Class-11
Climate change:
Technology solutions

16th October 2023

Ways ‘negative emissions’ could slow climate change

The Paris Agreement, adopted at the COP21 sets out a global aim to limit average global surface temperatures to 1.5C

To get to net-zero emissions, we need “negative emissions” technologies (NETs), or things which will suck the CO_2 out of the air to compensate for the ongoing release.”

1. Afforestation and reforestation

A/R-sequester CO_2 at a rate of 3.7 tonnes/ hectare/ year, and comes with an associated cost of $20-100 per tonne

Obstacles???

2. Biochar

The potential to sequester up to 4.8bn tonnes of CO_2e per year

- Advantages / Disadvantages?

3. Blue carbon' habitat restoration

What is blue carbon?

Emissions from degraded mangroves, tidal marshes and seagrasses are thought to be equivalent to 3–19%

4. Building with biomass

Timber and bamboo - structural elements, hemp and wool - insulation, and hemp-lime for walling.

5. Cloud or ocean treatment with alkali

CO2 emissions could be offset by spraying 56m tonnes of KOH into clouds across 0.4% of the Earth's surface (the area of Greenland. (ocean acidification…..)

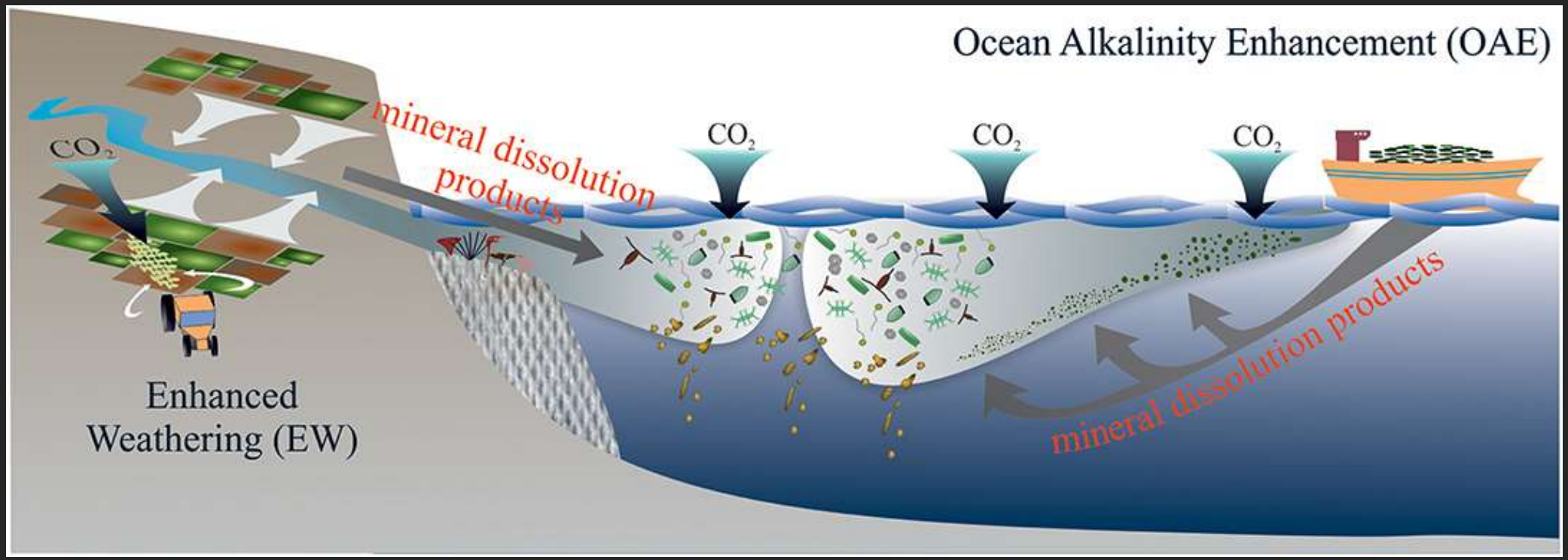
6. Enhanced weathering

Natural rock weathering absorbs around 3% of global fossil fuel emissions.

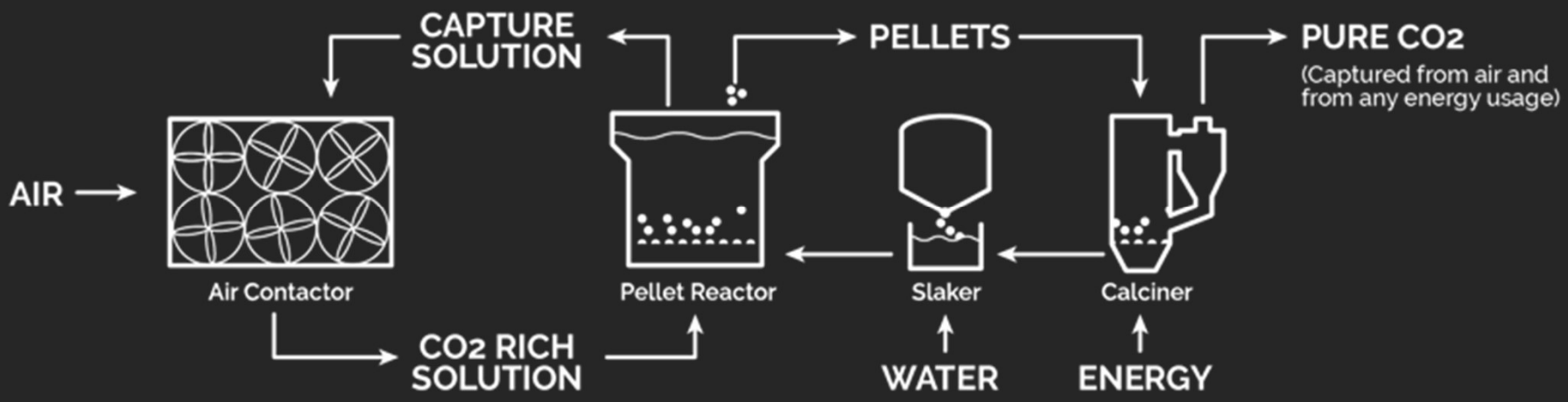
EW ramps up this process

Partially counteracting ocean acidification.

EW could be used to sequester up to 3.7bn tonnes of CO2eq per year globally

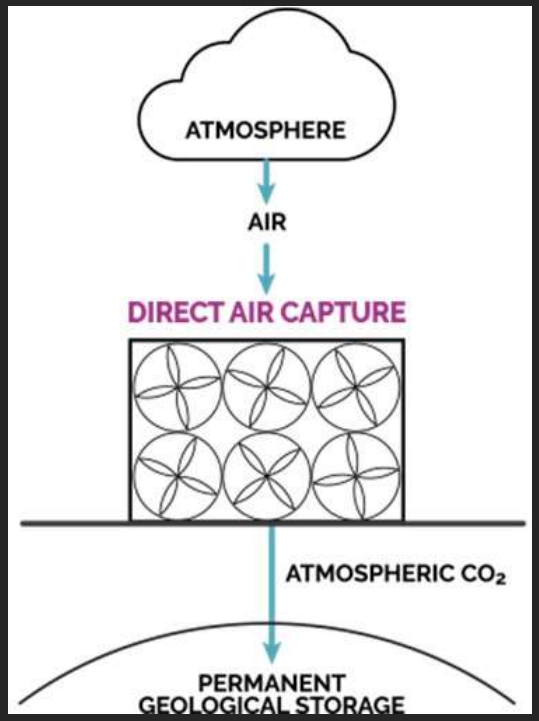


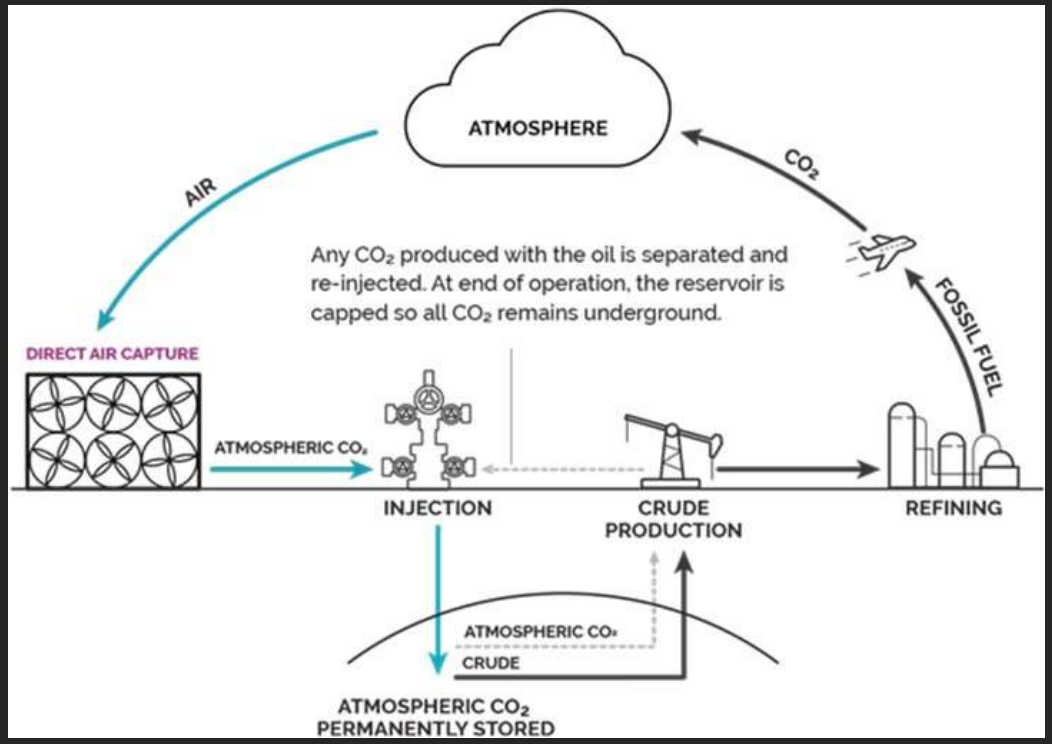
7. DIRECT AIR CAPTURE



1. DAC + STORAGE PLANTS

STANDALONE GEOLOGIC STORAGE

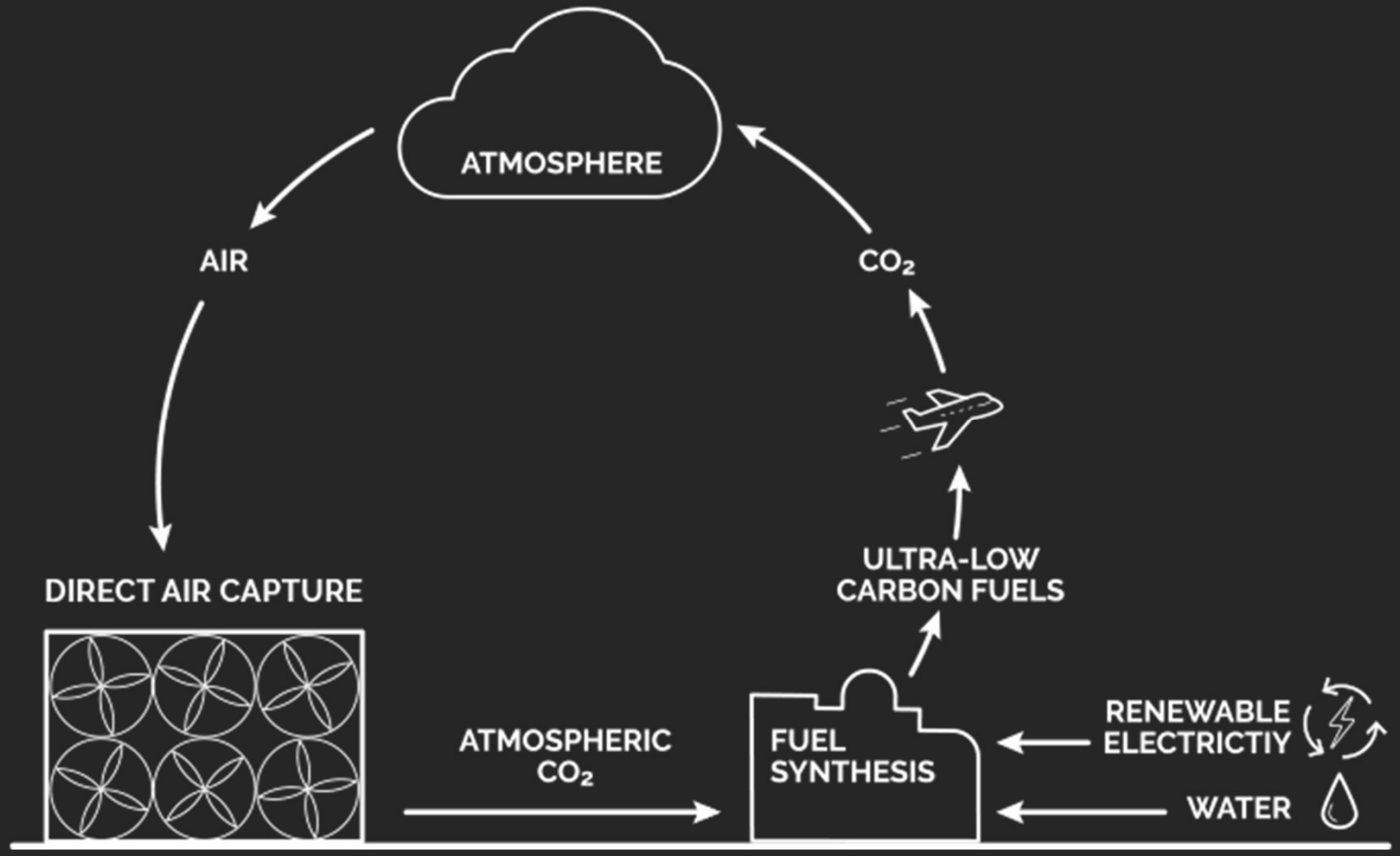




ENHANCED OIL RECOVERY

2. AIR TO FUELS PLANTS

CE's process delivers synthetic, low carbon intensity fuels – such as gasoline, diesel, and jet-A – out of air, water and renewable electricity.



Features and Benefits of the AIR TO FUELS™ Solution

Low lifecycle carbon intensity

CE's AIR TO FUELS™ process can deliver fuels that have a low life-cycle carbon intensity. Burning this fuel would re-release the CO_2 that was captured to make it, but the process would add very little new carbon emissions to the air.

Drop-in compatible

These fuels are drop-in compatible with today's refineries, infrastructure and engines so do not require the financial and environmental cost of completely replacing the world's transportation network.

Highly scalable

Due to an unlimited feedstock – atmospheric CO_2 – these fuels can be produced in global-scale quantities to meet growing demand for low carbon intensity fuels.

Cost competitive

The cost to produce these fuels at scale is cost competitive with biodiesels. While currently more expensive than the production cost of fossil fuels, when paired with regulatory incentives for low carbon intensity fuels, such as Low Carbon Fuel Standard regulations, the cost becomes competitive in leading jurisdictions today.

Cleaner burning

These fuels are cleaner burning than fossil fuels, with no sulfur and low particulates, meaning they not only reduce Greenhouse Gas emissions, but contribute far less to local air pollution too.

Less resource dependent

These fuels can be produced with 100 times less land and significantly less water than biofuels, and thus don't suffer the fundamental limits to scaling associated with biofuels.

Location independent

AIR TO FUELS™ plants can be built in any country and in multiple climates, and can be economically located to take advantage of low cost local energy or proximity to demand center.

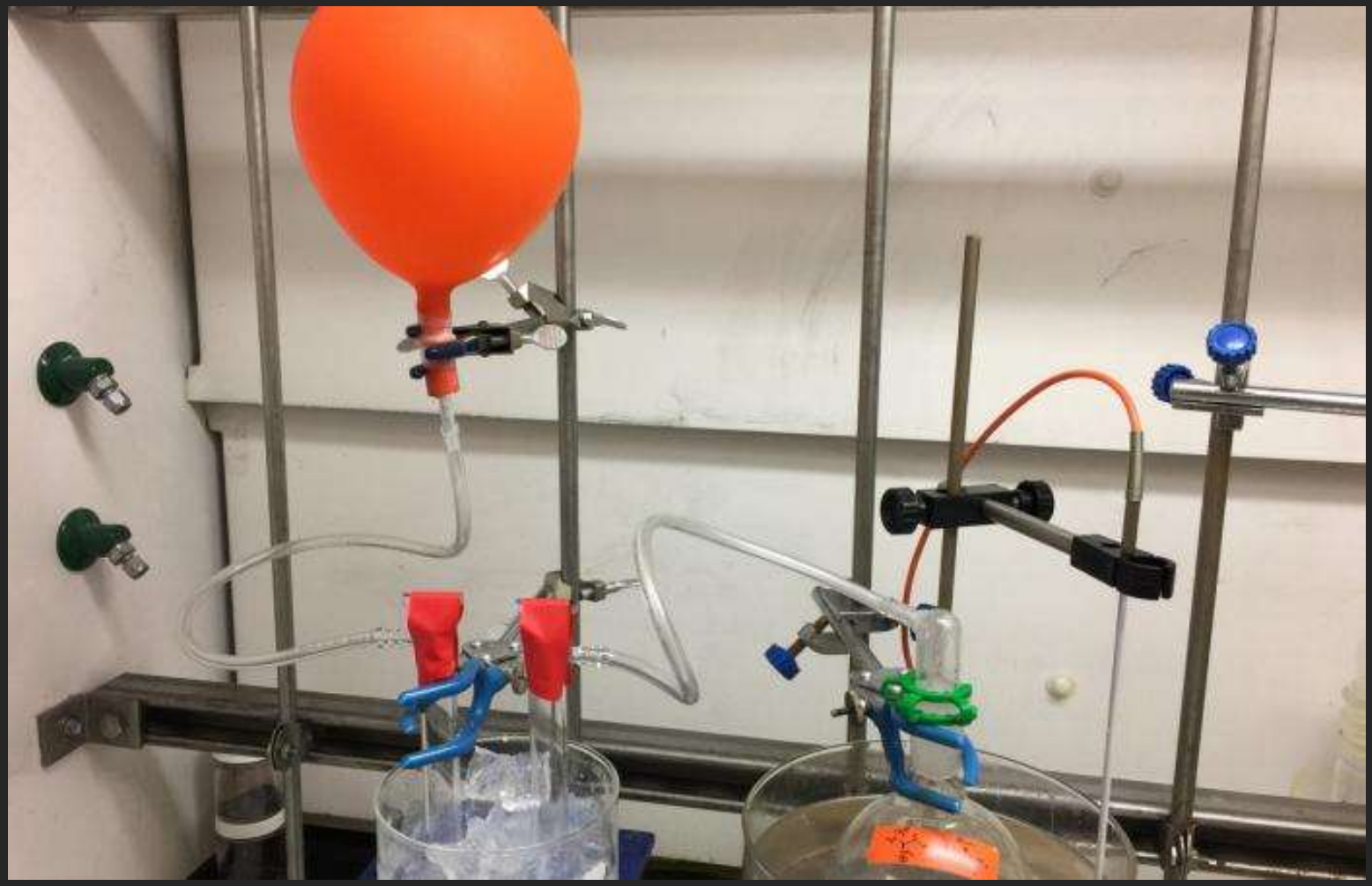
Blendable

These fuels can be blended with traditional fossil fuels to allow progressive emissions reductions by gradual fuel switching, with no blending limit.

Provides an early market for green hydrogen

Synthetic fuels provide an early, additional route for green hydrogen to decarbonize the energy system, which is important for sectors where direct use of hydrogen may require retro-fits or new infrastructure. By combining green hydrogen with atmospheric CO_2 to produce fuels, the AIR TO FUELS™ process provides a pathway for hydrogen use in today's infrastructure, and increases the ability of these sectors to quickly displace fossil fuels.

Carbon-capture technology scrubs CO2 from power plants like scuba-diving gear



CO2 release by mild heating of the BIG-bicarbonate solid. The released CO2 gas is trapped in the orange balloon, while the released water vapors are trapped by condensation in the ice-cooled U-shaped tube. Credit: Neil J. Williams and Erick Holguin.

Companies with the most developed technologies today include .

Together these companies have 18 plants of varying sizes (1 tCO_2/yr up to 4,000 tCO_2/yr capacity, the largest plant in operation today) capturing a total of just under 8,000 tCO_2/yr

Around half of that is sequestered permanently — similar to the annual emissions from 870 cars — while the other half is sold for use in various products.

Aether: In A First, Diamonds Made From Air Pollution Certified As Vegan

1. Purchasing Co2 from Climeworks'-shipping it to the US, where the diamonds are grown.
2. CO2 is put through a proprietary process to convert it into high purity CH4.
3.CH4 is then injected directly into the diamond reactors, where "chemical vapor deposition" is used to grow rough diamond material over the course of several weeks.

The chemical vapor deposition involves heating gasses to very high temperatures under near-vacuum conditions.
The Verge that this process and other manufacturing stages are powered entirely by carbon-free sources like solar and nuclear.
Once the diamonds finish growing, they're shipped to Surat, India, where they're cut and polished before being sent back to New York City's for sale.
Each carat removes the equivalent of 20 tons of carbon (half energy consumption/avoid 127 gallons of water).

NZT Project

Net Zero Teesside aims to sequester carbon emissions under the sea

Carbon captured by Net Zero Teeside will be buried beneath the North Sea

NZT aims to capture CO2 produced in industrial processes and power plants and transport these emissions by pipeline to offshore storage sites several km beneath the North Sea

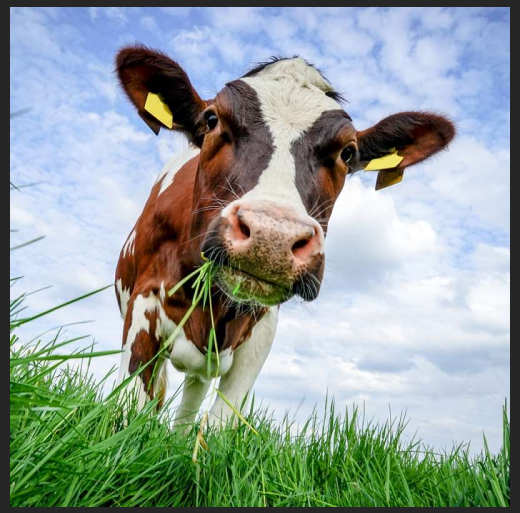
The aim, as the NZT project's name suggests, will be to reduce carbon emissions in a number of carbon-intensive industries in the North East to zero by as early as 2030.

Feeding cows seaweed

Cows are a major methane polluter

Feeding cows seaweed could help reduce methane emissions

1. A red seaweed which grows in the tropics can reduce methane emissions by 80% in cows when it is added as a supplement to cattle feed. (1.5 billion head of cattle globally- seaweed?)



2. Halter – Catalyst-----water+Co2

Delicious insects

Burgers made from insects such as grasshoppers could tackle cattle farming emissions – Beef replacement???

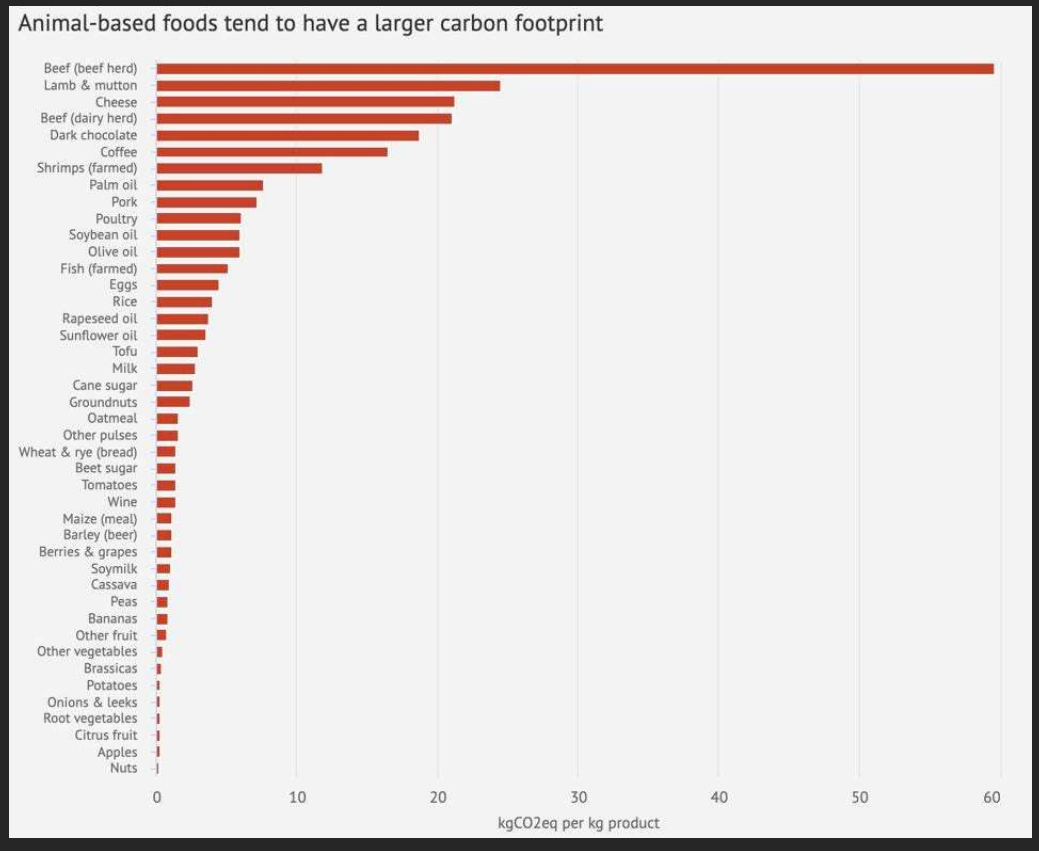
Insects farmed without the demands on land or water that cattle farming requires

Giving up beef will reduce carbon footprint more than cars, says expert

Study shows red meat dwarfs others for environmental impact, using 28 times more land and 11 times water for pork or chicken

Beef production results in five more climate-warming emissions than chicken or pork. Photograph: Alamy Photograph: Alamy

The meat and dairy industries create 7.1 gigatons of GHG annually—that's 14.5% of total man-made emissions. But beef is by far the biggest offender, generating 60 kgs of GHG emissions per kg of meat produced—that's more than twice the emissions of the next most polluting food, lamb.



Impact on forest Ecosystems

TRASE Platform

(Stockholm Environment Institute and Global Canopy)

Climate repair

Refreezing the poles has been suggested as a climate repair tactic (Marine Cloud Brightening and Greening Oceans)

A satellite image shows the trails left behind by ships as they cross the Pacific Ocean. *NASA*

A conceptualized image of an unmanned, wind-powered, remotely controlled ship that could be used to implement cloud brightening. *John MacNeill (4 step process)*

There's a science question about *can* we do it, but there's also an ethical question about *should* we do it, and a policy question about *how would* we do it

Remote working

Remote working from home could address transport emissions

Greater use of data centres

Energy-efficient datacentres could provide more efficient computation

Hydrogen Ships

Maritime shipping emissions contribute 2.5 percent of global CO2

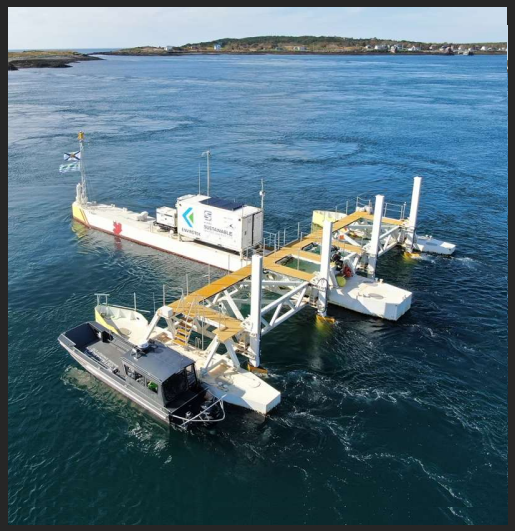
Tree Corridors

Colombia planted more than 350,000 trees (3C)

Electric Planes

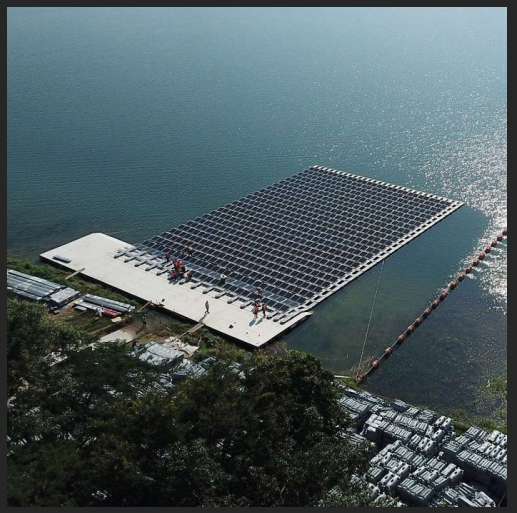
2% of the world's carbon emissions

Tidal Energy



First floating tidal-energy platform in Canada

Floating Solar



Floating solar plant in South Korea (41MW)

The ‘battle of technologies’

Blockchain to revolutionize the commodity markets
(Illegal Tuna fishing – RS-GPS)

Remote sensing in planning and monitoring
(deforestation - Palm oil expansion….)

Drones and crowdsourcing help monitor forest health and detect illegal logging
(WRI- Global Forest Watch (GFW)

Thermal imaging to combat poaching
(Savanna of Kenya NP – poachers from Tanzania)

AI to track wildlife
(Protect wild tigers and their habitats – China)
Wild Me

NASA Technologies Spin off to Fight Climate Change

More NASA Tech Helping to Solve Climate Challenges

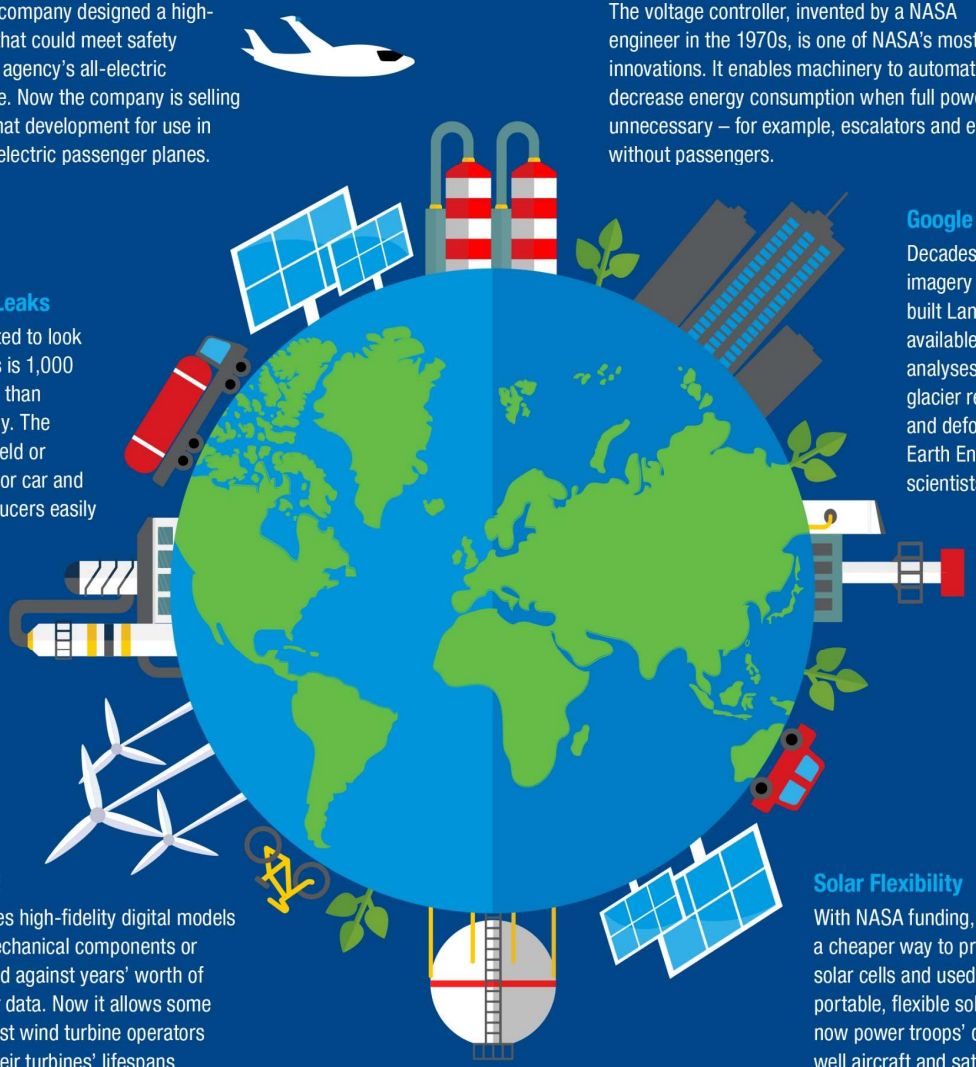
NASA research and innovations have led to more environment-saving spinoffs than we can count. Besides the ones described in this feature, here are a handful of additional technologies helping curb greenhouse gas emissions, advance renewable energy technologies, and better understand the processes leading to warming.
For more, visit spinoff.nasa.gov/climate-change

All-Electric Flight

With NASA's help, a company designed a high-power battery pack that could meet safety requirements for the agency's all-electric experimental airplane. Now the company is selling batteries based on that development for use in some of the first all-electric passenger planes.

Running on Empty

The voltage controller, invented by a NASA engineer in the 1970s, is one of NASA's most-used innovations. It enables machinery to automatically decrease energy consumption when full power is unnecessary – for example, escalators and elevators without passengers.



Google Searches Earth

Decades' worth of Earth imagery gathered by the NASA-built Landsat satellites is now available for free, enabling global analyses of surface trends like glacier retreat, desertification, and deforestation. Google Earth Engine is partnering with scientists to mine all that data.

Sniffing Out Gas Leaks

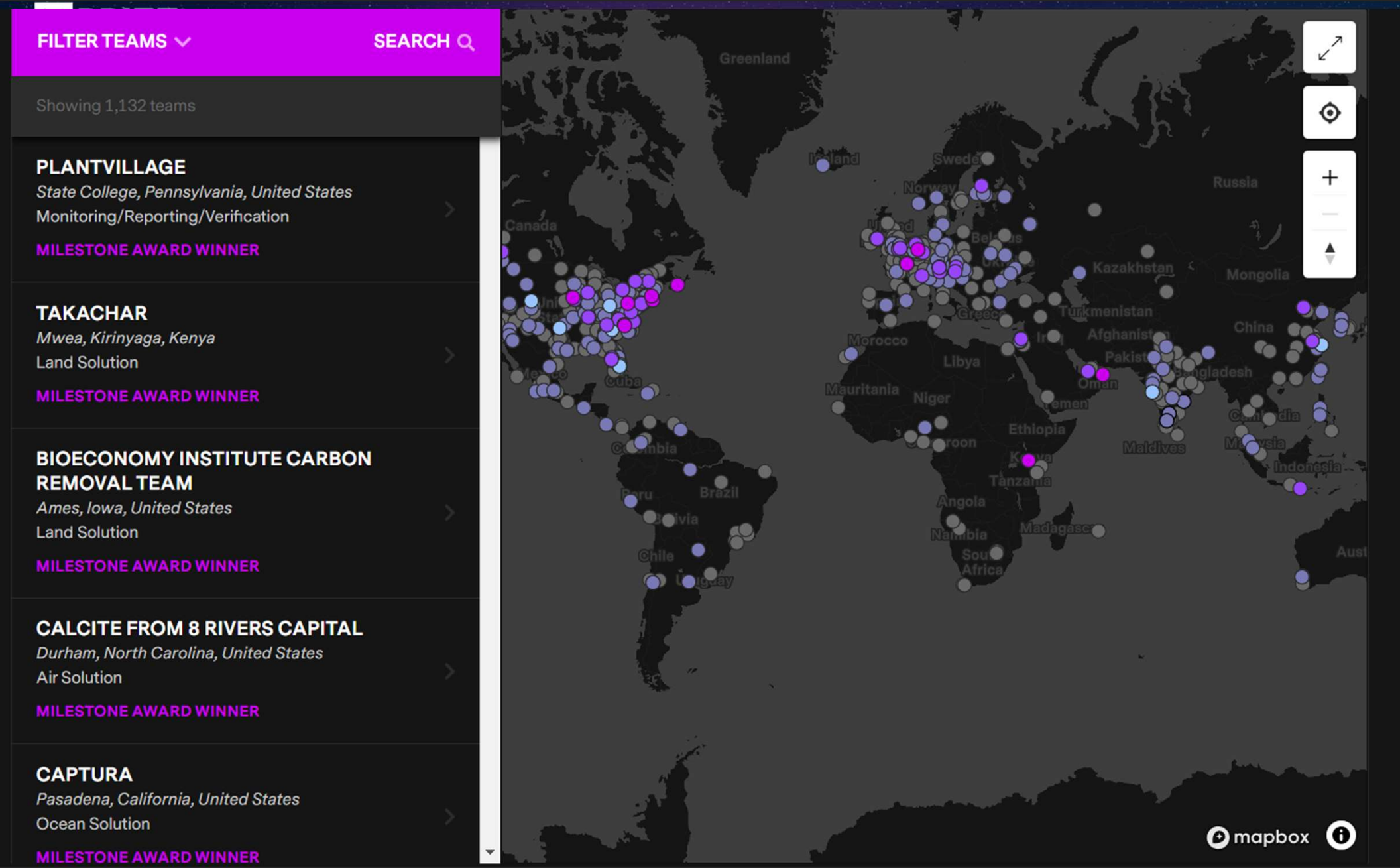
A spectrometer created to look for methane on Mars is 1,000 times more sensitive than competing technology. The device can be handheld or mounted on a drone or car and lets natural gas producers easily spot and stop leaks.

Send In the Clone!

A program that creates high-fidelity digital models – or "clones" – of mechanical components or systems was validated against years' worth of NASA helicopter gear data. Now it allows some of the country's largest wind turbine operators predict and extend their turbines' lifespans

Solar Flexibility

With NASA funding, one company developed a cheaper way to produce high-efficiency solar cells and used it to make affordable, portable, flexible solar panels. Its solar cells now power troops' devices in the field, as well aircraft and satellites.


FILTER TEAMS
SEARCH
Showing 1,132 teams
PLANTVILLAGE
State College, Pennsylvania, United States
Monitoring/Reporting/Verification
MILESTONE AWARD WINNER
TAKACHAR
Mwea, Kirinyaga, Kenya
Land Solution
MILESTONE AWARD WINNER
BIOECONOMY INSTITUTE CARBON REMOVAL TEAM
Ames, Iowa, United States
Land Solution
MILESTONE AWARD WINNER
CALCITE FROM 8 RIVERS CAPITAL
Durham, North Carolina, United States
Air Solution
MILESTONE AWARD WINNER
CAPTURA
Pasadena, California, United States
Ocean Solution
MILESTONE AWARD WINNER
Greenland
Canada
Russia
Kazakhstan
Mongolia
China
Morocco
Libya
Mauritania
Niger
Ethiopia
Maldives
Brazil
Angola
Tanzania
Madagascar
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Indonesia
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