Quantifying the Social Cost of Carbon Emissions for Major Oil and Gas Companies

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1 Introduction

This document presents an analysis to quantify the economic damages associated with carbon emissions from nine leading investor-owned oil and gas companies since the signing of the Paris Agreement. The emissions data are sourced from the Carbon Majors Database, and the corresponding damages are calculated using the Social Cost of Carbon (SCC). These damages are then reverse-discounted to 2025, providing a present-day valuation of their historical emissions impact.

2 Data

Social cost of carbon values are taken from the U.S. EPA's 2023 Report on the Social Cost of Greenhouse Gases [3]. We use the 2% near-term discount rate results. These are available for pulse years from 2020 to 2080, and reported in 2020 USD. The values are displayed in figure 1.

Emission estimates by investor-owned oil and gas companies were provided by the Carbon Majors Database on September 8, 2025[1]. [2]. The values take into account mergers, and represent how parent companies inherit merged company emissions.

3 Methodology

The analysis involves the following steps:

1. **Social Cost of Carbon Estimation:** A quadratic regression model is used to estimate the SCC values over the years. Specifically, the model is specified as:

$$\log(\text{scc}_t) = \beta_0 + \beta_1 \cdot \text{year}_t + \beta_2 \cdot \text{year}_t^2 + \epsilon_t \tag{1}$$

   where t represents the year and ϵ_t is the error term. The predicted SCC values are then exponentiated to yield estimates of SCC in USD per metric ton of CO_2. We generate predictions for each year from 2016 to 2026 based on this model.

   Figure 1 shows the SCC over time.

[1] Direct data source linked here

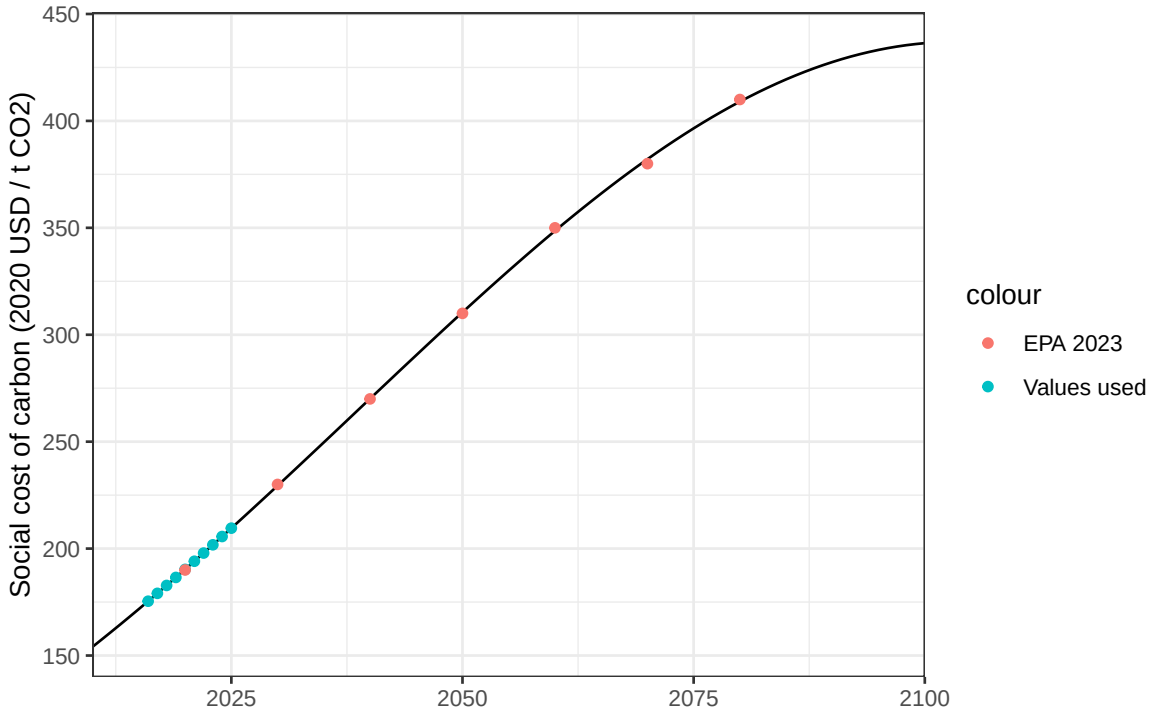

Figure 1: Estimated Social Cost of Carbon (SCC) over Time: This figure illustrates the projected values of the SCC from 2010 to 2100, derived from the quadratic regression model.

2. **Emissions Data Handling:** Emissions data for the selected companies are filtered for emissions after 2015. To address gaps in emissions reporting for 2025, we apply a conservative approach where emissions are capped at the last recorded value for 2024 and are linearly extrapolated to these future years, ensuring that no company report higher emissions than those reported prior.

   Figure 2 depicts the emissions trends for the selected companies.

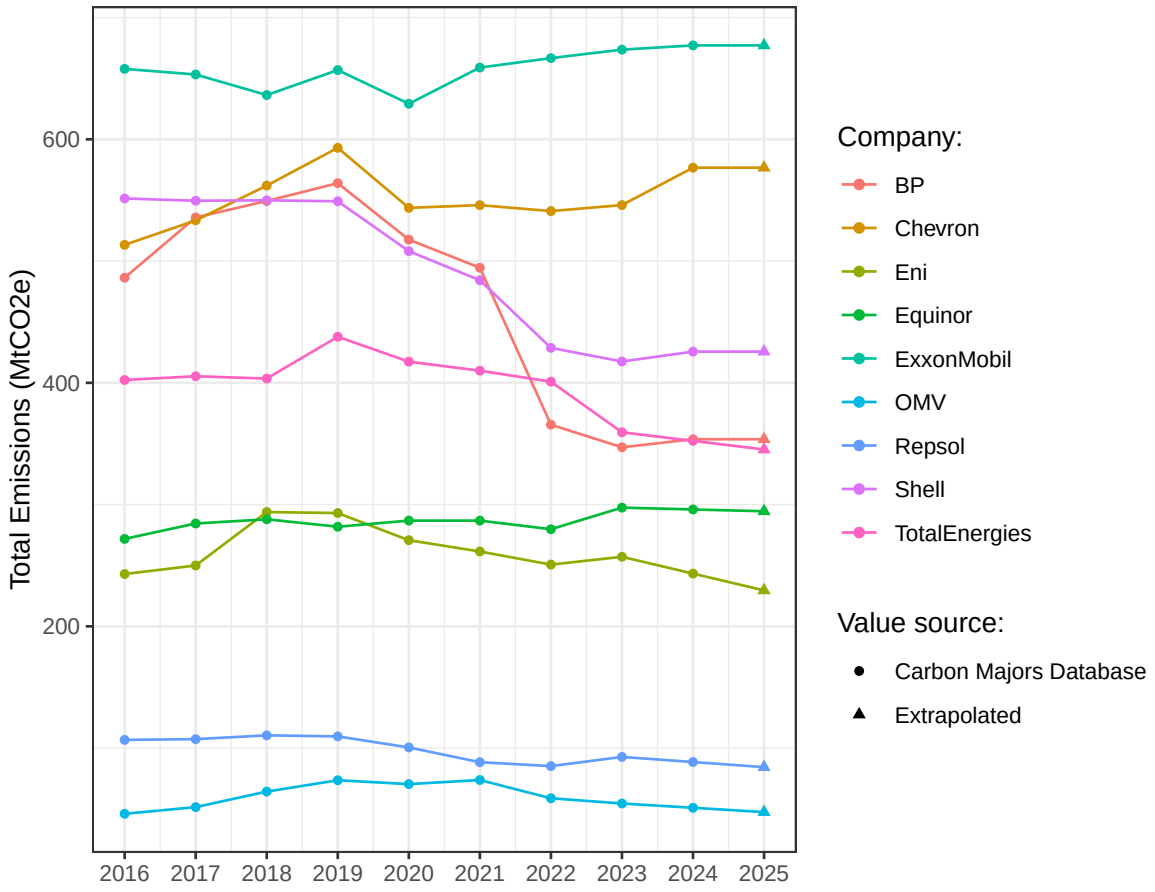

Figure 2: Emissions Trends of Investor-Owned Oil and Gas Companies (MtCO2e): This figure displays the total emissions (in million tons of CO2 equivalent) for the selected investor-owned companies from 2016 to 2025, highlighting both reported values and extrapolated estimates.

3. **Economic Damage Calculation:** The annual emissions are multiplied by the respective year's SCC to determine the yearly economic damage associated with each company's emissions.

   The resulting economic damages are reverse-discounted to 2025. The methodology for this approach relies on the framework presented by Burke et al. in their working paper on linking specific emissions to damages [1].

4 Results

The calculated damages by invest-owned company are summarized in Table 1.

References

[1] Marshall Burke, Mustafa Zahid, Noah Diffenbaugh, and Solomon M Hsiang. Quantifying climate change loss and damage consistent with a social cost of greenhouse gases. Working Paper 31658, National Bureau of Economic Research, September 2023.

[2] Carbon Majors. Personal communications, 2025-09-08, 2025. `https://carbonmajors.org/`.

[3] U.S. EPA. Report on the social cost of greenhouse gases: Estimates incorporating recent scientific advances, 2023.

IOC	Damages (Trillion 2020 USD)
ExxonMobil	1.38
Chevron	1.16
Shell	1.03
BP	0.96
TotalEnergies	0.83
Equinor	0.60
Eni	0.54
Repsol	0.20
OMV	0.12

Table 1: Total Damages by Company (Trillion 2020 USD)