PACTA for Banks Methodology Document

Climate scenario analysis for corporate lending portfolios

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PACTA Paris Agreement Capital Transition Assessment

2° investing initiative

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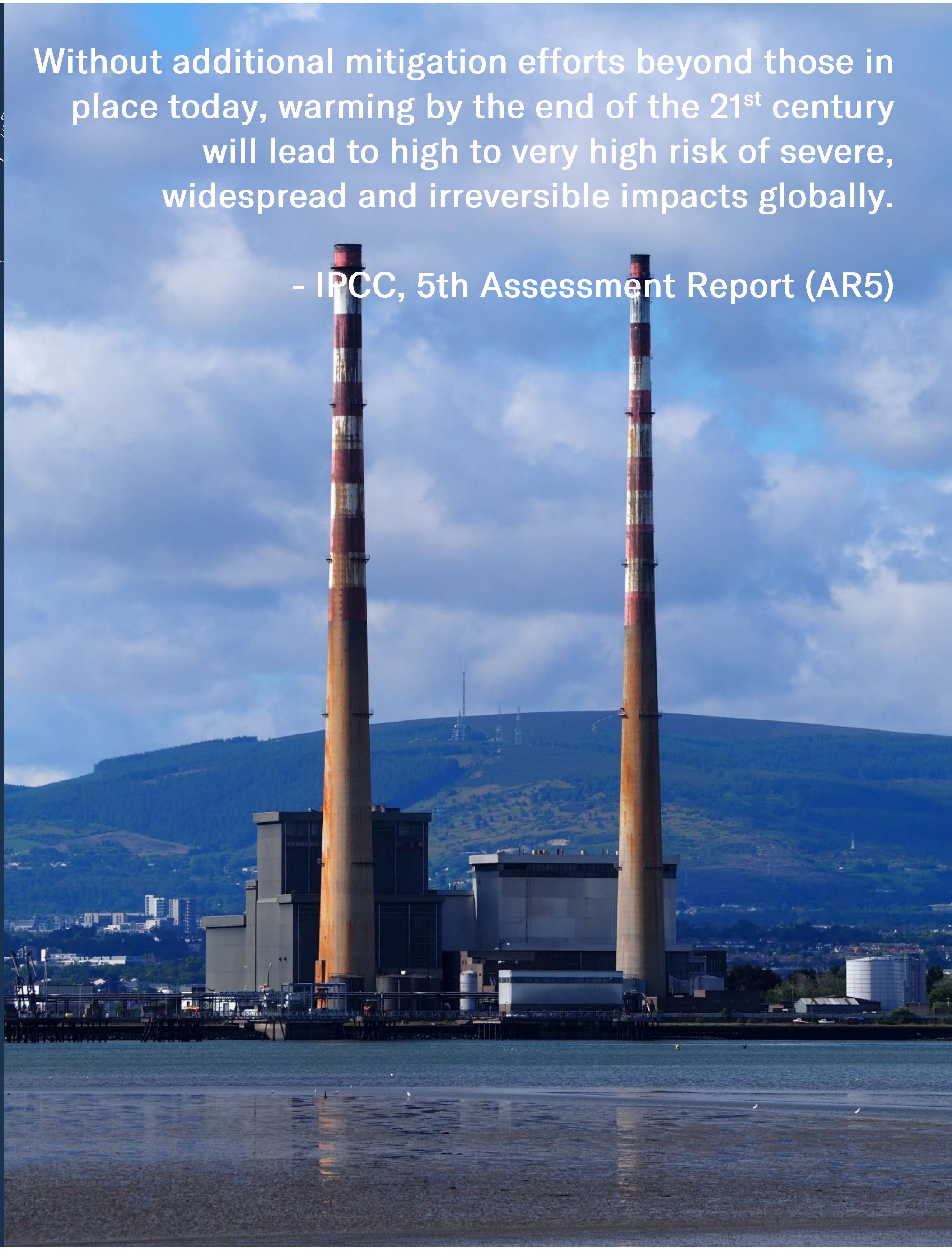
Contents

*Version control based on Semverdoc (https://semverdoc.org/) – older versions are available upon request from 2DII. Please request via banks@2degrees-investing.org

Without additional mitigation efforts beyond those in place today, warming by the end of the 21st century will lead to high to very high risk of severe, widespread and irreversible impacts globally.

- IPCC, 5th Assessment Report (AR5)



Foreword

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As the world continues to reel from the COVID-19 outbreak, nearly all our efforts are now geared towards fighting the economic and social impact of the pandemic. Across the globe, governments and banks have injected trillions of dollars to try to stave off a new recession and to help people in a time of crisis.

It is only right to focus on crisis response – but the COVID-19 pandemic is also a painful reminder of the need to prepare for and tackle other global issues, especially climate change. If anything, the current crisis shows us the importance of early, concerted action in order to prevent the worst effects of massive but foreseeable global risks.

Indeed, even amid the current pandemic we continue to see the early yet disastrous effects of global warming: wildfires, droughts, floods, and torrential storms. If we do not address this, the 21st century will undoubtedly see significantly more shocks like COVID-19.

The financial system and the fight against climate change

Since the founding of 2° Investing Initiative in 2012, we have focused on developing research, tools, and data to help the financial sector contribute to the fight against climate change, as well as manage the risks of a potentially disruptive transition to a more sustainable economy. Climate scenario analysis is a critical instrument in this regard: it allows users to assess the alignment or misalignment of their portfolios with a variety of climate change scenarios, and to take action accordingly.

For many years, however, the banking industry was unable to take advantage of climate scenario analysis, which was mostly used for assessing investors' portfolios. Instead, the banking sector focused mainly on questions such as sectoral sustainability, setting lending targets to pre-defined "green" sectors, or limiting lending to fossil fuel projects. Much of this was due to limited environmental data as well as the technical complexity of processing large loan books.

If we are to achieve the Paris Agreement goals, however, it is crucial to involve the banking sector more deeply in these efforts. After all, banks play a central role in the fight against climate change, through the lending decisions they make and the engagement they carry out with clients. This is why over the past 2+ years, 2° Investing Initiative has worked to extend its flagship Paris Agreement Capital Transition Assessment (PACTA) methodology to the corporate lending sector.

Bringing climate scenario analysis to the banking sector

Now, with the advent of new data collection techniques and more sophisticated, granular data, as well as text matching software, we are proud to say we have laid the groundwork for banks to meaningfully assess the alignment of corporate lending practices with climate scenarios across a set of key climate-relevant sectors.

This report presents the first methodology to assess climate scenario alignment for corporate lending, along with the data and software tools to implement the methodology independently. The PACTA methodology enables banks to measure the alignment of their corporate lending portfolios with climate scenarios across a set of key climate-relevant sectors and technologies. It represents a major step forward in climate scenario analysis for lending, by providing banks with insights into the climate alignment of their corporate clients' capital stock and expenditure plans.

2DII developed PACTA for Banks as a free-of-charge public good, in partnership with and funding from a range of stakeholders across the banking, academic, and NGO sectors. Over the course of the last two years, the toolkit has been road-tested by 17 leading global banks from Europe, North and South America. It has also been reviewed by over a dozen academic institutions and designed with the input of NGOs and industry experts.

While much work remains to be done, we are proud of how far we have come. PACTA represents a milestone in allowing us to understand a portfolio's alignment across key climate relevant sectors. It opens the door to setting meaningful climate targets, to designing more sophisticated climate action strategies, and to refining our understanding of the impact of these actions in the real economy. We look forward to continuing to enhance this "living" methodology, in close partnership with existing and new research partners.

Finally, we hope that the current crisis will serve, if anything, as an impetus to "build back better" – to trigger deep reflection on systemic threats, to pave the way towards a more resilient and sustainable economy, and to better prepare for inevitable global crises like climate change. Thanks to new solutions like PACTA for Banks, the financial sector is more equipped than ever before to contribute to these efforts. We look forward to continuing this journey and further fostering the tools that will be needed for financial institutions to contribute to a greener, more sustainable recovery.

- September 2020

Acknowledgments

2° Investing Initiative is proud to have developed PACTA for Banks as a free-of-charge public good, with input and funding from a diverse array of stakeholders. It would not have been possible to develop and launch PACTA for Banks without the dedication and collaboration of our partners.

2° Investing Initiative extends its heartfelt thanks notably to the members of the banking pilot group, with whom we have worked closely to road-test, enhance, and prepare PACTA for Banks for wider industry use. In addition to the dedicated pilot group members, we are also grateful to **Handelsbanken, HSBC, and Rabobank** for contributing their input and expertise. The members of the pilot group are as follows:

The PACTA for Banks pilot group

2DII's other partners in the academic and NGO sectors

2° Investing Initiative would also like to extend its thanks to more than a dozen academic institutions, NGOs, and industry experts who provided their input on PACTA for Banks over the course of the past months. Contributors notably include Julia Anna Bingler, doctoral researcher at the Center of Economic Research at **ETH Zurich**; Stéphane Voisin and Peter Tankov from the Green & Sustainable Finance Research Program at **Institut Louis Bachelier**, as well as Julia Raynaud, member of the ILB network; and David McCollum, Principal Technical Leader in the Energy Systems and Climate Analysis Group at the **Electric Power Research Institute (EPRI)**.

Testimonies

"BBVA, BNP Paribas, ING, Société Générale and Standard Chartered, all partner banks in favor of climate-aligned finance, congratulate 2DII on the launch of the PACTA for Banks methodology. Months of dedication, honest collaboration and scientific analysis have yielded an open-source toolkit which will provide transparent, comparable results across sector portfolios, allowing banks to understand their degree of alignment. With this, 2DII has made a critical step in helping the financial sector to realize its full potential to finance the transition. It has been a pleasure working closely with 2DII towards this goal and we are already benefitting from applying PACTA for Banks: the publication of our PACTA Application Paper is planned for mid-September. We join 2DII in welcoming more peers to take advantage of the advanced tools now at their disposal and start aligning portfolios in line with the goals of the Paris Agreement."

- ***The Katowice Banks (BBVA, BNP Paribas, ING, Société Générale and Standard Chartered)***

"ABN AMRO is committed to contributing to the Paris Agreement goals and started measuring and reporting to enable the steering of portfolios in line with the Paris Agreement. This is why ABN AMRO and 16 other global banks teamed up with 2DII to help road test the PACTA for Banks methodology and notably to assess the energy mix of our portfolio. Now that PACTA for Banks is freely available, we encourage our industry peers to adopt 2DII's methodology in order to ramp up their contributions to the Paris objectives."

- ***Jan Raes, Global Sustainability Advisor, ABN AMRO Bank***

"For Bancolombia, sustainability is not isolated from business, is the actual strategy that materializes our purpose of promoting sustainable economic development to achieve everyone's well-being. In this context, the bank is committed to incorporate climate change as a factor for decision-making, in line with its link to the Business Ambition for 1.5 ° C Campaign, to mitigate global warming. Participating in PACTA will allow access to information and standards that will us to accompany clients in the transition towards a low carbon economy."

- ***Juan Carlos Mora, CEO of Bancolombia***

"Developing effective climate tools for banks is a key enabler in helping the sector address the challenge of climate change. Santander will continue to work with PACTA and support in the development of approaches to facilitate the transition to a low carbon economy."

- ***Lara de Mesa, Head of Responsible Banking, Banco Santander***

"PACTA for banks methodology has set a precedent for assessing the climate alignment of corporate lending portfolios. UBS has been using scenario-based approaches since 2014 to assess our exposure to climate change risks. Pilot-testing the PACTA toolkit underscores our commitment to continue working collaboratively to further develop climate risk methodologies."

- ***Liselotte Arni, Head of Environmental and Social Risk, UBS***

"HSBC is proud to have been involved in beta-testing PACTA for Banks. The toolkit and methodology are an important tool to enable the financial sector to begin aligning its lending portfolio with the Paris Agreement goals."

- ***Daniel Klier, Global Head of Sustainable Finance, HSBC***

"The PACTA methodology has provided useful insights into the level of climate alignment of our power generation portfolio and helps to build the groundwork for future portfolio simulations that support our strategic planning process. The support from the 2DII team has been instrumental in allowing us to perform the beta test under very ambitious timelines."

- ***Michel van den Berg, Sustainability Advisor, Rabobank***

Executive summary

The Paris Agreement Capital Transition Assessment (PACTA) is a free, open-source climate scenario analysis tool for financial institutions. PACTA allows users to measure the alignment of their financial portfolios to various climate scenarios across a set of key climate-relevant sectors, based on granular, physical asset-level data. This granular level of analysis allows users to take concrete climate action based on the alignment or misalignment of the companies they finance. The main goal of PACTA is to foster the **alignment of financial markets and the real economy with a Paris Agreement-compatible world** – one that limits global warming to below 2°C warming.

PACTA was first introduced by the 2° Investing Initiative (2DII) for equity and corporate bond portfolio analysis. Since 2018, PACTA has had **over 1,500 users** worldwide, including a number of financial supervisors and central banks (e.g. European Insurance and Occupational Pensions Authority (EIOPA), California Department of Insurance, Bank of England, and more).

Over the past months, 2DII has worked together with a group of more than **17 international banks** and external stakeholders from the NGO and university sectors to adapt the PACTA methodology to **corporate lending portfolios** – hence, allowing banks to assess the alignment of their corporate loan books with climate change objectives.

This document presents the **PACTA for Banks Methodology.** This methodology is a crucial first step for banks that wish to understand their **contributions to climate change** and to **begin defining climate strategies that have meaningful impact.**

This is achieved by first linking a bank's **financial exposure to physical assets (e.g. steel or power plants) in the real economy.** Then, the economic units of output (e.g. steel or electricity) coming from the physical assets financed by the bank are compared to different climate change scenarios. This informs the bank of the current **climate pathway its loan book and clients** are on. By basing the analysis on **economic units of output** (for example MW of power capacity or number of cars) it is possible, using business intelligence data, to make **forward-looking projections.** It follows that the bank can assess its portfolio and clients against **business-as-usual and Paris-aligned scenarios**. From this, it can make informed decisions around steering capital towards a Paris-aligned world and communicate on its climate scenario alignment to stakeholders and civil society.

The PACTA output metrics look to control two key climate issues:

1. **Controlling for the absolute production limits of high carbon technologies**. For example, fossil fuel production must ultimately decrease to achieve the goals set out in the Paris agreement.
2. **Identify the required production shift from high-carbon to low-carbon production needed to be compatible with a Paris-aligned world.** In other words, identifying the required shift from high- to low-carbon technologies.

PACTA for Banks currently covers five climate-critical sectors: **Power, Fossil Fuels, Automotive, Steel and Cement**. Alignment results are given at the level of each **sector [and technology level within those sectors].**

The climate alignment of these sectors and their companies is calculated differently depending on whether clearly identified technology decarbonization pathways exist for these sectors. For Power, Fossil Fuels and Automotive, there are clear low- or zero-carbon technologies available. For example, in the Power sector, power generation has to transition from fossil fuels to renewables. For these sectors, two metrics are used to measure alignment:

1. **Production Volume Trajectory** - this measures the alignment of a loan book and/or client's production volume per technology/fuel against trends prescribed in climate change scenarios. This addresses climate issues 1 and 2, listed above.
2. **Technology/Fuel Mix** - this metric shows the sectoral technology/fuel mix of a loan book and/or client (e.g. what % of the automobile production a bank finances relates to electric vehicles, internal combustion engines, etc.) and how this mix should evolve to be considered aligned with various climate change scenario. This identifies the required shift to low carbon technologies.

Results are calculated using different accounting principles at the loan book level and client level. At the **loan book level, a portfolio weighted approach** is used, whereby the production of a client is allocated to the portfolio based on the size of the exposure to that client. At the **client level, an unweighted approach** is used, whereby the absolute production of the client is given. The interpretation of the results is therefore different between the two. The details behind these accounting principles and alternative options are described in sections 1.10 and 1.1 of this document.

For sectors where technology decarbonization pathways **are not so well defined,** such as **Steel** and **Cement**, a different approach is needed. For these sectors, climate change scenarios do not currently prescribe production to **specific technologies producing the economic units of output** (e.g. a ton of steel), although trials for some solutions may already exist. They do however give **absolute values of production and carbon emissions.** From this, an emission intensity is calculated and used to measure alignment.

1. **Emission Intensity** - This metric compares the current and projected emission intensity of a sector within a loan book to an emission intensity prescribed by climate change scenarios. The emission intensity of the loan book is calculated **based on production coming from the technologies a bank is exposed to in these sectors.** An emission intensity model is applied here. This metric is an adaptation of the **Sectoral Decarbonization Approach** (SDA) designed by the Science Based Targets Initiative (SBTI) (more details can be found in section 2.4.1).

For each metric, results are given at **present and up to 5 years in the future.** A **market benchmark** is given for comparison (benchmarking options are discussed in detail in section 1.14).

Section 1 of this document explains t**he methodology and the underlying rationale** in more detail. It describes the **output metrics** and discusses the **required inputs**. It details the **scope** of the methodology. It discusses **different options** for **allocating the macro carbon budgets (scenarios) to micro-economic actors (portfolios/clients) and for allocating the physical asset-level data to financial instruments such as a loan.**

Section 2 provides the **mathematical formulization** behind the metrics.

Section 3 concludes with a breakdown of the sectors, including **sector overviews, the metrics used, and data inputted.**

The PACTA for Banks Toolkit

The 2° Investing Initiative and its commercial data provider spin off, Asset Impact, have prepared a series of free tools allowing banks to implement the methodology on their own loan books. The PACTA for Banks Toolkit consist of the following elements:

- **The PACTA for Banks Software** - 2DII has created a software package written in R for users to use for free (basic R skills are required to run the code). It is compatible with the scenarios provided as part of the supporting documentation and the PACTA for Banks Data Set. It is publicly available via CRAN and open source under the MIT license.

- **PACTA for Banks Methodology** – presented on these pages. It is a standalone methodology, i.e., in principle any climate change scenario, data source, or software can be used to implement the methodology. This methodology is publicly available.
- **PACTA for Banks Supporting Documents** - 2DII has provided a series of documents including formatted scenarios, guidelines on disclosing and communications, and a series of regional average emission factors (should a bank want to disclose using such emission intensities).
- **The PACTA for Banks Training Materials** - This is a set of practical user guides provided by 2DII to guide a bank through installing the relevant software, preparing the loan book, and running the PACTA for Banks Software.
- **The PACTA for Banks Data Set** - This is provided by Asset Impact and is formatted to be compatible with the PACTA for Banks Software. It is based on physical asset data at the company level. Users will receive the data set after agreeing to the terms & conditions.

All of the above can be accessed at www.transitionmonitor.com

More about 2° Investing Initiative

The 2º Investing Initiative (2DII) is an international, non-profit think tank working to align financial markets and regulations with the Paris Agreement goals.

Working globally with offices in **Paris, New York, Berlin, Brussels and London,** we coordinate the world's largest research projects on climate metrics in financial markets. In order to ensure our independence and the intellectual integrity of our work, we have a multi-stakeholder governance and funding structure, with representatives from a diverse array of financial institutions, regulators, policymakers, universities, and NGOs.

More on PACTA

2DII coined the concept of aligning investment portfolios with climate objectives at the time of its founding in 2012, culminating with the launch of the **Paris Agreement Capital Transition (PACTA) methodology** in 2018.

As of June 2020, PACTA for investment portfolios has been used by over 1,500 financial institutions in more than 90 countries. In addition, a number of financial supervisory authorities across Europe, Japan and the US have employed PACTA to assess their regulated entities (e.g. European Insurance and Occupational Pensions Authority (EIOPA), Japanese Financial Services Agency, California Department of Insurance, and more).

Additional research areas

In addition to PACTA, 2DII has been closely involved with policy-related work particularly at the European level. 2DII helped draft the first version of France's groundbreaking article 173, the first climate-related financial regulation in Europe, in addition to the first report commissioned by the European Commission on sustainable finance and HLEG recommendations on disclosure, supervisors and retail investors.

Our latest research streams include climate stress-tests for insurers and investment product labelling for retail investors. In 2020, 2DII also launched the Evidence for Impact Working Group in partnership with leading financial institutions, NGOs, and universities, to evaluate the real-world impact of individual climate actions.

A note on our funders

PACTA for Banks is part of the International Climate Initiative (IKI). The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) supports this initiative on the basis of a decision adopted by the German Bundestag. The views expressed here are the sole responsibility of the authors and do not necessarily reflect the views of the funders.

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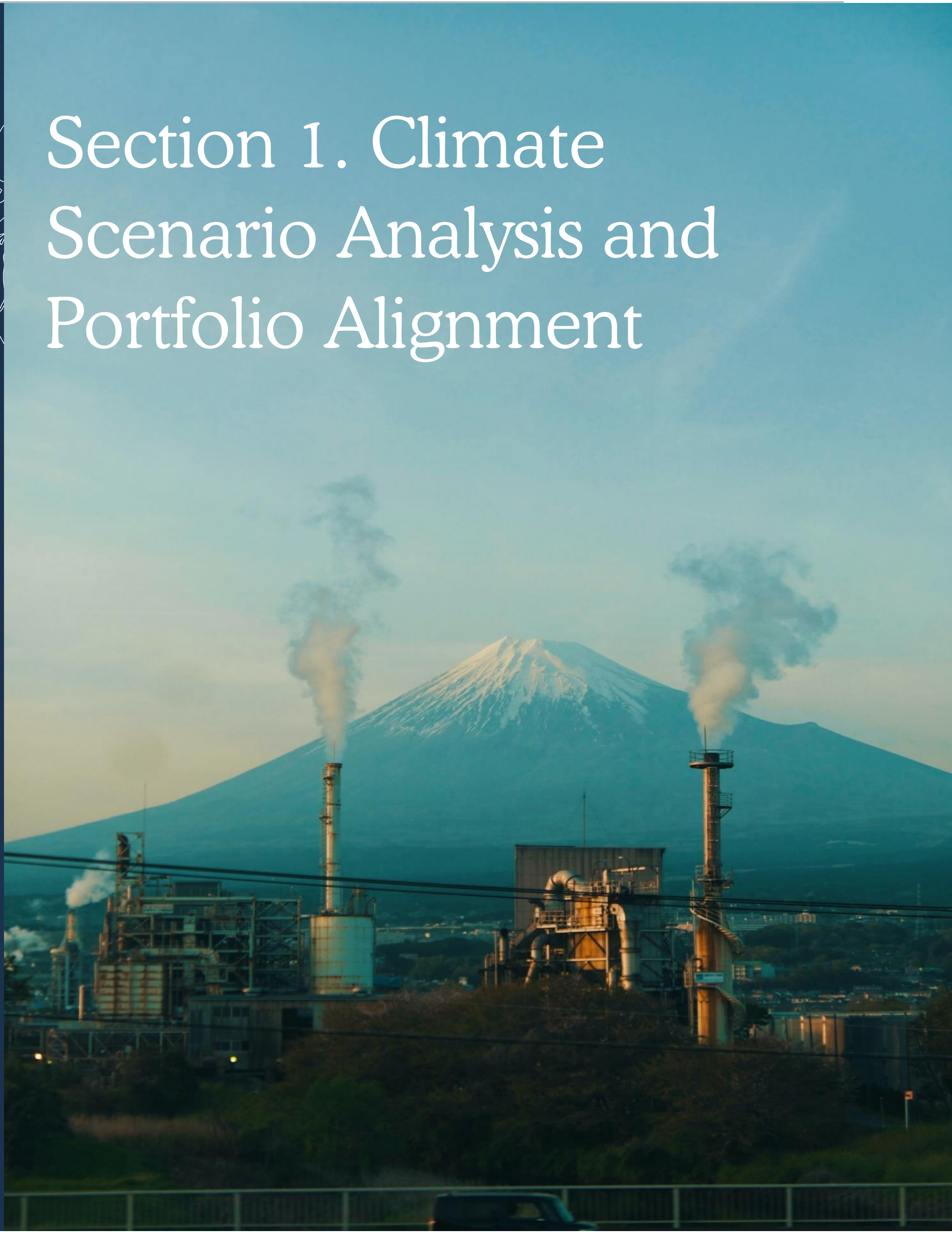
Section 1. Climate Scenario Analysis and Portfolio Alignment



This document aims to answer the following questions:

- What is the scope of PACTA in terms of economic activities & financial assets?
- What are the required inputs of the methodology (for climate data, financial assets, and climate scenarios)?
- How does this methodology allocate climate-critical economic activity to those that are financing it? I.e. how are the actions of microeconomic actors attributed to corporate lending portfolios?
- How can banks use the results?

1.1 Introduction

Why is climate change important to financial institutions?

The 2018 Intergovernmental Panel on Climate Change (IPCC) Special Report on the impacts of global warming of 1.5°C reported that "human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels" and "global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate."[1]

Containing anthropogenic impact on the climate system requires **"the upscaling and acceleration of far-reaching, multilevel and cross-sectoral climate mitigation.**"[2] Managing to stay on a pathway limiting global warming to 1.5°C "would require rapid and far-reaching transitions in energy, land, urban and infrastructure, and industrial systems. [...] These systems transitions are unprecedented in terms of scale [...] and imply deep emissions reductions in all sectors."[3] These transitions are required to mitigate the risk that climate change poses to prosperity and peace.

In response to this challenge, a growing number of financial institutions are seeking to understand the contribution their clients are making to this collective decarbonization effort.

These efforts are driven by a combination of business and normative drivers:

From a **business perspective**, understanding clients' and investees' contributions to decarbonization efforts can help assess their adaptive capacity and thus act as an input into the **assessment of financial risk associated with decarbonization (transition risk).**

It can also help inform potential reputational or litigation risk associated with conducting business with these clients, which in turn can impact the social or political license to operate. Independent of the policy momentum associated with transition risk, financial institutions may also directly face regulatory and supervisory pressures to address this issue, as evidenced by the EU Sustainable Finance Action Plan,[4] the Network for Greening the Financial System,[5] and related initiatives.

From a **normative perspective**, a number of financial institutions accept a collective responsibility with regard to the political and social mandate to limit global warming and are seeking ways to contribute in

1 IPCC (2018) p. 3

2 IPCC (2018) p. 5

3 IPCC (2018) p. 15

4 COM(2019)640

5 NGFS (2020)

the context of their business model to that mandate. These institutions are looking for ways to measure the consistency of their investees' and clients' business model and ultimately their own business with climate goals and mechanisms to contribute to achieving these goals.

To tackle these challenges, the 2° Investing Initiative developed the Paris Agreement Capital Transition Assessment methodology, which measures the exposure and alignment of financial portfolios and companies to a series of decarbonization scenarios across a number of key climate-relevant sectors.

The methodology can help inform both the normative and business objectives of financial institutions. This document provides substantial insight into the rationale underpinning the methodology. The first section outlines the key concepts and methodological approaches in a way that is designed to be accessible to non-practitioners. The second section presents the full mathematical formalization of the methodology. Finally, Section 3 gives a sector-specific breakdown, covering a sector overview, the metrics used, and the data points used.

At its heart, the PACTA methodology requires answers to two questions in order to respond to the challenge of modeling "portfolio alignment":

- How should we allocate the global macroeconomic efforts associated with decarbonization scenarios to microeconomic actors (portfolios, companies)?
- How can we draw links between the ultimate drivers of climate change – the emissions of real industrial economic assets – and the financial instruments associated with these assets?

These two questions lead to a range of other economic-modelling challenges, including: What is the time horizon over which an alignment with a scenario is measured? What is the unit in which this alignment should be measured? And what is the boundary of financial assets that we should analyze?

PACTA for Banks Toolkit consists of three elements. First, the PACTA for Banks Methodology Document, which you find outlined on these pages and which is publicly available. Second, the open source[6] PACTA for Banks Software. Third, the PACTA for Banks asset-level data set, which is provided by Asset Impact.

2° Investing Initiative, which developed PACTA for Banks, has a 100% non-commercial business model with all its work funded by grants and membership fees. As policymakers and private sector initiatives seek to build standards and common approaches around addressing these questions, such a model serves to avoid commercial biases when designing standards and ensuring a transaction-cost minimizing solution.

Users and interested parties reading this document should be aware that PACTA is a tool that can inform two objectives.

First, it informs financial institutions on defining climate actions and setting aspirations related to the alignment of their portfolio with climate goals. While it does not measure the contribution that financial institutions make in terms of real-world emissions reduction, it represents a first step on that journey. A

6 Licensed under MIT.

related project (Evidence for Impact) is currently under way to help design methods and approaches to better understand the real-world impact of climate actions by financial market actors.

Second, PACTA can also be considered a mechanism to understand the evolution of transition risk. By measuring portfolio alignment, it informs on the extent to which companies are adapting their business plans to climate scenarios. Misalignment can then speak to potential higher future risk. A number of financial supervisors are currently using the PACTA model for this purpose. However, while PACTA can be an input into risk frameworks, it does not model actual financial losses. A complementary module on stress-testing is currently available for download via github here[7]. This module is currently undergoing a road-testing phase and those wishing to know more can contact stresstest@2degrees-investing.org.

7 https://2degreesinvesting.github.io/r2dii.climate.stress.test/

1.2 PACTA at a Glance[8]

Measures a portfolio's climate alignment

It assesses the alignment of a financial portfolio with any climate scenario, revealing where the portfolio stands between business-as-usual (BAU) and Paris-aligned <2°C scenarios

Covers key climate-critical sectors

It tackles key climate-critical sectors: Fossil Fuels, Power, Automotive, Cement, Steel, Shipping (forthcoming) and Aviation (forthcoming) which together account for over 75% of global CO_2 emissions

Uses granular physical asset-level data

It provides a precise, technology-focused insight into the current and future activities of companies, mapped over a five-year time horizon

Forward-looking

It tracks the forward-looking alignment of the economic activities financed by the portfolio and uses long-term macroeconomic decarbonization scenarios

Enables steering and comparison between peers

It informs the design of portfolio-steering strategies to reach 2°C alignment, the identification of best and worst in class companies, and the benchmarking of a portfolio against the market

Allocates necessary collective greening efforts

It translates <2°C scenarios into portfolio specific targets by allocating the macroeconomic trends prescribed by climate scenarios to the companies and assets in the portfolio, based on market share

Allows the use of any climate scenarios

The methodology is adaptable to any climate scenario (IEA, IPCC, NDC, etc) that models the evolution of the economy (specifying by sector and technology) under a decarbonization pathway

Sector-specific approach

It provides specific metrics and targets for each type of economic activity in different sectors – as opposed to an aggregated portfolio-level target

8 CO_2 sources (2020) – 75% figure. Note that this is a high-level estimate and only intended as an estimation. Note that this figure is likely to be higher in corporate lending portfolios considering that the other sectors not included here are often state-owned.

1.3 PACTA's Scope and Analytical Focus

How can PACTA help banks?

PACTA for Banks aims to address the following questions:

- To what extent is a corporate lending portfolio aligned with climate change scenarios across climate critical sectors?
- To what extent are clients aligned to climate change scenarios across climate critical sectors?
- Based on a corporate lending portfolio's current exposure, what will its climate change scenario alignment be in the future?

This can help a bank to:

- Identify exposure to climate change transition risk
- Inform decision making around climate strategy at both the portfolio and client level
- Identify required alignment pathways for a portfolio to be deemed aligned with climate change scenarios in the present and in the future
- Compare a portfolio and client's climate scenario alignment to that of the market

To answer these questions and to allow banks to set targets, **corporate client-level insights and prescriptive climate scenarios are brought together** in a methodology that ultimately aims at informing decision-making.

At the **portfolio level,** these metrics aim to draw up a picture of the bank's total financing within the relevant sectors. At the **client level**, they inform on the climate alignment of each individual company and can help support the definition of a climate strategy.

Examples for each type of metric, their full mathematical formalization (section 2), and further details on the different parameterization choices are provided in this paper.

1.4 Metrics

The three metrics used in this methodology are described briefly below. Their full mathematical formulation is set on in Section 2.

1) **Technology/Fuel Mix** – this metric shows the sectoral technology/fuel mix of a loan book and/or client (e.g. what percentage of the automobile production a bank finances relates to electric vehicles, internal combustion engines, etc.) and how this mix should evolve to be considered aligned with various climate change scenario.
2) **Production Volume Trajectory** – this measures the alignment of a loan book and/or client's production volume per technology/fuel against trends prescribed in climate change scenarios.
3) **Emission Intensity** – This metric compares the current and projected emission intensity of a sector within a loan book to an emission intensity prescribed by climate change scenarios.

1.4.1 Technology/Fuel Mix

Figure 1. Simplified representation of a technology/fuel mix metric. The left column shows current technology/fuel mix and the right column shows the target for the same technology/fuel mix. The green dash suggests low carbon technologies/fuels must increase and the red that high carbon technologies/fuels should decrease.

The technology mix metric focuses on technology shifts within the power, fossil fuels and automotive sectors, namely: (i) the **changes in the technological processes by which outputs are produced** (e.g. shift from coal-fueled to renewable-fueled power capacity), and (ii) **changes in the nature of the output** itself (e.g. shift from internal combustion engines to electric vehicles).

This metric measures the bank's relative exposure to the economic activities that are impacted by the transition to a low-carbon economy. This is achieved at the portfolio level by weighting the production values coming from each technology in a client's technology mix by the bank's exposure to that client (section 2.1). It is **a function of how diversified the bank's portfolio is across clients, and how diversified these companies' activities are across technologies or output types.**

This metric is essentially a fuel or production mix, calculated based on how the bank has distributed its lending capacity.

The portfolio's profile - as drawn up by these metrics - **can then be compared to market benchmarks, to a series of peers if available, and crucially to different climate scenarios**. Results can be calculated for the current day and at 5 years in the future.

Currently, methodology calculates the bank's financial exposure to different technologies for the following sectors:

- **Automotive:** Engine types for light-duty vehicle production
- **Power:** Electricity-generation technologies across installed capacity
- **Fossil Fuels:** Energy sources across primary energy extraction

1.4.2 Production Volume Trajectory

The production volume trajectory metric aims to measure the alignment of a portfolio's projected production volumes to those given in climate scenarios. It is used for the fossil fuels, power, and automotive sectors.

Changes in production volumes result either from transfer of production from one technology to another (e.g. internal combustion engines to electric vehicles) or from sheer expansion or contraction in the production coming from the technology/fuel (e.g. a company brings a new coal-fired power plant online).

Projected production volumes at a 5-year horizon are considered at the individual client level at the technology level.

The resulting volume trajectories are then compared with the trends set as targets in climate scenarios.

Clients' production functions are also compared to that of the industry as a whole. This is telling of the relative changes in market shares. For example, if a bank's clients increase their production of EVs at a

Figure 2. Simplified representation of a production volume trajectory metric. The blue line shows the production volume trajectory of a portfolio and/or client for any given technology/fuel in a sector and the green line denotes its alignment target. Hence the red area highlights the misalignment.

higher rate than the automotive industry on average, then the bank that finances them will account for a growing share of global EV production.

Following the **market share approach – which distributes decarbonization efforts based on constant market positions** – all market players are required to adjust their production volumes based on their market share. The market share approach is one of a number of options for allocating the emissions associated with economic actors to their financiers. Other options are explored in section 1.10.

Section 2 of this paper presents examples of the volume-trajectory metric and ways to interpret it, illustrating the rationale behind the different calculation rules for low-carbon and high-carbon technologies (section 2.3).

1.4.3 Emission intensity

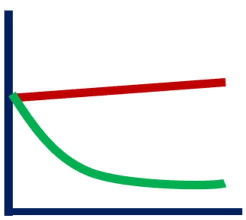


Figure 3. Simplified representation of the emission intensity metric. The red line represents the emission intensity trajectory of any given portfolio and the green line represents target emission intensity for that sector.

The emission intensity metric measures the average CO_2 intensity of the portfolio in the steel and cement sector. This emission intensity is given as CO_2/economic unit of output (for example, CO_2/per ton of steel produced). This is then compared to an emission intensity reference point set by a climate scenario.

While this is not the main metric of choice for the largest sectors tackled in this methodology, the emission-intensity of the activities financed by the portfolio is nonetheless the first metric in sectors for which no clear technology pathways have been set out (namely, steel and cement). Put differently, for these sectors no zero-carbon alternative yet exists. As such, it is not possible to use the technology mix metric or the volume production volume trajectory metric to measure alignment. However, it is still imperative to steer capital in a way that aims to decrease carbon emissions in these sectors – hence the emission intensity metric is used.

To obtain the metric, PACTA assigns 'emissions factors' to the physical assets. For example, a steel plant in Sweden will be assigned an average emissions intensity based on either the known emissions of that plant or will be estimated based on the characteristics of the asset. Hence, tons of economic output (e.g. tons of steel) are converted to tons of CO_2 per ton of steel. The scenarios for these sectors are also reconstructed in such a way as to measure emissions intensity. Once that is achieved (the methodology behind this can be found in the "Scenario Supporting Document" at www.transitionmonitor.com), the alignment of a portfolio is then measured based on an adaptation of the Sectoral Decarbonization approach (section 2.4).

1.5 Scope

The sectors currently in scope are the amongst the most climate-critical (spanning energy, transport and industry). Together, they are responsible for **over 75% of all CO_2 emissions.**[9]

All primary energy sources (except unreported biomass) are covered, as well as the main contributors in the transport and industry sector. 2DII's firsthand experience suggests these sectors make up around 20-25% of a typical wholesale banking portfolio in terms of lending volume – a share that can vary substantially across banks.

Within these sectors, the scope is circumscribed such as to only include **the segment of the value chain (i) that controls the bulk of the impact on the climate system**, and (ii) on which decarbonization efforts must be concentrated in order to spur the entire sector to fall into alignment (dark green in the chart below):

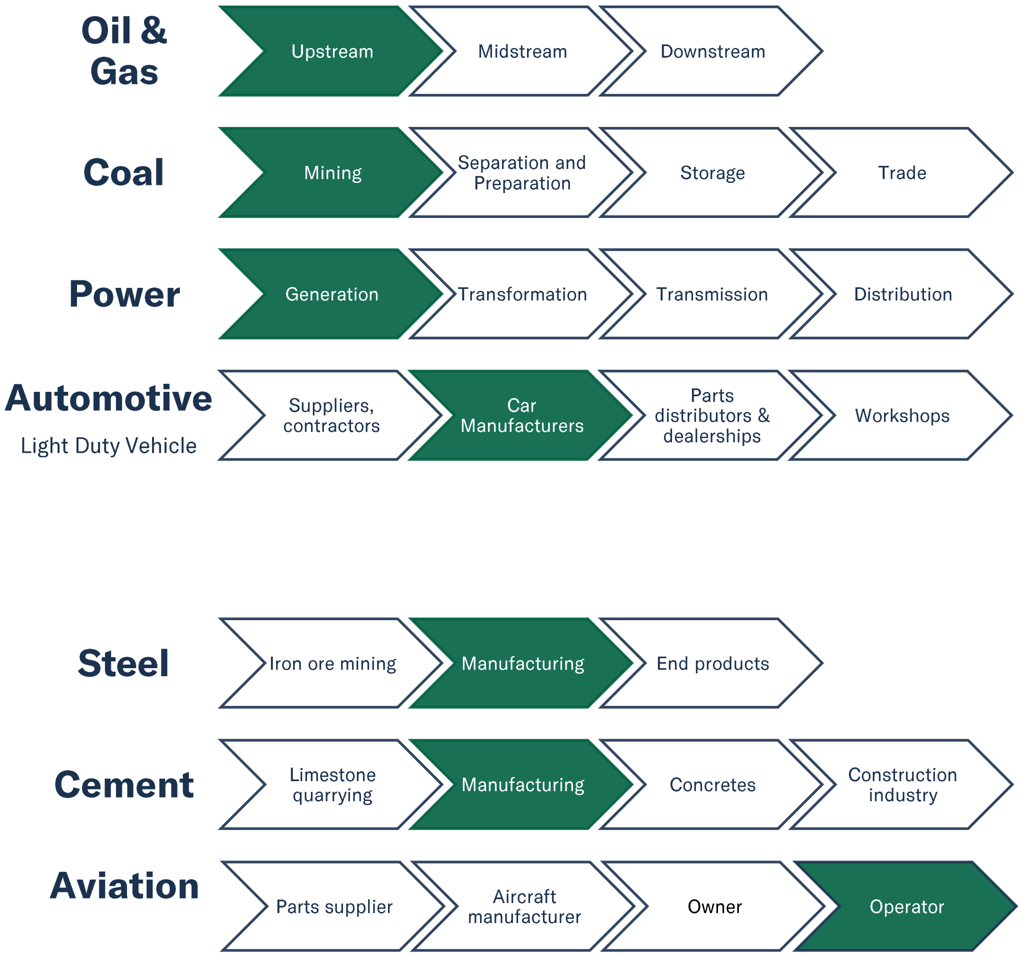
The application of PACTA thus hinges on the identification of the loans associated with each sector and then the asset-level data underpinning it. Identifying the loans sector can be done using industry standard sector classification codes (NACE, ISIC, NAICS, BICS, GICS, etc.) or a bank's internal classification. Mapping assets in a bank's loan book to their respective physical assets can be achieved using the PACTA for Banks Toolkit (mapping performed in the software and physical assets provided in the PACTA for Banks Dataset).

Where companies are active in several sectors, and where loans are assumed to be general-purpose, revenues data can help **model capital allocation to the different business segments of companies.** This is the preferred option, but implementation faces significant data-quality issues (discussed below).

As PACTA continues to evolve, new sectors will be added. Initially, this will include the addition of heavy-duty vehicles into the automotive sector, followed by the aviation and shipping sectors. Other solutions are sought for climate-relevant sectors that are currently hard to tackle due to insufficient data availability – most importantly, agriculture and real estate.

9 CO_2 sources (2020) - Note that this is a high-level estimate and only intended as an estimation. Note that this figure is likely to be higher in corporate lending portfolios considering that the other sectors not included here are often state-owned.

Figure 4. Sectors in the PACTA scope with segment of value chain considered in PACTA highlighted in green



1.6 Coverage of Financial Asset Classes

1.6.1 Financial asset classes

PACTA was initially designed as a tool for listed equity and corporate bonds portfolios in 2015 and has since been expanded to corporate credit portfolios. The PACTA methodology can be adapted in principle to any individual or group of financial relationships between a company and a financial institution.

This methodology document focuses on the specifics of the PACTA methodology for **loans (including credit facilities) to listed and unlisted companies.**

1.6.2 Choice of loan book indicator and value

Banks can use different financial variables in order to identify the portfolio value used in the analysis, and the interpretation will be slightly different for each option.

The drawn amount (referred to as debt outstanding in the PACTA for Banks Software) is arguably the best variable to use, as it reflects the current amount contributing to economic activity in the real economy. This is particularly the case in situations where lending facilities exist that are rarely drawn upon, and where including them the portfolio's contribution to activity in the real economy may be overestimated. The downside is that it hides the "potential access" to capital that companies have through undrawn credit lines.

The committed amount of the loan (i.e. including drawn and undrawn amounts, not including guarantees, and referred to as credit limit in the PACTA for Banks Software) could also be a good fit for the analysis, as it reflects the extent to which the bank finances its clients' business activities without introducing risk-modelling bias.

Some banks have expressed their preference for using the exposure at default. This can arguably serve to reflect a risk rather than impact perspective, wherein clients that represent a larger potential liability are weighted accordingly and thus influence the results more. Ultimately, the methodology is open to different options. Please refer to the forthcoming "Disclosure and Communication Guidelines" at www.transitionmonitor.com for more information on the importance of transparency and accuracy when interpreting and disclosing results.

Box 1. A word on derivatives, guarantees and underwriting, and project finance loans
Derivatives cannot easily be associated with climate impact, as their ties with the real-economy activities are more complex than classical credit instruments. Derivatives are therefore not considered in scope; however, they could be an area of future research.

While project finance loans warrant being included in portfolio-level results in order to give an aggregate picture of the bank's lending, when tackled in isolation they require a different approach altogether, in that they cannot reasonably be subjected to the same steering and diversification approach that is adopted for portfolios. Hence, they are not included. Indeed, whereas a portfolio and a company (mostly integrated companies) can be assigned technology-shift objectives, a single project cannot transition in the same way. It can serve the improvement of the portfolio's overall alignment extent but cannot have scenario pathways applied to it in the same way as to the portfolio. Hence, project finance can be added but should be interpreted with the knowledge that the project is an asset in isolation.

On the other hand, guarantees and underwriting are more easily adapted. For example, instead of analyzing the climate alignment of economic activities financed via all credit lines open at any given time, we can analyze the same issue for all underwriting deals struck within a x-year period.

1.6.3 Segmentation of general-purpose loans to integrated or cross-sectoral companies

The prominence of general-purpose loans given out to integrated companies can obscure the identification of the precise economic activities and climate-relevant assets that are being financed via the loan. In these cases, loans are assumed to finance all of the company's activities and the company's overall climate profile (e.g. technology mix, production plans, carbon intensity, etc.) is taken into account in the analysis.

This issue could be remedied by using revenues/CAPEX/debt data (i.e. a dataset recording how a company's revenues/CAPEX/debt is split across business lines), with the aim of modelling how its debt is distributed across business lines. This would allow for **general-purpose loans being distributed across a company's activities in different sectors and segments**.

For example, using revenues data, a general-purpose loan to oil major A which derives 40% of its revenues from upstream O&G, 40% of its revenues from mid- & downstream O&G, and 20% of its revenues from new power-generation activities would be split accordingly – across the two sectors and segments – before the set of weighting coefficients for all clients are calculated.

This way, in the results (i) this loan to oil major A is not unduly over-weighted compared to a same-size loan to oil major B which derives 100% of its revenues from upstream O&G, and (ii) the bank's participation in financing A's power-generation activities is not overlooked. On the flipside, such segmentation may artificially understate exposures as the different business segments thus segmented may actually be co-dependent.

2DII noted data-quality and availability issues for this segmentation of loans. Though desirable to render the results more precise, the integration of this feature in the model formulization is far from straightforward. It is not done in the current iteration of PACTA. However, this does not prevent a bank from doing so as an additional level of analysis and there is reason the believe it can increase the overall accuracy, data permitting. If a bank chooses to do so they are then encouraged to disclosure the data sources, they are using to provide the revenue split.

1.6.4 Amortization of loans

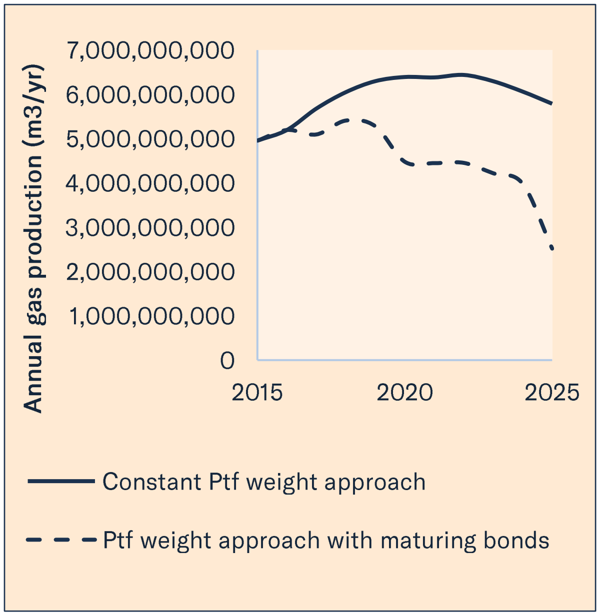
At this point, *current* outstanding debt and/or open credit lines are considered within the scope of the analysis. The methodology does not currently consider forward-looking changes in credit distribution. The reason is that – except for specific exclusion policies (e.g. coal phase-out strategies) – it is difficult to estimate how a loan book will evolve over time.

Due to this, taking into account amortization profiles in the absence of data on future loans is likely to be misleading (albeit mathematically possible). The portfolio-weighting element in the metrics (detailed in Section 1.11) means that clients' production plans taper off over time, or that they disappear from technology mixes, in such a way that makes it impossible to know whether the evolution is due to changes in the technologies in use at the physical asset-level or to changes in the group of clients.

Figure 5 below illustrates the reason for making this constant-portfolio default choice, on the basis of a real-world portfolio. The annual gas production of a credit portfolio, allocated based on the portfolio weight approach, is shown over a 10-year time horizon. The solid line shows the trajectory assuming no maturity of credit instruments, whereas the dotted line represents the annual gas production assuming the maturity of credit instruments.

In the second case (dotted line), the gas production in the portfolio is seemingly reduced by 50% over a ten-year time horizon by the sheer merit of maturing instruments, with no heed paid to the fact that this bank is likely to give out new loans to the same companies in the coming years.

Figure 5. The impact of 'accounting' calculation rules regarding maturing credit instruments



Taking into account maturity without taking into account the new loans being given is thus arguably misleading. Therefore, by default, in t+5 projections the methodology keeps portfolio composition constant and does not include an amortization modelling that would introduce such a bias.

Only when there is certainty on future loans (e.g. their absence in the case of an exclusion policy, or reliable modelling of upcoming loans) should loan maturity be taken into account.

This does not prevent a bank from performing additional analysis whereby they could make theoretical changes in their loan book in an attempt to develop portfolio level climate strategies.

1.6.5 Constraints to expanding the scope

The following considerations highlight key external constraints faced collectively by all actors seeking to calculate portfolio alignment that limit the scope and application of the PACTA methodology.

- **'Financed emissions' (emissions normalised by a financial indicator) cannot be used as a measurement of alignment given that climate scenarios do not provide a roadmap for this indicator**

Climate scenarios are expressed in almost all cases in real economic units (either emissions over unit of production or a technology unit over unit of production). The analysis must be expressed in the same units. By extension, financed emissions therefore cannot be used to calculate the warming potential or alignment of portfolios, since there no scientific scenarios that project these values. Where climate scenarios use investment or financing volume figures, these are absolute figures that would require ‘absolute’ volume analysis for portfolios. Moreover, these are often investment needs and/or gaps. Given the uncertainty of both the actual investment roadmaps, their volatility over time, and data gaps, alignment analysis based on the investment or financing footprints are currently impossible. However, it may be useful to consider investment/financing indicators from a steering perspective where these control for exogenous changes (see second bullet) and as a way to understand exposure evolution and targets as part of a holistic climate strategy. They also respond to certain strategic constraints and can inform metrics that respond to some stakeholder expectations. However, given the lack of meaningful scenarios as a reference point and challenges of downscaling them, these approaches are currently not integrated into the PACTA methodology (which focuses on alignment with a climate scenario). This does not dismiss their usefulness in other use cases, and they may be formally integrated at a future stage.

- **The analysis must rely on indicators that are not skewed by external factors outside of the scenario (e.g. changes in financial asset prices)**

The analysis should ensure that climate performance does not improve simply because of changes to financial parameters. For example, when analyzing companies' emissions intensity related to financial units (revenues, enterprise value), they exhibit high degrees of volatility in response to revenue and enterprise-value volatility, independent of the underlying decarbonization of those companies. Of course, they may be influenced by actual changes to loan exposures themselves.

1.7 Inputs into the methodology

1.7.1 Underlying data

The PACTA for Banks Methodology relies on an assessment of physical assets linked to financial assets and the alignment of these assets with climate scenarios.

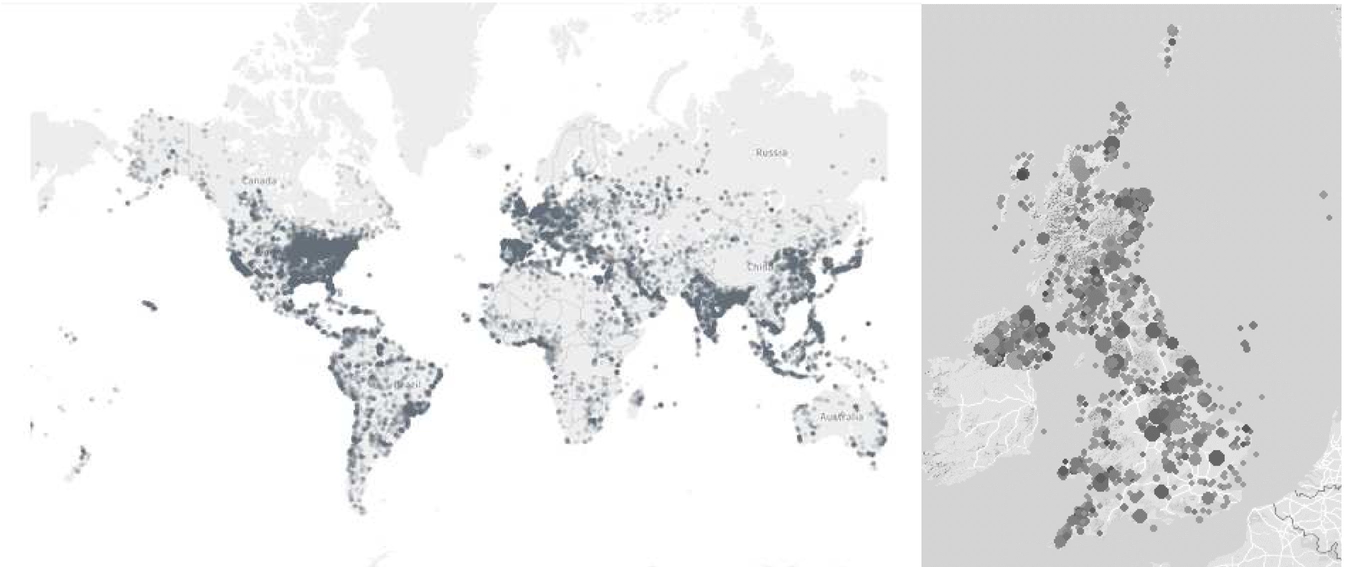
Physical-asset data exists for all sectors covered in PACTA.

The data sources used in PACTA record current and future levels of production, enabling a forward-looking analysis. They are updated on a regular basis – from continuously, in quickly moving sectors such as automotive, fossil fuels, and power, to annually for more 'stable' sectors such as cement

While physical asset-level data is an important pillar of the methodology, the choice of the source for this information is left open: corporate disclosures, regulatory filings, business intelligence databases, the bank's internal data (usually granular but not always aggregated in a standardized way enabling to mobilize it at scale), etc. Hypothetically, PACTA can also be applied with corporate data if provided in the right format. Ultimately, however, such data also relies on aggregation of asset-level data at some point in the data generation process.

Hence, PACTA as a methodology is data-agnostic, meaning any data provider/source can be used.

Figure 6. Global geolocation of the physical assets in the databases used by 2DII– Zoom over the UK (Source: 2DII)



1.7.2 Aggregating production up the ownership chain

In the free PACTA for Banks Data Set, the production forecasts of companies are based on physical asset-level data (e.g. a power plant, a steel plant, an oil field). These physical assets are aggregated through the corporate structures chain (asset, company, parent etc.) as follows:

Physical assets' production figures are aggregated to the companies that own them using the "equity share approach": if company A owns x% of Asset 1, it gets attributed x% of its production. If ownership data is missing for any of the owners, then the remaining shares are equally divided between all the owners without data (for example, if company A owns 50%, company B owns an unknown %, and company C owns an unknown %, then company B and company C both get 25%). In the case of a single owner with an unknown share, 100% ownership is assumed.

Within the PACTA for banks data set the production values of companies (described as 'subsidiaries' in the following descriptions) are further aggregated to their respective corporate owners following a financial control (FC) consolidation methodology as described below.

1.7.2.1 Financial Control (FC) Consolidation Methodology

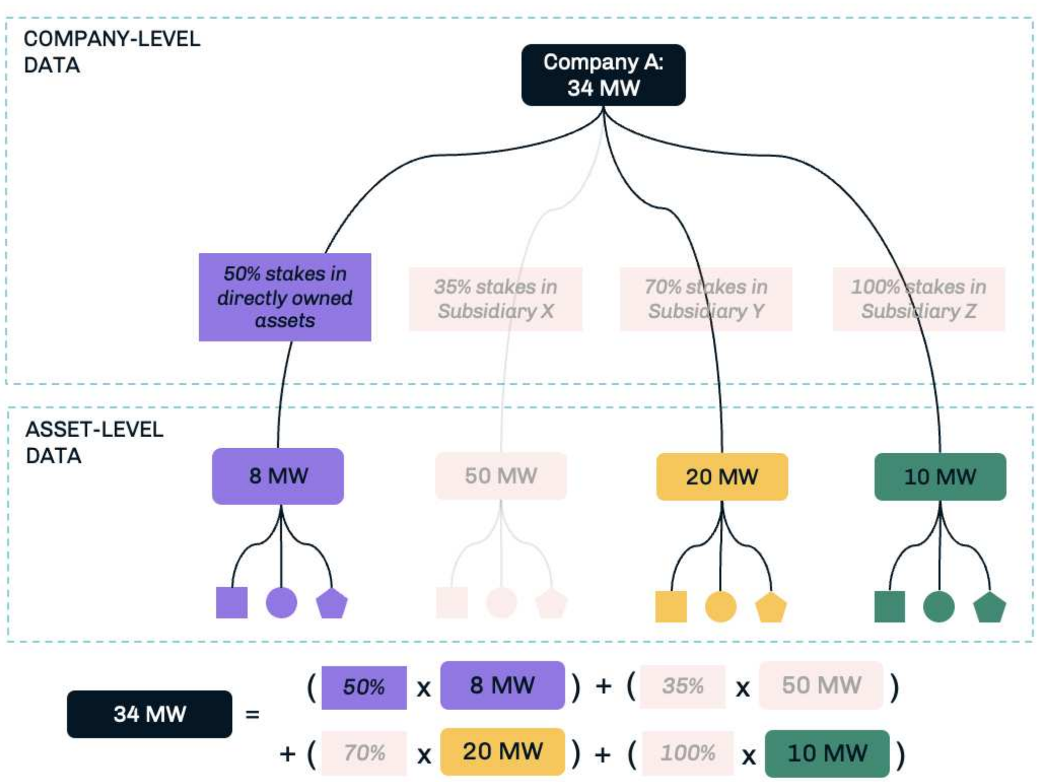
The FC consolidation methodology aggregates the relevant asset-based indicator (activity, capacity, or emissions) for each successive level of the ownership tree (from subsidiary to parent company) unweighted by the parent company's equity stake in the subsidiary. The relevant indicator is aggregated only for subsidiaries in which the parent company has at least 50% (majority) equity ownership stakes.

For example (see Figure 7), Subsidiary X owns assets with 50 MW installed capacity, Subsidiary Y has 20 MW, and Subsidiary Z has 10 MW. Company A has majority ownership stakes (>50%) in Subsidiaries

Y and Z, minority ownership stakes (<50%) in Subsidiary X, and directly owns 50% stakes in assets with 8 MW of installed capacity, then Company A's aggregated, unweighted installed capacity will be 34 MW, where the capacity from minority-owned Subsidiary X is excluded. This consolidation methodology is applied all the way up the corporate ownership tree to the ultimate parent company.

A parent company's aggregated activities, capacities, and emissions will thus include the sum of all indicators directly owned (weighted by equity stakes of the company in directly owned assets) and indirectly owned (consolidated by the FC methodology described above).

Figure 7. Illustrative example of Financial Control (FC) Consolidation



Whereas the above-described FC methodology is used in the PACTA for Banks Data set. There are alternative consolidation methodologies available. For example, the Equity Ownership (EO) consolidation

1.7.2.2 Equity Ownership (EO) Consolidation Methodology

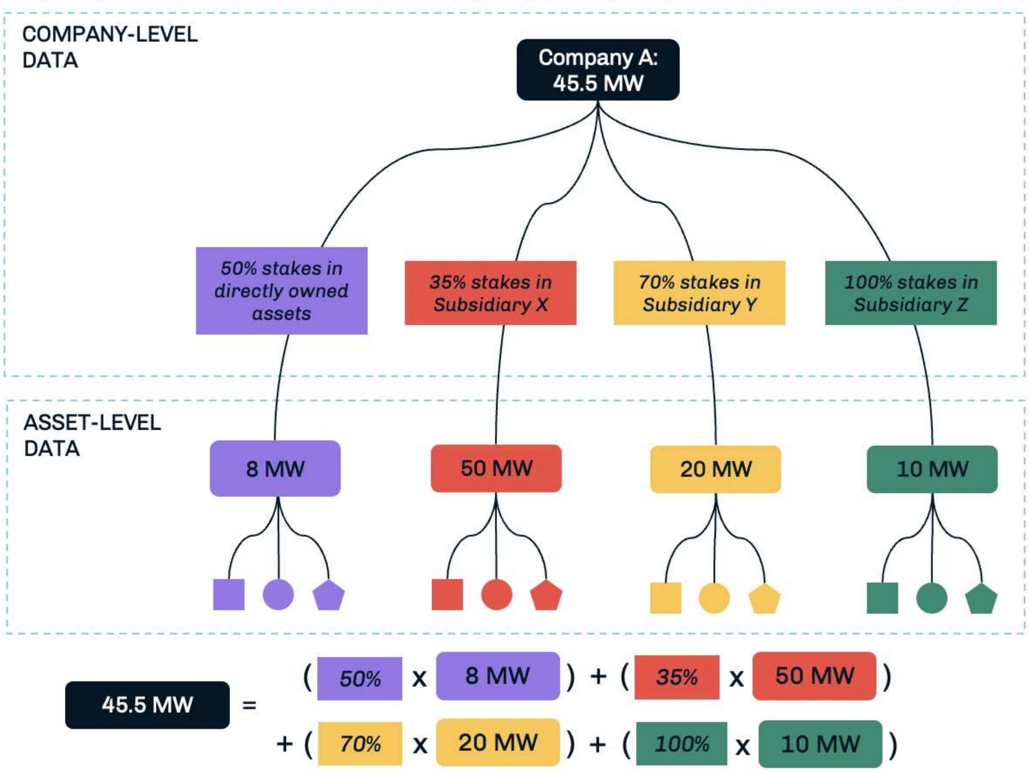
The EO consolidation methodology aggregates the relevant asset-based activity (activity, capacity, or emissions) for each successive level of the ownership tree (from subsidiary or affiliate to parent company) weighted by the parent company's equity stake in the subsidiary or affiliate. This also includes subsidiaries and affiliates in which the parent company has minority equity stakes (<50%).

For example (see Figure 8), Subsidiary X has 50 MW installed capacity, Subsidiary Y has 20 MW, and Subsidiary Z has 10 MW. The parent Company A has 35% ownership stakes in Subsidiary X, 70% ownership stakes in Subsidiary Y, and 100% ownership stakes in Subsidiary Z, and directly owns 50%

stakes in assets with 8 MW of installed capacity. Then, Company A's aggregated, equity-weighted installed capacity is 45.5 MW. This consolidation methodology is applied all the way up the corporate ownership tree to the ultimate parent company.

A parent company's aggregated activities, capacities, and emissions will thus include the sum of all indicators directly owned (weighted by equity stakes of the company in directly owned assets) and indirectly owned (consolidated by the EO methodology described above).

Figure 8. Illustrative example of Equity Ownership (EO) Consolidation Methodology.



A note on double counting: Regardless of the consolidation methodology, the physical asset ownership link is linear, so a parent company cannot own the same stake in an asset, subsidiary, or affiliate more than once. This linearity ensures that there is no double counting of the asset-based indicators linked to the parent company.

As the PACTA for Banks methodology is a standalone methodology. It is therefore data input agnostic, given that the data used is consistent with the methodology. Namely, that it is forward looking bottom-up physical asset data. (As described in section 1.7.1. above). This means that a user can chose which data source and provider they use to conduct the analysis.

Table 1. Pros and cons of ABCD and company reporting

	Pros	Cons
Physical asset-level databases	• More precise and high degree of global coverage of climate-relevant sectors (80-100%), (for example 80% of global steel plants)[10] far-reaching even up to assets belonging to small companies • Generally, provides forward-looking data, reviewed using best business-intelligence practices (e.g. critical review of overly optimistic production plans)	• Generally, not applicable in the context of non-carbon intensive sectors, which cannot be evaluated through ABCD • Challenge around communicating that the assessment does not cover 100% of a corporate lending portfolio • Uncertainty in corporate ownership trees may lead to some errors in the data aggregation process • Data is collected and critically reviewed by the data provider (i.e. not via independent audit)
Company reporting	• Audited data (when reported in annual reports)	• Limited reporting on listed companies and hardly any reporting on non-listed companies. The latter is a large share of a bank's exposure within wholesale banking • Aggregated company reporting across different sectors is not compatible with scenario analysis as scenarios are provided on a sector by sector basis. • Inconsistent accounting rules and scope across companies, which leads to incomparability and incompleteness in coverage – often leaving out emissions related to the technologies or products which make up their core climate function

10 Note this figure is an example

1.8 Scenario Data

The PACTA for Banks Methodology offers scenario inputs based on IEA scenarios. However, in theory, any climate scenario can be used provided that the scenario lays out targets in production capacity at technology level or – for the relevant sectors – emission-intensity units. This last indicator could also be indirectly calculated if the scenarios provide absolute carbon and production values.

It is important to note, however, that the choice of scenario can dramatically influence results. It is therefore imperative that the **scenarios' assumptions are well understood.** The use of multiple scenarios with varying levels of climate ambition is encouraged. This provides banks with a better understanding of their current and future alignment to benchmarks. As part of PACTA, it is essential that at least one scenario is ambitious enough to achieve the goals set out in the Paris agreement.

Should a bank's economists or strategists fundamentally disagree with a scenario, it is important that they note the assumptions and modelling underlying the scenario they are measuring alignment against.

Scenarios typically differ as follows:[11]

- They lay out decarbonization paths that occur at **different speeds** (rapid ramp-up or long-term adjustment)
- They make different assumptions around innovation and thus around technologies' availability, scalability, and cost
- As a result, they favor or rule out **different technologies** (e.ge prominent use of carbon capture and storage (CCS) in the IEA's Beyond 2 degrees scenario (B2DS) scenario but not in the ISFs NZE scenario)
- They implement decarbonization paths of **different levels of ambition**
- They offer varying levels of granularity, e.g. they are expressed at different times and geographic scales

Note that the targets laid out in climate scenarios can vary by region depending the sector's value-chain and geographic constraints (e.g., power distribution). It is advisable to measure alignment at the geographical level in which the sector tends to operate. For example, for the power sector, markets tend to be regional or national, and as such alignment should be measured at that level. However, the oil sector operates in a global market and in such a case it makes more sense to use a global scenario target.

As part of the PACTA for Banks Toolkit, a set of scenarios have been prepared for use with the PACTA for Banks Software. This can be accessed at www.transitionmonitor.com. Please see the "Scenario Supporting Document" for more information on the scenarios and details on the methodology used to prepare these files.

1.9 Portfolio Data

Performing a scenario analysis of a loan book requires the following data points as input to the assessment framework:

- Company or Project Name (direct loan taker and/or economic/legal parent)
- Loan value (financial variable used is optional, section 1.6.2)
- Sector classification code (e.g. NAICS, BICS, GICS, NACE, ISICS)

11 Please refer to the Scenario Supporting Document at www.transitionmonitor.com document for further details.
For further reading, please see article produced by the UNPRI: https://www.unpri.org/inevitable-policy-response/pathways-to-net-zero-scenario-architecture-for-strategic-resilience-testing-and-planning/6006.article

- Further information for matching purposes such as company level details: parent company, unique identifier, etc.

All of these data elements typically exist in banks' data infrastructure and collection process, and thus would be accessible without additional data collection. The loan value is used for the weighting of the clients' contribution to the corporate lending portfolio results.

As mentioned above, to identify the loan book's sectoral exposure, the client company's business segmentation needs to be considered. Where a general-purpose loan is given to a conglomerate that has activities in more segments of the value chain than those covered in the methodology (e.g. General Electric, for which power generation makes up a small share of total activities, compared with utility construction), this should be reflected by approximating the share of debt that can be assumed to go towards the financing of the activity in scope. This is desirable but comes with substantial data-quality challenges and hence is not currently done.

The counterparties in the bank's loan book are identified amongst the companies in the asset-level data, in order to retrieve their production and technology profiles. This record-linkage process is referred to as 'matching.'

Whenever unique identifiers - Legal Entity Identifiers, Bloomberg Global IDs, or the tickers for securities issued by these counterparties (ISINs, Financial Instrument Global Identifiers, Stock Exchange Daily Official List (UK), CUSIPs (USA)) – are recorded in the loan book, they can be used for matching. However, the coverage of such unique identifiers is often low for corporate lending portfolios. Hence when no or few unique identifiers are recorded, this matching process is performed using company names.

The PACTA for Banks Software provides a fuzzy-matching algorithm to do the name matching. Please see r2dii.match website for more details.

A special purpose vehicle will be – wherever possible – matched directly with the asset it finances, and the specific profile for that asset will be retrieved.

Where a loan is only known to have been granted to a company as a whole, and in the absence of information on possible restrictive covenants, loans are assumed to be general-purpose and the overall profile of the company is retrieved (i.e. encompassing of all that company's activities across technologies), preferably undertaking the business-segmentation modelling explained above.

Loans are matched at the most precise level – in the corporate structure – for which data is available in both sources (loan book and asset-level data). When matched at both parent and subsidiary level, by default the production and technology profile of the direct loan taker (e.g. branch of the company to which the loan was granted) is retrieved, so as to best circumscribe and reflect the economic activities being financed.

Loans can alternatively be matched at the level of the counterparty's parent company, to reflect the broader counterparty risk that may be incurred via the loan, depending on the structure.

Box 2. Discussion and rational behind the metric and units used

The unit of measure is arguably the most basic element when it comes to analytics, and indeed the one that has received the most attention in the academic and practitioners' literature. The units are generally classified in four categories:

- CO_2 emissions accounting
- Technology profile
- Financial indicators (e.g. investment levels)
- Qualitative metrics

As outlined above, for climate scenario alignment analysis, the units used to measure alignment need to logically be the same the ones used in the scenarios. Thus, the data point may either be expressed in production capacity, production, investment/financing, and/or CO_2/GHG emissions). Given the balance of pros and cons (see table on next page), the methodology developed here relies on the technology/fuel mix capacity where possible. The reasons being that it:

- minimizes the data uncertainty in the economic activity data
- can be linked to equivalent units in the scenario
- reflect the 'supply decisions' that companies control, i.e. allows client level engagement by banks to encourage climate action
- allows for comparability across portfolios

The caveat to this choice is that for some sectors, a technology profile may not be intuitive. For example, in the cement sector, a myriad of adjustments to the fuel, production process, etc. determine the climate impact of the production of a ton of cement. Both from a data availability perspective and the ease of use (navigating 20 indicators), a technology profile at this stage may not be intuitively applicable. Here, CO_2-intensity indicators can represent a 'proxy' for the technology profile of the product and production process. Similarly, a technology profile is a translation of a global carbon target into investment and economic activity profiles.

Qualitative metrics can be used to inform decisions around the climate change strategy and positioning of a company or portfolio. However, they are not conducive to measuring the alignment of a portfolio or a company to a climate scenario, where quantitative data points are needed. Hence it follows that a quantitative and comparable data point is required from the company or portfolio for which scenario alignment is being evaluated.

Table 2. Pros and cons of different types of metrics

	Pros	Cons
Production capacity (categorized by technology or CO_2 intensity input)	• In most sectors, this is the data point with highest degree of accessibility and quality • Requires limited to no additional estimates around utilization rates • Directly relates to 'supply' investment decisions of companies	• Not directly related to financial indicators • May over- or understate climate impact given that capacity may not be fully utilized • For some sectors (e.g. cement), lack of technology alternatives does not allow for a discrimination of production processes
Production	• Directly related to financial indicators (revenues, sales) • More closely related to climate impact	• Requires uncertain estimates around utilization rates • Since production relates to current demand profile, does not necessarily reflect the investment decisions of companies
CO_2 emissions	• Indicator most directly related to climate impact • Easy to understand for the wider public • Can be aggregated across sectors and applied across all sectors. Note that this must be done in a way that prevents double counting	• Uncertainty in GHG emissions estimates may not be linked directly to company decisions • Normalizing by financial indicator needs the same indicator by sector, which will put certain technologies and sectors at an advantage or disadvantage depending on their financial efficiency. Resulting policy making would point to an exclusion of GHG intensive sectors, which does not necessarily help the economy align • May hide technology diversification and thus exposure to low-carbon/zero-carbon alternatives (e.g. renewables)

Table 3. PACTA metrics monitor the following mixes and trajectories

Sector	Production mix/Production processes (across the whole sector)	Production volume (per technology and across the whole sector)
Oil & Gas	Distribution of converted energy (PJ) across fossil fuels in the primary energy mix (studied along with coal)	Change in planned production (BOE/day and bcm/day)
Coal	Distribution of converted energy (PJ) across fossil fuels in the primary energy mix (studied along with oil & gas)	Change in planned production (MT/day)

Power	Distribution of installed capacity (MW) across power-generation technologies	Change in installed capacity (MW)
Automotive	Distribution of production across powertrain types	Change in production capacity (cars)
Steel	Distribution across different production technology types. Note this is converted to an intensity as described above.	Change in production (tons of Steel)
Cement	Distribution across different production technology types. Note this is converted to an intensity as described above.	Change in production (tons of Cement)

1.10 Distributing macro carbon budgets to micro-economic actors

In order to measure the alignment of companies and thereby portfolios with climate scenarios, one needs to attribute the climate responsibility to an economic actor. Put differently, global or regional decarbonization requirements need to be allocated to micro-economic actors.

Four approaches could be considered:

1. **Market share approach *(adopted in PACTA for Banks).*** This approach uses a 'market share' allocation rule, wherein all sector-level production and capacity trends are proportionally distributed across companies such that by contracting/expanding their production in each technology at the same rate, they retain their initial market share. If a sector's decarbonization efforts can be measured as *y* measured and company A has 10% of the market share, it needs to conduct 10% of *y.*

2. **Economic efficiency/least cost approach (*not applied).*** This approach uses the cost structure of a company's existing, planned, and potential capital stock to estimate which assets meet a sector-wide output constraint under the assumption that low-cost assets will be deployed first. This logic has been applied by the Carbon Tracker Initiative for oil, gas, and coal production and capital expenditure (CTI 2014, 2016). 2DII is currently working with the Carbon Tracker Initiative to integrate this approach into PACTA.

3. **Historic responsibility *(not applied).*** This approach allocates the responsibility based on historic contributions. It represents a notable framework in the context of climate litigation analysis in terms of liabilities for climate damage but isn't currently considered in the context of alignment analysis. This is the same approach as applied by the Nationally Determined Contributions (NDC) as part of the Paris Agreement.

4. **Bottom up approach *(not applied).*** The bottom-up approach essentially mirrors the concept of equity and credit research analysts and considers a combination of economic efficiency considerations, political factors (e.g. regulatory frameworks), adaptive capacity and corporate agility, as well as other determinants potentially driving the evolution of companies' market share and positioning.

1.11 Allocating physical economic assets to financial instruments

Another requirement to measure scenario alignment is to attribute the physical assets (such as steel plants or power plants) to the financing instrument and by aggregation to the portfolio or loan book level.

2DII has identified five approaches to assigning accountability:

1. **Ownership approach** ***(not applied).*** This approach allocates the physical assets to financial assets as a function of the ownership share that the financial asset represents. This ownership approach can only be applied for equity stakes – it is not transposable to debt. A variant of this approach has been developed to allocate across asset classes based on enterprise value or book value. This approach, however, is not applied in the PACTA for Banks Methodology given that is does not support steering decisions and also given the existence of data challenges. It is however applied in PACTA for Investors for listed equity portfolios.

2. **Portfolio-weight approach** ***(adopted in PACTA for Banks).*** This approach allocates economic assets based on the weight of the financial asset in the portfolio. In debt values, when using book value, it represents a proxy for capital allocation decisions. For equity, this logic does not apply. See box 3 below for more details.

3. **Unweighted approach** ***(adopted in PACTA for Banks).*** This approach allocates absolute production values of a company to the portfolio level (i.e. there is no weighting). This approach can be used to gain insight at the client level. This can be interpreted more as the climate impact that the client is having in the real economy as opposed to the bank's contribution to that impact.

4. **Voting power approach** ***(not applied – area of further research).*** This approach allocates economic assets based on the 'voting power'. It is a variant of the ownership approach but allocates assets based on the actual decision-making power associated with the financial asset, which can deviate significantly from the ownership share. This ownership approach can only be applied for equity stakes.

5. **Financing footprint approach** ***(not applied – area of further research).*** This approach seeks to estimate the actual 'financing contribution' to various emissions/assets based on the sources of financing of a company, the allocation of capital within a company, and the relative contribution an individual financial asset makes.

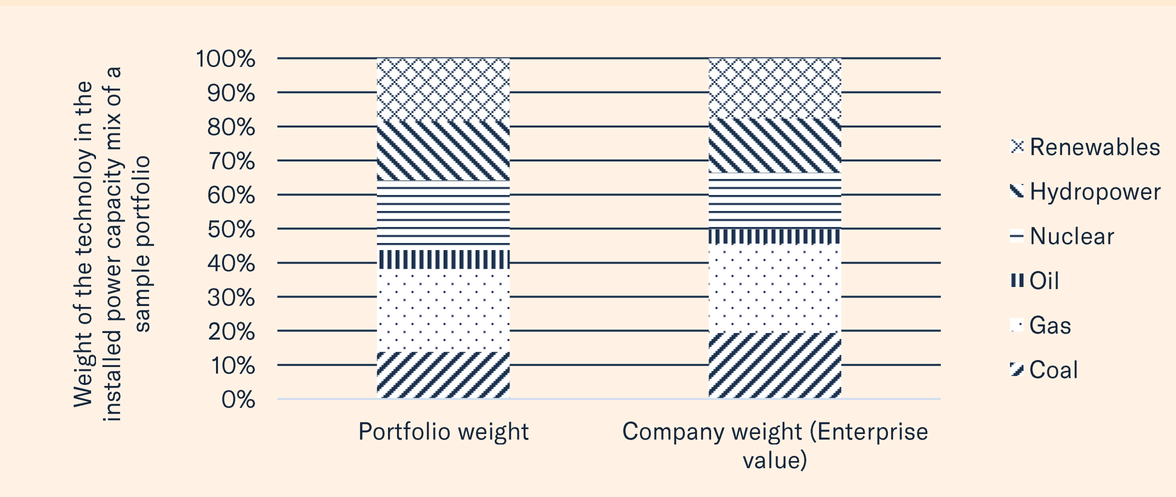
6. **Impact approach** ***(not applied – area of further research).*** This approach allocates economic assets to financial instruments based on the actual impact/contribution that this instrument made in decarbonizing that asset. It relates to concept of impact and allocating impact. Research is currently under way to see if such an approach can be developed.

Box 3. Discussion on the Portfolio-Weight Approach

The portfolio-weight approach consists of **allocating economic activity based on the weight of the company in the portfolio**. It is the approach chosen in the ESG ratings of both MSCI and Morningstar/Sustainalytics, as well as the climate ratings of ISS-Ethix/CDP.[1] This approach is generally used to weight normalized or scored indicators rather than allocating absolute climate units, as it represents the relative weight of different scores or intensities in the portfolio.

While the ownership approach described above can be said to be more intuitive for equity portfolios, the **portfolio weight approach** is more intuitive for credit portfolios, since it can be said to represent the capital allocation decision of the relationship manager behind the portfolio. In other words, the portfolio value of a credit instrument, as measured in book value, can be said to represent the capital allocation of the portfolio manager. Another factor that speaks for the portfolio weight approach is the **more intuitive link to financial risk**. While out of scope, accounting based on portfolio weight allows for a representation of the size of the exposure of the portfolio to the company in terms of overall 'capital at risk'/capital invested (a function of the portfolio size and weight of the company). However, this approach is not well suited to a production-volume metric and is not recommended – it should only be used with caution in this instance.

Figure 9. Fuel mixes of a portfolio on two different allocation rules, based on Bloomberg and GlobalData (in other examples, the two can differ from one another more significantly (Thomä, Dupré and Hayne, 2018)



1 (Thomä, Dupré and Hayne, 2018)

1.12 Two approaches to measuring alignment

After allocating macro-decarbonization efforts to micro-actors as well as allocating asset-level data to financial instruments and corporate lending portfolios, we also need to determine how to measure alignment with various scenarios. There are two “alignment concepts” that can be applied in the portfolio analysis under PACTA. Both can be used and are valid methods of thinking about alignment.

The two approaches in PACTA are called the “convergence” and the “trajectory” approach. The **trajectory approach** is the main alignment approach in PACTA for the power, fossil fuels and automotive sectors, **consistent with the market share principle laid out above.** However, alignment targets being set for the **steel and cement** sectors that used the **emission intensity metric** are done so by using the **convergence approach**.

(Here the term “market benchmark” refers to a target derived from the scenario. This can be set at different levels of regionality depending on the scenario (section 1.14). For the purposes of the explanation below it is assumed to be a Paris-aligned one. The market benchmark (i.e. the target) represents for a given sector, the corporate economy’s emission intensity or production across a range of technologies consistent with the referenced scenario.)

1) **The convergence approach** – requires a corporate lending portfolio and/or clients to converge to the market benchmark’s end point in the scenario. It follows that a corporate lending portfolio with a higher emission intensity than the market benchmark would have to decrease its emission intensity at a faster rate than a corporate lending portfolio with an initial emission intensity lower than the market benchmark.

2) **The trajectory approach** – requires a corporate lending portfolio and/or clients to align at the same rate of change as prescribed by the climate scenario. This means that regardless of the starting point (i.e. whether they are currently doing better or worse than the market in terms of climate), all portfolios and/or clients are required to decrease or increase production – depending on the technology – at the same rate as the market benchmark. It follows that the target set out by the scenario will be met collectively with all the players responsible for their market share.

Box 4. The Sectoral Decarbonization Approach
The SDA is a method used to set carbon-intensity reduction targets based on sectoral carbon budgets. It was designed for homogenous sectors. The SDA was developed by the Science-Based Targets Initiative (SBTI), an international initiative on science-based target setting for companies initiated by CDP, the United Nations Global Compact, the World Resources Institute (WRI), and the Worldwide Fund for Nature (WWF).

The PACTA methodology is based on this approach for the cement and steel sectors. It can also be applied to the other sectors' emission-intensity pathways, in addition to the production capacity-based metrics.

The SDA undergoes (limited) adaptation in order to fit the modelling underpinning the PACTA methodology (section 2.4).

These alterations allow to account for a different data universe (third-party databases) than the original one of the SDA (IEA), and to preserve consistency in market share over time, as in the case in PACTA's core modelling. Similarly, the extent of a portfolio's carbon-intensity reduction target in t+5 will differ from one portfolio to the next, in relation to the portfolio's initial carbon intensity.

The difference between the portfolio's projected intensity and the target set under the SDA can be used as approximation of the portfolio's current degree of alignment with the climate scenario.

A key tenet of the SDA is that all portfolio targets will converge to equal the sector intensity target at the end date prescribed by the scenario.

SBTI (2020)

1.13 Time horizon of analysis & portfolio

For all regions, universes (portfolio, market, company) and scenarios, several projections are generated:

- a **current-day** estimate
- a **5-year forecast**, which reflects capital expenditures plans of the counterparties
- a **scenario-aligned target** profile, at a 5-year horizon or any further horizon within the scenario's timeframe

Acknowledging that the furthest meaningful horizon varies across sectors, this 5-year horizon is adopted as best common denominator. The expected alignment of the portfolio is thus only assessed at a 5-year horizon, but the portfolio's target future profile and future aligned benchmarks can also be calculated at further time horizons – depending on climate scenarios.

1.14 Comparing your loan book to benchmarks

Benchmarks allow us to perform comparisons. In the PACTA for Banks Methodology, there are currently two viable benchmarking options: (i) the corporate economy (defined as the sum of all the production values for a sector contained in the data set to which the loan book is being compared); and (ii) the scenario benchmark. There are many scenarios against which a loan book can be benchmarked, and within these, there are varying levels of granularity. Please refer to the forthcoming "Disclosure and Communications Guidelines document" at www.transitionmonitor.com for a further description of appropriate benchmarks to be used. There are additional benchmarking options, some of which are discussed in the table below.

Table 4. Short description of benchmarking options

Universe	Description
Economy	All actors, including households, governments, and corporates.
Corporate economy	All data points contained in the data set.
Companies represented in different certain asset classes (note this document only refers to the credit portfolios. Equities and corporate bonds portfolios are show for reference)	For **wholesale credit portfolios**, the 'lendable' universe benchmark used is the whole corporate economy, listed and unlisted. It differs from the economy as a whole in as much as there is some household-owned capacity of e.g. renewables. For **equity portfolios**, the benchmark is a representation of the investable universe as approximated by listed companies' free-float shares. For **corporate bond portfolios**, the benchmark represents the entire universe of companies that issue bonds and could be connected to production capacity, done by assessing which companies are bond issuers within the assessed climate-relevant sectors. In view of the vast variety in the types of activities financed via general purpose loans (CAPEX, OPEX, trade, etc.), no modelling of the differences in capital-intensiveness across technologies is introduced.
Index of companies	An index of companies based on certain characteristics (e.g. large-capitalization companies, companies in certain sectors/sub-sectors).
A set of 'peer' portfolios	A set of companies represented in the portfolios of 'peers', that could be defined based on different criteria (type of institution, geography of portfolios).
Own portfolio	The universe of companies represented either in their own portfolio or in 'portfolio of assets' defined based on other criteria (e.g. divested list).

1.14.1 Benchmark Limitations

It is important to bear in mind that the benchmark's profile represents the overall economy's actual technology mix based on capacity, whereas the loan book's profile reflects technology exposure based on financial allocation (i.e. a portfolio-weighted sum of the companies' mixes).

This key difference between the portfolio mix and the benchmark (i.e. market) mix must be kept in mind when comparing the two. If not done so, it can create a bias where in comparing the two, the portfolio mix appears overly invested in low-carbon technologies compared to the benchmark:

- By using the companies' technology mixes and weighting them by corresponding loan-size in the portfolio, the same capital intensity ($/MW) is assumed for all technologies. However, renewables tend to be more capital intensive and thus it is warranted that they should account for a larger share of the portfolio mix than the market (i.e. more capital needs to be invested in renewable infrastructure for the renewable share to catch up with the fossil fuels share of the technology mix). When a bank has an exposure to renewables that is larger than that of the market and the assumption is made that low-carbon technologies are more capital-intensive than high-carbon technologies, then a comparison between the portfolio's profile and global production may underestimate the portfolio's misalignment given that results are portfolio-weighted technology mixes. Note that this is very much an assumption and it is subject to change as the transition to a low carbon economy happens.
- The portfolio finances both CAPEX and OPEX, whereas the market benchmark reflects only total capital stock. Therefore, technologies that tend to be over-represented in current debt (e.g. renewable technologies) will feature more prominently in the portfolio profile than in the market. In other words, if not interpreted correctly, the study of the benchmark – in relation to the portfolio – may lead to unduly underestimating the necessary investments in low-carbon technologies.

1.15 Limitations of the methodology

As is a central caveat of modern portfolio theory, a truly diversified market portfolio cannot be accurately observed not replicated. Not all relevant assets can be satisfactorily mapped, and their main variables measured. While a limitation, the modelling work outlined in this document still arguably goes some way in offering a clearer view of climate-related issues as channeled from economic assets to financial institutions – though its first purpose and what drove its design is climate alignment rather than risk mitigation.

Different asset classes (e.g. equity vs. credit) are tackled using different mathematical modelling choices – to preserve economic meaningfulness - which may make the overall framework more complex to grasp.

Companies' relative extents of climate alignment are approximated using production capacity-based figures, and do not encapsulate R&D investment, historical record, lobbying expenditures, etc.

Another limitation in the approach resides in the necessary choice of climate scenarios: while there exists an endless number of combinations of technology-specific pathways, the methodology relies on a small number of scenarios and accepts their uncertainty and margins of error.

Beyond the methodology's reliance on the quality of climate-scenario data, it also relies on that of the asset-level data, and crucially, on that of the financial data fed into it, provided by the bank. The road-testing phase has attracted attention to the need for accurate and faithful financial-data inputs.

Last, and while less a limitation than a feature that deliberately falls out of the scope of this methodology, the approach is not a risk quantification approach. The analytics presented here address relative exposure to climate-relevant economic activities and impact, but do not aim at providing quantitative insight into credit risk. While model outputs can be used as input into existing risk models to calculate sectoral or company-specific financial risks, their aim is not to comprehensively map all sources of financial risk (e.g. pipelines, distribution networks, upstream supply chain, etc. are not covered).

1.16 Communications and disclosure guidelines

Because there is not one fixed way to run the PACTA analysis and there are multiple different parameters a user may choose, it is important that if disclosing the results publicly, the user communicates clearly on these choices and its implication.

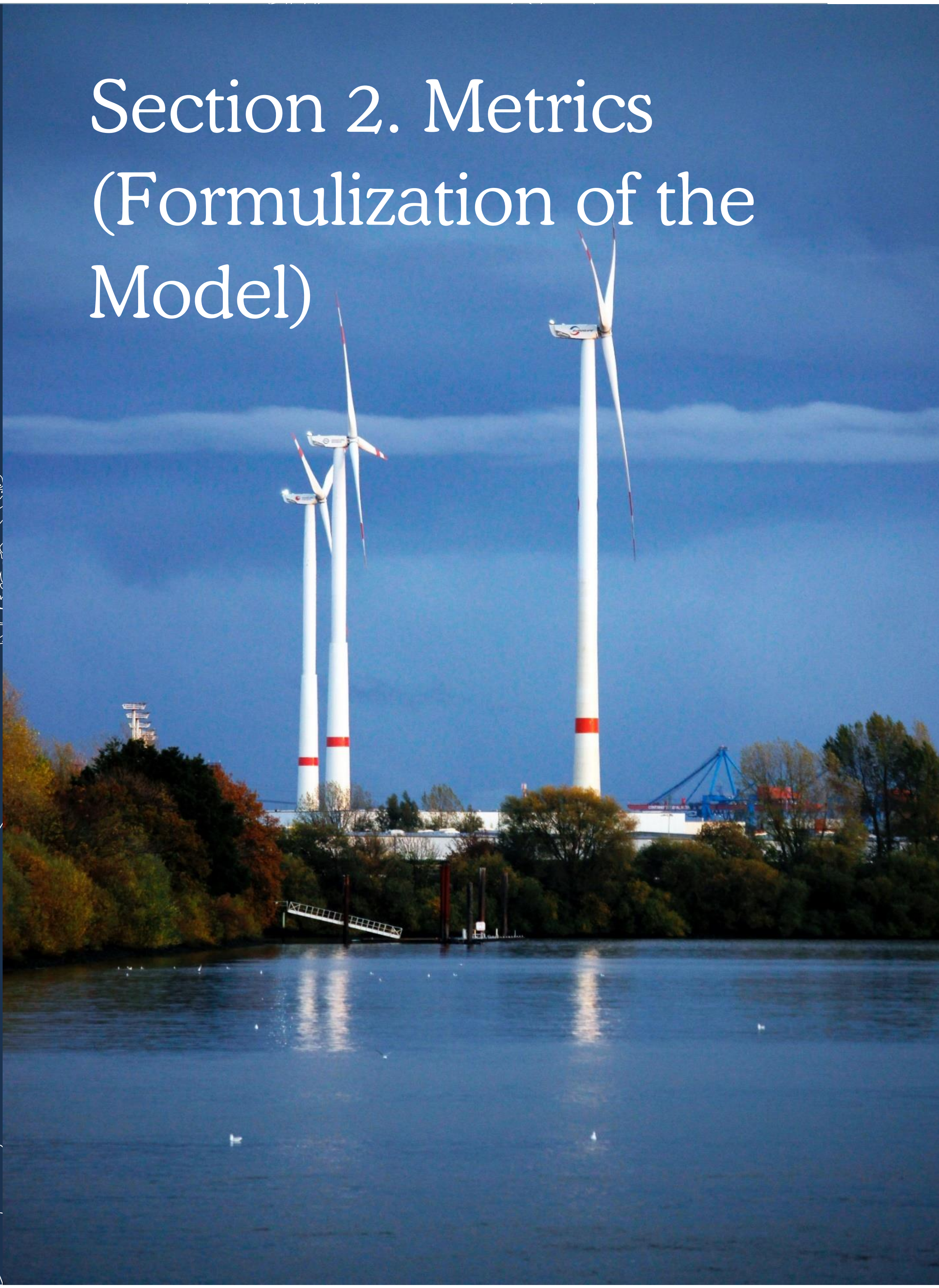
This is important for 2 key reasons:

1. **Interpretation of results** - This will change depending on the different parameters used. This is important to understand if the results of the PACTA analysis are to be used to inform decision making.

2. **Communication** - It is important to communicate to external stakeholders and the wider public with transparency and accuracy. This will prevent any misleading claims or unintended commitments being made. It is also important to ensure comparability of results between different users.

The best way to ensure communications and disclosures are accurate is to understand the methodology documented here and the underlying assumptions/uncertainties behind the data and scenario inputs.

Section 2. Metrics (Formulization of the Model)



2.1 Introduction

The following section provides a recap of the general parameterization of the methodology. It provides for the mathematical formulization of the three metrics used in the PACTA analysis, namely (i) the **technology mix**, (ii) the **volume production trajectory**, and (iii) the **emission intensity metric**. For the **technology mix** a portfolio-weighted approach is applied to obtain portfolio level results. For the **volume production trajectory**, both an unweighted and a weighted approach can be used for portfolio level results, however client level results are given unweighted, i.e. in absolute terms (production, emission intensity) (see section 1.11). For the **emissions intensity metric** results are only given at the portfolio level where again a portfolio weighted-approach is used. For the **technology mix** and the **volume production trajectory**, a description of how the portfolio, corporate economy (market) benchmark and company level results are calculated are given in this section. A description of how the scenario targets are calculated using the market share approach (Section 1.10), combined with the trajectory approach to alignment is given for both the **technology mix** and the **volume production trajectory.** For the **emissions intensity metric** a convergence approach to alignment is applied (see Section 1.12). This is described in a separate section.

For the purposes of simplification, “production” is used for both “production” as well as “production capacity” (which is used in the power sector).

2.2 Technology Mix

The climate transition requires a transition from high-carbon technologies to low-carbon technologies. Assessing the technology mix within a sector and how it is changing over time thus helps us analyze the transition compatibility of micro-economic actors.

The analysis focuses on the **changes in the technology used to produce the sector’s given output** (e.g. shift from coal-fueled to renewable-fueled power generation), and on **changes in the nature of the output** itself (e.g. shift from combustion engines to electric vehicles).

Results take the form of a distribution across technologies (i.e. fuel mix or production mix), which in the case of portfolio-level results (as opposed to company-level results) are weighted by the portfolio’s capital allocation across counterparties, reflecting how the portfolio is invested across technologies. In the case of company level results this mix is unweighted (Section 1.10).

The technology mix analysis measures the bank’s relative exposure to the economic activities that are impacted by the transition to a low-carbon economy. It is a function of how dispersed the investor’s portfolio is across companies, and how dispersed these companies’ activities are across technologies.

The fuel/production mixes studied are:

- for the **fossil fuels sector:** the distribution of total energy content (physical units converted into GJ/d across fossil primary energies (oil, gas, and coal), based on production
- for the **power generation sector:** the distribution of installed production capacity (in GW) across primary-energy sources (oil, gas, coal, hydro, nuclear and renewable energies), whereby bioenergy, geothermal, solar photovoltaic (PV), concentrating solar power (CSP), wind and marine (tide and wave) and considered renewable) are all are considered for electricity and heat generation.
- for the **automotive sector**: the distribution of production (in number of vehicles) across powertrain types (internal combustion engine (ICE), hybrid and electric vehicle (EV))

2.2.1 Modelling choices to allocate company-specific technology exposures to the portfolio

Consider some indicator, P, for some company, i. This could represent production, capacity, CO_2-efficiency or some other economic indicator. In general, this indicator will vary with time:

$$P_i \equiv P_i(t)$$

In general, t is not written. It is implied throughout.

For any given sector, we can split P by the technology, j, used to generate the indicator in question:

$$P_i = \sum_j P_{i,j}$$

It follows that the company's share, ρ, of technology j is:

$$\rho_{i,j} = \frac{P_{i,j}}{\sum_j P_{i,j}}$$

In practice, a portfolio will be composed of many companies, with varying loan-sizes to each company.

We define the portfolio's technology share, γ as the loan-weighted average of each client company's technology share, ρ:

$$\gamma_j = \sum_i \left[\rho_{i,j} * \frac{A_i}{\sum_i A_i}\right]$$

where A_i is the loan given to company i, and the summation occurs only over companies within the sector (e.g. "power").

Disambiguation: under the portfolio-weight approach:

$$\gamma_j \neq \frac{P_{i,j}^{pf}}{\sum_j P_{i,j}^{pf}}$$

Box 5. The portfolio's technology exposure v. clients' activities

The visualisation below aims at illustrating the difference between a basic fuel mix and the technology-exposure metric at the root of this methodology.

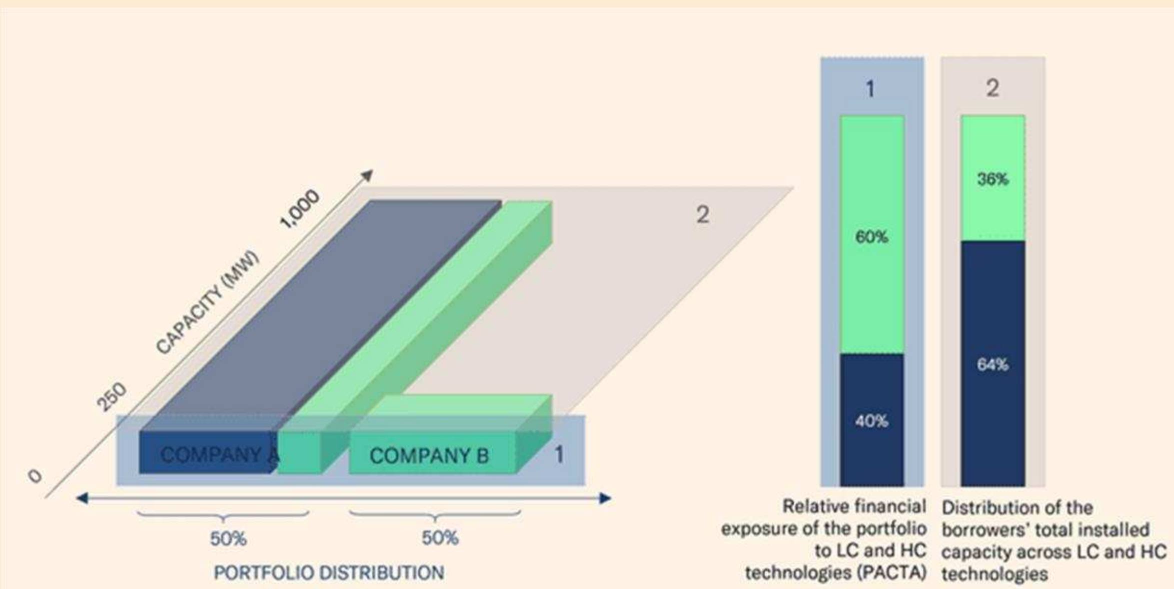
The **x-axis below represents the portfolio's distribution** across counterparties. The width of a company corresponds to the size of the loan granted to that company. This portfolio consists of 2 companies with equal loan sizes.

The **y-axis represents the installed production** operated by the companies. The length of a company corresponds to the size of that company's production. Green volumes represent production fuelled by low-carbon (LC) technologies; dark blue volumes represent production fuelled by high-carbon (HC) technologies.

Company A operates 1,000 MW, with an 80%-20% split across high-carbon and low-carbon technologies. Company B operates 250 MW, entirely powered by low-carbon technologies.

The companies' technology mixes are represented lengthwise, such that each mix is displayed on each company's vertical surface, at the front. This is because these are **general-purpose loans** i.e. modelled as going towards the financing of all of a client's technology mix.

Figure 10. Graphical representation of different technology mix metrics



The technology-exposure metric (blue vertical surface) synthetizes the portfolio's relative financial exposure to LC and HC technologies. The values on the y-axis (production size) do not come into play in this metric. This is **because capital-intensiveness (and risk) is assumed to not vary with size** (company B operates or builds no fewer MW with a same amount of $ than company A).

The technology mix (light grey horizontal surface) is a simple distribution of these companies' total installed production capacity across LC and HC technologies.

Interpretation:

- 40% of this portfolio is exposed to the transition- and impact risk associated with HC technologies
- 60% of the capital provided by this bank goes towards financing LC technologies
- 36% of the power production capacity owned by these two clients is powered by LC technologies

In plain terms, if the portfolio's share of nuclear is equal to x%, this does not mean that in absolute values, x% of all installed MW of all clients are powered by nuclear. It means that x% of the value of the loan book is exposed to nuclear.

In practice, the "technology mix" is the set of technology shares for each technology in a sector:

$$\{\gamma_1, \ldots, \gamma_j\}$$

2.2.2 Time factor

The loan size is kept constant over time. The time dependency of the technology share is entirely driven by changes in the production.

$$\gamma_j(t) = \sum_i \left[\rho_{i,j}(t) * \frac{A_i}{\sum_i A_i}\right]$$

2.2.3 Corporate economy (market) Benchmark mix

For the market benchmark (section 1.14) the technology share is computed as for an individual company. For the market benchmark all production owned by all the companies present in the data set is summed and used for the analysis as follows:

$$\rho_j = \frac{P_j}{\sum_j P_j}$$

It is calculated based on **absolute production figures**. No financial weighting could be applied with reasonable modelling accuracy, due to a lack of data (i.e. no way to approximate a global lending universe).

2.2.4 Company level mix

The company level results are calculated in the same way as the market benchmark described above, with the scope being limited to only one company. This takes the unweighted approach as described in section 1.10. This can be understood as the absolute technology mix of a company.

2.3 Production-volume trajectory

Aligning with the Paris Agreement target does not only require shifting from high-carbon to low-carbon alternatives; it also requires aligning with the absolute production trends. This is especially important for technologies that need to decline over time, i.e. high-carbon technologies and sectors. The main metric to assess absolute production trends in PACTA is the production-volume trajectory.

Alignment in either the production-volume trajectory or the technology mix metric does not equate to alignment in the other.

Furthermore, reaching alignment may be more climate-critical in one than in the other, depending on the sector (e.g. reduction in volume is especially critical in the fossil fuels sector, arguably more so than the speed at which the re-balancing across fuels is performed).

The rate at which the borrowers' aggregated production volume is projected to change (at a 5-year horizon) is compared with the trends set as targets in climate scenarios, as well as to the production function of the industry as whole.

The production-volume trajectory metric **displays trends that may not be visible in the technology exposure metric**, e.g. an increase in coal-fired power generation that would not be observable if renewable-fuelled power generation increased faster.

PACTA offers two options of the production-volume trajectory:

1) The unweighted production trajectory, which takes the total absolute production of all clients within the portfolio
2) The loan-weighted production trajectory proxy, which weights the total absolute production of the clients within the portfolio by the loan size to reflect the financial allocation

Both options are normalized to 1 in the start year to focus on the build out trends of the production.

2.3.1 Unweighted production trajectory

In this approach the unweighted production of all companies in the loan-book is aggregated:

$$P_j = \sum_i P_{i,j}$$

This shows the raw volume of production trend over time associated with the portfolio, regardless of financial exposure.

2.3.2 Loan-weighted production trajectory proxy

The same portfolio-weighting as explained in the technology mix can be applied to the borrowers' production volumes to calculate the portfolio's loan-weighted production proxy, P':

$$P'_j = \sum_i \left[P_{i,j} * \frac{A_i}{\sum_i A_i} \right]$$

The proxy is an aggregation of the banks' borrowers' production volumes, weighted by the relative amount of capital loaned to each borrower. The portfolio-weighting of the production proxy reflects the bank's lending decisions.

2.3.3 The company level results

The portfolio-level metric (weighted) serves the purpose of drawing up a picture of the portfolio's profile, it does not reveal which client is aligned and which is not. The unweighted approach can be used to give the **absolute production volume metrics at company level.** This information can inform decision making and help compare clients as well as understand their importance in the sector. In PACTA, the company results are calculated using the unweighted approach.

2.3.4 The corporate economy (market) benchmark

The corporate economy benchmark is the sum of the total (unwieghted) production per technology of all companies present in the data set being used for the analysis.

2.4 Scenario allocation

2.4.1 Applying the Market-share approach to climate scenarios

This section covers how the scenario benchmarks (targets) are set. The same mathematical formalization is applied to both the production volume trajectory and the technology mix metrics. This follows a trajectory approach to alignment as described in section 1.12.

2.4.2 Economic rationale

The rationale is the following: **the targets laid out in a climate scenario are applied to the portfolio's current profile** in such a way as to ensure that the portfolio-specific pathway **fosters alignment**. Each technology-specific element (technology share, production volume) is set to change at a rate consistent with the climate scenario. This is the trajectory approach as described in section 1.12.

The decarbonization efforts are equally distributed amongst companies depending on the market share of the company within the sector: a 10% market share means having to contribute 10% of decarbonization efforts. In other words, companies are expected to provide the same proportion of efforts **relative to their size**, and regardless of their initial starting point.

In the methodology, companies are prescribed **custom targets that are calculated using the same required rate of change.** Assigning companies targets under the form of industry-wide required change guarantees that the methodology keeps market shares constant.

The required change applied to companies' technology-specific production figures are calculated using the pathways laid out in climate scenarios, expressed in absolute values.

Two ways market definitions are combined:

- **for low-carbon technologies**, what matters is how much of a sector's total production (i.e. across all technologies – e.g. the whole power sector) the portfolio holds.
- **for high-carbon technologies**, what matters is how much of total production powered by a single technology (e.g. all coal-powered production capacity) the portfolio holds. This serves the purpose of **distributing the decarbonization effort only to companies that can take action**, i.e. only those that do currently operate some of that technology's existing production. Without this, and given the market share approach adopted, macroeconomic goals would not be reached.

Accounting for the current global lag in low-carbon technologies

Targets are applied differently for high-carbon and low-carbon technologies:

- For high-carbon-technologies,[12] the required change used is simply the rate by which the climate scenario prescribes that the global production volume should decrease. This is the technology market share ratio mathmatically formalized below.
- For low-carbon technologies, the required additional production is expressed as a share of initial total production within the sector. This is the sector market share percentage mathematically formalized below.

Portfolios are being prescribed identical changes: **a same rate of reduction of their financing to high-carbon activities**, and **a same additional volume** (expressed as a share of the portfolio's total activities) by which to increase their **financing to low-carbon activities**.

In other words, depending on a portfolio's initial distribution, **this low-carbon increase prescribed under the form of an addition of percentage points of the initial total is such that a 'laggard' portfolio** (i.e. one that initially displays exposure to a low-carbon technology that is smaller than that technology's prominence in the market) **will see its share of that technology - when studied in isolation - grow faster than a 'leader' portfolio**.

Two portfolios of identical size – i.e. both deemed to finance a same-size market share – will be required to add the same volume (expressed as share of their total) of low-carbon technology production to the activities they finance. Only when we look at the internal shift that undertaking this addition amounts to, does this same target represent varying levels of effort.

Indeed, if a portfolio finances no renewable power production capacity, applying any rate of change to it will leave that production capacity at zero in the portfolio's custom pathway. Therefore, laggards would not be expected to build out renewable power production capacity; they would fall behind in terms of market share as the sector shifts towards an increasing volume of renewable power, and the bulk of the necessary build-out would fall upon historical leaders in the field. Therefore, the target is set in the form of a percentage-point increase that is expressed in relation to the initial distribution. A portfolio is not required to increase its low-carbon production capacity by x%, but rather to increase it by a volume equivalent to y% of its total production capacity within the sector.

Conversely, for decreasing (high carbon) technologies, the pace at which production has to decline is set in isolation from initial distribution across technologies.

Both calculation rules yield the same result, wherein all decarbonization efforts are distributed to microeconomic actors. However, **the combination of the two generates a different distribution than if either had been exclusively used**. It is not feasible to use one exclusively due to the relative lack of low carbon technologies. Hence, a combination of the two is required. This is consistent across all portfolios.

2.4.3 Applying Technology Market Share Ratio to set Scenario Targets (High-carbon technologies)

Consider a scenario, $s_j(t)$, perscribing a pathway for high-carbon technology, j. We define the technology market share target as:

12 And for all technologies for the fossil fuels sector

$$p_{i,j}^{tmsr} = p_{i,j}(t_0) * \frac{s_j(t)}{s_j(t_0)}$$

for some intial production value, $P_j(t_0)$.

We define the "technology market share ratio" as:

$$\frac{s_j(t)}{s_j(t_0)}$$

2.4.4 Applying the Sector Market Share Percentage (smsp) to set scenario targets (Low-carbon technologies)

With p_j and s_j being the portfolio production and scenario production of some technology, j, let P and S be the portfolio and scenario production of the sector, across all technologies, i.e.:

$$P_i \equiv \sum_j p_{i,j} \quad \& \quad S \equiv \sum_j s_j$$

We define the sector market share target, for low-carbon technology j, as:

$$p_{i,j}^{smsp} = p_{i,j}(t_0) + P_i(t_0) * \left(\frac{s_j(t) - s_j(t_0)}{S(t_0)}\right)$$

We define the "sector market share percentage" as:

$$\left(\frac{s_j(t) - s_j(t_0)}{S(t_0)}\right)$$

2.5 Emission-intensity metric

The emission-intensity metric is applied in PACTA where no well-defined technology decarbonization pathway is given for sectors in climate scenarios. In PACTA, this is applied to the steel and cement sectors. The metric is taken from the SBTI's Sectoral Decarbonization Approach (SDA)[13] with a few alterations. This section first sets out a description of how the approach is applied in the SBTI framework. Secondly, a description of the adjustments made to the SDA when applied in PACTA to form the PACTA emission intensity metric is given. Finally, two case studies illustrate the main takeaways. This metric takes a convergence approach to alignment as described in Section 1.12. For this metric, results are only given at the portfolio level.

2.5.1 The Sectoral Decarbonization Approach

The Sectoral Decarbonization Approach (SDA) is a method designed to set corporate emission reduction targets in line with best available climate science. It was developed by the Science-Based Targets Initiative (SBTI), an international initiative on science-based target setting for companies initiated by CDP, the United Nations Global Compact, the World Resources Institute (WRI), and the

13 SBTI (2015)

Worldwide Fund for Nature (WWF). The SDA is a convergence approach whereby all portfolio intensity targets will converge to equal the sector intensity target at the end date prescribed by the scenario.

2.5.2 Overarching modelling. The SDA as applied by the SBTI

Company intensity pathways are derived from the company's base year intensity and the sectoral intensity pathway.

- **Distance to target (d)**

First, the distance to the target is calculated, d. This is the distance between the company's carbon intensity at a given base year, $I^{CO}(t_0)$, and the target market carbon intensity at the end point of the climate scenario, in this case 2050, $I^{in}(t_{2050})$:

$$d^{co} = I^{CO}(t_0) - I^{Sc}(t_{2050})$$

Where co denotes a company, Sc denotes the sector wide target as set out by the scenario and I is the intensity.

- **Company market share parameter (m(t))**

Second, the company's market share parameter, m(t) is calculated. The company's expected future activity, $P^{CO}(t)$ is divided by the sector's predicted future activity, $P^{Sc}(t)$, to reflect the expected forward-looking market share of the company.

This is given as a ratio to the company's base year market share, derived from its activity, $P^{CO}(t_0)$, divided by the sector's activity in the same year, $P^{Sc}(t_0)$. In both cases, the former is provided by the company and the latter is derived from the scenario.

This parameter is summarized in the following equation:

$$m(t) = \frac{\frac{P^{CO}(t_0)}{P^{Sc}(t_0)}}{\frac{P^{CO}(t)}{P^{Sc}(t)}}$$

Where P is production, Co denotes a company and Sc denotes the sector wide production – which is taken from the scenario.

It should be noted that this parameter does not capture the change in the market share of the company but rather the inverse. This is useful as it equates to a decreasing parameter when the company's market share is increasing. This equates to larger reduction efforts when the company's market share is increasing over time.

- **Sector decarbonization variable (p(t))**

Third, the sector decarbonization variable, p is calculated. This variable captures the remaining effort needed from the market to meet the target at the end point of the scenario, per year. Under the SDA assumptions the CO_2 intensity for all companies in a sector converge at the end point of the scenario.

Thus, 100% of the expected decarbonization efforts are still to be met at the base year and 0% should be left at the end point. Essentially, the percentage of efforts still needing to be met at any given year is given by:

$$p(t) = \frac{I^{Sc}(t) - I^{Sc}(t_{2050})}{I^{Sc}(t_0) - I^{Sc}(t_{2050})}$$

Where $I^{Sc}(t)$ is the average scenario emission intensity at time t.

- **Carbon intensity target (I^{target})**

We define the company-level emission intensity target as:

$$I^{target}(t) = (d^{CO} * p(t) * m(t)) + I^{Sc}(t_{2050})$$

2.5.3 The PACTA emission intensity metric

The PACTA emission intensity metric differs slightly from that of the SDA as applied by the SBTI. This difference aims to align the approach with the bottom-up asset-level data being used in PACTA – as opposed to the top-down approach applied by SBTI through their interpretation of the scenario. One assumption and one adjustment are made. This reflects the difference in data scope and preserves consistency with PACTA by not making any assumptions about changes in market share.

When applied in PACTA the target is set at the portfolio level. The portfolio's emission intensity is calculated using the portfolio weighted approach. (section 1.10)

- **Assumption:** setting market share changes (m(t)) to 1

Due to the lack of quantitative data on the expected market share changes throughout the entire time horizon, m is set to 1 for all years.

Under the SBTI method for calculating m, there will be a higher intensity reduction target in cases where the absolute pathway of the sector exceeds the scenario target. However, applying this at company level is counter-intuitive, as companies that decrease their market share would be allowed to have a higher CO_2 intensity than the average market player, while companies that are increasing their market share are forced to do more in terms of CO_2 intensity than ones whose market share remains constant. It follows that if a company reaches the targeted CO_2 intensity, that company would not be allowed to increase its share in the market.

Given that m is currently not available, it is set to 1, which simplifies the equation to

$$I^{target}(t) = \left(d^{CO} * p(t)\right) + I^{Sc}(t_{2050})$$

- **Adjustment:** adjusting sector intensity *(I^{sc})* in the base year and thus at the end point of the scenario to ensure consistent scope and methodology applied to portfolio and market target.

In both SBTI's and the PACTA methodology, the target emissions for the sector are taken from climate scenarios. This is a global economy top-down approach which applies an absolute emissions value in the end year and then coverts this to yearly emission intensities.

However, a discrepancy arises between the scenario and PACTA's asset based company data. This is a divergence of data universe, i.e. the scenario has estimated the global production whereas the PACTA asset-level data set is based on physical assets present in the data set. As a result, the former will have built in assumptions and the later will have imperfect coverage. The two are therefore not comparable.

To reflect this difference, a required change, (g) in a specific year, t, is taken from the sector CO_2 - intensity in a specific year, t, compared to the base year, t0. This ensures consistency in calculating CO_2 intensity targets at any given time as the average sector intensity is calculated on a rolling basis based of real asset data. So, any changes in sector intensity on a year to year basis will be reflected in the portfolio's intensity reduction target.

$$g(t) = \frac{I^{Sc}(t)}{I^{Sc}(t_0)}$$

This required change is then multiplied to the sector intensity in the base year based on the bottom-up asset-level data from 2DIIdatabase. Given the following equation:

$$I'^{Sc}(\mathrm{t}) = g(t) * I^{ALD}(t_0)$$

Hence the SDA equation as amended by the adjustment above and including the assumption (m) here is given as:

$$I^{target}(t) = \left(d^{CO} * p(t)\right) + I'^{Sc}(t_{2050})$$

Note that the d variable is now calculated as the difference between the company's intensity at start year and the market target in the end year as adjusted to the PACTA data universe.

$$d^{co} = I^{CO}(t_0) - I^{ALD}(t_{2050})$$

2.5.4 Emission Intensity Scenarios data input

As the PACTA for Banks Methodology is scenario-agnostic, users are free to use whichever scenario they want. However, as this metric focuses on intensities, it is important that scenarios are used that give emission intensity or where intensities can be derived from other metrics in the scenarios. For example, if absolute production and absolute carbon emissions are presented in the scenario, it is possible to infer an emissions intensity (CO_2/product). As part of the PACTA for Banks Toolkit, such an intensity scenario has been prepared from the IEA's ETP. This scenario and the methodology behind calculating the emission intensity can be found at www.transitionmonitor.com.

2.5.5 Emission Intensity Asset-level data input

A core tenant of the PACTA methodology is that the analysis is centered around production coming from physical assets in the real economy. Asset-level data for the steel and cement sector is given in production values coming from physical plants at present and up to 5 years in the future. As there is no technology breakdown in current given climate scenarios, it follows that an emission intensity model must be applied to the production values to achieve the portfolios emission intensity. This is taken as the portfolio weighted average of the bank's exposures (see 1.10). At the company level this is calculated as the production weighted average emission intensity across the technologies that a company produces with.

2.5.6 The Corporate economy (market) benchmark

As with the technology mix and volume trajectory metric, a market benchmark is given for comparison. This market benchmark is defined by the corporate economy, which constitutes all the assets present in the asset based company data set being used to run the analysis. This benchmark is calculated as the production weighted average emission intensity of all the assets present in the data set.

Section 3. Sectors

3.1 Power

3.1.1 Sector Overview

The **transformation and ramp-up of the power sector** is at the heart of the transition to a low-carbon energy system. A growing share of total primary energy will have to be converted into (low-carbon) electricity as ever more industrial sectors switch from fossil fuels to clean power. Increases in electricity demand in developed economies will be mitigated by energy efficiency gains, such that 90% of additional power demand will stem from emerging economies.[14]

In 2018, the power sector accounted for 42% of global carbon dioxide emissions. The majority of these came from coal fired electricity generation, which alone accounted for 30% of global CO_2 emissions. In addition, the IEA has found that coal combustion has been responsible for 0.3°C of the 1°C increase in global temperature above pre-industrial levels and thus represents the single largest source of temperature increase.[15]

Accordingly, the transitioning of the power sector is crucial to meeting the Paris Agreement's goal of limiting the global average temperature rise to well below 2°C above pre-industrial levels.

Power generation at the heart of the power sector's transition

The power sector can be broken down into up-, mid- and downstream:

- The upstream segment covers actual **power generation** and is dominated by electric utilities. This segment accounts for the vast majority of emissions in the value chain. The majority of decarbonization efforts will come from a shift in from high-carbon to low-carbon technologies, with additional efforts coming from improved efficiencies in the process.
- The midstream segment refers to the **distribution and transmission of power**. This segment is often but not necessarily owned by different entities distinct from the power generating utilities (e.g. National Grid in the UK). Most decarbonization efforts in this segment will come from improved efficiencies via minimizing energy leakage, and further investments in grids.
- The downstream segment relates to the **consumption of electricity**. Here, decarbonization efforts are related to demand side changes, in part coming from improved efficiency (e.g. more efficient household appliances), and innovations around decentralized energy production, opening the sector to new players and innovative business plans.

In the methodology, the alignment of the sector is studied via an analysis of **power generation,** i.e. the **upstream segment**, as (i) it is by far the most carbon intensive segment of the sector, (ii) supply-side emissions are the most relevant in terms of steering capital, (iii) asset based company data in this sector covers individual power plants and comparable datasets on transmission or distribution assets have not yet been developed.

Primary energy sources for power

Coal is both the first global source of generated power and the most carbon-intensive one. As a result, it is prescribed the steepest reduction rates in Paris-aligned climate scenarios.

Oil is highly carbon-intensive and plays a sizeable role as a backup technology. It is used in places with limited electricity infrastructure.

14 IEA-WEO (2019) p. 253
15 IEA – status report (2019)

Gas is generally considered as a transition fuel and hence in different scenarios and different regions it is treated differently. In most scenarios it is required to decrease in the long term but is allowed a steady increase in the short to medium term. The regional distribution is also highly variable.

Renewable technologies (onshore wind, bioenergy, solar PV, solar CSP, offshore wind, geothermal and ocean tidal) are massively relied upon by most climate scenarios in order to deliver a significant reduction of the emission intensiveness of power generation globally. All are at different stages of development and deployment and will require significant R&D investments to further scale these technologies to the extent that is required by climate scenarios.

For the most part, nuclear – a very low-carbon, baseload technology - is given increasing though limited targets in climate scenarios.

Hydropower currently accounts for a larger share of global installed capacity than all other renewables combined. Large-scale global potential has however largely been tapped already, and environmental issues surrounding the technology are rife. Potential and therefore targets vary widely regionally.

3.1.2 Metric Used

Climate scenario alignment in the power sector is measured through a combination of the technology mix – i.e. the mix of primary energy sources used in overall power generation – and production volume trajectory metrics. As part of the PACTA for Banks Toolkit the technology mix is broken down into Coal, Oil, Gas, Hydro, Nuclear and renewable power. A more granular break down by sub-technology can be used given accessibility to the data and respective climate scenarios. The volume trajectory is also given for each individual technology listed above.

Please refer to section 2 for an explanation of the design and thinking behind PACTA power-sector metrics.

3.1.3 Data Overview

2DII's analysis of the upstream segment of the power sector is based on one key measurement: the **installed capacity of power generating** assets. **This modelling choice is discussed at length in earlier sections of this paper.** Forward-looking data on installed capacity is vastly more reliable than generation/emission data, as it is tied to the physical asset itself, whereas capacity-, efficiency- and emissions-factors vary.

Capacity is allocated to each company based on direct ownership of power generating assets and based on majority ownership of subsidiary companies that own power generating assets. 5-year investment plans take into account plants coming online and upcoming decommissions.

3.2 Fossil Fuels

3.2.1 Sector Overview

More than any other industry, the fossil fuels industry has been the catalyst of unprecedented economic growth as well as responsible for the majority of global emissions. Even today, fossil fuels, such as coal, oil and gas, account for around 80% of the world's energy consumption.

Fossil fuel extraction is at the heart of PACTA's fossil fuels sector analysis

The fossil fuels sector can be broken down into up-, mid- and downstream:

- The upstream segment covers actual **extraction of fossil fuels** out of the ground. This segment constitutes the most climate critical part of the value chain. If the world is to achieve the goals set out by the Paris Agreement, there will need to be a decrease in extraction across all fossil fuel resources.
- The midstream segment refers to the **refining, processing, and transportation**. This segment is often but not necessarily owned by the same entities that hold the upstream assets. This segment will be directly affected by changes in the segment before it. Most decarbonization efforts in this segment will come from improved efficiencies via minimizing leakage, and more efficiency improvements in processing.
- The downstream segment relates to the **consumption of the final products.** This is wide-ranging and covers the power sector, transportation, petrochemicals and various other industries. The decarbonization efforts needed for downstream are captured by the decarbonization effort needed for the various sectors that use fossil fuels. Some of these downstream sectors are covered in this document or currently fall out of scope of the PACTA analysis.

In this methodology, the alignment of the fossil fuels sector is studied via an analysis of the **upstream segment**, as alignment here will have a knock-on effect throughout the rest of the value chain. Emissions related to the downstream of this segment are covered in the scope of Automotive, Power, Cement and Steel sectors in this methodology or currently fall out of scope. Furthermore, this segment is also highly vulnerable to transition risk. With the ever-looming risk of stranded assets, it is important that banks understand their climate scenario alignment in this part of the value chain.

3.2.2 Metric Used

Climate scenario alignment in the fossil fuels sector is measured by the combination of the technology mix (i.e. mix of fossil fuel resources that are being extracted) and volume trajectory metrics. As part of the PACTA for Banks Toolkit, the technology mix is broken down into Coal, Oil, Gas. A more granular break down by sub-technology can be used given accessibility to the data and respective climate scenarios. The volume trajectory mix is also given for each individual resource listed above.

Please refer to section 2.2 for an explanation of the design and thinking behind PACTA fossil fuel-sector metrics.

3.2.3 Data Overview

2DII's analysis of the upstream fossil fuels sector is based on one key measurement: the **production capacity of fossil fuel extracting physical** assets, i.e. oil fields, gas fields, coal mines. **This modelling choice is discussed at length in earlier sections of this paper** (section 1).

For coal, **total** coal production is considered regardless of the type of coal or the use of the coal, given that we cannot distinguish between thermal and metallurgical coal production at this state. While the current formatted input scenario uses total coal, further research will be done to assess possibilities to distinguish between these two use cases. Ultimately most scenarios will require thermal coal production to decline faster than the metallurgical coal production. We realize also that most coal policies of banks focus on thermal coal. In case banks want to use PACTA to report on thermal coal decline, they need to demonstrate that the coal production they finance is used as metallurgical coal.

3.3 Automotive

3.3.1 Sector Overview

The transportation sector accounts for 14% of global emissions, with the majority of emissions produced by light-duty vehicles.[16] Over the last decade, automotive emissions have continually risen, offsetting the declines in other sectors. Emerging markets are increasingly a significant source of demand growth, but **developed markets are still responsible for the largest proportion of vehicle miles.**[17]

For measuring climate scenario alignment, the manufacturing segment of the automotive value chain is considered. This segment is deemed the most climate critical as it is at the root of decarbonization efforts in the sector. Furthermore, it is directly linked to the rest of the value chain, so any changes in production will have a knock-on effect both up and down the value chain.

3.3.2 Metric Used

Climate scenario alignment in the automotive sector is measured by a combination of the technology mix (i.e. what part of your car production is based on what kind of engine technology) and volume trajectory metrics. As part of the PACTA for Banks Toolkit the technology mix is broken down into electric vehicles, hybrids and internal combustion engines. The volume trajectory mix is also given for each individual technology listed above.

Please refer to Section 2 for an explanation of the design and thinking behind PACTA metrics.

3.3.3 Data Overview

2DII's analysis of the automotive sector is based on one key measurement: the **number of cars produced by each asset.** An asset in this sector is defined as a light duty vehicle (LDV) production line. **This modelling choice is discussed at length in earlier sections of this paper** (section 2).

16 EIA (2019)
17 IEA (2019)

3.4 Cement

3.4.1 Sector overview

Cement is used to bind together the elements that make up concrete (sand, gravel), which is the world's widest-used manufactured material. Cement is produced by decomposing and calcinating limestone in a rotating kiln heated up to 1,450°C (where limestone is sintered with other materials, in a very emission-intensive process), thereby creating clinker, which is finally grinded with other components.

Emissions from cement production can be categorized in **process related** emissions, as well as **direct and indirect energy** related emissions.

- The process-related emissions are due to a chemical process called limestone *calcination*. For the production of clinker (the main component in cement), limestone is heated in a rotary kiln. It causes the calcium carbonate $CaCO_3$ present in the limestone to decompose into calcium oxide (CaO) and carbon dioxide (CO_2). The limestone calcination process accounts for about 50% of emissions from cement production[18].
- Fossil fuel is combusted to reach the high kiln temperatures that are required to produce clinker. This direct energy related emissions account for about 40% of emissions from cement production.
- Finally, indirect emissions are the result of electricity consumption for powering additional plant machinery.

As raw materials are available globally and transportation is costly, cement production is spread across the globe. Global cement production was estimated at 4.1 billion tons in 2017 by the United States Geological Survey,[19] of which 52% is produced in China, ahead of India (6.2%), the European Union (5.3%) and the USA (1.9%).[20]

According to IEA estimates, the emissions caused by cement production accounted for **7% of anthropogenic carbon dioxide emissions in 2017**, and global cement production is **set to grow by 12 to 23% by 2050 in comparison with 2018 levels.**[21]

3.4.2 Metric Used

This methodology measures the alignment of the cement sector to climate change scenarios by using the Emission Intensity metric described in section 2.4. This metric is different from e.g. the automotive or power sectors, where 'technology switching' plays a big role (i.e. moving from fossil fuel power generation to renewable). This is because for those sectors, clear low- or zero-carbon technologies already exist today, while for cement this is not the case. Hence emissions intensity (absolute emissions divided by production) is used as there is currently no well-defined decarbonization technology pathway available for the cement sector.

3.4.3 Data used

As with the other sectors covered in this methodology, production figures at the asset level are a key part of measuring portfolio alignment. Assets are defined as integrated cement manufacturing facilities. An emission factor is then applied to the production figures from each asset, giving an

18 Columbia Climate Centre (2012)
19 USGS (2012-2018)
20 GCCA (2017)
21 IEA & CSI (2018), p. 8

emission intensity. The emission factor is based on the most granular level data available, which can be as granular as the technology that is being used, or more higher-level regional emission averages for specific technologies. The production weighted average is calculated for each company. Please refer to “Cement Asset Emission Model” document on www.transitionmonitor.com for a description of the asset level emission methodology.

Please refer to “Scenario Supporting document” at www.transitionmonitor.com for a description as to how absolute carbon emission and production figures are converted into emission intensity targets in the scenario. This is the scenario benchmark used in the emission intensity metric used for this sector.

3.5 Steel

3.5.1 Sector Overview

As an essential material to industrialized economies, global annual steel production has doubled over the past two decades from 850 to 1,850 tones. Most of the increased steel output has been driven by the rapid expansion of emerging economies, in particular China, which now accounts for 51% of global crude steel production.[22]

According to the IEA (2019) steel now accounts for 8% of global carbon emissions and is the largest consumer of energy in the manufacturing sector. While the emission intensity has declined by an average of 0.7% from 2010 to 2016, under the IEA’s Sustainable Development Scenario this curtailment must rise to an annual rate of 1% until 2030. With 75% of steel production’s primary energy consumption derived from coal, simple fossil fuel switching will only achieve marginal emissions reductions. In the long-term, deep decarbonization will require more ambitious technologies and production methods.[23]

3.5.2 Metric used

The PACTA methodology measures the alignment of steel portfolios to climate change scenarios by using the emission intensity metric described in section 2.4. This metric is used as there are currently no well-defined decarbonization technology pathways available for the steel sector, meaning that a technology mix of volume trajectory by technology is not feasible.

3.5.3 Data overview

As with the other sectors covered by the PACTA for Banks Methodology production figures at the asset level are a key part to measuring portfolio alignment. Assets are defined as steel manufacturing plants. An emission factor is then applied to the production figures from each asset, giving an emission intensity. The emission factor is based on the most granular level data available, which can be as granular as the technology that is being used, or more higher-level regional emission averages for specific technologies. The production weighted average is calculated for each company. Please refer to “Steel Asset Emission Model” document on www.transitionmonitor.com for a description of the asset level emission methodology.

22 World Steel Association (2018)
23 IEA SDS (2018)

Please refer to "Scenario Supporting document" on www.transitionmonitor.com for a description as to how absolute carbon emission and production figures are converted into emission intensity targets in the scenario. This is the scenario benchmark used in the emission intensity metric used for this sector.

3.6 Aviation

3.6.1 Sector Overview

Within the transport sector, aviation was – until the recent Covid-19 pandemic – one of the fastest growing modes of passenger transport and the fastest growing source of CO_2 emissions sources globally. World-wide passenger aviation activity grew by 350% between 2000 and 2019. According to the IEA (2020) the aviation sector in 2019 accounted for 3% of global direct CO_2 emissions from fossil fuel combustion, based on the use of kerosene fossil fuel[24].

Under the IEA's Sustainable Development Scenario the overall emissions from the sector must fall 6% by 2030 and nearly 30% by 2050 whilst emissions intensity measured in tonnes of CO_2 emissions per Revenue Passenger Kilometre must reduce from a global sector average in 2019 of 118 gCO_2/rpk by over 30% in 2030 and by nearly 70% in 2050[25].

While energy efficiency improved annually by 2.9% between 2000 to 2014, the growth in flights has off-set these efforts. Therefore, a decoupling of growth in demand and emissions is necessary in the next decades (IEA, 2020). Efficiency is a core cost driver for the aviation sector with fuel comprising 20% of most companies' operating expenses. Reducing a fleet's passenger km fuel consumption can be achieved in two main areas: better fleet utilization and the acquisition of new, more efficient planes. Over the past decades, the average passenger occupancy has increased by 10% to a global average of nearly 83% in 2019[26].

The main players in the aircraft industry that will need to be engaged in the transition are the aircraft manufacturers, leasing companies who own aircrafts, and aircraft operators. Aircraft operators are primarily passenger airlines and dedicated freight companies who operate a mix of leased aircraft and self-owned aircraft assets. Over 40% of aircraft are currently leased to airlines by companies that own the assets[27]. Corporate lending plays an important role in financing both leasing companies and aircraft operators such as passenger airlines (note that due to licensing restrictions, the free PACTA for Banks data set only contains data at the operator level; data at the level of the aircraft can be purchased from Asset Resolution or other data providers).

The sector faces major challenges in seeking to reduce emissions because of long aircraft lifetimes and lead times for innovation. The IEA in its Energy Technology Perspectives 2020 identifies technology pathways for the sector to 2050 that suppose investment in a combination of:

- further improvements in the energy efficiency of aircraft,
- improvements in operations and flight routines,
- alternative power trains for aircraft, and
- the substitution of fossil kerosene fuel with biofuels and synthetic fuels.

With the majority of the current passenger aircraft in operation having been introduced before 2000 there is the opportunity over the coming decade to implement progressive improvements on multiple fronts. This will need to involve not just the designers and purchasers of new aircraft but also those involved in producing aviation fuel.

24 IEA, ETP (2020) 2020
25 Calculated from the IEA ETP 2020 dataset
26 IATA, (2020)
27 Yu.D, (2017)

3.6.2 Metric used

The PACTA methodology measures the alignment of aviation portfolios to climate change scenarios by using the emission intensity metric described in section 2.4. This metric is used as there are currently no well-defined decarbonization technology pathways available for the aviation sector, meaning that a technology mix or volume trajectory by technology is not currently feasible.

The emission factor methodology only accounts for the emission of CO_2 from the combustion of aviation fuel (i.e., scope 1 emissions), which are responsible for the majority of the sector's Global Warming Potential. The methodology does not currently consider scope 2 and 3 CO_2 emissions, such as biofuels' lifecycle emissions.

The aviation sector activity level metric is calculated by linking each individual aircraft's fuel consumption performance (by flight distance category) to real flight data. The fuel consumption is then converted to CO_2 emissions and multiplied by the global average load factor (passenger occupation of seats) for passenger aircraft of 82%. The company-level emissions intensity (expressed in annual CO_2 emissions per revenue passenger kilometre) is calculated by aggregating the emission factor per year weighted by the passenger-km per year for all operational aircraft in the company's fleet.

3.6.3 Data overview

As with the other sectors covered by the PACTA for Banks Methodology production figures at the asset level are a key component of measuring portfolio alignment.

Assets are defined as individual aircraft. An emission factor is then applied to the performance of each asset and an emission intensity is then calculated at company level. The emission factor is based on the most granular level data available, namely a combination of the performance of each specific aircraft and accurate flight data. The two data points are linked by the specific aircraft registration.

The production weighted average is calculated for each company based on the annual passenger kilometres of each aircraft in the fleet of assets operated.

Please refer to "Aviation Asset Emission Model" document on www.transitionmonitor.com for a description of the asset level emission methodology.

Please refer to "Scenario Supporting document" on www.transitionmonitor.com for a description as to how absolute carbon emission and production figures are converted into emission intensity targets in the scenario. This is the scenario benchmark used in the emission intensity metric used for this sector.

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4.2 List of Figures

4.3 List of Boxes

4.4 List of Tables

4.5 Photography credits

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