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Environmental Science & Other Innovations:

I. Environmental Science & Climate Solutions:

Quantum Secure Communication for Environmental Monitoring: A significant development is the successful demonstration of free-space quantum secure communication over more than 1 km by DRDO and IIT-Delhi. While primarily a defence innovation, the underlying technology (Quantum Key Distribution - QKD) has profound implications for secure data transmission in highly sensitive environmental monitoring networks, ensuring the integrity of critical climate data.

Water, Sanitation, and Hygiene (WASH) Innovations: Research is focusing on "systems transformation and innovation" for resilient and equitable WASH services. This includes climate-resilient WASH infrastructure, data monitoring approaches (including decentralized, digitalized, and citizen science methods), and new financing models for sustainable water and sanitation.

PFAS (Forever Chemicals) Research and Mitigation: There's intense activity around PFAS chemicals. Research from Cambridge University suggests certain gut bacteria may absorb toxic PFAS, offering a promising new approach to detoxification. Conversely, a national study in the Netherlands (RIVM) found widespread PFAS levels in the blood of all Dutch citizens exceeding health guidelines, highlighting the pervasive nature of this pollution. New PFAS-free coatings are also being developed for textiles, packaging, and kitchenware.

Agricultural Liming as a CO2 Sink: New research indicates that agricultural liming in the US can effectively remove CO2 from the atmosphere, presenting a potential climate mitigation strategy.

Marine Forest Restoration: EU-funded researchers are actively restoring marine forests, involving local communities to turn citizens into "ocean stewards" and improve marine biodiversity.

Microplastic Pollution Insights: A Plymouth study linked sewage spills and coastal winds to fueling microplastic pollution, providing clearer understanding of sources for targeted mitigation.

II. Other Innovations & Technologies with Environmental Impact:

Green Construction & Building Systems:

Cement-Free Concrete: CarbiCrete, a Canadian company, showcased a cement-free concrete that uses industrial steel slag and injects captured CO2 during curing. This not only avoids CO2 emissions from cement manufacturing but actively sequesters CO2.

Low-Maintenance Facade Solutions: New materials like Cor-Ten weathering steel facade systems are emerging. These naturally resist corrosion without paint or frequent upkeep, extending product lifespan and reducing chemical use.

Smart LED Lighting & Indoor Air Quality: Advancements include smart LED fixtures with adjustable brightness and color temperature for energy efficiency, and medical-grade HEPA filters and UV-C sterilization in portable purifiers to remove airborne contaminants.

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Waste Management Technologies:

AI-Powered Sorting Systems: Advanced computer vision and machine learning are being used in material recovery facilities (MRFs) for highly accurate identification and sorting of recyclables, reducing contamination and labor costs.

Smart Waste Bins and IoT Sensors: Bins equipped with fill-level sensors send real-time data for optimized pickup schedules and route planning, reducing unnecessary trips and emissions.

Decentralized Waste Processing: More communities are adopting on-site organics composting and small-scale plastics recycling to keep resources local, cut transportation emissions, and support circular economy goals.

Anaerobic Digestion: This technology is increasingly used for organic waste, producing biogas for energy and nutrient-rich digestate for fertilizer, diverting waste from landfills.

Urban Mining and E-Waste Recovery: Facilities are extracting precious metals from discarded electronics, reducing toxic waste and providing secondary sources of valuable elements.

Electrification of Collection Fleets: Waste haulers are increasingly switching to electric trucks for zero tailpipe emissions, lower costs, and quieter operations.

Renewable Energy Advancements:

Solar Energy Dominance: Solar power continues to lead, with ongoing advancements in photovoltaic technology and decreasing costs driving growth in both large-scale farms and rooftop installations.

Offshore Wind Expansion: Driven by government prioritization and technological improvements, offshore wind capacity is expanding rapidly, offering higher energy yields.

Energy Storage Solutions: Crucial for balancing intermittent renewables and ensuring grid stability, energy storage technologies are maturing, allowing for more efficient integration of renewable power.

Green Hydrogen: The global green hydrogen market is projected for remarkable growth (CAGR over 50% between 2025 and 2030), becoming vital for industrial decarbonization. India's National Green Hydrogen Mission aims to make it a global hub.

EV Acceleration: The electric vehicle (EV) sector is set to accelerate, with further deployment of charging infrastructure.

Circular Economy Adoption: Businesses are making circular initiatives standard practice, designing products for longer lifecycles, and focusing on eliminating waste through design. Collaboration across sectors is seen as critical for sharing infrastructure and developing new circular business models. The EU is accelerating its shift to a circular economy with new initiatives ahead of the 2026 Circular Economy Act.

AI and Digital Twins for Sustainability: AI is being used to optimize resource usage, predict energy consumption, and reduce waste. Digital twins (virtual copies of physical systems) are enhancing environmental performance by tracking and predicting energy use and emissions, potentially cutting consumption by up to 30% in manufacturing.





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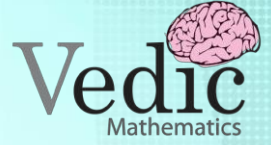
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Satellite for Air Quality Monitoring: The Copernicus Sentinel-4 satellite, launched from Cape Canaveral on July 1, 2025, represents a major advance in Europe's efforts to monitor air quality, specifically tracking pollutants like ozone, nitrogen dioxide, and sulfur dioxide.

MCQS

1. The successful demonstration of free-space quantum secure communication over what distance was achieved by DRDO and IIT-Delhi?

- A) Less than 100 meters
- B) More than 1 km
- C) 10 km
- D) 100 km

Answer: B) More than 1 km

The text states, "A significant development is the successful demonstration of free-space quantum secure communication over more than 1 km by DRDO in collaboration with the Indian Institute of Technology (IIT)-Delhi."

2. Research from which university suggests that certain gut bacteria may absorb toxic PFAS, offering a new approach to detoxification?

- A) Oxford University
- B) Stanford University
- C) Cambridge University
- D) Harvard University

Answer: C) Cambridge University

The text mentions, "Research from Cambridge University suggests certain gut bacteria may absorb toxic PFAS, offering a promising new approach to detoxification."

3. What is the key innovation of CarbiCrete's cement-free concrete?

- A) It uses a new type of sand.
- B) It's cured with UV light.

- C) It uses industrial steel slag and injects captured CO₂ during curing.
- D) It relies solely on natural drying.

Answer: C) It uses industrial steel slag and injects captured CO₂ during curing. The text describes, "CarbiCrete, a Canadian company, showcased a cement-free concrete that uses industrial steel slag and injects captured CO₂ during curing."

4. What is the projected Compound Annual Growth Rate (CAGR) for the global green hydrogen market between 2025 and 2030?

- A) Less than 10%
- B) 25% - 30%
- C) Over 50%
- D) Over 100%

Answer: C) Over 50%

The text states, "The global green hydrogen market is projected for remarkable growth (CAGR over 50% between 2025 and 2030)..."

5. The Copernicus Sentinel-4 satellite, launched on July 1, 2025, is primarily designed to monitor what?

- A) Ocean currents and temperatures
- B) Forest cover and deforestation
- C) Air quality, specifically pollutants like ozone and nitrogen dioxide
- D) Sea ice extent in the Arctic

Answer: C) Air quality, specifically pollutants like ozone and nitrogen dioxide

The text says, "The Copernicus Sentinel-4 satellite, launched from Cape Canaveral on July 1, 2025, represents a major advance in Europe's efforts to monitor air quality, specifically tracking pollutants like ozone, nitrogen dioxide, and sulfur dioxide."





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6. When is the EU's Circular Economy Act, which aims to accelerate the transition to a circular economy, expected?

- A) 2025
- B) 2026
- C) 2027
- D) 2030

Answer: B) 2026

The text mentions, "...prepare the ground for the Circular Economy Act, expected in 2026."

7. What type of waste management technology is increasingly used for organic waste to produce biogas for energy and nutrient-rich digestate for fertilizer?

- A) Incineration
- B) Landfilling
- C) Anaerobic Digestion
- D) Pyrolysis

Answer: C) Anaerobic Digestion

The text notes, "Anaerobic Digestion: This technology is increasingly used for organic waste, producing biogas for energy and nutrient-rich digestate for fertilizer, diverting waste from landfills."

8. A study from Plymouth linked sewage spills and what other factor to fueling microplastic pollution?

- A) Agricultural runoff
- B) Industrial discharge
- C) Coastal winds
- D) Riverine input

Answer: C) Coastal winds

The text mentions, "A Plymouth study linked sewage spills and coastal winds to fueling microplastic pollution..."

