مدينة الملك عبد الله للطاقة
الذرية والمتجددة K•A•CARE

Energy Observatory
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المقدمة

تُـــعد نشرة مـــرصد الطاقة منصة معرفية دورية تقدم لمحات شامـــــلة حول المستجدات في مـــجال الـطاقة عـــالميًا ومحليـــاً

تهدف النشرة إلى تسليط الضوء على :

- أحدث التطورات في مجالات الطاقة المتجددة والذرية.
- استعـــراض التـــقنيات الحديثة والـــتحولات العالمية.
- مـــــقالات خـــــبـــراء
- ملخصات أوراق علمية بارزة
- تقـــــارير مـــــتخصصة

تسعى النشرة إلى توفير محتوى غني ومتنوع يلبي احتياجات صناع القرار والباحثين والمهتمين بمجال الطاقة، مما يساهم في تعزيز المعرفة ودعم الابتكار في القطاع.

Renewable Energy News

Saudi Arabia connects 7.8 GWh battery storage project to grid.

Image: Algihaz Holding – PV Magazine

Saudi Arabia has successfully connected a massive 7.8 GWh battery energy storage system (BESS) to the national grid, marking a significant step in its renewable energy ambitions. Spread across three sites—Najran, Khamis Mushait, and Madaya—each location holds a capacity of 2.6 GWh and connects to the 380 kV transmission network.

This project, developed by Saudi Electricity Co. with National Grid SA as the offtaker, is considered the world's largest BESS once fully operational. Delivered by Algihaz Holding under a turnkey EPC contract, the system includes operations and maintenance, as well as integration of high-voltage transformer equipment to enhance grid stability and support renewable integration.

Source

Renewable Energy News

GCCIA and EPRI Sign Strategic Cooperation Agreement for Future of Energy.

Image: https://x.com/gccia/status/1996558065718428003

The Gulf Cooperation Council Interconnection Authority (GCCIA) and the Electric Power Research Institute (EPRI) have signed a strategic amendment to their current framework agreement to strengthen grid resilience and enhance readiness for the evolving energy landscape.

The new amendment has broadened the scope of cooperation by including important areas focused on improving operational flexibility, achieving economic and reliability benefits for GCC states, and developing a multi-year roadmap to integrate the outcomes of EPRI & GCCIA joint studies into national planning and operations frameworks, and addressing emerging needs driven by rapid renewable energy deployment and advanced grid technologies.

Source

Renewable Energy News

PV redox flow battery with 4.2% solar-to-electricity conversion efficiency.

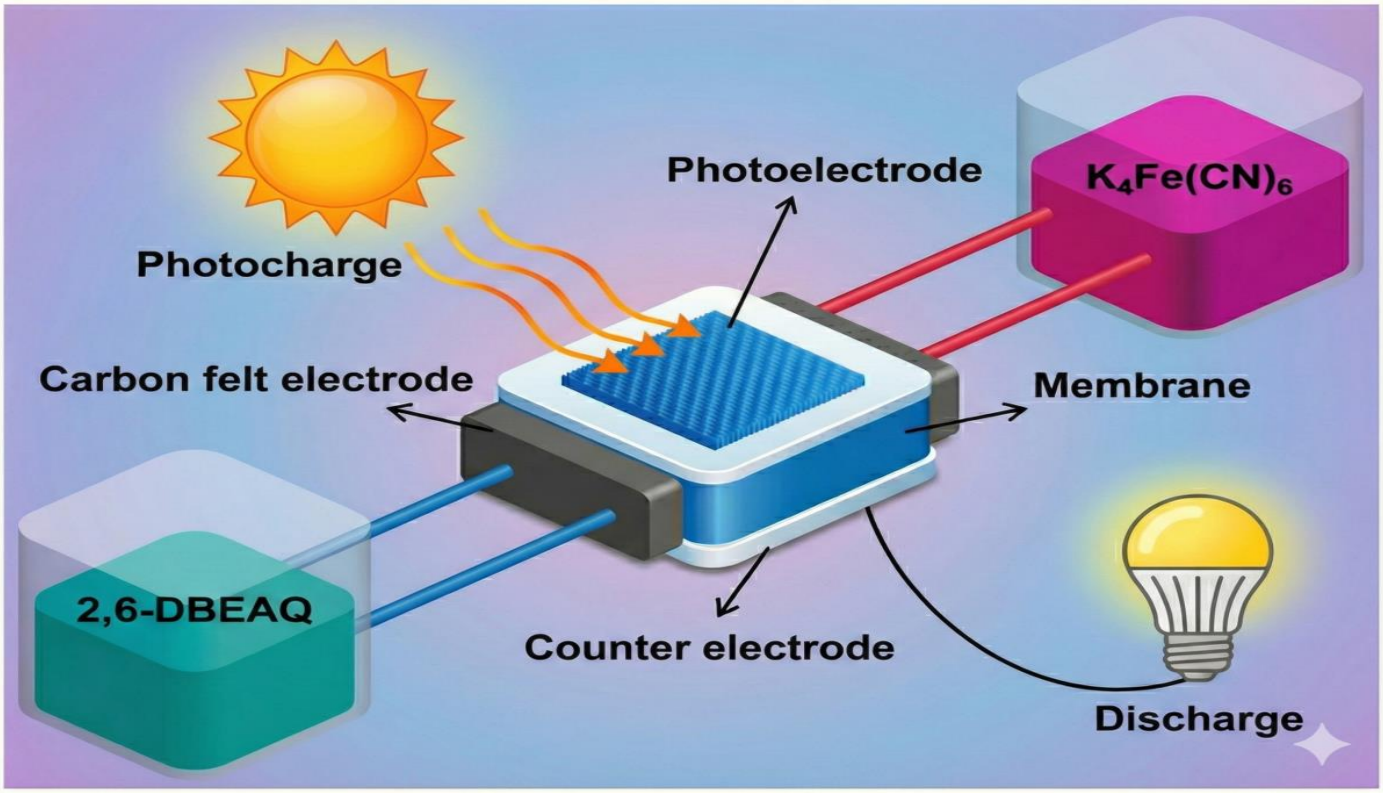

Image: The SRFB device – PV Magazine

Researchers at Nanjing Tech University in China have developed a solar redox flow battery (SRFB) using anthraquinone-based redox couples and a triple-junction amorphous-silicon photoelectrode. The device achieved an average solar-to-electricity conversion efficiency of 4.2% under simulated sunlight conditions. The system captures solar energy and stores it as chemical energy using flowing electrolytes, providing both generation and storage in a single device.

The photoelectrode reduces 2,6-DBEAQ in the catholyte while oxidizing $K_4[Fe(CN)_6]$ in the anolyte, separated by a Nafion membrane. The device operated across 10 charge-discharge cycles without external bias and demonstrated promising performance, offering potential for future integrated solar energy storage solutions.

Source

Renewable Energy News

ABB completes acquisition of power electronics business of Gamesa Electric.

Image: : https://seeklogo.com/vector-logo/1844/abb.

ABB (Swedish-Swiss multinational corporation headquartered in Zurich) has completed its acquisition of Gamesa Electric's power electronics business in Spain from Siemens Gamesa, following the initial announcement of the deal on December 18, 2024.

Gamesa Electric's power electronics business, which generated around €145 million in revenues for FY2025, includes wind converters for doubly fed induction generator, industrial BESS, and utility-scale solar inverters, along with two factories in Madrid and Valencia and approximately 400 employees worldwide. In addition, ABB signed a supply and services agreement with Siemens Gamesa.

Source

Renewable Energy News

VCM Expands Global Reach and Regional Collaboration in Asia with New Partnerships.

Image: : https://www.spa.gov.sa/en/N2458675.

The Regional Voluntary Carbon Market Company (VCM) has expanded its presence in Asia by signing a memorandum of understanding (MoU) with Japan's Marubeni Corporation for collaboration on carbon markets and signing a partnership agreement with Climate Bridge International from Singapore as an advisory partner.

These agreements were announced during the Future Investment Initiative (FII) Priority Summit in Tokyo, strengthening VCM position as a world-leading, transparent, high-integrity platform that connects buyers and suppliers of carbon credits across regions, while expanding access to credible, high-quality climate solutions.

Source

Renewable Energy News

Researchers find sodium-ion batteries using hard carbon anodes can intrinsically charge faster.

Image: : Ra Boe, Wikimedia Commons, CC BY-SA 3.0 DE.

Researchers at Tokyo University of Science examined the intrinsic charging kinetics of sodium-ion batteries using hard carbon anodes and compared them with lithium-ion systems. By applying a diluted electrode method that reduces electrolyte transport limitations, the study isolated ion insertion behavior within hard carbon.

Electrochemical measurements showed that sodium insertion proceeds faster than lithium insertion, with higher apparent diffusion coefficients. The analysis identified pore filling in hard-carbon nanopores as the rate-limiting step, where sodium requires lower activation energy to form pseudo-metallic clusters. These results clarify hard carbon's rate capability and charging behavior in sodium-ion batteries.

Source

Renewable Energy News

China National Petroleum Corporation achieves 25.05% efficiency for inverted perovskite solar cell.

Image: : Charlie fong, Wikimedia Commons, Public Domain – PV Magazine.

China National Petroleum Corporation (CNPC) announced a certified 25.05% power conversion efficiency for its inverted "p-i-n" perovskite solar cell, verified by the Shanghai Institute of Microsystem and Information Technology. The company said the design uses "dipole-precisely adjustable" interface molecules to address stability challenges and increase the open-circuit voltage to 1.68 V. The cell is intended for use as a top device in perovskite-silicon tandem configurations.

CNPC also reported certified tandem efficiencies of 34% for silicon-perovskite devices and 30% for all-perovskite stacks. The company claims the technology could lower LCOE to CNY 0.212/kWh and plans a 100 MW pilot line in 2026, followed by large-scale manufacturing in 2028, as part of its broader renewable energy expansion strategy

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Source

Nuclear Energy News

Nuclear Emergency Summit Opens in Riyadh.

Image:IAEA Deputy Director General and Head of the Department of Nuclear Safety and Security.

The International Conference on Nuclear and Radiological Emergencies (EPR2025) opened in Riyadh, organized by the IAEA in cooperation with Saudi Arabia's Nuclear and Radiological Regulatory Commission (NRRC), with participation from over 100 countries. The conference focuses on strengthening global emergency preparedness and response through innovation, capacity building and international cooperation.

Source

Nuclear Energy News

Argentina and Brazil progressing their multipurpose reactors.

Image:CNEA.

Argentina and Brazil are advancing their multipurpose research reactor programmes, with Argentina targeting radioisotope self-sufficiency and export capability once its 30 MWt RA-10 reactor enters operation. RA-10 commissioning is expected to begin in 2026, with full operation in 2027, and will support large-scale production of medical radioisotopes, advanced materials testing, silicon doping and fuel research.

In Brazil, plans for the similar Brazilian Multipurpose Reactor (RMB) are moving forward, with construction now expected to start in the first half of 2026 following renewed engagement with reactor supplier Invap. The RMB, part of a broader nuclear research campus, is intended to strengthen Brazil's radioisotope supply and research infrastructure, with overall project completion targeted for around 2030.

Source

Nuclear Energy News

Korean floating SMR design certified.

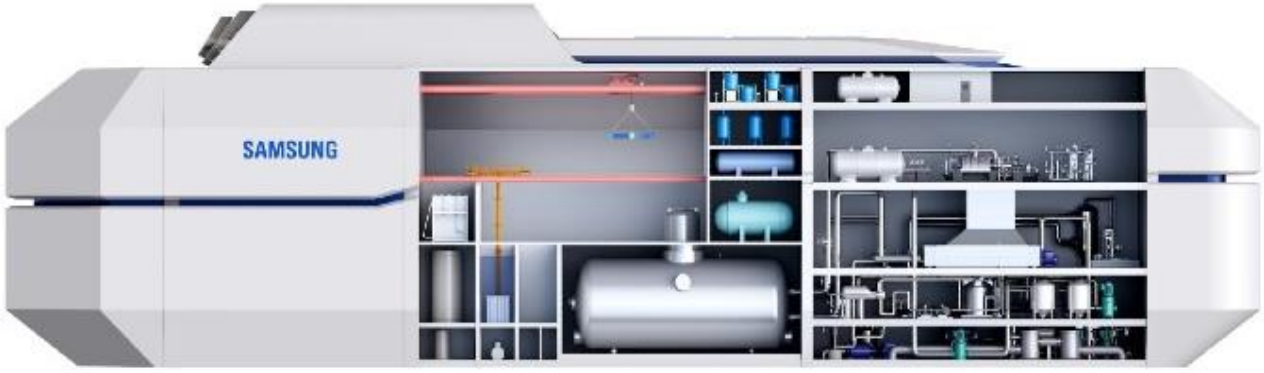


Image:Korea Atomic Energy Research Institute

Samsung Heavy Industries has received Approval in Principle from the American Bureau of Shipping for a floating nuclear power platform incorporating two SMART100 small modular reactors developed by the Korea Atomic Energy Research Institute. The certification confirms the conceptual feasibility of integrating SMRs with a floating offshore structure and compliance with relevant safety rules and standards.

Samsung led the overall platform and containment design, while KAERI adapted the land-based SMART100 for marine use. The modular "compartment design" allows flexibility to accommodate different SMR types and enables land-based testing before offshore installation, reducing construction time. The SMART100 is an advanced integral pressurised water reactor with fully passive safety systems, increased thermal and electrical output, and applications including power generation and desalination, positioning South Korea as a potential leader in marine nuclear power.

Source

Nuclear Energy News

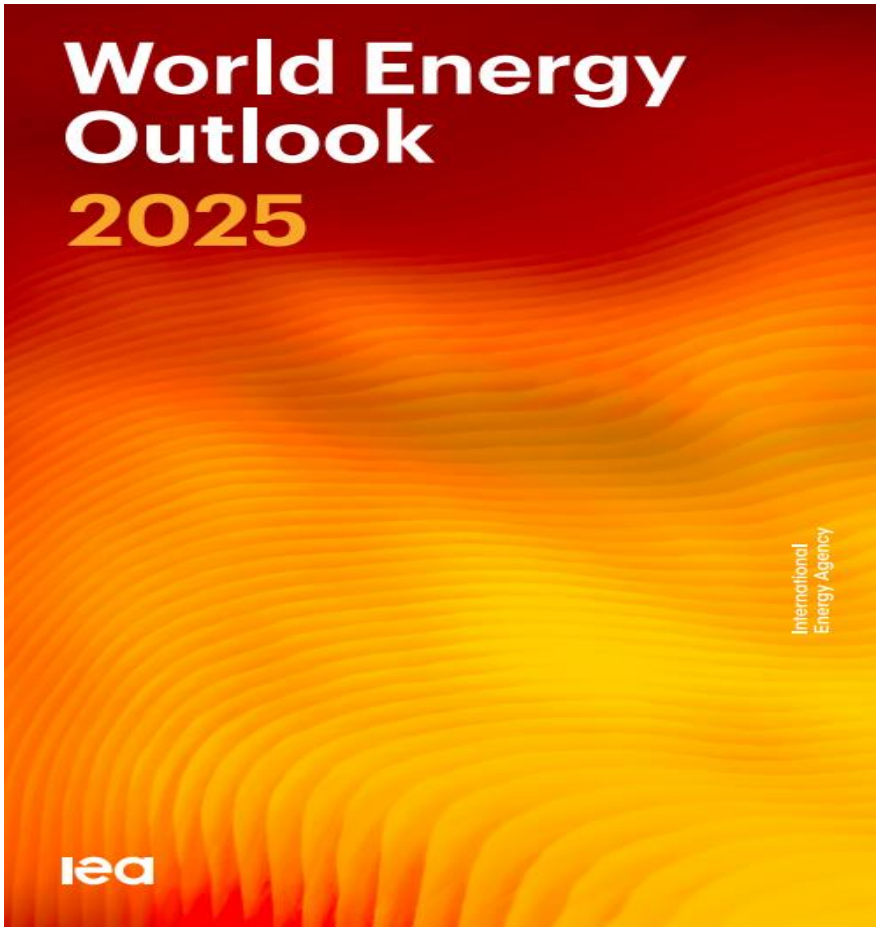
IAEA Hosts First International Symposium on AI and Nuclear Energy.

Image: IAEA.

The IAEA hosted its first International Symposium on Artificial Intelligence and Nuclear Energy, bringing together global leaders from the energy, technology and regulatory sectors to explore the convergence of AI and nuclear power. Discussions focused on meeting rising electricity demand from AI data centres while enhancing nuclear safety, efficiency and sustainability.

Source

1) Report title: World Energy Outlook 2025 - IEA



The IEA's World Energy Outlook (WEO) is widely recognized as a leading global reference for energy projections and analysis. Published annually with updated data, technology developments, market trends, and policy updates, it examines multiple potential energy pathways and assesses their implications for energy security, access, and emissions.

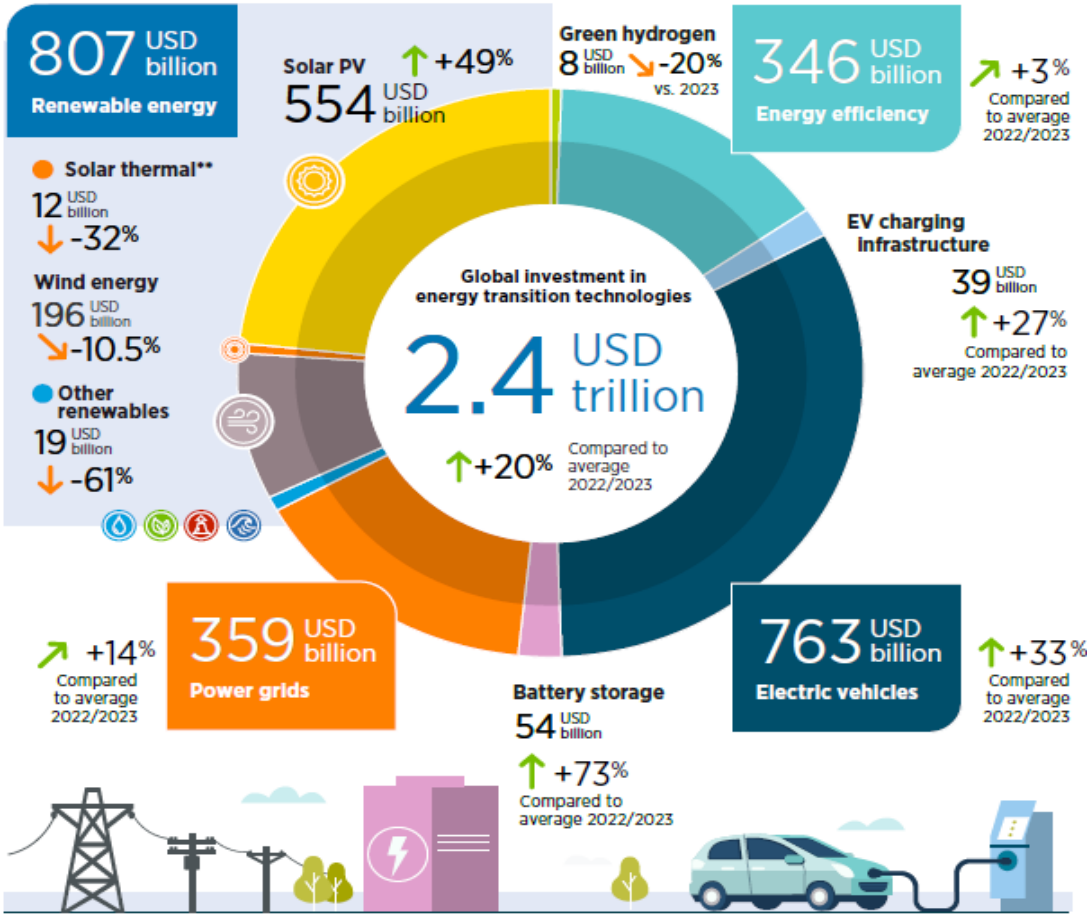
The report covers the full energy system and uses a scenario-based approach to clarify major strategic choices and their possible outcomes. It includes exploratory scenarios based on different policy assumptions, as well as normative pathways that show how specific climate and energy goals can be achieved in full. By comparing these scenarios, the WEO illustrates how the evolution of the energy system depends on key variables, particularly government policy and investment decisions.

This year's edition provides detailed insights into the consequences of different energy strategies and investment directions, with a notable emphasis on the security of supply for critical minerals.

Prepared by: Mohammed Al Essa

Source

1) Energy transition investment in 2024



The figure above highlights the key findings on energy transition investment in 2024. The figure is part of IRENA Global landscape of energy transition finance 2025 report, which provides comprehensive data and analysis on renewable energy investments, examining trends by technology, end use, region, investment type (public or private), and financial instruments.

The following insights can be drawn from the figure and the report:

• Global investment in energy transition technologies hit a record USD 2.4 trillion in 2024, up 20% from the 2022/2023 average.

• Renewable energy maintained a stable share of about one-third (35%) of total investments, while EVs and charging infrastructure grew sharply from 13.6% in 2019 to 31.6% in 2024. In contrast, the share for power grids and energy efficiency shrank from 26% and 20%, respectively, to a combined 29%, split almost equally.

Prepared by: Omar Al Owain

Source

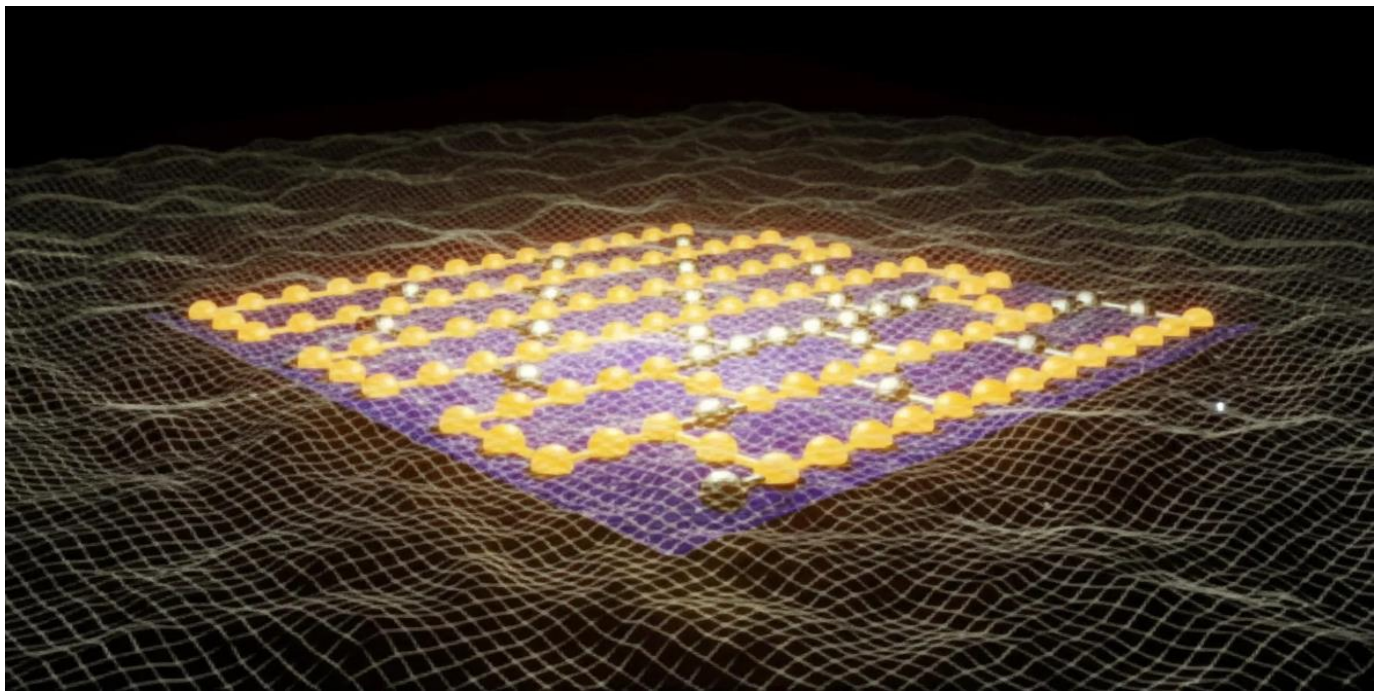
3 TAKE A LOOK AT DATA VISUALIZATION

- Renewable energy investment reached USD 807 billion in 2024 (up 22% compared to the levels in 2022/2023), with solar PV hitting a record USD 554 billion (up 49%), solar thermal dropping to USD 12 billion (down 32%) and wind falling to USD 196 billion (down 10.5%) (a slight 6% increase in onshore wind and a 45% drop in offshore wind).
- Power grid investment rose 14% to USD 359 billion in 2024.
- EV investment surged to USD 763 billion (up 33% from 2022/2023), with charging infrastructure reaching USD 39 billion (up 27%).
- Global investment in energy storage (batteries) reached USD 54 billion in 2024, up 73% from the 2022/2023 average and more than 11 times the levels in 2019/2020.
- Energy efficiency investment increased slightly to USD 346 billion (up 3%).
- Investment in green hydrogen fell 20% to USD 8 billion compared with 2023.

Prepared by: Omar Al Owain

Source

Paper Title: Quantum Computers Take a Major Step Toward Simulating Extreme Physics. By: DOE/US Department of Energy.



In a significant development at the intersection of quantum computing and nuclear physics, researchers have demonstrated for the first time that scalable quantum circuits can simulate key aspects of fundamental physics on more than 100 qubits a scale beyond what classical supercomputers can feasibly model. This advance marks a pivotal moment in the use of quantum machines to study matter under extreme conditions, with potential implications for understanding particle collisions, dense nuclear environments, and deep cosmological questions.

Background & Challenge

The **Standard Model of particle physics** provides the theoretical framework for describing fundamental forces and particles. However, solving these equations in complex scenarios such as rapidly evolving systems or ultra-dense matter becomes computationally prohibitive for classical supercomputers. Quantum computers, by contrast, naturally process information in quantum bits (qubits) that can encode superposed and entangled states, offering a route to more efficient simulations of inherently quantum systems.

A key barrier has been the preparation of the initial quantum state required for meaningful simulations. Such states often represent complicated correlated systems (e.g., the quantum vacuum before a particle collision) that classical algorithms struggle to prepare reliably.

Prepared by: Talal Al Harbi

Source

What Was Achieved

The research team addressed this challenge by developing scalable quantum circuit designs that can be established on small systems using classical computation and then systematically extended to much larger quantum computers. These circuits efficiently prepare complex initial states that are essential for simulating dynamics governed by the strong force a fundamental interaction described by quantum chromodynamics and other elements of the Standard Model. Using **IBM's quantum hardware** with over 100 qubits, the team executed these circuits and successfully simulated:

- **Vacuum states** of a simplified quantum field model, and
- **Hadrons and their dynamic evolution**—particles such as protons and neutrons which are central to nuclear physics.

The results showed that crucial physical properties, such as features of the vacuum state, could be extracted with **percent-level accuracy,** providing confidence that the circuits are both **scalable and systematically improvable.**

Implications & Future Directions

This milestone opens a promising pathway toward performing fully dynamical simulations of particle collisions and high-density matter—domains currently inaccessible to classical computation. Looking ahead, such quantum simulations could help scientists investigate:

- Why matter predominates over antimatter in the universe,
- How heavy elements are forged in stellar explosions (supernovae), and
- The behavior of matter at ultra-high densities, such as in neutron stars.

The scalable circuits developed in this work also lay a foundation for applying quantum simulations across other fields with complex quantum behavior, including exotic condensed matter systems.

As quantum hardware continues to improve**, quantum simulations may soon surpass classical limits,** reshaping how we tackle some of the deepest questions in physics.

Prepared by: Talal Al Harbi

Source

Nuclear and Radiological Emergencies: From Post-Incident Response to Integrated Proactive Preparedness.

Eng. Aseel Atif Zamzam,

30 December 2025

As the global use of nuclear and radiological technologies continues to expand across energy production, healthcare, industry, research, and waste management, the issue of nuclear and radiological emergencies has gained increasing strategic importance. Ensuring effective protection of people and the environment now requires a shift away from reactive, post-incident response models toward proactive, integrated preparedness frameworks that anticipate risks and strengthen national readiness before an emergency occurs.

Modern emergency preparedness and response (EPR) systems are built on a comprehensive, risk-informed approach. This approach recognizes that emergencies may arise not only from nuclear power plants, but also from medical and industrial sources, radioactive waste storage and transport, orphan sources, or cross-border radiological events. As a result, preparedness must be scalable, flexible, and capable of addressing a wide range of potential scenarios with varying levels of complexity and consequences.

From a technical perspective, proactive preparedness relies heavily on early detection and real-time situational awareness. National radiation monitoring networks, mobile detection systems, and environmental sampling capabilities form the backbone of early warning mechanisms. When integrated with data analysis tools and decision-support systems, these technologies enable authorities to rapidly assess radiological conditions, predict dispersion patterns, and implement protective actions such as access control, sheltering, or contamination mitigation. Advances in modelling and simulation tools have further enhanced the ability to evaluate potential exposure pathways and support evidence-based decision-making during the early phases of an emergency.

Another critical technical pillar is the application of the defence-in-depth concept to emergency management. This includes layered safety measures, redundant communication systems, and predefined operational procedures that remain effective even under degraded conditions. Regular emergency exercises and drills play a vital role in validating these systems, testing interoperability among agencies, and identifying gaps that may not be apparent during routine operations. Lessons learned from exercises are essential inputs for continuous improvement and system resilience.

Human capacity development remains equally important. Effective preparedness requires well-trained personnel across regulatory bodies, emergency response teams, technical support organizations, healthcare institutions, and decision-making authorities. Training programmes must combine technical expertise with crisis management skills, ensuring that responders can operate under pressure while maintaining clear communication and coordination. A strong safety and preparedness culture, supported by continuous learning and knowledge sharing, significantly enhances national readiness over the long term.

At the institutional level, coordination among national stakeholders represents one of the most challenging aspects of emergency preparedness. Nuclear and radiological emergencies demand a whole-of-government approach that integrates technical, regulatory, security, health, environmental, and communication functions. Clear governance structures, defined roles and responsibilities, and unified command and control mechanisms are essential to avoid duplication of efforts or delays in response.

In this context, the Kingdom of Saudi Arabia provides an important example of institutional preparedness. The Kingdom has established a National Nuclear and Radiological Emergency Response Plan involving more than 20 governmental and technical entities. This national framework ensures coordinated preparedness and response across all relevant sectors, with the King Abdullah City for Atomic and Renewable Energy (K.A.CARE) playing a key role as a technical and coordinating body. The plan reflects international best practices and demonstrates a strong national commitment to preparedness, inter-agency coordination, and the safe and secure use of nuclear and radiological technologies.

In conclusion, the transition from post-incident response to proactive, integrated preparedness is no longer optional. It is a fundamental requirement for countries seeking to responsibly benefit from nuclear and radiological applications. Investment in technical systems, human capacity, institutional coordination, and continuous improvement forms the foundation of effective emergency preparedness. By adopting proactive strategies and aligning national frameworks with international standards, countries can significantly enhance resilience, protect public health and the environment, and reinforce public confidence in the safe use of nuclear and radiological technologies.