2021 Report

The Production Gap

The discrepancy between countries' planned fossil fuel production and global production levels consistent with limiting warming to 1.5°C or 2°C

ONLINE APPENDICES B-C

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SEI, IISD, ODI, E3G, and UNEP. (2021). The Production Gap: The discrepancy between countries' panned fossil fuel production and global production levels consistent with limiting warming to 1.5°C or 2°C.

Full report available at: http://productiongap.org/2021report

Appendix B: Methodology for estimating the fossil fuel production gap

The calculation of the production gap relies on two major elements. The first is the global level of future fossil fuel production implied by national governments' plans and projections. The second is the pathway of global fossil fuel production consistent with limiting warming to 1.5°C or 2°C, as modelled by the mitigation scenarios compiled by the Intergovernmental Panel on Climate Change for their Special Report on Global Warming of 1.5°C (IPCC SR1.5) (IPCC 2018b; Rogelj et al. 2018). This appendix details our methods for deriving these pathways and for estimating the production gap in terms of extraction-based emissions, energy, and physical units, and summarizes how the global production gap has changed compared to our 2019 assessment.

B.1 Estimating global production levels under the "countries' plans and projections" pathway

This year's analysis of the "countries' plans and projections" (CPP) pathway relies on our compilation of future coal, oil, and gas production as projected in recent and publicly available government documents[1] of 15 major producer countries (countries added this year are denoted with an asterisk*): Australia, Brazil*, Canada, China, Germany*, India, Indonesia, Kazakhstan*, Mexico*, Norway, Russia, Saudi Arabia*, the United Arab Emirates (UAE)*, the United Kingdom (UK)*, and the United States (US). On an energy basis, these producer countries accounted for 75% of global fossil fuel production in 2020 – around 90% for coal (8 countries), 70% for oil (14 countries), and 65% for gas (13 countries) (IEA 2021a)[2].

Production data provided by each country's source documents differ in terms of the units (physical versus energy basis as well as actual units specified), the years covered between 2019 and 2040, and fuel subtypes included under liquids (i.e., crude oil, condensate, and/or natural gas liquids (NGLs)). Since the IPCC mitigation scenarios provide modelled outputs of coal, oil, and gas supply in units of exajoules (EJ) per year, we harmonized all original country data to units of EJ per year and, where needed, linearly interpolated between available years to derive a complete annual time series for 2019-2040[3]. Conversion factors between physical and energy units for each country and fuel were estimated using 2019 national production statistics from the IEA's World Energy Statistics and Balances (IEA 2021a). This therefore assumes that coal and liquid subtypes (e.g., anthracite versus bituminous coal, or crude versus condensate oil) stay constant at 2019 ratios. For a given country and fuel for which projections end prior to 2040, values are extrapolated from the last year available based on that country and fuel's projected percent changes as modelled (at 5-year intervals between 2020-2040) under the IEA's Stated Policies Scenario (STEPS) in the World Energy Outlook 2020 (IEA 2020b). For example, for Australia, where the government's projections end in 2026 (and which showed a compound annual growth rate of 0.9% between 2020 and 2026), we extend to 2030, 2035, and 2040 based on the

[1] Throughout the report, we collectively refer to the sources from which future fossil fuel production is estimated as "plans and projections", given that there are varying levels of details, certainty, and intent associated with each document published by governments and affiliated institutions. Governments take a variety of factors into consideration in assembling these plans and projections, including the state of each country's fossil fuel reserves, the evolution of technologies and costs of extraction, the presence of subsidies and regulations, and foreseeable dynamics of domestic and international demand. Some of these factors are described further in Chapters 3 and 4.

[2] Our 2019 analysis relied on the plans and projections from eight countries that altogether accounted for around 90% of coal (6 countries), 40% of oil (8 countries), and 57% of gas production (8 countries) in 2017.

[3] We develop an annual time series for all countries, where needed, so that their aggregate can be scaled up to derive the global CPP pathway with values in 2019, 2020, 2025, 2030, 2035, and 2040, corresponding to future years for which their estimated global shares of production are available from the IEA STEPS, since that is what we use to scale the country-derived totals to the entire world. This set of dates also overlaps with the IPCC model scenario outputs that occur at 10-year intervals for all scenarios (i.e., 2010, 2020, 2030, etc.), allowing us to quantify the gap in 2030 and 2040.

percent changes modelled by IEA STEPS between these years (and which shows a compound annual growth rate of 0.6% between 2026 and 2040). Given that global production levels estimated under our CPP pathway are higher than those under the STEPS (as shown in Figures 2.1-2.2), this is likely a conservative extrapolation approach.

Detailed sources, methods, and conversion factors for each country and fuel are provided in Table B1 (see next page).

After aggregating the coal, oil, and gas production projections from these 15 countries, their combined production levels are then scaled up to a global estimate by assuming that their future shares of global coal, oil, and gas production follow the values under a scenario that reflects existing and announced climate policies as of mid-2020, as modelled by the International Energy Agency (IEA) in their Stated Policies Scenario (STEPS) in the World Energy Outlook 2020 (IEA 2020b, p.415). The STEPS projects that production from these 15 countries continue to account for around 72-75% of global fossil fuel production (in energy terms) through 2040; detailed shares by fuels are shown in Table B2.

Table B2. Estimated percentage shares of global coal, oil, and gas production (on an energy basis) by 15 major producer countries as modelled by the IEA's Stated Policies Scenario (IEA 2020b).

	2019	**2020**	**2025**	**2030**	**2035**	**2040**
Coal (Australia, Canada, China, Germany, India, Indonesia, Russia, USA)	87%	89%	90%	91%	91%	92%
Oil (Australia, Brazil, Canada, China, India, Indonesia, Kazakhstan, Mexico, Norway, Russia, Saudi Arabia, UAE, UK, USA)	69%	70%	71%	70%	69%	68%
Gas (Australia, Brazil, Canada, China, India, Indonesia, Kazakhstan, Mexico, Norway, Russia, Saudi Arabia, UK, USA)	65%	65%	67%	65%	63%	62%
Total (15 countries)	74%	75%	75%	74%	73%	72%

Table B1. Data sources, methods, and conversion factors used to derive the "countries' plans and projections" pathway from 15 key producer countries. Unit abbreviations are as follows: EJ = exajoules; Mtce = million tonnes of coal equivalent; Mt = million tonnes; Bcm = billion cubic meters; Bf = billion cubic feet; Qbtu = quadrillion British Thermal Units; Mtoe = million tonnes of oil equivalent; Mboe = million barrels of oil equivalent; Mb/d = million barrels per day. Conversion factors are rounded to 2 significant figures.

Country	Fossil fuel	Data sources	Years of projections provided (annual timeseries unless otherwise specified)	Notes		Units of original data	Conversion factors from physical units to net EJ, where needed
Australia	Coal	2020-2026 projections: Resources and Energy Quarterly, March 2021 (Australian Department of Industry, Science, Energy and Resources 2021); 2030 projections: Australia's emissions projections 2020 (Australian Department of Industry, Science, Energy and Resources 2020)	2020-2026, 2030	Projections of lignite production only available for 2020, 2025, and 2030. Annual values are linearly interpolated. 2030 projection of raw black coal production is scaled to saleable production by 80% following the Table 14 footnote in (Australian Department of Industry, Science, Energy and Resources 2020).	Projections are extended to 2035 and 2040 based on IEA STEPS trends. More recent projections from Resources and Energy Quarterly, June 2021 only include values out to 2023, so we rely on the March 2021 version.	Physical (Mt)	0.025 EJ per Mt
	Oil			Crude oil, condensate, and NGLs included.		Physical (Mb/d)	2.0 EJ/y per Mb/d
	Gas					Physical (Bcm)	0.036 EJ per Bcm
Brazil	Coal	No projections available					
	Oil	2021-2025 projections: Brazilian National Agency of Petroleum, Natural Gas and Biofuels (ANP 2021); 2026-2040 projections: 2050 Energy Plan (Ministério de Minas e Energia 2020)	2020-2050	Crude oil and condensate included.		Physical (Mb/d)	2.1 EJ/y per Mb/d
	Gas			Brazil's reported gas production includes fractions that are re-injected, self-consumed, and flared. Following the IEA's World Energy Statistics and Balances methodology, gas production projections are reduced by 38%, the 2019 fraction of re-injection and flaring.		Physical (Bcm)	0.037 EJ per Bcm
Canada	Coal	Canada's Energy Future 2020 (Canada Energy Regulator, 2020) – "evolving" scenario	2020-2050	The 2020 edition introduced a new "evolving" scenario as its main scenario, which is used in our analysis. Crude oil, condensate, and NGLs included.		Physical (Mt)	0.022 EJ per Mt
	Oil					Physical (Mb/d)	2.1 EJ/y per Mb/d
	Gas					Physical (Bcf)	1.3 EJ per Bcf
China	Coal	Projections from the 2050 World and China Energy Outlook (2020 Edition) (CNPC Economics & Technology Research Institute 2020) – "reference" scenario	2020-2050 (at 5-year intervals)	CNPC's Outlook only provides coal consumption projections. 2020-2040 production values are estimated from consumption projections (at 5-year intervals), assuming that imports will account for around 7% of total domestic consumption, the 2016-2020 average (National Bureau of Statistics of China 2021).		Physical (Mt)	0.023 EJ per Mt
	Oil			Crude oil included.		Physical (Mt)	0.042 EJ per Mt
	Gas					Physical (Bcm)	0.035 EJ per Bcm

Germany	Coal	Climate mitigation scenario from the National Energy and Climate Plan (BMWi 2019)	2020-2030 (at 5-year intervals)	Assume lignite production reaches zero in 2038 according to Germany's Coal Phase-out Act		Physical (Mt)	0.0090 EJ per Mt
	Oil	Future global shares not available from IEA STEPS					
	Gas						
India	Coal	2024 projections from the Five Year Vision Document 2019-2024 (Indian Ministry of Coal 2021)	2024		Projections are extended to 2025, 2030, 2035, and 2040 based on IEA STEPS trends	Physical (Mt)	0.016 EJ per Mt
	Oil			Oil constituents unspecified. Crude oil only assumed based on 2019 reported value. 2024 oil and gas production projections are estimated from the reported total, assuming the oil-to-gas ratio remains constant at 2019 values.		Physical (Mt)	0.043 EJ per Mt
	Gas					Physical (Bcm)	0.035 EJ per Bcm
Indonesia	Coal	Indonesia's Energy Outlook 2019 provided projections for 2017-2050 (PPIPE and BPPT 2019). The 2020 edition only has production projections out to 2024, with "optimistic" and "pessimistic" scenarios that consider the impacts of the COVID-19 pandemic (PPIPE and BPPT 2020).	2020-2050	2020-2024 projections are derived from the averages of the "optimistic" and "pessimistic" scenarios. The 2024 values are then extended to 2040 using the annual scaling factors provided in the 2019 Outlook.		Physical (Mt)	0.022 EJ per Mt
	Oil					Energy (Mboe)	-
	Gas					Physical (Bcf)	1.3 EJ per Bcf
Kazakhstan	Coal	No projections available					
	Oil	2020 — announcement by the Minister of National Economy (Ruslan Dalenov) on 13 Oct 2020 (Argus 2020); 2025 — Explanatory note to the draft Law of the Republic of Kazakhstan "On the republican budget for 2021 - 2023" (Government of the Republic of Kazakhstan 2020); 2030 — based on speech made by the Vice-Minister of Energy (on 17 Mar 2018 at the AEF-2018 Global Challenges Summit) (Ministry of Energy of the Republic of Kazakhstan 2020).	2020-2030 (at 5-year intervals)	Crude oil, condensate included.	Projections are extended to 2035 and 2040 based on IEA STEPS trends	Physical (Mt)	0.043 EJ per Mt
	Gas	Projections are estimated based on the "Ministry of Energy production forecast" pathways as reported in Figure 4.2 of the	2020-2040 (at 5-year intervals)	Average of two scenarios used: "Ministry of Energy production forecast" and "Ministry of Energy		Physical (Bcm)	0.036 EJ per Bcm

		2019 KAZENERGY report — the underlying government source is unknown (Kazenergy 2019).		production forecast including prospective new fields".			
Mexico	Coal	No projections available					
	Oil	Crude oil and petroleum products Outlook 2018-2032 ("Prospectiva de Petróleo Crudo y Petrolíferos 2018-2032") (Secretaría de Energía SENER 2018b, p.60).	2018-2032	Given that the 2018-2020 projected values do not match actual production, projections for 2020-2032 are derived by extending actual 2019 production values to 2032 using the annual scaling factors provided in the Outlooks. Values are then extended to 2035 and 2040 based on IEA STEPS trends. Mexico's reported gas projections likely include NGLs, based on comparisons to 2018-2020 actual production values reported by the government and the IEA (IEA 2021a; Sistema de Información de Hidrocaburos 2021). Gas projections are therefore reduced by 20%, the fraction of NGLs between 2016-2021 reported by the government of Mexico (Sistema de Información de Hidrocaburos 2021). This fraction is instead added to the production projections for liquids.		Physical (Mt)	0.043 EJ per Mt
	Gas	Natural Gas Outlook 2018-2032 ("Prospectiva de Gas Natural 2018-2032") (Secretaría de Energía SENER 2018a, p.71).				Physical (Bcm)	0.035 EJ per Bcm
Norway	Coal	No projections available					
	Oil	2021-2025 projections (Norwegian Petroleum Directorate 2021); 2026-2050 projections from the Long-term perspectives on the Norwegian economy 2021 (Norwegian Ministry of Finance 2021)	2020-2050	2026-2040 oil and gas projections are estimated from the reported total, assuming the liquids-to-gas ratio remains constant at average 2020-2025 values. Crude oil, condensate, and NGLs included.		Energy (Mboe)	-
	Gas					Physical (Bcm)	0.035 EJ per Bcm
Russia	Coal	Projections from the Ministry of Energy's Forecast Energy Strategy (Ministry of Energy of the Russian Federation 2020)	2024, 2035	Average of two scenarios: "optimistic" and "conservative". Crude oil and condensate included. Projections are extended to 2040 based on IEA STEPS trends.		Physical (Mt)	0.025 EJ per Mt
	Oil					Physical (Mt)	0.042 EJ per Mt
	Gas					Physical (Bcm)	0.034 EJ per Bcm
Saudi Arabia	Coal	No production					
	Oil	Two scenarios – "Long term growth case" (LTGC) and "Accelerated transition case" (ATC) – are taken from Saudi Aramco's Global Medium Term Note Programme, Base Prospectus (Saudi Aramco 2020b, p.87)	2020-2040 (at 5-year intervals)	Average of two scenarios. Crude oil, condensate, and NGLs included.		Physical (Mb/d)	2.0 EJ/y per Mb/d
	Gas	Saudi Aramco's Strategy flows toward natural gas (Saudi Aramco 2020a)	2030	Projections are extended to 2035 and 2040 based on IEA STEPS trends		Physical (Bcm)	0.034 EJ per Bcm
United Arab Emirates	Coal	No production					
	Oil	Projections – ADNOC's plans as reported by (Kerr 2020)	2030	Oil constituents unspecified. All liquids assumed. Projections are extended to 2035 and 2040 based on IEA STEPS trends		Physical (mb/d)	2.0 EJ/y per Mb/d

	Gas	No projections available				
United Kingdom	Coal	No projections available				
	Oil	Projections of UK oil and gas production and expenditure, February 2021 (OGA 2021).	2020-2050	Crude oil, condensate, and NGLs included.	Physical (Mb/d) and energy (Mtoe)	(Mtoe values used since historical values better match IEA statistics)
	Gas				Physical (Bcm) and energy (Mtoe)	
United States	Coal	EIA Annual Energy Outlook 2021 (US EIA, 2021) – "reference" case	2020-2050		Physical (Mt) and energy (gross Qbtu)	0.023 EJ per Mt
	Oil			Crude oil, condensate, and NGLs included.	Physical (Mb/d) and energy (gross Qbtu)	1.9 EJ/y per Mb/d
	Gas				Physical (Bcm) and gross energy (Qbtu)	0.034 EJ per Bcm

B.2 Estimating global production levels consistent with 1.5°C- or 2°C-warming pathways

Pathways of global fossil fuel production that would be consistent with limiting warming to 1.5°C or 2°C are derived from the mitigation scenarios compiled by the Intergovernmental Panel on Climate Change (IPCC) for their Special Report on Global Warming of 1.5°C (IPCC 2018b; Rogelj et al. 2018). These scenarios provide modelled outputs of primary energy supplied by coal, oil, and gas under different emissions pathways with varying probabilistic global warming outcomes, from which we calculate the median values and interquartile ranges. These low-carbon pathways remain the same this year as in prior assessments of the production gap, as new scenario sets from the IPCC are not yet available as of August 2021.

The raw timeseries data from all models and scenarios, plus metadata, were downloaded from the IPCC 1.5°C scenario database (release 2.0)[4] maintained on the International Institute for Applied Systems Analysis website (Huppmann et al. 2018). Global annual fossil fuel production values are taken from the "Primary Energy|Coal", "Primary Energy|Oil", and "Primary Energy|Gas" variables, which are provided in units of exajoules (EJ) per year and at 10-year intervals between (2000 and 2100) for all model-scenarios. These variables generally include "non-energy" uses of coal, oil, and gas (such as for chemical or plastics feedstocks), though this reporting may vary between models[5]. Consequently, in quantifying or displaying the production gap in energy terms (i.e., Figure 2.2 and associated text), we do not adjust the results to exclude non-energy uses of fossil fuel supply for either the IPCC scenarios or our estimated CPP pathway.

The mitigation pathways rely on varying scales and types of carbon dioxide removal (CDR) deployment, with bioenergy with carbon capture and storage (BECCS) and afforestation being the most common CDR measures included. As the IPCC SR1.5 states, "CDR deployed at scale is unproven, and reliance on such technology is a major risk in the ability to limit warming to 1.5°C" owing to "multiple feasibility and sustainability concerns" (IPCC 2018a, p.19). In this analysis, we identify "1.5°C-consistent" and "2°C-consistent" mitigation pathways following the methodology outlined in the 2018 Climate Action Tracker (CAT) Warming Projections Global Update report (Climate Action Tracker et al. 2018), which considers the degree of overshoot for each temperature limit and imposes additional CDR constraints that are aligned with sustainability and economic considerations. Specifically, that report cites the IPCC (2018b) as the source for sustainable and economic constraints on BECCS of 5 $GtCO_2$ annually, and 3.6 $GtCO_2$ annually for forest sequestration. The IPCC, in turn, cites Fuss et al. (2018) for both the limit on BECCS and that on afforestation and reforestation, due to "a number of constraints" (de Coninck et al. 2018, p.343). Fuss et al. describe the 5 $GtCO_2$ limit on BECCS as a "technological potential that remains cognizant of other sustainability aims" (Fuss et al. 2018, p.14), and the 3.6 $GtCO_2$ limit on afforestation and reforestation as being based on Houghton et al.'s (2015) estimate of 500 million hectares of reforestable land in the tropics "constitut[ing] approximately 3.6 GtCO2/year of carbon removal by 2050, albeit declining to 0 by the end of the century" (Fuss et al. 2018, p.16). Applying these additional CDR constraints results in us selecting 19 out of 53 scenarios that the IPCC classifies as "below-1.5°C" or "1.5°C-low overshoot", and 55 out of 111 scenarios that the IPCC classifies as "1.5°C-high overshoot" or "lower-2°C".

Table B3 summarizes the classification and criteria of the 1.5°C- and 2°C-consistent pathways used in this report. Table B4 lists the number of scenarios analysed by each model under each temperature limit. The full list of models and scenarios used in this report are shown in Table B5.

Table B3. Classification of pathways used in the production gap report (PGR). The "pathway class" and "pathway selection criteria and description" definitions are drawn from Table 2.1 of the IPCC SR1.5 Chapter 2. The same additional CDR constraints are applied to each pathway group.

[4] Available at https://data.ene.iiasa.ac.at/iamc-1.5c-explorer/
[5] Source: Volker Krey, IIASA, personal communication to Roberto Schaeffer, October 27, 2019.

PGR pathway group	IPCC SR1.5 pathway class	IPCC SR1.5 pathway selection criteria and description	Additional CDR constraints	Number of scenarios
"1.5°C-consistent"	Below-1.5°C	Pathways limiting peak warming to below 1.5°C during the entire 21st century with 50-66% likelihood	Pathways in which the average 2040-2060 BECCS values (variable name: Carbon Sequestration|CCS|Biomass) are lower than 5.0 $GtCO_2$/yr and average 2040-2060 afforestation values (variable name: Emissions|CO2|AFOLU) are lower than 3.6 $GtCO_2$/yr. (Pathways with missing values for these variables are excluded.)	4
	1.5°C-low overshoot	Pathways limiting median warming to below 1.5°C in 2100 and with a 50-67% probability of temporarily overshooting that level earlier, generally implying less than 0.1°C higher peak warming than Below-1.5°C pathways		15
"2°C-consistent"	1.5°C-high overshoot	Pathways limiting median warming to below 1.5°C in 2100 and with a greater than 67% probability of temporarily overshooting that level earlier, generally implying 0.1-0.4°C higher peak warming than Below-1.5°C pathways		8
	Lower-2°C	Pathways limiting peak warming to below 2°C during the entire 21st century with greater than 66% likelihood		47

Table B4. Number of scenarios from each model analysed under the 1.5°C-consistent or 2°C-consistent pathways

Model	1.5°C-consistent	2°C-consistent
AIM/CGE 2.0	2	6
GCAM 4.2	2	5
IMAGE 3.0.1	2	7
MESSAGE v.3	-	3
MESSAGE-GLOBIOM 1.0	3	10
MESSAGEix-GLOBIOM 1.0	1	2
POLES ADVANCE	-	2
POLES EMF33	7	5
REMIND 1.7	-	1
REMIND-MAgPIE 1.7-3.0	-	10
WITCH-GLOBIOM 4.2	-	3
WITCH-GLOBIOM 4.4	2	1
Total	19	55

Table B5. Full list of models and scenarios identified as 1.5°C- or 2°C-consistent in this report.

PGR pathway	Model	Scenario	Category
1.5C	AIM/CGE 2.0	SSP1-19	1.5C low overshoot
1.5C	AIM/CGE 2.0	SSP2-19	1.5C low overshoot
1.5C	AIM/CGE 2.1	TERL_15D_LowCarbonTransportPolicy	1.5C low overshoot
1.5C	AIM/CGE 2.1	TERL_15D_NoTransportPolicy	1.5C low overshoot
1.5C	IMAGE 3.0.1	IMA15-LiStCh	1.5C low overshoot
1.5C	IMAGE 3.0.1	SSP1-19	1.5C low overshoot
1.5C	MESSAGE-GLOBIOM 1.0	ADVANCE_2020_1.5C-2100	1.5C low overshoot
1.5C	MESSAGE-GLOBIOM 1.0	SSP1-19	1.5C low overshoot
1.5C	MESSAGE-GLOBIOM 1.0	SSP2-19	1.5C low overshoot
1.5C	MESSAGEix-GLOBIOM 1.0	LowEnergyDemand	1.5C low overshoot
1.5C	POLES EMF33	EMF33_1.5C_cost100	Below 1.5C
1.5C	POLES EMF33	EMF33_1.5C_limbio	Below 1.5C
1.5C	POLES EMF33	EMF33_1.5C_nofuel	Below 1.5C
1.5C	POLES EMF33	EMF33_WB2C_limbio	1.5C low overshoot
1.5C	POLES EMF33	EMF33_WB2C_nobeccs	1.5C low overshoot
1.5C	POLES EMF33	EMF33_WB2C_nofuel	1.5C low overshoot
1.5C	POLES EMF33	EMF33_WB2C_none	1.5C low overshoot
1.5C	WITCH-GLOBIOM 4.4	CD-LINKS_NPi2020_1000	1.5C low overshoot
1.5C	WITCH-GLOBIOM 4.4	CD-LINKS_NPi2020_400	Below 1.5C
2C	AIM/CGE 2.0	ADVANCE_2020_WB2C	Lower 2C
2C	AIM/CGE 2.0	ADVANCE_2030_Price1.5C	Lower 2C
2C	AIM/CGE 2.0	ADVANCE_2030_WB2C	Lower 2C
2C	AIM/CGE 2.0	SSP1-26	Lower 2C
2C	AIM/CGE 2.0	SSP2-26	Lower 2C
2C	AIM/CGE 2.0	SSP4-26	Lower 2C
2C	AIM/CGE 2.1	CD-LINKS_NPi2020_1000	Lower 2C
2C	AIM/CGE 2.1	EMF33_WB2C_cost100	1.5C high overshoot
2C	AIM/CGE 2.1	EMF33_WB2C_full	Lower 2C
2C	AIM/CGE 2.1	TERL_2D_LowCarbonTransportPolicy	Lower 2C
2C	AIM/CGE 2.1	TERL_2D_NoTransportPolicy	Lower 2C
2C	IMAGE 3.0.1	ADVANCE_2020_WB2C	Lower 2C
2C	IMAGE 3.0.1	ADVANCE_2030_WB2C	Lower 2C
2C	IMAGE 3.0.1	CD-LINKS_NPi2020_1000	Lower 2C
2C	IMAGE 3.0.1	IMA15-LoNCO2	1.5C high overshoot
2C	IMAGE 3.0.1	SSP1-26	Lower 2C
2C	IMAGE 3.0.1	SSP2-26	Lower 2C
2C	IMAGE 3.0.1	SSP4-26	Lower 2C
2C	MESSAGE-GLOBIOM 1.0	ADVANCE_2020_WB2C	Lower 2C
2C	MESSAGE-GLOBIOM 1.0	ADVANCE_2030_Price1.5C	1.5C high overshoot
2C	MESSAGE-GLOBIOM 1.0	ADVANCE_2030_WB2C	Lower 2C
2C	MESSAGEix-GLOBIOM 1.0	CD-LINKS_NPi2020_1000	Lower 2C
2C	MESSAGEix-GLOBIOM 1.0	CD-LINKS_NPi2020_400	1.5C high overshoot
2C	POLES ADVANCE	ADVANCE_2020_Med2C	Lower 2C
2C	POLES ADVANCE	ADVANCE_2030_Med2C	Lower 2C
2C	POLES EMF33	EMF33_Med2C_cost100	Lower 2C
2C	POLES EMF33	EMF33_Med2C_limbio	Lower 2C
2C	POLES EMF33	EMF33_Med2C_nobeccs	Lower 2C
2C	POLES EMF33	EMF33_Med2C_nofuel	Lower 2C
2C	POLES EMF33	EMF33_Med2C_none	Lower 2C
2C	REMIND 1.7	ADVANCE_2020_WB2C	Lower 2C
2C	REMIND-MAgPIE 1.7-3.0	CD-LINKS_NPi2020_1000	Lower 2C
2C	REMIND-MAgPIE 1.7-3.0	EMF33_WB2C_nobeccs	Lower 2C
2C	REMIND-MAgPIE 1.7-3.0	EMF33_WB2C_none	Lower 2C
2C	REMIND-MAgPIE 1.7-3.0	PEP_2C_full_eff	Lower 2C
2C	REMIND-MAgPIE 1.7-3.0	PEP_2C_full_netzero	Lower 2C
2C	REMIND-MAgPIE 1.7-3.0	PEP_2C_red_goodpractice	Lower 2C
2C	REMIND-MAgPIE 1.7-3.0	PEP_2C_red_netzero	Lower 2C
2C	REMIND-MAgPIE 1.7-3.0	SMP_2C_Def	Lower 2C
2C	WITCH-GLOBIOM 4.2	ADVANCE_2020_WB2C	Lower 2C
2C	WITCH-GLOBIOM 4.2	ADVANCE_2030_Price1.5C	Lower 2C
2C	WITCH-GLOBIOM 4.2	ADVANCE_2030_WB2C	Lower 2C
2C	WITCH-GLOBIOM 4.4	CD-LINKS_NPi2020_1600	Lower 2C
2C	MESSAGE V.3	GEA_Eff_1p5C	Lower 2C
2C	MESSAGE V.3	GEA_Eff_1p5C_Delay2020	Lower 2C

2C	MESSAGE V.3	GEA_Eff_AdvNCO2_1p5C	Lower 2C
2C	MESSAGE-GLOBIOM 1.0	EMF33_Med2C_nobeccs	Lower 2C
2C	MESSAGE-GLOBIOM 1.0	EMF33_Med2C_none	Lower 2C
2C	MESSAGE-GLOBIOM 1.0	EMF33_tax_hi_full	Lower 2C
2C	MESSAGE-GLOBIOM 1.0	EMF33_WB2C_cost100	1.5C high overshoot
2C	MESSAGE-GLOBIOM 1.0	EMF33_WB2C_full	1.5C high overshoot
2C	MESSAGE-GLOBIOM 1.0	EMF33_WB2C_limbio	1.5C high overshoot
2C	MESSAGE-GLOBIOM 1.0	EMF33_WB2C_nofuel	1.5C high overshoot
2C	REMIND-MAgPIE 1.7-3.0	PEP_2C_red_NDC	Lower 2C
2C	REMIND-MAgPIE 1.7-3.0	SMP_2C_early	Lower 2C

B.3 Estimating the global production gap in terms of extraction-based CO_2 emissions, energy, and physical units

Quantities of fossil fuel production – and thus the size of the production gap – can be expressed in three different units: physical units, energy units, or units of extraction-based emissions. Figure 2.2 shows the production gaps in terms of its component fuels in energy (primary axis) and physical (secondary axis) units. Quantifying the coal, oil, and gas production gaps in energy terms (i.e., exajoules per year) allows for a direct comparison to the outputs of primary energy supply as reported in the integrated assessment model scenarios compiled by the IPCC (IPCC 2018b), as well as by other parties, such as the IEA (IEA 2021b). In order to translate the gap from energy to physical terms, we apply a constant conversion factor to all future years for each fuel, derived from 2019 global production statistics from the IEA's World Energy Statistics and Balances (IEA 2021a): 0.022 exajoules per million tonnes for coal; 2.0 exajoules per year per million barrels per day for oil; and 0.035 exajoules per billion cubic meters for gas.

In Figure 2.1, we aggregate across all fossil fuels to represent the gap in terms of extraction-based emissions, an accounting method that reflects the amount of of CO_2 emissions expected to be released from the combustion of extracted coal, oil, and gas (Davis et al. 2011). Here, we derive top-down emission factors for each fuel, calculated as the ratio of the global annual sum of CO_2 emissions from fuel combustion to the global annual sum of fuel production based on IEA statistics for 2014-2018, the most recent years available (IEA 2020a; IEA 2021a). The following emission factors are applied to all four pathways in Figure 2.1 for all years (2019-2040): 0.091 billion tonnes of carbon dioxide ($GtCO_2$) per exajoules (EJ) for coal, 0.061 for oil, and 0.052 for gas. These values all assume, implicitly, that some coal, oil, and gas are not combusted, according to IEA's estimates of what fossil fuels go to other, non-energy uses, such as the use of metallurgical coal as a feedstock for making iron, or the use of gas or oil as a feedstock for making petrochemicals.

Our top-down approach has three main limitations:

1) It does not consider other greenhouse gases besides CO_2 and does not account for fugitive emissions from extraction processes.
2) We assume that globally averaged emission rates per unit of coal, oil, and gas produced remains the same in all future years, though this could vary as coal and liquid subtype ratios (e.g., anthracite versus bituminous) change.
3) The IPCC SR1.5 mitigation scenarios generally do not report what fraction of coal, oil, or gas primary energy is for non-energy uses (such as for chemical or plastics feedstocks) in past or future years. We assume that these fractions remain constant at recent levels (i.e., 2014-2018, as specified above) for each fuel for all future years.

For a detailed discussion of other methodological approaches for estimated extraction-based emissions, please refer to Appendix B of the 2019 Production Gap Report (SEI et al. 2019).

B.4 Changes in the production gap compared to our 2019 assessment

Compared to our 2019 assessment, the low-carbon pathways have remained the same. Consequently, any changes in our estimate of the size of the production gap stem from changes in our derivation of the countries' plans and projections (CPP) pathway. As explained in Chapter 2 and section B.1 above, our derivation of the CPP pathway primarily relies on our own compilation of fossil fuel production as projected in recent and publicly available national energy outlooks of major producer countries. Their combined production levels are then scaled up to a global estimate based on these countries' projected future shares of global production, as modelled by the IEA.

Our 2019 analysis relied on the plans and projections of eight major producer countries: Australia, Canada, China, India, Indonesia, Norway, Russia, and the US. These countries accounted for around 90% of coal (6 countries), 40% of oil (8 countries), and 57% of gas production (8 countries) in 2017. This year's analysis derives from more recent plans and projections from these eight countries and seven additional countries: Brazil, Germany, Kazakhstan, Mexico, Saudi Arabia, the UAE, and the UK. Altogether, the 15 countries accounted for around 90% for coal (8 countries), 70% for oil (14 countries), and 65% for gas (13 countries) in 2020 (IEA 2021a). The source documents for these 15 countries are listed in Table B1. The source documents used in our 2019 assessment can be found in Table A1 of the 2019 report's Appendix A.

The expansion in countries analysed, along with the fact that there is limited transparency and lack of standardized and/or regular reporting on planned domestic fossil fuel production by different countries, mean that it is difficult to directly compare the CPP pathways in our 2021 and 2019 assessments and tease out the factors that have led to changes. For example, some governments – such as the US and Canada – issue long-term, national energy outlooks annually which means that their projections can be readily compared year-to-year. Even so, the latest energy outlook from Canada features a new, different scenario as their primary pathway. For other countries, such as India and China, some of the underlying projections in this year's assessment come from source documents issued by different government ministries and/or state-owned companies.

Nevertheless, since the purpose of our Production Gap Report series is to track the discrepancy between global coal, oil, and gas levels implied by governments' plans and projections and those consistent with the Paris Agreement's goals, we show how the CPP pathways – and consequently our estimates of the size of the production gap – have changed between our 2019 and 2021 assessments in Figures B.1 and B.2. These figures also shown how global production levels implied by governments' climate pledges have changed between our two assessments.

*Figure B.1 – Global fossil fuel production under four pathways from 2019 to 2040 (including comparison to pathways from the 2019 Production Gap report), denominated in extraction-based CO_2 emissions. (*Note: The 2019 CPP pathway has been updated; see text for details.)*

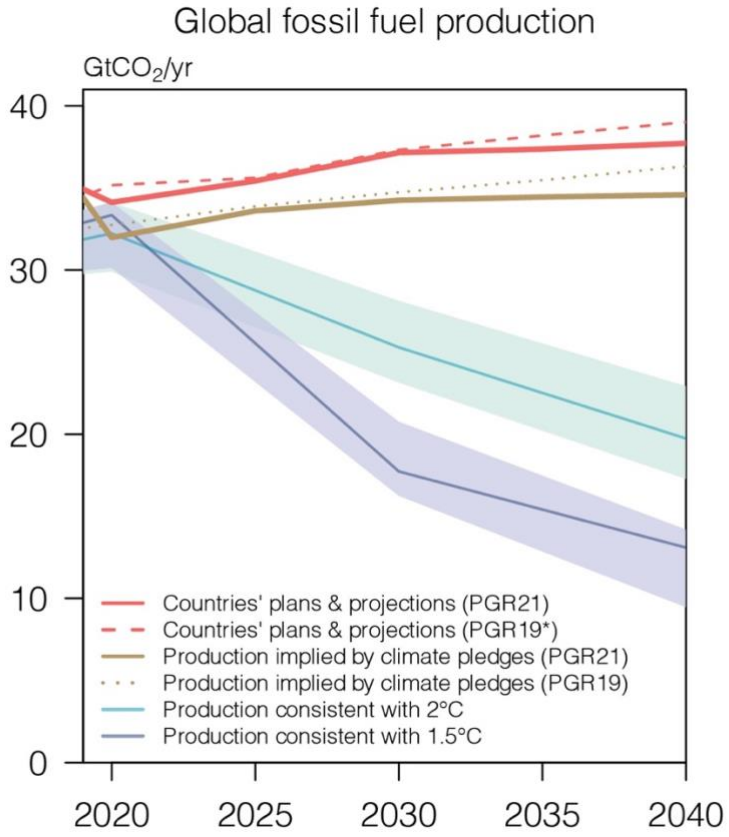
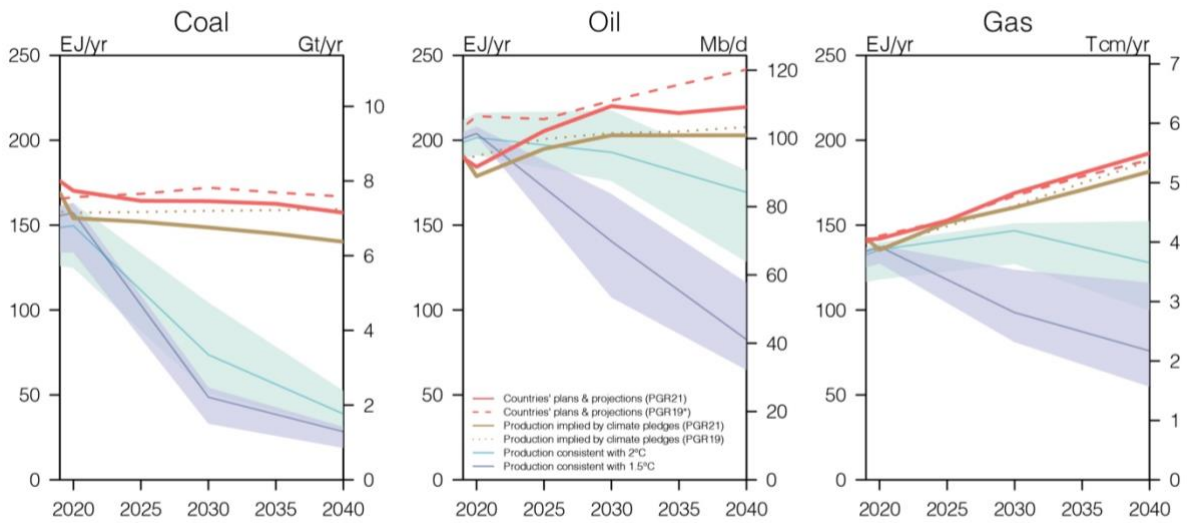


*Figure B.2 – Global coal, oil, and gas production under four pathways from 2019 to 2040 (including comparison to pathways from the 2019 Production Gap report), denominated in energy units (exajoules per year). Physical units are displayed as secondary axes: billion tonnes per year for coal, million barrels per day for oil, and billion cubic meters per year for gas. (*Note: The 2019 CPP pathway has been updated for coal; see text for details.)*



Since the publication of our 2019 Production Gap Report, we have also discovered that we misinterpreted the units of India's coal projections published in the Draft National Energy Policy 2017 from the National Institution for Transforming India (NITI Aayog 2017, p.27), which was used in our 2019 gap assessment. Specifically, Table 3 in that report specified values of historical coal production in 2012 and projections for the years 2022 and 2040 in units of "million tonnes of coal equivalent (Mtce)". We had originally interpreted this "Mtce" unit to represent standard energy units, whereas we now believe, based on comparison to other sources, that the "Mtce" in this instance reflects physical units adjusted to the average energy contents of coal produced in 2012 in India. When we account for this reinterpretation of India's projections, using production statistics reported in both physical (tonnes) and energy (petajoules) units in India's 2011-2012 Coal Statistics (Government of India et al. 2013), we find that our 2019 coal CPP pathway would have been 7% lower in 2030 and 9% lower in 2040. The overall CPP pathway for all fuels would have been 11% lower in 2030 and 2040. The corrected CPP pathways are shown in figures B.1 and B.2. and are denoted in the legend with an asterisk (*). Consequently, the size of the production gap in 2030 would have been around 110% relative to the 1.5°C pathway and 46% relative to the 2°C pathway. (The estimates originally given in our 2019 report were around 120% relative to the 1.5°C pathway and 52% relative to the 2°C pathway; all reported results are rounded to two significant figures.)

Compared to the findings in our 2019 report, we find that the global CPP pathways have remained almost unchanged for gas (increase of 1-2% in 2030-2040) and are slightly lower for coal, while larger differences are visible for oil (figure B.2).

For oil, the COVID-19 pandemic has played some role in lowering the CPP pathway in the near term. The sharp decrease in travel associated with the response to the pandemic did push down oil demand forecasts (and, in turn, investment levels in new oil supply), as depicted by the sharp near-term divergence between our 2019 assessment of the CPP pathway for oil (labelled PGR19 in Figure B.2) and our current estimates through 2025. However, these economic effects are projected to be short-lived (IMF 2021). By 2030, plans for oil production grow to nearly the levels foreseen in our 2019 analysis, before flattening out to levels about 9% below our previous analysis by 2040.

The decline in the oil CPP pathway in later years relative to our 2019 assessment is due to two related factors. One is that the plans and projections for some countries (e.g., the US and Canada) have declined slightly relative to the 2019 assessment. The other factor is that future oil production in other countries besides the fourteen countries whose outlooks we analyse is expected to have decreased by an even greater amount relative to our 2019 assessment (these countries are represented by the rest-of-the-world block in Figure 2.3). This trend is based on changes in the IEA STEPS, as government plans and projections for most of these other countries are not readily available. These other countries currently account for 30% of global oil production. This update in IEA's expectations (under the STEPS in their 2020 versus 2018 World Energy Outlooks) has the effect of decreasing the global CPP pathway for oil relative to our 2019 analysis. More specifically, since the IEA now sees the future market share of our focus countries as being higher in the future than they did previously, the scale-up factor applied to our sample countries to estimate the global total is now smaller, meaning that the global total CPP pathway is lower. For future editions of this report, we will consider other methods to account for countries not analysed, which might better reflect their own plans and projections rather than solely on trends implied by the IEA STEPS which is driven, at least in part, on relative production costs.

For coal, we find that the CPP pathway has declined by 4-6% in 2030, 2035, and 2040 compared to our re-analysed 2019 CPP pathway. The reasons for this decline are similar to oil, reflecting a combination of slightly lower coal projections in some of the government plans we analysed, as well as a change in our methodological assumption of how production by the rest of the world could evolve as a result (based on model results from the IEA STEPS).

Altogether, we estimate that global fossil fuel production levels under the CPP pathway have decreased by less than 3% in all future years analysed (2025-2040 in five-year increments). In the year 2030 that we focus on in the text, the decrease is 0.5%. In the year 2040, the decrease is 3%. Because this difference is so small overall –

and because this difference partly stems from methodological differences – we consider the production gap to be largely unchanged.

Further research on the additional countries currently modelled in our “rest-of-the-world” block – though difficult since government plans and projections for future fossil fuel production are not readily available – would help constrain the uncertainty in our estimate of the CPP pathways for coal, oil, and gas.

Appendix C. Overview of transparency initiatives focused on fossil fuel production and climate change

Name of initiative	Main objective(s)	Type of fossil fuel(s) covered	Membership Public (governmental and intergovernmental) Public-private Private (NGOs and businesses)	Types of data reported/collected Relevant for addressing the Production Gap	Link(s)
Governmental, intergovernmental, and joint (public-private) transparency initiatives					
Extractive Industries Transparency Initiative (EITI)	Promoting open and accountable management of oil, gas, and mineral resources through a standard, which requires the disclosure of information along the extractive industry value chain from the point of extraction, to how revenues make their way through the government and how they benefit the public	Oil, gas, and coal	Public-private (incl. 55 "implementing countries")	For implementing countries, annual updates on among others: Exploration activities, production figures, and export data Assumptions about future production, revenues, commodity prices and resource dependency Collection and allocation of government revenues from the extractive industry Payments from companies to governments, disaggregated by revenue stream, company and project Links to license and contracts registries	https://eiti.org/
Joint Organisations Data Initiative (JODI)	Improving market transparency and facilitating well-informed decision-making that enhances market stability and confidence, strengthens energy	Oil and gas	Public-private (privately held, 8 international organizations are partners, more than 90	Monthly updated database including 13 product categories and 14 flows (e.g., production, consumption, trade, stocks)	https://www.jodidata.org/ Oil World Database: https://www.jodidata.org/oil/database/overview.aspx

	security, and accelerates the energy transition, through a freely accessible and comprehensive database of energy statistics		countries submitting data)	from more than 90 countries (Oil World Database) Monthly updated database including natural gas and LNG, 12 flows (e.g., production, imports, exports, stocks) from around 80 countries (Gas World Database)	Gas World Database: https://www.jodidata.org/gas/
Network for Greening the Financial System (NGFS)	Enhancing the role of the financial system to manage risks and to mobilize capital for green and low-carbon investments, by defining and promoting best practices to be implemented within and outside of the Membership of the NGFS and conducting or commissioning analytical work on green finance	Oil, gas, and coal	Public (91 central banks and other financial institutions)	No data-collection effort, but includes a workstream focused on identifying data gaps for climate-related risks analysis, including physical asset level data, physical and transition risk data or financial assets data Call for convergence on a set of global disclosure standards, accepted global taxonomy and development and creation and use of certification labels and methodological standard	https://www.ngfs.net/en
OECD-IEA Inventory of Support Measures for Fossil Fuels	Supporting international efforts to reform fossil fuel subsidies	Oil, gas, and coal	Public (estimates for 81 economies)	Continuously updated information on nature and scale of government budgetary transfers and tax expenditures in support of fossil fuel production and consumption Includes a sectoral breakdown of support measures, across production and supply, energy transformation, and final consumption in transport, residential, and industry end-use sectors	https://www.oecd.org/fossil-fuels/
IEA Databases on energy statistics	Developing effective and efficient national energy policies and allow for long-term planning for investment in the energy sector	Oil, gas, and coal	Public (30 IEA members)	Energy statistics on supply and demand, compiled into energy balances in addition to other key energy-related indicators, including energy prices, public RD&D and measures of energy efficiency Platform for modelling work and tracking both short-term shifts and long-term	https://www.iea.org/data-and-statistics

				trends in countries' energy transitions, particularly for clean energy	
IEA Methane Tracker	Helping to reduce methane leaks	Oil and gas	Public (30 IEA members)	Data on large-scale methane leaks in oil and gas operations	https://www.iea.org/reports/methane-tracker-2021
WTO subsidies reporting	Notify specific subsidies that may have adverse trade effects every 3 years	Oil, gas, and coal	Public (164 WTO members)	Information on subsidies: period covered, objective, legal basis, form of subsidy, beneficiaries, subsidy per unit (or total annual amount), duration, and data on trade effects (notified on rolling basis)	https://www.wto.org/english/tratop_e/scm_e/notif_e.htm
Fossil Fuel Subsidy Tracker	Bring together existing international estimates of support for fossil fuels to help bridge the reporting gap	Oil, gas, and coal	Public-private (OECD, IISD, IMF)	Fossil fuel subsidies and other support measures (direct budgetary transfers, tax expenditures, price support) for 194 economies (until 2017) and 81 economies (until 2019)	https://fossilfuelsubsidytracker.org/
Non-governmental: Civil society and private transparency initiatives					
Taskforce for Climate-Related Financial Disclosures (TCFD)	Developing recommendations for more effective climate-related disclosures	Oil, gas, and coal	Private (31 members, including providers of capital, insurers, large non-financial companies, accounting and consulting firms, and credit rating agencies)	N/A – reporting framework rather than data-collecting initiative	https://www.fsb-tcfd.org/
Publish What You Pay (PWYP)	Pushing for governments to regulate natural resource extraction in an open and accountable way, for companies to operate within an effective governance framework, and for a civil society with the skills and freedom to drive natural resource extraction that benefits all	Oil, gas, and coal	Private (NGO, over 1000 civil organizations are members)	Campaign for oil, gas and mining companies to publish their payments to governments (e.g., licence fees, royalties, and taxes), and for governments to be transparent about the revenues they receive Calling for stronger disclosures by companies of climate-related financial risks and of decision factors around new licensing, in order to promote more sustainable policy Works for open, competitive bidding processes in which contracts between governments and companies are made publicly accessible	https://www.pwyp.org/

				Seek information about how governments and companies spend revenues	
Global Energy Monitor (GEM)	Producing reports, databases, and interactive data tools (e.g. trackers) to make energy data available to everyone	Oil, gas, and coal	Private (NGO)	Foreign flows of financing for coal from public finance institutions (Global Coal Public Finance Tracker) Number of coal-fired power units, coal mines, and gas-fired plants operating in the world (Global Coal Plant, Global Gas Plant, Global Coal Mine Trackers) Calculation of life-cycle methane leakage Fossil fuel infrastructure projects worldwide (LNG terminals, pipelines) (Global Fossil Infrastructure Tracker) Tracker for fossil gas infrastructure across the EU (Europe Gas Tracker)	https://globalenergymonitor.org/
Global Energy Observatory	Promoting understanding of the dynamics of change in energy systems, quantifying emissions and their impacts, and accelerating the transition to carbon-neutral, environmentally benign energy systems while providing affordable energy to all	Oil, gas, and coal	Private (NGO)	Data on coal, gas, oil, power plants, and transport infrastructures, as well as gas and oil fields, coal and uranium mines, crude oil refineries (last updated 2018)	http://www.globalenergyobservatory.com/
Carbon Majors database	Highlighting the role that corporations can play in driving the global energy transition	Oil, gas, and coal	Private (NGO)	Data on fossil fuel company operational and product-related GHG emissions (last updated 2020)	https://climateaccountability.org/carbonmajors.html
Oil Change International – Shift the Subsidies database	Expose costs of fossil fuels and facilitating the ongoing transition to clean energy	Oil, gas, and coal	Private (NGO)	Information on the quantity, sources, and types of energy finance	http://priceofoil.org/shift-the-subsidies/
NRGI National Oil Company Database	Assess NOC performance and develop strategies for how these influential entities can generate greater benefits for citizens	Oil and gas	Private (NGO)	Information on the production, revenues and performance of 71 NOCs	https://www.nationaloilcompanydata.org/

NRGI Resource Governance Index	Measure transparency and integrity rules and practices across major fossil fuel producer countries and emerging producers	Oil and gas	Private (NGO)	Data on transparency of disclosures on fossil fuel licensing, revenues, environmental protection measures, state-owned enterprise spending Data on transparency of plans and assumptions on future public support to fossil fuel production Integrity mechanisms to reduce corruption and promote natural resource management in the long-term public interest	https://resourcegovernanceindex.org/
World Benchmarking Alliance Oil and Gas Benchmark	Measure and rank the world's 100 most influential oil and gas companies on their low-carbon transition and the compatibility of their actions with progress toward the Paris goals	Oil and gas	Private (NGO)	Data assessing the investments and progress of 100 companies (private and state-owned) toward energy transition, including company policy, spending on fossil and non-fossil projects, and carbon-intensity of production	https://www.worldbenchmarkingalliance.org/research/launching-the-oil-and-gas-benchmark/
Energy Policy Tracker	Showcasing and tracking public money invested in different energy types, including coal, oil, and gas, since the beginning of the COVID-19 pandemic	Oil, gas, and coal	Private (five NGOs and one university)	Public money commitments for different energy types, and other policies supporting energy production and consumption for 31 major economies and 8 MDBs	https://www.energypolicytracker.org/
Oil and Gas Climate Initiative (OGCI) Performance Data	OGCI is a voluntary, industry-led initiative to deliver transparent information about member company contributions to climate change solutions.	Oil and gas	Private (13 oil and gas companies)	Member companies report on oil and gas production (Mboe/day), GHG emissions (upstream intensity, Scope 1&2 emissions), methane emissions, flaring and low-carbon investment and R&D	https://www.ogci.com/knowledge-base/ogci-performance-data/
IPIECA Climate Change Reporting Framework	Providing a reporting framework for oil and gas companies to publicly disclose information on climate risks in a simple, straightforward and transparent manner, offering a broad coverage of the issues and providing a consistent reporting methodology	Oil and gas	Private (oil and gas companies)	Topics to include in external reporting, incl. climate positions, principles, and policies; responsibilities and accountabilities; stakeholder engagement; implications of shifting energy supply/demand and climate policy; corporate risk management; mitigation strategies and activities; addressing GHG regulation; R&D; GHG and energy data; and assurance	https://www.ipieca.org/our-work/sustainability/performance-reporting/ghg-reporting/

Global Reporting Initiative Sector Standard for Oil and Gas	Disclosure standard (due for approval in late 2021) for oil and gas companies on material information related to their impacts on environment, economy, and human rights	Oil and gas	Private (NGO)	Disclosure by oil and gas companies of financial impact of climate change on the viability of their business, including impact on future production, spending and revenues, and internal carbon pricing and oil and gas pricing Disclosure by oil and gas companies of emissions potential from their proven and probable reserves Disclosure by oil and gas companies of goals and targets on reduction of GHG emissions	https://www.globalreporting.org/standards/standards-development/sector-standard-project-for-oil-and-gas/ (description of process); https://www.globalreporting.org/media/xxijhypc/item-02-gri-sector-standards-project-for-oil-and-gas-oil-and-gas-sector-standard-2021.pdf (board-approved draft)
Carbon Tracker databases: -Company profiles -ARO database	Carbon Tracker has multiple databases, including an examination of ~65 companies in the Oil & Gas and Power & Utilities sectors, and assessment of asset retirement obligations for oil and gas companies	Oil and gas	Private (NGO)		https://carbontracker.org/company-profiles/ https://carbontracker.org/tools-and-insights/aro-portal/
BP Statistical Review of World Energy	BP has published annual reporting on global energy statistics for the past 70 years. The BP statistical review provides an historical dataset of energy production and consumption	Oil, gas, and coal	Private (oil and gas company)	Summarizes energy production, consumption, trade annually	https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html
Rystad Energy U-Cube	Rystad Energy is an independent oil and gas consulting services and business intelligence data firm offering global databases, strategy consulting and research products	Oil and gas	Private (company)	U-Cube is a database of historic and future production data, including engineering and financing of all oil and gas fields (requires subscription, though some data is available through free database)	https://www.rystadenergy.com/energy-themes/oil--gas/upstream/u-cube/

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