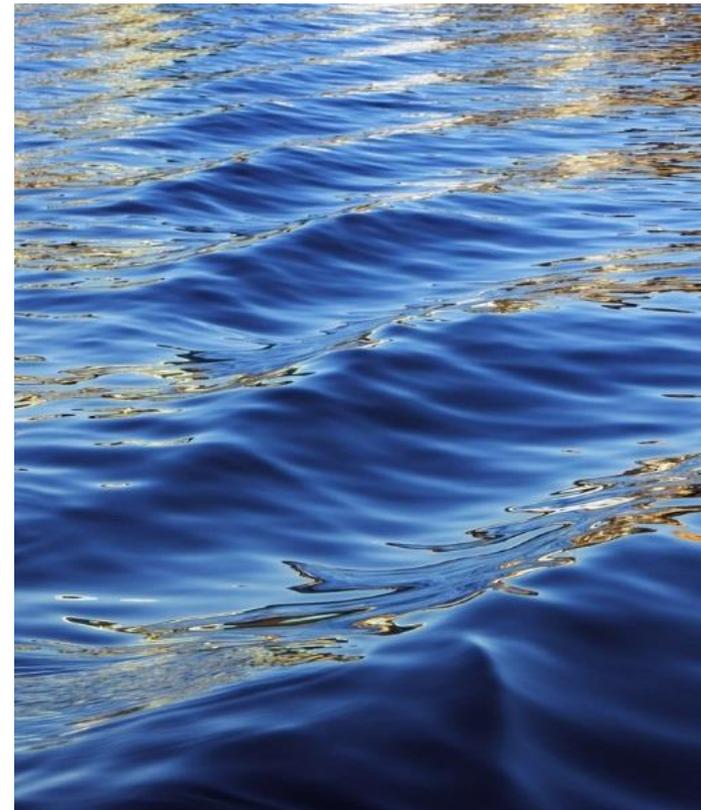




# Singapore's response to Climate Change and the OEM opportunities

Dr Joshua Wong  
Head and Consultant  
Occupational Medicine Service  
Sengkang General Hospital



# Outline

- Introduction
- Impact on Singapore
- The Singapore's Response Toward Climate Change
- Green Growth Opportunities
- Opportunities for OEM?

# Climate Change

- While Earth's climate [has changed throughout its history](#), the current warming is happening at a rate not seen in the past 10,000 years.
- According to the Intergovernmental Panel on Climate Change ([IPCC](#)), "Since systematic scientific assessments began in the 1970s, the influence of human activity on the warming of the climate system has evolved from theory to established fact."<sup>1</sup>
- Scientific information taken from natural sources (such as ice cores, rocks, and tree rings) and from modern equipment (like satellites and instruments) all show the signs of a changing climate.
- From global temperature rise to melting ice sheets, the evidence of a warming planet abounds.
- [Evidence | Facts – Climate Change: Vital Signs of the Planet \(nasa.gov\)](#)

QUICK FACTS ABOUT

# SINGAPORE

HOME OF THE FOUR SEAS COLLEGE OF BIBLE AND MISSIONS

## GEOGRAPHY



CITY-STATE  
ISLAND NATION  
SOUTHEAST ASIA  
NEAR TIP OF MALAYSIA  
2/3 SIZE OF NEW YORK CITY

## POPULATION & LANGUAGE

5.6 MILLION PEOPLE



4 OFFICIAL LANGUAGES

ENGLISH  
MANDARIN

TAMIL  
MALAY



## RELIGION



BUDDHISM (33.9%)

CHRISTIANITY (18.1%)

ATHEIST/NO RELIGION (16.4%)

ISLAM (14.3%)

TAOISM (11.3%)

HINDUISM (5.2%)

OTHER (0.7%)

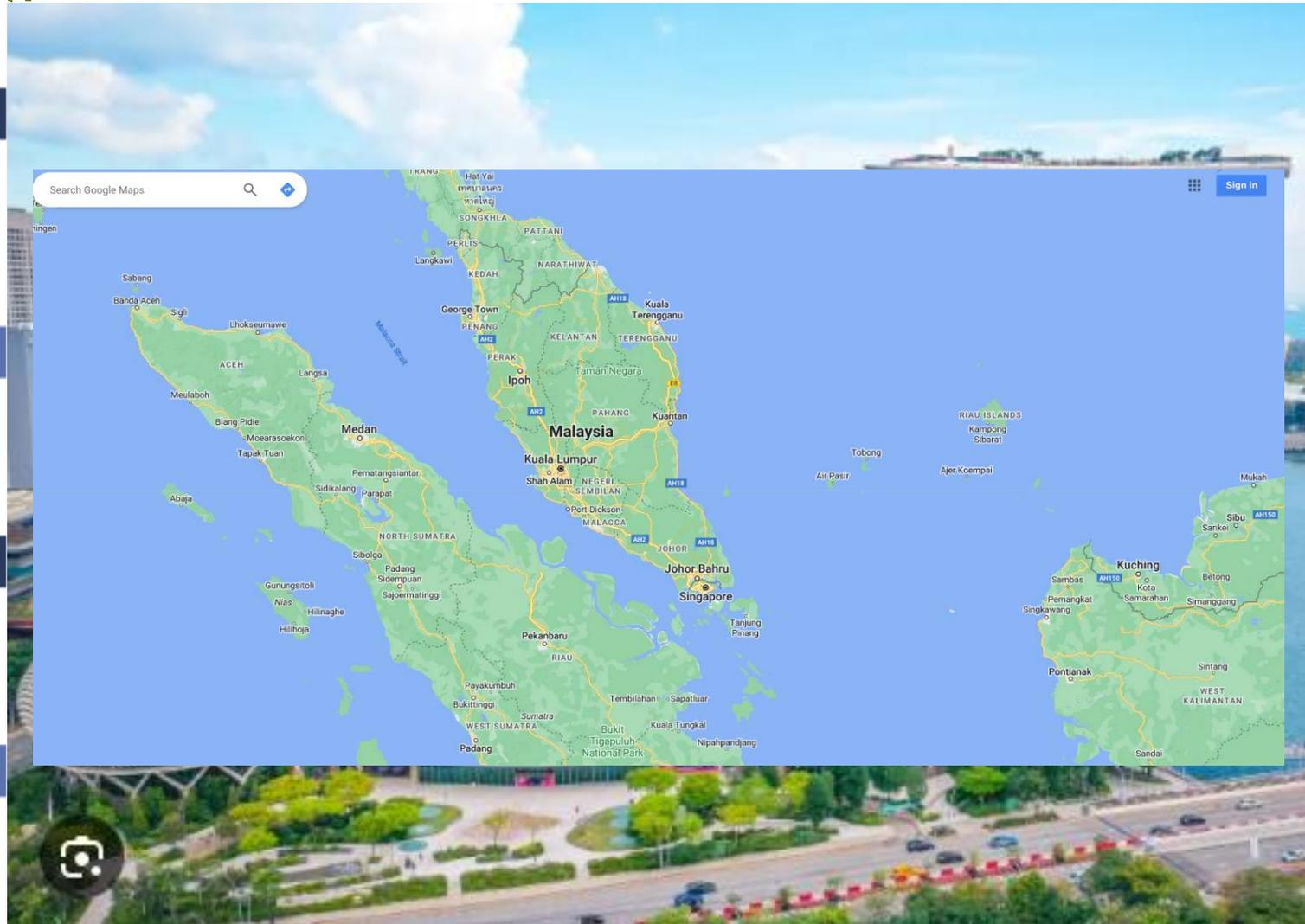
## COST OF LIVING

THE MOST EXPENSIVE CITY IN THE WORLD (FORBES 2017)

\$75/MONTH  
SUBWAY PASS

\$2,000.00/MONTH  
3 BEDROOM APARTMENT  
1300-1400 SQ. FT.

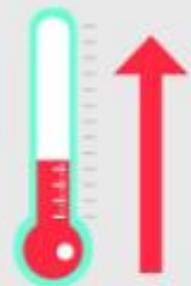
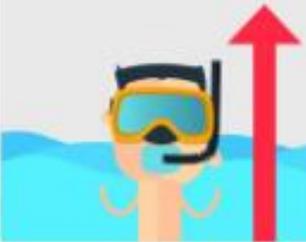
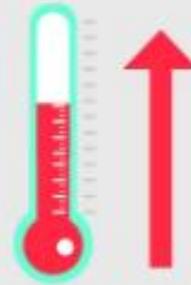
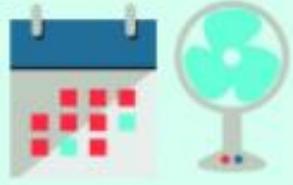
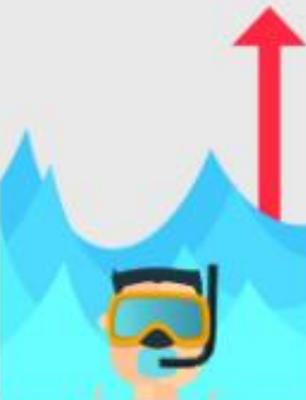
\$9.56  
1 GAL. MILK



# Quick facts about Singapore

- Singapore is alternative energy disadvantaged – we are a low-lying island state of 733.1 km<sup>2</sup> with one of the highest population densities globally (7,485 persons per km<sup>2</sup>).
- Our urban density and limited land area, relatively flat land, low wind speeds and lack of high-quality hydrothermal resources present serious difficulties in pursuing alternative energy options.
- Current nuclear fission technologies are not suitable for deployment in Singapore.
- Limited scope for solar photovoltaics (PV) deployment and for Singapore's forests to be a significant carbon sink.

# CLIMATE CHANGE IN SINGAPORE

SINGAPORE'S CLIMATE	DAILY TEMPERATURE 	FREQUENCY OF WARM DAYS & NIGHTS 	RAINFALL 	WIND 	SEA LEVEL RISE 
OBSERVED CHANGES	<p>From 1948 to 2016, annual mean temperatures rose at an average rate of 0.25°C per decade</p> 	<p>Since 1972, the number of warm days and nights has increased, and the number of cool nights has decreased</p> 	<p>From 1980 to 2016, annual total rainfall rose at an average rate of 101mm per decade</p> 	<p>General wind patterns influenced by northeast and southwest monsoons. There are no clear trends for wind speed as it is dependent on the environment</p> 	<p>Between 1975 to 2009, the sea level in the Straits of Singapore rose at the rate of 1.2mm to 1.7mm per year</p> 
FUTURE CLIMATE PROJECTIONS	<p>Daily mean temperatures are projected to increase by 1.4°C to 4.6°C</p> 	<p>More warm days and warm nights for February to September throughout the 21st century</p> 	<p>The contrast between the wet months (November to January) and dry months (February and June to September) is likely to be more pronounced. Intensity and frequency of heavy rainfall events is expected to increase as the world gets warmer</p> <p>Feb &amp; Jun-Sep      Nov-Jan</p> 	<p>Singapore will continue to be influenced by the northeast and southwest monsoons with potential increase in wind speeds during northeast monsoon season</p> 	<p>Sea levels are projected to rise by up to about 1 metre</p> 

# Singapore's Response

- 25 October 2022, raise its national climate target to achieve net zero emissions by 2050 as part of our Long-Term Low-Emissions Development Strategy (LEDS).
- Reduce emissions to around 60 MtCO<sub>2</sub>e in 2030 after peaking emissions earlier, as part of our revised 2030 Nationally Determined Contribution (NDC).
- Submitted an addendum to the LEDS and the revised 2030 NDC to the United Nations Framework Convention on Climate Change (UNFCCC) in 2022.
- In 2009, pledged to reduce our emissions by 16% below BAU levels by 2020 ahead of the Copenhagen Summit. Singapore has achieved this pledge with a 32% reduction below BAU levels in 2020.
- Given Singapore's national circumstances — we are a **resource-constrained** and **alternative energy-disadvantaged city-state** — these are ambitious targets.

# About NCCS

## About NCCS

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Inter-Ministerial Committee  
On Climate Change

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## About NCCS

The National Climate Change Secretariat (NCCS) was established on 1 July 2010 under the Prime Minister's Office (PMO) to develop and implement Singapore's domestic and international policies and strategies to tackle climate change. NCCS is part of the Strategy Group which supports the Prime Minister and his Cabinet to establish priorities and strengthen strategic alignment across Government. The inclusion of NCCS enhances strategy-making and planning on vital issues that span multiple Government ministries and agencies.

NCCS' areas of responsibility are to:

- facilitate efforts to mitigate carbon emissions in all sectors
- help Singapore adapt to the effects of climate change
- harness economic and green growth opportunities arising from climate change
- encourage public awareness and action on climate change



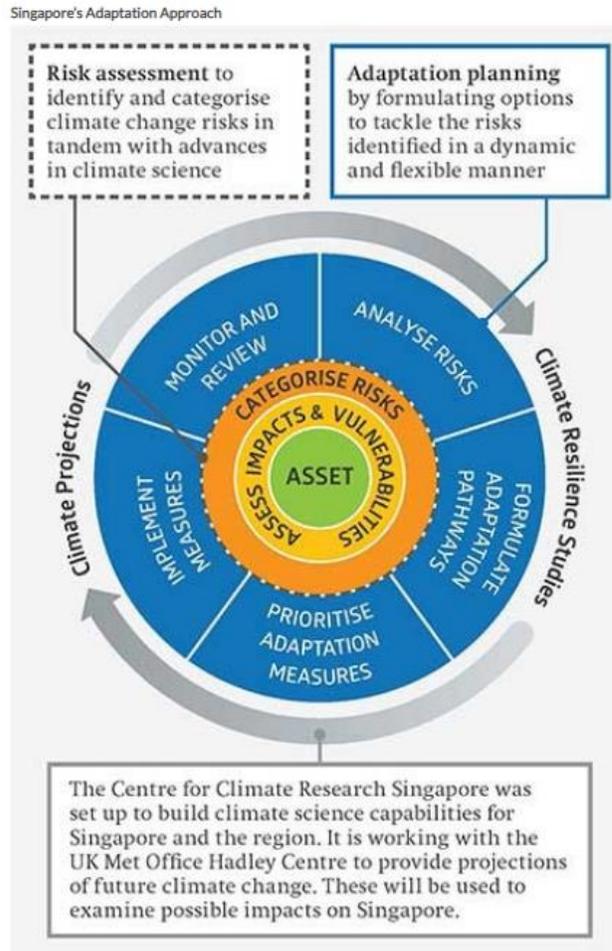
# Inter-Ministerial Committee on Climate Change

- The Inter-Ministerial Committee on Climate Change (IMCCC) enhances Whole-of-Government coordination on climate change policies to ensure that Singapore is prepared for the impacts of climate change. Established in 2007, IMCCC is chaired by Mr Teo Chee Hean, Senior Minister and Coordinating Minister for National Security.

Committees and Work Groups Addressing Singapore's Climate Change-related Issues



# Singapore's Approach to Adaptation



- Began making early preparations to adapt to the impact of climate change.
- To address the projected effects of climate change over the next 50 to 100 years, introduced a resilience framework.
  - Enhancing knowledge and expertise
  - Coastal protection
  - Water resource management
  - Drainage and flood prevention

# Singapore's Response – Mitigation Efforts

## Charting Singapore's Net Zero Future

**Achieve net zero emissions by 2050**  
Long-Term Low-Emissions Development Strategy (LEDS)

**Reduce 2030 emissions to 60 MtCO<sub>2</sub>e**  
after peaking emissions earlier  
2030 Nationally Determined Contribution (NDC)

### Accelerating Low-Carbon Transition in Industry, Economy and Society

**Catalyse business transformation**

- Sustainable energy and chemicals hub in conjunction with industry
- Grants for energy efficiency and emissions reduction

**Invest in low-carbon technologies**

- Carbon Capture Utilisation and Storage
- Low-carbon hydrogen
- Solar and energy storage systems

**Pursue effective international cooperation**

- International carbon markets with high quality carbon credits
- Regional power grids for green energy

**Adopt low-carbon practices**

- Green commutes via public transport, Walk-Cycle-Ride & cleaner energy vehicles

**KEY ENABLER** Right-pricing carbon to shape business decisions and consumer behaviour

Carbon tax  
S\$50-80/tCO<sub>2</sub>e  
by 2030

**EVERYONE CAN PLAY A PART**

**Public sector**  
Achieve net zero emissions across public sector around 2045 as part of GreenGov SG



**Private sector**  
Develop and adopt low-carbon solutions, and pursue green growth opportunities



**Individuals**  
Contribute to climate friendly initiatives



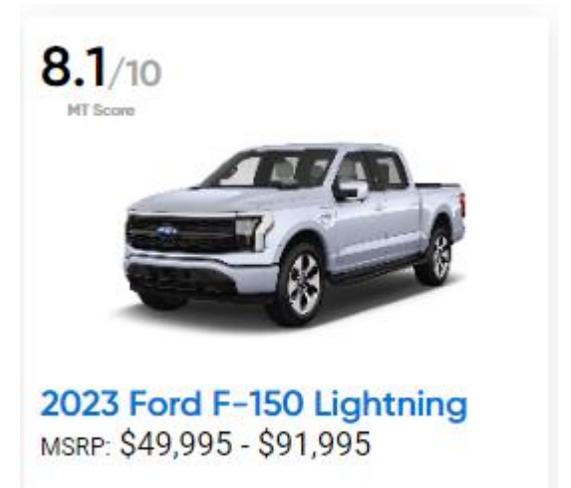
# Green Growth Opportunities

- Solar
  - To achieve at least 2 GWp by 2030, enough to meet around 3% of projected electricity demand in that year
  - SolarNova programme to encourage solar energy deployment
- Carbon Capture, Utilisation and Storage (CCUS)
  - Exploring possible CCUS deployment pathways
  - At Jurong Island, plans to realise at least 2 MtCO<sub>2</sub>e of carbon capture potential per annum by 2030, and achieve > 6 MtCO<sub>2</sub>e of carbon abatement per annum by 2050
- Zero waste Masterplan
  - Transforming the Environmental Services Industry
  - Increase recycling efforts
  - Technology and Innovation



# Green Growth Opportunities

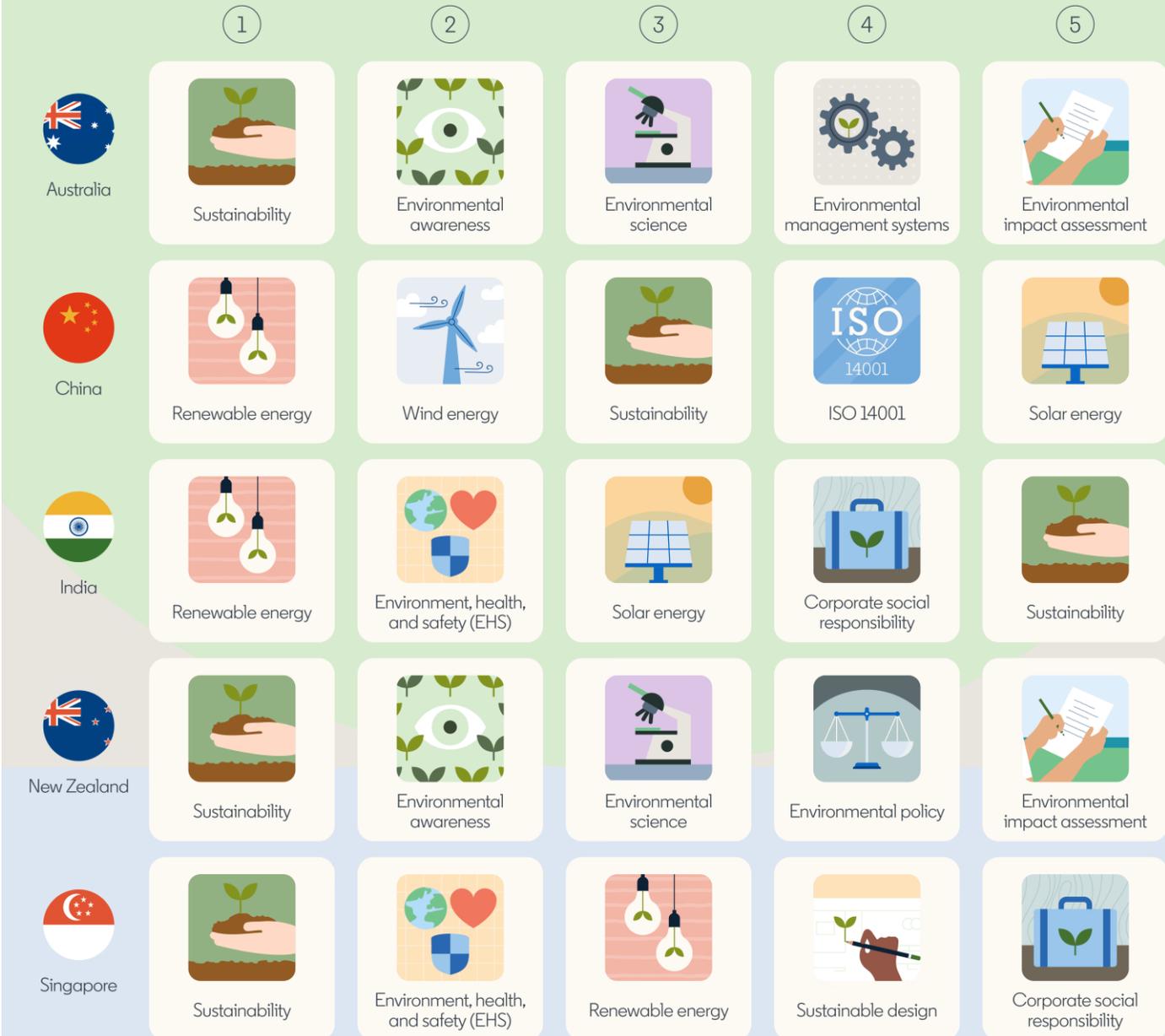
- Transport
  - Expansion of MRT network
  - Since 2020, all new public bus purchases are cleaner energy buses
  - Deploy 60,000 EV charging points nationwide by 2030
  - “Greening” of public transport facilities
- Buildings
  - Singapore Green Building Masterplan
  - Minimum Energy Performance Requirements and Green Mark Standards
  - Mainstreaming Super Low Energy (SLE) Buildings
  - Green Buildings Innovation Cluster (GBIC)
    - Alternative Cooling Technologies
    - Data-drive Smart Building Solutions
    - Advanced Ventilation Technologies



# Green Jobs in Singapore

- According to LinkedIn's Global Green Skills Report 2023, some of the most popular green skills sought after by companies in Singapore include those related to
  - sustainability;
  - environment, health and safety;
  - renewable energy;
  - sustainable design; and
  - corporate social responsibility.

## A ranking of Green Skills in APAC



# Top 5 Skills in Demand for Careers in Sustainability

## 1. Green process design

- also known as sustainable design, is a comprehensive process that looks at a company's various operational aspects

## 2. Carbon footprint management

- Helping companies or clients measure their greenhouse gas emissions

## 3. Environmental management system framework or policy

- This is for companies required to comply with environmental laws, regulations, or who simply want to improve their environment metrics.

## 4. Sustainability management

- Help companies plan, determine, and execute sustainability processes and initiatives

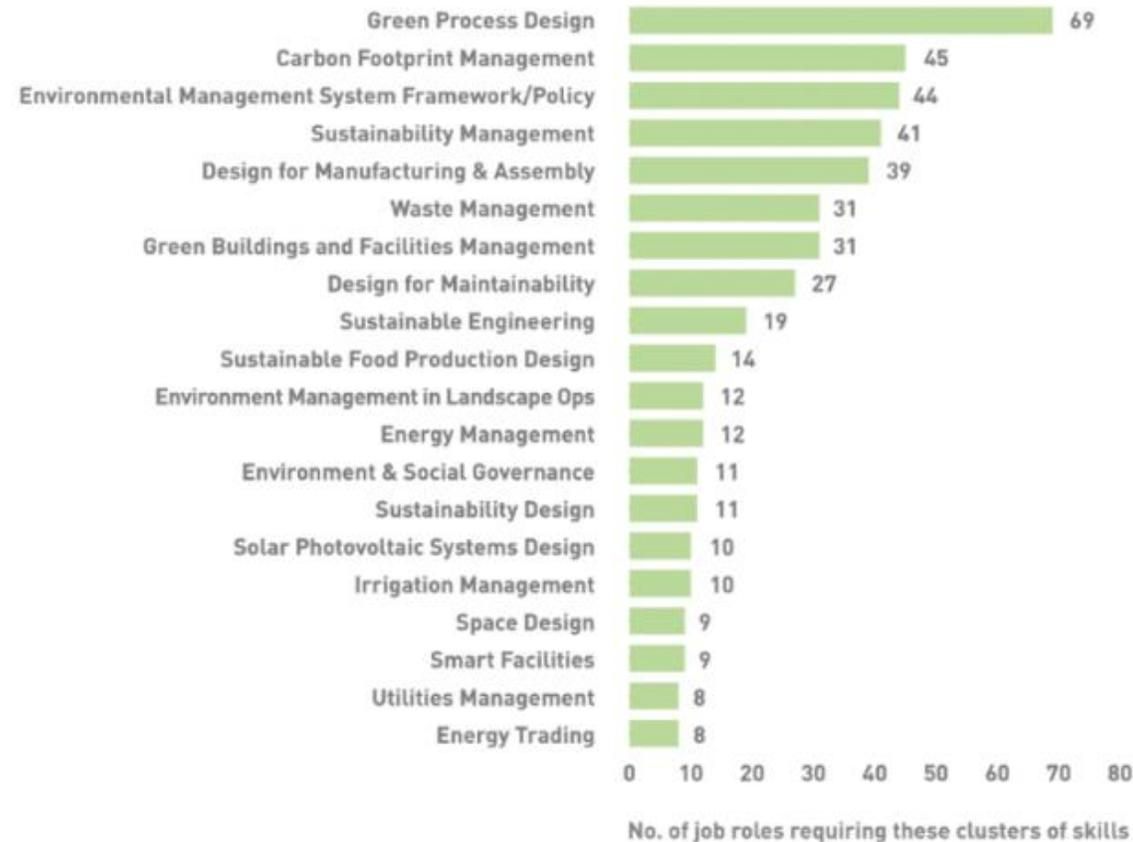
## 5. Design for manufacturing and assembly

- Designing for greener manufacturing and assembly methods

# PRIORITY SKILLS IN SINGAPORE'S GREEN ECONOMY



Diagram 8: Top 20 Clusters of Priority Skills for Green Economy



# What are the OEM opportunities?

- Direct effects of climate change
- Working in the green economy



## Direct effects

### Expected exposure related to climate change

- Increasing temperatures
- Extreme weather events
- UV radiation
- Vector-borne diseases



## Impacts on workers

### Outdoor workers

- At the highest risk are those who do **intense physical work in direct exposure to sunlight and heat**
- **Heat stress** is the most important risk, which may lead to increased **internal body temperature, dehydration, mental fatigue, physical exhaustion, heat stroke and collapse**
- **UV radiation** exposure increases the risk of **skin cancer and impaired motor-cognitive performance**
- Wider spread of **pathogens and disease vectors** increases the **biological risk** for workers
- **Extreme weather** events expose workers to **dangerous working conditions**, which increases the risk of **infectious diseases, accidents and impaired mental health**
- Sectors at risk include **agriculture, forestry, fisheries, construction, mining and quarrying, transport and maintenance and utilities supplies**



### Indoor workers

- At the highest risk of **increased heat stress** are those who work in **poorly cooled buildings** or in settings with high **industrial heat production**, carry out **heavy physical work** or must use **protective personal equipment**
- High indoor temperatures, combined with poor air quality, may lead to **decreased cognitive capacities**
- Health care workers' use of **protective equipment in hot conditions** can contribute to **heat stress**, while the **high demand and stressful conditions** during extreme events may increase **physical and mental health risks**



## Policy responses

- **European Framework Directive on Safety and Health at Work (89/391 EEC):** workplace risk assessment and preventive measures to protect workers
- **European Directive on biological agents at work (2000/54/EC):** workplace risk assessment and preventive measures to protect workers to exposure to biological agents
- National legislation and/or recommendations
- Guidelines on action plans and measures





# OSH and Green Jobs

- Global challenges for sustainable development
  - Climate change, deterioration of natural resources and our environment
  - The need for economic growth, social equity and environmental protection
- Green Jobs/Green Economy
  - Decent & safe work
  - Emerging” risks related to the introduction of new technologies, substances, processes, workforce changes, etc.
  - Retraining or Reskilling
  - Market forces, political pressures
  - Different shades of **Green**
    - Protection of biodiversity and the environment
    - Resource efficiency and low-carbon development in “green sectors”
    - “Greening” industries

Summary of the  
Making Green Jobs Safe Workshop

December 14-18, 2009  
Mandarin Hotel  
Washington, DC

DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Centers for Disease Control and Prevention  
National Institute for Occupational Safety and Health



# OSH and Green Jobs - Opportunities



## Photovoltaic (PV) solar technologies

Potential occupational hazards and risks are mostly associated with the **semiconductor manufacturing** industry phase and/or the **construction industry** phase (for example, falls from rooftops when installing and maintaining solar panels):

- **Ergonomic risk factors**, mostly in production and assembly lines making silicon wafers and semiconductors in some countries.
- Possible **reproductive hazards** (birth effects and miscarriage) and cancer risks.
- **Chemical hazards and risks** in the production of **crystalline silicon (x-Si) solar cells** include hydrofluoric acid (HF) burns and irritation, gas silane ( $\text{SiH}_4$ ) fires/explosions and lead (Pb) solder/module disposal(decommissioning).
- Risks in the production of **amorphous silicon ( $\alpha$ -Si) solar cells** include gas silane ( $\text{SiH}_4$ ) and hydrogen ( $\text{H}_2$ ) fires/explosions and leaks of toxic dopinggases ( $\text{AsH}_3$ ,  $\text{PH}_3$ ,  $\text{GeH}_4$ ).
- Risks in the production of **cadmium telluride (CdTe) solar cells** include cadmium (Cd) toxicity, carcinogenicity, module disposal.
- Risks in the production of **copper indium selenide (CIS) solar cells, gallium arsenide (GaAs) high-efficiency solar cells...**

# OSH and Green Jobs - Opportunities

## Materials recycling

In addition to the general OSH prevention principles, the following measures should be taken:

- Special legal and technical provisions to regulate the recycling world in connection with environmental regulatory agencies;
- Special policies and programmes for/with workers in the informal sector, who usually are not covered by labour inspections and other formal structures related to OSH.
- Special primary health care (PHC) policies and programmes for “waste pickers” or scavengers should be developed, using PHC and family health strategies and approaches, including health and workplace surveillance.



## 2022 Waste Statistics and Overall Recycling Table

Waste Type	Total Generated ( <sup>'000 tonnes</sup> )	Total Recycled ( <sup>'000 tonnes</sup> )	Recycling Rate	Total Disposed ( <sup>'000 tonnes</sup> )
Ferrous metal	1,338	1,331	99%	7
Paper/Cardboard	1,064	394	37%	671
Construction & Demolition	1,424	1,419	99%	5
Plastics	1,001	57	6%	944
Food	813	146	18%	667
Horticultural	221	188	85%	32
Wood	419	298	71%	121
Ash & sludge	241	27	11%	213
Textile/Leather	254	5	2%	249
Used slag	169	166	99%	2
Non-ferrous metal	92	91	98%	2
Glass	73	11	14%	63
Scrap tyres	26	25	95%	1
Others (stones, ceramics, etc.)	249	30	N.A. <sup>1</sup>	219
<b>Overall</b>	<b>7,385</b>	<b>4,188</b>	<b>57%</b>	<b>3,197</b>

# OSH and Green Jobs - Opportunities

## Energy efficiency of buildings / Green Buildings

While some researchers and occupational safety and health organizations have begun compiling lists of hazards associated with green construction, very few formal studies analyze such hazards.

Other workplace hazards are not new but are found in new contexts:

- Increased risk of existing hazards: lead and asbestos in weatherization.
- Hazards associated with new technologies and products: exposure to isocyanate (insulation) and to nanomaterials
- 'Reintroduction' of wood in construction
- Green buildings are often tightly sealed and more thoroughly insulated in order to save energy, ventilation may be reduced during internal finishing work.

# OSH and Green Jobs - Opportunities

## Transportation: embracing EV

- Fire and explosion: Hydrogen used in fuel cells is a very flammable gas and can cause fires and explosions if it is not handled properly.
- Hydrogen fires are invisible and if a worker believes there is a hydrogen leak, it should always be presumed that a flame is present. <<emergency responders>>
- Freeze burns: Workers may also be exposed to freeze burns when liquid hydrogen comes into contact with skin.
- Electrical hazards: Hydrogen fuel cell workers are exposed to potential high voltage (300-500V) electrical hazards present in their work environment, increasing electrocution and arc flash risks.
- Exposure to hazardous chemicals: methanol
- Nano-sized catalysts, like cesium oxide in fuel cells, could raise new exposure concerns

# OSH and Green Jobs - Opportunities

## Carbon dioxide capture & storage techniques

Little bibliographic evidence exists of accumulated experience with OSH hazards and risks.

The risk of leakage of CO<sub>2</sub> from pipelines is a major concern. A sudden and large release of CO<sub>2</sub> would pose an immediate danger to human life and health in cases of exposure to concentrations of CO<sub>2</sub> greater than 7–10% by volume in the air.

Similar concerns are applicable to the risk of leakage of CO<sub>2</sub> from storage sites.

# OSH and Green Jobs - Opportunities

## Sustainable Aviation Fuel (SAF)

Produced from renewable raw materials, such as used cooking oil, or animal fat from food industry waste. It meets all quality and performance requirements of conventional fossil fuels but costs 3 to 5 times more.

RETURN TO ISSUE | < PREV REVIEW NEXT >

## Conventional and Alternative Aviation Fuels: Occupational Exposure and Health Effects

Nektarios Karanikas\*, Cherry Foster, Adolfo Beltran Hernandez, Alice Harvey, Ozan Targal, and Nathan Horswill

Cite this: *ACS Chem. Health Saf.* 2021, 28, 3, 159–170

Publication Date: March 10, 2021

<https://doi.org/10.1021/acs.chas.0c00120>

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**SUBJECTS:** [Aromatic compounds](#), [Fossil fuels](#), [Fuels](#), [Hydrocarbons](#), [Synthetic fuels](#)

### Abstract

The use of fossil fuels in aircraft over the last few decades has driven several studies on health effects due to occupational exposure. Relatively recently, alternative fuel types have emerged, but their implications on the health of exposed workers have not attracted proportional attention. In our paper, we review both academic and gray literature about the health risks related to exposure to jet and alternative fuels. The literature suggests that, although the health effects on workers exposed to conventional fuels are concerning, there is no universally accepted dose–response relationship. The limited current research with animals on alternative fuels indicates that these fuels have not resulted in a reduction of health risks. Overall, it seems that, while aviation fuels are tested for efficiency and lower emissions, studies on health impacts in an occupational context have not been a priority. As occupational exposure to aviation fuels might increase due to the growth of the aviation industry, it is essential to conduct further research on the effects of exposures to both conventional and alternative aviation fuels and ensure that the latter do not pose the same risks or even greater ones than those of conventional fuels.



ACS Chemical Health & Safety

AIRCRAFT FUELS		
RELATIVE ENVIRONMENTAL IMPACT	AIRCRAFT PERFORMANCE	OCCUPATIONAL HEALTH**
Fossil Fuels   Alternative Fuels*	Fossil Fuels   Alternative Fuels*	Fossil Fuels   Alternative Fuels*
<b>Alternative Fuels</b>		<b>Fossil Fuels</b>
<b>Studies:</b> Limited; animal only		<b>Studies:</b> Several on humans and animals
<b>Results:</b> Similar but inconclusive		<b>Results:</b> Concerning for inhalation & dermal contact. Occasionally controversial
<b>Exposure limits:</b> None		<b>Exposure limits:</b> Regional—only for inhalation

\*Alternative fuels include bio, synthetic, mixed with fossil fuels etc.  
\*\*Effects from prolonged exposure

# Singapore to have world's largest sustainable aviation fuel plant

27 Apr 2022 • 3 min read

in f X



Finnish producer Neste can produce as much as 1 million metric tonnes of fuel a year when 1.5b-euro refinery in Tuas is completed in 2023.

Singapore would have the world's largest sustainable aviation fuel (SAF) production capacity when Finnish producer Neste's Tuas facility is completed in the first quarter of 2023.

Currently, Neste is the top SAF producer globally in terms of output and capacity with an annual production capacity of 100,000 metric tonnes at its facility in Finland.

It will be able to roll out as much as 1 million metric tonnes of SAF per annum at its 1.5-billion-euro (\$2.2-billion) refinery in Tuas when the plant is ready by April next year, making Singapore Neste's main SAF production site.

# The Way Ahead

- Climate change – ignoring the signs will be disastrous
- Green economy – environment protection + decent employment
- Social equity and well-being
- OSH or OEM as an integral part of the strategy:
  - Green job creation policies
  - Risk assessment and management from design phase to life-cycle analysis implementation and monitoring
  - Enforcement of OSH quality standards in green jobs
- Stakeholders dialogue and participation of policy makers, employers, trade unions in policy making and governance

# Thank you



Former PSG coach Galtier replaces Crespo as Al-Duhail coach



Actress Jin Yirji's husband dies of heart attack at 85



## Forum: Time to focus on the new health risks workers may face in green industries

UPDATED OCT 7, 2023, 5:00 AM SGT



I applaud the Government's vision and efforts in taking a whole-of-nation approach to tackling the environmental issues brought about by climate change.

Singapore is vested in this as we do not have many sources of alternative energy, and being able to continue our growth in a sustainable manner is very much a matter of survival.

The various measures will lead to new employment opportunities in the green industries such as solar energy, waste management and carbon capture, and I believe these sectors will continue to bloom in years to come.



Diversify your portfolio and gain exposure to leading US companies

These jobs will open up new career opportunities, but "green jobs" do not necessarily mean safe jobs.

Workers in the green industries may face health and safety hazards that are commonly known in workplaces, such as falls, working in confined spaces, and electrical, fire, and other similar hazards.

Additionally, workers may be exposed to new hazards which may not have been previously identified.

For example, workers in the solar energy industry may be exposed to cadmium telluride, a known carcinogen, if adequate controls are not implemented.

Along with ensuring the right manpower and skillsets are in place, the authorities should also look into the workplace safety and health aspects of workers in the green industries.

The Workplace Safety and Health Council promotes workplace safety and health guidelines for different industries, and it is perhaps time to have guidelines for green industries too to set safety and health standards, and to update these along the way.

Wong Shiu Hong (Dr)