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ECON 366: Energy Economics

Topic 2.2: The Global Energy Economy

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Energy Scenarios

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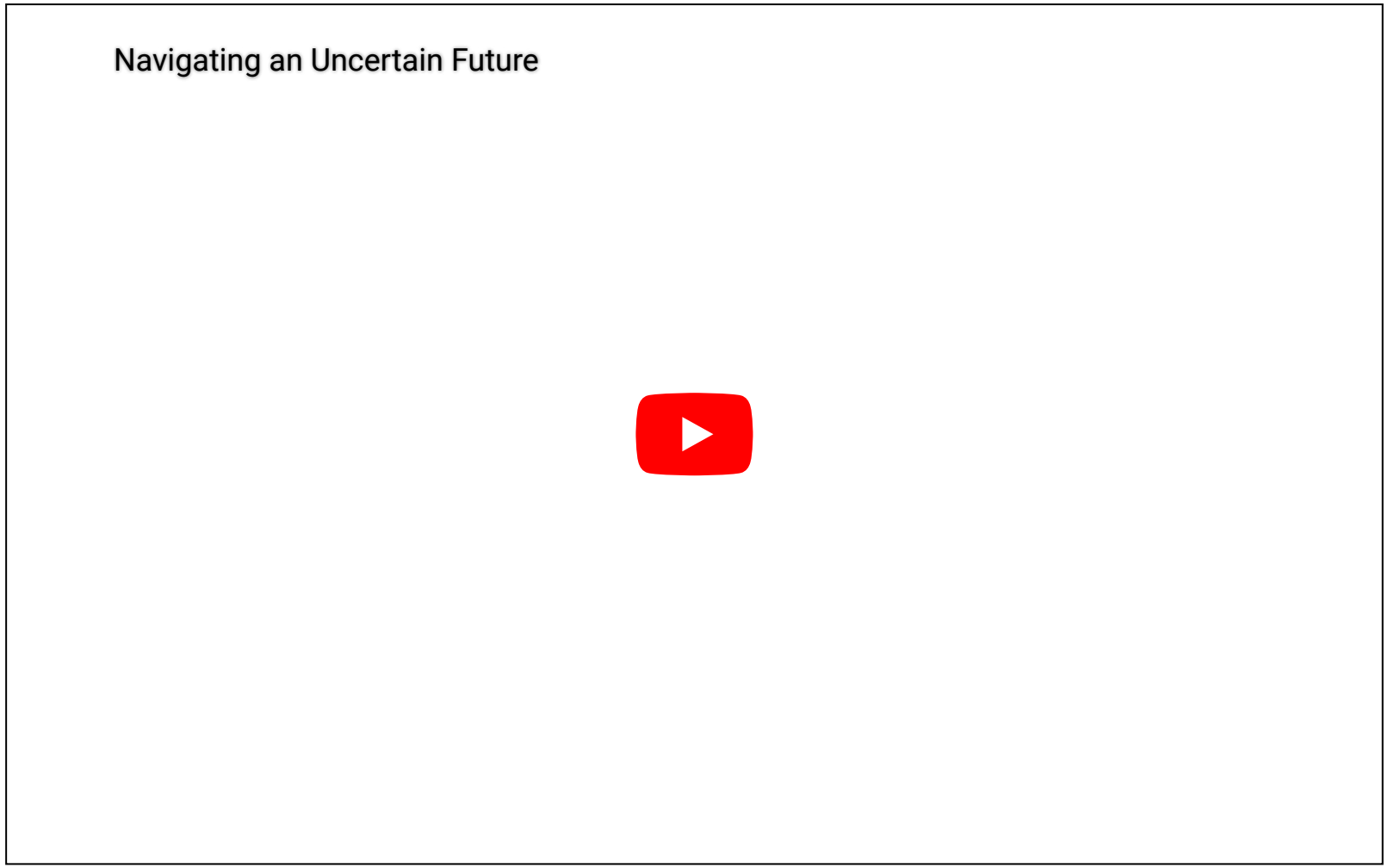

See Shell Scenarios and added documentation

Energy Scenarios

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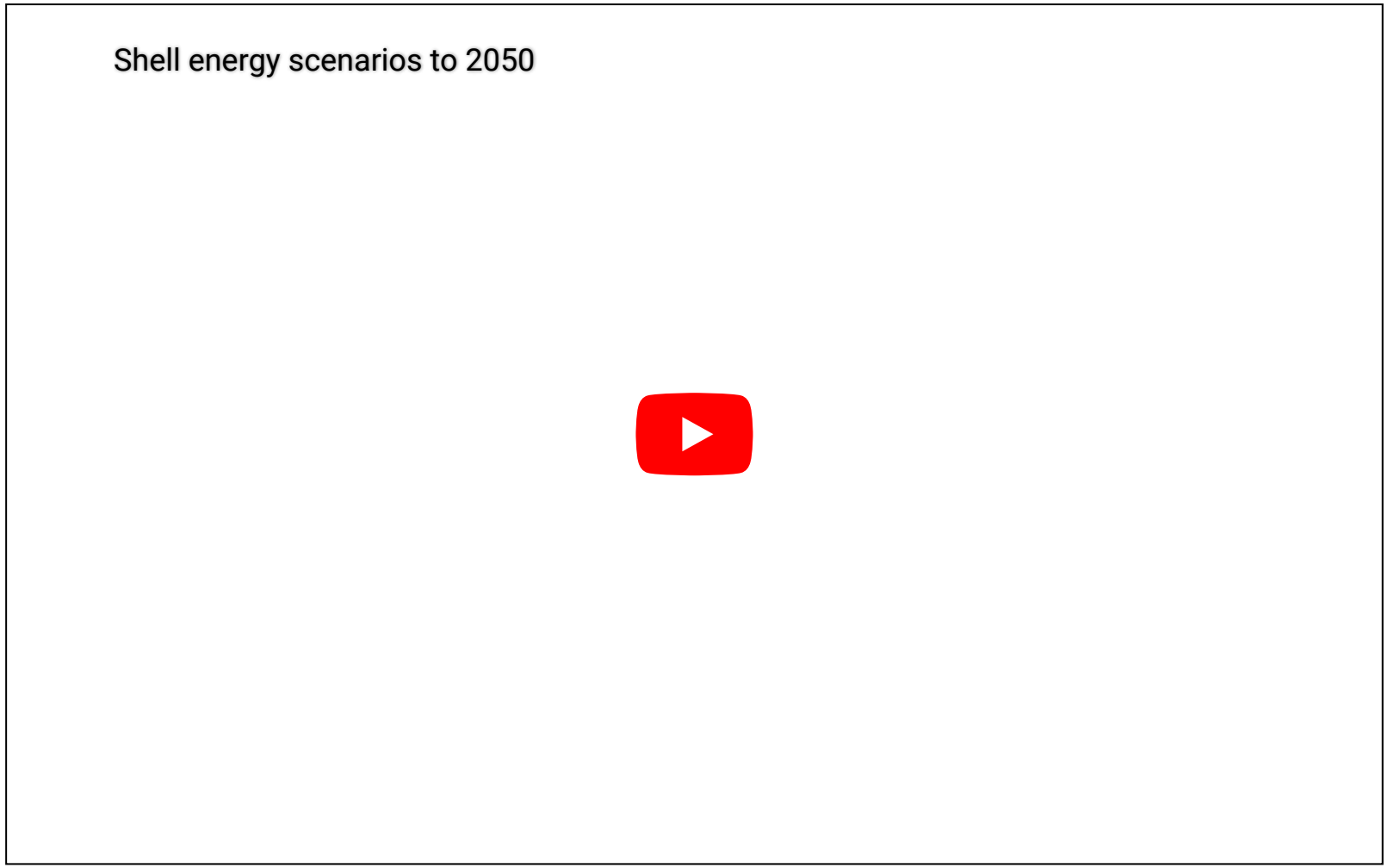

See Shell Scenarios and added documentation

Suncor Scenarios

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Rivalry[9]

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.

See Suncor Climate Report 2022

Suncor Scenarios

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Autonomy[9]

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).

See Suncor Climate Report 2022

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Discord[9]

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.

See Suncor Climate Report 2022

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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 CO_2.
- 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)

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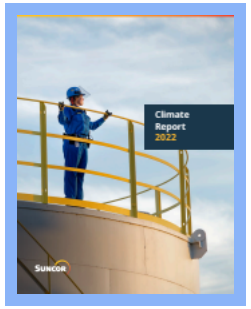
Climate Report 2022 1 / 8 97%



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IEA Scenarios

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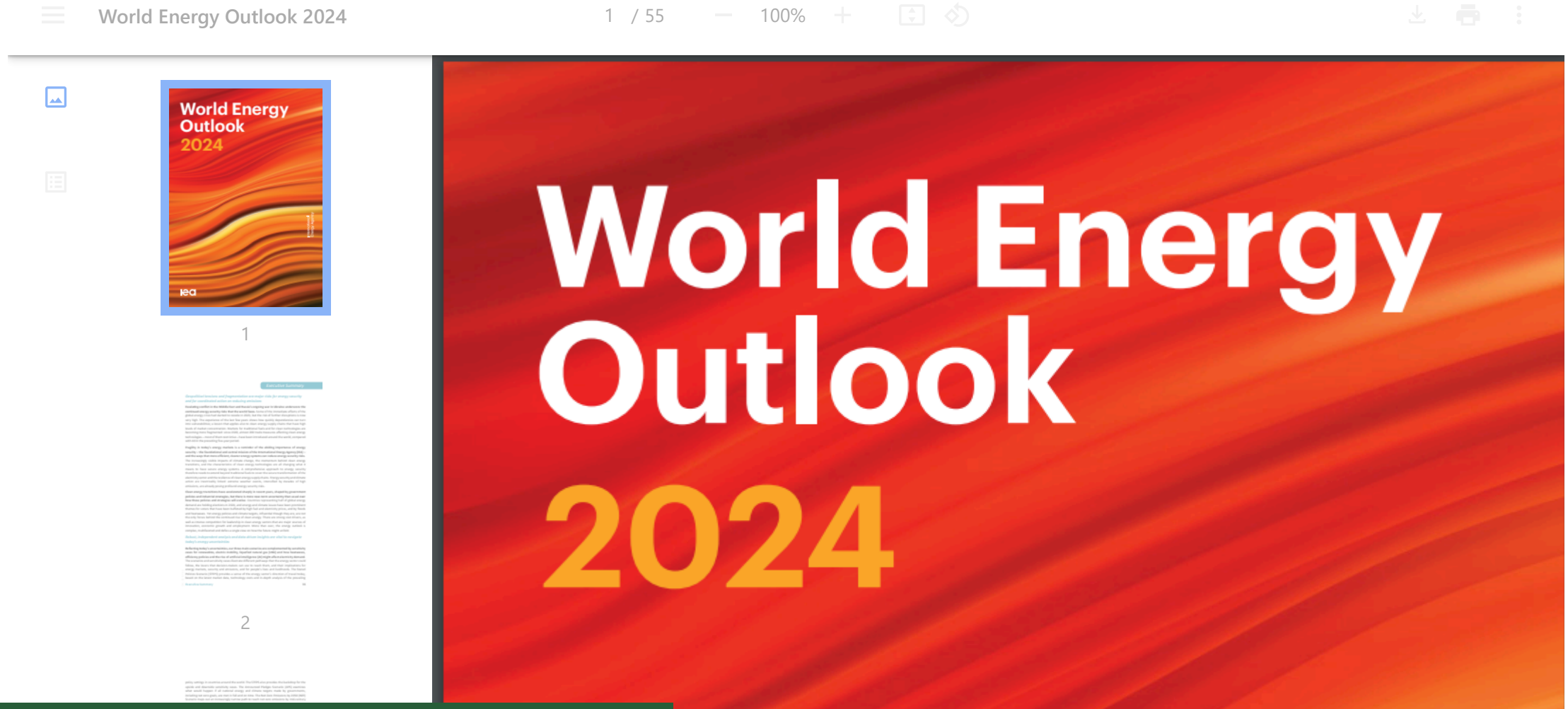
Table 1.1 ▻ Definitions and objectives of the *GEC Model 2024* scenarios

	Stated Policies Scenario (STEPS)	Announced Pledges Scenario (APS)	Net Zero Emissions by 2050 Scenario (NZE Scenario)
Definitions	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 2024, as well as those that are under development. The scenario also takes into account currently planned manufacturing capacities for clean energy technologies.	A scenario which assumes that all climate commitments made by governments and industries around the world by the end of August 2024, 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 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 updated with the latest available data in 2024.
Objectives	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.	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 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.

IEA World Energy Outlook

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



IEA WEO: Net Zero

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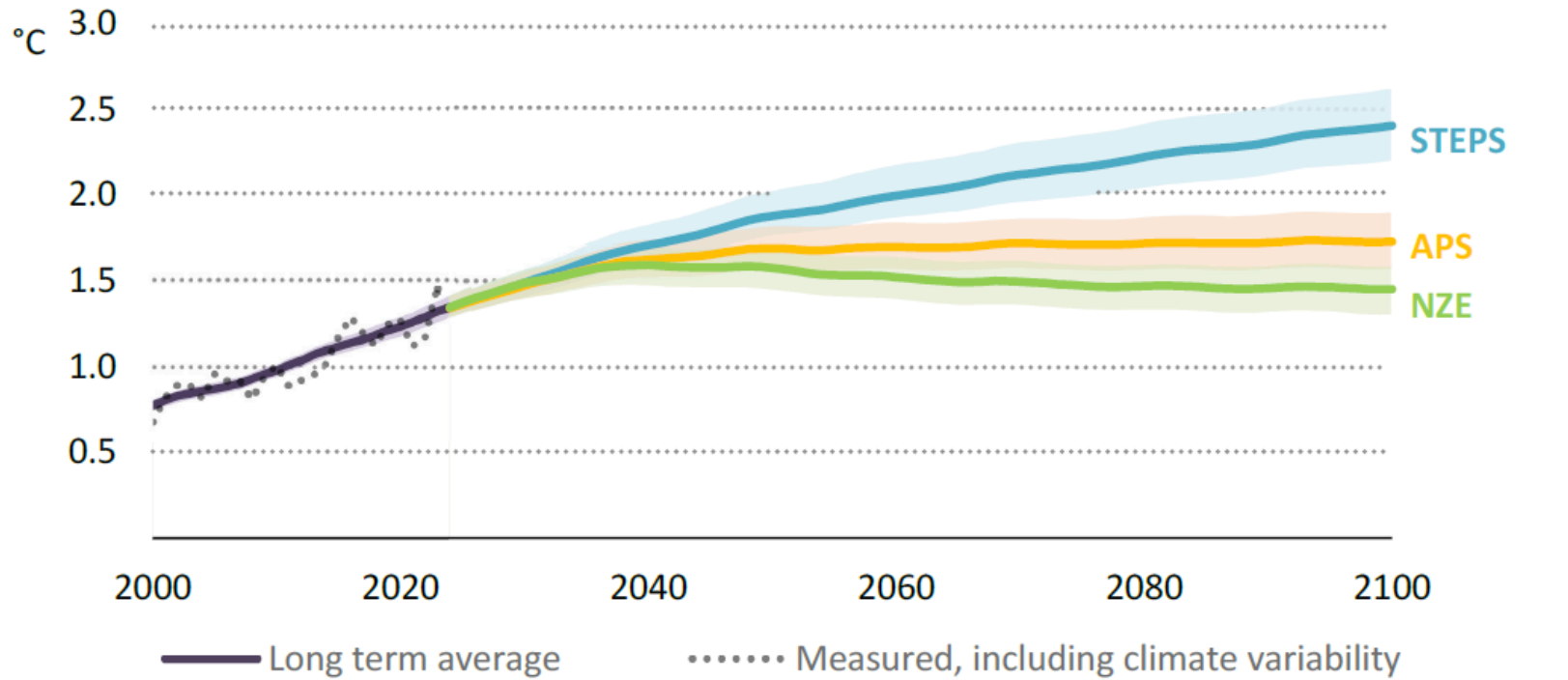
Figure 5.26 ▷ Global average temperature rise including natural variability since 2000 and long-term average temperature rise by scenario



In the STEPS, the temperature rise reaches 2.4 °C in 2100; in the APS it reaches 1.7 °C, and in the NZE scenario it peaks below 1.6 °C and then falls to below 1.5 °C in 2100

IEA WEO: Net Zero

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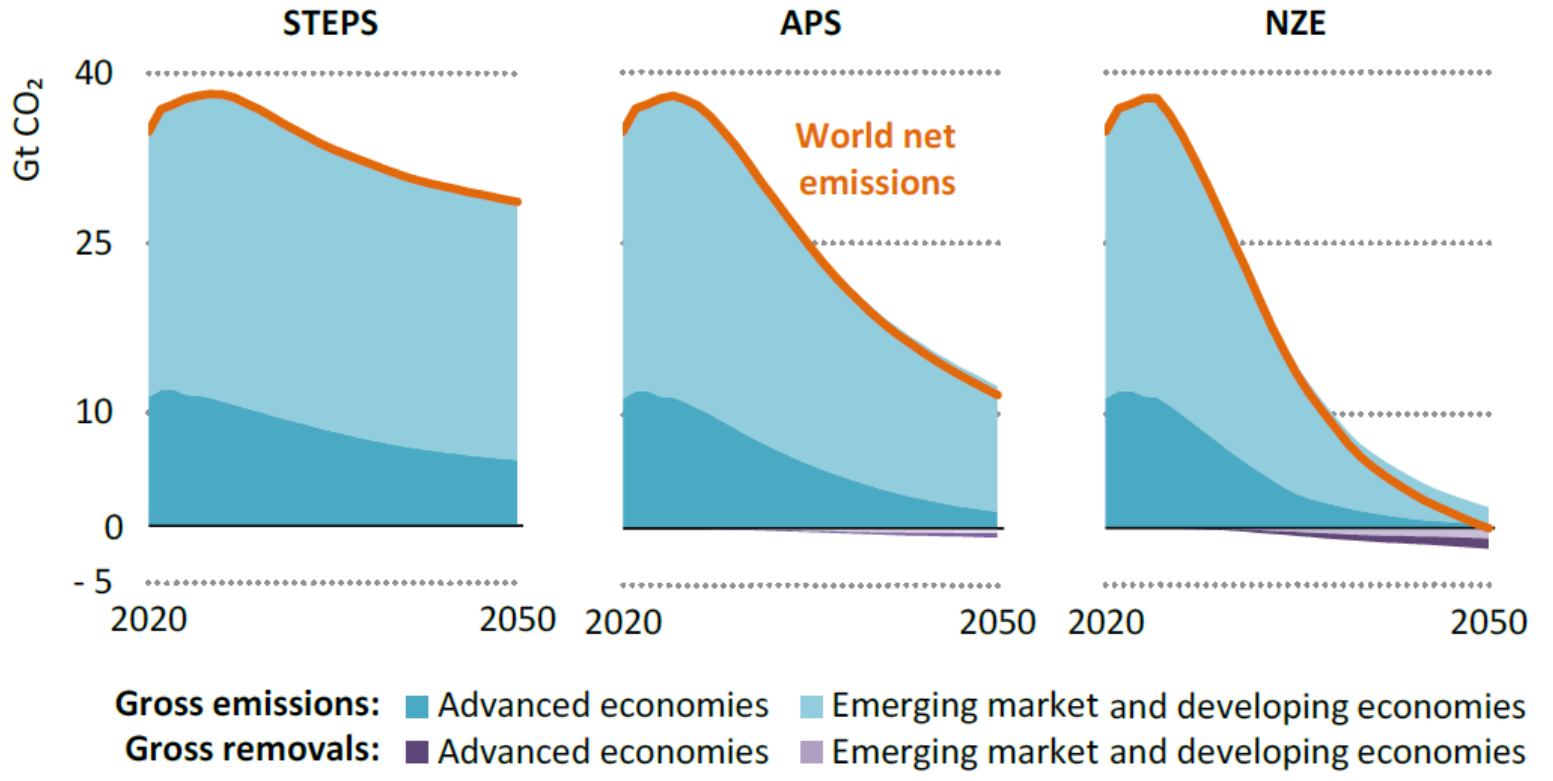
Figure 5.25 ▷ Energy-related CO_2 emissions in advanced and emerging market and developing economies by scenario, 2020-2050



Emissions peak and fall in the STEPS, they fall much faster in the APS and NZE Scenario, net zero is achieved in aggregate in advanced economies around 2045 and globally by 2050

IEA WEO: Net Zero TPES

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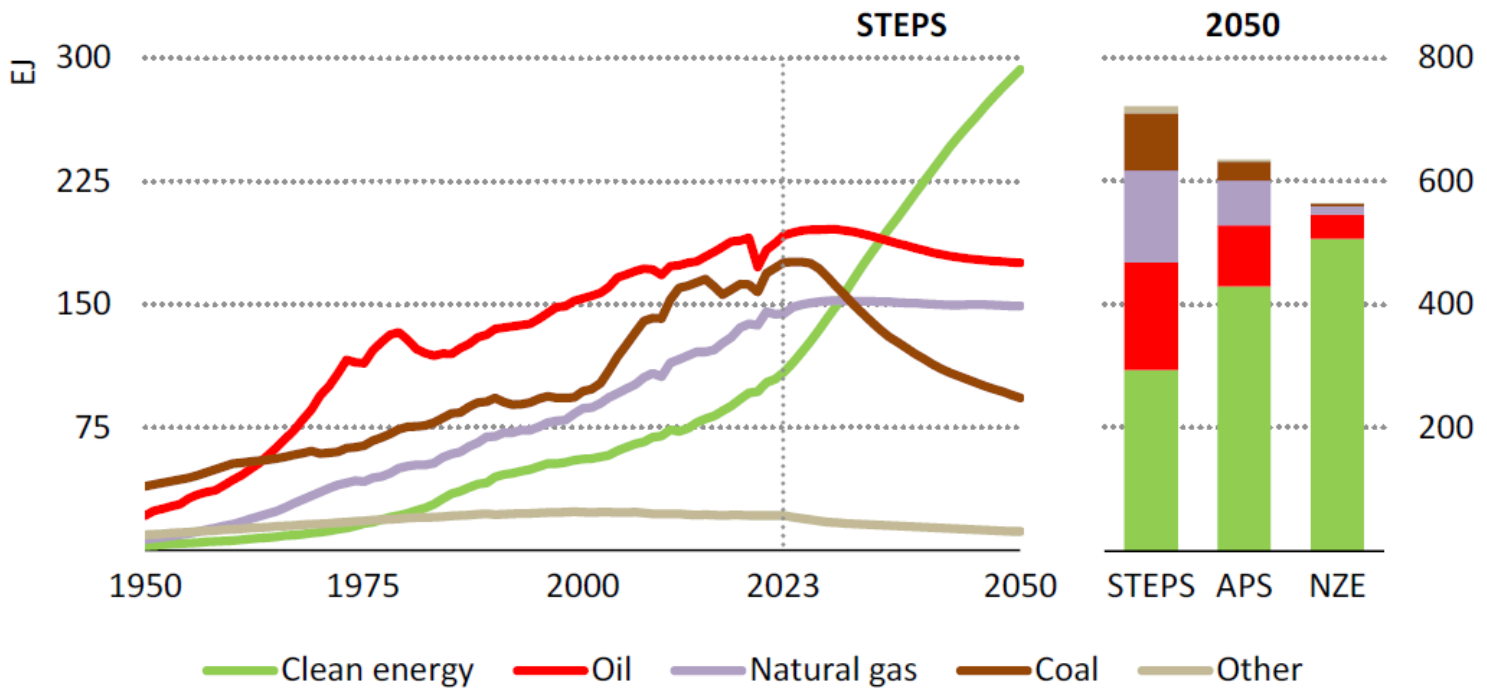
Figure 1.1 ▷ Global energy mix by scenario to 2050



STEPS, a scenario based on current policy settings, sees clean energy poised for huge growth, while coal, oil and natural gas each reach a peak by 2030 and then start to decline

Notes: EJ = exajoules; STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; NZE = Net Zero Emissions by 2050 Scenario. Oil, coal and natural gas refer to unabated uses as well as non-energy use. Clean energy includes renewables, modern bioenergy, nuclear, abated fossil fuels, low-emissions hydrogen and hydrogen-based fuels. Other includes traditional use of biomass and non-renewable waste.

IEA WEO: Net Zero Power Generation

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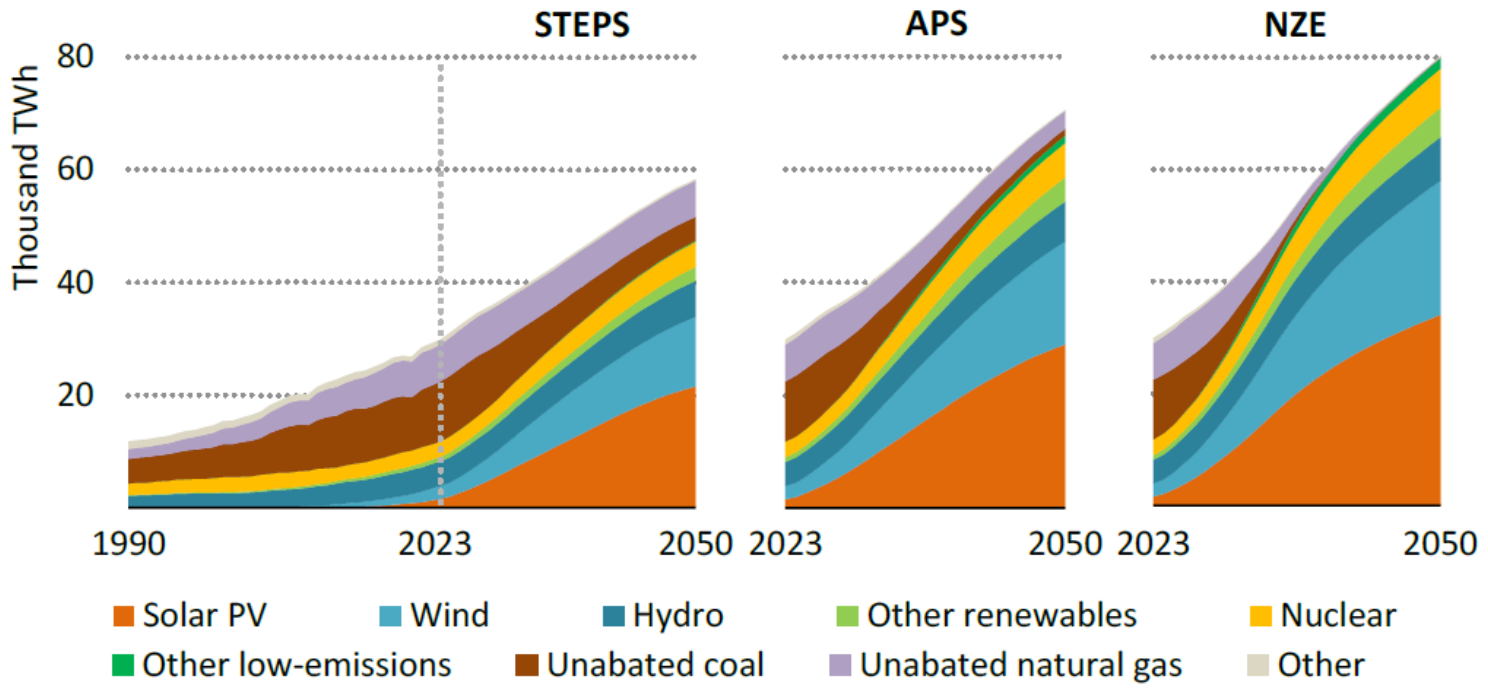
Figure 3.21 ▷ Global electricity generation by source and scenario, 1990-2050



After decades of fossil fuels generating most of the world's electricity, renewables are set to become the main pillar of electricity supply

Notes: TWh = terawatt-hours. Other renewables includes bioenergy, geothermal, concentrating solar power and marine; other low-emissions includes fossil fuels with CCUS, hydrogen and ammonia. Other includes non-renewable waste.

IEA WEO: Net Zero Power Generation

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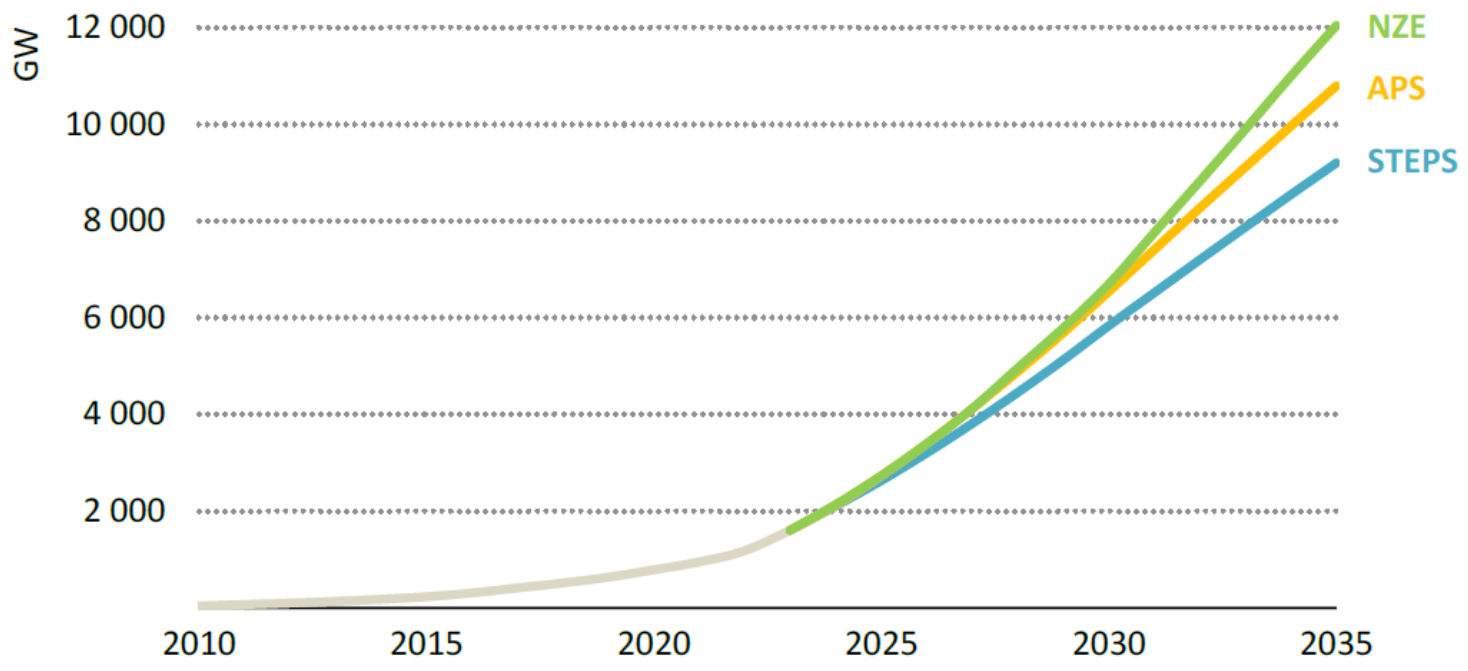
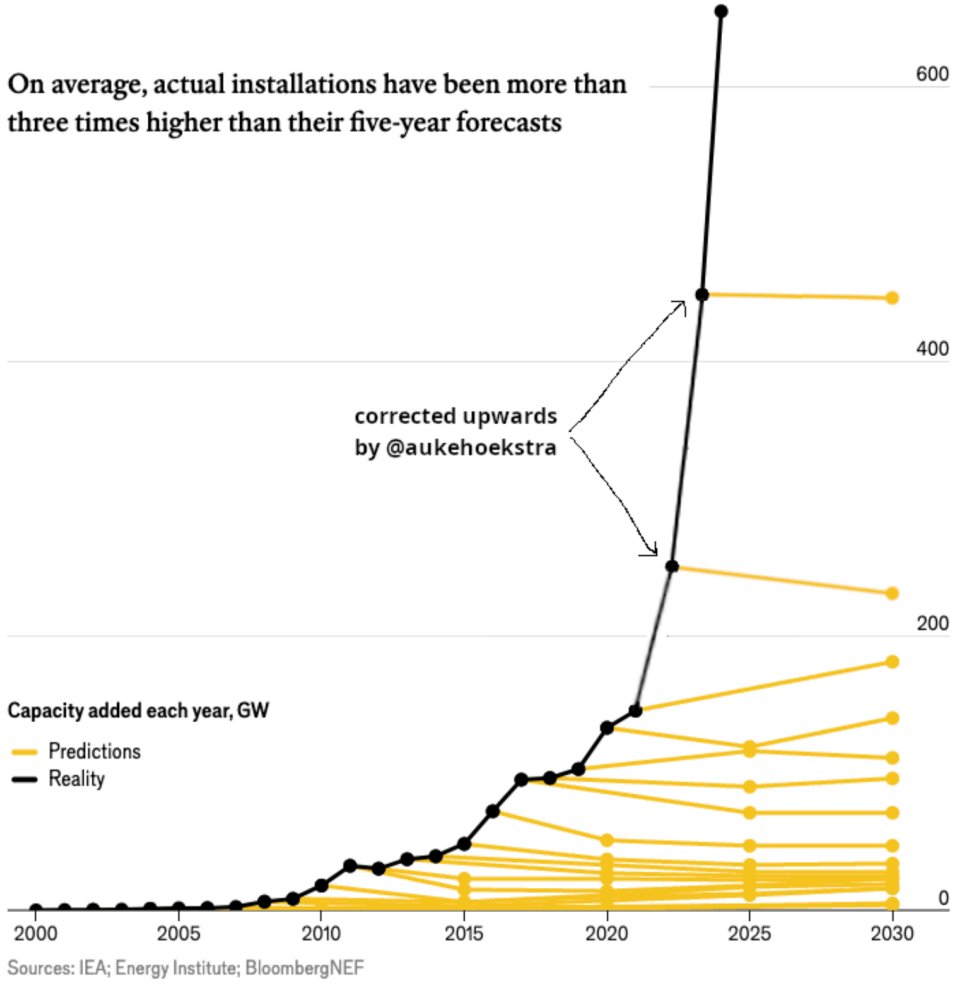
Figure 3.43 ▷ Solar PV capacity by scenario, 2010-2035



Solar PV capacity additions increase dramatically by 2030 in each scenario, and by far become the fastest growing source of electricity over the next decade

Beware Solar Predictions



Credit: Auke Hoekstra

IEA WEO: Prices

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Table 2.3 ▻ Wholesale fossil fuel prices by scenario

		STEPS			APS			NZE Scenario		
USD (MER, 2023)	2023	2030	2040	2050	2030	2040	2050	2030	2040	2050
IEA crude oil (USD/barrel)	82	79	77	75	72	63	58	42	30	25
Natural gas (USD/MBtu)										
United States	2.7	3.9	4.1	4.2	3.2	3.0	2.9	2.1	2.0	2.0
European Union	12.1	6.5	7.6	7.7	6.0	5.2	5.2	4.4	4.1	4.0
China	11.5	7.2	8.2	8.3	6.9	6.2	6.2	5.0	4.8	4.8
Japan	13.0	8.3	8.8	8.7	6.8	6.1	6.2	5.0	4.8	4.8
Steam coal (USD/tonne)										
United States	57	51	42	40	42	31	27	28	23	23
European Union	129	68	69	64	64	51	48	57	43	39
Japan	174	105	86	82	81	66	61	66	53	49
Coastal China	150	101	88	82	78	67	61	64	54	49

IEA WEO: Oil

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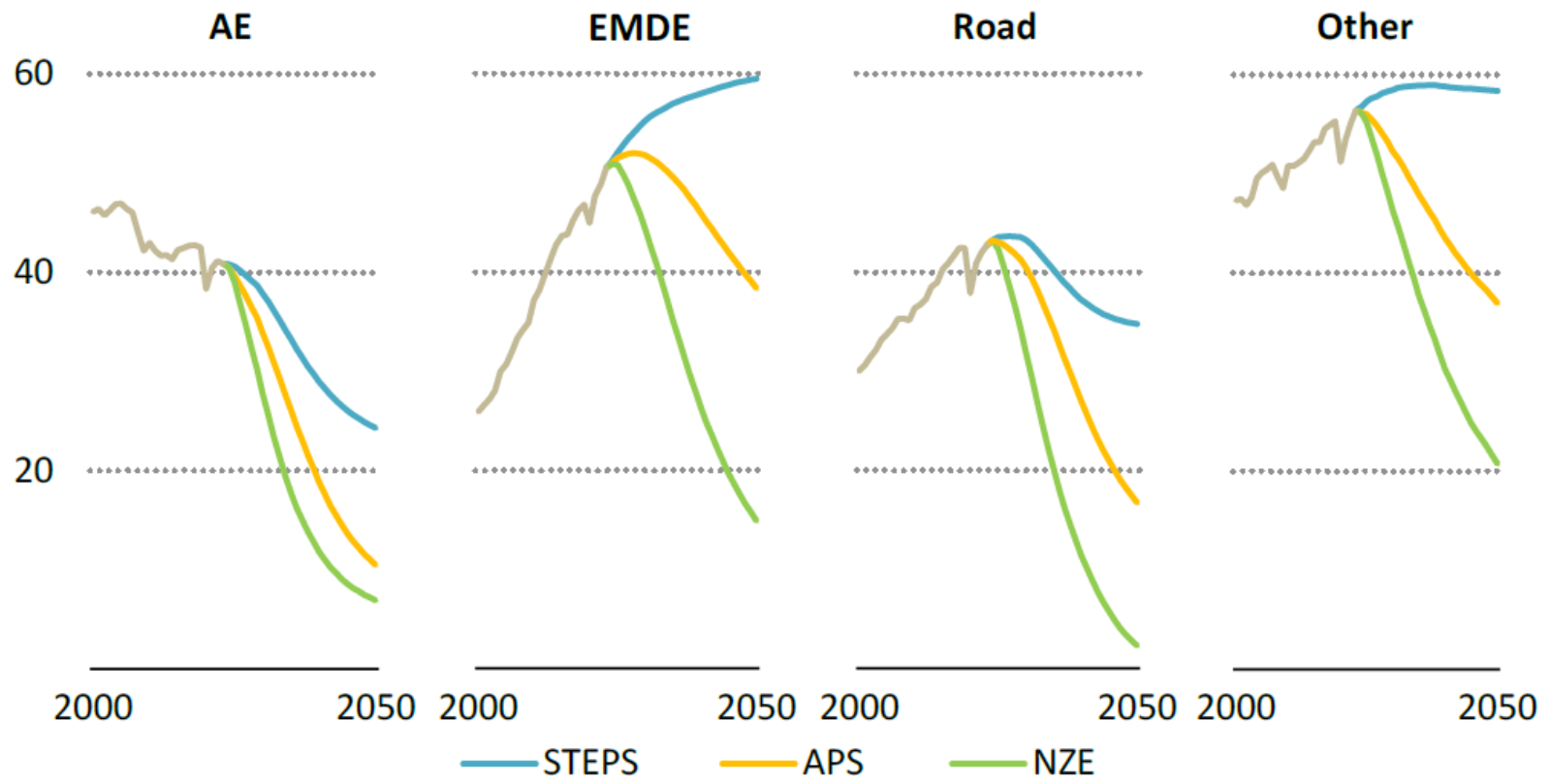
Figure 3.30 ▷ Oil demand by region, sector and scenario, 2000-2050



Oil demand falls as EV ownership expands in advanced economies in all scenarios; oil demand is more resilient in aviation, shipping and petrochemicals in the STEPS and APS

IEA WEO: Oil Products

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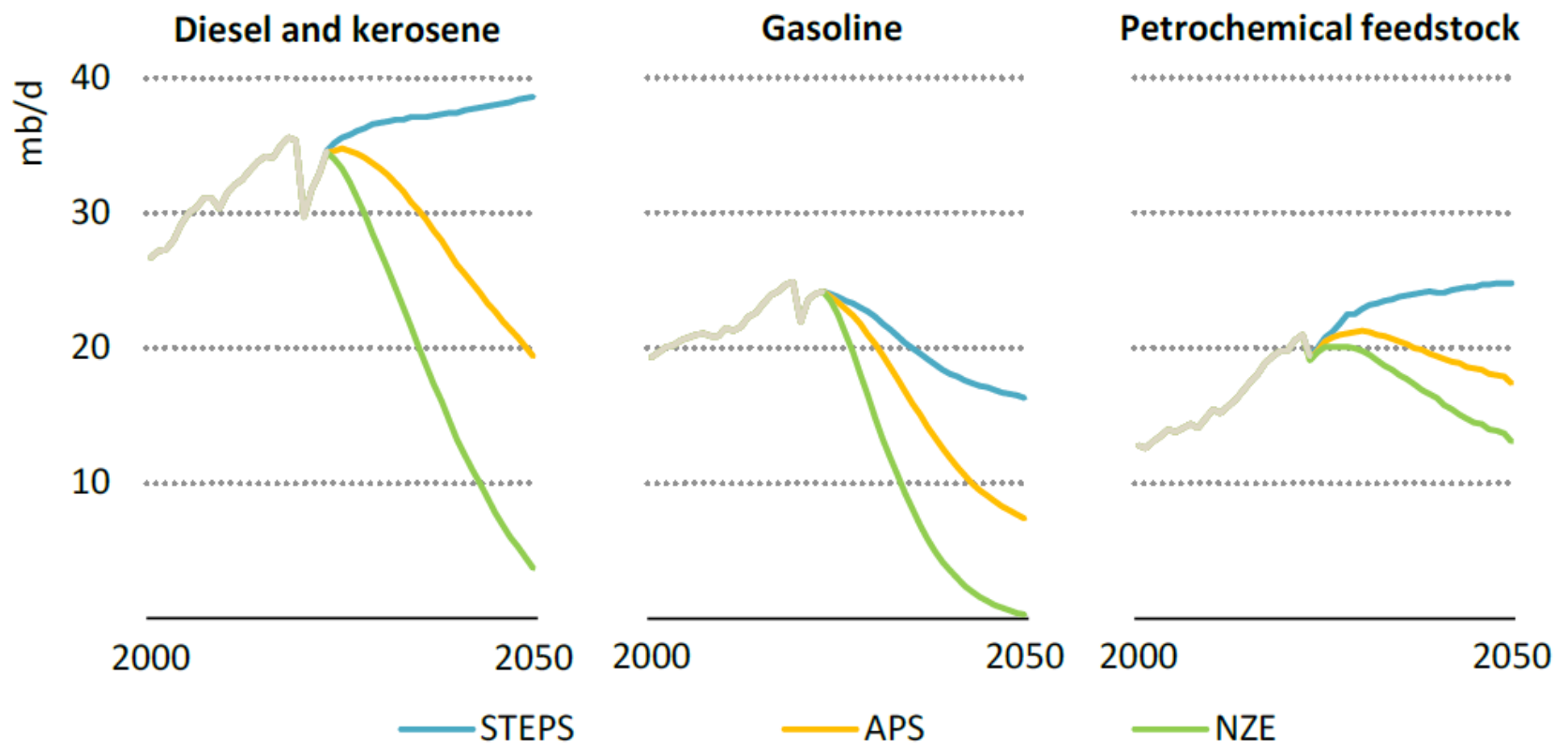
Figure 3.34 ▹ Demand for selected oil products by scenario, 2020-2050



Middle distillates such as diesel and gasoline fall much more sharply in the APS and NZE Scenario than petrochemical feedstocks

IEA WEO: Gaseous Fuel Use

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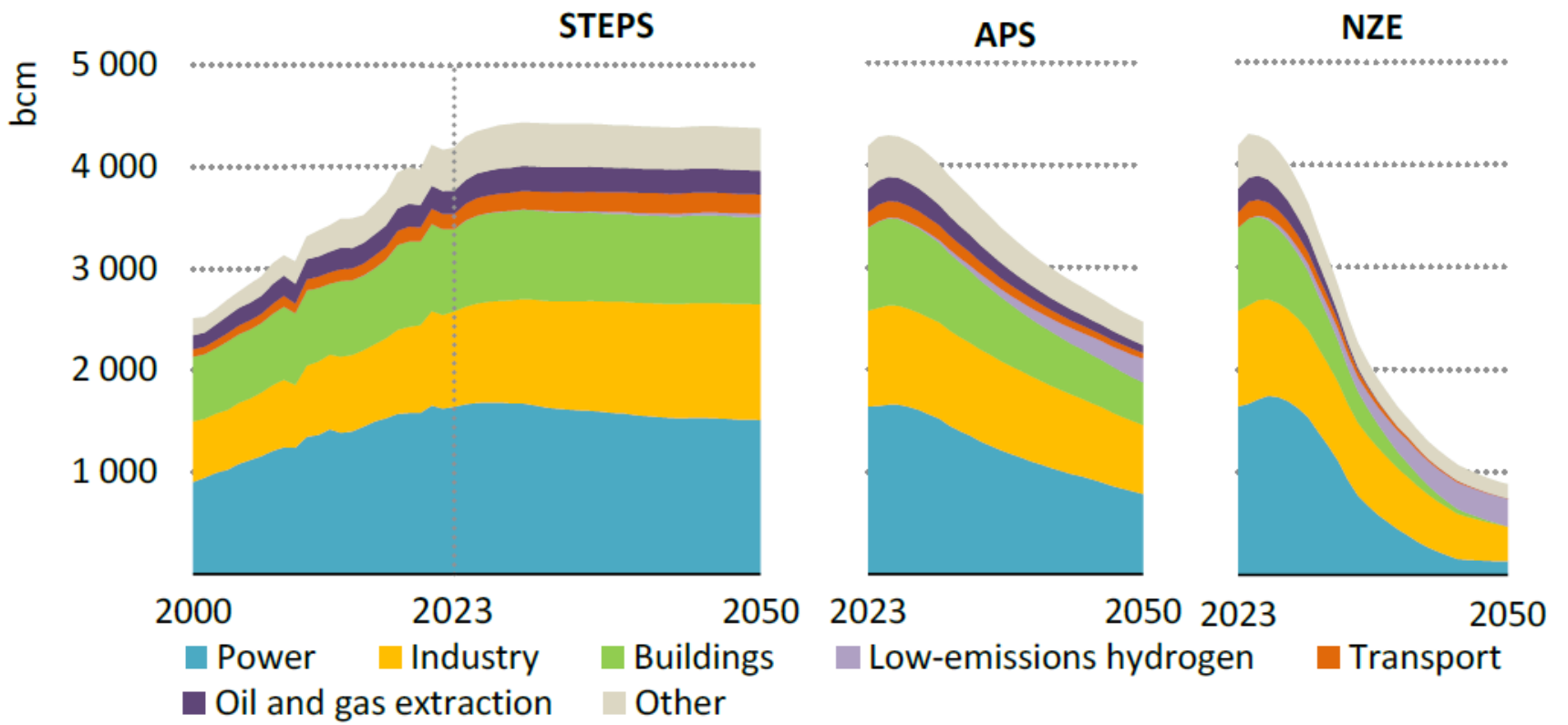
Figure 3.35 ▷ Natural gas demand by sector and scenario, 2000-2050



After decades of growth, natural gas demand is set to plateau by 2030 under current policy settings; demand falls 40% in the APS by 2050 and 80% in the NZE Scenario

IEA WEO: The Business Case for LNG

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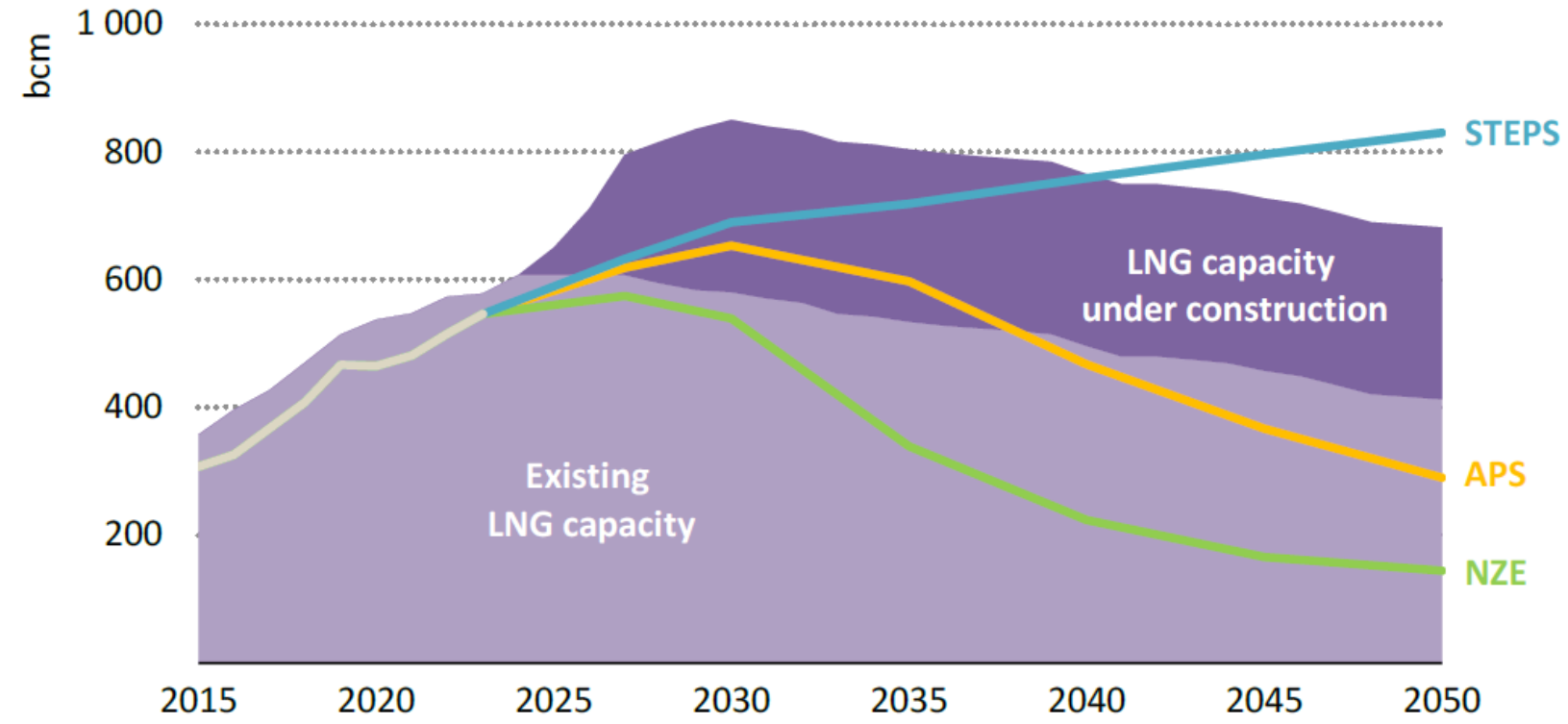
Figure 4.7 ▷ LNG trade by scenario relative to existing and under construction export capacity to 2050



IEA. CC BY 4.0.

There is additional surplus of around 130 bcm of LNG by 2030 in the STEPS based on current project announcements; this surplus declines after 2030 as LNG capacity reduces

IEA WEO: Oil and Gas Investment

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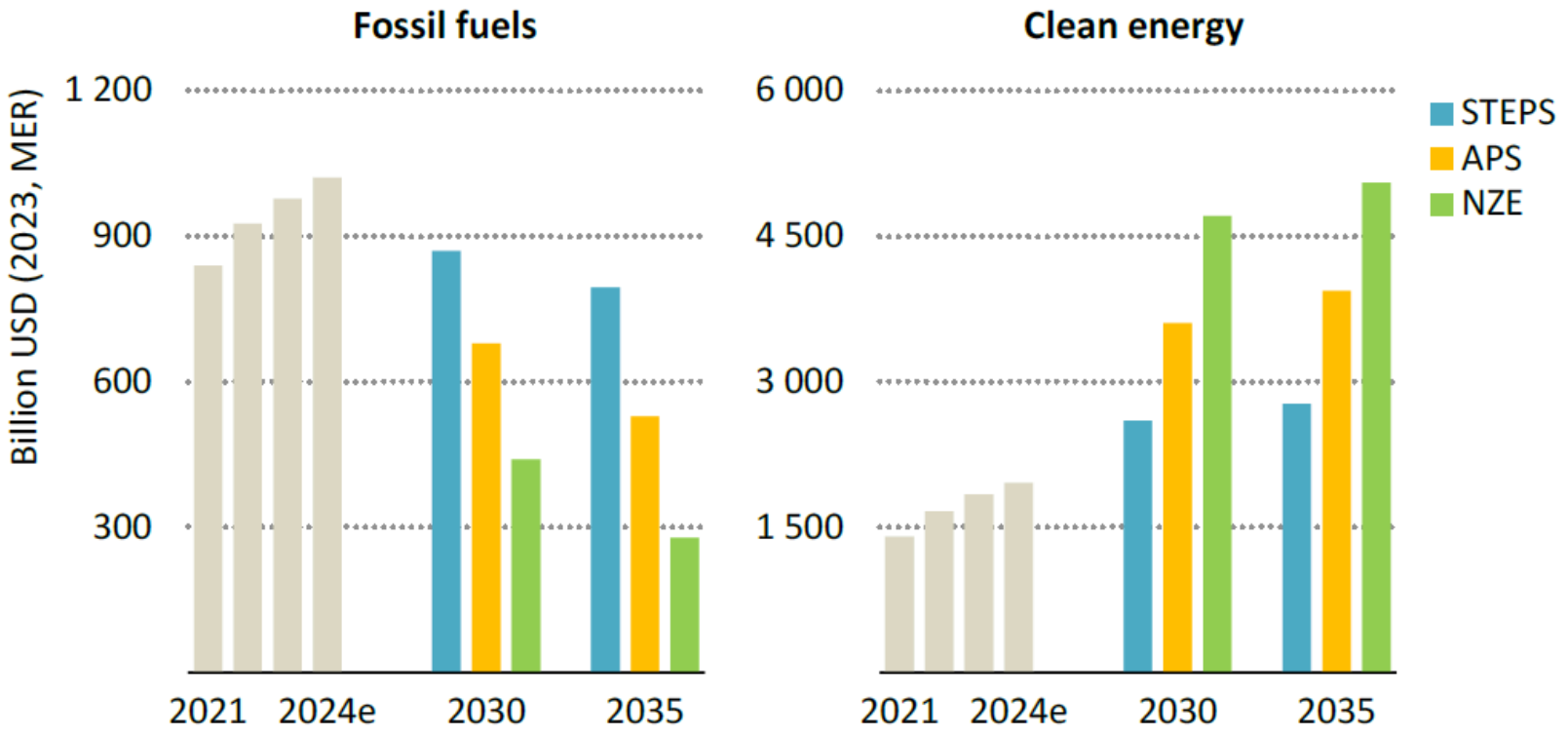
Figure 5.2 ▷ Annual investment in fossil fuels and clean energy by scenario, 2021-2035



Cutting investment in fossil fuels ahead of scaling up investment in clean energy would push up prices and undermine just, orderly and equitable clean energy transitions

IEA WEO: Coal's Future (?)

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Table 3.3 ▷ Global coal demand, production and trade by scenario (Mtce)

		STEPS			APS			NZE		
	2023	2030	2035	2050	2030	2035	2050	2030	2035	2050
World coal demand	5 986	5 307	4 453	3 191	4 702	3 231	1 370	3 440	1 743	501
Power	3 916	3 349	2 609	1 612	2 944	1 800	686	2 015	738	228
Industry	1 606	1 581	1 539	1 367	1 396	1 175	608	1 199	864	219
Other sectors	464	377	305	213	362	257	76	226	140	54
of which abated with CCUS	*0%*	*0%*	*0%*	*1%*	*0%*	*4%*	*25%*	*2%*	*13%*	*77%*
Advanced economies	878	502	357	219	336	196	75	249	122	53
Emerging market and developing economies	5 108	4 806	4 096	2 973	4 365	3 035	1 295	3 191	1 620	447
World coal production	6 278	5 308	4 454	3 191	4 702	3 231	1 370	3 441	1 743	501
Steam coal	5 079	4 262	3 479	2 398	3 743	2 423	985	2 619	1 192	409
Coking coal	970	911	861	711	851	724	346	759	533	89
Peat and lignite	229	135	114	82	107	84	39	62	18	3
Advanced economies	1 041	628	519	412	451	332	127	310	198	36
Emerging market and developing economies	5 237	4 680	3 934	2 779	4 251	2 899	1 243	3 131	1 544	465
World coal trade	1 144	965	877	712	797	629	307	612	368	97

Notes: Mtce = million tonnes of coal equivalent; NZE = NZE Scenario; CCUS = carbon capture, utilisation and storage. The difference between production and demand is due to stock changes.