Syllabus_Energy Economics and Policy

Energy and Economy

Introduction to different forms of energy; Understanding energy-economy linkages; Accounting energy balance; Understanding energy intensity and efficiency; Tradeoffs between energy-environment, Role of globalization and urbanization on energy demand

Economics of Non-renewable Energy

Economics of coal, petroleum and natural gas; Pricing of exhaustible energies - theories and practical issues; Regulation of fossil fuels energy markets

Economics of Renewable Energy

Drivers and sources of renewable energy; Economics of renewable energy supply; Developing markets for renewable energies

Environmental Implications of Energy

Energy-economic growth-environment Interactions; Income inequality-energy-pollution linkages; Climate change and environmental Kuznets Curve; Pollution haven hypothesis; Analysis on energy mixclimate change-market failure; natural resources management, The Clean Development Mechanism

Current Energy Issues and Policies

Current energy market trend and challenges; Energy policies in selected countries; Energy governance in India; Policy and institutional arrangement for energy efficiency and management in developing countries; Promoting clean energy usage for sustainable development goals

Suggested Readings

1.Griffin, J. M., & Steele, H. B. (2013). Energy economics and policy. Elsevier.

2.Tietenberg, T. Environmental and Natural Resource Economics, seventh edition, Addison Wesley, 2006

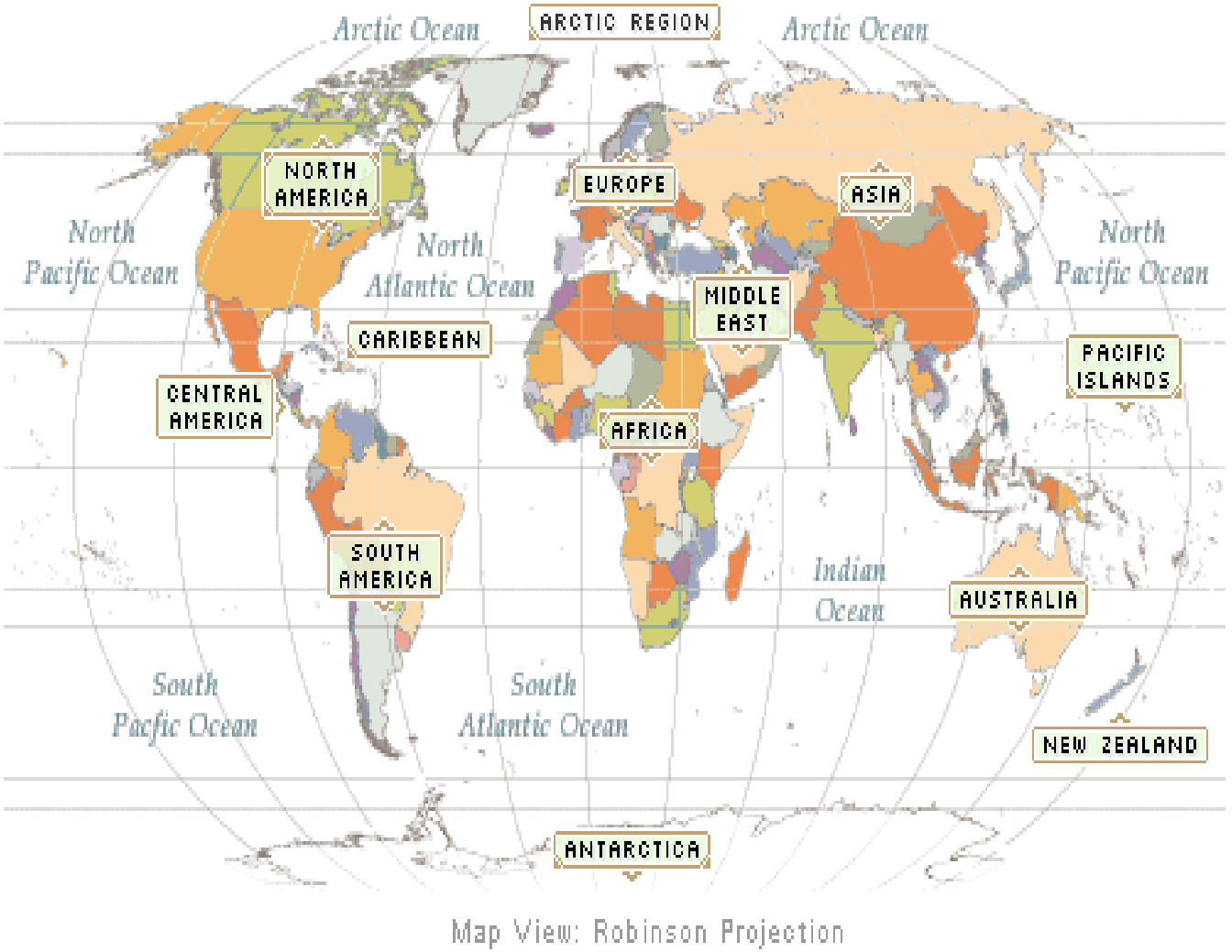
3.Munasinghe, M. and P. Meier, Energy Policy Analysis and Modelling. U.K.: Cambridge University Press, 1993

4. Ristinen, R. and J. Kraushaar, Energy and the Environment, John Wiley and Sons, 1998.

5. Wright, R.T., Environmental Science: Towards Sustainable Future, Pearson, Eleventh Edition, 2011

Country Maps: The Middle East

1. Bahrain
2. Cyprus
3. Egypt
4. Iran
5. Iraq
6. Israel
7. Jordan
8. Kuwait
9. Lebanon
10. Oman
11. Qatar
12. Saudi Arabia
13. Syria
14. Turkey
15. United Arab Emirates
16. Yemen



Map View: Robinson Projection

https://www.infoplease.com/atlas/middle-east

FIGURE 1.3 Map of the Middle East. Major oil pipelines are shown as broken lines. Major oil fields are indicated by small black spots of irregular shape.

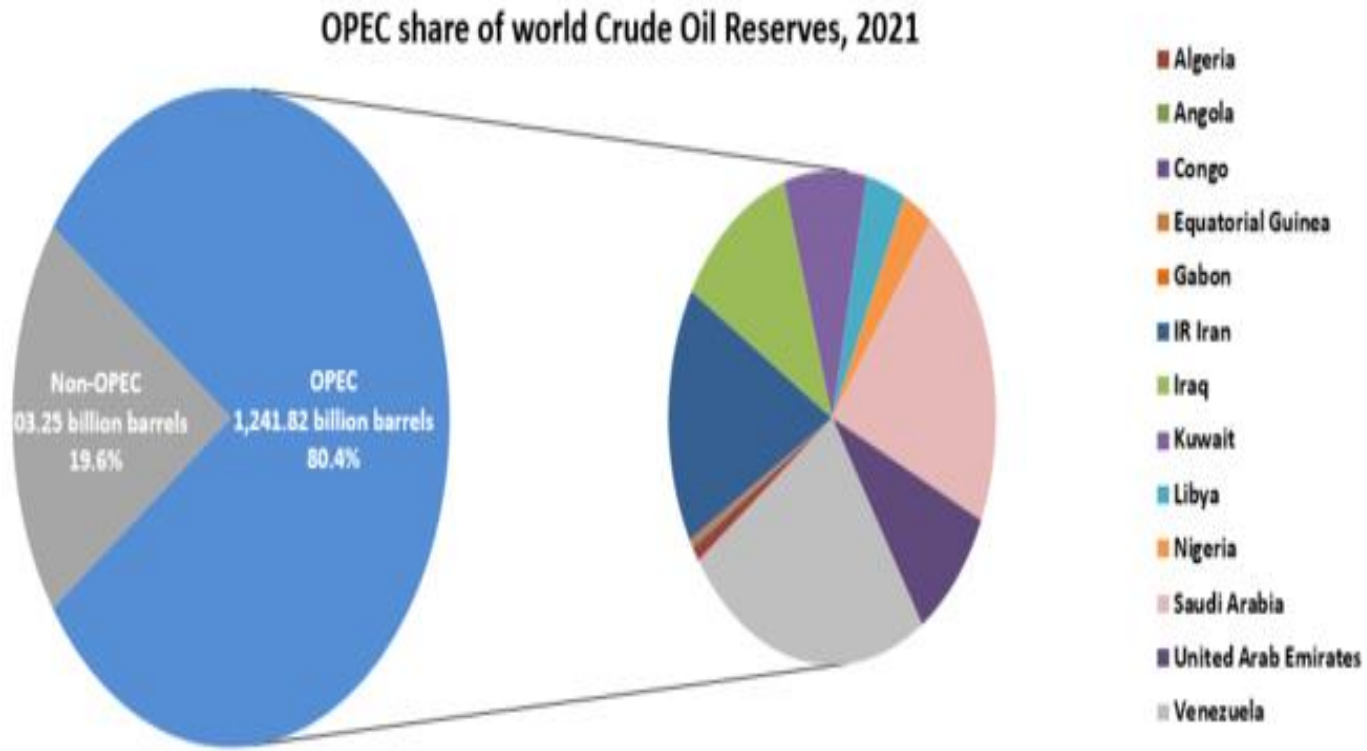
Organization of the Petroleum Exporting Countries (OPEC, 1960, Iraq)

1. Iran (1960)
2. Iraq (1960)
3. Kuwait (1960)
4. Saudi (1960)
5. Arabia (1960)
6. Venezuela (1960)
7. Qatar (1961)
8. Indonesia (1962)
9. Libya (1962)
10. the United Arab Emirates (1967)
11. Algeria (1969), Nigeria (1971)
12. Ecuador (1973)
13. Gabon (1975)
14. Angola (2007)
15. Equatorial Guinea (2017)
16. Congo (2018)

- "any country with a substantial net export of crude petroleum, which has fundamentally similar interests to those of Member Countries, may become a Full Member of the Organization"

- Currently, the Organization has a total of 13 Member Countries

https://www.opec.org/opec_web/en/about_us/25.htm



OPEC proven crude oil reserves , at end 2021 (billion barrels, OPEC share)

Venezuela	303.47	24.4%	United Arab Emirates	111.00	8.9%	Algeria	12.20	1.0%	Equatorial Guinea	1.10	0.1%
Saudi Arabia	267.19	21.5%	Kuwait	101.50	8.2%	Angola	2.52	0.2%			
IR Iran	208.60	16.8%	Libya	48.36	3.9%	Gabon	2.00	0.2%			
Iraq	145.02	11.7%	Nigeria	37.05	3.0%	Congo	1.81	0.1%			

https://www.opec.org/opec_web/en/data_graphs/330.htm

Percentage of World Crude Oil Production by Country, 1850-1984

	United States	Russia	Indonesia	Mexico	Venezuela	Middle East	Africa	Other
1860	98							2
1865	92	2						6
1870	91	3						6
1875	91	5						4
1880	88	10						2
1885	60	34						6
1890	60	37						3
1895	51	44	1					4
1900	43	52	2					3
1905	63	25	4					8
1910	64	27	4	1				4
1915	65	14	3	8				10
1920	64	4	3	23				6
1925	71	5	2	12	2	3		5
1930	64	8	2	3	10	3		10
1935	60	9	2	2	9	4		14
1940	63	10	3	2	10	4		8
1945	66	6	1	2	12	7		6
1950	52	7	1	2	15	15		8
1955	45	9	2	2	14	19		9
1960	35	14	2	1	14	23	1	10
1965	27	16	2	1	12	25	6	11
1970	22	17	2	1	8	30	13	7
1975	16	18	2	1	4	36	16	7
1980	14	20	3	3	4	30	16	10
1984	16	22	3	5	3	20	6	25

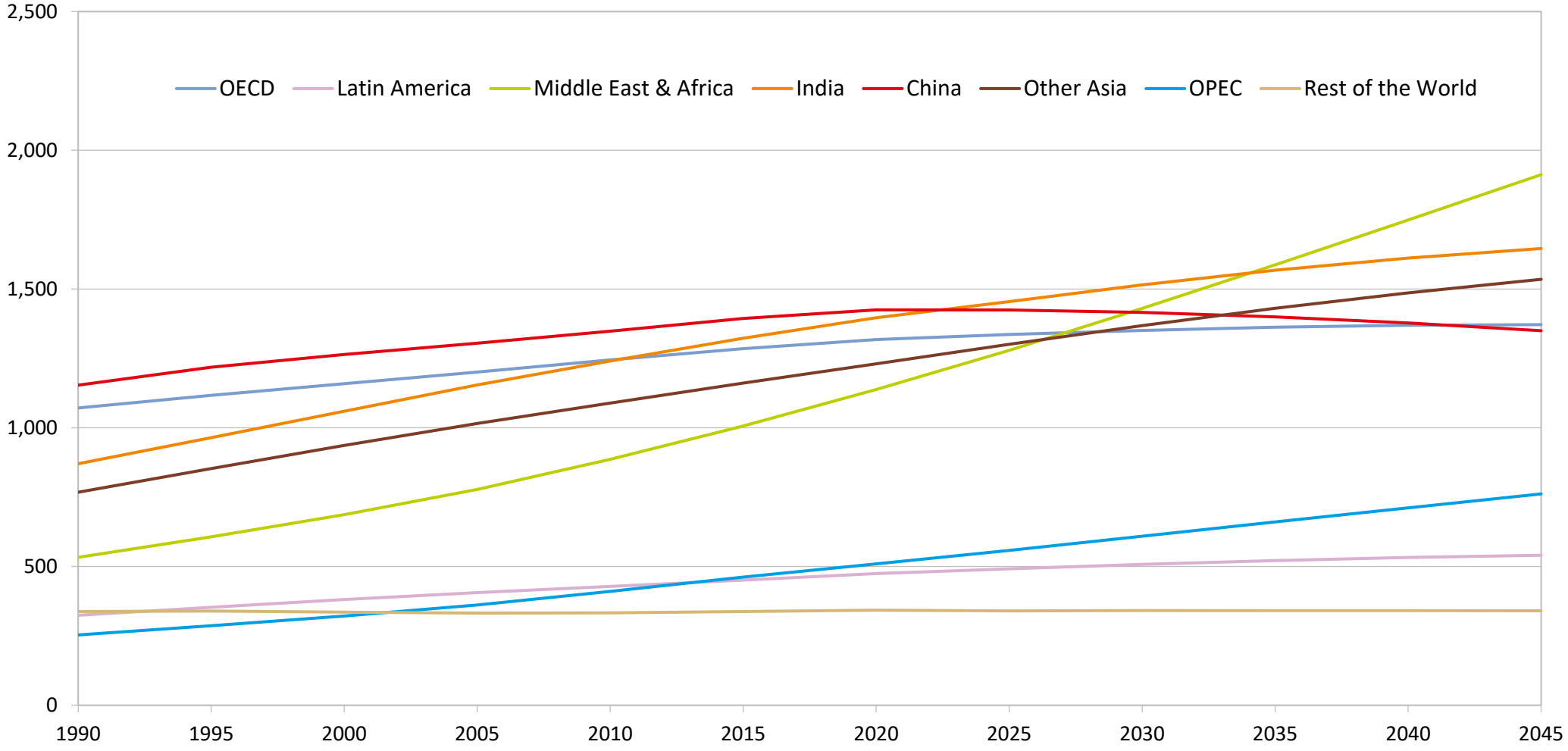
SOURCES: 1860–1920: U.S. Bureau of Mines; 1925–1965: Energy in the World Economy; *1970–1984: Monthly Energy Review.*

Percentage of Government Owned Oil Production for Selected Years in OPEC Countries

Country	1970	1972	1974	1976	1978	1980
Saudi Arabia	.9	.7	58.5	58.7	58.7	97.7
Iran	4.5	5.0	96.2	96.2	94.6	100
Kuwait	1.2	1.2	55.1	90.6	94.1	90.6
Iraq	0	53.8	77.2	100	100	100
Libya	0	3.6	60.7	64.2	65.7	67.5
U.A.E.	0	0	49.5	62.1	64.4	64.4
Venezuela	1.2	1.9	2.5	100	100	100
Qatar	0	0	60.0	78.5	99.4	100
Nigeria	0	0	54.9	55.1	54.9	71.1
Indonesia	11.7	16.2	30.5	36.6	44.6	45.7
Algeria	14.6	76.9	88.2	90.5	89.1	93.7
Ecuador	—	1.3	25.4	25.5	62.9	62.7
Gabon	0	0	0	0	0	0

SOURCE: OPEC Annual Statistical Yearbook.

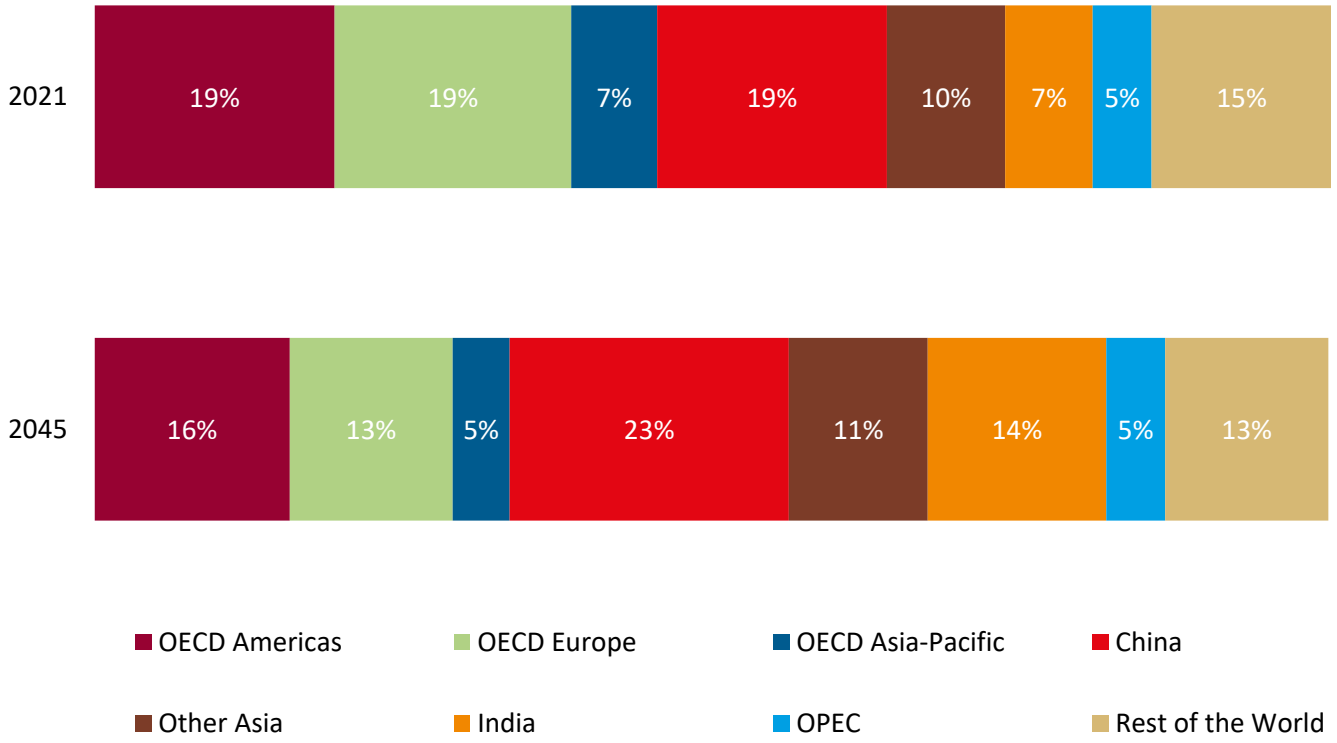
World population trends, 1990-2045 (Millions)



Source: UN, OPEC

Distribution of the global economy, 2021 and 2045 (%)

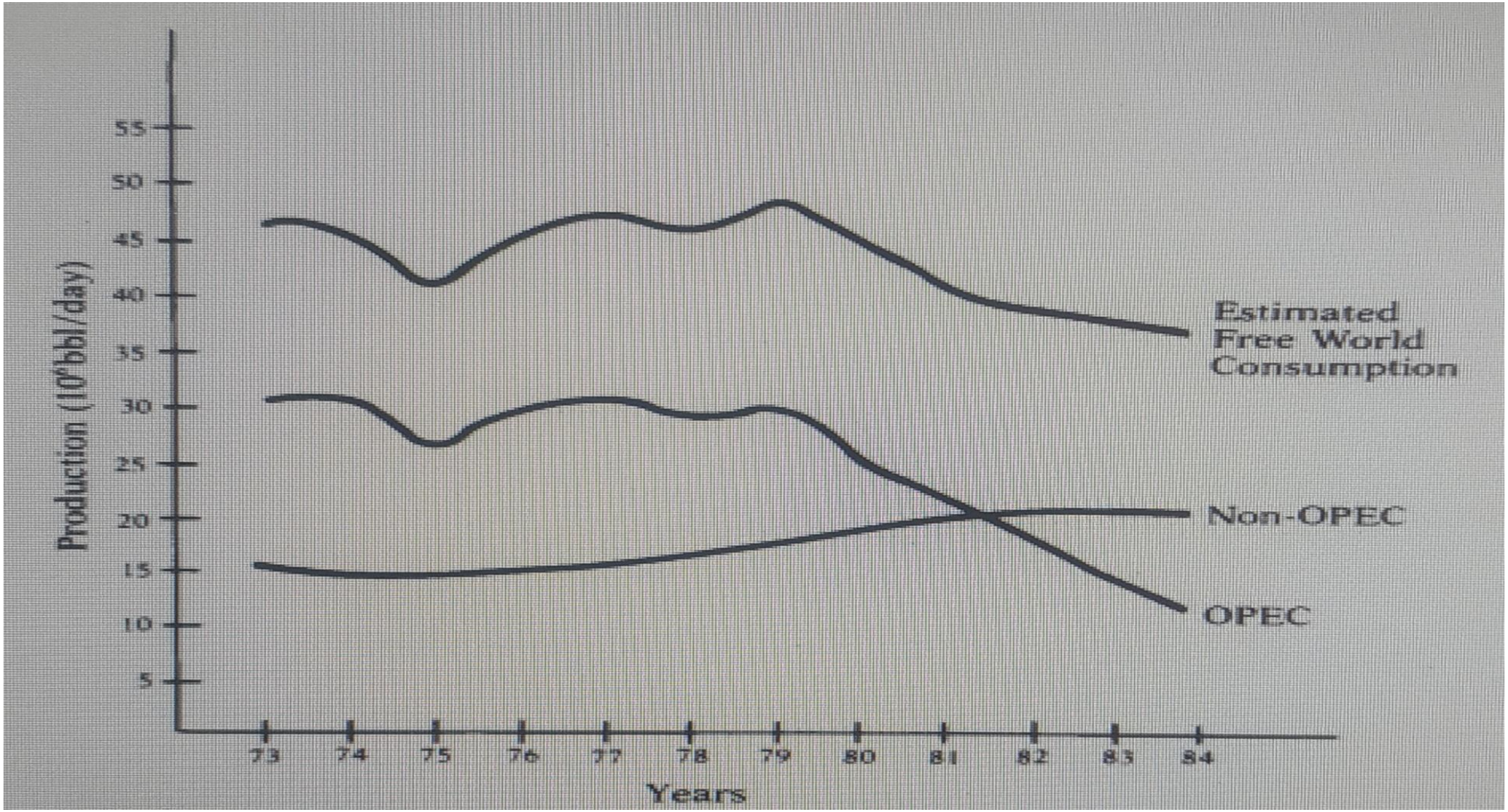
	2045	2021
OECD Americas	15.81%	19.45%
OECD Europe	13.21%	19.18%
OECD Asia-Pacific	4.62%	6.96%
China	22.63%	18.63%
Other Asia	11.25%	9.58%
India	14.47%	7.10%
OPEC	4.78%	4.78%
Rest of the World	13.23%	14.60%



Implications for OPEC

- Urbanised Asia is the key to growth of OPEC region.
- Growth performance in OPEC appears to be stagnant.
- It is a concern for OPEC if no growth in long-run.
- Resources depletion or low oil generation could be a reason for no growth.
- The countries in OPEC region may think of oil diversification for society welfare.
- Massive renewable energy investment is required on the ground of environmental quality and domestic consumption.

CHANGING PUBLIC PERCEPTIONS OF THE "ENERGY PROBLEM"



Real U.S. and World Crude Oil Prices, 1955-1982 [PRE-AND POST-OPEC]

- Rising energy price started in 1973
- We still live in a world of high-priced oil
- It is due to higher demand for oil
- Oil supply disruption in OPEC region
- Price escalations due to labour problems in oil fields interrupted production

Year	Real U.S. Price ($/bbl)	Real World Price ($/bbl, hereafter barrel)
1955	2.97	1.75
1965	2.70	1.43
1970	2.50	1.21
1971	2.37	.94
1972	2.34	1.14
1973	**2.26**	**1.23**
1974	**2.53**	**1.89**
1975	**3.85**	**6.15**
1976	**4.10**	**5.73**
1977	**4.05**	**6.02**
1978	**4.06**	**6.27**
1979	**3.96**	**5.85**
1980	**5.00**	**7.98**
1981	**7.52**	**11.22**
1982	**10.02**	**11.07**

Source: Griffin, J.M. & Steele, H. B. (1986). Energy Economics and Policy. Page no. 16

“Energy problem” becomes a history

- Increasing oil consumption is stable.
- Gap between oil demand and supply is higher.
- Energy problem occurs with supply uncertainty.
- OPEC monopoly action of reducing oil supply drives such gap, resulting for oil price rise.
- Poor economies can not create pressure on OPEC in reducing oil price.
- Because poor economies are beneficiary of remittances, commodity export and oil import.
- Cartel formation among poor economies may not be effective due to their insignificant share of import.

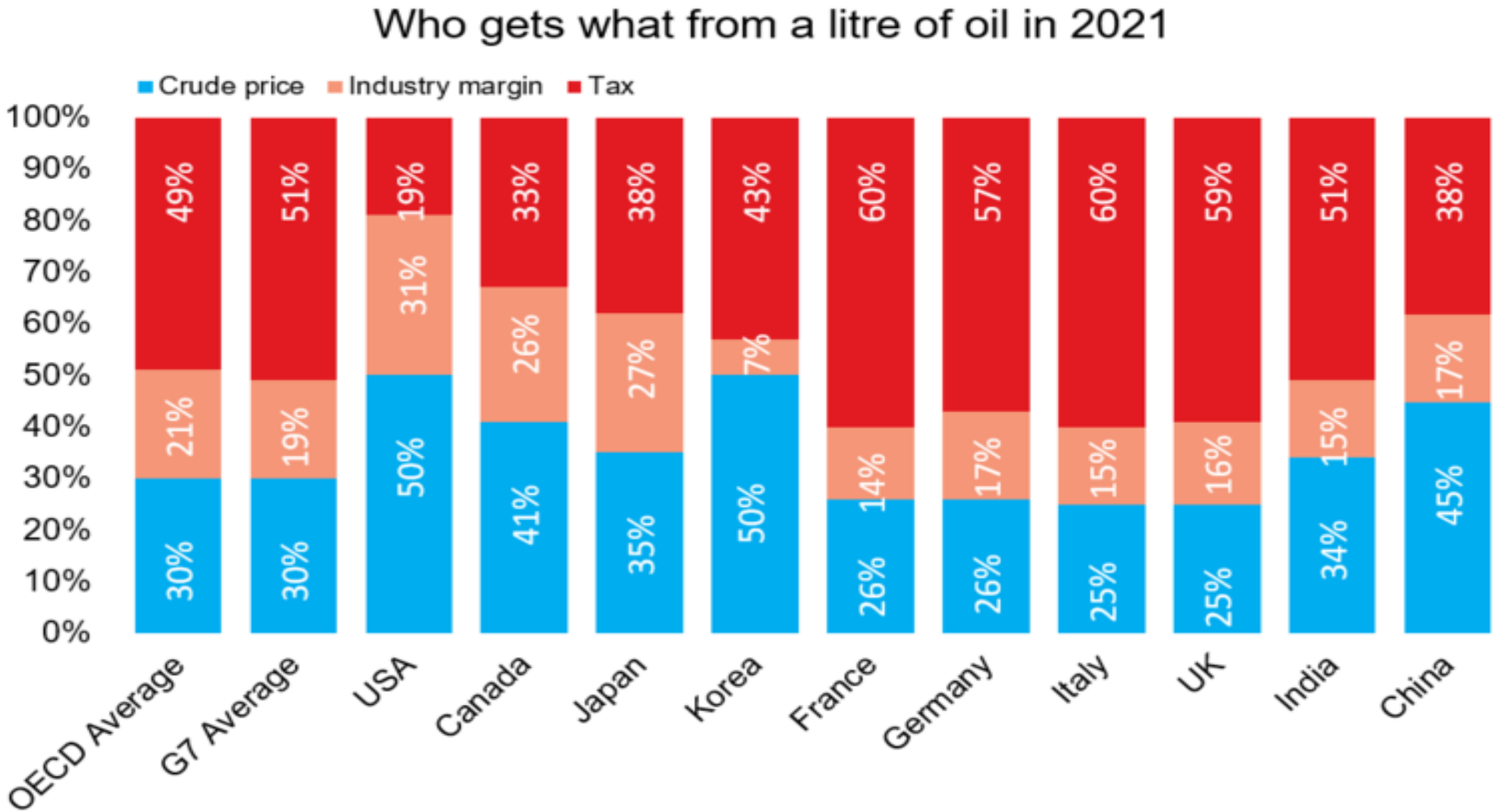
Way out for ‘‘energy problem’’

- Monopoly action of OPEC region is checked with oil supply reduction.
- Accept the energy issue with public opinion.
- So public opinion matters a lot.
- Reduce oil dependency.
- Energy diversification may be an option for solving energy problem.
- Easy option for advanced economies due to wealth reserve.
- Poor economies may think of energy efficiency.

Total World Crude Oil Reserves by Region in 1975 and 1984, in Billions of Barrels of Proved Reserves

OPEC areas:		
Saudi Arabia	152	169
Other Middle East	208	201
Other OPEC	90	81
Total OPEC	450	451
North America	40	82
Western Europe	25	23
Rest of Noncommunist World	40	29
Total Non-OPEC	105	134
Total, All Noncommunist Areas	555	585
Communist Areas	103	85
Total World	658	670

SOURCE: Oil and Gas Journal, Year-end Summary Issues, 1975 and 1984.



https://www.opec.org/opec_web/en/data_graphs/333.htm

WHY ENERGY ECONOMICS AND POLICY?

❑ THE DIMENSIONS OF THE ENERGY PROBLEM

- ➢ Arab Oil Embargo between 1973-1983 [Currently 13 member countries]
- ➢ OPEC Monopoly
- ▪ Oil prices hike in 1973: energy crisis
- ▪ Inflation & unemployment in Non-OPEC countries
- ▪ Environmental threat in Non-OPEC countries

The Role of Energy in Economic Development

❑ Role of Energy

- Energy is an input in economic activities.
- Energy consumption matters for households, firms and governments.
- Energy is the driver of economic growth (*energy-led economic growth hypothesis, Apergis and Tang, 2013*).

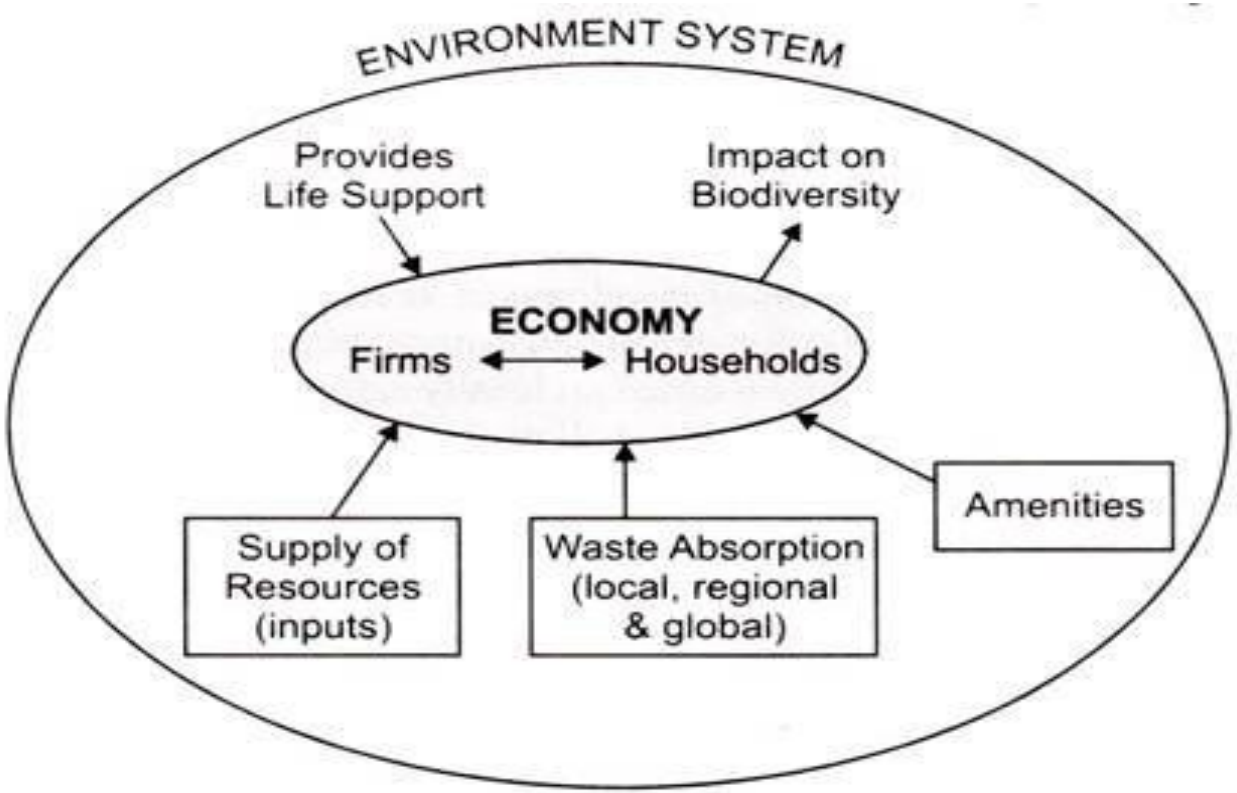


Fig. 56.1. *Economy–environment linkages or relations*

https://adamasuniversity.ac.in/man-economy-and-nature-why-study-environmental-economics/

Causality Results (Apergis and Tang, 2013; Energy Economics Journal)

- Validity of energy-led growth hypothesis for 85 countries (developed, developing and less developing)
- Though results are mixed among countries, but we do find a systematic pattern.
- Energy-led growth hypothesis remains valid at least in the 46 out of 85 selected countries.
- Both developed and developing countries are more likely to support the energy-led growth hypothesis compared to the less developed economies.
- Energy conservation policies should only focus on low income countries as these policies may not retard the process of economic growth

Causality Results

No	Countries	Income group	Energy consumption Granger-causes economic growth		
			Bivariate model	Trivariate model	Multivariate model
1.	Algeria	Upper middle			✓
2.	Argentina	Upper middle	✓	✓	✓
3.	Australia	High	✓	✓	✓
4.	Austria	High	✓	✓	✓
5.	Bangladesh	Low			✓
6.	Belgium	High	✓	✓	✓
7.	Benin	Low			✓
8.	Bolivia	Lower middle		✓	✓
9.	Brazil	Upper middle	✓	✓	✓
10.	Brunei	High			✓
11.	Cameroon	Lower middle			✓
12.	Canada	High	✓	✓	✓
13.	Chile	Upper middle	✓	✓	✓
14.	China	Lower middle			✓
15.	Colombia	Upper middle	✓	✓	✓
16.	Congo dem. Rep	Low			✓
17.	Congo Rep.	Lower middle	✓	✓	✓
18.	Costa Rica	Upper middle			✓
19.	Cote d'Ivoire	Lower middle			✓
20.	Cuba	Upper middle	✓	✓	✓
21	Cyprus	High			✓
22	Denmark	High	✓	✓	✓
23	Dominican Republic	Upper middle	✓		✓
24	Ecuador	Lower middle	✓	✓	✓
25	Egypt	Lower middle			✓
26	El Salvador	Lower middle	✓	✓	
27	Finland	High	✓	✓	✓
28	France	High		✓	✓
29	Gabon	Upper middle		✓	
30	Germany	High			
31	Ghana	Low		✓	✓
32	Greece	High	✓	✓	✓
33	Guatemala	Lower middle		✓	✓
34	Honduras	Lower middle			✓
35	Hong kong	High	✓	✓	✓
36	Hungary	High			
37	Iceland	High	✓		✓
38	India	Lower middle	✓	✓	✓
39	Indonesia	Lower middle	✓	✓	✓
40	Iran	Upper middle	✓	✓	✓
41	Ireland	High	✓		✓
42	Israel	High		✓	✓
43	Italy	High	✓	✓	✓
44	Jamaica	Upper middle			✓
45	Japan	High	✓	✓	✓
46	Jordan	Lower middle	✓		✓
47	Kenya	Low	✓	✓	✓
48	Korea	High	✓	✓	✓
49	Luxembourg	High			✓
50	Malaysia	Upper middle	✓	✓	✓
51	Malta	High			✓
52	Mexico	Upper middle	✓	✓	✓
53	Morocco	Lower middle			
54	Nepal	Low			✓
55	Netherland	High		✓	✓
56	New Zealand	High			
57	Nigeria	Lower middle			✓
58	Norway	High	✓	✓	✓
59	Oman	High	✓	✓	✓
60	Pakistan	Lower middle	✓	✓	✓
61	Panama	Upper middle		✓	
62	Paraguay	Lower middle	✓	✓	✓
63	Peru	Upper middle	✓	✓	✓
64	Philippines	Lower middle	✓	✓	✓
65	Portugal	High	✓		✓
66	Saudi Arabia	High	✓	✓	✓
67	Senegal	Lower middle		✓	
68	Spain	High	✓	✓	✓
69	Sri Lanka	Lower middle			
70	Sudan	Lower middle			✓
71	Sweden	High		✓	✓
72	Switzerland	High		✓	
73	Syrian Arab Rep	Lower middle		✓	✓
74	Thailand	Lower middle	✓	✓	✓
75	Togo	Low			
76	Trinidad and Tobago	High			
77	Tunisia	Lower middle	✓	✓	✓
78	Turkey	Upper middle	✓	✓	✓
79	UAE	High	✓	✓	✓
80	UK	High	✓	✓	✓
81	USA	High	✓	✓	✓
82	Uruguay	Upper middle	✓	✓	✓
83	Venezuela	Upper middle	✓	✓	✓
84	Zambia	Low			✓
85	Zimbabwe	Low			

❑ The services that environment provides

- Flow resources
- Stock resources

✓ Flow resources: no link between current use and future availability

- Solar radiation-if a roof has a solar water heater on it, amount of water heating today
- Same water heating can be done tomorrow
- Renewable resources-biotic, plant & animal populations
- Capacity to grow over time via biological reproduction

✓ Stock resources: current use does affect future availability

- stocks of minerals-coal, oil [non-renewable-abiotic]
- Don’t have capacity to grow over time
- No positive constant rate of use
- Exhaustible or depletable resources
- Resources are exhaustible if harvested too long exceeding their generation capacities
- If harvest exceeds natural growth, unsustainable resources or declining stock size
- No natural reproduction except geological timescales

Renewable & exhaustible resources

- How they are managed?
- How they should be managed?

Renewable resource:

- It regenerates itself
- Examples-fish and trees
- Fishery-catch a number of fish and leave the rest to grow naturally
- Fish stock does not die with reproduction

Exhaustible resource [Gray, 1914; Hotelling, 1931]:

- It is fixed in overall quantity
- Usage in a given time is less available for other time
- Does not have regenerating capability
- Examples-coal and oil [fossil fuels] & minerals

Management Issue:

- Fish & trees are exhaustible if not managed in a sustainable way.

Advantages of Renewable and Non-Renewable Energies

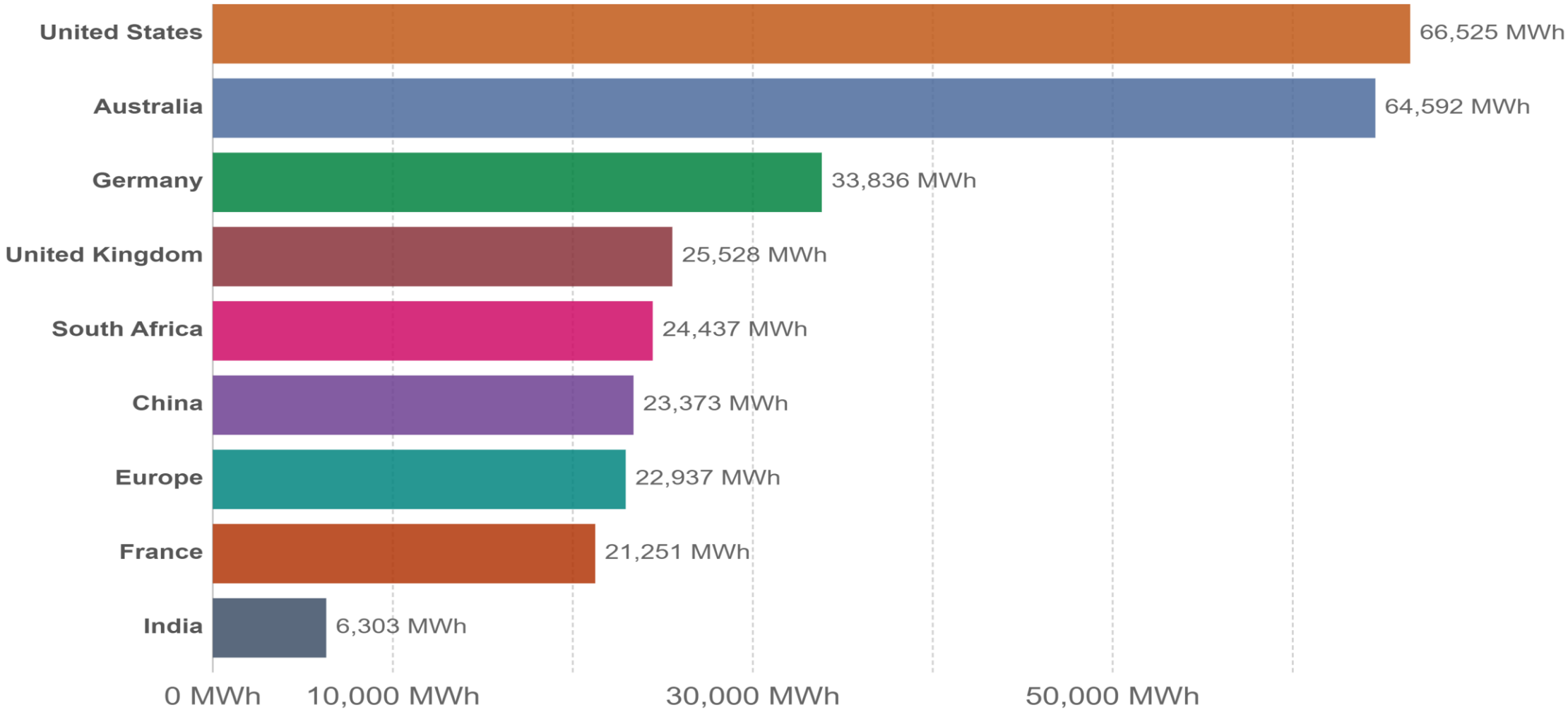
Renewable Energy	Non-Renewable Energy
✓ Operating cost is low.	✓ It is affordable and easily available.
✓ Environmental Friendly.	✓ Easy to use and more reliable in the short-run.
✓ Clean energy and more can be produced in the long-run.	✓ More can be produced in the short-run.
✓ Produces Low carbon emissions and stimulates green economy.	✓ known for its quick exploration.
✓ Infinite	✓ Expandable in response to human effort

Dis-advantages of Renewable and Non-Renewable Energies

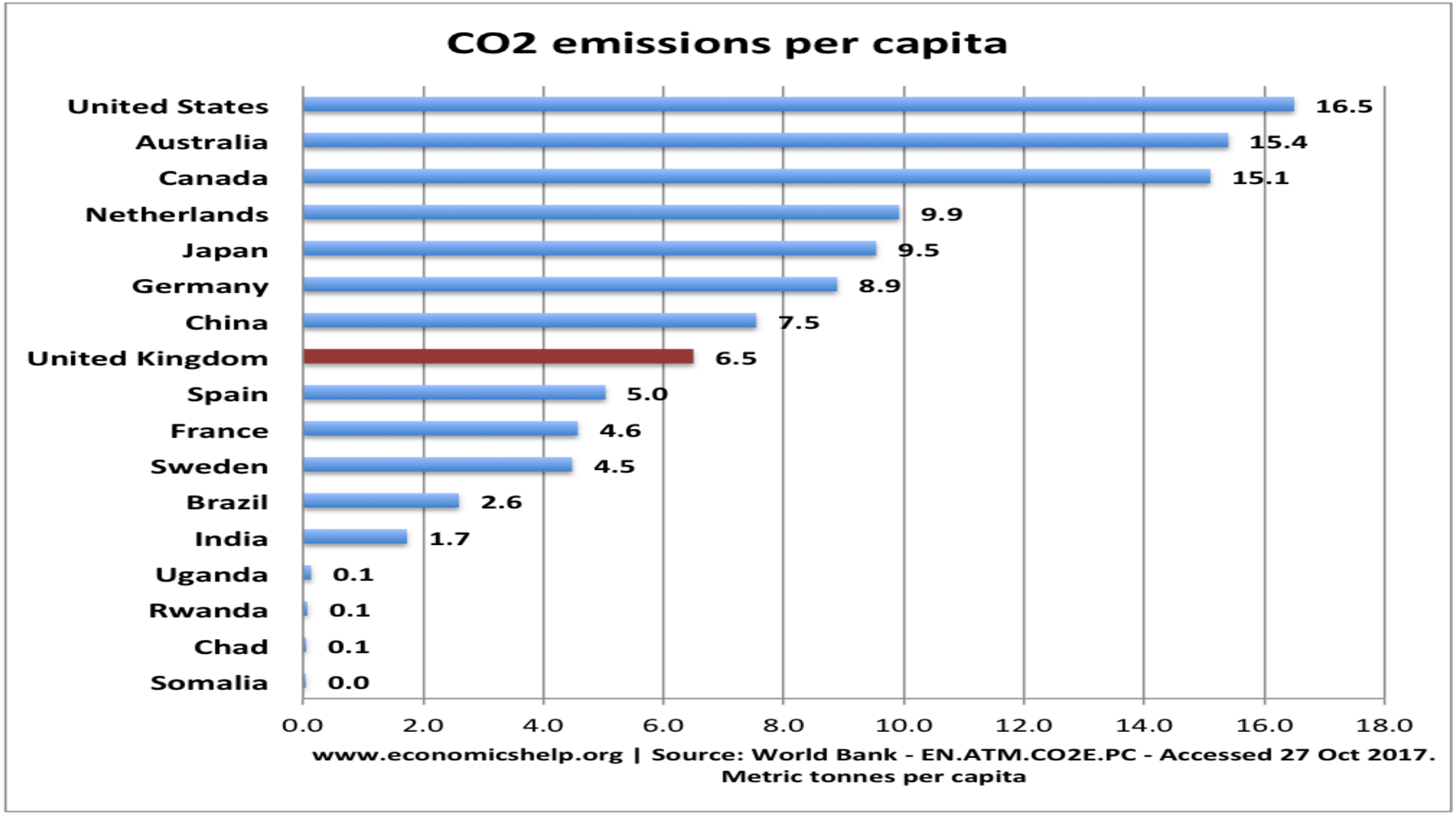
Renewable Energy	Non-Renewable Energy
✓ Expensive in the short-run, and less reliable and becomes affordable in the long-run.	✓ Eventually run out, becomes scarce and also becomes expensive.
✓ Not effective of producing energy in massive scale, particularly in the short-run.	✓ Threatening to the natural environment.
✓ It can be noisy and requires more space.	✓ Dirty Energy.
✓ Finite at a given time	✓ Finite

Fossil fuel consumption per capita, 2019

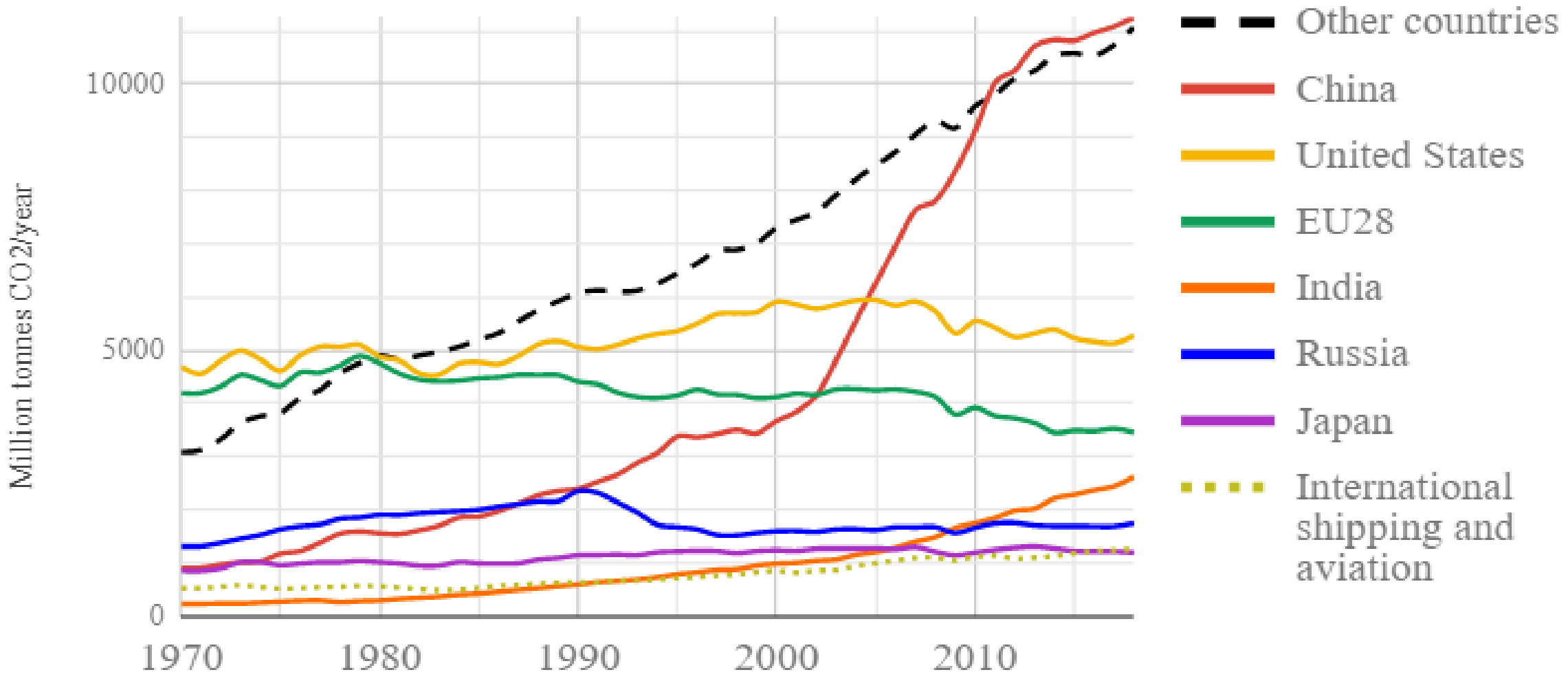
Fossil fuel consumption per capita is measured as the average consumption of energy from coal, oil and gas per person.



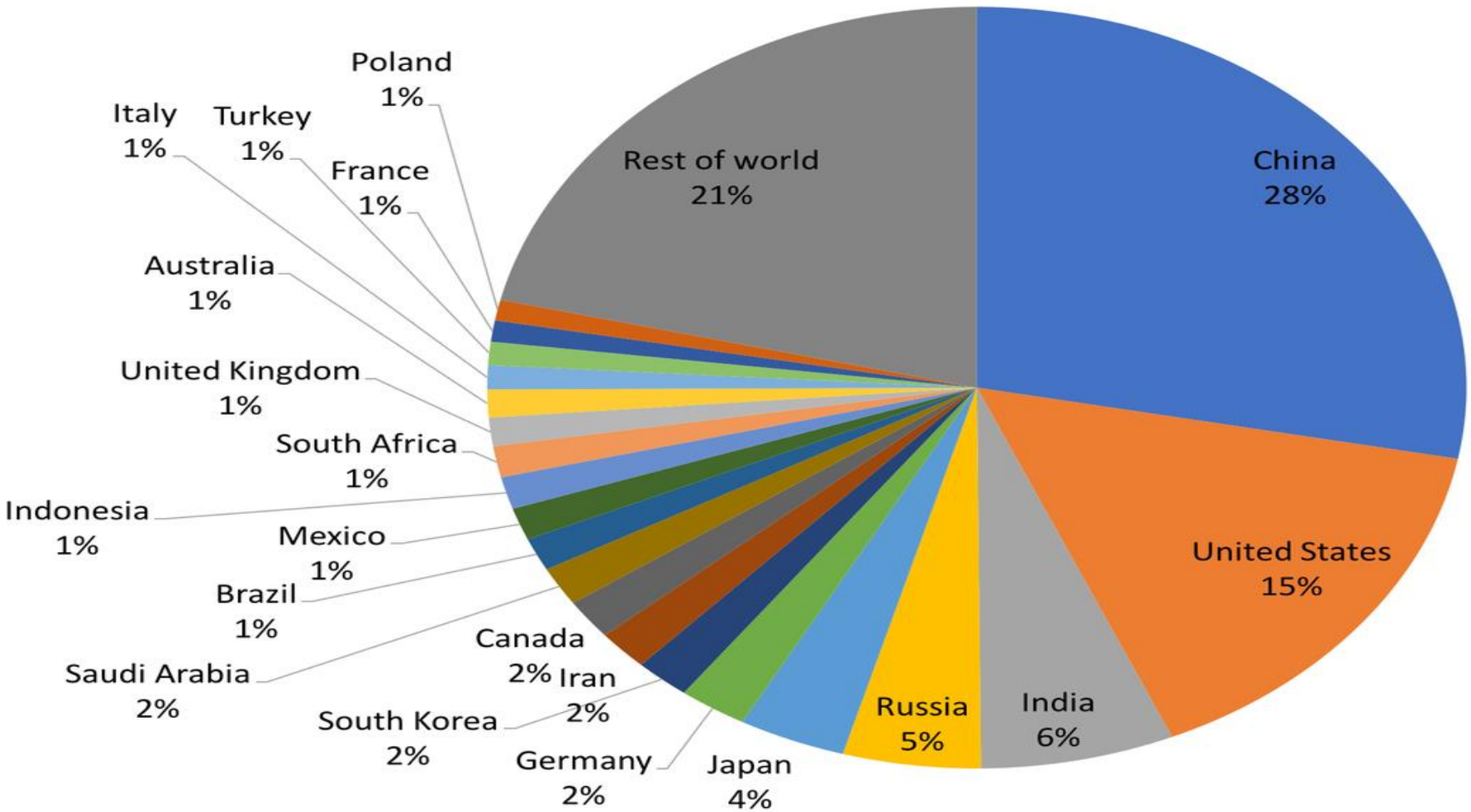
Source: Our World in Data based on BP Statistical Review of World Energy


CO2 emissions per capita
United States
Australia
Canada
Netherlands
Japan
Germany
China
United Kingdom
Spain
France
Sweden
Brazil
India
Uganda
Rwanda
Chad
Somalia
16.5
15.4
15.1
9.9
9.5
8.9
7.5
6.5
5.0
4.6
4.5
2.6
1.7
0.1
0.1
0.1
0.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
www.economicshelp.org | Source: World Bank - EN.ATM.CO2E.PC - Accessed 27 Oct 2017.
Metric tonnes per capita

World fossil carbon dioxide emission 1970-2018

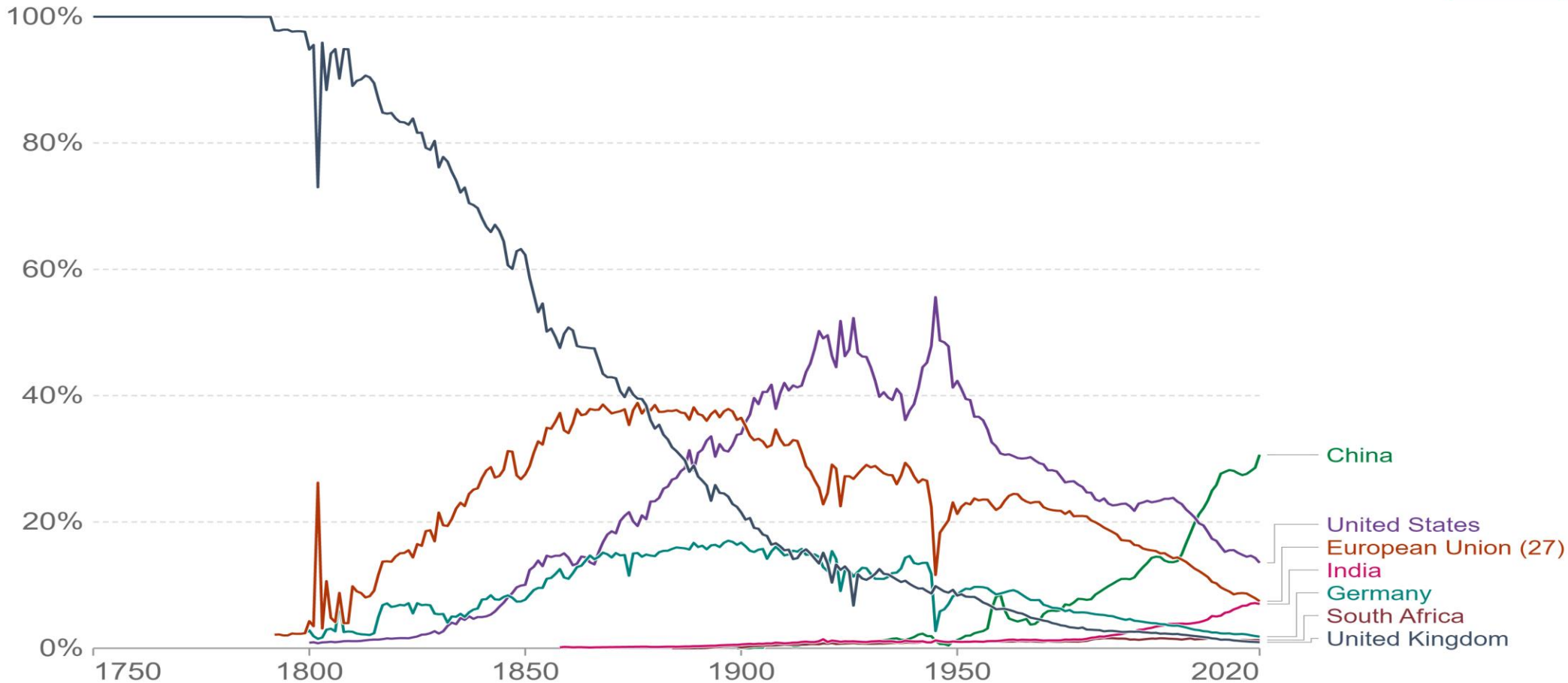


Share of global carbon dioxide emissions from fuel combustion (2015)



Data: IEA
Image: Union of Concerned Scientists

Annual share of global CO_2 emissions



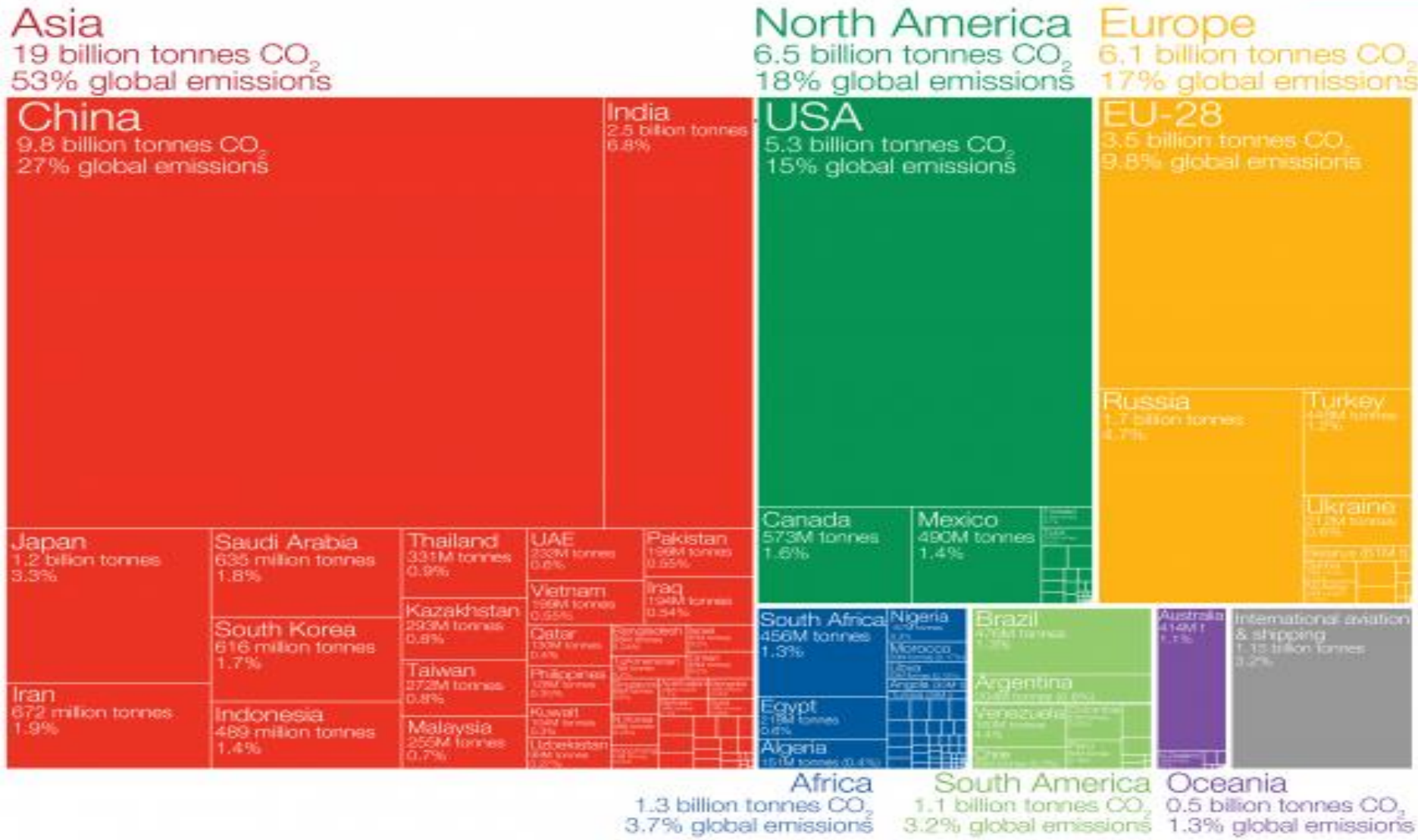
Source: Our World in Data based on the Global Carbon Project OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY

Note: This is measured as each country's emissions divided by the sum of all countries' emissions in a given year plus international aviation and shipping (known as 'bunkers') and 'statistical differences' in carbon accounts.

Who emits the most CO_2?

Global carbon dioxide (CO_2) emissions were 36.2 billion tonnes in 2017.

Our World in Data



Shown are national production-based emissions in 2017. Production-based emissions measure CO_2 produced domestically from fossil fuel combustion and cement, and do not adjust for emissions embedded in trade (i.e. consumption-based).

Figures for the 28 countries in the European Union have been grouped as the 'EU-28' since international targets and negotiations are typically set as a collaborative target between EU countries. Values may not sum to 100% due to rounding.

Data source: Global Carbon Project (GCP).

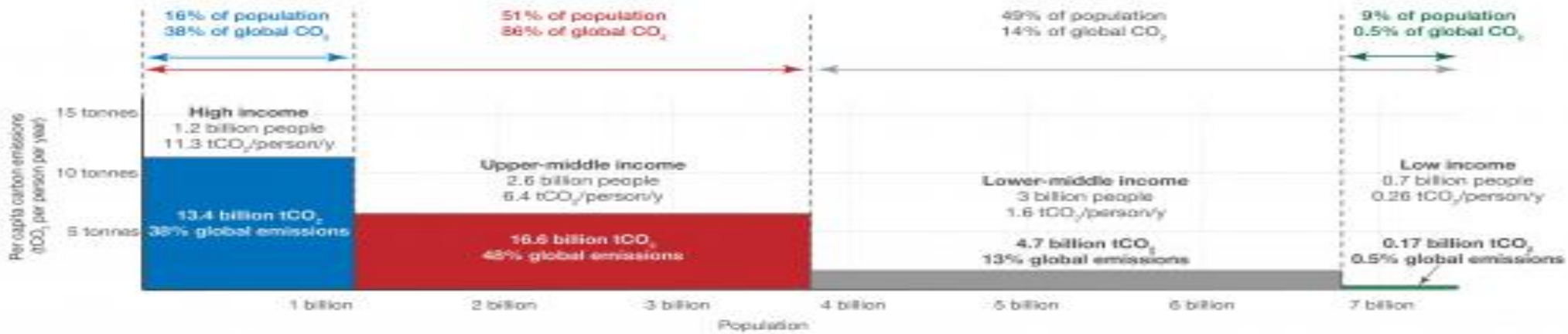
Global CO_2 emissions by income and region

Our World in Data

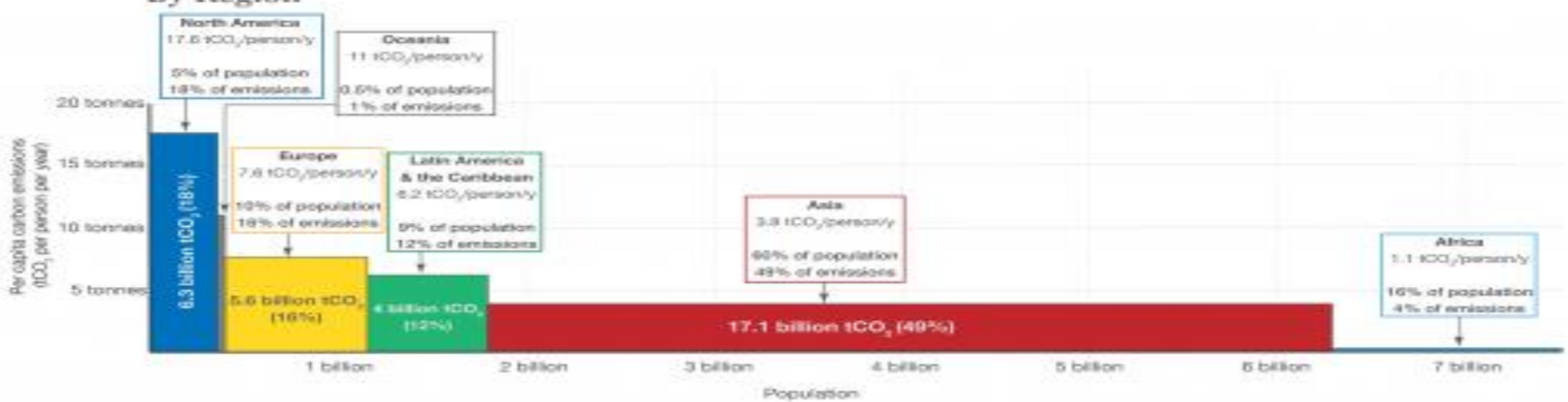
Breakdown of global carbon dioxide (CO_2) emissions in 2016 by World Bank income group (top) and world region (bottom). This is shown based on average per capita emissions (y-axis) and population size (x-axis), with the area of the box representing total annual emissions in 2016.

- Emissions represent domestic production (not accounting for embeddded emissions in traded products), and do not include cross-boundary emissions such as international aviation & shipping.
- Aggregation by income is based on the total emissions of countries within each of the World Bank's income groupings. It reflects average national incomes rather than the distribution of incomes within countries. E.g. 'Low income' reflects the total emissions of all countries defined as low income, rather than the emissions of global individuals defined as low income. If defined on the basis of individuals (without country contexts), the global inequality would be even larger.

By Income Group



By Region



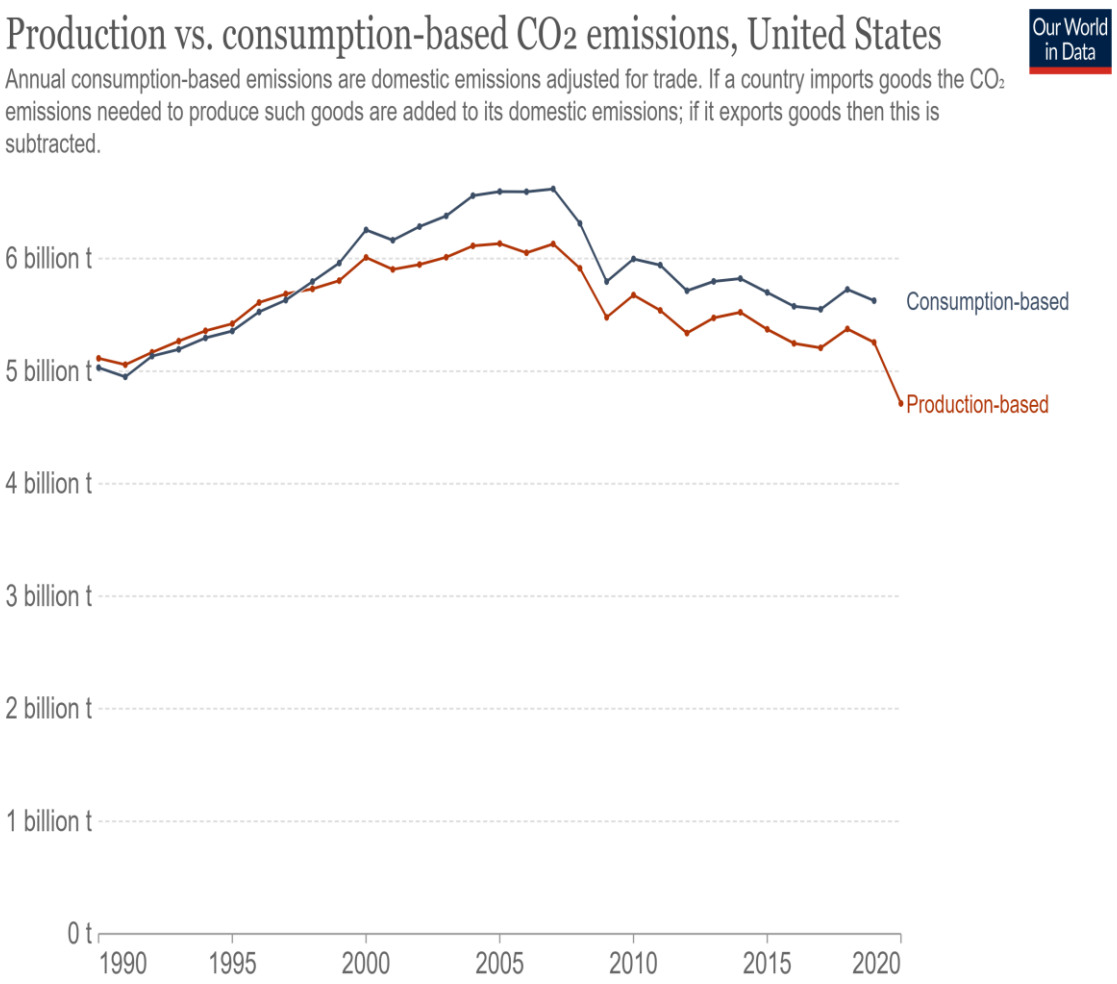
Source: Our World in Data based on data from the Global Carbon Project, UN Population Division (2018) & World Bank income groups.
This is a visualization from OurWorldInData.org, where you find data and research on how the world is changing.

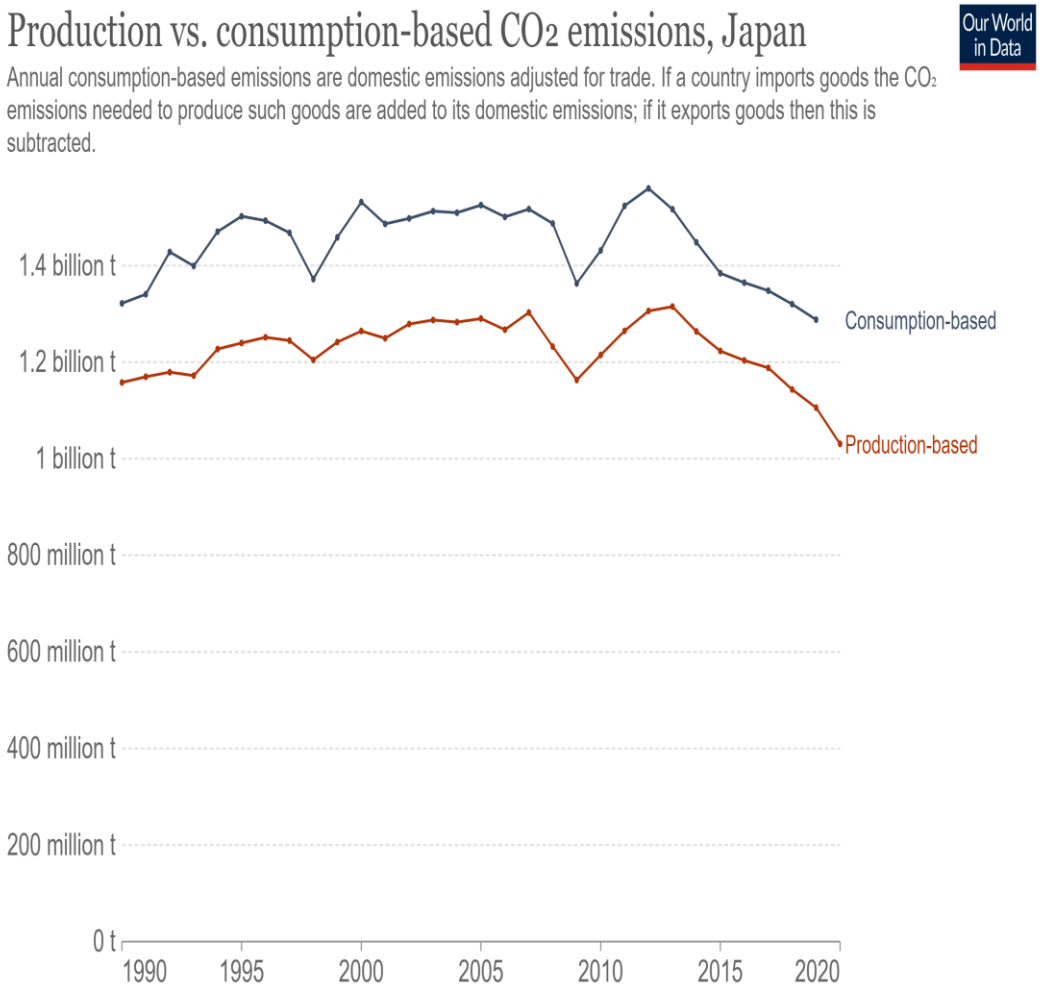
Global Pollution Inequalities

Income or regional group	Share of population (%)	Share of production-based CO_2 emissions (%)	Share of consumption-based CO_2 emissions (%)
High income [83 countries]	16%	39%	**46%**
Upper-middle income [56 countries]	35%	**48%**	41%
Lower-middle income [50 countries]	40%	13%	13%
Low income [28 countries]	9%	0.4%	0.4%
North America [40 countries]	5%	17%	**19%**
Europe [50 countries]	10%	16%	**18%**
Latin America & the Caribbean [33 countries]	9%	6%	6%
Asia [50 countries]	60%	**56%**	52%
Africa [57 countries]	16%	**4%**	3%
Oceania [23 countries]	0.5%	1.3%	1.3%

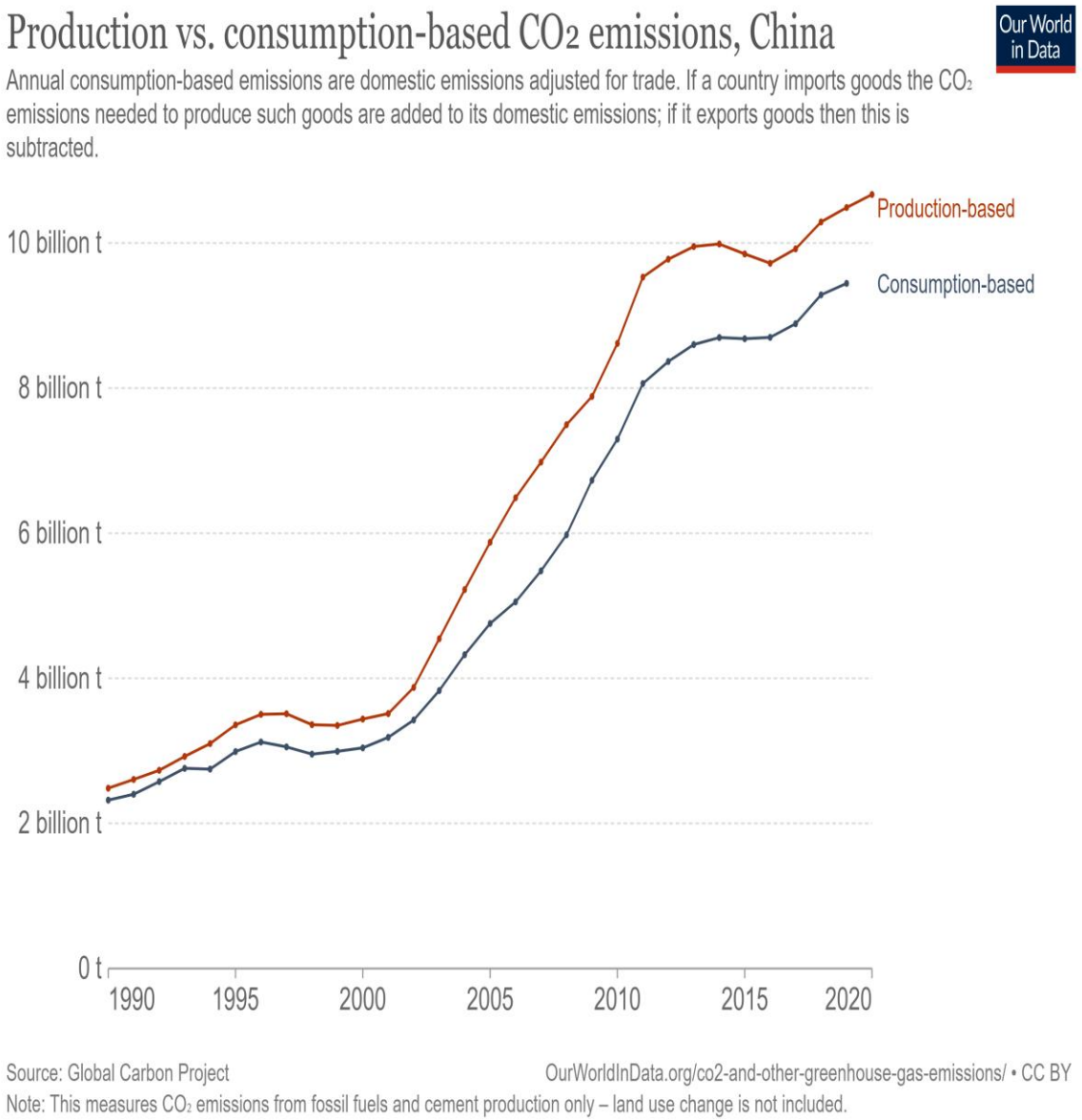
https://ourworldindata.org/co2-emissions

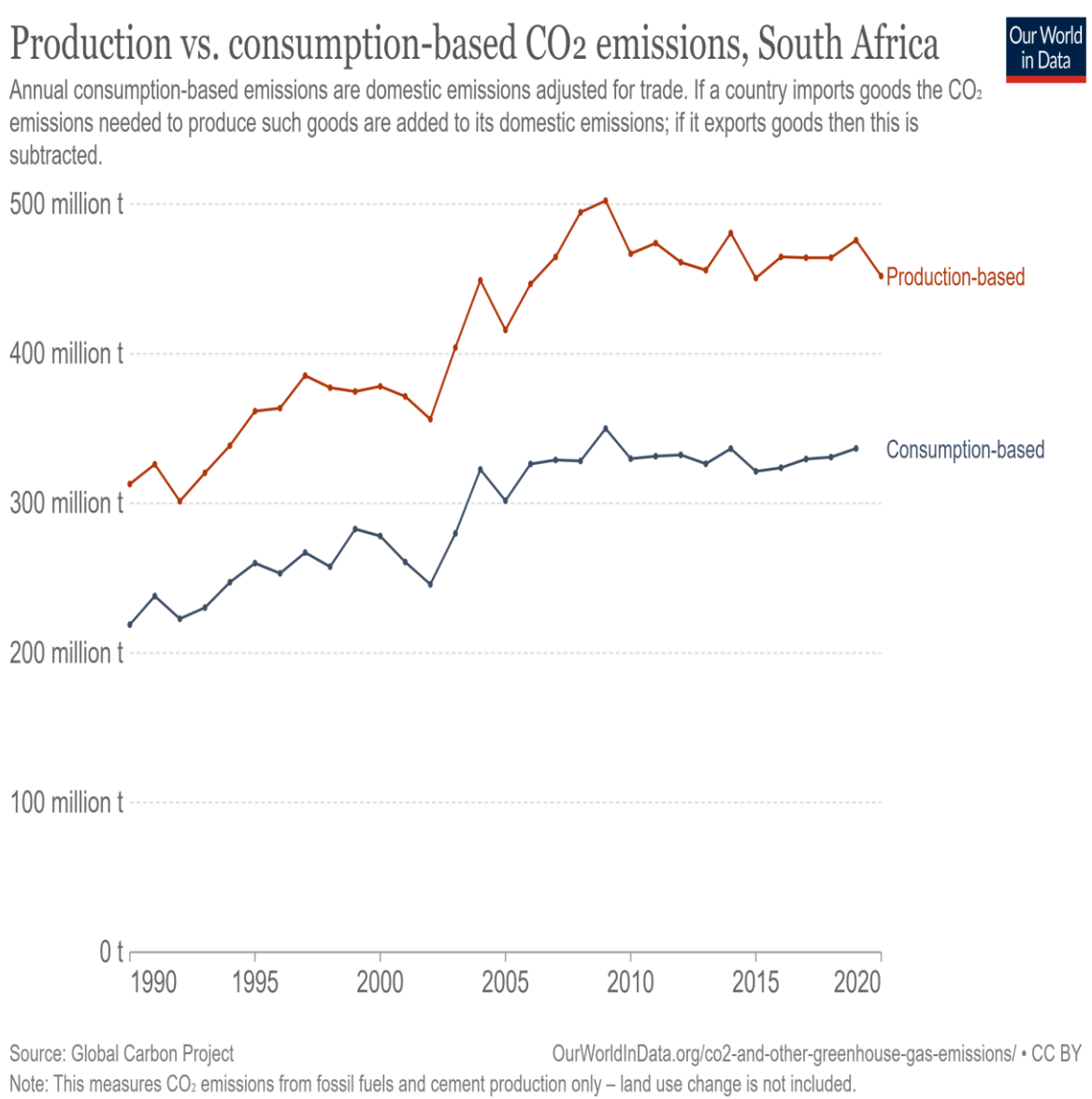
High Income Countries





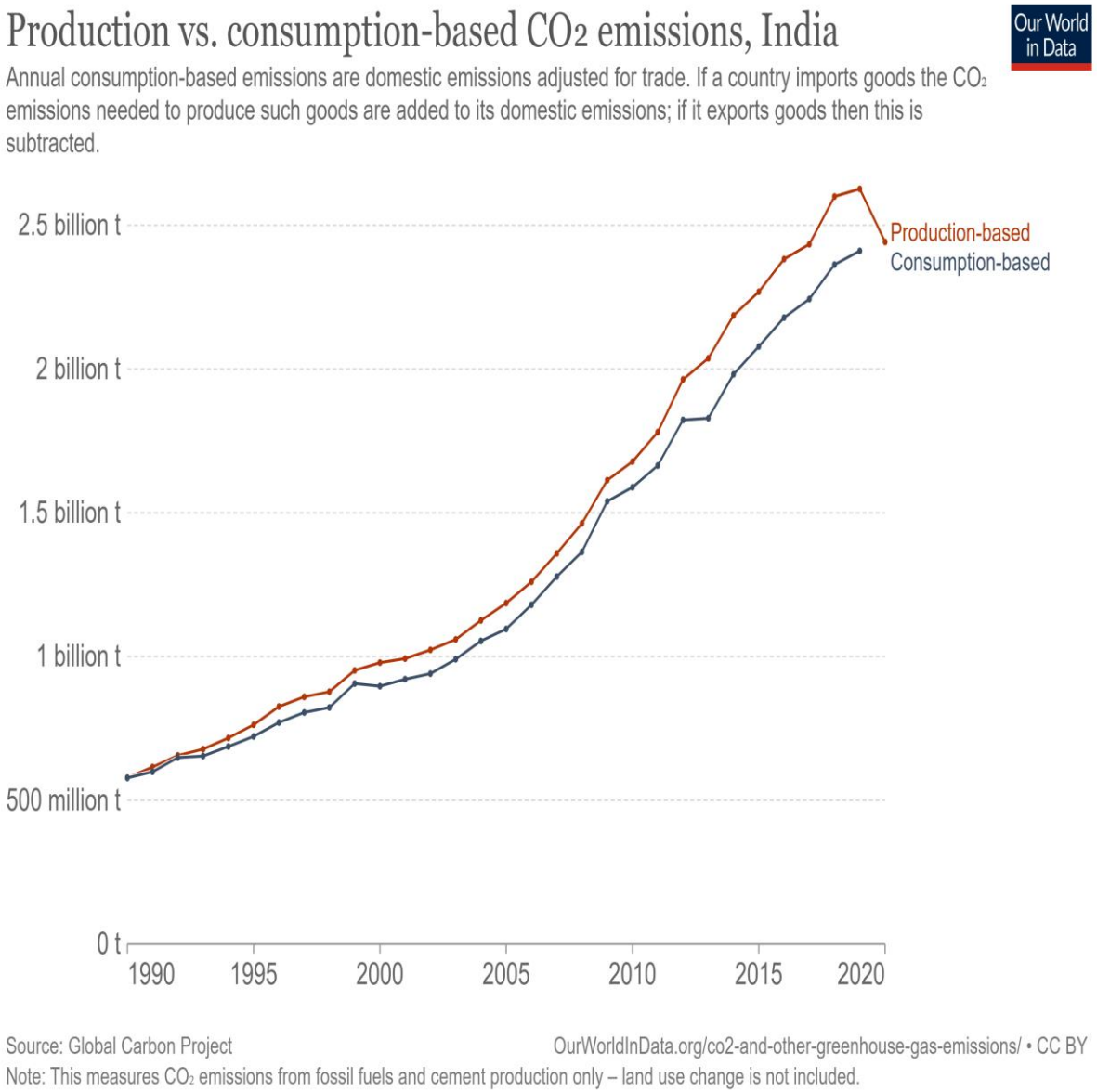
Upper-Middle Income Countries

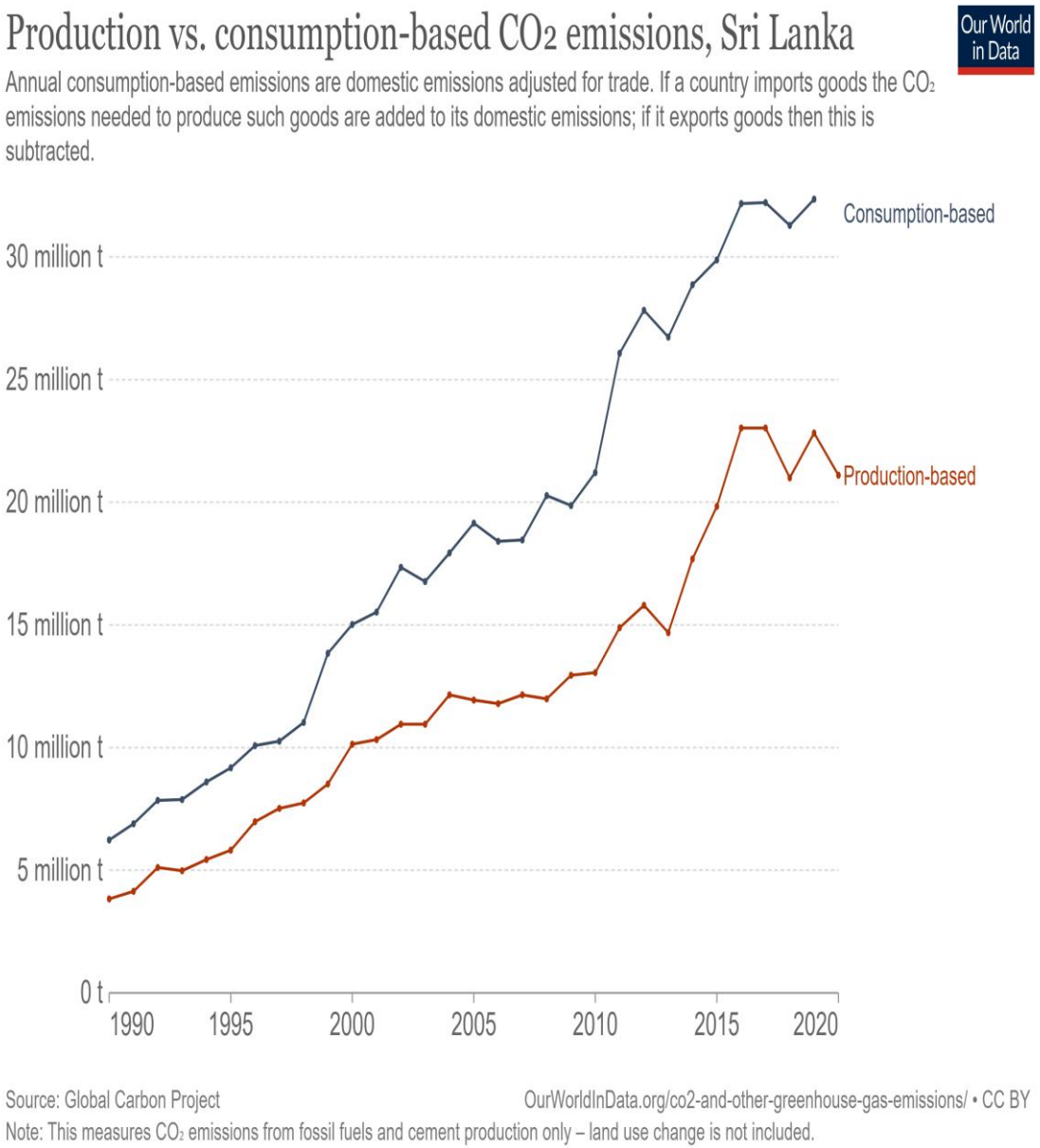




https://ourworldindata.org/grapher/production-vs-consumption-co2-emissions?country=~ZAF

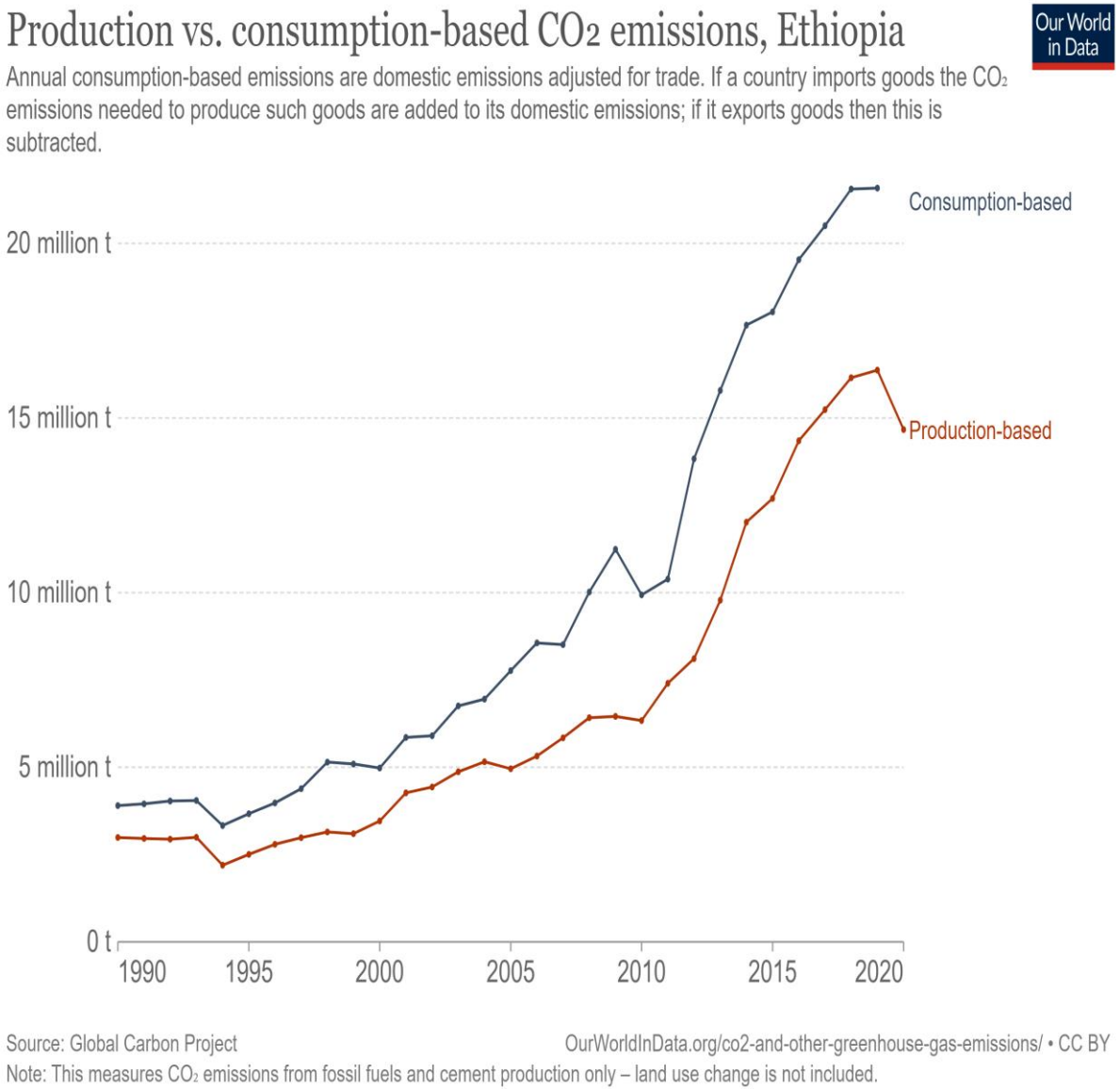
Lower-Middle Income Countries

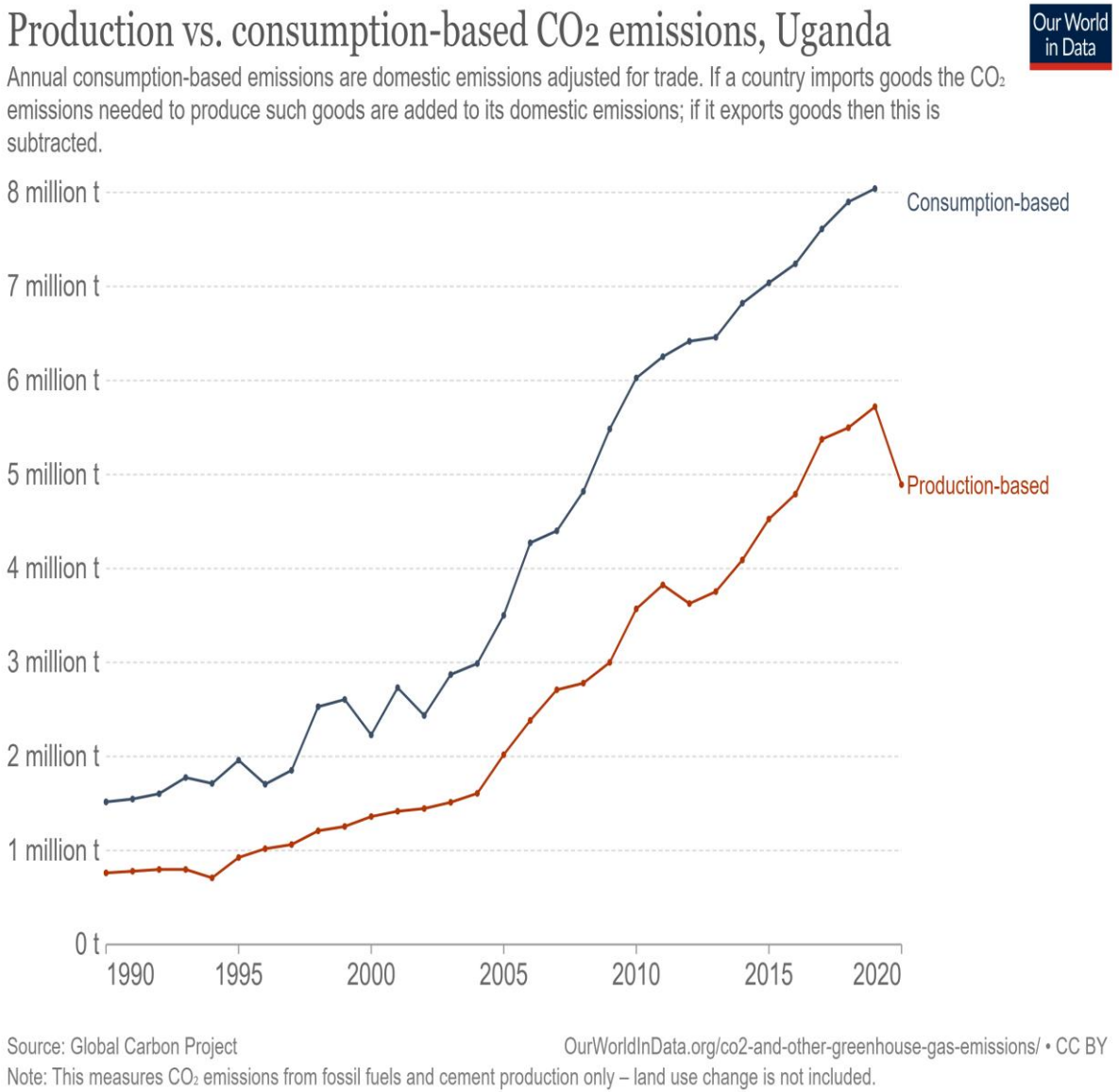




https://ourworldindata.org/grapher/production-vs-consumption-co2-emissions?country=~IND

Low Income Countries





https://ourworldindata.org/grapher/production-vs-consumption-co2-emissions?country=~UGA

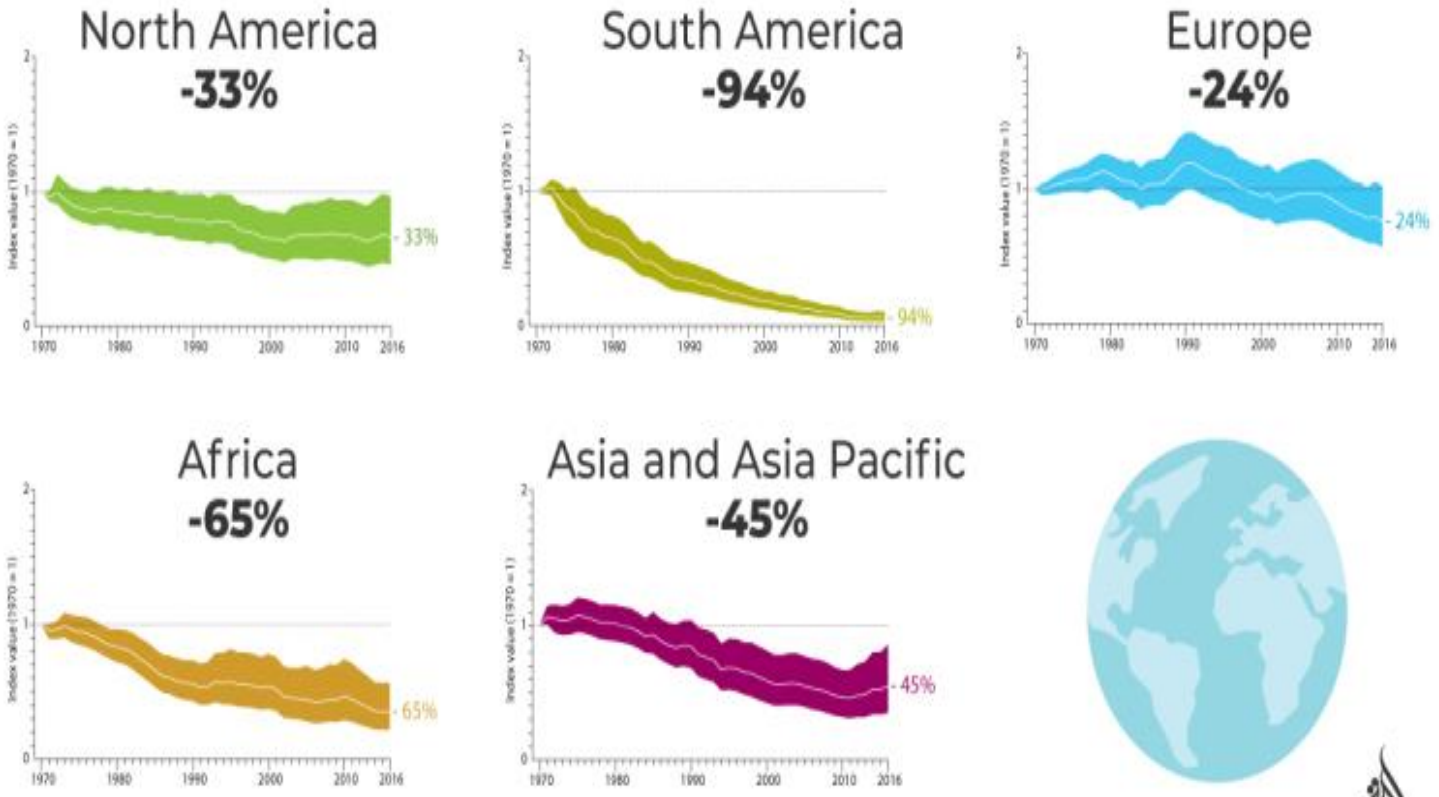
❑ Environmental Consequences

- Planet is becoming hotter because of fossil fuels extraction and usage.
- Excessive energy usage creates ‘‘anthropogenic carbon emissions’’.
- Pollution level in the atmosphere is increasing due to ‘‘human activities’’.
- Environmental change caused by ‘‘people’’.

- ✓ Growing economic growth with massive fossil fuels consumption accounts for the depreciation of the natural assets.
- ✓ Then sustainable development will be at risk if planetary system is destroyed.
- ✓ The life would also cease to exist.
- ✓ We need to protect the health of natural assets as nature is our home.

GLOBAL BIODIVERSITY LOSS

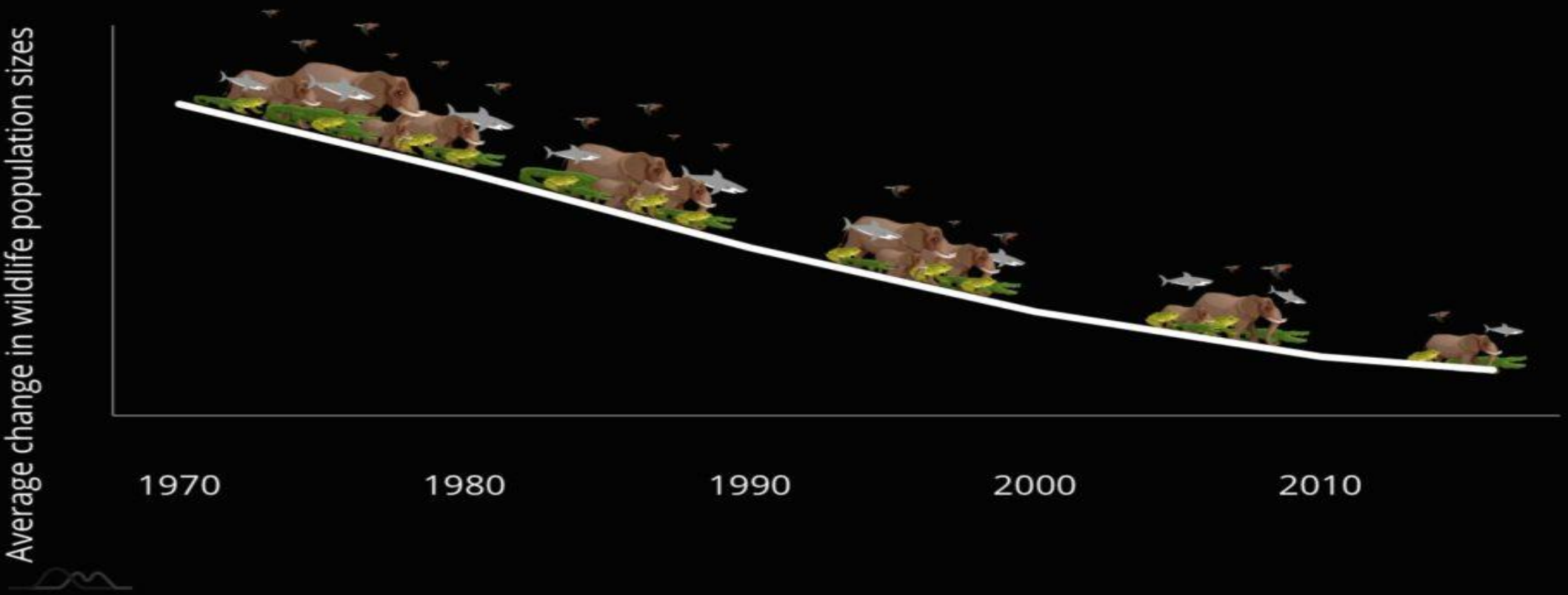
Biodiversity is declining at different rates in different places, with the largest losses occurring in tropical areas



Source: WWF Living Planet Report (2020)

THE LIVING PLANET INDEX

The population sizes of mammals, birds, fish, amphibians and reptiles have seen an alarming average drop of 68% since 1970.



Interaction Between the Capitals

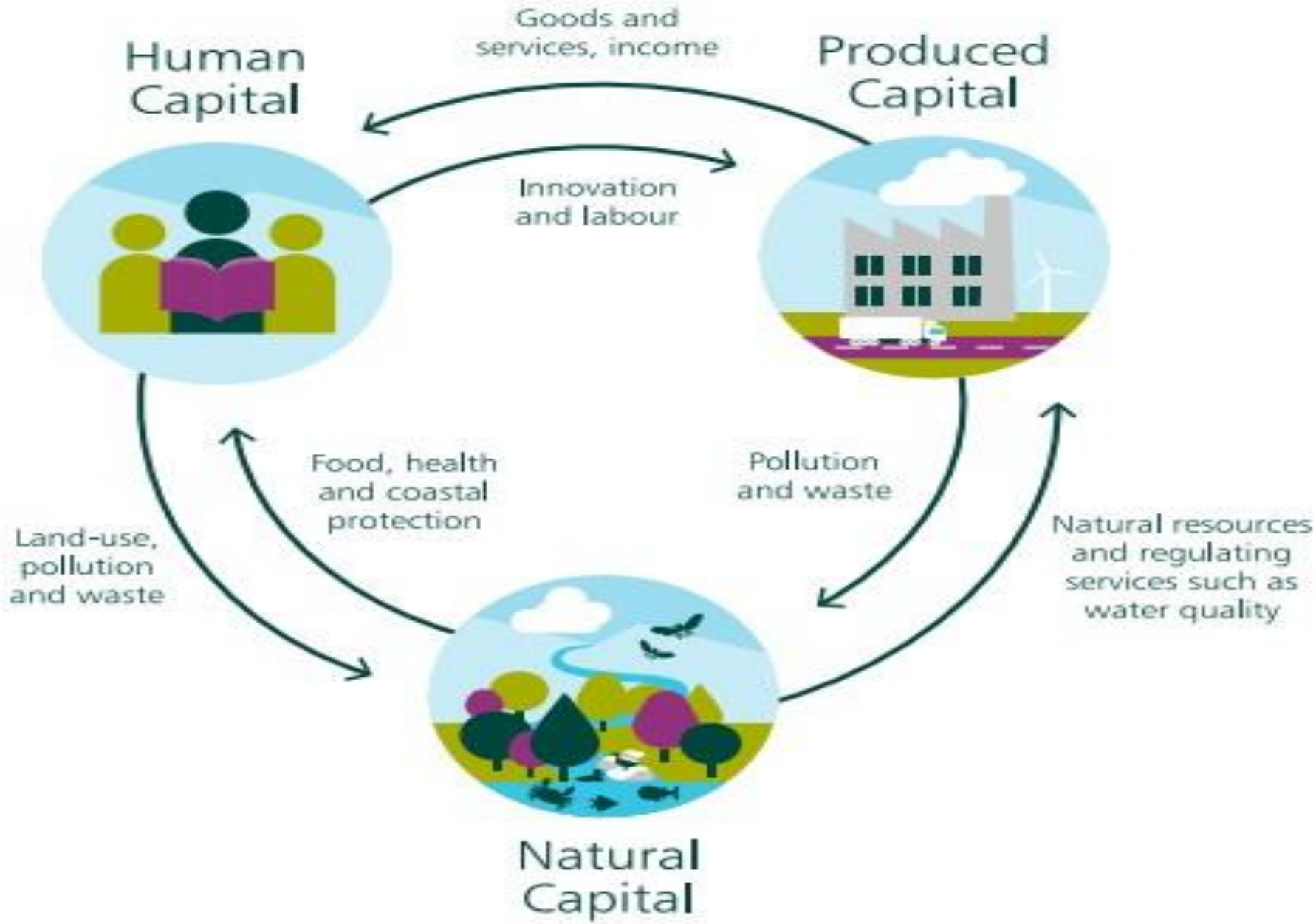


Figure 4.8 Global Wealth Per Capita, 1992 to 2014

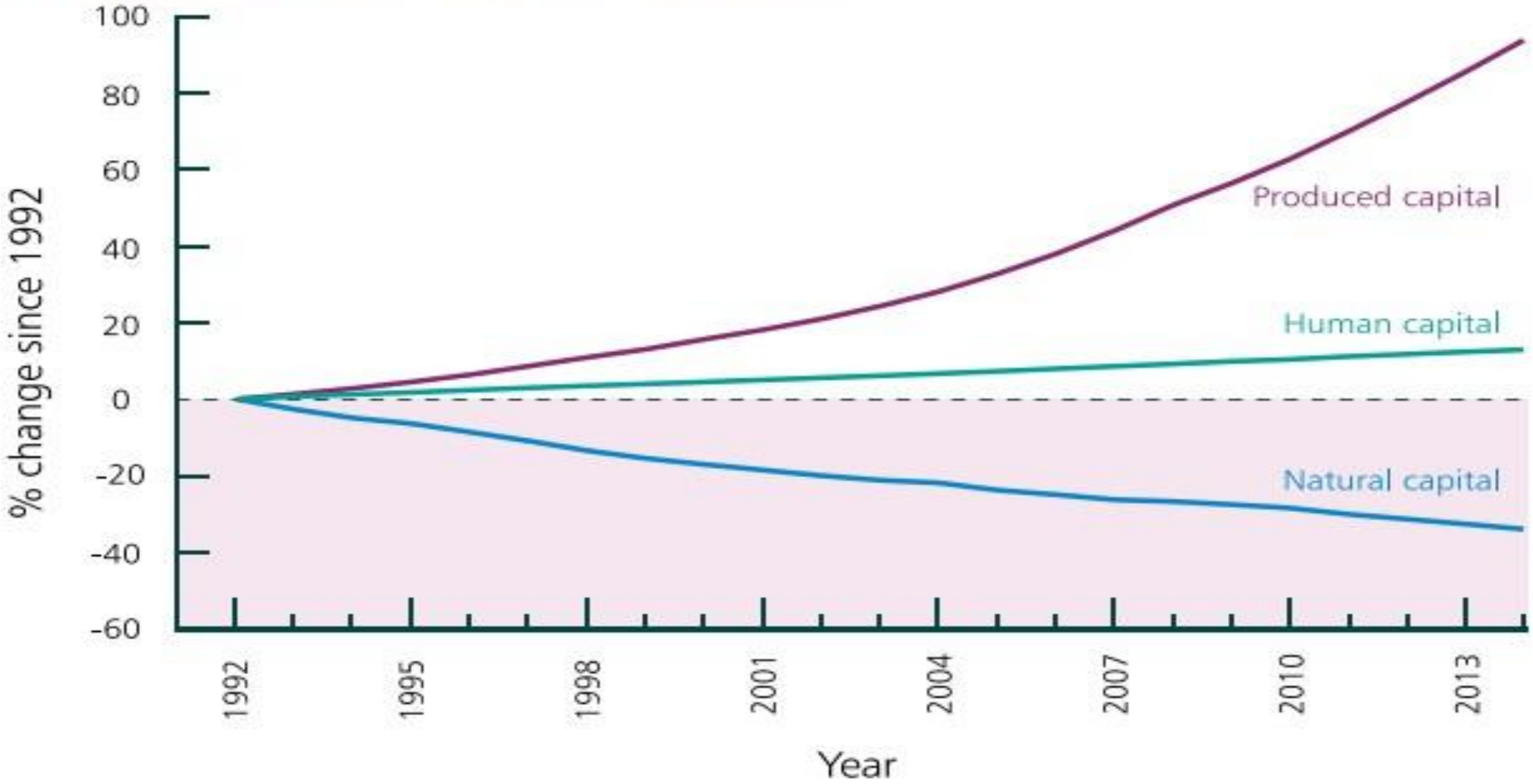
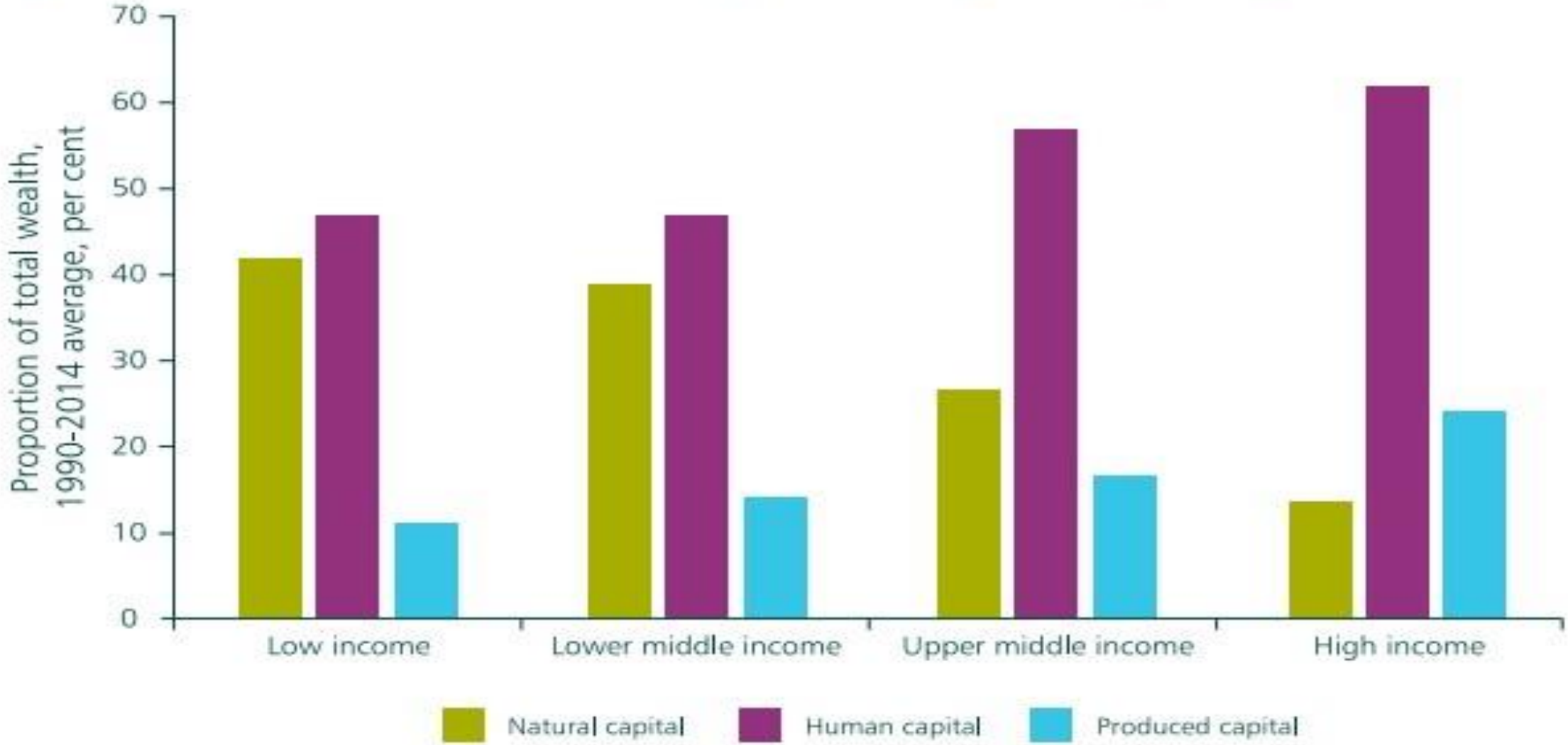


Figure 14.3 Inclusive Wealth of Countries by Income Group and Capital Type



Source: Based on Managi and Kumar (2018) and Review calculations.