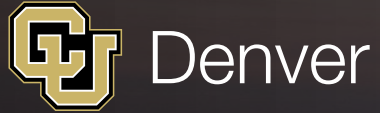




Denver

BUSINESS SCHOOL
J.P. MORGAN CENTER
FOR COMMODITIES



Denver

Commodities & Inflation
Tom Brady
April 2022

**BUSINESS
SCHOOL**

Tom.Brady@UCDenver.edu



Denver

Business School



J.P. Morgan Center for Commodities (JPMCC)

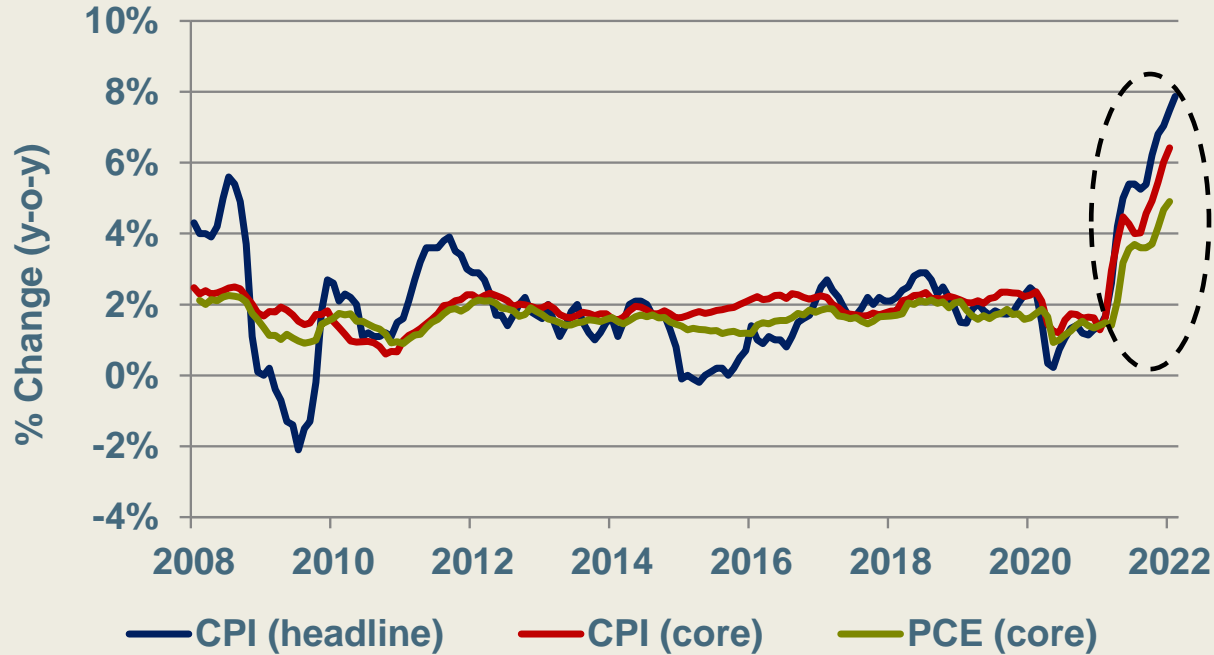
“A World-Class Commodities Center”

- » The J.P. Morgan Center for Commodities focuses upon a broad range of commodities, including agriculture, metals & minerals and traditional & renewable energy
 - » Launched in 2012
 - » Innovative undergraduate, graduate & professional education:
 - » Commodity market fundamentals, trading, finance and investment, risk management and policy & regulation
 - » State of the art software and technology tools
 - » Deep interaction with industry executives as advisory council members, guest speakers and mentors



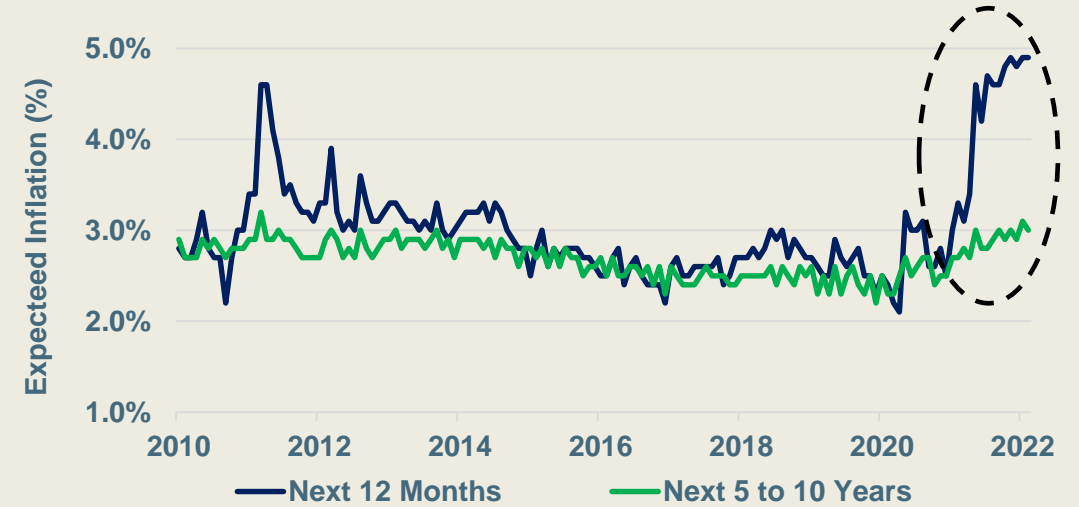
Inflation Returns!

“Current” Inflation (U.S. consumer indices)

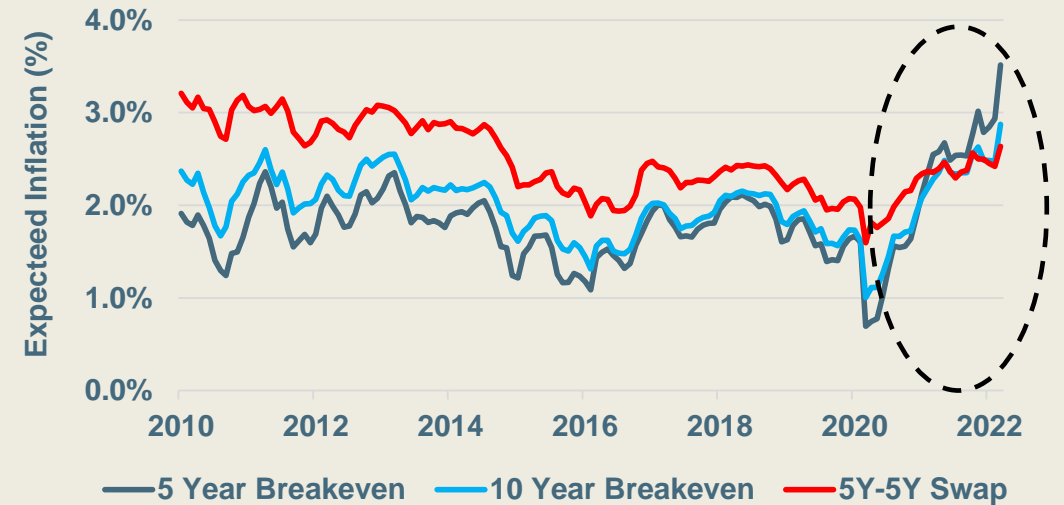


Source: Bloomberg

Inflation Expectations (survey-based)



Inflation Expectations (market-based)

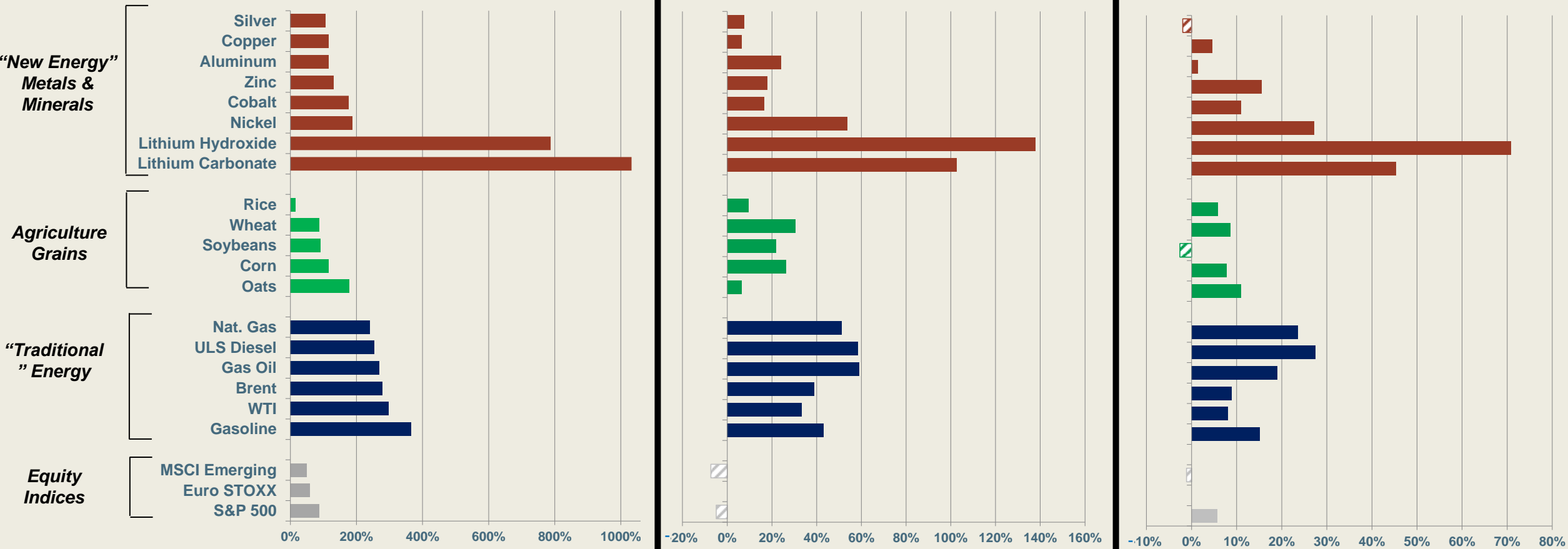


Across Sectors, Commodity Prices Have Climbed

Since Onset of Covid (Mar. 2020)

2022 (1st Quarter)

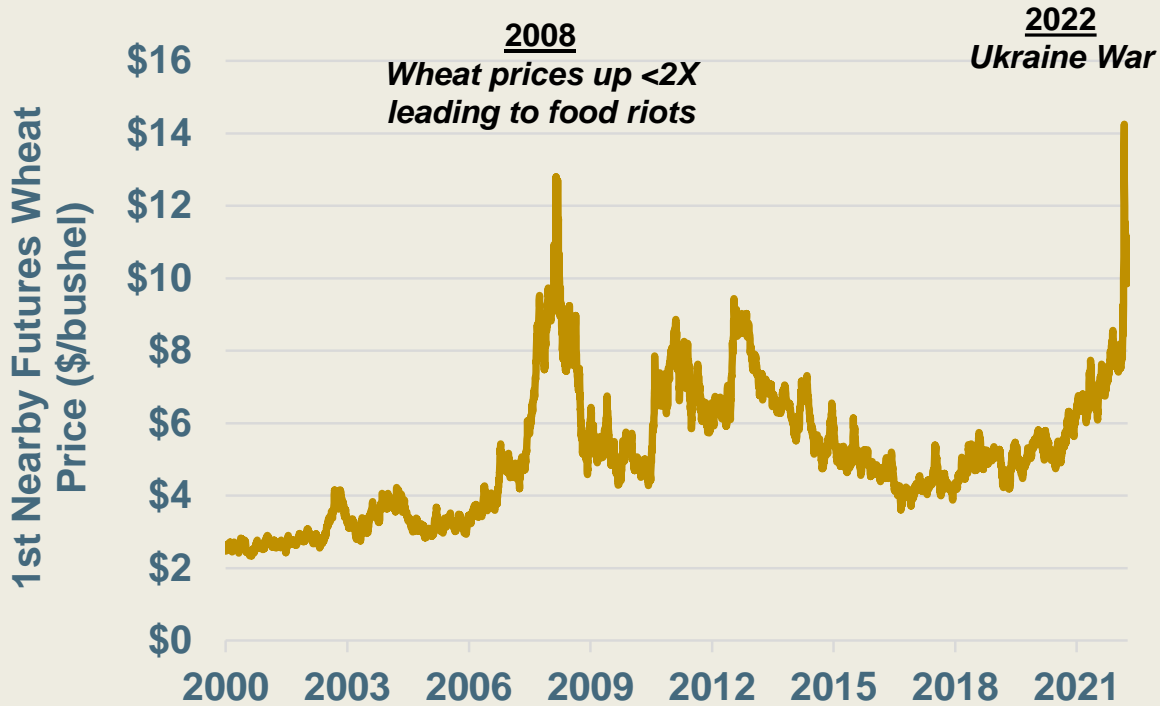
Since Start of Ukraine War



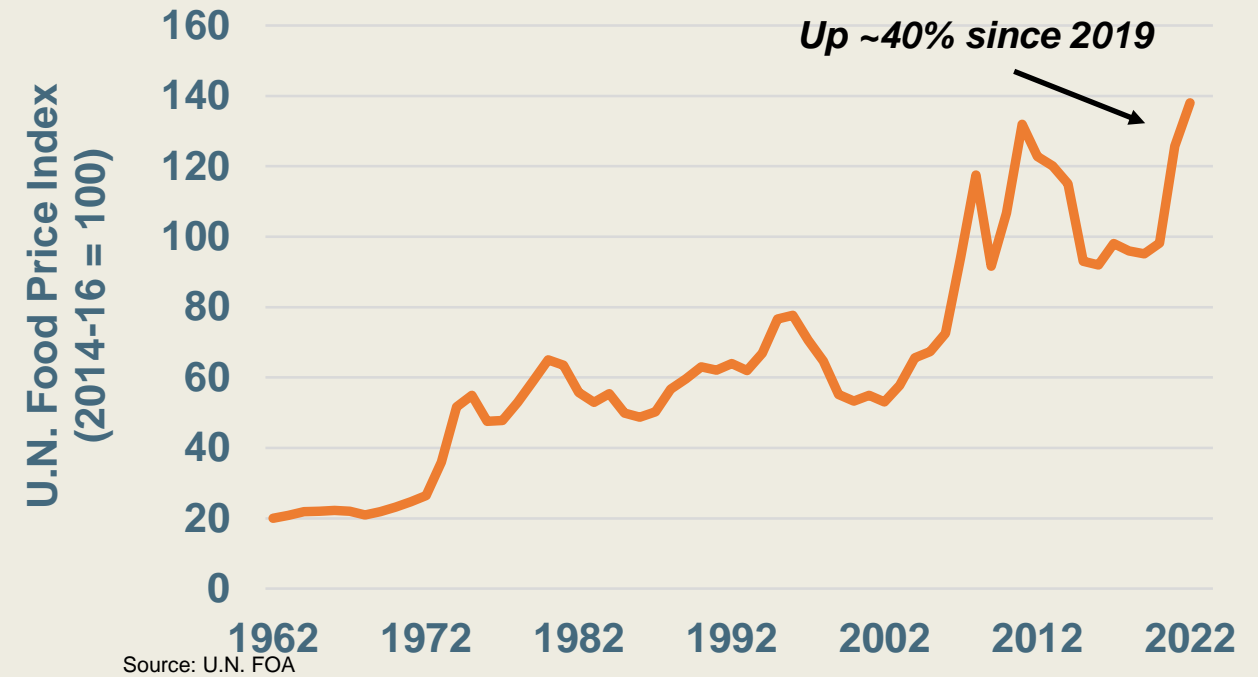
Grains & Food Prices: Significantly Higher

- Draughts in 2006 in grain producing countries and increases in oil prices, led to price spikes in wheat

Wheat Prices



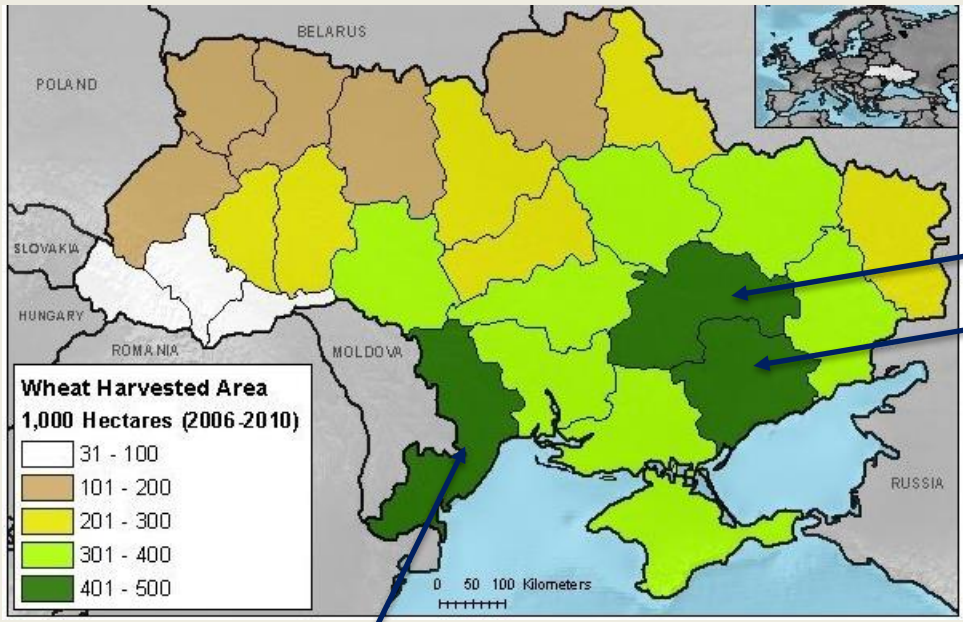
U.N. Global Food Price Index¹



¹ International prices of a food commodities (Average of 5 commodity groups Cereal, Vegetable Oil, Dairy, Meat, Sugar)

Building Food Crisis...

Ukraine: Wheat Harvest Areas



Odessa

Source: USDA

Dnipropetrovsk

Zaporizhia

Ukraine War Map (Mar. 20, 2022)

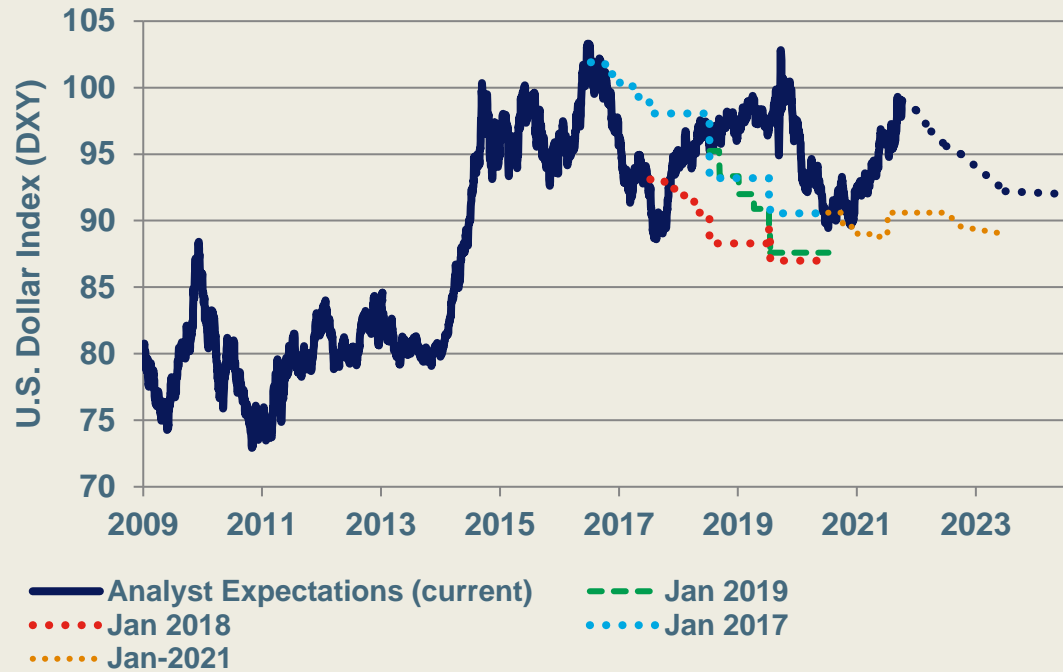


Source Institute for the Study of War

- Major exporters of wheat to Africa (2020 \$B): Russia (~\$3.6B), France (~2.2B), Ukraine (~\$1.5B), Canada (~\$1.3B), U.S. (~\$0.7B)
- Potential war impact: lower harvests in Ukraine & Russia; lower future harvests globally (Russia is a major exporter of potash & nat. gas (fertilizer)) and higher diesel prices
- N. African countries could be most negatively affected: Tunisia, Egypt, Libya, Algeria, ...

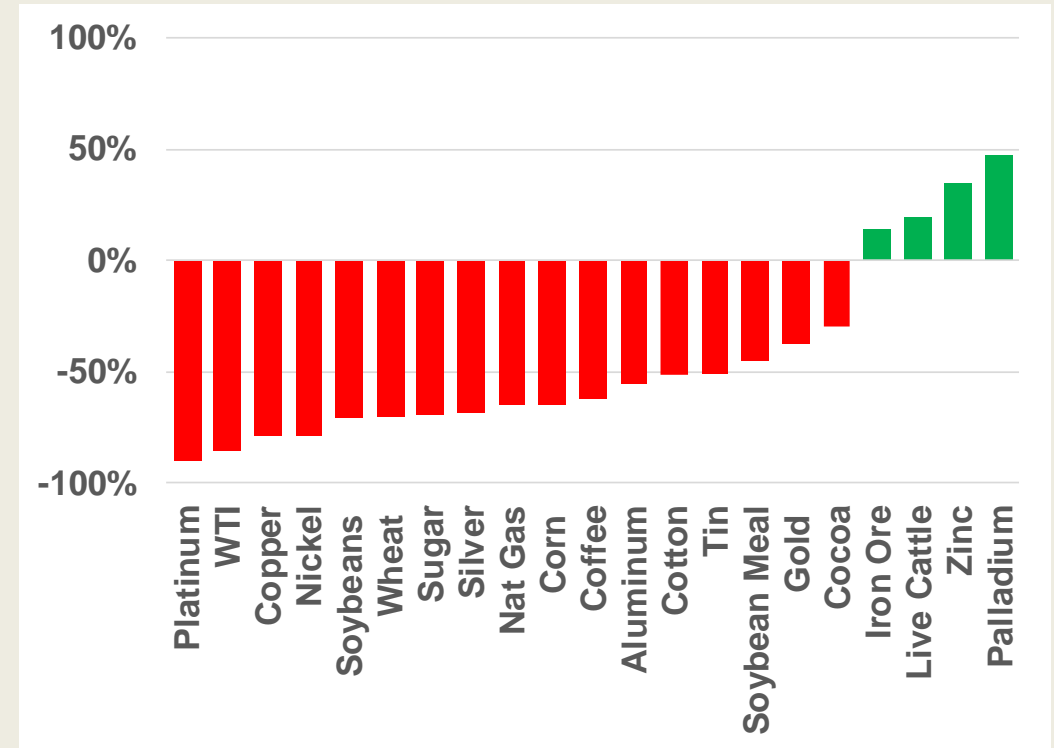
Commodity Prices: U.S. Dollars

Trade-Weighted U.S. Dollar



Source: Bloomberg

Commodities negatively correlated w/US \$



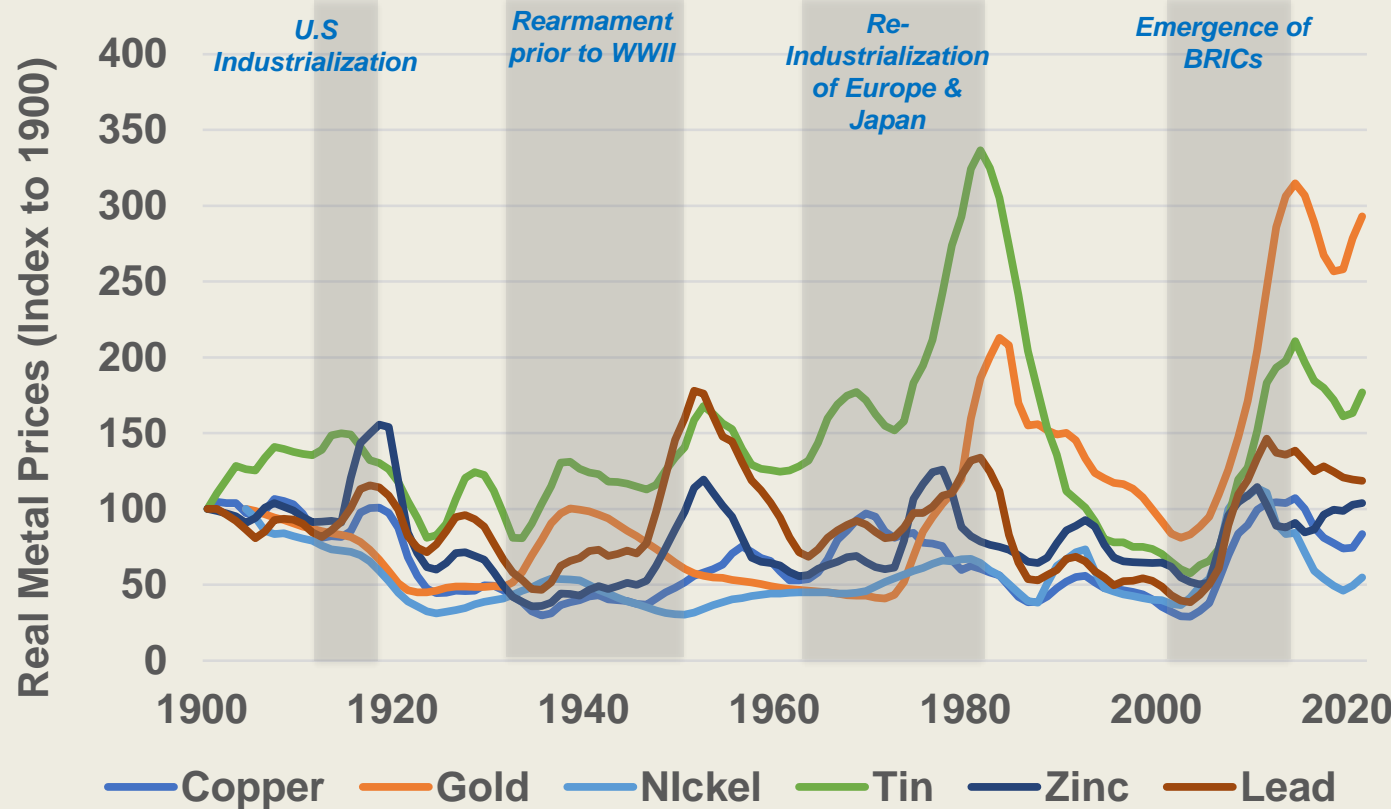
Daily price correlation (2000 onward); Source: Bloomberg

- Most commodities are priced in U.S. Dollars both here in the U.S. as well as around the world
- When the U.S. Dollar weakens against other global currencies, this is typically bullish for commodity prices
 - This could add further pressure to commodity price increases

Commodity Prices: Long-term cycles

- Many commodity prices go through periods of extended boom and busts (“super cycles”);
- Prices move well above or below their long-term trends;
- Economists believe there have been ~4 super cycles since 1900;
 - It can take ~5 to ~15 years to reach a peak; and
 - It can take another 15 to ~25 years to reach a trough (or low point)

Select Commodity Prices (in real terms, indexed to 1900)

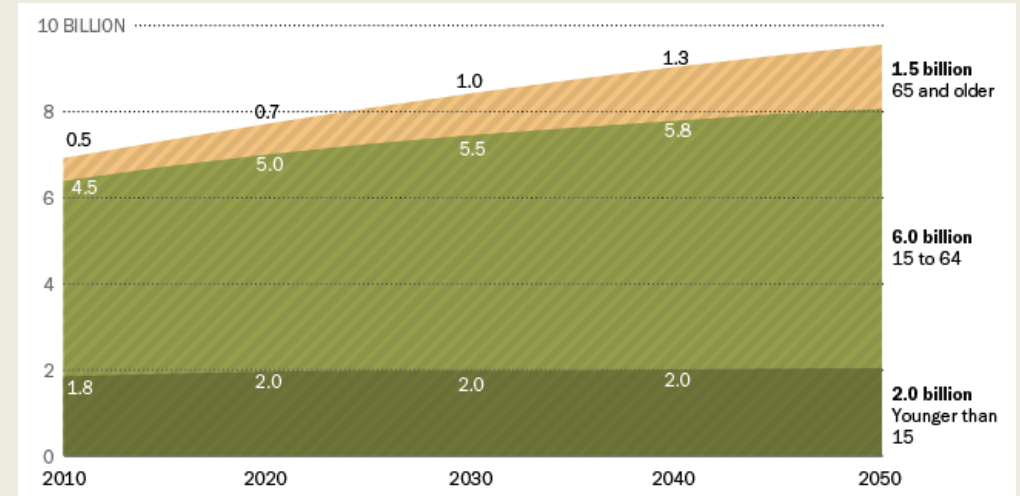


Shaded Grey Periods = Commodity Boom Periods; Source: Bloomberg data

Global Population: Projections

- Currently, there are **7.8** billion people living on earth
 - The United Nations projects the global total to grow to **~9.6** billion by 2050 (or by nearly 25%)
 - Over 60% will be between the ages of 15 to 64 years old
- Currently, there are nearly 340 million people living in the U.S.
 - This is expected to grow to over 400 million by 2050 (19%)
- Currently, ~1.39 and ~1.35 billion people live in China and India, respectively

Projected Global Population

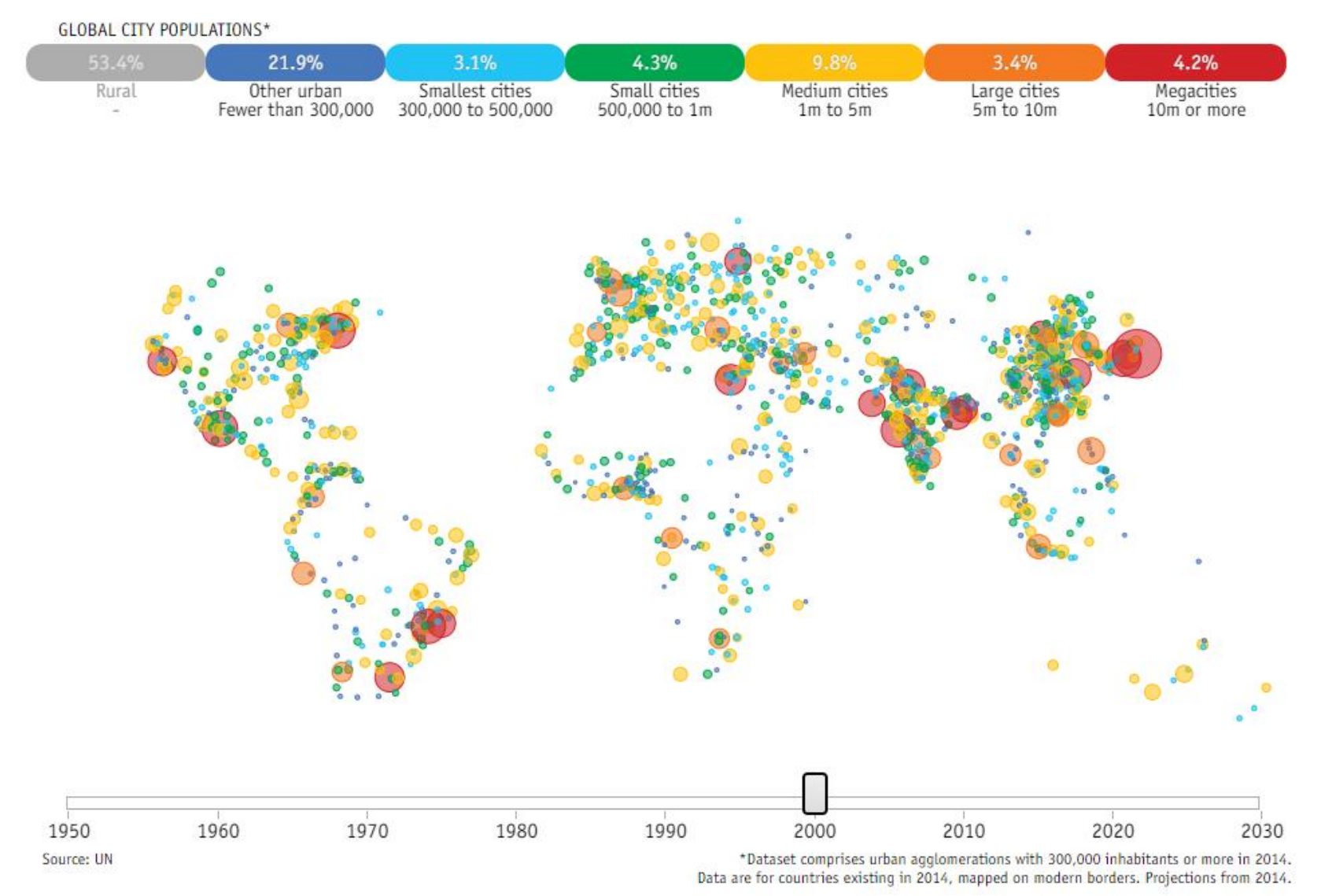


Projected U.S. Population



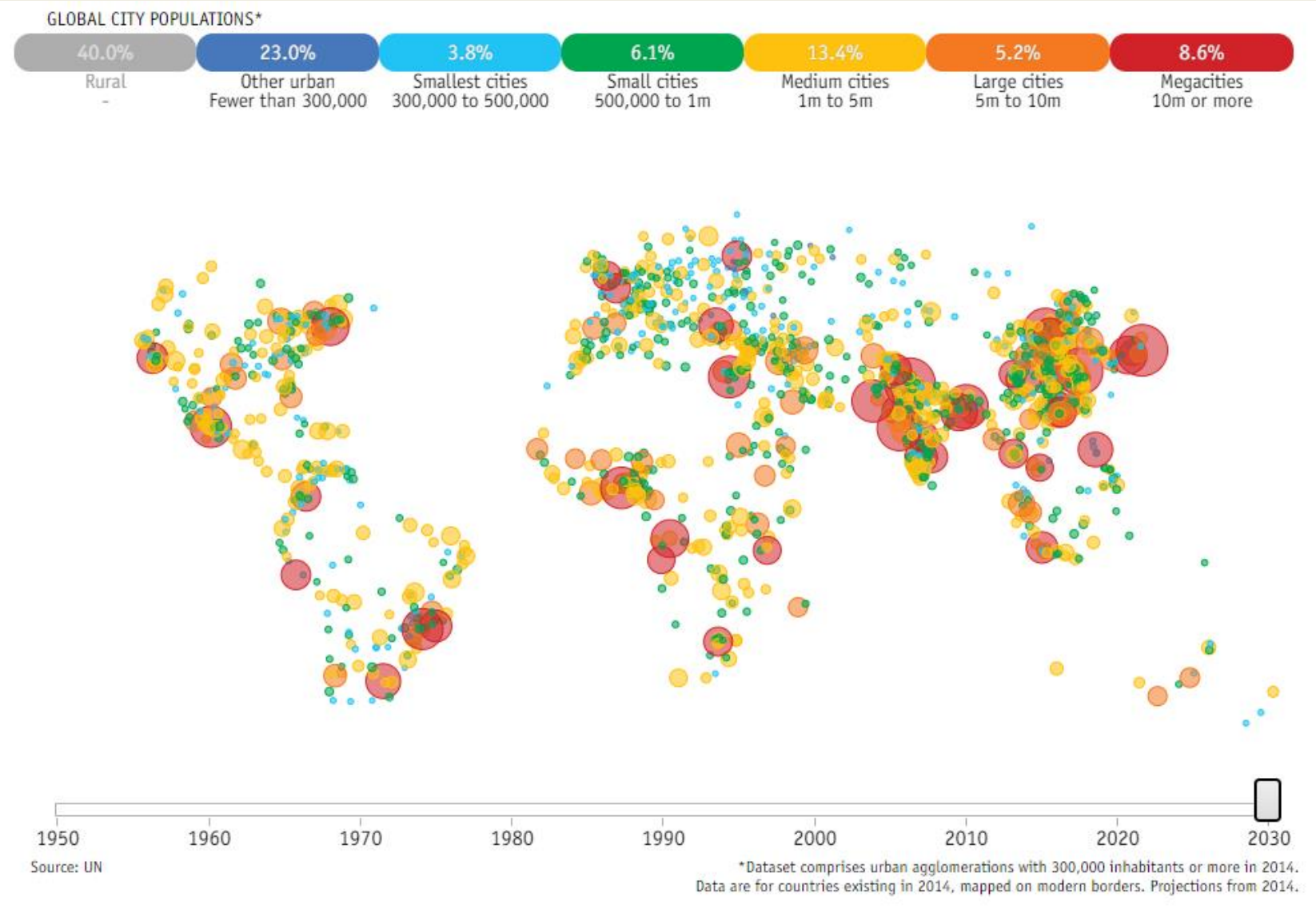
Source: U.N.

Global Population: Urbanization in 2000



Saad Rahim, Chief Economist, Trafigura; 2021 JPMCC Commodity Research Symposium

Global Population: Urbanization in 2030E



Saad Rahim, Chief Economist, Trafigura; 2021 JPMCC Commodity Research Symposium

Global Population: Largest global cities (current)

Tokyo, Japan (~37.4M)



Dehli, India (~30.3M)



Shanghai, China (~27.1M)



San Paolo, Brazil (~22.0M)



Mexico City, Mexico (~21.8M)



Dhaka, Bangladesh (~21.0M)



Cairo, Egypt (~20.9M)



Beijing, China (~20.5M)



Source: Business Insider, 2016

Largest U.S. cities: New York: ~18.4M, Los Angeles: ~12.2M; Chicago: ~8.6M; Miami: 5.5M



Global Population: Largest global cities (in 2050) – Primarily Africa & Asia

Mumbai, India (~42.4M)



Dehli, India (~36.2M)



Dhaka, Bangladesh (~21.0M)



Kinshasa, DRC (~35.0M)



Kolkata, India (~33.0M)



Lagos, Nigeria (~36.2M)



Tokyo, Japan (~32.6M)



Karachi, Pakistan (~31.7M)



Source: Business Insider, 2016

Largest U.S. cities (2050): New York: ~24.7M, Los Angeles: ~16.4M; Chicago: ~11.9M; Miami: 7.96M



Global Population: Largest global cities (in 2100) - Primarily Africa & Asia

Lagos, Nigeria (~88M)



Kinshasa, DRC (~83.0M)



Dar es Salaam, Tanzania (~74.0M)



Mumbai, India (~67M)



Dehli, India (~57M)



Khartoum, Sudan (~57M)



Niamey, Niger (~33.0M)



Dhaka, Bangladesh (~54.0M)



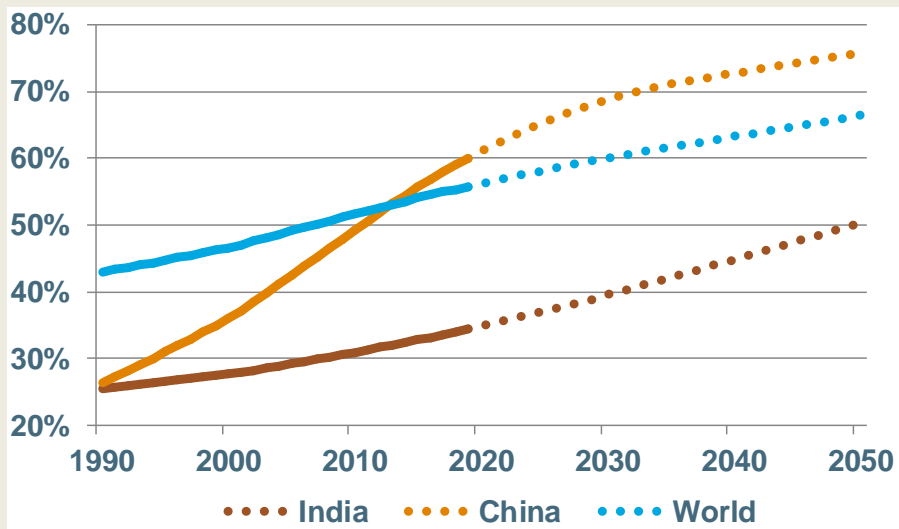
Source: Trafigura; The B1M, 2021



Commodity Demand: Urbanization & Wealth

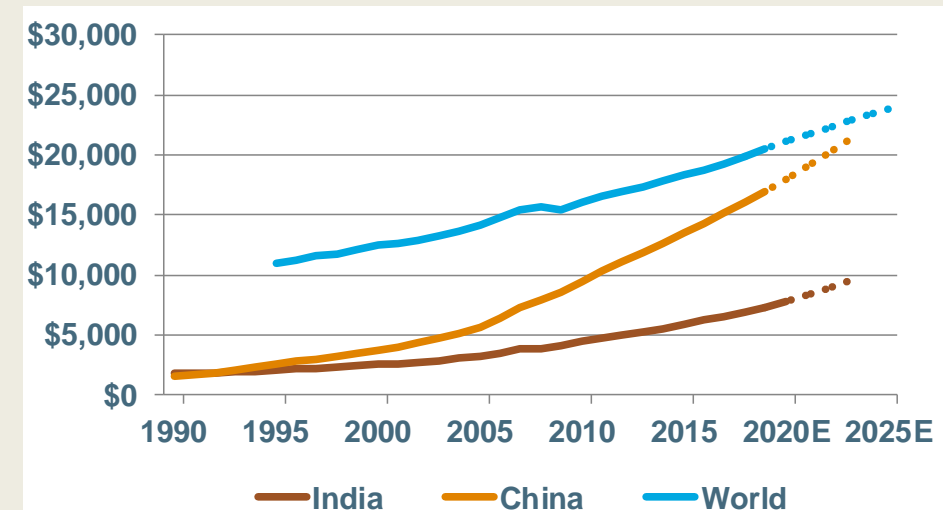
- Current urbanization in China ~60%
 - Expected to climb toward OECD average of ~80% by mid-century
- Urbanization in India currently ~30%, to climb over 50% next 30 years
- Per capita wealth trending up in India and China and Globally
 - Per capita income in the U.S. = ~\$60K; China = ~\$17K, India = ~\$7K

Urbanization expected to progress



Source: U.N. Projections

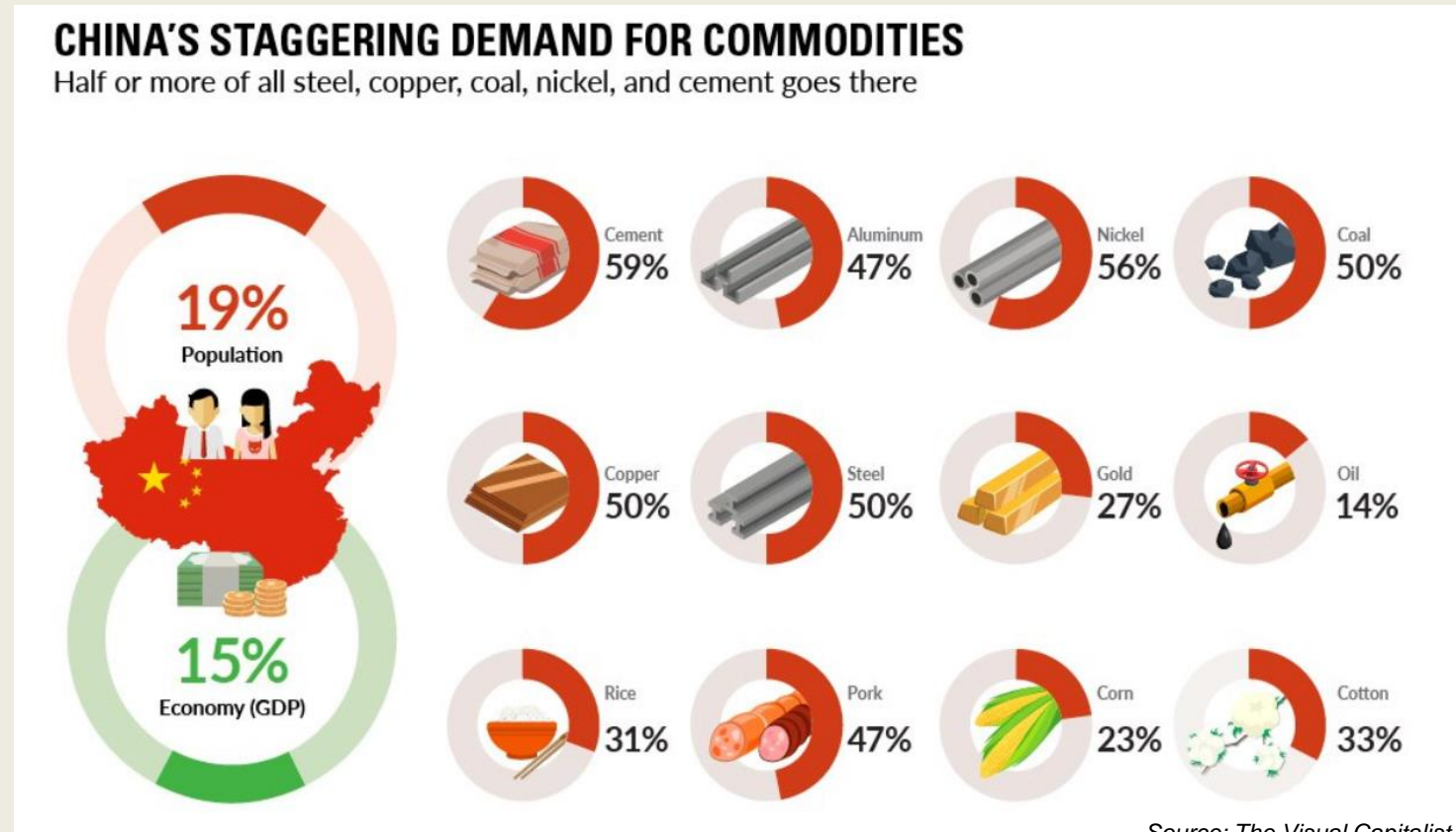
Per capita wealth also trending upward



Source: IMF World Economic Outlook

Commodities: China

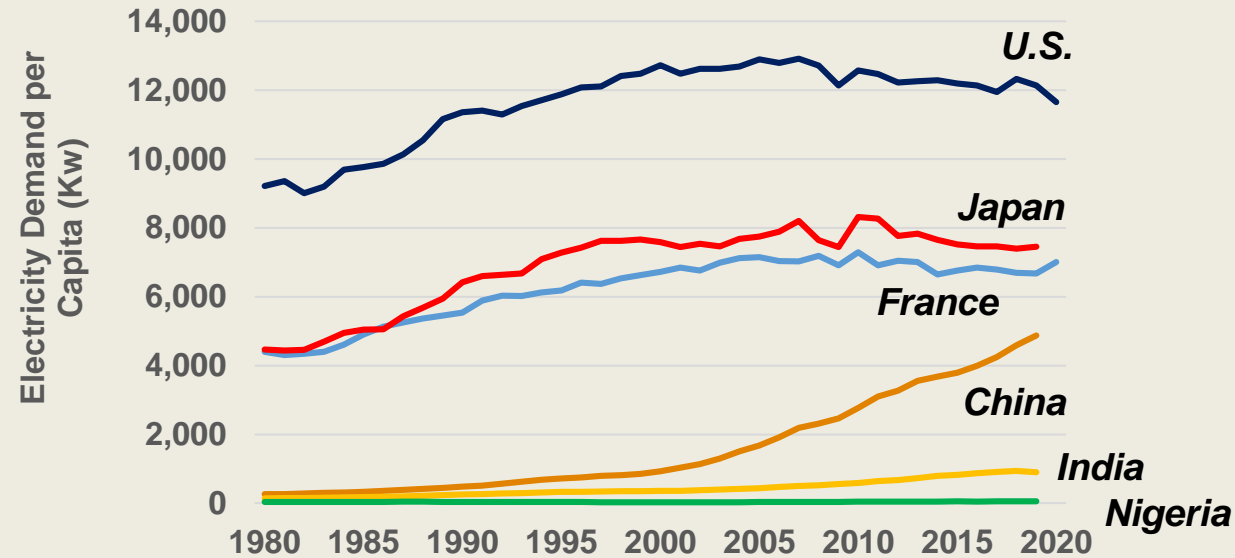
- China is a very important demand center for many commodities
 - Increasing urbanization (buildings, electricity grids, railroads, roads, ...)
 - Personal wealth trends [meat, gold, cars (copper, aluminum, rubber, rare earths, lithium, ...)]



Source: The Visual Capitalist

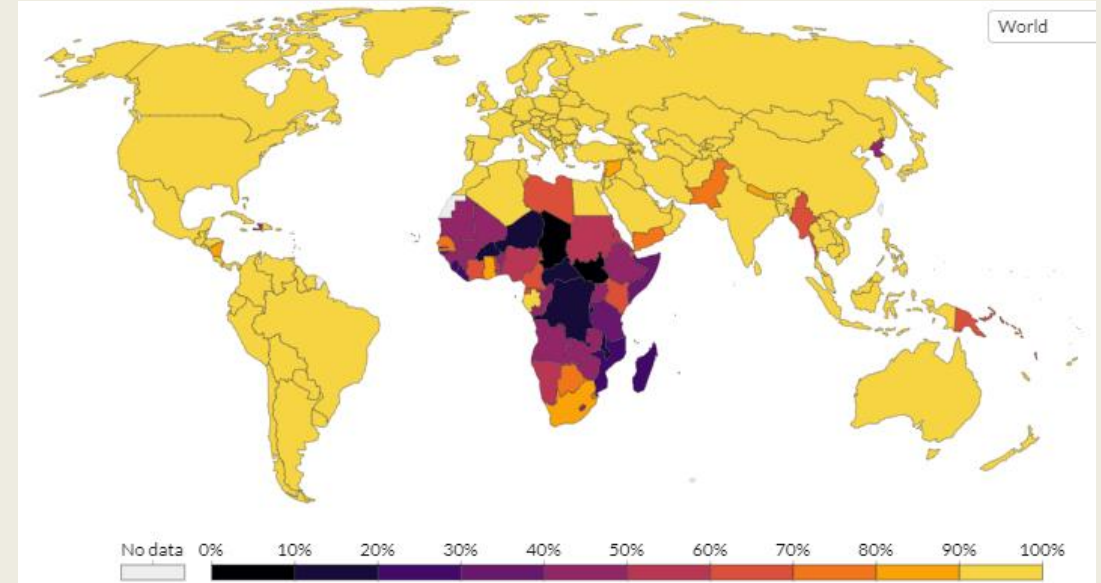
Commodity Demand: Electricity & Copper

Per Capita Electricity Demand



Source: <https://countryeconomy.com/energy-and-environment/electricity-consumption>

Access to Electricity

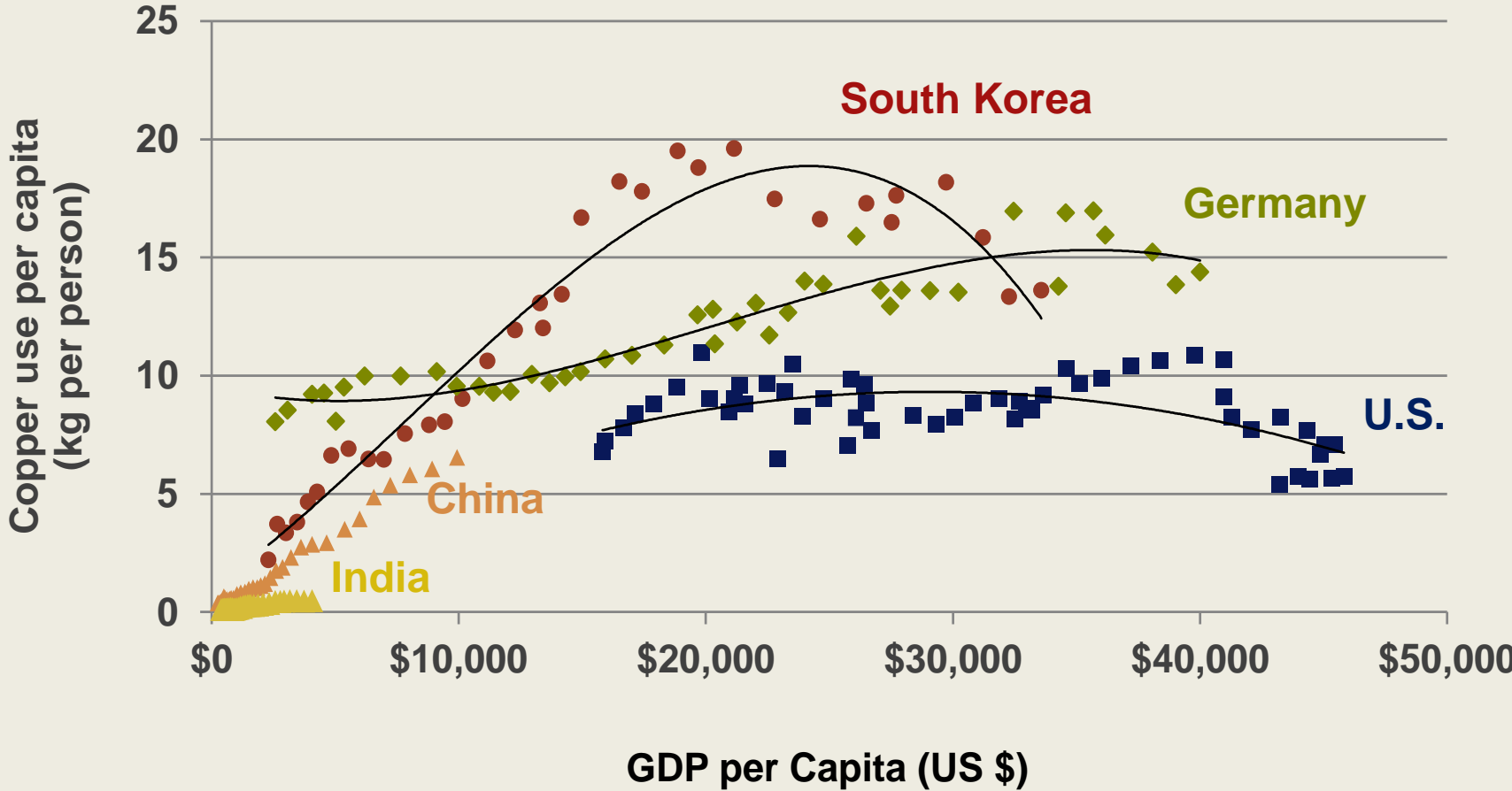


Source: U of Oxford

- Each American citizen uses an average of ~12MW of electricity per year; Chinese: ~5MW; Indians: ~0.9; Nigerians: ~0.06.
- Primarily in Africa, there are ~750M people without access to electricity (~1.2B in 2010)
- ~39% of global copper demand is in electrical & electrical components; >30% of copper is in the building & construction;

Commodity Demand: Intensity of Use - Copper

Per Capita Copper Demand and GDP per Person



- Urbanization is a key driver of commodity demand
- Urbanization rates 2020
 - OECD (>80%)
 - China (~60%)
 - India (35%)
 - Nigeria (~50%)
 - Tanzania (35%)

Source: Bloomberg and Macrobond (2014)



Metals & Minerals: What is in a Tesla?

Frame

- **Bauxite (aluminum):** Mined in Australia, China, Brazil, India, Guinea, Jamaica, Russia, Venezuela, Suriname, Kazakhstan, Guyana and Greece
- **Coal (by-product coke):** is used to make steel): Coal used to make steel and mined world-wide
- **Iron ore (steel):** Mined in China, Brazil, Australia, India, Russia, Ukraine, United States, South Africa, Iran, Canada, Sweden, Kazakhstan, Venezuela and Mexico.
- **Manganese (steel alloy):** Mined in South Africa, Australia, China, Gabon, Brazil, India, Ukraine
- **Vanadium (alloy):** Mined in China, South Africa and Russia.
- **Molybdenum (steel alloy):** Mined in China, United States, Chile, Peru, Mexico, Canada, Armenia, Iran, Russia and Mongolia.

Wiring and Circuitry

- **Copper:** Mined in Chile, United States, Peru, China, Australia, Russia, Indonesia, Canada, Zambia
- **Gold:** Mined in China, United States, Australia, South Africa, Peru, Canada, Uzbekistan, Ghana, Papua New Guinea, Indonesia, Brazil, Mexico and Chile.
- **Platinum:** Mined in South Africa, Russia, Canada, Zimbabwe, United States and Columbia.
- **Tungsten:** Mined in China, Russia, Canada, Austria, Bolivia and Portugal



***An electric car uses
~3X more copper
than an internal
combustion vehicle***

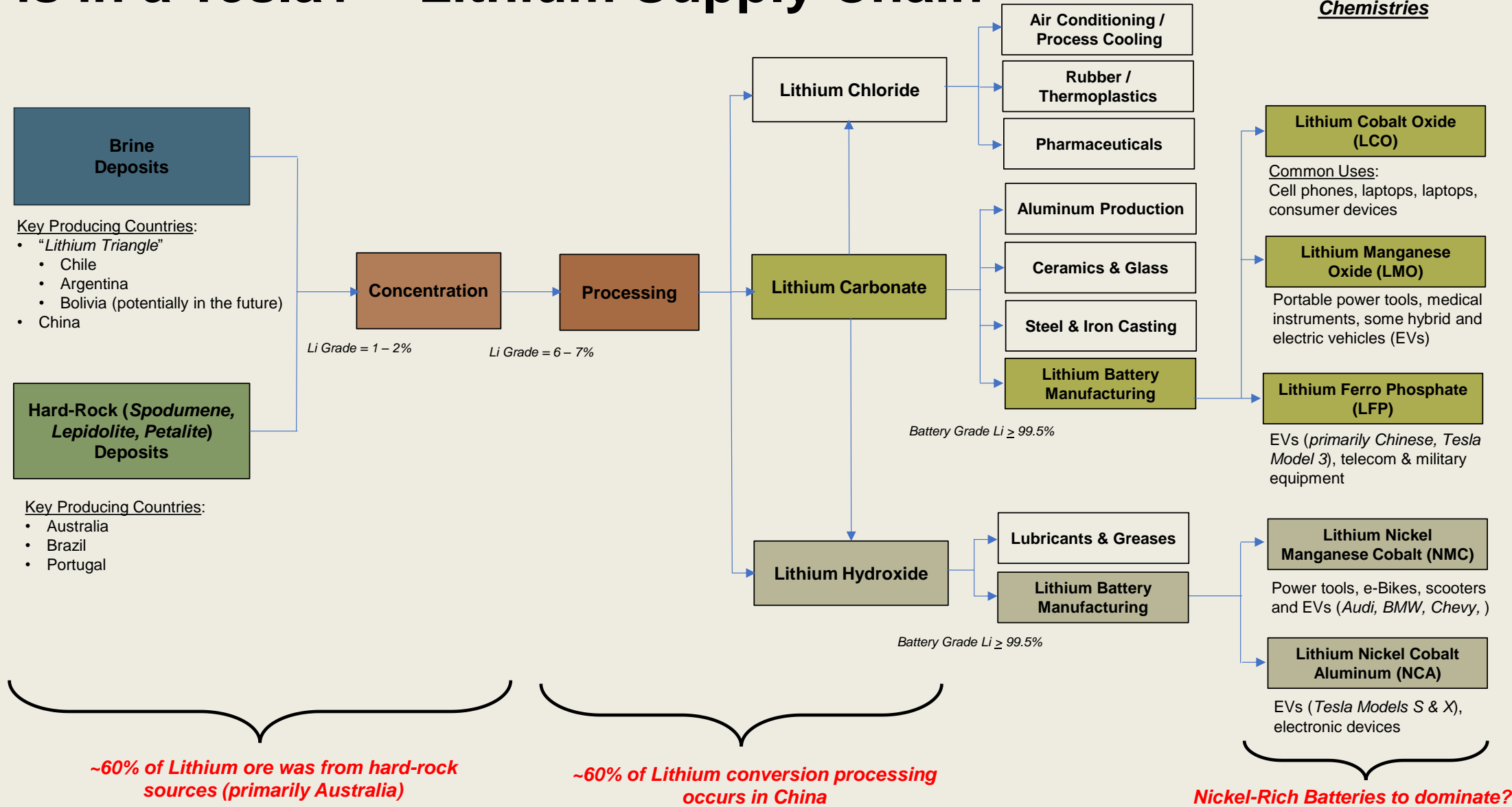
Batteries

- **Cadmium (batteries):** Mined in China, Republic of Korea, Japan, Kazakhstan, Mexico, Canada, Russia, United States, India, Netherlands, Poland, Germany and Australia.
- **Cobalt (alloy; batteries):** Mined in Congo- Kinshasa, Canada, Zambia, Russia, Australia, China, Cuba, Morocco, New Caledonia and Brazil.
- **Lead (batteries):** Mined in China, Australia, United States, Peru, Mexico, Canada, India, Bolivia, Poland, Russia, Sweden, Ireland and South Africa.
- **Lithium (batteries):** Mined in Chile, Australia, China, Argentina, Portugal, Zimbabwe and Brazil.
- **Rare Earth Oxides (Lanthanum):** Mined in China, India and Brazil
- **Nickel:** Mined in Russia, Canada, Australia, Indonesia, New Caledonia, Philippines, Columbia, China, Cuba, Brazil, Botswana, South Africa, Dominican Republic, Greece, Venezuela and Spain

Other

- **Rare Earth Oxides (Niobium):** Used in motors. Mined in Brazil and Canada.
- **Zinc:** Used in galvanizing. Mined in China, Peru, Australia, United States, Canada, India, Kazakhstan, Ireland and Mexico.
- **Silica:** Used in paint, autoglass, airbags, etc.. Mined in many places

What is in a Tesla? – Lithium Supply Chain



Outlook

- Commodity prices to remain elevated driven by global demographic trends (and geopolitics)
- Declining ore grades with key infrastructure and “new energy” minerals and metals
 - Copper grades are 30 to 40% lower compared to 2000
- Ukraine War is adding to a building food crisis (particularly in Africa)
 - Natural gas represents 75-90% of fertilizer production costs
- Unrealistic expectations for the “Energy Transition”
 - Example:
 - Global automobile sales expected to more than double by 2030 to nearly 125M
 - “Base Scenarios” include nearly 35% to be electric by 2030
 - “Net Zero by 2050 Scenarios” have nearly 60%
 - This will require global Lithium mine supplies to increase 3X and 5X in ~8 years...Not Likely!

Appendix



Commodity Prices Indices: Bloomberg

- Rather than invest in specific commodities, some investors want exposure to the overall commodity sector and will by commodity indices
 - Bloomberg Commodity Index (BCOM)
 - S&P Goldman Sachs Commodity Index (GSCI)
 - Sub-indices (precious metals, energy, ...)
- Weightings are generally determined annually by trading volumes in futures contracts and by production volumes

Energy is currently heavily weighted in the BCOM Index

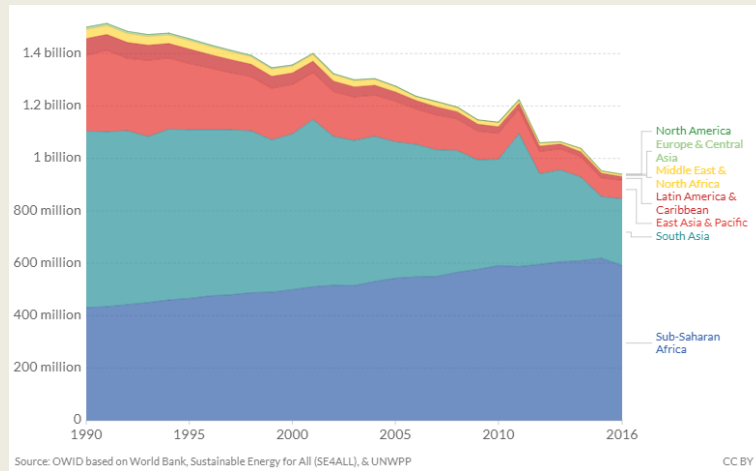
Bloomberg Commodity Index weightings

Group	Commodity	Ticker	2020	2019
<i>Energy</i>	WTI Crude Oil	CL	7.9906450%	7.6578610%
	Natural Gas	NG	7.9601350%	8.2601380%
	Brent Crude Oil	CO	7.0093550%	7.3421390%
	Low Sulphur Gas Oil	QS	2.5990850%	2.6247780%
	RBOB Gasoline	XB	2.2583580%	2.2941050%
	ULS Diesel	HO	2.1137150%	2.1596670%
			29.93%	30.34%
<i>Grains</i>	Corn	C	5.8331390%	5.8921720%
	Soybeans	S	5.6367600%	6.0250010%
	Soybean Meal	SM	3.2950770%	3.4430260%
	Wheat	W	3.0422510%	3.1403970%
	Soybean Oil	BO	2.8985800%	3.1037850%
	HRW Wheat	KW	1.4859640%	1.2937850%
			22.19%	22.90%
<i>Industrial Metals</i>	Copper	HG	6.9605820%	7.3185670%
	Aluminum	LA	4.3266510%	4.4126180%
	Zinc	LX	3.4262380%	3.2068700%
	Nickel	LN	2.7507970%	2.7093210%
			17.46%	17.65%
<i>Precious Metals</i>	Gold	GC	13.6224130%	12.2425030%
	Silver	SI	3.7785780%	3.8878360%
			17.40%	16.13%
<i>Softs</i>	Sugar	SB	3.0098940%	3.1480610%
	Coffee	KC	2.7121520%	2.4780560%
	Cotton	CT	1.4915570%	1.4194190%
			7.21%	7.05%
<i>Livestock</i>	Live Cattle	LC	4.0201190%	4.0907470%
	Lean Hogs	LH	1.7779520%	1.8491490%
			5.80%	5.94%

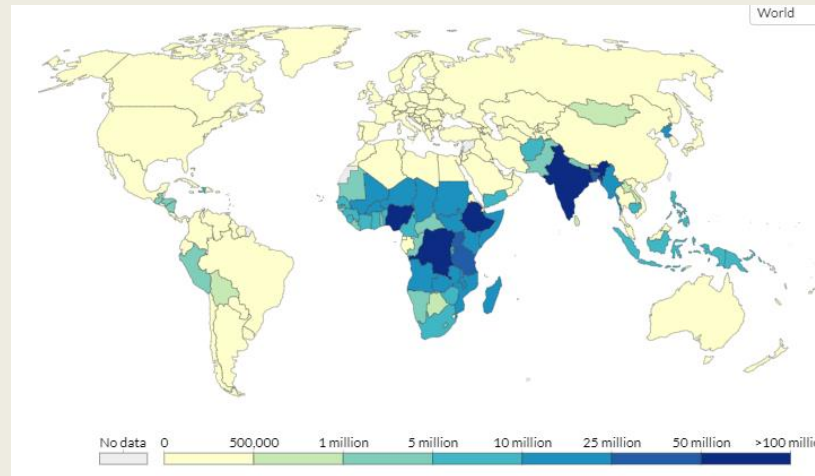
Commodities: Infrastructure demand

- Copper demand in power infrastructure mainly consists of copper usage in power generation and the power grid.
- Within power, 67% of copper is consumed as wire & cable in the power grid,
- 20% is used in power equipment and;
- The remaining 13% is consumed in power generation

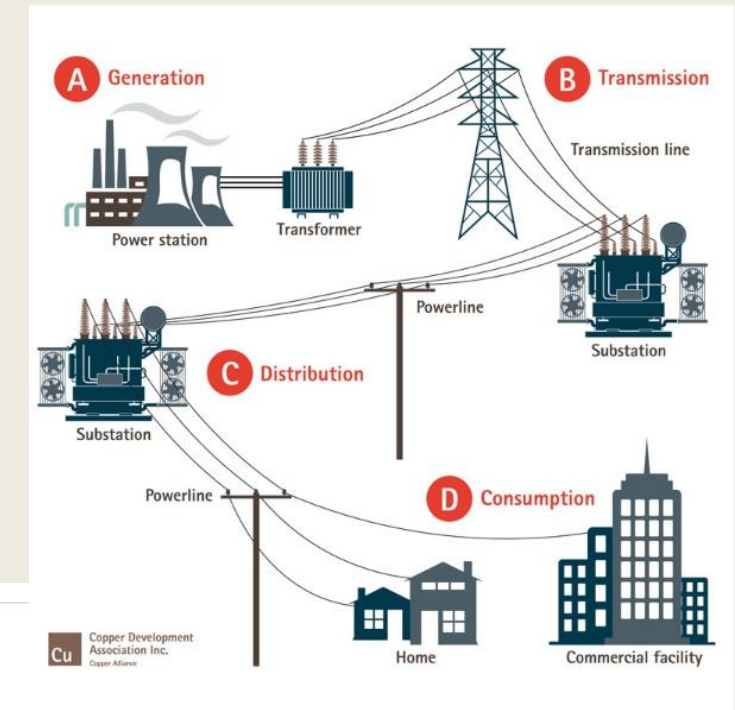
People without access to electricity...



...centered in Africa and India...

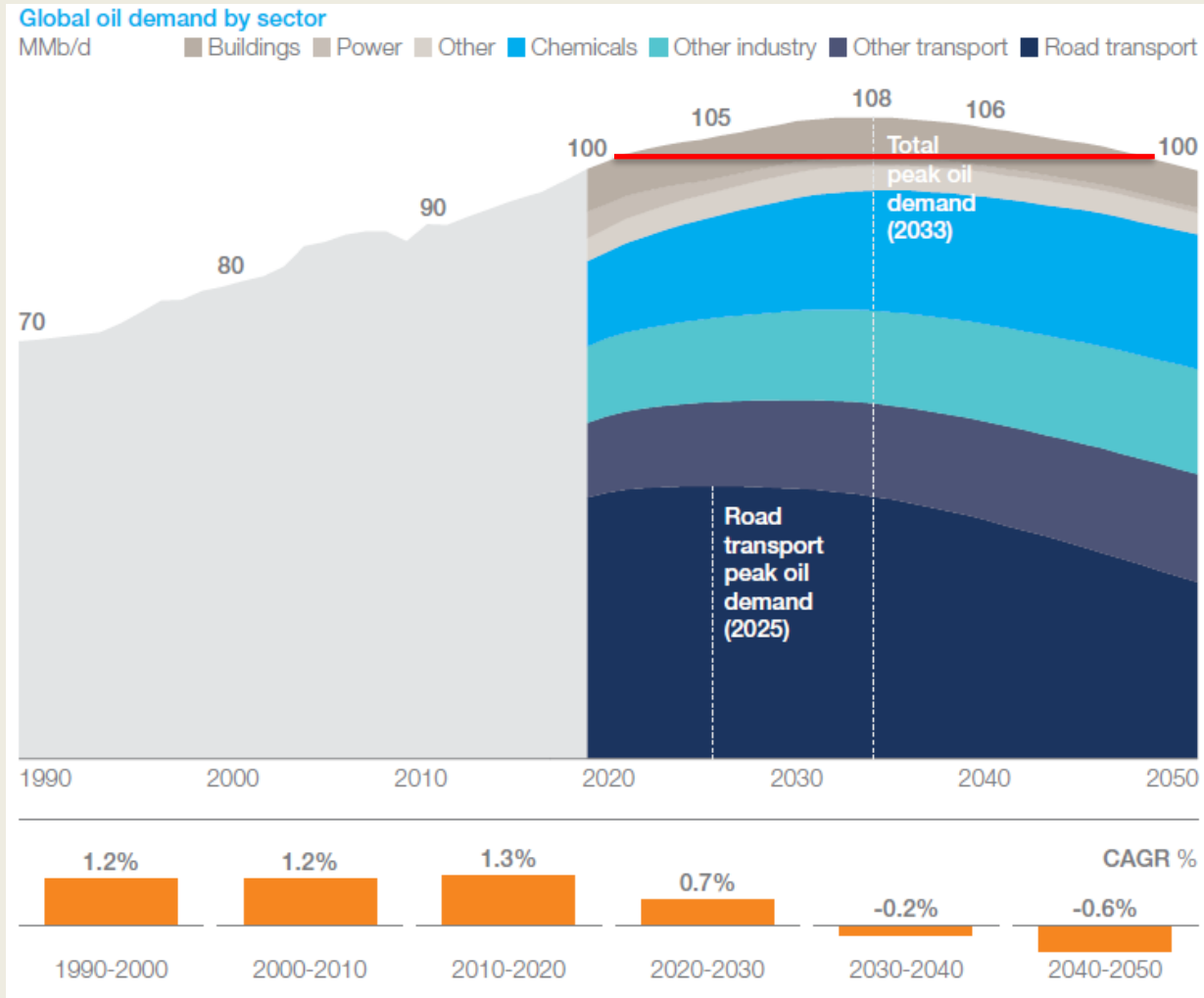


Copper in Electricity Grids



Global Oil Demand: 2050 = ~2020 levels

Global Oil Demand to Peak ~108Mbpd in ~2035



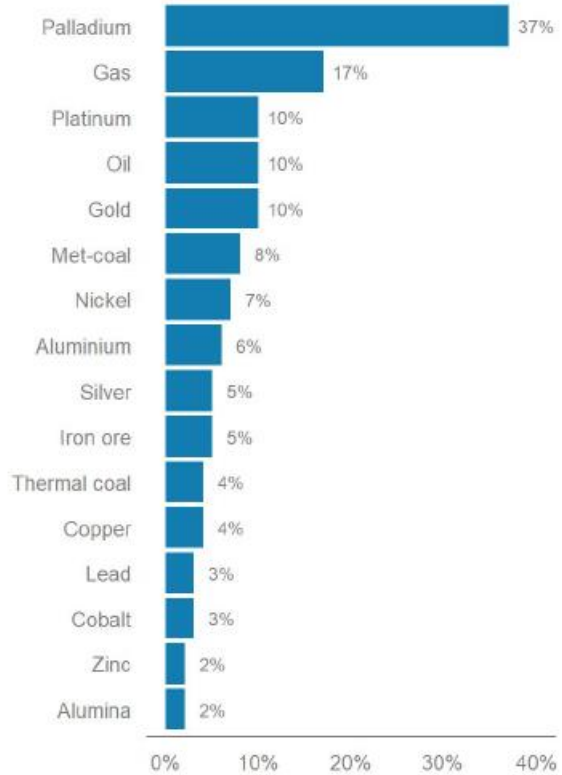
Source: McKinsey Energy Insights, Global Energy Perspectives, Jan. 2020

- Global demand has grown at >1% annually over last 3 years
- Global demand will climb 0.7%/year over coming decade
- Increased adoption of EVs (demand for transportation to peak in 2025)
- 2050 demand expected to be ~100Mbpd (*pre-Covid estimates*)

Appendix

Russia's commodity output

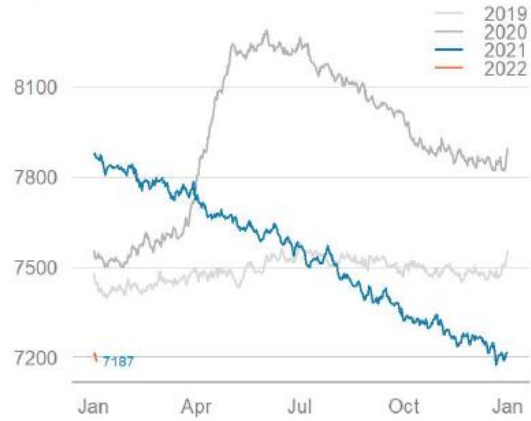
Share of global production (%)



Source: WBMS, IEA, Wood Mackenzie, Morgan Stanley Research

Observable oil inventories

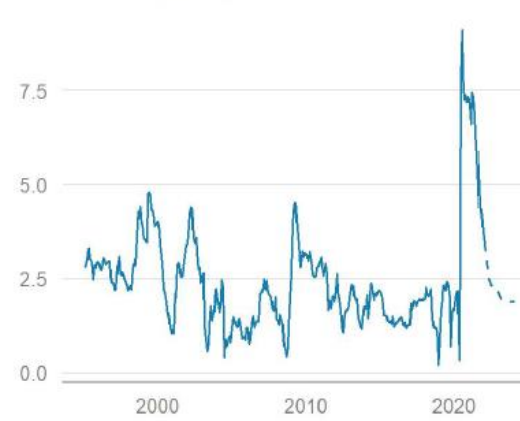
(million bbl)



Source: IEA, EIA/DOE, PJK, IE, PAJ, Platts, Kpler, BP Statistical Review, IHS, Rystad Energy, Morgan Stanley Research analysis

OPEC+ spare capacity

Incl. forecast (mb/d)



Real-term capex

Per mtoe of oil & gas consumed (\$/mtoe)

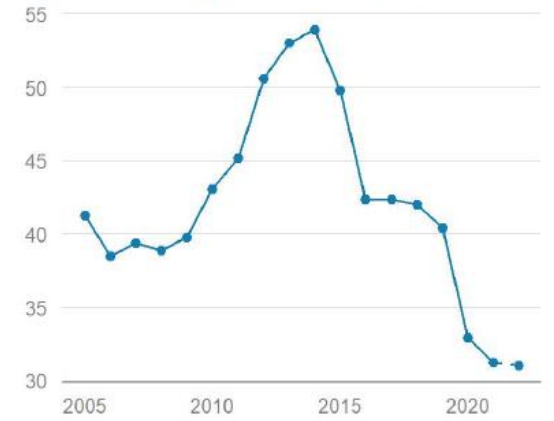
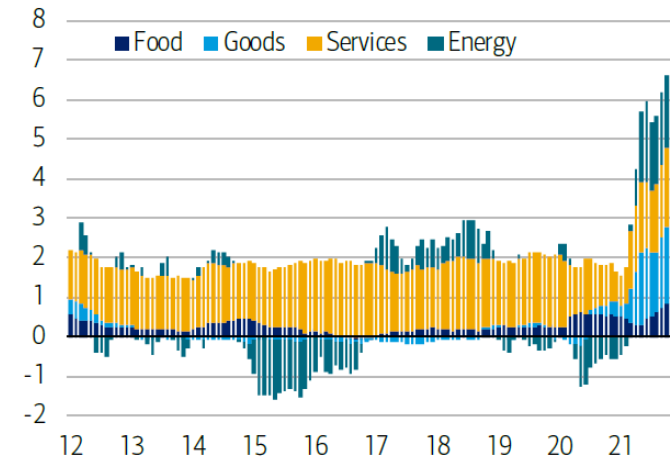


Exhibit 12: US, breakdown of CPI inflation

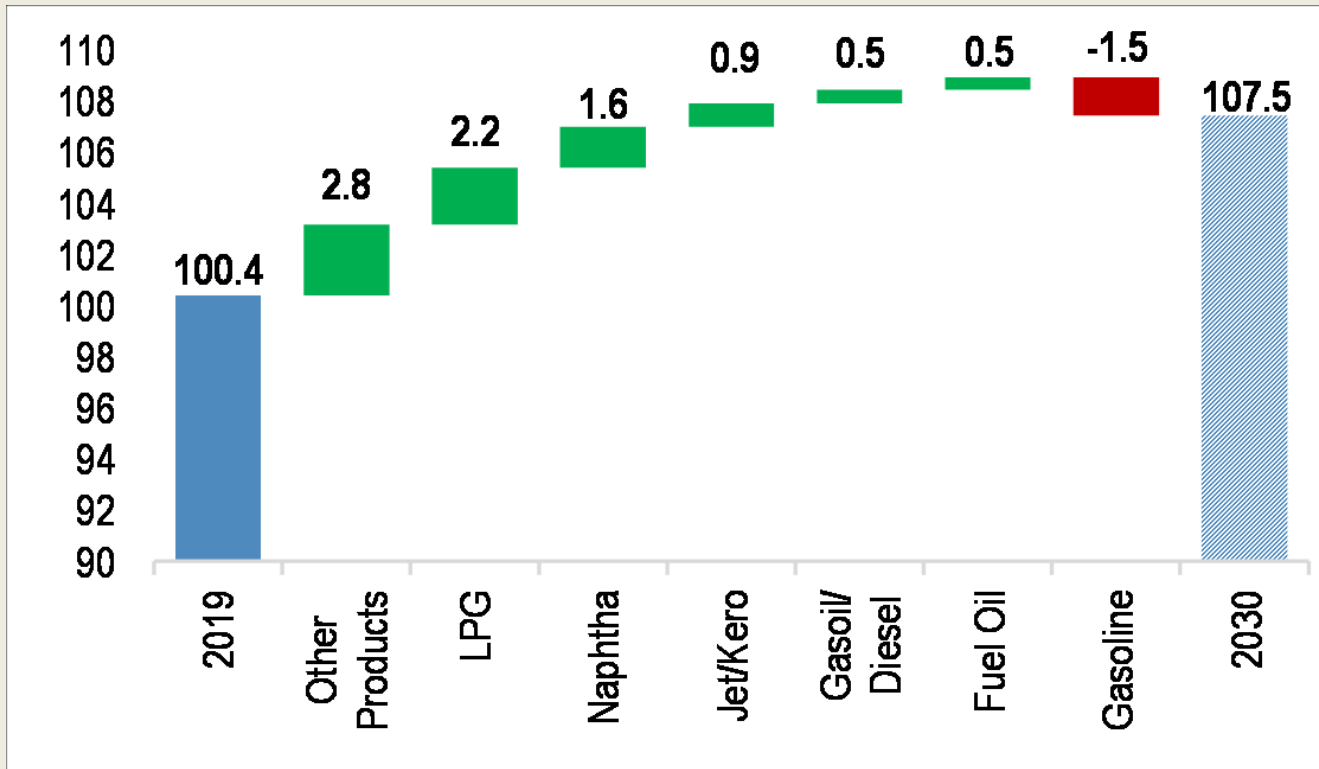
Inflation is broad based and has been accelerating



Source: Bloomberg, BofA Global Research

Global Oil Demand: 2020s

Global Oil Demand by Product (Mbpd)



- While global oil demand is projected to increase 10Mbpd over 2021-2030
- Gasoline will likely be the only product where global demand ends this decade lower than the last

Source: J.P. Morgan, Global Commodities Energy, Mar. 23, 2022