

The Climate Equity Reference Calculator

Ceecee Holz ¹, Eric Kemp-Benedict ², Tom Athanasiou³, and Sivan Kartha ²

1 Department of Geography and Environmental Studies, Carleton University, Ottawa 2 Stockholm Environment Institute US, Somerville 3 EcoEquity, Berkeley

DOI: [10.21105/joss.01273](https://doi.org/10.21105/joss.01273)

Software

- [Review](#) 
- [Repository](#) 
- [Archive](#) 

Editor: [Jed Brown](#)  

Reviewers:

- [@mtobis](#)

Submitted: 19 November 2018

Published: 14 March 2019

License

Authors of papers retain copyright and release the work under a Creative Commons Attribution 4.0 International License ([CC BY 4.0](#)).

Summary

In the context of the global response to the threat of anthropogenic climate change, the question arises of how to fairly share the overall global effort required to mitigate climate change. A rich body of literature exists that addresses this question, with several such effort-sharing approaches being proposed, reflecting different ethical positions with regards to fairness and justice. The Climate Equity Reference Project (CERP) framework ([Holz et al., 2018b](#)), formerly called Greenhouse Development Rights (GDRs) ([Baer et al., 2008](#); [Baer, 2013](#)) is such an approach. It takes nations' historical responsibility for greenhouse gas emissions and their financial capacity to reduce emissions and otherwise address climate change as the basis for assigning fair shares of the overall global effort. Importantly, it does so while at the same time protecting the right of the world's poorest to pursue a life free of poverty.

The Climate Equity Reference Calculator and its web interface, *cerc-web*, allows users to calculate such fair share contributions for each country, based on a user's selection of equity-related parameters. The *cerc-web* interface serves as a user interface to, and enhances the capabilities of the calculator "engine" backend. The "engine," written in C, has been released by the authors as a separate package ([Kemp-Benedict et al., 2014](#)). A technical documentation of the quantitative effort-sharing model that is implemented by the calculator is also available ([Kemp-Benedict et al., 2018](#)). Taken together, the "engine" and *cerc-web* represent the only official implementation of the theoretical GDRs and CERP frameworks by their authors, although implementations by other teams exist ([Meinshausen et al., 2015](#); [Pan et al., 2017](#); [Robiou du Pont et al., 2017](#)), often obtaining substantially different results that have not yet been fully explored.

In addition to the calculator "engine," the calculator requires a "core database" as an external component, which contains historical data and future projections for greenhouse gas emissions, GDP, population, Gini coefficients and exchange rates for all countries. The default database, currently in version 7.2, is being frequently updated and is available online, together with its documentation ([Holz et al., 2018a](#)). To our knowledge, at present only a single installation of *cerc-web* exists. It is located at <https://calculator.climateequityreference.org> and is maintained by the authors.

The web interface serves three distinct purposes: (i) to clarify the ethical choices before users and their implications, (ii) to visualize the results of the effort-sharing calculations, and (iii) to allow users to contrast the fair share results with actual climate action pledges made by countries.

On (i) the Climate Equity Reference framework is an effort sharing *framework*, meaning that it supports a virtually unlimited set of different possible choices with regards to the concrete parameterization of the framework and the calculator, each reflecting specific ethical positions. Particularly significant choices include start dates to calculate historical responsibility (from 1850 to "now"), different options to apply different treatment to the income of each country's

poorest as opposed to its richest people in assessing a country's capacity to act, the relative weight of responsibility and capability as well as the stringency of the global greenhouse gas emissions reductions pathway. The cerc-web user interface launches with a splash screen that clearly lays out the most salient of these choices along with commonly-chosen options, as well as help texts designed to assist users in understanding the ethical implications of their choices. Beyond the splash screen, the full interface allows for very granular tuning of each of the options available.

On (ii), the calculator "engine" takes as its input an SQLite (Hipp et al., 2015) database that contains the "core database" as well as the specific choices selected by users through the cerc-web interface and likewise returns an SQLite database with the results of the effort-sharing calculations. While this allows the "engine" to run very fast and flexibly, it requires a front end to present the results in a more user-friendly manner for most users. The cerc-web interface serves this purpose by dynamically generating a number of different tables and reports, including a "country report" presenting the result data for any individual country, as well as several groups of countries, in graphical and tabular format. Owing to the ability of the calculator "engine" to perform whole model runs in seconds or fractions thereof, depending on hardware, the cerc-web user interface also allows dynamic updating of results tables and charts affording users to see in near-real-time the implications of changing their parameterization of the equity framework.

Finally, on (iii), cerc-web complements the core calculator "engine" functionality in that it, in its current version, allows end-users to compare countries' actually-articulated emissions reductions pledges with the results of the fair-share calculations based on users' specific ethical position, reflected through their inputs in the user interface. This is achieved through an auxiliary "pledge database" into which maintainers can enter emission reductions pledges as communicated by countries. The authors maintain a published list of their quantifications of these pledges (Holz et al., 2017) and also maintain the pledge database for the cerc-web instance at <https://calculator.climateequityreference.org>. cerc-web also includes a custom user interface for supporting users in managing the pledge database. Finally, for flexibility of use, cerc-web complements the capabilities of the calculator "engine" by exposing most of the calculator functionality to an API, which can be used by other projects to dynamically incorporate queries to the calculator. The API is comprehensively documented elsewhere (Climate Equity Reference Project, 2015).

cerc-web and its results have been used extensively in research by the authors and others (Adow et al., 2018; CSO Equity Review, 2015, 2016, 2017, 2018; most recently in Holz et al., 2018b; Kartha et al., 2018; Metcalfe, 2015; Richards et al., 2018, among other pieces). Several of these studies are cited in the recent Special Report on Global Warming of 1.5°C by the Intergovernmental Panel on Climate Change (IPCC, 2018), highlighting the research relevance of the software. Especially the feature of cerc-web, described under (iii) above, to allow comparison of countries' climate mitigation pledges with equitable shares of the global effort as calculated by cerc-web has enabled innovative research. With regards to the mitigation pledges submitted in the context of the Paris Agreement (UNFCCC, 2015a), this functionality enabled the first-ever research report that went beyond an aggregated, global-level assessment of these pledges (e.g., UNEP, 2015; UNFCCC, 2015b) and instead assessed all of these pledges individually relative to normatively-derived, quantitative benchmarks (CSO Equity Review, 2015; Holz et al., 2018b).

Acknowledgements

We acknowledge contributions of Tyler Kemp-Benedict in coding the user interface and the assistance of Douglas Wang in the early programming. Paul Baer was a founder and seminal contributor to the overall CERP/GDRs project for many years.

References

- Adow, M., Ware, J., & Viita, T. (2018). *Climate inequality in the Commonwealth: A call for urgent action*. Christian Aid. <https://www.christianaid.org.uk/sites/default/files/2018-04/Climate-inequality-Commonwealth-J63028-Apr2018.pdf>
- Baer, P. (2013). The Greenhouse Development Rights Framework for global burden sharing: Reflection on principles and prospects. *Wiley Interdisciplinary Reviews: Climate Change*, 4(1), 61–71. <https://doi.org/10.1002/wcc.201>
- Baer, P., Athanasiou, T., Kartha, S., & Kemp-Benedict, E. (2008). *The Greenhouse Development Rights Framework. The right to development in a climate constrained world, second edition*. Heinrich Böll Foundation, Christian Aid, EcoEquity; Stockholm Environment Institute. <http://www.ecoequity.org/docs/TheGDRsFramework.pdf>
- Climate Equity Reference Project. (2015). *The Climate Equity Reference Calculator web API*. Stockholm Environmental Institute; EcoEquity. <https://doi.org/10.5281/zenodo.2590636>
- CSO Equity Review. (2015). *Fair shares: A Civil Society Equity Review of INDCs*. CSO Equity Review Coalition. <https://doi.org/10.6084/m9.figshare.5917399>
- CSO Equity Review. (2016). *Setting the path towards 1.5°C: A Civil Society Equity Review of pre-2020 ambition*. CSO Equity Review Coalition. <https://doi.org/10.6084/m9.figshare.5917402>
- CSO Equity Review. (2017). *Equity and the ambition ratchet: Towards a meaningful 2018 Facilitative Dialogue*. CSO Equity Review Coalition. <https://doi.org/10.6084/m9.figshare.5917408>
- CSO Equity Review. (2018). *After Paris: Inequality, fair shares, and the climate emergency*. CSO Equity Review Coalition. <https://doi.org/10.6084/m9.figshare.7637669>
- Hipp, D. R., Kennedy, D., & Mistachkin, J. (2015). *SQLite (version 3)*. SQLite Development Team. <https://www.sqlite.org>
- Holz, C., Athanasiou, T., & Kartha, S. (2017). *Estimates of emissions levels associated with the Nationally Determined Contributions (NDCs)*. Harvard Dataverse. <https://doi.org/10.7910/DVN/RIBJXF>
- Holz, C., Kartha, S., & Athanasiou, T. (2018a). *Climate Equity Reference Calculator database, version 7.2.0 (Sep 2018), V4*. Harvard Dataverse. <https://doi.org/10.7910/DVN/O3H22Z>
- Holz, C., Kartha, S., & Athanasiou, T. (2018b). Fairly sharing 1.5 – national fair shares of a 1.5°C-compliant global mitigation effort. *International Environmental Agreements: Politics, Law and Economics*, 18, 117–134. <https://doi.org/10.1007/s10784-017-9371-z>
- IPCC. (2018). *Special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. Intergovernmental Panel on Climate Change. <http://www.ipcc.ch/report/sr15/>
- Kartha, S., Holz, C., & Athanasiou, T. (2018). *Norway's fair share of meeting the Paris Agreement*. Kirkens Nødhjelp, Regnskogfondet, Forum for utvikling og miljø, Naturvernforbundet. https://www.kirkensnodhjelp.no/globalassets/lanserte-rapporter/2018/norways-fair-share-2018_web.pdf
- Kemp-Benedict, E., Athanasiou, T., Baer, P., Holz, & Kartha, S. (2018). *Calculations for the Climate Equity Reference Calculator (CERC)*. Stockholm Environment Institute; EcoEquity. <https://doi.org/10.5281/zenodo.1748847>

- Kemp-Benedict, E., Baer, P., Kartha, S., & Athanaisou, T. (2014). *The Greenhouse Development Rights and Climate Equity Reference Calculator engine*. Stockholm Environment Institute; EcoEquity. <http://gdrs.sourceforge.net>
- Meinshausen, M., Jeffery, L., Gütschow, J., Robiou du Pont, Y., Rogelj, J., Schaeffer, M., Höhne, N., den Elzen, M., Oberthür, S., & Meinshausen, N. (2015). National post-2020 greenhouse gas targets and diversity-aware leadership. *Nature Climate Change*, 5, 1098–1106. <https://doi.org/10.1038/nclimate2826>
- Metcalfe, S. (2015). Fast, fair climate action crucial for health and equity. *New Zealand Medical Journal*, 128(1425), 14–23.
- Pan, X., den Elzen, M., Höhne, N., Teng, F., & Wang, L. (2017). Exploring fair and ambitious mitigation contributions under the Paris Agreement goals. *Environmental Science & Policy*, 74, 49–56. <https://doi.org/10.1016/j.envsci.2017.04.020>
- Richards, M. B., Wollenberg, E., & van Vuuren, D. (2018). National contributions to climate change mitigation from agriculture: Allocating a global target. *Climate Policy*, 18(10), 1271–1285. <https://doi.org/10.1080/14693062.2018.1430018>
- Robiou du Pont, Y., Jeffery, L., Gütschow, J., Rogelj, J., Christoff, P., & Meinshausen, M. (2017). Equitable mitigation to achieve the Paris Agreement goals. *Nature Climate Change*, 7, 38–43. <https://doi.org/10.1038/nclimate3186>
- UNEP. (2015). *The Emissions Gap Report 2015*. United Nations Environment Programme. http://uneplive.unep.org/media/docs/theme/13/EGR_2015_Technical_Report_final_version.pdf
- UNFCCC. (2015a). *Paris Agreement*. United Nations Office. http://unfccc.int/files/meetings/paris_nov_2015/application/pdf/paris_agreement_english_.pdf
- UNFCCC. (2015b). *Synthesis report on the aggregate effect of the Intended Nationally Determined Contributions*. UNFCCC. <http://unfccc.int/resource/docs/2015/cop21/eng/07.pdf>