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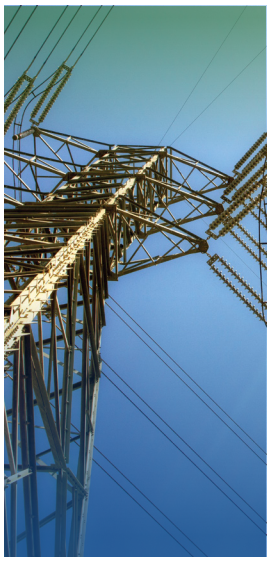
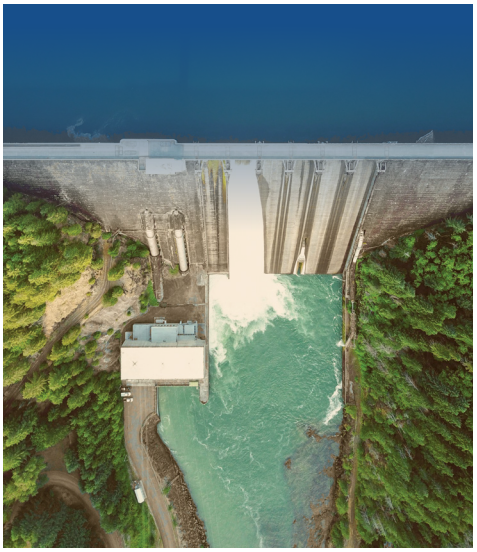
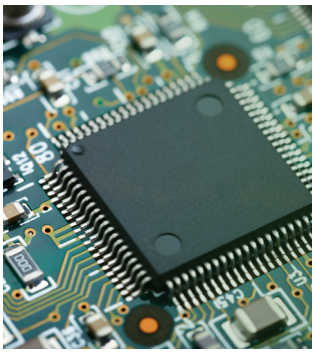


# THE 2025 GLOBAL ENERGY AGENDA





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## GLOBAL ENERGY CENTER

The Atlantic Council Global Energy Center develops and promotes pragmatic and nonpartisan policy solutions designed to advance global energy security, enhance economic opportunity, and accelerate pathways to net-zero emissions.

The editors would like to thank their knowledge partners for providing invaluable support in distributing the *Global Energy Agenda* annual survey to their respective communities around the world. These partners are the Africa Centre for Energy Policy; the Council on Energy, Environment and Water; the Institute of the Americas; the Institute of Energy Economics, Japan; and the Latin American Energy Organization. These partners enabled the *Agenda* survey to reach new audiences, resulting in the largest number of respondents in the publication's five-year history and lending greater depth and breadth to the analysis.



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# THE 2025 GLOBAL ENERGY AGENDA

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# FOREWORD

**SINCE THE LAUNCH OF THE ATLANTIC** Council's *Global Energy Agenda* in 2021, I have reflected on the progress global leaders have made toward stewarding a secure, prosperous, and sustainable energy system in the face of an ever-changing geopolitical environment. Yet, this year, the challenges of transforming the energy system weigh more heavily than usual as new leadership begins to leave an imprint on the management of nations' energy and climate goals.

The *Global Energy Agenda*, through a survey of experts and leadership essays from across sectors, takes the pulse of the energy community and presents an outlook for the year ahead. The first edition, released as the world was grappling with the COVID-19 pandemic, revealed an optimism around the pace of the energy transition. Amid the immense uncertainty of that time, our survey respondents believed the pandemic would spur action toward net-zero emissions, despite the economic fallout the virus caused.

We took this year's survey against the backdrop of four geopolitical challenges: Russia's full-scale invasion of Ukraine; conflict in the Middle East, although, as of this writing, Israel and Hamas had agreed to a cease-fire; an eroding relationship between Beijing and Washington; and the strengthening of an axis of collaboration between Russia, Iran, China, and North Korea. The assessment by energy leaders and our community in this year's *Agenda* mirrors the anxiety of these challenges across energy markets—more than half of our survey respondents highlighted the geopolitical risk of the conflicts in Europe and the Middle East as the primary threat to the energy system.

Meanwhile, over the course of 2024 when nearly half of the democratic world went to the polls, voters in several countries chose to unseat incumbents, with major implications for navigating dangerous geopolitical challenges. Most significant among these leadership changes is the return of Donald Trump to the Oval Office. His reelection reflects a dramatic change in how constituents expect policymakers to manage the energy system. Ten years into a global energy transition, the economic opportunities it presents combined with increasing geopolitical pressure points have elevated prosperity and security as priorities. As a consequence, national interests, protectionism, and trade fragmentation are now dominant themes in energy and climate. The solution, for better or worse, has been the use of industrial policy as a tool for strategic competition in new technologies, re-examination of key partnerships and regional spheres of influence, and disruptive approaches to trade and diplomacy.

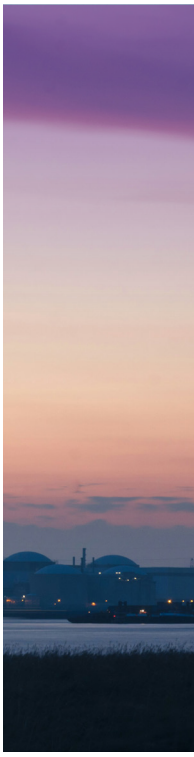
Yet none of these new realities will be as transformative as the challenges and opportunities of artificial intelligence that emerged in the past year, and will shape our energy pathways in 2025. Energy planners are scrambling to meet the surge in energy demand across advanced economies as business leaders incorporate AI into their operations. I have often spoken of how a number of historical inflection points in global affairs reflect a race to seize the commanding heights of the global economy. The past year exemplifies this idea, showing not only how consequential AI will be in pursuit of those goals, but also what resources are needed to compete in the first place.

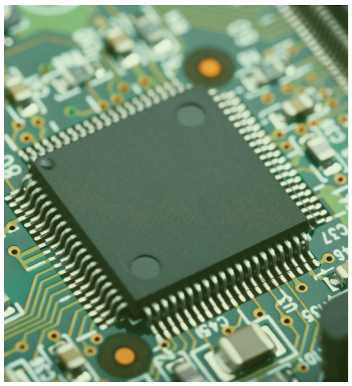
However, just as artificial intelligence introduces another layer of complexity to our shared energy future, it might be the right tool at the right time. AI has the potential to help us better understand our use of energy, to improve the efficiency of our energy system, and to accelerate our deployment of an "all of the above" approach to energy security, access, and sustainability. The technology also offers a profound opportunity to navigate uncertainty and achieve the energy objectives that society demands of new leadership.

This context for the 2025 edition of the *Global Energy Agenda* features strongly in the findings of our global community of industry experts and policy leaders. In its fifth year, our assessment illustrates the realities of an energy system under stress from geopolitical risk and surprising sources of new energy demand. Indeed, the challenges of 2024 have added new complexities to our community's assessment of the path to net-zero emissions, which, on average, respondents predict we will reach by 2066, more than fifteen years after the Paris Agreement target.

Relatedly, this year's *Agenda* also reflects the pragmatism and ambition needed to mold that system in a way that enables security, prosperity, and sustainability. Across the board, there is optimism that technological advancements can meet the energy demands of society. This shows that even as the energy transition has become more difficult to navigate, the enthusiasm from energy leaders to seize opportunities is cause for hope.

*Frederick Kempe*
*President and Chief Executive Officer*
*Atlantic Council*



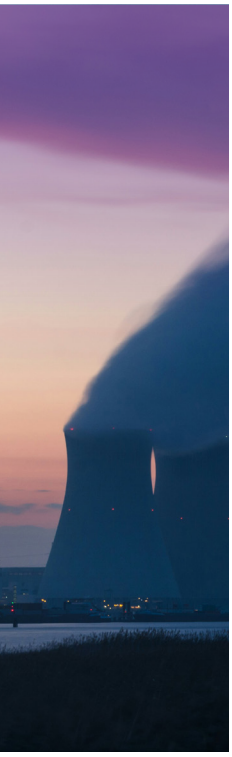


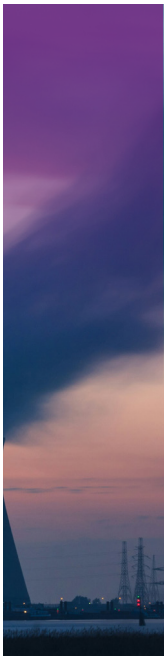
# INTRODUCTION

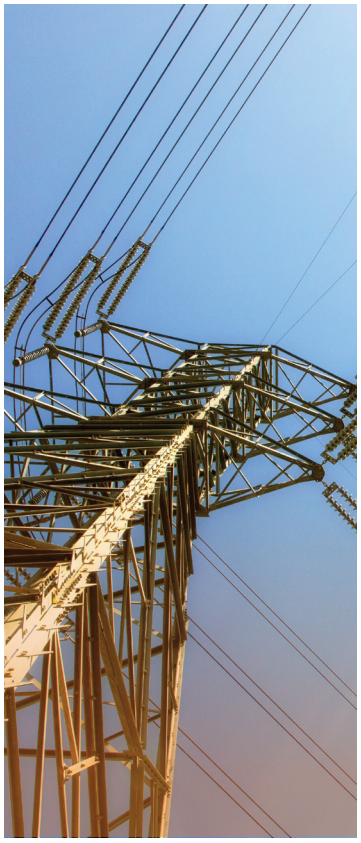
**THE SCALE OF POLITICAL TRANSFORMATION** that took place throughout the democratic world in 2024 will be evident when the Group of Seven (G7) convenes under new Canadian leadership later this year. Following Prime Minister Justin Trudeau's resignation in January, the G7 is likely to see five new heads of state join the roundtable of free nations. While not unprecedented in its fifty-year history—the world experienced similar turnover once before in the wake of the Asian financial crisis—the monumental shift in the G7 leadership is exceptionally rare and reflective of broader global sentiment desiring new and innovative action from political leaders.

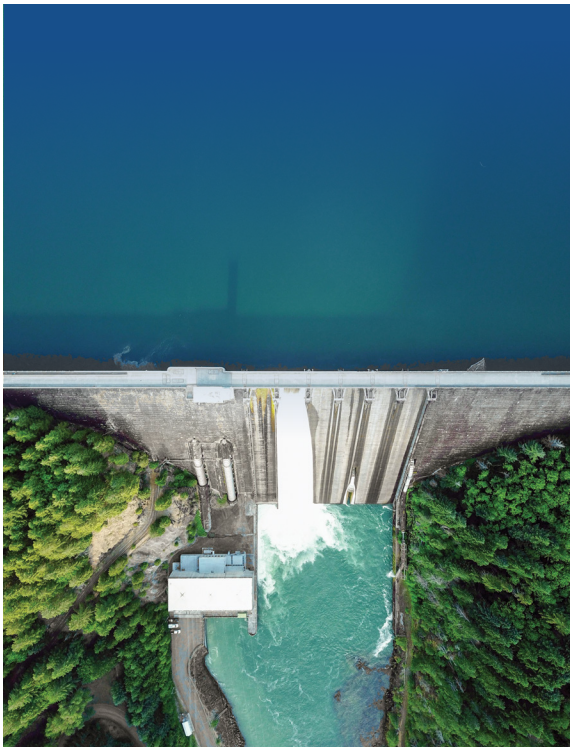
Ultimately, elections last year led to a notable political shift to the right, laying the foundation for a new international energy and climate architecture. Through words and actions, world leaders are increasingly emphasizing the importance of national security and economic competitiveness, at times upstaging long-term sustainability and climate goals. During his acceptance speech, Prime Minister Shigeru Ishiba pledged to "create a society resilient to rising energy costs." In Europe, Le Berlaymont's solar-panel adorned RePowerEU facade was replaced by a more modest appeal for unity. Yet, nowhere has this political transformation been more prominent than in the United States.

The rapidly evolving and, at times, chaotic electoral landscape of the preceding twelve months captured the dichotomies of American energy and climate policy well. The Biden administration's move to pause authorization of additional liquefied natural gas (LNG) infrastructure, for example, contrasted with the Trump campaign's promise to again exit the Paris Agreement. Bold plans to hasten America's clean energy future through the Inflation Reduction Act parried with equally impassioned battle cries for US energy dominance. For vastly different reasons, energy and climate were core components of both parties' plat-









forms. In retrospect, however, it was Trump's "drill, baby, drill" mantra that resonated best with voters, many seized by a promise that abundant low-cost energy would fight inflation, stimulate the economy, and further bolster domestic manufacturing.

In his return to the Oval Office, Trump inherits a world that is starkly different than when he left office in 2020. As always, geopolitics weigh heavily on the global agenda. Russia's unjust war in Ukraine, for example, has now surpassed one thousand days, while war in Gaza and Lebanon placed Iran and its proxies in a weakened position in the Middle East, precipitating changes like the fall of Syrian President Bashar al-Assad. Global affairs are only part of the story, however.

The release of generative artificial intelligence (AI) models like ChatGPT and OpenAI illustrate the emergence of novel challenges with global consequences on par with those stemming from foreign affairs. Electricity consumption from data centers and supercomputing is upending decades of placid energy demand growth within Organisation for Economic Co-operation and Development (OECD) economies. For a world still largely pursuing net-zero imperatives, its leaders must now also contend with yet another competitive race between the United States and China, this time for dominance over key aspects of the development, deployment, and governance of a technology central to global military and economic primacy.

How officials rationalize this new demand growth against a seemingly insatiable desire to win the AI sprint remains to be seen. Nonetheless, given that the commanding share of global energy is derived from fossil fuels (oil, natural gas, and coal again comprising 80 percent of supply in 2024), it's hard to imagine a scenario in which coal in China and natural gas in the United States fail to play a driving role in the immediate future. As demonstrated by Google and Microsoft's 2024 announcements that they will enter

the nuclear energy market, over longer horizons, new low- and zero-emissions technologies are certain to grow in significance for this sector as well.

It's with this backdrop that the Atlantic Council is pleased to present its fifth *Global Energy Agenda*. To illuminate this period of profound democratic transition, where the urgent need to secure reliable and sustainable energy systems remains a defining issue, this year's publication shares the insights from leading industry, civil society, and government voices. It includes essays by Jim Farley, the president and CEO of Ford Motor Company, who explores how the interplay of energy innovation and American manufacturing affect national security; Josh Parker, senior director of corporate sustainability at Nvidia, who highlights the role of AI in facilitating energy efficiency across a wide range of critical sectors; and European Union Commissioner Dan Jørgensen, who outlines the imperative for transatlantic cooperation to achieve energy security and environmental sustainability goals.

Together, their perspectives underscore the potential for democracies to seize on this period of transition to build a more resilient and prosperous global community, one that is empowered by the innovation and industriousness of a sector relevant to every aspect of daily life.

As in prior years, this collection of essays is complemented by the results of the Atlantic Council Global Energy Center's annual global energy survey, which was disseminated in November 2024. This year's poll is by far the largest and most multi-national in the series, with more than one thousand experts from more than one hundred countries across the globe contributing their insights (see appendix for details). For consistency year-on-year, the cross sampling of experts from the energy sector and affiliated fields draws from a similar bank of questions addressing geopolitics, markets, technologies, and the pursuit of net-zero emissions. In answering these questions, the participation of such a wide community yields a more detailed look at specific parts of the field than was possible in the past, and a more nuanced view of thinking among those involved in the energy field.

Insights from a detailed analysis of the survey appear throughout this report. Key findings of this year's survey include:

**Elected leadership and corresponding public policy have a disproportionate impact on perceptions about the probable sources of near- to medium-term energy market volatility.**

Following a major election year, it's telling that policy-related factors were cited by nearly three-fifths of respondents as the leading driver of market volatility. With several enduring military conflicts ongoing around the world, it's no wonder that the most commonly-cited driver of market volatility is—like last year—use of energy for geopolitical leverage. Notably related, resource nationalism, which is particularly relevant to clean energy supply chains in an era of industrial policy, comes in fourth. Interestingly, respondents citing underinvestment due to environmental, social, and governance (ESG) considerations doubled year-on-year, becoming the second-most cited driver of market volatility and the most widespread answer among energy producers, including those in renewables. This suggests that whatever the long-term future of fossil fuels, concerns are growing about a lack of energy supply to support global demand even as renewables production rises.

Meanwhile, the top issue for respondents from the Global South is the growth of energy demand in emerging markets. In the rest of the world, those surveyed are only about half as likely to see this as a leading issue.

**Conflict remains the main geopolitical risk facing the energy sector, but as the war in Ukraine enters its third year, other global flare-ups are garnering greater attention.**

On Christmas Eve last year, Russia fired an overwhelming missile and drone barrage targeting critical energy infrastructure in Ukraine. As Volodymyr Kudrytskyi, the former CEO of Ukrenergo, writes in his essay (page 12), "Russia's strategic goal is clear: to devastate the Ukrainian power grid to benefit Russian troops on the battlefield." It also was an undeniable factor in Kyiv's decision to end transit of Russian natural gas to Europe when a five-year preinvasion contract between Ukraine and Russia concluded on December 31, 2024. With this context, it is foreseeable that those living in proximity to Ukraine are still more likely to view the war there as the greatest geopolitical danger. Nonetheless, when it comes to global sentiment, prior to the cease-fire, fighting in the Middle East was seen as the dominant risk factor facing energy in 2025. This result shifted the order of last year's two leading drivers of geopolitical energy instability.

> **"Elections last year led to a notable political shift to the right, laying the foundation for a new international energy and climate architecture."**

Collectively the war in Ukraine and the Middle East represent the views of over half of respondents.

Meanwhile, respondents have also grown increasingly skeptical about whether the Ukraine fighting will have much effect on the energy transition. Prior to the war in Ukraine entering its first year, 56 percent of respondents believed that the conflict would hasten efforts toward net zero. This is compared to only 31 percent today.

**A clearer global vision for the future of oil and natural gas is beginning to take shape.**

Respondents expect, on average, global demand for oil to peak in mid-2038, slightly before last year's projection of early 2039. In the survey pool overall, and for most of the groups within it, this year's answers represent convergence around a common view. While oil is the fuel most widely expected to decline, many in the industry itself are looking at ways to survive longer: 33 percent of those working in oil and gas expect to see the biggest proportional increase in research investment in 2025 to focus on the areas of fossil fuels, carbon capture, and biofuels—twice the proportion in the rest of the survey.

Meanwhile, a large majority (74 percent) see a long-term future for natural gas, although most (48 percent of all respondents) expect that by 2050 this will be as a complement to renewable energies. Finally, few respondents expect a substantial spread in the use of traditional nuclear technologies for civilian power by that same year, but 82 percent foresee the widespread adoption of small modular reactors (SMRs) and microreactors.

**A majority of respondents consider net zero by 2050 to be unlikely, even though most say that its achievement would boost economic growth.**

Only 26 percent of respondents expect that the world will achieve net-zero emissions by 2050, not far off the 21 percent who say that it will never happen. The overall median year is 2066. Nevertheless, 62 percent say that reaching this milestone by 2050 would lead to positive economic growth, with only 23 percent believing the opposite.

This apparent paradox indicates that something beyond GDP must explain the expected failure to reach net zero by 2050. A majority of participants (61 percent) cite political will as the main barrier to success. Money also matters greatly. More than half of those surveyed (53 percent) say that some form of cost-related issue will constitute a leading impediment to progress. Strong beliefs about net-zero's impact on GDP shape respondents' thinking: those who believe that net zero would greatly harm the economy, for example, are highly likely to think that the goal will never be reached (62 percent). On the other hand, 78 percent say that the extent of economic opportunities that might arise from efforts to accelerate the energy transition will have a very or extremely important impact on popular support for net-zero policies. Financial considerations, then, will either drive or slow the push for net zero, depending on whether its economic promises prove true or not.

With these key findings, we launch into this year's *Global Energy Agenda* narrative that reflects on where energy leaders see geopolitical risk, market influences, and factors affecting the world's pace toward net-zero emissions. The following pages cover the complete analysis of our survey results and the insightful perspectives of energy leaders who will inform and shape energy policy in the year ahead.

# CHAPTER I

# Geopolitics and energy security

In writing the prior year's Global Energy Agenda, it was impossible to fully grasp the scale of geopolitical transformation we would see in the Middle East following the October 7, 2023, attack perpetrated by Hamas against thousands of innocent men, women, and children. Hezbollah's fateful decision to join Hamas by launching a war against Israel on October 8 and Israel's decisive response in the subsequent year have not only expanded the suffering of civilians throughout the region and left the terrorist organizations "diminished, decapitated, and in disarray," but it has precipitated a full-scale revamp of the political and security architecture of the region.[1] President Bashar al-Assad was forced to flee to Moscow as rebel forces closed in on Damascus, the leadership of Hezbollah and Hamas were hobbled through targeted Israeli strikes, and two waves of Iranian missile attacks on Israel were largely swatted down by a coalition that, in addition to Israel, included the United States, the United Kingdom, France, and Jordan.

Through all of this, energy prices remained steady. Yes, the fields of the oil rich Arabian Gulf sit thousands of miles away from the recent conflict (Gaza City is 997

1 William F. Wechsler, "Hezbollah is diminished, decapitated, and in disarray—but still dangerous,: September 28, 2024, https://www.atlanticcouncil.org/wp-content/uploads/2024/06/AC-Style-Guide-2018.pdf.

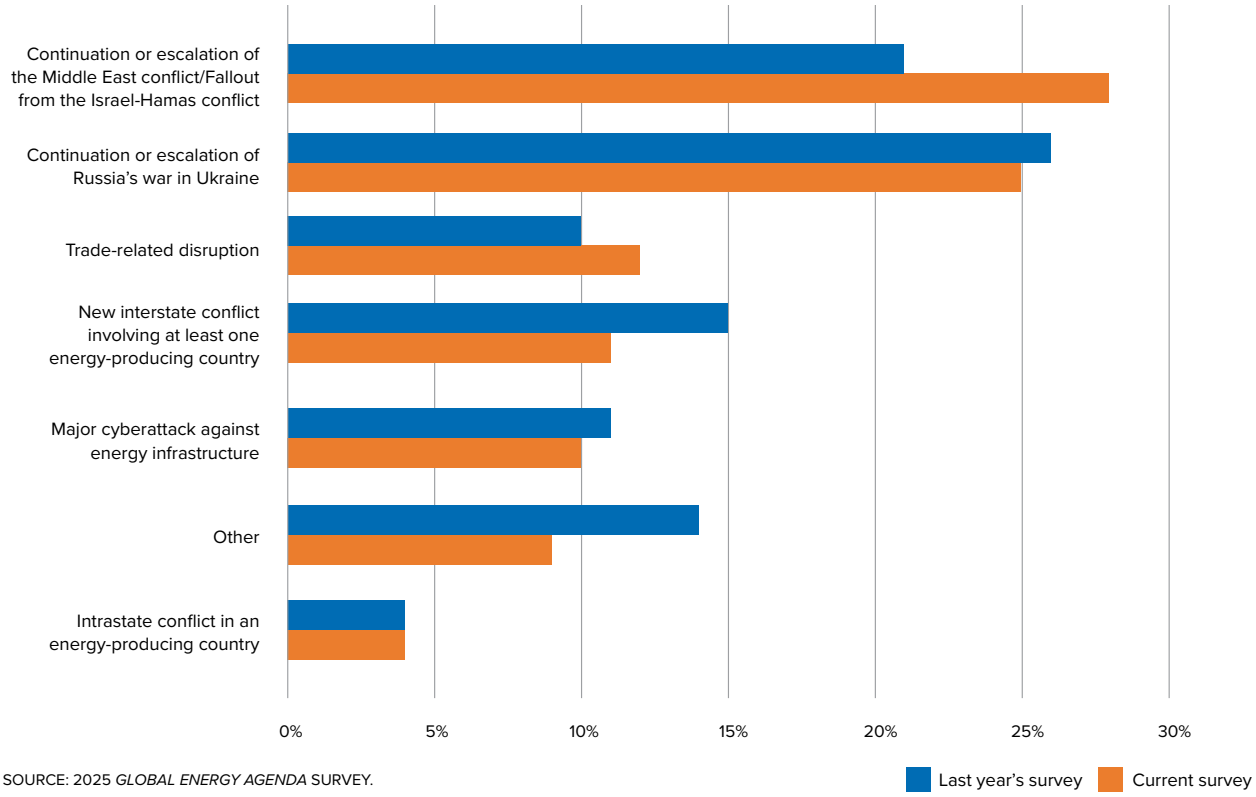
An Israeli tank maneuvers at the border with Gaza, amid a cease-fire between Israel and Hamas, as seen from Israel, January 21, 2025.

REUTERS/Amir Cohen

miles from Saudi Arabia's Ghawar, the largest conventional oil field in the world), but simple fear of supply disruptions has long been a feature of volatility caused by regional tensions. Though some conflicts, like the Iran-Iraq war, have directly impacted production and shipping routes, a kinetic conflict in the region is not a prerequisite for global market instability. The Arab Spring corresponded with a 40 percent uptick in the prices of oil from start to finish. Yet, in 2024 prices averaged $81 per barrel, two dollars less than in 2023, and the lowest annual price since the conclusion of the COVID-19 pandemic. More remarkable, perhaps, is that in an era of intense price inflation, international benchmark Brent crude oil ended the year only 6 percent above the twenty-year average and more than $18 per barrel less than a decade earlier. Nonetheless, according to this year's survey results, a lack of market volatility did little to allay perceptions of foreboding geopolitical risk.

Following trends of prior years, conflict and war remain the flagbearer of geopolitical risk in the minds of our pool of international respondents. Unlike last year, however, conflict in the Middle East was perceived as the top challenge to the energy sector (28 percent, up from 21 percent in the prior survey), outpacing the second most significant factor, the war in Ukraine (25 percent). While directionally, a cease-fire that took hold in the region in the new year may indicate a prospect for less market volatility than was perceived when the survey was undertaken in November,

**Figure 1. What will be the biggest risk in energy geopolitics in the coming year?**




SOURCE: 2025 *GLOBAL ENERGY AGENDA* SURVEY.

the situation in Israel and Gaza remains fragile. Even under current circumstances it would be reasonable to anticipate that instability in the Middle East would remain a more pressing concern than the other answers that, like last year, are spread among a variety of risks.

## THE INFLUENCE OF PROXIMITY, PROFESSION, AND EXPERIENCE

Geography inevitably affects risk perceptions. Still, the immediacy of a crisis appears to sustain a disproportionate influence over respondents' answers irrespective of where they live. Results from those in Europe are particularly telling of this trend, with changing views toward the relative dangers of the war in Ukraine apparent when contrasted with the conflict in the Middle East. Given the war in Ukraine is about to enter its third year, energy prices still 44 percent higher than prior to the Kremlin's advances on Kyiv, there is a temptation to assume Ukraine remains the preeminent threat in the minds of Europeans. Not so, however. Last year, respondents from this region named the Russia-Ukraine war more often than the Israel-Hamas conflict as the biggest risk facing the sector (32 percent to 21 percent). This time, the situation has reversed, with 29 percent of European respondents saying that fighting in the Middle East is the greatest geopolitical danger, and 26 percent the situation in Ukraine.

Within Europe, the countries closest to Ukraine remain more highly focused on that risk, possibly indicating that in terms of energy geopolitics, the Russia-Ukraine war may have begun to transform from a global risk to one of more of a regional one. In the eighteen European countries geographically nearest to the Ukraine conflict, 36 percent listed the war there as the biggest risk they would face next year, while 24 percent named fighting in the Middle East (still their second choice). In the rest of Europe, though, the equivalent numbers were 21 percent and 33 percent respectively.

Survey participants' tenure in the industry along with levels of seniority also modestly affect risk perceptions. Those with less experience in the sector and in more junior positions are more likely to consider the Russia-Ukraine war as the biggest threat, with fighting in the Middle East a close second. Those

LEADERSHIP INSIGHT

# Ushering the US auto industry into a new energy era

by Jim Farley

Political and policy change are part of the American democratic experiment and integral to the business landscape. As the auto industry navigates its transformation, it's important to keep the choices and needs of the customer front and center. Automakers must prioritize choice for our customers, listening to their preferences at every turn. That is our north star, and it is a valuable lesson for all of us in the automobile industry and for those who have a role in how we build our global energy future. We must put people first.

It starts with listening to the people who use our products in a thousand ways, big and small, every day. Whether it's dropping kids off at school or towing heavy equipment, a diverse vehicle lineup serves customers in unique ways. We want to give customers services and experiences they can't live without. Automakers will continue to build iconic gas-powered vehicles that customers love. We'll also innovate new forms of hybrid powertrains that fit the way that Americans work and play.

And the industry will be making new electric cars, trucks, and vans with technological innovations to take the driving experience to new levels of performance. The next generation of electric vehicles will be even better and include features that customers haven't yet imagined.

It is imperative for the future of domestic manufacturing that the best electric cars in the world are made by American automakers. But domestic automakers face stiff international competition in this race. To win, our focus must be clear: The United States cannot cede energy, innovation, or manufacturing leadership to China, Europe, or other regions. If we want to maintain our competitive edge while securing our supply chains and shoring up our manufacturing capacity, we must invest in America's auto industry.

We can win this race because we have the road map. When it comes to history's most pivotal achievements, Americans have led the way—from the moon landing to the microchip to artificial intelligence. US automaking history, like Ford's, is entwined with America's greatest moments of achievement: the moving assembly line, converting automobile factories to military factories in World War II, and retooling our operations to build lifesaving equipment during the COVID-19 pandemic.

This is another moment of upheaval in our industry, and in the global economy as a whole. And if we are going to meet the demands of Americans and our future, we need to adopt the same kind of mindset that has always set our country apart.

This is important because today, as we navigate winning the energy, technological, and manufacturing future, we have a burst of new innovations at our doorstep and increasingly intricate supply chains around the world. We face both uncertainty and great opportunity.

We must build the necessary manufacturing plants and components—including the batteries and materials that will power our future—here on our shores. An America that controls its own supply chains, that invests in cutting-edge technology, and that brings innovation home is one that secures its future. Right now, Ford is doing that through industry-leading investments in multiple states, where we're building vehicles Americans want today and making big bets on the high-tech vehicles of the future.

We know that battery demand in the United States has grown and that China controls key sectors of our energy supply chain. It's why US automakers have taken bold steps to scale our advanced battery manufacturing right here in America. Investments to onshore this battery technology are an essential part of improving affordability and availability of choice for Americans. It will take time and commitment to build up this capability in the United States, but

the more we delay, the greater our reliance on foreign materials will be and the farther behind American auto companies will fall. If American companies don't do this, those in other nations will.

Onshoring our manufacturing also protects us from geopolitical conflicts, pain points, and uncertainty. Last year, we saw escalations of war and conflict around energy-producing countries. When we invest in American facilities, there is less risk to the American people.

I am confident that we can step up to the task at hand. The US auto industry will be working with policymakers to prioritize American manufacturing and energy security. We'll collaborate to ensure America sets the terms in the great energy race, so that our auto industry and manufacturing sector continue to lead the world. And we'll make smarter decisions for our country if we keep the choices and needs of Americans front and center.

The United States was built for moments like this, and we will continue to usher the auto industry into a new era by investing in our team, our customers, our country, and our future.

*Jim Farley is the president and CEO of Ford Motor Company.*

**Innovation in the auto industry is key to global competitiveness and energy transition.**

REUTERS/Mike Blake

with greater seniority in both respects see things the other way around. To illustrate, among assistants and researchers with under five years' time working on energy matters, 29 percent cite the European fighting as the biggest geopolitical risk for 2025 and 22 percent the Middle East conflict. Among executives and managers who have worked in the sector for more than ten years, those figures are 22 percent and 32 percent. For each group, though, these are the most common choices.

When dividing respondents by economic sector, alternatively, their answers reveal a few variations as well. Respondents from oil and gas, for example, are much more likely than average to see fighting in the Middle East as the primary risk (43 percent), but the war in Ukraine still comes second (22 percent). With one-third of global supply stemming from the Middle East and Russian oil production effectively unchanged since the start of the war in Ukraine, it's little surprise those closest to industry would more heavily fear tensions in the Middle East.

Collectively, these distinctions should not obscure one key finding: Ukraine remains high on the agenda for risk managers in the energy field overall. Other than the conflict in the Middle East, no risk is mentioned nearly as frequently. It is for this reason that we continue to assess perceptions of the war's impact on overall transformation of the energy system.

Currently, opinions are split roughly evenly on how the war in Ukraine is affecting global efforts to reach net-zero emissions: 38 percent of respondents believe that the conflict is slowing that process, 31 percent that it is accelerating it, and the remainder that it is having no effect. Just as important, only a minority think that the war is significantly affecting the transition, with 25 percent answering that the conflict is having a lot of impact, whether positively accelerating action (8 percent) or impeding a net-zero future (13 percent). On the national level, however, rebuilding Ukraine's energy system to be resilient in the face of continued attacks sets it on a path toward decarbonization.

"Rolling out decentralized balancing capacity along with renewables would not only make the Ukrainian power system resilient to Russian attacks, it would also enable Ukraine to virtually complete the clean transition of its power system, as the new electricity mix would be about 90 percent carbon free," writes Volodymyr Kudrytskyi, the former CEO of Ukrenergo.

In this area, the current consensus is widespread. No meaningful variation exists in the overall split among respondents when accounting for differences in experience in the energy field, organizational seniority, gender, or age. Similarly, the answers from most economic fields covered in the survey paint roughly the same picture. The sole notable difference is for those working in renewables, who are much more likely than others to see the war accelerating the energy transition (46 percent). Though the overwhelming number of respondents (71 percent) say that any impact is at most modest.

Meanwhile, comparing this year's answers with those in the past two surveys shows a continuing shift away from belief that the war in Ukraine will accelerate the transition. Two years ago, 56 percent believed that the conflict would hasten net-zero. Last year, that view was held by 41 percent of respondents, and now 31 percent share that perspective.

While this drop has occurred globally, the shift is the most pronounced in Europe—the region that has always had the highest proportion of respondents saying that the war is helping to drive the energy transition. Currently, 43 percent of this group agree with that assessment. This figure is higher than the proportion from the region who disagree (31 percent). Nevertheless, it is much lower than the 55 percent who saw a positive impact on the energy transition last year, and the 59 percent in the survey before that. This shift in sentiment is reflected more broadly, as analyses find that the bloc remains offtrack to achieve its renewable energy targets for 2030.[2]

The sentiment, "never let a good crisis go to waste," has been attributed to everyone from Machiavelli to Churchill. It seems, however, that such events exert diverse, sometimes contradictory, impacts of their own beyond the control of those who seek to use them for one end or the other. This would explain why so many of those in the sector now believe that the Russia-Ukraine war is not having that much net effect on efforts to bring about the energy transition and are largely equivocal about the nature of that impact.

2 "Europe Off-Track For 2030 Climate Targets, Despite Record Clean Energy Investment, According to BloombergNEF," BloombergNEF, December 3, 2024, https://about.bnef.com/blog/europe-off-track-for-2030-climate-targets-despite-record-clean-energy-investment-according-to-bloombergnef.]

LEADERSHIP INSIGHT

# Ukraine can unleash energy investment even amid war

by Volodymyr Kudrytskyi

The Ukrainian power system is in the midst of one of the greatest trials in human history. It has already survived thirty-one Russian onslaughts since February 2022. Of this unprecedented number, thirteen missile and drone attacks took place in 2024. According to officials, more than 2,000 missiles and countless drones have targeted Ukrainian power plants and high-voltage substations since the beginning of full-scale war.

Russia's strategic goal is clear: to devastate the Ukrainian power grid to benefit Russian troops on the battlefield. The tactics of this Russian energy terrorism are also obvious: to destroy the grid's ability to deliver power to consumers and to remove balancing capacity from the system. While nuclear generation still covers most baseload consumption, Ukraine has already lost more than 10 gigawatts (GW) of balancing power plants—mostly thermal and hydropower—which play a crucial role in meeting peak demand.

After the integration of Ukraine's power system into the European continental grid in March 2022, the national grid operator, Ukrenergo, discovered how to defend and recover transmission capabilities of Ukraine's high-voltage infrastructure. With the help of US and European Union (EU) financing, we built unique passive engineering protection for critical elements of the grid. Ukrenergo has accumulated one of the largest stocks of high-voltage equipment in the world. There are 1,500 trained and highly qualified specialists on Ukrenergo's restoration teams, working 24/7 to keep the lights on for the Ukrainian people. Of course, without adequate air-defense systems, this will not suffice. The high-voltage grid remains a primary target for the adversary's aerial attacks, but the Ukrainian transmission operator is gaining experience in quick recoveries after massive shelling and is strengthening its ability to balance the grid in wartime.

As the grid becomes more resilient with time, the traditional electricity generation base is being deteriorated. Big power plants are also trying to restore capacity, but sometimes take on irreversible damage or require years to be brought back online. Therefore, the main strategic task for Ukraine to achieve in 2025 and beyond is to rebuild its balancing generation capacity to compensate for the power shortages caused by Russian missile attacks on thermal and hydropower plants.

Building back better the Ukrainian way means rolling out hundreds of new generation facilities of up to 10 megawatts (MW) each, instead of dozens of larger plants that could be exhausted with Russia's latest assault. At Ukrenergo, we determined that the Ukrainian power system will need 12 to 13 GW of new generation capacity in the next three to five years. This means adding more wind and solar plants, high-maneuverability gas peakers, biomass plants, and battery storage. Such technologies should be spread throughout the country to deprive Russia of the ability to knock out large amounts of power capacity with one strike.

To roll out this decentralized generation, Ukraine would require around €10 billion in investments. Such a volume could be effectively deployed only by the private sector—the public sector doesn't have the money, and it is impossible to decentralize generation in a centralized way.

The interest of Ukrainian and foreign investors in reshaping the country's energy system was demonstrated in August 2024, when Ukrenergo provided special auctions for the ancillary service market. In two auctions, we received nearly 1,000 bids from different businesses, which were ready to roll out nearly 1 GW of new generation to receive five-year-term offtake contracts with Ukrenergo for the provision of grid-balancing services.

It was like a gunshot at the start of a big race. But to get across the finish line, these pioneers in deploying decentralized generation still face three key obstacles.

## 1. Uncertainty in regulation and market debts

The current price for electricity on the Ukrainian market determines the whole process. Price on the Ukrainian wholesale electricity market is measured by regulated price caps. In the periods of highest demand, these price caps are not relevant to the prices on the EU market, which is regulated only by supply and demand without any political interference. This difference impacts trade between the EU and Ukraine, and investors' ability to finance new generation capacity. So, investors need assurances that price depends on supply and demand, and not the wishes of politicians to manually control it through administrative measures like price caps.

It is critical that Ukrainian regulators exercise fully independent judgment and decision-making. Wise decisions would include setting cost-reflective tariffs for natural monopolies (including Ukrenergo) and taking measures against customers who consume energy without paying for it. This would eliminate market debts, which currently do not allow businesses to achieve their full market potential and make returns on investment less certain.

## 2. Access to finance

The Ukrainian energy sector could be injected into the power system. However, access to financing remains one of the main problems for potential investors.

A state program offers low interest rates for businesses willing to build new generation facilities, but a typical efficient energy project investment far exceeds the program cap, disqualifying many projects from accessing these loans.

Moreover, Ukrainian businesses don't have access to liquidity from international financial institutions and multinational banks, which require at least five-year offtake contracts and have extensive pledge requirements to secure credit lines.

To roll out up to 13 GW of new generation in Ukraine, we must connect businesses and financial institutions so that they can cooperate effectively. Unused donor money could be leveraged to create financial instruments like insurance, guarantees, and extra collateral to make investments more attractive for banks. This would effectively multiply the generation capacity that every donated euro can pay for.

## 3. Coordinating between communities and businesses

Installing new generation facilities requires finding land and securing permits, both of which fall under the responsibility of local communities. These communities are interested in technologies that will benefit their local area, not the whole system. Better communication and cooperation are needed between the private businesses that are able and willing to roll out new generation and the local communities that need it.

## Unleash the private sector

Rolling out decentralized balancing capacity along with renewables would not only make the Ukrainian power system resilient to Russian attacks, it would also enable Ukraine to virtually complete the clean transition of its power system, as the new electricity mix would be about 90 percent carbon free. Moreover, the new power system would be cheaper to run than the current one, because of the domination of nuclear and renewable generation with lower marginal cost than the Soviet-era coal-fired power plants.

Ukraine has unique starting parameters to achieve this quickly: strong nuclear and hydropower, good solar and wind potential, and a sharp deficit of electricity, which supports high market prices and quick payback on energy projects. The main priority of Ukrainian energy strategy for the next five years should be to remove the stumbling blocks and let private initiative do the job—it always does.

*Volodymyr Kudrytskyi is the former CEO of Ukrenergo, Ukraine's transmission system operator.*

LEADERSHIP INSIGHT

# The US must assure its energy-secure future

by Meredith Berger

Energy is both a tool and a weapon. At the US Department of the Navy, energy security is mission assurance, and unless we meet this critical requirement, we cannot protect our national interests. It is the responsibility of the Navy and Marine Corps, and the civilians who serve the department, to make sure that we are ready—that we have what we need for whatever comes our way, regardless of time or task, to defend our nation.

Our 2022 National Security Strategy acknowledges and prioritizes this energy requirement, calling upon the country to start an energy revolution: to accelerate our diversified, reliable, redundant, independent energy portfolio; to advance technology and talent; and to generate renewable and clean energy sources that reduce climate threat and conflict, as well as emissions and waste. Energy security provides warfighting advantage, deterrence, economic benefit, a healthy, safe environment, and geopolitical stability. Our sailors and Marines are the world's first responders; dangerous changes to the physical environment put them at heightened risk.

During my tenure as assistant secretary of the Navy for energy, installations, and environment, I have focused on energy security as a critical driver of mission success: a catalyst for climate action, a defense for critical infrastructure, and a source of resilience for our communities, our homeland.

## On climate action

Reliable, clean, resilient, independent energy allows us to keep mission first, so we are prepared to fight and win in any environment. Climate change generates extremes: floods, droughts, temperatures, stronger storms, and fewer resources. These are the conflict generators that make the world a more volatile place.

A more volatile world increases exponentially the demands on the Navy and Marine Corps, while simultaneously decreasing their ability to respond to those demands. In the Department of the Navy, climate readiness is mission readiness, and energy reliability and resilience are critical to mission success. Reliable, resilient energy ensures that our forces are trained, equipped, and ready so that at a moment's notice, they can launch, fight, and win. As we focus on this decisive decade, we are mindful of the pacing threat that shapes our mission, and the climate threat that shapes how we operate and execute our mission. By advancing and diversifying our energy sources, technology, and supplies, we reduce our emissions, logistics tails and vulnerabilities, and increase readiness and adaptability.

## On critical infrastructure

The means to our ends—our ports, roads, runways, depots, barracks, and utilities—they connect us, sustain us, prepare us, and ultimately, they protect us. Our installations in the United States and abroad are essential platforms from which we project our military power, and we need reliable, uninterruptable energy to assure physical and cyber protection of this infrastructure. As we confront the new truth that the homeland is no longer a sanctuary, we must continue to defend against a key vulnerability: inadequately protected, aging energy infrastructure that often lacks redundancy, leaving military mission, commerce, health, safety, livelihood, and lives at risk.

## On communities

This is our homeland: shared spaces between installations and town halls, not divided by a fence line, but instead united by values, traditions, and resources. They are the ecosystems that allow us to thrive, succeed, and achieve. Communities are also connected by vulnerabilities, and when


USS John Basilone is commissioned in New York, US, November 9, 2024.

EJ Hersom, Department of Defense

it comes to utilities such as energy, single sources and dependencies yield a comprehensive threat, whether it is the Department of the Navy's national security mission or the community mission of health, safety, and welfare.

Energy is life or death: We learned that lesson the hard way in the Department of the Navy. During a three-month period in Afghanistan in early 2010, the United States suffered a Marine casualty for every fifty convoys of fuel. Seven years earlier, then-Major General James Mattis, while serving as commanding general of the First Marine Division in Iraq, and who later served as Secretary of Defense, pleaded with leadership to "unleash us from the tether of fuel." He knew that single reliance is a single point of failure, and, despite his warning, we saw the cost of inaction paid in young Marines' lives.

As we execute our energy future, we cannot afford a single point of failure, and we cannot compromise our own position. My job every day has been to make sure that when Marines and sailors raise their hands and volunteer for our defense, willing to make the ultimate sacrifice for our nation, values, and freedoms, I take on every known threat, prepare for every contingency, and clear a path toward mission success. For energy security, we have done that at the Department of the Navy through integrated, advanced investments in renewable, reliable energy; we've taken actions that question the status quo, and increase mission success and quality of life for our forces, bases, and surrounding communities. The United States needs to take that same approach for the nation: build an energy portfolio for the future we anticipate and defend against the threats we know so that we can face the ones we don't see coming. Energy is a matter where everyone has a strong stake in our collective security: defense, finance, environment, climate, health, and safety. Through our energy revolution, we must be ready as a nation to assure our most critical missions no matter what form they take.

*Meredith Berger is the former assistant secretary of the US Department of the Navy for energy, installations, and environment.*


# CHAPTER II

# Energy markets

**DESPITE THE PANDEMIC-INDUCED** slowdown of recent years and disruptions caused by Russia's invasion of Ukraine, the oil and gas sector reasserted its role as a critical component of the global energy mix in 2024. Unapologetically, Amin Nasser, Aramco's president and CEO, took the stage in Houston in March to deliver a frank rebuttal to the international community's declaration only three months earlier at COP28 that it would "transition away from fossil fuels." He called on world leaders to abandon the "fantasy" of quickly pivoting from oil and gas, in favor of a transition that protects the planet and consumer pocket books.[3] Nasser's remarks complemented the Trump campaign's "drill-baby-drill" slogan, which focused on lowering energy prices for consumers, and illustrate why some in Europe are pushing to "rebalance" green transition and energy security priorities.[4]

Statistically, there is merit to this debate. Demand for oil grew by nearly one million barrels a day (bpd) in 2024, reaching a record 103 million bpd overall.[5] Natural gas, similarly, saw the market expand by 115

3 "CERAWeek, Houston, U.S.A. Remarks by Amin H. Nasser Aramco President & CEO," Aramco, March 18, 2024, https://www.aramco.com/en/news-media/speeches/2024/ceraweek-keynote-speech-by-amin-h-nasser.

4 András Simonyi, Olga Khakova, Pau Ruiz Guix, Andrei Covatariu, and Elena Benaim, "Will the New Parliament Change Europe's Course on Energy Security and Climate?" June 14, 2024, https://www.atlanticcouncil.org/blogs/energysource/will-the-new-parliament-change-europes-course-on-energy-security-and-climate.

5 "Oil Market Report 2024," International Energy Agency, December 2024, https://www.iea.org/reports/oil-market-report-december-2024.

REUTERS/Annegret Hilse

**"Neptune," a liquefied natural gas terminal, in the port of Lubmin, Germany, January 14, 2023.**

billion cubic meters (bcm),[6] an amount that eclipses the total annual demand of Japan, which is the 8th largest consumer of natural gas globally. Once again, the world needs more energy, not less, and oil and gas remain the dominant drivers for meeting demand.

Despite the International Energy Agency's (IEA) premature prediction of the end of the "golden age of gas," natural gas has proven particularly indispensable in meeting demographics-driven energy demand growth, while also filling the gaps left by intermittent renewable generation.[7] Even in Europe, where demand for natural gas contracted 20 percent since the Kremlin's ill-advised advances on Kyiv began nearly three years earlier, the need to diversify energy sources away from Russian supply has invigorated investment in gas infrastructure, with the United States emerging as a key supplier.[8] The race to dominate AI has further bolstered the case for the fuel source, with power-intensive data centers that support AI applications requiring reliable and scalable energy, which gas provides. At the moment, "AI is currently demanding more energy faster than computing is getting more

6 "Gas Market Report," International Energy Agency, updated January 2025, https://iea.blob.core.windows.net/assets/23968aa1-73c7-4f29-86e8-38d9818fadfc/GasMarketReport%2CQ1-2025.pdf.

7 "World Energy Outlook 2023," International Energy Agency, October 2023, https://www.iea.org/reports/world-energy-outlook-2023.

8 Ana Maria Jaller-Makarewicz, "Europe's Gas Consumption Falls to 10-year Low as Peak LNG Demand Nears," Institute for Energy Economics and Financial Analysis, February 21, 2024, https://ieefa.org/articles/europes-gas-consumption-falls-10-year-low-peak-lng-demand-nears.

LEADERSHIP INSIGHT

# The importance of US LNG for economic growth and the global energy transition

By Daniel Yergin and Madeline Jowdy

The emergence of US liquefied natural gas (LNG) is a remarkable story. In less than a decade, the United States has gone from zero exports to being the world's largest exporter. Moreover, US LNG is at the nexus of the global energy transition, providing affordable and freely traded gas in a global market of some fifty importing countries. This flow promotes security of supply for regions such as Europe and East Asia, supports trade balances with China and India, and serves as a substitute for higher carbon-intensive energy sources in Southeast Asia and elsewhere.

The geopolitical importance and strategic urgency of the industry were demonstrated when Vladimir Putin cut pipeline gas to Europe in an effort to undermine the European economy and shatter the coalition supporting Ukraine. He miscalculated, failing to recognize the potential of US LNG to play a significant role in filling the gap. US LNG replaced 40 percent of the missing Russian pipeline gas. And the Trump administration is looking to US LNG exports to help rebalance trade with other countries.

The critical role of US LNG is significant both for the domestic economy and on the international stage. For the continued growth of US LNG exports, it is essential that the United States demonstrate, day in and day out, that it is a supplier on which other countries can rely. As US exports are projected to double in the coming decade, the influence of US LNG is expected to grow. However, despite a more favorable policy climate with the new administration, further success is not guaranteed due to substantial federal and state regulatory, political, and environmental challenges facing the industry, which will need to be addressed.

As the US LNG sector re-emerges after a year of stagnation caused by the Biden administration's pause on LNG export authorizations, it is important to recognize the industry's overall contribution to US GDP, economic influence, and global LNG trade innovation. In our new study *Major New US Industry at a Crossroads: A US LNG Impact Study*, conducted with the US Chamber of Commerce, we found that the US LNG industry is valued at $34 billion and has contributed more than $400 billion to US GDP since 2016, when the first LNG cargoes were shipped from Sabine Pass, Louisiana.[1] The industry has created an average of 273,000 skilled jobs annually since 2016. Its impact penetrates deep into the heartland where gas is produced and transported, and supports supply chain and manufacturing communities in the Northeast, Midwest, and Southeast. What really brings home the industry's impact is its comparison with other US industries. The value of LNG exports is more than that of soya beans and double those of Hollywood and entertainment exports. It is currently half that of semiconductors, but within a few years, could equal the value of all semiconductor exports.

What has made this unprecedented growth possible is the vast resource base developed during the US shale revolution, compounded by entrepreneurial energy, infrastructure, and industrial skill. Despite a 13 billion cubic feet per day (Bcf/d) growth in LNG feedgas requirements since 2016, domestic wholesale gas prices have continued their downward trend, with only temporary interruptions due to rapid post-COVID growth and geopolitical events such as Russia's full-scale invasion of Ukraine in 2022.

While US LNG exports account for only 12 percent of the domestic gas market, they supply nearly a quarter of global LNG supplies, making the United States the world's largest LNG sup-

1 *Major New US Industry at a Crossroads: A US LNG Impact Study – Phase 1*, S&P Global, December 17, 2024, https://www.spglobal.com/en/research-insights/special-reports/major-new-us-industry-at-a-crossroads-us-lng-impact-study-phase-1

plier. This outsized role in the international gas market is supported by the flexibility and reliability of US LNG, which is traded with fewer restrictions on destinations, volumes, or pricing compared to much of the global LNG market. Additionally, US LNG has significantly contributed to emissions reductions in countries that have replaced more carbon-intensive coal and fuel oil with LNG.

In terms of trade, US LNG helps offset trade deficits with both Europe and China. In Europe, US LNG is viewed as a reliable and strategic supply mechanism, while in China, it helps mitigate the United States' largest single trade deficit. US LNG exports to Japan, South Korea, and Taiwan also support energy security for these key allies.

Growth projections for US LNG, as analyzed by S&P Global, align with a global energy system transitioning to lower carbon-intensive modes of production and consumption. With more favorable conditions under the new administration, US LNG exports are forecast to double by 2030, with projects currently under construction accounting for approximately 60 percent of that projected growth.

With this anticipated growth, our LNG study projects that US LNG industry is poised to contribute approximately $1.3 trillion to GDP by 2040 and create an annual average of 500,000 jobs. On the global front, the US share of the LNG market is expected to exceed one quarter by 2040, supporting a large and liquid gas market that might not exist otherwise.[2]

However, there is a big "if": if domestic regulatory, legal, and environmental barriers persist, the United States risks losing over 100,000 jobs annually and more than $250 billion in GDP. Moreover, it appears that 85 percent of the resulting energy gap in the rest of the world would be filled by fossil fuels sourced from outside of the United States. This jeopardizes US geopolitical influence and its reputation as a reliable and affordable energy supplier to allies and trading partners.

As the global energy transition progresses, US LNG will have a crucial role in reducing carbon emissions. The transition from coal to natural gas in the US power sector has already driven a 40 percent reduction in carbon emissions since 2000. In the medium term, US LNG will be a vital substitute for higher carbon-intensive coal and oil products, especially in the developing world. Long term, it will support reliable and resilient energy systems as renewable energy sources become more prevalent.

This is not a one-way street; the United States needs the commitment of its allies and other global trading partners to secure long-term supplies of US LNG and avoid an extended halt in development. This nascent industry was advanced over the last decade in part by financial commitments by Japan and other allies. Future growth will likely rely on a diverse array of European and Asian partners, compensating for lost Russian pipeline gas and LNG, while benefiting from this important new export industry that enables the United States to deliver a clean, reliable supply of natural gas to the global economy.

*Daniel Yergin is vice chairman of S&P Global, and author of The Prize and The New Map.*

*Madeline Jowdy is head of Global LNG Consulting at S&P Global.*

*Both are among co-authors of A Major New U.S. Export Industry at a Crossroads conducted with the US Chamber of Commerce.*

2 *Major New US Industry at a Crossroads*

efficient," writes Nvidia's Senior Director of corporate sustainability, Josh Parker, in his *Agenda* essay. But in the long run, he adds, AI is getting more efficient, and "there's significant opportunity to build future data centers in parts of the world where there's excess energy, such as near geothermal reservoirs."

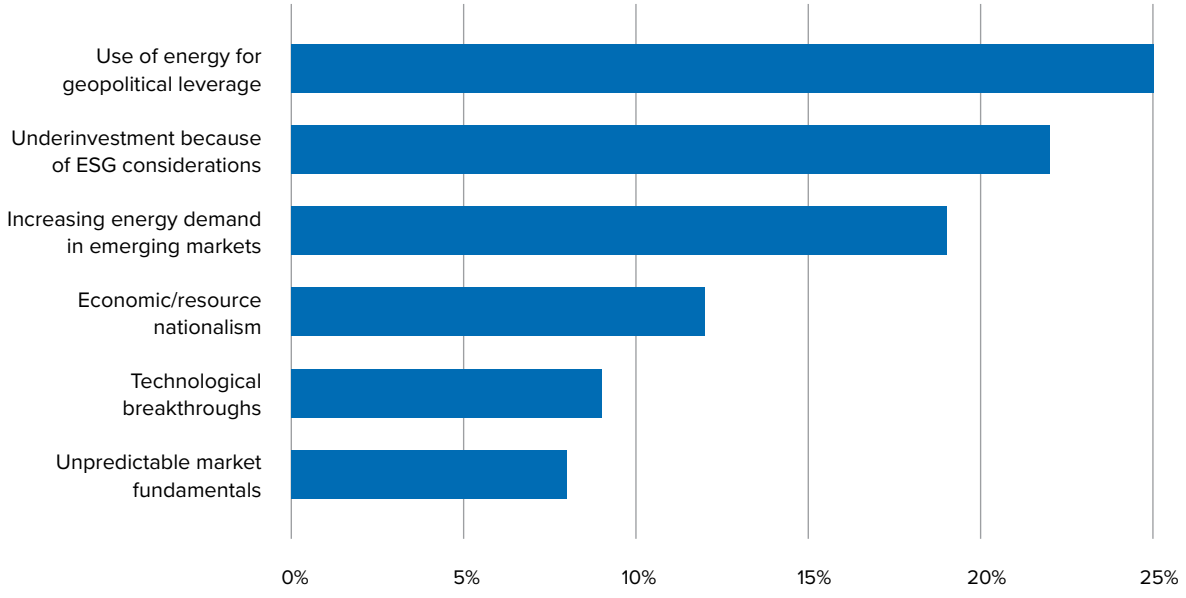
As we look ahead, a doubling of US LNG exports by 2030 is poised to solidify natural gas's role in enhancing global energy security.[9] Expanded export capacity enables the United States to reliably supply the European and Asian markets, reducing their exposure to geopolitically risky suppliers and hopefully allaying US concerns over broader trade imbalances. Those who follow the market closely, however, know that volatility is a feature of energy trade. To help predict where volatility might arise over the following decade, we asked our survey respondents for their views. The top three answers are below.

1. Use of energy for geopolitical leverage (cited by 25 percent), which is notably aligned with economic/resource nationalism (12 percent)
2. Underinvestment because of economic, social, and governance (ESG) considerations (22 percent)
3. Increasing energy demand in emerging markets (19 percent)

Last year's survey had the same question with a slightly longer list of options (the least commonly selected responses were eliminated for this year). The same four factors were the top concerns a year ago. When comparing year-on-year responses, however, one important shift is apparent. Those that see "underinvestment due to ESG considerations" doubled.

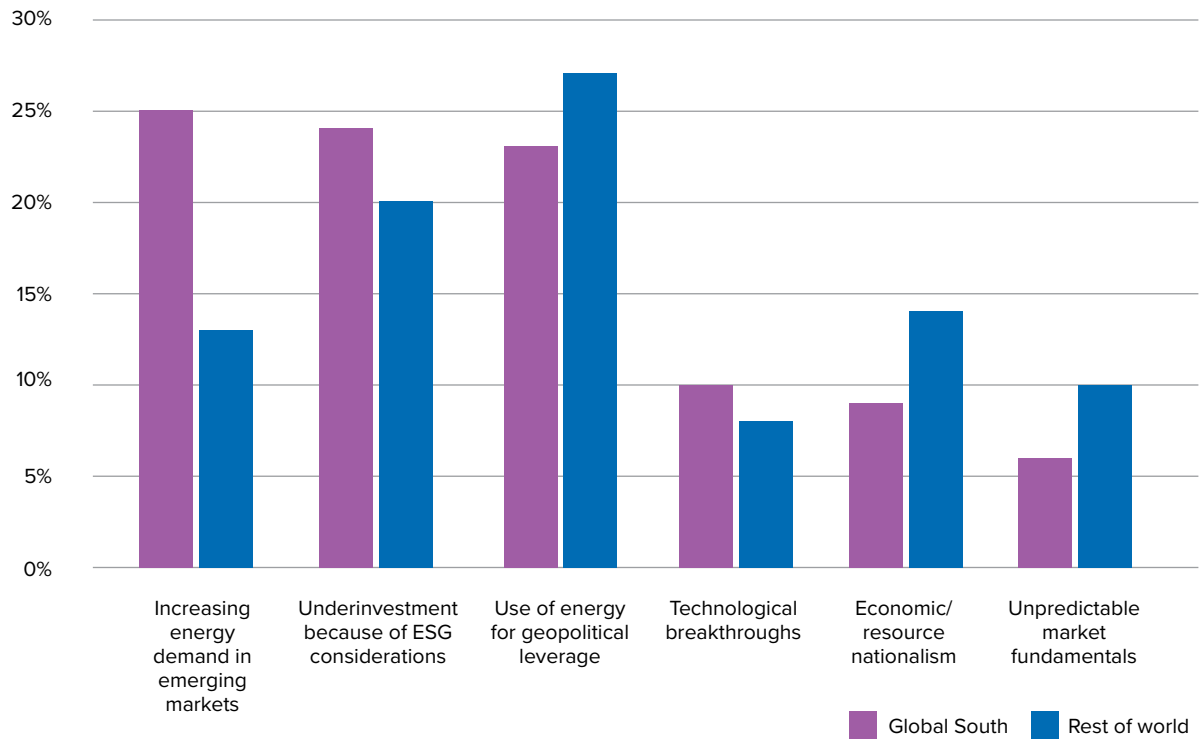
Unsurprisingly, ESG pressures weighed heavily on those in the oil and gas industry. They were clearly the most likely group to respond that volatility would arise from ESG-related underinvestment in energy (28 percent). Yet, the hydrocarbon industry was not alone in this assessment. Irrespective of which segment of the energy industry respondents work in—oil and gas, renewables, or nuclear energy—as a uniform community of energy professionals, this issue ranked number one, with one-in-four ranking this issue as their top concern. Intriguingly, this group responded as a block across several survey questions, including those about the likely future of gas as a fuel, the timing of peak oil and net zero, and possible barriers to the latter. As a testament to the enduring nature of fossil fuels in the global energy mix, even those in the renewables sector are as likely as other energy producers (29 percent) to see this kind of underinvestment as the most likely cause of market volatility in the coming decade. For the remainder of the survey respondents, the use of energy for geopolitical leverage (27 percent) is the biggest driver of volatility, with ESG related underinvestment dropping to 20 percent.

**Figure 2. Over the next ten years, what will be the most important cause of energy market volatility?**




9 *Major New US Industry at a Crossroads: A US LNG Impact Study – Phase 1*, S&P Global, December 17, 2024, https://www.spglobal.com/en/research-insights/special-reports/major-new-us-industry-at-a-crossroads-us-lng-impact-study-phase-1

**Figure 3. Over the next ten years, what will be the most important cause of energy market volatility?**




Breaking down the data further based on geographic demographics presents deeper insights. Although rising demand in emerging markets is the third-most cited volatility risk overall (19 percent), in the United States and Europe, it gets less attention (13 percent and 12 percent respectively). For developing countries, where a rising population, growing economy, and increase in industrial output have driven energy demand up around 2.6 percent per year over the past decade, the issue has a far higher salience.[10] In Sub-Saharan Africa, for example, 29 percent marked demand growth as their principal concern, and in Latin America 27 percent. In his essay for the *Agenda*, Devon Energy CEO Rick Muncrief echoes the importance of meeting the rising energy demand of emerging economies, noting that it enables "billions of people to drive, access new goods and services, and power their homes." As we highlighted last year, however, the Middle East and North Africa (MENA) region often diverges from the other emerging economies. For MENA respondents, emerging-market demand is conceivably an opportunity, not a risk. Only 13 percent of MENA respondents see this as a challenge.

Finally, among those surveyed in Asia-Pacific countries, 31 percent expect that economic and resource nationalism will be the most important cause of market volatility in the coming decade—a striking divergence from the rest of global respondents, only 11 percent of whom prioritized this issue. Whether a product of import dependence for energy resources (Japan and Korea, for example are reliant on imports for approximately 90 percent of their energy needs), an emphasis on economic security in the face of trade tensions between the United States and China, or China's encroachment in the South China Sea, the notable departure of the Asia-Pacific region on this response compared to the rest of the world suggests that the impact of economic and resource nationalism on trade flows, commodity prices, and investment patterns is felt more acutely in the region.

10 *World Energy Outlook 2024*, International Energy Agency, October 2024, https://www.iea.org/reports/world-energy-outlook-2024.

LEADERSHIP INSIGHT

# Southeast Asia aims for sustainability through connectivity

By Kok Keong Puah

Southeast Asia's energy transition stands at an inflection point. As the region's energy demand accelerates—spurred by both rapid economic growth and a growing population—the stakes are higher than ever. The ASEAN Centre for Energy (ACE) estimates that Southeast Asia's energy demand will more than double from 2022 levels by 2050. By that year, the International Energy Agency predicts that the region's energy demand will surpass the European Union's.

This growth presents an enormous challenge: How can we ensure energy security, meet climate ambitions, and address the needs of a growing population at the same time? Yet there is a silver lining: Southeast Asia has the potential to lead the way in the global energy transition.

ACE estimates suggest that renewable energy could meet more than two-thirds of the region's energy needs by 2050. However, unlocking this potential is far from straightforward. Large upfront capital investments, profitability concerns, and a lack of adequate grid infrastructure all stand in the way.

The solution? A more connected Southeast Asia.

Regional interconnectivity is key to unlocking Southeast Asia's decarbonized future. The ASEAN Power Grid (APG) vision aims to connect power grids, creating a borderless network throughout Southeast Asia that links regions rich in renewable energy to demand centers. A connected system would lay the foundation for a robust and integrated regional energy market. It would allow countries to diversify their energy sources and strengthen resilience by drawing upon mutual support from neighboring nations.

Through the APG, countries could establish long-term power purchase agreements for renewable energy projects that improve project bankability and attract high-quality investments. For example, *The Business Times* in Singapore reported that planned electricity export projects from Indonesia to Singapore could bring as much as $20 billion in investments to Indonesia. The APG would also increase access to electricity in exporting countries as domestic grid infrastructure is strengthened to support cross-border trade. Domestic manufacturing and related economic activities would likely see an uptick as developers source parts and services locally.

Southeast Asia is already taking strides toward realizing the APG vision. Pathfinding projects, such as the Lao PDR-Thailand-Malaysia-Singapore Power Integration Project, have proven the feasibility of multilateral cross-border power trade among multiple Southeast Asian countries. Its success has paved the way for further initiatives such as the Brunei-Indonesia-Malaysia-Philippines Power Integration Project.

These efforts are laying the groundwork for an interconnected regional grid. But significant investment and infrastructure development are still needed.

Singapore is supporting projects from Australia, Cambodia, Indonesia, and Vietnam to provide a total of 7.35 gigawatts of low-carbon electricity imports to Singapore. Doing so has allowed us to kick-start discussions within the region on how we can collaborate to realize the APG vision.

Collaboration beyond the Association of Southeast Asian Nations (ASEAN) is essential. No one country can realize the APG alone. ASEAN has collaborated with dialogue partners such as Australia, Japan, and the United States on renewable energy technologies and regional power integration. These partnerships not only bring financial support, but also a wealth of expertise to accelerate the sustainable energy transition.

An example of such collaboration is the joint feasibility study between Singapore and the United States on regional energy connectivity. The first phase demonstrated the technical fea-

Singapore is proving to be a key leader in the global energy transition.

Swapnil Bapat, Unsplash

sibility and socioeconomic benefits of regional connectivity, while the second phase will focus on studying the necessary legal and financial frameworks to support it.

Southeast Asia's renewable energy resources make the region an ideal testing ground for emerging low-carbon technologies. Hydrogen, geothermal energy, and carbon capture and storage (CCS) hold immense potential. Singapore, in collaboration with ExxonMobil and Shell through the S Hub consortium, is studying cross-border CCS projects to enhance the region's climate resilience.

The inaugural Singapore-US Forum, co-hosted with the US Department of Commerce at the 2024 Singapore International Energy Week (SIEW), brought together government and industry leaders to discuss strategies to accelerate the development of hydrogen in Asia. These partnerships are critical for driving innovation and ensuring that Southeast Asia remains at the forefront of the global energy transition.

Similarly, organizations like the Atlantic Council play a key role in driving the region's decarbonization by facilitating important discussions that shape energy transition narratives. As our strategic insights partner for SIEW, the Atlantic Council's advocacy efforts on energy security have helped to build mindshare among participants on the benefits of regional interconnectivity, renewables, and low-carbon energy technologies.

The energy transition in Southeast Asia has global implications. A stable, prosperous, and decarbonized Southeast Asia will not only benefit the region but also strengthen global supply chains, promote economic growth, and contribute to climate stability. Through our continued partnerships with the United States and other global partners, we will build a connected and sustainable world for all.

*Kok Keong Puah is the chief executive of Singapore's Energy Market Authority.*

## THE FUTURE OF OIL AND GAS IN THE ENERGY MIX

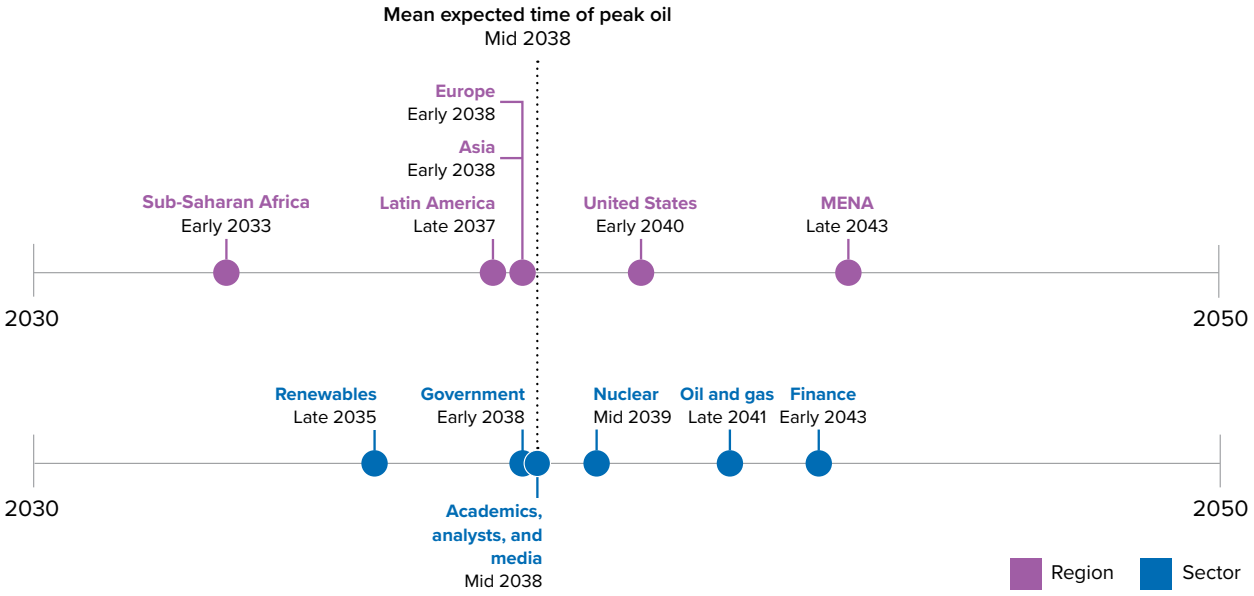
Since our first edition of the Global Energy Agenda in 2020, reflections on risk and volatility in the energy sector have been measured against expectations for the future of the global energy mix. A core component of this analysis has long hinged on our respondents' expectations about the date of peak oil, a figure that has shifted markedly over the years. This year's survey, however, diverges from this trend, showing expectations for the oil sector holding fairly steady from the year prior, with the average expected date for oil demand now anticipated a year earlier in 2038 (last year's projection being 2039).

As the graphic shows, in the majority of geographies, the average forecast date for global peak oil ranges between early 2037 and early 2040. Often, there is little change year-on-year for each region. The largest shifts are featured in Europe and the Global South. The bookends of this data are the oil-rich MENA region and the energy-impoverished Sub-Saharan Africa region. Respondents from MENA expect demand to increase for longer (late 2043) relative to others' expectations, while those in Sub-Saharan Africa have set an ambitious inflection point for oil in 2033. Nonetheless, the average forecast for respondents across the Global South is early 2037, not far from the overall average of mid-2038.

Even across sectors, there is strong convergence among survey respondents on the approximate year when oil demand will begin to ebb. Of course, those in renewables see peak oil arriving earlier than the overall survey average, just as those in oil and gas expect it later. Expectations of those from the nuclear sector, meanwhile, come close to the mean date. Amid a broad contraction in net-zero pledges from the sector, it was finance that articulated the most conservative estimates for a change away from heavy reliance on oil—targeting 2043 as a sector. Overall, however, the average opinion about the arrival of peak oil seems to have settled, for now, around late next decade.

Contrasting these findings with analyses by international experts demonstrates that our pool of respondents was even-handed in their views of how quickly the world would shift from the current global energy mix. The International Energy Agency suggests in its 2024 "stated policies scenario (STEPS)," which is based on current policy settings, that oil and natural gas will peak by 2030,[11] while Goldman Sachs Research estimates that demand for oil will reach its highest point by 2034.[12] The Organization of the Petroleum Exporting Countries (OPEC), alternatively,

**Figure 4. Mean expected time of peak oil (by region/country and sector)**




11 *World Energy Outlook 2024*

12 "Peak Oil Demand is Still a Decade Away," Goldman Sachs Research, June 17, 2024, http://goldmansachs.com/insights/articles/peak-oil-demand-is-still-a-decade-away.

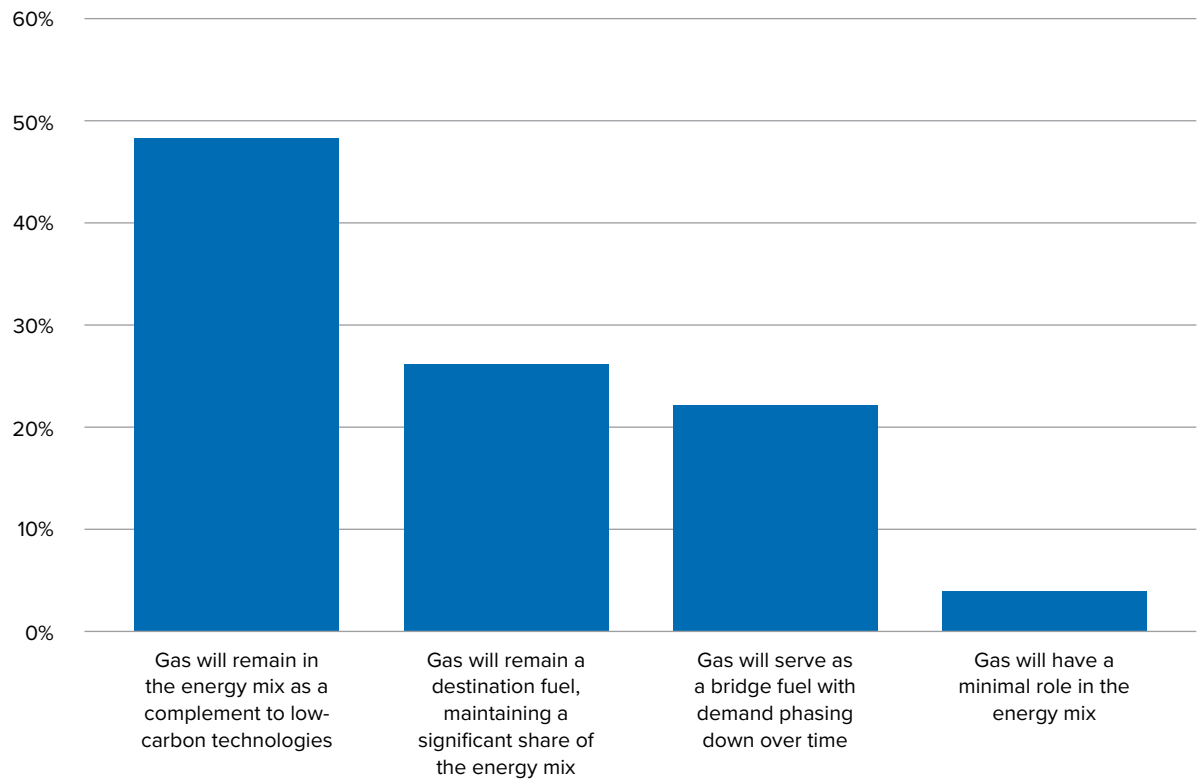
sees a longer arc for oil demand, with consumption continuing to climb until at least 2050.[13]

Shifting away from oil, as with prior years, our survey respondents as a whole projected more confidence in the future of natural gas. Nearly half (48 percent) expect it to remain a complement to renewables and low-carbon technology, while just over a quarter (26 percent) say that it will be a destination fuel. Most of the rest (21 percent) see it as a bridge fuel, meaning the world slowly divests from gas in the energy mix. These figures are almost identical to those in the previous survey. They also reflect views within many parts of the energy field. While a few statistically significant differences exist by gender, age, occupational seniority, and time in the industry—for example, 28 percent of men believe that gas will be a destination fuel, compared to 20 percent of women—none meaningfully deviate from the overall trends of the survey.

Among the economic sectors covered in our survey, the fluctuations in views are larger but still modest. The only notable variations from the norm come from the oil and gas sector, in which 46 percent of respondents see gas as a destination fuel. This may be a sign of slightly growing confidence in that industry about their long-term future: last year, only 36 percent thought that it would be a destination fuel, with a majority (57 percent) projecting that natural gas would be a long-term complement to low-carbon technologies.

From a regional perspective, Europeans, are more likely to believe that natural gas will serve as a bridge fuel (33 percent) and less often say that it will be a destination one (18 percent). Those surveyed in MENA and East Asia, on the other hand, seem more likely to see gas having a permanent role (42 percent and 41 percent respectively). Notably, the East Asian results likely stem from the large Japanese representation within that part of the survey pool: Japan lacks large domestic reserves, but the country's companies are an indispensable part of the entire global liquefied natural gas supply chain.

**Figure 5. Which of these statements best describes the future of natural gas?**




13 "OPEC Launches WOO 2024 and Sees Global Oil Demand at Over 120 mb/d in 2050," Organization of the Petroleum Exporting Countries, accessed February 5, 2025, https://www.opec.org/opec_web/en/press_room/7377.htm.

LEADERSHIP INSIGHT

# Energy realities

By Rick Muncrief

Energy is the lifeblood of modern civilization, enhancing the lives of billions of people around the world. It is fundamental to human health, economic opportunity and prosperity, and global security.

With over four decades of experience in the oil and natural gas industry, I am excited by the opportunity that is in front of us: how to grow the energy system, while making it cleaner and more resilient. As we look to the future, in a world that is becoming increasingly fragmented, it's crucial to address the energy realities we collectively face.

## The world needs more energy, not less.

The first reality is that the world needs exceedingly more energy, not less. According to the US Energy Information Administration, global energy demand is projected to grow more than 30 percent by 2050. This surge in demand is fueled not only by the meteoric rise of artificial intelligence and data centers, but also growth in manufacturing and transportation. In emerging economies, energy demand will continue to rise as populations grow and incomes increase, enabling billions of people to drive, access new goods and services, and power their homes.

Despite significant progress in expanding energy access in the past decades, over one billion people still live in energy poverty, lacking reliable, affordable, productive power. More than two billion people still do not have access to clean cooking fuels or technologies, like natural gas or electricity. Every human being deserves access to the energy they need to thrive—the privileges that so many of us enjoy every day.

## Energy security underpins global security.

The second reality is that energy security, economic security, and global security are intertwined and interdependent. Diverse, resilient energy systems are necessary to avoid economic disruptions, geopolitical instability, and the likelihood of conflict around the world. The European Union's (EU) previous reliance on oil and natural gas supplies from Russia highlights the dangers of overweighted dependencies on rogue nations that have the power to weaponize energy to serve as political leverage or tools of coercion in foreign affairs. The devastating invasion of Ukraine and resulting energy supply constraints in the EU also highlight the importance of global energy leadership and international cooperation, as Russian gas supplies were replaced with other sources of energy, including liquefied natural gas (LNG) from the United States.

Nations with access to diverse, reliable, and affordable energy sources and supply chain inputs—either domestically produced or sourced from exporting international allies around the world—can ensure their people and economies thrive.

## All sources of energy have tradeoffs.

The third reality is that just as each source of energy has life-changing, transformative benefits that fuel human prosperity, each source also has tradeoffs and negative externalities that should be acknowledged and appropriately balanced in the development of sound public policy and in business.

To meet growing global demand, we need to produce more energy from traditional and non-traditional sources—and we must produce it more responsibly tomorrow than we do today. For oil and natural gas development, this means committing to reducing carbon and methane emissions. For wind, solar, and battery development, this means minimizing land-use impact and diversifying supply chains. For all energy development, this means ensuring we keep our people and communities safe. We must also be reasonable about the pace, magnitude, and time

A drilling crew works on an oil rig in the Permian Basin, Texas, U.S., August 22, 2018.

REUTERS/Nick Oxford

required to scale new energy resources and enhance existing resources— and the tradeoffs for doing so.

We cannot prioritize clean energy over reliability and affordability, we cannot pursue reliability and affordability at the expense of the environment, and we cannot develop energy policies and systems that do not account for geopolitical risks domestically and abroad.

**Clear eyes are critical to simultaneously growing energy systems without sacrificing reliability, affordability, or the environment.**

Energy has become a politically polarized flashpoint. It has become "good" versus "bad" and "you" versus "them," at a time when we should all be coming together to solve the challenges and opportunities in front of us. Now more than ever, we need a pragmatic approach to removing barriers that prevent us from providing the energy access and security the world needs. This includes building infrastructure to move energy where it's needed most—from oil and natural gas pipelines to transmission lines to LNG terminals to geothermal wells to carbon capture systems and everything in between. In the United States, we need common-sense policies to address meaningful permitting reform that unlocks our vast energy resources and bolsters not only our nation's energy and economic security, but also those of our allies. While globalism may be receding, energy systems and markets should continue to be highly integrated. We must continue to invest in economic partnerships and trade policies that minimize supply chain disruptions, distort trade flows, slow growth, raise energy costs, and accelerate fragmentation.

Energy is essential to the technological revolutions unfolding before our eyes and to bringing billions of people into a higher standard of living across the globe. Let us seize this moment to come together in the pursuit of pragmatic and durable policy, technology, and market solutions that grow our collective energy resources to meet the needs of today—and tomorrow.

*Rick Muncrief is the president and CEO of Devon Energy.*
*Devon Energy is a sponsor of the Global Energy Center.*

## CHAPTER III

# Path to net-zero emissions

**THE GLOBAL PUSH TOWARD ACHIEVING** net-zero emissions was marked by a distinctly multipolar landscape in 2024, reflecting a wide array of approaches, priorities, and challenges as global leaders seek to balance sustainability and security goals in an environment of intense competition between great powers. While many governments and corporations are accelerating their investment in clean energy, the journey to net zero is increasingly shaped by divergent strategies and policy debates. In the throes of the US general election, for example, then-Senator J.D. Vance penned an op-ed in *The Wall Street Journal* calling for an end to net-zero mandates and advocating instead for streamlined permitting and expanded private investment to boost energy production. It's a familiar critique that aligns with growing concerns about the economic and practical implications of rigid net-zero policies. Emphasis internationally, however, is largely placed on policy reform and strategy, not abandonment of climate aims.

Nowhere was this more vividly on display than in the European Union, where Mario Draghi unveiled a sharp critique of engaging in business as usual on the continent. In unveiling his report on the "Future of European competitiveness," Draghi emphasized that decarbonization is "an opportunity for Europe." Yet, he stressed that a failure to coordinate policies risks an outcome that "could run contrary to competitiveness—and ultimately be delayed or even rejected." For Dan Jørgensen, as he takes on the role of European Commissioner for Energy and Housing, it is critical that this coordination take place across the Atlantic as well. As Jørgensen writes for this publication, transatlantic cooperation is imperative "to ensure strong and secure supplies of affordable energy."

Similarly, in Latin America, Andrés Rebolledo Smitmans writes in his essay that collective action

Dams above the Nant de Drance pumped storage electricity power plant in Finhaut, Switzerland, August 4, 2022.

REUTERS/Denis Balibouse

in the region is needed to "advance progress on our common energy and climate goals." Halfway around the world, the Japanese labored over similar issues as Prime Minister Ishiba's government sought to finalize the country's Strategic Energy Plan.[14] The draft plan highlights a careful balancing act that prioritizes energy security, while pursuing decarbonization and maximizing the use of renewable energy and nuclear power.[15] In reflecting on the plan, Tatsuya Terazawa, chairman of the Institute of Energy Economics, Japan (IEEJ), emphasized the need for "multiple pathways" to navigate the energy transition, recognizing that different regions require tailored approaches as they maintain overarching momentum toward decarbonization.[16]

From government to industry, the multipolar nature of the net-zero landscape in 2024 was equally evident in the private sector's growing role in putting policy into action. Major technology companies, driven by the substantial energy needs of AI development, are increasingly seeking to align sustainability goals with energy security imperatives by investing in zero-emission energy solutions, including nuclear energy technologies. This reflects a broader trend of the private sector stepping in to address the dual imperatives of carbon neutrality and reliable energy supply. The Electric Power Research Institute's President and

14 "Call for Opinions on the 'Draft Global Warming Countermeasures Plan,'" December 27, 2024, https://public-comment.e-gov.go.jp/pcm/detail?CLASSNAME=PCMMSTDETAIL&id=195240104&Mode=0.

15 Ken Koyama, "Japan Drafts 7th Strategic Energy Plan," December 19, 2024, https://eneken.ieej.or.jp/data/12236.pdf.

16 "Building the Low-Carbon Global Energy System of the Future," GE Vernova, accessed February 4, 2025, https://www.gevernova.com/news/cop-collection/future-energy-system.

LEADERSHIP INSIGHT

# EU-US energy cooperation: forging stronger connections in times of division

By Dan Jørgensen

Looking from Europe to the United States, across the great span of the Atlantic Ocean, it is not always easy to find our common connections.

I discovered this first-hand when my academic pursuits brought me to Seattle. For instance, I realized early on that we certainly do not share the same definition of "football." We also have different ideas on what constitutes a "large" portion size. A visit to a pastry shop shows that we even have different definitions of "Danish."

But as I grew accustomed to life in the Emerald City, and, in particular, as I met neighbors and made friends, I came to recognize many of the same qualities that I admired among my own people: an appreciation for hard work, humility, and shared human values.

Many years later, as we begin the latest chapter in EU-US relations, some in Europe have looked across the Atlantic and speculated about potential differences and divisions. However, as I take on the role of European Commissioner for Energy and Housing, I see more ways in which our relationship is defined by our common interests.

First and foremost, we have a common interest in a stable, secure, and rules-based international order, in which freedoms are upheld and borders are respected. That is why we have committed our support and solidarity to the people of Ukraine. Since Russia began its illegal aggression, I have visited Ukraine twice. During these visits, I met people who have lost their families and their homes. I met people who have been living without basic necessities, such as electricity and heating. In fact, during the first two years of the war, Ukraine lost two-thirds of its overall electricity capacity due to brutal and relentless Russian attacks. The united support of the European Union and the United States, including through the Group of Seven Plus (G7+), offers Ukraine a crucial counterbalance to reinforce its energy security. Maintaining this cooperation in the coming years, to support the reconstruction and reform of Ukraine's energy sector, will be equally essential.

Of course, in the context of geopolitical instability, we must also protect our own energy systems. Here, EU-US cooperation on cybersecurity will be important. Digitalization helps to make our energy systems more efficient, reliable, and sustainable. However, without proper precautions, it can also make our systems more vulnerable to malicious attacks, which are expanding in their reach and increasing in their frequency. We must tackle these threats together, for example, by maintaining our engagement via EU-US cyber dialogues and Group of Seven (G7) meetings on Cybersecurity for Digital Energy Infrastructure Systems.

Another priority shared across the Atlantic is to ensure strong and secure supplies of affordable energy. We want to bring down bills for our citizens and strengthen the competitiveness of our companies. In this regard, there are a number of areas where it is plainly in our common interest to cooperate. For example, liquefied natural gas (LNG) from the United States could continue to play a vital part in completing our REPowerEU objective to phase out Russian energy supplies to the EU.

A key aspect of this joint work will be to diversify our sources of energy. For instance, nuclear will continue to be an integrated part of our energy mix and an important part of the solution to decarbonize our energy systems. Continuing our long-standing cooperation with the United States in the nuclear sector is therefore a priority—in particular, to diversify nuclear fuel and fuel services, to spur investment in small mod-

Photovoltaic panels on the roofs of homes northwest of Munich, Germany, October 20, 2021.

REUTERS/Lukas Barth

ular reactors, and to foster EU-US leadership in advancing nuclear fusion.

Similarly, we must continue our cooperation in securing critical raw materials. EU-US collaboration enables us to source vital minerals for our energy systems, reduce vulnerabilities in our supply chains, and reward responsible economic actors by sharing the benefits of next-generation energy.

Taking a longer-term view of our energy security, the EU remains committed to pursuing sustainable energy and decarbonization. We do not pursue these objectives for ideological reasons, but for logical reasons. From a competitiveness point of view, the EU is a global leader in key clean tech segments such as wind and heat pumps. We are also leading on hydrogen—including electrolyzers. As a result of our work in these and other clean energy sectors, the share of renewables in our electricity mix increased from 36 percent in 2021 to 46 percent in 2024. As we continue our work to combine competitiveness, innovation, and decarbonization, this share will only increase, ensuring a strong, secure, and sustainable supply of affordable energy for our citizens.

The EU will never close its door on any international partner who is willing to share the path toward a global energy system that is fair, secure, and sustainable. We take this path not because it is easy, but because it is essential.

Similarly, in the face of challenges to come, it will be essential to find and reinforce our common connections, wherever they exist.

*Dan Jørgensen is the EU Commissioner for Energy and Housing.*

LEADERSHIP INSIGHT

# Technology- and power-sector partnerships can accelerate the energy transition

By Arshad Mansoor

In 2017, Google published a groundbreaking paper titled "Attention Is All You Need."[1] It not only revolutionized the field of artificial intelligence but also triggered a boom in the construction of data centers worldwide. This surge in data-center demand has had profound implications for global power consumption, presenting both challenges and opportunities for the transformation of the energy sector.

## Data centers' impact on power demand

The proliferation of data centers has led to a substantial rise in global power demand. According to projections by the Oak Ridge National Laboratory, the electricity requirements for these facilities are expected to grow exponentially. This trend is particularly pronounced in the United States: The Electric Power Research Institute (EPRI) estimates that American data centers could consume up to 9 percent of electricity generation by 2030—more than double the estimated 4 percent they consume today.[2]

In addition to data centers, other factors such as the onshoring of manufacturing and the electrification of industry are further driving up power consumption. This escalating demand poses a challenge for regions that are already struggling with electricity reliability, leading to delays in the retirement of coal-fired plants and the addition of new natural gas-fired generation to ensure stable supply.

## High-tech commitments to low-carbon energy

Despite these challenges, the high-tech industry has been a staunch advocate for the clean energy transition. Companies like Google have set ambitious goals to achieve net-zero emissions by 2030. The increasing power demand from their data centers, however, threatens to derail these targets.

Google's 2018 paper on 24/7 carbon-free energy (CFE)[3] highlighted the limitations of relying solely on renewable energy certificates and emphasized the need for true carbon neutrality, where consumption is matched with zero-carbon energy production on a 24/7 basis.

The paper laid the foundation for the current push toward 24/7 CFE, which aims to ensure that data centers and other high-tech facilities are powered entirely by low-carbon energy around the clock. While achieving this goal presents significant challenges, it also offers an opportunity for the high-tech and power industries to collaborate and drive the energy transition forward.

## Navigating the path to net zero

In the short term, the increased reliance on natural gas and the delayed retirement of coal plants may seem like a setback for the clean energy transition. However, these measures are necessary to maintain grid reliability as we work toward a more sustainable energy future. The real challenge lies in accelerating the deployment of emerging carbon-free technologies such as advanced nuclear reactors, carbon capture

1 Ashish Vaswani et al., "Attention Is All You Need," Advances in Neural Information Processing Systems, Proceedings, 2017, https://research.google/pubs/attention-is-all-you-need.

2 "Powering Intelligence: Analyzing Artificial Intelligence and Data Center Energy Consumption," EPRI, May 28, 2024, https://www.epri.com/research/products/3002028905.

3 Moving toward 24x7 Carbon-Free Energy at Google Data Centers: Progress and Insights, Google Sustainability, October 2018, https://sustainability.google/reports/24x7-carbon-free-energy-data-centers.

> **"The path to net zero is fraught with challenges, but it also presents significant opportunities for innovation and collaboration."**
>
> —*Arshad Mansoor*

and storage (CCS), and long-duration energy storage (LDES).

Public-private partnerships, such as technology deployment hubs, can play a crucial role in this effort. These hubs would facilitate the phased deployment of advanced energy technologies, with specific targets for LDES, small modular reactors, new large nuclear plants, and gas with CCS. By sharing the financial, regulatory, and licensing risks associated with these technologies, these collaborations can help bring them to market more quickly and at scale.

## Technology deployment hubs

The concept of technology deployment hubs involves a series of phased deployments, each building on the lessons learned from previous projects. Experience suggests that it takes decades and at least ten full-scale deployments for new technologies to achieve cost reductions and supply chain efficiencies.

Just as early tech company commitments to renewable energy helped drive rapid cost decreases and widespread deployment, similar commitments today can accelerate progress on the new and emerging technologies needed to meet growing electricity demand. By adopting this phased approach, we can ensure that each deployment maximizes cost efficiencies and technological refinements, ultimately accelerating the clean energy transition.

## Relighting the spark

The collaboration between the high-tech and power industries is essential for achieving our long-term clean energy goals. By working together, these sectors can drive the development and deployment of advanced energy technologies, supported by regulatory and policy frameworks that enable innovation and investment. This partnership has the potential to create a second spark in the energy transition, similar to the one ignited by Google's early investments in renewable energy.

While the next few years may see a temporary increase in natural gas use and extended coal plant operations, these measures are necessary to ensure grid reliability during the transition. The ultimate goal is to achieve a net-zero economy. The high-tech industry's commitment to 24/7 CFE, combined with the power sector's expertise in energy generation and distribution, can help us reach this target more quickly.

The path to net zero is fraught with challenges, but it also presents significant opportunities for innovation and collaboration. By seizing the opportunity to accelerate the low-carbon transition through emerging partnerships between high-tech and power companies, we can ensure a sustainable and reliable energy future. Let's not be distracted by short-term detours; instead, let's focus on the long-term goal of achieving a net-zero economy and work together to make it a reality.

*Arshad Mansoor is the president and CEO of the Electric Power Research Institute.*

Chief Executive Officer Arshad Mansoor echoed this sentiment, noting in his essay that "the collaboration between the high-tech and power industries is essential for achieving our long-term clean energy goals."

Yet, any optimism is tempered by signs of retrenchment in the financial sector. Some banks have started to scale back or exit their commitments to net-zero financial targets for 2050, citing the complexities of balancing fiduciary duties with long-term climate benchmarks. The latest wave of some of Wall Street's biggest banks leaving net-zero alliances, just years after touting their membership, also follows a growing threat of litigation.

As conveyed through the responses to our survey, the net-zero agenda is influenced by a vast community of individuals across multiple regions, each pursuing strategies shaped by their unique circumstances and priorities. Despite hints of divergence on the global stage, the lessons from our respondents are clear: while the timeline toward net zero is under pressure, the broader trajectory to net-zero emissions remains a key objective that will benefit the global community.

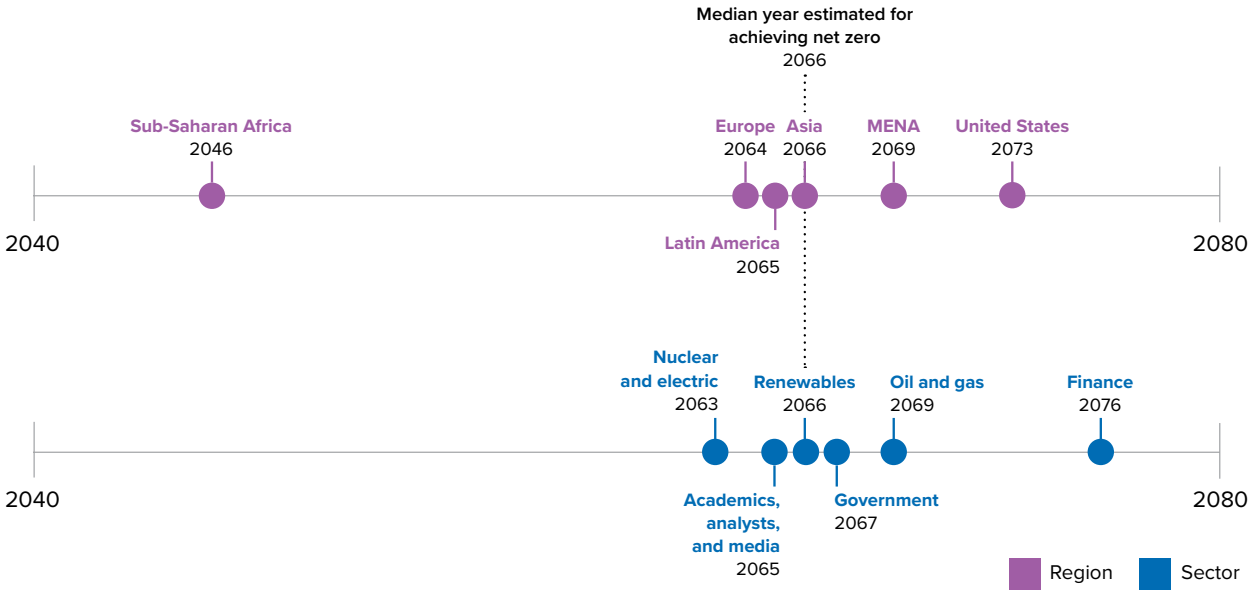
Reinforcing this analysis, only 26 percent of respondents believe that net zero will occur before the 2050 goal adopted by UNFCCC as the international community's benchmark. Alternatively, 34 percent say that it will not happen until 2076 at the earliest. Of that community, the majority are confident that net zero will not occur at all.

Given the time scale involved and the uncertainties inherent in such a major economic and social change, it is striking how similar the average estimates are across various groups within the survey pool. No clear differences are apparent by gender or experience within the industry. While those aged under 45 predict a slightly earlier date than do older respondents, the difference is not great (2062 for the former; 2068 for the latter).

Groups from different economic sectors within the survey also have very similar expectations about when net-zero might occur. The only outlier is finance, the respondents from which think peak oil will come later than those surveyed in other sectors. Geographically, six regions have estimates within the range of 2064 to 2073. The only outlier is Sub-Saharan Africa, which anticipates net-zero by 2046. This is consistent with the region's early estimate of early 2033 for peak oil. Amid these minor differences, the principal message from respondents in the energy industry—both as a whole and in most of its divisions—is that they do not expect net zero until well into the 2060s.

Most of the survey pool (62 percent), however, believe that reaching net zero by 2050 would be an economic boon. The responses to this question are similar to those of last year, albeit with a slight but perceptible increase in the proportion of people who

**Figure 6. Median year estimated for achieving net zero (by sector and region/country)**

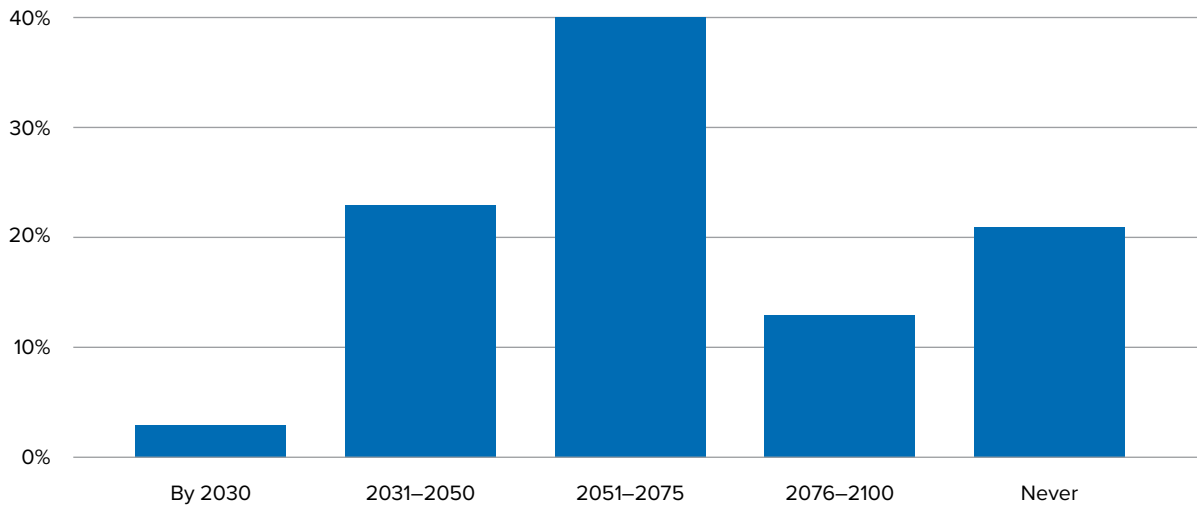


expect that such a development would have a positive impact. In particular, 24 percent now say that net zero would be accompanied by strong positive growth, up from 17 percent from a year earlier. As our essayists Andrés Rebolledo Smitmans from Latin America and Lassina Zerbo from Africa write, advancing net-zero objectives will vastly improve the lives of millions who currently live in energy poverty, but achieving this goal will require favorable regulatory frameworks to encourage investment.

As with other elements of this year's survey, geographical and sectoral demographics tell a bigger story. Compared to other regions, MENA is less optimistic than alternatives to see net zero as a strong driver of growth. Even so, the region is roughly evenly split with 39 percent anticipating an economic upside and 33 percent assuming a net-zero economic contraction. More than one quarter (27 percent) of MENA assumes net zero will balance out when it comes to the economy. As with prior year's results, the Global South outside of MENA, modestly diverges from the Middle East. Nearly two-thirds of respondents in the Global South outside of MENA see a positive effect from net zero, even if modest.

Sectoral distinctions are comparably muted, when contrasted to regional differences. Those in renewables, for example, are more likely to say net zero would drive strong growth (40 percent), but even so, only 69 percent say that it will lead to any kind of positive growth, a number that is moderated by the fact that the overall survey average is 62 percent. Expectedly, those in the oil and gas sector were more likely than average to say that net zero would lead to negative growth (38 percent); with those in finance somewhere in between at 26 percent. In every case, however, more respondents answer that the effect of reaching net zero by 2050 would be positive for the economy rather than negative, a heartening fig-

**Figure 7. When will net-zero greenhouse gas emissions be achieved?**




**"The lessons from our respondents are clear: while the timeline toward net zero is under pressure, the broader trajectory to net-zero emissions remains a key objective that will benefit the global community."**

LEADERSHIP INSIGHT

# Latin America and the Caribbean: Leading the green energy transition amid climate challenges

By Andrés Rebolledo Smitmans

Latin America and the Caribbean constitute a green region. It is home to the planet's most significant natural lung: the Amazon rainforest. In addition, it has an energy matrix with the highest levels of renewable energy participation at 33 percent compared to a global average of 14 percent. This fact allows us to state with pride, but aware of our responsibility, that we are the greenest region on Earth.

At the same time, this highly renewable resources region suffers more than any other from the growing and visible impacts of climate change. Events of unprecedented magnitude and frequency, such as extreme and prolonged droughts, coupled with unprecedented floods and hurricanes that most frequently affect Caribbean countries, are causing damage to infrastructure and families, and seriously jeopardizing the security of energy supply. The situation is reaching extreme levels in some countries, with cases of rationing impacting their economies and populations.

We live in a region with a great wealth of natural resources, especially renewable resources, all of which are waiting for adequate exploitation. We have used only 30 percent of the water, 12 percent of the wind, and 1 percent of the solar radiation available. Our energy transition industry also has large reserves of critical minerals. In other words, the enormous availability of energy resources also promotes us as one of the world's major producers and suppliers of low-emission hydrogen.

The region shows substantial progress in its energy transition toward more decarbonized economies. According to the latest data published by the Latin American Energy Organization (OLADE) in the 2024 Energy Outlook for Latin America and the Caribbean, the share of renewable energy in electricity generation increased from 53 percent to 68 percent in the past ten years, while greenhouse gas emissions were reduced by 26 percent. In addition, 77 percent of the new electricity generation capacity incorporated last year was renewable.

In the social aspect, 97.4 percent of electricity service coverage was achieved. However, 17 million people still lack access to electricity, 180 million live in poverty, and 77 million do not have access to clean cooking systems, which primarily affects women. These facts compel us to seek alternatives and encourage the region to work together in the search for more robust, flexible, and resilient energy systems that can benefit all. Based on the region's energy wealth, it is essential to generate local value chains through the development of sources that create jobs and wealth.

In this context, there are increasingly demanding and pressing challenges. The energy transition and the decarbonization of economies require investments in unprecedented volumes of materials, which must flow and materialize in relatively short periods. This endeavor requires consolidated institutional schemes, with policy and regulatory frameworks that spread the signals of stability and security sought by investors while maintaining the flexibility required by a changing technological environment.

The lessons learned by countries that have already made progress in their energy transition processes also show that it is just as important to diversify energy production as it is to strengthen transmission and distribution. Also, this goal requires significant investments and favorable environments for their development.

There are, jointly with opportunities, relevant economic and social challenges. We are responsible for focusing our efforts on making energy a transversal axis of development, contributing to

closing the poverty gaps afflicting our region with better levels of access to energy, healthy cooking systems, and access to information and, in short, creating conditions of equity in the broadest sense of the concept.

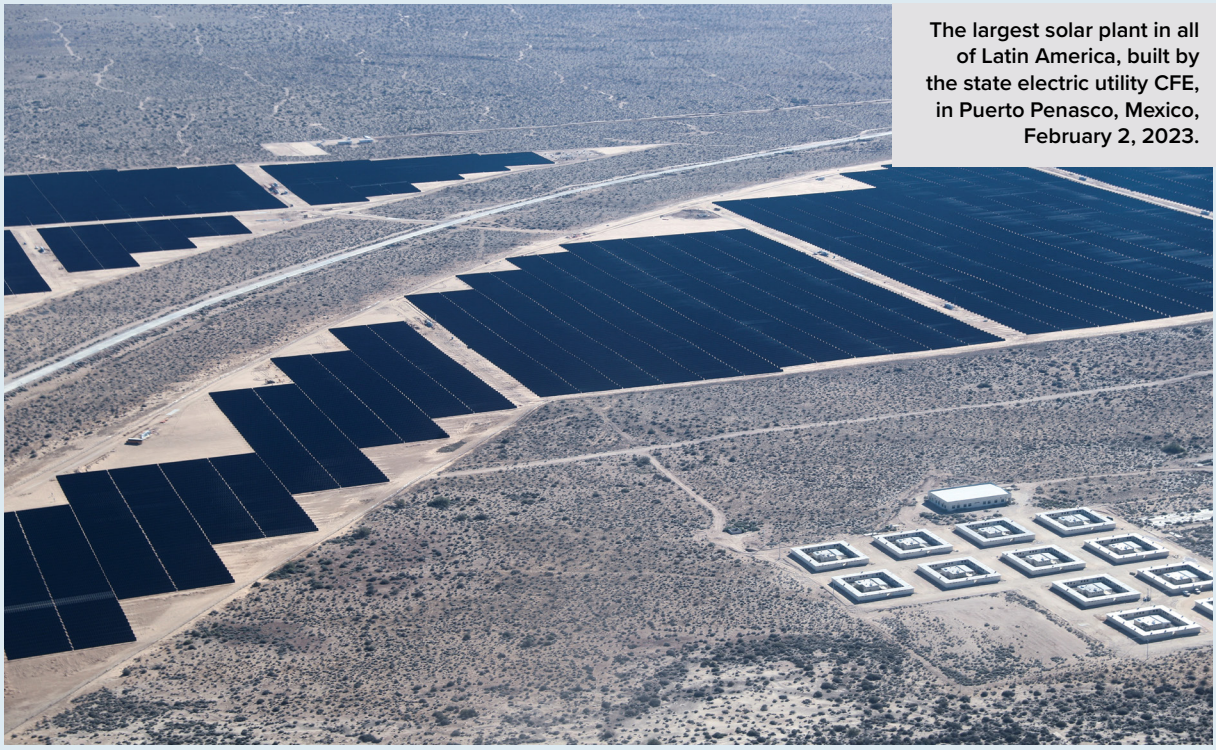
The energy setting experienced currently by the world and our region reaffirms the urgency and shared responsibility to act against climate change and its effects, as well as the need to increase and strengthen collective action. In this regard, the region needs to advance energy integration. Significant progress has been made in this area, but there is still a long way to go in consolidating a regional market. Collective action involves dialogue at the intersection of all public- and private-sector actors, academia, international organizations, multilateral banks, and civil society.

Beyond expressions of goodwill, OLADE, an intergovernmental organization that brings together twenty-seven countries in Latin America and the Caribbean, has been working hard to create the right conditions to deepen and fast-track the energy transition processes in these regions.

The OLADE Meeting of Ministers is the highest governance structure of our organization, which brings together the highest energy authorities of its member countries. At its recent meeting in Asunción, Paraguay, it adopted a series of resolutions that mark the path to be followed by the region. These decisions seek to improve energy efficiency in all member countries, eliminate the use of coal for electricity generation, and institute a Regional Energy Planning Council, which aims to further advance progress on our common energy and climate goals.

Our main commitment is to integrate the region's energy as an instrument that will allow us collectively to better face the impacts of the current environment, plan our future, and build, with the support of all, a better world for future generations.

*Andrés Rebolledo Smitmans is the executive secretary of OLADE.*



**The largest solar plant in all of Latin America, built by the state electric utility CFE, in Puerto Penasco, Mexico, February 2, 2023.**

REUTERS/Raquel Cunha

ure considering the challenges the same group anticipates will delay achieving net-zero targets.

The main barrier to reaching net zero, according to those surveyed, is a lack of political will (61 percent), but any number of other issues also stand in the way, not least of which is the expense involved. For several years now, our surveys have made clear that this is a crucial factor in overcoming the range of difficulties in the way of reaching this goal. A close second is finance. Throughout our annual survey results, we have seen a consistent emphasis on the importance of access to capital in considerations around net zero. Rising cost pressures are cited by 37 percent of those surveyed (the second most common choice) and high borrowing costs by 31 percent (ranking fifth). Overall, 53 percent of respondents name at least one of these two. Other important issues include interstate conflicts (33 percent) and the limits of current technology (32 percent).

There is even a cohesiveness across demographic groups overall. Those working in renewables are more likely to choose political will (67 percent compared to 61 percent for all other respondents), while those in oil and gas are more likely than average to select cost pressures (43 percent) and technological limitations (41 percent), but overall, political will remains a constant driver of perceptions about the achievability of net-zero aims.

According to respondents, popular support for the transition to an emissions-free energy system hinges largely on concerns about climate change and the potential for economic growth. While climate concern had more people labelling it extremely important to shaping popular views (50 percent), economic opportunity had a greater number calling it either very or extremely important (78 percent to 77 percent). Climate change and economic opportunities were not alone in driving support for the energy transition, however. Well over half of respondents acknowledge national security concerns (64 percent) and generational perspectives (61 percent) as significant drivers of popular support for net zero.

**Figure 8. What do you think would be the impact of achieving net-zero emissions by 2050 on global economic growth?**

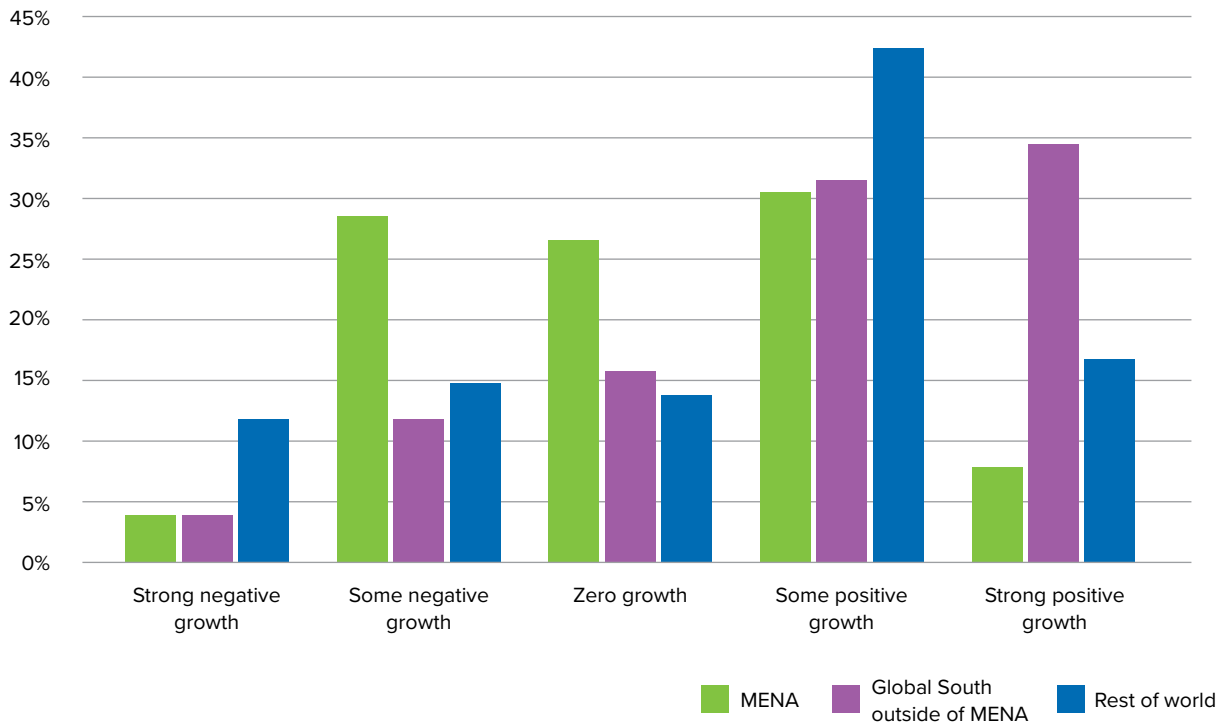
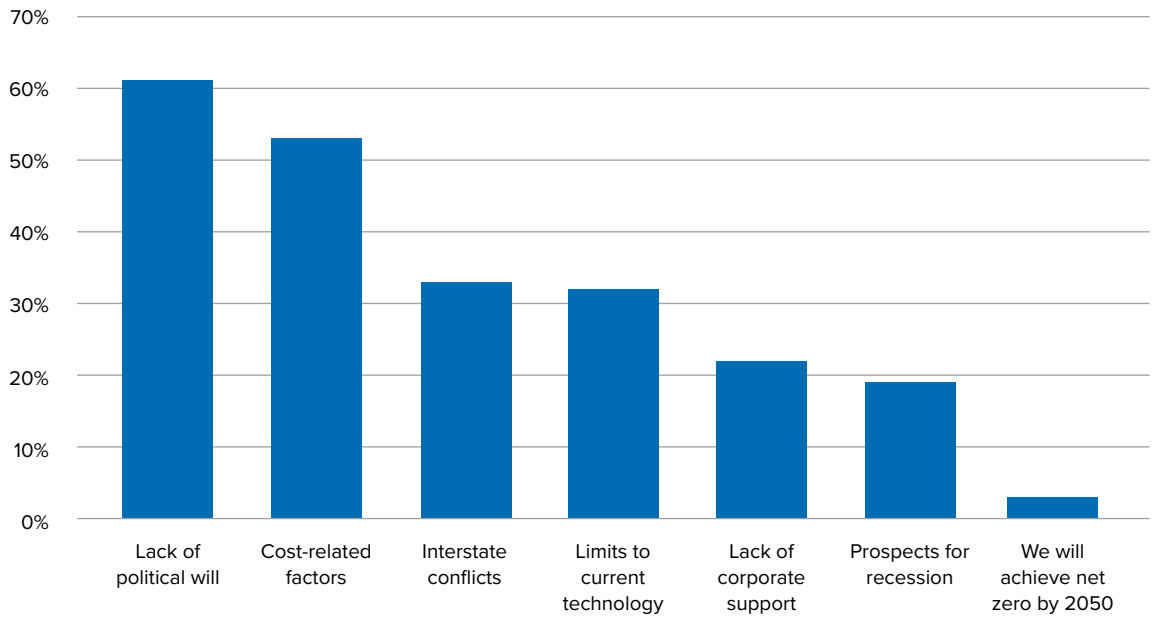
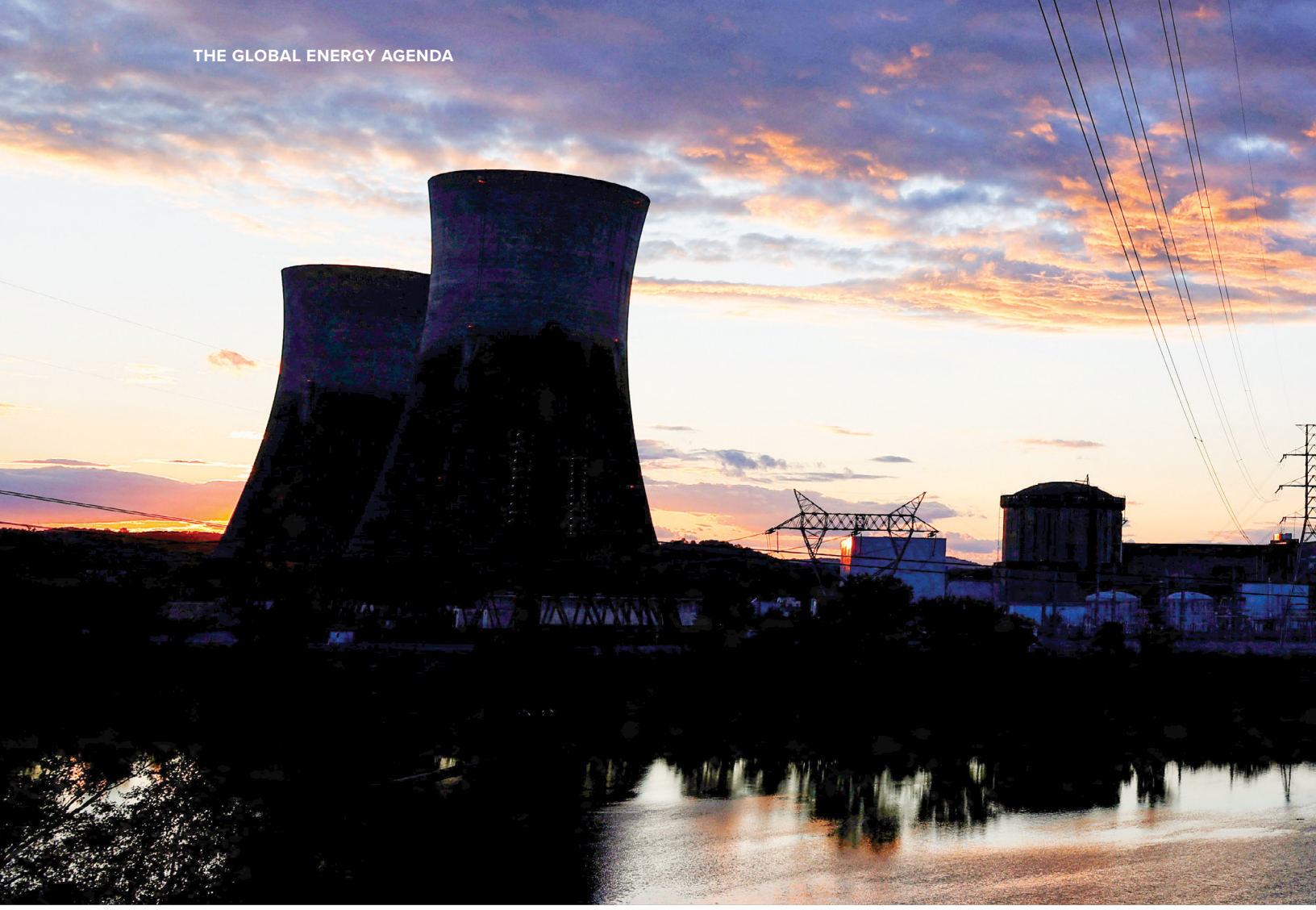


**Figure 9. Which of the following are likely to impede global energy systems from reaching net-zero emissions by 2050?**





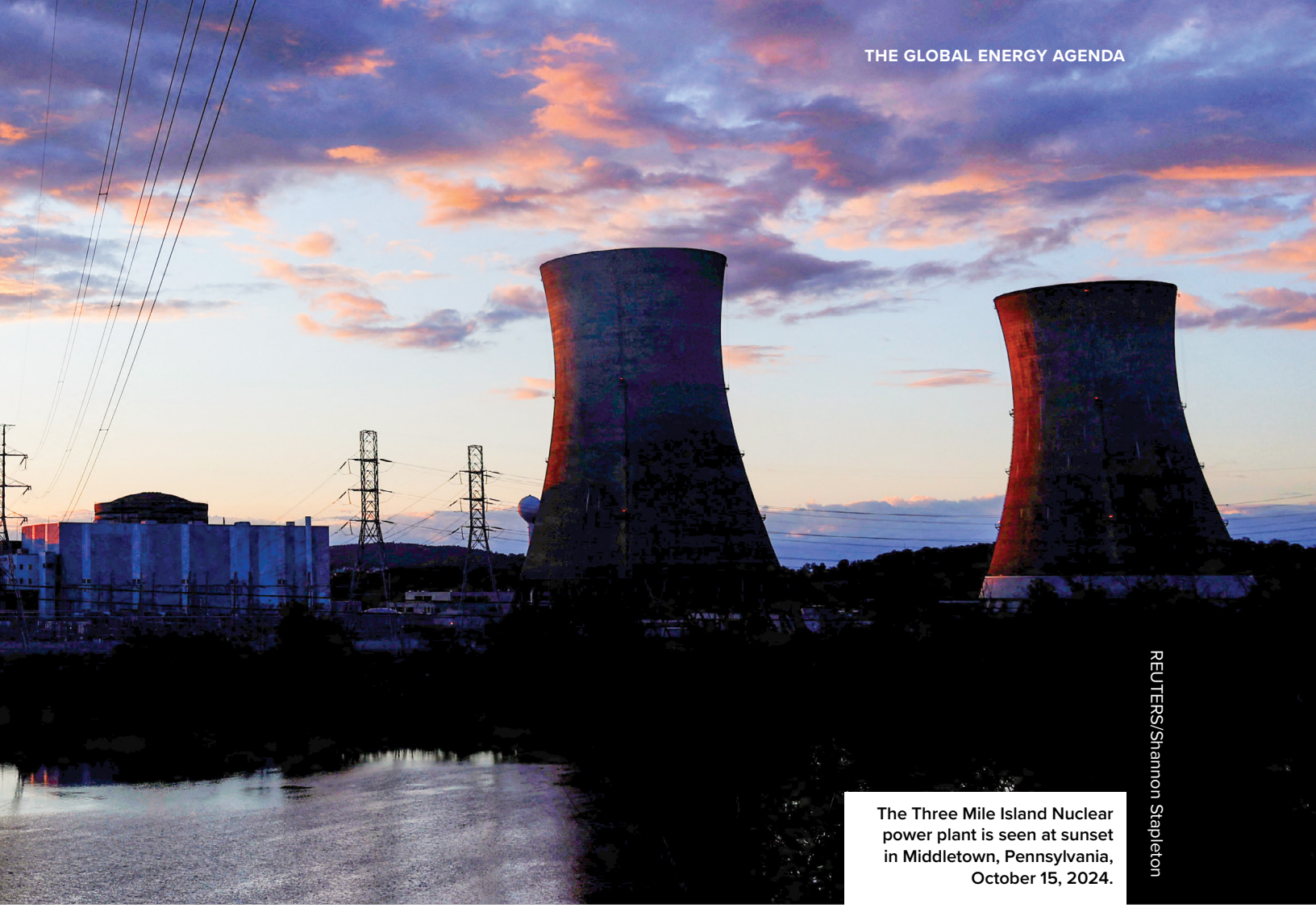
## CHAPTER IV

# Technological drivers of the energy transition

**THE PURSUIT OF EVER CLEANER** and more sustainable energy systems remained a feature of global investment and deployment of clean energy technologies in 2024. The IEA, in its annual *World Energy Investment* outlook, noted that last year the ratio of clean power to unabated fossil fuel power investment was 10:1 around the world.[17] Investment in solar photovoltaic (PV) technologies alone surpassed $500 billion last year. As in prior years, much of this growth is anchored in China. Nonetheless, the United States' Inflation Reduction Act (IRA) remained a preeminent driver for the clean energy sector in the west. The IRA's incentive structures notably accelerated US clean energy manufacturing, particularly in the development of domestic battery technologies.

The complexity of clean energy supply chains, however, cannot be overstated. The need for diversified sourcing of critical minerals and for reform of regulatory processes, reinforce the improbability of any single country successfully realizing its energy transition aims on its own. To achieve scale and reduce

17 *World Energy Investment 2024*, International Energy Agency, June 2024, https://www.iea.org/reports/world-energy-investment-2024.



The Three Mile Island Nuclear power plant is seen at sunset in Middletown, Pennsylvania, October 15, 2024.

REUTERS/Shannon Stapleton

reliance on geopolitical adversaries, in 2024 nations increasingly embraced a strategy of building resilient and transparent supply chains together. International partnerships, such as the US-led Minerals Security Partnership (MSP), exemplified efforts to align industrial policy with global collaboration, aiming to secure sustainable critical mineral supplies while fostering clean energy innovation.

Through programs like the MSP, the United States forged strategic alliances with countries like Canada and Australia to enhance access to lithium, cobalt, and nickel, critical inputs of the clean energy economy. Meanwhile, regions like Europe separately advanced cross-border infrastructure for hydrogen and renewable energy to complement their vision for industrial competitiveness. The variations between regions reflect the necessity of pursuing solutions that match each region's unique resource base and sustainability goals.

In 2024, no technology reinforced this perspective more than nuclear energy. As AI and other energy-intensive technologies multiply, nuclear power offers a carbon-free, reliable energy source capable of delivering the baseload necessary for these facilities. The comparative advantages of nuclear have not been lost on tech companies such as Microsoft, Google, and Amazon. Collectively the sector is driving new demand for nuclear energy, restarting legacy nuclear power plants such as the Three Mile Island and Duane Arnold plants, and increasing investment into next generation reactors such those being developed by Kairos Power and TerraPower.

LEADERSHIP INSIGHT

# Busting the top myths about AI and energy efficiency

By Josh Parker

The rapid growth of AI in recent years has sparked an unprecedented rush of investment in data centers worldwide to develop the next generation of algorithms, fueling concerns that running these systems will push the world toward an energy crisis.

However, to determine the true impact of AI on global energy consumption, consider the full picture:

- AI computing still makes up a tiny slice of the world's energy consumption. Data centers accounted for about 2 percent of energy-related carbon emissions in 2022, according to the International Energy Agency[1]—and today, not all data centers run AI.
- AI, powered by rapidly advancing accelerated computing technology, is becoming much more energy efficient every year.
- AI delivers insights and results that can increase energy efficiency in the domains that use energy the most—including energy generation, manufacturing, transportation, and residential heating and cooling.

Recent advancements in AI and accelerated computing have enabled developers to harness more computational capabilities while using less energy. Some—in climate science, financial services, and healthcare—already are. But to achieve widespread adoption, it's critical to separate misconceptions from reality.

To that end, here are the top myths around AI and energy efficiency, and the long-term perspectives and facts that dispel them.

## MYTH: The carbon footprint and energy consumption of data centers will grow at the same rate as computation.

Growing demand for computing power does not result in an equivalent rise in energy consumption.

Global data centers saw a 550 percent increase in compute instances—which are virtual machines—and a 2,500 percent jump in storage capacity between 2010 and 2018, while electricity use rose only 6 percent, noted a report from the Information Technology and Innovation Foundation, a Washington-based think tank.

These initial energy savings were largely due to the effects of Moore's Law, which predicted that the number of transistors on a chip would double approximately every two years, leading to a biannual doubling in computing power while maintaining similar energy consumption.

However, by the mid-2010s, Moore's Law began to slow as the physical limits of shrinking transistors became more challenging to overcome. This slowdown highlighted the need for new approaches to maintain and accelerate efficiency gains. Accelerated computing emerged as the solution, leveraging specialized hardware like graphics processing units (GPUs) to perform tasks more efficiently than central processing units (CPUs).

Today, accelerated computing is transforming the world's data centers, with GPUs and advanced networking technology replacing traditional CPU servers that struggle to keep pace with the rise in computing demand. The parallel computing capabilities of GPUs make them twenty times more energy-efficient than CPUs. If every data center shifted from CPU-based to GPU-based infrastructure, the world would save an estimated 40 terawatt-hours of energy, equivalent to the annual energy usage of five million US homes.

1 Carlos Finat et al., "Electricity 2024, Analysis and Forecast to 2026," International Energy Agency, January 2024, https://iea.blob.core.windows.net/assets/18f3ed24-4b26-4c83-a3d2-8a1be51c8cc8/Electricity2024-Analysisandforecastto2026.pdf.

## MYTH: The computing processes required to run AI systems are much more resource intensive than previous methods.

The demand for new AI models, and therefore compute demand, is growing exponentially. The result is that AI is currently demanding more energy faster than computing is getting more efficient.

But both the performance and energy efficiency of accelerated computing increase with each GPU generation: meaning that with every advancement, developers and scientists can accomplish more compute work with less energy. Today's most advanced AI chip matches the performance of supercomputers that were among the fastest in the world a decade ago.

The newest GPUs deliver thirty times more compute performance with a twenty-five-fold increase in energy efficiency compared to those built just two years ago. This adds up to greater efficiency over several years by a factor of 45,000.

## MYTH: AI is consuming more energy than it will save.

The rate of AI adoption today is resulting in short-term increases in energy usage, but one long-term view is optimistic.

Claims of an "AI doomsday" often rely on extrapolations from published AI training statistics. But training predictive and generative AI models isn't a goal in itself—the real goal is to use those models. The insights that an AI model provides during inference can save time and energy and reduce carbon emissions in resource-intensive domains such as agriculture, weather forecasting, transportation, manufacturing, and drug discovery.

Accelerated computing and AI can also power climate models that help global organizations more effectively predict weather patterns, manage natural disasters, build climate-resilient infrastructure, and save lives.

It takes a holistic, longitudinal view to fully calculate the efficiencies that stem from AI adoption. While many AI initiatives are currently in the infrastructure building or training phases, with widespread implementation still to come, early adopters are already seeing benefits.

Efforts to increase energy efficiency and decarbonize buildings across industries are one critical use case for AI. In the United States, buildings are responsible for 40 percent of total energy usage—and, according to the Environmental Protection Agency, 30 percent of energy used in commercial buildings is wasted.

Peter Herweck, former CEO of Schneider Electric, has predicted that in the next few years AI could reduce energy consumption in buildings by up to 25 percent.[2] Data collected by smart home devices and smart meters are producing data that could train AI models to find optimizations across residential and commercial buildings.

For example, a pharmaceutical company worked with BrainBox AI, which helps customers optimize their buildings with AI, to boost equipment efficiency at its California campus, making improvements that resulted in annualized electricity savings of 156,000 kilowatt-hours.[3]

Healthcare is energy intensive: The industry's facilities account for close to 10 percent of commercial building energy consumption in the United States and about 4.6 percent of global greenhouse gas emissions. The life-saving research processed within them is also computationally demanding.

Genome sequencing is one example. Sequencing the DNA of tumors and healthy tissues is crucial to understanding genetic drivers of cancer and identifying treatments. Using AI, the Wellcome Sanger Institute[4] has significantly reduced the "runtime" (i.e., how long a program runs to execute its function) and energy consumption of genomic analysis—saving approximately 1,000 megawatt-hours annually and potentially reducing costs by $1 million compared to traditional CPU-based methods.

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2 Carol Ryna, "Energy-Guzzling AI Is Also the Future of Energy Savings," Wall Street Journal, April 12, 2024, https://www.wsj.com/business/energy-oil/ai-data-centers-energy-savings-d602296e.

3 "Pharmaceutical Campus Uses AI to Reduce Carbon Footprint," Brainbox AI, https://brainboxai.com/en/case-studies/pharmaceutical-campus-uses-ai-to-reduce-carbon-footprint.

4 "Accelerating Cancer Research: Saving Energy While Saving Lives," Nvidia, August 2024, https://resources.nvidia.com/en-us-energy-efficiency/gen-ai-for-finding-cancer-faster?ncid=prsy-503733-vt12.

### MYTH: Electric grids can't handle the energy load of growing AI use.

AI models can be trained anywhere—and there's a significant opportunity to build future data centers in parts of the world where there's excess energy, such as near geothermal reservoirs, which act as 24/7 renewable energy sources, unaffected by weather conditions.

Rather than placing every data center in urban areas that already have significant power demands, they could be built near these sources of renewable energy. Doing so minimizes transmission issues while simultaneously decreasing or eliminating operational carbon footprints.

Once they're trained, models can be deployed to GPUs, which are twenty times more efficient for AI inference tasks than CPUs. Beyond large data centers, lightweight models optimized for inference can run anywhere—on small embedded systems on a robot or other edge device, on desktop workstations, or on cloud servers located in any part of the world.

AI is becoming an essential technology for businesses in nearly every industry to improve productivity and enable rapid new advancements and discoveries. And although AI's direct energy footprint is certainly growing, AI is also proving to be a powerful tool for finding ways to save energy and may very well become the best tool we have for advancing sustainability worldwide.

*Josh Parker is the senior director of corporate sustainability at Nvidia.*

**"Claims of an 'AI doomsday' often rely on extrapolations from published AI training statistics. But training predictive and generative AI models isn't a goal in itself—the real goal is to use those models. The insights that an AI model provides during inference can save time and energy and reduce carbon emissions in resource-intensive domains such as agriculture, weather forecasting, transportation, manufacturing, and drug discovery."**

*—Josh Parker*

According to the World Nuclear Association, as of 2023, traditional nuclear reactors contributed to civilian generation in thirty-one countries; traditional reactors were under construction in three more countries; and had been proposed in an additional five.[18] The twenty countries that generate the most nuclear power are mostly in Europe, North America, and developed Asia, but also include China, India, the United Arab Emirates, and Pakistan. Meanwhile, several additional countries in developing regions either have operational, are building, or are planning nuclear reactors. In other words, the countries that use nuclear power extensively are largely, although not exclusively, developed, and the technology is spreading to more emerging markets.

With this context and given the growing importance of the global nuclear energy landscape, this year's survey directly assessed perspectives on nuclear energy. In the survey, respondents were asked to consider the likelihood of three possible trends in this sector.

- Overall spread—whether a significant number of countries that currently do not have civilian nuclear power will adopt it in some form.
- The spread of large reactor technology—whether countries that do not have traditional civilian nuclear power will adopt it.
- The spread of SMRs and microreactors—whether these new nuclear technologies are likely to be adopted.

More than 40 percent of respondents believe that a significant number of new states will adopt nuclear technology of some kind. Most of our survey sub-populations give a similar response. Perhaps unsurprisingly, 52 percent of nuclear and electricity respondents expect to see newcomer countries build new nuclear energy reactors. In MENA, 53 percent say that more newcomer countries will use nuclear energy. This likely reflects local experience: the region includes states with active nuclear energy programs, like the United Arab Emirates, and those currently building or considering civil nuclear programs—Egypt, Turkey, and Saudi Arabia.

Far fewer respondents, however, foresee a more widespread deployment of traditional nuclear reactors—just 14 percent overall. This figure is noticeably higher for MENA (25 percent), likely for the reasons noted above. In this case, though, among our nuclear and electric respondents, the figure rises only to 18 percent.

In contrast to the limited expectations for traditional reactors, respondents have expansive expectations for advanced reactor technologies. Overall, 82 percent predict adoption of next-generation nuclear technology, with roughly half saying that this will occur at least partially in countries currently without nuclear power. On this matter, every group—including MENA respondents—falls within the widespread consensus.

The energy world clearly agrees that some form of nuclear power will play a global role, even if the technology that will be the mainstay of its expansion still requires licensing and deployment. This view of a growing nuclear fleet is also reflected in respondents' predictions for which segments of the energy sector will see the greatest growth in investment in 2025, although it is not the top selection.

18 "Nuclear Power in the World Today," World Nuclear Association, accessed December 2024, https://world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today#world-overview.

LEADERSHIP INSIGHT

# The small reactor revolution can transform African energy systems

By Lassina Zerbo

Africa is at a decisive point in its energy journey. With a rapidly growing population and a persistent energy deficit, the continent faces a dual challenge of ensuring reliable access to energy while contributing to global carbon-neutrality goals. Nuclear energy—and in particular small modular and micro reactors (SMRs)—can revolutionize the African energy landscape and promote sustainable development.

Currently, over 600 million Africans lack access to electricity, a situation exacerbated by weak electrical infrastructure and heavy dependence on biomass. This energy deficit hampers economic growth and contributes to widening social inequalities.

Although promising, renewable energy sources are often limited by their intermittent nature. So far, solar and wind power have not provided the stable baseload power that is essential for industrialization and urbanization. Africa needs an energy-intensive low-carbon alternative that complements renewable energy to sustainably meet its energy needs.

The potential of nuclear power in Africa is immense. It provides stable, carbon-free energy with the best return on investment among current technologies. However, traditional nuclear reactors require large initial investments and extensive existing infrastructure, which can be prohibitive for many African countries. This is where micro reactors and SMRs offer a breakthrough solution.

SMRs, characterized by their compact size and modular design, typically generate up to 300 megawatts per unit. Unlike conventional reactors, SMRs are factory built, reducing construction costs and lead times. They can be deployed in remote areas with limited grid capacity, making them ideal for Africa's diverse landscape. In addition, SMRs feature enhanced safety mechanisms, such as passive cooling systems, which minimize the risk of accidents.

SMRs offer a combination of economic and environmental advantages that make them well suited to Africa's energy needs. The fact that their initial investment cost is generally lower than that of large reactors, coupled with the possibility of setting up innovative financing models, makes their adoption more accessible. Their modularity enables flexible deployment, ideal for electrifying rural areas and supporting industrial development without the need for heavy electrical infrastructure.

On the environmental front, SMRs have a reduced carbon footprint, in line with global climate objectives. Their integration into the energy mix complements intermittent renewable energy sources, ensuring a stable electricity supply while reducing greenhouse gas emissions. Finally, the development of this technology encourages the transfer of skills and strengthening of local capacities, laying the foundations for long-term technological autonomy.

To attract investors and ensure public support, African governments need to put in place favorable policies, notably by strengthening their regulatory frameworks and conducting information campaigns to allay any public concerns.

Skills development is also an important pillar for the successful integration of nuclear power in Africa. Implementing this technology requires a skilled and experienced workforce. Ambitious training programs, supported by international organizations such as the International Atomic Energy Agency, are helping to train the sector's future experts. Countries such as Rwanda have already shown the way by investing heavily in the training of nuclear scientists and engineers, demonstrating the feasibility of such projects.

International partnerships are also important to accelerate the deployment of nuclear


An electric bus assembled by electric vehicle manufacturer Roam in Nairobi, Kenya, October 19, 2022.

REUTERS/Monicah Mwangi

power in Africa. The West African Economic and Monetary Union is opening up new prospects for energy cooperation by launching a study on the feasibility of installing nuclear power plants in its member countries. The technical and financial complexity of these projects also require close collaboration between African countries and international players. Public-private partnerships, as well as the support of financial institutions like the African Development Bank, the West African Development Bank, and the Economic Commission for Africa, are key to mobilizing the necessary investments.

But the deployment of nuclear energy in Africa faces a number of challenges. Public distrust, often fueled by misinformation about the risks involved, is a major obstacle. In addition, existing energy infrastructure is often insufficient, necessitating major investment and enhanced regional cooperation, as shown by the example of the West African Power Pool, an association of public and private power entities. Finally, political stability and continuity of energy policies are essential to ensure the long-term success of such projects.

Small modular and micro reactors offer Africa a real opportunity to transform its energy landscape. With enhanced international cooperation, the continent can build a safer, cleaner energy future, while improving the quality of life for millions of Africans.

*Lassina Zerbo is the chairperson of the Rwanda Atomic Energy Board, former prime minister of Burkina Faso, and executive secretary emeritus of the Comprehensive Nuclear-Test-Ban Treaty Organization.*

In this year's survey, energy storage (21 percent) was viewed as the top technology for investment for the year ahead, followed closely by solar (18 percent). Tied for third are hydrogen and nuclear at 11 percent. The variations from last year's predictions are small. The most notable are the increase in the numbers choosing storage, solar, and nuclear. Only minor differences appear when dividing up the results by gender, age, time in the industry, or level of seniority. The figures for the Global South are also similar to those of the overall average, other than a higher number who chose hydrogen (18 percent) and a lower one for nuclear (5 percent). Bias to one's own industry is prevalent throughout the survey results, however.

Nearly half of those involved in renewable energy answered either energy storage (32 percent) for this question or hydrogen (17 percent). These choices are consistent with one of the current problems of the renewables sector: that it can frequently produce substantial amounts of energy for local grids, but intermittency and variability remain a challenge. In this context, it is also noteworthy that just 3 percent of those in the renewable sector chose wind as a likely field of extensive research, less than those who name fossil fuels (4 percent). Wind technologies have matured substantially, but infrastructure constraints and supply chain challenges continue to bog down the industry.

Drawing a parallel, respondents in oil and gas are the most likely to expect research on fossil fuels (19 percent) and carbon capture and storage (7 percent)—which could make their products less carbon intensive. While those in the nuclear and electricity transmission space were the most likely to select nuclear and electricity transmission (15 percent and 11 percent respectively). In summary, those in a given industry are more likely to foresee—or perhaps hope for—research on their products or the tools to deliver them.

The most interesting takeaway from the survey results lies with the geographic distribution of the survey pool. Sub-Saharan Africa, for example, has a particularly high number selecting solar energy (33 percent). Of course, the continent's solar resources are immense, and the distributed nature of the technology makes deployment easier than some alternative sources of energy for the continent. South Asia, alternatively, places a primary emphasis on grid infrastructure, underscoring the importance of ensuring affordable power generation can reach demand centers throughout these large geographies.

**Figure 10. Which segment of the energy sector will see the greatest growth in investment in 2025?**

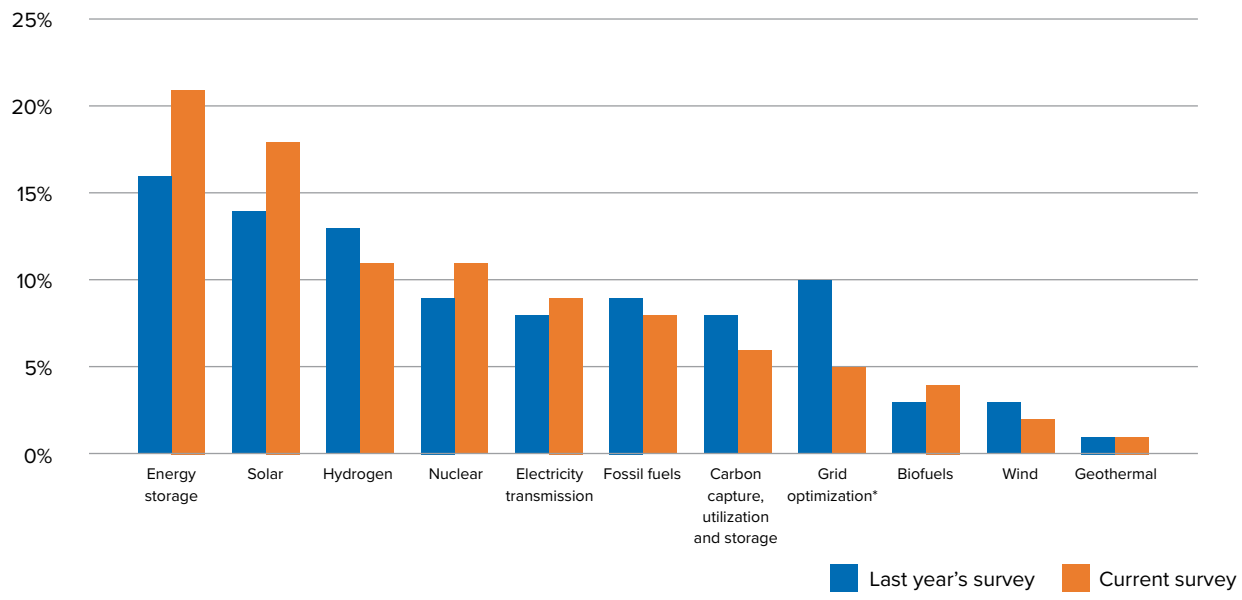
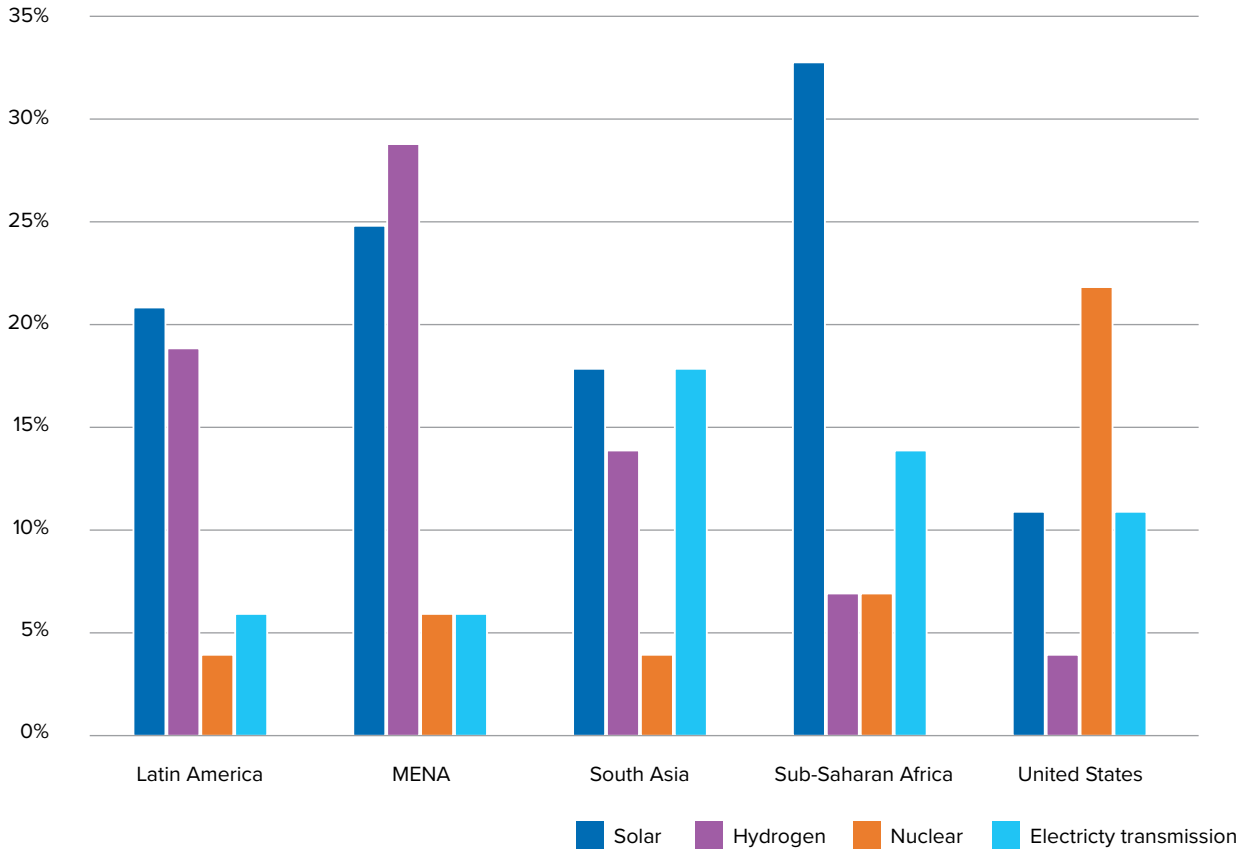


**Figure 11. Which segment of the energy sector will see the greatest growth in investment in 2025 (by region)?**




A quarter of respondents living in MENA, like Sub-Saharan Africa, believe investment will grow in solar resources. More striking, however, the most common selection in this group is research on hydrogen (29 percent). The reason is simple: the region is in search of new sources of energy exports as a backstop to ebbing reliance on hydrocarbon resources. Saudi Arabia, for example, is undertaking the world's largest green hydrogen project, seeking to turn the Kingdom's relatively low-cost energy from the sun and wind into an export commodity.

Finally, 22 percent of respondents from the United States chose nuclear, slightly more than three times the proportion in the rest of the survey (7 percent). While certain other regions may be wary of nuclear in any form, in the United States it provides around half of carbon-free electricity. Moreover, a range of companies are already drawing on the country's research strength to develop and deploy small modular reactors.

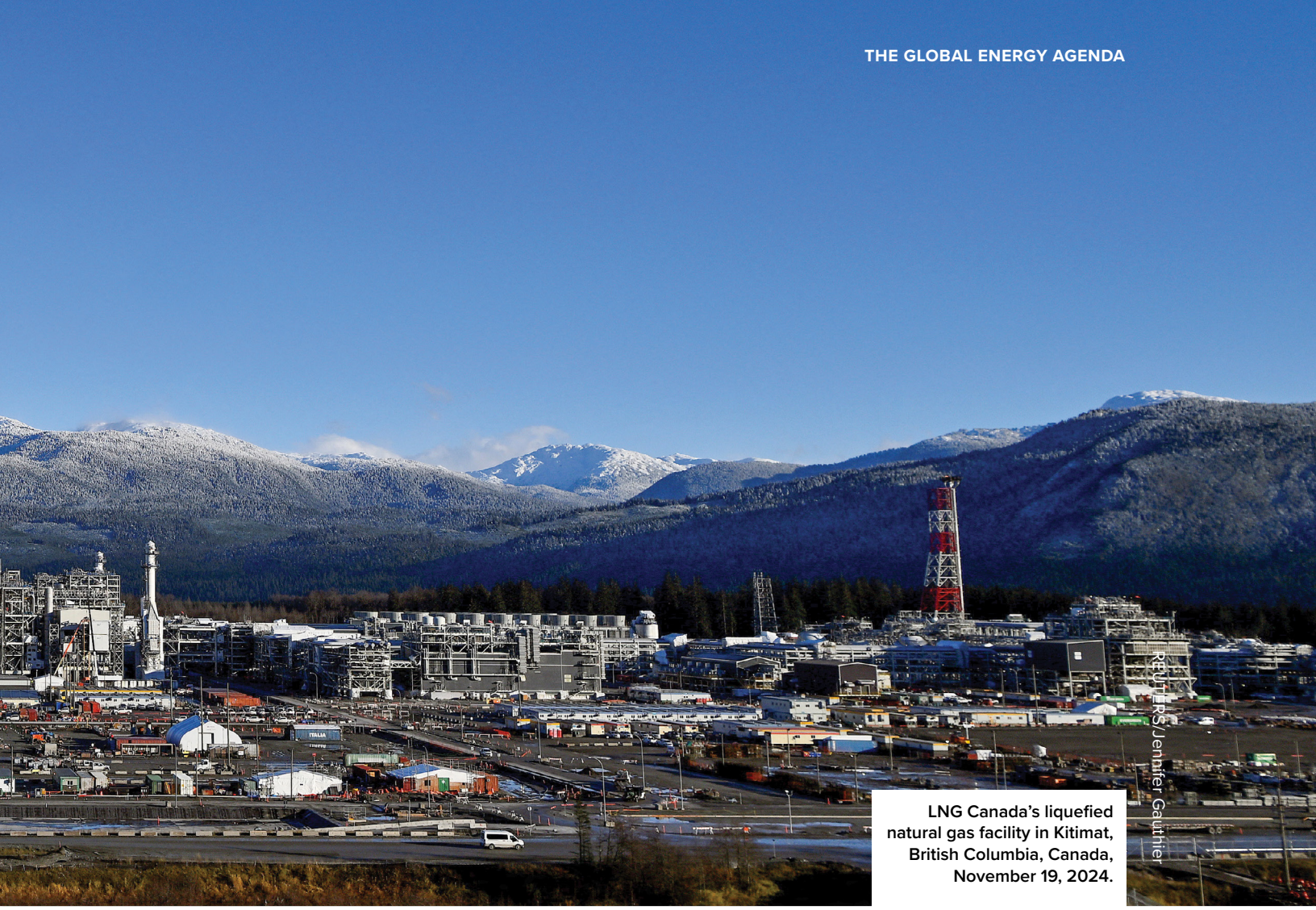
Overall, investment expectations vary widely by industry and geography. For those in the energy sector, it will therefore be advisable to keep abreast of developments worldwide that might be relevant to their own work and needs.

# CONCLUSION

IN CONTRAST TO THE SENSE OF momentum the world experienced following the impactful and wide-reaching energy and climate cooperation on display in Dubai at COP28 a year prior, the insights we gained from responses to this year's survey evoke a period of suspense and anticipation. As though in a holding pattern due to the series of pivotal elections around the world in 2024, our survey respondents' views of the global energy landscape vacillated little year-on-year. This steadiness is reinforced in collective certainty around the trajectory of the energy transition, but also poised to see where global affairs will head in a moment of vast political transformation. Given how deeply interwoven energy and climate policy are with national security and economic competitiveness, it is an understandable posture: Elections have consequences, and change is inevitable.

As Jim Farley acknowledges in his essay, "Political and policy change are part of the American democratic experiment and integral to the business landscape." This truism, however, does not ease the challenges affiliated with overcoming the uncertainty of new political paradigms. Nowhere is this more relevant than in the United States. With the reelection of Donald Trump, the world is likely to see a recalibration of US energy policy, one that not only emphasizes domestic production and export expansion but also one that is inextricably linked to the president's penchant for wielding trade policy as a tool for stimulating growth and prioritizing American industries.

Yet, as significant as Trump's resurgence on the global stage might be, focusing solely on the United States underrepresents the collective influence of



LNG Canada's liquefied natural gas facility in Kitimat, British Columbia, Canada, November 19, 2024.

REUTERS/Jennifer Gauthier

leaders from around the world as they too seek to transform international affairs to their advantage. President Claudia Sheinbaum's "Plan México" aspires to elevate her country's global standing through investment in strategic industries. Prime Minister Narendra Modi hopes to double India's share of global manufacturing through a strategy of tax cuts and infrastructure development. President Ursula von der Leyen is deploying a new "Competitiveness Compass" to transform Europe into the future of global innovation and technological deployment. These priorities represent just a glimpse of a world brimming with political ambition. And as has been the case in prior years, it is all but certain that each of these political journeys will require strategies to secure reliable, sustainable, and affordable energy supplies.

As this year's *Global Energy Agenda* illustrates, ongoing conflicts in Europe and the Middle East alongside the strategic realignment of supply chains and industrial policy, demonstrate that the pursuit of energy security remains paramount. The feedback of our survey respondents and essayists highlights, however, that new and disruptive events and technologies are growing in their influence over the arc of the energy transition—chief among these emerging trends is artificial intelligence. While AI's net impact on the energy system is still unknown, optimism for its reach abounds. Whether a producer that is enthusiastic about the prospect of stronger energy demand or a technologist hungry for data center efficiency gains, AI appears to be providing forward momentum in an otherwise tense period.

Given the sweeping reach of AI across the global economy, including in critical sectors such as healthcare, finance, and manufacturing, one can hope that this technological revolution will be as unifying as it is catalytic. As though an olive branch to a world grappling with how to define what it means to be competitive and secure in an era of new global leadership, innovation and technology stand out as the defining feature of *The 2025 Global Energy Agenda*.

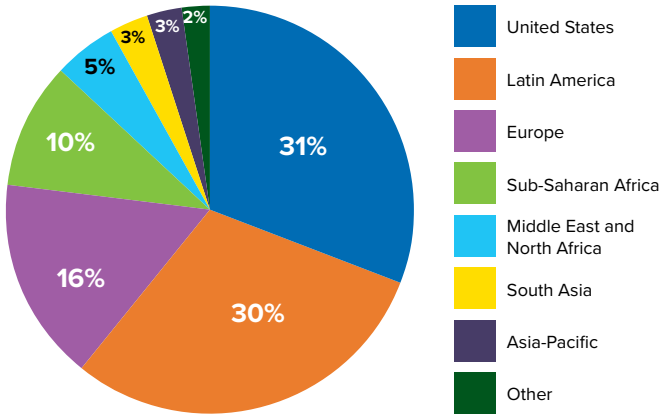
# APPENDIX

This year, more than one thousand experts from more than one hundred countries across the globe took part in the Atlantic Council's fifth annual *Global Energy Agenda* survey.

## BY GEOGRAPHY

The respondents form a globally diverse group; Just under one-third (31 percent) are based in the United States; 30 percent are in Latin America; 16 percent in Europe; 10 percent in Sub-Saharan Africa; 5 percent in the Middle East; and 3 percent and 2 percent from South Asia and Asia-Pacific (respectively).

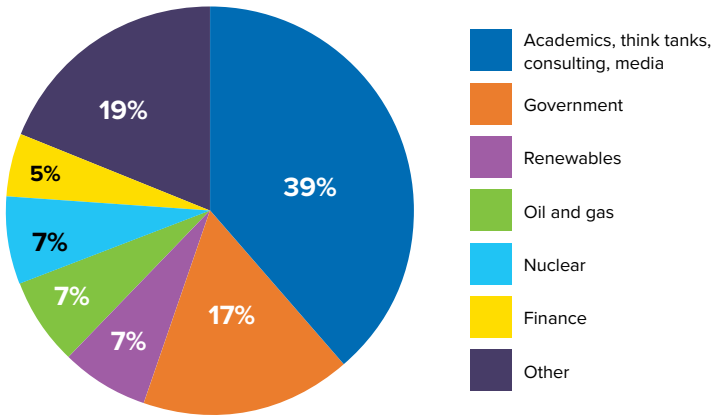
**In what country do you live? (grouped by regions outside of the United States)**




## BY SECTOR

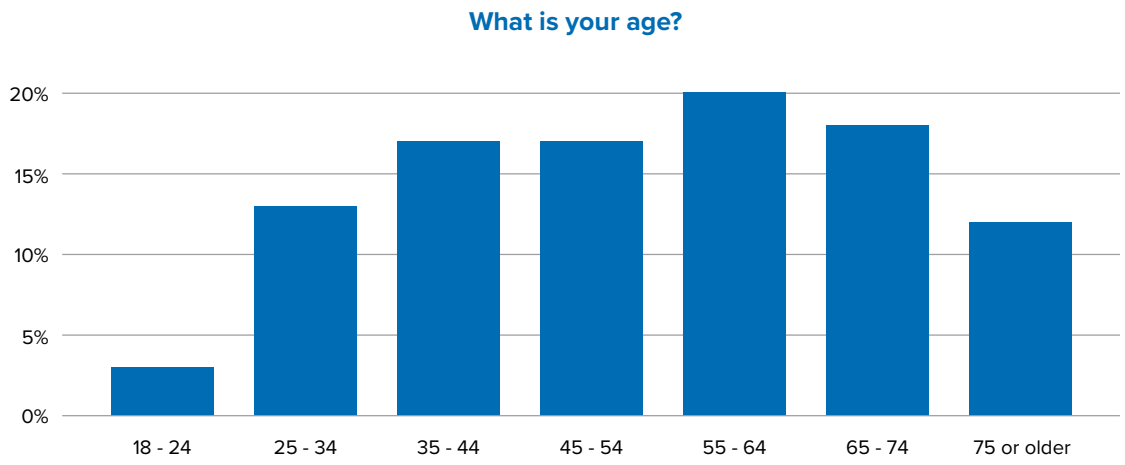
For the purposes of analysis, respondents are grouped by employment categories including: academics, think tanks, consulting, and the media; government employees; low-carbon producers, which include those working in renewables and nuclear and electricity; finance; and oil and gas.

**In which sector do you work?**



## BY AGE, EXPERIENCE, AND GENDER

Respondents range from 18 to over 75 with a mean age of 53, two years younger compared to last year. Consistent with the survey pool's mean age, many respondents are experienced in the industry. Overall, 40 percent have worked on policies and/or technologies related to energy for more than sixteen years, and a further 14 percent for more than ten. Similarly, 51 percent work at the executive or management levels of their respective organizations.



# KNOWLEDGE PARTNERS OF THE *2025 GLOBAL ENERGY AGENDA*

The Atlantic Council is deeply appreciative of our knowledge partners, who supported the *Agenda* by disseminating the survey to their communities. This outreach gave us the largest and most geographically diverse audience yet in the five years we have fielded the survey.

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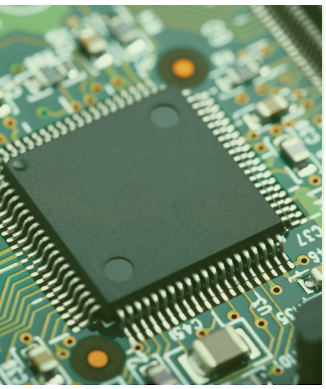

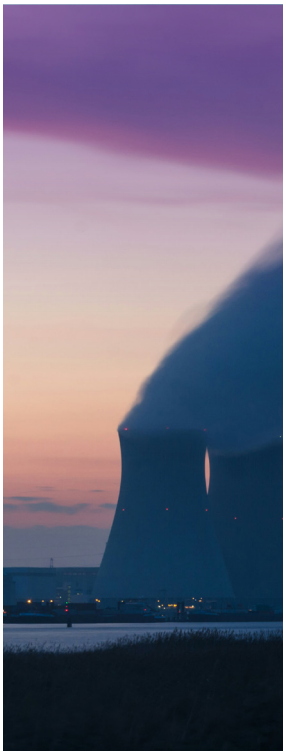

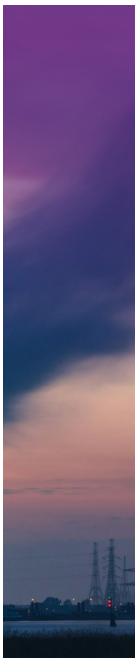

## Atlantic Council

The Atlantic Council is a nonpartisan organization that promotes constructive US leadership and engagement in international affairs based on the central role of the Atlantic community in meeting today's global challenges.



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