

GREEN NEW WORLD



Introduction

Mapping the Transition in the 21st Century

GREEN NEW WORLD

What is this about?

- 1) Overview of green technologies
 - How they are made
 - Global supply chains
- 2) Global trends
 - Manufacturing
 - Energy
 - Demographics
 - Finance
- 3) Impacts on California's Transition
 - Electric Vehicles
 - Renewables

Bottom Line Up Front

- Transition to sustainable model *must* happen
- The world is rapidly changing
- At risk of missing our target
- Develop a resilient transition strategy

What will we take away?

- 1) Expand understanding on global system
- 2) Inform business and regulatory planning
- 3) Food for thought how best to apply efforts

About the Presenter

Acknowledgements

Andrew Aguilar, PE, IPSWQ, QISP

Professional Background

Manager, Environmental Engineering - NASSCO

- Air compliance - painting, blasting, diesels, welding, air toxics

Senior Engineer/Project Manager - Wood

Environmental Consulting for US DoD

- Water/wastewater utility design and maintenance
- Stormwater quality
- Asbestos sampling and abatement
- Soil remediation
- Cost estimation

Agriculture



Gas/Electric Utilities



International Security



Acknowledgements and Sources

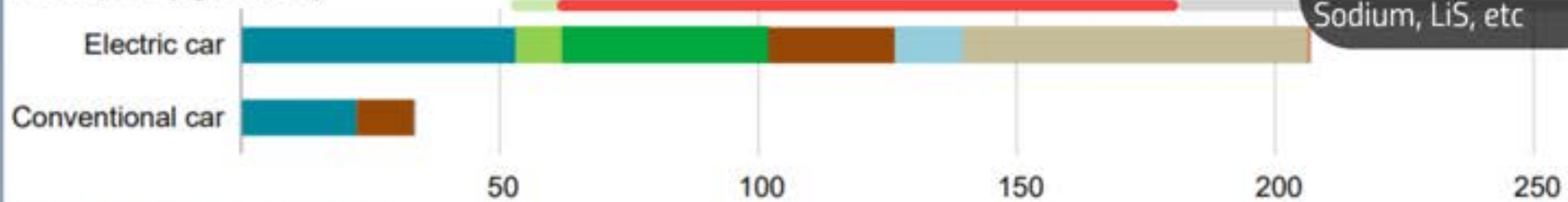
- Adamas Intelligence
- **Ashley Nunes PhD - Breakthrough Institute**
- Benchmark Mineral Intelligence
- Bloomberg
- Bureau of Labor Statistics
- Caltrans
- Chris Shimoda - California Trucking Association
- Edelman Trust Barometer
- EMBER - Sandbag Climate Campaign CIC
- Emissions Analytics
- Environmentally Benign Manufacturing
- Food and Agriculture Organization
- International Copper Study Group
- International Energy Agency
- International Maritime Organization
- International Transport Workers' Federation
- **Mark P. Mills - Sr. Fellow Manhattan Institute**
- **Nouriel Roubini PhD - Harvard University**
- Our World in Data
- Observatory of Economic Complexity
- **Peter Zeihan - Geopolitical Strategist**
- Port of Long Beach
- **Robert Rapier - Chemical Engineer**
- **Simon Michaux, PhD - Geological Survey of Finland**
- Survey of Consumer Finance, 2019
- United Kingdom Air Quality Expert Group
- United Nations Population Division
- United States Energy Information Administration
- United States Geological Survey
- United States Department of Energy
- United States Federal Reserve
- World Bureau of Metal Statistics
- World Steel Association
- *My Wife*

Current Green Technology



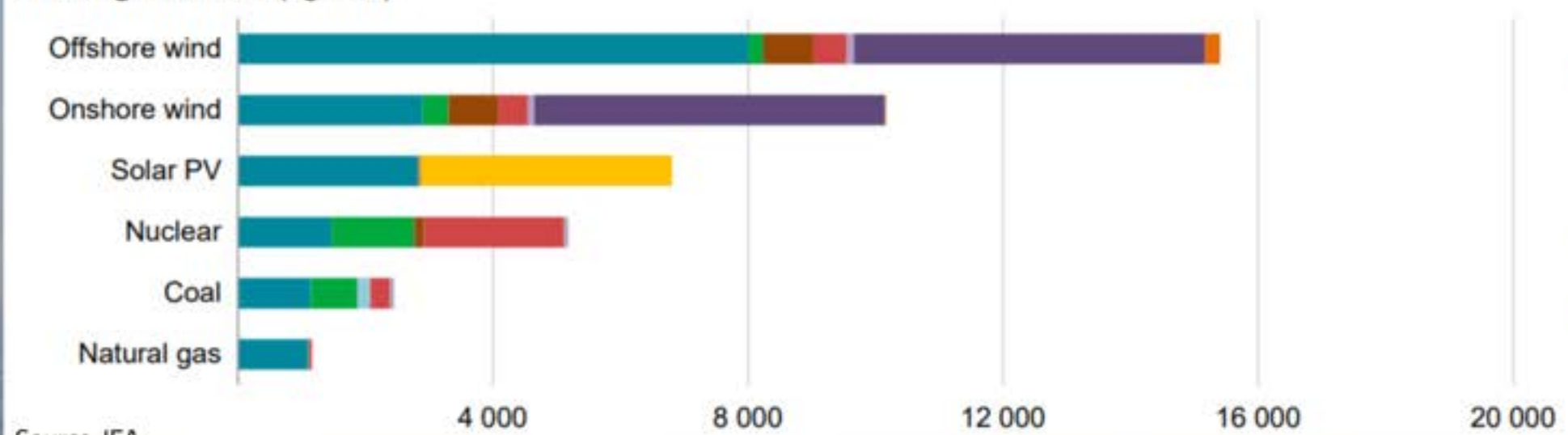
Minerals used in selected clean energy technologies

Transport (kg/vehicle)



On the Horizon:
Solid State Batteries
Vanadium-Flow
Sodium, LiS, etc

Power generation (kg/MW)

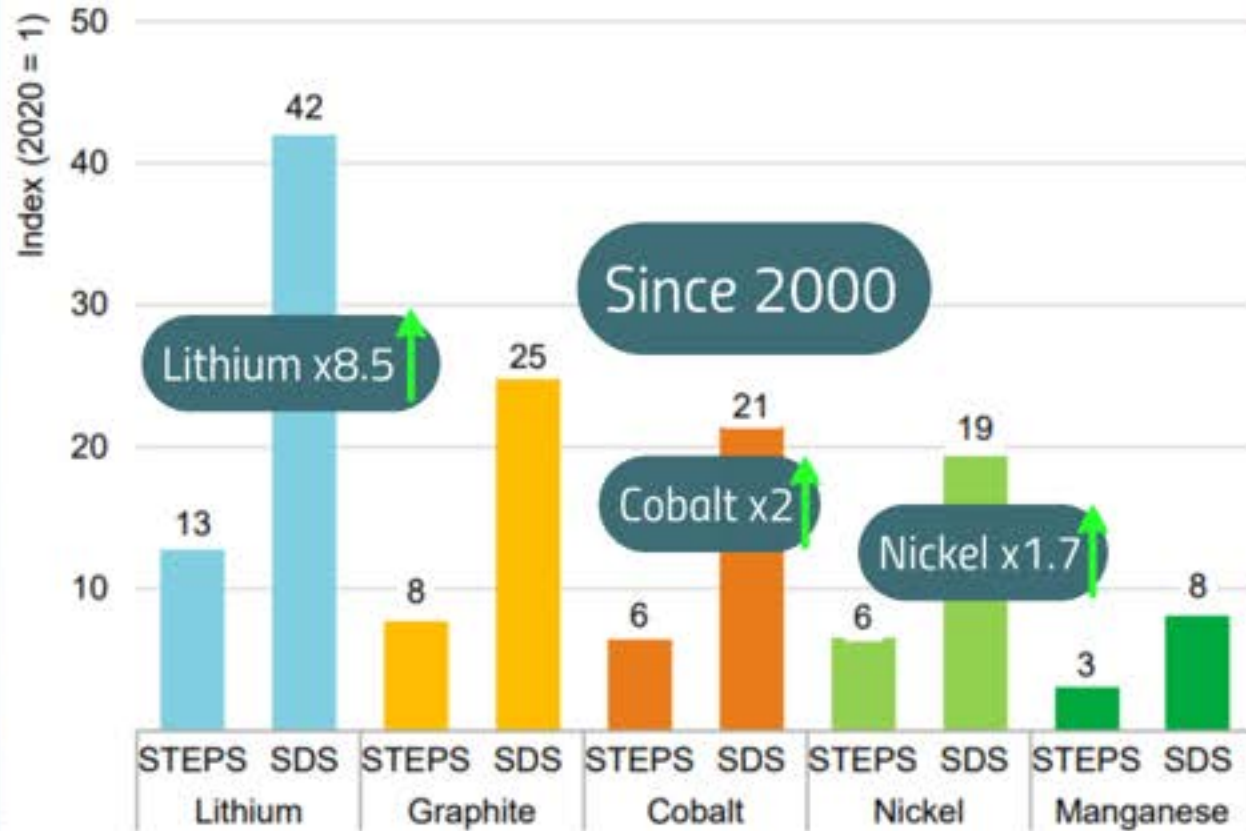


Source: IEA

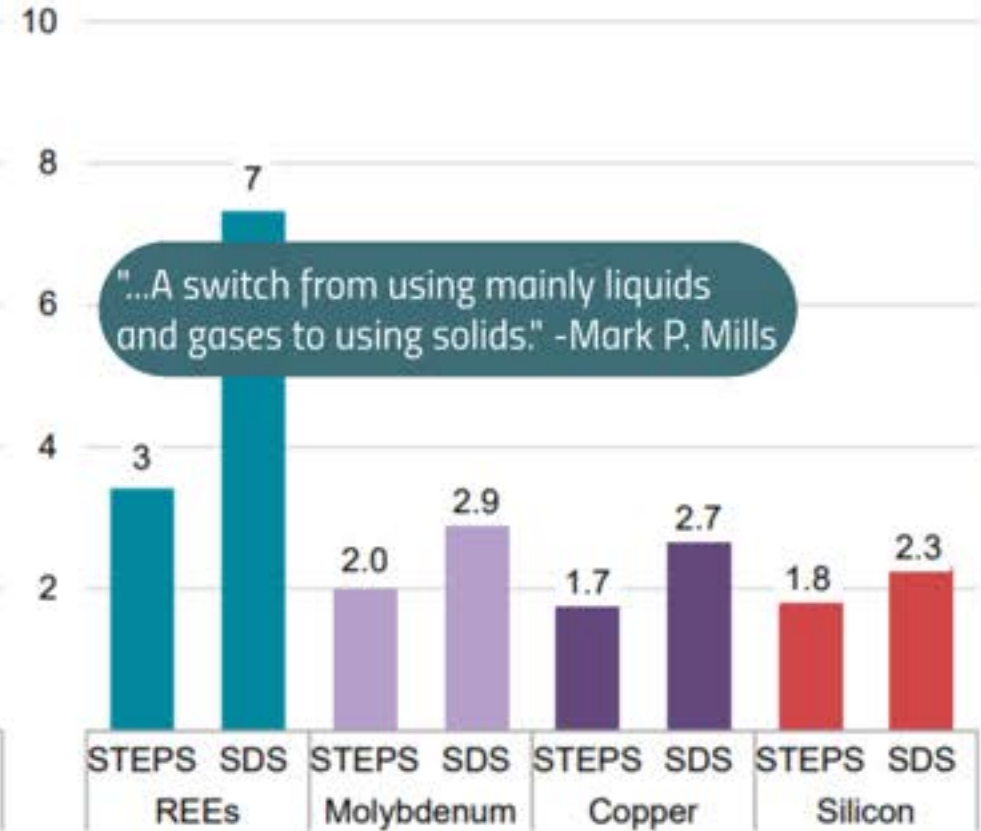
Current Green Technology



Battery-related minerals



Renewables- and network-related minerals



Projected Demand by 2040

Making Stuff in a Global Economy



Supply Chains
and Shipping

Metals

Semiconductors
and Chips

Source Raw Materials
Country A

Refine Materials
Country B

Process into Finished
Goods
Country C

Consume Goods
Trade Around World





Mild Steel

"SIMPLE SUPPLY CHAIN"

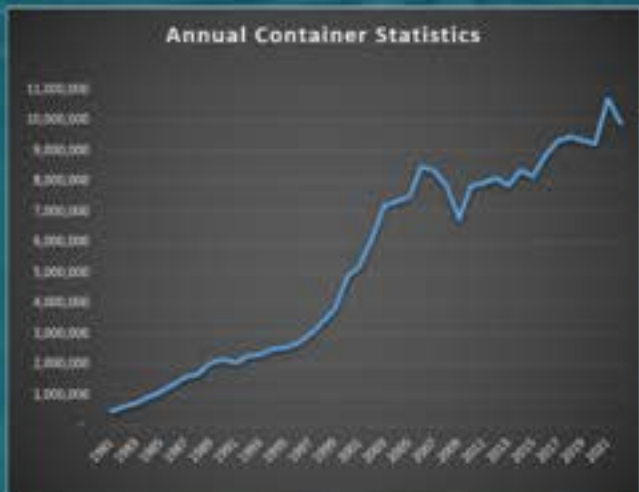
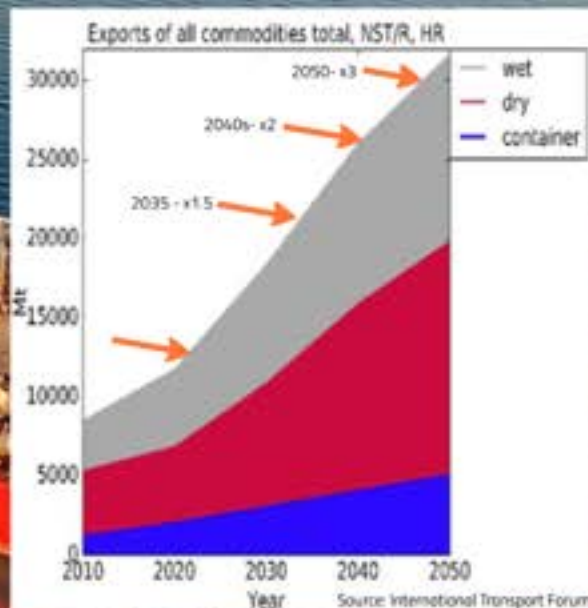
Takeaway: Every component has a global supply chain



Ocean Freight



Volume of Trade - x3 from 2020
Since 1990 - 4 to 10.1 billions tons



Expansion of global Port / Working Waterfront - 270% = 1,400 sq. miles

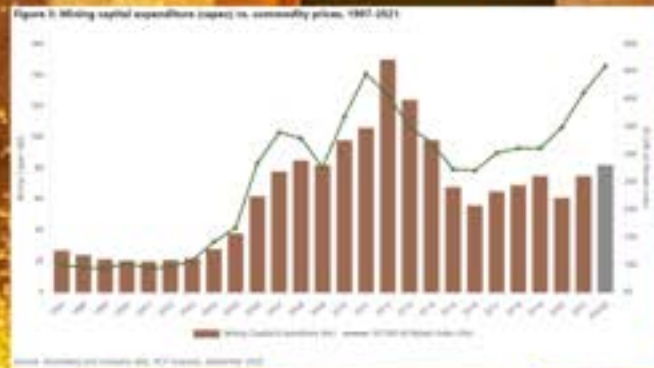
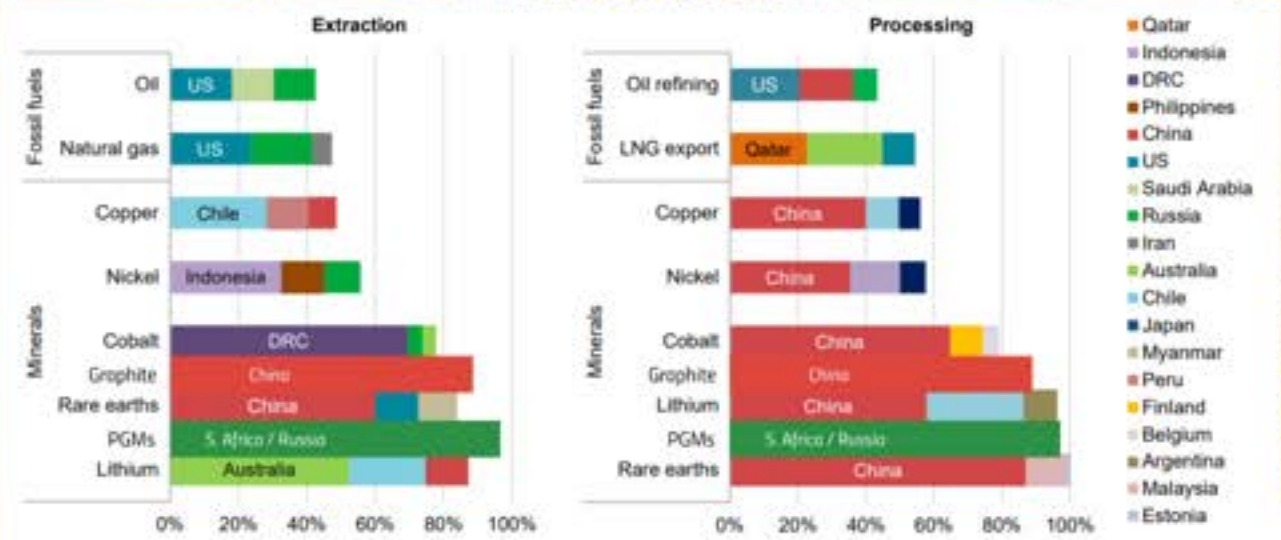
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Critical Green Tech Metals



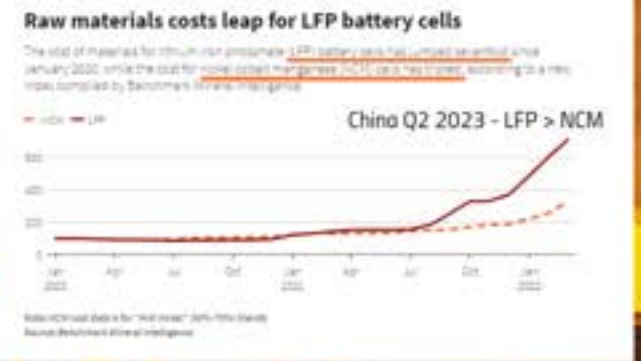
Risks - Resource Availability
 -Diminishing ore grades
 -Lack of investment
 -Increasing costs



Notes: LNG = liquefied natural gas; US = United States. The values for copper processing are for refining operations.
 Sources: IEA (2020a); USGS (2021); World Bureau of Metal Statistics (2020); Adamas Intelligence (2020).

IEA. All rights reserved.

Dependent on Nations:
 -Disproportionately large producers/refiners
 -Poor Geopolitical relations
 -Stability at risk





Semiconductors



Division of Labor
 Inputs - China, Middle East
 Design - US, Korea, Japan
 Equipment - Holland, Germany
 Fabrication

"Foundry Model"

Future Demand

Demand to **sky-rocket**
 ICE = 300 chips
 EV = 1,300 chips
 Chip lead times to **52 weeks**
 Semiconductor equipment lead times to **18-36 months**

Future Supply

US/EU decoupling from China
 -Uyghur Forced Labor Protection Act
 Tariffs on "conflict" solar, electronics
 -US ban on chip, AI, quantum computing support to China
 -Seeking opportunities in India
 CHIPS Act reshore to US
 -Facing labor shortage
 -Disbursement delays

Challenges
 - Polysilicon sourcing
 - Reshoring is a **downgrade**

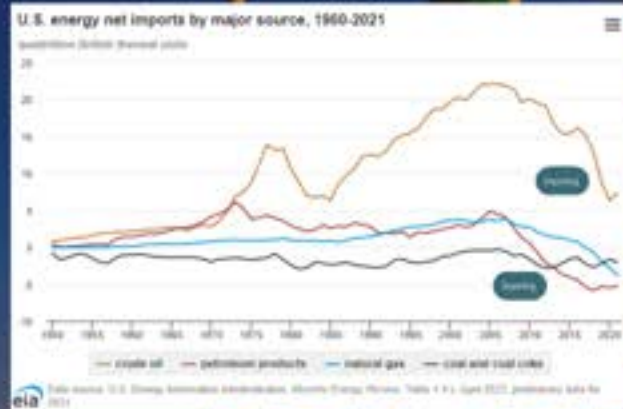


...and Neon

Powering the Globe



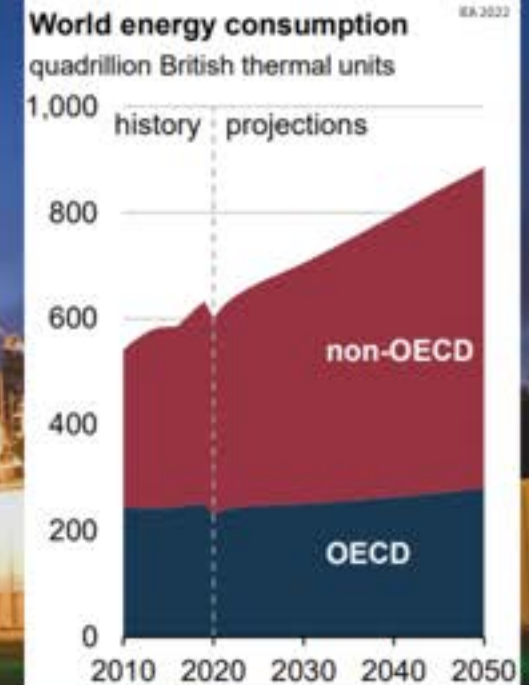
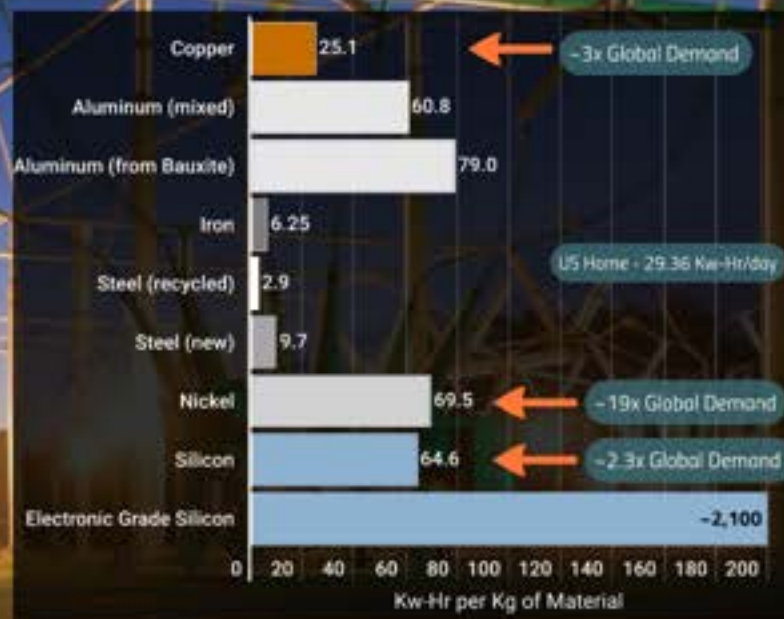
The Shale Revolution



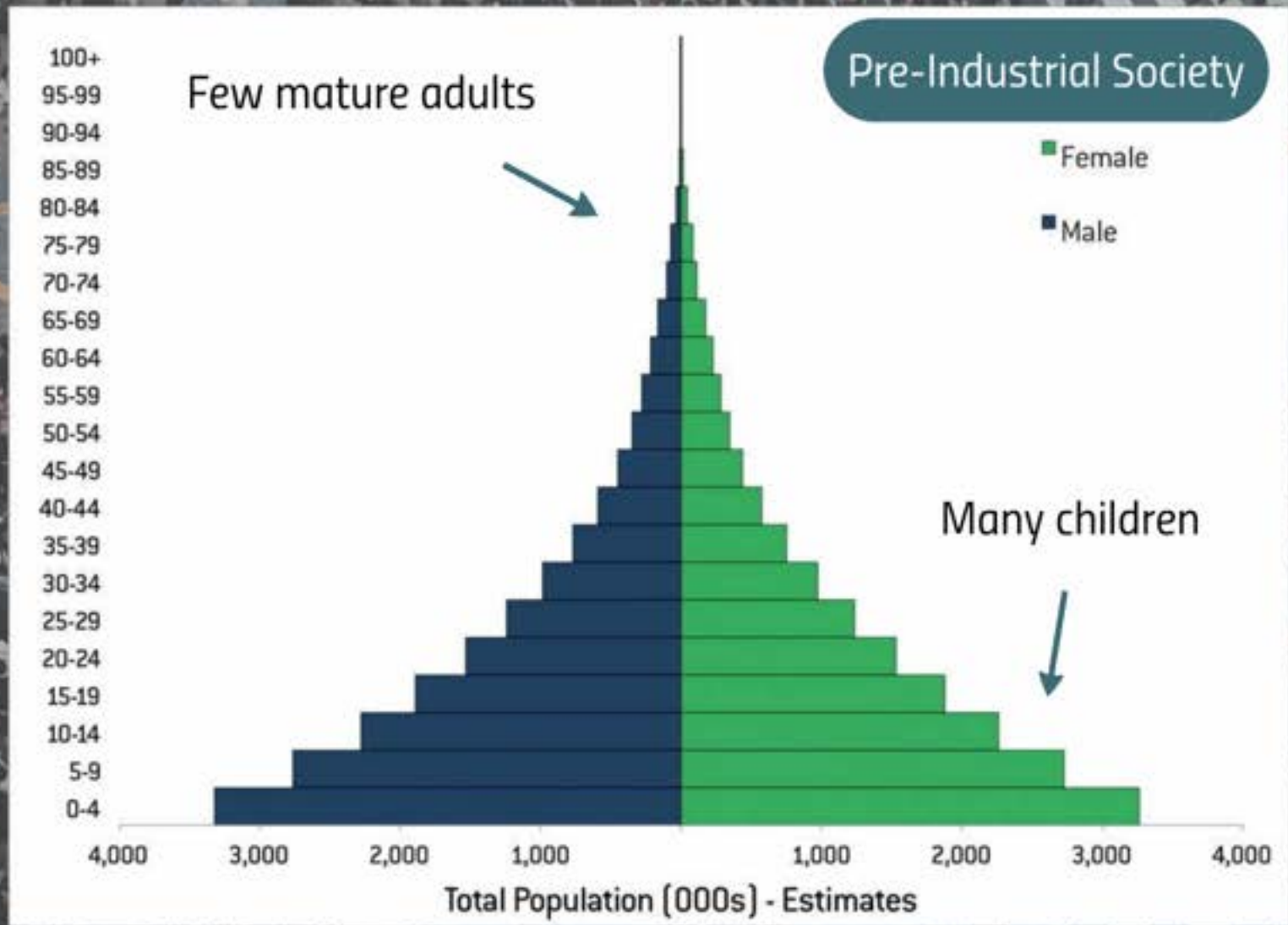
Increasing System Fragility
-Europe, Russia, Africa

Marginal Supply = Price Volatility

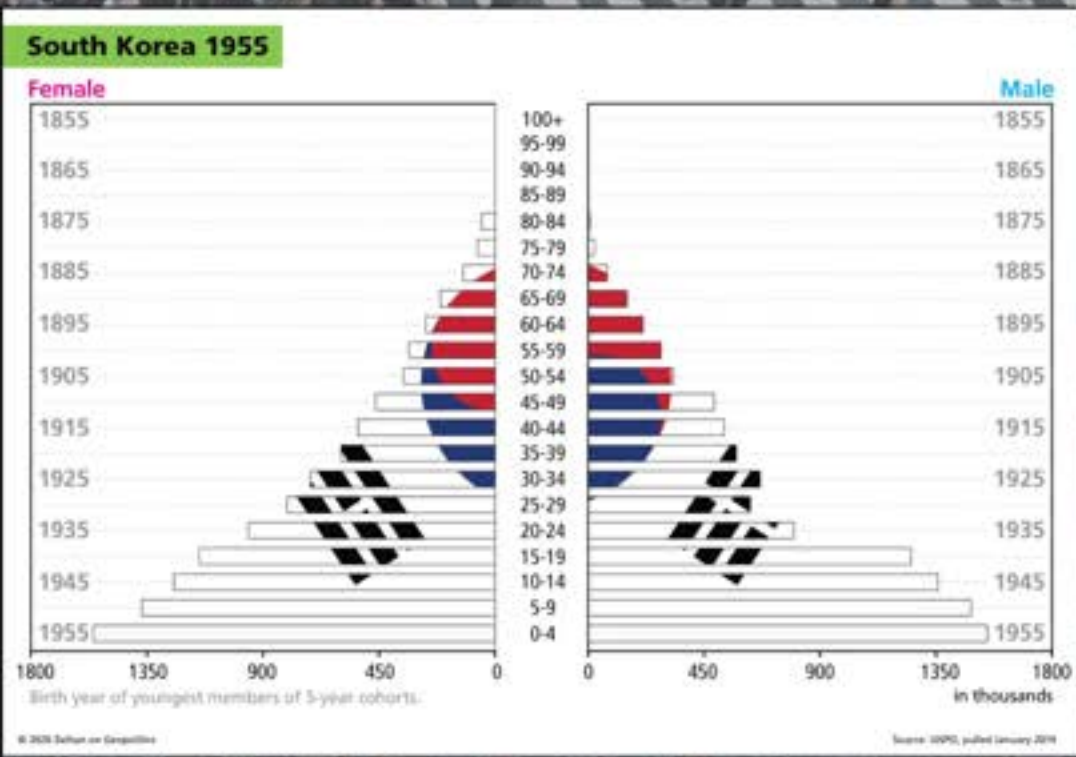
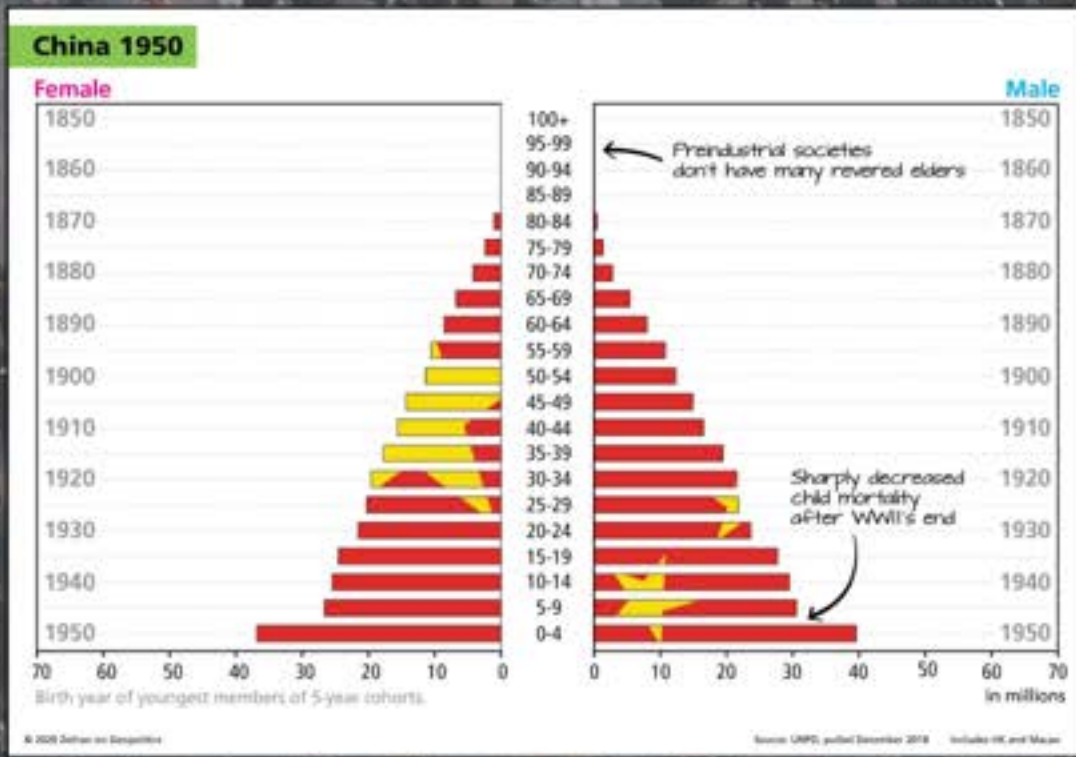
Mining, Refining, Manufacturing need energy:
-Abundant, Cheap, Reliable



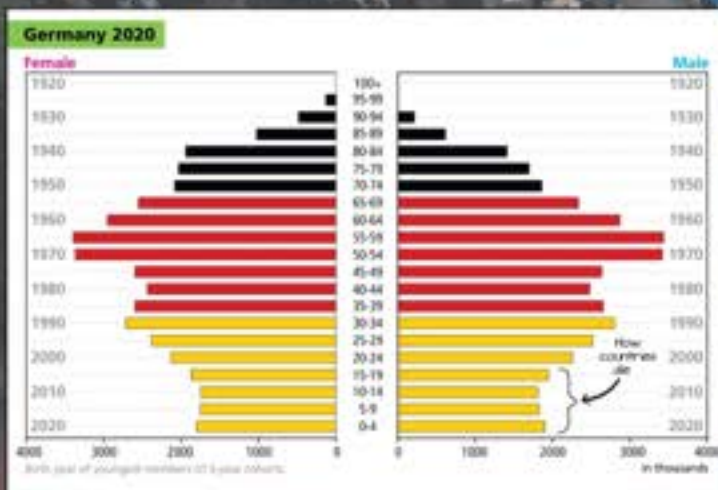
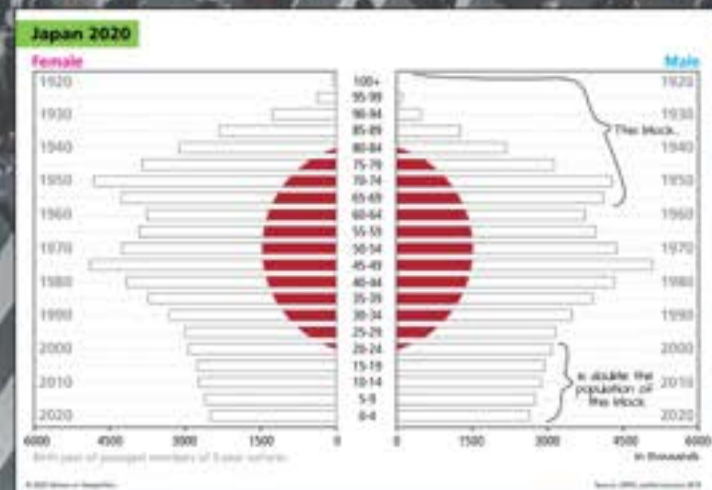
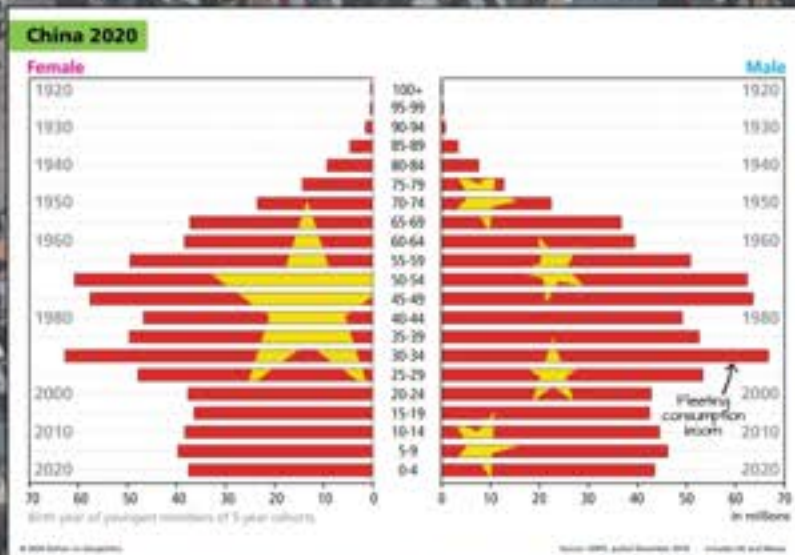
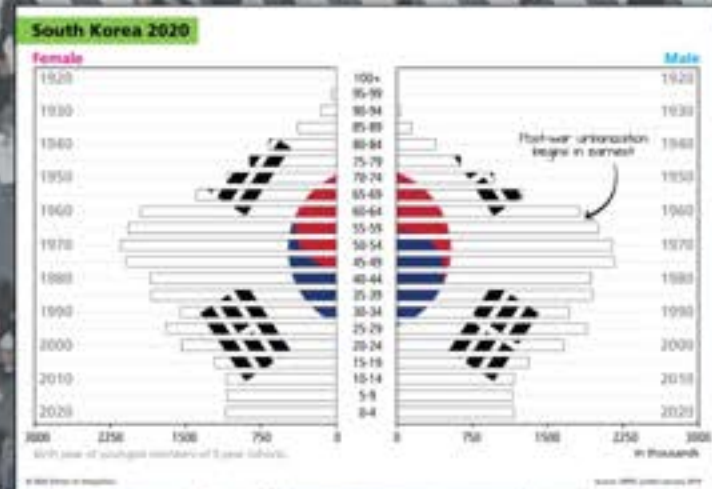
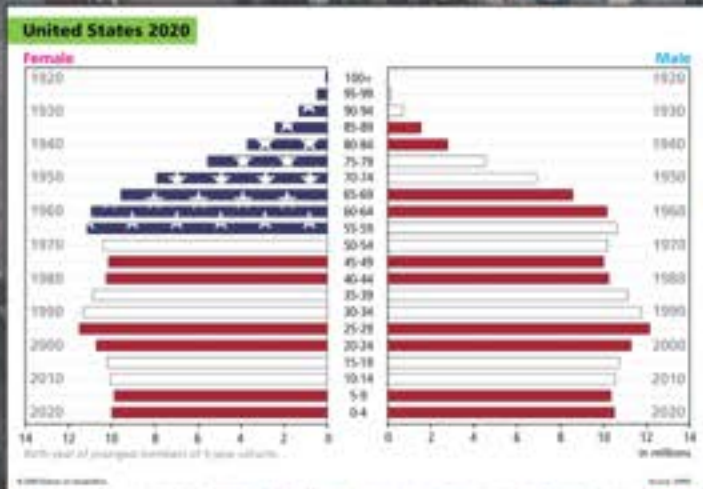
DEMOGRAPHICS



DEMOGRAPHICS

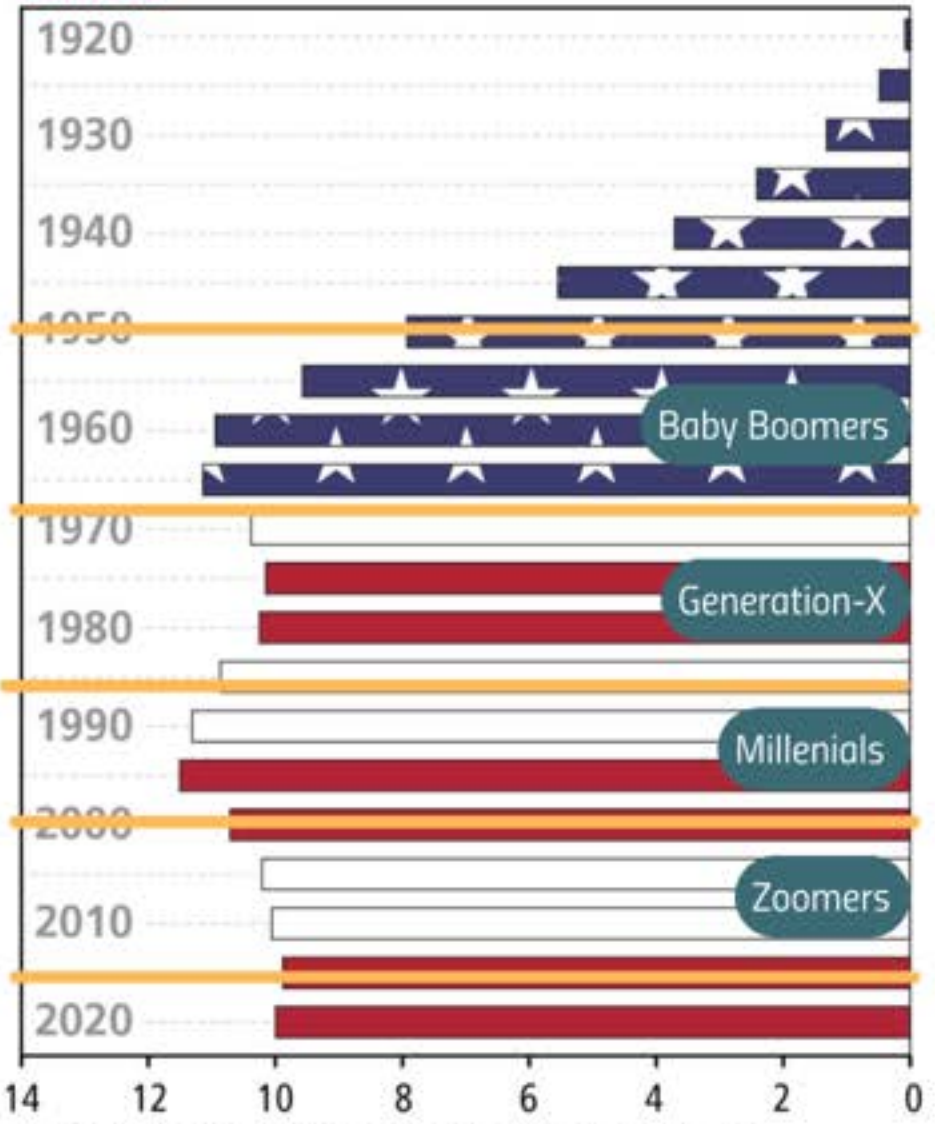


DEMOGRAPHICS

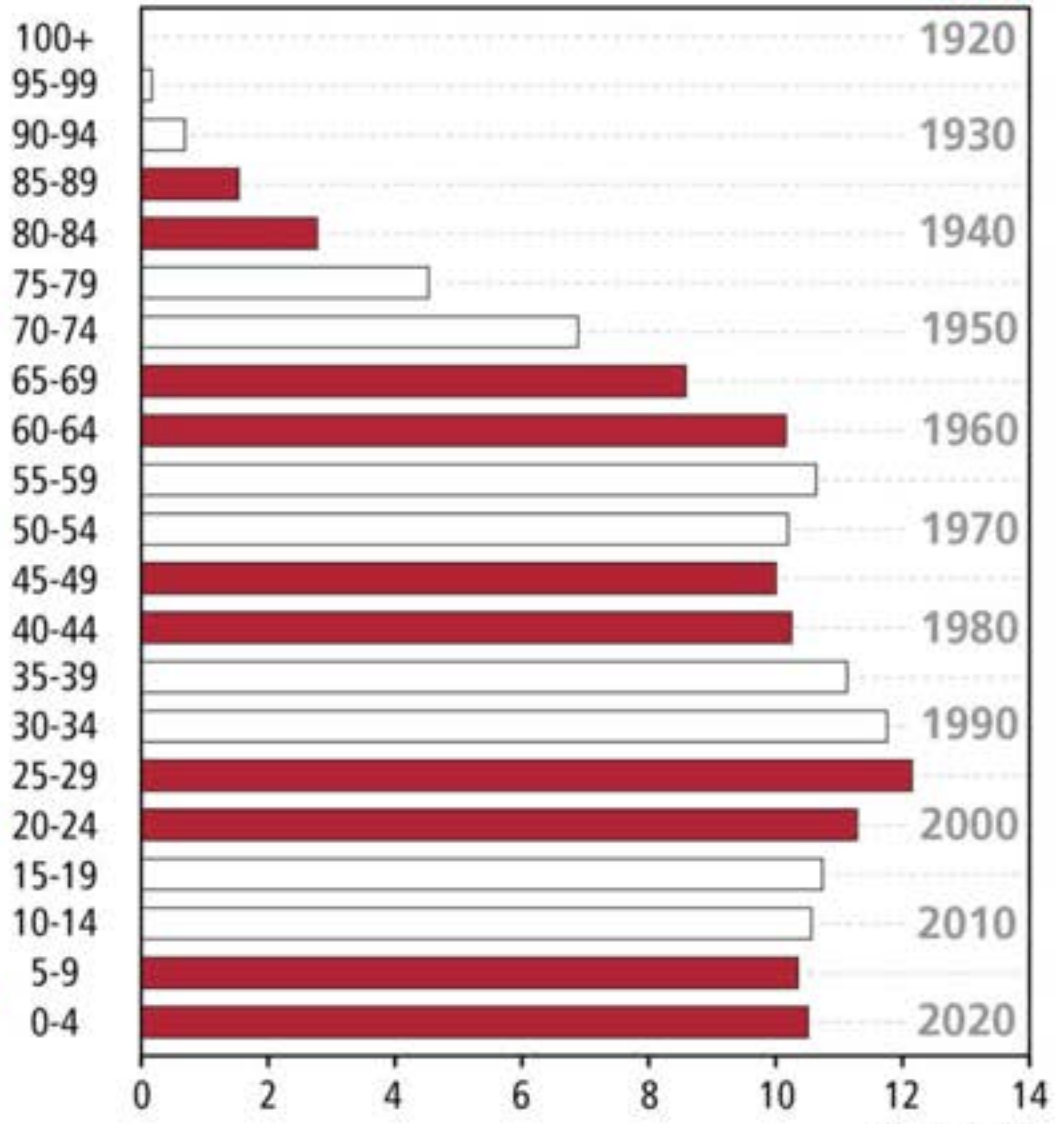


United States 2020

Female



Male



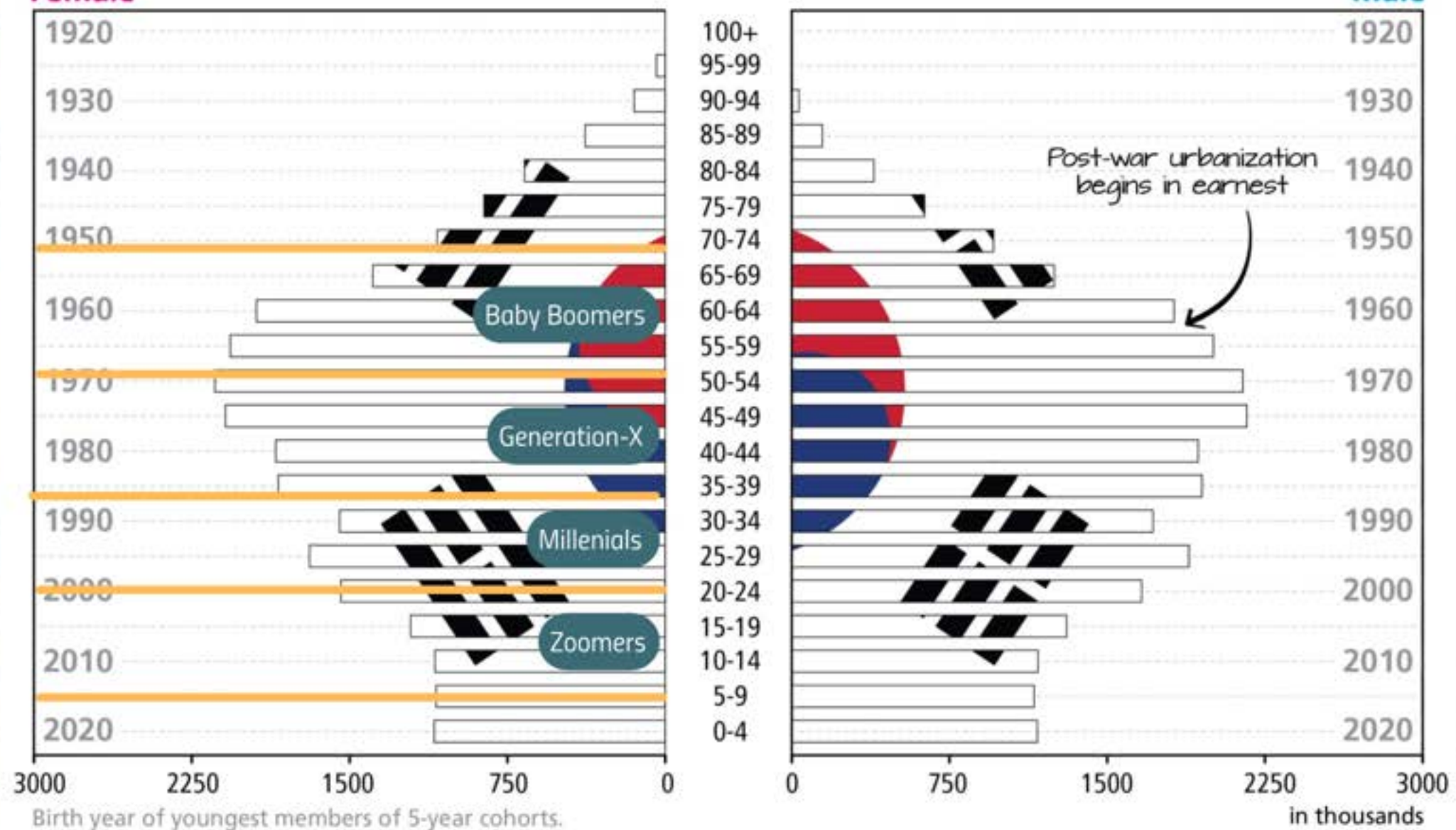
Birth year of youngest members of 5-year cohorts.

in millions

South Korea 2020

Female

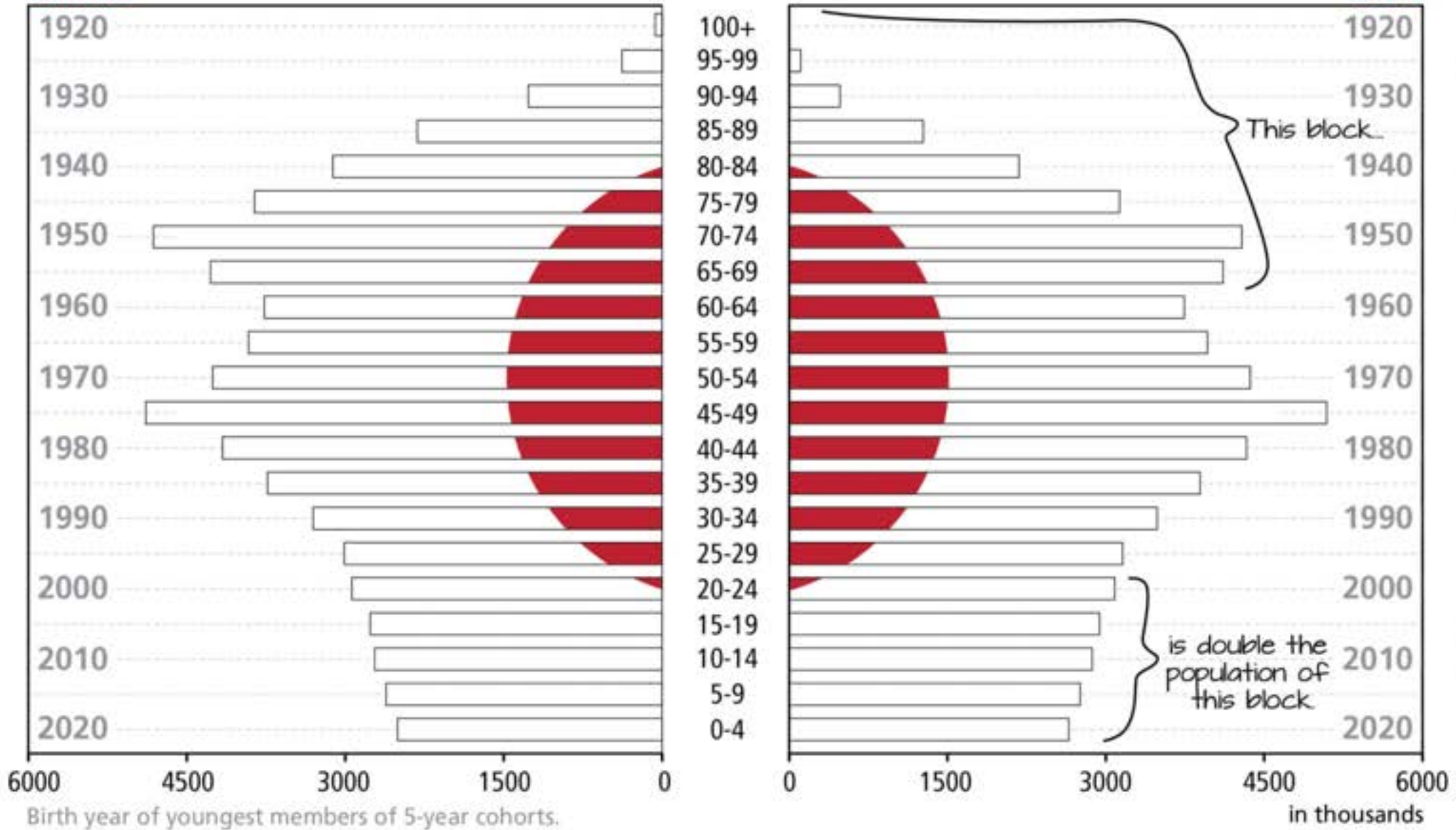
Male



Japan 2020

Female

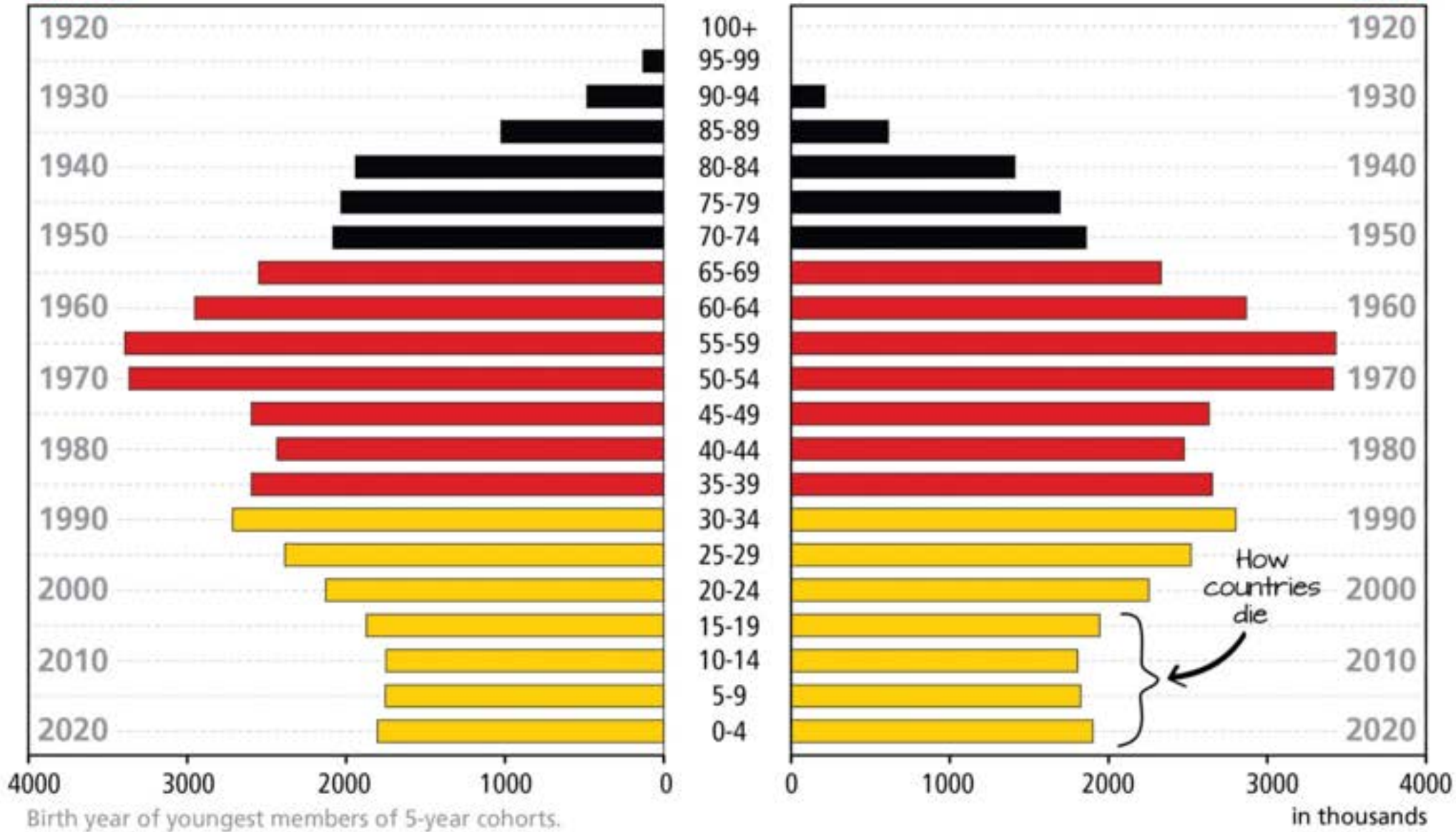
Male



Germany 2020

Female

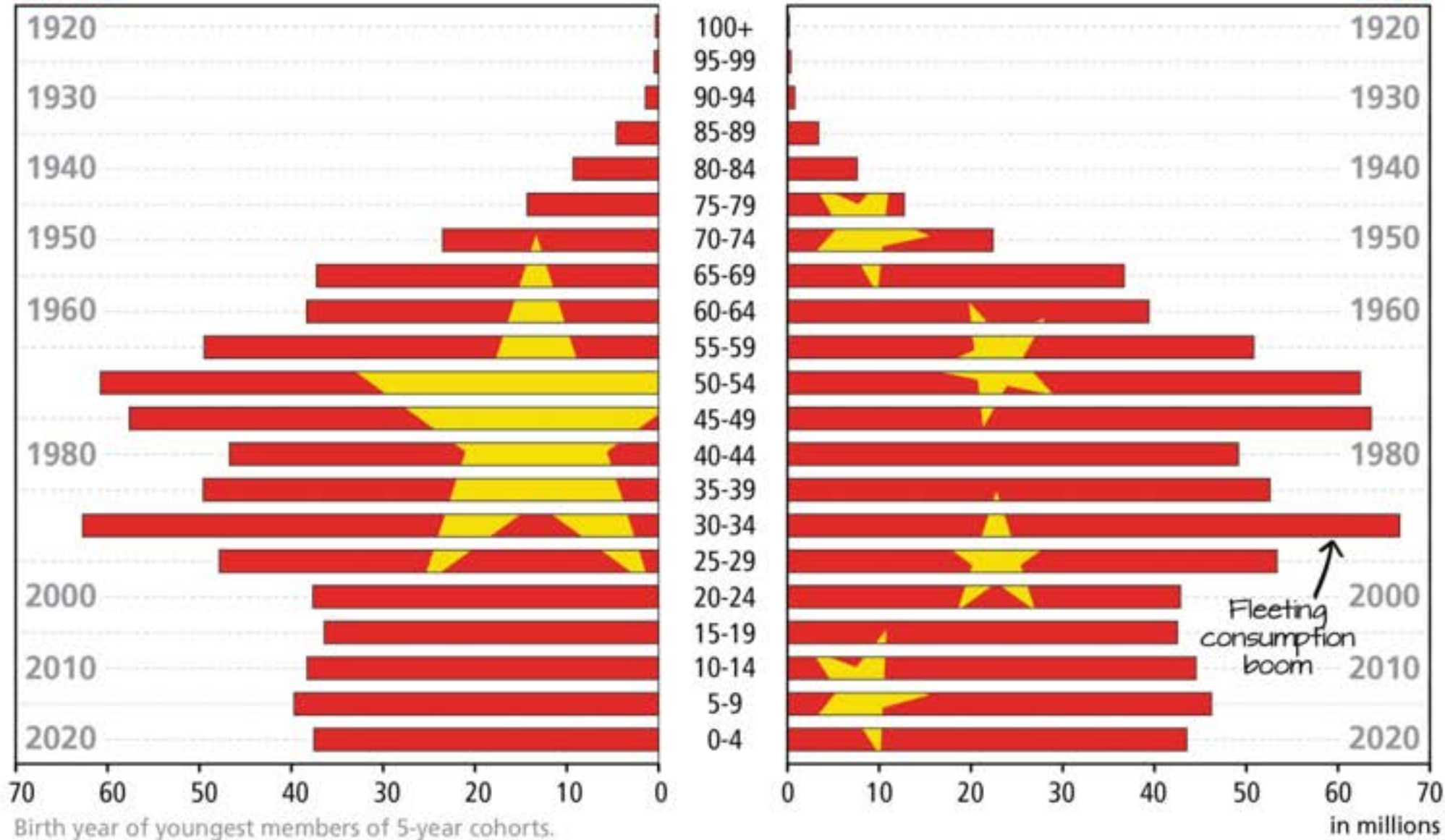
Male



China 2020

Female

Male

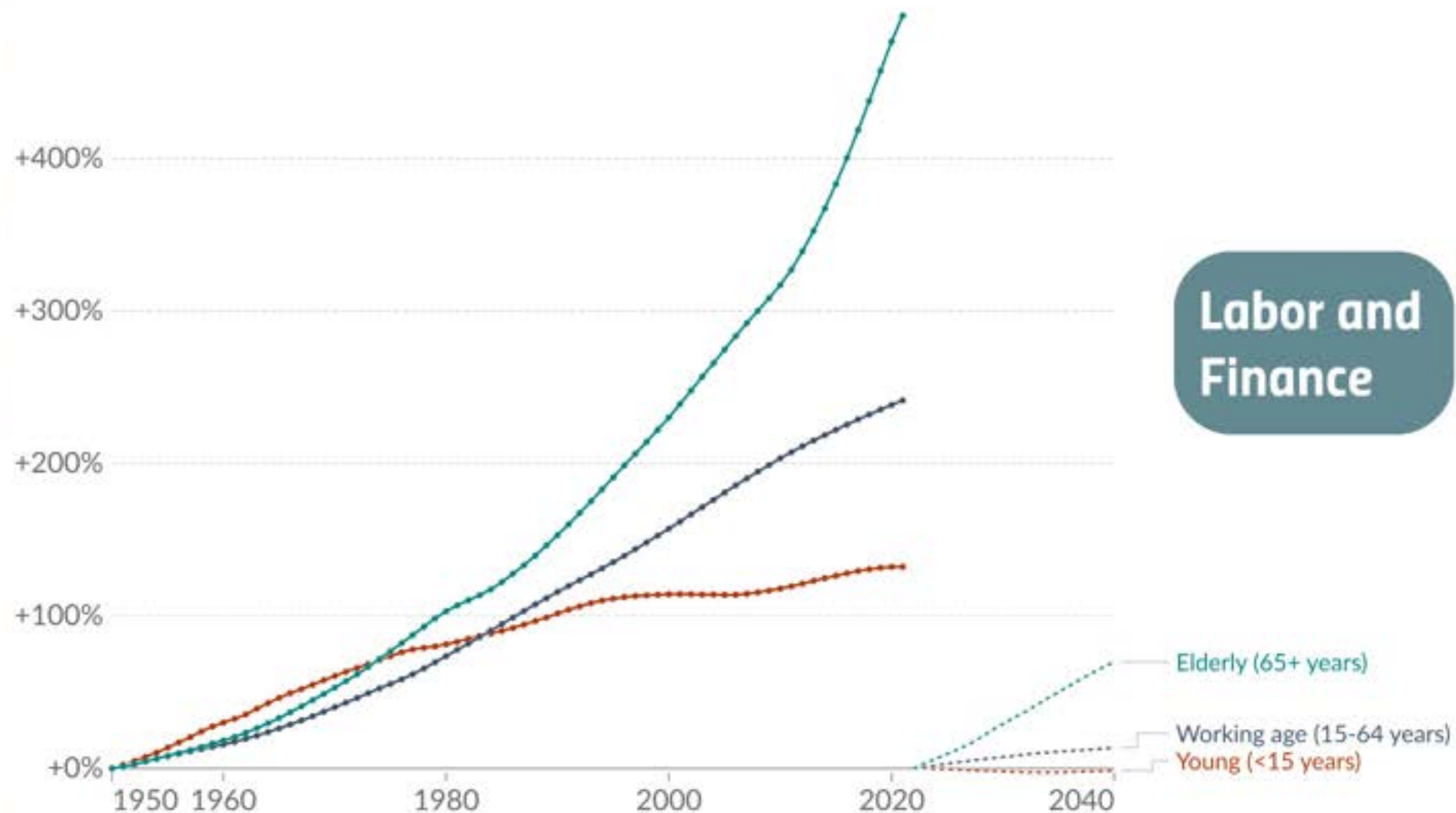


Change in size of young, working-age and elderly populations, World, 1950 to 2040

Our World
in Data



Historic estimates from 1950 to 2021, and projected to 2100 based on the UN medium scenario.



Source: United Nations - Population Division (2022)

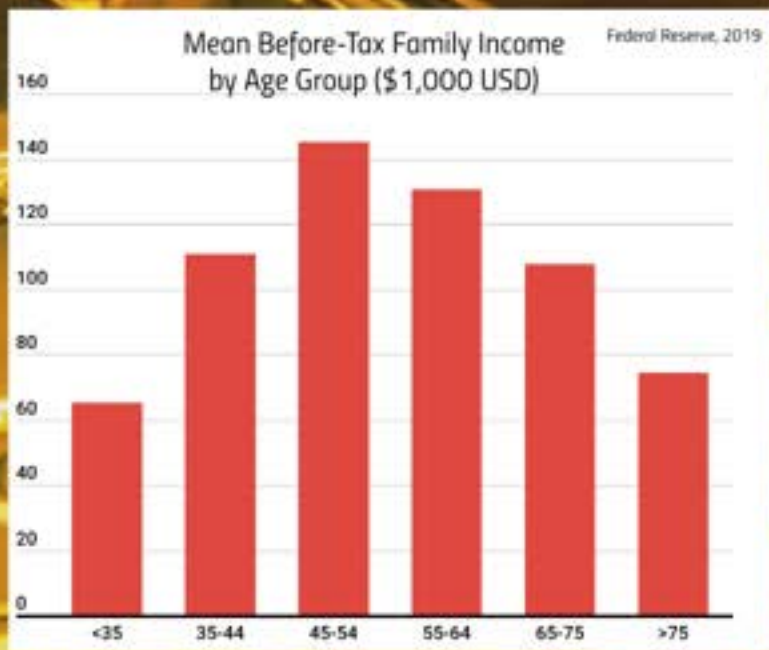
OurWorldInData.org/age-structure • CC BY

Financing the Future

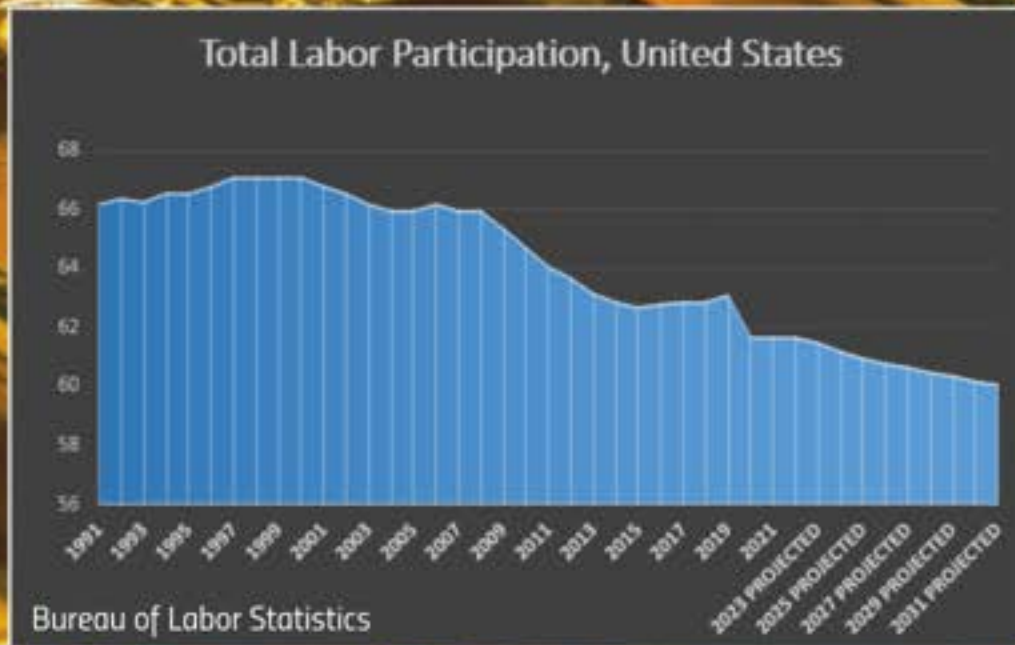


Population and National Income

Demographics affect:
Income Tax 35-64 : highest income taxes and investment
Private Investment <25-54 : highest consumer spending
Domestic Consumption



Retirees minimize taxable income
Small young generation = less spending



Leaving Boomers - gap from Gen X, Millennials, and Zoomers
Natural inflation from Labor

Cost of Living

Food and Costs of Living

"Three missed meals from chaos"



Increased costs of living:

- food
- energy
- necessities

Costs



Unrest



Global Food +23.9% (since 2019)

July 2023 - Russia pulls out of grain deal

Energy (since 2019) - EU + 86.2% , US +21%

SPR withdrawals to end 2023

Decreasing Stability in Key Nations:

Chile

China

Brazil

S. Africa/Niger

Peru

Argentina

Gabon

EU

Russia

Ukraine



Moving Forward Tying it All Together

**California
Regulation**

**Environmental
Justice**

Regulations for Climate and Public Health



Advanced Clean Fleets:

ZEV only, medium- and heavy-duty trucks - **2040**

State and local fleets - **60% of additions by 2024** and **100% by 2027**

Drayage fleets- ZEV additions only, All ZEV by **2035**

High-Priority and Federal - ZEV additions in **2024**
or
2025, phase in % of ZEVs in fleet by type

Advanced Clean Trucks:

Phase 2 GHG and Fuel Standards
CA Hevy-Duty Engine and Vehicle Omnibus Regulation

EPA:

Lower fuel use and NOx/CO2 emissions

CARB:

Prevent premature deaths and save billions in healthcare

Off-Road Diesel Fleets:

Tier 4F additions only

Progressive operation ban

ZEV phase-in



Freightliner eCascadia



Nikola Tre BEV



Tesla Semi



BYD line

Freightliner, Nikola, Tesla, Volvo, Peterbilt, KW, BYD

First deliveries Q4 2022

Implementation Challenges

Assuming wide availability:

- Charge times up to 160 minutes
- Range and capability issues
- Energy grid infrastructure
- Uncertain OEM support
- Low Profitability for OEMs

Global Disruptions and Emerging Technologies

Risk: Transition bottleneck, logistics, and sunk costs

Expansion of Exemptions

Site Electrification Delays - Maximum 5 years

Delivery Delays

Daily Usage - EV duty cycle deficiencies

Unavailable Configurations

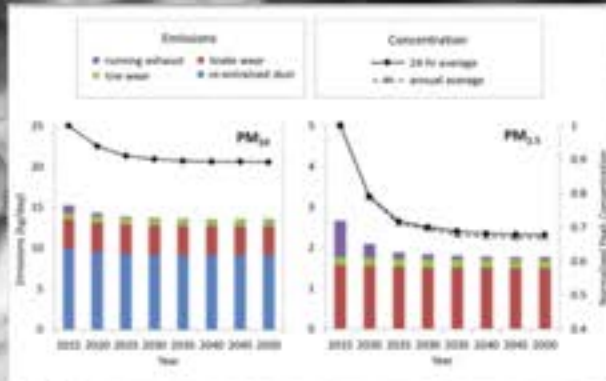
Water/Wastewater fleet extensions

Rental Vehicles

Regulatory Burden and Recordkeeping - High

Non-Tailpipe Emissions

Is there a baseline for mobile source pollution?



Up to 1,000x greater than tailpipe emissions

-EVs weigh 20-30% more than ICE
-instant torque

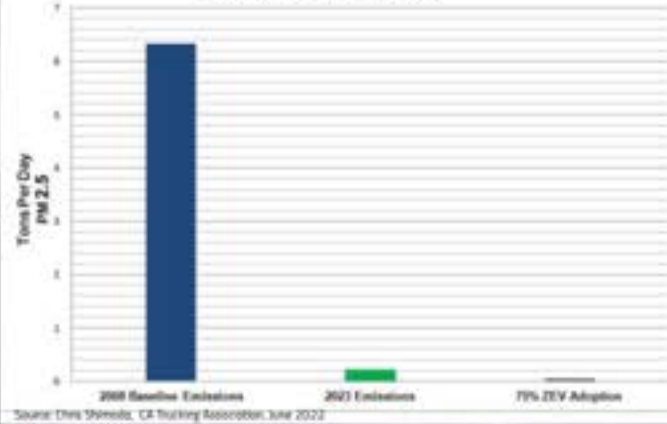
-ASCE 2021 Infrastructure Report Card:
43% of roads are mediocre or poor

Environmental Justice

Opportunity Costs?

New or Pending Regulation

Expected PM_{2.5} Emissions from Trucking



Pursuing 100% ZEVs at expense of other innovation

Hybrids?

-Return on CO₂ reductions for minerals used

Combined Cycle with Carbon Capture?

Developing countries?

-Feasibility of ZEVs
-Externalities

Renewable diesel?

70-80% reduction in lifecycle carbon, diverts landfill waste, **more accessible**

Climate over Environment?

Cerro Verde, Peru

-42 square miles

500,000 tons/yr

New mine - 16 years
Declining ore grades
Tailing ponds and waste

By 2030, short 6 million tons/yr

Siting and Permits



Indigenous Land Encroachment



What the Future May Hold

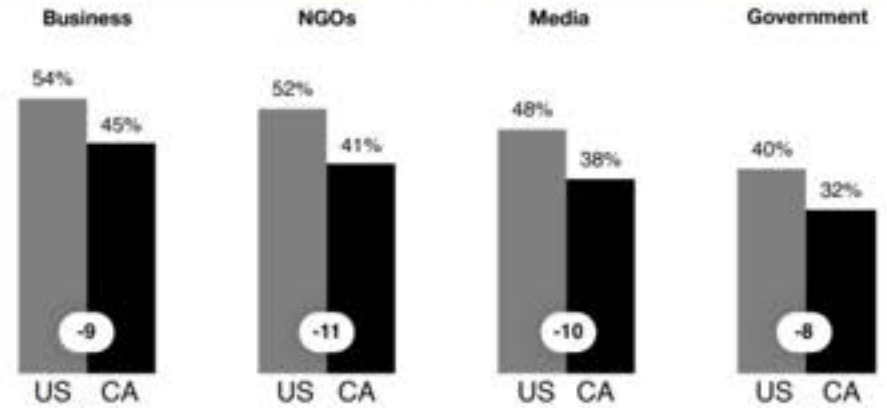
CHALLENGES

- Global Disruptions to:
Manufacturing, Labor, Energy, Finance
- Critical partners at risk of de-industrializing
- Need to re-assess feasibility and timeline of Green solutions
 - Constraints to production and refining
 - Energy insecurity
 - Limitations of materials science

OPPORTUNITIES

- N. America is energy/food independent with good geography and demographics
- Positioned be the global leader in "new" Green Transition
- Demographic and financial mobility for reshoring manufacturing/industry
- Innovations are coming
 - time scale - decades

What CA Needs of its Future Leaders



Average Trust in CA: 39%

-10 compared to US

Source: Edelman Trust Barometer

1- Restore public trust

- Open, honest conversations with ourselves and the general public
- Benefits, limitations, disadvantages, and expectations

2 - Continue collaboration to develop rules for the Green Transition

- Made to real-world conditions
- Realistic timelines for innovation and rollout

3 - Open to innovations in "legacy" technologies

- Solutions need effective, sustainable, and **worldwide accessibility**