



Carbon Compass

Climate Change & Natural Capital

18 March 2016

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Is carbon footprinting on sovereign bonds possible?

In November 2015, we published our *Carbon Compass: Investor guide to carbon footprinting*, in which we answered the most commonly-asked questions about carbon metrics at the portfolio level, in a context of increased voluntary initiatives (Montreal Pledge, Portfolio Decarbonisation Coalition) and regulatory pressures (e.g. Article 173 of the French Law on Energy Transition)

As investors apply these methodologies, the question of footprinting on other asset classes is often raised, in particular sovereign bonds. Data providers such as South Pole and Trucost (in partnership with the Global Footprint Network and Beyond Ratings, respectively) released their methodologies at end-2015 and in January 2016.

So is carbon footprinting on sovereign bonds possible, and what should investors know about this?

A.

Yes, it is; different asset class, same questions

Yes, carbon footprinting on sovereign bonds is possible and may help foster ESG integration across asset classes. The same questions that apply to carbon footprinting on equity also apply to sovereign bonds.: are investors focusing on “risk” or “contribution to climate change”? Should investors only include the government’s direct emissions or total emissions at the country level? What metric should be used to normalise? What about double-counting? We explore these questions in a simple and user-friendly way to complement our previous insights and findings in this post-COP context.

Main author

Julie Raynaud

ESG Research

jraynaud@keplercheuvreux.com

+44 (0) 207 621 5186

ESG research team

Biographies at the end of the report

Beyond the Q.

ESG

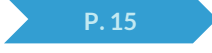
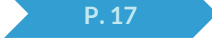
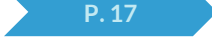
Different asset class, same questions

In November 2015, we published our *Carbon Compass: Investor guide to carbon footprinting*, where we reviewed current and developing tools, including carbon footprints, avoided emissions, green-brown metrics, static and forward-looking benchmarks, to help investors navigate the landscape of carbon metrics.

There is a trend towards including additional asset classes, such as fixed income and in particular sovereign bonds. As we heard a lot of questions on this topic while on the road, we decided to publish a short follow-up focusing specifically on the methodological issues and state of research on this asset class.

We find that performing this type of analysis can still provide interesting insights and signal investors' positioning to policy-makers. The steps of the analysis are the same; they are: 1) Define the perimeter; 2) Collect data; 3) Aggregate at the portfolio level; and 4) Expand our understanding. We review the implications of choosing one approach over another at each of these steps. We also argue that data quality is set to improve and that additional indicators should be taken into account to complement the carbon footprint results.

12 burning questions

-  Should I only include government emissions or country-wide emissions? 
-  Should I correct for imports and exports? 
-  Should I use annual or cumulative emissions? 
-  Where can I find the data? 
-  Are land-use change and other greenhouse gases emissions important? 
-  Will the COP 21 agreement improve the quality of data? 
-  How do I aggregate emissions at portfolio level? 
-  Can I compare the sovereign bond footprint with the equity footprint? 
-  How to treat double-counting in multi-asset portfolios? 
-  What other metrics can I use? 

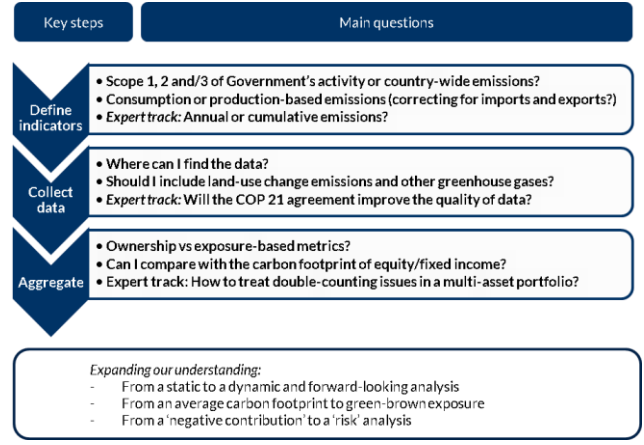
Our main questions in six charts

Chart 1: Our past report looked at carbon footprinting



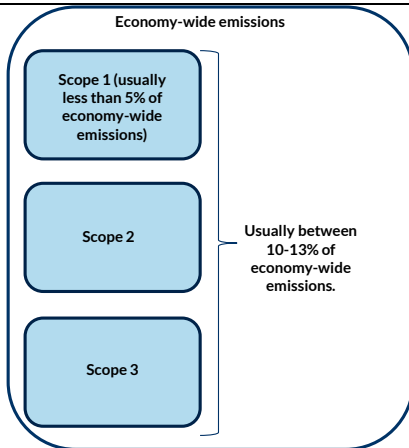
Source: Kepler Cheuvreux

Chart 2: We answer 12 questions on the topic



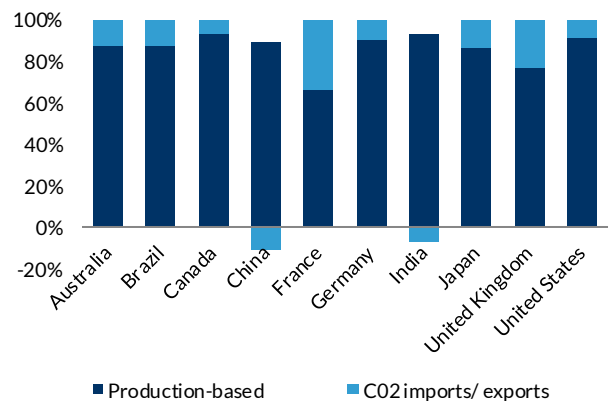
Source: Kepler Cheuvreux

Chart 3: What should the perimeter be?



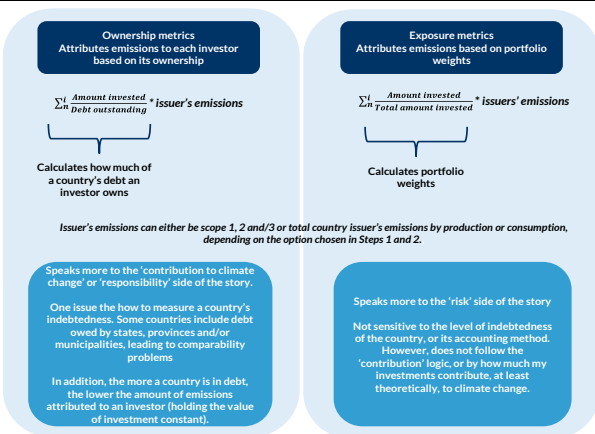
Source: Kepler Cheuvreux

Chart 4: Should it be production- or consumption-based?



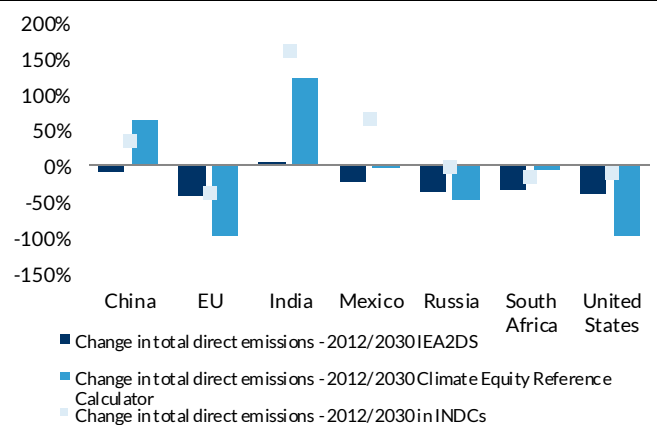
Source: Kepler Cheuvreux

Chart 5: Ownership- or exposure-based metrics?



Source: Kepler Cheuvreux

Chart 6: What other elements should I look at?



Source: Kepler Cheuvreux

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Carbon footprinting on sovereign bonds?

So far, the overwhelming majority of carbon footprint analysis has been done on listed equity (and to some extent corporate bonds). Recently, interest on sovereign bonds has been growing. Data providers have been developing methodologies to allow investors to analyse sovereign bonds and the first analyses are being published. So what should investors know?

Key dynamic 1: Broadening the scope of asset classes

In November 2015, we published our *Carbon Compass: Investor guide to Carbon footprinting*, in collaboration with the Institutional Investor Group on Climate Change (IIGCC), 2° Investing Initiative and Deloitte, where we reviewed current and developing tools, including carbon footprints, avoided emissions, green-brown metrics, static and forward-looking benchmarks, to help investors navigate the landscape of carbon metrics.

The guide revolved mostly around listed equity, as the vast majority of analysis has been carried out on these asset classes. Since November 2015, new methodologies have been published by data providers and investors on how to calculate the carbon footprint of sovereign bonds. We are now carrying out a review in this add-on to our *Carbon Compass* guide.

The overwhelming majority of carbon footprint analysis has been done on publicly-listed equity so far

New methodologies have been published by data providers and investors on how to calculate the carbon footprint of sovereign bonds

Chart 7: Carbon Compass: investor guide to carbon footprinting ([Click here](#))



Source: Kepler Cheuvreux

Key dynamic 2: Increased focus on the objective

As highlighted in our *Carbon Compass* guide, investors should first define their investment belief and strategy and select appropriate metrics, while ensuring that the methodological foundations are suitable to what they are trying to measure and accomplish. **In short, the choice of metrics depends on what investors are trying to achieve and how investors will use them.**

As for other asset classes, the analysis can focus on **mitigating the negative contribution to climate change versus optimising the positive contribution**. The analysis can also focus on **risk or 'climate-friendliness'**. The carbon footprint is mainly an indicator of negative contribution to climate change – it also sends a signal to governments that better climate performance is expected; it is not a measure of risk *per se*, especially when incomplete in perimeter, but can be used as a proxy together with other indicators.

The **'ownership' link is less marked when looking at sovereign bonds**: it is impossible to vote and engage with a country's government in the same way as with a company in which one owns equity. Similarly, there is a lack of transparency in the use of proceeds (e.g. which could be used to finance the energy transition in a very carbon-intensive country), although it could be argued that the same holds true with company-level analyses. The difference in maturity is not reflected in current carbon footprint methodologies either.

Key dynamic 3: Regulatory and voluntary developments

Article 173 of the French Law on Energy Transition, specifying reporting requirements on environmental/social/governance (ESG) criteria for investors, was finally published on 29 December 2015. It requires investors to disclose relevant environmental, social and governance information on their investments, including how they contribute to the energy and ecological transition. We have also been observing international momentum on this topic, with discussions taking place in the UK, Switzerland, Sweden and the Netherlands.

The regulation is on a "comply-or-explain" basis and specifies that the reporting entity chooses the way the information is segmented (by activity, asset class, portfolio, source, sector, etc.). In practice, this means that investors may justify why sovereign bonds and other classes were not included in the analysis.

Carbon footprint is mainly an indicator of negative contribution to climate change

We review other metrics that exist at sovereign bond level analysis in the last section of this report.

In practice, it means that investors may justify why sovereign bonds and other classes were not included in the analysis

Table 1: High-level summary of Article 173 requirements (more details below)

Reporting entity	General process and information on how environmental, social and governance (ESG) criteria are taken into account.
	Description of the main criteria – including their link with environmental risk and the international objective on climate change and the ecological/ climate transition.
	Information used to analyse each criteria – it can be financial or extra-financial data, internal or external analysis or scoring, or any other material information.
ESG criteria	Methodology and results of the analysis: it can include information on the general characteristics of the methodology; main underlying hypothesis and their alignment with international climate change objectives; commentary on the relevance of the methodology and boundary of the analysis; information on risk; information on the alignment of investments with a low-carbon strategy and/or in thematic funds; past, current or future carbon footprint.
	Integration of the results in the investment policy.

Source: Kepler Cheuvreux, based on Article 173 of the French Law on the Energy Transition

Table 2: Detailed requirements of Article 173

Reference	Sections	Reporting elements
Article 1, section II, Sub-section 1°	1. Information on the reporting entity	* Presentation of the general process to take into account social, environmental and governance criteria in the entity's investment policy, and where appropriate, risk management.
		* Content/ frequency/ means used to keep clients informed.
		* List of funds that take into account environmental, social and governance criteria and percentage of the amount that this represents in the overall portfolio.
		* Adherence to a convention/code/initiative or label and general description.
		* Description of internal procedures to identify risks when the entity has one.
Sub-section 2°	2. Information on social, environmental and governance criteria in the entity's investment policy	Segmentation - the entity chooses the way the information is segmented (by activity, asset classes, portfolio, source, sector or any other relevant segmentation) – and justification.
		a. Description of the main criteria taken into account (see below for more information).
		b. Information used to analyse the criteria (see below for more information).
		c. Methodology and results of the analysis of the criteria (see below for more information).
		d. Integration of the results of the analysis in the investment policy (see below for more information).
		e. Description of changes following the analysis.
		f. Engagement strategy (engagement strategy, vote policy, assessment).
		g. Engagement strategy for asset managers.
Sub-section 3°	3. Funds managed by asset managers	Criteria a.-g. above.
Sub-section 4°	"Comply-or-explain" approach	Where applicable, reasons why the entity provides only part of the information mentioned above.
Details on points a, b, c, d above (in bold)		
Article 1, section III, section 1°	a. Description of the main criteria taken into account	Justification of the choice of criteria.
		For environmental criteria, link with environmental risk (physical, transition) and how they contribute to the international objective on climate change/ energy and ecological transition.
Section 2°	b. Information used to analyse the criteria	Financial or extra-financial data, internal/external analysis or scoring, any other material information.
Section 3°	c. Methodology and results of the analysis of the criteria	Description of the methodology can include (in general):
		* General characteristics of the methodology.
		* Where applicable, details on the main underlying hypothesis and their alignment with international climate change objectives.
		* Commentary on the relevance of the method and boundary of the analysis.
		Description of the methodology can include (for environmental criteria):
		* Clarification on climate change and consequences of extreme events.
		* Evolution of the availability and price of natural resources and the alignment of their use with climate and ecological objectives.
		* Alignment of investments with a low-carbon strategy, in particular, for actors involved in fossil reserve operations, underlying hypotheses to investment spent on the development of these reserves.
		* Any element linked to the implementation of the Government of the international objective on climate change and the climate and ecological transition.
		* Greenhouse gas metrics - past, actual or future, direct or indirect - detailing the general characteristics and boundaries of the methodology used, the way it is used for risk analysis; if an intensity metric is calculated, the denominator used; if the metric is aggregated, details on the weighting method.
		* Metrics on investments in thematic funds or funds with a label, code or initiative to contribute to the international objective on climate change and the climate and ecological transition.
		* Any other relevant information.
Section 4°	d. Integration of the results in the investment policy	Information on how the entity analyses the coherence of its investment policy with climate and ecological transition objectives, targets, actions taken. Where applicable, reasons that may explain it.

Source: Kepler Cheuvreux, based on Article 173 of the French Law on the Energy Transition

Key dynamic 4: An increasing body of work

Until recently, the majority of work had been focussed on the integration of ESG factors in sovereign risk analysis, without a specific focus on the carbon footprint element ([link](#)) due to a lack of methodological approaches.

Five main data providers are positioning themselves in the carbon footprinting market for sovereign bonds: Beyond Ratings & Trucost, the Global Footprint Network & South Pole Group, and ET Index.

These organisations are also putting together working groups on the topic:

- The Global Footprint Network and South Pole have put in place an investor working group on the topic (with seven investors participating so far), with the aim of publishing a white paper on the topic summer 2016.
- ET Index is seeking investor partners to develop a methodology for allocating carbon emissions across portfolios of all asset classes (including sovereign bonds), with the ambition of creating a standard that the wider industry can use, and potentially applicable to the allocation of other extra-financial risks in the ESG space.

As for the financial sector, an increasing number of investors are trying this type of analysis internally, with a couple disclosing the results publicly.

Very little work has been done so far on other bond issuers, such as supranational organisations or municipal bonds – with the notable exception of corporate bonds (see our previous guide ‘Carbon Compass’).

Until recently, the majority of work had been focussed on the integration of ESG factors in sovereign risk analysis, without a specific focus on the carbon footprint element

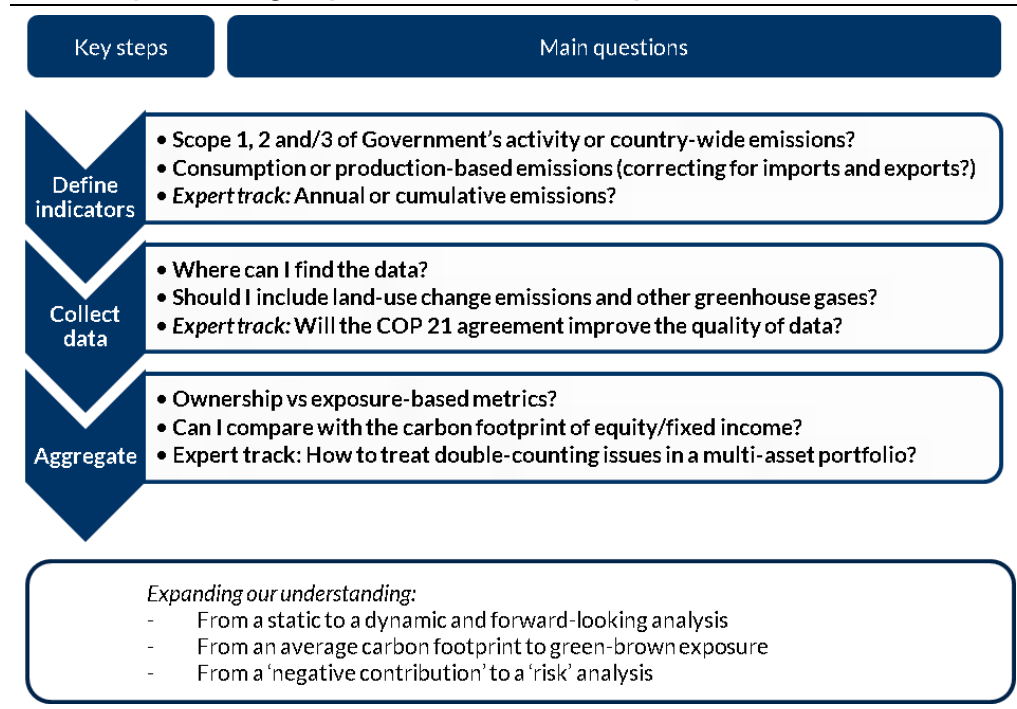
Different asset class, same questions

The steps to perform a carbon footprint analysis on sovereign bonds are similar to those followed to carry out a carbon footprint analysis on listed equity, i.e.:

1. Define perimeter.
2. Collect data.
3. Aggregate at portfolio level.
4. Expand our understanding.

However, there are some specific challenges at each step that we review in the following sections.

Chart 8: Key methodological questions we tackle in this report



Source: Kepler Cheuvreux

Step 1: What perimeter should I choose?

There are two broad options to define the perimeter of the analysis:

1. Just as we are talking about "scopes" to define the perimeter of the analysis in the case of companies, we can also use this concept in the context of governments.
 - Scope 1 and 2 are understood as the carbon emissions related to the government's energy and electricity consumption.
 - Scope 3 encompasses the upstream and downstream value chain emissions of the government purchases.

The steps to perform a carbon footprint analysis on sovereign bonds are similar to those followed to carry out a carbon footprint analysis on listed equity...

...but there are some specific challenges at each step

There are two broad options to define the perimeter of the analysis

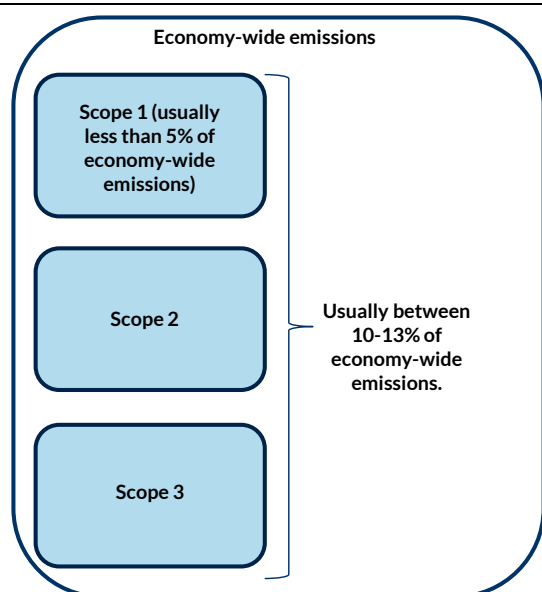
While this approach yields a more conservative (lower) number, the question is whether it is logical – are investors only financing the government when buying a bond?

2. **Emissions of the entire economy** (beyond Scope 1, 2, and 3 of the government and state-owned enterprises). This approach supports the view that the state has a regulatory role through its climate policies and hence is responsible for the country's entire emissions.

There is a trade-off between coverage and double-counting across asset classes. Limiting the analysis to Scope 1 avoids the risk of double-counting when aggregating the carbon emissions of different asset classes, but takes a limited view of the role of the state in piloting the national carbon strategy.

We tackle the question of double-counting on page 17 when discussing aggregation

Chart 9: Perimeter choices illustrated



Source: Beyond Ratings, Kepler Cheuvreux. Research by Beyond Ratings found that the Scope 1 and 2 of the public sector (public administration and defence, education, health and social services, community/social and personal service activity) is usually less than 5% of a country's total emissions. When taking into account Scope 1, 2 and 3 (upstream, i.e. through carbon emissions embodied in Government purchases), it represents between 10-13% of the country's total emissions (including emissions embodied in imports).

Table 3: Trade-offs in the choice of perimeter

	Cross-asset double counting?	Responsibility attribution
Scope 1	No.	Own emissions only.
Scope 1 and 2	Yes, potentially.	Total energy-use emissions (incl. electricity).
Scope 1, 2, and 3	Yes, potentially.	As above, and full supply-chains emissions through procurement policy.
Economy-wide emissions	Yes, most likely.	Whole economy's emissions (indirectly, through regulatory role).

Source: Kepler Cheuvreux

When using the total emissions of a country, the next question is whether to include **production- or consumption-based emissions, i.e. whether to correct for imports and exports**. This can make a significant difference: see as an example the following table taken from a study of the French Economist Thomas Piketty on the difference between consumption- and production-based emissions by region ([link](#)).

From a 'contribution-to-climate-change' perspective, one could imagine using the total carbon footprint by production + imports (without subtracting exports). However, this would lead to double-counting across countries and does not follow the accounting logic of international agreements. Chart 11 highlights the implications of choosing one method over another.

Production- or consumption-based emissions?

Table 4: Production versus consumption accounting

	tCO ₂ e per person per year	% change with production	Ratio to world average
World average	6.2	0	1
N.Americans	22.5	13	3.6
W.Europeans	13.1	41	2.1
Middle East	7.4	-8	1.2
Chinese	6	-25	1
Latino Americans	4.4	-15	0.7
S. Asians	2.2	-8	0.4
Africans	1.9	-21	0.3
Sustainable level	1.3	0	0.2

Source: Piketty and Chancel, 2015, based on Peter and Andrew (2015) and WRI (2015). Key: Western Europeans emit on average 13.1t CO₂e per year and per person, including consumption-based emissions. This figure is 41% higher than production-based emissions and 2.1x higher than world average. Note: Data from 2013.

Table 5: Implications of choosing one method over another

	Aligned with International agreements	Double counting across countries	Biased towards?
Production-based	Yes	No	Large exporters
Consumption-based	No	No	Large imported
Production + Imports	No	Yes	No bias

Source: Kepler Cheuvreux

Expert track: What about temporal boundaries?

Should annual or cumulated emissions be included?

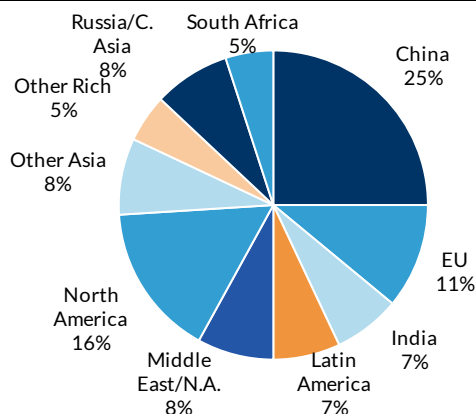
According to analysis by Piketty and Chancel in 2015, European countries are responsible for less than 11% of current emissions (as of 2012) and 20% of cumulated emissions since the industrial revolution.

While this way of slicing the data adds an interesting perspective in the context of international climate finance (following the principles of “retributive justice” and “common but differentiated responsibilities”), it raises additional methodological questions: should the cumulated emissions be normalised by annual GDP or by cumulated GDP for example? Should investors be held responsible for the historical cumulated emissions of the countries they invest in? Should the length of debt be taken into account? Is it an appropriate measure to get a sense of the change in carbon performance of countries?

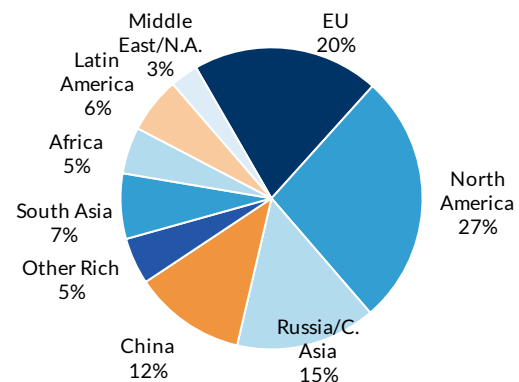
In addition, this metric is backward-looking and hence does not fit the forward-looking lenses of investments. For these reasons, we argue that only annual emissions should be taken into account.

We discuss this further on page 18.

Should annual or cumulated emissions be included?

Chart 10: Distribution of current emissions (production)


Source: Piketty and Chancel (2015) based on CAIT (WRI, 2015). Key: China represents 25% of global CO₂e emissions when measured from a production base (data from 2012)

Chart 11: Distribution of cumulated emissions (production)


Source: Piketty and Chancel (2015) based on CAIT (WRI, 2015) and CDIAC (Boden et al., 2015). Key: Emissions from North America represent 27% of all CO₂e emissions ever emitted since the industrial revolution

Step 2: Where can I find the data and how good is it?

Depending on the perimeter chosen in Step 1, data sources will vary.

Scope 1, 2 and/or 3: more difficult to find than it seems!

- **Scope 1 and 2** data may be difficult to find, depending on the country. Some countries report their Scope 1 and 2 emissions, or at least the energy consumption and mix that could allow us to calculate the associated carbon emissions. This is time-intensive and little data exists.

Another method consists of using databases that aggregate data from several sources – a core question is whether government activities are disentangled from other sectors (e.g. does it differentiate between public and private education?)

- **Scope 3** data are even more challenging to find, and may need to be estimated using sophisticated modelling techniques such as input-output models that provide data on household and government consumption.

As explained in our previous *Carbon Compass* report, these models quantify the economic exchanges between industries. They can be extended to include the greenhouse gas emissions associated with these exchanges.

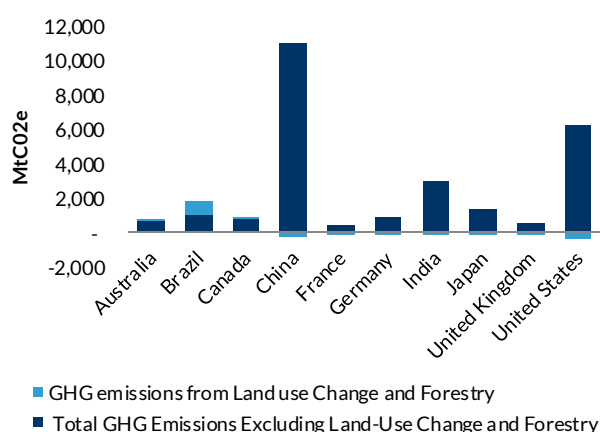
Country-level emissions: a question of tradeoffs...

- **For country-level production-based emissions:** our preferred publicly-available source is WRI ([link](#)), which incorporates several data sources to build their estimates, in order to overcome the main limitations of some datasets: it includes not only carbon but also other greenhouse gases, energy/cement/land-use change emissions.

Depending on the perimeter chosen in Step 1, data sources will vary

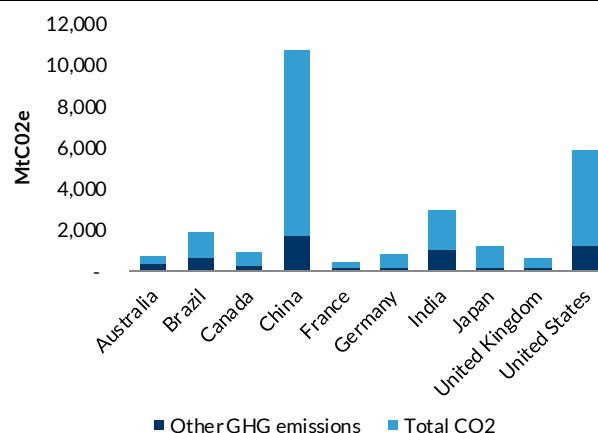
Our preferred publicly-available source is WRI

Chart 12: What about land use change emissions...



Source: Based on WRI data, 2012 ([link](#))

Chart 13: ... and other greenhouse gases?



Source: Based on WRI data, 2012 ([link](#))

Land-use change emissions and the concept of “net carbon footprint” in particular are gaining momentum at international policy level – see Samuel Mary’s latest report *Integrating landscape into investments* ([link](#)). Afforestation, reducing deforestation and managing land for increased carbon sequestration are ways to mitigate climate impacts and their positive effect should thus be included in the analysis, in our view.

See Samuel Mary’s latest report “Integrating Landscape into Investments”

A core limitation is that the latest data is from 2012. Extrapolation (based on GDP and past trends in decoupling) may be used, as well as other data sets (e.g. the EDGAR database from the European Commission, [link](#)) that cover only carbon, but only until 2014.

Other data sources include the International Energy Agency, which tracks carbon emissions from fossil fuel combustion and data from the Carbon Dioxide Information Analysis Center. The FAO has data on carbon emissions from land use change. WRI, WIOD and data providers aggregate these data sources to build their own estimates.

- **To adjust for imports and exports (consumption-based):** the OECD publishes Excel tables ([link](#))¹ that are easier to use (because the data is already calculated) but only include CO₂ emissions from fuel combustion and no other GHGs (see comment above).

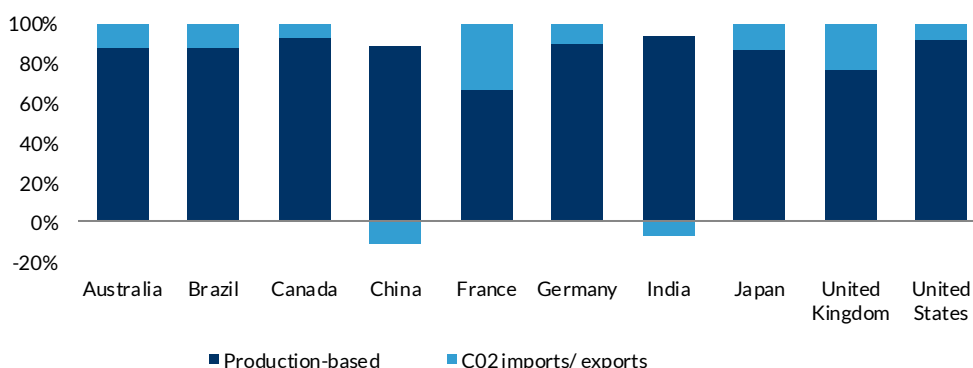
Methods based on input-output modelling can be used but require additional analysis and time. These models quantify the economic exchanges between industries and can either be based on a single region (generally the US) or on several regions. Multi-region models can be used to estimate emissions associated with imports and exports.

The advantage of these datasets is that they are harmonised between countries. One limitation of these models is that they are as good as the underlying data sources used, and significant assumptions may be made when trying to match and split the datasets used with the sector classification the models rely on.

While WIOD ([link](#)), funded by the European Commission, is the easiest to use, the latest data are from 2009. Others include GTAP, EORA, and OECD. Another option, possibly more time-intensive, consists in understanding the quantity of commodities traded between countries (e.g. using the COMTRADE database) and applying life-cycle analysis factors.

To adjust for imports and exports (consumption-based): OECD tables are easier to use but suffer from several limitations

Chart 14: When adding imports and exports to the story



Source: Kepler Cheuvreux calculations based on OECD 2011 (CO₂ only, excluding land use change and forestry emissions)

¹ Click under "Environment", "Carbon Dioxide Emissions Embodied in International Trade"

Expert track: Will the COP 21 improve the quality of data?

The greenhouse gas data submitted by countries under the Climate Convention to the UNFCCC is often used to build country-level datasets and is considered one of the most accurate sources of data. Note that this concerns only production-based emissions.

Previously, only Annex I countries (industrialised) were required to report according to IPCC guidelines, leading to good data coverage from 1990 to 2012. Others (non-Annex I, developing) were not required to, leading to some gaps.

Research institutes (WRI, WIOD, others) that rely on reported data to build the databases investors then had to either use UNFCCC data and rely on alternative databases such as EDGAR for other countries (e.g. WIOD), or combine alternative data sources (WRI).

Without going into too much detail, the largest sources of uncertainties pertain to the emission factors used (e.g. kg of CO₂e per unit of energy) and the inclusion of other GHGs (e.g. methane and refrigerants). In that context, a core question is that of comparability.

There was a big focus during COP 21 on enhancing transparency and allowing comparability between parties' efforts to tackle climate change. Under the new scheme, each country must annually establish and report on GHG inventories in a way that is consistent with the IPCC guidelines, and the information will be verified by a panel of independent experts.

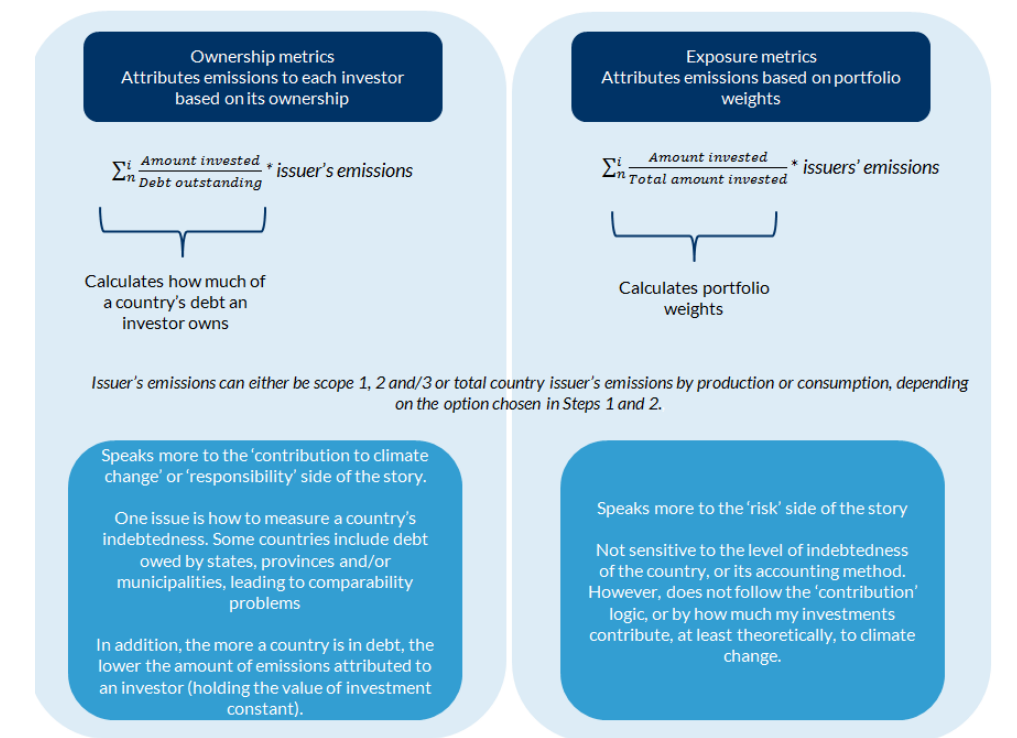
While incentives for countries to report on high-quality data are also planned to be set up, we have to wait until COP 24 to know the details of the common guidelines and procedures related to the Monitoring, Reporting and Verification (MRV) system.

While we currently have little visibility on the new Monitoring, Reporting and Verification system, we think it will improve data quality due to increased geographical coverage: as of 2023, all parties (including non-Annex I countries in the previous system) will have to submit a new or upgraded national climate plan every five years and report on performance versus targets. The Monitoring, Reporting and Verification of emissions will go through a common accountability system.

Step 3: How should I aggregate at portfolio level?

As highlighted in the *Carbon Compass* report, there are two high-level methods to allocate and aggregate emissions at portfolio level: ownership versus exposure-based metrics.

Chart 15: An important distinction

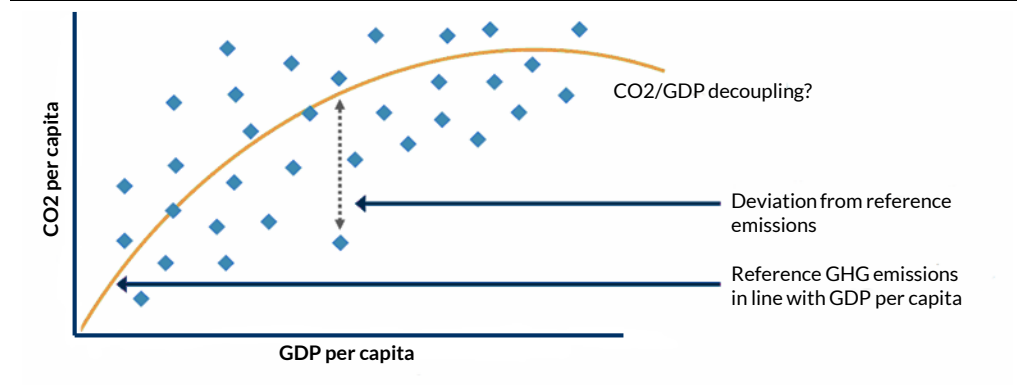


Source: Kepler Cheuvreux

In both cases, in order to allow for comparisons of portfolios of different sizes, data may be normalised by capita, public debt, GDP or other factors. GDP is preferred, in our view, as a measure of economic performance. "Emissions per unit of GDP" is thus a measure of efficiency. It can also be normalised by emissions per capita, in order to understand how efficient a specific country is in creating value for its inhabitants.

In both cases, in order to allow for comparisons of portfolios of different sizes, data may be normalised by capita, public debt, GDP or other factors

Chart 16: Deviation from a reference level of emissions



Source: Beyond Ratings, Trucost

A note on comparing with a company-level carbon footprint: for simplicity of reporting, some investors might prefer to have single figure cross-asset classes. In our view, such a number loses its explanatory power, and if reported publicly, should be done alongside more granular indicators, such as asset classes.

As GDP is a measure of income rather than revenue, carbon emissions per unit of GDP may not be directly comparable with a company's carbon emissions per unit of revenue. Instead, carbon emissions per unit of income may be used to facilitate the comparison. Note that the firm's income is one component of GDP and will thus lead to double-counting. However, when using carbon emissions at country level as a nominator, there will also be double-counting, so that should be acceptable.

Other options include normalising by government taxes (this may speak more to a risk-oriented approach).

Expert track: How to treat double-counting issues in a multi-asset portfolio?

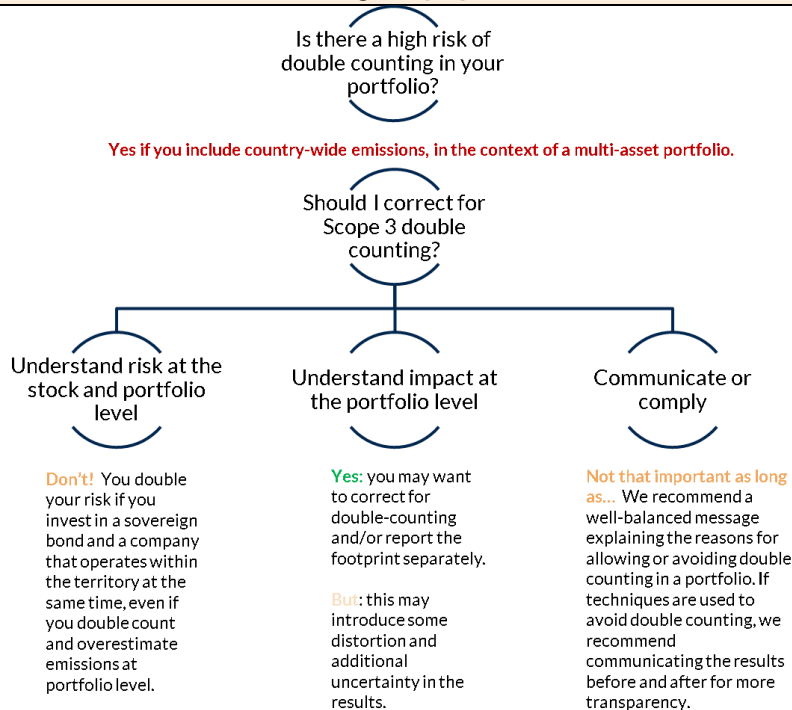
This question arises when including economy-wide emissions.

As highlighted in our *Carbon Compass* report, if the carbon footprint is used as a proxy for risk (with all the caveats associated), it is best not to avoid double-counting, as the government is dependent on the tax revenues from companies operating on its soil.

When trying to understand the 'climate-friendliness' of an investment, double-counting might become an issue. However, as we highlighted at the start of this report, the 'responsibility' link is not clear in the case of sovereign bonds.

This question arises when including economy-wide emissions

Chart 17: Decision tree – is double-counting really a problem?



Source: Kepler Cheuvreux

If there is still a desire to try to decrease double-counting, based on Beyond Ratings' research, suggested approaches include:

- **Option 1:** Using a rating methodology rather than total carbon footprint and calculating an average rating based on portfolio weights.
- **Option 2:** Determining the government's "responsibility share" in non-public emissions and subtracting that share from corporate emissions; this share could be based on a standard share of the public sector's added value or a broader assessment of the government's policy-making role by sector. At the moment, data needs favour the use of a single ratio.

Step 4: Expanding our understanding

The carbon footprint is a **static** (and backward-looking due to the use of older data) and **average** figure which by itself shows the **negative contribution of investments to climate change** (rather than risk, depending on the methodology chosen in the previous steps). Additional analysis could tackle these limitations; we now look at these.

From a static to a dynamic and forward-looking analysis

The question of **dynamic benchmarking** and alignment with a 2°C trajectory has been investigated at company and portfolio level, mainly for listed equities, with methodologies such as Science-Based Targets or the 2°C portfolio. However, it could in theory be investigated at country level.

1. In theory, all countries that have signed the Paris agreement are committed to a 'less than 2°C world', so all these countries can be considered aligned.
2. In practice, the sum of commitments (or Intended Nationally Determined Contributions, INDCs) submitted so far overshoots the 2°C target, and some countries could be more proactive and credible than others.

One could potentially use the pledges to assess which country is better aligned with a 2°C (or even 1.5°C) world compared to its peers.

The carbon footprint is a static and average figure which by itself shows the negative contribution of investments to climate change

Expert track: using INDCs as an additional element of analysis

As of February 2016, 161 Intended Nationally Determined Contributions representing 188 countries had been submitted, covering 97.1% of the GHG emissions released worldwide in 2011. Could these be used in one way or another?

Unfortunately, it is not that easy.

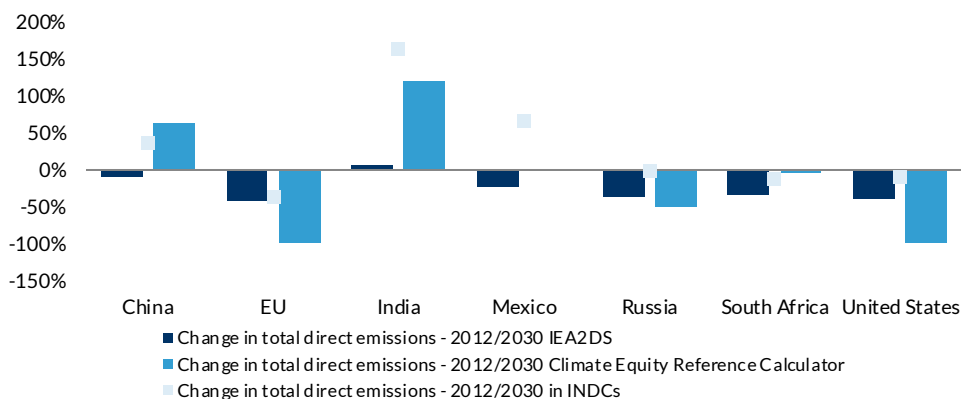
INDCs may not always take the form of a GHG target (only 66.9% of the INDCs submitted to date). When targets are submitted, the type, base year, sector and GHGs covered will vary. Adding to this, differences in INDC are also crystallised in scope and coverage. Sectors and greenhouse gases falling under each INDC can vary substantially.

One could use this to estimate the future emissions of a country. The question then, is whether it is “fair” or not.

To be able to assess a country’s climate change position and commitments, a handful of organisations have undertaken an assessment of INDCs, especially under the “fair” and “ambitious” angle.

- The International Energy Agency 2°C scenario looks at the ‘capacity’ side of the story and determines what is needed by sector/region up to 2050.
- Other tools (such as the one developed by the Stockholm Environment Institute) allocate emissions based on historical responsibility or a mix between capacity and responsibility ([link](#)). Additional questions arise when including the responsibility element: should it be calculated since 1850, 1950, or 1990? Should a development threshold be set?

Chart 18: Difference in percentage decrease using IEA scenario and ‘fair’ share approach



Source: Kepler Calculations based on IEA 2015 and Stockholm Environment Institute 2015. Includes CO2 only and excludes land use emissions. Data compares the % change in emissions between 2012 and 2030. See the Carbon Compass report with the required decrease in emissions under the 2°C scenario of the IEA, from 2012 to 2050. Note that we took the most conservative part of the pledge that could be quantified. The results of this analysis are very sensitive to the assumptions taken. This chart is only provided as an illustrative example.

The CAIT tool from WRI also forecasts emissions according to different scenarios and may be an interesting source of data in this type of analysis ([link](#)).

Another potential analysis relates to how likely decision-makers are to keep their promises. A study from the Grantham Research Institute on Climate

One could use this to estimate the future emissions of a country. The question then, is whether it is “fair”

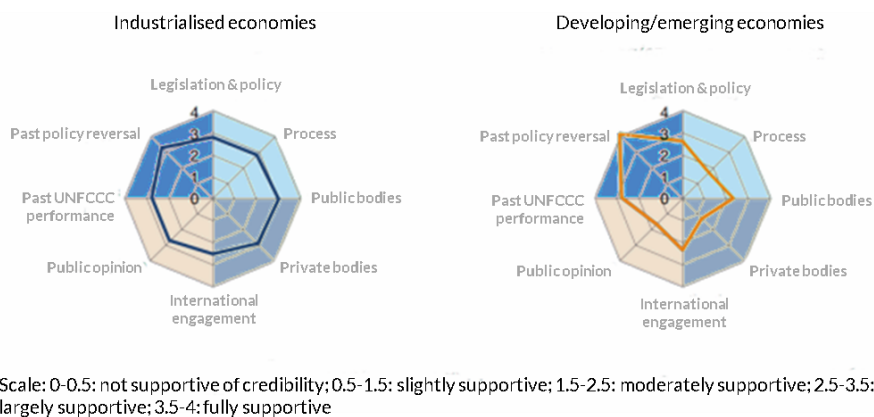
Capacity versus responsibility

Another potential analysis relates to how likely decision-makers are to keep their promises

Change and Environment ([link](#)) has developed a framework to assess the credibility of pledges and tested it on G20 countries based on: 1) rules and procedures; 2) players and organisations; 3) norms and public opinion; and 4) past performance in implementing international commitments and domestic policies.

The World Resource Institute also published a report discussing key performance indicators to evaluate the implementation of climate change policies and their effects ([link](#)).

Chart 19: Average score of the determinants supporting the credibility of pledges



Source: Grantham Research Institute on Climate Change and Environment, 2016 ([link](#)). Country-specific analysis is available in the report itself.

From an average carbon footprint to green-brown exposure

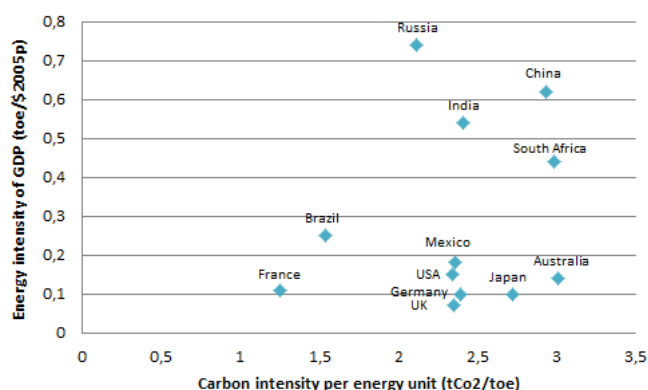
To understand what lies beneath the average country-level carbon emissions, breaking down energy-related emissions into further components may be useful and help to assess a country's exposure to renewable and fossil energy.

In our view, using the so-called Kaya identity can be a good starting point to identify the main drivers under carbon emissions. The identity breaks down total carbon emissions from energy (T) into four components, namely: 1) population (P); 2) GDP per capita (G/P); 3) energy use per unit of GDP (E/G); and 4) carbon emissions per unit of energy (C/E).

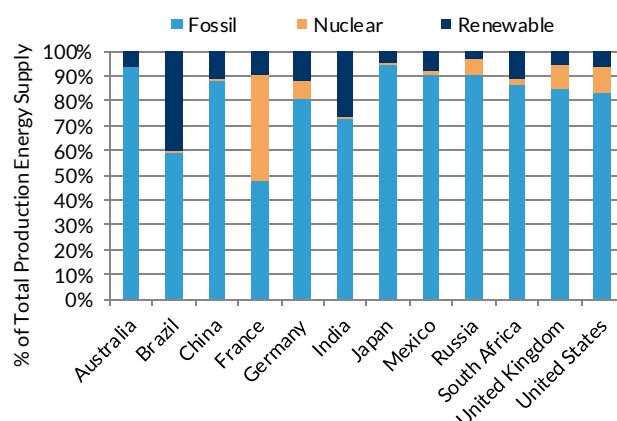
$$\text{Equation (3): } T = P * G/P * E/G * C/E$$

This equation can then be used to assess the contribution of each factor to total emissions, how they evolve, and even what the energy intensity (energy use per unit of GDP) and carbon intensity (carbon emissions per unit of energy) should be to achieve a certain emission level while keeping population and GDP per capita at a predetermined (or evolving) level. Note that this can also be used at company level

Breaking down energy-related emissions into further components may be useful

Chart 20: Comparing energy and carbon intensity profiles


Source: Kepler Cheuvreux calculations, based on IEA 2013 Statistics

Chart 21: Green vs Brown from an energy-consumption angle


Source: Kepler Cheuvreux calculations, based on IEA 2013 Statistics- Total primary energy supply (production + imports - exports - international marine and aviation bunker +/- stock changes) excluding heat and electricity figures

Carbon intensity will also depend on the fossil fuel energy breakdown. Russia ends up having a lower carbon intensity compared to India (Chart 20), despite a higher brown exposure (as shown in Chart 21), which is explained by a higher recourse to natural gas versus other carbon-intensive emitting fossil fuels. Alternatively to the total primary energy supply, another option is looking at the total production and imports of primary energy when assessing the carbon footprint of a country:

Further exploring the green/brown exposure of a country can be achieved by going beyond traditional indicators (e.g. share of renewable and non-renewable energy), to wider indicators assessment, which nonetheless give valuable indications about the green forward-looking orientation of the country. Since 2012, the OECD, the World Bank, UNEP and Global Green Growth Institute have worked together to develop a global approach to green growth indicators ([link](#)), unveiling at the same time each of the organization's own indicators to measure green growth.

Table 6: Selected alternative indicators

Indicators	Source
Patents of importance to green growth	OECD database (link)
Fossil fuel subsidies	EA/OECD database (link), IMF (link)
R&D expenditure related to energy and environment	OECD database (link)
Environmentally-related taxation	OECD database (link)
Eurostat database (link)	
Energy pricing (share of taxes in end-use prices)	OECD database (link)
Carbon market financing	OECD database (link)

Source: OECD, IEA

Green forward-looking orientation of the country?

Expert track: financing the transition

International financial tools to promote green growth are evolving, and talking about sovereign carbon footprinting necessarily leads us to the following question: wouldn't it be easier to invest in sovereign green bonds? While financial institutions, corporates, municipalities, cities and sub-national entities are increasingly issuing green bonds, we are still longing to see sovereign enter the market. This might take a new turn, as Sean Kidney, CEO of the Climate Bond Initiative, recently stated that four countries (possibly China, Bangladesh and Sweden) were seeking to issue sovereign green bonds.

Another innovative tool which has recently been put on the table is the environmental policy performance bond, where the interest rates are linked to CO2 reduction targets ([link](#)). However, as proceeds are not supposed to be earmarked for green projects and no guarantee is given that CO2 targets will be achieved, we do not see a direct translation in terms of carbon footprinting reduction (vs. green bonds, where the traceability of proceeds towards "green" projects is key). It rather sends a strong signal to the market that countries are confident in meeting their CO2 emission reduction target, thus constituting a good indicator of which sovereign to include in a portfolio from an environmental and forward-looking perspective.

From a 'negative contribution' to a 'risk' analysis

The carbon footprint is an indicator of 'negative contribution' rather than risk. There is an increased body of research that looks at integrating climate risk into countries' assessments (e.g. the IMF announced that it would start including climate risk in its countries assessment for the World Economic Outlook ([link](#)), the European Systemic Risk Board and Financial Stability Board recent papers on climate change, transition and financial stability).

Understanding a country's green-brown exposure (e.g. fossil fuel dependence, reliance on fossil fuel exports, national ownership of oil and gas reserves, etc.) is a start in analysing the transition/carbon risk attached to sovereign bonds. Tools have also been developed to assess countries' vulnerability to the physical risk of climate change ([link](#) to an article from South Pole and the Global Footprint Network on Institutional Investors).

However, these tools lack comparability due to different research focus and methodologies. One can distinguish between:

- Analysis that look at the vulnerability to the effect of climate change (physical risk) versus the effect of energy transition (carbon risk).
- Perimeter of the analysis (number of impacts taken into account).
- Forward- versus backward-looking, the use of modelling and time horizon.
- The use of scoring versus quantified impact (stress-testing) on key variables such as GDP and sovereign credit rating.

Sovereign green bonds?

Several tools have been developed to assess the risk linked to climate change and energy transition

However, these tools lack comparability due to different methodologies

Table 7: Selected publicly-available studies on the impact of the energy transition and climate change (not exhaustive)

Source	Impacts included quantitatively	Climate modelling	Time horizon	Scoring vs. impact on GDP/specified sectors
Standards & Poor's (2015)	Climate change effect on tropical cyclone and floods (a one-in-250-year event) and implication on the sovereign's economy and creditworthiness (through GDP per capita losses, increased public spending on reconstruction, negative cyclical effect of the resulting economic downturn, and deterioration of trade balance).	Yes	2050	Expressed in GDP terms and change in credit ratings
Standards & Poor's (2014)	Share of population living in coastal areas below five metres of altitude; share of agriculture in national GDP; vulnerability index from Notre Dame University (ND- GAIN, see below for a commentary on this data source).	No	Unclear	Score
ERISC I and II (GFN, UNEP FI and 14/7 financial institutions) (2012/ Forthcoming Q2 2016)	ERISC I: Exposure through 'resource balance', 'trade-related risks', 'degradation-related risks', and 'financial resilience'. ERISC II: focus on the impact of food supply and demand on trade balance.	No	Unclear	Ranking; stress-testing changes in price volatility and productive capacity on trade balance.
OECD (2015)	Includes quantitative impacts of climate change on agriculture, coastal zones, losses from extreme events, increased mortality, changes in energy demand, and changes in tourism demand. Other impacts such as biodiversity losses, increased water stress, human security and large-scale disruptive events are considered either qualitatively or separately.	Yes	2060	% change in GDP in 2060 compared to no-damage baseline
GermanWatch (CRI Index) (2016)	Level of exposure and vulnerability to extreme events (scoring based on death toll, absolute and relative, and losses, total and per unit GDP).	No	Past data	Score
Dara Climate Vulnerability Monitor (2012)	Climate Change and Carbon Economy: Environmental Disasters, Habitat Change, Health Impact, Industry Stress (34 indicators in total.	Yes	2030	Additional economic costs and mortality - classified into a vulnerability score
Notre Dame - GAIN index (2014)	Assesses a country's vulnerability to the effects of climate change (36 indicators classified between exposure, sensitivity and adaptive capacity) and readiness to adapt (nine indicators classified between economic, governance and social readiness).	Partial	Unclear	Score

Source: Compiled by Kepler Cheuvreux

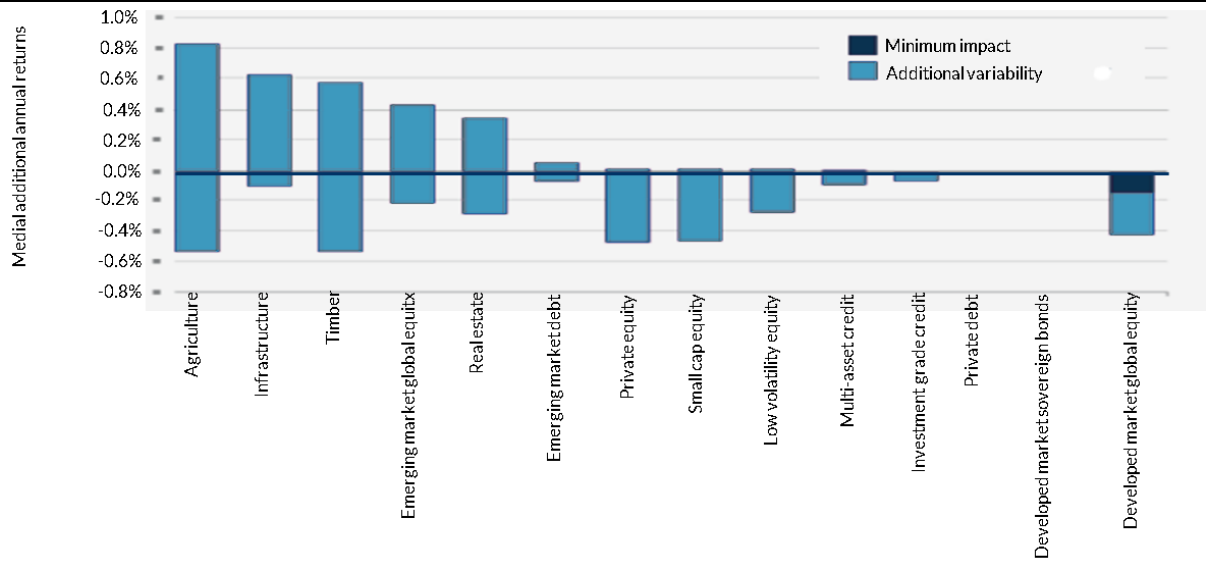
Mercer ([link](#)) recently performed a top-down analysis of how the strategic asset allocation of a long-term investor can be affected by different climate scenarios and pathways across asset classes and sectors.

- The original analysis looks at four scenarios, from transformation (more ambitious climate change mitigation action that puts us on a path to limiting global warming to 2°C above pre-industrial era temperatures this century, with fossil fuels representing half of the mix at 2050) to fragmentation (limited climate action and lack of coordination result in warming rising to 4°C or above pre-industrial era temperatures this century, with fossil fuels representing 85% of the energy mix at 2050).
- The analysis includes both carbon and climate risks (the exact typology is technology, resource availability, impact and policy) which, depending on the scenario, will play out in different ways, and sometimes in different directions, leading to a different distribution of winners and losers.

The findings are broadly consistent with the other studies above, namely that emerging markets' sovereign bonds are more exposed than those of developed markets. The originality of this study is that it includes both carbon and physical risk, it is underpinned by climate modelling, and it quantifies the average additional annual returns, which is what we ultimately want to understand.

Findings broadly consistent with other studies above, namely that emerging markets' sovereign bonds are more exposed than those of developed markets

Chart 22: Climate impact on returns by asset class (35 years)



Source: Mercer

That said, recent credit rating downgrades (Saudi Arabia, Bahrain, and Brazil) in the context of low oil prices illustrate the risk of oil dependency. This metric is taken into account in the ERISC I but does not seem to be included in Mercer's analysis at the country level. Note that this risk will be captured through the carbon footprint of the 'exports' component. The Global Footprint Network has developed a methodology to assess the "stranded asset risk" at country-level, taking into account variables such as the differential between sectoral carbon intensity across countries, fossil fuel reserves owned by the country, dependence on tax revenues from private companies operating fossil fuel assets.

Recent credit rating downgrades (Saudi Arabia, Bahrain, and Brazil) in the context of low oil prices illustrate the risk of oil dependency

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Source: Kepler Cheuvreux

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Europe

Amsterdam

+31 20 573 06 66

Frankfurt

+49 69 756 960

Geneva

+41 22 361 5151

London

+44 20 7621 5100

Madrid

+34 914365100

Milan

+39 02 85507 1

Paris

+33 1 53 65 35 00

Stockholm

+46 8 723 51 00

Vienna

+43 1 537 124 147

Zurich

+41 43 333 66 66



America & Asia

Boston

+1 617 295 0100

New York

+1 212 710 7600

San Francisco

+1 415 255 9802

ESG research team



Julie Raynaud

ESG Research

Main Author

jraynaud@keplercheuvreux.com

+44 207 621 5190

Julie Raynaud is a Senior Sustainability Analyst in Kepler Cheuvreux's ESG team, specialising in environmental research.

Prior to joining Kepler Cheuvreux in September 2015, Julie worked for nearly four years in the corporate research team at Trucost, an ESG data and insight provider specialising in natural capital risks, ecosystem services and monetary valuations.

In particular, she led public reports such as the UNEP-funded Valuing Plastics report and participated in private research for clients such as General Mills, Carlsberg, LVMH and Novo Nordisk. She was also part of the Puma product-level Environmental Profit and Loss account team.

She graduated first in her class with an MSc in Management from Imperial College London Business School and has a BA 1:1 Honours in International Development Studies from McGill University in Montreal.



Marie Fromaget

ESG Research

mfromaget@keplercheuvreux.com

+33 1 70 81 57 67



Sudip Hazra

ESG Research

shazra@keplercheuvreux.com

+33 1 70 81 57 61



Samuel Mary

ESG Research

smary@keplercheuvreux.com

+44 207 621 5190

With the contribution of Marie Fromaget