



**UNIVERSITY
OF ALBERTA**

ECON 366: Energy Economics

Topic 2.2: The Global Energy Economy

Andrew Leach, Professor of Economics and Law

 aleach@ualberta.ca

 [leachandrew](https://github.com/leachandrew)

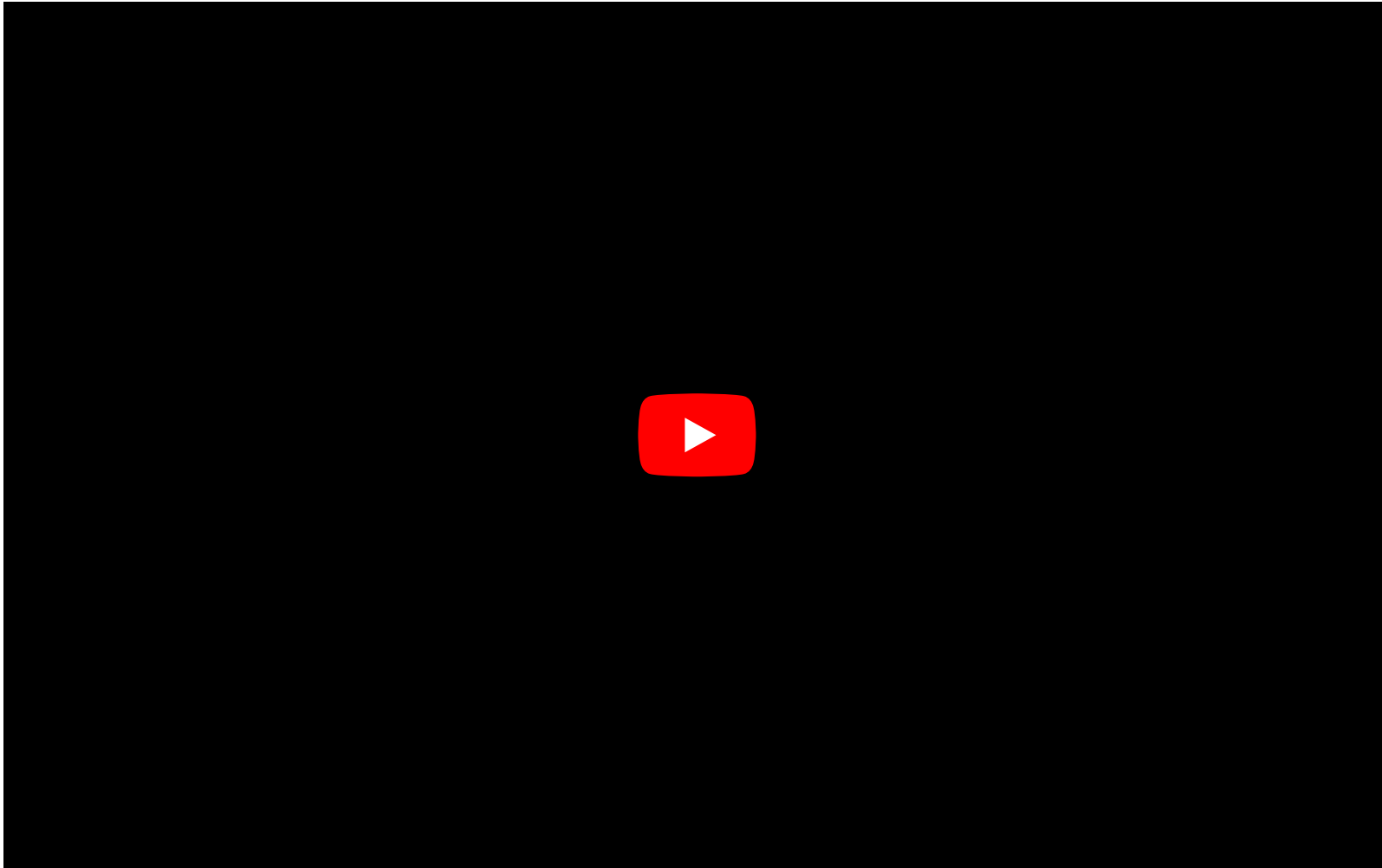
 [._andrew_leach](https://twitter.com/_andrew_leach)

Energy Scenarios



See [Shell Scenarios](#) and added documentation

Energy Scenarios



See [Shell Scenarios](#) and added documentation

Rivalry⁹

Population growth, urbanization and a growing middle class drive energy demand. Diverse sources of supply are required to satisfy demand, with intense competition for market share between energy sources.

- A mix of social, market and government forces drives fundamental changes in energy use and emissions pathways, but realization of climate goals remains limited.
- Politics and fiscal challenges constrain governments and inhibit co-operation.
- The marketplace often outpaces the government in driving change and investment.
- Energy transition accelerates but moves in different ways and at different speeds around the world.
- Citizens' conceptual aspirations to address climate change increase but support is fickle, with limited willingness to bear the full financial and social costs associated with realizing governments' climate change ambitions.

Indicative signpost that points to Rivalry

- Growing pressure to reduce absolute emissions, enhanced public discourse and competition to secure clean energy supply chains drives climate policy forward; however, co-ordinated global climate change action remains stalled.

Energy markets impact

- Energy mix evolves gradually and steadily – fossil fuels still dominate by 2050, but oil and coal lose ground to cleaner-burning natural gas and renewables.
- Oil demand stays largely flat during the scenario period.
- Natural gas demand growth is supported by abundant supply and policies favouring its lower carbon intensity over oil and coal.
- Renewables expand globally, enabled by coal-constraining policies in favour of cleaner power generation options.
- Hydrogen demand increases steadily.

Expected impact on Suncor

- Existing upstream assets are retired at their normal end of producing life.
- Higher prices and stricter emissions policies incentivize new technologies to lower our cost and carbon footprint.
- Competitive downstream provides robust returns and more aggressive investment in low-carbon fuels and electricity.
- Collaboration to reduce emissions continues, albeit at a more measured pace than in the Autonomy scenario.

Autonomy⁹

Revolutionary change in societal and political attitudes toward energy, climate and the environment drives the transformation to a low-carbon economy

- Pressure from stakeholders continues to push companies and governments toward faster action on ESG measures.
- Greater international co-operation ensures sufficient progress on climate change.
- Free and open markets in a technology-driven economy are strongly intertwined with climate change action.
- The massive changes to the global energy system to transition to a low-carbon world come at enormous cost, where people, companies, infrastructure and whole industries are made redundant, with significant investments required to replace the old and grow the new.

Indicative signpost that points to Autonomy

- In Canada, provinces and the federal government have improved the level of climate change co-operation as public concern for climate action continues to grow and political platforms converge on climate issues.

Energy markets impact

- Oil is still required for decades to come, but its share of energy demand declines over time as economic growth becomes less oil-intensive.
- Natural gas demand remains steady, overtaking oil as the largest source of global non-renewable energy by the end of the scenario period.
- Renewable power generation becomes the largest source of energy by the end of the period to meet growing electricity demand.
- Biofuels and biomass demand nearly doubles, replacing a share of decreasing fossil fuel use.
- Production of low-carbon hydrogen grows as technologies for its use also improve.

Expected impact on Suncor

- Some producing upstream assets may be retired before the end of their producing life.
- Base business is sustained and optimized, providing stable cash flow to support shareholder returns and fund growth of expanded low-carbon energy businesses (renewable fuels, electricity and hydrogen).
- Only top-tier refineries globally remain profitable – Suncor’s downstream maintains a focus on reliable, efficient, low-carbon and low-cost operations.
- Collaboration to reduce emissions accelerates (e.g., Pathways Alliance).

Discord⁹

Political instability and nationalistic tendencies inhibit governments, cause market uncertainty and slow the energy transition.

- Environmental progress and climate change mitigation weakens in the face of constant economic concerns and political and market instability.
- Chronic economic crises make governments short-term focused, insular and confrontational in international affairs
- The global supply chain breaks down, raising the cost of living for the emerging middle class.
- Decarbonization efforts continue in some key sectors and countries, but the scale and pace are insufficient to significantly alter global emissions growth.
- Global GDP growth falters with the weight of debt burdens, lack of financing availability and the inability of governments to generate growth.

Indicative signposts that point to Discord

- Heightened focus on national energy security, self-interest and protectionism as evidenced by Russia's invasion of Ukraine.
- Continued tension between the U.S. and China.
- Rising inflation among global economies.

Energy markets impact

- Change in the global energy mix slows; conventional fuels and technologies retain market leadership.
- Slower economic growth limits growth in energy, oil and refined product demand.
- Natural gas demand growth slows due to a constrained global economy and ongoing competition from lower-cost coal and falling-cost renewables.
- Despite continued competitiveness, renewables see less growth compared to Autonomy and Rivalry scenarios.

Expected impact on Suncor

- Existing upstream assets may be extended beyond their normal end of producing life.
- High-return energy investments continue to be funded.
- Suncor downstream well positioned to compete, with a focus on reliable, efficient and low-cost operations. Compared to Rivalry, there is less competition expected in both our traditional refined product businesses and low-carbon fuels and electricity businesses.

2°C

A plausible pathway to keep global temperatures from rising 2°C or less by 2100 compared with pre-industrial levels.

- Peak emissions are reached following a combination of cost and generational pressures, technological innovation and political unity that bring enough of the world together to take dramatic and unified action to change the trajectory of GHG emissions.
- Aggressive emission reductions occur in all sectors and solutions to remove GHGs from the atmosphere are implemented to reduce the total concentration of CO₂.
- An international alliance with a shared 2°C ambition, along with transparent collaboration in technology, trade and environmental approaches, is established.
- A broad-based price on carbon throughout the economy reduces consumption and incents the adoption and improvement of low-carbon technology.
- In conjunction with carbon pricing, governments implement market-based solutions within the alliance, including open carbon markets to buy, sell and trade offsets across a vast economy.

Energy markets impact

- Oil plays a continued, albeit diminished, role to 2100, while renewables and nuclear power become more prominent post-2050.
- In the power sector, the demand for coal faces sustained pressure globally because of its relatively high emissions intensity. Renewables continue to gain market share on improved cost profiles, dedicated policy support and the firm capacity offered by improved storage in the form of hydro, batteries and hydrogen. Nuclear power market penetration increases, given lower costs and new, safer technologies and policies.
- In the transportation sector, the world shifts away from oil. Oil demand in the second half of the century transitions to demand for petrochemical feedstock. The decline is most pronounced in the light-duty vehicle segment where electrification, biofuel and hydrogen supply opportunities grow. The decline is slower in the heavy goods vehicle segment and hydrogen as a transportation fuel grows as costs decrease.

Expected impact on Suncor

- Some producing upstream assets may be retired before the end of their producing life.
- We grow our business in renewable fuels, low-carbon power and hydrogen.
- We sustain and optimize our existing hydrocarbon business, reducing its carbon footprint.

Suncor Scenarios (PDF excerpt for reference)

Couldn't load plug-in.

Table 1.1 ▶ **Definitions and objectives of the GEC Model 2023 scenarios**

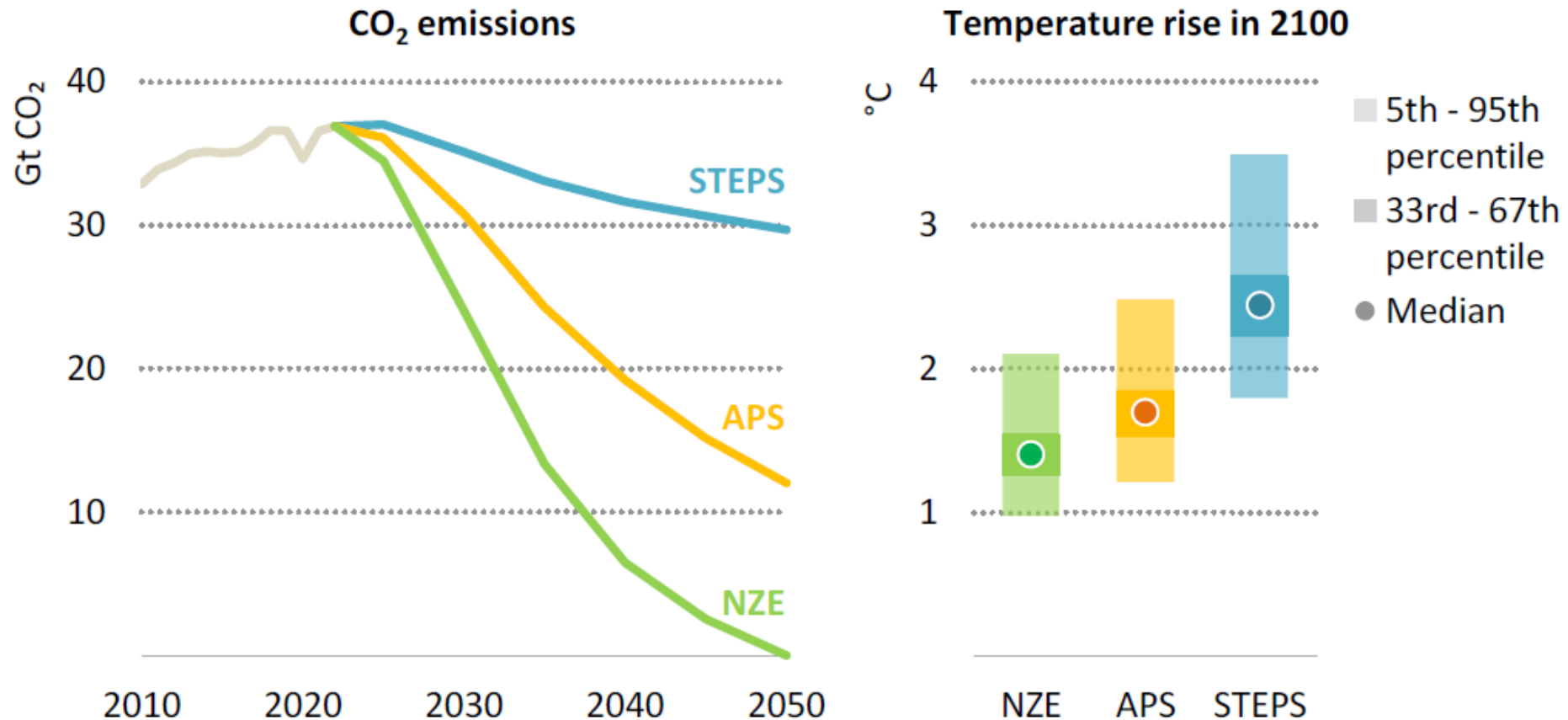
	Net Zero Emissions by 2050 Scenario (NZE Scenario)	Announced Pledges Scenario (APS)	Stated Policies Scenario (STEPS)
Definitions	A scenario which sets out a pathway for the global energy sector to achieve net zero CO ₂ emissions by 2050. It does not rely on emissions reductions from outside the energy sector to achieve its goals. Universal access to electricity and clean cooking are achieved by 2030. The scenario was fully updated in 2023.	A scenario which assumes that all climate commitments made by governments and industries around the world by the end of August 2023, including Nationally Determined Contributions (NDCs) and longer-term net zero targets, as well as targets for access to electricity and clean cooking, will be met in full and on time.	A scenario which reflects current policy settings based on a sector-by-sector and country-by-country assessment of the energy-related policies that were in place by the end of August 2023, as well as those that are under development. The scenario also takes into account currently planned manufacturing capacities for clean energy technologies.
Objectives	To show what is needed across the main sectors by various actors, and by when, for the world to achieve net zero energy-related and industrial process CO ₂ emissions by 2050 while meeting other energy-related sustainable development goals such as universal energy access.	To show how close current pledges get the world to the target of limiting global warming to 1.5 °C. The differences between the APS and the NZE Scenario highlight the “ambition gap” that needs to be closed to achieve the goals of the Paris Agreement adopted in 2015. It also shows the gap between current targets and achieving universal energy access.	To provide a benchmark to assess the potential achievements (and limitations) of recent developments in energy and climate policy. The differences between the STEPS and the APS highlight the “implementation gap” that needs to be closed for countries to achieve their announced decarbonisation targets.

IEA World Energy Outlook

Uses STEPS, APS, and NZE scenarios. Read the Executive Summary and glance at Chapter 1.

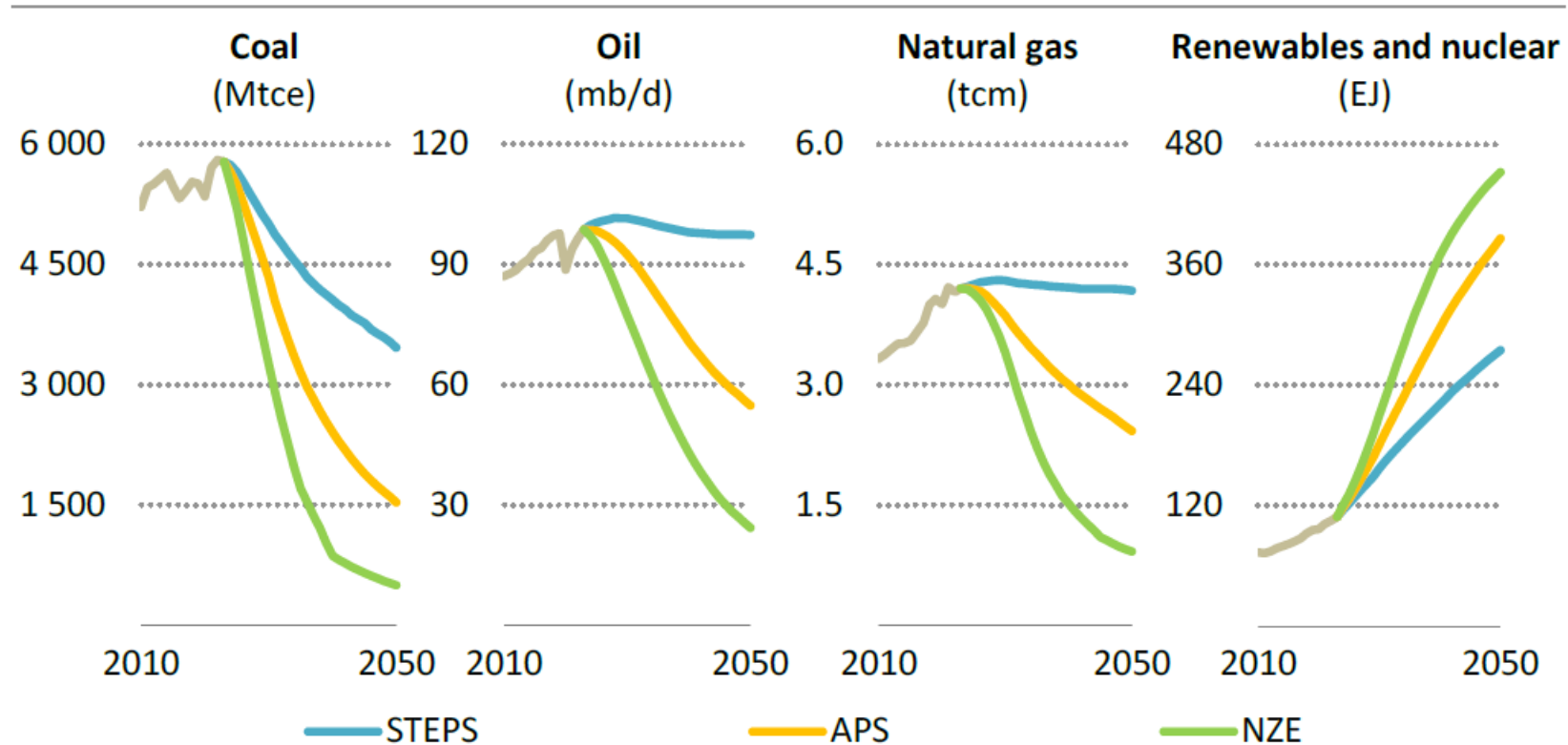
Couldn't load plug-in.

Figure 4.1 ▶ Global energy-related and industrial process CO₂ emissions by scenario and temperature rise above pre-industrial levels in 2100



IEA WEO: Net Zero TPES

Figure 3.1 ▶ Global total energy demand by fuel and scenario, 2010-2050



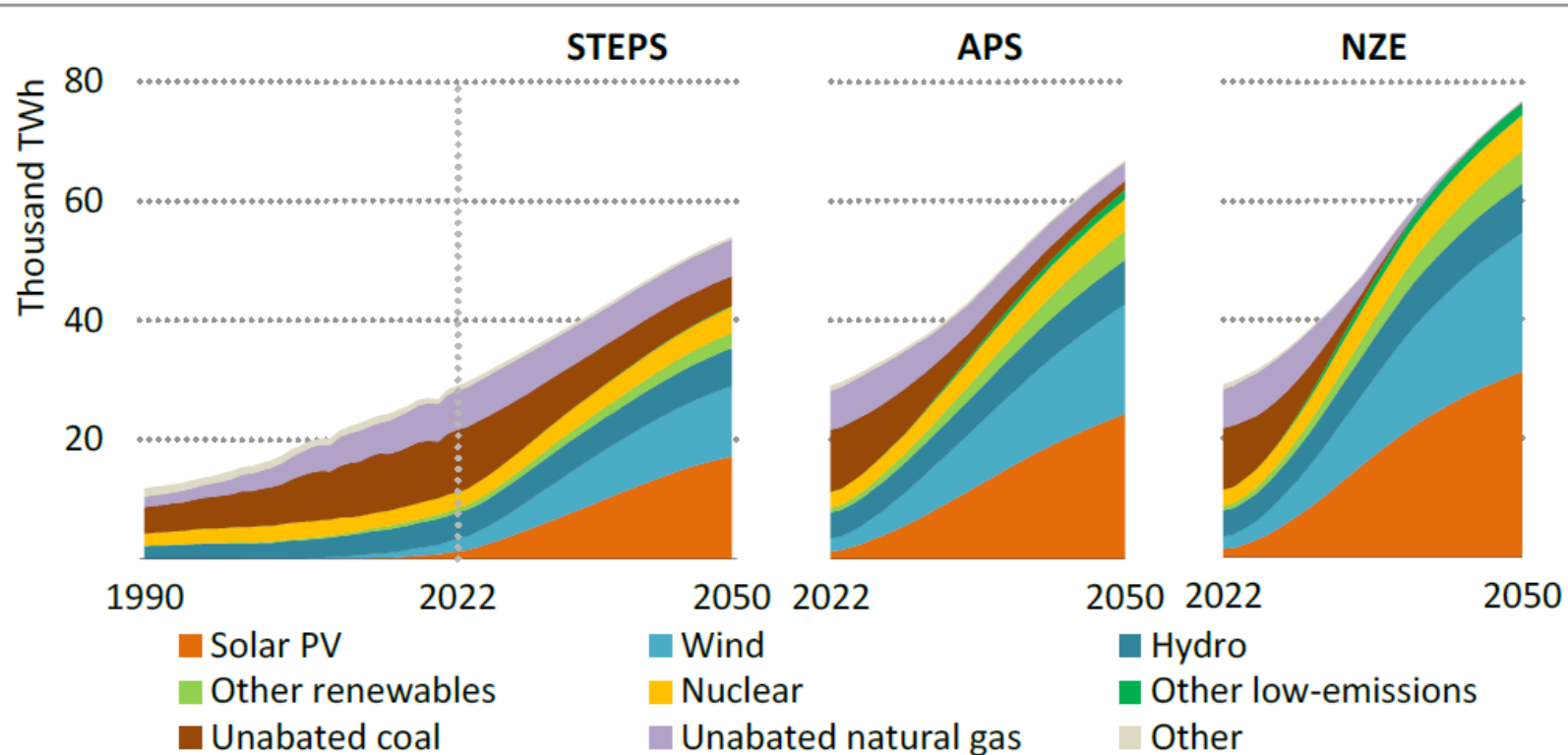
IEA. CC BY 4.0.

Low-emissions sources expand significantly and – for the first time – all fossil fuels peak and start to decline before 2030 in each scenario

Note: Mtce = million tonnes of coal equivalent; mb/d = million barrels per day; tcm = trillion cubic metres;

IEA WEO: Net Zero Power Generation

Figure 3.15 ▶ Global electricity generation by source and scenario, 1990-2050



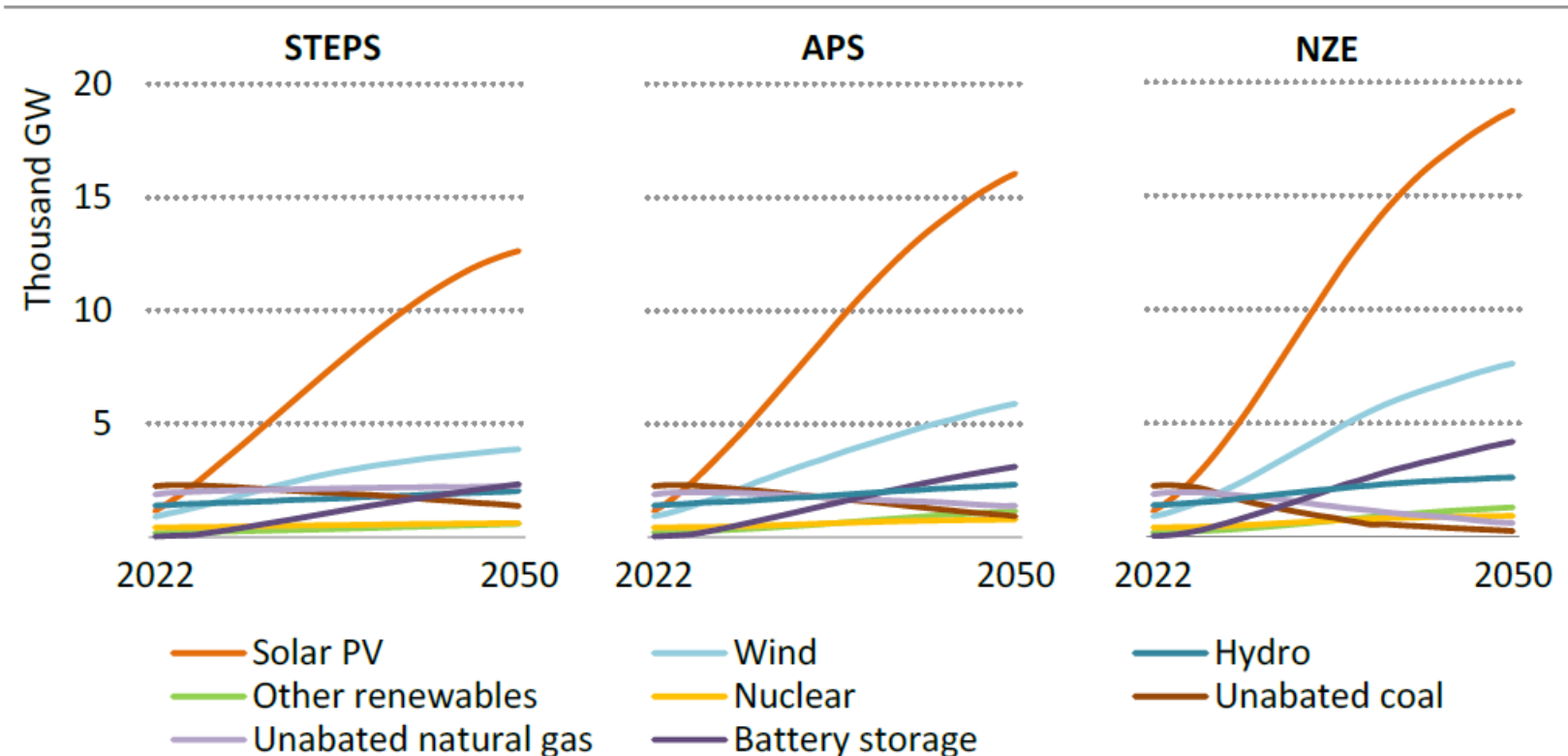
IEA. CC BY 4.0.

Renewables outpace electricity demand growth to 2030 in the STEPS, leading to a peak in coal-fired power in the near term though announced pledges call for faster declines

Notes: TWh = terawatt-hours. Other low-emissions include fossil fuels with CCUS, hydrogen and ammonia.

IEA WEO: Net Zero Generating Capacity

Figure 3.16 ▶ Global installed power capacity by selected technology and scenario, 2022-2050

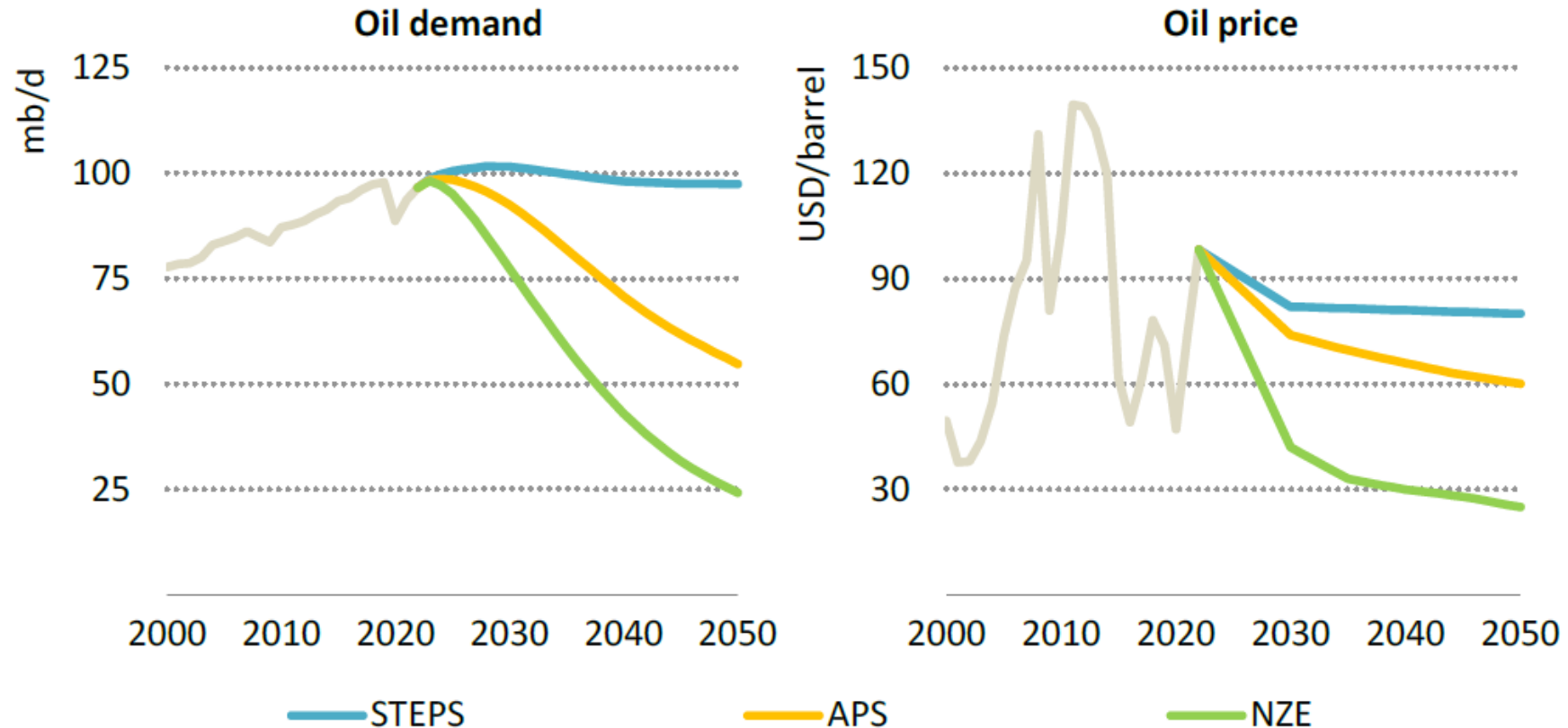


IEA. CC BY 4.0.

Solar PV capacity takes off in all scenarios, with only wind power at the same scale in the long term; their variable nature leads to increased deployment of battery storage

IEA WEO: Oil Prices and Quantities

Figure 3.19 ▶ Global oil demand and crude oil price by scenario, 2000-2050

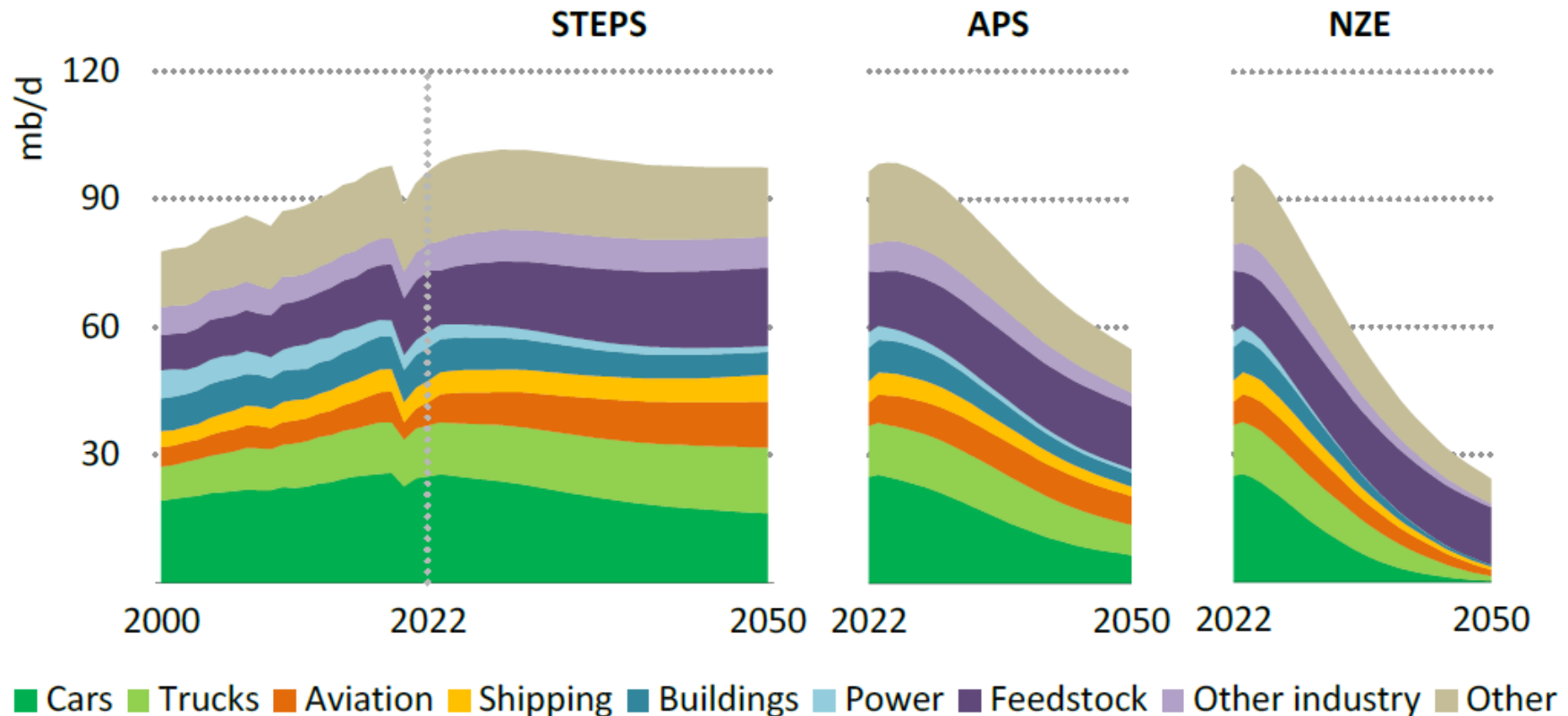


IEA. CC BY 4.0.

*Oil demand and prices peak in the late-2020s in the STEPS;
there are much sharper declines in both the APS and NZE Scenario*

IEA WEO: Oil Consumption

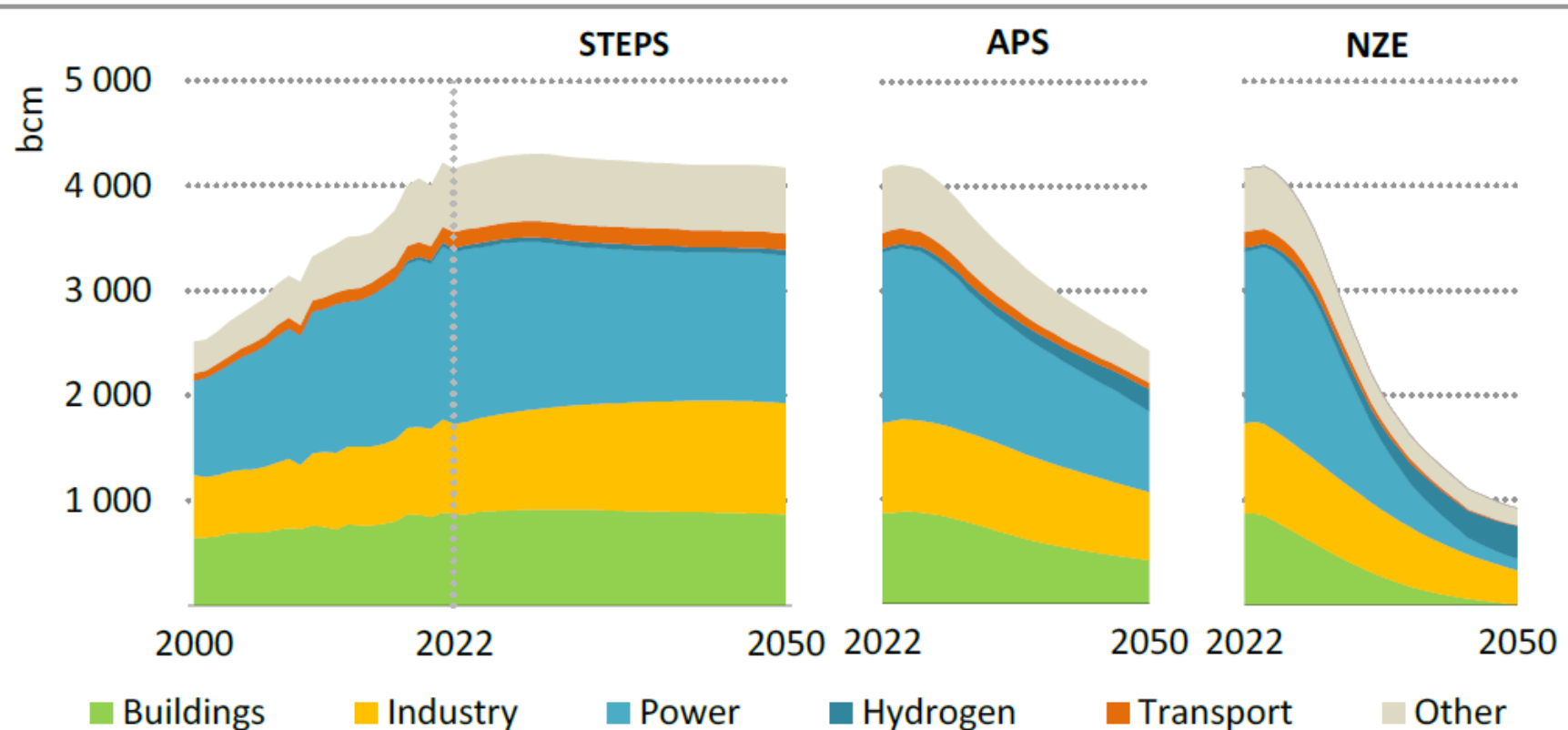
Figure 3.20 ▶ Global oil demand by sector and scenario, 2000-2050



IEA. CC BY 4.0.

Demand in the STEPS peaks by 2030; increases in aviation and petrochemicals mostly offset declines elsewhere through to 2050; demand declines rapidly in the APS and NZE Scenario

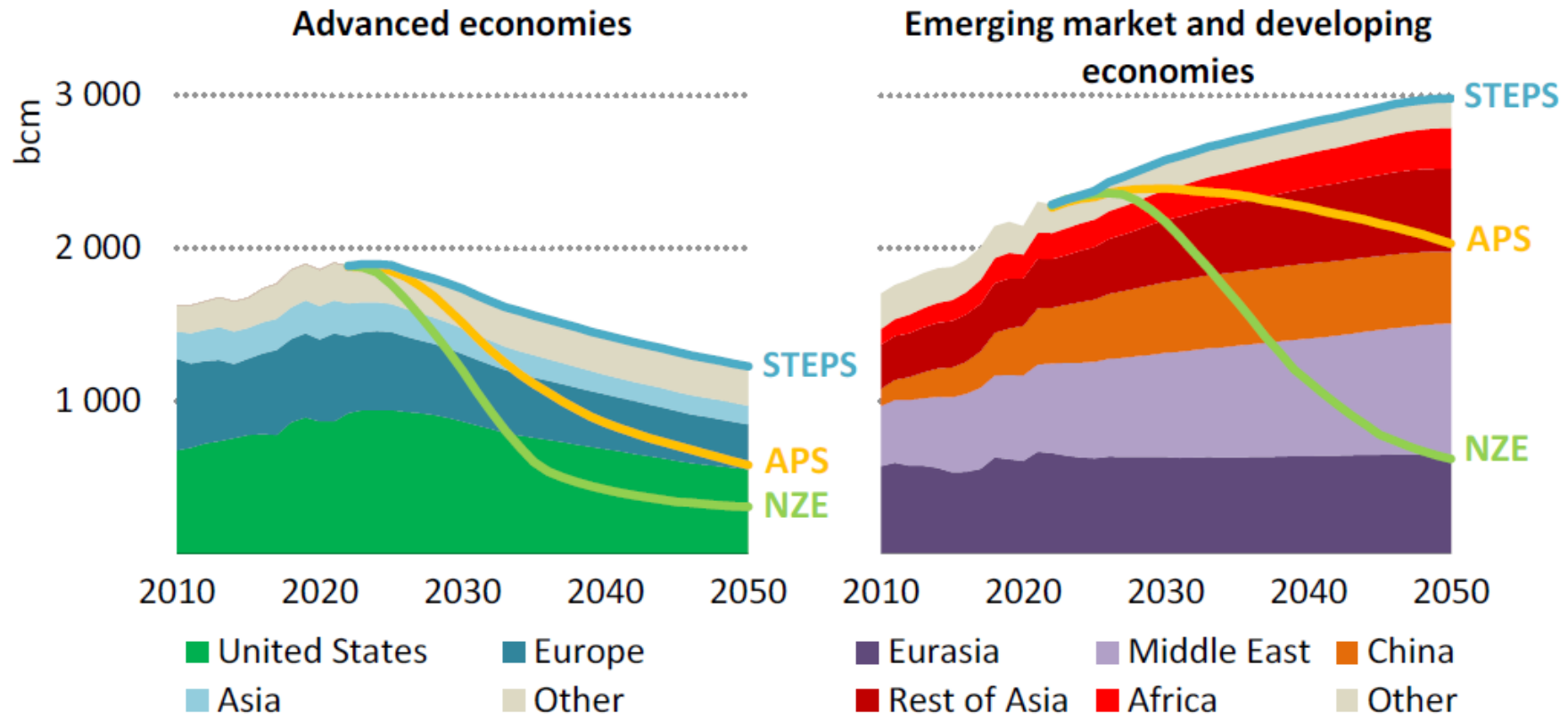
Figure 3.23 ▶ Global natural gas demand by scenario, 2000-2050



IEA. CC BY 4.0.

Each scenario projects an end to growth for gas; future prospects depend largely on the pace and scale of growth in clean power, electrification and efficiency improvements.

Figure 3.24 ▶ Natural gas demand by region and scenario, 2010-2050

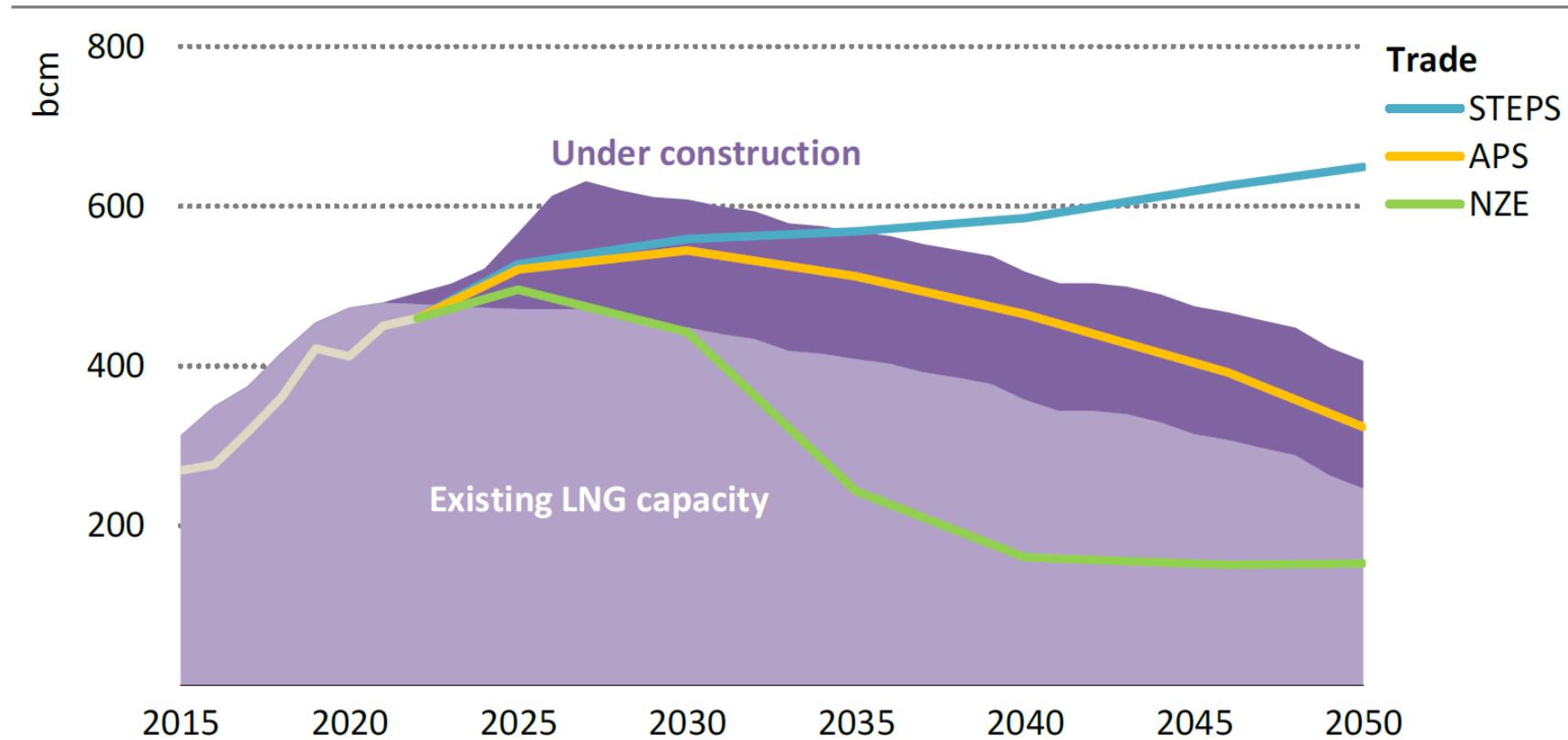


IEA. CC BY 4.0.

Natural gas demand declines in advanced economies in each scenario; in emerging market and developing economies the difference between scenario outcomes is larger

IEA WEO: The Business Case for LNG

Figure 8.8 ▶ Existing and under construction LNG capacity and total inter-regional LNG trade by scenario, 2015-2050

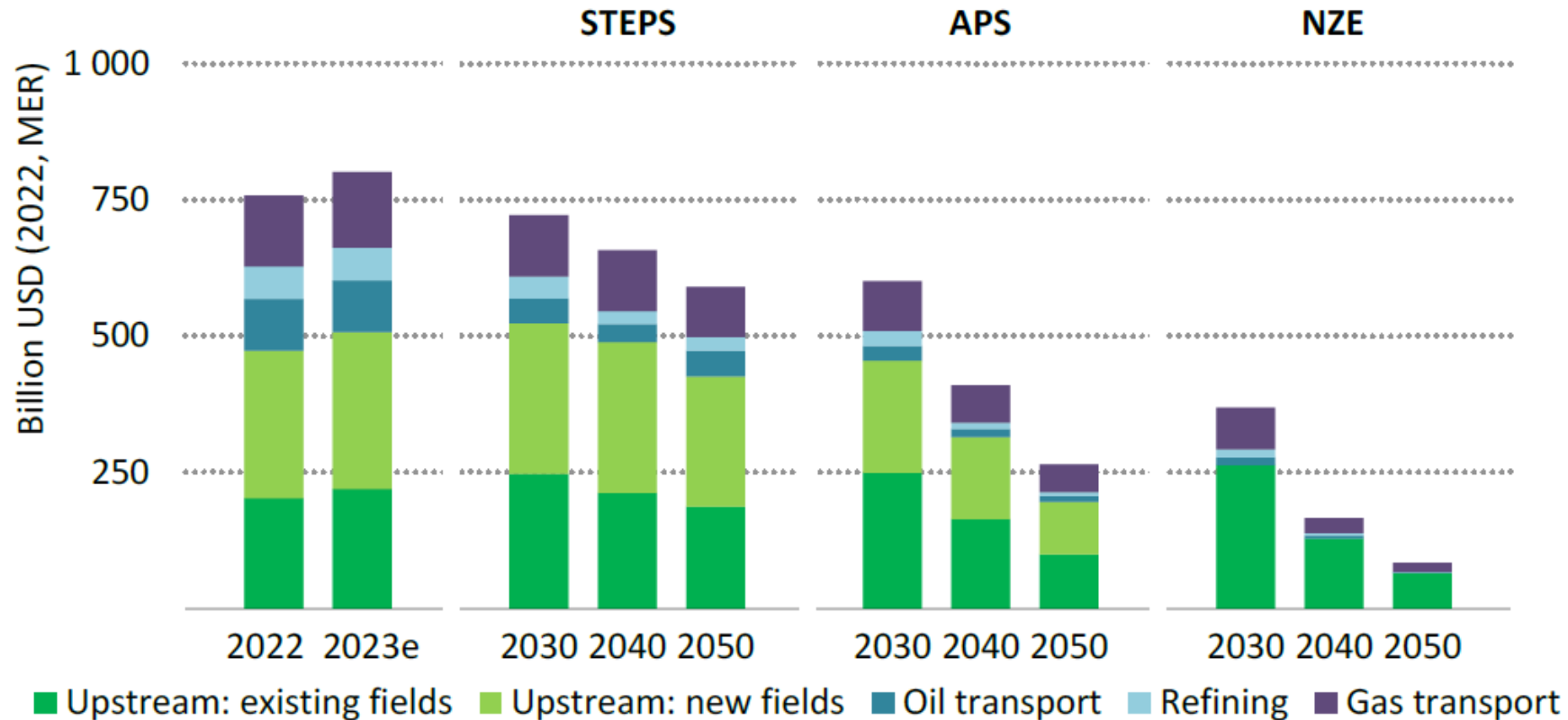


IEA. CC BY 4.0.

There is near-term growth in LNG trade in all scenarios, but sharp divergences thereafter

IEA WEO: Oil and Gas Investment

Figure 3.22 ▶ Global oil and natural gas investment by scenario, 2022-2050

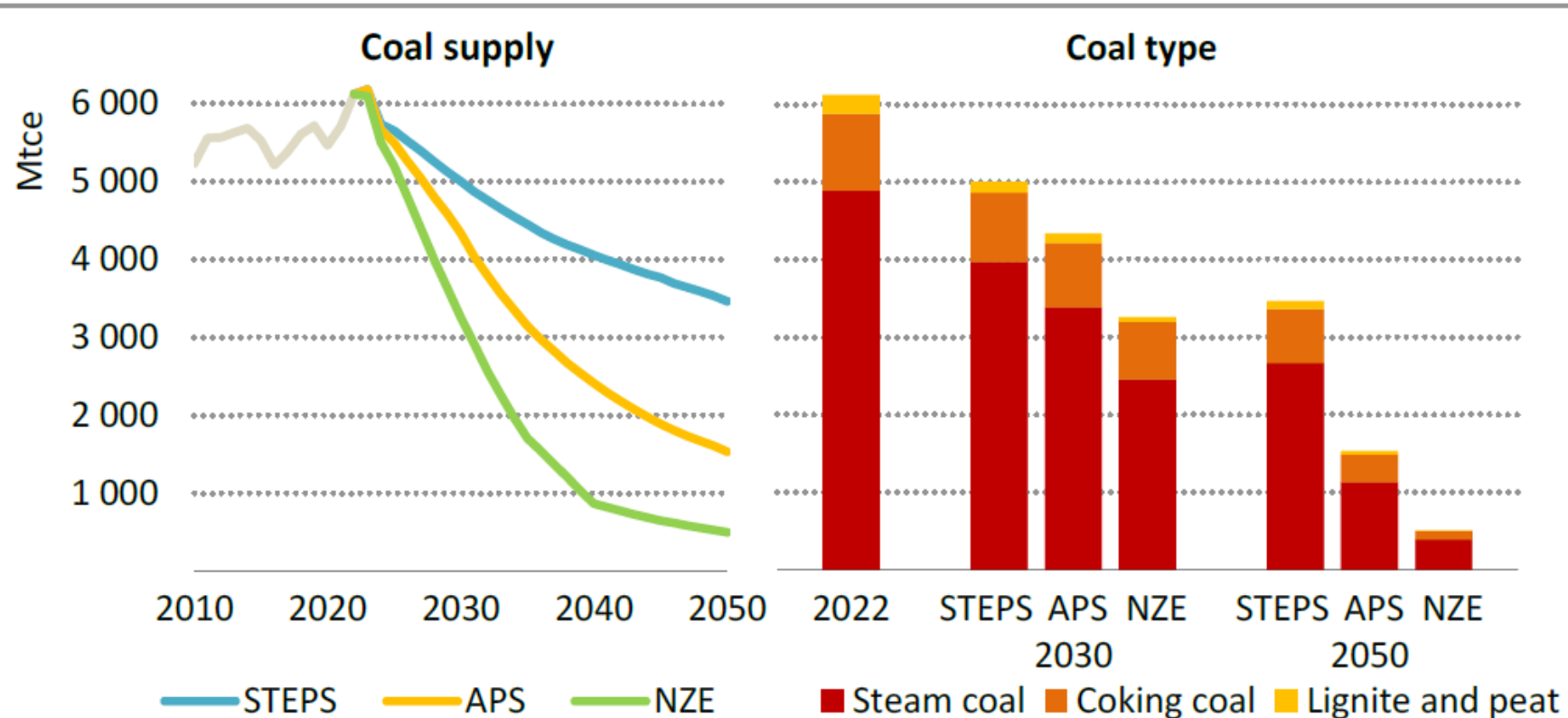


IEA. CC BY 4.0.

Oil and gas investment is expected to increase in 2023 and to be similar to 2030 levels in the STEPS; it is much higher than the levels needed in the APS and NZE Scenario

IEA WEO: Coal's Future (?)

Figure 3.28 ▶ Global coal supply and type by scenario



IEA. CC BY 4.0.

Coal production falls by nearly 45% between 2022 and 2050 in the STEPS, 75% in the APS and over 90% in the NZE Scenario; coking coal supply declines much less than steam coal