

# Bulletin Board

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### ASIA PACIFIC

#### Potential reforms to the regulation of nicotine vaping products Consultation paper

2022-11-30

The Therapeutic Goods Administration (TGA) is seeking comments on potential reforms to the regulation of nicotine vaping products (NVPs) in Australia. NVPs are nicotine-containing products intended to be used in vaping devices such as ecigarettes, e-cigars and other electronic nicotine delivery systems (ENDs). This includes vape liquids, e-liquids and e-juices that contain nicotine and/or nicotine salts. NVPs do not include other nicotine replacement therapies (NRTs) for smoking cessation containing nicotine, such as patches, gum, lozenges, mouth spray and inhalators nor nicotine-containing products that are not intended for use in ENDs, such as chewing tobacco and snuff. The regulatory requirements for NVPs changed on 1 October 2021, when a TGA decision to classify NVPs as prescription medicines (Schedule 4 to the Standard for the Uniform Scheduling of Medicines and Poisons (Poisons Standard)) took effect, meaning that NVPs are subject to the regulatory controls for prescription medicines (the 2021 reforms). The aim of the 2021 reforms was to prevent children and adolescents from accessing NVPs, whilst allowing smokers to access these products for smoking cessation with a doctor's prescription. However, evidence is emerging that the reforms are not meeting these aims. Children and adolescents are continuing to obtain NVPs in higher numbers. Commonwealth law prevents the importation, and State and Territory laws prevent the domestic supply, of NVPs without a prescription. However, there is evidence that many adults are accessing NVPs without a prescription, rather than through lawful supply channels with a prescription from an Australian doctor.

Read More

TGA, 30-11-2022

[https://consultations.tga.gov.au/medicines-regulation-division/proposed-reforms-to-the-regulation-of-nicotine-vap/user\\_uploads/tga-consultation-paper---nicotine-vaping-products---nov-22-1.pdf](https://consultations.tga.gov.au/medicines-regulation-division/proposed-reforms-to-the-regulation-of-nicotine-vap/user_uploads/tga-consultation-paper---nicotine-vaping-products---nov-22-1.pdf)

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#### China Consults on Guidelines for Determination of New Cosmetic Ingredients

2023-01-24

On Jan. 19, 2023, China National Institutes for Food and Drug Control (NIFDC) released the draft of Technical Guidelines for Determination of New Cosmetic Ingredients for public consultation.

The draft regulates the principles for the determination, classification and naming of new cosmetic ingredients. All notifiers and registrants of new cosmetic ingredients shall conduct research and safety assessment in accordance with the requirements prescribed.

Although China has clearly specified the definition of new cosmetic ingredients and released the reference inventory to figure out the status of ingredients -Inventory of Existing Cosmetic Ingredients in China (IECIC), during the actual compliance work, various companies encounter difficulties in correctly determining if an ingredient is a new cosmetic ingredient.

Read More

Chemlinked, 24-01-23

<https://cosmetic.chemlinked.com/news/cosmetic-news/china-consults-on-guidelines-for-determination-of-new-cosmetic-ingredients>

#### India Proposes to Revise Standard for Acetylene

2023-01-19

Read More

Chemlinked, 19-01-23

<https://chemical.chemlinked.com/news/chemical-news/india-proposes-to-revise-standard-for-acetylene>

### AMERICA

#### Illinois Pollution Control Board Poised to Adopt Regulations Establishing PFAS Groundwater Standards

2022-12-20

The Illinois Pollution Control Board is currently considering proposed amendments to the Illinois Part 620 groundwater regulations that would

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establish the first enforceable PFAS standards under Illinois law. The rulemaking proposal, filed by the Illinois Environmental Protection Agency on December 8, 2021, would establish groundwater standards for six (6) per- and polyfluoroalkyl substances (PFAS).

The PFAS standards were included in proposed amendments to Illinois' Part 620 groundwater quality regulations, 35 Ill. Adm. Code Part 620, which provides a broader range of proposed updates and modifications to the groundwater standards.[1] The Part 620 groundwater standards are also utilized in the state's risk-based remediation regulations, the Tiered Approach to Corrective Action (TACO) regulations at 35 Ill. Adm. Code Part 742, used to set standards under remedial programs such as the Site Remediation Program (SRP) regulations, 35 Ill. Adm. Code 740, and the Leaking Underground Storage Tank (LUST) Regulations, 35 Ill. Adm. Code 734.

The proposed amendments would establish standards for the following PFAS compounds:

- 1) Perfluorobutane Sulfonic Acid (PFBS)
- 2) Perfluorohexane Sulfonic Acid (PFHxS)
- 3) Perfluorononanoic Acid (PFNA)
- 4) Perfluorooctanoic Acid (PFOA)
- 5) Perfluorooctane Sulfonic Acid (PFOS)
- 6) Hexafluoropropylene oxide dimer (HFPO-DA, also known as GenX).

In addition, the proposal would classify PFOA as a carcinogen based on its 2B classification by the World Health Organization's International Agency for Research on Cancer ("IARC"), which means that it is considered possibly carcinogenic to humans.

Read More

Dickinson Wright, 20-12-22

[https://www.dickinson-wright.com/news-alerts/illinois-pollution-control-board-poised-to-adopt-regulations-establishing-pfas-groundwater-standards?utm\\_source=Mondaq&utm\\_medium=syndication&utm\\_campaign=LinkedIn-integration](https://www.dickinson-wright.com/news-alerts/illinois-pollution-control-board-poised-to-adopt-regulations-establishing-pfas-groundwater-standards?utm_source=Mondaq&utm_medium=syndication&utm_campaign=LinkedIn-integration)

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### PFAS Bans, Restrictions Go Into Effect in States in 2023

2023-01-04

Laws and regulations restricting "forever chemicals" in more than a half dozen states are entering effect in 2023, including the start of a timeline for a first-in-the-nation ban on PFAS in all products in Maine.

The newly effective measures range from labeling requirements to bans of the substance in products including food packaging, firefighting foam, and personal care products.

Per- and polyfluoroalkyl substances (PFAS) are a class of chemicals that don't naturally break down, and so they accumulate in water, soil, and in the human body. Studies have shown that high levels increase the risk of cancer and other adverse health effects.

#### Now in Effect

##### Maine

LD 1503 bans intentionally added PFAS from all products of any kind sold in the state, broken up with intermediate deadlines designed to allow industry to adapt.

The first mandate took effect Jan. 1, requiring a PFAS phaseout for rugs, carpets, and fabric treatments. The state law aims to ban the substance in products across the board by 2030, except when their use is unavoidable. The law's approach is similar to the "essential use" concept for PFAS restrictions in the EU.

More sweeping is a reporting requirement for all companies to report or make public the amount of and purpose of PFAS added to any products, with no exemptions yet granted by the state.

That's left many companies concerned about compliance, according to John Gardella—shareholder of CMBG3 Law—who said that uncertainty and confusion could arise over the state law's use of the words "intentionally added PFAS" and its exemption for "unavoidable" uses of the substances.

"In the perhaps not too distant future, when products liability lawsuits start—in other words, this particular consumer good caused me an ill health effect and therefore you need to compensate me—there's going to be a database full of potential targets for litigation," Gardella said.

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Read More

Bloomberg Law, 04-01-23

<https://news.bloomberglaw.com/environment-and-energy/pfas-bans-restrictions-go-into-effect-in-states-as-year-begins>

### **EPA Issues Next Test Order Under National Testing Strategy for PFAS Used in Plastics, Chemical Manufacturing**

2023-01-04

Today, the U.S. Environmental Protection Agency (EPA) issued the next Toxic Substances Control Act (TSCA) test order requiring testing on per- and polyfluoroalkyl substances (PFAS) under EPA's the National PFAS Testing Strategy. Today's action orders companies to conduct and submit testing on trifluoro(trifluoromethyl)oxirane (HFPO), a perfluoroalkyl substance used in making plastics. This is the second test order under the strategy and the latest action taken under EPA's PFAS Strategic Roadmap to confront contamination from forever chemicals nationwide.

The information EPA receives under this order will not only improve the Agency's understanding of human health effects of HFPO, but also the effects of dozens of PFAS that are structurally similar to HFPO and in the same Testing Strategy category of PFAS, improving the agency's overall data on PFAS.

"PFAS can pose a serious risk to communities, especially those overburdened with pollution, but many of these chemicals have limited or no toxicity data. That's why we're working quickly to establish stronger, more robust data on PFAS to better understand and ultimately reduce the potential risks," said Assistant Administrator for the Office of Chemical Safety and Pollution Prevention Michal Freedhoff. "Communities deserve transparency from the companies that use or produce these substances and we'll continue to use our data-gathering tools to collect information on the potential environmental and human health impacts of PFAS like HFPO."

HFPO (CASRN 428-59-1) is used in making plastics and in organic chemical manufacturing. More than 1,000,000 pounds of HFPO are manufactured each year, according to TSCA Chemical Data Reporting rule reports.

After thoroughly examining existing hazard and exposure data, EPA has concluded that HFPO may present an unreasonable risk of injury to health

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or the environment. The potential hazards from exposure to this chemical could include neurotoxicity, reproductive effects and cancer. EPA also found there is insufficient information to determine the effects on human health from inhalation of HFPO (which is a gas at room temperature). This test order will address this data need.

The Chemours Company FC LLC, DuPont De Nemours Inc., E. I. du Pont de Nemours and Company, and 3M Company are the recipients of this test order. Prior to issuing the test order, EPA engaged in discussions with the recipient companies to encourage them to voluntarily submit existing data on HFPO to EPA. Based on information in existing studies provided by cooperating companies, EPA determined that certain data were no longer needed and thus excluded the relevant testing requirements from the issued order. EPA has made the data voluntarily provided by these companies publicly available in docket EPA-HQ-OPPT-2021-0910 on [www.regulations.gov](http://www.regulations.gov).

Read More

US EPA, 04-01-23

<https://www.epa.gov/newsreleases/epa-issues-next-test-order-under-national-testing-strategy-pfas-used-plastics-chemical>

### **Maine DEP reverses course and clarifies food packaging containing PFAS need not be reported**

2023-01-04

The Maine Department of Environmental Protection (DEP) made important updates to its website last week, stating that product packaging, including food packaging, that contains intentionally added per- and poly-fluoroalkyl substances (PFAS) is not required to be reported under 38 Maine Revised Statutes (MRS) § 1614, An Act To Stop Perfluoroalkyl and Polyfluoroalkyl Substances Pollution (the Law). Based on the updated statements, it appears the DEP has reversed its previous position that food packaging containing intentionally added PFAS must be reported under the Law.

In late October 2022, DEP indicated on its website that food packaging is subject to the Law's PFAS reporting requirement.<sup>1</sup> This interpretation came as a surprise to industry, which had interpreted the Law's exemption for "Products subject to Title 32, chapter 26-A or 26-B" as exempting food packaging from the reporting requirement and eventual ban under the Law. As a reminder, Chapter 26-A prohibits the sale in Maine of packaging

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containing certain contaminants, including PFAS when DEP determines a safer alternative to PFAS is available in food packaging; Chapter 26-B provides mechanisms for Maine to identify priority food contact chemicals and prohibit sales of food packaging containing those chemicals. DEP took the position that because it had not yet completed a rulemaking under Chapter 26-A or designated PFAS as a priority food contact chemical under Chapter 26-B, the exemption for "Products subject to Title 32, chapter 26-A or 26-B" was not operative.

However, recent updates to DEP's Frequently Asked Questions (FAQs), available on its website, indicate the Department has reversed its position.<sup>2</sup> In response to the FAQ "What products must be reported?" DEP now states "[t]he packaging of a product is not required to be reported." Further, the FAQ "Which products are exempted from the program?" clarifies, "The statutory exemption of products subject to Title 32, §26-A, Reduction of Toxics in Packaging, and Title 32, §26-B, Toxic Chemicals in Food Packaging, applies to all packing, packing components and food packaging as defined in as defined in 32 MRS § 1732 regardless of whether the Department has specifically regulated such items." The response continues, "These exemptions apply only when items are actually used as packaging, packing components, or food packing, intended for marketing, handling, or protection of products."

Based on these revised responses, DEP appears to be taking the position that food packaging that contains intentionally added PFAS is not subject to the reporting obligation or other requirements of 38 MRS § 1614, including the 2030 ban on PFAS in products. The changes also indicate that product packaging generally is not subject to the reporting requirement.

Read More

JD Supra, 04-01-23

<https://www.jdsupra.com/legalnews/maine-dep-reverses-course-and-clarifies-6665734/>

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### EUROPE

#### European Commission - Transition pathway for the chemical industry

2023-02-01

In January 2023, the European Commission published the transition pathway for the chemical industry. The pathway is an actionable plan co-developed by the European Commission with EU countries, chemical industry stakeholders, NGOs and other interested parties. It identifies the actions and conditions needed to achieve the green and digital transition and improve resilience in the chemical industry, in line with the updated EU industrial strategy

The chemical industry, the fourth largest industry in the EU, plays a key role in the European twin transition. Chemicals are present in about 95% of manufactured goods and are at the basis of Europe's major value chains. In addition, the chemical industry is one of the largest CO2 emitters in the EU.

Therefore, the European Commission co-created the transition pathway for the chemical industry with stakeholders. It provides a list of more than 150 actions, grouped under 26 topics, to be implemented by the concerned stakeholders within an agreed timeframe.

Read More

European Commission, 01-02-23

[https://single-market-economy.ec.europa.eu/sectors/chemicals/transition-pathway\\_en](https://single-market-economy.ec.europa.eu/sectors/chemicals/transition-pathway_en)

#### How microplastics are infiltrating the food you eat

2023-01-09

Microplastics have infiltrated every part of the planet. They have been found buried in Antarctic sea ice, within the guts of marine animals inhabiting the deepest ocean trenches, and in drinking water around the world. Plastic pollution has been found on beaches of remote, uninhabited islands and it shows up in sea water samples across the planet. One study estimated that there are around 24.4 trillion fragments of microplastics in the upper regions of the world's oceans.

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But they aren't just ubiquitous in water – they are spread widely in soils on land too and can even end up in the food we eat. Unwittingly, we may be consuming tiny fragments of plastic with almost every bite we take.

In 2022, analysis by the Environmental Working Group, an environmental non-profit, found that sewage sludge has contaminated almost 20 million acres (80,937sq km) of US cropland with per- and polyfluoroalkyl substances (PFAS), often called “forever chemicals”, which are commonly found in plastic products and do not break down under normal environmental conditions.

Sewage sludge is the byproduct left behind after municipal wastewater is cleaned. As it is expensive to dispose of and rich in nutrients, sludge is commonly used as organic fertiliser in the US and Europe. In the latter, this is in part due to EU directives promoting a circular waste economy. An estimated 8-10 million tonnes of sewage sludge is produced in Europe each year, and roughly 40% of this is spread on farmland.

Due to this practice, European farmland could be the biggest global reservoir of microplastics, according to a study by researchers at Cardiff University. This means between 31,000 and 42,000 tonnes of microplastics, or 86 trillion to 710 trillion microplastic particles, contaminate European farmland each year.

Read More

BBC News, 09-01-23

<https://www.bbc.com/future/article/20230103-how-plastic-is-getting-into-our-food>

### Is Water Management The Next Priority For Europe And The Chemical Industry?

2023-01-17

In summer 2022, Europe experienced its most severe drought in 500 years. In addition to affecting many communities across Europe, the drought and water scarcity had consequences for the manufacturing sector as well, including the chemical industry.

This is why Cefic together with France Chimie organised a dedicated workshop to discuss how the chemical industry could deal with water scarcity and raise awareness on other water related challenges for the sector.

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“We see the impact of droughts directly on the chemical industry’s activities, for instance on our ability to transport”, said Cefic’s Director General Marco Mensink. In Europe, inland waterway plays an important role for the transport of goods. Marie Zimmer, Head of Responsible Care / Corporate Social Responsibility at France Chimie, added that “water has become an issue of industrial and environmental performance. We need to support companies to tackle water scarcity and further improve their water management, so the industrial sites can better defend themselves in case of crisis”.

Water scarcity is an emergency of our times, especially due to the interplay between climate change, increasing fluctuations in water availability, and the higher energy, food, digital and industrial transition needs. According to the European Environmental Agency (EEA), every year, 40% of European population is either permanently or seasonally affected by water scarcity.

Read More

CEFIC, 17-01-23

<https://cefic.org/media-corner/newsroom/is-water-management-the-next-priority-for-europe-and-the-chemical-industry/>

### The recognition of the Mass Balance Chain of Custody is key to accelerating chemical recycling and meeting the EU’s climate and circularity targets

2023-01-11

The EU’s Single-Use Plastics Directive and the proposal for a revised Packaging and Packaging Waste Regulation set out recycling targets for used packaging in order to reduce packaging waste and promote the use of recycled content in new packaging. In particular, the European Commission’s proposal for the Packaging and Packaging Waste Regulation stipulates that at least 50% of all plastic waste in the EU be recycled by 2025.

The EU chemical industry supports a broad EU action to tackle waste and accelerate recycling. Where recycled content targets are concerned, chemical recycling technologies developed by the industry are a viable option to curb plastic waste and can complement mechanical recycling.

For the chemical recycling rates to accelerate in the EU, industry needs to invest more in chemical recycling facilities. For the investments to take off, clarity about the use of a mass balance chain of custody method

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to calculate the recycled content of plastics in products is required. Unfortunately, the current Commission proposal does not provide enough clarity on the use of this method which can hamper further progress of chemical recycling.

Read More

CEFIC, 11-01-23

<https://cefic.org/media-corner/newsroom/the-recognition-of-the-mass-balance-chain-of-custody-is-key-to-accelerating-chemical-recycling-and-meeting-the-eus-climate-and-circularity-targets/>

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## REACH Update

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### Next EU-wide REACH enforcement project to focus on imported products

2022-12-11

ECHA/NR/22/18

The Enforcement Forum of ECHA agreed that the next REACH enforcement project will investigate how companies fulfil the registration, authorisation and restriction obligations for products and chemicals they import from outside the EU. The project will be done in 2023-2025 and will require close cooperation between REACH enforcement and national customs authorities in the Member States.

Helsinki, 16 November 2022 – In its November meeting, the Enforcement Forum, responsible for harmonising the enforcement of EU chemicals legislation, agreed to focus its next project on the control of imports of substances, mixtures and articles.

This subject was triggered by high levels of non-compliance in imported goods detected in previous Forum projects, including a recent pilot project. The pilot found that 23 % of inspected products were non-compliant with requirements set by EU law and further controls are necessary.

Control of imports at the point of entry is the most effective means of checking that non-compliant substances, mixtures and articles do not enter the European market. The project will also work on further developing and strengthening existing cooperation between REACH inspectors and customs. By strengthening the control of imports, the project will also contribute to the goals of the EU's Chemicals Strategy for Sustainability.

The Forum also agreed to publish its future advice on enforceability of new restriction proposals under REACH.

Opportunities for expanding the future role of the Forum, strengthening the control of imports and other areas were on the agenda in an open session where 41 representatives from stakeholder organisations and four candidate countries joined. Among other topics, the open session also addressed the enforceability of REACH restrictions, for example, in textiles or on the use of lead gunshot in wetlands as well as analytical methods relevant for the control of REACH duties.

The Forum's Biocidal Products Regulation Subgroup (BPRS) re-elected Helmut de Vos (BE) for a second term as a Vice-Chair.



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## REACH Update

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Read More

ECHA, 12-11-22

<https://echa.europa.eu/-/next-eu-wide-reach-enforcement-project-to-focus-on-imported-products>

### ECHA's Programming Document 2023-2026 now available

2023-02-01

We have released our programming document for 2023-2026. It includes our Work Programme for 2023, which details our planned activities and objectives, as well as the resources for the year. It also provides a multiannual outlook for ECHA's main activities until 2026.

Read More

ECHA, 01-02-23

[https://echa.europa.eu/view-article/-/journal\\_content/title/9109026-268](https://echa.europa.eu/view-article/-/journal_content/title/9109026-268)

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## Janet's Corner

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### Easy or Hard

2023-02-10

	ACTUALLY PRETTY EASY TO FIND OUT	VERY HARD, BUT THERE HAVE BEEN RECENT BREAKTHROUGHS	EXTREMELY HARD, CURRENTLY UNSOLVED
SOUNDS BORDERLINE UNSOLVABLE	HOW MUCH DOES THE EIFFEL TOWER'S GRAVITY DEFLECT BASEBALLS IN BOSTON?	WHAT TIME OF YEAR DID THE CRETACEOUS IMPACT HAPPEN?	HOW CAN RELATIVITY BE RECONCILED WITH QUANTUM MECHANICS?
SOUNDS PRETTY HARD, BUT YOU'D ASSUME THAT SOMEONE KNOWS	WHERE WAS MARS IN THE SKY FROM PARIS ON THE DAY THE EIFFEL TOWER OPENED?	HOW MANY ANTS ARE THERE?	HOW DOES TYLENOL WORK?
SOUNDS LIKE IT WOULD BE EASY TO LOOK UP	HOW TALL IS THE EIFFEL TOWER?	HOW DOES GENERAL ANESTHESIA WORK?	WHY DOES YOUR HAIR GET A STATIC CHARGE WHEN YOU RUB IT WITH A BALLOON?

<https://xkcd.com/2682/>

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## Hazard Alert

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### Nickel carbonyl

2023-02-10

Nickel carbonyl is the organonickel compound with the formula  $\text{Ni}(\text{CO})_4$ . [1] It is a volatile, yellow liquid with a musty odour. Nickel carbonyl is flammable and explosive. It is slightly soluble in water, but soluble in other organic solvents. [2] Nickel carbonyl is formed when metallic nickel combines with carbon monoxide. It is considered to be one of the most toxic chemicals used industrially and the magnitude of its morbidity and mortality has been compared to that of hydrogen cyanide. [3]

#### USES [2]

Nickel carbonyl is used in refining nickel ore, forming nickel films and coatings, as a catalyst in various chemical reactions, and in glass plating.

#### SOURCES OF EMISSION & ROUTES OF EXPOSURE

##### Sources of Emission [2]

- Industry sources: The primary sources of nickel carbonyl are the industries that manufacture it or use it in production, such as nickel mining and refining, the chemical industry, glass and metal plating companies.
- Diffuse sources: Sub-threshold facilities in the industries that use the substance.
- Natural sources: Nickel carbonyl is not expected to be found occurring naturally.
- Transport sources: There are no known sources of mobile emissions of nickel carbonyl.
- Consumer products: There are no known consumer products containing nickel carbonyl.

##### Routes of Exposure [4]

Nickel carbonyl enters the body via:

- inhalation,
- ingestion,
- skin absorption,
- skin and/or eye contact

**Nickel carbonyl is the organonickel compound with the formula  $\text{Ni}(\text{CO})_4$ .**

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### HEALTH EFFECTS

#### Acute Effects [4]

- Initial exposure to nickel carbonyl can cause headache, chest tightness, dizziness, weakness, sweating, cough, nausea and vomiting.
- These may improve, but hours later (12 hours to five days) following a severe exposure, lung (pulmonary) symptoms may appear including fever, pneumonia, respiratory failure, cerebral oedema and death.
- At lower concentrations these vapours cause irritation, congestion, and oedema of the lung.

#### Chronic Effects [5]

- Dermatitis is the most common effect in humans from chronic dermal exposure to nickel. Cases of nickel dermatitis have been reported following occupational and non-occupational exposure, with symptoms of eczema (rash, itching) of the fingers, hands, wrists, and forearms.
- Chronic inhalation exposure to nickel in humans also results in respiratory effects, including a type of asthma specific to nickel, decreased lung function, and bronchitis.

#### Reproductive/Developmental Effects [2]

- Nickel carbonyl may be a teratogen (cause harm to a foetus).

#### Cancer Risk [5]

- Nickel carbonyl has been reported to produce lung tumours in rats exposed via inhalation.
- EPA has classified nickel carbonyl as a Group B2, probable human carcinogen.

### SAFETY [6]

#### First Aid Measures

- Inhalation: If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. If breathing is difficult, oxygen should be administered by qualified personnel. Get immediate medical attention.
- Skin Contact: Wash skin with soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical

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attention, if needed. Thoroughly clean and dry contaminated clothing and shoes before reuse.

- Eye Contact: Flush eyes with plenty of water for at least 15 minutes. Then get immediate medical attention.
- Ingestion: If vomiting occurs, keep head lower than hips to help prevent aspiration. If person is unconscious, turn head to side. Get medical attention immediately.
- Antidote: dimercaprol/oil, intramuscular.
- Note to Physician: For inhalation, consider oxygen. For ingestion, consider gastric lavage.

### Fire Hazard Information

- Nickel carbonyl poses a severe fire and explosion hazard.
- As the vapour is heavier than air, it may ignite at distant ignition sources and flash back.
- Vapour/air mixtures are explosive.
- Alcohol-resistant foam, carbon dioxide, regular dry chemical and water should be used to extinguish a nickel carbonyl fire.
- For large fires, use alcohol-resistant foam or flood with fine water spray.
- Thermal decomposition or combustion products of nickel carbonyl include oxides of carbon, oxides of nickel.

### Exposure Controls & Personal Protection

#### Engineering Controls

- Ventilation: Ventilation equipment should be explosion-resistant if explosive concentrations of material are present.
- Provide local exhaust or process enclosure ventilation system. Ensure compliance with applicable exposure limits.

#### Personal Protective Equipment

The following personal protective equipment is recommended when handling nickel carbonyl:

- Eye protection: Wear splash resistant safety goggles with a face-shield. Provide an emergency eye wash fountain and quick drench shower in the immediate work area.
- Clothing: Wear appropriate chemical resistant clothing.
- Gloves: Wear appropriate chemical resistant gloves.

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- Respirator: The following respirators and maximum use concentrations are drawn from NIOSH and/or OSHA.

#### At any detectable concentration

- Any self-contained breathing apparatus that has a full-face piece and is operated in a pressure-demand or other positive-pressure mode.
- Any supplied-air respirator with a full-face piece that is operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure demand or other positive-pressure mode.

#### Escape

- Any air-purifying full-face piece respirator (gas mask) with a chin-style, front-mounted or back-mounted canister providing protection against the compound of concern.
- Any appropriate escape-type, self-contained breathing apparatus.

#### For Unknown Concentrations or Immediately Dangerous to Life or Health

- Any supplied-air respirator with a full-face piece that is operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure demand or other positive-pressure mode.
- Any self-contained breathing apparatus that has a full-face piece and is operated in a pressure-demand or other positive-pressure mode.

## REGULATION

### United States [7]

OSHA: The Occupational Safety & Health Administration has set the following Permissible Exposure Limits (PEL) for nickel carbonyl:

- General Industry: 29 CFR 1910.1000 Z-1 Table -- 0.001 ppm, 0.007 mg/m<sup>3</sup> TWA (PEL listed under Nickel carbonyl (as Ni))
- Construction Industry: 29 CFR 1926.55 Appendix A -- 0.001 ppm, 0.007 mg/m<sup>3</sup> TWA (PEL listed under Nickel carbonyl (as Ni))
- Maritime: 29 CFR 1915.1000 Table Z-Shipyards -- 0.001 ppm, 0.007 mg/m<sup>3</sup> TWA (PEL listed under Nickel carbonyl (as Ni))

ACGIH: The American Conference of Governmental Industrial Hygienists has set a Threshold Limit Value (TLV) for nickel carbonyl of 0.05 ppm, 0.12 mg/m<sup>3</sup> TWA (TLV listed under Nickel carbonyl, as Ni)

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NIOSH: The National Institute for Occupational Safety and Health has set a Recommended Exposure Limit (REL) for nickel carbonyl of 0.001 ppm, 0.007 mg/m<sup>3</sup> TWA; Appendix A - NIOSH Potential Occupational Carcinogens

### Australia [4]

Safe Work Australia: Safe Work Australia has set an eight hour time weighted average (TWA) exposure limit of 0.05 parts per million for nickel carbonyl.

Australian Drinking Water Guidelines (NHMRC and ARMCANZ, 1996):

For nickel: Maximum of 0.02 mg/L (i.e. 0.00002 g/L).

### REFERENCES

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## Gossip

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### US renewable energy farms outstrip 99% of coal plants economically – study

2023-01-30

Coal in the US is now being economically outmatched by renewables to such an extent that it's more expensive for 99% of the country's coal-fired power plants to keep running than it is to build an entirely new solar or wind energy operation nearby, a new analysis has found.

The plummeting cost of renewable energy, which has been supercharged by last year's Inflation Reduction Act, means that it is cheaper to build an array of solar panels or a cluster of new wind turbines and connect them to the grid than it is to keep operating all of the 210 coal plants in the contiguous US, bar one, according to the study.

"Coal is unequivocally more expensive than wind and solar resources, it's just no longer cost competitive with renewables," said Michelle Solomon, a policy analyst at Energy Innovation, which undertook the analysis. "This report certainly challenges the narrative that coal is here to stay."

The new analysis, conducted in the wake of the \$370bn in tax credits and other support for clean energy passed by Democrats in last summer's Inflation Reduction Act, compared the fuel, running and maintenance cost of America's coal fleet with the building of new solar or wind from scratch in the same utility region.

On average, the marginal cost for the coal plants is \$36 each megawatt hour, while new solar is about \$24 each megawatt hour, or about a third cheaper. Only one coal plant – Dry Fork in Wyoming – is cost competitive with the new renewables. "It was a bit surprising to find this," said Solomon. "It shows that not only have renewables dropped in cost, the Inflation Reduction Act is accelerating this trend."

Coal, which is a heavily carbon-intensive fuel and responsible for 60% of planet-heating emissions from electricity generation, once formed the backbone of the American grid, generating enough power to light up 186m homes at its peak in 2007. However, by 2021 this output had dropped by 55%, while jobs in the coal mining sector have more than halved over the past decade, to less than 40,000.

Most of the US's coal plants are aging and increasingly expensive to maintain, while their fuel source has been widely displaced by cheap sources of gas. Environmental regulations, which Donald Trump vowed to roll back in an unfulfilled mission to revive the coal industry when

**It is cheaper to build solar panels or cluster of wind turbines and connect them to the grid than to keep operating coal plants.**

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president, have also imposed costs on the sector by enforcing cuts to toxic emissions such as mercury and sulphur dioxide.

Coal production hit a 55-year low in 2020 but the industry saw subsequent signs of an uptick in the wake of Russia's invasion of Ukraine, which pushed up the price of energy worldwide and saw pressure on countries to find an alternative fuel source to Russian gas.

Supporters of coal contend it is a reliable fuel source at a time of instability and have attacked Joe Biden for attempting to shift the US away from fossil fuels. "Forcing essential coal capacity off the grid – without reliable alternatives and the infrastructure to support them – will only deepen reliability and economic challenges," said Rich Nolan, president of the National Mining Association, in November.

"Look to our friends in Europe, who blindly rushed to close coal plants at a rapid pace and are now working from Germany to Denmark to bring those same plants back online. The global energy crisis is real and imposing costly burdens on people around the world and here at home; taking deliberate steps to intensify that crisis is reckless and unthinkable."

While coal is in long-term decline it is unlikely to disappear in the immediate future – many utilities are still deeply invested in the fuel source and the scale of renewable infrastructure, including energy projects, new transmission lines and battery and other storage to cope with intermittent delivery, isn't yet vast enough to trigger a mass shutdown of coal. But analysts say the broader trends, bolstered by last year's climate spending, look set to call time on the era of coal.

"We can't just snap our fingers and retire all coal plants but we need to accelerate the buildout of wind and solar so that when the time comes we can wean ourselves off coal," said Solomon.

"There's a huge opportunity here to invest in coal communities, build local economic resilience and save money in the process."

James Stock, an economist at Harvard University who was not involved in the Energy Innovation report, said the analysis "rings true" and that coal is no longer economically competitive.

"We can't shutter all these plants tomorrow, we need to do it in an orderly fashion to support grid reliability but we should be able to do it in fairly fast order," he said. "Coal has been on a natural decline due to economics and those economics are going to continue, this is a transition that's just going to happen."

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"We built a lot of coal plants in the US around 50 years ago because we were worried about energy security in the world. That made sense at the time and they made an important contribution. But we know a lot more now about climate change, so now we need to make different decisions."

The Guardian, 30 January 2023

<https://theguardian.com>

### In polluted cities, reducing air pollution could lower cancer rates as much as eliminating smoking would

2023-02-03

Exposure to air pollution has a significant impact on rates of cancers typically associated with smoking, according to a recent study.

The study, published in the International Journal of Environmental Research and Public Health, found that in polluted urban areas, reducing air pollution could do as much as completely eliminating smoking would to lower rates of the 12 types of cancer most commonly associated with smoking, including lung cancer, stomach cancer, kidney cancer, bladder cancer, pancreatic cancer, liver cancer, cervical cancer, oral cancer, colon cancer, esophageal cancer, cancer of the larynx and acute myeloid leukemia.

"Getting people to quit smoking is a really important way to prevent cancer, but we found that it's not going to do as much in places that are highly polluted," David Kriebel, a professor and director of the Lowell Center for Sustainable Production at the University of Massachusetts and one of the study's authors, told Environmental Health News (EHN).

The study builds on previous research by the same authors that estimated how much cancer rates would have declined in counties across the U.S. if everyone had quit smoking 20 years ago. That study found that in many urban counties with high levels of air pollution, lung cancer rates would not be significantly lower if everyone had quit smoking.

For example, in Allegheny County, which encompasses Pittsburgh — a region with some of the worst air quality in the country — lung cancer rates would only have dropped by 11% if everyone had quit smoking 20 years ago. For comparison, the average cancer reduction for all 612 counties included in the study was 62% if everyone had quit smoking 20 years ago — suggesting that there is something else driving cancer rates in places like Allegheny County.

**"Places with high levels of air pollution would still have higher cancer rates even if smoking was eliminated."**

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“We hypothesized that air pollution was playing a role,” Doug Myers, a professor at Boise State University and another of the study’s authors, told EHN. “We tested that in this new study and confirmed that places with high levels of air pollution would still have higher cancer rates even if smoking was eliminated.”

#### “Air pollution was the primary driver”

The study measured air pollution by looking at Air Quality Index data, which measures four major air pollutants regulated by the federal Clean Air Act — ground level ozone, particle pollution, carbon monoxide and sulfur dioxide — along with other hazardous air pollutants, including carcinogens like chloroprene, formaldehyde, and vinyl chloride.

The researchers found that the higher the Air Quality Index was in a county, the more likely it was that eliminating smoking would make little difference in rates of the types of cancer associated with smoking.

“We also looked at some other factors, like land and water pollution, the built environment and sociodemographic factors,” Myers explained. “We found air pollution was the primary driver of counties where cancer rates would remain high even if everyone quit smoking.”

#### Addressing air pollution

Next, the researchers hope to investigate the effects of specific air pollutants and look at their effects on rates of individual types of cancer. It can take 20 years or more for cancer to develop following a harmful exposure, so one challenge is finding pollution data that goes back far enough.

“That makes it challenging to study the effects of something like fracking on cancer risk, for example,” Kriebel said. “It’s just too early — we don’t yet have 20 years of exposure data on a big enough population.”

In the meantime, the researchers hope public health departments across the U.S. will use their findings to allocate additional cancer-prevention resources to lowering air pollution.

“Tobacco control is critical, but if you only talk about personal behaviors when you talk about cancer risk, it can sound like you’re blaming people,” Kriebel said. “In polluted places like Pittsburgh, it’s more effective public health messaging to also acknowledge that there are risk factors that are

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beyond people’s control, like air pollution, and show that you’re working on addressing those, too.”

Environmental Health News, 3 February 2023

<https://ehn.org>

#### The Best Catalyst Particles: Cubes Outperform Spheres

2023-02-05

#### Making electrolysis competitive.

In the fight against climate change, the reduction of CO<sub>2</sub> emissions is crucial. Currently, grey hydrogen, produced from oil and natural gas, is widely used, but efforts are underway to replace it with green hydrogen, generated from renewable sources. Green hydrogen is produced through electrolysis, a process where electricity splits water into hydrogen and oxygen. Despite its potential, several challenges must be overcome to make electrolysis a viable option.

At present, the water-splitting process is only efficient to a limited degree, and there are not enough powerful, durable, and cost-effective catalysts for it.

“Currently, the most active electrocatalysts are based on the rare and expensive precious metals iridium, ruthenium, and platinum,” lists Kristina Tschulik. “As researchers, our job is therefore to develop new, highly active electrocatalysts that are free of precious metals.”

Her research group studies catalysts in the form of base metal oxide nanoparticles that are a million times smaller than a human hair. Manufactured on an industrial scale, they vary in shape, size, and chemical composition.

“We use measurements to examine so-called catalyst inks, in which billions of particles are mixed with binders and additives,” outlines Kristina Tschulik. This method only allows researchers to measure an average performance, but not the activity of individual particles – which is what really matters.

“If we knew which particle shape or crystal facet – the surfaces that point outwards – is most active, we could specifically produce particles with that exact shape,” says Dr. Hatem Amin, a postdoctoral researcher in analytical chemistry at Ruhr University Bochum.

#### Winner of the nanoparticle race

**Electrocatalysts are crucial components in many energy conversion and storage technologies, improving the efficiency and stability of these systems.**

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The research group has developed a method to analyze individual particles directly in solution. This enables them to compare the activity of different nanomaterials with each other in order to understand the influence of particle properties such as their shape and composition on water splitting. "Our results indicate that cobalt oxide particles in the form of individual cubes are more active than spheres, as the latter always have several other, less active facets."

### Theory confirms experiment

The Bochum group's experimental findings were confirmed by its cooperation partners headed by Professor Rossitza Pentcheva from the University of Duisburg-Essen as part of the Collaborative Research Centre/Transregio 247. The latter's theoretical analyses indicate a change in the active catalyst regions, namely from cobalt atoms that are surrounded by oxygen atoms forming an octahedron to cobalt atoms that are surrounded by a tetrahedron.

"Our insights into the correlation between particle shape and activity lay the foundation for the knowledge-based design of viable catalyst materials and, consequently, for the transformation of our fossil energy and chemical industries towards a circular economy based on renewable energy sources and highly active, long-lasting catalysts," concludes Kristina Tschulik.

Sci Tech Daily, 5 February 2023

<https://scitechdaily.com>

### A dozen new moons have been discovered spinning around Jupiter

2023-02-06

Jupiter has edged ahead of Saturn in the seemingly ongoing title fight for having the most moons in the solar system.

Twelve recently discovered moons have been published by the International Astronomical Union, bringing the total number orbiting the massive planet to 92.

Among the new discoveries, fewer than half are at least eight kilometres in diameter and nine are among the outermost moons in orbit – taking just shy of an Earth year to orbit their parent planet.

**Jupiter has edged ahead of Saturn in the seemingly ongoing title fight for having the most moons in the solar system.**

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Many of the small moons are likely to have formed after collisions between much larger objects.

Earth's own moon is believed to be one such example, with a common hypothesis that a clash between our planet and another large object likely led to debris coalescing into our lunar neighbour.

### Don't count Saturn out just yet

The observations published by the Minor Planet Centre, may be the first of many, according to Scott Shppard from Carnegie Institute of Science, an accomplished discoverer of objects in the solar system.

That may see Jupiter squeezed out of top spot again.

Saturn currently has 83 confirmed natural satellites, but also has a substantial number of objects in proximity which are yet to be formally tracked. Research published in 2021 identified 120 objects believed to be 'irregular moons', of diameters around three kilometres moving around the planet.

If tracked and verified formally as moons, these would hand the title back to Saturn, at least giving fans of the solar system's second-largest planet something to crow about.

Cosmos, 6 February 2023

<https://cosmosmagazine.com>

### South Australia plans world's largest electrolyzer and H2 power plant

2023-02-05

The state that built the world's first grid-level "big battery" is striking out on an even more ambitious green energy project: the world's biggest hydrogen power station, fed by an electrolysis facility 10 times larger than anything running today.

South Australia has made impressive strides in decarbonization, on the back of its huge solar and wind potential – to the point where nearly 70% of all its electricity is renewably generated. It's expected to cross the 100% threshold well before the scheduled date of 2030, and back in 2021, this state, with its population of 1.7 million people, met 100% of its operational demand from renewables alone on 180 days of the year.

**The state government also sees this project as a way to kickstart a broader hydrogen scene in the area**

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Indeed, it's also been among the first places in the world to face the issue of over-generation, when a storm late last year brought down a long-distance power line used to export excess renewable energy to the neighboring state of Victoria. The Australian Energy Market Operator had to scramble to switch off a lot of the state's remote-controllable solar resources, and even ask consumers to switch on as many high-powered electrical devices as they could, just to keep energy levels in the grid under control.

By working with Tesla and Neoen to build the world's first grid-level big battery plant back in 2017, the state established itself as a world leader in grid-level energy storage as well as renewable generation, and it's approved several other large-scale energy storage projects in the form of bigger batteries and pumped hydro projects on the back of the first battery facility's success.

But its new project takes an even bigger leap into the unknown, with a far less obvious financial payoff. In the absence of businesses willing to take the lead, the South Australian State Government is set to fully bankroll an AU\$600 million (US\$415 million) hydrogen power plant near Whyalla, hoping to have it up and running by 2025.

This plant will absorb excess renewable energy from the grid, and run it through an enormous 250-MW electrolysis facility – 10 times larger than any operational electrolysis facility in the world today – producing large amounts of hydrogen, which will be stored on-site. Then, when renewable energy drops off in the evenings, or through the winter, it'll run that hydrogen back through a 200-MW generator facility and put energy back in the grid – either by burning it to drive steam turbines, or by converting it back to electricity through a huge fuel cell stack.

As a pure short-term energy storage and dispatch technology, though, hydrogen frankly sucks in comparison to batteries. The round-trip efficiency is less than 50%, compared to high-90s for lithium batteries, so you're effectively throwing half your precious renewable energy away doing things this way. It's also a pain to store, unless you take an extra step to convert it into ammonia or some other more easily managed solid or liquid. It's unlikely to come close to competing with big batteries on a Levelized Cost of Storage (LCoS) basis, which is largely why nobody else is moving forward on a similar project.

So why throw this kind of money at something that looks like such a drain on state financial, energy and water resources? Well, depending on how much storage is built, it could be useful over a longer timeframe than

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batteries, as a key backup to a fully renewable grid in times of extended energy drought.

But it seems the state government also sees this project as a way to kickstart a broader hydrogen scene in the area, with the ability to supply excess hydrogen to a range of other companies looking to use it in transport, green steel, domestic gas supply, manufacturing or export projects. With such short timelines – proposals are due next month, so the plant is expected to go from greenlight to operational in about two years – the government is setting a challenge that could ramp up a broad hydrogen-based supply chain, and for better or worse, it'll prove the benefits and drawbacks of hydrogen as a grid-level storage solution.

New Atlas, 5 February 2023

<https://newatlas.com>

### Groundbreaking Discovery of Hidden Molten Rock Layer Under Earth's Tectonic Plates

2023-02-06

Scientists have discovered a new layer of partly molten rock under the Earth's crust that might help settle a long-standing debate about how tectonic plates move.

Researchers had previously identified patches of melt at a similar depth. But a new study led by The University of Texas at Austin revealed for the first time the layer's global extent and its part in plate tectonics.

The research was published today (February 6, 2023) in the journal *Nature Geoscience*.

The molten layer is located about 100 miles from the surface and is part of the asthenosphere, which sits under the Earth's tectonic plates in the upper mantle. The asthenosphere is important for plate tectonics because it forms a relatively soft boundary that lets tectonic plates move through the mantle.

The reasons why it is soft, however, are not well understood. Scientists previously thought that molten rocks might be a factor. But this study shows that melt, in fact, does not appear to notably influence the flow of mantle rocks.

"When we think about something melting, we intuitively think that the melt must play a big role in the material's viscosity," said Junlin Hua, a

**Researchers at The University of Texas at Austin have discovered a previously unknown layer of partly molten rock in a key region just below the tectonic plates.**



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postdoctoral fellow at UT's Jackson School of Geosciences who led the research. "But what we found is that even where the melt fraction is quite high, its effect on mantle flow is very minor."

According to the research, which Hua began as a graduate student at Brown University, the convection of heat and rock in the mantle are the prevailing influence on the motion of the plates. Although the Earth's interior is largely solid, over long periods of time, rocks can shift and flow like honey.

Showing that the melt layer has no influence on plate tectonics means one less tricky variable for computer models of the Earth, said coauthor Thorsten Becker, a professor at the Jackson School.

"We can't rule out that locally melt doesn't matter," said Becker, who designs geodynamic models of the Earth at the Jackson School's University of Texas Institute for Geophysics. "But I think it drives us to see these observations of melt as a marker of what's going on in the Earth, and not necessarily an active contribution to anything."

The idea to look for a new layer in Earth's interior came to Hua while studying seismic images of the mantle beneath Turkey during his doctoral research.

Intrigued by signs of partly molten rock under the crust, Hua compiled similar images from other seismic stations until he had a global map of the asthenosphere. What he and others had taken to be an anomaly was in fact commonplace around the world, appearing on seismic readings wherever the asthenosphere was hottest.

The next surprise came when he compared his melt map with seismic measurements of tectonic movement and found no correlation, despite the molten layer encompassing almost half the Earth.

"This work is important because understanding the properties of the asthenosphere and the origins of why it's weak is fundamental to understanding plate tectonics," said coauthor Karen Fischer, a seismologist and professor at Brown University who was Hua's Ph.D. advisor when he began the research.

Sci Tech Daily, 6 February 2023

<https://scitechdaily.com>

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### A fossil fruit from California shows ancestors of coffee and potatoes survived cataclysm that killed the dinosaurs

2023-02-07

Brian Atkinson, assistant professor of ecology & evolutionary biology at the University of Kansas and curator of paleobotany at the KU Biodiversity Institute, recently published a study of the fossil plant, named *Palaeophytocrene chicoensis*, in the peer-reviewed journal *Nature Plants*.

"This fossil tells us a really diverse group of flowering plants evolved prior to our original understanding," Atkinson said. "The fossil belongs to a group of lianas, which are woody vines that add structural complexity to rainforests. It shows us this group of flowering plants appeared super early in the fossil record. There'd been some hypotheses that they were around in the Cretaceous period -- but no good clear evidence. This is a great indicator that structurally complex, modern-type rainforests may have been around as early as 80 million years ago."

According to the KU researcher, the fossil fruit sheds new light on a "critical interval" in the history of life on Earth.

"It's a time when forests are transitioning from being dominated by gymnosperms such as conifers to being dominated by flowering plants," Atkinson said. "We know these ecological transitions occurred during the Late Cretaceous -- but we still need critical pieces of evidence, like how certain ecosystems formed, such as rainforests, which today comprise over half of plant species that are alive today. This fossil shows this diverse group of plants, the lamiids, were older than previously thought, and Cretaceous ecosystems on the west coast of North America may have resembled structurally complex rainforests."

The well-preserved fossil was unearthed in the 1990s by construction crews building housing near Granite Bay in Sacramento, California. Located in deposits of the Chico Formation tied to the Campanian (fifth of six ages of the Late Cretaceous epoch), the fossil was collected by Richard Hilton and Patrick Antuzzi of Sierra College and housed at their natural history museum.

"I spent seven years looking for these things [Cretaceous lamiids], and I couldn't find them," Atkinson said. "I'd been collecting and studying Cretaceous plants on the West Coast to better understand the evolution of flowering plants. Somebody said, 'Oh, you should check out the Sierra College Museum of Natural History,' as it wasn't on my radar to contact

**The discovery of an 80-million-year-old fossil plant pushes back the known origins of lamiids to the Cretaceous period.**

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them. They gladly had me over to look at their fossil plant collection, and I was just kind of blown away by the diversity of plants that these guys were able to dig up in this housing development.”

It wasn't until Atkinson saw the fossil plant recovered decades earlier from the construction site that the specimen's potential significance was understood.

“As I was opening this drawer, I noticed this fruit with really striking patterns on its surface,” the KU researcher said. “I immediately recognized it as belonging to this lamiid family called Icacinaceae, which is well-known in younger, post-Cretaceous deposits after the mass-extinction event. It's all over the place. But before, there are no clear known fossils that belong to that family. And I thought, ‘Oh my God, this is it!’ You know, this family of plants have just these really striking fruits.”

To confirm his thinking about the fossil, Atkinson needed to take a closer look. He studied the fossil fruit's structures using light microscopy, which allowed him to generate beautiful photographs of the specimen. By scrutinizing its arrangement of ridges, pits, rows and tubercles, the KU investigator could make comparisons to previously described fossils to place it correctly within its family tree. The work challenged Atkinson because he'd never described a “compression fossil” of its kind.

“I'm used to working on fossils that preserve in a different mode called ‘permineralization,’” Atkinson said. “This is my first paper on a compression fossil, and it was a little bit nerve-wracking, working in a different preservation type than you're used to. Imaging it is a whole different process -- I'm glad this turned out so well.”

After placing the fossil plant within the genus *Palaeophytocrene*, Atkinson named the species *chicoensis* after the Chico Formation where it was found.

“I just named it after the formation it was recovered from,” he said. “Part of my job is coming up with scientific names for new species that I describe, but I'm not that creative about it -- usually I look up the location where it was discovered. Has that name been taken already?”

If the fossil fruit's name is humdrum, its significance isn't. The KU researcher said the findings help establish that one of the most diverse flowering plant groups survived the cataclysm that killed the dinosaurs to evolve into thousands of familiar modern species, including vital food crops for humanity.

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“My research involves understanding deep time to better reconcile how modern biodiversity came to be -- and potentially how it will fare in the future with climate change,” said Atkinson. “I've been trying to characterize these evolutionary events of flowering plants in the Cretaceous period, when the diversity of these plants just exploded. The Cretaceous record of lamiids has been hard to establish, but I knew these fossils had to be around. The West Coast of North America is under-sampled for Cretaceous plants compared to the Western Interior and East Coast of North America. By broadening our sampling geographically, we'll come across more and more plants to help us understand Cretaceous diversification that led to modern biodiversity.”

Science Daily, 7 February 2023

<https://sciencedaily.com>

### Brain ‘zips and unzips’ information to perform skilled tasks

2023-02-07

Experts discovered that the order and timing of movements in complex sequences are separated by the brain, before being zipped and transferred into specific movement commands, or ‘muscle memory’, as the person begins the action.

They found that high-level sequencing of movement (such as order and timing) can be stored across several motor areas of the brain, often across several days of training and memorising action sequences, before being activated following a particular trigger such as a musical cue or a starting gun.

Publishing their findings today (6 Feb) in *Journal of Neuroscience*, researchers from the University of Birmingham and Bangor University believe the discovery may help to improve motor rehabilitation for stroke victims.

Principal investigator Dr Katja Kornysheva, from the Centre for Human Brain Health at the University of Birmingham, commented: “From handwriting to playing a musical instrument, performing sequences of movements from memory is a hallmark of skilled human behaviour.

“What is surprising is that the brain separates these skills into their constituent features rather than encoding them as an integrated muscle

**The human brain prepares skilled movements such as playing the piano, competing in athletics, or dancing by ‘zipping and unzipping’ information about the timing and order of movements.**

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memory, even after extensive training. There is a shift in information states within the brain when performing such tasks.

“Information is retrieved from memory unzipped when we prepare it for execution, before being zipped together to start the task. Perhaps this unzipping mechanism helps us to stay flexible for adjustments, even in the final hundreds of milliseconds before we start the movement, e.g. if we need to change the speed or timing of an upcoming action.”

A series of almost 1000 trials saw right-handed participants -- excluding professional musicians -- learn and memorise four keyboard sequences which they prepared and subsequently produced after a visual cue. After training, participants produced the keyboard sequences in an MRI scanner which measured activity patterns across the brain during the task. The go cue didn't appear on some trials which allowed the researchers to separate preparation from the movement itself.

First author Rhys Yewbrey, from Bangor University, commented: “We also found several brain regions which control timing during movement production, but none seemed to control order without integrating it with timing.”

“There was a matching effect in our participants' behaviour -- they were faster in acquiring a sequence with a new order of finger presses when they were familiar with the timing yet struggled to learn a sequence when they had to pair a previously trained order with a new timing. Perhaps timing control staying active during production allows for flexibility even after the movement has started.”

Researchers believe that the brain separates sequence order and timing as ‘what’ elements representing higher-level control, which are combined to define ‘how’ exactly the task should be performed.

These new results help us to better understand how skilled actions are stored and controlled in the brain for everyday skills such as typing, tying shoelaces and playing a musical instrument, and what makes them flexible and resilient to changes in the environment or in neurological disorders.

Science Daily, 7 February 2023

<https://sciencedaily.com>

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### The City Where Third Graders Train to Be Engineers

2023-02-03

The brown paper bag hit the ground with a smack. A Michelin engineer picked it up off the concrete and opened it, revealing a cracked, leaking egg. The third graders at A.J. Whittenberg Elementary School of Engineering groaned in disappointment when they saw the runny mess. Then, they made way for the next group of students, who were eager to drop their own bag from the staircase in hope of a different result.

A coffee filter parachute was attached to the bag, and inside, an egg sat nestled in cotton balls. The students were anxious to see if the paper contraption they built would blunt, or at least slow, the egg's fall.

Alas, it didn't. “Scrambled eggs!” the engineer called out.

It was engineering week at A.J. Whittenberg, a public elementary school in downtown Greenville, South Carolina, that focuses on science, technology, engineering and math (STEM) in its curriculum. One week per month, engineers from local industries visit the classrooms and talk to students about their careers.

Across the country, schools have shifted toward career-focused education in recent years, reviving a long-running debate on whether the purpose of education is to prepare students for jobs or to be well-rounded citizens.

“We're not really wanting them to make a decision — ‘I'm in the second grade and now I'm locked in to being whatever when I graduate from high school in 10 years,’” said Burke Royster, superintendent of the Greenville County School District, home to more than 77,000 students, 60 percent of whom live in poverty. “But you want them to have a kind of better, more full understanding of careers.”

A.J. Whittenberg has been around since 2010, when Greenville County Schools opened it as a magnet school in an area that is historically low-income and majority Black. The district decided a focus on engineering at the school would both attract more students from outside its attendance zone and help integrate the school. Its diversity efforts have been successful — the school's population is 48 percent Black, 32 percent white and 11 percent Hispanic. But in recent years, the school has also become the first step on a longer career runway for young students interested in engineering.

Greenville is now introducing the idea of a career path to students in elementary school and giving students the option to follow those

**Since Greenville, South Carolina started offering “career education” for its youngest students, the number of graduates earning industry certifications has soared.**

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programs to middle and high schools, hoping by eighth grade they will have a better understanding of what they want to do after high school and what it will take to get there. Each elementary school focuses on a specific area — engineering, math and science, the arts, leadership, or foreign languages, among others. The district allows student to attend schools outside of their attendance zones as long as space is available, which means students can opt to continue to follow their chosen career pathway at a middle school with corresponding programs. In high school, students are expected to complete a career cluster by taking several courses in a subject area, such as health sciences, manufacturing, arts or business.

The effort in Greenville is part of a growing national trend in which school districts partner with local industries to develop curriculum and expose students to specialized careers at a young age. These programs serve a dual purpose, district leaders say: Students get career training that could help land them an in-demand job in their hometown, and industries get a pipeline of workers with the qualifications they're looking for. But some education experts worry the focus on industry qualifications has resulted in schools taking on responsibilities that should fall to businesses, like training workers for specific job duties, to the detriment of a more comprehensive education in schools.

Districts across the country have been ramping up career education programs spurred, in part, by federal legislation updated in 2018 that provides funding for career education (commonly referred to as Perkins V), said Matt Giani, a research associate professor in sociology at the University of Texas at Austin who studies education policy.

In upstate South Carolina, automotive industries have replaced the once thriving textile mills as a dominant force in the region, paving the way for a growing demand for highly skilled workers in engineering and robotics. Greenville County Schools has begun partnering with companies in the area, such as BMW and Michelin, to develop courses in mechatronics and automotive research.

But the approach has taken hold in totally different business landscapes, too.

Since 2017, for example, students in Roscoe, Texas, a rural community of about 1,300 residents, have been able to earn associate degrees and receive college credit by taking career education courses in health care, veterinary services and agriculture through a program called P-TECH. Since livestock is a major part of Roscoe's economy, the district's high school

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even has an embryo lab where students can get experience in high-tech, selective cattle breeding.

"It's not an education model as much as it's rural economic and community development — trying to create a highly educated rural population that will lead to the innovation that leads to rural job creation," said Kim Alexander, former superintendent of Roscoe Independent School District and chief executive of Collegiate Edu-Nation, a nonprofit that builds career education programs for rural schools.

In 2020, policies in 27 states allowed students to earn credentials through career education coursework, such as industry certifications, according to an analysis from the Education Commission of the States.

"We're seeing this really becoming increasingly popular across states, and it's fairly recent," said Giani, the research associate professor at the University of Texas at Austin.

But the increasing focus on industry needs in K-12 has also drawn criticism.

"We need to question the degree to which we should be paying for things that ultimately are going to return value to shareholders rather than return value to the American people," said Jack Schneider, an associate professor of education at the University of Massachusetts Lowell.

Schneider was one of thousands of people who responded, many of them critically, to a tweet in December from U.S. Secretary of Education Miguel Cardona that stated, "Every student should have access to an education that aligns with industry demands and evolves to meet the demands of tomorrow's global workforce." (The Education Department did not respond to a request for comment about Cardona's tweet.)

For the past several decades, education policy rhetoric has suggested that the purpose of education is to prepare people for work and strengthen the economy, Schneider said, but schools are also a place where students should experience art, music and literature and think creatively.

"For me, it's about recognizing both of those things at the same time, and figuring out how then can we support a vision of public education that has room for both of those truths," Schneider said.

In a study published this fall, Giani found that some industry certifications, such as cosmetology and health sciences, were associated with significant boosts in earnings and employment in those fields, while others had little to no change in outcomes for students.

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And even though the industry certifications were associated with higher earnings for students who did not attend college, wages earned by those students immediately after high school were still generally at or below poverty level.

“Overall, yes, certifications are good. But not if we’re using them as the sole or primary indicator of students’ career readiness,” Giani said.

Instead, industry certifications should be one piece of a larger program that includes college credit and work experience, said Joel Vargas, vice president of programs at Jobs for the Future, a national nonprofit focused on workforce education and policy.

But Vargas said schools are still trying to overcome a belief held by many parents, and even educators, that students in career education will immediately start working after high school instead of enrolling in college or additional training.

“The jobs today require such a high level of skill — and increasingly will in the future of work — that a lot of the kinds of skills that you need you also can make an argument that those are the skills you need in college as well,” Vargas said. “And yet, we have this kind of false segregation of well, that pathway is for kids going to college, and that one is for kids who are just going to start to work.”

In 2017, Greenville County Schools awarded 601 industry certifications to students. By 2022, that number grew to 8,745.

Next fall, the school district will open a \$12.7 million CTE Innovation Center, where high school students can attend specialized career education courses and earn industry certifications in programs such as aerospace, clean energy technology or automotive research. Those programs will change based on demand, said program director Katie Porter; the more popular offerings are likely to get rolled out to the district’s traditional career centers.

The idea of connecting students in Greenville schools to career paths started with magnet schools like A.J. Whittenberg.

A decade ago, students who attended magnet schools with a focus on engineering, arts or foreign languages did not have a clear path to continue the programs in middle or high school, said Royster, the superintendent.

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Now, most of the district’s schools have a focus: Students can go from A.J. Whittenberg to Dr. Phinnize J. Fisher Middle School, for example, to continue in an engineering and STEM curriculum, or they can attend League Academy for a middle school more focused on arts. Each high school has specialties as well: Fountain Inn High School, which opened in 2021, was built with manufacturing and STEM in mind.

These programs still offer all the traditional classes of a typical school. Royster counts the elementary school program a success even if students finish fifth grade realizing that engineering is not their field — they are still one step closer to figuring out what they do want.

“At the elementary level, it’s important Whittenberg’s theme towards engineering doesn’t become so focused on engineering that students aren’t well prepared to go another direction or to consider other directions,” Royster said.

In the past, career days for young students often focused on high-interest jobs children already knew about — doctors, lawyers, firefighters, Royster said. The goal now is to also show young students jobs they’ve never heard of.

Career exposure can have a big impact on young kids, particularly those who aren’t introduced to various careers in their own families, according to Vargas, of Jobs for the Future.

“The point is to get them to try it on through experience,” he said.

For Olivia Spencer, attending A.J. Whittenberg Elementary allowed her to realize early on that she wanted to be an engineer. In sixth grade, she enrolled at Fisher Middle School to continue robotics and STEM programs. In high school, Spencer took mechatronics classes at one of the district’s career centers, which landed her an apprenticeship with Michelin. Now, she’s a freshman studying civil engineering at Clemson University.

“I don’t know if I would have necessarily focused in on engineering as much as I did, especially from such a young age,” Spencer said. “I probably wouldn’t have jumped into robotics so early or anything like that, and that’s kind of what put me on the path to today.”

Spencer said the exposure to STEM programs at a young age helped her break into a field that is dominated by men.

“A lot of these interests are developed from a young age, and stereotypically, as a society, we push guys more into that at a young age,”

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Spencer said. "Once you hit that middle school age especially, it's hard to start developing those interests. So, I'm hoping there will be more things like A.J. schools or programs that get girls into it early on so more people can realize they have an interest."

Developing career interests was the focus one day last November, as thousands of seventh graders weaved through a maze of tables and displays set up by hundreds of local industries at the Greenville Convention Center. Students intubated dummies at a station run by a local hospital, while others hammered nails into a log at a station for a construction company.

The school district hosts this seventh-grade career fair every fall. In just one year, the students will be in eighth grade, when they will meet with a guidance counselor to start making decisions about what they want to do when they graduate and which high school classes will get them there.

Justin Mullis, a skills development manager at local Sage Automotive Interiors, handed out wireless phone charging pads while talking to students about the kinds of jobs Sage offers.

Sage has only partnered with the district for a year, but the company has already started attracting some interest from students currently in career programs. Two of the district's recent graduates started working there while they were in high school last year. When they graduated in 2022, they kept working at Sage while attending Greenville Technical College.

The workforce shortage companies experienced at the height of the pandemic has made partnerships like Greenville's more attractive, Mullis said. "It's a dividend that's paid in a small amount so far with the people we have, but I feel like the work we're doing now we'll see three to five years from now," he said.

A spokesperson for Greenville County Schools said the district, like most school districts, doesn't track students' careers after graduation, given the difficulties and costs involved. Administrators do not know if their investment in career education will lead to more students getting higher paying jobs, but they hope it will result in more students walking across the graduation stage with plans for a career in mind.

One thing is clear to Royster: A high school diploma is not enough.

"When you leave us, you need to either be already down your road to college, if that's what you're going to do, or we need to give you

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something that allows you to get to work and earn a living," Royster said. "And just getting out with a high school diploma doesn't do that."

Reasons to be Cheerful, 3 February 2023

<https://reasonstobecheerful.world>

### Can pigeons match wits with artificial intelligence?

2023-02-07

In a new study, psychologists at the University of Iowa examined the workings of the pigeon brain and how the "brute force" of the bird's learning shares similarities with artificial intelligence.

The researchers gave the pigeons complex categorization tests that high-level thinking, such as using logic or reasoning, would not aid in solving. Instead, the pigeons, by virtue of exhaustive trial and error, eventually were able to memorize enough scenarios in the test to reach nearly 70% accuracy.

The researchers equate the pigeons' repetitive, trial-and-error approach to artificial intelligence. Computers employ the same basic methodology, the researchers contend, being "taught" how to identify patterns and objects easily recognized by humans. Granted, computers, because of their enormous memory and storage power -- and growing ever more powerful in those domains -- far surpass anything the pigeon brain can conjure.

Still, the basic process of making associations -- considered a lower-level thinking technique -- is the same between the test-taking pigeons and the latest AI advances.

"You hear all the time about the wonders of AI, all the amazing things that it can do," says Ed Wasserman, Stuit Professor of Experimental Psychology in the Department of Psychological and Brain Sciences at Iowa and the study's corresponding author. "It can beat the pants off people playing chess, or at any video game, for that matter. It can beat us at all kinds of things. How does it do it? Is it smart? No, it's using the same system or an equivalent system to what the pigeon is using here."

The researchers sought to tease out two types of learning: one, declarative learning, is predicated on exercising reason based on a set of rules or strategies -- a so-called higher level of learning attributed mostly to people. The other, associative learning, centers on recognizing and making connections between objects or patterns, such as, say, "sky-blue" and "water-wet."

**Researchers tested pigeons' learning abilities and concluded the birds employ the same basic process, called associative learning, as the most advanced AI technologies.**

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Numerous animal species use associative learning, but only a select few -- dolphins and chimpanzees among them -- are thought to be capable of declarative learning.

Yet AI is all the rage, with computers, robots, surveillance systems, and so many other technologies seemingly "thinking" like humans. But is that really the case, or is AI simply a product of cunning human inputs? Or, as the study's authors put it, have we shortchanged the power of associative learning in human and animal cognition?

Wasserman's team devised a "diabolically difficult" test, as he calls it, to find out.

Each test pigeon was shown a stimulus and had to decide, by pecking a button on the right or on the left, to which category that stimulus belonged. The categories included line width, line angle, concentric rings, and sectioned rings. A correct answer yielded a tasty pellet; an incorrect response yielded nothing. What made the test so demanding, Wasserman says, is its arbitrariness: No rules or logic would help decipher the task.

"These stimuli are special. They don't look like one another, and they're never repeated," says Wasserman, who has studied pigeon intelligence for five decades. "You have to memorize the individual stimuli or regions from where the stimuli occur in order to do the task."

Each of the four test pigeons began by correctly answering about half the time. But over hundreds of tests, the quartet eventually upped their score to an average of 68% right.

"The pigeons are like AI masters," Wasserman says. "They're using a biological algorithm, the one that nature has given them, whereas the computer is using an artificial algorithm that humans gave them."

The common denominator is that AI and pigeons both employ associative learning, and yet that base-level thinking is what allowed the pigeons to ultimately score successfully. If people were to take the same test, Wasserman says, they'd score poorly and would probably give up.

"The goal was to see to what extent a simple associative mechanism was capable of solving a task that would trouble us because people rely so heavily on rules or strategies," Wasserman adds. "In this case, those rules would get in the way of learning. The pigeon never goes through that process. It doesn't have that high-level thinking process. But it doesn't get in the way of their learning. In fact, in some ways it facilitates it."

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Wasserman sees a paradox in how associative learning is viewed.

"People are wowed by AI doing amazing things using a learning algorithm much like the pigeon," he says, "yet when people talk about associative learning in humans and animals, it is discounted as rigid and unsophisticated."

The study, "Resolving the associative learning paradox by category learning in pigeons," was published online Feb. 7 in the journal *Current Biology*.

Study co-authors include Drew Kain, who graduated with a neuroscience degree from Iowa in 2022 and is pursuing a doctorate in neuroscience at Iowa; and Ellen O'Donoghue, who earned a doctorate in psychology at Iowa last year and is now a postdoctoral scholar at Cardiff University.

The National Institutes of Health funded the research.

Science Daily, 7 February 2023

<https://sciencedaily.com>

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### The surprising chemicals used to embalm Egyptian mummies

2023-02-01

Labelled pots found in a 2,500-year-old embalming workshop have revealed the plant and animal extracts used to prepare ancient Egyptian mummies — including ingredients originating hundreds and even thousands of kilometres away.

Chemical analysis of the pots' contents has identified complex mixtures of botanical resins and other substances, some of them from plants that grow as far away as Southeast Asia. The discovery was reported in a 1 February paper in *Nature*.

Previously, insights into the embalming process have come from two main sources: historical texts and chemical analyses of the mummies themselves. But linking these strands of information has proved difficult, says Salima Ikram, an archaeologist and mummy specialist at the American University in Cairo. "You might have the name of something, but you don't know what the hell it is, except the hieroglyphics suggesting it's an oil or a resin."

That has now changed thanks to an underground embalming workshop discovered in 2016 at Saqqara, an ancient Egyptian burial ground in use from 2900 BC or earlier. The site also includes burial chambers, and it is likely that elite members of society were interred there, the authors say. Inside the Saqqara workshop, which dates to 664–525 BC, archaeologists discovered dozens of ceramic vessels used in the embalming process, many labelled with the ingredients they contain and their use. "This is the first time you've got jars with labels of the contents," says Ikram.

To identify the specific contents of the vessels, an Egyptian–German team analysed the mixtures using a technique called gas chromatography–mass spectrometry, at a National Research Centre laboratory in Giza, Egypt. This showed that the pots contained substances previously linked to mummification, including extracts from juniper bushes, cypress trees and cedar trees, which grow in the eastern Mediterranean region. The team also found bitumen from the Dead Sea, along with animal fats and beeswax, probably of local origin.

But the researchers also identified two surprising ingredients: one resin called elemi, which comes from *Canarium* trees that grow in rainforests in Asia and Africa; and another called dammar that comes from *Shorea* trees found in tropical forests in southern India, Sri Lanka and southeast Asia.

**Resins used to prepare bodies for the afterlife are found in vessels in an ancient workshop.**

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"Egypt was resource poor in terms of many resinous substances, so many were procured or traded from distant lands," says Carl Heron, an archaeological scientist at the British Museum in London.

### Imported ingredients

Ancient trade networks connected India and southeast Asia with the Mediterranean region. But it's not clear whether Egyptian embalmers sought out these specific ingredients or came across them through trial and error, says Ikram. "Absolutely amazing", she says. "Who would have thought that they were getting stuff that might be coming from India?"

Ancient Egyptian embalmers had a sophisticated understanding of the raw materials' properties, the authors say. Pots contained complex mixtures of ingredients that, in some cases, had been carefully heated or distilled. Many of the resins had antimicrobial properties — one bowl containing elemi and animal fat was inscribed "to make his odour pleasant" — or characteristics that promoted preservation.

"Their knowledge of these substances was incredible," says study co-author Maxime Rageot, a biomolecular archaeologist at the University of Tübingen in Germany.

Chemical studies of mummies suggest that embalming recipes became more complex over time, notes Rageot. But one open question is how ancient Egyptians developed specific embalming procedures and recipes — and why they selected certain ingredients over others, said study co-author Mahmoud Bahgat, a biochemist at Egypt's National Research Centre in Cairo, at a press briefing. "We need to be as clever as them to discover the intentions."

*Nature*, 1 February 2023

<https://nature.com>

### Microplastics Are Filling the Skies. Will They Affect the Climate?

2023-02-01

Plastic has become an obvious pollutant over recent decades, choking turtles and seabirds, clogging up our landfills and waterways. But in just the past few years, a less-obvious problem has emerged. Researchers are starting to get concerned about how tiny bits of plastic in the air, lofted into the skies from seafoam bubbles or spinning tires on the highway, might potentially change our future climate.

**Recent studies reveal that tiny pieces of plastic are constantly lofted into the atmosphere. These particles can travel thousands of miles and affect the formation of clouds.**



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“Here’s something that people just didn’t think about — another aspect of plastic pollution,” says environmental analytical chemist Denise Mitrano of ETH Zürich University, in Switzerland, who co-wrote an article last November highlighting what researchers know — and don’t yet know — about how plastics can change clouds, potentially altering temperature and rainfall patterns.

Clouds form when water or ice condenses on “seeds” in the air: usually tiny particles of dust, salt, sand, soot, or other material thrown up by burning fossil fuels, forest fires, cooking, or volcanoes. There are plenty of these fine particles, or aerosols, in the skies — a lot more since the Industrial Revolution — and they affect everything from the quality of the air we breathe, to the color of sunsets, to the number and type of clouds in our skies.

In 2019, researchers found microplastics in the Pyrenees that had arrived via rain or snowfall.

Until recently, when chemists thought of the gunk in our air, plastics did not leap to mind. Concentrations were low, they thought, and plastic is often designed to be water repellent for applications like bags or clothing, which presumably made them unlikely to seed cloud droplets. But in recent years, studies have confirmed not only that microscopic pieces of plastic can seed clouds — sometimes powerfully — but they also travel thousands of miles from their source. And there are a lot more particles in the air than scientists originally thought. All this has opened researchers’ eyes to their potential contribution to atmospheric murk — and, possibly, to future climate change.

“The people who invented plastics all those decades ago, who were very proud of inventions that transformed society in many ways — I doubt they envisaged that plastics were going to end up floating around in the atmosphere and potentially influencing the global climate system,” says Laura Revell, an atmospheric scientist at the University of Canterbury in New Zealand. “We are still learning what the impacts are for humans, ecosystems, and climate. But certainly, from what we know so far, it doesn’t look good.”

Global annual production of plastics has skyrocketed from 2 million tons in 1950 to more than 450 million tons today. And despite growing concerns about this waste accumulating in the environment, production is ramping up rather than slowing down — some oil companies are building up their plastic production capacity as the demand for fossil fuel declines. To date, more than 9 billion tons of plastic has been produced, and about half of

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it has gone to landfills or been otherwise discarded. Some project that by 2025, 11 billion tons of plastic will have accumulated in the environment.

Plastic has been found in soils, water, crops, and on the ocean floor. And in recent years, several studies have suggested that microplastics (pieces less than 5 millimeters in length) and nanoplastics (smaller than approximately 1,000 nanometers) were being transported long distances through the air. In 2019, for example, researchers found microplastics in the Pyrenees that had arrived via rain or snowfall. In 2020, Janice Brahney of Utah State University and four coauthors published a high-profile Science paper revealing high amounts of plastic in federally protected areas of the United States. Brahney had found the plastic by accident; she had been looking for phosphorus, but was surprised by all the colorful bits of gunk in her ground-based filters. Her study led to a slew of headlines warning, “It’s raining plastic.”

Brahney’s extensive U.S. dataset also opened the door for modelers to figure out where, exactly, all this plastic was coming from. “It’s a really beautiful data set,” says Cornell University’s Natalie Mahowald, who did the modeling work.

Mahowald took the plastic concentrations Brahney had cataloged and mapped them against atmospheric patterns and known sources of plastics, including roads, agricultural dust, and oceans. On roadways, tires and brakes hurl microplastics into the air. Plastic winds up in agricultural dust, notes Mahowald, in part from plastics used on farm fields and in part because people toss fleece clothing into washing machines: the wastewater flows to treatment plants that separate solids from liquids, and about half the resulting biosolids get sent to farms for use as fertilizer. As for the ocean, Mahowald says, big globs of plastic in places like the Pacific Gyre degrade into microscopic pieces, which then float to the surface and are whipped up into the air by chopping waters and bursting air bubbles.

Plastic bits are now found in human lungs. “We’re definitely breathing them right now,” says a scientist.

Mahowald’s model concluded that over the western U.S., 84 percent of microplastics were coming from roads, 5 percent from agricultural dust, and 11 percent from the oceans. Plastic is so lightweight that even chunks tens of micrometers across — the width of a human hair — can be lofted and blown great distances. The model revealed that some of this plastic was found thousands of miles from its presumed source. The smaller the pieces, the longer they can stay aloft.

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While individual bits of plastic may stay in the air for only hours, days, or weeks, there's so much being kicked up so consistently that there's always some in the air: enough that plastic bits are now also found in human lungs. "We're definitely breathing them right now," says Mahowald.

Working out exactly how much plastic is in our skies is extremely difficult. Most of these studies are done by painstakingly teasing bits of plastic out of filters and examining them under a microscope to get an estimate of shape and color, then using spectroscopic techniques to confirm their source material. The smaller the pieces, the harder they are to identify. Studies can also be plagued by contamination: walking into a lab wearing a fleece sweater, for example, can skew results with shedding plastic microfibers.

Nearly a dozen studies have shown airborne microplastic concentrations ranging from between 0.01 particles per cubic meter over the western Pacific Ocean to several thousand particles per cubic meter in London and Beijing. The cities showing higher levels are probably genuinely more polluted, says Revell, but it's also true that those studies used a more-sensitive technique that could identify smaller bits of plastic (under 10 micrometers in size). The other studies would have missed such smaller pieces, which made up about half the plastic found in the London and Beijing studies.

Concentrations of airborne nanoplastics are understood even less. The numbers floating around today, says atmospheric chemist Zamin Kanji, Mitrano's colleague at ETH Zürich, are likely to be "significantly underestimated."

For now, the proportion of plastics to total airborne aerosols is tiny, so plastics aren't contributing much to aerosol climate impacts, says Mahowald. Even in London and Beijing, plastic may account for only a millionth of the total aerosols. But plastic production, and the accumulation of plastic in the environment, keeps going up. Says Mahowald, "It's only going to get worse."

That's especially true in less polluted regions — like over the oceans of the Southern Hemisphere, Kanji says. Since plastic can likely travel farther than other, denser aerosols, it could become a dominant airborne pollutant in more pristine areas. Brahney and Mahowald's paper concludes that plastic currently makes up less than 1 percent of anthropogenic aerosols landing on the ground but they could, "alarmingly," make up more than 50 percent of the aerosols landing on some parts of the ocean downwind from plastic sources.

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Exactly how aerosols affect climate has been a critical sticking point in climate models, and many of the details are still unknown. Different aerosols can change the climate by either reflecting or absorbing sunlight, which can depend, in part, on their color. Black soot, for example, tends to have a warming effect, while salt reflects and cools. Aerosols can land on the ground and change the albedo, or reflectivity, of ice and snow.

In the lab, preliminary tests show that battered plastic pieces can be potent cloudmakers.

Aerosols also affect cloud formation: different bits and pieces can seed more and smaller droplets of water or ice, making for different types of clouds at different elevations that last for different amounts of time. High-altitude, thin, icy clouds tend to warm the Earth's surface like a blanket, while low-altitude, bright and fluffy clouds tend to reflect sunlight and cool the Earth.

Though tiny, aerosols have an oversized influence on climate. The murk of anthropogenic aerosols in the sky has, overall, had a dramatic cooling effect since the Industrial Revolution (without them, global warming would be 30 to 50 percent greater than it is today). And they have more sway on extreme weather than greenhouse gases do: a world warmed by removing aerosols would have more floods and droughts, for example, than a world warmed the same amount by CO<sub>2</sub>.

Revell and her colleagues took a stab at trying to model how microplastics might affect temperature by either reflecting or absorbing sunlight, a calculation of what's known as "radiative forcing." For simplicity's sake, they assumed that plastic is always clear, even though that's not true (and darker material tends to absorb more sunlight), and that the global concentration is uniformly one particle per cubic meter, which is on the order of 1,000 times lower than concentrations measured in, say, London.

With those assumptions, Revell found that plastic's direct impact on radiative forcing is "so small as to be insignificant." But, importantly, if concentrations reach 100 particles per cubic meter (which they already have in many spots), plastics could have about the same magnitude of radiative forcing as some aerosols already included in Intergovernmental Panel on Climate Change assessments. In other words, plastics become noteworthy. But whether they would warm, or cool, the Earth is unknown.

Aerosols often have a greater impact on the climate through their influence on clouds. Pristine plastic beads, Kanji notes, repel water and so are unlikely to affect clouds. But plastic can "age" in a matter of hours, says

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Kanji, during its transit to the sky: it can be abraded, or it can accumulate salt from the ocean and other chemicals from the atmosphere, all of which can make the particles more water-loving. Plastic pieces can also contain nooks and crannies, which aid in the formation of ice.

In the lab, Kanji's student Omar Girlanda has run preliminary tests showing that under such battered conditions, plastic pieces can be potent cloudmakers. "Some of them are as good as mineral dust particles," says Kanji, "which is the most well-known, effective ice nucleus out there."

Kanji says skies heavily polluted with plastic will probably make both more high-altitude ice clouds, which tend to warm the Earth's surface, and more low-altitude water clouds, which tend to cool the Earth. Which effect will dominate is unknown. "It doesn't make sense to model it at the moment, given the poor estimates we have of [atmospheric] plastic," says Kanji. Plastic could also affect precipitation patterns: in general, Kanji says, clouds that are more polluted tend to last longer before bursting into rain than do less polluted clouds, and then they rain more heavily.

Revell and her colleagues are now whittling down the assumptions in their paper, working out more detailed calculations for more realistic estimates of plastic concentrations, colors, and sizes. "All we know is that the problem is not going to go away anytime soon," she says. "These plastics are incredibly long lived. They're breaking down, and they're going to be forming new microplastics for centuries. We just don't know how big the problem is that we've committed ourselves to."

Yale Environment 360, 1 February 2023

<https://e360.yale.edu>

### TGA approves psilocybin, MDMA for mental health treatment

2023-02-03

From July this year, medicines containing psilocybin and MDMA will be able to be prescribed by psychiatrists for mental health treatment, the Australian Therapeutic Goods Administration (TGA) has announced.

MDMA is being approved for the treatment of PTSD and psilocybin is approved for treatment-resistant depression. MDMA is frequently referred to as "ecstasy": and psilocybin is the main ingredient in what some people refer to as "magic mushrooms."

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MDMA and magic mushrooms can be dangerous, and these compounds should only be prescribed by a psychiatrist.

This decision makes Australia the first country to officially recognise the two drugs as medicines.

"Recognising that illegal drugs like MDMA and psilocybin have medical utility is an important step in drug policy reform; however, the safe provision of these treatments requires extensive training, which is why they have been limited to clinical research in Australia to date," says Edith Cowan University addiction researcher Dr Stephen Bright.

"To ensure that people accessing these treatments are not harmed, it will be important that the TGA provides a clear expectation regarding the minimum training standards required for psychiatrists who the TGA approves to prescribe these drugs."

Other researchers are excited by the news.

"The safe 're-medicalisation' of certain historically illicit drugs is a very welcome step away from what has been decades of demonisation," says Dr David Caldicott, an Emergency Consultant and Senior Clinical Lecturer in Medicine at the Australian National University.

"In addition to a clear and evolving therapeutic benefit, it also offers the chance to catch up on the decades of lost opportunity in delving into the inner workings of the human mind, abandoned for so long as part of an ill-conceived, ideological 'war on drugs'."

This is only a year after a controversial decision by the TGA that MDMA and psilocybin would not be rescheduled from a from Schedule 9 (Prohibited Substances) to Schedule 8 (Controlled Medicines).

The TGA has now confirmed that for the specific uses in PTSD and treatment resistant depression, psilocybin and MDMA will be listed as Schedule 8 (Controlled Medicines), but for all other uses, they will remain in Schedule 9 (Prohibited Substances).

There's also a number of psychedelic start-ups in Australia that have been calling for change in this space for the last few years.

"There is initial evidence that MDMA can be beneficial in treating PTSD but there is much we do not know. We currently have strong evidence-based treatments for PTSD, and to date, we do not know how MDMA compares relative to these proven treatments which are much cheaper and simpler

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to administer," says University of New South Wales psychologist Professor Richard Bryant.

The science is at a point where we can say it is too early to be prescribing MDMA for PTSD patients. Instead, we should be investing in research to understand how MDMA can be used in relation to proven treatments."

Cosmos Magazine, 3 February 2023

<https://cosmosmagazine.com>

### Purifying the 'miracle metal': How to decarbonize aluminum

2023-02-03

Aluminum has been described as a "miracle metal." While it's the most abundant metal in the earth's crust, the complexities involved with refining it made aluminum more precious than silver or gold during the 19th century. Napoleon III so valued it that he would serve his most honored guests their food on aluminum plates. It remains a high-value material today, prized for its lightweight versatility, military-grade strength, resistance to corrosion and because it is infinitely recyclable.

So, what's not to like? Well, the energy-intensive series of processes that turn raw bauxite ore into a pure metal emit on average 16 metric tons of CO<sub>2</sub> for every metric ton of primary aluminum produced. The sector as a whole generates around 1.1 billion metric tons of CO<sub>2</sub> each year, accounting for 2 percent of global man-made emissions. More than 60 percent of these emissions come from producing the electricity consumed during the smelting process.

What's more, demand for the miracle metal — driven by industries such as transportation, construction, packaging and the electrical sector — is predicted to increase by almost 40 percent by 2030. Two-thirds of this growth is expected from China and Asia, a concern given China's smelting process is heavily reliant on captive coal-fired power plants. Without advances in recycling and decarbonization, the sector's emissions could careen towards nearly 2 billion metric tons by 2050.

#### Tough target from First Movers Coalition

A handful of new technologies hold the potential to clean up aluminum, but only the most ambitious meet the tough target of the World Economic Forum's First Movers Coalition (FMC), a global initiative to harness the purchasing power of companies to decarbonize the planet's heaviest-

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emitting industries. Members of the FMC have committed to a goal that at least 10 percent of the primary aluminum they procure annually by 2030 will be produced via near-zero emissions processes. The definition of "near zero" is the tough bit: emitting less than three metric tons of CO<sub>2</sub> per metric ton of primary aluminum. That represents a huge reduction in current emissions of 85 percent or more.

To understand how to achieve such deep decarbonization, we need a speedy tour of the aluminum manufacturing process. Bauxite is the raw material — it's mined from the ground and refined into aluminum oxide, or "alumina," through a multi-phase process that includes heating it to around 1,000 degrees Celsius. To achieve this heat, many refineries burn fossil fuels onsite, which emit large amounts of CO<sub>2</sub> in the process. The second process, known as smelting, turns the alumina into pure aluminum metal through electrolysis, which uses a lot of electricity and carbon anodes that also emit large amounts of CO<sub>2</sub>.

Existing forms of renewable energy — such as hydro or solar — will get us about two-thirds of the way to zero-emissions aluminum.

The good news is that existing forms of renewable energy — such as hydro or solar — will get us about two-thirds of the way to zero-emissions aluminum. We can use clean energy for the new electrified boilers and calciners involved in refining bauxite ore into alumina — and also for the electricity-intensive smelting process. But this can be expensive in the short term. It means moving the plants to locations with access to renewable power and retrofitting the refineries to install the new equipment.

Some emerging new technologies — which can be implemented at existing aluminum plants — can help narrow the gap towards zero-emissions aluminum. The smelting process can be fully decarbonized by replacing those carbon anodes with inert anodes that emit oxygen instead of CO<sub>2</sub>. A process known as "mechanical vapor recompression" enables the thermal energy needed for refining to be recycled rather than released. And for the remaining emissions, there are technologies such as carbon capture, use and storage (CCUS) to intercept emissions from both the refining and smelting processes. When a few of these breakthrough technologies are used in conjunction, they can get the whole aluminum production process below the threshold of 3 metric tons of CO<sub>2</sub> per metric ton of primary aluminum.

Unlike most other sectors in the FMC, recycling can play a large part in the journey towards decarbonizing the aluminum sector, especially as the metal is considered infinitely recyclable. Recycling takes around 5 percent

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of the energy needed to make new aluminum, so it makes commercial as well as environmental sense. Aluminum remelting is widespread at scale today with more than 30 million metric tons of recycled aluminum flowing back to new products annually. It can also contribute towards a just transition, as collection, sorting and recycling offer the potential to create new jobs while reducing the natural resource extraction required to support primary aluminum production.

Consequently, the FMC has set an additional target for its members to ensure that at least 50 percent of the aluminum they use annually by 2030 is recycled. However, recycling alone won't be enough to slake the growing global thirst for the metal — in fact, it will supply just half the expected demand by 2050, according to the 1.5 degrees C-aligned transition strategy published by the Mission Possible Partnership. So getting primary aluminum production as near to zero emissions as possible remains a top priority.

### The tech solution is there. Now to make it happen

While the technologies to decarbonize aluminum production may exist in prototype forms, like all new technologies that have yet to reach scale, they are expensive. Commercializing them is challenging — and it's not just the cost; aluminum's value chain is complicated and extended.

Take a beer can, for example, which is typically made of more than 50 percent recycled aluminum but still requires primary aluminum. First you mine the bauxite, then you refine it into alumina. It often goes somewhere else to be smelted into pure aluminum. The metal is then processed into discs or coils, bought by companies that punch them into cans, sold to beverage businesses and bottlers, distributed to retailers and only then reaches the consumer. This long supply chain is compounded by the size of the buyers. Whereas steel and concrete have big "anchor buyers," such as auto manufacturers or state procurement agencies, aluminum is bought in small amounts by lots of players. And all the players involved — from the mine company to the beverage retailer — must be aligned to share the goal and the cost of decarbonization.

Ball Corporation, a major manufacturer of aluminum packaging and a member of the FMC, has made a first move towards aligning with its value chain partners. The company has teamed up with aluminum suppliers and fellow FMC members Novelis and Rio Tinto to create Canada's first specially-marked, low-carbon beverage can for Corona beer. The can is made partly from recycled aluminum along with near-zero emission primary aluminum refined with hydropower and smelted

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using a greenhouse gas-free inert anode technology called Elysis. This breakthrough has been made possible by an unprecedented collaboration between two competing aluminum industry giants — Alcoa and Rio Tinto — along with \$13 million (CAD) of investment and technical support from Apple, plus additional investment of \$80 million (CAD) each from the Canadian and Quebec governments. Elysis is still at the prototype stage, but the team is aiming to make the technology commercially available by 2024.

Aligning the value chain, through coalitions such as the FMC, is critical to decarbonization efforts. Without an aligned value chain, demand signals to producers may not lead to any change. These kinds of coalitions also lead to better conversations with governments around a range of subjects, from tightening policies on recycling to co-investing in R&D.

When breakthrough technologies are used in conjunction, they can get the whole aluminum production process below the threshold of 3 metric tons of CO<sub>2</sub> per metric ton of primary aluminum.

Governments have a key role to play in encouraging the decarbonization of primary aluminum refining and smelting. The Middle East has an opportunity to contribute, using its plentiful solar power potential. China is showing movement in the right direction, shutting some coal-powered refining operations and opening new plants in regions abundant with hydropower. But governments may also need to provide direct financial support to the sector. The new technologies needed to decarbonize aluminum — including additional renewable power, CCUS and redesigning the smelting process around inert anodes — will cost around \$1 trillion up to 2050, so it is likely that states will have to step in with incentives, investment and market-based measures. The production of materials such as lithium or copper — vital to the low-carbon transition — already attract government subsidies. So, too, must aluminum, given its role in helping decarbonize other sectors such as transportation and battery technology.

In Europe, the European Union's proposed carbon border adjustment mechanism (CBAM) is a wake-up call to aluminum suppliers looking to export into the single market. By 2030, the CBAM could levy a tax of 100 euros per metric ton of CO<sub>2</sub> contained in imported products and materials, mimicking the cost of the E.U.'s emissions trading scheme (ETS) for local producers. For a metric ton of aluminum with a 16 metric ton CO<sub>2</sub> footprint, that could add 60 percent to the cost of the metal. While such a mechanism may help decarbonized aluminum compete on an ongoing

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basis once commercialized, the model of direct government investment in breakthrough technology may be necessary to crowd in corporate finance and derisk the decarbonization pathway.

The sector is in a race against time to scale-up its nascent near-zero emissions production to deliver the supply required. Companies need to take a clear leadership position, to support the deployment of the deep decarbonization technologies that are needed to align the sector along a pathway to net zero by 2050. There will be additional costs, but coalitions such as the FMC will help create the transparency and collaboration required to address those costs. The technology is there to make it happen — and that's worth raising if not a glass, then certainly a low-carbon beer can.

Green Biz, 3 February 2023

<https://greenbiz.com>

### Cars are rewiring our brains to ignore all the bad stuff about driving

2023-02-01

Unsurprisingly, most Americans frown upon antisocial behavior. Stealing people's stuff, bending food safety rules, or smoking in large crowds tend to generate a lot of stern reactions.

But get behind the wheel of a car, and all that disapproval tends to melt away.

That's because a lot of us suffer from a malady called "car brain" — though Ian Walker, a professor of environmental psychology at Swansea University in Wales, prefers to call it "motonormativity." This is the term coined by Walker and his team to describe the "cultural inability to think objectively and dispassionately" about how we use cars.

Think of it like "heteronormativity," the idea that heterosexual couples "automatically, but inappropriately, assume all other people fit their own categories," but for cars.

Walker noticed that people tend to have a giant blindspot when it comes to certain behaviors associated with driving, whether it's speeding, carbon emissions, traffic crashes, or any other of the vast litany of negative external effects that result from a culture that caters to automobile drivers.

**A new study reveals how unconscious bias leads us to neglect negative externalities of driving. You may call it 'car brain,' but this research team calls it 'motonormativity.'**

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"One of the things you notice if you spend your career trying to get people to drive less is people don't like driving less," Walker said in an interview. "We said, well, let's try and measure this. Let's just demonstrate the extent to which the population as a whole will make excuses, will give special freedom to the context of driving."

To accomplish this, he devised a series of statements aimed at rooting out these unconscious biases. The statements were separated into two categories: one about cars and driving and another with key words and phrases replaced to make it about some other activity. An independent polling firm was contracted to find a sampling of 2,157 adults in the UK, who were then asked to either agree or disagree. Half were given the car-related statements, while the other half presented with the non-car ones.

For example, people were asked to agree or disagree with the following statement: "People shouldn't smoke in highly populated areas where other people have to breathe in the cigarette fumes." Then they were asked to respond to a parallel statement about driving: "People shouldn't drive in highly populated areas where other people have to breathe in the car fumes."

While three-fourths of respondents agreed with the first statement ("People shouldn't smoke..."), only 17 percent agreed with the second ("People shouldn't drive...").

Another statement addressed values around theft of personal property. Respondents were asked whether they agreed or disagreed with the statement, "If somebody leaves their belongings in the street and they get stolen, it's their own fault for leaving them there and the police shouldn't be expected to act," as well as the parallel statement, "If somebody leaves their car in the street and it gets stolen, it's their own fault for leaving it there and the police shouldn't be expected to act."

Only 8 percent of people disagreed with the first statement, while 55 percent of people disagreed with the second one.

Similar outcomes were discovered in questions about food and health safety, alcohol consumption, and workplace injuries. People were less tolerant of bad behavior that didn't involve a car and vastly more tolerant of similar-sounding behaviors that involved driving.

For Walker, this disconnect is where motonormativity comes into play. "We wanted to demonstrate that when you talk about driving, people are not applying their normal values," he said.

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The smoking question in particular fascinated Walker for several reasons. For decades, society tolerated — even encouraged — public smoking. But then a growing awareness around public health risks associated with secondhand smoke, combined with harsher government regulations, led to a shift in public perception. The same could eventually hold true for driving, he said.

“The fact that smoking has shifted so much, to where almost everybody we spoke to said no, that’s not acceptable — those same people wouldn’t have said that 20 years ago,” Walker said. “And so the smoking and driving comparison interests me because it shows us where we could get to in the future if people’s minds start to change.”

Given how entrenched car culture is in countries around the world, it may take a lot longer to change people’s minds about driving than it did with cigarettes. For one, we don’t tend to view driving through the lens of public health, which shields most of us from thinking about the societal harms and inequities associated with car use.

That’s because, for most people, driving is a convenience. And because it’s easy, we tend to assume it’s part of the natural order to drive. That’s why there’s so much hostility around cycling and alternate forms of transportation: because, for many people, it challenges the natural order of driving.

“Not only do people do what the world makes easy, but because it feels easy, people conclude that it’s right,” Walker said.

The Verge, 1 February 2023

<https://theverge.com>

### World’s oldest vertebrate brain found in 319-million-year-old fossil

2023-02-05

Most of what we know about ancient extinct animals comes from their bones, since soft tissues don’t usually fossilize well. But now, scientists have discovered the oldest preserved vertebrate brain, in a fossilized fish almost 320 million years old.

After an animal dies, its flesh and organs usually disappear very quickly, thanks to scavengers or decomposition. That leaves just the bones, which in some cases can fossilize to become the museum exhibits we’re familiar with. But if a carcass avoids exposure to the elements, such as being

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buried quickly or getting encased in materials like amber, soft tissues like skin or feathers can survive to the present day.

Now, scientists have discovered the oldest known fossilized brain in a vertebrate animal. The record belongs to a 319-million-year-old fish known as *Coccocephalus wildi*, an early ancestor of ray-finned fishes, which make up the biggest group of modern vertebrates. The previous record-holder was a shark dating back 300 million years, but other notable fossil brains include a 310-million-year-old horseshoe crab and a 133-million-year-old dinosaur. It’s got nothing on the oldest known heart though, which was found in a 380-million-year-old fish fossil.

The fossil of *C. wildi* isn’t a new discovery however – it was dug out of a coal mine almost a century ago. But in the new study, researchers conducted a CT scan of the specimen to examine its insides without damaging it, and spotted a bright blob in the skull, indicating a denser mineral, perhaps pyrite. This blob looked suspiciously brain-like, the team said: it was symmetrical down the middle, had hollow spaces that resembled ventricles, and filaments that seemed to be cranial nerves.

“It had all these features, and I said to myself, ‘Is this really a brain that I’m looking at?’” Said Matt Friedman, senior author of the study. “So I zoomed in on that region of the skull to make a second, higher-resolution scan, and it was very clear that that’s exactly what it had to be.”

The team says the pristine preservation likely occurred because the fish was buried beneath sediments very quickly after it died, with little oxygen present. A chemical micro-environment that was conducive to fossilizing soft tissues also seemed to have formed inside its skull.

The discovery can also fill in some blanks in the story of the evolution of fish. According to the researchers, the brain of *C. wildi* is most similar to that of sturgeons and paddlefish, which are considered primitive because they diverged from other ray-finned fishes over 300 million years ago.

“Unlike all living ray-finned fishes, the brain of *Coccocephalus* folds inward,” said Friedman. “So, this fossil is capturing a time before that signature feature of ray-finned fish brains evolved. This provides us with some constraints on when this trait evolved – something that we did not have a good handle on before the new data on *Coccocephalus*.”

**In the new study, researchers conducted a CT scan of the specimen to examine its insides without damaging it, and spotted a bright blob in the skull**

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The team believes that this kind of brain preservation occurs more often than previously thought. In future work they plan to start looking for them.

New Atlas, 5 February 2023

<https://newatlas.com>

### How do deep sea microbes survive with no sunlight? A world-first study from Monash University provides answers

2023-02-08

What fuels the creatures that call the ocean's deep depths home? It has long been a mystery, but a world-first study led by Monash University researchers finally gives us the answer.

And it might have provided added weight to the theory of where life first emerged on our planet.

It has long been thought that the bulk of ocean life was fuelled by photosynthesis via sunshine. This process is commonly associated with land plants. The organism uses sunlight to turn carbon dioxide and water into organic molecules. It is a process which occurs in almost all algae as well.

But the sun's light can't penetrate all the way down into the dark depths.

A five-year study led by Monash University's Dr Rachael Lappan and Professor Chris Greening shows that fuel in the dark depths comes from a distinct process called chemosynthesis. Unlike photosynthesis, which uses light for organic growth, chemosynthesis uses inorganic compounds.

The ocean can be divided into three zones based on the amount of light that gets through at different depths.

On average, the ocean floor is roughly 3,688 metres below sea level. So a lot of ocean is shrouded in darkness.

Lappan and Greening's research found that the chemicals responsible for fuelling chemosynthesis in the deep sea are two common gases: hydrogen and carbon monoxide.

Greening says that their analysis showed that chemosynthesis was the energetic process of choice for trillions of deep-sea microbes from the tropics to the poles.

**It is hydrogen and carbon monoxide which give deep ocean microbes their energy.**

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"Hydrogen and carbon monoxide in fact "fed" microbes in all regions we've looked at: from urban bays to around tropical islands to hundreds of metres below the surface," Greening says. "Some can even be found beneath Antarctica's ice shelves."

The research involved chemical analysis from oceanic voyages as well as lab-based analysis of microbial cultures and the genes present.

"We found the genes that enable hydrogen consumption across eight distantly related types of microbes, known as phyla, and this survival strategy becomes more common the deeper they live," explains Lappan.

The study followed the researchers' previous work on soil bacteria which found that they too can live by consuming hydrogen and carbon monoxide from the atmosphere.

"The surface layers of the world's oceans generally contain high levels of dissolved hydrogen and carbon monoxide gases due to various geological and biological processes. So it made sense that oceanic bacteria used the same gases as their terrestrial cousins," Lappan adds.

The researchers say that their findings also shed some light on how life may have evolved.

"The first life probably emerged in deep-sea vents using hydrogen, not sunlight, as the energy source," Greening says. "It's incredible that, 3.7 billion years later, so many microbes in the oceans are still using this high-energy gas and we've completely overlooked this until now."

The study is published in Nature Microbiology.

Cosmos Magazine, 8 February 2023

<https://cosmosmagazine.com>

### This Antarctic EV goes where other electric vehicles can't tread

2023-02-04

In 2009, Prince Albert II of Monaco asked experimental vehicle manufacturer Venturi to take a crack at designing an electric vehicle that could handle the harsh cold of Antarctica. Over the next 12 years, the company went to work. After testing out two full prototypes, the company pulled off a final product launch on June 1, 2021. The Venturi Antarctica, as

**A machine built for South Pole conditions faces another engineering challenge: climate change.**



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the vehicle is called, has been transporting scientists and lab equipment in eastern Antarctica since December 2021.

Designing an electric vehicle for the harsh climate of Antarctica is no easy feat. The battery and other components have to be able to tolerate the frigid Antarctic temperatures, and there needs to be space to store research equipment and transport the researchers comfortably. Venturi has experience with experimental electric vehicles going back to 2000, and has competed in Formula E, the top-tier electric car racing competition in the world, since its inaugural season in 2014.

According to Venturi, scientists based at the Belgian Princess Elizabeth research station have driven the Antarctica EV over 500 kilometers (310 miles) in just one summer of use. The vehicle has a range of 50 kilometers (31 miles), with space for a second battery if the scientists need more range. However, its range can vary depending on how compact the snow it has to drive on is, and scientists started noticing some problems.

As climate change has affected global temperatures, Antarctica has warmed. Average temperatures on the icy continent ranges from a frigid -50 degrees Celsius (-58 F) inland to around minus 10 C (14 F) on the coasts, and the vehicle, designed for the extra cold, needed tweaks to tolerate the relative warmth. Venturi instructed researchers to limit trips to 40 kilometers (25 miles), and is beginning work on modifications to restore the vehicle to its true glory.

Since Antarctica is covered almost entirely in snow, the Antarctica EV uses a continuous track system, just like you'd expect on a snowcat or a snowmobile. The treads spread the 5,500 pounds of vehicle over its entire surface area, preventing the Antarctica EV from sinking into the snow like a wheeled vehicle would. But the warmer temperatures have caused the snow to stick to the sprockets that drive the treads, creating unwanted vibrations that could further damage the vehicle. The company has since redesigned and replaced the sprockets in an attempt to keep the vehicle in working order.

Increasing temperatures also made it more likely for the cabin, which is packed with electronics and exposed to the sun, to overheat. To balance that out, Venturi has had to install a new ventilation system for a more comfortable riding experience. They also made a new cooling system for the power electronic systems themselves.

Venturi announced on January 24 that their next set of improvements will be focused on redesigning the treads and increasing the vehicle's range

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in Antarctica. Barring any other unforeseen circumstances, these should allow the vehicle to putter around the ice and snow of the southern continent more and more in the years to come.

Popular Science, 4 February 2023

<https://www.popsci.com>

### Team finds black hole 'table for two'

2023-02-06

The finding could have a profound impact on our understanding of later-stage galaxy mergers and suggests that the phenomenon of side-by-side black holes occurring during a merger may be more common than previously known.

"Relatively few dual black holes like this have ever been confirmed," says Meg Urry, professor of physics and astronomy at Yale University and director of the Yale Center for Astronomy & Astrophysics. "This pair has the closest separation yet measured, only about 750 light years."

Urry, part of the international research team that made the discovery, is coauthor of the new study in *The Astrophysical Journal Letters* and presented at the 241st meeting of the American Astronomical Society in Seattle on January 9.

A considerable body of research exists on the early phases of galactic mergers, which occur when gravity slowly draws two or more galaxies together. However, relatively little is known about the later stages. A key component in such mergers is the behavior of black holes—areas of space that have intense gravity and can grow by gobbling up gas and dust from their immediate surroundings.

For the study, astronomers enlisted a variety of powerful instruments to observe the late-stage merger of the galaxy UGC4211, located 500 million light years from Earth in the constellation Cancer. Using multiple instruments enabled researchers to observe the side-by-side black holes in different wavelengths and gather a more complete picture of the phenomenon.

Urry contributed data from the W.M. Keck Observatory's OSIRIS near-infrared field spectrograph in Hawaii; Yale has maintained a years-long association with Keck that has yielded significant data.

**Astronomers have discovered a galactic table for two—a pair of unusually close black holes that are feeding together after their respective galaxies collided.**

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“It’s super important that we can make these kinds of observations with Keck,” Urry says. “First, with Keck’s NIRC2 instrument, to survey the remnants of galaxy mergers to find hidden dual nuclei—supermassive black holes that will eventually merge—and then, in this particular case, to confirm the presence of two galactic nuclei with Keck’s OSIRIS near-infrared field spectrograph.

“OSIRIS found broad infrared lines in the southern nucleus, confirming it is certainly an active galactic nucleus, and measured the velocity offset between the two nuclei.”

Data from the Atacama Large Millimeter/submillimeter Array (ALMA)—an international observatory co-operated by the US National Science Foundation’s National Radio Astronomy Observatory—enabled astronomers to find the exact location of the two black holes in the UGC4211 galaxy. Additional data came from the Chandra and Hubble telescopes, the ESO’s Very Large Telescope, and the Dark Energy Camera Legacy Survey (DECaS) on the Blanco 4-meter telescope at Cerro Tololo Inter-American Observatory.

“Simulations suggested that most of the population of black hole binaries in nearby galaxies would be inactive because they are more common, not two growing black holes like we found,” says Michael Koss, a senior research scientist at Eureka Scientific and the lead author of the new research.

Koss added that the use of ALMA was a game-changer, and that finding two black holes so close together in the nearby universe could pave the way for additional studies of the phenomenon.

Urry and her colleagues says that if close-paired binary black hole pairs are indeed commonplace, there could be significant implications for future detections of gravitational waves, as well.

“It will help us develop estimates of black hole merger rates for future gravitational wave detectors,” Urry says.

Futurity, 6 February 2023

<https://futura.org>

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### Debunking the myth that electric trucks and buses are not cleaner than diesel

2023-02-07

Unlike conventional vehicles, electric vehicles (EVs) don’t physically emit CO<sub>2</sub>. But they’re not completely emissions-free: there may be greenhouse gas emissions associated with making and disposing of them, as well as emissions from generating the electricity they use.

These indirect emissions are often the focus of those who argue that manufacturing an EV produces more greenhouse gasses than non-EVs.

However, research usually shows that EVs are better for the environment than conventional vehicles. In almost all scenarios, electric cars still lower emissions compared to conventional cars: but different studies come up with different amounts by which EVs improve things.

And now this new report from the International Council on Clean Transportation has thrown trucks and buses – some of the dirtiest vehicles – into the mix and discovered that electric heavy vehicles too are cleaner than conventional vehicles.

The report finds that, in Europe, battery-powered trucks and buses deliver the biggest emissions reductions over their lifetimes, compared to hydrogen, gas, and diesel vehicles.

Trucks and buses make up 2% of vehicles on Europe’s roads, but a quarter of its transport emissions.

The researchers found that, including manufacturing, a battery-electric 40-tonne semi-trailer entering service in 2021, would produce at least 63% lower emissions compared to diesel over its lifetime.

This also accounts for Europe’s non-emissions-free electricity grid. If using only renewable electricity, such a vehicle would provide an 84% emissions reduction.

Hydrogen fuel vehicles using emissions-heavy hydrogen are 15% less polluting than diesel cars. Using hydrogen made only from renewable electricity (green hydrogen), hydrogen vehicles can lower their emissions by 85%.

Trucks and buses powered by fossil gas (also called “natural gas”) only provided a 4-18% reduction in emissions compared to diesel. This gas

**A new report from the International Council on Clean Transportation has thrown trucks and buses – some of the dirtiest vehicles – into the mix.**

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is mostly methane, which is itself a potent greenhouse gas, as well as combusting to make CO<sub>2</sub>.

“The climate benefits of natural gas urban buses compared to diesel are marginal at best,” says Nikita Pavlenko, Fuel Program Lead at the International Council on Clean Transportation.

“Methane leakage may undermine the benefits of transitioning bus fleets to natural gas. Cities should consider their transport policy strategies with these numbers at hand.”

Felipe Rodríguez, also a program lead, says that increasing energy efficiency is the main reason battery electric trucks and buses have the lowest lifetime emissions impact.

“Our study addresses the uncertainties surrounding the share of emissions in all stages of the vehicle’s life,” says Rodríguez.

“It shows that only battery electric and some fuel cell electric trucks can meet the climate targets in the sector.”

Cosmos Magazine, 7 February 2023

<https://cosmosmagazine.com>

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## Technical Notes

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### ENVIRONMENTAL RESEARCH

[Urban particulate air pollution linked to dyslipidemia by modification innate immune cells](#)

[Characterization of Polycyclic Aromatic Hydrocarbons \(PAHs\) associated with fine aerosols in ambient atmosphere of high-altitude urban environment in Sikkim Himalaya](#)

### PHARMACEUTICAL/TOXICOLOGY

[Results of the Austrian Children’s Biomonitoring Survey 2020 part A: Per- and polyfluorinated alkylated substances, bisphenols, parabens and other xenobiotics](#)

[Long-term exposure to fine particulate matter and site-specific cancer mortality: A difference-in-differences analysis in Jiangsu province, China](#)

[Paternal occupational exposures and infant congenital heart defects in the Japan Environment and Children’s Study](#)

### OCCUPATIONAL

[Occurrence of emerging bisphenol S analogues in urine from five occupational populations in South China](#)

[Nosocomial transmission of mpox virus to healthcare workers -an emerging occupational hazard - a case report and review of the literature](#)

[Polybrominated diphenyl ethers and bromophenols in paired serum, hair, and urine samples of e-waste dismantlers: Insights into hair as an indicator of endogenous exposure](#)