This lesson is intended to explain and extend student's understanding of global warming.

This lesson is intended to provide a real-life example demonstrating the effects of changes to pH. It introduces students to the important, lesser-known environmental issue of ocean acidification and includes a practical activity.

US: Next Generation Science Standards
MS-ESS3 Earth and Human Activity
MS-ESS3-1 – Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy and groundwater resources are the result of past and current geoscience processes.
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MS-ESS3-5 – Ask questions to clarify evidence of the factors that have cause the rise in global temperature over the past century.

KS3 Science curriculum
Earth and atmosphere: the production of carbon dioxide by human activity and the impact on climate.
Chemical reactions: the pH scale for measuring acidity/alkalinity; and indicators

Chemical reactions: representing chemical reactions using formulae and using equations

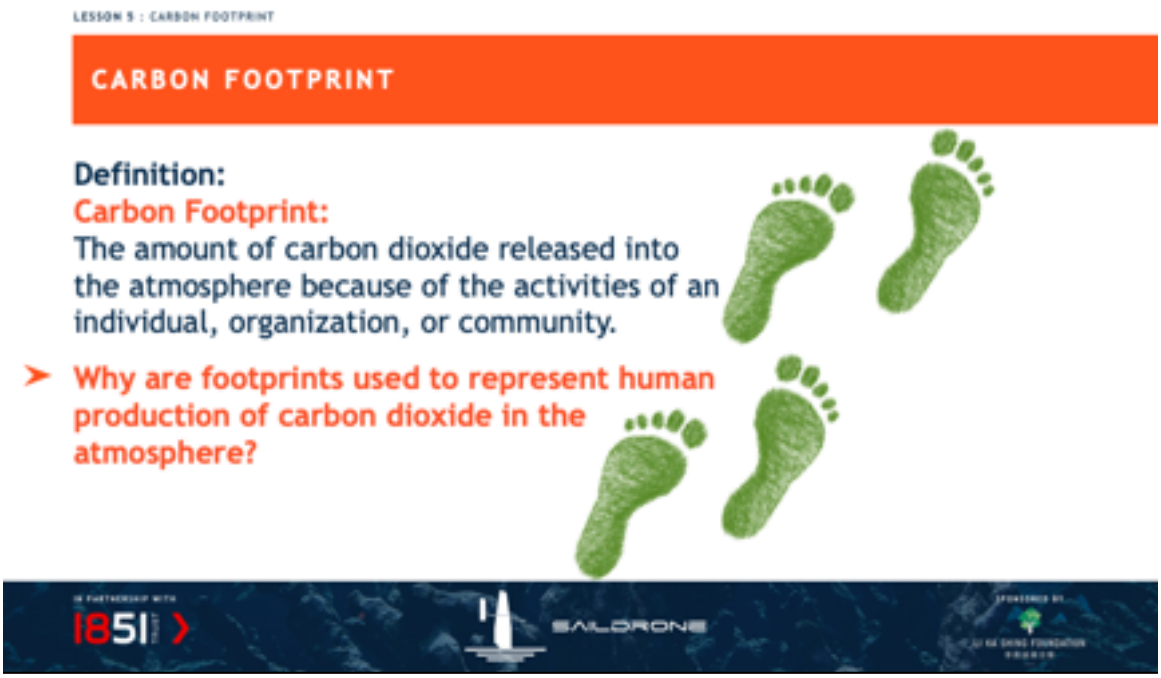
KEY VOCABULARY

Acidity	How acidic a solution is, measured in pH.
Carbon fiber	The material consisting of thin, strong filaments of carbon. It is often used as a strengthening material, including in America's Cup boats.
Carbon footprint	The amount of carbon dioxide released into the atmosphere because of the activities of an individual, organization, or community.
Coral reefs	Rock-like organic material made up of tiny animals called polyps. The coral polyps produce hard calcium carbonate which builds up over thousands of years.
Global warming	A gradual increase in the overall temperature of the Earth's atmosphere, caused by an increase in greenhouse gases.
Industrial era	The industrial era was a period of history when there was a rapid growth in industry and manufacturing. During this period, the use of fossil fuels increased significantly.
Ocean acidification	A process by which oceans become more acidic due to increased absorption of carbon dioxide gas (CO_2), which reacts with the seawater to produce carbonic acid.
pH	A scale that measures the acidity or alkalinity of a solution. 7 is neutral, lower values are more acidic and higher values more alkaline.

Students will complete this starter to build their understanding of what Carbon Footprint means.

Have the students discuss with a neighbour the carbon transfers taken place in the pictures.

The pictures include: Burning fossil fuels in factories and in cars release carbon dioxide into the atmosphere. The increased production of cattle ranching increases the amount carbon dioxide (from respiration) and methane in the atmosphere leading to global warming. Deforestation reduces the amount of carbon dioxide taken in by green plants from the atmosphere, as well as, when burnt release carbon dioxide into the atmosphere.



From the previous slide, explain all of these human caused carbon transfers increasing carbon dioxide in the atmosphere are considered our carbon footprint. We trace the carbon footprint of individuals, whole communities, organizations, companies, etc.

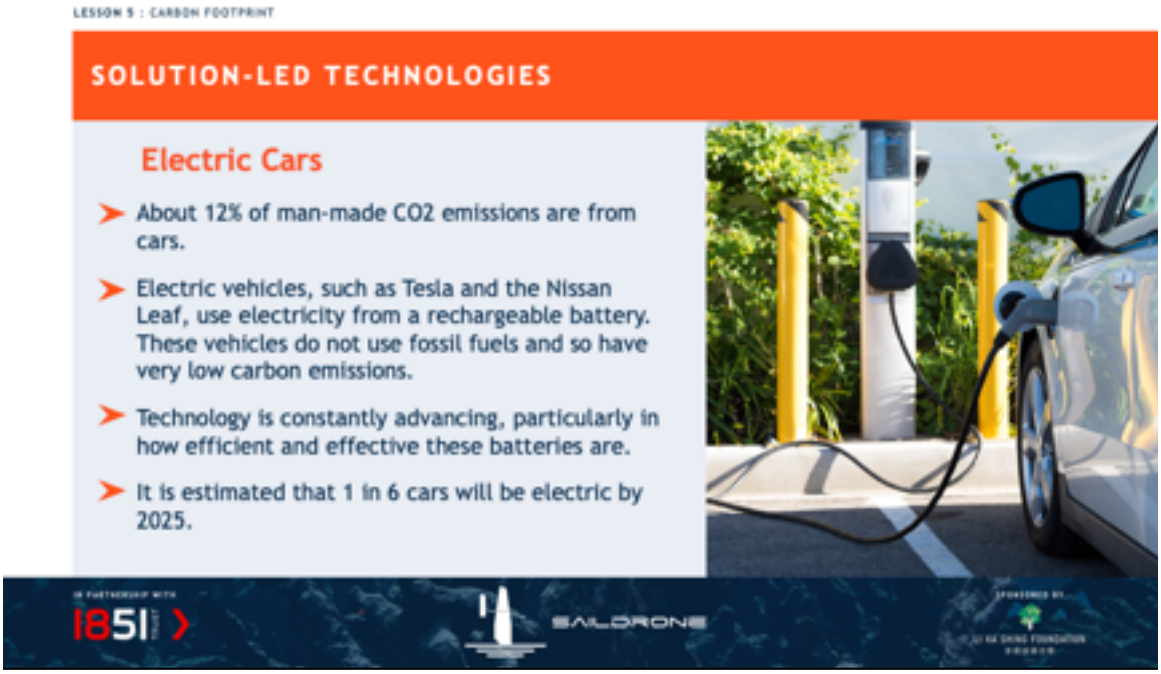
Have students each think about and discuss with a neighbour, why footprints are used to represent this concept. Call on a few students to share. Help students come to the conclusion that people are leaving behind carbon in the atmosphere just as footprints are left behind on a journey. We need to be aware of how much carbon dioxide is being left behind from our life journeys.


LESSON 5 : CARBON FOOTPRINT
REDUCING OUR CARBON FOOTPRINT
As we have learned, the increased amount of green house gasses, including carbon dioxide, lead global warming and ocean acidification.
How can we help?
We need to figure out ways that individuals, communities and organizations can reduce our carbon footprint to keep our Earth healthy.
1851
SAILDRONE

This is maybe a good opportunity to revisit all or parts of the film.

Many organisations are working hard to keep their carbon footprint as low as possible you could discus some of the ways organisations and companies can achieve this including ideas from the slide above.

- Increasing use of solar panels.
- The livestock sector is responsible for 18% of global greenhouse gas emissions. Providing meat-free Monday meals reduces the carbon footprint by 1%.
- Many companies are working towards a 'zero waste to landfill' target, with non-recyclable items heading for 'waste to energy' plants.
- Buildings are being designed to be as energy efficient as possible through maximising natural light and solar energy along with low energy LED lights with movement sensors that turn them off automatically when they are not needed.
- Promote the use of the 5R's – Refuse, Reuse, Reduce, Recycle, Rethink.
- Banning single-use plastics including plastic straws, single use water bottles and cups.
- Companies can try to support local businesses wherever possible, helping to keep transportation mileage low.



Sometimes making a difference as an individual can seem small and hard to measure. It's useful to know about the current developments in science and technology that are helping to reduce carbon footprints around the world. A lot of these developments include making processes more efficient or streamlined, for example the teardrop shaping of some freight trucks creates a 10% fuel saving. For Marks & Spencer's, a UK grocery/department store, this reduces their carbon footprint by over 800 tonnes per year by using teardrop shaped freight trucks. In 2016 in the US 26% of CO2 emissions came from the transportation sector*.

EV cars have zero emissions while on the road. They are still dependent on electricity, which may or may not be sourced from fossil fuels. EV cars use energy more efficiently than traditional internal combustion engines.

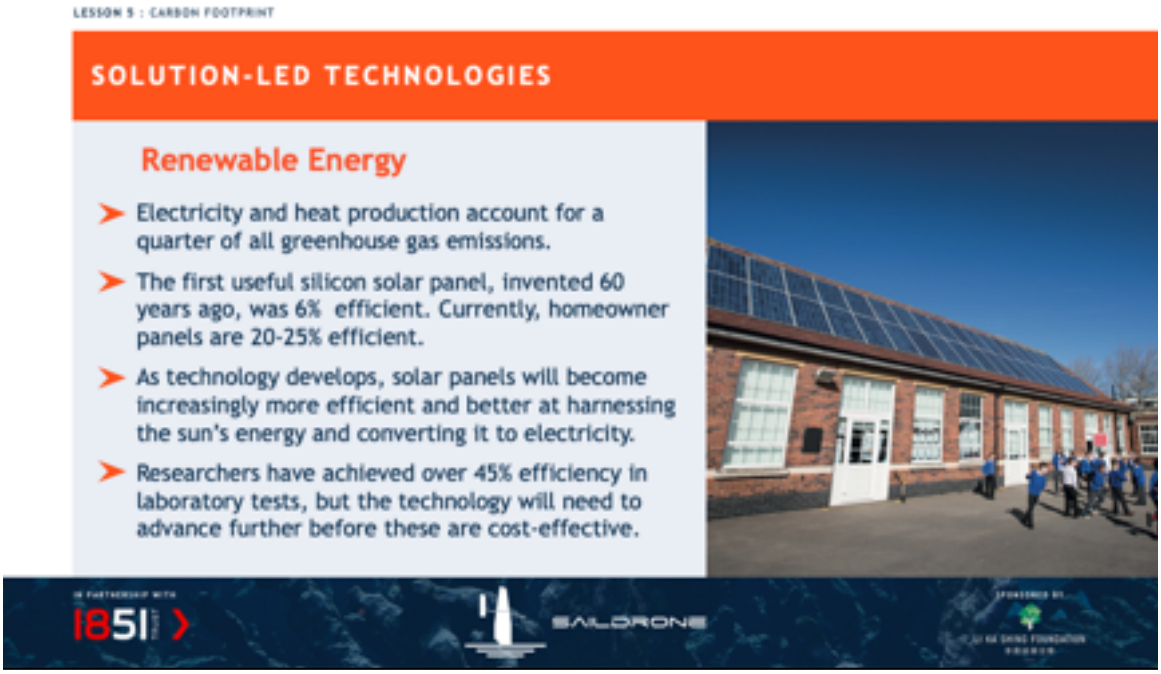
In 2018 the US electric vehicle sales rose 81% when compared with 2017**. As the market for EV cars expands, more technologies are being explored, making EV cars even more efficient. The biggest difficulties for this technology arise in transferring and storing the electricity. Binary fluids and NanoFlowcell technology are being developed to advance batteries. There is some debate about the environmental impacts over the life of EV car batteries. However, changing to an EV car is still one of the best ways to reduce your carbon footprint.

*United States Environmental Protection Agency
**Source: Inside EVs

SOLUTION-LED TECHNOLOGIES

Meat-Free Food

- A third of all greenhouse gas emissions come from food production, with raising animals for meat being the biggest problem.
- Technology and research into meat-free food options are developing. One example of this is Beyond Meat, who have created plant-based burgers and sausages that 'look and cook' like real meat.



Saildrone uses solar panels to power the data collection instrumentation and wind power for its propulsion.

The charity WWF have a useful and short questionnaire to discover how big your environmental footprint is. It is quite a good and simple way to look at some key areas that make a big difference to individual carbon footprints. It also has some easily accessible, useful information on how to reduce your carbon footprint in different areas of your life.
http://footprint.wwf.org.uk/

Students should research and create a poster outlining the ways that individuals can reduce their carbon footprint.
Common examples include:

- Walking/cycling or using public transport more
- Turning off lights and putting equipment on standby
- Turning down the thermostat
- Turning down the heating on your shower and having shorter showers
- Buying locally- grown food or growing your own food
- Using a reusable water bottle and keeping a cup for hot drinks

Provide students with materials to create posters about 'Reducing your Carbon Footprint.' Depending on what materials are available, they may create a poster on poster board, paper or using a computer. Provide students who need additional support with Carbon Footprint Planning Sheet.

When students are finished, have them share their posters with others in the class. Emphasize the strategies students come up with to reduce their carbon footprint. Be sure to encourage students to try these strategies in school and at home. Have students hang their posters in the classroom, school or community to educate others about the importance of reducing your carbon footprint and how it can be done!

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Ask students to name three environmental issues linked to anthropogenic (human caused) carbon dioxide emissions
Some impacts of increasing atmospheric carbon dioxide:

- Rising global temperature (global warming)
- Rising ocean temperature
- Shrinking ice sheets
- Glacial retreat
- Decreased snow cover
- Rising sea levels
- Ocean acidification
- Extreme weather events such as hurricanes, storms, flooding, droughts

Review and remind students about the process of ocean acidification. What do they think the consequences of more acidic oceans might be?

LESSON 5 : CARBON FOOTPRINT

SELF ASSESSMENT

✓	I can identify what the term carbon footprint means.
✓	I can describe how carbon footprint is linked to global warming and ocean acidification.
✓	I can explain how some solutions-led technologies are helping reduce the carbon footprint of people.
✓	I can integrate knowledge of carbon footprint and solutions-led technologies to educate others on how to help.

Aims from the national curriculum:
The national curriculum for science aims to ensure that all pupils are equipped with the scientific knowledge required to understand the uses and implications of science, today and for the future.

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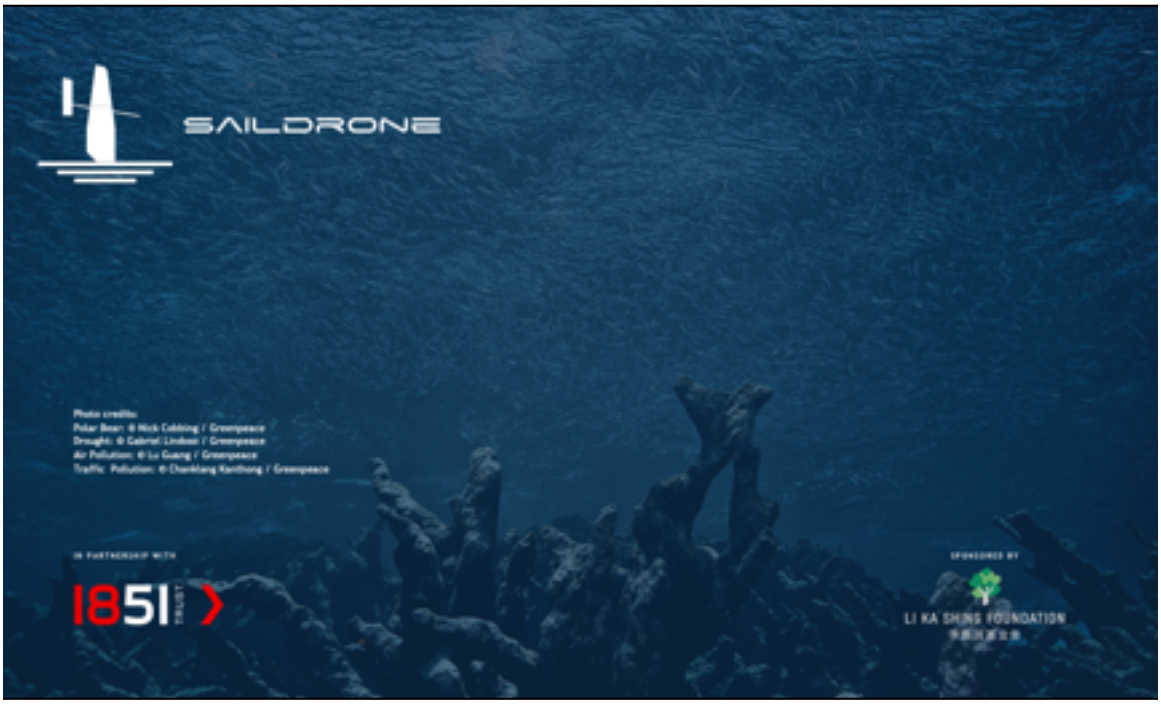
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