Dataset on tax dollars per tonne of CO2e: Scope, sources and methodology

1. Scope

The data relate to EITI-verified payments of $227 billion made to 20 governments for about 13% of global oil and gas production in 2018, triggering emissions of 4.5 gigatonnes CO2e. Emissions have been calculated according to the methodology developed in the context of the project to develop the Global Registry of Fossil Fuels.

The data include carbon emissions along all stages of the value chain, from energy used in production of the oil and gas in the upstream, through transportation and refining, to final combustion as fuel. These correspond to the three scopes of emissions in the Greenhouse Gas Protocol,[1] as used by the US Environmental Protection Agency and many other regulators. The statistical model includes a breakdown of total emissions estimates into combustion (Scope 3), the largest category of emissions in the fossil fuel industries by volume, and upstream (combining Scopes 1 and 2).

Government revenues per tonne of CO2e have a weighted average of just over $50/tonne of CO2e. But this average is pushed up considerably by five high volume long-standing producers with strong national participation in their industries: Nigeria, Norway, Iraq, Kazakhstan and Mexico. Minus these five, the other 15 countries collectively achieve $27 billion of payments for an estimated 1.6 gigatonnes of CO2e, or a weighted average of about $17/tonne of CO2e.

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[1] https://ghgprotocol.org/about-us

2 Data Sources

2.1 Production

Production figures are sourced from the Energy Information Administration (EIA). For oil, the broadest category of all petroleum, natural gas liquids and refinery gains, has been taken. For gas, the category "dry natural gas" has been taken to offer the most consistency since although other categories of gas production, such as vented, flared and reinjected natural gas, exist in the EIA taxonomy, they are very largely blank in international coverage.

2.2 Revenues Received

Government receipts from oil and gas companies have been compiled from summary data held by the EITI International Secretariat, and in the other cases directly from 2018 EITI country reports. It should be recognised that not all payments in the fossil fuel upstream relate to that year's production. Some payments are one-off events, such as signature or production bonuses, or capital gains tax, and other regular payments are affected by past accounting, such as cost recovery in production sharing contracts. Where data has been reported in local currencies, they have been converted into US dollars at an average rate for 2018, using commercial foreign exchange quotations.

3 Emissions Estimation Methodology

Carbon Tracker Initiative, as part of the project to review the Global Registry of Fossil Fuels, has reviewed upstream carbon accounting from the Intergovernmental Panel on Climate Change (IPCC), the International Energy Agency (IEA), various government agencies and providers of commercial analysis and data. In doing so, it has become clear that significant uncertainty exists around emissions figures, that there is a wide range of values between different sources.[2] Emissions methodologies are expected to become more

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[2] See for example the Registry's presentation to the EU DG Energy, showing discrepancies between upstream emissions estimates provided by Wood Mackenzie compared to Stanfrod University's Opgee project of as much as a gigatonne a year: https://github.com/JesperWe/grff-portal/blob/main/reference-models/GRFF_EUBriefing_210621.pptx

standardised and robust, with considerably greater direct measurement, as carbon pricing extends in both reach and price.

3.1 Combustion: IPCC Constant Range

For the largest scope of emissions, combustion of oil and gas, this research uses the range of constant factors embedded in the IPCC process. The latest IPCC Assessment Report[3], refers to values first published in 2006 to assess emissions from crude oil and gas.

The IPCC approach[4] works in two stages. First, a ratio is expressed for the conversion of oil and gas into amounts of energy. Then a second set of ratios are used to convert the energy into emissions. Each of these conversion stages is expressed as a range of low, medium and high for both oil and gas.

For oil, volume is converted into energy from 40.2 terajoules (TJ) per thousand tonnes (low) to 44.8 TJ (high). For natural gas the Registry uses the volume-to-energy conversion ratio provided by the BP Statistical Analysis of 36 Petajoules per billion cubic metres.

Conversion into emissions levels is provided by a second range of constants. For oil, these vary from 71.1 (low) through 73.3 (mid) to 75.5 (high) tonnes of CO2E per terajoule. The ratios for gas are lower, reflecting the lower carbon intensity of gas per unit of energy produced by combustion: from 54.3 (low) through 56.1 (mid) to 58.3 tonnes of CO2E per terajoule.

The two separate ranges must be compounded to show the potential range of emissions per volume. For oil, one tonne of crude oil could therefore produce emissions between 2.85 and 3.38 tonnes of CO2E. For gas the range is from 1.95 thousands tonnes of CO2E per million cubic metres to 2.10 thousand tonnes.

3.2 Upstream: IEA Global

Emissions from the upstream are lower than those from the combustion process of fossil fuels, but with an acknowledged much wider range of variance. The Registry's global base

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[3] https://www.ipcc.ch/assessment-report/ar5/

[4] https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

for estimating upstream emissions is a data set published by the International Energy Agency[5] in January 2021.

The data set takes 2,204 oil projects around the world, and 1,155 gas projects, representing total global production of each fossil fuel. Each project has estimates and projections for a range of causes of carbon emissions in the upstream, including energy used in the extraction process, flaring, vented and fugitive methane emissions, and transportation into the refining unit. Each of the projects then has an estimate of emissions per barrel (or barrel of oil equivalent, in the case of gas) attached to it.

The project data are anonymised in the IEA data set, so individual producers cannot be directly associated with the upstream emissions intensities. The approach underpinning the Registry has therefore adopted is in three steps: first, the estimates are ordered by carbon intensity and multiplied by the volume of production in the project. Second, the cumulative totals of the projects are added. Third the corresponding level of emissions per barrel is selected at the 10th and 90th percentiles (by volume), as well as the weighted average.

The resulting ranges for oil are 21 kg of CO2E per barrel (10th percentile), rising to 57 kgs/barrel (weighted average) and 106 kgs CO2e per barrel (90th percentile). For gas the range starts at 54 kg per boe (10th percentile), through 76 kg / boe (weighted average), rising to 140 kgco2e/boe (90th percentile).

These ranges are the basis for global-level upstream emissions estimates.

3.3 Mid-range estimation: Opgee

The estimates in this paper use the middle ranges of the IPCC estimates for the combustion stage of oil and gas (Scope 3 emissions). For upstream, it uses the IEA for gas, but a narrower set of country-specific emissions factors produced by the Opgee research unit of Stanford University[6]. Opgee has produced upstream emissions factors for 91 oil-producing countries.

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[5] https://github.com/JesperWe/grff-portal/blob/main/reference-models/IEA_Emissions_intensities_210410.xlsx

[6] Opgee has been embedded in the US State of California's clean fuel standard, effective since 2007, and has been widely used in industry and by other policymakers.

3.4 Methane Factoring

The mid-range estimate numbers use the most common factorisation for methane as carbon dioxide equivalence, that of "GWP100", or the Global Warming Potential of methane over 100 years compared to carbon dioxide. But the IPCC process provides for two factorisations of methane, GWP100 and GWP20, which tracks methane in the atmosphere over 20 years. GWP20 gives a higher factorisation of methane to carbon dioxide.

Although GWP100 has been deployed more often by public agencies to build the estimates included in Greenhouse Gas inventories, the IPCC process explicitly states, when offering both ratios, that it does not recommend one rather than another. GWP20 is growing in terms of significance.

In the dataset, therefore, GWP100, with its lower CO2E factors, has been used as part of the low-range estimate, while GWP20 factors for methane have been used in the high range estimate.

The carbon intensity of gas projects, in particular, rises very significantly using a GWP20 factoring, since methane emissions are a large part of overall estimates of CO2E emissions.