**Change Makers** 

For Review only

# EXPERIMENT NO.

A Handbook on Climate Change for the World's Young Keepers



Hwee Goh Illustrated by David Liew



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## AN ANCIENT POWER

The world is mostly powered by fossil fuels — these come from living things that have died and decomposed over a long time. The three main fossil fuels are coal, petroleum and natural gas, but the reality is that these will run out.

Wow!

What is that?

#### Did You Know?

This is why fossil fuels are non-renewable, because they are exactly that, and it is not possible to make more. Scientists estimate these might run out by the middle of this century.

> No idea... But I have this feeling it's a sign of something big that'll come after we're gone.



#### We Are Recyclables

Plants and animals are made mostly from hydrogen and carbon. When they die, their bodies decompose to become **fossils** that store this "hydrocarbon" energy. Millions of years later, these fossils deep in the ground can be burned to produce new energy. This is how the ancient living world has been a source of **fuel** for our modern one.

#### What's That?

Fossils are the preserved remains of ancient plants and animals. Fuel is any material that is burned to produce heat and power.

#### Plant and Plankton Power

Scientists say it is a myth that dinosaur remains are part of these fossil fuels, but the coal we burn today does date back to the time dinosaurs roamed **Earth**.

• **Coal**: Plants decay and turn into peat, a natural layer of moss, which transforms into coal with heat, pressure and time. This was about 300 million years ago, and the reason why it is called the Carboniferous (coal-laden) period.

What's That?

When used as

a proper noun

to refer to our

planet, the word "**Earth**"

- Petroleum: Small organisms called plankton die and sink to the bottom of ancient seas. The substance is buried and chemically transformed over millions of years. Under pressure and heat, this becomes a hydrocarbon substance we call crude oil, which is refined to become petroleum.
- Natural gas: Under even hotter temperatures, these hydrocarbons become natural gas. It also lies in pockets of gas deep in the ground.





#### A Black Rock and a Hard Place

Archaeologists believe that 4,000 years ago, a person in Northern China came across an odd piece of black rock

and discovered it could burn. In a time before electricity and gas, this must have been a groundbreaking discovery. By the Han dynasty in the 3rd century BC, these 'stones' were used for fuel and extracting iron ore from the ground.

#### Did You Know?

The use of coal worldwide peaks in the early 2000s, driven mainly by the growth of China's economy.

## THE EARTH EXPERIMENT

The last decade was the hottest on record, and 2020 was the hottest year ever. The question now is whether global warming will keep trending upward, causing hottest to become even hotter.

> Give peace a chance, will you?

#### Did You Know?

The UN Secretary-General António Guterres has called on people to change the game on the climate, before the climate changes our lives forever.

"Making peace with nature is the defining task of the 21st century. It must be the top priority for everyone, everywhere." What's That? To change the game is to do something to change the direction for the better.



CURRENT

TEMPERATURE

ARE YOU KIDDING?

VER

GETTING

JUST

COLD

ARRRGH

HELOI

HOTTER

WARM

COOL

GLOBAL

#### A Global Chain Reaction

Since the late 19th century, the global temperature has gone up about 1°C. Such a seemingly small number has had devastating effects on everything — the weather, the oceans and all creatures big What's That? Geoengineering is to make large scale changes to how the planet works, to slow down or reverse the effects of climate change.

and small. The excessive burning of fossil fuels, releasing CO<sub>2</sub> which causes global warming, has made this a giant "**geoengineering**" experiment for Earth.

#### Too HOT to Be Cool

The impact of higher temperatures is no longer a concept in a far-flung future. Changes due to a warming Earth is happening right here, right now.

• Ice melts: Glaciers and ice sheets are melting, especially at the earth's poles. Animals that live in icy regions are losing their habitat, or homes.  Migration: When it is too warm, animals seek cooler regions to survive. Some do not make it. He's rather far from

home, no?

At least

he's not hot

anymore.

ditor's note: In nature, you won't find olar bears and penguins together. hey live on opposite poles!

• Sea levels rise: Low-lying islands and countries may lose their land, and animals and plants living near shorelines may die out.



HEI P

ADELLE PENGUIN



 Under the sea: Excess CO<sub>2</sub> is absorbed by the oceans, making the water more acidic. This makes it harder for some corals and organisms to survive.

THE

#### A Climate Catastrophe

Warmer temperatures collide with cooler air, creating weather disasters and distress over the last two decades. What's That? A catastrophe is a disaster.

 Greater evaporation: Higher temperatures cause plants and soil to lose water, making the climate in drier regions even warmer.  Flooding: Warm air expands, forcing winds to spiral upward. As the winds cool, water vapour condenses and falls as rain. Together with rising sea levels, heavy rains cause floods, disrupting lives.

 Extreme heat waves: These are periods of abnormally hot weather, lasting days to weeks. Intense heat waves have caused droughts and uncontrolled wildfires.  Hurricanes: Warmer temperatures and sea surfaces are causing more superstorms coming from the oceans. Scientists are also studying trends in severe snow and thunderstorms.

## SCIENCE OF THE SEAS

Humans have a direct hand in the CO<sub>2</sub> they produce, driving up temperatures and melting the world's ice sheets into the sea. What we have underestimated is the power of the massive ocean in tempering the

effects of global warming. Even so, it cannot cope anymore. Every **molecule** of CO<sub>2</sub> that we do not put into the air now is important to our future.

#### What's That?

CO<sub>2</sub> is a **molecule** made up of one carbon atom and two oxygen atoms. When fossil fuels (hydrocarbons) are burnt, carbon combines with oxygen to form CO<sub>2</sub>.



#### A Giant Buffer

Even in the late 19th century, scientists already suspected that CO<sub>2</sub> in the atmosphere could cause global warming. What they could not figure out was why it was not as hot as they had calculated. Where was the missing heat? As it turns out, our oceans have been hard at work absorbing most of this excess heat caused by greenhouse gases.

#### Did You Know?

Water covers more than 70 per cent of the planet's surface and it is able to absorb and store large amounts of heat, stabilising the earth's climate.



A bit melodramatic, no?

Fish and other sea creatures breathe oxygen and give off CO<sub>2</sub>. Ocean plants take in CO<sub>2</sub> and give off oxygen. As it is, our vast ocean is already helping to suck up about a quarter of the CO<sub>2</sub> from fossil fuels. The problem is, besides causing higher temperatures, the CO<sub>2</sub> also makes the sea water more acidic.

#### Did You Know?

We have a Great Ocean Conveyor Belt: warm surface water travels up north, and in return, cold water sinks and travels down south, moderating temperatures all over the globe. Global warming and excessive ice melting upset this system.

#### A Recycling Revolution

Less than 10 per cent of plastics get recycled every year. The game changer is going to be a "zero-waste" plan where plastic never becomes waste.

- Some plastics are already being processed into pellets to be reused for making new plastics.
- Plastics, which are made up of hydrocarbons, can be converted back into fuel.
- "Bioplastics" are made from plants so that they are biodegradable and will break down naturally.

Grandma?

Oh, hello dear. So nice to see you! Did you know that Grandpa and Auntie Rosa are nearby too? They're part of Leech Road.

0

#### Did You Know?

Reused plastic has been made into new shoes, skateboards and other products. There are roads in Melbourne, Australia, that are paved with material recycled from plastic bags, glass and printer cartridges.

Did You Know? Sweden has a waste-toenergy (WTE) programme that converts the energy from burning trash, to heat and electricity.



Global warming and climate change have brought to the fore, the idea that **minute** changes in temperature caused by excessive CO<sub>2</sub>, will lead to large unpredictable events like superstorms, flooding and, not least the loss of animals and plants.

What's That? minute (mai-newt): Very tiny.







#### **Chaos Theory**

The butterfly effect predicts that the flap of a butterfly's wings in one part of the world might cause a tornado in another. It was a concept made popular in weather science by Edward Lorenz in the 1960s. Lorenz's mathematical theory found that a small change in conditions could produce 'chaos', and a large number of different, unpredictable outcomes.

#### Did You Know?

A 2015 study in England ran a reverse calculation and found that CO<sub>2</sub> emissions and a 2°C increase in global temperature could wipe out some butterfly species.

#### Did You Know?

Science fiction writer Ray Bradbury's A Sound of Thunder (1952) is about a man who travels 65 million years back in time to shoot a dinosaur. He panics at the sight of a tyrannosaur, and steps on and crushes a butterfly under his boot. He returns to a completely changed world.

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#### Sea Butterflies

The ocean's chemistry has changed, becoming more acidic as it absorbs excess CO<sub>2</sub>. This dissolves the shells of an important species called pteropods, also known as sea butterflies for the way they flutter and move with wing-like extensions. These **molluscs** are a very important part of the food web, and if they die off, could affect the organisms above them, including humans.

#### What's That?

There are at least 50,000 known species of **molluscs**, including snails, octopuses, scallops and clams.

#### Did You Know?

About 250 million years ago, excessive CO<sub>2</sub> from volcanic eruptions caused a similar acidification of the oceans, killing off more than 90 per cent of marine species. This period coincided with the Permian-Triassic extinction (page 56).



## HWEE'S HANDBOOK TOOLKIT

Climate change is one of very few areas that the adults in your life probably have not done better. I certainly haven't. This is your world, and you will take the lead for change. Here, I have mapped out some ideas to send you on your way to greatness!

#### Science Is True Whether You Believe It or Not

Astrophysicist Neil deGrasse Tyson said this, and science is indeed our best weapon. If we know the definite science that causes global warming and climate change, we also know the definite science to solve this.



#### Never Too Late

The issue of climate change may bring about a sense of hopelessness — that we are too late. The strategy now is to (1) cut greenhouse gases by a significant amount in the near future but (2) adapt to changes that have been set in motion, such as rising sea levels. However, a true solution needs a global response.

#### Good Is the Enemy of Great

Is it good enough if your government or local business is pledging to go net zero? If we are already in a climate emergency, solutions have to make a difference to the future of you, Earth's young keeper. Write letters, share your knowledge and persuade others to act.



#### Be Your Own Butterfly

Build your own circle of impact. If everybody does so, they can create a butterfly effect on climate change. Research ways you can reduce your carbon footprint — make sure to turn off the lights when not in use, cut down on food waste and take public transport.



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Climate scientists since the 19th century, for putting their instincts to the test and laying the groundwork for what we know today.



### ABOUT **HWEE AND DAVID**

Trained at the Northwestern University Medill School of Journalism, former CNA (Channel NewsAsia) reporter 0 and editor Hwee Goh put together this handbook from current 2021 climate change titles and a few hundred sources online. Hwee, who is a media and editorial consultant. is also a veteran on the school circuit.



She continues to curate stories on @hweezbooks.



Illustrator **David Liew** and Hwee were in junior college together studying strange but true moments in history. They grew up being warned that climate change is coming. This book is the least they could do for young readers who are now born into it. David taught history, before becoming illustrator to many bestselling

book series. David's art often takes on humorous angles appreciated by his fans, young and old. It is with this added layer of art that the Change Makers team hopes to engage young readers on their own journey.





A detailed look into the history of global warming and climate change through curated stories and engaging art. With every rise in temperature, there is a domino effect, and only knowledge can propel us forward.

He's rather

far from home, no?

- What was the Little Ice Age?
- How does the butterfly effect work?
- Who is responsible for the carbon footprint?
- When are greenhouse gases dangerous?

This book seeks to engage the future caretakers of Earth with a fun but persuasive call to action, for they were born in a time of climate change.

Former TV journalist Hwee Goh and historian/artist David Liew turn the lens on global warming with

their signature storytelling. Are you ready to embark on this journey to save your world?

#### **Change Makers**

The Change Makers series of books will build in children a strong sense of inquiry, to arm them with knowledge in S.T.E.A.M (Science, Technology, Engineering, Art and Math) to tackle this brave new world of unknowns.

visit our website at: www.marshallcavendish.com





At least

he's not hot

anymore...