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GLOBAL ENERGY PATHWAY

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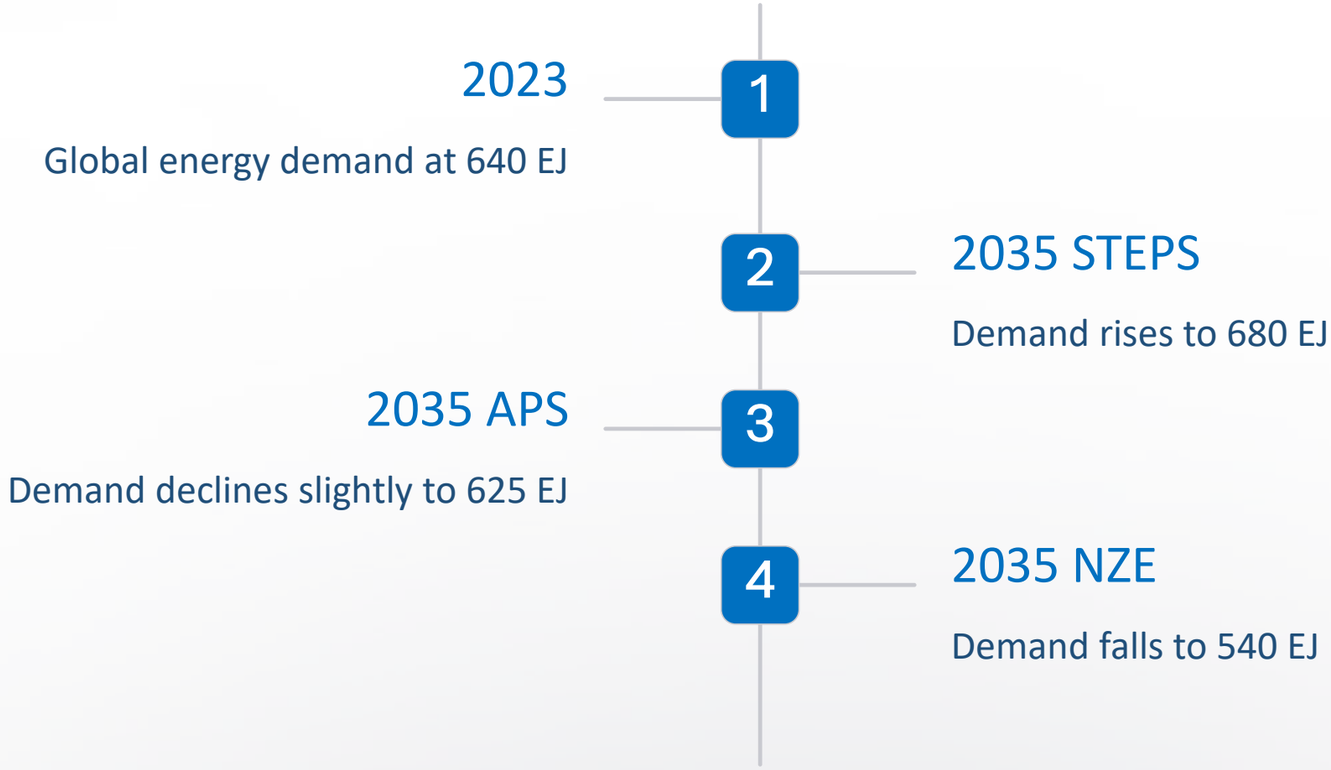
Pathways for the Global Energy Mix

The global energy landscape is undergoing a significant transformation. While demand for energy services continues to grow, efficiency gains and electrification are slowing the overall energy demand growth rate. Clean technologies like renewables and electric vehicles are reshaping the energy mix, leading to a projected peak in demand for oil, natural gas, and coal by 2030 across all scenarios examined. However, accelerated clean energy investment must fulfill climate pledges and move towards a net zero emissions pathway. This chapter explores various pathways for meeting the world's future energy needs and examines how policy decisions shape the choices ahead.

Global Energy Demand Trends

Global energy demand growth is slowing across all scenarios, with varying trajectories. In the Stated Policies Scenario (STEPS), demand rises to 680 exajoules (EJ) by 2035, growing at only one-third the rate of the past decade. The Announced Pledges Scenario (APS) sees a slight decline to 625 EJ, while in the Net Zero Emissions by 2050 (NZE) Scenario, demand falls to 540 EJ. Notably, all growth in the STEPS comes from emerging market and developing economies. These divergent paths stem from the same economic and population growth assumptions, highlighting the impact of policy choices and technology deployment on energy consumption patterns.



Peak and Decline of Fossil Fuels

A significant finding across all scenarios is that demand for each fossil fuel - coal, oil, and natural gas - peaks by 2030 and then declines. In the STEPS, coal demand begins to decline around 2025, while oil and natural gas demand peak towards the end of the decade. The fossil fuel share of total energy supply, which has long hovered around 80%, declines to 75% by 2030 and below 60% by 2050 in this scenario. The APS and NZE Scenario show more rapid declines, with fossil fuels making up around 35% and 15% of total energy supply by 2050, respectively.

Coal Peak

Demand begins to decline around 2025 in STEPS

Oil and Gas Peak

Demand peaks towards the end of the decade in STEPS

Fossil Fuel Share 2030

Declines to 75% in STEPS

Fossil Fuel Share 2050

Below 60% in STEPS, 35% in APS, 15% in NZE

Rise of Electricity in Final Consumption

Electricity's share in final energy consumption is set to increase significantly across all scenarios. From 20% today, it rises to 26% by 2035 in the STEPS, 29% in the APS, and 36% in the NZE Scenario. This growth is driven by economic expansion, increasing electrification of end-uses (notably electric vehicles), and rising demand for data centers. China's electricity demand is growing particularly rapidly and is projected to surpass the combined demand of all advanced economies by 2030. This shift towards electrification is a key factor in reducing overall energy intensity and facilitating the integration of renewable energy sources.

STEPS 2035	APS 2035	NZE 2035
26% electricity share in final consumption	29% electricity share in final consumption	36% electricity share in final consumption

Renewable Energy Growth in Electricity Generation

Low-emissions sources, led by renewables, are increasing faster than electricity demand in all scenarios, pushing down the share of fossil fuels in electricity generation. In 2023, renewables provided 30% of global electricity supply, while fossil fuels edged down to 60%, their lowest share in 50 years. By 2035, the share of solar PV and wind in electricity generation exceeds 40% globally in the STEPS, and by 2050 increases to nearly 60%. The share of nuclear power remains close to 10% in all scenarios, providing a stable baseload of low-carbon electricity. This rapid growth in renewables is crucial for decarbonizing the power sector and enabling clean electrification across the economy.

1 **2023 Electricity Mix**

30% renewables, 60% fossil fuels, 10% nuclear

2 **2035 STEPS**

Over 40% solar PV and wind

3 **2050 STEPS**

Nearly 60% solar PV and wind

4 **Nuclear Power**

Remains close to 10% in all scenarios

Key Clean Energy Technologies

Seven clean energy technologies are identified as crucial for affordable and secure energy transitions: solar PV, wind, nuclear, electric vehicles, heat pumps, hydrogen, and carbon capture. Together, these technologies account for three-quarters of the CO2 emissions reductions to 2050 in the APS and the NZE Scenario. They are complemented by other renewables such as bioenergy and geothermal, as well as energy efficiency measures. Overcoming barriers to their deployment, including developing necessary network and storage infrastructure, should be a priority worldwide to accelerate the transition to a low-carbon energy system.

Solar PV

Rapidly expanding clean electricity source

Wind Power

Growing onshore and offshore deployment

Nuclear

Stable low-carbon baseload power

Electric Vehicles

Transforming transportation sector

Energy Efficiency and Electrification

Energy efficiency improvements and increased electrification play a crucial role in slowing energy demand growth across all scenarios. These factors, combined with the deployment of clean technologies, lead to a significant reduction in the energy intensity of the global economy. In the STEPS, energy demand growth from 2023 to 2030 is only 0.7% per year, half the rate of the past decade. The APS and NZE Scenario show even more pronounced effects, with global energy demand slightly declining or falling significantly, respectively. This decoupling of economic growth from energy demand is essential for achieving climate goals while maintaining economic development.

Energy Intensity Reduction

Significant decrease in energy use per unit of GDP across all scenarios

Electrification

Increasing share of electricity in final energy consumption, enabling efficient end-use technologies

Clean Technologies

Deployment of renewables and other low-carbon solutions further reducing energy intensity

Economic Decoupling

Maintaining economic growth while reducing energy demand and emissions

Regional Variations in Energy Transitions

The pace and nature of energy transitions vary significantly across regions. While advanced economies are seeing stagnant or declining energy demand, emerging markets and developing economies continue to experience growth, albeit at a slower rate than in the past. China's rapid electrification and renewable energy deployment stand out, with its electricity demand set to surpass that of all advanced economies combined by 2030. Other regions, such as India and Southeast Asia, are also seeing significant growth in clean energy technologies, but face challenges in phasing out existing fossil fuel infrastructure. These regional differences highlight the need for tailored approaches to energy transitions that consider local economic, social, and resource contexts.

Region	Energy Demand Trend	Key Transition Focus
Advanced Economies	Stagnant/Declining	Renewables, Electrification
China	Rapid Growth	Electrification, Renewables
India	Moderate Growth	Clean Energy, Fossil Phase-out
Southeast Asia	Moderate Growth	Clean Energy, Infrastructure

Investment Needs for Clean Energy Transition

Achieving the clean energy transitions outlined in the APS and NZE Scenario requires a significant scaling up of investment in clean energy technologies and infrastructure. While global clean energy investment has increased rapidly over the last five years, nearly all of this increase has been in advanced economies and China. Increasing capital flows to clean energy projects in other emerging markets and developing economies is essential to meet their rapidly rising demand for energy services sustainably and support economic growth. However, higher financing costs and perceived risks in many of these markets present challenges. Addressing these barriers and mobilizing both public and private capital will be crucial for accelerating the global energy transition.

Clean Energy Investment

Rapid growth in advanced economies and China, but lagging in other regions

Public-Private Partnerships

Essential for mobilizing capital in emerging markets

Risk Mitigation

Addressing financing barriers in emerging markets

Policy Implications and Future Outlook

The scenarios presented in this World Energy Outlook highlight the critical role of policy decisions in shaping the future energy landscape. While current policies in the STEPS show progress towards clean energy transitions, they fall short of meeting climate goals. The APS demonstrates that fulfilling all announced pledges would significantly accelerate the transition, but this is not enough to limit global warming to 1.5°C. The NZE Scenario outlines the rapid and far-reaching changes needed to achieve net zero emissions by 2050. Key policy priorities include supporting the deployment of clean energy technologies, investing in energy infrastructure, addressing regional disparities, and ensuring a just and inclusive transition. The choices made in the coming years will be crucial in determining the trajectory of the global energy system and its environmental impact.

Current Policies

Progress, but insufficient for climate goals

Announced Pledges

Accelerated transition, still short of 1.5°C target

Net Zero Pathway

Rapid, comprehensive changes needed

Policy Priorities

Clean tech deployment, infrastructure, just transition

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