

World Energy Outlook 2025

By John Benson

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1. Introduction

This ended up being a very long post, verses my normal one, but the title report (reference 1 below) is very important very large and very complex.

This latest edition of the International Energy Agency (IEA) flagship publication, the World Energy Outlook (WEO), comes at a time when energy is increasingly at the center of political and geopolitical tensions. Of course, the links between energy and politics have always been close, but when we look at the energy world in recent decades, there is no other time when energy security tensions have applied to so many fuels and technologies at once.¹

Governments are contending with a formidable array of potential threats, vulnerabilities, dependencies and uncertainties spanning areas such as oil, natural gas, electricity, energy infrastructure, critical minerals, technology supply chains, data centers and AI, and more.

Energy security today is truly a matter of economic and national security – and safeguarding it requires the same spirit of cooperation and focus that governments showed when the IEA was created after the 1973 oil shock.

2. Executive Summary

Pressing threats and longer-term hazards are elevating energy to a core issue of economic and national security. Energy is at the heart of today's geopolitical tensions, with traditional risks to fuel supply now accompanied by restrictions affecting supplies of critical minerals. The electricity sector – so essential to modern economies – is also increasingly vulnerable to cyber, operational and weather-related hazards. Decisions taken by energy policy makers will be crucial to address these risks, but they do so against a complex backdrop:

- Geopolitical fragility coexists with subdued oil prices. Ongoing conflicts and instability sit alongside oil market balances showing a large surplus of energy supply over energy-demand.*
- Countries are prioritizing energy security and affordability but are reaching for different levers to achieve them. Some, including many fuel-importing countries, lean towards renewables and efficiency as solutions. Others focus more on ensuring ample supplies of traditional fuels.*
- There are fractures in the international system and uncertainties over the outlook for trade, but energy trade is more important than ever. Abundant supplies of oil, solar panels, batteries and, before long, liquefied natural gas (LNG) create strong incentives for producers to seek out international markets.*

¹ Note that this source (the primary source for this paper) was found by performing a search using a query-phrase “World Energy Outlook 2025” in my Microsoft Bing Browser. The main site for this is linked below, and from this a reader can download all or part of this report.

<https://www.iea.org/reports/world-energy-outlook-2025?s=0>

- *There is less momentum than before behind national and international efforts to reduce emissions, yet climate risks are rising. 2024 was the hottest year on record and the first in which global temperatures exceeded 1.5 degrees Celsius (°C) above preindustrial levels.*

At the same time, the world remains thirsty for energy. New technologies are entering the system at speed, and renewables set new records for deployment in 2024 for the 23rd consecutive year. Oil, natural gas and coal consumption, and nuclear output, all reached record highs as well. Driven mainly by China, since 2019, demand for coal has grown 50% faster than the next fastest growing fossil fuel, natural gas, a key reason why energy-related emissions have continued to grow.

There is no single storyline about the future of energy, which is why the World Energy Outlook presents multiple scenarios, none of which is a forecast. The framework presented in this Outlook is based on the latest and most comprehensive data on policies, technologies and markets, together with rigorous modelling. This allows readers to explore the implications of different choices and pathways.

3. Scenarios

The World Energy Outlook 2025 (WEO-2025) has three main scenarios. Two of these set starting conditions and then examine where they lead – the Current Policies Scenario (CPS) and the Stated Policies Scenario (STEPS). A third, the Net Zero Emissions by 2050 (NZE) Scenario, maps out a pathway to achieve specific energy and climate-related goals.

The Current Policies Scenario (CPS) considers a snapshot of policies and regulations that are already in place and offers a cautious perspective on the speed at which new energy technologies are deployed and integrated into the energy system.

The Stated Policies Scenario (STEPS) considers the application of a broader range of policies, including those that have been formally put forward but not yet adopted, as well as other official strategy documents that indicate the direction of travel. Barriers to the introduction of new technologies are lower than in the CPS, but the Stated Policies Scenario (STEPS) does not assume that aspirational targets are met.

The Net Zero Emissions by 2050 Scenario takes a different approach, describing a pathway to reduce global energy-related carbon dioxide (CO₂) emissions to net zero by 2050, while recognizing that each country will have its own route.

*An additional standardizing scenario, the **Accelerating Clean Cooking and Electricity Services Scenario (ACCESS)**, provides a new roadmap to achieve universal access to electricity and clean cooking – crucial development goals that the IEA has actively supported for more than two decades. The WEO-2025 does not include the **Announced Pledges Scenario**, which models a future for the energy system in which key national energy and climate targets, such as countries' nationally determined contributions (NDCs), are achieved in full and on time. Our assessment of the new round of NDCs that were due this year, generally covering the period to 2035, will follow once there is a more complete picture of these commitments.*

What do the WEO scenarios allow us to assert with confidence about the future? Our scenarios cover a wide range of trajectories, highlighting different opportunities and vulnerabilities, but there are common elements. Most fundamentally, as economies expand and populations and incomes grow, each scenario sees the world's need for energy services increase with demand rising for mobility; heating, cooling, lighting and other household and industrial uses. More and more, demand for data and artificial intelligence (AI)-related services is increasing.

Beyond this, four other commonalities stand out: the changing nature of energy security, with the supply of critical minerals as an acute vulnerability; the arrival of the Age of Electricity; a shift in the center of gravity of the energy system towards India and other emerging economies beyond China; and a rising role for renewables, accompanied by the comeback of nuclear energy.

4. Serious Threats to Critical Minerals Supply

Traditional hazards affecting the security of oil and gas supply are now accompanied by vulnerabilities in other areas, most visibly in critical minerals supply chains. These new dimensions to energy security have been a consistent focus for the International Energy Agency. They were central to our Summit on the Future of Energy Security in London in 2025 and have been underscored by China's new export controls on rare earth elements and battery components/technologies. The key risk for critical minerals is high levels of market concentration. A single country is the dominant refiner for 19 out of 20 energy-related strategic minerals, with an average market share of around 70% as these minerals are vital for power grids, batteries and EVs, but they also play a crucial role in AI chips, jet engines, defense systems and other strategic industries. As of November 2025, more than half of these minerals are subject to some form of export controls.

*Fostering more diverse and resilient supply chains for critical minerals will take a concerted policy effort; market forces alone will not deliver. Since 2020, most of the growth in refined production of key energy minerals came from the leading suppliers. As a result, geographic concentration in refining increased for nearly all key energy minerals, and particularly for nickel and cobalt. Our analysis of announced projects suggests that reversing this process is set to be slow. In the CPS, supply concentration would be likely to remain higher than in the **Stated Policies Scenario (STEPS)**, as weaker minerals demand translates into lower prices that favor incumbent producers with lower costs. Determined action is required today to enhance preparedness against potential disruptions, and over the longer term to build up new partnerships and projects that diversify supply chains more quickly.*

Author's comment: Although the risk addressed in this section is a serious one, the U.S. is taking some steps to mitigate it. I performed a search using the Microsoft Bing Copilot engine with the query phrase "Serious Threats to U.S. Critical Minerals Supply" and the following resulted.

4.1. Geopolitical Concentration and China's Dominance

China controls or refines the majority of global supply for many critical minerals, including rare earths, gallium, tungsten, and graphite. It has used export restrictions as geopolitical leverage in response to U.S. trade and technology measures. This creates a "China chokepoint" that could be exploited in conflict or trade disputes.

4.2. Extreme Weather and Environmental Disruption

Droughts, heat waves, and other climate shocks are already disrupting mining and processing in countries the U.S. is trying to diversify with. These events can halt production and destabilize supply chains without warning.

4.3. Structural Supply Chain Fragility

Global supply chains are long, complex, and concentrated in a few countries. Even with domestic mining, the U.S. lacks reserves for all critical minerals, and building new mines, smelters, and processing plants takes years to decades.

4.4. Limited Domestic Reserves and Processing Capacity

The U.S. does not have enough of all critical minerals domestically, and smelting/refining capacity is insufficient. Even aggressive expansion would leave the U.S. dependent on imports for key minerals like copper, lithium, nickel, and graphite.

4.5. Policy & Strategic Responses to Threats

Onshoring – Expand domestic mining and processing.

Friend-shoring – Secure supply with allied nations.

Recycling – Build circular economy for critical minerals.

Technological innovation – Develop new extraction and separation methods.

4.6. Other Measures

Streamlined permitting and investment incentives (e.g., One Big Beautiful Bill Act, Industrial Base Fund) Strategic stockpiles and trade policies to ensure access and price stability.

International agreements and partnerships to diversify supply.

4.7. Reality Check

Even with maximum effort, domestic production will not meet all demand by 2035; some minerals will still require imports. The challenge is to build resilience, not just self-sufficiency.

5. Resilience is Key with Rising Security Risks

There is also an urgent need to build greater resilience to rising weather-related risks, cyberattacks and other malicious activity targeting critical infrastructure. A new IEA dataset shows that recent annual operational disruptions to critical energy infrastructure affected energy supplies to more than 200 million households around the world. Droughts constrain output from hydropower and some thermal generators, while storms, floods and wildfires force shutdowns and damage different types of energy facilities, from solar plants to offshore oil and gas facilities. Power lines are particularly vulnerable: transmission and distribution grids were affected in about 85% of incidents. Weather-related risks are set to rise across our scenarios, which all exceed 1.5 °C warming on a regular basis by around 2030, diverging only after 2035.

6. The Age of Electricity is Here

Electricity is at the heart of modern economies and electricity demand grows much faster than overall energy use in all scenarios. It rises by around 40% to 2035 in both the CPS (Current Policies Scenario) and the STEPS (Stated Policies Scenario), and by more than 50% in the NZE (Net Zero Emissions by 2050) Scenario. Demand growth comes in varying proportions from appliances and air conditioners, advanced manufacturing and other light industries, electric mobility, data centers and electrified heating. Investors are reacting to this trend: spending on electricity supply and end-use electrification already accounts for half of today's global energy investment. Rising electricity use means that electricity prices are becoming a key reference point for consumers and policy makers. For the moment, electricity accounts for only 21% of total final consumption globally, but it is the key source of energy for sectors accounting for over 40% of the global economy and the main source of energy for most households. This underscores the importance of secure and affordable electricity supply, and the economic and social costs of blackouts such as those seen in 2025 in Chile and the Iberian Peninsula.

A pivotal issue for electricity security in the Age of Electricity is the speed at which new grids, storage and other sources of power system flexibility are put in place. For the moment, some of these elements are lagging. Investments in electricity generation have charged ahead by almost 70% since 2015 to reach USD 1 trillion per year, but annual grid spending has risen at less than half the pace to USD 400 billion. This increases congestion, delays the connection of new sources of electricity generation and demand, and pushes up electricity prices. Curtailment of wind and solar output is on the rise, as are incidences of negative pricing in wholesale markets, but slow permitting is holding back grid projects, as are tight markets for transformers and other components. Risks have been mitigated in part by the rise of battery storage, where annual additions rose to more than 75 gigawatts (GW) in 2024, but batteries cannot provide all the answers – especially where seasonal flexibility needs rise alongside short-term ones.

*Rising incomes and temperatures underpin a surge in electricity use for air conditioning. Cooling is a rising source of electricity demand in all scenarios, led by emerging and developing economies, with important potential impacts on peak electricity demand. In the **STEPS (Stated Policies Scenario)** (see Page 3), for example, income-driven air conditioning use adds around 330 GW to global peak demand by 2035, and higher temperatures add another 170 GW. The efficiency of new air conditioners is a critical factor for managing future strains on power systems. In all markets, there are already much more efficient air conditioners available on the shelves, at no or modest additional cost, than the average models being bought today.*

Explosive growth in electricity demand for data centers and AI is concentrated in advanced economies and China. Investment in data centers is expected to reach USD 580 billion in 2025. Those who say that “data is the new oil” will note that this surpasses the USD 540 billion being spent on global oil supply. A tripling of the amount of electricity consumed by data centers by 2035 represents less than 10% of total global electricity demand growth, but it is highly concentrated geographically. More than 85% of new data center capacity additions over the next ten years are expected in the United States, China and the European Union – and many are located near existing data center clusters, putting additional strain on congested grids.

7. New players

Energy market dynamics are increasingly shaped by a group of emerging economies, led by India and Southeast Asia and joined by countries in the Middle East, Latin America and Africa. Collectively, they take up the baton from China – which accounted for more than half of global oil and gas demand growth and 60% of electricity demand growth since 2010 – although no country comes close to replicating China's energy trajectory on its own.

Mapping the new geography of demand onto the distribution of global energy resources reveals that, by 2035, 80% of energy consumption growth occurs in regions with high-quality solar irradiation. This is a sharp contrast with the past decade when medium- to low-solar regions drove half of the growth. This helps explain the swift uptake of solar technologies in our scenarios, as well as the rise in demand for cooling. Many of the new demand centers in Asia have some domestic coal resources and rely on imported oil and gas.

8. Renewable Energy & Nuclear

The pace varies, but renewables grow faster than any other major energy source in all scenarios, led by solar photovoltaics (PV). In the CPS (Current Policies Scenario), where they face stronger headwinds, renewables still meet the largest share of total energy demand growth, followed by natural gas and oil, even though annual solar PV additions in the power sector stall at around today's levels of 540 GW to 2035. In the STEPS (Stated Policies Scenario), policy changes mean that the United States has 30% less renewables capacity installed in 2035 than in last year's Outlook, but at the global level renewables continue their rapid expansion. A boom in solar deployment is accompanied by robust growth across wind, hydropower, bioenergy, geothermal and other technologies, and by improvements in energy efficiency. China continues to be the largest market for renewables, accounting for 45-60% of global deployment over the next ten years across the scenarios, and remains the largest manufacturer of most renewable technologies.

Ample production capacity of solar panels and batteries, much of it in China, keeps prices competitive, but also raises concerns in some markets. In 2024, there was sufficient manufacturing capacity to have produced more than twice as many solar PV modules as were actually deployed, and almost three-times as many battery cells. China's exports of new energy technologies, including EVs, have grown to account for nearly 5% of its total goods exports, and Chinese companies have been investing in manufacturing facilities abroad in Indonesia, Morocco, Hungary, Brazil and elsewhere. While some countries, notably developing economies, see a major opportunity to access cost-competitive technologies, there are also concerns about China's dominance of these new value chains. A key question is what happens to this surplus capacity in the context of trade barriers, demand-side uncertainties, substantial pressures on technology prices, and falling profit margins for some producers.

Another common element across scenarios is the revival of fortunes for nuclear energy, with investment rising in both traditional large-scale plants and new designs, including small modular reactors (SMRs). More than 40 countries now include nuclear energy in their strategies and are taking steps to develop new projects. In addition to reactors that are restarting operation, notably in Japan, there are more than 70 GW of new capacity under construction, one of the highest levels in 30 years. Innovation, cost control and greater visibility on future cash flows is essential to diversify a sector that has been characterized by high market concentration, including for construction, uranium production and enrichment services. Technology companies are supporting the emergence of new business models, with agreements and expressions of interest for 30 GW of SMRs, mainly to power data centers.

With these developments, after more than two decades of stagnation, global nuclear power capacity is set to increase by at least one-third through 2035.

9. Recent U.S. Policy and Other Changes

The United States' multibillion-dollar campaign to loosen China's grip on critical minerals is beginning to reshape supply chains, according to The Wall Street Journal.²

Washington's effort to back mines, processing plants and magnet makers through equity stakes, loans, price guarantees and offtake supports has accelerated after China imposed export controls on key rare earth elements in April 2025, the Journal says in a roundup of the strategy (see footnote 2, below).

More than 180 critical-minerals-related projects have since been advanced by the Trump administration, while U.S. government non-equity investment in rare earth and magnet projects reached \$7.6 billion in the 18 months through June, more than four times the amount from 2020 through 2024, the New York-based news outlet reported.

The significance is that Washington is no longer relying mainly on grants or permitting reform. Its emerging model tackles several problems at once: high construction costs, exposure to low prices, uncertainty over customers and the shortage of processing and manufacturing capacity between mine output and finished products.

The clearest example is the Pentagon's purchase of \$400 million of MP Materials' (NYSE: MP) preferred shares. It also provided a \$150-million loan while guaranteeing a \$110-per-kg floor price for neodymium-praseodymium products and buyers for magnets from a planned second plant in Texas.

Lithium Americas (TSX, NYSE: LAC) is receiving similar backing for Thacker Pass in Nevada. The project has a \$2.23-billion loan from the Department of Energy, which also holds warrants equivalent to a 5% stake in Lithium Americas and a separate 5% non-voting interest in the project joint venture. Thacker Pass is 62% owned by Lithium Americas and 38% by General Motors.

² Colin McClelland, "US minerals push starts to dent China's grip: WSJ, September 29, 2026." Colin McClelland is currently the Editor in Chief at The Northern Miner, a Canadian mining and energy news outlet.

9.1. Energy Fuels

Energy Fuels (TSX: EFR; NYSE-A: UUUU) received a conditional \$725-million loan commitment in June from the U.S. Office of Strategic Capital to expand rare earth and critical-minerals production and processing.

The strategy is also extending offshore. Washington has struck more than two dozen mineral-development agreements with countries including Australia, Japan, Brazil, Argentina, Uzbekistan and the Democratic Republic of Congo. The Journal's tally of government-backed transactions includes USA Rare Earth (Nasdaq: USAR), Korea Zinc (KRX: 010130) and Sunrise Energy Metals (ASX: SRL).

China nevertheless retains commanding positions in the mining, separation and refining of several strategic materials, and rebuilding western-capacity could take a decade or more.

But London-based commodities research and consulting firm CRU projects China will lose market share by 2030 in several areas it now dominates, suggesting the U.S. push is beginning to create the alternative supply chains Washington has sought for years.

Final Author's Comment: *De trop près se chauffe, qui se brûle* ("He who gets too close to the fire burns himself"). China needs to pay heed to this old French Proverb. Now that the above moves from China have passed the point of being a minor annoyance and have become a real threat to national security, the U.S. (and our allies) have the resources and obligation to strongly counter these moves.