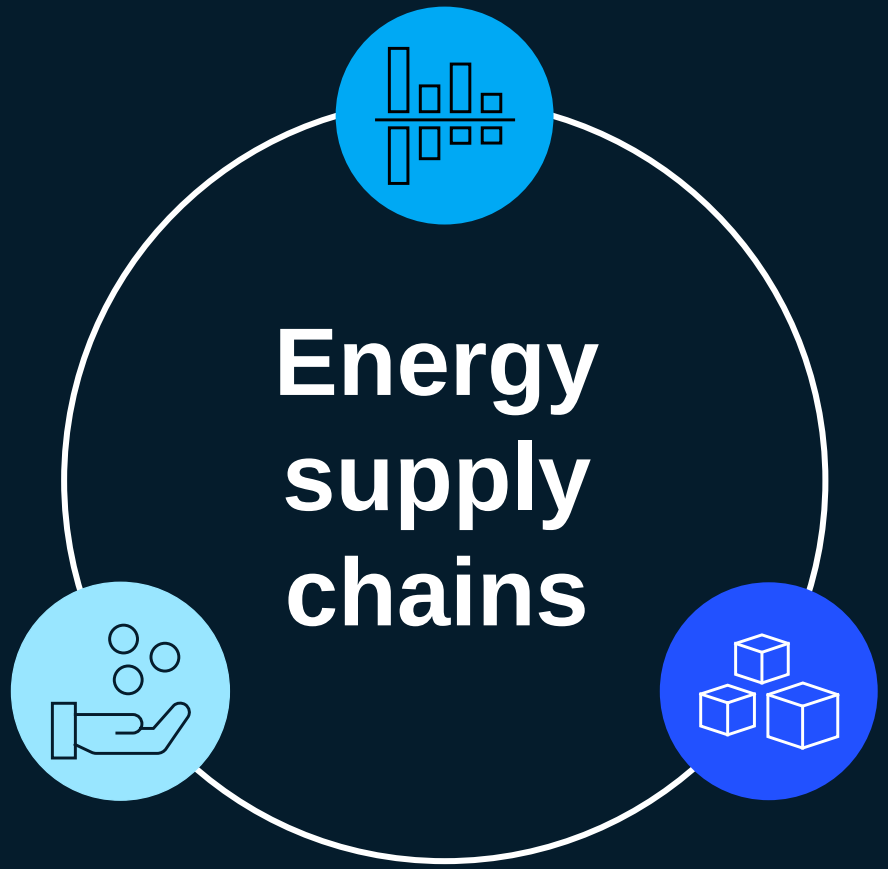
McKinsey & Company

Energy supply chain perspective:, challenges, demands and opportunities

Energy supply chains are at the center of changing demands, strong trends and challenging market forces



1. Market Forces

- Commodity volatility
- Scarcity & supply disruption
- Labor inflation
- Regionalization
- Geopolitical risk

2. Increasing Demands

- Rapid CAPEX growth
- Cost leadership non negotiable
- Cross-functional collaboration
- Strategic supplier management
- Agility for resilience

3. Need for Functional Leadership

- Digital & high value analytics
- Risk and resiliency focus
- ESG targets
- Talent challenges

Source: McKinsey Procurement Practice

Contents

"These have been the most challenging years in my 20+ year career in procurement"

Fortune 100 Global CPO

Unprecedented set of disruptions

Highest inflation since 1970s

Rates increasing to combat inflation

Sentiment at record lows

Declining consumer balance sheet

Supply chain woes continue

Labor imbalances persist

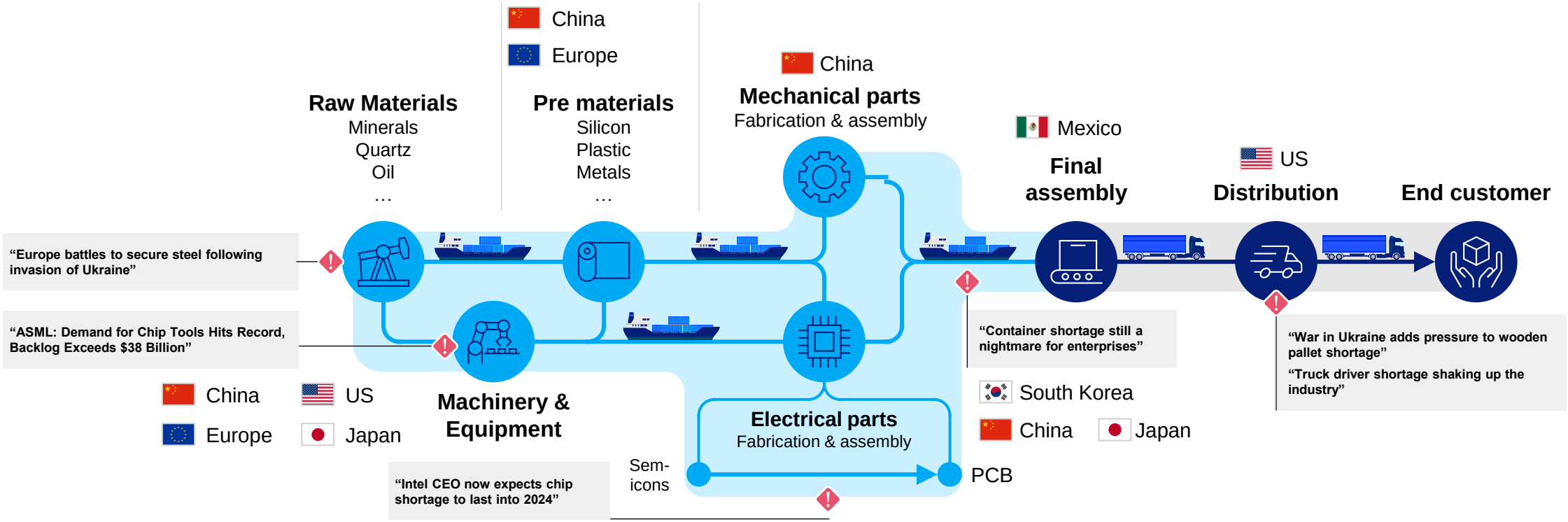
Commodity prices remain elevated

Geopolitical tensions

Sources: U.S. Bureau of Labor Statistics (BLS); Bloomberg; University of Michigan; FAO; St. Louise Federal Reserve; Federal Reserve Chair press conferences; Microsoft, Bureau of Economic Analysis

Highly interconnected global value chains were vulnerable by design – "perfect storm"

Simplified view of disruptions along the value chain in 2020 / 2021 / 2022 / 2023



1 **Ukraine invasion**

2 **COVID**

3 **Inflation**

4 **Price volatility**

5 **Changing consumer behavior**

6 **Supply Chain disruptions**

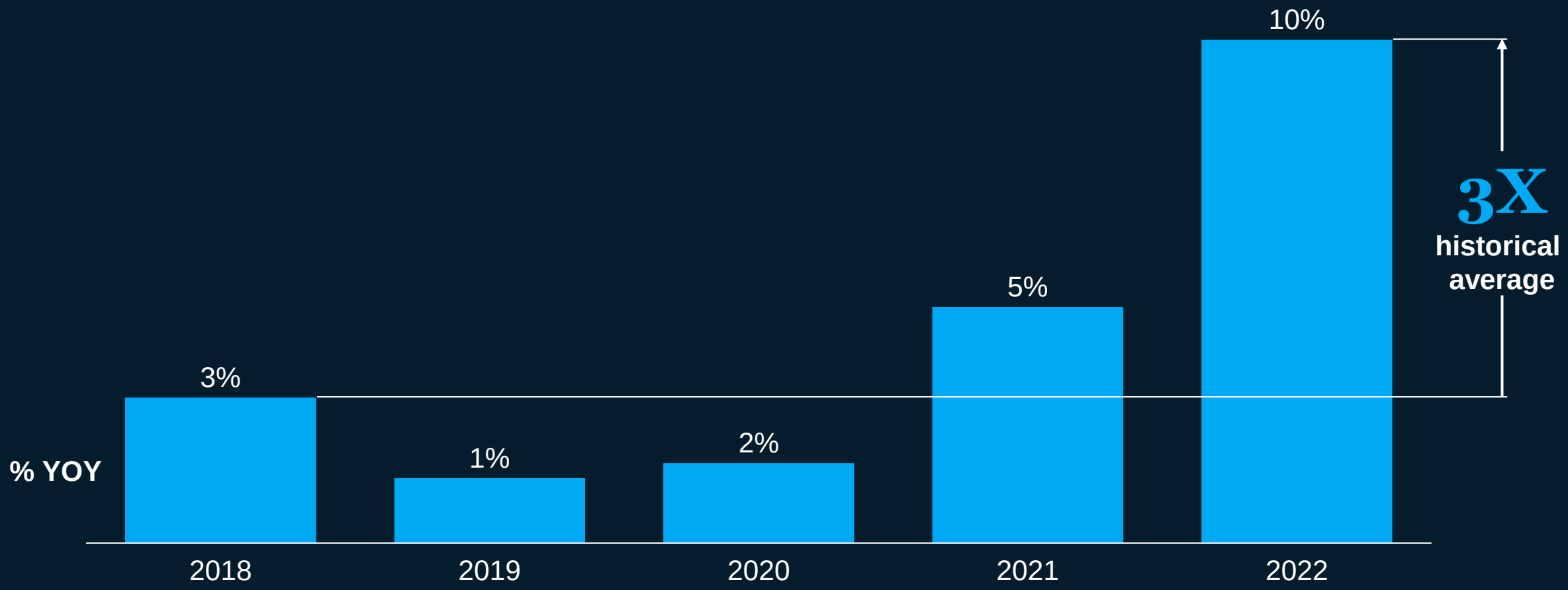
7 **Semicon crisis**

8 **Increasing cyber threads**

9 **Accelerating impacts from climate change**

Example inflation experienced by a typical electric utility

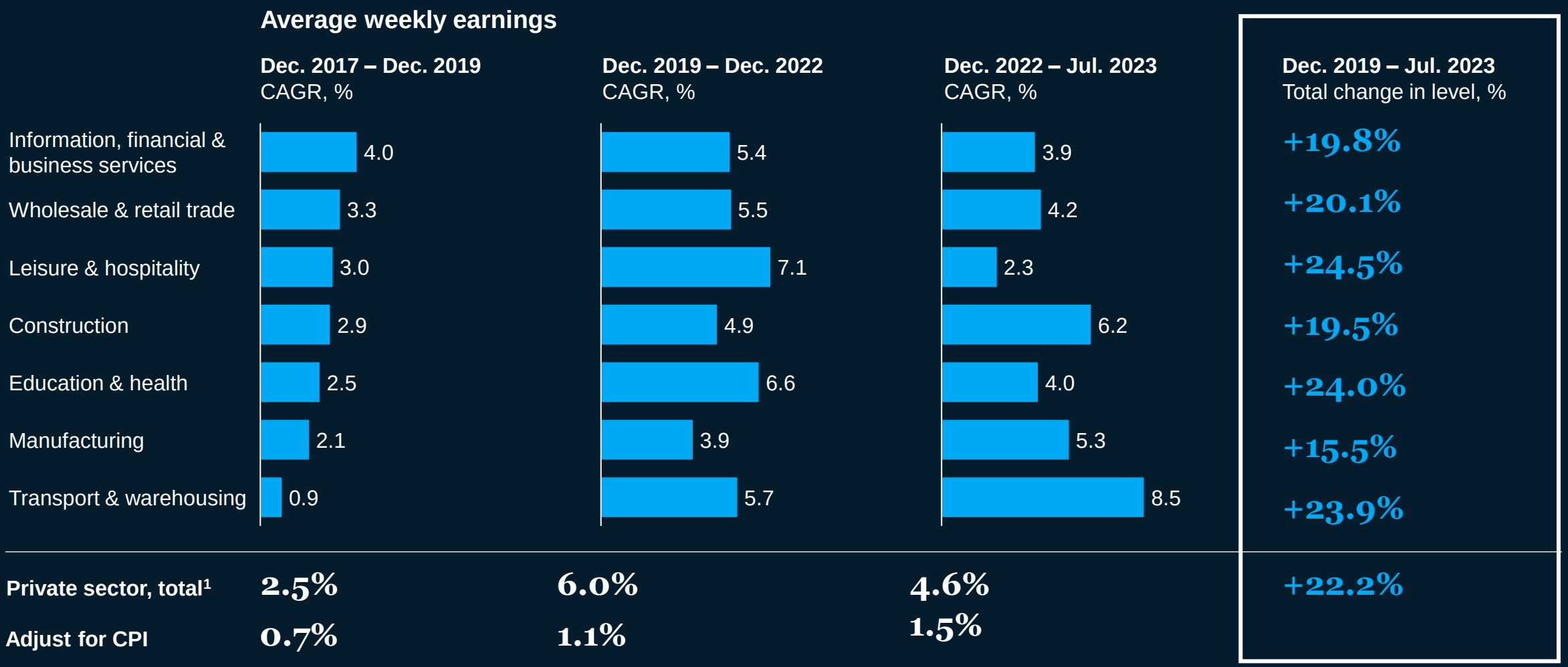
Synthetic embedded cost inflation benchmark using 10 representative T&D utility categories based on underlying input cost changes



Source: Metals from Consensus Economics, labor from Bureau of Labor Statistics; equipment and CPI from FRED; freight-shipping from Coyote truckload market analysis

Private-sector wages 20+% higher than December 2019 ~5% annual inflation = structurally higher cost base

Nominal money wages in the US do not fall



1. Private sector workers, all industries; sector detail for Mining & Logging, Utilities, and Other Services, not shown

Source: BLS, Mckinsey analysis

Uncertainty and volatility expected to persist driven by global forces and policy choices

Global and structural forces

The result of global interactions that no single country can control

Institutions, frameworks, and rules that shape international affairs, pace of technological advancement, development of resources and energy systems

	C	B	A
1	"Limited recession" Pre-COVID trend Inflation > target	"Soft landing" Trend growth Inflation > target ⊕	"Soft landing" Trend growth Target inflation ⊕⊕
2	"Deep recession" Trend growth Target inflation ⊖	"Soft landing" Trend growth Target inflation	"Soft landing" Trend growth Target inflation ⊕
3	"Extended downturn" Trend growth Inflation regime-change ⊖⊖	"Shallow recession" Trend growth Entrenched inflation ⊖	"Limited recession" Trend Growth Inflation > target

Fiscal, monetary and regulatory policy choices

How policy makers respond to the structural challenges surrounding them. Strongly influenced by national political dynamics

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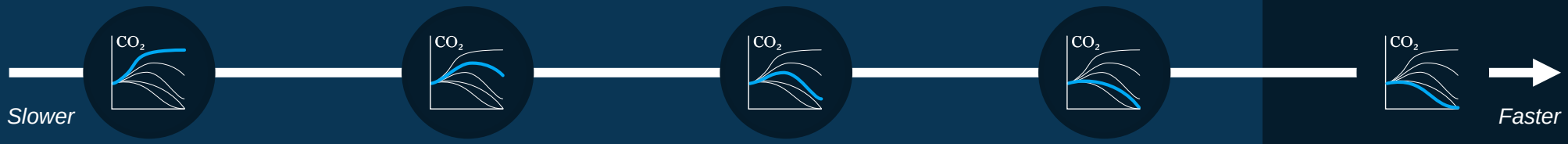
McKinsey Global Energy Perspective model covers five scenarios

Scenarios center around pace of technological progress and level of policy enforcement

Speed of energy transition



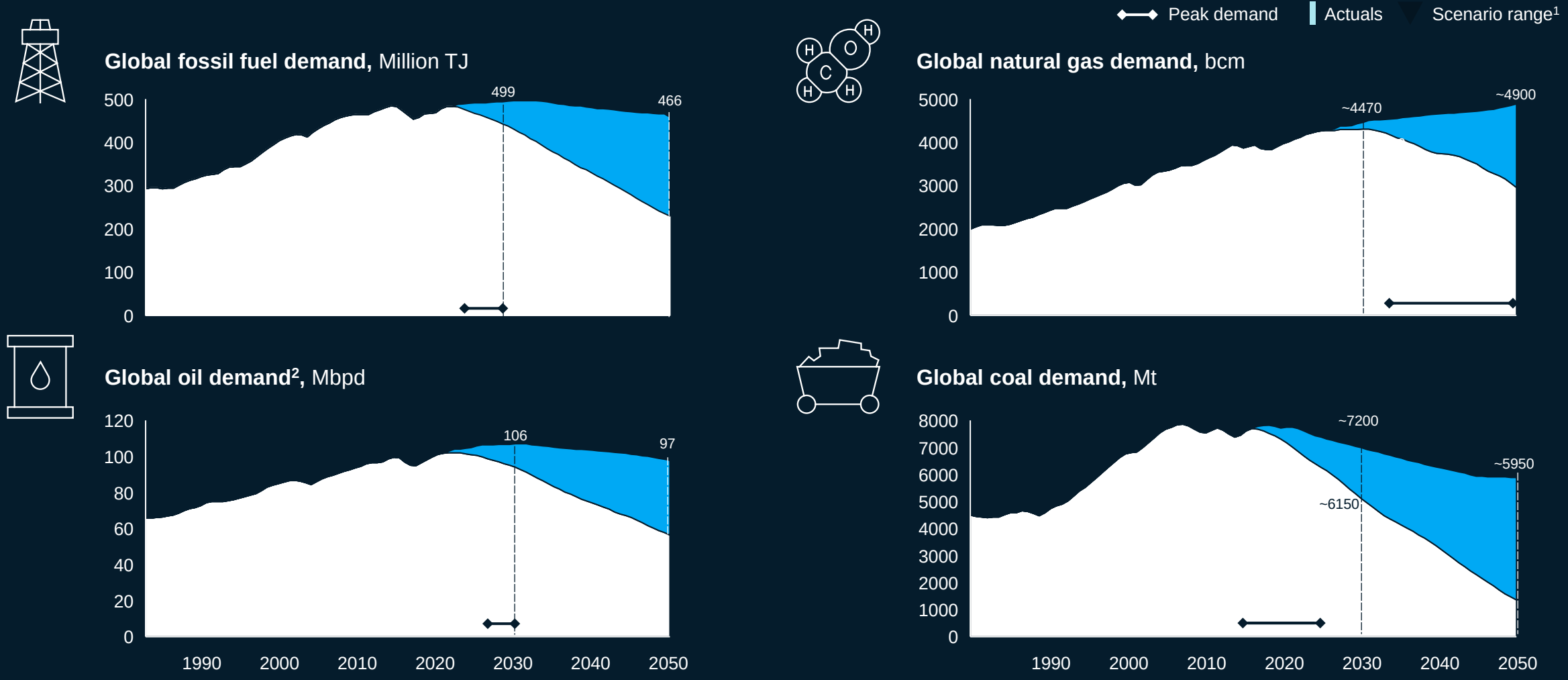
Scenario description	Fading Momentum	Current Trajectory	Further Acceleration	Achieved Commitments	1.5° Trajectory
	Fading momentum in cost reductions, climate policies and public sentiment will lead to prolonged dominance of fossil fuels	Current trajectory of renewables cost decline continues, however currently active policies remain insufficient to close gap to ambition	Further acceleration of transition driven by country-specific commitments, though financial and technological restraints remain	Net-zero commitments[2] achieved by leading countries through purposeful policies, followers transition at slower pace	A 1.5° pathway is adopted globally, driving rapid decarbonization investment and behavioral shifts

1. Global average CO_2 prices required in 2030 and 2050 to trigger decarbonization investments sufficient to fulfil the scenario. Prices are weighted by country and sector emissions and are holistic in that they include both explicit costs (e.g., carbon tax, emission trading system) and implicit costs (e.g., subsidies, feed-in-tariffs) to incentivize abatement
2. Excluding international bunkers
3. Warming estimate is an indication of global rise in temperature by 2100 versus pre-industrial levels (range 17-83rd percentile), based on MAGICCv7.5.3 as used in IPCC AR6. Given the respective energy and non-energy (e.g. agriculture, deforestation) emission levels and assuming continuation of trends after 2050 but no net-negative emissions.

Source: McKinsey Energy Solutions' Global Energy Perspective 2023

Range in demand for Fossil Fuels is 4% (natural gas), 10% (oil), and up to 12% (coal) by 2030

Oil demand peaks between 2025-2028, whereas coal is anticipated to continue its downward trend



1. Scenario range between Achieved Commitments and Fading Momentum
2. Includes biofuels, synfuels

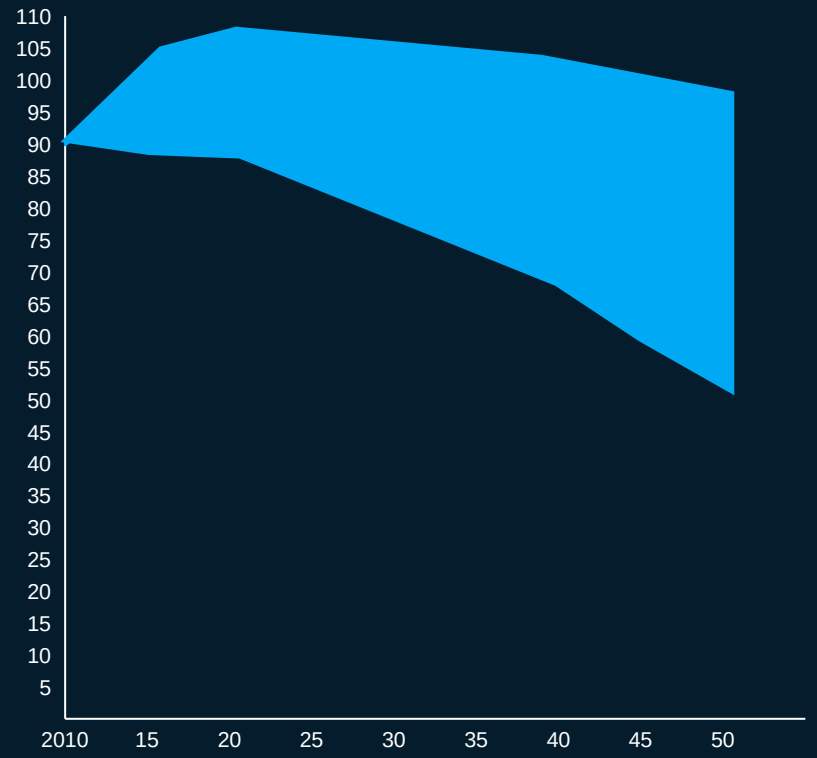
Source: McKinsey Energy Solutions' Global Energy Perspective 2023, IEA World Energy Balances

Trends in road transport, aviation, and chemicals drive oil demand decline

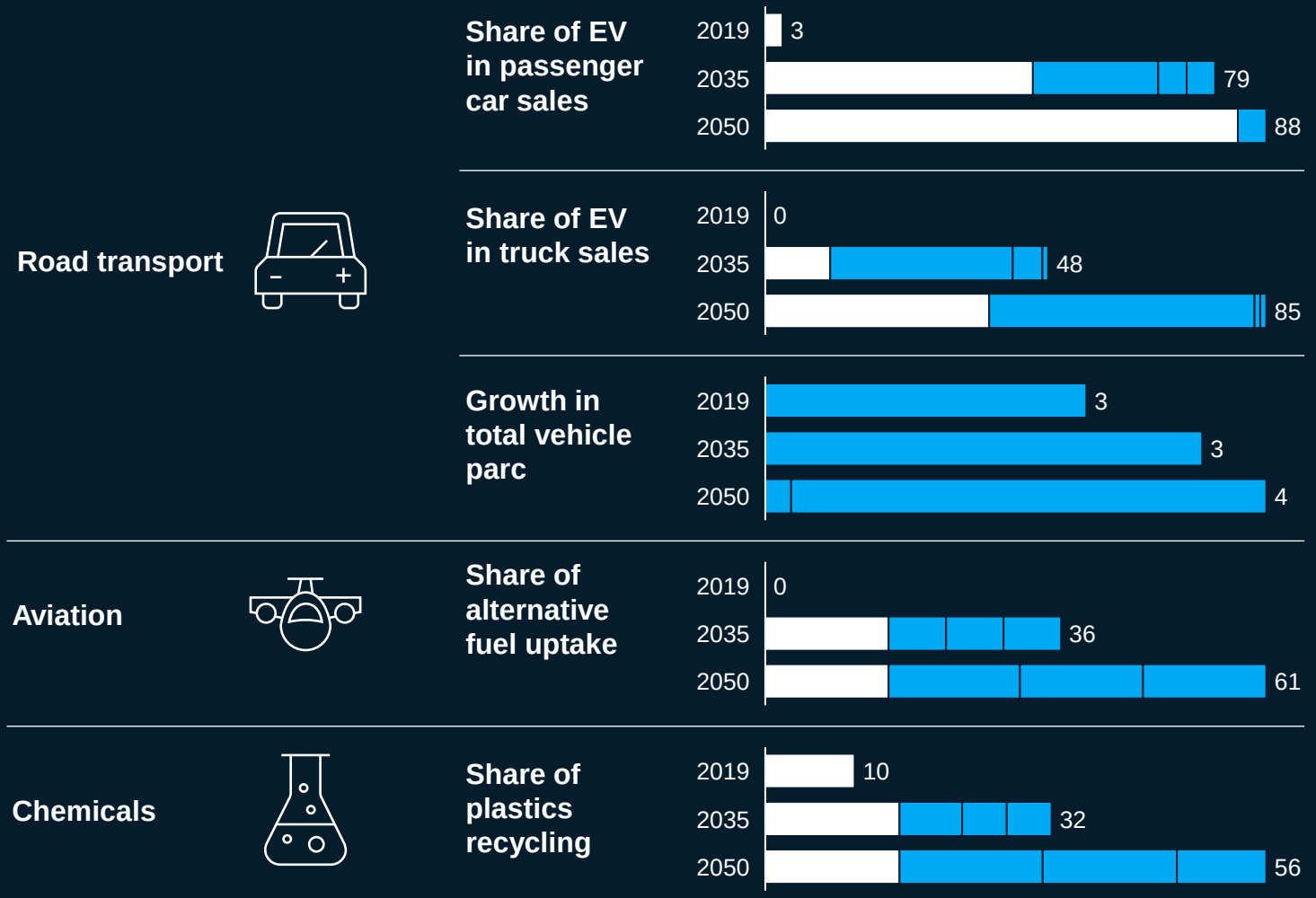
These sectors account for >60% of the difference in the range of liquids demand in 2050

Low High

Oil demand[1], MMb/d



Oil demand drivers

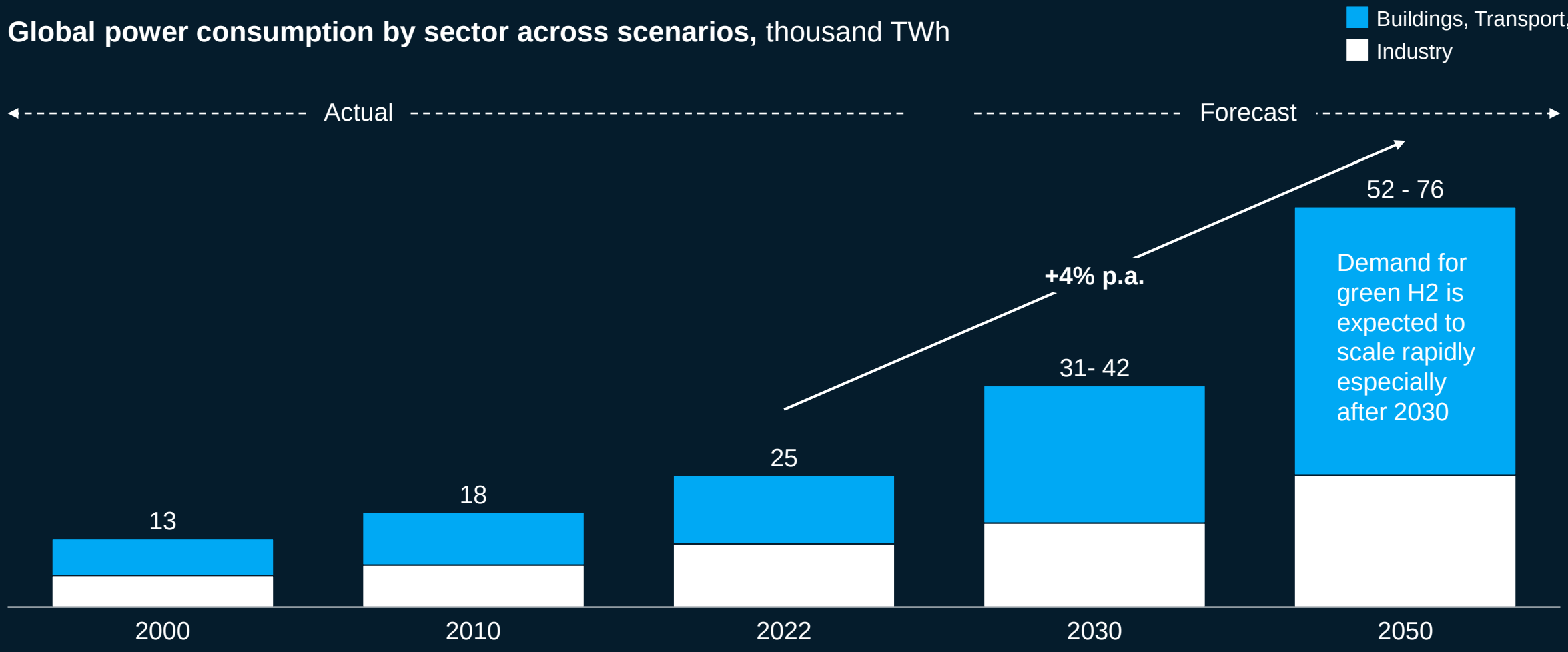


1. Includes biofuels, synfuels

Source: McKinsey Energy Solutions' Global Energy Perspective 2023, IEA World Energy Balances

Power demand is expected to keep increasing 3-4% p.a. across scenarios due to electrification and a rising green H2 demand

Global power consumption by sector across scenarios, thousand TWh



Source: McKinsey Energy Insights Global Energy Perspective 2023, IRENA, IEA World Energy Balances

10 emerging investment themes that are driving hydrogen and clean fuels in the US

Technology: Carbon capture · Blue hydrogen · Green hydrogen · Clean fuels

	Investment theme	Project example
1	**CO2 hub development for large scale storage**	Shell-Equinor steel CCUS hub, Houston CCS hub, Louisiana CCS Hub, Louisiana Clean Energy Complex
2	**CO2 pipeline infrastructure in the Midwest**	Summit Navigator, ADM
3	**Emergence of large-scale DAC projects**	Project Bison, Oxy King Ranch, Gulf Coast Sequestration hub
4	**CCS on biofuels for CI[1] improvement**	Bridgeport Ethanol, DG Fuels Aroostock (FT), USA Bioenergy Bon Weir (FT)
5	**Hydrogen hub development**	Appalachian H2 Hub , H2 City Texas, Mississippi Clean H2 Hub; Tri-state hub, North Dakota H2 hub
6	**Green and blue hydrogen for biofuel / renewable fuel CI[1] improvement**	Blue hydrogen: Air Products – World Energy SAF, Green: Heliogen Sustainable Aviation Fuel
7	**New build blue ammonia for export (ATR + CCS)**	OCI Blue Ammonia, ConocoPhilipps-JERA, Ascencion Clean Energy, Enbridge-Humble Ingleside
8	**Retrofitting SMR with CCS in ammonia[2] and refining**	CF Industries Donaldsonville, MMEX West, Texas Javelina refinery
9	**Synthetic fuels mega projects (500 MW+)[3]**	GHI, DG Fuels-St James, HIF Matagorda eFuels
10	**Green hydrogen for FCEV forklifts and trucks**	Element Resources, Plug Power West Coast, Amazon-Plug Power

1. Carbon intensity 2. Clean fuels mark for ammonia 3. Carbon capture involved for PtL fuels using CO2 from biogenic / air

Significant bottlenecks across energy transition value chains

Analyses for 2030

Critical bottlenecks:

1. Green hydrogen

— High risk due to infrastructure needs and high investments required to achieve large-scale deployment

2. Materials

— Rare materials are required for most of the energy transition technologies, with EVs and wind generation being highly impacted

3. Manufacturing & labor

— Labor challenges delay additions of critical manufacturing capacity as well as construction & engineering

1. Medium risk represents bottlenecks are identified as well as potential unlocks of historic examples that demonstrate ramp-up is realistic, high risk represents bottleneck are identified and no unlocks to address issue are available yet.
2. T&D for Wind & Solar, transport and fueling infrastructure for (green) H2, EVCI for electric vehicles

Source: McKinsey Energy Solutions' Global Energy Perspective 2023[1]

Power: IRA and BIL provided significant funding for energy transition and electrification. Impacts face multiple constraints

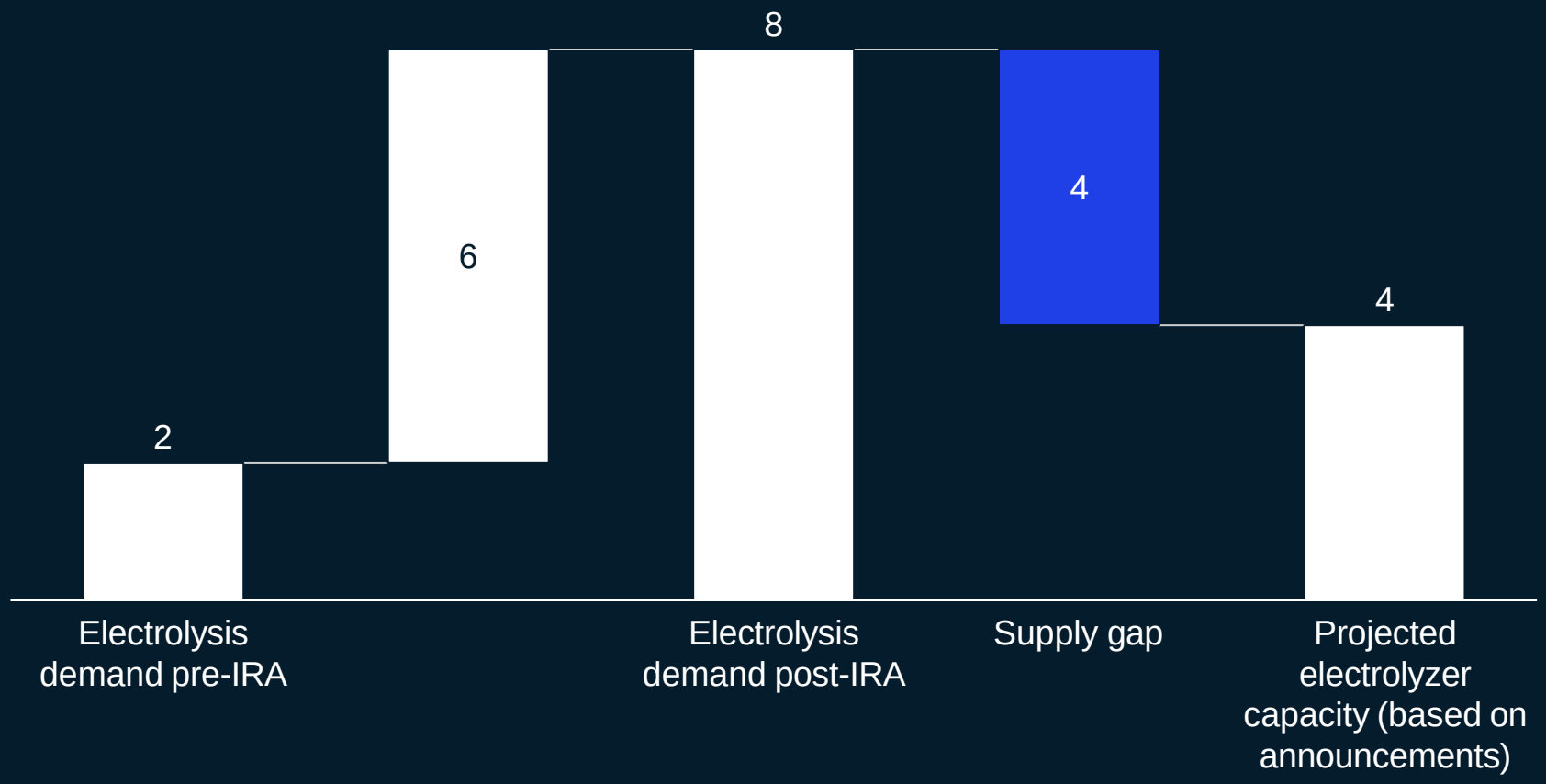
Constraints	Description	What we hear from industry
Affordability cap	Affordability will be the **major constraint for utilities to expand their T&D rate base** dramatically	*The need for T&D is almost infinite…utilities could easily do 10% if that was possible, but **affordability will be the real barrier…***
Interconnection queue challenges	Further **expansion of interconnection queues** driven by increased volume of renewable projects, could delay capacity deployments despite tax credit extensions	*We have projects in the MISO **queue that have been there for four and a half years now**… In Southwest Power Pool we're looking at **8 years start to finish on a project…***
Scale-up of local supply chains	**Qualified labor shortages** and **long lead times required for domestic manufacturing** could lead to delayed energy projects and adoption	*Suppliers are making investments in additional lines to produce transformers, **finding a shortage of labor** - preventing the scaling up…*
Local regulatory / legislative context	Implementation and support of IRA / BIL will differ based on the local context; **regions with limited resiliency challenges / tighter affordability controls** might not permit significant T&D capex	*Beyond 5 years, T&D capex growth will **depend on regulatory/legislative mindset on tradeoffs of resiliency + electrification vs. affordability of each state**…*

Source: Expert interviews

Electrolyzers: North America is under-supplied in the short-term after projected demand increase

Not Exhaustive

Annual additional electrolyzer demand vs. total electrolyzer manufacturing capacity in North America by 2025, GW



Key takeaway

NA announced electrolyzer manufacturing capacity will **not suffice in the short-term** considering the increase electrolyzer demand through the IRA

Source: McKinsey ELY supply tracker (Oct 2022), McKinsey GEP (2022)

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Multiple actions are needed to enable resilient supply

Supplier Network

Diversification of supply base through **multi-sourcing** and **regionalization**

Increased **vertical integration** for strategic high-risk commodities

Planning

E2E dashboards and **collaboration** (supplier / customer / LSP / CM)

Inventories further increased – policies will be revised going forward

Digitization

SC visibility, demand and supply **planning** is key

Digital talent remains a challenge, reskilling and external hiring.

IT landscape focus on **E2E solutions**

Supplier collaboration

New contract models with long-term commitments from both parties

Strategic **technological partnerships** and development cooperations

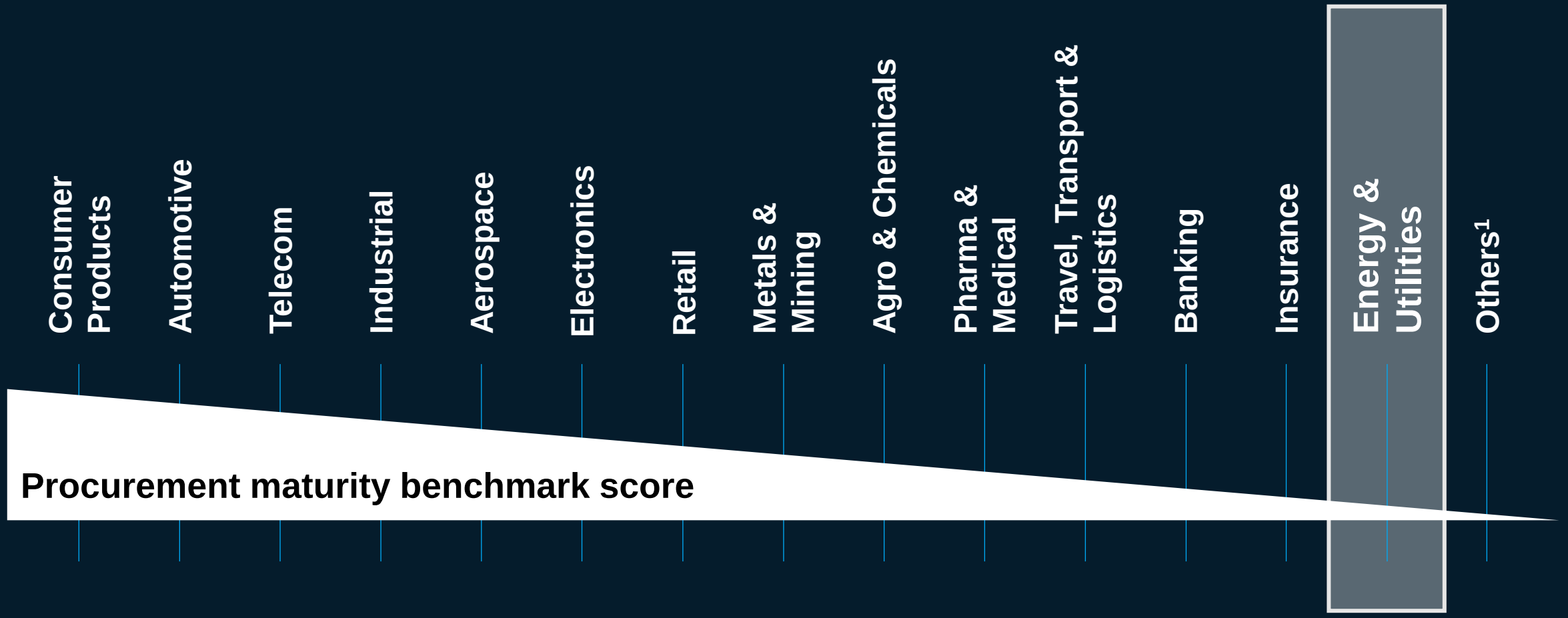
SC risk management

Primary focus is on managing supplier risks.

Multi-tier supplier transparency

Source: McKinsey survey of global Supply Chain leaders (March 28 – April 19, 2022, N=113)

Most energy supply chain organizations are immature



While purchasing leaders exist in every industry most energy supply chain organizations are far from world class

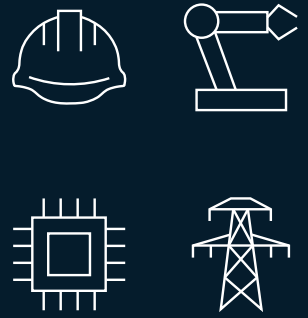
1. Includes Private equity, Social sector, Health sector, Environment, Water & Waste, Public sector, Business and consumer services, Media and Infrastructure

No more “one size fits all procurement”

Capacity constrained “seller” market

Playing “defense”

Categories

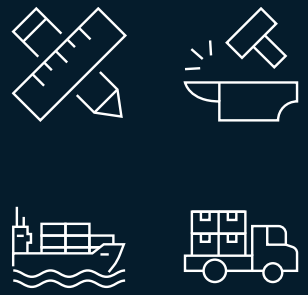


Levers

- Proactively manage demand
- Establish favorable LTAs
- Design-to-Value
- Complexity reduction
- Inform end-product pricing
- Nearshoring

Lower Inflation environment

Launching “offense”



- Negotiate prices leveraging clean sheets
- Monitor indices & claw back increases
- Introduce alternatives
- Broaden supply base leveraging spend
- Out of cycle auctions and mini-bids

Faster economic cycles demand agility

Source: McKinsey Procurement Practice

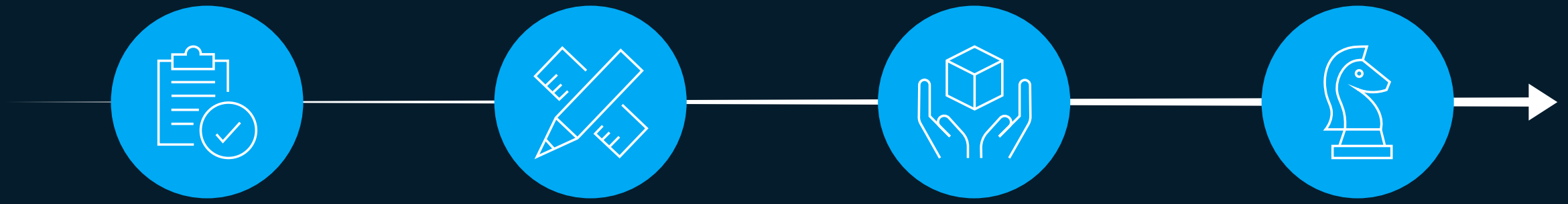
Cross functional partnerships is a must to deploy all levers

Core procurement | With Ops | With Finance | With Commercial

Source: McKinsey Procurement Practice

Collaboration with suppliers – no longer optional

Degree of engagement



Source: https://www.mckinsey.com/business-functions/operations/our-insights/taking-supplier-collaboration-to-the-next-level

What types of collaborations are your exploring to…

1. Support increased availability of critical materials
2. Encourage local manufacturing capabilities
3. Invest and support the formation of reliable foreign supply chains
4. Increase the adoption and deployment of clean energy
5. Attract a skilled workforce
6. Support enhanced supply chain knowledge and decision making

What could it take?

1. **Understand exposures** to the different macroeconomic drivers (e.g., interest rates, commodities, inflation, consumer confidence)

2. Have **talent with deep insights of supply market dynamics, risks, and economics.** And share these insights with other functions

3. Identify **and enable the full suite of value levers** to mitigate exposures / secure supply via pricing, technical, demand, process, design, financial, and commercial approaches

4. Have a **well-designed and practiced playbook to recover and then control costs** as inflationary pressures subside (or shift) and supply chains are redesigned

5. Embed **the lessons learned into sustainable processes, systems, and organizational design** to permanently upgrade the operating model

Source: McKinsey Procurement Practice

Q&A

Thank you!