MONTHLY RESEARCH DIGEST

An Executive Briefing on New & Notable Sustainability Research

In This Issue – **November 2025**

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EMERGING TECHNOLOGIES

10 Emerging Technology Solutions for Planetary Health

By World Economic Forum, in collaboration with Frontiers

View the full report here

Notable Highlights

- **Ten emerging technologies have significant potential to move the planet back toward operating within planetary boundaries:** precision fermentation, green ammonia production, automated food waste upcycling, methane capture and utilization, green concrete, next-gen bi-directional charging, timely and specific Earth observation, modular geothermal energy, regenerative desalination, and the convergence of soil health technologies.
- New timely, specific Earth observation tools can **help companies identify hotspots** of deforestation, water stress, and emissions within their supply chains.
- Green concrete can **eliminate emissions from cement production**, create a **permanent storage route for captured carbon**, and **cut demand for raw materials.**
- The **global market for upcycled food products was valued at over $50 billion,** with strong growth anticipated over the next decade.
- Modular geothermal systems **require significantly less land, water, and materials** than many other renewable energy sources, while also delivering **weather-independent heating, cooling, and baseload electricity.**
- The following Notable Findings break down the **planetary boundaries supported** by each technology, as well as the key **policy, financial, and equity conditions** that the success of each technology may depend on.

Objective.

- To spotlight 10 emerging technologies with significant potential to move the planet back toward operating within planetary boundaries.

Background

- The planetary boundaries are scientifically defined boundary levels that collectively define the safe operating space of Earth's natural systems. As of 2025, seven of the nine planetary boundaries have been breached (pg. 5, 38).

- The 10 technologies were nominated through a survey of experts, which included input from WEF partners, Global Future Council members, the Frontiers network of chief editors, and the Frontiers Planet Prize National Champions and a 100-member jury. Survey responses were combined with previous submissions for the Frontiers Planet Prize to nominate a total of 123 technologies (methodology on pg. 6).
- A shortlist of 20 technologies was developed based on AI analysis of their growing presence in research. An expert steering committee assessed the shortlist based on novelty, the potential for a significant planetary boundary response, and whether the technology is developed across multiple entities and/or has broad, sustained interest.

Report Findings

10 emerging technology solutions for planetary health (pg. 8-9):

#1: Precision fermentation (producing animal-free proteins for food, materials, and medicine) (pg. 8-9):

Precision fermentation mitigates the need to harvest nutritionally relevant proteins from animals by generating identical or nearly identical proteins from microbes.

- When coupled with renewable energy inputs and sustainable feedstock sourcing, precision fermentation can **reduce GHG emissions by 72-97%, cut water use by 81-99%, and lower land use by up to 99%** compared to conventional dairy protein production.
- In addition to the rapid expansion of this method in the food sector, it is **reducing reliance on low-yield, fossil fuel-intensive chemical synthesis** for vitamins, pigments, flavors, cosmetic ingredients, biodegradable textile coatings, and pharmaceutical compounds, such as insulin.
- **High energy requirements** and the need for refined sugar inputs **may limit the technology's climate benefits** unless it is powered by renewables and coupled with sustainable feedstocks.
- **The success of precision fermentation may depend on** adaptive regulatory frameworks for food safety and intellectual property, blended finance, practical scale-up routes (e.g., shared manufacturing hubs), and equitable access to tools and markets.

#2: Green ammonia (pg. 11-12):

Green ammonia is ammonia synthesized using renewable energy.

- Widespread deployment can **eliminate fossil fuel use in hydrogen production** and synthesis and **drive investment** in electrolyzers, storage systems, and retrofitted plants.

- Ports are evaluating how to store and deliver ammonia as a clean marine fuel. The first ammonia-powered maritime engines are undergoing operational testing.
- Significant barriers include **high upfront costs** and the need for port, transport, bioproduction, and safety infrastructure.
- **The success of green ammonia may depend on** supportive policy frameworks (e.g., procurement standards and permitting frameworks), targeted investment in infrastructure to lower long-term costs and expand regional capacity, and equitable access to production that benefits local needs.

#3: Automated food waste upcycling (using AI-driven sorting and recovery) (pg. 14-15):

- Recent advancements in automation and robotics are enabling the large-scale recovery of food waste for composting or upcycling.
- Food waste automation can **reduce landfill emissions and demand for newly sourced agricultural inputs,** open **new markets** for upcycled food waste products (e.g., compost blends), strengthen **circular food systems**, and reduce environmental burdens in low-income communities disproportionately affected by landfills.
- **The success of automated food waste upcycling may depend on** regulatory clarity (e.g., national and municipal mandates for food waste diversion), investment in decentralized facilities, and equitable access across diverse waste infrastructures, especially in middle-income countries with growing waste volumes.

#4: Methane capture and utilization (pg. 17-18):

Methane capture and utilization technologies intercept methane before it reaches the atmosphere and convert it into energy or products.

- These technologies could **reduce GHG emissions**, surface ozone, and reliance on flaring; limit aerosols and chemical byproducts that contribute to novel entities; **generate power,** thereby increasing energy security; **create new markets** and job opportunities (from converting methane into industrial inputs); and **lessen respiratory health risks.**
- In the energy sector, there is concern that methane capture **could be used as a stopgap solution**, focusing on mitigation rather than accelerating the phaseout of fossil fuel use.
- **The technology's success may depend on** policy frameworks that direct methane capture toward existing emissions (e.g., landfill or farm emissions), balanced investment across sectors, and access to mitigation technologies in low-income regions.

#5: Green concrete (pg. 20-21):

Green concrete eliminates Portland cement (the key binding ingredient) and uses binders derived from industrial byproducts or construction and demolition waste.

- In regions with limited technical expertise and financing, procurement standards, workforce development, and **investment in regional recycling and manufacturing capacity** can help ensure green concrete technologies deliver environmental and economic benefits where they are most needed.
- **The success of green concrete may depend on** supportive policies (e.g., building codes), standards, third-party verification, clear demand signals to offset high upfront costs, green bonds, major buyer commitments, and equitable access to low-carbon construction materials.

#6: Next-gen bi-directional charging (pg. 23-24):

Bi-directional charging allows electricity to move into and out of batteries, turning stored battery power into flexible energy sources that can be redirected based on use needs.

- Well-designed bi-directional charging systems could **decrease urban emissions and air pollution** through efficient load balancing, reduce reliance on fossil-fueled backup generators, expand access to backup power, **lower energy costs** through local energy sharing, and support the **efficient redistribution of renewable energy.**
- **Technologies are being piloted** in real-world settings (e.g., electric school buses in the U.S. equipped with vehicle-to-grid systems), allowing personal EVs to supply electricity for local energy management, such as peak demand response in homes.
- If battery charging occurs when fossil fuels dominate the grid mix, or if batteries are cycled inefficiently, **emissions may increase rather than decrease**.
- **The success of bi-directional charging may depend on** coordinated regulation (including grid participation, compensation schemes, and equipment standards), targeted incentives for bi-directional-ready vehicles and distributed energy programs, and integration into affordable housing, public infrastructure, or microgrid programs to enhance energy resilience in underserved communities.

#7: Timely, specific Earth observation (EO) (pg. 26-27):

- New Earth observation tools that fuse satellite, drone, and ground-based data with AI-powered analytics offer **high-resolution, near-real-time views of planetary change**, from whole-Earth observations to micro-local, tree-by-tree health evaluations.
- Frequent, granular environmental monitoring would improve tracking of freshwater depletion, land degradation, and biodiversity loss, **enabling earlier interventions.**

- EO could make actionable environmental data more accessible to communities facing climate risk, guiding decisions on agriculture, relocation, or disaster response.
- High costs, infrastructure demands, and limited internet access may constrain uptake.
- **The success of AI-powered EO may depend on** transparent governance, investment in open-access platforms and applied tools for climate monitoring, disaster preparedness, and land-use planning, as well as support for local infrastructure and technical capacity.

#8: Modular geothermal energy (pg. 29-30):

Modular geothermal energy solutions are scalable, often prefabricated systems that harness the Earth's heat for power generation or heating. Unlike traditional large geothermal plants tied to specific high-temperature reservoirs, modular systems don't require specific geological conditions and can be deployed in various formats.

- The technology could **strengthen energy resilience** in underserved communities by enabling locally managed power and support job creation, particularly in regions where existing fossil fuel expertise and infrastructure can be redirected toward clean energy.
- **Co-locating modular units** with data centers, manufacturing plants, or agricultural facilities can **provide consistent energy,** enable energy cogeneration, and reduce reliance on volatile fuel markets.
- **The success of modular geothermal energy may depend on** clear permitting frameworks, public procurement standards, early-stage investment, and incentives for modular manufacturing to reduce upfront costs. Additionally, it requires planning in regions new to geothermal development and repurposing oil and gas infrastructure and workforce capacity.

#9: Regenerative desalination (pg. 32-33):

Regenerative desalination reuses and recycles water and resources within the water purification process.

- A projected 40% gap is expected between global freshwater supply and demand by 2030. Regenerative desalination **could help ease pressure on freshwater resources.**
- The technology **minimizes waste, energy demand, and environmental impacts** compared to conventional desalination methods.
- Powering these systems with **renewable energy can further reduce emissions** associated with water treatment. However, doing so could compete with other energy needs, especially in energy-constrained regions.

- Pilot projects are already demonstrating the **feasibility of recovering valuable materials**, such as high-purity magnesium, **from high-salinity brine,** which can help preserve the integrity of the biosphere and prevent the spread of novel entities.
- Widespread deployment may take a decade or more due to high costs, high energy demands, and uncertain markets for recovered materials.
- **The success of regenerative desalination may depend on** regulatory support for chemical recovery and brine reuse, as well as the combination of public and private capital to mitigate early-stage deployment risks, and equitable access to affordable water treatment.

#10: Soil health technology convergence (pg. 35-36):

- A convergence of AI-enabled diagnostics, proximate and remote sensing, and microbiome engineering is **making soil health maintenance measurable and actionable.**
- Proximate sensing enables frequent, localized soil monitoring, which can **improve soil resilience and crop productivity, reduce nutrient runoff, and enhance carbon storage.**
- Soil microbes regulate nutrient cycling and carbon storage. Microbiome engineering seeks to enhance soil function by introducing targeted mixes of beneficial species.
- Recent developments in machine learning can facilitate the integration of soil data from multiple sources into diagnostic tools, **enabling targeted land management practices.**
- The Open Soil Index is an **open-source framework** to assess soil quality.
- **The success of soil health technologies may depend on** clear standards for soil diagnostics (e.g., agreed thresholds for organic matter), targeted investment in public-private data platforms, and affordable tools and capacity strengthening to ensure farmers in digitally underserved areas are included.

ADAPTATION & RESILIENCE

Returns on Resilience: Investing in Adaptation to Drive Prosperity, Growth and Competitiveness

By Systemiq, in collaboration with AAI (Africa Adaptation Initiative), the Africa Climate Foundation, the Africa Europe Foundation, Ambition Loop, the Ban Ki-moon Centre for Global Citizens, the Bridgetown Initiative, British International Investment, the ClimateWorks Foundation, the DCA Act Alliance, E3G, FAS, FSD Africa, the Gates Foundation, the Global Center on Adaptation, Global Citizen, the Grantham Research Institute on Climate Change and the Environment, the IHLEG on Climate Finance, the Institute for Climate & Society, iyaleta Pesquisa, Ciências e Humanidades, Mercy Corps, Talanoa Políticas Climáticas, the United Nations Foundation, the World Business Council for Sustainable Development

View the full report here

Notable Highlights

- Investing in climate and nature resilience could unlock **$500 billion to $1.3 trillion in annual market opportunity by 2030**, generate over **280 million jobs in emerging markets and developing economies (EMDEs) by 2035**, and limit the 1-2 million additional annual deaths expected by 2050 without action.
- Across sectors, **adaptation investments deliver a median of 4x more benefits than costs** and provide a 25% median economic internal rate of return. **Nature and forestry investments** yield an average annual economic **return of 40%.**
- **Investing $350 billion per year** to build resilience **in EMDEs by 2035 would avoid $690-850 billion in socioeconomic losses**. However, **current resilience investment flows are only $54 billion per year.**
- Investing in resilience can **create an "upward spiral" for companies**, economies, and communities, where disruptions and maintenance **costs decline**, investor confidence, insurability, and productivity increase, new **market opportunities** emerge, and early adopters gain a **competitive edge**.
- The following Report Findings break down **barriers to resilience investment**, identify **priority actions, and outline key enablers** to scale investment. Additionally, it highlights **15 adaptation and resilience "Best Buy" solutions** that are high-impact, cost-effective, and can be financed and scaled now, particularly in low- and middle-income countries.

Objective

- To present evidence that climate adaptation and resilience (A&R) are a strategic investment for companies, identify priority actions to embed resilience into investment decisions, and present high-impact A&R solutions that can be scaled now.

Background

- The report data is based on insights and contributions from over 120 organizations, 70 publications, and 10 consultations at international forums, with guidance and comments provided by dozens of organizations (methodology on pg. 3-5).
- Boston Consulting Group developed the Adaptation & Resilience Best Buys based on an analysis of countries' National Adaptation Plans and Technology Needs Assessments, consultations with over 50 climate and development experts, and a literature review.

Report Findings

Investment in resilience (or lack thereof) can create a downward or upward spiral for companies, countries, and communities (pg. 37-62):

The Downward Spiral (details and corporate case studies on pg. 39-49):

- Economic and financial systems do not fully account for the impacts of climate change and nature loss. The costs are not accounted for in investment decisions and balance sheets, while the value of resilience interventions remains unrecognized. **This inaction risks setting in motion a "downward spiral," or worst-case trajectory of capital erosion, elements of which are already visible today, wherein:**

  1. **Capital is exposed and liabilities mount:** For every $1 spent on climate-resilient infrastructure today, $87 is spent on infrastructure that lacks resilience considerations. Only 30% of the world's largest companies have quantified their exposure to climate and nature risks. This results in a build-up of liabilities in reconstruction bills and uninsurable assets.
  2. **Losses compound, including** an 18-23% decline in global GDP by 2050, $25 trillion in net losses due to supply chain disruptions, $1.2 trillion in losses for the world's largest companies by the 2050s, labor productivity losses equivalent to 80 million jobs by 2030, and an additional 25 million people experiencing extreme poverty.
  3. **Financial, fiscal, and social risks and instability increase** (e.g., due to properties losing value from climate risks, inflation, and rising emergency spending).

4. **Investment** in resilience interventions and other areas **stalls further**, undermining growth and competitiveness.

The Upward Spiral (details and corporate case studies on pg. 50-62):

- Investing in resilience enables companies, economies, and communities to protect the foundational capital stocks that underpin productivity and long-term economic growth, **creating an upward spiral where:**

1. **Capital is protected and liabilities shrink**: Companies can protect and enhance their assets and value chain security (e.g., waterproofed factories reduce flood damage).
2. **Savings are achieved and value is created:**
    a. Scaling resilience investments in the health, agriculture, infrastructure, and water, sanitation, and hygiene sectors could avoid $690-850 billion in annual socioeconomic losses by 2050.
    b. Disruptions and maintenance costs decline, while measures like on-site water efficiency reduce demand for critical inputs and stabilize supply.
    c. Investor confidence and insurability increase.
    d. Productivity increases: Regenerative agricultural practices, such as agroforestry and cover cropping, can increase primary crop yields by an average of 11%.
    e. New market opportunities emerge: Global demand for adaptation and resilience solutions is estimated to reach $500 billion to $1.3 trillion by 2030.
    f. Early adopters gain a competitive edge: Investors report 1-44x increases in enterprise value multiples for firms operating in the water resilience space.
3. **Fiscal, financial, and social stability is created:** In some countries highly vulnerable to climate and nature impacts, adaptation **interventions could increase GDP by up to 15% by 2050**, while strengthening fiscal stability and reducing debt risk.
4. When investment accelerates, **development, growth, and competitiveness are bolstered**.

Resilience investment needs and progress (pg. 64-67, 69-85):

- **Investing $350 billion per year to build resilience in EMDEs by 2035 would avoid $690-850 billion in socioeconomic losses.** However, current resilience investment flows are only $54 billion per year.
    - Over half of the $350 billion is needed for coastal and river flood protection, power and transport infrastructure, and the built environment.

    - Roughly **25% of those investment needs ($90 billion) lie in revenues that can be captured by the private sector** or sectors that could generate predictable savings, including agriculture, water and sanitation, and real estate. Just $4 billion flows from private sources into publicly oriented resilience in EMDEs today, leaving a **$85 billion financing gap.** (Pages 71-74 include detailed insights and **case studies**.)
    - The remaining **75%** of investments needed are **best suited to public funding** (e.g., to generate significant public goods) (details on pg. 75-81).
- **Existing investments must be redirected and scaled for resilience** (e.g., roads should be built to withstand acute climate impacts). **Additional investments are needed to address specific climate and nature-related risks** (e.g., to construct new cooling facilities and sea walls).
- **Policy is crucial for mobilizing private investment and redirecting investment flows toward resilience, given that governments can:**
    - Correct mispriced risk, making invisible liabilities visible and shifting incentives for investors and lenders.
    - Require resilience in public procurement and regulation.
    - Implement targeted subsidies and public safety nets to prevent losses from escalating into fiscal crises (e.g., when smaller firms or poorer households can't absorb shocks and experience revenue shortfalls and defaults).

Barriers to scaling resilience investment (pg. 87-89):

- The **economic value of resilience investment** is often **poorly measured** and rarely reported, so investments are perceived as a cost.
- Companies lack **reliable risk data**.
- **Technical expertise** is limited, and organizations have limited capacity.
- **"Resilience offerings"** are only starting to be defined, and there is a lack of clarity about investable project opportunities.
- Subsidies, price signals, and regulations often encourage **private-sector behavior that undermines resilience.**
- Businesses and governments tend to **prioritize short-term returns** and electoral or market cycles over long-term risks and, therefore, resilience measures.
- Many **countries that are most affected** by climate change and nature loss are poor and **face a high cost of capital**.

Priority actions to embed resilience into investment decisions (pg. 91-97):

- **CEOs and CFOs** should develop resilience strategies and make targeted investments across core functions to reduce physical risk exposure, as well as identify when to initiate, suspend, or scale back investments.
- **Financial institutions and asset owners/managers** should integrate climate risk and resilience assessments into their disclosures, risk-return assessments, and portfolio decisions.
- **Insurance companies** should develop tools and markets that reward resilience and reduce systemic exposure (pg. 82-85).
- **Enabling actions for all stakeholders:**
  - To better price the economic value of resilience, quantify resilience-adjusted profitability under a range of scenarios, and develop more effective risk models, benchmarks, metrics, and data to assess opportunities.
  - Develop a shared typology for how climate and nature risks accumulate across physical, natural, human, and social capital. Emerging efforts include the Tailwind Futures Taxonomy for Adaptation and Resilience Investments.
  - Enhance access to high-quality, reliable, comparable, and geolocated physical risk data, particularly in emerging markets and developing economies.
  - Track progress and positive outcomes of resilience investments to inform best practices, strengthen the investment case, and avoid maladaptation.
- **Key considerations when assessing A&R investment opportunities (pg. 125):**
  - Prioritize A&R solutions that **most significantly improve human well-being**, especially for at-risk populations where the impacts of extreme weather events can exacerbate poverty and poor health.
  - **Tailor interventions** to local climate risks, geophysical conditions, and sectoral and country priorities.
  - Finance and implement **solutions in integrated bundles** that reinforce one another, not isolated approaches. For example, solutions for resilient agriculture will only achieve impact if water security is also addressed.
  - Factor in cascading risks to ensure solutions **minimize potential unintended risks** and deliver long-term benefits.
  - Develop a **balanced portfolio** of “no-regrets” measures that can be scaled now (e.g., early warning systems), longer-term investments (e.g., climate-resilient infrastructure), and innovation to address future A&R needs.

Adaptation and Resilience (A&R) "Best Buys" (pg. 99-126):

The "Best Buys" are high-impact, cost-effective A&R solutions that can be financed and scaled now, particularly in low- and middle-income countries. ***Deep dives on each Best Buy*** *(see subchapters below)* ***include examples of innovative solutions and enablers for scaling****.*

- **Subchapters:** Best Buy deep dives on food (pg. 102), water (pg. 106), health (pg. 108), infrastructure (112), community and business resilience (115), nature, ecosystems, and biodiversity (118), and cross-sector enablers (119); key considerations for funders (122)

Resilience sector		Best Buy	Description	Exemplar solutions	Primary impacts
Food	1	**Crop resilience**	Inputs, tools and practices that help farms withstand climate shifts (e.g. drought) that affect crop yields and increase productivity	Climate-resilient/hybrid varieties, irrigation systems, biofertilisers	Increased productivity, which enhances farmer incomes and livelihoods, improves food security and diet quality and drives environmental co-benefits, economic stability and growth including GDP and job creation
	2	**Livestock, fisheries and aquaculture resilience**	Improved breeds, feeds, animal health, and pasture/pond management practices that increase productivity	Alternative feed innovations, animal disease management, fish and livestock breeds better suited to the environment	
Water	3	**Water collection and storage**	Nature-based or grey solutions to capture and manage water resources	Rainwater harvesting systems, watershed restoration	Increased water security including quantity and quality, which improves health outcomes and economic stability and growth
Health	4	**Prevention and control of climate-sensitive diseases**	Approaches that reduce burden and accelerate eradication of climate-sensitive diseases (e.g. malaria driven by increased flooding)	Disease surveillance systems, vaccines for climate-sensitive diseases, vector control measures	Reduced disease burden, morbidity and mortality; increased access to essential healthcare services including maternal, newborn and child health services due to fewer closures or interruptions in fixed health facilities, which protect lives and livelihoods and drive economic stability and growth
	5	**Improving nutrition**	Measures to protect nutrition and child growth amid rising climate risks	Food fortification, multiple micronutrient supplementation	
	6	**Health systems resilience**	Strengthened health facilities or mobile care for increased access, supply chains, and workforce capacity	Reduced facility dependence, strengthening health product supply chains	
	7	**Heat mitigation**	Strategies to reduce extreme heat-related deaths, illness, and system strain including for maternal, newborn, and child health	Heat action plans, passive cooling infrastructure, early warning systems for heatwaves	

Infra-structure	8	Energy infrastructure resilience	Resilient power systems that sustain communities and critical services amid climate disasters	Solar microgrids, battery storage	Minimised service disruptions and damages, keeping essential services and economies running amid climate events
	9	Coastal and riverine infrastructure resilience	Engineered or nature-based defenses to minimise impacts from coast and river floods	Mangrove protection and restoration, urban drainage and stormwater management	
Community and business	10	Early warning systems	Monitoring and communication tools to alert communities to prepare before disasters strike	Disaster risk early warning system, agriculture early warning system	Faster recovery and financial protection for households and SMEs, reducing poverty
	11	Financial inclusion, insurance and social protection	Financial tools and safety nets for preparedness and disaster recovery	Adaptive social protection, index-based insurance, financial innovation	

Nature, ecosystems and biodiversity	12	Terrestrial protection and rehabilitation	Healthy land ecosystems to ensure continued resilient resources, ecosystem services	Reforestation, assisted natural regeneration, wildfire prevention	Preserved biodiversity and natural buffers against climate risks; continued access to ecosystem services
Cross-sector enablers	13	Climate information systems	Access and availability of integrated weather- and climate-data systems for decision-making	Spatial data collection tools, improved weather data availability and seasonal forecasts	Adaptation solutions and emergency response measures reach and are co-created with vulnerable populations – quickly, reliably and securely to enable communities to build back in a more resilient way
	14	Planning, preparation and response	Informed planning, readiness, and response to reduce losses and speed recovery	Anticipatory action plans, national and sectoral adaptation plans	
	15	Digital public infrastructure	Digital systems and services to help climate solutions scale	Digital identity systems, inclusive digital payment platforms	

Image taken from pg. 101

NATURE

AI for Nature: How AI Can Democratize and Scale Action on Nature

By World Resources Institute, Google

View the full report here

Notable Highlights

- **AI can help scale action for nature by** (1) improving **nature monitoring**, (2) facilitating **greater access to nature-related information** and lowering barriers to optimized decisions, and (3) **synthesizing complex nature data** to improve forecasting, inform stakeholders on where to focus investments, and **identify optimal solutions**.
- **Risks and challenges of AI applications** include the environmental impacts of increased demand for computing infrastructure and energy, the availability of quality nature-related data, limited organizational capacity, and biases or limitations in LLM training data.
- The following Notable Findings include **actions to mitigate the risks and challenges** of AI applications.
- To scale and democratize AI solutions for nature, **companies should prioritize investment in** primary biodiversity data collection, the development of open, transparent AI systems, and capacity sharing.

Objective

- To explore the opportunities where AI can help scale action for nature, including the risks and challenges of AI applications, actions to mitigate those risks, and priority areas for investment.

Background

- The data is based on 22 interviews with business and civil society experts and practitioners at the intersection of AI and nature conservation and a literature review, with support from Google's Nature working group (methodology on pg. 2, 4, 9, 24-26).

Report Findings

Opportunities where AI can help scale action for nature (pg. 9-18):

Note: The report chapter includes detailed insights and examples of AI applications.

Monitoring (pg. 9-14):

- Although global declines in biodiversity are well-documented, there is a **lack of transparent monitoring at a granular level.**
- AI can enable the increased speed and volume of nature observations, providing **globally consistent and locally relevant nature metrics** to inform local decision-making and regulatory enforcement.
- By better quantifying their dependency on nature, as well as the risks to the bottom line of not investing in nature, **companies can determine what indicators need monitoring**, thereby informing risk-based decisions and unlocking financing for nature.
- Wildlife Insights is a publicly accessible database that enables automated identification of species in camera trap images.

Accessibility (pp. 14-17):

- **AI can facilitate greater access to nature-related information**, leading to more informed decisions and increased participation in conservation efforts (e.g., by reducing language and cultural barriers and enhancing practitioners' technical capabilities).
- Companies can utilize **LLMs to research how they can mitigate their impacts on nature within their supply chains** and to read news and social media to stay informed about new policies and monitor emerging threats.
- Applying Indigenous and local knowledge systems to AI can open modes of understanding that represent different value systems worldwide.

Complexity (pg. 17-18):

- The complexity of human and natural systems makes it challenging to identify optimal solutions for nature.
- By synthesizing diverse sources of data and knowledge, AI can **improve forecasting and inform stakeholders on where to focus investments.**
- Combining scientific knowledge and theoretical constraints into AI frameworks ("knowledge-guided machine learning") can ensure that AI outputs remain scientifically consistent, interpretable, and robust, even in data-limited domains.

The risks and challenges of AI applications (pg. 19-21):

- The rapid uptake of commercial AI applications is driving **increased demand for computing infrastructure and energy.** Responsible management of AI's energy, water, and other environmental impacts is needed.
- **Limitations in organizational capacity and resources are a key barrier.** Developing and running AI models may require access to additional computing infrastructure, and applications built with proprietary AI systems will require ongoing costs.
- Sufficient nature data must be gathered to power AI applications. However, companies may see it as a **competitive advantage to keep data private**, and in some cases, data protection is necessary to avoid adverse impacts, such as poaching.
- Nature conservation and restoration are inherently local and must be tailored to specific communities and ecosystems; however, **AI expertise and infrastructure are not evenly distributed globally.**
- **Hype around AI can distract from more fundamental investments.** The capabilities of AI systems are constrained by the availability of data, which may require investment in extensive fieldwork or training for practitioners. Advancing nature-related regulations can take years of investment and engagement.
- The tendency of LLMs to hallucinate may lead to **misinformation**.
- **Biases or limitations in LLM training data can exacerbate performance issues in AI systems.** If training data predominantly originate from Western literature, and if most open-access nature observations pertain to species in North America and Europe, AI systems will lack diverse conservation knowledge (including Indigenous practices) and may struggle to identify species in other regions.

Actions to mitigate AI risks and challenges (pg. 19-21):

- Implement **data center cooling and water stewardship projects** to help mitigate the environmental impact of AI on nature.
- To reduce bias in LLM training data, expand nature data collection, **increase linguistic, cultural, and geographic representation,** and develop regional AI systems.
- Provide **access, training, and infrastructure**, especially in less well-resourced areas, can increase the awareness of existing AI tools and lower barriers to use.
- Recognize the role of AI as an enabler for human experts. **Develop AI tools with multidisciplinary teams** to ensure that AI systems support human processes and provide better knowledge to more people.
- Provide **human oversight** and embed domain expertise into AI workflows to ensure the responsible stewardship of nature.

- Develop **nature-specific benchmarks or evaluation criteria** for AI to increase transparency in the capabilities and limitations of models, thereby incentivizing performance improvements.
- **AI developers can** provide transparency regarding the environmental impacts of their applications and partner with conservation organizations (e.g., through networks such as WILDLABS) to share knowledge and align solutions with conservation challenges.
- **Engage Indigenous and local voices** early and consider co-designing solutions to ensure that AI research and systems are inclusive, reducing inequalities rather than exacerbating them.

Three priority areas for investment to scale AI for nature (pg. 22-23):

1. **Invest in primary biodiversity data collection** and data infrastructure for open-access sharing. This will require scaling efforts, such as the Global Biodiversity Information Facility, to handle greater volumes of diverse data.
2. **Invest in the development of open, transparent AI systems** to address information gaps in species and ecosystem monitoring, thereby building trust in AI approaches.
    - Develop customizable models that can be deployed worldwide, along with standardized evaluation principles and datasets.
    - Open licensing allows models trained on sensitive data to be shared without disclosing the original data.
3. **Invest in capacity sharing** to scale up the use of existing AI tools and facilitate their adaptation to diverse local contexts. Capacity sharing should happen in both directions, where developers and practitioners incorporate each other's knowledge and feedback.

Forest Declaration Assessment 2025: Tracking Progress on 2030 Forest Goals

By Forest Declaration Assessment

View the full report here

Notable Highlights

- The world is 63% off track from world leaders' 2021 declaration to halt and reverse forest loss by 2030.
- Global **deforestation totaled 8.1 million hectares (Mha) in 2024** (about half the size of England), while the target maximum (consistent with the 2030 pledge) was 3.1 Mha.
- **Permanent agriculture** (permanent conversion of forested land for agriculture use) has accounted for **86% of annual global deforestation** in the past decade.
- **At least 10.6 Mha of deforested and degraded land now host forest restoration projects.** However, **restoration monitoring is a challenge** due to the fragmented nature of the data.
- While $**8.9 trillion of private finance was directed into forest-risk sector**s in 2024, **$5.6 billion** was directed toward **land-based climate mitigation** in 2023 (**a 14x increase** from 2018), and an estimated **$2.9 billion was allocated to forest management, conservation, and restoration** through the certification of forest-risk commodity supply chains.
- **International public finance for forest protection and restoration tripled** from 2022 to 2024, to $5.7 billion per year on average. However, this is **far below the estimated $117-299 billion needed** annually by 2030 and the $409 billion of finance being directed toward environmentally harmful agricultural subsidies per year.
- **40% of the financial institutions** most exposed to commodity-driven deforestation risk in their investment portfolios **have a policy to address deforestation**.

Objective

- To examine global progress toward the 2030 forest goals, including changes in forest loss, degradation, and restoration, forest loss in production systems and supply chains, forest finance, and governance.

Background

- This annual report tracks progress on deforestation, loss of humid tropical primary forests, tree cover loss in forested Key Biodiversity Areas, degradation of tropical moist forests, areas of forest under restoration, and regrowth of tropical moist forests.
- The report data was provided by CDP, Forest Trends, Global Canopy, the Global Forest Watch, the ZSL SPOTT platform, and other organizations (methodology on pg. 3-4).
- Financial datasets from Climate Funds Update, the ClimateWorks Foundation, Ecosystem Marketplace, and other organizations were also analyzed (pg. 68).
- Much of the data is housed in the Forest Declaration Dashboard.
- The "2030 forest goals" refer to the Glasgow Leaders' Declaration on Forests and Land Use, which aims to eliminate global deforestation and forest degradation and restore 30% of degraded forests by 2030.

Report Findings

Global progress on forest loss, degradation, and restoration (pg. 8-31):

- In 2024, tropical deforestation accounted for **94% of deforestation** and emitted 4.2 billion metric tons of CO2 equivalents into the atmosphere.
- In 2024, 8.8 million hectares of tropical moist forests were degraded—**more than double the annual rate needed to halt degradation by 2030.**
- Forest loss in Key Biodiversity Areas (fKBAs) grew by 47% from 2023 to 2024.
- **Commodity production remains the predominant driver of deforestation and ecosystem conversion (pg. 37).**
    - Global production of primary crops increased by 56% from 2000 to 2022.
    - Total demand for minerals used in clean energy technologies is projected to double by 2040.
    - Global coal production reached a record 8.8 Gt in 2024.
    - The EU and China accounted for approximately 40% of all deforestation embodied in international trade in agricultural commodities between 2020 and 2022.
- **At least 10.6 Mha of deforested and degraded land now host forest restoration projects. However, restoration monitoring is a challenge due to the fragmented nature of the data.**
    - Regrowth rates of tropical moist forests increased by nearly 750% in Latin America and 450% in Asia from 2015 to 2021.

  - Monitoring efforts have primarily focused on a single metric, “area under restoration,” which impairs holistic monitoring of the many benefits delivered by landscape restoration approaches.
  - Given the diversity of socioeconomic and ecological contexts, restoration activities must be tailored to meet local conditions.
- **High-quality, granular data is essential** for addressing deforestation drivers at the national and sub-national scale. Data on non-permanent tree cover loss is a valuable proxy for identifying potential forest degradation pressures (see page 25 for details).
- **Political transitions and good governance can dramatically improve forest conservation** outcomes. For example, Brazil has consistently reduced deforestation rates since 2022, under an administration that has prioritized forest conservation.
- Because deforestation commodities are consumed domestically and exported internationally, national land-use policies and practices are deeply intertwined with global demand. This highlights the **urgent need for structural change in how production and trade are regulated, monitored, and governed.**

Forest loss in production systems and supply chains (pg. 36-58):

Company progress:

- **Only 27% of agricultural and forestry companies** assessed by Forest 500 in 2024 **have commitments covering all forest-risk commodities**. However, **encouraging ambition is seen in the palm oil, timber, and pulp and paper sectors**, with 76%, 73%, and 53% of companies having publicly available evidence of deforestation-free commitments.
- **Only 3% of companies assessed by Forest 500 provided evidence of adequate implementation of their deforestation-related commitments**. 63% of companies show partial commitments and/or weak implementation.
- 302 companies have set and validated FLAG targets under the SBTi.
- **Companies are using third-party certification and auditing to mitigate their forest-risk exposure**. Around 20% of global palm oil production has been certified by the Roundtable on Sustainable Palm Oil, and around 26% of coffee was purchased as standard-compliant in 2021.
- Among companies assessed by CDP, **23.5% engage direct or indirect suppliers** on no deforestation and/or no conversion of natural ecosystems.
- The growth in mineral production is leading to an increased overlap between mining sites and areas of high ecological value. An estimated **77% of mines are now located within 50 kilometers of Key Biodiversity Areas.**

  - **Only half (52%) of mining and coal extractive companies** disclosing to CDP reported **having a biodiversity and/or forest policy.** Fewer than 10% have set no-net-loss biodiversity targets.
  - Companies in mineral supply chains are increasingly adopting voluntary certification and auditing standards to produce materials responsibly.
- More companies are **engaging with landscape and/or jurisdictional initiatives** (356 in 2024, up from 27 in 2020), though only one-third have transparent governance.
- Page 58 includes **examples of successful international and regional multistakeholder partnerships** to advance sustainable production and development.

Government progress:

- Fewer than half of the country NDCs assessed included a specific emissions-mitigation target for forests, and only 28% set a quantitative deforestation target.
- **Geopolitical and economic turbulence**, including conflict, debt, and trade disputes, is leading to weakened regulations, delays in policy implementation, and reduced foreign aid, thereby **threatening conservation efforts** (examples on page 42).
- Some initiatives, such as the EU Green New Deal, show promise for incentivizing sustainable production and forest conservation; however, this legislation has faced significant political pushback.
- **When policies are robust, adapted to local contexts, and designed in coordination with related policies, they can protect forest ecosystems** while improving rural incomes and livelihoods (examples on pages 44-46).

Finance for forests (pg. 65-84):

- **Voluntary carbon markets mobilized $342 million** in private finance for forest protection and restoration in 2024. Mandatory carbon market schemes raised $942 million in forestry-related private finance in 2023.
- The **Tropical Forest Forever Facility** partnership between tropical forest countries and investors **recognizes standing forests as an asset class**. It will be structured as an investment fund, with funds serving to de-risk private investment in tropical forests and provide a reliable, long-term source of funding.
- Developing countries have received **$3.3 billion in funding for REDD+** in the last 15 years, far below the intended scale and speed.
- Annual **funding for the tenure rights of Indigenous Peoples (IPs), Local Communities** (LCs), and Afro-descendant Peoples **increased by 41%** from 2021-24 to $728 million.

  - Maintaining this improved pace would still leave a $2.9 billion gap from the estimated $10 billion needed by 2030.
  - Several Indigenous and community-led funding mechanisms are emerging as tools to align finance with local priorities (examples on page 71).

Forest rights and governance (pg. 89-112):

- **Corporations maintain outsized influence on forest policies and practices**, while IPs, LCs, women, and civil society organizations face increasing barriers and restrictions on their involvement in forest-related decision-making.
  - At least 18 countries tightened controls over civil society organizations in 2024.
  - Only 2% of community forest tenure frameworks ensure women's voting rights.
- **Import regulations can drive positive change for forests and for communities, but their impact is limited by inconsistent implementation.**
  - Some governments have pushed for legal reforms that dilute corporate accountability and forest protections.
  - In the U.S., **legislation introduced in March 2025 would prohibit some US companies from complying with foreign sustainability due diligence regulations** like those in the EUDR.

CORPORATE SUSTAINABILITY TRENDS

Global Corporate Sustainability Report 2025

By OECD

View the full report here

Notable Highlights

- In 2024, nearly **12,900 companies** out of 44,152 listed companies worldwide, **representing 91% of listed companies** by global market capitalization, **disclosed sustainability-related information** (up from 9,600 companies representing 86% of market cap in 2022).
- Companies representing 88% of market capitalization disclosed their Scope 1 and 2 emissions, and 76% disclosed at least one category of Scope 3 emissions.
- **67%** of companies (by market capitalization) with variable executive compensation **linked the compensation to sustainability factors** (up from 60% in 2022).
- The top three accounting standards and frameworks used are the GRI Standards (utilized by over 6,500 companies), the TCFD recommendations (utilized by over 4,800 companies), and the SASB Standards (utilized by nearly 3,500 companies).
- The following Report Findings break down sustainability **indicators where risks were financially material** for companies in 2024 and insights on **energy companies' sustainability disclosures**.

Objective

- To examine global trends in corporate sustainability, including sustainability disclosures, assurance and disclosure frameworks used, GHG emission-reduction targets, and sustainability indicators with material risk.

Background

- The report data is based on information mainly sourced from LSEG, Bloomberg, and MSCI on the 12,900 companies worldwide disclosing sustainability-related information as of September 2025, as well as an analysis of 42 double materiality assessments undertaken by energy companies under the first CSRD reporting cycle (methodology on pg. 3, 77-78).
- Unless otherwise specified, all shares of companies and market capitalization are calculated based on the 44,152 total listed companies worldwide.

Report Findings

Companies' 2024 sustainability disclosures (pg. 21-52):

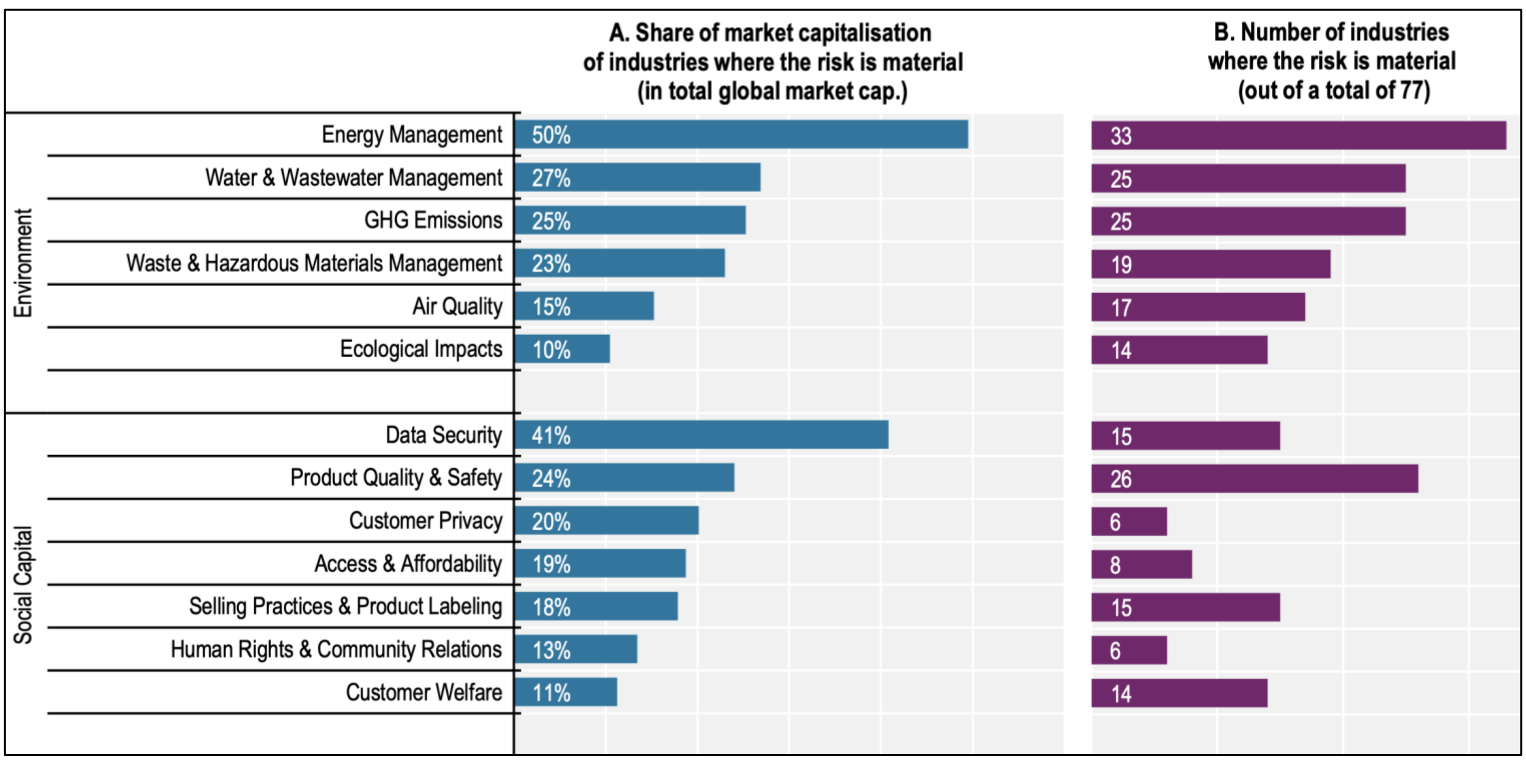
> ▷ **Subchapters:** sustainability-related disclosure (pg. 22), investor landscape (34), board of directors (41), stakeholder interests and engagement (43), disclosure of human rights information (49)

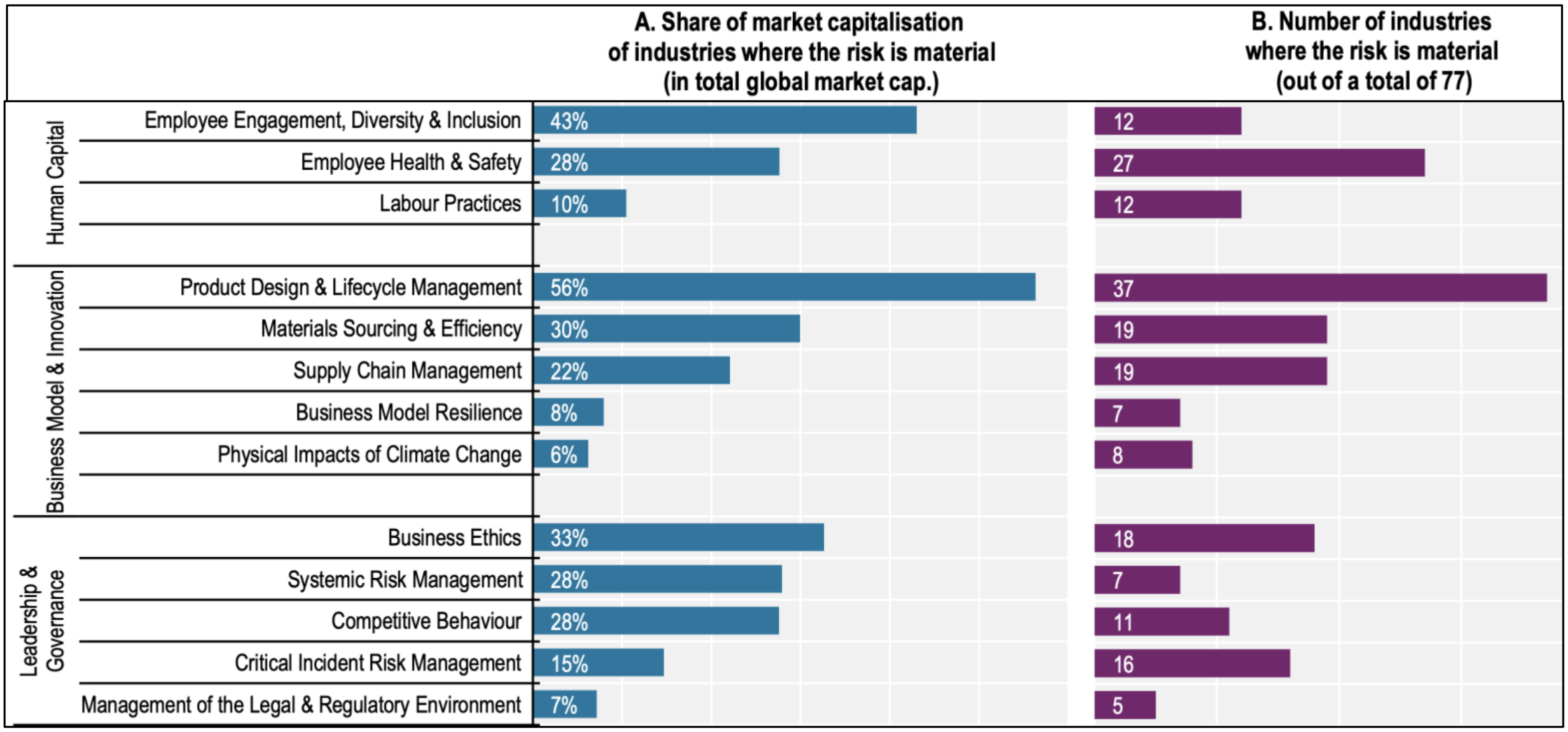
- Energy companies have the **highest rate of disclosure**, covering 94% of the industry's market capitalization. Real Estate has the lowest share at 78%.
- **76% of companies by market capitalization disclosed a target to reduce their GHG emissions over a specified time horizon, including 85% in the U.S. and 92% in Europe.**
  - 88% of them have the target date set before or by 2030.
  - 32% of them committed to reducing their GHG emissions intensity, and 88% set a reduction target in absolute terms.
- **The top three accounting standards and frameworks used** are the GRI Standards, the TCFD recommendations, and the SASB Standards.
  - 582 companies worldwide use the IFRS S1 and S2.
  - At least 1,800 companies listed in the EU are expected to fall under ESRS requirements starting in 2025.
  - Page 31 includes **examples of efforts by regulatory bodies to improve the interoperability of sustainability standards**.
- **42% of companies disclosing sustainability-related information obtained assurance from an external service provider.**
  - **56% of those companies rely on limited assurance** (which provides a lower degree of confidence due to fewer tests and procedures), and 17% rely on reasonable assurance (based on a broad and detailed set of procedures to provide a high level of confidence).
  - 14% of companies had a reasonable level of assurance for Scope 1, 13% for Scope 2, and 6% for Scope 3.
- Companies representing 70% of global market capitalization reported that their **boards of directors oversee climate-related issues** (up from 53% in 2022).
- Institutional investors hold significant equity stakes (~35%) in both the 100 companies disclosing the highest GHG emissions and the 100 companies with the highest number of green patents.
  - This indicates that, despite public commitments to support the low-carbon transition, **portfolio allocations have not differentiated between high-emitting companies and those investing in new green technologies.**

  - Investor-led engagement initiatives targeting high emitters may need to be complemented by new initiatives that consider investment allocation and stewardship efforts toward innovative companies.

- Companies representing **26% of global market capitalization report on salient human rights impacts identified in their operations and supply chains**, compared to the 91% that disclosed sustainability-related information.
  - The most widely disclosed human rights-related information is the existence of corporate policies/commitments on human rights (81% of companies by market capitalization) and key human rights issues, such as child labor (around 85%).
  - The lack of quantitative indicators to measure human rights performance can hinder companies' ability to provide meaningful reports on their practices.

Sustainability indicators where risks were financially material for companies in 2024 (pg. 35-37):





Images taken from pg. 36

Energy companies' 2024 sustainability disclosures (pg. 55-76):

▷ **Subchapters:** GHG emissions (pg. 57), emission-reduction targets (60), lobbying and influence (63), R&D and capital expenditure (66), executive remuneration (70), double materiality assessments (72)

- **Energy companies account for 31% of total emissions disclosed globally.** Governments have a significant role to play in curbing sector emissions, as state-owned enterprises account for nearly a third of listed companies' emissions.
- **57% of US energy companies disclose Scope 1 and 2 emissions, and 36% disclose at least one category of Scope 3 emissions.** Europe leads, with energy companies representing 99% of market capitalization disclosing Scope 1 and 2, and 98% disclosing at least one Scope 3 category.
- **7% publicly disclose their position on climate-related public policy**, and 7% disclose environmental capital expenditures (CapEx).
- **34 large energy companies were assessed. Of those companies:**
    - 94% disclose their current emissions, but only 44% disclose baseline emissions.
    - 71% disclose their current Scope 3 emissions.
    - 12% have established an interim Scope 3 emission-reduction target with an average period of 10 years against the baseline value.

  - Of the large companies that disclose environmental CapEx, 43% of CapEx is allocated toward low-carbon assets.
- Based on an analysis of 42 double materiality assessments undertaken by energy companies under the first reporting cycle of the CSRD, **98% identified climate change as both a material negative impact and a financial risk,** making it the **most consistently reported material issue.**
- Between 2015 and 2024, net cash flow from listed energy companies' operating activities increased by 32%, enabling them to triple dividend payments and share repurchases. However, net cash used in investing activities increased by less than 5%, **suggesting that companies are prioritizing shareholder payouts rather than investment in clean technologies.**

CLIMATE ACTION PROGRESS

State of Climate Action 2025

By Systems Change Lab

View the full report here

Notable Highlights

- **Zero of 45 global climate indicators are on pace for 1.5°C-aligned 2030 goals.** Thirty-five indicators are trending in the right direction, albeit too slowly; five are heading in the wrong direction; and five have insufficient data to measure progress.
- **Private climate finance has increased sharply,** from $870 billion in 2022 to a record $1.3 trillion in 2023, shifting this indicator from "Well Off Track" to "Off Track."
- **An enormous acceleration in effort is needed across every sector:**
  - Deforestation rates must decline 9x faster
  - Electricity from coal and unabated gas must be phased out 10x and 7x faster, respectively
  - The share of wind and solar in the electricity mix must double to 29%
  - Carbon removal technologies must scale up more than 10x faster
  - Growth in climate finance must increase 4x faster (by nearly $1 trillion annually)
- The sector chapters provide **a detailed global assessment of progress and a snapshot of notable developments** that have occurred since COP28, including advancements in technology innovation, supportive policies, institutional strengthening, leadership, and shifts in behaviors and societal norms.

Objective

- To analyze sectors making up 85% of global GHG emissions on their progress toward 1.5°C-aligned climate targets and offer a roadmap on how to close the global gap in climate action.

Background

- The latest installment of this report translates the Paris Agreement's 1.5°C temperature limit into sectoral targets. It provides 45 indicators of sectoral progress toward (or away from) targets, primarily for 2030, 2035, and 2050 (methodology on pg. 13-15).

- Indicators are based on historical data collected from open, independent, reliable sources. They are ranked as "On Track," "Off Track" (moving in the right direction but not fast enough), "Well Off Track" (moving in the right direction but at a significantly slow pace), "Wrong Direction," and "Insufficient Data" (can't assess gaps).
- Some indicators and targets are new compared to previous reports (labeled as "new indicator" in the report), while others have been discontinued (labeled as such) (pg. 95).
- Peer-reviewed journal articles, newsletters, policy trackers, and government plans were analyzed to identify notable recent developments in each sector. The developments are primarily global in scope and/or from influential locations (e.g., major emitters).

Report Findings (by Sector)

Note: The following findings encompass the progress made on all 45 indicators toward achieving the 2030 targets. Pages 81-84 show the progress made toward 2030, 2035, and 2050 targets. The last page of each sector chapter includes notable recent developments that have occurred since COP28.

Power (pg. 17-23):

- **The anticipated new buildout of clean power capacity in the U.S. is estimated to be 53-59% lower from 2025-2035 than it would have been** without the new legislation enacted under President Trump.
- There is already **more than enough manufacturing capacity** for solar panels and batteries to allow for a rapid acceleration of deployment.
- Insufficient transmission and distribution lines are a bottleneck in the growth of zero-carbon power.
- **Page 18 offers a visual summary of global progress toward power targets.**

Buildings (pg. 25-29):

- **Operational building emissions have rebounded to pre-pandemic levels. Further decarbonization of the sector will require** retrofitting and improving the energy efficiency of existing buildings, decarbonizing the remaining energy used, and constructing new buildings that are zero-carbon in operation.
- A handful of **countries have adopted or strengthened their building codes** between 2023 and 2025. The EU revised its Energy Performance of Buildings Directive to set a goal of 100% zero-emissions new construction by 2030.
- **Page 26 offers a visual summary of global progress toward buildings targets.**

Industry (pg. 31-35):

- Increasing demand for industrial products, driven by rising incomes, population growth, urbanization, and infrastructure development, has fueled the **ongoing upward trajectory of GHG emissions from industry.**
- 89% of all existing **low-carbon steel projects** were added between 2021 and 2024. Nearly 60% of recently announced projects are full-scale projects; however, they are facing challenges such as high energy costs and **require strong demand signals**.
- **Page 32 offers a visual summary of global progress toward industry targets.**

Transport (pg. 37-43):

- **Transforming the sector requires** (1) bringing jobs, goods, and services closer to where people live and work to help avoid motorized travel altogether, (2) shifting from vehicle trips to shared, collective, or active transport modes, and (3) scaling up zero- and low-carbon transport options and sustainable aviation and shipping fuels.
- **Developments in decarbonizing shipping and aviation** may drive faster growth of low-carbon technologies. The IMO approved its Net-Zero Framework regulating emissions from international shipping, and the EU set binding targets requiring airports in the region to reach a 2% SAF share by 2025 and a 70% share by 2050.
- **Pages 38-39 offer a visual summary of global progress toward transport targets.**

Forests and land (pg. 45-53):

- Protecting high-carbon ecosystems through land**-based mitigation measures can deliver the lion's share of GHG mitigation**, conserve biodiversity, and bolster climate resilience. However, collective **progress in deploying measures is far short** of what it needs to be.
- **Large-scale land restoration efforts must also accelerate significantly**, but only as a complement to mitigation measures, not a replacement.
- **Pages 46-47 offer a visual summary of global progress toward forests and land targets.**

Food and agriculture (pg. 55-61):

- Transforming the global sector **requires a combination of supply-side shifts** (on-farm practices and the deployment of new technologies) **and demand-side shifts** (reducing food loss and waste and changing diets).

- These shifts **must occur in conjunction with broader changes to agricultural production and consumption** practices to enhance food and nutrition security, improve agricultural resilience, and safeguard water, soil, and other natural resources.
- The **share of total climate finance** dedicated to agriculture and food systems **increased** from 3.6% in 2019-20 to 7.2% in 2021-22, but **finance remains far below** the $1.1 trillion needed annually by 2030 to meet climate goals.
- **Pages 56-57 offer a visual summary of global progress toward food and agriculture targets.**

Technological CO2 removal (pg. 63-67):

- **Meaningful progress has been made in scaling carbon removal**, from around 0.5 million tons of CO2 removed by CDR technologies in 2019 to around 1.5 million tons in 2023. However, current **progress remains well off track.**
- **Voluntary purchases of carbon removals increased** from approximately 0.5 million tons in 2022 to 8 million tons in 2024 and 13 million tons by May 2025. However, more than 80% of these purchases have come from CEF member Microsoft. **Developing a broader and more diverse base of buyers will be critical to enable long-term demand growth.**
- The **US federal government has scaled back policies** that support carbon removal, creating uncertainty about the future of federally supported CDR projects.
- **Page 63 offers a visual summary of global progress toward the technological CO2 removal target.**

Finance (pg. 69-76):

- Shifting financial flows from investments in fossil fuels, commodities that drive deforestation, and other high-emissions **activities to finance that unlocks mitigation and adaptation objectives will enable the climate transition** and climate-resilient development.
- **US political forces opposing climate action, as well as tariff policies**, have created instability and uncertainty, **resulting in reduced US climate finance flows**, the cancellation of substantial climate mitigation projects (particularly for emerging technologies), and firms rebranding sustainability activities to avoid backlash.
- Efforts to mandate climate-related reporting have been deprioritized or paused in the U.S. in Canada, while China, Japan, and Mexico have adopted such requirements.
- **Pages 69-70 offer a visual summary of global progress toward finance targets.**

10 Years Post-Paris: A Decade That Defied Predictions

By Energy & Climate Intelligence Unit (ECIU)

View the full report here

Notable Highlights

- A decade ago, **the world was heading for** around 4°C of warming by 2100. Today, that projection is **closer to 2.6°C.**
- The compounded annual **growth rate of global carbon emissions has been 0.3%** since the Paris Agreement, **compared to 1.7%** in the decade preceding it.
- **Net zero** has evolved from an obscure concept in 2015 to **covering 83% of the global economy today, with** nearly **two-thirds of the world's largest companies having net-zero targets.**
- **Global clean energy investment is outpacing fossil fuel investment at a rate of 2 to 1**—more than double what it was in 2015 (including a 2.6 to 1 ratio in the U.S., the EU, China, and India).
- **91% of renewable energy projects worldwide are now cheaper** than the most cost-competitive fossil fuel alternatives.
- **Electric vehicles account for 20% of new car** sales globally, six years ahead of forecasts.

Objective

- To provide an overview of progress in the decade since the Paris Agreement was signed, including clean energy, emissions, nature, risk, policy, and jobs.

Background

- The report is based on data from the ECIU and third parties, including the IEA and IRENA. Additional methodological notes are included in the report sections (see methodology on pg. 7).
- Where possible, the data compares projections and forecasts made around 2015 with later outcomes.

Report Findings

Clean energy (pg. 8-19):

Renewables deployment and cost:

Electricity generation:

- **Clean power now accounts for 41% of the global power supply**—more progress in 10 years than was predicted over 20 years.
- Renewables have met two-thirds of the global electricity demand increase since 2015, including meeting 80% of demand growth in 2024.

Global wind and solar capacity growth:

- Global installed **solar capacity** now stands at over **four times the deployment predicted** in 2015, with capacity added in 2024 at 15 times the 2015 prediction.
- Total global installed **wind capacity in 2024 was 42% higher** than forecast in 2015, with capacity expected to double again by 2030.

Renewable energy cost:

- Solar PV prices have **fallen by 66%** over the past decade.
- Installed costs of offshore wind have **declined by 48%** since 2010. In 2023, new onshore wind projects produced electricity at a cost of 67% below fossil alternatives.
- Onshore costs are projected to decrease by approximately 40% by 2060, and offshore costs are projected to decline by 67%.
- Lithium-ion **battery pack prices have decreased by 90%** since 2010, with average battery prices declining by at least 20% in 2024 alone.

Electric vehicles (EVs):

- The Paris target to reach 100 million EVs globally by 2030 is **on track to be met two years early**.
- 1 in 5 cars sold globally is electric (including 1 in 2 in China), up from 1 in 100 in 2015.

Energy investment:

- **Growth in clean energy and fossil fuel investment from 2015 to 2024:**

Geography	Clean Energy investment growth, 2015-2024	Fossil Fuel investment growth, 2015-2024
World	68%	-20%
US	73%	-28%
China	97%	19%
India	50%	17%
EU	112%	-26%

Image taken from pg. 16

- China, the U.S., the EU, and India account for 62% of global energy investment.
- The annual investment in solar PV surpasses the investment in all other forms of generation combined.

Clean energy jobs and economic impacts:

- **Clean energy now outpaces fossil fuels for employment**—an estimated 36.2 million jobs compared to 33 million.
- Renewable energy jobs have nearly doubled since 2015, reaching 16.2 million in 2023, driven primarily by growth in solar PV and wind.
- **The clean energy sector in China now accounts for roughly 10% of GDP** (US$1.9 trillion). The sector grew three times faster than the broader economy in 2024.

Policy (pg. 20-27):

- Nearly **100 countries have embedded net zero into formal documents** or enshrined their net-zero targets in law.
- National-level climate policy tools (e.g., transition planning and carbon credits) have increased sevenfold since 2015, with nearly 40% being introduced since 2022.
- Over 100 countries voluntarily **participate in CORSIA** (Carbon Offsetting and Reduction Scheme for International Aviation), **covering around 80% of global aviation emissions**.
- The International Maritime Organization adopted an Initial Greenhouse Gas Strategy in 2018 and, in 2023, increased its ambitions to net zero "by or around" 2050.

- As of 2024, over 2,600 cases of climate litigation have been filed across more than 70 countries, with nearly 70% of these cases being filed after 2015. In 2023, **47 "climate-washing" cases were brought, with over 70% decided in favor of the plaintiffs.**

Emissions (pg. 28-32):

- The **U.S. has sustained emissions reductions despite growing backlash against ESG** and changes in federal policy.
- EU emissions reductions have accelerated following the signing of the Paris Agreement.
- China's 10-year average emissions growth has declined from 8% leading up to Paris to below 2% today.
- **Emissions from land use and deforestation declined by 33%** from 2015 to 2023.
- **Deforestation in the Brazilian Amazon has decreased by 50% since 2021**, largely due to renewed policy and enforcement efforts.