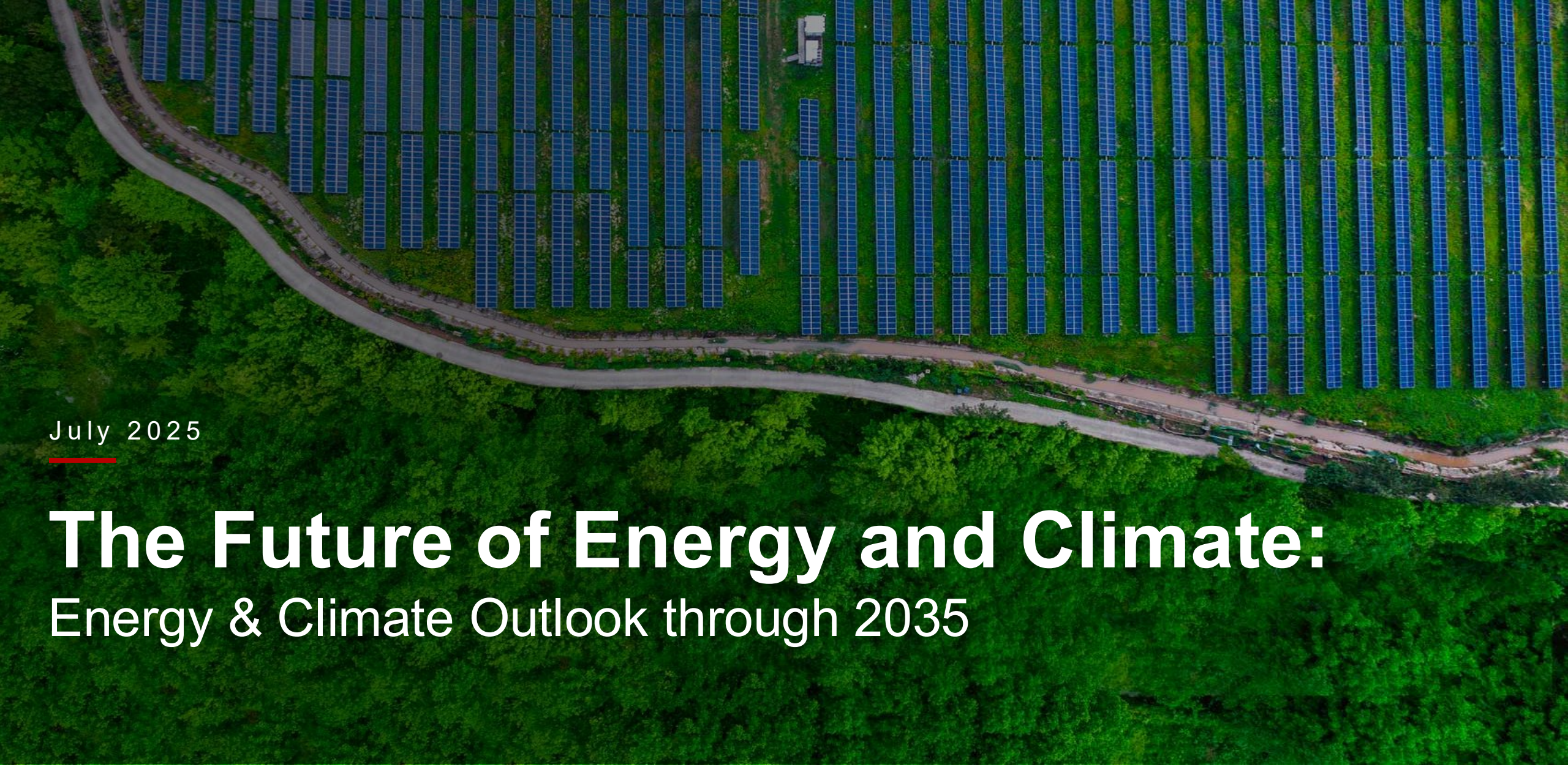


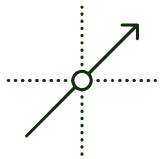
July 2025

The Future of Energy and Climate:

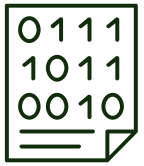
Energy & Climate Outlook through 2035

OpenMinds

OpenMinds ‘P50’ Outlook Objectives



Develop a **non-biased view** of where we’re really heading on energy supply & consumption, power, and emissions



Quantify **what’s needed to close the gap** between our current energy mix and what’s needed to affordably and efficiently bend the curve

Provide an **annually-refreshed perspective to track** global & US progress against the Dual Challenge and to identify high-impact areas for improvement

OpenMinds ‘P50’ Outlook Scope and Contributors

2035 forecasts included in the ‘P50’ Outlook

	Global	US
Energy Demand	✓	✓
Supply Mix	✓	✓
Emissions	✓	✓

Developed and reviewed by industry leaders

MODEL CREATION

Intersect℠ BAIN & COMPANY

Additional detail in appendix

Copenhagen Economics

CE

Agenda

1 **P50 Global Outlook**

- Executive summary
- Energy supply, mix, and emissions
- Key changes compared to last year
- How P50 compares to other outlooks

2 **P50 U.S. Outlook**

- Executive summary
- Energy supply, mix, and emissions
- Key changes compared to last year
- How P50 compares to other outlooks

Executive Summary – Global Outlook

‘P50’ 2025 key takeaways

- Global energy demand continues to grow overall, largely driven by developing economies and industry
- Global energy supply mix is shifting, with renewables rapidly gaining share, largely from coal
- Electricity demand expected to grow ~3.6% p.a.; ~36% of the growth is driven by HVAC electrification, and ~26% by broader industrial electrification
- Electricity generation from wind & solar will grow rapidly but face supply chain constraints; new natural gas to meet growing residual demand
- Global carbon emissions are peaking, with China’s emissions declining after 2030; partially offset by fuel-driven industrialization in developing economies

Key changes since last year’s outlook

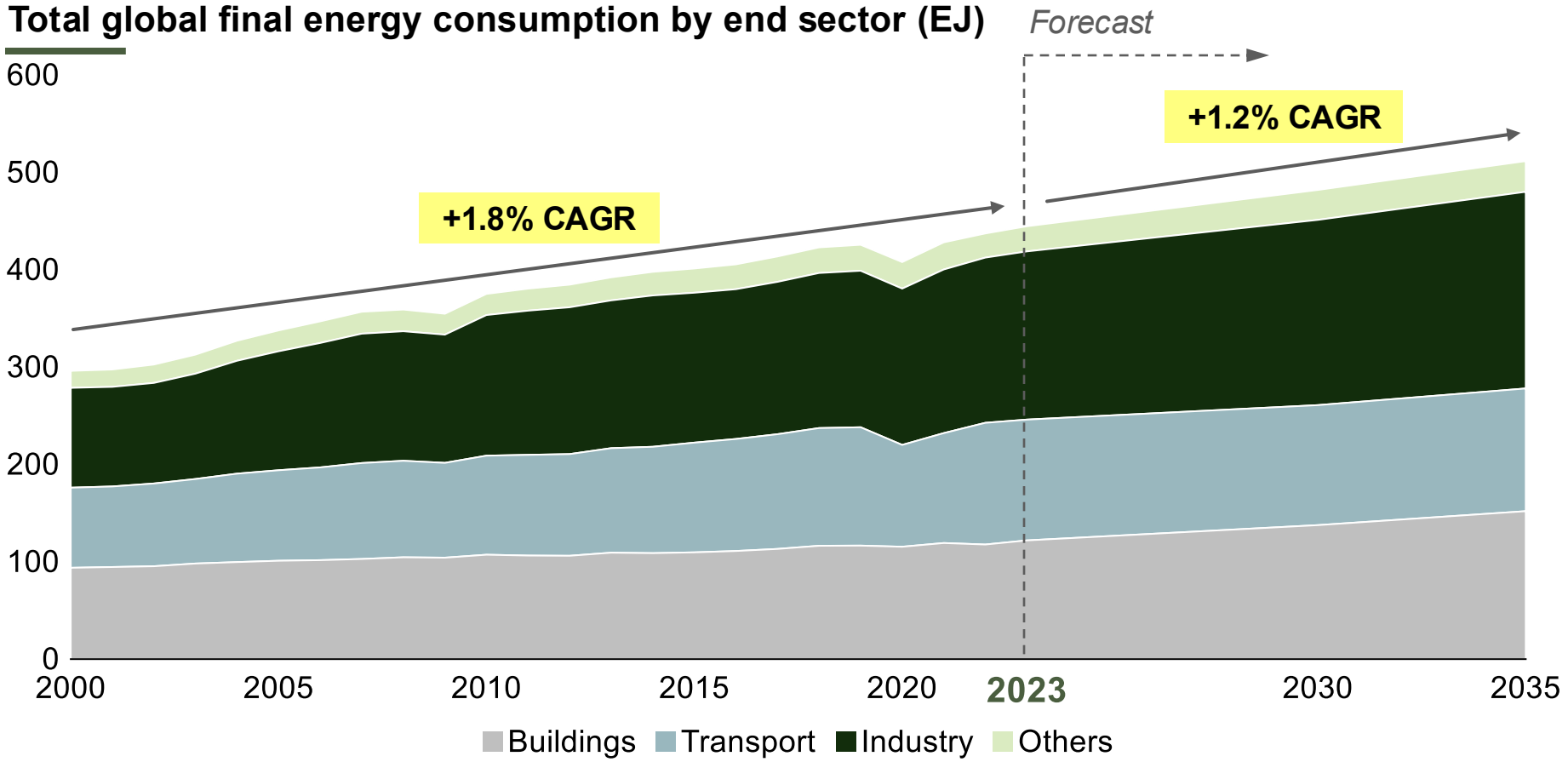
- While EV penetration will continue to increase, growth is expected to be more modest compared to last year’s expectations
- Electricity demand from data centers and AI increases by ~2x in the US and ~1.5x globally, as we expect AI adoption to accelerate significantly
- Emissions have increased from last year’s outlook due to slower retirements of coal

High-level comparison to other outlooks

- P50’s Total Energy Supply and Total Final Consumption are broadly in line with other outlooks
- P50’s emissions, while higher than IEA STEPS, are roughly in line with various other outlooks (including BP and IEA) that see higher fossil fuel share in energy mix

Global Energy Demand Continues to Grow

Total global final energy consumption by end sector (EJ)



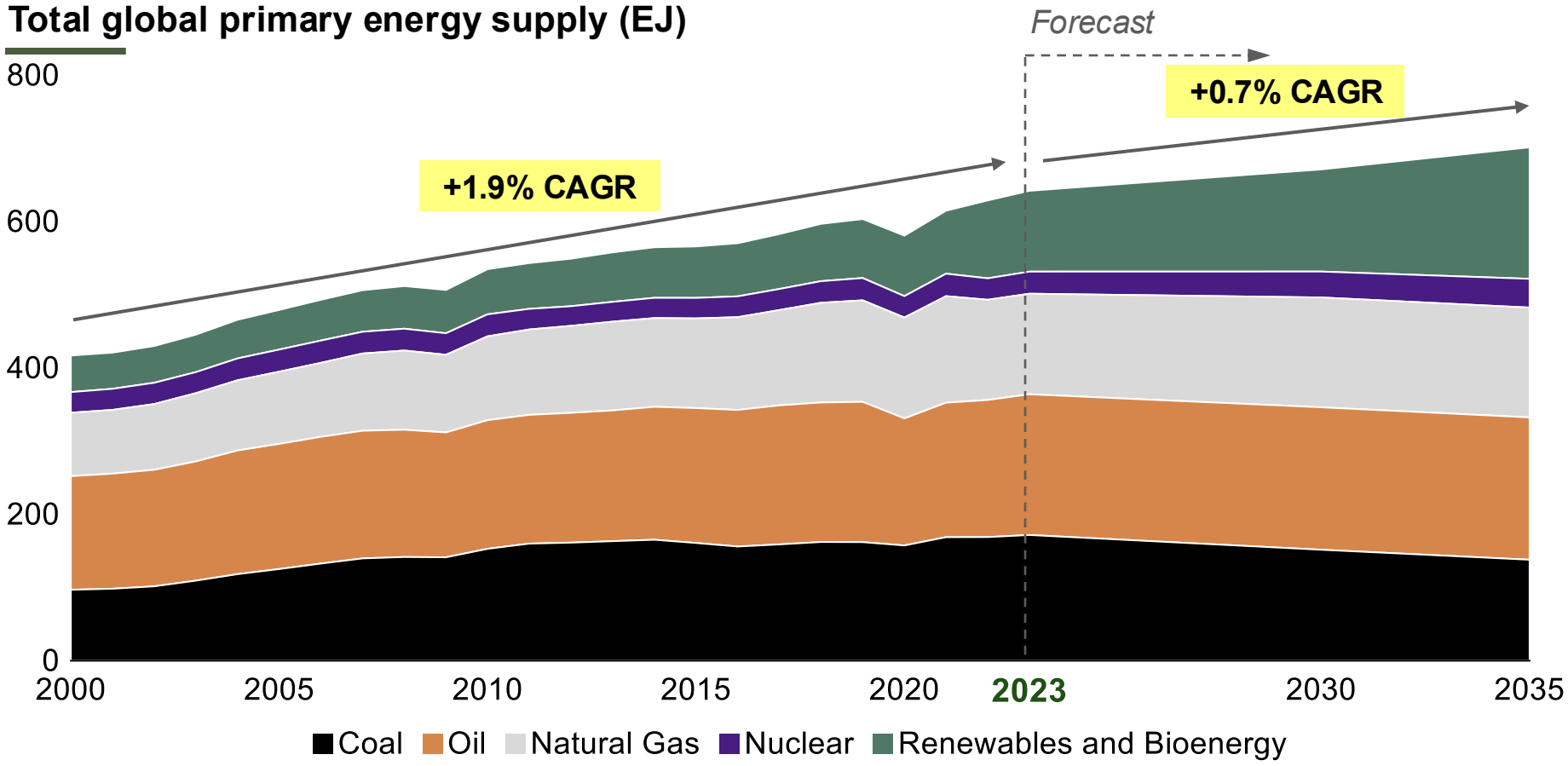
Outlook through 2035

+15% growth

- …driven by **developing economies**
- …with **largest share from industry and highest growth from buildings**
- …partially offset by **improved energy efficiency**

The Global Energy Supply Mix is Shifting

Total global primary energy supply (EJ)



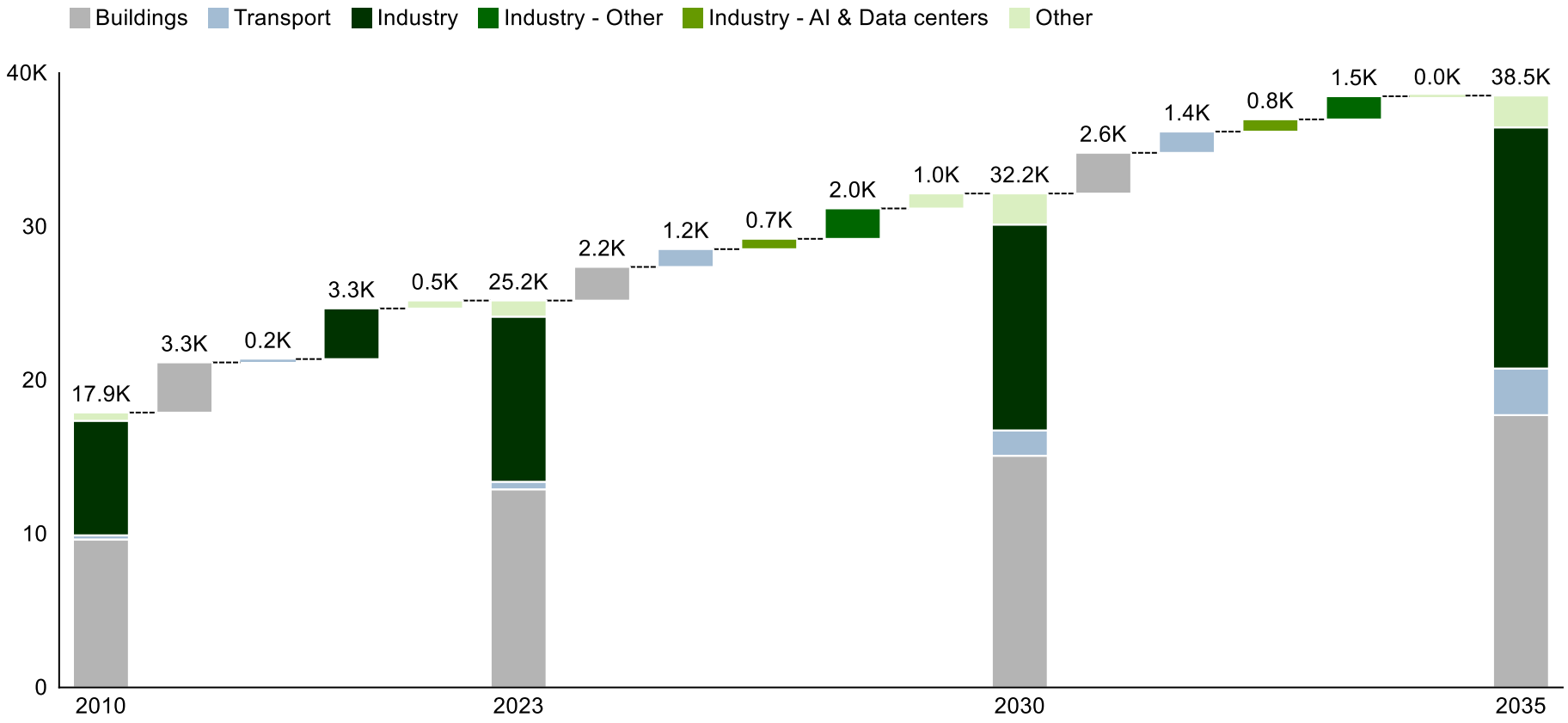
Outlook through 2035

+9% growth

- …partially offset by high conversion **efficiency renewable resources**
- … as **renewables surge to ~26% of energy mix**

Electricity Growth Far Exceeds Total Energy Supply Growth

Global electricity demand (TWh)



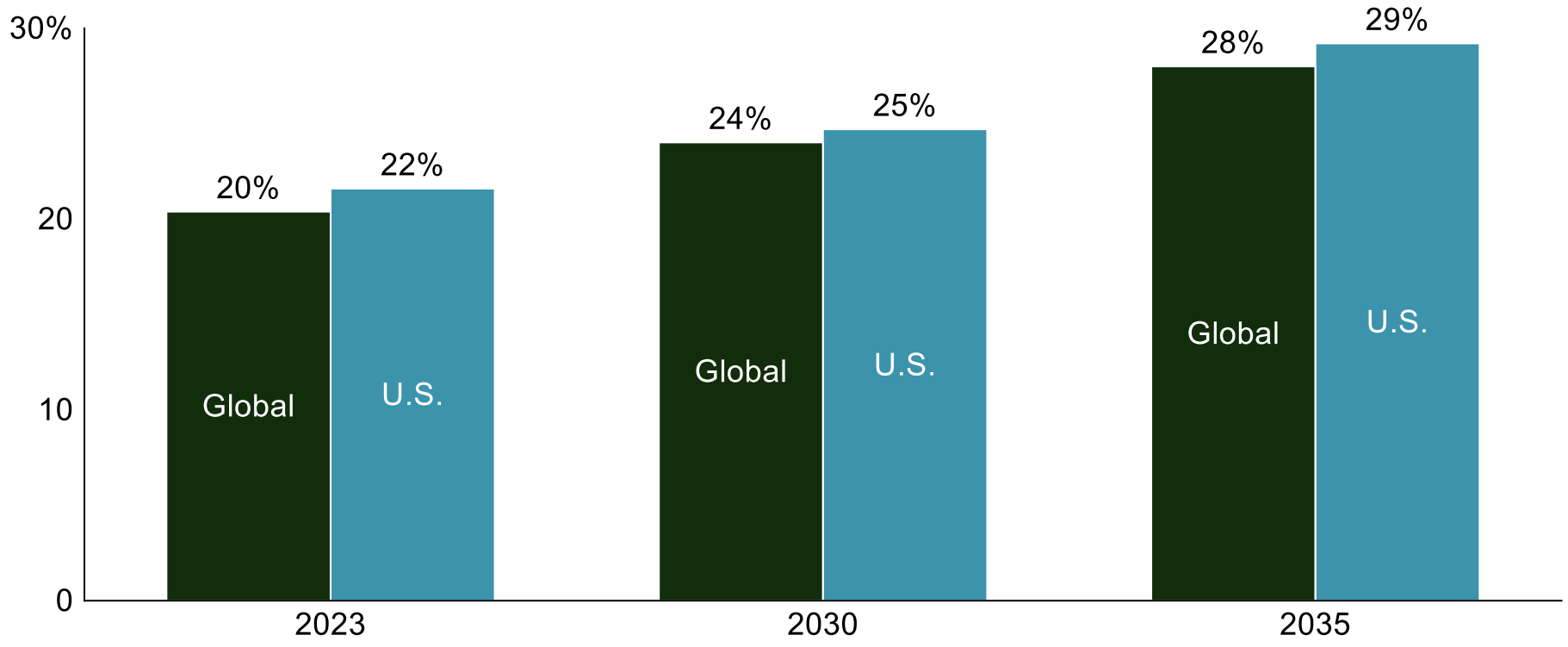
Outlook through 2035

+50-60% growth

- ~36% of overall growth driven by electrification of buildings incl. **HVAC systems**
- ~11% of overall growth from **AI uptake and data center expansion**; ~26% more from **broader industry electrification**
- ~19% of overall growth from increased **EV adoption**

Electrification Will Continue Globally and in the U.S.

Electrification share of total final energy consumption (%)



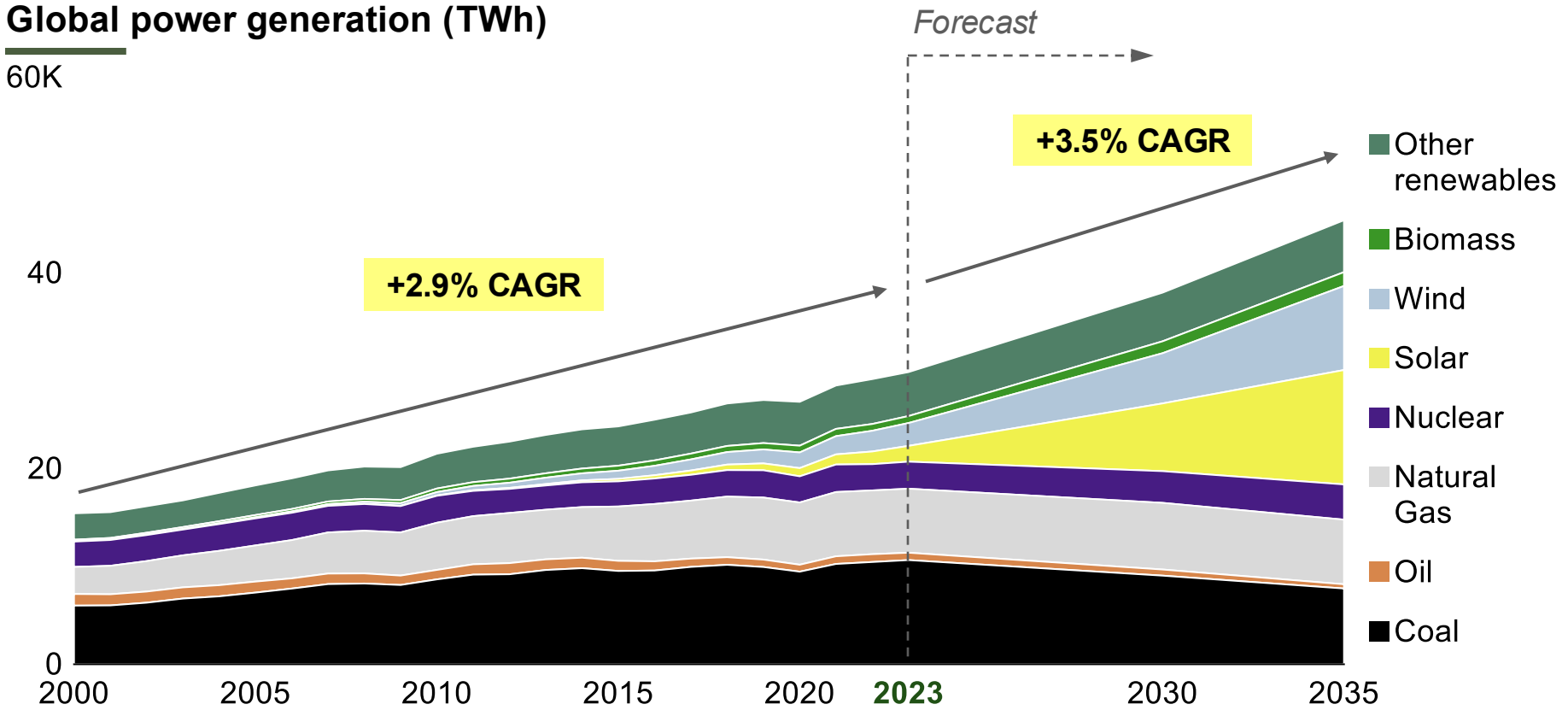
Outlook through 2035

+7-8 pp increase

- Global: **~53% additional energy consumption** from electricity
- U.S.: **~32% additional energy consumption** from electricity

Wind & Solar Will Grow Rapidly to Meet Electricity Demand

Global power generation (TWh)

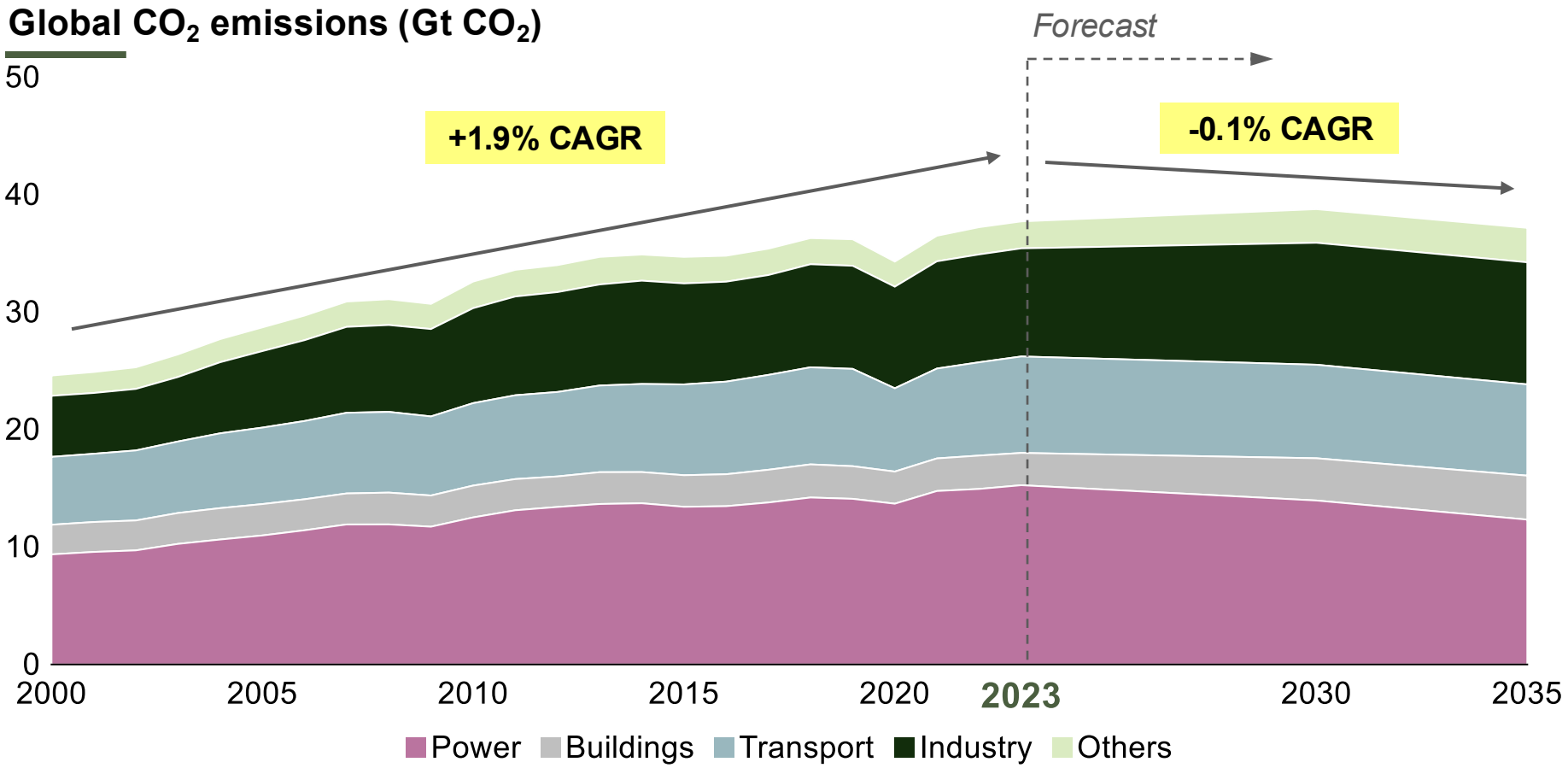


Outlook through 2035

+50-60% growth

- …as electricity **grows** from **21% to 28% of total final consumption**
- …as **Solar and wind surge to 45%** of generation
- …amplified by **cheaper battery storage**

Global Carbon Emissions are Peaking

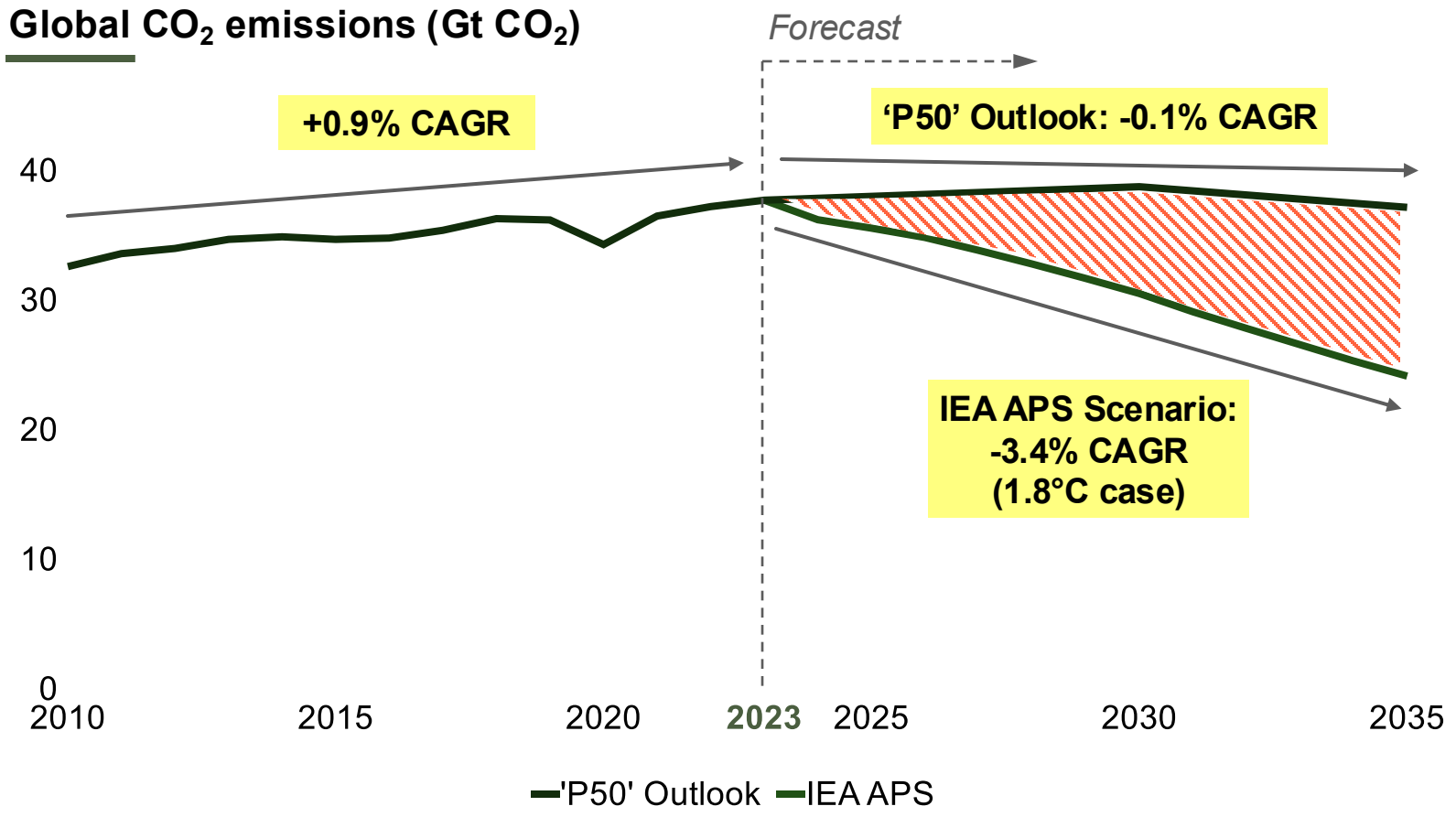


Outlook through 2035

~1% decline

- …as **China emissions peak by 2030**
- …as **Transport and industry electrify** in developed economies
- …partially offset by **fuel-driven industrialization** in developing economies

We’re Bending the Emissions Curve, Yet Face a Big Gap



The gap through 2035

~89Gt

Total global CO_2 emissions gap between the ‘P50’ Outlook and 1.8°C scenario

-18%

Total global CO_2 emissions reduction needed to stay on track from ’23-’35

Implications for Global Energy & Climate Outlook

Energy Demand...

is set to grow 15% by 2035, largely driven by developing economies

Oil Demand...

peaks in 2030, as the world passes a tipping point in EV adoption

Natural Gas Demand...

will grow in line with the total energy demand, keeping its share stagnant at ~21% by 2035

Renewable Energy...

share of energy mix is forecast to increase from ~17% to ~26% in 2035, as strong growth continues

Carbon Emissions...

will decrease slightly, declining ~1% to reach ~37 Gt in 2035

Different Priorities...

in developing and developed world, with former focused on energy access, latter on affordability and climate change

Comparison to last year: OpenMinds ‘P50’ Outlook Model Assumptions (Global)

Key assumptions

		2030 Assumptions			2035 Assumptions		
		2024 model	2025 model	% difference	2024 model	2025 model	% difference
Energy and Electricity Demand	GDP growth (% p.a.)	2.70%	3.10%	15%	2.70%	2.90%	7%
	Total energy supply (EJ)	703	671	-5%	724	702	-3%
	Total final consumption (EJ)	506	482	-5%	522	512	-2%
	Energy conversion efficiency (% TFC/TES)	71%	72%	1%	73%	73%	0%
	Heat pump # units growth (% p.a.)	7%	7%	0%	8%	8%	0%
	EV sales penetration (% of new car sales)	45%	36%	-20%	64%	50%	-22%
	Electricity demand from data-centers and AI (TWh)	1060	1100	4%	1230	1900	54%
Power Sector	Battery storage intensity[1]	8%	12%	50%	11%	15%	36%

Legend

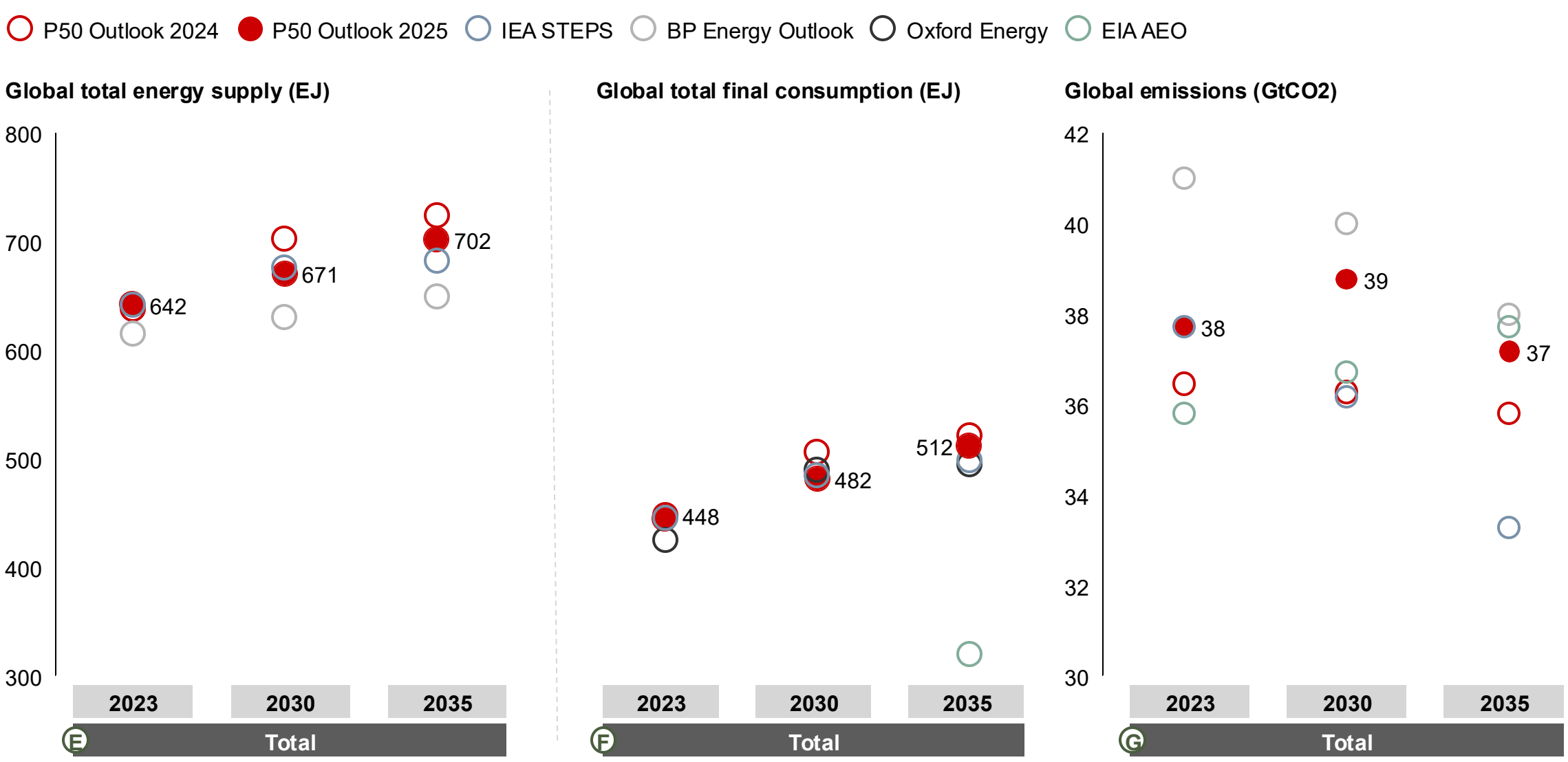
= Key changes since 2024

Note: [1]Battery storage intensity calculated as the total installed battery capacity as a % of total installed variable renewable energy (wind and solar) capacity; [3]Baseline values revised to $65/MWh for gas and $103/MWh for nuclear in latest modelling | Source: IEA, Goldman Sachs, IRENA, Intersect$_{SM}$ Carbon & Energy Transition CGE Model, JP Morgan, Market participants

Comparison to last year: Total Energy Supply Outlook by Energy Source

	2024 Data		2025 Data	
Energy Source (TWh)	TES ’23-’35 CAGR	Share of ’23-’35 TES Growth	TES ’23-’35 CAGR	Share of ’23-’35 TES Growth
Coal	**-2.3%**	**-46%**	**-1.8%**	**-57%**
Oil	**+0.6%**	**17%**	**+0.1%**	**4%**
Natural Gas	**+1.2%**	**27%**	**+0.7%**	**21%**
Nuclear	**+2.4%**	**11%**	**+2.2%**	**15%**
Renewables & Bioenergy	**+4.8%**	**91%**	**+4.1%**	**117%**
Total	**+1.1%**	**100%**	**+0.7%**	**100%**

Benchmarking | Global TES, TFC and emissions



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- Energy supply, mix, and emissions
- Key changes compared to last year
- How P50 compares to other outlooks

Executive Summary – US Outlook

'P50' 2025 key takeaways

- US energy demand continues to grow overall, largely driven by industry
- US energy supply mix is shifting, with gas and renewables gaining share from coal
- Electricity demand expected to grow ~3.3% p.a., driven largely by AI and data center growth
- Wind & solar will grow rapidly but face supply chain constraints; new natural gas to meet growing residual electricity demand
- US CO_2 emissions will decline at a slower rate as ramp-down of fossil fuels extends to meet power demand surge

Key changes since last year's outlook

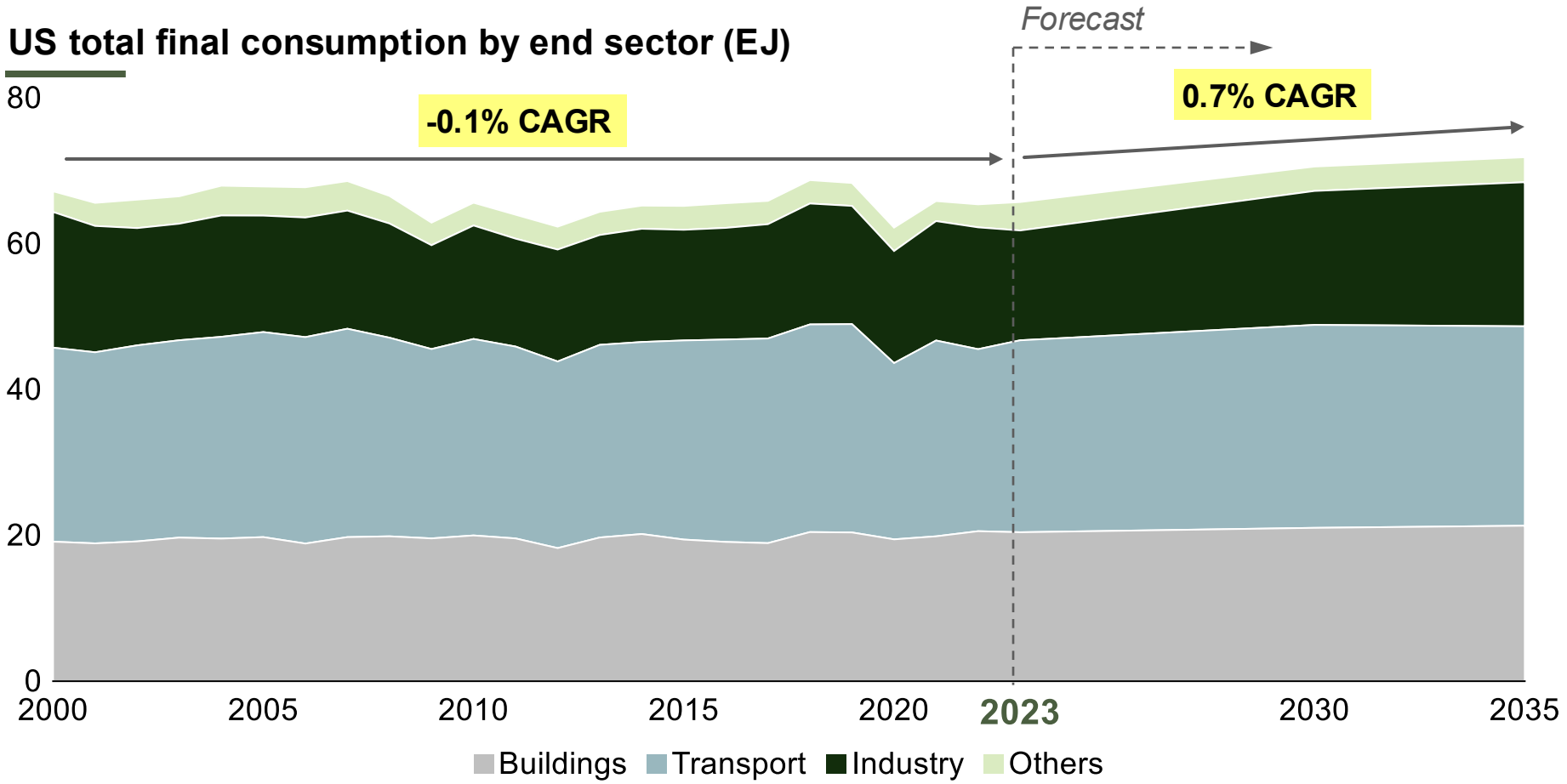
- Electricity demand from data centers and AI increases by ~2x in the US as we expect AI adoption to accelerate significantly
- Coal generation is ~1.6x higher than last year's projection (~2.5% of power mix in 2035), as surging power demand is likely to slow coal retirement
- Wind adoption is slowing, with expected generation haircut by 14% in 2035 compared to last year, driven by industry uncertainty around policy (incl. Executive Orders around permitting and leasing and IRA tax credits) and interconnection delays

High-level comparison to other outlooks

- Broadly speaking, the U.S. specific P50 outlook falls in line with middle-of-the-road projections of other 3rd party outlooks
- The P50 outlook is in particular more bullish on AI data center growth and less convinced of accelerated coal retirements than some of the outlooks published 6+ months ago

US energy demand continues to grow overall, largely driven by industry

US total final consumption by end sector (EJ)



Outlook through 2035

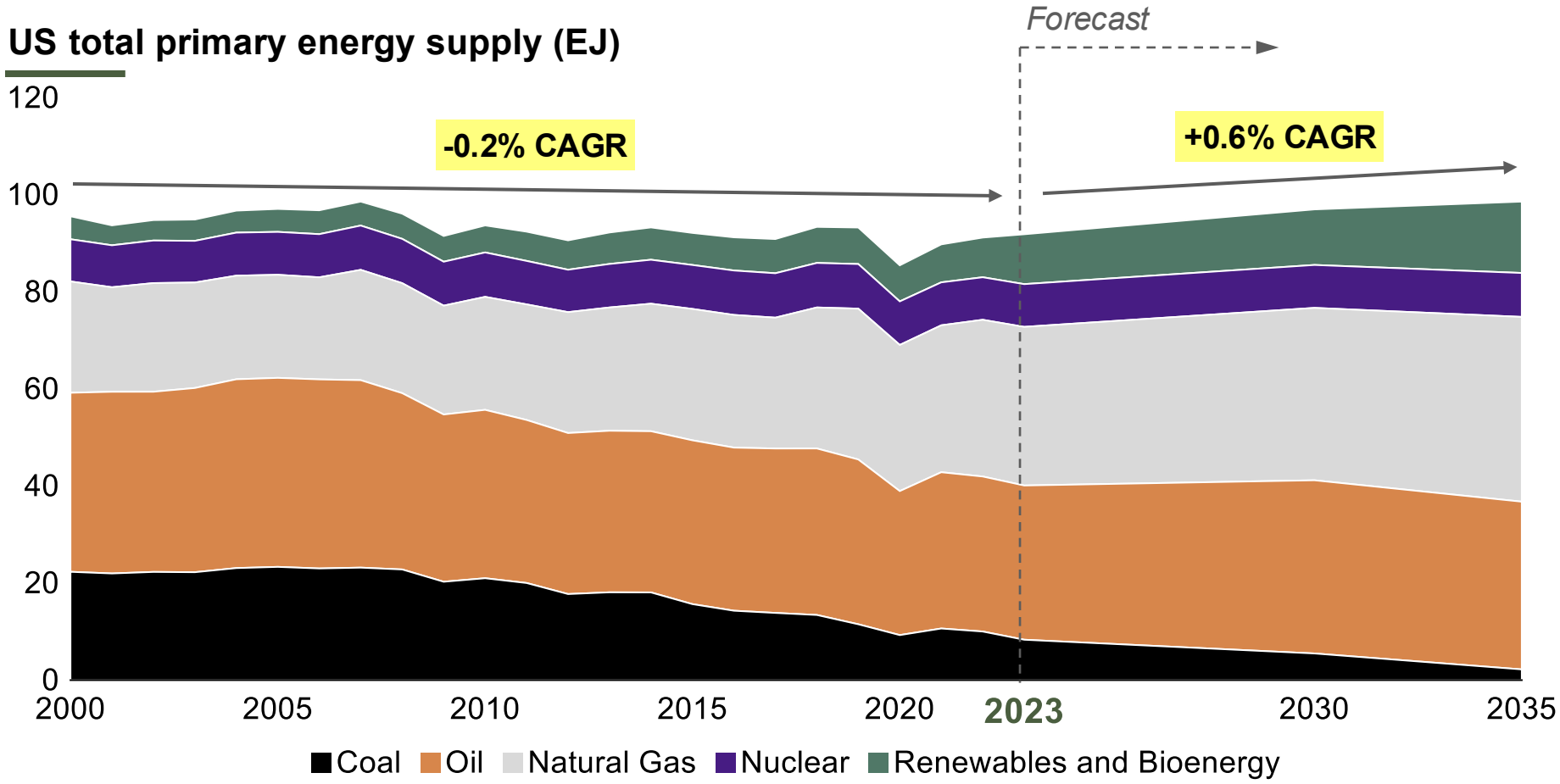
~9% growth

- ...driven by **increased electricity use for data centers and AI in industry**
- …partially offset by **increased energy efficiency in transport due to EV adoption**

Note: “Others” include non-energy use of non-oil products in chemical / petrochemical applications and all other non-energy use, agriculture and fishing | Source: OpenMinds P50 Model; IEA WEO 2024

US energy supply mix is shifting, with gas and renewables gaining share from coal

US total primary energy supply (EJ)



Outlook through 2035

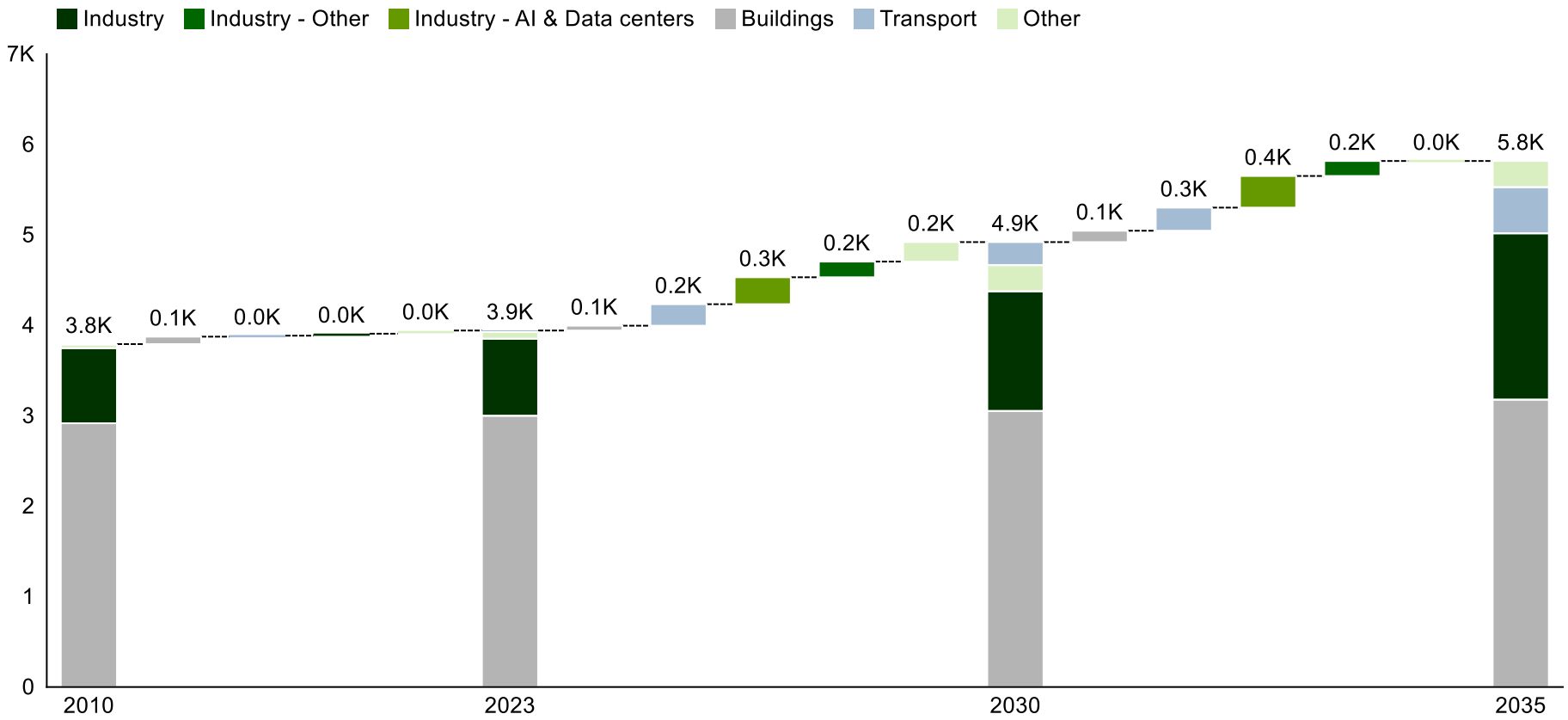
~7% growth

- …as **renewables grow to ~15% of energy mix**
- ...while **oil peaks around 2030** and **natural gas gains ~3% share**
- …partially offset by high conversion **efficiency of renewable sources**

Source: OpenMinds P50 Model; IEA WEO 2024

Electricity growth far exceeds total energy supply growth, driven mainly by industrial applications

US electricity demand (TWh)



Note: "Others" include non-energy use of non-oil products in chemical / petrochemical applications and all other non-energy use, agriculture and fishing | Source: OpenMinds P50 Model; IEA WEO 2024

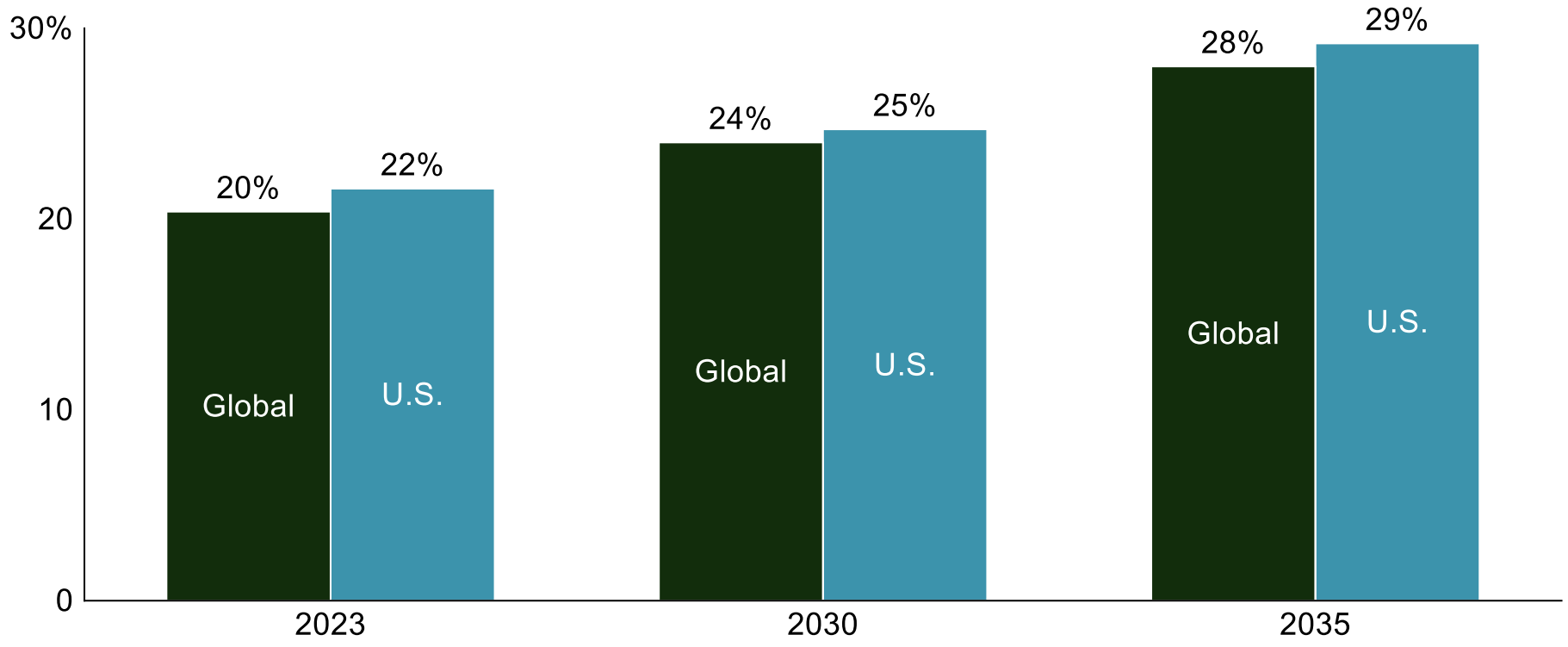
Outlook through 2035

~40-50% growth

- ... ~700 TWh from **AI uptake and data center expansion**; further ~400 TWh from **broader industry electrification**
- … ~500 TWh owing to increased **EV adoption**
- … ~200 TWh driven by demand for **appliances and heating / cooling**

Electrification Will Continue Globally and in the U.S.

Electrification share of total final energy consumption (%)



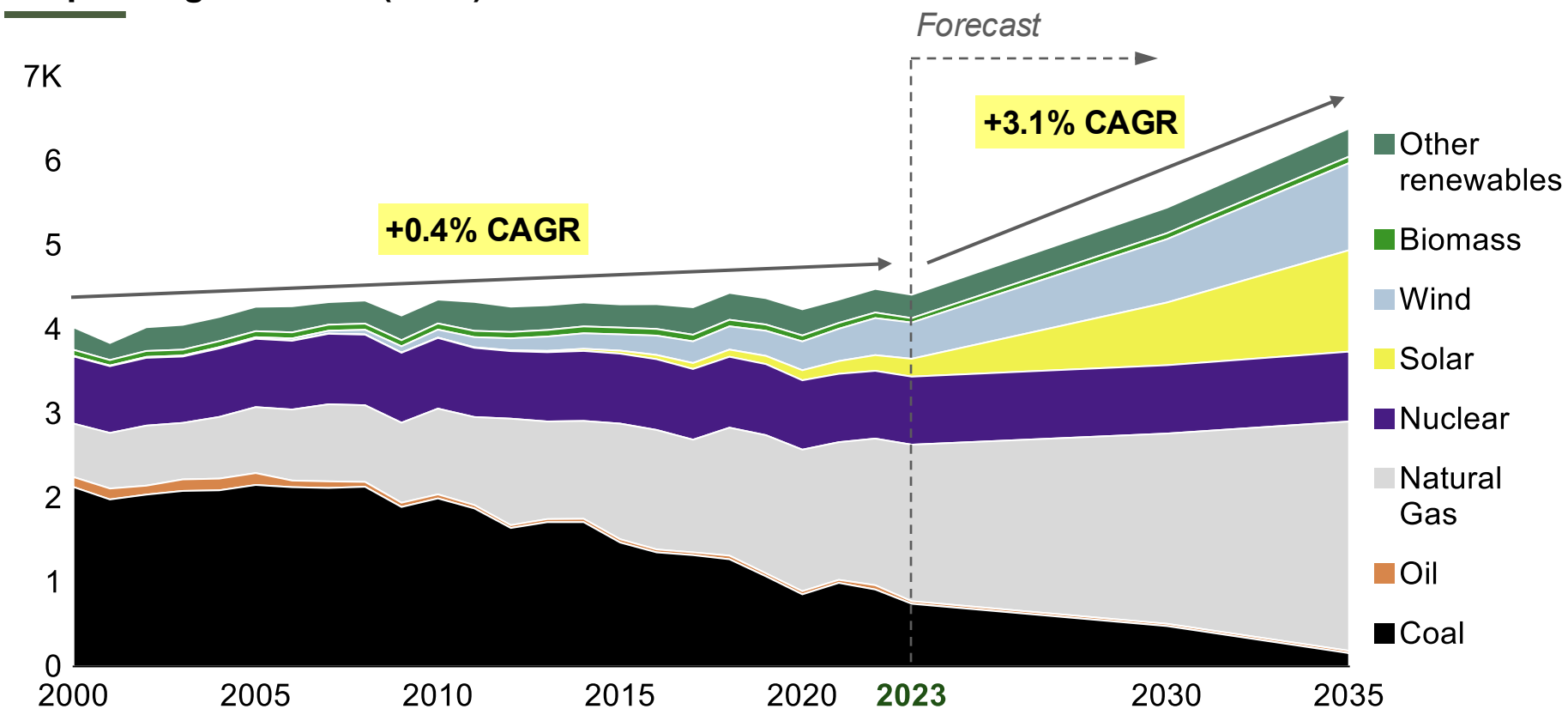
Outlook through 2035

+7-8 pp increase

- Global: **~53% additional energy consumption** from electricity
- U.S.: **~32% additional energy consumption** from electricity

Wind & solar will grow rapidly to meet US electricity demand; natural gas growth to meet residual demand

US power generation (TWh)



Outlook through 2035

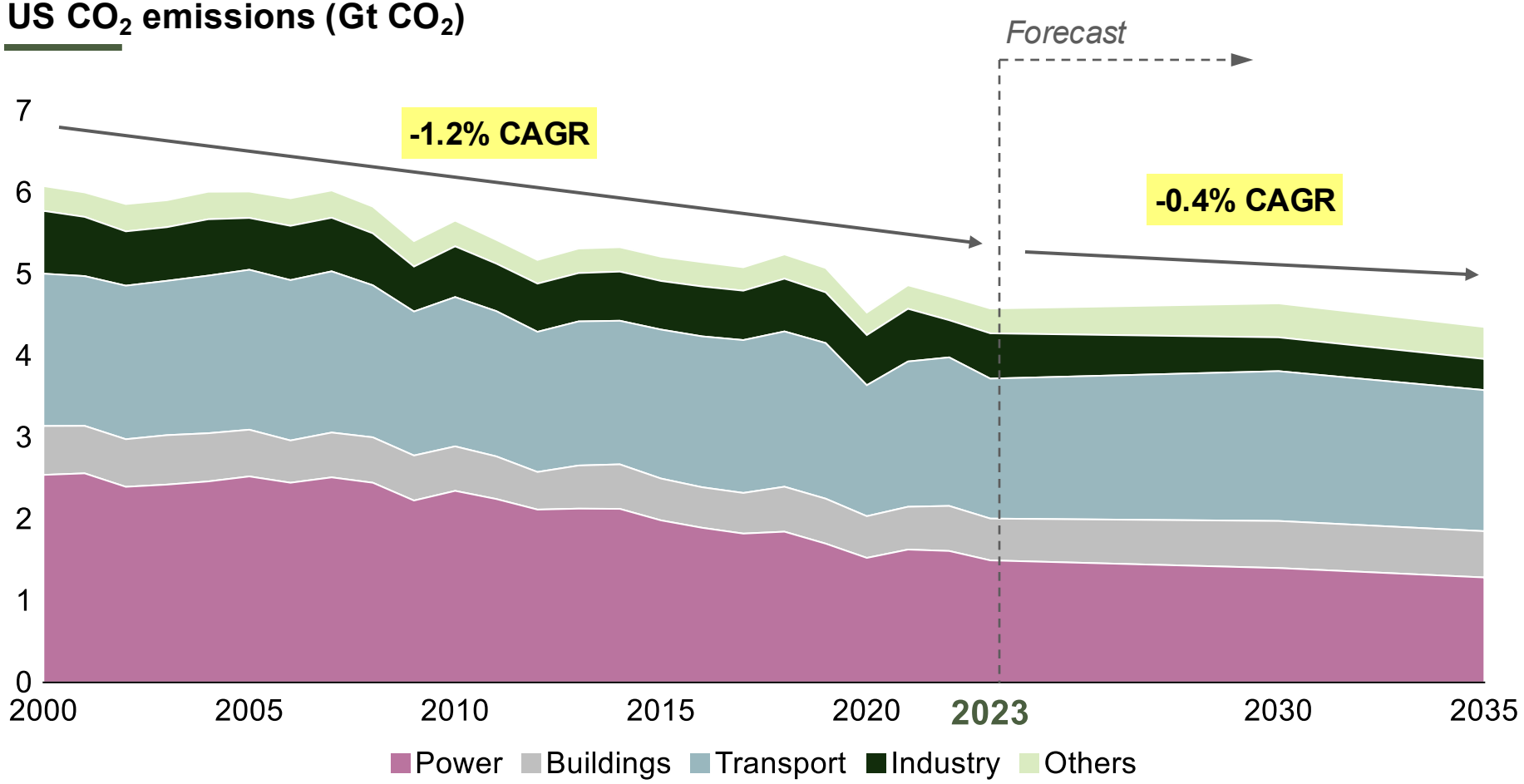
~40-50% growth

- … as **electricity grows from ~21% to ~29% of total final consumption**
- … while **solar and wind increase to ~35% of generation**
- ... with **expansion limited by policy and supply chain issues**

Source: OpenMinds P50 Model; IEA WEO 2024

Decline in US carbon emissions forecasted to slow, due to more gas in power mix and steady transport emissions

US CO_2 emissions (Gt CO_2)



Outlook through 2035

~5% decline

- … as **consumption sectors electrify**
- …and **power sector moves to renewables or gas**
- …partially offset by **overall growth in consumption and power requirements**

Note: "Others" include energy industry own use outside of power sector, a subset of non-energy, agriculture and fishing | Source: OpenMinds P50 Model; IEA WEO 2024

Implications for US Energy & Climate Outlook

Energy Demand...

is set to grow 9% by 2035, with booming electricity demand as a key driver

Power Generation...

will rapidly increase, growing 40-50% by 2035, with accelerating AI demand as a key driver

Coal Power...

continues to decline, although recent plant retirement delays will slow mix shift

Natural Gas Demand...

will grow faster than total energy demand, increasing its share by 3 percentage points to ~40% through 2035

Renewable Energy...

is forecast to nearly double from ~9% of energy mix today to ~15% in 2035

Carbon Emissions...

will slightly decrease by ~0.4% p.a. to reach ~4.5 Gt in 2035

Comparison to last year: OpenMinds 'P50' Outlook Model Assumptions (US)

Key assumptions

			2030 Assumptions			2035 Assumptions		
			2024 model	2025 model	% difference	2024 model	2025 model	% difference
Energy and Electricity Demand	GDP growth (% p.a.)		1.70%	2.10%	24%	1.90%	2.00%	5.26%
	Total energy supply (EJ)		99.7	97	-3%	101.3	98.6	-2.67%
	Total final consumption (EJ)		71.7	71.6	-0.1%	71.7	71.9	0.28%
	Energy conversion efficiency (% TFC/TES)		71%	73%	3%	71%	73%	2.82%
	Heat pump # units growth (% p.a.)		3%	3%	0%	6%	6%	0.00%
	EV sales penetration (% of new car sales)		35%	31%	-11%	55%	46%	-16.36%
	Electricity demand from data-centers and AI (TWh)		~390	~480	~23%	~450	~830	~84.44%
Power Sector	USA – Value-Adjusted Levelized Cost of Electricity (VALCOE, $/MWh)	*Solar*	64	61	-5%	62	57	-8.06%
		Wind	71	63	-11%	77	63	-18.18%
		Gas	59	64	8%	59	65	10.17%
		Nuclear	105	103	-2%	105	103	-1.90%
	LCOE learning rate[1]	*Solar*	20%	20%	0%	20%	20%	0.00%
		Wind	15%	15%	0%	15%	15%	0.00%
	USA – Annual capacity additions (GW)	*Solar*	40	36	-10%	40	45	12.50%
		Wind	15	10	-33%	20	20	0.00%
	Battery storage intensity[2]		19%	22%	16%	22%	26%	18.18%

Legend

⬚ = Key changes since 2024

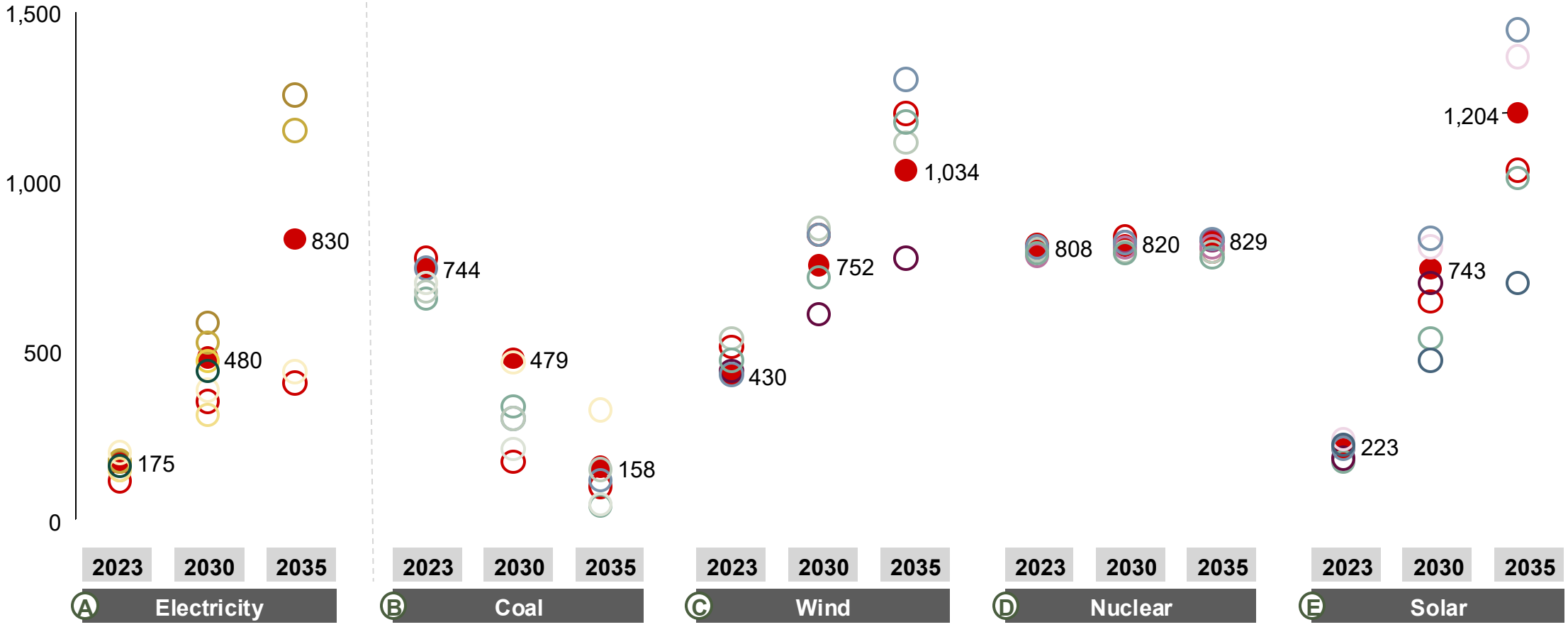
Note: [1]LCOE learning rate is the percentage decrease in LCOE for every doubling of installed capacity; [2]Battery storage intensity calculated as the total installed battery capacity as a % of total installed variable renewable energy (wind and solar) capacity; [3]Baseline values revised to $65/MWh for gas and $103/MWh for nuclear in latest modelling | Source: IEA, Goldman Sachs, IRENA, Intersect$_{SM}$ Carbon & Energy Transition CGE Model, JP Morgan, Market participants

Benchmarking | US power stack and data centre & AI demand

P50 Outlook 2024 · P50 Outlook 2025 · Bain POV · Enchanted Rock · Barclays · EPRI · S&P Global · IEA Report · IEA STEPS · EIA AEO · Wells Fargo · EPA Proposal · WoodMac · OM25 Pre-Read · RBC · GlobalData Power · Enerdata

US data center & AI demand (TWh)

US power generation by fuel type (TWh)



Appendix

OpenMinds

Solving for the
Dual Challenge

openminds203x.org

How the Intersect Model Works

Outlook based on most cost-effective path, limited by real world constraints

Inputs

- Population Growth
- GDP
- Technology costs *(incl. commodity intensities)*
- Experience curves
- CO_2 intensity

Simulation Engine

STEP 1

Model is run as a **constrained optimization** to ensure sectors **decarbonize** based on the **most cost-effective path**

EXAMPLE: Decarbonization levers for transportation

- Switch Technology *e.g., ICE to EV*
- Improve Efficiency
- Lower demand

STEP 2

Demand = Supply

Model uses prices to reach **demand and supply equilibrium** across all sectors subject to input output matrix constraints

STEP 3

Forces consistency by ensuring changes in sector output and factor incomes still sum to GDP. Process repeats each year until decarbonization targets are met each year

Real World Constraints

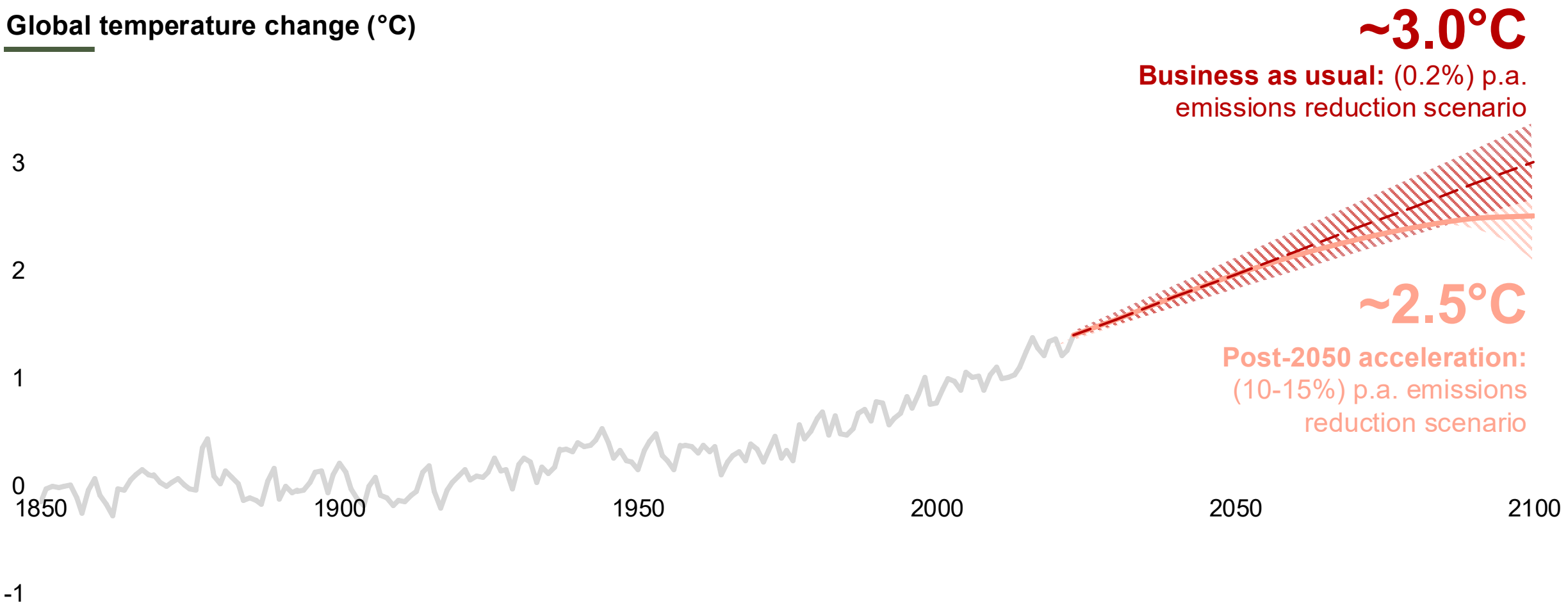
- Impact of intermittency of renewables on grid stability
- Assume electricity is priced on basis of average cost
- Physical availability of agricultural land for biomass activities
- Pace of roll out, amount of VRE installed per year

Outputs

- Energy demand
- Energy supply mix
- Sales and total stock of EVs
- Electrification pace
- Carbon emissions

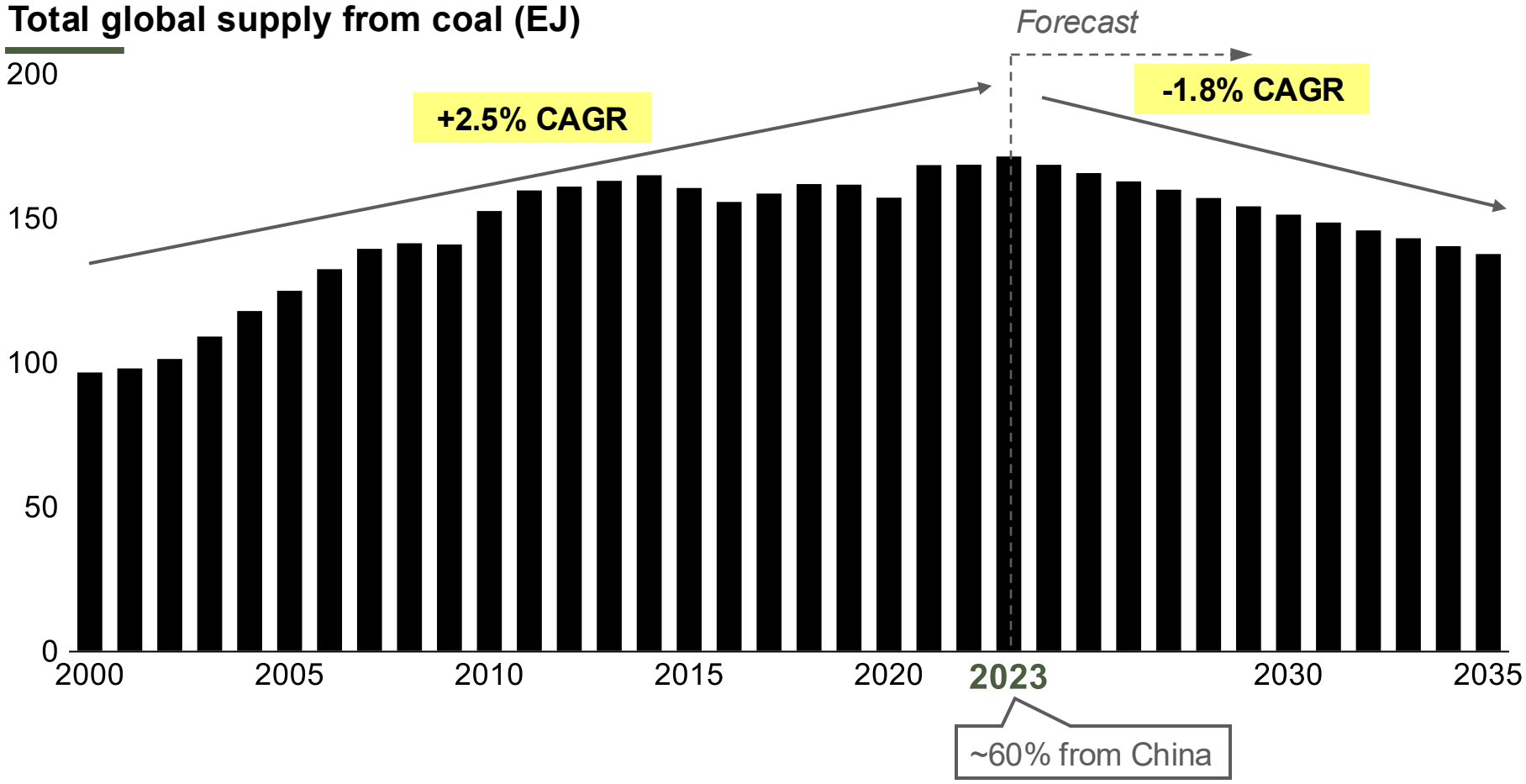
Temperatures Will Increase Without Further Progress

Global temperature change (°C)



Coal Fades Amid Plant Retirements and Cheaper Options

Total global supply from coal (EJ)



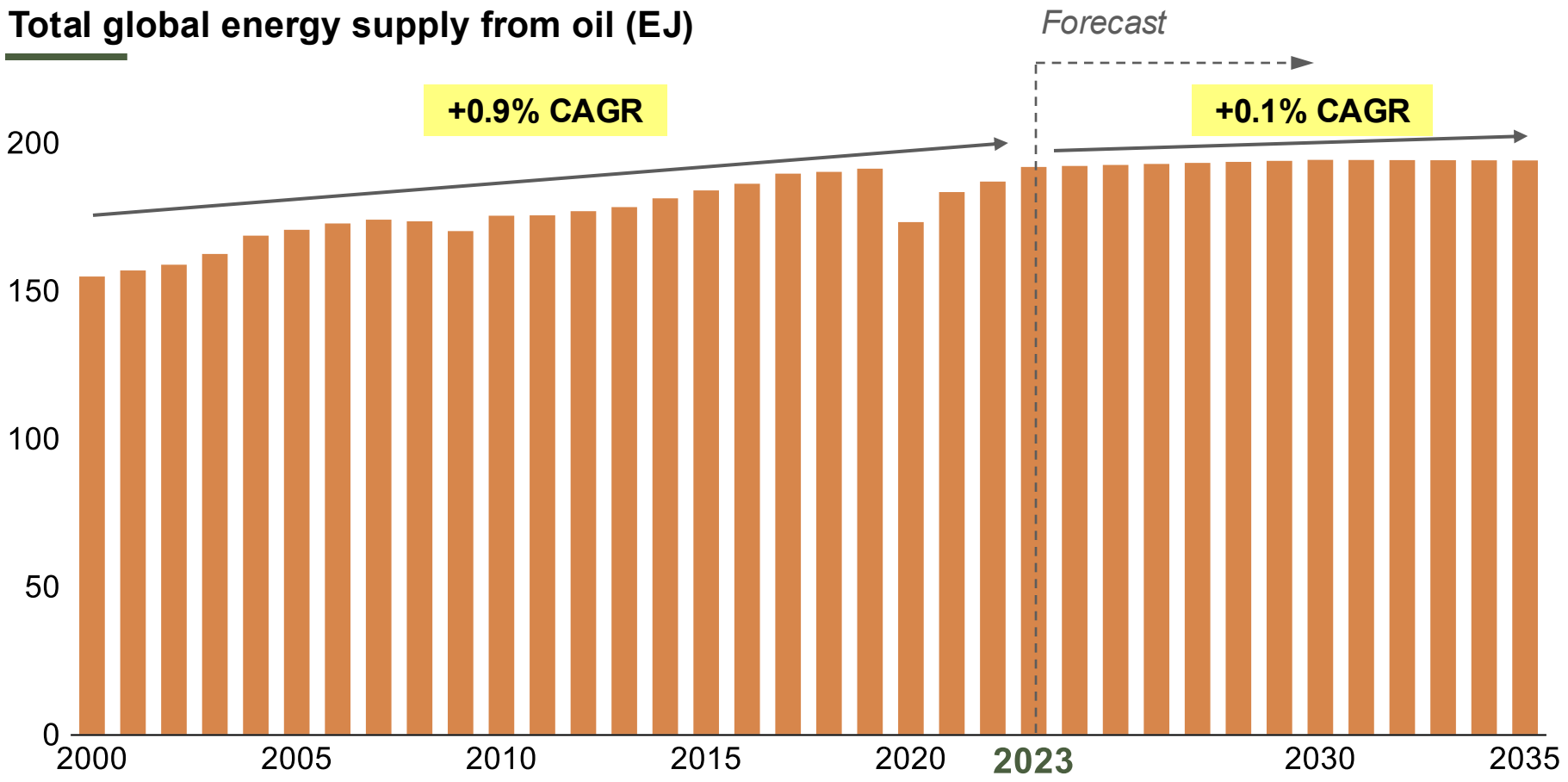
Outlook through 2035

-20% decline

- **Demand in China & India remains,** but growth is slowing
- **Aging fleets in U.S. & EU retiring,** not replaced
- Renewables and gas increasingly **undercut coal on cost**

Oil Demand Plateaus by 2030 But Remains Critical

Total global energy supply from oil (EJ)



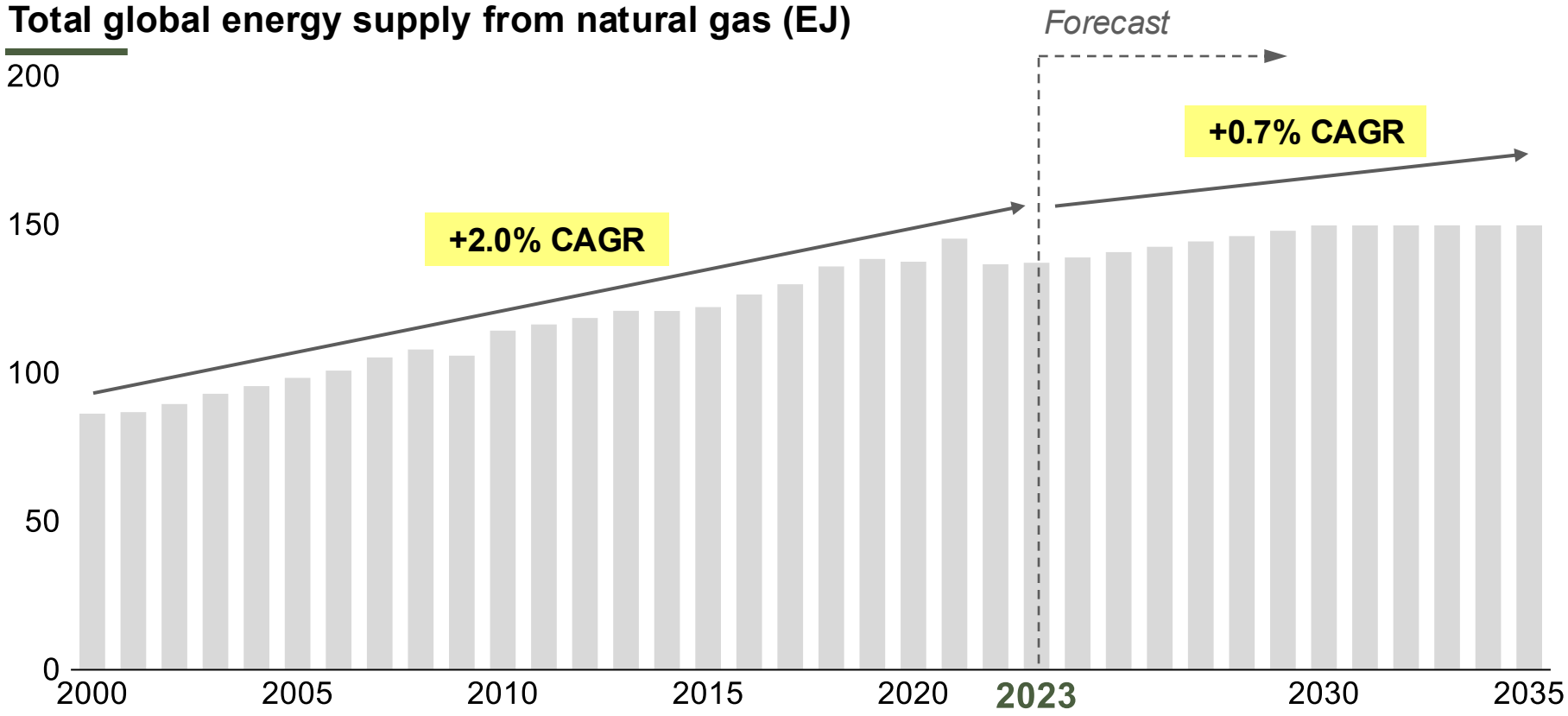
Outlook through 2035

+1% growth

- **EV adoption slows demand growth** post-2030
- Petrochemicals demand continues to support **baseline oil use**
- **Developing markets offset declines** in mature economies

Natural Gas Grows as a Flexible Bridge in the Transition

Total global energy supply from natural gas (EJ)



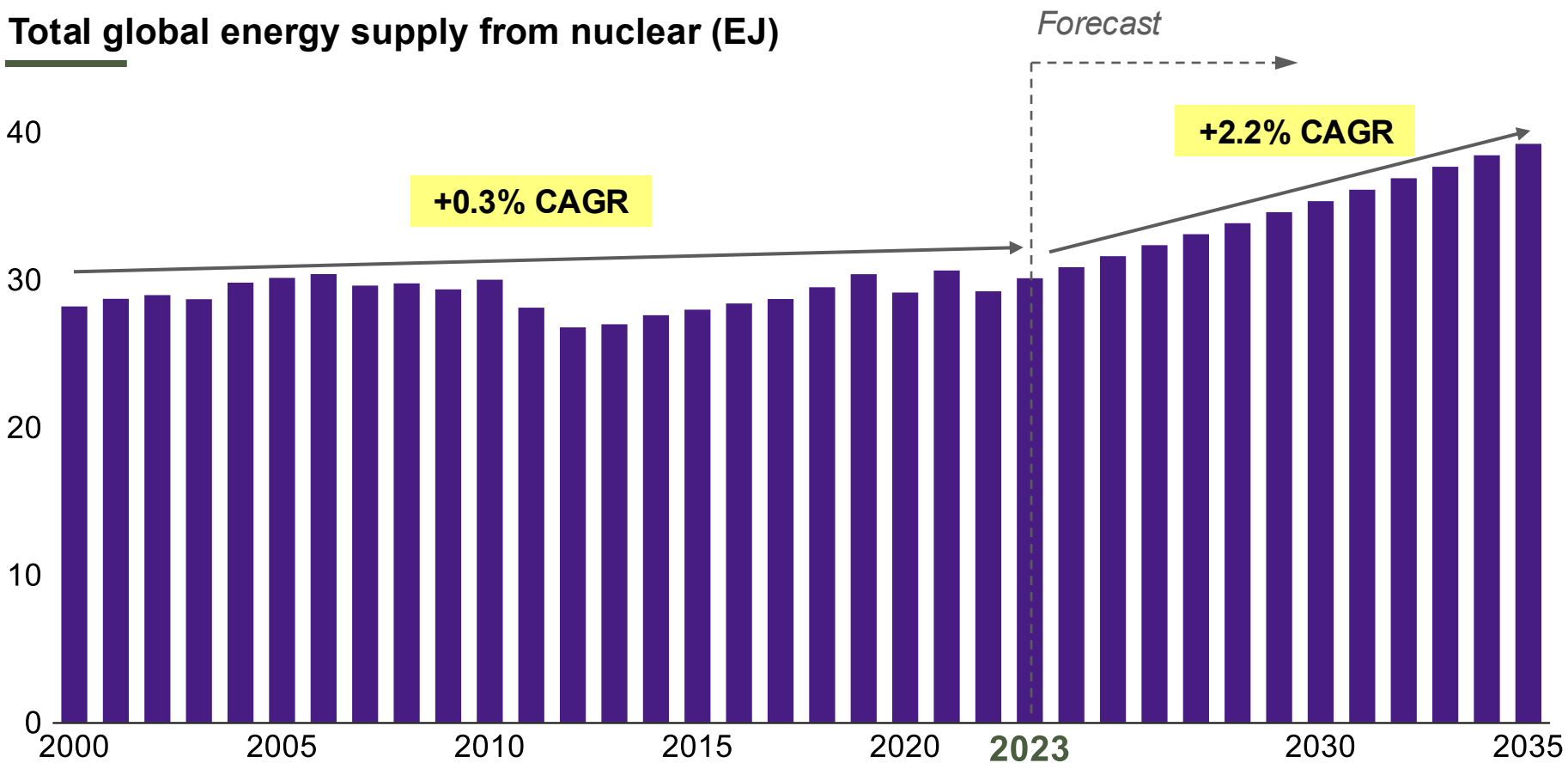
Outlook through 2035

+9% growth

- **Supports variable renewables** as flexible dispatchable supply
- **LNG expands access** and drives global trade growth
- **Industrial and heating demand remains strong** in key regions

Nuclear Rebounds with Long-Term, Steady Growth

Total global energy supply from nuclear (EJ)



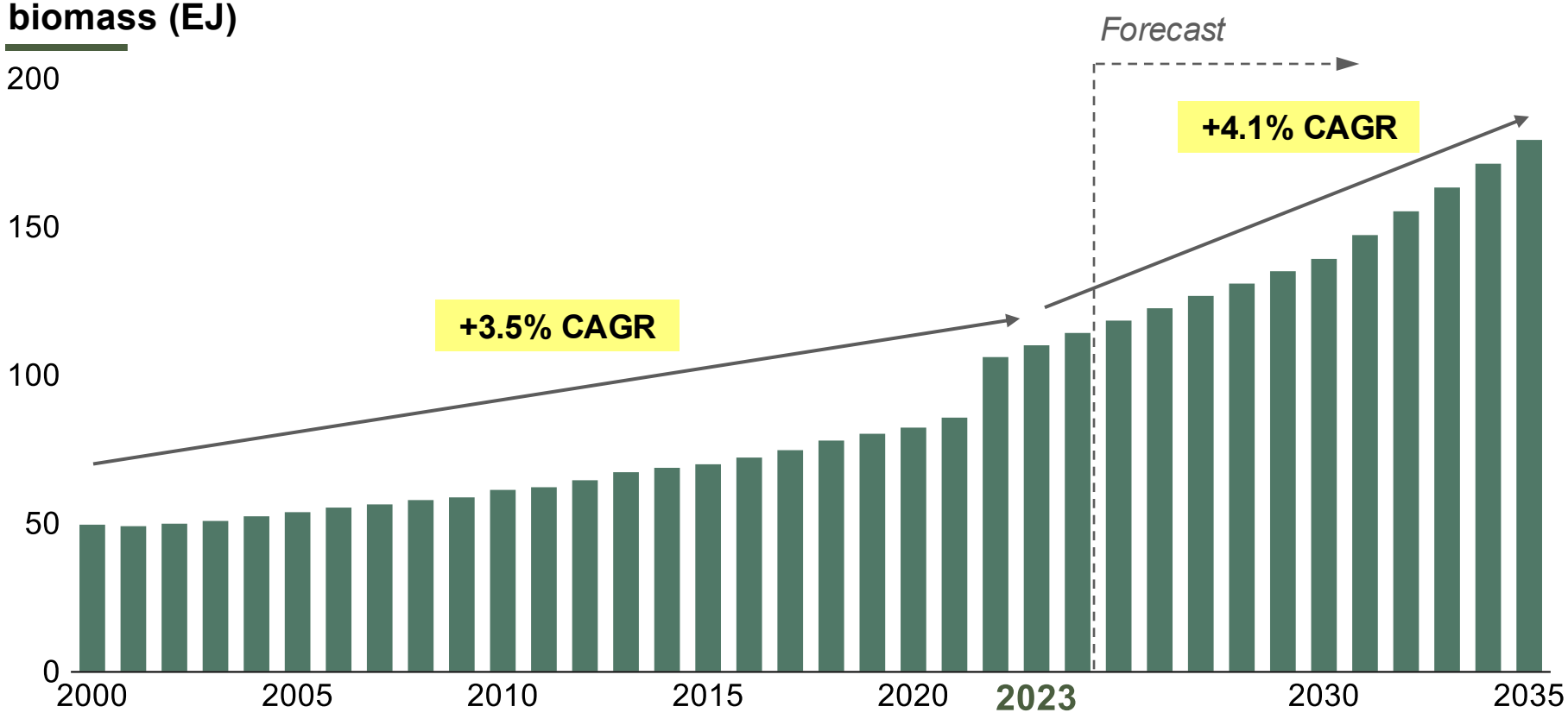
Outlook through 2035

+30% growth

- **Growth off small base –** gas supply ~5x nuclear
- **License renewals and restarts** boost near-term capacity
- New builds accelerate in **China, India, and Eastern Europe**

Renewables Surge to Dominate New Supply Growth

Total global energy supply from renewables & biomass (EJ)



Outlook through 2035

+63% growth

- Continued **cost declines** of solar & wind (though the pace is slowing)
- Multiplier effect from **cheaper energy storage**
- **Faster deployment timelines** vs. other energy sources

Known Global Trends in an Uncertain World

Trend	Drivers	Implications for Investors
Energy demand is increasing	• Urbanization and industrial growth in emerging markets • Expanding middle class driving higher per-capita energy use • Electrification spreading to underserved regions	• Energy infrastructure growth – known known • Rising demand for distributed energy (e.g., solar, batteries, mini-grids) • Strategic exposure to energy-intensive sectors (AI, manufacturing)
Energy supply mix is shifting	• Coal declining due to policy and economics in developed markets • Plateauing oil growth, mainly in petrochemicals and emerging markets • Natural gas gaining share due to flexibility, cost, and LNG trade growth • Renewables and energy storage scaling fast, driven by cost declines • Nuclear seeing renewed interest as a zero-carbon baseload option	• Rotation to renewables, storage, and clean fuels • LNG offers near-term bridge opportunity • Long-term upside in nuclear (e.g., SMRs); carbon capture emerging • Stranded asset risk from coal – reassess legacy holdings • Private equity plays in energy infrastructure buildout & maintenance
Electricity will make up a growing share of final energy consumption	• EV adoption accelerating, especially in China, Europe, and U.S. • Buildings shifting to electric heating and smart controls • Data center growth driven by AI, cloud computing, and digital services • Grid expansion & modernization to accommodate rising electricity loads • Rooftop solar and batteries supporting local generation • Policy mandates pushing electrification (e.g., ICE bans, building codes)	• Grid and interconnection buildout opportunities • EV & charging networks as transport electrifies • Building upgrades (HVAC, smart controls, retrofits) gaining traction • Data centers driving demand for clean energy + real estate pairing
Temperatures are increasing	• Fossil fuel combustion raising atmospheric CO_2 levels & heat retention • Methane from agriculture and energy sectors accelerating warming • Policy delays increasing long-term climate risk	• Growth in adaptation infrastructure (water, fire, flood resilience) • Carbon markets and nature-based solutions gaining value • ESG and disclosure shaping capital flows and asset pricing • Be prepared for policy shocks (carbon taxes, mandates)

OpenMinds

Solving for the Dual Challenge

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