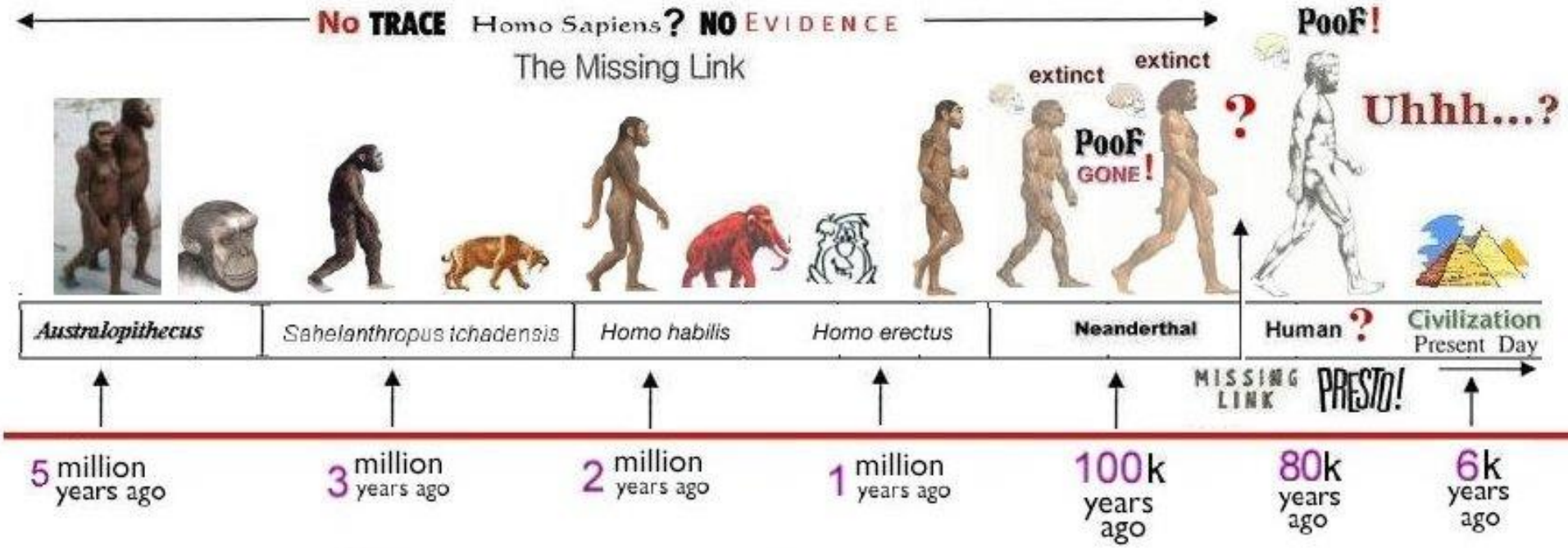

No TRACE Homo Sapiens? NO EVIDENCE
The Missing Link
PooF!
extinct
extinct
PooF
GONE!
?
Uhhh...?
Australopithecus
Sahelanthropus tchadensis
Homo habilis
Homo erectus
Neanderthal
Human ?
Civilization
Present Day
MISSING LINK
PRESTO!
5 million years ago
3 million years ago
2 million years ago
1 million years ago
100k years ago
80k years ago
6k years ago

Carbon Neutrality, Resources, Prosperity and other Musings

Adam C. Simon

UNIVERSITY OF MICHIGAN

An historical perspective on resources

"Men know how to mine silver and refine gold, to dig iron from the earth and melt copper from stone " (Job 28:1-2)

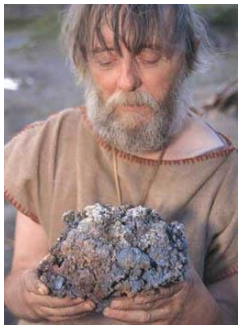
Gold, 6000 BCE

Copper, 4200 BCE

Silver, 4000 BCE

Tin, 1750 BCE

Lead, 3500 BCE



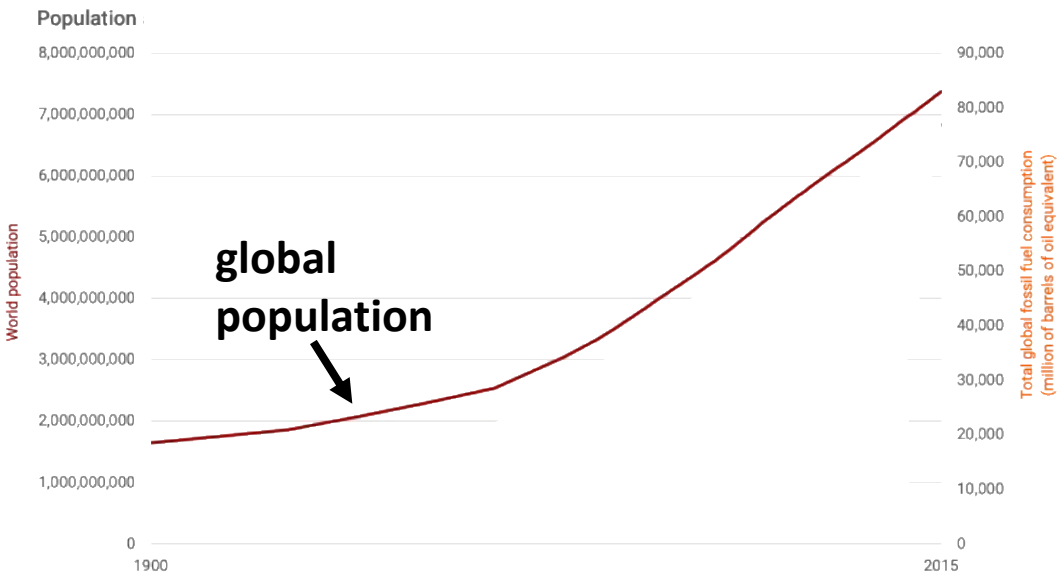
Iron, 1500 BCE

Mercury, 750 BCE

These seven "Metals of Antiquity" were critical for the development of human civilization.

Where are we as a society?

Since 1900, global population, economic activity and prosperity have increased significantly.



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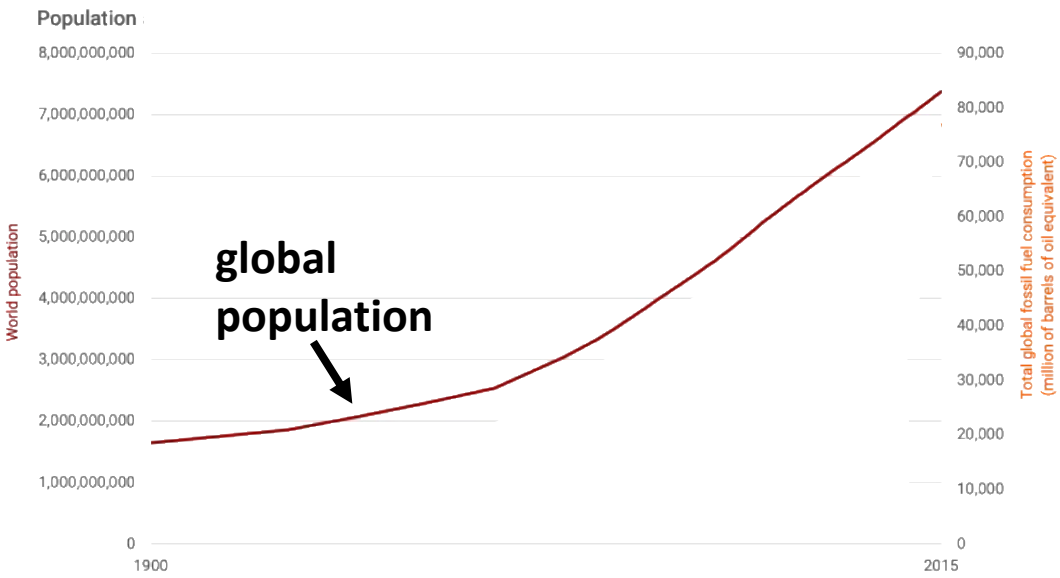
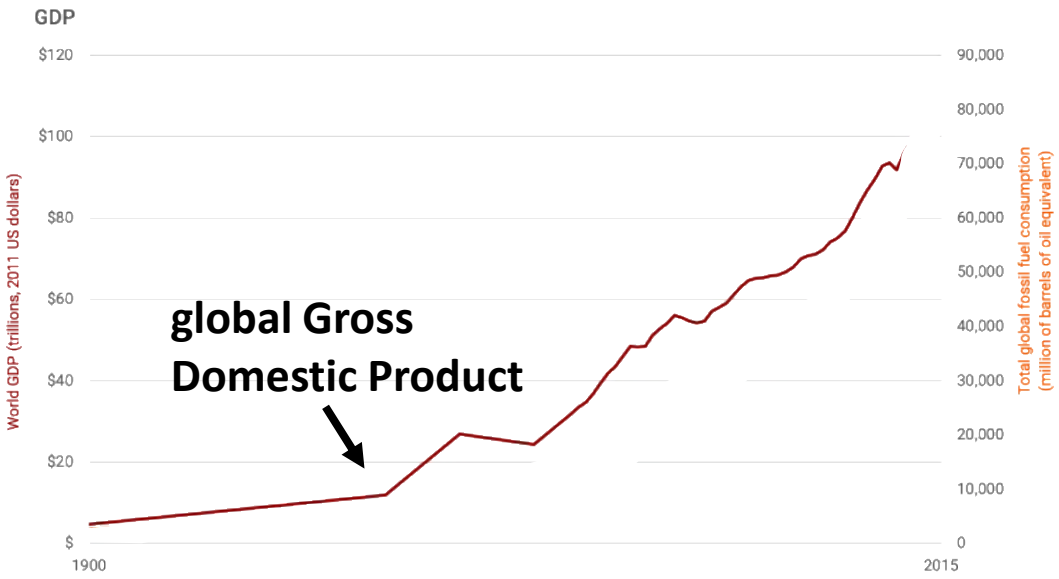
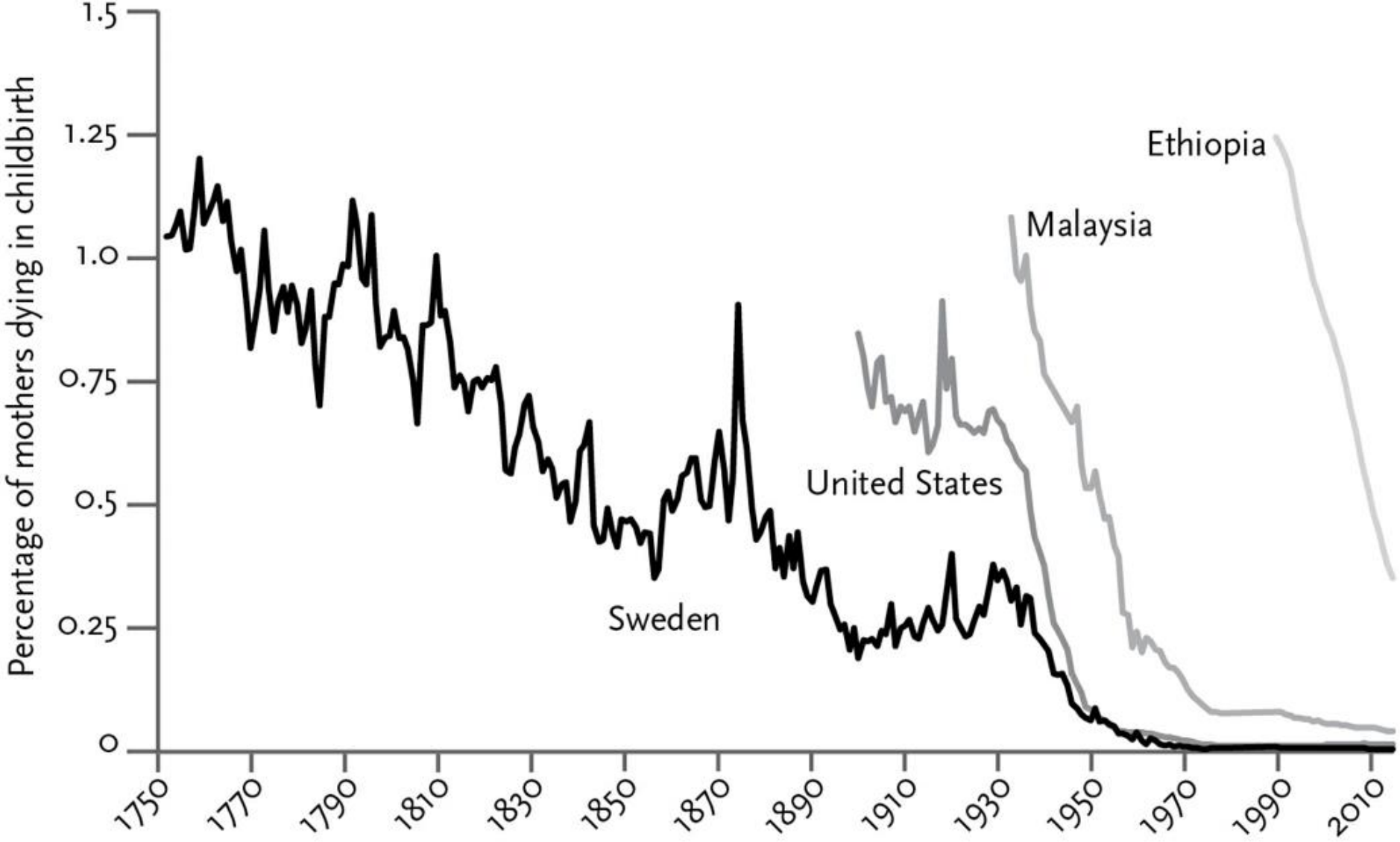


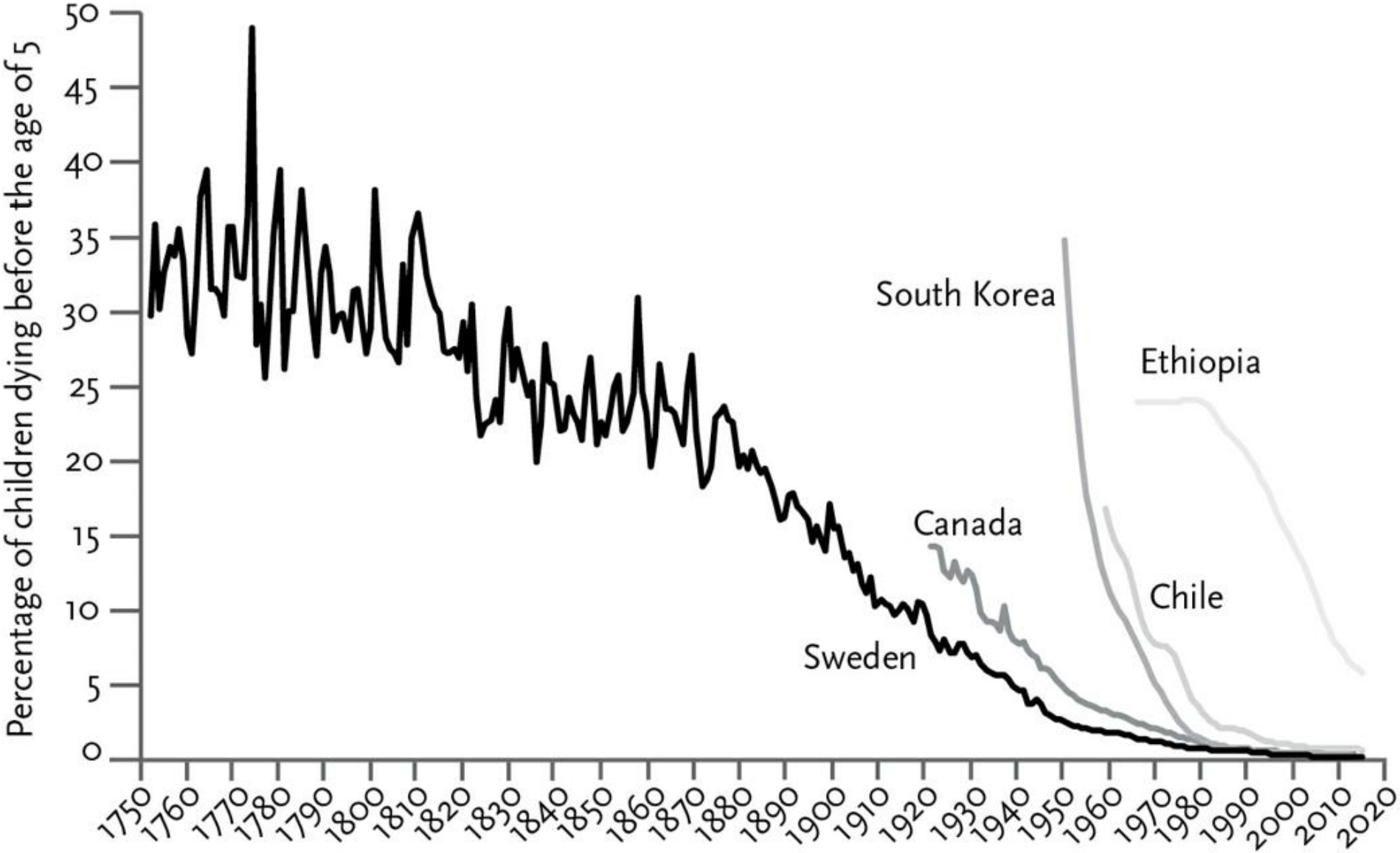


Life Expectancy

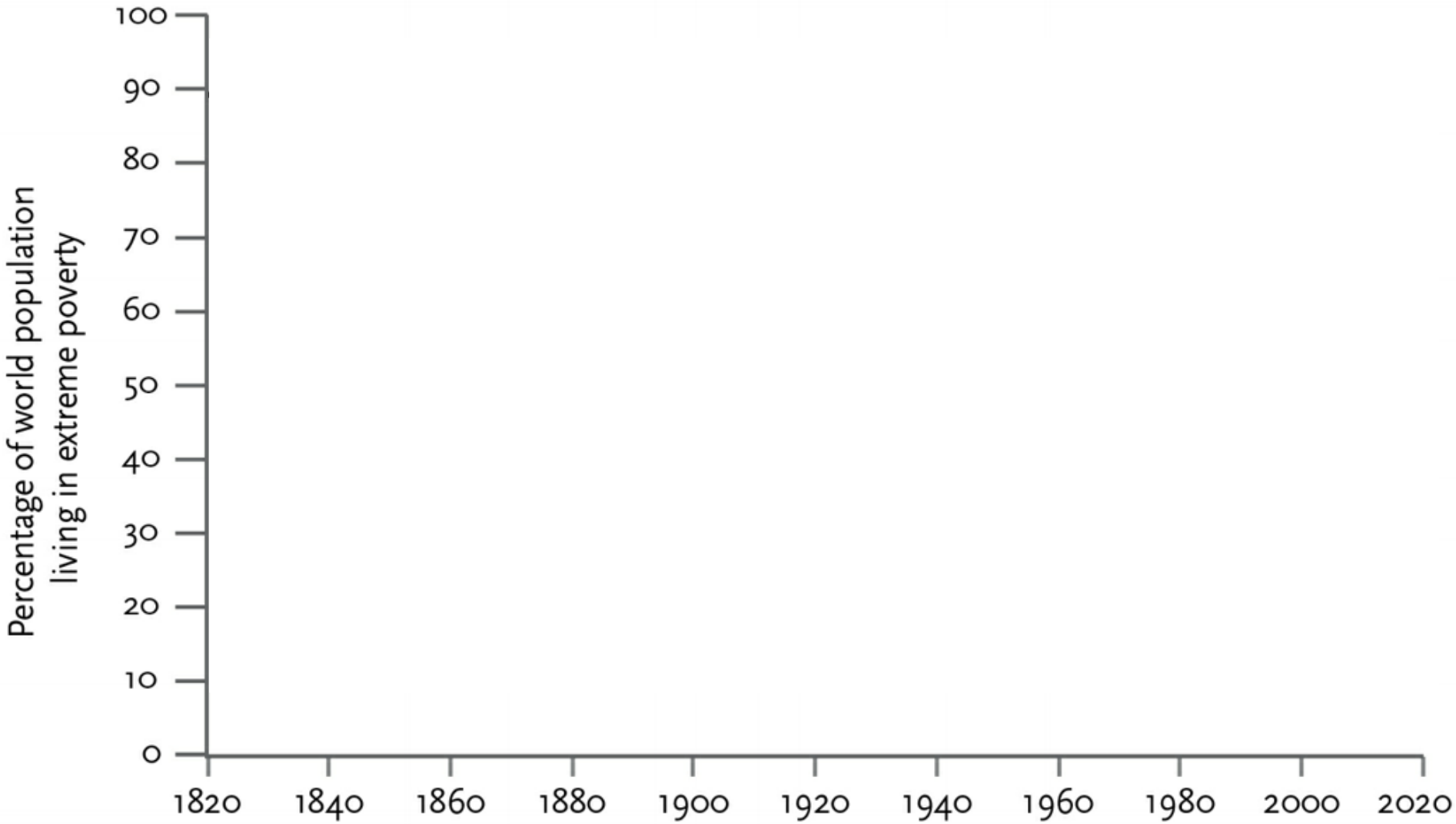
Maternal Mortality, 1751-2013



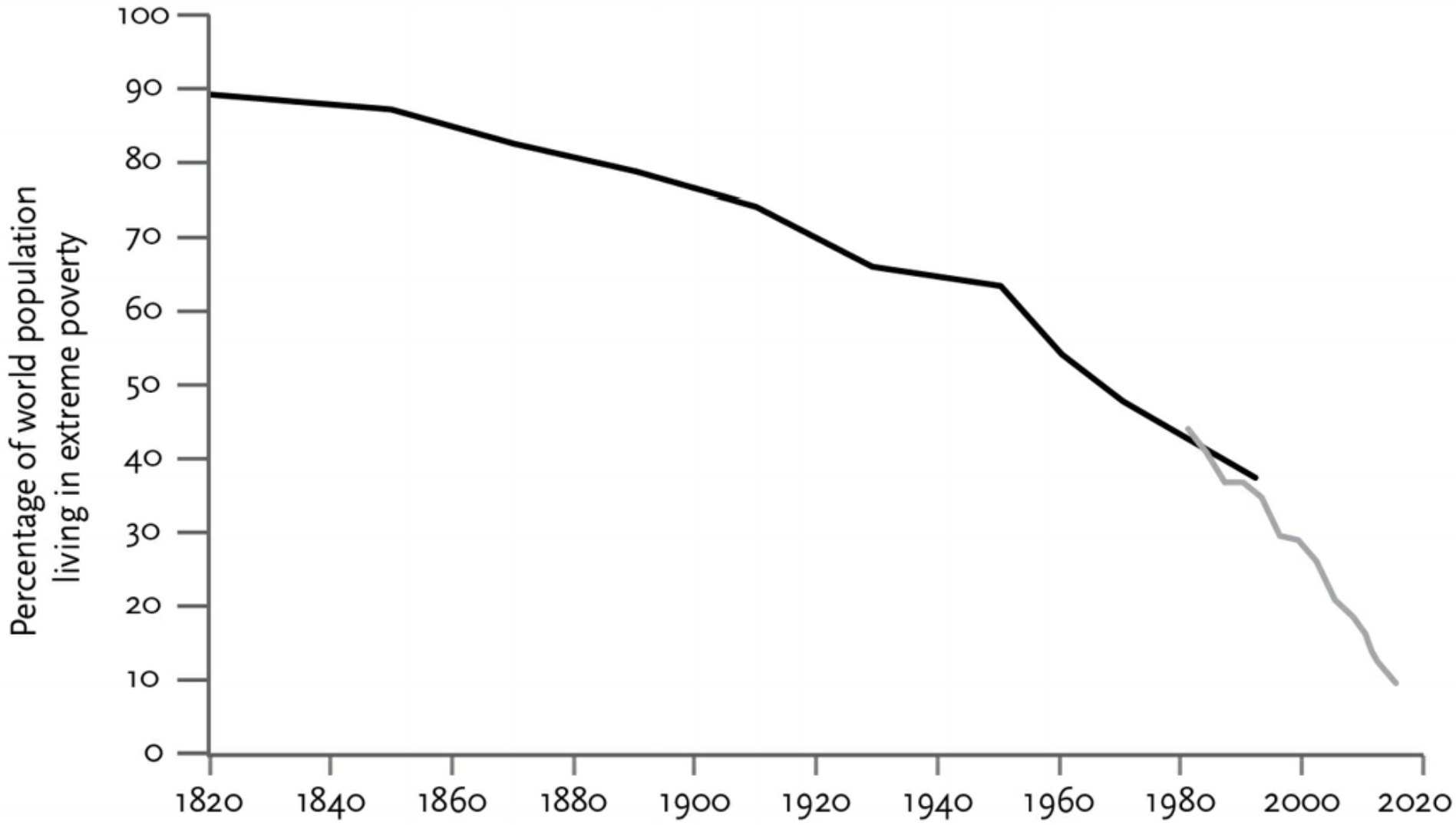
Child Mortality, 1751-2013



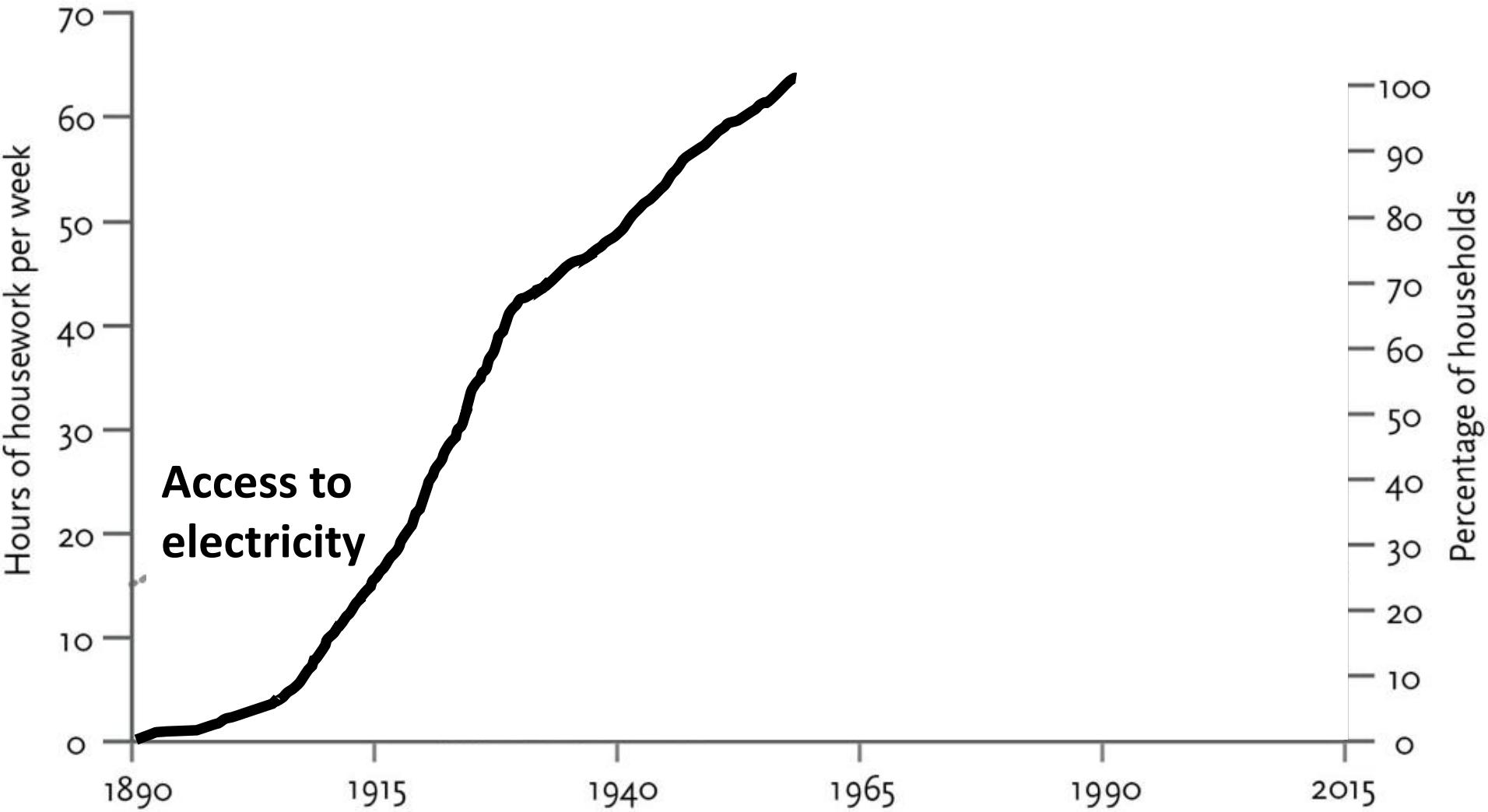
World Population Living in Extreme Poverty



World Population Living in Extreme Poverty



Resources consumption and discretionary ("free") time



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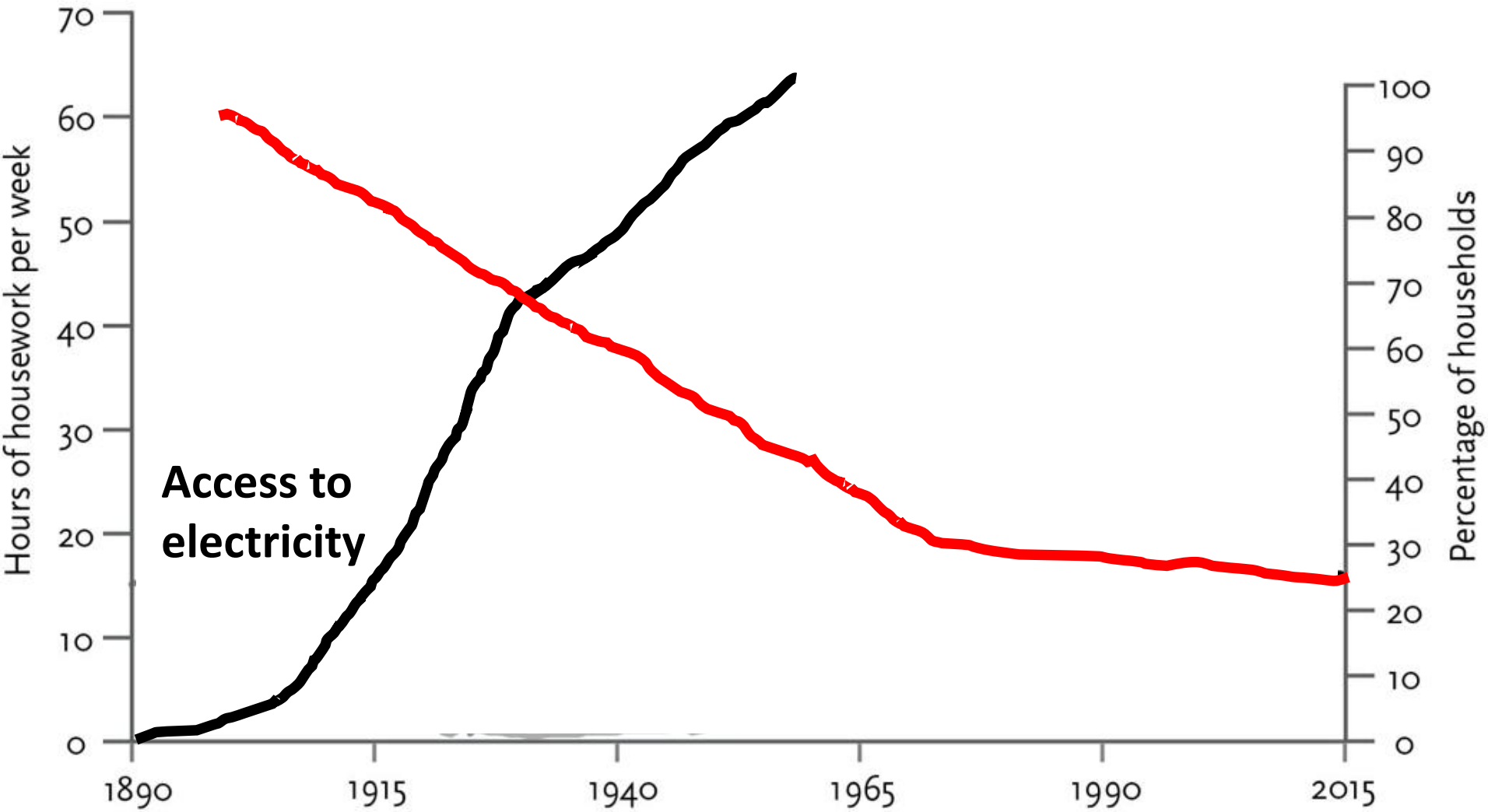
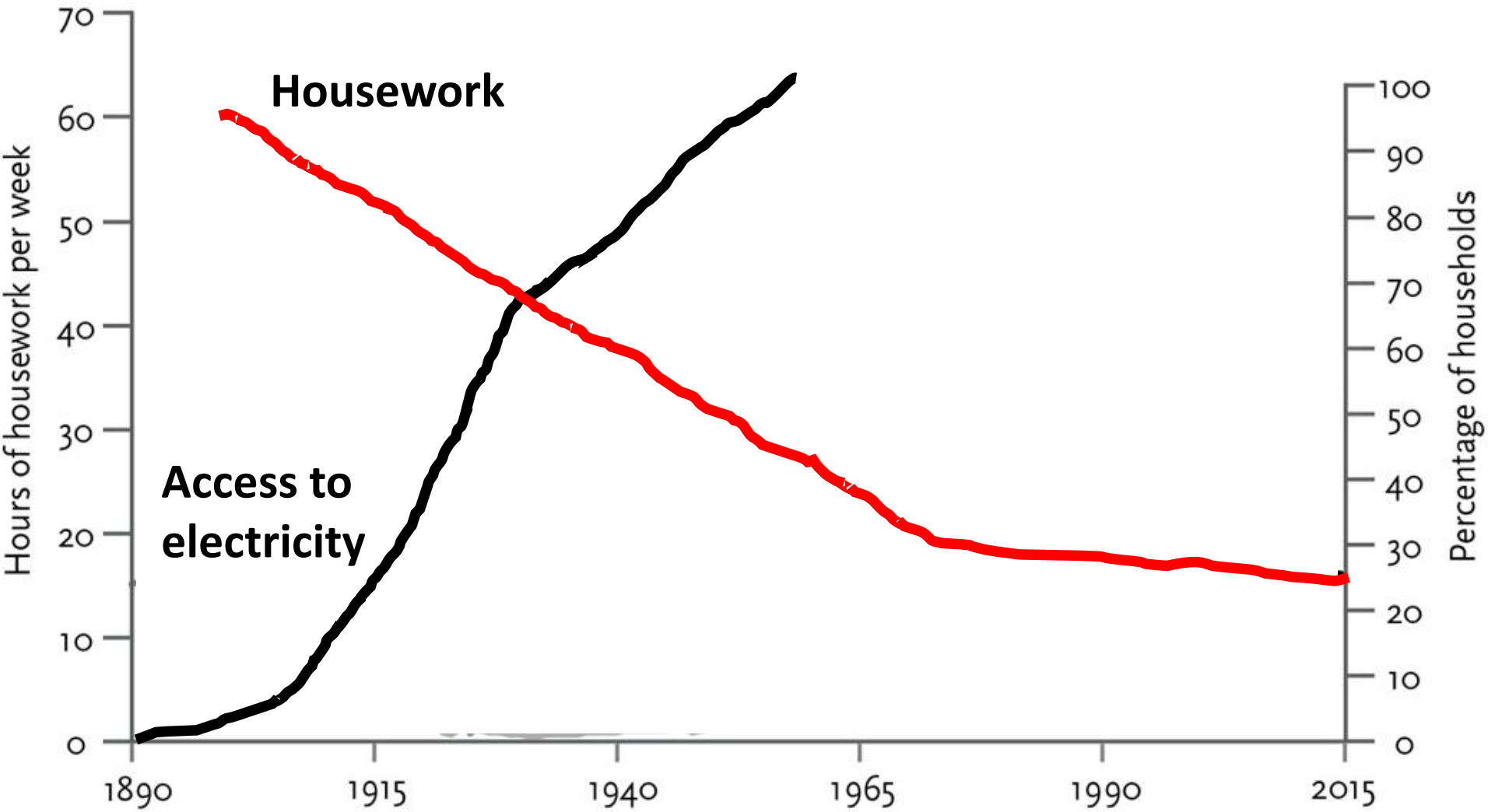
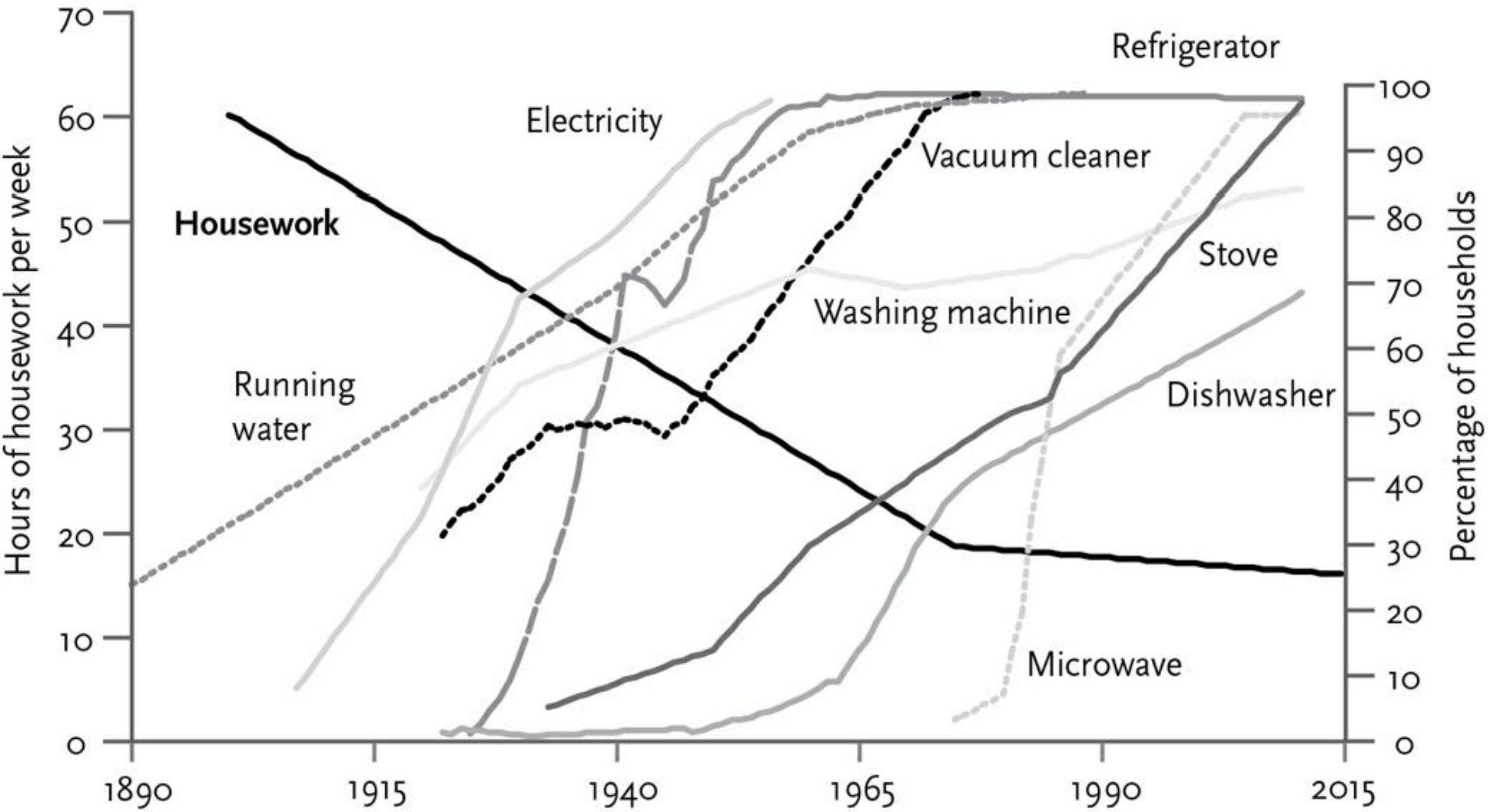


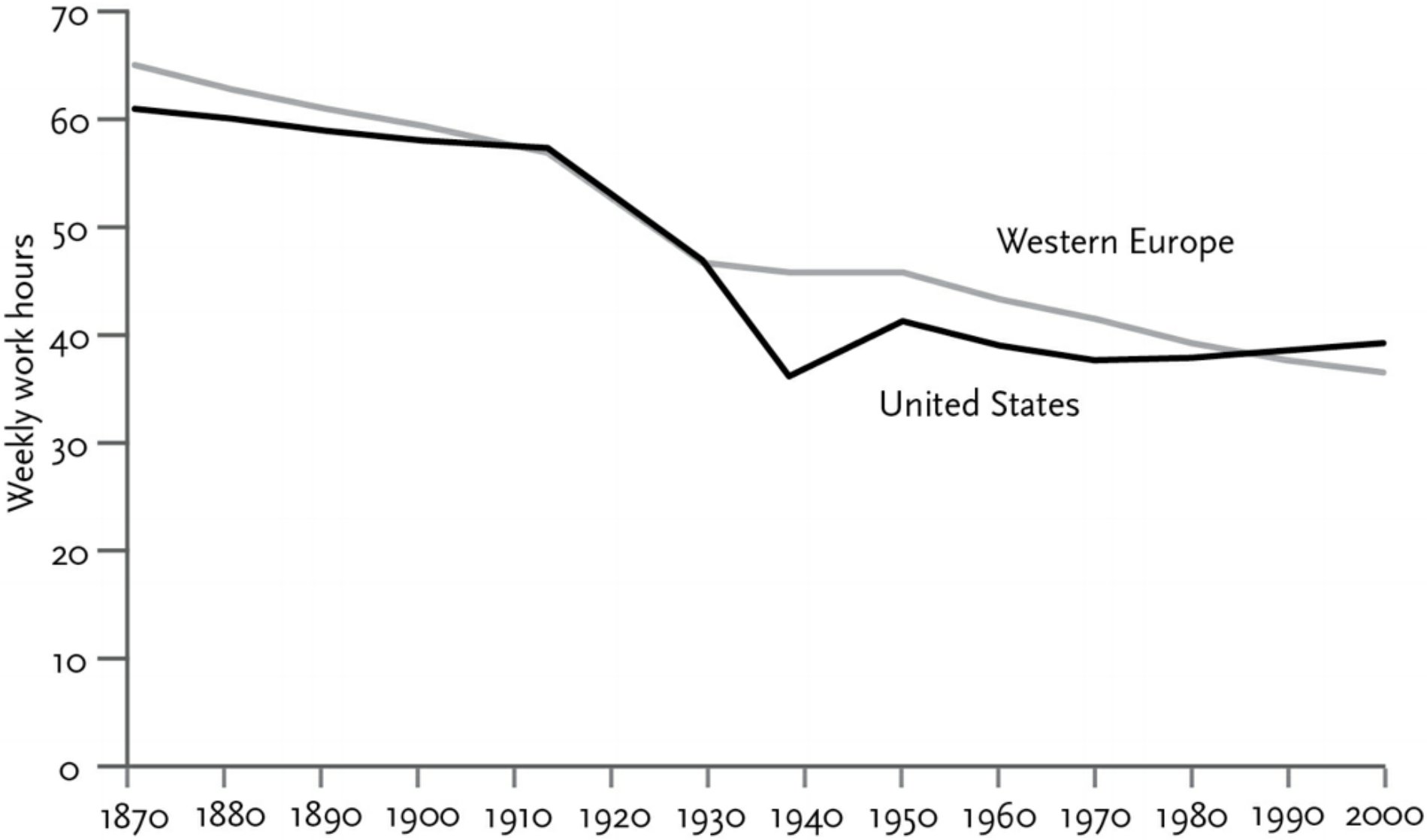
Resources consumption and discretionary ("free") time



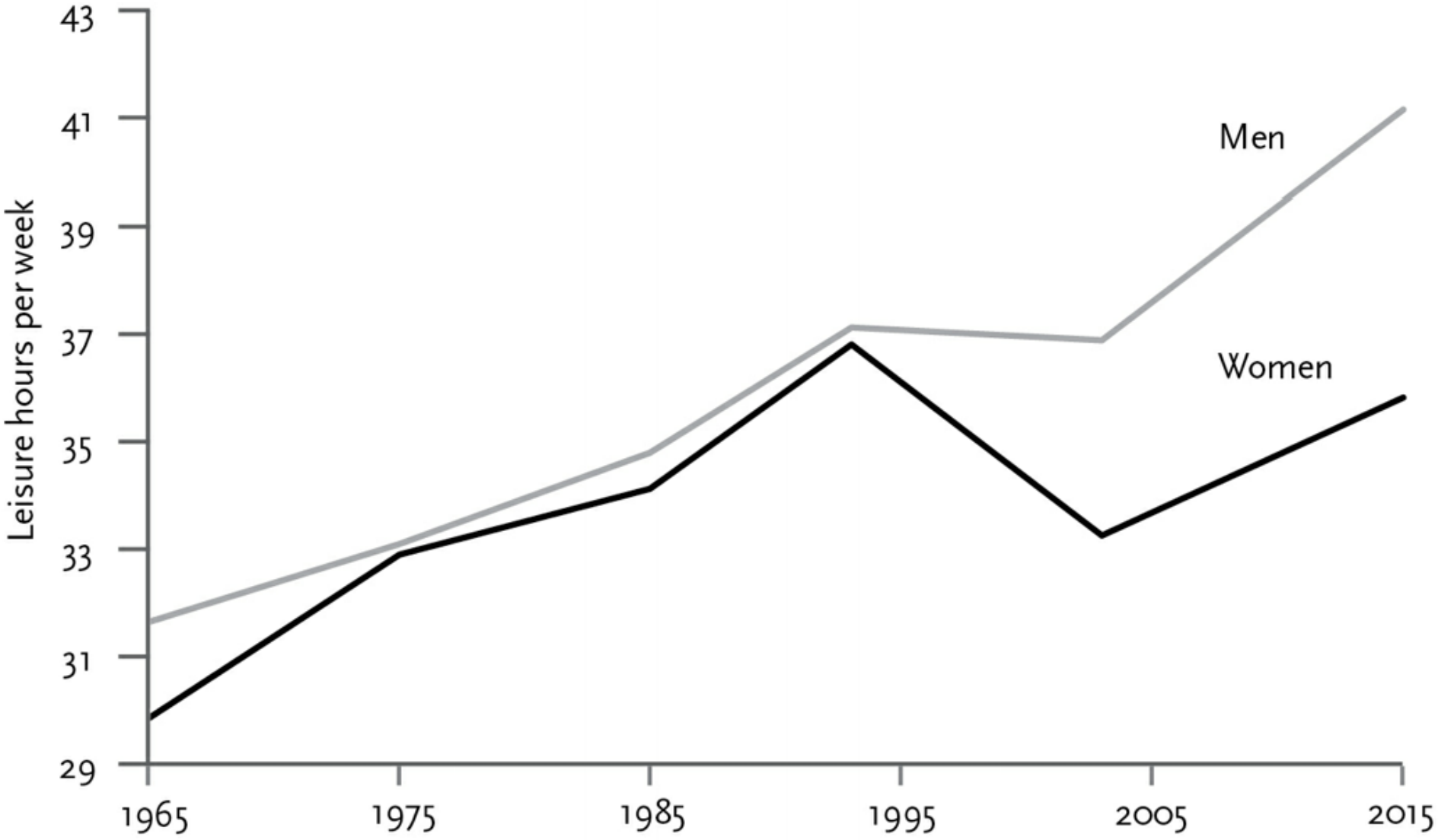
Inventions and discretionary time, 1890-2015



Weekly work hours, 1870-2000



Leisure time in the U.S., 1965-2015



Corbis/Rick Dalton

With manual labor and manual tools, it took 25 men a full day (dawn to dusk) to harvest and thresh a ton of grain, **compared to one person on a GPS-guided, air conditioned, lumbar-seat-heated combine (the big green tractor) that does this in 6 minutes.**

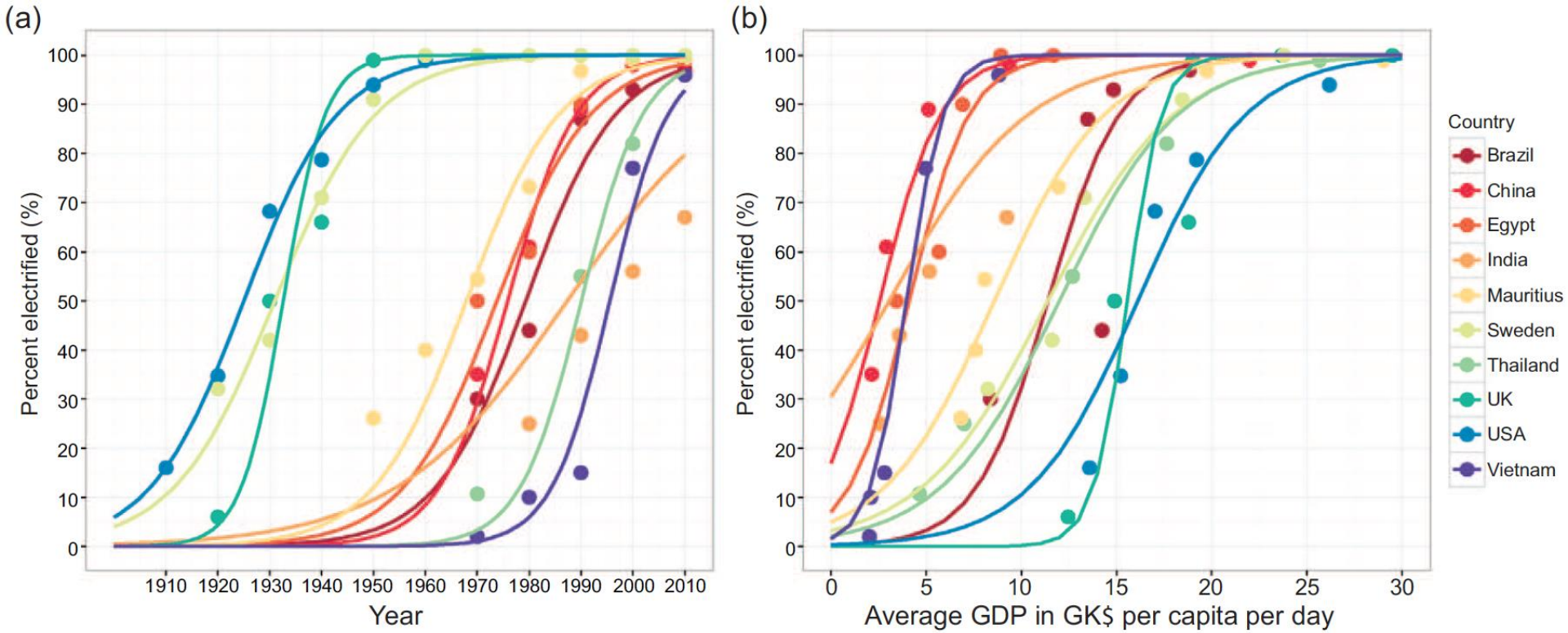


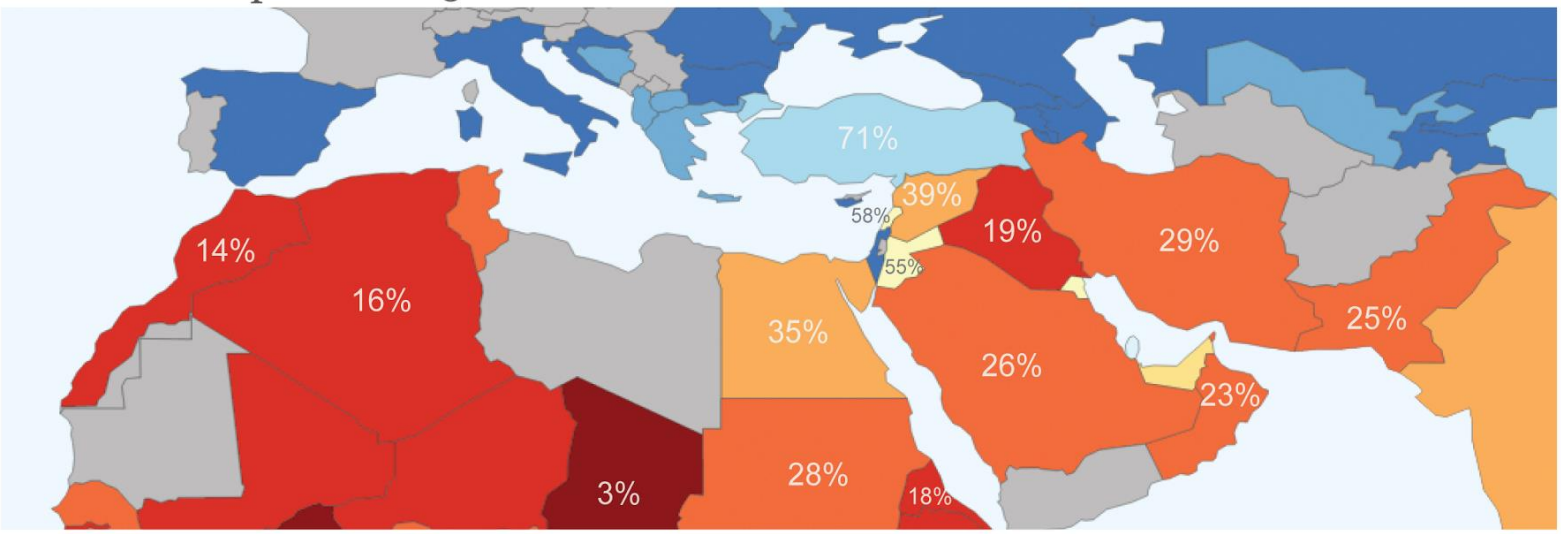
Figure 1. S-curve fits to historical electricity access data by year and average income level in international Geary–Khamis dollars (GK$).


I Qatar.net
1980
Credits: www.facebook.com/OldQatar1

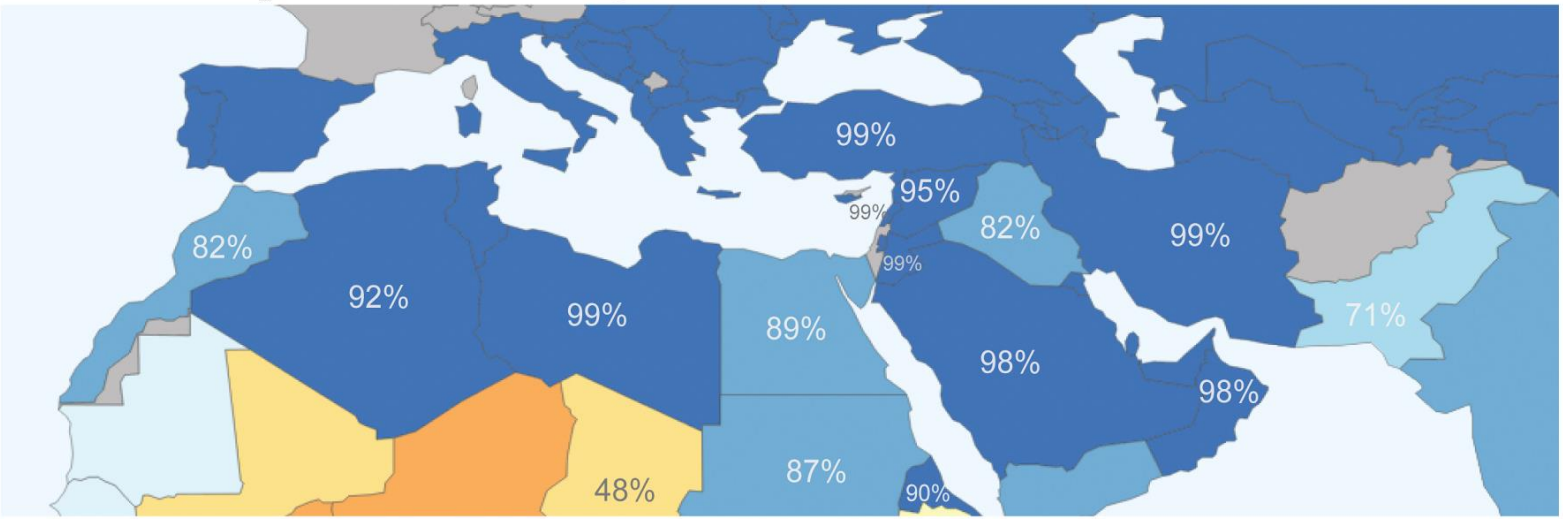

2020

Literacy Rate in the Middle East and Northern Africa, by Age Group – by Max Roser

Literacy Rate of the Population 65 and older



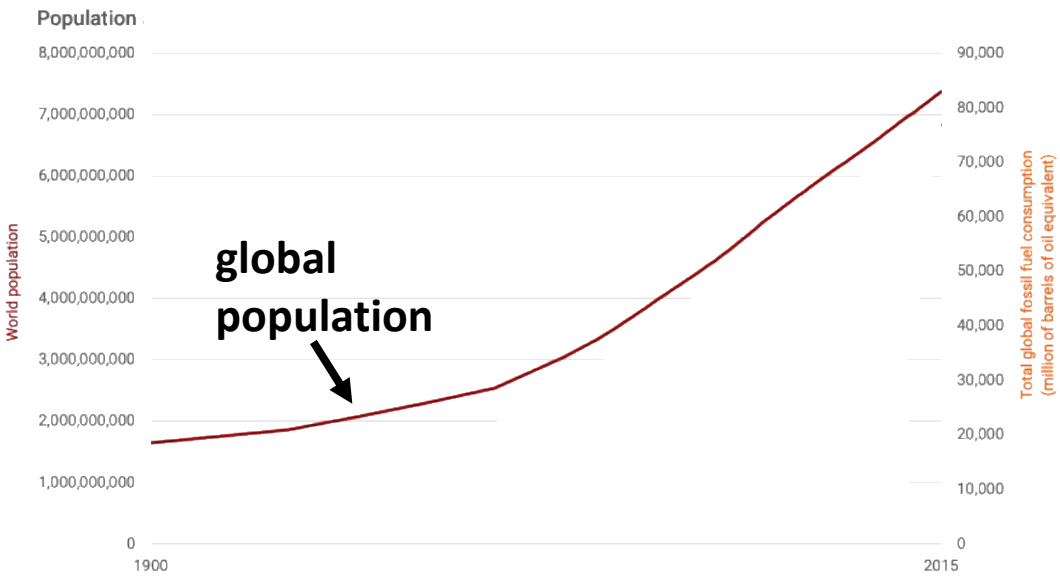
Literacy Rate of the Population between 15 and 24

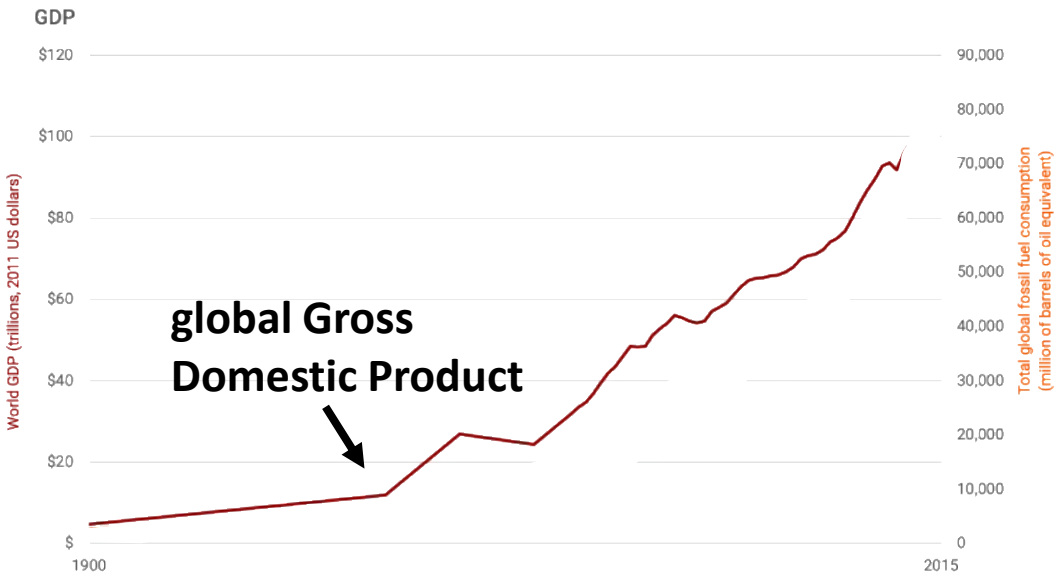


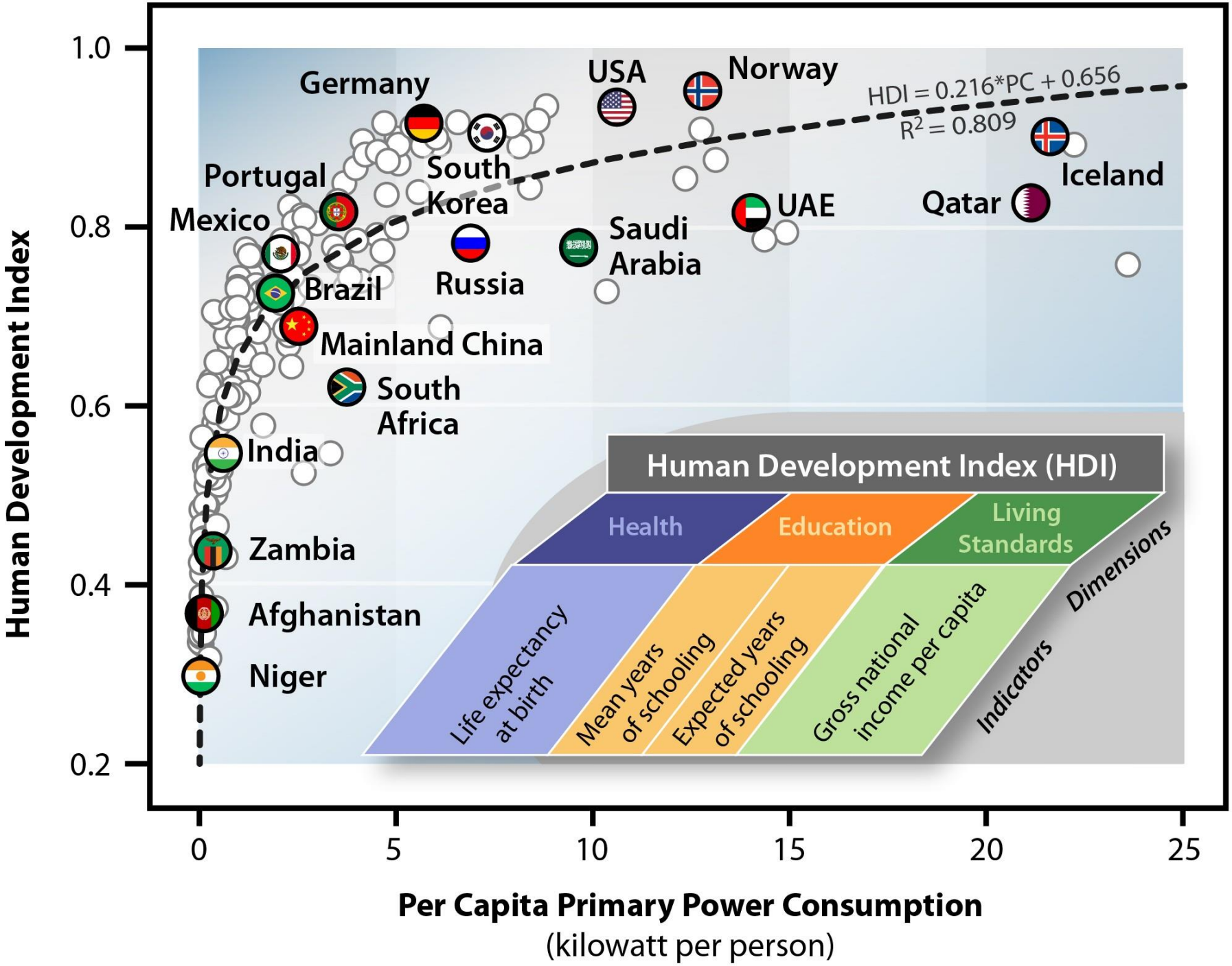
Data source: UNESCO.

The interactive data visualisation is available at OurWorldinData.org. There you find the raw data and more visualisations on this topic.

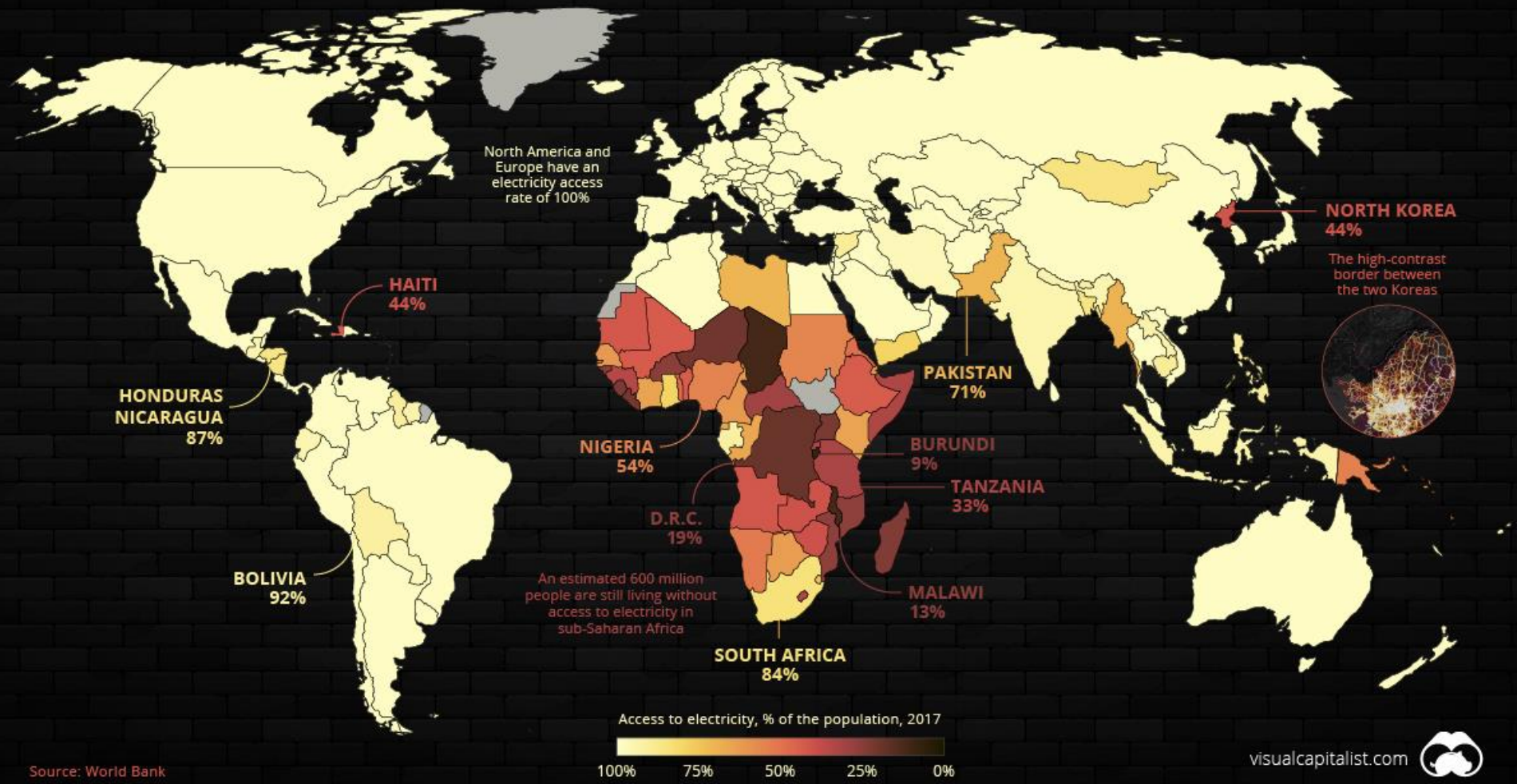
Since 1900, global population, economic activity and prosperity have increased significantly.






Human Development Index
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
Per Capita Primary Power Consumption
(kilowatt per person)
HDI = 0.216*PC + 0.656
R² = 0.809
Germany
USA
Norway
South Korea
Portugal
Mexico
Iceland
Qatar
UAE
Saudi Arabia
Russia
Brazil
Mainland China
South Africa
India
Zambia
Afghanistan
Niger
Human Development Index (HDI)
Health
Education
Living Standards
Dimensions
Life expectancy at birth
Mean years of schooling
Expected years of schooling
Gross national income per capita
Indicators

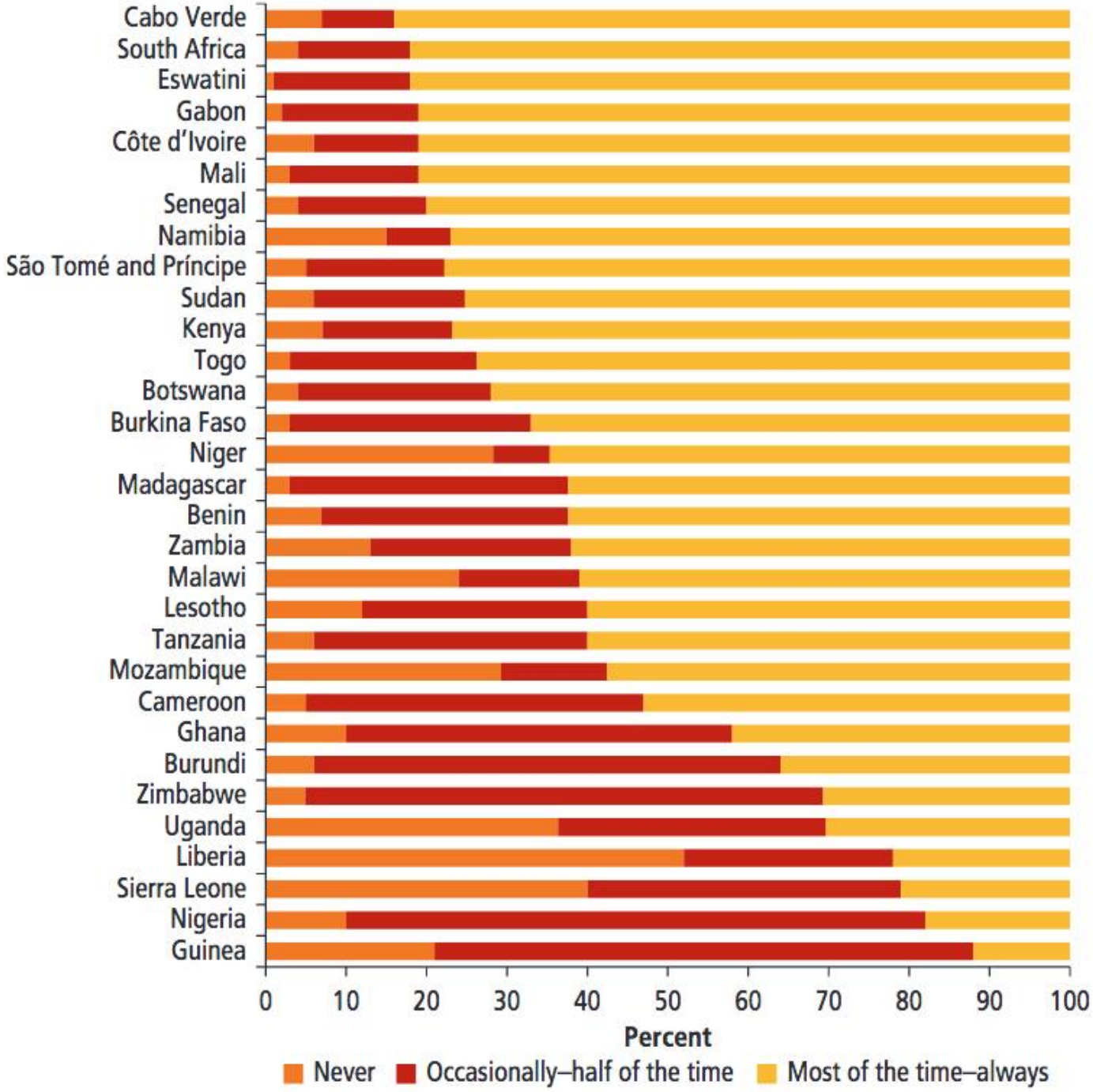
GLOBAL ACCESS TO ELECTRICITY



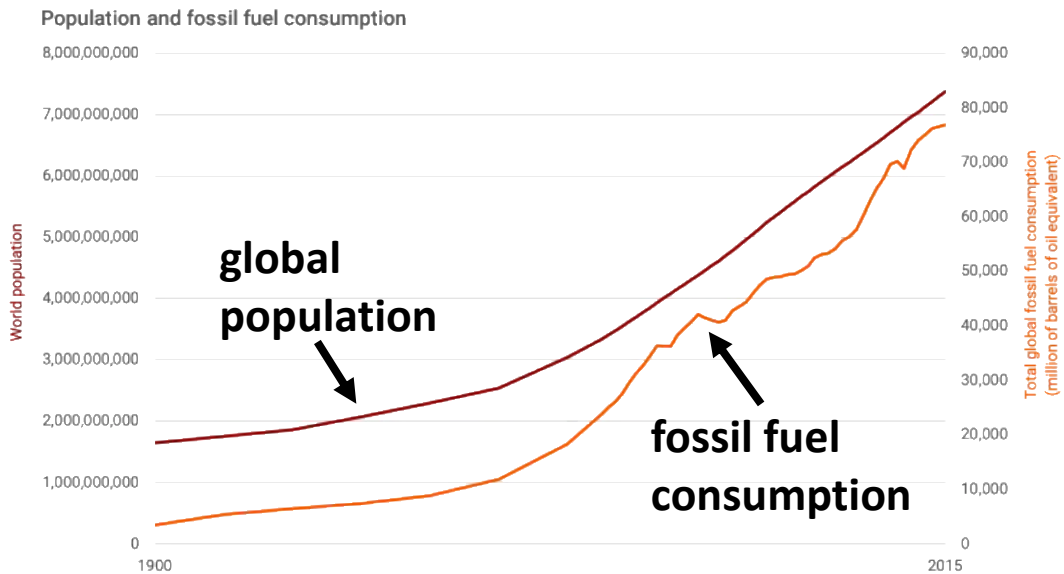
Source: World Bank

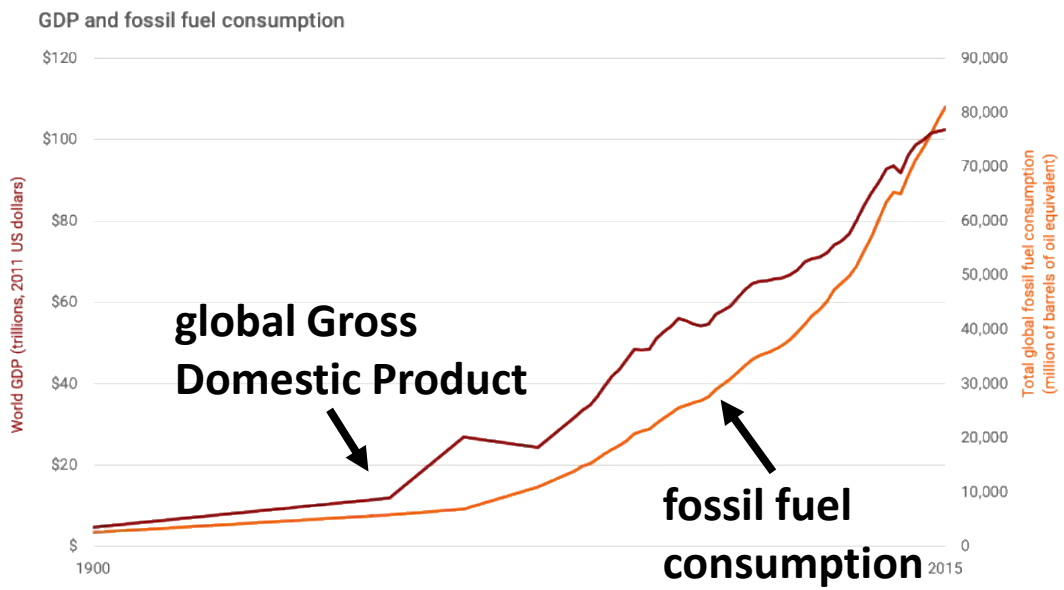
visualcapitalist.com

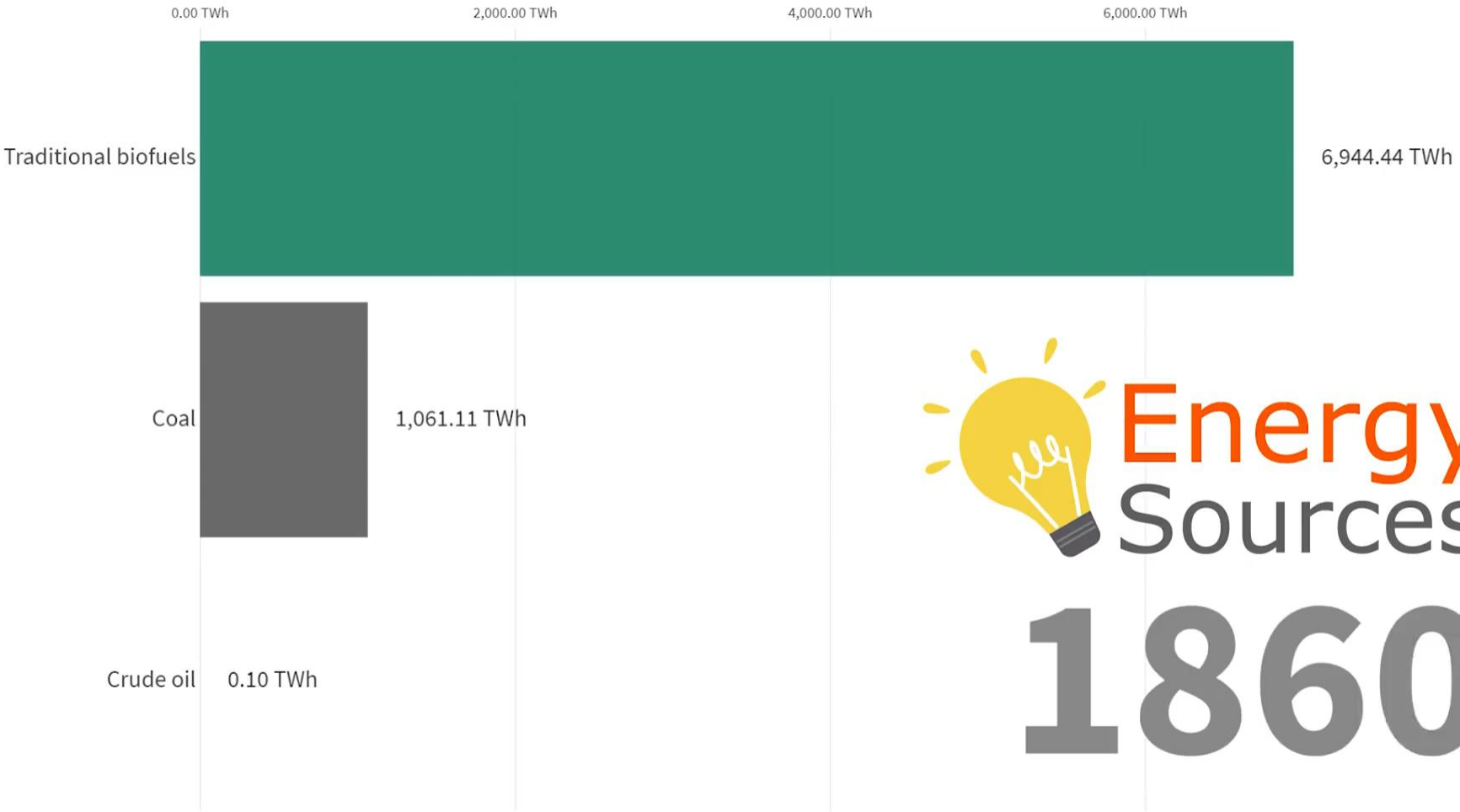
RELIABILITY OF GRID ELECTRICITY IN CONNECTED HOUSEHOLDS



Since 1900, global population and economic activity have increased significantly, along with fossil fuel consumption.





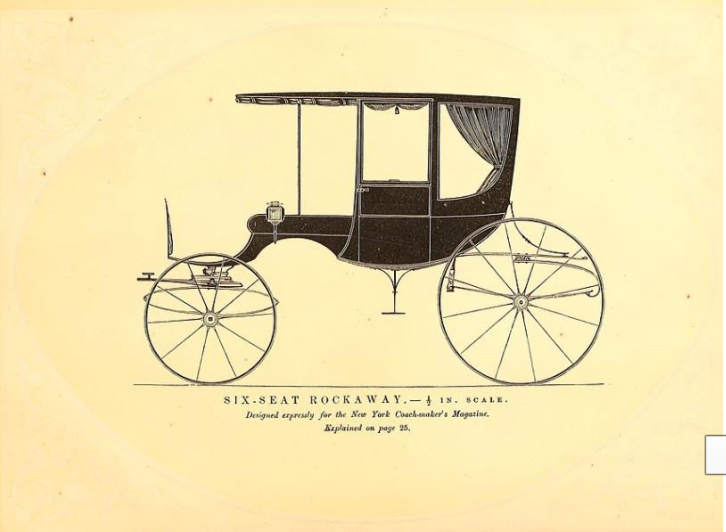


Energy Sources 1860

The positive and negative consequences of prosperity?

Easter morning 1900: 5th Ave, New York City. Spot the automobile.

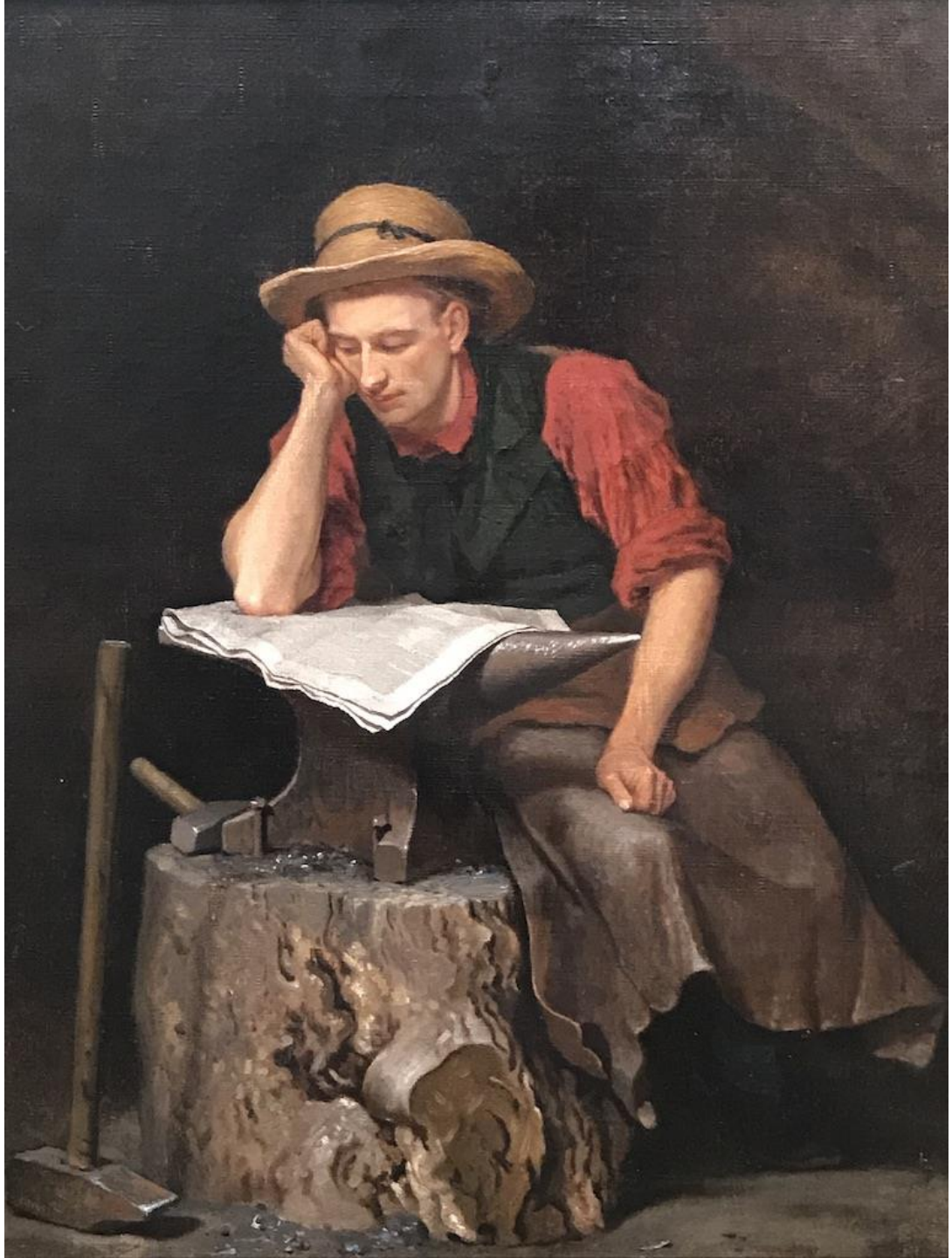
Source: US National Archives.



Easter morning, 1900.
New York City's Fifth Avenue

Easter morning, 1913.
New York City's Fifth Avenue

Source: George Grantham Bain Collection.



The Nineteenth Century, 1868

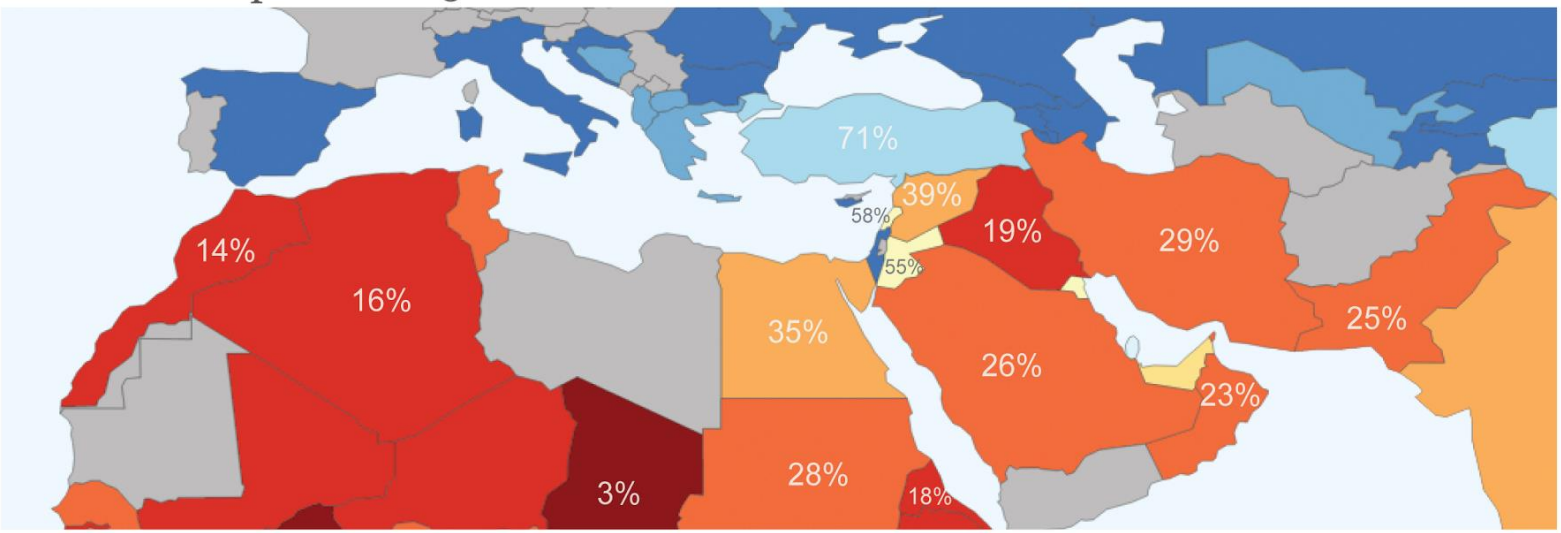
Frank Blackwell Mayer
(b. 1827, Baltimore, 1827;
d. 1899 Annapolis)

The leather-aproned blacksmith was a potent American symbol of noble handcrafts during the increasingly mechanized 19th century. His tools lie idle, and his anvil is nearly covered by an open newspaper, that all important vehicle for mass dissemination of information.

Our World in Data

Literacy Rate in the Middle East and Northern Africa, by Age Group – by Max Roser

Literacy Rate of the Population 65 and older



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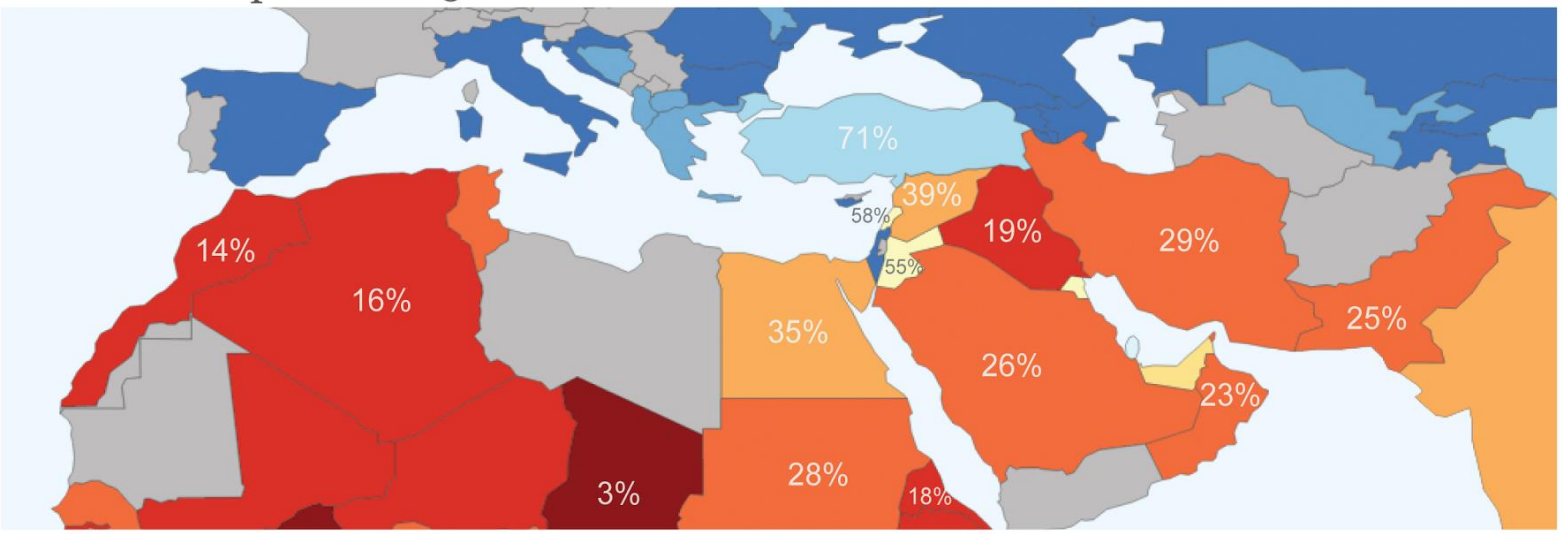
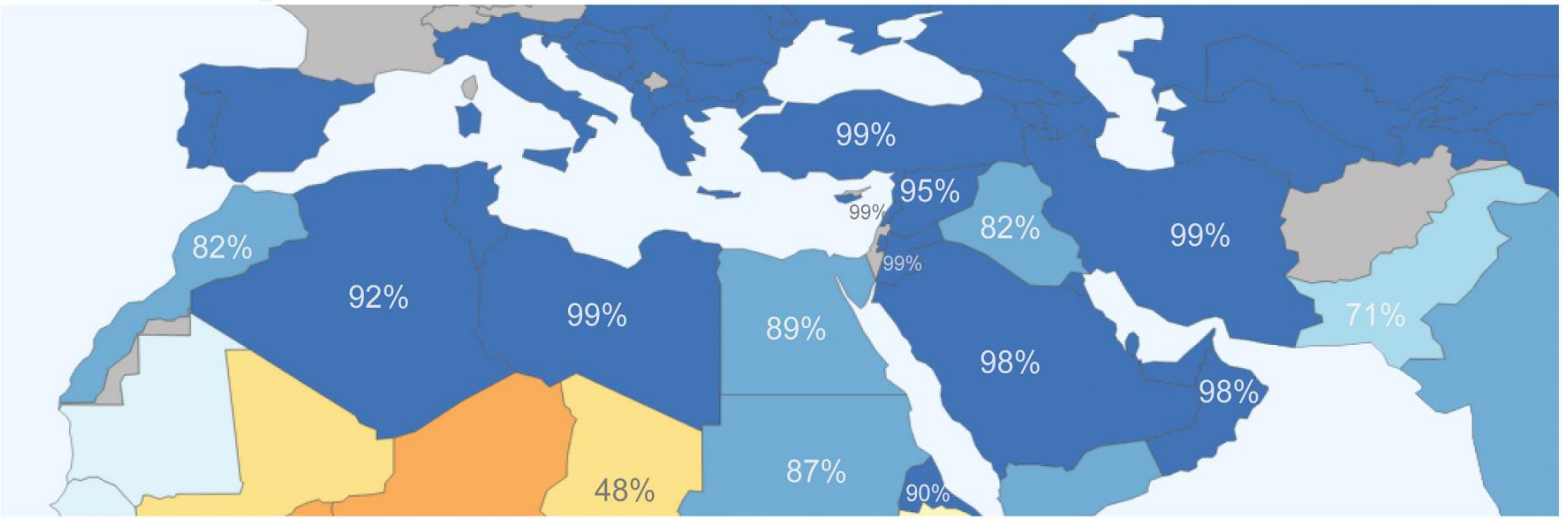


Literacy Rate of the Population between 15 and 24



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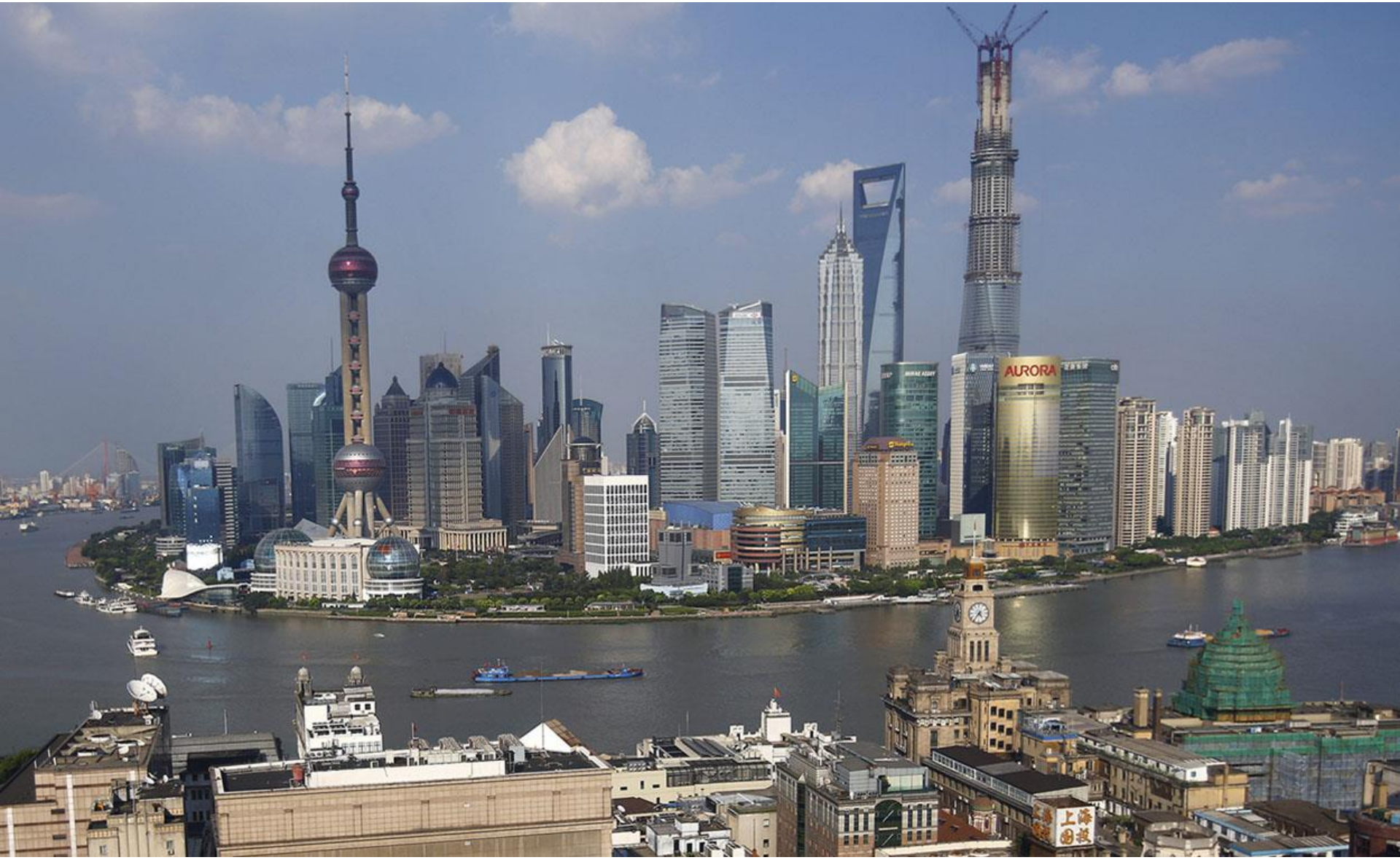
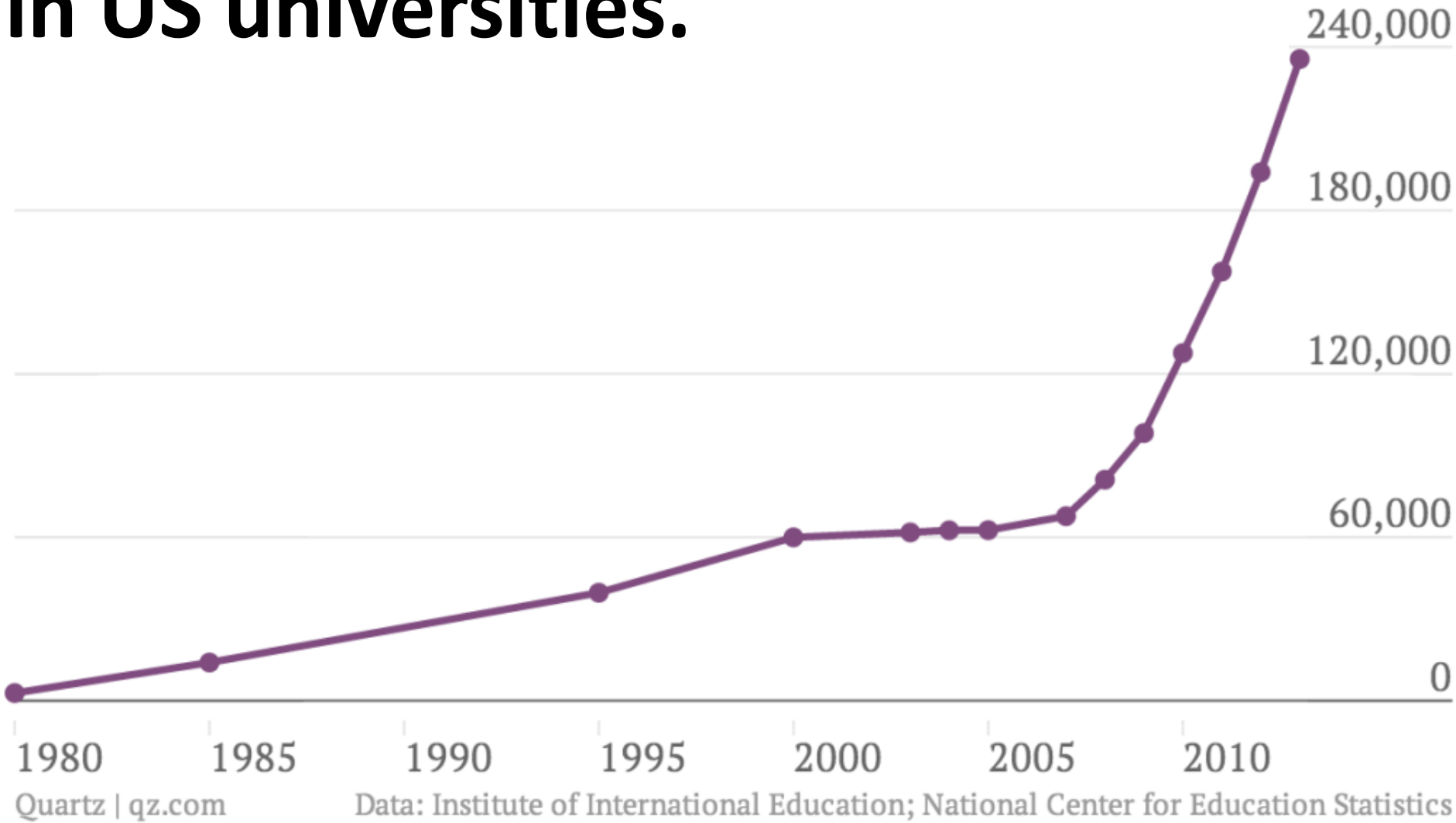
Shanghai 1987

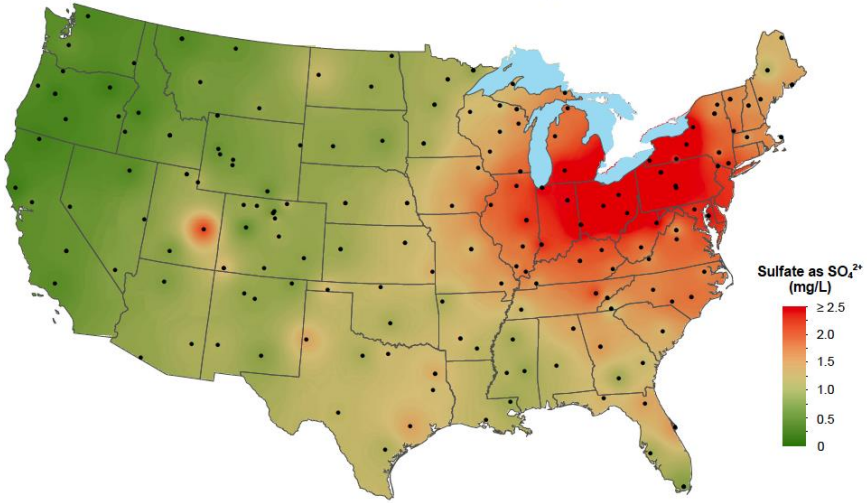
Shanghai 2013



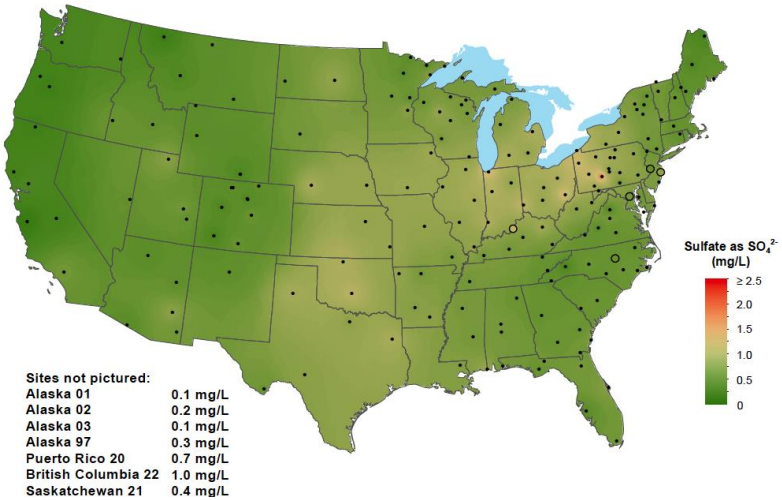
Chinese students enrolled in US universities.



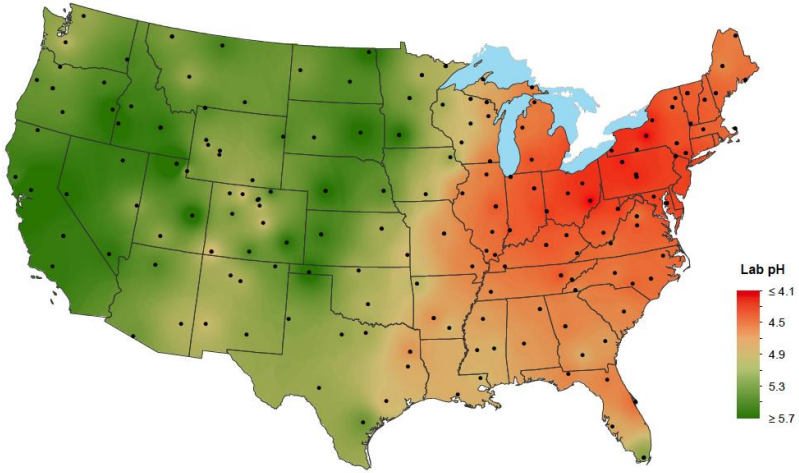
Sulfate ion concentration, 1990



Sulfate ion concentration, 2013



Hydrogen ion concentration as pH from measurments made at the Central Analytical Laboratory, 1990



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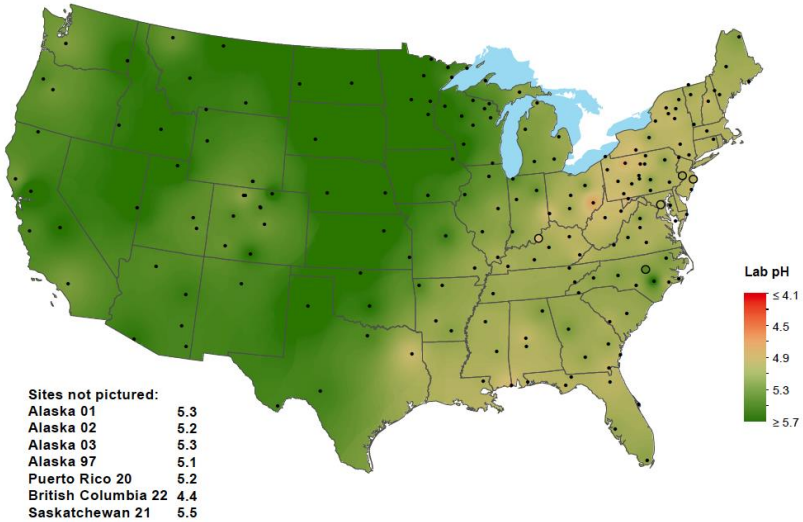
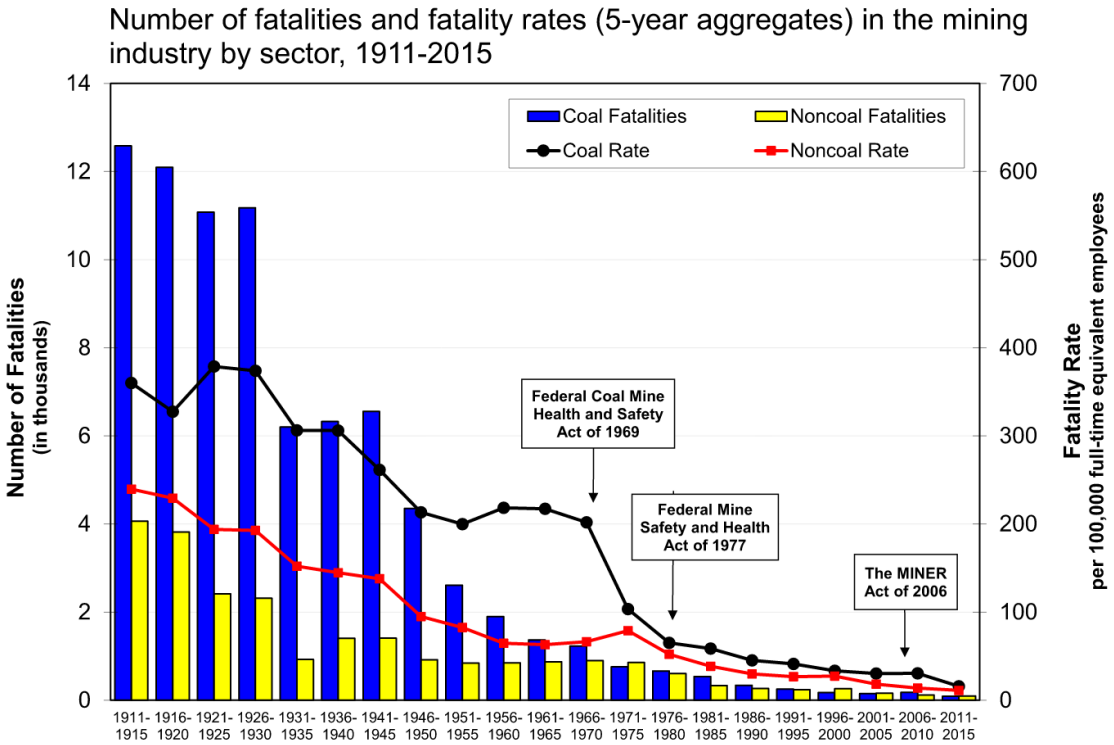


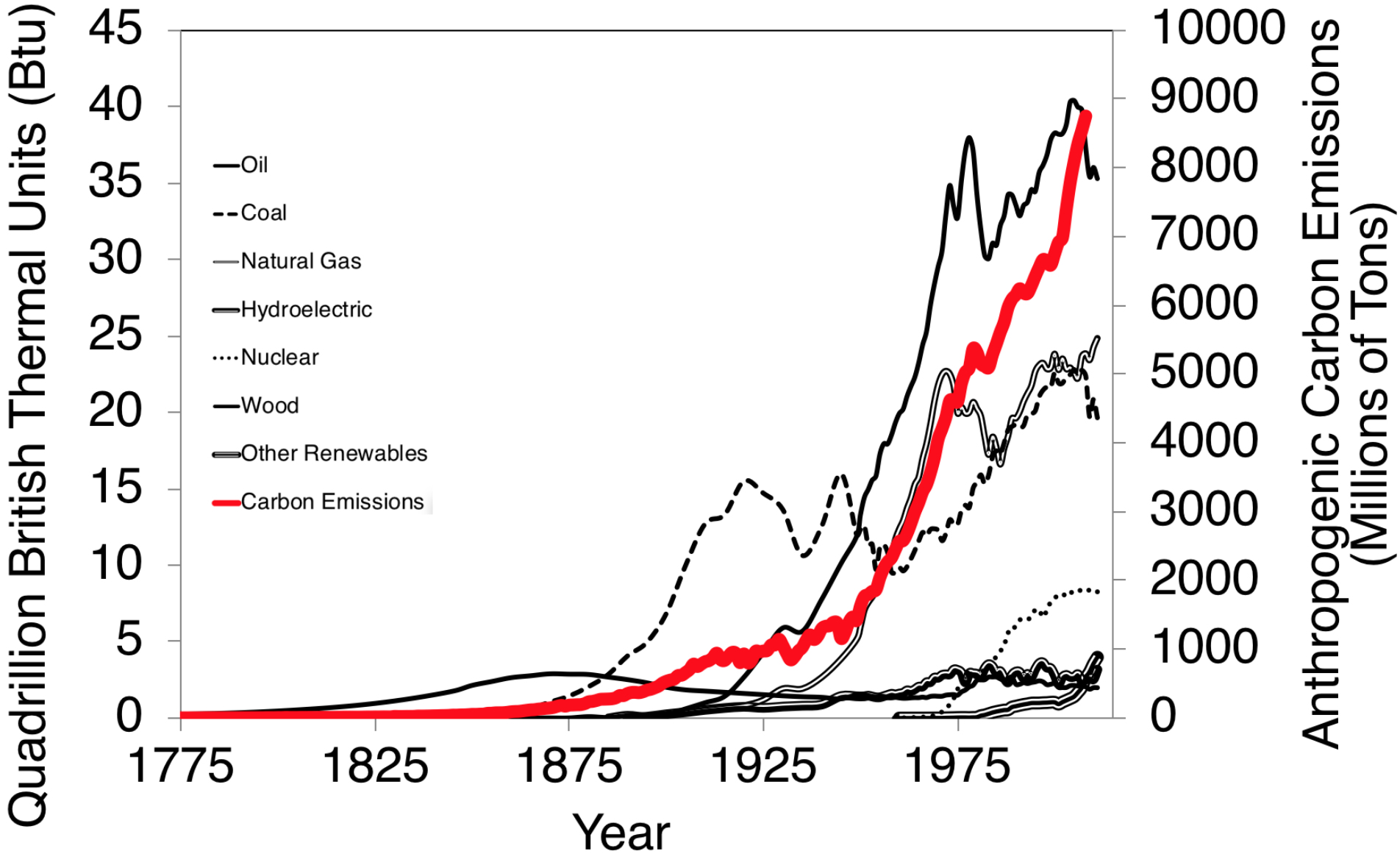


NOTE: Excludes office employees. Noncoal includes metal, nonmetal, stone, and sand & gravel operations. Sand & gravel miners included starting in 1958. Hours for 1911-1923 computed on assumption that weighted average length of workday was 9.36 hours. Full-time equivalent employees (2,000 hours = 1 FTE employee). Data source: USBM and MSHA

U.S. Department of Labor
MSHA
Mine Safety & Health Administration

USA

- 1891: First mining regulations; only ventilation
- 1910: Bureau of Mines established; coal focus; could not enter mines
- 1941: Congress directed inspectors to enter mines
- 1952: Federal Coal Mine Safety Act; required annual inspections of some mines
- 1966: amended to require annual inspections at all mines
- 1977: Mine Safety and Health Act (MSHA)
- 2006: Mine Improvement and New Emergency Response Act (MINER Act); underground mines inspected four times annually


Quadrillion British Thermal Units (Btu)
45
40
35
30
25
20
15
10
5
0
Oil
Coal
Natural Gas
Hydroelectric
Nuclear
Wood
Other Renewables
Carbon Emissions
1775
1825
1875
1925
1975
Year
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Anthropogenic Carbon Emissions (Millions of Tons)


Carbon
Neutrality
Straight Ahead

How can we stay below a

2°C

rise in global temperatures?

Reduce carbon emissions to

0

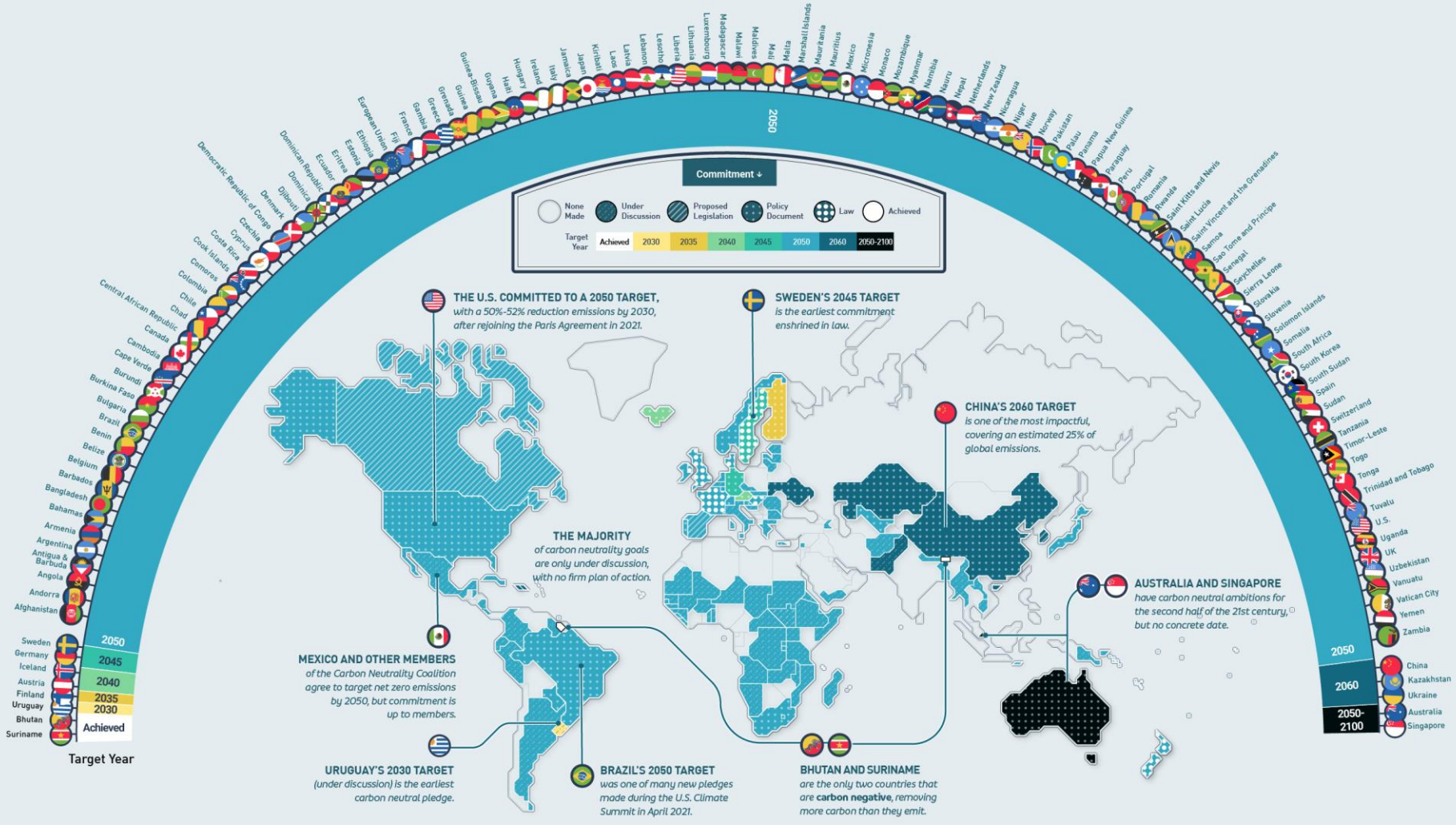
by

2050

RACE TO NET ZERO

CARBON NEUTRAL GOALS BY COUNTRY

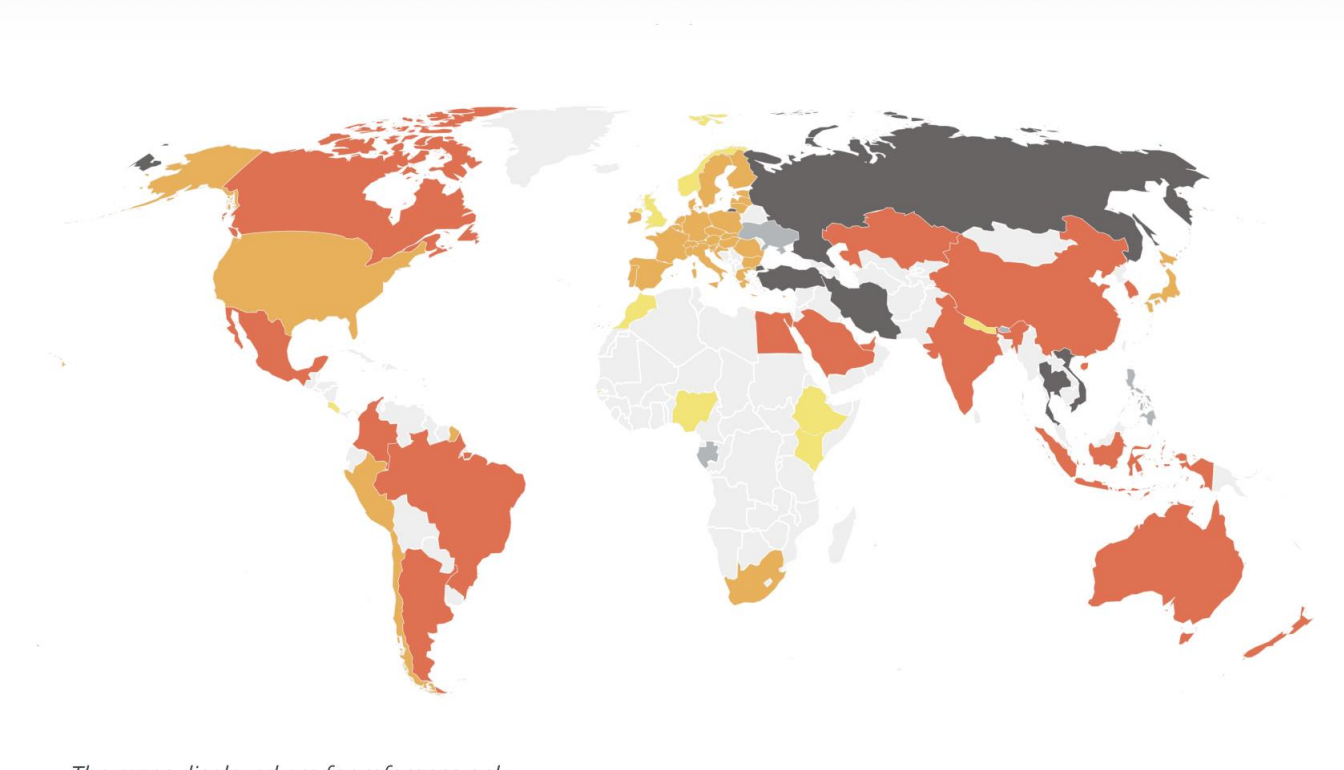
Which countries have made a carbon neutral pledge?
This map breaks down pledges by target year and level of commitment.

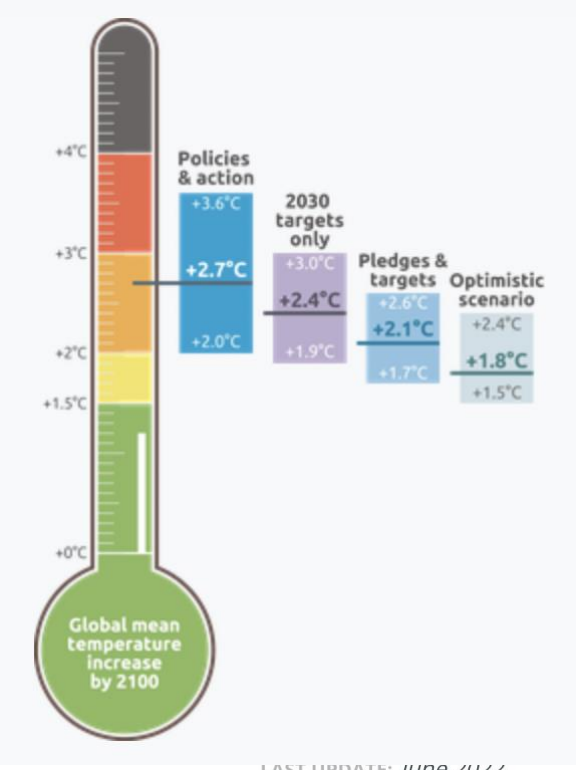


SOURCES: *Energy and Climate Intelligence Unit, Carbon Neutrality Coalition, Climate Action Tracker*

Calls for 100% of U.S. primary energy to be replaced with renewable energy resources including wind turbines, solar panels and grid-scale battery storage,

Progress toward targets.





The maps displayed are for reference only.

LAST UPDATE: *June 2022*

CRITICALLY INSUFFICIENT	HIGHLY INSUFFICIENT	INSUFFICIENT	ALMOST SUFFICIENT	1.5°C PARIS AGREEMENT COMPATIBLE

12:44

Done whitehouse.gov AA

WH.GOV

BRIEFING ROOM

FACT SHEET: President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies

APRIL 22, 2021

STATEMENTS AND RELEASES

Building on Past U.S. Leadership, including Efforts by States, Cities, Tribes, an Territories, the New Target Aims at Percent Reduction in U.S. Greenhouse

MENU

12:45

◀ Gmail

An official EU website

European Commission

EN English Search

Climate Action Menu

European Commission > ... >

European Green Deal > 2030 Climate Target Plan

2030 Climate Target Plan

The Commission's proposal EN ••• to cut greenhouse gas emissions by at least 55% by 2030 sets Europe on a responsible path to becoming climate neutral by 2050 EN •••.

Based on a comprehensive impact assessment, the Commission has proposed to increase the EU's ambition on reducing greenhouse gases and set this more ambitious path for the next 10 years. The assessment shows how all sectors of the economy and society can contribute, and sets out the policy actions required to achieve

AA ec.europa.eu

12:53

pewresearch.org

REPORT | JUNE 23, 2020

Two-Thirds of Americans Think Government Should Do More on Climate

Bipartisan backing for carbon capture tax credits, extensive tree-planting efforts

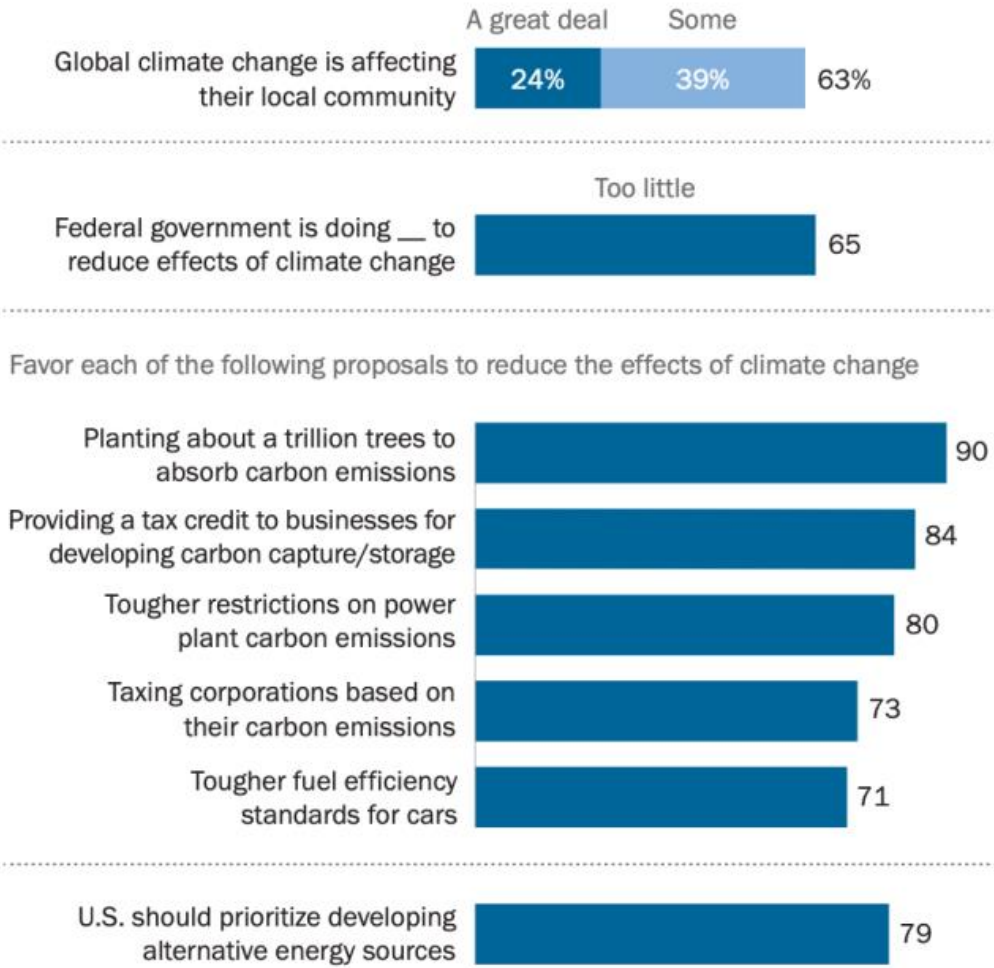
BY ALEC TYSON AND BRIAN KENNEDY

TABLE OF CONTENTS

A nursery manager plants a whitebark pine at Glacier National Park in Montana in September 2019, part of an effort to restore vegetation following a wildfire. (Chip Somodevilla/Getty Images)

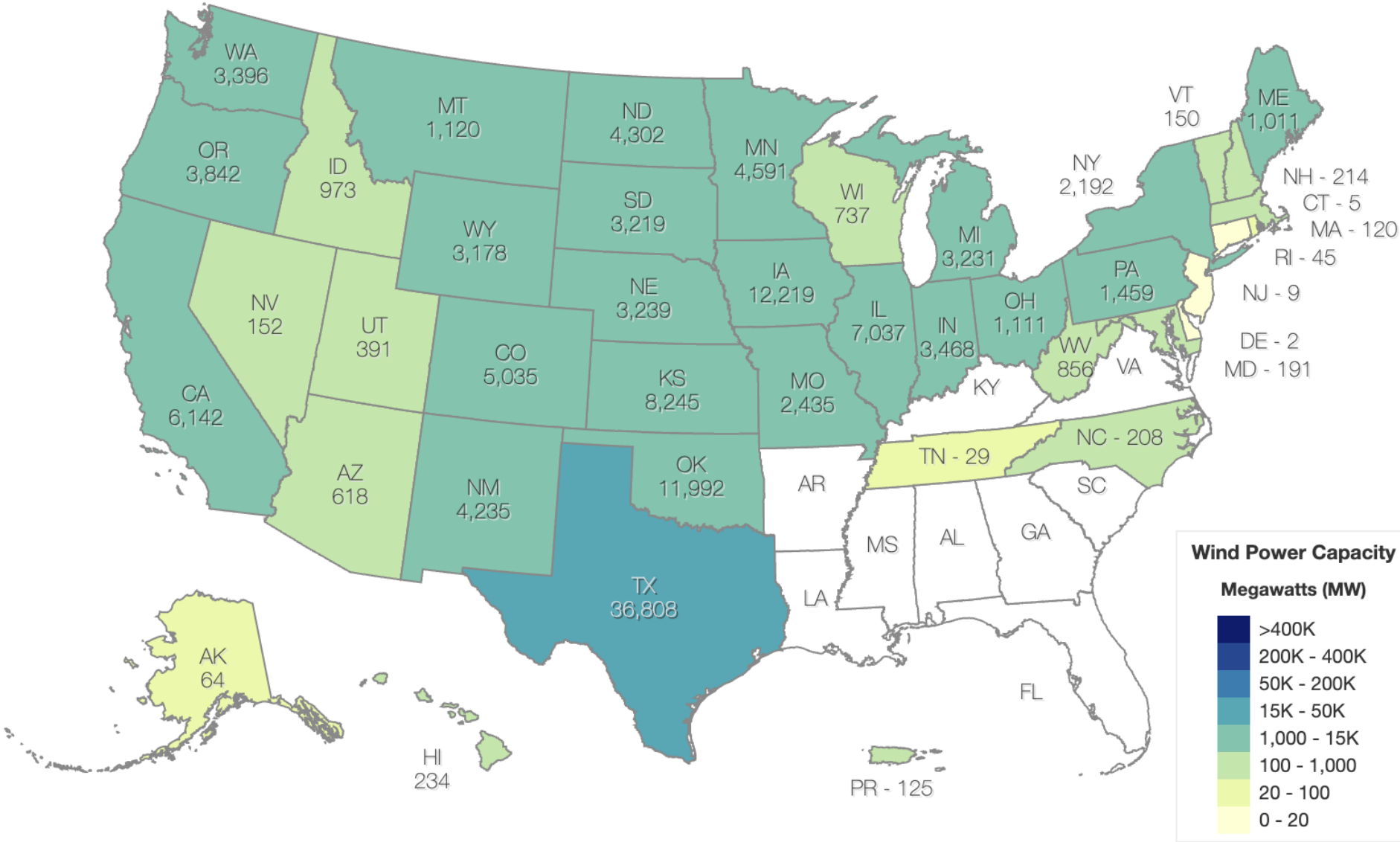
Americans see too little federal action on climate change, back range of policies to reduce its effects

% of U.S. adults who say ...



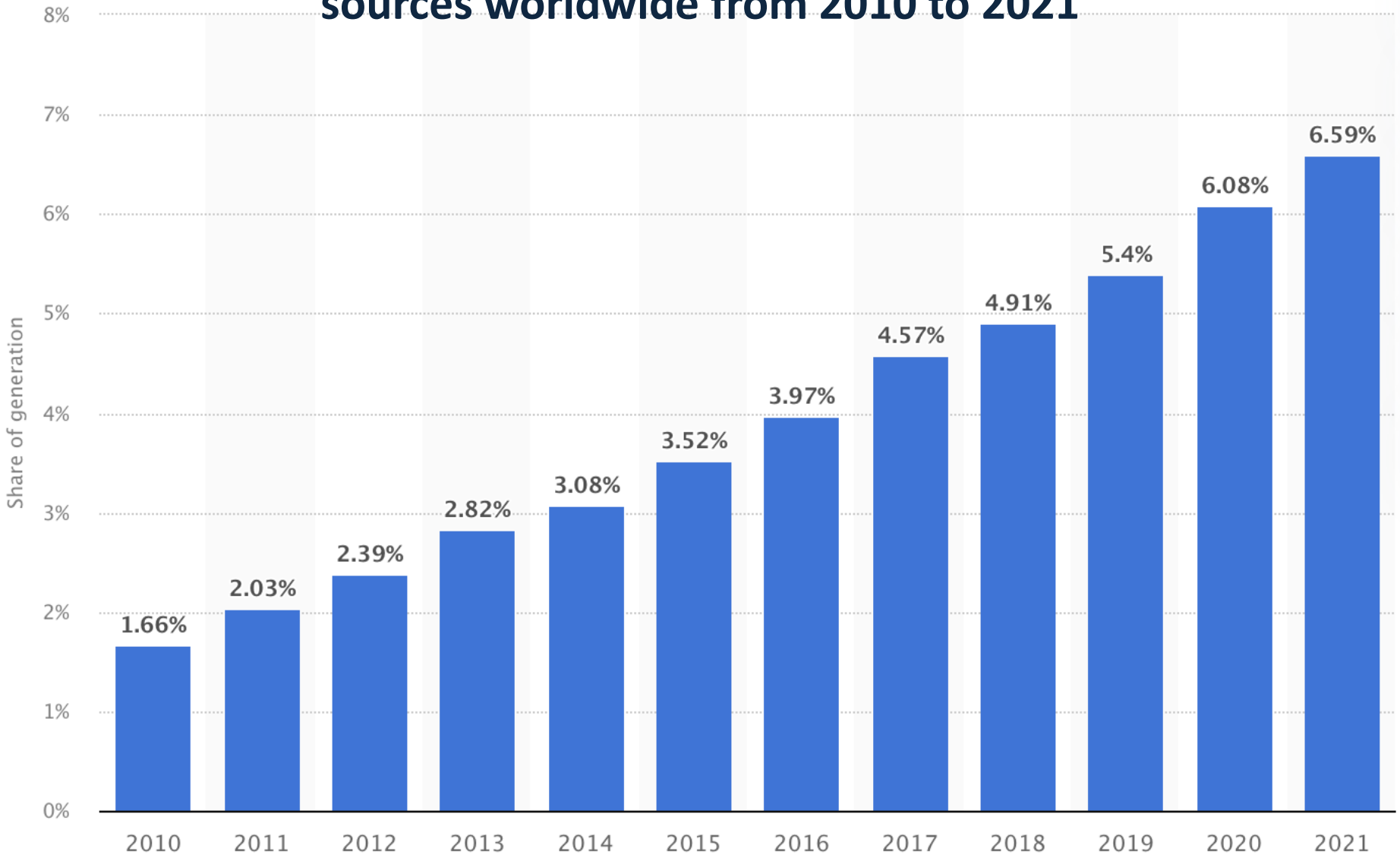
Note: Respondents who gave other responses or did not give an answer are not shown.
Source: Survey conducted April 29-May 5, 2020.
"Two-Thirds of Americans Think Government Should Do More on Climate"

PEW RESEARCH CENTER

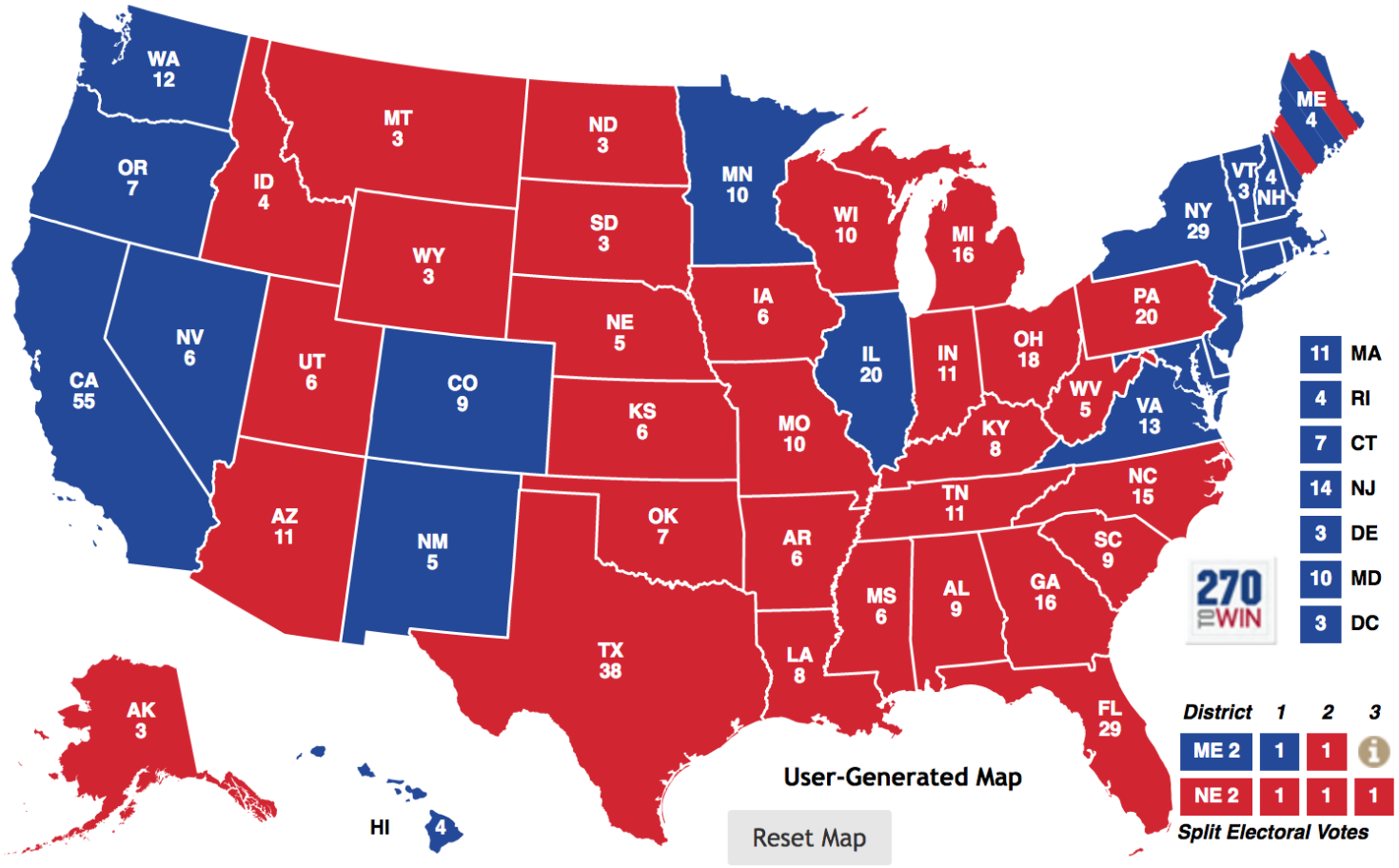


Total Installed Wind Capacity: 138,630 MW

Share of electricity generation from wind energy sources worldwide from 2010 to 2021



Conservative Liberal

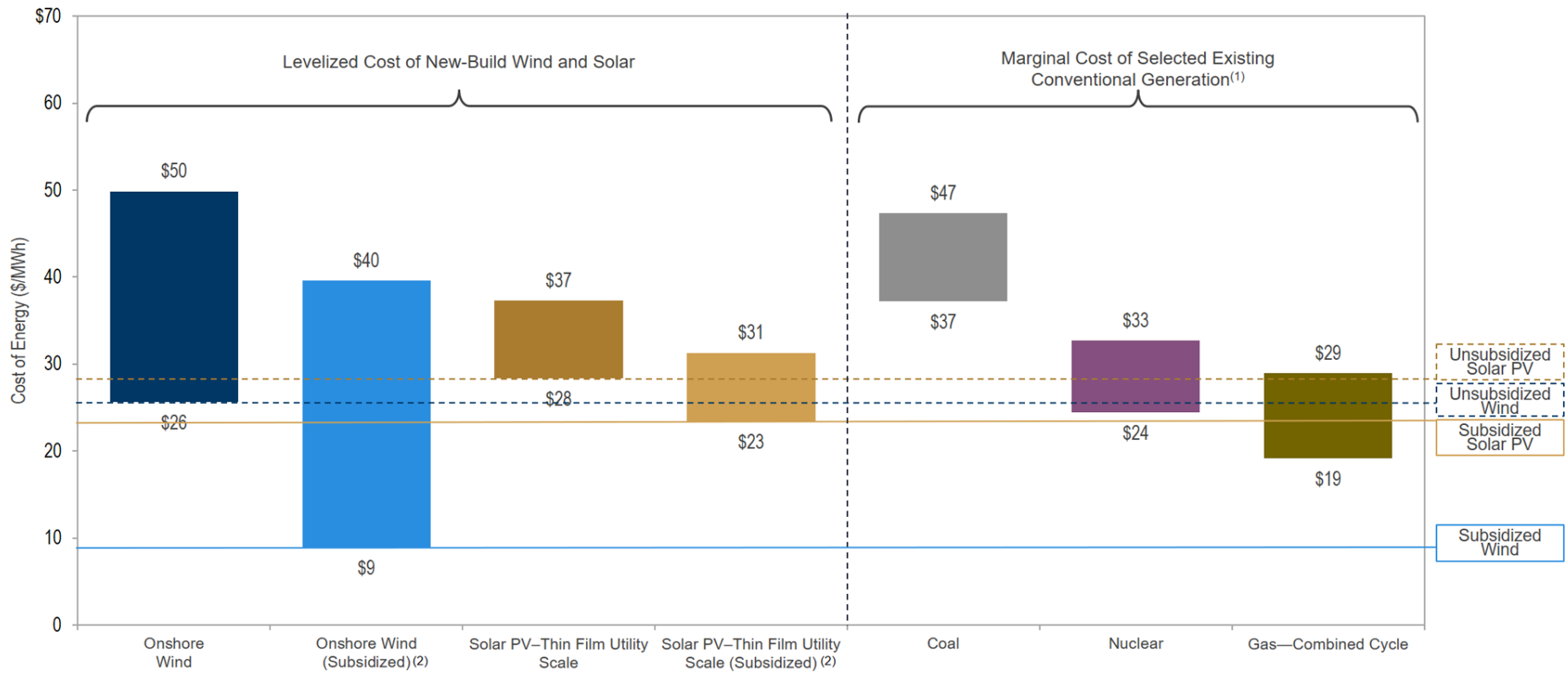


Map Updated Jul 20, 2017 2:15PM

Lazard's Levelized Cost of Energy Analysis, Version 15.0

Levelized Cost of Energy Comparison—Renewable Energy versus Marginal Cost of Selected Existing Conventional Generation

Certain renewable energy generation technologies have an LCOE that is competitive with the marginal cost of existing conventional generation



Source: *Lazard estimates.*

Note: Unless otherwise noted, the assumptions used in this sensitivity correspond to those used in the global, unsubsidized analysis as presented on the page titled "Levelized Cost of Energy Comparison—Unsubsidized Analysis".

(1) Represents the marginal cost of operating fully depreciated gas combined cycle, coal and nuclear facilities, inclusive of decommissioning costs for nuclear facilities. Analysis assumes that the salvage value for a decommissioned gas combined cycle or coal asset is equivalent to its decommissioning and site restoration costs. Inputs are derived from a benchmark of operating gas combined cycle, coal and nuclear assets across the U.S. Capacity factors, fuel, variable and fixed operating expenses are based on upper and lower quartile estimates derived from Lazard's research.

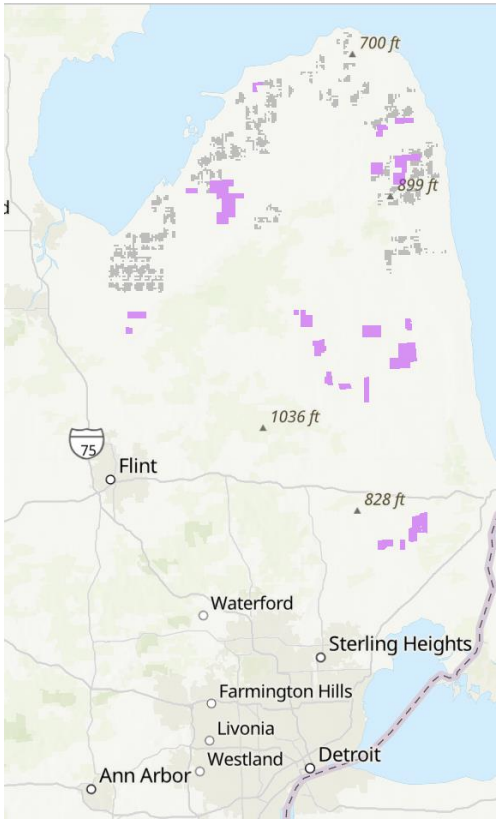
(2) The subsidized analysis includes sensitivities related to the TCJA and U.S. federal tax subsidies. Please see page titled "Levelized Cost of Energy Comparison—Sensitivity to U.S. Federal Tax Subsidies" for additional details.

https://www.lazard.com/perspective/levelized-cost-of-energy-levelized-cost-of-storage-and-levelized-cost-of-hydrogen/


simpliphi

What resources are required to achieve carbon neutrality?

How much land is needed for 100% renewable energy?



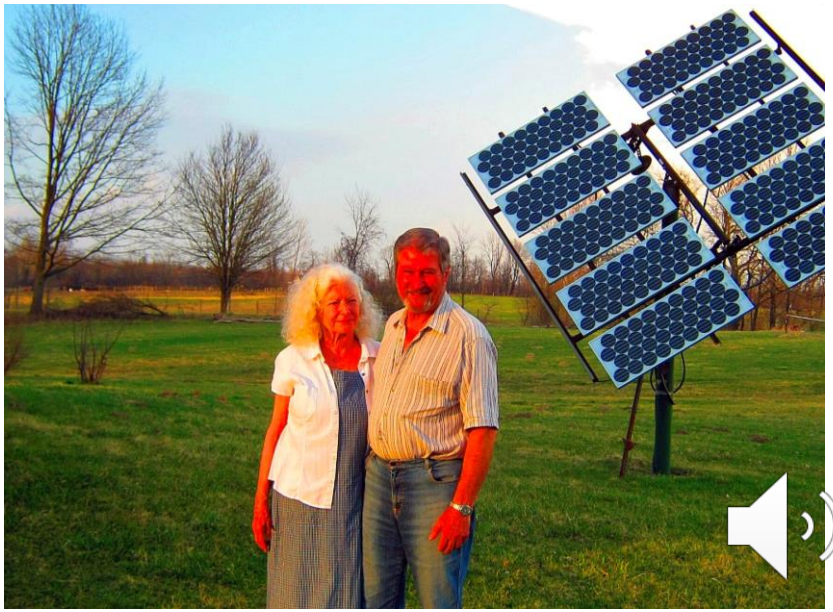
Utility scale solar
Utility scale wind

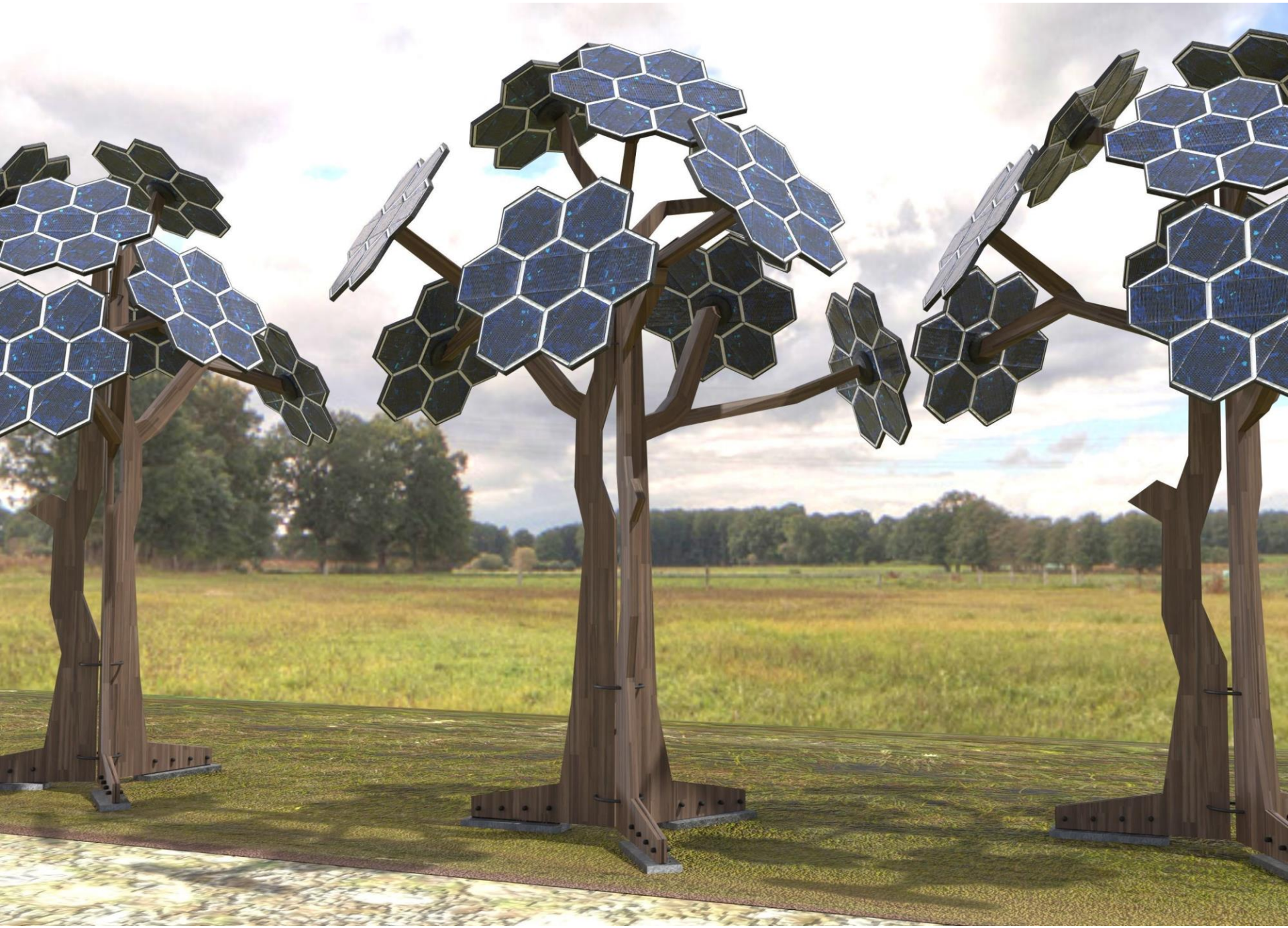
Includes all vehicle miles driven, heating, air conditioning, hot water, #electrifyeverything

Ann Arbor

Ann Arbor bans solar panels in residential front yards

Updated: Jan. 30, 2019, 9:53 a.m. | Published: Mar. 02, 2018, 5:20 p.m.





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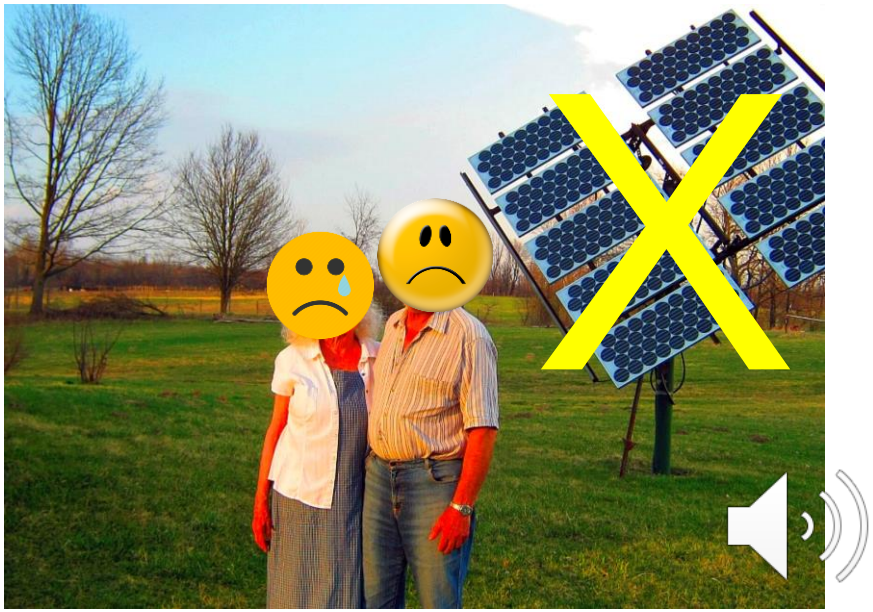
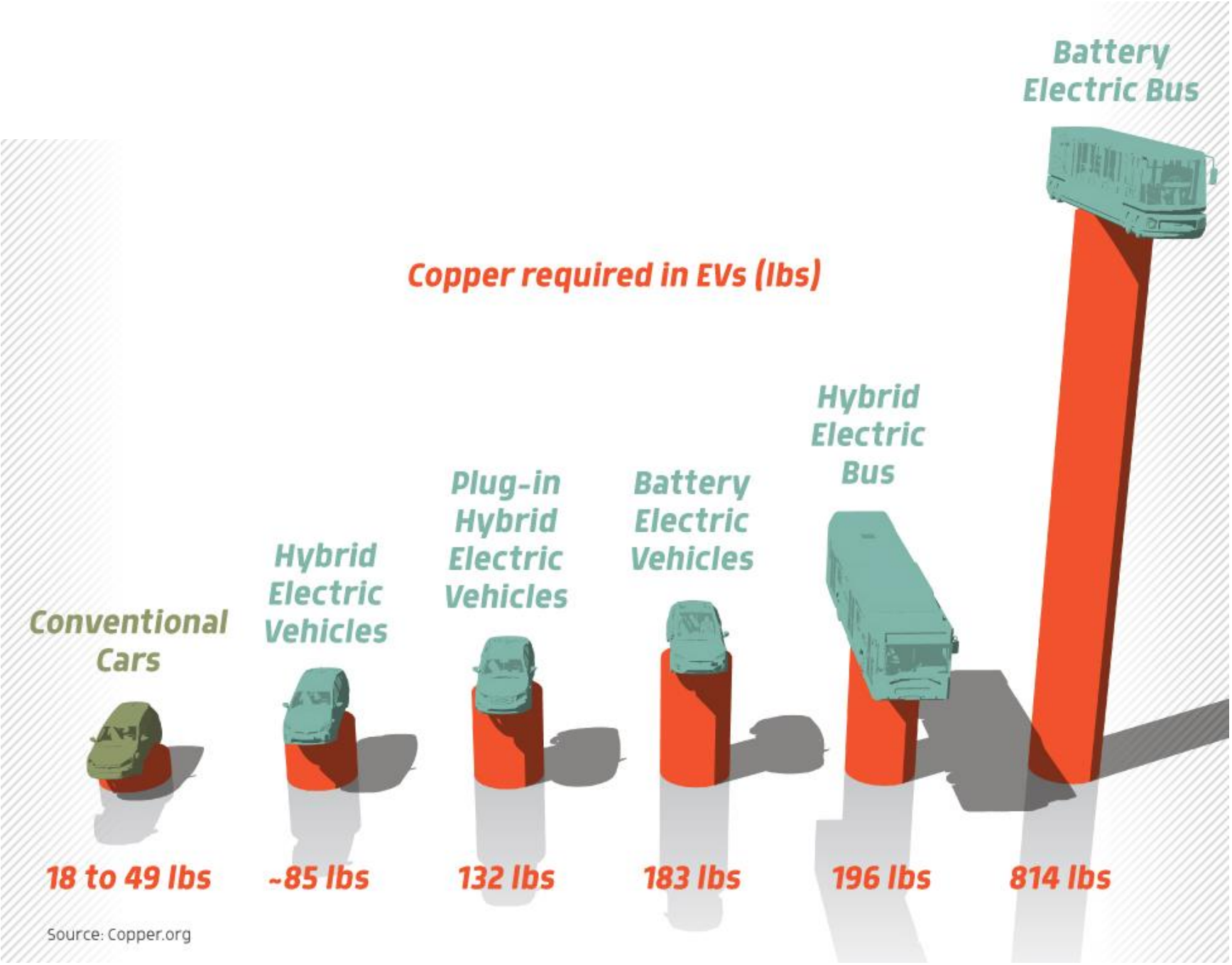
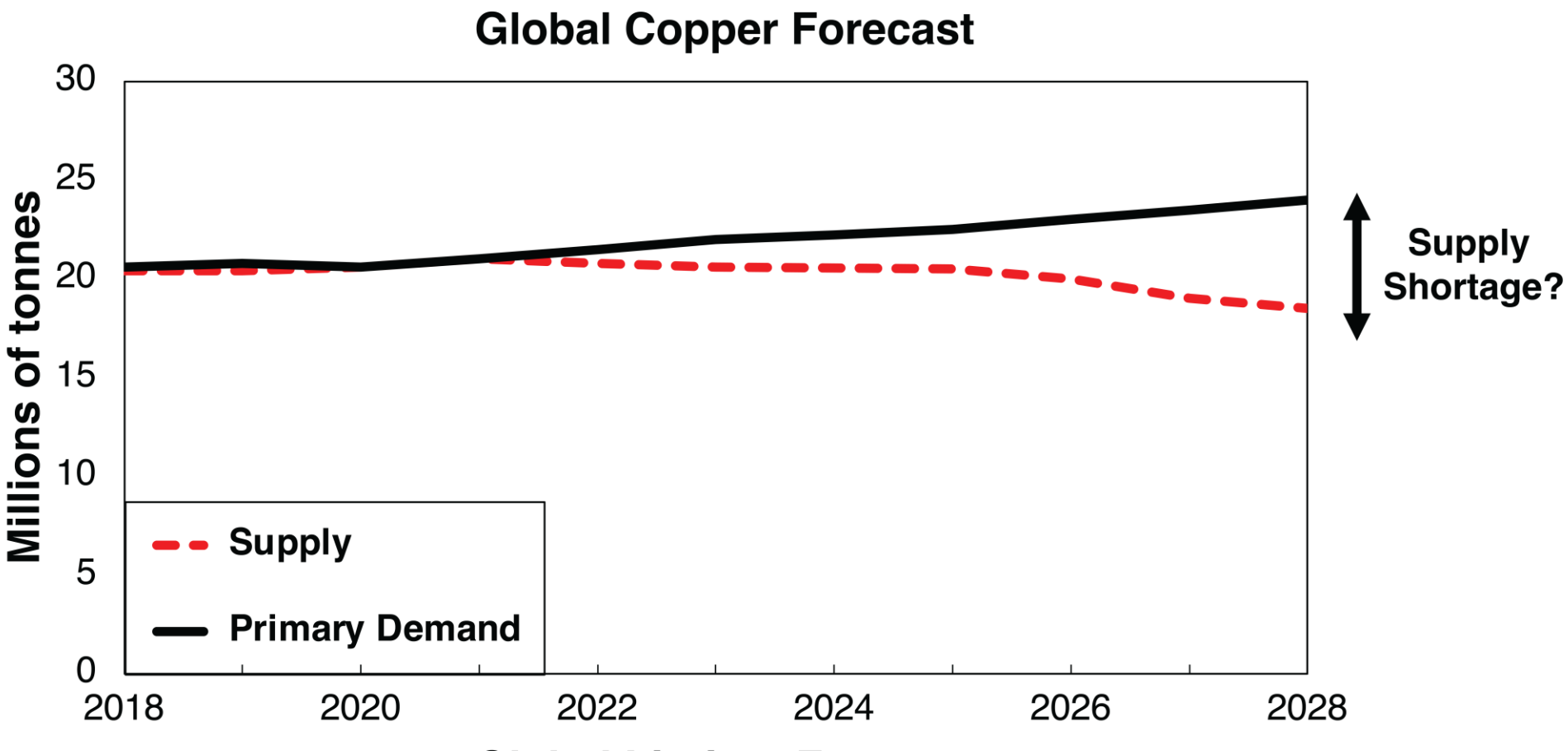



Copper required in EVs (lbs)
Conventional Cars
18 to 49 lbs
Hybrid Electric Vehicles
~85 lbs
Plug-in Hybrid Electric Vehicles
132 lbs
Battery Electric Vehicles
183 lbs
Hybrid Electric Bus
196 lbs
Battery Electric Bus
814 lbs
Source: Copper.org

Metals come from mines.


Global Copper Forecast
Millions of tonnes
30
25
20
15
10
5
0
2018
2020
2022
2024
2026
2028
Supply
Primary Demand
Supply
Shortage?

So You Want Wind Turbines But Don't Want Copper Mines?

Renewable energy advocates generally believe the United States should use renewable energy sources like wind and solar to generate electricity and stop using fossil fuels like coal and natural gas for our energy needs.

Many of these same people also oppose the proposed copper and nickel mines in Northern Minnesota.

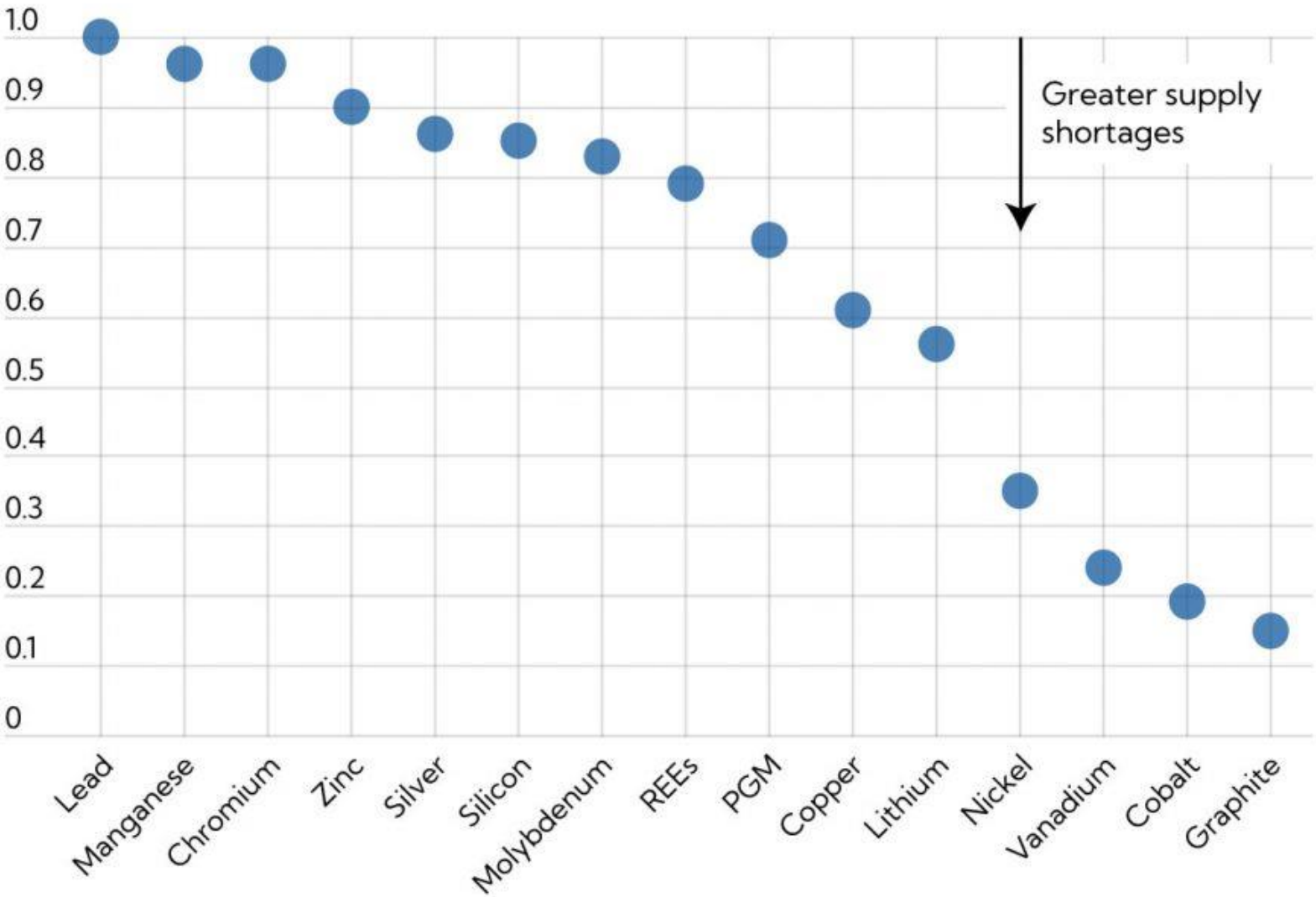
There's only one problem:

Windmills use an enormous amount of copper. For example, a single wind turbine can contain 335 tons of steel, 4.7 tons of copper, 3 tons of aluminum and 700-plus pounds of rare earth minerals.

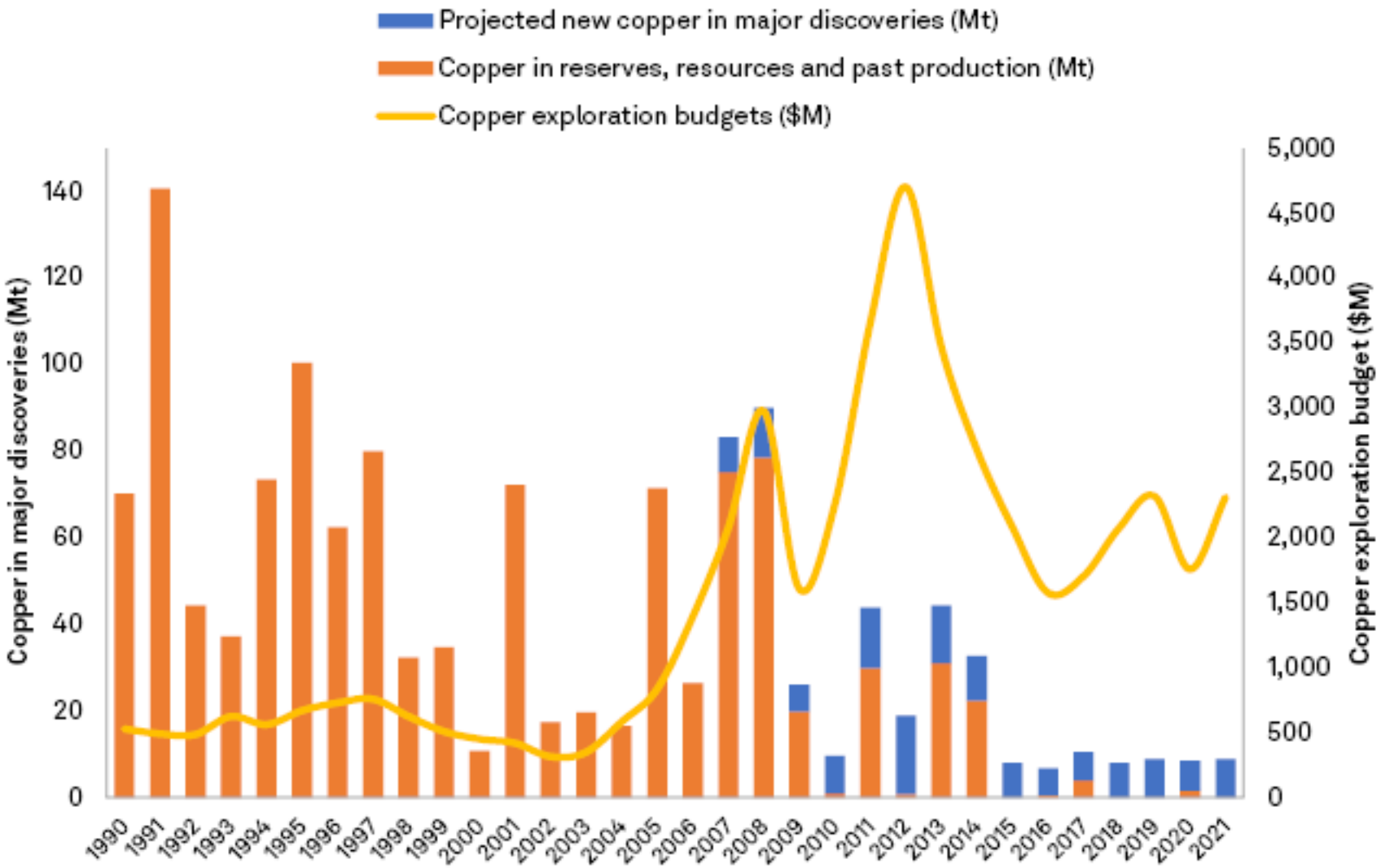
Metals in a net-zero scenario

Current production rates of some important metals, including copper, are likely to be inadequate to satisfy future demand.

(supply/demand ratio, energy and non-energy demand coverage)

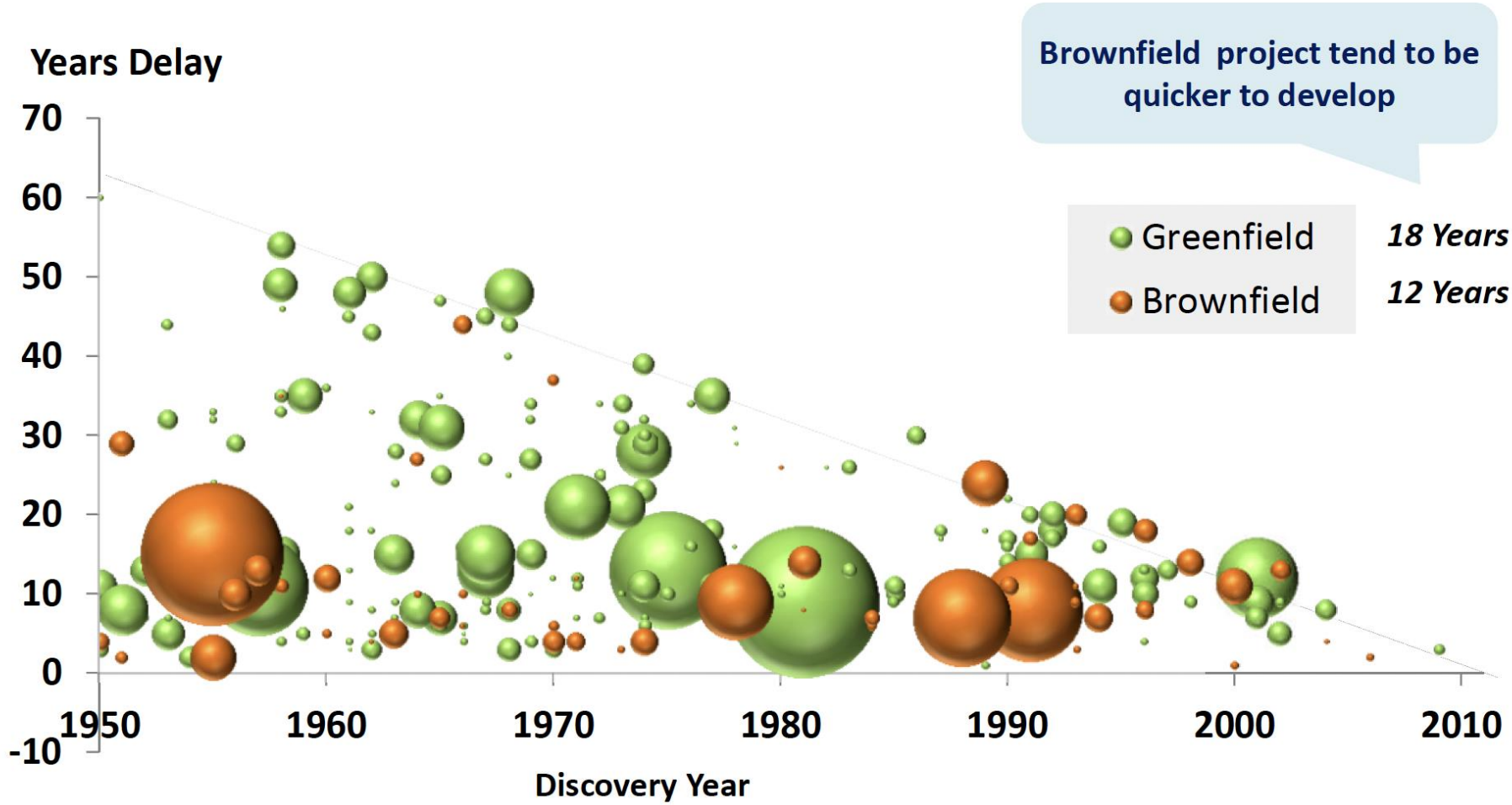


Discovery drought continues



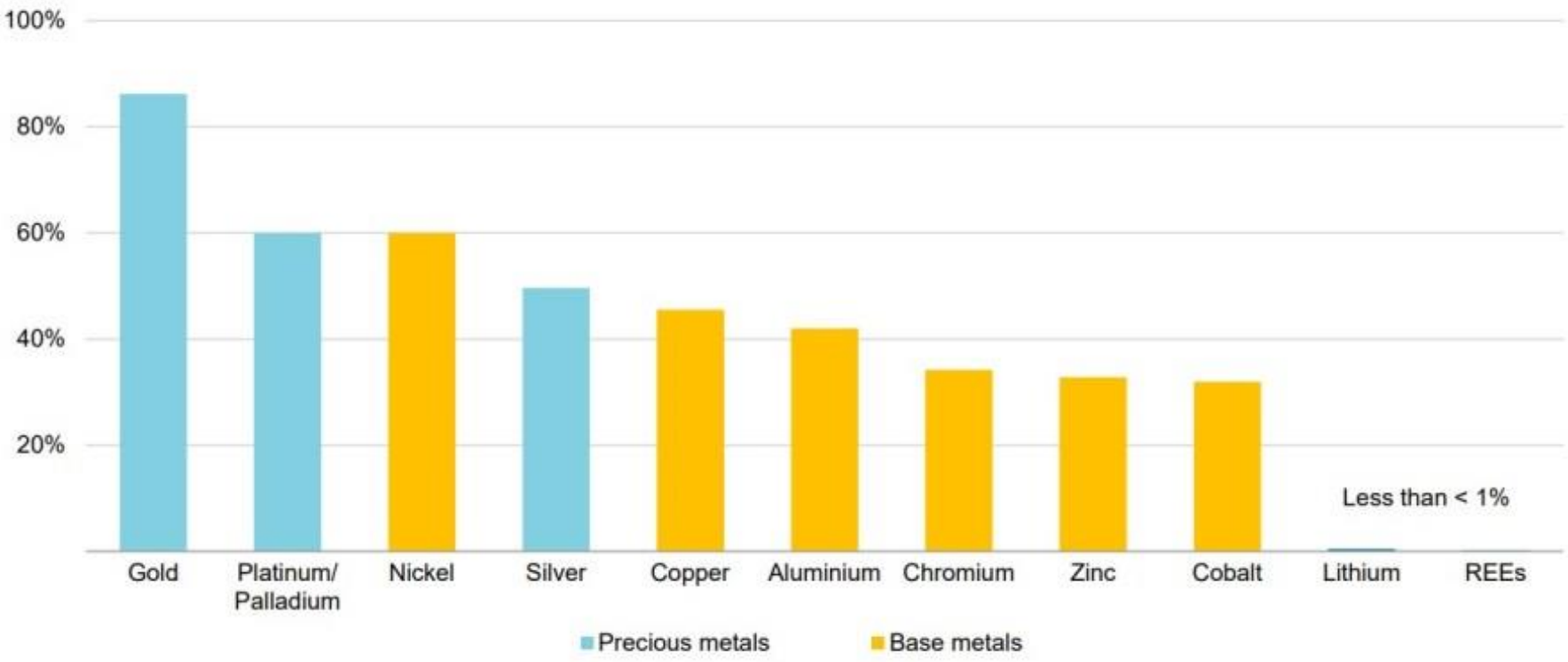
Data as of May 10, 2022.
* Annual average London Metal Exchange Copper Grade A cash price.
Source: S&P Global Market Intelligence

For those deposits that are developed into mines, it takes on average 16 years from discovery to production



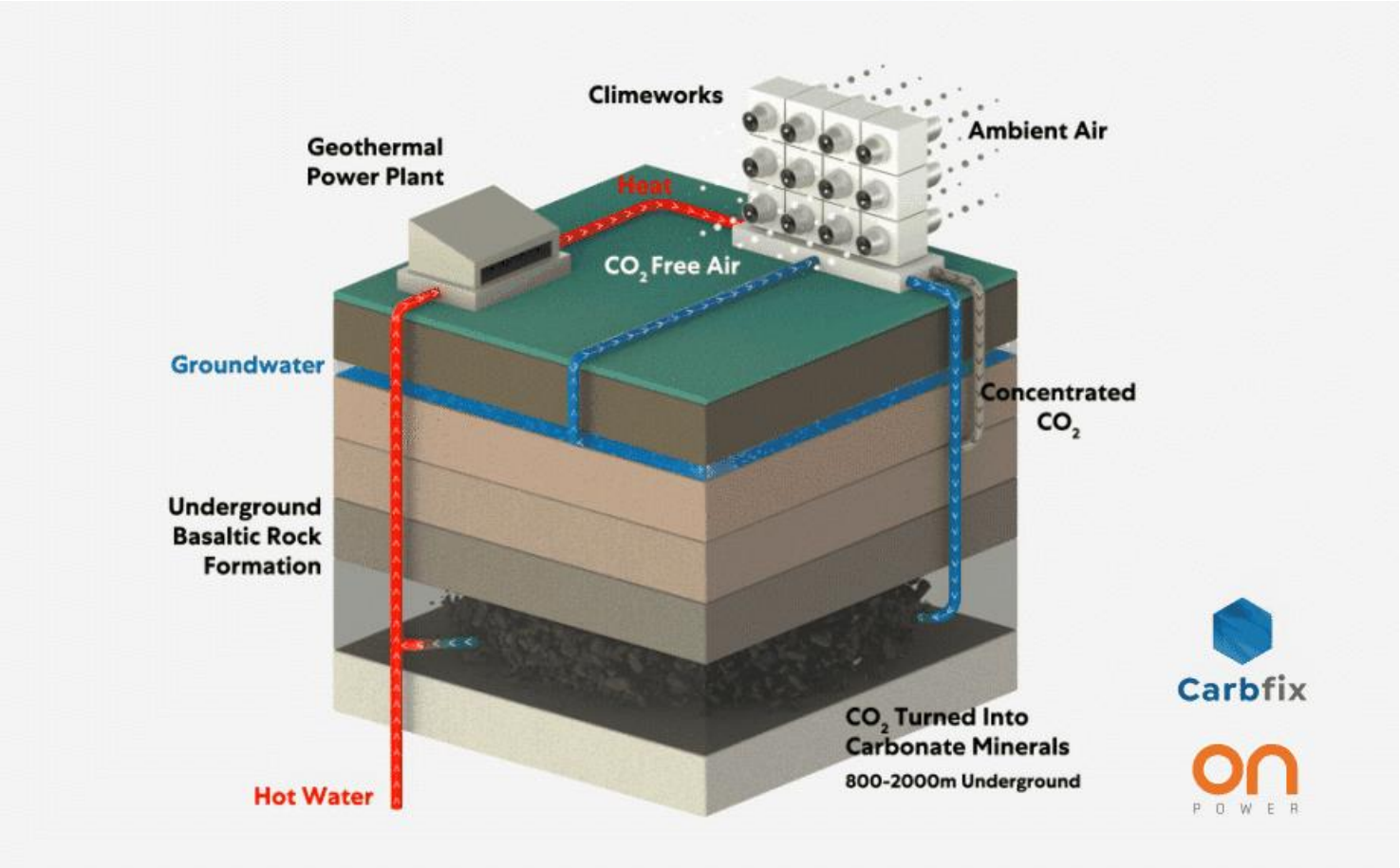
We must rapidly increase the permitting process for metals resources.

End-of-life recycling rates, global.



New direct air capture industry body aims to build public support

By **Cecilia Keating** June 3, 2022



Energy resources, identities, economics