

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



ENERGETIKA

Studij: Kemijsko inženjerstvo (V semestar)

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Ugljen – fosilno gorivo nastalo iz organskih sastojaka kroz dugi period u anaerobnim uvjetima pri visokim tlakovima i temperaturama

	Gustoća, kg/m ³	Donja toplinska vrijednost, MJ/kg	Udio vlage,%	Hlapljivi sastojci, % suhe tvari	Udio ugljika, % suhe tvari
Drvo	0,2-1,3	14,7	Suho d.	80	50
Treset	1,0	6,3-8,4	60-90	65	55-65
Lignit	1,2	7,5-12,6	30-60	50-60	65-70
Mrki ugljen	1,25	16,7-29,3	10-30	45-50	70-80
Plameni kameni ugljen	1,3	29,3-33,5	3-10	17-45	80-90
Mršavi kameni ugljen	1,35	33,5-35,6	3-10	7-17	90-93
Antracit	1,4-1,6	35,6-37,7	1-2	4-7	93-98

Izgled pojedinih vrsta ugljena



KAMENI UGLJEN



MRKI UGLJEN

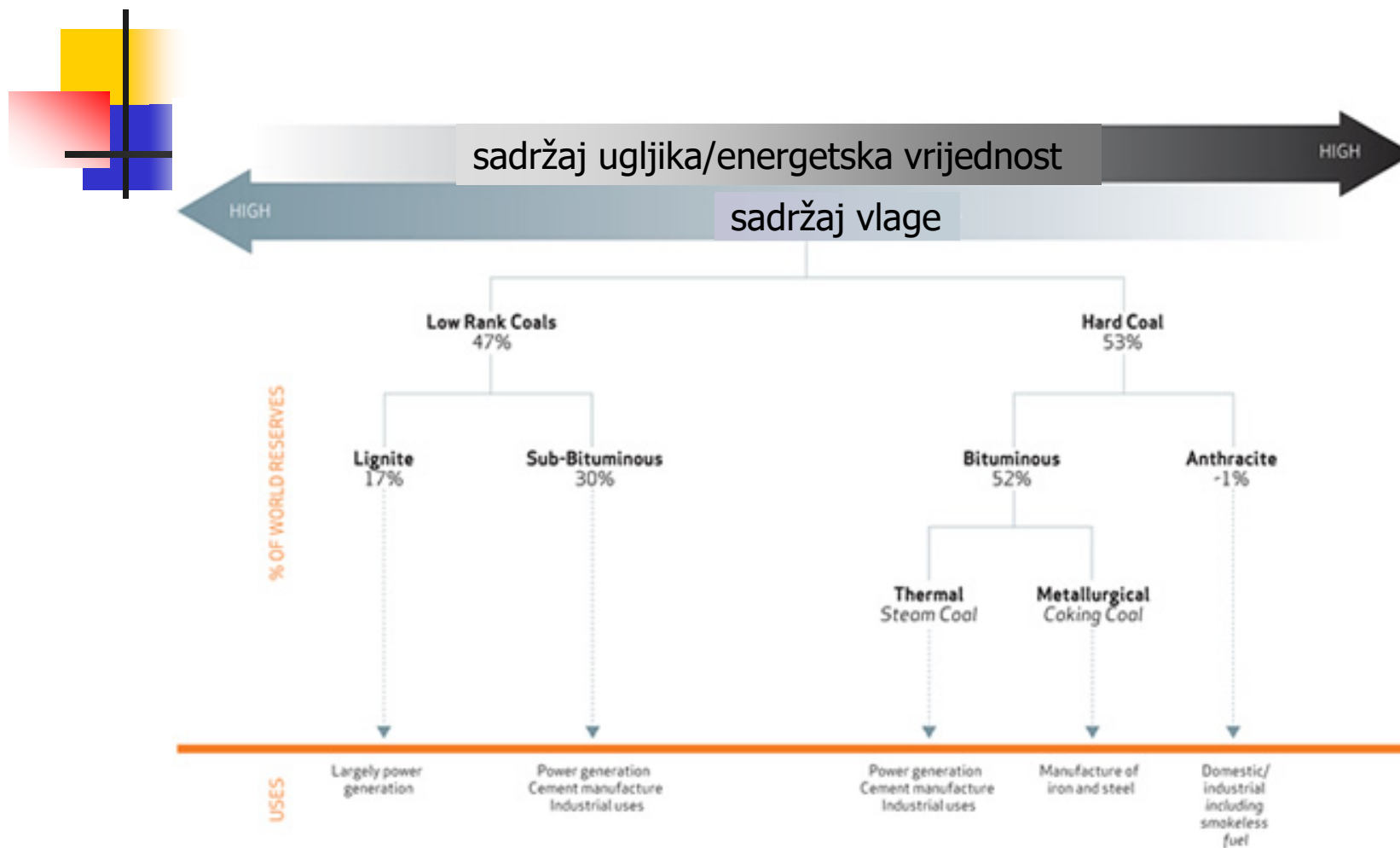


LIGNIT



TRESET

Vrste ugljena i njihove karakteristike i upotreba

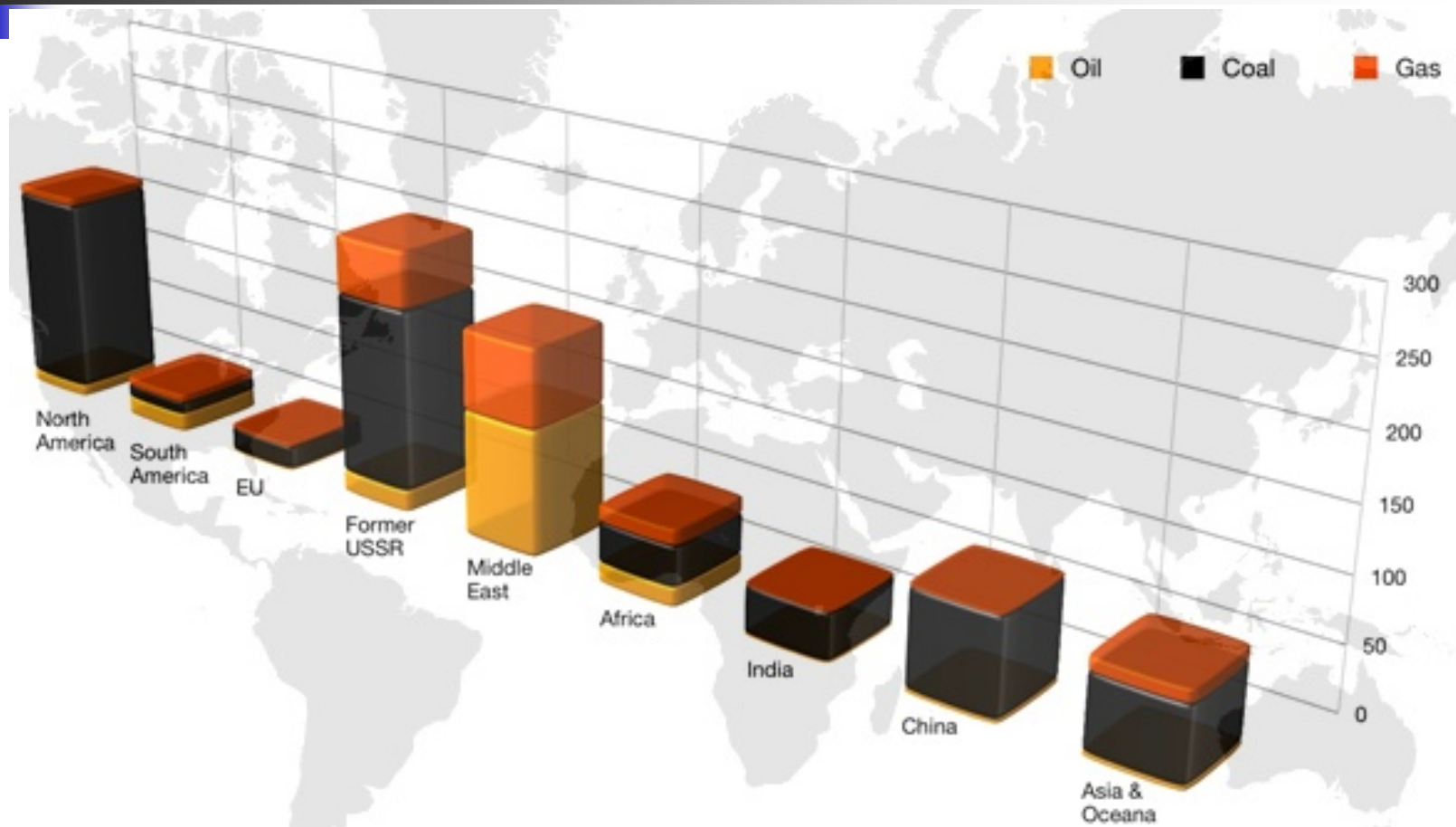


Struktura kapaciteta za proizvodnju električne energije na teritoriju Republike Hrvatske (izvor: EI Hrvoje Požar)

Kapaciteti za proizvodnju električne energije Electricity generation capacity	Raspoloživa snaga • Available power [MW]	Proizvedena električna energija u 2019. godini (na generatoru) Gross Electricity produced in 2019 [GWh]
Hidroelektrane • Hydro power plants	2 199,7	5 932,6
Akumulacijske • Storage	1 485,7	3 584,5
Crpne • pumped-storage	275,4	502,0
Protočne • Run-of-river	405,3	1 731,1
Male HE • Small HPP	33,3	115,0
Termoelektrane • Thermal power plants	1 781,0	5 277,1
Ugljen • Coal	331,0	1 639,4
Prirodni plin • Natural gas	969,1	2 629,4
Naftni derivati • Oil derivatives	343,5	38,3
Biomasa • Biomass	75,5	477,1
Geotermalna energija • Geothermal	10,0	91,9
Bioplin • Biogas	51,9	401,0
Vjetroelektrane • Wind Power Plants	646,3	1 467,3
Sunčane elektrane • Solar Power Plants	84,8	83,1
Ukupno • Total	4 711,8	12 760,1

Izvor: EIH, HEP, HOPS, HROTE, DZS • Source: EIH, HEP, Croatian TSO, Croatian Energy Market Operator, CBS

Raspored svjetskih rezervi ugljena



Total proved reserves at end 2020

Million tonnes	Anthracite and bituminous	Sub-bituminous and lignite	Total	Share of Total	R/P ratio
Canada	4346	2236	6582	0.6%	166
Mexico	1160	51	1211	0.1%	185
US	218938	30003	248941	23.2%	*
Total North America	224444	32290	256734	23.9%	484
Brazil	1547	5049	6596	0.6%	*
Colombia	4554	-	4554	0.4%	90
Venezuela	731	-	731	0.1%	*
Other S. & Cent. America	1784	24	1808	0.2%	*
Total S. & Cent. America	8616	5073	13689	1.3%	240
Bulgaria	192	2174	2366	0.2%	192
Czech Republic	1081	2514	3595	0.3%	113
Germany	-	35900	35900	3.3%	334
Greece	-	2876	2876	0.3%	205
Hungary	276	2633	2909	0.3%	475
Poland	22530	5865	28395	2.6%	282
Romania	11	280	291	*	19
Serbia	402	7112	7514	0.7%	189
Spain	868	319	1187	0.1%	282
Turkey	550	10975	11525	1.1%	168
Ukraine	32039	2336	34375	3.2%	*
United Kingdom	26	-	26	*	16
Other Europe	1109	5172	6281	0.6%	189
Total Europe	59084	78156	137240	12.8%	299
Kazakhstan	25605	-	25605	2.4%	226
Russian Federation	71719	90447	162166	15.1%	407
Uzbekistan	1375	-	1375	0.1%	333
Other CIS	1509	-	1509	0.1%	336
Total CIS	100208	90447	190655	17.8%	367
South Africa	9893	-	9893	0.9%	40
Zimbabwe	502	-	502	*	153
Other Africa	4376	66	4442	0.4%	280
Middle East	1203	-	1203	0.1%	*
Total Middle East & Africa	15974	66	16040	1.5%	60
Australia	73719	76508	150227	14.0%	315
China	135089	8128	143197	13.3%	37
India	105979	5073	111052	10.3%	147
Indonesia	23141	11728	34869	3.2%	62
Japan	340	10	350	*	453
Mongolia	1170	1350	2520	0.2%	58
New Zealand	825	6750	7575	0.7%	*
Pakistan	207	2957	3064	0.3%	396
South Korea	326	-	326	*	320
Thailand	-	1063	1063	0.1%	80
Vietnam	3116	244	3360	0.3%	69
Other Asia Pacific	1421	726	2147	0.2%	33
Total Asia Pacific	345313	114437	459750	42.8%	78
Total World	753639	320469	1074108	100.0%	139
of which: OECD	331303	177130	508433	47.3%	363
Non-OECD	422336	143339	565675	52.7%	90
European Union	25539	53051	78590	7.3%	268

*More than 500 years.

*Less than 0.05%.

Notes: Total proved reserves of coal – generally taken to be those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions. The data series for total proved coal reserves does not necessarily meet the definitions, guidelines and practices used for determining proved reserves at company level, for instance as published by the US Securities and Exchange Commission, nor does it necessarily represent bp's view of proved reserves by country.

Reserves-to-production (R/P) ratio – if the reserves remaining at the end of any year are divided by this production in that year, the result is the length of time that those remaining reserves would last if production were to continue at that rate.

Reserves-to-production (R/P) ratios are calculated excluding other solid fuels in reserves and production.

Shares of total and R/P ratios are calculated using million tonnes figures.

Source: Federal Institute for Geosciences and Natural Resources (BGR) Energy Study 2021.



Najveći svjetski proizvođači ugljena

Coal: Production*

Exajoules	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Growth rate per annum		Share 2020
												2020	2009-19	
Canada	1.48	1.48	1.49	1.53	1.51	1.36	1.37	1.33	1.22	1.14	0.89	-22.0%	-2.0%	0.6%
Mexico	0.31	0.39	0.31	0.30	0.30	0.29	0.25	0.31	0.28	0.23	0.15	-33.1%	-1.0%	0.1%
US	22.09	22.27	20.72	20.05	20.33	17.99	14.70	15.66	15.40	14.29	10.71	-25.2%	-4.1%	6.7%
Total North America	23.88	24.15	22.53	21.87	22.15	19.64	16.33	17.30	16.90	15.66	11.76	-25.1%	-3.9%	7.4%
Brazil	0.11	0.11	0.12	0.15	0.15	0.12	0.11	0.09	0.10	0.09	0.09	3.9%	-3.4%	0.1%
Colombia	2.14	2.47	2.56	2.46	2.55	2.46	2.60	2.60	2.42	2.43	1.46	-40.2%	1.5%	0.9%
Venezuela	0.08	0.08	0.06	0.04	0.02	0.02	0.01	0.01	†	0.01	0.02	181.9%	-22.8%	*
Other S. & Cent. America	0.01	0.02	0.02	0.07	0.12	0.10	0.08	0.05	0.05	0.03	0.03	-10.5%	7.4%	*
Total S. & Cent. America	2.35	2.68	2.76	2.72	2.85	2.70	2.81	2.76	2.57	2.56	1.60	-37.6%	0.9%	1.0%
Bulgaria	0.21	0.26	0.23	0.20	0.21	0.25	0.21	0.24	0.22	0.20	0.16	-20.6%	0.6%	0.1%
Czech Republic	0.87	0.88	0.85	0.74	0.71	0.71	0.67	0.64	0.62	0.56	0.43	-24.3%	-4.3%	0.3%
Germany	1.92	1.96	2.00	1.89	1.85	1.79	1.66	1.65	1.58	1.19	0.98	-17.9%	-4.8%	0.6%
Greece	0.31	0.31	0.34	0.28	0.27	0.24	0.17	0.19	0.18	0.21	0.11	-49.0%	-4.6%	0.1%
Hungary	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.05	0.05	0.04	0.04	-10.8%	-4.4%	*
Poland	2.32	2.33	2.42	2.39	2.26	2.22	2.18	2.08	1.98	1.87	1.68	-10.1%	-2.3%	1.1%
Romania	0.25	0.28	0.27	0.19	0.19	0.20	0.18	0.19	0.17	0.16	0.11	-30.9%	-5.0%	0.1%
Serbia	0.30	0.33	0.31	0.32	0.24	0.30	0.30	0.30	0.29	0.29	0.29	1.7%	-0.7%	0.2%
Spain	0.14	0.11	0.10	0.07	0.07	0.05	0.03	0.05	0.03	0.07	0.08	14.3%	-8.4%	*
Turkey	0.73	0.75	0.71	0.65	0.68	0.54	0.65	0.63	0.69	0.73	0.60	-18.1%	*	0.4%
Ukraine	1.35	1.52	1.64	1.60	1.09	0.72	0.76	0.57	0.59	0.58	0.54	-8.0%	-8.0%	0.3%
United Kingdom	0.48	0.48	0.44	0.33	0.31	0.23	0.12	0.09	0.07	0.06	0.05	-23.0%	-18.0%	*
Other Europe	0.66	0.66	0.59	0.69	0.66	0.60	0.56	0.57	0.82	0.51	0.46	-8.6%	-2.4%	0.3%
Total Europe	9.60	9.94	9.96	9.44	8.60	7.90	7.56	7.25	7.28	6.48	5.53	-14.8%	-4.0%	3.5%
Kazakhstan	1.99	2.08	2.16	2.15	2.05	1.93	1.85	2.02	2.13	2.07	2.04	-1.7%	1.3%	1.3%
Russian Federation	6.32	6.60	7.05	7.25	7.39	7.80	8.12	8.62	9.23	9.23	8.37	-9.6%	4.5%	5.2%
Uzbekistan	0.04	0.05	0.04	0.05	0.05	0.04	0.05	0.05	0.05	0.05	0.05	1.8%	1.2%	*
Other CIS	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.09	0.12	0.12	0.12	-2.3%	12.8%	0.1%
Total CIS	8.39	8.77	9.31	9.51	9.56	9.84	10.10	10.78	11.52	11.47	10.58	-8.0%	3.9%	6.6%
Total Middle East	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.05	-0.3%	3.8%	*
South Africa	6.03	6.00	6.14	6.08	6.20	5.96	6.01	5.97	6.01	6.21	5.97	-4.1%	0.6%	3.7%
Zimbabwe	0.07	0.07	0.04	0.08	0.16	0.12	0.07	0.08	0.09	0.07	0.09	24.5%	4.7%	0.1%
Other Africa	0.04	0.05	0.18	0.21	0.24	0.25	0.33	0.61	0.76	0.55	0.41	-25.8%	34.3%	0.3%
Total Africa	6.15	6.11	6.36	6.38	6.59	6.33	6.42	6.66	6.87	6.84	6.47	-5.6%	1.4%	4.1%
Australia	10.49	10.26	11.13	11.97	12.81	12.80	12.83	12.50	13.09	13.21	12.42	-6.2%	2.7%	7.8%
China	69.72	77.53	78.44	79.32	78.05	76.59	70.82	73.17	76.87	79.76	80.91	1.2%	2.2%	50.7%
India	10.57	10.49	10.68	10.71	11.28	11.77	11.89	11.99	12.80	12.60	12.68	0.4%	2.0%	7.9%
Indonesia	6.79	8.72	9.52	11.71	11.30	11.39	11.25	11.38	13.76	15.20	13.88	-9.0%	9.2%	8.7%
Japan	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	1.5%	-4.5%	*
Mongolia	0.48	0.63	0.59	0.64	0.47	0.46	0.67	0.94	1.04	1.09	0.82	-24.8%	14.7%	0.5%
New Zealand	0.14	0.13	0.13	0.12	0.10	0.09	0.07	0.07	0.08	0.08	0.07	-8.6%	-3.7%	*
Pakistan	0.06	0.06	0.06	0.06	0.06	0.06	0.08	0.08	0.08	0.13	0.15	14.0%	6.8%	0.1%
South Korea	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	-6.3%	-7.9%	*
Thailand	0.21	0.25	0.20	0.20	0.19	0.16	0.18	0.17	0.16	0.15	0.14	-7.3%	-2.8%	0.1%
Vietnam	1.05	1.09	0.99	0.96	0.96	0.98	0.91	0.90	0.99	1.09	1.14	4.5%	0.5%	0.7%
Other Asia Pacific	0.87	0.93	0.96	0.98	0.99	1.06	1.33	1.14	1.06	1.48	1.37	-7.5%	6.2%	0.9%
Total Asia Pacific	100.45	110.16	112.76	116.72	116.30	115.40	110.09	112.41	119.99	124.81	123.62	-1.2%	2.9%	77.5%
Total World	150.84	161.85	163.71	166.66	166.07	161.85	153.23	157.20	165.17	167.86	159.61	-5.2%	1.6%	100.0%
of which: OECD	43.99	44.39	43.70	43.43	44.42	41.31	37.81	38.28	38.18	36.42	29.93	-18.0%	-1.7%	18.8%
Non-OECD	106.85	117.46	120.00	123.23	121.65	120.54	115.52	118.92	127.00	131.44	129.67	-1.6%	2.8%	81.2%
European Union	6.45	6.57	6.59	6.24	5.99	5.83	5.44	5.39	5.20	4.56	3.79	-17.1%	-3.6%	2.4%

* Commercial solid fuels only, i.e. bituminous coal and anthracite (hard coal), and lignite and brown (sub-bituminous) coal, and other commercial solid fuels. Includes coal produced for coal-to-liquids and coal-to-gas transformations.

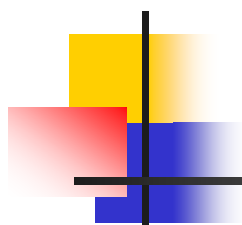
† Less than 0.005.

* Less than 0.05%.

Note: Growth rates are adjusted for leap years.

Coal production data expressed in million tonnes is available at bp.com/statisticalreview.

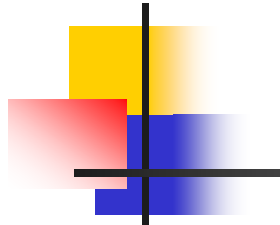
Najveći svjetski potrošači ugljena



Coal: Consumption*

Exajoules	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Growth rate per annum		Share 2020
												2020	2009-19	
Canada	1.03	0.93	0.89	0.86	0.82	0.82	0.77	0.78	0.65	0.63	0.50	-22.2%	-4.5%	0.3%
Mexico	0.53	0.62	0.54	0.53	0.53	0.53	0.52	0.64	0.57	0.54	0.21	-61.5%	-2.3%	0.1%
US	20.88	19.70	17.42	18.08	18.04	15.58	14.26	13.87	13.28	11.34	9.20	-19.1%	-5.4%	6.1%
Total North America	22.45	21.25	18.85	19.48	19.39	16.94	15.55	15.29	14.50	12.52	9.91	-21.1%	-5.1%	6.5%
Argentina	0.05	0.05	0.05	0.05	0.06	0.06	0.04	0.05	0.05	0.03	0.03	8.8%	-1.7%	*
Brazil	0.61	0.65	0.64	0.69	0.73	0.74	0.67	0.70	0.69	0.65	0.58	-10.9%	3.4%	0.4%
Chile	0.19	0.24	0.28	0.32	0.32	0.31	0.31	0.32	0.31	0.31	0.30	-4.4%	6.5%	0.2%
Colombia	0.20	0.16	0.20	0.21	0.22	0.21	0.23	0.17	0.16	0.20	0.27	31.4%	1.8%	0.2%
Ecuador	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peru	0.03	0.03	0.04	0.04	0.04	0.03	0.04	0.04	0.05	0.03	0.02	-26.8%	-0.9%	*
Trinidad & Tobago	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Venezuela	0.01	0.01	0.01	0.01	0.01	0.01	0.01	†	†	†	†	-35.1%	-21.9%	*
Other S. & Cent. America	0.10	0.11	0.11	0.13	0.14	0.15	0.16	0.13	0.15	0.23	0.28	21.6%	9.5%	0.2%
Total S. & Cent. America	1.18	1.26	1.32	1.45	1.52	1.50	1.45	1.42	1.41	1.45	1.48	1.5%	4.1%	1.0%
Austria	0.14	0.15	0.13	0.14	0.13	0.14	0.13	0.13	0.12	0.12	0.09	-21.8%	-0.1%	0.1%
Belgium	0.16	0.15	0.14	0.15	0.14	0.14	0.13	0.13	0.13	0.13	0.11	-17.6%	0.5%	0.1%
Czech Republic	0.79	0.77	0.74	0.71	0.69	0.68	0.69	0.65	0.65	0.60	0.49	-19.0%	-2.3%	0.3%
Finland	0.28	0.23	0.19	0.21	0.19	0.16	0.18	0.17	0.18	0.15	0.13	-10.4%	-4.1%	0.1%
France	0.48	0.41	0.46	0.48	0.36	0.36	0.35	0.38	0.34	0.27	0.19	-27.9%	-5.1%	0.1%
Germany	3.23	3.28	3.37	3.47	3.33	3.29	3.20	3.01	2.90	2.25	1.84	-18.2%	-2.9%	1.2%
Greece	0.33	0.33	0.34	0.29	0.28	0.24	0.19	0.20	0.19	0.22	0.11	-47.3%	-4.7%	0.1%
Hungary	0.11	0.11	0.11	0.10	0.09	0.10	0.09	0.09	0.09	0.08	0.07	-6.7%	-3.3%	*
Italy	0.57	0.64	0.66	0.57	0.55	0.52	0.46	0.40	0.37	0.28	0.21	-26.1%	-6.0%	0.1%
Netherlands	0.32	0.31	0.34	0.34	0.38	0.46	0.43	0.39	0.35	0.27	0.18	-33.4%	-1.5%	0.1%
Norway	0.03	0.04	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.03	-0.3%	3.4%	*
Poland	2.31	2.30	2.14	2.23	2.07	2.04	2.07	2.08	2.09	1.86	1.67	-10.4%	-1.5%	1.1%
Portugal	0.07	0.09	0.12	0.11	0.11	0.14	0.12	0.14	0.11	0.05	0.02	-53.8%	-7.9%	*
Romania	0.29	0.34	0.32	0.25	0.24	0.25	0.22	0.23	0.21	0.21	0.15	-27.0%	-4.1%	0.1%
Spain	0.29	0.54	0.65	0.48	0.49	0.57	0.44	0.56	0.46	0.16	0.07	-53.7%	-8.8%	*
Sweden	0.12	0.10	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.07	-9.3%	-0.2%	*
Switzerland	0.01	0.01	0.01	0.01	0.01	0.01	†	†	†	†	†	-0.3%	-4.7%	*
Turkey	1.32	1.42	1.53	1.32	1.51	1.45	1.61	1.65	1.71	1.76	1.66	-5.8%	3.1%	1.1%
Ukraine	1.60	1.74	1.79	1.73	1.49	1.14	1.36	1.08	1.17	1.08	0.98	-8.9%	-3.3%	0.6%
United Kingdom	1.29	1.32	1.63	1.55	1.25	0.97	0.46	0.38	0.32	0.22	0.19	-11.3%	-16.0%	0.1%
Other Europe	1.60	1.71	1.55	1.55	1.42	1.44	1.44	1.43	1.39	1.34	1.10	-18.0%	-1.4%	0.7%
Total Europe	15.34	15.99	16.34	15.81	14.84	14.21	13.70	13.23	12.90	11.13	9.40	-15.8%	-2.7%	6.2%
Azerbaijan	†	†	†	†	†	†	†	†	†	†	†	-0.3%	-16.4%	*
Belarus	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.04	0.05	0.06	0.06	-0.7%	8.0%	*
Kazakhstan	1.40	1.52	1.58	1.57	1.55	1.43	1.42	1.52	1.70	1.66	1.64	-1.8%	2.5%	1.1%
Russian Federation	3.79	3.94	4.12	3.79	3.67	3.86	3.74	3.51	3.63	3.57	3.27	-8.5%	-0.8%	2.2%
Turkmenistan	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uzbekistan	0.03	0.04	0.05	0.07	0.07	0.05	0.06	0.06	0.09	0.08	0.10	32.4%	6.6%	0.1%
Other CIS	0.04	0.05	0.05	0.06	0.07	0.08	0.08	0.09	0.09	0.09	0.11	27.9%	7.8%	0.1%
Total CIS	5.29	5.57	5.84	5.52	5.39	5.45	5.33	5.22	5.56	5.45	5.17	-5.2%	0.3%	3.4%

Najveći svjetski potrošači ugljena



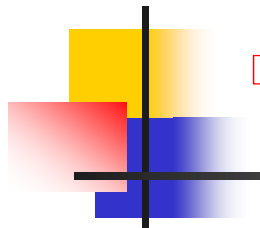
Exajoules	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Growth rate per annum		Share 2020	
												2020	2009-19		
Iran	0.05	0.06	0.05	0.06	0.07	0.07	0.06	0.07	0.07	0.07	0.07	-0.3%	2.7%	*	
Iraq	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Israel	0.32	0.33	0.37	0.30	0.28	0.27	0.23	0.21	0.20	0.21	0.17	-19.8%	-4.3%	0.1%	
Kuwait	†	†	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	†	-82.3%	-	*	
Oman	†	†	†	†	†	†	†	†	†	†	0.01	90.7%	61.6%	*	
Qatar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saudi Arabia	†	†	†	†	0.01	0.01	†	†	†	†	†	†	-0.3%	16.4%	*
United Arab Emirates	0.03	0.02	0.06	0.07	0.08	0.07	0.08	0.09	0.08	0.08	0.11	30.6%	21.9%	0.1%	
Other Middle East	0.01	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.4%	6.1%	*	
Total Middle East	0.42	0.43	0.50	0.47	0.47	0.44	0.41	0.40	0.38	0.40	0.38	-3.9%	-0.1%	0.3%	
Algeria	0.01	0.01	0.01	0.01	0.01	0.01	†	0.01	0.02	0.02	0.02	-0.3%	-1.6%	*	
Egypt	0.02	0.02	0.02	0.02	0.02	0.03	0.05	0.05	0.09	0.08	0.03	-62.1%	12.3%	*	
Morocco	0.12	0.12	0.13	0.13	0.17	0.19	0.18	0.19	0.22	0.28	0.28	0.1%	9.4%	0.2%	
South Africa	3.89	3.79	3.70	3.70	3.75	3.52	3.78	3.72	3.53	3.64	3.48	-4.6%	-0.8%	2.3%	
Other Africa	0.15	0.18	0.17	0.22	0.32	0.28	0.26	0.31	0.35	0.30	0.30	-0.4%	7.8%	0.2%	
Total Africa	4.19	4.13	4.02	4.07	4.26	4.02	4.28	4.27	4.20	4.32	4.11	-5.1%	0.2%	2.7%	
Australia	2.19	2.13	2.00	1.89	1.88	1.95	1.94	1.88	1.83	1.75	1.69	-4.0%	-2.9%	1.1%	
Bangladesh	0.03	0.05	0.04	0.05	0.03	0.09	0.07	0.08	0.09	0.14	0.15	11.1%	11.0%	0.1%	
China	73.22	79.71	80.71	82.44	82.49	80.94	80.21	80.59	81.11	81.79	82.27	0.3%	1.5%	54.3%	
China-Hong Kong SAR	0.28	0.31	0.31	0.33	0.34	0.28	0.28	0.26	0.26	0.26	0.14	-48.9%	-1.5%	0.1%	
India	12.16	12.75	13.82	14.79	16.23	16.55	16.84	17.44	18.59	18.60	17.54	-6.0%	4.7%	11.6%	
Indonesia	1.65	1.96	2.22	2.39	1.89	2.14	2.23	2.39	2.84	3.41	3.26	-4.9%	9.4%	2.2%	
Japan	4.87	4.62	4.88	5.07	4.99	5.03	5.02	5.10	4.99	4.91	4.57	-7.0%	1.4%	3.0%	
Malaysia	0.62	0.62	0.66	0.63	0.64	0.73	0.79	0.87	0.93	0.95	1.14	18.7%	7.9%	0.8%	
New Zealand	0.06	0.06	0.07	0.06	0.06	0.06	0.05	0.05	0.06	0.06	0.06	-4.8%	-0.5%	*	
Pakistan	0.19	0.17	0.17	0.13	0.20	0.19	0.22	0.30	0.50	0.56	0.62	11.0%	10.5%	0.4%	
Philippines	0.29	0.32	0.34	0.42	0.45	0.49	0.55	0.65	0.68	0.73	0.73	-0.9%	11.2%	0.5%	
Singapore	†	†	†	0.01	0.02	0.02	0.02	0.04	0.02	0.02	0.02	2.3%	60.6%	*	
South Korea	3.23	3.50	3.38	3.41	3.53	3.58	3.41	3.61	3.63	3.44	3.03	-12.2%	1.8%	2.0%	
Sri Lanka	†	0.01	0.02	0.02	0.04	0.05	0.05	0.06	0.05	0.06	0.07	7.0%	38.1%	*	
Taiwan	1.63	1.89	1.65	1.68	1.70	1.65	1.64	1.70	1.70	1.67	1.63	-2.5%	1.0%	1.1%	
Thailand	0.65	0.66	0.69	0.68	0.75	0.73	0.75	0.75	0.80	0.71	0.73	1.6%	1.3%	0.5%	
Vietnam	0.61	0.73	0.67	0.72	0.87	1.10	1.19	1.19	1.58	2.07	2.10	1.4%	16.0%	1.4%	
Other Asia Pacific	0.67	0.56	0.58	0.45	0.51	0.49	0.62	0.62	0.63	1.23	1.23	-0.6%	6.0%	0.8%	
Total Asia Pacific	102.34	109.85	112.20	115.19	116.62	116.07	115.90	117.57	120.30	122.37	120.97	-1.4%	2.3%	79.9%	
Total World	151.21	158.47	159.08	161.97	162.50	158.64	156.61	157.40	159.26	157.64	151.42	-4.2%	0.9%	100.0%	
of which: OECD	45.99	45.12	43.29	43.63	42.94	40.24	37.96	37.65	36.33	32.30	27.46	-15.2%	-2.9%	18.1%	
Non-OECD	105.22	113.36	115.79	118.34	119.56	118.40	118.65	119.75	122.93	125.34	123.96	-1.4%	2.2%	81.9%	
European Union	10.44	10.75	10.70	10.50	10.00	9.99	9.58	9.44	9.03	7.32	5.91	-19.4%	-3.0%	3.9%	

* Commercial solid fuels only, i.e. bituminous coal and anthracite (hard coal), and lignite and brown (sub-bituminous) coal, and other commercial solid fuels. Excludes coal converted to liquid or gaseous fuels, but includes coal consumed in transformation processes.

† Less than 0.005.

* Less than 0.05%.

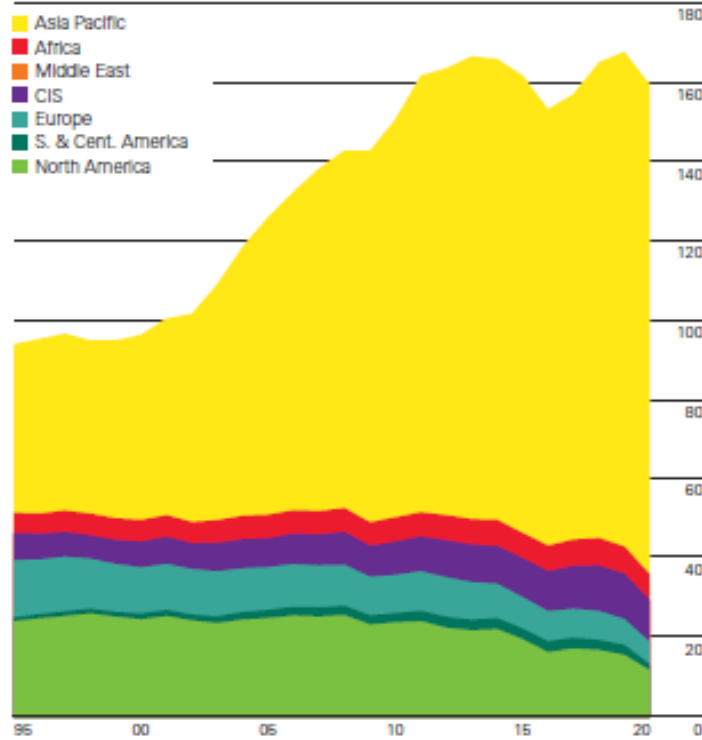
Notes: Differences between these world consumption figures and the world production statistics are accounted for by stock changes, and unavoidable disparities in the definition, measurement or conversion of coal supply and demand data. Growth rates are adjusted for leap years.



Coal: Production by region

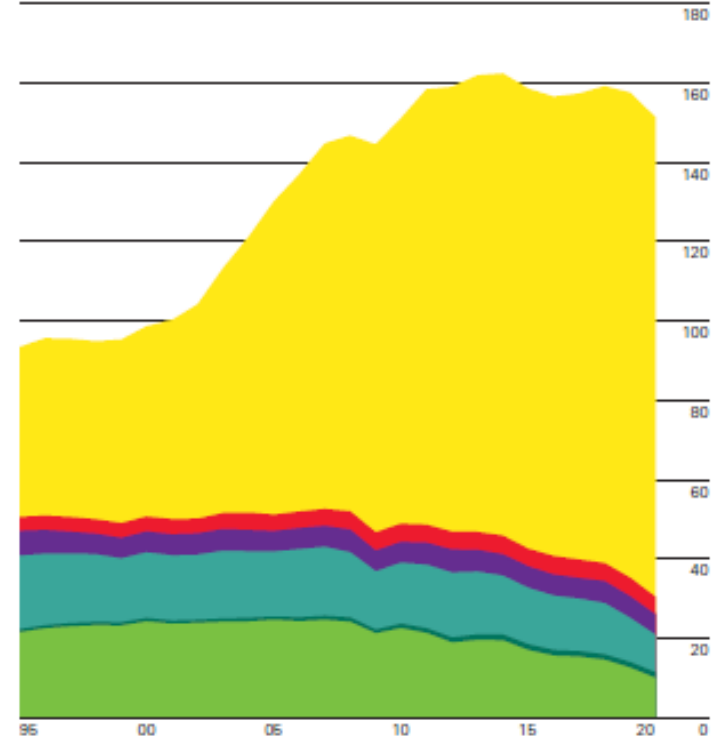
Exajoules

- Asia Pacific
- Africa
- Middle East
- CIS
- Europe
- S. & Cent. America
- North America



Coal: Consumption by region

Exajoules



World coal consumption fell by 4.2%, its fourth decline in six years. In the non-OECD, the only notable increases in consumption were in China (0.3%) and Malaysia (18.7%), while significant consumption declines were recorded for India (-6.0%) and Indonesia (-4.9%). OECD demand fell sharply, led by the US (-19.1%) and South Korea (-12.2%), to the lowest level in our data series (which goes back to 1965). Global coal production declined by -5.2%, with China providing the only significant increase (1.2%). The largest declines in production also came from the US (-25.2%) and Indonesia (-9.0%).

Uvoz/izvoz ugljena

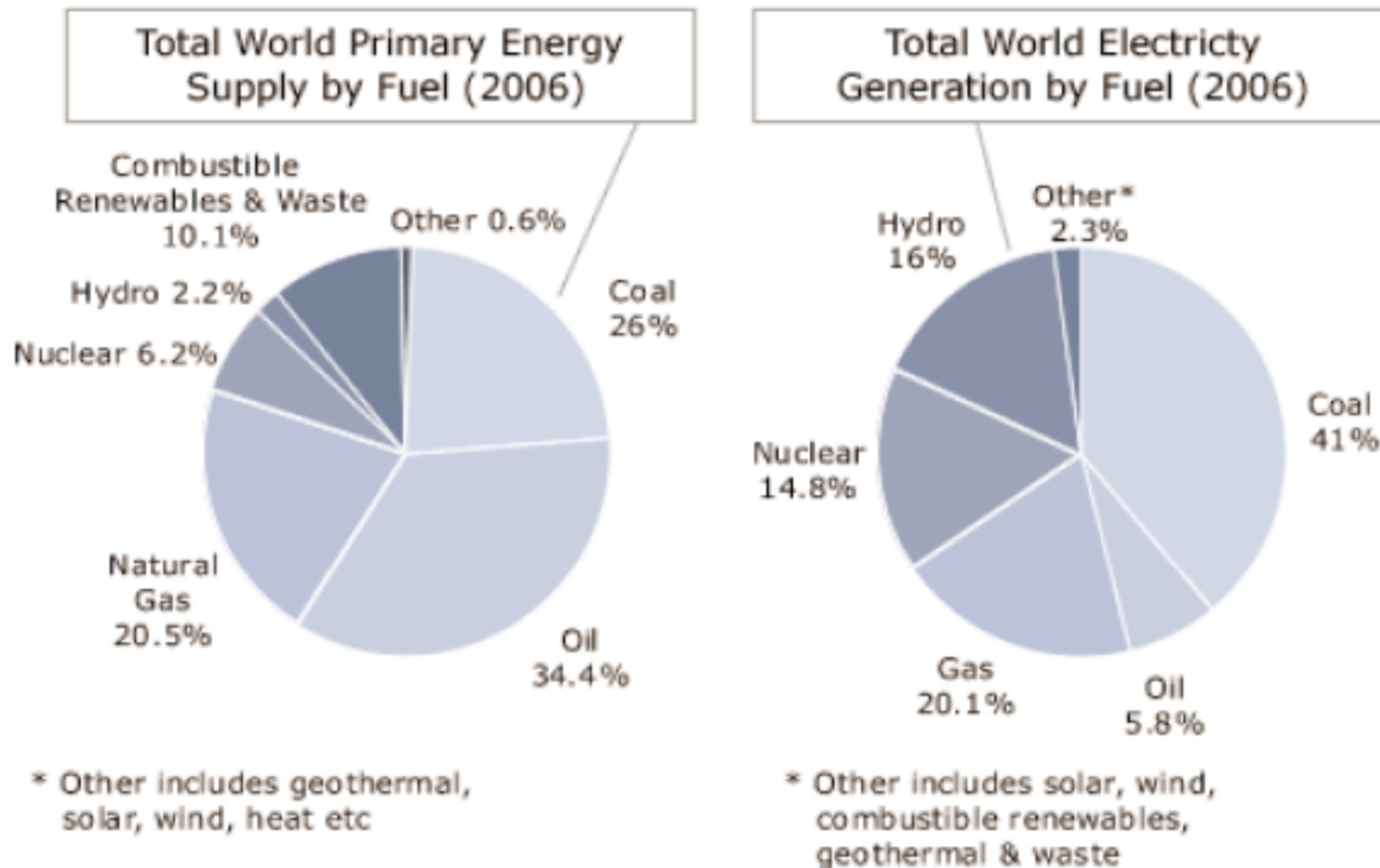
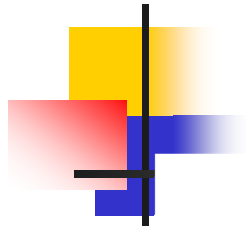
Coal: Trade movements

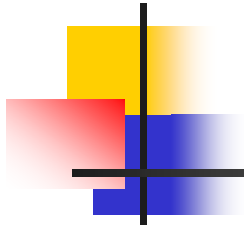
Exajoules	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Growth rate per annum		Share 2020	
												2020	2009-19		
Imports															
Canada	0.36	0.24	0.23	0.22	0.26	0.22	0.19	0.22	0.23	0.21	0.18	-14.7%	-5.3%	0.6%	
Mexico	0.22	0.21	0.22	0.20	0.22	0.23	0.21	0.34	0.34	0.24	0.03	-87.1%	3.1%	0.1%	
US	0.51	0.36	0.27	0.24	0.28	0.28	0.25	0.19	0.15	0.17	0.14	-15.3%	-11.5%	0.4%	
S. & Cent. America	0.85	0.99	0.88	1.06	1.06	1.00	1.06	1.21	1.19	1.12	1.04	-7.4%	5.3%	3.3%	
Europe	4.82	5.63	6.09	5.85	6.09	6.03	5.40	5.86	6.44	5.12	3.90	-24.0%	0.2%	12.3%	
CIS	0.37	0.59	0.53	0.56	0.56	0.53	0.48	0.56	0.61	0.65	0.58	-11.0%	2.3%	1.8%	
Middle East	0.35	0.43	0.49	0.44	0.49	0.38	0.34	0.36	0.37	0.34	0.31	-9.3%	-1.7%	1.0%	
Africa	0.32	0.34	0.31	0.81	0.37	0.44	0.50	0.59	0.80	0.64	0.49	-23.0%	9.2%	1.6%	
China	4.45	5.20	6.71	7.63	6.62	4.69	5.65	5.87	6.13	6.40	6.61	3.1%	6.9%	20.8%	
India	2.00	2.37	3.09	3.66	4.65	4.92	6.46	5.25	5.88	4.70	4.22	-10.4%	10.1%	13.3%	
Japan	4.84	4.61	4.87	5.06	5.00	5.05	5.01	5.06	5.01	4.90	4.56	-7.2%	1.5%	14.3%	
South Korea	3.11	3.38	3.30	3.32	3.43	3.54	3.53	3.89	3.92	3.73	3.26	-12.8%	3.3%	10.3%	
Other Asia Pacific	3.18	3.29	3.65	3.61	2.73	3.96	4.60	5.05	5.55	5.57	6.45	15.6%	7.1%	20.3%	
Total World	25.39	27.64	30.61	32.65	31.76	31.27	33.69	34.45	36.42	33.78	31.78	-6.2%	4.0%	100.0%	
Exports															
Canada	0.92	1.03	0.99	1.13	1.00	0.86	0.78	0.94	1.04	1.02	0.97	-5.9%	3.5%	3.0%	
US	2.02	2.50	3.02	2.88	2.38	1.89	1.52	2.38	2.88	2.19	1.62	-26.4%	4.2%	5.1%	
Colombia	1.78	2.02	2.25	2.05	2.27	2.19	2.33	2.48	2.43	2.08	1.66	-20.5%	2.5%	5.2%	
Europe	0.12	0.16	0.20	0.68	0.13	0.10	0.13	0.19	0.25	0.24	0.22	-10.0%	0.3%	0.7%	
Russia	2.50	2.86	3.23	3.55	3.78	4.11	4.47	5.09	5.78	5.79	5.66	-2.4%	9.0%	17.8%	
Other CIS	0.35	0.58	0.50	0.51	0.51	0.48	0.45	0.47	0.51	0.52	0.52	-0.1%	0.4%	1.6%	
South Africa	1.98	2.04	2.22	2.10	2.18	2.30	2.16	2.71	3.03	1.62	1.64	0.9%	-1.7%	5.2%	
Other Africa	0.11	0.04	0.13	0.11	0.18	0.26	2.02	0.62	0.22	0.27	0.15	-43.3%	25.4%	0.5%	
Australia	7.46	7.04	7.96	9.19	9.12	9.95	9.87	9.70	9.77	9.63	9.25	-4.3%	3.3%	29.1%	
China	0.59	0.44	0.28	0.28	0.36	0.45	0.51	0.42	0.42	0.34	0.18	-47.7%	-5.3%	0.6%	
Indonesia	6.20	7.18	8.16	8.57	8.42	7.48	7.73	8.08	8.56	8.49	8.51	*	5.3%	26.8%	
Mongolia	0.48	0.58	0.63	0.49	0.53	0.41	0.73	0.95	0.99	1.04	0.79	-24.3%	19.8%	2.5%	
Other Asia Pacific	0.76	1.01	0.90	0.92	0.77	0.65	0.77	0.30	0.39	0.30	0.25	-17.0%	-9.6%	0.8%	
Rest of World	0.13	0.16	0.15	0.19	0.14	0.14	0.22	0.12	0.15	0.25	0.37	49.6%	5.0%	1.2%	
Total World	25.39	27.64	30.61	32.65	31.76	31.27	33.69	34.45	36.42	33.78	31.78	-6.2%	4.0%	100.0%	

*Less than 0.05%.

Note: Commercial solid fuels only, i.e. bituminous coal and anthracite (hard coal), and lignite and brown (sub-bituminous) coal, and other commercial solid fuels. Intra-area movements (for example between countries in Europe) are excluded.

Ugljen u svjetskoj statistici proizvodnje primarne i el. energije





Korištenje ugljena za proizvodnju el. energije

Poland	93%	Israel	71%*	Czech Republic	59%
South Africa	93%*	Kazakhstan	70%*	Greece	58%
Australia	80%	India	69%*	USA	50%
PR China	78%	Morocco	69%*	Germany	47%

** only 2005 figures available for these countries*

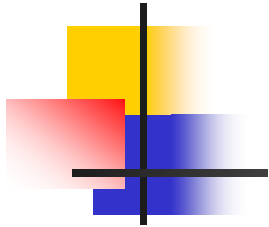
Electricity generation by fuel*

Terawatt-hours	2020							2021								
	Oil	Natural Gas	Coal	Nuclear energy	Hydro electric	Renew-ables	Other†	Total	Oil	Natural Gas	Coal	Nuclear energy	Hydro electric	Renew-ables	Other†	Total
Canada	2.9	73.6	38.6	97.5	386.5	49.3	0.6	649.1	2.9	75.9	38.7	92.0	380.8	50.0	0.7	641.0
Mexico	32.4	200.1	18.9	11.2	26.9	36.2	-	325.7	32.8	203.3	13.6	11.9	34.7	39.7	-	336.0
US	18.6	1746.4	844.3	831.5	282.8	547.7	13.5	4284.8	20.2	1693.8	978.5	819.1	257.7	624.5	12.7	4406.4
Total North America	54.0	2020.1	901.9	940.1	696.3	633.2	14.1	5259.7	55.9	1973.0	1030.7	923.0	673.3	714.1	13.5	5383.5
Argentina	7.1	88.0	1.6	10.7	23.7	13.0	0.6	144.6	7.9	93.3	2.9	10.8	19.6	17.2	0.6	152.5
Brazil	10.5	53.5	20.3	14.1	396.4	126.5	-	621.3	21.9	89.9	24.1	14.7	362.8	144.0	-	654.4
Other S. & C. America	66.3	90.5	49.1	-	271.2	59.5	†	536.6	66.1	100.9	45.3	-	277.7	68.1	†	558.0
Total S. & C. America	83.9	231.9	71.1	24.7	691.2	199.1	0.6	1302.5	95.9	281.1	72.3	25.5	660.1	229.3	0.6	1364.8
Germany	4.7	95.0	134.6	64.4	18.3	231.8	24.8	573.6	4.8	89.0	162.6	69.0	19.1	217.6	22.4	584.5
Italy	11.4	133.7	15.1	-	45.7	68.8	5.8	280.5	8.3	146.4	14.5	-	43.1	71.4	3.5	287.2
Netherlands	1.4	72.6	7.6	4.1	†	33.0	4.9	123.6	1.4	56.3	17.8	3.8	0.1	40.1	2.1	121.6
Poland	1.7	17.3	109.4	-	2.1	25.3	1.3	157.1	1.5	15.5	131.7	-	2.3	27.8	1.3	180.0
Spain	10.7	69.7	6.1	58.3	30.5	83.2	4.7	263.4	10.3	69.2	6.1	56.5	29.6	95.8	4.7	272.1
Turkey	0.3	70.9	105.8	-	78.1	51.5	-	306.7	0.3	110.4	104.2	-	55.7	62.7	-	333.3
Ukraine	0.3	14.2	40.2	76.2	7.6	9.4	-	147.8	0.8	10.3	36.8	86.2	10.4	11.0	-	155.5
United Kingdom	0.8	111.4	5.5	50.3	6.8	127.8	9.3	312.0	1.5	124.2	6.5	45.9	5.0	116.9	9.9	309.9
Other Europe	17.4	180.5	145.4	580.0	468.8	291.8	30.3	1714.2	19.1	178.1	151.9	621.4	484.4	303.2	30.3	1788.3
Total Europe	48.9	765.4	569.7	833.2	657.9	922.7	81.1	3879.0	47.9	799.3	632.0	882.8	649.7	946.5	74.2	4032.5
Kazakhstan	0.1	27.3	69.4	-	9.7	2.3	-	108.6	0.1	32.9	69.3	-	9.1	3.0	-	114.4
Russian Federation	8.2	464.9	175.8	215.9	212.4	3.5	4.7	1085.4	8.5	496.8	204.7	222.4	214.5	5.4	4.7	1157.1
Other CIS	2.7	153.6	4.3	3.1	41.1	1.0	0.7	206.6	3.4	156.6	4.3	7.8	42.7	1.2	0.6	216.5
Total CIS	11.0	645.8	249.5	219.0	263.2	6.8	5.3	1400.7	11.9	686.4	278.3	230.2	266.3	9.6	5.3	1488.0
Iran	37.0	268.2	0.7	6.3	23.2	1.8	-	337.2	48.7	288.3	0.7	3.5	14.9	1.8	-	357.8
Saudi Arabia	130.8	207.0	-	-	-	0.2	-	338.0	139.9	215.9	-	-	-	0.8	-	356.6
United Arab Emirates	†	132.7	-	1.6	-	4.6	-	137.3	†	123.7	-	10.5	-	5.2	-	139.4
Other Middle East	114.7	282.7	19.0	-	4.9	9.1	†	430.4	117.6	301.8	17.0	-	4.6	10.7	-	451.7
Total Middle East	282.5	890.7	19.7	8.0	28.1	15.7	†	1243.0	306.1	929.7	17.7	14.1	19.5	18.5	-	1305.6
Egypt	22.7	151.3	-	-	14.9	9.7	-	198.6	26.9	157.6	-	-	14.6	10.5	-	209.7
South Africa	1.4	-	202.6	13.9	0.7	15.7	5.1	239.5	1.6	-	209.6	10.4	1.4	16.5	4.8	244.3
Other Africa	42.5	185.8	37.2	-	130.8	20.0	0.7	417.0	47.7	197.9	37.8	-	137.4	22.0	0.7	443.5
Total Africa	66.7	337.0	239.8	13.9	146.4	45.4	5.8	855.1	76.2	355.6	247.4	10.4	153.4	49.0	5.5	897.5
Australia	4.5	53.1	142.9	-	14.4	49.9	0.4	265.2	4.7	47.6	137.4	-	16.0	61.3	0.4	267.5
China	10.8	252.5	4920.8	366.2	1321.7	863.2	43.8	7779.1	12.2	272.6	5339.1	407.5	1300.0	1152.5	50.2	8534.3
India	2.1	74.5	1125.8	44.6	163.7	152.0	0.6	1663.3	2.3	64.2	1271.1	43.9	160.3	171.9	1.1	1714.8
Indonesia	6.8	51.3	180.9	-	24.3	28.6	†	291.8	6.6	56.3	190.0	-	24.7	31.5	0.3	309.4
Japan	36.7	353.6	298.0	43.0	77.4	117.8	70.6	997.0	31.3	326.1	301.9	61.2	77.6	130.3	91.3	1019.7
Malaysia	0.9	53.6	84.2	-	27.9	2.8	-	169.5	1.1	63.3	77.3	-	32.4	3.1	-	177.2
South Korea	6.7	159.9	209.8	160.2	3.9	31.1	3.7	575.3	7.0	176.4	211.7	158.0	3.1	40.2	4.1	600.4
Taiwan	4.4	99.9	125.9	31.4	3.0	10.4	4.9	280.0	5.3	108.3	128.9	27.8	3.5	12.1	5.0	290.9
Thailand	0.7	113.9	36.8	-	4.5	20.5	†	176.5	0.7	113.1	36.1	-	4.5	21.9	†	176.3
Vietnam	1.3	34.0	114.8	-	73.4	12.1	-	235.4	0.2	26.2	114.1	-	75.9	28.3	-	244.8
Other Asia Pacific	39.9	234.6	147.8	9.5	148.5	35.4	0.6	616.3	54.7	239.3	158.1	15.9	153.7	36.9	0.7	659.1
Total Asia Pacific	114.8	1490.7	7387.7	655.0	1862.9	1323.7	124.7	12949.3	126.3	1493.4	7965.6	714.3	1851.6	1690.1	153.1	13994.4
Total World	661.7	6371.7	9439.3	2694.0	4346.0	3146.6	230.0	26889.2	720.3	6518.5	10244.0	2800.3	4273.8	3657.2	252.2	28466.3
of which: OECD	145.6	3399.6	2065.6	1872.3	1483.3	1766.1	168.2	10900.7	142.5	3372.4	2253.0	1911.0	1440.3	1910.1	181.0	11210.2
Non-OECD	516.0	2972.0	7373.7	821.7	2862.7	1380.5	61.8	15988.5	577.8	3146.1	7991.0	889.2	2833.6	1747.2	71.2	17256.1
European Union	45.5	561.4	369.1	683.8	343.2	710.6	65.4	2779.0	43.0	548.0	439.2	732.2	344.4	730.2	58.4	2895.3

*Based on gross output.

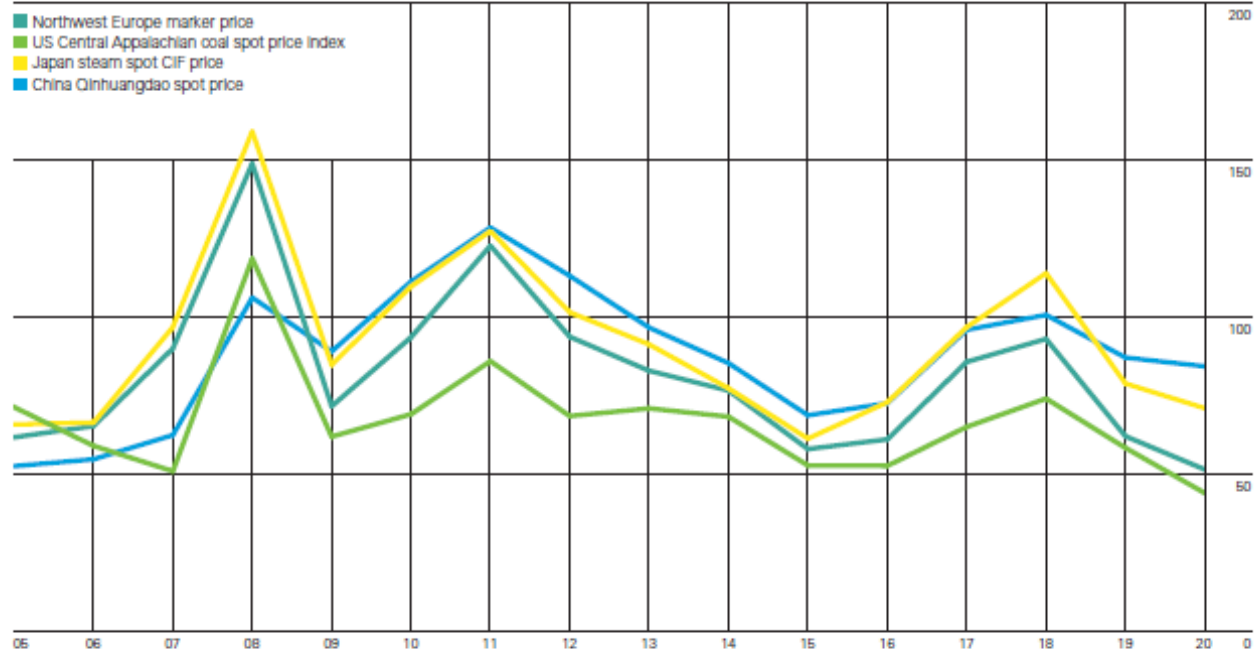
†Less than 0.05.

Note: Growth rates are adjusted for leap years.



Coal prices

US dollars per tonne



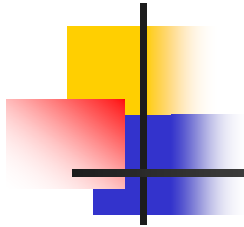
Coal: Prices

US dollars per tonne	Northwest Europe marker price†	US Central Appalachian coal spot price index‡	Japan steam spot CIF price†	China Qinhuangdao spot price†
2001	39.03	50.15	37.69	31.78
2002	31.65	33.20	31.47	33.19
2003	43.60	38.52	39.61	31.74
2004	72.13	64.90	74.22	42.76
2005	60.54	70.12	64.62	51.34
2006	64.11	57.82	65.22	53.53
2007	88.79	49.73	95.59	61.23
2008	147.67	117.42	157.88	104.97
2009	70.39	60.73	83.59	87.86
2010	92.50	67.87	108.47	110.08
2011	121.48	84.75	126.13	127.27
2012	92.50	67.28	100.30	111.89
2013	81.69	69.72	90.07	95.42
2014	75.38	67.08	76.13	84.12
2015	56.79	51.57	60.10	67.53
2016	60.09	51.45	71.66	71.35
2017	84.51	63.83	96.02	94.72
2018	91.83	72.84	112.73	99.45
2019	60.86	57.16	85.48	85.89
2020	50.16	42.77	69.01	83.10
2021	121.70	68.54	155.41	153.55

† Source: IHS Northwest Europe prices for 1990-2000 are the average of the monthly marker, 2001-2021 the average of weekly prices. IHS Japan prices basis = 6,000 kilocalories per kilogram NAR CIF). The Asian prices are the average of the monthly marker. Chinese prices are the average monthly price for 2000-2005, weekly prices 2006-2021, 5,500 kilocalories per kilogram NAR, including cost and freight (CFR).

‡ Source: S&P Global Platts ©2021, S&P Global Inc. Prices are for Central Appalachian 12,500 Btu, 1.2 SO₂ coal, FOB. Prices for 1996-2000 are by coal price publication date, 2001-2005 by coal price assessment date. 2006-2021 weekly CAPP 12,500 Btu, 1.6 SO₂ coal, FOB.

Note: CIF = cost+insurance+freight (average prices); FOB = free on board.

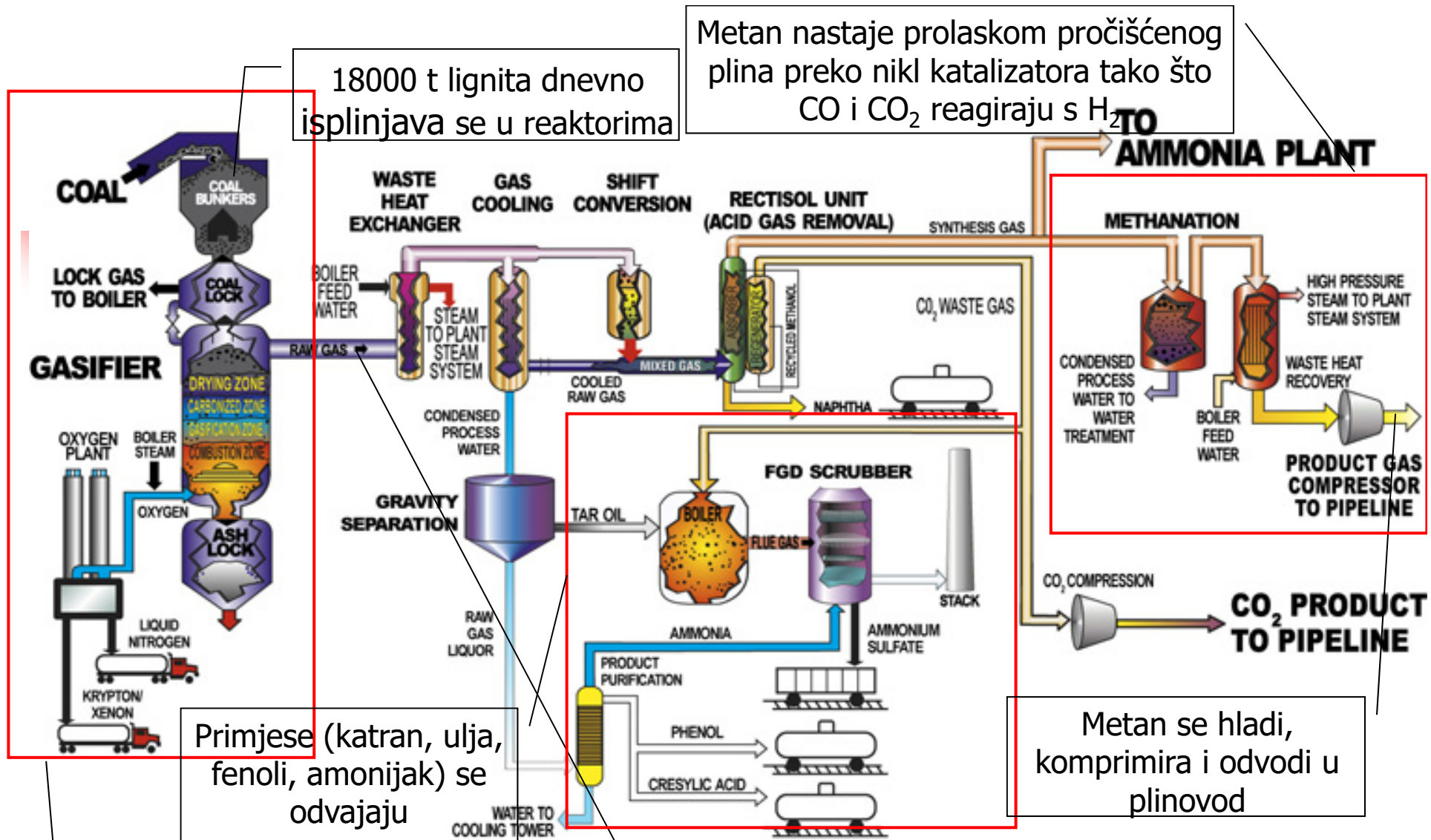


- Budućnost energetske upotrebe ugljena (i ostalih fosilnih goriva) povezana je s ekološkim problemima odnosno s emisijama stakleničkih plinova – GHG- Greenhouse Gas Emission),
- Najveći porast potrošnje ugljena u energetske svrhe očekuje se u zemljama u razvoju, prvenstveno zbog povećanja proizvodnje električne energije.
- Nužno je riješiti problem emisija stakleničkih plinova.



Hvatanje (capture) CO₂

- poslije izgaranja (post-combustion) - sastoji se od izdvajanja CO₂ iz dimnih plinova
- prije izgaranja (pre-combustion) – gorivo se posebnim postupkom razdvaja na vodik i CO (sintetski plin). Vodik se koristi kao gorivo, a CO se prevodi u CO₂ koji se skuplja
- korištenjem kisika za izgaranje (oxyfuel) – gorivo izgara uz prisustvo čistog kisika što u odsustvu dušika dovodi do veće koncentracije CO₂ u dimnim pinovima što ga čini lakšim za hvatanje



18000 t lignita dnevno isplinjava se u reaktorima

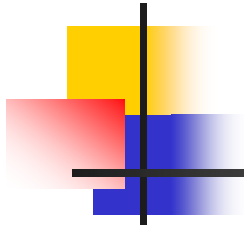
Metan nastaje prolaskom pročišćenog plina preko niki katalizatora tako što CO i CO₂ reagiraju s H₂

Primjese (katran, ulja, fenoli, amonijak) se odvajaju

Para i kisik ubacuju se u dno reaktora da dođe do intenzivnog izgaranja (temp. 1200°C)

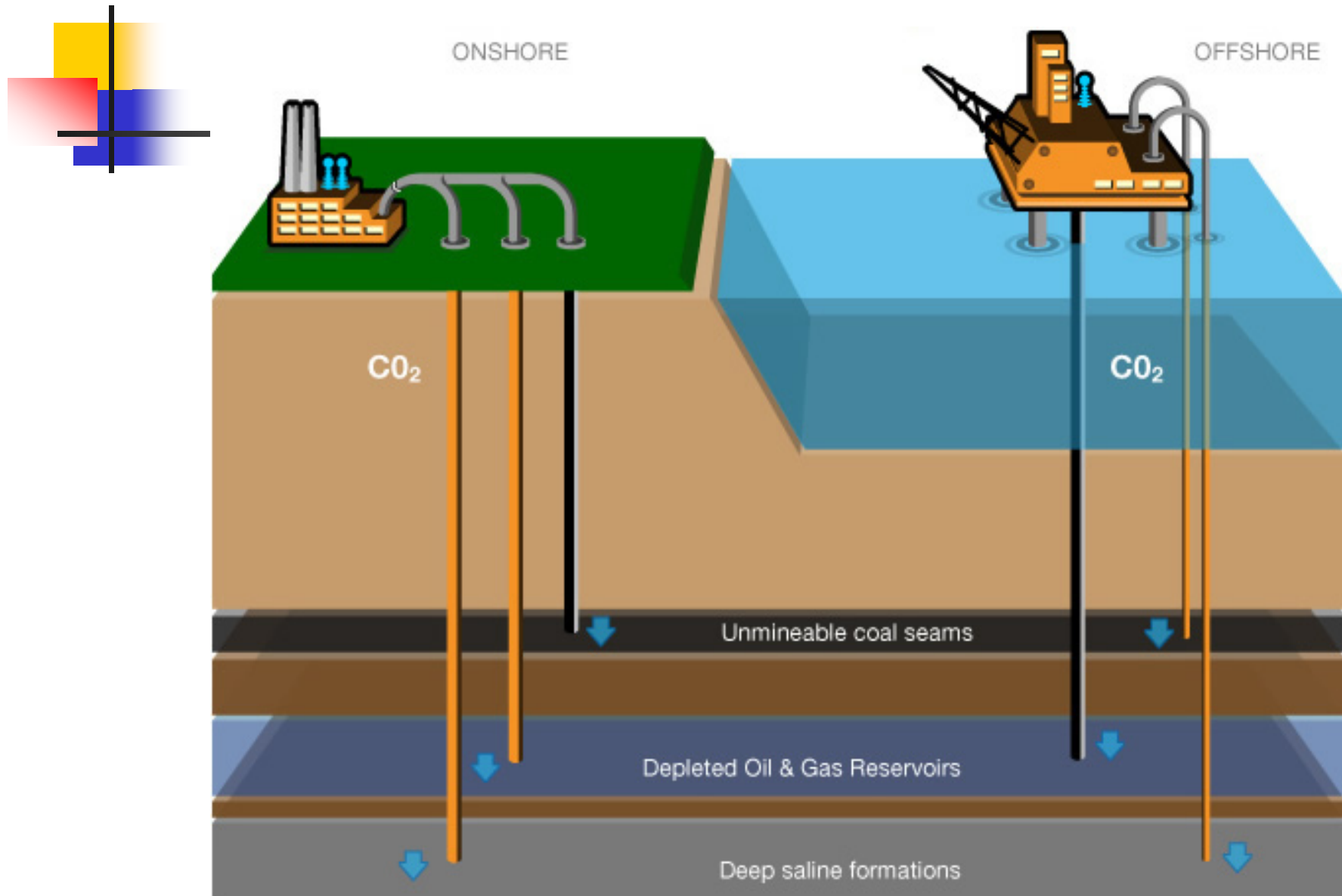
Tako pucaju molekularne veze u ugljenu i pari čime nastaju ugljik, vodik, sumpor, dušik i ostalo tvoreći sirovi plin

Metan se hladi, komprimira i odvodi u plinovod

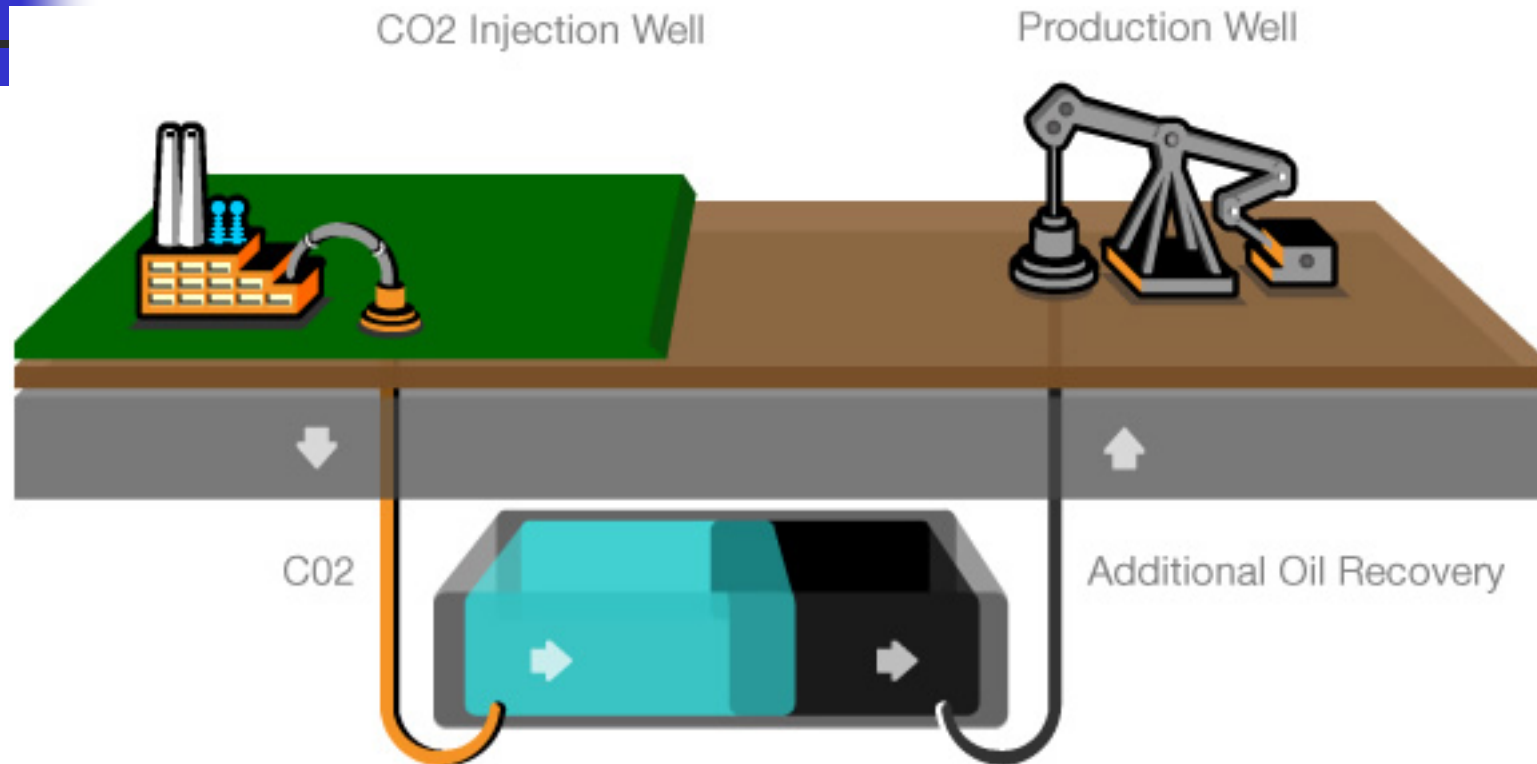


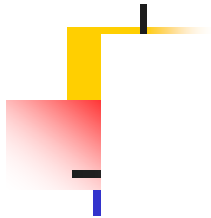
- 18000 tona ugljena (lignita) dnevno koristi se u reaktorima za isplinjavanje .
- Para i kisik ubacuju se u dno reaktora da dođe do intenzivnog izgaranja (temp. 1200°C),
- Tako pucaju molekularne veze u ugljenu i pari čime nastaju ugljik, vodik, sumpor, dušik i ostalo tvoreći sirovi plin koji izlazi iz reaktora,
- sirovi plin se hladi,
- Primjese (katran, ulja, fenoli, amonijak) se odvajaju,
- Metan nastaje prolaskom pročišćenog plina preko nikl katalizatora tako što ugljični monoksid i ugljični dioksid reagiraju s vodikom tvoreći metan,
- preostali ugljični dioksid se odvaja, komprimira i odvodi plinovodom do potrošača
- Metan se hladi, komprimira i odvodi u plinovod.

Fakultet kemijskog inženjerstva i tehnologije, Zavod za termodinamiku, strojarstvo i energetiku
Carbon Capture and Storage – tehnologija prikupljanja i skladištenja CO₂ - CO₂ se ne ispušta u atmosferu

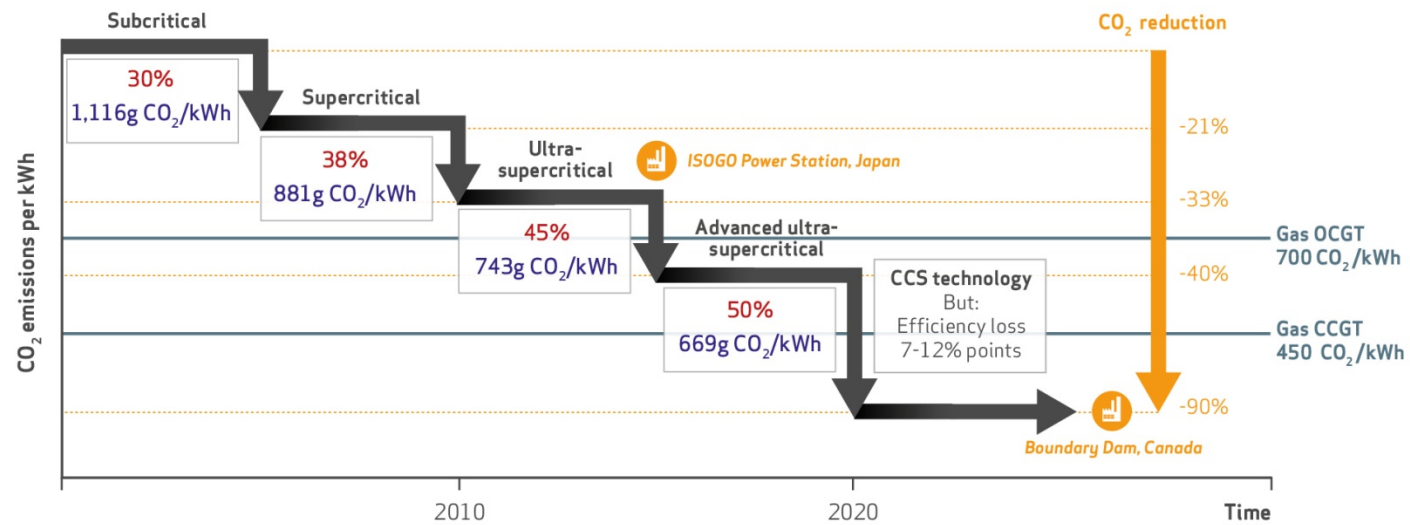


Iskoištavanje CO₂ za povećanje iscrpka nafte (EOR)



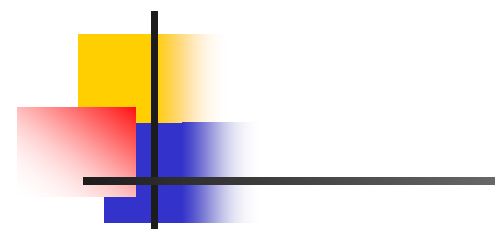


CO₂ reduction potential of coal-fired power plants by increased efficiency



- Efficiency
- CO₂ emissions

Source: VGB PowerTech 2013



Stanje i perspektiva CCS postrojenja u Svijetu

	Location	Capacity (MW)	Year	Comments
FutureGen	USA	275	2012	FutureGen is a public-private partnership to build a first-of-its-kind coal-fired, near-zero emissions power plant. The project will cost approximately US\$ 1.5 billion to develop and will test the feasibility of producing low-cost electricity and hydrogen from coal with near-zero CO ₂ emissions.
ZeroGen	Australia	530	2015	ZeroGen is a joint State Government/coal industry project to build a commercial scale 530 MW (gross) IGCC plant with up to 90% CCS. The Mitsubishi Corporation and Mitsubishi Heavy Industries have joined the project, with the latter to provide ZeroGen with both the IGCC and carbon capture technologies. Pre-feasibility and feasibility studies are expected to be completed by September 2011 enabling construction to commence in 2012 and commissioning in late 2015 .
GreenGen	China	650	2015	GreenGen is a joint government-industry alliance with project leaders including Peabody Energy. The planned IGCC plant will capture CO ₂ for enhanced oil recovery.
SaskPower	Canada	100	2015	SaskPower's Boundary Dam project will use low-sulphur lignite with post-combustion capture or oxyfuel technology. The project will use the CO ₂ for enhanced oil recovery in the region.
Powerfuel	UK	900	2014	The Powerfuel IGCC CCS project is to be located at the Hatfield Colliery (South Yorkshire). The colliery is owned and operated by Powerfuel.
E.ON	UK	450	Post-2012	The E.ON IGCC project will be built alongside their existing gas-fired power plant in Killingholme. The first phase of the project would be the construction of the power plant with CCS being added in a second phase.
E.ON	Netherlands	1 100	Post-2012	E.ON Benelux and the Rotterdam Climate Initiative plan to develop the project on the Maasvlakte, with a view to implementing CCS at a new fleet of power stations from 2020 onwards .
RWE	Germany	400-450	2014	The first of the RWE proposals will use IGCC technology. This project will be able to separate hydrogen after gas treatment and cleaning to use directly as an energy source or in synthetic fuel production.
RWE nPower	UK	1 000	2016	The second of the RWE proposals will investigate supercritical technology combined with post-combustion CCS.
ScottishPower	UK	3 390	2014	ScottishPower plans to demonstrate CCS at its 3 390 MW Longannet coal power station using a full-scale carbon capture unit from 2014 onwards, following initial testing of a prototype unit which began in 2009.
Vattenfall	Germany	250	2015	Vattenfall has been operating a 30 MW CCS pilot plant at Schwarze Pumpe since 2008. This plant will provide a platform for the R&D required in order to build a 250 MW Oxyfuel demonstration plant at Jänschwalde, with construction scheduled to start in 2011, for completion in around 2015.