

Look Forward

Energy at the Crossroads

March 2025



S&P Global



Energy at the crossroads

The global energy industry stands at a major crossroads.

The intersection of policy, politics, finance and technology with the energy industry has rarely been as significant as it is today. More than half of the world's population across 70 countries held national elections in 2024. New governments are leading significant changes in energy and climate policies, reevaluating the pace of the energy transition. Affordable and secure energy for economic growth is taking priority, especially in countries where prohibitive energy costs are contributing to high and persistent inflation.

At the same time, technological factors are reshaping global energy markets. New datacenters, built to power rapid acceleration in the use of AI models, are creating a major surge in electricity demand and renewed interest in nuclear energy as a source of carbon-free firm power. Demand for some clean technologies such as solar photovoltaics and batteries continues to grow, but restructuring cleantech supply chains is proving a challenge.

This issue of the S&P Global Research Council's *Look Forward* publication explores a broad spectrum of topics, assessing the state of the energy transition and the pragmatic path forward. It highlights essential truths about the direction of global energy markets and climate change, the progress being made by the oil and gas industry to measure and mitigate methane emissions, how to assess climate risks, and the potential impact of AI on optimization and innovation across energy value chains.

Look Forward: Energy at a Crossroads provides a window into the broad spectrum of topics that S&P Global researchers, analysts and economists cover throughout the year for our clients globally. We encourage you to read previous volumes of this publication, including *Look Forward: Multidimensional Transition*, published in March 2024.

S&P Global is a reliable and trusted source of data and insights that helps companies and countries navigate an uncertain and dynamic world. Please get in touch: We welcome your feedback and suggestions as we strive to improve and evolve this publication.



Mark Eramo, Co-president
S&P Global Commodity Insights



Dave Ernsberger, Co-president
S&P Global Commodity Insights



The multidimensional energy transition is more evident today than a year ago. After 12 months of persistently high inflation, weak economic growth and elevated energy costs, countries and companies around the world are starting to reassess their energy strategies and climate policies. The energy industry is at a crossroads, with new pathways and directions emerging.

Consumers want affordable energy and governments are prioritizing security over sustainability. Many are reassessing the ambition to redesign the global energy system and, by inference, the global economy in the next 25 years. All eyes are on the US and how the Trump administration's actions will alter the direction of the country's energy industry and climate policies — actions with impacts far beyond US borders.

At the same time, energy demand and emissions continue to grow. The world remains in energy-addition mode, with demand growth for hydrocarbons and renewables such as wind and solar. Electricity demand is surging due to the accelerating construction of AI datacenters by hyperscalers. Such demand growth is likely to be met by natural gas and renewables through the end of this decade, even though interest and investments in nuclear technologies are at a generational peak.

Progress in scaling clean energy technologies has been variable. The cost of solar photovoltaics, onshore wind, electric vehicles and battery power are declining globally, with a commensurate increase in deployment. China, with its vast manufacturing base, is a leading deployer of clean energy technologies. Meanwhile, the euphoria surrounding green hydrogen has cooled significantly due to its high production cost and lack of customers. The carbon capture and storage (CCS) project pipeline is moving slowly, with few final investment decisions made in 2024. Successful execution of projects in the next five years will be critical to prove that CCS can reach gigaton scale.

The combination of strong growth in energy demand and slow to no change in the primary energy mix indicates that it is no longer possible to reach net-zero emissions by 2050. It also means that the goal of the Paris Agreement on climate change — limiting the global average temperature increase to 1.5 degrees C above preindustrial levels by 2100 — is unachievable.

The articles in this edition of *Look Forward* provide a window into the complex and fast-changing nature of the global energy industry. Our authors highlight the predetermined elements of the energy transition, the reasons for a global resurgence in nuclear power and the feasibility of creating new clean technology supply chains outside of China. They discuss how observation data is upending our understanding of methane emissions, how AI is advancing optimization and innovation in the energy sector, the physical risks from climate change, and what role indexes can play in the energy transition.

Our goal is to shine a light on the global energy system — the progress made, the challenges ahead and the potential solutions. As we navigate the energy transition, S&P Global will continue to provide timely and insightful analysis to prepare our readers for whatever road lies ahead.

Atul Arya, Ph.D., Chief Energy Strategist

S&P Global Commodity Insights

Co-chair, S&P Global Research Council

Contents



Energy at the crossroads



Inarguable truths: Searching for predetermined elements of the energy transition



Breaking free: Can the West build independent cleantech supply chains?



The reckoning: How observation data is upending our understanding of methane emissions



A multidimensional nuclear resurgence: Differing drivers and challenges



The role of indexes in the energy transition



Climate costs are rising, but few companies have an adaptation plan



AI's role in propelling the energy sector

Inarguable truths: Searching for predetermined elements of the energy transition

Despite heightened uncertainty in global energy markets, it is possible to discern indisputable truths regarding the energy transition.

Paul McConnell, Head, Outlooks and Scenarios Analysis
S&P Global Commodity Insights

Highlights

Demographics are pointing to slower energy demand growth, and electricity is bound to be the center of the world's future energy system.

China's role in driving demand — outsized over the past three decades — is slowing, and no successor country is positioned to dominate commodity markets in the same way.

While greenhouse gas emissions are expected to decline, achieving net-zero GHG emissions by 2050 or limiting global warming to below 1.5 degrees C above preindustrial levels is no longer possible.

Scenario analysis shows that today's energy system could plausibly evolve into a vast range of future states, with each offering myriad challenges and opportunities to industry participants. S&P Global Commodity Insights scenarios illustrate global oil (liquids) demand of 61 million-106 million b/d in 2050, depending on the outlook. Expectations for the role of clean technology in power systems, demand for natural gas or the penetration of electric vehicles are similarly broad. However, despite this range of outcomes, definitive statements can be made about what will happen to the world's energy system, rather than what might. What are these inarguable truths, and what implications do they have for the energy industry in the next five, 10 and 30 years?



Is energy market volatility hiding the real trends? Scan the QR code to uncover what's driving the energy transition beneath the uncertainty.

Breaking free: Can the West build independent cleantech supply chains?

As Western economies grapple with localizing clean technology manufacturing, they face an uphill battle to reduce their dependence on China.

Sam Wilkinson, Director, Clean Energy Technology
S&P Global Commodity Insights

Edurne Zoco, Executive Director, Clean Energy Technology
S&P Global Commodity Insights

Gavin Montgomery, Principal Analyst, Metals and Mining
S&P Global Commodity Insights

Highlights

Western economies face major challenges in reducing their dependence on China for clean technology manufacturing. China's dominance in this sector is remarkable, having built the necessary scale, supply chains and technological expertise over more than a decade.

Despite China's preeminence, which stems from strategic investments and technological advancements, Western countries are striving to develop local manufacturing to boost their economies and create more resilient supply chains.

However, this transition is expected to be costly and complex, requiring significant government intervention, coordinated planning and long-term investment to level the playing field and achieve a more localized supply chain.

After decades of strategic investments, China is the undisputed leader in cleantech manufacturing and dominates the associated supply chains. Western economies are engaged in an uphill battle to develop domestic manufacturing to boost their economies and create more resilient supply chains. While the benefits are clear, a more expensive transition is inevitable.



China leads in cleantech manufacturing, but can the world build a more diverse supply chain? Scan the QR code to explore the challenges ahead.

The reckoning: How observation data is upending our understanding of methane emissions

Observation technologies yield higher emissions than traditional data collection methods but provide oil and gas producers with more accurate, actionable information.

Raoul LeBlanc, Vice President, North American Upstream
S&P Global Commodity Insights

Highlights

The deployment of direct methane emissions observation has been a key driver of oil and gas producers' progress toward their emission reduction pledges.

The emissions shown by this new data stream, however, are almost always substantially higher than the historical record calculated using methodologies required by regulatory authorities, creating controversy and confusion.

Operators choosing observation technologies as their primary tool will need to reset their baseline higher but should derive long-run benefits from rapid mitigation, greater data credibility for investors and alignment with third-party estimates.

In a notable advancement for environmental performance, oil and gas producers in the Permian Basin reduced the methane emissions intensity of their operations by an impressive 32% in 2023 compared with 2022, lowering it to 0.63% of barrels of oil equivalent production. This progress highlights ongoing efforts to address greenhouse gas emissions in response to regulatory frameworks and industry pledges. However, the disparity between observation-based methane detection and traditional regulatory reporting raises serious questions about the reliability of historical emissions baselines and complicates comparisons over time. S&P Global Commodity Insights concludes that observation technologies, while imperfect, are more accurate and yield actionable data, allowing companies to verify, address and prevent leaks.



Airplanes and satellites are tracking methane emissions, and what they reveal is surprising. Scan the QR code to uncover the progress and persistent challenges.

A multidimensional nuclear resurgence: Differing drivers and challenges

Highlights

Governments, utilities and large electricity users increasingly view uranium-based electrons as a sensible solution to decarbonize the energy sector while ensuring firm power — subject to favorable policy, notably financial incentives.

The AI-fueled boom in energy-intensive server-housing facilities has magnified nuclear energy's renewed momentum in the US, with this dynamic expected to take hold in Europe, where the datacenter sector is expanding more slowly.

Despite numerous nuclear new-build announcements in Europe and North America, actual project construction is limited. In contrast, nuclear growth in China is accelerating, with ongoing construction and a healthy project pipeline.

Nuclear power is increasingly in the headlines, driven by energy security needs, growing AI datacenter power demand and decarbonization agendas — but challenges remain in getting projects underway in Europe and the US.

Emmanuel Dubois-Pelerin, Managing Director
S&P Global Ratings

Tony Lenoir, Senior Analyst
S&P Global Commodity Insights

Sylvain Cognet-Dauphin, Executive Director
S&P Global Commodity Insights

Dan Thompson, Principal Analyst
S&P Global Market Intelligence, 451 Research

As the world grapples with climate change and energy security challenges alongside steepening AI-related load forecasts, nuclear power is experiencing a global resurgence in interest. This was evinced by a goal set at the 2023 UN Climate Change Conference (COP28) to triple nuclear capacity by 2050. Nuclear energy can provide 24/7 carbon-free power while helping countries diversify their energy mix — a political imperative in parts of Europe following the energy crisis, heightened after Russia's invasion of Ukraine. Technological maturity, construction costs and financing, however, must be addressed for a true nuclear renaissance.



Nuclear power is making a comeback. Scan the QR code to explore how Europe, the US, and China are shaping its decarbonized future.

The role of indexes in the energy transition

Indexes can help market participants navigate the energy transition, enabling them to align their portfolios with relevant risks and opportunities.

Maya Beyhan, Ph.D., Senior Director, Index Investment Strategy
S&P Dow Jones Indices

William Kennedy, Analyst
S&P Dow Jones Indices

The global energy landscape is undergoing a remarkable transformation, driven by a combination of technological advancements and fundamental market forces that are shaping the low-carbon transition. This analysis explores how indexes can facilitate the energy transition, emphasizing that the shift toward renewable energy sources is a response to climate change and offers a strong business case. By examining various indexes across asset classes, including equities, fixed income and commodities, we highlight how they can be valuable tools for market participants looking to align their portfolios with emerging risks and opportunities associated with the energy transition.

Highlights

Companies in the S&P 500 decarbonized by a cumulative 62% over the last 20 years, with market forces driving the energy transition.

Various indexes are available across asset classes, including equities, fixed income and commodities, highlighting different facets of the energy transition.

The S&P Global Carbon Credit Index displayed a low correlation with traditional assets in the last three years, potentially offering diversification benefits and protection against carbon price volatility.

Companies in the S&P Global LargeMidCap Carbon Efficient Index reduced carbon intensity by 44% compared with the index's benchmark, with a low three-year annualized tracking error of 0.8%, appealing to those with a low tracking error tolerance.

The S&P Clean Energy Index grants insight into the growing clean energy sector.



The S&P 500® has cut carbon emissions by 62% over the past 20 years — but what does that mean for the energy transition? Scan the QR code to uncover the pivotal role of indexes.

Climate costs are rising, but few companies have an adaptation plan

Even under a medium climate change scenario (SSP2-4.5), major companies face trillions of dollars in climate-related financial costs. Yet relatively few are creating climate adaptation plans to soften the blow.

Lindsey Hall, Global Head of Thought Leadership
S&P Global Sustainable1

Matt MacFarland, Senior Editor
S&P Global Sustainable1

Paul Munday, Global Adaptation and Resilience Specialist
S&P Global Ratings

Highlights

Companies face rising exposure to the physical impacts of climate change, which comes with big financial costs — potentially \$25 trillion by 2050 for the world's largest companies under a medium climate change scenario (SSP2-4.5), according to analysis by S&P Global Sustainable1.

Our data shows that many large companies globally have yet to create climate adaptation plans to build resilience to these hazards: Only 35% of companies in our analysis have an adaptation plan.

As physical climate risks become more frequent and severe, the slow progression of many companies' adaptation planning presents crucial risks to the global economy.

The year 2025 began with a stark warning: 2024 was the warmest on record, with average global temperatures 1.5 degrees C higher than preindustrial levels for the entire year, according to the US' NASA and the EU's Copernicus. In this analysis, we surveyed companies' potential financial costs resulting from the physical impacts of climate change and explored whether the world's largest companies are preparing for these rising risks. In short, we found that although the potential financial costs are significant, many large companies around the world are not creating adaptation plans to build resilience to climate shocks.



Are companies ready for escalating climate risks? Scan the QR code to explore how they're preparing and what it means for the future.

AI's role in propelling the energy sector

Integrating AI into operational efficiency, decision-making and innovation could transform how energy is produced and distributed.

Judson Jacobs, Executive Director, Energy Technology and Innovation
S&P Global Commodity Insights

Etienne Gabel, Senior Director, Global Power and Renewables
S&P Global Commodity Insights

Dr. Carolyn Seto, Executive Director, Energy Technology and Innovation
S&P Global Commodity Insights

Highlights

The range of potential AI applications in energy systems is immense. S&P Global categorizes these applications into three groups to serve as a road map for industry AI progression: improving efficiency, managing large and complex systems, and accelerating the innovation cycle.

The early returns from AI are impressive. S&P Global Commodity Insights data and analysis reveal individual assets lowering costs by 10%-25%, improving productivity by 3%-8% and increasing energy efficiency by 5%-8%, easing the path for clean energy investment.

Achieving results at an enterprise or industry scale is far more challenging. Navigating regulatory issues, establishing effective partnerships and engendering workforce trust are critical to realizing widespread adoption.

Al models are developing capabilities that could transform the energy sector. Today though, they are mostly used as efficiency tools, automating and optimizing routine processes and acting as digital assistants for office workers. Deployed at the enterprise scale, AI holds the potential to drive further industrial productivity gains, slash emissions, manage power grids and other complex energy systems, and catalyze clean technology innovations. Experience shows, however, that capturing AI's full potential in the energy sector will not be easy and will require increased coordination across energy value chains and workforce buy-in.



AI is reshaping the energy sector, but the transition won't be easy. Scan the QR code to uncover the challenges and opportunities ahead.

Copyright © 2025 S&P Global Inc. All rights reserved.

These materials, including any software, data, processing technology, index data, ratings, credit-related analysis, research, model, software or other application or output described herein, or any part thereof (collectively the “Property”) constitute the proprietary and confidential information of S&P Global Inc its affiliates (each and together “S&P Global”) and/or its third party provider licensors. S&P Global on behalf of itself and its third-party licensors reserves all rights in and to the Property. These materials have been prepared solely for information purposes based upon information generally available to the public and from sources believed to be reliable.

Any copying, reproduction, reverse-engineering, modification, distribution, transmission or disclosure of the Property, in any form or by any means, is strictly prohibited without the prior written consent of S&P Global. The Property shall not be used for any unauthorized or unlawful purposes. S&P Global’s opinions, statements, estimates, projections, quotes and credit-related and other analyses are statements of opinion as of the date they are expressed and not statements of fact or recommendations to purchase, hold, or sell any securities or to make any investment decisions, and do not address the suitability of any security, and there is no obligation on S&P Global to update the foregoing or any other element of the Property. S&P Global may provide index data. Direct investment in an index is not possible. Exposure to an asset class represented by an index is available through investable instruments based on that index. The Property and its composition and content are subject to change without notice.

THE PROPERTY IS PROVIDED ON AN “AS IS” BASIS. NEITHER S&P GLOBAL NOR ANY THIRD PARTY PROVIDERS (TOGETHER, “S&P GLOBAL PARTIES”) MAKE ANY WARRANTY, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, FREEDOM FROM BUGS, SOFTWARE ERRORS OR DEFECTS, THAT THE PROPERTY’S FUNCTIONING WILL BE UNINTERRUPTED OR THAT THE PROPERTY WILL OPERATE IN ANY SOFTWARE OR HARDWARE CONFIGURATION, NOR ANY WARRANTIES, EXPRESS OR IMPLIED, AS TO ITS ACCURACY, AVAILABILITY, COMPLETENESS OR TIMELINESS, OR TO THE RESULTS TO BE OBTAINED FROM THE USE OF THE PROPERTY. S&P GLOBAL PARTIES SHALL NOT IN ANY WAY BE LIABLE TO ANY RECIPIENT FOR ANY INACCURACIES, ERRORS OR OMISSIONS REGARDLESS OF THE CAUSE. Without limiting the foregoing, S&P Global Parties shall have no liability whatsoever to any recipient, whether in contract, in tort (including negligence), under warranty, under statute or otherwise, in respect of any loss or damage suffered by any recipient as a result of or in connection with the Property, or any course of action determined, by it or any third party, whether or not based on or relating to the Property. In no event shall S&P Global be liable to any party for any direct, indirect, incidental, exemplary, compensatory, punitive, special or consequential damages, costs, expenses, legal fees or losses (including without limitation lost income or lost profits and opportunity costs or losses caused by negligence) in connection with any use of the Property even if advised of the possibility of such damages. The Property should not be relied on and is not a substitute for the skill, judgment and experience of the user, its management, employees, advisors and/or clients when making investment and other business decisions.

The S&P Global logo is a registered trademark of S&P Global, and the trademarks of S&P Global used within this document or materials are protected by international laws. Any other names may be trademarks of their respective owners.

The inclusion of a link to an external website by S&P Global should not be understood to be an endorsement of that website or the website’s owners (or their products/services). S&P Global is not responsible for either the content or output of external websites. S&P Global keeps certain activities of its divisions separate from each other in order to preserve the independence and objectivity of their respective activities. As a result, certain divisions of S&P Global may have information that is not available to other S&P Global divisions. S&P Global has established policies and procedures to maintain the confidentiality of certain nonpublic information received in connection with each analytical process. S&P Global may receive compensation for its ratings and certain analyses, normally from issuers or underwriters of securities or from obligors. S&P Global reserves the right to disseminate its opinions and analyses. S&P Global Ratings’ public ratings and analyses are made available on its sites, www.spglobal.com/ratings (free of charge) and www.capitaliq.com (subscription), and may be distributed through other means, including via S&P Global publications and third party redistributors.