



ICE CLIMATE

Sovereign Transition Risk Methodology

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1. Introduction

ICE Climate (referred to throughout as “ICE”) offers a range of cross-asset data and analytics that provide a comprehensive view of sustainability for the financial industry, including both physical and transition climate risks to help market participants identify opportunities, manage risk, create impact, and help meet compliance and regulatory requirements.

ICE Data Services Ireland Ltd is the entity through which ICE intends to establish its ESG ratings business within the European Union and apply for authorization under ESG Ratings Regulation (EU) 2024/3005 (ERR) by 2 November 2026.

ICE’s Sovereign Transition Risk Dataset (“Sovereign Transition Risk Dataset”) provides comprehensive emissions data and climate alignment metrics for sovereign debt issuers. This dataset is designed to help investors assess the climate transition risk profile of sovereign bond holdings by providing both territorial production and trade-adjusted consumption CO₂ and CO₂-equivalent (CO₂^e) greenhouse gas (GHG) emissions data, normalized production and consumption emission metrics including per Capita, per Gross Domestic Product (GDP), and per GDP/Purchase Power Parity (PPP), and forward-looking Implied Temperature Rise (ITR) metric.

The Sovereign Transition Risk Dataset is designed to help institutional investors transparently measure transition risks of sovereign issuers and enable them to integrate these metrics into their portfolio construction and ongoing management processes.

2. Scope and Coverage Summary

2.1. Data Inputs

The table below provides an overview of the public, open-source datasets used to produce the Sovereign Transition Risk Dataset. The primary data sources include¹:

Emissions Data	
Data Source	Data Type
Climate Watch	National Reporting - Country-level emissions reporting
Global Carbon Project	National Reporting - Carbon budget and emissions estimates
Emissions Database for Global Atmospheric Research (EDGAR)	National Reporting - Country-level emissions reporting
Economic and Demographic Data	
Data Source	Data Type
World Bank	Population, GDP, GDP/PPP
Landscan	Gridded population (gap-filling)
Organisation for Economic Co-operation and Development (OECD)	Economic indicators
Climate Scenario Data	
Data Source	Data Type
Network for Greening the Financial System (NGFS) Phase 5	Climate scenario pathways for ITR metric methodology

2.1. Coverage

The Sovereign Transition Risk Dataset provides comprehensive coverage across countries and territories that issue debt instruments:

¹ For data sources see Appendix 1.

- **Geographic Coverage:** 170+ debt-issuing countries and territories²
- **Emission Year Coverage:** from 2000 to 2024
- **Update Frequency:** Annual

² As of January 2026.

3. Process and Methodology

3.1. Process

This section provides a high-level step-by-step process of how the data inputs are collected and processed, and Sovereign Transition Risk metrics are calculated.

1. **Data Collection** - Sovereign emissions data is collected from the three primary data sources - Climate Watch, Global Carbon Project and EDGAR. Economic and demographic data is collected from the World Bank, supplemented by Landscan population data where gaps exist.
2. **Data Integration** - The collected datasets are integrated and standardized to create consistent emission time-series for each sovereign. Complete datasets are not always available for all historical years. For years where not all datasets are available, the mean values and ranges are computed by first inferring the values for the missing datasets.
3. **Emissions Methodology** - Production (CO₂ and CO₂^e) and Consumption (CO₂ and CO₂^e) emissions are calculated using the methodologies described in Section 3.2 below, including normalization by population (per capita), GDP, and GDP/PPP. Minimum, mean, and maximum values are provided for each emissions metric.
4. **ITR Metric Methodology** - ITR metrics are calculated by benchmarking each Sovereign's Nationally Determined Contributions (NDCs) climate scenario against NGFS Phase 5 climate scenarios. The ITR methodology is described in more detail in Section 3.2.4 below.
5. **Instrument Linkage** - ICE maintains an extensive database for linking fixed income instruments to sovereign issuers, leveraging the ICE Entity Mapping Service. For each sovereign issuer, country-level emissions values are maintained and linked to sovereign bonds for portfolio analysis.

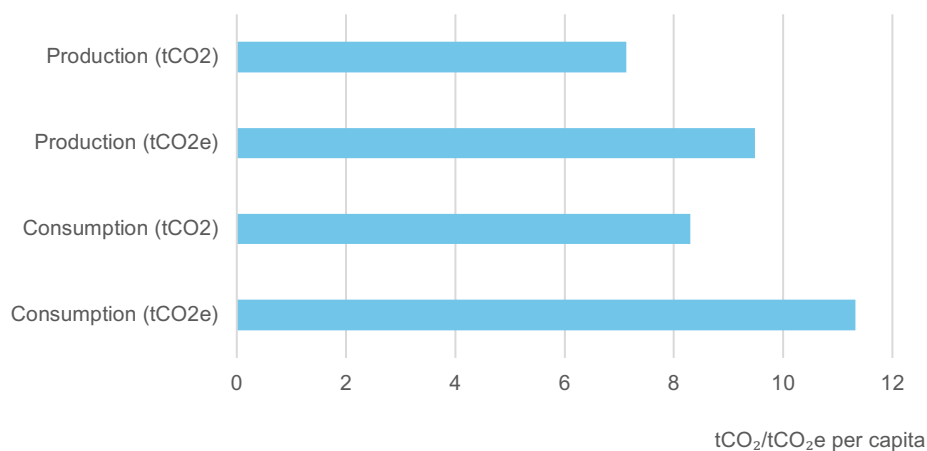
3.2. Methodology

The Sovereign Transition Risk Dataset comprises of three key metrics, i) Emissions, ii) Normalized Emissions, and iii) ITR at the sovereign-level. Minimum, maximum, and mean values are provided for each of the emissions and normalized emission metrics. Mean values are provided for the ITR metrics. This section provides explanations of the methodologies used to calculate each of the metrics below.

The three key Sovereign Transition Risk metrics can be broken down as follows:

- i) Emissions
 - Production CO₂ & CO₂^e emissions (min, max, mean)
 - Consumption CO₂ & CO₂^e emissions (min, max, mean)
- ii) Normalized Emissions
 - Production CO₂ & CO₂^e per capita (min, max, mean)
 - Consumption CO₂ & CO₂^e per capita (min, max, mean)
 - Production CO₂ & CO₂^e per GDP (min, max, mean)
 - Consumption CO₂ & CO₂^e per GDP (min, max, mean)
 - Production CO₂ & CO₂^e per GDP/PPP (min, max, mean)
 - Consumption CO₂ & CO₂^e per GDP/PPP (min, max, mean)
- iii) ITR's for 7 NGFS Phase 5 climate scenarios

Figure 1: Sovereign G20 Production & Consumption Emissions (Portfolio-level)



Source: ICE Climate Sovereign Transition Risk - Portfolio-level Emissions per capita (FY 2023), data as of February 2026.
Figure for illustrative purposes only.

3.2.1. Production Emissions

ICE provides territorial production CO₂ and CO₂^e emissions, as well as normalized production CO₂ and CO₂^e emissions (described in Section 3.2.3 below). Production emissions account for emissions created within a country's territorial boundaries (i.e., emissions produced domestically).

Production CO₂ Emissions:

Production CO₂ values are derived from three publicly available national reporting datasets: Climate Watch, Global Carbon Project and EDGAR.

When all three datasets are available, the minimum, maximum, and mean CO₂ emissions are computed using all data sources. In years where not all datasets are available, a regression model is used to first infer the mean values, and then the minimum and maximum values.

Production CO₂^e Emissions:

CO₂^e emissions are defined as the Kyoto basket of Greenhouse Gases, consisting of:

- Carbon dioxide (CO₂)
- Methane (CH₄)
- Nitrous oxide (N₂O)
- F-gases (hydrofluorocarbons and perfluorocarbons)

These gases are converted to CO₂^e at a 100-year timescale.

CO₂^e emissions are estimated by applying a linear model of the relationship between Climate Watch's CO₂ and CO₂^e to the minimum, mean, and maximum production CO₂ values. For countries with no Climate Watch CO₂^e data, the CO₂^e value is computed by multiplying the production values by a mean scaling ratio of CO₂ to CO₂^e from countries with similar populations.

3.2.2. Consumption Emissions

ICE provides trade-adjusted consumption CO₂ and CO₂^e emissions, as well as normalized consumption CO₂ and CO₂^e emissions (described in Section 3.2.3 below). Trade-adjusted consumption emissions reallocate internationally produced emissions to those countries that consume the final goods of the emission by-product, disregarding the production source, ensuring that the sum of global consumption equals the sum of global production so that consumption emissions only account for products consumed within the country. A country's consumption emissions are defined as: **Consumption Emissions = Production Emissions + Import Emissions – Export Emissions**

Consumption CO₂ Emissions:

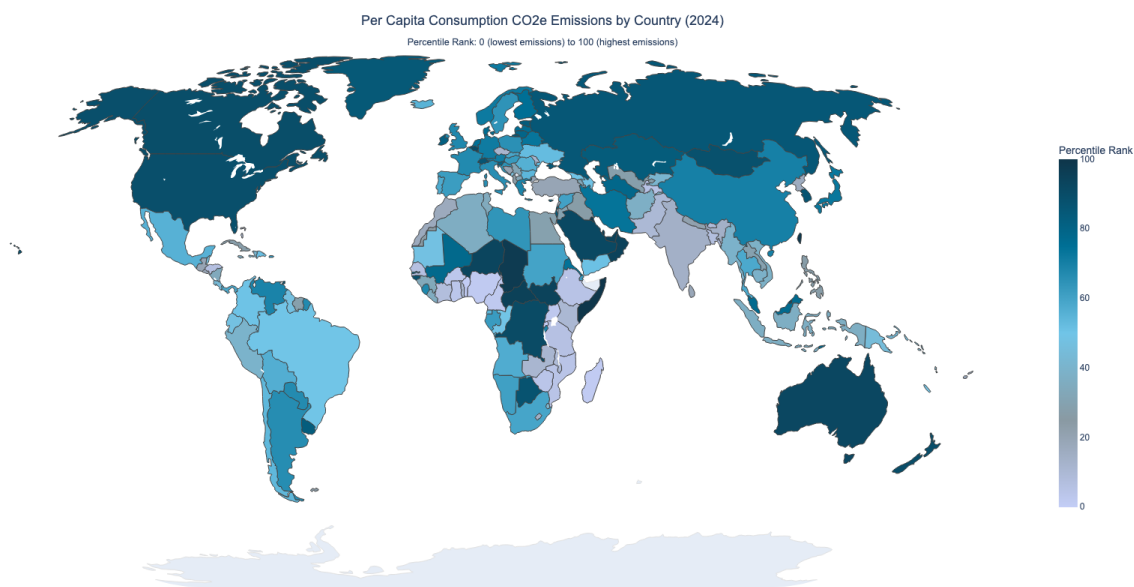
Consumption CO₂ values are calculated by scaling production CO₂ emissions values (mean, minimum, and maximum) by the ratio of Global Carbon Project's carbon consumption to production estimates. A country's most recent ratio is used for years not covered by the Global Carbon Project's estimates.

This trade adjustment ratio is available for 118 countries, accounting for approximately 95% of global production emissions in each year. The remaining 5% of the residual emissions (i.e., those without the trade adjustment ratio) are allocated to the remaining countries based on their relative population.

Consumption CO₂^e Emissions:

The same methodology is followed as described above in Section 3.2.1 - Production CO₂^e Emissions, but using Climate Watch's CO₂ and CO₂^e minimum, mean, and maximum consumption CO₂ values.

Figure 2: Consumption CO₂^e Emissions Intensity per capita in 2024



Source: ICE Climate - Per Capita Consumption CO₂^e emissions intensity (2024) ranked by country percentile, as of January 2026. Figure for illustrative purposes only.

3.2.3. Normalized Emissions - Emission Intensities

To enable comparisons across sovereigns of different sizes and economic development levels, emissions are normalized using three metrics.

Metric	Description	Data Source
Emissions per Capita	Tonnes of CO ₂ /CO ₂ e per person	World Bank population; Landsat where World Bank unavailable
Emissions per GDP	Tonnes of CO ₂ /CO ₂ e per million USD	World Bank GDP
Emissions per GDP/PPP	Tonnes of CO ₂ /CO ₂ e per million international currency	World Bank GDP/PPP

3.2.4. Emissions per Capita

Normalized production and consumption (CO₂ and CO₂^e) emissions are calculated by dividing a country's emissions by its population. Population data is reported by the World Bank. Where the World Bank does not report population, the most recent year is used to normalize CO₂ and CO₂^e emissions.

3.2.5. Emissions per Capita Impact Score

In addition to the per-capita emissions intensities described above, ICE has developed two Emissions per Capita Impact Scores; by production CO₂^e and consumption CO₂^e. For each year, the natural logarithm of the estimated mean GHG emissions per Capita is calculated. Calculating the natural logarithm transforms each country's emissions on a proportional scale, to reduce the skew across the wide range of countries' emission intensities (e.g., most countries emit a relatively small amount, whilst others will emit a larger amount). The log-transformed values are rescaled to a 0-1 range, whereby countries with lower per-capita emissions will receive higher scores, and vice-versa. The two Emissions per Capita Impact Scores are used only in the construction of a sovereign transition risk index.

3.2.6. Emissions per GDP

Normalized production and consumption (CO₂ and CO₂^e) emissions are calculated by dividing a country's emissions by its GDP. GDP (per million USD) data is reported by the World Bank. Where the World Bank does not report GDP, the most recent year is used to normalize CO₂ and CO₂^e emissions.

3.2.7. Emissions per GDP/PPP

Normalized production and consumption (CO₂ and CO₂^e) emissions are calculated by dividing a country's emissions by its GDP/PPP. GDP/PPP (million international currency) data is reported by the World Bank. Where the World Bank does not report GDP/PPP, the most recent year is used to normalize CO₂ and CO₂^e emissions.

Assumptions used when normalizing production and consumption CO₂ and CO₂^e emissions:

- Where World Bank does not provide population data for a specific country, Landscan gridded population data is used to compute CO₂ and CO₂^e per capita.
- CO₂ or CO₂^e per unit of econometric (i.e. GDP or GDP/PPP) is not calculated for countries that are missing GDP data in the World Bank dataset. When this occurs we cannot estimate and therefore there will be nulls within the dataset for emissions per GDP and emissions per GDP/PPP.
- Small territory economies (such as Puerto Rico) are combined with mainland sovereigns, and only national reporting datasets are used when nation boundaries are smaller than grid resolution.

3.2.8. Implied Temperature Rise (ITR)

ICE's Sovereign ITR metric is designed to measure the alignment of decarbonization targets to a global temperature outcome under a set of forward-looking scenarios. The temperature corresponds to end-of-century (2100) temperature, aligned with Paris Agreement goals. The ITR metric benchmarks a country's NDCs against its emissions pathways under different NGFS Phase 5 climate scenarios.

NGFS is a coalition of central banks and financial supervisors that, among other mandates, develop climate scenarios to help assess the impact of climate change on economies and financial systems. NGFS Phase 5 scenarios include multiple pathways such as NDCs, Net Zero 2050, and Current Policies, each reflecting different assumptions about climate policy and technological progress.

NDCs are climate action plans submitted by countries under the Paris Agreement. They outline targets for reducing greenhouse gas emissions and adapting to climate impacts, serving as the foundation for global efforts to limit warming.

ITR Methodology:

Sovereign ITR is calculated using the linear relationship between cumulative emissions of country-level pathways and scenario temperatures from NGFS Phase 5 climate scenarios. The “linear relationship” methodology applies the Transient Climate Response to Cumulative Emissions (TCRE) framework, which simplifies the link between emissions and warming to estimate long-term temperature outcomes under different emissions pathways. TCRE is a scientific concept introduced by the Intergovernmental Panel on Climate Change (“IPCC”) in its Fifth Assessment Report³. It represents the near-linear relationship between cumulative CO₂ emissions and global mean temperature increase. The ITR metric uses the country’s mean production CO₂ emissions to model the cumulative pathway. This metric is widely used in climate modeling because it simplifies the link between emissions and warming, making it easier to estimate long-term temperature outcomes under different emissions pathways.

3.2.8.1. ITR Impact Score

In addition to the ITR metric described above, ICE has developed an ITR Impact Score that is used only in the construction of a sovereign transition risk index. The ITR Impact Score captures each country’s mid- and long-term pledges to reduce GHG, and a lower ITR reflects more ambitious decarbonization pledges. The country-level NGFS Phase 5 ITR values are rescaled to a 0–1 range, whereby a country with higher score indicates more ambitious pledges and vice versa.

³ IPCC, 2013: 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, 1535 pp. See Section 12.5 and Box 12.2.
<https://www.ipcc.ch/report/ar5/wg1/>

4. Quality Assurance

ICE Climate employs a multi-source quality assurance process designed to help maintain the quality of Sovereign Transition Risk data:

- **Multi-Source Validation:** By utilizing three independent emissions datasets, ICE can cross-reference and validate emissions estimates, providing minimum, maximum, and mean values to indicate data uncertainty.
- **Gap-Filling Procedures:** Standardized gap-filling methodologies are applied when datasets are incomplete, using historical relationships between time series to maintain consistency.
- **Regular Updates:** The dataset is updated annually to incorporate the latest available emissions data and economic indicators from source providers.

5. Appendices

5.1. Appendix 1 - Data Sources

The table below sets out data source URL's used within the Emissions and Normalized emissions methodology in Sections 3.2.1, 3.2.2, and 3.2.3.

Source	URL
Climate Watch	www.climatewatchdata.org
Global Carbon Project	https://www.icos-cp.eu/science-and-impact/global-carbon-budget
EDGAR	https://edgar.jrc.ec.europa.eu
World Bank Population	https://data.worldbank.org/indicator/SP.POP.TOTL
World Bank GDP	https://data.worldbank.org/indicator/NY.GDP.MKTP.CD
World Bank GDP/PPP	https://data.worldbank.org/indicator/NY.GDP.MKTP.PP.CD
Landscan	https://landscan.ornl.gov

5.2. Appendix 2 - Kyoto Basket Greenhouse Gases

The following gases are included in CO₂e:

Gas	Chemical Formula	Description
Carbon Dioxide	CO ₂	Primary greenhouse gas from fossil fuel combustion
Methane	CH ₄	Emitted from agriculture, waste, and energy production
Nitrous Oxide	N ₂ O	Emitted from agricultural and industrial activities
Hydrofluorocarbons	HFCs	Synthetic gases used in refrigeration and air conditioning
Perfluorocarbons	PFCs	Synthetic gases from aluminum production and electronics

5.3. Appendix 3 - ITR Metric Key Terms

The table below sets out key terms used within the ITR methodology in Section 3.2.4.

Term	Acronym	Description
Network for Greening the Financial System	NGFS	A coalition of central banks and financial supervisors that, among other mandates, develop climate scenarios to assess the impact of climate change on economies and financial systems. NGFS Phase 5 scenarios include multiple pathways such as NDCs, Net Zero 2050, and current policies.
Nationally Determined Contributions	NDCs	Climate action plans submitted by countries under the Paris Agreement, outlining targets for reducing greenhouse gas emissions and adapting to climate impacts.
Transient Climate Response to cumulative Emissions	TCRE	A scientific concept introduced by the IPCC representing the near-linear relationship between cumulative CO ₂ emissions and global mean temperature increase.
Intergovernmental Panel on Climate Change	IPCC	A United Nations body established in 1988 to provide policymakers with scientific assessments on climate change, its impacts, and potential adaptation and mitigation strategies. It synthesizes research from thousands of scientists worldwide and publishes comprehensive reports that underpin global climate policy, including the Paris Agreement.



More information: ice.com/climate

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