the latitude.

Therefore, extreme rainfall on daily timescales is predicted to strengthen in response to human-induced global warming. Nevertheless, changes in the atmospheric circulation patterns that trigger heavy rainfall events could potentially decrease, hence masking this effect.

A study of Singapore's two monsoon seasons has revealed that despite the increase of available atmospheric moisture, average rainfall is not likely to increase notably during these periods. This is, however, not necessarily true for extreme rainfall.

The wettest part of the year in Singapore is during the Northeast monsoon, often linked to large-scale cold surges. While climate models project no definite changes in the frequency or duration of cold surge events by the end of the century, the amount of rainfall they contribute increases significantly in most models—indicating that when cold surges do occur in the future, they are likely to bring more intense rainfall.

In fact, daily extreme rainfall in Singapore has already been increasing (as is the case in most locations around Southeast Asia), although it is important to recognise that it cannot be directly linked to increased flooding.

To better understand rainfall, more research is underway to employ convection permitting regional climate models with horizontal grid sizes between one to two km. These studies demonstrate some improvements in the models' ability to simulate observed sub-daily extremes, although there are still deficiencies because convective processes are yet to be fully understood.

When dealing with climate change, it is about making the best use of the information we have. One way is by reviewing the likely changes in intensity, frequency and duration for extreme rainfall for various future scenarios, helping us to adapt. These projections can then be combined with other information, such as changes in sea level and storm surges, to provide a larger picture of changes in flooding within Singapore. Future predictions can also help emphasise the importance of mitigating (or reducing) climate change, and avoiding the worst impacts.

Understanding more about what causes extreme rainfall and developing tailored projections can help Singapore prepare and be more resilient in the face of climate change.

Specialisations:
Renewable Energy

Asian Sunrise

Solar is proving a disruptive force in energy markets around the world. What factors are needed to make its future brighter, especially in Asia?

Chris Tobias, National Environment Agency

Recent years have witnessed unprecedented growth in solar technology and other renewables, resulting in an evolution in energy markets. Analysts, policymakers and financiers are struggling with the rapid shifts underway.

In Asia, "Solar's regional historic boom and bust cycles are smoothing out and becoming more stable due to increased global adoption of it," says Steve O'Neil, CEO of REC. "Solar PV is becoming economically viable and competitive without the need for government subsidies. But the industry must be prepared to expand much more and much faster going forward, to improve efficiency, quality, and reliability of products."

Technology-wise, there have been vast improvements in solar. For instance, Eicke Weber of Fraunhofer ISE notes that in silicon PV, efficiencies of 30 per cent or more are now possible. He also believes that perovskite solar—a new, cheap light harvesting material—is the future and will someday reach similar efficiency levels as silicon.

In general, though there is much work yet to be done, many energy industry leaders agree that many of the necessary solar technologies are already available and that renewables will play the most important role in energy for the foreseeable future.

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Need to advance policy support

What is needed now are better enablers in terms of policy to support development and integration, and finance to ensure that new solar projects can continue to be implemented. This is especially true across Asia to help overcome many complex regulatory, transmission, geographic, and environmental challenges that exist to solar projects.

For instance, Thomas Reidl, Deputy Chief Executive at SERIS, believes that 2.5GW of solar deployment per month is possible with the right regulatory and policy frameworks in place for a leading solar market like China. Elsewhere in the region, other growth markets exist like Thailand, Malaysia, Philippines and Indonesia. Thailand and Vietnam have good support for solar development, according to Allard Nooy of InfraCo. In Thailand, Malaysia, and Philippines, renewables are already out-competing coal, according to Bloomberg's Justin Wu.

But Mr Wu notes that in many countries, industry trends are still moving faster than many government expectations, subsidies and targets can keep up. Sembcorp's Head of Renewables, Sunil Gupta, observes that the presence and continuity of subsidies can create enormous changes in a market, as well as in the involvement of solar industry players, and in the type of projects that ultimately materialise.

> In many parts of the world, experts see great promise both in floating solar on reservoirs or lakes, and offshore where conditions are calm enough.

Challenges in financing

From a finance perspective, Bloomberg projects that energy needs worldwide will require US$10.2 trillion in investments by 2040 and the bulk of it will be spent in Asia, with 86 per cent likely to be on renewables. Unfortunately, unlocking finance proves a tricky feat for many solar developers.

Sunseap's Founder and Director Lawrence Wu notes that many financiers like banks consider solar riskier than the more familiar fossil fuel-based projects.

For instance, solar projects may be deemed too small, have unconventional business models, or lack government backing, and are therefore viewed as less bankable. As Patrick Jaeger, Vice-President at Conergy puts it, "There is plenty of liquidity in finance for solar, just not enough good projects."

Progress with banks may be inching along, but NGOs are increasingly calling for improvements in lending practices, and for banks to adopt the Equator Principles to guide their due diligence practices.

In some instances, however, Mr Wu has witnessed insurers emerge as less conventional sources of finance, bypassing banks and working directly with developers of solar projects.

Role of digitalisation

Beyond policy and finance, there is enormous interest in how solar energy is integrated into the grid. Part of integration involves digitisation and better data management.

"Solar is first and foremost a technology, not a commodity like oil and gas," says Envision Group CEO Lei Zhang. As a result, the way it is looked at from an energy point of view is fundamentally different.

Mr Zhang highlighted that renewable technologies like solar PV has become more cost competitive vis a vis conventional

02

energy sources. This will contribute to increasing demand for solar and energy democracy will flourish from the bottom up as better choices in energy sources begin to surface. As companies and consumers begin to utilise other energy sources like solar, conventional market structures and players will inevitably fragment and lose some of their control. With this fragmentation and progression, previous systems and structures for managing energy will become less relevant and suitable, especially for intermittent renewable sources.

He believes that in order to better integrate renewable technologies like solar, stabilise grids and minimise fluctuations, optimise its function, and store its energy, digitalisation is required to handle these complexities. In fact, artificial intelligence and IOT platforms in the near future may play a big role in helping this to take place, but will need appropriate security precautions.

New solar applications

Singapore, for example, is aiming to utilise more "urban solar" technologies—the use of building integrated PVs, the scaling up of micro-grids and distributed generation of renewable energy, the test-bedding of floating solar PV installations, movable installations on vacant land parcels, new energy storage sites, as well as enhancements to its smart grid are all in progress. These support a 1GW peak solar target by 2025 that the city-state has recently adopted.

In many parts of the world, experts see great promise both in floating solar on reservoirs or lakes, and offshore where conditions are calm enough. "In man-made reservoirs alone, there is a 1TW opportunity for floating solar worldwide," says SERIS' Reidl.

Places like Indonesia, with many isolated islands have an urgent need for micro-grids to help improve accessibility for some 30 million people still living without energy. According to Fazil Alfitri, President Director of PT Medco Power in Indonesia, special hybrid systems coupling solar panels, batteries, and diesel gensets are currently being tested as a possible solution.

Elsewhere, grid scale battery storage in Australia is advancing in tandem with renewables development, with the help of major industry players like Tesla.

Applications like these provide new avenues that will continue to evolve, and the future of energy is poised to be an exciting one.

01 ACES 2017–Clean Energy Leaders' Dialogue.
02 Singapore has set a 1GW peak solar target by 2025.

A different world by 2030

In general, global energy use is expected to peak by 2030, in part empowered by energy efficiency measures, according to the World Energy Council. Furthermore, due to a global surge in renewables and increasing electrification of energy needs for the first time in human history, DNV GL notes that a decoupling between energy-related CO_2 emissions and economic growth is imminent in the coming years.

In this context, Fraunhofer ISE's Mr Weber believes that solar's advancement is unstoppable. "We're now in an embryonic stage, but will be heading to terawatt range [for solar] by 2030. But the real question now is–will it help [prevent] the 2°C climate change scenarios from unfolding and unseat the established [fossil fuel energy] players fast enough?"

Insights from this article were shared at the latest Asia Clean Energy Summit.

Asia Pacific Outlook for Energy and Environment

Take a look at what is happening regionally in 2018 and beyond, courtesy of Frost & Sullivan

Trend 1 - Is it the beginning of an end for coal power in Asia as investments dwindle second year in a row?

Mounting challenges to get coal-fired power plants off the ground is a strong indication that coal is losing its sheen.

India

Increasingly, coal is not being favoured in India as the country is keen to meet its emission targets and renewable power becomes cost competitive. Indian coal power market is likely to witness very low growth as many of the existing power plants that cannot be modernized will be shut down.

Indonesia

The coal-centric 35GW power generation program faces setbacks due to delays and cancellations to coal projects affecting investments in this market.

China

China's energy regulator has ordered 11 provinces to stop more than 100 coal-fired power projects. These projects are in the planning and initial under-construction stage with a combined installed capacity of more than 100GW. This is its latest dramatic step to curb the use of fossil fuels and cap coal power generation at 1,100GW by 2020.

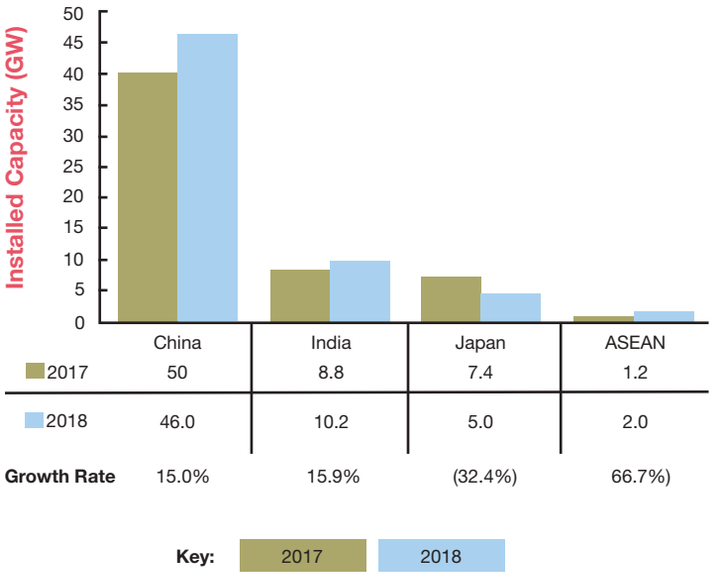
Vietnam

Three new coal-fired power plants with a combined capacity of 3,720MW, entailing an investment of US$7.5 billion, have been approved for construction in 2018.

Trend 2 - Distributed projects will be the growth driver for solar in Asia

Solar PV capacity growth will be above 10 per cent in 2018

Annual Installations in Solar Power Plant, APAC, 2017 and 2018 (projected)



Key Markets

China

India

China: In July 2017, China has already surpassed its 13th Five-Year Plan (2016-2020) target of 105GW solar installations. During the first half of 2017, the country added a massive 24.4GW of PV capacity alone.

Japan: The solar power market in Japan moves from large utility-scale installation to rooftop solar installations. Cut in Feed in Tariff rates leads to a drop in large-scale solar PV installations in 2018.

ASEAN: Phillipines, Singapore and Malaysia will be the key markets in 2018. For the first time, Indonesia and Vietnam will witness solar power capacity building efforts in 2018.

India: Uncertainty surrounding GST rate is likely to cause a slow-down in tenders and auctions. Record low solar prices (US$0.04/kWh) in India during reverse auctions create a very high risk of making the industry unsustainable in the long run. Hence, annual market growth rate is expected to fall significantly from 165 per cent in 2017 to 15.9 per cent in 2018.

Trend 3 - Singapore energy sector–issues to watch out in 2018

POWER

- Impact of carbon tax on electricity markets and wider economy–incentivizing energy efficiency improvements through tax collected, and more.
- Minimum energy performance standards (MEPS) for motors in Singapore will be introduced at Premium level in October 2018.
- Singapore-based banks and companies, will face increased scrutiny for any further investment in coal-fired projects in the region.

ENERGY

- Initiatives to raise consumer awareness on retail competition; options available with innovative product bundling.
- Switch rates in the pilot roll out of Open Electricity Market; expansion of demand response programs.
- Progress of utility scale energy storage test beds by Red Dot Power and CW Group.
- Further push for urban solar–building integrated PV, temporary movable PV plants and floating offshore solar generators.
- Power generators continue to be impacted due to over capacity of electricity and gas, carbon tax and competition.

Well-Grounded

The Science Based Targets initiative provides a useful framework for businesses to take on emissions reductions. How has it been working out for Singtel?

01

In October 2017, Singtel became the first company in Asia (ex-Japan) to have its 2030 carbon reduction targets approved and aligned with the Science Based Targets initiative (SBTi). The SBTi is a collaboration between CDP, World Resources Institute, World Wide Fund for Nature and the UN Global Compact that aims to recognise organisations complying with the Paris Agreement to keep the rise in global temperature below 2°C compared to pre-industrial temperatures, as described in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5).

ENVISION connects with Andrew Buay, Vice President of Group Sustainability at Singtel, on the background to their carbon targets, progress, challenges and opportunities, regarding the topic of carbon reduction.

Q: What efforts have been undertaken by Singtel so far to reduce energy consumption and tackle carbon emissions?

AB: Climate change has been a global issue, and is deeply anchored in the Singtel Group's environmental sustainability strategy to leave "the smallest footprint". Our strategy is built around the four pillars of climate change and carbon reduction, sustainable supply chain management, product stewardship and stakeholder engagement.

While our telecom and ICT services enable our customers to improve efficiency and help reduce their carbon footprint, our energy footprint continues to grow as consumers and enterprises use more data on our networks, or as enterprises increasingly outsource their ICT services to us.

Our industry's main unit of production is Terabyte (TB) capacity. In 2016, we set an initial target to reduce our carbon emissions intensity of kWh/TB by 30 per cent by 2020 and 50 per cent by 2030 using 2015 as baseline. We have undertaken a number of initiatives to ensure that we are conscientiously improving our energy intensity, such as constantly upgrading our networks to more energy efficient mobile technologies and cyclical replacement of chillers for our facilities and data centres. We have also implemented new lighting systems, and built new data centres to the latest energy efficient standards and technologies.

As of 31 March 2017, 98.8 per cent of all our base stations in Singapore are already "green" base stations, and this upgrade continues. Over the next three to five years, for instance, we will be replacing 33 units of aging chillers and related Mechanical and Engineering (M&E) equipment located at our exchanges and office buildings. This latter exercise alone will be reducing our carbon footprint by 3,725 tCO_2e per year.

Our latest data centre, Singtel DC West (launched in early 2017) was awarded the BCA-IDA Green Mark Award (Platinum), under which a building is rated based on criteria such as energy and water efficiency as well as environmental protection.

Measures like these, among many others, have enabled us to deliver better electricity and carbon efficiency on our networks, leading to a 49 per cent improvement on energy intensity to date. This is well ahead of our original target to reduce our carbon emission intensity of kWh/TB by 50 per cent by 2030.

Q: Why has the company chosen to pursue SBTi?

AB: In spite of all these efforts, the reality is that we were running very hard just to level


Singtel

03

out our energy consumption and carbon emission, not yet to reduce it. A greater concern was that the growth of our business projected an ongoing increase in electricity consumption and carbon emissions leading up to 2030. Hence we were looking for a new way to "reset" our carbon reduction target, even as we were significantly improving our energy intensity.

The SBTi framework and methodology has provided us with a 'top-down' approach to develop our aspirational targets and guide the business strategy going forward—one that was in line with the international agenda to keep the global temperature increase to below 2°C.

The SBTi's methodology begins with identifying what global carbon reductions are needed in order to come below 2°C, and these absolute reductions are "allocated" by sector supply chains, (for example, the telecommunications sector, comprising the electronics and construction sectors) as well as by country.

The latter also factors in current and future carbon coefficients of power generation in a particular country. For example, Optus, our subsidiary in Australia, takes into account that today's energy is mainly derived from coal power generation which has a higher carbon coefficient compared to Singapore, which uses mainly natural gas for power generation.

For a company like ours, the SBTi framework and methodology has been quite helpful in providing us a basis for setting up and carrying through targets that are related to our business and areas of operation.

We will also need to explore a greater scale of direct renewable energy deployment in our infrastructure or larger scale projects, wherever available and economically viable–not just in Singapore, but also in Australia.

Q: What targets did Singtel set?

AB: The Singtel Group aims to cut our absolute Scope 1 and 2 direct and indirect carbon emissions across our Singapore and Australian operations by 42 per cent from the 2015 base-year by 2030—after factoring in further organic business growth. If we take our peak carbon levels in the future, the reduction should be even greater. We will also be working with our suppliers to reduce Scope 3 third-party emissions by 30 per cent over the same period.

Our scope 3 carbon reduction is complex, but also a significant measure. In 2016, we undertook a Life Cycle Assessment of our value chain and identified that 60 per cent of the Group's carbon footprint was in our supply chain. As our mobile and ICT networks expand to support increasing data usage and improve coverage and reliability, both Singtel and the supply chain face the common industry challenge of decoupling our carbon footprint from business growth.

Q: What more will be done going forward?

AB: Many of the energy and operational efficiencies mentioned above will continue to develop, as they are not one-off exercises but part of our ongoing investment in networks, infrastructure and operating systems. However, we need to work progressively and extensively with our major vendors on their own carbon footprint in their supply chain, in order to effect quantum reduction.

In particular, we will have to work closely with energy providers and the authorities, especially due to the dependency on the supply side, for some of the reductions on the renewable energy roadmap. Lastly, we will also need to explore a greater scale of direct renewable energy deployment in our infrastructure or larger scale projects, wherever available and economically viable—not just in Singapore, but also in Australia.

01 Singtel has upgraded 98.8 per cent of its base stations to more efficient technologies.
02 Singtel Comcentre building.
03 There is an ongoing challenge in the telco industry to improve energy efficiency amidst increasing data use and network expansion.

Q: What leadership benchmarks did Singtel achieve with regard to its climate-related initiatives?

AB: We are honoured that our efforts in the area of climate change and carbon reduction have been recognised locally and regionally. Singtel is among one of four companies in the Hong Kong and South-east Asia region, and one of two companies in Singapore to have attained an A- in the "Leadership level" score for CDP 2017, a global environmental disclosure system that recognises companies for their achievements in combating climate change. We have also recently been awarded Asia's Best Carbon Disclosure at the Asia Sustainability Reporting Awards 2017.

Additionally, Singtel is one of the first companies globally to endorse the Task Force on Climate-related Financial Disclosures (TCFD) recommendations on voluntary disclosures around climate-related risks and opportunities when it was first released in 2017. The TCFD's recommendations will help secure more complete, meaningful, reliable and consistent data across all companies and sectors for climate-related financial disclosures.

Q: How can others learn from your experience?

AB: The reality is that it took us several years of progressive work to achieve the recognitions and accolades that have just been outlined, and to be in a state ready to move toward SBTi and TCFD. Yet, we are still only at the beginning of our journey. Many corporate counterparts have shared with us that they too are struggling with the climate agenda and these rapid developments in the industry, both in terms of regulations and reporting.

That said, we have committed 2018 to contribute by cross-sharing, guiding and collaborating with both private and government organisations in terms of climate and carbon action. The plan is to do so through business roundtables, forums and conferences, and also to connect with interdependent agencies and other partners involved in the climate change agenda. Through the Global Compact Network Singapore's Sustainability Professionals Programme, we will also be augmenting their training programme with sharing and discussions, alongside various sustainability professionals in Singapore.

Singtel hopes that every company takes the Year of Climate Action seriously because of the cumulative impact that everyone has on global climate change. Every company can start somewhere, and progressively build up their strategy and plans over time.

Scoping Emissions

- Scope 1:
  All direct GHG emissions
- Scope 2:
  Indirect GHG emissions from consumption of purchased electricity, heat or steam
- Scope 3:
  Other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities not covered in Scope 2, outsourced activities, waste disposal, and more

What are STBi companies doing?

341 companies are taking science-based climate action and 90 companies have approved science-based targets.

Global	
Total companies taking action	341
Committed	251
Targets set	90

Asia	
Total companies taking action	79
Committed	62
Targets set	17

Telecommunication sector	
Total companies taking action	14
Committed	7
Targets set	7

Asia Region	Total	Committed	Targets set
Japan	47	33	14
Singapore	3	2	1 (Oct-17)
Hong Kong	3	2	1 (Nov-17)
Taiwan	8	7	1 (Dec-17)
China	2	2	0
India	6	6	0
Pakistan	1	1	0
South Korea	3	3	0
Thailand	1	1	0
Turkey	5	5	0

Telecommunication sector	Total	Committed	Targets set
Europe	8	3	5
Asia	4	3	1 (Singapore)
North America	1	0	1
Africa	1	1	1

Source: http://sciencebasedtargets.org/companies-taking-action/ (as of 12 February 2018)

Command and Control

Manufacturing is taking a bold step into the future with new technology–what operational, financial and environmental improvements are possible?

Chris Tobias, National Environment Agency

Industry 4.0 technologies—like sensors and robotics—are revolutionising manufacturing, and the future of factories is poised to move towards exciting new directions (see *ENVISION* Issue 13). A wide variety of innovations are available to connect and control factories like never before.

In Singapore, the A*STAR SIMTech Model Factory provides a tantalising glimpse into the many options available to manufacturers via its Manufacturing Control Tower (MCT) platform. The Model Factory is a demonstration site allowing companies to experience and experiment with advanced manufacturing technologies, and to test-bed and jointly develop innovative solutions. Behind the automated machines, slick technology and touch screens however, what are the operational, financial and environmental benefits of using this technology?

Modern manufacturing

Factories around the world are inching towards more modern and advanced processes to help them run more efficiently, with less downtime, and with decreased energy usage and material wastage. However, there is still a long way to go.

In many facilities, most commonly among SMEs, the shop floor may still run on outdated,

manual, or even paper-based systems. These are manpower-heavy processes to run, with machines prone to breakdown, and can be challenging to manage in a coordinated fashion.

Not only that, tracking what is produced, how it is shipped and received, and how it meets client expectations are separate and somewhat disconnected functions for an enterprise to manage. This can result in inventory imbalances, late shipments, obsolete products, and loss of business.

Fortunately, a better option exists–using some 15 different technological interventions, the MCT platform connects the shop floor, enterprise functions, and the supply chain. It uses sensors, wireless technology, automation, and analytics to make this happen in new and seamless ways.

Operational benefits

Almost in an instant, information across operations are now visible and can be used to better inform decision making. Dashboards and tablets keep managers connected to different functions, providing a "pervasive nerve centre" view of the business.

Data from different processes can be viewed and analysed, both in terms of aggregated and real-time applications. For example, status of machines, energy and material efficiency, OEE, availability, performance and quality can all be managed from the shop floor.

At the enterprise level, sales and work order data is readily available and visible, while processes can be tracked and optimised at various stages. Inventory can be carefully planned and managed, jobs and manpower can be readily scheduled, and lean processes and packaging can be handled digitally in lieu of cumbersome paper-based approaches.

In terms of the supply chain, orders can be optimised for delivery and tracked right up to the point they are delivered, while customer sentiment analysis can also be monitored, either through company-owned channels, or even via a customer's social media.

Since these processes all have the capacity to become interconnected and visible, quick decisions can be made on the go, and improvements can be realised more quickly. This results in greater efficiency, up-time, and financial profitability.

01

Environmental performance

While all of these translate to great news from the business point of view, in terms of environmental performance—that companies are increasingly being held to account for and to report on to a wide range of stakeholders—how can MCT technology derive benefits?

There are several key areas identified that could prove environmentally beneficial for businesses implementing MCT technology. In terms of supply chain, utilising this new technology could yield improvements especially with regards to how fleets are managed.

Being constantly on the move, delivery vehicles can be a significant source of air pollution in an urban environment. Thankfully, using supply chain and mapping tools, delivery routes can be carefully planned and vehicle loads optimised. This can mean fewer trips, more efficient fuel economy for delivery vehicles, and less air pollution generated on their way to customers.

On the shop floor, in terms of smart waste management, each workstation can be monitored for the waste it generates, both in terms of the weight of the waste, but also the total cost of the materials. This will allow processes to be improved, and opportunities for waste to be designed out of manufacturing where possible.

Furthermore, as receptacles get filled up, sensors can generate notification for waste collection. This could consequently prompt a compilation of waste materials for recycling or reuse by other companies embracing circular economy business models. As an added benefit, automated waste reports can be compiled and generated.

From the smart energy management point of view, real-time monitoring and analysis of machine and energy performance is also possible. Energy can be measured in terms of value-added and non-value added activities, and performance can be measured in terms of kWh of energy used, as well as the costs to the business. This can allow a manufacturing business to identify historical best practices to learn from and improve energy efficiency over time—energy reports can likewise be generated for use.

Therefore, beyond mere operational or financial benefits, MCT technology can also help a company improve their environmental performance and make data tracking simpler to manage.

Overall gains

For manufacturing businesses embracing MCT technology, SIMTech Model Factory estimates that improvements like a 30 per cent increase in productivity for local companies can be achieved through more effective asset utilistation with this technology.

Several businesses, including local precison engineering enterprise, CKE Manufacturing, have already estimated a 50 per cent improvement in manpower deployment.

It seems that manufacturers have a great opportunity to improve both their operational, financial, and environmental performance by using technologies like these.

01 MCT technology allows tracking of production floor activities like never before.
02 Delivery routes can be planned and optimised, and specific deliveries carefully tracked from factory to customer.

02

How can these technologies help stop climate change and how can manufacturers get going? *ENVISION* reaches out to SIMTech Model Factory's *Dr Tan Puay Siew* for insights.

Q: How can Industry 4.0 technologies and more efficient manufacturing help solve climate change?

PS: Through technology, manufacturing can be more sustainable. Examples include being more efficient in energy usage and promoting more reuse of resources through better waste-resource management.

Q: Of the companies that visit the Model Factory, what are some of the typical technologies choosen to implement, and why?

PS: Different companies have different needs; though many start with our standardised ready-to-go (RTG) packages. Some examples of RTG packages are the Mobile Workflow for workforce on-the-go, to perform user-configurable business operational transactions using Android devices. Shop-floor Equipment Monitoring is an integrated software to provide real-time machine status, overall equipment effectiveness (OEE) and fast response to deteriorating machine condition, to provide visibility and early warning. Real Time Dashboard is customised to suit company needs and to connect to multiple sources for congregation and analysis of real-time data. That said, some companies require more customised solutions, whereas others require help in their digital transformation journey.

Q: How would a manufacturing business get started using these technologies, and what might a typical implementation pathway look like across five years?

PS: For companies looking to start a journey, we have a Digital Transformation Programme that we will be rolling out soon. For those who have not visited the Model Factory @SIMTech, please do visit us.

More information is available at *https://bit.ly/2mvJhrj*

Q: What sort of typical ROI or payback period can companies experience?

PS: This is highly implementation dependent. Nonetheless, our standardised RTG packages payback period is considerably shorter as these are very cost-effective solutions.

Q: What are some of the quantifiable environmental benefits derived from using these approaches?

PS: Like all technologies rolled out through SIMTech, we target for at least 20 per cent improvement, though the improvements are typically better.

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Into the Cool Future

How can a novel approach to air conditioning chill, while improving environmental performance?

Chua Kian Jon Ernest, Associate Professor, Department of Mechanical Engineering, National University of Singapore

01

Air conditioning, once dubbed the most important invention of the 20th Century, is a necessity in many parts of the world. In the tropics, the need for both cooling and dehumidification of air is particularly acute in order to facilitate a number of human and industrial functions.

The conventional aircon process is environmentally damaging in a number of ways. It is energy intensive to operate, and can increase greenhouse gas emissions that have a negative impact on climate change. The use of coolant substances like CFCs and HCFCs are damaging to the ozone layer if system leaks take place. Heat expelled to the local environment can negatively affect the surrounding microclimate, impacting human and natural functions taking place outside buildings.

Taking a thermo-engineering approach, a new process that values heat as a useful form of energy was created, and the aircon system was redesigned from the ground up. A revolutionary alternative to conventional aircon systems is now available.

First, an innovative hydrophilic membrane technology was developed to remove moisture from humid outdoor air as it is blown across. The captured moisture from this process can be condensed into potable water. A small amount of working air that is near the exterior temperature is discharged at this stage. The dehumidified air is then blown along multiple-passes of a water-based, indirect evaporative cooler. Once through this process, the cool, dry air can then be used inside building environments.

The prototype now available can cool air down to 18°C, maintaining 10 to 12g of moisture in the air, and an achievable COP of 8 to 12. Using the system to produce 12,000BTU of cooling in a standard residential apartment-sized room for 20 hours of continuous operation requires the potential energy from 1L of water, while producing 12 to 15L of potable water from its operation. In water-scarce environments like Singapore, this is a useful byproduct.

By limiting the need for mechanical components required to perform cooling through this new approach, the energy consumption can be reduced by 40 per cent when compared with conventional air conditioning systems. There is no need for coolants, so the related ozone concerns become obsolete. Air expelled to the external environment is not much different than ambient temperature, thereby having minimal effect on the nearby locality.

Work is currently underway to refine this prototype system's performance and to further decrease its size for residential application but already, interest from the media, research industry and governmental sectors has been significant. Many are realising the potential of this new technology—its adoption and advancement in the coming years could deliver conditioned air for those living in hot climates while cutting greenhouse gas emissions to tackle climate change. Here's to a cool future!

To learn more about the details of this technology, please source the following papers:

- A thermodynamic perspective to study energy performance of vacuum-based membrane dehumidification
- Evaluation of a dehumidifier with adsorbent coated heat exchangers for tropical climate operations
- Experimental and modelling analysis of membrane-based air dehumidification
- Experimental investigation of a mechanical vapour compression chiller at elevated chilled water temperatures
- Water vapour permeation and dehumidification performance of poly (vinylalcohol)/lithium chloride composite membranes

01 Current air-conditioning technologies are a necessity for hot tropical climates, but are often energy intensive.
02-03 Lab-scale prototype of Hybrid Membrane–Evaporative Water-Based Cooling.

Figure 1 - A decoupled dehumidification and cooling process to reach thermal comfort conditions

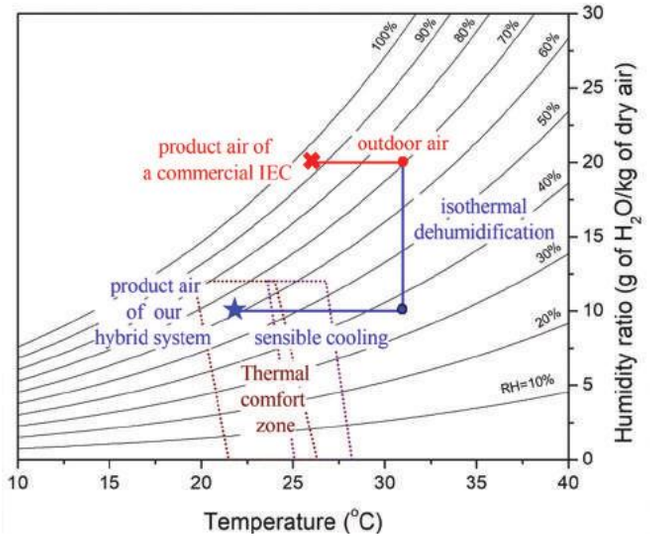
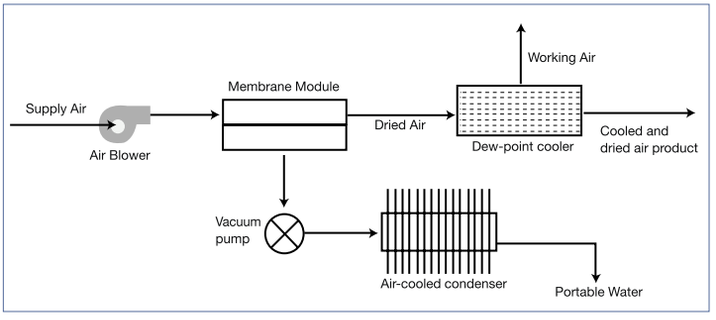
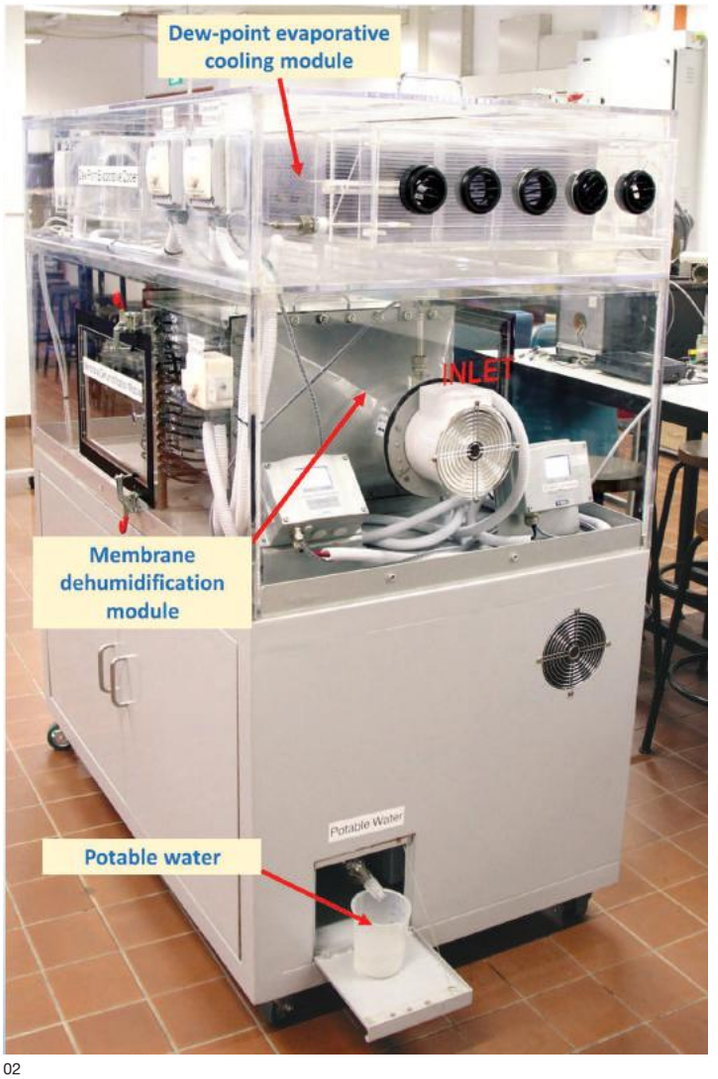


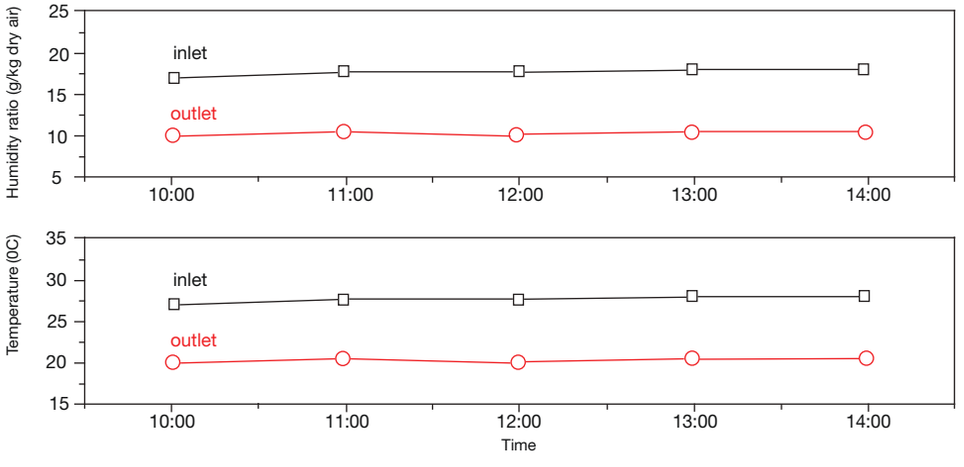
Figure 2 - Schematic diagram of Hybrid Membrane–Evaporative Water-Based Cooling





02

Inlet Air Conditions		Outlet Air Conditions	
Temp. (deg C)	Abs Humi. (g/kg d.a.)	Temp. (deg C)	Abs Humi. (g/kg d.a.)
30-32	18-22	22-24	10-12



03

The Growing Menace

Climate change and food-borne diseases may seem like unlikely allies, but the connections are clear and the implications are eye-opening. What needs to be done to protect public health?

Ramona Gutierrez and
Associate Professor Ng Lee Ching,
National Environment Agency

01

Most people are well aware of the effects of climate change on global or local food production. Weather events have an obvious impact on agriculture and fisheries, and food security and global hunger are issues that reside highly on the global agenda.

Interestingly, the impact of climate change on the safety of food produced has not gained as much attention. The distribution and load of disease-causing human pathogens in food are influenced by environmental and climatic factors at all stages of the food chain. The conversation on food security ensures access not just to food, but to safe food, and the threat of climate change can have enormous impacts on both aspects.

At the micro level

Oceanic ecosystems are subject to changes in temperature, changes in pH caused by increased carbon dioxide concentrations, changes in salinity caused by changes in precipitation, as well as exposure to storms, cyclones and other extreme weather events. As a result, micro-organisms in water are also affected by climate change. All these physical changes have been shown to affect aquatic animal and microbial communities. These events could ultimately lead to food safety and public health threats, especially when human pathogens are involved. *Vibrio* is a notorious example of a bacteria, pathogenic to humans, that thrives in warm seawater with low salinity. With the insurgence of global warming, instances of human *Vibrio* illnesses have been growing, expanding to regions with no previously recorded cases. For example, in 2014, an emergence of *Vibrio* human infections in Sweden and Finland, at unusually high latitudes for these bacteria, was linked to an extreme heatwave in the Baltic Sea.

Aside from those related to aquatic ecosystems, several food-borne diseases have also been associated with various weather variables. For instance, human campylobacteriosis have displayed strong seasonality in Europe, with peak transmissions over the summer months. *Campylobacter* typically resides in the guts of warm-blooded animals, with poultry being a major reservoir. Several studies have described increased *Campylobacter* prevalence in poultry flocks in the summer months too, with warmer temperatures and heavy rainfalls often being associated with these increases.

Campylobacter's thermophilic nature (that is, it only grows at 30°C and above) and its sensitivity to drying, as well as other factors such as changes in husbandry

01 *Vibrio* is a notorious example of a bacteria, pathogenic to humans.
02 Group B *Streptococcus* (GBS) can be spread through certain seafood dishes, as a recent case in Singapore showed.

02

practices and human food consumption habits during the summer months, may all be possible contributors to the seasonality of Human Campylobacteriosis.

The outbreak

One local example would be the 2015 food-borne Group B *Streptococcus* (GBS) outbreak in Singapore. GBS bacterial infection in humans, or in fish, is nothing new; the transmission of GBS from fish to humans through food, however, was unexpected then. Indeed, this was the first human GBS outbreak ever reported as transmitted through consumption of food–namely through a Chinese raw fish dish (*yusheng*).

As of today, it remains unclear what exactly triggered the GBS outbreak: where did that particular outbreak bacterial strain come from? Why did it transmit through food? How did it cause such a severe infection in humans? Understandably, attributing these concerns immediately to climate change-associated extreme weather events could seem a little far-fetched.

The climate connection

Or is it? The years 2015 to 2016 were marked by a strong El Niño event that lasted from mid-2015 through mid-2016, witnessing to a total of seven records for the warmest calendar month either broken or tied in Singapore. Several studies have documented the impact of environmental changes on aquatic diseases.

Higher temperatures for instance can affect fish immunity and pathogens' virulence, leading to faster transmission and higher pathogenicity and rendering fish more susceptible to infections. A local team of researchers from Temasek Life Sciences Laboratory has demonstrated these observations on Tilapia infected with GBS at different temperatures, with warmer temperatures leading to more severe outcomes.

The impact of weather on different pathogens is a complex interplay of variables, and the underlying mechanisms are poorly understood. That said, climate change is bringing new challenges to the management of food safety and public health. Pathogens themselves are evolving to adapt to this changing environment, while new strains and new routes of transmission are emerging. Food-borne diseases are, undoubtedly, quickly evolving.

The right approach

In these conditions, with the limited understanding currently available on the extent of the impact of climate change on food safety, predicting the next big threat to food safety is nearly impossible. Yet, there is a need to prepare communities ourselves for the next eventuality.

Climate change is bringing new challenges to the management of food safety and public health.

Intersectoral coordination between public health, veterinary, food safety and environmental health services, known as the One Health framework, is the central element for preparedness and adaptation to climate change. Robust cross-sectoral risk assessment, research and surveillance programmes are needed for early detection and mitigation of emergences, or shifts in trends.

The Singapore GBS outbreak in 2015 is a clear example of how strong ties between animal, human and environmental health were key in curbing the outbreak, especially when facing the unexpected. As new food safety challenges loom overhead, continous efforts must be put into strengthening and nurturing these ties, so as to ensure a prompt and coordinated response to future incidents.

Feeling the Heat

Rising temperatures and climate variability may increase the instances and spread of vector-borne diseases. What will help meet this unfolding challenge?

Grace Yap and
Associate Professor Ng Lee Ching,
National Environment Agency

Ongoing trends of increasing temperature and variable weather patterns contribute to favourable conditions for mosquitoes to thrive. This presents new uncertainties about the transmission risks of vector-borne diseases. Scientists have long expressed concerns for diseases such as West Nile, chikungunya, dengue fever and Zika. Based on the World Health Organization's (WHO) latest estimates, over half of the world's population is at risk for these vector-borne diseases.

The tropical regions in South East Asia, the Middle East, Africa, and South America provide suitable habitats for *Aedes Aegypti*, the main vector involved in many vector-borne disease transmissions. Climate variability can also influence the geographical expansion of vectors, as well as vector population dynamics by accelerating their life cycles and enhancing their capacity to carry infectious diseases.

Changes in inter-annual climate variability such as the El Niño Southern Oscillation have been shown to be important drivers for dengue, malaria and more recently, Zika transmission.

Climate variability and disease transmission

Changes in inter-annual climate variability such as the El Niño Southern Oscillation have been shown to be important drivers for dengue, malaria and more recently, Zika transmission. The first large outbreak of Zika was reported in 2007 on Yap Island. Subsequently in 2013, a major Zika epidemic occurred in French Polynesia, followed by transmission to neighbouring pacific islands.

Subsequently, Zika was introduced to other countries such as Australia, Italy, Norway, and Brazil, especially via travel. In 2015, an outbreak took off in Brazil, coinciding with what was then the hottest year in South America. According to US National Oceanic and Atmospheric Administration, El Niño brought extremely warm conditions to northern and eastern regions of South America. The Zika epidemic in Brazil then led to WHO declaring Zika as a major public health threat in 2016, and even Singapore was not spared.

The strong El Niño in 2015 effected high temperatures in the first half of 2016, with temperatures climbing well above the long-term average for the rest of the year. Unsurprisingly, a Zika outbreak with over 450 cases was also reported that same year.

Temperature and vector reproduction

Temperature is a well known modulator of epidemic growth rates of viruses like dengue and Zika. The relationship between temperature and the *Aedes* mosquitoes is complex and non-linear, likewise, the basic reproduction number of dengue, R_0—the average number of subsequent infections produced by an infected individual is known to behave differently at different temperatures.

In many studies, it has been demonstrated that while an increase in temperature can cause a steady rise in R_0 beyond peak temperature, which can range from 31 to 35°C, R_0 also decreases drastically due to rapidly increasing mosquito mortality. However, this does not mean that with the projected increase in temperature, tropical locales like Singapore will be spared.

Factors associated with the transmission of vector-borne diseases go beyond weather parameters. Environmental, entomological, virological and sociodemographic risk factors each play integral roles in disease transmission and should be taken into consideration, especially when it comes to studying the long term impact of climate change on vector-borne disease incidence. In the absence of effective vaccines for diseases like Zika, chikungunya and dengue, these studies are important for the development of climate change adaptation strategies.

Meeting the challenge

To this end, the NEA has been conscientious in exploring new ways to manage the spread of dengue and other mosquito-borne diseases. Interestingly, an adult mosquito surveillance system using Gravitraps was established in 2017, as part of an enhanced dengue control programme which includes risk-based pre-emptive checks where the inspection of these areas is targeted at locations with high *Aedes* mosquito populations. Reduction of mosquito population remains the core risk mitigation strategy. NEA is also conducting research on vector control tools such as the *Wolbachia* technology, to complement existing control measures.

Furthermore, climate change adds complexity and uncertainty to other mosquito-borne and zoonotic diseases that NEA is also monitoring, such as malaria, Japanese encephalitis and leptospirosis. A One Health approach among medical, veterinary and public health professionals to understand movement of these diseases through ecosystems is imperative for the understanding of the impact of climate change on environmental, animal and human health.

In 2008, WHO formulated a Regional Framework for Action to Protect Human Health from the Effects of Climate Change in the Asia Pacific Region. NEA's effort is consistent with WHO's call for countries to develop national strategies for incorporation into public health policies. Strategies like these will ultimately help meet the vector-borne illness challenges of the future that may be exacerbated by climate change.

Seeing the Forest and the Trees

Consumers and companies have a part to play in stopping problems like haze and climate change. How can eco-labels help?

Karen Ng, Singapore Environment Council

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As a small island city-state, Singapore is vulnerable to the effects of climate change. Rising sea levels and extreme weather events resulting from global warming have real and far-reaching implications.

Climate change is primarily due to an increase in greenhouse gases, such as carbon dioxide, in the atmosphere. A significant source of carbon emissions and an active contributor to global warming is land-use change, such as tropical deforestation. It is thus crucial to find ways to manage forests and tree resources properly and more efficiently, which can subsequently bring about an effective response for the mitigation of climate change.

The need for sustainable land use

Agroforestry refers to land-use systems in which trees are grown in association with agricultural crops, pastures, or livestock—consequently increasing the ability of the land to resist environmental challenges. Agriculture, forestry, and grazing are interlinked, and are affected by climate and other environmental pressures.

The overexploitation of natural resources as a result of an increasing demand for land, trees, and water has threatened the sustainability of the development of agriculture. Clearing of forests by burning, though a common technique used by farmers to clear land for new planting—for crops like palm oil or pulp and paper plantations–is a major source of carbon to the atmosphere. The damaging "slash and burn" method also reduces ecosystem integrity, triggers soil erosion, and leads to habitat destruction.

For close to two decades, transboundary haze pollution has affected ASEAN neighbouring countries, particularly Singapore and Malaysia. 2015 saw one of the worst haze crises on record, exposing 43 million people to particulates from wildfire smoke and costing Indonesia an estimated US$33.5 billion in economic costs.

At the heart of the issue lies poor peatland management. Plantation companies looking to plant on peat will first drain peatland, which is waterlogged. However, drained peat soil, which characterises much of the affected areas, is highly flammable, thereby causing localised fires to spread and making them difficult to stop. They can also burn and smoulder for prolonged periods, contributing significantly to the increase in carbon emissions.

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01 Deforestation for various kinds of agroforestry plantations is a serious environmental issue in Asia and elsewhere.
02 The Singapore Green Labelling Scheme has recently had enhanced measures introduced for pulp and paper products.

Sustainable sourcing through eco-labelling

Calling for consumers and companies to reduce the risk of another haze crisis and to reduce the carbon emissions caused by forest fires, the Singapore Environment Council launched the enhanced Singapore Green Labelling Scheme (SGLS) for pulp and paper products in January 2017. The enhanced measures feature strict requirements such as peatland protection and fire management.

The new scheme requires applicants to meet some of the world's toughest environmental standards. For instance, companies are required to map areas of high fire risk and invest in daily hotspot monitoring, training and firefighting equipment. As forest fires emit large amounts of greenhouse gases, apart from causing haze pollution, reducing fire risk will also significantly reduce the carbon footprint of these companies.

To achieve the enhanced SGLS certification, applicants undergo a thorough audit and evaluation of their entire production chain. Certified products are also subject to an annual audit as well as periodic ground surveillance to ensure compliance.

To date, products from three companies have successfully achieved the enhanced SGLS certification. Among these companies, UPM Specialty Papers APAC, part of the UPM Group, have achieved their certification in February 2018.

Mr Ian Hamilton, UPM's Area Sales Director for SEA welcomed the SGLS certification, expressing that the company is proud to make paper products that meet the highest standards of sustainable manufacturing.

"UPM's products are made from renewable, recyclable and biodegradable materials. We continuously work towards reducing the environmental footprint of our operations and products throughout the entire product lifecycle."

Hence, the enhanced SGLS provides clarity for consumers and proves the authenticity of a firm's environmental claims. By choosing SGLS-certified products, consumers are able to reward pulp and paper companies that practise sustainable land management, and play their part to eliminate environmental scourges like haze and climate change.

Knowing Your Eco-labels

The enhanced SGLS is one of more than 450 eco-labelling schemes in the world, each one focusing on different environmental aspects of a product or service. How do you know which ones to trust?

Look out for members of eco-labelling bodies like the Global Eco-Labelling Network (GEN) and International Social and Environmental Accreditation and Labelling (ISEAL) Alliance. Both GEN and ISEAL are non-profit membership-based organisations, which seek to improve and strengthen systems for eco-labelling and sustainability standards. Members need to undergo strict audit and member peer review processes, thus increasing their credibility.

Another indicator of a label's credibility is the recognition given by leading green building rating systems, such as the BCA Green Mark, Leadership in Energy and Environmental Design (LEED), and Building Research Establishment Environmental Assessment Method (BREEAM).

Useful Resources

To find out how you can have your products certified under the Singapore Green Labelling Scheme visit: *www.sgls.sec.org.sg*

Adding Up

Why a ground-up approach with a scale-up effect is needed to fight climate change

Darryl Teo, National Environment Agency

Former US President Barack Obama once commented that "there's one issue that will define the contours of this century more dramatically than any other, and that is the urgent and growing threat of a changing climate". This assessment rings ever more accurate–based on 2017 Global Climate Report, the annual average temperature record has been broken five times since the start of the 21st century, three of which were set from 2014 to 2016. In fact, shifts like these will ultimately alter life as we know it.

Climate change is real, and it requires the efforts of everyone–from scientists and industries, to the man on the street and policymakers–to collectively fight for a sustainable future. Unfortunately in the case of Singapore, the National Climate Change Secretariat's Climate Change Public Perception Survey in 2016 finds a third of respondents believed that their individual actions would not make a difference to climate change.

Effecting change at ground level

The reality is that every little action counts. As a case in point, take for instance the Health Promotion Board's National Steps Challenge, where each individual effort to take 10,000 steps a day collectively results in covering 6,400 million km a year. On its own, this is already equivalent to 0.13 megatonnes of carbon emissions abated, as compared to if this same distance were to be covered by public buses.

Similarly, if three simple energy conservation practices are widely adopted at home–namely switching off the main outlets when not in use, using thermal flasks instead of electric airpots, and running the air conditioner for just a short while, then switching to a fan later on–then each household can save up to S$665 a year. In other words, each household can save five to six per cent of the electricity bill. While modest for an individual household, collectively we can save 455GWh of electricity consumption or abate 190kT of carbon emission annually–equivalent to the removal of more than 58,000 cars off the roads! Now imagine what is possible across businesses and industries.

Efforts need not end at energy conservation. Greater social and economic impact would also be felt if we further adopt water conservation, waste reduction, and recycling practices as well. All these little actions, if taken together as a nation and sustained over time, has the capacity to yield an enormous impact.

A little goes a long way

As the story goes, an old man was strolling along a beach that was littered with thousands of starfish that had been washed ashore by the high tide. He chanced upon a young boy who was eagerly throwing the starfish back into the ocean, one by one.

Puzzled, the man asked the boy what he was doing. Without looking up from his task, the boy simply replied, "I'm saving these starfish, Sir". The old man commented aloud, "Son, there are thousands of starfish and only one of you. What difference can you make?" The boy picked up a starfish, gently tossed it into the water and turning to the man, said, "I made a difference to that one!"

We can all make a difference. The boy's action was driven by his love for the starfish. This motivated him to persevere in saving the starfish even when others may disregard the impact of his actions as insignificant. Let us love our environment and make it our responsibility to safeguard, nurture, and cherish it. Our efforts will show over time, eventually helping to meet the challenge of climate change.

Big Data for Climate Action

The paradox of citizen informedness

Kustini Lim-Wavde and Robert J. Kauffman,
School of Information Systems,
Singapore Management University

Advanced sensor technology, social media, and other information technologies have provided us with "big data" on climate change. Due to the World Meteorological Organization's Global Climate Observing System, climate observations and records, as well as discussions on climate-related concerns such as measurement of air temperature, are widely available now (Figure 1).

The United Nations' Global Pulse visualises public engagement on climate change globally, with data such as the volume of climate-related tweets (Figure 2). Big data, data analytics, and the sharing of scientific results in the popular press have created, as a result, an unprecedented level of citizen informedness—the degree to which citizens have the necessary information to make appropriate decisions to aid in the fight against climate change.

Information on climate change has become increasingly accessible for citizens over the past 10 years, through governmental information programs and reports, news and magazine articles, TV documentaries, and websites and blogs.

Yet citizen-level participation in climate change-related actions, rather paradoxically, has not gotten to the point where attention

has been galvanised, and there are few well-defined efforts that can be identified. This paradox is occurring in many places around the globe in spite of the availability of related "big data", especially in Europe and North America, and in countries that have the most sensitivity to climate change, for example, through the rising sea levels in coastal and island nations.

Hypothetically, Singapore is no exception to this paradox. Despite having been exposed to the undesirable effects of climate change, the mass of citizens ready to take action in concert with government organizations such as the Ministry for the Environment and Water Resources (MEWR), the National Environment Agency (NEA), along with other non-governmental organizations (NGOs) in Singapore has yet to reach a groundswell. Meanwhile, MEWR, NEA and the NGOs have been working concurrently to inform and ensure broad understanding of the need to act on climate change.

Symptoms of the paradox

Despite the unequivocal evidence that has been shared through leading scientific periodicals in recent years (including Science, Nature, Climatic Change, and Environmental Research Letters, among others), climate change is still viewed in many parts of the world as a subject of controversy, and debate as to whether it is true, false, or the scientific evidence has often been misinterpreted.

For instance, according to a survey conducted by researchers in the US from 2010 to 2015, more than half of the public has accepted that climate change is already happening. However, many remain unconvinced and constitute a "politically opposite minority" who believe that climate change is due to "natural causes." The persistence of such public opinion has been heavily influenced by political rhetoric and the predispositions of leading politicians and candidates running for office.

In addition to these conflicting information, another recent phenomenon, commonly known as "fake news," has been plaguing social media and influencing public opinion.

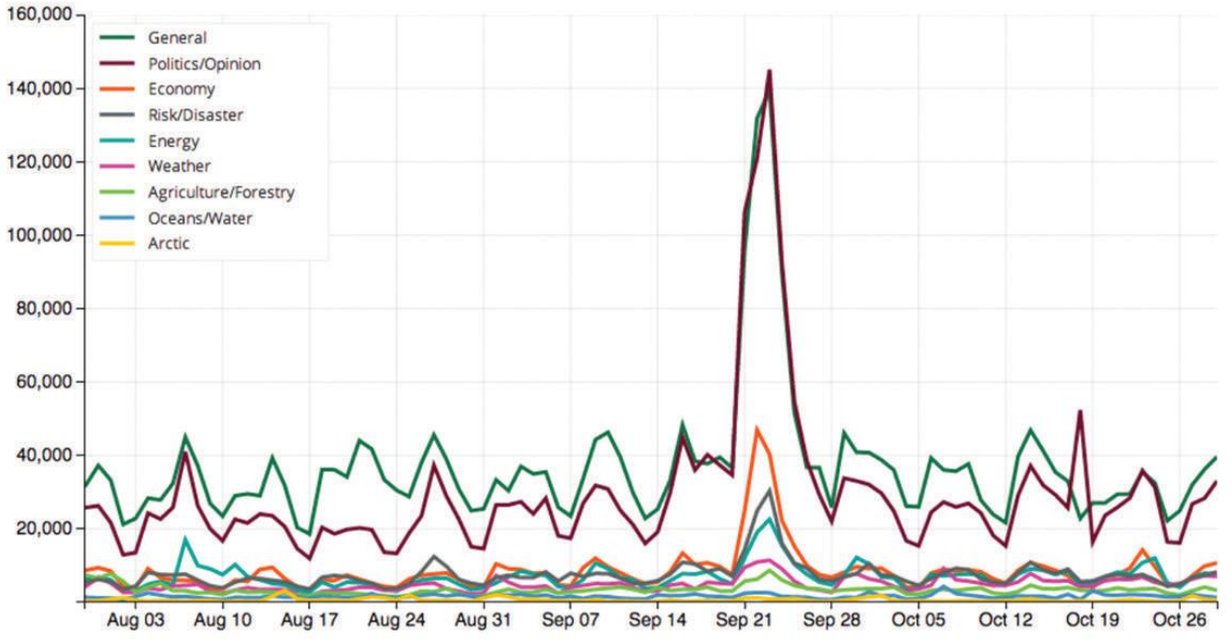
For example, a scientific article published in the Nature Geoscience journal in September 2017 discussed the temperature goals associated with Paris Climate Agreement, developed in association with the United Nations' Framework Convention on Climate Change. Unfortunately, the article was misrepresented in other media as a report on the technical fault and overestimation of the impact of carbon dioxide on the climate on the part of the scientists, and evidently misinformed many readers. Furthermore, as the story continued to circulate globally through social media, readers often fell short of verifying the information of the original article.

This demonstrates the potential for misinformation, or "fake news", to constitute the confusion of the information society. However, there have been few scientific or scholarly findings regarding the regulations required to address this issue.

Possible solutions

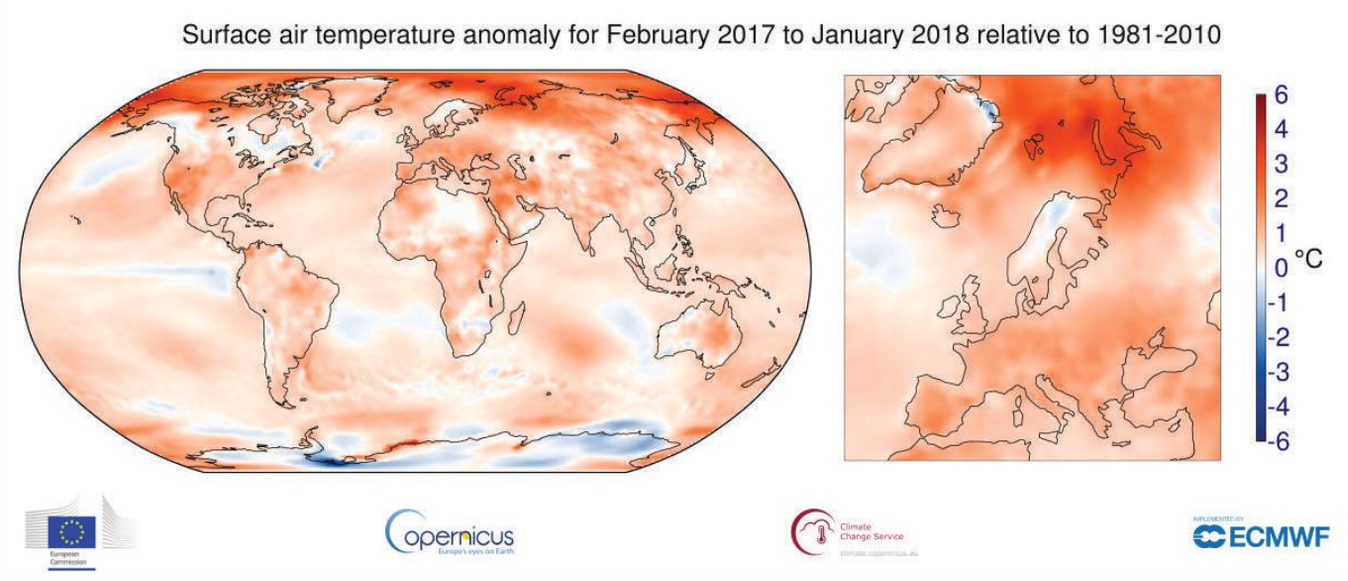
Researchers in the US have found that strengthening the foundation for climate literacy through education is the first crucial step to helping audiences overcome the

Figure 1 - Daily volume of tweets about climate change by sub-topic



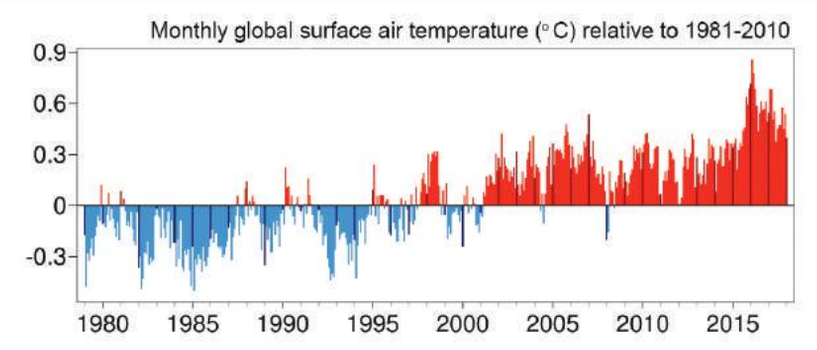
Source: U.N. Global Pulse. Results from the daily volume of tweets about climate change by sub-topic, in English, from April to November 2014–the spike observed in September occurred during the People's Climate March and the Climate Summit with the highest volume of tweets recorded on the sub-topic "Politics/Opinion."

Figure 2 - A GCOS essential climate variable



Source: Copernicus Climate Change Service. Measurements of air temperature demonstrate that the average temperature from February 2017 to January 2018 was well above average in the Arctic, the western USA, much of Europe and the Middle East, and offshore West Antarctica. The global temperature for January 2018 was well above average as well, and the warmest instance occurred in October 2015.

Figure 3 - A GCOS essential climate variable



Useful Resources

WMO Climate Change Observing System:
http://bit.ly/2p6yJ2f

UN Global Pulse:
http://bit.ly/2Gm0Str

MEWR'S Climate Action SG Pledge:
http://bit.ly/2Da0X1W

social residue of false news and information distortion. Additionally, a recent study involving semi-structured interviews in Singapore has shown that there is a considerable extent of misconception regarding climate change among Secondary 3, or Grade 9, students.

Studies have also highlighted the importance of bridging the gap between science and the society's understanding of climate change, through the implementation of systems-thinking approaches across interdisciplinary boundaries, where various social problems need to be addressed. There is ample opportunity today to transform climate, economic, and social data from trusted information sources into meaningful content through data science and visual analytics. While appealing to the audience's emotional and intuitive functions may be effective in the presentation of this information, studies have found it to be counter-productive as well as daunting and disheartening to the audience, thereby discouraging their ability to act.

Instead, policymakers should measure the uptake from their information programmes and policies in measures such as citizen informedness, providing a strong foundation for formulating effective strategies to create the most impact in terms of improving environmentally sustainable actions.

Ultimately, transforming information on climate change to prompt impactful actions requires a coordinated effort amongst individuals, organisations, and policymakers. Social media, mobile applications, and recent information technology innovations can aid in providing greater informedness to the citizens of a country in terms of what they are willing to commit to doing or have done thus far, thereby supporting the effort to deal with climate change, promoting urban sustainability, and understanding other environmental issues.

The MEWR's Climate Action SG Pledge is a good starting point for bringing people together to fight climate change in Singapore and the world. When citizens are informed about the actions that have been undertaken in their neighbourhoods and how they can participate, they are more likely to become involved and make a difference in achieving a critical mass of participation.

Floating Plastic, Hidden Danger

Marine plastics are silent, omnipresent, ever increasing, more toxic than previously thought, and they are making their way back into our consumption cycle. What needs to be done to fix this?

Neo Mei Lin, Yip Yong Jie and Samarth Bhargava, National University of Singapore

80 per cent of the world's marine pollution comes from land-based sources, and 60 to 95 per cent of this waste is plastic debris, according to the United Nations Joint Group of Experts on the Scientific Aspects of Marine Pollution. The costs of marine pollution can be damaging for the myriad of marine life in the ocean, whose homes have been littered with pollutants and plastics.

We have already seen drinking straws stuck in sea turtles' nostrils, and dolphins and whales drowned by floating plastic debris. More shockingly, microplastics are now found in the guts of many fish species—with this amount of plastic in our seas, the problem is severe, yet it remains invisible to the general populace. It is peculiar, considering how common plastics are to us.

The mobility of plastic

In chemistry, plastics are described as synthetic or semi-synthetic materials composed of numerous repeated segments, with carbon backbones, to become a large molecule called polymer. Today, plastics are prevalent in a multitude of household products at different scales due to their numerous advantages, such as low cost, ease of manufacture, versatility, and imperviousness to water.

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We have already entered the "Age of Plastics" with them seemingly indispensable to our lives. However, the impeccable design trait that makes it so suitable for its use on land is also exactly what creates the most problems at sea: their durability. This global pollution problem is further compounded by how plastic debris of all shapes and sizes can travel long distances via ocean currents.

Once in the ocean, these light buoyant plastics can travel fast and far, and eventually form massive oceanic plastic patches. Generated by ocean currents that gather the flotsam together, there are seven such plastic gyres—one in every ocean on Earth. The most well-known of these garbage patches is the Great Pacific Garbage Patch.

While the size of this patch is unknown, since the exact distribution of debris cannot easily be determined, the Great Pacific Garbage Patch has one of the highest levels of known microplastics suspended in the upper water column. Marine plastics in these garbage patches can be very harmful to marine life in the gyre. In fact, the media has recently reported that by 2050, it is estimated that the pieces of plastics in the ocean will outnumber the fishes in the sea.

A recent study by researchers from the National University of Singapore demostrated that microscopic barnacle larvae exposed to nanoplastics (in fluorescent green for visualisation) ingested, retained, and translocated these particles within their bodies–monitored at 3, 24, and 48 hours. These larvae are no larger than three-tenths of a millimetre and are capable of eating and transporting plastics through the food chain.

Credits to: Samarth Bhargava, NUS.

Unintended consequences

One of the major casualties in this war against plastics is the albatross, a type of large seabird that often mistakes plastic resin pellets for fish eggs and feeds them to chicks that ultimately die of starvation or ruptured organs. Scientists reveal that more than 97 per cent of dead Laysan albatross chicks and more than 89 per cent of dead adult birds were found to have contained plastic in their stomach—undeniably, not a mere coincidence.

The danger of ocean microplastics lies in their size. Large plastic debris in the environment can become altered due to sunlight, or degrade due to mechanical and chemical forces at sea, causing them to break up into smaller pieces. These small particles can range from millimetres to nanometres, in other words, sizes that can easily be consumed by plankton and fish.

Plastics of these sizes not only pose choking hazards for smaller marine animals, the microplastics are also capable of exerting harmful effects by soaking up and facilitating the transference of toxic pollutants present in the water to bodies of organisms. Unfortunately, these small and invisible microplastics are already insidiously entering the food chain through our seafood supply.

01 Spit Island, in the Midway Atoll, has seen increased amounts of marine debris washed ashore, affecting the habitat of the Laysan albatross which can mistake debris for food and eat it. (Photography courtesy of Forest & Kim Starr)

How do we identify the different types of plastics?

The following seven symbols were used to make identification of plastics easier:

These symbols depict the various types of plastics along with appropriate recycling symbols to help differentiate recyclables from waste.

(Source: *http://www.plasticsindustry.org/*)

WHAT OFTEN ENDS UP IN THE OCEAN:

Polyethylene Terephthalate (PET): This is commonly used to make bottles for beverages. These plastics, being less dense than water, float on the ocean surface.

High Density Polyethylene (HDPE): Cleaning materials such as liquid detergent, bleach and toilet cleaner along with liquid soaps and shampoo are commonly packaged into containers made of HDPE.

Polyvinyl Chloride (PVC): A flame retardant polymer that is used for making pipes and shower curtains. It is usually recycled into vinyl flooring.

Low Density Polyethylene (LDPE): Probably one of the most prolific polymers that is used to make shopping bags and cling wraps. Several countries have already taken active measures to ban plastic bags and reduce plastic pollution.

Polypropylene (PP): Exfoliating facial wash and whitening toothpaste contain abrasive microbeads made of PP. These beads pose a serious hazard to the marine ecosystem as they can readily be ingested by small animals leading to death from the choking of the alimentary canal. PP is also moulded into bottle caps.

Polystyrene (PS): Disposable cutlery, coffee cups, packaging and many other products are made from PS. Due to its low mechanical strength, PS can easily break up into smaller pieces.

Others: Includes a mix of different plastics which are more difficult to recycle. Polyesters are found in fashion accessories and apparels, polyamides such as nylon are used to make stockings, acrylates are used to make lenses, and fibre glass and biopolymers are a new class of biodegradable plastics.

What's for dinner

Research has demonstrated that seafood products are likely a major route of human exposure to microplastics and other toxic compounds such as heavy metals and persistent organic pollutants. One study suggests that Malaysians could possibly consume up to 246 pieces of microplastics a year, simply from eating dried fish products such as mackerel, anchovies, mullets and croakers.

Although Singapore has but a small aquaculture industry, we largely import our food from many countries in the region that are also not spared from marine pollution. Studies have reported that almost 60 per cent of plastic waste comes from five countries in Asia alone. While the impact of plastics on Singapore's food supply is not yet well-understood, some of the plastic waste washes up on our shores nonetheless.

Tackling the problem

By monitoring marine trash collected from shorelines, the International Coastal Cleanup Singapore (ICCS) has reported a little over 14,000 kg of trash over a span of two months in 2017. The trash articles were predominantly foam pieces, likely made from polystyrene that degrades into microplastics after adequate exposure to sunlight; Cigarette butts come in a close second, and these contain filters made from cellulose acetate fibres.

As the 20 year-old citizen science-led programme continues to survey annually to understand the seasonal trends in trash quantity and composition, ICCS is now embarking on a nation-wide study on figures related to microplastics across local beaches. The interest group known as Our Singapore Reefs has also started a movement, involving recreational divers who have volunteered to pick up trash found underwater. That helps to prevent further damage to coral reefs and its associated organisms.

As an affluent city, Singapore is fortunate enough to be equipped with sound governance and good public policies on managing waste. That said, it becomes concerning when Singaporean citizens fail to see the bigger picture of the impact of marine plastics on both the environment and also our own health and safety. As much as the war with plastics is a global issue, there is more that we can do locally, and we certainly need to take bolder steps when it comes to addressing these national problems.

Local businesses and industries can benefit greatly from the cooperation of adopting plastic-reducing initiatives. For instance, with more than 200 signatories from various industry players, the Singapore Packaging Agreement has cumulatively reduced 39,000 tonnes of packaging waste, and has saved about S$93 million in material costs over a period of a decade.

Beyond this, every Singaporean has the capacity to play a major role in driving market forces to reduce plastic use. Ask yourselves: do you need plastic utensils or bags when you take away food for home? Can we become responsible consumers by reducing our wasteful reliance of single-use plastics? Can we be more mindful not to litter, and to pick up what we see, especially near waterfront areas? We urgently need to keep plastics out of our oceans before irreversible damage is done to our seas– damage that could eventually make it to our dinner plates.

Turning the Tide on Plastic Waste

Action is underway in the UK to stop plastic pollution, especially in the marine environment. What are the plans that have been put in place?

Marcus Gover, CEO, WRAP UK

Distressing images of sea creatures and marine life harmed by plastic waste have been circulated relentlessly through the media in recent months. This has generated an unprecedented collective political, industrial and public inclination to tackle the problem.

Recent research conducted by US scientists at the University of California, has estimated that 79 per cent of the 8.3 billion tonnes of plastic that have ever been produced is still in the environment. There are an estimated 8 to 12 million tonnes of plastic waste leaching into the oceans every year from various sources such as rivers. UK Prime Minister Theresa May recently described ocean plastic waste as "truly one of the great environmental scourges of our time".

The solution to the problem is complex. Plastic packaging is inextricably linked with food and the environmental damage caused by food waste is overwhelming. For example, if the 7.3 million tonnes of food wasted by UK households each year was prevented, it would have the same environmental benefit of taking every one in four cars off the road. Another issue is getting an accurate account of what waste already is in oceans, on beaches, and where it's coming from. There is very little baseline data on what is being washed up along our beaches over specific time periods.

UK's political action

The UK Government is taking action and has pledged to eliminate all avoidable plastic waste by the end of 2042. A landmark step came into force earlier this year, with a ban on the manufacture of products containing microbeads—one of the world's toughest bans on these harmful pieces of plastic. New funding will also be injected into plastics innovation through a £7 billion research and development pot.

WRAP, the sustainability not-for-profit, has been tasked by the UK's environment secretary, Michael Gove, to lead an ambitious plan to transform the plastic recycling system in the UK and fundamentally change how plastic is made, used, and disposed of, so that it stays within the economy and away from the environment. The focus is on plastic packaging, which accounts for 70 per cent of UK's plastic waste.

The guiding principle behind WRAP's approach is that any solution needs to retain the value of plastic, whilst eradicating the harm that plastic waste inflicts on the environment.

They also stress that the key to success will be to ensure that everyone—from business, to government, to civil society and all citizens—plays their part.

Business-friendly advocacy

WRAP is advocating action by businesses to change how they design and use plastic packaging, action by government to reform the plastic packaging producer responsibility regulation, action by local authorities and the recycling sector to increase the quantity and quality of plastic packaging collected for recycling, and action by citizens to change how they use and dispose of plastics.

As announced in the UK Government's 25-year environment plan, the vehicle for delivering this change will be the highly anticipated cross-sector nationwide plastics initiative that WRAP has set up with the Ellen MacArthur Foundation, as part of their global New Plastics Economy.

The initiative will involve major retailers, brands and plastic packaging suppliers, allowing them the opportunity to demonstrate leadership in tackling the problem. This may be done by signing up to meet ambitious targets that eliminate unnecessary and problematic packaging and products, ensuring all plastic packaging is practically recyclable and using only recycled plastic where possible.

Aside from businesses, the initiative will also be asking the UK Government and devolved administrations to align future plastic packaging legislation with its goals, as well as local authorities to offer consistent collections, and NGOs and campaigners to join and share best practice and to scale up action.

There will also be a launch of a major citizen engagement campaign, encouraging citizens to reduce waste and increase the quantity and quality of recycling, thus reducing leakage into the environment.

There has never been a better time to turn back the tide on plastic waste. Nonetheless, while the UK is shaping up to play a pioneering role, this is a global problem which requires a global solution. There is growing momentum for us to come together and tackle one of the biggest issues of our age—let's not waste it.

The Next Course

Singapore's hawker culture is experiencing a renaissance, with the building of new hawker centres which brings about new opportunities for innovative food options, and an exciting industry revitalisation underway. What do these developments mean for the future of local food culture?

Chris Tobias, National Environment Agency, with inputs from Hawker Centre Division

The ubiquitous hawker centre is an integral part of the Singaporean cultural identity and a unique draw card for international visitors. Since the country's early days, hawker centres have presented tasty and affordable food options across a variety of diverse cuisines, served to people of all backgrounds in an informal, alfresco setting.

Though it is not hard to understand why this has been a winning formula over the decades, hawker centres and the entire food hawker industry is undergoing an evolution in order to keep up with times.

In with the new

Keeping pace with Singapore's rapid urban development, the construction of new centres are in the works, with many conveniently situated in newer communities. In fact, it has previously been announced that the Government will be building a total of 20 new centres by 2027.

Since 2015, seven new hawker centres have already opened with great interest at locations including Hougang, Bukit Panjang, Tampines, Yishun, Jurong West, Admiralty, and Pasir Ris. Diners can expect to see more new hawker centres in areas such as Sembawang, Sengkang, Punggol, Bidadari, Bukit Panjang, Bukit Batok and Choa Chu Kang in the coming years.

These new centres have been designed from the ground up to be "green" buildings, with many having achieved the BCA Green Mark Gold Plus or Platinum awards. They are designed to accommodate about 40 food stalls, with enhanced features including high ceilings and high velocity low speed fans for a more comfortable dining experience, family-friendly amenities for better inclusiveness, as well as other supporting facilities such as a central wash area and a food waste digestion area. An automated Tray Return system and e-payment facilities have also been introduced in some of these centres to help boost productivity.

Many of these centres are integrated with other compatible community facilities such as community centres, healthcare facilities, sports complexes, or transport hubs for convenience and ease of use.

Innovating operations

However, providing new centres and features are only part of the story. To help spur innovation and improve dining experience, NEA has also appointed socially-conscious operators (also known as managing agents) to manage the new, and some existing, centres on a not-for-profit basis. There are currently seven new hawker centres and six existing ones managed by these socially-conscious operators.

Thus far, the results have been encouraging as the operators have demonstrated a capacity to value-add to the hawker centres that they manage, ensuring that the stalls offer at least a few affordable meals in their menu and that they monitor the prices of basic food items. The operators also organise events and activities on-site to enhance the vibrancy and engagement of these centres.

Operators have also implemented some innovative practices or productivity measures to help any hawkers with manpower constraints to manage related costs. One measure is the introduction of self-payment kiosks or e-payment systems at the stalls.

To attract and support new entrants to the hawker trade, several operators have also come up with "hawker-entrepreneurship" programmes for aspiring hawkers. For example, Fei Siong at Hougang Ci Yuan Hawker Centre has come up with an Entrepreneurship Programme where aspiring hawkers are given on-the-job training to learn how to operate and manage hawker stalls.

Our Tampines Hub Hawker Centre has launched its Train and Place Entrepreneurship Programme where trainees are paired with veteran hawkers. Similarly, at Jurong West Hawker Centre, Hawker Management's Happy Hawkerpreneur Programme matches aspiring hawkers with hawkers from an older, more experienced generation. Timbre at Yishun Park Hawker Centre has set aside a few incubation stalls which are fully equipped for first-time chefs or F&B entrepreneurs under 35 years old. Likewise, NTUC Foodfare at Pasir Ris Central Hawker Centre has also set aside a few stalls that are fitted out for new hawkers to lower their entry costs.

Beyond infrastructure

As more and more hawker stallholders inch towards retirement, the industry has increasingly greyed as a whole, with little indication of succession planning. Admittedly, the fundamental offerings and operations of hawker centres have changed little over the years, while the dining experiences and technologies have gained a competitive foothold elsewhere.

This has introduced a strong sense of urgency, both within the industry itself and amongst policymakers, to consider how hawker centres can evolve over the coming decades.

In 2016, a "Hawker Centre 3.0" Committee was formed to help review this. The Committee gathered feedback and insights from the hawkers, general public and industry, identified key trends and explored ways that could help to sustain Singapore's hawker culture.

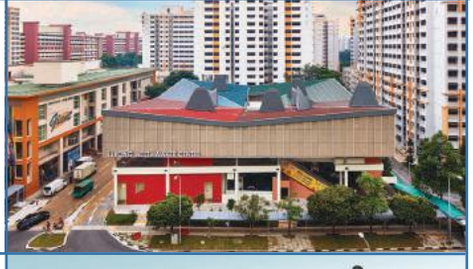
Later in 2017, the Committee's recommendations were put forward and accepted by the Government for further implementation. Broadly organised, the proposed recommendations focused on improving productivity, sustaining the hawker trade and supporting new entrants, increasing the vibrancy of the hawker centres and promoting graciousness.

Improving productivity

As hawker stalls are often family or individually run, enhancing productivity is important to facilitate management of the workload and to overcome manpower challenges.

Previously, hawkers have usually had

Table 1 - Key facts and photos for newly completed hawker centres

Area	Description of Hawker Center Development	Photos
Bukit Panjang Hawker Centre and Market	**Type:** Standalone development **No. of stalls:** 28 cooked food stalls, 14 Market slabs, 14 lock up stalls, 1 sundry store, and provision of 16 kiosks **Award:** BCA Green Mark Platinum Award 2014 Operational on 29 December 2015	
Ci Yuan Hawker Centre	**Type:** Co-located with Community Club; Development led by People's Association **No. of stalls:** 40 cooked food stalls located on 1st storey **Award:** BCA Green Mark Platinum Award; BCA Universal Design Mark Gold Plus (Design) Operational on 6 August 2015	
Hawker Centre @ Our Tampines Hub	**Type:** Co-located development includes facilities such as Community Club, Hawker Centre, Regional Library, Swimming Complex / Sports Facilities, etc; Development led by People's Association **No. of stalls:** 42 stalls located on 1st storey **Award:** BCA Green Mark Platinum Award Operational on 9 November 2016	
Pasir Ris Central Hawker Centre	**Type:** Standalone development **No. of stalls:** 41 Cooked Food stalls and 1 drink kiosk **Award:** BCA Green Mark Gold Plus Award; BCA Universal Design Mark Gold Plus (Design) Operational on 25 January 2018	
Kampung Admiralty Hawker Centre	**Type:** Co-located development includes facilities such as Studio Apartments, Supermarket and Shops, Hawker Centre, Childcare Centre, etc; Development led by HDB & AHS **No. of stalls:** 43 cooked food stalls located on 2nd storey **Award:** Excellence in Public Service–Best Practice Award (Inter-Agency Collaboration); Universal Design Gold Plus award; BCA Green Mark Gold Plus Award Operational on 12 August 2017	
Jurong West Hawker Centre	**Type:** Standalone development **No. of stalls:** 48 stalls (14 Market Slab stalls and 34 Cooked Food stalls) **Award:** BCA Green Mark Gold Operational on 8 October 2017	
Yishun Park Hawker Centre	**Type:** Standalone development **No. of stalls:** 45 Cooked Food stalls **Award:** BCA Green Mark Gold (Design); BCA Universal Design Mark Gold (Design) Operational on 20 September 2017	

to supply and wash their own crockery, which can be exhausting for their resources. Additionally, handling cash transactions with customers during peak hours can also slow down operations, especially compared to card-based payment methods available in many restaurants.

At the hawker-centre level, NEA has embarked on a programme to implement initiatives like automated tray return systems and centralised dishwashing services to enhance productivity at selected existing hawker centres. These initiatives allow the hawkers to focus on preparing and cooking their food, saving them from the time and resources spent collecting and washing crockery. They also help to make the cleaners' work easier, allowing them to focus on cleaning tables, not having to sort used crockery. Diners also benefit as they have access to clean tables quickly and are able to enjoy a hygienic dining experience. More hawker centres are likely to develop similar initiatives in the future.

At stall level, NEA is also helping stallholders to reduce their workload through greater productivity in food preparation. Many hawker offerings are handmade and meticulously prepared, requiring a significant investment of time. Automation helps to lighten these manual preparation processes, thus speeding up food production. To this end, a Hawkers' Productivity Grant to co-fund kitchen automation equipment by cooked food stallholders has also been launched by NEA—each eligible stallholder can claim 80 per cent of the qualifying cost of suitable equipment on a reimbursement basis, up to a total of S$5,000 within three years.

A vibrant community

Hawker centres have a role to play not only for their food offerings, but as a central gathering point for the community and a place for family and friends to engage in a variety of activities. As part of the Government's effort to encourage the vitality and vibrancy of hawker centres, a new programme called the Vibrant Hawker Centres programme has been established. This programme enables public and private partners such as the People's Association, grassroots and community organisations, as well as educational institutions, to adopt hawker centres and organise activities there on a sustained basis.

Each adopting organisation can apply for a grant of up to S$2,000 for organised events or activities, up to an annual cap of S$10,000 for each adopter. As of early 2018, 11 organisations have stepped forward as adopters, and 29 events have been held, including art demonstrations, games, music events, and festive performances.

The need for graciousness

When patrons leave behind trays and crockery on tables, it adds on to the workload for cleaners and also affects the turnover of tables for other patrons until the tables are cleaned by the cleaners.

With the aim of promoting gracious behaviour and a more pleasant dining experience, various methods are being explored to improve tray return rates. For example, at new and upgraded hawker centres, tray return stations are located at highly accessible and visible locations

Upcoming New Hawker Centres

In line with the latest target to build 20 new hawker centres by 2027, more new hawker centres are expected, especially in new towns such as Sembawang, Sengkang, Punggol, Bidadari, Bukit Panjang, Bukit Batok and Choa Chu Kang in the coming years. All new upcoming centres would be designed to accommodate 40 to 50 stalls and continue to have enhanced features including high ceilings and High Velocity Low Speed (HVLS) fans for a more comfortable dining experience, family-friendly amenities for better inclusivity, as well as other supporting facilities such as automated Tray Return systems and Cashless payments to help boost productivity.

Table 2 - Key facts and photos for newly completed replacement hawker centre

Besides the new centres, there is one newly completed replacement centre, which is meant to replace the existing centre at Blk 4A Woodlands Centre Road affected by HDB's SERS plans. The new replacement centre will follow the design requirements of the new generation of hawker centres.

Area	Description of Hawker Center Development	Photos
Marsiling Mall Hawker Centre (Replacement Centre @ Woodlands Street 12)	**Type:** Co-located development includes facilities such as Supermarket, HDB Retail Shops and Hawker Centre; Development led by NEA **No. of stalls:** 72 Cooked Food stalls **Award:** BCA Green Mark Gold (to be awarded in 2018) Operational on 15 December 2017	

to promote tray returning for patrons. The appearance of tray return stations have also been cleaned up to make the experience more pleasant.

At the same time, a project at Zion Riverside Food Centre and Adam Food Centre has been piloted, using behavioural prompts and visual cues to test for the improvement of tray return rates. Under this project, cleaners encourage patrons to clear their own trays after meals through the use of aprons displaying a message reminding patrons to return their trays, as well as similar posters on the tables. At Adam Food Centre, tray return messages are also broadcast at regular intervals through portable speakers. The results at both hawker centres have been encouraging, prompting NEA to roll out these initiatives to more centres this year.

Additionally, an automated tray return system with a deposit system has also been piloted at two existing hawker centres, urging patrons to return their trays. Behavioural prompts and cues were used at these two hawker centres to further reinforce the tray return message, in hopes that over the longer term there will be no need to continue such a system, after tray return becomes second nature.

Sustaining hawker trade and supporting new entrants

To encourage newcomers to join the trade, NEA has been working with a number of stakeholders to develop new programmes and provide assistance for interested hawkers. This includes collaborating with the People's Association to develop culinary classes under the "Hawker Fare Series", where interested members of the public can learn to cook hawker fare from veteran hawkers.

NEA also worked with the Institute of Technical Education to develop a short course on hawker business management to equip participants interested in the hawker trade with the necessary skills to manage and operate a hawker business.

The programmes have been well received, and many participants have given feedback and indicated interest in the hawker trade in the future.

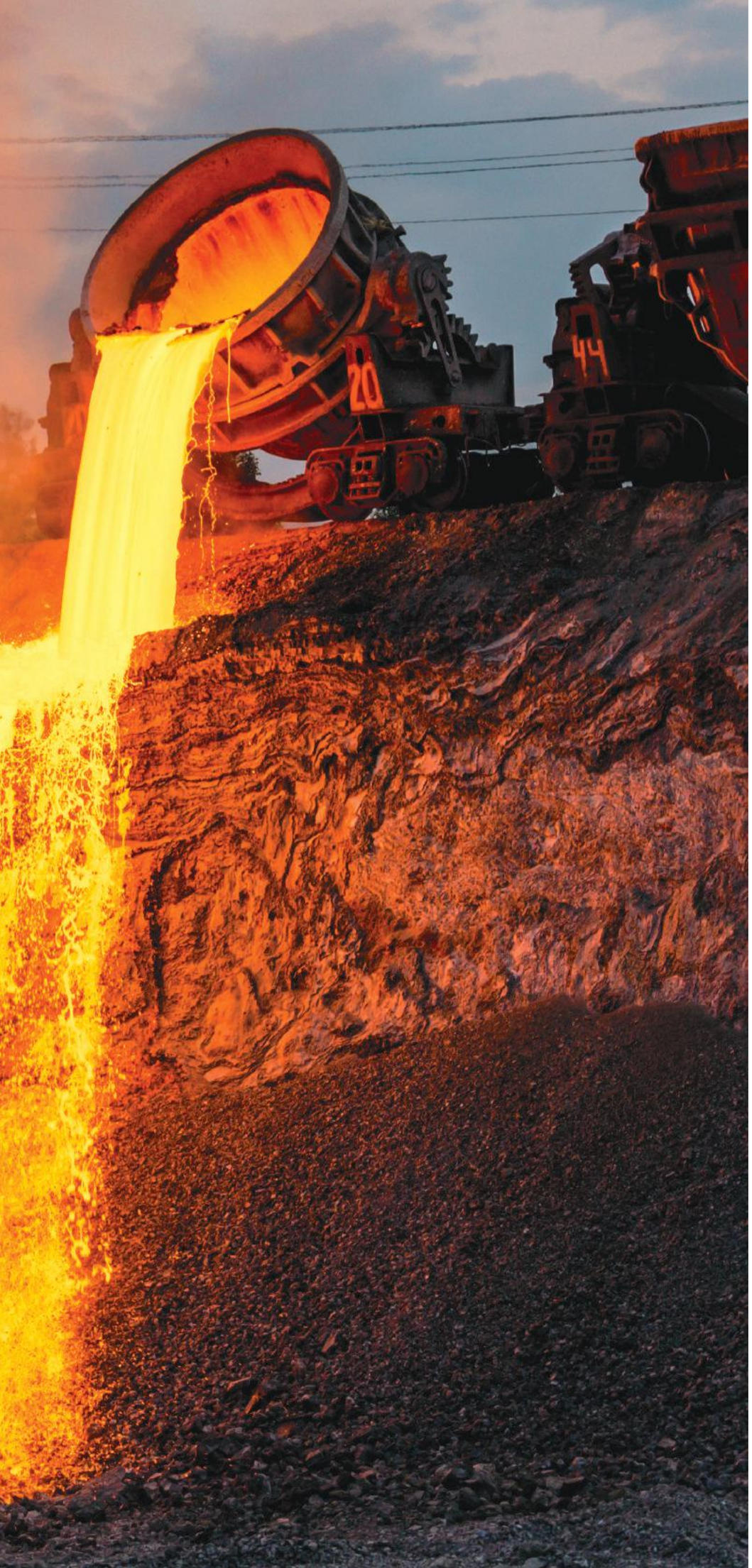
A one-stop Information and Service Centre has also been set up to help provide essential information on the hawker trade—including stall tendering, details of available food hygiene courses, applying for the Incubation Stall Programme and funding for kitchen automation equipment, and training courses on the hawker trade.

Culinary delights

While traditional hawker fare has consisted mainly of classics suiting local palates, the next generation of hawkers have also introduced new food types.

Pasir Ris Central Hawker Centre for instance has two levels—one with the common favourites and another with "modern" offerings for the adventurous. In general, many hawker centres in recent years have seen an emergence of Korean, Japanese, Western, fusion cuisine, and even options for baked goods. These options provide diners with more diverse choices without having to rely on shopping malls or expensive restaurants.

Ultimately, the hope is that the combination of new hawker centres and features, innovative management approaches, improvements to the dining experience, productivity enhancements, industry support and development, and unique food options available will ensure that the hawker culture continues to thrive as an integral part of Singapore life, and that hawker centres remain a relevant and uniquely Singaporean institution.



Circle of Life

Impetus, practices and the future of Life Cycle Assessment

Professor Michael Hauschild, Division of Quantitative Sustainability Assessment, Department of Manufacturing Engineering and Management, Technical University of Denmark, Lyngby Denmark; and Professor Sami Kara, Sustainability in Manufacturing and Life Cycle Engineering Research Group
The University of New South Wales, Sydney Australia

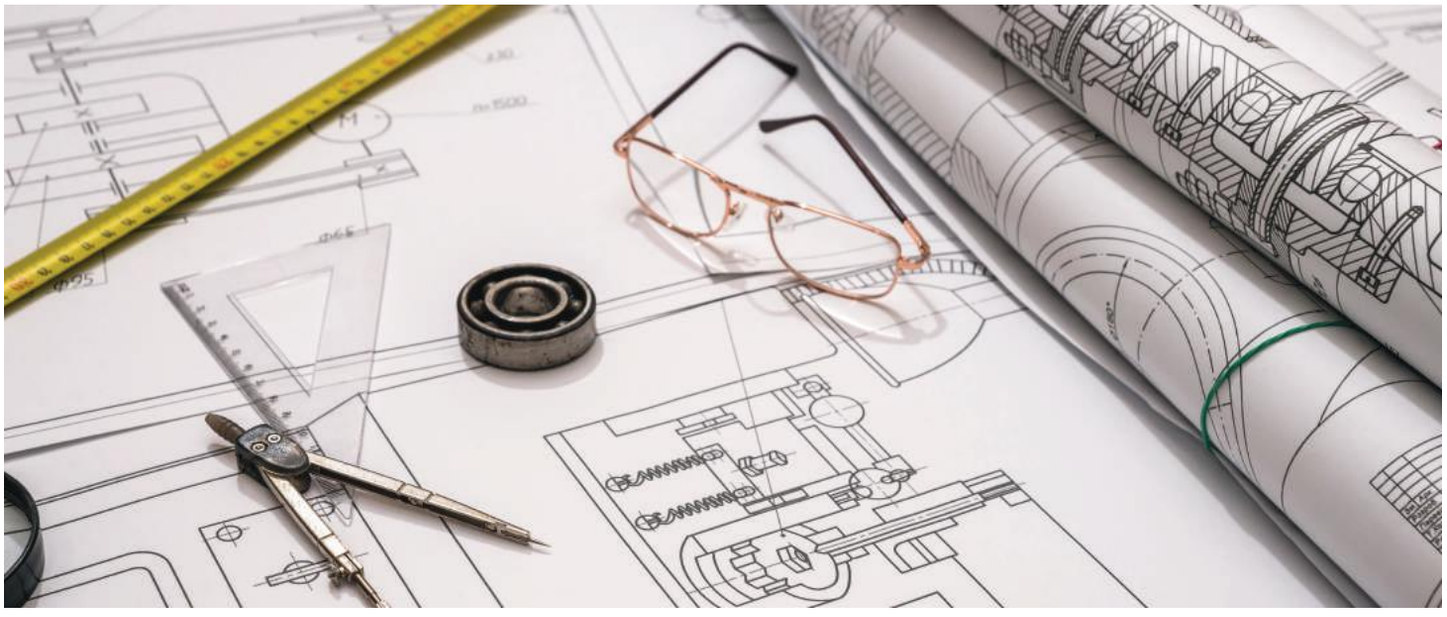
Since the industrial revolution, human-made activities have resulted in a dramatic increase in environmental pollution and associated climate change. This development has not only environmental, but also societal and economic consequences.

As the old proverb goes, "what gets measured, gets managed". What is needed now are decisive tools that take a systematic approach with a life cycle perspective (from cradle to grave), giving consideration to relevant environmental issues and providing a quantitative and science-based result. This will allow the decision maker to anticipate the full impact of the choices for a product or system.

Life Cycle Assessment (LCA) is a tool that offers this insight. Even though the main focus of LCA is environmental impact, the latest developments in this field now allow users to carry out social and economic impact assessments as well.

LCA strengths

The strengths of the LCA reside in two main characteristics of the method. The first is its focus on products and services that are viewed in a full life cycle perspective—from the extraction of raw materials through



to the production process (including the materials and manufacturing industries), the distribution, use and maintenance of the product, even until the end of life treatment, such as recycling or terminal disposal (Figure 1).

The life cycle perspective is needed to reveal any problem shifting between different parts of the life cycle, such as obtaining a lower environmental impact from the use of the product at the expense of a higher environmental impact in the manufacturing phase (for example, with the insulation of houses or the shift from petrol-fuelled cars to electrical cars).

The other main characteristic of LCA is its broad coverage of impacts to reveal any problem-shifting that also occurs throughout the life cycle. A typical LCA will cover a full profile of environmental issues, ranging from global concerns like climate change and stratospheric ozone depletion to regional concerns like acidification, nutrient enrichment of water ecosystems and damage to human health and ecosystems from chemicals, even to local impacts from land use and fresh water depletion.

To support assessment of the full triple bottom line of sustainability ("Planet, People and Profit"), recent developments of LCA aim to also support assessment of social and economic impacts throughout the life cycle of the product.

According to the ISO standards, LCA proceeds through four phases as illustrated in Figure 2. Firstly, the goal of the study is defined and the assessment scoped accordingly in terms of the subject of the LCA (the so-called "functional unit" describing in quantitative and technical terms the service provided by the compared product alternatives), the choice of environmental impacts to be covered, the drawing of the boundaries around the product system, and the choice of modelling principles (such as the use of marginal or average data).

Secondly, an inventory is created of all physical flows entering and leaving the processes in the product system as illustrated in Figure 3. Even for simple products, the product system can have hundreds of processes (at suppliers and their suppliers), and the modelling of the product system often relies on dedicated LCA software and databases with environmental flow data for thousands of processes.

Indicated by the bi-directional arrows in Figure 2, LCA is an iterative exercise and sensitivity analysis is performed in all phases to identify the most important data and method choices for further refinement in the next iteration.

The LCA translates the inventory into an environmental impact profile that shows the contribution of the product or service to the selected categories of environmental impact. The results can also be expressed as scores for the overall damage to ecosystems, human health and resources–the three areas of protection considered by the LCA.

Finally, the LCA interprets the results in accordance with the definitive goal to answer the question that was posed at the onset of the study.

LCA in practice

LCA has been adopted by industry from all trades as a decision support tool for product development. It is used to establish focus points for the development of greener products, to evaluate the environmental perfor-

Figure 1 - LCA identifies the main environmental hotspots throughout the life cycle of the product and helps to streamline the product developmental processes, throughout the life cycle of the product

mance of alternative designs and to document its improvements. Environmental management standards require a life cycle perspective on the environmental performance of companies, and environmental product declarations are used to market the greener products to businesses, while LCA-based eco-labels target the green consumer segment of the market.

Governments also use LCA for environmental sustainability assessment of large system choices, with regards to waste management (for example, recycling versus incineration of plastic waste, returnable or single-use packaging, or the enforcement of bio-based and bio-degradable plastics at the expense of petrochemical plastics), energy supply (for example, wind, solar, biomass, or nuclear energy), transportation (for example, electromobility versus petrol-fuelled cars, biofuels or petrochemical fuels, or air and land freight transport as compared to person-to-person transport), or housing standards for more sustainable housing–relying on the LCA for identifying the best designs.

Consumers may use LCA-based information for choosing products (such as in determining which product is the most environmentally benign) or behaviour (such as comparing the sustainability of washing dishes by hand rather than in a dishwasher, or of eating organic rather than conventionally grown vegetables).

The future: from efficiency to effectiveness

Common to the majority of the LCA applications by the different groups of stakeholders mentioned above is the comparison of the *eco-efficiency* of different choices. Eco-efficiency is defined as the ratio between the service or functionality that is offered, divided by the environmental impact that is caused. In a comparative LCA, the functionality of the alternative products is the same (as specified in the functional unit of the study), and the alternative with the lowest environmental impact is thus the most eco-efficient and the most environmentally sustainable.

The original definition of sustainability presented by the Brundtland Commission, however, is strongly focused on human consumption and discusses meeting the needs of the present in a way that doesn't compromise the ability of future generations to meet their own demands.

But what does this mean for a specific company, a specific product or an individual? What is a sustainable company, a sustainable product, or a sustainable lifestyle? How much "more sustainable" must a product be as a competing alternative, in order to be "sustainable" in absolute terms (in other words, contributing to meet the demands of the present in a way that does not compromise future generations)?

These are conclusive and ideal questions, while Eco-efficiency is a relative measure, hence a classical LCA will not be able to provide adequate answers. Instead, the discussion should revolve around *effectiveness instead of efficiency*.

In order to provide absolute sustainability-decision support, the outcomes of the LCA need to relate the product's life cycle impact to absolute sustainability requirements, that take into account both the foreseeable growth in population, affluence and its related consumption. It needs to set absolute limits for the environmental impact that we can cause without irreversibly compromising the conditions for future generations.

With an absolute perspective, the LCA can shed light on not merely whether a product or company is better, but whether it is *good enough*, or sustainable enough—and if not, determine what improvements are needed to achieve this requirement, consequently enabling the company to play its part in a future sustainable world.

Figure 2 - Framework for LCA according to the ISO 14040 standard

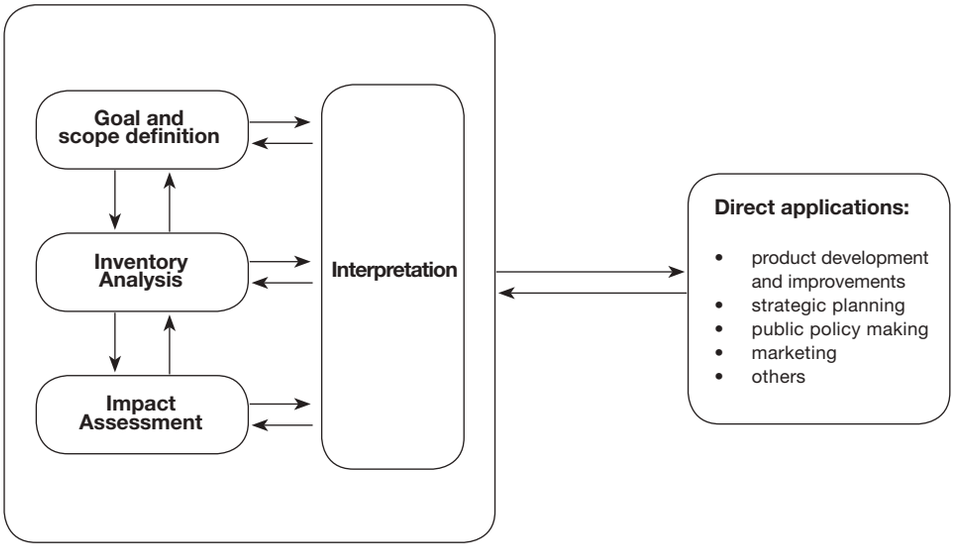
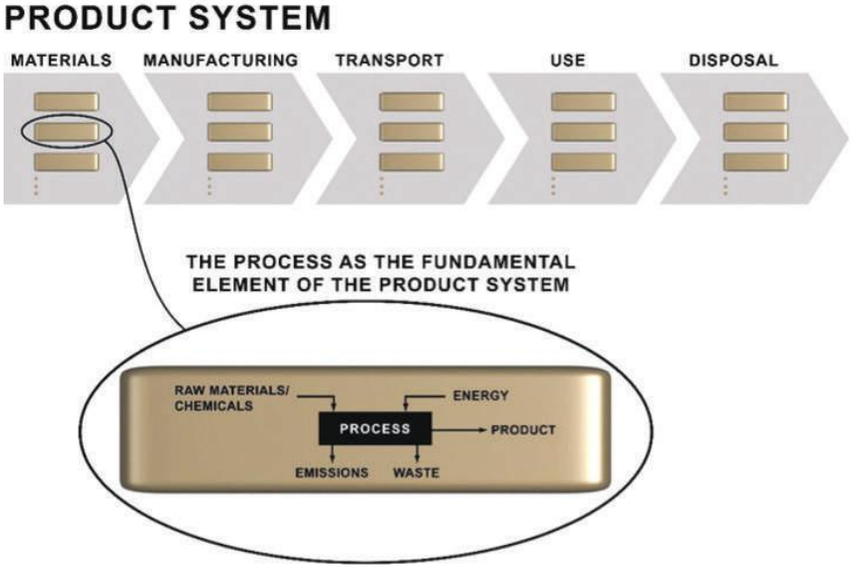


Figure 3 - LCA collects information about input of materials and output of products and emissions to the environment from all processes, throughout the life cycle of the product



Hacks

From unexpected business practices to new energy options, take a look at some of the most innovative solutions popping up around the globe

URBAN SOLUTIONS

01

Playing it Cool

Many growing cities will need to start considering mitigation measures to tackle one common challenge. The Urban Heat Island (UHI) Effect involves areas of urban terrain kept at warmer temperatures than other natural environments due to human activity. UHI can cause extra energy use for cooling and also heat stress among those in the area—however, a new modeling tool has been developed to help shed a light on solutions to UHI. See how to lose a few degrees:
http://bit.ly/2IoSsCp

GREEN BUSINESS

02

No Need for Housekeeping

In a cost-cutting, ecologically friendly move, some hotels have offered incentives like F&B vouchers, reward points, and even organic herbs for guests to forgo housekeeping, and the frequent changing of sheets and towels that often come with it. Good and green idea, or just a gimmick?
http://nyti.ms/2peE6eX

AIR QUALITY

03

Tower of Power

The air in the city of Xian in the Shaanxi province has gotten cleaner due to a 100-metre tall air purification tower. As polluted air, warmed by the sun's heat, moves up and through multiple filters, the concentration of fine particulates reduces by 15 per cent.
http://bit.ly/2FFBpdy

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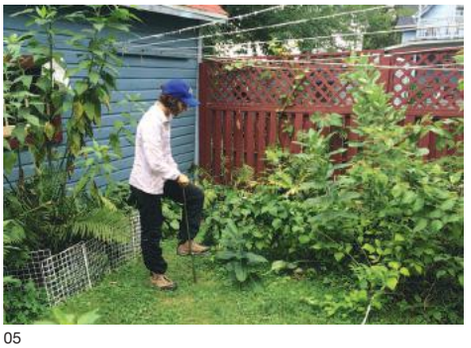
04



05

06

EMISSIONS REDUCTIONS

04

A Rocky Road to Reductions?

Normally a slow natural process, the 'enhanced' weathering of tiny basalt rocks in large quantities could help eliminate greenhouse gases. Some scientists believe that scaling up this natural process could be a boon—but with more than three billion tonnes of basalt required to sequester one billion tonnes of CO_2, is it worth it?

http://bit.ly/2Go4Kdv

05

Backyard Bonanza

While urban green spaces are often cited as a potential solution to mitigate the effects of global warming, studies show that the soil in forest ecosystems is best at absorbing water, whereas soil on open and developed land—like golf courses and backyard lawns—is better at absorbing carbon. Research suggests that fragmented backyard ecosystems can benefit cities and should be factored into urban planning.

http://nyti.ms/2peCmSX

WASTE MANAGEMENT & RECYCLING

06

Out of This World

Recycling in space should happen soon, all thanks to US space equipment manufacturer, Made In Space, and sustainable chemical and plastic solutions firm, Braskem–both of whom will be expanding their partnership to include plastic recycling on the International Space Station. This will be the first commercial plastic recycling operation in the history of space missions.

http://bit.ly/2FHsokf

07

Under Z in the Yellow Pages

To boost recycling rates, Calwell Zoo in Texas will be granting free admission to visitors bringing unwanted phone books to the zoo. These phone books will be packed and delivered to a local recycling plant for processing.

http://bit.ly/2FR3VvV

08

Rush to Recycle

The NFL, PepsiCo and other players have come up with a zero waste project in hopes of recycling up to 90 per cent of stadium waste. Watch the video to learn an innovative way to recycle right:

http://bit.ly/2FTUtIw

ENERGY

09

Solar Shrooms

Two farms in northeastern Japan have combined solar power generation and agriculture, producing a combined 4,000 kilowatts of solar power and an annual yield of 40 tons of cloud-ear mushrooms. With a change in regulations, solar power has become more viable. Could energy-efficient combinations like this become more popular in the future?

http://bit.ly/2xycYLC

10

CO_2 to Fuel

Researchers at MIT have developed a new membrane system that facilitates the separation of oxygen from carbon dioxide, where the latter can be used as a fuel for cars, trucks and planes. Carbon monoxide is also a useful raw element that is commonly used as chemical feedstock for other products. Researchers believe that a technology like this could ultimately play an instrumental role in mitigating global warming.

http://bit.ly/2DnwgVn

11

Proton Power

Intensive research has led to the creation of a low-cost, environmentally friendly carbon proton battery that uses carbon electrodes, water, and a permeable membrane to store electricity. While the newly created battery can store as much energy as a lithium ion battery, more work will need to be done to further improve its performance.

http://bit.ly/2pb8Gap

07

09

08

10

11

Reads

Get a handle on the latest trends, facts, and resource guides from experts around the world

EMISSIONS REDUCTIONS

Lowering Limits

Researchers came up with scenario modeling in an attempt to test the feasibility of achieving one of the Paris Agreement goals of limiting global warming to 1.5°C. The research provided possible barriers that need to be overcome in order to meet this ambitious goal.
http://bit.ly/2Fq25lH

Peak Flow

Understanding countries' emission trends and reduction commitments can provide a clearer picture of how these factors will affect the peaking of global emissions, and the ability to meet the Paris Agreement's temperature targets. WRI has identified trends in peaking across countries globally, with an objective to help many of them achieve lower emission levels more quickly.
http://bit.ly/2FRG13u

GLOBAL ENVIRONMENTAL TRENDS

Sustainability Trends 2018

10 trends have been identified as having a significant impact on global corporate sustainability. Learn what is affecting corporations this year:
http://bit.ly/2Gvw7SK

Global Risks Report

The World Economic Forum has published its annual update of major global risks identified by business leaders, and the list seems to grow longer by the year. One major focus area, environmental degradation, lingers as a dominant area to watch. Learn more about this and other highlighted areas:
http://bit.ly/2EOF8EM

State of Corporate Energy and Sustainability Programmes

Three Ds are reshaping the energy market: digitisation, decarbonisation and decentralisation. Find out how companies are linking the energy they buy with sustainability initiatives, and where the typical barriers might lie:
http://bit.ly/2pbdifE

SUPPLY CHAIN

Map Couture

The Natural Resources Defense Council (NRDC) and China's Institute of Public & Environmental Affairs (IPE) have worked together to come up with a new mapping tool. The IPE Green Supply Chain Map gives apparel brands an opportunity to demonstrate the transparency of their supply chain and environmental data from their suppliers. Are there other industries where such an approach could be useful?

http://bit.ly/2CYtE5g

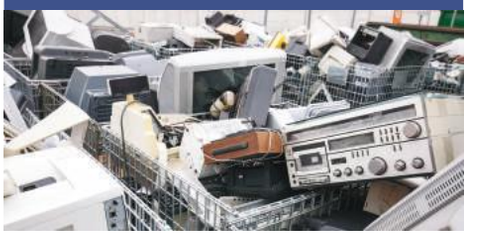
ENVIRONMENTAL RESTORATION

The Money Tree

In recent years, many companies have entered the forest restoration industry, adopting various and diverse business models that deliver financial returns while rejuvenating forest and agricultural land. Learn more about these promising investment themes being employed by businesses to help put trees back in the ground while padding out pockets:

http://bit.ly/2GodcJL

TECHNOLOGY



Unprecedented E-waste

While technology has undeniably delivered many social benefits, there is growing recognition of its shortcomings, namely e-waste. UN University and other stakeholders have banded together to look at the global trends and negative side effects of this increasing global problem. Learn more and see how e-waste is affecting your region:

http://bit.ly/2E0MDN1

INDOOR AIR QUALITY

Dead Air

A study of workers over a decade by a team of researchers has shown that polluted air stymies workers' ability to do their work, thereby reducing productivity. If your office has low productivity, getting some fresh air might be a good idea.

http://bit.ly/2FvX4J9

CLEAN ENERGY

Clean Energy Stock Take

Climatescope's annual review of clean energy initiatives—this time across 71 countries—highlights what has been and is being done in developing nations to embrace clean energy and to avert dirtier development pathways. While great progress has been made in recent years despite some pessimism, several troubling obstacles have also come to light. Find out what might be holding up progress:

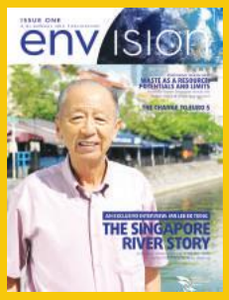
http://bit.ly/2Gv3aXD

FOOD WASTE

Food for Thought

The NEA and the Agri-Food & Veterinary Authority of Singapore have worked with various industry stakeholders to develop a food waste minimisation guidebook for food retail establishments, supermarkets and food manufacturing establishments to reduce food waste across the supply chain. Learn what can be done by these businesses to slash food waste:

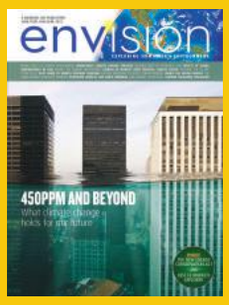
- Food Waste Minimisation for Food Retail Establishments
  http://bit.ly/2DqqTFa
- Food Waste Minimisation for Supermarkets
  http://bit.ly/2FQaRd0
- Food Waste Minimisation for Food Manufacturers
  http://bit.ly/2GqgRXy



#1
The Singapore River Story
An exclusive interview: Mr Lee Ek Tieng

#2
Sustainable Development
Urban environmental management in the Rio+20 era.

#3
Safeguarding Wellbeing
Better understanding the environmental dimensions



#4
450ppm and Beyond
What climate change holds for our future

#5
The Empowered Crowd
Deciphering our environment

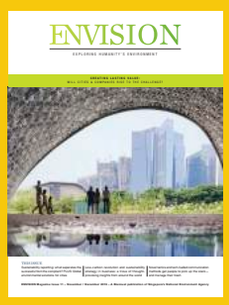
#6
Strengthening the Green Economy
Stepping up in Asia?

#7
Threats and Opportunities
How environment shapes life and business

#8
From Blueprint to Reality
Creating sustainable city life

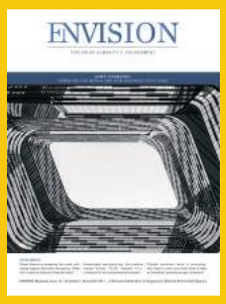
#9
The Future of Food
Digesting the complexity and serving up solutions

#10
Better Tech
How cleaner, greener solutions are improving the urban environment



#11
Creating Lasting Value
Will cities and companies rise to the challenge?

#12
The Growing Gravity Of The Circular Economy:
Will Asia be Next?



#13
Game-Changers
Remaking the world and how business gets done

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- Job match locals to your vacancies through career fairs and direct referrals.
- Hire and train job seekers through **Professional Conversion Programmes (PCP)** and **Place-and-Train (PnT)** programmes.
- Tap on **Career Support Programme (CSP)** to hire Professionals, Managers, Executives and Technicians (PMETs).

Productivity

- **WorkPro** funding up to 80% of project cost to redesign workplaces and processes to create easier, safer and smarter jobs for older workers.
- Tap on e2i's **Inclusive Growth Programme (IGP)** with project funding to increase productivity through process automation, software and training.

Professional Development

- Upskill your workers and bridge skills gaps to meet the changing business landscape.
- Connect with our network of professional development course providers and tap on funding to train your workers.

Contact our e2i industry officers for more information:
https://e2i.com.sg/contact-an-industry-specialist/

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* Source from NEA Website