



HAL
open science

Carbon dioxide emissions continue to grow amidst slowly emerging climate policies

G. P. Peters, R. M. Andrew, J. G. Canadell, P. Friedlingstein, R. B. Jackson, J. I. Korsbakken, C. Le Quéré, A. Pregon

► **To cite this version:**

G. P. Peters, R. M. Andrew, J. G. Canadell, P. Friedlingstein, R. B. Jackson, et al.. Carbon dioxide emissions continue to grow amidst slowly emerging climate policies. *Nature Climate Change*, 2020, 10, pp.3-6. 10.1038/s41558-019-0659-6 . insu-03660271

HAL Id: insu-03660271

<https://insu.hal.science/insu-03660271>

Submitted on 6 May 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

1 Carbon dioxide emissions continue to grow despite emerging climate policies

2 G.P. Peters^{1*}, R.M. Andrew¹, J.G. Canadell², P. Friedlingstein^{3,4}, R.B. Jackson⁵, JI. Korsbakken¹, C. Le
3 Quéré⁶, A. Peregon^{7,8}

4 ¹CICERO Center for International Climate Research, Oslo, Norway

5 ²Global Carbon Project, CSIRO Oceans and Atmosphere, Canberra, ACT 2601, Australia

6 ³College of Engineering, Mathematics and Physical Sciences, University of Exeter, Exeter EX4 4QF, UK

7 ⁴Laboratoire de Météorologie Dynamique, Institut Pierre-Simon Laplace, CNRS-ENS-UPMC-X,
8 Département de Géosciences, Ecole Normale Supérieure, 24 rue Lhomond, 75005 Paris, France

9 ⁵Department of Earth System Science, Woods Institute for the Environment, and Precourt Institute
10 for Energy, Stanford University, Stanford, CA 94305-2210, USA

11 ⁶Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East
12 Anglia, Norwich Research Park, Norwich, NR4 7TJ, UK

13 ⁷Laboratoire des Sciences du Climat et de l'Environnement, Institut Pierre-Simon Laplace, CEA-CNRS-
14 UVSQ, CE Orme des Merisiers, 91191 Gif-sur-Yvette Cedex, France

15 ⁸Institute of Soil Science and Agrochemistry, Siberian Branch of the Russian Academy of Sciences
16 (ISSA SB RAS), Pr. Akademika Lavrentyeva, 8/2, 630090, Novosibirsk, Russia

17 *Correspondence to glen.peters@cicero.oslo.no

18 *A failure to recognise the factors behind continued emissions growth could limit the world's ability to*
19 *shift to a pathway consistent with 1.5°C or 2°C of global warming. Continued support for low-carbon*
20 *technologies need to be combined with policies directed at phasing out the use of fossil fuels.*

21 Global fossil CO₂ emissions grew at 1% per year in the 1990's, accelerated to 2.9% per year in the
22 2000's, but have returned to a slower growth rate of 0.9% per year since 2010 with a more
23 pronounced slowdown from 2014 to 2016. Despite modest declines in emissions in the United States
24 and the European Union over the last decade, the growth in emissions in China, India, and most
25 developing countries have dominated global emission trends over the last 20 years. The Global
26 Carbon Budget projection¹ suggests global fossil CO₂ emissions will grow 0.5% (range –0.4% to 1.4%)
27 in 2019, with emissions projected to decline in the US and the EU28, but projected to increase in
28 China, India, and the Rest of the World (Figure 1a).

29 While a focus on countries and regions is important, a focus on type of fossil fuels and key emitting
30 sectors is particularly relevant for monitoring changes and implementing adequate mitigation
31 policies. Globally, and over the last decade (2009-2018), 42% of fossil CO₂ emissions were from coal,
32 34% from oil, 19% from natural gas, and the remaining 5% from cement and other smaller sources
33 (Figure 1b). In 2019, CO₂ emissions from coal are projected to decline 1.1% with substantial drops in
34 emissions from coal use in the US (–13%) and the EU28 (–10%) and weak growth in China and India
35 due to economic and weather anomalies. Oil is projected to grow 0.9% in 2019 and natural gas 2.5%,
36 both in line with growth over the last decade.

37 At the most aggregated level, over the last decade, 45% of fossil CO₂ emissions come from the energy
38 sector, dominated by electricity and heat production. Industry sectors, such as metals production,
39 chemicals, and manufacturing, cover 22% of global emissions. Land transport combined with national
40 shipping and aviation contribute 20% of global emissions, while international shipping and aviation
41 add another 3.7%. The remaining 10% is from buildings, agriculture, fishing, and other sectors not
42 elsewhere covered (e.g., military). In the following, we detail key changes in fossil CO₂ emissions
43 across these sectors for the different fossil fuels: coal, oil, and gas.

44 *Coal is still king, but losing power*

45 The changes in global emissions have primarily been driven by changes in coal use, while growth in
46 the use of oil and gas continued unabated since 1980 following the oil crises in the 1970s (Figure 2a).
47 Many analysts have speculated that coal use may have peaked. The decline in coal use in
48 Organisation for Economic Co-operation and Development (OECD) countries is clear, with a 25%
49 decline in the last decade. Growth in coal use in non-OECD countries has remained strong but is
50 heavily influenced by China. A global peak in coal use is highly dependent on the pathway in China,
51 which now accounts for 50% of global coal use. While changes in the structure of China's economy
52 may have contributed to a recent decline in coal use², Chinese emissions are rising again and it is too
53 early to proclaim a coal peak in China or globally¹.

54 The dramatic shifts in coal use have occurred in different sectors (Figure 2). The largest share of
55 global coal use is for electricity & heat (around 67%), followed by industry such as metals, chemicals,
56 and manufacturing (27%). The levelling off global coal use in the 1990s resulted largely from the
57 collapse of the Soviet Union³ but was partially offset by strong growth in electricity and industry in
58 China and India. The recent modest decline in global coal use has primarily occurred due to
59 continued declines in coal power in the US and European Union and a slowdown in coal power
60 growth in China, combined with a slowdown in the growth in industrial production in China. The
61 declines in electricity generation likely represent a more systematic structural change with electricity
62 generation from coal being replaced by non-fossil energy sources or with natural gas. The recent
63 decline in coal use by industry may represent the effects of economic headwinds in China, as there
64 are very few technologies to guarantee declines in the hard-to-mitigate industrial sectors⁴.

65 *Oil shows resilient growth*

66 Global oil use has grown almost unimpeded for several decades (Figure 2b), with the main
67 disruptions occurring during the oil crises³ in 1973 and 1979. The oil crises primarily hit oil use in
68 OECD countries, but more so in sectors where oil was used inefficiently (electricity and industry) with
69 limited effects in transport (Figure 2b). Global oil use is dominated by land transport, representing
70 50% of emissions from oil use and growing at 1.9% per year (104MtCO₂ per year) in the last decade.
71 Oil use in OECD countries declined after the global financial crisis in 2009 but has since begun to rise
72 again, making current oil use similar to the levels in 2009. Oil use in non-OECD countries continues to
73 grow strongly, despite a slowdown in the growth rate in the last few years. National and
74 international aviation represent around 8% of the emissions from oil use and is growing at around 3%
75 per year (25MtCO₂ per year) in the last decade. Other sectors (industry, power, other) are flat at the
76 global level, with declines in OECD countries offset by increases in non-OECD countries.

77 While aviation is receiving increased public attention, the continued growth in emissions from land
78 transport are far more significant in aggregate terms and is the main driver of CO₂ emissions from oil
79 globally. The deployment of electric vehicles is promising, but demand for transport services is
80 growing more rapidly. In many markets, electric vehicles are adding to demand and not replacing
81 existing vehicles, therefore having minimal effect on oil use. If electrical grids are not decarbonised
82 fast enough, then the addition of electric vehicles may partly shift emissions from transport to the
83 energy sector. Oil is generally an inefficient energy source outside of transport, suggesting there are
84 many opportunities to reduce oil use in the power sector and industry.

85 *Natural gas is only a temporary fix*

86 CO₂ emissions from natural gas use have been growing steadily and almost uninterrupted for over
87 half a century, and they are currently the fastest growing fossil fuel (Figure 2b). Natural gas has
88 contributed to the largest increase in global fossil CO₂ emissions in recent times, accounting for
89 around 35% of the growth in the last decade and 50% in the last few years. Natural gas use is

90 growing strongly in most countries, with the 44% of gas use in electricity and heat growing the most
91 rapidly globally. OECD countries generally have more diverse usage of gas, with significant gas use in
92 industry, energy, and buildings. Non-OECD gas use is more concentrated in the electricity sector.

93 Natural gas has been portrayed as a bridge fuel from coal power to non-fossil power generation
94 because it emits about 40% less CO₂ than coal per unit of energy and can therefore reduce emissions
95 if gas substitutes coal in electricity generation. While natural gas can help begin decarbonisation in
96 electricity generation, it still emits CO₂ and natural gas use without Carbon Capture and Storage (CCS)
97 needs to be phased out not long after it displaces coal use. In some instances, natural gas could lead
98 to worse outcomes for the climate than coal depending on methane leakage rates⁵. Natural gas is
99 also an attractive alternative in industrial, commercial, and residential applications, but without CCS,
100 the emissions still contribute significantly to global warming.

101 While natural gas may be necessary to aid a transition from coal to non-fossil energy in some
102 national circumstances, expanded natural gas use without CCS could limit the ability to meet
103 ambitious climate targets. The rapidly growing global Liquefied Natural Gas (LNG) market will support
104 the expansion and reach of natural gas in the coming decades, while plans to develop CCS that could
105 limit the climate impacts of natural gas still lagging at the small-scale demonstration stage.

106 *Shift focus to fossil fuels*

107 The continued growth in global fossil CO₂ emissions is taking place despite growing public and policy
108 attention, five cycles of the Intergovernmental Panel on Climate Change (IPCC) Assessment Reports,
109 and almost 30 years of international climate negotiations. While some climate policies have fallen
110 into place, leading to rapid progress in the deployment of clean energy technologies in the last
111 decade, few policies are in place to phase out fossil fuel technologies in parallel, and CO₂ emissions
112 continue to grow globally. Even following the apparent policy breakthrough leading to the Paris
113 Agreement in 2015, it is likely that global fossil CO₂ emissions will have grown over 4% through to the
114 end of 2019. Current national policies still put the world on a pathway of increasing greenhouse gas
115 emissions through to 2030⁶.

116 The continued growth in fossil fuel use and associated CO₂ emissions is happening despite significant
117 progress in low carbon technologies⁷ and progress in some countries in reducing energy use⁸. Growth
118 in energy use and emissions is dominated by developing countries, as they strive to close the large
119 disparity between per capita energy use compared to developed countries⁹. This suggests current
120 policies are either not enough to effect global emissions, are slow to have a detectable effect, or
121 simply fail to directly address the root cause of the problem: phase out CO₂ emissions from the use of
122 fossil fuels¹⁰. The rapid growth in solar and wind will help reduce the use of coal in power generation,
123 but current policies to phase out coal use are focussed in countries with old coal fleets^{11,12}. Natural
124 gas may displace some coal in power generation, but it at best only offers a short-term solution, as
125 once coal is displaced CO₂ emissions continue at an albeit lower rate. The rapid growth in electric
126 vehicles has been insufficient to alter global oil use, as the growth in transport demand far outpaces
127 the deployment of electric vehicles. Very little attention has been placed on the difficult-to-mitigate
128 sectors⁴, such as industry, aviation and shipping, and a complete decarbonisation of electricity
129 generation.

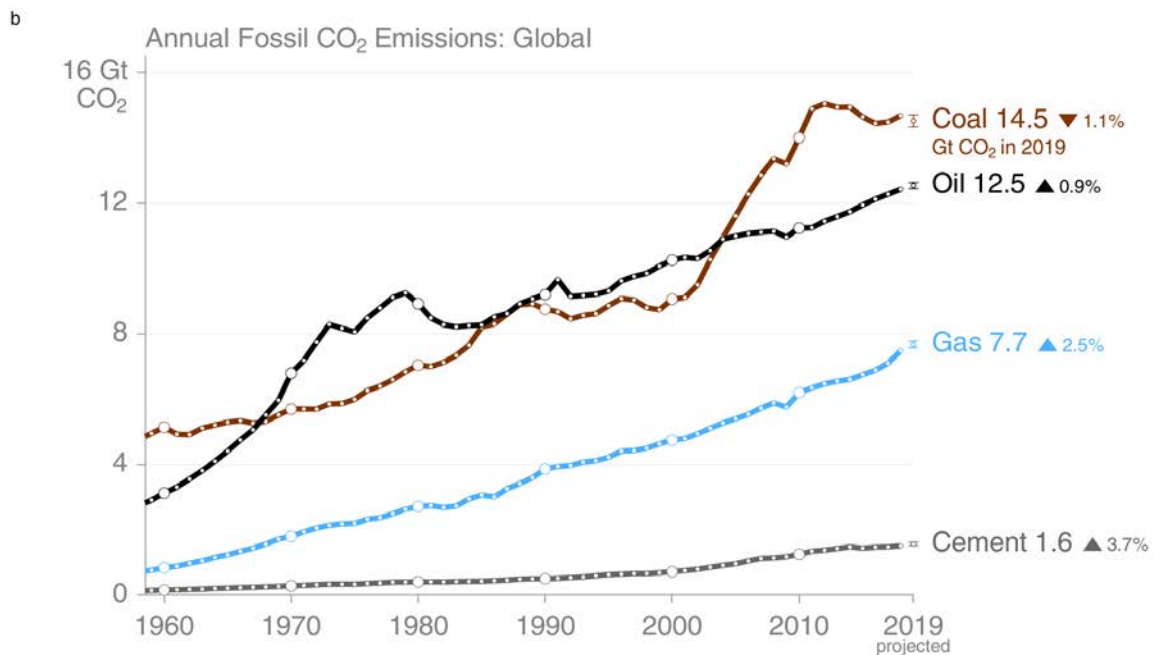
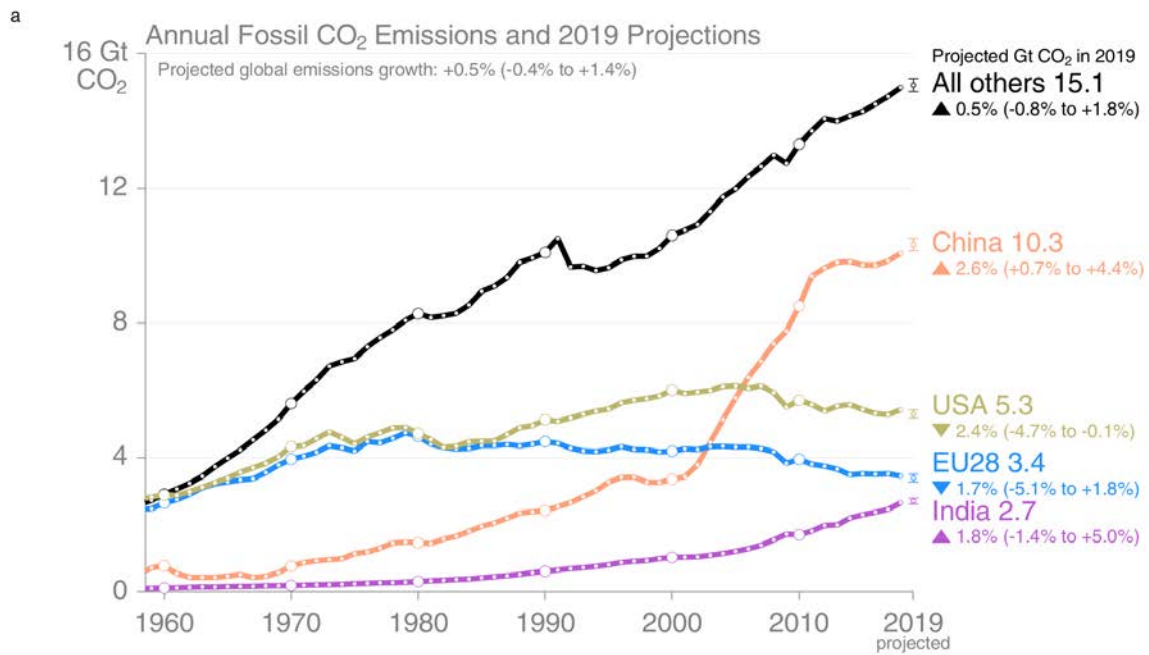
130 The failure to mitigate global emissions, despite positive progress on so many aspects of climate
131 policy, suggests the full bag of policy options are not being effectively deployed. Most policies tend
132 to focus on supporting low-carbon alternatives, such as solar, wind, or electric vehicles, but these
133 technologies often add to existing demand and therefore do not significantly displace fossil fuel
134 use¹³. Public policies need to place far more attention on directly cutting back the use of fossil fuels

135 or remove their emissions through CCS, particularly the phasing out of coal power plants¹⁴ and
136 conventional vehicles, well before they reach their productive end-of-life.

137 **Acknowledgements**

138 We thank Roberta Quadrelli and Francesco Mattion from the International Energy Agency (IEA) for
139 provision of data and understanding of appropriate use thereof. GPP, RA, PF, JIK acknowledge
140 funding from the European Union’s Horizon 2020 research and innovation programme under grant
141 agreement No 821003 (CCiCC) and GPP, RA, JIK, CLQ acknowledge funding from the European
142 Union’s Horizon 2020 research and innovation programme under grant agreement No 776810
143 (VERIFY). JGC acknowledges the support of the Australian National Environmental Science Program –
144 Earth Systems and Climate Change Hub. AP acknowledges Climate & Biodiversity Initiative of BNP
145 Paribas Foundation for support of Global Carbon Atlas hosting the Global Carbon Budget emissions
146 data set.

147



148

149

150

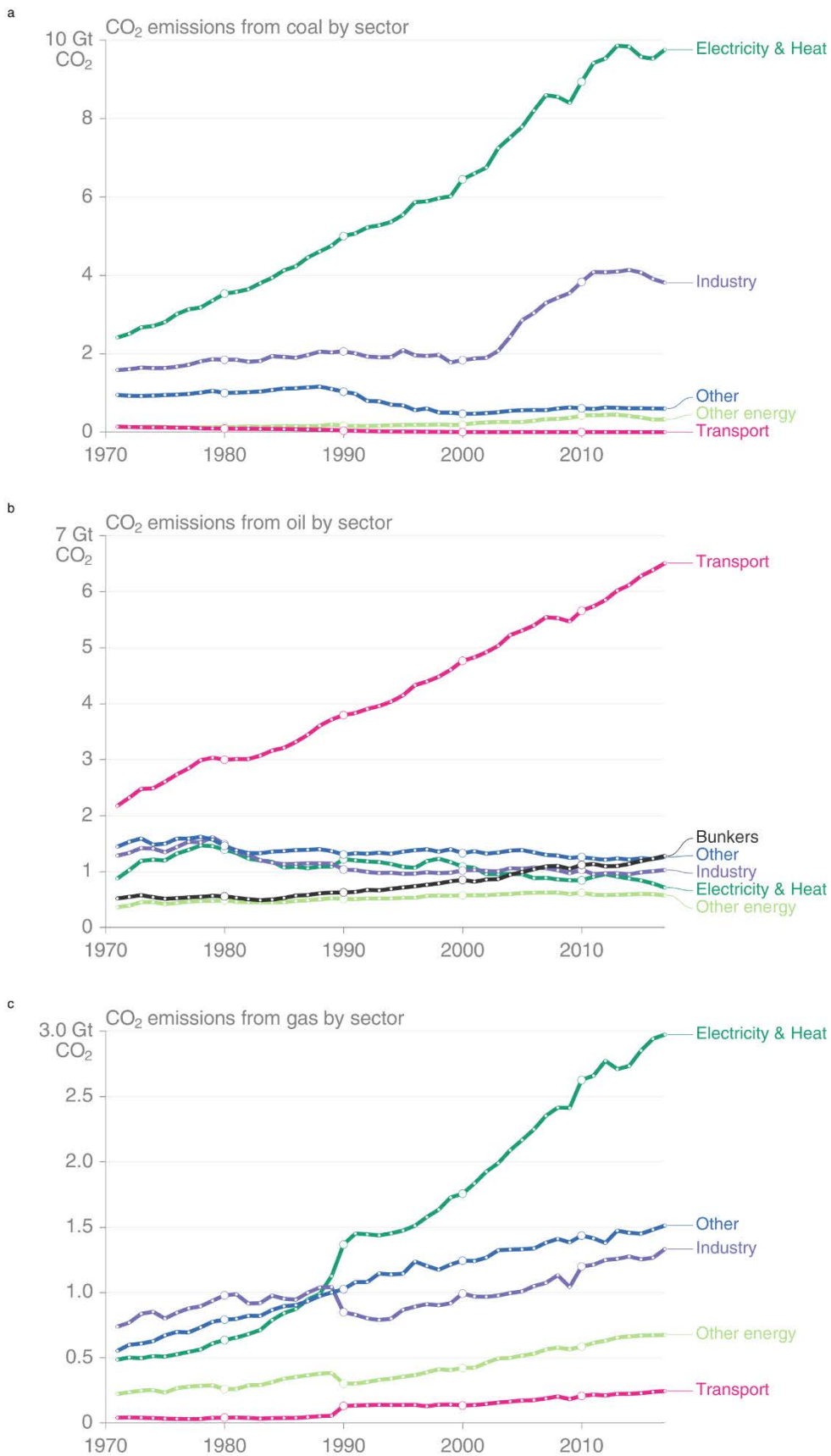
151

152

153

154

Figure 1: Global fossil CO₂ emissions showing projections¹ for 2019 for a) regions and b) fossil fuels and cement. The projections for China, USA, EU28, and India in 2019 are based on monthly data available at the time of submission, while all others are projected based on economic data. The projections are done separately for coal, oil, gas, and cement in each region. The Indian projection is based on the Indian financial year, April 2019 to March 2020. Both China and India exhibit higher uncertainty than usual because of unusual economic (China and India) and monsoon (India) events.



155
156
157

Figure 2: CO₂ emissions from different fossil fuels by sector. Bunkers are emissions from international aviation and shipping. Source: IEA¹⁵ based on detailed data on energy demand and IPCC Guidelines.

158 **References**

- 159 1 Friedlingstein, P. *et al.* Global Carbon Budget 2019. *Earth Syst. Sci. Data Discuss.* **2019**, 1-4,
160 doi:10.5194/essd-2019-183 (2019).
- 161 2 Qi, Y., Stern, N., Wu, T., Lu, J. & Green, F. China's post-coal growth. *Nature Geosci* **9**, 564-566,
162 doi:10.1038/ngeo2777 (2016).
- 163 3 Peters, G. P. *et al.* Rapid growth in CO₂ emissions after the 2008–2009 global financial crisis.
164 *Nature Climate Change* **2**, 2-4 (2012).
- 165 4 Davis, S. J. *et al.* Net-zero emissions energy systems. *Science* **360**, eaas9793,
166 doi:10.1126/science.aas9793 (2018).
- 167 5 Hausfather, Z. Bounding the climate viability of natural gas as a bridge fuel to displace coal. *Energy*
168 *Policy* **86**, 286-294, doi:<https://doi.org/10.1016/j.enpol.2015.07.012> (2015).
- 169 6 UNEP. The Emissions Gap Report 2018. (United Nations Environment Programme, Nairobi, 2018).
- 170 7 Figueres, C. *et al.* Emissions are still rising: ramp up the cuts. *Nature* **564**, 27-30,
171 doi:10.1038/d41586-018-07585-6 (2018).
- 172 8 Le Quéré, C. *et al.* Drivers of declining CO₂ emissions in 18 developed economies. *Nature Climate*
173 *Change* **9**, 213-217, doi:10.1038/s41558-019-0419-7 (2019).
- 174 9 Jackson, R. B. *et al.* Persistent Fossil Fuel Growth Threatens the Paris Agreement and Planetary
175 Health. *Environmental Research Letters* **(to appear)** (2019).
- 176 10 Asheim, G. B. *et al.* The case for a supply-side climate treaty. *Science* **365**, 325,
177 doi:10.1126/science.aax5011 (2019).
- 178 11 Jewell, J., Vinichenko, V., Nacke, L. & Cherp, A. Prospects for powering past coal. *Nature Climate*
179 *Change* **9**, 592-597, doi:10.1038/s41558-019-0509-6 (2019).
- 180 12 Tong, D. *et al.* Committed emissions from existing energy infrastructure jeopardize 1.5 °C climate
181 target. *Nature* **572**, 373-377, doi:10.1038/s41586-019-1364-3 (2019).
- 182 13 York, R. Do alternative energy sources displace fossil fuels? *Nature Clim. Change* **2**, 441-443
183 (2012).
- 184 14 Cui, R. Y. *et al.* Quantifying operational lifetimes for coal power plants under the Paris goals.
185 *Nature Communications* **10**, 4759, doi:10.1038/s41467-019-12618-3 (2019).
- 186 15 IEA. CO₂ emissions from fuel combustion <https://www.iea.org/statistics/co2emissions/>.
187 (International Energy Agency, Paris, 2019).

188