Energy Markets, Hydrocarbons and Critical Minerals

in Numbers

Barış Sanlı

28.12.2023

Calendar - Climate

8 February 2024	Pakistan general election
14 February 2024	Indonesia general election
1 March 2024	Submission date for the JTWP
June 2024	UNFCCC intersessional meeting in Bonn, Germany
2 June 2024	Mexico general election
6-9 June 2024	European parliament election
17-19 June 2024	G7 summit, Puglia, Italy
22-30 June 2024	London climate action week
12-14 July 2024	G20 summit, Rio de Janeiro, Brazil
22-29 September 2024	Climate week New York City
10-24 September 2024	UN General Assembly (UNGA 79), New York City, US
21 October - 1 November 2024	UN Biodiversity Conference (COP16), Expected to be in Colombia
5 November 2024	US elections
11-24 November 2024	COP29, Baku, Azerbaijan

https://www.carbonbrief.org/cop28-key-outcomes-agreed-at-the-un-climate-talks-in-dubai/

Calendar - Elections

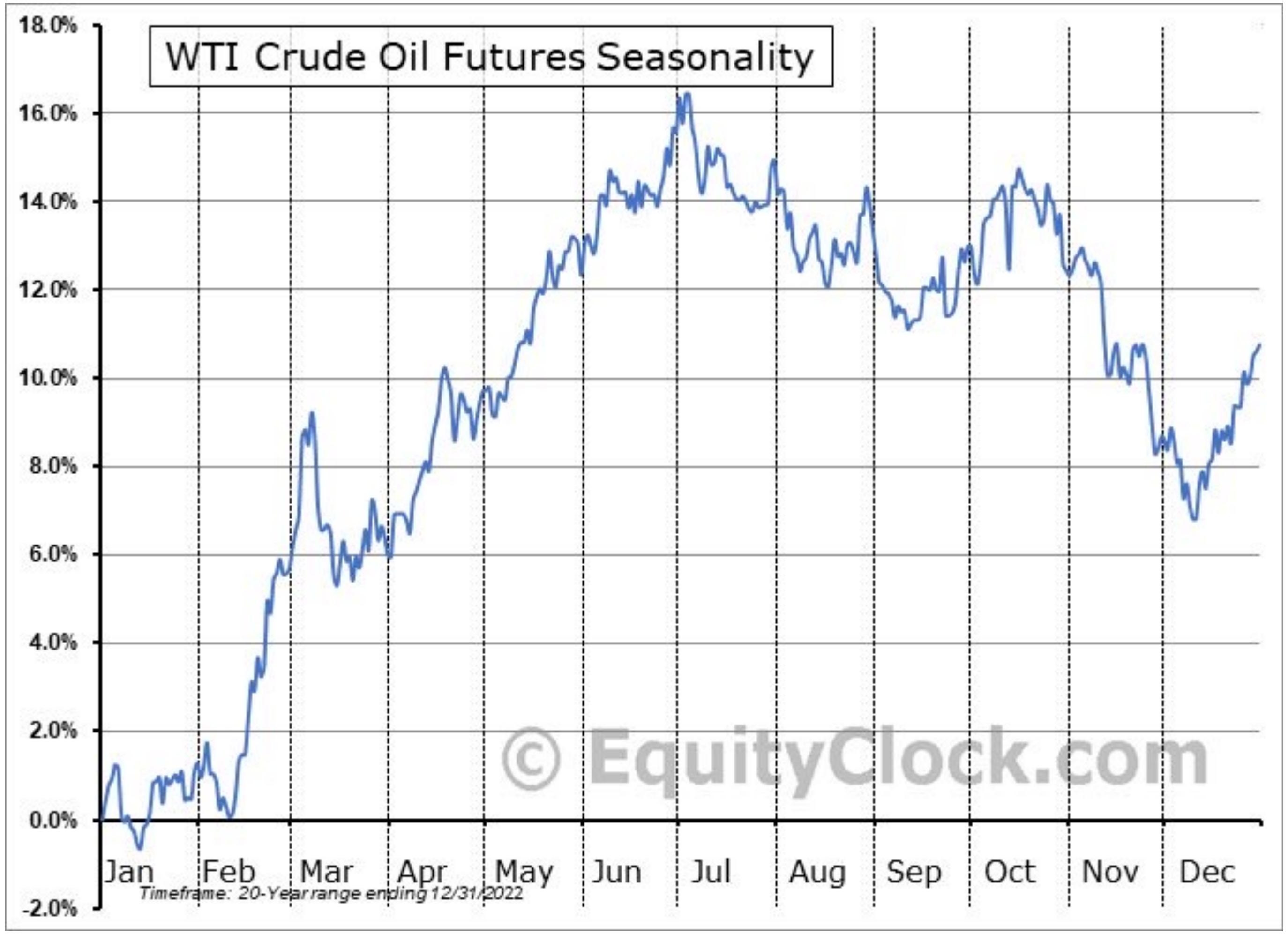
	European Union	Parliamentary Elections	06 Jun 2024
	Belgium	Federal Election, Territorial Elections	09 Jun 2024
	United States	President, House of Representatives, Senate and Gubernatorial elections	05 Nov 2024

March 2024 [edit]

- **March 2**: Republican caucuses in Idaho, Michigan, and Missouri[104][91]
- **March 3**: District of Columbia Republican primary
- **March 4**:
  - North Dakota Republican caucuses[194]
  - The trial for *United States v. Donald Trump* is set to begin.[195][196]
- **March 5**: Super Tuesday
  - Last date of mail-in voting in the Iowa Democratic caucuses.[152]
  - Democratic primaries in Alabama, American Samoa, Arkansas, California, Colorado, Maine, Massachusetts, Minnesota, North Carolina, Oklahoma, Tennessee, Texas, Utah, Vermont, and Virginia
  - Republican primaries in Alabama, Alaska, Arkansas, California, Colorado, Maine, Massachusetts, Minnesota, North Carolina, Oklahoma, Tennessee, Texas, Utah, Vermont, and Virginia
- **March 9**: Guam Republican caucuses
- **March 10**: Republican primaries in the Northern Mariana Islands and Puerto Rico
- **March 12**:
  - Democratic primaries in Georgia, Mississippi, the Northern Mariana Islands, Washington, and abroad[69]
  - Republican primaries in Georgia, Hawaii, Mississippi, and Washington[69]
- **March 19**:
  - Democratic primaries in Arizona, Florida, Illinois, Kansas, and Ohio
  - Republican primaries in Arizona, Florida, Illinois, Kansas, and Ohio[197][198][199][200]
- **March 20**: American Samoa Republican presidential caucuses
- **March 23**:
  - Democratic primaries in Louisiana and Missouri
  - Louisiana Republican primary[201]
- **March 25:** The trial for *New York v. Donald Trump* is set to begin.

http://www.aweb.org/eng/bbs/B0000007/list.do?menuNo=300052

Seasonality in prices



IEA World Energy Outlook 2023

IEA World Energy Outlook 2023

Tables for Scenario Projections

Source: IEA.

https://www.iea.org/weo/

CC BY NC SA

Total Energy Supply (TES)	Total Final Consumption	Electricity generation Electrical capacity	CO_2 emissions Economic and activity indicators	Fossil fuel production and demand
A.1: World energy supply	A.2: World final energy consumption	A.3: World electricity sector	A.4: World CO2 emissions	A.8: Oil production
A.6: TES for key regions	A.23: Total final consumption for key regions	A.16: Electricity generation for key regions	A.5: World economic and activity indicators	A.9: Oil demand
A.7: Renewables energy supply for key regions	A.24: Industry consumption for key regions	A.17: Renewables generation for key regions	A.29: Total CO_2 emissions for key regions	A.10: World liquids demand
	A.25: Transport consumption for key regions	A.18: Solar PV generation for key regions	A.30: Electricity and heat sectors CO_2 emissions for key regions	A.11: Refining capacity and runs
	A.26: Buildings consumption for key regions	A.19: Wind generation for key regions	A.31: Total final consumption CO_2 emissions for key regions	A.12: Natural gas production
	A.27: Hydrogen demand for key regions	A.20: Nuclear generation for key regions		A.13: Natural gas demand
	A.28: World hydrogen balance	A.21: Natural gas generation for key regions		A.14: Coal production
		A.22: Coal generation for key regions		A.15: Coal demand

Tables for scenario projections (Annex A)
https://www.iea.org/data-and-statistics/data-product/world-energy-outlook-2023-free-dataset-2

World Energy Supply & Final Consumption

Energy supply: World

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				Stated Policies Scenario (EJ)				Shares (%)			CAAGR (%) 2022 to:	
	2010	2021	2022	2030	2035	2040	2050	2022	2030	2050	2030	2050
Total energy supply	541	624	632	668	678	692	725	100	100	100	0,7	0,5
Renewables	43	71	75	120	150	178	227	12	18	31	6,0	4,0
Solar	1	5	7	23	35	49	70	1	3	10	17	8,8
Wind	1	7	8	19	27	33	42	1	3	6	12	6,3
Hydro	12	15	16	18	19	20	23	2	3	3	1,6	1,3
Modern solid bioenergy	23	33	35	44	48	51	57	6	7	8	3,0	1,7
Modern liquid bioenergy	2	4	4	6	7	8	9	1	1	1	4,4	2,7
Modern gaseous bioenergy	1	1	1	2	3	5	8	0	0	1	7,7	6,7
Traditional use of biomass	25	24	24	19	18	18	16	4	3	2	-3,0	-1,4
Nuclear	30	31	29	37	40	43	48	5	6	7	2,9	1,8
Unabated natural gas	115	146	144	148	145	143	142	23	22	20	0,3	-0,0
Natural gas with CCUS	0	1	1	1	2	2	3	0	0	0	10	6,2
Oil	173	182	187	195	191	187	186	30	29	26	0,5	-0,0
Non-energy use	25	31	32	38	40	41	41	5	6	6	2,3	0,9
Unabated coal	153	167	170	147	130	119	101	27	22	14	-1,8	-1,8
Coal with CCUS	-	0	0	0	0	0	1	0	0	0	23	13
Electricity and heat sectors	200	244	247	263	275	291	321	100	100	100	0,8	0,9
Renewables	20	39	41	77	102	126	166	17	29	52	8,0	5,1
Solar PV	0	4	5	19	31	43	62	2	7	19	20	9,7
Wind	1	7	8	19	27	33	42	3	7	13	12	6,3
Hydro	12	15	16	18	19	20	23	6	7	7	1,6	1,3
Bioenergy	4	9	9	14	16	17	21	4	5	6	4,8	2,9
Hydrogen	-	-	-	0	0	0	0	-	0	0	n.a.	n.a.
Ammonia	-	-	-	0	0	0	0	-	0	0	n.a.	n.a.
Nuclear	30	31	29	37	40	43	48	12	14	15	2,9	1,8
Unabated natural gas	47	57	57	55	51	49	49	23	21	15	-0,5	-0,6
Natural gas with CCUS	-	-	-	0	0	0	0	-	0	0	n.a.	n.a.
Oil	11	8	8	5	4	4	3	3	2	1	-5,1	-3,3
Unabated coal	91	108	110	89	75	66	52	45	34	16	-2,7	-2,6
Coal with CCUS	-	0	0	0	0	0	0	0	0	0	29	15
Other energy sector	50	64	65	68	69	69	73	100	100	100	0,7	0,4
Biofuels conversion losses	-	5	6	8	8	9	10	100	100	100	3,6	1,9
Low-emissions hydrogen (offsite)												
Production inputs	-	0	0	1	2	3	4	100	100	100	n.a.	n.a.
Production outputs	-	0	0	1	1	2	3	100	100	100	83	25
For hydrogen-based fuels	-	-	-	0	0	1	1	-	27	29	n.a.	n.a.

Total final consumption: World

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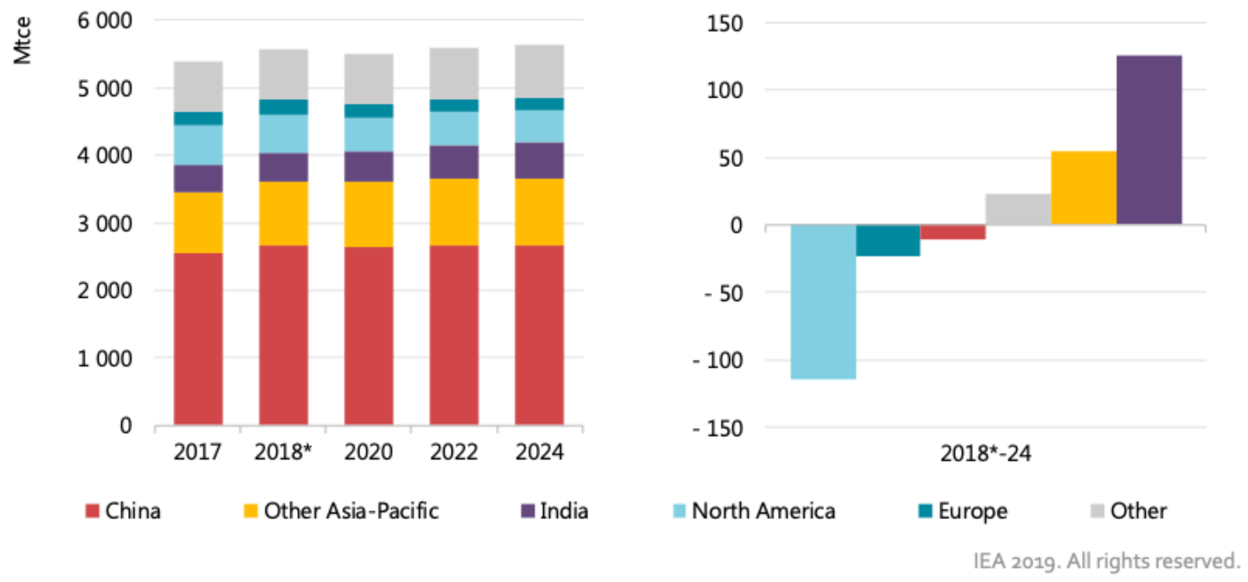
				Stated Policies Scenario (EJ)				Shares (%)			CAAGR (%) 2022 to:	
	2010	2021	2022	2030	2035	2040	2050	2022	2030	2050	2030	2050
Total final consumption	383	436	442	482	496	509	536	100	100	100	1,1	0,7
Electricity	64	87	89	108	121	135	159	20	22	30	2,5	2,1
Liquid fuels	154	168	172	186	184	183	185	39	39	34	0,9	0,2
Biofuels	2	4	4	6	7	8	9	1	1	2	4,4	2,7
Ammonia	-	-	-	0	0	0	0	-	0	0	n.a.	n.a.
Synthetic oil	-	-	-	-	-	-	-	-	-	-	n.a.	n.a.
Oil	151	164	168	180	177	175	176	38	37	33	0,8	0,2
Gaseous fuels	58	72	71	78	80	82	85	16	16	16	1,2	0,6
Biomethane	0	0	0	1	1	2	4	0	0	1	13	11
Hydrogen	-	0	0	0	0	1	1	0	0	0	58	22
Synthetic methane	-	-	-	-	-	-	-	-	-	-	n.a.	n.a.
Natural gas	57	72	70	76	78	79	78	16	16	15	1,1	0,4
Solid fuels	95	92	93	90	88	87	84	21	19	16	-0,4	-0,3
Solid bioenergy	38	39	40	38	39	39	40	9	8	7	-0,6	-0,0
Coal	56	52	52	51	49	47	44	12	11	8	-0,2	-0,6
Heat	12	15	15	16	16	16	16	3	3	3	1,1	0,3
Industry	143	167	167	187	194	201	207	100	100	100	1,4	0,8
Electricity	27	37	38	44	47	50	56	23	23	27	1,8	1,4
Liquid fuels	29	33	32	39	41	42	43	19	21	21	2,4	1,0
Oil	29	33	32	39	41	42	43	19	21	21	2,4	1,0
Gaseous fuels	24	31	30	34	36	38	39	18	18	19	1,6	1,0
Biomethane	0	0	0	0	0	1	2	0	0	1	16	12
Hydrogen	-	0	0	0	0	0	0	0	0	0	61	20
Unabated natural gas	24	31	30	34	35	36	37	18	18	18	1,5	0,7
Natural gas with CCUS	-	0	0	0	0	0	0	0	0	0	11	8,5
Solid fuels	58	58	59	62	62	62	60	35	33	29	0,6	0,1
Modern solid bioenergy	8	10	11	13	14	15	17	7	7	8	2,2	1,5
Unabated coal	49	47	47	48	47	46	43	28	26	21	0,2	-0,4
Coal with CCUS	-	0	0	0	0	0	0	0	0	0	9,7	7,2
Heat	5	7	7	8	8	8	8	4	4	4	1,0	0,3
Chemicals	38	48	48	57	60	62	63	29	31	31	2,2	1,0
Iron and steel	31	37	35	36	37	37	37	21	20	18	0,5	0,1
Cement	9	12	12	12	12	12	12	7	7	6	0,4	0,0
Aluminium	5	7	7	7	7	7	7	4	4	3	0,5	-0,0

Bad news – Coal defy expectations?

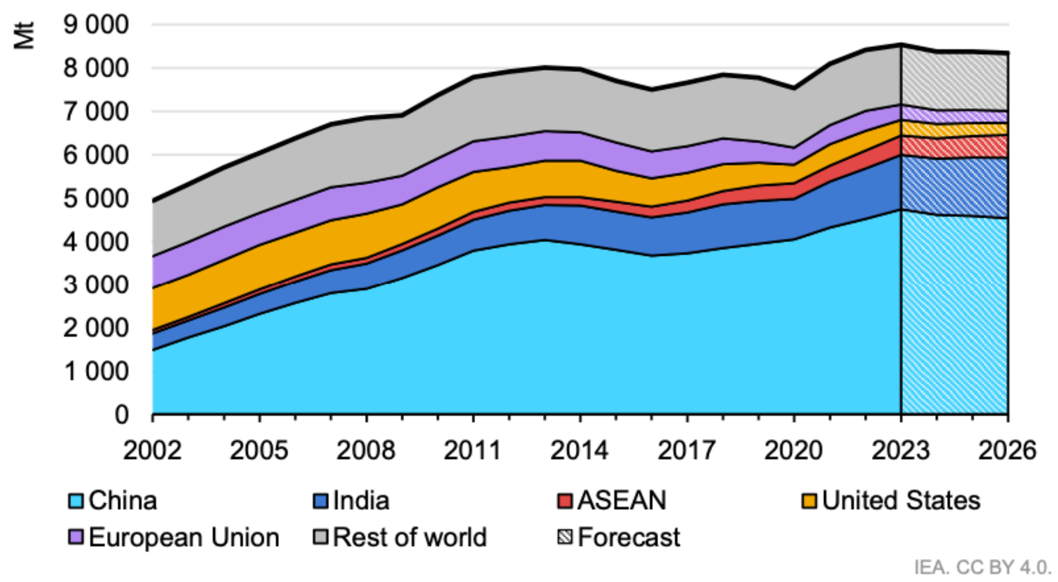
Figure 3.16. Global coal production development, 2017-24



*Estimated.

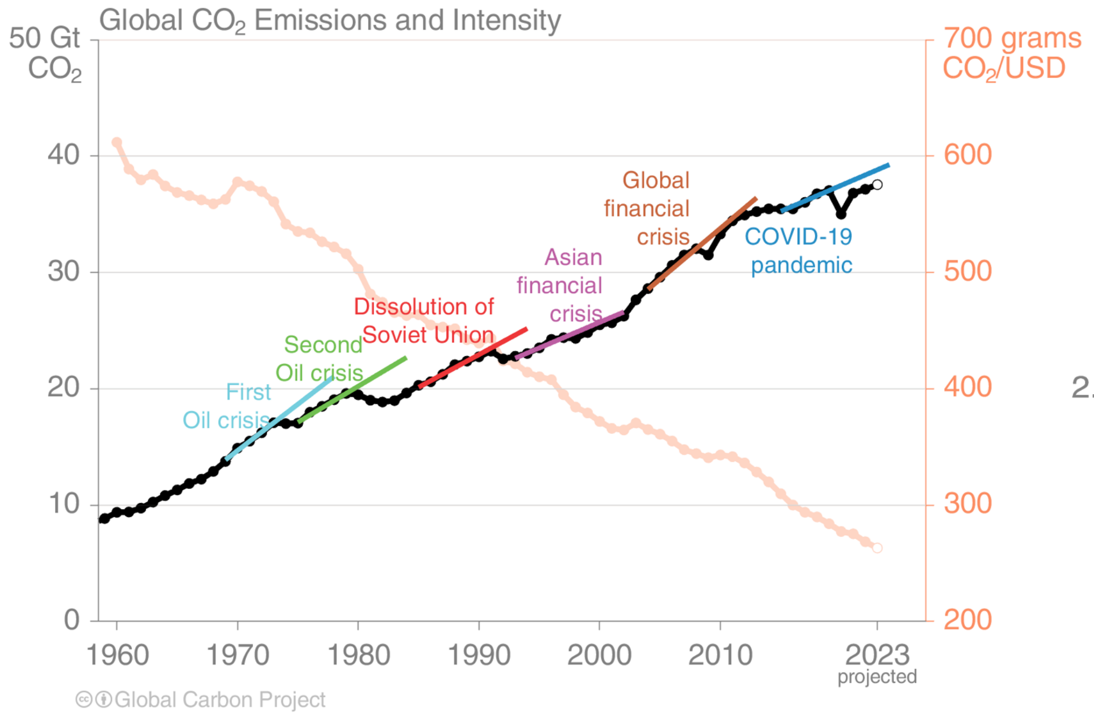
https://www.iea.org/reports/coal-2019

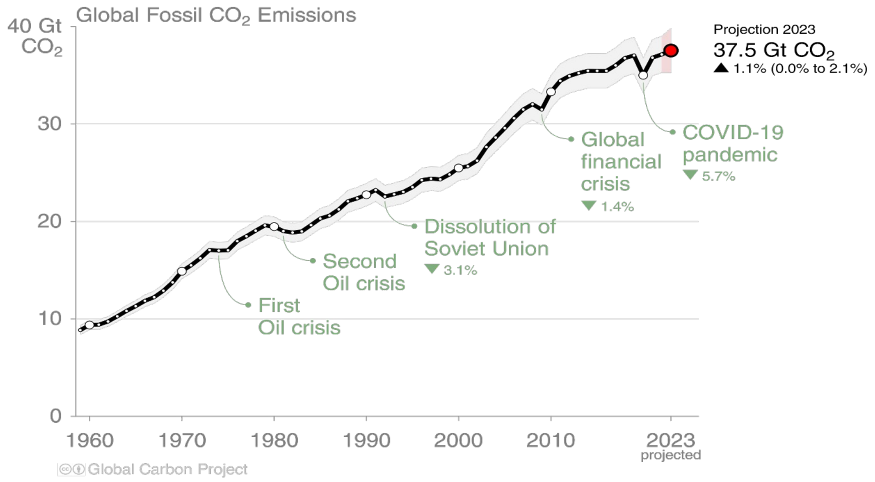
Global coal consumption, 2002-2026

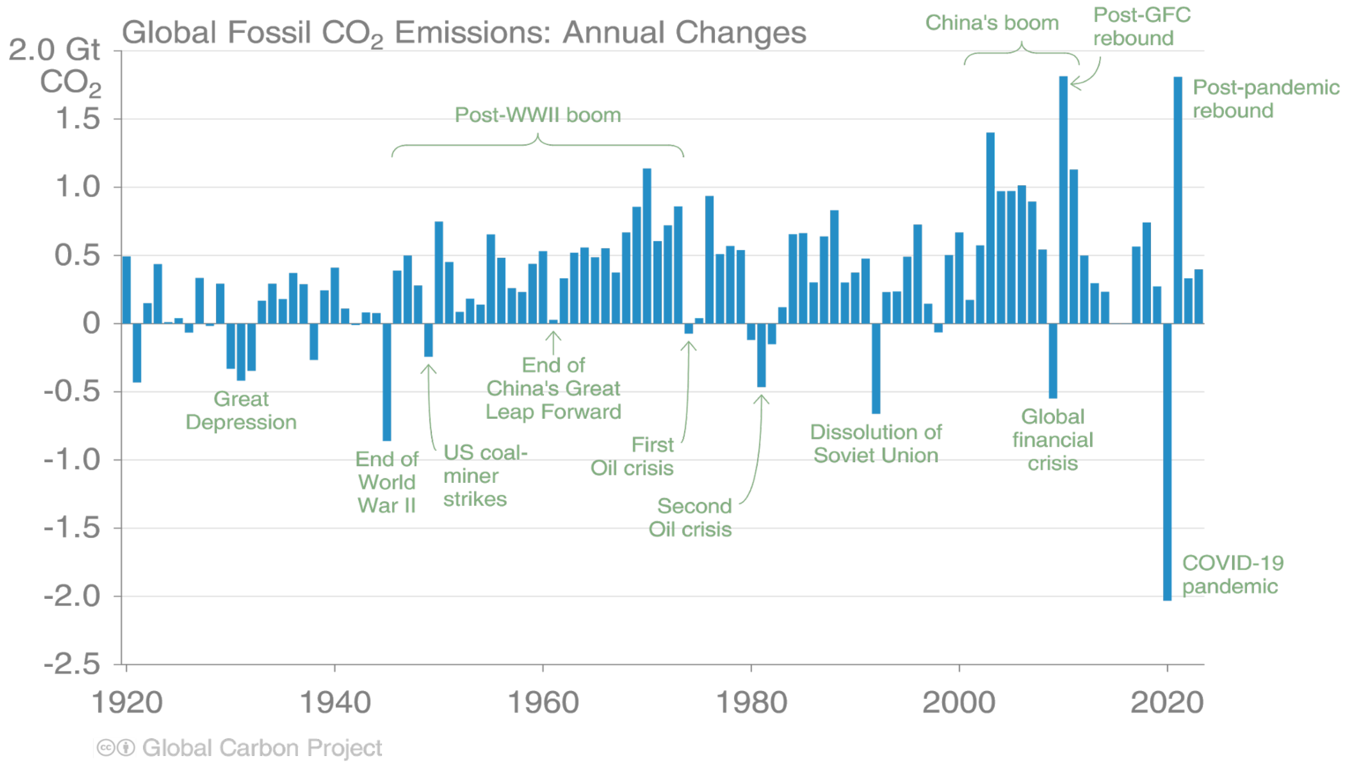


https://www.iea.org/reports/coal-2023

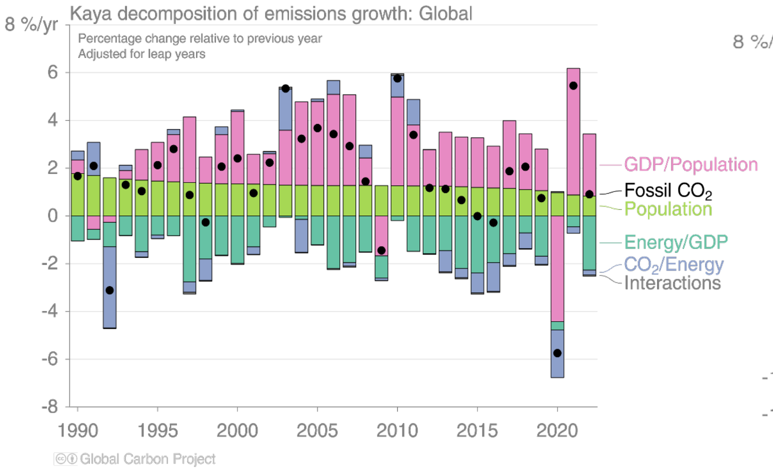
Good news – Emissions slowed

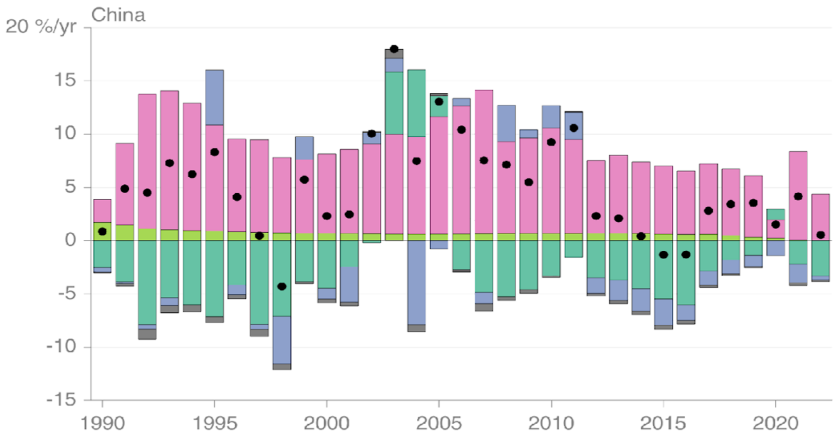


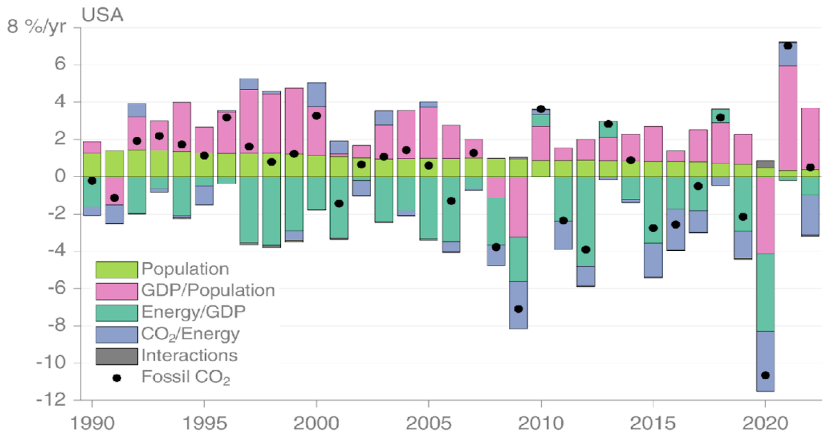


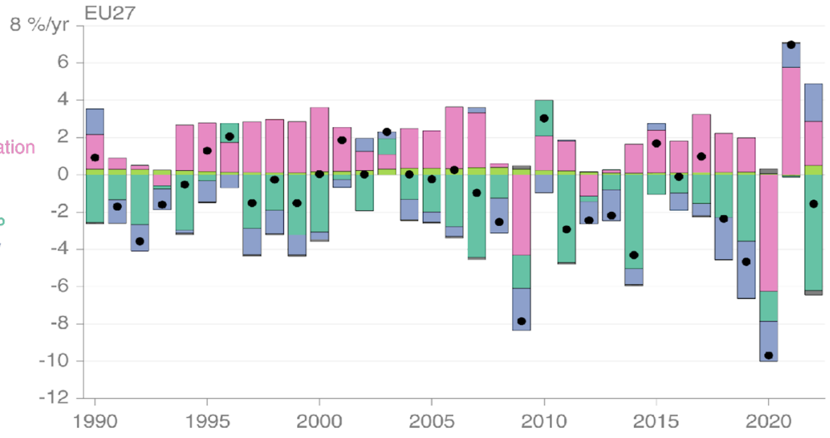


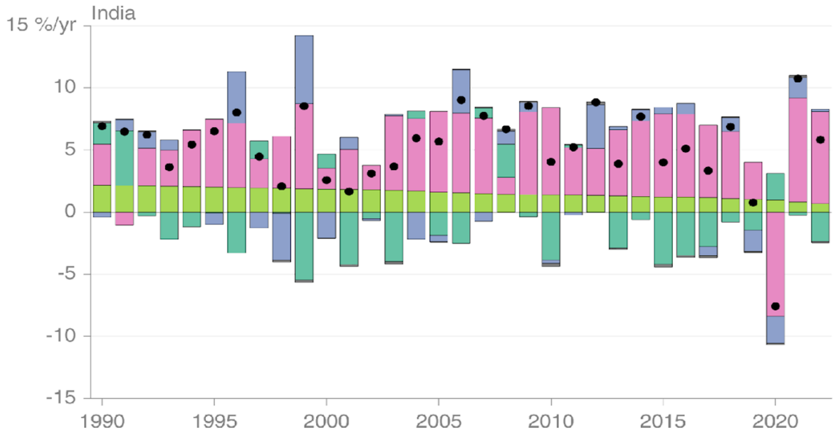
Kaya Decomposition

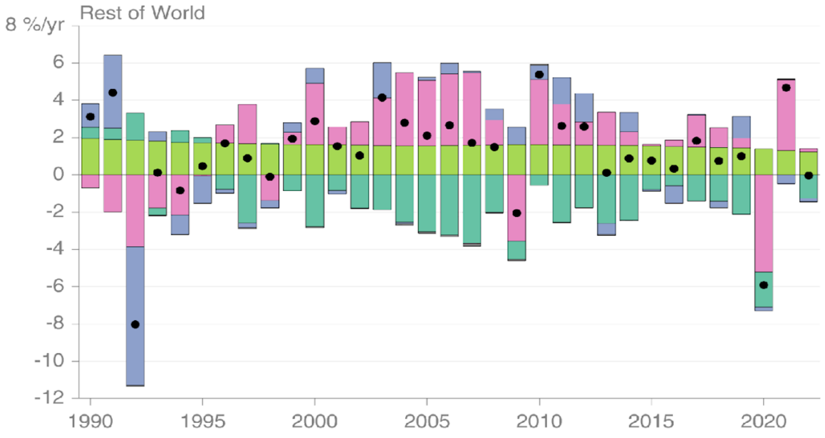


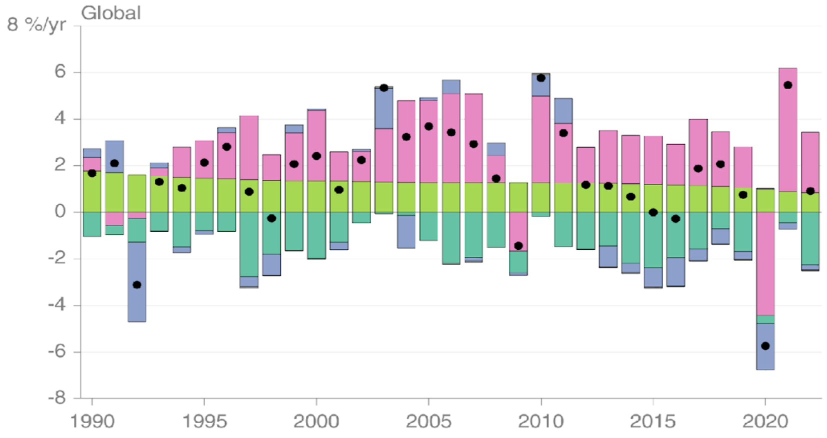




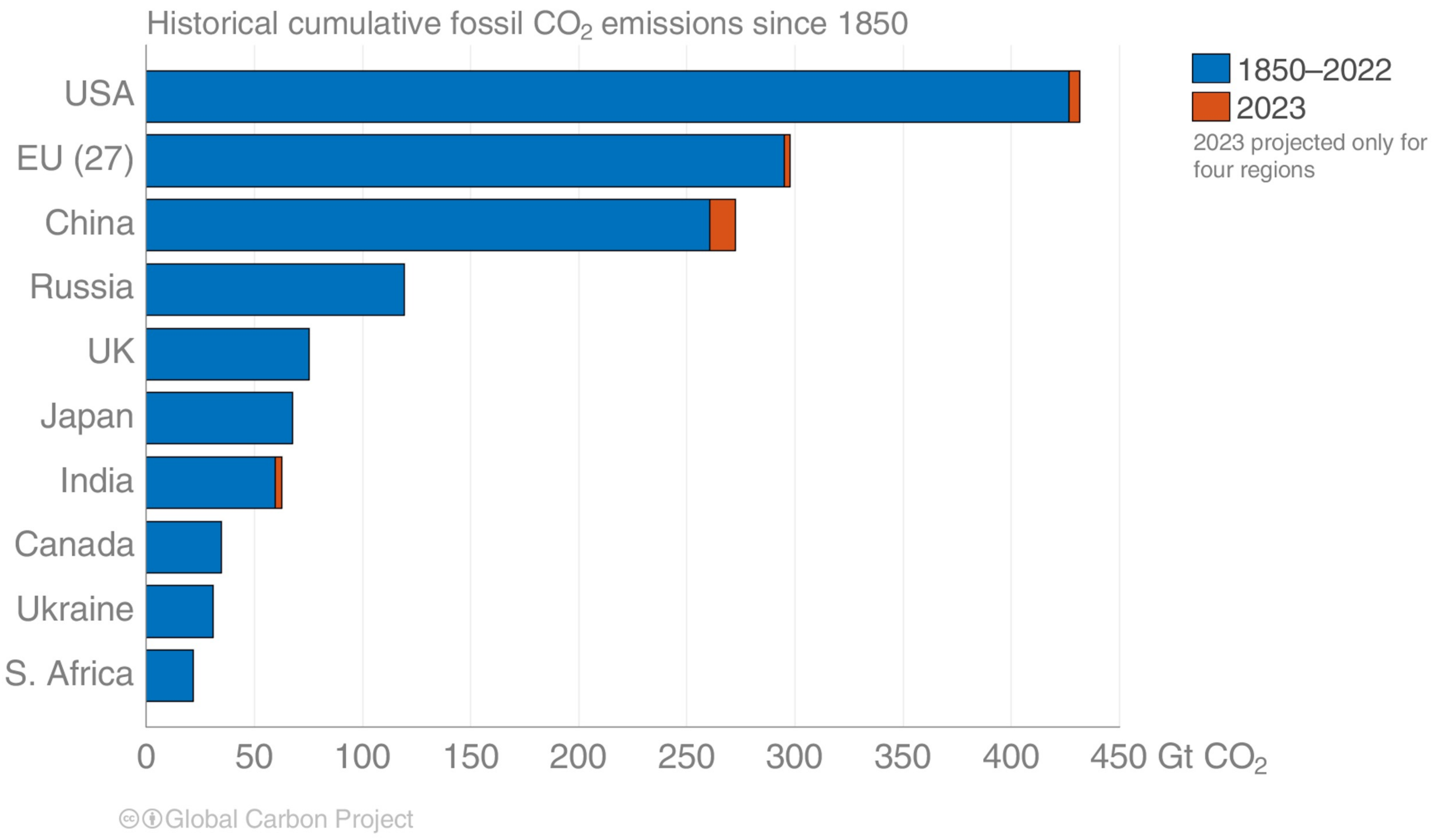




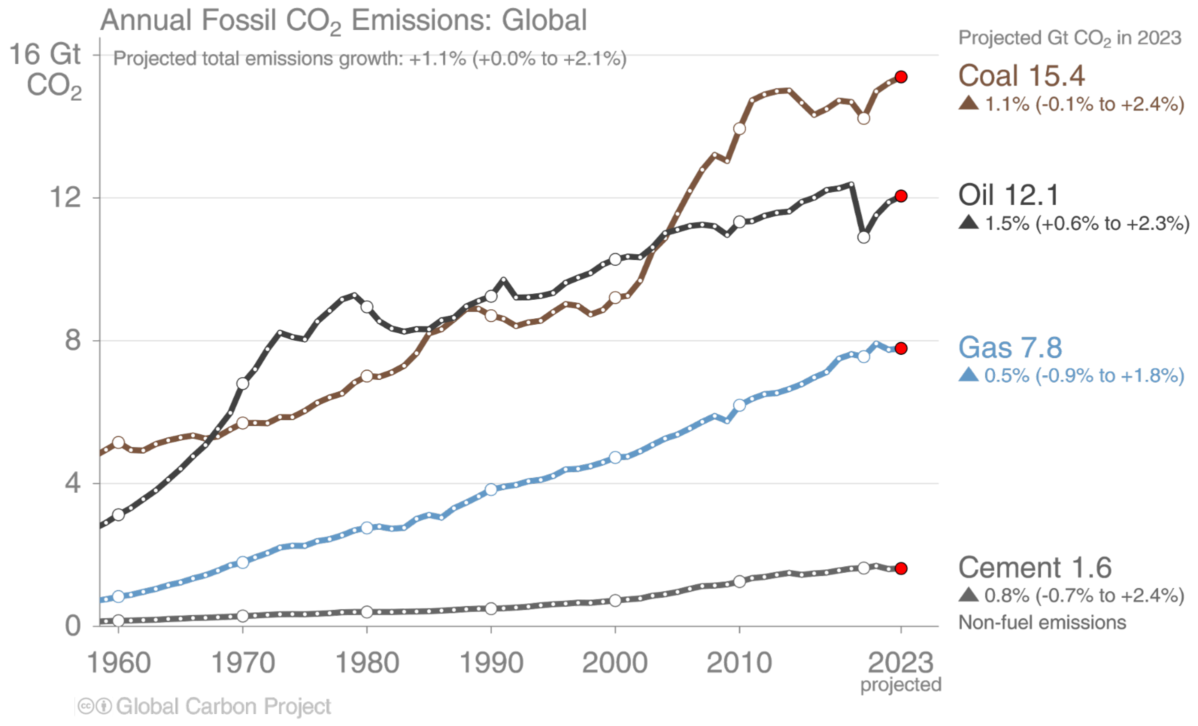


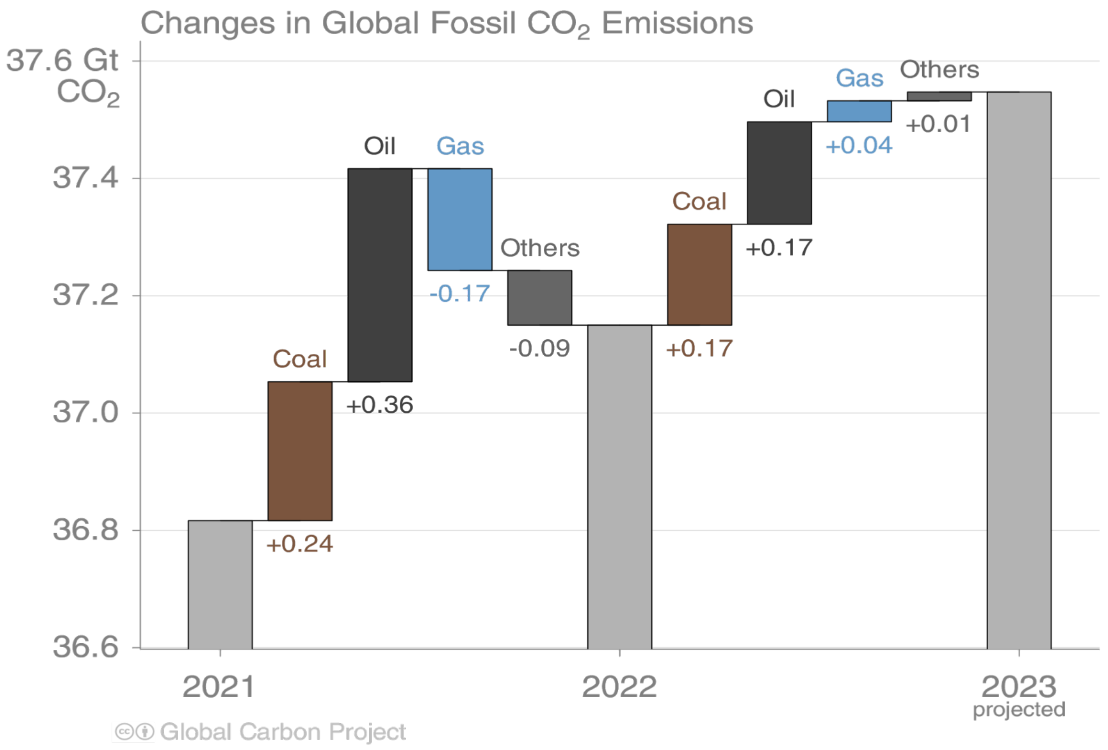


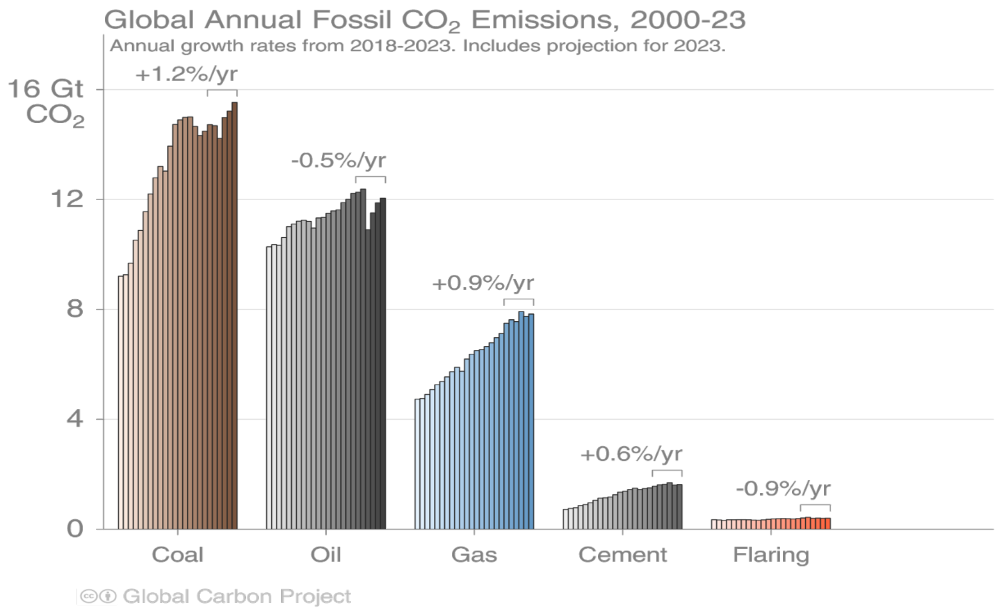
Historical Emissions



Emission change

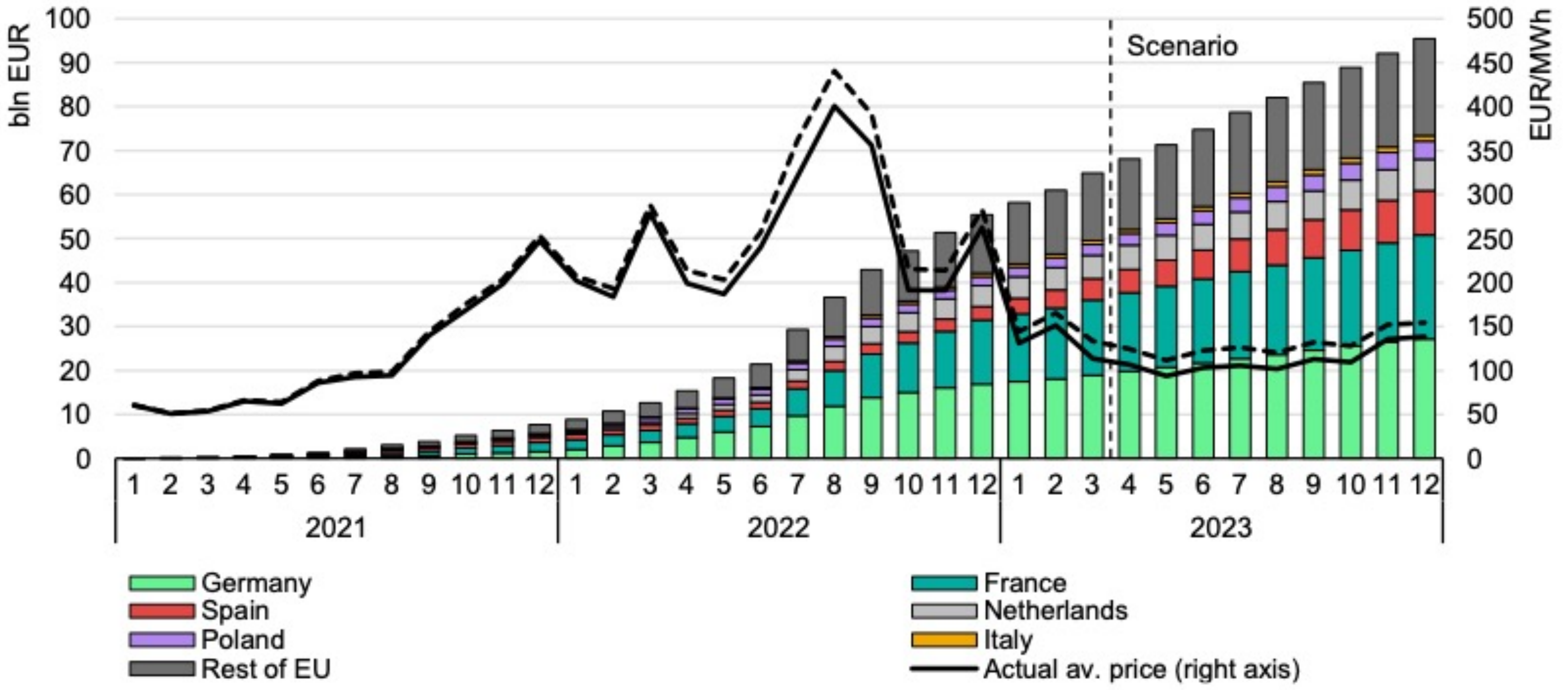






Solar and Wind: Double Benefits

Figure 1 Savings in electricity costs thanks to solar PV and wind additions in the European Union, 2021-2023

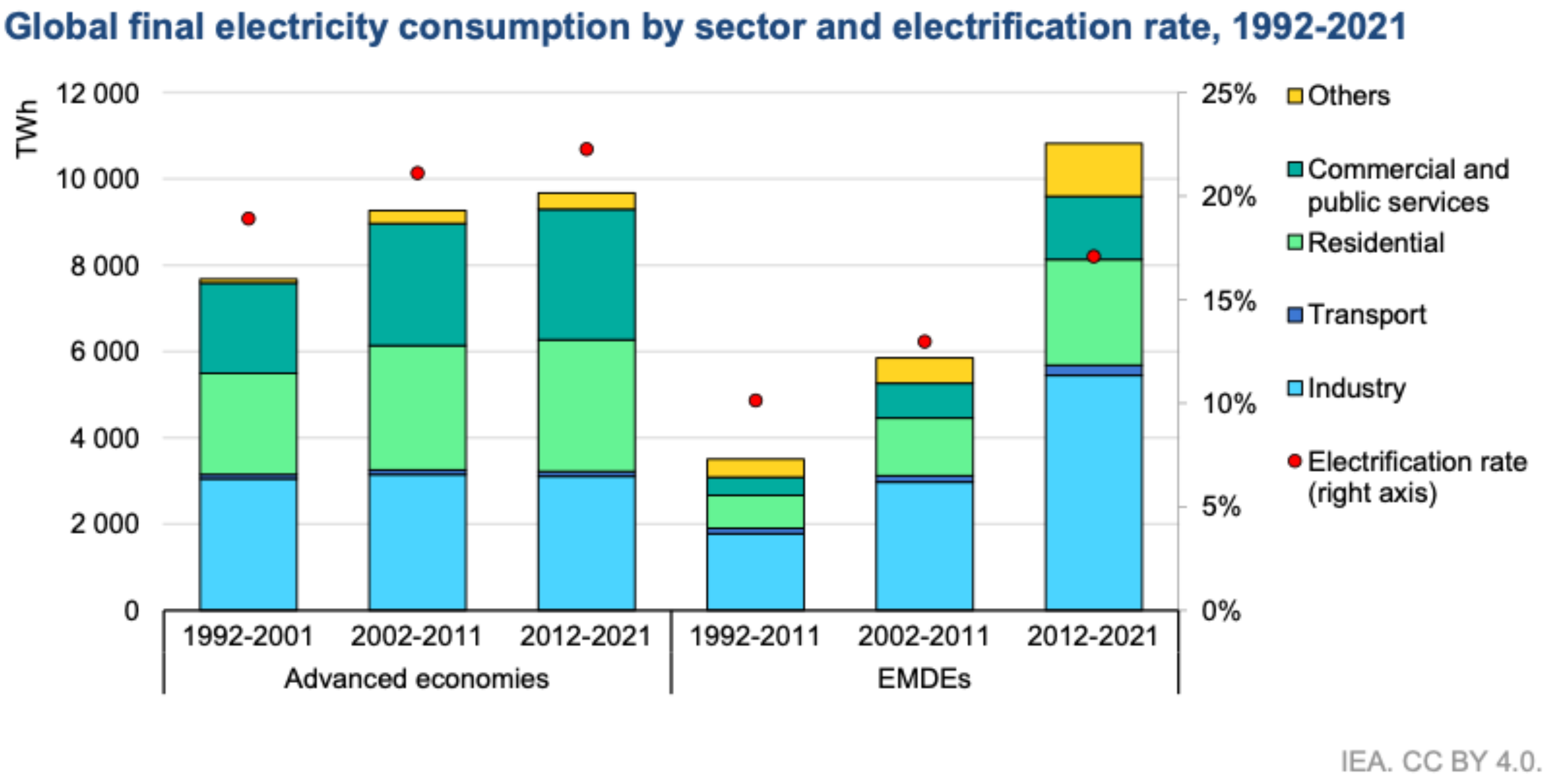


Note: Cumulative costs are calculated based on EU wholesale spot electricity prices.

Source: IEA (2023), Renewable Energy Market Update – June 2023.

https://www.iea.org/reports/overcoming-the-energy-trilemma-secure-and-inclusive-transitions

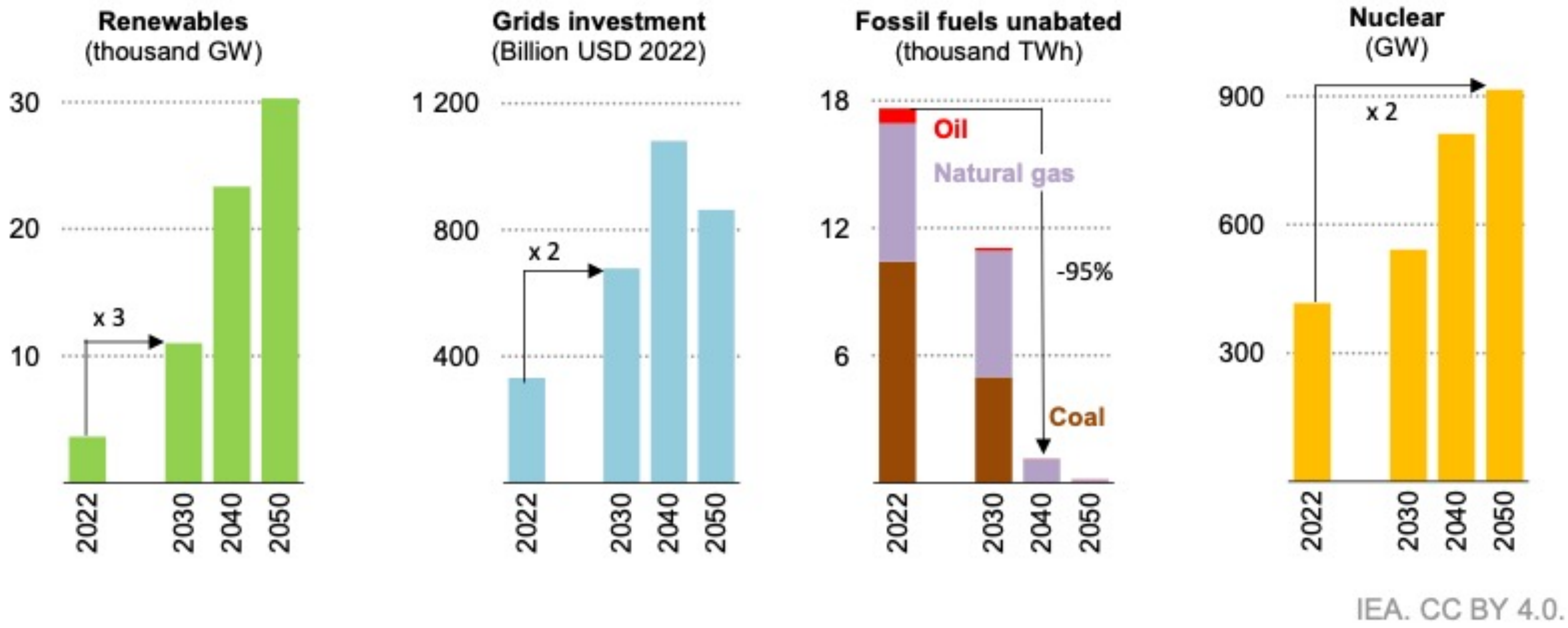
Global Electrification Indicators



Note: "Others" includes agriculture/forestry, fishing and final consumption not specified elsewhere.
Source: IEA (2023), World Energy Statistics

Electricity challenges

Figure 9 Key milestones for the electricity sector in the net zero emissions scenario, 2022-2050

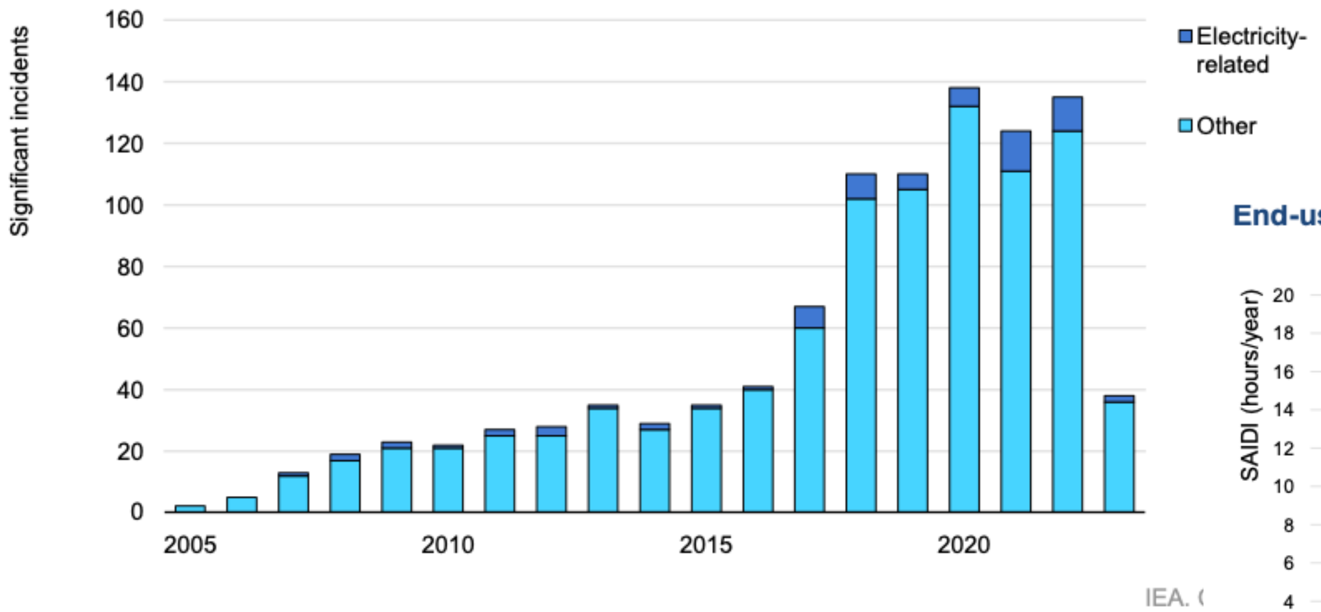


Source: IEA (2023), World Energy Outlook 2023.

https://www.iea.org/reports/overcoming-the-energy-trilemma-secure-and-inclusive-transitions

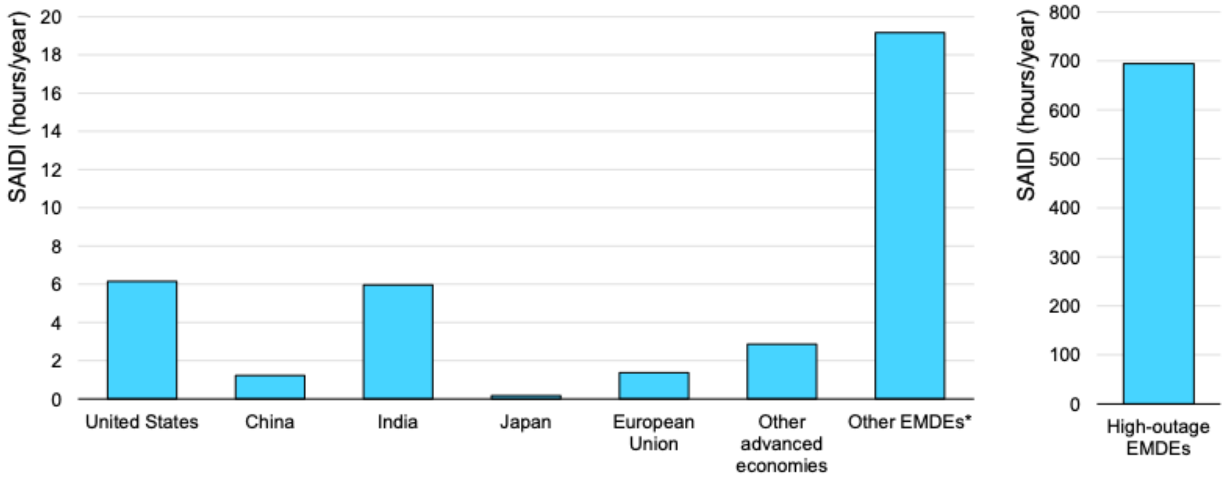
Cybersecurity and Interruption

Total and electricity-related significant cybersecurity incidents per year

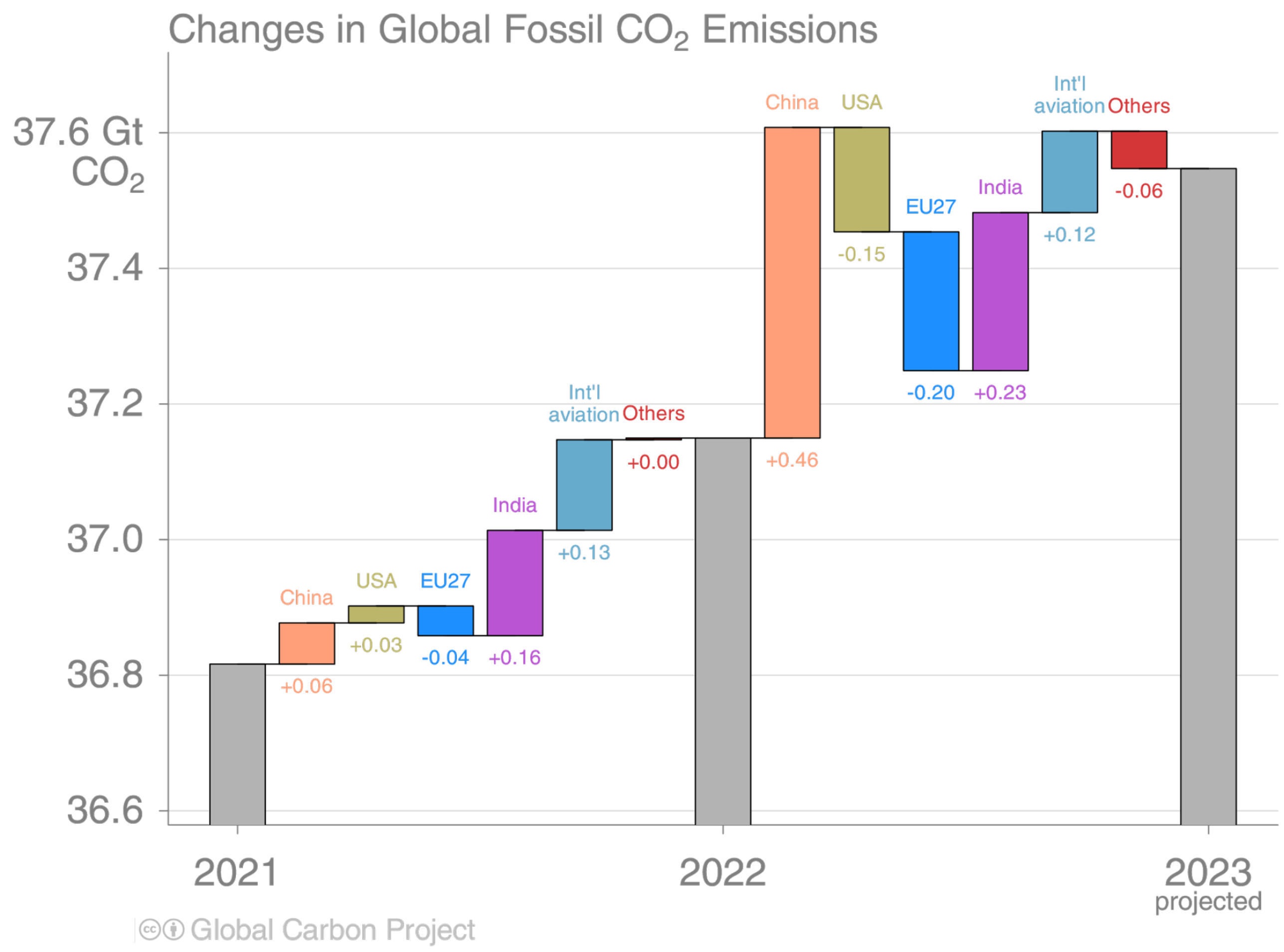


Source: IEA analysis based on CSIS (2023).

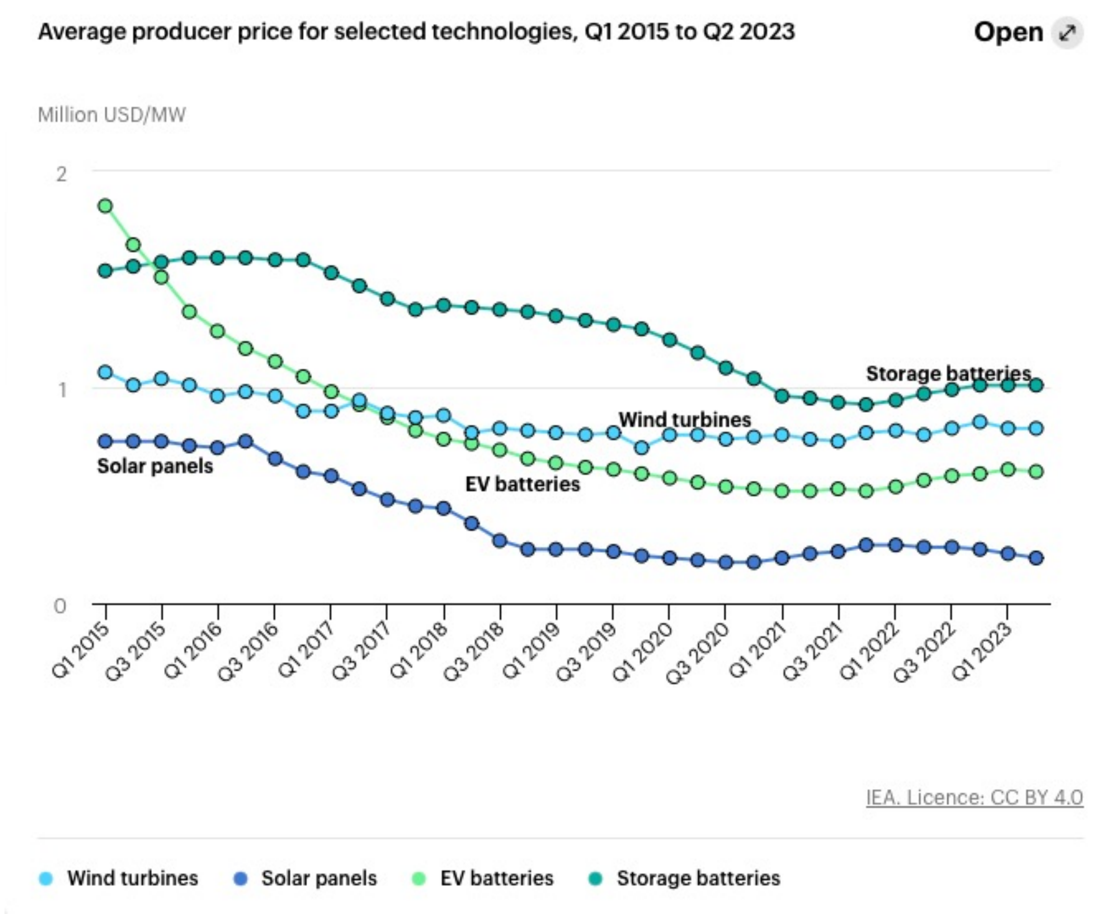
End-user power supply interruption indicators by country/region, 2016-2020 average

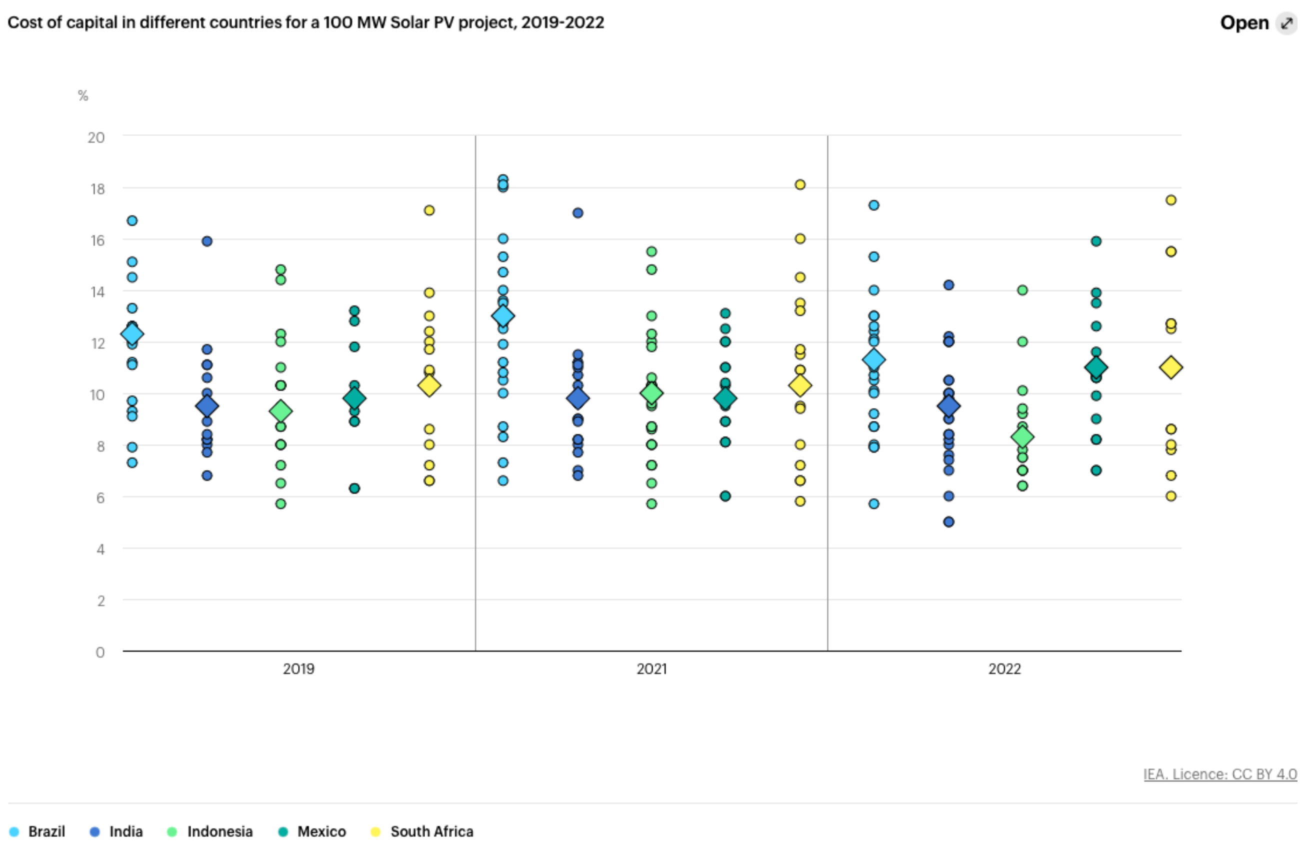


Why energy transition slow? 2 Gear progress



Why energy transition is slow? Finance

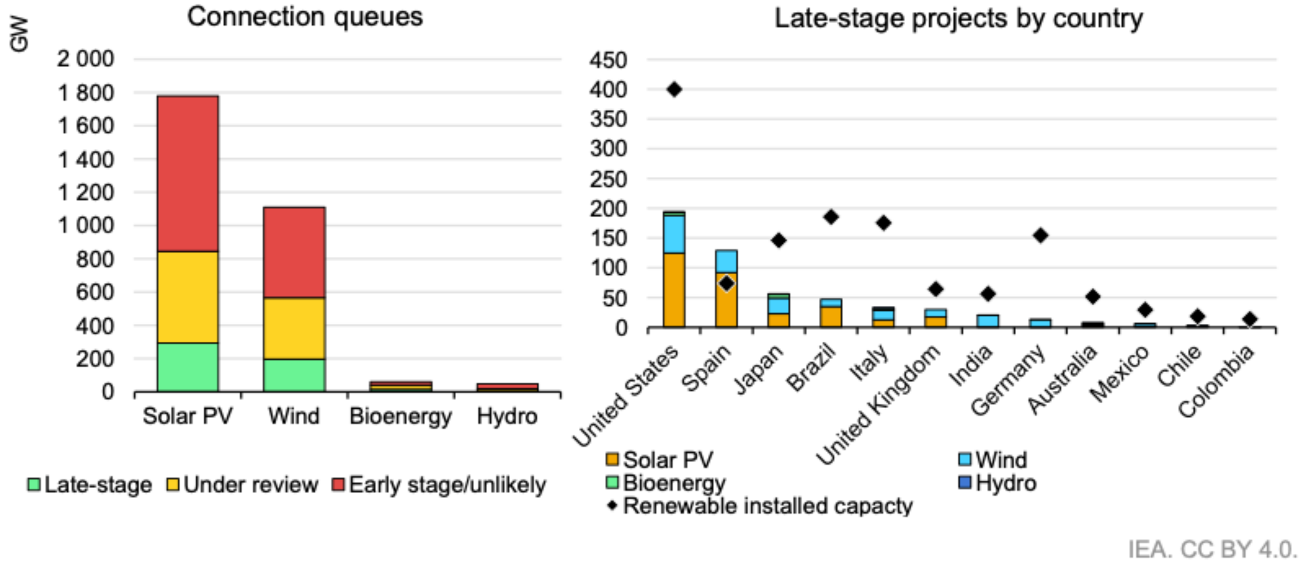




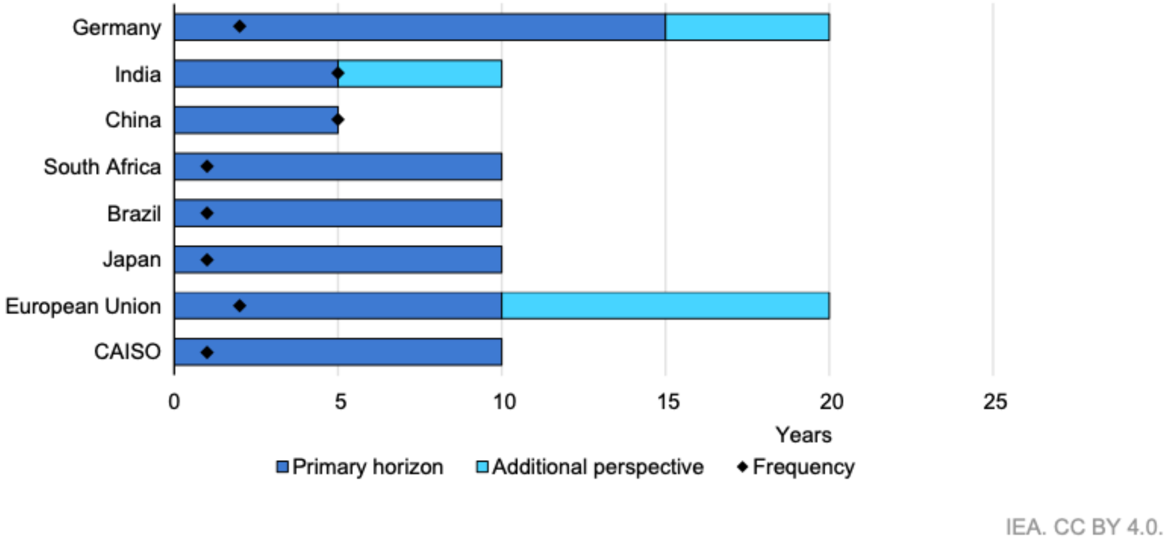
https://www.iea.org/reports/cost-of-capital-observatory/dashboard-2

Why energy transition is slow? Regulation

Capacity of renewable energy projects in connection queues, selected countries by technology



Length of planning horizons and update frequency for grid planning studies



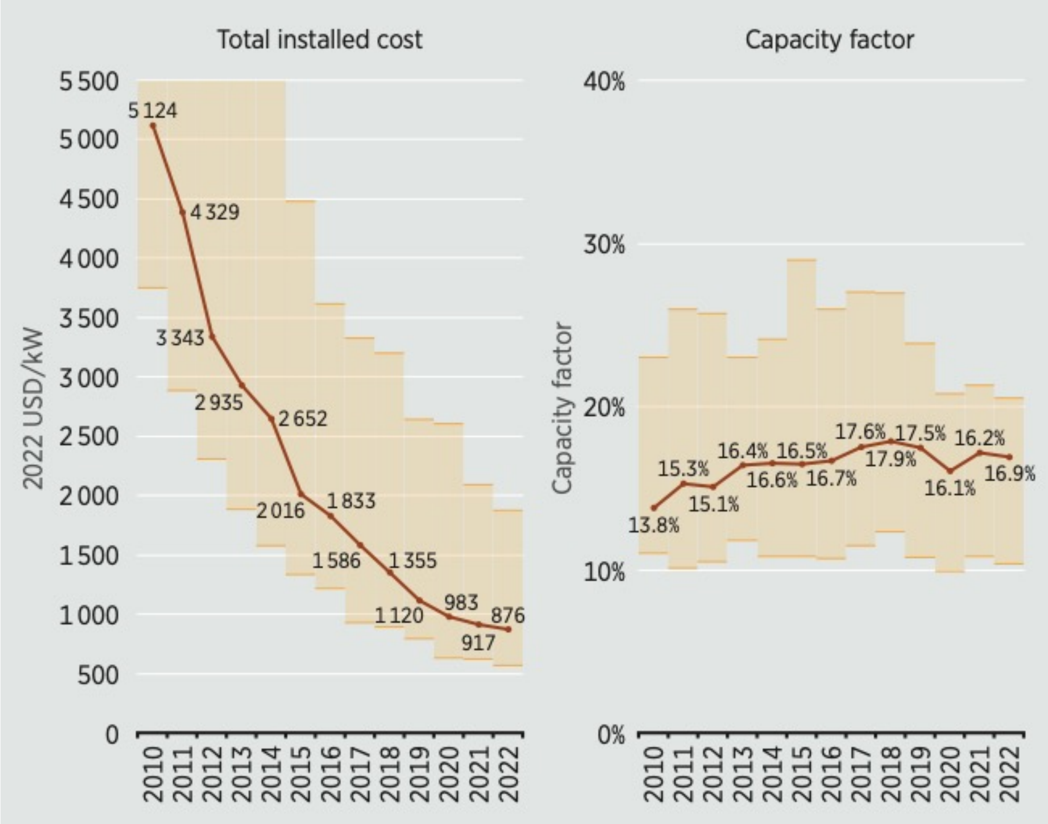
Note: Horizons are based on the main transmission planning study for each region, noting that some have additional longer-term studies used to inform the main plan.

Sources: The National Transmission Needs Study for the United States; the Ten Year Network Development Plan for the European Union; the Electricity Supply Plan for Japan; the Plano Decenal de Expansão de Energia for Brazil; the Transmission Development Plan for South Africa; the Five-Year Plans for China; and the National Electricity Plan Volume II (Transmission) for India.

https://www.iea.org/reports/electricity-grids-and-secure-energy-transitions

Some maths

- Rule of 70
  - 5% interest rate   : 70/5 = 14 years to double
  - 12% interest rate: 70/12 = 6 years to double
- Security of Supply
  - 1 TWh of electricity
    - 500 MW solar - installed capacity
      - 500*800=400 million $
    - 150 MW gas - installed capacity
      - 150*1100 = 165 million $



https://www.irena.org/Publications/2023/Aug/Renewable-Power-Generation-Costs-in-2022

How the demand for fossil fuels look like?

Yıllık Büyüme Oranları	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Birincil Enerji	1%	2%	1%	0,8%	1,2%	2,1%	2,7%	1,1%	-3,6%	5,5%	1,1%
CO2 Emisyonları	1%	1%	0%	0,0%	0,1%	1,5%	2,1%	0,1%	-5,2%	5,5%	0,9%
Petrol ve ürünleri	1%	2%	1%	2,3%	2,0%	2,1%	1,4%	0,4%	-8,9%	5,9%	3,2%
Gaz Tüketimi	3%	2%	1%	2,4%	2,3%	2,6%	5,0%	1,8%	-1,2%	5,4%	-3,1%
LNG iihracatı	-1%	1%	2%	1,0%	6,3%	9,8%	9,5%	12,5%	1,2%	5,3%	5,2%
Kömür üretimi	3%	1%	-1%	-2,8%	-5,9%	2,9%	4,8%	0,5%	-4,5%	5,4%	7,9%
Elektrik Üretimi	2%	3%	3%	1,0%	2,6%	3,0%	4,1%	1,3%	-0,4%	5,7%	2,3%
Yenilenebilir Üretimi	18%	17%	14%	16,0%	13,0%	18,0%	14,1%	12,6%	12,8%	16,3%	14,7%
Güneş Üretimi	55%	37%	42%	29,8%	28,3%	35,6%	29,2%	22,5%	21,1%	24,0%	24,9%
Rüzgar Üretimi	20%	20%	11%	17,8%	15,7%	18,6%	11,2%	11,9%	12,2%	16,3%	13,5%
GJ/capita	0%	1%	0%	-0,4%	0,0%	0,9%	1,6%	0,0%	-4,5%	4,6%	0,3%
Nüfus	1%	1%	1%	1,2%	1,2%	1,1%	1,1%	1,1%	1,0%	0,8%	0,8%

10 Yıllık Hareketli Ortalamalar	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Birincil Enerji	2,6%	2,4%	2,0%	1,8%	1,6%	1,5%	1,7%	1,9%	1,1%	1,4%	1,4%
CO2 Emisyonları	2,8%	2,4%	1,9%	1,5%	1,2%	1,0%	1,1%	1,4%	0,4%	0,7%	0,7%
Petrol ve ürünleri	1,4%	1,4%	1,1%	1,2%	1,2%	1,3%	1,5%	1,7%	0,4%	0,9%	1,1%
Gaz Tüketimi	2,9%	2,8%	2,5%	2,4%	2,4%	2,2%	2,5%	2,9%	2,0%	2,3%	1,8%
LNG iihracatı	7,8%	6,8%	6,5%	5,8%	5,3%	5,5%	6,4%	7,0%	5,0%	4,7%	5,3%
Kömür üretimi	5,1%	4,5%	3,7%	2,7%	1,6%	1,5%	1,6%	1,5%	0,4%	0,3%	0,8%
Elektrik Üretimi	3,4%	3,3%	3,1%	2,8%	2,7%	2,5%	2,7%	3,0%	2,3%	2,5%	2,5%
Yenilenebilir Üretimi	15,1%	15,9%	15,8%	16,2%	16,2%	16,5%	16,3%	16,0%	15,3%	15,0%	14,8%
Güneş Üretimi	50,9%	52,0%	53,1%	51,9%	51,0%	51,0%	47,7%	43,3%	39,4%	32,4%	29,4%
Rüzgar Üretimi	26,1%	26,0%	23,6%	23,2%	22,0%	21,0%	19,2%	17,9%	16,6%	15,5%	14,8%
GJ/capita	1,3%	1,1%	0,7%	0,5%	0,4%	0,3%	0,4%	0,7%	-0,1%	0,3%	0,3%
Nüfus	1,3%	1,3%	1,3%	1,3%	1,2%	1,2%	1,2%	1,2%	1,2%	1,1%	1,1%

Data: Energy Institute, calculation, Baris Sanli, http://barissanli.com/calismalar/2023/20231219-model.xlsx

Energy per capita

Gigajoule per capita	2015	2016	2017	2018	2019	2020	2021	**2022**	2022	2012-22
Canada	406,4	396,7	397,8	396,2	388,7	361,8	362,7	**367,8**	1,4%	-1,0%
Mexico	66,0	66,7	67,3	65,8	64,5	59,0	63,1	**68,4**	8,5%	-0,2%
US	285,5	283,0	281,8	290,1	286,2	263,7	277,2	**283,5**	2,3%	♦
Total North America	**239,6**	**237,3**	**236,6**	**241,7**	**238,1**	**219,5**	**229,6**	**235,6**	**2,6%**	**-0,2%**
Total S. & Cent. America	**58,7**	**57,6**	**57,6**	**56,6**	**55,6**	**51,0**	**54,7**	**56,5**	**3,4%**	**-0,4%**
Austria	164,5	168,1	170,7	166,3	173,9	162,1	162,9	**153,7**	-5,6%	-1,4%
Belgium	210,4	225,7	226,4	224,6	230,9	206,8	228,9	**210,2**	-8,2%	-0,6%
Bulgaria	110,7	105,9	109,4	110,7	108,0	100,8	116,0	**123,0**	6,1%	1,8%
Croatia	77,0	80,7	81,4	84,9	83,5	80,3	87,2	**84,5**	-3,1%	1,5%
Cyprus	88,5	95,4	97,1	95,9	95,2	82,3	86,3	**91,3**	5,7%	-0,7%
Czech Republic	161,0	158,8	167,7	167,1	163,3	151,3	159,8	**159,3**	-0,3%	-0,7%
Denmark	123,5	124,8	124,8	122,6	119,3	105,8	115,7	**115,9**	0,2%	-1,0%
Estonia	187,9	193,6	214,4	212,0	170,3	159,2	167,0	**167,4**	0,3%	-1,8%
Finland	216,1	218,9	213,9	217,9	213,2	203,9	208,0	**212,3**	2,1%	-0,6%
France	158,1	155,0	153,5	156,0	152,4	137,0	145,7	**129,8**	-10,9%	-2,3%
Germany	165,8	168,0	169,6	164,8	160,1	149,0	153,2	**147,5**	-3,7%	-1,2%
Greece	103,8	102,8	108,5	109,7	107,9	94,8	104,3	**109,5**	5,0%	-0,5%
Hungary	91,8	93,7	99,0	99,9	101,3	99,8	105,3	**96,0**	-8,8%	0,5%
Iceland	665,6	658,9	673,1	677,9	631,9	560,7	564,9	**597,1**	5,7%	-0,7%
Ireland	134,2	138,7	137,6	138,9	137,8	128,3	129,6	**135,9**	4,9%	0,3%
Italy	108,5	109,1	110,6	111,4	109,7	99,9	107,0	**104,1**	-2,7%	-1,1%
Latvia	75,4	81,2	90,2	81,0	84,2	77,5	81,5	**77,2**	-5,3%	-0,4%
Lithuania	77,6	79,9	85,1	88,6	89,5	89,7	90,6	**83,3**	-8,0%	0,3%
Luxembourg	272,1	262,0	267,8	275,0	274,6	231,3	243,7	**217,2**	-10,9%	-4,0%
Netherlands	218,5	219,4	220,0	213,7	211,8	204,1	208,8	**201,6**	-3,5%	-1,5%
North Macedonia	50,4	52,2	50,2	50,1	52,9	46,2	48,4	**50,0**	3,2%	-0,8%
Norway	380,1	382,3	381,2	372,8	347,0	374,0	379,2	**348,9**	-8,0%	-1,4%
Poland	103,9	108,4	112,7	114,0	110,8	106,3	115,2	**108,2**	-6,0%	0,2%
Portugal	101,1	108,5	105,4	107,6	102,5	92,8	93,2	**90,3**	-3,1%	-0,1%
Romania	69,2	69,6	71,1	72,8	71,4	68,4	72,1	**66,0**	-8,4%	-0,6%
Slovakia	121,4	122,5	128,8	126,4	122,0	119,5	129,0	**122,0**	-5,4%	-0,4%
Slovenia	129,5	137,8	138,7	141,0	136,5	131,6	130,2	**123,8**	-4,9%	-1,4%
Spain	122,1	123,2	124,3	126,0	121,6	109,4	117,0	**121,0**	3,5%	-0,6%
Sweden	230,0	223,5	228,3	221,4	227,8	213,8	216,7	**215,7**	-0,4%	-1,3%
Switzerland	146,1	135,9	135,0	136,1	141,0	128,8	123,7	**120,1**	-3,0%	-2,7%
Turkey	72,6	75,0	78,4	76,8	79,1	77,2	82,1	**82,2**	♦	1,9%
Ukraine	80,3	84,3	78,6	82,0	78,0	75,3	77,3	**58,7**	-24,0%	-6,5%
United Kingdom	125,6	123,5	122,8	121,6	118,4	105,9	107,0	**108,4**	1,3%	-2,1%
Other Europe	81,5	86,7	86,6	91,1	89,4	87,1	91,1	**90,2**	-0,9%	1,5%
Total Europe	**125,7**	**126,9**	**128,0**	**127,8**	**125,6**	**117,1**	**122,6**	**118,0**	**-3,7%**	**-1,1%**
Iran	120,8	124,4	127,2	129,8	135,5	139,3	137,6	**137,3**	-0,2%	1,4%
Iraq	44,8	49,5	54,3	53,6	55,5	46,8	47,8	**51,8**	8,5%	1,3%
Israel	123,9	124,1	124,3	124,2	126,3	117,3	117,3	**121,1**	3,2%	-1,0%
Kuwait	413,3	394,2	393,5	385,0	340,6	328,1	353,0	**374,0**	5,9%	-1,6%
Oman	289,2	276,5	280,1	294,0	291,9	284,5	313,8	**326,7**	4,1%	1,3%
Qatar	883,0	803,7	744,8	729,3	748,9	662,7	717,9	**699,2**	-2,6%	-1,8%
Saudi Arabia	336,0	342,6	335,0	318,9	298,8	289,1	299,2	**315,7**	5,5%	♦
United Arab Emirates	496,4	511,6	488,2	478,0	485,6	453,9	503,4	**534,9**	6,3%	1,8%
Total Africa	**15,1**	**15,1**	**15,1**	**15,1**	**15,1**	**13,9**	**14,5**	**14,2**	**-2,1%**	**-0,6%**

There is no energy poor, rich country !

Gigajoule per capita	2015	2016	2017	2018	2019	2020	2021	**2022**	Growth rate per annum 2022	2012-22
Australia	242,0	239,1	234,5	234,3	238,5	222,6	221,2	**228,5**	3,3%	-0,6%
Bangladesh	8,8	8,7	9,0	9,5	10,5	9,8	10,2	**10,5**	2,9%	4,2%
China	90,8	90,6	93,6	97,6	101,8	104,9	110,8	**111,8**	0,9%	2,7%
China Hong Kong SAR	158,8	162,2	173,4	175,0	165,6	123,9	116,9	**104,9**	-10,2%	-4,0%
India	21,6	22,3	22,8	23,9	24,2	22,7	24,5	**25,7**	4,9%	2,7%
Indonesia	26,2	26,0	26,6	28,9	30,5	28,0	28,3	**35,5**	25,2%	2,7%
Japan	149,8	148,2	150,4	150,1	147,1	136,9	144,0	**143,9**	♦	-0,8%
Malaysia	129,2	133,9	133,8	134,4	136,2	129,6	136,4	**142,5**	4,5%	1,2%
New Zealand	197,8	196,6	197,1	192,3	191,7	170,6	165,3	**161,8**	-2,1%	-1,8%
Pakistan	13,9	15,0	15,7	15,9	15,8	15,5	16,9	**15,3**	-9,4%	2,2%
Philippines	15,5	16,7	18,0	18,1	18,4	16,4	17,3	**18,2**	5,7%	3,3%
Singapore	559,7	584,1	593,3	588,7	571,2	555,3	551,9	**529,5**	-4,1%	-0,2%
South Korea	234,0	239,4	240,9	244,2	240,8	231,5	242,4	**245,3**	1,2%	0,5%
Sri Lanka	16,1	17,6	17,0	17,6	17,9	17,5	17,6	**15,7**	-11,0%	1,6%
Taiwan	205,7	206,4	205,5	207,7	203,6	197,5	208,8	**200,2**	-4,1%	♦
Thailand	70,8	71,9	73,0	75,0	74,9	69,5	69,9	**70,6**	1,0%	0,4%
Vietnam	32,4	34,8	37,1	41,2	45,3	44,9	44,6	**46,7**	4,9%	6,4%
Other Asia Pacific	12,8	13,6	16,1	16,7	17,2	17,4	18,0	**18,0**	-0,1%	4,2%
Total Asia Pacific	**56,1**	**56,4**	**57,9**	**59,8**	**61,2**	**60,5**	**63,4**	**64,4**	**1,6%**	**1,8%**
Total World	**73,7**	**73,7**	**74,4**	**75,6**	**75,6**	**72,2**	**75,5**	**75,7**	**0,3%**	**0,3%**
of which: OECD	175,0	174,8	175,5	177,1	174,6	161,8	169,1	**169,9**	0,5%	-0,4%
Non-OECD	51,5	51,8	52,6	53,9	54,6	53,3	55,9	**56,0**	0,3%	1,0%
European Union[#]	138,7	140,0	141,9	141,5	139,0	128,6	135,4	**130,1**	-4,0%	-1,0%

"Green policies"?

FINANCIAL TIMES

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Global trade Added

Rich world uses green policies to hold back the poor, says UN trade chief

Rebeca Grynspan condemns subsidies and environmental protectionism in US and EU

Share

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Unctad secretary-general Rebeca Grynspan: 'Developing countries see a lot of these policies as protectionist. They don't have the fiscal space to go the path of subsidies, so they have to go the path of restrictions to trade or even duties or taxes' © Javier Soriano/AFP/Getty Images

Andy Bounds and **Javier Espinoza** in Brussels DECEMBER 24 2023

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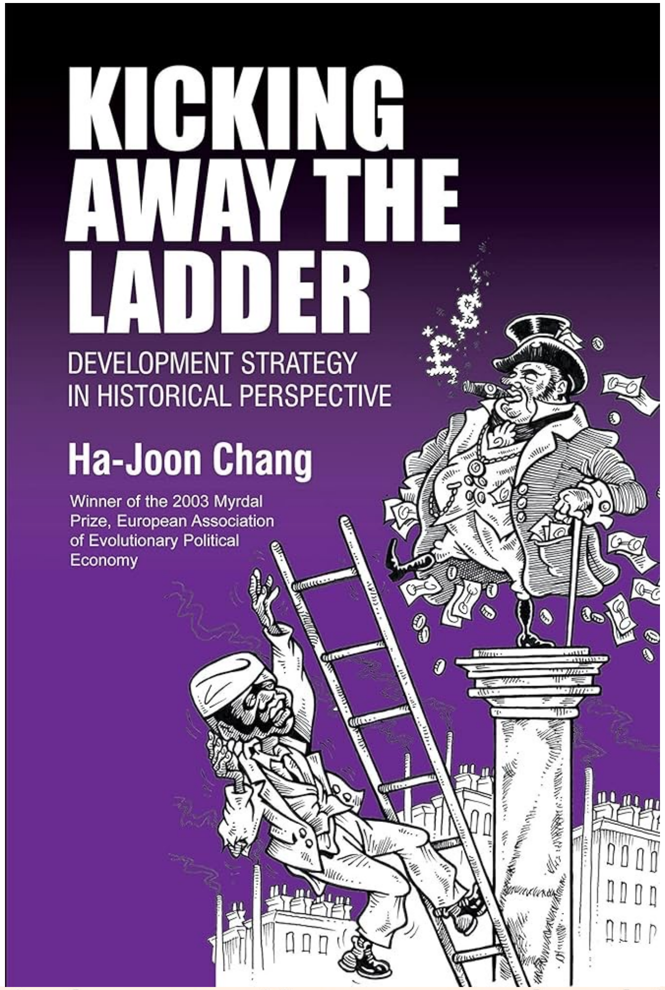


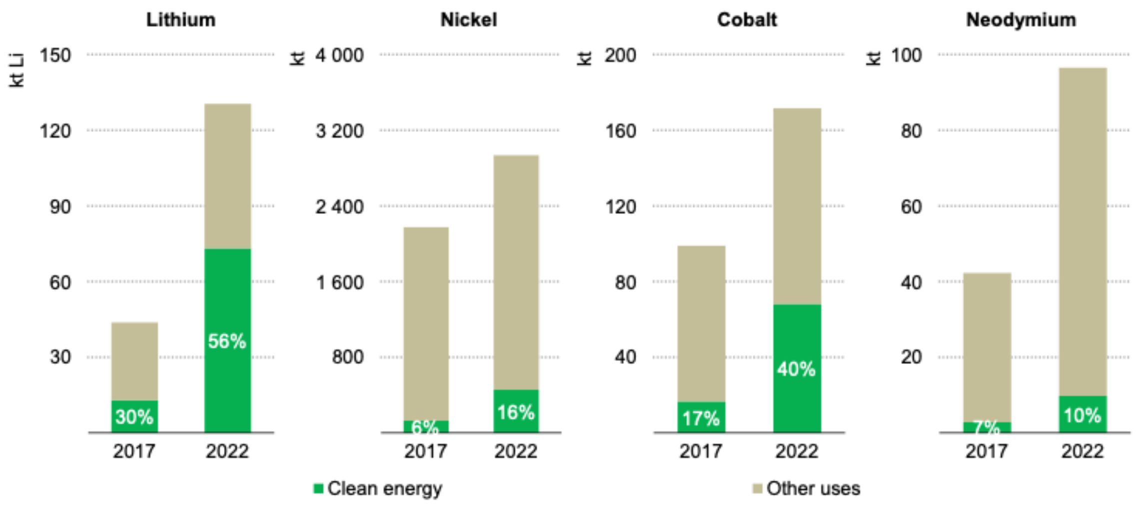
Rich countries are using the green transition as an excuse to boost their own economies at the expense of developing ones, exploiting outdated World Trade Organization rules, according to the UN's trade chief.

"Many trade rules forbid policies that can be used by developing countries. And the developed countries have more fiscal space to subsidise in the areas that are good for 'quote, unquote', the environment," Rebeca Grynspan, secretary-general of United Nations Conference on Trade and Development, told the Financial Times in an interview.

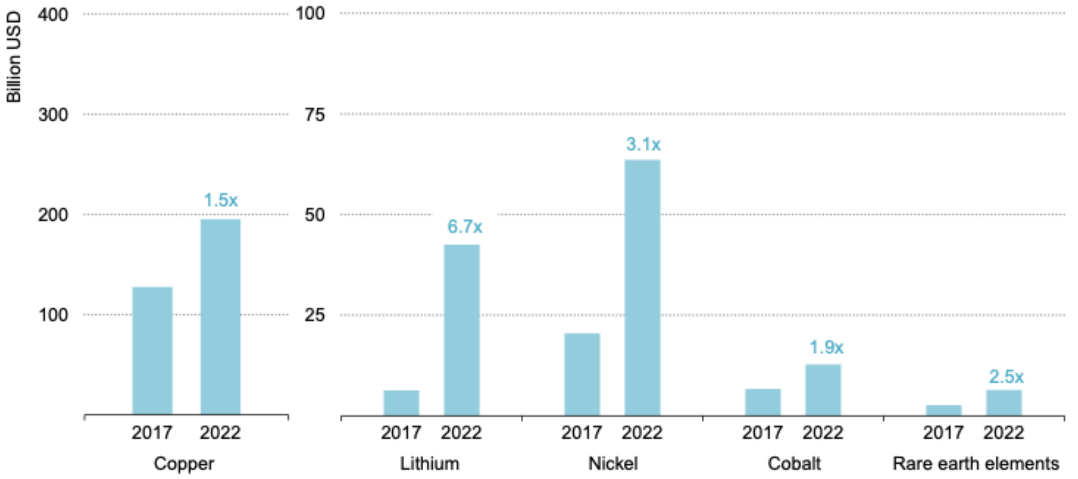
https://www.ft.com/content/e8b9d884-a210-46a7-9ad2-00cb07cfb08e

Critical Minerals

Demand for key materials and share of clean energy in total demand

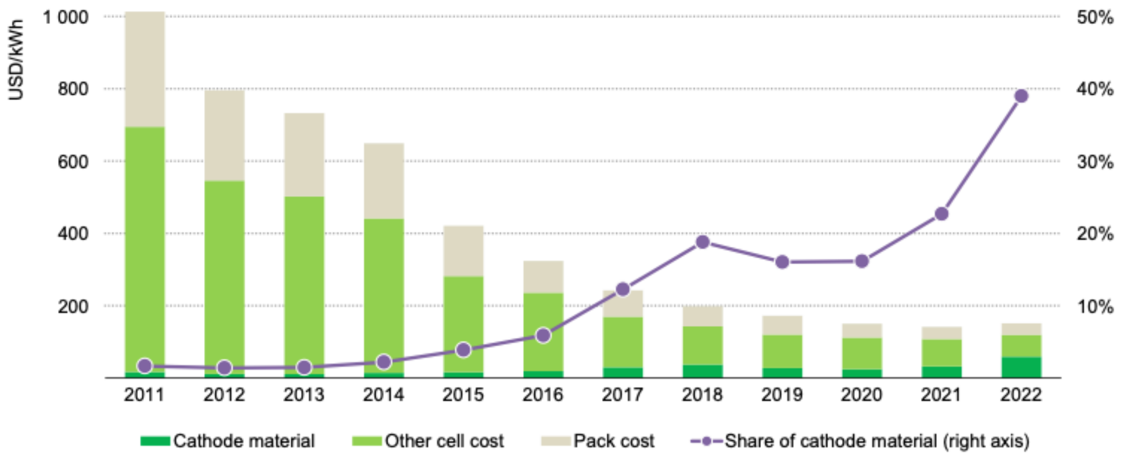


Market size for key energy transition minerals



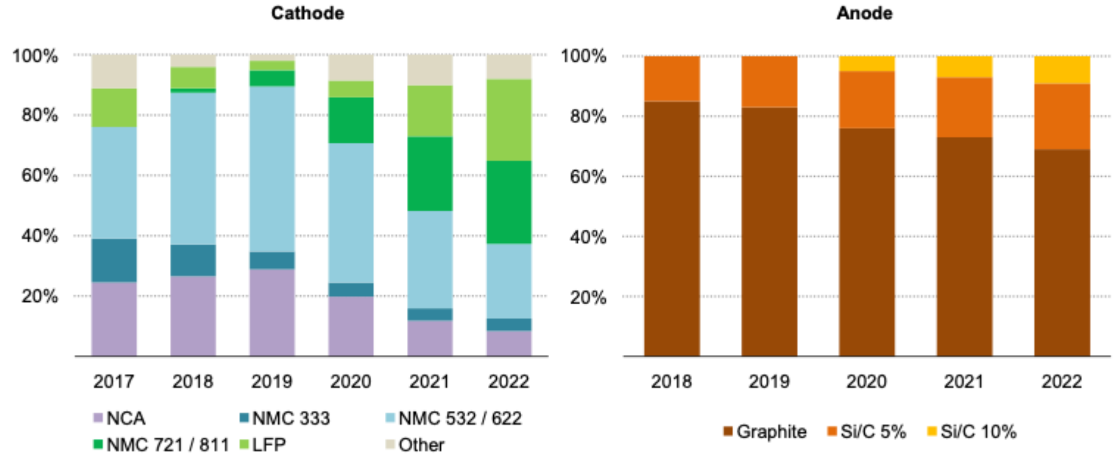
Note: The market size for nickel includes both Class 1 (battery grade) and Class 2 nickel.
Source: IEA analysis based on S&P Global.

Average pack price of lithium-ion batteries and share of cathode material cost



Notes: Cathode material costs include lithium, nickel, cobalt and manganese. Other cell costs include costs for anode, electrolytes, separator and other components as well as costs associated with labour, manufacturing and capital depreciation.
Source: IEA analysis based on BNEF (2022).

Evolution of sales shares for EV batteries (cars) by cathode and anode chemistry, 2018-2022



Notes: LFP = lithium iron phosphate; NCA = nickel cobalt aluminium; NMC = nickel manganese cobalt. Si/C refers to silicon-graphite anodes, with the silicon doping ratio alongside.
Source: IEA analysis based on data from EV Volumes, Benchmark Minerals Intelligence and BNEF.

https://www.iea.org/reports/critical-minerals-market-review-2023#downloads

A Critical Point at Critical Minerals

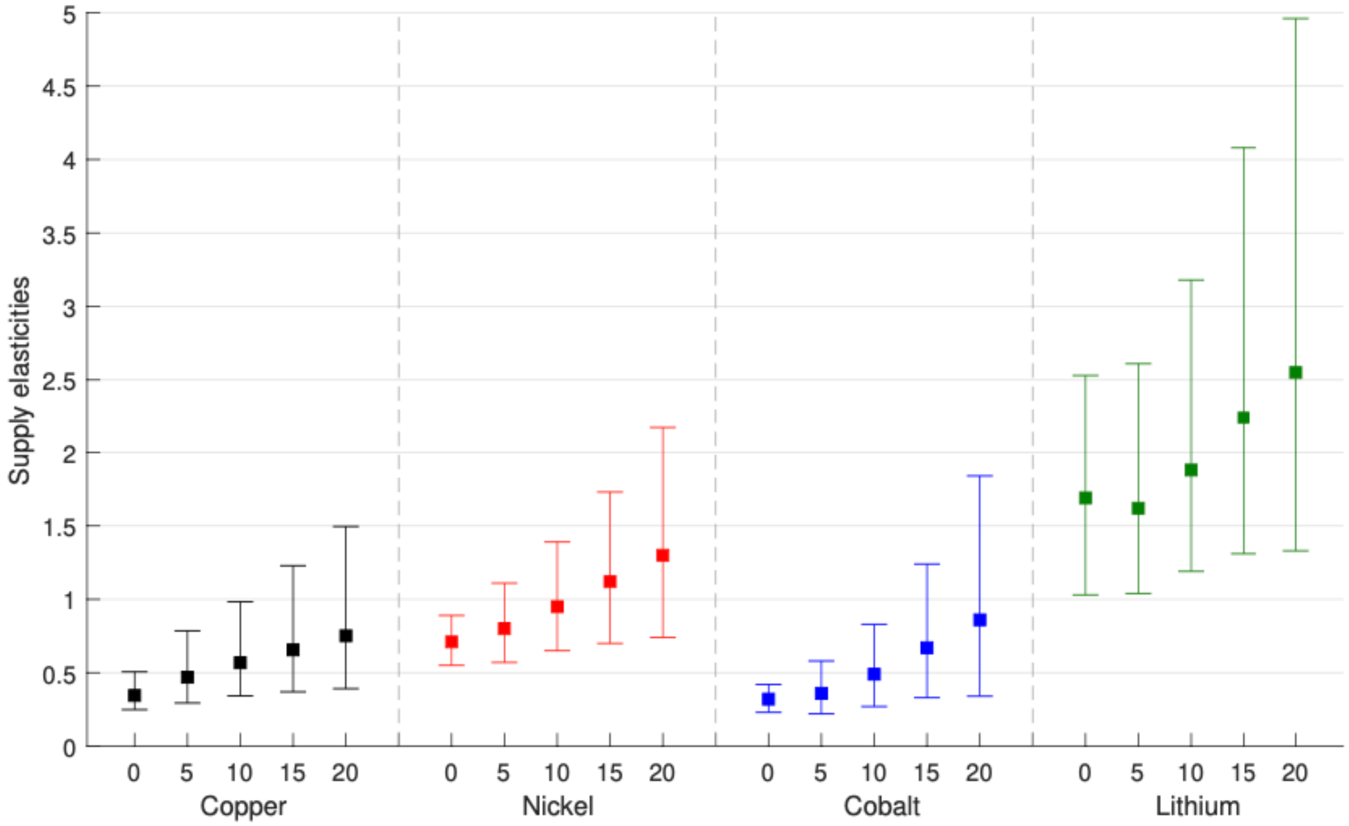


Figure 3: Supply elasticities at annual horizons based on the metal-specific demand (MD) shock with 68% point-wise credible sets. Elasticities are calculated via equation (3).

A demand-induced positive price shock of respectively 10 percent increases the same-year output of copper by 3.5 percent, nickel by 7.1 percent, cobalt by 3.2 percent and lithium by 16.9 percent

elasticities directly from the B0 matrix (with 68% confidence bands): copper: 0.23 [0.18, 0.30]; nickel: 0.62 [0.49, 0.79]; cobalt: 0.28 [0.21, 0.37]; lithium: 1.51 [0.89, 2.37].

https://www.imf.org/en/Publications/WP/Issues/2021/10/12/Energy-Transition-Metals-465899

But don’t polarize – we need a green future

- Electricity generation
  - Battery
  - Steam
  - Gas turbine
  - Solar (a new kind of physics)+++ (like microchip, LCD etc dynamics)
- Electric cars +++
  - Tesla: Car + AI
  - A new strategic competition
    - Future of Mobility
- More electricity (20-25% to 50%)

Not very conclusive

- Maths do not add up
  - Africa : 1.4 Billion People
- But this is the future
- Transition will be very disturbing
- What if China surpasses the rest?
- Mitigation/Adaptation more important
- Finance, regulation
- Digitalization