

Fakultet kemijskog inženjerstva i tehnologije
Zavod za termodinamiku, strojarstvo i energetiku



ENERGETIKA

Studij: Kemijsko inženjerstvo (V semestar)

prof. dr. sc. Igor Sutlović

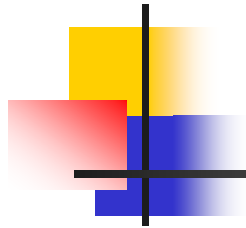



photo: reuters

BEZ DLAKE NA JEZIKU

CLARKSON U KOLUMNINI POPLJUVAO GRETU THUNBERG "Ti si razmaženo derišće, tvoje grimase i histerično plakanje neće spasiti planet već znanstvenici!"

AUTOR: Zvonimir Jurčić (<https://www.jutarnji.hr/autori/zvonimir-jurcic>) OBJAVLJENO: 29.09.2019. u 19:52





Što god snađe zemlju snaći će i sinove zemlje. Čovjek ne tka tkivo života; on je samo struk u tome. Što god čini tkanju čini i sebi samome.

Zemlju nismo naslijedili od svojih predaka, već smo je posudili od svojih potomaka." (indijanska mudra misao)

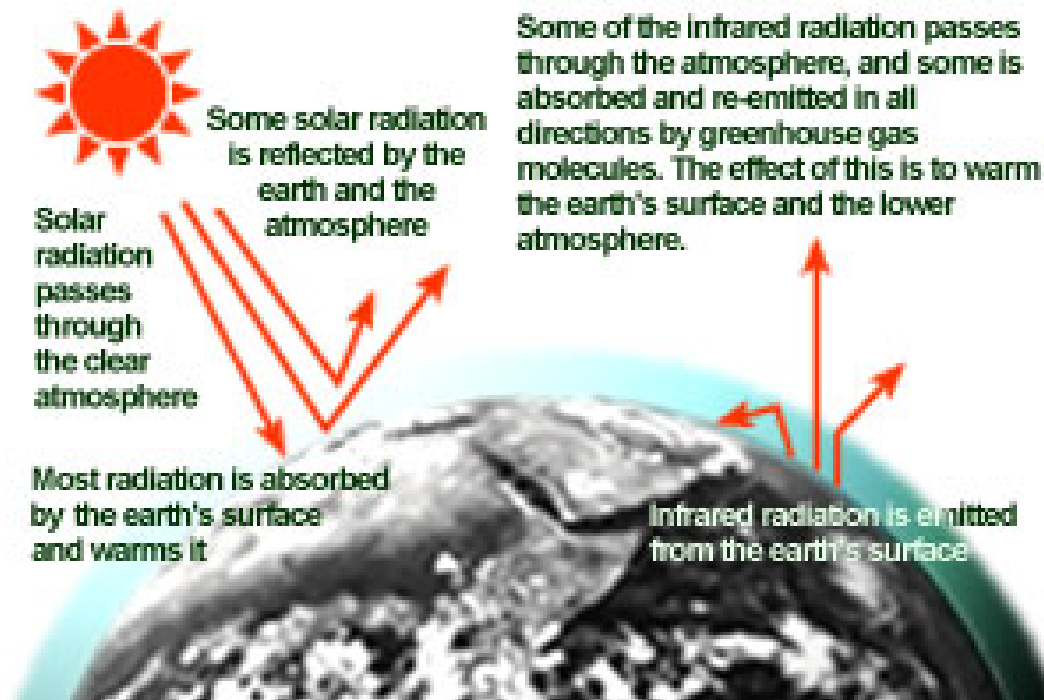
»Bog vam je dao u baštinu predivnu zemlju čija nacionalna himna počinje riječima: 'Lijepa naša domovino'. Kako u ovim riječima ne vidjeti podsjećanje na dužnosti poštovanja prirode, postupajući s osjećajem odgovornosti za životni prostor što ga je Providnost dala čovjeku? Svijet je pozornica na kojoj je svatko pozvan odigrati svoju ulogu na hvalu i slavu Boga Stvoritelja i Spasitelja« (Ivan Pavao II, Bit ćete mi svjedoci, Zagreb: KS, Dokumenti 115, 1998:25.)

Ekološka kriza je ponajprije kriza morala i zbiljski prijezir spram čovjeka." (Sv. Ivan Pavao II.)

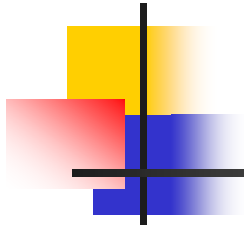


Što je to efekt staklenika (greenhouse effect):
prirodna pojava da neki plinovi ne propuštaju zračenje određene
valne duljine toplinskog spektra – prirodnom efektu staklenika
dugujemo život na Zemlji

The Greenhouse Effect



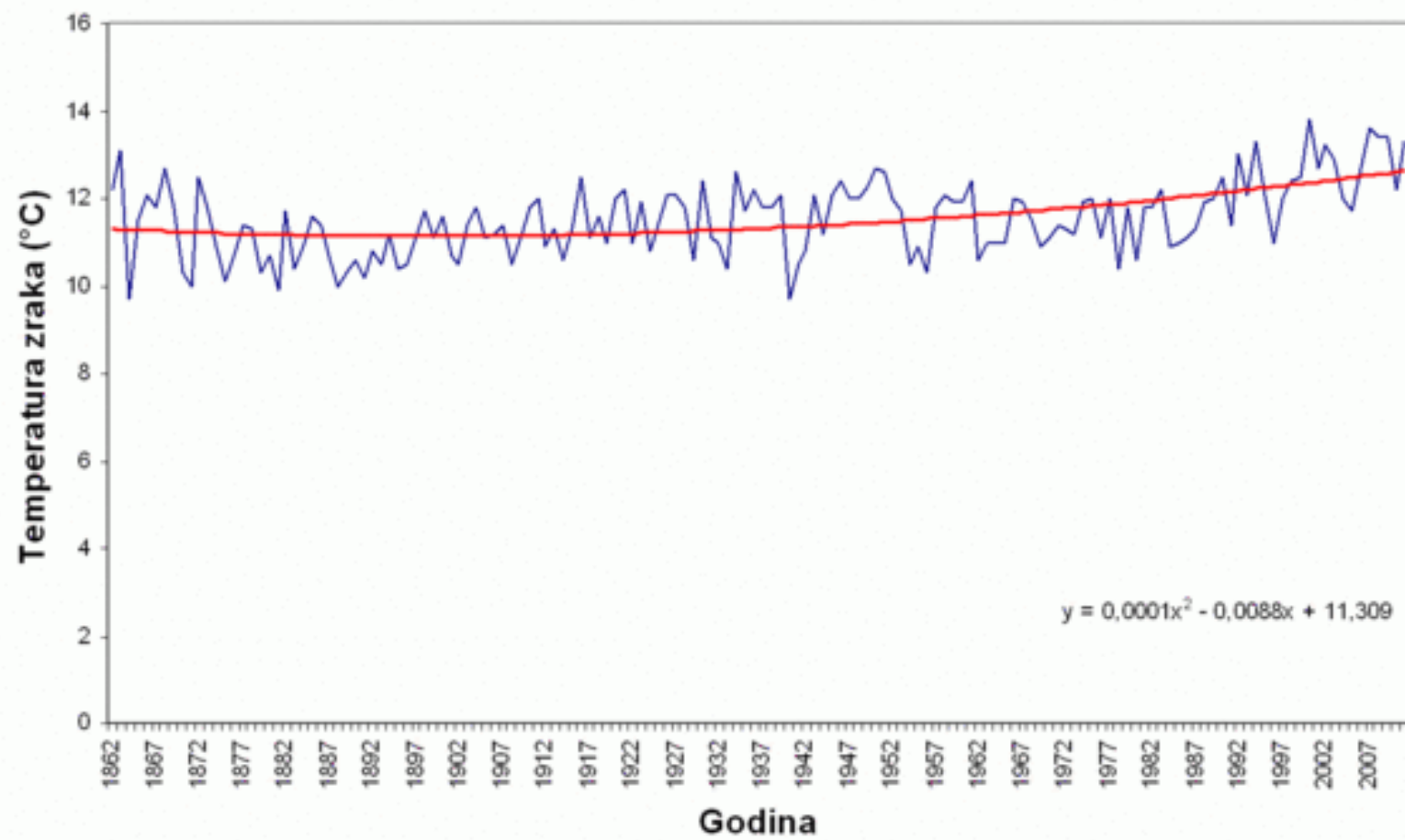
Problem nastaje
pojačanim
antropogenim
utjecajem na efekt
staklenika!



Nema nikakvih naznaka usporavanja koncentracije stakleničkih plinova u atmosferi, a kamoli opadanja, unatoč svim obvezama preuzetim u skladu s Pariškim sporazumom o klimatskim promjenama, rekao je glavni tajnik Svjetske meteorološke organizacije Petteri Taalas. Te obveze moramo pretočiti u djelovanje i povećati razinu ambicije radi dobrobiti čovječanstva u budućnosti, izjavio je.

Vrijedi se prisjetiti da je **Zemlja posljednji put doživjela koncentraciju CO₂ koja bi se mogla usporediti sa sadašnjim razinama prije 3-5 milijuna godina. U to vrijeme, temperature su bile više za 2-3 °C, a razina mora bila je za 10-20 metara viša nego danas**, rekao je g. Taalas. (www.meteo.hr – wb stranica DHMZ-a)

https://meteo.hr/objave_najave_natjecaji.php?section=onn¶m=objave&el=priopcenja&daj=pr25112019





Staklenički plinovi su prema (UNFCCC- United Nation Framework Convention on Climate Change):

Ugljični dioksid (CO_2)

Metan (CH_4)

Dušični oksid (N_2O)

Hidrofluorougļjici – grupa spojeva (HFC)

Perfluorougļjik (PFC)

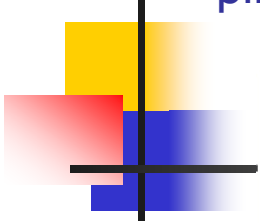
Sumporni heksafluorid (SF_6)

i indirektni plinovi kao SO_2 , NO_x , CO and NMVOC
(ne-metanske hlapive organske tvari)

Glavni izvori stakleničkih plinova

Plin	Izvor	Udio u ukupnoj emisiji u Svijetu 2004.
Ugljični dioksid (CO ₂)	<ul style="list-style-type: none"> - proizvodnja energije iz fosilnih goriva - uništavanje šuma 	76,7%, od čega 56.6% od izgaranja fosilnih goriva
Metan (CH ₄)	<ul style="list-style-type: none"> - poljoprivreda - proizvodnja energije - otpad 	14.3%
Dušični oksid (N ₂ O)	- poljoprivreda	7.9%
Hidrofluorouglicji (HFC) Perfluorugljik (PFC)	- zamjena za spojeve koji uništavaju ozonski omotač	1.1%
Sumporni heksafluorid(SF ₆)	- industrija i električna oprema	

Osim samog utjecaja na efekt staklenika, važna je i postojanost pojedinog plina.



Staklenički plin	Kemijska formula	Konc. prije ind. revolucije	Konc. nakon ind. revolucije	Godine života u atmosferi	Glavni izvori	Relativni staklenički potencijal
Ugljični dioksid	CO ₂	280	358 ppmv	50-200	Fosilna goriva Sječa šum	1
Metan	CH ₄	700	1720 ppmv	12-17	Fosilna goriva Rižina polja	21
Didušik oksid	N ₂ O	275	312 ppmv	120-150	Gnojenje Ind. procesi	310
CFC	CFC ₁₂	0	503 pptv	102	Tek. rashladna sredstva Pjene	125-152
HCFC	HCFC-22	0	105 pptv	13	Tek. rashladna sredstva	125
Perfluoro ugljik	CF ₄	0	110 pptv	50000	Proizvodnja aluminija	6500
Sumpor heksafluorid	SF ₆	0	72 pptv	1000	Proizvodnja magnezija	23900

Koncentracija stakleničkih plinova (ukupnih)

Koncentracija prije ind. revolucije	278 ppm
Koncentracija 1990.	350 ppm
Koncentracija (najnovija)	381 ppm

Carbon dioxide emissions from energy

Million tonnes of carbon dioxide	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Growth rate per annum		Share 2021
												2021	2011-21	
Canada	550.2	546.5	560.7	566.4	566.2	547.7	563.7	573.5	571.3	517.3	527.4	2.2%	-0.4%	1.6%
Mexico	465.8	474.0	472.8	459.6	463.1	468.8	476.9	468.2	449.3	357.7	373.8	4.8%	-2.2%	1.1%
US	5336.2	5089.1	5246.6	5251.7	5137.5	5038.0	4978.8	5132.7	4980.9	4420.6	4701.1	6.6%	-1.3%	13.9%
Total North America	6352.2	6109.6	6280.2	6277.7	6168.8	6054.5	6019.4	6174.5	6001.6	5295.6	5602.2	6.1%	-1.2%	16.5%
Argentina	173.1	181.9	187.8	187.8	191.2	190.1	188.5	185.9	175.5	164.8	181.7	10.5%	0.5%	0.5%
Brazil	424.2	444.5	483.0	505.2	476.6	440.8	446.4	427.6	425.1	390.5	436.6	12.1%	0.3%	1.3%
Chile	87.0	89.4	91.1	88.4	88.9	94.1	92.4	93.0	94.6	84.4	87.0	3.3%	•	0.3%
Colombia	69.1	77.5	80.5	85.6	86.7	91.4	84.5	86.6	92.7	80.9	86.5	7.3%	2.3%	0.3%
Ecuador	32.8	34.2	38.5	38.4	37.6	35.4	34.3	37.1	35.7	28.7	35.5	24.2%	0.8%	0.1%
Peru	45.0	46.0	46.9	47.8	50.2	54.8	54.0	56.5	58.5	46.4	56.0	21.0%	2.2%	0.2%
Trinidad & Tobago	24.6	24.2	25.5	24.8	24.0	21.9	21.3	20.6	18.3	16.1	16.0	-0.4%	-4.2%	•
Venezuela	167.3	177.9	183.4	173.3	172.2	149.3	146.3	121.1	100.1	82.8	89.2	8.0%	-6.1%	0.3%
Central America	58.3	59.4	60.3	62.3	68.4	71.2	70.6	67.8	74.9	63.5	72.5	14.5%	2.2%	0.2%
Other Caribbean	110.2	107.4	104.8	103.9	107.1	110.7	107.0	110.2	113.9	100.2	112.3	12.4%	0.2%	0.3%
Other South America	33.5	34.0	34.7	35.0	35.5	37.4	38.1	39.5	39.4	36.2	39.8	10.3%	1.7%	0.1%
Total S. & Cent. America	1225.1	1276.4	1334.6	1352.6	1338.4	1297.1	1283.4	1246.0	1228.5	1094.6	1213.1	11.1%	-0.1%	3.6%
Austria	64.7	62.2	62.9	58.6	60.7	61.6	64.4	62.1	63.6	56.0	58.4	4.5%	-1.0%	0.2%
Belgium	120.6	116.3	117.3	109.0	115.2	116.9	118.8	125.4	121.7	105.5	114.7	9.0%	-0.5%	0.3%
Bulgaria	50.5	45.8	40.7	43.1	45.8	43.0	45.7	42.5	41.3	35.9	41.7	16.7%	-1.9%	0.1%
Croatia	18.2	16.6	16.1	15.8	16.2	16.7	17.1	16.3	16.3	14.8	15.7	6.4%	-1.4%	•
Cyprus	8.7	8.1	7.3	7.3	7.5	8.1	8.3	8.2	8.2	7.0	7.2	3.9%	-1.8%	•
Czech Republic	113.1	109.3	105.0	102.0	102.8	104.8	102.9	101.9	98.2	87.9	92.4	5.4%	-2.0%	0.3%
Denmark	46.3	40.9	43.4	40.0	36.7	37.9	35.3	35.6	32.5	26.8	28.1	5.0%	-4.9%	0.1%
Estonia	23.5	22.8	24.5	23.5	21.4	22.1	24.6	24.1	18.3	15.9	18.0	13.6%	-2.6%	0.1%
Finland	57.1	51.0	52.0	47.7	44.9	47.7	45.0	46.5	43.1	36.7	37.2	1.5%	-4.2%	0.1%
France	334.1	335.6	334.9	301.5	307.5	313.1	317.8	306.7	299.3	251.6	273.6	9.0%	-2.0%	0.8%
Germany	763.7	773.0	797.6	751.1	755.6	770.5	760.9	733.1	680.1	600.8	628.9	5.0%	-1.9%	1.9%
Greece	94.5	88.2	79.1	75.6	73.2	69.8	54.5	72.7	68.6	56.0	56.5	1.2%	-5.0%	0.2%
Hungary	48.7	44.6	42.0	41.3	43.8	44.7	46.9	47.3	47.1	44.6	45.7	2.8%	-0.6%	0.1%
Iceland	2.5	2.5	2.7	2.7	2.9	2.8	3.1	3.3	2.8	1.8	1.8	2.2%	-3.0%	•
Ireland	38.9	38.8	37.4	37.1	38.9	40.5	39.3	39.1	37.5	33.0	34.8	5.6%	-1.1%	0.1%
Italy	389.5	371.0	341.4	318.8	334.4	331.4	335.5	336.1	328.6	283.8	311.2	9.9%	-2.2%	0.9%
Latvia	8.3	8.0	8.0	7.7	7.8	8.2	8.0	7.8	8.4	7.1	7.4	4.2%	-1.2%	•
Lithuania	12.4	12.4	11.7	11.0	11.3	11.7	11.9	12.5	12.3	11.8	12.1	3.5%	-0.2%	•
Luxembourg	11.7	11.4	10.9	10.5	10.1	10.0	10.3	10.8	10.9	9.0	9.3	3.6%	-2.3%	•
Netherlands	219.4	212.2	208.2	197.6	206.7	209.8	202.7	198.8	194.8	174.6	178.2	2.3%	-2.1%	0.5%
North Macedonia	9.3	8.9	7.9	7.5	7.2	7.1	7.5	7.1	8.1	6.6	6.9	3.7%	-3.0%	•
Norway	37.1	36.8	37.0	36.1	36.0	35.1	35.1	35.3	34.3	32.9	33.4	1.5%	-1.1%	0.1%
Poland	324.0	308.1	310.4	293.3	293.3	306.0	315.4	320.1	302.0	284.2	309.1	9.1%	-0.5%	0.9%
Portugal	51.4	50.7	49.3	49.6	53.1	52.4	57.3	54.3	50.3	40.7	39.7	-2.2%	-2.6%	0.1%
Romania	85.1	81.7	69.8	71.1	71.9	69.5	72.9	73.4	71.7	64.6	70.3	9.2%	-1.9%	0.2%
Slovakia	33.9	32.4	32.5	30.0	30.3	30.7	32.8	32.3	30.0	27.8	31.7	14.4%	-0.7%	0.1%
Slovenia	15.2	14.7	14.1	12.6	12.7	13.6	13.9	13.9	13.3	11.9	11.6	-1.8%	-2.7%	•
Spain	308.5	306.3	274.5	271.9	287.9	280.6	298.3	293.0	276.2	223.6	245.7	10.2%	-2.3%	0.7%
Sweden	52.0	49.1	48.1	46.1	46.4	46.5	45.5	44.7	47.3	43.1	40.1	-6.8%	-2.6%	0.1%
Switzerland	40.1	41.4	43.6	38.7	39.5	38.0	38.8	37.2	38.1	32.7	33.4	2.4%	-1.8%	0.1%
Turkey	298.8	314.4	303.3	335.1	340.6	359.0	397.1	390.8	386.7	373.9	403.3	8.1%	3.0%	1.2%
Ukraine	303.2	299.1	296.5	246.8	195.1	215.6	187.9	198.7	185.5	172.9	167.9	-2.7%	-5.7%	0.5%
United Kingdom	494.0	510.2	498.0	456.1	437.8	413.6	401.3	393.5	377.5	316.9	337.7	6.8%	-3.7%	1.0%
Other Europe	121.0	112.8	113.0	102.3	111.6	116.8	120.5	119.3	119.3	115.6	89.9	-22.0%	-2.9%	0.3%
Total Europe	4599.1	4537.5	4431.0	4199.1	4207.0	4255.7	4277.5	4244.4	4073.7	3608.3	3793.7	5.4%	-1.9%	11.2%
Azerbaijan	28.6	29.6	30.3	31.0	33.6	33.1	32.0	33.5	34.4	33.7	35.3	5.2%	2.2%	0.1%
Belarus	59.3	60.8	60.2	59.2	54.9	55.0	55.7	60.6	60.9	56.1	57.2	2.2%	-0.4%	0.2%
Kazakhstan	202.0	212.0	211.9	214.7	202.2	204.0	214.2	238.5	235.0	221.2	219.4	-0.5%	0.8%	0.6%
Russian Federation	1558.8	1572.4	1538.8	1539.8	1507.0	1520.5	1507.8	1564.7	1548.8	1456.2	1581.3	8.9%	0.1%	4.7%
Turkmenistan	59.9	65.2	58.3	60.5	71.5	70.9	70.2	77.6	84.1	79.2	94.3	19.3%	4.6%	0.3%
Uzbekistan	113.4	109.8	111.1	114.4	108.8	104.1	106.9	109.7	109.5	108.3	112.3	4.0%	-0.1%	0.3%
Other CIS	24.6	26.6	25.5	27.4	28.6	29.1	29.4	33.2	31.2	29.9	32.7	9.8%	2.9%	0.1%
Total CIS	2046.5	2076.3	2036.0	2047.0	2006.6	2016.7	2016.2	2117.7	2103.9	1984.5	2132.5	7.7%	0.4%	6.3%

Carbon dioxide emissions from energy

Iran	517.0	522.7	545.2	557.2	551.0	569.8	581.1	606.1	628.1	645.4	660.5	2.6%	2.5%	1.9%
Iraq	94.2	103.5	115.2	110.8	107.0	122.0	129.0	156.2	145.4	130.0	141.0	8.7%	4.1%	0.4%
Israel	68.6	74.2	66.9	64.1	66.8	66.1	66.8	67.0	69.2	63.0	63.3	0.7%	-0.8%	0.2%
Kuwait	89.9	92.2	94.6	96.3	99.6	97.8	99.8	101.9	103.7	95.9	103.1	7.9%	1.5%	0.3%
Oman	52.2	57.6	65.7	65.2	68.7	69.1	74.3	76.2	76.1	73.1	82.1	12.6%	4.6%	0.2%
Qatar	74.2	89.2	99.6	109.6	123.3	123.1	115.7	119.0	124.8	107.6	115.3	7.4%	4.5%	0.3%
Saudi Arabia	499.8	525.0	534.1	573.3	591.2	618.5	608.1	604.5	582.2	569.2	575.3	1.4%	1.4%	1.7%
United Arab Emirates	220.8	231.9	247.1	242.9	265.2	275.9	277.7	272.2	270.3	247.4	260.1	5.4%	1.7%	0.8%
Other Middle East	148.8	141.2	135.4	135.0	124.5	120.8	125.9	121.2	121.3	112.3	116.6	4.1%	-2.4%	0.3%
Total Middle East	1764.5	1837.3	1903.9	1954.4	1997.3	2063.1	2078.5	2124.2	2121.1	2044.0	2117.2	3.9%	1.8%	6.2%
Algeria	100.6	108.9	115.4	123.6	129.0	127.7	130.7	137.7	142.5	133.3	139.7	5.1%	3.3%	0.4%
Egypt	192.5	199.6	201.3	200.0	203.0	215.4	220.3	217.7	223.8	203.3	219.6	8.4%	1.3%	0.6%
Morocco	52.9	53.9	54.3	56.5	56.7	57.1	60.1	61.7	67.8	62.1	68.9	11.4%	2.7%	0.2%
South Africa	466.3	462.1	462.8	467.2	455.1	473.9	469.9	451.7	473.7	437.2	438.9	0.7%	-0.6%	1.3%
Eastern Africa	80.2	81.0	89.9	100.7	104.7	103.3	111.9	117.5	115.1	102.9	110.5	7.6%	3.3%	0.3%
Middle Africa	39.3	43.3	48.7	51.1	50.7	50.0	47.5	47.9	48.4	45.6	49.7	9.3%	2.4%	0.1%
Western Africa	103.5	107.4	109.2	110.9	126.5	130.4	139.5	156.7	159.8	161.6	174.8	8.5%	5.4%	0.5%
Other Northern Africa	57.4	70.9	75.7	75.3	71.7	70.6	70.4	71.2	71.5	63.5	75.0	18.4%	2.7%	0.2%
Other Southern Africa	10.9	12.3	12.5	13.7	13.8	13.6	14.5	14.4	14.4	13.2	13.7	4.3%	2.3%	•
Total Africa	1103.6	1139.3	1169.8	1198.9	1211.1	1242.0	1264.7	1276.4	1317.1	1222.6	1290.7	5.9%	1.6%	3.8%
Australia	406.8	398.1	395.0	398.5	407.2	405.6	403.7	401.5	406.6	378.2	369.4	-2.1%	-1.0%	1.1%
Bangladesh	56.5	60.4	62.7	65.4	78.0	79.2	83.2	89.2	99.1	96.8	100.9	4.5%	6.0%	0.3%
China	8793.5	8978.7	9219.1	9256.7	9226.2	9234.4	9444.9	9676.0	9668.5	9974.3	10523.0	5.8%	1.8%	31.1%
China Hong Kong SAR	92.0	88.7	91.5	89.7	90.5	92.7	98.9	100.1	94.6	68.1	64.6	-5.0%	-3.5%	0.2%
India	1728.4	1861.4	1934.0	2090.7	2146.5	2241.5	2320.2	2442.6	2465.8	2281.2	2552.8	12.2%	4.0%	7.5%
Indonesia	470.6	489.5	460.6	469.0	489.0	487.8	514.6	565.6	613.2	560.8	572.5	2.4%	2.0%	1.7%
Japan	1207.5	1293.8	1282.2	1248.7	1209.1	1189.3	1182.7	1161.5	1121.7	1029.5	1053.7	2.6%	-1.4%	3.1%
Malaysia	209.8	227.7	234.1	243.1	247.1	252.6	241.2	251.1	256.9	240.6	238.6	-0.6%	1.3%	0.7%
New Zealand	34.4	36.0	35.6	35.6	36.2	35.5	37.6	37.4	38.5	33.4	32.7	-1.8%	-0.5%	0.1%
Pakistan	145.2	144.6	145.3	151.7	160.3	176.5	188.7	196.9	207.1	206.3	226.4	10.0%	4.5%	0.7%
Philippines	80.7	83.1	91.9	97.3	106.2	116.4	128.9	133.7	140.7	127.2	136.8	7.8%	5.4%	0.4%
Singapore	192.7	192.0	191.4	191.0	202.8	217.0	228.9	225.2	217.3	211.6	215.7	2.2%	1.1%	0.6%
South Korea	613.7	612.6	620.0	615.0	622.8	633.2	641.8	659.1	635.3	588.8	603.8	2.8%	-0.2%	1.8%
Sri Lanka	16.4	18.2	15.9	19.6	21.6	24.7	24.4	23.4	25.3	23.8	22.8	-3.9%	3.4%	0.1%
Taiwan	273.0	266.8	268.4	275.3	275.5	280.8	286.7	284.7	279.1	264.6	279.2	5.8%	0.2%	0.8%
Thailand	249.3	266.7	265.8	273.7	281.1	286.8	287.5	293.2	288.4	270.0	269.4	•	0.8%	0.8%
Vietnam	132.1	129.7	134.5	151.0	184.2	198.7	200.4	241.9	292.6	276.3	272.7	-1.0%	7.5%	0.8%
Other Asia Pacific	431.5	443.3	422.2	447.7	476.1	519.6	597.9	613.1	641.0	630.4	638.0	1.5%	4.0%	1.9%
Total Asia Pacific	14813.5	15264.7	15555.4	15790.4	15910.2	16091.5	16486.7	16965.4	17249.9	16829.0	17734.6	5.7%	1.8%	52.3%
Total World	31904.6	32241.1	32710.9	32820.2	32837.4	33020.6	33426.4	34148.5	34095.8	32078.5	33884.1	5.9%	0.6%	100.0%
of which: OECD	12842.4	12655.7	12741.3	12518.7	12436.2	12348.5	12346.5	12459.4	12083.5	10744.7	11292.5	5.4%	-1.3%	33.3%
Non-OECD	19062.2	19585.4	19969.6	20301.4	20401.2	20672.1	21079.9	21689.2	22012.3	21333.9	22591.5	6.2%	1.7%	66.7%
European Union	3300.8	3218.7	3146.0	2980.8	3043.7	3075.7	3095.7	3069.0	2931.5	2564.2	2728.2	6.7%	-1.9%	8.1%

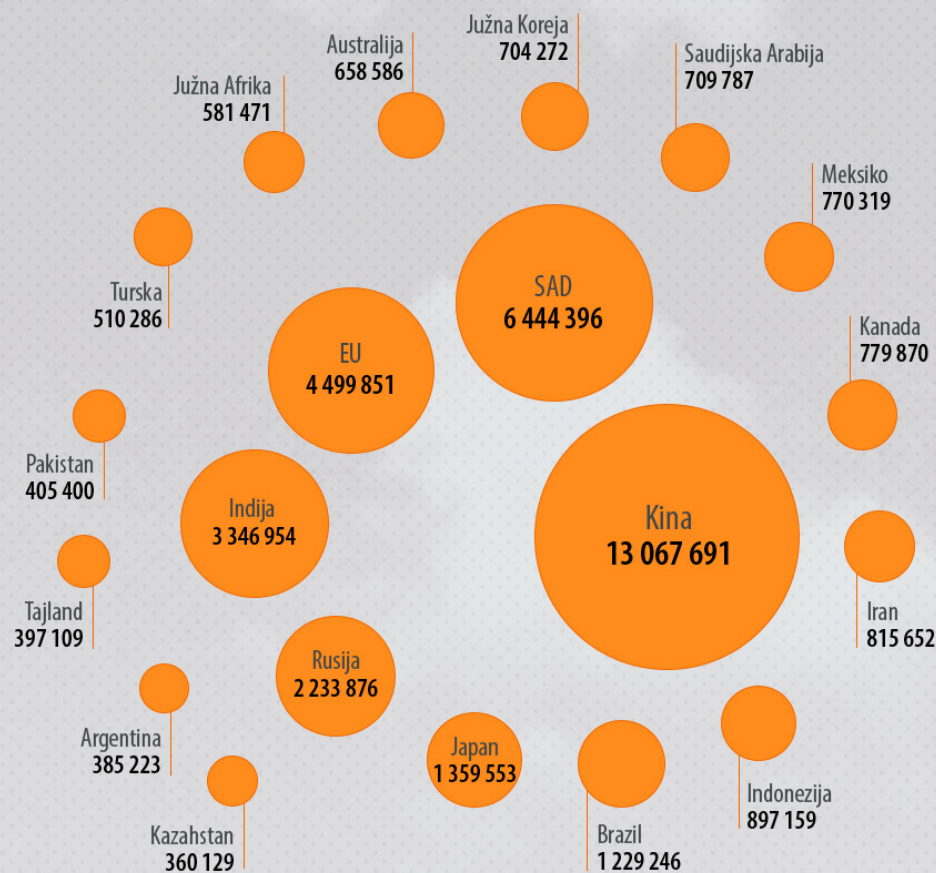
Source: statistics are taken from national statistical agencies, international organizations, and other proprietary sources.

•Less than 0.05%.

Notes: The carbon emissions above reflect only those through consumption of oil, gas and coal for combustion related activities, and are based on 'Default CO₂ Emissions Factors for Combustion' listed by the IPCC in its Guidelines for National Greenhouse Gas Inventories (2006). This does not allow for any carbon that is sequestered, for other sources of carbon emissions, or for emissions of other greenhouse gases. Our data is therefore not comparable to official national emissions data. Growth rates are adjusted for leap years.

Najveći zagađivači stakleničkim plinovima na svijetu u 2015.

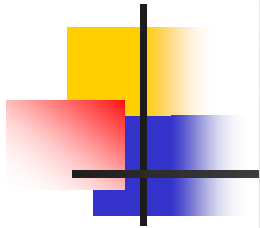
[kilotona ekvivalenta CO₂**]



Izvor: Zajednički istraživački centar (JRC)



© EU/EP



Emisije stakleničkih plinova u EU-u po zagađivaču*

2019.



<0,2% perfluorirani ugljik (PFC), neodređena mješavina PFC i HFC,
sumporov heksafluorid (SF₆) i dušikov trifluorid (NF₃)

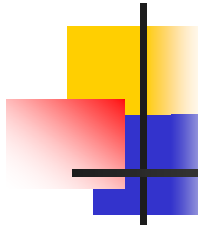
Zbroj nije jednak 100% zbog zaokruženih postotaka

* Ukupne emisije stakleničkih plinova osim korištenja zemlje, izmjena i šumarstva (LULUCF)

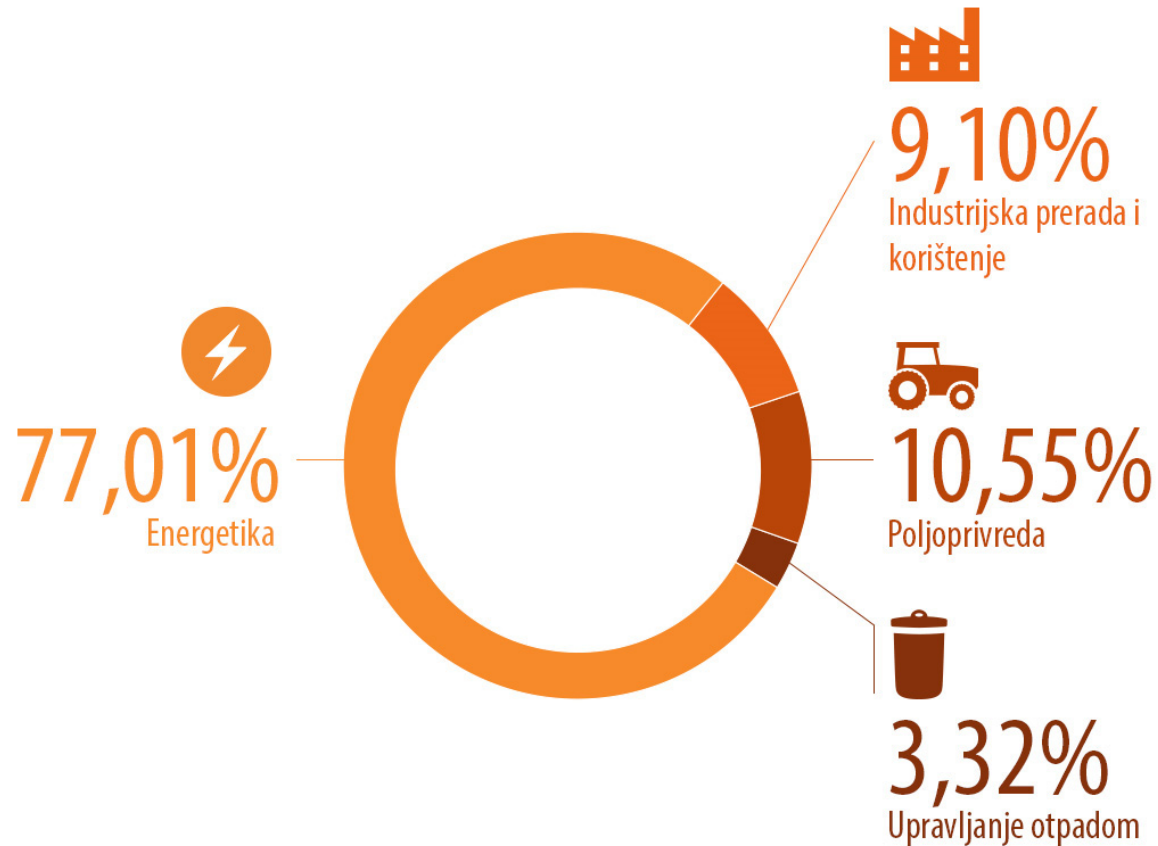
Izvor: Europska agencija za okoliš (EEA)



© EEA/EP



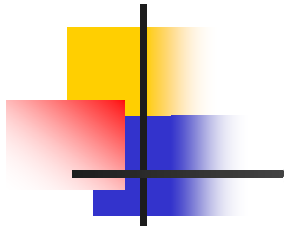
Emisije stakleničkih plinova u EU-u po sektoru* u 2019.



* Svi sektori osim korištenja zemlje, izmjena i šumarstva (LULUCF)
Zbroj nije jednak 100% zbog zaokruženih postotaka

Izvor: Europska agencija za okoliš (EEA)





Total GHG emissions 1990–2021 (GtCO₂e/year)

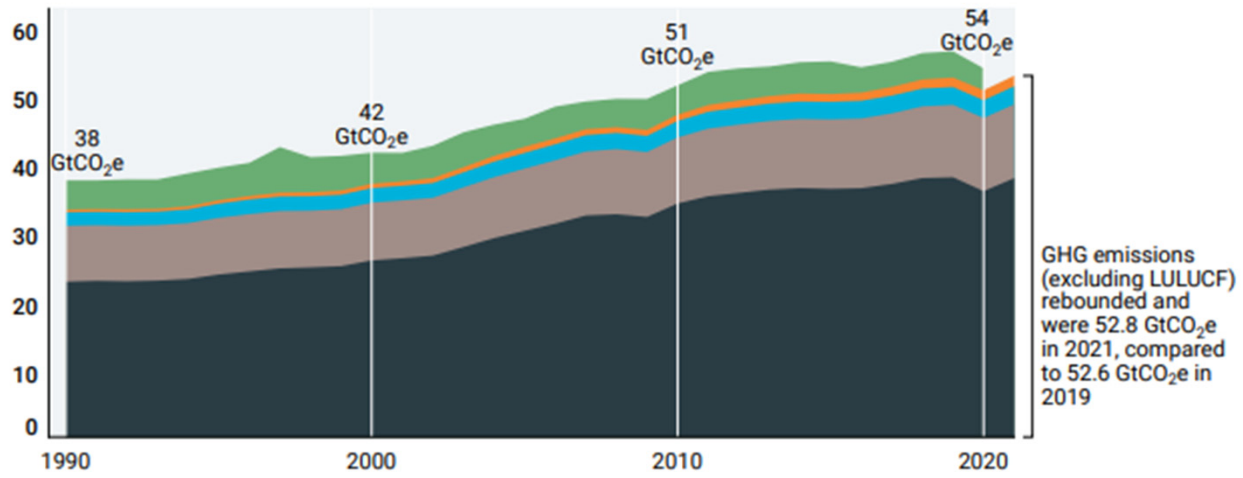
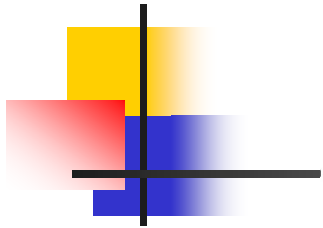
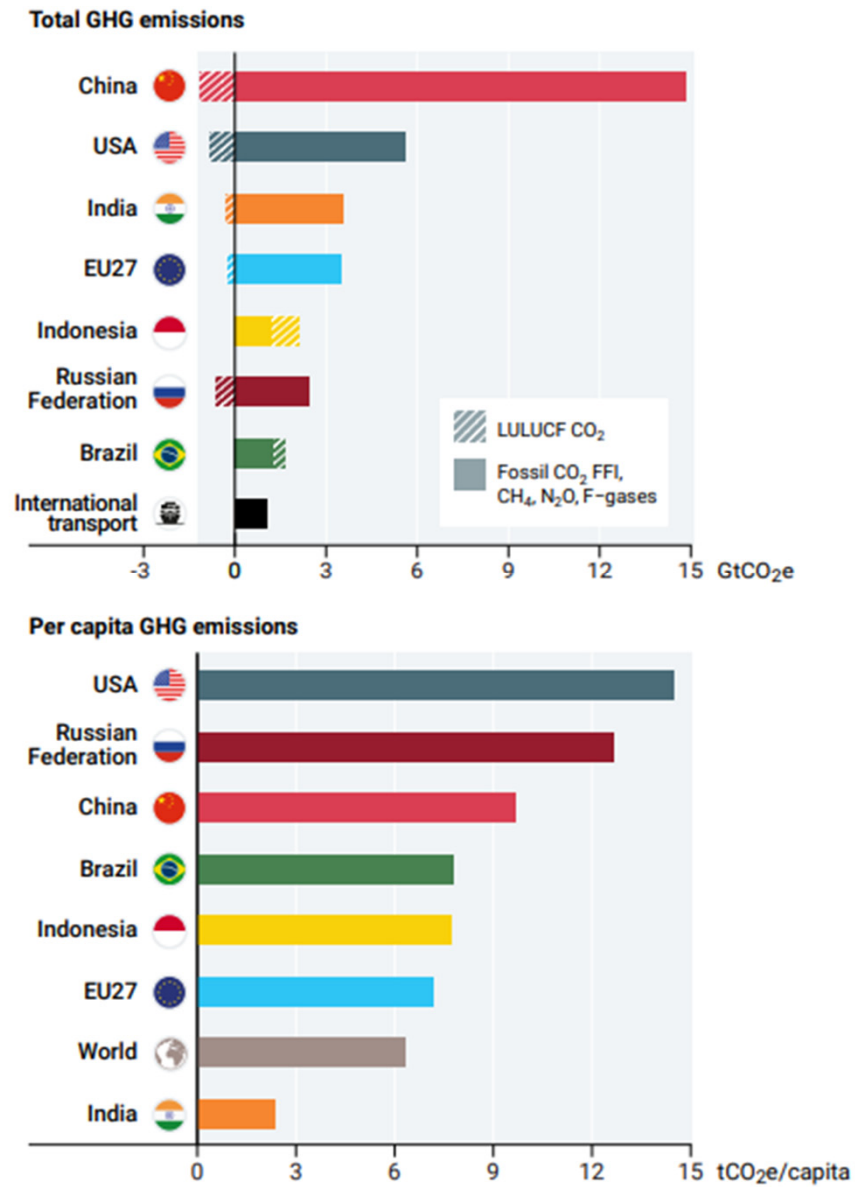


Figure ES.1 Total and per capita GHG emissions of major emitters in 2020, including inventory-based LULUCF





BP statistical review of World energy 2018. i 2019.

Carbon emissions

- Carbon emissions from energy consumption increased by 1.6%, after little or no growth for the three years from 2014 to 2016.

2017./16.

- ▶ Carbon emissions grew by 2.0%, the fastest growth for seven years.

2018./17.

My guess is that when our successors look back at Statistical Reviews from around this period, they will observe a world in which there was growing societal awareness and demands for urgent action on climate change, but where the actual energy data continued to move stubbornly in the wrong direction.

Conclusion

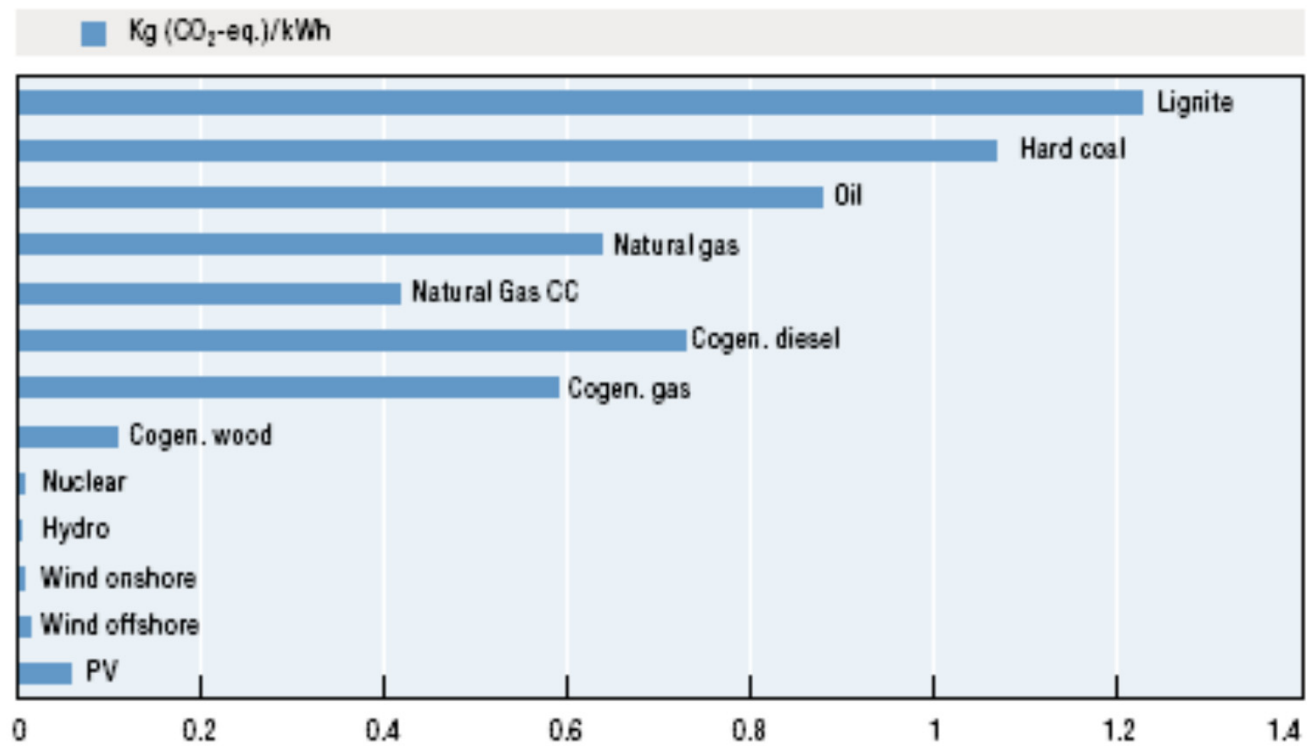
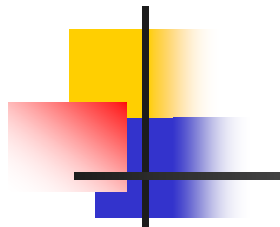
At a time when society is increasing its demands for an accelerated transition to a low carbon energy system, the energy data for 2018 paint a worrying picture, with both energy demand and carbon emissions growing at the fastest rates seen for years.

As I explained, in a statistical sense, it's possible to explain this acceleration in terms of a combination of weather-related effects and an unwinding of cyclical movements in China's pattern of growth. What is less clear is how much comfort we can take from this explanation.

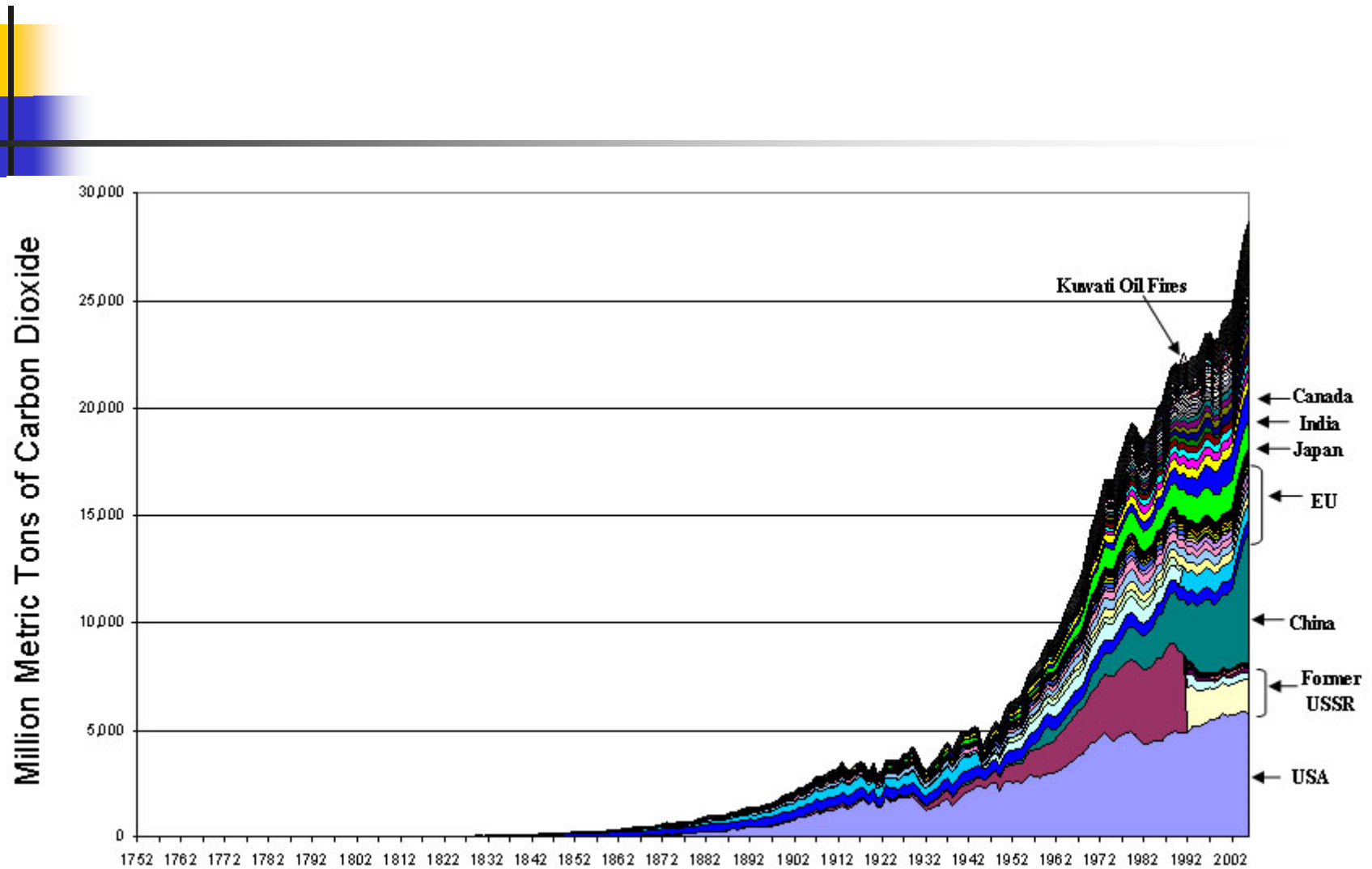
What does seem fairly clear is that the underlying picture is one in which the actual pace of progress is falling well short of the accelerated transition envisaged by the Paris climate goals.

Last year's developments sound yet another warning alarm that the world is on an unsustainable path.

Spencer Dale



Source: OECD/NEA (2007), NEA News 2007 – No. 25.2.





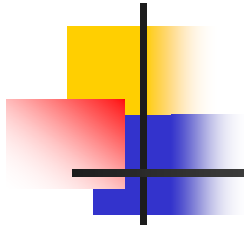
Dugoročni ciljevi u kontroli emisije CO₂ (prema scenariju IPCC-intergovernmental panel on climate change) - znanstveni aspekti

- maksimum emisije očekuje se u sljedećih 10 do 15 godina
- smanjenje emisija za 50% do 2050. u odnosu na one iz 2000.
- to bi dovelo do stabiliziranja koncentracije od 450ppm ekv. CO₂ i povišenja temperature od 2 do 2,4°C



Sustavno praćenje klimatskih promjena započelo je osnivanjem IPCC-a

The Intergovernmental Panel on Climate Change (IPCC) osnovan je 1988. od strane Svjetske meteorološke organizacije (World Meteorological Organization-WMO) i Programa za okoliš Ujedinjenih naroda (United Nations Environment Program-UNEP) sa željom da se vladama država omogući čisto znanstveni pogled na pojave vezane uz promjenu klime. Polazni zadatak IPCC-a, kao što je naglašeno rezolucijom br. 43/53 Glavne skupštine UN-a od 6. prosinca 1988., bio je pripremiti temeljiti pregled i preporuke obzirom na znanstvene spoznaje o promjene klime, socijalno-ekonomskim posljedicama promjene klime, te moguće strategije i pretpostavke koje treba ugraditi u buduće konvencije o klimi. Danas je uloga IPCC-a također "odrediti temeljitu, objektivnu, otvorenu i transparentnu osnovu za znanstvenu, tehničku i socijalno ekonomsku informaciju bitnu za razumijevanje rizika i utjecaja izazvanih promjenom klime uslijed djelovanja čovjeka, te mogućnosti kako se prilagoditi tim utjecajima ili ih smanjiti. IPCC izvještaji moraju biti neutralni prema politici, iako se moraju baviti znanstvenim tehničkim i socijalno ekonomskim čimbenicima bitnim za primjenu određenih politika."

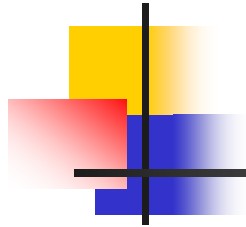


Kyoto protokolu prethodilo je 1992. godine potpisivanje sporazuma pod nazivom "United Nations Framework Convention on Climate Change (UNFCCC)". Time je trebalo pospješiti zajedničke napore za ograničavanjem porasta temperature i posljedica koje bi trebale zbog toga nastupiti.

Jedan od najpoznatijih dokumenata koji regulira to pitanje je Kyoto protokol potpisan 11. prosinca 1997., a postao obvezujući 16. veljače 2005.

Uključuje tri mehanizma:

- trgovina emisijama
- mehanizam "čistog razvoja"
- zajednička implementacija



- Pariški sporazum (2016. u RH ratificiran 2017) COP 21
- Porast temp znatno ispod 2°C

- Trenutno COP 25 u Madridu

2020 climate & energy package

Paket postavlja tri osnovna cilja:

- **20%** smanjenja stakleničkih plinova (u odnosu na razine iz 1990.)
- **20%** energije u EU iz OIE (ukupne potrošnje)
- **20%** povišenje energetske učinkovitosti

2030 climate & energy framework

Ključni ciljevi do 2030.:

- Barem **40%** smanjenja stakleničkih plinova (u odnosu na razine iz 1990.)
- Barem **32%** udjela OIE (ukupne potrošnje)
- Barem **32.5%** povišenje energetske učinkovitosti

**German Energiewende -2010
+ Fukushima!**