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EXPERT REPORT OF JOSEP G. CANADELL

Pabai & Anor v Commonwealth of Australia (VID622/2021)

Introduction

This report has been prepared at the request of the Australian Government Solicitor on behalf of the Commonwealth for use in the above proceeding. The questions I was asked and materials I was provided are set out in the instruction letters at **Annexure A**.

I have read, understood and complied with the Expert Evidence Practice Note (GPN-EXPT) of the Federal Court of Australia, including the Harmonised Expert Witness Code of Conduct at Annexure A to that Practice Note, and agree to be bound by those documents.

The opinions set out in this report are based wholly or substantially on my specialised knowledge as set out below.

I have made all the inquiries that are desirable and appropriate (save for any matters identified explicitly in the report), and no matters of significance I regard as relevant have, to my knowledge, been withheld from the Court.

Basis of expertise

1. **Please describe your academic qualifications, professional background and experience that is relevant to your answering the questions in the letter of instruction. You may wish to do so by reference to a current curriculum vitae.**

I am a Chief Research Scientist in CSIRO Environment, Chief Lead Investigator in the Climate Systems Hub of the National Environmental Science Program, and Executive Director of the Global Carbon Project, a global consortium of scientists under the umbrella of Future Earth and a scientific partner of the World Climate Research Programme.

I have a PhD in Terrestrial Ecology from the University Autonomous of Barcelona, Catalonia (Spain). After my PhD and throughout the 1990s, I held three research positions in the USA working on the impacts of climate change on terrestrial ecosystems, at San Diego State University, University of California at Berkeley, and Stanford University. After this period, I took a position at CSIRO, Canberra, where I have worked since.

Throughout my career, I have worked on regional and global biogeochemical cycles, particularly the carbon cycle and the impacts of rising atmospheric CO_2. For the last 21 years, I have been the executive director of the Global Carbon Project, a project in which we develop the most authoritative global greenhouse budgets, including the global carbon,

methane, and nitrous oxide budgets. I have contributed to the scientific assessments of the United Nations Intergovernmental Panel on Climate Change over the last 18 years (AR4, AR5, AR6) and was a coordinating lead author in the last assessment cycle, focusing on global greenhouse gas budgets. I have also contributed to analyses of greenhouse gas trends and budgets for multiple reports of the World Meteorological Organization.

I am a fellow member of the American Geophysical Union, and Reuters named me the 8th most influential climate scientist in the world in 2021[1]. I have co-authored over 220 peer-reviewed research papers, about a quarter published in the prestigious journals of Nature and Science, and edited 14 books and special research journal issues. My published work has attracted over 100,000 citations in the scientific literature[2].

You will find my CV at **Annexure B** to this report.

Australia's GHG emissions

2. **What were Australia's annual greenhouse gas (GHG) emissions from 2014 to date, as:**

a. total tCO_2-eq;

Table 1 and Figure 1 show the annual GHG emissions from human activities (anthropogenic emissions) for the period 2014 to 2021; 2021 is the last full year reported in the National Greenhouse Gas Accounts and submission to the United Nations Framework Convention on Climate Change (UNFCCC). During this period, emissions declined from 555.82 $MtCO_2e$ in 2014 (million tonnes of carbon dioxide equivalents) to 464.77 $MtCO_2eq$ in 2021.

Table 1. Annual Greenhouse Gas emissions of Australia in million tonnes of carbon dioxide equivalents ($MtCO_2e$). Source: National Greenhouse Accounts, DCCEEW

Year	2014	2015	2016	2017	2018	2019	2020	2021
Australia	555.817	540.912	512.483	509.809	514.226	505.857	494.233	464.770

Australia's National Greenhouse Gas Accounts and its National Greenhouse Gas Inventory (NGHGI) are the most comprehensive accounts and reporting of anthropogenic GHG emissions for Australia, compiled by the Department of Climate Change, Energy, Environment and Water (DCCEEW). The emissions estimates are produced with the methodologies for GHG accounting developed by the IPCC, and their subsequent refinements and supplements[3]. They were specifically developed for reporting under the UNFCCC, including reporting to the Kyoto Protocol, and now to the Paris Agreement.

[1] https://www.reuters.com/investigates/special-report/climate-change-scientists-list/

[2] https://scholar.google.com/citations?user=4QU11c4AAAAJ&hl=en

[3] 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html

These quantities include all anthropogenic GHGs covering energy generation, transport, fugitive emissions, industrial processes, agriculture, waste and land use, land use change, and forestry. Emissions are expressed in CO_2 equivalents to give a proportional weight to the different warming potential of each GHG over a 100-year period, and use the warming potential of carbon dioxide as the reference unit. This unit and the warming potentials of the different GHGs are also established by the IPCC[4].

The data are available via an interactive online database[5]. More up-to-date quarterly reports are also available.

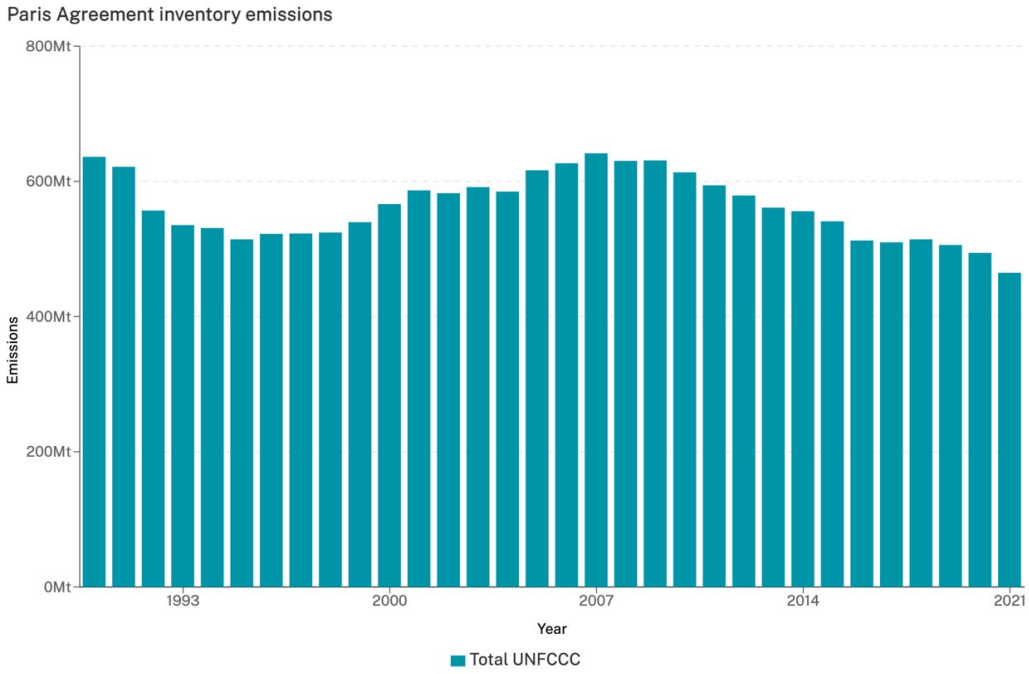

Figure 1. Anthropogenic GHG emissions in CO_2 equivalents 1990-2021. 1990 was the reference year for the Kyoto Protocol (the predecessor of the Paris Agreement), and it is the

2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands
https://www.ipcc-nggip.iges.or.jp/public/wetlands/index.html

2006 IPCC Guidelines for National Greenhouse Inventories.
https://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html

[4] Myhre, G., D. Shindell, F.-M. Br.on, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang, 2013: Anthropogenic and Natural Radiative Forcing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf

[5] https://www.greenhouseaccounts.climatechange.gov.au/ (choose “Emissions inventories”, then “Paris Agreement inventory”).

first year for which GHG emissions data are available. Source: Australia's National Greenhouse Gas Accounts, DCCEEW. Accessed 26 September 2023.

The data reported here covers all GHG emissions from human activities that have been produced in the territorial limits of Australia, often called territorial emissions. These are the ones that Australia needs to report annually under the UNFCCC and the Paris Agreement. The reporting includes carbon dioxide (CO_2), methane (CH4), and nitrous oxide (N_2O) as the three main GHGs, and other industrial GHGs comprising hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6). A few other industrial GHGs are regulated under the Montreal Protocol because they are also ozone-depleting substances.

Territorial emissions are not equivalent to any of the specific emissions often referred to as scope 1, scope 2, and scope 3 emissions in the corporate world or being adopted by cities or jurisdictions across the world. Scope 1 GHG emissions are direct emissions from a physical place (e.g., the combination of GHG sources from a city, such as emissions from cars and gas heaters in buildings). Scope 2 emissions are GHG emissions associated with the use of energy by a given corporation or jurisdiction, with emissions occurring outside of that jurisdiction or corporation grounds (e.g., emissions from the combustion of coal power plant outside of the city producing electricity for that city). Scope 3 GHG emissions are emissions associated with the products and services that are part of the supply chain associated with that jurisdiction or corporation (e.g., GHG emitted from producing food far away but consumed in a city). Scope 3 also includes emissions that result from products and services that are part of the global supply chain and trade of that jurisdiction or corporation, and, therefore, emissions occurring outside of Australia's territorial limits.

Territorial emissions provided in this report include scope 1 emissions, and scope 2 and 3 emissions to the extent emissions occur within Australia's territory. GHG emissions occurring outside of Australia are referred to as non-territorial emissions and are not part of Australia's reporting obligations under the UNFCCC. Because Australia is a large exporter of coal and fossil gas, a recent study shows that non-territorial CO_2 emissions from fossil fuels are 2.6 times larger than territorial fossil fuel CO_2 emissions[6].

b. a percentage share of global GHG emissions;

To find Australia's percentage share of global GHG emissions, I use the Emissions Database for Global Atmospheric Research (EDGAR) by the Joint Research Centre of the European Commission, updated to 2022[7]. The EDGAR database provides independent estimates from those reported by countries to the United Nations Framework Convention on Climate Change (UNFCCC), based on international statistics and using IPCC methodology. From year 1990, the database also includes land use, land use change and forestry (LULUCF), and

[6] Yohanna Villalobos Josep G Canadell, Elizabeth D Keller, Peter Briggs, Beata Bukosa, Donna L Giltrap, Ian Harman, Timothy W Hilton, Miko UF Kirschbaum, Ronny Lauerwald, Liyin L Liang, Taylor Maavara, Sara E Mikaloff-Fletcher, Peter J Rayner, Laure Resplandy, Judith Rosentreter, Eva-Marie Metz, Oscar Serrano, Benjamin Smith (2023) A comprehensive assessment of anthropogenic and natural sources and sinks of Australasia's carbon budget. Global Biogeochemical Cycles (in review).

[7] https://edgar.jrc.ec.europa.eu/report_2023

therefore covers all sectors required by the UNFCCC reporting. The database is well-established and the most widely used database in research and global policy analyses. It was also the basis for a GHG database compiled by Minx et al. 2021)[8] used in the last IPCC cycle, the Sixth Assessment Report.

Global GHG emissions in 2021 were 53,056 $MtCO_2e$ (updated to 53,786 $MtCO_2e$ for 2022), and Australia's emissions were 561.65 in 2021 (updated to 571.38 MtCO2e for 2022). Thus, Australia's contribution to the global GHG emissions was 1.06% in 2021 (and remained at about 1.06% in 2022). Table 2 shows this fraction for each of the years between 2014 and 2022. This fraction is consistent with that of Minx et al. 2021. Notice that EDGAR reports emissions about 92.5 $MtCO_2e$ higher emissions for Australia in 2021, and also throughout 2014-2021, than those reported by DCCEEW.

Table 2. Global and Australian GHG emissions, Australia's contribution to the global GHG emissions (fraction of total), and Australia's global ranking from the top. Source: EDGAR[9].

Year	Global GHG emissions $MtCO_2e$ (EDGAR)	Australia GHG emissions $MtCO_2e$ (EDGAR)	Australia Fraction of Global emissions (%) (EDGAR)	Australia's Place in Global Ranking (EDGAR)
2014	50243	585.44	1.165	15th
2015	50134.38	593.561	1.184	14th
2016	50343.04	594.024	1.180	14th
2017	51195.42	601.065	1.174	15th
2018	52398.14	597.774	1.141	17th
2019	52557.34	596.031	1.134	16th
2020	50632.31	572.833	1.131	15th
2021	53056.61	561.654	1.059	15th
2022	53786.04	571.382	1.062	15th

c. per capita tCO2-eq?

To calculate per capita emissions, I took Australia's total GHG emissions, as reported by DCCEEW, and Australia's population per year from the Australian Bureau of Statistics (ABS). I divided emissions by population to calculate emissions per capita (Table 3, first three columns). Both sources of data, emissions from DCCEEW and population from ABS are the most accurate source of data for Australia. Australia's per capita GHG emissions per year were 18.0 tCO_2e in 2021. The mean global GHG emissions per capita was 6.74 tCO_2e in 2021 (based on the EDGAR database).

Table 3. Anthropogenic GHG emissions in CO_2 equivalents from Australia's National Greenhouse Gas Inventory, DCCEEW, and Australian population from the Australian Bureau of Statistics, both accessed 26 September 2023. Per Capita CO_2eq per year is calculated from

[8] Minx et al. 2021 https://essd.copernicus.org/articles/13/5213/2021/essd-13-5213-2021.html

[9] https://edgar.jrc.ec.europa.eu/report_2023

the two first quantities. The fourth column is Australian per capita emissions based on the EDGAR database, and from there, the place Australia occupies in the global ranking from the top.

Year	Australia GHG emissions (DCCEEW) $MtCO_2eq$	Australia Population (ABS)	Per Capita tCO_2eq/yr (DCCEEW, ABS)	Per Capita tCO_2e/yr (EDGAR)	Australia's Place in Global Ranking per Capita (EDGAR)
2014	555.8175	23,633,762	23.52	24.94	10th
2015	540.9122	23,978,081	22.56	24.94	10th
2016	512.483	24,376,709	21.02	24.62	10th
2017	509.8095	24,750,353	20.60	24.58	10th
2018	514.2264	25,137,059	20.46	24.13	10th
2019	505.8571	25,510,998	19.83	23.76	10th
2020	494.233	25,620,615	19.29	22.55	9th
2021	464.7707	25,760,867	18.04	21.85	10th
2022				21.98	10th

3. **What was Australia's global ranking in terms of total and per capita annual GHG emissions from 2014 to date?**

Australia's global ranking in total annual emissions is shown for each year from 2014 to 2022 in Table 2. To do this comparison and for global data consistency, I base the ranking on the global EDGAR database, given its reputation in research and global analyses. Australia's global ranking in absolute GHG emissions per year in 2022 was 15th highest (571.38 $MtCO_2e$) of about 200 countries covered by the database (Table 2). From highest to lowest emissions, these are the 14 countries with higher GHG emissions than Australia in 2022: China (15,684.63 $MtCO_2e$), USA (6,017.44 $MtCO_2e$), India (3,943.26 $MtCO_2e$), Russia (2,579.80 $MtCO_2e$), Brazil (1,310.50 $MtCO_2e$), Indonesia (1,240.83 $MtCO_2e$), Japan (1,182.77 $MtCO_2e$), Iran (951.98 $MtCO_2e$), Mexico (819.87 $MtCO_2e$), Saudi Arabia (810.51 $MtCO_2e$), Germany (784.00 $MtCO_2e$), Canada (756.81 $MtCO_2e$), South Korea (725.74 $MtCO_2e$), and Turkey (687.53 $MtCO_2e$).

Using the same database from EDGAR and ranking from highest to lowest emissions, Australia's global ranking in per capita emissions is shown for each year from 2014 to 2022 in Table 3. Australia's per capita GHG emissions ranked 10th highest in the world in 2022 at 21.98 tonnes of CO_2e per person. The nine countries which have higher per capita emissions than Australia in 2022 were: Qatar (67.38 tCO_2e), Palau (61.65 tCO_2e), Bahrain (39.29 tCO_2e), Kuwait (37.96 tCO_2e), Trinidad and Tobago (33.27 tCO_2e), Brunei (32.66 tCO_2e), United Arab Emirates (29.33 tCO_2e), Oman (25.59 tCO_2e), and Saudi Arabia (22.64 tCO_2e). Notice that Australia's per capita's emissions in the EDGAR database are higher than those estimated with DCCEEW and ABS data.

Counterfactuals

Meinshausen Report [69(a)]

4. **If Australia had in 2014 implemented a GHG emissions reductions target of 47% reduction over 2005 levels by 2025, and assuming Australia had a straight line path to 47% reduction by 2025:**

a. How much less would Australia's total annual GHG emissions have been each year and in total to date compared to Australia's actual GHG emissions in the same time period?

Australia emitted 616.29 MtCO2e in 2005 according to the National GHG Inventory of DCCEEW. A 47% emissions reduction in 2025 over the level of emissions in 2005 will lead to emissions of 326.63 $MtCO_2e$ in 2025. This is an emission reduction of 289.66 $MtCO_2$ between 2005 and 2025, equivalent to a mean annual reduction of 14.48 $MtCO_2e$ (over 20 years).

However, the 47% counterfactual reduction policy is implemented in 2014 (I assume here January 2014), with a linear decline from 2013 emissions (the year before the policy began) of 562.10 $MtCO_2$ to the 47% reduction of 326.63 $MtCO_2e$ in 2025. This is equivalent to an annual mean decline of 19.62 $MtCO_2e$ per year over the period 2014-2025 (Table 4). From here, the cumulative emissions reduction (or avoided emissions) of this counterfactual to date (2021, the last full year reported by DCCEEW) is 307.63 $MtCO_2e$.

Table 4. Australia's National Greenhouse Gas Inventory emissions for 2005-2021 and annual emissions from a counterfactual 47% emissions reductions ($MtCO_2e/yr$).

year	NGHGI Inventory 2005-2021 $MtCO_2e/yr$	Counterfactual 47% reduction implemented 2014-2025 $MtCO_2e/yr$	Difference $MtCO_2e/yr$
2005	616.29	616.29	0
2006	626.79	626.79	0
2007	641.52	641.52	0
2008	630.25	630.25	0
2009	630.91	630.91	0
2010	613.33	613.33	0
2011	594.03	594.03	0
2012	579.08	579.08	0
2013	562.10	562.10	0
2014	555.82	542.48	13.34
2015	540.91	522.86	18.05
2016	512.48	503.24	9.24
2017	509.81	483.62	26.19
2018	514.23	464	50.23
2019	505.86	444.38	61.48

2020	494.23	424.76	69.47
2021	464.77	405.14	59.63
Total			307.63

b. What effect, if any, would the reduction in Australia's total GHG emissions from 2014 to date have had on:

i. global temperature increase; and

The conversion between global emissions and temperature change is done with complex Earth System Models (ESMs) and used in all IPCC assessment reports. An ESM is a model of the Earth's physical, chemical, and biological systems that includes sub-models of the atmosphere, oceans, land surface, and cryosphere (the ice components)[10]. They require supercomputing resources and run over multiple months to produce an outcome. Simple climate simulators benchmarked against the ESMs results are also available and are faster to run. Neither option was available for this report, nor are best suited to test a small temperature change, as I explain further in answer to question 4(b)(ii) below.

However, the IPCC has found a quasi-linear relationship between cumulative anthropogenic CO_2 emissions and changes in global mean surface temperature based on historical and future simulated emissions and temperature. This relationship is robust moving forward to mid-century and beyond for most emission scenarios, although it begins to break down for the highest carbon-intense and lowest carbon-intense scenarios after mid-century (the extreme ends of the scenarios distribution). For this report, the period covered and the amount of change in GHGs, I find this relationship the most robust approach to estimate the temperature implications of the counterfactuals above.

I use the latest relationship developed by the IPCC 6th Assessment Report published in Working Group 1, Chapter 5, page 749, Section 5.5.1.4 (Canadell et al. 2021)[11], which is defined as the Transient Climate Response to Cumulative CO_2 emissions, (TCRE). The IPCC formulation states that: "Based on expert judgment that accounts for the incomplete coverage of all Earth system components, this results in a consolidated assessment that TCRE would fall likely in the range of 1.0–2.3°C per 1000 PgC, with a best estimate of 1.65°C per 1000 PgC (0.45°C per 1000 $GtCO_2$)."

The unit equivalences are 1 PgC = petagrams of carbon (C) = 1 Gt gigatons of C = 1 Bt billion tons of C = 1 x 10^{15} grams. To change from C to CO_2, multiply by 3.664 (Friedlingstein et al. 2022)[12].

Notice this relationship is done with cumulative CO_2 emissions and changes in the global mean surface temperature, and not between all GHG (CO_2e) and temperature. That is because CO_2 accumulates in the atmosphere for thousands of years, while other GHGs have

[10] https://www.ipcc.ch/report/ar6/wg1/chapter/chapter-4/

[11] https://www.ipcc.ch/report/ar6/wg1/chapter/chapter-5/

[12] https://essd.copernicus.org/articles/14/4811/2022/

shorter lifetimes in the atmosphere for which current levels of emissions are more important than the total cumulative. It is important to notice that the relationship is between the cumulative CO_2 emissions and the actual observed temperature change that results from all GHGs, aerosols, and other associated changes in the Earth System that influence the global mean surface temperature. This relationship and approach allow to calculate the remaining carbon budget to a given temperature objective independently of the specific temporal emissions pathway, a method first used by the IPCC Fifth Assessment Report in 2013[13].

The data I have provided in the previous sections for Australia's emissions (from Australia's National Greenhouse Gas Accounts[14]) was for all GHG in CO_2 equivalents. Because it is not known how the GHG emissions reductions driven by the counterfactuals will affect CO_2 emissions versus non-CO_2 emissions, I assume that the proportion between the two will remain the same as during the historical emissions of the counterfactuals (2014-2021). That is a proportion of about 70% CO_2 of the total GHGs emissions.

Based on the above, I estimate that the cumulative emissions avoided from the counterfactual 47% emission reduction of 307.63 $MtCO_2e$ is equivalent to 215.34 $MtCO_2$ (CO_2-only). Based on the IPCC relationship of 1,000,000 $MtCO_2$ (1,000 $GtCO_2$) = 0.45°C, we expect the counterfactual emission scenario will lead to the best estimate of 0.00009°C (range: 0.00005°C - 0.00013°C) reduction or avoided increase in the global mean surface temperature. The range provided is based on the IPCC likely range of 1.0–2.3°C per 1000 PgC given in this section (third paragraph), which converts to 0.27°C to 0.63°C per 1,000 $GtCO_2$ or 1,000,000 $MtCO_2$.

ii. the impacts of climate change,

as at today's date?

It is not possible to quantify the actual and specific climate impacts that would have been avoided with a temperature reduction of 0.00009°C.

Earth System Models (ESMs, global climate models) are sophisticated computer models that are well suited to study changes in the mean conditions and extremes of climate over long periods and over the entire earth. Thanks to the work of ESMs, the IPCC has been able to establish unequivocally that increasing anthropogenic GHGs in the atmosphere are warming the planet and changing the climate and associated weather[15]. However, ESMs have limitations at present in their capacity to resolve very small changes in the atmospheric load of GHGs or at small spatial scales.

[13] https://www.ipcc.ch/report/ar5/wg1/

[14] https://www.greenhouseaccounts.climatechange.gov.au/ (choose "Emissions inventories", then "Paris Agreement inventory").

[15] https://www.ipcc.ch/report/ar6/wg1/chapter/summary-for-policymakers/

Some key limitations to being able to resolve small changes include, a) the large natural variability of the climate system (annual to decadal), which limits the detection of small temperature changes given the much larger temperature swings due to natural variability onto which anthropogenic climate trends or a GHG perturbation are superimposed; b) low resolution of the models often operating with grids (the smallest spatial unit for which models withdraw and provide information) from about 50 km to more than 200 km; and c) uncertainty in the climate sensitivity to increasing atmospheric GHGs for which a small global mean temperature change would be undetectable amidst the range of climate sensitivities given by different models.

However, beyond these limitations, the physical science basis of climate change has established very robustly that every ton of GHG emissions leads to an increase in global mean surface temperature. Likewise, the physical science of climate change has also established that every additional increment of global warming contributes towards the increase in frequency and/or intensity of many different types of climate extremes, including land and marine heatwaves, short-term heavy rain, and further amplification of sea level rise, the loss of glaciers and Arctic Sea ice, among other impacts in the physical (IPCC 2021), biological and socioeconomic world (IPCC 2022).

In summary, it is very unlikely that an increase of 0.00009°C has material and/or quantifiable climate impacts with our current climate observation networks and attribution modelling capability. However, emissions of 307.63 $MtCO_2e$ associated with that temperature change (or avoidance in the counterfactual) do contribute to the accumulation of GHGs in the atmosphere (or avoidance), contributing to global warming (or slowing global warming). It has been the sum of small and big emission sources that is responsible for the increase of 1.09°C of the global mean surface temperature above the mean of 1850-1900[16].

Meinshausen Report [69(b)]

5. **If Australia had in 2014 implemented a GHG emissions reductions target of net zero by 2024, and assuming Australia had a straight line path to net zero by 2024:**

a. How much less would Australia's total annual GHG emissions have been each year and in total to date compared to Australia's actual GHG emissions in the same time period?

The counterfactual starts with emissions of 562.02 $MtCO_2e$ in 2013 (the year before the counterfactual is implemented) and ends with zero emissions in 2024. That is a mean annual decline of 51.1 $MtCO_2e$ given the 11 years available to reach net zero emissions (Table 5).

The total avoided cumulative GHG emissions of this counterfactual to 2021, the latest year for which data are available from the National GHG Inventory, is 1440.91 $MtCO_2e$.

Table 5. Annual GHG emissions from Australia's National Greenhouse Gas Inventory for 2013-2021 and annual emissions from a counterfactual policy to reach net zero emissions in 2024 ($MtCO_2e$/yr).

[16] https://www.ipcc.ch/report/ar6/wg1/chapter/chapter-2/

year	GHG Inventory 2005-2021 $MtCO_2e/yr$	Counterfactual Zero emissions by 2024 $MtCO_2e/yr$	Difference $MtCO_2e/yr$
2013	562.10	562.10	0
2014	555.82	511	44.82
2015	540.91	459.9	81.01
2016	512.48	408.8	103.68
2017	509.81	357.7	152.11
2018	514.23	306.6	207.63
2019	505.86	255.5	250.36
2020	494.23	204.4	289.83
2021	464.77	153.3	311.47
2022		102.2	
2023		51.1	
2024		0	
Total			1440.91

b. What effect, if any, would the reduction in Australia's total GHG emissions from 2014 to date have had on:

i. global temperature increase;

Based on the same method described in the previous counterfactual, 1,440.91 $MtCO_2e$ would be equivalent to 1,008.64 $MtCO_2$ (CO_2-only), and to an avoided global mean surface temperature of 0.00045°C (range: 0.00027°C – 0.00063°C).

ii. the impacts of climate change,

as at today's date?

The answer from the previous counterfactual applies here as well, even if the temperature difference is larger in this second counterfactual. Nevertheless, it is still a small change in the global mean surface temperature.

Redactions for public file

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6 October 2023

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ANNEXURE A

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Our ref. 21008585

14 August 2023

Dr Pep Canadell
CSIRO Black Mountain
2 - 40 Clunies Ross Street
ACTON ACT 2601

By email: Redactions for public file

PRIVILEGED & CONFIDENTIAL

Dear Dr Canadell

Pabai & Anor v Commonwealth of Australia (VID622/2021) | Provisional engagement letter

PROVISIONAL ENGAGEMENT

1. We confirm we act for the Commonwealth of Australia (the **Commonwealth**) in the above class action before the Federal Court of Australia.

2. The applicants (Pabai Pabai and others) commenced this class action on 26 October 2021 on their own behalf and on behalf of all persons who at any time during the period from about 1985 and continuing, are of Torres Strait Islander descent and suffered loss and damage as a result of the alleged acts and omissions of the Commonwealth (**Group Members**).

3. The proceeding relates to the impacts of climate change in the Torres Strait. In summary, the applicants allege that the Commonwealth:

    a) owes a legal duty to Torres Strait Islanders to take reasonable steps to protect Torres Strait Islanders, their traditional way of life and the marine environment in and around the Torres Strait from the current and projected impacts of climate change, and breached that duty by (amongst other things) failing to identify a GHG emissions reduction target consistent with the 'best available science'; or

    b) further or alternatively, owes a legal duty to Torres Strait Islanders to take reasonable steps to avoid causing property damage, loss of fulfilment of *Ailan Kastom* and other damage arising from a failure to implement or adequately implement adaptation measures to prevent or minimise the impacts of climate change in the Torres Strait, and breached that duty.

4. The Commonwealth (amongst other things) denies that it owes the pleaded duties of care, and denies that it breached any such duties of care.

5. We are instructed to engage you, on a provisional basis, as an expert in this matter.

6. The provisional engagement will consist of an initial conference between you, an internal CSIRO lawyer and the Commonwealth's legal team. The purpose of this conference will be to determine the capacity, if any, in which you may be able to act as an independent expert retained by the Commonwealth in this proceeding.

7. Following that conference, the Commonwealth may offer you an ongoing engagement as an independent expert in this proceeding.

8. We confirm that any engagement would be with you as an individual independent expert, and not to give evidence on behalf of the CSIRO. Any opinions expressed by you should be your own and need not reflect the opinions of the CSIRO.

9. We enclose the following documents by way of general reading for you before the conference with us:

   a. The Federal Court's Expert Evidence Practice Note (GPN-EXPT). This Practice Note sets out guidelines for expert witnesses to follow in proceedings before the Court. Please read these guidelines carefully. You are requested to follow this Practice Note in your dealings with us.

   b. The pleadings in the proceeding, namely the:

      – Applicants' second further amended statement of claim dated 11 April 2023 (**SFASOC**).

      – Respondents' defence to the SFASOC dated 9 May 2023.

      – Applicants' amended concise statement dated 15 May 2023.

      – Respondents' amended concise statement in response dated 29 May 2023.

OTHER MATTERS

10. Your communications with us are confidential and subject to the Commonwealth's legal professional privilege.

11. To ensure that the Commonwealth retains legal professional privilege in relation to your work, we request that you comply with the following communication and information management protocol during the course of this engagement:

    a. Unless instructed otherwise, communications (written or oral) should be with Dejan Lukic, Grace Ng and Sam Nitschke of the Australian Government Solicitor.

    b. This letter, any other materials provided to you, and any working notes prepared by you, should also be maintained in a file clearly marked 'Confidential and subject to legal professional privilege – for the Commonwealth of Australia'.

12. Subject to any orders of any court, our instructions, and any information obtained and working notes prepared by you in relation to this matter (including this engagement) must not be disclosed to any other person, except:

12.1. to persons within the CSIRO from whom you require assistance in the course of this engagement (including preparing any report), on the condition that they maintain the confidentiality required by clauses 10-12 of this letter;

12.2. where disclosure is required by law;

12.3. where disclosure is necessary for CSIRO to fulfil any obligations to report to its Minister; or

12.4. where disclosure is in response to a request from Parliament or a Parliamentary Committee, in which case you will also give the Australian Government Solicitor notice of the disclosure (by email to the persons listed in clause 11(a) above).

For the avoidance of doubt, we confirm that this clause 12 does not preclude you from disclosing matters in relation to this engagement (including any draft reports or communications) to CSIRO's internal legal advisers.

NEXT STEPS

13. Please confirm your availability for a conference on Friday 18 August 2023 or in the week commencing 21 August 2023. This will be conducted via videoconference.

14. If you have any questions please contact us.

Yours sincerely

Samuel Nitschke
Senior Lawyer
T 08 8205 4201
samuel.nitschke@ags.gov.au

FEDERAL COURT OF AUSTRALIA

EXPERT EVIDENCE PRACTICE NOTE (GPN-EXPT)

General Practice Note

1. INTRODUCTION

1.1 This practice note, including the *Harmonised Expert Witness Code of Conduct* ("**Code**") (see **Annexure A**) and the *Concurrent Expert Evidence Guidelines* ("**Concurrent Evidence Guidelines**") (see **Annexure B**), applies to any proceeding involving the use of expert evidence and must be read together with:

(a) the Central Practice Note (CPN-1), which sets out the fundamental principles concerning the National Court Framework ("**NCF**") of the Federal Court and key principles of case management procedure;

(b) the Federal Court of Australia Act 1976 (Cth) ("**Federal Court Act**");

(c) the *Evidence Act 1995* (Cth) ("**Evidence Act**"), including Part 3.3 of the Evidence Act;

(d) Part 23 of the *Federal Court Rules 2011* (Cth) ("**Federal Court Rules**"); and

(e) where applicable, the Survey Evidence Practice Note (GPN-SURV).

1.2 This practice note takes effect from the date it is issued and, to the extent practicable, applies to proceedings whether filed before, or after, the date of issuing.

2. APPROACH TO EXPERT EVIDENCE

2.1 An expert witness may be retained to give opinion evidence in the proceeding, or, in certain circumstances, to express an opinion that may be relied upon in alternative dispute resolution procedures such as mediation or a conference of experts. In some circumstances an expert may be appointed as an independent adviser to the Court.

2.2 The purpose of the use of expert evidence in proceedings, often in relation to complex subject matter, is for the Court to receive the benefit of the objective and impartial assessment of an issue from a witness with specialised knowledge (based on training, study or experience - see generally s 79 of the Evidence Act).

2.3 However, the use or admissibility of expert evidence remains subject to the overriding requirements that:

(a) to be admissible in a proceeding, any such evidence must be relevant (s 56 of the Evidence Act); and

(b) even if relevant, any such evidence, may be refused to be admitted by the Court if its probative value is outweighed by other considerations such as the evidence

being unfairly prejudicial, misleading or will result in an undue waste of time (s 135 of the Evidence Act).

2.4 An expert witness' opinion evidence may have little or no value unless the assumptions adopted by the expert (ie. the facts or grounds relied upon) and his or her reasoning are expressly stated in any written report or oral evidence given.

2.5 The Court will ensure that, in the interests of justice, parties are given a reasonable opportunity to adduce and test relevant expert opinion evidence. However, the Court expects parties and any legal representatives acting on their behalf, when dealing with expert witnesses and expert evidence, to at all times comply with their duties associated with the overarching purpose in the Federal Court Act (see ss 37M and 37N).

3. INTERACTION WITH EXPERT WITNESSES

3.1 Parties and their legal representatives should never view an expert witness retained (or partly retained) by them as that party's advocate or "hired gun". Equally, they should never attempt to pressure or influence an expert into conforming his or her views with the party's interests.

3.2 A party or legal representative should be cautious not to have inappropriate communications when retaining or instructing an independent expert, or assisting an independent expert in the preparation of his or her evidence. However, it is important to note that there is no principle of law or practice and there is nothing in this practice note that obliges a party to embark on the costly task of engaging a "consulting expert" in order to avoid "contamination" of the expert who will give evidence. Indeed the Court would generally discourage such costly duplication.

3.3 Any witness retained by a party for the purpose of preparing a report or giving evidence in a proceeding as to an opinion held by the witness that is wholly or substantially based in the specialised knowledge of the witness[1] should, at the earliest opportunity, be provided with:

(a) a copy of this practice note, including the Code (see Annexure A); and

(b) all relevant information (whether helpful or harmful to that party's case) so as to enable the expert to prepare a report of a truly independent nature.

3.4 Any questions or assumptions provided to an expert should be provided in an unbiased manner and in such a way that the expert is not confined to addressing selective, irrelevant or immaterial issues.

[1] Such a witness includes a "Court expert" as defined in r 23.01 of the Federal Court Rules. For the definition of "expert", "expert evidence" and "expert report" see the Dictionary, in Schedule 1 of the Federal Court Rules.

4. ROLE AND DUTIES OF THE EXPERT WITNESS

4.1 The role of the expert witness is to provide relevant and impartial evidence in his or her area of expertise. An expert should never mislead the Court or become an advocate for the cause of the party that has retained the expert.

4.2 It should be emphasised that there is nothing inherently wrong with experts disagreeing or failing to reach the same conclusion. The Court will, with the assistance of the evidence of the experts, reach its own conclusion.

4.3 However, experts should willingly be prepared to change their opinion or make concessions when it is necessary or appropriate to do so, even if doing so would be contrary to any previously held or expressed view of that expert.

Harmonised Expert Witness Code of Conduct

4.4 Every expert witness giving evidence in this Court must read the *Harmonised Expert Witness Code of Conduct* (attached in Annexure A) and agree to be bound by it.

4.5 The Code is not intended to address all aspects of an expert witness' duties, but is intended to facilitate the admission of opinion evidence, and to assist experts to understand in general terms what the Court expects of them. Additionally, it is expected that compliance with the Code will assist individual expert witnesses to avoid criticism (rightly or wrongly) that they lack objectivity or are partisan.

5. CONTENTS OF AN EXPERT'S REPORT AND RELATED MATERIAL

5.1 The contents of an expert's report must conform with the requirements set out in the Code (including clauses 3 to 5 of the Code).

5.2 In addition, the contents of such a report must also comply with r 23.13 of the Federal Court Rules. Given that the requirements of that rule significantly overlap with the requirements in the Code, an expert, unless otherwise directed by the Court, will be taken to have complied with the requirements of r 23.13 if that expert has complied with the requirements in the Code and has complied with the additional following requirements. The expert shall:

(a) acknowledge in the report that:

(i) the expert has read and complied with this practice note and agrees to be bound by it; and

(ii) the expert's opinions are based wholly or substantially on specialised knowledge arising from the expert's training, study or experience;

(b) identify in the report the questions that the expert was asked to address;

(c) sign the report and attach or exhibit to it copies of:

(i) documents that record any instructions given to the expert; and

(ii) documents and other materials that the expert has been instructed to consider.

5.3 Where an expert's report refers to photographs, plans, calculations, analyses, measurements, survey reports or other extrinsic matter, these must be provided to the other parties at the same time as the expert's report.

6. CASE MANAGEMENT CONSIDERATIONS

6.1 Parties intending to rely on expert evidence at trial are expected to consider between them and inform the Court at the earliest opportunity of their views on the following:

(a) whether a party should adduce evidence from more than one expert in any single discipline;

(b) whether a common expert is appropriate for all or any part of the evidence;

(c) the nature and extent of expert reports, including any in reply;

(d) the identity of each expert witness that a party intends to call, their area(s) of expertise and availability during the proposed hearing;

(e) the issues that it is proposed each expert will address;

(f) the arrangements for a conference of experts to prepare a joint-report (see Part 7 of this practice note);

(g) whether the evidence is to be given concurrently and, if so, how (see Part 8 of this practice note); and

(h) whether any of the evidence in chief can be given orally.

6.2 It will often be desirable, before any expert is retained, for the parties to attempt to agree on the question or questions proposed to be the subject of expert evidence as well as the relevant facts and assumptions. The Court may make orders to that effect where it considers it appropriate to do so.

7. CONFERENCE OF EXPERTS AND JOINT-REPORT

7.1 Parties, their legal representatives and experts should be familiar with aspects of the Code relating to conferences of experts and joint-reports (see clauses 6 and 7 of the Code attached in Annexure A).

7.2 In order to facilitate the proper understanding of issues arising in expert evidence and to manage expert evidence in accordance with the overarching purpose, the Court may require experts who are to give evidence or who have produced reports to meet for the purpose of identifying and addressing the issues not agreed between them with a view to reaching agreement where this is possible ("**conference of experts**"). In an appropriate case, the Court may appoint a registrar of the Court or some other suitably qualified person ("**Conference Facilitator**") to act as a facilitator at the conference of experts.

7.3 It is expected that where expert evidence may be relied on in any proceeding, at the earliest opportunity, parties will discuss and then inform the Court whether a conference of experts and/or a joint-report by the experts may be desirable to assist with or simplify the giving of expert evidence in the proceeding. The parties should discuss the necessary arrangements for any conference and/or joint-report. The arrangements discussed between the parties should address:

(a) who should prepare any joint-report;

(b) whether a list of issues is needed to assist the experts in the conference and, if so, whether the Court, the parties o r the experts should assist in preparing such a list;

(c) **t**he agenda for the conference of experts; and

(d) arrangements for the provision, to the parties and the Court, of any joint-report or any other report as to the outcomes of the conference ("**conference report**").

Conference of Experts

7.4 The purpose of the conference of experts is for the experts to have a comprehensive discussion of issues relating to their field of expertise, with a view to identifying matters and issues in a proceeding about which the experts agree, partly agree or disagree and why. For this reason the conference is attended only by the experts and any Conference Facilitator. Unless the Court orders otherwise, the parties' lawyers will not attend the conference but will be provided with a copy of any conference report.

7.5 The Court may order that a conference of experts occur in a variety of circumstances, depending on the views of the judge and the parties and the needs of the case, including:

(a) while a case is in mediation. When this occurs the Court may also order that the outcome of the conference or any document disclosing or summarising the experts' opinions be confidential to the parties while the mediation is occurring;

(b) before the experts have reached a final opinion on a relevant question or the facts involved in a case. When this occurs the Court may order that the parties exchange draft expert reports and that a conference report be prepared for the use of the experts in finalising their reports;

(c) after the experts' reports have been provided to the Court but before the hearing of the experts' evidence. When this occurs the Court may also order that a conference report be prepared (jointly or otherwise) to ensure the efficient hearing of the experts' evidence.

7.6 Subject to any other order or direction of the Court, the parties and their lawyers must not involve themselves in the conference of experts process. In particular, they must not seek to encourage an expert not to agree with another expert or otherwise seek to influence the outcome of the conference of experts. The experts should raise any queries they may have in relation to the process with the Conference Facilitator (if one has been appointed) or in

accordance with a protocol agreed between the lawyers prior to the conference of experts taking place (if no Conference Facilitator has been appointed).

7.7 Any list of issues prepared for the consideration of the experts as part of the conference of experts process should be prepared using non-tendentious language.

7.8 The timing and location of the conference of experts will be decided by the judge or a registrar who will take into account the location and availability of the experts and the Court's case management timetable. The conference may take place at the Court and will usually be conducted in-person. However, if not considered a hindrance to the process, the conference may also be conducted with the assistance of visual or audio technology (such as via the internet, video link and/or by telephone).

7.9 Experts should prepare for a conference of experts by ensuring that they are familiar with all of the material upon which they base their opinions. Where expert reports in draft or final form have been exchanged prior to the conference, experts should attend the conference familiar with the reports of the other experts. Prior to the conference, experts should also consider where they believe the differences of opinion lie between them and what processes and discussions may assist to identify and refine those areas of difference.

Joint-report

7.10 At the conclusion of the conference of experts, unless the Court considers it unnecessary to do so, it is expected that the experts will have narrowed the issues in respect of which they agree, partly agree or disagree in a joint-report. The joint-report should be clear, plain and concise and should summarise the views of the experts on the identified issues, including a succinct explanation for any differences of opinion, and otherwise be structured in the manner requested by the judge or registrar.

7.11 In some cases (and most particularly in some native title cases), depending on the nature, volume and complexity of the expert evidence a judge may direct a registrar to draft part, or all, of a conference report. If so, the registrar will usually provide the draft conference report to the relevant experts and seek their confirmation that the conference report accurately reflects the opinions of the experts expressed at the conference. Once that confirmation has been received the registrar will finalise the conference report and provide it to the intended recipient(s).

8. CONCURRENT EXPERT EVIDENCE

8.1 The Court may determine that it is appropriate, depending on the nature of the expert evidence and the proceeding generally, for experts to give some or all of their evidence concurrently at the final (or other) hearing.

8.2 Parties should familiarise themselves with the *Concurrent Expert Evidence Guidelines* (attached in Annexure B). The Concurrent Evidence Guidelines are not intended to be exhaustive but indicate the circumstances when the Court might consider it appropriate for

concurrent expert evidence to take place, outline how that process may be undertaken, and assist experts to understand in general terms what the Court expects of them.

8.3 If an order is made for concurrent expert evidence to be given at a hearing, any expert to give such evidence should be provided with the Concurrent Evidence Guidelines well in advance of the hearing and should be familiar with those guidelines before giving evidence.

9. FURTHER PRACTICE INFORMATION AND RESOURCES

9.1 Further information regarding Expert Evidence and Expert Witnesses is available on the Court's website.

9.2 Further information to assist litigants, including a range of helpful guides, is also available on the Court's website. This information may be particularly helpful for litigants who are representing themselves.

J L B ALLSOP
Chief Justice
25 October 2016

Annexure A

HARMONISED EXPERT WITNESS CODE OF CONDUCT[2]

APPLICATION OF CODE

1. This Code of Conduct applies to any expert witness engaged or appointed:

   (a) to provide an expert's report for use as evidence in proceedings or proposed proceedings; or

   (b) to give opinion evidence in proceedings or proposed proceedings.

GENERAL DUTIES TO THE COURT

2. An expert witness is not an advocate for a party and has a paramount duty, overriding any duty to the party to the proceedings or other person retaining the expert witness, to assist the Court impartially on matters relevant to the area of expertise of the witness.

CONTENT OF REPORT

3. Every report prepared by an expert witness for use in Court shall clearly state the opinion or opinions of the expert and shall state, specify or provide:

   (a) the name and address of the expert;

   (b) an acknowledgment that the expert has read this code and agrees to be bound by it;

   (c) the qualifications of the expert to prepare the report;

   (d) the assumptions and material facts on which each opinion expressed in the report is based [a letter of instructions may be annexed];

   (e) the reasons for and any literature or other materials utilised in support of such opinion;

   (f) (if applicable) that a particular question, issue or matter falls outside the expert's field of expertise;

   (g) any examinations, tests or other investigations on which the expert has relied, identifying the person who carried them out and that person's qualifications;

   (h) the extent to which any opinion which the expert has expressed involves the acceptance of another person's opinion, the identification of that other person and the opinion expressed by that other person;

   (i) a declaration that the expert has made all the inquiries which the expert believes are desirable and appropriate (save for any matters identified explicitly in the report), and that no matters of significance which the expert regards as relevant have, to the

[2] Approved by the Council of Chief Justices' Rules Harmonisation Committee

knowledge of the expert, been withheld from the Court;

(j) any qualifications on an opinion expressed in the report without which the report is or may be incomplete or inaccurate;

(k) whether any opinion expressed in the report is not a concluded opinion because of insufficient research or insufficient data or for any other reason; and

(l) where the report is lengthy or complex, a brief summary of the report at the beginning of the report.

SUPPLEMENTARY REPORT FOLLOWING CHANGE OF OPINION

4. Where an expert witness has provided to a party (or that party's legal representative) a report for use in Court, and the expert thereafter changes his or her opinion on a material matter, the expert shall forthwith provide to the party (or that party's legal representative) a supplementary report which shall state, specify or provide the information referred to in paragraphs (a), (d), (e), (g), (h), (i), (j), (k) and (l) of clause 3 of this code and, if applicable, paragraph (f) of that clause.

5. In any subsequent report (whether prepared in accordance with clause 4 or not) the expert may refer to material contained in the earlier report without repeating it.

DUTY TO COMPLY WITH THE COURT'S DIRECTIONS

6. If directed to do so by the Court, an expert witness shall:

(a) confer with any other expert witness;

(b) provide the Court with a joint-report specifying (as the case requires) matters agreed and matters not agreed and the reasons for the experts not agreeing; and

(c) abide in a timely way by any direction of the Court.

CONFERENCE OF EXPERTS

7. Each expert witness shall:

(a) exercise his or her independent judgment in relation to every conference in which the expert participates pursuant to a direction of the Court and in relation to each report thereafter provided, and shall not act on any instruction or request to withhold or avoid agreement; and

(b) endeavour to reach agreement with the other expert witness (or witnesses) on any issue in dispute between them, or failing agreement, endeavour to identify and clarify the basis of disagreement on the issues which are in dispute.

ANNEXURE B

CONCURRENT EXPERT EVIDENCE GUIDELINES

APPLICATION OF THE COURT'S GUIDELINES

1. The Court's Concurrent Expert Evidence Guidelines ("**Concurrent Evidence Guidelines**") are intended to inform parties, practitioners and experts of the Court's general approach to concurrent expert evidence, the circumstances in which the Court might consider expert witnesses giving evidence concurrently and, if so, the procedures by which their evidence may be taken.

OBJECTIVES OF CONCURRENT EXPERT EVIDENCE TECHNIQUE

2. The use of concurrent evidence for the giving of expert evidence at hearings as a case management technique[3] will be utilised by the Court in appropriate circumstances (see r 23.15 of the *Federal Court Rules 2011* (Cth)). Not all cases will suit the process. For instance, in some patent cases, where the entire case revolves around conflicts within fields of expertise, concurrent evidence may not assist a judge. However, patent cases should not be excluded from concurrent expert evidence processes.

3. In many cases the use of concurrent expert evidence is a technique that can reduce the partisan or confrontational nature of conventional hearing processes and minimises the risk that experts become "opposing experts" rather than independent experts assisting the Court. It can elicit more precise and accurate expert evidence with greater input and assistance from the experts themselves.

4. When properly and flexibly applied, with efficiency and discipline during the hearing process, the technique may also allow the experts to more effectively focus on the critical points of disagreement between them, identify or resolve those issues more quickly, and narrow the issues in dispute. This can also allow for the key evidence to be given at the same time (rather than being spread across many days of hearing); permit the judge to assess an expert more readily, whilst allowing each party a genuine opportunity to put and test expert evidence. This can reduce the chance of the experts, lawyers and the judge misunderstanding the opinions being expressed by the experts.

5. It is essential that such a process has the full cooperation and support of all of the individuals involved, including the experts and counsel involved in the questioning process. Without that cooperation and support the process may fail in its objectives and even hinder the case management process.

[3] Also known as the "hot tub" or as "expert panels".

CASE MANAGEMENT

6. Parties should expect that, the Court will give careful consideration to whether concurrent evidence is appropriate in circumstances where there is more than one expert witness having the same expertise who is to give evidence on the same or related topics. Whether experts should give evidence concurrently is a matter for the Court, and will depend on the circumstances of each individual case, including the character of the proceeding, the nature of the expert evidence, and the views of the parties.

7. Although this consideration may take place at any time, including the commencement of the hearing, if not raised earlier, parties should raise the issue of concurrent evidence at the first appropriate case management hearing, and no later than any pre-trial case management hearing, so that orders can be made in advance, if necessary. To that end, prior to the hearing at which expert evidence may be given concurrently, parties and their lawyers should confer and give general consideration as to:

   (a) the agenda;

   (b) the order and manner in which questions will be asked; and

   (c) whether cross-examination will take place within the context of the concurrent evidence or after its conclusion.

8. At the same time, and before any hearing date is fixed, the identity of all experts proposed to be called and their areas of expertise is to be notified to the Court by all parties.

9. The lack of any concurrent evidence orders does not mean that the Court will not consider using concurrent evidence without prior notice to the parties, if appropriate.

CONFERENCE OF EXPERTS & JOINT-REPORT OR LIST OF ISSUES

10. The process of giving concurrent evidence at hearings may be assisted by the preparation of a joint-report or list of issues prepared as part of a conference of experts.

11. Parties should expect that, where concurrent evidence is appropriate, the Court may make orders requiring a conference of experts to take place or for documents such as a joint-report to be prepared to facilitate the concurrent expert evidence process at a hearing (see Part 7 of the Expert Evidence Practice Note).

PROCEDURE AT HEARING

12. Concurrent expert evidence may be taken at any convenient time during the hearing, although it will often occur at the conclusion of both parties' lay evidence.

13. At the hearing itself, the way in which concurrent expert evidence is taken must be applied flexibly and having regard to the characteristics of the case and the nature of the evidence to be given.

14. Without intending to be prescriptive of the procedure, parties should expect that, when evidence is given by experts in concurrent session:

(a) the judge will explain to the experts the procedure that will be followed and that the nature of the process may be different to their previous experiences of giving expert evidence;

(b) the experts will be grouped and called to give evidence together in their respective fields of expertise;

(c) the experts will take the oath or affirmation together, as appropriate;

(d) the experts will sit together with convenient access to their materials for their ease of reference, either in the witness box or in some other location in the courtroom, including (if necessary) at the bar table;

(e) each expert may be given the opportunity to provide a summary overview of their current opinions and explain what they consider to be the principal issues of disagreement between the experts, as they see them, in their own words;

(f) the judge will guide the process by which evidence is given, including, where appropriate:

(i) using any joint-report or list of issues as a guide for all the experts to be asked questions by the judge and counsel, about each issue on an issue-by-issue basis;

(ii) ensuring that each expert is given an adequate opportunity to deal with each issue and the exposition given by other experts including, where considered appropriate, each expert asking questions of other experts or supplementing the evidence given by other experts;

(iii) inviting legal representatives to identify the topics upon which they will cross-examine;

(iv) ensuring that legal representatives have an adequate opportunity to ask all experts questions about each issue. Legal representatives may also seek responses or contributions from one or more experts in response to the evidence given by a different expert; and

(v) allowing the experts an opportunity to summarise their views at the end of the process where opinions may have been changed or clarifications are needed.

15. The fact that the experts may have been provided with a list of issues for consideration does not confine the scope of any cross-examination of any expert. The process of cross-examination remains subject to the overall control of the judge.

16. The concurrent session should allow for a sensible and orderly series of exchanges between expert and expert, and between expert and lawyer. Where appropriate, the judge may allow for more traditional cross-examination to be pursued by a legal representative on a particular issue exclusively with one expert. Where that occurs, other experts may be asked to comment on the evidence given.

17. Where any issue involves only one expert, the party wishing to ask questions about that issue should let the judge know in advance so that consideration can be given to whether

arrangements should be made for that issue to be dealt with after the completion of the concurrent session. Otherwise, as far as practicable, questions (including in the form of cross-examination) will usually be dealt with in the concurrent session.

18. Throughout the concurrent evidence process the judge will ensure that the process is fair and effective (for the parties and the experts), balanced (including not permitting one expert to overwhelm or overshadow any other expert), and does not become a protracted or inefficient process.

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Sydney
Melbourne
Brisbane
Perth
Adelaide
Hobart
Darwin

Our ref. 21008585

31 August 2023

Dr Pep Canadell
CSIRO Black Mountain
2-40 Clunies Ross Street
Acton ACT 2601

By email: Redactions for public

Dear Dr Canadell

Pabai & Anor v Commonwealth of Australia (VID622/2021) | Engagement as independent expert

1. We refer to our provisional engagement letter dated 14 August 2023. We confirm we are instructed to engage you as an independent expert in the above class action before the Federal Court of Australia.

2. We reiterate that our engagement is with you as an individual independent expert, and not to give evidence on behalf of the CSIRO. Any opinions expressed by you should be your own and need not reflect the opinions of the CSIRO.

BRIEFING MATERIALS AND INSTRUCTIONS

3. **Annexure A** contains a list of documents briefed to you.

4. You are required to undertake a review of the documents briefed to you and prepare a report responding to the questions set out in **Annexure B** to this letter.

5. Any expert evidence to be relied on by the Commonwealth is due to be filed by **6 October 2023**. Please let us know if you consider it will not be possible to meet that date and we will consider what arrangements can be made.

6. You may also be required to give oral evidence before the Court. The hearing is listed from 6 to 27 November 2023, in Melbourne. We will advise you closer to the date if you will be required to give oral evidence and, if so, on which dates.

YOUR ROLE AS AN EXPERT

7. We enclose in Annexure B the Federal Court of Australia Expert Evidence Practice Note (GPN-EXPT) (**Practice Note**) and Part 23 of the *Federal Court Rules 2011* (Cth). These documents set out guideline for expert witnesses to follow in proceedings before the Court. Please read these guidelines carefully. You are requested to follow these guidelines in your dealings with us, and in preparing your report.

8. We draw your attention to the following sections of the Practice Note:

a) Section 4 'Role and Duties of the Expert Witness': Paragraph 4.1 provides that your role is to provide relevant and impartial evidence in your area of expertise. You should never mislead the Court or become an advocate for the Commonwealth (as the retaining party).

b) Section 4 'Role and Duties of the Expert Witness': Paragraph 4.4 provides that every expert witness giving evidence must read and agree to be bound by the Expert Witness Code of Conduct. You are required to strictly comply with the terms of the Expert Witness Code of Conduct. Please ensure your report/s contains an acknowledgment that you have read and agree to be bound by the Expert Witness Code of Conduct.

c) Section 5 'Contents of an Expert's Report and Related Material': Paragraph 5.2 sets out the requirements for the contents of any report, in addition to those requirements set out in the Expert Witness Code of Conduct.

CONFIDENTIALITY AND LEGAL PROFESSIONAL PRIVILEGE

9. Your communications with us are confidential and subject to the Commonwealth's legal professional privilege.

10. To ensure that the Commonwealth retains legal professional privilege in relation to your work, we request that you comply with the following communication and information management protocol during the course of this engagement:

a. Unless instructed otherwise, communications (written or oral) should be with Dejan Lukic, Grace Ng, Emily Nance, Samuel Nitschke, Zoe Maxwell and Jacqueline Yates of the Australian Government Solicitor.

b. This letter, any other materials provided to you, and any working notes prepared by you, should also be maintained in a file clearly marked 'Confidential and subject to legal professional privilege – for the Commonwealth of Australia'.

c. Include on the front page of any draft report and any other document produced in the course of this engagement the following wording: 'Confidential and subject to legal professional privilege – for the Commonwealth of Australia'.

11. Subject to any orders of any court, our instructions, and any information obtained and working notes prepared by you in relation to this matter (including this engagement) must not be disclosed to any other person, except:

11.1. to persons within the CSIRO from whom you require assistance in the course of this engagement (including preparing any report), on the condition that they maintain the confidentiality required by paragraphs 9-10 of this letter;

11.2. where disclosure is required by law;

11.3. where disclosure is necessary for CSIRO to fulfil any obligations to report to its Minister; or

11.4. where disclosure is in response to a request from Parliament or a Parliamentary Committee, in which case you will also give the Australian Government Solicitor notice of the disclosure (by email to the persons listed in clause 10.a above).

For the avoidance of doubt, we confirm that this paragraph 11 does not preclude you from disclosing matters in relation to this engagement (including any draft reports or communications) to CSIRO's internal legal advisers.

12. In providing you with this information, the Commonwealth in no way waives any privilege or confidentially that may be claimed with respect to that information.

ANY ASSISTANCE IN PREPARING YOUR REPORT

13. It is not expected that you will require assistance from any other person to prepare the evidence requested. If you wish to involve another person, please let us know.

NEXT STEPS

14. Please proceed to prepare your written report.

15. If, after you have had the opportunity to consider the materials in Annexure A and questions in Annexure B, you consider there are further materials or information you require in order to answer those questions, please let us know.

16. If you have any other questions please contact us.

Yours sincerely

Grace Ng
Senior Lawyer
T 02 9581 7320
grace.ng@ags.gov.au

ANNEXURE A – BRIEFED DOCUMENTS

TAB	DOCUMENT	DATE
1.	Provisional engagement letter, enclosing:	14 August 2023
	a. Federal Court's Expert Evidence Practice Note (GPN-EXPT)	25 October 2016
	b. Applicants' second further amended statement of claim (**SFASOC**)	11 April 2023
	c. Respondent's defence to the SFASOC	9 May 2023
	d. Applicants' amended concise statement	15 May 2023
	e. Respondent's amended concise statement in response	29 May 2023
2.	Part 23 of the *Federal Court Rules 2011*	13 January 2023
3.	Expert report of David Karoly (sealed)	26 May 2023
4.	Expert report of Malte Meinshausen (sealed)	14 July 2023

ANNEXURE A – QUESTIONS FOR REPORT

Basis of expertise

1. Please describe your academic qualifications, professional background and experience that is relevant to your answering the questions in the letter of instruction. You may wish to do so by reference to a current curriculum vitae.

Australia's GHG emissions

2. What were Australia's annual greenhouse gas (**GHG**) emissions from 2014 to date, as:

    a. total tCO2-eq;

    b. a percentage share of global GHG emissions;

    c. per capita tCO2-eq?

3. What was Australia's global ranking in terms of total and per capita annual GHG emissions from 2014 to date?

In answering questions 2 and 3 above, please:

a. identify the source of the data used to answer the questions and explain how that data was compiled;

b. explain how your answers to questions 2-3 were calculated or otherwise arrived at using that data.

Counterfactuals

Meinshausen Report [69(a)]

4. If Australia had in 2014 implemented a GHG emissions reductions target of 47% reduction over 2005 levels by 2025, and assuming Australia had a straight line path to 47% reduction by 2025:

    a. How much less would Australia's total annual GHG emissions have been each year and in total to date compared to Australia's actual GHG emissions in the same time period?

    b. What effect, if any, would the reduction in Australia's total GHG emissions from 2014 to date have had on:

        i. global temperature increase; and

        ii. the impacts of climate change,

        as at today's date?

    If it is not possible to answer this question, or any part thereof, then please explain why.

Meinshausen Report [69(b)]

5. If Australia had in 2014 implemented a GHG emissions reductions target of net zero by 2024, and assuming Australia had a straight line path to net zero by 2024:

    a. How much less would Australia's total annual GHG emissions have been each year and in total to date compared to Australia's actual GHG emissions in the same time period?

    b. What effect, if any, would the reduction in Australia's total GHG emissions from 2014 to date have had on:

        i. global temperature increase;

        ii. the impacts of climate change,

    as at today's date?

    If it is not possible to answer this question, or any part thereof, then please explain why.

ANNEXURE B

Curriculum Vitae
Dr. Josep G. Canadell
October 2023

Summary

- Chief research scientist in the CSIRO Climate Science Centre, Australia; Chief Investigator of the National Environmental Science Program –Climate Systems Hub; Executive Director of the Global Carbon Project.
- Focus on large-scale and global biogeochemistry and ecology as it relates to the drivers of anthropogenic climate change, its impacts, and climate mitigation pathways.
- Over 220 peer-reviewed journal papers (Web of Science), of which one quarter are published in Nature journals and Science. Edited books and journal special issues: 14.
- >100,000 citations and h-index of 118 (Google Scholar).
- The 8th most influential climate scientist in the world in 2021 according to Reuters, based on scientific productivity, impact and public outreach.
- Fellow of the American Geophysical Union.
- Climate change briefings to governments and United Nations bodies.

Expertise

Expert on the human disturbance of the carbon cycle and other biogeochemical cycles, including the global carbon, methane and nitrous oxide cycles and budgets, CO_2 sources/sinks and trends, and vulnerabilities of the carbon cycle as they relate to carbon-climate feedbacks, including permafrost, peatlands, wildfires, and ecosystem collapse. Potential and efficiency of nature-based solutions for climate mitigation, including negative emissions. Paths to decarbonization.

Contact

Global Carbon Project, CSIRO Environment, Black Mountain Laboratories , Australian Capital Territory 2600, Australia; Tel.: Redactions for
Email: Redactions for Project website: http://www.globalcarbonproject.org

Education

B.S. Biology (Biology)	1984	University Autonomous of Barcelona, Spain
M.S. Biology (Terrestrial Ecology)	1988	University Autonomous of Barcelona, Spain
Ph.D. Biology (Terrestrial Ecology)	1995	University Autonomous of Barcelona, Spain

History of Employment

- 2018-present: Chief Research Scientist, CSIRO Environment; CSIRO Oceans and Atmosphere
- 2012-2017: Senior Principal Research Scientist at CSIRO Oceans and Atmosphere
- 2002-present: Executive Director of the Global Carbon Project at CSIRO
- 1998-2011: Research Scientist at CSIRO Marine and Atmosphere
- 1998-2002: Executive Director of the Global Change and Terrestrial Ecosystems (GCTE) core project of IGBP, CSIRO Sustainable Ecosystems and the Australian National University, Canberra, Australia
- 1998-2000: Director of the Impacts Center for Southeast Asia (IC-SEA), Bogor, Indonesia (based in Canberra)
- 1995-1998: Research Associate at Stanford University, California, USA, and Scientific Officer for Global Change and Terrestrial Ecosystems (GCTE)

- 1993-1994: Research Associate, University of California, Berkeley, California, USA
- 1992: Adjunct Professor, San Diego State University, San Diego, CA, USA
- 1991: Lecturer, San Diego State University, San Diego, CA, USA

Current Member of Editorial Journals/Book Boards

- Ecological Studies, Springer (Series editor)
- Earth System Dynamics
- Carbon Balance and Management
- Climate Policy

Current/recent Member of Scientific Boards

- External Expert Advisory Board (EEAB) member of EYE-CLIMA (Verifying Emissions of Climate Forcers).
- External Advisory Board member for CDRterra, German research project (2022-2025).
- External Advisory Board member for Climate-Carbon Interactions in the Current Century (4C), EU-Horizon 2020 (2020-2023).
- External Advisory Board member for CONSTRAIN, EU-Horizon 2020 (2020-2023).
- Panel member for Advanced Grants of the European Research Council. 2021-2023.
- Group on Earth Observations – GEO-Carbon and Greenhouse Gas Initiative.
- Scientific Team of the World Meteorological Organization "Integrated Global Greenhouse Gas Information System" (IG3IS)
- Australian National Committee for Earth System Science of the Australian Academy of Sciences
- External Advisory Board of Climate-Carbon Interactions in the Current Century, EU-project
- Scientific Marie Curie Training Network C-CASCADES, Carbon Cascades from Land to Ocean in the Anthropocene (European Union). Ended.
- International Scientific Advisory Board, Center for Ecological Research and Applied Forestry, University Autonomous of Barcelona, Catalunya.
- Coordinating Lead Author of the 6th Assessment Report of the Intergovernmental Panel on Climate Change, Working Group 1: The Physical Science Basis (2015-2021)
- Premi Ramon Margalef (2018-2020)
- AGU Fellows selection committee (2018-2020)

Honors and Peer Recognition

- 2022. IPCC co-laureate with the Gulbenkian Prize for Humanity.
- 2022. Member of the Green Power Players 2022 (The Australian). Australians who are leading the way with innovative ideas, new technology and bold vision.
- 2022. Member of the Institut d'Estudis Catalans (equivalent to Fellow of the Academies of Catalonia, Spain).
- 2021. Pep was selected by Reuters as the 8th most influential climate scientist in the world https://www.reuters.com/investigates/special-report/climate-change-scientists-list/
- 2017-2022. Highly Cited Researcher (top 1%) in Geoscience and/or in Ecology/Environment (Web of Science – Clarivate Analytics).
- 2018. Prospect Think Tank Award on Energy and Environment on behalf of the Global Carbon Project.
- 2017. Fellow of the American Geophysical Union.
- 2014. CSIRO Newton Turner Career Award (award designed to expand the scientific career of exceptional senior scientists at CSIRO).
- 2007. Member of the United Nations Intergovernmental Panel on Climate Change (Fourth Assessment Report) awarded the Nobel Peace Prize.

Guest Journal Editor/Book Editor

AGU journals, Biogeosciences, Cambridge University Press, Carbon Balance and Management, Climatic Change, Climate Policy, Current Opinion in Environmental Sustainability, Earth System Dynamics, Ecological Applications, Ecological Studies, Elsevier, Environmental Research Letters, Journal of Vegetation Science, Plant and Soil, Science in China, Springer, Tellus, Vegetatio, Wiley

Research Peer-Reviewed Publications

212 papers in Web of Science (50 of which in journals of Nature/s and Science)
100,151 citations (Google Scholar); 54,155 (Web of Science)
118 H-index (Google Scholar); 97 (Web of Science)

List of Research papers and links to papers:

- Google Scholar: http://scholar.google.com/citations?user=4QU11c4AAAAJ
- ResearchID: http://www.researcherid.com/rid/E-9419-2010
- Orcid ID: http://orcid.org/0000-0002-8788-3218
- Semantic Scholar: https://www.semanticscholar.org/author/J.-Canadell/66251280
- Research.com: Josep G. Canadell: H-index & Awards - Academic Profile | Research.com

Top 20 most cited papers (>1000 citations):

1	Global carbon budget 2021 P Friedlingstein, MW Jones, M O'sullivan, RM Andrew, DCE Bakker, ... Earth System Science Data 14 (4), 1917-2005	2022
2	A large and persistent carbon sink in the world's forests Y Pan, RA Birdsey, J Fang, R Houghton, PE Kauppi, WA Kurz, OL Phillips, ... Science 333 (6045), 988-993	2011
3	Carbon and other biogeochemical cycles P Ciais, C Sabine, G Bala, L Bopp, V Brovkin, J Canadell, A Chhabra, ... Climate change 2013: the physical science basis. Contribution of Working …	2014
4	A global analysis of root distributions for terrestrial biomes RB Jackson, J Canadell, JR Ehleringer, HA Mooney, OE Sala, ... Oecologia 108, 389-411	1996
4	Contributions to accelerating atmospheric CO2 growth from economic activity, carbon intensity, and efficiency of natural sinks JG Canadell, C Le Quéré, MR Raupach, CB Field, ET Buitenhuis, P Ciais, ... Proceedings of the national academy of sciences 104 (47), 18866-18870	2007
6	Soil organic carbon pools in the northern circumpolar permafrost region C Tarnocai, JG Canadell, EAG Schuur, P Kuhry, G Mazhitova, S Zimov Global biogeochemical cycles 23 (2)	2009
7	The global carbon cycle: a test of our knowledge of earth as a system P Falkowski, RJ Scholes, EEA Boyle, J Canadell, D Canfield, J Elser, ... science 290 (5490), 291-296	2000
8	A meta-analysis of the response of soil respiration, net nitrogen mineralization, and aboveground plant growth to experimental ecosystem warming Oecologia 126 (4), 543-562	2001
9	Global and regional drivers of accelerating CO2 emissions MR Raupach, G Marland, P Ciais, C Le Quéré, JG Canadell, G Klepper, ...	2007

Proceedings of the National Academy of Sciences 104 (24), 10288-10293

10 Trends in the sources and sinks of carbon dioxide

C Le Quéré, MR Raupach, JG Canadell, G Marland, L Bopp, P Ciais, ...

Nature geoscience 2 (12), 831-836 2009

11 Maximum rooting depth of vegetation types at the global scale

J Canadell, RB Jackson, JB Ehleringer, HA Mooney, OE Sala, ...

Oecologia 108, 583-595 1996

12 Temporary reduction in daily global CO2 emissions during the COVID-19 forced confinement

C Le Quéré, RB Jackson, MW Jones, AJP Smith, S Abernethy, ...

Nature climate change 10 (7), 647-653 2020

13 Three decades of global methane sources and sinks

S Kirschke, P Bousquet, P Ciais, M Saunois, JG Canadell, ...

Nature geoscience 6 (10), 813-823 2013

14 Greening of the Earth and its drivers

Z Zhu, S Piao, RB Myneni, M Huang, Z Zeng, JG Canadell, P Ciais, ...

Nature climate change 6 (8), 791-795 2016

15 Recent patterns and mechanisms of carbon exchange by terrestrial ecosystems

DS Schimel, JI House, KA Hibbard, P Bousquet, P Ciais, P Peylin, ...

Nature 414 (6860), 169-172 2001

16 Vulnerability of permafrost carbon to climate change: Implications for the global carbon cycle

EAG Schuur, J Bockheim, JG Canadell, E Euskirchen, CB Field, ...

BioScience 58 (8), 701-714 2008

17 Managing forests for climate change mitigation

JG Canadell, MR Raupach

science 320 (5882), 1456-1457 2008

18 Climate Change 2021: the physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change; technical summary

P Arias, N Bellouin, E Coppola, R Jones, G Krinner, J Marotzke, V Naik, ... 2021

19 Biophysical and economic limits to negative CO2 emissions

P Smith, SJ Davis, F Creutzig, S Fuss, J Minx, B Gabrielle, E Kato, ...

Nature climate change 6 (1), 42-50 2016

20 The global methane budget 2000–2017

M Saunois, AR Stavert, B Poulter, P Bousquet, JG Canadell, RB Jackson, ...

Earth system science data 12 (3), 1561-1623 2020

21 Betting on negative emissions

S Fuss, JG Canadell, GP Peters, M Tavoni, RM Andrew, P Ciais, ...

Nature climate change 4 (10), 850-853 2014

22 Contribution of semi-arid ecosystems to interannual variability of the global carbon cycle

B Poulter, D Frank, P Ciais, RB Myneni, N Andela, J Bi, G Broquet, ...

Nature 509 (7502), 600-603 2014

23 The dominant role of semi-arid ecosystems in the trend and variability of the land CO2 sink
A Ahlström, MR Raupach, G Schurgers, B Smith, A Arneth, M Jung, ...
Science 348 (6237), 895-899 2015

24 Global carbon budget 2017
C Le Quéré, RM Andrew, P Friedlingstein, S Sitch, J Pongratz, ...
Earth System Science Data 10 (1), 405-448 2018

25 The challenge to keep global warming below 2 C
GP Peters, RM Andrew, T Boden, JG Canadell, P Ciais, C Le Quéré, ...
Nature Climate Change 3 (1), 4-6 2013

26 Peatlands and the carbon cycle: from local processes to global implications–a synthesis
J Limpens, F Berendse, C Blodau, JG Canadell, C Freeman, J Holden, ...
Biogeosciences 5 (5), 1475-1491 2008

27 Rapid growth in CO2 emissions after the 2008–2009 global financial crisis
GP Peters, G Marland, C Le Quéré, T Boden, JG Canadell, MR Raupach
Nature climate change 2 (1), 2-4 2012

28 The global methane budget 2000–2012
M Saunois, P Bousquet, B Poulter, A Peregon, P Ciais, JG Canadell, ...
Earth System Science Data 8 (2), 697-751 2016

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1. WMO (2023) United In Science. A multi-organization high-level compilation of the latest weather-, climate- and water-related sciences and services for sustainable development. Geneva.
2. WMO (2022) United In Science. A multi-organization high-level compilation of the latest weather-, climate- and water-related sciences and services for sustainable development. Geneva.
3. Canadell JG, RB Jackson, RM Andrew, P Friedlingstein, M Jones, et al. (2021) Global Fossil GHG Emissions and Budgets - Global Carbon Project. In: Jürg Luterbacher, Laura Paterson, Rosa von Borries, Kate Solazzo, Rose Devillier and Sylvie Castonguay (eds), United in Science 2021: A multi-organization high-level compilation of the latest climate science information. World Meteorological Organization, Switzerland.
4. Smith AJP, MW Jones, JT Abatzoglou, JG Canadell, RA Betts (2020) Climate Change Increases the Risk of Wildfires: September 2020. ScienceBrief
5. Canadell JG, RB Jackson, RM Andrew, P Friedlingstein, M Jones, et al. (2020) Global Fossil CO_2 Emissions: Global Carbon Project, p. 6-7. In: United In: Jürg Luterbacher; Laura Paterson; Sylvie Castonguay (eds), United in Science 2020: A multi-organization high-level compilation of the latest climate science information. World Meteorological Organization, Switzerland.
6. WMO (2020) WMO Statement on the State of the Global Climate in 2019. World Meteorological Organization WMO-No 1248.
7. WMO (2019) WMO Statement on the State of the Global Climate in 2018. World Meteorological Organization WMO-No 1233.
8. Siegmund P, Abermann J, Baddour O, Canadell Pep, Cazenave A, Derksen C, Garreau A, Howell S, Huss M, Isensee K, Kennedy J, Motram R, Nitu R, Ramasamy S, Schoo K, Sparrow M, Tarasova O, Trewin B, Ziese M (2019) The Global Climate in 2015-2019. WMO, Switzerland
9. IPCC (2003) IPCC meeting on current scientific understanding of the processes affecting terrestrial carbon stocks and human influences upon them. Expert Meeting Report, Geneva, Switzerland, 2123 July 2003. IPCC – XXI/INF.1 (22.IX.2003), IPCC Twenty-First Session, 3 and 6–7 November 2003, Vienna.
10. CSIRO/BOM Australia State of the Climate 2019, 2022.

11. DeCola P., Tarasova O., Brunner D., Maksyutov S., Manning A., Vogel F., Gurney K., Turnbull J, Zavala-Araiza D, Kort E, Robisnon R, Canadell P, Ciais P, Vladu F, Houweling S, Lauvaux T, Mueller K (2019) An Integrated Global Greenhouse Gas Information System (IG3 IS) Science Implementation Plan. GAW Report No. 245. Geneva: WMO.

Broader Engagement and Outreach

Policy Briefings

Scientific briefings to United Nations agencies and bodies, and governments. Regular briefings to the Australian Government agencies, Ministers, and office of the Chief Scientist.

Articles for The Conversation – research-based journalism
https://theconversation.com/profiles/pep-canadell-16541/articles

1. Pep Canadell (2023) The green energy surge still isn't enough for 1.5C degrees. We'll have to overshoot, adapt and soak up carbon dioxide. The Conversation.
2. Pep Canadell et al. (2022) Global carbon emissions at record levels with no signs of shrinking, new data shows. Humanity has a monumental task ahead. The Conversation
3. Stefan Doerr, Cristina Santin, Matthew Jones, Pep Canadell, John Abatzoglou (2022) Climate change: wildfire risk has grown nearly everywhere – but we can still influence where and how fire strike. The Conversation
4. Garry Cook, Andrew Dowdy, Juergen Knauer, Mick Meyer, Peter Briggs (2021) Australia's Black Summer of fire was not normal – and we can prove it. The Conversation
5. Pep Canadell, Corinne Le Quéré, Glen Peters, Pierre Friedlingstein, Robbie Andrew, Rob Jackson (2021) Global emissions almost back to pre-pandemic levels after unprecedented drop in 2020, new analysis shows. The Conversation
6. Pep Canadell, Corinne Le Quéré, Glen Peters, Pierre Friedlingstein, Robbie Andrew, Rob Jackson (2021) Las emisiones globales vuelven a los niveles prepandemicos despues de la caida del 2020. The Conversation.
7. Pep Canadell, Corinne Le Quéré, Glen Peters, Pierre Friedlingstein, Robbie Andrew, Rob Jackson (2021) Combien de tonnes d'emissions de CO2 pouvons-nous encore nous permettre? The Conversation
8. Pep Canadell, Joelle Gergis, Malte Meinhausen, Mark Hemer, Michael Grose (2021) This is the most sobering report card yet on climate change and Earth's future. Here's what you need to know. The Conversation.
9. Michael Grose, Malte Meinhausen, Pep Canadell, Zebedee Nicholls (2021) IPCC says Earth will reach temperature rise of about 1.5℃ in around a decade. But limiting any global warming is what matters most. The Conversation.
10. Michael Grose, Joelle Gergi, Pep Canadell, Roshanka Ranasinghe (2021) Climate change has already hit Australia. Unless we act now, a hotter, drier and more dangerous future awaits, IPCC warns. The Conversation.

11. Pep Canadell, Le Quéré, C, Glen Peters, Matthew Jones, P Friedlingstein, R Andrew, R Jackson, S Davis (2021) We've made progress to curb global emissions. But it's a fraction of what's needed. The Conversation
12. Pep Canadell, G Peters, M Jones, P Ciais, P Friedlingstein, R Andrew, Rob Jackson (2020) Global emissions are down by an unprecedented 7% — but don't start celebrating just yet. The Conversation
13. Pep Canadell, Eric Davidson, Glen Peters, Hanqin Tian, Michael Prather, P Krummel, R Jackson, R Thompson, W Winiwarter (2020) New research: nitrous oxide emissions 300 times more powerful than CO_2 are jeopardising Earth's future. The Conversation.
14. Pep Canadell, R Jackson (2020) Earth may temporarily pass dangerous 1.5℃ warming limit by 2024, major new report says. The Conversation
15. Pep Canadell, A Stavert, B Poulter, M Saunois, P Krummel, R Jackson (2020) Las emisiones de metano aumentan peligrosamente: ¿quién tiene la culpa?. The Conversation
16. Pep Canadell, A Stavert, B Poulter, M Saunois, P Krummel, R Jackson (2020) Emissions of methane – a greenhouse gas far more potent than carbon dioxide – are rising dangerously. The Conversation
17. Pep Canadell, C Le Quéré, F Creutzig, G Peters, M Jones, P Friedlignstein, R Jackson, Y Shan (2020) Coronavirus is a 'sliding doors' moment. What we do now could change Earth's trajectory. The Conversation
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